Gowin_EMPU(GW1NS-4C) IDE Software

Reference Manual

IPUG928-2.0E, 03/14/2024

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Revision History

Date	Version	Description
04/20/2020	1.0E	Initial version published.
02/08/2021	1.1E	• AHB PSRAM Memory Interface peripheral supported. • AHB HyperRAM Memory Interface peripheral supported. • APB SPI Nor Flash peripheral supported. • GPIO supports multiple port types. • I^2C supports multiple port types. • ARM Keil MDK and GOWIN MCU Designer versions upgraded.
12/16/2022	1.2E	Software development kit updated.
03/14/2024	2.0E	Software programming reference design updated.

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1 ARM Keil MDK

1.1 Software Installation

For the detailed information, please refer to *Getting Started with MDK* (V5.26 and above) provided by ARM Keil MDK website.

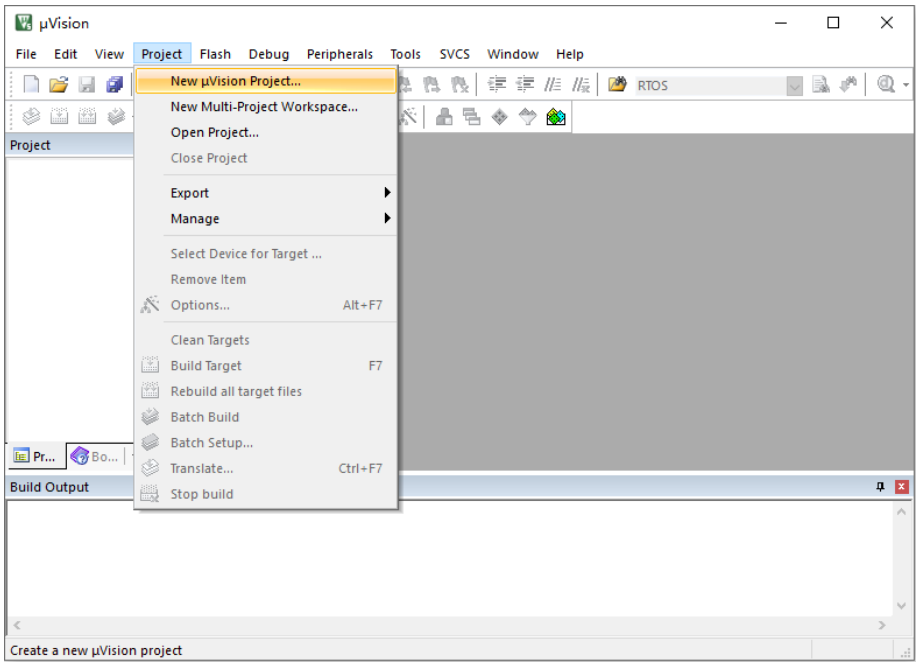
1.2 Project Template

ARM Keil MDK can be used for Gowin_EMPU(GW1NS-4C) software programming. The steps include project creation, configuration, coding, build, download and debug.

1.2.1 Create a New Project

Open ARM Keil MDK and select "Project > New uVision Project…" to create a new project, as shown in Figure 1-1.

Figure 1-1 Create a New Project

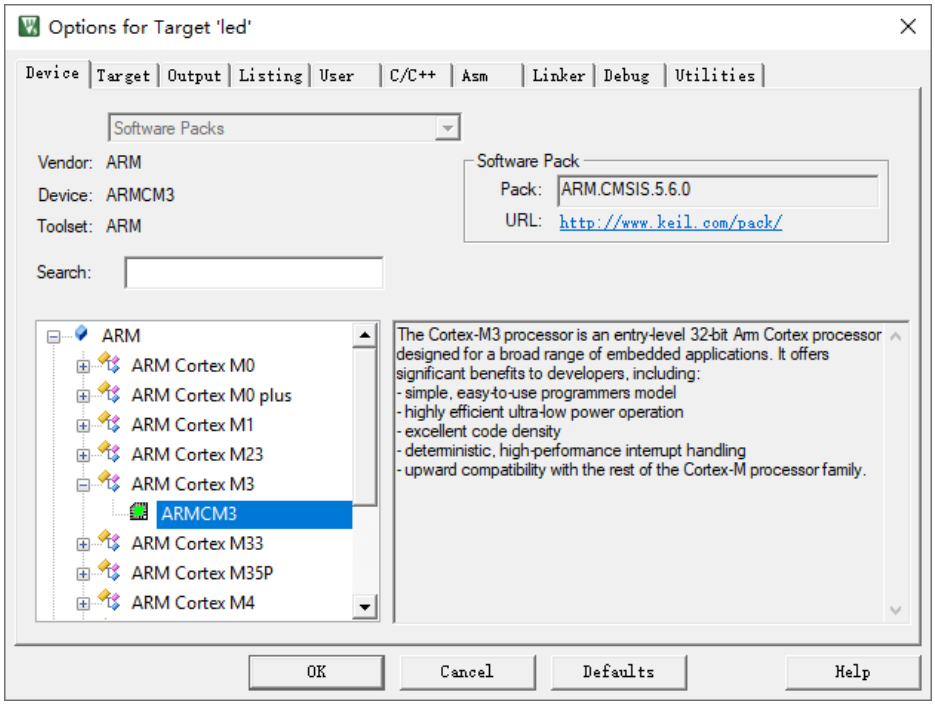


1.2.2 Configuration Option

Device Configuration

ARM Cortex-M3 is embedded in Gowin_EMPU(GW1NS-4C), and the device is configured as "ARM Cortex M3 > ARMCM3", as shown in Figure 1-2.

Figure 1-2 Device Configuration



ROM and RAM Configuration

Configure the start address and size of Flash for instructions and SRAM for data, as shown in Figure 1-3.

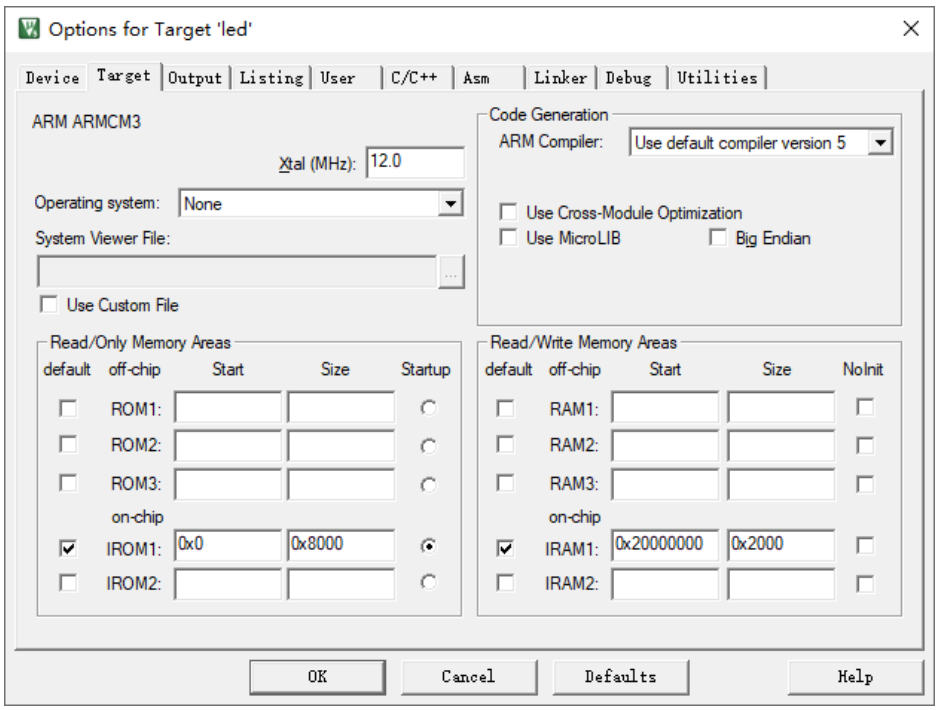
ROM Configuration

- Start Address: 0x00000000
- Size: 0x8000 (32KB)

RAM Configuration

- Start Address: 0x20000000
- Size: Consistent with the SRAM Size configuration of the Gowin_EMPU(GW1NS-4C) IP Core in the IP Core Generator tool of Gowin Software, which can be configured as 2KB, 4KB, 8KB, or 16KB.

Figure 1-3 ROM and RAM Configuration



Output File Format Configuration

Gowin_EMPU (GW1NS-4C) software programming design requires the generation of a software programming binary file. Therefore, it is necessary to convert the axf format to the binary format.

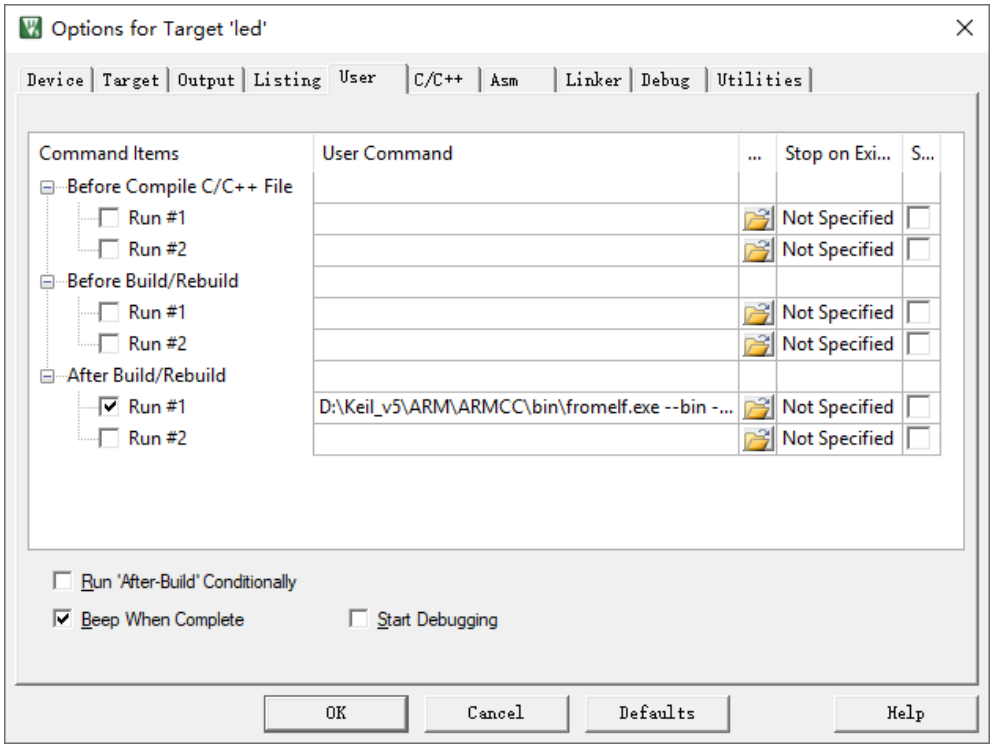
In the user command line option, convert the format of output file from axf to bin using fromelf, the output file format conversion tool. The call

method is as shown in Figure 1-4.

The format conversion command of fromelf is: fromelf.exe --bin -o bin-file axf-file. For example, C:\Keil_v5\ARM\ARMCC\bin\fromelf.exe --bin -o led.bin .\Objects\led.axf.

The path of fromelf should be modified according to the user's local installation path of ARM Keil MDK.

Figure 1-4 Output File Format Configuration



Header File Path Configuration

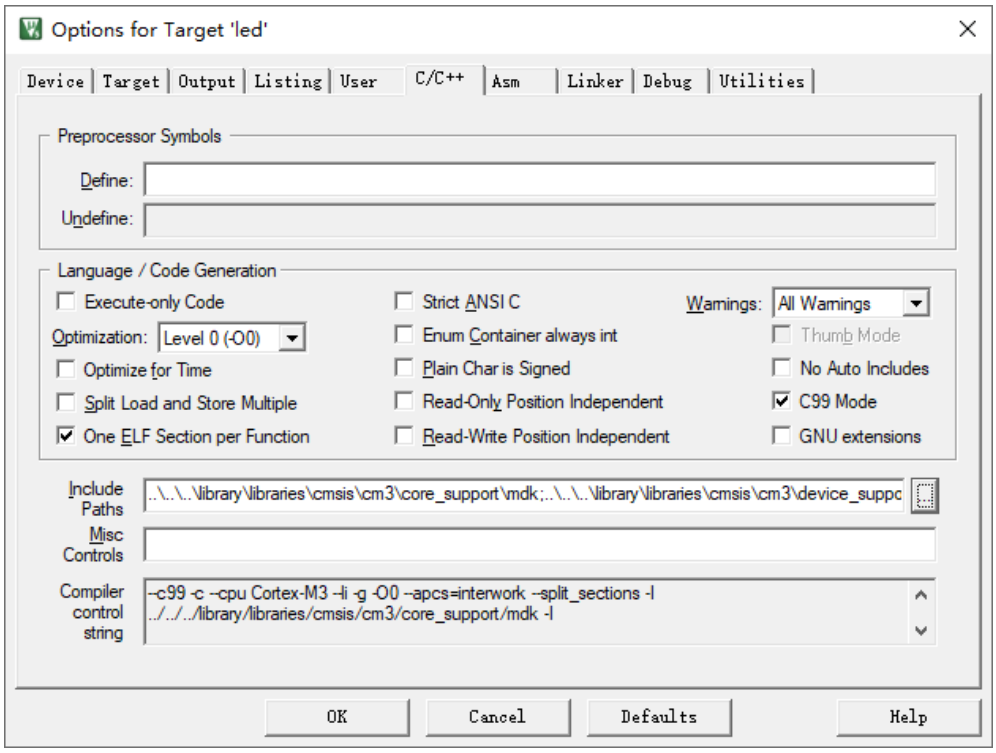
Configure C code header file path and different header file C paths are called during building, as shown in Figure 1-5.

For example:

- "..\..\..\library\libraries\cmsis\cm3\core_support\mdk"
- "..\..\..\library\libraries\cmsis\cm3\device_support"
- "..\..\..\library\libraries\drivers\inc"
- "..\..\..\library\middlewares\delay"
- "..\..\..\library\middlewares\gpio"

- "..\inc"

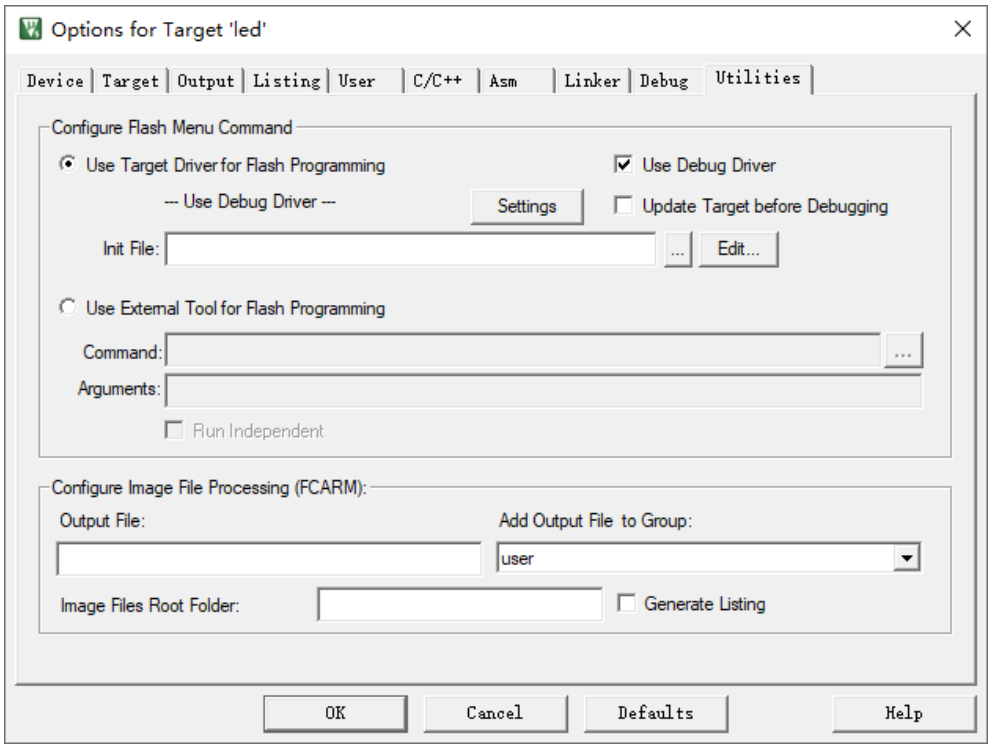
Figure 1-5 Header File Path Configuration



Flash Configuration

If online debugging is required, disable "Utilities > Update Target before Debugging" option as shown in Figure 1-6.

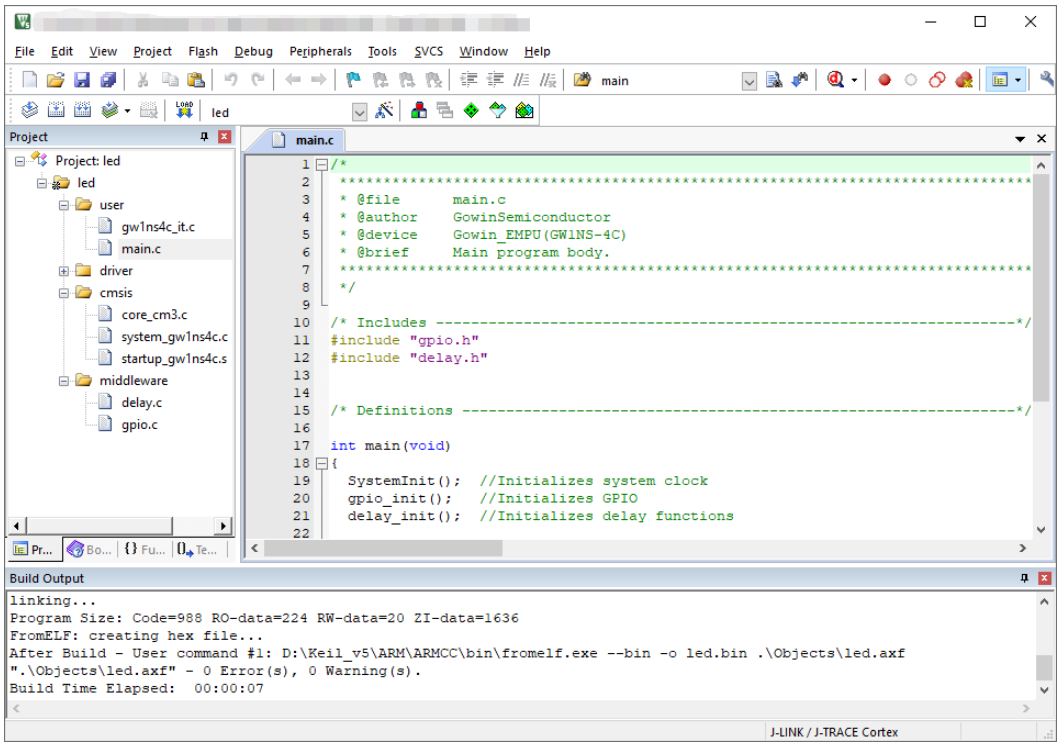
Figure 1-6 Flash Configuration



1.2.3 Build

After encoding and configuration, click "Build" ( ) or "Rebuild" ( ) on tool bar, or click "Project > Build Targets" or "Project > Rebuild All Target Files" on the menu bar to generate software programming Binary File, as shown in Figure 1-7.

Figure 1-7 Build



1.2.4 Download

Download the programming Binary file using Gowin Programmer.

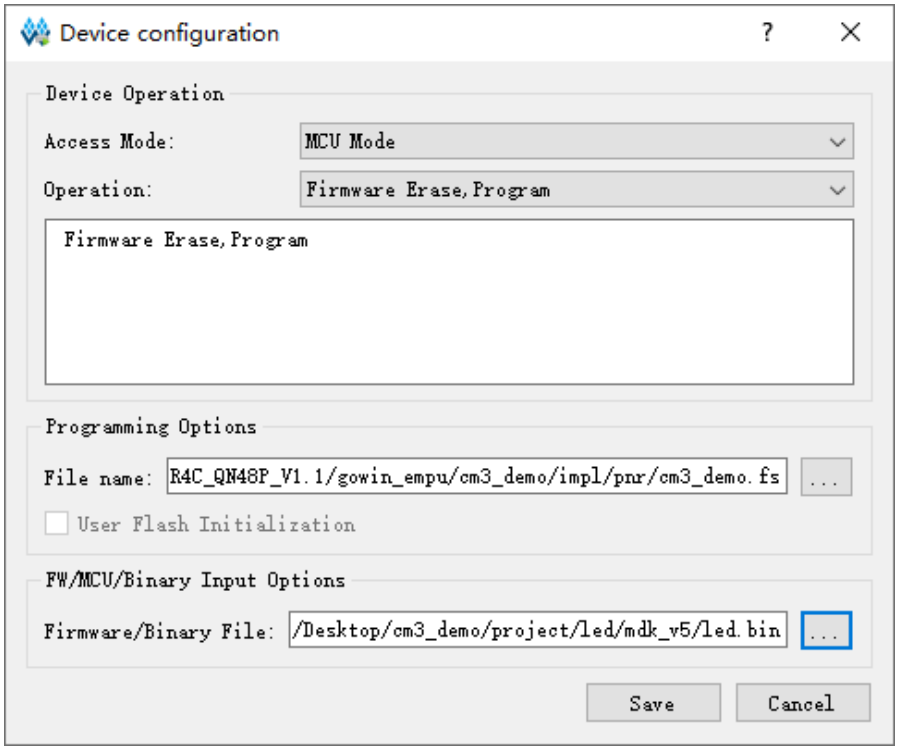
Open Programmer in Gowin Software or under the installation path.

Click "Edit > Configure Device" on the menu bar or "Configure Device " ( ) on the tool bar to open the "Device configuration".

If FPGA product GW1NS-4C or GW1NSR-4C is selected, configuration options are as shown in Figure 1-8..

- Select "MCU Mode" in "Access Mode" drop-down list.
- Select "Firmware Erase, Program" or "Firmware Erase, Program, Verify" in "Operation" drop-down list.

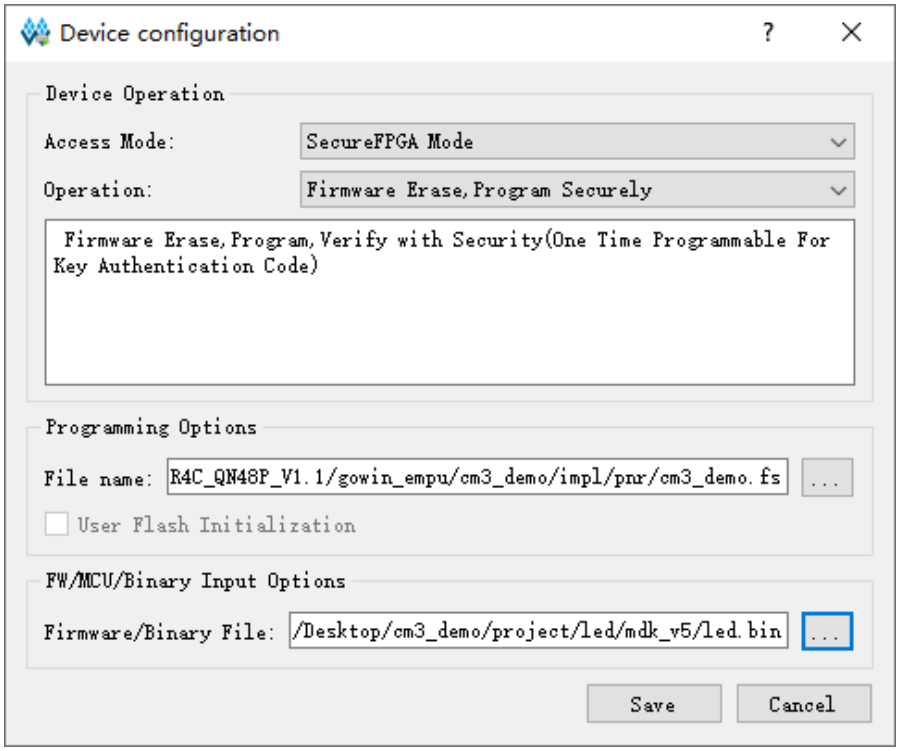
Figure 1-8 Configuration Options for GW1NS-4C or GW1NSR-4C



If FPGA product GW1NSER-4C is selected, configuration options are as shown in Figure 1-9.

- Select "SecureFPGA Mode" in "Access Mode" drop-down list;
- Select "Firmware Erase, Program Securely" in "Operation" drop-down list.

Figure 1-9 Configuration Options for GW1NSER-4C



- Import software programming Binary file in "FW/MCU/Binary Input Options > Firmware/Binary File".
- Click "Save" to complete the configuration.

Note!

Import hardware design bitstream in "Programming Options > File name", please refer to *IPUG932, Gowin_EMPU(GW1NS-4C) Hardware Design Reference Manual*.

After device configuration, click Program/Configure ( ) on the Programmer toolbar to complete the download of the software programming Binary file and the hardware bitstream file.

1.2.5 On-line Debug

After completing the download of the software programming Binary file and the hardware bitstream file, if there are any design issues, you can use U-LINK and J-LINK to debug online.

The single-step debug flow includes:

- Switch MCU JTAG mode
- Switch MCU JTAG interface
- Configure software debug
- Connect debug emulator

- Start software debug

MCU JTAG Mode Switch

Switch JTAG mode from the downloading to debug mode using Programmer.

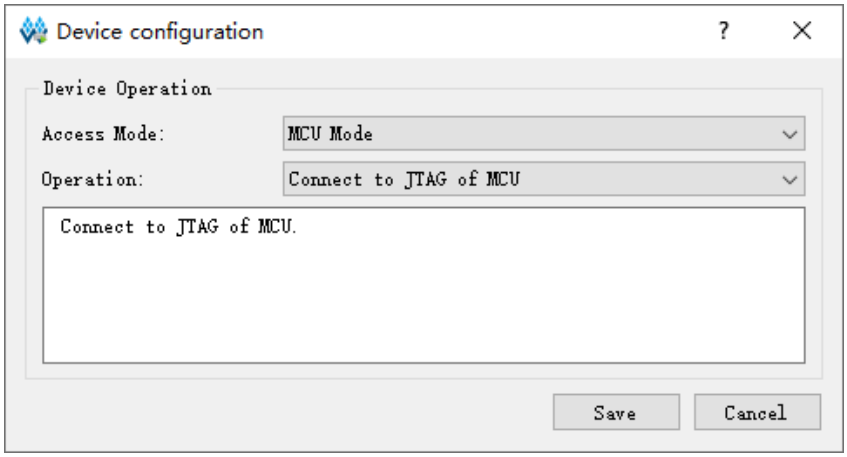
Open Programmer in Gowin Software or under the installation path.

Click "Edit > Configure Device" on the menu bar or "Configure Device " ( ) on the tool bar to open the "Device configuration".

If FPGA product GW1NS-4C or GW1NSR-4C is selected, MCU JTAG mode configuration options are as shown in Figure 1-10.

- Select "MCU Mode" in "Access Mode" drop-down list.
- Select "Connect to JTAG of MCU" in "Operation" drop-down list.

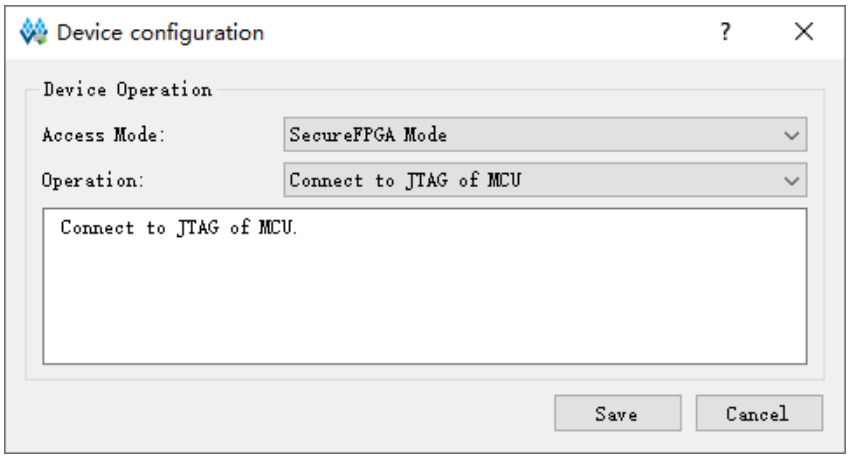
Figure 1-10 MCU JTAG Mode Configuration for GW1NS-4C or GW1NSR-4C



If FPGA product GW1NSER-4C is selected, MCU JTAG mode configuration options are as shown in Figure 1-11.

- Select "SecureFPGA Mode" in "Access Mode" drop-down list.
- Select "Connect to JTAG of MCU" in "Operation" drop-down list.

Figure 1-11 MCU JTAG Mode Configuration for GW1NSER-4C



- Click "Save" to complete the configuration.

After device configuration, click "Program/Configure" ( ) in the Programmer tool bar to complete MCU JTAG mode switch.

MCU JTAG Interface Switch

Taking DK-START-GW1NSR4C-QN48G V1.1 for an instance, switch SW3, SW4, SW5, SW6 (TCK, TDO, TDI, and TMS of JTAG interface) on the development board from "FT232" (Download） to "J-LINK" (debug).

Note!

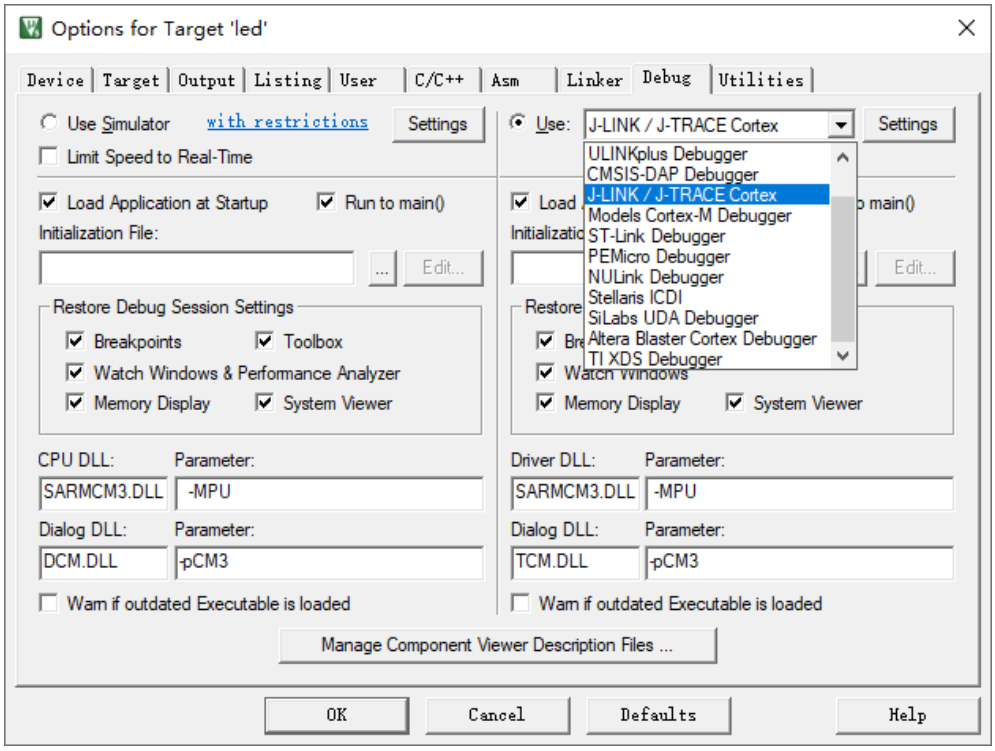
- The development board must be kept on power in MCU JTAG mode and interface switch.
- If the development board powers off in the process, it will restore to MCU JTAG download mode automatically after power on.

Software Debug Configuration Option

In the ARM Keil MDK software, click "Options for Target..." ( ) on the tool bar to configure "Debug" option.

- Emulator Type Configuration
  Click the Debug emulator type drop-down list to configure type, as shown in Figure 1-12.
  - U-LINK Emulator
    If the U-LINK emulator is used, select "ULNK2/ME Cortex Debugger".
  - J-LINK Emulator
    If the J-LINK emulator is used, select "J-LINK/J-TRACE Cortex".

Figure 1-12 Emulator Type Configuration

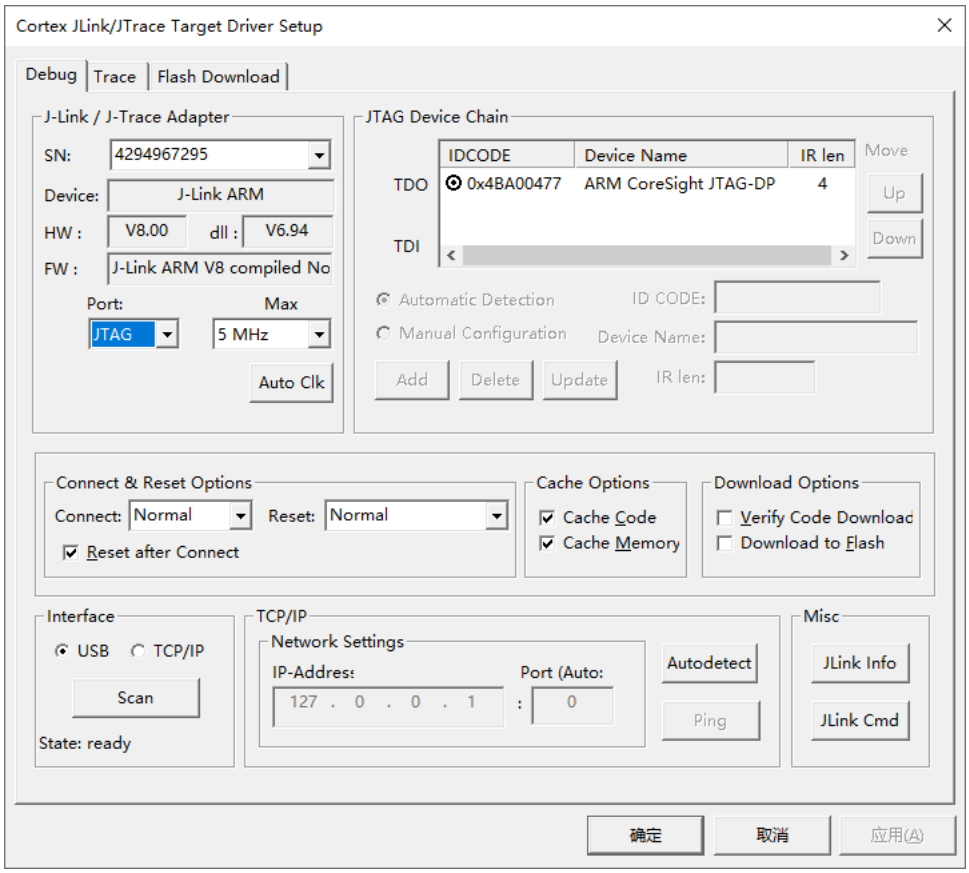


- Debug Interface Type Configuration
  Click Settings and open Cortex JLink/JTrace Target Driver Setup if J-LINK is selected, or ULINK2/ME Cortex-M Target Driver Setup if U-LINK is selected.

  For example, the J-LINK emulator is selected, as shown in Figure 1-13.

  - JTAG Debug Interface
    Gowin_EMPU(GW1NS-4C) supports JTAG debug interface and configure Port to "JTAG".
  - SW Debug Interface
    Gowin_EMPU(GW1NS-4C) does not support SW debug interface, so do not select this one.

Figure 1-13 Debug Interface Type Configuration



Disable "Verify Code Download" and "Download to Flash" options in "Download Options".

If the debug options configuration is successful, after switching MCU JTAG mode and interface and connecting the emulator, the IDCODE, Device Name and other information of Gowin_EMPU(GW1NS-4C) will be displayed in the JTAG Device Chain".

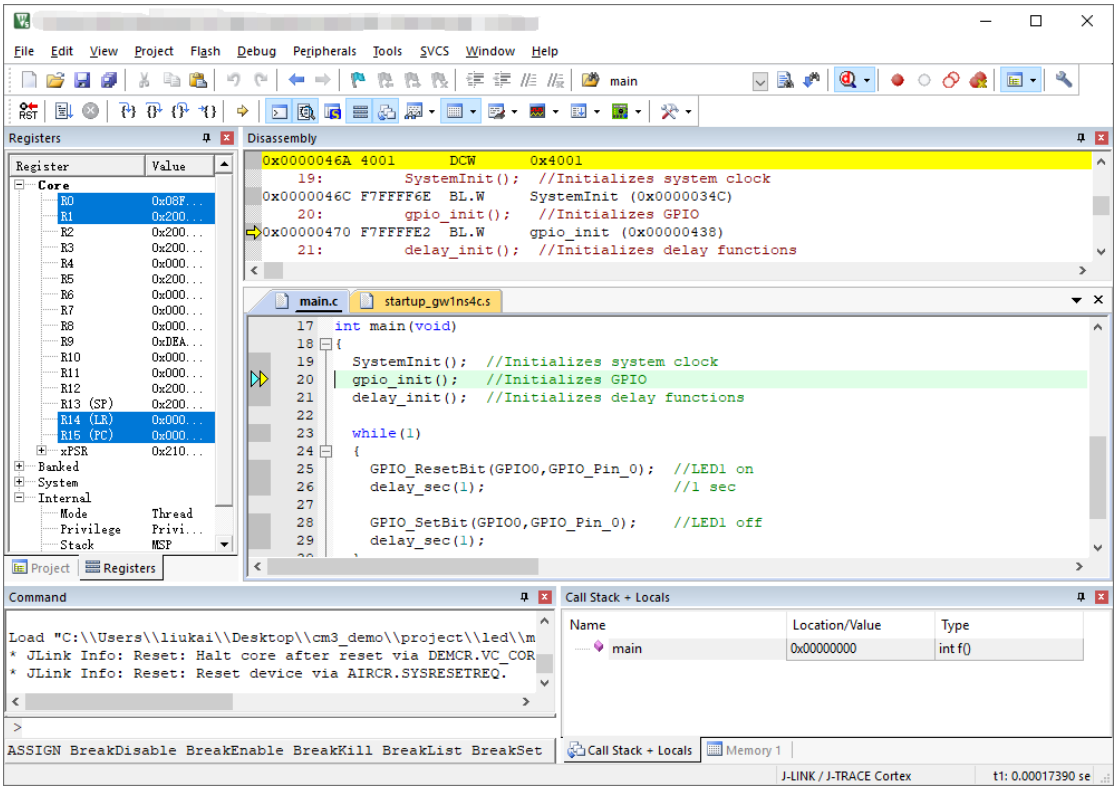
Start Software Debug

Connect the U-LINK or J-LINK debug emulator after software debug configuration.

Click the Debug "" on the tool bar, or click "Debug > Start/Stop Debug Session" on the menu bar to start software debug.

You can perform operations of breakpoint setting, single-step debug, reset, run, etc. as shown in Figure 1-14.

Figure 1-14 Start Software Debugging



1.3 Reference Design

Gowin_EMPU (GW1NS-4C) supports the reference design in ARM Keil MDK (tested software version V5.26), and you can click here to get the following reference design:

…\ref_design\MCU_RefDesign\MDK_RefDesign\cm3_demo、cm3_freertos、cm3_rtthread_nano、cm3_ucos_iii

2 GOWIN MCU Designer

2.1 Software Installation

The installation package of GMD is available at website http://www.gowinsemi.com.cn/prodshow.aspx.

Note!

For the details of GMD, please refer to *SUG549, GOWIN MCU Designer User Guide*.

2.2 Project Template

GMD can be used for Gowin_EMPU(GW1NS-4C) software programming. The steps include project creation, configuration, coding, building, download and debug.

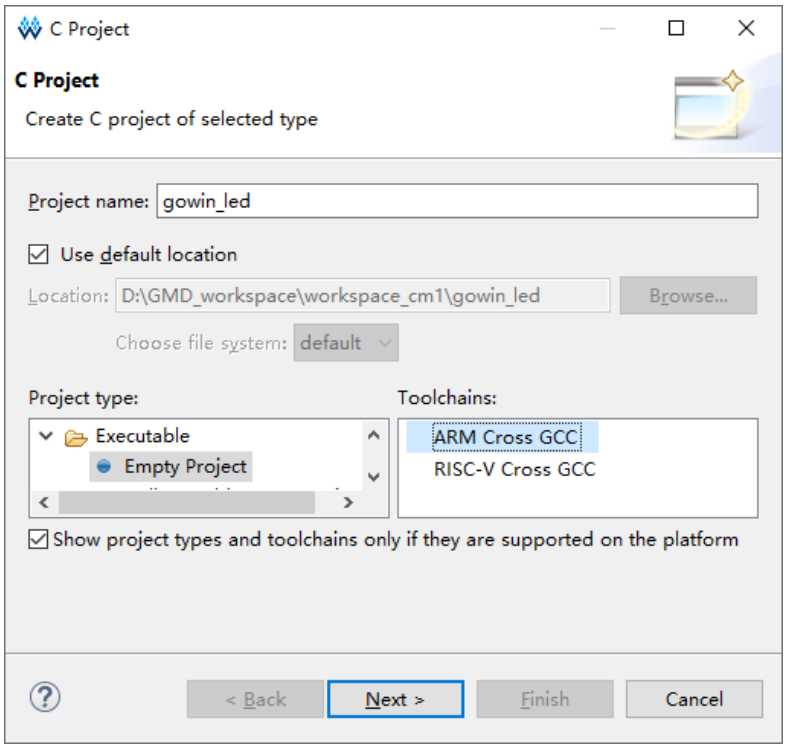
2.2.1 Create a New Project

Create a New Project

Select "New" ( ) on the tool bar, or click "File > New > C Project" on the menu bar, as shown in Figure 2-1.

- Create a project name and location;
- Select the "Empty Project" type;
- Select the "Cross ARM GCC" build toolchain.

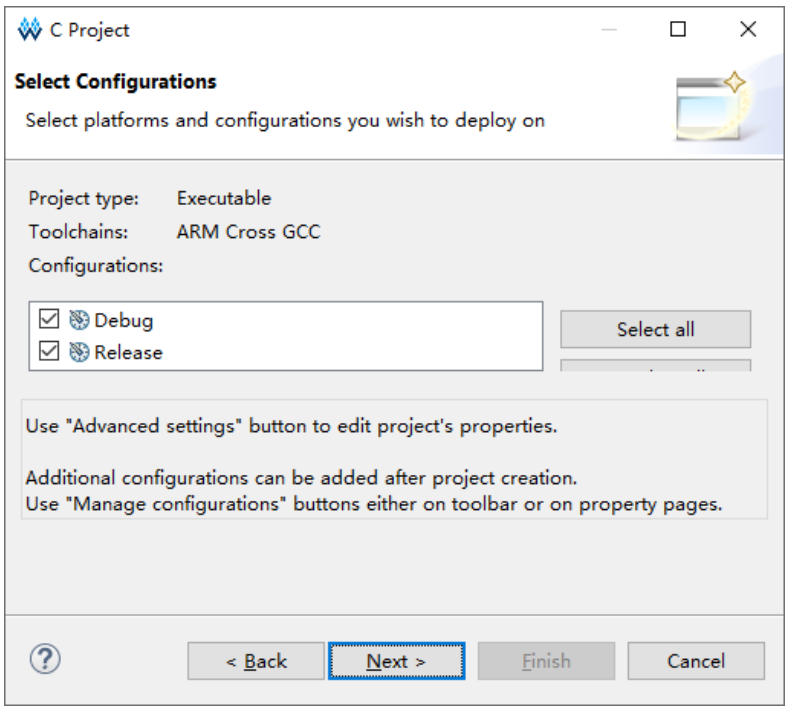
Figure 2-1 Create a New Project



Select Platform and Configuration

Select "Debug" and "Release" as the platform and configuration, as shown in Figure 2-2.

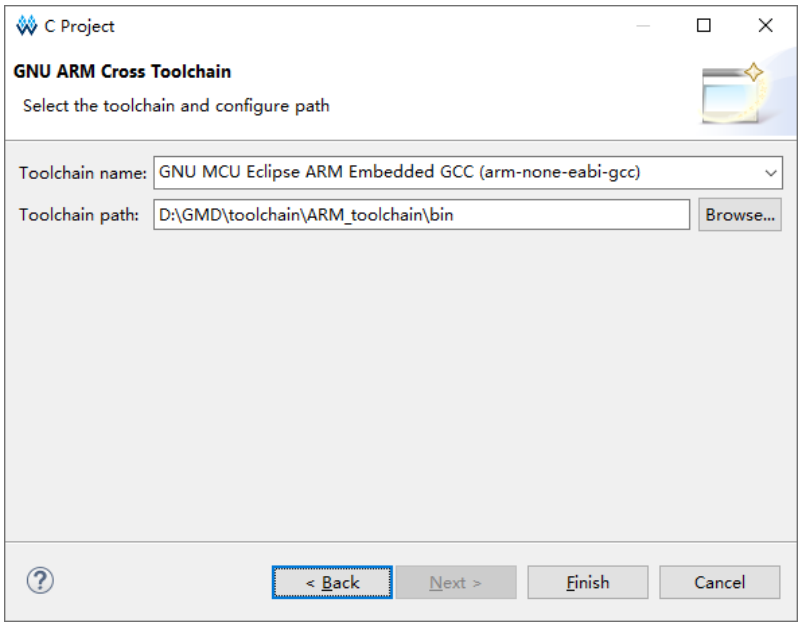
Figure 2-2 Select Platform and Configuration



Select Toolchain and Path

Select "arm-none-eabi-gcc" as the cross toolchain and its path, the default Toolchain name and Toolchain path are recommended, as shown in Figure 2-3.

Figure 2-3 Select Toolchain and Path



Create a Project

After completing the project creation, navigate to the Project Explorer view, select the newly created project, add project structure and code, and import the software programming design.

In the Project Explorer view, select the current project, right-click and choose "Refresh" option to automatically update the structure and code of the current project.

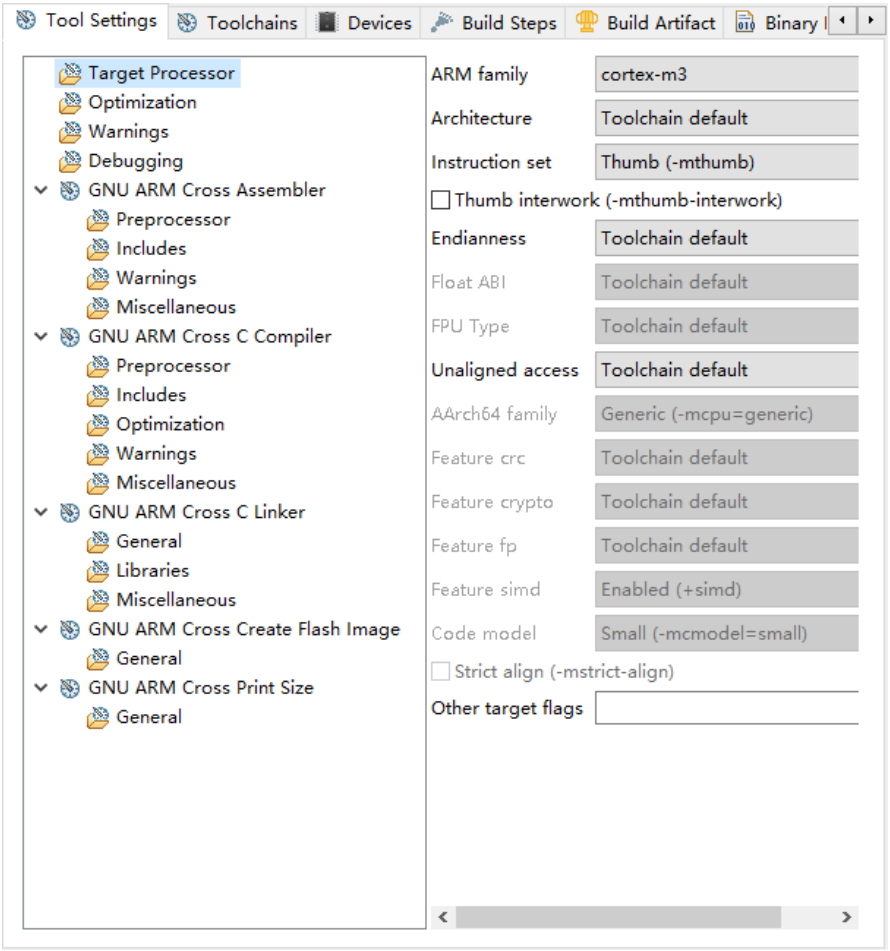
2.2.2 Configuration Option

In the Project Explorer view, select the current project, right click and select "Properties > C/C++ Build > Settings" to configure the project parameters.

Target Processor Configuration

Configure "Target Processor > ARM family", and set this option as "cortex-m3", as shown in Figure 2-4.

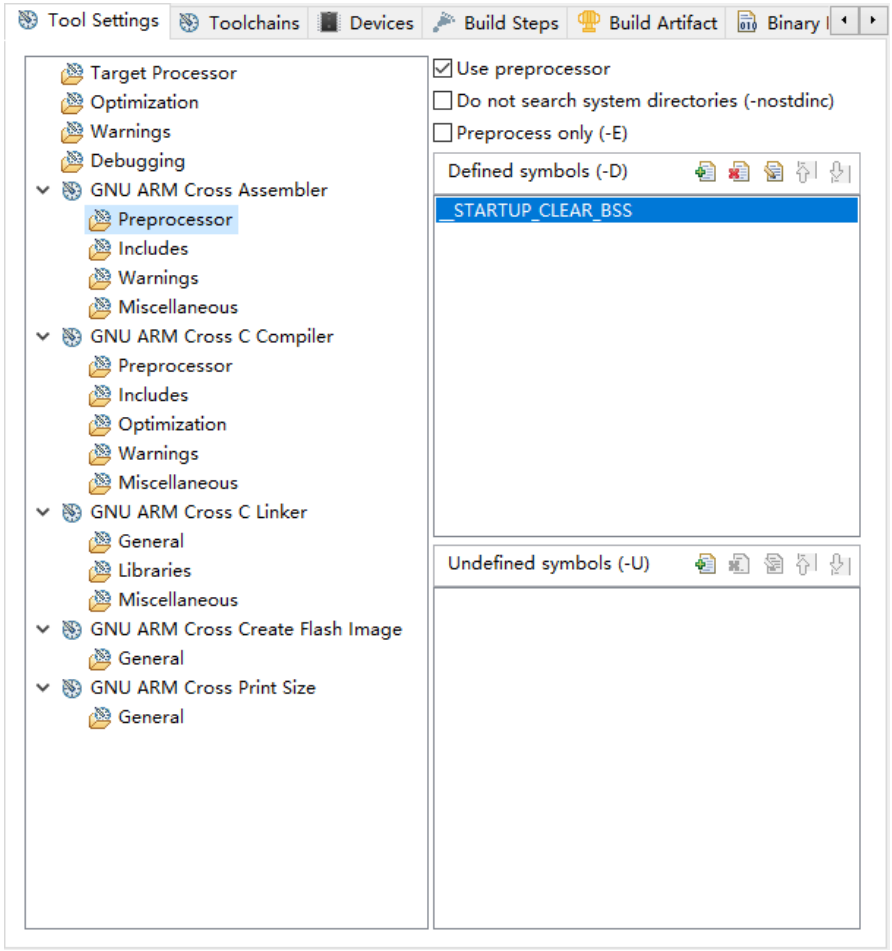
Figure 2-4 Target Processor Configuration Option



GNU ARM Cross Assembler > Preprocessor Configuration

Configure "GNU ARM Cross Assembler > Preprocessor > Defined symbols (-D)" as "__STARTUP_CLEAR_BSS" as shown in Figure 2-5.

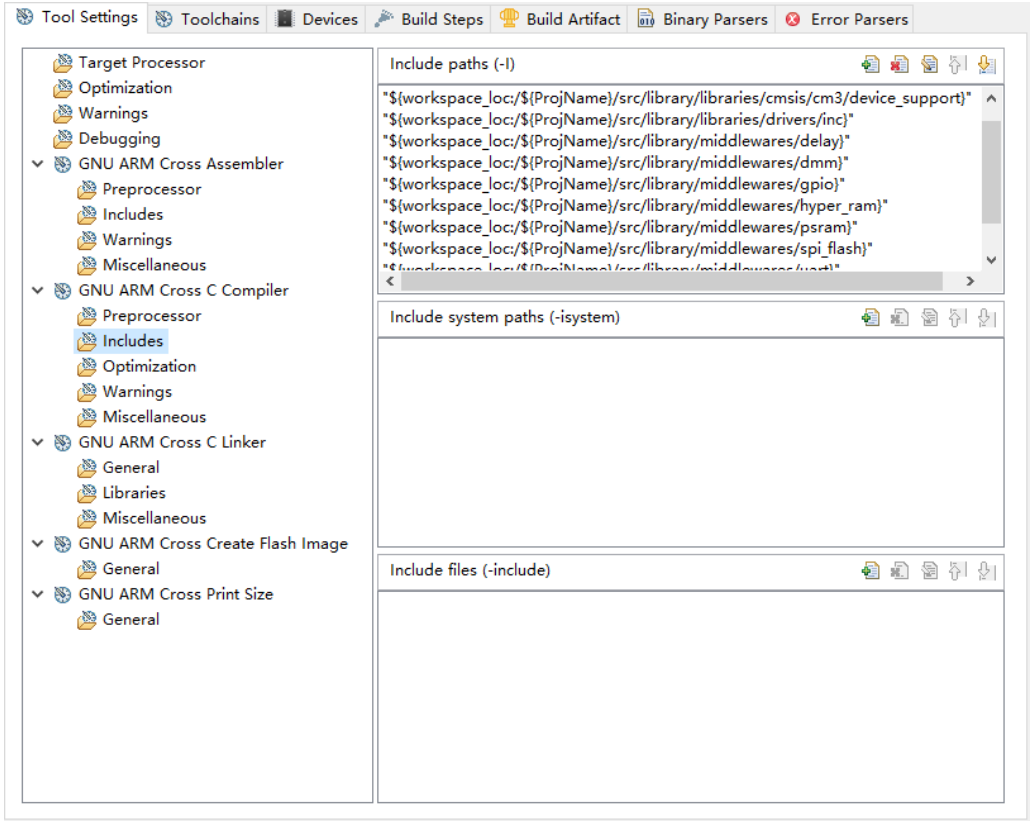
Figure 2-5 Cross ARM GNU Assembler > Preprocessor Configuration Option



GNU ARM Cross C Compiler > Includes Configuration

Select "GNU ARM Cross C Compiler > Includes > Include paths (-I)" to configure the C header file path, as shown in Figure 2-6.

Figure 2-6 Cross ARM C Compiler > Includes Configuration Option



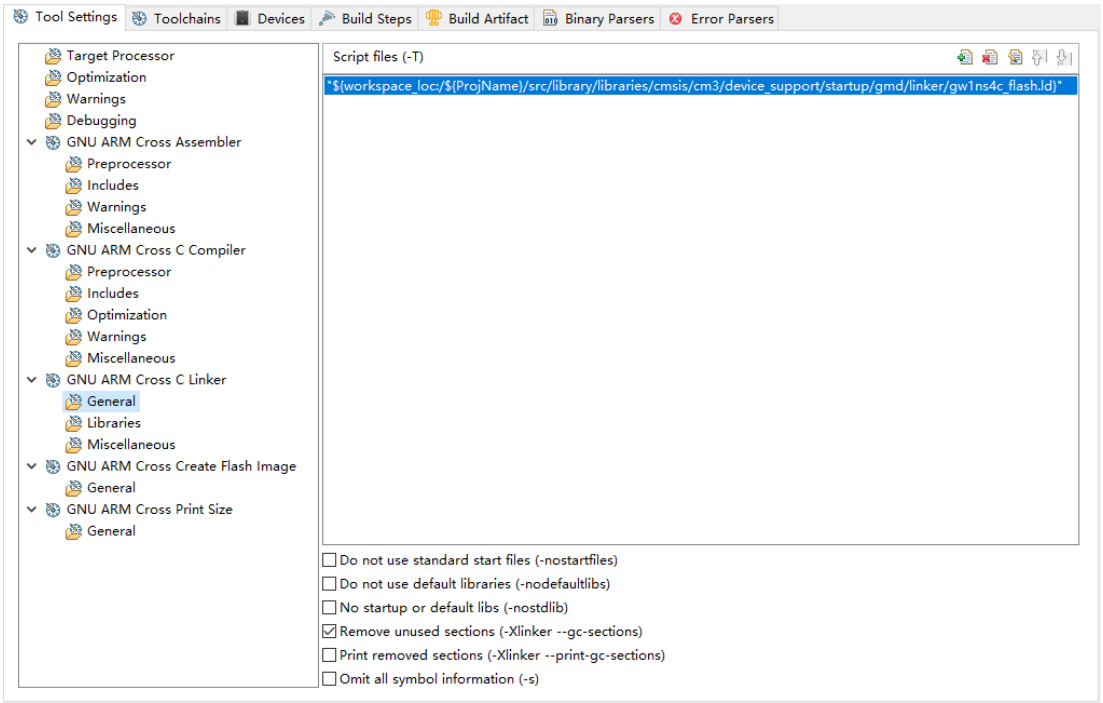
Take GMD_RefDesign\cm3_demo software programming reference design for an instance, the C header file paths are listed as follows.

- "${workspace_loc:/${ProjName}/src/library/libraries/cmsis/cm3/device_support}"
- "${workspace_loc:/${ProjName}/src/library/libraries/cmsis/cm3/core_support/gmd}"
- "${workspace_loc:/${ProjName}/src/library/libraries/drivers/inc}"
- "${workspace_loc:/${ProjName}/src/library/middlewares/delay}"
- "${workspace_loc:/${ProjName}/src/library/middlewares/dmm}"
- "${workspace_loc:/${ProjName}/src/library/middlewares/gpio}"
- "${workspace_loc:/${ProjName}/src/library/middlewares/hyper_ram}"
- "${workspace_loc:/${ProjName}/src/library/middlewares/psram}"
- "${workspace_loc:/${ProjName}/src/library/middlewares/spi_flash}"
- "${workspace_loc:/${ProjName}/src/library/middlewares/uart}"
- "${workspace_loc:/${ProjName}/src/project}"

GNU ARM Cross C Linker Configuration

Configure the "GNU ARM Cross C Linker > General > Script files (-T)" option, and "gw1ns4c_flash.ld" is used as the GMD Flash linker, as shown in Figure 2-7.

Figure 2-7 Cross ARM C Linker Configuration Options



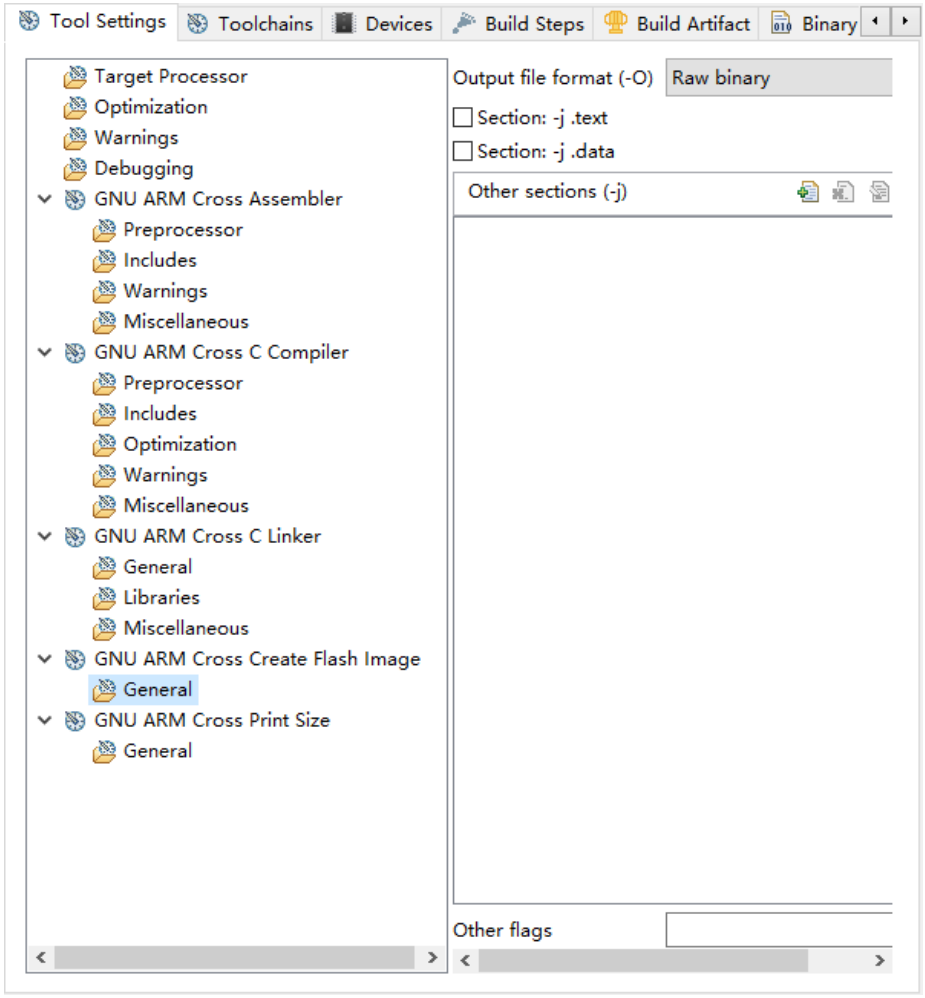
Take GMD_RefDesign\cm3_demo software programming reference design for an instance, the Flash linker configuration is as follows.

"${workspace_loc:/${ProjName}/src/library/libraries/cmsis/cm3/device_support/startup/gmd/linker/gw1ns4c_flash.ld}"

GNU ARM Cross Create Flash Image Configuration

Configure "Cross ARM GNU Create Flash Image > General > Output file format (-O)", and set this option as "RAW binary" to generate software programming Binary file, as shown in Figure 2-8.

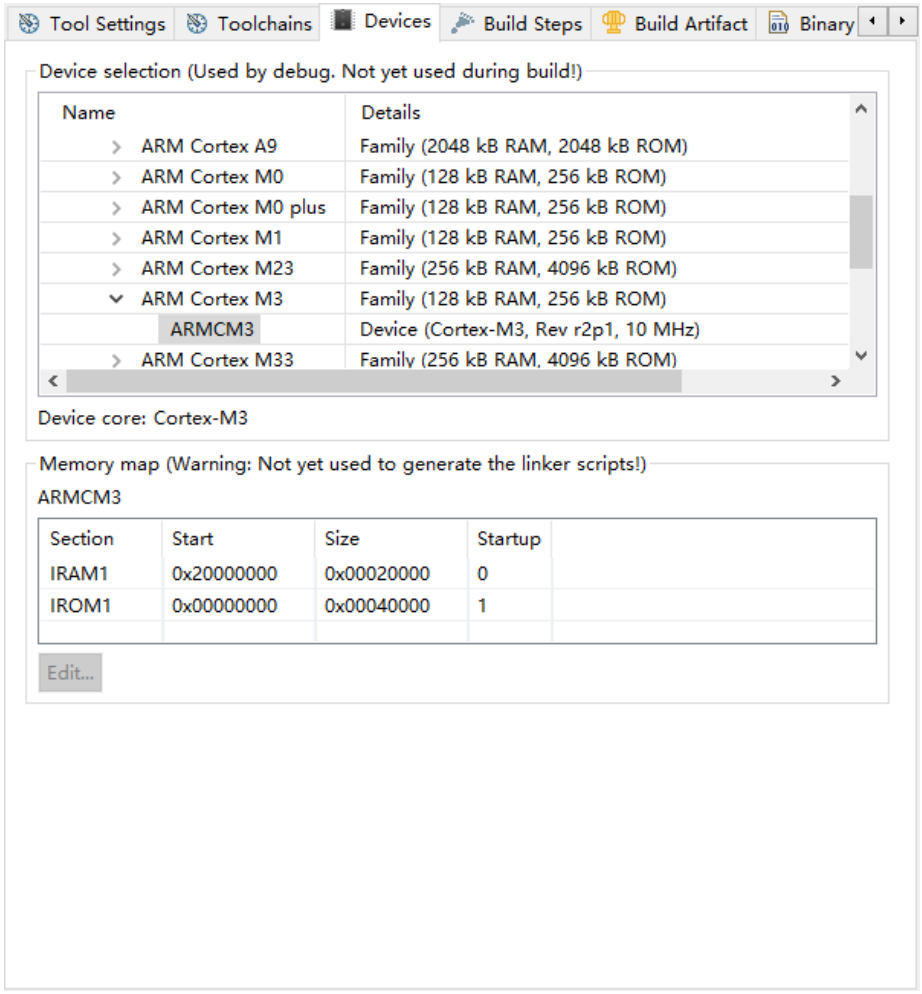
Figure 2-8 Cross ARM GNU Create Flash Image Configuration Option



Devices Configuration

Configure "Devices > Device selection" option, and set this option as "ARM Cortex M3 > ARMCM3" in, as shown in Figure 2-9.

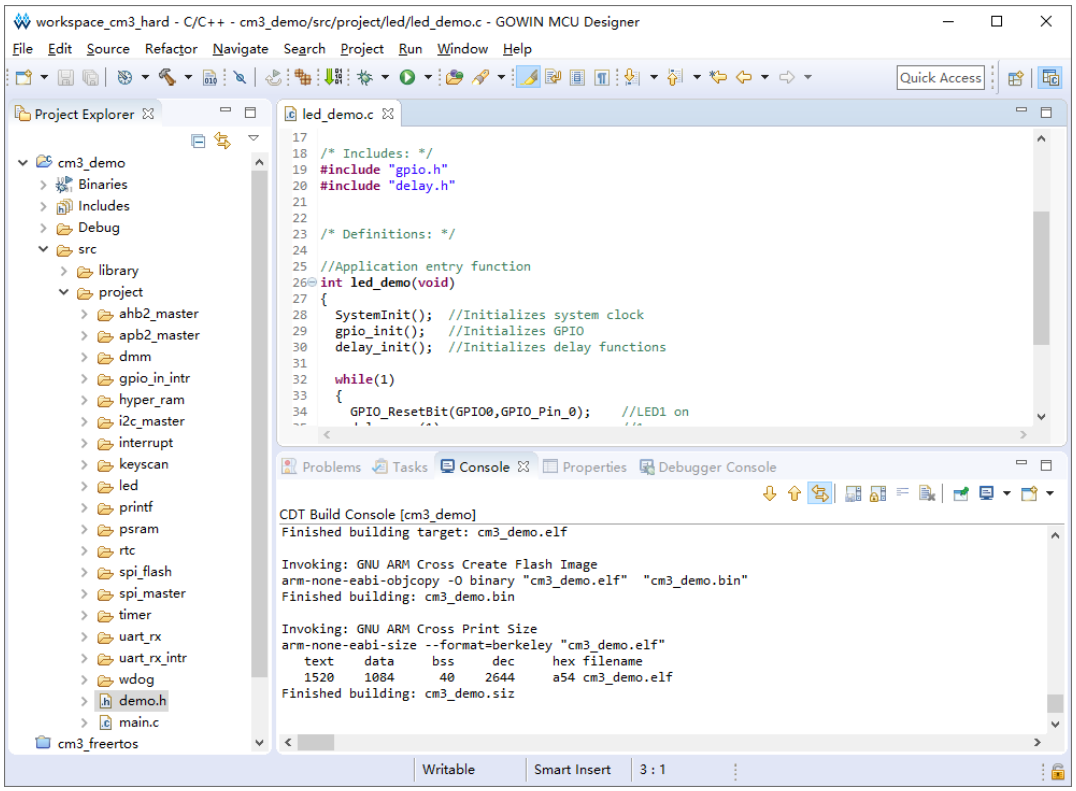
Figure 2-9 Devices Configuration Option



2.2.3 Build

After completing the project configuration and code writing, build the current project; click "Build" ( ) or "Build All" ( ) on the tool bar, or click "Project > Build Project" or "Project > Build All" on the menu bar to build to generate the software programming Binary file, as shown in Figure 2-10.

Figure 2-10 Build

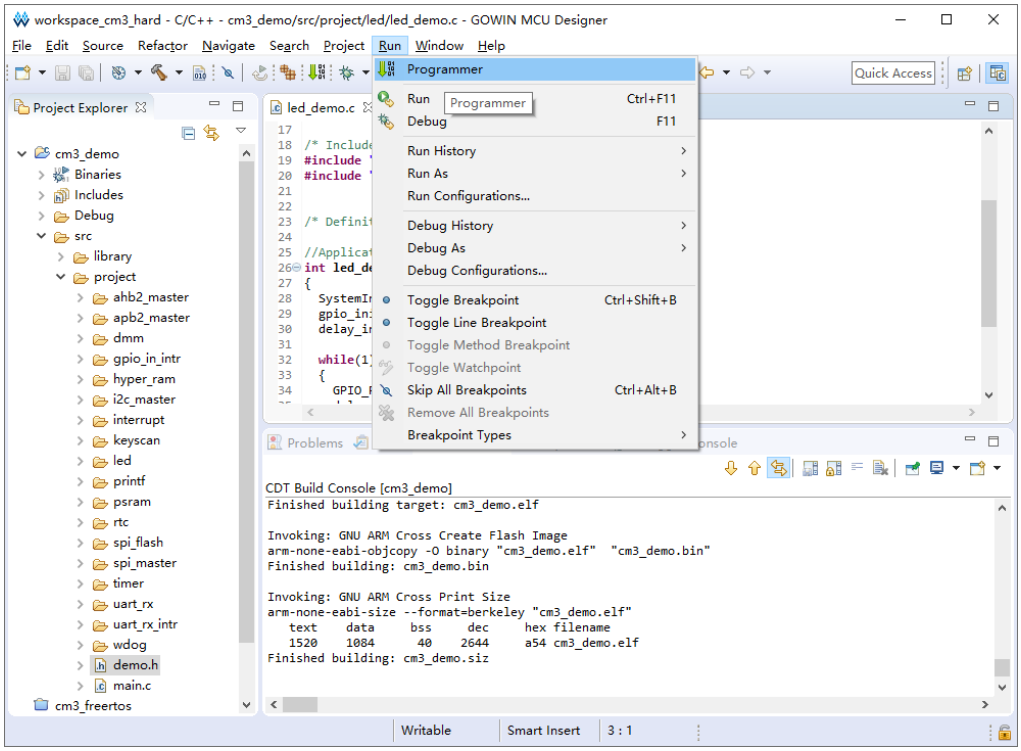


2.2.4 Download

Download software programming design BIN files using Programmer.

Click "Run> Programmer" on the GMD menu bar or Programmer "" on the tool bar to open Programmer, as shown in Figure 2-11.

Figure 2-11 Programmer Option

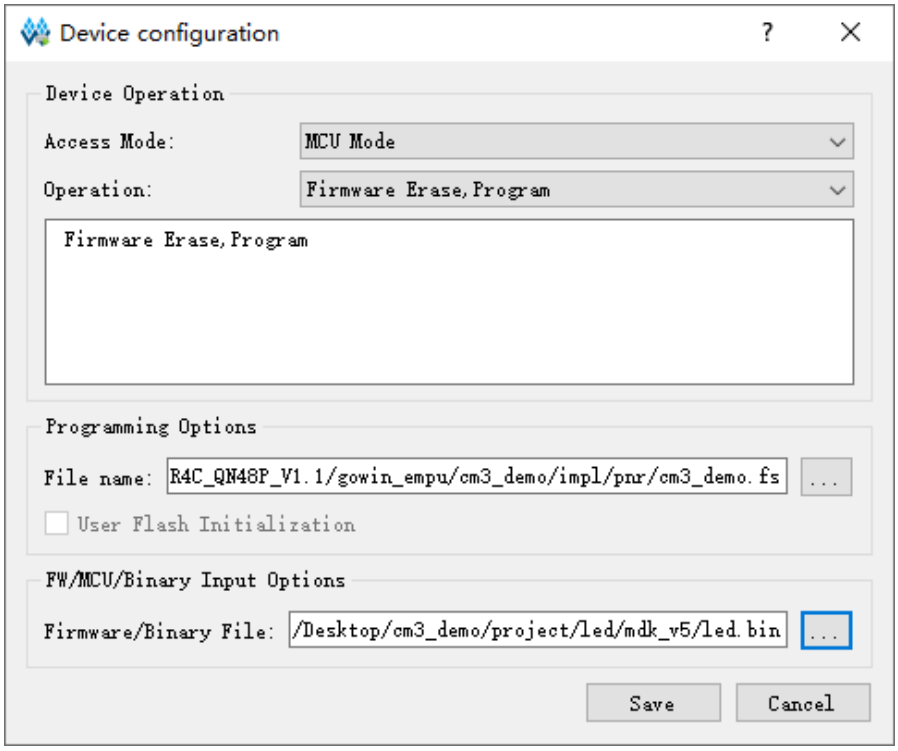


Click "Edit > Configure Device" on the menu bar or Configure Device "  " on the tool bar to open the "Device configuration".

If FPGA product GW1NS-4C/GW1NSR-4C is selected, configuration options are as shown in Figure 2-12.

- Select "MCU Mode" in "Access Mode" drop-down list.
- Select "Firmware Erase, Program" or "Firmware Erase, Program, Verify" in "Operation" drop-down list.

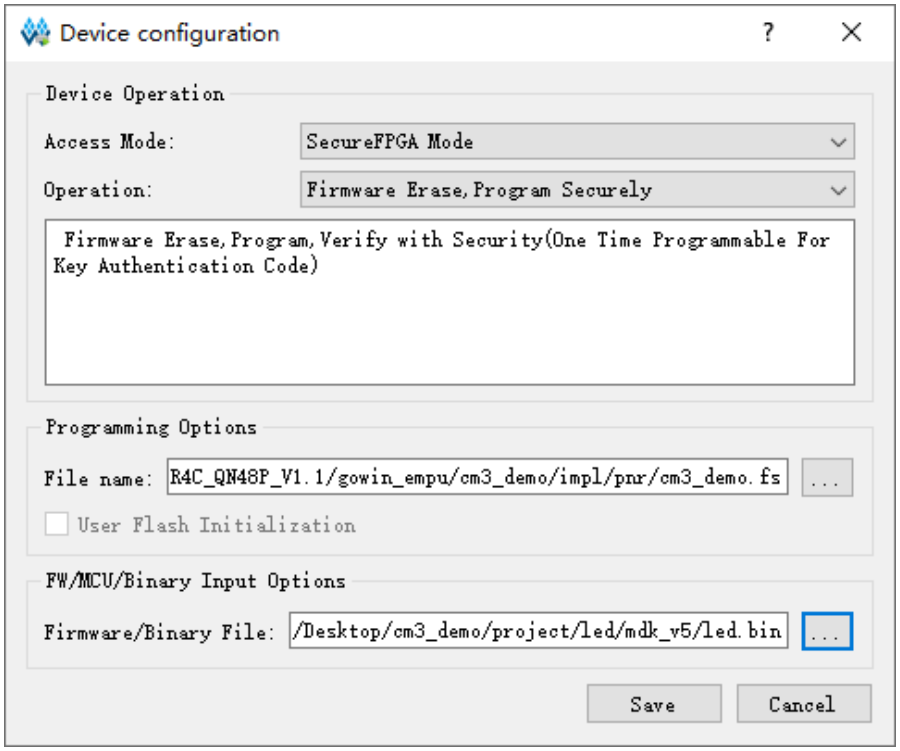
Figure 2-12 Configuration Options for GW1NS-4C/GW1NSR-4C



If FPGA product GW1NSER-4C is selected, configuration options are as shown in Figure 2-12.

- Select "SecureFPGA Mode" in "Access Mode" drop-down list.
- Select "Firmware Erase, Program Securely" in "Operation" drop-down list.

Figure 2-13 Configuration Options for GW1NSER-4C



- Import software programming BIN file in "FW/MCU/Binary Input Options > Firmware/Binary File".
- Click "Save" to complete the configuration.

Note!

Import hardware design bitstream in "Programming Options > File name", please refer to *IPUG932, Gowin_EMPU(GW1NS-4C) Hardware Design Reference Manual*.

After device configuration, click Program/Configure ( ) on the Programmer toolbar to complete the download of software programming Binary file and hardware bitstream file.

2.2.5 On-line Debug

After downloading software programming Binary file and hardware bitstream file, if there are any design issues, you can use J-LINK emulator to debug on-line (The on-line debug design must be same with the one downloaded to the chip) .

The single-step debug flow includes:

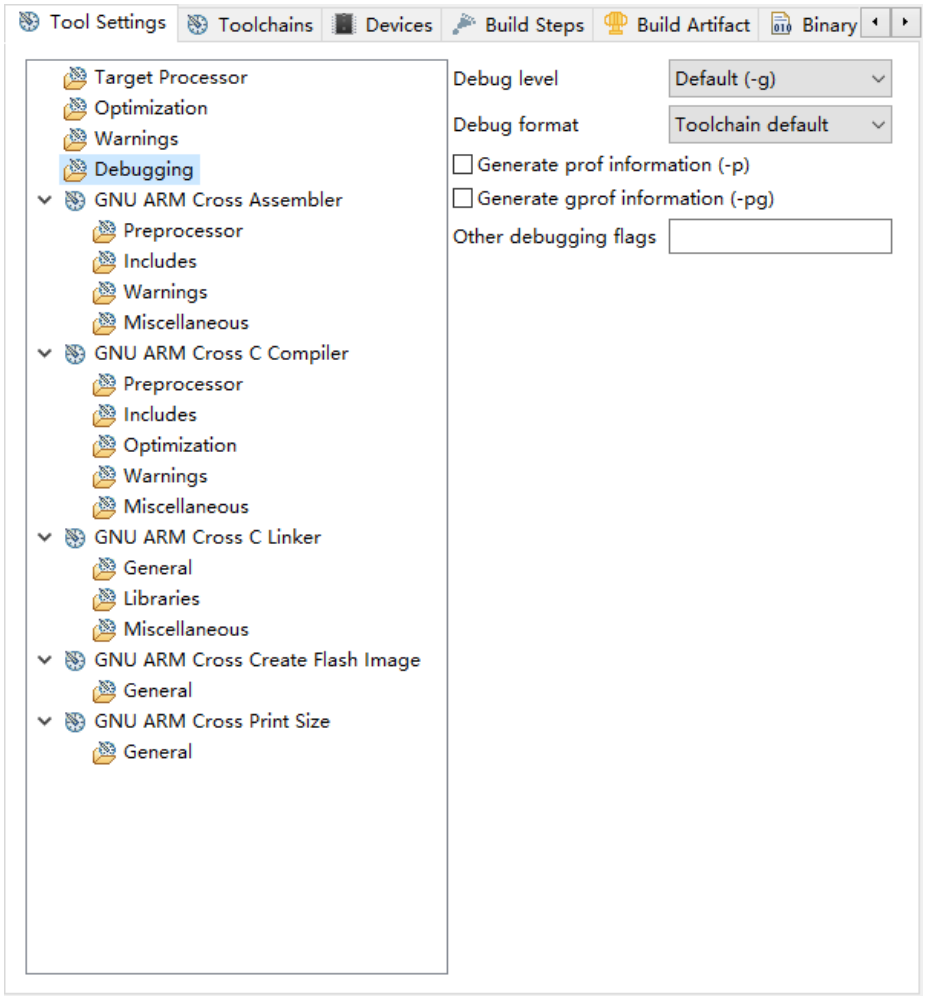
- Software debug level configuration
- Configure software debug
- MCU JTAG mode switch

- MCU JTAG interface switch
- Connect debug emulator
- Start software debug

Software Debug Level Configuration

In the Project Explorer view, select "Properties> C/C + + Build> Settings> Settings> Tool Settings> Debugging> Debug level", and the level Default(-g) or Maximum(-g3) is recommended, as shown in Figure 2-14.

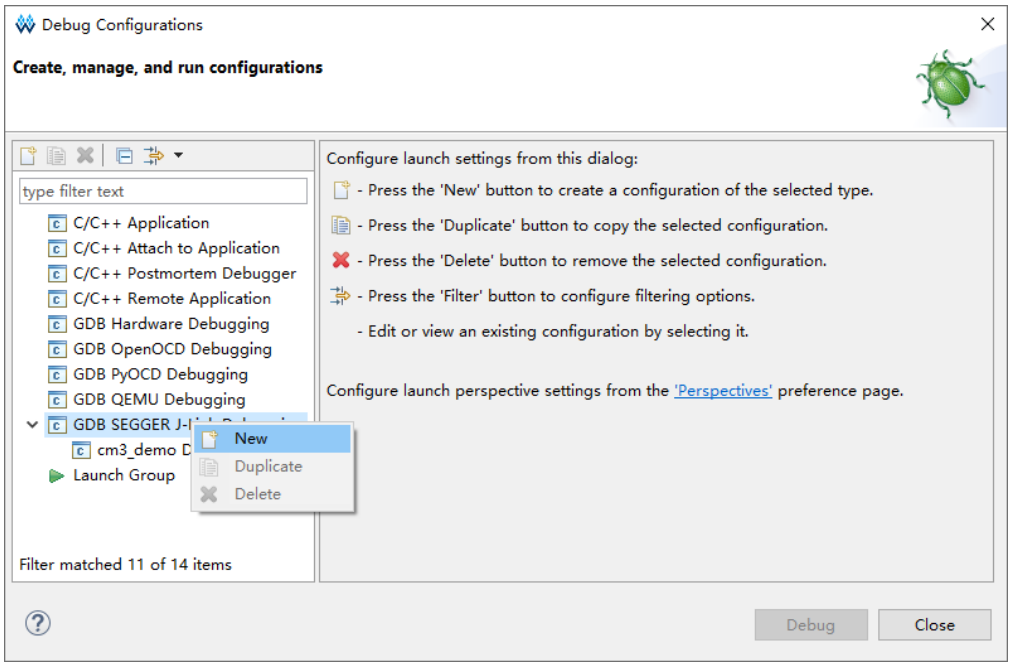
Figure 2-14 Software Debug Level Configuration



Software Debug Configuration Option

Select "Run > Debug Configurations > GDB SEGGER J-Link Debugging " and right-click "New" to create the project debug configuration options, as shown in Figure 2-15.

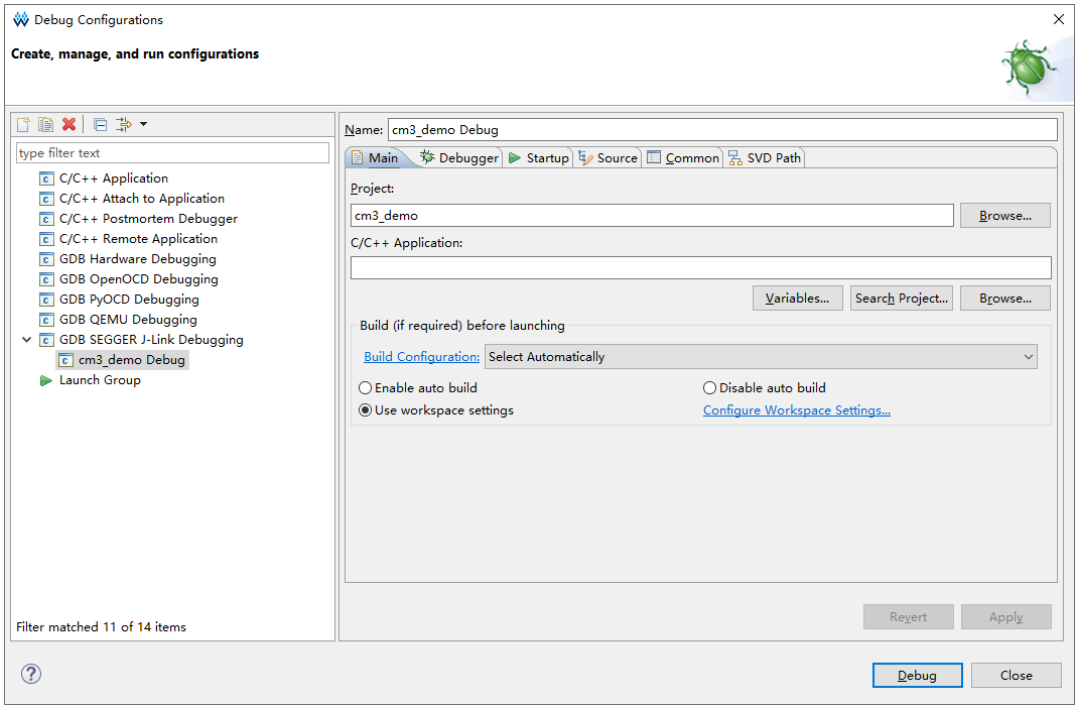
Figure 2-15 Software Debug Configuration Option



Select the created debug options.

1. Select "Main" to configure the Project and C/C++ Application options of the current debugging project, as shown in Figure 2-16.

Figure 2-16 Main Configuration Option



2. Select "Debugger" to configure the J-Link and GDB options of the

current debugging project, as shown in Figure 2-17.

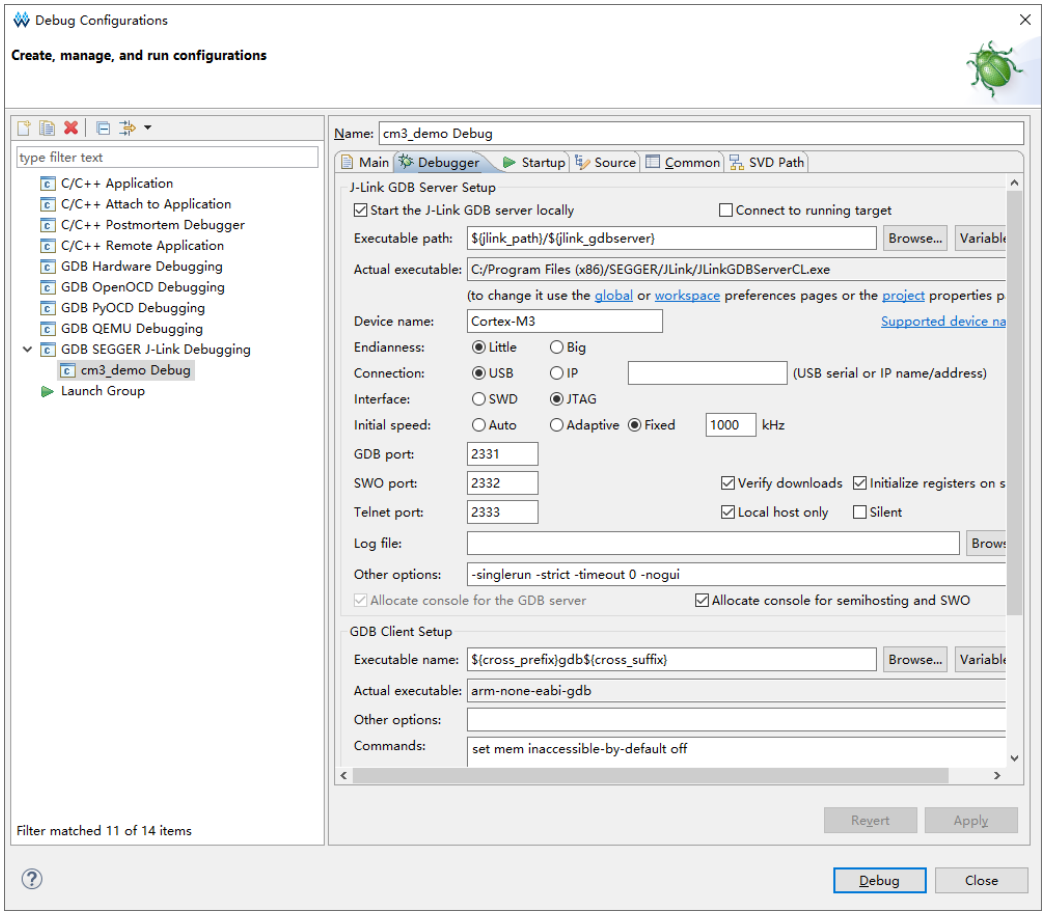
For example:

- Device Name: Cortex-M3
- Endianness: Little
- Connection: USB
- Interface: JTAG
- Connect to running target：Close
- Initial speed：Fixed 1000KHz
- GDB port：2331
- SWO port：2332
- Telnet：2333
- Verify downloads：Open
- Initialize registers on start：Open
- Local host only：Open
- Other options：-singlerun –strict –timeout 0 –nogui
- Command：set mem inaccessible-by-default off

Gowin_EMPU(GW1NS-4C) supports JTAG debug interface. SWD debug interface is not supported.

"Connect to running target" option is disabled.

Figure 2-17 Debugger Configuration Option



MCU JTAG Mode Switch

Switch JTAG mode from the download to debug mode using Programmer.

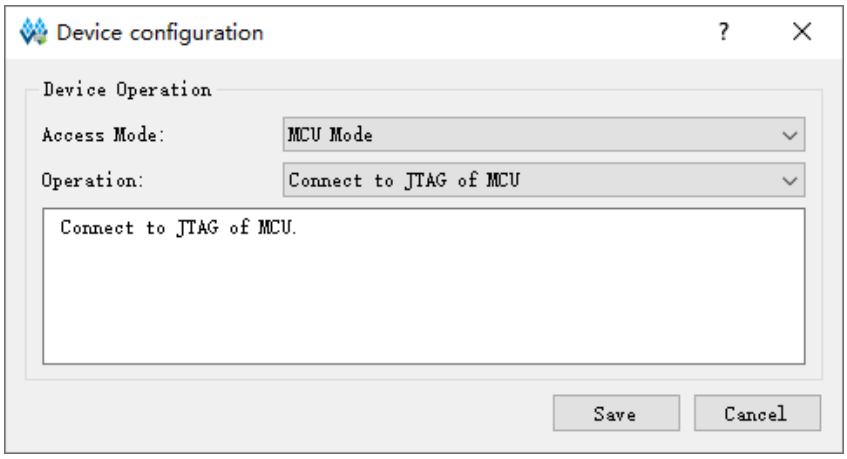
Click "Run> Programmer" on the GMD menu bar or Programmer "" on the tool bar to open Programmer as shown in 2-11.

Click "Edit > Configure Device" on the menu bar or "Configure Device " () on the tool bar to open the "Device configuration".

If FPGA product GW1NS-4C/GW1NSR-4C is selected, MCU JTAG mode configuration options are as shown in Figure 2-18.

- Select "MCU Mode" in "Access Mode" drop-down list.
- Select "Connect to JTAG of MCU" in "Operation" drop-down list.

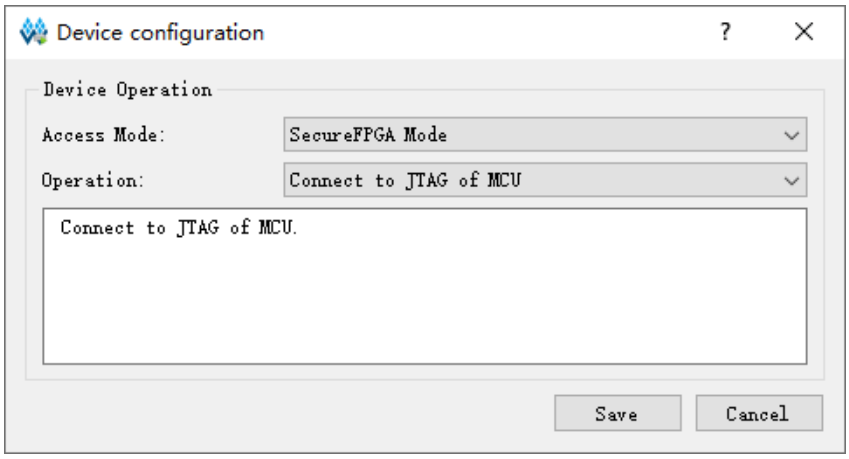
Figure 2-18 MCU JTAG Mode Configuration for GW1NS-4C/GW1NSR-4C



If FPGA product GW1NSER-4C is selected, MCU JTAG mode configuration options are as shown in Figure 2-19.

- Select "SecureFPGA Mode" in "Access Mode" drop-down list.
- Select "Connect to JTAG of MCU" in "Operation" drop-down list.

Figure 2-19 MCU JTAG Mode Configuration for GW1NSER-4C



- Click "Save" to complete the configuration.

After device configuration, click "Program/Configure" ( ) in the Programmer tool bar to complete MCU JTAG mode switch.

MCU JTAG Interface Switch

Taking DK-START-GW1NSR4C-QN48G V1.1 for an instance, switch SW3, SW4, SW5, SW6 (TCK, TDO, TDI, and TMS of JTAG interface) on the development board from "FT232" (Download to "J-LINK" (debug).

Note!

- The development board must be kept on power in MCU JTAG mode and interface

switch.

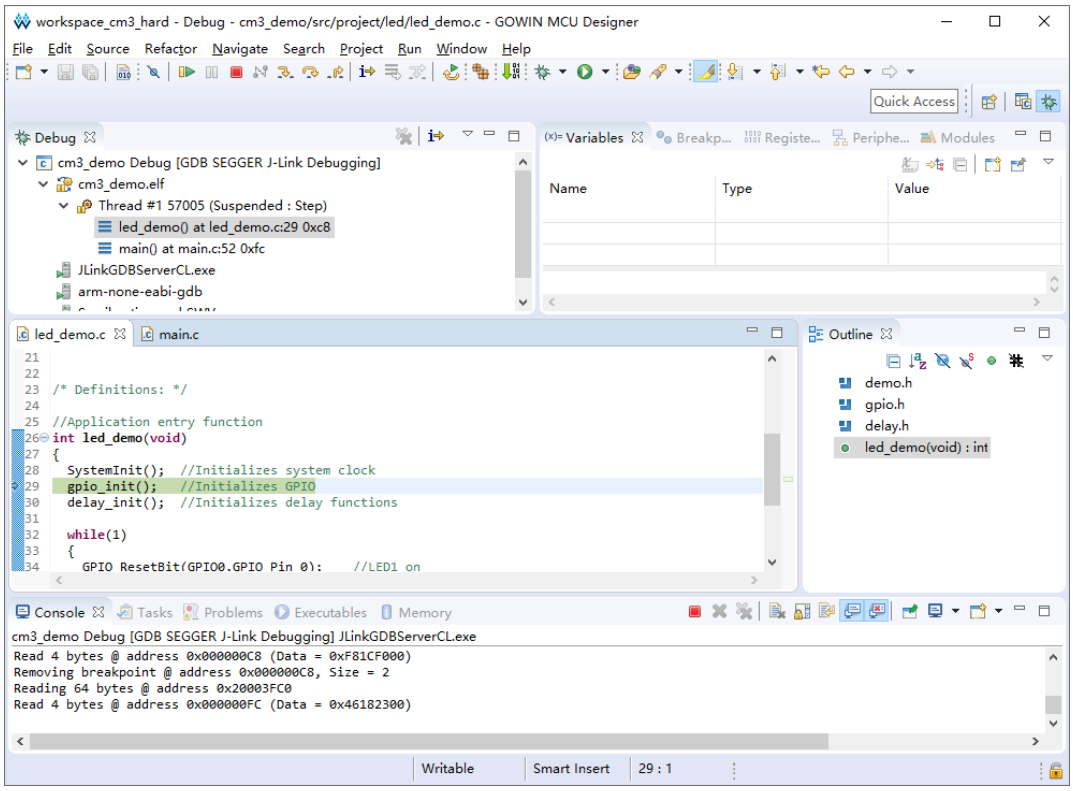
- If the development board powers off in the process, it will restore to MCU JTAG download mode automatically after power on.

Start Software Debug

Connect J-LINK emulator.

You can perform operations of breakpoint setting, single-step debug, reset, run, etc. by clicking Debug "  ", as shown in Figure 2-20.

Figure 2-20 Start Software Debug



2.3 Reference Design

Gowin_EMPU(GW1NS-4C) supports reference design in GMD (tested software version V1.2), and you can click here to get the following reference design:

…\ref_design\MCU_RefDesign\GMD_RefDesign\cm3_demo、cm3_freertos、cm3_rtthread_nano、cm3_ucos_iii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