# Vector Table的重新映射

NuMicro® 32 位系列微控制器范例代码介绍

## 文件信息

| | |
|---|---|
| 代码简述 | 透过 Vector table 的重新映像，实现两套程序相互切换执行 |
| BSP 版本 | NUC123 Series BSP CMSIS V3.01.001 |
| 开发平台 | NuTiny-EVB-123-LQFP64_V1.0 |

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# 1 功能介绍

## 1.1 简介

Nuvoton NUC123系列微控制器提供重新映像Vector table的功能，开发者可以将两套程序分别下载到APROM不同的位置。透过重新映像Vector table与函式指标的方式，达到两套程序可以相互切换执行。

## 1.2 原理

由于Cortex-M0规范Vector table必须放置于地址0的位置，若有两套程序需要在APROM切换执行，将会有地址覆盖的问题发生。此时，可以将两套程序的地址适当的安排于APROM中，再透过重新映像Vector table地址，避免地址覆盖造成程序错误。
本范例分为APP1与APP2，APP1的地址为0x0，APP2的地址为0x3000，如图 1-1所示。当APP1执行完毕，首先重置周边IPs，接着使用ISP指令将0x3000的地址映像至0x0的位置，并且将堆栈指针设为0x3000地址的值。完成上述步骤后，可切换至APP2执行，即使用指标函式跳至APP2的Reset函式(0x3000+0x4)。当APP2执行完毕，切换至APP1的步骤与上述相同，但必需将映射0x3000至0x0的设定复原，且堆栈指针设为0x0地址的值。

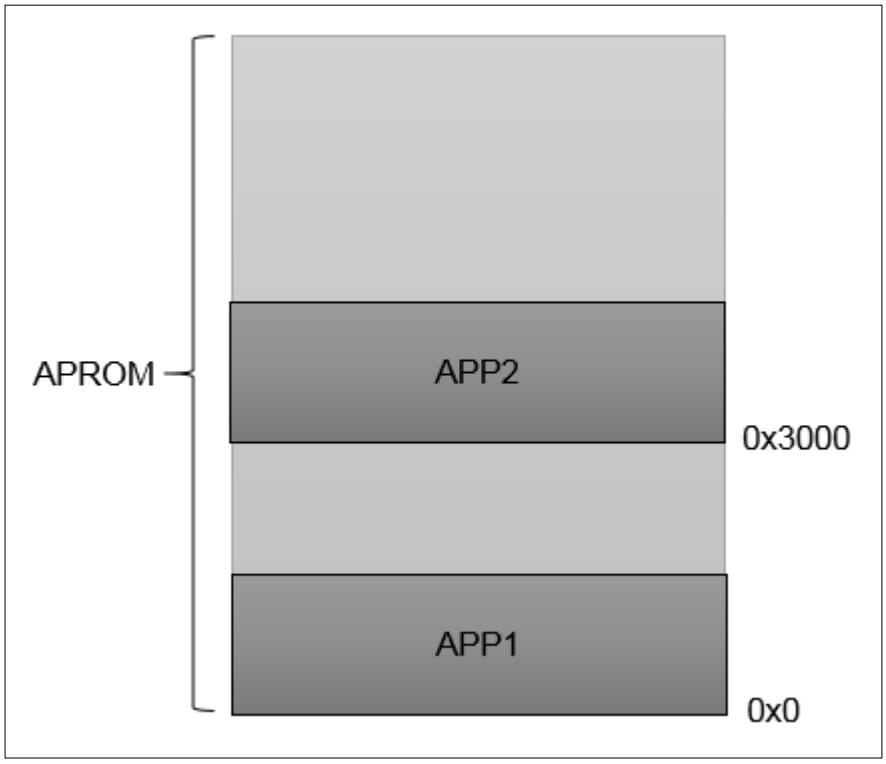


图 1-1 Memory map

## 1.3 执行结果

APP1与APP2分别印出不同的字符串，并且toggle PB4脚位使LED灯闪烁，APP1 toggle频率较快，APP2较慢，如图 1-2所示。经由打印的字符串以及LED灯闪烁的频率，可以观察到APP1

与APP2不断的切换执行。

```
/*---------------------------------------------------------------*/
/***   NUC123 Change Vector Table Address Sample Code(App1)  ***/
/*---------------------------------------------------------------*/
/*---------------------------------------------------------------*/
/***   NUC123 Change Vector Table Address Sample Code(App2)  ***/
/*---------------------------------------------------------------*/
/*---------------------------------------------------------------*/
/***   NUC123 Change Vector Table Address Sample Code(App1)  ***/
/*---------------------------------------------------------------*/
/*---------------------------------------------------------------*/
/***   NUC123 Change Vector Table Address Sample Code(App2)  ***/
/*---------------------------------------------------------------*/
```

图 1-2 Massage on the terminal

# 2 代码介绍

## 2.1 APP1

打印讯息与闪烁 LED

```
    printf("/*****************************************************************/\n");
    printf("/***   NUC123 Change Vector Table Address Sample Code(App1)  ***/\n");
    printf("/*****************************************************************/\n");

    /* Set GPIO to output mode */
    GPIO_SetMode(PB, BIT4, GPIO_PMD_OUTPUT);

    /* Flashing LED */
    while(u8LEDFlashNum--)
    {
        PB4 = 0;
        for(i = 0; i < LED_TIME_LENGTH; i++);
        PB4 = 1;
        for(i = 0; i < LED_TIME_LENGTH; i++);
    }
```

初始化周边 IPs 与重新映像地址

```
    /* Reset IPs */
    SYS->IPRSTC1 = SYS_IPRSTC1_PDMA_RST_Msk;
    SYS->IPRSTC2 = (SYS_IPRSTC2_I2S_RST_Msk|SYS_IPRSTC2_ADC_RST_Msk
                   |SYS_IPRSTC2_USBD_RST_Msk|SYS_IPRSTC2_PS2_RST_Msk
                   |SYS_IPRSTC2_PWM03_RST_Msk|SYS_IPRSTC2_UART1_RST_Msk
                   |SYS_IPRSTC2_UART0_RST_Msk|SYS_IPRSTC2_SPI2_RST_Msk
                   |SYS_IPRSTC2_SPI1_RST_Msk|SYS_IPRSTC2_SPI0_RST_Msk
                   |SYS_IPRSTC2_I2C1_RST_Msk|SYS_IPRSTC2_I2C0_RST_Msk
                   |SYS_IPRSTC2_TMR3_RST_Msk|SYS_IPRSTC2_TMR2_RST_Msk
                   |SYS_IPRSTC2_TMR1_RST_Msk|SYS_IPRSTC2_TMR0_RST_Msk
                   |SYS_IPRSTC2_GPIO_RST_Msk);
    SYS->IPRSTC1 &= ~SYS_IPRSTC1_PDMA_RST_Msk;
    SYS->IPRSTC2 &= ~(SYS_IPRSTC2_I2S_RST_Msk|SYS_IPRSTC2_ADC_RST_Msk
                   |SYS_IPRSTC2_USBD_RST_Msk|SYS_IPRSTC2_PS2_RST_Msk
                   |SYS_IPRSTC2_PWM03_RST_Msk|SYS_IPRSTC2_UART1_RST_Msk
                   |SYS_IPRSTC2_UART0_RST_Msk|SYS_IPRSTC2_SPI2_RST_Msk
                   |SYS_IPRSTC2_SPI1_RST_Msk|SYS_IPRSTC2_SPI0_RST_Msk
                   |SYS_IPRSTC2_I2C1_RST_Msk|SYS_IPRSTC2_I2C0_RST_Msk
                   |SYS_IPRSTC2_TMR3_RST_Msk|SYS_IPRSTC2_TMR2_RST_Msk
                   |SYS_IPRSTC2_TMR1_RST_Msk|SYS_IPRSTC2_TMR0_RST_Msk
                   |SYS_IPRSTC2_GPIO_RST_Msk);
```

```
    /* Remap vector table address to APP2 address */
    CLK->APBCLK |= CLK_AHBCLK_ISP_EN_Msk;
    FMC->ISPCON |= FMC_ISPCON_ISPEN_Msk;
    FMC->ISPCMD = FMC_ISPCMD_VECMAP;
    FMC->ISPADR = APP2_ADDR;
    FMC->ISPTRG |= FMC_ISPTRG_ISPGO_Msk;
```

重设堆栈指针与执行 APP2

```
    /* Set stack pointer to the value stored in APP2 address */
    pu32SP = (uint32_t *)APP2_ADDR;
    spChange(pu32SP);

    /* Execute another application */
    func = (FUNC_PTR *)(*(uint32_t *)(APP2_ADDR+ 4));
    func();
```

## 2.2 APP2

打印讯息与闪烁 LED

```
    printf("/*****************************************************************/\n");
    printf("/***   NUC123 Change Vector Table Address Sample Code(App2)  ***/\n");
    printf("/*****************************************************************/\n");

    /* Set GPIO to output mode */
    GPIO_SetMode(PB, BIT4, GPIO_PMD_OUTPUT);

    /* Flashing LED */
    while(u8LEDFlashNum--)
    {
        PB4 = 0;
        for(i = 0; i < LED_TIME_LENGTH; i++);
        PB4 = 1;
        for(i = 0; i < LED_TIME_LENGTH; i++);
    }
```

初始化周边 IPs 与重新映像地址

```
    /* Reset IPs */
    SYS->IPRSTC1 = SYS_IPRSTC1_PDMA_RST_Msk;
    SYS->IPRSTC2 = (SYS_IPRSTC2_I2S_RST_Msk|SYS_IPRSTC2_ADC_RST_Msk
                   |SYS_IPRSTC2_USBD_RST_Msk|SYS_IPRSTC2_PS2_RST_Msk
                   |SYS_IPRSTC2_PWM03_RST_Msk|SYS_IPRSTC2_UART1_RST_Msk
                   |SYS_IPRSTC2_UART0_RST_Msk|SYS_IPRSTC2_SPI2_RST_Msk
                   |SYS_IPRSTC2_SPI1_RST_Msk|SYS_IPRSTC2_SPI0_RST_Msk
                   |SYS_IPRSTC2_I2C1_RST_Msk|SYS_IPRSTC2_I2C0_RST_Msk
                   |SYS_IPRSTC2_TMR3_RST_Msk|SYS_IPRSTC2_TMR2_RST_Msk
                   |SYS_IPRSTC2_TMR1_RST_Msk|SYS_IPRSTC2_TMR0_RST_Msk
                   |SYS_IPRSTC2_GPIO_RST_Msk);
    SYS->IPRSTC1 &= ~SYS_IPRSTC1_PDMA_RST_Msk;
    SYS->IPRSTC2 &= ~(SYS_IPRSTC2_I2S_RST_Msk|SYS_IPRSTC2_ADC_RST_Msk
                   |SYS_IPRSTC2_USBD_RST_Msk|SYS_IPRSTC2_PS2_RST_Msk
                   |SYS_IPRSTC2_PWM03_RST_Msk|SYS_IPRSTC2_UART1_RST_Msk
                   |SYS_IPRSTC2_UART0_RST_Msk|SYS_IPRSTC2_SPI2_RST_Msk
                   |SYS_IPRSTC2_SPI1_RST_Msk|SYS_IPRSTC2_SPI0_RST_Msk
                   |SYS_IPRSTC2_I2C1_RST_Msk|SYS_IPRSTC2_I2C0_RST_Msk
                   |SYS_IPRSTC2_TMR3_RST_Msk|SYS_IPRSTC2_TMR2_RST_Msk
                   |SYS_IPRSTC2_TMR1_RST_Msk|SYS_IPRSTC2_TMR0_RST_Msk
                   |SYS_IPRSTC2_GPIO_RST_Msk);

    /* Remap vector table address to 0x0 */
    CLK->APBCLK |= CLK_AHBCLK_ISP_EN_Msk;
    FMC->ISPCON |= FMC_ISPCON_ISPEN_Msk;
    FMC->ISPCMD = FMC_ISPCMD_VECMAP;
    FMC->ISPADR = APP1_ADDR;
    FMC->ISPTRG |= FMC_ISPTRG_ISPGO_Msk;
```

重设堆栈指针与执行 APP1

```
    /* Set stack pointer to the value stored in APP1 address */
    pu32SP = (uint32_t *)APP1_ADDR;
    spChange(pu32SP);

    /* Execute another application */
    func = (FUNC_PTR *)(*(uint32_t *)(APP1_ADDR+ 4));
    func();
```

# 3 软件与硬件环境

- 软件环境
  - BSP 版本
    - NUC123 Series BSP CMSIS V3.01.001
  - IDE 版本
    - Keil uVersion 5.26
  - IDE 环境设定
    - APP1 linker (R/O Base: 0x00000000, R/W Base: 0x20000000)，如图 3-1 所示

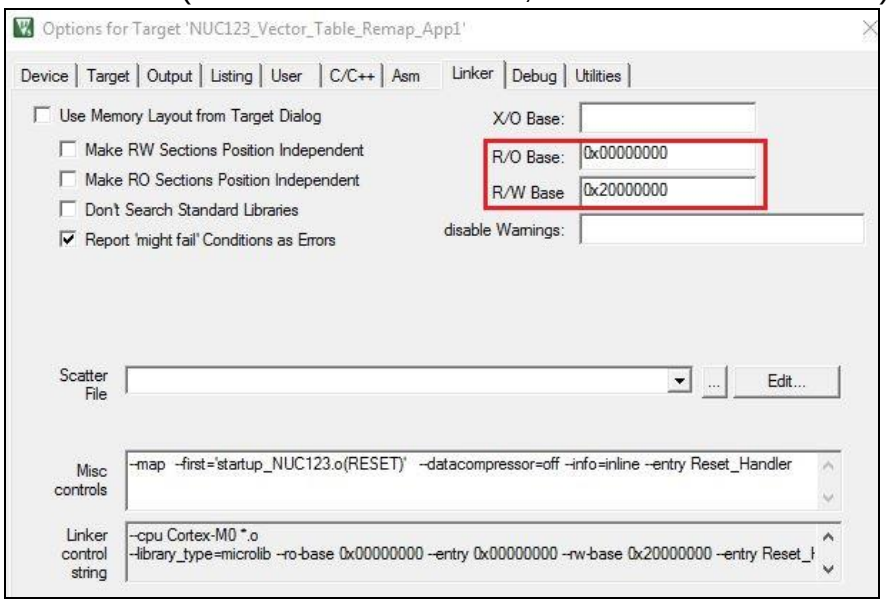


图 3-1 APP1 linker setting

- APP2 linker (R/O Base: 0x00003000, R/W Base: 0x20000000)，如图 3-2 所示

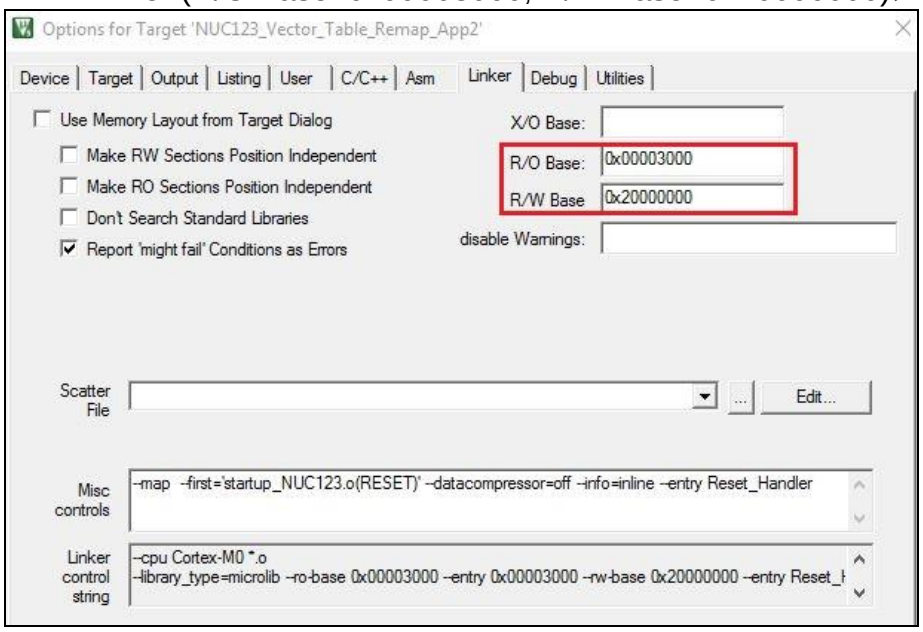


图 3-2 APP2 linker setting

## 硬件环境

- 电路组件
  - NuTiny-EVB-123-LQFP64_V1.0

# 4 目录信息

- EC_NUC123_Vector_Table_Remap_V1.00
  - Library — Sample code header and source files
    - CMSIS — Cortex® Microcontroller Software Interface Standard (CMSIS) by Arm® Corp.
    - Device — CMSIS compliant device header file
    - StdDriver — All peripheral driver header and source files
  - SampleCode
    - ExampleCode — Source file of example code

# 5 如何执行范例程序

1. 根据目录信息章节进入 ExampleCode 路径中的 KEIL 文件夹，双击 NUC123_Vector_Table_Remap_App1.uvprojx
2. 进入编译模式接口
   a. 编译
   b. 下载代码至内存
3. 双击 NUC123_Vector_Table_Remap_App2.uvprojx
4. 进入编译模式接口
   c. 编译
   d. 下载代码至内存

# 6 修订纪录

| Date | Revision | Description |
|---|---|---|
| Aug. 7, 2019 | 1.00 | 1. 初始发布. |

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