BG95&BG77&BG600L Series
FTM Application Note

LPWA Module Series

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Our aim is to provide customers with timely and comprehensive service. For any assistance, please contact our company headquarters:

Quectel Wireless Solutions Co., Ltd.
Building 5, Shanghai Business Park Phase III (Area B), No.1016 Tianlin Road, Minhang District, Shanghai 200233, China
Tel: +86 21 5108 6236
Email: info@quectel.com

Or our local office. For more information, please visit:
http://www.quectel.com/support/sales.htm

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About the Document

Revision History

Version	Date	Author	Description
1.0	2020-05-28	Hyman DING/ Miles MA	Initial

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1 Introduction

The document describes the AT commands which are used to test the receiving and transmitting performance of Quectel BG95 series, BG77 and BG600L-M3 modules under FTM (Factory Test Mode) so as to facilitate RF calibration.

1.1. Applicable Modules

Table 1: Applicable Modules

Module Series	Model	Description
BG95	BG95-M1	Cat M1 only
	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 Only
BG77	BG77	Cat M1/Cat NB2
BG600L	BG600L-M3	Cat M1/Cat NB2/EGPRS

NOTE

See the firmware release notes of corresponding module models to check whether the function has been supported.

2 FTM 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 command line.
- **[...]**   Optional parameter of a command or an optional part of TA information response. Square brackets do not appear on command line. When an optional parameter is omitted, the new value equals its previous value or its default setting, unless otherwise specified.
- <u>**Underline**</u>   Default setting of a parameter.

2.1.2. AT Command Syntax

The **AT** or **at** prefix must be added at the beginning of each command line. Entering **<CR>** will terminate a command line. Commands are usually followed by a response that includes **<CR><LF><response><CR><LF>**. Throughout this document, only the response **<response>** will be presented, **<CR><LF>** are omitted intentionally.

Table 2: Type of AT Commands and Responses

Test Command	**AT+<cmd>=?**	This command returns the list of parameters and value ranges set by the corresponding Write Command or internal processes.
Read Command	**AT+<cmd>?**	This command returns the currently set value of the parameter or parameters.
Write Command	**AT+<cmd>=<p1> [,<p2>[,<p3>[...]]]**	This command sets the user-definable parameter values.
Execution Command	**AT+<cmd>**	This command reads non-variable parameters affected by internal processes in the module.

2.2. Description of FTM AT Commands

2.2.1. AT+QRFTESTMODE   Enter/Exit FTM

The Write Command makes the module enter/exit FTM (RF test mode).

AT+QRFTEST (see *Chapter 2.2.2*) and **AT+QRXFTM** (see *Chapter 2.2.3*) 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**
Characteristics	The command takes effect immediately. The configuration will be saved automatically.

Parameter

<mode>	Integer type. Enter/exit FTM.
	0 Exit FTM
	1 Enter FTM

2.2.2. AT+QRFTEST   Transmit in FTM

The Write Commands force the module to transmit in FTM.

AT+QRFTEST   Transmit in FTM

Test Command The command currently only returns the list of parameters set 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>** If there is any other error: **ERROR**
Write Command In NB-IoT: **AT+QRFTEST=<band>,<channel>,<tx_enable>, <rgi>,<waveform>,<ul_offset>,<mod_type>,<power>,<tone_bw>,<tone_idx>**	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**
Characteristics	The command takes effect immediately. The configurations will not be saved.

Parameter

<band>	String type. 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 BAND25" "LTE BAND26" "LTE BAND27" "LTE BAND28" "LTE BAND31" (Supported by BG95-M4 only) "LTE BAND66" "LTE BAND71" "LTE BAND72" (Supported by BG95-M4 only) "LTE BAND73" (Supported by BG95-M4 only) "LTE BAND85"
<channel>	Integer type. Supported uplink channels in GSM/LTE. The corresponding channels for different bands in GSM/LTE are as follows:

GSM band	Uplink Channels
GSM850	128–251
GSM900	1–124, 975–1023

GSM1800	512–885
GSM1900	512–810

LTE band	Uplink Channels
LTE BAND1	18000–18599
LTE BAND2	18600–19199
LTE BAND3	19200–19949
LTE BAND4	19950-20399
LTE BAND5	20400–20649
LTE BAND8	21450–21799
LTE BAND12	23010–23179
LTE BAND13	23180–23279
LTE BAND18	23850–23999
LTE BAND19	24000–24149
LTE BAND20	24150–24449
LTE BAND25	26040–26689
LTE BAND26	26690–27039
LTE BAND27	27040–27209
LTE BAND28	27210–27659
LTE BAND31	27760–27809 (Supported by BG95-M4 only)
LTE BAND66	131972–132671
LTE BAND71	131122–133471
LTE BAND72	133472–133521 (Supported by BG95-M4 only)
LTE BAND73	133522–133571 (Supported by BG95-M4 only)
LTE BAND85	134231–134280

Parameter	Description
<tx_enable>	String type. Enable/disable RF TX. "ON" Enable RF TX "OFF" Disable RF TX
<tx_burst>	Integer type. 0 Continuous TX mode
<tx_gain>	Integer type. GSM power level (GSM power in dBm × 100). Range: 0–3300.
<rgi>	Integer type. LTE power level. Range: 0–100.
<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.

NOTES

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.

2.2.3. AT+QRXFTM Receive in FTM

The Write 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**
Characteristics	The command takes effect immediately. The configurations will not be saved.

Parameter

<mode>	Integer type. 1 LTE RX test
<band>	String type. 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 BAND25"
"LTE BAND26"
"LTE BAND27"
"LTE BAND28"
"LTE BAND31" (Supported by BG95-M4 only)
"LTE BAND66"
"LTE BAND71"
"LTE BAND72" (Supported by BG95-M4 only)
"LTE BAND73" (Supported by BG95-M4 only)
"LTE BAND85"

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

GSM band	Downlink Channels
GSM850	128–251
GSM900	1–124, 975–1023
GSM1800	512–885
GSM1900	512–810

LTE band	Downlink Channels
LTE BAND1	0–599
LTE BAND2	600-1199
LTE BAND3	1200–1949
LTE BAND4	1950–2399
LTE BAND5	2400–2649
LTE BAND8	3450–3799
LTE BAND12	5010–5179
LTE BAND13	5180–5279
LTE BAND18	5850–5999

	LTE BAND19	6000–6149
	LTE BAND20	6150–6449
	LTE BAND25	8040–8689
	LTE BAND26	8690–9039
	LTE BAND27	9040–9209
	LTE BAND28	9210–9659
	LTE BAND31	9870–9919 (Supported by BG95-M4 only)
	LTE BAND66	66436–67335
	LTE BAND71	68586–68935
	LTE BAND72	68936–68985 (Supported by BG95-M4 only)
	LTE BAND73	68986–69035 (Supported by BG95-M4 only)
	LTE BAND85	70366–70545

\<path\> Integer type.
  0 Main antenna path.

\<lna\> Integer type. Gain stages. Range: 0–5.

\<bw\> Integer type. Bandwidth. Range: 0–5.
  This parameter is only valid for LTE RAT (that is, not applicable for GSM RAT).
  0 1.4 MHz bandwidth
  1 3 MHz bandwidth
  2 5 MHz bandwidth
  3 10 MHz bandwidth
  4 15 MHz bandwidth
  5 20 MHz bandwidth

\<agc_val\> Integer type. Result of receiving power range.

\<agc_to_pwr\> Integer type. Receiving power level in dBm converted from **\<agc_val\>**.

NOTES

1. The result of **AT+QRXFTM** is an instantaneous value.
2. In LTE RAT, the value of **\<agc_to_pwr\>** is equal to **\<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	
AT+QRFTESTMODE?	//Query the current FTM state of the module
+QRFTESTMODE: 1	
OK	
AT+QRFTESTMODE=0	//Exit FTM
OK	
AT+QRFTESTMODE?	//Query the current FTM state of the module
+QRFTESTMODE: 0	
OK	

3.2. Transmit in FTM

AT+QRFTESTMODE=1	//Enter FTM
OK	
//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	//Disable RF test mode
OK	

3.3. Receive in FTM

AT+QRFTESTMODE=1   //Enter FTM
OK

//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

//In GSM RAT
AT+QRXFTM=1,"GSM900",62,0,0   //Enable RF RX on 62 channel of GSM900
+QRXFTM: 3101799,-90

OK
AT+QRFTESTMODE=0   //Exit FTM
OK

4 Appendix A 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
LPWA	Low-Power Wide-Area
LTE	Long Term Evolution
NB-IoT	Narrow Band Internet of Things
QPSK	Quadrature Phase Shift Keying
RAT	Radio Access Technology
RF	Radio Frequency
RX	Receive
TX	Transmit