



Automatic Meter Reading Service Network Interface Specifications

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AUTOMATIC METER READING SERVICE NETWORK INTERFACE SPECIFICATIONS

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AUTOMATIC METER READING SERVICE NETWORK INTERFACE SPECIFICATIONS

1. GENERAL

This document provides the network interface specifications for the BellSouth Automatic Meter Reading (AMR) service. This service allows a utility company to collect its customers' utility meter data remotely by use of the public telephone switched network.

There are two new network interfaces associated with this service. The first interface is the Utility User interface, typically located on the utility company's premises. This interface provides the two-way communications capability between the utility company System Controller (SC) and the telephone network. The SC is a computer owned by the utility company. The second network interface is that between the Meter Interface Unit (MIU) at the utility customer's location and the telephone network. Both the utility company AMR equipment (including the SC) and the MIU are Customer Premises Equipment (CPE) under the Computer Inquiry II Rules of the FCC.

AMR service can only be provided on telephone company metallic facilities suitable for analog voice-band telephone service. The service is currently planned for limited deployment.

1.1. DOCUMENT ORGANIZATION

Section 1 of this document provides an overview of the BellSouth AMR service. An explanation of any future reissues of this document will be provided in this section.

Section 2 is a service description of AMR.

Section 3 provides the AMR session procedures.

Section 4 provides the network interface technical specifications for the Utility User interface.

Section 5 furnishes the technical specifications for the interface between the MIU and the telephone network.

Section 6 provides a list of reference documents for this technical reference.

2. AMR SERVICE DESCRIPTION

Figure 1 illustrates the major components of the AMR service network, and indicates the two network interfaces associated with the service.

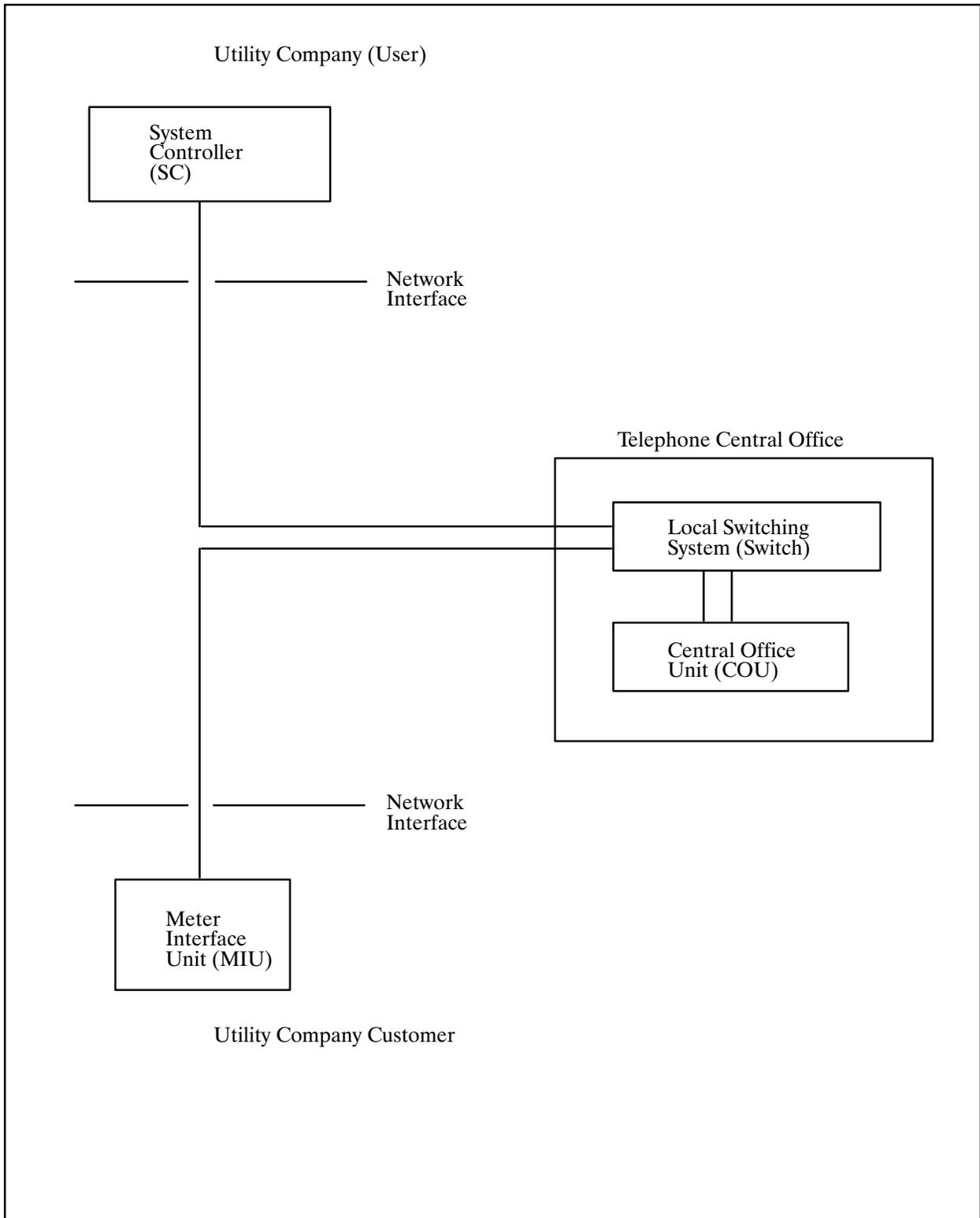


FIGURE 1 – AMR SERVICE NETWORK COMPONENTS

AMR service allows communication between the utility company CPE and the utility company customers' CPE, without disturbing the customer.

2.1. Network Components

The AMR network consists of the CPE located at the utility company location, telephone company voiceband metallic facilities, a Central Office Unit (COU) located in a telephone company central office, and the CPE equipment located at the utility company's customer location.

2.1.1 Utility Company CPE

The Utility Company SC is CPE at the utility company location that maintains a database of utility customer information. This information may include customer telephone number, MIU alerting tone, and utility customer billing information.

The SC requests and collects meter reading data from the utility company customer MIUs. The SC initiates and terminates AMR sessions with its customers by use of the telephone network. The network interface specifications at the utility company location for the session is described in Section 4.

2.1.2 Telephone Company Facilities

The public switched telephone network (PSTN) is used to provide AMR service. Standard grade message telephone facilities normally used for voice are generally satisfactory for the service.

The data jacks listed in Part 68 of Title 47 of the Code of Federal Regulations are suitable for AMR service access from the user's premises.

2.1.3 Central Office Unit (COU)

The COU is network equipment located in a telephone central office. The COU responds to requests and commands from the utility company SC, and establishes the network link between the SC and the MIU. The COU also terminates the session between the SC and MIU.

2.1.4 Meter Interface Unit (MIU)

The MIU is the CPE located at the utility company customer's location. The MIU responds to network commands to establish the link through the network to the utility company SC. The meter reading data is sent from the MIU through the telephone network to the SC.

2.2. Session Overview

The functionality of the two network interfaces is described in Sections 4 and 5 of this document. The information contained in Sections 4 and 5 provide the CPE industry with the technical specifications required to allow the CPE to fully interoperate with the telephone network. This section provides a general overview of the procedures used to establish and terminate a meter reading session from the utility company's location to its customer's MIU through the telephone network.

2.2.1 Establishing a Session

A session is initiated by the utility company's CPE accessing a dial-in port in the COU by using the PSTN. After a log-on procedure has been successfully completed, the call is disconnected, and the COU calls the utility company's CPE (the SC) through the PSTN. This dial-back procedure is required for network security purposes.

After the connection has been reestablished and set-up procedures between the SC and the COU have been successfully completed (as described in Section 4), the SC commands the COU to establish connection with a particular MIU (described in Section 5). The COU accesses the MIU requested, and then connects the SC to the MIU, allowing data transmission between the MIU and SC to take place.

2.2.2 Session Interactions

The telephone network does not manipulate or affect the information content of the customer data during the session. During each session, successive MIUs may be interrogated at the utility company's discretion.

Upon request, the COU accesses individual MIUs by transmitting an alerting tone towards the MIU. This tone is recognized by the MIU, without ringing the customer's telephone. The COU will not attempt to alert the customer's MIU if the customer's telephone is in the off-hook condition. If the COU detects that the customer line under test goes to an off-hook condition (e.g., the customer picks up his/her telephone handset to attempt a PSTN call) while the MIU is accessed, the COU releases the line. Therefore, the AMR service does not affect the customer's use of normal telephone service.

When the MIU detects a valid alerting tone from the COU, it goes to an off-hook condition, and a connection is established by the COU from the MIU to the SC. The MIU interrogates the customer's appropriate utility meter, and sends the meter reading data to the SC.

2.2.3 Session Termination

The COU continues to access the individual MIUs, as commanded by the SC, until the SC ends the session by issuing a log-off command.

3. AMR SESSION PROCEDURES

This section describes the required procedures for a typical meter reading session.

3.1. AMR Session Overview

A typical AMR session is comprised of the following steps: 1) Log-on procedure, (2) Set-up procedure, (3) Next Command procedure, (4) MIU Access procedure, (5) Usage Data procedure and (6) Log-off procedure. A detailed discussion of each of the procedures is contained in Sections 3.1.1 through 3.1.6.

The following steps occur in a typical AMR session:

1. The utility company accesses the COU via Log-on procedures described in Section 3.1.1.
2. The utility company sets up parameters for MIU interrogation using Set-up procedures described in Section 3.1.2.
3. Using the MIU Access procedure described in Section 5.1.4, the network accesses the specific MIU requested by the utility customer, and (if successful) establishes the connection between the MIU and the utility company SC. Subsequent data transmitted between the MIU and SC passes transparently through the network (except for the blocking of other utility companies' data when MIU Data Routing is used).
4. Upon completion of one MIU Access procedure, the utility company may proceed to: (1) another MIU Access procedure, (2) the Usage Data procedure, or (3) the Log-off procedure. The choice is made using the Next Command procedure described in Section 5.1.3.
5. If desired, the utility company can request AMR usage data using the Usage Data procedure described in Section 3.1.5.
6. When desired, the utility company can terminate an AMR session by using the Log-off procedures described in Section 3.1.6.

3.1.1 Log-on Procedure

The user (utility company) initiates the log-on procedure by placing a call to the COU (the network) through the PSTN. The COU will answer the call within 60 seconds, and after a two second pause, will transmit the modem answer tone signal on the line. After receiving at least 700 ms of answer tone, the user must transmit and sustain the modem originate carrier signal. After transmitting answer tone for at least 700 ms, the user must transmit the Log-on (I) command to the network. The COU must receive a valid Log-on command within 12 seconds of answering the call. The user is permitted only three log-on attempts per call. If the 12 second timer expires, or after three unsuccessful attempts, the line will be disconnected by the COU, after it transmits the ASCII letter "G" to the user.

If, during any procedure, the network does not receive a command from the user within any 5 minute period, the AMR session will be aborted.

After a valid Log-on command is received by the network, the call will be disconnected, and the network will call back the user through the PSTN. The information the network requires to identify and call back the user is contained in the Log-on command, as described in Section 5.2.2.1.

The user must answer the return call after one ring (to be expected after a maximum 60 second call processing delay), pause two seconds, and transmit modem answer tone. After receiving at least 700 ms of answer tone, the COU will transmit and sustain modem originate carrier frequency for at least 700 ms.

Upon completion of the above callback modem handshaking sequence, the network transmits a COU identification message to the user. This six-character COU identification message consists of a unique five-digit identification number followed by the ASCII "ENQ" (control code) character. The five-digit identification number is assigned to the user by BellSouth at subscription.

A simplified flowchart of the AMR Log-on procedure is contained in Appendix A.

3.1.2 Set-up Procedure

The Set-up procedure requires the successful exchange of three commands between the user and the network: a Select Facility (S) command, an Alert Tone (A) command, and a Connect Time (T) command. These commands can be sent in any order, and are normally issued only once during an AMR session. However, the user may elect to change the set-up parameters during a session by transmitting one or more of the three commands containing new parameter values. If any of the three commands are not transmitted, the network will assign a default value to the associated set-up parameter.

A description of the three set-up commands and their associated parameters follows. The format and structure of these commands are contained in Sections 4.2.2.2, 4.2.2.3 and 4.2.2.4.

Select Facility (S) Command

This command contains the one-digit ASCII number in its PARAMETER field required by the network. This number is assigned at the time of subscription by BellSouth.

Alert Tone (A) Command

The user designates which of the 13 frequency tones (see Section 5.1.4) is to be used to alert the MIU by use of this command.

Connect Time (C) Command

The user selects the maximum time that the MIU connection will be maintained after the MIU has been successfully alerted. The connect time parameter is a two or three digit ASCII number from 01 through 999, which specifies the maximum time, in seconds.

The MIU connection is normally terminated (ended) when the network determines that the MIU has disconnected. The Connect Time command parameter insures termination if conditions prevent a normal termination.

A simplified flowchart which illustrates the AMR Set-up procedure is contained in Appendix A.

3.1.3 Next Command procedure

After completion of the Log-on procedure, set-up procedure, the MIU Access procedure, or the Usage Data procedure, the session enters a transitory phase, in which the user can select the next session procedure to enter. The Next procedure is used to describe this phase. A simplified flowchart of the Next procedure is contained in Appendix A.

3.1.4 MIU Access Procedure

The MIU Access procedure must be completed for each MIU accessed during a session. The utility company user provides the necessary MIU access parameters using the Telephone Number (T) command described in Section 4.2.2.5. The two necessary parameters are the one-digit access method parameter and the seven-digit subscriber telephone number.

The access method parameter digit specifies which of three methods is being used to indicate to the network that a successful MIU alerting has occurred. The two methods are: (1) MIU loop current detection, (2) MIU carrier signal detected, and (3) Extended range. Additionally, for each of the three methods can be deployed with or without metallic bypass. Metallic bypass is necessary for local loops which involve subscriber carrier systems. This information is provided by BellSouth for each of the MIU locations.

After the reception of a valid Telephone Number command, the network attempts to access the MIU, and transport the MIU data message to the utility company user. This process may take as long as 20 seconds to complete. During the process, the network transmits progress status information to the user.

3.1.4.1 Successful MIU Access Description

Upon recognition of a successful subscriber line access and MIU alerting, the network will transmit the ASCII characters "FM" to the utility user. The "F" indicates the subscriber line was found to be free (on-hook), and the "M" indicates the MIU was successfully alerted by the network.

At this point, the network connects the MIU to the utility company user, allowing the MIU to transmit the meter reading data through the network. Spurious characters may be received from the network between the transmission of the "FM" characters and the transmission of data by the MIU. Similar spurious characters may also be sent by the network at the conclusion of MIU data transmission. It is the user's responsibility to identify and ignore these spurious characters.

3.1.4.2 Termination of the MIU Subscriber Line Connection

The network determines that the connection to the MIU is to be terminated (ended) when any of the following conditions occur:

1. The loop current of the MIU drops below 12 ma at any time during the procedure.
2. The Connect Time (C) command connect time parameter is exceeded.
3. The network detects a loss of MIU modem carrier for more than 1500 ms. The network will transmit the ASCII “ENQ” character to the user between 700 and 1700 ms after this condition is recognized. The network is at that point in the next command mode.
4. The network detects a change in loop current greater than 6 mA, after receiving the idle loop current for an initial 500 ms period. If this condition is detected at any time during the procedure, it is interpreted by the network as an attempt by the subscriber to make a telephone call.

3.1.4.3 Unsuccessful MIU Access Description

In event of an unsuccessful subscriber line access MIU alert, the network will transmit one of the seven error codes described in Section 3.2.3.4. The “B”, “D”, “R”, “X” and “F” ASCII characters described in this Section 3.2.3.5 will be transmitted within 30 seconds after the “ACK” character was transmitted.

After the network has sent the MIU access error response and terminated (ended) the MIU connection, an ASCII “ENQ” is transmitted to the utility company user. This character is sent within one second on connection termination. This is the network indication that the session has entered the Next Command procedure.

A simplified flowchart illustrating the MIU Access procedure is contained in Appendix A.

3.1.5 Usage Data Procedure

A record of AMR service usage data is available on–line to the utility company user. The data is provided using the Utility User Usage Data message (see Section 4.2.3.6).

Usage data is stored for up to four daily time intervals. The usage data information includes:

1. The total cumulative COU access time for each AMR session. The time is measured from the point the network recognizes the AMR identification message (see Section 3.1.1) to the point the session is terminated (log–off).
2. The total cumulative MIU connection time for each AMR session. The time is measured from the point of each successful MIU alert to the point of MIU subscriber line termination.
3. The total number of successful MIU alerts.
4. The total number of MIU subscriber line access attempts.

Although normally requested at the conclusion of an AMR session, the usage data may be requested at any time during a session.

Appendix A contains a simplified flowchart illustrating the Usage Data procedure.

3.1.6 Log-off Procedure

The Log-off (E) command is transmitted by the utility company user to terminate an AMR session. Upon receipt of a valid Log-off command, the network transmits an affirmative acknowledgment to the user with the Affirmative Acknowledgment Response described in Section 4.2.3.7.

A simplified flowchart illustrating the Log-off procedure is contained in Appendix A.

4. UTILITY USER INTERFACE SPECIFICATIONS

This section describes the specifications of the network interface between the utility company’s SC and the PSTN. These specifications describe the protocol and procedures required between the SC and the COU to conduct a meter reading session. It also describes the options supported by the interface.

The protocol used across the network interface consists of the physical level specifications, the message format structure, and the command and error checking codes used with AMR service.

4.1. Physical Level Protocol

Access to AMR from the utility customer equipment (the SC) is via the PSTN, and utilizes voiceband modems conforming to Bell 212 or Bell 103 modem characteristics and protocol.

Communication across the interface at the 1200 bits per second rate requires the use of Bell 212 compatible modems. Only full-duplex, asynchronous transmission is supported at 1200 bits per second.

Communication across the interface at the 300 bits per second rate requires the use of Bell 103 compatible modems. Only full-duplex, asynchronous transmission is supported at 300 bits per second.

The asynchronous data byte structure is a ten-bit character comprised of one start bit, seven data bits (ASCII characters), one even parity bit, and one stop bit. An optional ten-bit byte structure may also be utilized. This optional structure is comprised of one start bit, eight data bits, and one stop bit. The network does not echo characters received from the utility company.

4.2. Message Format Received by the Network

The format structure of messages sent from the CPE to the network is as follows:

STX	LENGTH	COMMAND CHARACTER	PARAMETERS	ERROR CHECK CODE	ETX
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Each of the six fields is populated with one or more characters, except for the PARAMETERS field, which is not required for all message types. The complete frame is transmitted beginning with STX and ending with ETX.

A description of the six Message Format frame fields is contained in Sections 4.2.1.1 – 4.2.1.6 below.

4.2.1 Description of Frame Fields

4.2.1.1 STX Field

Start of Text. Consists of the single ASCII STX character (2 decimal; 00000010)

4.2.1.2 LENGTH Field

Two characters indicating the number of characters in the Message Format frame excluding the STX, LENGTH, ERROR CHECK CODE, and ETX fields. The two characters in the field are ASCII encoded hexadecimal digits.

Assume, for example, the length field entry should indicate 29 characters for a particular frame. The hexadecimal representation of 29 is 1C. Therefore, the length field of this frame would contain the two ASCII characters 1C (49 and 67 decimal, 0011001 and 01000011 binary).

The maximum absolute value for the field is 255.

4.2.1.3 COMMAND CHARACTER Field

One ASCII character which identifies the command type. The permissible codes for this field are shown in Table A. This field identifies the command message type.

4.2.1.4 PARAMETERS

This optional field contains command data. The PARAMETERS field is not used for all types of Command Frames. The content of the PARAMETERS fields of the various types of command messages is described in Section 4.2.2.

4.2.1.5 ERROR CHECK CODE

This field contains a four byte ASCII error check code. One of two types of error check code schemes is used by the network – the Checksum method and the CCITT method.

It is desirable that CPE be capable of supporting both of the methods. Although the network supports either method, the same method must be used throughout an entire individual session.

Checksum Method

The four digit checksum entry is calculated by first summing together the numeric values of all the ASCII characters between, but not including, the LENGTH field and the ERROR CHECK CODE field. The four least significant digits of this summation are then retained, and entered as ASCII numbers in the ERROR CHECK CODE field.

CCITT Method

The four digit CCITT entry is calculated following CCITT CRC–16 procedures, as described in 1988 CCITT Fascicle VIII.2 Recommendation X.25 (the Blue Book), with the following exceptions:

1. The initial value for the calculation must be set to zero for each CRC calculation.
2. The CRC value is calculated using the seven bit ASCII values of all the characters in the message between, but excluding, the STX and ERROR CHECK CODE field.
3. The ERROR CHECK CODE field entry is four ASCII characters representing the hexadecimal values of the CRC–16 (2 byte) calculation.

4.2.1.6 ETX

The End of Text sequence. This field contains the single ASCII character ETX (ASCII 3 decimal; 0000011 binary).

4.2.2 Types of Command Messages

There are seven types of command messages that the network will accept. Sections 4.2.2.1 – 4.2.2.7 illustrate the format and contents of these message types. The tables contained in these section indicate the format field (LEN = LENGTH field, CMD = COMMAND CHARACTER field, PAR = PARAMETER field, and ECC = ERROR CHECK CODE field), the permissible ASCII characters that can be used to populate each field, and a description of the field entries.

Table A indicates the seven command message types. Also indicated in Table A is the valid COMMAND CHARACTER field entry associated with the message type.

TABLE A		
<u>COMMAND CHARACTER</u>	<u>COMMAND TYPE</u>	<u>DESCRIPTION</u>
I	Log-on	Initiates utility user session
S	Select Facility	Indicates which BellSouth facility is to be used for the session
A	Alert Tone	Selects the MIU alert frequency
C	Connect Time	Selects the maximum MIU connect time
T	Telephone No.	Selects the MIU telephone number to be accessed.
U	Usage Data	Requires that utility usage data information be transmitted from the network
E	Log-off	Ends the utility user session

4.2.2.1 Log-on (I) Command

LOG-ON (I) COMMAND			
FIELD	NO. OF BYTES	ASCII CHARACTER(S)	DESCRIPTION
STX	1	STX	Start-of-text character
LEN	2	07	Log-on message length, which is always seven characters
CMD	1	I	Command letter for Log-on command is always "I"
PAR	6	1 digit (0 - 9)	User identification number, assigned by BellSouth
		4 digits (0 - 9)	User password, assigned by BellSouth
		1 digit (0 - 9)	User callback reference no. (tel. no. is provided by the customer)
ECC	4	*	Log-on message error check code
ETX	1	ETX	End-of-text character

* This field contains a four ASCII character error check code calculated by one of the two methods described in Section 4.2.1.5.

Note

The user identification number and user password are unique to each utility company user. These numbers are assigned to the user at the time of AMR subscription.

4.2.2.2 Select Facility (S) Command

SELECT FACILITY (S) COMMAND			
FIELD	NO. OF BYTES	ASCII CHARACTER(S)	DESCRIPTION
STX	1	STX	Start-of-text character
LEN	2	02	Select Facility message length, which is always two characters
CMD	1	S	Command letter for Select Facility Command is "S"
PAR	1	1 digit (0 – 9)	BellSouth facility number
ECC	4	*	Select Facility message error check code
ETX	1	ETX	End-of-text character

* This field contains a four ASCII character error check code calculated by one of the two methods described in Section 4.2.1.5.

Note

The single digit PARAMETER field entry is assigned by BellSouth at the time of subscription.

4.2.2.3 Alert Tone (A) Command

ALERT TONE (A) COMMAND			
FIELD	NO. OF BYTES	ASCII CHARACTER(S)	DESCRIPTION
STX	1	STX	Start-of-text character
LEN	2	02	Alert Tone message length, which is always 2 characters
CMD	1	A	Command letter for Alert Tone command is always "A"
PAR	1 (A-K, M, or Z)	1 letter	Alert tone designation letter (see Section 4.1.4)
ECC	4	*	Alert Tone message error check code
ETX	1	ETX	End-of-text character

* This field contains a four ASCII character error check code calculated by one of the two methods described in Section 4.2.1.5.

4.2.2.4 Connect Time (C) Command

CONNECT TIME COMMAND			
FIELD	NO. OF BYTES	ASCII CHARACTER(S)	DESCRIPTION
STX	1	STX	Start-of-text character
LEN	2	03 or 04	Connect Time message length
CMD	1	C	Command letter for Connect Time command is always "C"
PAR	2 or 3	2 or 3 digits	Connect time in seconds (01 - 999)
ECC	4	*	Connect Time command error check code
ETX	1	ETX	End-of-text character

* This field contains a four ASCII character error check code calculated by one of the two methods described in Section 4.2.1.5.

4.2.2.5 Telephone Number (T) Command

TELEPHONE NUMBER (T) COMMAND			
FIELD	NO. OF BYTES	ASCII CHARACTER(S)	DESCRIPTION
STX	1	STX	Start-of-text character
LEN	2	09	Tel. No. Command message length, which is always nine characters
CMD	1	T	Tel. No. Command letter is always "T"
PAR	8	1 digit	Access Method Parameter Alert Detect Method 0 (Loop Current) 0 = Metallic Bypass Not Required 1 = Metallic Bypass Req'd Alert Detect Method 1 (MIU Carrier) 2 = Metallic Bypass Not Required 3 = Metallic Bypass Req'd Alert Detect Method 2 (Extended Range) 4 = Metallic Bypass Not Required 5 = Metallic Bypass Req'd
		7 digits (0 - 9)	Subscriber Telephone Number
ECC	4	*	Telephone Number Command message error check code
ETX	1	ETX	End-of-text character

* This field contains a four ASCII character error check code calculated by one of the two methods described in Section 4.2.1.5.

4.2.2.6 Usage Data (U) Command

USAGE DATA (U) COMMAND			
FIELD	NO. OF BYTES	ASCII CHARACTER(S)	DESCRIPTION
STX	1	STX	Start-of-text character
LEN	2	01	Usage Data Command message length is always 1 character
CMD	1	U	Usage data command designation letter is "U"
PAR	0	–	PARAMETER field not used
ECC	4	*	Usage Data Command message error check code
ETX	1	ETX	End-of-text character

* This field contains a four ASCII character error check code calculated by one of the two methods described in Section 4.2.1.5.

4.2.2.7 Log-off (E) Command

LOG-OFF (E) COMMAND			
FIELD	NO. OF BYTES	ASCII CHARACTER(S)	DESCRIPTION
STX	1	STX	Start-of-text character
LEN	2	01	Log-off Command message length, which is always one character
CMD	1	E	Log-off Command letter is always "E"
PAR	0	–	PARAMETER field not used
ECC	4	*	Log-off Command message error check code
ETX	1	ETX	End-of-text character

* This field contains a four ASCII character error check code calculated by one of the two methods described in Section 4.2.1.5.

4.2.3 Types of Response Messages

This section describes the types of response messages the network will provide across the Utility User Interface. These messages are sent in reply to command messages sent across the Utility User Interface from the utility company to the network, as described in Section 4.2.2.

The Response messages from the network for each of the seven types of command messages are described in Sections 4.2.3.1 through 4.2.3.7.

In general, an affirmative acknowledgement (ACK) is an indication the network has recognized the message as a valid command, and has responded to it. A negative acknowledgement (NAK) is an indication that the network has either not recognized the message as a valid command, or has recognized it but cannot respond to it.

4.2.3.1 Network Responses to Log-on Command

The network response to a Log-on (I) command is either an affirmative acknowledgment (ACK), or a negative acknowledgment (NAK). The format of the two responses are shown below.

AFFIRMATIVE ACKNOWLEDGMENT RESPONSE		
NO. OF BYTES	ASCII CHARACTER(S)	DESCRIPTION
1	ACK	Affirmative acknowledgment character

NEGATIVE ACKNOWLEDGMENT RESPONSE		
NO. OF BYTES	ASCII CHARACTER(S)	DESCRIPTION
1	NAK	Negative acknowledgment character

4.2.3.2 Network Responses to Select Facility Command

The network response to a Select Facility (S) command is either an affirmative acknowledgment (ACK), or a negative acknowledgment (NAK). The format of the two responses are shown below.

AFFIRMATIVE ACKNOWLEDGMENT RESPONSE		
NO. OF BYTES	ASCII CHARACTER(S)	DESCRIPTION
1	ACK	Affirmative acknowledgment character

NEGATIVE ACKNOWLEDGMENT RESPONSE		
NO. OF BYTES	ASCII CHARACTER(S)	DESCRIPTION
1	NAK	Negative acknowledgment character

4.2.3.3 Network Response to Alert Tone Command

The network response to an Alert Tone (A) command is either an affirmative acknowledgment (ACK), or a negative acknowledgment (NAK). The format of the two responses are shown below.

AFFIRMATIVE ACKNOWLEDGMENT RESPONSE		
NO. OF BYTES	ASCII CHARACTER(S)	DESCRIPTION
1	ACK	Affirmative acknowledgment character

NEGATIVE ACKNOWLEDGMENT RESPONSE		
NO. OF BYTES	ASCII CHARACTER(S)	DESCRIPTION
1	NAK	Negative acknowledgment character

4.2.3.4 Network Response to Connect Time Command

The network response to a Connect Time (C) command is either an affirmative acknowledgment (ACK), or a negative acknowledgment (NAK). The format of the two responses are shown below.

AFFIRMATIVE ACKNOWLEDGMENT RESPONSE		
NO. OF BYTES	ASCII CHARACTER(S)	DESCRIPTION
1	ACK	Affirmative acknowledgment character

NEGATIVE ACKNOWLEDGMENT RESPONSE		
NO. OF BYTES	ASCII CHARACTER(S)	DESCRIPTION
1	NAK	Negative acknowledgment character

4.2.3.5 Network Response to Telephone Number Command

The network response to a Telephone Number (T) command is either one of two types of affirmative acknowledgments, or a negative acknowledgment (NAK). The two types of affirmative acknowledgments are MIU Access Normal Acknowledgment and MIU Access Error Response. The format of the three types of responses are shown below.

NEGATIVE ACKNOWLEDGMENT RESPONSE		
NO. OF BYTES	ASCII CHARACTER(S)	DESCRIPTION
1	NAK	Negative acknowledgment character

MIU ACCESS NORMAL ACKNOWLEDGMENT		
NO. OF BYTES	ASCII CHARACTER(S)	DESCRIPTION
1	ACK	Affirmative acknowledgment character
2	FM	Subscriber Line Accessed; MIU Alerted (erroneous characters may be received in the interval between this transmission and the reception of the MIU data message below).
1 or more	1 or more	MIU data message. Message length is variable, n characters.
1	ENQ	Control code character

MIU ACCESS ERROR RESPONSE		
NO. OF BYTES	ASCII CHARACTER(S)	DESCRIPTION
1	ACK	Affirmative acknowledgment character
1 or 2	**	Error Status Option character(s)
1	ENQ	Control code character

** The following are the Error Status Options codes that may be sent from the network in this field:

<u>ASCII LETTER(S)</u>	<u>DESCRIPTION</u>
B	Subscriber Line Busy
D	Intercept
R	Overflow
X	Trunk Failure
FI	Subscriber Line Long Term Off-Hook
FN	Subscriber Line Accessed; Unable To Alert MIU
FE	Subscriber Line Accessed; MIU Response Error

4.2.3.6 Network Responses to Usage Command

The positive network response to a Usage (U) command is a Utility User Usage Data Message. The format of the response is shown below.

UTILITY USER USAGE DATA MESSAGE			
FIELD	NO. OF BYTES	ASCII CHARACTER(S)	DESCRIPTION
STX	1	STX	Start-of-text character
LEN	2	2 Digits	Utility User Usage Data message length (See Note 1)
LET	1	U	Utility User Usage Data letter is always "U"
PAR	134 max	1 Digit	Utility user number; assigned by telephone co.
		6 Digits [MMDDYY]	Date COU registers last reset by network
		4 Digits [HHMM]	Time registers last reset by network
		6 Digits [MMDDYY]	Current Date
		4 Digits [HHMM]	Current Time
		4 Digits [HHMM]	Interval 1 start time (See Note 2)
		4 Digits [HHMM]	Interval 2 start time (See Note 2)
		4 Digits [HHMM]	Interval 3 start time (See Note 2)
		4 Digits [HHMM]	Interval 4 start time (See Note 2)
		ETB	End-of-block character
		6 Digits [HHMMSS]	Interval 1: total MIU connect time (See Note 3)

(continued next page)

UTILITY USER USAGE DATA MESSAGE (cont.)			
FIELD	NO. OF BYTES	ASCII CHARACTER(S)	DESCRIPTION
		5 Digits [HHHMM]	Interval 1: total network access time
		6 Digits	Interval 1: total MIU alerts
		6 Digits	Interval 1: total line access attempts
		ETB	End-of-block character
		5 Digits [HHHMM]	Interval 2: total network access time (See Note 3)
		6 Digits [HHMMSS]	Interval 2: total MIU connect time (See Note 3)
		6 Digits	Interval 2: total MIU alerts (See Note 3)
		6 Digits	Interval 2: total line access attempts (See Note 3)
		ETB	End-of-block character (See Note 3)
		5 Digits [HHHMM]	Interval 3: total network access time (See Note 3)
		6 Digits [HHMMSS]	Interval 3: total MIU connect time (See Note 3)
		6 Digits	Interval 3: total MIU alerts (See Note 3)
		6 Digits	Interval 3: total line access attempts (See Note 3)
		ETB	End-of-block character (See Note 3)
		5 Digits [HHHMM]	Interval 4: total network access time (See Note 3)
		6 Digits [HHMMSS]	Interval 4: total MIU connect time (See Note 3)

(continued on next page)

UTILITY USER USAGE DATA MESSAGE (cont.)			
FIELD	NO. OF BYTES	ASCII CHARACTER(S)	DESCRIPTION
		6 Digits	Interval 4: total MIU alerts (See Note 3)
		6 Digits	Interval 4: total line access attempts (See Note 3)
		ETB	End-of-block character (See Note 3)
ECC	4	See Note 5	Error check code
ETX	1	ETX	End-of-text character

Notes

1. Since the Usage Data message includes data for enabled time intervals only, the LEN field is variable. The LEN field entry is the number of characters between, but not including, the LEN and ECC fields, expressed in hexadecimal code.
2. The interval start times are provided by the network. One use for multiple interval start times is to provide the user with time-of-day telephone company billing information. There is always a four digit entry in this field. However, there may be less than four daily intervals, in which case not all four intervals will be enabled. The entry in this field for those intervals not enabled is the four digit entry "0000".
3. This field is optional, and is only included in the message if the associated interval number is enabled. The usage registers can overflow, in which case they restart from zero.
4. The following is an explanation of the time and date abbreviations used in the above table:
 - MM = 2 digit month ASCII numerals (01 – 12)
 - DD = 2 digit date ASCII numerals (01 – 31)
 - YY = 2 digit year ASCII numerals
 - HH = 2 digit hour ASCII numerals (00 – 24)
 - MM = 2 digit minute ASCII numerals (00 – 59)
 - SS = 2 digit second ASCII numerals (00 – 59)
5. The ECC field does not contain ASCII characters, but rather the 16-bit code calculated by one of the two methods described in Section 4.2.1.5.

The negative acknowledgment of a Usage (U) command is shown below.

NEGATIVE ACKNOWLEDGMENT RESPONSE		
NO. OF BYTES	ASCII CHARACTER(S)	DESCRIPTION
1	NAK	Negative acknowledgment character

4.2.3.7 Network Response to Log-off Command

The network response to a Log-off (E) command is either an affirmative acknowledgment, or a negative acknowledgment. The format of the two responses are shown below.

AFFIRMATIVE ACKNOWLEDGMENT RESPONSE		
NO. OF BYTES	ASCII CHARACTER(S)	DESCRIPTION
1	ACK	Affirmative acknowledgment character
1	G	Goodbye

NEGATIVE ACKNOWLEDGMENT RESPONSE		
NO. OF BYTES	ASCII CHARACTER(S)	DESCRIPTION
1	NAK	Negative acknowledgment character

5. MIU INTERFACE SPECIFICATIONS

This section describes the specifications of the network interface between the telephone subscriber's (utility customer's) CPE, including the MIU, and the PSTN. These specifications include the protocol and procedures between the MIU and the COU required to conduct a meter reading session.

5.1. Physical Level Protocol and Requirements

The MIU is CPE, and is connected directly to the telephone subscriber's two-wire POTS local loop facility on the customer side of the Network Interface. MIUs used in the BellSouth network must be registered, labeled, and installed in accordance with Part 68 of Title 47 of the Code of Federal Regulations.

MIUs must operate in a manner that does not interfere with any other telephone service, or network operations and maintenance systems. Normal operations are defined in ANSI T1-401-1988, "Interface Between Customer Installation - Analog Voicegrade Switched Access Lines Using Loop-start and Ground-start Signaling".

5.1.1 Reference Documents for Operation with the PSTN

The following documents are also applicable to the Network Interface:

PUB 41005, “Data Communications Using The Switched Telecommunications Network”, Bellcore.

PUB 41008, “Analog Parameters Affecting Voiceband Data Transmission – Description of Parameters”, Bellcore.

TR-TSY-000506, LSSGR, Section 6 – Signaling, Bellcore.

ANSI IEEE Standard 820-1984, IEEE Standard Telephone Loop Performance Characteristics, ANSI.

5.1.2 MIU Operating States

The MIU operates in either the “Idle State” or the “Active State”. The MIU normally operates in the idle state, and switches to the active state when an MIU access request is recognized. Upon completion of the AMR session, the MIU must immediately revert back to the idle state.

The MIU must also be able to detect the subscriber’s telephone transition from an on-hook to off-hook condition via detection by the COU, and immediately abort the session and return to the idle state. The MIU must present an on-hook impedance to the network in the idle state.

5.1.3 MIU Powering

Direct current powering of the MIU in the active (off-hook) state is available from the two-wire local loop. The specifications for MIU powering are indicated in the table below. The -72 volt source voltage specification is optional, and is not available for all installations.

<u>NETWORK VOLTAGE</u>	<u>NETWORK VOLTAGE TOLERANCE</u>	<u>NETWORK CURRENT</u>	<u>CONDUCTOR-TO-CONDUCTOR D.C. RESISTANCE</u>
-48 V.	-42.5 to -52.5 Volts	12 to 130 mA	0 to 2000 ohms
-75 V.	- 72.0 to -77.0	12 to 50 mA	0 to 4000 ohms

5.1.4 MIU Alerting Tones

The network transmits one of thirteen possible alerting tones to the MIU across the Network Interface to initiate an AMR session. Each of the tones is an analog signal transmitted at a unique frequency. The signal level of the tones at the source is 0 to -22 dBm measured into 600 ohms. The duration of the alerting tone is 4 seconds. Each of the thirteen unique frequencies have been assigned a specific letter designation, called an alerting character. The thirteen alerting characters and their corresponding frequency tones are indicated in the table below.

The MIU must be capable of detecting and identifying one of the thirteen frequencies listed in the table. Upon identifying the alerting tone, the MIU goes from the idle state to the active state. Typically, it then acquires usage data from the subscriber’s meter(s), and transmits the data to the utility company user. This data is regenerated in the network, but is otherwise transported transparently through the network, except when the optional MIU Data Routing feature (Section 4.2.6) is employed, in which case the network blocks the usage data intended for other utility companies. The MIU then reverts back from the active state to the idle state. MIU activation is indicated by the MIU drawing a loop current of at least 12 mA.

ALERTING TONES	
ALERTING CHARACTER	TONE FREQUENCY
A	252.4 Hz
B	268.7
C	285.3
D	315.5
E	330.5
F	375.2
G	468.0
H	495.8
I	520.6
J	548.0
K	562.8
M	578.4
Z	404.3

The tolerance of the tone frequencies is plus or minus one percent.

5.1.5 Transmission Characteristics

MIU operation with the network conforms to Bell 103 voiceband modem transmission characteristics. Simplex asynchronous data transmission is required at the 300 bps (bits per second) rate, plus or minus one bps. The MIU operates using the modem originate mode carrier frequencies, and the network operates using modem answer mode carrier frequencies. The expected transmit level expected from the MIU at the Network Interface is from -9 dBm to -13 dBm. The expected receive level at the MIU from the network is -30 dBm to -13 dBm.

The asynchronous data byte structure is a ten-bit character comprised of one start bit, seven data bits (ASCII characters), one even parity bit, and one stop bit. In some locations, an optional ten-bit byte structure may be utilized. This optional structure is comprised of one start bit, eight data bits, and one stop bit.

5.1.6 Transmission Sequence

The following steps describe the sequence of events required to maintain and terminate an AMR session:

1. The MIU shall transmit the originate modem “mark” carrier frequency within 300 ms after entering the active state. The mark tone is transmitted for a period of 500 to 800 ms.
2. The MIU acquires the necessary meter data from the customer premises.
3. The MIU shall transmit the acquired data to the network using the protocol described in Section 4.2.
4. The MIU shall squelch originate carrier and return to the idle state within 50 to 150 ms after transmission of the data has been completed.

5.2. MIU Data Message Format

The MIU message format structure transmitted from the MIU to the network across the Network Interface shall be as follows:

STX	HEADER	PORT 1	PORT 2	PORT 3	PORT 4	ECC	ETX
-----	--------	--------	--------	--------	--------	-----	-----

Sections 5.2.1 through 5.2. describe the message format fields.

5.2.1 4STX Field

Consists of the ASCII STX (start-of-text) character

5.2.2 HEADER Field

The HEADER field is variable in length and is comprised of a serial string of ASCII characters terminated by the ASCII ETB control character.

CHARACTER STRING	ETB
------------------	-----

5.2.3 PORT Fields

The four PORT fields are optional. Zero through four PORT fields may be contained in a data message frame. There are two acceptable PORT field formats. These two are shown below:

Format 1:

PORT NUMBER	PORT I.D.	ETB	PORT METER DATA	ETB
-------------	-----------	-----	-----------------	-----

Format 2:

PORT NUMBER	SP	METER I.D.	SP	PORT METER DATA	ETB
-------------	----	------------	----	-----------------	-----

5.2.3.1 PORT NUMBER

A single ASCII number (1, 2, 3 or 4) which designates the MIU meter port transmitting the PORT I.D. or METER I.D., and the PORT METER DATA information.

5.2.3.2 PORT I.D.

A variable length field containing ASCII characters. The field may contain 0 through 20 characters.

5.2.3.3 METER I.D.

A variable length field whose contents are dependent on the AMR application.

5.2.3.4 SP

The single ASCII SP (space) character.

5.2.3.5 ETB

The single ASCII ETB control character.

5.2.4 ECC

The error check code, calculated by one of the two methods described in Section 4.2.1.5, except both calculations are made on the portion of the Data Message frame between (but excluding) the STX and the ECC fields.

5.2.5 ETX

The single ASCII ETX (end-of-text) character.

5.2.6 MIU Data Routing

MIU Data Routing is a network feature designed for situations in which more than one utility company user is served by AMR service from the same telephone central office. This capability allows the network to determine to which user the MIU data should be routed. This determination is made from examining the first character of each port identification of the PORT I.D. or METER I.D. fields. MIU Data Routing ensures that only the authorized user associated with the MIU receives the AMR data during the session.

When MIU Data Routing is utilized, the MIU Data Message format is as shown below.

STX	HEADER	PORT m	PORT n	ECC	ETX
-----	--------	--------	--------	-----	-----

The PORT m and PORT n fields are port data blocks which include the appropriate utility company user (first) character in the PORT I.D. or METER I.D. fields. The contents of the MIU messages routed to the appropriate user are exactly the same as those received by the network from the MIU, except for the ECC, which must be recalculated by the network.

6. REFERENCES

6.1. Reference Documents

The following documents were used as references for this technical reference:

- (1) Ameritech Technical Reference AM TR–MKT–000035, Issue 1; “Ameritech Automatic Meter Reading Services Interface Specifications;” March 1989.¹
- (2) Bell Atlantic Network Services, Inc. TR 72015, “Bell Atlantic Automatic Meter Reading Service Interface Specifications”, July, 1986.²

6.2. Related Documents

The following are documents referenced in this reference:

- (1) PUB 41005 “Data Communications Using The Switched Telecommunications Network”, Bellcore.³
- (2) PUB 41008, “Analog Parameters Affecting Voiceband Data Transmission – Description of Parameters”, Bellcore.³
- (3) TR–TSY–000506 LSSGR, Section 6 – Signaling, Belcore.³
- (4) ANSI IEE Standard 820–1984, “IEE Standard Telephone Loop Performance Characteristics”, ANSI.⁴
- (5) ANSI T1–401–1988 “Interface Between Customer Installations – Analog Voicegrade Switched Access Lines Using Loop–start and Ground–start Signaling”.⁴

FOOTNOTES

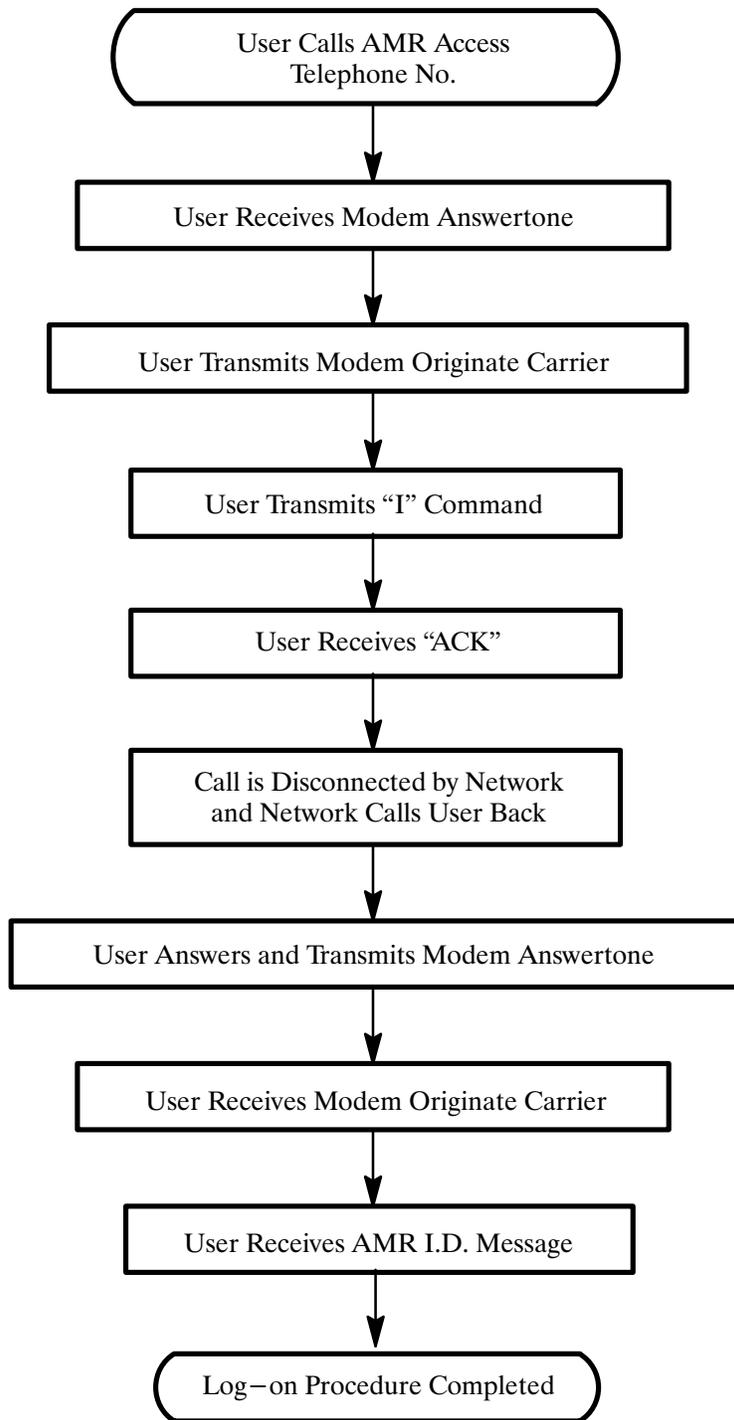
1. This document can be ordered through Ameritech Services, Inc., Information Management, 3040 West Salt Creek Lane 3–23, Arlington Heights, IL, 60005.
2. This document can be ordered through Bell Atlantic Network Services Staff, Staff Manager – Information Exchange, 1310 N. Court House Road, Arlington, VA, 22201.
3. This document can be ordered through Bellcore, Customer Service, 60 New England Avenue, Piscataway, NJ, 08854, telephone 1–800–521–CORE.
4. This document can be ordered through the American National Standards Institute, Inc., (ANSI), 1430 Broadway, New York, NY, 10018, telephone (212) 642–4900.

APPENDIX A

This appendix illustrates the six procedures involved in an AMR session. The flowcharts contained in this appendix indicate the events affecting the Network Interface at the utility user's location. These events are presented from the utility user's perspective.

The flowcharts are not comprehensive, but rather simplified illustrations of the principal steps involved in a typical successful meter reading session. The purpose of the flowcharts is not to provide additional network interface specifications, but rather to provide the reader with a high-level view of a typical AMR session. Detailed explanations of the procedures are described in the main text of the document. If there are any discrepancies between the main text of this document and the flowcharts contained in this appendix, the information contained in the main text should be considered accurate.

The "user" in the flowcharts refers to the utility company user.



A ————— A
Figure A-2

FIGURE A-1 – TYPICAL LOG-ON PROCEDURE FLOWCHART

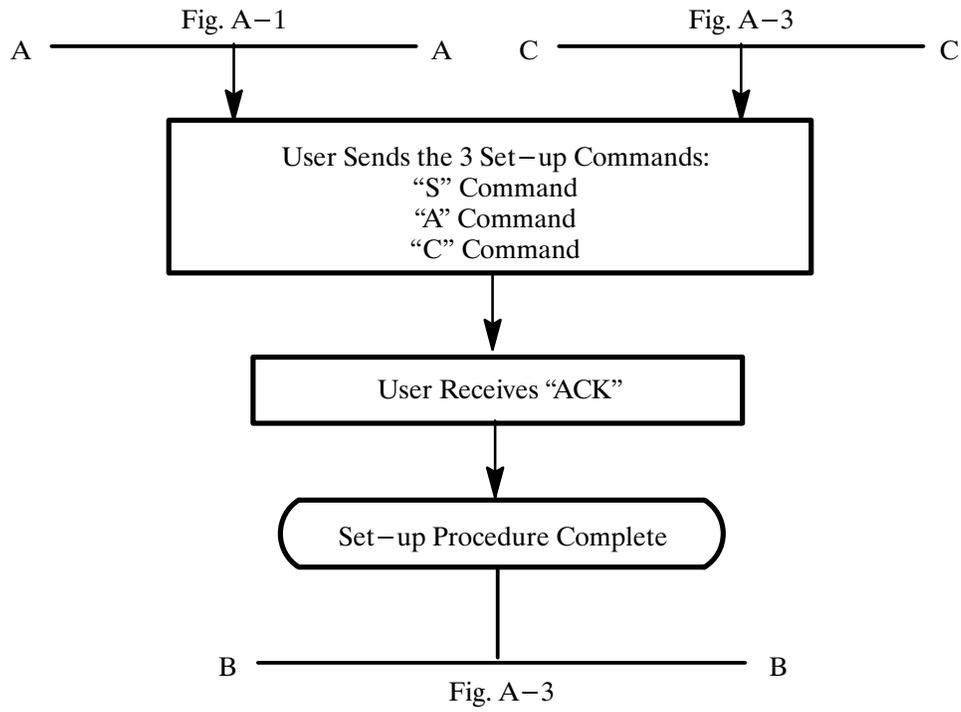


FIGURE A-2 – TYPICAL SET-UP PROCEDURE FLOWCHART

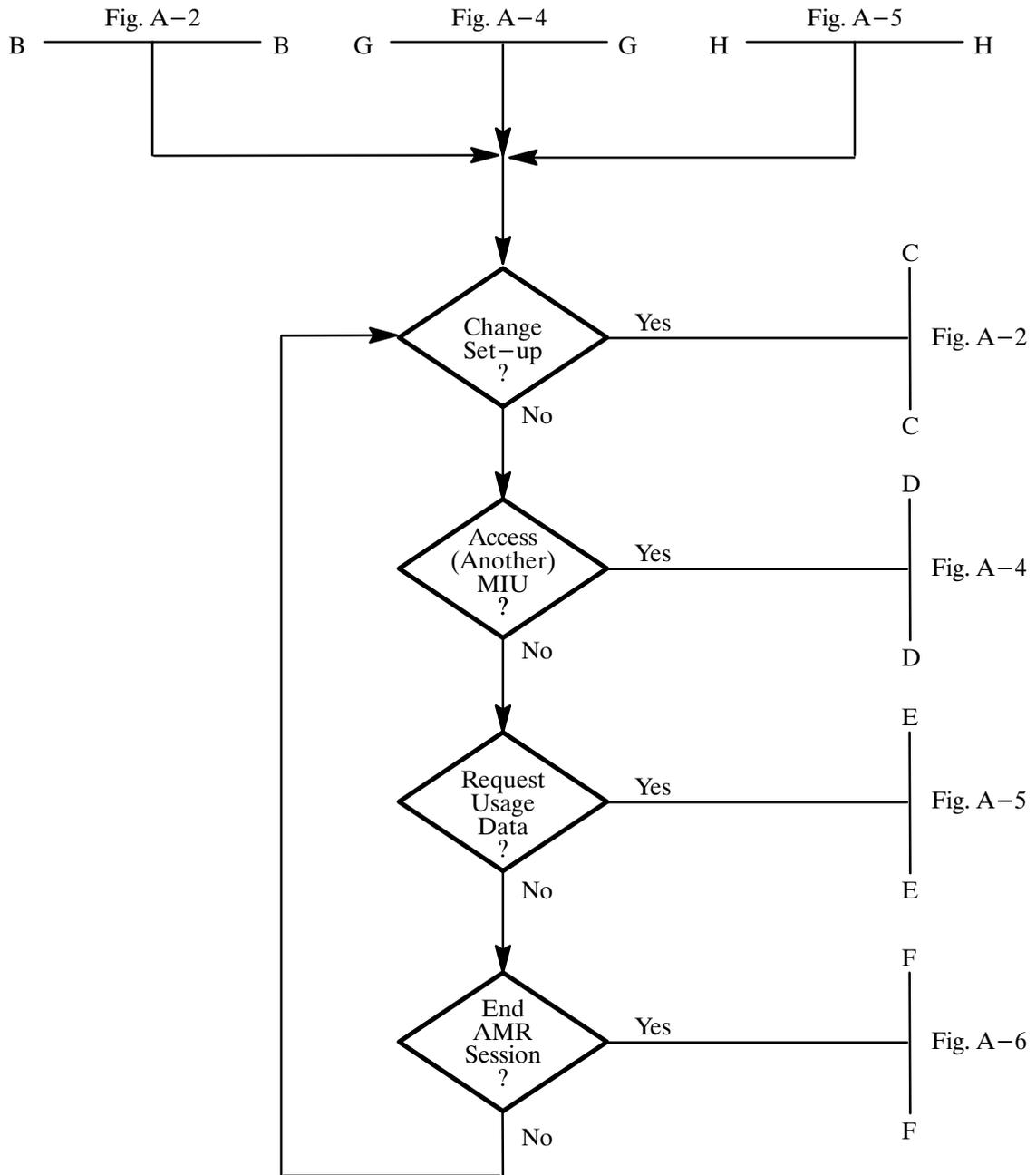


FIGURE A-3 – TYPICAL NEXT COMMAND PROCEDURE FLOWCHART

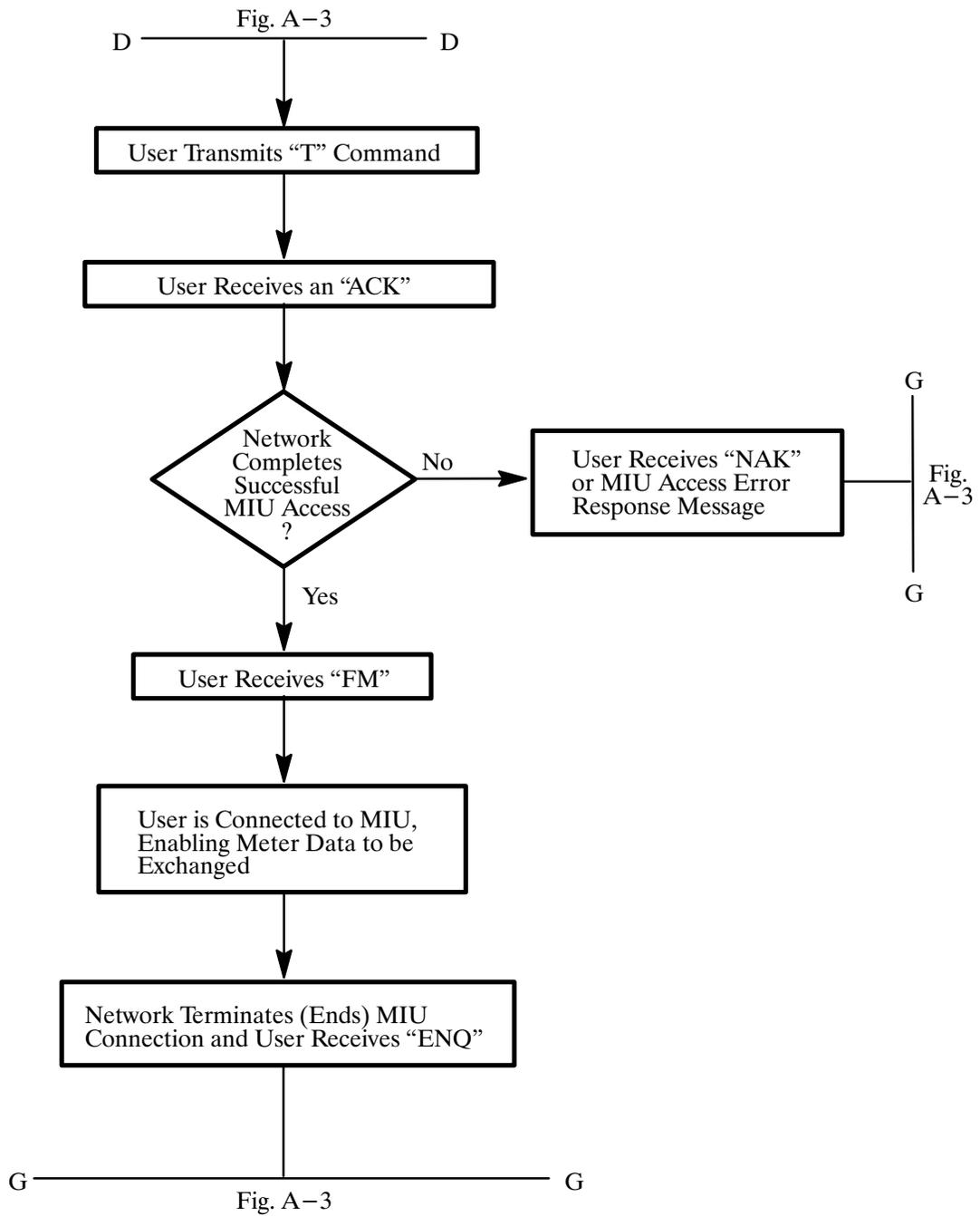


FIGURE A-4 – TYPICAL MIU ACCESS PROCEDURE FLOWCHART

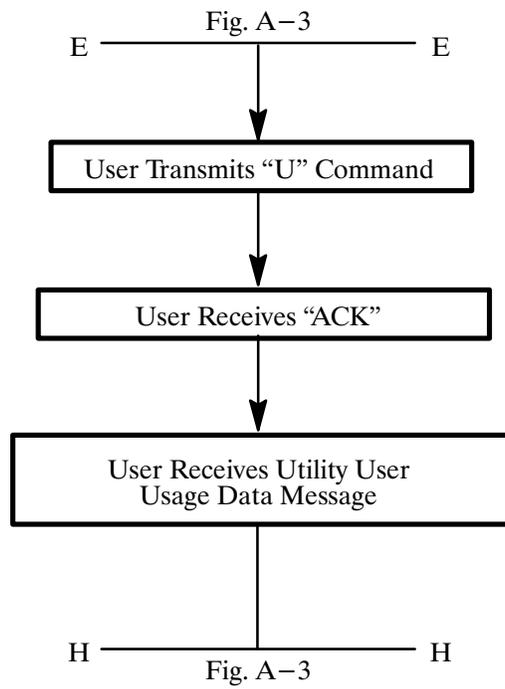


FIGURE A-5 – TYPICAL USAGE DATA PROCEDURE FLOWCHART

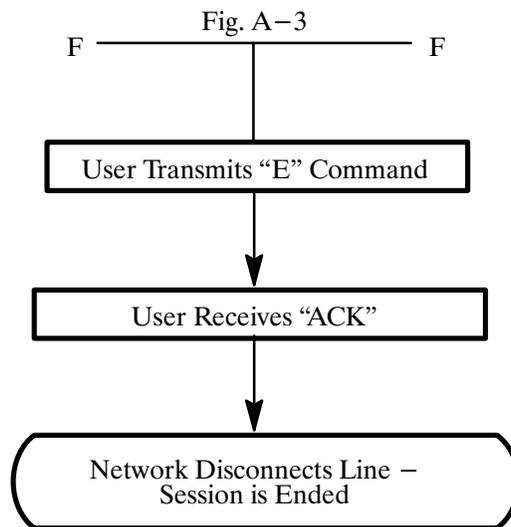


FIGURE A-6 – TYPICAL LOG-OFF PROCEDURE FLOWCHART