PUB41804

Bell System

TECHNICAL REFERENCE

Switched Network Transaction Telephone System Interfacing With Audio Response Units

July 1976

326-576

Bell System Data Communications

TECHNICAL REFERENCE

●

Switched Network Transaction Telephone System Interfacing With Audio Response Units

●

JULY 1976

Director - Data and Special 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 ANSI, 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 herein. Liability for difficulties arising from technical limitations is disclaimed.

If further information is required, please contact:

Director — Data and Special Services
American Telephone and Telegraph Company
295 North Maple Avenue
Basking Ridge, New Jersey 07920

TABLE OF CONTENTS

TABLE OF CONTENTS (Cont'd)

TABLE OF CONTENTS (Cont'd)

LIST OF TABLES

LIST OF FIGURES

LIST OF FIGURES (Cont'd)

1. INTRODUCTION

The Transaction telephone system is a short message inquiry/response system, connecting Transaction telephones to a customer's computer center via the switched telecommunications network. It provides a service in which inquiries are sent as TOUCH-TONE signals, and responses are returned as voice or data messages. The Transaction telephones are designed to serve as the user's main station telephone and to automate the short message, inquiry/response procedures which many users are now performing with less sophisticated telephones.

The users of this system include the financial industry, (including credit checking, check cashing and verification, and teller inquiry), those having inventory control applications for industry, hospitals, and airlines, and others utilizing the short message, inquiry/response format.

The Transaction telephone system provides the potential user with a choice of two distinct modes of operation. The first of these, Audio Response, utilizes either or both of the two generations of Transaction telephones, designated Transaction I and Transaction II. Communication with the customer computer is via an Audio Response Unit at the computer center. This is the system application discussed in this Technical Reference. The second mode of operation entails serial baseband data response, and will be covered in detail in another Bell System publication (PUB 41805 entitled *Transaction Telephone System Interfacing With Transmission Control Units).*

A transaction using the Audio Response system begins with a user lifting the handset on his Transaction I telephone and inserting two magnetic striped cards in the card reader. (Alternatively, when using the Transaction II telephone, the user can press the ON button, then insert the two cards.) One card contains information for addressing the desired data center; the second card is typically a customer's card. While the Transaction telephone automatically calls the data center and transmits the buffered data, the user keys in additional data, such as the amount of the transaction. The data center responds to this inquiry via a voice transmission or by causing response lamps on the Transaction telephone to light via tone or FSK signals. In addition, data can be sent using FSK signals to the Transaction II telephone for visual alphabetic character display.

1.1 Scope of this Document

This Technical Reference covers the operation of the Transaction telephone system. Specifically, the operation of the system at three interfaces is defined. They are the interfaces between the customer computer and the telephone company equipment, between the telephone line and the Transaction telephone, and between the Transaction telephone and the user. Additional telephone company equipment at the computer location, including automatic call distributors to concentrate and distribute calls, and CALL DIRECTORs are discussed. The functions and operation of both the Transaction I and Transaction II telephones are described in detail.

This Technical Reference defines all the operational characteristics of the Transaction telephone system interfacing with audio response units. Any characteristics of individual components not defined herein are subject to change and should not be presumed.

1.2 Use of this Document

This Technical Reference is of use to the system designers who will program the data center computer which interfaces with the Transaction telephone system. It is intended to provide sufficient information to generate all programming necessary for call control, message interpretation, and audio response for this system.

In addition, this reference is of value to the data center operations manager in that it describes in detail the size, amount, location, and operation of telephone company equipment located at the data center. It is valuable to potential Transaction telephone users, since it defines the operational characteristics of the telephones which they will operate.

credit card manufacturers and Bell System personnel will find this reference helpful as well.

1.3 Conventions

In order to clarify the operation of the Transaction telephone system, it is necessary to define the relationship among the alphabets utilized by the various parts of the system. For example, part of the transmitted data is a translation of data encoded on the magnetic striped cards used in the operation of the Transaction telephone into a TOUCH-TONE alphabet.

Data is transmitted in TOUCH-TONE form, using the digits 0 through 9, plus the special characters *, #, a, b, c, and d. Figure 1 shows the matrix which defines the TOUCH-TONE frequency components of the sixteen characters described above. TOUCH-TONE characters containing the B_4 frequency (shown in Figure 1) will always be represented as lower-case letters in this reference. Magnetic card information, on the other hand, is defined in a hexadecimal format. The characters are digits 0 through 9, A, B, C, D, E, and F. In this document, whenever reference is made to data transmitted from the Transaction telephone, the TOUCH-TONE characters will be used. Likewise, whenever reference is made to magnetic card data, the hexadecimal characters will be used. For a complete table of the relationships among all the codings, decimal, hexadecimal and TOUCH-TONE, used in this reference, refer to Table 1. Table 1 also shows special character sequences and their relation to the three buttons above the number pad on the face of the Transaction telephone.

Information is transferred from the data center to the Transaction telephone in voice or keyed answer tone (2025 Hz). In addition, the Transaction II telephone is capable of receiving FSK data. Data transmitted in this manner to the Transaction II telephone utilizes the American Standard Code for Information Interchange (ASCII) alphabet, with even parity, and start and stop bits. Transmission is asynchronous with a marking frequency of 2225 Hz and a spacing frequency of 2025 Hz.

Throughout this document, whenever it is necessary to clarify the operation of the system by the use of an example, the example of credit verification or check authorization will be used. Accordingly, the computer location will be called the data center. The Transaction telephone location will be called the merchant premises, and the telephone user will be called the merchant. Two magnetic cards are used in a typical transaction. The first is called the "dialing" card. The second is called the "customer" card.

1.4 References

There are other Bell System documents which describe in greater detail some of the components of the system. Some other references are:

1. Bell System Technical Reference — Data Set 407 Interface Specification (PUB 41408)
2. Bell System Brochure — 2B Automatic Call Distributor How-to-Operate Manuals #99-500-100, #99-500-101
3. Bell System Technical Reference — Data Communications Using the Switched Telecommunications Network (PUB 41005)
4. Subscriber Instruction Booklet SIB-2459B — How to Use the Transaction I Telephone
5. Subscriber Instruction Booklet SIB-2482C — How to Use the Transaction II Telephone
6. Subscriber Instruction Brochure #2473 — CALL DIRECTOR
7. Bell System Brochure — 999-100-140 — How to Use the 407-Type Data Set.

For further information contact your local Telephone Company business office.

2. SYSTEM CONFIGURATION

Figures 2A and 2B show the system configurations for the Transaction telephone system. The two systems differ in the equipment which provides for referral to a human operator. Referral capability is

recommended, although it is provided on an optional basis in this system. The Transaction telephones shown in the Figures may be Transaction I or Transaction II telephones, or both.

2.1 Telephone Company Provided Equipment

The telephone company provided equipment for the Transaction telephone system can be broken down into three categories: Transaction telephone, communication channel, and data handling equipment at the data center.

a. The Transaction telephone set is used in this system to make inquiries of, and receive responses from, a remotely located computer. The set is located at the merchant's premises.

b. The communication channel for this system is the voice telecommunications network.

c. Telephone company provided equipment at the data center includes the equipment necessary to provide referral switching, and the 407B Data Station.

The two forms of referral switching are shown functionally in Figures 2A and 2B. Utilization of these arrangements allows a call to be transferred from the computer to an attendant, to permit the Transaction telephone user (merchant) to talk with an attendant in certain situations.

Figure 2A shows the system with CALL DIRECTORs or other key telephones as the referral equipment. Note that there are equal numbers of input trunks and data sets. During referrals the attendant positions are bridged onto the incoming line by connections in the data sets.

Figure 2B shows the system with an Automatic Call Distributor (ACD) as the referral equipment. In this arrangement, call concentration is provided, thus reducing the required number of data sets by placing overflow calls in a queue. The attendants in this case are connected to referred calls by circuitry in the ACD.

The 407B Data Station is a multiple installation of data sets, one per computer port, each of which decodes a transmitted TOUCH-TONE signal into a 2-out-of-8 code for presentation to the Audio Response Unit (ARU). It provides the interface between the network and the customer's ARU.

Note: The system will also function with other compatible TOUCH-TONE receiving equipment, including 407A data sets. However, not all system features described herein are available with these alternative data sets. The answer tone duration of the Bell System 403-type data set is not adequate to assure activation of the Transaction telephone.

2.2 Customer Provided Equipment

The customer provided equipment for this system is located at the data center. As shown in Figure 2A and 2B, the 407B interfaces with an Audio Response Unit (ARU). In this context, ARU refers to any Automatic Voice Answer (AVA) equipment capable of generating voice and/or tone and/or FSK responses to the Transaction telephone. The interface between the 407B data sets and the ARU is covered in Section 4.2.

Overall control of system operation is done by the data center computer. The computer makes decisions based on the data received from the Transaction telephone and sends the appropriate response via the ARU. When referral is provided, the attendant positions usually have access to the computer as shown in Figure 2.

3. SYSTEM ELEMENTS

This section is intended to be a general description of each of the elements of the system. Complete operational characteristics are given in Section 4. In this section, each of the elements — the Transaction I and Transaction II telephones, the optional Auxiliary Manual Entry Pad, also known as the PIN (Personal Identification Number) pad, 407B Data Station, and referral equipment — will be discussed, with emphasis on its contributions to system operation.

3.1 Transaction Telephones

The Transaction I telephone is designed to provide efficient operation in short message, TOUCH-TONE inquiry/voice response applications. It provides a means of reading information from plastic cards with an encoded magnetic stripe, and a buffer for storing this information prior to transmission. Instruction lamps guide the telephone user through the transaction. In addition, means are provided for manual entry of data via a manual entry pad, and for transmission of data, in TOUCH-TONE form, to the data center. A tone decoder is included for reception of keyed answer tone signals.

Optionally, an Auxiliary Manual Entry Pad may be added for entry of customer Personal Identification Numbers (PINs). The PIN pad is described in greater detail in Section 3.1.3.

Other features include automatic dialing in dial pulse or TOUCH-TONE. The set can operate with key telephone systems and it can operate in an automatic dialing mode behind a PBX with two-part dialing when a second dial tone wait is required. It can also operate in a split mode, dialing the first part of a two-part number in dial pulse, the second in TOUCH-TONE, or vice-versa. For dial pulse service, button depressions on the manual entry pad are converted to dial pulses during dialing, but TOUCH-TONE is used after a call is completed to the data center.

The set provides response lamps (hereinafter called the green/yellow lamps) which can be activated by a special signal from the data center to indicate approval of transactions or the presence of a voice response. A "follow special instructions" lamp is also included, which tells the user to refer to instructions provided by the data center. This lamp, in conjunction with an optional automatic referral feature of the system, facilitates handling of transactions in a limited fashion when the data center computer is out of service.

Finally, the set provides basic telephone service. Manual dialing is via a TRIMLINE® handset provided with the telephone, or, optionally, using the manual entry pad. Appropriately encoded cards can be used to automatically dial telephone numbers.

®Registered Trademark of A.T.&T. Co.

The Transaction II telephone provides all the features of the Transaction I telephone, with the following added features:

1. The set has a data receiver for accepting and storing data sent from a remote data center.
2. It has a seven segment visual display with eight character positions for displaying both locally keyed data and data received from the data center.
3. It has on-and-off buttons and a call progress monitoring speaker, which allow the set to be used in a hands-free mode. The user need not lift the receiver for many applications.

3.1.1 Physical Description

Figure 3 is a picture of the Transaction I telephone. The set is 9¼ inches wide by 12 inches deep by 5¾ inches high. On top of the set at the rear is the card reader. On the face of the Transaction telephone is the manual entry pad. The button labeling differs from that found on a TOUCH-TONE telephone in that the (*) button is labeled by a (.) and the (#) button is replaced with a (/) button. The card reader, the manual entry pad, and an optional Auxiliary Manual Entry Pad are the ways of entering data into the Transaction telephone set.

Also on the face of the Transaction I telephone are a set of lamps and three additional buttons. The lamps and buttons are mounted above the manual entry pad. The lamps are functionally separated into three categories. The first category consists of the three instruction lamps. These lamps are lit in sequence to guide the user through a transaction. The second group of lamps are the green/yellow response lamps. These are lighted in response to answer tone signals from the data center. In the financial industry example, the green lamp might mean "credit approved" while the yellow lamp would mean "please listen for voice response." Finally, the "special instructions" lamp is provided on the faceplate of the Transaction I telephone for operation during computer down periods (see Section 5.4).

The three additional buttons mounted above the manual entry pad are labeled ATTN, END, and ERASE. The ATTN or "attention" button causes the TOUCH-TONE sequence "**" to be transmitted to the data center. Under certain conditions, this will cause a referral to occur. The ERASE button causes the erasure from the buffer of the entire block of data being entered. "Block of data" can be defined as all the data entered in response to a given instruction light on the face plate. If transmission of the block has already been started, depression of the ERASE button causes a TOUCH-TONE "bb" sequence to be transmitted to the data center. The END button signals the Transaction telephone that a block of data has been entered, and depending upon the particular entry, causes one of a variety of actions within the telephone (described in Section 7).

A TRIMLINE handset is incorporated so that the set can be used as a telephone when AC power fails, and the optional auxiliary manual entry pad is available, which allows for private entry of a personal identification number (PIN) into the Transaction telephone's buffer. The set is also compatible with key telephone service, utilizing a separate key strip.

Figure 4 shows the Transaction II telephone with the optional Auxiliary Manual Entry Pad. In addition to the Transaction I features, the visual display and the on-and-off buttons are visible. The call progress tone sounder is mounted under the handset cradle. On the right hand side of the set is the volume control for the tone sounder. The green/yellow response lamps on this set can be lighted in response to answer tone or FSK signals from the data center. The "special instructions" lamp on the Transaction I telephone is not provided on the Transaction II telephone. This function is performed by the visual display, and the 4th instruction lamp is lighted whenever a call is in progress.

3.1.2 Environmental Specifications

The Transaction telephones have been designed to operate in the temperature range of 50°F to 120°F. Storage temperature range is -40°F to 150°F. The telephone will operate over a relative humidity range of 20 percent to 95 percent at 75° F. The sets operate on a 117 VAC ±10 percent, 60 Hz ±5 percent non-switched power source, connected via a three-prong plug at the end of a six-foot power cord.

The Transaction I telephone dissipates a maximum of 16 watts of power and Transaction II telephone dissipates a maximum of 22 watts.

3.1.3 Auxiliary Manual Entry Pad (PIN pad)

An Auxiliary Manual Entry Pad is available as an option for both the Transaction I and Transaction II telephones. This pad is intended primarily for entry of Personal Identification Numbers and is therefore called the PIN pad. The PIN pad is equipped with 12 buttons configured as a standard TOUCH-TONE pad arrangement, except that the "*" button is labeled "." and the "#" button is labeled END as shown in Figure 4. The standard alphabetic arrangement is also shown on the buttons. In addition, the letters Q and Z (normally absent from a TOUCH-TONE pad) appear on the "1" button.

When a Transaction telephone is equipped with a PIN pad, a different faceplate with an additional button, illuminated with an LED is provided. The button enables or disables the PIN pad. The LED is on when the pad is enabled. There is also a light on the PIN pad itself which is on when the PIN pad is enabled.

The PIN pad may be used for entry of all or part of the manually entered data, and the buttons on the pad perform the same functions as the correspondingly labeled buttons on the manual entry pad on the face of the Transaction telephone.

The PIN pad is 4 inches wide by 4 inches deep by 2½ inches high and is connected to the Transaction telephone by means of a ⅜ inch diameter cable of length 4½ feet. Detailed operation of the PIN pad is described in Section 4.1.5.

3.2 Referral Switching Equipment

The equipment required at the data center to give attendants access to calls can be either of two types. The first is the CALL DIRECTOR and

the other is the Automatic Call Distributor (ACD).

3.2.1 CALL DIRECTOR

The CALL DIRECTOR arrangement provides each attendant with access to all incoming lines. When an attendant is required, a flashing lamp indicates the call to be handled. The attendant answering the referral request transfers the call to the TALK mode during which time no data can be received, nor can the data set associated with the call be made available for other calls. If more data transmission is required, the attendant can return the call to the DATA mode by depressing the HOLD key on the CALL DIRECTOR.

A typical CALL DIRECTOR station is shown in Figure 5.

3.2.2 2B and 3A Automatic Call Distributors (ACD)

If the data center installation includes a 2B or 3A ACD, a number of advantages over the CALL DIRECTOR system are provided. Among these are line concentration, which allows the use of fewer 407 data sets and fewer attendants for a given number of incoming lines, and queuing of incoming calls until a port becomes available. The queuing feature can be used to handle traffic peaks with a minimum number of data ports. In applications requiring short call-holding times (such as credit authorization) calls will reside in queue for a very short time if the system is properly engineered to handle the traffic. The ACD also allows the option of dropping the data set from a referred call once the attendant has been selected. This allows the data set to handle a new call while the referred call is handled by the attendant, thereby reducing the number of data sets and ports required to handle the traffic. In addition, the ACD system allows the use of recorded announcements.

The 2B and 3A ACDs have circuitry which transmits a two-digit code to the computer upon selection of an attendant position. This code may identify to the computer the location of the attendant answering the call. (See Section 4.2.4.)

The 2B ACD is a miniature crossbar switching system, while the 3A utilizes step by step switching. The 2B ACD can handle up to 70 output positions (attendants plus computer ports) and up to 68 incoming trunks. The 3A ACD can handle up to 48 data ports, 48 attendants and 198 trunks.

3.3 407B Data Station

The 407B Data Station is a multiple installation of 407B data sets, one data set per computer port. The sets decode incoming TOUCH-TONE signals to a 2-out-of-8 code for presentation to the ARU.

The 407B provides access to the telephone line for voice, tone and FSK signals from the ARU to the remote terminals. A means for keying its answer tone oscillator (2025 Hz) to provide response to inquiries from remote locations is also provided. The 407B is equipped with status lamps which indicate the state of some of the important interface control leads so that the data set status can be seen at a glance.

In addition to the features described above, the 407B data set has several new features unavailable on the 407A and earlier data sets. The 407B allows terminal initiated referral (TIR); it is possible for the calling party to request a referral to an attendant without ARU intervention. Another new feature is the "computer down" operation of the 407B. Under option control, set at installation, when the computer is down, the 407B will answer all incoming calls and respond with a 3.5-second answer tone (instead of the normal 1.5 second tone). This notifies the calling party that the computer is down so that appropriate action can be taken. (See Section 5.4.) The 407B also has the capability of detecting a special TOUCH-TONE code (*#*) to disconnect the call. This feature is provided to minimize inactive port time by promptly terminating the call at the completion of the transaction. This hang-up code is not sent by the Transaction I telephone, but is transmitted by the Transaction II telephone.

Several user options are available in the 407B data set. The interface between the Audio Response Unit (ARU) and the 407 can be either the Electronic Industries Association

(EIA) recommended voltage levels according to standard RS-232-C; or it can be the "contact equivalent" interface, which allows the set to operate with many terminals designed for closure-type interfaces. The set can be operated on DDD or private lines (the DDD option is normally exercised). In addition, the out-of-service indication (OS) can be made complementary to the Data Terminal Ready (DTR) control lead from the ARU so that a set can be taken out of service simply by turning DTR OFF. This option is compatible with those systems which operate by keeping DTR ON except during disconnect times (<200 msec).

Detection of the computer down condition can be done by either or both of two methods. One method is by a switch operated by data center personnel. The second method is a function of the DTR leads in the station. When all DTR leads in the station are OFF, the computer down mode is entered. Note that when OS is selected to be controlled by DTR and the computer down state is detected by means of the DTR leads, the state in which all DTR leads are OFF will result in the out of service condition being overridden by the computer down condition and the station will be returned to service.

Finally, terminal initiated referral (TIR) can be optioned to occur either always or only during computer down intervals.

The 407B Data Station is designed for ease of testing, both locally and remotely. Each data set can be tested locally by either the customer or Telephone Company personnel using a test set built into the data station. Remote testing can be done by the Telephone Company data test center over a service line provided with the station.

3.3.1 Physical Description

Figure 6 depicts a 41A2 data mounting equipped with eight 407B-L1 data sets, a power supply, and a test unit, installed in a KS20018, L12A cabinet (width 24 inches, height 17 inches, and depth 18 inches). Two data mountings, equipped with up to 16 data sets may be installed in a KS20018, L11A cabinet (width 24 inches, height 30 inches, and depth 18 inches). When two data mountings are mounted in the same cabinet, the top mounting must be a 41A2 type which includes the test unit. The bottom mounting would be a 41B2 unit which has no test unit.

Both the L11A and L12A cabinets are finished in a natural aluminum exterior with a tinted see-through plastic front door and a perforated metal rear door. The data station is capable of operating in a room ambient temperature between 40° and 120°F.

The 407B will operate over a relative humidity range of 20 to 95 percent at 75°F and 20 percent to 40 percent at 120°F.

3.3.2 Power and Grounding Requirements

Electric power is fed to the 407B from a customer-provided 117 volt ±10 percent, 60 Hz ±5 percent nonswitched source by means of a 3-prong plug-ended power cord. One 10 foot long AC power cord is provided with a data station. The nests in a multiple data mounting station are interconnected to distribute AC power between the nests. Each nest of eight data sets consumes approximately 115 watts of AC power.

Note: If fewer than eight sets are used in the nest the power consumption is reduced, but not linearly. For instance, four sets consume 65 watts of AC power, and just one set consumes 30 watts of AC power at 117-volt line voltage.

Protective Ground is established for the 407B through the ground wire of the power cord. A signal ground is provided to the customer for use as a signal level reference point. Provision is also made to connect signal ground and frame ground in the nest. If signal ground and frame ground are unconnected, then signal ground reference between nests is accomplished by installation wiring.

3.3.3 Location of Data Station

In accordance with the recommendations of EIA standard RS-232-C, the 407B Data Station should be located so that the customer-provided interface cord to the ARU will not exceed 50 feet in length.

3.4 Customer Provided Equipment

The customer provided equipment at the data center must be capable of receiving the 2-out-of-8 data from the 407B. In addition, it must provide voice response, keyed answer tone and/or FSK responses to inquiries. Customer provided equipment can accomplish keyed answer tone signaling either by operating the Tone Answer Back (TAB) lead provided by the 407 or by transmitting the appropriate audio signals itself. The data center should provide out of service switches to manually inhibit incoming calls to a malfunctioning port. The connection of these switches to the data set will depend on the out of service control option selected. If out of service (OS) control is by means of the OS lead, the switch should turn the lead ON to take the data set out of service. Otherwise, DTR should be placed in the OFF state during out of service periods.

4. SYSTEM OPERATION — ELEMENTS

This section contains a detailed description of the components of the Transaction telephone system. The Transaction telephones and the 407B Data Set are described, as is the operation of the 407B with a CALL DIRECTOR or an ACD used for referral.

4.1 The Transaction Telephones

The Transaction I telephone is a telephone augmented by features to increase its utility in Digital Inquiry/Voice Answerback transactions. It is intended primarily for use in applications where a single complete inquiry is followed by a single response, although a means is provided to enter additional data after the initial inquiry. Responses are unlimited, as the Transaction telephone *is* a telephone.

The Transaction II telephone has all the features of the Transaction I telephone; in addition it can receive Frequency-Shift Keyed (FSK) data to yield visual responses. It also allows hands-free operation, using ON and OFF buttons and a call progress sounder.

4.1.1 Sequence of Operation

There are three phases of operation of the Transaction telephone: data input, data transmission, and data center response.

4.1.1.1 Data Input

Typical usage of the Transaction I telephone proceeds as follows:

1. The user lifts the receiver and the first (topmost) instruction lamp comes on.
2. He listens for dial tone, then slides the dialing card through the card reader. The second lamp comes on.
3. The user may listen again for dial tone, and then slides the second (customer) card through. The Transaction telephone lights the third instruction lamp.*
4. Additional data are keyed in manually.

Meanwhile, the set automatically dials the data center or other telephone number and buffers all input data. The user may use the ERASE key to delete erroneous manual input, and depresses the END key when data input is complete.

Typical use of the Transaction II telephone is similar to that of the Transaction I set except that the Transaction II user typically utilizes the "hands-free" feature of the set. Instead of lifting the receiver to initiate the call, the user presses the ON button on the face of the set. Call progress tones (including dial tone) are audible via the tone sounder.

4.1.1.2 Data Transmission

When contact with the data center has been established, the set sends the data that has been entered and buffered. Data transmission is triggered by the 2025 Hz answer tone sent by the 407-type data set, and consists of TOUCH-TONE characters sent at a rate of 8.8 characters per second. If the user has not finished manual data entry, the Transaction telephone sends all data that has been entered, and then sends each additional individual character as it is entered by the user. When the END button is finally depressed, the set sends the End Of Text (ETX) sequence (that is, "##") followed by the longitudinal redundancy check character and character count, and is then ready to receive

*Listening for dial tone a second time allows for two-part dialing where a user must actually wait for the second dial tone before inserting the second card.

the data center response. If for any reason the answer tone is not detected by the Transaction telephone, data transmission may be triggered manually. This is done by pressing the END button two more times when entry of the transaction has been completed in the normal way. Extra depressions of the END button will not appear in the transmitted data sequence when they occur before transmission is complete. Note, however, that this procedure should only be used when the user is sure that the answer tone has been missed.

The data format is covered in detail in Section 7.

4.1.1.3 Data Center Response

After data entry, final depression of the END button, and transmission of the data, the data center normally responds to the inquiry. The response mode may be voice or keyed answer tone, or in the case of Transaction II telephone, FSK data.

Voice response could include an approval or acknowledgment of the transaction, a rejection or denial, or a request for additional information or reentry of information.

Keyed answer tones can be used to light either the green or yellow response lamp on the Transaction telephone. When either lamp is lit, the Transaction telephone acknowledges the action taken by sending an appropriate TOUCH-TONE character, as discussed in Section 4.1.6.

Both the voice and keyed answer tone response modes may be used with either the Transaction I or Transaction II telephone. In addition, the Transaction II telephone can receive FSK signals to control the response lamps, and provide data for the visual display.

4.1.2 The Magnetic Stripe Cards

The Transaction telephones accept input data through either a magnetic stripe card reader or a manual entry pad. The card reader is designed for the American Banking Association (ABA) track two, also described as the American National Standards Institute (ANSI) track two. The reader is hand powered, containing no moving parts, and is engineered for long service life and ease of use.

In its most general application, the set has as its input source two magnetic stripe cards. One card is encoded according to the ABA specification, and may be a bank card or credit card. The other card is a dialing card, encoded in a manner similar to the ABA standard but containing information pertinent to controlling the Transaction telephone.

The dialing card is used first, and has encoded on it the telephone number of the data center or other remote data set location to be reached. In addition, it contains identification information, access codes, or transaction codes associated with the user, to be transmitted to the data center when the connection has been established. The dialing card also contains special characters that control features of the Transaction telephone. These are addressed later in this section, and in this section, and in Section 6.3.

Typically, dialing cards are associated with and kept with the Transaction telephone in slots provided for them. There may be any number of dialing cards, one for reaching each of a number of data centers, or one containing each of several access or transaction codes.

The second card or customer card is typically not associated with a particular Transaction telephone, and contains information pertaining to the particular transaction being consummated. As a bank or credit card, it is carried by the customer, and has encoded on it an account number, an expiration date, and, possibly, additional discretionary data. Alternatively, the card could be an inventory control card, with a part number and inventory control information on it.

Magnetic stripe cards are inserted by placing the edge of the card containing the stripe into the right hand end of the long slot of the reader, with the stripe facing the user as he faces the keyboard. (See Figure 7.) Note that, although the figure shows a Transaction I telephone in use, the reader on the Transaction II telephone is identical. The edge of the card should be resting against the bottom of the slot, to align the encoded portion of the stripe with the reading equipment. The

card is then moved steadily from right to left through the slot.

The card reader is designed to be insensitive to the velocity at which the card is moved through the reading slot, and to accommodate reasonable changes in velocity as the card moves. However, jerky motion of the card, or extremely fast or slow motion, is not recommended. The card reader will accept velocities between 2.5 and 50 inches per second.

If a card is misread, the Transaction telephone will detect the error because it checks both the parity of each individual character and the card longitudinal redundancy check (LRC) character. (Detailed in Section 6.3.7.) The error condition is noted by flashing the corresponding instruction lamp on the face-plate. When an error is detected, the set does not transmit the suspected data but instead expects the data to be reentered. The card may be inserted again, or the information may be keyed manually. (**Note:** The set flashes an instruction lamp only when one would normally be lighted to correspond to a card entry.) The user may re-enter the data by card or manually without hanging up.

4.1.3 Manual Dialing

The Transaction telephone is equipped with a TRIMLINE handset which can be used for manual dialing, or the manual entry pad may also be used for manual dialing. Use of the manual entry pad for dialing may be disabled by the installer in accordance with the service order. The dialing feature of the TRIMLINE handset is not disabled by this option.

In the Transaction II telephone, disabling the manual entry pad for dialing also protects the information from the previous card from inadvertent erasure through untimely use of the manual entry pad. This information is used by the automatic one number dialing feature (described in Section 4.1.9). Note that previously stored numbers are lost whenever the manual entry pad is used for dialing in both sets.

When the manual entry pad is used to dial numbers, it is used just like a TOUCH-TONE pad. Both Transaction telephones will do automatic push-button to rotary dial pulse conversion, if required. When the manual entry pad is used to call a telephone number other than that of a data center, the END button should not be pressed at the end of the number.

When the manual entry pad is used to manually address a data center, the END button is pressed after dialing the telephone number. Then the user identification information is keyed in, and the END button is pressed again to signify the end of the user information before entering the customer data or card. User information may be punctuated with the (.) or (/) keys. The Transaction telephone will transmit this information after the answer tone from the data center is detected and after entry of customer data has begun.

The Transaction telephone can also be used as a TOUCH-TONE telephone to call data centers which are programmed to communicate with TOUCH-TONE telephones only. In this case, the manual entry pad is used exactly like the pad on the TOUCH-TONE telephone and the END key is not depressed.

For manual entry of dialing and user identification information, the ERASE button can only be used to clear the user identification information while the first instruction lamp is on. It does not affect the telephone number.

When the user data has been manually entered, data corresponding to the second card should not be entered until the second instruction lamp comes on. This will occur immediately after pressing the END button if dialing is TOUCH-TONE, but not until rotary dial pulsing is complete when rotary dialing is employed.

4.1.4 Manual Data Entry

Information can be manually entered using the manual entry pad in place of either card operation described in the Section 4.1.2. Section 4.1.3 deals with manual entry of information in place of the dialing card, or when the first instruction lamp is on. More typically, data is manually entered after the two cards have been inserted to provide specific information that is not reasonably

stored on cards. In the banking and credit industry, this information could include the dollar amount of the transaction.

Additional data that could be entered here includes a transaction code or inventory control number. Also a personal identification number (PIN) could be entered at this time by the bank's customer using the optional remote entry pad.

4.1.4.1 When the Third Instruction Lamp is On

The Transaction telephone has storage space for up to 61 additional characters in its buffer after the cards (or equivalent manual data) have been entered. If a field separator (/) is used, it can be placed any where in the 61 character data field.

Experience has shown that mistakes in manual entry are likely to be the most frequent cause of error when using the Transaction telephone. Therefore, when very reliable information transfer is required, it is suggested that such information as the amount of a transaction, be keyed in twice so that manual entry errors can be detected at the data center.

4.1.4.2 When the Second Instruction Lamp is On

Data may be entered manually to replace use of the customer card whenever the second instruction lamp is either on or blinking. It will be on after entry of the dialing card or after manual entry of the telephone number and user data as above. It will be blinking after a misread of the customer card.

Up to 47 characters can be manually entered in the "customer card" field, and can include any of the digits as well as the (.) and (/) keys. The Transaction telephone denotes manually entered data in this field by sending a different TOUCH-TONE character between the user identification field and the second field than it would if card entry were used. The ERASE button, if used when the second lamp is on, applies to all of the characters entered while the second lamp is on, and cannot affect entries made while the first lamp was on.

The END button should be depressed at the end of data to be manually entered in this block; it will cause the third instruction lamp to light. Data entry is completed from this point just as if cards had been inserted. When using manual entry, care should be taken not to press two buttons at once. The output of the Transaction telephone in response to multiple button depressions is not specified.

4.1.5 The Auxiliary Manual Entry Pad

4.1.5.1 Use With the Transaction I Telephone

When the optional Auxiliary Manual Entry Pad (PIN pad) is provided, the Transaction I telephone has a key (at the upper right of the faceplate) by which the merchant can enable and disable the PIN pad. The "push on-push off" type key is lighted when the PIN pad is enabled, as is a lamp on the pad itself. The manual entry pad of the Transaction telephone remains enabled, regardless of the state of the PIN pad.

The PIN pad may be used for keying all or part of any block of manually entered data. The PIN pad has 12 buttons labeled with the digits 0 through 9, a decimal point (.) and END. Because some personal identification numbers are based in part on customer initials, all 26 letters of the alphabet appear on the buttons of the pad (Q and Z appear on the 1 button).

As an illustration of the use of the PIN pad, consider a typical transaction. After the merchant has entered the second (customer) card, the third instruction lamp lights. Using the manual entry pad on the Transaction I telephone, the merchant then enters the dollar amount of the sale, followed by the field separator (/). The merchant then presses the PIN key to enable the pad, then instructs the customer to key in his PIN (or other information) on the PIN pad when the light on the pad comes on. The customer presses END when he has completed data entry. The merchant then presses the PIN key to disable the pad.

4.1.5.2 Use With Transaction II Telephone

When the PIN pad is provided with the

Transaction II telephone, the physical configuration is the same as described above. The operation with the Transaction II telephone is also the same as above except that the visual display information entered by either the Transaction II telephone manual entry pad or the PIN pad is not displayed when the PIN pad is enabled. This protects the security of the PIN or other information entered by the customer. The display, however, functions normally for displaying incoming FSK data. After the transaction is completed, it is important that the PIN pad be disabled. Otherwise, subsequent manually entered data will not be displayed, even if data is entered in a later transaction.

4.1.6 Data Center Response

After data entry, final depession of the END key, and transmission of data, both the manual entry pad and the card reader are active when the Transaction I and II sets are being used in a voice or keyed answer tone mode. They can be used to enter more data, usually as requested in the data center response.

Keyed answer tone responses can be used to light either the green or the yellow response lamp on the Transaction telephones. When either lamp is lit in this manner, the Transaction telephone acknowledges receipt of the answer tone by sending either a TOUCH-TONE "a" (for the green lamp) or a TOUCH-TONE "b" (for the yellow lamp) to verify that the correct response is received. If the incorrect response is indicated, the data center may retransmit the correct signal. If the user has not disconnected, the new signal will cause the appropriate response at the Transaction I telephone. The correct lamp will be lit, and the acknowledgment will be sent. In the Transaction II telephone, an erroneous green lamp can be corrected in this manner, with no time limit, as long as the user does not hang up or enter more data. The yellow lamp cannot be changed unless the user picks up the handset within 20 seconds of the lighting of the yellow lamp.

The two response lamps are intended to reduce the user's need for listening for a response from the data center. The green lamp may be used when an inquiry is approved, and no further action is necessary. The yellow lamp may be used to mean the response is more complicated, and that the user should listen for a detailed audio response. In the case of the yellow lamp response, the Transaction I telephone automatically sends a signal, "##", indicating it is ready for the audio response, after the "b" indicating activation of the yellow lamp. In this instance, the sequence "##" indicates the terminal is ready for voice.

The Transaction II telephone, when used in a tone-response mode, will transmit the same lamp responses as the Transaction I telephone. If the set is used with the receiver on-hook, then the ready for voice (##) signal following the yellow response will not be sent until the receiver is lifted.

Keyed answer tone reception will not work properly if buttons are pressed on the pad between the end of data transmission and receipt of the tone signal, unless the END button is used after such button depressions. Therefore, if extra data is needed by the data center after the initial transmission before lighting either response lamp, the additional data should be followed by pressing END.

When the Transaction II telephone is used with the data receiver activated, then the card reader and manual entry pad are disabled following transmission of the initial inquiry (or follow-up messages followed by END), until a data message is received. An exception to this is that the ATTN key can be used, by lifting the handset and pressing the button, to unlock the pad and send out the attendant request signal.

In the case of data receiver operation in the Transaction II telephone, numerous different responses are possible, using combinations of eight different response codes. These codes allow lighting either of the response lamps (or blinking them), causing the set to hang up, to hold on for an extended period, or to unmute the call progress sounder. (Normally, the call progress sounder is muted while the set is in contact with the data center.) In addition to control characters, the data receiver can receive characters for presentation on the

visual display. Although the visual display contains only eight characters, more characters can be sent for later presentation. These additional characters are accessed by operating the "ERASE" button, which clears the display contents and brings in the next display stored in the buffer. The total number of characters that can be received for display is limited by the buffer size. The buffer has a capacity of 63 characters, including control characters as well as characters for display. Details on use of the visual display are covered under message formats in Section 7.5.1. The visual display is a seven segment display. Thus, all of the digits and certain alphabetic characters can be displayed. Thus, the display can show a capital "A," but not, for example, a "W." Displayable characters are shown in Figure 8. Non-displayable characters are displayed as blanks.

The ASCII character "/" can be used as a display format control character. It is used as a display field delimiter when the user wants to display fewer than eight characters at a time.

The mode of response for the Transaction telephone set is normally selected by a control character on the dialing card. The character can select voice-only operation, keyed answer tone and voice operation, or FSK data reception only (Transaction II only), at either of two data rates. Data rates are selectable at 110 or 150, bits per second. The required control characters are given in Section 6.

4.1.7 Referral to an Attendant

With these telephone functions, the Transaction telephones offer a unique opportunity for referral to a human attendant of complicated inquiries, or inquiries that the computer is otherwise unable to answer. Referral under control of the ARU is a feature provided in the 407A or 407B data set. A simplified means of referring a call to an attendant at the initiative of the user is built into the Transaction telephone when operating with a 407B data set.

To request an attendant, the user depresses the "ATTN" button on the Transaction I telephone. Further data transmission is interrupted, and the special signal, "**", is sent immediately. Operation is the same with the Transaction II telephone, except that, when the receiver is on-hook, the "**" signal is not sent out until after the "ATTN" button is pressed and the receiver is lifted, in either order. If the data center is equipped with a 407B data set optioned for "Terminal Initiated Referral-Always," a referral is automatically executed by the 407B data set. (Details of data set operation are covered in Section 4.2.) If the data center is not equipped with a 407B with this option, appropriate action should be programmed into the host computer to handle the "**" situation. The ATTN button should not be depressed until the call has reached the data set and the initial 2025 Hz answer tone has been detected.

An attendant can also be requested by the data center by operating the AR lead on the 407A or 407B data set. This has application when the computer detects a condition which requires the intervention of an attendant. Note that if the AR lead is not operable by the computer, the computer can initiate a referral via an audio message, such as "please press ATTN button", to the Transaction telephone user.

Sometimes it will be useful to return to the data application of the Transaction II telephone after talking with an attendant. Therefore, after using the ATTN button, the user can key in additional data using the manual entry pad or he may use the card reader. Once this is done, and the END button has been pressed, the Transaction II telephone will return to its original mode of operation, be it voice only, KAT, or FSK. However, the receiver cannot be placed back on-hook until the end of the call.

4.1.8 When the Data Center Computer is Unavailable

When the computer is down, it may be advantageous to answer calls and notify the caller that problems exist. Or, there may be applications in which most calls can be handled in a limited manner without data center contact while only exceptional calls need be handled by attendants at the data center. For example, in credit authorization,

transactions below a floor limit might be handled by the merchant's use of a "hot card" list periodically distributed to all system users by the data center. Transactions which have a dollar amount above a certain threshold would be referred to an attendant having up to the minute information only available at the data center.

To provide these features, the Transaction telephone has a special "computer down" mode of operation that is operable with a 407B data set. If the computer down mode is in effect, the 407B responds to ringing with a 3.5 second answer tone rather than the normal 1.5 second answer tone. The Transaction telephone detects the long answer tone and goes into its computer down mode, in which it does one of two things, depending on "floor limit" characters entered from the dialing card and on the manually entered "dollar amount."

If the dollar amount is less than the floor limit specified by the data center in a special field on the dialing card, the Transaction I telephone will light the fourth instruction lamp, labeled "follow special instructions." Similarly, the Transaction II telephone will cause the word "SPECIAL" to appear on the visual display. If the dollar amount is greater, the telephone will light the yellow response lamp and send the "**" signal to automatically request an attendant for special processing. In the case of Transaction II, the "**" signal is sent out when the handset is lifted in response to the yellow lamp signal. The specified floor limit may be any 3-digit number between 000 and 999 or it may be omitted, in which case, whenever the computer down mode is detected, the set acts as if the floor limit were infinite (Transaction I lights the fourth instruction lamp; Transaction II displays the word "SPECIAL"). When no floor limit is used, the ATTN button can still be used to send out the "**" signal.

For purposes of floor limit comparison, the Transaction telephone uses as the "dollar amount" the numbers entered preceding either a decimal point (.) or a field separator (/) while the third instruction lamp is lit. Characters entered after the decimal point or field separator are not utilized in the comparison.

4.1.9 Dialing Card Options

In general, the data center need not be concerned with the dialing mode of the Transaction telephone. However, there are optional characters on the dialing card that can be used to control special dialing features. These include:

1. Two part dialing, to serve customers who must dial part of a telephone number, wait for dial tone, and then dial the rest.
2. Two part dialing, with a change in dialing mode (split-mode dialing) to allow for part rotary and part TOUCH-TONE dialing.
3. Predialing, to cause the telephone number to be dialed after insertion of the dialing card rather than the customer card. (Particularly useful on TOUCH-TONE lines for long distance calls).
4. Automatic one number dialing without insertion of the dialing card. In this case, the Transaction telephone automatically dials the number on the last dialing card entered.

These features are designed to facilitate user operation of the sets. The card requirements for control of the options are described in Section 6.3.

The two-part dialing option is used with PBX or tie line installations where a second dial tone wait is required. Note that in some installations, such as with CENTREX in some localities, the second dial tone is instantaneous so that no wait is required; one-part dialing can be used in these cases. The local telephone company should be consulted for details.

Note that if a dialing card that is not encoded with the characters for two-part dialing is used in a location requiring two-part dialing, the first portion of the telephone number should not be encoded on the card. Rather, the first part of the number, before the second dial tone, must be dialed using the TRIMLINE handset.

The predialing option is useful on TOUCH-TONE installations where the telephone

number is easily transmitted between card insertions, particularly when long distance calls are being placed. Dialing is accomplished in about 1 second, using TOUCH-TONE, which is less than the time usually required to enter the second card. However, in the predialing case, the second instruction lamp does not come on until after dialing is complete; the second card should not be inserted until after the lamp comes on. Therefore, predialing should not be used with rotary dialing because of the relatively long time required to complete dialing, during which time the user cannot enter the next card; nor should predialing be used when a short duration is anticipated for connection to the data center and a magnetic stripe customer card is used since the answer tone may be missed if it occurs while the customer card is being read. If the answer tone is missed, the data in the buffer can be transmitted by depressing the END key two more times, after data has been entered in the normal manner.

The automatic one number dialing feature is most useful when the user usually or always wants to call the same data center and provide the same identification information. Unless this feature is disabled by a special dialing card character, the Transaction telephones store the information from the dialing card. Insertion of the customer card will automatically cause the stored information to be utilized, and the set will dial the last number entered with a dialing card. All information on the stored dialing card is retained, and the set transmits data just as if the dialing card had been inserted. So long as power is continuously applied to the set, the old dialing and user information will remain in memory until different information is entered, either via a dialing card or by using the manual entry pad for dialing. If the power is removed from the set, and later restored, the yellow light will flash to indicate that the stored information has been lost.

When the manual entry pad is used for dialing, the dialed number is not stored for future use in the Transaction I telephone, and the previously stored data is erased. The information entered manually while the first instruction lamp is on is stored, however, by the Transaction II telephone.

For two-part dialing in the Transaction I using the one-number dialing feature, the predialed portion of the number must be entered on the TRIMLINE handset before the customer card is entered. The predialed portion must not be encoded on the dialing card.

The Transaction II telephone offers additional one-number dialing features. In the case of two-part dialing, the first part of the number can be recalled by pressing the ATTN button and, after the second dial tone begins, either inserting the customer's card or the beginning of entry of customer data on the manual entry pad causes transmission of the rest of the telephone number. In the case of single part dialing, depression of the ATTN button causes transmission of the entire telephone number, after which the customer data can be entered, in response to the second instruction lamp.

The options controlled by the dialing card are summarized in Table 2, and discussed in detail in Section 6.3.

4.1.10 Default Options With Manual Dialing

Control characters normally on the dialing card cannot be keyed in manually. Thus, when manual dialing is used, the following options are implemented in the Transaction I telephone:

1. The floor limit feature is set so that the fourth instruction lamp always comes on when the computer is unavailable.*
2. The second and subsequent card ABA check characters are checked.
3. Information keyed in is not stored for future automatic one-number dialing.
4. The green and yellow lamps are inoperable except when the computer-unavailable condition exists.

Operation with the Transaction II telephone is similar, with the following additions:

*Early versions of the Transaction I telephone will use whatever floor limit is stored from previous usage. Thus, they will sometimes light the yellow lamp when manual dialing is used to reach a data center which answers with the computer down signal.

1. The symbols "SPECIAL" appear on the display when the computer is down.
2. Information keyed in is saved for future automatic one-humber dialing if the END button is pressed at the end of the telephone number and at the end of the user number.
3. The set operates in the voice-only mode when the call is originated by lifting the receiver, then dialing. However, if the call is initiated by pressing the ON button, then dialing, the set will operate with the data receiver active at 150 bps.

4.1.11 Use With Operator Intercept

Special operating procedures must be followed when using the Transaction II telephone in areas where operator intercept is used to identify the calling telephone.

In normal operation involving intercept, the dialing card (which must be encoded for the pre-dial option) is entered in normal fashion. The user must wait for the intercepting operator before inserting the customer card or manually entering data. When the operator is heard through the call progress sounder, the user picks up the handset and gives the required information. Then the handset can be returned to the cradle while the ON button is simultaneously depressed. The call then proceeds normally.

In cases other than the one described above, (i.e., manual dialing or two-part dialing, etc.), the transaction may begin with the handset on-hook, but, after the intercept has occurred, the handset cannot be replaced on-hook.

4.1.12 Unrestricted Format Data Transmission

There are applications of the Transaction telephones where an extended dialogue between the user and the data center is desirable. Such a dialogue is possible with the Transaction telephones after the initial inquiry and response have taken place. In this mode of operation, magnetic stripe cards are read and transmitted exactly as encoded (except that the start and end sentinels and card LRC are not transmitted). The set appends the message LRC and character count to the message only if the original merchant number begins with hexadecimal D8 (See Section 7.1). Similarly, manually entered data is also transmitted exactly as entered. Manual entries in this mode should be limited to 64 characters before depressing the END button.

If it is desired to conduct an entire call in the unrestricted format mode, the user must depress the END button four times during the time that the call to the data center is being completed. Note that this requires use of a "pre-dial" dialing card. This operation causes transmission of the fixed format data originally stored in the Transaction telephone buffer and allows unrestricted dialogue with the data center once the call is completed. (Answer tone no longer has an effect on data transmission once the END button has been depressed four times.) The above mode of operation is useful in communicating with data centers which are intended for use with TOUCH-TONE telephones.

The instruction lights are not operative when the set is in the unrestricted mode. However, the Transaction II Visual Display is active. EOO appears on the display when the data center sends a NAK (negative acknowledgment) to the set following an error in a transmitted message.

4.1.13 Options Set at Installation

These options, summarized in Table 3, include selection of the primary dialing mode as either TOUCH-TONE or rotary dial pulse, and enabling or disabling manual dialing and entry of user data (normally read from a dialing card) via the manual entry pad. Disabling the manual entry pad for dialing and user data entry forces the user to have a dialing card to execute a transaction. Other options include installation of the Transaction telephone as part of a key telephone system utilizing a separate keystrip. The optional auxiliary manual entry pad (PIN pad) which allows the customer to privately enter his personal identification number (PIN) for security purposes is also available.

4.2 407B Data Set and Referral Equipment

The 407B data set provides an interface that, under option control, either conforms to the electrical characteristics (voltage levels only) of EIA standard RS-232-C or is compatible with Audio Response Units having a contact closure interface, by means of an option (see Section 4.2.6). A 25-pin connector that provides an interface similar to that of the Bell System Data Set 403 (except that leads 19 and 21 have different functions — see below) and identical to that of Data Set 407A, is employed for connection to the Audio Response Unit (ARU). ARU manufacturers must supply a matching plug and hood. The basic connector shall be a Cinch DB-19604-432, or equivalent, terminating a 25-conductor cable. If the cable used has a 1.125-inch maximum bending radius, such as that obtainable from Alpha Wire Company 1181/25-22 AWG, then a Cinch DB-51226-1 straight molded hood may be used. If the cable has a larger bending radius, a right-angle hood, Cinch 239-13-99-140 or its equivalent, must be used. Cables with a bending radius greater than four inches are not recommended. A summary of the interface leads is given below and is followed by a detailed description of each of the circuit functions.

4.2.1 Interface Summary

Pin No.	Designation	Discussed in Paragraph
1	Frame Ground (FG)	a
2	Voice Receive A (VRA)	b
3-A1	Data	c
4-A2	Data	c
5-A3	Data	c
6-A4	Data	c
7	Not Used	d
8	Voice Receive B (VRB)	b
9-B1	Data	c
10-B2	Data	c
11-B3	Data	c
12-B4	Data	c
13	Not Used	d
14	Ring Indicator (RI)	e
15	Attendant Request (AR)	f
16	Data Present (DP)	g
17	Voice Answer-Back A (VAA)	h
18	Voice Answer-Back B (VAB)	h
19	DATA Mode (DM)	i
20	Tone Answer-Back (TAB)	j
21	Data Receive (DR)	k
22	Data Terminal Ready (DTR)	l
23	Data Set Ready (DSR)	m
24	Signal Ground (SG)	n
25	Out-of-Service (OS)	o

a. Frame Ground, Lead 1: This conductor is electrically bonded to the data set frame. It is further connected to external grounds through the power cord. This should be the same ground as used for Frame Ground by the ARU.

b. Voice Receive, Leads 2 and 8 — From Data Set to ARU*: These two leads provide a 600-ohm balanced pair on which the line signals are passed to the customer. These signals are passed through a buffer circuit without attenuation or amplication, before being passed to the interface.

c. Data, Leads 3-6 (A Group), 9-12 (B Group) — From Data Set to ARU: The data set places the data leads in the MARKING (ONE) state for a period of 42 +1 milliseconds upon receipt of a character.

d. Leads 7 and 13 are not used in 407B Data Set.

e. Ring Indicator, Lead 14 — From Data Set to ARU: An ON condition on this circuit indicates that ringing signal is being received from the communications line. The ON condition approximately coincides with the application of ringing signal.

f. Attendant Request, Lead 15 — From ARU to Data Set: When a CALL DIRECTOR is employed to provide attendants with access to calls requiring human intervention, an ON condition of the Attendant Request lead while the

*These interface leads are not used in the Transaction telephone system, but are provided for other types of applications. They are only included here for completeness.

data set is in the DATA mode (see paragraph i below) will cause the lamp associated with the line to flash at a 1 Hz rate. No audible indication is given. When an ACD is employed for referral, an ON condition of the Attendant Request lead will cause the ACD to hunt for a referral clerk's line that is not in use, indicate (via the data set) to the ARU that a line was chosen, and signal (usually by ringing) the clerk to pick up the line.

When all the attendant lines are busy, the ACD does not queue attendant requests. Therefore, if within 2 seconds no indication is received that an attendant's line has been chosen, the AR lead should be turned OFF for a minimum of 100 milliseconds and then turned ON again in order to reattempt the referral request. The maximum number of attempts made to establish the referral is dependent upon system requirements. When the ACD indicates that an idle position has been found, the AR lead should be turned OFF.

g. Data Present, Lead 16 — From Data Set to ARU: A MARKING (ONE) condition on this lead indicates that the data set is receiving a valid TOUCH-TONE signal. The ONE condition is presented two to three milliseconds subsequent to signals on the Data leads, and will be maintained until the Data leads are placed in the SPACING (ZERO) state or until there is a loss of suitable input signal from the communications line, whichever occurs last.

h. Voice Answer-Back, Leads 17 and 18 — From ARU to Data Set: The Voice Answer-Back leads are terminated within the data set in a 600-ohm balanced-to-ground transformer. Voice signals should be delivered from the customer's equipment at -7 to 0 dBm. Tone signals should be delivered from the customer's equipment at -1 dBm ±1 dB. An internal limiter will clip any peaks above +3 dBm. Any direct current present must be less than five milliamperes. The impedance of the customer's equipment furnishing the voice signals should be balanced with respect to ground, to prevent unwanted noise transmission. The out-of-band power should meet the following specifications:

3995 — 4005 Hz	< — 19 dBm
4006 — 10000 Hz	< — 16 dBm
10000 — 25000 Hz	< — 24 dBm
25000 — 40000 Hz	< — 36 dBm
> 40000 Hz	< — 50 dBm

i. DATA Mode, Lead 19 — From Data Set to ARU: An ON condition of this lead indicates that the data set is in the DATA mode. An ON condition can occur only in conjunction with an ON condition of DSR (see paragraph m). An OFF condition of the DATA Mode (DM) lead in conjunction with an ON condition of DSR indicates that the set is in the TALK mode. DM and DSR initially come ON together three seconds after ringing is tripped, but if there is a transfer to the TALK mode and then a return to the DATA mode, there is another delay of three seconds before DM comes back ON. Note that there is no "TALK" mode when an ACD is employed for attendant access to referred calls, and DM will function the same as DSR in this case.

When the data set enters the TALK mode in response to an attendant request, the AR lead (see paragraph f) should be turned OFF when DM goes OFF.

j. Tone Answer-Back, Lead 20 — From ARU to Data Set: An ON condition of this lead will cause the data set to disable the Voice Answer-Back Port and to generate an answer-back tone of 2025 Hz.

k. Data Receive, Lead 21 — From ARU to Data Set: The ARU must place the Data Receive lead in the ON state to connect the TOUCH-TONE receiver to the line. This permits the reception of data. If it is desired to remove the TOUCH-TONE receiver from the communications channel, the ARU may place the Data Receive lead in the OFF state.

Transmission of answer-back signals is not dependent on the state of this lead, as it is in the 403 series of data sets.

l. Data Terminal Ready, Lead 22 — From ARU to Data Set: The ARU must place the Data Terminal Ready lead in the ON state to prepare the data set to be connected to the communications line and to maintain connection to the line once it is established. Placing the Data Terminal Ready lead in the OFF state will cause the data set to be removed from the communications channel. An OFF condition of at least 50 (100 with an ACD) milliseconds, or until Data Set Ready goes into the OFF state, is required to disconnect. If the option is used which causes Out-of-Service to be controlled by Data Terminal Ready, placing the Data Terminal Ready lead in the OFF state for longer than 200 milliseconds will cause the data set to appear busy to incoming calls.

m. Data Set Ready, Lead 23 — From Data Set to ARU: An ON condition on this circuit indicates that the data set is either in the DATA mode and is ready to receive data, transmit answer-back signals, or both, depending on the condition of the Data Receive lead (22), or is in the TALK mode. An OFF condition will appear at all other times and shall be an indication that the ARU is to disregard signals appearing on any other circuit in the interface, with the exception of the Ring Indicator. When an OFF condition occurs during the progress of a call before the Data Terminal Ready lead is placed in the OFF state, the ARU should interpret this as a lost or an aborted connection and take action to terminate the call.

n. Signal Ground, Lead 24: This conductor establishes a common ground for use as a signal reference point. At the power supply, which serves a nest of eight data sets, this lead is brought to one point and connected to frame ground by means of a wire strap. This strap can be connected or removed at installation, as may be required to meet applicable regulations or to minimize the introduction of noise into electronic circuits.

o. Out-of-Serivce, Lead 25 — From ARU to Data Set: The presence of an ON condition on this lead will make the data set appear busy to incoming calls. When an ACD is employed, or when the option to control the out of service function with DTR (lead 22) is enabled, this lead is not needed and should be OFF at all times.

4.2.2 Typical Call

A typical call to a 407B data set begins when the serving central office applies ringing current to the incoming line. The ringing signal is detected by the data set or ACD. With DTR ON, the set goes off-hook, tripping ringing, and, after a 1.5 second silent interval, it generates a 1.5 second, 2025 Hz answer tone. Approximately three seconds after ringing is tripped, DSR and DM go ON to indicate that the set is connected to the line and ready to receive data. If Data Receive (DR) is ON, data reception can then take place. The computer may respond to the Transaction telephone by voice transmission from the ARU via the voice answer-back port of the 407B, or by tones generated by the ARU and transmitted via the same port. In addition, tone answer-back can be generated by directly keying the Tone Answer-Back (TAB) lead of the 407B. Termination of the call can be effected in several ways, depending upon the referral equipment utilized.

4.2.3 Operation with CALL DIRECTORs

When a call is received in a 407 Data Station employing CALL DIRECTORs for attendant access to referred calls, the ringing signal is detected by the data set and this is indicated to the ARU by means of an ON condition of the RI lead. The Data Terminal Ready (DTR) interface lead may already be ON, but if it is not, the ARU must turn it ON in response to RI ON to answer the call, and the associated lamp on the CALL DIRECTOR is lighted, indicating that the connection has been made. The procedure described in the previous section beginning from the "ringing tripped" point, is followed.

When DM goes ON, the set enters the DATA mode, during which data may be received as long as DR is ON.

If the set is in the DATA mode and a referral request is initiated, the button on the CALL DIRECTOR corresponding to that line will flash at a rate of approximately one Hz, indicating that a referral clerk should pick up the handset and go into the TALK mode. The call is transferred to the TALK mode by depressing the flashing button and lifting the handset. While in the TALK mode, the data set cannot receive data (use of an ACD allows simultaneous voice and data operation — see Section 4.2.4). A return to the DATA mode for further data entry can be accomplished by depressing the DATA (HOLD) key. When this is done, another answering sequence occurs to indicate to the remote station that further data transmission can take place. The sequence is the same as that after ringing is tripped, described before. The handset can then be returned to the cradle. The DATA Mode lead (lead 19) can be used by the ARU to determine when the referral clerk has gone off-hook following referral request. When the clerk does so, the DATA Mode lead goes from ON to OFF and the ARU should respond by turning AR OFF. The ARU may choose to terminate the call if a referral clerk does not answer the phone (DM does not go from ON to OFF) within a suitable time period as determined by the system requirements. Return to the DATA mode is signified by DM returning to the ON state.

The call is terminated when the calling station hangs up and the equipment at the data center is in one of the following modes:

1. Data set in the TALK mode and the handset of the CALL DIRECTOR is returned to its cradle.
2. Data set in the DATA mode and the ARU turns OFF the Data Terminal Ready lead for a period of at least 50 milliseconds.

Note: The ARU should initiate disconnect directly, such as after a voice answerback is complete or by means of a time-out if no end-of-message signal is received from the remote location. In any case, the telephone central office should not be relied upon for ending the call. While some central offices will open the line, causing disconnect, and others will disconnect by means of a time-out circuit, these are not universal features of central offices.

4.2.4 Operation with an Automatic Call Distributor

When an Automatic Call Distributor (ACD) is used in place of CALL DIRECTORs, several additional functions are introduced into the system:

1. Concentration of incoming lines to fewer data sets (computer ports).
2. Queueing of incoming calls until a data set is available.
3. Automatic selection of an available attendant in response to a referral request.
4. Indication back to the ARU of selection of a referral clerk's line.
5. Ability of the data set to receive TOUCH-TONE data while the referral clerk is on the line.
6. Ability to free the data set and computer port for new calls once the attendant has been selected.

When a call comes into the data station through an ACD, ringing is detected by the ACD. This allows the ACD to hunt for an idle port (data set) that has DTR in the ON state, indicating that it is ready to accept a call. When a port with DTR ON is found, the call proceeds again as described in Section 4.2.1, beginning from the "ringing tripped" point. A ring indication is *not* given on lead 14 in this case.

When a referral request is initiated by receipt of "**" or the AR lead being turned ON, the 407B signals the ACD which searches for a nonbusy referral clerk's line and, upon finding one, generates two TOUCH-TONE digits and sends them to the ARU through the data set. In the 2B ACD, these digits specify which clerk's line has been selected. In the 3A ACD,

operated in the standard mode, or in the split-gate mode with direct transfer to attendants, these digits also specify which clerk's line has been selected. However, if the 3A ACD is operated in the split-gate mode, with the transfer trunks of one gate section connected to the input trunks of another gate section, the digits will not identify the line selected. In this case the two digit code indicates only that a transfer trunk has been selected.

If the ACD cannot find an idle referral trunk during a terminal initiated referral, the 407B will recognize this condition and cycle the AR lead ON and OFF to renew the request once every two seconds until an idle trunk is found. If the ARU initiates the referral, the ARU controls the AR lead. If the two-digit code is not received within two seconds, the AR lead should be turned OFF for at least 100 msec., then returned to the ON state to renew the request. When the two-digit code is received, the AR lead should be turned OFF.

At the same time as the digits are sent, a signal is transmitted to the referral clerk's terminal to cause ringing on this set. The ARU may either remain on-line or place DTR in the OFF condition, which causes the data set to disconnect from the line. The data set may then be made ready to receive other calls (by bringing DTR back ON) while the referral clerk completes the original call. Once the ARU has turned DTR OFF, no further data can be entered. Connection to a data set can then be reestablished only by redialing.

If DTR remains ON after the referral clerk has answered, the data set remains on-line and the referral clerk's line is bridged onto the original connection, so that data can be entered into the ARU during the referral. After the clerk hangs up, further data can be entered. The call is terminated when the calling party hangs up and the ARU turns OFF the Data Terminal Ready lead for a minimum of 100 milliseconds. Since data can be received during the clerk's conversation, there is no need for the capability of transferring the data set off-line and later bringing it back on-line. Consequently no "TALK" mode exists when an ACD is employed.

If the ARU places DTR in the OFF state before the receipt of the two digits, the call will be dropped prematurely. Also, if the ARU places AR in the OFF state before the two digits are received, the referral request will be dropped.

When an ACD is employed, out-of-service is accomplished by placing DTR in the OFF state, thereby making that data set appear busy to the ACD. the ACD will then direct the call to the next idle data set. The OS lead should be OFF at all times when operating with an ACD.

4.2.5 New Features

The 407B offers new features previously not available in TOUCH-TONE receivers. The 407B is equipped to allow terminal initiated referrals. As was mentioned briefly in the previous section, the 407B can be optioned to execute a referral upon receipt of the sequence "**" from a remote terminal. When the 407B is used with a CALL DIRECTOR, the referral request will remain in effect until the TALK mode is entered, or subsequent characters other than "*" are received. When it is used with an ACD, the request will cycle ON and OFF at a 0.5 Hz rate to account for an "all trunks busy" situation in the ACD. Receipt of non-"*" characters following the "**" will cause the 407B to abandon a referral in progress with the result that the referral may not be completed. Furthermore, if the computer-down mode is in effect, as described below, and an ACD is present, receipt of any character after the "**" will cause the 407B to be disconnected from the call.

In addition, the 407B is equipped to handle the computer down situation. When the 407B detects that the computer is down, either by detecting that all DTR leads are OFF, or detecting a manual switch closure, the 407B will answer all incoming calls and respond with a 3.5 second burst of answer tone. In the computer-down mode, the 407B will respond to a "**" sequence by executing a referral, as described above. If characters other than "*" are received, the first character received is used by the 407B to determine whether a supplemental computer-down signal is needed. The 407B will respond to any character other than "a", "b", "c", "d", or "*"

by cycling the answer tone ON and OFF at a 0.5 Hz rate. This notifies a merchant who may be using a simple TOUCH-TONE telephone that the computer is down. The 407B will time-out and disconnect after 15 seconds if the TOUCH-TONE sequence "**" is not received.

The 407B is also capable of detecting a hang-up code from a remote terminal. When the sequence "*#*" is detected, the 407B responds by interrupting DTR until the incoming line is dropped.

Finally, under option control, a 407B data set may be taken out-of-service by turning DTR OFF. If this option is chosen, it is overridden when all DTRs in a data station are OFF and "all DTRs OFF" is used to detect computer-down; at this point, the computer-down mode is entered.

4.2.6 Interface Electrical Signal Characteristics

The signals on the regular interface for the 407B conform to the electrical characteristics of EIA standard RS-232-C, but an installer option is available that allows the interface to be used with many ARUs that employ a closure interface. Hence, the electrical signal characteristics for the "regular" interface and the optional "closure-type" interface are somewhat different and are discussed separately below.

4.2.6.1 Regular Interface — EIA RS-232-C Electrical Characteristics

All leads in the regular interface except the Voice Answer-Back and the Voice Receive leads conform electrically to the voltage characteristics specified in EIA Interface Standard RS-232-C. The Voice Answer-Back leads are terminated within the data set in 600 ohms balanced to ground. The Voice Receive leads provide a 600 ohms balanced pair on which the line signals are passed to the customer. The characteristics of the regular interface leads are summarized below:

SUMMARY OF DATA CIRCUIT INTERFACE TERMS

Binary State	ONE	ZERO
Signal Condition	Marking	Spacing
Voltage State	Negative	Positive

SUMMARY OF CONTROL CIRCUIT INTERFACE TERMS

Control Function	OFF	ON
Voltage State	Negative	Positive

4.2.6.2 Closure-Type Interface

An installer option is provided on Data Set 407B that permits the interface to be used with many ARUs that were designed to operate with a closure interface. The option modifies both the driver and terminator circuits of the 407B.

The drivers of the 407B closure-type interface can be represented by an equivalent circuit of approximately 1000 ohms in series with a source of approximately ten volts (see Figure 9). The source will be positive or negative to ground, depending on the sense of the output, positive indicating a closure, and negative an open. Thus, closure sensors in ARUs which are the equivalent of 1000 ohms to a negative ten volts will see zero volts (simulating a closure to ground) at the interface when the 407B driver source is positive, and will see negative ten volts (simulating an open) at the interface when the 407B driver source is negative. The option modifies the driver in such a way that closure and opens are simulated at the proper times.

The closure-type interface option causes the terminators of the 407B to interpret an open (high-impedance) to ground on the interface lead as an OFF condition and a short (low-impedance) to ground as an ON condition, which is the correct logic for a closure interface. To ensure proper operation, the impedance or voltage conditions specified in this section must be met. Note that grounded contact drivers will meet these requirements. If solid-state closure devices are used, they must use a positive polarity to ground.

The overall characteristics of the optional interface correspond to a closure interface in the following ways:

SUMMARY OF DATA CIRCUIT INTERFACE TERMS

Binary State	ONE	ZERO
Signal Condition	Marking	Spacing
Closure State	Closed	Open

SUMMARY OF CONTROL CIRCUIT INTERFACE TERMS

Control Function	OFF	ON
Closure State	Open	Closed

It should be remembered that, with the optional interface, the "closed" and "open" states are only simulated and do not mean that there is a metallic contact in the circuit.

CAUTION:
Some customer closure terminators may be of a type different from that shown in Figure 9, approximately 1000 ohms in series with a negative 10 volts, and the optional 407B drivers may not provide the correct output for these terminators. For instance, a "worst case" would exist where the terminator in the customer's ARU is 1000 ohms in series with a positive 10 volts, which when used in conjunction with the optional closure-type interface would cause an open to be simulated when a closure was intended and vice versa. A more common occurrence may be that the impedance and voltage of the terminator are such that the ARU cannot distinguish between an "open" and a "closed" condition. Hence, when the closure terminator is not "typical," the customer must determine whether his ARU will make the correct interpretations. In some cases a conversion to standard EIA terminators (specified by RS-232-C) and use of the regular interface may be required.

The equivalent circuit for the 407B closure interface driver shown in Figure 10 can be used for calculations.

Values in this figure and the conditions which must be met at the interface are as follows:

RS is 909 ohms ±1 percent.

VS is between 7.5 and 12.5 volts for ON or ONE and is between -7.5 and -12.5 volts for OFF or ZERO.

VI must be a value that the customer terminal recognizes as ON or ONE when VS is 7.5 to 12.5 volts and as OFF or ZERO when VS is -7.5 to -12.5 volts. Typically, the values of VI would approximate 0 volts for ON or ONE and -10 volts for OFF or ZERO. The maximum range of VI should be ±15 volts.

Similarly, the customer must determine whether his closure-type driver will deliver the proper interface signal to the terminator in the 407B. The equivalent circuit of this terminator is shown in Figure 11. Values in this figure and the conditions which must be met at the interface are as follows:

RT is 2860 (4270 for the out-of-service lead — (OS)) ohms ±5 percent

VT is a minimum of 3.0 (1.25 for OS) volts and a maximum of 4.5 (1.75 for OS)

VI must be no more than 0.4 volt, but greater than -15 volts for an ON condition; and must be at least 2.0 volts (1.20 volts for OS), but less than 15.0 volts for an OFF condition.

If the equivalent circuit of the customer's driver is passive (such as for a metallic contact or a transistor switch), and its equivalent resistance is 250 ohms or less for an ON condition and 100,000 ohms or greater for an OFF condition, VI will meet the requirement just stated.

Note that the Out-of-Service (OS) circuit has a different equivalent circuit and voltage specification. This is because, for the regular interface (but not for the closure interface), OS goes to an ON condition instead of an OFF as the other leads do during a failure mode. If uniform active drivers are desired, the minimum requirement of 2.0 volts for an OFF can be used for all termination leads. Also, the requirement for a passive equivalent circuit specified above applies uniformly to all leads.

4.2.7 Options

Following is an option table summarizing all of the 407B data set options available to the customer.*

Option	Description	Explanation
A	DDD	Type of Operation
B	Private Line	
C	No ACD used	Means of Providing
D	ACD used	Referral Switching
H	EIA	Type of Interface
J	Contact Equivalent	

*A wiring option also exists which allows selection of the method of detection of the "computer down" state.

K	TIR-Always	Terminal Initiated
L	TIR-During Comp Down Only	Referral
M	OS not controlled by DTR	Out-of-Service Control
N	OS controlled by DTR	

5. SYSTEM OPERATION — TRANSACTIONS

This section describes, from start to finish, typical transactions accomplished via the Transaction telephone system. It details the activities and operations at both the Transaction I and Transaction II telephones, the 407B, and the data center computer/ARU. As an example, a financial industry application, namely credit checking, will be considered. In addition, certain other assumptions are made. It is initially assumed that the green/yellow lamps on the Transaction telephone are active, and that the transactions require two card operation. Subsequently, referrals, computer down operation and error conditions are described. At the data center, it is assumed that an ACD is present, and the 407B is optioned for Terminal Initiated Referral-Always.

5.1 Typical Transaction — Transaction I Telephone

To begin the transaction, the merchant lifts the handset of the Transaction telephone, waits for dial tone, and inserts both the dialing and customer cards. The telephone automatically dials the telephone number of the data center, and buffers the merchant and customer data.

At the data center, the ACD queues the call, if necessary, and directs it to the first available computer port. The 407B associated with that port answers the call and sends the 1.5 second answer tone.

While the call is being dialed, set up, and answered, the merchant can manually enter the transaction amount, then press the END button. Alternatively, the merchant can press the (/) button after the transaction amount, which allows additional data, such as inventory numbers or a PIN (Personal Identification Number), to be entered either on the manual entry pad, or via the PIN pad (if it is available and enabled). When the additional data has been entered, the merchant presses the END button. When the answer tone ends, the Transaction telephone begins to output the buffered data. If all the data in the buffer go out before the merchant has finished manual entry, the remaining keyed data is transmitted as it is entered.

The data is received and decoded by the 407B and presented to the ARU port. The data center computer processes the incoming data and decides whether or not to approve credit. It then causes the ARU to give the appropriate response to the Transaction telephone. If credit is approved, 1.5 seconds of answer tone are transmitted. If not, 3 seconds of answer tone are transmitted.

Note: If the green/yellow lamps are not active, the appropriate voice response is transmitted immediately.

The Transaction telephone responds to the answer tone by acknowledging receipt of the signal. The telephone sends TOUCH-TONE "a" for receipt of the 1.5 second answer tone and lights the green lamp. A TOUCH-TONE "b" indicates receipt of the yellow lamp signal. The Transaction telephone lights the yellow lamp, and sends "##".

The ARU responds to the receipt of "b##" by transmitting the selected voice message to the telephone. Since it is assumed in this case that no referral is necessary, the merchant hangs up, and the computer times out and turns DTR OFF to disconnect the call. This action is described schematically in Figures 12A, B and C. Figure 12A shows a normal transaction in which the green lamp is lit and no future action by the merchant or data center is necessary. Figure 12B illustrates a transaction in which the yellow lamp is lit and an ARU generated voice message is sent to the merchant. Finally, Figure 12C depicts the data transfer from cards and manual entry to the telephone and from the telephone to the telephone line.

5.2 Typical Transaction — Transaction II Telephone

When the data center is equipped for voice response and/or keyed answer tone only, the Transaction II telephone can be operated in exactly the same manner as the Transaction I telephone, and the transaction is identical to that of Section 5.1. However, if the data center is equipped for FSK transmission, or the user desires "hands free" operation the typical transaction is somewhat different.

In this case, the merchant leaves the handset in its cradle and presses the ON button on the Transaction II telephone to initiate the transaction. He listens for dial tone (via the call progress tone sounder) and, when it occurs, he inserts the dialing card in the card reader. In response to the instruction lamps, he inserts the customer card, keys the dollar amount of the transaction, or other variable data, on the manual entry pad and/or the PIN pad, and then presses the END button. The manually keyed data from the Manual Entry Pad only is displayed on the visual display as it is keyed in.

The call handling sequence at the data center is identical to that of Section 5.1. When the 1.5-second answer tone is returned to the Transaction II telephone, the call progress sounder is muted, and data transmission begins.

The data is received, decoded, and presented to the ARU port by the 407B. The data center computer will process the incoming data and decide whether or not to approve credit. It then causes the ARU to give the appropriate response to the Transaction II telephone. The response mode, selected by a dialing card character can take the form of keyed answer-tone (1.5 or 3 seconds, to light the green or yellow lamps, respectively), or FSK signals which can contain data to light or blink the green and yellow lamps, as well as data for display. If the response is in FSK, the message begins with the ASCII STX character. A "6?" following the STX will cause the green lamp to light, while a "7?" will cause the yellow lamp to light. Characters following the "?" will be displayed on the face of the Transaction II telephone. Characters which can be displayed are given in Figure 8. The FSK response message is ended with the ASCII character ETX. The ETX character is followed by a longitudinal redundancy check (LRC) character (see Section 7).

The Transaction II telephone responds to the ARU message by acknowledging recept of the signal. When the green or yellow light has been lighted in response to a tone signal, the telephone sends the "a" or "b" acknowledgment in the same manner as the Transaction I telephone. However, if the yellow lamp indicates, as in this example, that a voice message follows, the ARU must wait until the merchant lifts the handset. Accordingly, the Transaction II telephone will transmit "##" when the user lifts the handset while the yellow light is on in response to a keyed answer tone.

The ARU response to the receipt of "b##" by transmitting the selected voice message to the telephone. Since it is assumed in this case that no referral is necessary, the merchant hangs up after hearing the message. The Transaction II telephone then transmits "*#*" before disconnecting. The 407B recognizes this sequence, passes it to the ARU, and disconnects the call at the receiving end.

If the message to the Transaction II telephone was an FSK, rather than a KAT signal, the acknowledgment sequence is different. The Transaction II telephone will acknowledge all incoming FSK messages with an ACK sequence (4#4) if parity and the LRC are correct. (If the LRC check is disabled by a character in the response message, after a parity check, the ACK sequence is sent when ETX is received as described in Section 7.) If the parity or LRC is incorrect, the NAK sequence (3#3) is transmitted. No special code is transmitted to verify the lighting of the green or yellow lamp.

The Transaction II sends no signal when the merchant goes off hook. If the ARU has a voice message for the merchant following the FSK message, a suitable delay must be imposed before it is sent to allow the merchant enough time to pick up the handset. Alternatively, the message could be repeated several times. If no referral is necessary, the merchant hangs up

after hearing the message, and the telephone transmits the hang-up code (*#*) before disconnecting. The 407B detects the hang-up code and disconnects the call at the receiving end.

The sequence of operation utilizing FSK response is shown in Figures 13A and 13B for green and yellow lamp operation, respectively.

5.3 Referral

If the data center computer decides that a call should be handled by a human attendant, it transmits a signal (keyed answer tone or FSK, depending on the calling terminal type) to the terminal to light the yellow light to instruct the merchant to pick up the handset. Upon receipt of the correct acknowledgment which indicates the yellow light is on, the computer can generate a voice message asking the merchant to wait, then turn AR ON to request referral. Referral will then take place as described in Section 4.2.3 and 4.2.4. This is illustrated in Figure 14A.

During the transaction, the merchant may decide that he wants to speak with a human attendant at the data center. Alternatively, he may have received instructions, via a voice message or (in the case of the Transaction II telephone) via displayed FSK characters, to initiate a referral. In either case, the merchant will press the ATTN button. This sends a special code (**) to the data center. The 407B recognizes this code and, if the Terminal Initiated Referral-Always option has been selected, it executes a referral in the manner described in Sections 4.2.3 and 4.2.4. These activities are shown schematically in Figure 14B. With an ACD present, after the attendant line has been selected and the two-digit code has been sent to the ARU, the data set can be released (by turning DTR OFF for 100 msec) to handle other incoming calls while the referral is in progress.

5.4 Computer Down

When a merchant initiates a transaction in the normal manner during a period when the computer is down, and the 407B recognizes the fact, the 407B will answer the incoming call and send a 3.5-second burst of answer tone. The Transaction telephone will automatically compare the transaction amount entered by the merchant with a floor limit encoded on the merchant card. If the transaction amount is less than or equal to the floor limit, the Transaction I telephone will light the "Follow Special Instructions" lamp on its face. The Transaction II telephone will, in this case, display "SPECIAL" on the visual display. Either of these tells the merchant to refer to (probably written) instructions from the data center. If the transaction amount is greater than the floor limit, the telephone will light the yellow lamp and generate an automatic terminal initiated referral. In the Transaction I telephone, "**" is sent as soon as the yellow lamp is lit. The Transaction II telephone sends "**" as soon as the handset is lifted in response to the yellow lamp. If the handset is not lifted within 20 seconds after the yellow lamp is lit, the Transaction II telephone sends the hang-up code (*#*) and disconnects from the telephone line.

Note: Automatic terminal initiated referral during computer down periods can be eliminated by omitting the floor limit on the dialing card. However, the ATTN button is still active.

Computer down operation is described schematically in Figure 15.

5.5 Error Conditions

A number of anomalous conditions may arise in this system which are detectable and correctable by the computer. For example, the Transaction I telephone does not send a hang-up code. Thus if the 407B does not receive or recognize a battery interruption from the central office, the associated computer port will stay on the line. Accordingly, to minimize unnecessary port time and prevent a lock-up condition, the computer should have a time out feature which disconnects the call after a suitable silent interval.

The Transaction telephone is equipped to detect certain errors from the card reader, such as improperly coded or damaged cards. If this occurs, the set will flash the appropriate

sequence lamp, if it is on, instructing the merchant to try again or else manually enter the required data.

The Transaction telephone also verifies the lighting of the green or yellow light by tone responses by sending "a" or "b" as an acknowledgment. If, due to a transmission error, the wrong lamp is erroneously lit, the Transaction I telephone is receptive to a correction until the merchant presses a button on the manual entry pad, (provided the merchant has not hung up). The Transaction II telephone is receptive to green light correction in the same manner. Erroneous activation of the yellow lamp can be similarly corrected, with no time limit, in the Transaction I telephone (or the Transaction II telephone if the merchant goes off-hook within 20 seconds); or the ARU may correct false lighting of the yellow lamp by an appropriate voice message. Such errors and corrections are expected to be rare.

The coding of the customer and dialing cards includes a longitudinal redundancy character (LRC) which allows the telephone to check for data errors, (see Section 6.3.7 for a discussion of the LRC). In addition, the Transaction telephone adds an LRC and character count (CCT) to the first and sometimes subsequent (see Section 7) data transmissions (after "# #") so that the computer can check for transmission errors. If transmission errors are detected by the computer, either by format error or LRC check, a "rekey" can be requested. When operating with a Transaction I telephone, or a Transaction II telephone with the KAT receiver active, this is done by transmitting a 3-second answer tone, and giving the appropriate voice message to the merchant after receipt of a TOUCH-TONE "b" followed by "##" signaling that the yellow light is on and the handset is off-hook.

If the Transaction II telephone is operated with the data receiver active, retransmission of messages is facilitated by the use of FSK transmission. If the error detected indicates a transmission error in the initial inquiry, the ARU can send "1?" after the STX (and followed by ETX and LRC) and the Transaction II telephone automatically retransmits the message. Alternatively, the ASCII NAK character can be transmitted to the terminal with the same results. The number of times this sequence takes place is controlled by the ARU. If the error occurred in a subsequent message, transmission of the NAK character or the STX 1? ETX LRC sequence results in the legend E00 being displayed on the visual display.

If the response to a Transaction II telephone is in FSK, the Transaction II telephone sends ACK or NAK depending on the LRC and parity checks. If NAK is sent, the message is considered invalid, and no action (including lighting lamps) is taken by the telephone. Receipt of the NAK signal should cause retransmission of the FSK message. The number of retransmissions is under the control of the ARU.

If an error is detected in a message from the Transaction II telephone with the FSK data receiver active, a number of corrective measures can be taken. If the handset of the telephone is off-hook, a voice message can be used to request rekeyed data. If the handset is on-hook, a message for display can be sent. For instance, a display message preceded by an E could indicate any of several actions which could be taken by the merchant, such as rekeying of manual data, etc.

Figure 16A and B show the sequence for the above error conditions. Finally, Figures 17A and B summarize the system's operation considering "normal" transactions, referrals, computer down operation and error conditions.

Another type of error condition occurs in the case of Transaction II telephone FSK signaling, when either the inquiry message or the response message contains an error. This situation is examined in Section 7.5.

6. MAGNETIC STRIPE CARDS

As previously described, the Transaction telephone employs two cards in conducting a typical transaction: a dialing card, used to access the data center and enter information pertinent to the user, and a second or "customer" card containing information pertinent to the particular transaction (e.g., account number, etc.). The following sections

present requirements for the manufacturing and encoding of these cards.

When the card is made according to good practice and these requirements, card useful life expectancy will be over 50,000 insertions in the magnetic stripe reader.

5.1 Applicable Standards

The Transaction telephone is fully compatible with cards manufactured and encoded according to the American National Standards Institute, Inc., (ANSI) standards for credit cards. Specifically, cards produced in accordance with ANSI X4.13-1971 and ANSI X4.16-1976 are compatible with the Transaction telephone. Applicable paragraphs of these standards are:

X4.13-1971 — Paragraph 2.1 and 3.1

X4.16-1976 — All of sections 2, 3, and 4

— Paragraphs 5.1 through 5.4 and 5.6.*

6.2 Summary of Requirements

The assignment of 4-bit characters and the corresponding characters in decimal, hexadecimal, and TOUCH-TONE are given in Table 1.

6.2.1 Summary of Card Standards — Mechanical

Pertinent physical dimensions of the card and the location of the magnetic stripe are shown in Figure 18. The length of the card is not critical. Signature panels and the like should not be placed opposite the magnetic stripe due to possible damage from a tension spring in the card reader. Edge burrs normal to the card face shall not exceed 0.003 inch (0.08 mm) above the card surface. No point on any edge of the card shall lie more than 0.004 inch (0.10 mm) from a straight edge against which that edge is resting. The card material shall not contain elements which migrate into and modify the magnetic material. A warped card will be read by the card reader if a force of 0.5 pounds placed over any point along the magnetic stripe will render that card in contact with a flat surface on which the card rests.

Any surface distortions, irregularities, or raised areas which might interfere with a recording or playback head must be at least 0.250 inch from either the top or bottom edge of the magnetic stripe. Raised areas in excess of 0.005 inch from the card surface must reside in the area allowed for embossing as per Figure 18.

6.2.2 Magnetic Material — Physical Characteristics

Magnetic material shall be located on the card so that it permits the encoding of the data track specified in Section 6.2.4. The card shall contain no elements which migrate into and modify the magnetic material. The reading surface must not be lower than the surface of the surrounding card area. Thickness of the card plus the read surface shall not exceed 0.035 inch.

The average peak-to-peak surface irregularity of the reading surface shall not exceed 50 microinches (1.3 μm) Centerline Average in either the longitudinal or the transverse direction, using a cutoff wavelength of 0.01 inch (0.25 mm) or 0.03 inch (0.76 mm) when using a probe having a minimum radius of 100 microinches (2.54 μm).

The profile of the reading surface of the magnetic stripe, as measured parallel to the height of the card with a probe having a radius of 0.015 inch (0.38 mm) to 0.100 inch (2.54 mm), shall show a deviation from high point to low point of not more than 0.00015 inch (150 microinches, 3.8 μm) for each 0.100 inch (2.54 mm) of the stripe width.

6.2.3 Performance Characteristics of Magnetic Material

The magnetic material shall be capable of producing peak readback signals of not less than 80 percent of the read-head voltage calibration, when written with any current between 350 percent and 500 percent of a defined write-head current calibration.

*Note: An expansion of paragraph 5.6 to include control information encoded on the dialing card specific to the Transaction telephone is given in Section 6.3 below. Portions of Section 6 are reproduced with permission from American National Standards (X4.13 and X4.16) copyright 1971 and 1976 by the American National Standards Institute, copies of which may be purchased from the American National Standards Institute at 1430 Broadway, New York, New York 10018.

The 100 percent read-head voltage calibration is defined as the maximum peak readback signal obtained from a saturation plot of a "secondary signal amplitude reference tape" (Standard Reference Material [SRM] 3200 as given in American National Standard Unrecorded Magnetic Tape for Information Interchange (9-Track 200 and 800 CPI, NRXI, and 1600 CPI, PE), X3.40-1973), corrected to the primary standard, written at 200 flux reversals per inch [FRPI] (8 flux reversals per millimeter [FR/mm]), nonreturn-to-zero, and transported at a velocity equal to that of the card encoder/reader.

The 100 percent write-head current calibration is defined as that square wave current required to achieve 80 percent of maximum voltage from the National Bureau of Standards tape, corrected to the primary standard.

Note: Saturation plots for both the SRM 3200 tape and the plastic card specimen must be conducted using the same set of write heads and read heads, and associated electronics, and the same transport velocity.

Write heads and read heads must be aligned for maximum signal transfer on both the tape transport and the card encoder/reader.

Transport velocity differences should be kept to an absolute minimum since readback signal varies with transport velocity. Saturation plots should be performed at velocities such that head frequency response remains constant.

Head pressure should be applied to produce uniform results in readback signal throughout the length of the card specimen. It is desirable to provide minimum head-to-material spacing. Head pressure should not, however, be excessive enough to cause magnetic-material damage or head damage. This procedure characterizes the material and does not compensate for signal loss due to stripe curvature allowed in 6.2.1. **CAUTION:** This test does not guarantee any minimum or maximum value of intrinsic coercivity, H_{ci}.

The specification of this parameter (if required) is left to the individual card purchasers. In general, higher coercivities provide greater encoded permanence at increased cost.

The standard environment for signal amplitude measurements is 73°F ±5°F (23°C ±3°C) and 40 percent to 60 percent relative humidity. When tested under otherwise identical conditions, the readback signal amplitude from the magnetic stripe shall not deviate from its value in the standard environment by more than 15 percent over the range, as follows:

Temperature: -30°F to +122°F (-35°C to +50°C)

Relative humidity: 5 percent to 95 percent with a maximum wet bulb temperature of 77°F (25°C).

6.2.4 Encoding Specifications

Data read by the Transaction telephone is encoded on Track 2 of the magnetic stripe only. Other tracks may be encoded for other purposes.

The encoded data shall extend between two lines 0.353 inch (8.97 mm) and 0.463 inch (11.76 mm) from the top edge of the card.

Data shall be arranged as given below and shall begin in sequence from the right-hand side of the card as viewed from the side containing the stripe — with the encoded tracks at the top.

The centerline of the first data bit (low order bit of the start sentinel) is 0.293 ±0.020 inch (7.44 ±0.51 mm) from the right edge of the card. The centerline of the last data bit (longitudinal redundancy check [LRC] character) recorded shall not extend closer than 0.273 inch (6.93 mm) from the left edge of the card.

The lead-in up to the first data bit (start sentinel) shall be clocking bits (zeros), and the distance from the last data bit (LRC character) to the end shall also be clocking bits. The first clocking bit shall not begin further than 0.115 inch from the right hand edge of the card.

The encoding technique was developed by Aiken in 1954 and is known as Two-Frequency, Coherent Phase Recording. This

method allows for serial recording of self-clocking data (on one channel).

The data is comprised of data bits and clocking bits together. An intermediate flux transition occurring between clocking transitions signifies a "one"; the absence of an intermediate flux transition signifies a "zero."

The data shall be recorded as a synchronous sequence of characters without intervening gaps. Table 1 lists the hexadecimal characters which may be encoded on this stripe.

Recording shall be in a saturation mode with magnetization parallel to a line in the plane of the track. The direction is determined by the recording angle.

The signal on track 2 shall be recorded in such a way that the maximum playback amplitude will occur when the magnetic centerline along the head gap is at an angle of 0° ±20' for Track 2 to a line normal to the top edge of the card.

6.2.5 Additional Characteristics of Track 2-Bit Density

The average bit density of the recorded signal shall be 75 bits per inch (2.95 bits per millimeter) (±3 percent) when measured along a line parallel to the longitudinal centerline of the signal. The spacing between adjacent flux changes shall be 13,333 ±400 microinches (0.3387 ±0.0102 millimeter) (±3 percent) for a "zero" and 6667 ±267 microinches (0.1693 ±0.0068 mm) (±4 percent) for a "one." For a sequence of recorded "ones" the density corresponds to a nominal 150 FRPI (5.91.FR/mm).

6.3 The Dialing Card

The dialing card contains the telephone number of the remote data center to be accessed, the user or merchant identification information, and control characters that affect certain functions of the Transaction telephone. The possible combinations of these functions are shown in Table 4. The fields provided for on the dialing card in the order of their appearance are:

1. Start Sentinel and Dialing Card Identification — 2 characters.
2. Telephone number and control characters — up to 15 characters.
3. Field separator — 1 character.
4. Floor limit field — 0 or 3 characters.
5. Response mode identification — 1 character.
6. User Identification characters — up to 24 characters.
7. Special control character — 0 or 1 character.
8. End sentinel and LRC — 2 characters.

The total number of characters allowed on the card by most card encoders is 40. However, the Transaction telephone can handle the total number of characters indicated by summing items 1-8 above. That total is 49.

The recommended dialing card design is shown in Figure 19. Note that the magnetic stripe should be in the lower portion of the face of the card, on the same side as the printed information. This facilitates placing the cards in the card holding slots so that they can easily be removed and used in the card reader.

6.3.1 Dialing Card Identification

The dialing card is identified on the magnetic stripe by the appearance of the hexadecimal "C" as the first character after the start sentinel (hexadecimal "B"). The presence of this character instructs the Transaction telephone to treat the card as a dialing card.

6.3.2 Telephone Number

The telephone number field contains the telephone number of the data center to be accessed, along with control characters which dictate the mode of dialing to be used. There are four modes of dialing to be considered. Therefore, to provide optimal Transaction telephone service to data center users it is necessary to know the dialing modes required for a particular Transaction telephone installation. It is suggested that the data center management set up a means for acquiring this information prior to making dialing cards. The five dialing modes are:

1. Normal one part dialing, in which the entire telephone number is dialed after the customer card has been entered or manual entry has begun. In this mode, the entire number is encoded on the card, followed by a hexadecimal "D", as shown in the first card format in Table 4. This mode will serve most Transaction telephone installations, and all of those where a Transaction telephone is put on a regular business line.
2. Two-part dialing, in which the first part of a number, an access code requiring listening for a second dial tone, is dialed between card insertions. The rest of the number is dialed after the customer card has been inserted. Upon reading a card with a two-part number, the set immediately dials the first part of the number. The merchant is instructed to insert the customer card when the second dial tone is received. The call then progresses as in the normal dialing case. Two-part dialing is activated by a hexadecimal "C" between the parts of the telephone number as shown in the second example in Table 4.
3. Split mode dialing, which is two-part dialing in which the two parts are dialed in different modes. For instance, the first part of a number can be dialed in dial pulse, and the second part in TOUCH-TONE. The first part of the number will always be dialed in the mode selected by the installer for the type of service provided. The change in mode is invoked by replacing the hexadecimal "C" discussed in the previous paragraph with a hexadecimal "E" between the parts of the telephone number as shown in the third example of Table 4.
4. Predialing, in which the entire number is dialed immediately after the dialing card is entered, between the card insertions. This mode is activated by a hexadecimal "C" following the telephone number, as shown in the fourth example in Table 4. Predialing is recommended in TOUCH-TONE installations only, because the Transaction telephone cannot read the second card until it has finished dialing. Rotary dialing typically takes 7 to 8 seconds which may be too long a time for the user to wait between card insertions. In normal rotary dialing, the user would be keying manual data during the dialing interval. Even in TOUCH-TONE installations, however, care must be exercised in selection of predialing, because the answer tone may be missed if it occurs during customer card entry.
5. A fifth dialing option is specified for applications where the user does not want to use the Transaction telephone features except for automatic dialing. In this case, the dialing card should be encoded as shown in the last example of Table 4, that is, with a hexadecimal "B" following the encoded telephone number.

The total number of characters allowed in the telephone number field, including any two-part number separator is 15 characters. This does not include the hexadecimal "D" delineating the end of the telephone number.

6.3.3 The Floor Limit

After the hexadecimal "D" ending the telephone number field, three digits are optionally included indicating the floor limit. These three digits are a whole dollar amount. The card must be encoded with either the full three digits or no digits.

When the computer unavailable signal is received (see Section 4.1) the value in the floor limit section of the card is compared to the dollar amount entered on the manual entry pad. The pad entry used for the comparison is the value keyed into the amount field immediately after the third instruction lamp comes on and before the decimal point or first field separator, if any. The actions taken as a result of this comparison are described in detail in Section 5.4.

If no floor limit is specified on the dialing card, no matter what is keyed in on the pad, the "follow special instructions" lamp (4th instruction lamp) on the Transaction I telephone

always lights when the computer down indication is received. (A message indicating that the user should follow these instructions ("SPECIAL") is displayed visually in the Transaction II telephone.) It is recommended that the dialing card have printed on it special instructions to be followed when this lamp or display is activated. These may be printed on any part of the card, as appropriate. For example, such special instructions could say, "If the amount of this transaction is below your floor limit, consult the warning bulletin and proceed with the transaction."

6.3.4 Response Mode Control

The character following the floor limit, if there is a floor limit, or following the telephone number delimiter otherwise, controls the response mode of the Transaction telephone. This can be voice only, keyed answer tone (KAT) for lighting the green and yellow response lamps, or frequency shift keying (FSK). The frequency shift keying is not implemented in the Transaction I telephone design, but is available in the Transaction II telephone.

The control characters for the various response modes are as follows:

1. Hexadecimal "C" — voice only. In this mode, neither Transaction telephone will respond to any keyed answer tone or FSK signals. If this character is on a dialing card used in the "hands free" mode, the telephone lights the yellow lamp immediately upon completion of transmission of the inquiry message.
2. Hexadecimal "E" — voice or keyed answer tone. In this mode the Transaction telephone will respond to the appropriate keyed answer tone signals by lighting either the green or yellow response lamp.
3. Hexadecimal "A" — Data reception via FSK at 110 bits per second, when used in the Transaction II telephone. A card with an "A" in this position must not be used in the Transaction I telephone.
4. Hexadecimal "D" — Data reception via FSK at 150 bits per second, when used in the Transaction II telephone. When used in the Transaction I telephone, hexadecimal "D" will cause the same response mode as hexadecimal "E".
5. Hexadecimal "B" — Reserved for data reception via FSK at 300 bits per second, when used in potential future offerings. A card with a "B" in this position must not be used in the Transaction I telephone.

These response mode control characters are present to allow a single set to communicate with different data centers, some of which may have available only limited response capability. This is the only character on the dialing card which differentiates between the Transaction I and Transaction II telephones.

6.3.5 User Identification Characters

Characters following the response mode character are transmitted to the remote data center by the Transaction telephone when the connection is established. There may be between 0 and 24 characters in this field but the number of characters must be within the constraint of the total number of characters allowed on the card, including dialing and control characters.

Specifically, the characters that may be used in the user identification field are the digits 0 through 9 and the hexadecimal characters "D" and "E". The hexadecimal "E" can cause premature end of input to some ARUs. It is transmitted as a TOUCH-TONE "c" and if this character affects the ARU in use, it should be avoided. Other hexadecimal characters encoded on the magnetic stripe may cause error conditions and consequently should be avoided. In addition, only under the special circumstances described in Section 7.1 should the user identification field start with the hexadecimal character "D."

6.3.6 Special Control Character

The user identification is typically followed by the ANSI end sentinel and LRC. However, the hexadecimal characters A, B, and C preceding the end sentinel have special meaning.

The hexadecimal "A", if used, will inhibit testing of the LRC on the second card. This feature was included to allow use of certain

cards, known to be in use as of this writing, with incorrect LRC characters.

The hexadecimal "C" inhibits storage of the data entered by the dialing card and disables the one number repertory dialing feature (see Section 4.1). This feature has application when the user does not want information on the dialing card to be accessed subsequently.

A hexadecimal "B" will bring both of the features above into operation. If none of these characters is present before the end sentinel, then neither feature is operated, i.e., the repertory dialer is activated, and the set will check the LRC of the customer card. Calculation of the LRC is described in the next section.

6.3.7 End Sentinel and LRC

The final two characters on the dialing card are the end sentinel (hexadecimal "F") and the longitudinal redundancy check (LRC) character. The LRC is a binary sum without carry of the characters preceding it on the card. The parity bit on the LRC corresponds to the parity of the LRC character.

6.4 The Customer Card

Any customer credit card or other magnetically-encoded plastic card conforming to ANSI X4.16-1973 will work in the Transaction telephone. Typically, these cards begin with a start sentinel (hexadecimal "B") followed by the customer number, the expiration date of the card, the end sentinel (hexadecimal "F") and the LRC. As noted in Section 6.3, the LRC may be optionally ignored by the Transaction telephone.

Only the start sentinel and the end sentinel have control functions in the Transaction telephone when used on the customer card. If the start sentinel appears at the beginning of the card, and in another position as well, only the first appearance will be considered a control character. Subsequent appearances will be treated as data characters. However, precautions should be taken in encoding customer cards to avoid the following characters and sequences due to their effect on the parts of the system.

The hexadecimal "A" will be transmitted as the TOUCH-TONE "#" (A_4 B_3). This will cause a premature end of input in some manufacturer's audio response units. Similarly, two hexadecimal "A's", transmitted in sequence, will correspond to the end of text sequence sent by the Transaction telephone and should therefore be avoided. The hexadecimal "C" is transmitted as the TOUCH-TONE "*" (A_4 B_1). The hexadecimal sequence "CAC" will therefore correspond to the Transaction telephone system disconnect code, "*#*", (see Section 4.2). This, too, should be avoided. In addition, applications of the Transaction telephone are being considered in which the hexadecimal "A" will always have special significance.

The hexadecimal "D" corresponds to the field separator described in ANSI X4.16-1973, and is transmitted as the TOUCH-TONE "b" (A_2 B_4). This character transmitted twice in sequence is equivalent to depression of the ERASE button (see Section 7.3) on the Transaction telephone, and therefore this sequence should not appear on customer cards.

The hexadecimal "E" is transmitted as TOUCH-TONE "c" (A_3 B_4) and may cause a premature end of input in some Audio Response Units.

Finally, the hexadecimal "F" cannot be used as part of data because it will be recognized as the end sentinel and will terminate reading of the card.

7. MESSAGE FORMAT

The Transaction telephone transmits five kinds of information in a normal inquiry message. These include, in order of transmission: the telephone type identification (TID), the user (merchant) identification information, the customer identification information, the amount field, and the message check characters. The TID and message check characters are generated automatically by the Transaction telephone. The other kinds of information correspond directly to the information entered either through card entry or from the manual entry pad or PIN pad. The message format is illustrated in Table 5.

The Transaction telephone transmits TID characters at the beginning of data transmission immediately following the 1.5 second answer tone. These characters identify the type of set in use and provide certain information about how it is being used. The first character transmitted is always a TOUCH-TONE "b" (A_2 B_4) for Transaction telephone sets. The next two characters are digits in the range of 0 through 7 that identify features. The digits are interpreted in accordance with their binary representation as follows:

The low order bit of the first character after the "b" indicates whether the message check characters include both a character count (CCT) and a longitudinal redundancy check (LRC), or only an LRC. A one (1) in this position indicates an LRC only; a zero indicates both an LRC and a CCT. Early versions of the Transaction telephone have the LRC only. Calculation of LRC and CCT are detailed later in this section.

The next bit is used for the Transaction II telephone, which is offered with "hands free" operation. A one in this position indicates that the set is being used with the handset "off hook" so that it is ready to receive audio messages. A zero indicates it is "on-hook" and unable to receive an audio message. The bit is always a one in the Transaction I telephone.

The next bit, the highest order bit used for TID, indicates whether the user information, normally encoded on a dialing card, was entered on the manual entry pad or from the card reader. A one indicates manual entry, and a zero indicates that the dialing card was used in the reader.

The third TID character (second character following the initial "b") is nonzero only for the Transaction II telephone. If the high order TID bit is one, (the character has value 4) then the Transaction II telephone is in use and the data receiver is active. If it is a zero, the data receiver is inactive.

The middle bit in this TID character is reserved for future use and is always zero for the Transaction II telephone.

To allow for the possibility of expansion to more sophisticated sets, allowance has been made in the TID for additional characters by using the low order bit as a chain bit. Thus, if the low order bit of the third character is a one, the next character is also a TID character. The last TID character is then identified by a zero in the low order bit position. The chain bit is always zero in the Transaction I and Transaction II telephones. The TID characteristics are summarized in Table 6.

Following the telephone type identification characters the Transaction telephone transmits data in the order that it has been entered. The first transmitted data are the merchant identification information just as it is read from the dialing card or is keyed in. Next the customer data follows. Customer data is preceded by a TOUCH-TONE "a" (A_1 B_4) if a customer card is used. They are preceded by a TOUCH-TONE "b" (A_2 B_4) if the customer data were keyed in using the manual entry pad, and/or the PIN pad.

When customer data is entered via a customer card, only the data (and not the control characters) are transmitted to the data center. The start sentinel, end sentinel, and card LRC are replaced by the TOUCH-TONE "a" at the onset and at the end of the card data. The card LRC is checked automatically by the telephone unless the dialing card is optioned to inhibit the check.

Finally, data entered in the amount field is transmitted. This data is preceded by the TOUCH-TONE "a" sent at the end of customer data. When the merchant presses the END button after keying in the amount field, the telephone sends the end of text (ETX) character sequence (##) followed by the message check character(s).

These data fields correspond to use of the Transaction telephone as described in Section 4.1. Note that when manual entries are used, depression of the END button causes different TOUCH-TONE characters to be sent depending on its location in the sequence of data entry and on the way the characters that follow it are entered. Specifically, when the END button is pressed after manually entering

the user identification information, a TOUCH-TONE "a" or "b" is sent depending on the mode of entering the customer data. When the END button is used after manually entering the customer data the TOUCH-TONE "a" is sent. When the END button is used after the amount field, the end of text sequence and message check character(s) are sent. Finally, when the END button is used later on rekey messages, the telephone sends the ETX sequence, and, possibly the message check character(s). This situation is covered in Section 7.1.

The LRC on the transmitted message is calculated by summing the binary representation of the TOUCH-TONE characters, without carry, using translation Table 1. The transmitted LRC is the corresponding TOUCH-TONE character. The LRC calculation includes the first character transmitted (the TOUCH-TONE "b") through the end of text sequence.*

The CCT, if calculated, is the modulo-10 count of all characters, including the ETX sequence and LRC. It will appear immediately following the LRC in the message character sequence, if the TID so indicates.

Some Audio Response Units will be unable to detect the second "#" in the ETX sequence, the LRC, or the CCT. They will interrupt the host computer on detecting the first "#". Although failure to detect the LRC and the CCT and compare them to calculated values will compromise the error detection capability of the Transaction telephone system, the system will nevertheless operate satisfactorily.

7.1 Messages Following the Initial Message

After the Transaction telephone has sent the initial inquiry message, additional data can be sent either from the card reader or from the manual entry pad. Such data may be sent in response to data center-originated requests for reentry of information, or they may be sent as part of a normal procedure.

When used to send such additional messages, the Transaction I telephone sends what is entered from the card reader or keyed in from the manual entry pad; for card reader entries, data on the card, exclusive of the start sentinel, the end sentinel, and the LRC, is transmitted. Any card characters encountered in the text, exclusive of the end sentinel, will be sent. Thus, if the dialing card is reentered, the telephone number and control information will be transmitted. Before entering additional information after entering a card, the user must wait until the card data is sent. Manually entered information should not exceed 64 characters before pressing the END button, after which another 64 characters can be entered manually. This message format is also illustrated in Table 5.

Messages following the initial message for the Transaction II telephone are handled similarly in the voice and keyed answer tone modes. In the FSK mode, follow-on messages cannot be entered until after the set receives a response message from the data center. Until this occurs, the manual entry pad and PIN pad are locked out from further data entry and the card reader is inoperative.

The LRC and CCT are not appended to subsequent messages from a Transaction I telephone which does not calculate the CCT, as indicated by the TID. The Transaction I telephones which are equipped to calculate the CCT and the Transaction II telephone will append the LRC and CCT characters to all subsequent messages if and only if the user identification field on the dialing card (see Section 6.3.5) starts with the hexadecimal sequence "D8". If the user identification field begins with a hexadecimal "D8", the Transaction telephones also append a sequence (TOUCH-TONE "b9") to the beginning of the subsequent messages.

7.2 Keyboard Characteristics

The keyboard or manual entry pad is similar in appearance to an ordinary TOUCH-TONE dial. However, all entries through the pad go into the logic circuits of the Transaction telephone.

There are slight differences between the 12-button pad and the TOUCH-TONE dial with

*Note that the ETX sequence does not contribute to the LRC because the sum without carry of two identical characters — in this case, ## — is zero.

respect to characters transmitted. The (/) button, which is located in the lower right hand portion of the manual entry pad, causes transmission of the TOUCH-TONE "b" (A_2 B_4) character when the Transaction telephone is in the data mode after dialing and receipt of the answer tone. In the dialing mode, this button sends "#". This differs from the ordinary telephone which always transmits TOUCH-TONE "#" (A_4 B_3) when the button in the corresponding position is depressed. This change was made because many Audio Response Units interpret a single "#" as ETX.

In place of the (*) sign on the TOUCH-TONE telephone a decimal point (.) has been placed on the Transaction telephone's lower left hand button. The TOUCH-TONE signals transmitted in either the Transaction telephone or TOUCH-TONE telephone are the same for this button.

7.3 The Effect of ATTN and ERASE Keys

The ATTN and ERASE buttons have a number of separate functions in the Transaction telephones. When the ATTN key is depressed in the Transaction I telephone the character sequence "**" is transmitted. Transmission of this signal is accomplished immediately when the button is depressed. In the Transaction II telephone, the signal is transmitted when the merchant picks up the handset and presses the button, in either order. No further information is transmitted by either telephone until another button is depressed on the manual entry pad or the card reader is used.

The ERASE button, when pressed while any of the first three instruction lamps are on, will cause the Transaction I telephone to attempt to erase all of the manually entered data block corresponding to the instruction lamp which is ON. If any of the data block has already been transmitted, the set will not erase any data; instead it will transmit the TOUCH-TONE sequence "bb". The ERASE button must not be operated during the dialing or entry of a telephone number.

In addition to the above operation, the ATTN and ERASE buttons have additional functions in the Transaction II telephone.

The ATTN button, if it is pressed before any other button after going off hook (by lifting the handset or by pressing the ON button) has the same effect as inserting the last-used dialing card. If the card was a predial card, the telephone number will be sent immediately. If the card was coded for normal dialing, the telephone number will be sent as soon as a customer card is read or any digit is pressed. If two-part dialing was encoded, then the predial portion of the number will be sent when "ATTN" is pressed, and the rest will be sent when the customer card is inserted or the manual entry pad is used. This feature does not affect normal use of the repertory dialer, which is activated by inserting a customer card immediately after going off-hook.

The ERASE button in the Transaction II telephone, in addition to the function described above, also controls the visual display on the set. When more than eight characters have been received for display, pressing ERASE cycles the display to show the next eight characters. When ERASE is pressed and there are no further characters to display, the display is cleared. In this regard, the ERASE button functions whether the set is on or off hook. While additional characters for display are in the buffer and have not been retrieved, Transaction II telephone will not be receptive to FSK signals or data entry until the buffer is empty.

7.4 2025 Hz Answer Tone Signals

A 2025 Hz tone, with a duration of either 1.5 or 3.0 seconds, is used to control some features of the Transaction telephone. Because such a 2025 Hz tone is used after tripping ringing in the 407B data set, the 2025 Hz tone is called answer tone. The tone is generated automatically by the data set when the call is answered; in addition, the ARU can cause the 407 to generate the tone by operating the TAB lead (see Section 4.2). A similar tone for controlling Transaction telephone features could be recorded as part of an ARU vocabulary. The Transaction telephones receive keyed answer tone signals for triggering data transmission, for triggering computer down operation, or for operating the green and yellow response lamps.

Data transmission and computer-down operation are triggerable only after inserting a dialing card or after an initial depression of the END button when manual dialing is used. As described in Section 4.1, manual dialing is accomplished by first keying in the telephone number, then depressing the END button, then keying in any user identification information. For manual entries, the first END button depression must be accomplished before the keyed answer tone can be detected, even if no telephone number is to be dialed.

Data transmission is triggered by a 2025 Hz tone of 1.5 seconds (±5%) duration. The computer down operation is triggered by a 3.0 to 4.0 second answer tone.

In addition, the 1.5-second answer tone operates the green lamp indication (if enabled by the dialing card) on the Transaction telephone when it is received after transmission of the ETX and LRC sequence. (In the Transaction II telephone the lamp will not operate after the ATTN button has been depressed unless the END button has been subsequently pressed.) Upon receipt of the green lamp signal, the Transaction telephone lights the lamp and sends the TOUCH-TONE character "a" (A_2 B_4). In the Transaction I telephone, or the Transaction II telephone with the user off-hook, if the wrong lamp indication is received, the condition can be corrected by sending the correct signal (again), as described in Section 4.1.6.

A 3-second answer tone sent in lieu of the 1.5 second tone will operate the yellow lamp. Upon receipt of the lamp signal, the Transaction telephones light the lamp and send the TOUCH-TONE characters "b##" (A_2 B_4 -A_4 B_3 -A_4 B_3). (In the Transaction II telephone using KAT response, the "##" portion of this signal will not be sent until the merchant picks up the handset in response to the yellow light.) The "b" should be interpreted as meaning that the yellow lamp has been turned on and the "##" shall be interpreted as meaning that the set is ready to receive an audio message.

7.5 Use of FSK Data Signaling

There are two aspects to consider for using FSK signaling as a response mode for the Transaction II telephone. These are the message format and the data link control protocol. The format merely determines the content of the actual response message. The protocol determines the way that message integrity is guaranteed, for either the inquiry or response message, as well as the steps the user must take when using the terminal.

7.5.1 The Data Message Format

In general, response messages should be of the format shown in Figure 20. Messages sent under this format allow full control of the Transaction II telephone's features. In this format, the STX is always required to allow the terminal to synchronize to the incoming message. The action field, which appears next, is optional and is used to control operation of the set, exclusive of the numeric display. The action field can contain any number of characters, each having a control function. Note that these characters include provision for a negative acknowledgment, which requests retransmission of the inquiry message. Alternatively the negative acknowledgment function may be handled by the ASCII "NAK" character as discussed in 7.5.2.2.

The "?", used as a field separator, *must* be included whether or not there are any characters in the action field. The action field characters for control of set functions are shown in Table 7.

Only one lamp can be lit at once. However, any combination of up to four characters that does not violate this rule can be used. For example, to blink the yellow lamp and disconnect, send 789 in the action field.

Inclusion of a disconnect character in the message will cause the set to send *#* and disconnect immediately, if the receiver is on-hook. If disconnect is not included, the set will be ready for entry of more data by the user. If the user takes no action, then the set will send *#* and disconnect after 45 seconds. Alternatively, if the long time out control character (0) is received, the set will send *#* and disconnect after 3 minutes.

The LRC character in the message is optional in the sense that the character "3" may be included at the beginning of the action field to prevent checking of the LRC. This is to enable using the set in some systems unable to calculate the value of the LRC. When used, the LRC character is computed as the sum, without carry, of the bits of all 7-bit characters in the message, including the ETX, but not the STX, characters.

Characters following the first "?" delineating the action field will be displayed on the visual display. Displayable characters were given in Figure 8. Non-displayable characters are displayed as blanks. In addition, the ASCII character "/" can be used as a display field delimiter. An example of a message that would cause the green lamp to light and the display to show "A 456" is shown in Figure 20b. When the ERASE button is pressed, the display changes to "78" and when pressed again, it shows "9." Space characters can be used to center the display, as desired. The use of the "?" character in the display field is reserved for future offerings. Thus the question mark and the ETX character may not be used in the display field.

7.5.2 Data Link Protocol and Error Control

7.5.2.1 Control Sequences and Overview

The meaning of control sequences sent to the Transaction II telephone in FSK is in accordance with the American Standard Code for Information Interchange (ASCII). Similar codes have been defined as TOUCH-TONE sequences for the Transaction II telephone operating with the data receiver, and these are given in Table 8. Certain other codes have been defined, and their use will be described in the following. Remember that the Transaction telephone sends TOUCH-TONE and receives FSK.

The data line protocol for the Transaction II telephone has been designed so that three different levels of error control are possible, depending on the level of sophistication the data center operator wants to design into the system. The three levels are, in decreasing order of error control capability; the full protocol, discussed in Section 7.5.2.4; the simple protocol, discussed in Section 7.5.2.3; and an optional simplified protocol with a reduced character set, also discussed in Section 7.5.2.3. The level of protocol is invoked in the telephone by the response of the data center to the initial message sent by the telephone.

7.5.2.2 Response to Initial Messages: Invoking Protocol

After sending the initial message, the Transaction II telephone sets a timer for 20 seconds. During that interval, the keyboard is locked out, except for the ATTN button, as discussed earlier.

After sending the initial message, the Transaction II telephone is receptive to six control characters or sequences: The positive and negative acknowlegment characters (ACK and NAK), the STX character, the start of header character (SOH), the disconnect sequence (DLE-EOT), and the special NAK sequence (DLE-NAK). The use of these characters is explained in this section, and Section 7.5.2.6.

If, after transmission of an inquiry message, the ACK control character is received, then the set will send the EOT sequence (5#5) in TOUCH-TONE, set its internal timer to 45 seconds, and await a response message. The set also enters the full protocol mode. When a response is received correctly it will send the ACK sequence (4#4). But the terminal will not execute the contents of the message until after it has received the EOT control character from the data center.

Control of the protocol mode in which the set operates is accomplished by receipt of the ACK or STX control characters. If the set receives an ACK after the initial message, it will enter the full protocol mode. If the response message follows the initial inquiry directly, the STX character, which begins the response, invokes the simple protocol. If, instead, the set receives an NAK, it will retransmit the inquiry message without affecting the protocol mode. The subsequent response then selects the mode.

7.5.2.3 The Simple Protocol

Normally, the Transaction II will receive an FSK message in response to the initial inquiry. The STX at the beginning of this message will invoke the simple protocol. If the message has no detectable errors, then the terminal will send the TOUCH-TONE "ACK" sequence (4#4) and execute the contents of the message. If the set detects an error, it will instead send the "NAK" sequence (3#3) and await retransmission of the message for a new 20-second interval.

Detectable errors in the message include the following:

1. Incorrect message LRC
2. Incorrect parity on any character
3. Missing ETX character or an interruption in transmission lasting more than 3 seconds.

One of the two levels of error control can be selected here through use of the character "3" in the action field, as discussed in 7.5.1. If the "3" is present, then the message LRC is not checked, and the simplest protocol is in effect.

If, before receipt of a data message, 20 seconds elapse, and if the call was initiated by pressing the "ON" button and the receiver is still on hook, then the set will automatically send the disconnect sequence, *#*, and disconnect. If the receiver is off-hook and the time out elapses, no action will be taken automatically, and the set will still be able to receive messages until the user hangs up.

Use of the simple protocol in no way limits the receivable character set. However, because of the limited vocabulary storage available in some ARUs, it may be advantageous to operate the Transaction II telephone with a limited character set. If the simple protocol is used, full control of all set features and display of all digits can be accomplished with a character set consisting of the digits (0-9), the STX, ETX, and "?" characters, a total of 13 characters. If space permits, some additional characters, such as the "/", the space character, and some alphabetics can be added. In general, with a limited character set, an LRC cannot be generated. If all response messages begin with the sequence "STX 3", the telephone will not attempt check for an LRC, and error control is sacrificed. If error control is desired, however, it is possible to choose a constant value of the LRC and construct all messages so that, when received correctly, they yield that value.

7.5.2.4 Full Protocol

The full protocol is invoked, as mentioned before, by the receipt of the ACK signal following any message from the terminal. When the full protocol has been invoked, the set will transmit the EOT sequence (5#5), whenever it receives the ACK sequence. Moreover, when the set receives and verifies a valid FSK message, it will transmit the ACK sequence (4#4), but, unlike the simple protocol, the set will not act upon the message until an EOT signal is received. If the EOT is not received within 45 seconds, the set will disconnect, and send "*#*"

7.5.2.5 Rekeys

Messages following the initial messages are treated by the full protocol if that was invoked by the initial response. If the simple protocol was invoked, the set can be placed in the full protocol made at any time by the receipt of ACK following any follow-up message. If the full protocol is invoked, the Transaction II telephone will respond to a correct message with the ACK (4#4) sequence and await the EOT character before executing the message. In the simple protocol, the set will send the ACK sequence and execute the message immediately.

If the set receives the ASCII NAK character after transmitting a follow-up message, the message will not be retransmitted (as the initial message would be). Instead, the legend "EOO" is displayed on the face of the set.

7.5.2.6 Additional Control Characters

If at any time the set receives the DLE-EOT control sequence, it will send the disconnect signal (*#*) and automatically hang up, unless the receiver is off hook. If the receiver is off hook, then the characters HANG-UP will appear on the visual display.

When the set receives the DLE-NAK control sequence, it will send 5#5 signifying that it is ready to receive FSK data. This feature is useful in the case of slow data entry by the user, in which the data center wants to inform the user that he is taking too long. The set can receive the DLE-NAK sequence during the pauses between manual entry pad button depressions, when TOUCH-TONE characters are not being sent. However, such reception is not always reliable because of the possibility that TOUCH-TONE characters may be ready to go out concurrent with DLE-NAK reception. Therefore, DLE-NAK should always be sent again by the DATA center if an EOT is not received within a few seconds after the first transmission.

Similarly, the set can handle a DLE-EOT sequence during pauses between characters, in which case it will send the disconnect sequence and hang up. Once again, it is recommended that the DLE-EOT sequence be sent repeatedly until the "*#*" is received — when the Transaction II telephone is in a Transmit condition — because of the possibility of concurrent TOUCH-TONE and FSK transmission.

The SOH sequence has special application when sending error messages to the terminal. In this format, the SOH replaces the STX character. Characters following the SOH and preceding either the ETX or STX are displayed, following the word "CODE," which is generated by the set. A space follows the word, so that up to three data characters can be displayed in the eight available display positions. Any added data can be accessed by pressing the erase button, as in the normal messages beginning with STX. After executing the message, the set sends "*#*" and disconnects.

Another character that can be used by the data center is the ENQ control character. This is used, in the full protocol, when the data center does not receive the ACK or NAK control character after a response message; it will cause the set to retransmit the last control character. If there is no control character, which could happen if the set does not receive the ETX character in the message from the data center, then the set will send NAK. During that interval, the keyboard is locked out, except for the "ATTN" button, as noted earlier.

7.6 Signal Specifications

7.6.1 The Transaction I Telephone

This section describes the output and input signal specification for the Transaction I telephone.

Output: TOUCH-TONE frequencies

A Group	B Group	
697	1209	
770	1336	±1.5 percent
852	1477	
941	1633	

The input signal is a timed, keyed answer tone (KAT) of nominal frequency of 2025 Hz. Two durations are decoded by the Transaction telephone. Specifications are:

Input: Answer Tone

Durations: 1.5 sec ±5 percent
3.0 sec ±5 percent

Frequency: 2025 Hz ±0.5 percent

Minimum Level: -33 dBm (900 μ)

Some ARUs may generate these answer tone signals by concatenating signal elements of shorter duration. When this is done discontinuities (or gaps) may occur between elements. These discontinuities must be limited as follows:

Signal elements greater than 450 msec in duration may be separated by a gap of less than 50 msec. Signal elements less than or equal to 450 msec may be separated by a gap of less than 5 msec.

7.6.2 The Transaction II Telephone — FSK Response

The Transaction II telephone receives FSK data at speeds of 150 or 110 bits per second, ±1 percent. The data rate is selected by a character on the dialing card, as specified in Section 6. If no dialing card is used, and dialing information is manually entered, the data rate is set to 150 bits per second.

The mark frequency is 2225 Hz, and the space frequency is 2025 Hz. The frequencies should be held to within ±0.5 percent. The

Transaction II telephone is designed to operate at signal levels greater than -33 dBm (at 900μ) at the telephone line connection.

The receiver is designed with a carrier detector so that erroneous responses will not occur in the absence of carrier responses. When carrier is turned on, it should be present and in the MARK STATE for at least 200 milliseconds before actual data transmission begins.

If there are spaces (without carrier present) between characters, as there could be in the case of characters recorded on an audio response medium with fixed word length longer than a character interval, special care must be taken. To prevent undesirable transient responses that could cause errors in data reception, soft carrier turn-off should be employed. Instead of an abrupt termination of transmission, the carrier should be held on at the end of the stop bit, then attenuated at an exponential rate. The time constant of the turn-off should be at least 2 milliseconds, and the decay should continue until the amplitude of the signal is at least 26dB below its maximum value. This requires a total turn-off time of at least six milliseconds.

The soft carrier turn-off precaution need not be taken at the end of a message or control characters. Thus, when the ETX and LRC have been transmitted, the carrier may be turned off abruptly.

The Transaction II telephone utilizes standard Asynchronous START-STOP ASCII (USASCII) and 7-bit characters with even parity. The character set is given in Figure 8. Data is sent preceded by a single start bit characterized by a MARK-TO-SPACE transition lasting for one character duration. Then the actual character, comprised of 7 data bits, is sent, least significant bit first. Parity follows, and the end of the character is identified by a stop bit at marking frequency. At both bit rates, the stop bit may be any duration greater than or equal to a bit duration.

Ten bits must be transmitted as described above for each data character or control character. Thus, 15 characters per second may be sent at 150 bps, and 11 characters per second may be sent at 110 bps. Note that the stop bit may have duration longer than one bit interval, so that the character rate may be less than indicated. In particular, the more standard rate of 10 cps may be used at 110 bps.

When characters are recorded on an audio response medium, the character rate may be considerably slower than indicated by the bit rate, due to intercharacter gaps. Usually the desired effect can be obtained by recording complete characters on the audio response medium rather than individual tones. Usually the audio unit will have certain constraints on speech segment durations, which will in turn determine the length of individual recorded FSK characters. These characters may be recorded at either of the two convenient bit rates.

Four precautions must be observed when recording FSK data for the Transaction II telephone.

1. The resultant recording must obey the specifications on mark and space frequencies and bit rate.
2. While carrier is present there must be no abrupt phase discontinuities greater than 20 degrees in amplitude at 150 or 110 bits per second. Such phase discontinuities could be generated by differences in phase between the end of one recorded character and the beginning of the next one when switching between the segments is abrupt. Possible future offerings utilizing higher bit rates may have corresponding tighter tolerances on phase discontinuities.
3. Switching between characters can be made less abrupt by turning off the signal (mark frequency) before changing characters, and turning it back on again before the start bit of the ensuing character appears. If this is done, mark frequency must be present for at least 15 milliseconds before the mark/space transition.
4. When the data is being transmitted, the Data Receive (DR) interface lead to the

407B should be turned off to prevent activation of the TOUCH-TONE receiver by the FSK signal. Such activation can cause loss of outgoing FSK characters.

8. MAINTENANCE AND TESTING

A number of maintenance and testing features are included in the various components of the Transaction telephone system. The Transaction telephone, for instance, has self checks built-in for card reader failure and incorrectly coded or damaged cards.

8.1 Automatic Test Line For Testing the Transaction Telephones

The Bell System provides an automatic testing facility for use by customers for verifying the proper operation of the Transaction I and II telephones. To access this test line, the customer dials the number provided using the TRIMLINE handset. The test line will answer the call and send a 3-second 2025 Hz answer tone. At this point, the test procedures for the Transaction I and II telephones diverge. If the set is a Transaction I telephone, at the end of the tone, the person testing the set will insert the test card (Test Card A, supplied with the set) twice and key the manual entry pad in the following sequence: 1,2,3,4,5,6,7,8,9,.,0,/, followed by END. The test set will meanwhile send a 1.5 second answer tone, triggering the data transmission. When all the data has been transmitted (it can be heard on the handset), the green lamp will come on, and in 3 seconds the green lamp will go off and the yellow lamp will come on. The person testing the set will then press the ERASE and ATTN buttons to acknowledge proper operation of the lamps and test the operation of the buttons. If the test is good, he will hear a long (3-second) answer tone. If the test fails, the response will be a beeping tone beginning at the point of the failure, or failure of the lamps to light properly.

The test procedure for the Transaction II set is similar. After dialing the telephone number of the test line, the person testing the set will keep the handset off-hook. When he hears the 3-second answer tone, he will insert the test card (Test Card B) twice and key the 12 buttons of the manual entry in the sequence above, followed by END. Meanwhile the test line will send the 1.5-second answer tone to trigger data transmission. If the data is correct the visual display will fill with 8s and the green response lamp will flash. At this point, the user will press the ERASE button and the display will fill with decimal points. He then presses "1,2,3, END", the green lamp goes out and the yellow lamp lights while the display erases. Finally he presses ATTN; a single 3-second tone will indicate success. Failures will be indicated by a beeping tone when a failure is detected or failure of the lights or display to function properly.

To verify proper operation of the computer down feature, the testperson places a second call to the test line and depresses the END button four times before the answer tone is received. Proper operation of the Transaction I telephone is indicated by lighting of the fourth instruction lamp, normally labeled "follow special instructions". Proper operation of the Transaction II telephone is indicated by the appearance of the characters "SPECIAL" on the display.

8.2 Maintenance and Testing of the 407B

The 407B data set has several features that allow the data center personnel to detect data set malfunctions. There are essentially three stages in the trouble location procedure for the 407B data set: (1) lamp indications, (2) local test, and (3) remote test.

8.2.1 Lamp Indications

The seven lamps associated with each data set (see Section 3.3) have a certain "normal" operation. ON conditions of the lamps give the following indications:

1. ON — Indicates presence of +5 volt supply at the data set.
2. TR — Indicates that the ARU has placed Data Terminal Ready (lead 22) in the ON condition and is prepared to accept calls.
3. RI — Indicates that ringing is being applied to the data set.
4. MR — Indicates that the data set has placed Data Set Ready (lead 23) in the

ON condition. This lamp comes on three seconds after ringing is tripped if the data set is in the DATA mode and DTR is ON. Once DSR comes ON, it stays ON until the termination of the call, whether the set is in the TALK or the DATA mode.

5. DP — Indicates that the data set is receiving a signal which it interprets as a valid data character. Such reception can take place only when: (a) the set is in the DATA mode, (b) DSR is ON, and (c) the terminal has placed Data Receive (lead 21) in the ON condition.
6. AR — Indicates that a referral clerk has been requested by placing Attendant Request (lead 15) in the ON condition or through the Terminal Initiated Referral feature.
7. OS — Indicates, during computer up operation, that the data set is put out of service by one of the following conditions:
   a. Out of service (lead 25) is placed in the ON state by the ARU. Alternatively, if the OS controlled by DTR feature has been selected, this lamp is ON when DTR is OFF.
   b. The data set is under test.
   c. The connector to the ARU is not plugged in correctly. (With the closure interface option and out of service not controlled by DTR, OS will be OFF for this condition.)

During computer down operation, the OS lamp is OFF at all times except while the data set is under test. An out of service indication will be given to the ACD or central office, but the lamp will not be lit if:

a. Power is lost to the data set.
b. The data set is not plugged into the nest correctly or has been removed from the nest.

The above list indicates the order in which the lamps are located on each data set and also is the order in which the lamps usually come on when a call is received. RI and DP are flashing when they are ON (in the presence of an ACD, the AR lamp may flash); all the others are either steady ON or OFF. When the lamps do not come on at the appropriate times listed above, the "lamp test" switch should be depressed to activate all the lamps in the cabinet to ensure that they are in proper working order. If the lamp is not faulty, abnormal lamp operation indicates there is probably a malfunction in the data set which should be reported to the Telephone Company to initiate repairs.

8.2.2 Local Test

The local test is performed by the customer or by the Telephone Company craftsperson to obtain a rapid checkout of the data set receiver circuitry. The procedure for performing the local test is as follows:

1. Remove the interface plug and cord from the set to be tested and replace them with the cord from the test unit. This places the set in the "TEST" mode.
2. Place the test switch in the "Local Test" position. Approximately three seconds later the "Local Test" lamp should come on.
3. Using the TOUCH-TONE pad on the test unit, shown in Figure 21, depress each TOUCH-TONE key to see whether the lights at the ends of the corresponding row and column flash. Flashing indicates that the signal has been detected by the receiver properly. When the (*) button is depressed, the AR light will flash or light steadily if the Terminal Initiated Referral-Always option has been selected.
4. If some lights do not operate properly and the lamp test indicates that all the lights are in proper working order, there is trouble in the receiver circuitry and the Telephone Company should be called for repairs.
5. If all the lights operate properly but the circuit still does not function, verify that the ARU and computer are working properly. If the trouble still cannot be traced to any other part of the system, call the Telephone Company to obtain a remote test.

8.2.3 Remote Test

The remote test is performed from a Telephone Company test center, and it allows a more thorough checkout of the data set. The line control circuitry not included in the local test can now be checked along with parameters such as sensitivity and bandwidth. To activate the remote test, the test switch must be placed in the "Remote Test" position and the test cord must be connected to the data set under test as in Step 1 above. This links the data set to the telephone office via a separate service line. The "Remote Test" lamp on the test set lights when the test call is answered and will remain lighted while the remote test is in progress. At the end of the test procedure, the "Remote Test" lamp will go off and the test cord can be removed.

During both the local and the remote tests the incoming line is "made busy" so that, when the central office or an ACD is hunting for an idle port it will skip over the line under test.

A "Remote Test" can also be performed by the customer simply by calling the service line from another TOUCH-TONE phone. The cable from the test unit must be plugged into the set to be tested, and the test switch must be in the "Remote Test" position. This allows a checkout of the line control circuitry (by listening for the 2025 Hz answer tone) and the receiver circuitry (by watching the DP light and the row and column light as data is keyed in), but it doesn't allow measurement of specific parameters.

8.3 Statistics at Data Center

It is both instructive and helpful for the data center computer or ARU to monitor per-line statistics. This would aid greatly in speeding trouble location to a specific computer port or 407B. Among the statistics of value to the Telephone Company would be:

1. Number of incoming calls (number of times DSR comes ON).
2. Number of calls in which DSR came ON but no digital data was received (DP not activated).
3. Number of calls in which no normal end-of-message transmission was received.

These statistics could then be reported to the Telephone Company at the same time the malfunction is reported.

8.4 Test routine

In order to test the operation of the entire system, a test routine in the data center computer is strongly recommended. Such a routine might consist of a dummy account which generates an appropriate response when queried. System users should be instructed to try this mode of testing first, when trouble is suspected. If this test fails, they should call the auto test line, as described earlier, to test the Transaction telephone. If the auto test line test fails, the Telephone Company should be notified.

TABLE 1

SWITCHED NETWORK TRANSACTION TELEPHONE SYSTEM ALPHABETS

Card Coding (Hexadecimal)	Binary $2^3/2^2/2^1/2^0$	Buttons	Characters Sent On Switched Network (TOUCH-TONE)	Characters At 407B Interface (2 Out Of 8)
0	0000	0	0	A_4B_2
1	0001	1	1	A_1B_1
2	0010	2	2	A_1B_2
3	0011	3	3	A_1B_3
4	0100	4	4	A_2B_1
5	0101	5	5	A_2B_2
6	0110	6	6	A_2B_3
7	0111	7	7	A_3B_1
8	1000	8	8	A_3B_2
9	1001	9	9	A_3B_3
A	1010	/+	#	A_4B_3
B	1011		a	A_1B_4
C	1100		*	A_4B_1
D	1101	/+	b	A_2B_4
E	1110		c	A_3B_4
F	1111		d	A_4B_4
		ATTN	**	
		ERASE	bb	
		END	##, a or b (Depending on when used.)	

+ The / button causes the # (A_4B_3) signal to be sent during dialing before use of the END button or insertion of a card, and the b (A_2B_4) signal at all other times.

TABLE 2

TRANSACTION TELEPHONE

DIALING CARD CONTROLLED OPTIONS

1. Green/yellow response lamps enable
2. FSK receiver enable and data rate selection
3. Dialing mode change – dial pulse to TOUCH-TONE or TOUCH-TONE to dial pulse for split mode dialing
4. Two part dialing enable
5. Response mode in computer down – controlled by floor limit
6. Repertory dialer disable
7. Customer card LRC check inhibit
8. Predialing enable

TABLE 3

TRANSACTION TELEPHONE OPTIONS

SET AT INSTALLATION

1. Primary Dialing Mode – TOUCH-TONE/Dial Pulse
2. Manual Dialing from Manual Entry Pad – Enable/Disable
3. Key Strip Installation – For Key Systems
4. PIN Pad

TABLE 4

EXAMPLES OF DIALING CARDS

START SENTINEL	DIALING CARD IDENTIFICATION	TELEPHONE NUMBER	FIELD SEPARATOR	FLOOR LIMIT (OPTIONAL)	RESPONSE MODE	MERCHANT I.D.	SPECIAL CONTROL	END SENTINEL	LRC	FEATURES
B	C	NN . . . N	D		L	MM . . . M	K	F	LRC	One part dialing, no predialing, no floor limit
B	C	NCNN . . . N	D		L	MM . . . M	K	F	LRC	Two part dialing, basic dialing mode, no floor limit
B	C	NENN . . . N	D		L	MM . . . M	K	F	LRC	Two part dialing, basic mode for first part other mode for second, no floor limit.
B	C	NN . . . NC	D		L	MM . . . M	K	F	LRC	One part dialing, predialing, no floor limit.
B	C	NN . . . N	D	050	L	MM . . . M	K	F	LRC	One part dialing, no predialing, $50 floor limit (see NOTE)
B	C	NN . . . NC	B		D			F	LRC	One part dialing, telephone number only

LEGEND:

A,B,C,D,E,F = hexadecimal characters encoded on card

N = any hexadecimal digit (0-9)

M = any hexadecimal digit (0-9), or hexadecimal characters D or E

L =
- C – Voice only
- E – Enable Keyed Answer Tone receiver
- D – Enable FSK receiver at 150 BPS (if FSK receiver is not available, Keyed Answer Tone receiver is enabled)
- A – Enable FSK receiver at 110 BPS

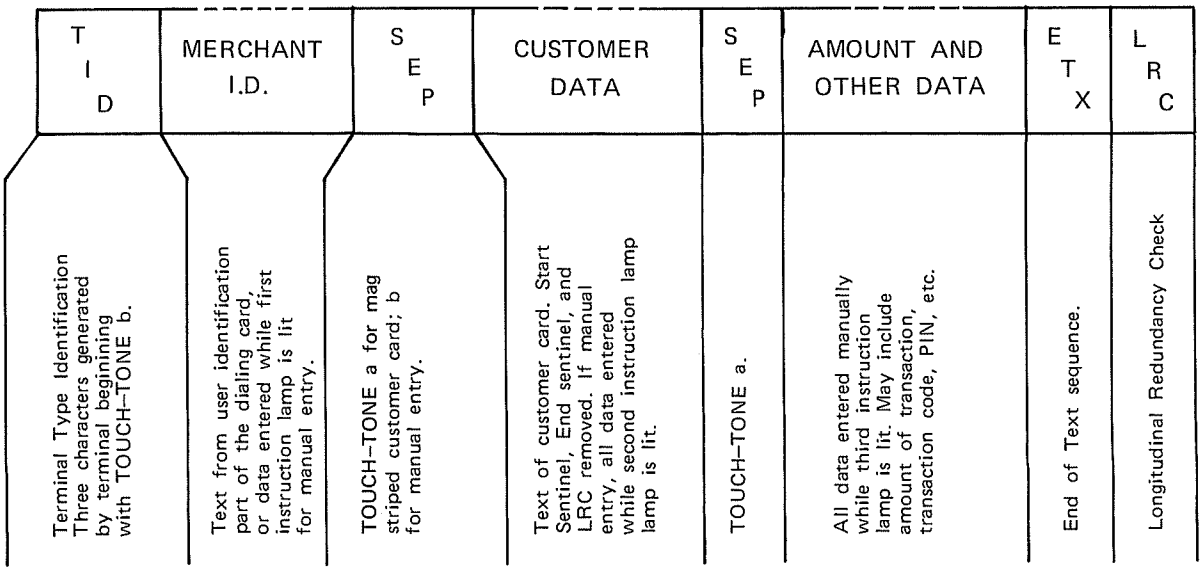
K =
- Omitted – Store card contents, check customer card LRC
- A – Store card contents, do not check customer card LRC
- B – Do not store card contents, do not check customer card LRC
- C – Do not store contents, check customer card LRC

LRC = Any hexadecimal character derived by summing (without carry) all previous characters on card.

NOTE: The floor limit is a 3-digit field, hence a $50.00 floor limit is coded as 050.

TABLE 5. MESSAGE FORMATS

A. Initial Inquiry Message



EXAMPLE: The Merchant I. D. is 1122334455, the customer number is 98177484589763, the amount of the sale is $10.45, and the PIN is 9876. The clerk inserts both cards, then keys in the amount, using the decimal point. She presses the / button, and then the customer keys in the PIN and presses END.
The transmitted message is:

b30 1122334455 a 98177484589763 a 10*45b 9876 ## $^{L}R_{C}$

Spaces have been inserted to separate data corresponding to the different steps in the input process.

B. Later Messages

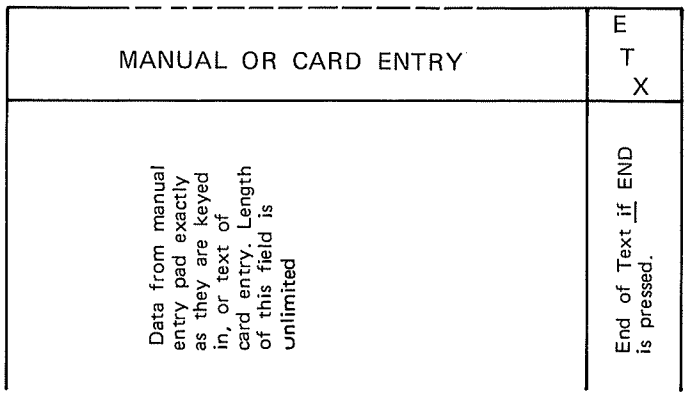


TABLE 6
TRANSACTION TELEPHONE TERMINAL ID CHARACTERS

First character is always TOUCH-TONE "b" = hex "D" for Transaction Telephone.

Character	Bit	Value	Meaning
Second	2^0	1	LRC only
		0	LRC and CCT transmitted
	2^1	1	Receiver off hook
		0	Receiver on hook
	2^2	1	User information manually entered
		0	User information entered via card
	2^3	0	Always
Third	2^0	1	Chain bit – next character is ID character
		0	Last ID character
	2^1	0	Reserved for future use
	2^2	1	Transaction II set-data receiver active
		0	No data receiver active
	2^3	0	Always

TABLE 7

ACTION FIELD CONTROL CHARACTERS

Characters received by Transaction II Telephone following STX and preceding the first "?":

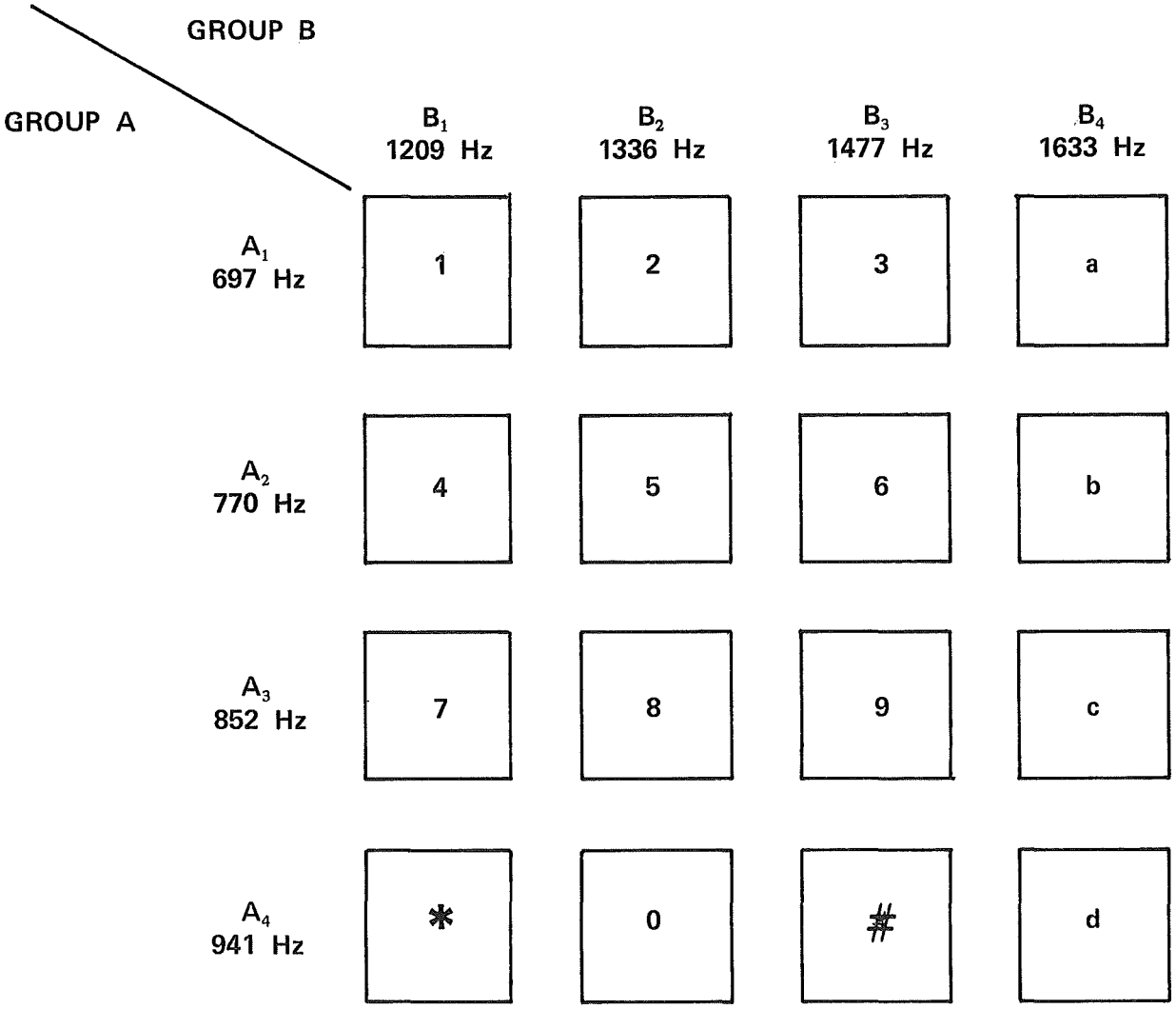
0	Set automatic disconnect timer to 3 minutes.
1	"NAK" – Retransmit last message.
2	Unmute call progress tone sounder.
3	Do not check message LRC (must appear immediately after STX).
4, 5	Reserved for future use.
6	Light green response lamp.
7	Light yellow response lamp.
8	Blink lamp.
9	Disconnect, send *#*.

TABLE 8

TOUCH-TONE CONTROL CHARACTER SEQUENCES

Meaning	TOUCH-TONE Sequence
SOH	b (0-7)[1]
RS	bc
GS	b8
NAK	3#3
ACK	4#4
EOT	5#5
STX	b9
ETX	##
DISCONNECT	*#*
Acknowledge green light lit by tone	a
Acknowledge yellow light lit by tone	b
Off Hook	##
ATTN	**
ERASE	bb

1. The first character following "b" is in the range 0-7.



Touch - Tone Frequency Assignments

Figure 1

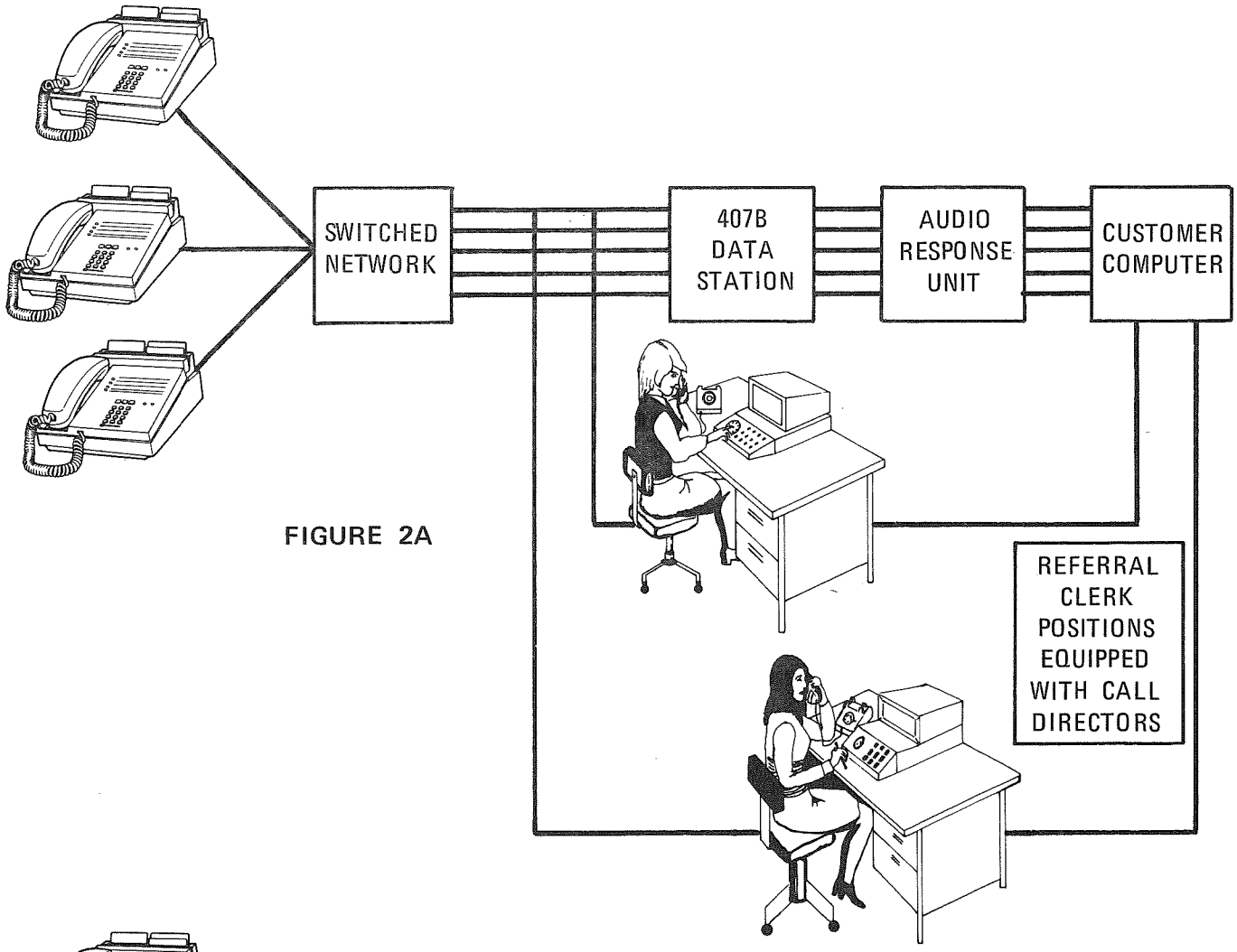


FIGURE 2A

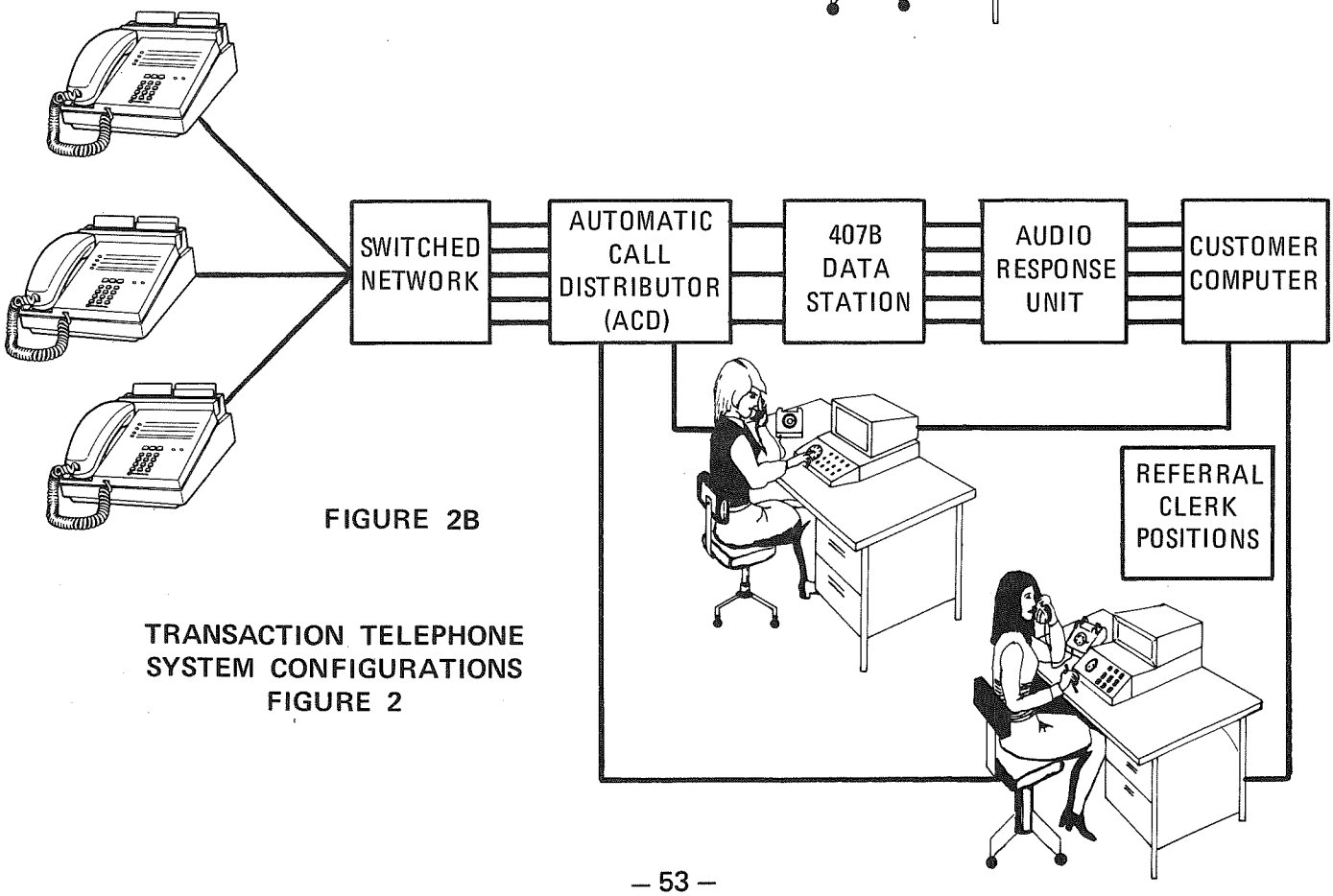
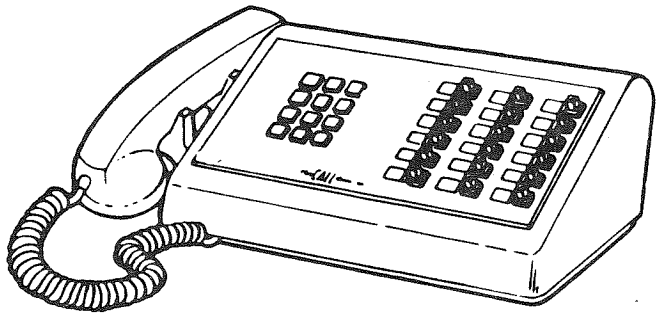


FIGURE 2B

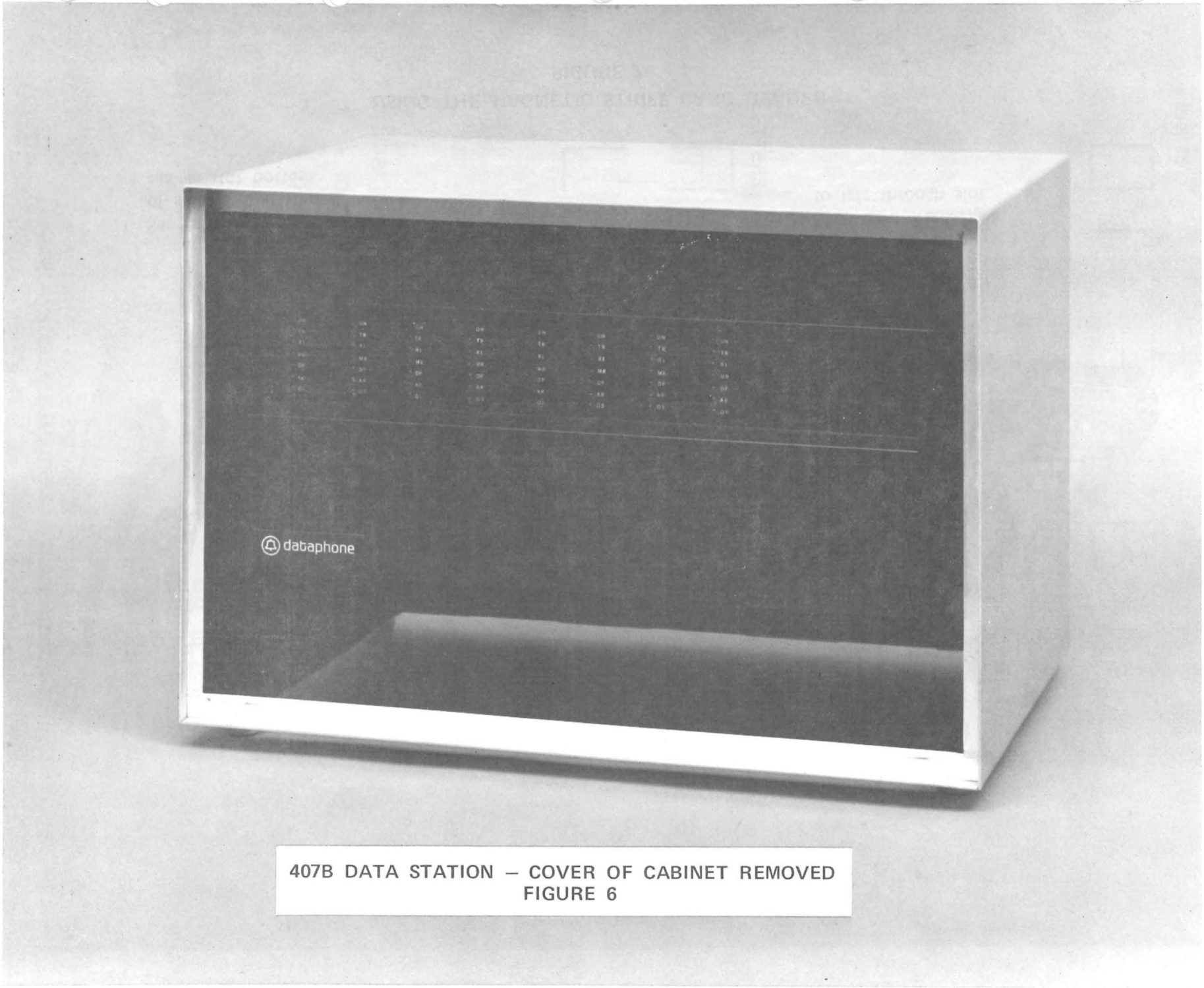
TRANSACTION TELEPHONE SYSTEM CONFIGURATIONS FIGURE 2

TRANSACTION TELEPHONE
FIGURE 3

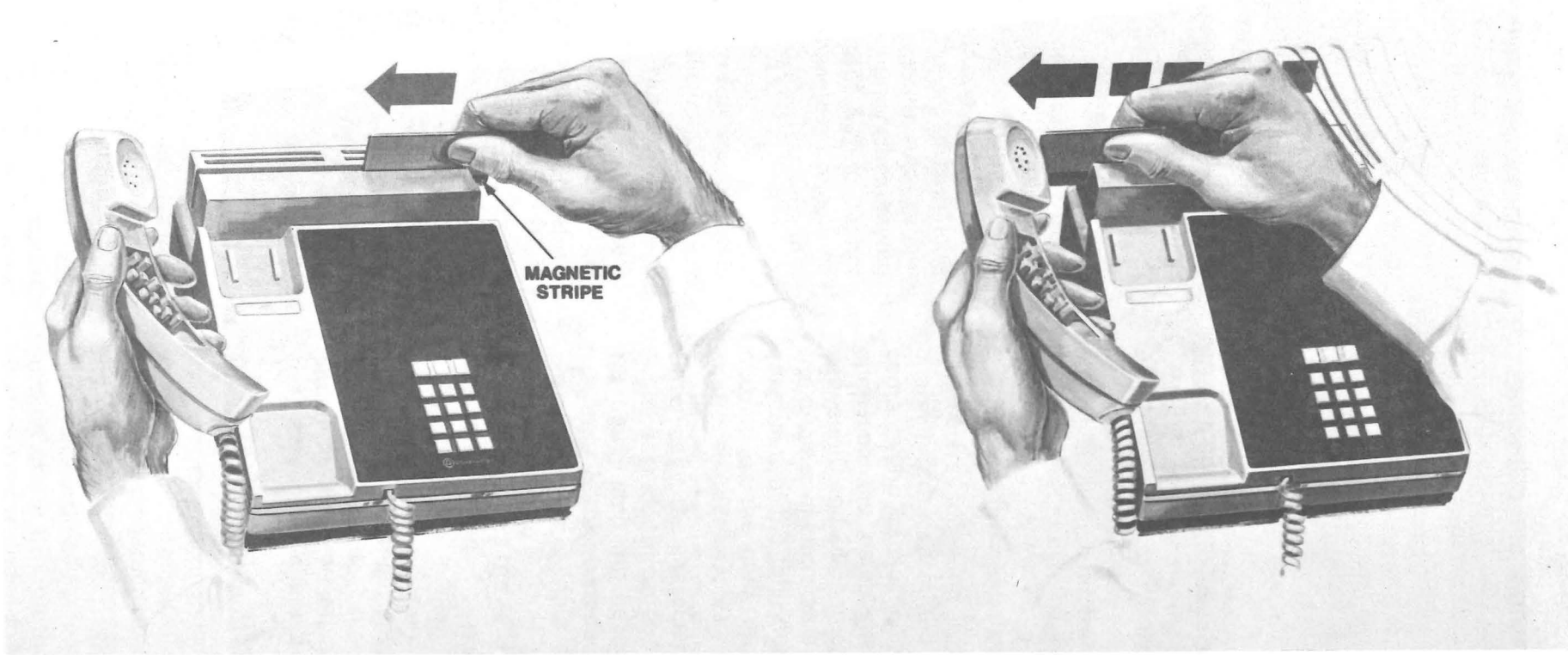
TRANSACTION II TELEPHONE
FIGURE 4



18-BUTTON CALL DIRECTOR
FIGURE 5



407B DATA STATION – COVER OF CABINET REMOVED
FIGURE 6

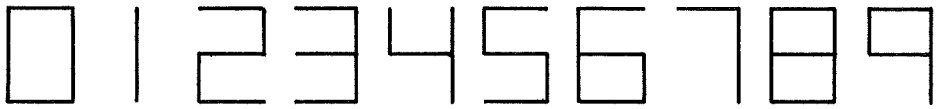


1. Set card in widened portion of slot so that it rests against slot bottom.

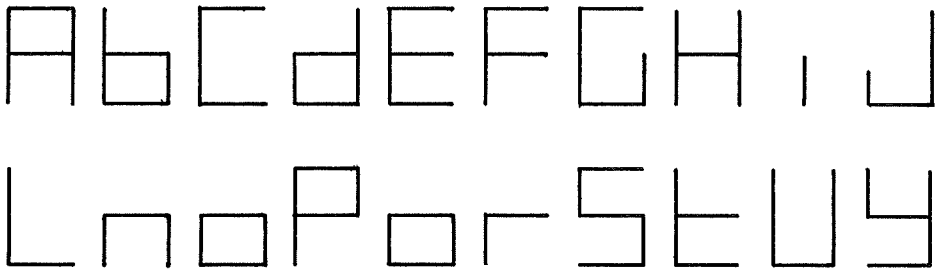
2. Slide card from right to left through slot.

USING THE MAGNETIC STRIPE CARD READER
FIGURE 7

DIGITS



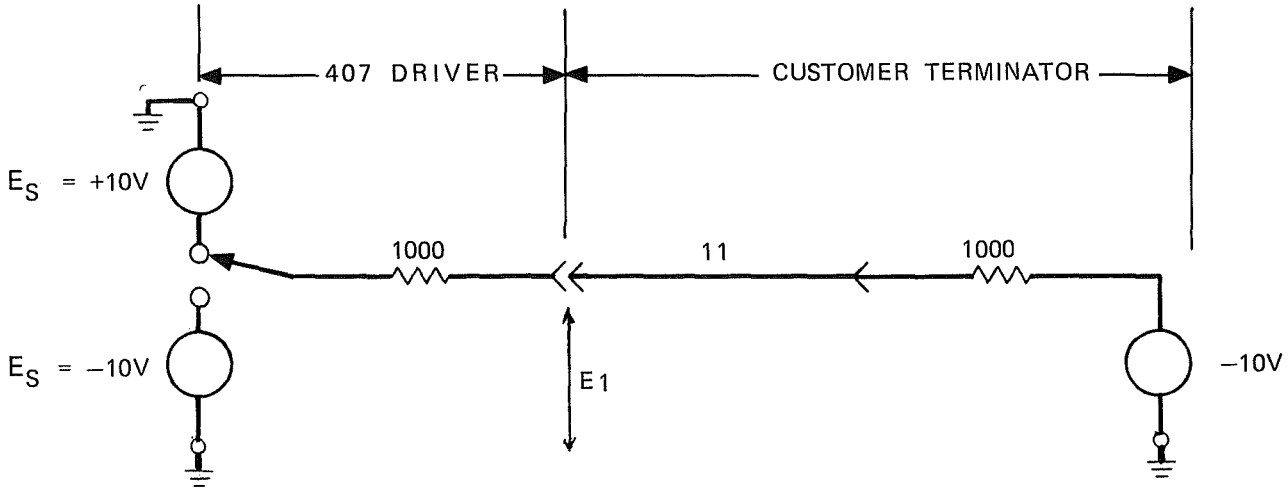
LETTERS



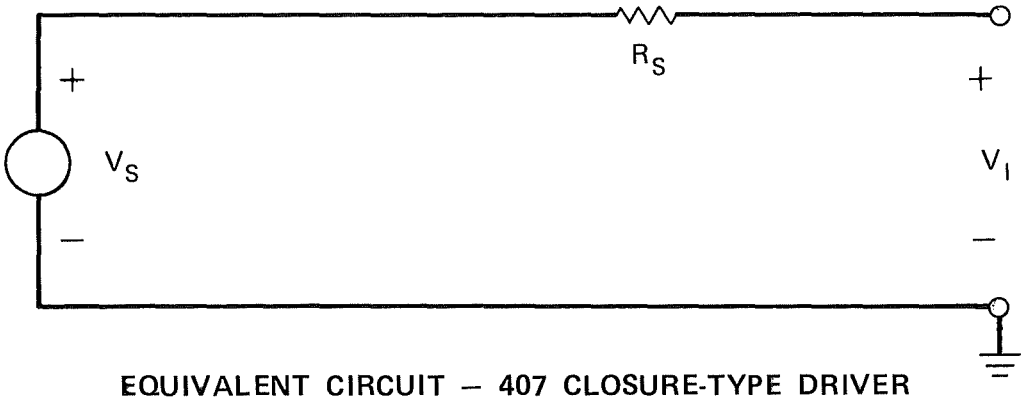
SPECIAL CHARACTERS

- • (DECIMAL POINT)
- – (DISPLAYED FOR (/) KEY OR FOR TRANSMITTED (–)

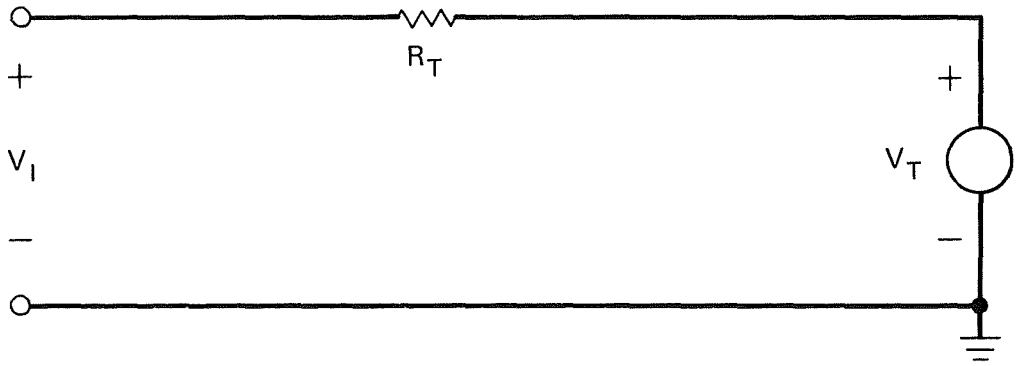
FIGURE 8
DISPLAYABLE CHARACTERS – TRANSACTION II



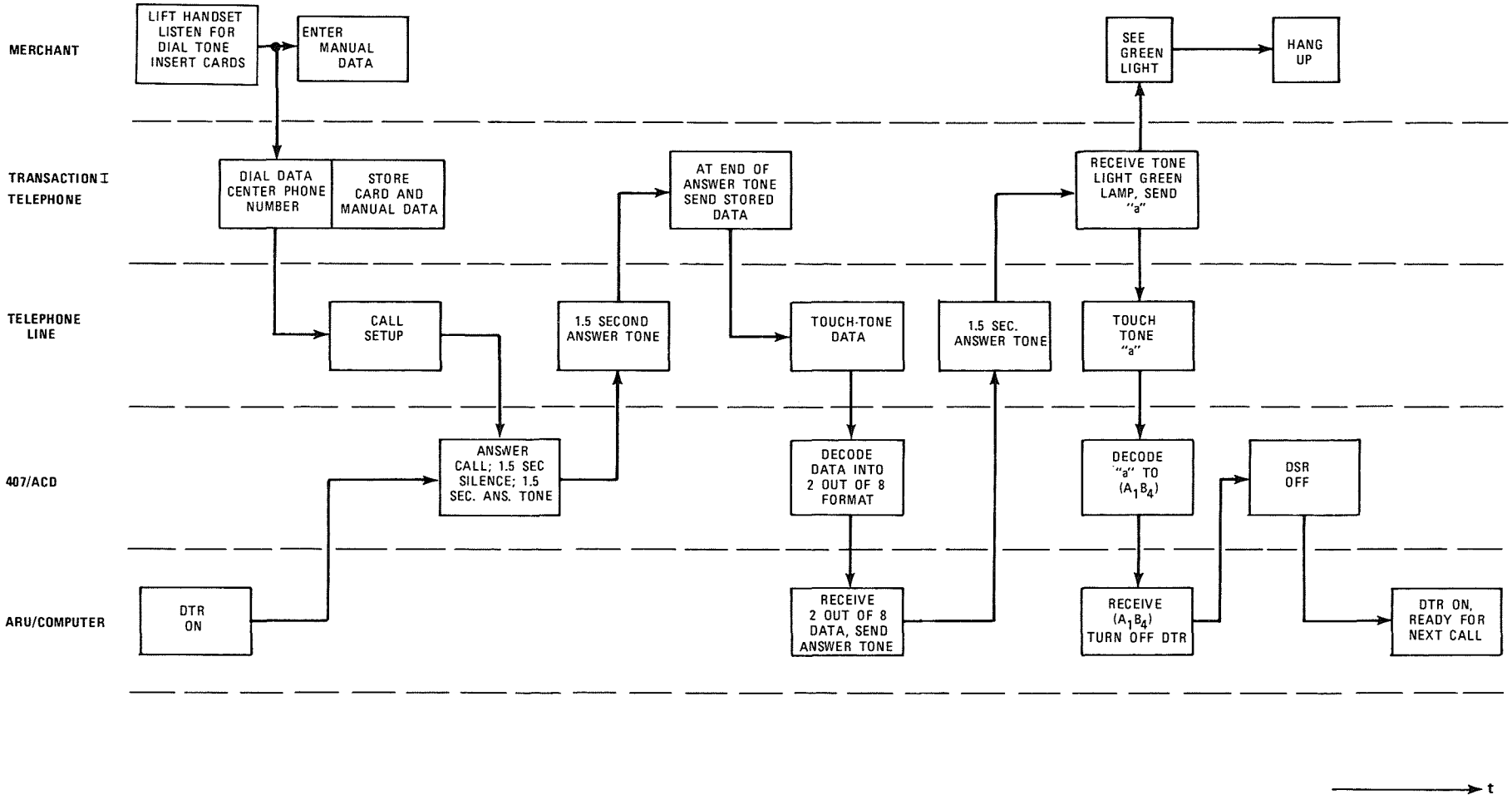
OPERATION OF 407B DRIVER WITH CLOSURE TERMINATOR
FIGURE 9



EQUIVALENT CIRCUIT – 407 CLOSURE-TYPE DRIVER
FIGURE 10



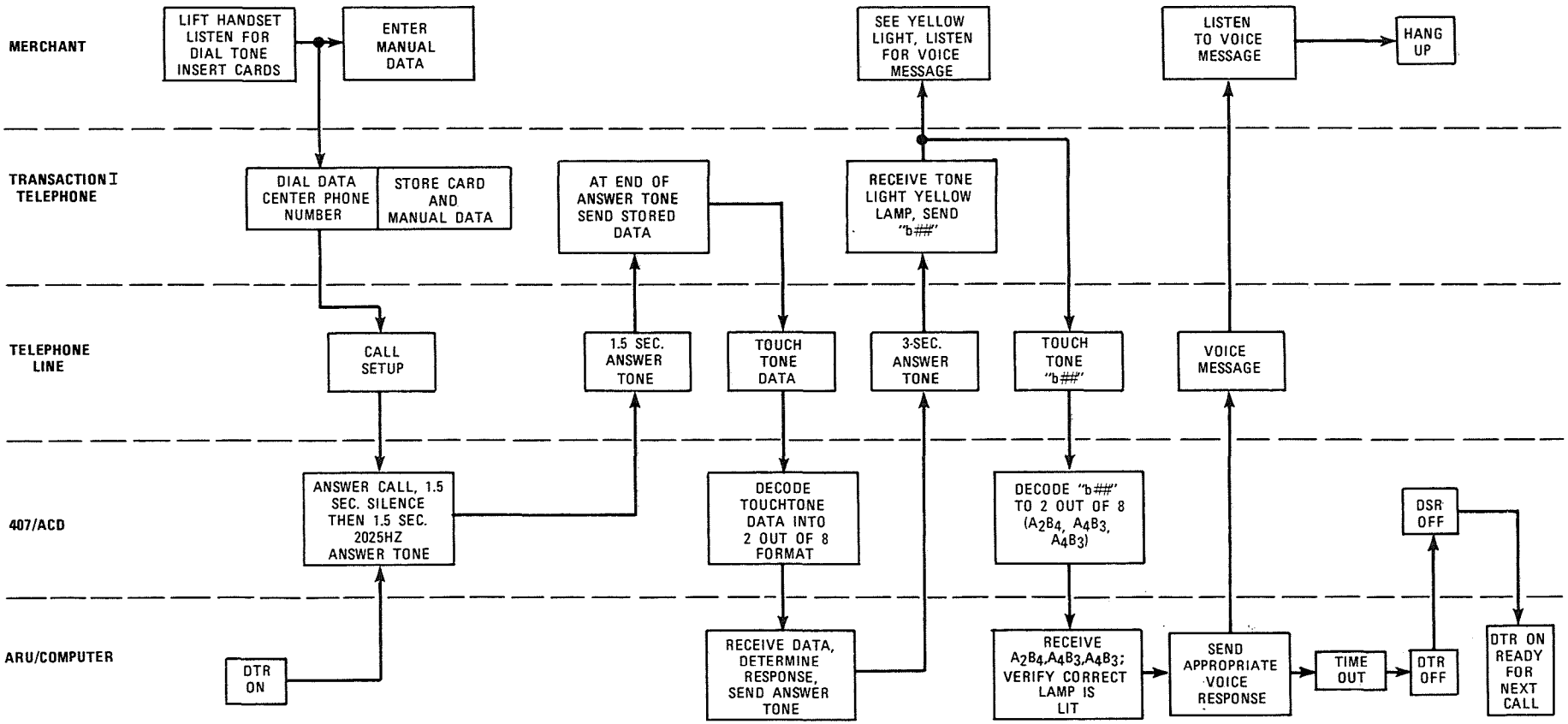
EQUIVALENT CIRCUIT – 407 CLOSURE-TYPE TERMINATOR
FIGURE 11



Transaction I

NORMAL TRANSACTION - GREEN LIGHT

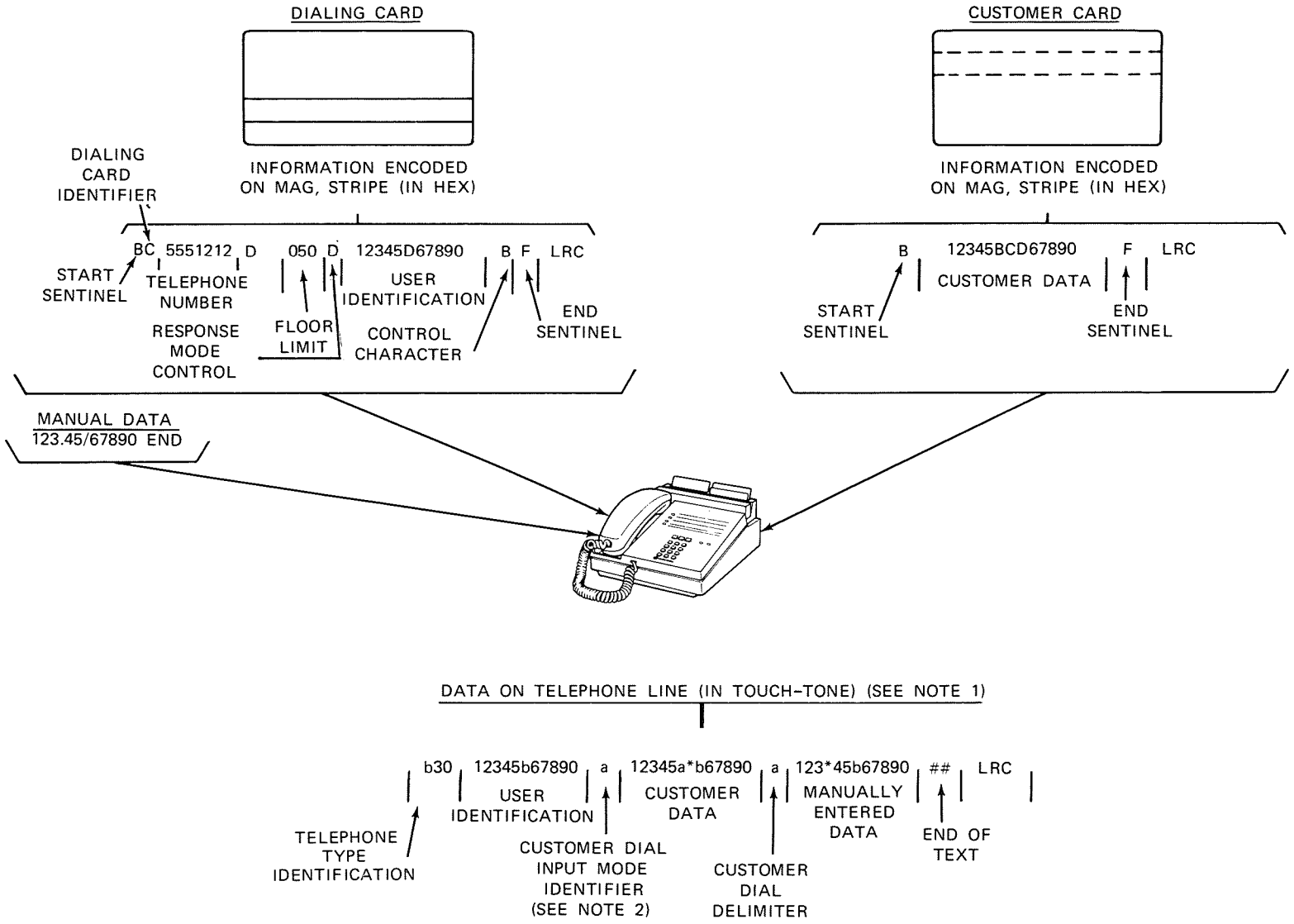
FIGURE 12 A



Transaction I

NORMAL TRANSACTION - YELLOW LIGHT

FIGURE 12B

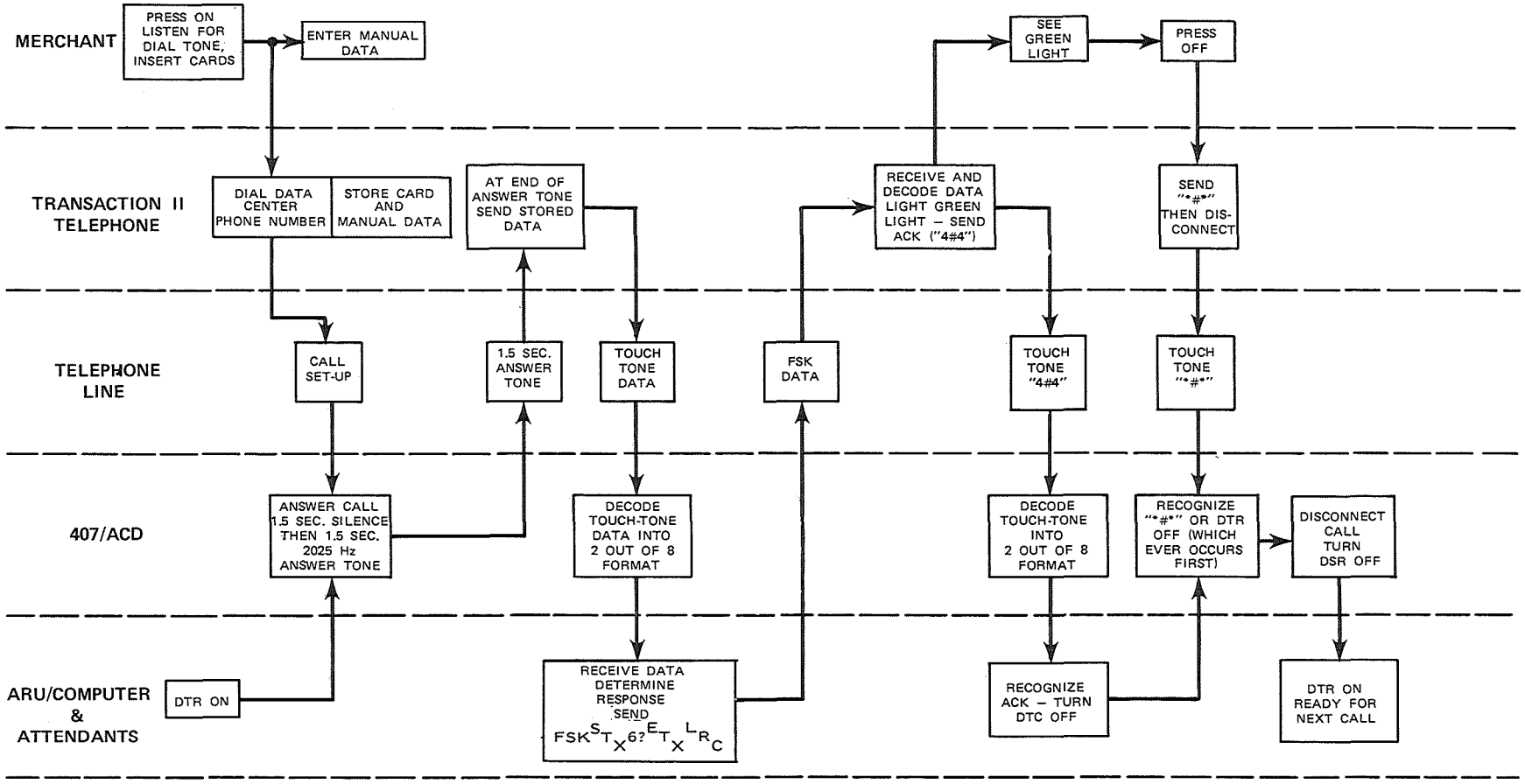


NOTES:

1. THE DATA TRANSMITTED BY THE TRANSACTION TELEPHONE IS SHOWN. A TELEPHONE NUMBER, NOT RECEIVED BY THE DATA BASE, IS TRANSMITTED BEFORE THE DATA.
2. IF CUSTOMER DATA IS MANUALLY ENTERED, CUSTOMER DATA INPUT MODE IDENTIFIER IS "B".

MESSAGE FORMAT

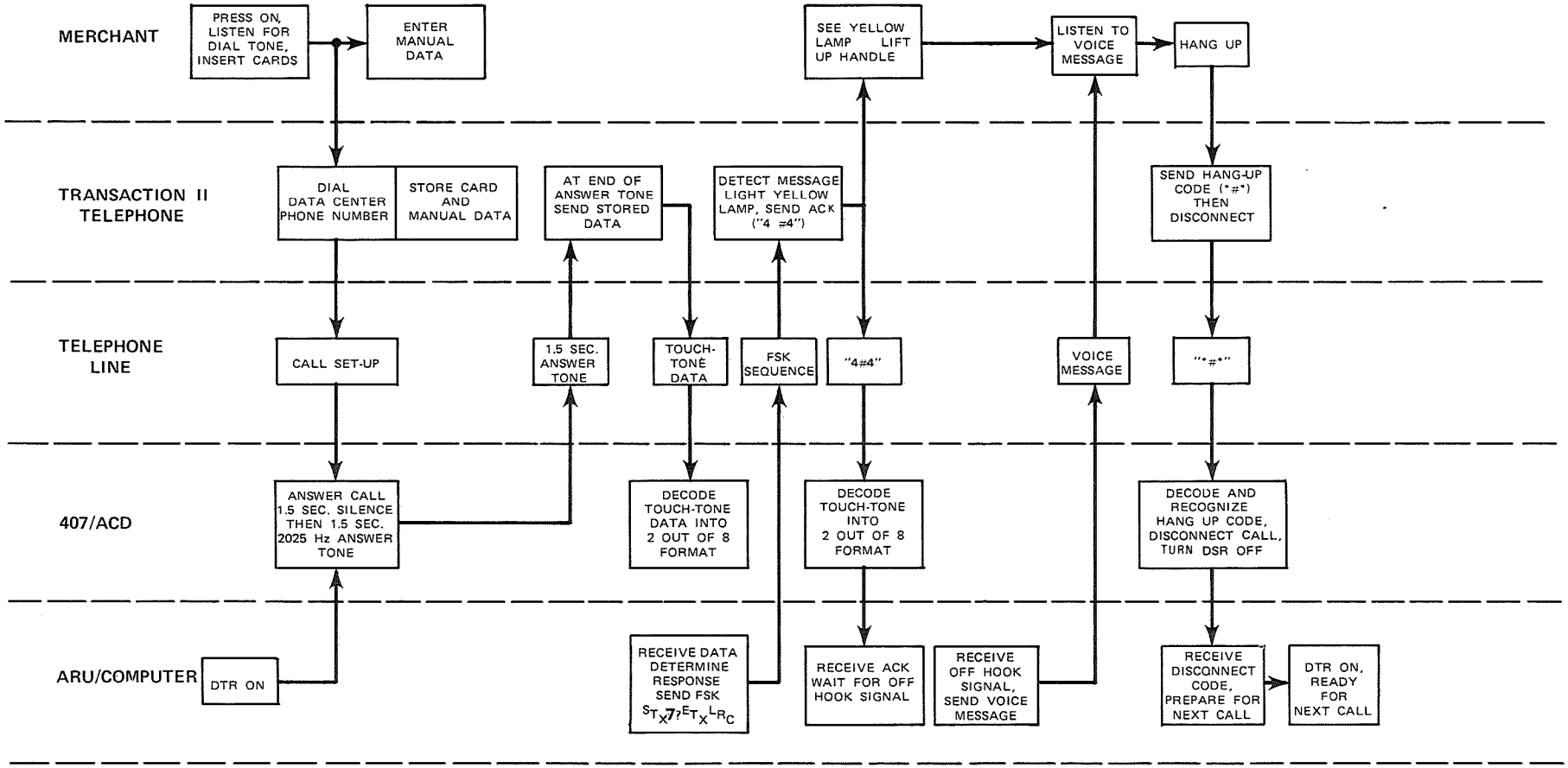
FIGURE 12 C



TRANSACTION II

NORMAL TRANSACTION - GREEN LIGHT - FSK RESPONSE

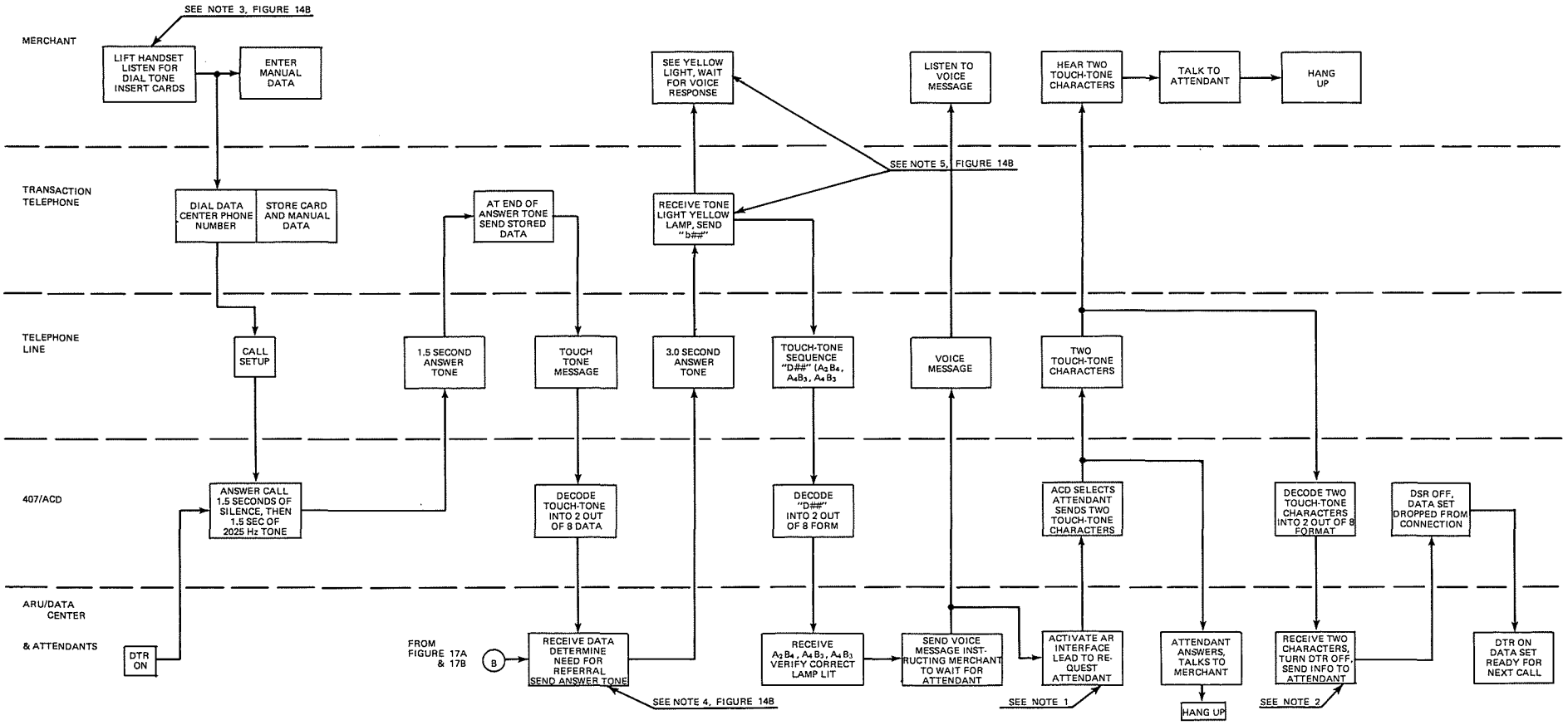
FIGURE 13A



TRANSACTION II

NORMAL TRANSACTION - YELLOW LIGHT - FSK RESPONSE

FIGURE 13B

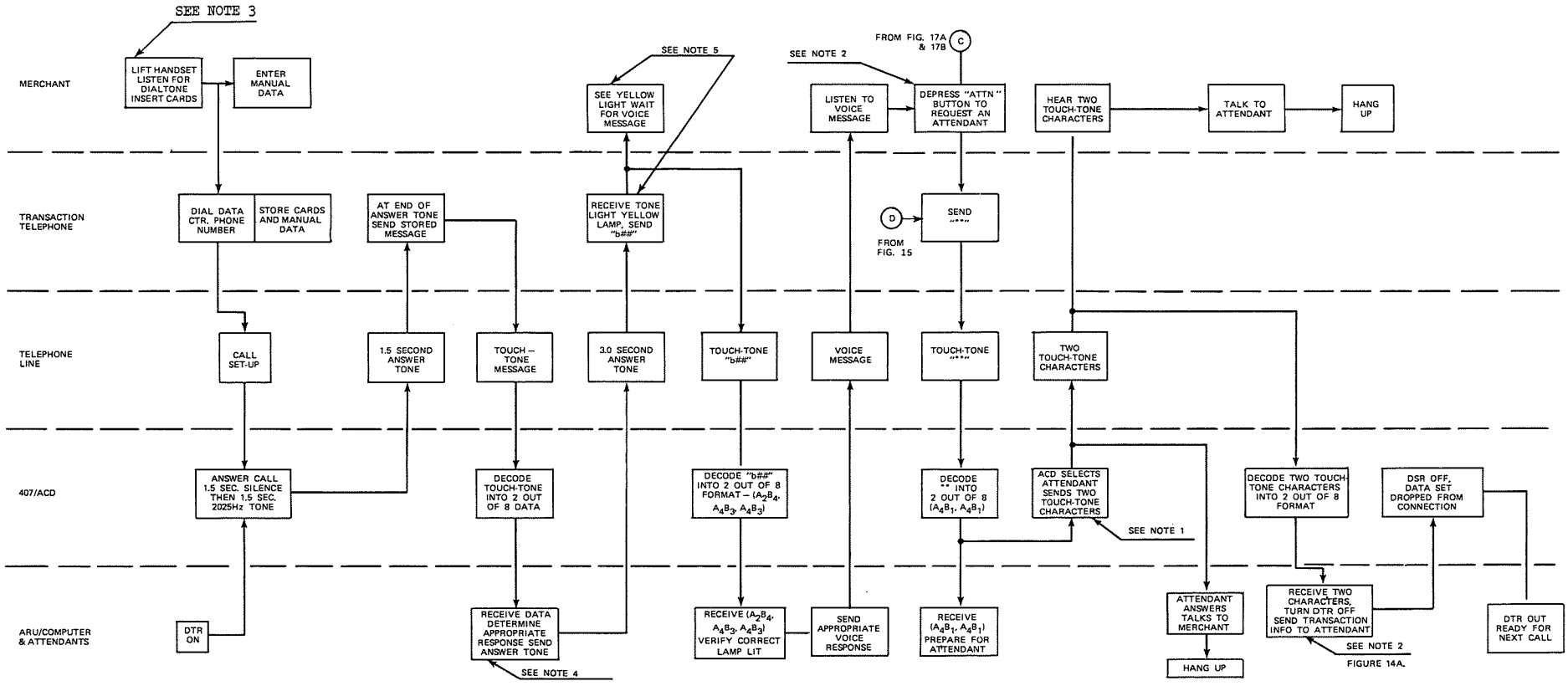


NOTES: 1: WHEN A CALL-DIRECTOR IS PRESENT, THE FOLLOWING DIFFERENCES IN THE SEQUENCE OCCURS: A) THE TWO-DIGIT TOUCH-TONE CODE IS NOT GENERATED. B) WHEN THE ATTENDANT ANSWERS, DM TURNS OFF, AND AR IS THEN TURNED OFF. THIS IS THE TALK MODE. C) THE ATTENDANT CAN RETURN TO THE DATA MODE BY PRESSING THE DATA (HOLD) BUTTON. D) DTR SHOULD REMAIN ON UNTIL CALL IS TERMINATED. DATA SET CANNOT BE DROPPED DURING TALK MODE.

2. ARU MAY ALSO LEAVE DTR ON, IN WHICH CASE THE DATA SET REMAINS ON-LINE, READY TO RECEIVE DATA.

ARU INITIATED REFERRAL USING GREEN/YELLOW LIGHTS - TRANSACTION I & II

FIGURE 14A



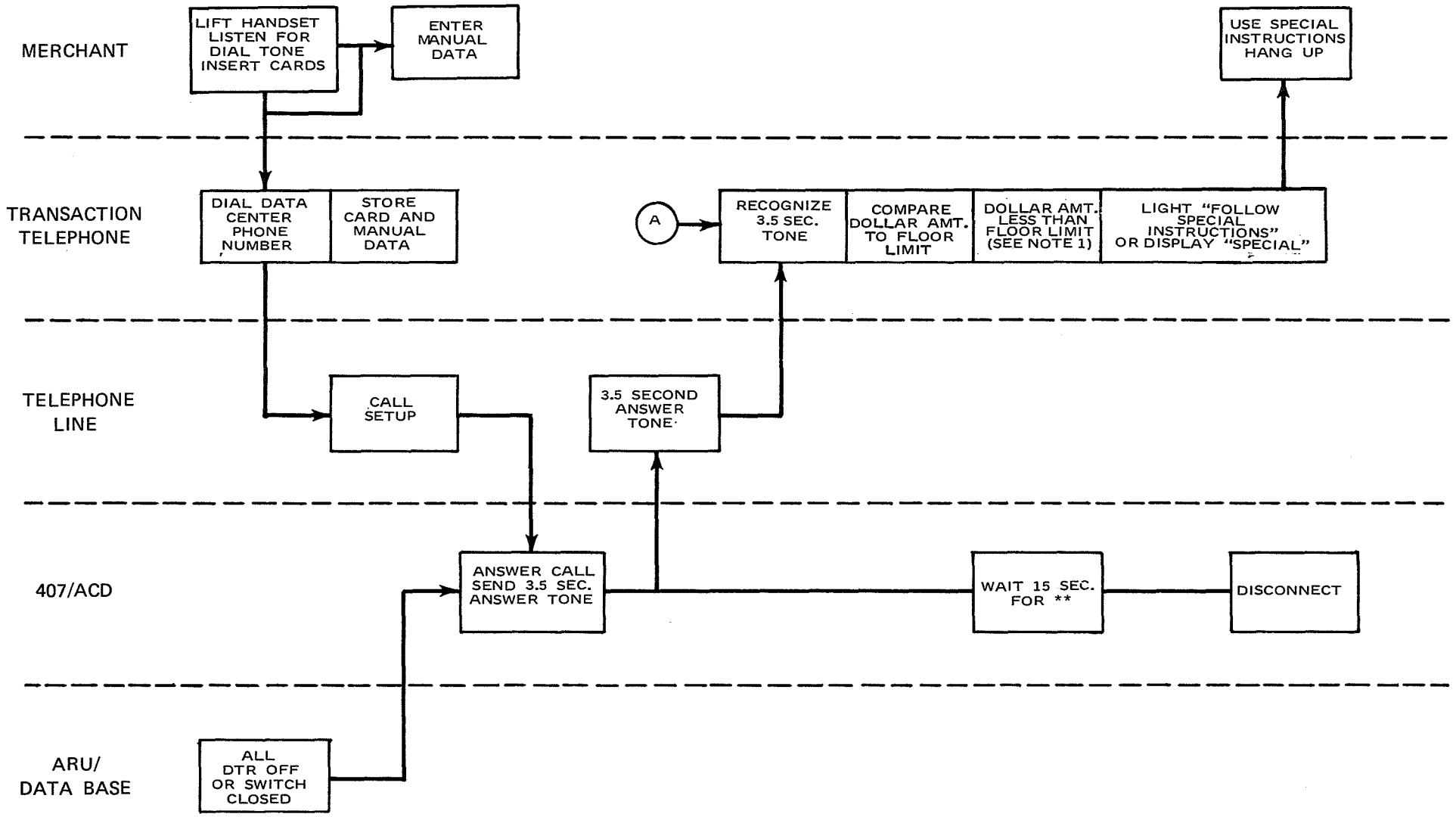
NOTES:

1. IF A CALL DIRECTOR IS PRESENT, NOTE 1 OF FIGURE 15A APPLIES.
2. WHEN A TRANSACTION II TELEPHONE IS USED, THE MERCHANT MUST LIFT THE HANDSET AND PRESS THE ATTN BUTTON TO CAUSE TRANSMISSION OF THE "***" SEQUENCE.
3. TRANSACTION II USERS MAY PRESS THE ON BUTTON AND LEAVE THE HANDSET ON HOOK.
4. ALTERNATIVELY, WHEN TRANSMITTING TO A TRANSACTION II, THE FSK SEQUENCE $S_{T_X 7} E_{T_X L_{R_C}}$ COULD BE SENT.
5. THE TRANSACTION II SENDS "b" WHEN IT LIGHTS THE YELLOW LIGHT IN RESPONSE TO ANSWER TONE. IT SENDS "#" AS SOON AS THE MERCHANT GOES OFF HOOK. IF THE YELLOW LIGHT IS LIT IN RESPONSE TO AN FSIC MESSAGE, THE ACK (4#4) SEQUENCE IS SENT IMMEDIATELY, AND NO OFF HOOK INDICATION IS GIVEN.

TERMINAL INITIATED REFERRAL - TRANSACTION I & II

FIGURE 14B

— 67 —

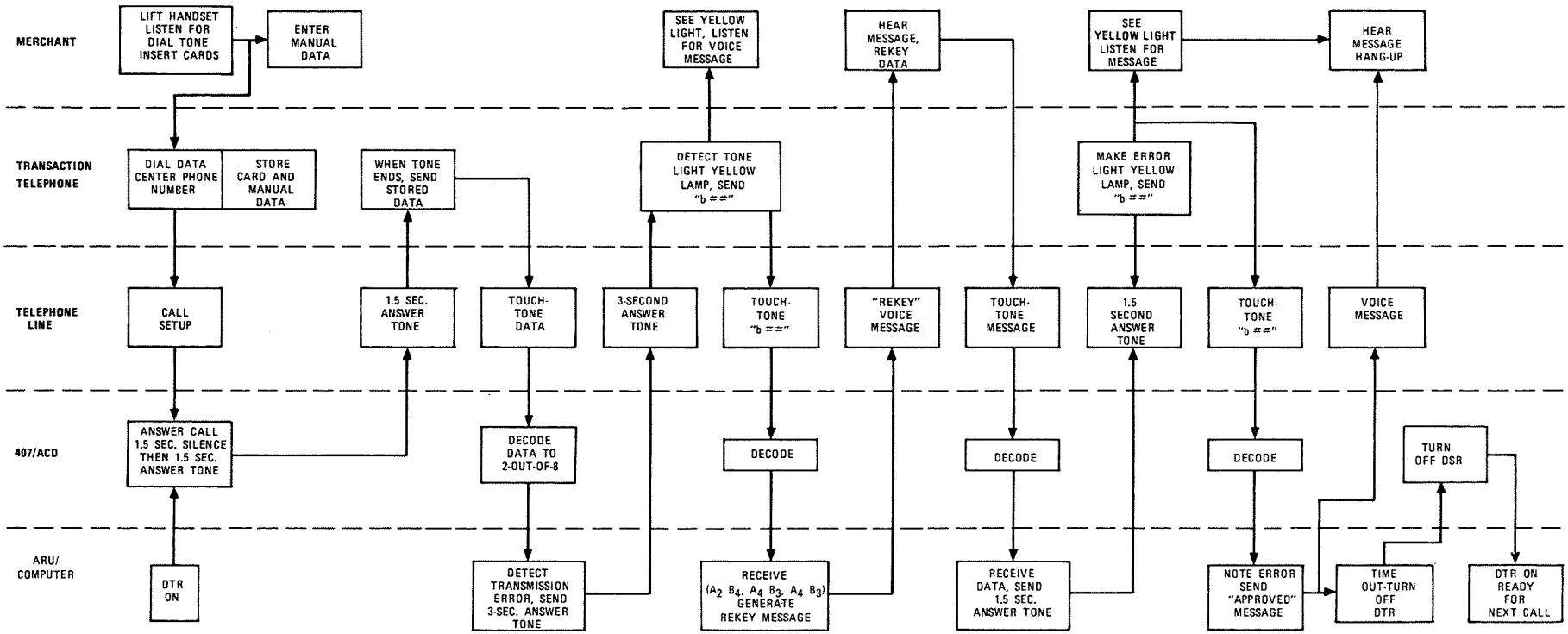


Note 1: If the dollar amount is above floor limit, Transaction II lights the yellow lamp, waits for the merchant to pick up the handset, and sends ** (Transaction I sends ** immediately). Referral then proceeds as in Figure 14B beginning at point) except that the data set automatically drops from the call upon receipt of two TOUCH-TONE characters from the ACD, and is readied for the next call.

Note 2: Transaction II Telephone displays the characters "Special" instead of lighting the "Follow Special Instructions" lamp.

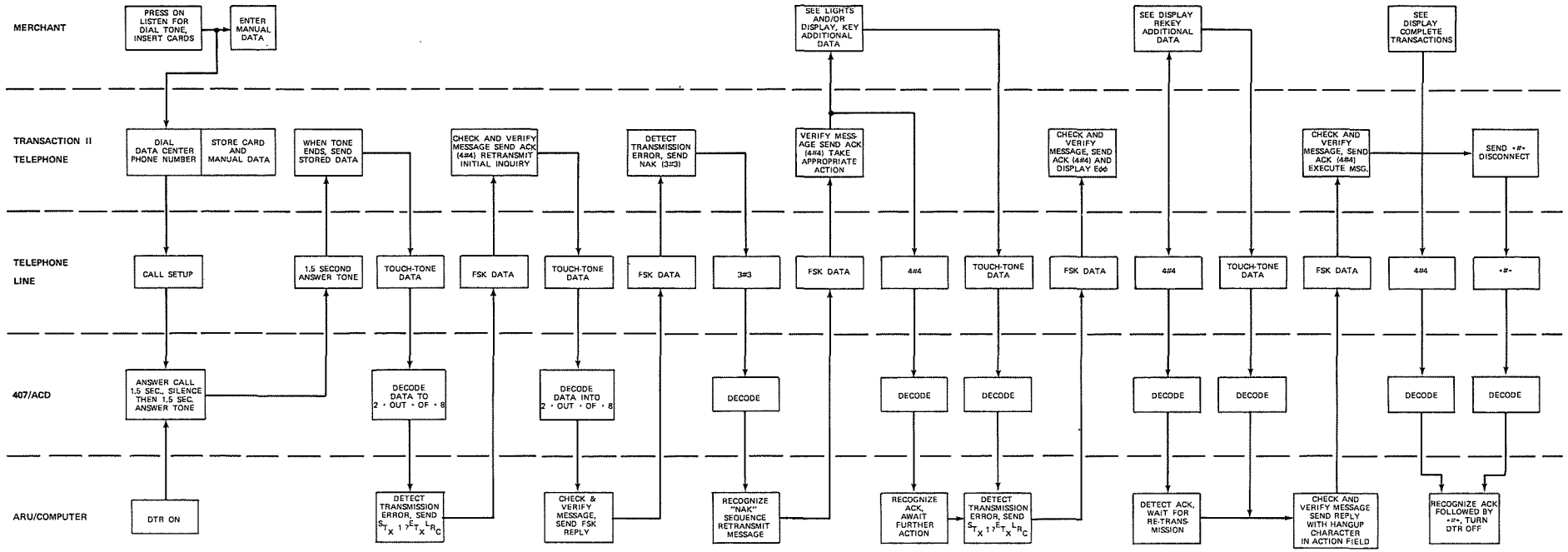
COMPUTER DOWN

FIGURE 15

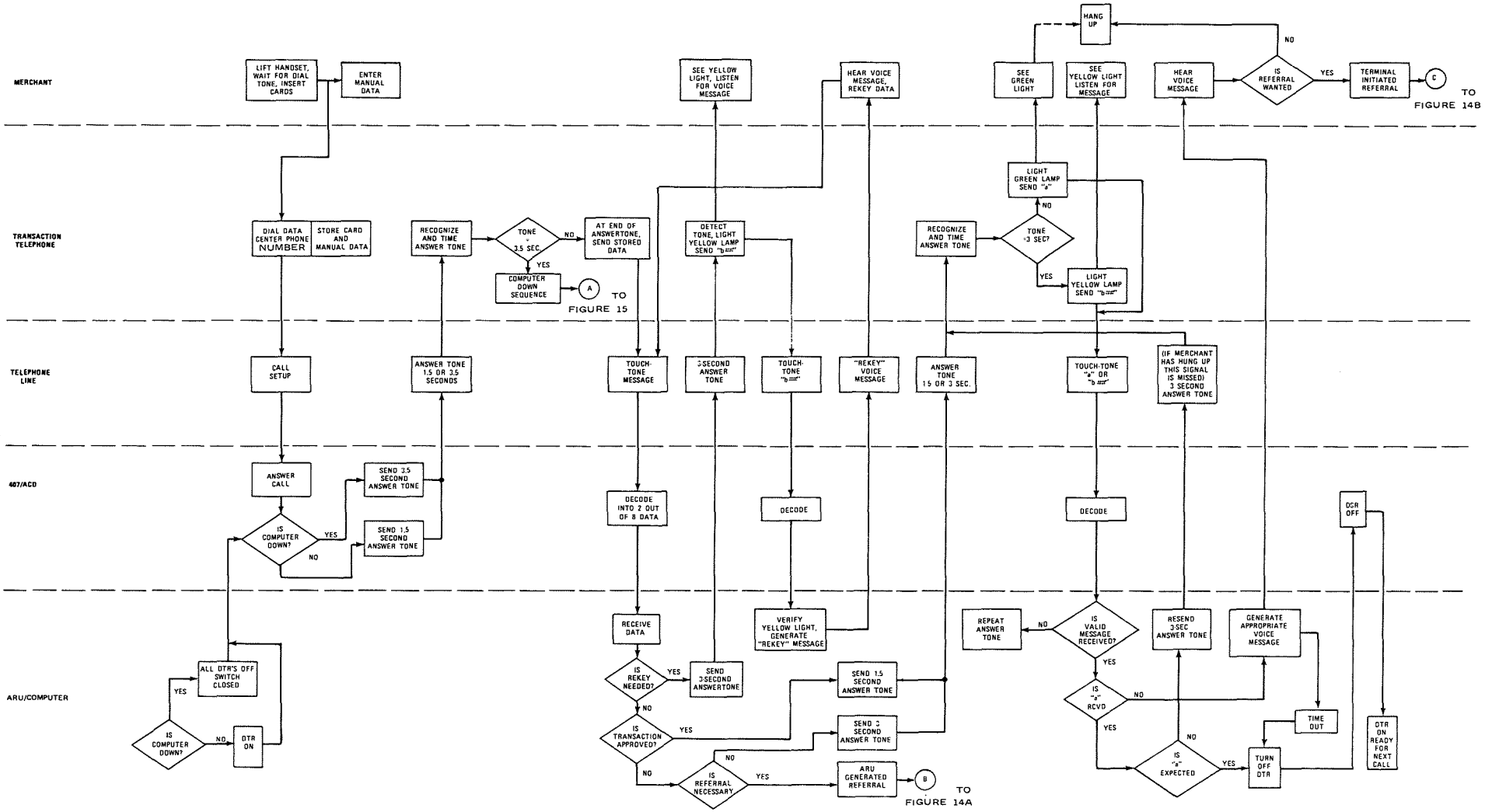


TYPICAL ERROR PROCEDURES – TRANSACTION I
FIGURE 16a

TYPICAL ERROR PROCEDURES - TRANSACTION II

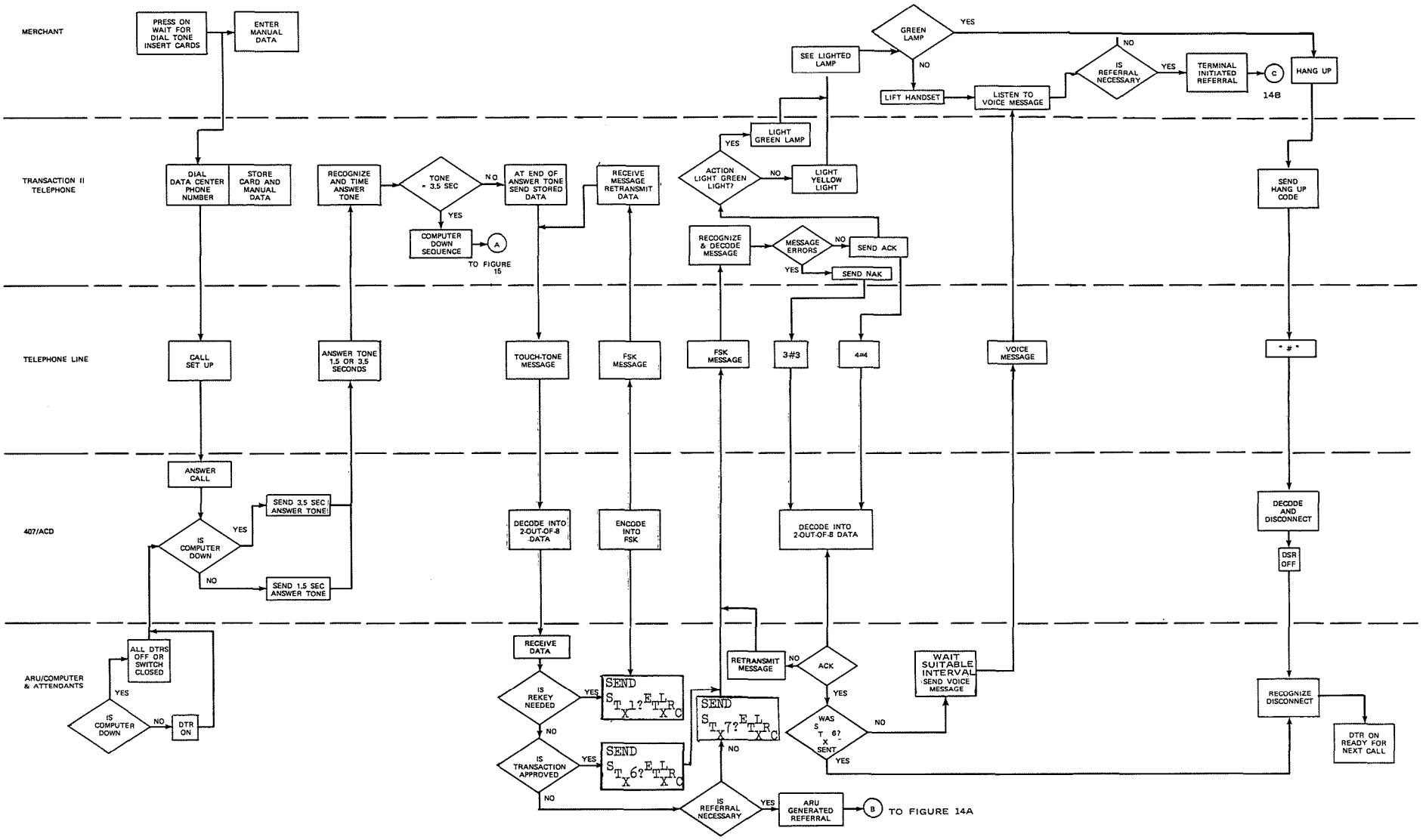


TYPICAL ERROR PROCEDURES TRANSACTION II
FIGURE 16B



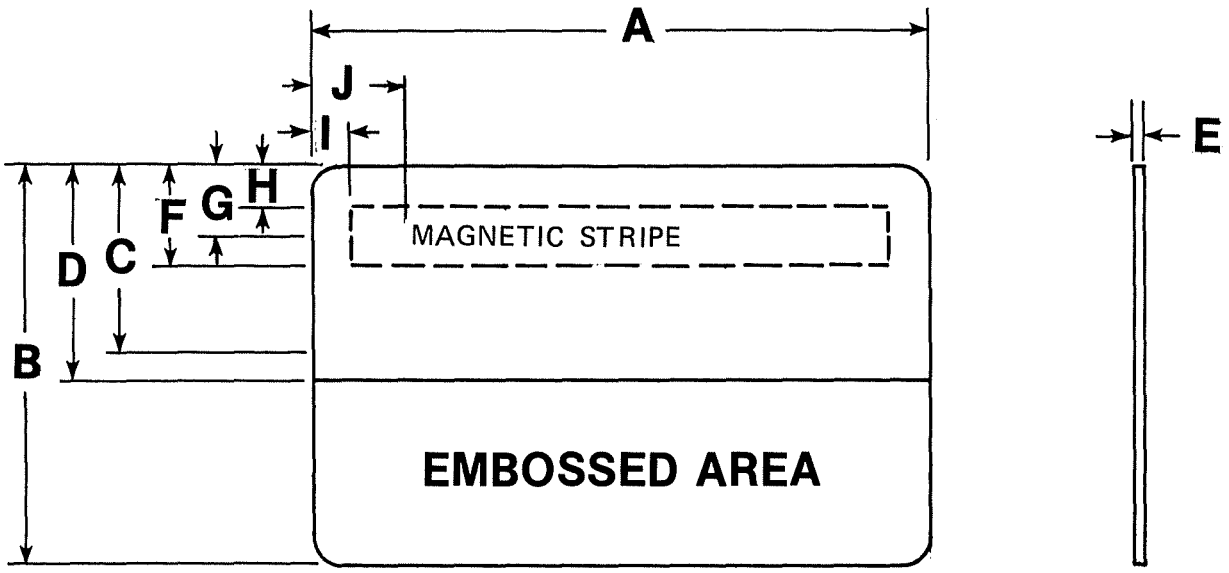
DETAILED FLOWCHART - TRANSACTION I

FIGURE 17a



DETAILED FLOWCHART - TRANSACTION II FSK SIGNALING

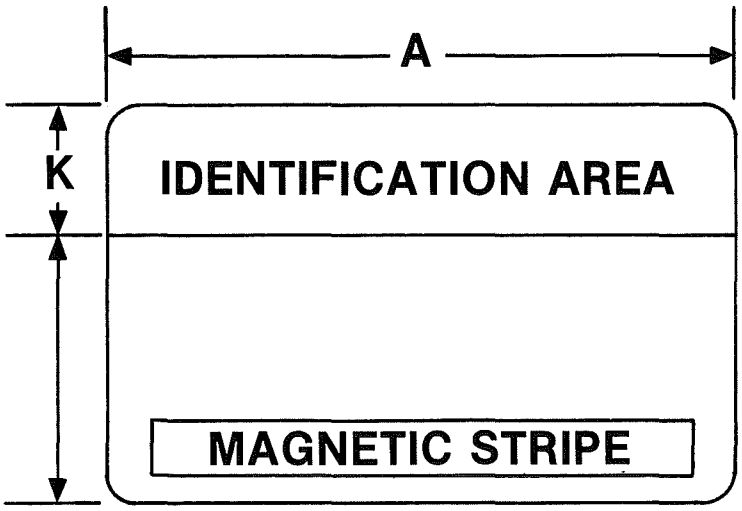
FIGURE 17B



A	NOT CRITICAL	LENGTH OF CARD
B	NOT CRITICAL	HEIGHT OF CARD
C	1.06	MINIMUM DISTANCE FROM TOP OF CARD FOR EMBOSSING PROTRUDING ON BACK FACE
D	1.22	MINIMUM DISTANCE FROM TOP OF CARD FOR EMBOSSING PROTURDING ON FRONT OF CARD
E	0.030 ±.003	THICKNESS OF CARD
F	0.463	BOTTOM OF ENCODED ANSI STRIPE 2 FROM TOP OF CARD
G	0.353	TOP OF ENCODED ANSI STRIPE 2 FROM TOP OF CARD
H	0.218 MAX.	TOP OF MAGNETIC MATERIAL FROM TOP OF CARD
I	0.115	MAXIMUM DISTANCE TO START OF MAGNETIC MATERIAL FROM CARD EDGE
J	0.273 ± 0.020	MINIMUM DISTANCE TO FIRST BIT OF START SENTINEL

NOTE: ALL DIMENSIONS IN INCHES

CARD DIMENSIONS CRITICAL
TO TRANSACTION TELEPHONE
FIGURE 18

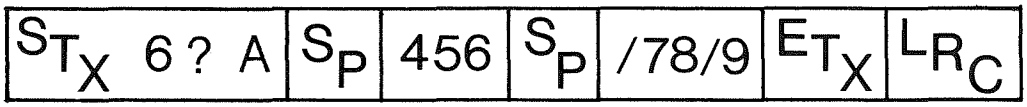


A	3.4	MAXIMUM CARD LENGTH FOR STORAGE IN CARD HOLDING SLOTS
K	0.65	LIMIT OF CARD VISIBLE AREA

NOTE: DIMENSIONS IN INCHES
AREA BOUNDED BY DIMENSIONS A AND K SHOULD BE USED TO IDENTIFY DIALING CARD FOR USER. READABLE PORTION SHOULD BE ON SAME SIDE OF CARD AS THE MAGNETIC STRIPE. ANY OTHER PERTINENT INFORMATION SUCH AS SPECIAL INSTRUCTIONS, ETC., CAN BE PRINTED ELSEWHERE ON THE CARD. HOWEVER, EMBOSSING CONSTRAINT (FIG. 15) MUST BE MET WITH RESPECT TO THE STRIPE LOCATION.

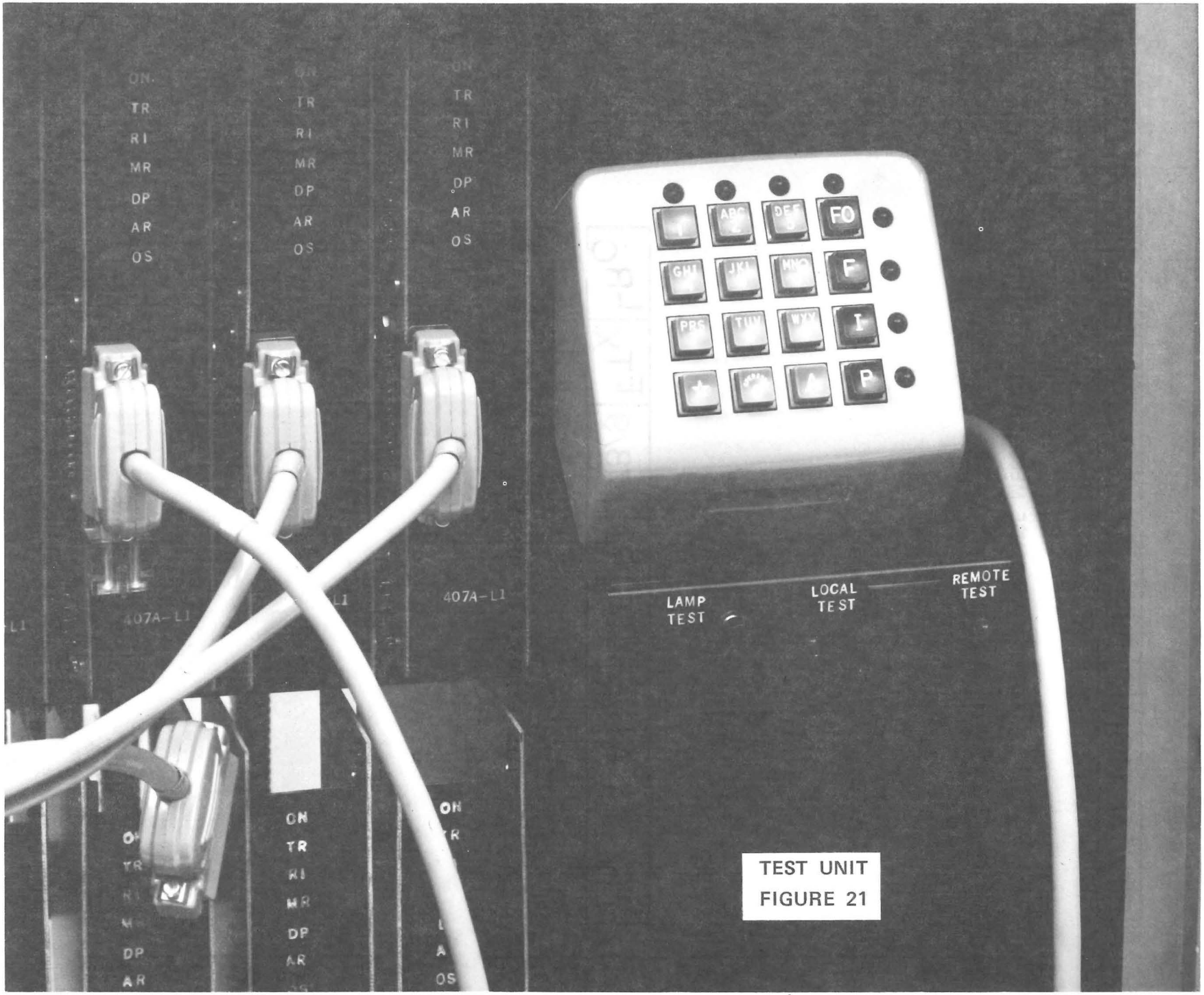
RECOMMENDED DIALING CARD CONFIGURATION
FIGURE 19

A. NORMAL RESPONSE MESSAGE



B. EXAMPLE OF MESSAGE

FIGURE 20
RESPONSE MESSAGE FORMATS



TEST UNIT
FIGURE 21