

如何使用闪存重新映射功能

URL: <https://www.nxp.com/docs/en/application-note/AN12255.pdf>

1. 产品介绍

i.MXRT1060芯片支持闪存重新映射功能，允许用户将闪存地址重新映射到FlexSPI接口。

闪存重新映射功能为以下使用案例带来了好处：

- 要闪存多个固件；
- 在满足某条件时，切换其中一个固件以运行；
- 要更新无线应用程序中的固件（通常的过程是下载固件到闪存，执行有效性检查，然后切换到新的固件以运行。闪存重新映射功能可以帮助在固件位于XIPflash的任何地方直接运行固件。）

本文档介绍如何使用闪存重新映射功能。

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2. 产品概述

闪存重映射功能仅在XIPflash上工作，它通过FlexSPI与闪存接口。该函数可以将当前的闪存地址重新映射到预期的地址。

3. 如何使用闪存重新映射功能

闪存重新映射功能提供了三个寄存器，以设置开始、结束和偏移地址。设置该地址后，可将其重新映射到指定的闪存地址。

3.1. 闪存地址重新映射设置

闪存重新映射设置有三个寄存器。

表1 闪存地址重新映射设置

寄存器名称	描述
IOMUXC_GPR_GPR30	指定flexspi1 和flexspi2的起始地址
IOMUXC_GPR_GPR31	指定flexspi1 和flexspi2的结束地址
IOMUXC_GPR_GPR32	指定flexspi1 和flexspi2的偏移地址

当 $ADDR_START[31:12] \leq Addr_i[31:12] < ADDR_END[31:12]$ 时，重新映射的地址必须是 $Addr_o = Addr_i[31:12] + \{偏移量[31:12], 12'h0\}$ 。否则， $Addr_o = Addr_i$ ，其中 $Addr_i$ 表示原始访问地址， $Addr_o$ 表示重新映射的地址。

例如：

不要设置任何FlexSPI重新映射寄存器，那么它会获取相应访问地址的闪存内容。不要进行任何重新映射。

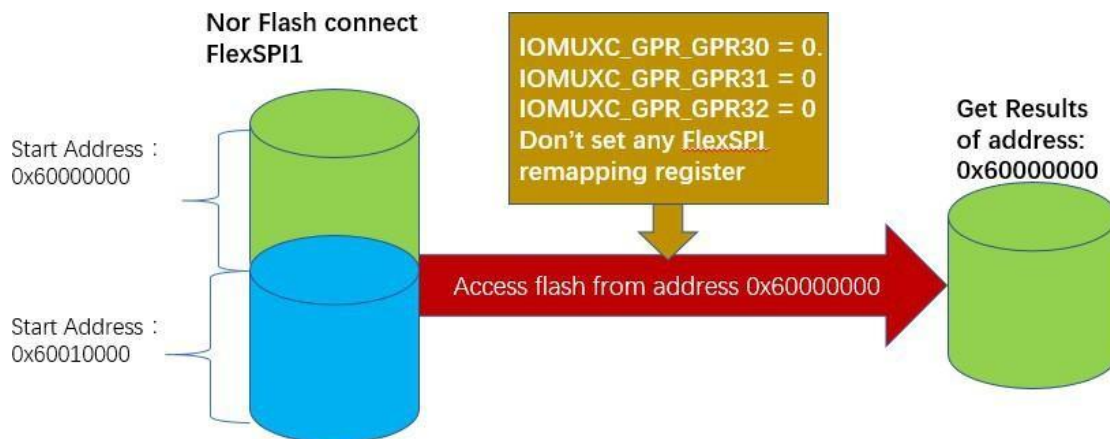


图1.不使用重新映射设置来访问FlexSPI

设置重新映射寄存器后，当尝试访问相同的闪存地址时，它将获取重新映射的地址内容。

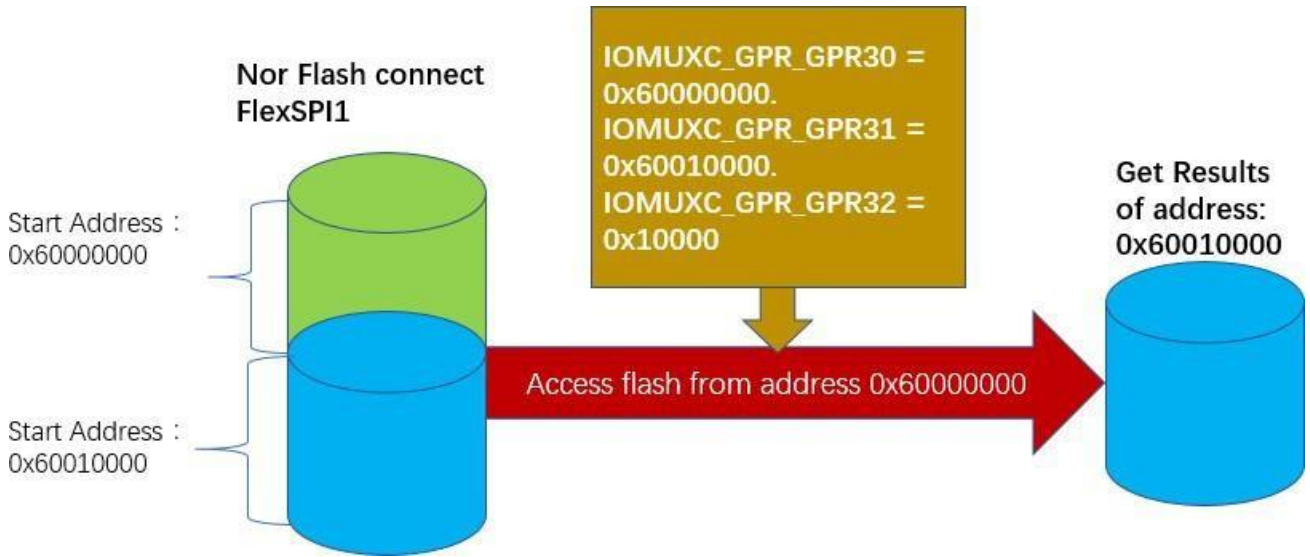


图2.使用重新映射的地址设置来访问FlexSPI

您可以从SW\src\boards\evkmimxrt1060\use_case\flash_remap_test\nor\polling_transfer\获得示例代码。在构建和运行项目后，图3显示了运行结果。

```

FLEXSPI example started!
Vendor ID: 0x16
Erasing Serial NOR on address 0x0...
Erasing Serial NOR on address 0x10000...
Erase data - successfully.

Read 16 bytes from flash address 0x60000000 ...
0x0,0x1,0x2,0x3,0x4,0x5,0x6,0x7,0x8,0x9,0xa,0xb,0xc,0xd,0xe,0xf,

Read 16 bytes from flash address 0x60010000 ...
0x80,0x81,0x82,0x83,0x84,0x85,0x86,0x87,0x88,0x89,0x8a,0x8b,0x8c,0x8d,0x8e,0x8f,

Set Flash remapping
Set Flash remapping start address is 0x60000000
Set Flash remapping end address is 0x60010000
Set Flash remapping offset is 0x10000
after enable flash remapping, re-read address 0x60000000

Read 16 bytes from flash address 0x60000000 ...
0x80,0x81,0x82,0x83,0x84,0x85,0x86,0x87,0x88,0x89,0x8a,0x8b,0x8c,0x8d,0x8e,0x8f,
    
```

Before enabling the flash remapping function, the contents flash address is 0x60000000 and 0x60010000.

Enabling the flash remapping function

After enabling the flash remapping function, the contents flash address is 0x60000000.

图3.闪存重新映射的运行结果

如图3所示，在读取相同的闪存地址（0x60000000）时，获取重映射的闪存地址内容（0x60001000），其中重映射的寄存器设置如下：

```
IOMUXC_GPR_GPR30 :0x60000000
IOMUXC_GPR_GPR31 :0x60010000
IOMUXC_GPR_GPR32 : 0x10000
```

3.2. ROM支持的闪存重新映射

通过fusion位的设置ROM支持闪存重新映射。

3.2.1. 闪存重新映射设置

ROM支持将两个固件下载到闪存上，并通过调用API函数轻松切换固件。要启用闪存重映射功能，可将以下fusion位熔断。

表1是FlexSPI重新映射设置的fusion位映射的一部分。

表2. FlexSPI1的fusion位定义

模块	地址	7	6	5	4	3	2	1	0
FlexSPI 1 - Serial NOR	0x6E0[7:0]	FLEXSPI_RESET_PIN_EN 0 - Disabled 1 - Enabled	JEDEC_HW_RESET_EN 0 - Disabled 1 - Enabled	xSPI FLASH HOLD TIME 0 – 500 us/1 - 1ms 2 – 3 ms/3 – 10 ms		xSPI FLASH BOOT FREQUENCY 0 – 100 MHz/1 – 120 MHz/2 – 133 MHz/3 - 166 MHz/4 - Reserved 5 – 80 MHz/6 – 60 MHz			SIP_TEST_EN
	0x6E0[15:8]	xSPI FLASH IMAGE SIZE 0-FLEXSPI_NOR_SEC_IMAGE_OFFSET*256 KB 1 - 12: 1 – 12 MB 13 – 256 KB, 14 - 512 KB, 15 - 768 KB				xSPI FLASH DUMMY CYCLE 0 - Auto probe Others - Dummy cycles (for example, 8 - 8 cycles)			
	0x6E0[23:16]	FLEXSPI_NOR_SEC_IMAGE_OFFSET[7:0] Actual offset = 256 KB * fuse value							

0x6E0[23: 16]指定图像偏移量，当它不是0时，将使能闪存重新映射。例如，如果image大小约为512KB，则fusion位设置为：0x6E0[23: 16]设置为2，0x6E0[15: 12]设置为0。

ROM为用户提供了轻松切换固件的API函数

这是引导加载程序API入口结构体。

```
typedef struct
{
    const uint32_t version;                //!< Bootloader version number const
    char *copyright;                       //!< Bootloader Copyright
    void (*runBootloader)(void *arg);      //!< Function to start the bootloader executing const uint32_t
    *reserved0;                             //!< Reserved
    const flexspi_nor_driver_interface_t *flexSpiNorDriver; //!< FlexSPI NOR Flash API const uint32_t *reserved1;
                                                //!< Reserved

    const clock_driver_interface_t *clockDriver; const
    rtwdog_driver_interface_t *rtwdogDriver; const
    wdog_driver_interface_t *wdogDriver; const uint32_t
    *reserved2;
} bootloader_api_entry_t;
```

用户可以通过API入口地址0x0020001c调用这些API函数。

一个例子如下：

```
g_bootloaderTree=(bootloader_api_entry_t*)(uint32_t*)0x0020001c;
```

引导加载器参数如下：

```
typedef union
{
    struct
    {
        uint32_t imageIndex : 4;
        uint32_t reserved : 12;
        uint32_t serialBootInterface : 4; uint32_t
        bootMode : 4;
        uint32_t tag : 8;
    } B;
    uint32_t U;
} run_bootloader_ctx_t;
```

imageIndex 定义了哪个image要被重新映射去运行。

其中一个例子如下：

```
run_bootloader_ctx_t boot_para;
boot_para.B.imageIndex = 1; // specified firmware index to 1
boot_para.B.serialBootInterface = kEnterBootloader_SerialInterface_USB; boot_para.B.bootMode =
kEnterBootloader_Mode_Default;
boot_para.B.tag = kEnterBootloader_Tag;
g_bootloaderTree->runBootloader( (void *)&boot_para ); // run the index 1 firmware
```

用户可以轻松地更改固件索引以切换固件。

3.2.2. 通过MFGTool烧录多个固件到闪存中

NXP提供了烧录工具，MFGTOOL，可在以下链接获得：

https://www.nxp.com/webapp/Download?colCode=FLASHLOADER-RT106x-1-GA&appType=license&Parent_nodeId=1517584717166704362897&Parent_pageType=product
https://cache.nxp.com.cn/secured/assets/downloads/en/programmers/FLASHLOADER-RT106x-1-GA.zip?gda_=1631531462_ac7044f27fff31d351bffedc8da4995e&fileExt=.zip

使用MFGTOOL，您可以通过USB接口下载固件到闪存中。详情请参见AN12108。

按照AN12108中所示的指南，MFGTOOL工具可以帮助将第一个固件下载到闪存中。

对于第二个固件，您需要按如下所述修改program_flexspinor_image_qspinor.bd文件。

1. 更改程序地址。第二个固件应该重新映射到地址0x60200000，如果固件重新映射到其他地址，则需要相应地修改地址值。

```
constants {
    kAbsAddr_Start= 0x60200000;
    kAbsAddr_lvt = 0x60201000;
    kAbsAddr_App = 0x60202000;
}
```

2. 擦除第二个固件的闪存地址空间。

```
#2 Erase flash as needed. erase
0x60200000..0x60400000;
```

3. 注释出“程序配置块”，因为闪存配置块默认地址为0x60000000，它不需要为第二个固件重新编程，也可以通过将BOOT_CFG[0]设置为1来启用自动探测。

```
#3. Program config block
# 0xf000000f is the tag to notify Flashloader to program FlexSPI NOR config block to the start of device
#load 0xf000000f > 0x3000;
# Notify Flashloader to response the option at address 0x3000 #enable flexspinor
0x3000;
```

4. 用于重新映射设置的fusion编程。

将以下命令添加到bd文件中，用于保险编程。

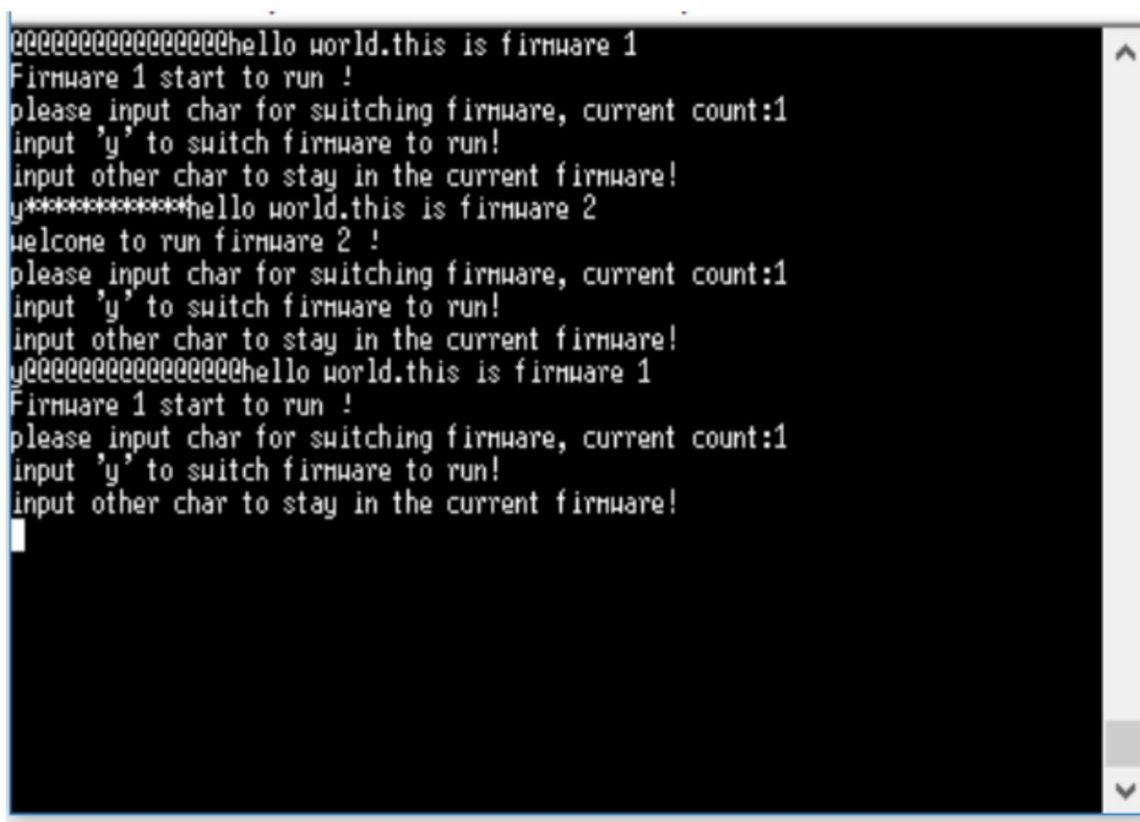
```
#7. set offset address8*256K load  
fuse 0x00080000 > 0x2e;
```

您可以按照上述步骤修改bd文件，也可以直接使用附带的bd文件 `program_flexspinor_image_qspi_flash_offset_2M.bd`，生成二级固件的sb文件。附加的软件包包含用于测试的s-record文件，其中 `firmware_swap1.srec` 用于固件1，`firmware_swap2.srec` 用于固件2。

您可以在 `SW\src\boards\levkmimxrt1060\use_case\firmware_swap\` 获得源码。

在这两个固件被烧录到闪存后，运行第一个固件并输入字符y来切换另一个固件。

图4显示了正在运行的结果。

A terminal window showing the execution of two firmware versions. The output is as follows:

```
hello world.this is firmware 1  
Firmware 1 start to run !  
please input char for switching firmware, current count:1  
input 'y' to switch firmware to run!  
input other char to stay in the current firmware!  
y*****hello world.this is firmware 2  
welcome to run firmware 2 !  
please input char for switching firmware, current count:1  
input 'y' to switch firmware to run!  
input other char to stay in the current firmware!  
yhello world.this is firmware 1  
Firmware 1 start to run !  
please input char for switching firmware, current count:1  
input 'y' to switch firmware to run!  
input other char to stay in the current firmware!
```

图4.固件交换的运行结果

4. 结论

本文档介绍了如何在i.MXRT1060上使用闪存重新映射功能。闪存重新映射功能给切换固件的应用带来了好处，特别是通过oOn The Air(OTA)的固件升级。该功能使用方便，可提供高可靠性的能力。

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