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Ameritech Automatic Meter Reading Service Interface Specifications

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Table of Contents

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1. General

This document describes the interface specifications for the Ameritech Automatic Meter Reading (AMR) Service. Specifications are provided for two points of connection with the service, the utility user interface and the Meter Interface Unit (MIU) network interface.

1.1. AMR Service

AMR Service permits utilities to collect meter reading data over the public switched telephone network. Using the service, computers operated by the utilities can directly communicate with CPE devices referred to as MIU's to collect reading data from encoded utility meters.

AMR Service is designed to operate over telephone facilities which provide for metallic access to subscriber loops furnishing analog voiceband telephone service (POTS or CENTREX). Digital Subscriber Lines (DSLs) and/or Integrated Services Digital Network (ISDN) are not compatible with AMR Service.

1.2. Change and Reissue

Changed contents or reissued documents will be noted in this section.

2. AMR Service Description

AMR Service provides access to a system which establishes a non-ringing low speed data communications path between the utility user and the customer premises. The utility user's interface to the system consists of a switched network connection between its system controller computer and central office based AMR Service Facilities (or ASF) which provide the communications path to the customer premises. The customer interface to the system consists of a connection between the Meter Interface Unit (or MIU) and the subscriber loop. Use of the service requires compatibility of the user utility's system controller with the ASF and compatibility of the MIU with the network including the ASF.

2.1. AMR Service System Components

AMR Service utilizes five related system components.

- The System Controller is a computer usually located at a utility user's offices. The system controller maintains a database of information pertaining to the utility's customers including telephone numbers, types of MIU's and meters. The system controller is owned and operated by the utility user.

- An AMR application program running on the system controller initiates communications and controls the meter reading polling operations. Section 3, UTILITY

USER INTERFACE, defines the sequence of commands to achieve customer loop access and collect the meter reading data. The AMR application program must be capable of detecting and resolving error and failure conditions which may occur within the system. The utility provides the AMR application program.

- An AMR Service Facility (ASF) consists of equipment located in an Ameritech Operating System (AOC) central office serving the meter reading sites. The AMR Service Facility responds to commands issued by the utility's system controller and provides the communication path to the Meter Interface Unit. The components of the AMR Service Facility are AOC property.

- The Meter Interface Unit (MIU) is the CPE interface between the network and the encoded utility meters. The MIU is connected to the subscriber loop tip and ring and does not interfere with normal customer telephone service. Section 4, MIU NETWORK INTERFACE, specifies the power and signaling compatibility requirements for connecting and operating the MIU with the network. The MIU is owned by the utility user or other service provider.

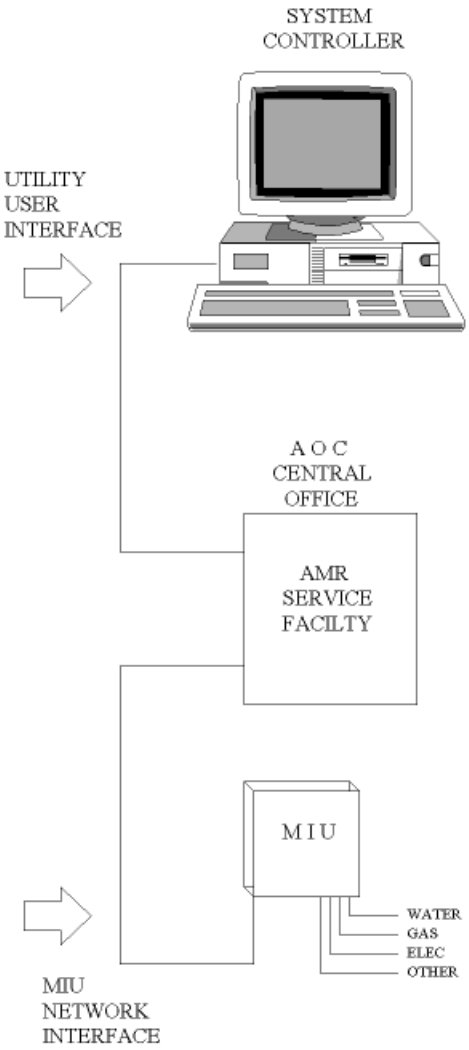
- Encoded utility meters convert the reading data to an electronic signal compatible with the MIU in accordance with the vendor's specifications. Meters and encoders are owned by the utility user or other service provider.

2.2. AMR Service System Operation

AN AMR Service session is initiated by the utility user's system controller with a switched network call to an ASF. The system controller and ASF execute a log-on procedure. The system controller and the ASF then disconnect. Next, the ASF places a call back to the system controller which completes the log-on procedure. After the connection has been reestablished, the system controller issues setup commands to the ASF. Following the initial setup, the system controller commands the ASF to access MIUs one at a time. As the ASF successfully accesses each subscriber loop, an alerting tone is applied to the loop by the ASF to activate the MIU. The ASF permits this connection process to be achieved without ringing the customer's telephone. Upon activation, the MIU draws nominal off-hook current, interrogates the connected meters and transmits the data via the ASF to the system controller. The MIU returns to its on-hook idle state after transmitting the meter reading data message. The ASF in turn breaks the connection with the subscriber loop and is ready for another command from the system controller. A session is concluded when the system controller issues a log-off command to the ASF. During the access and reading process, the ASF monitors loop status and immedi-

ately releases the meter reading connection if the customer begins to place a call. The system does not interfere with normal customer use of telephone service.

FIG 2-1 AMR SERVICE SYSTEM OPERATION



3. Utility User Interface

This section describes the interface through which utility users access and control the AMR Service Facility located in the central office serving the meter reading area. The interface consists of a data communications protocol used to communicate with the ASF and a set of

commands to control the data collection process. The interface defined in this section permits a utility user to:

1. Initiate and terminate a meter reading session.

2. Set certain ASF operational parameters.

3. Acquire data messages from MIUs connected to subscriber telephone lines.

4. Obtain utility user usage data which is accumulated by the ASF.

3.1. Data Communications Protocol

The utility user's system controller accesses and controls the ASF over the switched telephone network through a 103-type or 212A-type modem using a dial up connection.

Data communications between the utility user and the ASF is full-duplex, asynchronous, 300 bits-per-second or optionally 1200 bits-per-second if 212A-type modem capabilities are provided. Since the utility user application program communicates both with the ASF and the remote MIU, the speed selected for ASF command communications should match the speed of MIU data transmission.

Each data character consists of ten bits including one start bit, seven data bits encoded in ASCII, one even parity bit and one stop bit. The ASF does not echo received characters to the user.

If a valid command message is not received by the ASF over any two minute interval, the ASF will transmit the "G" character, terminate the user session, and disconnect.

If the ASF detects loss of modem carrier from the user for more than three seconds, the ASF will transmit the "G" character, terminate the user session, and disconnect.

3.2. ASF Command Protocol

The command protocol consists of transmitting a command message from the utility user to the ASF. In turn, the ASF responds to the user by transmitting an affirmative (ACK) or negative (NAK) acknowledgment character.

3.2.1. ASF Command Message Format

Each command message transmitted by the user to the ASF must begin with the ASCII STX character and be terminated with the ETX character. A message length value, a command letter, optional command parameters, and a four digit CRC code are framed by the STX and ETX.

STX	LENGTH	LETTER	PARAMETERS	CRC CODE	ETX

STX - ASCII start-of-text character = 02 decimal.

LENGTH - Two hexadecimal digits representing the number of characters in the message between (excluding) the length and the CRC code.

LETTER - One character identifying the ASF command.

PARAMETERS - An optional string of command parameters.

CRC - Four hexadecimal ASCII digits representing a sixteen bit cyclic redundancy check code.

ETX - ASCII end-of-text Character = 03 decimal.

3.2.2. ASF Command Message Acknowledgments

Affirmative Acknowledgment:

<ACK> ASCII Acknowledge Character = 06 decimal.

This response indicates that the command message was received without error(s) by the ASF and that the command was valid.

Negative Acknowledgment:

<NAK> ASCII Negative Acknowledge Character = 21 decimal.

This response indicates that either the command message as received contained a transmission error(s) or the command itself was not valid.

3.2.3. ASF Command Message Error Detection

Error detection for communications between the system controller and ASF is accomplished using 16-bit cyclic redundancy check (CRC). Error detection for MIU messages is described in Section 4.6.3, MIU Message Trailer. For processing MIU messages, the utility user's system controller software should be designed to support both CRC and checksum error detection as described in Section 4.

CRC Code Calculation and Transmission

The CCITT CRC standard polynomial X(16) + X(12) + X(5) + 1 is used to generate the sixteen bit CRC code. The most significant digit of the CRC code is transmitted first.

The initial value of all CRC buffers and shift registers must be zero for each calculation of the CRC Code by the transmitter or receiver. The CRC code is developed from eight bit (the most significant bit is zero) ASCII values for all of the characters in the message between (excluding) the STX and the CRC code. Only seven bits for each character are transmitted. The even parity bit of each transmitted character is not included in the CRC calculation.

3.2.4. ASF Command Messages

The following table summarizes all of the ASF commands. Associated with each command name is a letter designation which also identifies the command. ASF commands are referred to by either the name or the letter enclosed by brackets, e.g., the Log-On command or [I]. A detailed description of each command is included in Section 3.4, ASF Command Set.

ASF COMMAND SUMMARY TABLE		
COMMAND NAME	LETTER	COMMAND FUNCTION
Log-On	I	Initiate utility user session
Select Trunk	S	Selects the ASF trunk to use.
Alert Tone	A	Selects the MIU alert frequency.
Connect Time	C	Sets the max. MIU connect time.
MIU Access	T	Sets the MIU telephone number, access and alert detect methods, and interrogates the MIU.
Usage Data	U	Send usage data to utility user.
Log-Off	E	Terminate utility user session.

3.3. ASF Access and Control Procedures

This section describes the procedures for a utility user to access and control the AMR Service Facility. There are six basic procedures to a meter reading session: ASF Log-On, ASF Set-Up, Next Command, MIU Access, Usage Data Request, and ASF Log-Off. A session overview is provided followed by a description and flowchart illustration for each of the basic procedures.

3.3.1. Access Session Overview

The following example describes the procedure for conducting a typical meter reading session. Figures 3-1 through 3-6 illustrate the detailed sequence of events for each procedure. The complete command set is described in Section 3.4.

STEP	PROCEDURE
1	User calls the ASF.
2	ASF answers and waits for User Log-On.
3	User sends Log-On Command [I].
4	ASF disconnects and calls the User back using the call-back telephone number identified in the Log-On Command.
5	User answers and waits for ASF Identification Message.
6	ASF sends the Identification Message.
7	User sends Set-Up Commands to the ASF: A. Connect Time [C] B. Trunk Select [S] C. Alert Tone [A]
8	User sends MIU Access Command [T].
9	ASF accesses the requested subscriber line and alerts the MIU or sends an Error Response to the User.
10	The MIU transmits a data message to the User and returns to the "idle" state.
11	The ASF releases the subscriber line and sends the "ENQ" character to the User when ready for the next Command.
12	The User repeats Steps 8 through 11 until all required MIUs have been accessed. Steps 7b and 7c are repeated only if changes are necessary
13	The User requests Usage Data if desired with the Usage Data Command [U].
14	The User terminates the ASF session with the Log-Off Command [E].
15	The ASF sends "ACK" then "G" and disconnects.

3.3.2. ASF Log-On Procedure

The utility user system controller initiates an AMR session by placing a switched network call to the ASF. The user should allow up to 60 seconds for the ASF to answer. The ASF will answer the call after receiving two rings and, after a two second delay, the ASF returns a modem answer carrier signal to the user. After receiving the ASF modem carrier for at least 700 milliseconds, the user must return and maintain a modem originate carrier for at least 700 milliseconds. The user then transmits the log-on [I] command message to the ASF. The ASF must receive a valid log-on command from the user within 12 seconds after answering and the user is permitted only three log-on attempts during a call. The ASF will transmit the letter “G” and disconnect from the user if the log-on is unsuccessful.

The log-on command message includes a user identification number and a unique four digit passcode, assigned to the user by the AOC, which permits the ASF to identify the user. Associated with each assigned passcode within the ASF is a callback telephone number. After receiving and acknowledging a valid log-on message from the user, the ASF disconnects from the user and originates a call to the appropriate callback telephone number. The ASF allows 60 seconds for the user to answer the call-back.

The utility user answers the return call from the ASF after receiving one ring and, after a two second delay, returns a modem answer carrier to the ASF. After receiving the user carrier for at least 700 milliseconds, the ASF returns and maintains an originate modem carrier for at least 700 milliseconds.

Next, the ASF transmits its ASF identification message to the user. The ASF identification message is a five digit ASF identification number followed by the ASCII control code “ENQ” (decimal value 05). The identification number is assigned by the AOC and is unique for each ASF.

At this point, the utility user log-on procedure is complete and the AMR session is started.

Figure 3-1 illustrates the ASF log-on procedure.

FIG 3-1(A) AMR SERVICE LOG-ON PROCEDURE

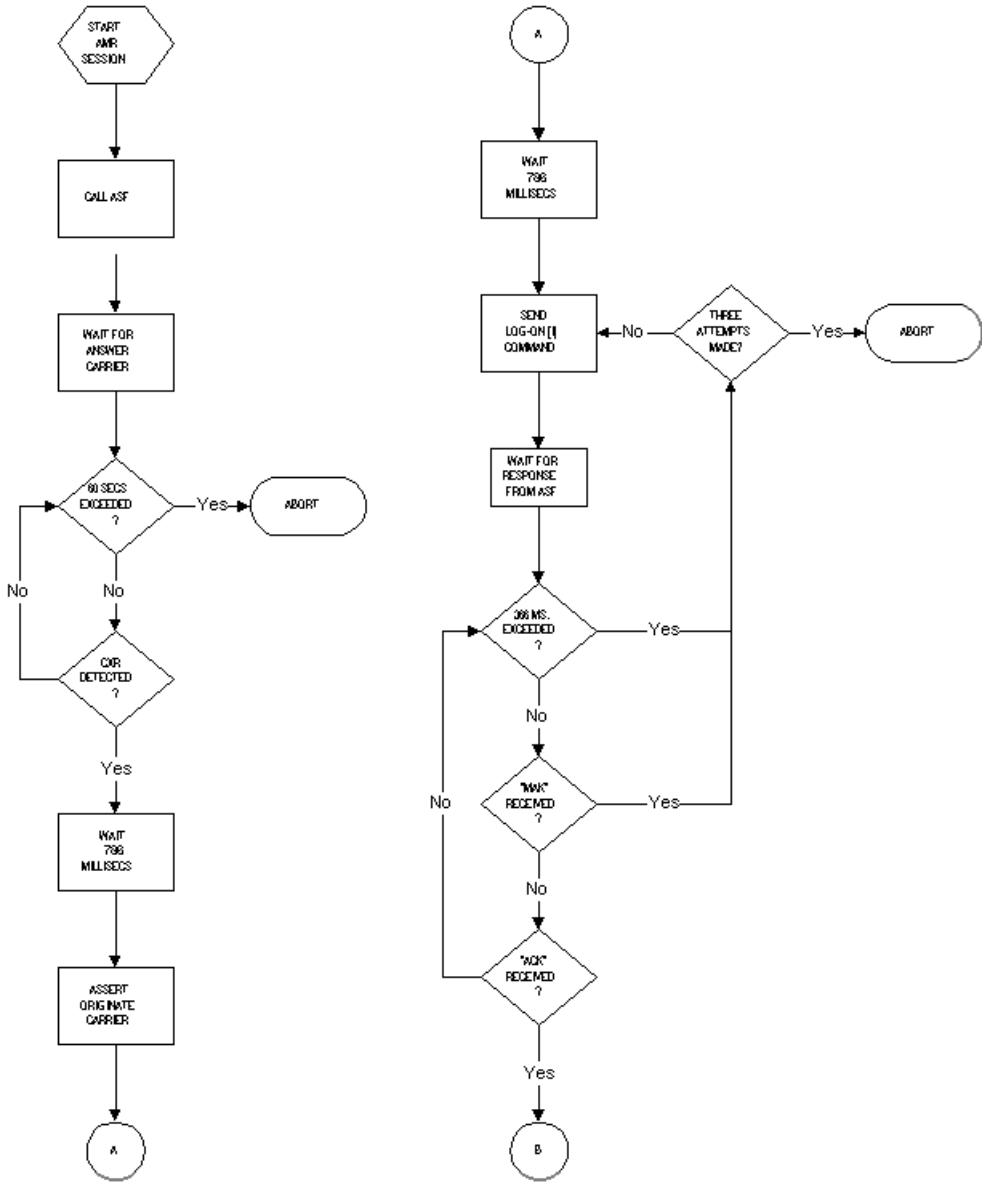


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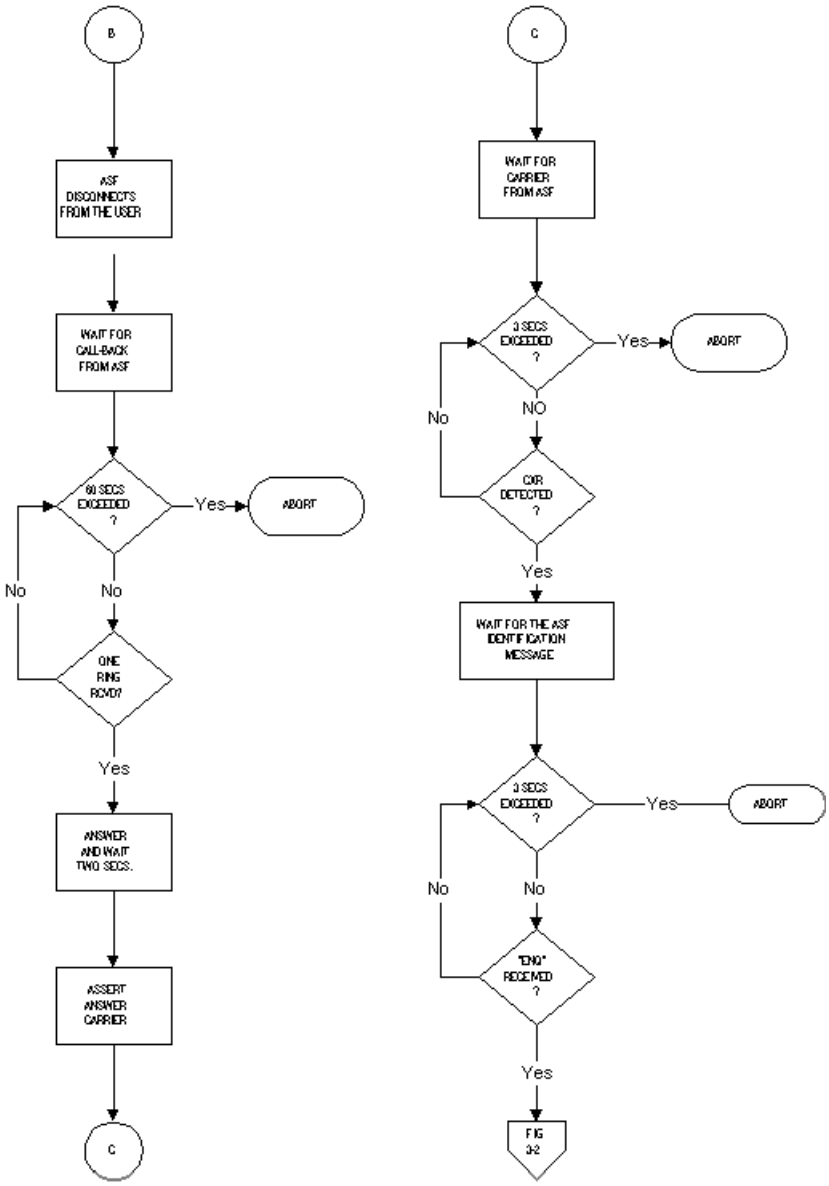
FIG 3-1(B) AMR SERVICE LOG-ON PROCEDURE



3.3.3. ASF Set-Up Procedure

Before beginning meter reading operations, three ASF configuration parameters should be set by the user: the ASF trunk number, the MIU alert tone frequency, and the MIU connect time. These parameters are set using three corresponding ASF commands called “set-up” commands.

The select trunk [S], alert tone [A], and connect time [C] ASF set-up commands are normally issued only once at the beginning of an AMR session, however, the user may reissue any of the commands at any time during a session to change a set-up parameter. These commands may be issued in any order. If any set-up command is not issued by the user, a default value for that configuration parameter is assigned by the ASF.

Select Trunk Command [S]

The select trunk command includes one parameter, the ASF trunk number, which is a single digit assigned by the AOD. The user sets the trunk number in the ASF by sending the select trunk set-up command.

Alert Tone Command [A]

Each MIU responds to one of thirteen possible alert tones. Section 4.4 includes a table of these frequencies. Each frequency is identified by an alphabetic character “A” through “K” and “M” and “Z.” The user specifies which frequency the ASF will use with the alert tone set-up command.

Connect Time Command [C]

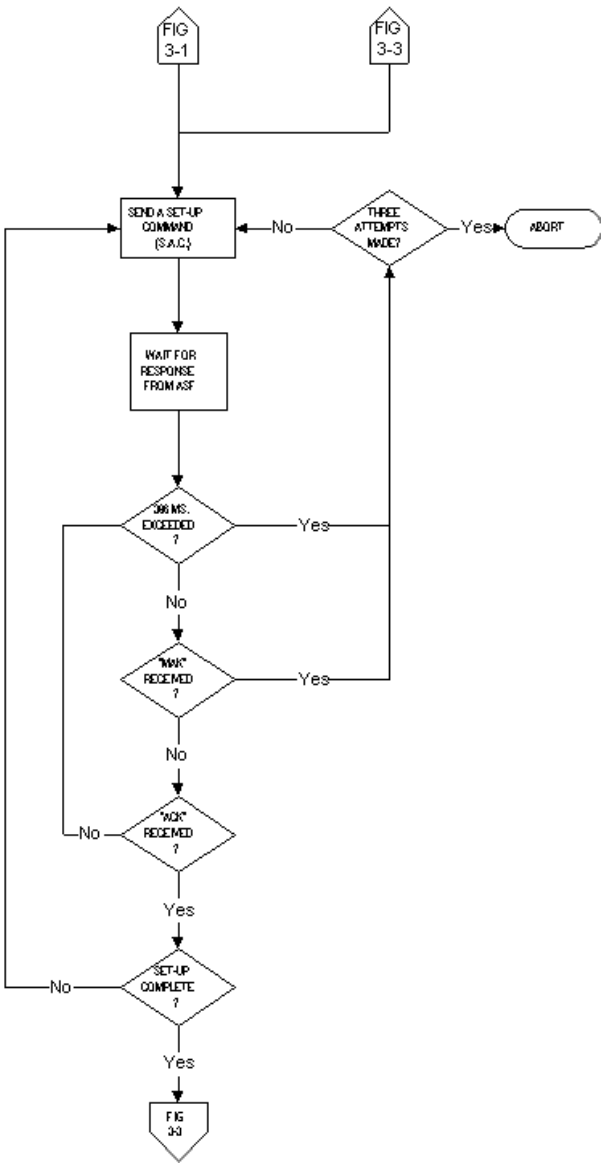
The connect time command sets the maximum time, in seconds, that the ASF will maintain the connection to a subscriber line after an MIU has been successfully alerted. This time can range in value from one second to 999 seconds and should be set to a value which slightly exceeds the maximum expected time for the MIU to acquire and transmit its message.

The connection to a subscriber line is normally terminated when the ASF detects that the MIU has disconnected. The connect time parameter sets an upper bound to the duration of the ASF connection should any condition prevent a normal termination.

Another configuration parameter, the connect time upper limit, is set up the AOC within the ASF. The connect time set by the user through the connect time command may not exceed the upper limit.

Figure 3-2 illustrates the ASF set-up procedure.

FIG 3-2 ASF SET-UP PROCEDURE

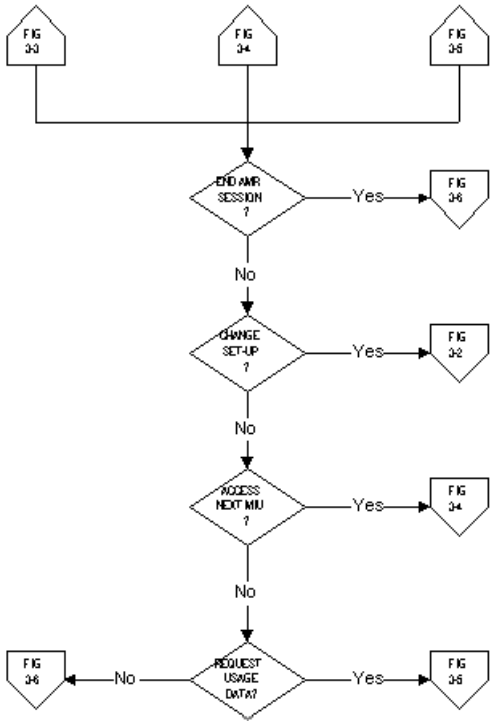


3.3.4. Next Command Procedure

After completing the log-on procedure, the ASF is prepared to accept and respond to any of the other commands in the suite. Figure 3-3 depicts a depicts a decision tree which may be followed by the user after completing each procedure to select the next procedure.

Figure 3-3 illustrates the next command procedure.

FIG 3-3 NEXT COMMAND PROCEDURE



3.3.5. MIU Access Procedure

The MIU access procedure is followed for each MIU to be accessed during an AMR session. The procedure begins when the user issues the MIU access command to the ASF. As with all commands, the ASF will respond to the user with either the “ACK” or “NAK” acknowledgment character within 300 milliseconds.

The MIU access command includes two parameters which inform the ASF how to access the required subscriber line: the access method parameter and the seven digit subscriber telephone number.

Access Method Parameter

The access method parameter is a single digit from one to three. The value of this parameter specifies the MIU alert detection method to be used by the ASF and if metallic bypass is required to access the MIU.

Two methods may be used by the ASF to determine when an MIU has been successfully alerted: either MIU loop current or the MIU carrier signal. Metallic bypass is required when a subscriber line is not connected directly to a central office but is instead connected to a “pair-gain” system.

Access Method

- O - Alert Detection Method O - Loop Current Metallic Bypass Not Required
- 1- Alert Detection Method O - Loop Current Metallic Bypass Required
- 2 - Alert Detection Method 1 - MIU Carrier Metallic Bypass Not Required
- 3 - Alert Detection Method 1 - MIU Carrier Metallic Bypass Required

After receiving the MIU access command, the ASF attempts to Access the required subscriber line, alert the MIU, and forward the MIU message to the user. The time required to complete this process may vary from less than a second to twenty seconds or more depending upon several factors which include the telephone network configuration, the availability of the subscriber line, and the type and configuration of the MIU.

During the access procedure, the ASF transmits access progress status information to the user. This status information may indicate error conditions or normal access progress.

Successful Subscriber Line Access and MIU Alert

A successful subscriber line access and MIU alert causes the ASF to transmit the characters “FM” to the user where:

“F” indicates that the accessed subscriber line was found to be free (not busy), and “M” indicates that the MIU was successfully alerted by the ASF.

The MIU data message follows shortly after transmission of the “FM”. However, a brief interruption of modem carrier to the user characteristically occurs which may also result in the reception of one or more spurious characters by the user. There may be a similar interruption at the conclusion of MIU data transmission. Spurious characters resulting from these interruptions must be “trapped” and eliminated by user software. The transmission of the MIU data message must conclude before the expiration of the connect time.

Following a successful MIU alert, indicated by transmission of the “FM” character sequence by the ASF to the user, the ASF permits any data received from the user to pass transparently to the alerted MIU until subscriber line access is terminated.

At the conclusion of the MIU message and after the connection to the line is released, the ASF transmits the ASCII control code “ENQ” (decimal 05) to the user to indicate that the ASF is ready to receive the next command. The “ENQ” character is transmitted not more than one second after access termination.

Subscriber Line Access Termination

Access to the subscriber line is terminated by the ASF when one of the following occurs:

A. The ASF determines that the MIU is no longer “alerted” as defined in Section 4.

B. The Connect Time is exceeded.

C. The ASF detects a loss of received modem carrier from the user for at least 1500 milliseconds.

D. The ASF detects an increase in loop current of 20 mA, or more which is interpreted as a telephone call being initiated by the subscriber.

In the event that subscriber line access has been terminated by the user through interruption of modem carrier, the ASF transmits the “ENQ” character within 700 to 1700 milliseconds after modem carrier is restored by the user.

Unsuccessful Subscriber Line Access or MIU Alert

An unsuccessful subscriber line access or MIU alert causes the ASF to transmit one of seven error responses to the user:

Subscriber Line Access Error Status Responses

“B” - Subscriber line is busy

“D” - Subscriber line is disconnected (intercept)

“R” - Switching system resources unavailable (reorder)

“X” - ASF error condition

“FI” - Long-Term subscriber line off-hook disconnect

“FN” - MIU failed to alert within 4 seconds (no MIU response)

“FE” - MIU message error

The “B”, “D”, “R”, “X”, or “F” character is transmitted not more than 30 seconds after the “ACK” character was sent.

The “FE” error status response is used when the MIU data routing feature is enabled (see below). This error response is sent by the ASF to the user when an error is detected in the MIU message which prevents proper routing of the MIU data, e.g., message format error(s), transmission error, etc.

After transmission of the error status response and release of the connection to the subscriber line (if required), the ASF transmits the ASCII control code “ENQ” (decimal 05) to the user to indicate that the ASF is ready to receive the next command. The “ENQ” character is transmitted not more than one second after access termination.

MIU Data Routing

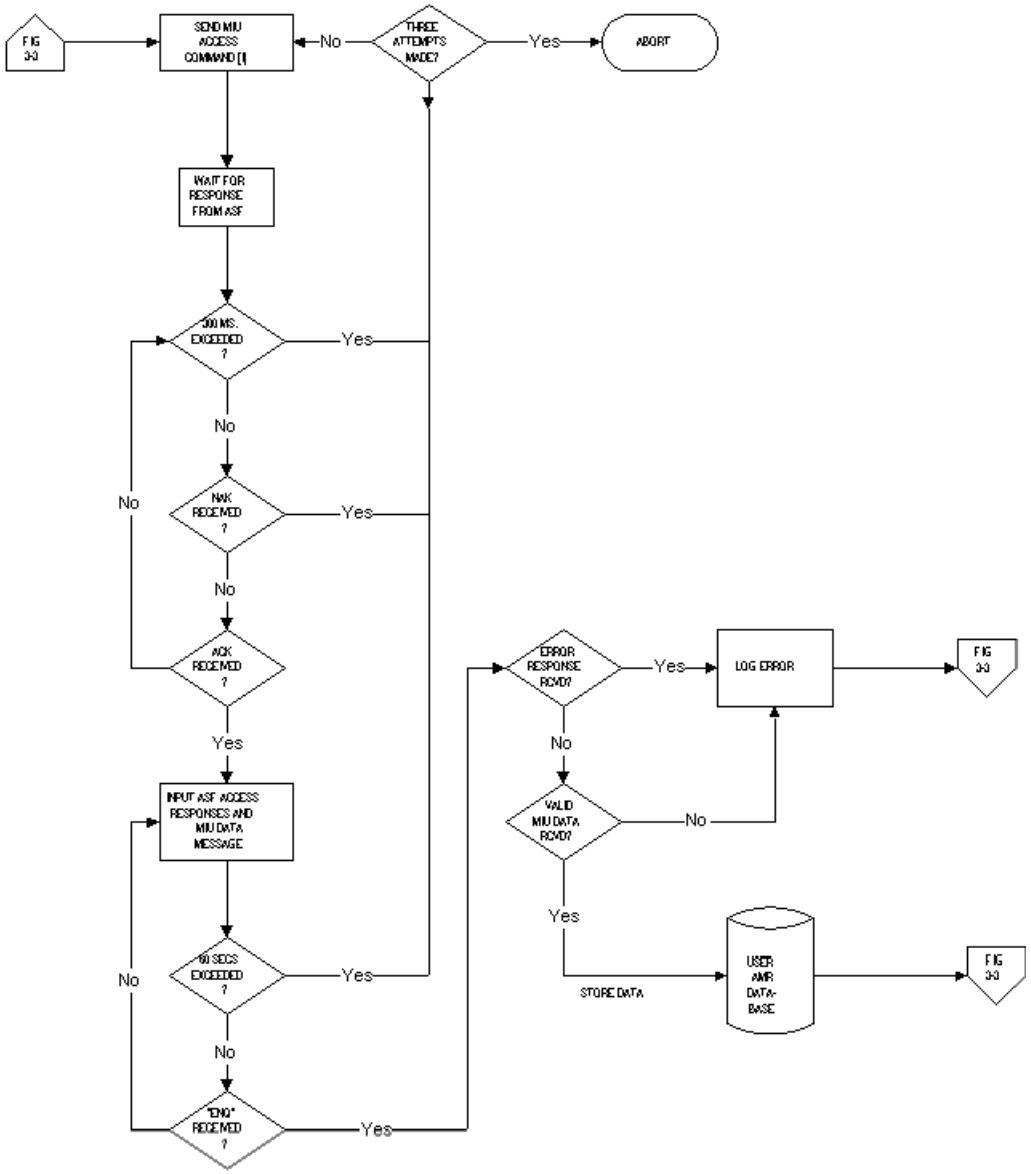
The ASF is capable of routing only designated portions of MIU data messages to a given user. This capability, called the MIU data routing feature, permits the ASF to send to the user only the MIU message header and MIU port data blocks which are addressed to that user. Refer to Section 4 for the complete description of MIU data routing. The AOC designates in the ASF which users have selected the MIU data routing feature.

MIU Message Error Detection

As described in Section 4, both cyclic redundancy check (CRC) and checksum error detection techniques are supported for the MIU. The error detection technique employed by a given MIU is user end-to-end, i.e., from the MIU to or through the ASF and finally to the utility user. For processing MIU messages, the utility user’s system controller software should be designed to support both the CRC and checksum error detection techniques.

Figure 3-4 illustrates the MIU access procedure.

FIG 3-4 MIU ACCESS PROCEDURE



3.3.6. Usage Data Request Procedure

The ASF maintains a record of AMR Service usage data which is available to the user on demand through the usage command. This usage data is continuously accumulated for each user and retained by the ASF until specifically cleared by the AOC. Usage data is accumulated for up to four daily time intervals and includes:

1. The total ASF access time accumulated from each AMR session, measured from transmission of the ASF identification message to the user at log=on to disconnection from the user at log-off.

2. The total accumulated MIU connect time from each AMR session, measured from each successful MIU alert to the release of the subscriber line of each MIU.

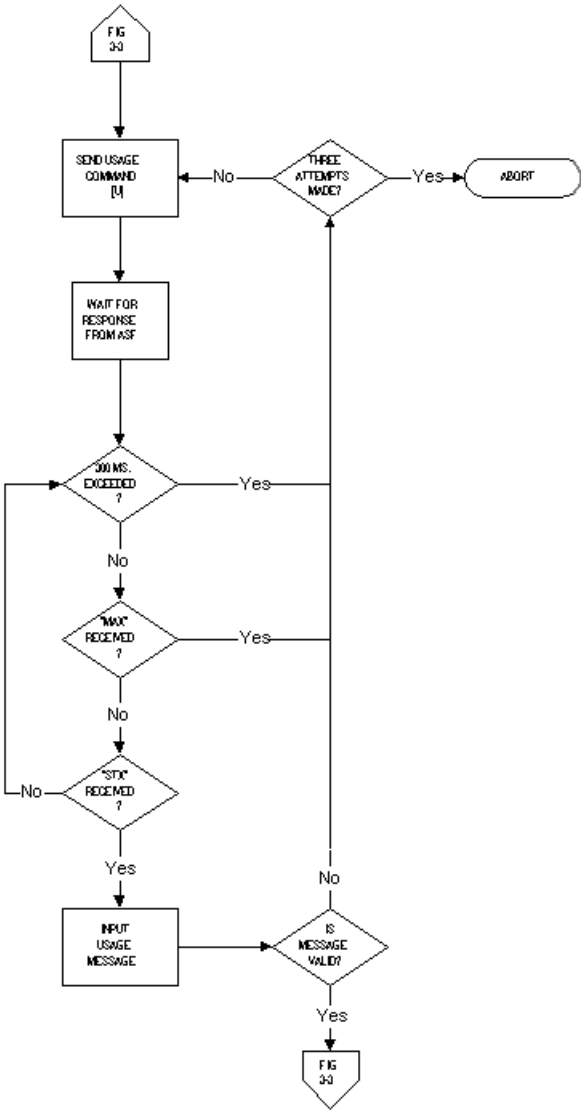
3. The total number of successful MIU alerts.

4. The total number of subscriber line access attempts.

The usage data is normally requested by the user at the conclusion of the AMR session, but may be requested at any time following log-on. To request the ASF to transmit the usage data message, the user issues the usage command. The format and contents of the usage data message are described in Section 3.4.7.

Figure 3-5 illustrates the usage data request procedure.

FIGURE 3-5 USAGE DATA REQUEST PROCEDURE

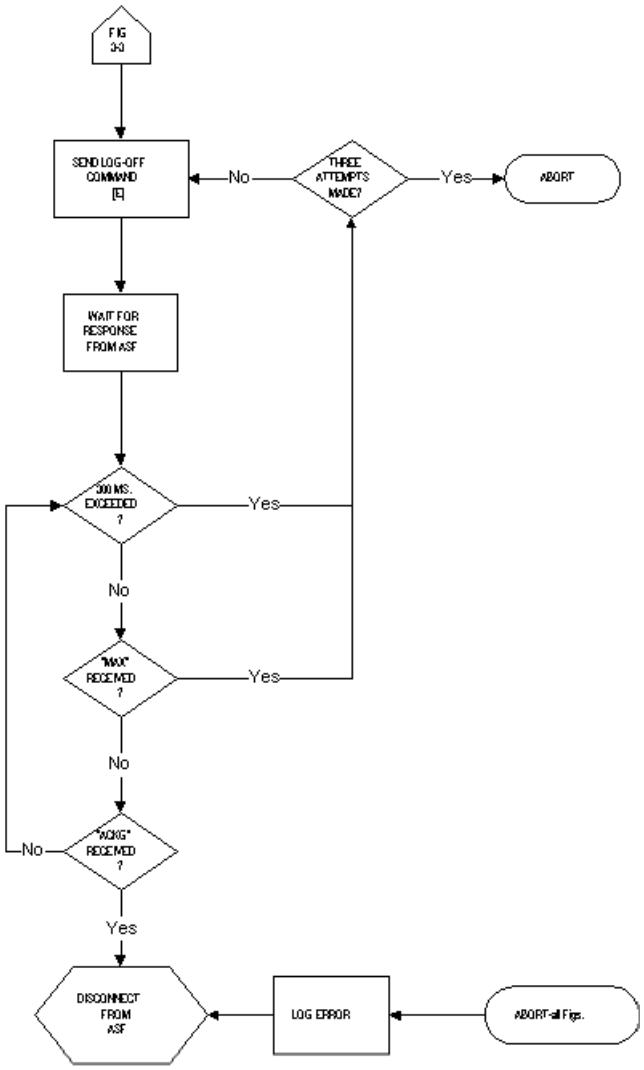


3.3.7. ASF Log-Off Procedure

The log-off command terminates the AMR session with the ASF. After receiving a valid log-off command from the user, the ASF transmits the affirmative acknowledgment character “ACK” followed by the letter “G” and then disconnects from the user.

Figure 3-6 illustrates the log-off procedure.

FIG 3-6 AMR SERVICE LOG-OFF PROCEDURE



3.4. ASF Command Set

This section describes the format and content of the ASF access and control command messages.

3.4.1. Log-On Command [I]

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LOG-ON COMMAND [I]		
MSG POS.	ASCII CHARACTERS	DESCRIPTION
1	STX	Start-Of-Text Character = 02 decimal
2-3	07	Log-On Message Length, Always 7 chars.
4	I	Command Letter, "I" for Log-On Command
5	1 digit (0 thru 9)	User Identification Number (Assigned by the AOC)
6-9	4 digits	User Passcode (Assigned by the AOC)
10	1 digit (0 thru 9)	User Call-Back Reference Number (Telephone Number is provided by User)
11-14	4 digits	Log-On Message CRC Code
15	ETX	End-Of-Text Character = 03 decimal

ASF RESPONSES TO LONG-ON COMMAND		
1	ACK	Affirmative Acknowledge = 06 decimal
1	NAK	Negative Acknowledgement = 21 decimal

3.4.2. Select Trunk Set-Up Command [S]

SELECT TRUNK SET-UP COMMAND [S]		
MSG. POS.	ASCII CHARACTERS	DESCRIPTION
1	STX	Start-Of-Test Character = 02 decimal
2-3	02	Select Trunk Message Length, always 2 characters.
4	S	Command Letter, "S" for Select Trunk
5	1 digit (0 thru 9)	ASF Trunk Designation Number (Assigned by the AOC)
6-9	4 digits	Select Trunk Message CRC Code
10	ETX	End-Of-Text Character = 03 decimal

ASF RESPONSES TO SELECT TRUNK COMMAND

1	ACK	Affirmative Acknowledge = 06 decimal OR
1	NAK	Negative Acknowledgment = 21 decimal

3.4.3. Alert Tone Set-Up Command [A]

ALERT TONE SET-UP COMMAND [A]		
MSG POS.	ASCII CHARACTERS	DESCRIPTION
1	STX	Start-Of-Text Character = 02 decimal
2-3	02	Alert Tone Message Length, always 2 characters.
4	A	Command Letter, "A" for Select Alert Tone Command
5	1 letter (A-K,M,Z)	Alerting Tone Designation Letter (Refer to alert tone table, Section 4.4)
6-9	4 digits	Alert Tone Message CRC Code
10	ETX	End-Of-Test Character = 03 decimal

ASF RESPONSES TO ALERT TONE COMMAND		
1	ACK	Affirmative Acknowledge = 06 decimal OR
1	NAK	Negative Acknowledgment = 21 decimal

3.4.4. Connect Time Set-Up Command [C]

CONNECT TIME SET-UP COMMAND [C]		
MSG POS.	ASCII CHARACTERS	DESCRIPTION
1	STX	Start-Of-Text Character = 02 decimal
2-3	04	Connect Time Message Length, always 4 characters.
4	C	Command Letter, "C" for Connect TIme
5-7	3 digits	Connect Time in seconds Decimal values from 001-999 seconds.

8-11	4 digits	Connect Time Message CRC Code
12	ETX	End-Of-Text Character = 03 decimal

ASF RESPONSES TO ALERT TONE COMMAND		
1	ACK	Affirmative Acknowledge = 06 decimal OR
1	NAK	Negative Acknowledment = 21 decimal

3.4.5. MIU Access Command [T]

MIU ACCESS COMMAND [T]		
1	STX	Start-Of-Text Character = 02 decimal
2-3	09	MIU Access Command Message Lenght, always 9 characters.
4	T	Command Letter, "T" for MIU Access
5	1 digit (0 thru 3)	Access Method Parameter Alert Detect Method 0 - Loop Current 0 = Metallic Bypass Not Required 1 = Metallic Bypass Required Alert Detect Method 1 - MIU Carrier 2 = Metallic Bypass Not Required 3 = Metallic Bypass Required
6-12	7 digits	Subscriber Telephone Number
13-16	4 digits	MIU Access Command Message CRC Code
17	ETX	End-Of-Text Character = 03 decimal

MIU ACCESS COMMAND NEGATIVE ACKNOWLEDGMENT

MSG POS.	ASCII CHARACTERS	DESCRIPTION
1	NAK	Negative Acknowledgment = 21 decimal

NOTE: The actual number of subscriber telephone number digits required from this field by a switching system to access subscriber lines may be fewer than seven, e.g., the last six, five, or four digits. However, all seven digits are always sent to the ASF within this command.

SUBSCRIBER LINE OR MIU ACCESS ERROR RESPONSES		
1	ACK	Affirmative Acknowledge = 06 decimal
		— ERROR STATUS OPTIONS —
2	B	Subscriber Line Busy
	D	Intercept
	R	Overflow
	X	ASF Trunk Failure
2-3	FI	Subscriber Line Long Term Off-Hook
2-3	FN	Subscriber Line Accessed; Unable to Alert MIU.
2-3	FE	Subscriber Lie Accessed: MIU Response Error.
3 or 4	ENQ	ASCII "ENQ" Control Code = 05 decimal.

NORMAL SUBSCRIBER LINE ACCESS AND MIU ALERT RESPONSE		
1	ACK	Affirmative Acknowledge = 06 decimal
2-3	FM	Subscriber Line Accessed; MIU Alerted.
		Erroneous characters may be received by the User during this interval.
4 thru 4+(n-1)	[MIU DATA]	MIU Data Message: Message Length Is Variable, n characters Erroneoue characters may also be received by the User during this interval.
4+n	ENQ	ASCII "ENQ" Control Code = 05 decimal.

3.4.6. Usage Command [U]

USAGE COMMAND [T]		
MSG POS.	ASCII CHARACTERS	DESCRIPTION
1	STX	Start-Of-Text Character = 02 decimal
2-3	01	Usage Command Message Length, always one character.
4	U	Usage Command Letter, "U"
5-8	4 digits	Usage Command Message CRC Code
9	ETX	End-Of-Text Character = 03 decimal

UTILITY USER USAGE DATA MESSAGE		
MSG POS.	ASCII CHARACTERS	DESCRIPTION
1	STX	Start-Of-Text Character = 02 decimal
2-3	2 digits	Usage Data Message Length (hexadecimal)
4	U	Usage Data Message Identifier, "U"
5	1 digit (0 thru 9)	Current utility user number
6-11	MMDDYY	Date Registers Last Reset [by the AOC]
12-15	HHMM	Time Registers Last Reset [by the AOC]
16-21	MMDDYY	Current Date
22-25	HHMM	Current Time
26-29	HHMM	Interval 1 Start Time
30-33	HHMM	Interval 2 Start Time
34-37	HHMM	Interval 3 Start Time
38-41	HHMM	Interval 4 Start Time
42	ETB	End-Of-Block Character = 23 decimal
43-47	HHHMM	Interval 1: Total ASF Access Time
48-53	HHMMSS	Interval 1: Total MIU Connect Time
54-59	6 digits	Interval 1: Total MIU Alerts

60-65	6 digits	Interval 1: Total Line Access Attempts
66	ETB	End-Of-Block Character = 23 decimal
A	HHHMM	Interval n: Total ASF Access Time
S	HHMMSS	Interval n: Total MIU Connect Time
R	6 digits	Interval n: Total MIU Alerts
E	6 digits	Interval n: Total Line Access Attempts
Q	ETB	End-Of-Block Character = 23 decimal
I	4 digits	Usage Data Message CRC Code
R	ETX	End-Of-Text Character = 03 decimal
E		
D		

Notes for Usage Data Message

The Usage Data Message includes data for enabled time intervals only. The Usage Data Message length is therefore variable. The message length is the number of characters, in hexadecimal, between (excluding) the message length and the CRC Code.

The usage registers overflow to zero and continue incrementing from zero.

In addition to the accumulated usage data for each enabled time interval, the Usage Data Message includes:

1. The data and time that usage registers were last cleared (Reset) by the AOC and the current data and time.

2. The start time for each of the four usage intervals. Start times for intervals which are NOT enabled are designated “0000.”

   Start times which begin at midnight are designated “2400.”

   Interval Start Times always appear in ascending order.

Usage Message Table Nomenclature

MMDDYY = 6 digits for Month, Day, Year

HHMMSS = 6 digits for Hour, Minute, Second

HHHMM = 5 digits for total Hours and Minutes

HHMM = 4 digits for Hour, Minute

Interval n = From one to four daily time intervals.

3.4.7. Log-Off Command [E]

LOG-OFF COMMAND [E]		
MSG POS.	ASCII CHARACTERS	DESCRIPTION
1	STX	Start-Of-Text Character = 02 decimal
2-3	01	Log-Off Command Message Length, always one character.
4	E	Log-Off Command Letter "E"
5-8	4 digits	Log-Off Command Message CRC Code
9	ETX	End-Of-Text Character = 03 decimal

ASF RESPONSES TO THE LOG-OFF COMMAND		
1	ACK	Affirmative Acknowledge = 06 decimal
2	G	Goodbye
1	NAK	Negative Acknowledgment = 21 decimal

4. MIU Network Interface

The MIU is a small remote terminal unit designed to collect meter reading data from encoded utility meters and send that data to the utility user's system controller. It provides the electrical and communications interface between the telephone network and the encoded utility meter devices. This section describes the minimum powering, signaling, and interconnection characteristics between the Meter Interface Unit and the telephone network to assure operational compatibility with AMR Service. MIUs used with Ameritech AMR Service must be designed, manufactured, and installed in a manner that does not interfere with any other telephone service or network operating and support systems.

4.1. MIU Network Interface Parameters

The MIU is customer premises equipment (CPE) and connects directly to tip and ring of the subscriber loop on the customer side of the Network Interface Device (NID). MIUs used with Ameritech AMR Service must be registered, labeled, and installed in accordance with the requirements of the Federal Communications Commission Rules and Regulations Part 68 as applicable to terminal equipment intended for connection to the telephone network. MIUs should in addition comply with ANSI Std T1.401-1988 (refer to Appendix 2).

The following documents describe electrical parameters present at the MIU Network interface which influence the operation and performance of the MIU:

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

B. PUB 41008, “Analog Parameters Affecting Voiceband Data Transmission - Description of Parameters.”

C. PUB 61100, “Description of the Analog Voiceband Interface Between the Bell System Local Exchange Lines and Terminal Equipment.”

D. TR-EOP-000001, Lightning and 60 Hz. Disturbances at the Bell Operating Company Network Interface.

E. TR-TSY-000506, LSSGR: Common Section 6 - Signaling.

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

4.2. MIU Operational States

The MIU functions in two operational states: the “Idle State” and the “Active State.”

The MIU routinely operates in the idle state, switching to the active state only in response to a designated alert tone. In the idle state, the MIU presents an on-hook impedance at the MIU network interface. In the active state, the MIU presents a nominal off-hook impedance.

MIUs used with Ameritech AMR Service must, when in the active state, incorporate a means to detect a customer on-hook to off-hook transition and immediately revert to the idle state.

4.3. MIU Power

Direct current power for an MIU in the active state is available through the metallic subscriber loop to the tip-ring interface at the MIU within the following parameters:

SOURCE VOLTAGE	SOURCE VOLTAGE RANGE	SOURCE CURRENT (mA.)	T-R RESISTANCE TO SOURCE (Ohms)
-48	-42.5 TO -52.5	12 TO 130	0 TO 2000

4.4. MIU Alerting

An MIU is capable of detecting one of the thirteen discrete frequencies listed below. When the appropriate alert tone is detected by the MIU, the MIU enters the active state, acquires meter reading data, transmits the acquired data, and then reverts to the idle state.

MIU activation is indicated by a minimum 12 mA. of tip-ring loop current within four seconds or less following application of the alert tone to the subscriber loop. While in the active state, the MIU must continuously draw at least 12 mA. of tip-ring loop current.

Each MIU alerting frequency is identified by a corresponding alphabetic character as shown in Table 4-1.

FIG 4-1 MIU ALERT TONE PARAMETERS

ALERTING CHARACTER	ALERT FREQUENCY (Hz)
A	252.4
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

Alert Tone Signal Level: 0 dBm to -22 dBm (measured into 600 Ohms)
Frequency Tolerance: +/- one percent
Duration: Four seconds maximum

4.5. MIU Signaling

The MIU utilizes 103-type modem characteristics for data communications with the MIU operating in the “originate” mode. Simplex asynchronous data transmission is employed using frequency shift keying (FSK) at 300 bits-per-second with ten bits-per-character wherein each character comprises one start bit, seven data bits encoded in ASCII, one even parity bit and one stop bit.

4.5.1. MIU Modulation Parameters

Mark (Binary 1) Frequency: 1270 Hz.

Space (Binary 0) Frequency: 1070 Hz.

Frequency Tolerance: +/- 10 Hz.

Amplitude: -9 dBm to -13 dBm

Transmission Rate: 300 Bits-Per-Second (BPS)

Rate Tolerance: +/- 1 BPS

4.5.2. MIU Data Transmission Protocol

For simplex data communication, the MIU:

1. assets the originate modem “mark” carrier frequency within 300 milliseconds after assuming the active state and maintains unmodulated carrier for 500 to 800 milliseconds,

2. acquires meter encoder data for encoders connected to the MIU,

3. transmits the acquired data according to the following MIU data message format description,

4. removes originate modem carrier and returns to the idle state 50 to 150 milliseconds after the last character has been transmitted.

4.6. MIU Data Message Format

Each data message transmitted by an MIU begins with the ASCII STX control character followed by a header, optional port data blocks, and a check code to assist with error detection.

The MIU data message is terminated by the ASCII control code ETX. The entire message is composed of ASCII characters:

STX	HEADER	PORT 1	PORT 2	PORT 3	PORT 4	Check Code	ETX

4.6.1. Message Header

The message header comprises a variable length string of ASCII characters terminated by the ASCII control code ETB (decimal 23):

HEADER FORMAT:

CHARACTER STRING	ETB

4.6.2. Port Data Blocks

The port data blocks are optional. Up to four port data blocks, composed in either of the two formats described below, may be included in an MIU message. The port data blocks include three fields of information: (1) the port number, (2) the port identification or meter identification, and (3) the port meter data:

Port Block Format 1:

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

Port Block Format 2:

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

Port Number - A single ASCII digit designating the MIU meter port (one through four) which produced the port or meter I.D. and the port meter data.

Port I.D. - A variable length string of alpha-numeric ASCII characters. The Port I.D. may comprise zero through 20 characters. [See MIU Data Routing]

Meter I.D. - A six digit meter identification number. [See MIU Data Routing]

Port Meter Data - A variable length string of alpha-numeric data the contents of which depends upon the characteristics of each meter and MIU type.

SP - The ASCII SPACE character (decimal value 32).

ETB - The ASCII ETB control character (decimal 23).

4.6.3. MIU Message Trailer

The MIU message trailer consists of four ASCII characters which represent an error detection check code.

Both cyclic redundancy check (CRC) and checksum error detection methods are supported by the AMR Service. However, the CRC method is the preferred method due to its superior error detection performance.

TRAILER FORMAT:

Check Code	ETX

Check Code Method 1 - Cyclic Redundancy Check (CRC) Code

The CCITT CRC standard polynomial X(16) + X(12) + X(5) + 1 is used to produce a sixteen bit CRC code. The CRC code is transmitted as four ASCII characters representing four hexadecimal digits. The most significant digit of the CRC code is transmitted first.

The initial value of all CRC buffers and shift registers is zero. The CRC code is developed from eight bit (the most significant bit is zero) ASCII values for all of the characters in the message between (excluding) the STX and the CRC code. Only seven bits for each character are transmitted. The even parity bit of each transmitted character is not included in the CRC calculation.

Check Code Method 2 - Checksum

The four ASCII character checksum comprises the four least significant digits which result from summing the ASCII codes for all of the characters in the message between (excluding) the STX and the checksum and converting the result to decimal. The most significant digit of the checksum is transmitted first.

4.7. MIU Data Routing

MIU data routing is an alternative feature which permits the AMR Service Facility to identify the destination (Utility User) for each of the four MIU port data blocks from the first character (which must be a digit) of each port identification or meter identification field.

When this feature is selected, only the MIU header and port data blocks where this digit matches the current AMR Service utility user number are routed to the current user.

When MIU data routing is in effect, MIU messages routed to the current utility user by the ASF are composed of the elements shown in the example below where “PORT m” and “PORT n”

are port data blocks which include the current utility user number within their port I.D. or meter I.D. fields. The contents of the MIU message routed to the current utility user are exactly as received by the ASF from the MIU except for the check code which must be recalculated by the ASF and may therefore differ from the value received from the MIU. The recalculate check code appended by the ASF is of the same type (CRC or Checksum) originally transmitted by the MIU.

STX	HEADER	PORT m	PORT n	Check Code	ETX

5. Glossary

ALERT TIME - The time duration, in seconds, between application of the alert tone to the subscriber line by the AMR Service Facility and the determination of a successful MIU alert condition by the AMR Service Facility.

ALERT TONE - Any one of thirteen discrete frequencies produces by the AMR Service Facility and applied to a subscriber telephone line for the purpose of “alerting” an MIU connected to the line thus causing the MIU to acquire and transmit meter reading data.

AMR - Automatic Meter Reading.

AMR SERVICE FACILITY (ASF) - Telephone network components (hardware and/or software) which interact with users and MIUs to support the Automatic Meter Reading (AMR) Service.

AOC - Ameritech Operating Company. Any of the five telephone operating company subsidiaries of Ameritech.

ASF IDENTIFICATION NUMBER - A five digit number which is transmitted by the AMR Service Facility to a user when the AMR Service Facility completes the Call-Back connection to the User.

CALL-BACK TELEPHONE NUMBER - A telephone number used by the AMR Service Facility to place a return call to a user after the user has completed an initial log-on call to the AMR Service Facility.

CALL-BACK REFERENCE NUMBER - A single digit number assigned to each user by the AOC. Associated with each reference number is a corresponding call-back telephone number.

CONNECT TIME - The maximum permissible time duration, in seconds, between the determination of a successful MIU alert condition by the AMR Service Facility and the release of the subscriber line by the AMR Service Facility. The connect time is set by the user during each AMR Service session.

CONNECT TIME UPPER LIMIT - The absolute upper boundary value for the MIU connect time. This value may range from 1 through 999 seconds. The connect time upper limit is set by the AOC.

MIU - Meter Interface Unit. Customer premise equipment (CPE) which acquires utility meter readings from one or more meters and transmits these readings over the customer (subscriber) telephone line to an AMR Service user.

PASSCODE - A private four digit access security number assigned by the AOC to each AMR Service user.

SYSTEM CONTROLLER - A computer system owned by a utility which interfaces with the AMR Service to perform mechanized collection of meter reading data for utility customers.

USER - Any computer system or data terminal which utilizes the AMR Service.

USAGE INTERVALS - One to four daily time intervals, established by the AOC, for recording AMR Service Facility usage data for each user.

USER IDENTIFICATION NUMBER - A single digit assigned to each user by the AOC. This number identifies the user to the AMR Service Facility. Associated with each user ID is a corresponding passcode.

6. References

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

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

2. ANSI T1.401-1988, American National Standard for Telecommunications - Interface between Carriers and Customer Installations - Analog Voicegrade Switched Access Lines Using Loop-Start and Ground-Start Signaling.

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1. PUB 41005, Data Communications Using The Switched Telecommunications Network.

2. PUB 41008, Analog Parameters Affecting Voiceband Data Transmission - Description of Parameters.

3. PUB 61100, Description of the Analog Voiceband Interface Between the Bell System Local Exchange Lines and Terminal Equipment.

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5. TR-TSY-000064, LATA Switching Systems Generic Requirements.

6. TR-TSY-000506, LSSGR: Common Section 6 - Signaling.