GigaDevice Semiconductor Inc.

基于 GD32F3x0 系列的 IEC60730 ClassB 库移植指南

应用笔记

AN171

1.0 版本

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1. 简介

GD32 MCU提供IEC60730 ClassB认证库支持，对于每个系列的GD32 MCU，都会提供常用系列的工程模板，用户在对同一系列不同型号的芯片进行IEC60730自检认证时，可通过移植模板程序来适配目标芯片。本应用笔记将详细介绍GD32F3x0系列芯片在不同IDE（Keil/IAR/eclipse）下，移植过程中的注意事项，帮助客户移植IEC60730 ClassB认证库。

2. IEC60730 ClassB 认证库移植

GD32 MCU提供IAR、Keil、eclipse环境下的IEC60730 ClassB认证库支持，三种开发环境下模板工程的移植存在差异。下面将从三种开发环境展开说明。

本应用笔记基于GD32F350RB进行工程移植说明。

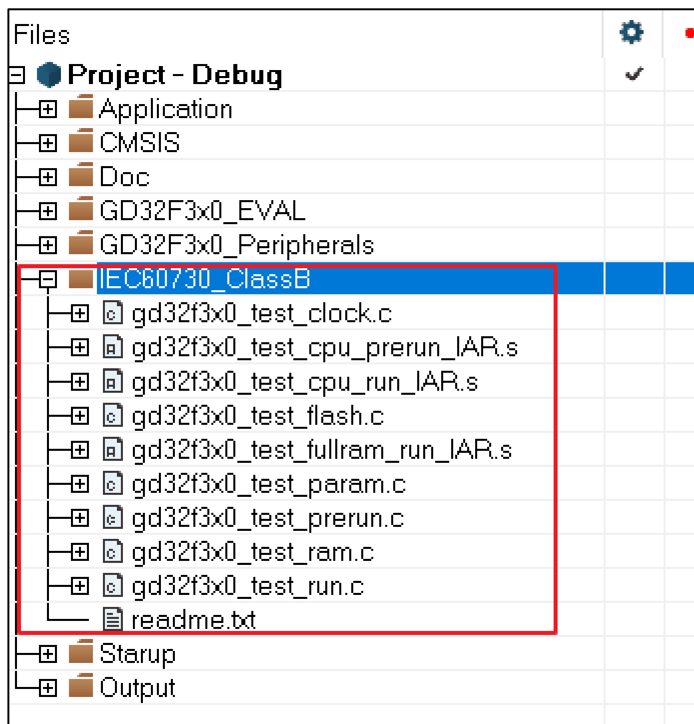
2.1. IAR 环境认证库工程移植

1、根据芯片数据手册修改gd32f3x0_test.h文件中编译宏__IAR_SYSTEMS_ICC__下的RAM边界，如*图2-1. 修改gd32f3x0_test.h中RAM边界*所示。

图 2-1. 修改 gd32f3x0_test.h 中 RAM 边界

```
#ifdef __IAR_SYSTEMS_ICC__

extern uint32_t __ICFEDIT_region_ROM_start__;
extern uint32_t __ICFEDIT_region_ROM_end__;
extern uint32_t __ICFEDIT_region_RAM_start__;
extern uint32_t __ICFEDIT_region_RAM_end__;
extern uint32_t __ICFEDIT_region_IECTEST_PARAM_start__;
extern uint32_t __ICFEDIT_region_IECTEST_PARAM_end__;

#define FLASH_START                (unsigned int *)&__ICFEDIT_region_ROM_start__
#define FLASH_SIZE                 (unsigned int)&__ICFEDIT_region_ROM_end__ -(unsigned int)&__ICFEDIT_region_ROM_start__ + 1 /* FLASH_SIZE in byte */
#define FLASH_SIZE_WORDS           ((uint32_t)&__ICFEDIT_region_ROM_end__ -(uint32_t)&__ICFEDIT_region_ROM_start__ + 1)/4     /* FLASH_SIZE in words */
#define FLASH_END                  ((uint32_t *)(&__ICFEDIT_region_ROM_end__))

#define FLASH_BLOCK_SIZE           ((uint32_t)512uL)
#define FLASH_BLOCKNUM             (uint32_t)((FLASH_SIZE) / FLASH_BLOCK_SIZE)
#define FLASH_BLOCKNUM_WORDS       ((uint32_t)(FLASH_SIZE_WORDS / FLASH_BLOCK_SIZE))

#define RAM_START                  (uint32_t *)0x20000000
#define RAM_END                    (uint32_t *)0x20003F40

#define IEC_TEST_PARAM_START       ((uint32_t *)(&__ICFEDIT_region_IECTEST_PARAM_start__))
#define IEC_TEST_PARAM_END         ((uint32_t *)(&__ICFEDIT_region_IECTEST_PARAM_end__))

extern void __iar_program_start(void);
extern void Reset_Handler(void);
#define DefaultSystemStartUp() Reset_Handler()

void test_fail_reset(void);

#endif /* __IAR_SYSTEMS_ICC__ */
```

图 2-2. 添加 ClassB 库文件到 IAR 工程



若启动文件符合当前芯片型号，则无需修改；若不符合，则需要在固件库文件夹GD32F3x0_Firmware_Library\CMSIS\GD\GD32F3x0\Source\ARM下，重新选择符合当前芯片类型的.s启动文件，并如*图2-3. 修改.s启动文件*所示进行修改，使芯片上电之后先进行自检测。

图 2-3. 修改.s 启动文件

```
        MODULE  ?cstartup

        ;; Forward declaration of sections.
        SECTION CSTACK:DATA:NOROOT(3)

        SECTION .intvec:CODE:NOROOT(3)

        EXTERN  test_prerun

        EXTERN  __iar_program_start
        EXTERN  SystemInit
        PUBLIC  __vector_table

        DATA
__vector_table
        DCD     sfe(CSTACK)                        ; top of stack
        DCD     test_prerun                        ; Vector Number 1,test_prerun

        DCD     NMI_Handler                        ; Vector Number 2,NMI Handler
        DCD     HardFault_Handler                  ; Vector Number 3,Hard Fault Handler
        DCD     MemManage_Handler                  ; Vector Number 4,MPU Fault Handler
        DCD     BusFault_Handler                   ; Vector Number 5,Bus Fault Handler
        DCD     UsageFault_Handler                 ; Vector Number 6,Usage Fault Handler
        DCD     0                                  ; Reserved
        DCD     0                                  ; Reserved
        DCD     0                                  ; Reserved
        DCD     0                                  ; Reserved
        DCD     SVC_Handler                        ; Vector Number 11,SVCall Handler
        DCD     DebugMon_Handler                   ; Vector Number 12,Debug Monitor Handler
        DCD     0                                  ; Reserved
        DCD     PendSV_Handler                     ; Vector Number 14,PendSV Handler
        DCD     SysTick_Handler                    ; Vector Number 15,SysTick Handler
```

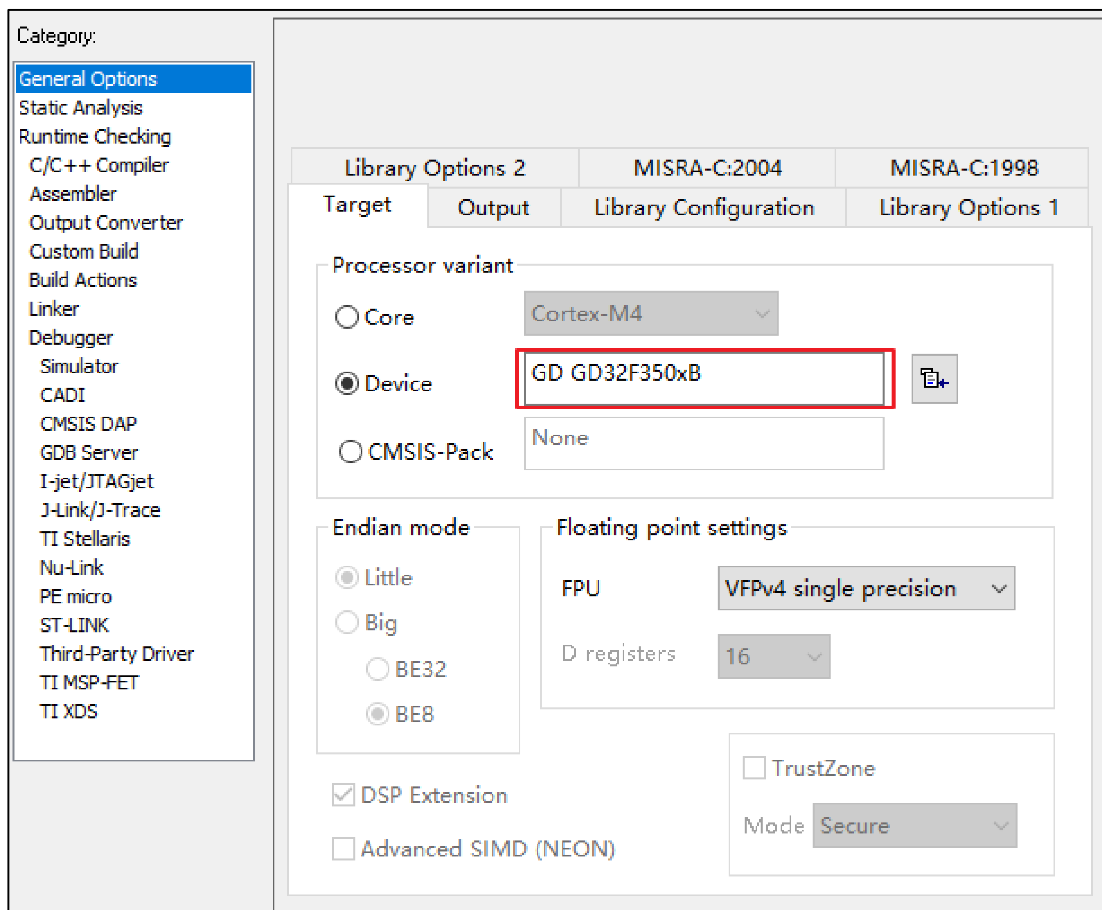
2、修改工程所在文件夹（在本例中为：..\GD32F3x0_IEC_Test\GD32350R_EVAL_Demo_Suites\Projects\IEC_Test\EWARM）下的IEC_TEST_BOOT_FLASH.icf文件，如图2-4. 修改分散加载文件所示为修改的部分，根据芯片数据手册修改Flash和RAM的大小适配当前芯片。

图 2-4. 修改分散加载文件

```
1  /*###ICF### Section handled by ICF editor, don't touch! ****/
2  /*-Editor annotation file-*/
3  /* IcfEditorFile="$TOOLKIT_DIR$\config\ide\IcfEditor\cortex_v1_0.xml" */
4  /*-Specials-*/
5  define symbol __ICFEDIT_intvec_start__ = 0x08000000;
6  /*-Symbols-*/
7  define symbol __ICFEDIT_region_ROM_start__          = 0x08000000;
8  define symbol __ICFEDIT_region_ROM_end__            = 0x0801FFFF;
9  define symbol __ICFEDIT_region_RAM_start__          = 0x200000B0;
10 define symbol __ICFEDIT_region_RAM_end__            = 0x20003FFF;
11 define symbol __ICFEDIT_region_IECTEST_PARAM_start__ = 0x20000040;
12 define symbol __ICFEDIT_region_IECTEST_PARAM_end__   = 0x200000B0;
```

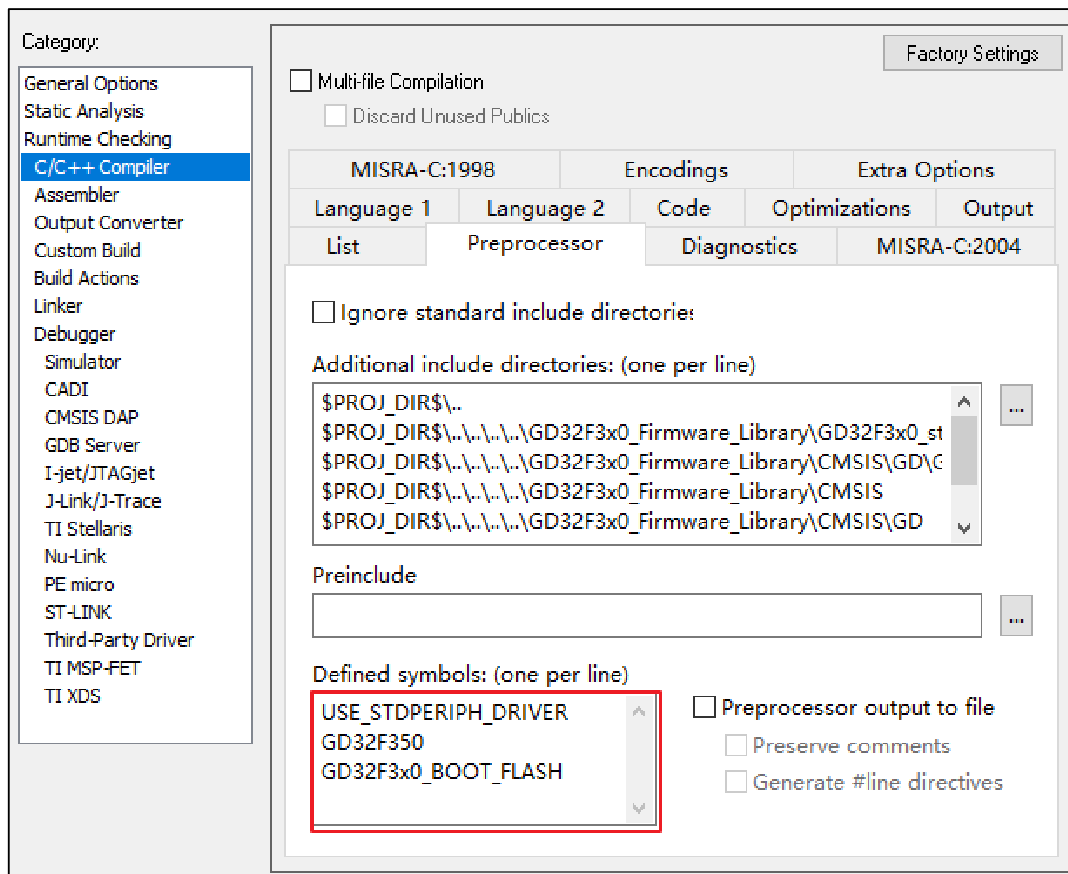
3、修改Options for node ‘Project’中Target的配置，选择当前芯片的型号，如图2-5. Device配置所示：

图 2-5. Device 配置



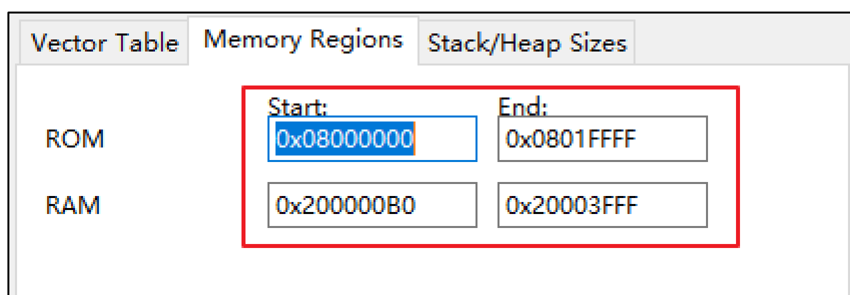
4、在Options for node ‘Project’->C/C++ Complier->Preprocessor中添加当前工程需要的预编译宏，主要修改符合当前芯片类型的预编译宏，如图2-6. 修改预编译宏所示：

图 2-6. 修改预编译宏



5、点击Options for node 'Project'->Linker->config->Edit->Memory Regions，根据当前芯片的数据手册修改ROM (Flash)和RAM的边界值，如*图2-7. 修改工程设置中的边界值*所示。

图 2-7. 修改工程设置中的边界值



6、在Options for node 'Project'->Linker->Checksum中，修改End address为Flash大小，如*图2-8. 修改工程属性中的Checksum配置*所示，在Extra Options选项卡中添加“--keep __checksum”。

图 2-8. 修改工程属性中的 Checksum 配置

Config | Library | Input | Optimizations | Advanced | Output | List
#define | Diagnostics | Checksum | Encodings | Extra Options

☑ Fill unused code memory
Fill pattern: 0xFF
Start address: 0x8000000 End address: 0x801FFFF
☑ Generate checksum
Checksum size: 4 bytes Alignment: 4
Algorithm CRC polynomia 0x4C11DB7
☐ Result in full size
Initial value: 0xFFFFFFFF
Complement: As is
Bit order: MSB first
☐ Use as input
☐ Reverse byte order within word
Checksum unit size: 32-bit

图 2-9. 在 Extra Options 选项卡中添加配置

Config | Library | Input | Optimizations | Advanced | Output | List
#define | Diagnostics | Checksum | Encodings | Extra Options

☑ Use command line options
Command line options: (one per

```
--keep __checksum
```

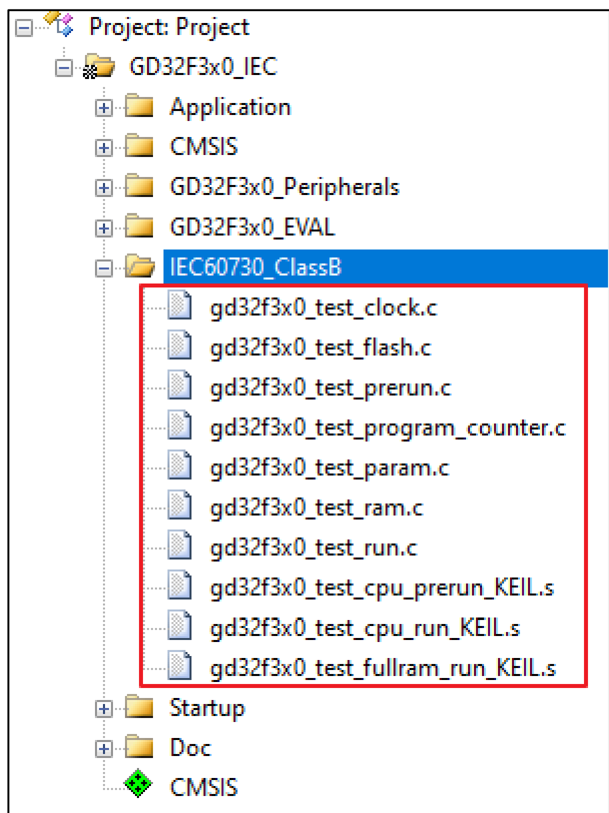
2.2. Keil 环境认证库工程移植

1、根据当前芯片型号的数据手册修改gd32f3x0_test.h文件中RAM和Flash边界，如*图2-10. 修改gd32f3x0_test.h文件中RAM和Flash边界*所示。

图 2-10. 修改 gd32f3x0_test.h 文件中 RAM 和 Flash 边界

```
#if defined (__ARMCC_VERSION) && (__ARMCC_VERSION >= 6010050)

#define FLASH_START                  ((uint32_t *)0x08000000)
#define FLASH_SIZE                   ((uint32_t)0x00020000 - 4)
#define FLASH_SIZE_WORDS             (uint32_t)(((uint32_t)FLASH_END-(uint32_t)FLASH_START)/4)
#define FLASH_END                    ((uint32_t *)0x08020000)

#define FLASH_BLOCK_SIZE             ((uint32_t)512uL)
#define FLASH_BLOCKNUM               (uint32_t)(((uint32_t)FLASH_END-(uint32_t)FLASH_START) / FLASH_BLOCK_SIZE)
#define FLASH_BLOCKNUM_WORDS         (uint32_t)((FLASH_SIZE_WORDS) / FLASH_BLOCK_SIZE)

#define IEC_TEST_PARAM_START         ((uint32_t *)0x20000040)
#define IEC_TEST_PARAM_END           ((uint32_t *)0x200000B0)

#define RAM_START                    (uint32_t *)0x20000000
#define RAM_END                      (uint32_t *)0x20003F40

extern void Reset_Handler(void);
#define DefaultSystemStartUp()  Reset_Handler()
void test_fail_reset(void);

#endif /* (__ARMCC_VERSION) && (__ARMCC_VERSION >= 6010050) */
```

图 2-11. 添加 ClassB 库文件到 Keil 工程



若启动文件适用当前芯片型号，则无需修改；否则需要在固件库文件夹GD32F3x0_Firmware_Library\CMSIS\GD\GD32F3x0\Source\ARM下，重新选择适用当前芯片型号的.s启动文件，并做如下代码中红色标注所示修改：

```
Stack_Size      EQU     0x00000400
```

```
                AREA      STACK, NOINIT, READWRITE, ALIGN=3
Stack_Mem        SPACE     Stack_Size
__initial_sp


; <h> Heap Configuration
;    <o>    Heap Size (in Bytes) <0x0-0xFFFFFFFF:8>
; </h>

Heap_Size        EQU       0x00000400

                AREA      HEAP, NOINIT, READWRITE, ALIGN=3
__heap_base
Heap_Mem          SPACE     Heap_Size
__heap_limit

        IMPORT    test_prerun

                PRESERVE8
                THUMB

;               /* reset Vector Mapped to at Address 0 */
                AREA      RESET, DATA, READONLY
                EXPORT    __Vectors
                EXPORT    __Vectors_End
                EXPORT    __Vectors_Size

__Vectors       DCD       __initial_sp              ; Top of Stack
                DCD       test_prerun               ; Reset Handler --> test_prerun
                DCD       NMI_Handler               ; NMI Handler
                 ......
                 ......
                 ......
                DCD       USBFS_IRQHandler          ; 83:USBFS

__Vectors_End

                AREA CHECKSUM, DATA, READONLY, ALIGN=2
                EXPORT __Check_Sum
                ALIGN
__Check_Sum           DCD 0xEEF15A05
```

```
__Vectors_Size  EQU     __Vectors_End - __Vectors

                AREA    |.text|, CODE, READONLY

;/* reset Handler */
Reset_Handler   PROC
                ......
                ......
                ......
```

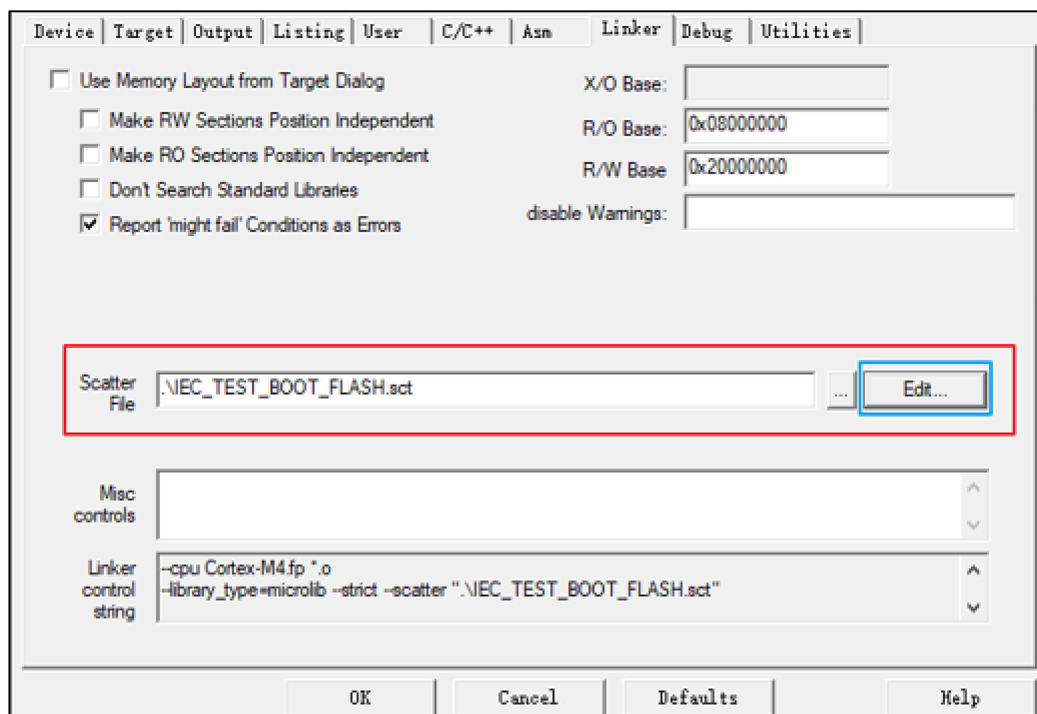
2、修改分散加载文件IEC_TEST_BOOT_FLASH.sct中的代码，如下表红色标注为需要修改的部分（根据当前芯片的数据手册修改Flash边界；修改与.s启动文件相对应.o文件的名称）：

```
; *************************************************************
; *************************************************************
; *** Scatter-Loading Description File generated by uVision ***
; *************************************************************

LR_IROM1 0x08000000 0x0001FFF8{
    ER_IROM1 0x08000000   0x0001FFF8{
        *.o (RESET, +First)
        *(InRoot$$Sections)
        .ANY (+RO)
    }

                ......
                ......
                ......

    ; RW data
    RW_IRAM1 0x200000B0   0x0002000
    {
        .ANY (+RW +ZI)
    }

    ; stack overflow test
    STACK_IRAM2 0x200020B0 UNINIT 0x00001F40
    {
        gd32f3x0_test_param.o (STACK_OV_TEST, .bss.STACK_OV_TEST)
```

```
            startup_gd32f3x0.o (STACK, +Last)
        }
    }

    LR_IROM2 0x0801FFFC 0x0000004 {
        ER_IROM2 0x0801FFFC 0x0000004
        {
            *.o (CHECKSUM, +Last)
        }
    }
```

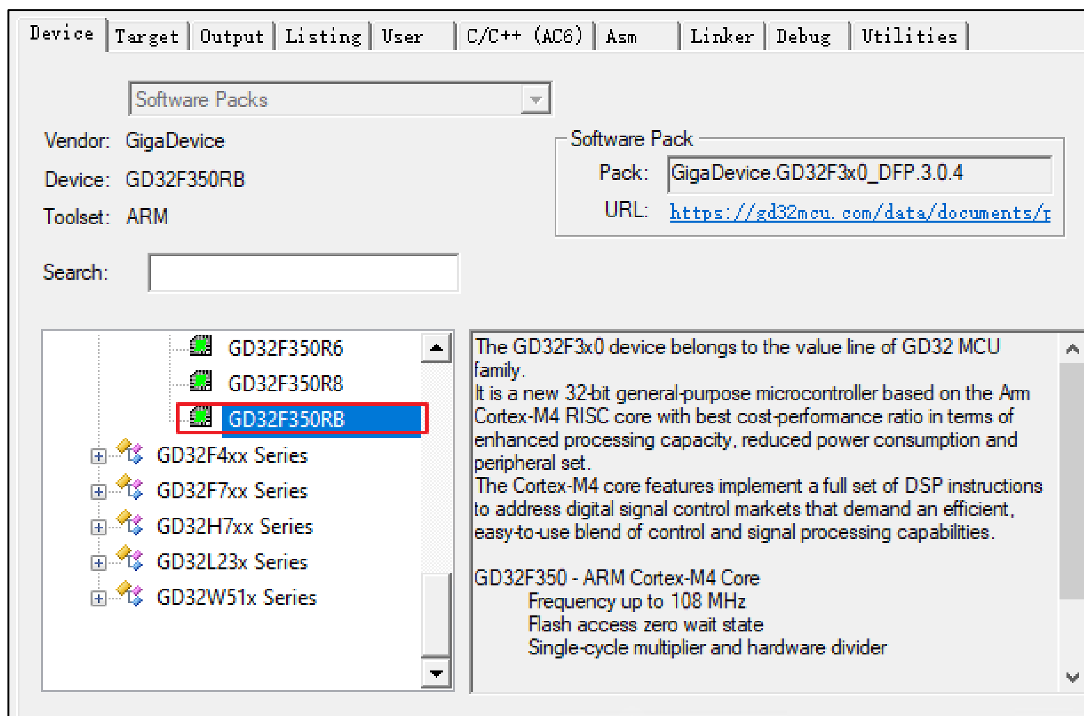
分散加载文件可在“Options for Target -->Linker-->Scatter File”中点击Edit按钮即可修改，如*图 2-12. 编辑分散加载文件*所示：

图 2-12. 编辑分散加载文件



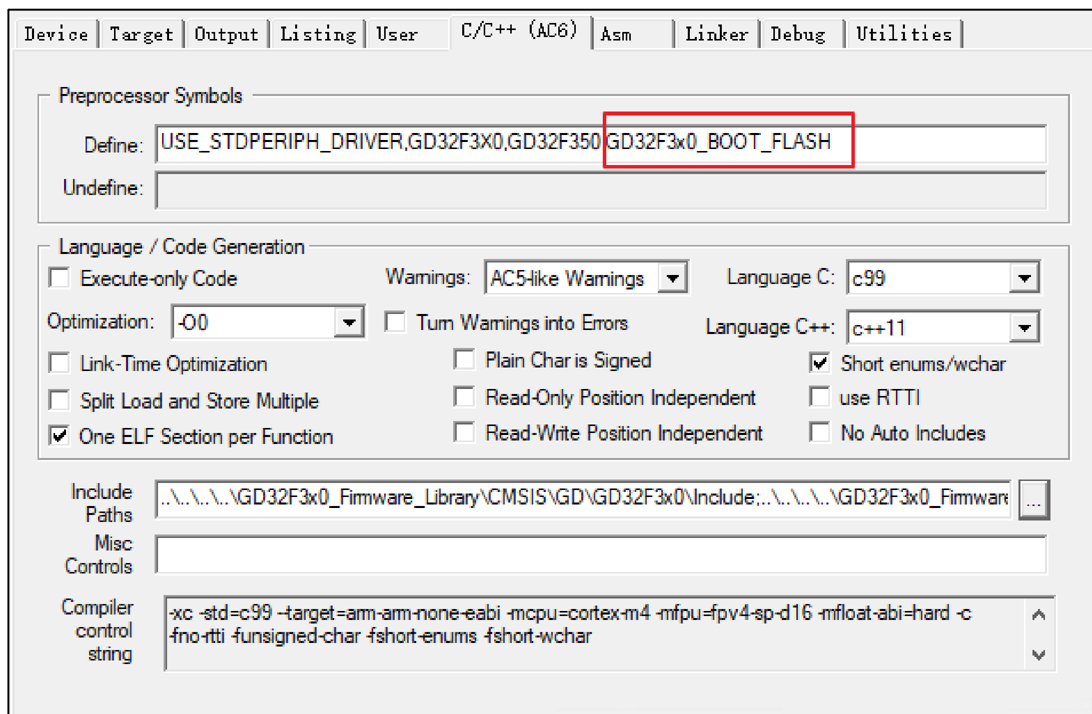
3、修改“Options for Target中DEVICE”的配置，选择当前芯片的型号，如*图2-13. Device配置*所示：

图 2-13. Device 配置



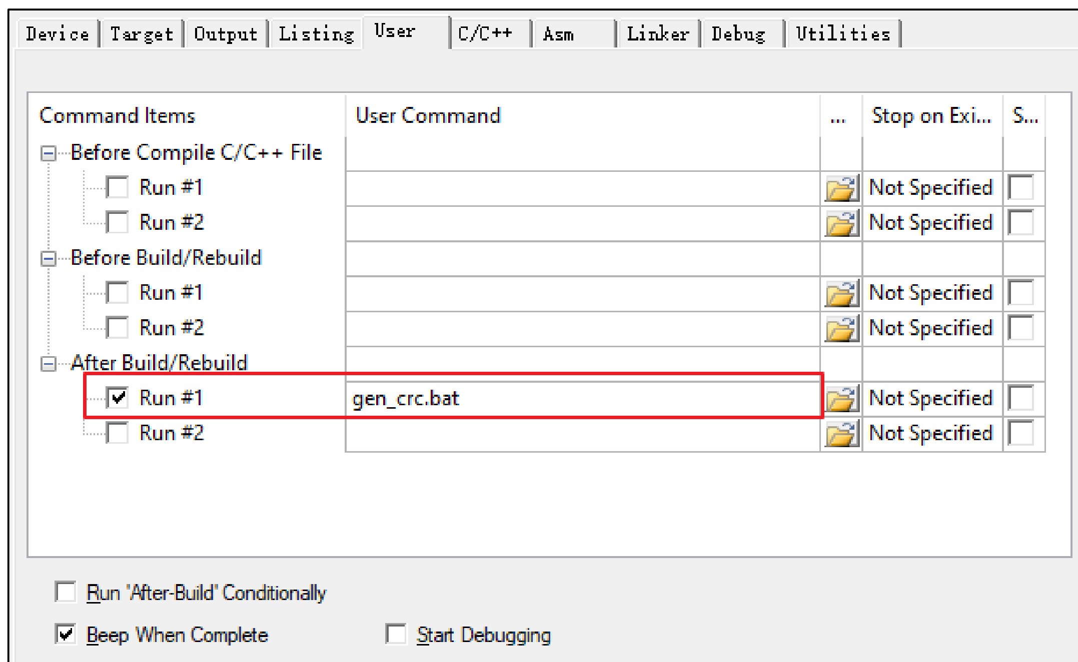
4、在Options for Target->C/C++->Preprocessor Symbols中添加当前工程需要的预编译宏与当前芯片一致，如*图2-14. 修改预编译宏*所示：

图 2-14. 修改预编译宏



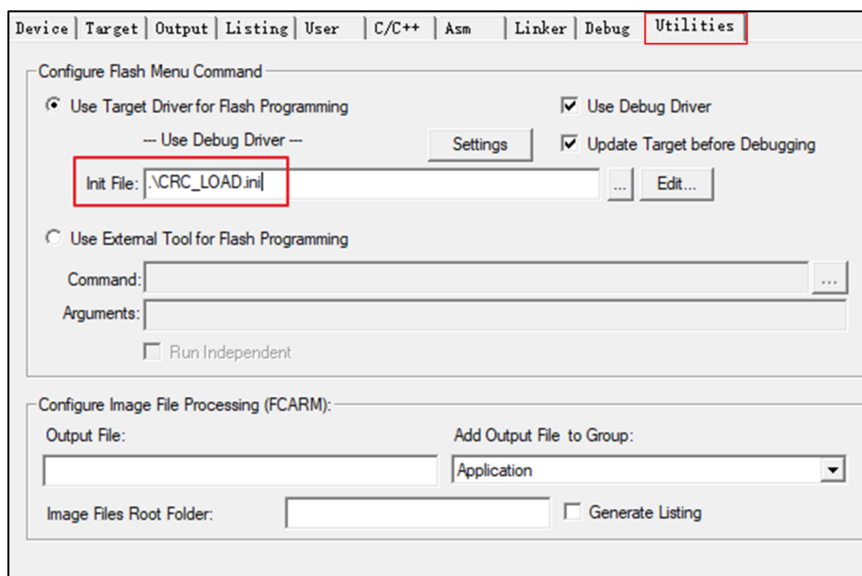
5、当需要使用批处理自动计算CRC时，需要添加gen_crc.bat文件，具体如*图2-15. 添加批处理文件*。

图 2-15. 添加批处理文件



6、最后，在Utilities选项卡中选择CRC_LOAD.ini，具体如*图2-16. 添加.ini配置文件*所示。

图 2-16. 添加.ini 配置文件



2.3. eclipse 环境认证库工程移植

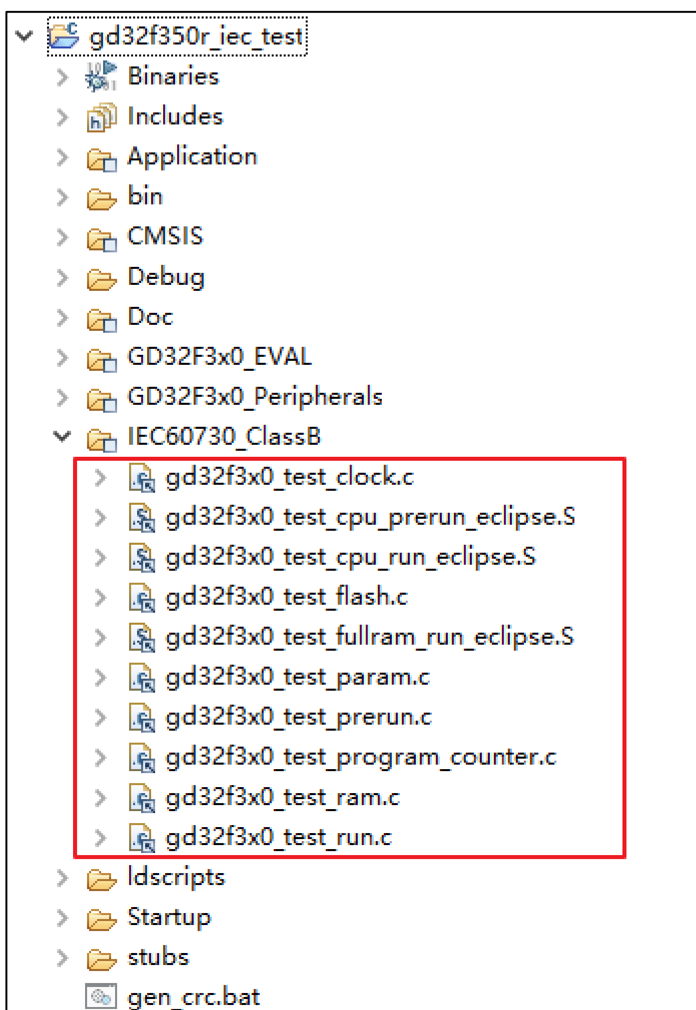
认证库工程在各个环境下的移植步骤类似，但是各开发环境下的编译链有所区别，导致 RAM 和 Flash 边界设置有所不同，eclipse 环境下的移植步骤如下：

1、根据芯片数据手册修改gd32f3x0_test.h文件中编译宏__GNU__下的RAM边界，保证芯片的Flash和RAM全部空间得到检测，如*图2-17. 修改gd32f3x0_test.h中RAM边界*所示。

图 2-17. 修改 gd32f3x0_test.h 中 RAM 边界

```
#if (!defined (__ARMCC_VERSION)) && (defined (__GNUC__))

#define FLASH_START               ((uint32_t *)0x08000000)
#define FLASH_SIZE                ((uint32_t)FLASH_END-(uint32_t)FLASH_START)
#define FLASH_SIZE_WORDS          (uint32_t)(((uint32_t)FLASH_END-(uint32_t)FLASH_START)/4)
#define FLASH_END                 ((uint32_t *)0x0801FFC0)

#define FLASH_BLOCK_SIZE          ((uint32_t)512uL)
#define FLASH_BLOCKNUM            (uint32_t)(((uint32_t)FLASH_END-(uint32_t)FLASH_START) / FLASH_BLOCK_SIZE)
#define FLASH_BLOCKNUM_WORDS      (uint32_t)((FLASH_SIZE_WORDS) / FLASH_BLOCK_SIZE)

#define IEC_TEST_PARAM_START      ((uint32_t *)0x20000040)
#define IEC_TEST_PARAM_END        ((uint32_t *)0x200000B0)

#define RAM_START                 (uint32_t *)0x20000000
#define RAM_DATAAREA_END          (uint32_t *)(0x20000B00 - 0x40)
#define RAM_STACK_START           (uint32_t *)0x20003800
#define RAM_END                   (uint32_t *)0x20003FC0

#define DefaultSystemStartUp()
void test_fail_reset(void);

#endif /* (!defined (__ARMCC_VERSION)) && (defined (__GNUC__)) */
```

图 2-18. 添加 ClassB 库文件到 eclipse 工程



若启动文件适用当前芯片型号，则无需修改；若不符合，则需重新选择符合当前芯片类型的.s 启动文件，并如*图2-19. 修改启动文件*所示进行修改，使芯片在运行之前进行自检测。

图 2-19. 修改启动文件

```
48
49   bl  test_prerun /* SystemInit */
50
51 /* Call SystemInit function */
52   bl  SystemInit
53 ///* Call static constructors */
54 //  bl __libc_init_array
55 /*Call the main function */
56   bl main
57   bx lr
58 .size Reset_Handler, .-Reset_Handler
59
60
61
62     .section .text.Default_Handler,"ax",%progbits
63 Default_Handler:
64 Infinite_Loop:
65   b Infinite_Loop
66   .size Default_Handler, .-Default_Handler
67
68
69    .section  .isr_vector,"a",%progbits
70    .global __gVectors
71
72
73
74 __gVectors:
75                     .word _estack                        /* Top of Stack */
```

2、修改如*图2-20. 分散加载文件位置*目录下的分散加载文件，如*图2-21. 修改eclipse工程分散加载文件*所示为修改的部分，根据芯片数据手册修改Flash和RAM的大小适配当前芯片。

图 2-20. 分散加载文件位置

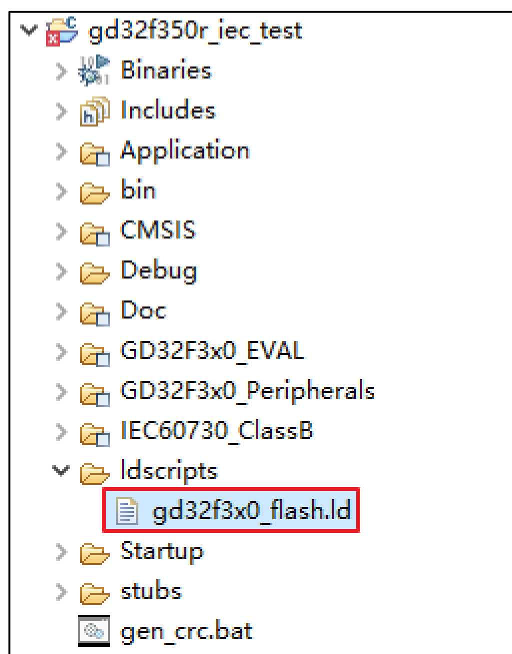
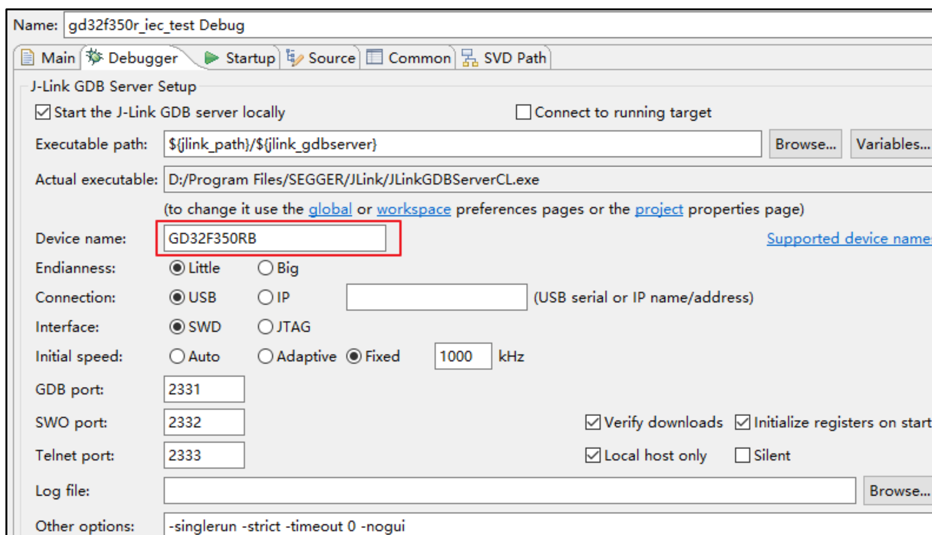


图 2-21. 修改 eclipse 工程分散加载文件

```
 1
 2 ENTRY(Reset_Handler)
 3
 4 /* end of Stack */
 5 _estack = 0x20004000;
 6
 7 /* memory map */
 8 MEMORY
 9 {
10   FLASH (rx)       : ORIGIN = 0x08000000, LENGTH = 128K
11   iec_test (wxa!ri) : ORIGIN = 0x20000000, LENGTH = 0xB0
12   RAM (xrw)        : ORIGIN = 0x200000B0, LENGTH = 0x3F50 /*8K*/
13   flash_end (rxai!w) : ORIGIN = 0x0801FFC0, LENGTH = 0x40
14 }
```

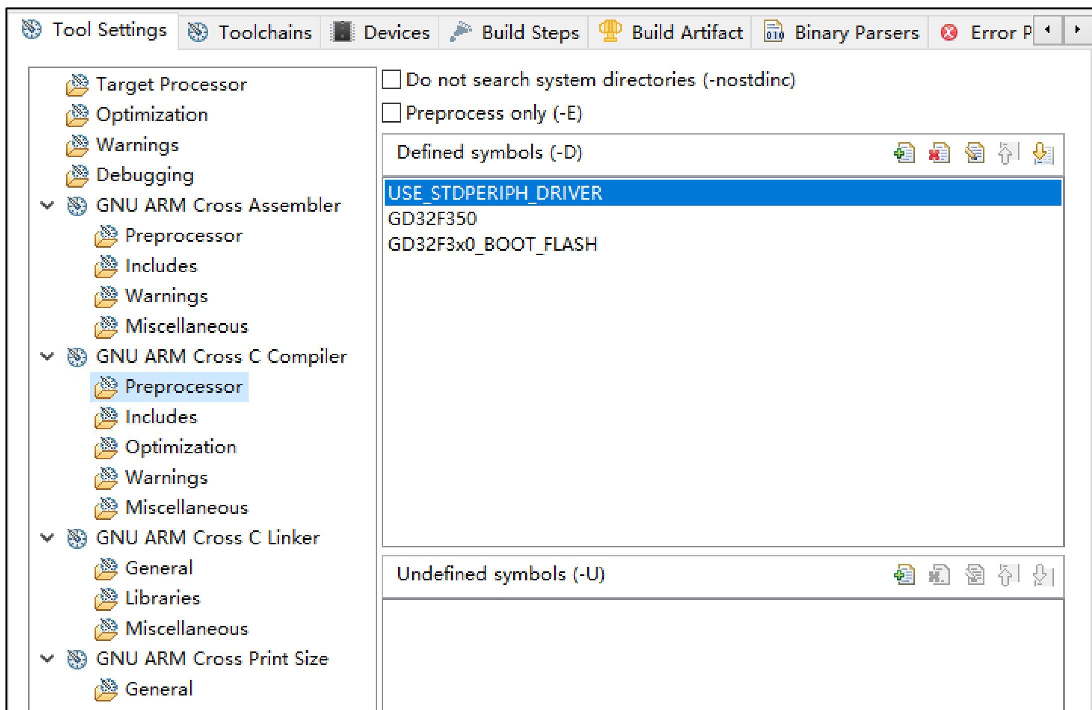
3、修改“Debug Configurations->Debugger”中Device name的配置，选择当前芯片的型号，如图2-22. Device name配置所示：

图 2-22. Device name 配置



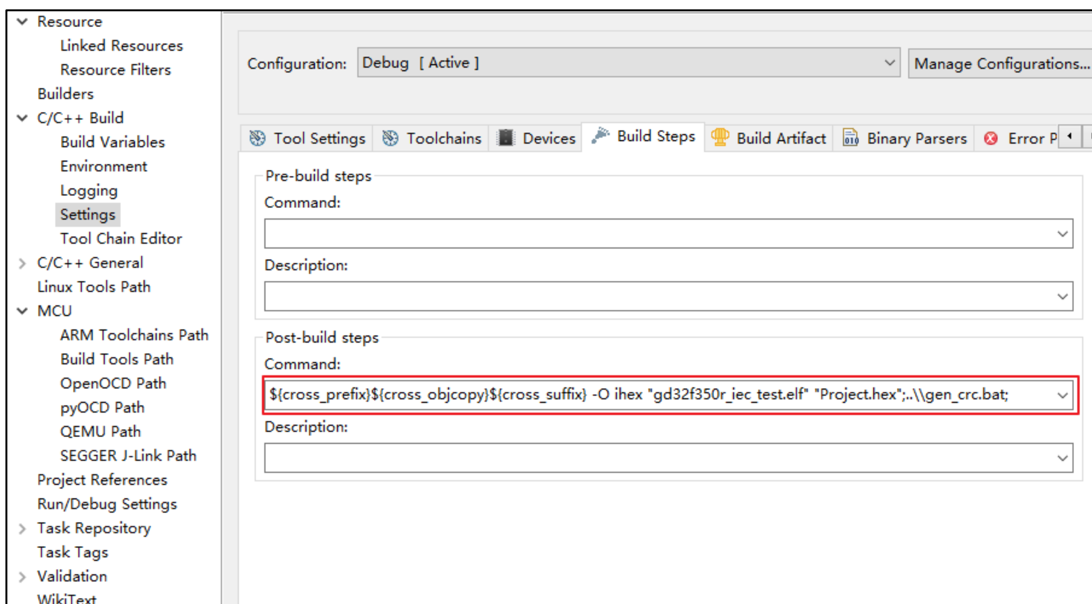
4、在工程属性“C/C++ Build->Settings->Tool Settings->Cross ARM GNU Assembler->Preprocessor”和“C/C++ Build->Settings->Tool Settings->Cross ARM GNU C Complier->Preprocessor”中添加当前工程需要的预编译宏，主要修改符合当前芯片类型的预编译宏（如图2-23. 修改汇编编译器预编译宏所示。

图 2-23. 修改汇编编译器预编译宏



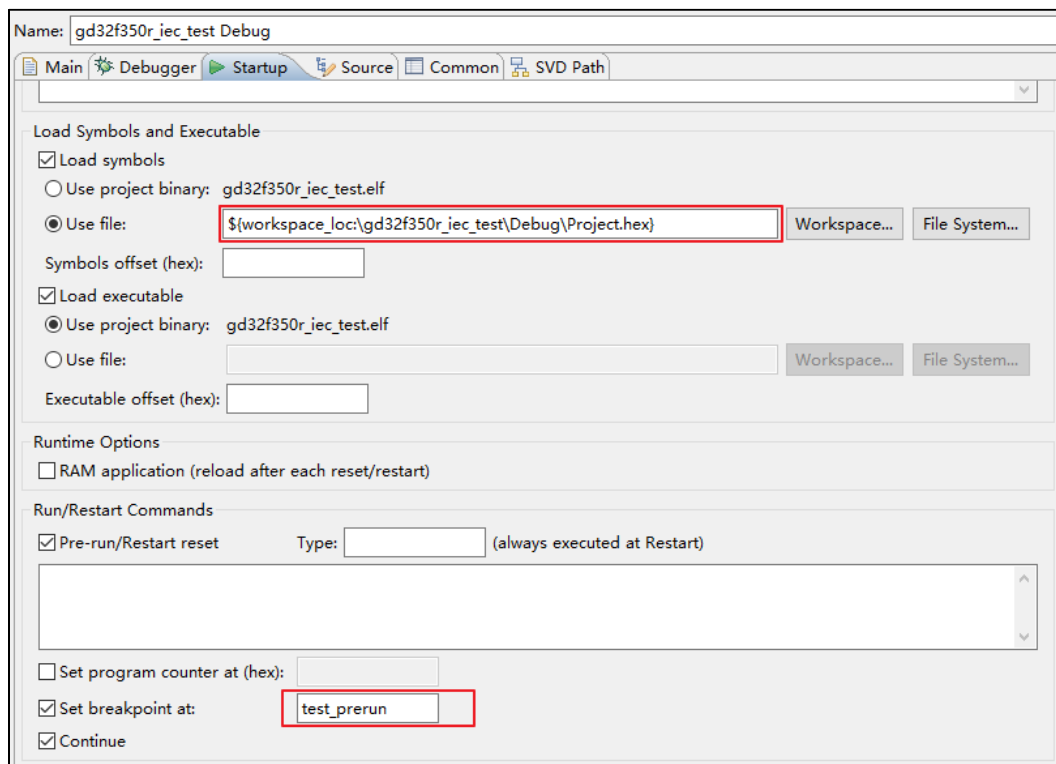
5、修改"C++ Build->Settings->Build Steps->Post-build steps->Command"中的命令，如*图2-24. 修改Post-build指令*所示更换为当前工程名称的elf文件。

图 2-24. 修改 Post-build 指令



6、修改"Debug Configurations->Startup"中的可执行文件的配置，选择当前工作空间中编译生成的Project.hex文件，如*图2-25. 修改可执行文件配置*所示：

图 2-25. 修改可执行文件配置



3. 三种环境下的测试结果

按照第二章的步骤修改代码和配置工程，在各个环境下编译下载工程并运行，测试结果如*图 3-1. 测试结果*所示。

图 3-1. 测试结果

```
>>>>>>>>>>>>>>  IEC60730 Test Board Init Success  <<<<<<<<<<<<<<

CPU Test(PreRun) Success!

... Power reset or software reset, next step --> FWDGT reset test ...

>>>>>>>>>>>>>>  IEC60730 Test Board Init Success  <<<<<<<<<<<<<<

CPU Test(PreRun) Success!

FWDGT reset
... FWDGT reset test OK, next step --> WWDGT reset test ...

>>>>>>>>>>>>>>  IEC60730 Test Board Init Success  <<<<<<<<<<<<<<

CPU Test(PreRun) Success!

FWDGT reset
WWDGT reset

... WWDGT reset test OK, WDGT test completed ...

UFull RAM Test Success!

FLASH CRC32 Test(PreRun) Success!
€
Clock Frequency Test Success!

Program counter test(PreRun) Success!y

**************************** Main program starts ****************************

FLASH CRC(Run-Time) Test running! Next Address --> 0x080001fc

FLASH CRC(Run-Time) Test running! Next Address --> 0x080003f8

FLASH CRC(Run-Time) Test running! Next Address --> 0x080005f4

FLASH CRC(Run-Time) Test running! Next Address --> 0x080007f0
```

4. 版本历史

表 4-1. 版本历史

版本号	说明	日期
1.0	首次发布	2023 年 08 月 01 日

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