RG50xQ&RM5xxQ Series

DFOTA Application Note

5G Module Series

Version: 1.1

Date: 2023-03-07

Status: Released

At Quectel, our aim is to provide timely and comprehensive services to our customers. If you require any assistance, please contact our 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 offices. For more information, please visit:
http://www.quectel.com/support/sales.htm.

For technical support, or to report documentation errors, please visit:
http://www.quectel.com/support/technical.htm.
Or email us at: support@quectel.com.

Legal Notices

We offer information as a service to you. The provided information is based on your requirements and we make every effort to ensure its quality. You agree that you are responsible for using independent analysis and evaluation in designing intended products, and we provide reference designs for illustrative purposes only. Before using any hardware, software or service guided by this document, please read this notice carefully. Even though we employ commercially reasonable efforts to provide the best possible experience, you hereby acknowledge and agree that this document and related services hereunder are provided to you on an “as available” basis. We may revise or restate this document from time to time at our sole discretion without any prior notice to you.

Use and Disclosure Restrictions

License Agreements

Documents and information provided by us shall be kept confidential, unless specific permission is granted. They shall not be accessed or used for any purpose except as expressly provided herein.

Copyright

Our and third-party products hereunder may contain copyrighted material. Such copyrighted material shall not be copied, reproduced, distributed, merged, published, translated, or modified without prior written consent. We and the third party have exclusive rights over copyrighted material. No license shall be granted or conveyed under any patents, copyrights, trademarks, or service mark rights. To avoid ambiguities, purchasing in any form cannot be deemed as granting a license other than the normal non-exclusive, royalty-free license to use the material. We reserve the right to take legal action for noncompliance with abovementioned requirements, unauthorized use, or other illegal or malicious use of the material.

Trademarks

Except as otherwise set forth herein, nothing in this document shall be construed as conferring any rights to use any trademark, trade name or name, abbreviation, or counterfeit product thereof owned by Quectel or any third party in advertising, publicity, or other aspects.

Third-Party Rights

This document may refer to hardware, software and/or documentation owned by one or more third parties ("third-party materials"). Use of such third-party materials shall be governed by all restrictions and obligations applicable thereto.

We make no warranty or representation, either express or implied, regarding the third-party materials, including but not limited to any implied or statutory, warranties of merchantability or fitness for a particular purpose, quiet enjoyment, system integration, information accuracy, and non-infringement of any third-party intellectual property rights with regard to the licensed technology or use thereof. Nothing herein constitutes a representation or warranty by us to either develop, enhance, modify, distribute, market, sell, offer for sale, or otherwise maintain production of any our products or any other hardware, software, device, tool, information, or product. We moreover disclaim any and all warranties arising from the course of dealing or usage of trade.

Privacy Policy

To implement module functionality, certain device data are uploaded to Quectel's or third-party's servers, including carriers, chipset suppliers or customer-designated servers. Quectel, strictly abiding by the relevant laws and regulations, shall retain, use, disclose or otherwise process relevant data for the purpose of performing the service only or as permitted by applicable laws. Before data interaction with third parties, please be informed of their privacy and data security policy.

Disclaimer

a) We acknowledge no liability for any injury or damage arising from the reliance upon the information.
b) We shall bear no liability resulting from any inaccuracies or omissions, or from the use of the information contained herein.
c) While we have made every effort to ensure that the functions and features under development are free from errors, it is possible that they could contain errors, inaccuracies, and omissions. Unless otherwise provided by valid agreement, we make no warranties of any kind, either implied or express, and exclude all liability for any loss or damage suffered in connection with the use of features and functions under development, to the maximum extent permitted by law, regardless of whether such loss or damage may have been foreseeable.
d) We are not responsible for the accessibility, safety, accuracy, availability, legality, or completeness of information, advertising, commercial offers, products, services, and materials on third-party websites and third-party resources.

About the Document

Revision History

Version	Date	Author	Description
-	2020-09-28	Shannon LIU	Creation of the document
1.0	2020-11-04	Shannon LIU	First official release
1.1	2023-03-07	Monan TIAN	1. Developed DFOTA function over HTTPS server. 2. Added introductions of URC report time after module restart (Examples in Chapter 3.3.1, 3.3.2, 3.3.3). 3. Updated notes in **AT+QFOTADL=<file_name>** (Chapter 3.3.3). 4. Added the chapter of exception handling (Chapter 4). 5. Updated the error code list and error code introduction (Chapter 5).

Contents

Table Index

Figure Index

1 Introduction

Quectel 5G modules support DFOTA (Delta Firmware Upgrade Over-The-Air) function to upgrade the firmware of partitions such as modem, system, boot, sbl, tz and so on.

With this function, the firmware can be upgraded to a new version and reverted to the old version. The delta firmware package only contains the difference between the original firmware version and the target firmware version, with the amount of data transmission greatly reduced and the transmission time greatly shortened.

1.1. Application Modules

Table 1: Applicable Modules

Module Family	Module
RG50xQ	RG500Q Series
	RG501Q-EU
	RG502Q Series
RM5xxQ	RM500Q Series
	RM502Q-AE
	RM505Q-AE
	RM510Q-GL

2 Firmware Upgrade Procedure Over DFOTA

The following chart illustrates the firmware upgrade procedure via DFOTA when the delta firmware package is stored on an FTP/HTTP(S) server.

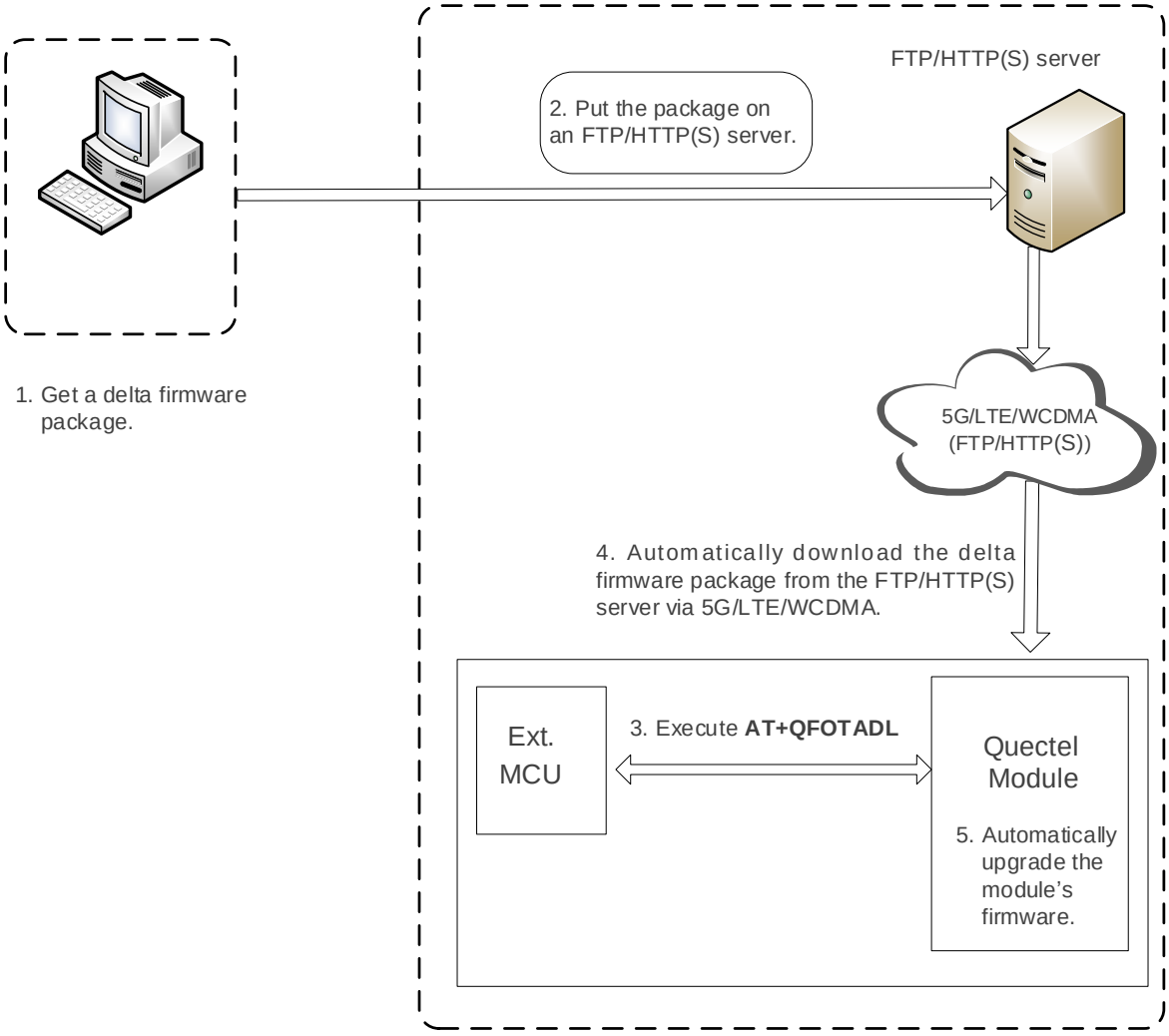

Figure 1: Firmware Upgrade Procedure via DFOTA

As shown in the above figure, the following steps need to be performed to update the firmware when the delta firmware package is stored on an FTP/HTTP(S) server:

Step 1: Get a delta firmware package from Quectel.
Step 2: Put the delta firmware package on an FTP/HTTP(S) server.
Step 3: Execute **AT+QFOTADL**.
Step 4: The module will automatically download the package from the FTP/HTTP(S) server or local file system via 5G/LTE/WCDMA.
Step 5: The module's firmware will be automatically upgraded.

2.1. Get Delta Firmware Package

Before upgrading, check the original firmware version name with **ATI** and confirm the target firmware version, and then send the two firmware versions to Quectel or the agent to get a delta firmware package.

2.2. Put Delta Firmware Package on FTP/HTTP(S) Server

Step 1: Please set up an FTP/HTTP(S) server before using DFOTA function. (Quectel does not provide such servers.)
Step 2: Put the delta firmware package on the server, and record the storage path.

2.3. Execute AT Command to Update the Firmware

After putting the delta firmware package on the FTP/HTTP(S) server, execute **AT+QFOTADL**, and then the module will download the delta firmware package from the FTP/HTTP(S) server over the air and update the firmware automatically. For more details about the AT commands, see ***Chapter 3***.

NOTE

Except for FTP/HTTP(S) server, module also supports firmware upgrade over local file system. For more details about the firmware upgrade over local file system, see ***Chapter 3.3.3***.

3 Description of DFOTA AT Commands

3.1. AT Command Introduction

3.1.1. 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 its previous value or the default settings, unless otherwise specified.
- **Underline** Default setting of a parameter.

3.1.2. 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 2: 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.

3.2. 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.

3.3. AT+QFOTADL Upgrade Firmware via DFOTA

This command enables automatic firmware upgrade via DFOTA. After the delta firmware package from FTP/HTTP(S) server or local file system is successfully downloaded, the module will automatically upgrade the firmware and then reboot.

AT+QFOTADL Upgrade Firmware via DFOTA	
Test Command **AT+QFOTADL=?**	Response **OK**
Maximum Response Time	300 ms

3.3.1. AT+QFOTADL=<FTP_URL> Upgrade Firmware over FTP Server

This command enables firmware upgrade over FTP server. The module will download the delta firmware package from the FTP server over the air, upgrade the firmware automatically and then reboot.

AT+QFOTADL=<FTP_URL> Upgrade Firmware over FTP Server	
Write Command **AT+QFOTADL=<FTP_URL>**	Response **OK** **+QIND: "FOTA","FTPSTART"** **+QIND: "FOTA","FTPEND",<FTP_err>** **+QIND: "FOTA","START"** **+QIND: "FOTA","UPDATING",<percent>** **+QIND: "FOTA","UPDATING",<percent>** **...** **+QIND: "FOTA","END",<err>** If there is any error: **ERROR**

Maximum Response Time	300 ms
Characteristics	-

Parameter

<FTP_URL>	String type. The URL that the delta firmware package stored on the FTP server. It should be started with "ftp://". For example: "ftp://**<username>**:**<password>**@**<serverURL>**:**<port>**/**<file_path>**". Maximum length is 512 bytes.
<username>	String type. The FTP user name for authentication.
<password>	String type. The FTP password for authentication.
<serverURL>	String type. The IP address or domain name of the FTP server.
<port>	Integer type. The port of the FTP server. Range: 1–65535. Default: 21.
<file_path>	String type. The path name of delta firmware package on FTP server.
<FTP_err>	Integer type. The FTP error code. 0 Downloaded the delta firmware package from the FTP server successfully Others Failed to download the delta firmware package from the FTP server. See ***Chapter 5*** for details
<percent>	Integer type. The upgrade progress in percentage. Range: 0–100.
<err>	Integer type. Error code of upgrading. 0 Upgraded the firmware successfully Others Failed to upgrade the firmware. See ***Chapter 5*** for more details

Example

```
//Upgrade firmware after the delta firmware package is stored on an FTP server. For example, the FTP server address is ftp://test:test@124.74.41.170:21/Jun/update-v12-to-v13.zip, execute the following command to enable automatic firmware upgrade via DFOTA.
AT+QFOTADL="ftp://test:test@124.74.41.170:21/Jun/update-v12-to-v13.zip"
OK

+QIND: "FOTA","FTPSTART"
+QIND: "FOTA","FTPEND",0        //Download the delta firmware package successfully from the FTP server.

//The module reboots automatically and the USB port is re-initialized. If the current port is USB port, MCU should close and reopen it. After the module is rebooted, the first URC should be reported within 90 seconds. Otherwise, it means an unknown error occurs.
+QIND: "FOTA","START"
+QIND: "FOTA","UPDATING",1
+QIND: "FOTA","UPDATING",20
...
```

```
+QIND: "FOTA","UPDATING",100
+QIND: "FOTA","END",0        //The module automatically restarts to complete the DFOTA upgrade.
```

3.3.2. AT+QFOTADL=<HTTP_URL> Upgrade Firmware over HTTP(S) Server

This command enables firmware upgrade over HTTP(S) server. The module will download the delta firmware package from the HTTP(S) server over the air, upgrade the firmware automatically and then reboot.

AT+QFOTADL=<HTTP_URL> Upgrade Firmware over HTTP(S) Server	
Write Command **AT+QFOTADL=<HTTP_URL>**	Response **OK** **+QIND: "FOTA","HTTPSTART"** **+QIND: "FOTA","HTTPEND",<HTTP_err>** **+QIND: "FOTA","START"** **+QIND: "FOTA","UPDATING",<percent>** **+QIND: "FOTA","UPDATING",<percent>** **...** **+QIND: "FOTA","END",<err>** If there is any error: **ERROR**
Maximum Response Time	300 ms
Characteristics	-

Parameter

<HTTP_URL>	String type. The URL that the delta firmware package stored on the HTTP(S) server. It should be started with "http(s)://". For example: "http(s)://**<HTTP_server_URL>**:**<HTTP_port>**/**<HTTP_file_path>**". Maximum length is 512 bytes.
<HTTP_server_URL>	String type. The IP address or domain name of the HTTP(S) server.
<HTTP_port>	Integer type. The port of the HTTP(S) server. Range: 1–65535. Default: 80.
<HTTP_file_path>	String type. The path name of delta firmware package on HTTP(S) server.
<HTTP_err>	Integer type. The HTTP(S) error code. 0 Downloaded the delta firmware package from the HTTP(S) server successfully Others Failed to download the delta firmware package from the HTTP(S) server. See ***Chapter 5*** for details
<percent>	Integer type. The upgrade progress in percentage. Range: 0–100.

<err>	Integer type. Error code of upgrading. 0 Upgraded the firmware successfully Others Failed to upgrade the firmware. See ***Chapter 5*** for more details

Example

```
//Upgrade firmware after the delta firmware package is stored on an HTTP(S) server. For example, the HTTP(S) server address is http://www.quectel.com:100/update.zip, execute the following command to enable automatic firmware upgrade via DFOTA.
AT+QFOTADL="http://www.quectel.com:100/update.zip"
OK

+QIND: "FOTA","HTTPSTART"
+QIND: "FOTA","HTTPEND",0      //Downloaded the delta firmware package from the HTTP server.

//The module reboots automatically and the USB port is re-initialized. If the current port is USB port, MCU should close and reopen it. After the module is rebooted, the first URC should be reported within 90 seconds. Otherwise, it means an unknown error occurs.
+QIND: "FOTA","START"
+QIND: "FOTA","UPDATING",1
+QIND: "FOTA","UPDATING",2
...
+QIND: "FOTA","UPDATING",100
+QIND: "FOTA","END",0       //The module automatically restarts to complete the DFOTA upgrade.
```

3.3.3. AT+QFOTADL=<file_name> Upgrade Firmware over Local File System

This command enables firmware upgrade over local file system. The module will download the delta firmware package from the local file system, upgrade the firmware automatically and then reboot.

AT+QFOTADL=<file_name> Upgrade Firmware over Local File System	
Write Command **AT+QFOTADL=<file_name>**	Response **OK** **+QIND: "FOTA","START"** **+QIND: "FOTA","UPDATING",<percent>** **+QIND: "FOTA","UPDATING",<percent>** **...** **+QIND: "FOTA","END",<err>** If there is any error: **ERROR**

Maximum Response Time	300 ms
Characteristics	-

Parameter

<file_name>	String type. The path where the delta firmware package stores in the local file system. It should be started with "cache/ufs/" in UFS. Maximum length is 512 bytes.
<percent>	Integer type. The upgrade progress in percentage. Range: 0–100.
<err>	Integer type. Error code of upgrading. 0 Upgraded the firmware successfully Others Failed to upgrade the firmware. See ***Chapter 5*** for more details

NOTE

1. Before DFOTA upgrade over local file system, make sure that the delta firmware package is stored in the module. You can upload the package to the module through **AT+QFUPL**. For details of **AT+QFUPL**, see ***document [1]***.
2. The first APN is used for data call during DFOTA upgrade over FTP/HTTP(S) server by default. If the first APN is occupied by the host for data call, the module cannot use this APN at the same time. Therefore, the module automatically performs data call for DFOTA upgrade after the host disconnects the data call with this APN.
3. If Verizon certification uses the first APN to perform data call, it is suggested to use AT command to switch channels for DFOTA upgrade. For details, please contact Quectel Technical Support.

Example

```
//Upgrade firmware when the delta firmware package is stored on the local file system.
AT+QFOTADL="/cache/ufs/update-v13-to-v12.zip"
OK

//The module reboots automatically and the USB port is re-initialized. If the current port is USB port, MCU should close and reopen it. After the module is rebooted, the first URC should be reported within 90 seconds. Otherwise, it means an unknown error occurs.
+QIND: "FOTA","START"
+QIND: "FOTA","UPDATING",1
+QIND: "FOTA","UPDATING",2
...
+QIND: "FOTA","UPDATING",100
+QIND: "FOTA","END",0          //The module automatically restart to complete the DFOTA upgrade.
```

4 Exception Handling

To improve the upgrade success rate, the module will set the upgrade flag before starting the upgrade. When an error is reported during the upgrade, the module will automatically restart. After the upgrade flag is found, the upgrade process will continue. If the upgrade fails for five consecutive times, the upgrade is a complete failure, and the module will delete the flag, exit and try to start the module normally. The upgrade interface is as follows:

```
+QIND: "FOTA","START"
+QIND: "FOTA","UPDATING",20
+QIND: "FOTA","END",520
…
//The module restarts automatically
…
+QIND: "FOTA","START"
+QIND: "FOTA","UPDATING",20
+QIND: "FOTA","UPDATING",30
...
+QIND: "FOTA","END",0
```

NOTE

The consecutive upgrade times is only valid when an upgrade error is reported, while there is no limit to the number of upgrades in the event of an abnormal power failure. If an abnormal power failure occurs during module upgrade process, the upgrade can also continue after the module is restarted. After the upgrade is successful, the upgrade mark will also be deleted.

5 Summary of Error Codes

This chapter introduces the error codes related to Quectel modules or network. The details about **<FTP_err>**, **<HTTP_err>** and **<err>** are described in the following tables.

Table 3: Summary of <FTP_err> Codes

<FTP_err>	Description
0	Downloaded the delta firmware package from the FTP server successfully
601	FTP Unknown error

Table 4: Summary of <HTTP_err> Codes

<HTTP_err>	Description
0	Downloaded the delta firmware package from the HTTP(S) server successfully
701	Failed to downloaded the delta firmware package from the HTTP(S) server

Table 5: Summary of <err> Codes

<err>	Description
0	Upgraded the firmware successfully
502	The upgrade process exits due to some unknown errors or exceptions. The system will retry five times.
504	Incorrect zip format
505	The project or the version of the package does not match
510	The delta firmware package file does not match the source package file of the module, and needs to be checked if it is wrong.
511	The file system has no enough space for upgrade.

520–530 540–546	Firmware upgrading failed. The module will reboot and retry to upgrade the firmware until the upgrade is successful.
550	The firmware package is too large

6 Appendix References

Table 6: Related Documents

Document Name
[1] Quectel_RG50xQ&RM5xxQ_Series_FILE_Application_Note

Table 7: Terms and Abbreviations

Abbreviation	Description
5G	5th Generation Mobile Networks
APN	Access Point Name
DFOTA	Delta Firmware Upgrade Over-The-Air
FTP	File Transfer Protocol
GSM	Global System for Mobile Communications
HTTP(S)	Hypertext Transfer Protocol (Secure/over Secure Socket Layer)
IP	Internet Protocol
LTE	(Long-Term Evolution) a 4G mobile communications standard
MCU	Microcontroller Unit
UFS	User File System
URC	Unsolicited Result Code
URL	Uniform/Universal Resource Locator
USB	Universal Serial Bus
WCDMA	Wideband Code Division Multiple Access