

BG96 RF FTM Application Note

LPWA Module Series

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About the Document

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Contents

About the Document	3
Contents.....	4
Table Index	5
1 Introduction	6
2 FTM AT Commands	7
2.1. AT Command Introduction	7
2.1.1. Definitions.....	7
2.1.2. AT Command Syntax	7
2.2. Declaration of AT Command Examples	8
2.3. Description of AT Commands	8
2.3.1. AT+QRFTESTMODE Enter/Exit FTM	8
2.3.2. AT+QRFTEST Transmit in FTM	9
2.3.3. AT+QRXFTM Receive in FTM.....	12
3 Examples	15
3.1. Set the Module into FTM	15
3.2. Transmit in FTM	15
3.3. Receive in FTM	18
4 Summary of CME ERROR Codes.....	19
5 Appendix References	20

Table Index

Table 1: Type of AT Commands and Responses	7
Table 2: Related CME ERROR Codes	19
Table 3: Terms and Abbreviations.....	20

1 Introduction

The document describes the AT commands used to test the receiving and transmitting performance of Quectel BG96 module under FTM (Factory Test Mode), to facilitate RF calibration.

2 FTM AT Commands

2.1. AT Command Introduction

2.1.1. Definitions

- **<CR>** Carriage return character.
- **<LF>** Line feed character.
- **<...>** Parameter name. Angle brackets do not appear on 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 not given in a command, the new value equals its 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>**. In tables presenting commands and responses throughout this document, only the commands and responses are presented, and **<CR>** and **<LF>** are deliberately omitted.

Table 1: Type of AT Commands and Responses

Command Type	Syntax	Description
Test Command	AT+<cmd>=?	Test the existence of the corresponding command and return information about the type, value, or range of its parameter.
Read Command	AT+<cmd>?	Check the current parameter value of the corresponding command.
Write Command	AT+<cmd>=<p1>[,<p2>[,<p3>[...]]]	Set user-definable parameter value.
Execution Command	AT+<cmd>	Return a specific information parameter or perform a specific action.

2.2. Declaration of AT Command Examples

The AT command examples in this document are provided to help you learn about the use of the AT commands introduced herein. The examples, however, should not be taken as Quectel's recommendations or suggestions about how to design a program flow or what status to set the module into. Sometimes multiple examples may be provided for one AT command. However, this does not mean that there is a correlation among these examples, or that they should be executed in a given sequence.

2.3. Description of AT Commands

2.3.1. AT+QRFTESTMODE Enter/Exit FTM

This command makes the module enter/exit FTM.

AT+QRFTEST (see [Chapter 2.3.2](#)) and **AT+QRXFTM** (see [Chapter 2.3.3](#)) are available only when the module enters FTM with this command.

AT+QRFTESTMODE Enter/Exit FTM

Test Command AT+QRFTESTMODE=?	Response +QRFTESTMODE: (list of supported <mode>s) OK
Read Command AT+QRFTESTMODE?	Response +QRFTESTMODE: <mode> OK
Write Command AT+QRFTESTMODE=<mode>	Response OK If there is any error related to ME functionality: +CME ERROR: <err> If there is any other error: ERROR
Maximum Response Time	300 ms
Characteristics	This command takes effect after rebooting. The configuration will be saved automatically.

Parameter

<mode>	Integer type. Enter/exit FTM. 0 Exit 1 Enter
<err>	See Chapter 4 .

2.3.2. AT+QRFTEST Transmit in FTM

This command forces the module to transmit in FTM.

AT+QRFTEST Transmit in FTM

Test Command Currently only returns the parameters supported by the Write Command in GSM AT+QRFTEST=?	Response +QRFTEST: <band>,<channel>,<tx_enable>,<tx_burst>,<tx_gain> OK
Write Command In GSM: AT+QRFTEST=<band>,<channel>,<tx_enable>,<tx_burst>,<tx_gain>	Response ALL ON OK Or ALL OFF OK If there is any error related to ME functionality: +CME ERROR: <err> If there is any other error: ERROR
Write Command In LTE-M: AT+QRFTEST=<band>,<channel>,<tx_enable>,<rgi>,<waveform>	Response ALL ON OK Or ALL OFF OK If there is any error related to ME functionality: +CME ERROR: <err>

	<p>If there is any other error:</p> <p>ERROR</p>
<p>Write Command</p> <p>In NB-IoT:</p> <p>AT+QRFTEST=<band>,<channel>,<tx_enable>,<rgi>,<waveform>,<ul_offset>,<mod_type>,<power>,<tone_bw>,<tone_idx></p>	<p>Response</p> <p>ALL ON</p> <p>OK</p> <p>Or</p> <p>ALL OFF</p> <p>OK</p> <p>If there is any error related to ME functionality:</p> <p>+CME ERROR: <err></p> <p>If there is any other error:</p> <p>ERROR</p>
Maximum Response Time	300 ms
Characteristics	<p>This command takes effect immediately.</p> <p>The configurations will not be saved.</p>

Parameter

<band>	<p>String type. The supported bands in GSM/LTE. The possible values are:</p> <p>For GSM:</p> <p>"GSM850"</p> <p>"GSM900"</p> <p>"GSM1800"</p> <p>"GSM1900"</p> <p>For LTE:</p> <p>"LTE BAND1"</p> <p>"LTE BAND2"</p> <p>"LTE BAND3"</p> <p>"LTE BAND4"</p> <p>"LTE BAND5"</p> <p>"LTE BAND8"</p> <p>"LTE BAND12"</p> <p>"LTE BAND13"</p> <p>"LTE BAND18"</p> <p>"LTE BAND19"</p> <p>"LTE BAND20"</p> <p>"LTE BAND25"</p> <p>"LTE BAND26"</p> <p>"LTE BAND28"</p>
<channel>	<p>Integer type. The supported uplink channels in GSM/LTE. The corresponding channels</p>

for different bands in GSM/LTE are as follows:

Uplink Channels	GSM band
128–251	GSM850
1–124, 975–1023	GSM900
512–885	GSM1800
512–810	GSM1900
Uplink Channels	LTE band
18000–18599	LTE BAND1
18600–19199	LTE BAND2
19200–19949	LTE BAND3
19950–20399	LTE BAND4
20400–20649	LTE BAND5
21450–21799	LTE BAND8
23010–23179	LTE BAND12
23180–23279	LTE BAND13
23850–23999	LTE BAND18
24000–24149	LTE BAND19
24150–24449	LTE BAND20
26040–26689	LTE BAND25
26690–27039	LTE BAND26
27210–27659	LTE BAND28

<tx_enable>	String type. Enable/disable RF TX. "ON" Enable "OFF" Disable
<tx_burst>	Integer type. 0 Continuous TX mode
<tx_gain>	Integer type. GSM power level (GSM power in dBm × 100). Range: 0–3300. Recommended value: not to exceed 3100.
<rgi>	Integer type. LTE power level. Range: 0–100. Recommended value: not to exceed 75.
<waveform>	Integer type. 1 LTE modulated TX mode
<ul_offset>	Integer type. Uplink carrier frequency offset. Range: -128 to 127.
<mod_type>	Integer type. Modulation type. 0 BPSK 1 QPSK
<power>	Integer type. TX power in dBm. Range: -128 to 127.
<tone_bw>	Integer type. Uplink tone bandwidth. 0 Single-tone, 3.75 kHz 1 Single-tone, 15 kHz 2 Multi-tone, 3 × 15 kHz 3 Multi-tone, 6 × 15 kHz 4 Multi-tone, 12 × 15 kHz
<tone_idx>	Integer type. Tone start index. Range: 0–255.
<err>	See Chapter 4 .

NOTE

1. Please refer to *Section 5.7.3F Carrier frequency and EARFCN for category NB1 and NB2 in 3GPP TS 36.101*, to calculate the specific uplink carrier frequency offset, namely, the value of **<ul_offset>**.
2. For LTE-M, the default bandwidth is 10 MHz currently.

2.3.3. AT+QRXFTM Receive in FTM

This command forces the module to receive in FTM.

AT+QRXFTM Receive in FTM

Test Command AT+QRXFTM=?	Response +QRXFTM: <mode>,<band>,<channel>,<path>,<lna>,<bw> OK
Read Command AT+QRXFTM?	Response OK
Write Command AT+QRXFTM=<mode>,<band>,<channel>,<path>,<lna>,<bw>]]	Response +QRXFTM: <agc_val>,<agc_to_pwr> OK If there is any error related to ME functionality: +CME ERROR: <err> If there is any other error: ERROR
Maximum Response Time	3000 ms
Characteristics	The command takes effect immediately. The configurations will not be saved.

Parameter

<mode>	Integer type. 1 LTE RX test
<band>	String type. The supported bands in GSM/LTE. The possible values are: For GSM: "GSM850" "GSM900" "GSM1800" "GSM1900"

For LTE:

"LTE BAND1"

"LTE BAND2"

"LTE BAND3"

"LTE BAND4"

"LTE BAND5"

"LTE BAND8"

"LTE BAND12"

"LTE BAND13"

"LTE BAND18"

"LTE BAND19"

"LTE BAND20"

"LTE BAND26"

"LTE BAND28"

<channel> Integer type. The supported downlink channels in GSM/LTE. The corresponding channels for different bands in GSM/LTE are as follows:

Downlink Channels	GSM band
--------------------------	-----------------

128–251	GSM850
---------	--------

1–124, 975–1023	GSM900
-----------------	--------

512–885	GSM1800
---------	---------

512–810	GSM1900
---------	---------

Downlink Channels	LTE band
--------------------------	-----------------

0–599	LTE BAND1
-------	-----------

600–1199	LTE BAND2
----------	-----------

1200–1949	LTE BAND3
-----------	-----------

1950–2399	LTE BAND4
-----------	-----------

2400–2649	LTE BAND5
-----------	-----------

3450–3799	LTE BAND8
-----------	-----------

5010–5179	LTE BAND12
-----------	------------

5180–5279	LTE BAND13
-----------	------------

5850–5999	LTE BAND18
-----------	------------

6000–6149	LTE BAND19
-----------	------------

6150–6449	LTE BAND20
-----------	------------

8690–9039	LTE BAND26
-----------	------------

9210–9659	LTE BAND28
-----------	------------

<path> Integer type.

0 Main antenna path.

<lna> Integer type. Gain stage. Range: 0–5. Default value: 0.

<bw> Integer type. Bandwidth. Range: 0–5.

This parameter is only valid for LTE RAT (i.e., not applicable for GSM RAT).

0 1.4 MHz

1 3 MHz

2 5 MHz

3 10 MHz

	4	15 MHz
	5	20 MHz
<agc_val>	Integer type. The value of the received power.	
<agc_to_pwr>	Integer type. Received power level in dBm converted from <agc_val>.	
<err>	See Chapter 4 .	

NOTE

1. The responses of **AT+QRXFTM=<mode>,<band>,<channel>[,<path>[,<lna>[,<bw>]]]** are instantaneous values.
2. Currently, this command only supports LTE RX in FTM.
3. In LTE RAT, the value of <agc_to_pwr> is equal to the value of <agc_val>/10.

3 Examples

3.1. Set the Module into FTM

```

AT+QRFTESTMODE=?           //Test command
+QRFTESTMODE: (0,1)

OK
AT+QRFTESTMODE=1           //Enter FTM
OK

//After the module reboots
AT+QRFTESTMODE?             //Query the current FTM state of the module
+QRFTESTMODE: 1

OK
AT+QRFTESTMODE=0           //Exit FTM
OK

//After the module reboots
AT+QRFTESTMODE?             //Query the current FTM state of the module
+QRFTESTMODE: 0

OK

```

3.2. Transmit in FTM

```

AT+QRFTESTMODE=1           //Enter FTM
OK

//After the module reboots
//In GSM RAT
AT+QRFTEST="GSM900",122,"ON",0,100 //Enable RF TX on 122 channel of GSM900
ALL ON

```



```

OK
AT+QRFTEST="GSM900",122,"OFF",0,100 //Disable RF TX on 122 channel of GSM900
ALL OFF

OK

//In LTE-M RAT
AT+QRFTEST="LTE BAND1",18300,"ON",50,1 //Enable RF TX on 18300 channel of LTE B1
ALL ON

OK
AT+QRFTEST="LTE BAND1",18300,"OFF",50,1 //Disable RF TX on 18300 channel of LTE B1
ALL OFF

OK
AT+QRFTEST="LTE BAND2",18900,"ON",50,1 //Enable RF TX on 18900 channel of LTE B2
ALL ON

OK
AT+QRFTEST="LTE BAND2",18900,"OFF",50,1 //Disable RF TX on 18900 channel of LTE B2
ALL OFF

OK
AT+QRFTEST="LTE BAND12",23095,"ON",50,1 //Enable RF TX on 23095 channel of LTE B12
ALL ON

OK
AT+QRFTEST="LTE BAND12",23095,"OFF",50,1 //Disable RF TX on 23095 channel of LTE B12
ALL OFF

OK
AT+QRFTEST="LTE BAND20",24300,"ON",50,1 //Enable RF TX on 24300 channel of LTE B20
ALL ON

OK
AT+QRFTEST="LTE BAND20",24300,"OFF",50,1 //Disable RF TX on 24300 channel of LTE B20
ALL OFF

OK
AT+QRFTEST="LTE BAND28",27435,"ON",50,1 //Enable RF TX on 27435 channel of LTE B28
ALL ON

OK
AT+QRFTEST="LTE BAND28",27435,"OFF",50,1 //Disable RF TX on 27435 channel of LTE B28

```

ALL OFF

OK

//In NB-IoT RAT

AT+QRFTEST="LTE BAND1",18300,"ON",50,1,100,0,50,4,0

//Enable RF TX on 18300 channel of LTE B1

ALL ON

OK

AT+QRFTEST="LTE BAND1",18300,"OFF",50,1,100,0,50,4,0

//Disable RF TX on 18300 channel of LTE B1

ALL OFF

OK

AT+QRFTEST="LTE BAND2",18900,"ON",50,1,100,0,50,4,0

//Enable RF TX on 18900 channel of LTE B2

ALL ON

OK

AT+QRFTEST="LTE BAND2",18900,"OFF",50,1,100,0,50,4,0

//Disable RF TX on 18900 channel of LTE B2

ALL OFF

OK

AT+QRFTEST="LTE BAND20",24300,"ON",50,1,100,0,50,4,0

//Enable RF TX on 24300 channel of LTE B20

ALL ON

OK

AT+QRFTEST="LTE BAND20",24300,"OFF",50,1,100,0,50,4,0

//Disable RF TX on 24300 channel of LTE B20

ALL OFF

OK

AT+QRFTEST="LTE BAND28",27435,"ON",50,1,100,0,50,4,0

//Enable RF TX on 27435 channel of LTE B28

ALL ON

OK

AT+QRFTEST="LTE BAND28",27435,"OFF",50,1,100,0,50,4,0

//Disable RF TX on 27435 channel of LTE B28

ALL OFF

```

OK
AT+QRFTESTMODE=0                                     //Exit FTM
OK
//Reboot the module

```

3.3. Receive in FTM

```

AT+QRFTESTMODE=1                                     //Enter FTM
OK

//After the module reboots
//In LTE RAT
AT+QRXFTM=1,"LTE BAND1",300,0,0,0                   //Enable RF RX on 300 channel of LTE B1
+QRXFTM: -1100,-110

OK
AT+QRXFTM=1,"LTE BAND2",900,0,0,0                   //Enable RF RX on 900 channel of LTE B2
+QRXFTM: -1100,-110

OK
AT+QRXFTM=1,"LTE BAND12",5095,0,0,0                 //Enable RF RX on 5095 channel of LTE B12
+QRXFTM: -1100,-110

OK
AT+QRXFTM=1,"LTE BAND20",6300,0,0,0                 //Enable RF RX on 6300 channel of LTE B20
+QRXFTM: -1100, -110

OK
AT+QRXFTM=1,"LTE BAND28",9435,0,0,0                 //Enable RF RX on 9435 channel of LTE B28
+QRXFTM: -1100,-110

OK
AT+QRFTESTMODE=0                                     //Exit FTM
OK
//Reboot the module

```

4 Summary of CME ERROR Codes

The CME ERROR code **<err>** indicates an error related to mobile equipment or network. The details about **<err>** are described in the following table.

Table 2: Related CME ERROR Codes

<err>	Meaning
4	Incorrect AT command name or parameter
-15	Invalid input parameter.

5 Appendix References

Table 3: Terms and Abbreviations

Abbreviation	Description
BPSK	Binary Phase Shift Keying
LTE-M	LTE-MTC (Machine Type Communication)
FTM	Factory Test Mode
GSM	Global System for Mobile Communications
LNA	Low Noise Amplifier
LPWA	Low-Power Wide-Area
LTE	Long Term Evolution
NB-IoT	Narrowband Internet of Things
QPSK	Quadrature Phase Shift Keying
RAT	Radio Access Technology
RF	Radio Frequency
RX	Receive
TX	Transmit