



Gowin_EMPU_M1 Download **Reference Manual**

IPUG532-1.6E,06/12/2020

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Revision History

Date	Version	Description
02/19/2019	1.0E	Initial version published.
07/18/2019	1.1E	<ul style="list-style-type: none">● MCU supports the automated merging tool for hardware design and software programming design;● MCU supports off-chip SPI-Flash downloading and startup.
08/18/2019	1.2E	<ul style="list-style-type: none">● MCU hardware design and software programming design support extended peripheral: DDR3 Memory;● Fixed known issues of ITCM, DTCM Size and IDE.
09/27/2019	1.3E	Software configuration description updated.
01/16/2020	1.4E	<ul style="list-style-type: none">● MCU hardware design and software programming design supports PSRAM;● MCU compiling software GMD V1.0 updated;● RTOS reference design updated;● Hardware and software reference design of AHB2 and APB2 extension bus interface added.
03/10/2020	1.5E	<ul style="list-style-type: none">● Fixed known issue of bootload size;● GW2A-18C/GW2AR-18C/GW2A-55C devices added.
06/12/2020	1.6E	<ul style="list-style-type: none">● MCU supports for external instruction memory;● MCU supports for external data memory;● Extension of 6 AHB bus interfaces;● Extension of 16 APB bus interfaces;● GPIO supports multiple interface types;● I²C supports multiple interface types;● The merge_bit tool supports the naming convention resolution for the synthesis tool, GowinSynthesis.

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1 Download Methods

Gowin_EMPU_M1 provides three methods of downloading hardware design and software programming design:

1. Use the image files generated by software programming design as the ITCM initial value of hardware design.
 - a) Generate a software design BIN file by Gowin_EMPU_M1 software programming design;
 - b) Convert the software design 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 initial value to be read-in;
 - d) Synthesis and place & route; Generate the hardware design bitstream files of software programming design and hardware design;
 - e) Download the hardware design bitstream file using the download tool, Gowin Programmer.
2. Merge the software design BIN file generated by software programming design and the hardware design bitstream file generated by hardware design.
 - a) Generate a hardware design bitstream file generated by Gowin_EMPU_M1 hardware design;
 - b) Generate a software design software design BIN file generated by Gowin_EMPU_M1 software design;
 - c) Merge the software design BIN file and the hardware design bitstream file using merge_bit tool;
 - d) Generate the new hardware design bitstream file after merging;
 - e) Download the new bitstream file using the download tool, Gowin Programmer.
3. Download the software design BIN file output by software programming design using off-chip SPI-Flash.
 - a) Use different bootloads based on ITCM Size as the ITCM

initiation value to be read-in;

- b) Gowin_EMPU_M1 hardware design generates a hardware design bitstream file with the function of off-chip SPI-Flash downloading;
- c) Download the hardware design bitstream file generated by hardware design using the download tool, Gowin Programmer;
- d) Generate a software design BIN file generated by Gowin_EMPU_M1 software programming design;
- e) Download the BIN file generated by software programming design using the download tool, Gowin Programmer.

2 Software Programming Output Used as ITCM Initialization Value

2.1 Tools

- Linux: Gowin_EMPU_M1\tool\linux\make_hex\bin\make_hex
- Windows:
Gowin_EMPU_M1\tool\windows\make_hex\bin\make_hex.exe

Note!

The above tools link is given at http://cdn.gowinsemi.com.cn/Gowin_EMPU_M1.zip

2.2 Command Parameters

- Linux: make_hex bin-file
- Windows: make_hex.exe bin-file

2.3 Software Configuration

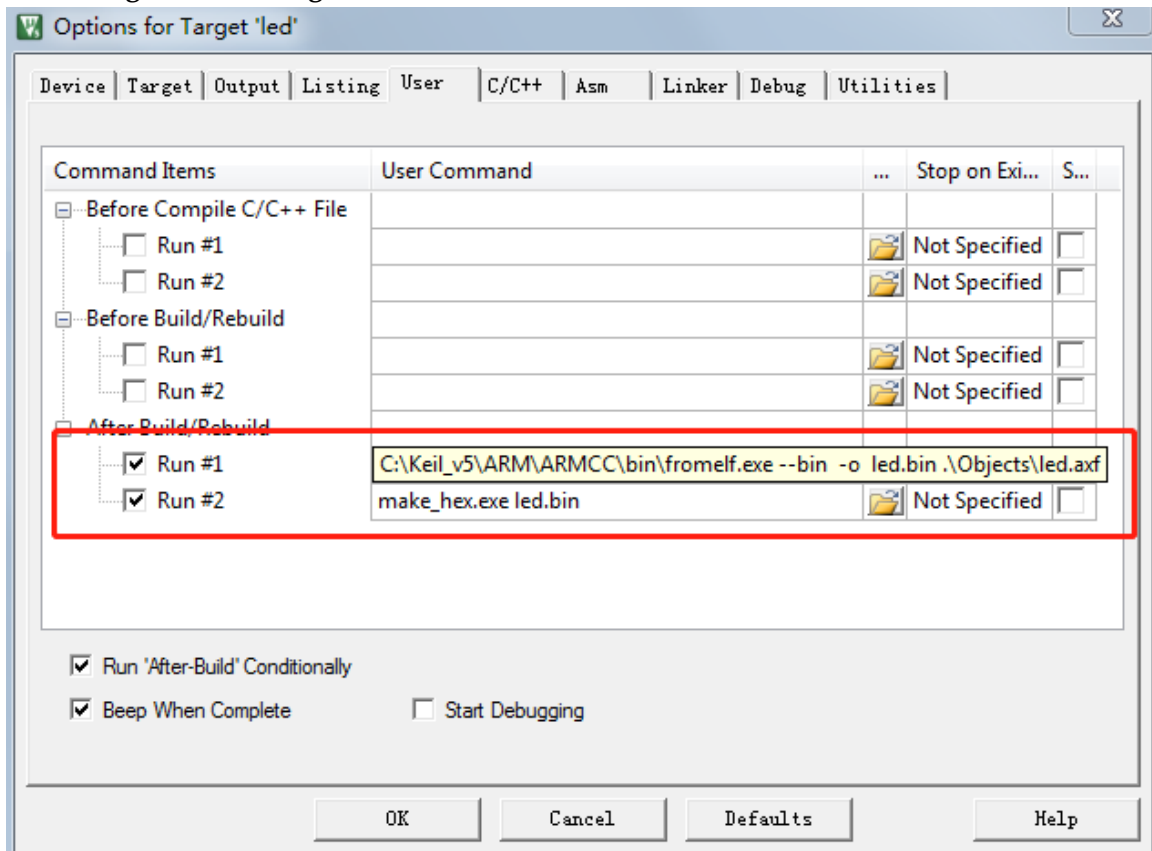
Software programming design generates a software design BIN file. Convert the software design software design BIN file to four hex format image files with "make_hex" tool: itcm0, itcm1, itcm2, and itcm3.

Configure "make_hex.exe" in ARM Keil MDK software (V5.24 and above) as an external tool, as shown in Figure 2-1.

- Run #1: fromelf.exe --bin -o bin-file axf-file
- Run #2: make_hex.exe bin-file

When the software is compiled, the make_hex.exe tool is automatically called to generate the software design BIN file and four Image files in hexadecimal format.

Figure 2-1 Configure External Tools

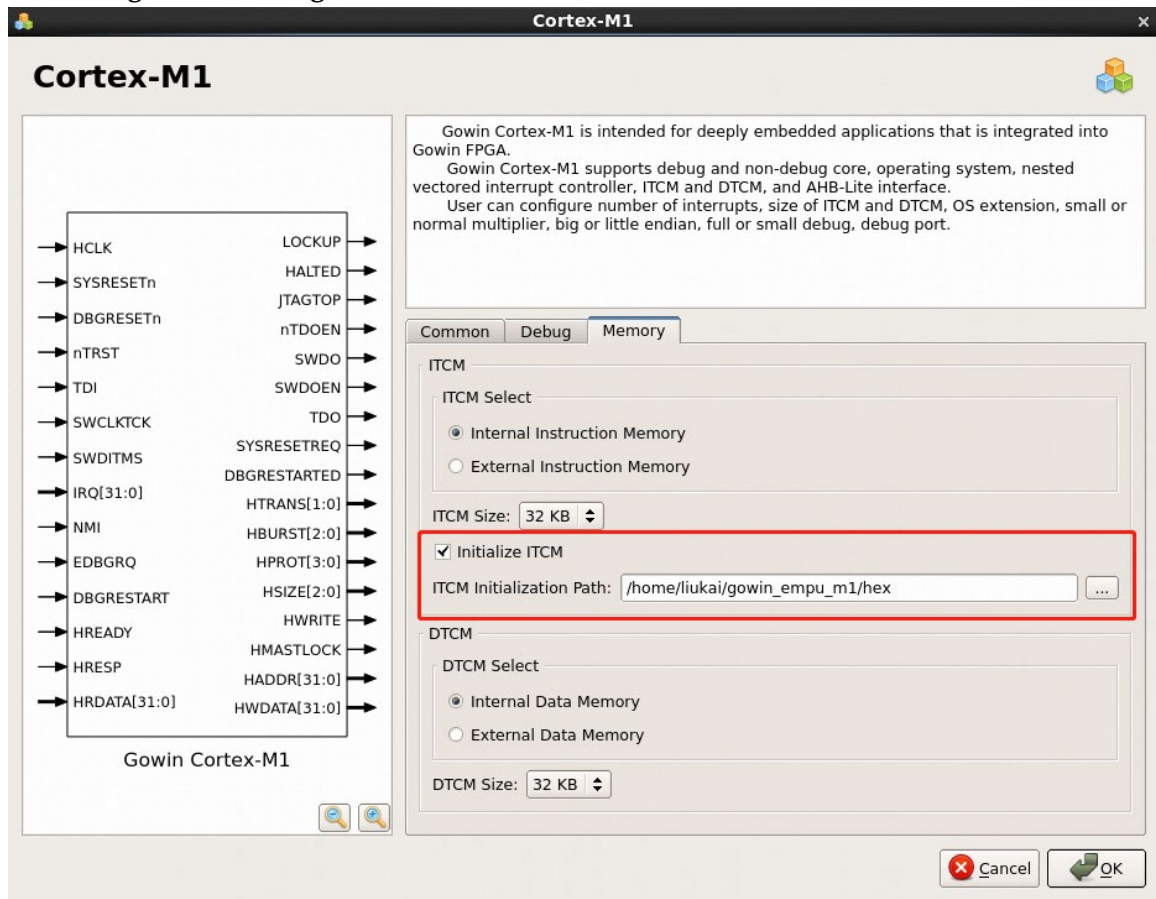


2.4 Hardware Configuration

In the IP Core Generator tool for Gowin Software:

- Select “Cortex-M1 > Memory > ITCM > ITCM Select > Internal Instruction Memory” options;
- Select “Cortex-M1 > Memory > ITCM > Initialize ITCM” options;
- Select “Cortex-M1 > Memory > ITCM > ITCM Initialization Path” options to 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.

Figure 2-2 Configure ITCM Initialization



2.5 Design Flow

1. Compile four Image files in hexadecimal format of itcm0, itcm1, itcm2, and itcm3 by ARM Keil MDK (V5.24 and above) or GOWIN MCU Designer (V1.1 and above);
2. Generate Gowin_EMPU_M1 hardware design in IP Core Generator tool of Gowin Software and use itcm0, itcm1, itcm2 and itcm3 generated by software programming design as initial value;
3. Instantiate Gowin_EMPU_M1 Top Module and connect user design;
4. Physical constraints and timing constraints;
5. Use synthesis tool, Synplify_Pro or GowinSynthesis, to synthesize;
6. Use Place & Route and generate hardware design bit stream file including software programming design;
7. Download the hardware design bitstream file using the download tool, Gowin Programmer.

2.6 Devices Supported

- GW1N-9/GW1NR-9/GW1N-9C/GW1NR-9C
- GW2A-18/GW2A-18C/GW2AR-18/GW2AR-18C/GW2ANR-18C
- GW2A-55/GW2A-55C

2.7 Reference Design

Get the following reference designs by this [link](#):

- Windows: Gowin_EMPU_M1\tool\windows\make_hex\example

3 Merge Software Programming Design and Hardware Design

3.1 Tools

- Linux: Gowin_EMPU_M1\tool\linux\merge_bit\bin\merge_bit.sh
- Windows:
Gowin_EMPU_M1\tool\windows\merge_bit\bin\merge_bit.bat

Note!

The above tools link is given at http://cdn.gowinsemi.com.cn/Gowin_EMPU_M1.zip

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_size [-d] -t synthesis_tool
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 Software configures " Place & Route > General > Generate Post-Place File " options and generates "Post-Place File".
-s	Set by the ITCM Size in Gowin_EMPU_M1 hardware design.
-d	Available options: <ul style="list-style-type: none"> ● If configuring Enable Debug, enable -d; ● If configuring Disable Debug, disable -d.
-t	Synthesis tool selection: <ul style="list-style-type: none"> ● If Synplify Pro is selected, the parameter is set to synplify_pro. ● If you choose GowinSynthesis, the parameter is set to

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

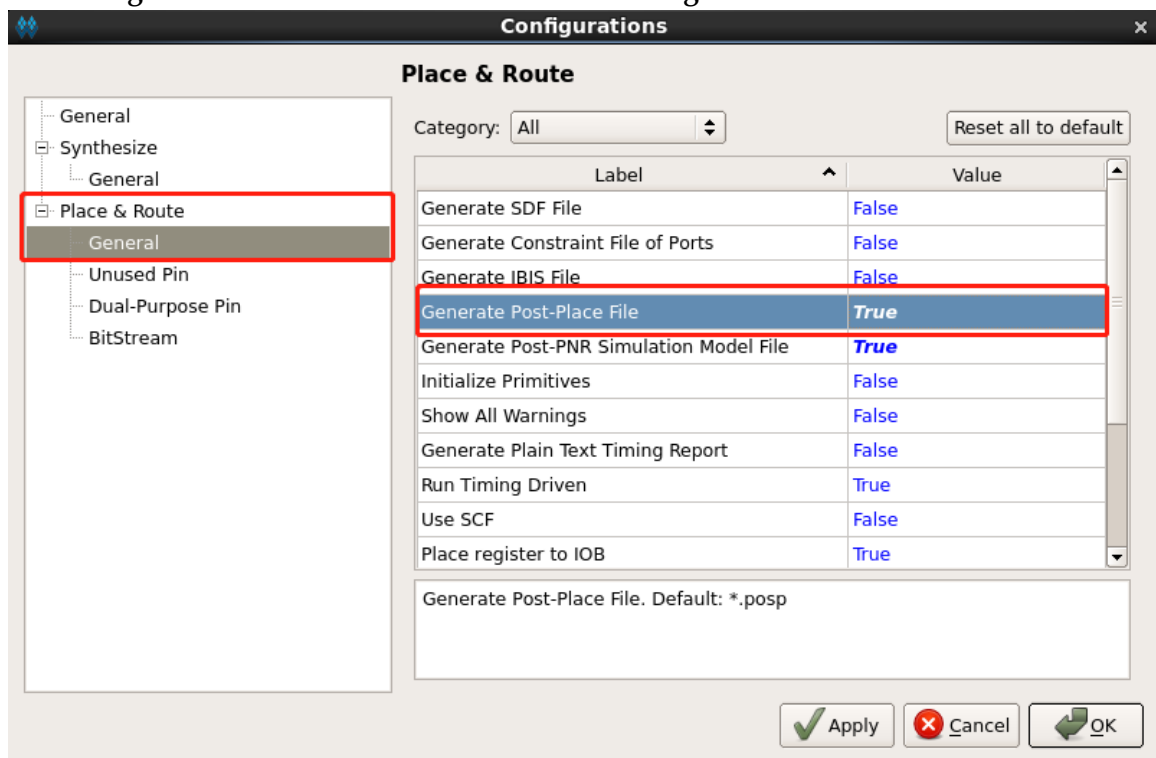
Merge software design BIN file generated by software programming design and the hardware design bitstream files generated by hardware design and then output a new bitstream file.

When using the merge_bit.sh or merge_bit.bat, users can modify the parameters, such as -i posp-file, -s itcm_size, -d, -t synthesis_tool, bin-file and fs-file, according to actual options.

3.3 Hardware Configuration

Post-Place File, as the input file of make_loc.exe -i, is generated when setting "True" in "Place & Route > General > Generate Post-Place File" options in Gowin Software configuration options, as shown in Figure 3-1.

Figure 3-1 Place& Route Post-Place File Configuration



3.4 Design Flow

3.4.1 Merge

1. Gowin_EMPU_M1 hardware design generates a hardware design bitstream file and Post-Place File;

2. Gowin_EMPU_M1 software programming design generates a software design BIN file;
3. Execute “merge_bit.sh” in Linux or execute “merge_bit.bat” in Windows, merge the hardware design bitstream file and the software design BIN file and then generates a new hardware design bitstream file, as shown in Figure 3-2.

Figure 3-2 Merge Software Programming Design and Hardware Design

```

----- GOWIN Merge Tool -----
Read bit stream file gowin_empu_m1.fs ...
Build bsram init value fusemap...
Reading original bsram init value map...
Location file itcm.loc reading...
Bsram R46[0] init value convert to fusemap success.
Bsram R46[1] init value convert to fusemap success.
Bsram R46[2] init value convert to fusemap success.
Bsram R46[3] init value convert to fusemap success.
Bsram R28[5] init value convert to fusemap success.
Bsram R46[4] init value convert to fusemap success.
Bsram R28[6] init value convert to fusemap success.
Bsram R28[7] init value convert to fusemap success.
Bsram R28[8] init value convert to fusemap success.
Bsram R28[9] init value convert to fusemap success.
Bsram R10[11] init value convert to fusemap success.
Bsram R28[10] init value convert to fusemap success.
Bsram R10[12] init value convert to fusemap success.
Bsram R10[13] init value convert to fusemap success.
Bsram R10[14] init value convert to fusemap success.
Bsram R10[15] 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 new hardware design bitstream file using the download tool, 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/GW2A-18C/GW2AR-18/GW2AR-18C/GW2ANR-18C
- GW2A-55/GW2A-55C

3.6 Software Supported

Applies to Gowin_EMPU_M1 hardware design generated by the synthesis tool, Synplify Pro and GowinSynthesis (v1.9.6 Beta and above) in the IP Core Generator tool.

3.7 Reference Design

Get the following reference designs by this [link](#):

- Windows: Gowin_EMPU_M1\tool\windows\merge_bit\example

4 Off-chip SPI-Flash Download

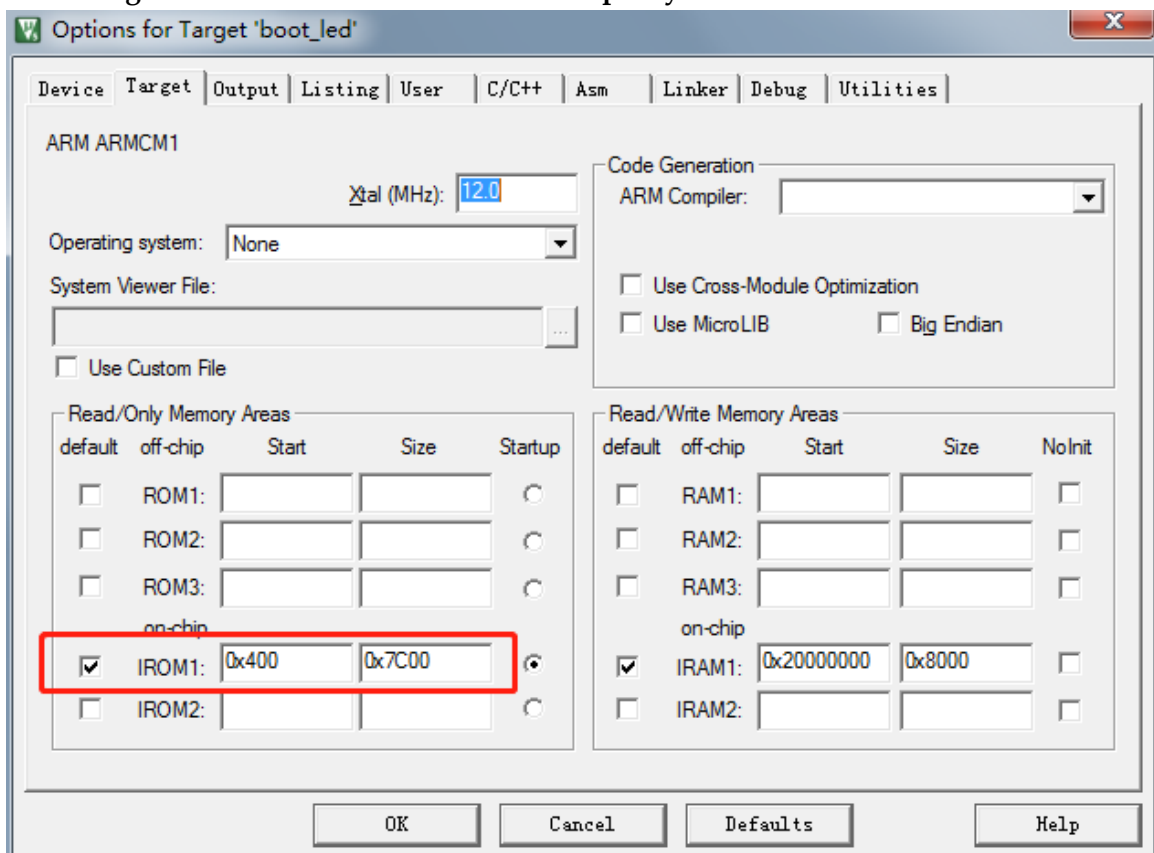
4.1 Software Configuration

For Gowin_EMPU_M1 software programming design:

If using ARM Keil MDK software (V5.24 and above) to develop, the initial address of IROM1 is set to 0x400, and IROM1 Size is set according to the ITCM Size.

Take development board reference design of DK-START-GW2A18 V2.0 in SDK 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 (V1.1 and above) to develop, modify

the Flash initial address "FLASH ORIGIN" to 0x00000400 in the Flash linker, GOWIN_M1_flash.ld.

4.2 Hardware Configuration

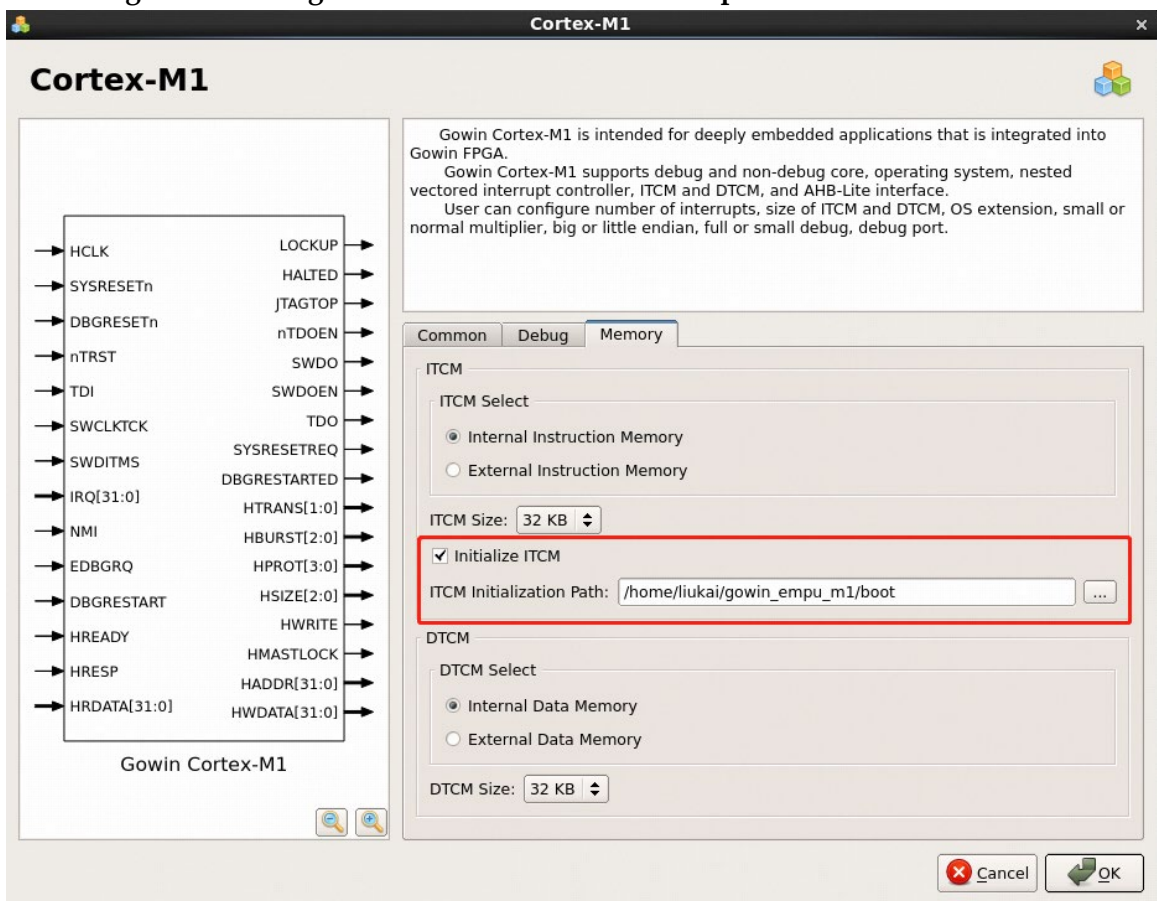
4.2.1 ITCM Initialization Configuration

During IP Core Generator tool of Gowin Software is configured to generate the Gowin_EMPU_M1 hardware design:

- Select Internal Instruction Memory as the instruction memory for Gowin_EMPU_M1;
- Select ITCM Size;
- Select Initialized ITCM;
- Select different bootloads according to different ITCM sizes as the initial ITCM values, and the ITCM Initialization Path imports the bootloader path;

ITCM Initialization option configurations are as shown in Figure 4-2.

Figure 4-2 Configure ITCM Initialization Path Options



The bootloads corresponding to the ITCM Sizes are shown in Table 4-1.

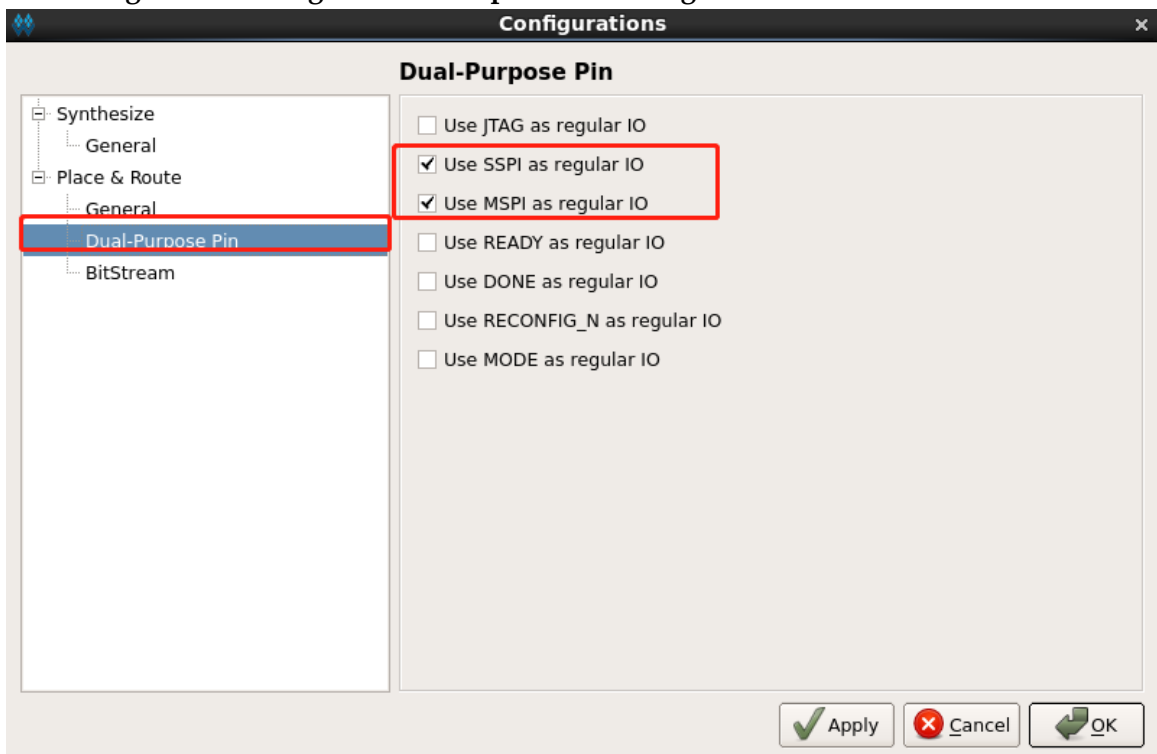
Table 4-1 ITCM Sizes and Bootloads

ITCM Size (KByte)	Bootload
2	Gowin_EMPU_M1\bootload\boot\ITCM_Size_2KB
4	Gowin_EMPU_M1\bootload\boot\ITCM_Size_4KB
8	Gowin_EMPU_M1\bootload\boot\ITCM_Size_8KB
16	Gowin_EMPU_M1\bootload\boot\ITCM_Size_16KB
32	Gowin_EMPU_M1\bootload\boot\ITCM_Size_32KB
64	Gowin_EMPU_M1\bootload\boot\ITCM_Size_64KB
128	Gowin_EMPU_M1\bootload\boot\ITCM_Size_128KB
256	Gowin_EMPU_M1\bootload\boot\ITCM_Size_256KB

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. During the Gowin_EMPU_M1 hardware design is configured:
 - Select Internal Instruction Memory;
 - Select ITCM Size;
 - Select Initialized ITCM;
 - Select different bootloads as initial ITCM values based on different ITCM sizes.


2. Generate Gowin_EMPU_M1 hardware design;
3. Synthesize, place & route and generate a bitstream file with the function of off-chip SPI-Flash downloading;
4. After configure "Device configuration", download the hardware design bitstream file using the download tool, Gowin Programmer.
5. Gowin_EMPU_M1 software programming design generates a software design BIN file;
6. After configure " Device configuration", download the software design BIN file using the download tool, Gowin Programmer.


4.4 Download

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

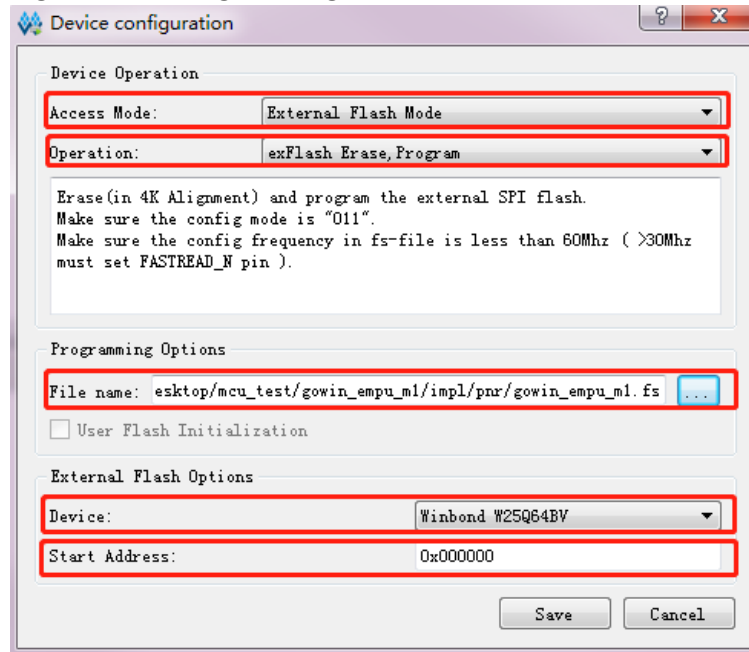
4.4.1 Download Hardware Design Bitstream File


Gowin_EMPU_M1 hardware design generates a hardware design bitstream file with bootload as ITCM initial value and the off-chip SPI-Flash downloading. Download the bitstream file using the download tool, Gowin Programmer.

Select "Tools > Programmer" in the menu bar of Gowin Software or "Programmer" () in the tool bar to open the download tool, Programmer.

Click "Edit > Configure Device" in the Programmer menu bar or click "" in the tool bar to open "Device configuration".

- Select "External Flash Mode" option from the drop-down list "Access Mode";
- Select "exFlash Erase, Program" option or "exFlash Erase, Program, Verify" option from the drop-down list "Operation";
- Import required hardware design bitstream file in " Programming Options > File name ";
- Select " External Flash Options > Device " according to the type of Flash chip on board of development board (e.g. Gowin DK-START-GW2A18 V2.0 development board Winbond W25Q64BV on board)
- Set to 0x000000 in "External Flash Options > Start Address" option;
- Click "Save" to complete configuration of hardware design bitstream file download options, 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.

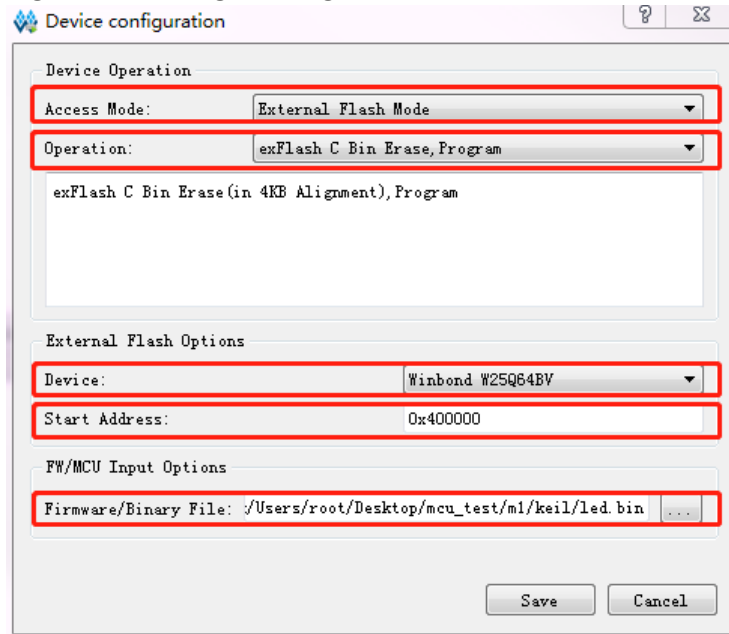
4.4.2 Download Software Design Binary BIN File


After downloading the bitstream file generated by Gowin_EMPU_M1 hardware design, download the BIN file generated by Gowin_EMPU_M1 software design using the download tool Programmer.

Open the download tool, Programmer, from Gowin Software or from the software installation path.

Click " Edit > Configure Device " in Programmer menu bar or "  " in tool bar to open Device configuration.

- Select "External Flash Mode" option from the drop-down list "Access Mode";
- Select "exFlash C Bin Erase, Program" option or "exFlash C Bin Erase, Program, Verify" option from the drop-down list "Operation".
- Import required BIN file in " FW/MCU Input Options > Firmware/Binary File "option;
- Select "Device" based on the Flash on board in "External Flash Options", such as, Winbond W25Q64BV. Select "0x400000" in "Start Address";
- Click "Save", to complete configuration of software design BIN file download options, 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 software design BIN file downloading.

4.5 Devices Supported

- GW2A-18/GW2A-18C/GW2AR-18/GW2AR-18C/GW2ANR-18C
- GW2A-55/GW2A-55C

4.6 Reference Design

Get the following reference design by this [link](#):

Gowin_EMPU_M1\bootload\example

