# GigaDevice Semiconductor Inc.

# Arm® Cortex®-M3/4/23/33 32-bit MCU

## 应用笔记

## AN039

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# 1. 介绍

在IEC60730自检测试中，要求对mcu片上flash进行自检，为了实现CRC值的自动计算和添加，需要在IDE中添加CRC校验步骤，为此，本应用笔记讲述如何在eclipse环境中添加CRC校验批处理方法，过程描述如下。

# 2. CRC 校验批处理

在 eclipse 环境中，没有提供自动计算 CRC 的功能，为了实现 IEC60730 标准要求的 flash 自检，通常预先计算出 CRC 值通过手动方式添加到分散加载文件中，这样的方式操作复杂，为此，通过添加批处理步骤来完成 CRC 值的自动计算和添加。

## 2.1. 添加 CRC 值批处理所需文件

1. 首先下载 Srecord 工具，在工程目录下新建 bin 文件夹，将 srec_cat.exe、srec_cmp.exe 和 srec_info.exe 拷贝到该文件夹下。

2. 在工程目录下添加 gen_crc.bat、gd32e10x_flash.ld 文件。在此以 gd32e10x 系列芯片为例进行说明，gen_crc.bat 文件用于调用 Srecord 工具计算 CRC 值，并将该值存储到.hex 文件的末尾以便于对整个 flash 进行自检测试，并在 build 窗口打印通过 Srecord 工具计算得到的 CRC 值。该文件的命令代码如下所示：

```
SET MAP_FILE=gd32e10x_iec_test.map
::-----------------get CRC address information line
SET TMP_FILE=crc_temp.txt
FINDSTR /R /C:"^ *.check_sum" %MAP_FILE%>%TMP_FILE%
SET /p crc_search=<%TMP_FILE%
DEL %TMP_FILE%
::-----------------CRC address
for /f "tokens=1 delims=(" %%a in ("%crc_search%") do set crc_search=%%a
SET crc_search=%crc_search:.check_sum=%
for /f "tokens=1 delims= " %%a in ("%crc_search%") do set CRC_ADDR=%%a


SET /a CRC_ADDR_END=%CRC_ADDR%+4


::-----------------choose CRC32 or CRC16
FINDSTR /R /C:"^ .*crc_block_data_calculate" %MAP_FILE% > nul && call :OK||call :NO
goto :eof

:OK
::--------------------CRC32
..\bin\srec_cat.exe Project.hex -intel -crop 0x08000000 %CRC_ADDR% -fill 0xff 0x08000000 %CRC_ADDR% -stm32-l-e %CRC_ADDR% -o Project_checked.hex -intel
..\bin\srec_cat.exe Project.hex -intel -crop 0x08000000 %CRC_ADDR%
```

```
Project_checked.hex -intel -crop %CRC_ADDR% %CRC_ADDR_END% -o
Project.hex -intel
..\bin\srec_cat.exe Project.hex -intel -crop %CRC_ADDR% %CRC_ADDR_END%
-o -hex-dump
del Project_checked.hex
goto :eof

:NO
::--------------------CRC16
..\bin\srec_cat.exe Project.hex -intel -crop 0x08000000 %CRC_ADDR% -fill 0xff
0x08000000 %CRC_ADDR% -crc16-l-e %CRC_ADDR% -POLYnomial ccitt -XMODEM
-o Project_checked.hex -intel
..\bin\srec_cat.exe Project.hex -intel -crop 0x08000000 %CRC_ADDR%
Project_checked.hex -intel -crop %CRC_ADDR% %CRC_ADDR_END% -o
Project.hex -intel
..\bin\srec_cat.exe Project.hex -intel -crop %CRC_ADDR% %CRC_ADDR_END%
-o -hex-dump
del Project_checked.hex
goto :eof

exit
```

gd32e10x_flash.ld 文件定义各个程序段和变量的加载地址，通过如下所示的代码，将 CRC 值（CHECKSUM）固定在 FLASH 空间的末尾位置。

```

ENTRY(Reset_Handler)

/* end of Stack */
_estack = 0x20008000;    /*ram size*/

/* memory map */
MEMORY
{
  FLASH (rx)          : ORIGIN = 0x08000000, LENGTH = 128K       /*flash size*/
  iec_test (wxa!ri) : ORIGIN = 0x20000000, LENGTH = 0xB0
  RAM (xrw)           : ORIGIN = 0x200000B0, LENGTH = 0x7F50    /*32K*/
  flash_end (rxai!w) : ORIGIN = 0x0801FFC0, LENGTH = 0x40 /*flash size - 0x40*/
}

SECTIONS
{
  __stack_size = DEFINED(__stack_size) ? __stack_size : 2K;

```

```
.isr_vector :
{
  . = ALIGN(4);
  KEEP(*(.isr_vector))
  . = ALIGN(4);
} >FLASH

.text :
{
  . = ALIGN(4);
  *(.text)
  *(.text*)
  *(.glue_7)
  *(.glue_7t)
  *(.eh_frame)

  KEEP (*(.init))
  KEEP (*(.fini))

  . = ALIGN(4);
  /* the symbol '_etext' will be defined at the end of code section */
  _etext = .;
} >FLASH

.rodata :
{
  . = ALIGN(4);
  *(.rodata)
  *(.rodata*)
  . = ALIGN(4);
} >FLASH

 .ARM.extab :
{
   *(.ARM.extab* .gnu.linkonce.armextab.*)
} >FLASH

  .ARM : {
  __exidx_start = .;
    *(.ARM.exidx*)
    __exidx_end = .;
  } >FLASH
```

```
.ARM.attributes : { *(.ARM.attributes) } > FLASH

.preinit_array     :
{
  PROVIDE_HIDDEN (__preinit_array_start = .);
  KEEP (*(.preinit_array*))
  PROVIDE_HIDDEN (__preinit_array_end = .);
} >FLASH

.init_array :
{
  PROVIDE_HIDDEN (__init_array_start = .);
  KEEP (*(SORT(.init_array.*)))
  KEEP (*(.init_array*))
  PROVIDE_HIDDEN (__init_array_end = .);
} >FLASH

.fini_array :
{
  PROVIDE_HIDDEN (__fini_array_start = .);
  KEEP (*(.fini_array*))
  KEEP (*(SORT(.fini_array.*)))
  PROVIDE_HIDDEN (__fini_array_end = .);
} >FLASH

._iec_classb(NOLOAD) :
{
  . = ALIGN(4);
  *(.ram_run_buf)
  *(.ram_run_buf*)
  *(.ram_run_ptr)
  *(.ram_run_ptr*)

  . = ALIGN(4);
  PROVIDE(_iec_start = . );

  *(.iec_test_ram)
  *(.iec_test_ram*)

  . = ALIGN(4);
  PROVIDE(_iec_end = . );
} >iec_test AT>iec_test

/* provide some necessary symbols for startup file to initialize data */
_sidata = LOADADDR(.data);
.data :
{
   . = ALIGN(4);
   /* the symbol '_sdata' will be defined at the data section end start */
   _sdata = .;
   *(.data)
   *(.data*)
   . = ALIGN(4);
   /* the symbol '_edata' will be defined at the data section end */
   _edata = .;
} >RAM AT> FLASH

.check_sum          :
{
   . = ALIGN(64);
   PROVIDE( __Check_Sum = . );

   LONG(0x904eae51);
} >flash_end AT>flash_end

. = ALIGN(4);
.bss :
{
   /* the symbol '_sbss' will be defined at the bss section start */
   _sbss = .;
   __bss_start__ = _sbss;
   *(.bss)
   *(.bss*)
   *(COMMON)
   . = ALIGN(4);
   /* the symbol '_ebss' will be defined at the bss section end */
   _ebss = .;
   __bss_end__ = _ebss;
} >RAM

PROVIDE ( end = _ebss );
PROVIDE ( _end = _ebss );
```

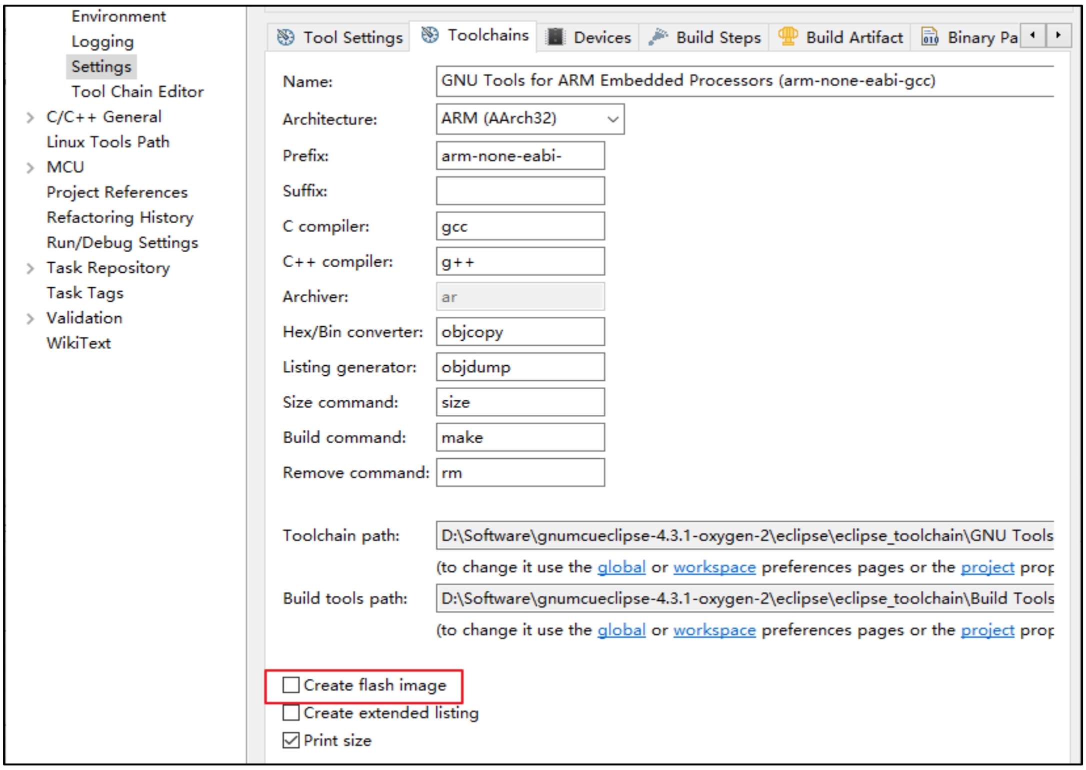
```
  .stack ORIGIN(RAM) + LENGTH(RAM) - __stack_size - 0x18:
  {
    *(.stack_ov_test)
    *(.stack_ov_test*)
    . = 0x18;
    PROVIDE( _heap_end = . );
    . = __stack_size + 0x18;
    PROVIDE( _sp = . );
  }
}

 /* input sections */
GROUP(libgcc.a libc.a libm.a libnosys.a)
```

## 2.2. 配置批处理

1. 在工程目录中添加了上述两个文件之后，打开工程，右击工程名，并在 Properties->C/C++ Build->Setting->Toolchains 中将 Create flash image 的勾选取消，这是为了实现利用批处理来生成可执行文件，如*图 2-1. 取消 Create flash image 勾选*所示。

图 2-1. 取消 Create flash image 勾选



Name: GNU Tools for ARM Embedded Processors (arm-none-eabi-gcc)
Architecture: ARM (AArch32)
Prefix: arm-none-eabi-
Suffix:
C compiler: gcc
C++ compiler: g++
Archiver: ar
Hex/Bin converter: objcopy
Listing generator: objdump
Size command: size
Build command: make
Remove command: rm

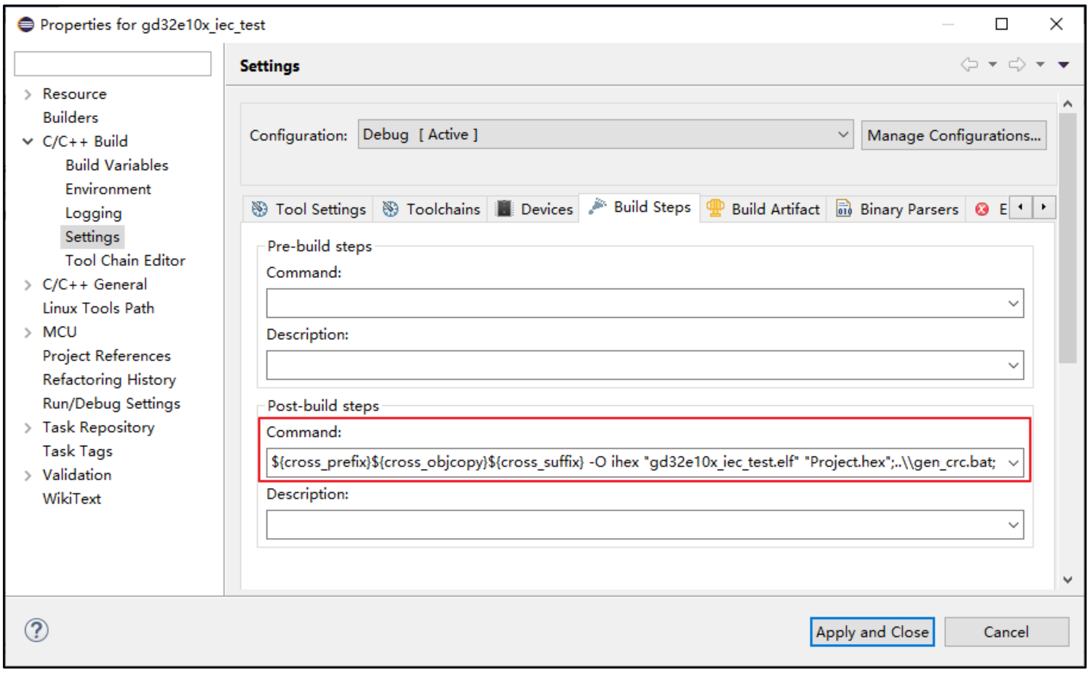
Toolchain path: D:\Software\gnumcueclipse-4.3.1-oxygen-2\eclipse\eclipse_toolchain\GNU Tools
(to change it use the global or workspace preferences pages or the project prop
Build tools path: D:\Software\gnumcueclipse-4.3.1-oxygen-2\eclipse\eclipse_toolchain\Build Tools
(to change it use the global or workspace preferences pages or the project prop

□ Create flash image
□ Create extended listing
☑ Print size

2. 右击工程名称->Properties->C/C++build->settings->build steps，在 Post-build steps 中添加以下命令：${cross_prefix}${cross_objcopy}${cross_suffix} -O ihex

"gd32f30x_iec_test.elf" "Project.hex";..\\gen_crc.bat;点击 apply，此命令是为了保证将.elf 文件转换成.hex 文件的操作在.bat 文件命令操作之前，设置方式如*图 2-2. steps 设置* 所示。

图 2-2. Post-build steps 设置



Properties for gd32e10x_iec_test

Settings

Configuration: Debug [ Active ]

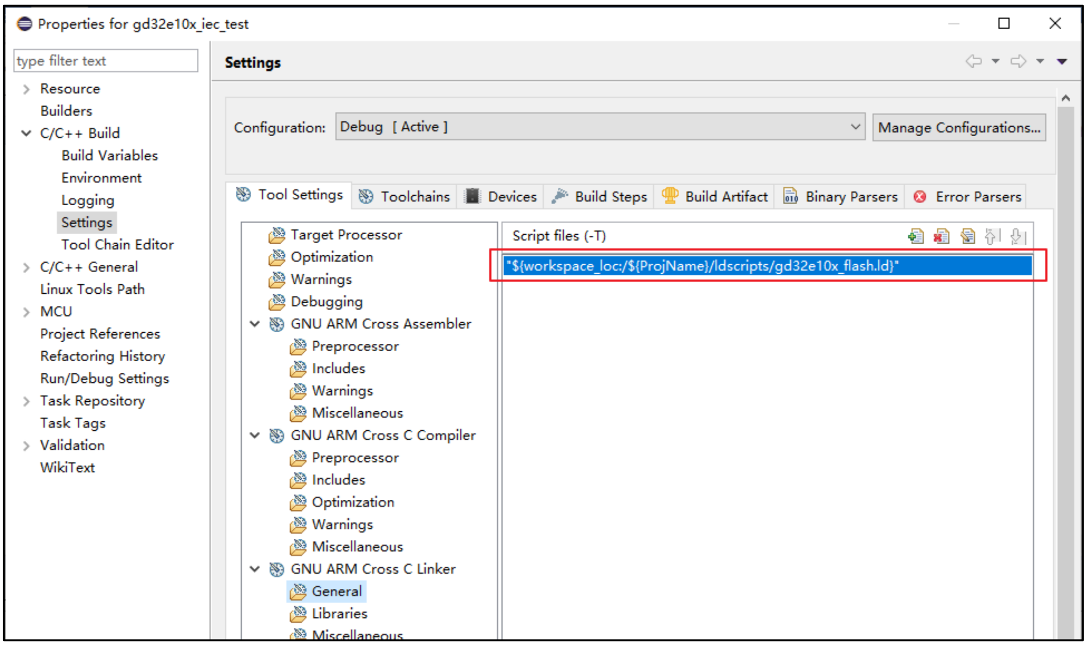
Post-build steps

Command:

```
${cross_prefix}${cross_objcopy}${cross_suffix} -O ihex "gd32e10x_iec_test.elf" "Project.hex";..\\gen_crc.bat;
```

3. 右击工程名称->Properties->C/C++build->settings->GNU ARM Cross C Linker->General, 在此添加链接文件，如*图 2-3. 添加链接文件*所示，修改之后点击 Apply and Close。

图 2-3. 添加链接文件



Properties for gd32e10x_iec_test

Settings

Configuration: Debug [ Active ]

GNU ARM Cross C Linker → General

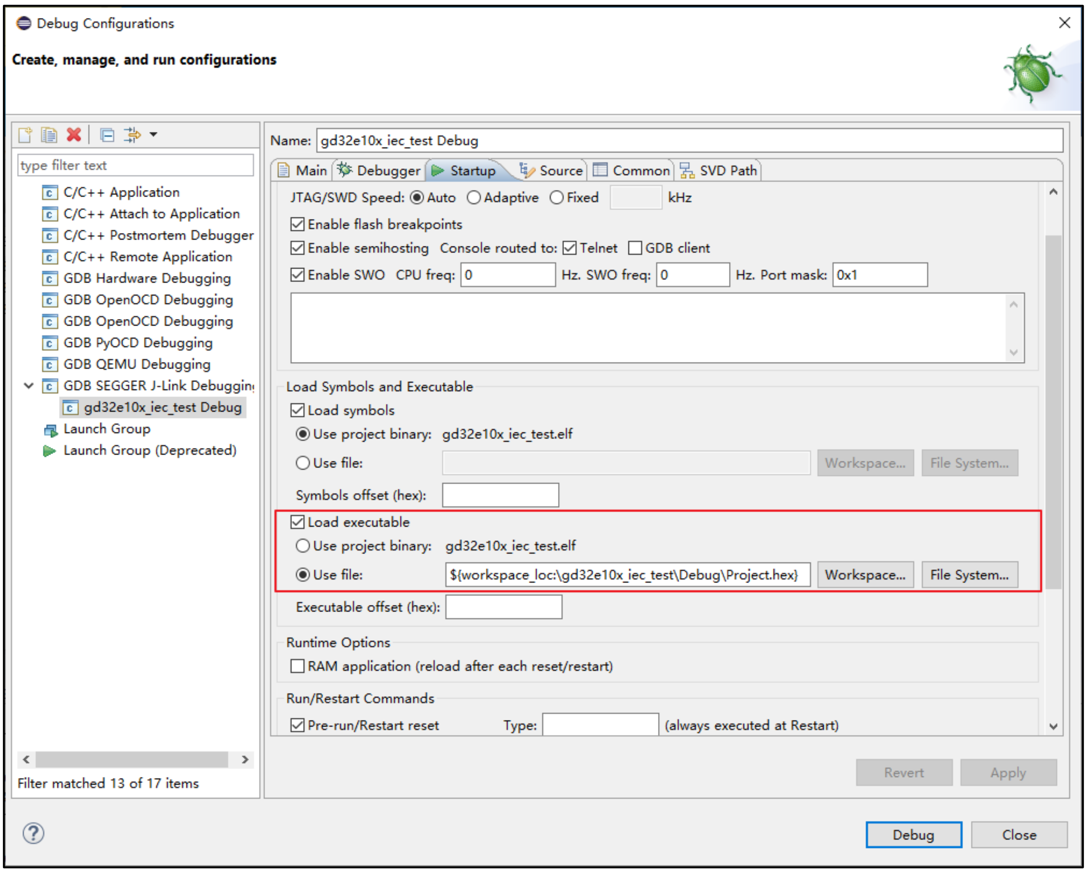
Script files (-T)

```
"${workspace_loc:/${ProjName}/ldscripts/gd32e10x_flash.ld}"
```

4. 在进行调试时，需要将可执行文件选择为批处理之后生成的 Project.hex 文件，在 Run->Debug Configuration->GDB SEGGER J-Link Debugging->gd32e10x_iec_test

Debug->Startup 界面的 Load excutable 中选择 Use file,批处理生成的 Project.hex 文件存储在工作空间中的 Debug 文件下，如*图2-4. 选择可执行文件*所示，修改之后点击 Apply.

**图 2-4. 选择可执行文件**



Debug Configurations

**Create, manage, and run configurations**

Name: gd32e10x_iec_test Debug

JTAG/SWD Speed: ● Auto ○ Adaptive ○ Fixed kHz

☑ Enable flash breakpoints

☑ Enable semihosting Console routed to: ☑ Telnet □ GDB client

☑ Enable SWO CPU freq: 0 Hz. SWO freq: 0 Hz. Port mask: 0x1

Load Symbols and Executable

☑ Load symbols

● Use project binary: gd32e10x_iec_test.elf

○ Use file: Workspace... File System...

Symbols offset (hex):

☑ Load executable

○ Use project binary: gd32e10x_iec_test.elf

● Use file: ${workspace_loc:\gd32e10x_iec_test\Debug\Project.hex} Workspace... File System...

Executable offset (hex):

Runtime Options

□ RAM application (reload after each reset/restart)

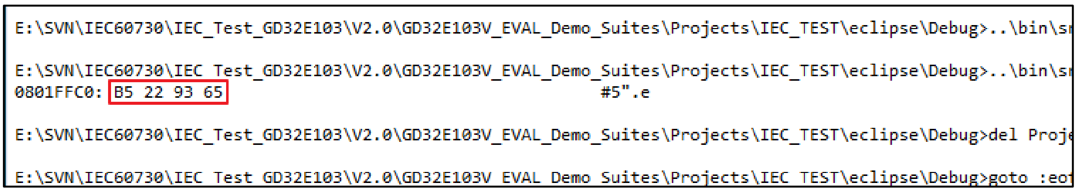
Run/Restart Commands

☑ Pre-run/Restart reset Type: (always executed at Restart)

# 3. 结果

配置完成后，点击编译，可以在 Build Output 窗口观察 build 信息，build 信息显示 CRC 值已存储在 0x0801FFF0 之后的位置,如*图 3-1. Build 信息*；配置 Debug 参数后，点击调试，并在 memory 观察窗口查询 0x0801FFF0 地址，如*图 3-2. memory 信息*所示，可以看出 memory 中的值与 Build Output 窗口显示的 CRC 值一致，CRC 值计算批处理添加成功。

**图 3-1. Build 信息**



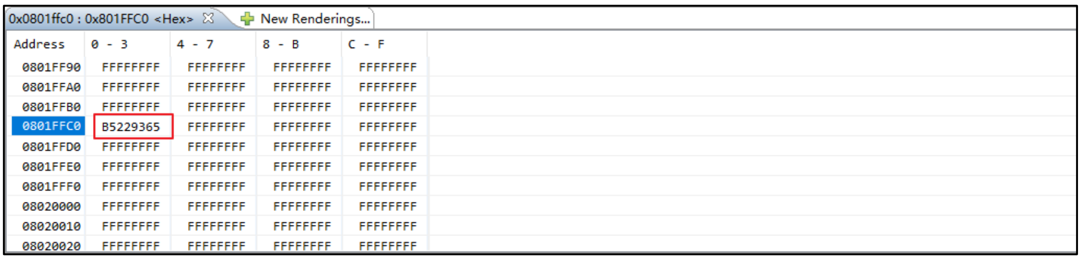
```
E:\SVN\IEC60730\IEC_Test_GD32E103\V2.0\GD32E103V_EVAL_Demo_Suites\Projects\IEC_TEST\eclipse\Debug>..\bin\s

E:\SVN\IEC60730\IEC_Test_GD32E103\V2.0\GD32E103V_EVAL_Demo_Suites\Projects\IEC_TEST\eclipse\Debug>..\bin\s
0801FFC0: B5 22 93 65                                        #5".e

E:\SVN\IEC60730\IEC_Test_GD32E103\V2.0\GD32E103V_EVAL_Demo_Suites\Projects\IEC_TEST\eclipse\Debug>del Proj

E:\SVN\IEC60730\IEC_Test_GD32E103\V2.0\GD32E103V_EVAL_Demo_Suites\Projects\IEC_TEST\eclipse\Debug>goto :eof
```

**图 3-2. memory 信息**



| Address | 0 - 3 | 4 - 7 | 8 - B | C - F |
|---|---|---|---|---|
| 0801FF90 | FFFFFFFF | FFFFFFFF | FFFFFFFF | FFFFFFFF |
| 0801FFA0 | FFFFFFFF | FFFFFFFF | FFFFFFFF | FFFFFFFF |
| 0801FFB0 | FFFFFFFF | FFFFFFFF | FFFFFFFF | FFFFFFFF |
| 0801FFC0 | B5229365 | FFFFFFFF | FFFFFFFF | FFFFFFFF |
| 0801FFD0 | FFFFFFFF | FFFFFFFF | FFFFFFFF | FFFFFFFF |
| 0801FFE0 | FFFFFFFF | FFFFFFFF | FFFFFFFF | FFFFFFFF |
| 0801FFF0 | FFFFFFFF | FFFFFFFF | FFFFFFFF | FFFFFFFF |
| 08020000 | FFFFFFFF | FFFFFFFF | FFFFFFFF | FFFFFFFF |
| 08020010 | FFFFFFFF | FFFFFFFF | FFFFFFFF | FFFFFFFF |
| 08020020 | FFFFFFFF | FFFFFFFF | FFFFFFFF | FFFFFFFF |

# 4. 版本历史

表 4-1. 版本历史

| 版本号. | 描述 | 日期 |
|---|---|---|
| 1.0 | 首次发布 | 2021 年 10 月 19 日 |

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