GigaDevice Semiconductor Inc.

Arm® Cortex®-M3/4/23/33 32-bit MCU

应用笔记

AN017

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1. 简介

本应用笔记采用 GD32F450i-EVAL 开发板，目标芯片为 GD25Q16BS SPI nor flash 芯片，通过 J-FLASH SPI 上位机或者修改 KEIL 下载算法，将文件到 GD25Qxx SPI nor flash 中。

2. 使用 J-Flash SPI 上位机下载文件到 SPI Nor Flash

2.1. 硬件连接

JLink 支持 SPI 协议，将 JLink 中的六根线 VTref、GND、TDI（MOSI）、TMS（nCS）、TCK（CLK）、TDO（MISO）对应连接到 SPI Nor Flash 的引脚上。本应用笔记采用 GD32F450i-EVAL V1.1 开发板中的 GD25Q16BS SPI nor flash 芯片，根据开发板原理图和 JTAG 引脚图，如*图 2-1. GD25Q16BS 原理图（左）与 JTAG 引脚图（右）*所示，使用杜邦线将 Jlink 与 Flash 硬件连接，连接方法参考*表 2-1. Jlink 与 SPI Flash 硬件连接*。

图 2-1. GD25Q16BS 原理图（左）与 JTAG 引脚图（右）

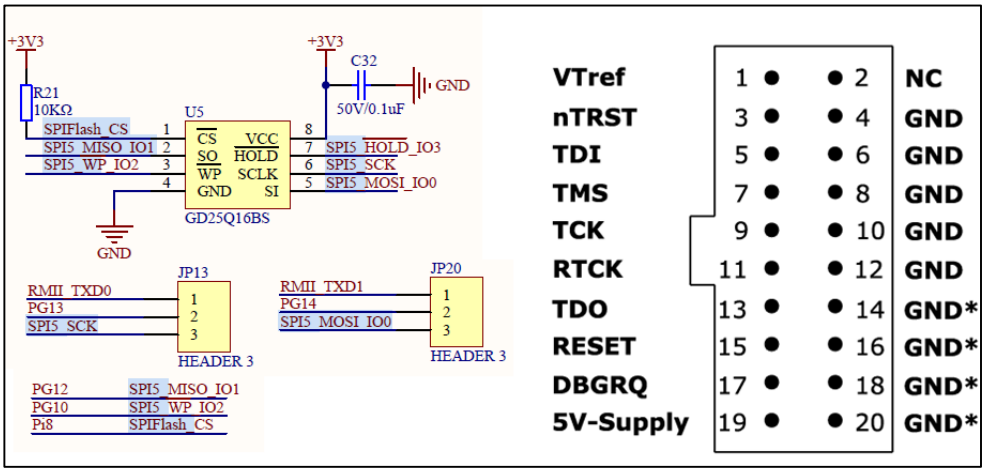


表 2-1. Jlink 与 SPI Flash 硬件连接

JTAG 引脚编号及名称	连接到 GD25Q16BS 的引脚
1(VTref)	开发板 VCC
5(TDI)	开发板 JP20 3 号引脚（MOSI）
7(TMS)	开发板 PI8 引脚(CS)
9(TCK)	开发板 JP13 3 号引脚（SCK）
13(TDO)	开发板 PG12 引脚(MISO)
4(GND)	开发板 GDN

2.2. Jflash-SPI 上位机配置与下载

首先单击打开 J-Flash SPI，如图 2-2 所示，打开界面见*图 2-2. SEGGER 中 J-Flash SPI 软件*。

图 2-2. SEGGER 中 J-Flash SPI 软件

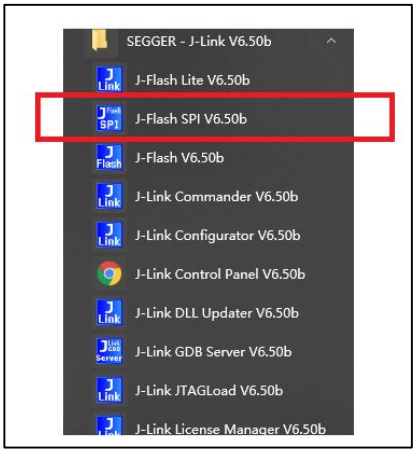
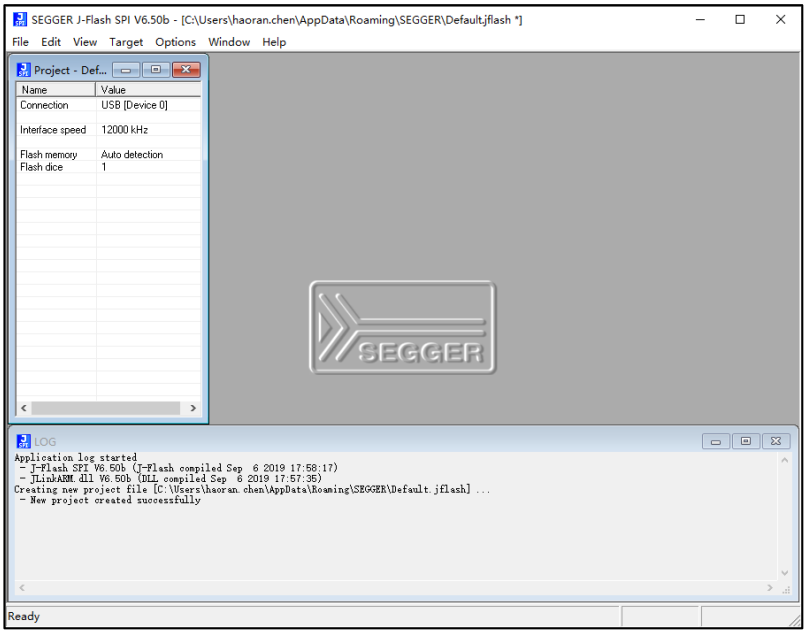
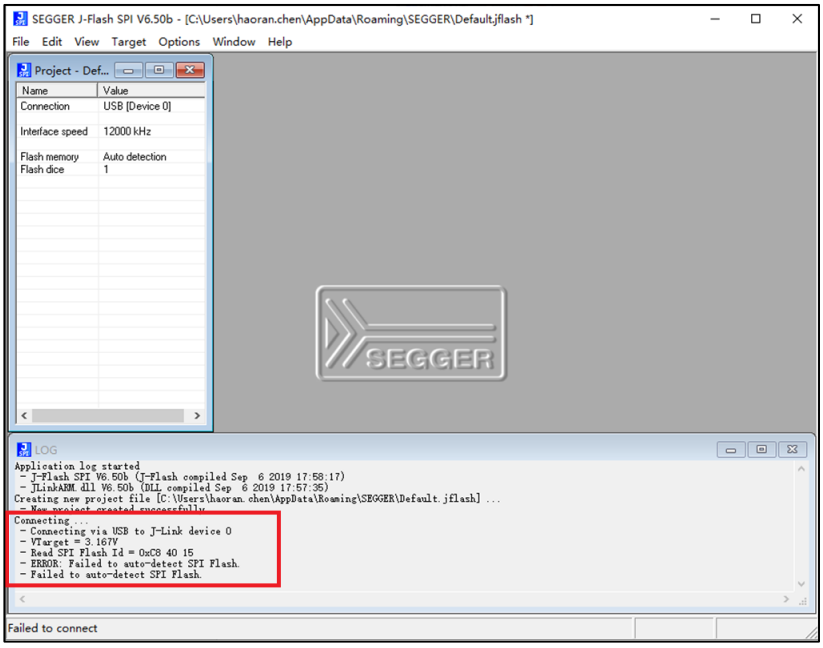


图 2-3. 打开 J-Flash SPI 软件界面



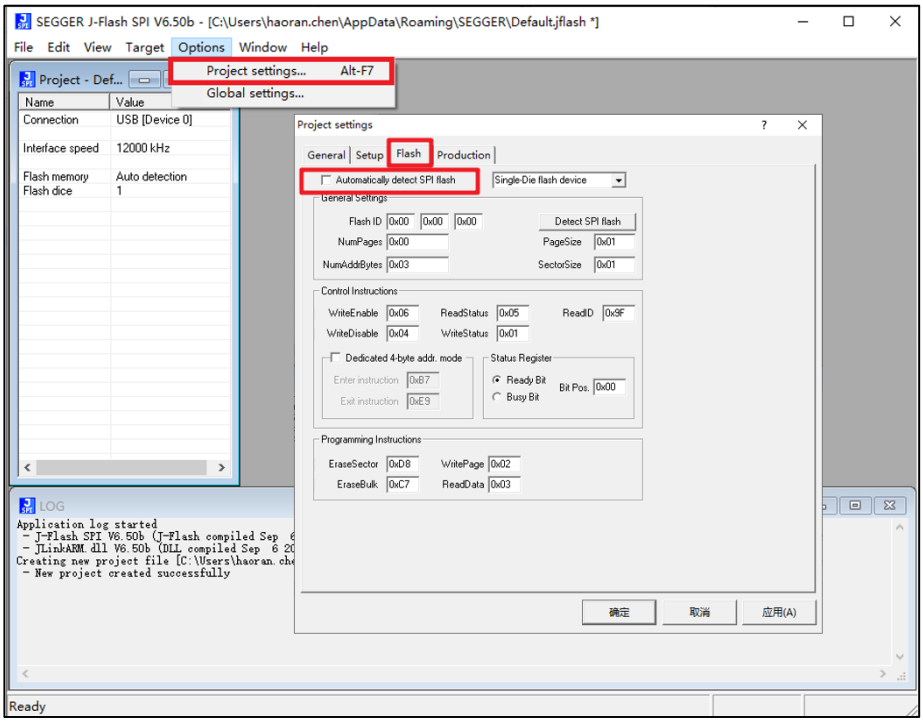
点击“Target-->Connect”，可以看到*图 2-3. 打开 J-Flash SPI 软件界面*中红色框图，此时已成功读出 SPI Flash Id，但是连接失败，接下来将配置 Flash 相关参数。

图 2-4. 连接目标 SPI Flash



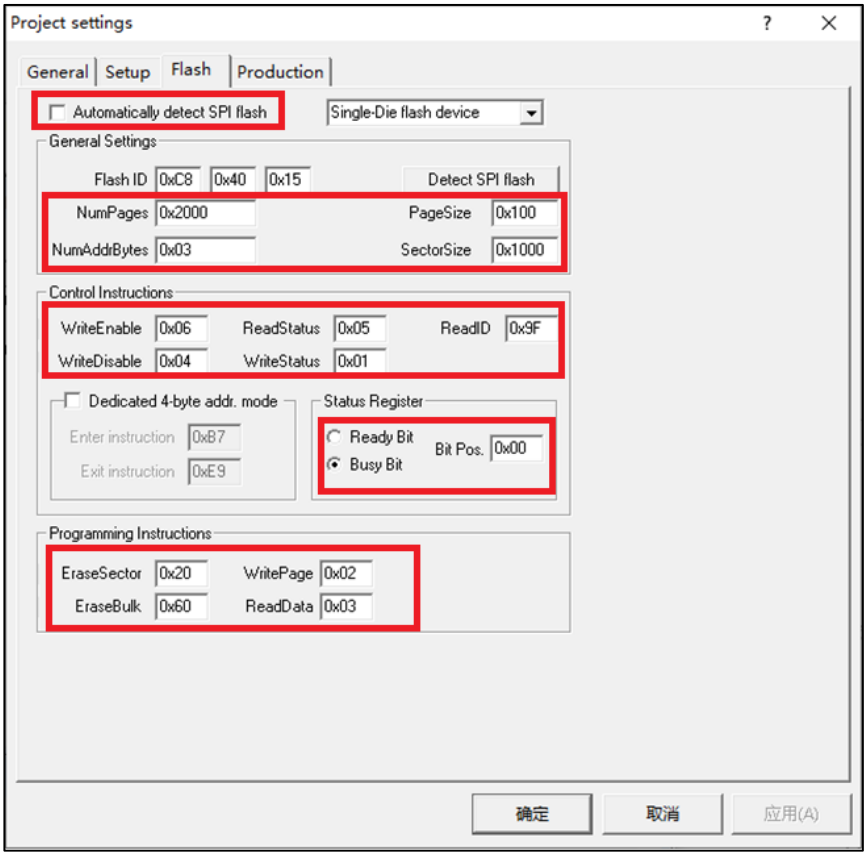
点击“Options-->Project settings”，选择 FLASH，将 Automatically detect SPI flash 取消勾选，参考界面*图 2-5. SPI Flash 配置界面*。

图 2-5. SPI Flash 配置界面



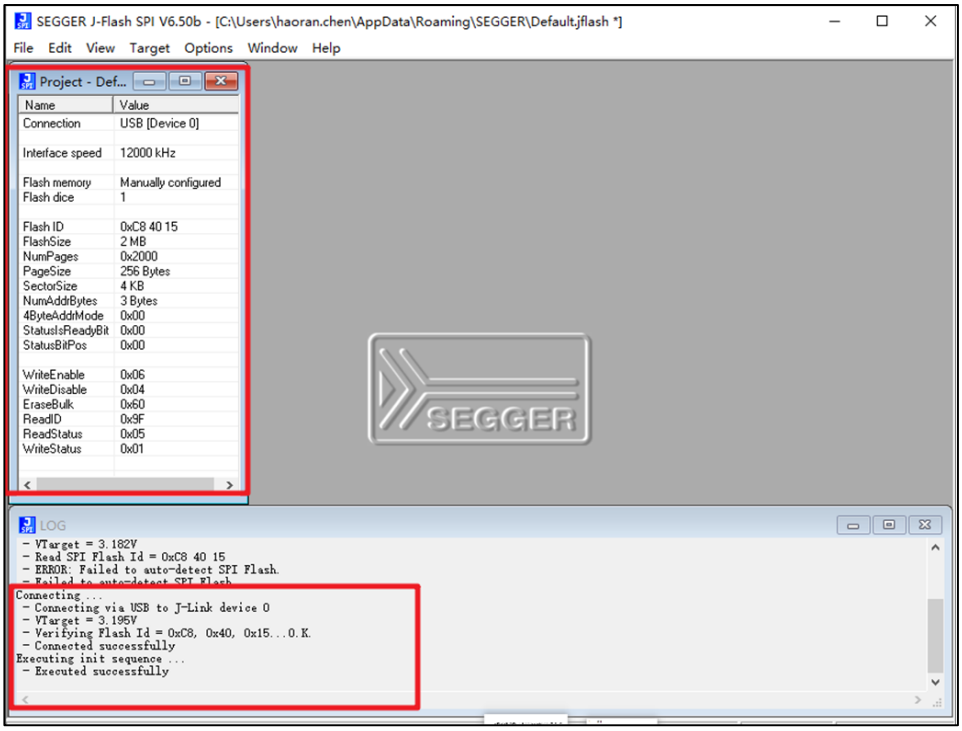
参考 GD25Q16B datasheet，填写 Flash 页大小、块大小、读写命令等相关参数，具体配置参考*图 2-6. GD25Q16B 参数配置*，配置完成后点击确定。

图 2-6. GD25Q16B 参数配置



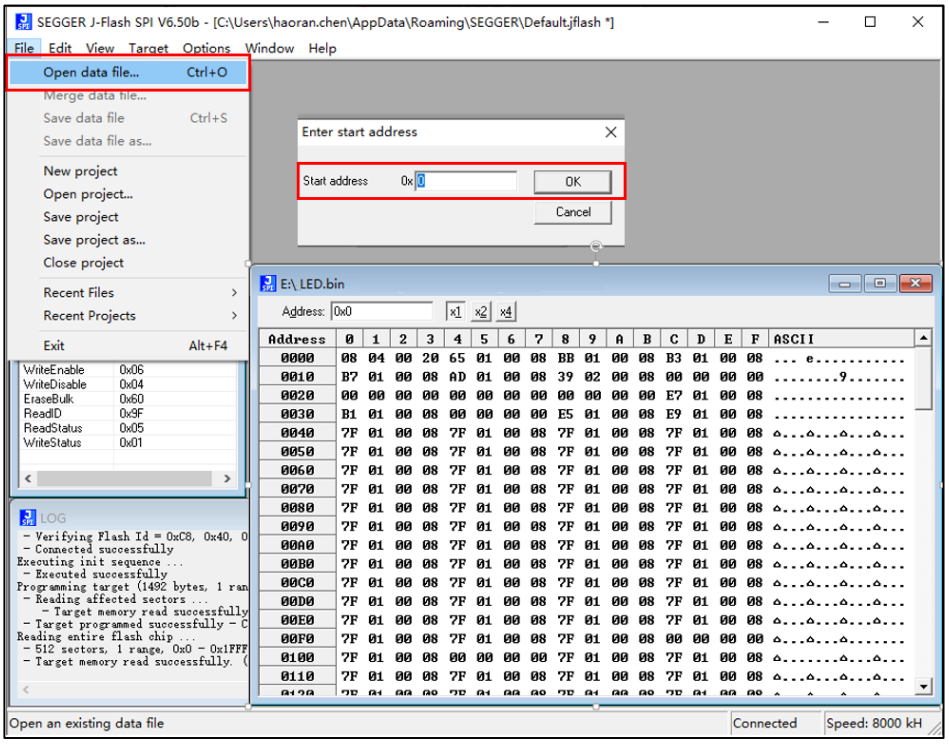
在主界面中再次点击“Target-->Connect”，可以看到*图 2-7. JLink 成功连接 SPI Flash* 所示红框，此时在左边显示相关参数，并且提示 JLink 与 Flash 连接成功。

图 2-7. JLink 成功连接 SPI Flash



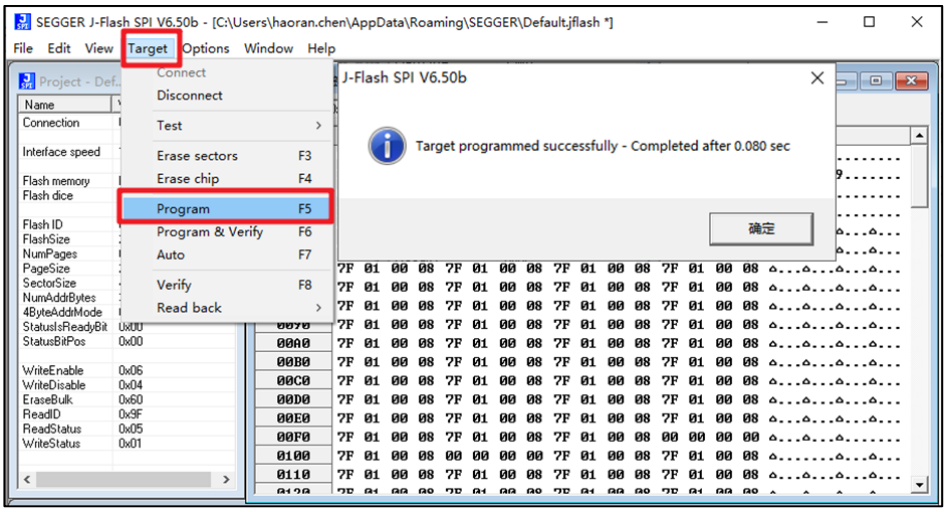
点击“File—>open data file”，打开需要下载的二进制文件，如*图 2-8. 打开下载的二进制文件*所示。

图 2-8. 打开下载的二进制文件



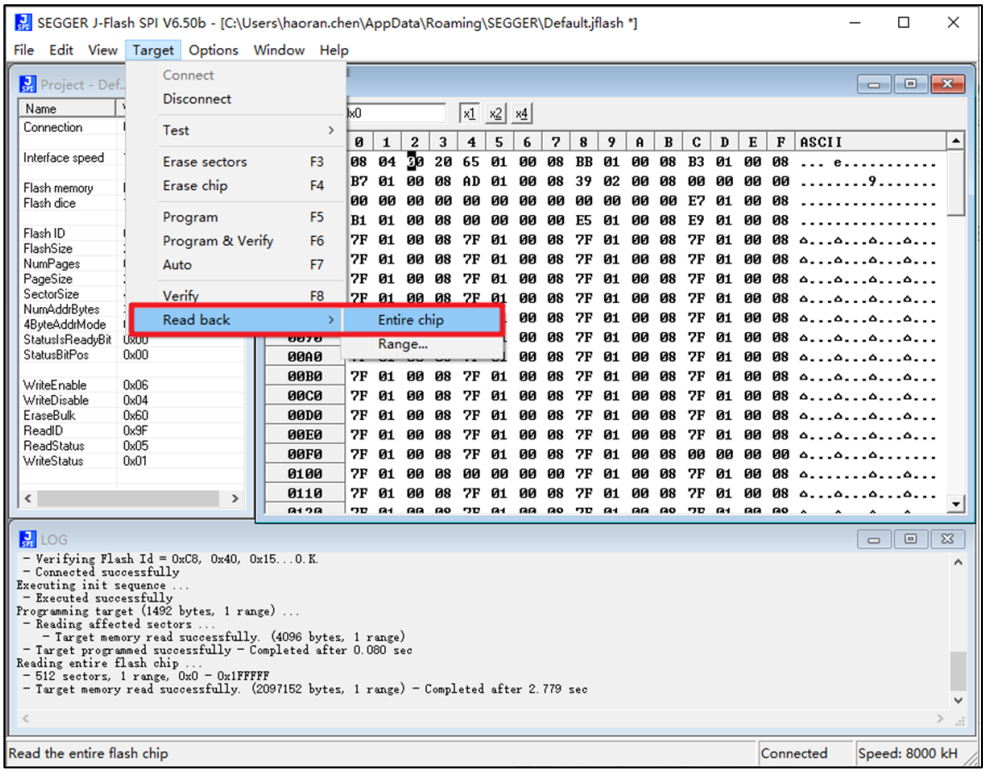
点击“Target-->Program”，如*图 2-9. 文件下载到 Flash 成功提示*所示，下载完成后，提示 Target programmed successfully。

图 2-9. 文件下载到 Flash 成功提示



为了验证是否成功下载二进制文件到 Flash 中，可以通过“Target-->Read back-->Entire chip”操作，读出所在地址的值，与源文件进行比对，如*图 2-10. 读取 Flash 中的数据*所示。

图 2-10. 读取 Flash 中的数据

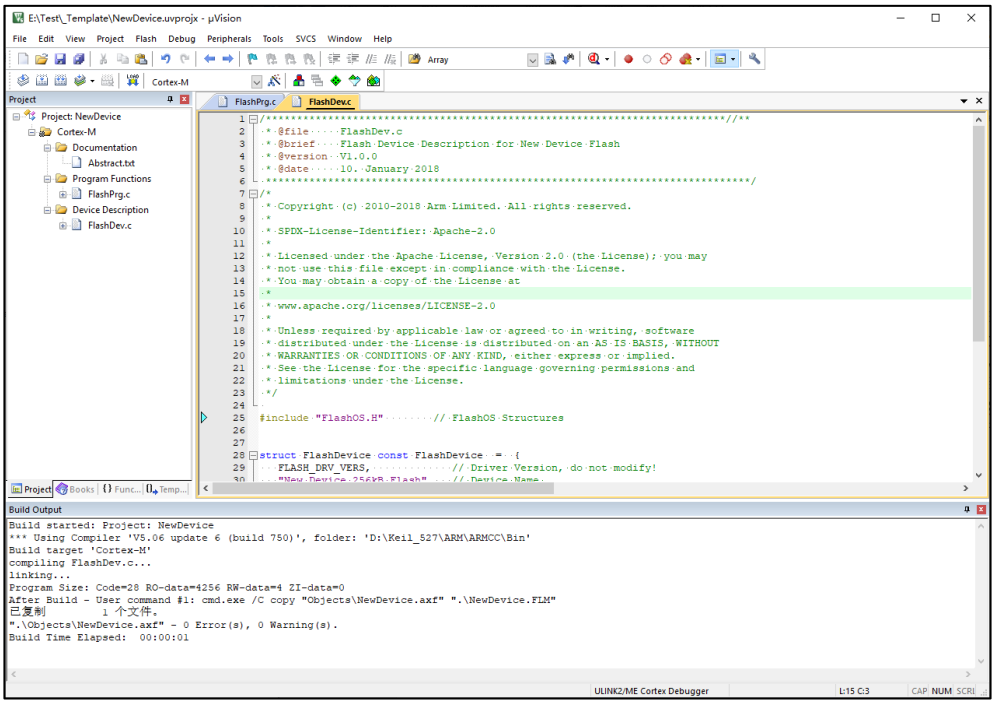


3. 使用 KEIL 下载文件到 SPI Nor Flash

3.1. 新建 FLM 工程

进入安装 KEIL 的盘符，将 Keil\ARM\Flash_Template 工程拷贝到 E 盘 Test 文件夹中（可自己设定），双击打开“NewDevice.uvprojx”工程，编译该工程，工程会报错“FlashDev.c(25): error: #5: cannot open source input file "..\FlashOS.H": No such file or directory”，再次进入 Keil\ARM\Flash 目录下找到“FlashOS.h”文件，拷贝到“E:\Test_Template”目录下，将 FlashDev.c 和 FlashPrg.c 中的 #include "../FlashOS.H" 修改为 #include "FlashOS.H"，再次编译工程，工程没有错误，并生成 NewDevicec.FLM。相关工程及编译如*图 3-1. 新建 FLM 工程*所示。

图 3-1. 新建 FLM 工程



3.2. 移植 SPI Flash 驱动代码

打开 FlashPrg.c 文件，该文件主要包含七个函数接口，如*表 3-1. FlashPrg.c 函数接口*所示

表 3-1. FlashPrg.c 函数接口

```
/* Flash Programming Functions (Called by FlashOS) */
extern          int   Init        (unsigned long adr,      /* Initialize Flash */
                                   unsigned long clk,
                                   unsigned long fnc);
```

```
extern              int   UnInit        (unsigned long fnc);      /* De-initialize Flash */
extern              int   BlankCheck    (unsigned long adr,       /* Blank Check */
                                         unsigned long sz,
                                         unsigned char pat);
extern              int   EraseChip     (void);                   /* Erase complete Device */
extern              int   EraseSector (unsigned long adr);        /* Erase Sector Function */
extern              int   ProgramPage (unsigned long adr,         /* Program Page Function */
                                         unsigned long sz,
                                         unsigned char *buf);
extern unsigned long Verify          (unsigned long adr,          /* Verify Function */
                                         unsigned long sz,
                                         unsigned char *buf);
```

这里主要实现 Init、EraseChip、EraseSector、ProgramPage 和 Verify 函数接口，函数接口实现如*表 3-2. FlashPrg.c 函数接口的实现*所示。

表 3-2. FlashPrg.c 函数接口的实现

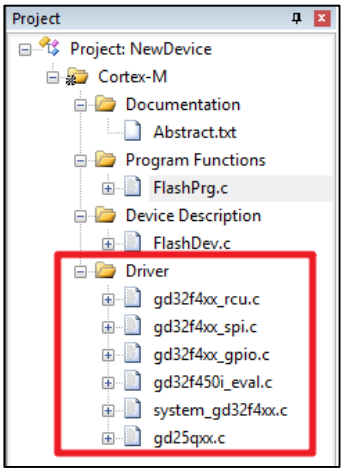
```
uint32_t base_adr;
/*
 *   Initialize Flash Programming Functions
 *      Parameter:          adr:   Device Base Address
 *                          clk:   Clock Frequency (Hz)
 *                          fnc:   Function Code (1 - Erase, 2 - Program, 3 - Verify)
 *      Return Value:     0 - OK,   1 - Failed
 */
int Init (unsigned long adr, unsigned long clk, unsigned long fnc) {

  /* Add your Code */
  spi_flash_init();
  base_adr = adr;
  return (0);                                   /* Finished without Errors */
}
/*
 *   Erase complete Flash Memory
 *      Return Value:     0 - OK,   1 - Failed
 */
int EraseChip (void) {

  /* Add your Code */
  spi_flash_bulk_erase();
  return (0);                                   /* Finished without Errors */
}
/*
 *   Erase Sector in Flash Memory
```

```
 *       Parameter:          adr:   Sector Address
 *       Return Value:     0 - OK,    1 - Failed
 */
int EraseSector (unsigned long adr) {

  /* Add your Code */
  spi_flash_sector_erase(adr);
  return (0);                                       /* Finished without Errors */
}
/*
 *   Program Page in Flash Memory
 *       Parameter:          adr:   Page Start Address
 *                           sz:     Page Size
 *                           buf:   Page Data
 *       Return Value:     0 - OK,    1 - Failed
 */

int ProgramPage (unsigned long adr, unsigned long sz, unsigned char *buf) {

  /* Add your Code */
  spi_flash_page_write(buf,adr,sz);
  return (0);                                       /* Finished without Errors */
}

unsigned long Verify (unsigned long adr, unsigned long sz, unsigned char *buf)
{
  uint8_t readbuf[256];
  uint32_t len;
  uint32_t count = 0;
  uint32_t readcount = 0;
  uint32_t readaddrs = 0;
  if((sz%256)==0)
  {
    readcount = sz/256;
  }else
  {
    readcount = sz/256 + 1;
  }
  readaddrs = (adr - base_adr);
  for(count=0;count<readcount;count++)
  {
    spi_flash_buffer_read(readbuf,(readaddrs+count*256),256);
    for(len=0;len<256;len++)
```

```
    {
      if(buf[len+count*256] != readbuf[len])
      {
        return count*256 + adr + len;
      }
    }
  }
  return adr+sz;
}
```

相关 SPI 驱动根据 GD32F4xx_Firmware_Library 和 GD25qxx.c 添加到 KEIL 工程中，所添加的文件如*图 3-2 移植 SPI 驱动和 GD25qxx 文件*所示。

图 3-2 移植 SPI 驱动和 GD25qxx 文件



3.3. 修改 FlashDevice 结构体

打开 FlashDev.c 文件，修改 FlashDevice 结构体中的相关内容，修改后代码如*表 3-3. FlashDevice 结构体实现*所示。

表 3-3. FlashDevice 结构体实现

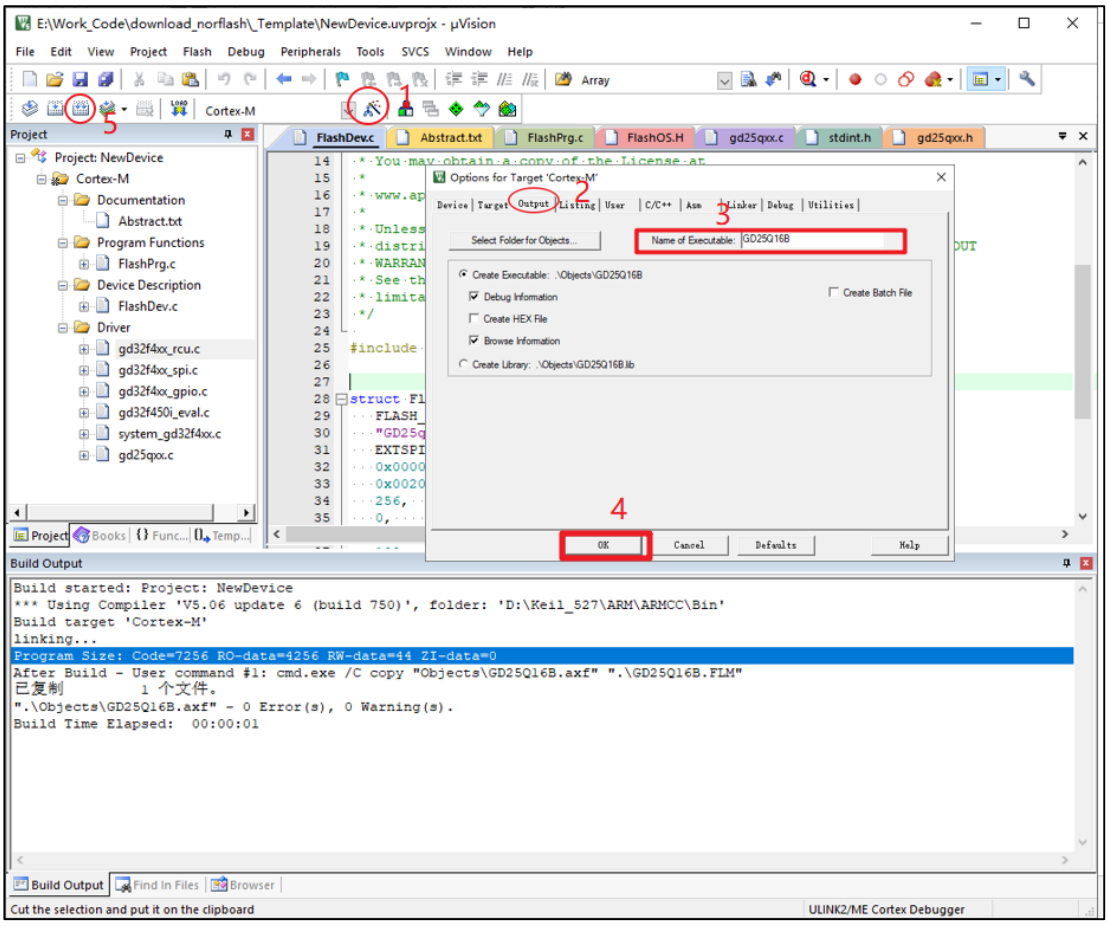
```
struct FlashDevice const FlashDevice  =  {
    FLASH_DRV_VERS,          /* Driver Version, do not modify! */
    "GD25qxx",               /* Device Name */
    EXTSPI,                  /* Device Type */
    0x00000000,              /* Device Start Address */
    0x00200000,              /* Device Size in Bytes (2M) */
    256,                     /* Programming Page Size */
    0,                       /* Reserved, must be 0 */
    0xFF,                    /* Initial Content of Erased Memory */
    100,                     /* Program Page Timeout 100 mSec */
    3000,                    /* Erase Sector Timeout 3000 mSec */
```

```
/* Specify Size and Address of Sectors */
    0x001000, 0x000000,          /* Sector Size   4kB (4096 Sectors) */
//    0x010000, 0x010000,        /* Sector Size 64kB (2 Sectors) */
//    0x002000, 0x030000,        /* Sector Size   8kB (8 Sectors) */
    SECTOR_END
};
```

3.4. 编译生成 FLM 文件

打开魔术棒，进入 Output 页面，修改 Name of Executable 为 GD25Q16B,编译工程，生成 GD25Q16B.FLM 文件。如*图 3-3. 编译生成 GD25Q16B.FLM 文件*所示。

图 3-3. 编译生成 GD25Q16B.FLM 文件



3.5. 添加算法文件到 KEIL 工程中

将编译生成好的 GD25Q16B.FLM 拷贝到 KEIL 安装目录下，D:\Keil_527\ARM\PACK\GigaDevice\GD32F4xx_DFP\2.0.0\Flash，接着返回上级目录打开 GigaDevice.GD32F4xx_DFP.pdsc 文件，将其属性修改为可读写，找到 GD32F450IK，添加代

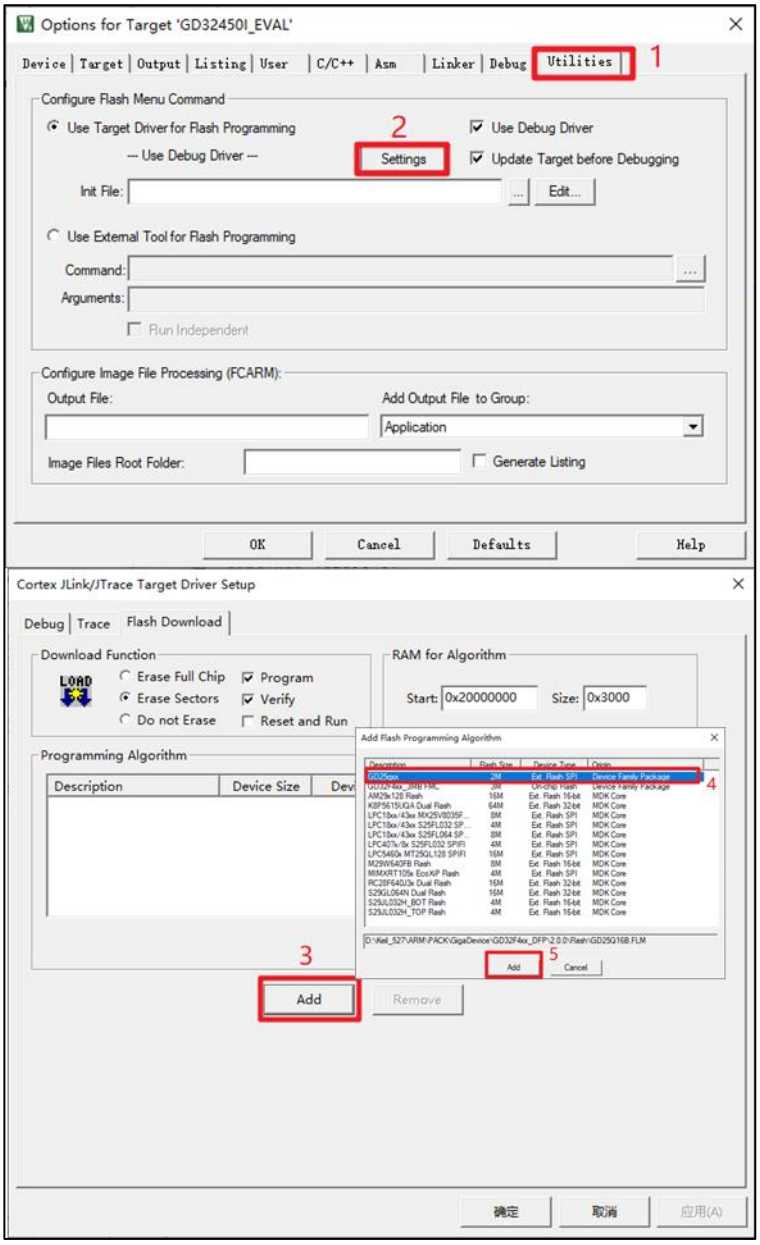
码如**表 3-4. 修改 pdsc 文件代码**红色所示：

表 3-4. 修改 pdsc 文件代码

```
<!-- ****************** Device 'GD32F450IK'   ****************** -->
<device Dname="GD32F450IK">
<memory   id="IROM1"    start="0x08000000" size="0x0300000" startup="1" default="1"/>
<memory   id="IRAM1"    start="0x20000000" size="0x030000" init ="0" default="1"/>
<memory   id="IRAM2" start="0x10000000" size="0x010000" init ="0" default="0"/>
<algorithm name="Flash/GD32F4xx_3MB.FLM" start="0x08000000" size="0x0300000" default="1"/>
<algorithm name="Flash/GD25Q16B.FLM"    start="0x00000000" size="0x01000000" default="1"/>
</device>
```

在 KEIL 工程，打开魔术棒 Utilities 页面 setting，添加 GD25qxx 算法，如***图 3-4. KEIL 中添加 GD25Qxx 下载算法***所示。

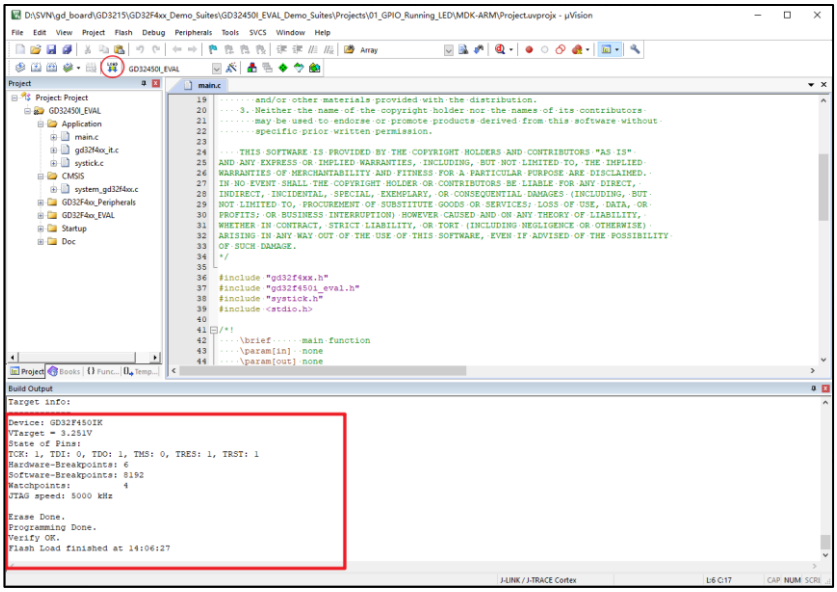
图 3-4. KEIL 中添加 GD25Qxx 下载算法



3.6. 编译和下载

在 KEIL 中编译工程，生成.axf 文件，点击 Download 按钮实现文件的下载，如*图 3-5. KEIL 中编译和下载文件到 SPI Flash* 所示，提示下载成功。

图 3-5. KEIL 中编译和下载文件到 SPI Flash



3.7. 测试和验证

为了确定文件是否成功下载到 GD25Q16BS Flash 中，参考 ***Jflash-SPI 上位机配置与下载***，通过 J-Flash SPI 上位机读取 Flash 中的数据，比较下载文件和读出文件是否相同，进行验证测试。

4. 历史版本

表 4-1. 历史版本

版本号.	描述	日期
1.0	首次发布	2021 年 04 月 30 日

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