



HUAWEI MU609 HSPA LGA Module

Application Guide

Issue 02

Date 2017-01-06

Copyright © Huawei Technologies Co., Ltd. 2017. All rights reserved.

No part of this manual may be reproduced or transmitted in any form or by any means without prior written consent of Huawei Technologies Co., Ltd. and its affiliates ("Huawei").

The product described in this manual may include copyrighted software of Huawei and possible licensors. Customers shall not in any manner reproduce, distribute, modify, decompile, disassemble, decrypt, extract, reverse engineer, lease, assign, or sublicense the said software, unless such restrictions are prohibited by applicable laws or such actions are approved by respective copyright holders.

Trademarks and Permissions



HUAWEI,

HUAWEI, and



are trademarks or registered trademarks of Huawei Technologies Co., Ltd.

Other trademarks, product, service and company names mentioned may be the property of their respective owners.

Notice

Some features of the product and its accessories described herein rely on the software installed, capacities and settings of local network, and therefore may not be activated or may be limited by local network operators or network service providers.

Thus, the descriptions herein may not exactly match the product or its accessories which you purchase.

Huawei reserves the right to change or modify any information or specifications contained in this manual without prior notice and without any liability.

DISCLAIMER

ALL CONTENTS OF THIS MANUAL ARE PROVIDED "AS IS". EXCEPT AS REQUIRED BY APPLICABLE LAWS, NO WARRANTIES OF ANY KIND, EITHER EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE, ARE MADE IN RELATION TO THE ACCURACY, RELIABILITY OR CONTENTS OF THIS MANUAL.

TO THE MAXIMUM EXTENT PERMITTED BY APPLICABLE LAW, IN NO EVENT SHALL HUAWEI BE LIABLE FOR ANY SPECIAL, INCIDENTAL, INDIRECT, OR CONSEQUENTIAL DAMAGES, OR LOSS OF PROFITS, BUSINESS, REVENUE, DATA, GOODWILL SAVINGS OR ANTICIPATED SAVINGS REGARDLESS OF WHETHER SUCH LOSSES ARE FORSEEABLE OR NOT.

THE MAXIMUM LIABILITY (THIS LIMITATION SHALL NOT APPLY TO LIABILITY FOR PERSONAL INJURY TO THE EXTENT APPLICABLE LAW PROHIBITS SUCH A LIMITATION) OF HUAWEI ARISING FROM THE USE OF THE PRODUCT DESCRIBED IN THIS MANUAL SHALL BE LIMITED TO THE AMOUNT PAID BY CUSTOMERS FOR THE PURCHASE OF THIS PRODUCT.

Import and Export Regulations

Customers shall comply with all applicable export or import laws and regulations and be responsible to obtain all necessary governmental permits and licenses in order to export, re-export or import the product mentioned in this manual including the software and technical data therein.

Privacy Policy

To better understand how we protect your personal information, please see the privacy policy at <http://consumer.huawei.com/privacy-policy>.



About This Document

Revision History

Document Version	Date	Chapter	Descriptions
01	2013-04-08		Creation
02	2017-01-06	1.2	Updated Organization of This Document
		1.3.2	Updated The MU609 supports AT commands
		6	Deleted chapter 6 in issue 01: Voice and Supplementary Service Application Scenarios
		9.3.4	Updated the content about “Other aperiodic events include”
		9.3.5	Updated the description of Wake-up Source
		9.4	Updated the description of Application Scenarios: System with USB Connection only
		9.4.2	Updated the table of Software Procedure
		9.4.3	Updated the description of Advantages
		9.5	Updated the description of Application Scenarios: System with USB and WAKEUP_OUT
		9.5.3	Updated the description of Advantages
		10.2	Updated the content of Notes
		13.1	Deleted section 13.1 in issue 01: Voice Calls and Text Messaging
		13.3	Deleted section 13.3 in issue 01: Internal/External Protocol Stacks and Voice Calls



Contents

1 Overview	9
1.1 Conventions and Definitions.....	9
1.1.1 Conventions.....	9
1.1.2 Definitions.....	9
1.2 Organization of This Document.....	10
1.3 Basic AT Command Processing Principles.....	11
1.3.1 Ports	11
1.3.2 AT Command Processing Mechanism	11
1.3.3 Recommended Timeout Mechanism for AT Commands Processed by a Host	14
2 Initialization Application Scenarios.....	16
2.1 Startup Indication ^SYSSTART	16
2.1.1 Reference Process	16
2.1.2 Troubleshooting	16
2.2 Querying Basic Information.....	17
2.2.1 Reference Process	17
2.2.2 Troubleshooting	17
2.3 Network Service Operations.....	18
2.3.1 Reference Process	18
2.3.2 Troubleshooting	19
3 Serial Port Configuration Application Scenarios.....	20
3.1 Baud Rate Configuration	20
3.1.1 Reference Process	20
3.1.2 Troubleshooting	20
3.2 DTR Hang Up Data Services	21
3.2.1 Reference Process	21
3.2.2 Troubleshooting	21
3.3 DCD Pin Control.....	21
3.3.1 Reference Process	21
3.3.2 Troubleshooting	22
3.4 Setting Hardware Flow Control	22
3.4.1 Reference Process	22
3.4.2 Troubleshooting	22



4 External Protocol Stack Application Scenarios.....	23
4.1 Prerequisites	23
4.1.1 Reference Process	23
4.1.2 Troubleshooting	24
4.2 Establishing Data Connections.....	24
4.2.1 Troubleshooting	25
4.3 Data Transmission.....	25
4.4 Switch Between Data Mode and Command Mode.....	27
4.4.1 Reference Process	27
4.4.2 Troubleshooting	28
4.5 Disconnecting Data Service Connections	28
4.5.1 Reference Process	28
5 Internal Protocol Stack Application Scenarios	30
5.1 Initializing Internet Services.....	30
5.1.1 Reference Process	30
5.1.2 Troubleshooting	30
5.2 Creating a Listen Server.....	31
5.2.1 Reference Process	31
5.2.2 Troubleshooting	32
5.3 Creating TCP/UDP Links.....	32
5.3.1 Reference Process	32
5.3.2 Troubleshooting	33
5.4 Sending Data	33
5.4.1 Reference Process	33
5.4.2 Troubleshooting	35
5.5 Closing TCP/UDP Links	35
5.5.1 Reference Process	35
5.5.2 Troubleshooting	36
5.6 Transparent Transmission Mode	36
5.6.1 Reference Process	36
5.6.2 Troubleshooting	38
5.7 Packet Statistics	38
5.7.1 Reference Process	38
5.8 TCP/UDP Link Change Indication	39
5.8.1 Reference Process	39
6 Text Message Application Scenarios	41
6.1 Pre-configuration (CPMS)	41
6.1.1 Reference Process	41
6.1.2 Troubleshooting	42
6.2 Sending English Text Messages in PDU Format.....	42
6.2.1 Reference Process	42



6.2.2 Troubleshooting	43
6.3 Sending Chinese Character Text Messages in Text Format	43
6.3.1 Reference Process	43
6.3.2 Troubleshooting	44
6.4 Receiving Text Messages.....	44
6.4.1 Reference Process	44
6.4.2 Troubleshooting	46
6.5 Segmenting and Reassembling Long Text Messages.....	46
6.5.1 Segmenting	46
6.5.2 Reassembling.....	47
7 Phonebook Application Scenarios.....	48
7.1 Memory Operations.....	48
7.1.1 Reference Process	48
7.1.2 Troubleshooting	48
7.2 Writing/Deleting Phonebook Entries.....	49
7.2.1 Reference Process	49
7.2.2 Troubleshooting	49
7.3 Reading Phonebook Entries.....	50
7.3.1 Reference Process	50
7.3.2 Troubleshooting	51
7.4 Searching for Phonebook Entries.....	52
7.4.1 Reference Process	52
7.4.2 Troubleshooting	52
7.5 Querying User Number	53
7.5.1 Reference Process	53
7.5.2 Troubleshooting	53
7.6 Setting the TE's Character Sets	53
7.6.1 Reference Process	53
7.6.2 Troubleshooting	54
8 SIM Operation Application Scenarios	55
8.1 PIN Operations.....	55
8.1.1 Reference Process	55
8.1.2 Troubleshooting	55
8.2 CRSM Command	56
8.2.1 Reference Process	56
8.2.2 Troubleshooting	58
9 Sleeping and Waking Up Application Scenarios	59
9.1 Hardware Interfaces.....	60
9.2 Sequence Diagram	61
9.3 Software Interfaces	62
9.3.1 Principle.....	62



9.3.2 USB and Sleep	63
9.3.3 UART and Sleep.....	64
9.3.4 Module Wake-up.....	64
9.3.5 Host Woken up by Module.....	64
9.4 Application Scenarios: System with USB Connection only	66
9.4.1 Hardware Connection	66
9.4.2 Software Procedure.....	66
9.4.3 Advantages.....	67
9.5 Application Scenarios: System with USB and WAKEUP_OUT.....	67
9.5.1 Hardware Connection	67
9.5.2 Software Procedure.....	67
9.5.3 Advantages.....	68
9.6 Application Scenarios: System with UART and WAKEUP_OUT	68
9.6.1 Hardware Connection	68
9.6.2 Software Procedure.....	68
9.6.3 Advantages.....	70
9.7 System with Other Connection Methods	70
10 Thermal Protection Application Scenarios	72
10.1 Pre-configuration.....	72
10.1.1 Troubleshooting	72
10.2 Thermal Protection Process	72
11 GPS Application Scenarios.....	74
11.1 Introduction to GPS	74
11.1.1 GPS Positioning Methods	74
11.1.2 GPS Ports	76
11.2 Standalone Positioning	77
11.3 MSB Positioning Using the User Plane Protocol	78
11.4 MSA Positioning Using the User Plane Protocol	79
11.5 XTRA Positioning.....	80
11.6 GNSS Positioning.....	81
12 Concurrent Service Application Scenarios.....	83
12.1 Internal/External Protocol Stacks and Text Messaging.....	83
12.2 Other Services	85
13 STK Application Scenarios.....	86
13.1 Unsolicited Report of STK Proactive Commands.....	86
13.1.1 Reference Process	86
13.1.2 Troubleshooting	87
13.2 Querying the STK Main Menu	88
13.2.1 Reference Process	88
13.2.2 Troubleshooting	89



13.3 STK Envelope Command.....	89
13.3.1 Reference Process	89
13.3.2 Troubleshooting	90
14 USSD Application Scenarios.....	91
14.1 USSD Initialize and Configuration	91
14.1.1 Reference Process	91
14.1.2 Troubleshooting	91
14.2 Send the USSD Command in non-Transparent Mode	92
14.2.1 Reference Process	92
14.2.2 Troubleshooting	93
14.3 Send the USSD Command in Transparent Mode.....	93
14.3.1 Reference Process	93
14.3.2 Troubleshooting	93
14.4 Network Initiated USSD Operation.....	94
14.4.1 Reference Process	94
14.4.2 Troubleshooting	94
15 Appendix	95
15.1 Relative Documents	95
15.2 Acronyms and Abbreviations	95



1 Overview

This document is intended to provide references for customers to choose appropriate command sequences to start using the MU609 in a faster manner. This document also contains examples and relevant description.

This document will be updated based on customers' requirements.

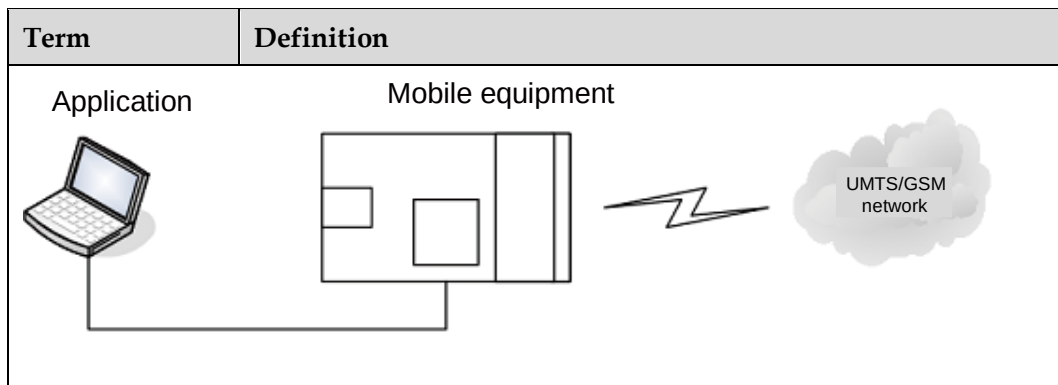
1.1 Conventions and Definitions

1.1.1 Conventions

Convention	Description
<...>	Value range of AT command parameters
XXXX	Personal Identification Number (PIN), Personal Unlock Key (PUK), or password

1.1.2 Definitions

Term	Definition
Connected	Indicates that a link has been set up between two modules or a module and a terminal.
Registered	Indicates that the module is registered with a UMTS/GSM network.
Module	HUAWEI UMTS/GSM/GPRS module



1.2 Organization of This Document

Chapter	Description
Chapter 1 Overview	Describes the contents and organization of this document
Chapter 2 Initialization Application Scenarios	Describes scenarios for initialization
Chapter 3 Serial Port Configuration Application Scenarios	Describes scenarios for serial port configuration
Chapter 4 External Protocol Stack Application Scenarios	Describes scenarios for external protocol stack
Chapter 5 Internal Protocol Stack Application Scenarios	Describes scenarios for internal protocol stack
Chapter 6 Text Message Application Scenarios	Describes scenarios for the text message
Chapter 7 Phonebook Application Scenarios	Describes scenarios for phonebook
Chapter 8 SIM Operation Application Scenarios	Describes scenarios for PIN management
Chapter 9 Sleeping and Waking Up Application Scenarios	Describes scenarios for power management
Chapter 10 Thermal Protection Application Scenarios	Describes scenarios for thermal protection
Chapter 11 GPS Application Scenarios	Describes scenarios for GPS
Chapter 12 Concurrent Service Application Scenarios	Describes scenarios for concurrent service of data service and text

Chapter	Description
Chapter13 STK Application Scenarios	Describes scenarios for STK
Chapter14 USSD Application Scenarios	Describes scenarios for USSD
Chapter15 Appendix	Appendix

1.3 Basic AT Command Processing Principles

1.3.1 Ports

The MU609 provides five ports to interact with its host:

- MODEM port: simulated using USB, for AT command interaction and establishing data connection.
Port name: HUAWEI Mobile Connect-3G Modem
- PCUI port: simulated using USB, for AT command interaction only.
Port name: HUAWEI Mobile Connect-3G PCUI Interface
- UART port: physical serial port, for AT command interaction and establishing data connection.
- NMEA port: simulated using USB, sending unsolicited indications for NMEA positioning data only.
Port name: HUAWEI Mobile Connect-3G GPS Interface.
- Control port: simulated using USB, for GPS AT command interaction only.
Port name: HUAWEI Mobile Connect-Control Interface.

The MU609 also provides a port for debugging:

- DIAG port: Simulated using USB, for DIAG (diagnostic) command interaction (mainly used to debug modules at present).
Port name: HUAWEI Mobile Connect-3G Application Interface

A host controls a module using AT commands. If AT commands are unavailable, a module can be deemed as unavailable.

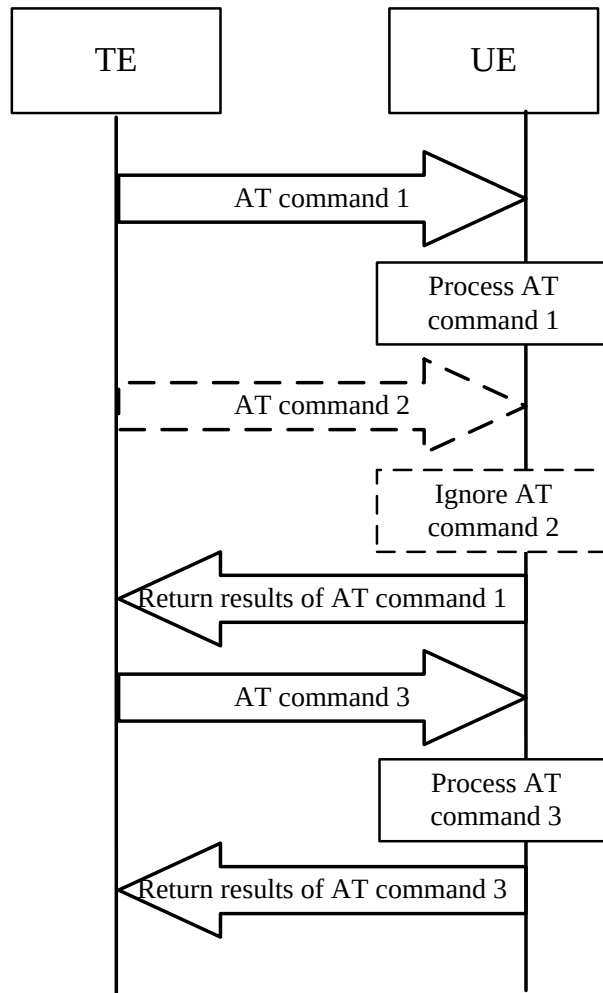
1.3.2 AT Command Processing Mechanism

A module processes AT commands from the ports (MODEM, PCUI, Control, and UART) in series. An AT command can be processed when and only when the previous AT command processing has been completed. If the module is processing an AT command, a new AT command from the same port will be ignored and other commands from other ports will be buffered until the current AT command is processed.

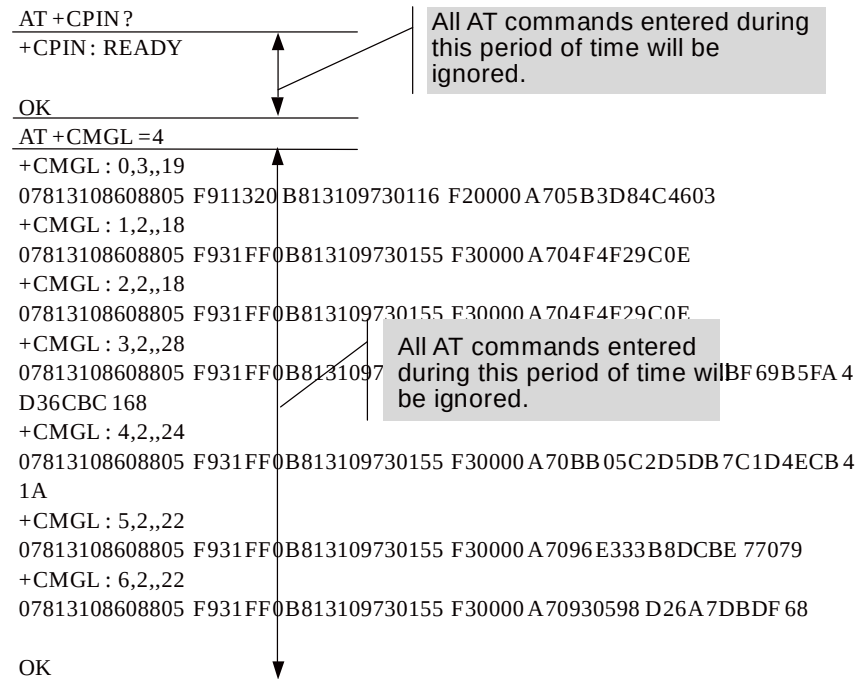
This rule also applies to COM ports converted from USB ports.

The processing of an AT command starts when the AT command is entered from the TE, and ends when the UE (the module) returns all the results in response the command.

Figure 1-1 AT command processing sequence diagram



Example:



Some special AT commands can be aborted by new AT commands. Such special commands are called abortive commands.

The MU609 supports the following abortive AT commands:

- The AT+COPS Set command
- AT+CLCK
- The IPINIT Execute command
- IPOPEN
- IPSEND
- IPSENDEX
- IPCLOSE

Example:

AT+COPS=1,2,23415
OK

Before the results of AT+COPS is returned, enter any characters (such as "AT"), the module will terminate the processing of AT+COPS and return **OK**. The entered characters are used to abort the command only.

Some commands can be executed when SIM card is inserted. It would return to SIM failure if SIM card is not inserted. For more information, see Property Description of related AT in [HUAWEI MU609 HSPA LGA Module AT Command Interface Specification](#).

Example:

AT+CREG?

+CME ERROR: SIM failure return to SIM failure if SIM card is not inserted

1.3.3 Recommended Timeout Mechanism for AT Commands Processed by a Host

A module processes AT commands in series. Do not send another AT command before the result for the current command is returned or the current command times out (except when the current command is an abortive AT command). The following table lists AT command timeout durations (starting from the time when an AT command arrives at a port).

Table 1-1 AT command timeout duration

AT Command	Timeout Duration
General AT commands	30s
AT+CMSS/AT+CMGS (used to send text messages)	60s
AT+COPS=? (used to search for networks)	120s

After an AT command times out, it is recommended that the host check whether the module is functioning normally. The following procedure is provided for your reference:

1. The host sends **AT** to the module.
2. If the module returns failure information, go to step 5.
3. If the module returns success information, the module is functioning normally.
4. If the host times out (the host waits for a response for over 30 seconds) three times when waiting for the response from the module, go to step 5. Otherwise go to step 1.



5. The host deems that the current module does not exist or is unavailable. Close the port, stop sending all AT commands, exit the procedure to determine whether the module is normal, and re-search for modules.

2 Initialization Application Scenarios

2.1 Startup Indication ^SYSSTART

2.1.1 Reference Process

Command	Description
	A module, without solicitation, presents ^SYSSTART to its host to indicate that the module is starting.
^SYSSTART	Indicates that a module is starting.

Notes:

- ^SYSSTART is presented only when a module is starting and will not be presented after a module has started.
- ^SYSSTART is presented only after the radio frequency (RF) initialization completes and will not be presented in offline mode.

2.1.2 Troubleshooting

Scenario	Possible Error Information	Solution
The module presents ^SYSSTART during startup. After that, the module presents ^SYSSTART again.	Indicates that the module has been reset.	If ^SYSSTART is presented repeatedly, send the module to the specified repair center.

2.2 Querying Basic Information

2.2.1 Reference Process

Command	Description
AT+GMR/CGMR	Queries software version
Software version	Software version. e.g. 11.103.03.00.00
OK	
AT+GMI/CGMI	Queries manufacturer identification
Manufacturer Identification	For example: Huawei Technologies Co., Ltd.
OK	
AT+GMM/CGMM	Queries model identification
Model identification	For example: MU609
OK	
AT+GSN/CGSN	Queries product IMEI
IMEI	For example: 865261010004010
OK	

Note:

The previously listed commands are Query commands and cannot be used to configure settings.

2.2.2 Troubleshooting

Scenario	Possible Error Information	Solution
AT+GSN/CGSN	+CME ERROR: memory failure	This error occurs when a module's IMEI is not specified. This problem is solved after the IMEI is written into the module.

2.3 Network Service Operations

2.3.1 Reference Process

Command	Description
AT+CFUN?	Queries a module's current mode. 1 indicates online mode.
+CFUN: 1	
OK	
AT+CPIN?	Queries whether a module's SIM card is password protected. READY indicates that the SIM card is ready.
+CPIN: READY	
OK	
AT+CSQ	Queries the network's signal strength.
+CSQ: 31,99	
OK	
AT+COPS?	Returns the current network selection mode, information about the operator with which the module is registered, and the wireless access standard.
+COPS: "Network status information"	For example: +COPS: 1,0, "China Mobile Com"
OK	
AT+COPS=0	Automatically searches for networks.
OK	
AT+CREG?	Queries the state of the currently registered network.
+CREG: 0,1	
OK	
AT+CREG=1	Sets the +CREG unsolicited indication.
OK	



2.3.2 Troubleshooting

Scenario	Possible Error Information	Solution
AT+COPS?	+CME ERROR: SIM failure	No SIM card is detected. Insert a SIM card.
AT+CREG?	+CME ERROR: SIM failure	No SIM card is detected. Insert a SIM card.

3

Serial Port Configuration Application Scenarios

3.1 Baud Rate Configuration

3.1.1 Reference Process

Command	Description
AT+IPR? +IPR: 115200 OK	Queries the baud rate currently used by a module.
AT+IPR="<baud rate>" OK	Sets a module's baud rate. After a new baud rate is specified, the module communicates using the new baud rate.

Notes:

- If a module's baud rate is too low, its communication speed will be slow.
- At present, the MU609 supports the following baud rates: 300, 600, 1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200, and 230400.

3.1.2 Troubleshooting

Scenario	Possible Error Information	Solution
Specify a baud rate not supported by a module.	AT+IPR="<baud rate>" ERROR	Check that the specified baud rate is within the range of supported baud rates.

3.2 DTR Hang Up Data Services

3.2.1 Reference Process

Command	Description
AT&D0	Establishes a dial-up connection through a serial port for data services. After this command is executed, data can be transferred properly.
OK	
AT&D2	This command is used to configure the action to be executed when DTR pin is high level or low level. Which is: After AT&D2 is executed, when DTR pin is high level, data will be transmitted normally; when DTR pin is low level, data transmission will be terminated.
OK	

Note:

At present, only **AT&D0** and **AT&D2** are supported. **AT&D1** is not supported.

3.2.2 Troubleshooting

Scenario	Possible Error Information	Solution
AT&D1	AT&D1 ERROR	At present, only AT&D0 and AT&D2 are supported. AT&D1 is not supported.

3.3 DCD Pin Control

3.3.1 Reference Process

Command	Description
AT&C0	Sets the DCD pin to be always valid regardless of data services.
OK	
AT&C1	Sets the DCD pin to be valid when there are ongoing data services and invalid after data services

are disconnected.

OK

3.3.2 Troubleshooting

Scenario	Possible Error Information	Solution
AT&C2	ERROR	Unsupported parameter value

3.4 Setting Hardware Flow Control

3.4.1 Reference Process

Command	Description
AT+IFC=0,0	Turns hardware flow control off. After hardware flow control is turned off, communication between the UE and the DTC is not restricted by flow control.
OK	
AT+IFC=2,2	Turns hardware flow control on. After hardware flow control is turned on, communication between the UE and the TE is restricted by flow control: Data transmission stops when UE's or TE's buffer level exceeds 80% and resumes when the buffer level is below 20%.
OK	

Note:

If hardware flow control is enabled, no AT commands can be executed.

3.4.2 Troubleshooting

None

4 External Protocol Stack Application Scenarios

4.1 Prerequisites

4.1.1 Reference Process

Command	Description
AT+CGDCONT=1,"IP","1234"	Configures PDP contexts. In this example provided in the left column, the APN is 1234 . In practice, the APN is provided by your network service provider.
OK	
AT+CGATT?	Obtains PS domain service status.
+CGATT: 1	If 1 is returned, attaching to the PS domain succeeded.
OK	If OK is returned, the command has been executed successfully

Note:

External protocol stack supports UART or MODEM ports only. After the pre-configuration is complete, ensure that the desired port is not occupied by other processes.

4.1.2 Troubleshooting

Scenario	Possible Error Information	Solution
AT+CGATT?	+CGATT: 0 OK The UE does not obtain any PS domain services.	Run AT+CGATT=1 to manually attach to the PS domain. If attaching to the PS domain still fails or time out (refer to 3GPP TS 24.008 4.7.3), refer to section 2.3 .

4.2 Establishing Data Connections

Reference process 1:

Command	Description
ATD*99#	*99# is the GPRS password. This command is usually used in Windows. The UE switches from command mode to data mode. After the TE starts the PPP negotiation process, the UE automatically performs the actions (including PS domain attaching and PDP activation) required for establishing data connections.
CONNECT xxx	CONNECT indicates that the data service dial-up command is being processed by the module. xxx indicates the data rate, which depends on the network standard and capability level.

Reference process 2:

Command	Description
AT+CGDATA="PPP",1	This command is equivalent to ATD*99# . This command is usually used in the Android Radio Interface Layer (RIL).
CONNECT	

Notes:

- Using the previously configured profile, the PPP negotiation between the TE and the UE, and the PDP negotiation between the UE and the network, the TE obtains the IP and DNS addresses to establish the routing between the TE and the network.
- When establishing data service connections, the TE must start the PPP negotiation after the UE enters data mode. Otherwise the UE will only enter data mode but will not establish data connections with the network.
- The data mode means: After entering data mode, the UE only transfers data packets between the UE and the network, and will not respond to any AT commands.

4.2.1 Troubleshooting

Scenario	Possible Error Information	Solution
Failure to open ports or register with a network	Error xxx: The modem (or other connected device) is in use. Note: xxx is usually a number indicating an error. For example, 633 .	1. Check whether the Modem port is in use. Ensure that the Modem port is not being used by other connections. 2. Check that the current network is operating normally. Data service connections can be established only when the network is operating normally.

4.3 Data Transmission

1. Data can be transmitted after data service connections are established.
2. According to 3GPP25.306, HSDPA (FDD) terminals are classified into 24 categories. Different categories have different peak data rates. The following table lists common categories and their key parameters.

Common Terminal Category	Maximum Number of Codewords	Soft Channel Size (Bits)	Minimum Transmission Time Interval (TTI)	Modulation Mode	Theoretical Peak Rate (Mbit/s)
Category 8	10	134400	1	QPSK 16QAM	7.2
Category 10	15	172800	1	QPSK 16QAM	14.4
Category 14	15	259200	1	QPSK 16QAM 64QAM	21.6

Common Terminal Category	Maximum Number of Codewords	Soft Channel Size (Bits)	Minimum Transmission Time Interval (TTI)	Modulation Mode	Theoretical Peak Rate (Mbit/s)
Category 16	15	345600	1	QPSK 16QAM MIMO+16QAM Note: 64QAM is not supported.	28.8
Category 18	15	345600	1	QPSK 16QAM 64QAM MIMO+16QAM	28.8
Category 20	15	518400	1	QPSK 16QAM 64QAM MIMO+16QAM MIMO+64QAM	43.2
Category 24	15	518400	1	QPSK 16QAM 64QAM DC	43.2

HSUPA (FDD) terminals are classified into seven categories. The following table lists common categories and their key parameters.

Common Terminal Category	Maximum Number of E-DCH	Minimum SF	Support 2 ms TTI	Modulation Mode	Theoretical Peak Rate (Mbit/s)
category 5	2	SF2	No	QPSK	2
category 6	4	SF2	Yes	QPSK	5.76

- According to the Radio Resource Control (RRC) version, the WCDMA/HSDPA/HSUPA/HSPA/DC_HSPA rate in theory are as follows:

WCDMA RRC Version	Modulation Mode		Theoretical Peak Rate (Mbit/s)	
	Downlink	Uplink	Downlink	Uplink
3GPP Rel				
R99/R4	QPSK	BPSK	0.384	0.384
Rel-5	16QAM+	QPSK	14.4	0.38
Rel-6	16QAM	QPSK	14.4	5.76
Rel-7	16QAM	16QAM	28.8	11.52
	64QAM	16QAM	21.6	11.52
Rel-8	64QAM	16QAM	43.2	11.52
	DC-SHDP+64QAM	16QAM	43.2	11.52
Rel-9	DC-SHDP+64QAM	DC-SHUPA	84	23

4.4 Switch Between Data Mode and Command Mode

4.4.1 Reference Process

Command	Description
ATD*99#	UE dials up.
CONNECT	
+++	Enters +++ (three plus signs) to switch the data service port from data mode to command mode. The UE can then respond to AT commands and perform corresponding actions.
ATO	Switches the data service port back to data mode so that the UE can continue to transmit data.
CONNECT	

Notes:

- If there are no data links available, the module will not switch back to data mode but remains in command mode.
- If the data link is connected, when the module switches from data mode to command mode, data transmission will be suspended.
- If the data link is connected, when the module switches from command mode to data mode, data transmission will be resumed.
- Switching between data mode and command mode applies to UART ports only.

4.4.2 Troubleshooting

Scenario	Possible Error Information	Solution
+++	Failed to switch to command mode.	+++ must be consecutively entered within 0.9s.

4.5 Disconnecting Data Service Connections

4.5.1 Reference Process

Process 1:

Command	Description
+++	
ATH	Before this command is executed at the data service port, the +++ sequence must be sent from the data service port. This command is used to disconnect data service connections. This command is usually used in Windows.
OK	

Process 2:

Command	Description
AT+CGACT=0	In Android RIL, after a PPP connection is disconnected, this command is executed to deactivate the PDP context to release the data link and disconnect the data services. The use of this command is the same as that of ATH.
OK	

1. Terminating a data service connection from the TE: the TE sends a PPP Terminate packet to the UE to pull down the DTR signal. The UE disconnects the PPP connection, releases the wireless link resource, pulls down the CD signal, and returns **NO CARRIER**. As a result, the data service connection is



disconnected. This method of disconnecting data service connections is usually implemented by the disconnection function of the TE's application.

2. Terminating a data service connection from the UE: The TE sends an AT command to the UE to pull down the DTR signal. After receiving the AT command, the UE releases the connection to the network, pulls down the CD signal, and returns **NO CARRIER**. As a result, the data service connection is disconnected. This mode of disconnecting data service connections requires an AT command interaction tool.
3. When disconnecting data service connections in Android RIL, the module must kill pppd to disconnect PPP connections before using **AT+CGACT=0** to deactivate PDP contexts and release wireless link resources.

5 Internal Protocol Stack Application Scenarios

5.1 Initializing Internet Services

5.1.1 Reference Process

Command	Description
AT^IPINIT="1234","card","card"	In this example provided in the left column, the APN is 1234 , and the user name and password are both card .
OK	
AT^IPINIT?	Queries the obtained IP and DNS addresses.
^IPINIT: 1, "192.168.70.59","1234","172.22.44.200", "172.22.44.201"	
OK	

Note:

Internal protocol stack supports UART ports only.

5.1.2 Troubleshooting

Scenario	Possible Error Information	Solution
AT^IPINIT?	^IPINIT: 0 OK	Initialization has not been performed. Initialize the internal protocol stack and query again.

Scenario	Possible Error Information	Solution
AT^IPINIT="1234","card","card"	+CME ERROR: Normal error	Initialization failed. 1. Check that the current network signal strength is good and the parameters are set correctly. 2. Ensure that no IP stack termination command has been executed.
AT^IPINIT="1234","card","card"	+CME ERROR: The link has been established already	AT^IPINIT? queries whether the internal protocol stack has been initialized. If the internal protocol stack has been initialized, it does not need to be initialized again. If it has not been initialized, there are ongoing dial-up services. Hang up the dial-up services and re-send ^IPINIT to start initialization.

5.2 Creating a Listen Server

5.2.1 Reference Process

Command	Description
AT^IPINIT="1234","card","card"	Initializes the internal protocol stack.
OK	
AT^IPLISTEN="TCP",5000	Creates a TCP server whose listen port number is 5000 (users can specify this number as required). For the method to create UDP servers, refer to the AT command document.
OK	
AT^IPLISTEN?	Queries the information about the server that has been created.
^IPLISTEN: "TCP",5000,5	
OK	

Notes:

- Only one server is supported by the internal protocol stack.
- The internal protocol stack must be initialized before you create a listen server.

5.2.2 Troubleshooting

Scenario	Possible Error Information	Solution
AT^IPLISTEN="TCP",5000	+CME ERROR: The network has not been opened yet	Run ^IPINIT to initialize the internal protocol stack, and then create the listen server.
AT^IPLISTEN="UDP",5000	+CME ERROR: The server has been established already	A listen server already exists. Run AT^IPCLOSE=6 to close the existing listen server.
AT^IPLISTEN="UDP",5000	+CME ERROR: Fail to bind the specified port with server	The local port is in use. Change the port and re-send the command.

5.3 Creating TCP/UDP Links

5.3.1 Reference Process

Command	Description
AT^IPINIT="1234","card","card" OK	Initializes the internal protocol stack.
AT^IPOPEN=1,"TCP","172.22.44.33",5000,5500 OK	Uses a specified IP address to connect to the remote server and establish a TCP link. For the method to create UDP links link, refer to the AT command document.
AT^IPOPEN=2,"TCP","www.huawei.com",80 OK	Uses a specified domain name to connect to the remote server and establish a TCP link.
AT^IPOPEN? ^IPOPEN: 1,"TCP",5500,"172.22.44.33",5000,3,0 OK ^IPOPEN: 2,"TCP",5600,"172.22.44.33",80,3,0	Queries link information.

OK

Notes:

- When creating a listen server, the local port number can be ignored. If the port number is ignored, the module will randomly assign a local port number.
- When creating a TCP link, ensure that the remote server has been started.
- The maximum segment size (MSS) for creating TCP links is 1220 bytes. Data larger than the MSS will be segmented into several packets.

5.3.2 Troubleshooting

Scenario	Possible Error Information	Solution
AT^IPOPEN=1,"TCP", "172.22.44.33",5000	+CME ERROR: The network has not been opened yet	Initialize the internal protocol stack before sending the command to create the link.
AT^IPOPEN=1,"TCP", "172.22.44.33",5000	+CME ERROR: The link has been established already	Run ^IPCLOSE to close the corresponding link. Alternatively, change the link ID and send the command to create the link.
AT^IPOPEN=1,"TCP", "172.22.44.33",5000, 5000	+CME ERROR: Fail to bind the specified port	Change the local port number, or leave the local port number blank.
AT^IPOPEN?	OK	No link information is available. Create a link, or accept the link as a server, and then query the link information again.

5.4 Sending Data

5.4.1 Reference Process

Command	Description
AT^IPINIT="1234", "card", "card"	Initializes the internal protocol stack.
OK	
AT^IPOPEN=1,"TCP", "172.22.44.33",5000,5500	Creates a link.
OK	

AT^IPSEND=1,"31323334"	Sends data. In this example, 31323334 is sent.
^IPSEND: 1	Data is successfully sent and received.
OK	
^IPDATA: 1,8,31323334	
AT^IPSENDEX=1,0,"31323334"	Sends data in mode 0. In this example, 31323334 is sent.
^IPSENDEX: 1	
OK	
^IPDATA: 1,8,31323334	
AT^IPSENDEX=1,1,"31323334"	Sends data in mode 1. In this example, 1234 is actually sent.
^IPSENDEX: 1	
OK	
^IPDATA: 1,4,1234	
AT^IPSENDEX=1,2,<datalen>	Sends data in mode 2.
OK	
(Wait for the user to enter user data with a length of <datalen>)	
^IPSENDEX: 1	
OK	

Notes:

- **IPSEND** and mode 0 of **IPSENDEX** can send displayable characters only. Mode 1 and mode 2 of **IPSENDEX** can send all characters.
- In Mode 2 of **IPSENDEX** (length restriction mode), except the port that receives data entered by the user, all other ports are unavailable before the user finishes entering the user data.

5.4.2 Troubleshooting

Scenario	Possible Error Information	Solution
AT^IPSEND=1,"data"	+CME ERROR: The network has not been opened yet	Before sending data, initialize the protocol stack or accept the link as a server.
AT^IPSEND=1,"data"	+CME ERROR: Remain data is sending	The module is exiting transparent transmission mode and cannot send data. Wait until the module completely exits transparent transmission mode.
AT^IPSEND=1,"data"	+CME ERROR: The link has not been established yet	Before sending data, create a link or accept the link as a server.
AT^IPSEND=1,"data"	+CME ERROR: Normal error	The module failed to send the data. Ensure that the current network's signal strength is good.
AT^IPSENDEX=1,2,<data length>	+CME ERROR: Too many data to be sent	The length of the data entered by the user exceeds the length specified by the command. Ensure that the length of the data is equal to the data length specified by mode 2 of IPSENDEX .

5.5 Closing TCP/UDP Links

5.5.1 Reference Process

Command	Description
AT^IPCLOSE=<link_id>	Closes the specified link, server, or network, and at the same time release the corresponding resources. For details about the parameters, refer to the related AT command document.
OK	
AT^IPCLOSE?	Queries the current link status. 1 indicates that the link is open, and 0 indicates that the link is closed.
^IPCLOSE: 1,0,0,0,0	

OK

5.5.2 Troubleshooting

Scenario	Possible Error Information	Solution
AT^IPCLOSE= <link_id>	+CME ERROR: Normal error	The command is terminated. Run the ^IPCLOSE command again.

5.6 Transparent Transmission Mode

5.6.1 Reference Process

Command	Description
AT^IPINIT="1234","card","card"	Initializes the internal protocol stack.
OK	
AT^IPOPEN=1,"UDP","172.22.44.33",5000,5500	Creates a link.
OK	
AT^IPCFL=12,0	Sets the transparent transmission mode to time- and length-based transmission mode.
OK	
AT^IPCFL=5,100	Sets the timer for triggering transparent transmission to 10s (100 x 0.1s).
OK	
AT^IPCFL=10,1220	Sets the TCP/UDP MSS to 1220 bytes.
OK	
AT^IPENTRANS=1	Enables transparent transmission mode.
OK	
313233347D5D7D5E7E	Sends user data. User data is sent once the data length reaches the segment length specified by parameter 10 of IPCFL . If the user data length is shorter than the specified length, the data will be sent when the timer set by parameter 5 of IPCFL counts down to 0. For details about the transmission mechanism,

	refer to the description of ^IPENTRANS in the AT command document. In this example, the data entered by the user is 313233347D5D7D5E7E in hexadecimal format. The data sent by the module is the original data entered by the user.
313233347D5D7D5E7E	Receives user data in time- and length-based transmission mode. In this example, the data received by the module is 313233347D5D7D5E7E. The original data received by the module is presented.
+++	Exits transparent transmission mode. For the rules about the +++ sequence, refer to the AT command document.
OK	
AT^IPCFL=12,1	Sets the transparent transmission mode to 7E detection mode.
OK	
AT^IPENTRANS=1	Enables transparent transmission mode.
OK	
AT^IPENTRANS?	Queries the link ID for entering transparent transmission mode from a non-transparent port.
^IPENTRANS: 1	
313233347D5D7D5E7E	Sends data in 7E detection mode (applies to UDP only). In this example, the data that the user wants to send is 313233347D7E in hexadecimal format. Therefore, the user needs to transform 7D to 7D5D and 7E to 7D5E, and adds 7E as the ending characters to the end of the data. After the module recognizes the data packet, the data actually sent by the module is 313233347D7E.
313233347D5D7D5E7E	Receives data in 7E detection mode (applies to UDP only). The data received by the module is 313233347D7E in hexadecimal format. After receiving the data, the module transforms 7D to 7D5D and 7E to 7D5E, and adds 7E as the ending characters to the end of the data before presenting the data to the user.

Notes:

- The transparent transmission mode of the internal protocol stack supports UART only.
- The internal protocol stack allows only one link to enter transparent transmission mode. In addition, before entering transparent transmission mode, ensure that only one link exists at the current physical port. If the module functions as a server, the link can enter transparent transmission mode only when the link is requested by a remote client and accepted by the server.
- The settings (including the time- and length-based transmission mode and 7E detection mode) of transparent transmission mode must be configured using **^IPCFL** before the transparent transmission mode is enabled. For details about how to configure the settings, refer to the AT command document.

5.6.2 Troubleshooting

Scenario	Possible Error Information	Solution
AT^IPENTRANS=1	+CME ERROR: Invalid port for transparent mode	This indicates that the link is not established at a UART port. To solve this problem, establish a link from a UART port and set the UART port to enter transparent transmission mode.
AT^IPENTRANS=1	+CME ERROR: More than one link in physical port	There are more than one link. Use ^IPCLOSE to close other links before entering transparent transmission mode.
AT^IPENTRANS=1	+CME ERROR: The physical port is in listen state and has no client	The module functions as the server but does not accept the link requested by the client. Accept the link before entering transparent transmission mode.
AT^IPCFL=5,10	+CME ERROR: Forbidden operation in transparent mode	IPCFL cannot be used during transparent transmission. Exit transparent transmission mode before running IPCFL .

5.7 Packet Statistics

5.7.1 Reference Process

Command	Description
AT^IPFLOWQ?	Queries packet statistics. In this example, the returned result indicates that 3 bytes of

	characters are successfully received by and sent from link 1. For details about the parameters. Refer to the AT command document.
^IPFLOWQ: 1,3,3,3,3,3 ^IPFLOWQ: 2,0,0,0,0,0 ^IPFLOWQ: 3,0,0,0,0,0 ^IPFLOWQ: 4,0,0,0,0,0 ^IPFLOWQ: 5,0,0,0,0,0	
OK	
AT^IPFLOWQ=<linkid>	Clears the traffic statistics on the specified link (link ID 1–5).
OK	
AT^IPFLOWQ=0	Clears the traffic statistics on all links.
OK	

5.8 TCP/UDP Link Change Indication

5.8.1 Reference Process

Command	Description
AT^IPINIT="1234","card","card"	Initializes the internal protocol stack.
OK	
AT^IPLISTEN="TCP",5000	Creates a server.
OK (The client requests to connect to the server.)	The server accepts the link requested by the client.
^IPSTATE: 1,1,1	
(The other party of the link closest the link.)	
^IPSTATE: 1,0,0	
(Network connection is broken.)	
^IPSTATE: 1,0,2	Indications presented without solicitation for broken links, connection to the server, and network connections.
^IPSTATE: 6,0,2	



^IPSTATE: 7,0,2

The number of current links has reached the supported maximum. New link requests will be rejected.

^IPSTATE: 0,0,3

The module rejects new link requests because it functions as the server and is in transparent transmission mode.

^IPSTATE: 0,0,4

6

Text Message Application Scenarios

6.1 Pre-configuration (CPMS)

6.1.1 Reference Process

Command	Description
AT+CPMS=?	Queries the types of supported storage.
+CPMS: ("ME","SM"),("ME","SM"),("ME","SM")	
OK	
AT+CPMS="SM","SM","SM"	For details about the parameters, refer to the HUAWEI MU609 HSPA LGA Module AT Command Interface Specification . It is recommended that you keep the three types of storage consistent.
+CPMS: 3,40,3,40,3,40	
OK	
AT+CPMS?	Queries the current storage type, used storage space and maximum storage capacity.
+CPMS: "SM",3,40,"SM",3,40,"SM",3,40	
OK	

6.1.2 Troubleshooting

Scenario	Possible Error Information	Solution
Error information is returned in response to one of the previous commands.	+CME ERROR: SIM PIN required	Enter the correct PIN.
	+CMS ERROR: 500	SIM card initialization has not completed. Try again later.
	ERROR	Unsupported storage.

6.2 Sending English Text Messages in PDU Format

6.2.1 Reference Process

Command	Description
AT+CMGF=0	Sets the message format to PDU format (see the note).
OK	
AT+CMGS=21 >0891683108608805F911000B81310973 0137F10000FF07EDF27C1E3E9701 \0x1A	Sends a text message using PDU of 21 bytes in length (excluding the service center number 0891683108608805F9). The message content is "message". Press ctrl+z (0x1A) to stop entering message content and send the message.
+CMGS: 4	The message is successfully sent. <TP-MR> is returned. For details about <TP-MR>, refer to the 3GPP TS 23040.
OK	
AT+CMGS=10 >0891683108608805F911000B81310973 0137F10008FF0677ED6D88606F \0x1A	Sends a text message using PDU of 20 bytes in length (excluding the service center number 0891683108608805F9). The message content is "短消息". Press ctrl+z (0x1A) to stop entering message content and send the message.
+CMGS: 5	The message is successfully sent.
OK	

Note:

For details about the structure of a PDU packet, refer to the 3GPP TS 23040.

6.2.2 Troubleshooting

Scenario	Possible Error Information	Solution
Error information is returned in response to one of the previous commands.	+CMS ERROR: 500	The text message cannot be sent because of network errors, incorrect service center number, or other errors. Resend the message.
	+CMS ERROR: 304	Incorrect PDU packet content.

6.3 Sending Chinese Character Text Messages in Text Format

6.3.1 Reference Process

Command	Description
AT+CMGF=1 OK	Sets the message format to Text format.
AT+CSMP=,,0,8 OK	Sets the data coding scheme to UCS-2.
AT+CSCA="8613800688509",145 OK	Sets the service center number.
AT+CSCS="UCS2" OK	Sets the TE's character set to UCS-2 encoding.
AT+CMGS="00310033003300310032003300340035003600370038"> 534E4E3A 0x1A	Sends the message to the destination address "13312345678" that must be enclosed in double quotation marks. The message content is the UCS-2 codes for the Chinese characters "华为". Press ctrl+z (0x1A) to stop entering message content and send the message.

+CMGS: 6	The message is successfully sent.
OK	
AT+CSMP=,,0,0	Sets the data coding scheme to GSM 7bit
OK	
AT+CSCS="GSM"	Sets the TE's character set to GSM 7bit encoding.
OK	
AT+CMGS="13312345678" >huawei \0x1A	Sends the message to the destination address "13312345678" that must be enclosed in double quotation marks. The message content is the UCS-2 codes for the Chinese characters "华为". Press ctrl+z (0x1A) to stop entering message content and send the message.
+CMGS: 7	The message is successfully sent.
OK	

6.3.2 Troubleshooting

Scenario	Possible Error Information	Solution
Error information is returned in response to one of the previous commands.	+CMS ERROR: 305	The message content does not comply with the encoding scheme specified by +CSMP .

6.4 Receiving Text Messages

6.4.1 Reference Process

Command	Description
AT+CNMI=2,1,0,0,0	Stores the message on the SIM card or ME, and presents the new message indication.
OK	Presents the storage and location

+CMTI: "SM",4	without solicitation.
AT+CNMI=1,2,0,0,0	Receives and directly presents the message instead of storing it.
OK +CMT: " +8613312345678",,"12/05/05,18:10:36 +00" huawei ^SMMEMFULL: "SM"	Directly presents the message instead of storing it. In this example, the message is in Text mode. In PDU mode, PDU packets are presented.
	Presents an indication, without solicitation, when the message storage is full.
AT+CMGR=4	Reads the message stored in index 4.
+CMGR: "REC UNREAD", "+8613312345678",,"12/05/17,16:13:08+00" huawei	
OK	
AT+CMGL="ALL"	In Text mode, lists all the messages in the current storage.
+CMGL: 2,"REC READ", "+8613903710742",,"12/05/17,16:12:30+00" test1 +CMGL: 3,"REC READ", "+8613903710742",,"12/05/17,16:13:08+00" test2	
OK	
AT+CMGL=0	In PDU mode, lists all the received unread messages.
+CMGL: 1,0,,25 0891683108608805F9040D9168310973 0147F200002150716172350005F4F29C 4E03	
OK	
AT+CMGD=1	Deletes the message stored in index 1.
OK	
AT+CMGD=1,4	Deletes all the messages in the

current storage.

OK

6.4.2 Troubleshooting

Scenario	Possible Error Information	Solution
Error information is returned in response to one of the previous commands.	ERROR	In Text mode, run AT+CMGL=4 (number), or in PDU mode, run AT+CMGL="ALL" (string), and ERROR is returned.
	+CMS ERROR: 500	During SIM card initialization, run AT+CMGL or AT+CMGD to read or delete a message, and an error is returned.

6.5 Segmenting and Reassembling Long Text Messages

6.5.1 Segmenting

In PDU mode, text messages can be encoded using GSM 7-bit, 8-bit or UCS-2. The GSM 7-bit encoding scheme is used to encode common ASCII characters, compressing every 8 characters into 7 characters. The 8-bit encoding scheme is usually used to encode data such as pictures and ringtones. The UCS-2 encoding scheme is used to encode Unicode characters. According to the existing 3GPP protocols, the size of the user data contained a PDU is 140 bytes. Therefore, the maximum number of characters contained in a single message is 160, 140 and 70 for the GSM 7-bit, 8-bit, and UCS-2 encoding schemes respectively. If the number of characters contained in a text message exceeds the maximum number, the message will be segmented into several messages. An English letter, a Chinese character, or a byte of data is considered as a character.

According to the existing 3GPP protocols, after a long text message is segmented, the number of characters that each message segment can contain is as follows:

- GSM 7-bit encoding: 153 characters
- 8-bit encoding: 134 characters
- UCS-2 encoding: 67 characters

The number of available characters per segment is lower, because each segment must contain segmentation information.

The storage space occupied by a character is as follows:

- GSM 7-bit encoding: 7 bits

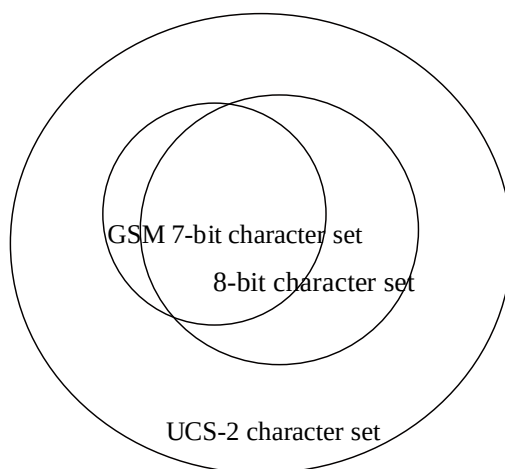
- 8-bit encoding: 8 bits
- UCS-2 encoding: 16 bits

The storage space occupied by a segment of a long text message is as follows:

- GSM 7-bit encoding: $153 \text{ bits} \times 7 = 1071 \text{ bits}$
- 8-bit encoding: $134 \text{ bits} \times 8 = 1072 \text{ bits}$
- UCS-2 encoding: $67 \text{ bits} \times 16 = 1072 \text{ bits}$

For all the three encoding schemes, a short message occupies a maximum of 1120 bits (160×7 , 140×8 , or 70×16) in the storage. If a text message's size is larger than 1120 bits, the message is a long message.

Figure 6-1 Relationships between character sets



Relationships between character sets

6.5.2 Reassembling

The host applications can reassemble the segments of a long text based on the following:

- The protocol header in the user data (TP-UD) of a PDU (see the *3GPP 23.040 9.2.3.24.1*)
- The sender's number contained in each segment
- The interval between the time when each segment is received (The interval between the two neighboring segments' receiving time is less than 60 seconds, and the maximum interval between the first and the last segments' receiving time is 24 hours)

7 Phonebook Application Scenarios

7.1 Memory Operations

7.1.1 Reference Process

Command	Description
AT+CPBS=? +CPBS: ("SM","EN","ON") OK	Queries the current storage type.
AT+CPBS="SM" OK	Sets the current storage type to "SM".
AT+CPBS? +CPBS: "SM",241,250 OK	241 indicates that 241 entries have been stored in the storage. 250 indicates that the maximum storage capacity of the current storage ("SM") is 250 entries.

7.1.2 Troubleshooting

Scenario	Possible Error Information	Solution
Error information is returned in response to one of the previous	+CME ERROR: SIM busy	Phonebook initialization has not completed. Try again later.

Scenario	Possible Error Information	Solution
commands.	+CME ERROR: SIM PIN required	Enter the correct PIN.
	+CME ERROR: SIM PUK required	Enter the correct PUK.

7.2 Writing/Deleting Phonebook Entries

7.2.1 Reference Process

Command	Description
AT^CPBW=1,"1234567890",129,"HUAWEI",0 OK	Writes an entry in GSM 7-bit format into index 1 in the phonebook.
AT^CPBW=1,"1234567890",129,"80534E4E3A",1 OK	Writes an entry in raw data format into index 1 in the phonebook.
AT^CPBW="12345678901234567890123",128,"80534E4E3A",1 OK	Writes an entry into the first empty location in the phonebook.
AT^CPBW=1 OK	Deletes the entry in index 1 in the phonebook.

7.2.2 Troubleshooting

Scenario	Possible Error Information	Solution
Error information is returned in response to one of the previous commands.	+CME ERROR: SIM busy	Phonebook initialization has not completed. Try again later.
	+CME ERROR: SIM PIN required	Enter the correct PIN.
	+CME ERROR: SIM PUK required	Enter the correct PUK.

Scenario	Possible Error Information	Solution
Error information is returned when writing an entry into the phonebook.	+CME ERROR: dial string too long	Check that the phone number is not too long.
Error information is returned in response to one of the previous commands.	+CME ERROR: invalid index	Check that the location index and phone number type are valid.
Error information is returned when writing an entry into the phonebook.	+CME ERROR: invalid characters in dial string	The phone number to be written into the phonebook contains invalid characters. Delete the invalid characters and try again.
AT^CPBW="12345678901234567890123",128,"80534E4E3A",1	+CME ERROR: memory full	The storage is full. Delete some entries and try again.

7.3 Reading Phonebook Entries

7.3.1 Reference Process

Command	Description
AT^CPBR=<index1>	Reads the entry stored in index 1 in the phonebook memory.
OK	
AT^CPBR=<index1>,<index2>	Reads all entries stored in locations between index 1 and index 2 (including index 1 and index 2).
^CPBR: <index1>,<number>,<type>,<text>,<coding> >	
^CPBR: <index>,<number>,<type>,<text>,<coding>	
.....	
^CPBR: <index2>,<number>,<type>,<text>,<coding> >	
OK	

AT^CPBR=?

Queries the index range of storage locations in the phonebook, the maximum length (<nlength>) of a phone number, and the maximum length (<tlength>) of a name.

(list of supported<index>s,<nlength>,<tlength>)

OK

7.3.2 Troubleshooting

Scenario	Possible Error Information	Solution
Error information is returned in response to one of the previous commands.	+CME ERROR: SIM busy	Phonebook initialization has not completed. Try again later.
	+CME ERROR: SIM PIN required	Enter the correct PIN.
	+CME ERROR: SIM PUK required	Enter the correct PUK.
AT^CPBR=<index1>	+CME ERROR: invalid index	The index is invalid. Check that index 1 is within the supported range
AT^CPBR=<index1>,<index2>	+CME ERROR: invalid index	The index is invalid. Check that index 1 and index 2 are within the supported range and that index 1 is not greater than index 2.
AT^CPBR=<index1>	+CME ERROR: not found	No entries are found in the storage locations in index 1. Check that there have been entries successfully written into these locations.
AT^CPBR=<index1>,<index2>	+CME ERROR: not found	No entries are found in the storage locations between index 1 and index 2. Check that there have been entries successfully written into these locations.

7.4 Searching for Phonebook Entries

7.4.1 Reference Process

Command	Description
AT+CPBF=<findtext> +CBPF: <index1>,<number>,<type>,<text> +CBPF: <index2>,<number>,<type>,<text> ... OK	Searches the current storage for phonebook entries that contain the <findtext> field.
AT+CPBF=? +CPBF: <nlength>,<tlength> OK	Returns the maximum phone number length and maximum name length supported by the current phonebook storage.

7.4.2 Troubleshooting

Scenario	Possible Error Information	Solution
Error information is returned in response to one of the previous commands.	+CME ERROR: SIM busy	Phonebook initialization has not completed. Try again later.
	+CME ERROR: SIM PIN required	Enter the correct PIN.
	+CME ERROR: SIM PUK required	Enter the correct PUK.
AT+CPBF=<findtext>	+CME ERROR: not found	No matches were found. Check whether the current phonebook storage has entries that match the search criterion.

7.5 Querying User Number

7.5.1 Reference Process

Command	Description
AT+CNUM	Queries the SIM number.
+CNUM: [<alpha1>,<number1>,<type1> +CNUM: [<alpha2>,<number2>,<type2> ...	
OK	

7.5.2 Troubleshooting

Scenario	Possible Error Information	Solution
Error information is returned in response to one of the previous commands.	+CME ERROR: SIM busy	Phonebook initialization has not completed. Try again later.
	+CME ERROR: SIM PIN required	Enter the correct PIN.
	+CME ERROR: SIM PUK required	Enter the correct PUK.

7.6 Setting the TE's Character Sets

7.6.1 Reference Process

Command	Description
AT+CSCS=?	Queries the character sets supported by the UE.
+CSCS: ("IRA","GSM","UCS2") OK	
AT+CSCS?	Queries the current character set.
+CSCS: "IRA"	

OK

AT+CPBR=1

Reads the first phonebook entry. The TE character set is the International Reference Alphabet (IRA). The content of the first entry's name field is "HUAWEI".

+CPBR: 1,"0123456789",129,"HUAWEI"

OK

AT+CSCS="UCS2"

Sets the TE's character set to UCS-2 alphabet.

OK

AT+CPBW=1,"0123456789",129,"004800550041005700450049"

The character set is the UCS-2 alphabet. The content of the phonebook entry's name field is 004800550041005700450049, which is "HUAWEI" in the IRA.

OK

AT+CPBR=1

Reads the first phonebook entry. The TE character set is UCS-2 alphabet. The content of the first entry's name field is 004800550041005700450049 ("HUAWEI" in the IRA).

**+CPBR:
1,"0123456789",129,"004800550041005700450049"**

OK

7.6.2 Troubleshooting

None

8

SIM Operation Application Scenarios

8.1 PIN Operations

8.1.1 Reference Process

Command	Description
AT+CLCK="SC",1,"<pwd>"	Enables PIN authentication. (<pwd> specifies the PIN. See note 1.)
OK	
AT+CPIN="<pwd>"	Requests the PIN after the module restarts.
OK	
AT+CPWD="SC", "<oldpwd>", "<newpwd>"	Changes the PIN (<newpwd> will be the new PIN).
OK	

Notes:

- After PIN authentication is enabled using **+CLCK**, the module must be restarted for the change to take effect.
- Either **^CPIN** or **+CPIN** can be used to authenticate the PIN.

8.1.2 Troubleshooting

Scenario	Possible Error Information	Solution
AT+CLCK="SC",1,"<pwd>"	+CME ERROR: operation not allowed	If PIN authentication has been enabled, it cannot be enabled again. Check whether PIN authentication has been enabled.

Scenario	Possible Error Information	Solution
AT+CPIN="<pwd>"	+CME ERROR: incorrect password	Enter the correct PIN. The original PIN is provided by the operator.
	+CME ERROR: SIM PUK required	Incorrect PINs have been entered three times and the SIM card is blocked. Run AT+CPIN="<PUK>","<pwd>" to enter the PUK to unblock the SIM card. The PUK is provided by the operator and cannot be changed by users. If incorrect PUKs are entered 10 times, the SIM card will be permanently blocked.
AT+CPWD="SC","<oldpwd>","<newpwd>"	+CME ERROR: incorrect password	<oldpwd> must be the current PIN. Like the PIN authentication, if incorrect PINs are entered three times, the PUK will be required. If incorrect PUKs are entered 10 times, the SIM card will be permanently blocked.

8.2 CRSM Command

8.2.1 Reference Process

Command	Description
AT+CRSM=176,12258,0,0,10	Reads the file EFiccid with a transparent structure. (12258 is 0X2FE2, the EFiccid file's FID).
+CRSM: 144,0,"<record>"	After the command is processed successfully, the EFiccid file's content (<record>) is returned.
OK	
AT+CRSM=178,28476,1,4,176,,"7F10"	Uses an absolute path to read the first entry from the EFsms file on the SIM card's DFtelecom folder.
+CRSM: 144,0,"<record>"	<record> is the content of the first entry. The length of <record> is 176 bytes.
OK	
AT+CRSM=192,12258	Gets response of EFiccid.

+CRSM: 144,0,"<response> "	<response> is the response data of EFiccid. For details about <response>, refer to the <i>ETSI TS102221</i> protocol.
OK	
AT+CRSM=214,28421,0,0,2,"0012"	Updates the content of the transparent structure EFli file on the SIM card.
+CRSM: 144,0,""	Update succeeded.
OK	
AT+CRSM=220,28476,1,4,176,"1111", "7F10"	Updates the content of the linear fixed structure EFsms file on the SIM card.
+CRSM: 144,0,""	Update succeeded.
OK	
AT+CRSM=242	Obtains the current directory information.
+CRSM: 144,0,"<status>"	<status> indicates the current directory status.
OK	

Notes:

- To read or update a file, appropriate commands must be used according to the file's structure type (for details, refer to the description of file properties in the *3GPP TS31102* protocol). For transparent structure files, use 176 (Read Binary) and 214 (Update Binary). For linear fixed structure files, use 178 (Read Record) and 220 (Update Record).
- If <pathid> is not contained in the command, the module will prefer to access the files with the same FID in the current directory.
- Files can be accessed only when the access criteria are met. Otherwise the SIM card will return PSWs indicating that the access authentication failed. If an EF file's read privilege is PIN protected and the module does not have the PIN authenticated, PSWs indicating that the access authentication failed will be returned after the **CRSM** command is used to read the EF file.
- To use the **CRSM** command to access the file content on the SIM card, the parameters contained in the command must strictly meet the requirements in the *ETSI TS102221* and *3GPP TS31102*. For detailed requirements, refer to the *ETSI TS102221* and *3GPP TS31102*.



8.2.2 Troubleshooting

Scenario	Possible Error Information	Solution
AT+CRSM=178,12258,0,0,10	+CRSM: 105,129,"" OK	The status word (SW) indicates a Read command error occurred. Files with a transparent structure should be read using 176 (READ BINARY).
AT+CRSM=220,28476,1,4,176,"1111","7F10"	+CRSM: 105,130,"" OK	The PSW indicates that the security conditions were not met. To update the EFsms file, the correct PIN is required.

9

Sleeping and Waking Up Application Scenarios

As an embedded component in the host, the module also consumes power, which increases the power consumption of the integrated product. Therefore, the most important task of power management is to reduce the power consumption of the integrated product by enabling the module's sleep mode when necessary.

The host and the module need to wake each other up from sleep if communication is required. Therefore, another task of power management is to provide a wake-up control mechanism for the host and module.

Power management involves three parts: the host system software (including the USB driver/UART driver/GPIO driver/sleep mechanism functions), connection hardware between the host and module, and the module's software wake-up mechanism.

This chapter is mainly concerned with the module's software wakeup mechanism, including the wake-up principle, how USB related events impact on the waking up of the module and remotely waking up the module, and how the module remotely wakes up the host.

This chapter briefly describes the power management related connection hardware between the host and module.

This chapter does not describe the host system software. For example, if the host runs on a Windows or Mac system, Huawei will provide a USB driver program corresponding to the module. If the host runs on an Android system, Huawei will provide [HUAWEI Module Android Integration Guide](#) for users to configure the USB-based wakeup function of the module.

This document describes typical module application scenarios. A host can be designed based on the actual system features and the application scenarios of the module to reduce power consumption of both the module and integrated product.

After the host is designed as recommended by this document, the module's power consumption and the whole unit's power consumption can meet the performance requirements. For details, see related description in the product manual.

9.1 Hardware Interfaces

The module communicates with the host using mainly USB or UART. For details about pins related to power management, see Table 9-1 ..

For corresponding interface numbers and reference design for the pins, see *Hardware Guide* for each product.

Table 9-1 Power management related pins

Interface	Pin name	Pin Name	Input/Output	Description
LGA	WAKEUP_OUT	Output	When a wake-up source (see section 9.3.5) arrives, these pins output a low-level-voltage pulse lasting for 1s during which if other wake-up sources arrive, the module will ignore the later wake-up requests. In other words, the module will not output a second pulse during this 1s.	Figure 9-1
PCIE	WAKE#			
LGA	WAKEUP_IN	Input	When the pin carries a high-level voltage, the states of the module are as follows: The module will be prohibited to enter sleep mode if the module is awake. The module will be woken up if the module is in sleep mode. When the pin carries a low-level voltage, the module is allowed to enter sleep mode. (By default, the pin is set to INPUT/PD, which is, the software detects a low-level voltage on the pin when the pin is not connected.)	Figure 9-2
LGA	SLEEP_STATUS	Output	Indicates the state of the module. When the pin carries a high-level voltage, the module is in working mode. When the pin carries a low-level voltage, the module is in sleep mode.	Figure 9-3

Note:

The PCIE interface does not support UART.

9.2 Sequence Diagram

Figure 9-1 WAKEUP_OUT (when a NPN triode is externally connected to the WAKEUP_OUT pin) output sequence

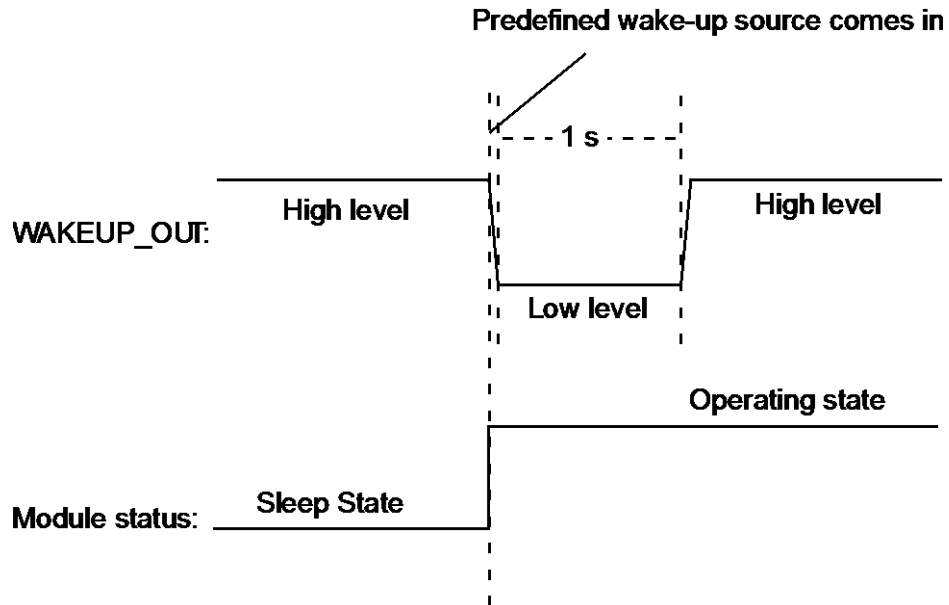
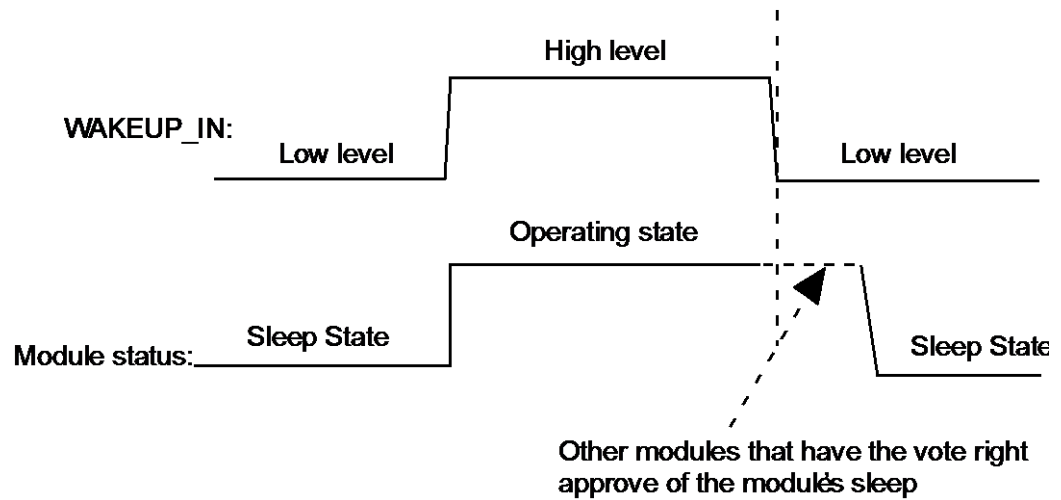
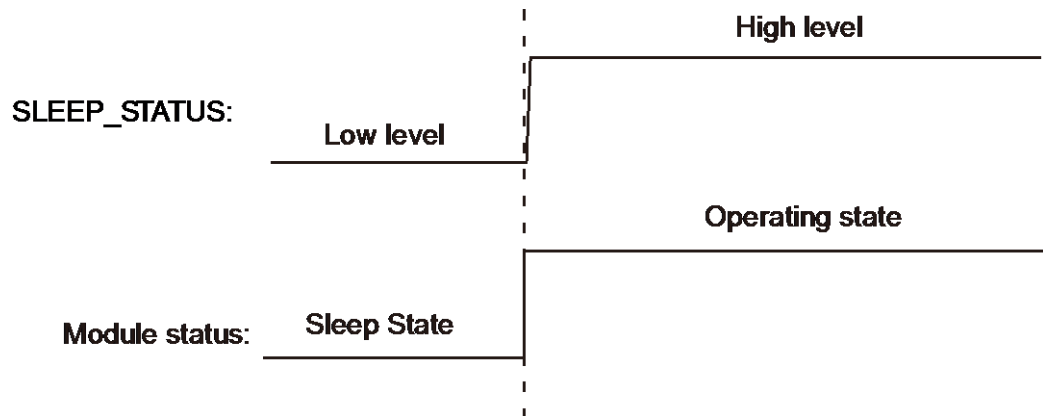


Figure 9-2 WAKEUP_IN input sequence



About the vote, see section 9.4.1 .

Figure 9-3 SLEEP_STATUS output sequence

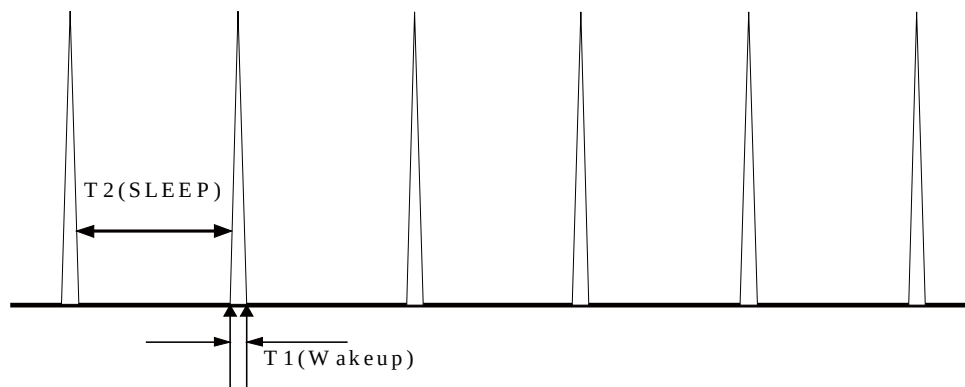


9.3 Software Interfaces

9.3.1 Principle

The module runs on a multi-task software system. The sleep task is granted with the lowest priority and assigned to detect whether the module can enter sleep mode. Other tasks (such as the RF, SIM card, USB, and UART) have voting rights. They vote to decide whether the module can enter sleep mode. When no other tasks are running, the sleep task is executed. If the sleep task detects that all other tasks agree on the module's sleep, the module enters sleep mode, as shown in Figure 9-4 . At this time, the baseband chip reduces the work frequency, and the RF enters the Discontinuous Reception (DRX) mode.

Figure 9-4 Currency state when the module is in sleep mode



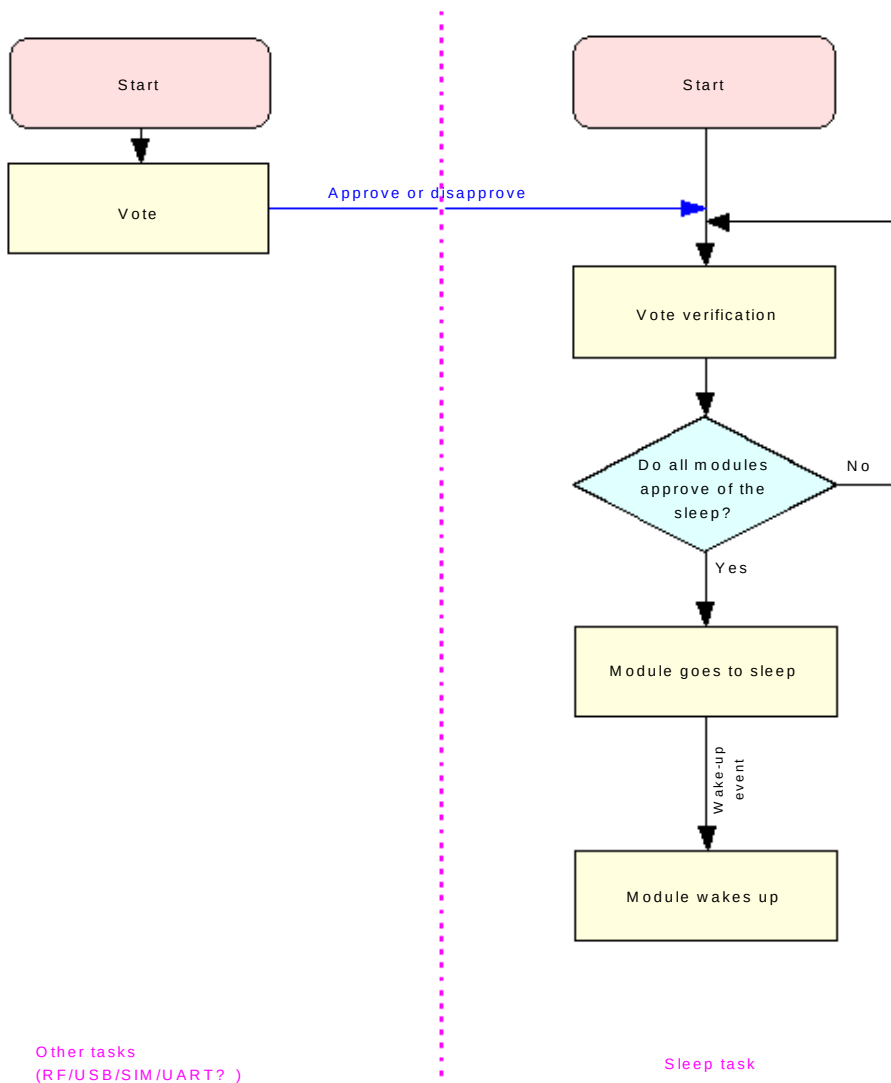
For more information about the module's sleep procedure, see Figure 9-5 .

Note:

The module's sleep mode is different from working mode or flight mode set using the **AT+CFUN** command. The RF will be turned off when the module enters LPM mode using the command **AT+CFUN=0** while the RF will enter DRX mode without being turned off when the module is in sleep mode. For more details, refer to [AT Command Interface Specification](#).

The module enters sleep mode automatically when the sleep task detects that all other tasks agree on the module's sleep. The sleep period of the module depends on the current working state and circumstance. The period may last for several seconds, or up to several minutes.

Figure 9-5 Sleep procedure



9.3.2 USB and Sleep

USB is an important communication channel between the module and the host. According to the USB protocol, normally a hub or a root hub periodically sends Start of Frame (SOF) data packages (one data package per ms using full-speed USB and one package per 125 μ s using high-speed USB). Through this mechanism, USB always votes to stop the module from entering sleep mode.

When the USB driver provided by Huawei detects that the module and the host have not exchanged data in 5 seconds, the USB driver will enable the port's suspend feature, stopping SOF data packages being sent and suspending the USB controller. This enables the USB to vote to agree the module's sleep.

Note:

If the USB driver used is developed by users or is integrated with external application, ensure that the USB driver supports the USB suspend features (including selective suspend and global suspend, as defined in the USB standard.)

9.3.3 UART and Sleep

UART is an important communication channel between the module and the host. If the host uses UART (a TTL level Interface), it can connect to the module's UART directly. If the host uses RS232, it can connect to the module's UART through a conversion chip such as MAX232.

Note:

Regardless of the connection modes, when there is no data transmitted on the UART, the host should set the RX pin of the module's UART to low level so that the module can enter sleep mode.

9.3.4 Module Wake-up

RF periodically wakes up the module based on the DRX cycle (depending on the actual configuration of the network system), as shown in Figure 9-4 .

Other aperiodic events include:

1. The host sends data using USB/UART or pulls WAKEUP_IN up.
2. Changes on the network, for example, an incoming text message, a signal change, a network working mode change, a network search, an IP data package (when a dial-up network connection is set up).
3. Software system events such as a timer
4. Abnormal events, for example, an antenna drops or a SIM card becomes loose.

9.3.5 Host Woken up by Module

Wake-up Source

A wake-up source is a module event that can wake up the host, for example, a text message, data (PPP data, TCP/UDP data from the network), and unsolicited messages.

Remotely Waking up the Host Using USB

When the host is in sleep mode and the USB controller is in suspended mode, if the module needs to send data to the host (for example, a wake-up source has arrived),

the module sends a remote wake-up signal that lasts 3 ms to inform the host to start USB resume (as shown in Figure 9-6). To complete the procedure, the following conditions must be met:

1. The USB controller on the host supports USB remote wake-up and can wake up the host.
2. The USB driver enables or disables remote wake-up by executing SET_FEATURE and CLEAR_FEATURE commands. Therefore, remote wake-up must be enabled on the USB driver before USB enters suspended mode.
3. When the host receives the remote wake-up signal from the module, the host needs to send a full speed K signal that lasts at least 20 ms. When the USB controller resumes, the host must send the SOF token within 3 ms from the startup of the idle state. Otherwise, the module enters suspended mode again, as shown in Figure 9-6 .

Figure 9-6 USB resume time sequence

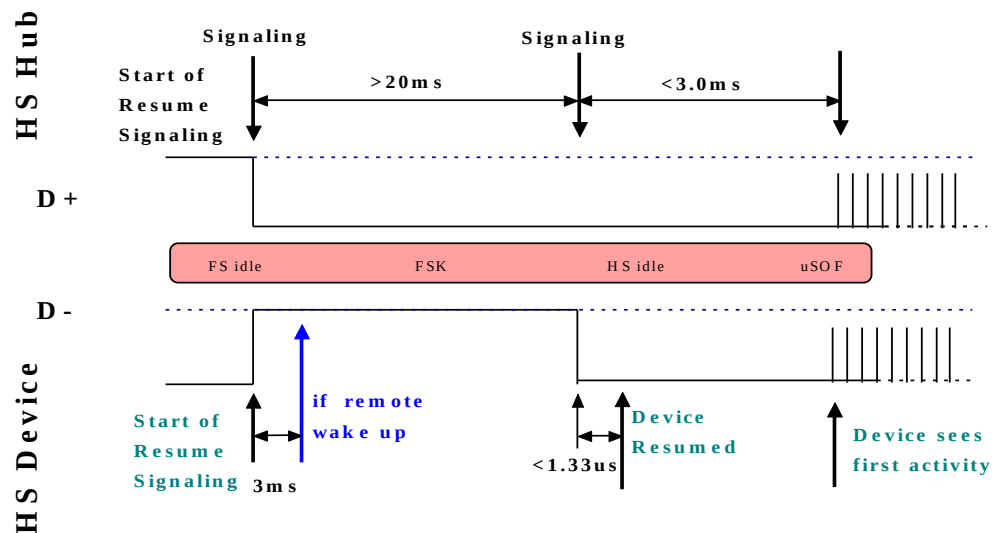


Figure 9-7 Successful procedure of remote wake-up

Transfer		F	Control	ADDR	ENDP	bRequest	wValue	wIndex	wLength	Time	Time Stamp	
5		S	SET	3	0	SET_FEATURE	DEVICE_REMOTE_WAKEUP	0x0000	0	3.519 ms	8 . 897 431 766	
Ch0	Packet	H	Suspend			Time Stamp						
	5356		12.022 sec			8 . 900 949 650						
Ch0	Packet	?	Resume			Time Stamp						
	5357		21.000 ms			20 . 923 255 382						
Ch0	Packet	H	Resume EOP			Time		Time Stamp				
	5358		1.333 µs			36.727 ms		20 . 944 255 448				
Transfer		F	Control	ADDR	ENDP	bRequest	wValue	wIndex	wLength	Data Select	Time	Time Stamp
6		S	GET	3	0	GET_STATUS	0x0000	USB 2.0 Standard Status	2	0x0002	1.162 ms	20 . 980 983 366
Transfer		F	Control	ADDR	ENDP	bRequest	wValue	wIndex	wLength	Time	Time Stamp	
7		S	SET	3	0	CLEAR_FEATURE	0x0001	0x0000	0	12.352 ms	20 . 982 145 182	

WAKEUP_OUT Waking up the Host

The module will output a 1s pulse using WAKEUP_OUT/WAKE# as shown in Figure 9-1 when a wake-up source arrives. The host wakes itself up after detecting the level change.

Remote Wake-up Configuration

The power consumption of the host increases if it is frequently woken up. The host can configure the module's wake-up sources using ^WAKEUPCFG and ^CURC command so as to reduce the power consumption.

The ^WAKEUPCFG command can be used to choose wake-up sources and the wake-up channel (USB or WAKEUP_OUT). The ^CURC command can choose unsolicited messages. For more details, refer to AT Command Interface Specification.

9.4 Application Scenarios: System with USB Connection only

A host running Android, with support for USB suspend, USB remote resume and text messages.

9.4.1 Hardware Connection

The host connects to the module using USB.

9.4.2 Software Procedure

Command	Description
AT^WAKEUPCFG=?	Queries the parameter range of WAKEUPCFG.
^WAKEUPCFG: (0-1),(0-3),(0-15)	
OK	
AT^WAKEUPCFG=1,2,15	Configures the module to make sure that incoming text messages, data, and unsolicited messages can remotely wake up the host using USB.
OK	
AT^CURC=?	Queries the parameter range of CURC.
^CURC: (0-2)	
OK	
AT^CURC=2,800820,1FFFFFFFFFFFFFFF	The host wakes up from sleep if any

of the following occurs: The SIM card state changes such as the SIM card is removed (^SIMST); the number of text messages exceeds the limit (^SMMEMFULL). Other unsolicited messages are saved in the cache when the host is in sleep mode, and reported to the host when it wakes up.

OK

9.4.3 Advantages

With software configuration, while the system requirements (text messages) are met, the number of times the host is woken up by unsolicited messages, and consequently the power consumption, are reduced.

9.5 Application Scenarios: System with USB and WAKEUP_OUT

A host running Android, with support for text messages, but not USB remote resume..

9.5.1 Hardware Connection

The host must connect to the module using USB and WAKEUP_OUT pins

9.5.2 Software Procedure

Command	Description
AT^WAKEUPCFG=?	Queries the parameter range of WAKEUPCFG .
^WAKEUPCFG: (0-1),(0-3),(0-15)	
OK	
AT^WAKEUPCFG=1,1,14	Configures the module to make sure that text messages, data, and unsolicited messages can remotely wake up the host using the WAKEUP_OUT pin.
OK	
AT^CURC=?	Queries the parameter range of CURC .
^CURC: (0-2)	

OK

AT^CURC=2,820,1FFFFFFFFFFFFFFF

The host wakes up from sleep if either of the following occurs: The SIM card state changes, such as the SIM card is removed (^SIMST); the number of text messages exceeds the limit (^SMMEMFULL). Other unsolicited messages are saved in the cache when the host is in sleep mode, and reported to the host when it wakes up.

When the host is awake, unsolicited messages are reported to the host.

OK

9.5.3 Advantages

A solution is provided for systems not supporting USB remote resume.

With software configuration, while the system requirements (text messages) are met, the number of times the host is woken up by unsolicited messages, and consequently the power consumption, are reduced.

9.6 Application Scenarios: System with UART and WAKEUP_OUT

A host is constructed based on a single-chip microcomputer. There is no user interface. The host supports UART and text messages. After receiving a text message, the host decodes it and takes corresponding actions.

9.6.1 Hardware Connection

The host must connect to the module using the UART and WAKEUP_OUT pins.

9.6.2 Software Procedure

Command	Description
AT^WAKEUPCFG=?	Queries the parameter range of WAKEUPCFG.
^WAKEUPCFG: (0-1),(0-3),(0-15)	
OK	
AT^WAKEUPCFG=1,1,2	Configures the module to make sure that text messages can remotely



wake up the host by WAKEUP_OUT.

OK

AT^CURC=?

Queries the parameter range of **CURC**.

^CURC: (0-2)

OK

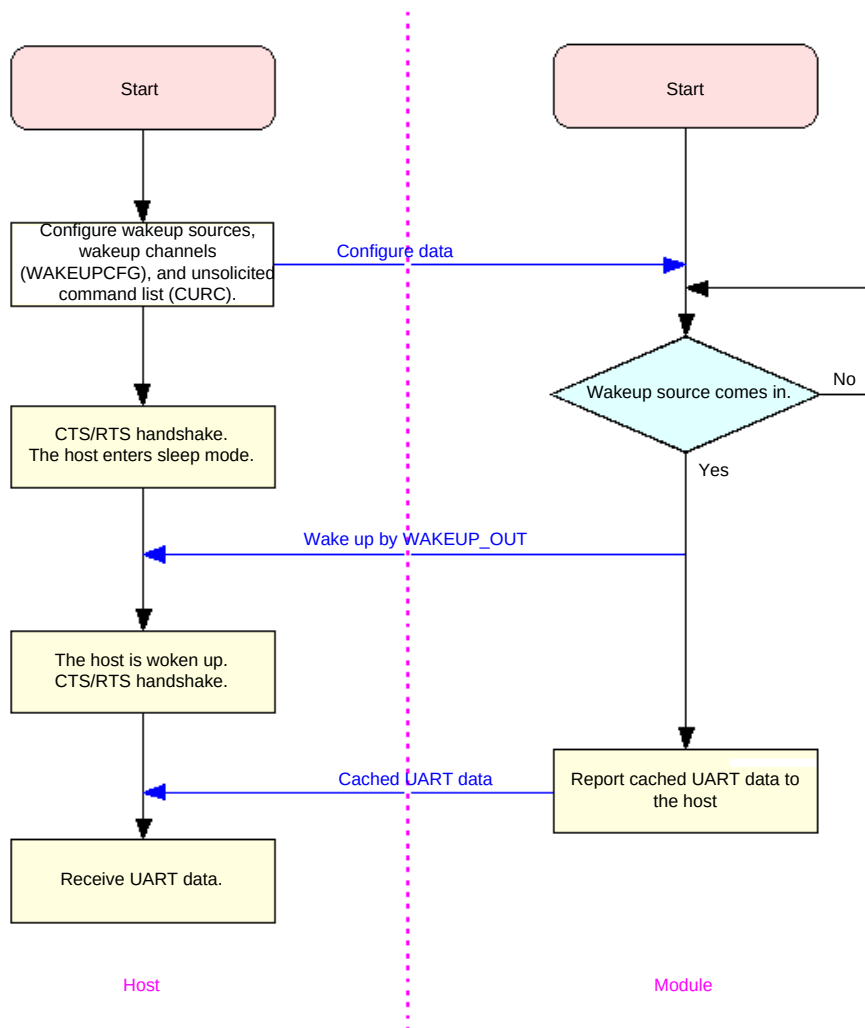
AT^CURC=2,800,1FFFFFFFFFFFFFFF

The host wakes up from sleep if the number of text messages exceeds the limit.

OK

The host and the module must handshake to prevent data loss when the module wakes up the host.

Figure 9-8 Wake-up and hand-shaking using UART(CTS/RTS) and WAKEUP_OUT pins



Note:

If the host connects to the module using the TXD or RXD pin only, handshake is not implemented and consequently data on the UART may be lost when the host is in sleep mode.

9.6.3 Advantages

This solution enables handshake between UART and WAKEUP_OUT.

With software configuration, the host can go to sleep with no data loss.

9.7 System with Other Connection Methods

If the host can be connected to the module only using UART, refer to the [HUAWEI Module UART Serial Port Design Guide](#). If the host can connect to the module using



USB/UART/WAKEUP_OUT and can support USB remote wake-up and UART remote wake-up, prioritize USB remote wake-up over WAKEUP_OUT remote wake-up. For details about the software procedure, refer to the earlier sections while considering the host system feature.

10 Thermal Protection Application Scenarios

10.1 Pre-configuration

Command	Description
AT^CURC=2,0x870,0x872	Enables the thermal protection unsolicited indication when the module is working or in sleep mode.
OK	
^THERM: 1	When the temperature is higher than the threshold, the module enables thermal protection: The module turns off its RF, and will automatically shut down if the temperature continues to rise to be higher than the module's turn-off threshold.
^THERM: 0	When the temperature is lower than the RF's turn-off threshold, the module turns on its RF and disables thermal protection.

10.1.1 Troubleshooting

None

10.2 Thermal Protection Process

- When the module's temperature is lower than 105°C, the module works normally.
- When the module's temperature reaches 105°C, the module enables thermal protection: turns off its RF and presents the **^THERM: 1** indication. When the



module's temperature is lower than 100°C, the module disables thermal protection: turns on its RF transmission, and presents the **^THERM: 0** indication.

- When the module's temperature reaches 100°C, the module automatically shuts down.

Notes:

Thermal protection is designed to protect the module from being damaged by overtemperature. To work in high temperature environments, both the module and its peripheral components must be able to resist the same temperature.

11

GPS Application Scenarios

11.1 Introduction to GPS

11.1.1 GPS Positioning Methods

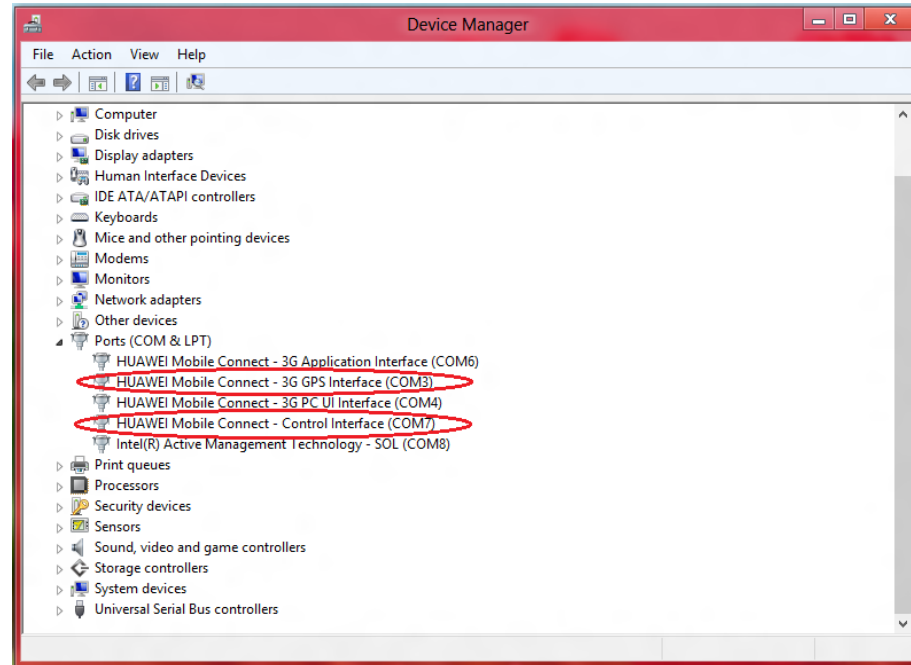
Table 11-1 GPS positioning methods

Positioning methods	Description	Benefits	Drawbacks
Standalone	This is a traditional GPS positioning method. Using this method, a module receives satellite signals directly and makes calculations to obtain positioning results.	No communication with the network is invoked, incurring no data traffic between the module and the network.	Long time to first fix (TTFF) in code mode.
Mobile Station Based (MSB) positioning using the User Plane Protocol	Requests the assistant data from the network to assist and accelerate the positioning. This method is one of the Assisted GPS (A-GPS) methods.	• Significantly reduces the TTFF after cold start and increases the rate of successful positioning. • Enables positioning in environments with very poor satellite signals.	Requires the assistant data from the network, incurring network traffic.

Positioning methods	Description	Benefits	Drawbacks
Mobile Station Assisted (MSA) using the User Plane Protocol	Requests data from the network to assist and accelerate the positioning. After receiving satellite data, the module sends the satellite data to the network for calculations, and the network returns the calculation results to the module. This method is one of the A-GPS methods.	- Reduces the TTFF after cold start and increases the rate of successful positioning. - Hands most workload to the network, reducing the module's workload. - Enables positioning in environments with poor satellite signals (network dependent).	Requires complex interaction with the network, incurring network traffic.
XTRA positioning	Downloads XTRA data from the Qualcomm's XTRA server to assist positioning. The XTRA data is valid for 7 days.	- Reduces the TTFF after cold start. - Long valid period for the XTRA data, eliminating frequent data downloading.	- Cannot reduce the TTFF after cold start as significantly as the A-GPS methods. - The XTRA data's ability to assist positioning declines as time goes by.
Cell ID	Base station mode, this approach will be based on the cell ID number of the mobile terminal is located to determine the location of the user.	This mode can be use when other optioning methods are failed.	Very low accuracy.
Global navigation satellite system (abbreviated as GNSS)	Uses both the GPS and GLONASS for positioning.	Using more satellites, increases the successful positioning rate and the positioning accuracy.	

11.1.2 GPS Ports

Figure 11-1 Control Interface and 3G GPS Interface detected after the module is connected to a computer

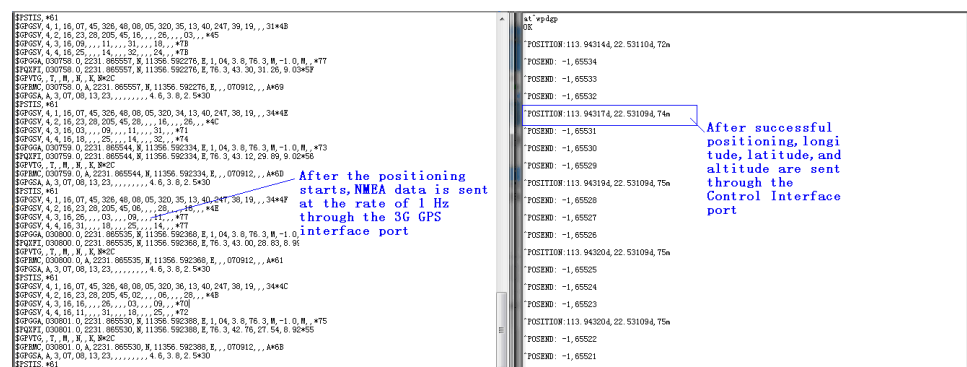


The Control Interface port is used to send GPS-related AT commands, and the 3G GPS Interface port is used to send unsolicited indications for NMEA positioning data.

Figure 11-2 Data sent through the control interface and 3G GPS interface ports

3G GPS Interface:

Control Interface:



11.2 Standalone Positioning

Command	Description
AT^WPDOM=0	Sets the positioning method to Standalone.
OK	
AT^WPDST=0	Sets the session type to single positioning.
OK	
AT^WPDST=1	Sets the session type to tracking and positioning.
OK	
AT^WPDFR=65535,1	Sets the number of positioning times and the interval between each positioning for the tracking and positioning. If the session is a single positioning, you do not need to set these parameters.
OK	
AT^WPQOS=255,500	Sets the positioning service quality. The first parameter indicates the response time, and the second indicates the horizontal accuracy threshold.
OK	
AT^WPDGP	Starts positioning.
OK	
^POSITION: 113.94026d,22.53206d,270m	Presents the positioning result.
^POSEND: -1,9	The first value indicates positioning end reason, and the second indicates the left positioning times.

Notes:

- The Standalone method can be used when the module has no SIM card inserted.
- If there is an ongoing positioning session, the session must be terminated before setting the positioning parameters so that the parameters can take effect for the positioning to be started. This rule applies to all positioning methods.
- Execute "AT^WPEND" command can terminate the current positioning session.

11.3 MSB Positioning Using the User Plane Protocol

Command	Description
AT^WPDOM=5	Sets the positioning method to MSB.
OK	
AT^WPDST=1	Sets the session type to tracking and positioning.
OK	
AT^WPDFR=65535,1	Sets the number of positioning times and the interval between each positioning for the tracking and positioning.
OK	
AT^WPQOS=255,500	Sets the positioning service quality. The first parameter indicates the response time, and the second indicates the horizontal accuracy threshold..
OK	
AT^WPURL=SUPL.GOOGLE.COM:7276	Sets the A-GPS server address and port number. This address is just Google AGPS server. Some of the AGPS server requires certificate authentication.
OK	
AT+CGDCONT=15, "IP", "CMNET"	Sets the PDP context required by A-GPS dial-up. By default, A-GPS dial-up uses the fifteenth PDP context. "CMNET" is the APN of network that module have registered.
OK	
AT^WPDGP	Starts positioning.

OK

^POSITION: 113.94026d,22.53206d,270m	Presents the positioning result.
^POSEND: -1,9	The first value indicates positioning end reason, and the second indicates the left positioning times.

Note:

The MSB method requires the module to register with a network, and will incur data traffic during positioning. When the MSB positioning fails, the module will automatically switch to the Standalone positioning if NV3756 = 1, but will not switch to the Standalone positioning if NV3756 = 0.

11.4 MSA Positioning Using the User Plane Protocol

Command	Description
AT^WPDOM=1	Sets the positioning method to MSA
OK	
AT^WPDST=1	Sets the session type to tracking and positioning.
OK	
AT^WPDFR=65535,1	Sets the number of positioning times and the interval between each positioning for the tracking and positioning.
OK	
AT^WPQOS=255,500	Sets the positioning service quality. The first parameter indicates the response time, and the second indicates the horizontal accuracy threshold.
OK	
AT^WPURL=SUPL.GOOGLE.COM:7276	Sets the A-GPS server address and port number. This address is just Google AGPS server. Some of the AGPS server requires certificate authentication.
OK	

AT+CGDCONT=15, "IP", "CMNET"

Sets the PDP context required by A-GPS dial-up. By default, A-GPS dial-up uses the fifteenth PDP context. "CMNET" is the APN of network that module have registered.

OK
AT^WPDGP

Starts positioning.

OK
Note:

The MSA method requires the module to register with a network, and incurs data traffic during positioning. If GPS response time in the positioning QoS is set to a too small value, the MSA positioning may fail.

11.5 XTRA Positioning

Command	Description
AT^WPDOM=6	Sets the positioning method to gpsOneXTRA.
OK	
AT^XTRASTA	Queries the status of XTRA data. If the date of the obtained XTRA data is more than seven days earlier than the current date, the XTRA data is invalid, and the module needs to download new XTRA data. (The XTRA data's ability to assist positioning declines as time goes by. Therefore, it would be appropriate to set the XTRA data's valid period to three days. You can also download the latest XTRA data without querying the existing XTRA data information.)
OK	Notify XTRA Data Query Result
^XDSTATUS: 0,0,0,0	
AT^XTRATIME.....	Upper layer applications use this command to access the SNTP server to obtain the current time information, and injects the information into the module.
OK	
^TIMESETRULT: 0	Notify XTRA Time Injected Result

AT^XTRADATA.....	Upper layer applications use this command to access the XTRA server to download XTRA data, packetize the data, and inject the data into the module. (You can also inject the XTRA data from the host into the module.) There are two types of XTRA files stored on the XTRA server: • xtra.bin file: contains predicted two-line orbital elements for GPS satellites, about 45 KB. • Xtra2.bin file: contains predicted two-line orbital elements for GPS and GLONASS satellites, about 80 KB.
OK	
^DATASETRULT: 50	Notify XTRA Data injected Result.
AT^WPDST=1	Sets the session type to tracking and positioning.
OK	
AT^WPDFR=65535,1	Sets the number of positioning times and the interval between each positioning for the tracking and positioning.
OK	
AT^WPQOS=255,500	Sets the positioning service quality. The first parameter indicates the response time, and the second indicates the horizontal accuracy threshold.
OK	
AT^WPDGP	Starts positioning.
OK	
^POSITION: 113.94026d,22.53206d,270m	Presents the positioning result.
^POSEND: -1,9	The first value indicates positioning end reason, and the second indicates the left positioning times.

Note:

XTRA data must be injected before XTRA data is injected.

11.6 GNSS Positioning

The GNSS positioning uses both the GPS and GLONASS satellites for positioning.

Command	Description
AT^WGNSS=1	Sets GNSS as the positioning system to use both the GPS and GLONASS satellites for positioning. To switch from one positioning system to another, the module must restart. To switch the module to use GPS satellites only, run AT^WGNSS=0 and restart the module.
OK	
AT^WPDOM=a value within the value range	For the MSA and MSB positioning methods, the data obtained from the server is two-line orbital elements of GPS satellites, which will not help the GLONASS positioning, but the module will still search for GLONASS satellites.
OK	
AT^WPDST=1	Sets the session type to tracking and positioning.
OK	
AT^WPDFR=65535,1	Sets the number of positioning times and the interval between each positioning for the tracking and positioning.
OK	
AT^WPQOS=255,500	Sets the positioning service quality. The first parameter indicates the response time, and the second indicates the horizontal accuracy threshold.
OK	
AT^WPDGP	Starts positioning.
OK	
^POSITION: 113.94026d,22.53206d,270m	Presents the positioning result.
^POSEND: -1,9	The first value indicates positioning end reason, and the second indicates the left positioning times.

Note:

After **AT^WGNSS** is executed, the module must be restarted to allow the settings configured by **AT^WGNSS** to take effect.

12 Concurrent Service Application Scenarios

12.1 Internal/External Protocol Stacks and Text Messaging

WCDMA networks support concurrent internal/external protocol stack services and text messaging.

When data is transmitted using the external protocol stack, text messages can be sent through only the ports on which no data is being transmitted.

When the internal protocol stack is in use, text messages can be sent through all ports in non-transparent transmission mode and through only the USB in transparent transmission mode.

Table 12-1 describes the details.

Table 12-1 Ports available to text messaging during data services

	Service Port	Message Sending Port	Message Receiving Port
External protocol stack application	MODEM	PCUI, UART	PCUI, UART
	UART	PCUI, MODEM	PCUI, MODEM
Internal protocol stack application	UART (non-transparent transmission mode)	MODEM, PCUI, UART	MODEM, PCUI, UART
	UART (transparent transmission mode)	MODEM, PCUI	MODEM, PCUI

Command	Description
AT+IPOPEN=1,"TCP","172.22.44.33",7000	Establishes a TCP link at the

,6000	module's UART port.
OK	The module transmits data through the UART port.
^IPDATA: 1,1024,No.6:**... **	
AT+CMSS=0	The module sends text messages through the PCUI port.
+CMSS: 48	The module can send text messages without interrupting the data transmission through the UART.
OK	
(UART)	
^IPDATA: 1,1024,No.7:**... **	
^IPDATA: 1,1024,No.8:**... **	
+CMTI: "SM",4	After receiving text messages, the module presents them through all ports (the format of the text messages is set by AT+CNMI).
^IPDATA: 1,1024,No.9:**... **	

On GSM/GPRS networks, data transmission using the internal/external protocol stack services will be suspended when text messages are sent and will be resumed after the text messages are sent.

Command	Description	
AT^IPOPEN=1,"TCP","172.22.44.33",7000,6000	Establishes a TCP link at the module's UART port.	
OK	The module transmits data continuously.	
^IPDATA: 1,1024,No.6:**... **		
AT+CMSS=0	The module sends text messages through the PCUI port.	
+CMSS: 48	The data transmission through the UART port is suspended for the text messaging service through the PCUI port. The data transmission will be resumed after the messages are sent or received.	
OK		
+CMT: "+8613912345",,"12/01/01,12:00:00+00"		
1234		
(UART)		



^IPDATA: 1,1024,No.7:**...**

^IPDATA: 1,1024,No.8:**...**

12.2 Other Services

Configuration operations (initialization and serial port configuration), phonebook operations, and PIN operations can be performed when the module is not in sleep mode, no matter the module is idle or processing services, because no interaction between the module and the network is required.

Especially, if the module is processing internal/external protocol stack services, operations such as configuration, phonebook and PIN operations must be performed at ports that are not used to provide data services.

Table 12-2 Ports available to configuration, phonebook and PIN operations when the module is processing data services

	Service Port	Ports Available to Configuration, Phonebook and PIN Operations
External protocol stack application	MODEM	PCUI, UART
	UART	PCUI, MODEM
Internal protocol stack application	UART	MODEM, PCUI

13 STK Application Scenarios

13.1 Unsolicited Report of STK Proactive Commands

13.1.1 Reference Process

Command	Description
AT^STSF =1,2	Activates the STK interface function, set the STK interface to 3GPP standard mode.
OK	
+CUSATP: " D081A2810301250082028182850F8000550053 0049004D53615E9475288F0A11807CBE54C16 3A883508F0A318059296C14988462A58F0A32 80822A73ED67E58BE28F0A338051FA884C63 0753578F0A34804F53575B5FEB8BAF8F0C51 8065B095FB65E9665A62A58F0A5280624B673 A97F34E508F0A5380624B673A96058BFB8F0 A5480624B673A90AE7BB18F0A558077ED4FE 152A974068F0C5680624B673A84254E1A5385 "	Content of the SET UP MENU proactive command. The string should be interpreted according to the ETSI protocol TS102223. The protocol states that the command type is determined by the 7th byte if the string length is greater than 127 bytes, and the 6th byte if the string length is 127 bytes or less. In the provided example, the 7th byte is 25, which indicates SET UP MENU.
AT+CUSATT="810301250082028281830100"	The CAT client uses the AT command to respond to the proactive command. This string means "command performed successfully".

OK

Notes:

- STK activation and deactivation still take effect after the device is restarted.
- **<proactive_command >** and **<terminal_response>** consist of the full BER-TLV data object as defined in 3GPP TS 31.111.
- For MU609, STK proactive commands can be divided into three categories:
 Category 1: proactive commands that must be processed by the CAT client, including DISPLAY TEXT, GET INKEY, GET INPUT, PLAY TONE, SELECT ITEM, SET UP MENU, LANGUAGE NOTIFICATION, and LAUNCH BROWSER.
 Category 2: proactive commands processed by the module (the CAT client is still notified), including **SEND SHORT MESSAGE**, **SEND SS**, **SEND USSD**, **SET UP EVENT LIST**, and **REFRESH**.
 Category 3: other proactive commands that are processed by the module (the CAT client is not notified).
- Only commands of categories 1 and 2 are reported using the +CUSATP interface.
- Only terminal responses to commands of category 1 can be delivered using the AT interface.

13.1.2 Troubleshooting

Scenario	Possible Error Information	Solution
The SIM card has sent an STK proactive command, but the module does not unsolicitedly report it to the CAT client.	None	AT^STSF=1,2
AT+CUSATT="<terminal_response>"	+CME ERROR: SIM PIN required	Unblock the PIN before delivering the terminal response.
AT+CUSATT="<terminal_response>"	+CME ERROR: SIM busy	Wait until the SIM card initialization is complete before delivering the terminal response.

Scenario	Possible Error Information	Solution
AT+CUSATT="<terminal_response>"	ERROR	1. Use AT^STSF? to check whether STK has been activated and the interface has been set to 3GPP standard mode. If yes, proceed to the next step. 2. Check whether the proactive command reported needs to be processed by the CAT client. If yes, proceed to the next step. 3. Check whether <terminal_response> complies with the 3GPP TS 31.111 protocol. If yes, proceed to the next step. 4. Check whether the terminal response is delivered more than 2 minutes and 5 seconds after the proactive command is reported. If yes, the module does not receive terminal responses sent from the CAT client.

13.2 Querying the STK Main Menu

13.2.1 Reference Process

Command	Description
AT^CUSATM?	Checks the content of SET UP MENU .
^CUSATM: "D081A2810301250082028182850F80005500530049 004D53615E9475288F0A11807CBE54C163A883508 F0A318059296C14988462A58F0A3280822A73ED67 E58BE28F0A338051FA884C630753578F0A34804F5 3575B5FEB8BAF8F0C518065B095FB65E9665A62A 58F0A5280624B673A97F34E508F0A5380624B673A 96058BFB8F0A5480624B673A90AE7BB18F0A55807 7ED4FE152A974068F0C5680624B673A84254E1A53 85"	Content of SET UP MENU
OK	

Notes:

- This command is not specified in the standard interface protocol but is introduced to prevent the main menu information from being lost because **SET UP MENU** is sent too quickly.
- If the SIM card does not deliver **SET UP MENU**, then **^CUSATM: ""** will be returned after the main menu is queried.

13.2.2 Troubleshooting

Scenario	Possible Error Information	Solution
AT^CUSATM?	ERROR	AT^STSF=1,2
AT^CUSATM?	+CME ERROR: SIM PIN required	Unblock the PIN before delivering the command.

13.3 STK Envelope Command

13.3.1 Reference Process

Command	Description
AT+CUSATE="D30782020181900156"	Delivers the envelope command MENU SELECTION .
+CUSATE: "",0	The SIM card's response to the envelope command. For details, see notes 2 and 3 below.
OK	

Notes:

- **<envelope_command>** and **<envelope_response>** consist of the full BER-TLV data object as defined in 3GPP TS 31.111.
- **<envelope_response>** is the SIM card's response to the envelope command. It may be empty.
- **<busy>** indicates the SIM card status. If **<busy>** is **0**, the SIM card is normal and the envelope command has been processed. If **<busy>** is **1**, the SIM card is busy. The envelope command can be resent when the SIM card is idle. If **<busy>** is **2**, the SIM card is faulty. Check the SIM card and do not resend the envelope command until the SIM card has been fixed.

13.3.2 Troubleshooting

Scenario	Possible Error Information	Solution
AT+CUSATE="<envelope_command>"	ERROR	AT^STSF=1,2
AT+CUSATE="<envelope_command>"	+CME ERROR: SIM PIN required	Unblock the PIN before delivering the envelope command.
AT+CUSATE="<envelope_command>"	+CME ERROR: SIM busy	Wait until the SIM card initialization is complete before delivering the envelope command.
AT+CUSATE="<envelope_command>"	ERROR	Check whether <envelope_command> complies with the 3GPP TS 31.111 protocol.

14 USSD Application Scenarios

14.1 USSD Initialize and Configuration

14.1.1 Reference Process

Command	Description
AT+CSCS="IRA"	Set the Te supported character set as "IRA"
OK	
AT^USSDMODE=0	Set the transmitted mode, select USSD non-transparent mode
OK	

Notes:

- The default transmitted mode is transparent mode.
- In non-transparent transmission mode:
When running AT+CSCS="IRA", the MT will transfer the USSD string to GSM 7bit directly;
When running AT+CSCS="UCS2", the MT will encode every four characters of the USSD string as hexadecimal.
- In transparent transmission mode, the USSD string is not controlled by AT+CSCS. The MT will transfer the USSD string to hexadecimal directly.

14.1.2 Troubleshooting

Scenario	Possible Error Information	Solution
The parameter is out of the correct range.	ERROR	Refer to the AT command document.

14.2 Send the USSD Command in non-Transparent Mode

14.2.1 Reference Process

Command	Description
AT^USSDMODE=0	Set as non-Transparent mode
OK	
AT+CSCS="IRA"	Set the TE supported character set as "IRA"
OK	
AT+CUSD=1,"*133*950#",15	Send the USSD code to network.
OK	The network sends the menu information to the TE.
+CUSD: 1,"0031002E80A17968537365F6884C60 C5000A0032002E80A18BC4000A003300 2E90FD5E02751F6D3B000A0034002E5F 697968000A0035002E751F6D3B5B9D51 78000A0036002E65F65C1A751F6D3B00 0A0037002E5A314E504F1195F2000A00 38002E516C51714FE1606F000A0039002 E592753434E16754C000A002A002E900 051FA000A0000",72	
AT+CUSD=2	End the USSD session
OK	
AT+CSCS="UCS2"	
OK	
AT+CUSD=1,"00310032",15	Send the USSD code to network, encoded as UCS2.
OK	The network does not support.
+CUSD: 2	

Note:

"*133*950#" is just available in China Mobile network in Shen Zhen area. The USSD code is various in different network.

14.2.2 Troubleshooting

Scenario	Possible Error Information	Solution
Network doesn't support the USSD	+CUSD: 2	Use correct USSD code that the network supports.
The PIN is not authenticated.	+CME ERROR: SIM PIN required	Enter the correct PIN.

14.3 Send the USSD Command in Transparent Mode

14.3.1 Reference Process

Command	Description
AT^USSDMODE=1	Set as transparent mode
OK	
AT+CUSD=1,"aad808",15	Send the USSD code to network.
OK	The network sends the MSISDN to the TE.
+CUSD: 0,"CD69724A74EA1A385B6C9683CD6E B1184E4603",15	

Note:

"aad808" is just available in dedicated lab network. The USSD code is various in different network.

14.3.2 Troubleshooting

Scenario	Possible Error Information	Solution
Network doesn't support the USSD.	+CUSD: 2	Use correct USSD code that the network supports.
The PIN is not authenticated.	+CME ERROR: SIM PIN required	Enter the correct PIN.

14.4 Network Initiated USSD Operation

14.4.1 Reference Process

Command	Description
+CUSD: 1, "7076393C2F83D26E789D0E0ABB41697 AB90D9287DDE732C82C7FB7413010FD 0DCA01"	USSD request is initiated by network. One of the digit "0–9" is required to be input.
AT+CUSD=1,"31",15	"1" is input to the network.
OK	The network notifies user that no response is needed.
+CUSD:0,"CF6508",15	

Note:

This function must be supported by the network. The request and notification content sent by the network depends on the manufactories.

14.4.2 Troubleshooting

Scenario	Possible Error Information	Solution
The PIN is not authenticated.	+CME ERROR: SIM PIN required	Enter the correct PIN.
Network has sent USSD request or notification, yet which is not unsolicitedly reported by the module .	None	USSD unsolicited report: AT+CUSD=1
The module cannot report USSD request or notification with non-GSM7bit code sent by network (such as UCS2 8bit code)	None	Set the transmitted mode as USSD transparent mode: AT^USSDMODE=1

15 Appendix

15.1 Relative Documents

1. HUAWEI MU609 HSPA LGA Module AT Command Interface Specification
2. 3GPP 27.007 AT command set for User Equipment (UE)
3. 3GPP 27.005 Equipment (DTE-DCE) interface for Short Message Service (SMS) and Cell Broadcast Service (CBS)
4. 3GPP 23.040 Technical realization of the Short Message Service(SMS)
5. 3GPP 31.102 Universal Subscriber Identity Module(USIM) application
6. 3GPP 24.008 Mobile radio interface Layer 3 specification; Core network protocols; Stage 3
7. 3GPP 29.002 Mobile Application Part (MAP) specification
8. 3GPP 22.004 General on supplementary services
9. ETSI TS_102.221 Smart Cards; UICC-Terminal interface; Physical and logical characteristics

15.2 Acronyms and Abbreviations

Table 15-1 List of Abbreviations

Acronym or Abbreviation	Expansion
3GPP	Third Generation Partnership Project
APN	Access Point Name
AT	Attention
CS	Circuit Switched (CS) domain
DCE	Data Circuit Equipment
DTE	Data Terminal Equipment
GPRS	General Packet Radio Service
GSM	Global System for Mobile Communications

Acronym or Abbreviation	Expansion
IMEI	International Mobile Equipment Identity
IP	Internet Protocol
ME	Mobile Equipment
MS	Mobile Station
PDP	Packet Data Protocol
PDU	Protocol Data Unit
PIN	Personal Identity Number
PPP	Point-to-Point Protocol
PUK	PIN Unblocking Key
PS	Packet Switched (PS) domain
QoS	Quality of Service
SIM	Subscriber Identity Module
SMS	Short Message Service
TE	Terminal Equipment
UE	User Equipment
UMTS	Universal Mobile Telecommunications System
USIM	Universal Subscriber Identity Module
WCDMA	Wideband CDMA

Table 15-2 Phonebook-related abbreviations

Abbreviation	Full Name
SM	SIM phonebook
EN	SIM emergency number
ON	SIM own numbers