LEXI-R10 series

Firmware update with FOTA, FOAT and EasyFlash

Application note

Abstract

LEXI-R10 series modules offer flexibility with multiple options of firmware (FW) updates. This application note covers all FW update options including EasyFlash, u-blox's FW flash tool over UART or USB; the tethered update (FOAT), and firmware over the air update (FOTA) via HTTP(S).

Document information

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This document applies to the following products:

Product name
LEXI-R10 series

Contents

1 Introduction

1.1 Overview

There are three options to update the firmware (FW) of LEXI-R10 series modules:

- EasyFlash
- FOAT
- FOTA

Figure 1 shows how EasyFlash and FOAT work. The u-blox EasyFlash tool for Windows flashes the FW image to the module. With FOAT, the FW image is transferred from host to module and automatically installed, with the +NFWUPD AT command.
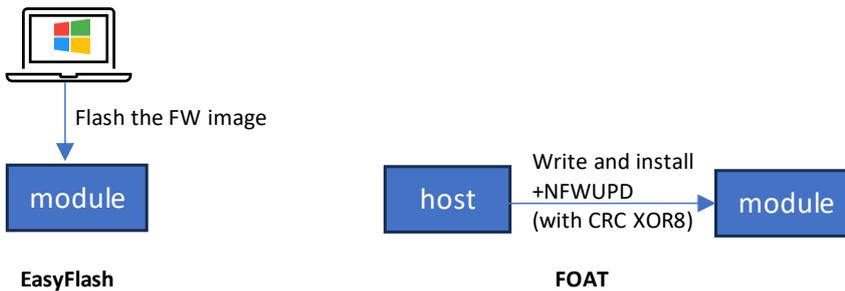
Figure 1 FW update by EasyFlash and by FOAT

Figure 2 shows how FW update by FOTA is done by 2 options. FOTA uses dedicated AT commands to download FW delta package from the server to module, or transfer from host to module, and install, as shown below:
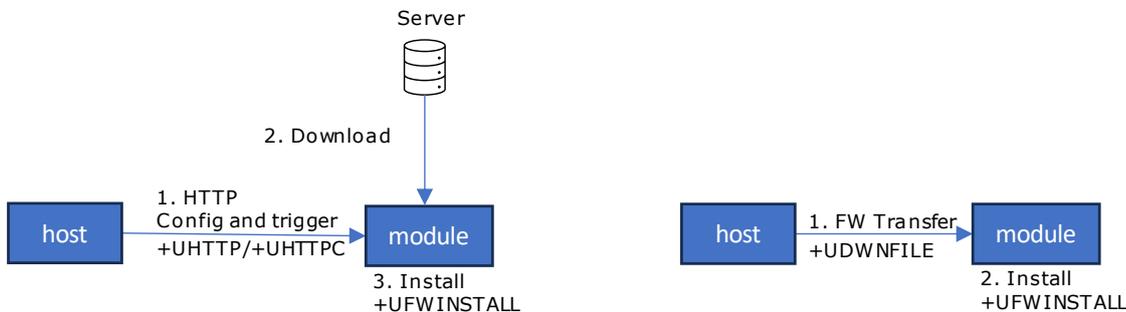
FOTA option 1: Download FW by HTTP, then install   FOTA option 2: Transfer FW from host to module, then install

Figure 2 FW update by FOTA, with 2 options

Table 1 summarizes the characters of the FW update methods.

	EasyFlash	FOAT	FOTA
Format	Full FW image	Delta	Delta
Duration	Fast	Medium	Slow (Download and installation)
Where to find FW update file info?	IN/PCN	IN/PCN	IN/PCN
Where to get the image	IN/PCN provides link to the image.	Contact u-blox technical support	Contact u-blox technical support
Pro	Easy	No PC required.	Wireless

	EasyFlash	FOAT	FOTA
			No host storage required.
Con	Require a PC	File must be stored on host. Require implementation of CRC XOR8 protocol.	An extra server required to store the delta file
Typical use cases	Development / production	Production / Field devices	Field devices
Complexity	Low	Medium	Medium

Table 1 Summary of module FW update methods

1.2   Firmware update process

The firmware update proceeds in three phases, as shown in Figure 3. During each phase, URCs are provided to report the progress.

- **Download phase:** The time to download the firmware update file to the module. The file size may vary depending on the downloading method (FOAT, HTTP). Furthermore, when using an OTA method, even with the same file size, the download time may vary according to the network condition.
- **Validation phase:** The time to validate the file as binary content and check signature.
- **Installation phase:** The time to install the new firmware. The installation time depends on the file size. The installation time for a FOAT and FOAT file depends on the installed firmware because it is a differential file between the installed and the target firmware.
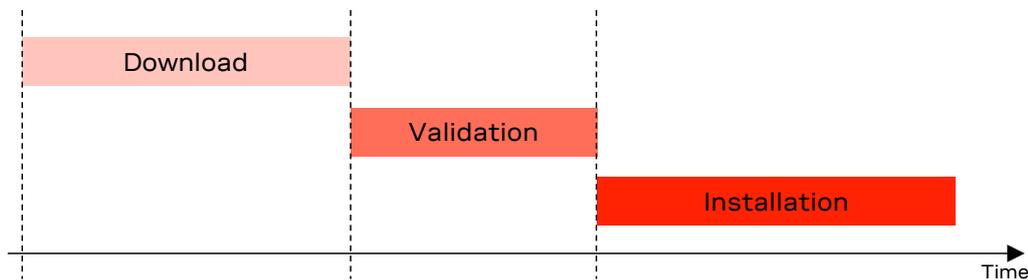

Figure 3: FW update process

The following symbols are used to highlight important information within the document:

☞   An index finger points out key information pertaining to integration and performance.

⚠   A warning symbol indicates actions that could negatively impact or damage the module.

2   EasyFlash

EasyFlash is a Windows-based application tool that allows LEXI-R10 series modules to be flashed via the USB interface.

☞   For each firmware release, there is a recommended version or minimal version of EasyFlash to be used with it. Consult u-blox support to identify which EasyFlash version shall be used. It is good practice to have the latest version available to have all the improvements and fixes.

2.1   OS requirements

EasyFlash requires a computer with Windows 10 or newer versions.

2.2   Flashing steps

1.   Select the path to the FW .dof flash file in the main window of the tool (see Figure 4).
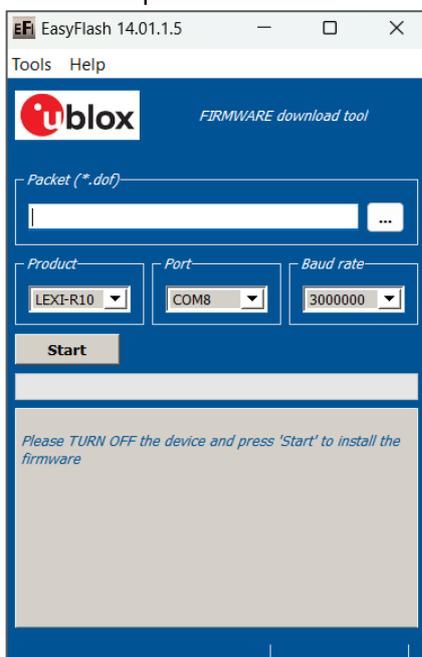
Figure 4: EasyFlash, select the ".dof" file path

2.   If there are any tools related to the module running on the computer, then close them. To ensure they are closed it may require checking and terminating them in Windows Task Manager.
3.   Open EasyFlash (run / open it as "Administrator" in Windows).
4.   Select in pull down
     a.   Product: LEXI-R10
     b.   Port: COMX
     c.   Baud rate: 3000000
5.   "Enable trace" from main menu (see Figure 5) is ticked by default. This will create a log per flash attempt. It is useful if something goes wrong, and it is needed to report the issue.
6.   Click "Start" button (see Figure 5).

Figure 5: Setting up EasyFlash and starting the FW installation

7. Power up the module.
8. Flash will start, wait for flash to complete (see Figure 6 and Figure 7)
9. Close EasyFlash.

Figure 6: Flash process in progress

Figure 7: Flash process complete and successful

2.3   EasyFlash tips

- Do not use a USB hub.
- If the flash process fails to complete, try again, or try rebooting the PC.

3 Firmware update via AT command (FOAT)

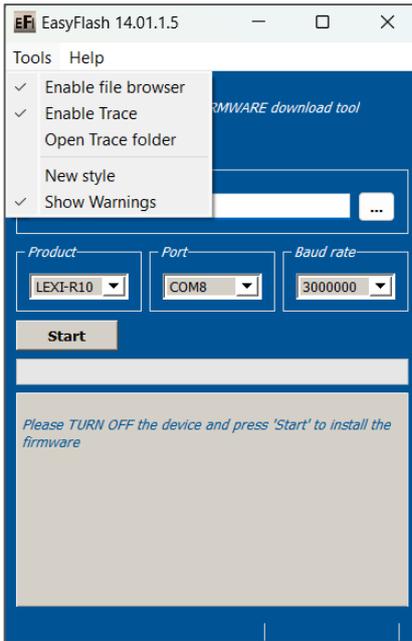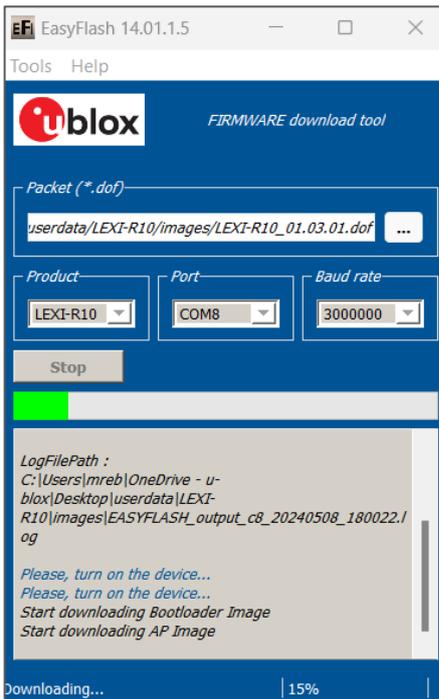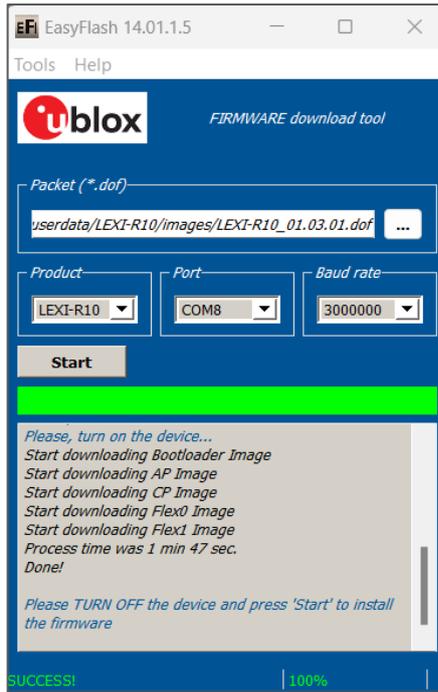FOAT download provides tethered data transfer methods to perform firmware download over USB/UART interfaces with a host processor.
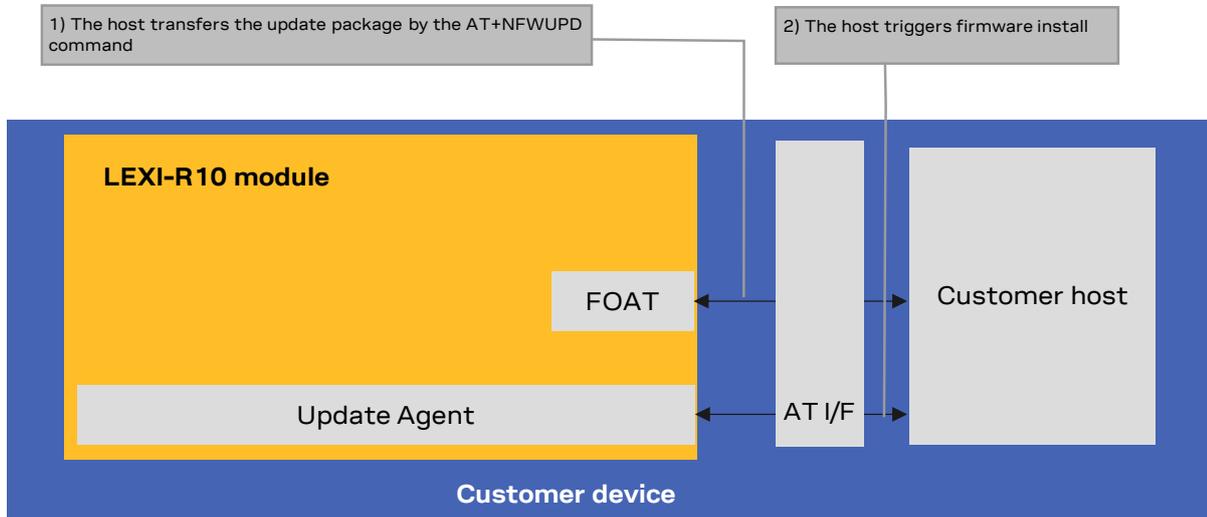

Figure 8: FOAT architecture

3.1 +NFWUPD AT command

The `+NFWUPD` AT command triggers the download of the update package over the AT command interface. The AT command allows the FW package download, validation, and installation. The FW package is a binary file provided by u-blox.

The host can start the download process on the USB interface or on any UART interface at speed set by the `+IPR` AT command (the factory-programmed value is 115200 bit/s). Steps for the update are:

Command	Response	Description
`AT+NFWUPD=0`	OK	Initialize the system to accept a new FW package.
`AT+NFWUPD=1, <sn>,<len>,<data>,<crc>` … `AT+NFWUPD=1, <sn>,<len>,<data>,<crc>`	OK OK	Download the FW package file by the package segment download command (AT+NFWUPD=1, <sn>,<len>,<data>,<crc>). If the file size exceeds 1024 bytes, then the download command should be issued several times, one for each segment.
`AT+NFWUPD=2`	OK	FW package validation. ☞ The validation cannot be aborted, hence do not issue any other command during the package validation.
`AT+UFWINSTALL`	OK	If the validation succeeds, firmware update triggered. ☞ Alternatively, use AT+NFWUPD=5 instead of the AT+UFWINSTALL command.
	`+UUFWINSTALL: 128`	Procedure concludes successfully.

The complete FW update takes about two minutes. In case of failure during the FW update, the process will be rolled back and an error result code will be provided. At the end of upgrade process the module will be rebooted and the data stored in the NVM are set to the factory-programmed values of the new firmware version.

4 Firmware download over the air (FOTA)

4.1 Firmware download via HTTP

This section goes through the AT commands required to download a firmware delta file from a server via HTTP or HTTPS.

The host shall first configure a HTTP profile with the server parameters before starting the FW download. After the firmware delta file has been downloaded, install the new firmware using the +UFWINSTALL AT command. For more details, see section 4.2.

⚠ If the HTTP FOTA download command is issued while a firmware package download is already in progress, an error result code will be returned. For more details, see section 5.

4.1.1 HTTP profile configuration +UHTTP

Before starting a firmware download via HTTP, the host shall first configure the HTTP application profile parameters.

The +UHTTP AT command defines one or more HTTP profiles and configures their parameters. The set command needs to be executed for each single parameter. The HTTP parameter values set with this command are all volatile (not stored in non-volatile memory).

☞ It is not possible to read the current setting for all parameters of a given HTTP profile, but it is possible to read one parameter at a time by issuing the set command specifying the profile and the parameter code.

☞ It is possible to reset all parameters of a given HTTP profile to their factory-programmed values by issuing the set command with only the profile ID parameter.

4.1.1.1 Example

The following command sequence indicates the HTTP profile parameters required to start a successful firmware download. The selected HTTP profile identifier is 0.

Syntax	Response	Example
HTTP server IP address		
AT+UHTTP=<profile_id>,0,<server_IP_addr>	OK	AT+UHTTP=0,0,"192.168.1.0"
HTTP server name		
AT+UHTTP=<profile_id>,1,<server_name>	OK	AT+UHTTP=0,1,"server.com"
Username		
AT+UHTTP=<profile_id>,2,<username>	OK	AT+UHTTP=0,2,"username"
Password		
AT+UHTTP=<profile_id>,3,<password>	OK	AT+UHTTP=0,3,"password"
Enable HTTPS with TLS		
AT+UHTTP=<profile_id>,6,1,<sec_profile>	OK	AT+UHTTP=0,6,1,0

The following syntax shows how to read a specific parameter of a HTTP profile and how to reset a given HTTP profile.

Syntax	Response	Example
Read HTTP server IP address		
AT+UHTTP=<profile_id>,0	+UHTTP: profile_id>,0,<server_IP_addr> OK	AT+UHTTP=0,0 +UHTTP: 0,0,"192.168.1.0" OK
HTTP reset all parameters		

Syntax	Response	Example
AT+UHTTP=<profile_id>	OK	AT+UHTTP=0

4.1.2 HTTP command +UHTTPC

The `AT+UHTTPC=<profile_id>,100,<path>` command triggers a firmware package download from a server via HTTP. When the file transfer is complete the `+UUHTTPCR URC`, reporting the md5 checksum of the FOTA update file, is sent to output.

4.1.2.1 Example

Syntax	Response	Example
Download the update file		
AT+UHTTPC=<profile_id>,100,<path>	OK	AT+UHTTPC=0,100,"/test/plain/uploads/update_file.zip"
Download success		
	+UUHTTPCR: <profile_id>,100,1,<status_code>,<md5_sum>	+UUHTTPCR: 0,100,1,200,"960d9502ed3d71505b681e8aa19f03c8"
Download failure		
	+UUHTTPCR: <profile_id>,100,0,0	+UUHTTPCR: 0,100,0,0

4.1.3 Error result codes

If a download session returns "`+UUHTTPCR: 100,0`", the host can retrieve the error reason using the `+UHTTPER` AT command. It retrieves the last +UHTTPC operation result for a given profile. For the definition of the <error_class> and <error_code> parameters, see the "HTTP class error codes" section of the LEXI-R10 series AT commands manual [1].

Syntax	Response	Example
AT+UHTTPER=<profile_id>	+UHTTPER: <profile_id>,<error_class>,<error_code> OK	AT+UHTTPER=0 +UHTTPER: 3,23 OK

In the example above, the operation failed due to server hostname lookup failure.

4.2 Firmware installation +UFWINSTALL

⚠️ Once the +UFWINSTALL AT command has been issued, the FW installation process shall begin. An interruption during the update process section can lead to image corruption of the module that is not recoverable. Types of interruptions include:

- o Removing or loss of power supply to the module
- o Unstable supply to the module
- o Host application applies an external reset to module
- o Turning off the module with **PWR_ON** or **RESET_N** pin

The +UFWINSTALL AT command triggers the firmware installation procedure once the firmware delta package (namely also 'update file') has been downloaded successfully to the device via AT command +NFWUPD, OTA with +UHTTPC. See Figure 9 for an overview diagram.
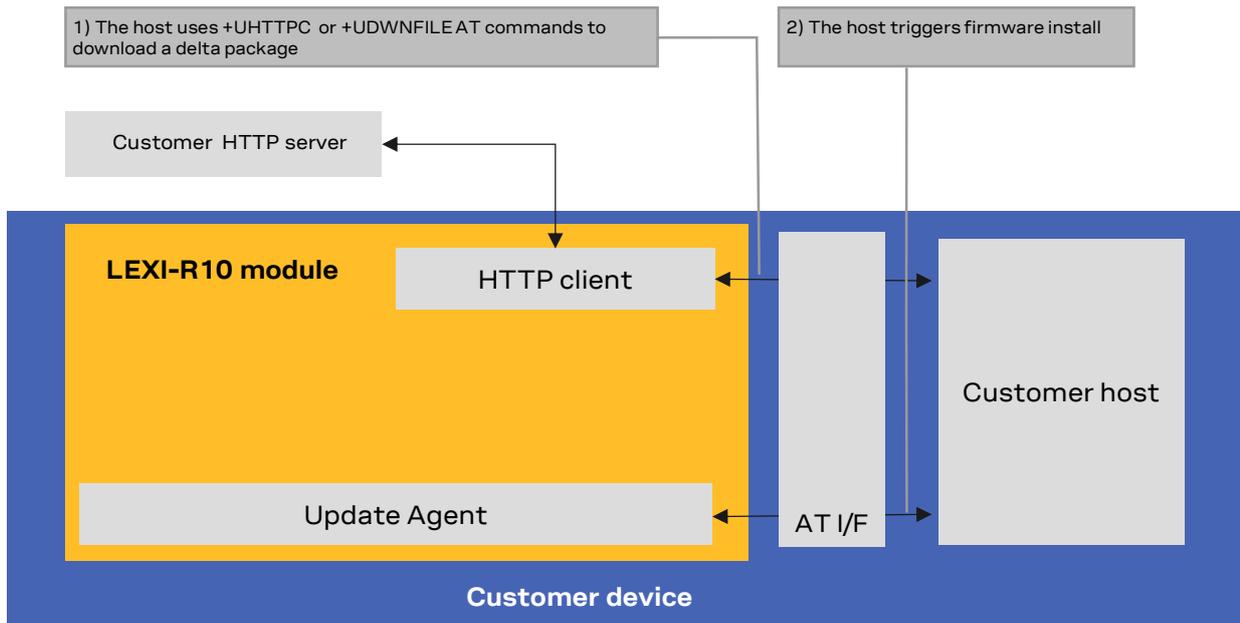
Figure 9: Firmware installation after FTPC, for FOAT file transfer

If the +UFWINSTALL command returns the "OK" final result code, the device will automatically reset and boot back up in boot loader mode, at which point it will process the firmware update.

Once the firmware installation completes, the device will reset again and enter a normal mode of operation with new firmware updated. The result of the firmware update can be confirmed by the ATI, ATI9 or +CGMR AT commands which indicate the firmware version.

During the update / installation process, the module cannot be used to make calls, even emergency calls. It is not available for communication via USB or UART interfaces. With the EVK on a Windows based PC, there will be no USB ports enumerated.

4.2.1   +UFWINSTALL AT command

Once the +UFWINSTALL command has been issued and package validation passed, the device will automatically reset and the update procedure starts. During the update no progress installation is shown on the terminal. At the end of the update, the device reboots and shows the result of the update with result code 128 (successful update) or 129 (error in update). For more details about firmware install final result codes, see the appendix A.

4.2.1.1   Installation performance

The installation time depends on the delta file size and the sections changed in the software memory map between two software versions.

4.2.1.2   Firmware installation with +UFWINSTALL example

Table 2 provides an example of firmware installation using the +UFWINSTALL AT command.

Command	Response	Description
AT+NFWUPD=1,352,36,62...d000,12	OK	Download the delta file in flash.
AT+UFWINSTALL	OK	Firmware update triggered.
	+UUFWINSTALL: 128	Procedure conclude successfully.

Table 2: +UFWINSTALL URCs example (delta file must be present in flash)

4.2.1.3 Recovery mechanism

In case of a failure (for instance due to power loss or cable detach), the FW installation procedure starts again until the end of the procedure (installation terminated). In the event of a firmware install failure but where the update process has still not written anything in the flash memory, the update procedure stops and runs the old firmware.

⚠ Even if the procedure is fault tolerant, it is strongly recommended to not remove the power supply or reset the module on purpose during the installation process! The module will reboot automatically at the end of the update procedure.

5 AT commands forbidden during FW download

Only one download method can be active at a time.

Table 3 presents the AT commands and firmware download methods that have a dependency upon one another.

☞ An error result code is returned if a command listed in Table 3 is issued during a firmware download.

Active download method	Forbidden AT commands	Note
AT+NFWUPD=1	AT+UHTTPC=<profile_id>,100	When +NFWUPD is in progress, the FOTA download via the forbidden commands will return an error.
AT+UHTTPC=<profile_id>,100	AT+NFWUPD=1,...	When AT+UHTTPC=<profile_id>,100 is in progress, the FOTA download via the forbidden commands will return an error.

Table 3: Firmware download methods dependency

6   Impacts of different FW update methods

Table 4 summarizes the update methods and their impact on user files and settings.

Item	EasyFlash	FW delta package via FOTA or FOAT
Description	Complete FW package applied by u-blox EashFlash tool	Differential update package applied with +UFWINSTALL
Package name example	`LEXI-R10401D-00B-00-ES-0103A0002-000K02.dof`	`LEXI-R10401D-00B-00-ES-0103A0002-000K02_LEXI-R10401D-00B-00-XX-0102A0001-000K02.par`
Files in user file system	Erased, then set to what is configured with FW image (if any).	No changes. Files are preserved.
LwM2M files stored in user file system	Erased, then set to what is configured with FW image (if any).	Erased, then set to what is configured with FW image (if any).
MNO profiles	Erased, then MNO profiles are loaded to only what is included in the FW image. After flashing select MNO profile with +UMNOPROF.	MNO profiles included in update package are modified. MNO profiles not included is restored by the new FW.
User NVM settings	Erased, then set to default values as configured in FW build image.	NVM items included in update package are modified, otherwise no change.
User certificate and private keys	Erased.	User certificate and private keys are preserved.

Table 4 Impact to device files and settings of each firmware update method

Appendix

A Extended error result codes

Table 5 lists the final result codes that may be issued at the finalization of the install procedure by the +UFWINSTALL command.

☞ Most of the following result codes are sent through the UART interface with the baud rate set by the +UFWINSTALL AT command. Where it is not possible to read the +UFWINSTALL configuration port, the UART and baud rate used is the primary UART interface and the baud rate of 115200 bit/s.

Error code	Description
128	FW installation successfully performed
129	Firmware installation generic failure
158	Delta file not recognized. It happens trying to update from a non-delta file format
168	Source firmware in flash mismatch with the one expected by the delta file.
180	Size of the delta file more than allowed

Table 5: Possible error result codes during +UFWINSTALL procedure

If a different error result code is provided, contact u-blox technical support.

B Glossary

Abbreviation	Definition
eDRX	Enhanced Discontinuous Reception
EVK	Evaluation Kit
FOAT	Firmware update AT command
FOTA	Firmware Over-The-Air
FW	Firmware
IMEI	International Mobile Equipment Identity
LwM2M	Light weight Machine to Machine
OTA	Over The Air
SRLT	Server Registration Life Timer
UART	Universal Asynchronous Receiver-Transmitter
URC	Unsolicited Result Code

Related documentation

[1]   u-blox LEXI-R10 series AT commands manual, UBXDOC-686885345-1786
[2]   u-blox LEXI-R10 series data sheet, UBX-23007594
[3]   u-blox LEXI-R10 series system integration manual, UBX-23008149
[4]   u-blox EVK-R10 user guide, UBXDOC-686885345-1985
[5]   u-blox LEXI-R10 application development guide, UBXDOC-686885345-1983

☞   For product change notifications and regular updates of u-blox documentation, register on our website, www.u-blox.com.

Revision history

Revision	Date	Name	Comments
R01	05-Jun-2024	mreb	Initial release
R02	25-Sep-2024	mreb	Updated section: Firmware download via HTTP.

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