



IRIDIUM

Short Message Service Developer's Guide

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Iridium Short Message Service Developers Guide

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1.0 Introduction

1.1 Purpose

The purpose of this document is to provide adequate technical and operational information for an Iridium Value Added Reseller (VAR), or Value Added Manufacturer (VAM), to develop and integrate a data application that utilizes Iridium's Short Message Service (SMS) feature. This document relates specifically to applications that use the serial data port of an Iridium Subscriber Unit (ISU). This document does not describe handset/keypad interfaces for SMS.

An overview of the satellite network is provided as well as descriptions of the terminal equipment and the end to end communications protocol for SMS. This document is intended for use by technical personnel and assumes a reasonable level of technical skill and familiarity with satellite and/or wireless data applications. It is emphasized that this is not an end user document.

1.2 Scope

This document is written to identify the elements required to use Short Message Service with an ISU on the Iridium Satellite Network. This includes the RS-232 "AT-Commands" to communicate with the ISU, examples of this are included in this document.

This document defines:

- Iridium Subscriber Units
- Physical interface requirements
- SMS Data Structures and Formats
- Specific SMS related AT commands and responses.
- How the SMS protocol works through an overview and command descriptions.

Additional documents are referenced which provide more specific detail on certain topics and these are listed in Section 1.6 of this document.

1.3 Definitions, Acronyms and Abbreviations

1.3.1 Definitions

ISU: For the purpose of clarity and brevity in this document the term "Iridium Subscriber Unit" (ISU) is defined as an Iridium communications device that is capable of both MO-SMS and MT-SMS. It shall not be inferred that all available ISUs are capable of SMS

Hexadecimal Notation: This document uses the form xyH to signify a hexadecimal encoded number where “x” and “y” are both numbers between 0 and 9 or letters between A and F.

Octet / Septet: The term octet is used to indicate an 8-bit representation of a value. The term septet indicates a 7-bit representation of a value. An octet is can be thought of as analogous or equivalent to a byte. However, for consistency the terms octet and septet are used in this document.

1.3.2 Acronyms and Abbreviations

The following are the definitions for the acronyms and abbreviations used in this document.

API	Application Programming Interface
ATC	AT Command or Attention Command
BCD	Binary Coded Decimal
BFR	Buffer
BM	Broadcast Mode Type
CR	Carriage Return
CTRL	Control key
DCE	Data Communications Equipment
DS	DTE Status Report Routing
DTE	Data Terminal Equipment
DTMF	Dual Tone Multi-Frequency
DTR	Data Terminal Ready
ECS	Earth Terminal Controller Communications Subsystem
EIA	Electronics Industry Association
ESC	Escape Key.
ESME	External Short Messaging Service
ET	Earth Terminal
ETC	Earth Terminal Controller
ETS	Earth Terminal Controller Transmission System
FA	Field Application
GSM	Global System for Mobile Communications
IRA	International reference alphabet (ITU-T T.50)
IMEI	International Mobile Equipment Identity
ISDN	Integrated Services Digital Network
ISU	Iridium Subscriber Unit
ITU	International Telecommunications Union
LBT	L-Band Transceiver
LF	Line Feed
MO	Mobile Originated
MT	Mobile Terminated
NC	Notification Center or Short Message Service – Center
PDU	Protocol Data Unit - (PDU) A packet of data passed across a network. The term implies a specific layer of the OSI seven layer model and a specific protocol.
RP	Relay layer Protocol
RS-232	The EIA equivalent of ITU-T standard V.24. The EIA EIA-232C electrical signal is unbalanced +/- 5 to +/- 12V. polar non return to zero and handles data speeds up to 19.2 Kilobits per second.
SBD	Short Burst Data
SC	Service Center
SCA	Service Center Address
SIM	Subscriber Information Module
SMS	Short Message Service

SMSC	Short Message Service – Center or Notification Center
SMPP	Short Message Peer to Peer
TOSCA	Service Center Type of Address
TP	Transfer Protocol (used in SMS)
TPDU	Transfer Protocol Data Units
V.24	The ITU-T Standard defining interchange circuits between DTE and DCE. V.24 is the ITU-T equivalent of EIA standard EIA-232C. V.24 recommends 12 modem carrier frequencies that will not interfere with Dual Tone Multi-Frequency (DTMF) or other telephone control tones. These are: GROUP A = 920 Hz, 1000 Hz, 1080 Hz, 1160 Hz GROUP B = 1320 Hz, 1400 Hz, 1480 Hz, 1560 Hz GROUP C = 1720 Hz, 1800 Hz, 1880 Hz, 1960 Hz
VAM	Value Added Manufacturer
VAR	Value Added Reseller

1.4 Development Tools

It is the responsibility of the Application Developer to acquire and learn how to use the necessary development tools. The following software was used for the purpose of producing the examples that appear in this document. The use of these products does not imply a recommendation or endorsement of these products by Iridium Satellite.

1. PDUspy by Nobbi, Downloadable from: <http://www.nobbi.com>

NOTE BENE: This software is used to decode the example messages. It is adequate as display tool. However, it is designed specifically for the GSM network it does not work properly with the Iridium network.

2. Procomm Plus® 32, Version 4.7, April 24, 1998, Copyright © 1992-1998 DATASTORM TECHNOLOGIES, INC., a subsidiary of Quarterdeck Corporation. All rights reserved worldwide.

Downloadable from <http://www.symantec.com/procomm/>

3. HyperTerminal, Hilgraeve Inc., Monroe, MI USA, Copyright 1999.

Generally provided as part of the Windows Operating System

1.5 Hardware, Software and SIM Requirements

To use SMS, developers need the relevant subscriptions and hardware, specifically:

1.5.1 Hardware:

- 9522 L-Band Transceiver (“Sebring”) OR
- 9505 Handset (“Laguna”) with the 9 pin serial cable adapter

- Destination device (mobile phone, DTE, PC with an application that supports SMS).

NOTE: SMS-MO is not supported by 9500 handsets or 9521 L-Band Transceivers. For Iridium terminals manufactured by an Iridium authorized Value Added Manufacturer please contact the VAM to determine whether the product has SMS-MO capability.

1.5.2 ISU Firmware

- The Firmware revision of the 9522 shall be SAC0307 or higher
- The Firmware revision of the 9505 shall be LAC0307 or higher

1.5.3 SIM Card

- SMS-MO & MT is a standard feature of SIMs provisioned for voice and circuit switched data
- The SMSC number must be programmed into the SIM card
 - The SMSC number for Iridium is 00881662900005

1.6 Reference Documents

The first three documents are accessible from the <http://vams.iridium.com>. This web site is only available to authorized Value Added Manufacturers or Value Added Resellers.

- [1] Motorola Satellite Series 9522 L-Band Transceiver Fact Sheets
- [2] Motorola Satellite Series 9522 L-Band Transceiver Interface Specification
- [3] ISU AT Command Reference, Version 2.0, May 20, 2003.
- [4] Short Message Service SMS Service Description

These documents are available from their publisher's respective web sites:

- [5] GSM 03.40 Version 5.4.1 April 1997 [Available from <http://www.etsi.org/>]
- [6] ITU-T Recommendations V.24, 03/93 [Available from <http://www.itu.int/>]

1.6.1 Other Useful Documents

These documents are accessible from the Iridium public web site: <http://www.iridium.com>.

- [1] Data Services Overview: The document includes Frequently Asked Questions (FAQs) for both Dial-up and Direct Internet Data Services. [<http://www.iridium.com/service/docs/Overview.pdf>]
- [2] Dial-Up Data User's Guide: Provides detailed description of the set-up and use of dial-up data services [<http://www.iridium.com/service/docs/Dial-Up%20Data%20Users%20Guide.pdf>]
- [3] Mobile Terminated Data User's Guide: Provides a detailed description of the set-up, operation, and constraints as it relates to terminating data calls. [<http://www.iridium.com/service/docs/Mobile%20Terminated%20Data%20Users%20Guide%20Rev%204.pdf>]

2.0 Overview

Iridium's Short Message Service (SMS) is a mechanism to deliver Mobile Originated (MO) and Mobile Terminated (MT) short data messages over the Iridium satellite network.

Note that:

- **The Iridium SMS service incorporates a subset of the GSM SMS features and that not all the GSM features are supported.**
- **The ISU is not capable of displaying, generating or storing 8-bit Text mode messages. All 8-bit Text mode messages must be generated and processed by the FA via the RS-232 / DTE interface.**
- **This document refers specifically to the commercial US based Gateway. US DoD gateway users should contact the DISA EMSS program office for questions related to specific operational capabilities.**

Each short message can be up to 160 "text" characters (7-bit coded) in length. The text characters are based on a 7-bit alphabet which is encoded and transmitted as 8-bit data. Hence the 140 octet (byte) maximum message size. Non-text based short messages (for example, in binary format) are also possible.

SMS is a store and forward method of transmitting messages to and from mobile devices. The short message from the originator is stored in a central Short Message Center (SMSC) which then forwards it to the destination. In the case that the recipient is not available, the SMSC which attempts to deliver the SMS until it is delivered or the validity period expires.

SMS supports a limited confirmation of message delivery. The sender of the short message can request to receive a return message notifying them whether the short message has been delivered or not. With this option, the originator gets a confirmation that the message was delivered to the SMSC. Unlike standard GSM, the Iridium SMS can only acknowledge that the message was delivered to the next node in the chain. However, if the next node is not on the network, SMS can only confirm that the message was successfully passed to the next node.

The end to end SMS architecture can be described by the Figure 1.

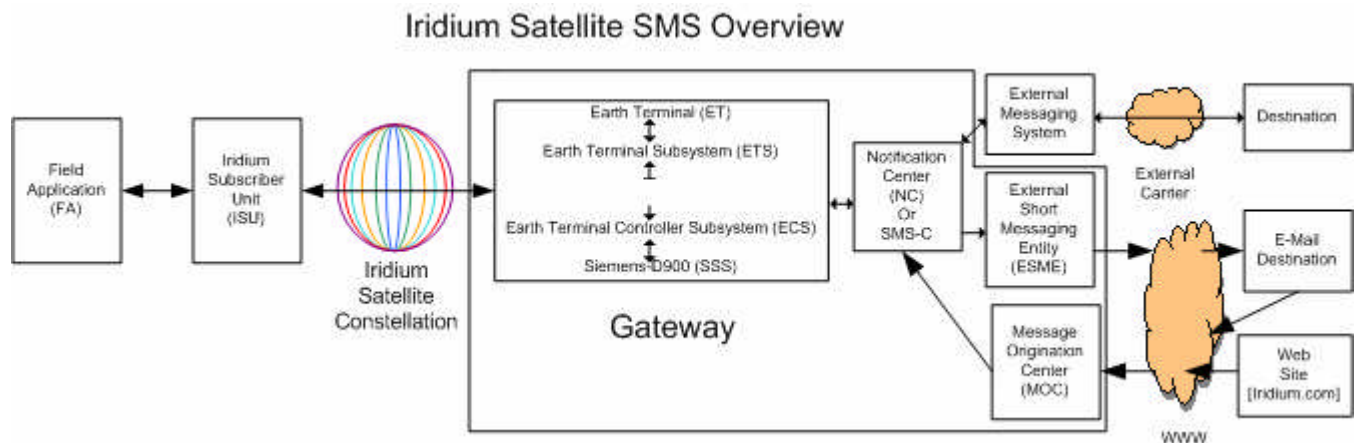


Figure 1: SMS Architecture Overview

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SMS permits the following call types. These call types support SMS messaging both during a voice call and while no call is in process.

Call Types
ISU SMS-MO to ISU SMS-MT
ISU SMS-MO to ESME
ISU SMS-MO to External System
ESME to ISU SMS-MT
External System to ISU SMS-MT

Short messages can be sent and received simultaneously while a voice call is in progress. This is possible because short messages travel over and above the radio channel using the signaling path, whereas the voice call uses a dedicated “traffic” radio channel for the duration of the call.

The Iridium system supports 7-bit PDU format messages and 8-bit Text mode with limited functionality. All 8-bit Text mode messages must be generated and processed by the Field Application (FA).

3.0 Application Interface Description

This section addresses the implementation of SMS features for a field application (FA) operating on the DTE. The DTE is connected to the Iridium network via an ISU. The FA frames the SMS message which is passed from the DTE to the ISU for transmission over the network. The interface between the DTE and the ISU is the RS232 serial port. The FA uses an extended proprietary AT Command set to manage the sending and receiving of the SMS messages. These commands are used to load and retrieve messages between the ISU and the FA.

3.1 Hardware Interface

The table below provides the full description of the physical wiring for the 9522 L-Band Transceiver.

Pin	Signal Name	Signal Description	Interface	RS232 DB9 Pin
1	EXT_ON_OFF	Power on/off control input. EXT_ON_OFF control input is pulled to a GND level to toggle the 9522 LBT on and off	DC Power	
2	Reserved	Reserved	Reserved	
3	GND	External GND input. Same as pin 17, both pins should be connected directly to the power source.	DC Power	
4	EXT_B+	External 4.4 VDC input. Same as pin 16, both pins should be connected directly to the power source.	DC Power	
5	Reserved	Reserved	Reserved	
6	Reserved	Reserved	Reserved	
7	RI	RS232 Ring Indicate	RS232 Data	9
8	RTS	RS232 Request To Send	RS232 Data	7
9	S_TX	RS232 Transmit Data	RS232 Data	3
10	DCD	RS232 Data Carrier Detect	RS232 Data	1
11	Reserved	Reserved	Reserved	
12	Reserved	Reserved	Reserved	
13	S_RX	RS232 Receive Data	RS232 Data	2
14	GND	Spare GND	Spare GND	
15	Reserved	Reserved	Reserved	
16	EXT_B+	External 4.4 VDC input. Same as pin 4, both pins should be connected directly to the power source.	DC Power	
17	GND	External GND input. Same as pin 3, both pins should be connected directly to the power source.	DC Power	
18	Reserved	Reserved	Reserved	
19	DTR	RS232 Data Terminal Ready	RS232 Data	4
20	Reserved	Reserved	Reserved	
21	DSR	RS232 Data Set Ready	RS232 Data	6
22	CTS	RS232 Clear To Send	RS232 Data	8
23	GND	RS232 ground level signal reference	RS232 Data	5
24	Reserved	Reserved	Reserved	
25	Reserved	Reserved	Reserved	

3.2 RS232 Interface

The RS-232 interface on the LBT is designed to auto-baud to the DTE device connected. The port configuration options are outlined in table below.

R232 Port Settings		
Parameter	Values	Default Setting
Baud Rate	1200, 2400, 4800, 9600, 19200, 38400	19200
Data Bits	7, 8	8
Stop Bits	1, None	1
Parity	Even, Odd, None	None

Note:

- It is recommended to operate the serial interface at 19200 baud or less.
- It is not recommended to operate the serial port above 38400. See also the AT Command +IPR in the AT Command Set Reference.

3.2.1 Three Wire Serial Operation

The ISU can also support most three-wire serial configurations. The three-wire DTE interface which only uses the TX, RX and GND signals is supported with restrictions. The ISU requires the following modifications:

- AT&Dn must be set to AT&D0 to ignore the DTR input from the DTE, since it is not be present.
- AT&Kn must be set to AT&K0 for no flow control or AT&K4 for XON/XOFF software flow control. The RTS (Request To Send) and CTS (Clear To Send) hardware flow control signals are not present.
- AT&Cn setting will have no affect, since DCD (Data Carrier Detect) is not present
- AT&Sn setting will have no affect, since DSR (Data Set Ready) is not present.
- RI (Ring Indicate) output to the DTE is not present.

For three-wire operation the ISU serial interface should not be operated higher than 9600 baud in order to prevent buffer overruns due to the inherent lack of any hardware or software flow control in three-wire operation.

To set up the 3-wire configuration follow these steps:

- Connect to the ISU using a standard 9-wire interface and configure fro 3-wire operation.
- AT&D0 - ignore DTR
- AT&K0 - no flow control
- AT&W0 – store active configuration as profile0
- AT&Y0 – select profile 0 as default configuration
- Power down the ISU

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- Connect the 3-wire interface

ISU DB25	DB9	Signal
Pin 13	Pin 2	Receive Data
Pin 9	Pin 3	Transmit Data
Pin 23	Pin 5	Ground

- Power up the ISU

Additionally in some instances it has been determined that DTR needs to be pulled high.

Note: Iridium strongly recommends the use of 9 wire serial connections wherever possible.

3.3 Software Interface

The FA uses AT Commands to manage the communications between the DTE and the ISU. This enables the FA to check device status, configure the communications port, and load and retrieve messages.

The full list of AT command is described in the ISU AT Command Reference document. This section describes the subset of AT commands that are specifically used to support the SMS Message functions.

3.3.1 +CMGF – SMS Message Format

This command tells the ISU which input and output format to use. The only mode that is supported at this time is PDU mode. The possible modes are “PDU” (entire TP data units used) or “text” (headers and body of the message are given separate parameters). If text is used it is controlled solely in the sending of the message. The actual data will still be processed by the ISU in the PDU format.

Command Examples:

Set Command: AT+CMGF = [<mode>]

Valid Values for <mode> are:

0 PDU format ONLY (default)

Read Command: AT+CMGF?

Returns the current <mode> in the ISU.

+CMGF: 0

Test Command: AT+CMGF=?

Lists the supported <modes> for the ISU.

3.3.2 +CSMS – Select SMS Message Service

This command selects the short messaging service. The returned values list the supported values of the ISU. There are three types of services returned. They are <MT> for Mobile Termination, <MO> for Mobile Origination, and <BM> for Broadcast type. If the set value is not supported an Error message will be returned. The ONLY message service type supported is type “0”.

Command Examples:

Set Command: AT+CSMS = <service>

Valid value for <service> is:

0 GSM 3.40 and 3.41 (the syntax of SMS AT commands is compatible with GSM 07.05 Phase 2 version 4.7.0)(default)

Returned values:

+CSMS: <MT>,<MO>,<BM>

Value of:

0 Type NOT supported

1 Type supported

Read Command: AT+CSMS?

Read command returns current ISU values in the following format:

+CSMS: <service>,<MT>,<MO>,<BM>

Test Command: AT+CSMS=?

Returns the supported message services of the ISU in the following format:

+CSMS: (list of supported services).

3.3.3 +CSCS – Select TE Character Set

The command for selecting the TE character set to be used by the ISU. Only the IRA character set is currently supported. When selecting a character set, characters must be in double quotes or “”, for example “IRA”.

Command Examples:

Set Command: AT+CSCS = <chset>

Values for <chset> are:

“IRA” International reference alphabet (ITU-T T.50)

Read Command: AT+CSCS?

Returns the Character set being used by the ISU.

+CSCS: <chset>

Test Command: AT+CSCS=?

Returns the supported character set in the form:

+CSCS: (character set).

3.3.4 +CSCA – SMS Service Center Address

This command is used to set/read/test the SMS Message Center Address (SMSC) or Notification Center (NC) in the Iridium Network. In PDU mode (which is the default mode for the ISU), this setting is used by the send and write commands, but only when the length of the SMSC Address coded into PDU parameter equals zero. This means that you do not have to encode the SMSC number into an SMS-MO message it can be retrieved from the ISU.

Set Command: AT+CSCA=<SCA>[,<TOSCA>]
 <SCA> GSM 04.11 RP SC address-value field in string format (i.e., enclosed quotes");
 <TOSCA> GSM 04.11 RP SC address Type of Address octet in integer format

Read Command: AT+CSCA?

Returns the current value in the ISU.

+CSCA: <SCA>,<TOSCA>

Example:

Example 1: Sets the SMSC or NC number without the "00". This is because of the 145 value. The 145 value notifies the phone that it is an International Numbering Plan.

AT+CSCA="881662900005", 145

Or

Example 2: Sets the SMSC or NC number with the "00". This is because of the 129 value. The 129 value notifies the phone that it is an unknown Numbering Plan and to use the exact string.

AT+CSCA="00881662900005", 129

Note: 145 = International & 129 = Unknown

3.3.5 +CNMI – New SMS Message Indications to DTE

This command is used to administer the receipt of messages from the network as indicated to the DTE when the DTE is active, i.e DTR signal is ON.

Set Command: AT+CNMI=[<MODE>[,<MT>[,<BM>[,<DS>[,<BFR>]]]]]

<Mode> Values:

- 0 Buffer unsolicited result codes in the ISU. If result code buffer is full, older indications are discarded and replaced with the new received indications (Default).
- 1 Discard indication and reject new received message unsolicited result codes when ISU-DTE link is reserved (e.g. in in-call data mode). Otherwise forward them directly to the DTE.

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- 2 Buffer unsolicited result codes in the phone when ISU-DTE link is reserved (e.g. in in-call data mode) and flush them to the DTE after reservation. Otherwise forward them directly to the DTE.

<MT> Values:

- 0 No SMS-DELIVER indications are routed to the DTE (Default).
- 1 If SMS-DELIVER is stored in the ISU, indications of the memory location is routed to the DTE using unsolicited result codes.
+CMTI: <MEM>,<INDEX>
- 2 SMS-DELIVERs (except class 2 messages and messages in the message waiting indication group (store message)) are routed directly to the TE using unsolicited result code:
+CMT: [<ALPHA>],<LENGTH><CR><LF><PDU> (PDU mode)
- 3 Class 3 SMS-DELIVERs are routed directly to TE using unsolicited result codes defined in <MT>=2. Messages of other data coding schemes result in indication as defined in <MT>=1.

<BM> Values:

- 0 No CBM indications are routed to the DTE (Default).

<DS> Values:

- 0 No SMS-STATUS-REPORTs are routed to the DTE (Default).
- 1 SMS-STATUS-REPORTs are routed to the DTE using unsolicited result code:
+CDS: <LENGTH><CR><LF><PDU> (PDU Mode)

<BFR> Values:

- 0 Buffer of unsolicited result codes defined within this command is flushed to the DTE when <MODE> 1...3 is entered (OK response is returned before flushing the codes) (Default).
- 1 Buffer of unsolicited result codes defined within this command is cleared when <MODE> 1...3 is entered.

Read Command: AT+CNMI?

Returns the current ISU settings for the SMS message indication.

+CNMI: <MODE>,<MT>,<BM>,<DS>,<BFR>

Test Command: AT+CNMI=?

Returns the supported settings for the ISU.

+CNMI: (<MODE>s supported),(<MT>s supported), (<BM>s supported),(<DS>s supported),(<BFR>s supported)

Example: AT+CNMI=2,2,0,1,0

This command sends the SMS message to the DTE as soon as the message is received (see description for each parameter above).

3.3.6 +CMS ERROR - Returned Error Codes

This returned value can be displayed from many of the SMS AT commands

Example of an Error Report:

```
+CMS ERROR: <CMS_ERR>
```

<CMS_ERR> Values:

1	Unassigned Number
8	Operator Barred
10	Call Barred
21	SM Transfer Rejected
27	Destination out of Service
28	Unidentified Subscriber
29	Facility Rejected
30	Unknown Subscriber
38	Network Out of Order
41	Temporary Failure
42	Congestion
47	Resources Unavailable
50	Facility Not Subscribed
69	Facility Not Implemented
81	Invalid SM Reference Value
95	Invalid Message
96	Invalid Mandatory Information Element
97	Nonexistent Message Type
98	Incompatible Message
99	Nonexistent Information Element
111	Protocol Error
127	Inter-Working
128	Telephony Inter-Working Not Supported
129	SM Type 0 Not Supported
130	Cannot Replace SM
143	Unspecified TP-PID error
144	Coding Scheme Not Supported
145	Message Class Not Supported
159	Unspecified TP-DCS Error
160	Command Not Actioned
161	Command Unsupported
176	TPDU Not Supported
192	SC (SIM Card) Busy
193	No SC Subscription
194	SC System failure
195	Invalid SME Address
196	Destination SME Barred

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197	SM Rejected
208	SIM SMS Storage Full
209	No SMS Storage Capability in SIM
210	Error in MS
211	Memory capacity exceeded
255	Unspecified Error
300	ISU Failure
301	SMS Service Reserved
302	Operation Not Allowed
303	Operation Not Supported
304	Invalid PDU Mode Parameter
305	Invalid Text Mode Parameter
310	No SIM
311	SIM PIN Required
312	PH-SIM PIN Required
313	SIM Failure
314	SIM Busy
315	SIM Wrong
320	Memory Failure
321	Invalid memory Index
322	Memory Full
330	SM-SC Address Unknown
331	No Network Service
332	Network Timeout
500	Unknown Error

3.3.7 +CMGL – List SMS Messages

This command returns status/settings from the message storage memory (<MEM1> is the selected message storage from the +CPMS command) in the ISU to the DTE. If listing fails, final result code +CMS ERROR: <CMS_ERR> is returned.

Command Examples:

Set Command: AT+CMGL[=<stat>]

Valid values for <stat> are:

<STAT> Values:

PDU	Text	
0	“REC UNREAD”	Received unread message (i.e. new message)(Default).
1	“REC READ”	Received read message
2	“STO UNSENT”	Stored unsent message (only applicable to SMS)
3	“STO SENT”	Stored sent message (only applicable to SMS)
4	“ALL”	All messages (only applicable to +CMGL command)

Response is in the following format for PDU Mode:

+CMGL: <INDEX>,<STAT>,[<ALPHA>],<LENGTH><CR><LF><PDU>[<CR><LF>+CMGL:
<INDEX>,<STAT>,[<ALPHA>],<LENGTH><CR><LF><PDU> [. . .]]

Values:

<INDEX>: The sequential number that identifies the message in the message storage location.

<ALPHA>: String type alphanumeric representation of TP-destination address or TP-originating address corresponding to the entry found in the phonebook (optional field);

<LENGTH>: In PDU Mode, this is the length of the actual TP data unit in octets (i.e. the RP layer SMSC address octets are not counted in the length).

<PDU>: GSM 04.11 SC address followed by GSM 03.40 TPDU in hexadecimal format.

Test Command: AT+CMGL=?

This command returns a list of supported values by the ISU.

+CMGL: (List of supported <STAT>s)

3.3.8 +CMGS – Send SMS Message

The command sends a message from a DTE to the network (SMS-SUBMIT). In PDU mode, <LENGTH> is the length of the actual TPDU in octets. Therefore, the length value does not include the length of the SCA field. The <PDU> is the SC address followed by the TPDU in hexadecimal format.

PDU entry must be terminated by <CTRL-Z>. Sending can be cancelled by the <ESC> character.

Execute Command: AT+CGMS=<LENGTH><CR>

> <PDU><CTRL-Z/ESC> (PDU Mode)

After the carriage return, the AT Command displays the “>” prompt when the command is ready to accept the PDU data.

Response is in the following format for PDU Mode:

AT+CMGS: <MR>

NOTE: In the current version, the message reference number on the SIM is not available to the AT Command port user. The successful response from the AT+CMGS Command is “000”.

If sending fails, final result codes are displayed by +CMR ERROR: <CMS_ERR> (See section “+CMS ERROR - Returned Error Codes” above).

3.3.9 +CMGR – Read SMS Message

This command returns the SMS Message with the <index> location from the message storage <typically mem1> in the ISU. If the status of the message is “received unread”, the status of the stored message changes to “received read”. If an error occurs, the result code will be in the format of “+CMS ERROR: <cms_err>”.

Command Execution: AT+CMGR=<index>

The index is the sequential number that identifies the message in the message storage location. See the return values for the +CMGL Command.

Response is in the following PDU format:

+CMGR: <STAT>,[<ALPHA>],<LENGTH><CR><LF><PDU>

Values:

<STAT>

<ALPHA>: String type alphanumeric representation of the TP-Destination address or TP-Originating address corresponding to the entry found in the phonebook (optional field).

<LENGTH>: In PDU mode, this is the length of the actual TP data unit in octets (i.e. the SMSC address octets are not counted in the length)

<PDU>: SC address followed by the TPDU in hexadecimal format.

3.3.10 +CMGW – Write Message to Memory

This command stores a message to memory storage on the ISU<mem2> (<mem2> is selected by the +CPMS command). Using PDU mode, the length of the actual TPDU is in octets; PDU is the GSM 7-Bit Hexadecimal format. The default status is set to “stored unsent”, but the parameter status also allows values to be given.

Execute Command: AT+CMGW=<LENGTH>[,<stat>]<CR>
> <PDU><CTRL-Z/ESC> (PDU Mode)

After the carriage return, the AT Command displays the “>” prompt when the command is ready to accept the PDU data.

Response is in the following PDU format:

+CMGW: <INDEX>

Values:

<INDEX> I indicates the memory location where the message is stored. If an error results from the query see “+CMR ERROR: <CMS_ERR>”.

3.3.11 +CMGD – Delete SMS Message

This command deletes the message from the preferred message storage area <mem1> location <INDEX>.

Command Execution: AT+CMGD=<INDEX>

3.4 SMS Message Structures, Formats and Data Elements

Connecting an ISU and issuing AT commands is straightforward. However, to have the full control of the transmitted SMS data requires familiarity with the structure and composition of the Protocol Data Unit (PDU). A PDU is a hexadecimal string that contains not only the message, but also information about the sender chained to the packet used in the SMS transport layer (often referred as Transport Protocol Data Unit or TPDU). The latter includes many sub-fields in addition to the message text itself. Most data is packed in order to reduce the size of the transmitted bits. This is all framed and transmitted in the form of hexadecimal octets or decimal semi-octets.

3.4.1 Message Formats

The format of the Mobile Originated and Mobile Terminated SMS messages are similar but not identical although the structure of same type fields and parameters is the same within each message. The SMS-MO (SMS-SUBMIT in GSM terminology) message packet defines a message sent from an ISU; the SMS-MT (SMS-DELIVER in GSM terminology) packet is the message received at the ISU. The content and meaning of the fields within the message are predicated on the type of message being sent or received.

3.4.1.1 SMS MO (Mobile Originated) Message Format

SMS-MO (Mobile Originated) Message								
SCA	SMS-SUBMIT TPDU							
SCA	ID	MR	DA	PID	DCS	VP	UDL	UD

3.4.1.2 SMS MT (Mobile Terminated) Message Format

SMS-MT (Mobile Terminated) Message								
SCA	SMS-DELIVER TPDU							
SCA	ID	OA	PID	DCS	SCTS	UDL	UD	

3.4.2

3.4.3 Message Parameters and Data Elements

Parameter	Name	Size	Definition
SCA	Service Center Address	1 to 12 octets	Network operator's Service Center number.
ID	TPDU type identifier	1 octet	SMS-DELIVER or SMS-SUBMIT identifiers and flags.
MR	Message Reference	1 octet	Progressive number (0 to 255).
OA or DA	Originating or Destination Address	2 to 12 octets.	Sender or destination phone number.
PID	Protocol Identifier	1 octet	Nature of data transported used by the Service Centre for a better routing.
DCS	Data Coding Scheme	1 octet	Format of the data transported (7 or 8 bits, alphabet, etc.) and where to store it (Mobile memory, SIM module, or for immediate display).
SCTS	Service Center Time Stamp	7 octet	Year, month, day, hour, minute, seconds and time difference with respect to GMT
VP	Validity Period	0, 1, or 7 octet(s)	How long the network operator service centre will hold the message, if undelivered.
UDL	User Data Length	1 octet	Length of data, prior to encoding.
UD	User Data	0-140 octet(s)	User Message Data

3.4.3.1 SCA OA & DA Address Format

The SCA, Service Centre Address, is the phone number of the network service center. The OA, Originator Address, is the phone number of the device initiating the SMS call and the DA, Destination Address, is the phone number of the recipient of the SMS message.

The structure of the addresses is the same but the content and how the values are interpreted different for SCA than for the OA and DA. The general structure of the address is:

Length	Type of number	Address
1 octet	1 octet	0 – 10 octets

<i>Length</i>	For the SCA, the value is the number of <i>octets</i> in the number, plus one for the <i>type of number</i> field. For the OA and DA, the length is the number of <i>digits</i> in the number, not including the <i>type of number</i> field. NOTE: If the <i>length</i> is set to 0, the IS uses the default value of the SC set by the at+cscs command.
<i>Type of number</i>	81H: the number is a National Number. 91H: the number is an International Number xxH: the number is unknown for a value “unknown”: the mobile will use the default number
<i>Address</i>	The phone number encoded using BCD Format. If the length is an odd number of digits, the last octet is padded with 0FH.

The difference between SCA and OA/ DA is the interpretation of the *length* field. For the SCA, the value is the number of *octets* in the number, **plus** one for the *type of number* field. With the OA and DA, the length is the number of *digits* in the number, **not including** the *type of number* field.

3.4.3.2 SCA Address Packing Example

This is how the Iridium SMSC number **+8816 629 00005** is encoded as the SCA:

Length	Type of Number	Address
07H	91	88 61 26 09 00 50

07H	number of <i>octets</i> in the number, including the <i>type of number</i> field
91	<i>type of number</i> is an International Number
886126090050	SCA number 8816 629 00005 in BCD format. If the length of the phone number is odd, a trailing 0FH is added to form proper octets

3.4.3.3 OA and DA Address Packing Example

This is how the same number **+8816 629 00005** is encoded as the OA or DA:

Length	Type of Number	Address
0CH	91	88 61 26 09 00 50

0CH	Hexadecimal value of the number of <i>digits</i> in the number, not including the <i>type of number</i> field.
91	<i>Type of number</i> is an International Number
886126090050	SCA number 8816 629 00005 in BCD format. If the length of the phone number is odd, a trailing 0FH is added to form proper octets

3.4.3.4 ID Octet

The ID octet contains the SMS-DELIVER and the SMS-SUBMIT identifiers and flags. The structure of the ID is:

ID - TPDU Type Identifier							
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
RP	UDHI	SRI	VP		MMS	MTI	

The sub-fields of the ID have the following meanings:

Bit	Meaning
RP	Reply path. 0 : No reply path exists. 1 : Reply path exist.
UDHI	User data header indicator. 0 : User Data field does NOT start with a header 1 : User Data field does start with a header
SRI	Status report indication. 0 : No status report is returned to the SME 1 : Status report is returned to the SME
VP	Validity Period format. 0 0 : No VP present 0 1 : Enhanced format 1 0 : Relative format 1 1 : Absolute format
MMS	More messages to send. 0 : There are more messages to send 1 : There are NO more messages to send
MTI	Message type indicator. 0 0 : Indicate that this PDU is an SMS-DELIVER 0 1 : Indicate that this PDU is an SMS-SUBMIT

3.4.3.5 MR Message Reference

MR – Message Reference
Integer 0 – 255 (0 – FFH)

The MR is an integer representation of a reference number of the SMS-SUBMIT. The MR is incrementing by 1 for each SMS-SUBMIT. The value used for each SMS-SUBMIT is obtained by reading the Last-Used MR value from the SMS Status data field in the SIM and incrementing this value by 1. After each SMS-SUBMIT has been submitted to the network, the last used MR value in the SIM is updated with the MR that was used in the SMS-SUBMIT operation. The reference number may possess values in the range 0 to 255.

The MR is used by the SCME to discard an SMS Message which has the same MR value as the previous SMS-SUBMIT received from the same originating address.

NOTE: In the current version, the message reference number on the SIM is not available to the AT Command port user. The successful response from the AT+CMGS Command is “000”.

3.4.3.6 PID Protocol Identifier

The PID is the information element by which the Transport Layer either refers to the higher layer protocol being used, or indicates interworking with a certain type of telematic device. The Protocol Identifier field format is as follows:

PID Protocol Identifier		
1 octet		
Bits 7 - 6	Bit 5	Bits 4 - 0

The SC may reject messages with a TP-Protocol-Identifier containing a reserved value or one which is not supported.

Bits 7 6	
0 0	Assigns bits 0..5 as defined below
0 1	See GSM 03.40 TP-PID complete definition
1 0	Reserved
1 1	Assigns bits 0-5 for SC specific use

Bit 5	Indicates telematic interworking
0	no interworking, but SME-to-SME
1	telematic interworking

The definition of Bits 4 – 0 is determined by the combination of Bits 7 – 6 and Bit 5. For a complete definition of these bit configurations refer to GSM 03.40 chapter 9.2.3.9. **NOTE: It is not guaranteed that the SMSC supports every PID coding !**

3.4.3.7 DCS Data Coding Scheme

The DCS field indicates the type of coding, if any, used to format the data in the User Data field. Iridium does not support the entire range of DCS options. The only valid DCS option is 7-bit alphabet. The 8-bit text mode alphabet may be used but is handled as a special case and does not adhere to the GSM standards.

The octet is parsed as 2 semi-octets. The high order semi-octet, bits 7 – 4, are the Coding Group Bits. These bits dictate the meaning of the bits in the low order semi-octet, bits 3 – 0. The only Coding Group Bits supported by Iridium are hexadecimal values 0H and FH, (0000 & 1111).

The DCS is coded as follows:

Coding Group Bits 7..4	Use of bits 3..0
	General Data Coding indication
00xx	Bits 5 = Text compression 0 : Text is uncompressed 1 : Text is compressed (not supported)
	Bits 4 = Message class meaning 0 : Bits 1 and 0 are reserved 1 : Bits 1 and 0 have message class meaning (not supported)
	Bit 3 & Bit 2 = Alphabet Used 0 0 : 7-bit alphabet 0 1 : 8-bit data 1 0 : UCS2 (16bit) (not supported) 1 1 : Reserved
	Bit 1 & Bit 0 = Message Class 0 0 : Class 0 - Immediate Display (not supported) 0 1 : Class 1 – ME Specific (not supported) 1 0 : Class 2 – SIM Specific (not supported) 1 1 : Class 3 – TE Specific (not supported)

0100..1011	Reserved coding groups
1100	Message Waiting Indication Group: Discard Message (not supported)
1101	Message Waiting Indication Group: Store Message (not supported)
1110	Message Waiting Indication Group: Store Message (not supported)
1111	Data coding/message class Bit 3 is reserved, set to 0. Bit 2 = Message Coding 0 : 7-bit alphabet 1 : 8-bit alphabet Bit 1 & Bit 0 = Message Class 0 0 : Class 0 - Immediate Display (not supported) 0 1 : Class 1 – ME Specific (not supported) 1 0 : Class 2 – SIM Specific (not supported) 1 1 : Class 3 – TE Specific (not supported)

NOTE: The special case 0000 0000 indicates the Default Alphabet

3.4.3.8 SCTS - Service Center Time Stamp

The SCTS is the information element by which the SMSC informs the recipient the time of arrival of the short message at the SMSC. The time value is included in every SMS-DELIVER being delivered to the SMSC. The Date, Time and Time Zone are encoded in BDC format. The Time Zone indicates the difference, expressed in quarters of an hour, between the local time and GMT (Greenwich Mean Time).

Service Center Time Stamp SCTS						
Year	Month	Day	Hour	Minute	Second	Time Zone
1 octet	1 octet	1 octet	1 octet	1 octet	1 octet	1 octet

For example: the date and time of March 17, 2004 09:35:12 for Tempe, AZ would appear as:

Year	Month	Day	Hour	Minute	Second	Time Zone
0 4	3 0	7 1	9 0	5 3	2 1	C 9

The high order bit of the Time Zone field represents the algebraic sign of the difference between local time and GMT (0: positive, 1: negative).

3.4.3.9 VP Validity Period

Validity Period, VP, specifies the time when SMS message is no longer available for delivery by the switch. If SMS message isn't delivered before that time it is discarded. The VP can be in three different format; Relative, Absolute and Enhanced. The enhanced VP is not currently supported in the Iridium SMS.

3.4.3.9.1 Relative VP

Relative VP consists of a 1 octet integer value for the length of the validity period, counted from when the SMS-SUBMIT is received by the SC. The representation of time is as follows:

TP-VP value	Validity period value
0 to 143	$(VP + 1) * 5 \text{ minutes}$ (i.e. 5 minutes intervals up to 12 hours)
144 to 167	$12 \text{ hours} + ((VP - 143) * 30 \text{ minutes})$
168 to 196	$(VP - 166) * 1 \text{ day}$
197 to 255	$(VP - 192) * 1 \text{ week}$

3.4.3.9.2 Absolute VP

The Absolute VP field is 7 octets long and contains the time when the SMS Message expires. The time is formatted the same as the SCTS formatted time.

3.4.3.9.3 Enhanced

This mode is not supported in the Iridium version of SMS.

3.4.3.10 User Data Length (UDL) and User Data (UD)

The User Data Length, UDL, is a one octet field that contains the integer representation of the number of characters within the User Data field that follows. If the DCS field indicates 7-bit data is used, the integer is the number of *septs* (i.e. characters) in the message. If the DCS field indicates 8-bit data is used, the integer is the number of *octets* in the message.

For example:

UDL	UD
7-bit data	hellohello
0AH	E8 32 9B FD 46 97 D9 EC 37

The UDL hexadecimal value of AH (10 decimal) is the number of *septs* in the data field. If the message format was 8-bit data, the UDL would be 9, the number of *octets* in the data field.

3.4.4 UD Message Packing

SMS messages use characters represented by the 7-bit alphabet. The 7-bit characters are packed into octets. This is accomplished by putting the first 7-bit character into the low order 7-bits of the first octet. Packing is done by completing this octet with the low order bit(s) of the next character or, if this is the final character, 0s.

The following is an example of how a 7-bit data is packed between successive octets.

The 7-bit binary encoding of string "ABC" is: A = 1000001, B = 1000010, C = 1000011

Let A0 be the bit 0 of letter A, A1 be the bit 1 of letter A, and so on. The high order bit ("7") is set to 0.

"A"							
A7	A6	A5	A4	A3	A2	A1	A0
0	1	0	0	0	0	0	1

"B"							
B7	B6	B5	B4	B3	B2	B1	B0
0	1	0	0	0	0	1	0

"C"							
C7	C6	C5	C4	C3	C2	C1	C0
0	1	0	0	0	0	1	1

The PDU will pack data as:

First Octet							
B0	A6	A5	A4	A3	A2	A1	A0
0	1	0	0	0	0	0	1

Second Octet							
C1	C0	B6	B5	B4	B3	B2	B1
1	1	1	0	0	0	0	1

Third Octet							
ZP	ZP	ZP	C6	C5	C4	C3	C2
0	0	0	1	0	0	0	0

Note how the last three spare bits are padded with 0s.

The hexadecimal value of the number of *semi-octet* is used to represent the message data length when transmitting using the AT Command.

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The hexadecimal representation of the packed data "ABC is:

First Octet							
0	1	0	0	0	0	0	1
4H				1H			

Second Octet							
1	1	1	0	0	0	0	1
EH				1H			

Third Octet							
0	0	0	1	0	0	0	0
1H				0H			

The SMS message can be up to 140 *octets* long (bytes). Using this packing scheme the maximum length of the data transmitted can be 160 characters ($140 * 8 / 7 = 160$ characters).

The ISU is not capable of displaying, generating or storing 8-bit Text mode messages. All 8-bit Text mode messages must be generated and processed by the FA via the RS-232/DTE interface.

4.0 8-Bit or Text Format SMS Messaging

The 8-bit message format is not supported by the Iridium network. However, it is possible to send an 8-bit Text message with limitations. This format is NOT recommended.

The specification for SMS-MO states that a message can transmit up to 140 octets. If Iridium supported the full SMS, a message could contain 140 8-bit message characters. However, the Network only supports 7-bit PDU formatting messages and it handles the 8-bit messages as if they are 7-bit data. Consequently, the maximum number of 8-bit characters/octetets that can be sent using the 8-bit format is 122. The following formula shows the number of possible character.

$$\begin{aligned} 7 \text{ bits} * 140 &= 980 \text{ bits} \\ 980 \text{ bits} / 8 \text{ bits} &= 122.5 \text{ 8-bit characters} \\ &(\text{round down to } 122) \end{aligned}$$

The ISU is not capable of displaying, generating or storing 8-bit Text mode messages. All 8-bit Text mode messages must be generated and processed by the FA. Iridium does not recommend using 8-bit Text format.

****** Note the following items ******

- Iridium only supports 7-bit PDU mode. Character set of "IRA". The ISU itself does not work with the Text mode.
- A user can use 8-bit encoding via the RS-232 port but we do not support it or recommend it.
- Since Iridium is configured for 7-bit encoding the system treats even the 8-bit Data as seven bit.
-
- The 8-bit message when sent MUST be received at the Data Port on the ISU. The handset will not display or store an 8-bit message.
- To use the 8-bit format the "Data Coding Scheme" parameter should be set to "F6". This sets the scheme to a setting the Iridium system will accept.

```
DATA CODING SCHEME      (0xF6)
MESSAGE CLASS:          2 (SIM-specific)
MESSAGE CODING:         8bit data
```

5.0 Sequence of Operations

This section provides general guidelines to enable the FA to implement the SMS service via AT commands. It does not provide a list of step by step instructions for specific applications since they tend to vary in scope but rather to define a process to assist in developing and debugging the application.

The FA manages the communications between the DTE and the ISU. It encodes the SMS data, frames the Submit packets and sends them to the ISU. The AT commands below itemize the logical steps required to set up the communications in the FA and send a SMS message. This does not take into account how the data is captured by the FA or the content of the SMS messages.

This section includes all possible AT commands that may be used to send a SMS message. This is for information and documentation purposes only. Some AT Commands do not need to be repeated for each message. For example, the +CSCA command to initialize the SMS Service Center Address need only be performed once. However, it is recommended to execute the +CSCA? Command and verify the number is correct prior to sending the SMS.

To encode an SMS Message for transmission via the AT commands requires an understanding of the data elements and structures that make up the PDU message format. These data structures are defined in Section 3 of this document.

The Commands are organized into the following general classifications:

- Power-Up
- ISU Identification
- SMS Initialization
- SMS Transmission
- SMS Maintenance

Included in each of these steps are examples captured using Hyperterminal. In the economy of space, the extraneous line feed from HyperTerminal have been deleted.

Start - Power Up

AT - Attention command. If the ISU is powered up it will respond "OK".

AT
OK

ISU Identification

ATIn - Requests information about the LBT.

ATI0 - Request the traffic channel rate

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**ATI0
2400
OK**

ATI1 - Request ROM Checksum – not supported by Iridium

**ATI1
0000
OK**

ATI2 - Verify ROM Checksum – not supported by Iridium

**ATI2
OK**

ATI3 - Software version level

**ATI3
SAC0307
OK**

ATI4 - Product description

**ATI4
Motorola IRIDIUM
OK**

ATI5 - Country code

**ATI5
8816
OK**

ATI6 - Hardware specification

**ATI6
1C4
OK**

AT+CGSN - Get LBT serial number (IMEI)

**AT+CGSN
300003000710210
OK**

AT+CGMI - Get Manufacturer's Identification

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AT+CGMI
Motorola
OK

AT+CGMM - Get Model Identification

AT+CGMM
9522 Satellite Series
OK

AT+CGMR - Retrieve the get Revision Number

AT+CGMR
Call Processor Version: SAC0307
DSP Version: SAC0108
NVM Version: SAC0200
OK

AT+CREG? - Check the registration status of the LBT

AT+CREG?
+CREG:000,001
OK

AT+COPS=1 - Attempt to manually register the LBT if not registered

AT+COPS=1
OK

AT+CBST - Select Bearer Service Type

AT+CBST=7
OK

AT+CBST?
+CBST:007,000,001
OK

SMS Initialization

AT+CSMS - Select SMS Message Service

AT+CSMS=0
+CSMS:001,001,000
OK

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AT+CSCS – Select TE Character Set (only 1 valid for SMS)

```
AT+CSCS="IRA"  
OK
```

```
AT+CSCS?  
+CSCS:"IRA"  
OK
```

AT+CMGF – SMS Message Format (PDU mode only valid format)

```
AT+CMGF=0  
OK
```

```
AT+CMGF?  
+CMGF:000  
OK
```

AT+CPMS – Select memory storages for SMS Messages

```
AT+CPMS="SM"  
+CPMS:000,030,000,030,000,030  
OK
```

```
AT+CPMS?  
+CPMS:"SM",000,030,"SM",000,030,"SM",000,030  
OK
```

AT+CSCA – Update the SMS Service Center Address

```
AT+CSCA="881662900005",145  
OK
```

AT+CSCA? – Verify the SMS Service Center Address

```
AT+CSCA?  
+CSCA:"881662900005",145  
OK
```

SMS Transmission

AT+CNMI – Indicate how new SMS Message are identified to the DTE

```
AT+CNMI=2,2,0,1,0  
OK
```

AT+CSQ – Check the signal strength

AT+CSQ
+CSQ:5
OK

AT+CMGS – Send SMS Message

AT+CMGS=46
>
0011000C918861131020980000AA2354747A0E4ACF416110BD3CA783DAE5F93C7C2E83CCF
2771B9494A7C9E97A1B<cntrl-z>
+CMGS:000
OK

AT+CNMI - When the FA has completed the transfer, it is recommended to reset the SMS storage back to the LBT (i.e. AT+CNMI=0,0,0,0,0).

AT+CNMI=0,0,0,0,0
OK

SMS Maintenance

AT+CMGL – List SMS Message

AT+CMGL=1

+CMGL:001,001,,039
0791886126090050040E800088612699000020F1405051319591001472BB985D6F03C6EFF638
3CA7BBDC653A480C

+CMGL:003,001,,044
0791886126090050040E800088612699000020F1405051413550001A72BB985D6F03C6EFF638
3CA7BBDC653A282C1E93CBE633

+CMGL:004,001,,037
0791886126090050040E800088612699000020F1405051413534001272BB985D6F03C6EFF638
3CA7BBDC653A

OK

AT+CMGR – Read SMS Message

AT+CMGR=1

+CMGR:001,"881662900005",039

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**0791886126090050040E800088612699000020F1405051319591001472BB985D6F03C6EFF638
3CA7BBDC653A480C**

OK

AT+CMGD – Delete SMS Message

AT+CMGD=1

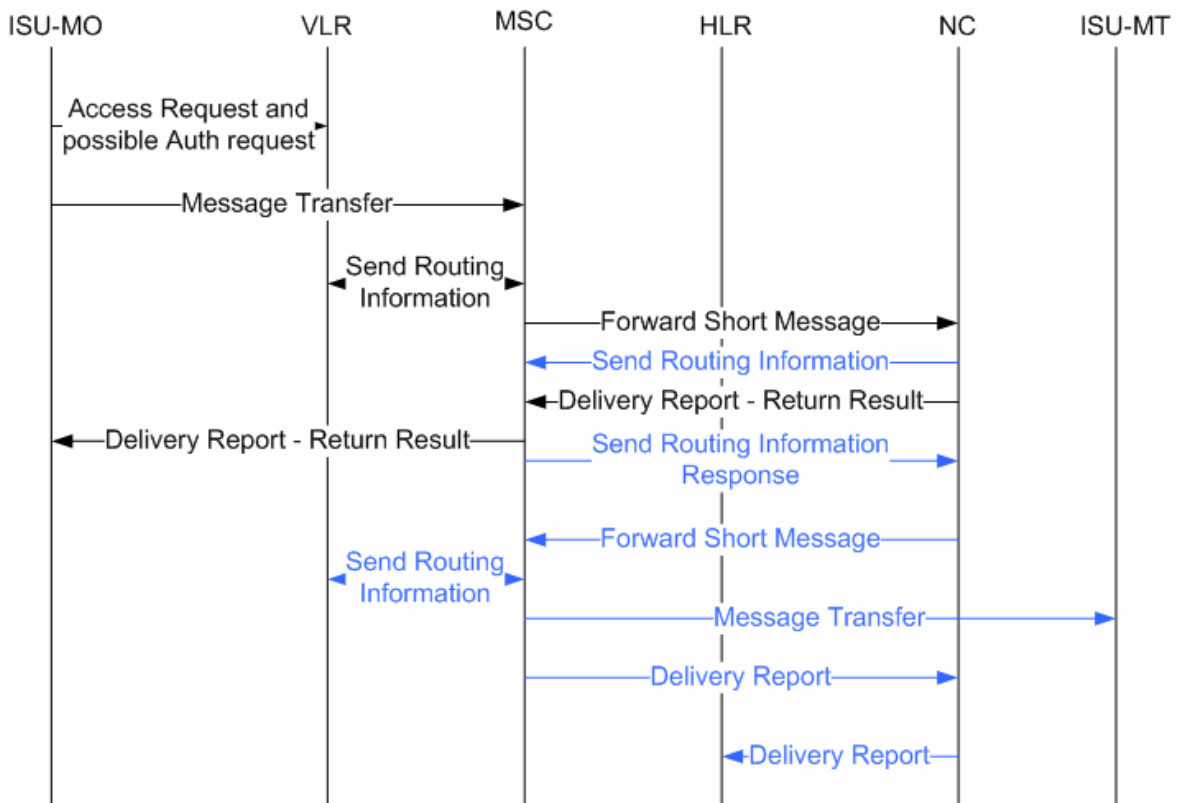
OK

6.0 SMS Call Flows

There are several possible SMS-MO Call Flows. This section shows only the flow of the messages and not the SS7 information/Format.

6.5 ISU SMS-MO to ISU SMS-MT Call Flow

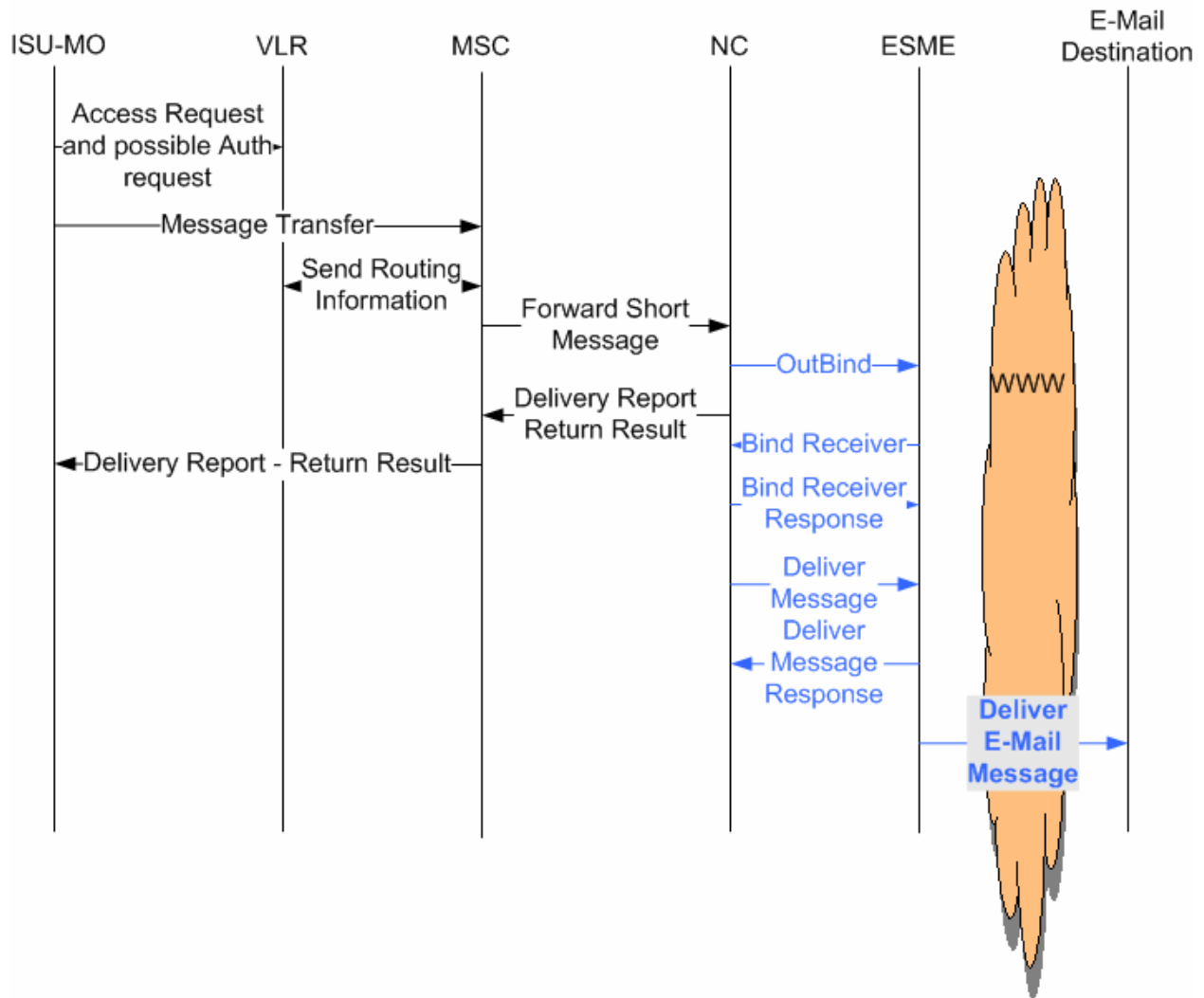
This call flow shows the messaging which transpires for a Mobile to Mobile SMS message.



6.6 ISU SMS-MO to EMSE Call Flow

This diagram below shows the call flow for a Mobile Originated SMS message to an e-mail address. To send an SMS-MO to an e-mail address the destination number must be set to "+*2". The message must contain the destination e-mail address at the very beginning of the message followed by a comma for additional e-mail addresses or a space followed by the message text.

ISU SMS-MO to ESME (E-Mail) Call Flow

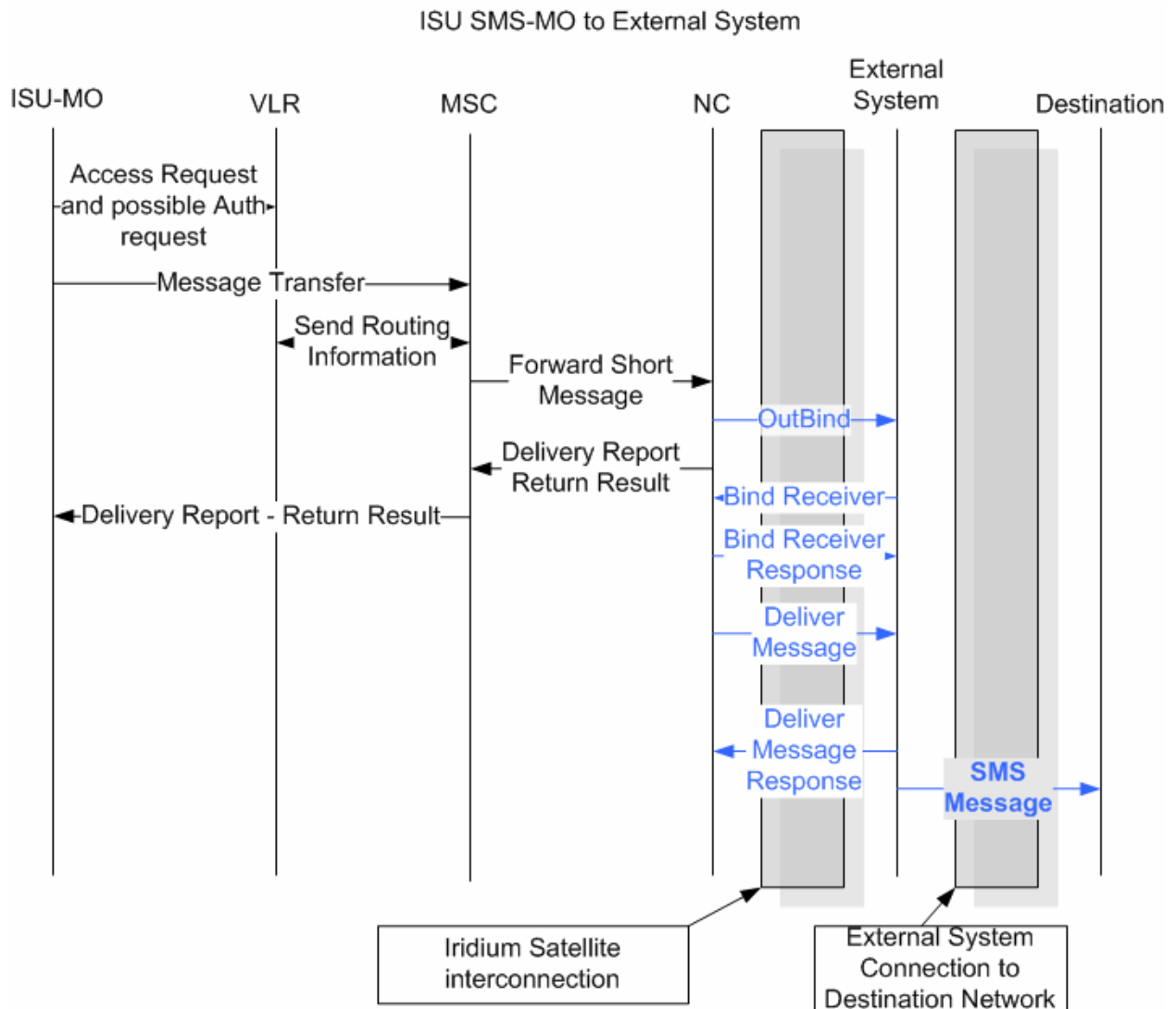


6.7 ISU SMS-MO to External System

This diagram shows the call flow for a Mobile Originated SMS message to an External System. (Cellular Phone via an inter-carrier SMS broker) The destination number of a cellular phone is entered as the destination number of the SMS-MO. Do not change the SMSC number, this number remains the same.

Note:

- That connectivity to terrestrial carriers is dependent on Iridium's SMS broker; Iridium does not have interconnection agreements with terrestrial carriers directly.
- While Iridium to an external cellular system SMS may be possible, the receiving party will require sufficient privileges on the cellular network to allow it to send an international SMS back to Iridium. Cellular subscribers should contact their cellular service provider to verify or order this capability.



7.0 Examples of SMS-Mobile Originated Usage

This section contains representative samples of SMS messages and their usage. Software tools called Procomm & PDUSpy were used to develop these examples. Each of the examples follows the same basic sequence of steps:

1. Set the SMS Service Center Address in the ISU
2. Set up the ISU to send the SMS Data to the DTE upon receiving Data
3. Format the message into a PDU String
4. Transmit the Message
5. Receive the Message

The generic details of each of these steps are itemized in this section and will not be explained in depth in each subsequent example. However, the differences between each example are noted. Detailed explanations of the parameter settings and message encoding and decoding can be found in the AT Reference Command Document and in prior sections of this document. For the examples the SMSC number is set in each one. In practice the definition of the SMSC into the phone is required once and need not be repeated each time.

General Steps

From the Mobile Originated Side:

Set the SMS Service Center Address in the ISU (only required once)

```
at+cscsca=<sca>,<tosca><cr><lf> (only required once)
```

Set up the ISU to send the SMS Data to the DTE upon receiving Data.

```
at+cnmi=<mode>,<mt>,<bm>,<ds>,<bfr><cr><lf>
```

Format the message into a PDU String

```
<SMS-MO Message> = <sca><id><mr><da><pid><dc><vp><udl><ud>
```

Transmit the SMS Message from the DTE to the network.

```
at+cmgs=<length><cr><lf>
```

```
<SMS-MO Message><ctrl-z>
```

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On the Terminated Side:

Receive the Message.

```
at+cmgl=<stat><cr><lf>
```

```
+CMGL:<index>,<stat>,<alpha>,<length><cr><lf>  
<SMS-MO Message>
```

7.1 SMS-MO to SMS-MT : 7-bit PDU Format Example:

Origination Address: 881631010289
 Destination Address: 881631010289
 Message: "This is a test message from Iridium"

Format SMS-MO (Submit) Message

Name	Value	Meaning
SCA	00	Use SCA stored in the LBT
TPDU	11	SMS-MO (Submit) Message
MR	00	Message Reference
DA Len	0C	12 digits in OA
DA Type	91	International Number Format
DA	886113102098	88163101289 in BCD Format
PID	00	PDU is Short Message
DCS	00	7-bit IRA
VP	AA	Message is valid for 4 days
UDL	23	35 (23H) characters in the message
UD	54747A0E4ACF416110BD3CA783DAE5F93 C7C2E83CCF2771B9494A7C9E97A1B	"This is a test message from Iridium" encoded using 7-bit IRA and BCD Format

Mobile Originated Side:

```

Procomm Screen <Begin>:
at+csca="881662900005",145<CR><LF>
OK
at+cnmi=2,2,0,1,0<CR><LF>
OK
at+cmgs=47<CR><LF>
>
0011000C918861131020980000AA2354747A0E4ACF416110BD3CA783DAE5F93C7C2E83CCF2771B9
494A7C9E97A1B<CTRL-Z>
+CMGS:000

OK

Procomm Screen <End>:
    
```

Mobile Terminated Side:

```

Procomm Screen <Begin>:
+CMT:;051
0791886126090050040C918861131020980000401092913583002354747A0E4ACF416110BD3CA783DA
E5F93C7C2E83CCF2771B9494A7C9E97A1B

OK
Procomm Screen <End>:
    
```

Parse the SMS Message upon Delivery:

Name	Value	Meaning
OA Len	07	Length of OA is 7 octets including the Type field
OA Type	91	International Number Format
OA	886126090050	88166290005
TPDU	04	SMS-MT (Deliver) Message
DA Len	0C	12 digits in OA
DA Type	91	International Number Format
DA	886113102098	881631010289 in BCD Format
DCS	00	7-bit IRA
VP	00	Message is valid for 4 days
SCTS	40109291358300	January 29, 2004 19:53:38
UDL	23	35 (23H) characters in the message
UD	54747A0E4ACF416110BD3CA783DAE5F93 C7C2E83CCF2771B9494A7C9E97A1B	"This is a test message from Iridium" encoded using 7-bit IRA and BCD Format

<PDUsPY (1.0.0.412) Software Decode Begin>

PDU LENGTH IS 58 BYTES

ADDRESS OF DELIVERING SMSC

NUMBER IS : +881662900005

TYPE OF NR. : (0x10) International

NPI : (0x01) ISDN/Telephone (E.164/163)

MESSAGE HEADER FLAGS (0x04)

MESSAGE TYPE : SMS DELIVER

MSGS WAITING IN SC : NO

REQ. STATUS REPORT : NO

USER DATA HEADER : NO UDH

REPLY PATH : NO

ORIGINATING ADDRESS

NUMBER IS : +881631010289

TYPE OF NR. : (0x10) International

NPI : (0x01) ISDN/Telephone (E.164/163)

PROTOCOL IDENTIFIER (0x00)

MESSAGE ENTITIES : SME-to-SME

PROTOCOL USED : Implicit / SC-specific

DATA CODING SCHEME (0x00)

COMPRESSION : OFF

MESSAGE CLASS : NONE

ALPHABET USED : 7bit default

SMSC TIMESTAMP : 29/01/04 19:53:38 GMT

USER DATA PART OF SM

USER DATA LENGTH : 35 septets

USER DATA (TEXT) : This is a test message from Iridium

<PDUsPY (1.0.0.412) Software Decode End>

7.2 SMS-MO to ESME – 7-bit PDU Example:

Origination #: 881631010289

Destination #: +*2

Destination E-mail: kent.keeter@iridium.com

Message: kent.keeter@iridium.com This is a test message from Iridium

Receive the Message at the destination E-Mail Account.

Format SMS-MO (Submit) Message

Name	Value	Meaning
SCA	00	Use SCSA stored in the LBT
TPDU	11	SMS-MO (Submit) Message
MR	00	Message Reference
DA Len	02	2 digits in DA
DA Type	91	International Number Format
DA	2A	Destination is an email address in the message
PID	00	PDU is a Short Message
DCS	00	7-bit IRA
VP	AA	Message is valid for 4 days
UDL	3B	59 (3BH) characters in the message
UD	EBB29BEE5A97CBF4B21C9096A7C9E97 ADB357EB74154747A0E4ACF416110BD3 CA783DAE5F93C7C2E83CCF2771B9494 A7C9E97A1B	"kent.keeter@iridium.com This is a test message from Iridium" encoded using 7-bit IRA and BCD Format

Mobile Originated Side:

```

Procomm Screen <Begin>:
at+cscs="881662900005",145<CR><LF>
OK
at+cnmi=2,2,0,1,0<CR><LF>
OK
AT+CMGS=62<CR><LF>
>
00110002912A0000AA3BEBB29BEE5A97CBF4B21C9096A7C9E97ADB357EB74154747A0E4ACF416
110BD3CA783DAE5F93C7C2E83CCF2771B9494A7C9E97A1B<CTRL-Z>
+CMGS:000

OK
Procomm Screen <End>:
    
```

<PDUsby (1.0.0.412) Software Decode Begin>

PDU LENGTH IS 62 BYTES

NO SMSC ADDRESS PRESENT

MESSAGE HEADER FLAGS (0x11)
MESSAGE TYPE: SMS SUBMIT
REJECT DUPLICATES: NO
VALIDITY PERIOD: RELATIVE
REPLY PATH: NO
USER DATA HEADER: NO UDH
REQ. STATUS REPORT: NO
MSG REFERENCE NR.: 0 (0x00)

RECIPIENTS ADDRESS

NUMBER IS: +*2
TYPE OF NR.: (0x10) International
NPI: (0x01) ISDN/Telephone (E.164/163)

PROTOCOL IDENTIFIER (0x00)
MESSAGE ENTITIES: SME-to-SME
PROTOCOL USED: Implicit / SC-specific

DATA CODING SCHEME (0x00)
COMPRESSION: OFF
MESSAGE CLASS: NONE
ALPHABET USED: 7bit default

VALIDITY OF MESSAGE: 4 days

USER DATA PART OF SM

USER DATA LENGTH: 59 septets
USER DATA (TEXT):

kent.keeter@iridium.com This is a test message from Iridium

<PDUsby (1.0.0.412) Software Decode End>

E-Mail Message <begin>:

From: 881631010289@msg.iridium.com

Sent: Friday, January 30, 2004 9:24 AM

To: Kent Keeter

Subject: SMS from 881631010289@msg.iridium.com

This is a test message from Iridium

E-Mail Message <End>:

7.3 SMS-MO to ESME: 8-bit Text Mode Example:

Origination #: 881631010289
 Destination #: +*2
 Destination E-mail: kent.keeter@iridium.com
 Message: "kent.keeter@iridium.com This is a test message from Iridium"
 Receive the Message at the destination E-Mail Account.

Format SMS-MO (Submit) Message

Name	Value	Meaning
SCA	00	Use SCSA stored in the LBT
TPDU	11	SMS-MO (Submit) Message
MR	00	Message Reference
DA Len	02	2 digits in DA
DA Type	91	International Number Format
DA	2A	Destination is an email address in the message
PID	00	PDU is a Short Message
DCS	F6	8-bit Text Format
VP	AA	Message is valid for 4 days
UDL	3B	59 (3BH) characters in the message
UD	6B656E742E6B6565746572406972696469756D2E636F6D205468697320697320612074657374206D6573736167652066726F6D204972696469756D	"kent.keeter@iridium.com This is a test message from Iridium" in 8-bit Text Format

Mobile Originated Side:

```

Procomm Screen <Begin>:
at+cscs="881662900005",145<CR><LF>
OK
at+cnmi=2,2,0,1,0<CR><LF>
OK
at+cmgs=69<CR><LF>
>00110002912A00F6AA3B6B656E742E6B6565746572406972696469756D2E636F6D205468697320697320612074657374206D6573736167652066726F6D204972696469756D<CTRL-Z>
+CMGS:000

OK

Procomm Screen <End>:
  
```

E-Mail Message <begin>:

From: 881631010289@msg.iridium.com

Sent: Friday, January 30, 2004 9:24 AM

To: Kent Keeter

Subject: SMS from 881631010289@msg.iridium.com

This is a test message from Iridium

E-Mail Message <End>:

<PDUsby (1.0.0.412) Software Decode Begin>

PDU LENGTH IS 69 BYTES

NO SMSC ADDRESS PRESENT

MESSAGE HEADER FLAGS (0x11)

MESSAGE TYPE: SMS SUBMIT

REJECT DUPLICATES: NO

VALIDITY PERIOD: RELATIVE

REPLY PATH: NO

USER DATA HEADER: NO UDH

REQ. STATUS REPORT: NO

MSG REFERENCE NR.: 0 (0x00)

RECIPIENTS ADDRESS

NUMBER IS: +*2

TYPE OF NR.: (0x10) International

NPI: (0x01) ISDN/Telephone (E.164/163)

PROTOCOL IDENTIFIER (0x00)

MESSAGE ENTITIES: SME-to-SME

PROTOCOL USED: Implicit / SC-specific

DATA CODING SCHEME (0xF6)

MESSAGE CLASS: 2 (SIM-specific)

MESSAGE CODING: 8bit data

VALIDITY OF MESSAGE: 4 days

USER DATA PART OF SM

USER DATA LENGTH: 59 octets

USER DATA (TEXT):

kent.keeter@iridium.com This is a test message from Iridium

<PDUsby (1.0.0.412) Software Decode End>

7.4 SMS-MO to External System (Cellular): 7-bit PDU Example:

Origination #: 881631010289
 Destination #: +16028209515
 Message: "This is a test message from Iridium"
 Receive the Message at the destination phone (typically).

Format SMS-MO (Submit) Message

Name	Value	Meaning
SCA	00	Use SCSA stored in the LBT
TPDU	11	SMS-MO (Submit) Message
MR	00	Message Reference
DA Len	0B	11 digits in DA
DA Type	91	International Number Format
DA	6120289015F5	16028209515 in BCD Format NOTE: since the DA is an odd length, the last octet is padded with FH
PID	00	PDU is a Short Message
DCS	00	7-bit IRA
VP	AA	Message is valid for 4 days
UDL	23	35 (23h) characters in the message. NOTE: the UDL is the number of septets (characters) in the message content – not the length of the message (octets)
UD	54747A0E4ACF416110BD3CA783DAE5F93 C7C2E83CCF2771B9494A7C9E97A1B	"This is a test message from Iridium" encoded using 7-bit IRA and BCD Format

Mobile Originated Side:

```

Procomm Screen <Begin>:
at+cscs="881662900005",145<CR><LF>
OK
at+cnmi=2,2,0,1,0<CR><LF>
OK
at+cmgs=46<CR><LF>
>0011000B916120289015F50000AA2354747A0E4ACF416110BD3CA783DAE5F93C7C2E83CCF2771B
9494A7C9E97A1B<CTRL-Z>
+CMGS:000

OK
Procomm Screen <End>:
    
```

<PDUsby (1.0.0.412) Software Decode Begin>

PDU LENGTH IS 46 BYTES

NO SMSC ADDRESS PRESENT

MESSAGE HEADER FLAGS (0x11)

MESSAGE TYPE: SMS SUBMIT

REJECT DUPLICATES: NO

VALIDITY PERIOD: RELATIVE

REPLY PATH: NO

USER DATA HEADER: NO UDH

REQ. STATUS REPORT: NO

MSG REFERENCE NR.: 0 (0x00)

RECIPIENTS ADDRESS

NUMBER IS: +16028209515

TYPE OF NR.: (0x10) International

NPI: (0x01) ISDN/Telephone (E.164/163)

PROTOCOL IDENTIFIER (0x00)

MESSAGE ENTITIES: SME-to-SME

PROTOCOL USED: Implicit / SC-specific

DATA CODING SCHEME (0x00)

COMPRESSION: OFF

MESSAGE CLASS: NONE

ALPHABET USED: 7bit default

VALIDITY OF MESSAGE: 4 days

USER DATA PART OF SM

USER DATA LENGTH: 35 septets

USER DATA (TEXT): This is a test message from Iridium

<PDUsby (1.0.0.412) Software Decode End>

7.5 SMS-MO to External System – 8 Bit Text Mode Example:

Origination #: 881631010289
 Destination #: +16028209515
 Message: "This is a test message from Iridium"
 Receive the Message at the destination E-Mail Account.

Format SMS-MO (Submit) Message

Name	Value	Meaning
SCA	00	Use SCSA stored in the LBT
TPDU	11	SMS-MO (Submit) Message
MR	00	Message Reference
DA Len	0B	11 digits in DA
DA Type	91	International Number Format
DA	6120289015F5	16028209515 in BCD Format NOTE: since the DA is an odd length, the last octet is padded with FH
PID	00	PDU is a Short Message
DCS	F6	8-bit Text Format
VP	AA	Message is valid for 4 days
UDL	23	35 (23H) characters in the message
UD	5468697320697320612074657374206D6573736167652066726F6D204972696469756D	"This is a test message from Iridium" encoded using 8-bit Text and BCD Format

Mobile Originated Side:

```

Procomm Screen <Begin>:
at+cscs="881662900005",145<CR><LF>
OK
at+cnmi=2,2,0,1,0<CR><LF>
OK
at+cmgs=50<CR><LF>
>
0011000B916120289015F500F6AA235468697320697320612074657374206D6573736167652066726F6
D204972696469756D<CTRL-Z>
+CMGS:000
OK
Procomm Screen <End>:
    
```

<PDUsby (1.0.0.412) Software Decode Begin>

PDU LENGTH IS 50 BYTES

NO SMSC ADDRESS PRESENT

MESSAGE HEADER FLAGS (0x11)

MESSAGE TYPE: SMS SUBMIT

REJECT DUPLICATES: NO

VALIDITY PERIOD: RELATIVE

REPLY PATH: NO

USER DATA HEADER: NO UDH

REQ. STATUS REPORT: NO

MSG REFERENCE NR.: 0 (0x00)

RECIPIENTS ADDRESS

NUMBER IS: +16028209515

TYPE OF NR.: (0x10) International

NPI: (0x01) ISDN/Telephone (E.164/163)

PROTOCOL IDENTIFIER (0x00)

MESSAGE ENTITIES: SME-to-SME

PROTOCOL USED: Implicit / SC-specific

DATA CODING SCHEME (0xF6)

MESSAGE CLASS: 2 (SIM-specific)

MESSAGE CODING: 8bit data

VALIDITY OF MESSAGE: 4 days

USER DATA PART OF SM

USER DATA LENGTH: 35 octets

USER DATA (TEXT): This is a test message from Iridium

<PDUsby (1.0.0.412) Software Decode End>

8.0 Mobile Terminated SMS

The Iridium network supports both Mobile Originated and Mobile Terminated SMS Messages. Mobile Terminated SMS messages can be initiated from a terrestrial cell phone, an ISU, www.iridium.com or from an external email service.

An SMS-MT generated from an email server is similar to other email applications that use the Iridium network. The MSISDN of the ISU is the destination or "TO" address of the email and the domain name is "msg.iridium.com". The "data" of the SMS message is put in the message body of the email.

The FA running on the DTE uses the AT+CNMI command to indicate to the ISU how to handle the MT-SMS message. For example, by setting the +CNMI to 2,2,0,1,0 the ISU will send the SMS message to the FA as it is received by the LBT.

The data is received in PDU format and must be decoded by the application. The "length" parameter of the CMGL command is the number of octets in the PDU packet less the number of octets in the "SCA". Note; the SMS is encoded using hexadecimal characters, each comprised of 4 bits. The length is the number of octets, each containing 8 bits, not the number of characters.

Example: Compose an email message to the mobile device using the MSISDN as the recipient.

E-Mail Message <begin>:

To: 881631013955@msg.iridium.com
From: smstst@iridium.net
Subject:

abcdefghijklmnopqrstuvwxy0001

E-Mail Message <End>:

On the Mobile Terminated side:

```
+CMT:,064
0791886126090050040E800088612699000020F1405061617040003172BB985D6F03C6EFF6383CA7BB
DC653A282C1E93CBE6333AAD5EB3DBEE373C2E9FD3EBF63B3EAF87C16031
```

OK

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Parse the SMS Message upon Delivery

Name	Value	Meaning
OA Len	07	Length of OA is 7 octets including the Type field
OA Type	91	International Number Format
OA	886126090050	88166290005 SMSC Address
TPDU	04	SMS-MT (Deliver) Message
DA Len	0E	14 digits in DA
DA Type	80	Unknown Number Format
DA	00886126990000	881631010289 in BCD Format
DCS	20	8 bit alphabet
VP	F1	Message is valid for 1 year
SCTS	40506151147000	May 16, 2004 15:41:07
UDL	31	49 (31H) characters in the message
UD	72BB985D6F03C6EFF6383CA7BBDC653A 282C1E93CBE6333AAD5EB3DBEE373C2E 9FD3EBF63B3EAF87C16031	" smstst@iridium.net abcdefghijklmnopqrstu vwxyz0001" encoded using 7-bit IRA and BCD Format

9.0 7-Bit Default Alphabet

SMS Messages are encoded using a 7-bit alphabet. The 7-bit default alphabet is specified by GSM 03.38. The corresponding ISO-8859-1 decimal codes are in the rightmost column.

Note: The euro sign (€) is part of the ISO-8859-1 character set.

Hex	Dec	Character name	Character	ISO-8859-1 DEC
0x00	0	Commercial AT	@	64
0x01	1	Pound Sign	£	163
0x02	2	Dollar Sign	\$	36
0x03	3	Yen Sign	¥	165
0x04	4	Latin small letter E /w grave	è	232
0x05	5	Latin small letter E /w acute	é	233
0x06	6	Latin small letter U /w grave	ù	249
0x07	7	Latin small letter I /w grave	ì	236
0x08	8	Latin small letter O /w grave	ò	242
0x09	9	Latin Capital Letter C /w Cedilla	Ç	199
0x0A	10	Line Feed		10
0x0B	11	Latin Capital Letter O /w Stroke	Ø	216
0x0C	12	Latin Small Letter O /w Stroke	ø	248
0x0D	13	Carriage Return		13
0x0E	14	Latin Capital Letter A /w Ring Above	Å	197
0x0F	15	Latin Small Letter A /w Ring Above	å	229
0x10	16	Greek Capital Letter Delta	Δ	
0x11	17	Low Line	_	95
0x12	18	Greek Capital Letter Phi	Φ	
0x13	19	Greek Capital Letter Gamma	Γ	
0x14	20	Greek Capital Letter Lambda	Λ	
0x15	21	Greek Capital Letter Omega	Ω	
0x16	22	Greek Capital Letter Pi	Π	
0x17	23	Greek Capital Letter Psi	Ψ	
0x18	24	Greek Capital Letter Sigma	Σ	
0x19	25	Greek Capital Letter Theta	Θ	
0x1A	26	Greek Capital Letter Xi	Ξ	
0x1B	27	Escape to Extension Table		
0x1B0A	27 10	Form Feed		12
0x1B14	27 20	Circumflex Accent	^	94
0x1B28	27 40	Left Curly Bracket	{	123
0x1B29	27 41	Right Curly Bracket	}	125
0x1B2F	27 47	Reverse Solidus (Backslash)	\	92
0x1B3C	27 60	Left Square Bracket	[91

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0x1B3D	27 61	Tilde	~	126
0x1B3E	27 62	Right Square Bracket]	93
0x1B40	27 64	Vertical Bar		124
0x1B65	27 101	Euro Sign	€	164 (ISO-8859-15)
0x1C	28	Latin Capital Letter AE	Æ	198
0x1D	29	Latin Small Letter AE	æ	230
0x1E	30	Latin Small Letter Sharp S (German)	ß	223
0x1F	31	Latin small letter E /w acute	É	201
0x20	32	Space		32
0x21	33	Exclamation Mark	!	33
0x22	34	Quotation Mark	"	34
0x23	35	Number Sign	#	35
0x24	36	Currency Sign	¤	164 (ISO-8859-1)
0x25	37	Percent Sign	%	37
0x26	38	Ampersand	&	38
0x27	39	Apostrophe	'	39
0x28	40	Left Parenthesis	(40
0x29	41	Right Parenthesis)	41
0x2A	42	Asterisk	*	42
0x2B	43	Plus Sign	+	43
0x2C	44	Comma	,	44
0x2D	45	Hyphen-Minus Sign	-	45
0x2E	46	Full Stop	.	46
0x2F	47	Solidus (Slash)	/	47
0x30	48	Digit Zero	0	48
0x31	49	Digit One	1	49
0x32	50	Digit Two	2	50
0x33	51	Digit Three	3	51
0x34	52	Digit Four	4	52
0x35	53	Digit Five	5	53
0x36	54	Digit Six	6	54
0x37	55	Digit Seven	7	55
0x38	56	Digit Eight	8	56
0x39	57	Digit Nine	9	57
0x3A	58	Colon	:	58
0x3B	59	Semicolon	;	59
0x3C	60	Less-Than Sign	<	60
0x3D	61	Equal Sign	=	61
0x3E	62	Greater-Than Sign	>	62
0x3F	63	Question Mark	?	63
0x40	64	Inverted Exclamation Mark	¡	161
0x41	65	Latin capital letter A	A	65
0x42	66	Latin capital letter B	B	66

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0x43	67	Latin capital letter C	C	67
0x44	68	Latin capital letter D	D	68
0x45	69	Latin capital letter E	E	69
0x46	70	Latin capital letter F	F	70
0x47	71	Latin capital letter G	G	71
0x48	72	Latin capital letter H	H	72
0x49	73	Latin capital letter I	I	73
0x4A	74	Latin capital letter J	J	74
0x4B	75	Latin capital letter K	K	75
0x4C	76	Latin capital letter L	L	76
0x4D	77	Latin capital letter M	M	77
0x4E	78	Latin capital letter N	N	78
0x4F	79	Latin capital letter O	O	79
0x50	80	Latin capital letter P	P	80
0x51	81	Latin capital letter Q	Q	81
0x52	82	Latin capital letter R	R	82
0x53	83	Latin capital letter W	S	83
0x54	84	Latin capital letter T	T	84
0x55	85	Latin capital letter U	U	85
0x56	86	Latin capital letter V	V	86
0x57	87	Latin capital letter W	W	87
0x58	88	Latin capital letter X	X	88
0x59	89	Latin capital letter Y	Y	89
0x5A	90	Latin capital letter Z	Z	90
0x5B	91	Latin capital letter A /w diaeresis	Ä	196
0x5C	92	Latin capital letter O /w diaeresis	Ö	214
0x5D	93	Latin capital letter N /w tilde	Ñ	209
0x5E	94	Latin capital letter U /w diaeresis	Ü	220
0x5F	95	Section Sign	§	167
0x60	96	Inverted Question Mark	¿	191
0x61	97	Latin small letter A	a	97
0x62	98	Latin small letter B	b	98
0x63	99	Latin small letter C	c	99
0x64	100	Latin small letter D	d	100
0x65	101	Latin small letter E	e	101
0x66	102	Latin small letter F	f	102
0x67	103	Latin small letter G	g	103
0x68	104	Latin small letter H	h	104
0x69	105	Latin small letter I	i	105
0x6A	106	Latin small letter J	j	106
0x6B	107	Latin small letter K	k	107
0x6C	108	Latin small letter L	l	108
0x6D	109	Latin small letter M	m	109
0x6E	110	Latin small letter N	n	110
0x6F	111	Latin small letter O	o	111

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0x70	112	Latin small letter P	p	112
0x71	113	Latin small letter Q	q	113
0x72	114	Latin small letter R	r	114
0x73	115	Latin small letter S	s	115
0x74	116	Latin small letter T	t	116
0x75	117	Latin small letter U	u	117
0x76	118	Latin small letter V	v	118
0x77	119	Latin small letter W	w	119
0x78	120	Latin small letter X	x	120
0x79	121	Latin small letter Y	y	121
0x7A	122	Latin small letter Z	z	122
0x7B	123	Latin small letter A /w diaeresis	ä	228
0x7C	124	Latin small letter O /w diaeresis	ö	246
0x7D	125	Latin small letter N /w tilde	ñ	241
0x7E	126	Latin small letter U /w diaeresis	ü	252
0x7F	127	Latin small letter A /w grave	à	224