




Gowin_EMPU_M1 Quick Design Reference Manual

IPUG534-1.8E, 07/16/2021

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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 hardware design and software programming design support extended peripherals: CAN, Ethernet, SPI-Flash, RTC, DualTimer, TRNG, I2C, SPI, SD-Card; ● 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; ● Fixed known issues of Size and IDE.
09/27/2019	1.3E	<ul style="list-style-type: none"> ● MCU hardware design and software programming design support read, write and erasure of SPI-Flash; ● MCU software programming design supports a continuous multi-byte read and write of I2C; ● Fixed known issues of address mapping of AHB2 and APB2 extended interface in MCU software programming design; ● Fixed known issues of continuous read and write of DDR3 Memory in MCU software programming design.
12/06/2019	1.4E	<ul style="list-style-type: none"> ● MCU hardware design and software programming design supports PSRAM; ● Updated MCU compiling software GMD V1.0; ● Updated RTOS reference design; ● Hardware and software reference design of AHB2 and APB2 extension bus interface added;
03/04/2020	1.5E	Updated the version of software.
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.
01/25/2021	1.7E	<ul style="list-style-type: none"> ● The reference design of GW1N-9C, GW2A-18C and GW2A-55C (Version C) updated. ● The reference design of Gowin Software version updated.
07/16/2021	1.8E	<ul style="list-style-type: none"> ● SynplifyPro, the synthesis tool, deleted; ● The version of FPGA and MCU updated.

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1 Reference Design

1.1 Software Reference Design

Gowin_EMPU_M1 provides software reference designs with ARM Keil MDK (V5.26 and above) and GNU MCU Designer (V1.1 and above) software environment. Get following reference designs by the link:

http://cdn.gowinsemi.com.cn/Gowin_EMPU_M1.zip

- Gowin_EMPU_M1\ref_design\MCU_RefDesign\Keil_RefDesign
- Gowin_EMPU_M1\ref_design\MCU_RefDesign\GMD_RefDesign

1.2 Hardware Reference Design

Gowin_EMPU_M1 provides hardware reference design. Get the reference design by the link:

http://cdn.gowinsemi.com.cn/Gowin_EMPU_M1.zip

- Gowin_EMPU_M1\ref_design\FPGA_RefDesign\Debug_RefDesign
- Gowin_EMPU_M1\ref_design\FPGA_RefDesign\NoDebug_RefDesign

Taking development board reference design of DK-START-GW2A18 V2.0 in SDK for an instance, the reference design includes two parts:

- Cortex-M1 core
- AHB-Lite interface, extension AHB, and APB peripheral interface

1.2.1 Cortex-M1

The configured function modes of Cortex-M1 core are shown in Table 1-1.

Table 1-1 Cortex-M1 Configuration of the Reference Design

Function Mode	Configuration
Number of external interrupts	32
Extended operating system	Supported
Data storage format	Little-endian format
MULT	Standard mode
Debugger	<ul style="list-style-type: none"> ● Integrated mode, four break points and two observation points

Function Mode	Configuration
	<ul style="list-style-type: none"> Debugger disabled
Debug interface	Support JTAG and Serial Wire
ITCM Select	Internal Instruction Memory
ITCM size	32KB by default
ITCM Initialization value	Enable
ITCM Initialization path	32KB Bootload
DTCM Select	Internal Data Memory
DTCM Size	32KB

1.2.2 AHB-Lite

The configured peripheral interfaces of AHB-Lite are shown in Table 1-2.

Table 1-2 AHB-Lite Configuration of the Reference Design

Peripheral Interface	Configuration
UART0	Supported
UART1	Supported
GPIO	Supported
Timer0	Supported
Timer1	Supported
WatchDog	Supported
Real-time Clock	Supported
True Random Number Generator	Supported
Dual Timer	Supported
Internal integrated circuit, I2C	Supported
SPI	Supported
SD-Card	Supported
Ethernet	Supported
SPI-Flash	Supported
APB Master [1]	Supported
AHB Master [1]	Supported

2 Software Programming Design

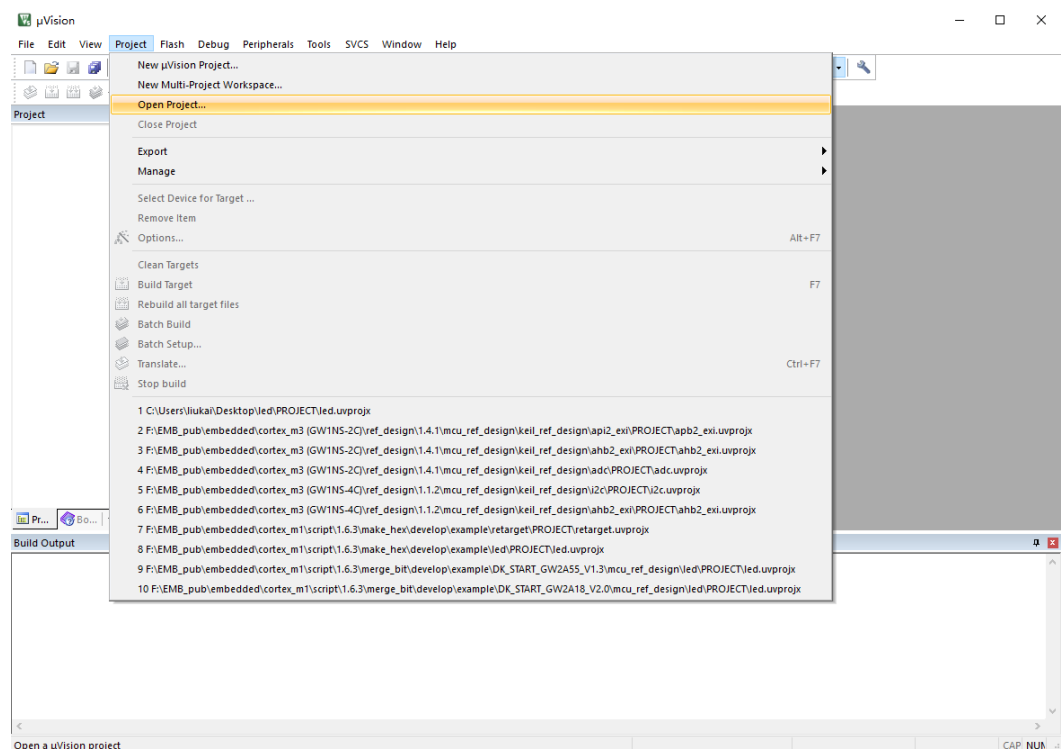
2.1 Software Environment

- ARM Keil MDK (V5.26 and above)
- GOWIN MCU Designer (V1.1 and above)

2.2 Import Software Reference Design

Double click to open ARM Keil MDK, select "Project > Open Project..." to import the software reference design, as shown in Figure 2-1.

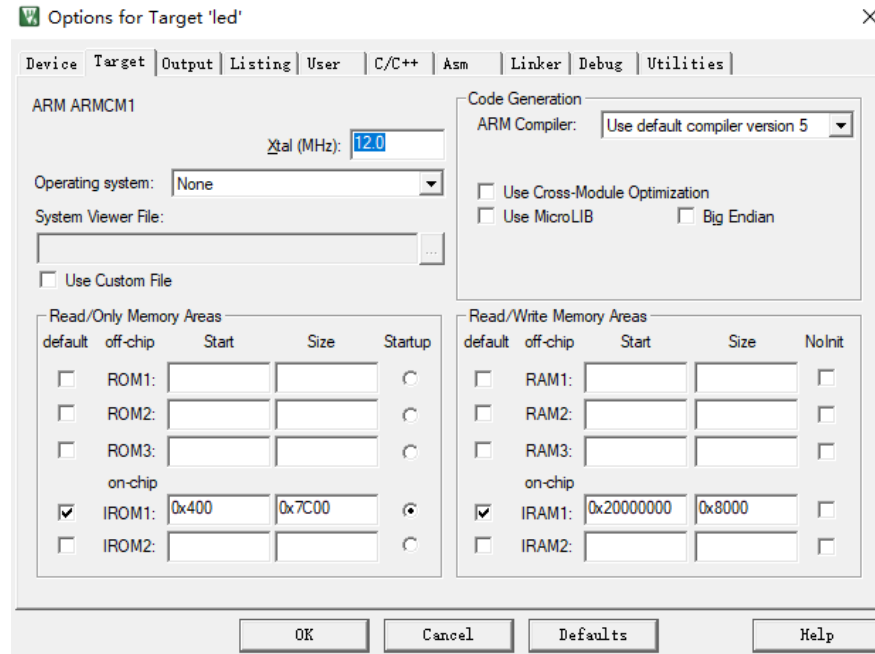
Figure 2-1 Import Software Reference Design



2.3 ROM Configuration

Take development board reference design in of DK-START-GW2A18 V2.0 SDK for an instance, you can use off-chip SPI-Flash download method, set the ROM start address as "0x400" and the ROM Size as "0x7C00", as shown in Figure 2-2.

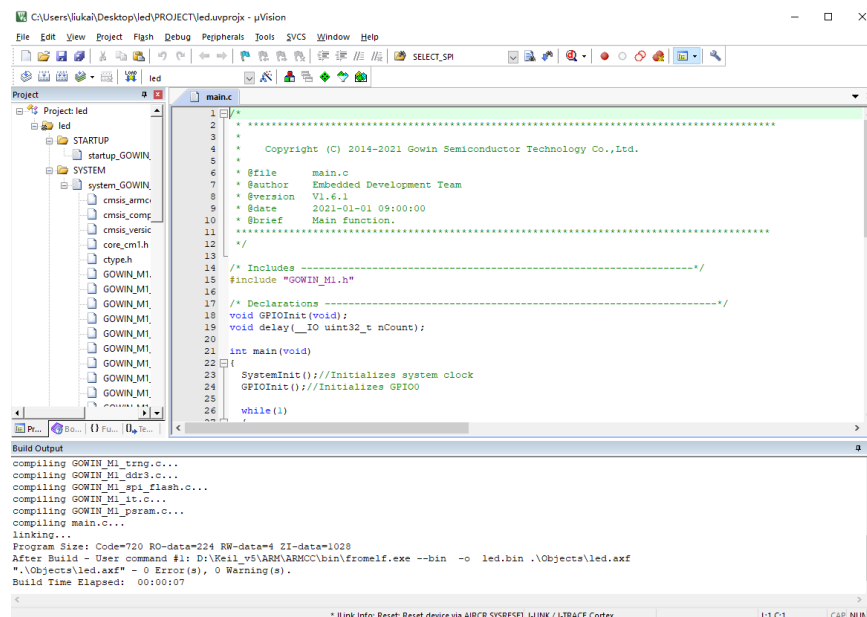
Figure 2-2 ROM Start Address and Size Configuration



2.4 Compile


Click the "Compile" button to compile the reference design and generate software design BIN file, as shown in Figure 2-3.

Figure 2-3 Compiling



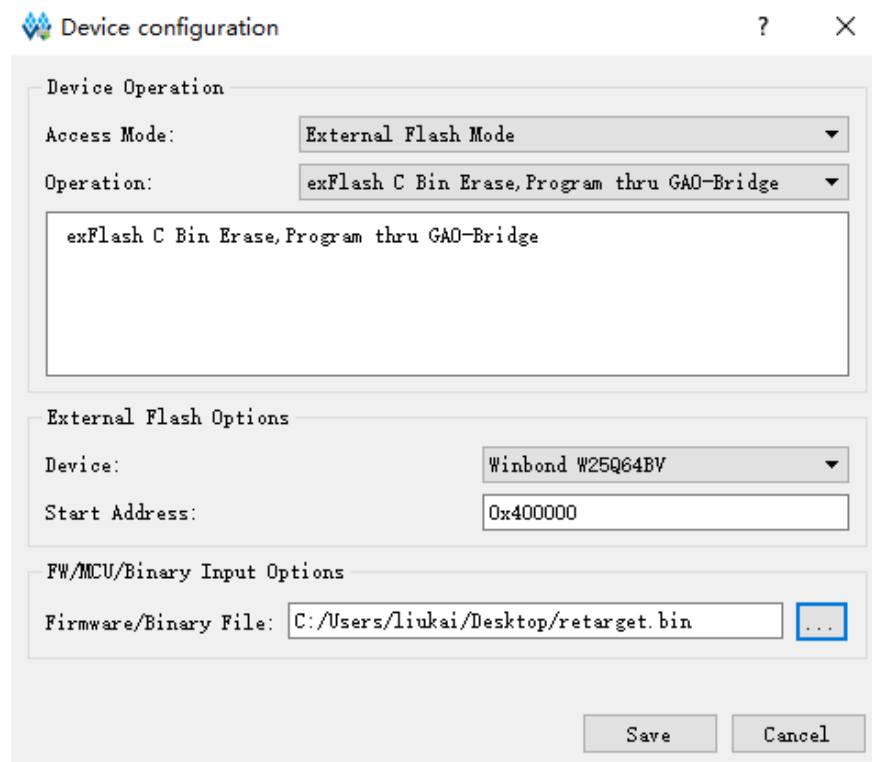
2.5 Download


Take development board reference design of DK-START-GW2A18 V2.0 in SDK for an instance.

Run the download tool "Programmer" in the Gowin Software or in the software installation path. Click "Edit > Configure Device" in the Programmer menu bar or Configure Device  in the tool bar to open the "Device configuration".

- Select "External Flash Mode" from the "Access Mode" drop-down list.
- Select "exFlash C Bin Erase, Program thru GAO-Bridge " or "exFlash C Bin Erase, Program, Verify thru GAO-Bridge" from the "Operation" drop-down list.
- Import the software programming BIN file in binary format required in "FW/MCU/Binary Input Options > Firmware/Binary File".
- Select " External Flash Options > Device " option according to the on-board Flash chip type, such as Gowin DK-START-GW2A18 V2.0 onboard development board Winbond W25Q64BV.
- Set " External Flash Options > Start Address" as "0x400000".
- Click "Save" to finish configuring the software design BIN file download option, as shown in Figure 2-4.

Figure 2-4 Device configuration



After device configuration, click Program/Configure  to complete software design BIN file downloading.

2.6 Reference Manual

For Gowin_EMPU_M1 of software design method, please refer to the following manuals:

- [IPUG533](#), Gowin_EMPU_M1 Software Programming Reference Manual
- [IPUG536](#), Gowin_EMPU_M1 IDE Software Reference Manual
- [IPUG532](#), Gowin_EMPU_M1 Download Reference Manual
- [IPUG535](#), Gowin_EMPU_M1 Serial Debugging Reference Manual
- [SUG502](#), Gowin Programmer User Guide

3 Hardware Design

3.1 Hardware Environment

DK-START-GW2A18 V2.0

- GW2A-LV18PG256C8/I7
- GW2A-18C (Version C)

3.2 Software Environment

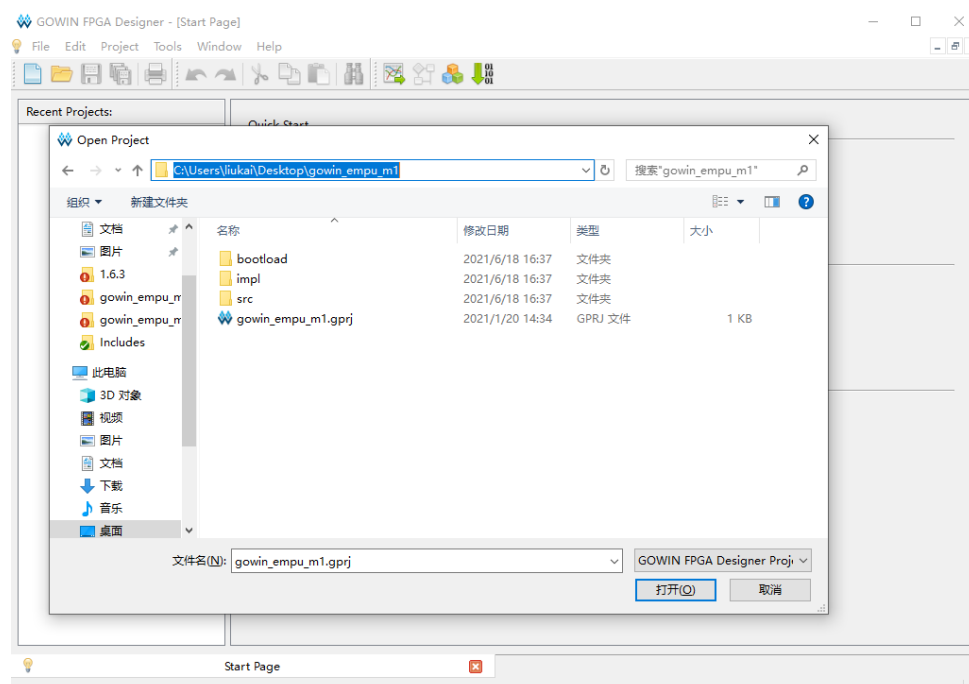
Gowin_V1.9.8 Beta and above

3.3 Import Hardware Reference Design

Double click to run Gowin Software. Click "File > Open..." to import hardware reference design, as shown in Figure 3-1.

Or you can open the IP Core Generator tool, reconfigure and generate Gowin_EMPU_M1 hardware design according to your requirements.

Figure 3-1 Import Hardware Reference Design



Take development board reference design of DK-START-GW2A18 V2.0 in SDK for an instance. The hardware reference design files are as shown in Table 3-1.

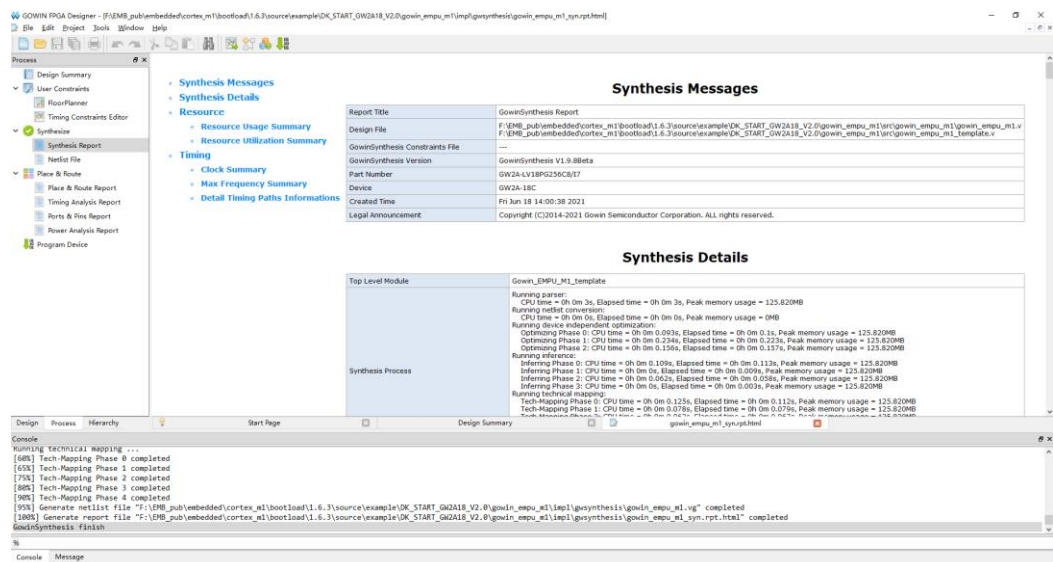
Table 3-1 Hardware Reference Design Examples

File	Description
gowin_empu_m1.v	Gowin_EMPU_M1 hardware design
gowin_empu_m1_template.v	Gowin_EMPU_M1 Top Module instantiation and user application design
ahb_multiple.v	AHB Master [1] user peripheral extensions
apb_multiple.v	APB Master [1] user peripheral extensions
gowin_empu_m1.cst	Physical Constraints

3.4 Synthesize

Run GowinSynthesis®, the synthesis tool, to generate the Netlist File, as shown in Figure 3-2.

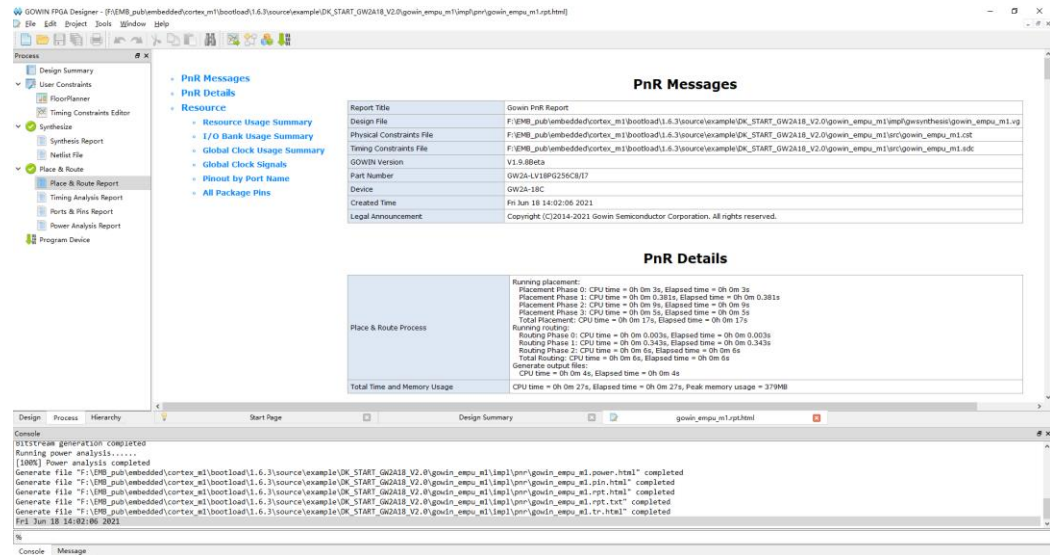
Figure 3-2 Synthesis Reference Design



3.5 Place & Route

Run Place & Route tool to complete the Place & Route and generate the bitstream files, as shown in Figure 3-3.


Figure 3-3 Place & Route



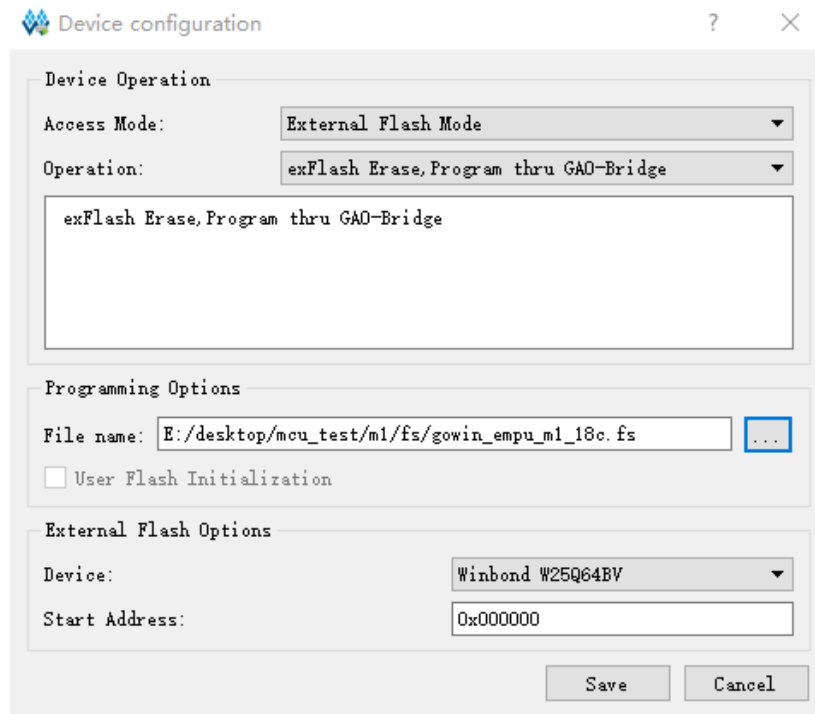
3.6 Download


Take development board reference design of DK-START-GW2A18 V2.0 in SDK for an instance.

Run the download tool "Programmer" to complete the hardware design bitstream file download.

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

- Select "External Flash Mode" from the "Access Mode" drop-down list.
- Select "exFlash C Bin Erase, Program thru GAO-Bridge " or "exFlash C Bin Erase, Program, Verify thru GAO-Bridge" from the "Operation" drop-down list.
- Import the hardware design bitstream file required in " Programming Options > File name " option.
- Select " External Flash Options > Device " option according to the on-board Flash chip type, such as Gowin DK-START-GW2A18 V2.0 onboard development board Winbond W25Q64BV.
- Set " External Flash Options > Start Address" as "0x000000".
- Click "Save" to finish configuring the software design BIN file download option, as shown in Figure 3-4 .

Figure 3-4 Device configuration

After device configuration, click Program/Configure "  " in the Programmer tool bar to complete hardware design bitstream files download.

3.7 Reference Manual

Please refer to the following manuals for Gowin_EMPU_M1 hardware design:

- [IPUG531](#), Gowin_EMPU_M1 Hardware Design Reference Manual
- [SUG100](#), Gowin YunYuan Software User Guide
- [SUG101](#), Gowin Design Constraints Guide
- [SUG502](#), Gowin Programmer User Guide

4 Debug

4.1 Hardware Debugging Method

Use Gowin Analyzer Oscilloscope (GAO) to debug the Gowin_EMPU_M1 FPGA hardware design.

4.2 Software Debugging Method

Gowin_EMPU_M1 supports two software programming debugging methods:

- Emulator Software On-line Debugging
- Serial Debugging

4.2.1 Emulator Debugging

Emulator Type

Gowin_EMPU_M1 supports the following emulator to set break points and perform single-step debugging:

- J-LINK emulator
- U-LINK emulator

Debug interface

Gowin_EMPU_M1 supports the following debugging interfaces:

- JTAG
- Serial Wire

4.2.2 Serial Debugging

Use serial and serial debugging assistant to print the running status.

4.3 Reference Manual

For Gowin_EMPU_M1 debugging method, refer to following manuals:

- [SUG114](#), Gowin Analyzer Oscilloscope User Guide
- [IPUG536](#), Gowin_EMPU_M1 IDE Software Reference Manual
- [IPUG535](#), Gowin_EMPU_M1 Serial Debugging Reference Manual

