

GR551x DFU Application Note

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Preface

Purpose

This document introduces principles and applications for Device Firmware Update (DFU) of GR551x SoCs, to help you quickly get familiar with GR551x firmware update modes, and get started with secondary development.

Audience

This document is intended for:

- GR551x user
- GR551x developer
- GR551x tester
- Technical writer

Release Notes

This document is the sixth release of *GR551x DFU Application Note*, corresponding to GR551x SoC series.

Revision History

Version	Date	Description	
1.0	2019-12-08	Initial release	
1.3	2020-03-16	Updated the release time in the footers.	
1.5	2020-05-30	Updated the structure figure of Boot_Info sector in flash in "DFU Storage"; optimized the descriptions of "DFU Mode".	
1.6	2020-06-30	Updated the data contents sent from the Host in "Configure External Flash Command".	
1.7	2020-12-25	 Updated the contents in "Steps" and "Why Does DFU for Application Firmware on a Bare Device Fail?"; Added "Why Do Exceptions Occur in OTA DFU for Application Firmware on a Device with an Operating System?". 	
1.8	2021-08-09	Changed the section "Supported Development Platform" into "Preparation".	



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1 Introduction

Device Firmware Update (DFU) is a boot loading mechanism to update firmware for target devices, allowing developers to quickly fix defects and provide more functions for their products.

This document introduces the methods and principles of DFU for GR551x SoCs, and how to enable and test DFU functionalities.

Before getting started, you can refer to the following documents.

Table 1-1 Reference documents

Name	Description	
GR551x Developer Guide	Introduces the software/hardware and quick start guide of GR551x SoCs.	
Bluetooth Core Spec	Offers official Bluetooth standards and core specification from Bluetooth SIG.	
J-Link/J-Trace User Guide	Provides J-Link operational instructions. Available at www.segger.com/downloads/jlink/ www.segger.com/downloads/jlink/ www.segger.com/downloads/ <a "="" docs="" href="https:</td></tr><tr><td>Keil User Guide</td><td>Offers detailed Keil operational instructions. Available at www.keil.com/support/man/docs/uv4/ .	
GR551x OTA Example Application	Introduces how to implement Over The Air (OTA) for GR551x firmware on GRToolbox (Android).	
GR551x Bluetooth Low Energy Stack User Guide	Introduces the BLE Protocol Stack supported by GR551x SoCs.	



2 GR551x DFU

This chapter introduces fundamental concepts about GR551x DFU such as mode, device role, and file format.

2.1 DFU Mode

GR551x SoCs support two DFU approaches (update through Bluetooth LE connection):

- Approach 1: Perform update in application firmware. Run the application firmware to download the target firmware. After download, the system jumps to the target firmware for running. During update, users can update firmware directly without disabling Bluetooth connection on a mobile phone. This approach provides smooth user experience.
- Approach 2: Jump to Boot firmware for firmware update. During firmware update, the system jumps from
 applications to the Boot firmware, and the Boot firmware enables download of the target firmware. After
 download, the system jumps to the target firmware for running. During update, it is required to first disable
 Bluetooth connection on the mobile phone and then scan and reconnect to the Boot firmware via Bluetooth.
 Compared with the first approach, this approach makes the best use of flash.

Note:

- To choose the Approach 1, you need to pre-define the load addresses of the current application firmware and
 the target firmware, and set different code load addresses for the current application firmware and the target
 firmware.
- The Approach 1 supports "Copy Mode". That is, before DFU, first update the target firmware to another unused flash address; then copy it to the required run address. For details, see "Connect to SK Board and Update Firmware" in GR551x OTA Example Application.

2.2 DFU Device Role

Two DFU device roles are defined:

- Control device (the host): a device, such as a mobile phone, that sends update data to the target device
- Target device (the device): a device, such as a wristband, that receives update data from the control device

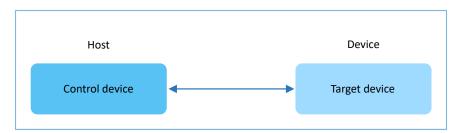


Figure 2-1 DFU device role

2.3 DFU File Format

Firmware files transferred in DFU mode are in BIN format, including encrypted and non-encrypted BIN files.



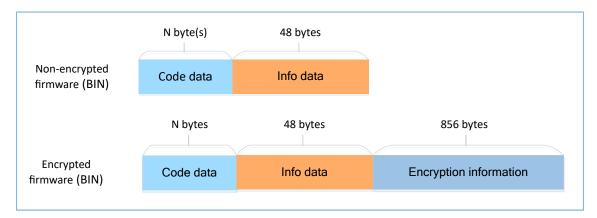


Figure 2-2 Data format of BIN files

Each field of the data format is detailed as below:

- Code data: firmware data that shall be 16-byte aligned. N indicates a variable length.
- Info data: firmware descriptions
- Encryption information: information used in encrypting non-encrypted firmware

The info data format (little-endian mode) is shown in the table below:

Table 2-1 Info data format

Byte	Field	Description		
0–1	pattern	Data identifier for SoCs, value: 0x4744		
2–3	version	Version info	rmation	
4–7	bin_size	Code data le	ength (byte)	
8–11	check_sum	Checksum o	f code data bit	
12–15	load_addr	Start addres	s of code data storage area	
16–19	run_addr	Run address	of code data	
20–23	xqspi_xip_cmd	SPI access mode		-
24–27	boot config	[0:3]: clock speed [4]: code copy mode [5:7]: system clock [8]: check image [9]: boot delay time [10:31]: reserved		Boot info (24 bytes)
28–39	comments	Firmware descriptions		
40–47	reserved	Used for 16-byte alignment; value: 0x00		

2.3.1 DFU Storage



The firmware information is stored in the Img_Info area in GR551x flash. This area (start address: 0x01000040; length: 400 bytes) can store up to 10 firmware packages.

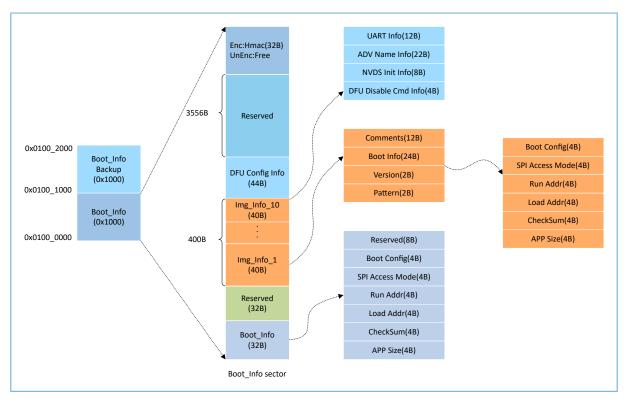


Figure 2-3 Structure of Boot_Info sector in flash

2.4 DFU Communications Protocol

The firmware update between the host and the device is based on DFU communications protocols.

2.4.1 Basic Frame

The basic frame defines the lowest-level data packet structure in communications. The application data packet protocol is based on the basic frame, in the "Data" field of the basic frame. If the basic frame length exceeds the maximum payload of link communications, the host needs to segment the frame for transmission. After receiving the correct frame header and data length, the device starts processing data.

2.4.2 Frame Structure

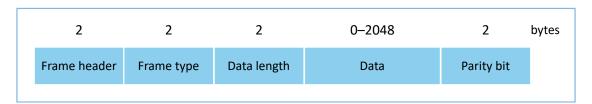


Figure 2-4 Frame structure



- Frame header: the start of a frame, represented by 0x47 and 0x44 which are the ASCII code values of characters 'G' and 'D'
- Frame type: used to distinguish data types in the "Data" field
- Data length: length of data in the "Data" field
- Data: data with configurable length; maximum length: 2048 bytes
- Parity bit: 16-bit checksum for frame type, response, data length, and data

2.4.3 Byte Order

The little-endian mode is adopted for the "Data" field of the basic frame. The low byte data shall be stored at low addresses in flash, and the high byte data at high addresses.

2.5 DFU Command Set

DFU commands are delivered by the host and received by the device.

Table 2-2 DFU command description

Command	Command Code	Description
Program Start	0x0023	The host sends Image Info when programs are downloaded to the device.
Program Flash	0x0024	Write up to 1024 bytes of data for one time to a specified address of flash. This command can specify the way to write data to flash (erasable write/non-erasable write).
Program End 0x0025		The host sends this command to notify the device that the programming data has been sent. The first byte of the data field is Reset Flag, which indicates the device to reset and run the current application or not after the programming data is sent.
Configure External Flash	0x002A	Configure external flash.
Get Flash Information	0x002B	Get flash information.

2.5.1 Program Start Command

The host sends this command to send the Image Info (data excluding the "reserved" field; 40 bytes) to the device. After the device receives the Image Info:

- For internal flash programming, check whether the Code Load Address of the programming data is the internal flash address.
- For external flash programming, specify the programming address and the data length.

2.5.1.1 Data Sent from the Host



Table 2-3 Format of data sent through the Program Start command

Byte No.	Description		Valid Value	Note
0–1	Frame header		0x4744	Represented by 0x47 and 0x44 which are the ASCII code values of characters 'G' and 'D'
2–3	Frame type	е	0x0023	Program Start command
4–5	Data length		0x0029/0x0009	 If the Program Start command targets firmware, the "Data" field has 41 bytes, including 1 byte for flash type and 40 bytes for Image Info. If the Program Start command targets data, the "Data" field has 9 bytes, including 1 byte for flash type, 4 bytes for start address, and 4 bytes for data content.
6		Flash type	0x00/0x01	 0x00: internal flash 0x01: external flash
7–14 or 7–46	Data	Data to be written to flash	Value range for each byte: 0x00–0xFF	Data content
15–16 or 47–48	Checksum		0x0000-0xFFFF	16-bit checksum for frame type, data length, and data field

2.5.1.2 Response Data from the Device

Table 2-4 Format of data replied through the Program Start command

Byte No.	Description	Valid Value	Note
0–1	Frame header	0x4744	Represented by 0x47 and 0x44 which are the ASCII code values of characters 'G' and 'D'
2–3	Frame type	0x0023	Program Start command
4–5	Data length	0x0001	Length of data in the "Data" field
6	Response	0x01/0x02	 0x01: Data send succeeds. 0x02: Data send fails.
7–8	Checksum	0x0000-0xFFFF	16-bit checksum for frame type, data length, and response field

2.5.2 Program Flash Command

The host sends this command to write data to a valid (internal or external) flash address of the device. After receiving the command, the device parses the start address, length, and content of the data. If the start address is valid, the device starts writing data from this address (see Table 2-5 for data format), and returns ACK. Otherwise, the device returns NACK.



2.5.2.1 Data Sent from the Host

Table 2-5 Format of data sent through the Program Flash command

Byte No.	Description		Valid Value	Note
0–1	Frame header		0x4744	Represented by 0x47 and 0x44 which are the ASCII code values of characters 'G' and 'D'
2–3	Frame type	Frame type 0x0024		Program Flash command
4–5	Data lengt	h	0x0007-0x0800	Length of data in the "Data" field
6	Data	Program type	0x00/0x01/0x02/ 0x10/0x11/0x12	 0x00: Store data after erasing the internal flash page at a specified address. 0x01: Store data in internal flash according to Image Info sent by the Program Start command. 0x02: Call a flash write API to write data to internal flash. 0x10: Store data after erasing the external flash page at a specified address. 0x11: Store data in external flash according to Image Info sent by the Program Start command. 0x12: Call a flash write API to write data to external flash.
7–10		Start address	Value range for each byte: 0x00–0xFF	Valid flash address of the device
11–12			Length of data to be written to flash	0x0000-0x00FF
13-N		Data to be written to flash	Value range for each byte: 0x00–0xFF	Data to be written to flash
N+1 to N+2	Checksum		0x0000-0xFFFF	16-bit checksum for frame type, data length, and data field

Note:

N in Table 2-5 indicates variable length for the "Data" field, ranging from 14 to 1036.

2.5.2.2 Response Data from the Device

Table 2-6 Format of data replied through the Program Flash command

Byte No.	Description	Valid Value	Note
0–1	Frame header	0x4744	Represented by 0x47 and 0x44 which are the
0-1	riaille fleadei		ASCII code values of characters 'G' and 'D'
2–3	Frame type	0x0024	Program Flash command



Byte No.	Description	Valid Value	Note
4–5	Data length	0x0001	1 byte (for response)
6 Response	Response	0x01/0x02	0x01: Data write succeeds.
U	Response	0.01/0.02	0x02: Data write fails.
7–8 Checksum 0x0000–0xF		0x0000-0xFFFF	16-bit checksum for frame type, data length, and
7-0	CHECKSUIII	UXUUUU-UXFFFF	response field

2.5.3 Program End Command

The host sends this command to notify the device that the programming data has been sent. The data field contains the start address after the next reset and the Reset Flag. The Reset Flag decides whether the device runs the downloaded application or not immediately after receiving the Program End command.

2.5.3.1 Data Sent from the Host

Table 2-7 Format of data sent through the Program End command

Byte No.	Description		Valid Value	Note
0–1	Frame header		0x4744	Represented by 0x47 and 0x44 which are the ASCII code values of characters 'G' and 'D'
2–3	Frame type	e	0x0025	Program End command
4–5	Data lengt	h	0x0005	Length of data in the "Data" field
6	Data	Reset Flag	0x00/0x01/0x02/0x12	 0x00: Store the firmware information in the img_info area in flash. 0x01: Store the firmware information in the img_info and boot_info areas in flash, and run the programming firmware after reset. 0x02: Download data to internal flash without operations to the img_info and boot_info areas. 0x12: Download data to external flash.
7–10		Checksum of programming file	Value range for each byte: 0x00–0xFF	Checksum of BIN file
11–12	Checksum		0x0000-0xFFFF	16-bit checksum for frame type, data length, and data field

2.5.3.2 Response Data from the Device



Table 2-8 Format of data replied through the Program End command

Byte No.	Description	Valid Value	Note
0–1	Frame header	0x4744	Represented by 0x47 and 0x44 which are the ASCII code values of characters 'G' and 'D'
2–3	Frame type	0x0025	Program End command
4–5	Data length	0x0001	1 byte (for response)
6	Response	0x01/0x02	 0x01: Notification succeeds. 0x02: Notification fails.
7–8	Checksum	0x0000–0xFFFF	16-bit checksum for frame type, data length, and response field

2.5.4 Read/Update Data in System Configuration Area Command

The host sends this command to handle data in the System Configuration Area of the device, including reading and updating the data. For addresses of System Configuration Area, see "Section 2.3.1 DFU Storage".

2.5.4.1 Data Sent from the Host

Table 2-9 Format of data sent through the Read/Update Data in System Configuration Area command

Byte No.	Description		Valid Value	Note
0–1	Frame header		0x4744	Represented by 0x47 and 0x44 which are the ASCII code values
0-1	riaille liea	uei	0.4744	of characters 'G' and 'D'
2–3	Frame type	9	0x0027	Read/Update Data in System Configuration Area command
4–5	Data lengtl	h	0x0007-0x0407	Length of data in the "Data" field
6		Operating	0x00/0x01	Ox00: Read the data in the System Configuration Area.
0		command	0x00/0x01	0x01: Update the data in the System Configuration Area.
7–10	Data	Start address	0x01000000-0x01002000	A valid address in the System Configuration Area
11–12	Dala	Data length	0x0000-0x0400	Length of data to be read or updated
12 N		Illustata data	Value range for each byte:	N/A for data yand assumed
13-N		Update data	0x00-0xFF	N/A for data read command
N+1 to N+2	Checksum		0x0000–0xFFFF	16-bit checksum for frame type, data length, and data field

Note:

N in Table 2-9 indicates variable length for the "Data" field:

- For a data update command, N ranges from 14 to 1036.
- For a data read command, the "Data" field has a fixed length of 7 bytes.



2.5.4.2 Response Data from the Device

Table 2-10 Format of data replied through the Read/Update Data in System Configuration Area command

Byte No.	Description		Valid Value	Note
0–1	Frame header		0x4744	Represented by 0x47 and 0x44 which are the ASCII code values of characters 'G' and 'D'
2–3	Frame type		0x0027	Read/Update Data in System Configuration Area command
4–5	Data length		0x0002-0x0402	Length of data in the "Data" field
6		Response	0x01/0x02	 0x01: Data handling succeeds. 0x02: Data handling fails.
7	Data	Operating command	0x00/0x10 0x01/0x11	 0x00: Read the data in the System Configuration Area (non-encrypted SoCs). 0x10: Read the data in the System Configuration Area (encrypted SoCs). 0x01: Update the data in the System Configuration Area (non-encrypted SoCs). 0x11: Update the data in the System Configuration Area (encrypted SoCs).
8–11		Start address of the System Configuration Area	0x01000000-0x01002000	
12–13		Length of data in the System Configuration Area	0x0000-0x0400	N/A for data update command
14-N		Content of data in the System Configuration Area	Value range for each byte: 0x00– 0xFF	
N+1 to N+2	Checksum		0x0000-0xffff	16-bit checksum for frame type, data length, and data field

2.5.5 Configure External Flash Command

The host sends this command to configure the external flash SPI of the device.

2.5.5.1 Data Sent from the Host



Table 2-11 Format of data sent through the Configure External Flash command

Byte No.	Description		Valid Value	Note
0–1	Frame header		0x4744	Represented by 0x47 and 0x44 which are the
0-1			0.47.44	ASCII code values of characters 'G' and 'D'
2–3	Frame type		0x002A	Configure External Flash command
4–5	Data length		0x0014	Length of data in the "Data" field
6		External flash type	0x01/0x02	0x01: SPI flash0x02: QSPI flash
		CS IO TYPE	00–03	GPIO type selection
7–9		CS PIN	00–31	GPIO pin selection
		CS IO MUX	00–09	Pin Mux selection
		CLK IO TYPE	00–03	GPIO type selection
10–12		CLK PIN	00–31	GPIO pin selection
		CLK IO MUX	00–09	Pin Mux selection
		MOSI(IO0) IO TYPE	00–03	GPIO type selection
13–15		MOSI(IO0) PIN	00–31	GPIO pin selection
	Data	MOSI(IO0) IO MUX	00–09	Pin Mux selection
		MOSI(IO1) IO TYPE	00–03	GPIO type selection
16–18		MOSI(IO1) PIN	00–31	GPIO pin selection
		MOSI(IO1) IO MUX	00–09	Pin Mux selection
		IO2 IO TYPE	00–03	GPIO type selection, valid for QSPI only
19–21		IO2 PIN	00–31	GPIO pin selection, valid for QSPI only
		IO2 IO MUX	00–09	Pin Mux selection, valid for QSPI only
		IO3 IO TYPE	00–03	GPIO type selection, valid for QSPI only
22–24		IO3 PIN	00–31	GPIO pin selection, valid for QSPI only
		IO3 IO MUX	00–09	Pin Mux selection, valid for QSPI only
25		QSPI ID	00–02	QSPI Module ID, valid for QSPI only
26–27	Checksum		0x0000-0xFFFF	16-bit checksum for frame type, data length, and data field

2.5.5.2 Response Data from the Device



Byte No.	Description	Valid Value	Note
0–1	Frame header	0x4744	Represented by 0x47 and 0x44 which are the ASCII code values of characters 'G' and 'D'
2–3	Frame type	0x002A	Initialize external flash commands.
4–5	Data length	0x0001	1 byte (for response)
6	Response	0x01/0x02	 0x01: Configuration succeeds. 0x02: Configuration fails.
7–8	Checksum	0x0000-0xFFFF	16-bit checksum for frame type, data length, and response field

2.5.6 Get Flash Information Command

The host sends this command to get internal/external flash information from the device, including flash ID and flash size. External flash size is available through the Serial Flash Discoverable Parameters (SFDP) protocol. For all flash chips supporting the SFDP protocol, the host can get the flash size by sending this command.

2.5.6.1 Data Sent from the Host

Table 2-13 Format of data sent through the Get Flash Information command

Byte No.	Description	Valid Value	Note
0–1	Frame header	0x4744	Represented by 0x47 and 0x44 which are the ASCII code values of characters 'G' and 'D'
2–3	Frame type	0x002B	Get flash ID.
4–5	Data length	0x0001	1 byte
6	Flash type	0x00/0x01	 0x00: internal flash 0x01: external flash
7–8	Checksum	0x0000-0xFFFF	16-bit checksum for frame type, data length, and data field

2.5.6.2 Response Data from the Device

Table 2-14 Format of data replied through the Get Flash Information command

Byte No.	Description	Valid Value	Note
			Represented by 0x47 and 0x44 which
0-1	Frame header	0x4744	are the ASCII code values of characters
			'G' and 'D'
2–3	Frame type	0x002B	Get flash ID.



Byte No.	Description			Valid Value	Note	
4–5	Data length			0x0009	9 bytes (for response)	
6	_	Response		0x01/0x02	 0x01: Data get succeeds. 0x02: Data get fails.	
7 14	Data		Flash	Flash ID	Value range for each byte: 0x00–0xFF	Flash ID (4 bytes)
7–14	information	Flash size	Value range for each byte: 0x00–0xFF	Flash size (4 bytes)		
15–16	Checksum			0x0000-0xFFFF	16-bit checksum for frame type, data length, and data field	



3 Enablement of DFU

This chapter introduces how to enable DFU for GR551x SoCs.

3.1 Add DFU to Application Firmware

The DFU functionality is encapsulated in the SDK_Folder\components\libraries\dfu_port module. To add DFU to applications, you only need to call related APIs. Details are provided below by taking ble_dfu_boot as an example.

Note:

SDK Folder is the root directory of GR551x SDK.

3.1.1 ble_dfu_boot Project

The source code and project file of the example ble_dfu_boot are in

SDK_Folder\projects\ble\dfu\ble_dfu_boot, and project file is in the Keil_5 folder.

Double-click the project file, *ble_dfu_boot.uvprojx*, to view the project directory structure of ble_dfu_boot in Keil. For related files, see Table 3-1.

Group	File	Description
gr profiles	ble_prf_utils.c	This file contains profile-related operational tools.
gr_profiles	ota.s	This file implements OTA Service.
	user_gap_callback.c	This file implements GAP callback, such as connection,
user callback	user_gap_camback.c	disconnection, and GAP parameter update.
usei_caliback	user gatt common callback.c	This file implements GATT common callback, such as MTU
	user_gatt_common_camback.c	exchange.
user platform	user periph setup.c	This file configures the serial port parameters, device address,
user_plationiii	user_peripri_setup.e	power management mode, and DFU.
user ann	main.c	This file contains the main() function.
user_app	user_app.c	This file implements OTA profile registration and logical processing.

Table 3-1 File description of ble_dfu_boot

3.1.2 Steps

- 1. Configure the interfaces for DFU. Two approaches are available: Update through Bluetooth LE connection and update through UART. Users can choose as needed.
 - Update through Bluetooth LE connection.

Path: user\user_app.c under the project directory

Name: services_init();

Call dfu_service_init() in this function to initialize the Bluetooth LE services for update.



```
static void services_init(void)
{
    dfu_service_init(NULL);
}
```

Path: user_callback\user_gatt_common_callback.c under the project directory

Name: app gatt mtu exchange cb();

Call dfu_ble_set_mtu_size() in this function to configure the MTU value for update through Bluetooth LE connection.

```
static void app_gatt_mtu_exchange_cb(uint8_t conn_idx, uint8_t status, uint16_t mtu)
{
    if(BLE_SUCCESS == status)
    {
        dfu_ble_set_mtu_size(mtu);
    }
}
```

Path: platform\user_periph_setup.c under the project directory

Name: app_periph_init();

Call dfu_port_init() in this function to initialize the DFU module.

```
void app_periph_init(void)
{
SYS_SET_BD_ADDR(s_bd_addr);
bsp_uart_init();
app_log_assert_init();
pwr_mgmt_mode_set(PMR_MGMT_SLEEP_MODE);
dfu_port_init(NULL,NULL);
}
```

Update through UART.

Path: platform\user_periph_setup.c under the project directory

Name: app_uart_evt_handler();

Call app_uart_receive_async() and dfu_uart_receive_data_process() in the APP_UART_EVT_RX_DATA event to update through UART.



}

Path:platform\user_periph_setup.c under the project directory

Name: app_periph_init();

Initialize UART and the DFU module in this function (it is required to mount uart_send_data in the DFU module), and call the UART asynchronous receiving API.

```
void app_periph_init(void)
{
    SET_BD_ADDR(BD_ADDR_NVDS_TAG, BD_ADDR_LENGTH, s_bd_addr);
    bsp_uart_init();
    app_uart_receive_async(APP_UART_ID_0, uart_rx_data, UART_RX_SIZE);
    dfu_port_init(uart_send_data, &dfu_pro_call);
    pwr_mgmt_mode_set(PMR_MGMT_ACTIVE_MODE);
}
```

Table 3-2 Input parameter description for dfu_port_init()

Parameter	Description	Value
uart_send_data	Enable/Disable DFU through UART	Yes: The UART send function which is implemented by users is assigned to this parameter. No: NULL is assigned to this parameter.
dfu_pro_call	Enable/Disable monitoring on update status at the application layer	Yes: The DFU status handling callback function is assigned to this parameter. No: NULL is assigned to this parameter.

2. Call dfu_schedule() in the while(1) { } loop of the main() function.

Path: user\main.c under the project directory

Name: main();

Call dfu_schedule() in this function to schedule tasks.

```
int main (void)
{
    // Initialize user peripherals.
    app_periph_init();

    // Initialize BLE Stack.
    ble_stack_init(&s_app_ble_callback, &heaps_table);

    // loop
    while (1)
    {
        dfu_schedule();
    #if SK_GUI_ENABLE
            gui_refresh_schedule();
    #endif
        pwr_mgmt_schedule();
    }
}
```



Note:

To implement DFU on an OS device, it is recommended to create a task for DFU to implement dfu_schedule, and the task stack assigned shall be no less than 6 KB, otherwise task stack overflow may occur.

3.2 Jump to Boot Firmware for Firmware Update

To jump to Boot for firmware update, you need to download the DFU Boot firmware (such as ble_dfu_boot) to be updated to a GR551x SoC. Update applications then jump to DFU Boot for firmware update. Details are provided below by taking ble_app_template_dfu as an example.

The source code and project file of the project ble_app_template_dfu are in SDK_Folder\projects\ble\ble_peripheral\ble_app_template_dfu, and project file is in the Keil_5 folder.

Double-click the project file, *ble_app_template_dfu.uvprojx* in Keil for compilation. Information about the DFU Boot firmware displays in the log pane of Keil.

Path: user_app.c under the project directory

Name: dfu_enter();

When receiving an update command, applications call dfu_start_address() in this function to load boot information of the DFU Boot firmware.

```
static void dfu enter (void)
    //use flash dfu boot
    boot info t boot info =
    .bin size = 0x26cf0,
    .check sum = 0xf04eff,
    .load addr = 0x1002000,
    .run addr = 0x1002000,
    .xqspi xip cmd = 0xeb,
    .xqspi speed = 0x0,
    .code copy mode = 0x0,
    .system clk = 0x0,
    .check image = 0x0,
    .boot delay = 0x1,
    .is dap boot = 0x1,
    };
    dfu start address(&boot info);
```



4 GR551x OTA DFU

The host can implement OTA firmware update for target devices through wireless transmission. To update through Bluetooth LE connection, set the OTA Profile and the OTA Service.

4.1 Bluetooth LE OTA Profile

The Goodix-customized OTA Profile defines two device roles:

- Host: the Central that sends user application and fixed user data, including font library/image data and external application data. The Central can be a PC, a mobile phone, or other devices.
- Device: the Peripheral that receives user application and fixed user data. The Peripheral can be a wristband, a heart rate meter, or other devices.

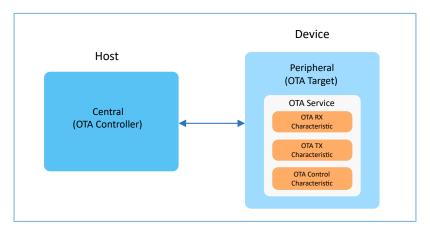


Figure 4-1 OTA Profile device roles

4.2 Bluetooth LE OTA Service

The Goodix-customized OTA Service provides necessary information for DFU. The OTA Service is independent and supports the following GATT operations:

- Write Characteristic Value
- Notifications
- Read Characteristic Descriptors
- Write Characteristic Descriptors

4.2.1 OTA Service and OTA Characteristics

The UUID of OTA Service is a6ed0401-d344-460a-8075-b9e8ec90d71b. OTA characteristics are divided into 3 types, as listed in Table 4-1.

Table 4-1 OTA characteristics

Description	UUID	Property
OTA RX Characteristic	a6ed0402-d344-460a-8075-b9e8ec90d71b	Write without Response



Description	UUID	Property
OTA TX Characteristic	a6ed0403-d344-460a-8075-b9e8ec90d71b	Notify, Indicate
OTA Control Characteristic	a6ed0404-d344-460a-8075-b9e8ec90d71b	Write without Response, Indicate

The role of each characteristic:

- OTA RX Characteristic: Receive data from the host with a property of Write without Response to speed up data transmission.
- OTA TX Characteristic: Send data to the host with a property of Notify. Data is reported by the device to the host in this way.
- OTA Control Characteristic: Receive control commands from the host, such as a command to start DFU process for a device.

4.3 OTA DFU Test

To perform an OTA DFU test, see GR551x OTA Example Application for details.



5 DFU Test Through UART

This chapter introduces how to perform DFU tests through UART by using a SK Board.

5.1 Preparation

Perform the following tasks before the test.

• Hardware preparation

Table 5-1 Hardware preparation

Name	Description
Development board	GR5515 Starter Kit Board (SK Board); 2 boards in total
Connection cable	Micro USB 2.0 cable

Software preparation

Table 5-2 Software preparation

Name	Description
Windows	Windows 7/Windows 10
J-Link driver	A J-Link driver. Available at www.segger.com/downloads/jlink/.
Keil MDK5	An integrated development environment (IDE). MDK-ARM Version 5.20 or later is required. Available
	at www.keil.com/download/product/.
GProgrammer (Windows)	A programming tool. Available in SDK_Folder\tools\GProgrammer.

5.2 Test and Verification

The DFU tests through UART include:

- DFU test by using GProgrammer
- DFU test by using DFU Master and DFU Boot firmware in a GR551x SDK

5.2.1 Test with GProgrammer

Download the firmware *ble_dfu_boot_fw.bin* to the SK Board serving as the device (DFU Boot) through GProgrammer via UART and run the firmware. For details, see *GProgrammer User Manual*.

Note:

The $ble_dfu_boot_fw.bin$ is in SDK_Folder\projects\ble\dfu\ble_dfu_boot\build\.

5.2.2 Test with DFU Master and DFU Boot

For this test, SK Board A serves as the host (DFU Master), and SK Board B as the device (DFU Boot).



Note:

The source code and project file of DFU Master are in $SDK_Folder\projects\ble\dfu\dfu\master$, and project file $dfu\master.uvprojx$ is in the Keil_5 folder.

For the project directory of the DFU Boot firmware ble_dfu_boot_fw.bin, see "Section 5.2.1 Test with GProgrammer".

Steps for tests by using DFU Master and DFU Boot firmware in a GR551x SDK:

- 1. Remove jumper caps of Pins 5–6 and Pins 7–8 at J5 pin header on the SK Board A and B.
- 2. Connect Pin 5 at J5 on the SK Board A to Pin 7 at J5 on the SK Board B and Pin 7 at J5 on the SK Board A to Pin 5 at J5 on the SK Board B with DuPont wires, to establish connection between serial ports on the two boards.
- 3. Download dfu master fw.bin to the SK Board A and ble dfu boot fw.bin to the SK Board B with GProgrammer.
- 4. Download the BIN file to be updated to the SK Board A with GProgrammer.
- 5. Press appropriate keys on SK Board A to update firmware through UART according to tips on the display of SK Board A.

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- The load address and run address of ble_dfu_boot_fw.bin (DFU Boot) are 0x01002000.
- To prevent the downloaded DFU Boot firmware being overwritten, you need to set different load addresses for the firmware to be updated and the DFU Boot firmware. For details, see "Create Target Firmware for Update" in *GR551x OTA Example Application*.



6 FAQ

This chapter lists possible problems with corresponding solutions in DFU process for GR551x SoCs.

6.1 Why Does DFU for Application Firmware on a Bare Device Fail?

Description

DFU through Bluetooth LE connection fails.

Analysis

There may be multiple reasons: For update through Bluetooth LE connection at 2.4 GHz with severe interference, the Bluetooth connection may be broken; improper configurations may also lead to update failure.

- Solution
 - 1. To update through Bluetooth LE connection, check the Bluetooth connection state of the device.
 - 2. To update through UART, check whether the baud rates of the host and of the device are consistent.
 - 3. Check whether the address of the firmware to be updated conflicts with the address of the current firmware.

6.2 Why Do Exceptions Occur in OTA DFU for Application Firmware on a Device with an Operating System?

Description

DFU fails when a device uses FreeRTOS, leading to exceptions in other tasks or exceptions such as HardFault.

Analysis

The reason may be those described in "Section 6.1 Why Does DFU for Application Firmware on a Bare Device Fail?"; it may also be because that a task stack with insufficient space has been assigned, leading to overflow of the task stack. The OTA task stack assigned shall be no less than 6 KB.

Solution

Assign a task stack no less than 6 KB to the OTA task.