

PRELIMINARY

**Bell System Data Communications
TECHNICAL REFERENCE**

**THE DISPLAY DATA SET F-58167
USED TO PROVIDE COMPUTER
ACCESS SERVICE FOR PICTUREPHONE[®] STATIONS**

•
August, 1970
•

ENGINEERING DIRECTOR - TRANSMISSION SERVICES



NOTICE

This Technical Reference is published by American Telephone and Telegraph Company as a guide for the designers, manufacturers, consultants and suppliers of customer-provided systems and equipment which connect with Bell System communications systems or equipment. American Telephone and Telegraph Company reserves the right to revise this Technical Reference for any reason, including, but not limited to, conformity with standards promulgated by USASI, EIA, CCITT, or similar agencies, utilization of new advances in the state of the technical arts, or to reflect changes in the design of equipment or services described therein. The limits of responsibility and liability of the Bell System with respect to the use of customer-provided systems or equipment are set forth in the appropriate tariff regulations.

If further information is required, please contact:

Engineering Director - Transmission Services
American Telephone and Telegraph Company
195 Broadway
New York, New York 10007

TABLE OF CONTENTS

	<u>Page</u>
1. INTRODUCTION	1
2. GENERAL CHARACTERISTICS OF THE DISPLAY DATA SET	2
3. ON-LINE SIGNAL CHARACTERISTICS	3
3.1 Code	3
3.2 Transmission Speed	5
3.3 Character Structure	5
3.4 Bit Order	5
3.5 Distortion Requirements	5
3.6 Timing Considerations	6
3.7 Display Format Requirements	7
4. INTERFACE CHARACTERISTICS	7
4.1 General	8
4.2 Functional Description of "Local" Interface Circuits	8
4.3 Functional Description of "Remote" Interface Circuits	10
5. OPERATIONAL CHARACTERISTICS	13
5.1 General	13
5.2 Call Establishment	13
5.3 TOUCH-TONE Mode	14
5.4 Data Mode	15
5.5 Edit Mode	16
5.6 Cursor Controls	17
5.7 Dump to Computer	17
5.8 Call Termination	18
5.9 Clear Screen on Hang-Up	20
6. PHYSICAL CHARACTERISTICS	21
7. TESTING AND MAINTENANCE CONSIDERATIONS	21

1. INTRODUCTION

This Technical Reference describes the physical, electrical and logical interface characteristics of the preliminary Display Data Set F-58167 developed by the Bell System for use by computers in the provision of computer access for PICTUREPHONE® stations. The F-58167 design is preliminary in nature but is being offered to correspond with initial PICTUREPHONE service. A standard version of the display data set is presently under development and is expected to be available late in 1971. Although the basic services provided by the preliminary and the standard arrangements are expected to be the same, the details of how functions are provided are subject to change. Therefore, the standard arrangement, when available, will be described by a separate Technical Reference.

The primary function of a display data set is to provide an interface between a customer-provided computer and a PICTUREPHONE switching network that will support a viable data communication service without 1) requiring physical modification of the PICTUREPHONE stations involved, or 2) introducing significant changes in the way computers normally interact with remote data terminals. In this way, display data sets allow PICTUREPHONE stations to be used for information retrieval purposes in addition to their primary face-to-face communication function.

In general terms, a display data set permits a PICTUREPHONE subscriber to access an appropriately programmed computer and to interact with it using the TOUCH-TONE® dial at the station as an input device and the PICTUREPHONE station screen as a visual display output device. The display data set translates TOUCH-TONE signals received from the PICTUREPHONE station into the American National Standard Code for Information Interchange (ANS X3.4 - 1968), commonly referred to as ASCII, for use by the computer, and, likewise, translates ASCII signals received from the computer into the video signals required to draw alphanumeric symbols and graphic symbols on the distant PICTUREPHONE station screen. The display data set stores the information received from the computer and repetitively transmits the corresponding video signals to the PICTUREPHONE station at the frame rate required to refresh the display. Thus, it is not necessary for the computer to repetitively transmit the message to be viewed.

Figure 1 depicts how a display data set and an associated computer fit into a typical PICTUREPHONE service arrangement. To the PICTUREPHONE network employed (Exchange service, key telephone systems, or intercom arrangement), the display data set appears as a standard PICTUREPHONE station that can be "called" by any PICTUREPHONE station on the network that is aware of its telephone number. To the computer, the display data set presents a standard EIA (Electronics Industries Association) electrical interface. As illustrated, the computer display data set connection may be made directly ("Local" arrangement), or it may be made via a standard, private line, 4-wire voiceband data link using 202D-type data sets ("Remote" arrangement).

2. GENERAL CHARACTERISTICS OF THE DISPLAY DATA SET

The display data set is designed such that it may be located on the computer site and connected directly to the computer (as most data sets are) or located remote from the computer site and connected to the computer over a dedicated 4-wire voiceband data link. The remote arrangement is provided so that a computer not located within a PICTUREPHONE service area may still offer computer access service to PICTUREPHONE users by effectively extending its computer port to some installation that is located on customer premises within the PICTUREPHONE service area. Also, the remote arrangement will allow the computer provider to offer computer access service to his customers in any distant city.

Functionally, in terms of the features that the PICTUREPHONE users and the computer are capable of providing, the "local" and "remote" physical arrangements are equivalent. However, operationally, the interface arrangements provided for the two cases do differ slightly, particularly in the manner in which call establishment and call disconnect are accomplished.

The display data set offers the PICTUREPHONE user a variety of operating modes and features, each of which is selectable under the control of the computer. Normally, the PICTUREPHONE user requests a particular operating feature or capability of the system by sending to the computer a user defined request code for that function. The computer then responds by sending a specific command signal to the display data set to initiate the particular features. With one exception (see Section 5.5 - Edit Mode), the display data set is arranged to react only to signals received from the computer and not to signals received from the PICTUREPHONE user. This aids in insuring that the PICTUREPHONE user, the computer, and the display data set remain in step with one another during the progress of a call.

The basic computer access service is one where a PICTUREPHONE user uses his TOUCH-TONE dial to input requests for specific files or programs in accordance with some system defined control scheme and views the display of this information on his video screen. When the user is inputting TOUCH-TONE signals, the display data set itself imposes no requirements or restrictions on the input request format employed, e.g., number of characters per input request, or use of a specified beginning or ending delimiter. The choice of such system disciplines is left solely to the judgment of the provider of the computer access service. The display data set is arranged to accept any number of combination of input digits, to translate them into equivalent ASCII characters, and to transmit them to the computer without concern for what they are or how they are to be utilized. With regard to the output display format, the only disciplines imposed by the display data set are, 1) those that relate to the explicit display characteristics of the PICTUREPHONE station set itself (e.g., the number of characters that can be displayed at one time) and 2) those that relate to the control of operating features that are available with the display data set.

To allow for expanded interaction between a PICTUREPHONE user and the computer, an alternate mode of operation called the Data Mode can be employed

in place of the TOUCH-TONE Mode described above. In the Data Mode, the display data set accepts low-speed ASCII data (100 wpm) in place of the normal TOUCH-TONE signals on the audio facility provided between the PICTUREPHONE station and the display data set. Thus, the PICTUREPHONE user can electrically or acoustically couple a customer-provided low-speed data device, such as a keyboard, to the PICTUREPHONE station handset and operate with a greatly expanded input vocabulary. Provision for such a capability in the display data set was predicated primarily on the need for some PICTUREPHONE users to be able to edit and update files that are stored in the computer.

The Edit Mode feature provides the ability for a PICTUREPHONE user to call for a particular file, have it displayed on the PICTUREPHONE screen, and by the use of an appropriate keyboard device (for instance) change or modify it as he sees fit. To facilitate this operation, a nondestructive cursor is provided that can be controlled by the PICTUREPHONE user. During such an edit operation, the display data set is placed in a local mode configuration that allows the PICTUREPHONE user to input directly into the display storage contained with the display data set without involving the associated computer. Once the file has been edited to the PICTUREPHONE user's satisfaction, the user can signal for the computer to terminate the Edit Mode and return the system to the Data Mode.

A feature is also provided that permits the computer to call for the transmission of the information that is contained within the storage of the display data set. Use of this feature then allows an edited or updated file to be stored in the computer for subsequent access by the user updating it or by other PICTUREPHONE users.

In addition to a normal alphanumeric and special symbol character set, the display data set provides for a variety of special graphic-type symbols that are especially useful when generating displays that incorporate bar graphs, histograms or point-dot curves. Sixteen unique symbols have been specified. Lower case alphas of ASCII are employed to represent these characters for data transmission purposes between the computer and the display data set. The display repertoire available is illustrated in Figure 2. The graticule shown is automatically generated when any of the sixteen special symbols are displayed. It is retained until the screen is "cleared" for a new display.

3. ON-LINE SIGNAL CHARACTERISTICS

A computer implementing this service for PICTUREPHONE stations should have the following on-line signal characteristics in order to be compatible with the display data set operation.

3.1 Code

The transmission code employed on line should be ANS X3.4-1968, the American National Standard Code for Information Interchange (commonly referred to as ASCII). This code is shown in Figure 3.

The display data set is arranged to accept and to generate for display the 60 standard ASCII alphanumeric characters from columns 2 to 5 of Figure 3 with the exception of @, ^, __, and \. These four characters received by the display data set will be displayed as spaces. The display data set is also arranged to generate for display the 16 special graph symbols shown in Figure 4. The on-line transmission codes used to designate these graph symbols are chosen from column 6 of Figure 3. The characters from column 7 of Figure 3, if received by the display data set, will be displayed as spaces.

Certain of the control codes from columns 0 and 1 of Figure 3 are interpreted by the display data set as display affecting and cursor control functions. These control characters are:

RS	Clear screen and move cursor to top left of screen
BS	Move cursor one space to the left
HT	Move cursor one space to the right
VT	Move cursor up one line
FF	Move cursor down one line
LF	Move cursor to start of next line
SYN	Provide time fill without affecting cursor

Other control codes from columns 0 and 1 of Figure 3 are employed in the operation and control of the display data set. These control characters are:

From computer to display data set:

DC1	Instructs display data set to assume Data Mode
DC2	Instructs display data set to send contents of display storage to the computer
SUB	Instructs display data set to assume Edit Mode

From display data set to computer:

ENQ	Indicates working connection established with calling PICTUREPHONE user.
ETX	Indicates the end of an input unit
EOT	Indicates display data set has gone on-hook
DC1	Indicates establishment of Data Mode
DC2	Indicates termination of Edit Mode
DC3	Indicates termination of Data Mode and return to TOUCH-TONE Mode.

All other codes from columns 0 and 1 of Figure 3 will be displayed as spaces if received by the display data set.

The input to the computer from the user will always consist of ASCII characters. When the display data set is in the TOUCH-TONE mode, the set of valid input characters will be restricted to the ASCII representations of 0-9, *, and #. When the display data set is in the Data Mode, all 128 characters of ASCII must be considered as valid inputs, subject to software imposed restraints.

3.2 Transmission Speed

Acceptable asynchronous transmission speeds are 1200-baud or 2400-baud when the display data set is located "local" to the computer and is connected directly to the computer, and 1200-baud only when the display data set is located "remote" from the computer and is connected to the computer via a dedicated 4-wire voiceband data link that employs 202D-type data sets. All transmission between the display data set and the computer is asynchronous, i.e., nonsynchronous.

3.3 Character Structure

All characters transmitted from the display data set to the computer will employ an on-line character structure of 11.0 units -- a 1.0 unit start pulse, seven 1.0 unit information bits, a 1.0 unit parity bit, and a 2.0 unit stop pulse. Even parity will be employed for all characters.

The on-line character structure for characters transmitted from the computer to the display data set should be either 10.0 units or 11.0 units, depending upon whether or not a single unit or double unit stop pulse is required by the computer. Even parity should be employed for all characters transmitted on-line.

3.4 Bit Order

Transmission of information bits within a character should be low order bit first. The parity bit is considered to be the eighth bit following the start pulse.

3.5 Distortion Requirements

The display data set transmits data with no more than 5% start-stop distortion and will accept data with up to 45% start-stop distortion. When the display data set is located at the computer site, these figures apply directly to the transmit and receive distortion requirements for the computer.

When operating over a 4-wire voiceband data link including 202D-type data sets, the computer should transmit data with no more than 10% start-stop distortion and be capable of accepting data with up to 35% start-stop distortion. Any decrease in the distortion of transmitted data or increase in the acceptable distortion of received data will improve the system error performance. In cases where the computer is unable to meet the above requirements, special engineering shall be required.

For further information regarding distortion, reference may be made to Electronic Industries Association Standards Proposal No. 1080, "Standard for Start-Stop Signal Quality Between Data Terminal Equipment and Non-synchronous Data Communication Equipment."

3.6 Timing Considerations

This Section provides information concerning the various timing considerations that a computer should observe when working with a display data set in the provision of computer access for PICTUREPHONE stations.

3.6.1 Display Control Functions

After sending a clear screen character (RS) or one of the cursor control characters FF, VT, or LF, the computer should provide a sufficient interval of time to allow the display data set to perform the specified operation before sending the next valid action character. This time may be provided by a measured interval of transmission inactivity (steady marking being transmitted) for each function, or it may be provided by the transmission of a specified number of SYN characters for each function. The number of SYN characters (or equivalent time) required depends on the control character in question and the transmission speed employed as follows:

	<u>1200 wpm</u>	<u>2400 wpm</u>
RS	3	6
FF	3	6
VT	3	6
LF	40	80

The SYN character is the only character that should be employed to provide this time fill function. Use of alternate characters may result in unwanted spaces in the display or undesirable system operation.

3.6.2 End of Message Indicator

Every character burst that is sent to the computer from the display data set will end with the character ETX, even if the message is only one character. Each control character (e.g., ENQ or DC1) and each translated TOUCH-TONE digit sent by the display data set will be followed by an ETX character to define the end of message entity. When the display data set is operating in the DATA mode, receiving ASCII instead of TOUCH-TONE signals, each ASCII character received and transmitted along to the computer will also be followed by an ETX character. When the display data set memory is dumped to the computer, only one ETX character is involved, following the entire display.

3.6.3 Dump-to-Computer Delay

The display data set is arranged to time for 105 + 30 milliseconds after the receipt of a DC2 character from the computer before it will initiate the transmission of the contents of its display memory to the computer. This delay is provided so that half-duplex computer ports can be turned around before the first character of the display is transmitted.

3.7 Display Format Requirements

The display data set has the capacity to store 484 characters received from the computer. This information is then displayed as 22 lines of 22 characters each when it is transmitted to a PICTUREPHONE station. Because of possible drift in alignment of the PICTUREPHONE station set display, the top and bottom lines of this PICTUREPHONE display cannot always be relied upon to be visible to the user. Hence, it is recommended that both the top and bottom lines of each display be left blank. To accomplish this at the start of each display, the computer may either send 22 ASCII SP characters (or any 22 other characters that are not displayable but that provide spacing) to fill out the first line on the display, or send the ASCII character FF to automatically move the writing point down to the second line. (Note that as indicated in Section 3.6.1, a specified time fill function must be provided after the cursor control character FF is transmitted in order to allow the display data set time to perform the required function.)

To erase an existing display in preparation for sending a new display, the computer initiates a clear screen function by sending the ASCII character RS. As in the case of the FF character above, the RS character also requires a specified time fill function in order to allow the display data set time to perform the required function.

Thus, to clear one display and generate another, the computer should precede the actual displayable information with a preamble that incorporates the above functions. The following is an example of such a preamble for a system operating at a transmission speed of 1200-baud--

```

R S S S   S S S
Y Y Y F   Y Y Y ----- Displayable Information
S N N N F   N N N

```

Cursor controls, as well as other action controls, are not stored in the display data set memory. Only the result of the action that they may initiate is retained. For instance, the receipt of the cursor control character FF causes the printing position to move down one line, leaving the remaining character positions on the original line plus those on the next line up to the new printing position undisturbed, without the FF character itself being stored in the display memory.

The ability to move the printing position (cursor) around in a nondestructive manner means that the computer can add information to an existing display or override selected portions of a display without having to clear the entire screen and generate a completely new display. Of course, utilizing this capability requires that the computer keep track of where the cursor (printing position) is on the PICTUREPHONE station screen.

4. INTERFACE CHARACTERISTICS

4.1 General

Interconnection with the display data set will be via an interface arrangement that conforms with the electrical specifications set down by the Electronic Industry Association (EIA). Either of two such interface arrangements may be encountered depending on whether or not a voiceband data link is required to connect the computer to the display data set. When there is no voiceband data link required, the interface arrangement provided conforms with the electrical specifications of EIA standard RS-232-C and is referred to herein as the "Local" interface arrangement. When there is a voiceband data link required, the interface arrangement provided is the Data Set 202D3 interface arrangement that conforms with EIA standard RS-232-A and is referred to herein as the "Remote" interface arrangement. A standard 25-pin connector* is used as the interface exit and entry point to either display data set interface arrangement.

A brief summary of the electrical characteristics of the above EIA specifications follows. All signals generated by the display data set arrangement have a magnitude in the 5- to 25-volt range when measured across a load of 3000 ohms or greater. The receiving circuit of a display data set arrangement will accept computer signals with a magnitude in the 3- to 25-volt range measured at the input terminal with respect to signal ground. In accordance with EIA specifications, the computer is expected to generate signals with a magnitude of at least 5 volts. The negative voltages are considered "OFF" or "marking" and, the positive voltages are considered "ON" or "spacing". During normal operation, the input impedances of all display data set arrangement circuits which accept signals from the computer have DC resistances of at least 3000 ohms, but not more than 7000 ohms, and an effective shunt capacitance of 2500 picofarads or less. For more specific details, the appropriate EIA standard itself should be consulted.

4.2 Functional Description of "Local" Interface Circuits

The 10 interchange leads that are provided in the "Local" interface arrangement for connection to the computer are described in this Section. Figure 5 indicates the logical relationship between certain of these interchange leads during a normal call. The status of these leads when a test feature is activated is described in Section 7 - Testing and Maintenance Considerations.

- a) AA - Protective Ground: Common to the AC power service ground
- b) AB - Signal Ground: Connected to Protective Ground.
- c) BA - Transmitted Data: The BA circuit is designed to accept serial data from the customer's computer.

* The connector to be provided is the same for both the local and remote arrangements. The Technical Reference on the same Data Set 202D3 calls for either a Cinch or Cannon DB-19604-432 plug mounted in a Cinch DB-51226-1 hood assembly or equivalent.

Generally, whenever the computer is not transmitting data, it should maintain a steady marking signal on this circuit, including the interval between incoming calls. This is because, 1) the display data set is always sensitive to signals on the BA circuit, even between calls, and 2) characters detected by the display data set at any time are stored as parts of a new display. Thus, any spurious characters detected between calls as a result of the computer not maintaining a marking signal on circuit BA would be transmitted as the initial display to the next incoming caller.

This sensitivity of circuit BA to signals from the computer at any time affords the computer the opportunity to purposely store a message in the display data set between calls. Such an action might be desirable, for instance, to explain why the computer is not available for normal service and when it is expected to be back in operation. Thus, the computer need merely arrange for the automatic answer of calls during such a period.

Normally, the computer will receive the connection-established signal (ENQ) from the display data set to indicate the beginning of a call before it will send on the BA circuit.

- d) BB - Received Data: The BB circuit is designed to deliver serial data to the customer's computer.

This circuit is effectively clamped marking whenever the display data set is on-hook or circuit CD is in the OFF condition. This clamp condition is removed when the computer turns circuit CD (Request to Send) ON to answer or permit answering of an incoming call.
- e) CA - Request to Send: The CA circuit is electrically strapped to circuit CD (Data Terminal Ready) in the display data set. (See circuit CA for description of logical operations.)
- f) CB - Clear to Send: This circuit is strapped to circuit CC (Data Set Ready), circuit CF (Received Line Signal Detector) and the positive voltage supply in the display data set. Consequently, so long as there is power supplied to the display data set, an ON condition will exist on all three of these circuits.
- g) CC - Data Set Ready: The CC circuit is permanently strapped to the CB circuit.
- h) CD - Data Terminal Ready: The CD circuit is electrically strapped to circuit CA in the display data set. Consequently, the computer may equip either or both of these control circuits to provide the desired function. If both circuits are provided, they must be turned ON and OFF together. The computer turns circuit CD (or circuit CA or both) ON to enable the answering of incoming calls. Likewise, at the end of a call, the computer turns circuit CD (or circuit CA or both) OFF in order to effect a disconnect.

- i) CE - Ring Indicator: The CE circuit is normally held in the OFF condition by the display data set. When ringing is received, circuit CE will be turned ON during the ringing portion of the ring cycles (nominally 2 seconds) and OFF during the quiet interval (nominally 4 seconds).
- j) CF - Received Line Signal Detector: The CF circuit is permanently strapped to the CB circuit.

Pin assignments are as follows:

<u>Pin #</u>	<u>Circuit</u>
1	AA
2	BA
3	BB
4	CA
5	CB
6	CC
7	AB
8	CF
9-19	-
20	CD
21	-
22	CE
24-25	-

4.3 Functional Description of "Remote" Interface Circuits

The 11 interchange leads that are provided in the "Remote" interface arrangement for connection to the computer or to the installer's test equipment are described in this Section. The interface described is that of the Data Set 202D3 as used in the provision of the required 4-wire voice-band data link. Figure 6 indicates the logical relationship between certain of these interchange leads during a normal call. For additional details concerning general Data Set 202D3 capability, refer to:

Bell System Data Communications Technical Reference
Data Sets 202C and 202D
May 1964

which is available from:

Engineering Director - Data Communications
American Telephone and Telegraph Company
195 Broadway
New York, New York 10007

The status of these leads when a test feature in the display data set is activated is described in Section 7 - Testing and Maintenance Considerations.

- a) AA - Protective Ground: Electrically bonded to the equipment frame and common to the AC power service ground.
- b) AB - Signal Ground: Connected to the frame and to Protective Ground.

- c) BA - Transmitted Data: The BA circuit is designed to accept serial data from the customer's computer.

The computer has control of this circuit whenever circuit CA (Request to Send) is turned ON. Between the time that circuit CA is turned ON and the connection-established signal (ENQ) is received, the computer should hold circuit BA marking. This is because, 1) the display data set at the distant end of the 4-wire voiceband data link is always sensitive to incoming signals when the computer has circuit CA turned ON, and 2) characters detected by the display data set at any time are stored as parts of a new display. Thus, any spurious characters detected by the display data set as a result of the computer not maintaining a marking signal on circuit BA would be transmitted as the initial display to the next incoming caller.

Normally, the computer will receive the connection-established signal (ENQ) from the display data set to indicate the beginning of a call before it will send on the BA circuit.

- d) BB - Received Data: The BB circuit is designed to deliver serial data to the customer's computer.

This circuit is effectively held marking between incoming calls, and whenever circuits CA is OFF, by a marking signal that is received from the distant display data set. The computer should treat this circuit as if the marking clamp is removed when circuit CA is turned ON.

- e) CA - Request to Send: The CA circuit is used to control the call answering and call disconnecting functions of the remote display data set. Carrier signal is transmitted during the ON condition of this circuit.

The computer should turn ON circuit CA to condition the remote display data set to automatically answer the next incoming call. The ON condition should then be maintained for the entire length of the call. The computer should turn OFF circuit CA to instruct the remote display data set to terminate the connection. Circuit CA should be held in the OFF condition until the display data set responds with a disconnect-completed signal (EOT) over circuit BB.

- f) CB - Clear to Send: The CB circuit indicates when the data set is prepared to transmit data. The ON condition is a response to the ON condition on circuit CA delayed 200 ± 20 milliseconds. When circuit CA is turned OFF, circuit CB is also turned OFF.

Since the "remote" interface arrangement relies on digital data signals to indicate when a communication channel has been established through the display data set to a PICTUREPHONE user, this circuit either can be ignored or can be treated solely as an indication that the data set has responded to a change in the condition of circuit CA.

- g) CC - Data Set Ready: The CC circuit indicates that the local data set is ready to operate.

The OFF condition indicates an abnormal or test condition which disables or impairs the service furnished. The ON condition appears at all other times.

This circuit indicates the status of the local data set. The ON condition should not be interpreted either as an indication that a communication channel has been established to a PICTUREPHONE station or as the status of the distant display data set.

- h) CD - Data Terminal Ready: The CD circuit in the Data Set 202D3 normally controls switching the data set to the communication channel. Since this is a private line arrangement there is no need for this function. Therefore, the computer need not provide circuit CD. However, if the computer does connect to this circuit, then it must hold the circuit ON to insure that the data set remains active. It should be noted that the CA circuit must also be ON to keep the data set in the Data Mode.
- i) CF - Received Line Signal Detector: This circuit indicates the presence of incoming carrier signal from the display data set location. The ON condition indicates that carrier signal is being received and has been received for at least 40 ± 10 milliseconds. When the incoming carrier signal is lost because the transmitting data set is turned OFF or because of a fault condition, the OFF condition follows after 15 milliseconds guard time delay.
- j) +P - Positive Power: For use with Telephone Company test equipment only.
- k) -P - Negative Power: For use with Telephone Company test equipment only.

Pin assignments are as follows:

<u>Pin #</u>	<u>Circuit</u>
1	AA
2	BA
3	BB
4	CA
5	CB
6	CC
7	AB
8	CF
9	+P
10	-P
11-19	-
20	CD
21-25	-

5. OPERATIONAL CHARACTERISTICS

5.1 General

This Section generally describes the operational aspects of computer access service with special emphasis on the required and optional interactions between the computer and the display data set. Both the "local" and the "remote" interface arrangements are covered in this one Section. Where different actions result or are required because of the particular arrangement employed, special note is made of the difference.

For discussion purposes, a transmission speed of 1200-baud is assumed throughout the following description. To correct for 2400-baud operations, the number of SYN characters used for time fill functions illustrated herein should be doubled.

5.2 Call Establishment

To place a call to the computer, a PICTUREPHONE user will dial a number associated with the display data set connected to the computer just as he would dial another PICTUREPHONE user. The manner in which this connection is established is a function of whether a "local" or "remote" interface arrangement is employed.

If the display data set is "local" to the computer, the display data set will indicate the incoming call to the computer by turning circuit CE (Ring Indicator) ON during the ringing intervals and OFF during the quiet intervals. The computer should then turn ON circuit CA or circuit CD (or both) if the call is to be answered. If the call is not to be answered, these circuits should be held in the OFF condition. Alternatively, by having turned ON circuit CA or circuit CD (or both) previously, the computer could have conditioned the display data set to automatically answer an incoming call. Because in this arrangement, the display data set holds circuits CB, CC and CF in the ON condition as long as there is power supplied, the computer cannot utilize circuit CB to indicate when a working connection has been established between the display data set and the calling PICTUREPHONE user. For this service, this indication will be the transmission of the ENQ character (followed by an ETX character) from the display data set to the computer on circuit BB. This indication is generated only once. The display data set can only go off-hook during a ringing interval. Therefore, the ENQ can be expected within five seconds from the time that circuit CA or circuit CD (or both) is turned ON in response to a signal on circuit CE. Hence, in cases where answer control is exercised (CD turned ON in response to ringing) the computer can institute a timeout function to protect against an undetected ENQ character or a false ringing situation.

If the display data set is "remote" from the computer, the computer must hold circuit CA in the ON condition in order to condition the distant display data set to answer incoming calls. In the "remote" arrangement, the computer is not informed of impending incoming calls as in the case of the "local" arrangement. There is no active CE circuit in the "remote" interface arrangement. Thus, once the computer turns ON circuit CA to condition

the distant display data set to answer, the receipt of the ENQ character (followed by an ETX character) from the display data set is the only indication that a working connection has been established between the display data set and a calling PICTUREPHONE user. Because the voiceband data link between the computer and the display data set is vulnerable to noise and hits, it is possible that ENQ or ETX characters may be received as invalid characters. To help protect against this situation, it is recommended that the computer treat any signal (valid or not) received while circuit CA is held in the ON condition as an indication of an incoming call. If the signal was a valid one, then the PICTUREPHONE user can be expected to generate an input. This would then prove that the proper choice was made. On the other hand, if the signal detected had been invalid, there will be no user interaction, and the computer can exercise a time-out function, send the sequence RS SYN SYN SYN to erase the display data set memory and return the system to the normal idle condition.

As stated above, in both the "local" and "remote" arrangements, the receipt of the ENQ character serves to indicate that a PICTUREPHONE user is requesting service. The computer should respond to the ENQ character by sending a "Hello" message that will serve as the initial display to the calling station. To insure that only desired information is displayed, it is recommended that the computer always send the sequence RS SYN SYN SYN as a preamble to each display. Then each display message will start on a blank screen.

To serve both the functions of identifying the calling party and verifying that a proper connection has been established, it is recommended that the "Hello" message include a request for a response from the user. An example of such a response might be the user's telephone number or a specifically assigned numerical password.

5.3 TOUCH-TONE Mode

Once the call has been established, the user and display data set are operating in the TOUCH-TONE Mode. The user keys in requests using his TOUCH-TONE pad, the display data set translates from TOUCH-TONE to ASCII and transmits the ASCII information to the computer. The computer, in turn, transmits ASCII to the display data set where it is transformed into video format and displayed on the PICTUREPHONE station screen. This type of interaction may continue for as long as the PICTUREPHONE user wishes or the computer discipline will allow.

There are no restrictions or requirements imposed by the display data set concerning the format or the length of the TOUCH-TONE inputs employed. However, the display data set will send an ETX character to the computer after every TOUCH-TONE input that it translates into ASCII.

In the TOUCH-TONE Mode of operation, the only valid characters that the PICTUREPHONE user can generate are 0-9, * and #. The ASCII equivalents of these characters are the only inputs (besides ETX) that the computer should expect from the display data set during the TOUCH-TONE Mode of operation.

In order to insure an orderly operation, it would be highly desirable if the computer is arranged to either operate in a full-duplex mode (i.e., accept input characters from the display data set while it is outputting to the display data set), or include in each display transmitted some definitive end-of-display symbology so administrative rules can be established as to when the user can send. The PICTUREPHONE user then would either be completely unconfined as to when input requests can be initiated or, at least, be informed as to when the next input can be made. Experience has shown that, on occasion an anxious user can initiate a request for a second file before the first file has been completely drawn. Such a situation can easily arise when a listing of available files is requested and the first item displayed satisfies the request. An experienced user can easily key in a new request code before the entire display has been drawn. The display data set, being capable of two-way simultaneous operation, will pass this new request forward to the computer at the same time that it is accepting information from the computer. Thus, if the computer is unable to accept an input while it is outputting, or if there have been no system administrative rules established pertaining to when the user may initiate requests, such user requests will effectively be lost and not honored by the system. It is true that after a period of waiting the user will generally reinitiate the request, but if this situation happens very often, his opinion of the system and service provided will undoubtedly suffer.

5.4 Data Mode

The display data set can be optionally arranged to support a mode of operation with the PICTUREPHONE user where a low-speed (110-baud) data terminal device can replace the TOUCH-TONE dial as the user input device. The display data set includes a low-speed, serial, frequency shift-keying (FSK) data set (Data Set 108A1) that can be activated under control of the computer to operate with a compatible data set and terminal device that has been coupled to the PICTUREPHONE station.

To establish the Data Mode, the user would generate an input request that would be interpreted by the computer as a request to go to the Data Mode. (The matter of choosing what this input request should be is a system dependent function.) The computer should then send the ASCII character DC1 to the display data set. The display data set will assume the Data Mode and will enable the Data Set 108A1, cause it to send F₂ marking carrier toward the PICTUREPHONE station, and start a 10-second timer. If return carrier is received from the PICTUREPHONE user before the end of the 10-second period, the display data set will remain in the Data Mode and will send DC1 (followed by ETX) to the computer. If return carrier is not received within 10 seconds, the display data set will revert to the normal TOUCH-TONE mode and will inform the computer by sending DC3 (followed by ETX).

In the Data Mode, the PICTUREPHONE user has a greatly extended input and control capability. Instead of being restricted to twelve input characters, he now has the repertoire of the terminal device employed. The computer should be arranged to accept and honor an extended code capability that includes all of the ASCII characters that are capable of being generated by the terminal device used. As in the case of the TOUCH-TONE mode, every input character generated by the user will be followed by an ETX character that is provided by the display data set.

To return to the TOUCH-TONE Mode from the Data Mode, it is recommended that the PICTUREPHONE user inform the computer of this impending action before breaking the data set connection at the PICTUREPHONE station. This will allow the computer to guard against reacting to false characters that may be received while awaiting the indication that the display data set is back in the TOUCH-TONE Mode. The Data Set 108A1 in the display data set will detect a loss of carrier when the data set connection is broken and will revert to the TOUCH-TONE Mode automatically, sending a DC3 character (followed by ETX) to the computer to indicate the change in input state. When the computer detects the DC3 character, it should return to the TOUCH-TONE Mode where it need only honor the restricted input capability of the TOUCH-TONE dial.

5.5 Edit Mode

The Edit Mode provides the PICTUREPHONE user with a very convenient file editing or file generating tool. The display data set incorporates a local mode of operation that allows an authorized user to enter information directly into the display storage in the display data set without involving the computer.

To enter the Edit Mode, the user must first establish the Data Mode (see Section 5.4 - Data Mode). The user must then request the particular file that he wishes to edit or update. The computer should honor the request and transmit that file to the display data set. The user will then input a code (to be defined by the computer) requesting the use of the Edit Mode. The computer, in turn, may then verify that this user has clearance to edit this particular file. If the user's request is valid, the computer should send the character SUB to the display data set. The display data set will then assume the Edit Mode, enable the cursor (see Section 5.6 - Cursor Control), and on the computer side, connect its output to its input so that the user may access the memory of the display data set directly. The data path from the display data set to the computer is effectively inactive during the Edit Mode of operation. However, the data path from the computer to the display data set remains active so that the computer is able, if necessary, to interrupt an edit operation for the purpose of displaying an emergency-type message.

When the user is finished editing the file, he will input the character DC2. The display data set detects this character as a request to revert to the Data Mode. The display data set will send a DC2 character (followed by ETX) to the computer to indicate that the Edit Mode is being terminated and will automatically reestablish the Data Mode. The user may then input to the computer from his data device to affect the next step in their interaction.

If the PICTUREPHONE user should terminate the edit operation by breaking the data set connection at the PICTUREPHONE station, the display data set will automatically revert to the TOUCH-TONE Mode (as described in Section 5.4 - Data Mode) and will send the DC3 character (followed by ETX) to the computer. As explained in Section 5.4, it is being recommended that the PICTUREPHONE user inform the computer when he is planning to return to the TOUCH-TONE Mode. Thus, depending on the character received, the computer

will know whether the user is operating in the Data Mode or the TOUCH-TONE Mode when the Edit Mode is terminated.

5.6 Cursor Controls

When the system is put into the Edit Mode by the computer, the display data set, in addition to the functions listed earlier, enables a visible cursor for the user's use. (The cursor is a blinking underline that is movable to any character position on the screen.) The ASCII characters that are used to control the cursor are listed in Section 3.1 - Code. The cursor is non-destructive and can be directed to any position on the screen subject to the timing considerations given in Section 3.6.1 - Display Control Functions.

The PICTUREPHONE user can use the cursor controls during the course of editing a display. However, the display data set does not store the cursor control characters themselves. Therefore, updated and edited files that are returned to the computer for refile at some later time (see Section 5.7 - Dump to Computer) will not contain cursor control functions.

The computer can also utilize the available cursor controls when generating displays for PICTUREPHONE users. Although no visible cursor need appear on the PICTUREPHONE screen, the use of such controls can simplify the display generation process. Selective overwriting or adding-on when interacting with a PICTUREPHONE user becomes easier because it is not necessary to generate a completely new display each time a change or addition is called for during the interaction. However, the timing restrictions associated with certain of the cursor controls (see Section 3.6.1 - Display Control Functions) must be followed. For instance, if a series of four cursor controls are required (e.g., move down four lines) then each FF character used to move the cursor down one line must be followed by the specified number of SYN characters (or equivalent idle time) as required for the particular transmission speed.

5.7 Dump to Computer

If the Edit Mode is used for the purpose of updating files for the computer, then some way is required for the updated or corrected information to be returned to the computer. The display data set includes the ability to dump (send) the display that it has stored to the computer upon request from the computer. What tells the computer to perform this function is a system dependent function. For instance, it can be automatically linked to the termination of the Edit Mode, or it can be instituted by the user under separate control.

To request a dump of the display storage, the computer should send the DC2 character. Receipt of this character from the computer will cause the display data set to time for 105 ± 30 milliseconds before sending the entire contents of its message storage to the computer while still retaining the display for the user. The pause is provided to insure that half-duplex computer ports have time to turn around and accept the incoming data.

The transmission will consist of 485 characters - the 484 characters that constitute the display (from top left to bottom right on the PICTUREPHONE screen) and one ETX character to define the end of the message burst. Spaces in a display that are blank from a previous clear screen function will be represented by DELETES in the dump. Those blanks introduced by the PICTUREPHONE user during an editing operation will be represented by the particular character employed to effect the spacing function. Thus, the computer should be arranged to accept any of those characters that are listed in Section 3.1 - Code as being nonaction, nondisplayable "spacing" characters as valid "blank" characters (subject to system disciplines established between PICTUREPHONE users and computer service provider).

The computer should check to see that a dump received from the display data set does not include any of the cursor control characters (RS, BS, HT, VT, FF, LF, SYN) or any of the mode control action characters (ENQ, ETX, EOT, DC1, DC2, DC3, and SUB). Because of the way the display data set is designed, these characters could not have been in the display storage. Consequently, if they are received, they are the result of an error situation. Therefore, the computer should reject any display received from a display data set that incorporates any of these characters. When such irregularities are observed, the computer can reinitiate the "dump" command once the entire transmission has been received.

When a correct updated file has been stored away, the computer can inform the PICTUREPHONE user by sending a new display that lists the various choices open to the user at this time. If the user wishes to repeat the edit process for another file, then the procedures described above in Sections 5.4 and 5.5 would be repeated.

Files that are entered into computer storage by other means (e.g., batch processing) can include cursor controls in their format. Such controls may be employed in files for the purpose of conserving computer storage space or for the purpose of speeding up the writing of the display on the PICTUREPHONE screen. However, once such a file is edited by a PICTUREPHONE user and refiled in the computer using the display data set dump feature, the cursor control information is gone. A full 484-character display format must then be accommodated by the computer.

Any file that is transmitted to a display data set, whether an edited file or an original file, should be screened to see that it does not include any of the mode control action characters DC1, DC2, or SUB. Upon receipt of any of these characters, the display data set will attempt to perform the associated action. This will generally lead to a system trouble situation.

5.8 Call Termination

Calls may be terminated either by the computer initiating a disconnect action or, under certain circumstances, by the display data set detecting a line signal condition that indicates that the PICTUREPHONE user has gone on-hook. This latter case actually covers two possibilities - detection of loss of video sync signal from the distant PICTUREPHONE station or detection of central office supervision indicating that the calling party has gone on-hook.

Although the display data set is designed to react to central office supervision as a valid disconnect signal, the variance that exists in this supervisory signal in the telephone plant makes detection of it unreliable as far as the display data set is concerned. Also, the time between when the PICTUREPHONE user initiates this action (goes on-hook) and when the supervisory signal is propagated to the display data set can be the order of ten's of seconds. Therefore, this means of disconnecting is not recommended for standard use.

Disconnect upon detection of a loss of video sync signal from the connected PICTUREPHONE station is an available option in the display data set. This signal is always transmitted by a distant PICTUREPHONE station and so can be utilized as a positive indication of when the video path from the display data set to the PICTUREPHONE station has been terminated. However, the use of this option has certain drawbacks. It disallows the type of operation where the PICTUREPHONE user can place the display data set on HOLD while he answers another call, or where the connection to the display data set is originally set up by his secretary using a telephone set without video capability. Also, this option cannot be used with some Key Telephone systems.

In general, it is strongly recommended that a system discipline be established, whenever possible, where the computer initiates the disconnect of the display data set independent of the PICTUREPHONE user. This will generally require that the user indicate when the desired interaction with the computer is over. In some instances, the designation of a system disconnect code may satisfy this function. However, it may be difficult to convince users to perform such a function when all he needs to do from his standpoint is go on-hook. Therefore, it may be necessary to provide the user with some useful system function that can, by system definition, be requested only as the final display of the interaction. Such a display, when requested, would be displayed for a specified period of time (long enough for the user to ingest it) before the disconnect action would commence. How successful such an approach would be would undoubtedly be a direct measure of the usefulness of this final display to the user.

The actual manner in which the computer initiates a disconnect action is a function of whether a "local" or "remote" interface arrangement is employed.

If the display data set is "local" to the computer, the computer should turn OFF circuit CA or circuit CD (or both) to cause a disconnect of the PICTUREPHONE circuit. The display data set will then go on-hook and will send an EOT character (followed by ETX) to the computer over the BB circuit. The computer should treat the BB circuit as an active circuit until the EOT character is received. It is recommended that the computer hold circuit CA or circuit CD (or both) in the OFF condition until the EOT character is received to insure that the disconnect signal is detected.

If the display data set is "remote" from the computer, the computer should turn OFF circuit CA in the Data Set 202D3 interface to turn carrier OFF toward the remote Data Set 202D3 at the display data set location. The display data set will interpret this loss of carrier condition as a disconnect signal. The display data set will then go on-hook and send an ~~EOT~~ character (followed by ETX) to the computer. The computer should detect

the EOT character as an indication that disconnect has occurred. It is recommended that the computer hold circuit CA in the OFF condition until the EOT character is received to insure that the disconnect signal is detected. Once the EOT character has been received, the computer may turn ON circuit CA to permit answering of the next incoming call.

In those cases when disconnect occurs as a result of either the detection of a loss of video sync signal or the detection of central office supervision, the display data set will also send an EOT character (followed by ETX) to signify the disconnect action.

5.9 Clear Screen on Hang-Up (Option)

The call termination procedures described above leave the contents of the display data set message storage undisturbed when disconnect takes place. Thus, the next caller will probably see this last display before the "Hello" message could overwrite it. To overcome this situation, an option is provided in the display data set that will automatically erase the information stored in the display data set and clear the screen when the EOT character is sent to the computer. Implementation of this option in the display data set will insure that the last display of one user is not displayed, even momentarily, to the next user.

This option does not, however, disable the visible cursor if it should happen to be on at the time of call termination. The computer would have to send a DC2 character to the display data set to disable the visible cursor.

6. PHYSICAL CHARACTERISTICS

A display data set arrangement consists of two physical equipment entities, a standard Data Set 403E2 and a cabinet containing the remaining display data set logic and circuits. The Data Set 403E2 measures 11 inches high and 12 x 24 inches at the base. The other cabinet measures 30 inches high and 17 x 24 inches at the base. Normally, the Data Set 403E2 is mounted on top of the other equipment cabinet, as shown in Figure 6. The combined weight of these two units is approximately 166 pounds.

The power requirement for a display data set arrangement is approximately 250 watts of $117 \text{ v} \pm 10$ percent, $60 \text{ Hz} \pm 0.75$ percent AC power. Two standard, grounded receptacles that are fused separately from other services are required. These power sources should be of the uninterrupted type since momentary interruptions will affect calls in progress.

The display data set will operate properly in an ambient temperature between 40°F and 120°F and a relative humidity between 20 and 95 percent.

When the display data set is located remote from the computer, Data Sets 202D3 are employed to provide a 4-wire voiceband data link to connect the display data set to the computer. Consequently, at the display data set site, a Data Set 202D3 4-wire installation will be added to the above display data set arrangement. At the computer site then there will be only the Data Set 202D3 4-wire installation.

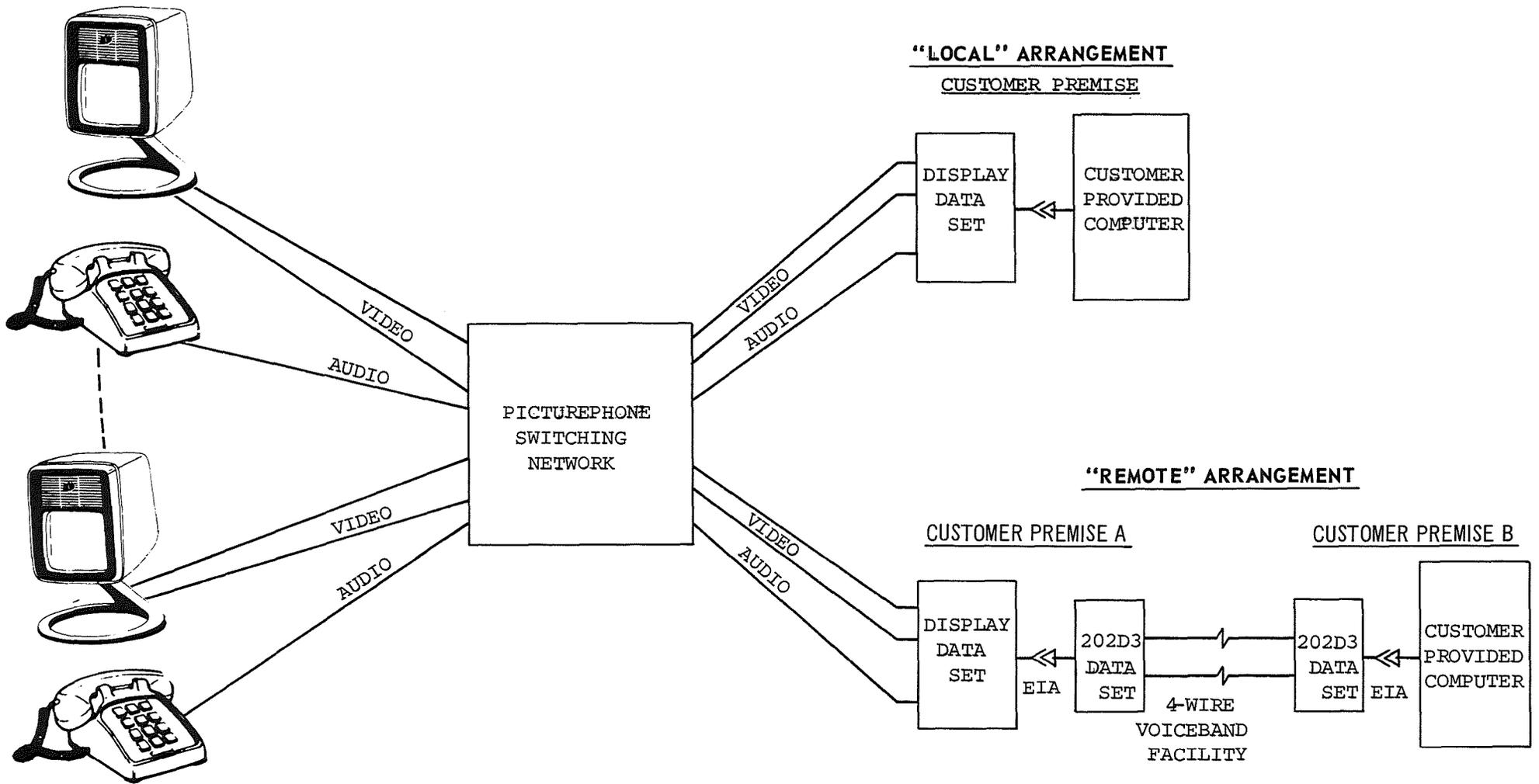
A Data Set 202D3 measures 5-1/2 inches high and 10 x 11 inches at the base. It weighs approximately 14 pounds and will operate satisfactorily over a temperature range of 50°F to 120°F and a relative humidity range of 20 to 95 percent. It requires its own electrical outlet (standard, grounded receptacle) capable of providing 11 watts of 117 v \pm 10 percent, 60 Hz \pm 0.75 percent AC power.

7. TESTING AND MAINTENANCE CONSIDERATIONS

A manually operated test feature is provided with the display data set that permits the output of the set to be connected to the input of the set so dynamic loop-around tests of the unit can be made remotely from a test desk location. Normally, the customer will be requested to operate this test feature, when required, to facilitate trouble isolation within the system. However, when necessary, Telephone Company personnel will be dispatched to perform this function.

Operation of the test feature opens up both circuit BA and circuit BB of the display data set and leaves them in an open-circuited condition. The control circuits to and from the display data set, however, are unaffected. The display data set is also conditioned to automatically answer an incoming call.

If the display data set is "Local" to the computer, the computer must be arranged to accept an open circuit on circuit BB. On the other hand, if the display data set is "remote" from the computer, the Data Sets 202D3 used in the voiceband data link will normally provide a steady marking condition toward the computer even when circuit BB in the display data set is open circuited. When the test feature is operated, the display data set does not send an ENQ character to the computer when the incoming call is answered.



TYPICAL PICTUREPHONE SWITCHING SYSTEM ILLUSTRATING
 "LOCAL" AND "REMOTE" DISPLAY DATA SET ARRANGEMENTS

FIGURE 1

AMERICAN NATIONAL STANDARD
 CODE FOR INFORMATION INTERCHANGE
 ANS X3.4 - 1968

Bits					0	0	0	0	1	1	1	1			
					0	0	1	1	0	0	1	1			
b ₇	b ₆	b ₅	b ₄	b ₃	b ₂	b ₁	Column	0	1	2	3	4	5	6	7
					0	1	2	3	4	5	6	7			
					0	1	2	3	4	5	6	7			
0	0	0	0	0	0	0	0	NUL	DLE	SP	0	@	P	\	p
0	0	0	1	1	1	1	1	SOH	DC1	!	1	A	Q	a	q
0	0	1	0	2	2	2	2	STX	DC2	"	2	B	R	b	r
0	0	1	1	3	3	3	3	ETX	DC3	#	3	C	S	c	s
0	1	0	0	4	4	4	4	EOT	DC4	\$	4	D	T	d	t
0	1	0	1	5	5	5	5	ENQ	NAK	%	5	E	U	e	u
0	1	1	0	6	6	6	6	ACK	SYN	&	6	F	V	f	v
0	1	1	1	7	7	7	7	BEL	ETB	/	7	G	W	g	w
1	0	0	0	8	8	8	8	BS	CAN	(	8	H	X	h	x
1	0	0	1	9	9	9	9	HT	EM	)	9	I	Y	i	y
1	0	1	0	10	10	10	10	LF	SUB	*	:	J	Z	j	z
1	0	1	1	11	11	11	11	VT	ESC	+	;	K	[	K	{
1	1	0	0	12	12	12	12	FF	FS	,	<	L	\	l	|
1	1	0	1	13	13	13	13	CR	GS	-	=	M	]	m	}
1	1	1	0	14	14	14	14	SO	RS	.	>	N	^	n	~
1	1	1	1	15	15	15	15	SI	US	/	?	O	-	o	DEL

FIGURE 3

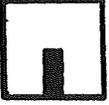
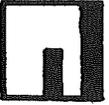
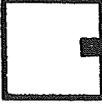
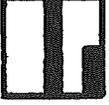
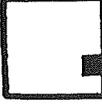
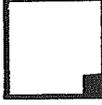
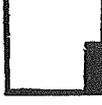
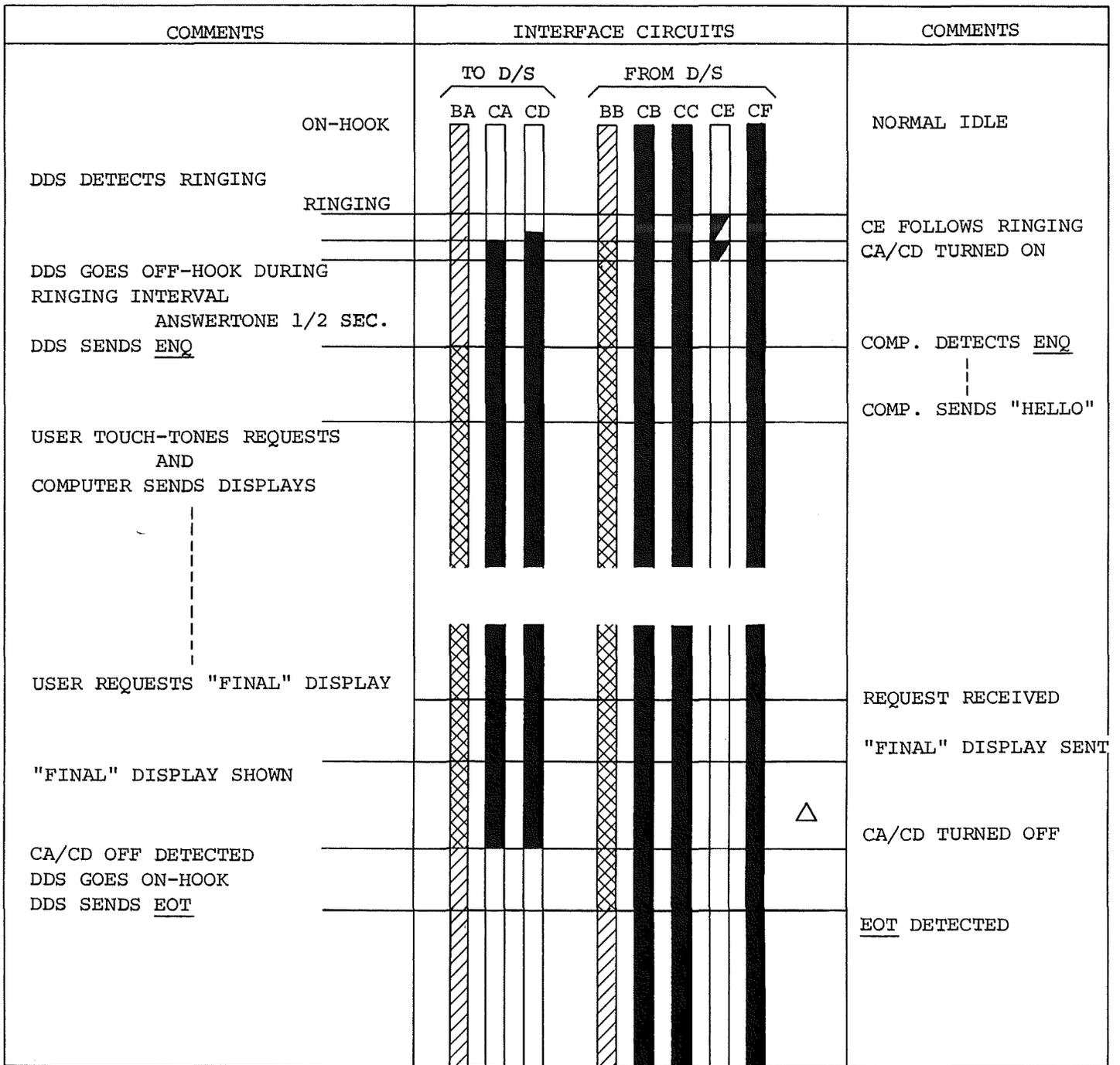
<u>ASCII Code</u>	<u>Graphic Symbol</u>	<u>ASCII Code</u>	<u>Graphic Symbol</u>
		h	
a		i	
b		j	
c		k	
d		l	
e		m	
f		n	
g		o	

FIGURE 4 - Special Graphic Characters



- MARKING (ON)
- SPACE (OFF)
- ⊠ DATA IS TRANSMITTED AND RECEIVED
- ▨ MARK HOLD
- △ COMPUTER TIMED INTERVAL

**"LOCAL" INTERFACE SEQUENCE OF EVENTS DURING
CALL ESTABLISHMENT & CALL TERMINATION**

FIGURE 5

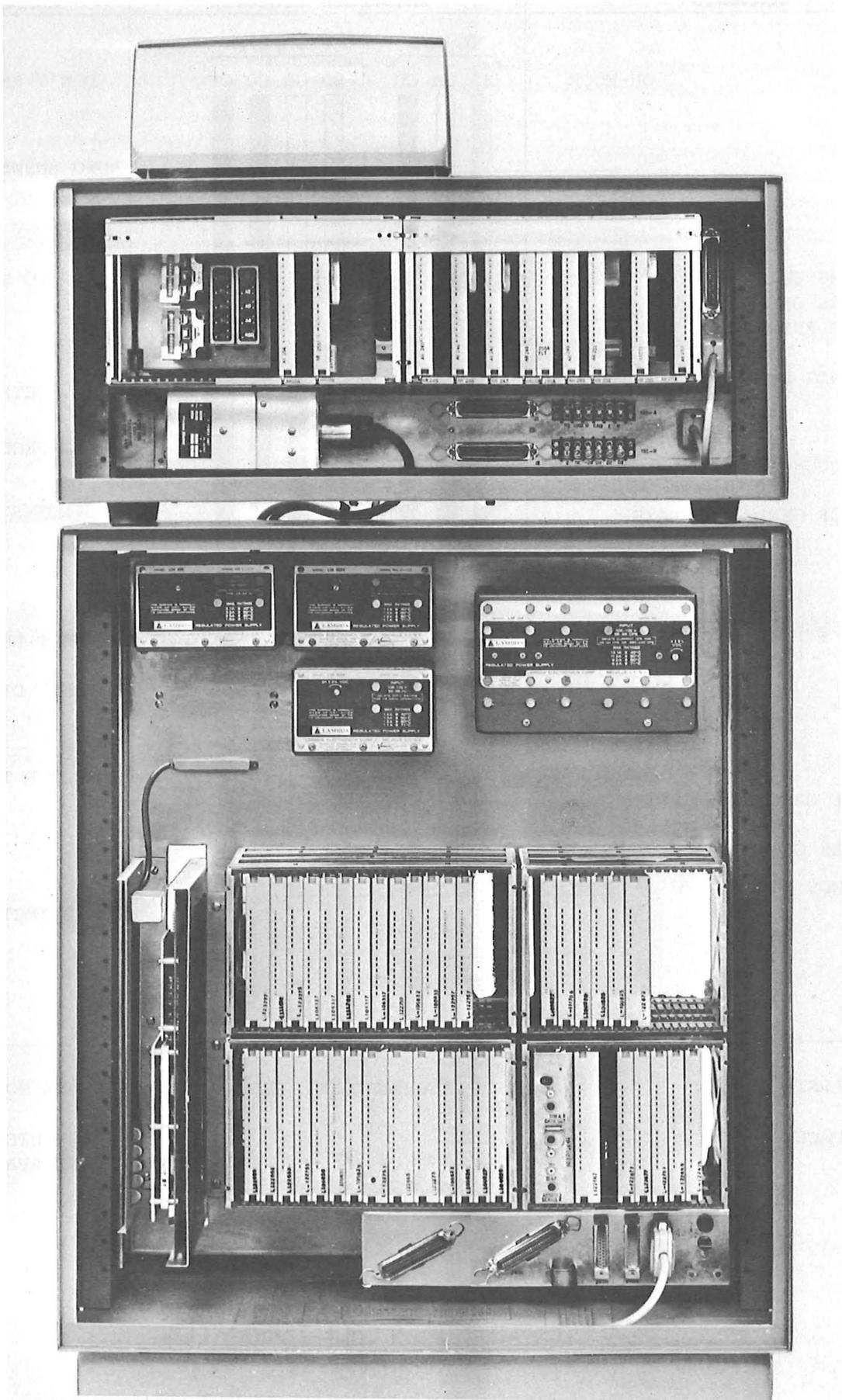


FIGURE 7 - EQUIPMENT CONFIGURATION FOR DISPLAY DATA SET ARRANGEMENT

PROCEDURES FOR OBTAINING COPIES OF REFERENCED ARTICLES

AND

ADDITIONAL COPIES OF TECHNICAL REFERENCES

- I. Bell System Technical Journals (BSTJ), Institute of Electrical and Electronics Engineers (IEEE), American Institute of Electrical Engineers (AIEE) and most other material from technical journals may be ordered from:

Engineering Societies Library
345 East 47th Street
New York, New York 10017

- II. Bell Telephone Laboratories, Inc., "Transmission Systems for Communications," Fourth Edition; and additional Technical References may be obtained in the following manner:

A. IN THE UNITED STATES

1. Bell System Organizations may order these publications using Form SD-1.80.80 and address it to:

Western Electric Company, Incorporated
Indiana Publication Center
P.O. Box 26205
Indianapolis, Indiana 46226

Order as follows:

(Quantity) - Book - Transmission Systems for Communications, Fourth Edition

(Quantity) - Technical Reference - (Complete Title)

2. Departments of the U.S. Government may purchase these publications from:

Western Electric Company, Incorporated
Defense Activities
Manager - Government Communications Contracting
83 Maiden Lane
New York, New York 10038

3. All other companies in the United States (non-Bell System) may purchase these publications from their nearest Graybar Electric Company, Incorporated.

Should there be any difficulty in obtaining any of these publications from the Graybar Electric Company, please contact:

Western Electric Company, Incorporated
Technical Information and Sales Policy Administration Department
53 Halsey Street
Newark, New Jersey 07102
Telephone: 201 565-6146

B. IN CANADA

1. Bell Canada and all other companies may obtain "Transmission Systems for Communications," Fourth Edition, from:

Northern Electric Company
121 Shearer Street
P.O. Box 6124
Montreal, Quebec

2. Technical References may be obtained from:

Bell Canada
Staff Engineer - Data Equipment Design
1050 Beaver Hall Hill
Montreal, Quebec

C. IN ALL COUNTRIES OUTSIDE THE UNITED STATES AND CANADA

These publications may be obtained from:

Western Electric Company, Incorporated
Director of Patent Licensing International
195 Broadway
New York, New York 10007
U.S.A.