

RG50xQ&RM5xxQ Series

RF FTM Application Note

5G Module Series

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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 offices. For more information, please visit:

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About the Document

Revision History

Version	Date	Author	Description
-	2021-03-16	Duke XIN/ Evan JIN	Creation of the document
1.0	2021-04-20	Duke XIN/ Evan JIN	First official release
1.1	2023-12-27	Evan JIN	- Updated the document name from "Quectel_RG50xQ&RM5xxQ_Series_FTM_Application_Note" to "Quectel_RG50xQ&RM5xxQ_Series_RF_FTM_Application_Note". - Updated the applicable modules (Table 1). - Deleted value 6 of <bw> in AT+QRFTEST="rx" and AT+QRFTEST="tx" (Chapter 2.3.1.2 and 2.3.1.3). - Updated the ranges of <band> in AT+QRFTESTNR5G="rx" and AT+QRFTESTNR5G="tx"; Added values 4/5/6/7 of <bw> in AT+QRFTESTNR5G="rx" and AT+QRFTESTNR5G="tx" (Chapter 2.3.2.2 and 2.3.2.3). - Updated the tables of RX/TX Channel of WCDMA/LTE Bands (Table 3 and 4). - Updated the tables of RX/TX Channel Distribution of 5G NR Bands (Table 5 and 6). - Deleted the table of supported channels and frequency mapping in FTM for 5G and related note; updated antenna port related note (Chapter 2.3.2.3). - Deleted Appendix B "Antenna Mapping".

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1 Introduction

Quectel's 5G RG50xQ and RM5xxQ family modules support transmitting and receiving in FTM (Factory Test Mode). This document mainly introduces the related AT commands and checks whether the antenna connection is normal.

1.1. Applicable Modules

Table 1: Applicable Modules

Module Family	Module Series	Model
RG50xQ	RG500Q series	RG500Q-EA/-CN/-EU/-GT
	-	RG501Q-EU
	RG502Q series	RG502Q-EU/-EA/-GT
RM5xxQ	RM500Q series	RM500Q-GL/-AE/-CN
	-	RM502Q-AE
	-	RM510Q-GL
	-	RM505Q-AE

2 Description of 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 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 not given in a command, the new value equals to 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: Types of AT Commands

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 RF FTM AT Commands

2.3.1. AT+QRFTEST RF Tests in FTM for WCDMA/LTE

AT+QRFTEST RF Tests in FTM for WCDMA/LTE	
Test Command AT+QRFTEST=?	Response +QRFTEST: "rx",<type>,<band>,<bw>,<channel>,<chain_idx>,<expected_rxagc> +QRFTEST: "tx",<type>,<band>,<bw>,<channel>,<tx_enable>,<tx_power> +QRFTEST: "mode", (list of supported <mode>s) OK

2.3.1.1. AT+QRFTEST="mode" Query/Set FTM

AT+QRFTEST="mode" Query/Set FTM	
Write Command AT+QRFTEST="mode"[,<mode>]	Response If the optional parameter is omitted, query the current configuration: +QRFTEST: <mode> OK If the optional parameter is specified, set FTM: OK Or ERROR
Maximum Response Time	300 ms

Characteristics	This command takes effect immediately; The configuration will not be saved.
-----------------	--

Parameter

<mode>	Integer type. RF test mode.
0	Online mode
1	FTM

2.3.1.2. AT+QRFTEST="rx" Receiving in FTM

AT+QRFTEST="rx" Receiving in FTM	
Write Command AT+QRFTEST="rx",<type>,<band>,<bw>,<channel>,<chain_idx>,<expected_rxagc>	Response +QRFTEST: <rx_agc>,<gain> OK Or ERROR
Maximum Response Time	300 ms
Characteristics	This command takes effect immediately; The configuration will not be saved.

Parameter

<type>	Integer type. LTE/WCDMA configuration.
0	WCDMA
1	LTE
<band>	Integer type. LTE/WCDMA band.
1	LTE B1/WCDMA B1
2	LTE B2/WCDMA B2
3	LTE B3/WCDMA B3
4	LTE B4/WCDMA B4
5	LTE B5/WCDMA B5
6	LTE B6/WCDMA B6
7	LTE B7/WCDMA B7
8	LTE B8/WCDMA B8
9	LTE B9/WCDMA B9
10	LTE B10/WCDMA B10
11	LTE B11/WCDMA B11
.....	

	19	LTE B19/WCDMA B19
	20	LTE B20
	28	LTE B28
		
<bw>	Integer type. LTE/WCDMA bandwidth.	
	0	1.4 MHz
	1	3 MHz
	2	5 MHz
	3	10 MHz
	4	15 MHz
	5	20 MHz
<channel>	Integer type. LTE/WCDMA channel. See Table 3 for details.	
<chain_idx>	Integer type. Receiving antenna type.	
	0	PRx
	1	DRx
	2	Rx2
	3	Rx3
<expected_rxagc>	Integer type. Expected Rx AGC. Test equipment power level in dBm × 10.	
<rx_agc>	Integer type. Tested Rx AGC.	
<gain>	Integer type. Rx AGC/10. Unit: dBm.	

NOTE

When performing receiving in FTM for LTE, the setting of the receiving antenna type needs to be in the order of PRx, DRx, Rx2, and Rx3, that is, **<chain_idx>** needs to be set in the order of 0, 1, 2, and 3.

Table 2: Rx Channel of WCDMA/LTE Bands

WCDMA/LTE Bands	Rx Channel
LTE B1	300
LTE B2	900
LTE B3	1575
LTE B4	2175
LTE B5	2525
LTE B6	2700
LTE B7	3100

LTE B8	3625
LTE B9	3975
LTE B10	4450
LTE B11	4850
LTE B12	5095
LTE B13	5230
LTE B14	5330
LTE B17	5790
LTE B18	5925
LTE B19	6075
LTE B20	6300
LTE B21	6525
LTE B22	7000
LTE B23	7600
LTE B24	7870
LTE B25	8365
LTE B26	8865
LTE B27	9125
LTE B28	9435
LTE B29	9715
LTE B30	9820
LTE B31	9895
LTE B32	10140
LTE B33	36100
LTE B34	36275

LTE B35	36650
LTE B36	37250
LTE B37	37650
LTE B38	38000
LTE B39	38450
LTE B40	39150
LTE B41	40620
LTE B42	42590
LTE B43	44590
LTE B46	50665
LTE B47	54890
LTE B48	55990
LTE B66	66886
LTE B71	68761
WCDMA B1	10700
WCDMA B2	9800
WCDMA B3	1338
WCDMA B4	1638
WCDMA B5	4408
WCDMA B6	4400
WCDMA B7	2400
WCDMA B8	3012
WCDMA B9	9312
WCDMA B10	3250
WCDMA B11	3762

WCDMA B19

738

2.3.1.3. AT+QRFTEST="tx" Transmitting in FTM

AT+QRFTEST="tx" Transmitting in FTM	
Write Command AT+QRFTEST="tx",<type>,<band>,<bw>,<channel>,<tx_enable>,<tx_power>	Response OK Or ERROR
Maximum Response Time	300 ms
Characteristics	This command takes effect immediately; The configuration will not be saved.

Parameter

<type>	Integer type. LTE/WCDMA configuration. 0 WCDMA 1 LTE
<band>	Integer type. LTE/WCDMA band. 1 LTE B1/WCDMA B1 2 LTE B2/WCDMA B2 3 LTE B3/WCDMA B3 4 LTE B4/WCDMA B4 5 LTE B5/WCDMA B5 6 LTE B6/WCDMA B6 7 LTE B7/WCDMA B7 8 LTE B8/WCDMA B8 9 LTE B9/WCDMA B9 10 LTE B10/WCDMA B10 11 LTE B11/WCDMA B11 19 LTE B19/WCDMA B19 20 LTE B20 28 LTE B28
<bw>	Integer type. LTE/WCDMA bandwidth. 0 1.4 MHz 1 3 MHz 2 5 MHz 3 10 MHz

	4	15 MHz
	5	20 MHz
<channel>	Integer type. LTE/WCDMA channel. See Table 4 for details.	
<tx_enable>	Integer type. Enable/disable Tx.	
	0	Disable
	1	Enable
<tx_power>	Integer type. A parameter that affects the actual Tx power, and it is recommended to set it to 60.	

Table 3: Tx Channel of WCDMA/LTE Bands

WCDMA/LTE Bands	Tx Channel
LTE B1	18300
LTE B2	18900
LTE B3	19575
LTE B4	20175
LTE B5	20525
LTE B6	20700
LTE B7	21100
LTE B8	21625
LTE B9	21975
LTE B10	22450
LTE B11	22850
LTE B12	23095
LTE B13	23230
LTE B14	23330
LTE B17	23790
LTE B18	23925
LTE B19	24075

LTE B20	24300
LTE B21	24525
LTE B22	25000
LTE B23	25600
LTE B24	25870
LTE B25	26365
LTE B26	26865
LTE B27	27125
LTE B28	27435
LTE B29	N/A
LTE B30	27710
LTE B31	27785
LTE B32	N/A
LTE B33	36100
LTE B34	36275
LTE B35	36650
LTE B36	37250
LTE B37	37650
LTE B38	38000
LTE B39	38450
LTE B40	39150
LTE B41	40620
LTE B42	42590
LTE B43	44590
LTE B46	50665

LTE B47	54890
LTE B48	55990
LTE B66	132322
LTE B71	133297
WCDMA B1	9750
WCDMA B2	9400
WCDMA B3	1112
WCDMA B4	1412
WCDMA B5	4182
WCDMA B6	4175
WCDMA B7	2175
WCDMA B8	2788
WCDMA B9	8837
WCDMA B10	3025
WCDMA B11	3537
WCDMA B19	338

2.3.2. AT+QRFTESTNR5G RF Tests in FTM for 5G

AT+QRFTESTNR5G RF Tests in FTM for 5G

Test Command	Response
AT+QRFTESTNR5G=?	+QRFTESTNR5G: "rx",<type>,<band>,<bw>,<channel>,<chain_idx>,<expected_rxagc>,<tx_relate> +QRFTESTNR5G: "tx",<type>,<band>,<bw>,<channel>,<tx_relate>,<tx_enable>,<RGI>,<PA Bias>,<PA current> +QRFTESTNR5G: "mode",(list of supported <mode>s)
	OK

2.3.2.1. AT+QRFTESTNR5G="mode" Query/Set FTM

AT+QRFTESTNR5G="mode" Query/Set FTM	
Write Command AT+QRFTESTNR5G="mode"[,<mode>]	Response If the optional parameter is omitted, query the current configuration: +QRFTESTNR5G: <mode> OK If the optional parameter is specified, set FTM: OK Or ERROR
Maximum Response Time	300 ms
Characteristics	This command takes effect immediately; The configuration will not be saved.

Parameter

<mode>	Integer type. RF test mode.
0	Online mode
1	FTM

2.3.2.2. AT+QRFTESTNR5G="rx" Receiving in FTM

AT+QRFTESTNR5G="rx" Receiving in FTM	
Write Command AT+QRFTESTNR5G="rx",<type>,<band>,<bw>,<channel>,<chain_idx>,<expected_rxagc>,<tx_relate>	Response +QRFTESTNR5G: <rx_agc> OK Or ERROR
Maximum Response Time	300 ms
Characteristics	This command takes effect immediately; The configuration will not be saved.

Parameter

<type>	Integer type. 5G NR configuration. 2 5G NR
<band>	Integer type. 5G NR band. 41 n41 77 n77 78 n78 79 n79
<bw>	Integer type. 5G NR bandwidth. 0 1.4 MHz 1 3 MHz 2 5 MHz 3 10 MHz 5 30 MHz 6 40 MHz 7 50 MHz
<channel>	Integer type. 5G NR channel. See Table 5 for details.
<chain_idx>	Integer type. Receiving antenna type. 0 PRx 1 DRx
<expected_rxagc>	Integer type. Expected Rx AGC. Test equipment power level in dBm × 10. The recommended value is -500.
<rx_agc>	Integer type. Tested Rx AGC.
<tx_relate>	Integer type. Tx1/Tx2 related PRx and DRx. This parameter needs to be used in conjunction with <chain_idx> to specify a specific receiving chain. 0 Tx1 related PRx and DRx 1 Tx2 related PRx and DRx

Table 4: Rx Channel Distribution of 5G NR Bands

5G NR Bands	Range of Rx Channels (Minimum–Maximum)
n41	499200–537999
n77	620000–680000
n78	620000–653333
n79	693334–733333

2.3.2.3. AT+QRFTESTNR5G="tx" Transmitting in FTM

AT+QRFTESTNR5G="tx" Transmitting in FTM	
Write Command AT+QRFTESTNR5G="tx",<type>,<band>,<bw>,<channel>,<tx_relate>,<tx_enable>,<RGI>,<PAbias>,<PA current>	Response OK Or ERROR
Maximum Response Time	300 ms
Characteristics	This command takes effect immediately; The configuration will not be saved.

Parameter

<type>	Integer type. 5G NR configuration. 2 5G NR
<band>	Integer type. 5G NR band. 41 n41 77 n77 78 n78 79 n79
<bw>	Integer type. 5G NR bandwidth. 0 1.4 MHz 1 3 MHz 2 5 MHz 3 10 MHz 5 30 MHz 6 40 MHz 7 50 MHz
<channel>	Integer type. 5G NR channel. See Table 6 for details.
<tx_relate>	Integer type. Used to specify the actual Tx. 0 Tx1, refers to the actual Tx1 port 1 Tx2, refers to the actual Tx0 port
<tx_enable>	Integer type. Enable/Disable Tx. 0 Disable 1 Enable
<RGI>	Integer type. Transceiver output gain. Range: 55–65. The recommended value is 65.
<PA Bias>	Integer type. PA Bias voltage. Range: 3500–4000. The recommended value is 4000.
<PA current>	Integer type. PA current. Range: 2500–3800. The recommended value is 3000.

Table 5: Tx Channel Distribution of 5G NR Bands

5G NR Bands	Range of Tx Channels (Minimum–Maximum)
n41	499200–537999
n77	620000–680000
n78	620000–653333
n79	693334–733333

NOTE

For RF tests in FTM mode for WCDMA/LTE//5G:

1. It is recommended to reboot the module after the RF test is completed to ensure that the module works normally.
2. It is recommended to complete the RF tests under the same network type at one time. Do not enter or exit the RF modes repeatedly, otherwise the module will easily restart. After completing the RF tests for one network type (5G NR/LTE/WCDMA), it is recommended to restart the module, and then perform the RF tests of the next network type. For example, after completing the 5G NR RF tests, restart the module first, and then perform the LTE RF tests.
3. After each TX is tested, it is recommended to disable this TX test first, and then perform other TX tests.
4. Try not to insert a (U)SIM card during RF tests in FTM.
5. RF tests in FTM only verify whether the antenna path is normal, and cannot be used as a test for the module performance.
6. Commands introduced in this document is only suitable for verification and not for stress testing due to the instability of these commands in stress testing. It is recommended to add a delay in millisecond after each command returns **OK**.
7. When testing, it is necessary to connect the equipment and antenna port correctly. For the definition of the antenna port, please see the corresponding HT document of the module. If you have any questions about the antenna connection, please consult Quectel Technical Support.

3 Examples

3.1. RF Tests in FTM for WCDMA/LTE

```

AT+QRFTEST=?
+QRFTEST: "rx",<type>,<band>,<bw>,<channel>,<chain_idx>,<expected_rxagc>
+QRFTEST: "tx",<type>,<band>,<bw>,<channel>,<tx_enable>,<tx_power>
+QRFTEST: "mode",(0,1)

OK
AT+QRFTEST="mode",1
OK
AT+QRFTEST="mode"
+QRFTEST: 1

OK
AT+QRFTEST="rx",1,42,3,42590,0,-600
+QRFTEST: -617,-61

OK
AT+QRFTEST="tx",1,42,3,42590,1,60
OK
AT+QRFTEST="mode",0
OK

```

3.2. RF Tests in FTM for 5G

```

AT+QRFTESTNR5G=?
+QRFTESTNR5G: "rx",<type>,<band>,<bw>,<channel>,<chain_idx>,<expected_rxagc>,<tx_relate>
+QRFTESTNR5G: "tx",<type>,<band>,<bw>,<channel>,<tx_relate>,<tx_enable>,<RGI>,<PA Bias>,<PA current>
+QRFTESTNR5G: "mode",(0,1)

OK

```

//Enter RF test mode.

AT+QRFTESTNR5G="mode",1

OK

AT+QRFTESTNR5G="mode"

+QRFTESTNR5G:1

OK

//Tests of Tx1 and related Rx.

AT+QRFTESTNR5G="rx",2,41,3,499200,0,-500,0

+QRFTESTNR5G: -49.2

OK

AT+QRFTESTNR5G="tx",2,41,3,499200,0,1,65,4000,3000

OK

AT+QRFTESTNR5G="tx",2,41,3,499200,0,0,65,4000,3000

OK

//Tests of Tx2 and related Rx.

AT+QRFTESTNR5G="rx",2,41,3,499200,0,-500,1

+QRFTESTNR5G: -49.1

OK

AT+QRFTESTNR5G="tx",2,41,3,499200,1,1,65,4000,3000

OK

AT+QRFTESTNR5G="tx",2,41,3,499200,1,0,65,4000,3000

OK

//Repeat other 5G NR sub-6 band tests.

.....

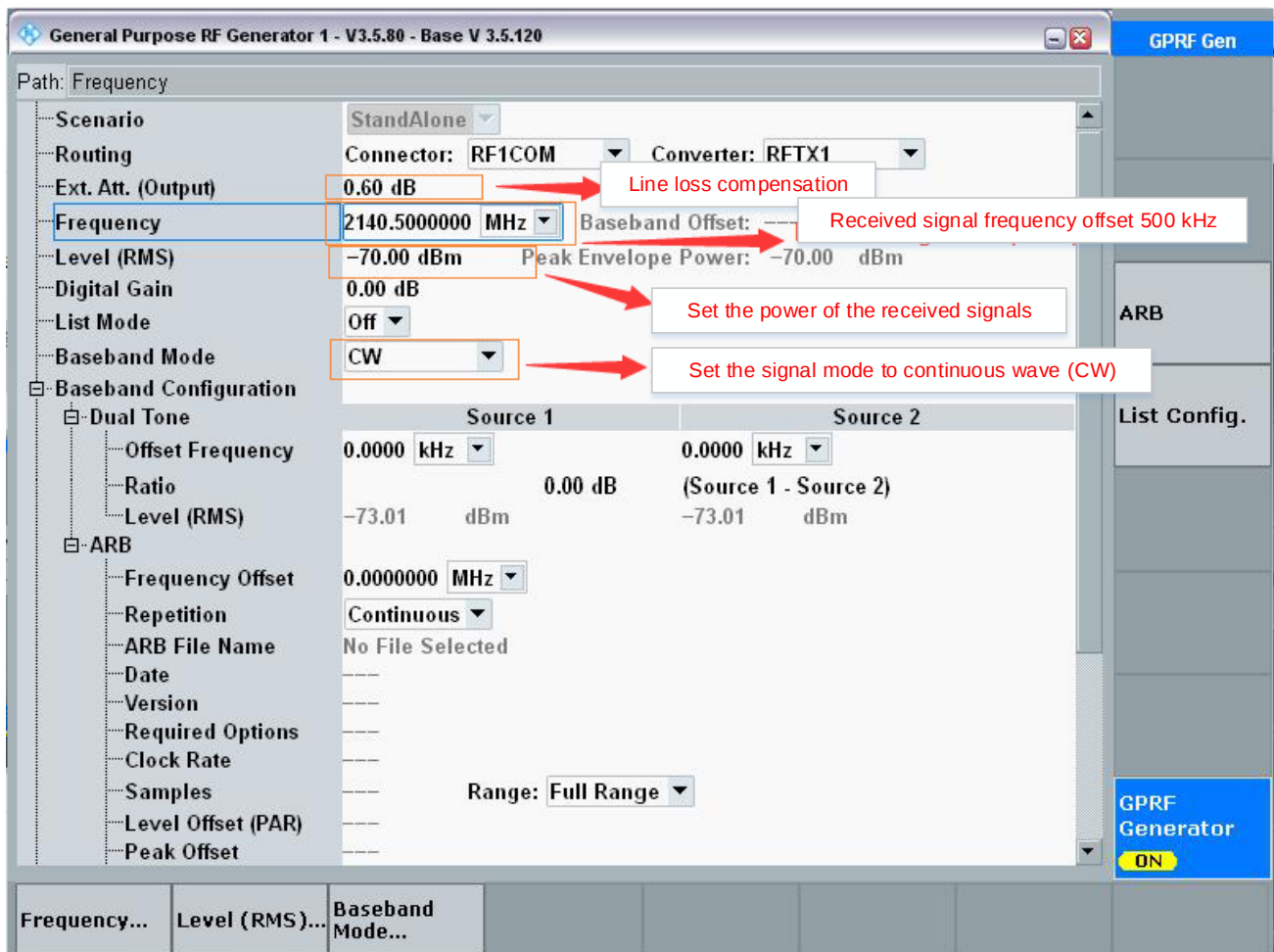
//Exit from test mode, and enter online mode.

AT+QRFTESTNR5G="mode",0

OK

4 CMW500 Configuration for RF Tests

Signal sources which emit continuous waves can be used as the downlink CW signals. If CMW500 is used as a signal source, the following settings can be applied:



5 Appendix Terms and Abbreviations

Table 6: Terms and Abbreviations

Abbreviation	Description
AGC	Automatic Gain Control
APT	Average Power Tracking
AWS	Amazon Web Services
CW	Continuous Wave
DRx	Diversity Receive
FTM	Factory Test Mode
LTE	Long Term Evolution
PA	Power Amplifier
PRx	Primary Receive
RF	Radio Frequency
Rx	Receive
Tx	Transmit
WCDMA	Wideband Code Division Multiple Access