RGx00U&RM500U Series
DFOTA Application Note

5G Module Series

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About the Document

Revision History

Version	Date	Author	Description
-	2021-03-23	Neil SHI	Creation of the document
1.0	2021-04-09	Neil SHI	First official release
1.1	2023-04-12	Jeffery JIANG	1. Added RG200U-CN module. 2. Added RM500U-CN module. 2. Updated RG500U-EA to RG500U series.

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1 Introduction

Delta Firmware Over-The-Air (DFOTA) function can realize the wireless upgrade or downgrade of the module firmware.

Quectel RG200U-CN, RG500U series and RM500U-CN modules support DFOTA (Delta Firmware Over-The-Air) function.

You can upgrade or degrade the firmware with delta firmware package over the air. The delta firmware package only contains the difference between the current firmware version and the target firmware version with the amount of data transmission greatly reduced and the transmission time greatly shortened.

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/HTTPS server.

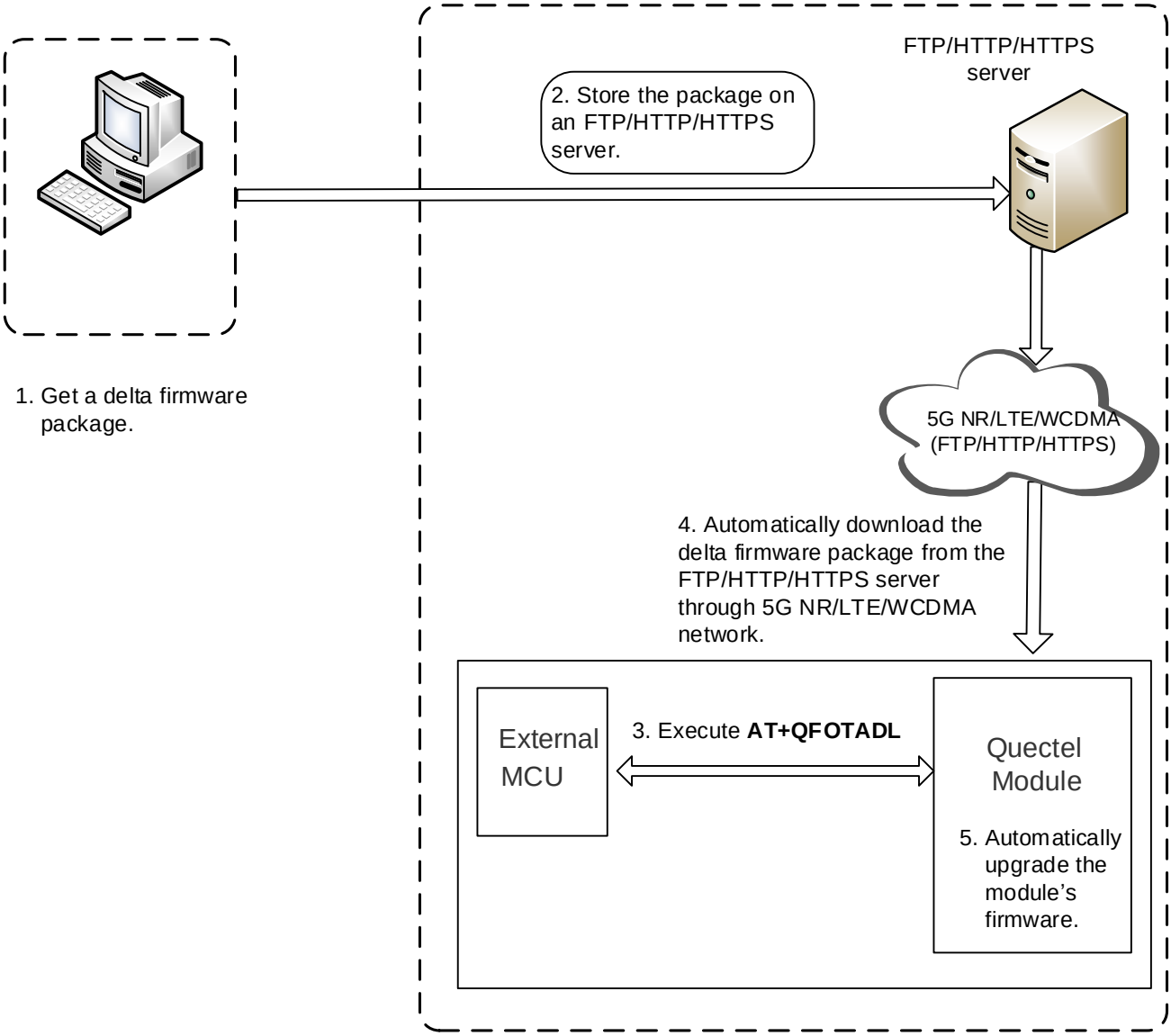

Figure 1: Firmware Upgrade Procedure via DFOTA

As shown in the above figure, the firmware is upgraded via DFOTA by following steps:

Step 1: Get a delta firmware package from Quectel or the agent.
Step 2: Store the delta firmware package on an FTP/HTTP/HTTPS server or in the local file system of the module.
Step 3: Execute **AT+QFOTADL**.
Step 4: The module automatically downloads the delta firmware package from the FTP/HTTP/HTTPS server via 5G NR/LTE/WCDMA network or upgrade the delta firmware package in the local file system directly.
Step 5: The module's firmware will be automatically upgraded.

2.1. Get Delta Firmware Package

Before upgrading, check the current firmware version by executing **ATI**, and also confirm the target firmware version. Then send the information of two firmware versions to Quectel or the agent to get the corresponding delta firmware package.

2.2. Store Delta Firmware Package on FTP/HTTP/HTTPS Server or in Local File System

The steps for storing delta firmware package on the FTP/HTTP/HTTPS server are as follows:

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

It is recommended that the storage path of delta firmware package in local file system is: */mnt/data/update/update.zip*.

NOTE

If the module automatically downloads the delta firmware package from the FTP/HTTP/HTTPS server via 5G NR/LTE/WCDMA network, the storage path of delta firmware package may not be */mnt/data/update/update.zip*.

2.3. Check Network Status

After the module is booted, make sure that the module has registered on the network before upgrading the firmware. Network registration commands are as follows. For more details, see ***document [1]***.

- **AT+COPS?**: Query the current network mode and the selected operator.
- **AT+CEREG?**: Query the EPS network registration status.
- **AT+CREG?**: Query the CS domain network registration status.
- **AT+CGATT?**: Query the PS domain attachment status.
- **AT+CGPADDR?**: Query the IP address assigned by the default PDP.
- **AT+C5GREG?**: Query the 5GS network registration status.
- **AT+QNETDEVSTATUS=<cid>**: Query the RmNet device status

2.4. Execute AT Command to Upgrade the Firmware

Execute **AT+QFOTADL** after the module has registered on the network, and then the module downloads the delta firmware package from the FTP/HTTP/HTTPS server over the air or gets the delta firmware package from the local file system and upgrade the firmware automatically. For more details about the AT commands, see ***Chapter 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 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.

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

After the delta firmware package is stored on the FTP/HTTP/HTTPS server or in the local file system, you can execute **AT+QFOTADL** related commands to enable the firmware upgrade via DFOTA automatically. After the package is downloaded from FTP/HTTP/HTTPS server or obtained from local file system successfully, the module will automatically upgrade the firmware and reboot.

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

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

If the delta firmware package is stored on an FTP server, execute **AT+QFOTADL=<FTP_URL>** to enable DFOTA upgrade over FTP server. Then the module will download the package from the FTP server over the air and upgrade the firmware automatically.

AT+QFOTADL=<FTP_URL> Upgrade Firmware over FTP Server	
Write Command **AT+QFOTADL=<FTP_URL>**	Response **OK** **+QIND: "FOTA","FTPSTART"** **+QIND: "FOTA","FTPDL",<percent>** **...** **+QIND: "FOTA","FTPDL",<percent>**

	+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. URL of the delta firmware package on FTP server. It should be started with "ftp://". For example, "ftp://**<usr_name>**:**<password>**@**<serverURL>**:**<port>**/**<file_path>**". Maximum length: 255. Unit: byte.	
	<usr_name>	String type. The user name for authentication. Maximum length: 50 Unit: byte.
	<password>	String type. The password for authentication. Maximum length: 50. Unit: byte.
	<serverURL>	String type. The IP address of the FTP server. Maximum length: 50. Unit: byte.
	<port>	Integer type. The port of the FTP server. Range: 1–65535. Default value: 21.
	<file_path>	String type. The file path on FTP server. Maximum length: 50. Unit: byte.
<percent>	Integer type. The download or upgrade progress in percentage. Range: 0–100.	
<FTP_err>	Integer type. FTP result code.	
	0	Download the delta firmware package successfully
	Other values	Fail to download the delta firmware package. See ***Table 2*** for details
<err>	Integer type. Result codes of upgrade.	
	0	Upgrade the firmware successfully
	Other values	Fail to upgrade the firmware. See ***Table 4*** for 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/update.zip". Execute the following command to enable DFOTA upgrade over FTP server. The module will start to download the delta firmware package and upgrade firmware automatically.
AT+QFOTADL="ftp://test:test@124.74.41.170:21/update.zip"
OK

+QIND: "FOTA","FTPSTART"

+QIND: "FOTA","FTPDL",1

+QIND: "FOTA","FTPDL",15

...

+QIND: "FOTA","FTPDL",100
+QIND: "FOTA","FTPEND",0          //Finish downloading the delta firmware package from the FTP server.

//The module will reboot automatically and enter recovery mode. The USB port will be re-initialized.
+QIND: "FOTA","START"

+QIND: "FOTA","UPDATING",1

+QIND: "FOTA","UPDATING",20

...

+QIND: "FOTA","UPDATING",100
+QIND: "FOTA","END",0             //Firmware is upgraded successfully.
//The module will reboot automatically and enter normal mode.
```

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

If the delta firmware package is stored on an HTTP server, execute **AT+QFOTADL=<HTTP_URL>** to enable DFOTA upgrade over HTTP server. Then the module will download the package from the HTTP server over the air and upgrade the firmware automatically.

AT+QFOTADL=<HTTP_URL> Upgrade Firmware over HTTP Server	
Write Command **AT+QFOTADL=<HTTP_URL>**	Response **OK** **+QIND: "FOTA","HTTPSTART"** **+QIND: "FOTA","HTTPDL",<percent>** **...** **+QIND: "FOTA","HTTPDL",<percent>** **+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. URL of the delta firmware package on HTTP server. It should be started with "http://". For example, "http://**<HTTP_server_URL>**:**<HTTP_port>**/**<HTTP_file_path>**". Maximum length: 255. Unit: byte.	
	<HTTP_server_URL>	String type. The IP address or domain name of the HTTP server.
	<HTTP_port>	Integer type. The port of the HTTP server.

		Range: 1–65535. Default value: 80.
	<HTTP_file_path>	String type. The file path on HTTP server.
<HTTP_err>	Integer type. HTTP result code.	
	0	Download the delta firmware package successfully
	Other values	Fail to download the delta firmware package. See ***Table 3*** for details
<percent>	Integer type. The download or upgrade progress in percentage. Range: 0–100.	
<err>	Integer type. Result codes of upgrade.	
	0	Upgrade the firmware successfully
	Other values	Fail to upgrade the firmware. See ***Table 4*** for details

Example

```
//Upgrade firmware after the delta firmware package is stored on an HTTP server. The HTTP server address is "http://www.quectel.com:100/update.zip". Execute the following command to enable DFOTA upgrade over HTTP server, and then the module will start to download the delta firmware package and upgrade firmware automatically.
AT+QFOTADL="http://www.quectel.com:100/update.zip"
OK

+QIND: "FOTA","HTTPSTART"

+QIND: "FOTA","HTTPDL",1

+QIND: "FOTA","HTTPDL",15

...

+QIND: "FOTA","HTTPDL",100
+QIND: "FOTA","HTTPEND",0      //Finish downloading the delta firmware package from the HTTP server.

//The module will reboot automatically and enter recovery mode. The USB port will be re-initialized.
+QIND: "FOTA","START"

+QIND: "FOTA","UPDATING",1

+QIND: "FOTA","UPDATING",2

...

+QIND: "FOTA","UPDATING",100
+QIND: "FOTA","END",0          //Firmware is upgraded successfully.
//The module will reboot automatically and enter normal mode.
```

3.3.3. AT+QFOTADL=<HTTPS_URL> Upgrade Firmware over HTTPS Server

If the delta firmware package is stored on an HTTPS server, execute **AT+QFOTADL=<HTTPS_URL>** to enable DFOTA upgrade over HTTPS server. Then the module will download the package from the HTTPS server over the air and upgrade the firmware automatically.

AT+QFOTADL=<HTTPS_URL> Upgrade Firmware over HTTPS Server	
Write Command **AT+QFOTADL=<HTTPS_URL>**	Response **OK** **+QIND: "FOTA","HTTPSSTART"** **+QIND: "FOTA","HTTPSDL",<percent>** **...** **+QIND: "FOTA","HTTPSDL",<percent>** **+QIND: "FOTA","HTTPSEND",<HTTPS_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

<HTTPS_URL>	String type. URL of the delta firmware package on HTTPS server. It should be started with "https://". For example, "https://**<HTTPS_server_URL>**:**<HTTPS_port>**/**<HTTPS_file_path>**". Maximum length: 255. Unit: byte.	
	<HTTPS_server_URL>	String type. The IP address or domain name of the HTTPS server.
	<HTTPS_port>	Integer type. The port of the HTTP server.

		Range: 1–65535. Default value: 80.
	<HTTPS_file_path>	String type. The file path on HTTPS server.
<HTTPS_err>	Integer type. HTTPS result code.	
	0	Download the delta firmware package successfully
	Other values	Fail to download the delta firmware package. See ***Table 3*** for details
<percent>	Integer type. The download or upgrade progress in percentage. Range: 0–100.	
<err>	Integer type. Result codes of upgrade.	
	0	Upgrade the firmware successfully
	Other values	Fail to upgrade the firmware. See ***Table 4*** for details

Example

```
//Upgrade firmware after the delta firmware package is stored on an HTTPS server. The HTTPS server address is "https://www.quectel.com:100/update.zip". Execute the following command to enable DFOTA upgrade over HTTPS server, and then the module will start to download the delta firmware package and upgrade firmware automatically.
AT+QFOTADL="https://www.quectel.com:100/update.zip"
OK

+QIND: "FOTA","HTTPSSTART"

+QIND: "FOTA","HTTPSDL",1

+QIND: "FOTA","HTTPSDL",20

...

+QIND: "FOTA","HTTPSDL",100
+QIND: "FOTA","HTTPSEND",0          //Finish downloading the delta firmware package from the HTTPS server.

//The module will reboot automatically and enter recovery mode. The USB port will be re-initialized.
+QIND: "FOTA","START"

+QIND: "FOTA","UPDATING",1

+QIND: "FOTA","UPDATING",2

...

+QIND: "FOTA","UPDATING",100
+QIND: "FOTA","END",0          //Firmware is upgraded successfully.
//The module will reboot automatically and enter normal mode.
```

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

If the delta firmware package has already been stored in the local file system, execute **AT+QFOTADL=<file_name>** to enable DFOTA upgrade over local file system. Then the module will upgrade the firmware automatically.

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 under which the delta firmware package is stored in the local file system. The recommended path is */mnt/data/update/update.zip*. Maximum length: 255. Unit: byte.
<percent>	Integer type. The upgrade progress in percentage. Range: 0–100.
<err>	Integer type. Result codes of upgrade. 0 Upgrade the firmware successfully Other values Failed to upgrade the firmware. See ***Table 4*** for details

Example

```
//Upgrade firmware when the delta firmware package is stored in the local file system.
AT+QFOTADL="/mnt/data/update/update.zip"
OK

//The module will reboot automatically and enter recovery mode. The USB port will be re-initialized.
+QIND: "FOTA","START"

+QIND: "FOTA","UPDATING",1

+QIND: "FOTA","UPDATING",2

...

+QIND: "FOTA","UPDATING",100
+QIND: "FOTA","END",0          //Firmware is upgraded successfully.
//The module will reboot automatically and enter normal mode.
```

4 Notes

Before upgrading the firmware, you need pay attention to the following when you have obtained the delta firmware package from FTP/HTTP/HTTPS server or the local file system:

1. If the module is powered down when it is in "UPDATING" state, it will automatically enter the forced upgrade mode, that is, the upgrade will continue after the module is rebooted next time. The upgrade progress is as follows:

```
+QIND: "FOTA","START"

+QIND: "FOTA","UPDATING",20

+QIND: "FOTA","UPDATING",30

...
+QIND: "FOTA","UPDATING",100
+QIND: "FOTA","END",0
```

2. When the module enters recovery mode after downloading the delta firmware package, it verifies the delta firmware package firstly.

- If an error occurs in the delta firmware package, an error code will be reported through URC. See ***Chapter 5*** for details of the error codes.
- If the firmware is upgraded successfully, the module will reboot and enter normal mode.
- If the firmware failed to be upgraded, the module will reboot and enter recovery mode again, and then retry to upgrade the firmware until the upgrade is successful. The firmware will try to be upgraded consecutively for a maximum of 10 times.

5 Result Codes

This chapter introduces the result codes related to Quectel module or network. The details about **<FTP_err>**, **<HTTP_err>**, **<HTTPS_err>** and **<err>** are described as follows.

Table 2: <FTP_err> Codes

<FTP_err>	Description
0	Download the delta firmware package from the FTP server successfully
601	FTP Unknown error
602	URL length exceeds limit

Table 3: <HTTP_err> and <HTTPS_err> Codes

<HTTP_err>/ <HTTPS_err>	Description
0	Download the delta firmware package from the HTTP/HPPTS server successfully
701	HTTP/HPPTS unknown error
702	HTTP/HPPTS URL length exceeds limit

Table 4: <err> Codes

<err>	Description
0	DFOTA upgrade successfully
502	The upgrade process exits due to some unknown errors or exceptions, or the delta firmware package is incorrect. The module will reboot and enter recovery mode, and then retry to upgrade the firmware until the upgrade is successful. The firmware will try to be upgraded consecutively for a maximum of 10 times.
505	Verification of the delta firmware package fails due to an error of Zip format. If the Zip format is wrong, the delta firmware package will be deleted.

510	The delta firmware package does not match the current firmware version of the module. Check whether the delta firmware package is correct.
511	The file system has no enough space for upgrade.
520	Fail to upgrade the firmware. The module will reboot and enter recovery mode, and then retry to upgrade the firmware until the upgrade is successful. The firmware will try to be upgraded consecutively for a maximum of 10 times.

6 Appendix References

Table 5: Related Document

Document Name
[1] Quectel_RGx00U&RM500U_Series_AT_Commands_Manual

Table 6: Terms and Abbreviations

Abbreviation	Description
5G NR	5th Generation New Radio
5GS	5G System
CS	Circuit Switched
DFOTA	Delta Firmware Upgrade Over-The-Air
EPS	Evolved Packet System
FTP	File Transfer Protocol
HTTP	Hypertext Transfer Protocol
HTTPS	Hypertext Transfer Protocol Secure
IP	Internet Protocol
LTE	Long Term Evolution
MCU	Microcontroller Unit
PDN	Public Data Network
PS	Packet Switch
URC	Unsolicited Result Code
URL	Uniform Resource Locator
USB	Universal Serial Bus
WCDMA	Wideband Code Division Multiple Access