



# Gowin\_EMPU\_M1 Download **Reference Manual**

IPUG532-1.4E,01/16/2020

**Copyright©2020 Guangdong Gowin Semiconductor Corporation. All Rights Reserved.**

No part of this document may be reproduced or transmitted in any form or by any denotes, electronic, mechanical, photocopying, recording or otherwise, without the prior written consent of GOWINSEMI.

### **Disclaimer**

GOWINSEMI<sup>®</sup>, LittleBee<sup>®</sup>, Arora, and the GOWINSEMI logos are trademarks of GOWINSEMI and are registered in China, the U.S. Patent and Trademark Office, and other countries. All other words and logos identified as trademarks or service marks are the property of their respective holders, as described at [www.gowinsemi.com](http://www.gowinsemi.com). GOWINSEMI assumes no liability and provides no warranty (either expressed or implied) and is not responsible for any damage incurred to your hardware, software, data, or property resulting from usage of the materials or intellectual property except as outlined in the GOWINSEMI Terms and Conditions of Sale. All information in this document should be treated as preliminary. GOWINSEMI may make changes to this document at any time without prior notice. Anyone relying on this documentation should contact GOWINSEMI for the current documentation and errata.

## Revision History

Date	Version	Description
02/19/2019	1.0E	Initial version published.
07/18/2019	1.1E	<ul style="list-style-type: none"><li>● MCU supports the automated merging tool for hardware design and software programming design;</li><li>● MCU supports off-chip SPI-Flash downloading and startup.</li></ul>
08/18/2019	1.2E	<ul style="list-style-type: none"><li>● MCU hardware design and software programming design support extended peripheral: DDR3 Memory;</li><li>● Known issues of ITCM, DTCM Size and IDE fixed.</li></ul>
09/27/2019	1.3E	Software configuration description updated.
01/16/2020	1.4E	<ul style="list-style-type: none"><li>● MCU hardware design and software programming design supports PSRAM peripheral;</li><li>● MCU compiling software GMD V1.0 updated;</li><li>● RTOS reference design updated;</li><li>● Hardware and software reference design of AHB2 and APB2 extension bus interface added.</li></ul>

# Contents

<b>Contents .....</b>	<b>i</b>
<b>List of Figures .....</b>	<b>iii</b>
<b>List of Tables .....</b>	<b>iv</b>
<b>1 Download Methods .....</b>	<b>1</b>
<b>2 Software Programming Output Used as ITCM Initialization Value .....</b>	<b>2</b>
2.1 Tools.....	2
2.2 Command Parameters.....	2
2.3 Software Configuration .....	2
2.4 Hardware Configuration.....	3
2.5 Design Flow .....	4
2.6 Devices Supported .....	4
2.7 Reference Design .....	4
<b>3 Merge Software Programming Design and Hardware Design.....</b>	<b>5</b>
3.1 Tools.....	5
3.2 Command Parameters.....	5
3.3 Hardware Configuration.....	6
3.4 Design Flow .....	6
3.4.1 Merge.....	6
3.4.2 Download.....	7
3.5 Devices Supported .....	7
3.6 Software Supported.....	7
3.7 Reference Design .....	7
<b>4 Off-chip SPI-Flash Download.....</b>	<b>8</b>
4.1 Software Configuration .....	8
4.2 Hardware Configuration.....	9
4.2.1 ITCM Initialization Configuration.....	9
4.2.2 Dual-Purpose Pin Configuration .....	9
4.3 Design Flow .....	10
4.4 Download .....	10
4.4.1 Download Hardware Design Bitstream File.....	10

4.4.2 Download Software Design BIN File .....	11
4.5 Devices Supported .....	12
4.6 Reference Design .....	12

# List of Figures

Figure 2-1 External Script Call .....	3
Figure 2-2 Configure ITCM Initialization .....	4
Figure 3-1 posp Configuration .....	6
Figure 3-2 Merge the Results of Software Design and Hardware Design .....	7
Figure 4-1 ROM Initial Address and Capacity .....	8
Figure 4-2 Configure ITCM Initialization Path .....	9
Figure 4-3 Configure Dual-Purpose Pin Configuration .....	10
Figure 4-4 Configure Programmer Bitstream Download Mode .....	11
Figure 4-5 Configure Programmer C-Bin Download Mode .....	12

# List of Tables

Table 3-1 merge\_bit Commands and Parameters ..... 5

# 1 Download Methods

Gowin\_EMPU\_M1 provides three methods of downloading hardware design and software programming design:

1. Use the image files output by software programming design as the ITCM initialization value of hardware design.
  - a). BIN file output by Gowin\_EMPU\_M1 software programming design;
  - b). Convert the BIN file to four hex format files with "make\_hex" tool: itcm0, itcm1, itcm2, and itcm3;
  - c). Use itcm0, itcm1, itcm2, and itcm3 as the ITCM initiation value to be read-in;
  - d). Synthesis and place & route; Output the bitstream files of software programming design and hardware design;
  - e). Download the bitstream file using Gowin Programmer.
2. Merge the BIN file output by software programming design and the bitstream file output by hardware design.
  - a). Output a bitstream file generated by Gowin\_EMPU\_M1 hardware design.
  - b). Output a BIN file generated by Gowin\_EMPU\_M1 software design;
  - c). Merge the BIN file and the bitstream file using merge\_bit tool;
  - d). Output the new bitstream file after merging;
  - e). Download the new bitstream file using Gowin Programmer.
3. Download the BIN file output by software programming design using off-chip SPI-Flash.
  - a). Use bootload itcm0, itcm1, itcm2, and itcm3 as the ITCM initiation value to be read-in;
  - b). Gowin\_EMPU\_M1 hardware design outputs a bitstream file with the function of off-chip SPI-Flash downloading;
  - c). Download the bitstream file output by hardware design using Gowin Programmer;
  - d). Output a BIN file generated by Gowin\_EMPU\_M1 software programming design;
  - e). Download the BIN file output by software programming design using Gowin Programmer.



# 2 Software Programming Output Used as ITCM Initialization Value

## 2.1 Tools

- Linux:  
Gowin\_EMPU\_M1\script\make\_hex\_script\linux\make\_hex\bin\make\_hex
- Windows:  
Gowin\_EMPU\_M1\script\make\_hex\_script\windows\make\_hex\bin\make\_hex.exe

## 2.2 Command Parameters

- Linux: make\_hex bin-file
- Windows: make\_hex.exe bin-file

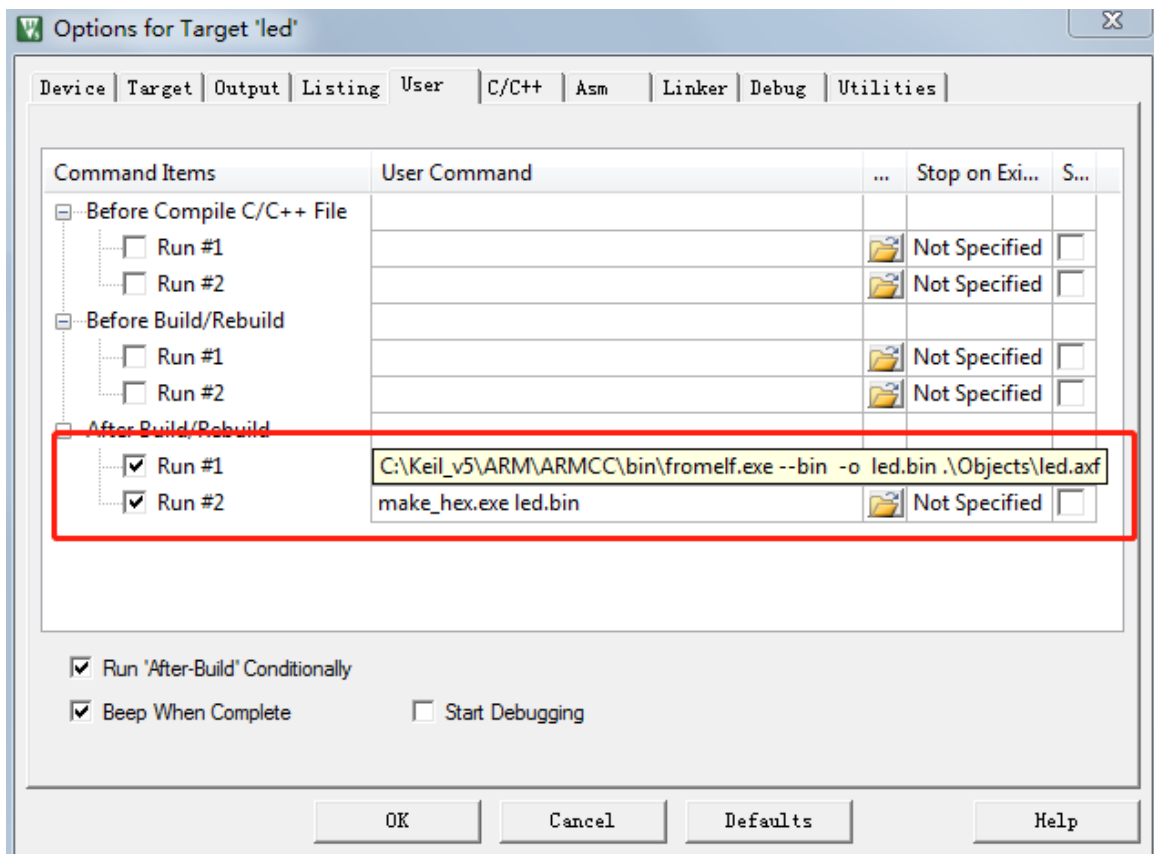
## 2.3 Software Configuration

Software programming design outputs a BIN file. Convert the BIN file to four hex format image files with "make\_hex" tool: itcm0, itcm1, itcm2, and itcm3.

External script can be configured in ARM Keil Microcontroller Tool. make\_hex.exe can be called automatically to generate hex format image files when compiling, as shown in Figure 2-1.

- Run #1  
fromelf.exe --bin -o bin-file axf-file
- Run #2  
make\_hex.exe bin-file

Figure 2-1 External Script Call

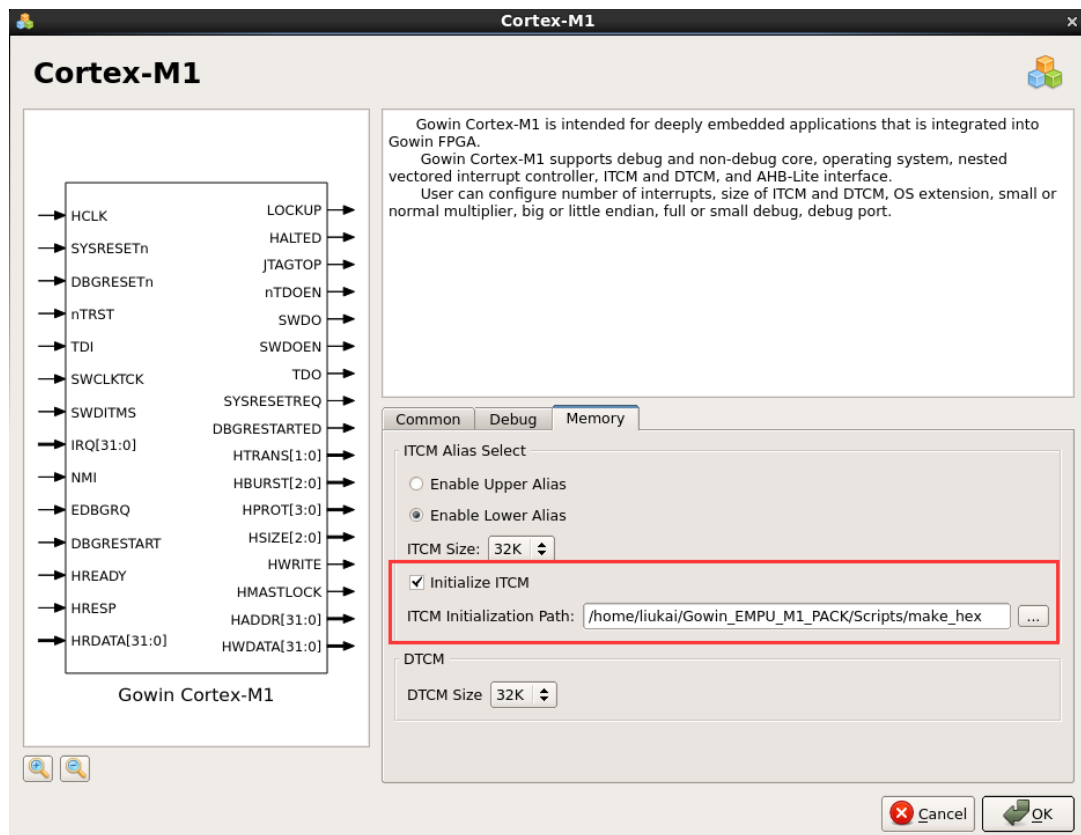


## 2.4 Hardware Configuration

When configuring Cortex-M1 in IP Core Generator, select "Initialize ITCM" and import the path of the four hex format image files of itcm0, itcm1, itcm2, and itcm3 as the initial value of "ITCM Initialization Path", as shown in Figure 2-2.

Import itcm0, itcm1, itcm2, itcm3 as the initial value. After Cortex-M1 and AHB/APB peripherals configuration in IP Core Generator, the generated hardware design of Gowin\_EMPU\_M1 includes software programming design output.

Figure 2-2 Configure ITCM Initialization



## 2.5 Design Flow

1. Compile the image files of itcm0, itcm1, itcm2, and itcm3 by ARM Keil MDK or GOWIN MCU Designer ;
2. Generate Gowin\_EMPU\_M1 hardware design in IP Core Generator and use itcm0, itcm1, itcm2 and itcm3 as initial value;
3. Instantiate Gowin\_EMPU\_M1 and connect user design;
4. Physical constraints and timing constraints;
5. Use Synplify\_Pro or GowinSynthesis to synthesize;
6. Use Place & Route and output bit stream file;
7. Download the bitstream file using Gowin Programmer.

## 2.6 Devices Supported

- GW1N-9
- GW1NR-9
- GW2A-18
- GW2AR-18
- GW2A-55

## 2.7 Reference Design

- Linux:  
Gowin\_EMPU\_M1\script\make\_hex\_script\linux\make\_hex\example
- Windows:  
Gowin\_EMPU\_M1\script\make\_hex\_script\windows\make\_hex\examp  
-l

# 3 Merge Software Programming Design and Hardware Design

## 3.1 Tools

- Linux:  
Gowin\_EMPU\_M1\script\merge\_bit\_script\linux\merge\_bit\bin\merge\_bit.sh
- Windows:  
Gowin\_EMPU\_M1\script\merge\_bit\_script\windows\merge\_bit\bin\merge\_bit.bat

## 3.2 Command Parameters

- Linux: bash merge\_bit.sh
- Windows: merge\_bit.bat

Take merge\_bit.bat for instance, the software commands and parameters are as follows:

```
call make_loc.exe -i posp-file -s itcm's size [-d]
```

```
call merge_bit.exe bin-file itcm.loc fs-file
```

For the description of commands and parameters, please refer to Table 3-1.

**Table 3-1 merge\_bit Commands and Parameters**

Parameter	Description
make_loc.exe	Input posp-file and generate the ITCM layout file: itcm.loc
-i	Gowin_EMPU_M1 hardware design configure posp file generated by "Place&Route > Generate Post-Place File"
-s	Set by the ITCM Size in Gowin_EMPU_M1 hardware design
-d	Option If configuring Enable Debug, enable -d; If configuring Disable Debug, disable -d
merge_bit.exe	Merge Gowin_EMPU_M1 software design and hardware design
bin-file	The BIN file output by Gowin_EMPU_M1 software programming design;

Parameter	Description
itcm.loc	Use make_loc.exe to generate the ITCM layout file: itcm.loc
fs-file	The bitstream file output by Gowin_EMPU_M1 hardware design.

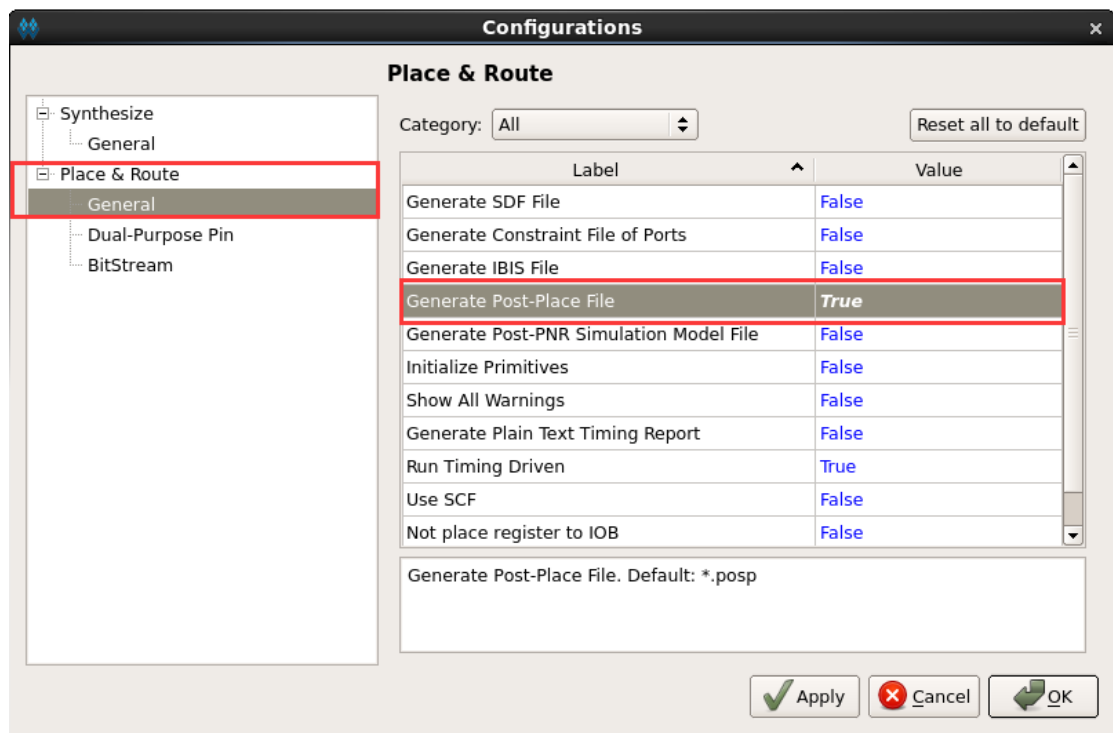
Merge BIN file output by software programming design and the bitstream files output by hardware design and then output a new bitstream file.

User can modify the parameters, such as -i posp-file, -s itcm's size, -d, bin-file, fs-file, according to your requirements.

## 3.3 Hardware Configuration

A posp file, as the input file of make\_loc.exe -i, is generated when setting True in "Place & Route > Generate Post-Place File", as shown in Figure 3-1.

Figure 3-1 posp Configuration



## 3.4 Design Flow

### 3.4.1 Merge

1. Gowin\_EMPU\_M1 hardware design outputs a bitstream file and a posp file;
2. Gowin\_EMPU\_M1 software programming design outputs a BIN file;
3. Execute merge\_bit.sh in Linux or execute merge\_bit.bat in Windows, merge the bitstream file and the BIN file and then output a new bitstream file, as shown in Figure 3-2.

Figure 3-2 Merge the Results of Software Design and Hardware Design

```

----- GOWIN Bin2FS -----
Read bit stream file gowin_empu_m1.fs ...
Build bsram init value fusemap...
Location file location.txt reading...
Bsram R28[9] init value convert to fusemap success.
Bsram R28[8] init value convert to fusemap success.
Bsram R28[7] init value convert to fusemap success.
Bsram R28[6] init value convert to fusemap success.
Bsram R46[4] init value convert to fusemap success.
Bsram R10[4] init value convert to fusemap success.
Bsram R28[5] init value convert to fusemap success.
Bsram R46[3] init value convert to fusemap success.
Bsram R10[3] init value convert to fusemap success.
Bsram R28[4] init value convert to fusemap success.
Bsram R46[2] init value convert to fusemap success.
Bsram R10[2] init value convert to fusemap success.
Bsram R28[3] init value convert to fusemap success.
Bsram R28[2] init value convert to fusemap success.
Bsram R28[1] init value convert to fusemap success.
Bsram R28[0] init value convert to fusemap success.
Replace new bsram init value map to file new_gowin_empu_m1.fs...
Build bsram init value replace completed.

```

### 3.4.2 Download

Download the new bitstream file using Gowin Programmer after the bitstream file and the BIN file are merged.

For further details on how to use Programmer, please refer to [SUG502](#), Gowin Programmer User Guide.

## 3.5 Devices Supported

- GW2A-18
- GW2AR-18
- GW2A-55

## 3.6 Software Supported

Gowin\_EMPU\_M1 hardware design generated by Synplify Pro in IP Core Generator

## 3.7 Reference Design

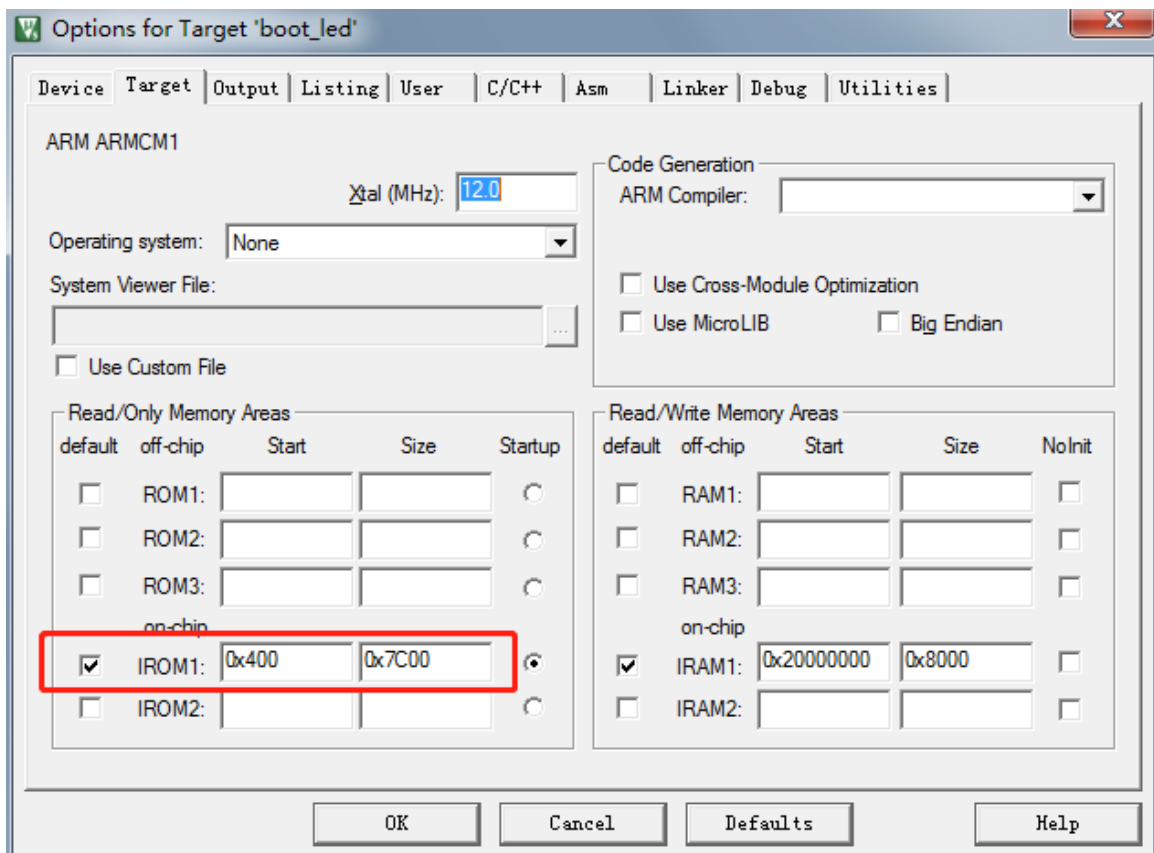
- Linux:  
Gowin\_EMPU\_M1\script\merge\_bit\_script\linux\merge\_bit\example
- Windows:  
Gowin\_EMPU\_M1\script\merge\_bit\_script\windows\merge\_bit\example

# 4 Off-chip SPI-Flash Download

## 4.1 Software Configuration

For Gowin\_EMPU\_M1 software programming design, if using ARM Keil MDK (V5.24.2.0 and above) software to develop, the initial address of IROM1 is set to 0x400, and IROM1 size is set according to the ITCM hardware configuration. Take DK-START-GW2A18 V2.0 development board reference design as an instance, it is set to 0x7C00, as shown in Figure 4-1.

Figure 4-1 ROM Initial Address and Capacity



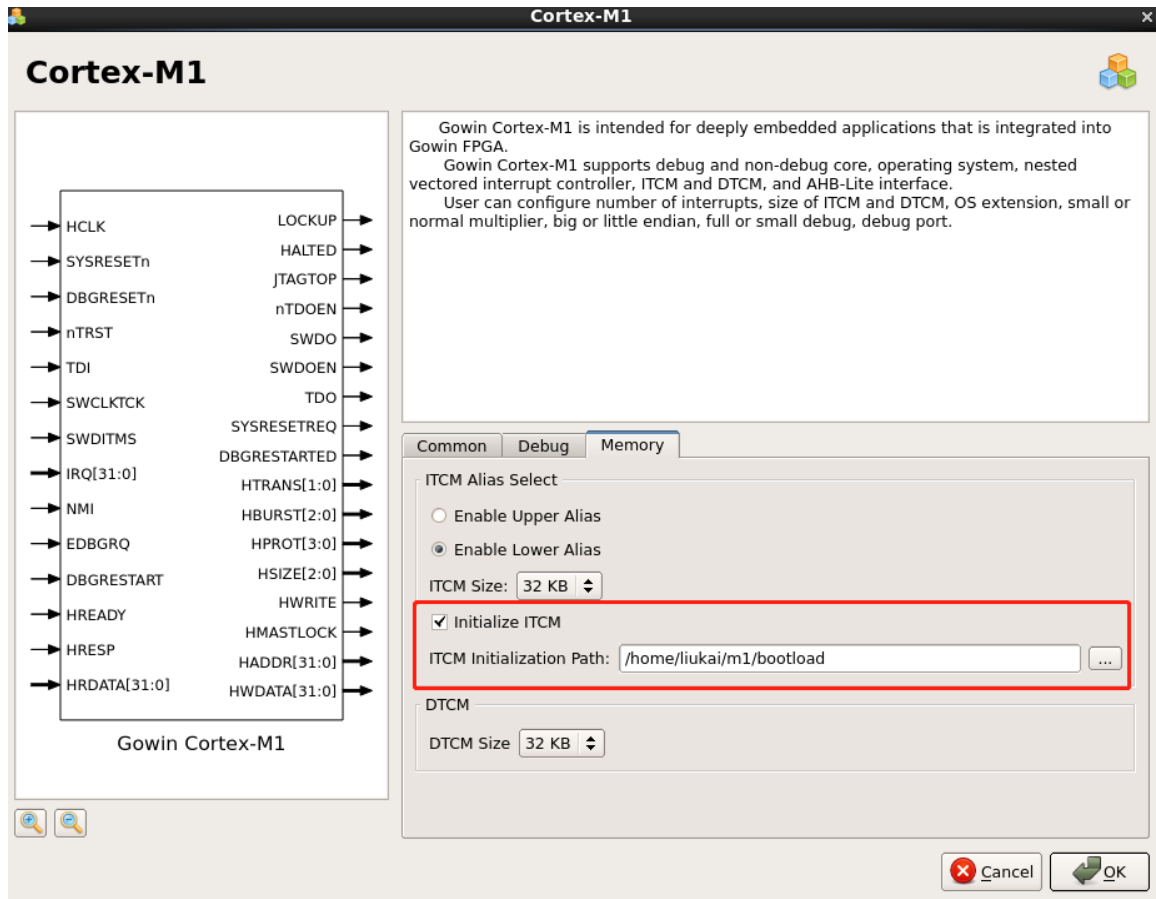
If using GOWIN MCU Designer software to develop, modify the initial address of Flash "FLASH ORIGIN" to 0x00000400 in GOWIN\_M1\_flash.ld.

## 4.2 Hardware Configuration

### 4.2.1 ITCM Initialization Configuration

In Gowin\_EMPU\_M1 hardware design, configure the ITCM Initialization Path of Cortex-M1 as the bootload path. bootload itcm0, itcm1, itcm2, and itcm3 is read as the ITCM Initialization value, as shown in Figure 4-2.

Figure 4-2 Configure ITCM Initialization Path



Gowin\_EMPU\_M1 provides off-chip SPI-Flash bootload:

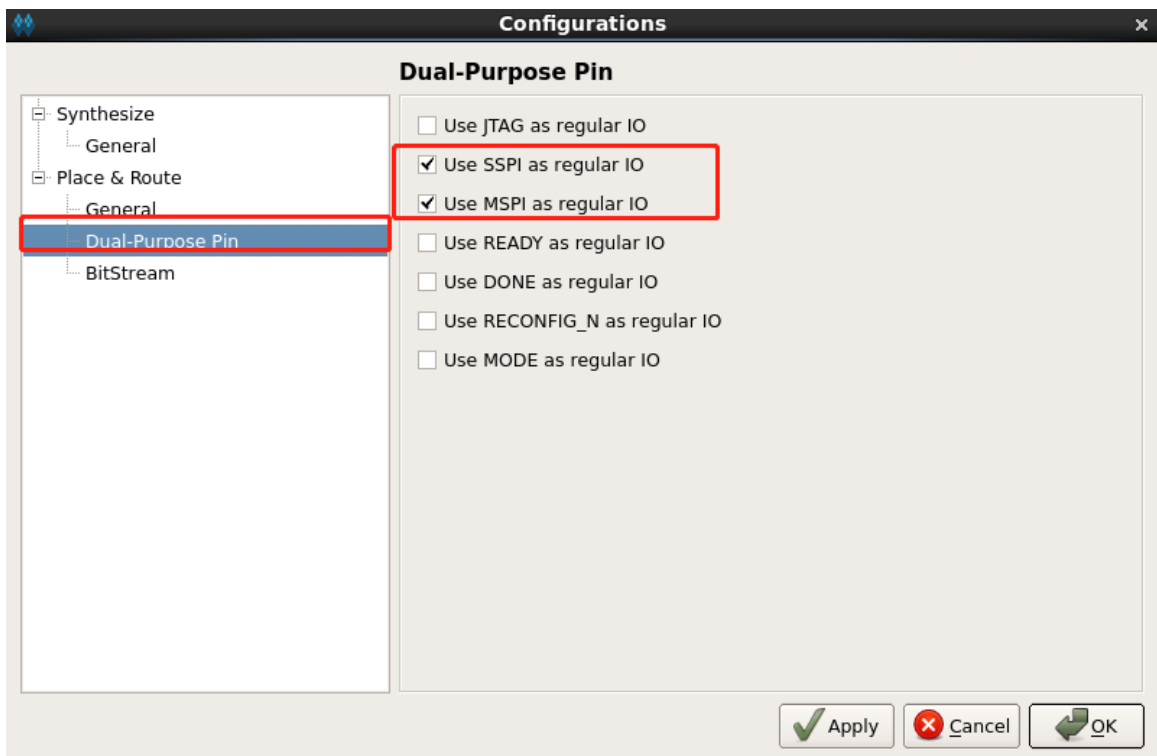
bootload\boot\itcm0、itcm1、itcm2、itcm3

### 4.2.2 Dual-Purpose Pin Configuration

In Gowin\_EMPU\_M1 hardware design, configure SSPI and MSPI as regular IO in "Place & Route > Dual-Purpose Pin", as shown in Figure 4-3.



Figure 4-3 Configure Dual-Purpose Pin Configuration



## 4.3 Design Flow


1. Use bootloader itcm0, itcm1, itcm2, and itcm3 as the ITCM initiation value in Gowin\_EMPU\_M1 hardware design;
2. Gowin\_EMPU\_M1 hardware design outputs a bitstream file with the function of off-chip SPI-Flash downloading;
3. Download the bitstream file using Gowin Programmer.
4. Gowin\_EMPU\_M1 software programming design outputs a BIN file;
5. Download the BIN file using Gowin Programmer.

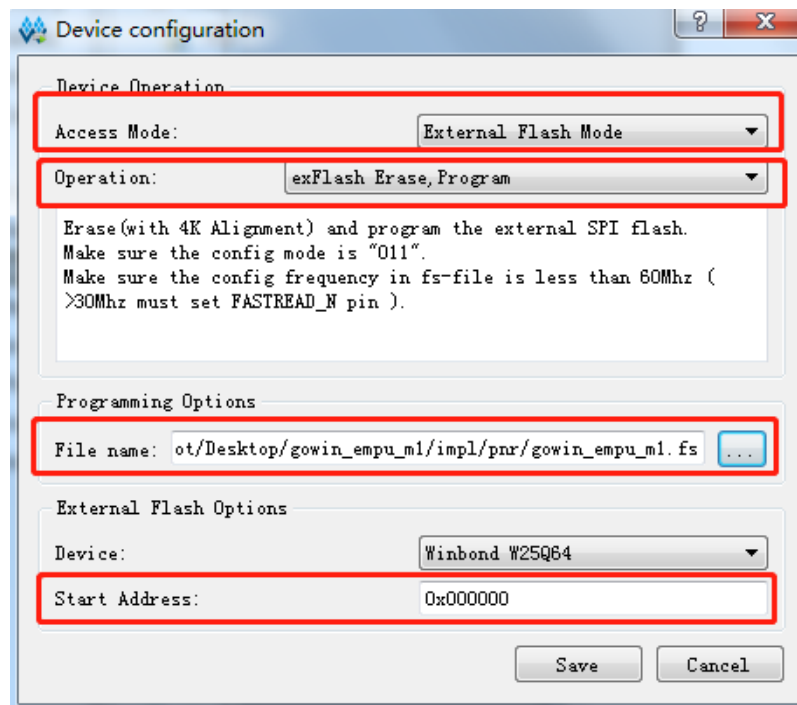
## 4.4 Download


For further details on how to use Programmer, please refer to [SUG502](#), Gowin Programmer User Guide.

### 4.4.1 Download Hardware Design Bitstream File

Gowin\_EMPU\_M1 hardware design outputs a bitstream file with bootloader as ITCM initial value and the off-chip SPI-Flash downloading. Download the bitstream file using Gowin Programmer.


Click "Tools > Programmer > Edit > Configure Device" or click "  " to open Device configuration dialog box. Select "External Flash Mode" from "Access Mode", select "exFlash Erase, Program" from "Operation", import required bitstream file in "File Name", select "Device" based on the Flash on board in "External Flash Options", select "0x000000" in "Start Address" and click "Save", as shown in Figure 4-4.

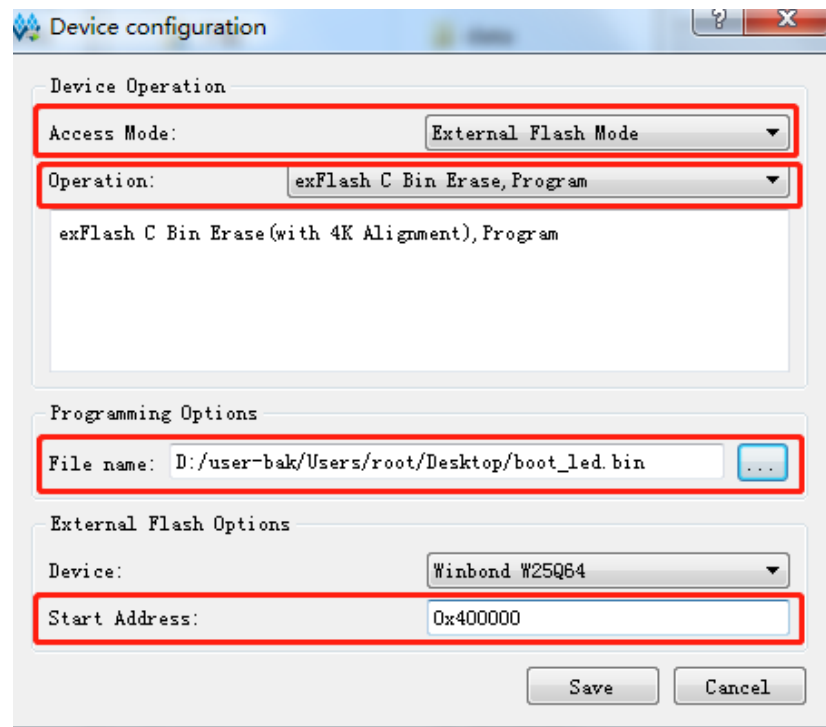
**Figure 4-4 Configure Programmer Bitstream Download Mode**

After device configuration, click "Program/Configure" in the Programmer toolbar or "  " to complete bitstream file downloading.

## 4.4.2 Download Software Design BIN File

After downloading the bitstream file output by Gowin\_EMPU\_M1 hardware design, download the BIN file output by Gowin\_EMPU\_M1 software design using Programmer.

Click "Tools > Programmer > Edit > Configure Device" or click "  " to open Device configuration dialog box. Select "External Flash Mode" from "Access Mode", select "exFlash C Bin Erase, Program" from "Operation", import required BIN file in "Firmware/Binary File", select "Device" based on the Flash on board in "External Flash Options", select "0x400000" in "Start Address" and click "Save", as shown in Figure 4-5.

**Figure 4-5 Configure Programmer C-Bin Download Mode**

After device configuration, click "Program/Configure" in the Programmer toolbar or "📁" to complete BIN file downloading.

## 4.5 Devices Supported

- GW2A-18
- GW2AR-18
- GW2A-55

## 4.6 Reference Design

Gowin\_EMPU\_M1\bootload\example.

