

# PRELIMINARY

**Bell System Data Communications  
TECHNICAL REFERENCE**

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## TRANSACTION NETWORK POLLED ACCESS INTERFACE SPECIFICATIONS

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**April 1976**

**ENGINEERING MANAGER – DATA NETWORK SERVICES**



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## 1.0 Introduction

The Polled Access Network (PAN) of the Transaction Network (see Figures 1 and 2) is a high traffic, short formatted message, switched, analog data system using voice grade lines (refer to Bell System Technical Reference "Transaction Network Service," Publication 41024, dated December 1975 for a description of the Transaction Network). The Transaction Network is capable of handling any sequence of inquiry and/or response messages from and to a polled terminal, however, it will not keep track of the sequences. Its function is the transfer of messages between the polled terminal and the Data Processing Center (DPC).

In a typical transaction the merchant loads information into the polled terminal buffer via a card passed through the magnetic stripe reader. The card contains Transaction Network heading address information for the DPC to which the message is intended. Other information on this card may be an identification code assigned to the merchant by that DPC. A customer's credit card would also be passed through the magnetic stripe card reader. This card would contain the identification code assigned to the customer by that DPC. This information, as well as additional information such as the amount, and type of transaction could also be keyed into the terminal buffer by a manual entry pad. When all the information is buffered, the merchant depresses the END key on the terminal. This arms the terminal for delivery of the message on the next poll it receives from the Transaction Network. Upon receiving the poll, the polled terminal will transmit the message to the Transaction Network in FSK at 1200 BPS. Data and addressing information is exchanged between the Transaction Network and the polled terminal in the form of 10 bit asynchronously transmitted characters. The Transaction Network acknowledges the message after establishing the validity of the information contained in the heading and performing parity checks. The positive acknowledgment will indicate that the message has been accepted by the Transaction Network. At this point the message is forwarded to the DPC specified. After the DPC receives and processes the inquiry message, it prepares a response message. The DPC will use the heading information on the inquiry message for the heading address information on the response message. The response message will then be transmitted to the Transaction Network. A correctly received response message is put into a queue for delivery to the terminal addressed in the heading. The Transaction Network will interrupt its polling cycle, completing any poll it has begun, address the terminal and deliver the response message to that

terminal. The terminal acknowledges the response message after verifying the information contained in the heading and performing parity checks. The positive acknowledgment indicates the terminal has accepted the response message. The text of the response message is then displayed by the polled terminal to indicate the disposition of the transaction.

### 1.1 Use of Document

This technical reference should be of use to designers of equipment and systems which will be connected to the PAN of the Transaction Network. It is assumed that the designer is thoroughly familiar with the contents of the Bell System Technical Reference, "Transaction Network Service," Publication 41024, dated December 1975. The polled terminal will hereinafter be referred to as the terminal. It will be located on the customer premises and provides access to the TN for conducting inquiry response data transactions to the DPC.

### 1.2 Scope

The terminal to Transaction Network interface will be precisely defined as regards to the transmission plan and parameters, message and signaling formats, coding, and error control protocols. The actual message (the text portion of the response and inquiry messages) and the method of entering the information into the terminal are not defined and will be determined by the terminal customer and the designer.

## 2.0 Transmission Plan

This section contains the transmission plan for the PAN including information covering the transmission levels, transmission parameters and modulation scheme.

### 2.1 Transaction Network to Terminal Interface

The terminal shall interface with the Transaction Network via a Channel Service Unit (CSU) which is part of the polled access circuit (PAC) shown in Figure 2. The CSU is a passive device providing a two-wire voiceband transmission path, balanced termination, current surge protection, hazardous voltage protection and dc isolation

between the PAC and the terminal. The CSU provides a balanced nominal 600 ohm termination at voiceband frequencies and the terminal shall present a nominal 600 ohm impedance. The terminal also shall cause no more than 1.0 ma. dc to flow through this termination. The CSU limits metallic surges from the line to less than 10 volt peak and provides a dielectric to longitudinal surges. The CSU requires no external customer supplied power source. This device also protects the network from hazardous voltages and longitudinal surges introduced by the terminal.

The CSU is shown in Figure 3 and consists of a printed wiring board assembly mounted on a grey metal base plate and enclosed by a grey plastic cover. The cover is secured to the base plate by a single screw accessible on the top of the CSU. The unit is 4 inches wide by 2-3/4 inches deep by 1-9/16 inches high. The unit may be mounted directly on a wall or a suitable flat surface. Access to the customer tip and ring terminals (CT and CR shown in Figure 4) is obtained by removing the cover. CT and CR are standard #4 screw type terminals to which the customer attaches the paired wires connecting to his terminal. The customer shall replace the cover after making the connection.

## 2.2 Transmission Levels

Transmission shall be half duplex. Simultaneous Data transmission by the Transaction Network and the terminal is never permitted and is controlled by means of a protocol specified in Section 7.

2.2.1 The transmission level at the terminal end of the polled PAC shall be as follows:

2.2.1.1 -20 dBm nominal for transmissions to the terminal (receiving).

2.2.1.2 Transmissions from the terminal shall not exceed at 0 dBm into 600 ohms (transmitting). The transmitted signal from the terminal shall conform to the requirements specified below as regards out of band power:

The power in the band from 3995 to 4005 Hertz shall not exceed 18 dB below the specified maximum in-band signal power.

The power in the band from 4 to 10 kHz shall not exceed -16 dBm.

The power in the band from 10 to 25 kHz shall not exceed -24 dBm.

The power in the band from 25 to 40 kHz shall not exceed -36 dBm.

The power in the band above 40 kHz shall not exceed -50 dBm.

### 2.3 Transmission Parameter Limit

Table 1 summarizes the limits for the band width and facility parameters affecting data transmission on the PAC. The bandwidth parameters (attenuation and envelope delay distortion) provide an indication of the usable bandwidth of the channel.

A description of each parameter is provided in Appendix A. For additional information, the designer may refer to the Bell System Technical References specified in section 8, References 2 and 3.

The facility parameters given in Table 1 represent potential impairment to a data signal that is transmitted over the PAC. In all cases the facility parameters exhibit some variation over a period of time. There is little information on the amount of time variability of these parameters. The parameter limits, unless otherwise stated, apply to measurements of steady-state phenomena and the measurements generally last less than one minute.

Transient phenomena (impulse noise, phase hits, gain hits, dropouts) are measured over longer periods and events meeting certain criteria are counted. The results of either steady-state or transient measurements may vary by time of day, day of week, season of year, or according to some other time dependency. In the face of this uncertainty, the attempt made is to determine the conditions representative of the channel during normal operation.

Limits for parameter values given in Table 1 are provided for informative purposes only. In some cases the

information is based on limited studies, and some changes may result as new information becomes available.

#### 2.4 Transmission Mode

All data transmission between the Transaction Network and the terminal shall employ frequency shift keying (FSK) compatible with data set 202T (see the Bell System Technical Reference specified in section 8, Reference 4). Data is defined as the 10 bit characters (defined in section 3) which comprise an inquiry or response message, a control sequence or signaling sequences.

2.4.1 The transmission rate from the Transaction Network System will be 1200 BPS  $\pm$  .1%. A space (Logic 0) will be represented by 2200 Hz  $\pm$  .1% and a mark (Logic 1) by 1200 Hz  $\pm$  .1%. The transition from a space to mark frequency or vice versa will be phase continuous. The space and mark frequencies are also referred to as the start and stop frequencies respectively.

2.4.2 The transmission rate from the terminal shall be 1200 BPS  $\pm$  .5%. A space (logic 0) shall be represented by 2200 Hz  $\pm$  .5% and a mark (logic 1) by 1200 Hz  $\pm$  .5%. The transition from a space to mark frequency or vice versa shall be phase continuous.

#### 2.5 Leading and Trailing Carrier

Unless otherwise specified, all data transmission shall be preceded and followed (without any drop in carrier) by padding intervals of carrier. The trailing intervals will include a soft "turn-off" carrier which is outside of the data band to prevent the generation of spurious spacing signals which can occur when the marking carrier is turned off. The soft turn-off carrier frequency shall be 900 Hz  $\pm$  1%.

2.5.1 The carrier transmitted before each data transmission from the Transaction Network will be 10.5  $\pm$  .5 milliseconds at the mark frequency.

2.5.2 The carrier transmitted before each data transmission from the terminal shall be at least 12 milliseconds but no more than 17 milliseconds in duration at the mark frequency.

2.5.3 Trailing carrier from the Transaction Network will consist of  $8.5 \pm .5$  milliseconds of "soft turn-off" carrier immediately following the stop bit of the last transmitted meaningful character.

2.5.4 Trailing carrier from the terminal shall consist of no more than 2 milliseconds of carrier at the mark frequency following the stop bit of the last transmitted, meaningful character and shall be followed immediately by  $8.5 \pm .5$  milliseconds of "soft turn-off" carrier.

### 3.0 Data Link Considerations

Inquiry and response (data) messages shall consist of streams of characters conforming to a format which is specified in Section 5 of this reference. Signaling sequences (Polls) will contain one or two characters as outlined in Section 4. The control sequence covered in section 6 is used for error control and consists of up to four characters. Signaling sequences are distinguished from message and control sequences by the BAL character which is described later in this section.

#### 3.1 Data Link Characters

Data link characters shall consist of 10 bits each and are defined as follows:

Bit 0	Start Bit	First bit transmitted - always a space/logic 0.
Bits 1-7	Information Bits	As defined by their appearance in the 7 bit ASCII Code Set - the least significant bit shall follow the start bit.
Bit 8	Parity Bit	Parity on the information bits - Parity sense is even.
Bit 9	Stop Bit	Last bit transmitted - always a mark/logic 1.

### 3.2 The BAL Character

The "Blind Alert" (BAL) character is a Transaction Network designated character which shall be the first transmitted character of all message and control sequence transmissions from the Transaction Network and also by the terminal to the Transaction Network. Its primary purpose is to distinguish signaling sequences from messages and control sequences on the PAC. Conversely, any data sequence which is not preceded by the BAL Character shall be considered by the terminal to be a signaling sequence (containing signaling characters) and shall be ignored. The bit pattern for the BAL Character shall be the same as the ASCII "?" Character (011 1111<sub>2</sub>). Usage of the BAL character as the first character transmitted does not restrict the use of its ASCII counterpart "?" in the text.

### 3.3 Control Characters

Control characters are used for data link control and to define or delimit message fields and subfields.

3.3.1 The following characters have been designated as Transaction Network data link control characters and in general have the same function as their ASCII counterpart. Unless otherwise specified, all characters shall be defined by their appearance in the ASCII code set: The bits increase in significance from right to left.

ACK	(000 0110)	Positive Acknowledgment
NAK	(001 0101)	Negative Acknowledgment
EOT	(000 0100)	End of transmission
ENQ	(000 0101)	Enquiry
BAL	(011 1111)	See subsection 3.2
SYN	(001 0110)	Reserved

3.3.2 The following characters have been designated as control characters used for message formatting and also have the same function as their ASCII counterparts. Unless otherwise specified, all characters shall be defined by their appearance in the ASCII code set.

SOH	(000 0001)	Start of Heading
STX	(000 0010)	Start of Text
ETX	(000 0011)	End of Text
FS	(001 1100)	Used as a subfield separator (may also be used in the text)
GS	(001 1101)	Used as a subfield separator (may also be used in the text)
RS	(001 1110)	Used as a subfield separator (may also be used in the text)
US	(001 1111)	Reserved
DLE	(001 0000)	Reserved
ETB	(001 0111)	Reserved

### 3.4 Clock Synchronization

The character start bit always follows the stop bit of the preceding character or the padding interval of leading carrier at the mark frequency. A transition from a Logic 1 level to a Logic 0 level is, therefore, always available (after demodulation) at the start of a message or control sequence and at the start of each character for synchronizing the terminal receiving clock.

### 4.0 Polling (Signaling) and Timing

4.1 A terminal connected to the PAC of the Transaction Network will be subject to two (2) types of polls. The first type will be the specific poll which permits the terminal to initiate a transaction if it is ready to do so. The second type is the selection poll. It occurs only when a response message is transmitted to the terminal by the Transaction Network.

4.2 The Specific Signaling Sequence and Poll is shown in Figure 7.

4.2.1 The signaling sequence is used by the Transaction Network to set up the path to the terminal. The signaling

characters are normally not seen by the terminal unless the path already exists. In any case, the signaling characters shall be ignored by the terminal since the initial burst of carrier is not followed by a BAL character. The signaling sequence for the next terminal polled will always be seen by the terminal and should be ignored for the same reason. The signaling characters contained in the signaling sequence will be any of the 128 characters contained in the ASCII repertoire, with the exception of NUL, BEL, ?, @, G and DEL.

4.2.2 The specific poll consists of  $10.5 \pm .5$  milliseconds of carrier at the mark frequency with no mark/space transitions, and is followed directly by  $8.5 \pm .5$  milliseconds of "soft turn-off" carrier. If signaling characters (or any mark/space transition) precede the poll as indicated in paragraph 4.2.1 above, the terminal shall ignore the poll if armed.

4.2.3 The terminal must detect the beginning of the received "soft turn-off" carrier within T1 milliseconds.

4.2.4 The terminal, when armed, shall raise inquiry message leading carrier within T2 milliseconds, as measured from the detection of "soft turn-off" carrier described above. In order to meet the access time stated in paragraph 4.2.8 below:

$$T1 + T2 \leq 10 \text{ milliseconds}$$

4.2.5 The leading carrier transmitted by the terminal shall persist for T milliseconds where T is determined as follows:

$$T = (9 - T1 - T2 + T3) \text{ when } T1 + T2 \leq 9 \text{ milliseconds}$$

$$T = T3 \quad \text{when } T1 + T2 > 9 \text{ milliseconds}$$

where  $12 \leq T3 \leq 17$  milliseconds.

4.2.6 If the polled terminal can not meet the above timing constraints, it shall not begin transmission and shall await the next specific poll from the Transaction Network. The above constraints are the sole timing constraints imposed on the terminal and are the basis for all Transaction Network time-outs.

4.2.7 A terminal will continue to receive a specific poll irrespective of the last returned inquiry message status indicated. The Transaction Network will remove a terminal from the polling list only upon the occurrence of a hardware failure.

4.2.8 Access delay is defined as the time interval that elapses between arming the terminal and receiving a specific poll. Access delays are statistical with the service objective: less than 1.25 seconds average delay as averaged over a time consistent busy hour of the average busy season.

4.3 The Selection Signaling Sequence and Poll is shown in Figure 8.

4.3.1 As soon as the Transaction Network has verified and accepted a response message from the DPC, it interrupts the normal specific polling cycle and issues a selection signaling sequence and poll (the response message).

4.3.2 The terminal shall accept the response message and check the message for the presence of an ENQ character, the proper sequence of BAL, SOH, STX and ETX with no multiple entries of SOH and STX before the receipt of ETX and the correct called number (TID). The terminal will also check the parity of each character (including the LRC character). A longitudinal parity check shall be accumulated and compared with the message LRC character.

## 5.0 Messages

Inquiry and response message are transmitted between the Transaction Network and the terminal. In order to maintain the specified access time, only one inquiry or only one response message is transmitted per specific or selection poll respectively.

### 5.1 Inquiry Message

5.1.1 The inquiry message is transmitted by the terminal to the Transaction Network.

5.1.2 The inquiry message is transmitted after a specific poll has been received by the terminal.

5.1.3 The terminal will start transmission in accordance with paragraphs 4.2.3 - 4.2.5.

5.1.4 The format of an inquiry message is shown in Figure 5. Refer to subsection 5.3 for a detailed description of the message format.

5.1.5 The Transaction Network will not keep track of any sequencing of inquiry and response messages. A message transfer shall occur in accordance with the protocol specified in section 7. Once the protocol has been satisfied the Transaction Network forwards the message to the called party.

## 5.2 Response Message

5.2.1 The response message is transmitted to the terminal by the Transaction Network.

5.2.2 When a valid response message is ready for transmission to the terminal, the normal specific polling cycle is interrupted and a selection poll (i.e., the response message) is issued.

5.2.3 The format of the response message is the same as that of an inquiry message except that it will never contain a station identifier subfield in the heading field.

## 5.3 Message Format

The basic message format is shown in Figure 5 and consists of two main fields, the message heading and the message text, followed by an LRC character.

5.3.1 The message heading field shown in figure 6 shall be the first field delimited by SOH and STX characters and shall consist of up to four subfields including the station identifier, the called number, calling number and message status subfield. The subfields are separated by field separators RS, FS, and GS. The subfield separators shall be used only when the following subfield exists.

5.3.1.1 The station identifier subfield shall consist of up to two characters whose contents may consist of any value between 40-5F (Hexadecimal) inclusive. This subfield appears only in an inquiry message immediately following

the SOH character and is optional. It is passed on unaltered in the heading of the message to the DPC by the Transaction Network.

5.3.1.2 The called number subfield shall be preceded by the subfield separator, RS, and both shall be present in all message headings except inquiry messages using implied addressing. This subfield shall follow the SOH character in a response message and the station identifier subfield (if present) in an inquiry message. The called number subfield contained in an inquiry message may consist of 1, 2, 3 or 7 numerical characters identifying the called DPC. Allocation of decimal digits is the range of  $X_1X_2X_3$  0000 -  $X_1X_2X_3$  0998 where  $X_1X_2X_3$  is a number assigned by the Telephone Company to the Transaction Network. In a response message the called number subfield will always contain four (4) numerical characters identifying the called terminal. The terminal identification number (TID) will be specified on the service order and allocation of decimal digits is the range 1000-7999. The most significant digit is transmitted first. In the case of terminals with restricted access, implied and/or abbreviated addressing shall be used in the called number subfield as follows:

Implied Addressing - In an inquiry message, a restricted access terminal may omit identification of the called DPC, and the Transaction Network will supply it per agreements reached with the DPC's served. The subfield separator, RS, shall also be eliminated.

Abbreviated Addressing - In an inquiry message, a restricted access terminal may use any one of the ASCII digits 1 through 9 to identify the called DPC. The Transaction Network will supply the proper DPC identification based on an internal list of DPC's. Numbering of the list is in the order 1, 2, --- 9. Ordering of the list is by agreement of the DPC's comprising the list.

Service Message Addressing - A terminal may transmit an inquiry message with a called number equal to 999. This is defined as a service message and the Transaction Network will reflect such a message back to the terminal.

5.3.1.3 The calling number subfield shall be preceded by the subfield separator, FS, and both shall be present in all message headings except response messages using implied

addressing. This subfield shall always follow immediately the called number subfield. The calling number subfield contained in an inquiry message shall always consist of four (4) numerical characters identifying the calling terminal (TID). Allocation of decimal digits is the range 1000-7999. The terminal designer shall provide a means of entering the Telephone Company assigned TID. In a response message the calling number subfield will always contain only the minimal number (1,2 or 3) of numerical characters required to identify the calling DPC (000-998). In cases where the service order so specifies (at the request of the customer) the Transaction Network will instead insert the full seven (7) digit DPC identification number ( $X_1X_2X_3$  0000 -  $X_1X_2X_3$  0998) in the calling number subfield. Again in the case of terminals having restricted access, the Transaction Network will recognize and utilize implied and/or abbreviated addressing in the calling number subfield as follows:

Implied Addressing - In the response message delivered to a restricted access terminal using implied addressing, the calling number subfield and the subfield separator, FS will not exist. Messages from only the specified DPC will be delivered. Refer to paragraph 5.3.1.2 above concerning constraints on implied addressing.

Abbreviated Addressing - In the response message delivered to a restricted terminal using abbreviated addressing, the originating DPC shall be identified by a digit from 1-9, as the DPC is placed in the list. Refer to paragraph 5.3.1.2 above concerning constraints on abbreviated addressing.

5.3.1.4 The message status subfield shall be preceded by the subfield separator character, GS. This subfield consists of two numerical characters and shall be present only in inquiry messages which are returned to the terminal. The contents of this subfield are described in subsection 5.4 below. This subfield does not appear in a response message transmitted to the terminal.

5.3.2 The message text field shall be the second field of each message, delimited by the STX and ETX characters. The usage of the text field is application dependent and the Transaction Network will remain transparent to the

text, except for a scan to detect the ETX and ENQ characters, subject to the following constraints.

The text shall not contain data link control characters as defined in section 3.

The text shall not exceed a character count of 128 characters.

### 5.3.3 The "Longitudinal Redundancy Check" Character (LRC)

Immediately following ETX is the LRC character which in conjunction with character parity shall be used for detecting transmission errors. The LRC character is the "exclusive OR" of each message character (not including the parity, stop and start bits) and shall be initialized to zero by the SOH character which is not accumulated, and shall be accumulated on every succeeding message character through the ETX character which is accumulated. The LRC character shall be the last meaningful character in each message. Parity shall be added to the LRC character.

5.3.4 The receipt of the ENQ character in the heading or text fields of a message shall indicate that the message has been aborted. If any characters follow it they shall be disregarded by the Transaction Network or terminal.

## 5.4 Message Status Subfield Format

Any inquiry message which encounters Telephone Company or customer equipment irregularities not covered by the data link protocols, upon being transmitted through the Transaction Network, will be returned with a corrected heading to the calling number (terminal). The returned message will have inserted in the message status subfield an indication (error code) of the specific irregularity encountered. Only those error codes that apply to the terminal are covered in this subsection. All terminals must accept the message status subfield as part of the data link message format specification. Subsequent usage of the information contained in the subfield is customer dependent.

5.4.1 Irregularities reported will be identified by two characters of the form X, Y (X transmitted first, followed

by Y) for all messages handled by the Transaction Network. X and Y represent any of the digits zero through nine. The first digit, X, indicates the generic class of the irregularity encountered while the second digit, Y, describes the specific irregularity. The irregularities have been classified according to the first digit, X, so that when multiple irregularities,  $X_1, \dots, X_n > 0$ , occur for a particular message, the  $X = \min(X_1, \dots, X_n)$  will be the only message status reported, it being the first encountered anomaly. For example, if irregularities  $(X, Y) = (1, 3)$  and  $(4, 1)$  are encountered, then  $(1, 3)$  will be the message status reported. If status indications  $(X, Y) = (5, Y_1)$  and  $(5, Y_2)$  are encountered then the Y field value corresponding to the most severe error, will be inserted into the delivered message.

5.4.2 Five generic classes of message status are defined:

5.4.2.1 Class 0 - Normally handled messages (X=0).

5.4.2.2 Class 1 - Irregularities encountered during message transmission to the Transaction Network (X=1,2).

5.4.2.3 Class 2 - Irregularities encountered by the Transaction Network routing algorithms while attempting to determine the called station (X=3). (X=4 is reserved for future uses of this type.)

5.4.2.4 Class 3 - Irregularities encountered by the Transaction Network which prevented forwarding the message to the DPC (X=5). X=6 is reserved for future uses of this type.

5.4.2.5 Class 4 - Irregularities encountered during attempted forwarding of message (X=7). (X=8 is reserved for future uses of this type.) (X=9 is reserved for future use of all classes.)

5.4.3 The above classes follow sequential actions in transferring a message through the Transaction Network. An irregularity encountered in Classes 1 through 4 will prevent the next sequential step in the message transfer process and cause the message to be returned to the terminal. The returned text field will not exceed the specified maximum length of 128 characters. If the original

text was greater than 128 characters, truncation is accomplished by removing the last transmitted text characters.

5.4.4 Normally Handled Messages (Class 0) - Class 0 Status subfields with  $(X,Y) = (0,0)$  indicate no irregularities were encountered during transfer of the accompanying message. This class is not reported over the PAN.

5.4.5 Reception Irregularities (Class 1) - Class 1 status fields ( $X=1$  or  $2$ ) indicate seeming data link protocol acceptance of a message, i.e., a positive acknowledgment was transmitted, with subsequent detection of an error in the received message which precludes it from any further processing for delivery through the Transaction Network.

5.4.5.1 Heading Format Error - Class 1 status subfields with  $(X,Y) = (1,0)$  indicate an error in the specified heading format. Such errors include no heading, required heading subfield missing, and incorrect heading subfield length.

5.4.5.2 Maximum Text Length Exceeded - Class 1 status subfields with  $(X,Y) = (1,1)$  indicate that the maximum character count of 128 characters for the text field has been exceeded. See paragraph 5.4.3 for handling of returned text.

5.4.5.3 Improper Use of Characters - Class 1 status subfields with  $(X,Y) = (1,2)$  indicate an illegal character, such as a data link control character improperly inserted into the heading or text fields.

5.4.5.4 Protocol Error - Class 1 status subfields with  $(X,Y) = (1,4)$  indicate an error in the data link protocol. For example, the status could apply to a message for which a positive acknowledgment has been sent but for which the remainder of the protocol was not successfully concluded.

5.4.6 Routing Irregularities (Class 2) - Class 2 status subfields ( $X=3$ ) indicate a message that was successfully received but that cannot be routed to the DPC.

5.4.6.1 No such number - Class 2 status subfields with  $(X,Y) = (3,0)$  indicate that no such called number is presently assigned within the Transaction Network.

5.4.6.2 Number Changed - Class 2 status subfields with  $(X,Y) = (3,1)$  indicate that the called number is no longer assigned within the Transaction Network. The called number had once been assigned to a DPC and a new number has now been assigned to that DPC.

5.4.6.3 Improper Class of Service - Class 2 status subfields with  $(X,Y) = (3,2)$  indicate an improper class-of-service identification. For example, this status applies to an attempt by a Restricted Access terminal to communicate with a DPC not specified in the Service Order, or a common user terminal trying to access a Restricted Access DPC.

5.4.6.4 Invalid Called Number - Class 2 status subfields with  $(X,Y) = (3,3)$  indicate a called number out of range.

5.4.7 Nonexistence of Forward Path (Class 3) - Class 3 status subfields  $(X=5)$  indicate that the message was not delivered because of an anomaly encountered in the forward path.

5.4.7.1 Called DPC Unavailable - Class 3 status subfields with  $(X,Y) = (5,0)$  indicate the the called DPC is not currently accepting messages. The unavailability of a called DPC can be caused by hardware failures in the forward path or by request of that DPC. For a called DPC with message forwarding arrangement, receipt of this status indicates, in addition, that either the forwarding mechanism is inoperative at the request of the called DPC or because all of the specified alternate delivery points are also unavailable.

5.4.7.2 Called DPC Queue Overflow - Class 3 status subfields with  $(X,Y) = (5,1)$  indicate the lack of available buffers in the message queues for the called DPC within the Transaction Network. For a called DPC with the queue-overflow-forwarding option receipt of this status indicates, in addition, the absence of an allowable alternate delivery point.

5.4.7.3 Network Trouble - Class 3 status subfields with  $(X,Y) = (5,3)$  indicate that the message cannot be forwarded due to trouble in the Transaction Network.

5.4.7.4 Unprocessed Service Message - Class 3 status subfields with  $(X,Y) = (5,6)$  indicate that the service message cannot be processed.

5.4.8 Forwarding Irregularities (Class 4) - Class 4 status subfields  $(X=7)$  indicate an irregularity encountered in delivery of the message. This irregularity does not prevent the message from being delivered.

5.4.8.1 Possible Duplicate Message - Class 4 status subfields with  $(X,Y) = (7,0)$  indicate a possible duplicate message originated by the Transaction Network. This status is not reported if any other irregularity is also to be reported.

## 6.0 Control Sequences

The control sequence shown in Figure 9A is a short transmission containing a single data link control character preceded by a BAL character. It is the means by which the error control protocol is implemented and is transmitted by both the Transaction Network and the terminal except as noted below. An optional two character calling number (two least significant digits of the TID) may be inserted between the BAL and control characters by the terminal only.

The control sequence is only transmitted when the connection or path has already been established by a specific or selection poll. If the connection is suspect, the Transaction Network will precede a control sequence with signaling characters to reestablish the connection as shown in Figure 9B. It is then referred to as a control signaling sequence. If a connection already exists when a control signaling sequence is transmitted, the terminal will see the signaling characters and shall ignore them but not the control sequence. The terminal shall not transmit a control signaling sequence.

### 6.1 Reply Control Sequence

A reply control sequence shall be used to positively or negatively acknowledge the receipt of a message. The Transaction Network will transmit a reply control sequence to the terminal upon receipt of an inquiry message. The "positive acknowledgement" (ACK) control character will

be used in a reply control sequence to indicate that the previous message was received without character parity, LRC and format error. A format error is defined as the presence of an ENQ character, BAL, SOH, STX, ETX unrecognizable, out of order or multiple entries of SOH and STX before the receipt of ETX or the TID is not the same as that expected by the Transaction Network. The "negative acknowledgment" (NAK) control character shall be used in a reply control sequence to indicate that the previous message was received with character parity, LRC or format error. The reply control sequence is hereinafter referred to as an ACK or NAK reply. The terminal shall transmit a reply control sequence within the timing constraints upon receipt of a response message. The reply will conform to the results of a message check defined in paragraph 4.3.2.

## 6.2 Termination Control Sequences

The termination control sequence shall be used to indicate the end of the data link protocol by means of which a single inquiry or response message was transmitted. The "end-of-transmission" (EOT) control character shall be used in termination control sequences. The terminal will transmit a termination control sequence to the Transaction Network within the timing constraints when it has successfully received a reply control sequence (either ACK or NAK) from the Transaction Network. The Transaction Network will transmit a termination (EOT) control sequence to the terminal when it has successfully received a reply control sequence (ACK or NAK) from the terminal acknowledging receipt of the response message. The termination control sequence is hereinafter referred to as a termination. A termination control signaling sequence is not transmitted by the Transaction Network system since the terminal interprets the next poll as a termination if it has not already received one.

## 6.3 Enquiry Control Signaling Sequence

An enquiry control signaling sequence will be transmitted only by the Transaction Network System to obtain a retransmission of the last control sequence transmitted by the terminal. The "enquiry" (ENQ) control character will be used for an enquiry control signaling sequence and is hereinafter referred to as an enquiry.

A Control Sequence Retry Count shall be maintained by the Transaction Network. The control sequence unlike the inquiry or response message, can be retransmitted a number of times during the same poll because of its low transmission time. The number of retransmissions (retries) is limited to three on the same poll after which the protocol is assumed to have failed and will be reinitialized. The control sequence retry counter is reset upon the initiation of each message transfer or the valid receipt of the control sequence.

## 7.0 Protocol

Positive control over the PAC and the terminal shall be maintained by the specification that data transmissions and error control procedures are initiated from the Transaction Network in accordance with a fixed protocol.

### 7.1 Data Transmission

Simultaneous data transmission over the half-duplex local loop is prevented by specifying that all transmissions from the terminal shall follow commands, either signaling sequences, messages or control sequences, issued from the Transaction Network. These commands shall implement the data link protocol by providing for the following normal sequence of transmissions: connection to the terminal through signaling sequences; message transfer with appropriate acknowledgment; and termination procedures. Unauthorized transmissions from the terminal shall cause the data link protocol to abort and shall cause the appropriate diagnostic and correction algorithms to be instituted by the Transaction Network.

### 7.2 Error Control

Error control is basically maintained through the transmission of positive or negative acknowledgments (replies) to the transfer of messages. Error recovery shall be achieved by retransmission of garbled transmissions. A response message retry count and a control sequence retry count shall be maintained by the Transaction Network and shall be considered disjoint. The terminal shall maintain a count of the inquiry message retransmissions. The counter shall be reset upon receipt of an ACK reply. After three retransmissions the terminal

shall indicate the message was undeliverable and reset the counter.

7.2.1 The Transaction Network shall maintain all timeouts with respect to protocol errors. The terminal shall remain responsible for implementation of the data link protocol, irrespective of any time-out considerations, until the receipt of a termination from the Transaction Network.

7.2.2 A maximum of three retransmissions shall be allowed per garbled transmission except as specified in paragraph 7.5.4.3.

7.2.3 Messages which cannot be delivered to a terminal due to unrecoverable failure of the protocol shall be returned to the originator as undelivered messages. In all cases of unrecoverable protocol failure, the Transaction Network shall institute diagnostic and maintenance procedures.

### 7.3 Terminal States

The terminal can assume three states:

7.3.1 A terminal shall be considered "idle" if it neither has an inquiry message to send nor will accept a response message. An "idle" terminal shall not be responsible for nor shall conduct any part of the data link protocol.

7.3.2 A terminal shall be considered "forward armed" if it has an inquiry message which has not yet been accepted by the Transaction Network. An inquiry message is accepted only when the protocol specified in subsection 7.5 has been successfully executed.

7.3.3 A terminal shall be considered as "return armed" if it is expecting or will accept a response message. A response message is accepted only when the protocol specified in paragraph 7.5.3 has been successfully executed.

7.3.4 A terminal shall be capable of coexisting in the "forward and Return Armed" states.

#### 7.4 Connection Procedures

A connection will be established by the Transaction Network by setting up a logical and physical path through the PAC to the appropriate terminal. This is accomplished by the transmission of selection and specific signaling sequences which establish the connection and contain the terminal's poll. The terminal shall not transmit signaling sequences.

7.4.1 A specific signaling sequence contains a specific poll to request an inquiry message from a "forward armed" terminal.

7.4.1.1 Specific or selection polls received by "idle" terminals shall be ignored.

7.4.1.2 A specific poll received by a "return armed" terminal shall be considered a termination sequence. This is discussed further in paragraph 7.5.4.4.

7.4.2 A selection signaling sequence is used to transmit a response message to the terminal.

7.4.3 A "return armed" terminal state shall be prepared to receive a message as evidenced by the receipt of carrier and the two character sequence, BAL, SOH, followed by a response message. Not more than two signaling characters may precede the BAL character and which signaling characters shall be ignored by the terminal.

7.4.3.1 An "idle" terminal will not accept a selection poll. The originator of the message will be informed, however, that the called terminal is unavailable and that the message was not delivered.

#### 7.5 Message Transfer Protocol

The message transfer protocol occurs upon completion of the connection, involves the transmission of a single message with the appropriate reply control sequence, and is followed by the termination procedures. Message transfers are checked for errors with retransmission occurring on successive appearances of the terminal in the normal polling cycle.

7.5.1 The protocol associated with the normal transmission of an inquiry message is as follows:

7.5.1.1 Upon receiving a specific poll, a "forward armed" terminal shall transmit the inquiry message to the Transaction Network within the timing constraints specified in paragraph 4.2.3-4.2.5.

7.5.1.2 Upon receiving the inquiry message without detecting an ENQ character and/or any format and/or parity errors, the Transaction Network will transmit an ACK reply to the terminal.

7.5.1.3 Upon receiving the reply, the terminal shall transmit a termination to the Transaction Network within the timing constraints. The terminal is then "return armed" and shall expect a response message.

7.5.1.4 Upon receiving the termination, the Transaction Network will forward the inquiry message to the called party.

7.5.2 The protocol associated with abnormal transmission of the inquiry message and/or the associated control sequences is as follows:

7.5.2.1 The Transaction Network receives an inquiry message with either format and/or parity errors and/or an ENQ character (after SOH but before the ETX character is received). The Transaction Network will transmit a negative acknowledgment (NAK reply) to the terminal. The terminal shall then transmit a termination to the Transaction Network within the timing constraints. The Transaction Network discards the incorrect message on receiving the termination. The terminal shall await the next specific poll before attempting to retransmit the inquiry message and remains "forward armed".

7.5.2.2 If the terminal receives no reply or at best a garbled reply, it shall remain silent and shall not transmit the termination. When the Transaction Network does not receive carrier, which would indicate an attempt by the terminal to send a termination, it times out and concludes that the reply was never received or was garbled. The Transaction Network will retransmit the reply. The reply is immediately preceded by a control signaling sequence

without any drop in carrier. This restores the connection in case garbling or loss of the reply resulted from network trouble. The Transaction Network also increments the control sequence retry counter.

7.5.2.3 The Transaction Network receives a garbled termination. If the Transaction Network detects carrier but cannot recognize the termination (garbled transmission), it will transmit an enquiry. This restores the connection in case garbling was due to network trouble and effectively requests the terminal to retransmit the last control sequence which was the termination. The terminal shall retransmit the last control sequence (ACK, NAK or EOT) within the timing constraints.

7.6.2.4 Maximum Message Holding\_Time Exceeded. Messages received from terminals shall also be subject to a time-out (3.0 seconds) instituted by the detection of carrier. If carrier is not dropped before completion of the time-out, the Transaction Network shall remove the terminal from the polling cycle and institute diagnostic and maintenance procedures. The terminal shall be assumed temporarily nonfunctionable and an NAK reply will not be sent.

7.5.3 The protocol associated with the normal transmission of a response message is as follows:

7.5.3.1 Upon receiving a response message from the data base the Transaction Network will check it for format and parity errors. When it has ascertained its validity, the Transaction Network will interrupt the normal specific polling sequence and transmit a selection poll immediately followed by the response message with no drop in carrier.

7.5.3.2 Upon receiving the response message without either detecting an ENQ character and/or any format and/or parity errors, the terminal shall transmit a positive acknowledgment (ACK reply) to the Transaction Network within the timing constraints.

7.5.3.3 Upon receiving the reply the Transaction Network will transmit a termination to the terminal.

7.5.4 The protocol associated with abnormal transmission of the response message and/or the control sequence is as follows:

7.5.4.1 Upon receiving a response message which does not pass its acceptance criteria (as specified in paragraph 4.3.2), the terminal shall transmit a NAK reply to the Transaction Network within the timing constraints and discard the response message. The Transaction Network then transmits a termination to the terminal. The Transaction Network will await the appearance of the terminal on the normal polling cycle for retransmission of the response message. The message retry counter is incremented.

7.5.4.2 If the Transaction Network receives a garbled reply, an enquiry will be transmitted. This is in case the garbling or loss of the reply was due to network trouble. The control sequence retry counter is incremented.

7.5.4.3 If the Transaction Network does not detect carrier indicating an attempt by the terminal to transmit a reply, it times out and transmits an enquiry. If the Transaction Network still does not detect carrier, it times out retransmits the enquiry. In all the Transaction Network transmits the enquiry a maximum of 3 times and then moves on the another terminal. When the Transaction Network returns to the terminal in the normal polling cycle it transmits a selection poll (the response message). A maximum of three enquiries will be transmitted if carrier indicating a reply is not detected. At this point the Transaction Network will notify the DPC that it was unable to deliver the response message. Thus only one retransmission will be attempted if no carrier is received from the terminal. The terminal is not removed from the polling cycle, however, if carrier is received at any time.

7.5.4.4 If the terminal does not receive a termination or at best a garbled termination, it will remain silent until a specific or selection poll is received. It shall interpret the poll as a termination and a simultaneous connection procedure. Premature receipt of a termination either EOT or a poll shall always abort and reinitialize the protocol.

## 8.0 References

8.1 Reference 1 - Bell System Technical Reference, "Transaction Network Service" Publication Number 41024 dated December 1975.

8.2 Reference 2 - Bell System Technical Reference, "Data Sets 202S and 202T Interface Specification Publication Number 41212 dated August 1975.

8.3 Reference 3 - Bell System Technical Reference, "Analogue Parameters Affecting Voiceband Data Transmission - Description of Parameters" Publication Number 41008 dated July 1974.

8.4 Reference 4 - Bell System Technical Reference, "Transmission Parameters Affecting Data Transmission Measuring Techniques" Publication Number 41009 dated January 1972.

PAC TRANSMISSION PARAMETER LIMITS

TABLE 1

BANDWIDTH PARAMETERS

- |                              |                           |
|------------------------------|---------------------------|
| 1. Attenuation Distortion    | -4 to +14 dB, 500-2800 Hz |
| 2. Envelope Delay Distortion | 1750 msec, 800-2600 Hz    |

FACILITY PARAMETERS

- |   |   |
|---|---|
| 3. Long Term 1004 Hz Facility Loss Variation                | ±6 dB   |
| 4. C-Message Noise  | 49 dBm  |
| 5. C-Notched Noise  | 21 dB below received<br>1004 Hz test tone power               |
| 6. Impulse Noise  |   |
| Threshold with respect to received 1004 Hz test tone power: | Maximum counts above threshold allowed in 15 minutes:         |
| -6 dB   | 30  |
| -2 dB   | 18  |
| +2 dB   | 10  |
| 7. Single Frequency Interference                            | -52 dBm (3 dB below C message noise power limit)              |
| 8. Frequency Shift (overall PAC)                            | ±5 Hz   |
| 9. Phase Jitter   | 15° Peak to Peak  |
| 10. Nonlinear Distortion (Four tone measurement method)     | Signal to second order - 25 dB: signal to third order - 28 dB |
| 11. Echo  |   |
| Listener Echo   | 20 dB below received data signal level                        |
| Talker Echo   | 10 dB below received data signal level                        |

- |                             |   |
|-----------------------------|---|
| 12. Gain Hits (objectives)  | No more than eight in<br>15 minutes $\geq$ 3 dB       |
| 13. Phase Hits (objectives) | No more than eight in<br>15 minutes $\geq$ 20 degrees |
| 14. Dropouts (objectives)   | No more than two in<br>15 minutes $\geq$ 12 dB        |

## APPENDIX A

### DESCRIPTION OF TRANSMISSION PARAMETERS

#### 1. Attenuation Distortion (Loss vs. Frequency)

One requirement for the PAC to provide distortionless transmission is that all signal frequencies experience the same loss in traversing the PAC. Typical PAC's however, have variation in loss with frequency. To control the magnitude of this variation, attenuation distortion limits are specified.

Attenuation distortion is a difference in loss at one frequency with respect to the loss at another frequency. It is specified by placing a limit on the maximum loss at any frequency, in a specified band of frequencies, with respect to the loss at a reference frequency. The reference frequency established in this country is 1004 Hz. The limit for attenuation distortion is -4 to +14 dB in the 500-2800 Hz band.

#### 2. Envelope Delay Distortion

Another PAC requirement for distortionless transmission is a linear phase vs. frequency characteristic. The typical PAC will only approximate such linearity over the 300 to 3000 Hz nominal voiceband. Measuring the phase vs. frequency PAC characteristic directly is difficult because of problems in establishing a phase reference. However, a usable approximation to the derivative of phase with respect to frequency, called envelope delay, can be more easily measured. The maximum variation in envelope delay over a band of frequencies is called envelope delay distortion. The quality of the PAC with respect to its phase characteristic is controlled by limiting the amount of envelope delay distortion allowed. The limit on envelope delay distortion is 1750 microseconds over the 800-2600 Hz band assuming the use of an 83-1/3 Hz modulating frequency for the measurement.

#### 3. 1004 Hz Loss Variation

The nominal 1004 Hz receive level is -20 dBm. However, variations can be expected. Short term loss variation may be caused by dynamic regulation of carrier system amplifiers, switching to standby facilities, and some

maintenance activities. "Short term" is meant to be a few seconds or less. Short term variations are considered to be gain hits, gain changes and dropouts (see 12, 13 and 14).

Long-term variations are primarily caused by temperature changes affecting local plant; component aging, amplifier drift, and other phenomena also contribute. "Long term" is meant to be periods of days, weeks, or even longer. Long-term variations should not exceed  $\pm 6$  dB, i.e. the 1004 Hz receive level must be between limits of -14 and -26 dBm.

#### 4. C-Message Noise

C-message noise is a weighted measurement of the background noise on a PAC in the absence of a signal. It is measured with an rms-responding noise measuring set such as the Western Electric 3C Noise Measuring Set. The weighting used is provided by a C-message filter. It offers less than 5 dB attenuation in the 600-3000 Hz band of interest for most voiceband data transmission, and sharply attenuates low frequency components, such as 60 Hz and its low harmonics, and high frequency components above 3200 Hz. Substantial low frequency noise components may be masked in measuring message noise by the attenuation of the C-message filter below approximately 500 Hz. In particular, 60 Hz and its harmonics up to 300 Hz may be present at relatively high levels. The C-message noise limit specified in Table 1, -49 dBm, is particularly important for modems operating without continuously present received signals since they apply to the channel in the idle condition.

#### 5. C-Notched Noise

The C-message noise described in section 4 above often is not the principal noise experienced when a signal is present. Quantizing noise in digital carrier systems and the effect of compandors in both digital and some analog systems result in signal dependent noise. Thus, the ratio of the received power of a 1004 Hz test tone to the received C-message noise power is not a reliable indication of the signal-to-noise ratio.

C-notched noise is a measure of the amount of noise on PAC when a signal is present. In making this measurement, a single frequency "holding tone" is applied at the transmitting end of the PAC to act as a signal. This tone operates compandors and other signal-dependent devices, and thus simulates a data signal. At the receiving end,

the tone is removed by a narrow band elimination filter (notch filter) and the noise is then measured through a C-message filter. The ratio of the received 1004 Hz test tone power to the C-notched noise power is indicative of the signal-to-noise ratio on the PAC. The limit for the received 1004 Hz power to C-notched noise power ratio is a minimum of 21 dB. Since the nominal standard receiving power is -20 dBm (70 dBrnC), the nominal C-notched noise limit is 49 dBrnC at the receiver.

## 6. Impulse Noise

Impulse noise is characterized by large peaks, or impulses, in the total noise waveform. It is measured with an instrument which counts impulses greater than a selected threshold value, using a counter having a maximum counting rate of approximately seven counts per second. Measurements are made through a C-message filter. A single frequency "holding tone" is transmitted and notched out at the receiver to activate any compandored facilities in the PAC.

The impulse noise measurement involves counting the number of noise peaks exceeding a threshold numerically 6 dB below the received 1004 Hz test tone power. For a -20 dBm receive level the threshold is -26 dBm or 64 dBrnC, and the limit is 30 counts in 15 minutes using an electromechanical counter.

In addition, there are limits of 18 counts in 15 minutes at a threshold 2 dB below the received 1004 Hz test tone power, and 10 counts in 15 minutes at a threshold 2 dB higher than the received 1004 Hz test tone power. These additional limits are designed to cover cases where impulses of relatively high power would interfere substantially with data transmission but would pass the single threshold test.

## 7. Single Frequency Interference

Spurious single - frequency tones may interfere with data signals. Message circuit noise is distributed across the voiceband. If, however, a single frequency tone of substantial power is present, it may interfere with data transmission. The limit for single-frequency interference is that the noise contribution at any frequency should, when measured with C-message weighting, be at least 3 dB below the C-message noise power limit at the modem receiver as given in Table 1.

## 8. Frequency Shift

Most long haul carrier systems operate in a single sideband suppressed carrier mode. Because the carrier is not transmitted and must be reinserted, there may be a slight difference in frequency between the modulating and demodulating carriers. The resulting frequency shift contributes a constant change at all frequencies in the voiceband. The limit on frequency shift for the PAC is  $\pm 5$  Hz.

## 9. Phase Jitter

Various sources cause the instantaneous phase, or zero crossings, of a signal to "jitter" at rates normally less than 300 Hz. This phase jitter is typically caused by ripple in the dc power supply appearing in the master oscillator of long haul carriers and then passing through many stages of frequency multipliers. Some phase jitter occurs in short haul systems from incomplete filtering of image sidebands. Digital carrier systems also will exhibit phase jitter at certain input frequencies. The most common jitter frequencies are 20 Hz (ringing current) and 60 Hz (commercial power), and the second through fifth harmonics of each of these.

Measurement of phase jitter is made with an instrument sensitive to frequencies within 300 Hz of an approximately 1004 Hz carrier. Noise may strongly influence this measurement, so phase jitter should be measured with a test tone at the data level. The limit for phase jitter is  $15^\circ$  peak to peak.

## 10. Non Linear Distortion (Harmonic Distortion)

Nonlinear distortion is that portion of a PAC output which is a nonlinear function of the PAC input. The limits given in table 1 of 25 dB and 28 dB for the signal to second order and signal to third order distortion, respectively, is based on the four tone measurement technique. With this technique four equal level tones, consisting of two pairs of tones, are transmitted with a composite signal power equal to nominal data signal level. Two of these tones are closely spaced around a center frequency "A" (860 Hz) and the other two tones are centered around a center frequency "B" (1380 Hz). The second order distortion is determined from the  $B - A$  and  $B + A$  products while the third order distortion is determined from the  $2B - A$  product.

## 11. Echo

Impedance mismatches in a PAC cause echoes to be returned to the transmitter (talker echo) or the receiver (listener echo). The impedance mismatches may occur at numerous locations in the PAC but the major contributors to echo problems occur at the interface between 2-wire and 4-wire operation (hybrid transformers).

The PAC, which is designed for half-duplex operation, will have a listener echo at least 20 dB below the received signal, provided the terminating impedances are reasonably close to 600 ohms resistive across the voiceband. An impedance of 600 ohms  $\pm 10\%$  will satisfy this condition. In addition, it is expected that the talker echo will be at least 10 dB below the received signal. This echo is expected to last for no longer than 14 msec after the end of transmission from the terminal.

## 12. Gain Hits and 13. Phase Hits

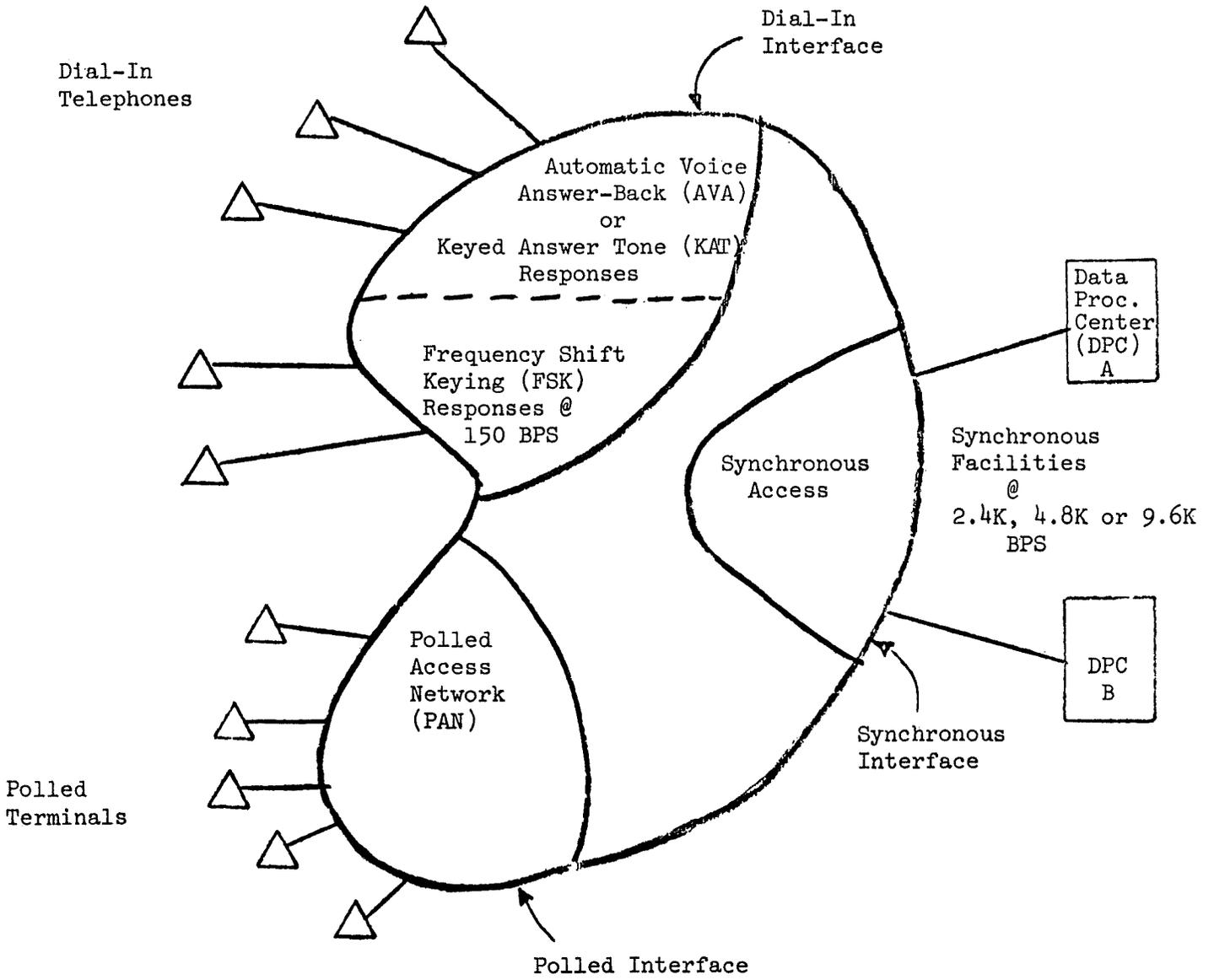
Gain hits and phase hits are defined to be sudden changes in the amplitude or phase of a signal lasting for at least 4 msec and returning to the original value within 220 msec. Changes in amplitude or phase which last for more than 220 msec are referred to as gain or phase changes. Changes that last for less than 4.0 usec are classified as impulse noise. Limits are not specified; objectives for these parameters for end-to-end connections are:

gain hits, no more than eight in 15 minutes  $\geq 3$  dB

phase hits, no more than eight in 15 minutes  $\geq 20$  degrees

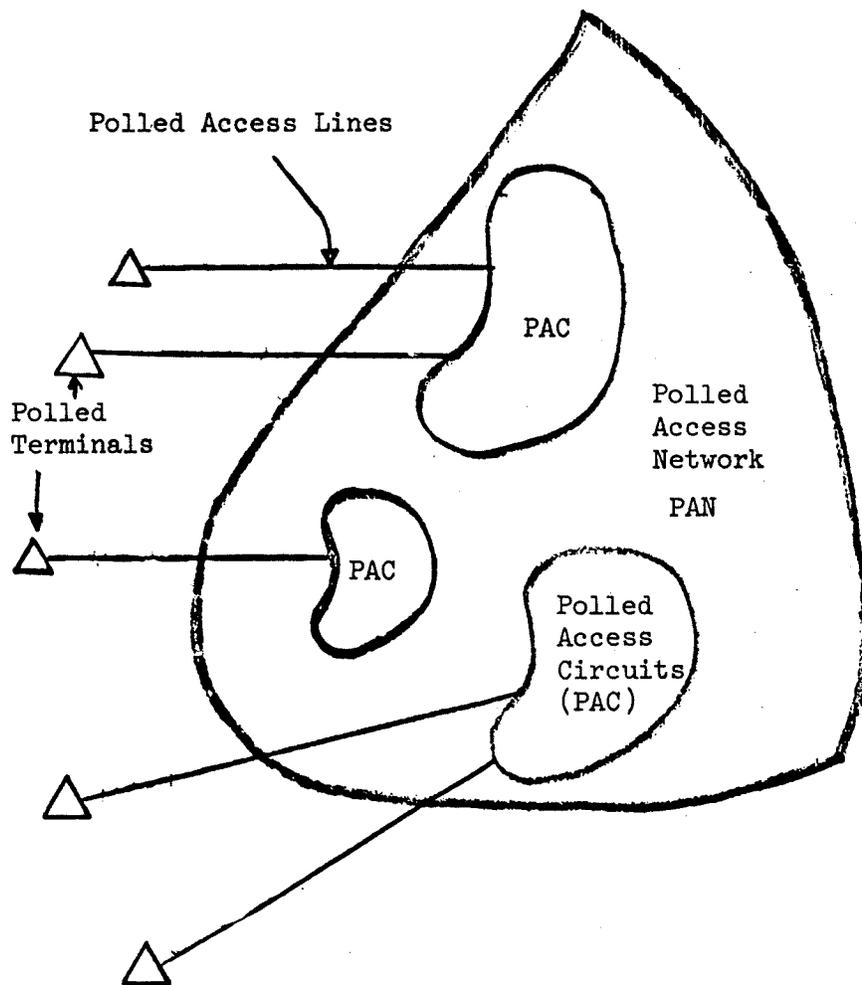
## 14. Dropouts

A dropout is a decrease in level  $\geq 12$  dB which lasts for at least 10 msec. Since dropouts tend to be long with more than 40 percent in excess of 200 usec, they frequently are responsible for serious performance degradations. Limits are not specified; however, the objective is that there will be no more than two dropouts in 15 minutes.



Transaction Network

FIGURE 1



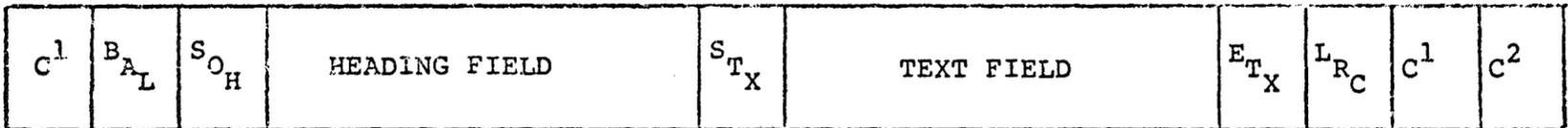
Transaction Network

Polled Access

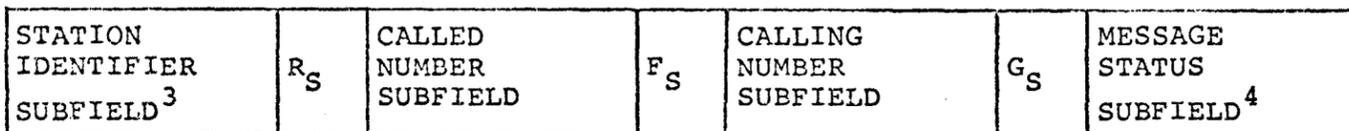
FIGURE 2

SOH - START OF HEADING DELIMITER  
 STX - START OF TEXT DELIMITER  
 ETX - END OF TEXT DELIMITER  
 LRC - LONGITUDINAL REDUNDANCY CHARACTER

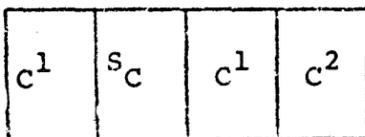
RS - RECORD SEPARATOR  
 RS - FILE SEPARATOR  
 GS - GROUP SEPARATOR  
 BAL - BLIND ALERT CHARACTER



INQUIRY AND RESPONSE MESSAGE FORMAT  
 FIGURE 5

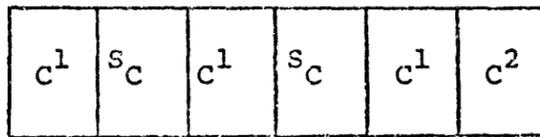


HEADING FIELD FORMAT  
 FIGURE 6



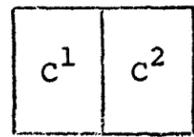
ONE SIGNALING CHARACTER (S<sub>C</sub>) AND SPECIFIC POLL

7A



TWO SIGNALING CHARACTERS (S<sub>C</sub>s) AND SPECIFIC POLL

7B

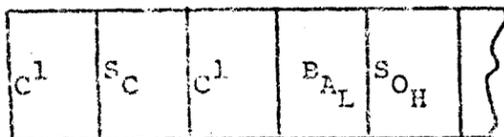


SPECIFIC POLL

7C

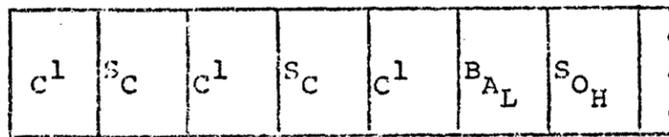
SPECIFIC SIGNAL SEQUENCE AND POLL

FIGURE 7



ONE SIGNALING CHARACTER (S<sub>C</sub>) AND SELECTION POLL

8A



TWO SIGNALING CHARACTERS (S<sub>C</sub>s) AND SELECTION POLL

8B

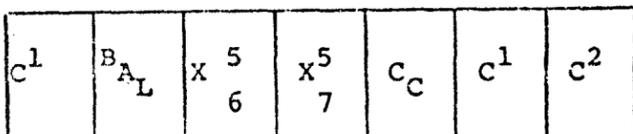


SELECTION POLL

8C

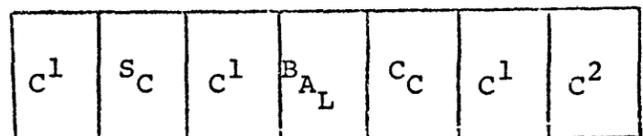
SELECTION SIGNALING SEQUENCE AND POLL

FIGURE 8



CONTROL SEQUENCE WITH CONTROL CHARACTER (C<sub>C</sub>) TRANSMITTED BY THE TRANSACTION NETWORK AND THE POLLED TERMINAL

9A



CONTROL SIGNALING SEQUENCE WITH SIGNALING CHARACTER (S<sub>C</sub>) AND CONTROL SEQUENCE. TRANSMITTED BY TRANSACTION NETWORK ONLY.

9B

CONTROL SEQUENCE AND CONTROL SIGNALING SEQUENCE

FIGURE 9

- NOTES:
- 1) CARRIER AT THE MARK FREQUENCY
  - 2) SOFT TURN-OFF CARRIER
  - 3) OPTIONAL SUBFIELD IN THE INQUIRY MESSAGE ONLY
  - 4) THIS SUBFIELD APPEARS IN A RETURNED INQUIRY MESSAGE ONLY.

- 5) X<sub>6</sub> AND X<sub>7</sub> ARE THE TWO LEAST SIGNIFICANT DIGITS OF THE TERMINAL IDENTIFICATION NUMBER (TID) AND ARE OPTIONAL FROM THE POLLED TERMINAL; NOT PRESENT TO THE POLLED TERMINAL.