Electronic Business Service Network Access Interface Specification

Switched Network Compatibility and
Performance Specification
for Two Wire Connection to a
Northern Telecom DMS-100 Family Switch

NIS S106-1

November 1988

PRELIMINARY

NOTICE

This Interface Specification is specifically intended for the developers, designers, and users of customer provided terminal equipment which is to be directly electrically connected to one of the Northern Telecom DMS-100 Family of Digital Multiplex Systems that provides Enhanced Business Service. Northern Telecom reserves the right to revise this Interface Specification for any reason, including, but not limited to, conformity with standards; utilization of new advances in the state of the technical arts; or to reflect changes in the design of equipment or services described therein.

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1.0 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 Electronic Business Service. It is intended for the use of both customers and manufacturers . It is specifically intended for the developers, designers and users of customer provided terminal equipment.

The scope of the document should be sufficient to allow CPE manufacturers to design and buid 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 equipment that is to be connected to this network interface shall be in compliance with the network protection requirements referred to in the specifications within Part 68 of FCC’s Rules and Regulations.

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. Compliance with Part 68 specifications necessitates that the ringer equivalency type be filed under the "type Z" exception. This is fully within the scope of the program.

The Electronic Business Service terminal will also be regulated under Part 15 of the FCC rules covering Radio Frequency Interference. Terminal equipment must comply with rules established for class B computing equipment.

1.2 SERVICE DESCRIPTION

The Electronic 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 and 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 acknowledgement.

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, intermessge timing, acknowledgements and retransmissions, and collision handling and priority. It operates under a contention scheme that anticipates occasional collisions and provides a method to clear them efficiently.

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.

1.3 TERMINOLOGY

The following terms and abbreviations are used within this specification:

ASK	Amplitude Shift Keying
CO	Central Office
CPE	Customer Premises Equipment
DMS machine	Digital Multiplex System switching machine (Northern Telecom DMS-100 Family)
DN	Directory Number
LCD	Liquid Crystal Display
NI	Network Interface
PACK	Positive ACKnowledgement
POTS	Plain Old Telephone Service
PDN	Prime Directory Number
Primary Set	The first voice terminal that is connected to the interface. It is the one device that is loop powered as well as providing the loop termination.

2.0 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 Electronic Business Service, in Figure 2.1.

The NI to Electronic 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 voicegrade data communications and is also utilized for conveying call progress and alerting signals to the CPE. The second is a secondary channel centered at 8000Hz used to pass supervisory and signaling 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 Electronic Business Service, however, it is appropriate to substitute 900 ohms for the given 600 ohms, wherever impendance is mentioned.

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

2.3 SECONDARY CHANNEL TRANSMISSION

The secondary channel used in Electronic Business Service is a half duplex channel implemented by amplitude shift keying (ASK) an 8000Hz 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 Enhanced 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 signaling 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 signaling 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 acknowledgement 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.

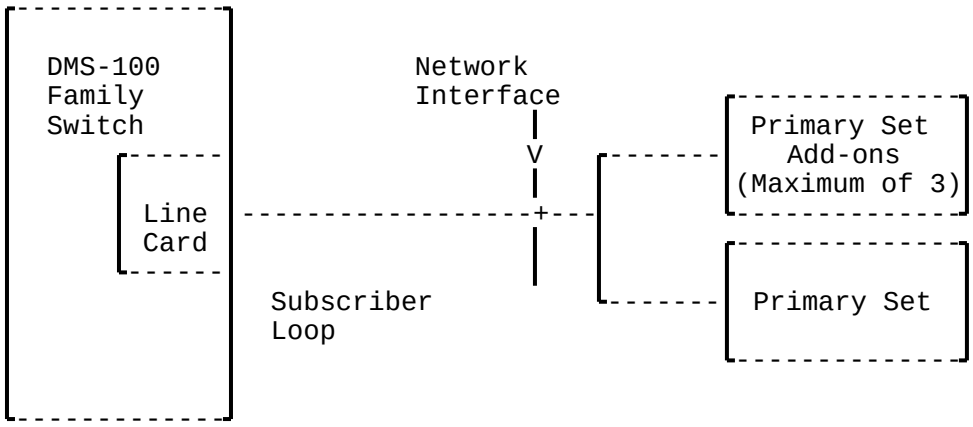


Figure 2-1
Electronic Business Service Configuration

GENERAL	
Modes	voice & signaling
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)	loop powered (Primary functions only)
Primary Set with a Display or Handsfree	alternate power (Fail to Pots supported)
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

SUMMARY OF INTERFACE CHARACTERISTICS
Table 2-1

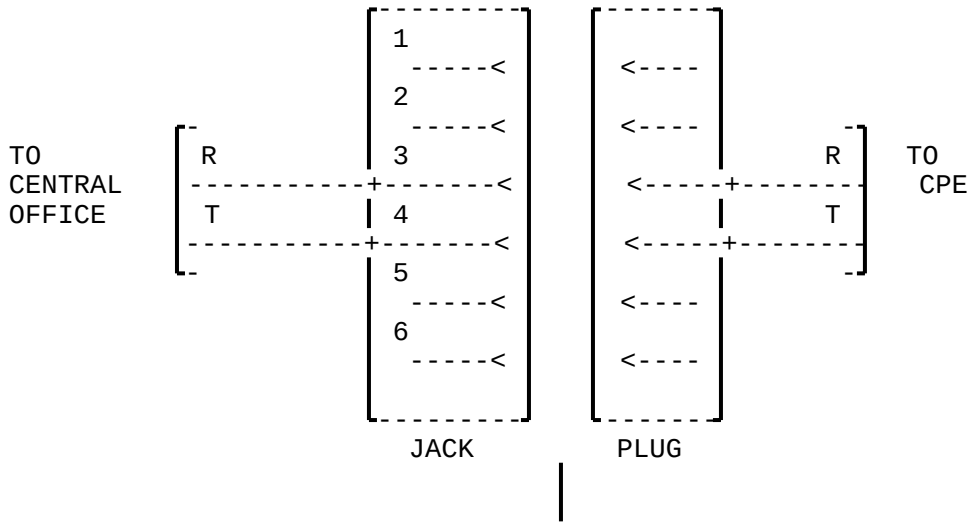
3.0 NETWORK INTERFACE PHYSICAL & ELECTRICAL CONNECTION REQUIREMENTS

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 following are the pin assignments for the jack and plug.

Note: Pins 1, 2, 5 & 6 at the CO end are reserved for Telco use.



NETWORK INTERFACE

Figure 3-1
Electronic Business Service Interface

3.2 ELECTRICAL CONNECTION REQUIREMENTS

3.2.1 AC Impendance

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 presented 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 Electronic Set Service terminal equipment should be in the acceptance region of Fig. 3-2 for all frequencies from 60 to 4,000Hz. 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 analog 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 measureable difference is a permanent 3dB loss inserted by the DMS line card to signals from the network to the NI. The loss is normally unperceptible to the CPE user, but may be overcome by the addition of a 3dB 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 500Hz plus 666Hz with a 10Hz warble rate, and it is transmitted at at level of -10dBV. The signal received at the NI shall be no lower than -18dBV into 900 ohms.

(c) Filtering

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

Note: Balance = $20 \log \left| \frac{Vs}{Vm} \right|$, where:
Vs = disturbing longitudinal voltage
Vm = resulting metallic voltage

Figure 3-2
Longitudinal-to-Metallic Criteria

3.2.4 Signaling Channel Requirements

(a) Modulation

The secondary channel is implemented by Amplitude Shift Key (ASK) an 8000Hz sinusoidal carrier. A logical one is represented by the presence of an 8KHz 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 8KHz 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 ^{1} 0.2 V, 8 KHz peak-to-peak. This level should not be exceeded as the terminal equipment may then not meet Part 68 requirements for power in the 4KHz to 12KHz bands. The level given will meet Part 68 requirements for 100 msec averaged power based on a predicated worst case of 12/23 ones density, for continuously repeated data. 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 8000Hz ^{1} 2% and modulated at a rate of 1Kb/s ^{1} 2%.

(c) Receive Specifications

The modulated carrier level received from the NI into the line card or set shall be a minimum of 50 mV Peak to Peak at 20^{0} C. It shall be a minimum of 55 mV Peak to Peak at 70^{0} C for the line card and a minimum of 55 mV Peak to Peak at 50^{0} C for the set. It will be at a frequency of 8000 Hz ^{1} 2% and modulated at a rate of 1Kb/s ^{1} 2%.

The carrier will be received with a signal to noise margin no less than 20dB, at the minimum receive level. Noise in the 6KHz to 10KHz 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 transmissions shall have a minimum roll-off of 24dB/octave below 7KHz.

CHARACTERISTIC	VALUE	TOLERANCE
Modulation Scheme	ASK	--------
Carrier Frequency - Transmit	8000 HZ	±1 2%
- Receive	8000 HZ	±1 2%
Bit Rate	1 Kb/s	±1 2%
Network Impedance	900 “	Nominal
CPE Impedance	900 “	±1 10%
Maximum Transmit Level (into 900 Ohms)	1.3 V P/P	±1 200 mV
Minimum Transmit Level (into 900 Ohms)	50 mV P/P	Min 20° C
	55 mV P/P	Min 70° C
Balance (@ 8000 HZ)	38dB	Min
RMS Signal - to - Noise* (Receive	20dB	Min
* Flat weighed noise in 6KHZ to 10KHZ band		

SECONDARY CHANNEL CPE TRANSMISSION SPECIFICATIONS

TABLE 3-1.

3.2.5 DC Battery Feed and Equalization

The balanced 440 ohm battery feed from the central office shall be used to power the primary voice terminal functions only. Any add-ons shall be powered by local commercial power.

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 ring 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 8kHz. 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 8kHz 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.

Bridge taps that cause the attenuation to exceed the 24 dB limit or add excessive inpulse noise must be removed.

CHARACTERISTIC		VALUE
Primary Set-Current Drawn-Standby Mode-	Max.	18mA
-Current Drawn-Active Mode-	Min.	15mA
	Max.	38mA
Normal Battery Feed Polarity		
DC Resistance - Add-ons (T to R)	Min.	2 Mohms
DC Resistance for any terminal equipmemt with the polarity of T and R reversed	Min.	2 Mohms
ASK (into 900 ohms)-Transmit Level (8KHz)	Max.	650 mVpeak
-Receive Level (8KHz)	Min.	25 mVpeak 20^0 C 27.5 mVpeak 70^0 C
Loop Range-Attenuation at 8 kHz from Line Card to Set or Add-ons	Max.	24 dB
-Loop DC Resistance Limit	Max.	1230 ohms
Voiceband AC Impedance		
-Primary Set Impedance (T to R)	Nominal	900 ohms
-Auxilliary Set Impedance (T to R)	Min.	25 kohms
-Add-ons (T to R)	Min.	25 kohms

Summary of Electrical Interface Characteristics

Table 3-2

3.3 ADD-ON MODULES

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.

4.0 NETWORK SIGNALING PROTOCOL

4.1 GENERAL

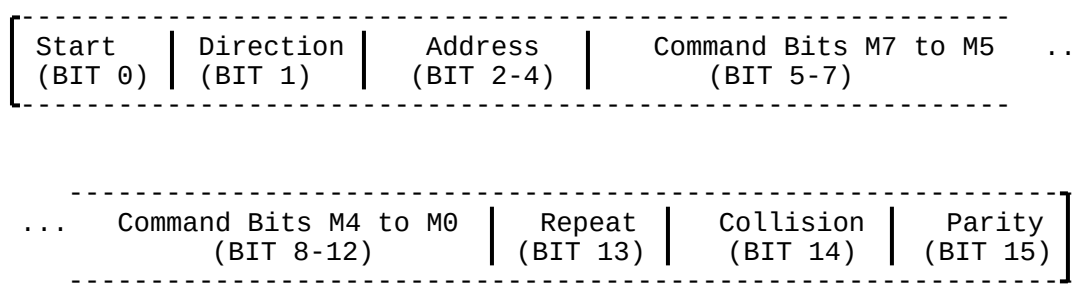
DMS-100 Enhanced Business Service Signaling capabilities are provided via the above voiceband channel. The messages sent over the channel use the protocol outlined below.

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)



BIT

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 line card. 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 auxillary voice terminal, where desired, 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 occuring as a result of collisions. If a positive acknowledgement is not received, the transmitter will repeat 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, colision 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 wakeup on a noice glitch. If the bit was low for linecard-to-set transmission, noise could wakeup set zero. The set would remain awake even though the false message would be rejected by the error bit checks.

All Electronic 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 retransmissions not occuring as a result of collisions. This normally low bit works in conjunction with an internal flag to judge whether a 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 set 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 Electronic 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 Electronic 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 acknowledgement to be returned, together with a guard time that is used to resolve line contention, should errors occur. This charactertistic 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 occurence.

(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 acknowledgement. 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 reocurring is very low. However, the protocol states that messages are to be repeated until the collision has been resolved.

4.4 PARITY ERROR DETECTION AND 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 acknowledgement is transmitted. A transmitter not receiving a positive acknowledgement 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 acknowledgement, the second time will cause the attempt at transmitting the message to be cancelled. Figure 4-2 gives the flow chart outlining how collisions and parity errors are handled by a device on the loop or the line card in the receive mode. Figure 4-3 gives the flow chart outlining the protocol for the transmission of a mesage by a device on the loop or the line card.

Figure 4-2
Parity Error and 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 acknowledgement on the line between 17 and 18 milliseconds into the transmit sequence. The positive acknowledgement 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 cases, 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 acknowledgement received, the earliest a new message may be sent is at 23 ms relative to t=0 (the beginning of the previous message).

B. Valid Message Not Acknowledged

For a valid message where no collision is detected and a positive acknowledgement 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

4.5.2 Receiving Device Timing

- The receiver begins timing after is has detected a valid start bit for 500 microseconds.
- Therefore, t=0 at 0.5 ms into the receive message envelope.
- Positive acknowledgement 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 acknowledgement is indicated by no acknowledgement.
- 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.

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 switch software load. BCS (Batch Change Supplement) 21 had its limit set to six messages per second. If this rate is exceeded, all messages from the CPE after the first six will be ignored by the switch).

5.0 COMMAND PROTOCOL

5.1 GENERAL

The Command Protocol specifies the rules for the exchange of switch control, signaling and status information between CO and Electronic 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.

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

Key 1 - Primary Directory Number

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

There are two versions of primary set:

The first version of the business set, here after referred to as Version A, supported eight feature keys with associated indicators and a ninth feature key without an indicator. A second version of the business set, here after referred to as Version B,

is now available. This version supports ten features keys all with associated indicators.

5.2 CO TO CPE COMMANDS

(See Tables 5-1, 5-2)

Indicators

The indicator commands are transmitted in response to stimulus signaling from the CPE or to enable the CO to indicate a change in a feature state. Each feature key no. 1 through 8 for Version A and no.1 through 10 for Version B, 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 dialling 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 differs 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 is active, Auto Answer Back-On is transmitted by the CO, after a short interval of ringing, to alternately indicate an incoming call. If the Off-hook command is returned by the CPE in response to this 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 sends the Auto Answer Back-Off command to the CPE at the answering end. The CPE shall then return the On-hook indication. Termination by the called end will be handled according to the procedure for such termination, i.e., Release or Hook Switch status (On-hook), and Auto Answer Back-Off will not be transmitted.

Echo (Open/Close) (Optional) Although the use of this command by CPE is optional, it is highly recommended since it enables the Telco 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.

Table 5-1

CO to CPE Commands

The following table includes all commands common to both versions of the Primary Set, for Address 0:

FUNCTION	COMMAND CODE	
	M7M6M5M4 M3M2M1M0	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-on	0 1 1 0 1 0 1 1	6B
Handsfree-off	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. V.A	V.B	FUNCTION	COMMAND CODE M7	M6	M5	M4	M3	M2	M1	M0	HEX
1	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	2	Key 2 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	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	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	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	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	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
		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	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
See	9	Key 9 off	0	0	0	1	0	0	1	1	13
Note		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
See	10	Key 10 off	0	0	0	1	1	1	1	0	1E
Note		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

Note: Version A does not have an indicator associated with key 9 and there is no feature key 10 for Version A.

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	
	M7M6M5M4 M3M2M1M0	HEX
Dial Pad Keys '1'	0 0 0 0 1 0 0 0	08
'2'	0 0 0 0 1 0 0 1	09
'3'	0 0 0 0 1 0 1 0	0A
'4'	0 0 0 0 1 1 0 0	0C
'5'	0 0 0 0 1 1 0 1	0D
'6'	0 0 0 0 1 1 1 0	0E
'7'	0 0 0 1 0 0 0 0	10
'8'	0 0 0 1 0 0 0 1	11
'9'	0 0 0 1 0 0 1 0	12
'0'	0 0 0 1 0 1 0 1	15
'*'	0 0 0 1 0 1 0 0	14
'#'	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

TELCO Key No. V.A	TELCO Key No. V.B	FUNCTION	COMMAND CODE M7	M6	M5	M4	M3	M2	M1	M0	HEX
1	1	Key 1	0	0	0	0	0	0	0	0	00
2	2	Key 2	0	0	0	0	0	0	0	1	01
3	3	Key 3	0	0	0	0	0	0	1	0	02
4	4	Key 4	0	0	0	0	0	0	1	1	03
5	5	Key 5	0	0	0	0	0	1	0	0	04
6	6	Key 6	0	0	0	0	0	1	0	1	05
7	7	Key 7	0	0	0	0	0	1	1	0	06
8	8	Key 8	0	0	0	0	0	1	1	1	07
9	9	Key 9	0	0	0	1	0	0	1	1	13
See Note	10	Key 10	0	0	0	1	0	1	1	1	17

Note: Version A does not have a feature key 10.

By the use of the feature keys, the DMS machine is provided with a form of stimulus signaling. 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 the DMS machine.

5.4 CPE PROTOCOL RELATED CHARACTERISTICS

Handset Interlock

The CPE shall provide an interlock between the handset and both its line monitor controlled by the command Voice-on and its ringer controlled by the command Alert-On. The CPE shall switch either of them to their off state, if on, automatically 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 handset-on. Alerts will be attenuated by 10 dB when Off-hook.

CPE Activation

The CPE may enter the active state when any one of the following conditions occur:

* The handset is taken Off-hook

* A valid command with matching address other than hard reset or save indicator reset command is received

* Any key depression

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 CO.

5.5 CO AND CPE COMMAND INTER-ACTION

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

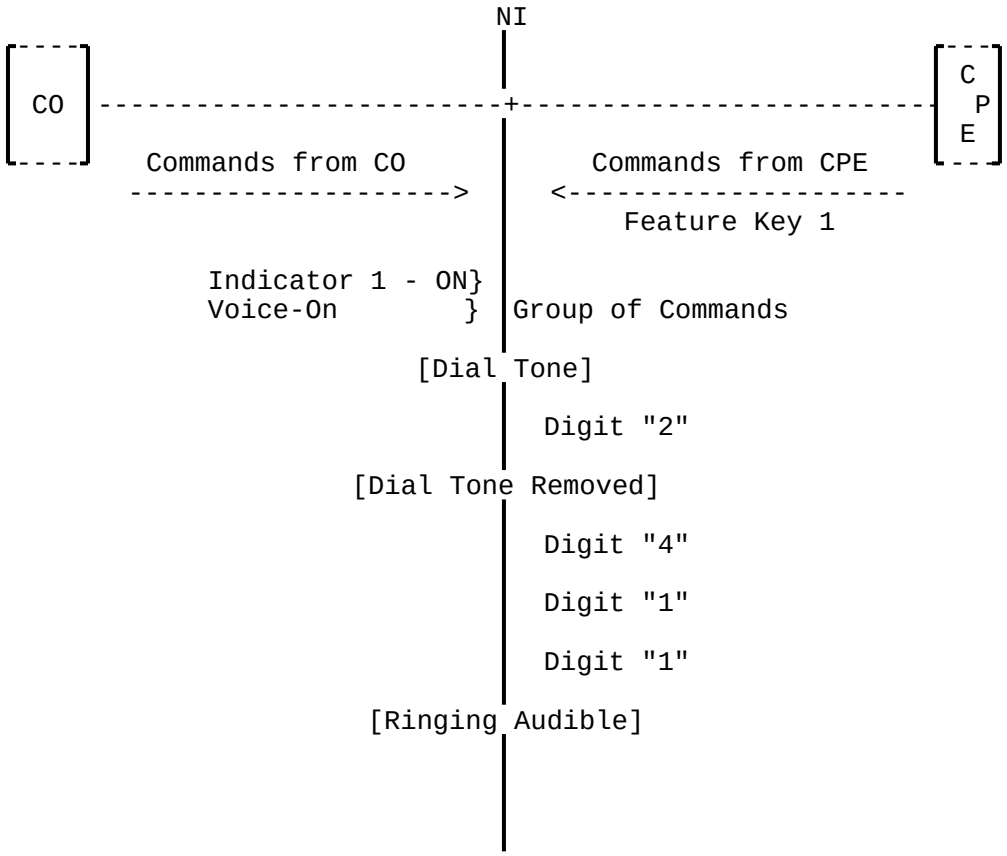
Hence, any attempt by the CPE to act in a manner other than responding as defined by the command protocol may result in the CPE being incompatible with the service offered. For example, if the CPE sends the feature key command for a key defined as a DN, the CO will respond by sending the associated Indicator-On 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

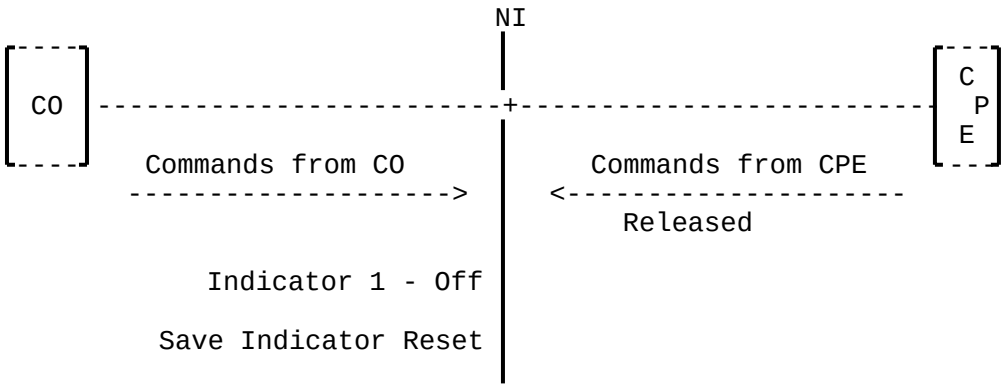
Assumptions: 1.CPE is Idle
2.PDN is on Feature Key No. 1
3.Number to be Called is 2411



Command Sequence 2

Situation: Use Of Release Key

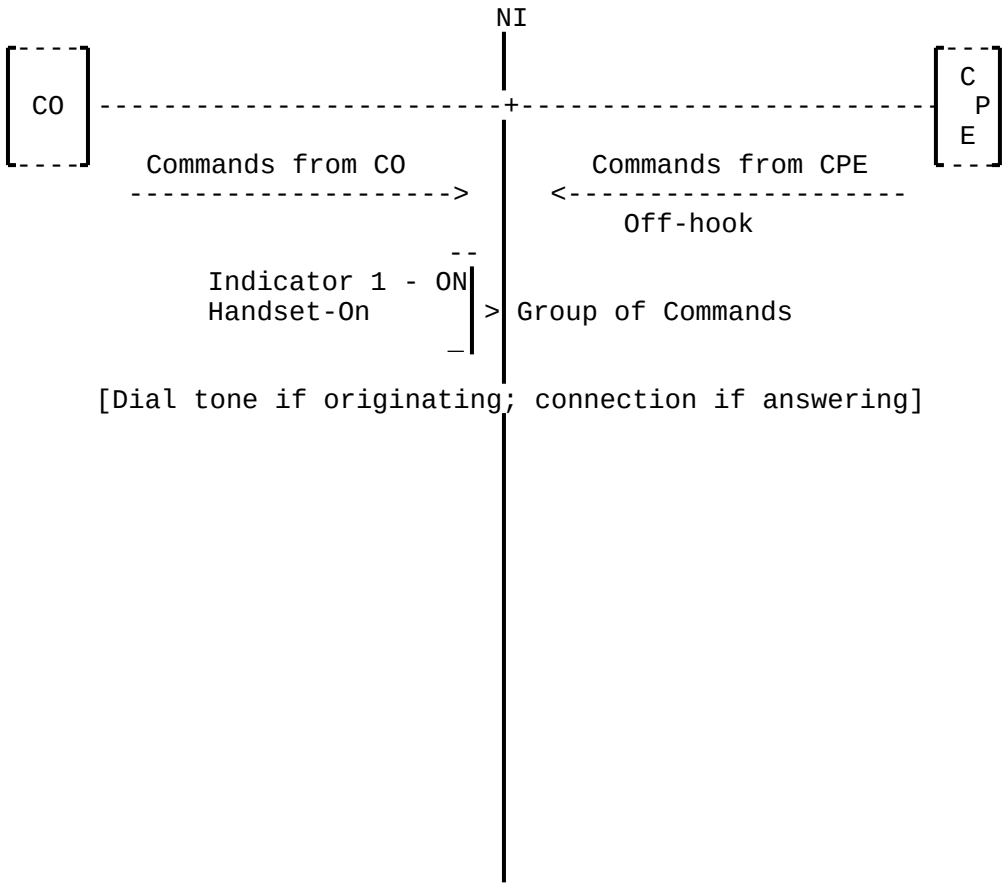
Assumptions: 1.Call Active on PDN
2.Feature Key No. 1 = PDN
3.Indicator 1 - On
4.Only PDN active



Command Sequence 3

Situation: Use Of Off-hook Command

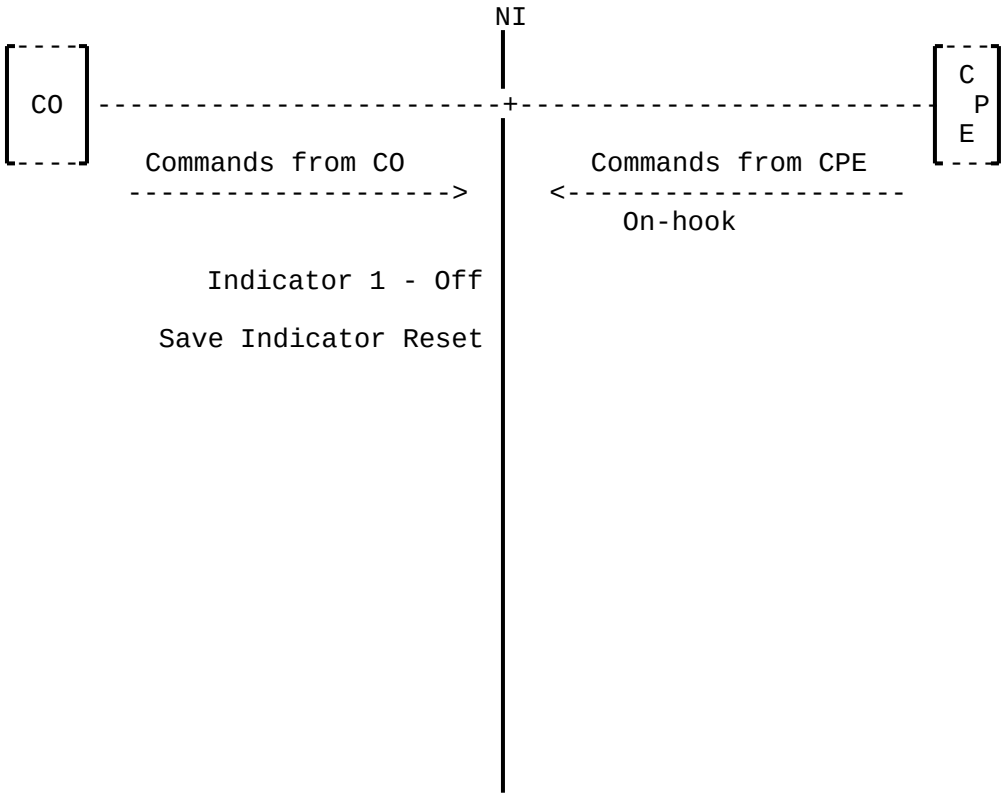
Assumptions: 1.CPE Idle
2.PDN = Feature Key No. 1



Command Sequence 4

Situation: Use Of On-hook Command

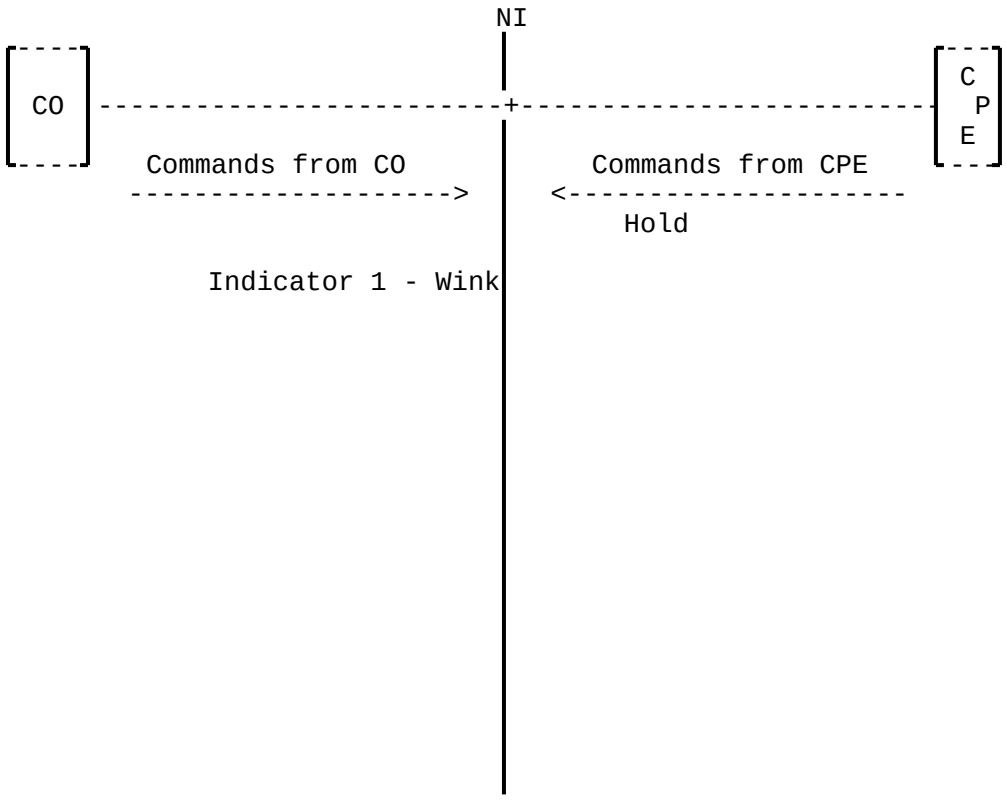
Assumptions: 1.PDN = Feature Key No. 1
2.Indicator 1 - On
4.Only one DN active i.e. PDN



Command Sequence 5

Situation: Use Of Hold Command

Assumptions: 1.PDN = Feature Key No. 1
2.Indicator 1 - On



6.0 PRIMARY SET WITH A DISPLAY

6.1 GENERAL

With the addition of an alphanumeric display to the primary set an additional group of primary set display related commands is required. The display related commands are outlined below. The full set of the commands that the display circuitry can respond to are given. Using these commands in conjunction with assigned primary set keying sequences, new display related features will be made available as they are developed for the DMS family of switching machines. The commands are designed to enable the DMS machine to control which features a particular customer has. Hence, the display features provided for a primary set with a display will be based on the cystomer’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 received by and transmitted from the display circuitry.

6.2 DISPLAYS AND RELATED BUFFERS

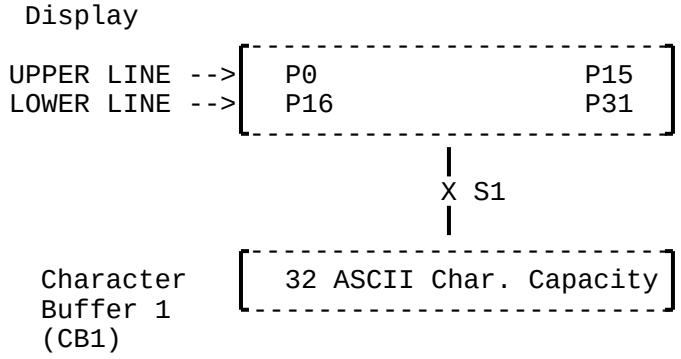
A. Thirty-Two Character Display (2x16)

The display consists of thirty-two alphanumeric characters that are arranged in two lines of sixteen 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 0 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.l

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, the CB1 is designated as the Working

buffer. It is only the Working buffer that the DMS machine can transmit ASCII characters to directly. Also, it is the Working buffer that the digits are echoed to locally, when the DMS machine enables the digit echo mode. The digits displayed are then removed by commands received from the DMS machine.



Display and the Related Buffers

Figure 6-1

B. Forty_Eight Character Display (2x24)

This display is an enhanced version of the 2*16. It has a larger screen consisting of 2 lines of 24 characters each. The new display offers to the station user the same types of display functions as currently available on the 2*16 display. However, there are areas of improvement (namely the ability to display a larger amount of information) due to the new larger screen size.

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

The related buffers to this display are functionally similar to the ones in the 2*16 display. They are:

- Working buffer, can be viewed as identical to the display buffer.
- Display buffer, governs what appears on the screen.

ASCII Character Set

The following is a list of the valid ASCII characters that may be received or transmitted by the display circuit.

ASCII Character	Meaning	Hexadec. 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
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
SP	Space (blank)	20	C0

Table 6-1 (continued)

ASCII Character	Meaning	Hexadec. Value (ASCII)	Command Code Trans. or Rec. (HEX)
!	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 Par-enthsis	28	C8
)	Closing Par-enthsis	29	C9
*	Asterisk	2A	CA
+	Plus Sign	2B	CB
,	Comma	2C	CC
-	Hypen (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
@	Commerical Art	40	E0
[	Left Square Bracket	5B	FB
\	Reverse Slant	5C	FC
]	Right Square Bracket	5D	FD
	Circumflex	5E	FE
-	Underscore	5F	FF

6.3 DISPLAY MODES

The display has two modes of operation. The two display modes are:

A. 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

B. 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.

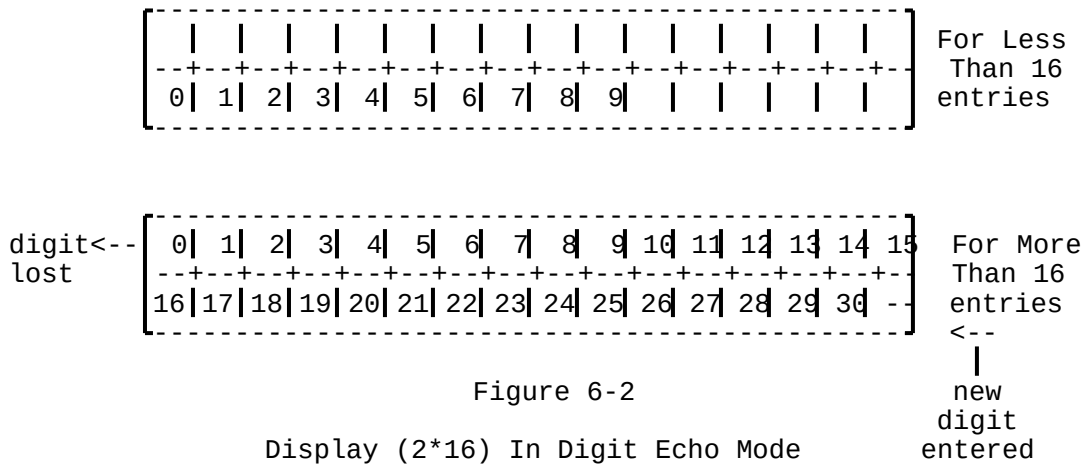


Figure 6-2

Display (2*16) In Digit Echo Mode

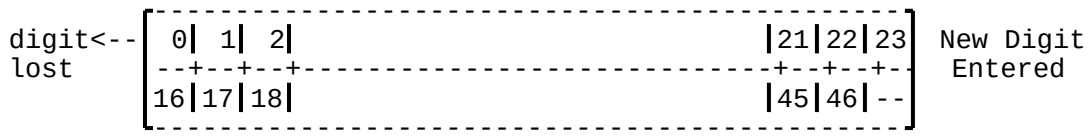


Figure 6-3

Display (2*24) In Digit Echo Mode

6.4 RECEIVED DISPLAY COMMAND HANDLING

The display circuit shall be 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 requires 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 circuit commands, it is required that a response be transmitted back to the DMS machine. This may be the ASCII characters in the Working Buffer. It is required that the display circuit data be merged with any basis primary set commands that are initiated. The 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 P0. 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