GigaDevice Semiconductor Inc.

Arm® Cortex®-M3/4/23/33 32-bit MCU

Application Note
AN017
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1. **Introduction**

   This application note uses the GD32F450i-EVAL board, the target chip is GD25Q16BS SPI nor flash, and the file is downloaded to the GD25Qxx SPI nor flash through the J-FLASH SPI host computer or modified KEIL download algorithm.
2. Use J-Flash SPI host computer to download files to SPI Nor Flash

2.1. Hardware connection

JLink supports the SPI protocol and connects the six wires: VTref, GND, TDI (MOSI), TMS (nCS), TCK (CLK), and TDO (MISO) in JLink to the pins of SPI Nor Flash. This application note uses the GD25Q16BS SPI nor flash chip in the GD32F450i-EVAL V1.1 development board. According to the schematic diagram of the development board and the JTAG pin diagram, as shown in Figure 2-1. GD25Q16BS schematic diagram (left) and JTAG pin diagram (right), use the DuPont cable to connect the Jlink and the Flash hardware. The method is shown in Table 2-1. Jlink and SPI Flash hardware connection.

Figure 2-1. GD25Q16BS schematic diagram (left) and JTAG pin diagram (right)

Table 2-1. Jlink and SPI Flash hardware connection

<table>
<thead>
<tr>
<th>JTAG pin number and name</th>
<th>Connect to the pins of GD25Q16BS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 (VTref)</td>
<td>Board VCC</td>
</tr>
<tr>
<td>5 (TDI)</td>
<td>Board JP20 No. 3 pin (MOSI)</td>
</tr>
<tr>
<td>7 (TMS)</td>
<td>Board PI8 pin(CS)</td>
</tr>
<tr>
<td>9 (TCK)</td>
<td>Board JP13 No. 3 pin (SCK)</td>
</tr>
<tr>
<td>13 (TDO)</td>
<td>Board PG12 pin(MISO)</td>
</tr>
<tr>
<td>4 (GND)</td>
<td>Board GND</td>
</tr>
</tbody>
</table>

2.2. Jflash-SPI host computer configuration and download

First, double-click to open J-Flash SPI, as shown in Figure 2-2. J-Flash SPI software in SEGGER, and open the interface as shown in Figure 2-3. Open the J-Flash SPI software interface.
Use Jlink to download files to SPI Nor Flash

**Figure 2-2. J-Flash SPI software in SEGGER**

![Image of J-Flash SPI software in SEGGER]

**Figure 2-3. Open the J-Flash SPI software interface**

![Image of J-Flash SPI software interface]

Click "Target->Connect", the result is shown in the red block diagram in **Figure 2-4. Connect target SPI Flash**. At this time, the SPI Flash Id has been successfully read, but the connection failed. Next, the Flash related parameters will be configured.
Use Jlink to download files to SPI Nor Flash

Click "Options--->Project settings", select FLASH, and uncheck automatically detect SPI flash. The reference interface is shown in Figure 2-5, SPI Flash configuration interface.

Refer to the GD25Q16B datasheet and fill in the relevant parameters such as the Flash page size, block size, read and write commands, and the specific configuration is shown in Figure 2-6, GD25Q16B parameter configuration. After the configuration is complete, click "OK".
Click "Target-->Connect" again in the main interface, the result is shown in the red block diagram in Figure 2-7. JLink successfully connected to SPI Flash, and the relevant parameters are displayed on the left, and it prompts that JLink and Flash are successfully connected.
Use Jlink to download files to SPI Nor Flash

Figure 2-7. JLink successfully connected to SPI Flash

Click "File—>open data file" to open the binary file to be downloaded, as shown in Figure 2-8. **Open the downloaded binary file.**

Figure 2-8. Open the downloaded binary file

Click "Target—>Program", as shown in Figure 2-9. File download to Flash successful prompt, after the download is complete, it will prompt Target programmed successfully.
In order to verify whether the binary file is successfully downloaded to the Flash, through the “Target--->Read back--->Entire chip” operation, read the value of the address and compare it with the source file, as shown in Figure 2-10. Read data in Flash.

Figure 2-10. Read data in Flash
3. **Use KEIL to download files to SPI Nor Flash**

3.1. **New FLM project**

Enter the drive letter where KEIL is installed, copy the Keil\ARM\Flash\_Template project to the Test folder of Disk E (the folder location can be modified as needed), double-click to open the "NewDevice.uvproj" project, compile the project, the project will report an error "FlashDev.c(25): error: #5: cannot open source input file ".\FlashOS.H": No such file or directory", enter againFind the "FlashOS.h" file in the Keil\ARM\Flash directory, copy it to the "E:\Test\_Template" directory, and change the #include ".\FlashOS.H" in FlashDev.c and FlashPrg.c to #include "FlashOS.H", compile the project again, there is no error in the project, and generate NewDevicec.FLM. Related projects and compilation are shown in **Figure 3-1. New FLM project**.

![Figure 3-1. New FLM project](image)

3.2. **Porting SPI Flash driver code**

Open the FlashPrg.c file, which mainly contains seven function interfaces, as shown in **Table 3-1. FlashPrg.c function interface**.

<table>
<thead>
<tr>
<th>Function</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Init</td>
<td>Initialize Flash</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Table 3-1. FlashPrg.c function interface**
It mainly implements Init, EraseChip, EraseSector, ProgramPage and Verify function interfaces. The function interface implementation is shown in Table 3.2, Implementation of FlashPrg.c Function Interface.

Table 3.2. Implementation of FlashPrg.c Function Interface

```c
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 */
}
```
Use Jlink to download files to SPI Nor Flash

/* 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++)
The related SPI driver is added to the KEIL project according to GD32F4xx_Firmware_Library and GD25qxx.c, and the added files are shown in Figure 3-2. Porting SPI driver and GD25qxx file.

Figure 3-2. Porting SPI driver and GD25qxx file

### 3.3. Modify FlashDevice structure

Open the FlashDev.c file and modify the relevant content in the FlashDevice structure. The modified code is shown in Table 3-3, FlashDevice structure realization.

<table>
<thead>
<tr>
<th>Field</th>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>FLASH_DRV_VERS</td>
<td>&quot;GD25qxx&quot;</td>
<td>Driver Version, do not modify!</td>
</tr>
<tr>
<td>&quot;GD25qxx&quot;</td>
<td>&quot;Device Name&quot;</td>
<td></td>
</tr>
<tr>
<td>EXTSPI</td>
<td>&quot;Device Type&quot;</td>
<td></td>
</tr>
<tr>
<td>0x00000000</td>
<td>&quot;Device Start Address&quot;</td>
<td></td>
</tr>
<tr>
<td>0x00200000</td>
<td>&quot;Device Size in Bytes (2M)&quot;</td>
<td></td>
</tr>
<tr>
<td>256</td>
<td>&quot;Programming Page Size&quot;</td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>&quot;Reserved, must be 0&quot;</td>
<td></td>
</tr>
</tbody>
</table>

Table 3-3, FlashDevice structure realization

```c
spi_flash_buffer_read(readbuf,(readaddr+count*256),256);
for(len=0;len<256;len++)
{
    if(buf[len+count*256] != readbuf[len])
    {
        return count*256 + adr + len;
    }
}
return adr+sz;
```
Use Jlink to download files to SPI Nor Flash

```
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, 0x0030000, /* Sector Size 8kB (8 Sectors) */
SECTOR_END
```

3.4. Compile and generate FLM file

Open the magic wand, enter the Output page, modify the Name of Executable to GD25Q16B, compile the project, and generate the GD25Q16B.FLM file. As shown in Figure 3-3, Compile and generate GD25Q16B.FLM file.

Figure 3-3. Compile and generate GD25Q16B.FLM file
3.5. **Add algorithm file to KEIL project**

Copy the compiled GD25Q16B.FLM to the KEIL installation directory, D:\Keil_527\ARM\PACK\GigaDevice\GD32F4xx_DFP\2.0.0\Flash, and then return to the upper-level directory to open the GigaDevice.GD32F4xx_DFP.pdsc file and modify its attributes. To read and write, find GD32F450IK, add the code as shown in red in **Table 3-4.**

**Modify the pdsc file code.**

**Table 3-4. Modify the pdsc file code**

```xml
<device Dname="GD32F450IK">
  <memory id="IROM1" start="0x08000000" size="0x0300000" startup="1" default="1"/>
  <memory id="IRAM1" start="0x20000000" size="0x0300000" init="0" default="1"/>
  <memory id="IRAM2" start="0x10000000" size="0x0100000" 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>
```

In the KEIL project, open the magic wand Utilities page setting, and add the GD25qxx algorithm, as shown in **Figure 3-4. Add GD25Qxx download algorithm to KEIL.**
3.6. **Compile and download**

Compile the project in KEIL, generate the .axf file, click the Download button to download the file, as shown in Figure 3-5. *Compile and download files in KEIL to SPI Flash*, indicating that the download is successful.
Use Jlink to download files to SPI Nor Flash

3.7. Testing and verification

In order to determine whether the file is successfully downloaded to the GD25Q16BS Flash, refer to JFlash-SPI host computer configuration and download, read the data in Flash through the J-Flash SPI host computer, compare whether the downloaded file and the read file are the same, and perform a verification test.
4. Revision history

Table 4-1. Revision history

<table>
<thead>
<tr>
<th>Revision No.</th>
<th>Description</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>Initial Release</td>
<td>Apr.30, 2021</td>
</tr>
</tbody>
</table>
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