BG95&BG77&BG600L Series
GNSS Application Note

LPWA Module Series

Rev. BG95&BG77&BG600L_Series_GNSS_Application_Note_V1.1

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About the Document

Revision History

Version	Date	Author	Description
1.0	2019-11-29	Matt YE/ Alfred LI	Initial
1.1	2020-07-17	Matt YE	1. Added an applicable module BG600L-M3. 2. Added the description of GNSS and WWAN coexistence management (Chapter 1.3). 3. Added AT command syntax (Chapter 2.1). 4. Added AT+QGPSCFG="qzssnmeatype" (Chapter 2.2.1.8). 5. Extended AT+QGPSCFG="priority" to enable saving of priority configuration (Chapter 2.2.1.11). 6. Added AT+QCFGEXT and its example (Chapter 2.2.6 and Chapter 3.4). 7. Added FAQ (Chapter 5).

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1 Introduction

Quectel BG95 series, BG77 and BG600L-M3 modules integrate the multi-GNSS engine, which supports GPS, BeiDou, Galileo, GLONASS and QZSS systems, with the gpsOneXTRA Assistance. The GNSS engine can receive simultaneous signals from maximum two constellations (GPS and another constellation) at any given time. The GNSS engine is therefore suitable for various applications where the accurate positioning at the lowest cost is needed, or position tracking without network assistance.

The modules are based on a cost-optimized architecture in which WWAN (LTE Cat-M1, LTE Cat-NB2 and GSM) and GNSS Rx chains share certain hardware blocks. However, the modules do not support concurrent operation of WWAN and GNSS.

The solution adopted in the modules is a form of coarse time-division multiplexing (TDM) between WWAN and GNSS Rx chains. Given the relaxed latency requirements of most LPWA applications, time-division sharing of resources can be made largely transparent to applications.

1.1. Applicable Modules

Table 1: Applicable Modules

Module Series	Model	Description
BG95	BG95-M1	Cat-M1
	BG95-M2	Cat-M1/Cat-NB2
	BG95-M3	Cat-M1/Cat-NB2/EGPRS
	BG95-M4	Cat-M1/Cat-NB2, 450 MHz Supported
	BG95-M5	Cat-M1/Cat-NB2/EGPRS, Power Class 3
	BG95-M6	Cat-M1/Cat-NB2, Power Class 3
	BG95-MF	Cat-M1/Cat-NB2, Wi-Fi Positioning
	BG95-N1	Cat-NB2

BG77	BG77	Cat-M1/Cat-NB2
BG600L	BG600L-M3	Cat-M1/Cat-NB2/EGPRS

1.2. Supported NMEA Sentence Types

The default NMEA sentences of the modules are compliant with the NMEA 0183 version 4.10 standard except for talker ID of RMC, GGA and VTG sentences, which uses Qualcomm-specific standards. Each satellite system uses distinct prefixes, so that NMEA sentences of different satellite systems can be easily distinguished, as is illustrated below.

GPS sentences have the prefix "GP":

- GPGGA - Global positioning system fix data, such as time and position.
- GPRMC - Recommended minimum specific GNSS data
- GPGSV - GNSS satellites in view, such as number of satellites in view or satellite ID numbers.
- GPGSA - GNSS DOP and active satellites
- GPVTG - Course over ground and ground speed

GLONASS sentences have the prefixes "GL" and "GN":

- GLGSV - GNSS satellites in view, such as number of satellites in view and satellite ID numbers.
- GNGSA - GNSS DOP and active satellites

For Galileo sentences, the prefixes are "GA" and "GN":

- GAGSV - GNSS satellites in view, such as number of satellites in view and satellite ID numbers.
- GNGSA - GNSS DOP and active satellites

For BeiDou sentences, the prefix is "PQ":

- PQGSV - GNSS satellites in view, such as number of satellites in view, satellite ID numbers, etc.
- PQGSA - GNSS DOP and active satellites

QZSS sentences also start with the prefix "PQ":

- PQGSA - GNSS DOP and active satellites

1.3. GNSS and WWAN Coexistence Management

As GNSS and WWAN cannot work simultaneously, either WWAN or GNSS takes priority during implementation. By default, the modules are configured into the GNSS priority mode, which can be

switched to the WWAN priority mode with **AT+QGPSCFG="priority"**. The command takes effect immediately. For more details, see ***Chapter 2.2.1.11***.

1.3.1. WWAN Priority Mode

In the WWAN priority mode, GNSS positioning request succeeds only when RRC is released and WWAN enters an idle sleep. Features of WWAN priority mode include:

- Data service works well all the time (No WWAN page is missed)
- RRC connection is not impacted by the GNSS operation
- GNSS session is deferred to the time when the UE goes to the eDRX state[1)]

For LPWA applications, the duration for WWAN in the active status is fairly short. Therefore, GNSS will have an opportunity to get a position fix.

NOTES

1. [1)] The eDRX cycle must be configured sufficiently long. In the WWAN priority mode, if the eDRX Sleep Cycle is shorter than the ***t*** + ***t1***, the GNSS will not be able to get a position fix. For more details, see ***Chapter 1.3.6.***
2. When the eDRX Sleep Cycle is less than ***t*** + ***t1*** or eDRX is not supported, it is recommended to set the modules into the GNSS priority mode.
3. When switching from the WWAN priority mode to the GNSS priority mode, the modules take about 1 second (in the open sky, see ***Chapter 1.3.3***) for GNSS to get a position fix (if GNSS have got a position fix before).

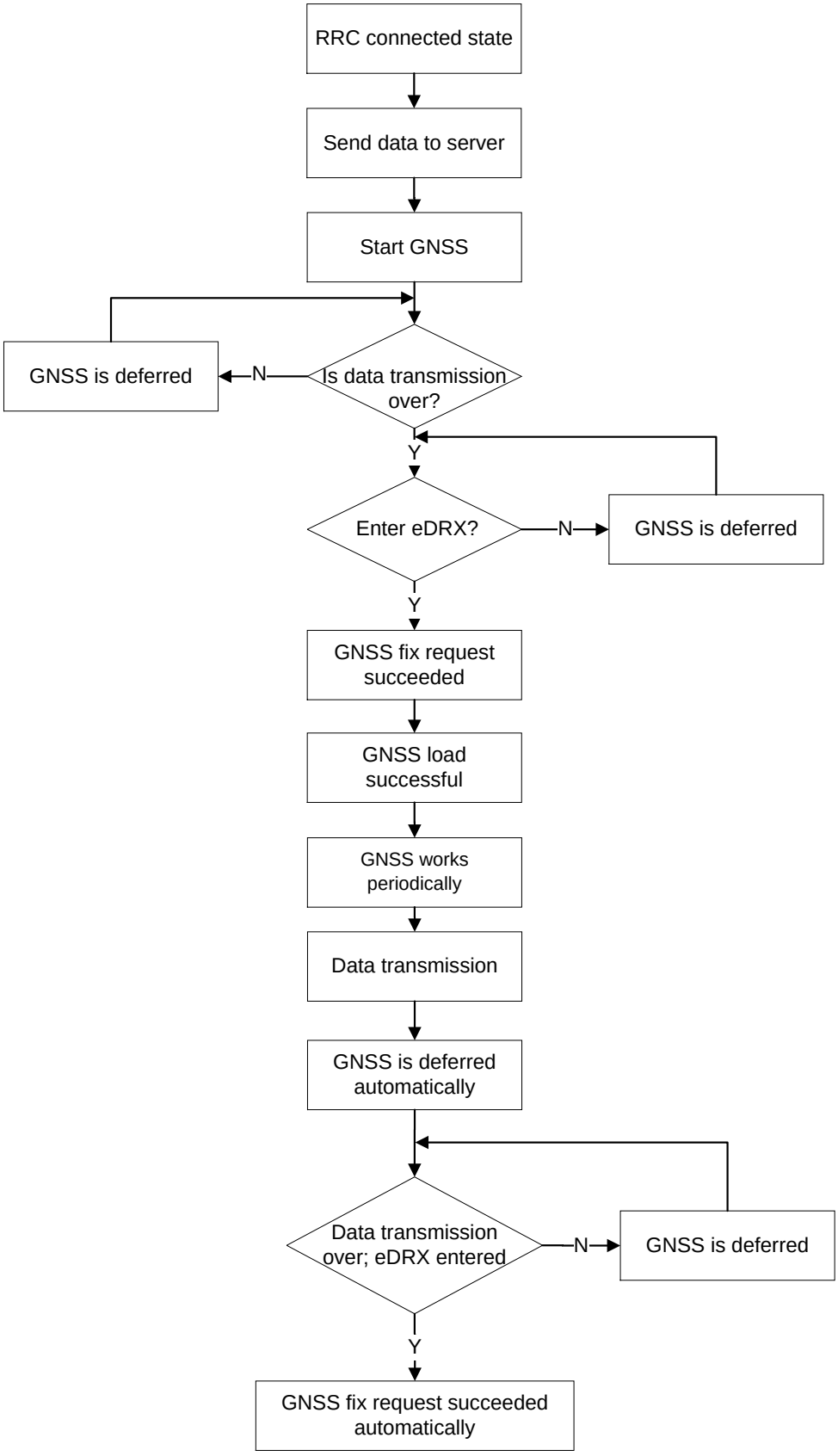

Figure 1: GNSS and WWAN Coexistence Management (WWAN Priority Mode)

1.3.2. GNSS Priority Mode

In the GNSS priority mode, GNSS positioning request succeeds in all WWAN states:

- **When UE is in the RRC connected state:**

  The UE locally releases the RRC connection and initiates the GNSS session. After the GNSS session is completed, if there is WWAN data to be sent, the RRC connection will be initiated again.

- **When UE in the eDRX state:**

  The UE may miss pages that were sent on the paging channel while the GNSS session is still active.

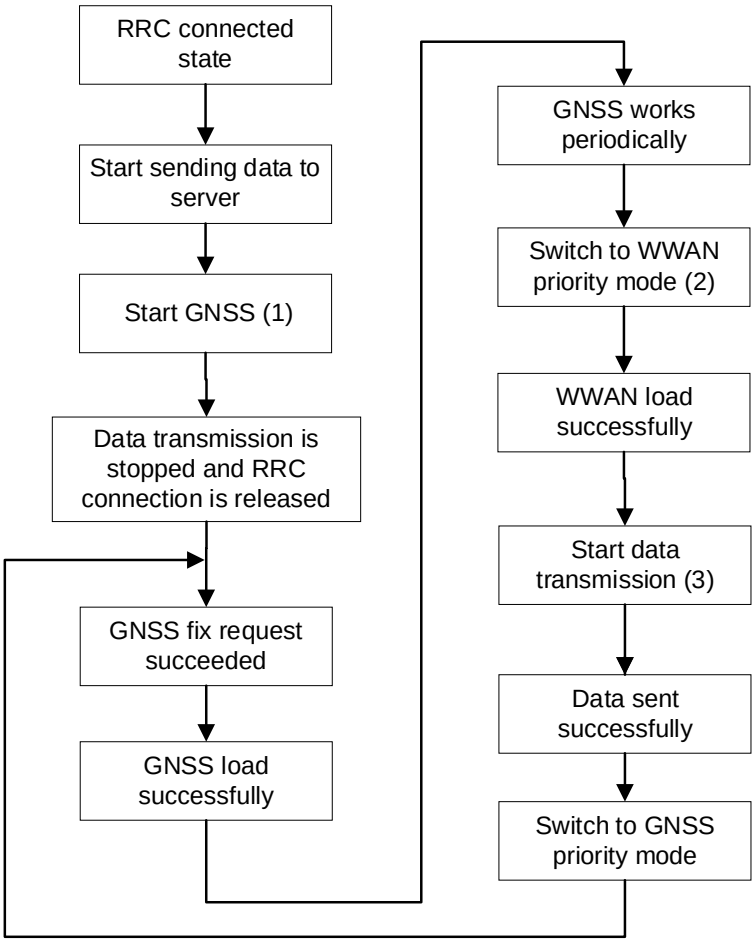

Figure 2: GNSS and WWAN Coexistence Management (GNSS Priority Mode)

NOTES

1. GNSS starts working as soon as the GNSS is started.
2. After switching to the WWAN priority mode, the GNSS is stopped automatically. In such a case, the

power consumption is the same as when the GNSS is stopped by **AT+QGPSEND** command.
3. It is recommended to delay 0.5 second before transmitting data as this is the time that the module needs to switch from the GNSS to the WWAN priority mode (see ***Chapter 1.3.3)***.
4. The following operations/procedures have higher priority than GNSS/WWAN:
   - Power-off/Power Saving Mode
   - PS detaching

1.3.3. WWAN and GNSS Switching Delays

The following table summarizes the average delays captured for different RATs. All tests were executed in the open sky, with the transmission of 500-byte data as an example. The presented average delays are given for the illustration purposes only and should be taken with precaution.

- **Test Environment**

GNSS CNR = 45 dB
LTE-M RSRP = -71 dBm
SINR = 21.4 dB
NB-IoT RSRP = -87 dBm
SINR = 15 dB
GSM RSSI = -48 dBm

- **Test Steps**

Load WWAN → Unload WWAN → Load GNSS → Get a position fix → Unload GNSS → Load WWAN → Transfer WWAN data.

Table 2: Average Delays Captured for Different RATs (Unit: s)

Network Type	LTE-M	NB-IoT	GSM
Load WWAN	0.251	0.177	0.259
Unload WWAN	0.153	0.087	0.339
Load GNSS	0.208	0.216	0.197
Unload GNSS	0.116	0.112	0.105
Delay Between “Switching to WWAN Priority Mode” and “Start Sending Data” [1)]	0.5	0.5	0.5
Time to Transfer WWAN Data (the delay for connection setup and connection close is not considered) [2)]	1.0	4.5	3.6

Delay Between “Switching to the GNSS Priority Mode” and “Getting GNSS Started”	0	0	0
GNSS Fix with/without gpsOneXTRA [3)]	1/1	1/1	1/1

NOTES

1. “Load” and “Unload” mentioned above mean loading/unloading WWAN/GNSS protocol stack.
2. [1)] Based on the test results, it is recommended to delay 0.5 second before sending data after switching from GNSS priority to WWAN priority mode.
3. [2)] The time used to transfer WWAN data varies depending on the coverage level and the data amount. In this example, we transferred 500-byte data.
4. [3)] The TTFF is about 10/30 seconds (with/without gpsOneXTRA in open sky, respectively) after a cold start. The data listed in the table above are the positioning time within 2 hours after a hot start.

1.3.4. GNSS/WWAN Priority and PSM

In the GNSS priority mode, PSM cannot be configured when GNSS is active. However, it can be configured before starting GNSS. After PSM is configured successfully, the modules will be able to enter PSM even when GNSS is active.

In the WWAN priority mode, the modules are able to configure and enter PSM no matter whether GNSS is active or not.

For actual scenario with PSM, see ***Chapter 4.1***.

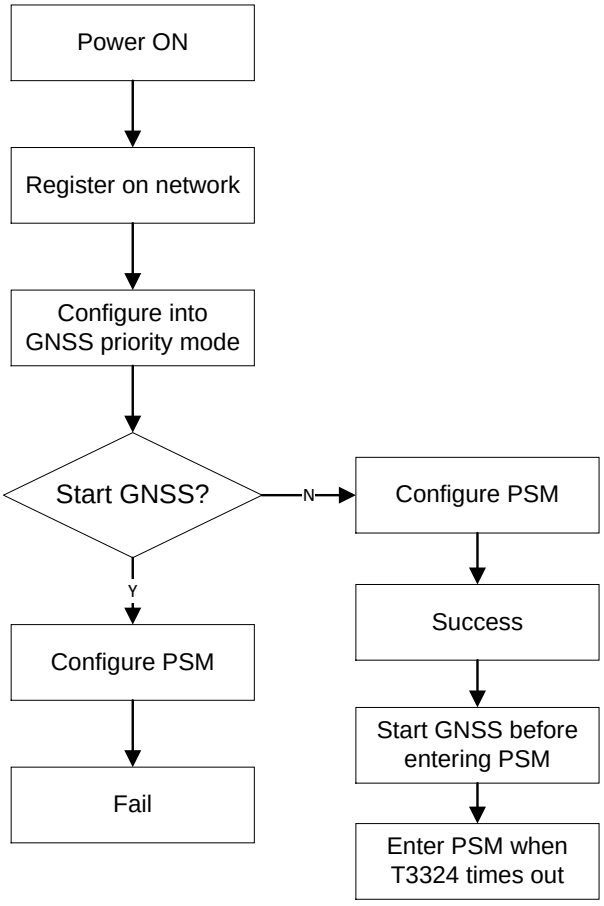

Figure 3: Configure PSM in GNSS Priority Mode

1.3.5. GNSS/WWAN Priority and eDRX

The eDRX can be configured in the GNSS priority mode when GNSS is turned off. However, the eDRX cannot be configured when GNSS is active under GNSS priority mode. In such a case, the modules cannot enter eDRX even if it has been configured successfully before starting GNSS.

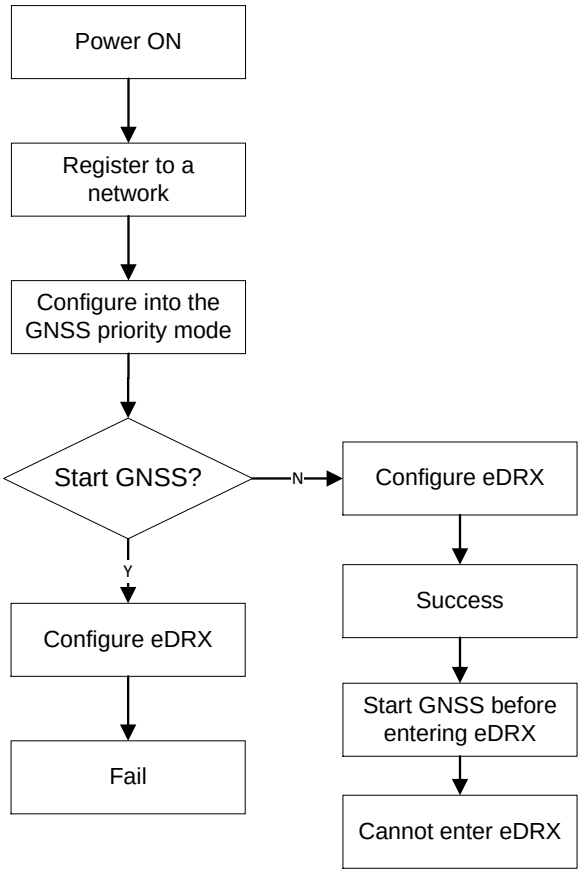

Figure 4: Configure eDRX in GNSS Priority Mode

In WWAN priority mode, the modules are able to configure and enter eDRX no matter whether GNSS is active or not.

1.3.6. Minimum eDRX Cycle Recommendation in WWAN Priority Mode

Assuming that a GNSS fix takes a maximum average of ***t*** seconds:

t1 = GNSS Unloading Time + WWAN Loading Time + Page Accepting Wake-up Time

From test observations, ***t1*** ≈ 1.5 seconds.

The recommended minimum eDRX Sleep Cycle should be > (***t*** + ***t1***) seconds.

eDRX Sleep Cycle = eDRX Cycle - PTW

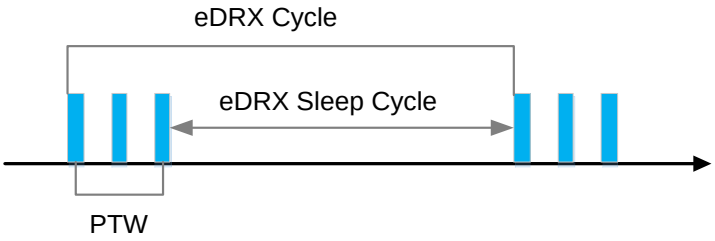

Figure 5: eDRX Diagram

Table 3: Recommended Minimum eDRX Cycle in WWAN Priority Mode (Unit: s)

Network Type	LTE-M	NB-IoT	GSM
Common eDRX Cycles	5.12 10.24 20.48 40.96 61.44 81.92 … 10485.76	20.48 40.96 61.44 163.84 …	eDRX not supported
Recommended Minimum eDRX Cycle (Cold start with gpsOneXTRA)	10.24 (PTW = 1.28)	20.48 (PTW ≤ 10.24)	/
Recommended Minimum eDRX Cycle (Cold start without gpsOneXTRA)	61.44 (PTW ≤ 20.48)	61.44 (PTW ≤ 20.48)	/

NOTES

1. The recommended minimum eDRX cycle is based on strong signal conditions. It is necessary to extend the eDRX Sleep Cycle under weak signal conditions.
2. The minimum eDRX Sleep Cycle must be greater than 8/40 seconds (cold start with/without gpsOneXTRA, respectively).

2 Description of GNSS AT Commands

2.1. AT Command Syntax

2.1.1. Definitions

- **<CR>** Carriage return character.
- **<LF>** Line feed character.
- **<...>** Parameter name. Angle brackets do not appear on the command line.
- **[...]** Optional parameter of a command or an optional part of TA information response. Square brackets do not appear on the command line. When an optional parameter is omitted, the new value equals to the previous value or the default settings, unless otherwise specified.
- **Underline** Default setting of a parameter.

2.1.2. AT Command Syntax

All command lines must start with "**AT**" or "**at**" and end with **"<CR>"**. Information responses and result codes always start and end with a carriage return character and a line feed character: **<CR><LF><response><CR><LF>**. Throughout this document, only the commands and responses are presented, while carriage return and line feed characters are deliberately omitted.

Table 4: Types of AT Commands and Responses

Command Type	Syntax	Description
Test Command	**AT+<cmd>=?**	Returns the list of parameters and value ranges set by the corresponding Write Command or internal processes.
Read Command	**AT+<cmd>?**	Returns the currently set value of a parameter or parameters.
Write Command	**AT+<cmd>=<p1>[,<p2>[,<p3>[...]]]**	Sets parameter values.
Execution Command	**AT+<cmd>**	Reads non-variable parameters affected by internal processes in the module.

2.2. AT Command Description

2.2.1. AT+QGPSCFG Configure GNSS

The command queries and configures various GNSS settings, including the NMEA output port and output types of NMEA sentences.

AT+QGPSCFG Configure GNSS	
Test Command **AT+QGPSCFG=?**	Response: **+QGPSCFG: "outport"**, (list of supported **<outport>**s), (list of supported **<baud_rate>**s) **+QGPSCFG: "gnssconfig"**, (range of supported **<GNSS_config>**s) **+QGPSCFG: "nmeafmt"**, (list of supported **<NMEA_fmt_config>**s) **+QGPSCFG: "gpsnmeatype"**, (list of supported **<GPS_NMEA_type>**s) **+QGPSCFG: "glonassnmeatype"**, (range of supported **<GLONASS_NMEA_type>**s) **+QGPSCFG: "galileonmeatype"**, (list of supported **<Galileo_NMEA_type>**s) **+QGPSCFG: "beidounmeatype"**, (range of supported **<BeiDou_NMEA_type>**s) **+QGPSCFG: "qzssnmeatype"**, (range of supported **<QZSS_NMEA_type>**s) **+QGPSCFG: "nmeasrc"**, (list of supported **<NMEA_src>**s) **+QGPSCFG: "autogps"**, (list of supported **<autoGPS>**s) **+QGPSCFG: "priority"**, (list of supported **<priority_type>**s), (list of supported **<save>**s) **OK**
Characteristics	/

2.2.1.1. AT+QGPSCFG="outport" Configure NMEA Output Port

The command queries and configures the NMEA output port and the port baud rate.

AT+QGPSCFG="outport" Configure NMEA Output Port	
Write Command **AT+QGPSCFG="outport"[,<outport>[,<baud_rate>]]**	Response If any of the optional parameters is omitted, the command queries the current configuration. **+QGPSCFG: "outport",<outport>[,<baud_rate>]** **OK**

	When the optional parameters are specified, the command configures the NMEA output port and the port baud rate when **<outport>** is "uartnmea" or "auxnmea". **OK** If there is any error related to the ME functionality: **+CME ERROR: <errcode>**
Maximum Response Time	300 ms
Characteristics	The command takes effect immediately. The configurations are saved automatically.

Parameter

<outport>	String type. NMEA output port. "none" Close NMEA sentence output "usbnmea" Output via USB NMEA port "uartnmea" Output via GNSS UART port "auxnmea" Output via debug UART port
<baud_rate>	Integer type. Baud rate of GNSS UART and debug UART port. Unit: bps. 4800 9600 19200 38400 57600 115200 230400 460800 921600
<errcode>	Integer type. Error code of an operation. Please refer to ***Chapter 6*** for details.

NOTES

1. The **<baud_rate>** is available only when **<outport>** is "uartnmea" or "auxnmea".
2. When **<baud_rate>** is 4800 or 9600, data loss may occur if a large amount of NMEA sentences are output.

2.2.1.2. AT+QGPSCFG="gnssconfig" Configure Supported GNSS Constellations

The command queries and configures the supported GNSS constellations of the module.

AT+QGPSCFG="gnssconfig" Configure Supported GNSS Constellations	
Write Command **AT+QGPSCFG="gnssconfig"[,<GNSS_config>]**	Response If the optional parameter is omitted, the command queries the current configuration. **+QGPSCFG: "gnssconfig",<GNSS_config>** **OK** If the optional parameter is specified, the command configures the supported GNSS constellations. **OK** If there is any error related to the ME functionality: **+CME ERROR: <errcode>**
Maximum Response Time	300 ms
Characteristics	The command takes effect after the module reboots. The configurations are saved automatically.

Parameter

<GNSS_config>	Integer type. Supported GNSS constellation. 1 GPS + GLONASS 2 GPS + BeiDou 3 GPS + Galileo 4 GPS + QZSS 5 Variable. One of the options (1–4) is selected based on MCC of the camped network
<errcode>	Integer type. Error code of an operation. Please refer to ***Chapter 6*** for details.

2.2.1.3. AT+QGPSCFG="nmeafmt" Configure NMEA Protocol Standard

The command queries and configures the protocol standard of NMEA sentences.

AT+QGPSCFG="nmeafmt" Configure NMEA Protocol Standard	
Write Command **AT+QGPSCFG="nmeafmt"[,<NMEA_fmt_config>]**	Response If the optional parameter is omitted, the command queries the current configuration. **+QGPSCFG: "nmeafmt",<NMEA_fmt_config>** **OK**

	If the optional parameter is specified, the command configures the NMEA protocol standard. **OK** If there is any error related to the ME functionality: **+CME ERROR: <errcode>**
Maximum Response Time	300 ms
Characteristics	The command takes effect immediately. The configurations are saved automatically.

Parameter

<NMEA_fmt_config>	Integer type. NMEA protocol standards. 0 The NMEA output sentences conform to Qualcomm's standards. 1 The NMEA output sentences conform to the NMEA 0183 version 4.10.
<errcode>	Integer type. Error code of an operation. Please refer to ***Chapter 6*** for details.

NOTE

For details of NMEA sentences in Qualcomm standards, please refer to ***Chapter 1.2***. NMEA sentences in Qualcomm standards and that in NMEA 0183 version 4.10 standard differ from each other only in the talker ID of RMC, GGA and VTG sentences.

2.2.1.4. AT+QGPSCFG="gpsnmeatype" Configure Output Type of GPS NMEA Sentences

The command queries and configures the output type of GPS NMEA sentences.

AT+QGPSCFG="gpsnmeatype"	**Configure Output Type of GPS NMEA Sentences**
Write Command **AT+QGPSCFG="gpsnmeatype"[,<GPS_NMEA_type>]**	Response If the optional parameter is omitted, the command queries the current configuration. **+QGPSCFG: "gpsnmeatype",<GPS_NMEA_type>** **OK** If the optional parameter is specified, the command configures the output type of GPS NMEA sentences. **OK** If there is any error related to the ME functionality: **+CME ERROR: <errcode>**

Maximum Response Time	300 ms
Characteristics	The command takes effect immediately. The configurations are saved automatically.

Parameter

<GPS_NMEA_type>	Integer type. Output type of GPS NMEA sentences by ORed. Range: 1–31. 0 Disable 1 GGA 2 RMC 4 GSV 8 GSA 16 VTG 31 All the five types above
<errcode>	Integer type. Error code of an operation. Please refer to ***Chapter 6*** for details.

2.2.1.5. AT+QGPSCFG="glonassnmeatype" Configure Output Type of GLONASS NMEA Sentences

The command queries and configures the output type of GLONASS NMEA sentences.

AT+QGPSCFG="glonassnmeatype" Configure Output Type of GLONASS NMEA Sentences	
Write Command **AT+QGPSCFG="glonassnmeatype"[,<GLONASS_NMEA_type>]**	Response If the optional parameter is omitted, the command queries the current configuration. **+QGPSCFG: "glonassnmeatype",<GLONASS_NMEA_type>** **OK** If the optional parameter is specified, the command configures the output type of GLONASS NMEA sentences. **OK** If there is any error related to the ME functionality: **+CME ERROR: <errcode>**
Maximum Response Time	300 ms
Characteristics	The command takes effect immediately. The configurations are saved automatically.

Parameter

<GLONASS_NMEA_type>	Integer type. Output type of GLONASS NMEA sentences by ORed. 0 Disable 1 GSV 2 GSA 3 GSV + GSA
<errcode>	Integer type. Error code of an operation. Please refer to ***Chapter 6*** for details.

2.2.1.6. AT+QGPSCFG="galileonmeatype" Configure Output Type of Galileo NMEA Sentences

The command queries and configures the output type of Galileo NMEA sentences.

AT+QGPSCFG="galileonmeatype" Configure Output Type of Galileo NMEA Sentences	
Write Command **AT+QGPSCFG="galileonmeatype"[,<Galileo_NMEA_type>]**	Response If the optional parameter is omitted, the command queries the current configuration. **+QGPSCFG: "galileonmeatype",<Galileo_NMEA_type>** **OK** If the optional parameter is specified, the command configures the output type of Galileo NMEA sentences. **OK** If there is any error related to the ME functionality: **+CME ERROR: <errcode>**
Maximum Response Time	300 ms
Characteristics	The command takes effect immediately. The configurations are saved automatically.

Parameter

<Galileo_NMEA_type>	Integer type. Output type of Galileo NMEA sentences by ORed. 0 Disable 1 GSV 2 GSA
<errcode>	Integer type. Error code of an operation. Please refer to ***Chapter 6*** for details.

2.2.1.7. AT+QGPSCFG="beidounmeatype" Configure Output Type of BeiDou NMEA Sentences

The command queries and configures the output type of BeiDou NMEA sentences.

AT+QGPSCFG="beidounmeatype" Configure Output Type of BeiDou NMEA Sentences	
Write Command **AT+QGPSCFG="beidounmeatype"[,<BeiDou_NMEA_type>]**	Response If the optional parameter is omitted, the command queries the current configuration. **+QGPSCFG: "beidounmeatype",<BeiDou_NMEA_type>** **OK** If the optional parameter is specified, the command configures the output type of BeiDou NMEA sentences. **OK** If there is any error related to the ME functionality: **+CME ERROR: <errcode>**
Maximum Response Time	300 ms
Characteristics	The command takes effect immediately. The configurations are saved automatically.

Parameter

<BeiDou_NMEA_type>	Integer type. Output type of BeiDou NMEA sentences by ORed. 0 Disable 1 GSA 2 GSV
<errcode>	Integer type. Error code of an operation. Please refer to ***Chapter 6*** for details.

2.2.1.8. AT+QGPSCFG="qzssnmeatype" Configure Output Type of QZSS NMEA Sentences

The command queries and configures the output type of QZSS NMEA sentences.

AT+QGPSCFG="qzssnmeatype"	Configure Output Type of QZSS NMEA Sentences
Write Command **AT+QGPSCFG="qzssnmeatype"[,<QZSS_NMEA_type>]**	Response If the optional parameter is omitted, the command queries the current configuration. **+QGPSCFG: "qzssnmeatype",<QZSS_NMEA_type>**

	OK If the optional parameter is specified, the command configures the output type of QZSS NMEA sentences. **OK** If there is any error related to the ME functionality: **+CME ERROR: <errcode>**
Maximum Response Time	300 ms
Characteristics	The command takes effect immediately. The configurations are saved automatically.

Parameter

<QZSS_NMEA_type>	Integer type. Output type of QZSS NMEA sentences by ORed. 0 Disable 1 GSA
<errcode>	Integer type. Error code of an operation. Please refer to ***Chapter 6*** for details.

2.2.1.9. AT+QGPSCFG="nmeasrc" Enable/Disable Acquisition of NMEA Sentences via AT+QGPSGNMEA

The command enables/disables the acquisition of NMEA sentences via **AT+QGPSGNMEA** and queries the current settings.

AT+QGPSCFG="nmeasrc" Enable/Disable Acquisition of NMEA Sentences via AT+QGPSGNMEA	
Write Command **AT+QGPSCFG="nmeasrc"[,<NMEA_src>]**	Response If the optional parameter is omitted, the command queries the current settings. **+QGPSCFG: "nmeasrc",<NMEA_src>** **OK** If the optional parameter is specified, the command configures whether to enable the acquisition of NMEA sentences via **AT+QGPSGNMEA**. **OK** If there is any error related to the ME functionality:

	+CME ERROR: <errcode>
Maximum Response Time	300 ms
Characteristics	The command takes effect immediately. The configurations are saved automatically.

Parameter

<NMEA_src>	Integer type. If enabled, original NMEA sentences can be acquired via **AT+QGPSGNMEA**. 0 Disable 1 Enable
<errcode>	Integer type. Error code of an operation. Please refer to ***Chapter 6*** for details.

2.2.1.10. AT+QGPSCFG="autogps" Enable/Disable GNSS to Run Automatically

The command enables/disables the automatic running of GNSS after the module is powered on or queries the current settings.

AT+QGPSCFG="autogps" Enable/Disable GNSS to Run Automatically	
Write Command **AT+QGPSCFG="autogps"[,<autoGPS>]**	Response If the optional parameter is omitted, the command queries the current settings. **+QGPSCFG: "autogps",<autoGPS>** **OK** If the optional parameter is specified, the command enables/disables the automatic running of GNSS. **OK** If there is any error related to the ME functionality: **+CME ERROR: <errcode>**
Maximum Response Time	300 ms
Characteristics	The command takes effect after the module reboots. The configurations are saved automatically.

Parameter

<autoGPS>	Integer type. Enable/disable GNSS to run automatically after the module is powered on.

	0 Disable GNSS to run automatically 1 Enable GNSS to run automatically
<errcode>	Integer type. Error code of an operation. Please refer to ***Chapter 6*** for details.

NOTES

1. GNSS runs automatically with a high positioning accuracy and 1 Hz fix rate.
2. After enabling this function, the module may fail to register to a network, since the module cannot search network when GNSS is active and in high priority.

2.2.1.11. AT+QGPSCFG="priority" Set GNSS or WWAN Priority Mode

The command sets the GNSS or WWAN priority mode, or queries the current settings.

AT+QGPSCFG="priority" Set GNSS or WWAN Priority Mode	
Write Command **AT+QGPSCFG="priority"[,<priority_type>[,<save>]]**	Response If any of the parameters is omitted, the command queries the current settings. **+QGPSCFG: "priority",<priority_type>,<state>** **OK** If the optional parameters are specified, the command configures the GNSS or priority mode. **OK** If there is any error related to the ME functionality: **+CME ERROR: <errcode>**
Maximum Response Time	300 ms
Characteristics	The command take effect immediately. Whether to save the configuration is decided by **<save>**.

Parameter

<priority_type>	Integer type. Switch between GNSS and WWAN priority mode. 0 GNSS priority mode 1 WWAN priority mode
<save>	Integer type. Choose whether to save the configuration to NVRAM. 0 Do not save to NVRAM 1 Save to NVRAM
<state>	Integer type. GNSS/WWAN state.

	0 WWAN/GNSS in unloaded state 1 WWAN in pending state 2 GNSS in pending state 3 WWAN in loaded state 4 GNSS in loaded state
<errcode>	Integer type. Error code of an operation. Please refer to ***Chapter 6*** for details.

2.2.2. AT+QGPS Turn on GNSS

The command turns on the GNSS function. When **<fix_count>** is 0, the GNSS continuously gets a position fix and is always on. In that case, you can turn off the GNSS with the **AT+QGPSEND** command. If **<fix_count>** is not zero, the GNSS will be turned off automatically when **<fix_count>** reaches the specified value.

AT+QGPS Turn on GNSS	
Test Command **AT+QGPS=?**	Response **+QGPS:** (list of supported **<GNSS_mode>), [(**range of supported **<accuracy>**s**), [(**range of supported **<fix_count>**s**), [(**range of supported **<fix_rate>**s**)]]]** **OK**
Read Command **AT+QGPS?**	Response **+QGPS: <GNSS_state>** **OK**
Write Command **AT+QGPS=<GNSS_mode>[,<accuracy>[,<fix_count>[,<fix_rate>]]]**	Response **OK** If there is any error related to the ME functionality: **+CME ERROR: <errcode>**
Maximum Response Time	300 ms
Characteristics	The command takes effect immediately. The configurations are not saved.

Parameter

<GNSS_state>	Integer type. GNSS state. 0 GNSS OFF 1 GNSS ON
<GNSS_mode>	Integer type. GNSS working mode. 1 Stand-alone mode

<accuracy>	Integer type. The desired level of accuracy that is acceptable for fix computation. 1 Low Accuracy 2 Medium Accuracy 3 High Accuracy The default value is 3.
<fix_count>	Integer type. Number of attempts for positioning or continuous positioning. Range: 0–1000. The default value is 0. 0 indicates continuous positioning. Other values indicate the number of attempts for positioning. When the value reaches the specified number of attempts, the GNSS will be stopped.
<fix_rate>	The interval time between the first- and second-time positioning. Unit: second. If **<fix_rate>** < 1, it is a float type. Available options: 0.1 0.2 0.5 If **<fix_rate>** ≥ 1, it is an integer type. Range: 1–65535.
<errcode>	Integer type. Error code of an operation. Please refer to ***Chapter 6*** for details.

2.2.3. AT+QGPSEND Turn off GNSS

The command turns off GNSS. It is used when GNSS is turned on and continuously fixes position (**<fix_count>** is 0). In such a case, GNSS can be turned off with **AT+QGPSEND** command.

You do not need to use this command when **<fix_count>** is not zero, as GNSS will be turned off automatically when **<fix_count>** reaches the specified value.

AT+QGPSEND Turn off GNSS	
Test Command **AT+QGPSEND=?**	Response **OK**
Execution Command **AT+QGPSEND**	Response **OK** If there is any error related to the ME functionality: **+CME ERROR: <errcode>**
Maximum Response Time	300 ms
Characteristics	The command takes effect immediately.

Parameter

<errcode>	Integer type. Error code of an operation. Please refer to ***Chapter 6*** for details.

2.2.4. AT+QGPSLOC Acquire Positioning Information

The command acquires positioning information. Before executing the command, GNSS must be turned on via **AT+QGPS**.

AT+QGPSLOC Acquire Positioning Information	
Test Command **AT+QGPSLOC=?**	Response **+QGPSLOC: (**range of supported **<mode>**s**)[,(**range of supported **<time>**s**)]** **OK**
Write Command **AT+QGPSLOC=<mode>[,<time>]**	Response **+QGPSLOC: <UTC>,<latitude>,<longitude>,<HDOP>,<altitude>,<fix>,<COG>,<spkm>,<spkn>,<date>,<nsat>** **OK** If there is any error related to the ME functionality: **+CME ERROR: <errcode>**
Read Command **AT+QGPSLOC?**	Response Return the positioning information in **<latitude>,<longitude>** format of ddmm.mmmmN/S,dddmm.mmmmE/W: **+QGPSLOC: <UTC>,<latitude>,<longitude>,<HDOP>,<altitude>,<fix>,<COG>,<spkm>,<spkn>,<date>,<nsat>** **OK**
Maximum Response Time	300 ms
Characteristics	The command takes effect immediately. The configurations is not saved.

Parameter

<mode>	Integer type. Latitude and longitude display format. 0 **<latitude>,<longitude>** format: ddmm.mmmmN/S,dddmm.mmmmE/W 1 **<latitude>,<longitude>** format: ddmm.mmmmmm,N/S,dddmm.mmmmmm,E/W 2 **<latitude>,<longitude>** format: (-)dd.ddddd,(-)ddd.ddddd
<time>	Integer type. The time period when the queried results should be reported. Range: 0–3600. Unit: s. 0 indicates that the feature is turned off.
<UTC>	String type. UTC time. Format: hhmmss.sss (Quoted from GPGGA sentence).
<latitude>	Float type. Latitude. If **<mode>** is 0:

	Format: ddmm.mmmmN/S (Quoted from GPGGA sentence) dd 00–89 (Unit: degree) mm.mmmm 00.0000–59.9999 (Unit: minute) N/S North latitude / South latitude If **<mode>** is 1: Format: ddmm.mmmmmm,N/S (Quoted from GPGGA sentence) dd 00–89 (Unit: degree) mm.mmmmmm 00.000000–59.999999 (Unit: minute) N/S North latitude/South latitude If **<mode>** is 2: Format: (-)dd.ddddd (Quoted from GPGGA sentence) dd.ddddd -89.99999 to 89.99999 (Unit: degree) - South latitude
<longitude>	Float type. Longitude. If **<mode>** is 0: Format: dddmm.mmmmE/W (Quoted from GPGGA sentence) ddd 000–179 (Unit: degree) mm.mmmm 00.0000–59.9999 (minute) E/W East longitude / West longitude If **<mode>** is 1: Format: dddmm.mmmmmm,E/W (Quoted from GPGGA sentence) ddd 000–179 (Unit: degree) mm.mmmmmm 00.000000–59.999999 (Unit: minute) E/W East longitude / West longitude If **<mode>** is 2: Format: (-)dd.ddddd (Quoted from GPGGA sentence) dd.ddddd -179.99999 to 179.99999 (Unit: degree) - West longitude
<HDOP>	Float type. Horizontal precision. Range: 0.5–99.9 (Quoted from GPGGA sentence).
<altitude>	Float type. The altitude of the antenna away from the sea level, accurate to one decimal place. Unit: meter. (Quoted from GPGGA sentence)
<fix>	Integer type. GNSS positioning mode (Quoted from GNGSA/GPGSA sentence). 2 2D positioning 3 3D positioning
<COG>	String type. Course Over Ground based on true north. Format: ddd.mm (Quoted from GPVTG sentence). ddd 000–359 (Unit: degree) mm 00–59 (Unit: minute)
<spkm>	Float type. Speed over ground. Format: xxxx.x. Unit: Km/h. Accurate to one decimal place (Quoted from GPVTG sentence).
<spkn>	Float type. Speed over ground. Format: xxxx.x. Unit: knots. Accurate to one decimal place (Quoted from GPVTG sentence).

<date>	String type. UTC time when fixing position. Format: ddmmyy (Quoted from GPRMC sentence).
<nsat>	Integer type. Number of satellites, from 00 (the first 0 should be retained) to 12 (Quoted from GPGGA sentence).
<errcode>	Integer type. Error code of an operation. Please refer to ***Chapter 6*** for details.

NOTE

The response of **AT+QGPSLOC?** is same with that of **AT+QGPSLOC=0**.

2.2.5. AT+QGPSGNMEA Acquire NMEA Sentences

The command acquires NMEA sentences. Before using this command, turn on the GNSS via **AT+QGPS**, and set **<NMEA_src>** to 1 with **AT+QGPSCFG="nmeasrc"** command.

The sentence output can also be disabled via **AT+QGPSCFG="gpsnmeatype",0**, **AT+QGPSCFG="glonassnmeatype",0**, **AT+QGPSCFG="galileonmeatype",0** and **AT+QGPSCFG="beidounmeatype",0**.

AT+QGPSGNMEA Acquire NMEA Sentences	
Test Command **AT+QGPSGNMEA=?**	Response **+QGPSGNMEA: (**list of supported **<NMEA_sentence>**s**)** **OK**
Write Command Acquire GGA sentences **AT+QGPSGNMEA="GGA"**	Response **+QGPSGNMEA: <GGA_sentence>** **OK** If there is any error related to the ME functionality: **+CME ERROR: <errcode>**
Write Command Acquire RMC sentences **AT+QGPSGNMEA="RMC"**	Response **+QGPSGNMEA: <RMC_sentence>** **OK** If there is any error related to the ME functionality: **+CME ERROR: <errcode>**
Write Command Acquire GSV sentences **AT+QGPSGNMEA="GSV"**	Response **+QGPSGNMEA: <GSV_sentence>** **OK**

	If there is any error related to the ME functionality: **+CME ERROR: <errcode>**
Write Command Acquire GSA sentences **AT+QGPSGNMEA="GSA"**	Response **+QGPSGNMEA: <GSA_sentence>** **OK** If there is any error related to the ME functionality: **+CME ERROR: <errcode>**
Write Command Acquire VTG sentences **AT+QGPSGNMEA="VTG"**	Response **+QGPSGNMEA: <VTG_sentence>** **OK** If there is any error related to the ME functionality: **+CME ERROR: <errcode>**
Maximum Response Time	300 ms
Characteristics	The command takes effect immediately.

Parameter

<GGA_sentence>	String type. GGA sentences.
<RMC_sentence>	String type. RMC sentences.
<GSV_sentence>	String type. GSV sentences.
<GSA_sentence>	String type. GSA sentences.
<VTG_sentence>	String type. VTG sentences.
<errcode>	Integer type. Error code of an operation. Please refer to ***Chapter 6*** for details.

2.2.6. AT+QCFGEXT Query and Configure Extended Settings

The command queries and configures various extended settings of the module.

AT+QCFGEXT Query and Configure Extended Settings	
Test Command **AT+QCFGEXT=?**	Response **+QCFGEXT: "addgeo",<geoid>,<mode>,<shape>,<lat1>,<lon1>,<lat2>[,<lon2>[,<lat3>,<lon3>[,<lat4>,<lon4>]]]** **+QCFGEXT: "deletegeo",<geoid>** **+QCFGEXT: "querygeo",<geoid>** **OK**

Maximum Response Time	300 ms
Characteristics	/
Reference	/

2.2.6.1. AT+QCFGEXT="addgeo" Add a Geo-fence

The command adds a geo-fence or queries the current settings.

AT+QCFGEXT="addgeo" Add a geo-fence	
Write Command **AT+QCFGEXT="addgeo",[<geoid>,[<mode>,<shape>,<lat1>,<lon1>,<lat2>,[<lon2>,[<lat3>,<lon3>[,<lat4>,<lon4>]]]]]**	Response If all parameters after **"addgeo"** are omitted, the command queries the current setting of all geo-fences that have been added. **[+QCFGEXT: "addgeo",<geoid>,<mode>,<shape>,<lat1>,<lon1>,<lat2>,[<lon2>,[<lat3>,<lon3>[,<lat4>,<lon4>]]]** **…** **+QCFGEXT: "addgeo",<geoid>,<mode>,<shape>,<lat1>,<lon1>,<lat2>,[<lon2>,[<lat3>,<lon3>[,<lat4>,<lon4>]]]]** **OK** If the parameters after **<geoID>** are omitted, the command queries the current setting of the specified geo-fence. **+QCFGEXT: "addgeo",<geoid>,<mode>,<shape>,<lat1>,<lon1>,<lat2>,[<lon2>,[<lat3>,<lon3>[,<lat4>,<lon4>]]]** **OK** If **<shape>**=0, the command adds a circular geo-fence and the parameters after **<lat2>** must be omitted. **OK** If **<shape>**=1, the command adds a circular geo-fence and the parameters after **<lon2>** must be omitted. **OK** If **<shape>**=2, the command adds a triangular geo-fence and the parameters after **<lon3>** must be omitted. **OK** If **<shape>**=3, the command adds a quadrangle geo-fence.

	All parameters must be specified. **OK** If there is any error related to ME functionality: **+CME ERROR: <errcode>**
Maximum Response Time	300 ms
Characteristics	The command takes effect immediately. The configurations are not saved.

Parameter

<geoid>	Integer type. Geo-fence ID. Range: 0–9.
<mode>	Integer type. URC report mode. 0 Disable URC to be reported when entering or leaving the geo-fence 1 Enable URC to be reported when entering the geo-fence 2 Enable URC to be reported when leaving the geo-fence 3 Enable URC to be reported when entering or leaving the geo-fence The URC is shown as below: **+QIND: "GEOFENCE",<ID>,<action>,<time>,<latitude>,<longitude>,<altitude>,<course>,<speed>,<PDOP>,<HDOP>,<VDOP>** The parameters of the URC are described as below: **<ID>** The ID of geo-fence which is to be entered or left. **<action>** The current action of the module. 1 Entering the geo-fence 2 Leaving the geo-fence **<time>** The UTC time when entering or leaving the geo-fence. Format: yyyy-MM-dd hh:mm:ss **<latitude>** The latitude of module when entering or leaving the geo-fence. Unit: degree. **<longitude>** The longitude of module when entering or leaving the geo-fence. Unit: degree. Format: ±ddd.dddddd. Range: -180.000000 to 180.000000. **<altitude>** Mean sea level altitude. Unit: meter. **<course>** Course over ground, relative to true north. Unit: degree. **<speed>** Speed over ground. Unit: m/s. **<PDOP>** Position dilution of precision. **<HDOP>** Horizontal dilution of precision. **<VDOP>** Vertical dilution of precision.
<shape>	Integer type. Geo-fence shape. 0 Circularity with center and radius 1 Circularity with center and one point on the circle 2 Triangle 3 Quadrangle

<lat1>	The latitude of a point which is defined as the center of the geo-fence circular region or the first point. Unit: degree. Format: ±dd.dddddd. Range: -90.000000 to 90.000000.
<lon1>	The longitude of a point which is defined as the center of the geo-fence circular region or the first point. Unit: degree. Format: ±ddd.dddddd. Range: -180.000000 to 180.000000.
<lat2>	When **<shape>** is 0, this parameter is a radius. Range: 0–6000000. Unit: meter. When **<shape>** is not 0, this parameter is a latitude. Unit: degree. Format: ±dd.dddddd. Range: -90.000000 to 90.000000. If **<shape>** is 0, the parameters after **<lat2>** must be omitted.
<lon2>	The longitude of the second point. Unit: degree. Format: ±ddd.dddddd. Range: -180.000000 to 180.000000. If **<shape>** is 1, the parameters after **<lon2>** must be omitted.
<lat3>	The latitude of the third point. Unit: degree. Format: ±dd.dddddd. Range: -90.000000 to 90.000000.
<lon3>	The longitude of the third point. Unit: degree. Format: ±ddd.dddddd. Range: -180.000000 to 180.000000. If **<shape>** is 2, the parameters after **<lon3>** must be omitted.
<lat4>	The latitude of the fourth point. Unit: degree. Format: ±dd.dddddd. Range: -90.000000 to 90.000000.
<lon4>	The longitude of the fourth point. Unit: degree. Format: ±ddd.dddddd. Range: -180.000000 to 180.000000.
<errcode>	Integer type. Error code of an operation. Please refer to ***Chapter 6*** for details.

2.2.6.2. AT+QCFGEXT="deletegeo" Delete a Geo-fence

The command deletes a geo-fence.

AT+QCFGEXT="deletegeo" Delete a Geo-fence	
Write Command **AT+QCFGEXT="deletegeo",<geoid>**	Response: **OK** If there is any error related to the ME functionality: **+CME ERROR: <errcode>**
Maximum Response Time	300 ms
Characteristics	The command takes effect immediately. The configuration is not saved.

Parameter

<geoid>	Integer type. Geo-fence ID. Range: 0–10. 10 means deleting all geo-fences.
<errcode>	Integer type. Error code of an operation. Please refer to ***Chapter 6*** for details.

2.2.6.3. AT+QCFGEXT="querygeo" Query the Position with Respect to Geo-Fence

The command queries the position with respect to the geo-fence.

AT+QCFGEXT="querygeo" Query the Position with Respect to Geo-Fence	
Write Command **AT+QCFGEXT="querygeo",<geoid>**	Response: **+QCFGEXT: "querygeo",<geoid>,<pos_wrt_geofence>** **OK** If there is any error related to the ME functionality: **+CME ERROR: <errcode>**
Maximum Response Time	300 ms
Characteristics	/

Parameter

<geoid>	Integer type. Geo-fence ID. Range: 0–9.
<pos_wrt_geofence>	Integer type. Position with respect to the geo-fence. 0 Position unknown 1 Position is inside the geo-fence 2 Position is outside the geo-fence
<errcode>	Integer type. Error code of an operation. Please refer to ***Chapter 6*** for details.

3 Examples

3.1. Turn on/off the GNSS

Default arguments are used in this example to turn on GNSS. After turning on GNSS, NMEA sentences will be output from "usbnmea" port by default, and GNSS can be turned off via **AT+QGPSEND**.

```
AT+QGPS=1                    //Turn on GNSS.
OK

//After turning on GNSS, NMEA sentences will be output from "usbnmea" port by default.
AT+QGPSLOC?                  //Obtain positioning information.
+QGPSLOC: 130618.0,3150.8076N,11711.9039E,0.8,89.5,2,0.00,0.0,0.0,110919,12

OK
AT+QGPSEND                   //Turn off GNSS.
OK
```

3.2. Acquire Positioning Information

In the following example, you can see how the positioning information can be acquired via **AT+QGPSLOC** after the GNSS has been turned on and the position fix obtained.

```
AT+QGPS=1                    //Turn on GNSS.
OK

AT+QGPSLOC?
+CME ERROR: 516              //Not fixed
AT+QGPSLOC?                  //Obtain positioning information.
+QGPSLOC: 130618.0,3150.8076N,11711.9039E,0.8,89.5,2,0.00,0.0,0.0,110919,12
OK

AT+QGPSLOC=0                 //Set the latitude and longitude display format to
                             ddmm.mmmmN/S,dddmm.mmmmE/W
```

```
+QGPSLOC: 131050.0,3150.8069N,11711.9032E,1.2,90.7,3,0.00,0.0,0.0,110919,08
OK

AT+QGPSLOC=1                    //Set the latitude and longitude display format to
                                ddmm.mmmmmm,N/S,dddmm.mmmmmm,E/W
+QGPSLOC: 131117.0,3150.806972,N,11711.903278,E,1.3,90.6,3,0.00,0.0,0.0,110919,07
OK

AT+QGPSLOC=2                    //Set the latitude and longitude display format to
                                (-)dd.ddddd,(-)ddd.ddddd
+QGPSLOC: 131140.0,31.84678,117.19838,1.3,90.5,3,0.00,0.0,0.0,110919,07
OK

AT+QGPSLOC=2,1                  //Obtain positioning information and enable periodical location report.
+QGPSLOC: 131305.0,31.84678,117.19838,1.8,89.9,3,0.00,0.0,0.0,110919,07
OK

+QGPSLOC: 131306.0,31.84678,117.19838,1.0,89.9,3,0.00,0.0,0.0,110919,08

+QGPSLOC: 131307.0,31.84678,117.19838,1.0,89.9,3,0.00,0.0,0.0,110919,08

+QGPSLOC: 131308.0,31.84678,117.19838,0.9,89.9,3,0.00,0.0,0.0,110919,08

AT+QGPSLOC=2,0                  //Obtain positioning information and disable periodical location report.
+QGPSLOC: 131431.0,31.84678,117.19838,0.9,89.7,3,0.00,0.0,0.0,110919,09
OK
```

3.3. Query Satellite System

```
AT+QGPSCFG="gnssconfig"     //Query enabled satellite systems
+QGPSCFG: "gnssconfig",1    //GPS and GLONASS are enabled.

OK
AT+QGPS=1                   //Turn on GNSS.
OK
AT+QGPSGNMEA="GSV"
$GPGSV,4,1,14,02,68,055,16,04,00,000,31,05,64,314,26,07,08,070,18,1*6D     //GPS GSV sentence.
$GPGSV,4,2,14,09,04,037,30,12,11,228,36,15,16,207,20,19,11,155,14,1*6B
$GPGSV,4,3,14,25,09,269,20,29,27,316,32,06,26,101,,13,41,177,,1*68
$GPGSV,4,4,14,17,00,000,,30,10,091,,1*6D
$GLGSV,2,1,05,22,32,332,26,20,25,136,13,21,78,073,18,07,57,243,21,1*78     //GLONASS GSV
                                                                            sentence
```

```
$GLGSV,2,2,05,08,10,224,,1*40

OK
AT+QGPSCFG="gnssconfig",2          //Enable GPS and BeiDou.
OK
/*Restarts module*/
RDY

APP RDY
AT+QGPSCFG="gnssconfig"            //Query enabled satellite systems.
+QGPSCFG: "gnssconfig",2           //GPS and BeiDou are enabled.

OK
AT+QGPS=1                          //Turn on GNSS.
OK
AT+QGPSGNMEA="GSV"
$GPGSV,3,1,11,02,64,089,36,04,00,000,39,05,63,346,45,06,21,113,27,1*6F    //GPS GSV sentence
$GPGSV,3,2,11,07,09,059,45,12,02,218,33,15,29,211,30,25,04,257,27,1*64
$GPGSV,3,3,11,29,37,307,41,30,16,090,29,13,57,173,,1*59
$PQGSV,1,1,03,13,65,343,34,14,72,329,26,21,08,052,42,1*45                  //BeiDou GSV sentence

OK
```

3.4. Implement Geo-Fence Function

```
AT+QCFGEXT="addgeo",0,3,0,31.826,117.2168,100      //Add a circular geo-fence 0.
OK
AT+QCFGEXT="addgeo",0                              //Query the setting of the circular geo-fence 0.
+QCFGEXT: "addgeo",0,3,0,31.826000,117.216800,100.0

OK
AT+QCFGEXT="addgeo",7,1,3,31.833348,117.212909,31.826453,117.213248,31.82873,117.222093,31.833502,117.2208623                                    //Add a quadrangle geo-fence 7.
OK
AT+QCFGEXT="addgeo",7                              //Query the settings of geo-fence 7.
+QCFGEXT:
"addgeo",7,1,3,31.833348,117.212909,31.826453,117.213248,31.828730,117.222093,31.833502,117.220862

OK
```

```
AT+QCFGEXT="deletegeo",7                    //Delete geo-fence 7.
OK

AT+QGPS=1                                   //Turn on the GNSS engine.
OK
AT+QCFGEXT="querygeo",0                     //Query the position with respect to geo-fence 0.
+QCFGEXT: "querygeo",0,1                    //The current position is inside the geo-fence 0.

OK

//When entering the geo-fence 0, this URC will be reported.
+QIND: "GEOFENCE",0,1,2017/08/25 08:35:53,31.825179,117.217127,34.0,0.2,13.8,1.1,0.7,0.8
//When leaving the geo-fence 0, this URC will be reported.
+QIND: "GEOFENCE",0,2,2017/08/25 08:36:07,31.826951,117.217071,38.0,359.0,13.4,0.9,0.6,0.6
```

4 Use Cases

Considering the complexity of GNSS feature of the modules and the fact that those use cases listed below cannot cover all tracking applications and extreme cases, we strongly suggest you to provide the specific application cases to Quectel Technical Support team for a review via support@quectel.com or http://e-service.quectel.com.

4.1. PSM Enabled

The recommended procedure for using the PSM is given below. For more information on PSM implementation, see ***document [6]***.

Procedure

1. Power on the module and then register to a network
2. Configure PSM (such as T3412 = 6 hours, T3324 = 10 minutes)
3. Wake up from PSM
4. Set the module into the GNSS priority mode
5. Turn on GNSS and get a position fix
6. Switch to the WWAN priority mode
7. Report positioning information and other data to the server
8. Enter PSM
9. Repeat 3-8

4.2. Recommended Mode: WWAN Priority Mode

The WWAN priority mode is recommended when there is a high demand for data transmission services. Before using the WWAN priority mode, make sure that both conditions are satisfied:

- The eDRX is used, and the eDRX cycle is longer than TTFF
- There is a low demand for GNSS positioning

The recommended procedure for using the WWAN priority mode is given below.

Procedure

1. Configure the eDRX cycle that is sufficiently longer than TTFF[1)]
2. Wake up from the sleep mode
3. Turn on GNSS (GNSS session may be deferred to eDRX)
4. Obtain the GNSS positioning information
5. Turn off GNSS or switch to the WWAN priority mode[2]
6. Report position information to the server
7. Return to the sleep mode
8. Repeat 2-7

NOTES

1. [1)] For details of TTFF values, refer to the corresponding hardware design manuals.
2. Step 5 is optional, as it depends on the practical applications and the current consumption requirements.

4.3. Recommended Mode: GNSS Priority Mode

The GNSS priority mode is recommended when there is high demand for GNSS positioning and low demand for data transmission.

The recommended procedure for using the GNSS priority mode is given below.

Procedure

1. Wake up from the sleep mode
2. Turn on GNSS (GNSS session starts immediately)
3. Collect data from sensors and obtain the GNSS positioning information
4. Turn off GNSS or switch to WWAN priority mode
5. Report sensor data and positioning information to the server
6. Return to sleep mode
7. Repeat 1-6

NOTE

It will take at least 44.5 seconds for one cycle if you transfer 500 bytes of data: TCP connect time (8 s) + Time used to send 500 bytes of data (4.5 s) + TCP close time (10 s) + GNSS fix time (30 s) + delay time (2 s). If gpsOneXTRA is enabled, this time can be reduced to 24.5 s.

4.4. Limitations of GNSS

In applications following the steps below, there may be limitations on reporting positioning and sensor data. A success of the query on step 7 cannot be guaranteed every time, because the page may be lost when GNSS is in active status with GNSS priority. Additionally, getting position on time cannot be guaranteed either if WWAN is preferential. In these cases, it is recommended to select a solution where GNSS and WWAN could work simultaneously, either Quectel BG96 module, or Quectel BG95/BG77/BG600L-M3 module with an external GNSS module.

Procedure

1. Wake up from sleep mode
2. Turn on GNSS (GNSS session started immediately)
3. Collect data from sensors and obtain the GNSS positioning information
4. Turn off GNSS or switch to WWAN priority mode
5. Report sensor data and positioning information to server
6. Return to sleep mode
7. The sensor data and positioning information may be queried from the network side anytime during 2–5
8. Repeat 1–7

5 FAQ

1. **Q:** Why cannot the module register to a network when the GNSS auto-start feature is enabled with the following command: **AT+QGPSCFG="autogps",1**?

   A: If your module is in the GNSS priority mode, If GNSS starts automatically when the module powers up, the module will be failed to register on network. Please configure the module into WWAN priority mode if GNSS auto-start feature is needed.

2. **Q:** When GNSS is active and in high priority, the module can detach from the network after executing **AT+CFUN=0**, but why cannot it register to the network after executing **AT+CFUN=1**?

   A: Network detachment has higher priority than GNSS/WWAN, so the module can detach from the network even if the module is in the GNSS priority mode. However, network attachment does not have the same priority as network detachment, so the module cannot register to the network when the module is in the GNSS priority mode.

3. **Q:** Why reporting sensor data and positioning information sometimes does not work?
   A: Reporting sensor data and positioning information cannot be guaranteed every time because the page may be lost when GNSS is in the active status with GNSS priority. Additionally, getting position on time cannot be guaranteed either if WWAN is preferential. In these cases, it is recommended to select a solution where GNSS and WWAN could work simultaneously, either Quectel BG96 module, or Quectel BG95/BG77/BG600L module with an external GNSS module.

6 Summary of Error Codes

The **<errcode>** indicates an error related to the GNSS operation. The details about **<errcode>** are described in the following table.

Table 5: Summary of Error Codes

<errcode>	Description
501	Invalid parameter
502	Operation not supported
503	GNSS subsystem busy
504	Ongoing session
505	Session not active
506	Operation timeout
507	Function not enabled
508	Time information error
509	gpsOneXTRA not enabled
512	Validity time is out of range
513	Internal resource error
514	GNSS locked
515	End by E911
516	No fix
517	Geo-fence ID does not exist
549	Unknown error

7 Appendix A References

Table 6: Related Documents

SN	Document Name	Remark
[1]	Quectel_BG95&BG77&BG600L_Series_AT_Commands_Manual	AT commands Manual for BG95 Series, and BG77 and BG600L-M3 Modules
[2]	Quectel_BG95&BG77&BG600L_Series_FILE_Application_Note	FILE Application Note for BG95 Series, and BG77 and BG600L-M3 Modules
[3]	Quectel_BG95_Series_Hardware_Design	Hardware Design for BG95 Series
[4]	Quectel_BG77_Hardware_Design	Hardware Design for BG77 Module
[5]	Quectel_BG600L-M3_Hardware_Design	Hardware Design for BG600L-M3 Module
[6]	Quectel_BG95&BG77&BG600L_Series_PSM_Application_Note	PSM Application Note for BG95 Series, BG77 and BG600L-M3 Modules

Table 7: Terms and Abbreviations

Abbreviation	Description
BeiDou	BeiDou Navigation Satellite System
CNR	Carrier-to-Noise Ratio
DOP	Dilution of Precision
EDGE	Enhanced Data Rates for GSM Evolution
EGPRS	Enhanced General Packet Radio Service
eDRX	Extended Discontinuous Reception
FAQ	Frequently Asked Questions
Galileo	Galileo Satellite Navigation System (EU)
GGA	Global Positioning System Fix Data

GLONASS	Global Navigation Satellite System (Russian)
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
gpsOneXTRA	Auxiliary Positioning Technology Provided by Qualcomm
GSA	GNSS DOP and Active Satellites
GSM	Global System for Mobile Communications
GSV	GNSS Satellites in View
HDOP	Horizontal Dilution of Precision
LPWA	Low-Power Wide Area
LTE	Long Term Evolution
MCC	Mobile Country Code
ME	Mobile Equipment
MO	Mobile Originated
NMEA	NMEA (National Marine Electronics Association) 0183 Interface Standard
NVRAM	Non-Volatile Random-Access Memory
PS	Packet Switch
PSM	Power Saving Mode
PTW	Paging Time Window
QZSS	Quasi-Zenith Satellite System
RAT	Radio Access Technology
RMC	Recommended Minimum Specific GNSS Data
RRC	Radio Resource Control
RSRP	Reference Signal Received Power
RSSI	Received Signal Strength Indicator
Rx	Receive

TDM	Time-Division Multiplexing
TTFF	Time to First Fix
UART	Universal Asynchronous Receiver/Transmitter
UE	User Equipment
USB	Universal Serial Bus
UTC	Universal Time Coordinated
VTG	Course over Ground and Ground Speed
WWAN	Wireless Wide Area Network