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Description of the Network Interface to Integrated Business Network Attendant Console for a DMS-100 Based Digital ESSX® Service

Technical
Reference

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DESCRIPTION OF THE NETWORK INTERFACE TO INTEGRATED BUSINESS NETWORK ATTENDANT CONSOLE FROM A DMS−100 BASED DIGITAL ESSX SERVICE

1. INTRODUCTION

1.1 General

This document is issued to define the physical, electrical, and protocol parameters at the network interface to an attendant console used with ESSX service provided from a DMS−100/200 serving central office. It should be sufficient to allow manufacturers of Customer Premises Equipment (CPE) to design and build CPE that will satisfactorily function with this service.

1.2 Revisions

This document is complete and accurate to the extent of the completeness and accuracy of the information disclosed to the BellSouth Companies by the manufacturer. It is offered in good faith, but errors of both content and omission may be found. The BellSouth Companies will do everything possible to correct such errors, and to resolve any confusion or uncertainty associated with the document. Any liability on the part of the BellSouth Companies is limited to such corrective action.

Changes in technology or market conditions may at some future date necessitate changes in ESSX service. Should this occur, this Technical Reference will be reissued, or another reference will be issued, depending on the nature of the change. The reissue, or new issue, will be sufficiently in advance of actual implementation to allow manufacturers to accommodate the changes in their design before they impact the end user.

1.3 FCC Rules Considerations

Since ESSX service connects to the public switched network, it is subject to FCC Rules and Regulations, including Part 68 specifications for Customer Premises Equipment.[1] All terminal equipment must be registered in compliance with Part 68. The compatibility specifications provided in this document are either in compliance with, or independent of, Part 68 requirements.

Customer Premises Equipment will also be regulated under Part 15 of FCC Rules covering Radio Frequency Interference. Terminal equipment must comply with rules established for Class B computing equipment.

2. SERVICE DESCRIPTION

2.1 Purpose

ESSX service is one of the BellSouth Operating Companies' (BOC's) business switched service offerings. The service makes use of a switching vehicle located at the serving central office. The interface described in this document is the interface between the switching vehicle and an attendant console.

2.2 Capabilities

The interface to an attendant console (AC) provides for those capabilities usually associated with Private Branch Exchange (PBX) attendant consoles. These capabilities include, but are not limited to the following:

Answering incoming calls
Completing incoming calls to called destinations
Originating calls on behalf of a station
Transferring calls
Private communication with either end of a call
Answering don't answer recalls
Arranging conference calls
Accessing paging calls

Thus, the attendant console enables a customer to have attendant controlled services on premises. Each DMS−100 central office can serve a maximum of 255 consoles. A Digital ESSX customer can have a minimum of 0 consoles up to 255 consoles. The console is designed to provide a basic set of features in addition to several undefined features that can be used for the specific needs of the customer.

2.3 Implementation

The capabilities mentioned above are implemented through a six wire (3−tip and ring pair) network interface. One pair of wires connects the console attendant to the network. The other two pairs are used to provide an asynchronous full duplex Frequency Shift Keying (FSK) four wire data circuit. Trunks and lines do not terminate directly on the attendant consoles but work in a virtual loop concept. The network provides for most of the necessary functions to provide the above capabilities. There are some functions required on the part of the CPE. These requirements are covered later in this document. All signaling between the network and the CPE is done over the data channel which is used to transfer signaling and supervision information between the attendant console and the network.

2.4 Limitations

ESSX service from a DMS−100 and a DMS−100/200 serving switch is available in selected BOC locations. Interested customers should contact their Account Executive or a BOC Business Office for availability information.

Service to an attendant console requires that the CPE conform to specific physical, electrical, and Data Link Layer protocol specifications, as covered in this document.

3. CPE FUNCTIONAL REQUIREMENTS

3.1 General

The AC signaling and supervision are provided by the four wire data circuit. Interaction between the attendant console and the ESSX machine occurs on a stimulus signaling basis over the data circuit. The term stimulus signaling as specified here refers to the use of signaling messages sent by the attendant console to the ESSX machine. Such messages are typically generated as a direct result of some action taken by the attendant console user, e.g., key pressed. Similarly, signaling messages sent by the ESSX machine to the attendant console provide data which can be used by the attendant console to provide sensory information to an operator, e.g., light a lamp. In order to communicate with the central office, the CPE must be capable of originating and detecting the data signals described below.

3.2 Assumed CPE Arrangement

This document does not prescribe any CPE arrangement, other than that necessary for proper operation of the service. This service does, however, make use of a complex signaling arrangement. To aid the reader in understanding the signaling, it is described in terms of controls and displays that **might** be incorporated into the CPE.

3.2.1 Keys

The protocol will support the transmission, by the CPE, of signals corresponding to the operation of the following keys:

Loop Keys 1 through 6	Used to identify which 'virtual loop' is being accessed. A 'virtual loop' is a circuit, held or connected by the serving central office, and accessed by the attendant console as necessary. The attendant console allows the user to cancel an incorrect string of digits by pressing a loop key. To correct a keying error while in the process of extending a call, press the accessed loop key to cancel the string of digits or press the release destination key.
Release Source Key	Used to release the calling party associated with the loop accessed, to release the attendant from a busy or reorder tone, and to correct a keying error made while dialing a source. This will be the attendant position for attendant initiated calls.
Release Destination Key	Used to release the called party associated with the loop accessed, to release the attendant from a busy or reorder signal, and to correct a keying error made while dialing a destination.
Signal Source Key	Used to signal the source party associated with the loop accessed. This signaling is restricted to calls originated within the ESSX, and served by the central office serving the attendant console. On−hook stations will receive standard alerting; ringing or incoming call alert on a data channel. Off−hook stations will receive tone on the voice circuit.
Signal Destination Key	Used to signal the destination party associated with the loop accessed. Off−hook stations will receive standard alerting. On−hook stations within the ESSX, and served by the same central office, will receive tone on the voice circuit.
Exclude Source Key	Used to allow private communication between the attendant and the destination party associated with the loop accessed by temporarily excluding the calling party while the attendant talks privately with the called party.
Exclude Destination Key	Used to allow private communication between the attendant and the source party associated with the loop accessed by temporarily excluding the called party while the attendant talks privately with the calling party.
Hold Key	Used to place the loop accessed in a hold state, allowing the attendant to receive call status information through the loop source and destination lamps while receiving new calls.
Release Key	Used to release calls from a loop. Operation of the key makes the loop idle and the position is ready to receive new calls.
Night Service Key	Used to request the network to forward all calls to a preselected Night Service position which could be a station or another console.

Feature Keys	The protocol supports up to 42 additional keys to enable the console to perform the centrex features specified by the central office. These keys will be assigned features as negotiated between the customer and BellSouth. Functional capabilities will reside in the network. The CPE will simply identify which key has been operated or depressed.
Dial Pad Keys	Used for the entry of digits. These are the 12 standard Dual Tone Multi−Frequency (DTMF) keys which are used here to generate machine readable codes. The network assumes that the asterisk (*) key will be used to enter a pause. The network also assumes that the octothorpe (#) key will be used to indicate the end of the keying sequence.
Test Key	Used to signal to the network that the console has been placed in the self test mode. The second transmission of this data sequence will signal the network that the console has been taken out of the self test mode.

3.2.2 Lamps

The protocol will support the transmission, by the network, of signals designated to reflect call status. The signals could be used to illuminate lamps and are designated as such below. A lamp may be in 1 of 5 different lamp states. The lamp states are:

- Off – state in which lamp is dark
- On – state in which lamp is glowing steadily
- Wink – low wink rate is state in which lamp winks slowly at 20 winks per minute
- Blink – medium wink rate is state in which lamp blinks moderately at 60 blinks per minute
- Flash – high wink rate is state in which lamp flashes quickly at 120 flashes per minute

Source Lamps 1 − 6	Used to indicate the status of the source party of each of the 6 'virtual loops'.
Destination Lamps 1 − 6	Used to indicate the status of the destination party of each of the 6 'virtual loops'.
Call Waiting Lamp	Used to indicate that there is an incoming call. If at least one call is in the queue, the lamp is on. If calls are in the queue beyond a specified time, the lamp flashes at 60 IPM (Indications Per Minute).
Release Lamp	Used to indicate the presence of one or more idle virtual loops. The lamp is on when the attendant console is on and ready to receive calls.
Night Service Lamp	Used to indicate that the network is forwarding all incoming calls to the Night Service position.
Test Lamp	Used by the network to acknowledge that the console is in the self test mode.
Exclude Source Lamp	Used to indicate that the network has broken the transmission path toward the source or calling party.

Exclude Destination Lamp	Used to indicate that the network has broken the transmission path toward the called party or destination.
Signal Source Lamp	Used to indicate that the network is signaling the calling party.
Signal Destination Lamp	Used to indicate that the network is signaling the called party.
Release Source Lamp	Used to indicate that the network is releasing the calling party.
Release Destination Lamp	Used to indicate that the network is releasing the called party.
Feature Lamps	Used to indicate that the network is processing the command initiated by the associated Feature Key command.

3.2.3 Displays and Associated Buffers

The signaling protocol supports one 32 character buffer in the CPE. This buffer will be addressed as the Digit Display Buffer (DDB) and is used for displaying the dial pad keying inputs by the AC operator. Two 16 character buffers in the CPE, Display Buffer 1 (DB1) and Display Buffer 2 (DB2), are also supported. The contents of DB1 and DB2 are assumed to be under the control of the network.

The network will assume that the attendant console is using the following display convention.

a. If any data is in the Digit Display Buffer, it is displayed.

b. If (a) is not true, and if DB2 has been loaded by the network since the last Clear Display Command (detailed in the Data Link Layer Protocol section, below), then DB2 is displayed.

c. If neither (a) nor (b) is true, then the contents of DB1 are displayed.

3.2.4 Headset

The protocol supports the transmission of attendant ready information. The ready signal is labeled the "IN" signal for "HEADSET IN". The not ready signal is labeled "OUT" for "HEADSET OUT".

3.3 Digit Collection

3.3.1 General

The Digit Collection Protocol provides for the transmission of address signaling from the attendant console to the network and for the return of network addressing progress from the network to the attendant console. Specifically, the network identifies which address digits (telephone number of the called party, for example) have been processed.

The attendant console shall transmit network address digits over the data circuit as individual start/stop characters. Character format is detailed in Section 6.

3.3.2 Digit Sequencing

In order for the network to identify the digits that have been processed, the attendant console must assign each digit an address called a Digit Sequence Number (DSN). For any given keying sequence the attendant console shall start its counter at zero and increment by one for each digit entered. The address of the first digit transmitted is 1, the next 2, etc. The protocol provides for addresses, 0 up to and including 31, which will accommodate 32 digits. This address refers to the character position in the Dig-

it Display Buffer (DDB) mentioned above. The network will assign sequence numbers to received digits and may return to the attendant console intermediate counts as Current Processed Sequence Number (CPSNs). A CPSN indicates which digits have been processed by the network and thus can be erased from the DDB and display. Therefore the display must show what is in the DDB as long as the Digit Sequence Number does not equal the Current Processed Sequence Number.

3.3.3 Digit Counter and Timer

The attendant console must count the number of digits transmitted. For each keying sequence the attendant console shall start a counter with zero and increments it by one for each digit entered. As long as this number is less than a minimum threshold (see section 3.3.3.1), the attendant console must transmit the current DSN plus a Start Code (HEX 1C) after 5 seconds have passed and no digit is transmitted. When the current DSN and Start Code are sent, the attendant console shall reset the digit counter and timer.

If the number of digits transmitted exceeds the minimum threshold (see section 3.3.3.1), the attendant console must transmit the current DSN plus Start Code using a short timer of 0.5 seconds nominal following the last digit sent. When the current DSN and Start Code are sent, the attendant console shall reset the digit counter and timer.

If the number of digits sent exceed a maximum threshold, the attendant console shall transmit the current DSN plus Start Code immediately. The digit counter and timer shall also be reset. Finally, the current DSN and Start Code shall be sent and, the counter and timer reset immediately following the transmission of any information byte other than an address digit, e.g., the end digit. A flow chart of the digit collection protocol is provided as Appendix B.

3.3.3.1 Digit Thresholds and End Digit

The Minimum Digit threshold (Min Dig) and Maximum Digit threshold (Max Dig) may be set by the network, using the Data Link Layer Protocol described below. The dial pad key denoting the end of the addressing sequence (End Key) may also be set by the network using the protocol below.

Upon initialization or reset, the attendant console should assume the following values for these three parameters:

Min Dig	31
Max Dig	31
End Key	#

4. MECHANICAL INTERFACE

The network interface consists of six wires to connect three cable pairs to the CPE. Figure 1 illustrates the network interface. The jack provided is a 50 pin miniature ribbon jack as shown in FCC Rules and Regulations, Part 68, Subpart F, Figure 68.500 (f)(1).[1] The pin assignments are indicated on Figure 1 below. Other pins will not be connected.

Note that the pair used to transmit data from the CPE into the network is labeled 'Transmit'. The pair used to receive data from the network is labeled 'Receive'.

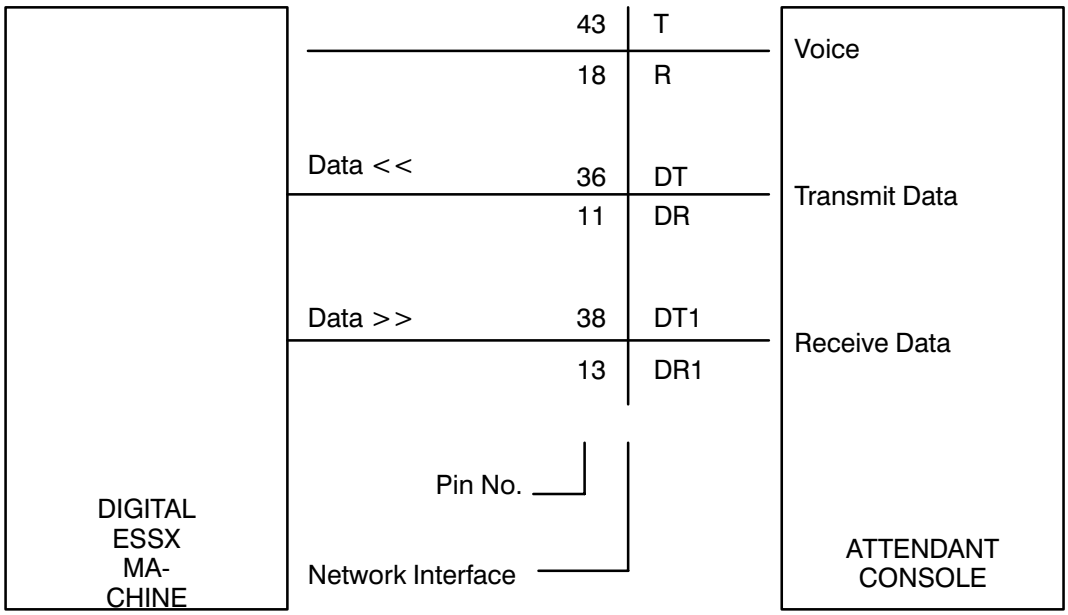


FIGURE 1 – ATTENDANT CONSOLE PHYSICAL CONFIGURATION

5. ELECTRICAL INTERFACE

5.1 General

5.1.1 Measurements

This document expresses signal levels in terms of decibels with respect to a milliwatt of power. Signal level measurements made on signals in or below the voiceband assume 900 ohms line impedance. Bridging measurements are actually measuring voltage, but are calibrated in dBm, assuming 900 ohms line impedance. Terminating measurements incorporate internal 900 ohms terminations, and are calibrated in dBm. One milliwatt, 0 dBm, equals 775 millivolts rms, for sinusoidal signals.

5.1.2 Network Characteristics

Except for differences noted below, each of the three cable pairs shown in Figure 1 may be considered to be an analog voiceband channel. The transmission requirements for the voice circuit are similar to those for the Public Switched Network.

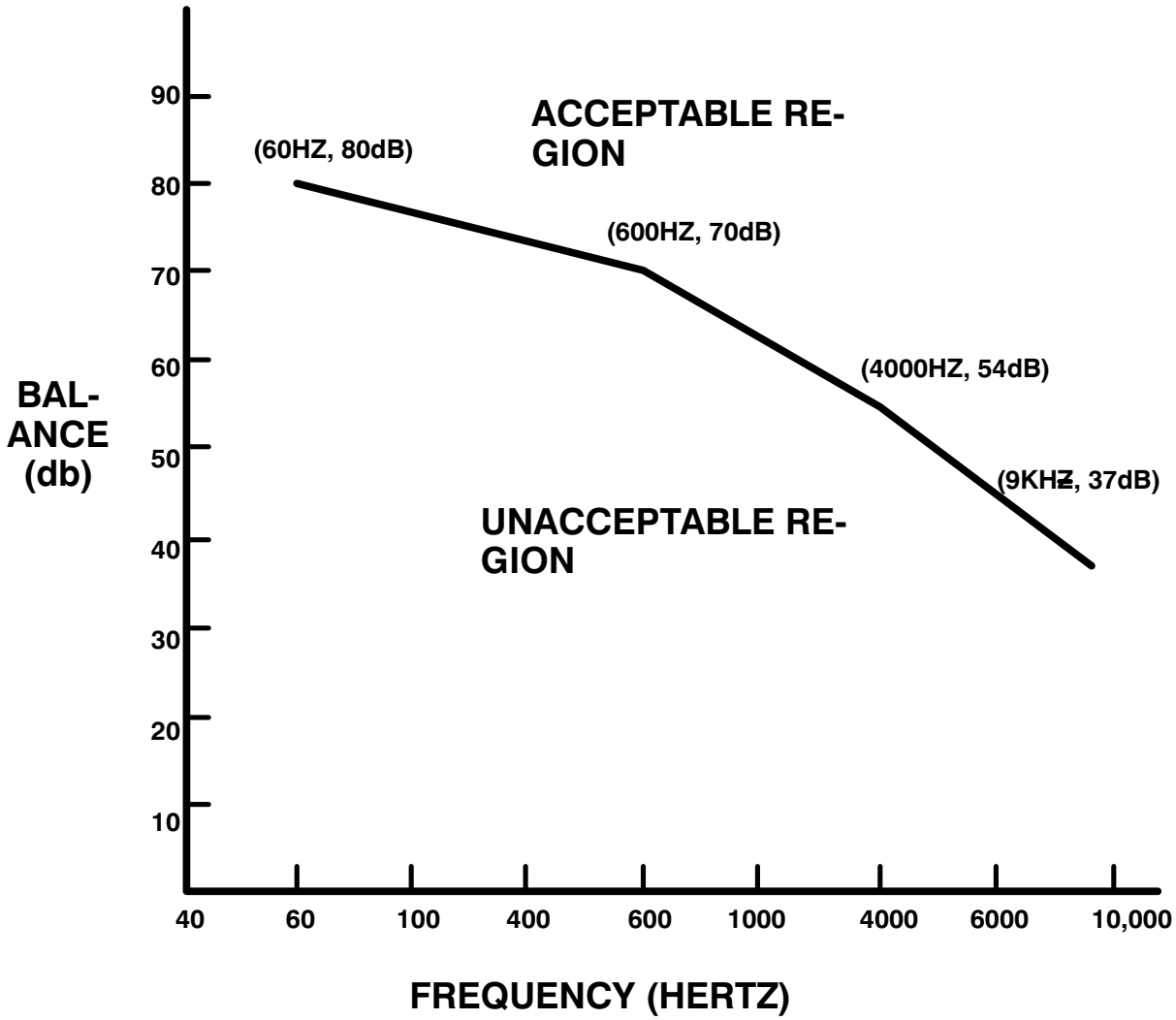
5.1.3 Balance

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. Good balance minimizes the conversion of mutually coupled longitudinal disturbances, such as 60 Hz AC and its harmonics, to audible metallic sounds. It also greatly reduces the incidence of interfering crosstalk coupling between adjacent facilities.

Due to the difficulty of measuring balance as an impedance ratio, it is expressed as the decibel (dB) relationship between a disturbing longitudinal voltage and the resulting metallic voltage of the same frequency. To avoid significantly degrading the service, the longitudinal to metallic balance of terminal equipment should be in the acceptable region of Figure 2 for all frequencies from 60 to 4000 Hz. Measurements should be made in accordance with ANSI/IEEE Standard 455–1985.[2]

5.1.4 Noise

The maximum noise attributable to the access loop and the ESSX switch shall be less than 30 dB when measured across a balanced termination at the network interface. This assumes a C message weighting characteristic, as defined in ANSI/IEEE Standard 743−1984.[3]



NOTE: BALANCE = 20 log | VS/VM | , where:

VS = disturbing longitudinal voltage
VM = resulting metallic voltage

FIGURE 2 – LONGITUDINAL–TO–METALLIC CRITERIA

5.1.5 Environmental Factors

The electrical connection between the NI and the serving telephone company's central office is normally made via wire pair facilities. These facilities traverse an environment where they can encounter disturbing influence from several electromagnetic sources. Preparation for these possible influences should be considered in the design of the terminal equipment.

The voltages and currents that may appear at the NI as a result of these influences are described in Bell Communications Research Document No. TR−EOP−000001, Lightning, Radio Frequency, and 60 Hz Disturbances at the Bell Operating Company Network Interface, June 1984.[4]

5.2 Voice Circuit

5.2.1 Signaling

It should be noted that for most local access lines, the network signals the CPE with ringing current, when a call is directed toward an on−hook customer. Ringing is not used on the voice circuit associated with the attendant console. Signaling of an incoming call is done over the data link.

The central office line card provides a balanced battery feed for the voice pair. Changes in the DC characteristics applied by the attendant console are not used to signal on−hook and off−hook, but rather to alert the network that the console is ready for traffic.

5.2.2 Required Terminations

The CPE must signal that it is ready for traffic by placing a termination across the Tip and Ring of the Voice Pair. The termination must present the following characteristics to the network.

	READY	NOT READY
DC Resistance	$\leq$ 460 Ω	5 MΩ minimum
AC (Voiceband) Impedance	900 Ω nominal	Undefined

5.3 Data Circuit

5.3.1 DC Termination

Except during testing described later in Section 7, there is no requirement on the DC termination of either data circuit pair.

During the test, the CPE must provide a DC path from DR to DT1. A path must also be provided from DT to DR1. The resistance presented to the network for each of these DC paths must be no greater than 165 Ω

The protocol required to place the CPE in the test mode shall be described later in Section 7.

5.3.2 AC Termination

The CPE shall present an AC voiceband impedance of 900 Ω at all times across both the Transmit and Receive pair.

5.3.3 Data Transmission

Data is transmitted and received full duplex, using Frequency Shift Keying (FSK). Chart 1, below, details the transmission specifications.

CHART 1

DMS−100/200 ATTENDANT CONSOLE DATA SPECIFICATIONS

Characteristic	Value	Tolerance
Type of Modulation	FSK	−
Data Rate	300 bps(See Section 5.3.4)	± 1%
'Mark' Frequency ('1' bit)		
Transmit Pair	1270 Hz	±1 Hz
Receive Pair	2225 Hz	±1 Hz
'Space' Frequency ('0' bit)		
Transmit Pair	1070 Hz	±1 Hz
Receive Pair	2025 Hz	±1 Hz
Network Impedance	900 Ω	nominal
Signal Level		
Transmit Pair	−13 dBm	maximum
Receive Pair	−13 dBm	maximum
	−30 dBm	minimum
Balance		
(at 60 Hz)	80 dB	minimum
(at 600 Hz)	70 dB	minimum
(at 4 kHz)	54 dB	minimum
Signal−to−noise ratio*	15 dB	minimum

* C message weighted

5.3.4 Optional 1200 bps Data Rate

The network may optionally be configured to accommodate an AC data rate of 300 bps transmit and 1200 bps receive. The frequencies at this data rate are 1200 Hz Mark and 2200 Hz Space in both directions. The tolerance at 1200 Hz Mark is ±.5 Hz, and the tolerance at 2200 Hz Space is ±1 Hz.

5.3.5 Signaling

The network will not apply ringing current to either of the wire pairs employed in the data channel.

6. DATA LINK PROTOCOL

6.1 Byte Format

The data transmission shall be asynchronous. Each Byte must consist of:

One start bit, '0' bit, followed by;
Eight data bits, followed by;
One Parity bit, followed by;
One Stop bit.

6.1.1 Start and Stop Bits

Start and Stop bits must be of the same bit width as all other bits.

6.1.2 Data Bits

The data must be transmitted and received in the order of increasing significance. This means bit 0 is transmitted first, bit 7 is transmitted last.

6.1.3 Parity bit

The parity bit must be sent so that the sum of all '1' bits, including the 8 data bits and the parity bit, is an even number.

6.2 Data Link Idle

The idle state for the four wire data circuit with a 300 bps transmit and receive data rate has a mark frequency of 2225 Hz $\pm$ 1 Hz for the Receive Pair (DT1, DR1) and a mark frequency of 1270 Hz $\pm$ 1 Hz for the Transmit Pair (DT, DR). The idle state for the four wire data circuit with a 300 bps transmit and a 1200 bps receive data rate has a mark frequency of 1200 Hz $\pm$ 1 Hz for both the transmit and receive pair.

6.3 Error Detection

The console should check the incoming message for errors. Two error detection schemes may be employed. The first makes use of the parity bit to check bit errors. The second makes use of the known number of bytes in a message. If the correct number of bytes is not received, an error should be assumed.

If an error is detected, the attendant console should send a "Network to Console Trouble" message. The format of this message is detailed later in Section 6.6.

6.4 Message Format

Each Message will consist of one to eighteen bytes. The first byte will describe the operation to be performed. Additional bytes, if any, will carry the values of any parameters needed. The value of the byte(s) will be shown in this document in either Hexidecimal or Binary format. The Hexidecimal values will be followed with a 'Hex'.

6.4.1 Clear All Command

This is a 1 byte message with a value of 81 Hex.

This message is intended to reset all lamps, buzzers, or other alerting instruments, associated with the CPE, to the idle state. The digital buffers, mentioned above, should not be cleared.

6.4.2 Lamp Control Command

This is a 2 byte message. Up to 60 lamps may be addressed. The 60 lamps are divided into four groups. The first byte determines which group of lamps the command is addressing.

BYTE 1

Value (hexidecimal)	Group addressed
82	0
83	1
84	2
85	3

The groups, and lamp assignments within each group, are shown below.

Group 0, 82 Hex

Lamp Assignment (Hexidecimal)	Lamp Designation
0	Loop 1, Source
1	Loop 1, Designation
2	Loop 2, Source
3	Loop 2, Destination
4	Loop 3, Source
5	Loop 3, Destination
6	Loop 4, Source
7	Loop 4, Destination
8	Loop 5, Source
9	Loop 5, Destination
A	Loop 6, Source
B	Loop 6, Destination
C	Exclude Source
D	Exclude Destination
E	Release
F	Call Waiting

Group 1, 83 Hex

Lamp Assignment (Hexidecimal)	Lamp Designation
0	Night Service
1	Test
2	Feature Key No. 2
3	Feature Key No. 3
4	Feature Key No. 4
5	Feature Key No. 5
6	Feature Key No. 6
7	Feature Key No. 7
8	Feature Key No. 8
9	Feature Key No. 9
A	Feature Key No. 10
B	Feature Key No. 11
C	Feature Key No. 12
D	Feature Key No. 13
E	Feature Key No. 14
F	Feature Key No. 15

Group 2, 84 Hex

Lamp Assignment (Hexidecimal)	Lamp Designation
0	Feature Key No. 16
1	Feature Key No. 17
2	Feature Key No. 18
3	Feature Key No. 19
4	Feature Key No. 20
5	Feature Key No. 21
6	Feature Key No. 22
7	Feature Key No. 23
8	Feature Key No. 24
9	Feature Key No. 25
A	Feature Key No. 26
B	Feature Key No. 27
C	Feature Key No. 28
D	Feature Key No. 29
E	Feature Key No. 30
F	Feature Key No. 31

Group 3, 85 Hex

Lamp Assignment (Hexidecimal)	Lamp Designation
0	Feature Key No. 32
1	Feature Key No. 33
2	Feature Key No. 34
3	Feature Key No. 35
4	Feature Key No. 36
5	Feature Key No. 37
6	Feature Key No. 38
7	Feature Key No. 39
8	Feature Key No. 40
9	Feature Key No. 41
A	Feature Key No. 42
B	Feature Key No. 43
C	Not used
D	Not used
E	Not used
F	Not used

The second byte of this message transmits the lamp number and the lamp state. The format is:

0,ASGN,STA

The Most Significant Bit, bit 7, is always a 0 in this message. The next 4 bits, 6 thru 3, define the lamp within the lamp group identified in the first byte. This 4−bit word equates to the Hexidecimal lamp assignment as shown in the tables above.

The last 3 bits, 2 through 0 identify the lamp state as shown below.

Lamp State	Bit 2	Bit 1	Bit 0
Off	0	0	0
On	0	1	1
Wink	1	1	1
Blink	0	0	1
Flash	0	1	0

6.4.3 Lamp Group 0 Control Command

This is a nine byte message used to set the state of every lamp in lamp group 0. The lamp assignments within each group are defined in the Lamp Control Command section.

The first byte is 86 Hex.

The second through ninth bytes (8 bytes) are used to set the state of each lamp within the group defined in the first byte. The format is:

Byte	Bit 7	Bits 6−4	Bit 3	Bits 2−0
2	0	State 1	0	State 0
3	0	State 3	0	State 2
4	0	State 5	0	State 4
5	0	State 7	0	State 6
6	0	State 9	0	State 8
7	0	State B	0	State A
8	0	State D	0	State C
9	0	State F	0	State E

where State 1, State 2, ... State F refer to the state of the lamp with that assignment in the group defined in the first byte of this message. Bits 2−0 and Bits 6−4 represent the lamp state values as shown in the Lamp Control Command.

6.4.4 Lamp Group 1 through 3 Control Command

This is a 5 byte message.

The first byte defines the group to be set. The groups and lamp assignments within each group are detailed in the Lamp Control Command section.

Byte 1

Value (Hexidecimal)	Group
87	1
88	2
89	3

The second through the fifth bytes define the state of each lamp within the group defined in Byte 1. The format is:

Byte	Bits 7&6	Bits 5&4	Bits 3&2	Bits 1&0
2	State 3	State 2	State 1	State 0
3	State 7	State 6	State 5	State 4
4	State B	State A	State 9	State 8
5	State F	State E	State D	State C

where State 1, State 2, ... State F are representing the 2 bit values of the states of the lamps with the corresponding lamp assignments, with the group defined in the first byte. The 2 bits represent the following states:

First Bit (0,2,4,6)	Second Bit (1,3,5,7)	State
0	0	Lamp Off
1	1	Lamp On
1	0	Flashing
0	1	Winking

6.4.5 Buzzer Command

This is a 2 byte command, intended to activate an audible indicator. The first byte is 8B Hex.

The next byte is intended to modulate the audible indication. The network will assume that each Buzzer Command provides 1.7 seconds of audible indication. While each bit is transmitted in a much shorter interval, each bit is intended to provide 213 milliseconds of audible indication, if the bit is set to 1. The first bit, bit 0, will always be set to 0. The network will assume, however, that audible indication is always provided for the first 213 milliseconds.

6.4.6 Soft Reset Command

This is a 1 byte message. The value of the byte is 8C Hex. This message is transmitted to instruct the attendant console to perform a reset. The network will not transmit any additional messages for a period of 100 milliseconds. The FSK carrier from the network will remain on during this period.

During this 100 millisecond period, the attendant console must not transmit any messages. The console should reset all lamps, buzzers, displays and buffers. The console must continue to transmit FSK carrier during this period.

6.4.7 Reset Command

This is a 1 byte message. The value of the first byte is 8D Hex. This message is transmitted to instruct the attendant console to perform a reset. The network will not transmit any additional messages for a period of 100 milliseconds. The FSK carrier from the network will remain on during this period.

The attendant console must discontinue FSK carrier during this 100 millisecond period. The attendant console should reset all lamps, buzzers, displays, and buffers.

Any momentary loss of FSK carrier from the network must also be interpreted as a Reset Command.

6.4.8 Query Headset Command

This is a 1 byte message. The value of the byte is 8E Hex. It is transmitted to the console to check the status of the attendant.

The CPE must respond. The response could be determined from contacts in a headset jack.

6.4.9 Test Command

This is a 1 byte message. The value of the byte is 8F Hex. This message is transmitted to the attendant console to initiate self−test. The provisions for testing are the responsibility of the manufacturer.

The console must transmit either the 'Test Ok' or 'Test Fail' messages within 5 seconds to notify the user of the test status.

6.4.10 Set Looparound Command

This is a 1 byte command. The value of the byte is 95 Hex.

This message is transmitted to instruct the attendant console to place itself in the 'looparound' mode. While in this mode, the attendant console must transmit to the network all data received from the network. The console should continue to check for errors as detailed in the 'Message Format' section above.

The attendant console must not transmit any messages other than the received messages while in the 'looparound' mode. The attendant console should remain in this mode until the 'Reset Looparound Command' is received.

6.4.11 Reset Looparound Command

This is a 1 byte message. The value of the byte is FF Hex.

This message is transmitted to instruct the attendant console to stop transmitting all received messages. The attendant console should also perform as if a 'Soft Reset Command' had been received, upon receipt of this command.

6.5 Display and Buffer Related Messages

6.5.1 Set Parameters Command

The network and attendant console interact in the timing of network address digit transmission, as described in the Digit Collection sub−section of the CPE Functional Requirements section. The network may set the values of parameters Min Dig, Max Dig, and End Key with the Set Parameters Command.

This is a 4 byte message. The value of the first byte is 96 Hex.

The first 5 bits, bits 0 through 4, of the second byte define the value of Min Dig. The remaining bits will be set to 0.

The first 5 bits of the third byte define the value of Max Dig. The remaining bits will be set to 0.

The first 4 bits of the third byte define the sequence that the attendant console must send as 'End Key'. The remaining bits will be set to 0. Note that the 'End Key' sequence is an 8 bit byte, these 4 bits only define which 8 bit byte is to be sent.

The possible 8 bit bytes, their corresponding Dial Pad key characters, and the four bit Hexidecimal value sent in this message are shown below.

End Dig Value (in Hex)	Corresponding Dial Pad Key	Four Bits Sent (in Hex)
0F	0	F
10	1	0
11	2	1
12	3	2
13	4	3
14	5	4
15	6	5
16	7	6
17	8	7
18	9	8
19	*	9
1A	#	A

6.5.2 Update Digits Command

As covered in the Digit Collection sub−section of the CPE Functional Requirements section earlier, the protocol allows the network to identify to the attendant console which digits have been processed. This command transmits the Address of the Last Digit (ALD) processed.

This is a two byte message. The value of the first byte is 9A Hex.

The second byte will carry the ALD in bit positions 0 through 4. Bits in positions 5 through 7 will be set to 0.

The network will assume that all digits in the Digit Display Buffer (DDB) with a Current Processed Sequence Number less than or equal to the ALD will be cleared from the display.

6.5.3 Clear Buffers Command

This command is transmitted to the attendant console to instruct it to clear Digit Buffer 1 (DB1) and Digit Buffer 2 (DB2).

This is a 2 byte message. The value of the first byte is 99 Hex.

The bits in positions 0 through 4 of the second byte represent the value of the ALD. Bits in position 5 through 8 will be set to 0. The network will assume that all digits in the DDB with a Current Processed Sequence Number less than or equal to the ALD will be cleared from the display.

6.5.4 Display Digital Buffer Command

This message transmits 16 alphanumeric characters to be loaded into either DB1 or DB2. The message identifies which buffer is to be loaded.

This is an 18 byte message. The value of the first byte identifies which buffer is to be loaded. A value of 97 Hex identifies DB1. A value of 98 Hex identifies DB2.

The bits in position 0 through 4 of the second byte represent the value of the ALD. Bits in position 5 through 7 will be set to 0. The network will assume that all digits in the DDB with a Current Processed Sequence Number less than or equal to the ALD will be cleared from the display.

Bytes 3 through 18 carry the 16 alphanumeric characters. Character 1 is in byte 3, character 2 in byte 4, etc.

These bytes will have a 0 in bit position 7. The remaining 7 bits will carry the American National Standard for Information Interchange (ASCII) character code. This code is fully defined in ANSI X3.4−1977 standard.[5] Not all ASCII codes will be transmitted. Only those described in columns 2 through 5 of the above standard will be used. Some messages that might be loaded using the ASCII characters are calling numbers, message that call has been forwarded, trunk identifiers, etc.

6.5.5 Transfer Data Command

This command instructs the attendant console to transfer all digits in the DDB with a Current Processed Sequence Number less than or equal to the transmitted ALD to DB1. This is a 2−byte message. The value of the first byte is 9B Hex.

The bits in positions 0 through 4 of the second byte will represent the value of the ALD. Bits in positions 5 through 7 will be set to 0.

The network will assume the following is performed upon receipt of this command:

If the DDB has any data stored, DB1 and DB2 are cleared, the digits in the DDB with a Current Processed Sequence Number less than the transmitted ALD are stored in DB1. DDB is cleared.

6.5.6 Send Start Code Command

This command instructs the attendant console to follow every message with a ‘start code’. This code is defined in the Messages from the Attendant Console section.

This is a 1−byte message. The value of the byte is 90 Hex.

Upon initialization, the console should send start code after every message.

6.5.7 Suppress Start Code Command

This command instructs the attendant console to suppress the start code mentioned above, until a Send Start Code Command is received. During this time, no message from the console may have a start code except the ‘Network to Console Trouble’ message which must always be followed with a start code.

This is a 1−byte message. The value of the byte is 91 Hex.

6.6 Messages from the Attendant Console

6.6.1 Key Operated Messages

The network expects each operation made by an attendant to generate a message. Additionally, the Digit Collection routine, mentioned above, requires that the Current Processed Sequence Number of the last digit also be transmitted.

The start code should comprise the second byte of every message, unless a ‘Suppress Start Code’ command has been received. Accordingly, every message will be either 1 or 2 bytes in length. The start code has Hex code value 1C.

6.6.2 Response Messages

The Query Headset command can have two responses. The first response 'Headset or Handset In' has Hex value 1D. The second possible response 'Headset or Handset Out' has Hex value 1E.

Test responses from the Test command are 'Test OK' with Hex value 4F and 'Test Fail' with Hex code 50.

The 'Network to Console Trouble' Message has a Hex code value of 61.

The codes for each byte are shown in Appendix A.

7. CONSOLE TESTING

7.1 General

Console Testing is divided into two procedures – the console itself and the interface between the console and the switch. Testing for the console itself is the responsibility of the provider of the CPE. The interface is tested by the network after a trouble is reported or as part of routine switch maintenance.

7.2 Console Interface Testing

Testing for the interface between the console and the switch is performed at the Line Test Position of the switch by the Operating Company. Evaluation of the condition of the three subscriber loops is made possible by the required signature of the attendant console interface as outlined in Sections 5.2 and 5.3. The looparound command enables the data circuit both transmit and receive, to be checked from the switching machine.

The Operating Company has a specific set of procedures for line maintenance so that they can automatically diagnose line and service conditions on a routine or demand basis. However, the success of these procedures are dependent upon the termination provided by the CPE.

8. REFERENCES

The following documents are referenced in this Technical Reference:

[1] Code of Federal Regulations 47, Part 68, "Connection of Terminal Equipment to the Telephone Network"[1]

[2] ANSI/IEEE Standard 455−1985, "Test Procedure for Measuring Longitudinal Balance of Telephone Equipment Operating in the Voiceband"[2]

[3] ANSI/IEEE Standard 743−1984, "Standard Methods and Equipment for Measuring the Transmission Characteristics of Analog Voice Frequency Circuits"[2]

[4] TR−EOP−000001, "Lightning, Radio Frequency and 60 Hz Disturbances at the Bell Operating Company Network Interface"[3]

[5] ANSI X3.4−1986, "Coded Characters Set − 7 bit American National Standard Code for Information Interchange"[2]

[1] This document may be obtained from the Government Printing Office, Washington, D.C. 20402 (202) 783−3228

[2] This document may be obtained from: Sales Department, American National Standards Institute, 1430 Broadway, New York, N.Y. 10018 (212) 642−4900

[3] This document can be obtained from BellCore, Customer Service, 60 New England Avenue, Piscataway, N.J. 08854 (800) 521−2673

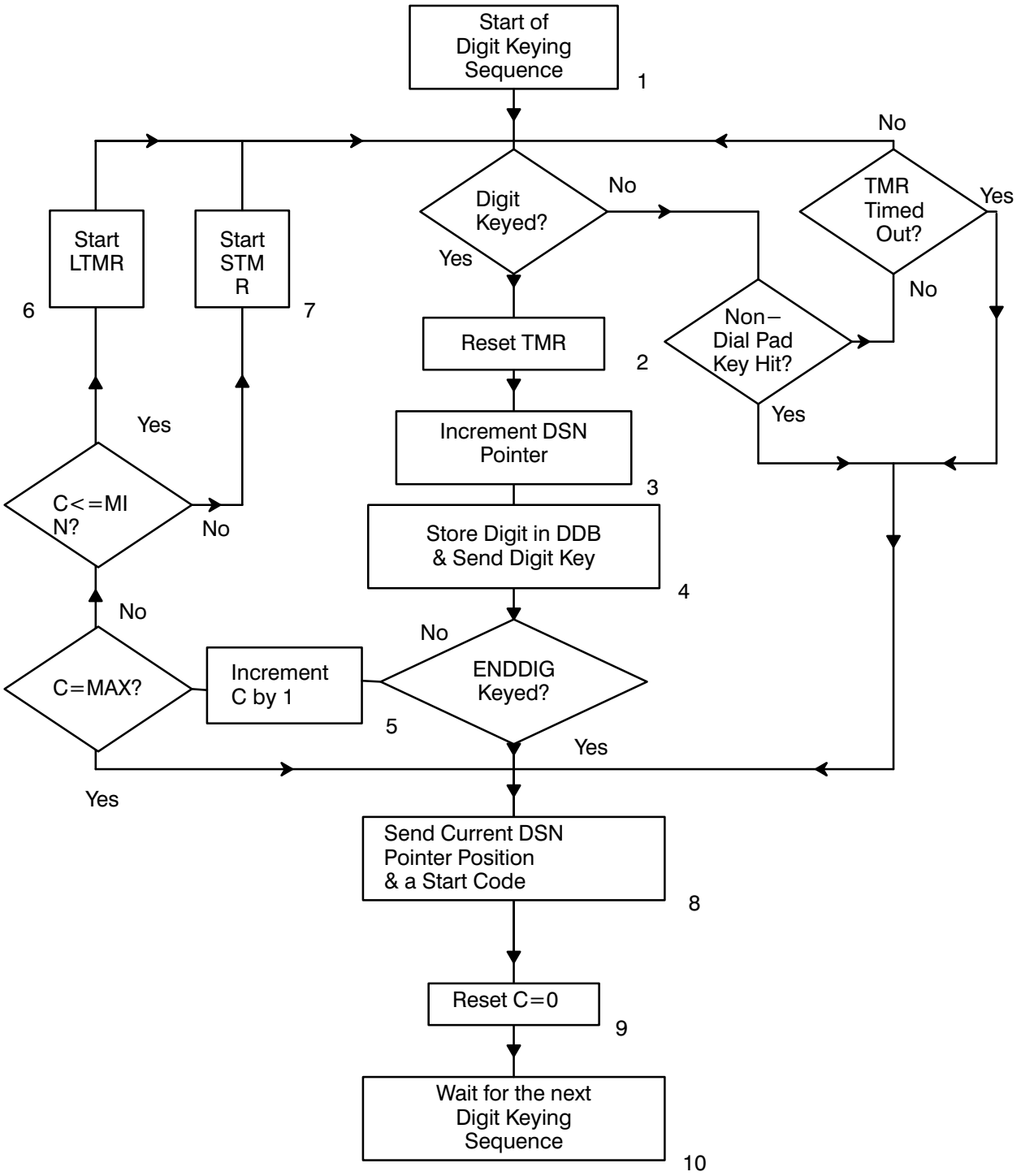
APPENDIX A

	Key or Function	HexCode
	Loop 1	01
	Loop 2	02
	Loop 3	03
	Loop 4	04
	Loop 5	05
	Loop 6	06
	Release Destination	07
	Release Source	08
	Signal Source	09
	Signal Destination	0A
	Exclude Source	0B
	Exclude Destination	0C
	Hold	0D
	Release	0E
Dial Pad Key	0	0F
	1	10
	2	11
	3	12
	4	13
	5	14
	6	15
	7	16
	8	17
	9	18
	*	19
	#	1A
	Start Code	1C
	Headset In	1D
	Headset Out	1E
	Test	20

	Key or Function	HexCode
Feature Key	2	21
	3	22
	4	23
	5	24
	6	25
	7	26
	8	27
	9	28
	10	29
	11	2A
	12	2B
	13	2C
	14	2D
	15	2E
	16	2F
	17	30
	18	31
	19	32
	20	33
	21	34
	22	35
	23	36
	24	37
	25	38
	26	39
	27	3A
	28	3B
	29	3C
	30	3D
	31	3E
	32	3F
	33	40
	34	41
	35	42
	36	43
	37	44
	38	45
	39	46
	40	47
	41	48
	42	49
	43	4A
	Test OK	4F
	Test Fail	50
	Network to Console Trouble	61

	Key or Function	HexCode
CPSN Number	0	62
	1	63
	2	64
	3	65
	4	66
	5	67
	6	68
	7	69
	8	6A
	9	6B
	10	6C
	11	6D
	12	6E
	13	6F
	14	70
	15	71
	16	72
	17	73
	18	74
	19	75
	20	76
	21	77
	22	78
	23	79
	24	7A
	25	7B
	26	7C
	27	7D
	28	7E
	29	7F
	30	80
	31	81

APPENDIX B


Start of Digit Keying Sequence
1
Digit Keyed?
No
Yes
TMR Timed Out?
Yes
No
Non– Dial Pad Key Hit?
Yes
No
Reset TMR
2
Increment DSN Pointer
3
Store Digit in DDB & Send Digit Key
4
ENDDIG Keyed?
No
Yes
Increment C by 1
5
C=MAX?
No
Yes
C<=MIN?
Yes
No
Start LTMR
6
Start STMR
7
Send Current DSN Pointer Position & a Start Code
8
Reset C=0
9
Wait for the next Digit Keying Sequence
10