在 RTX 下利用 PDMA 存取 SPI Flash

NuMicro® 32 位系列微控制器范例代码介绍

文件信息

代码简述	示范如何在一个 RTX 系统下使用 PDMA 存取 SPI Flash
BSP 版本	NUC230/240 Series BSP CMSIS v3.01.002
开发平台	NuEdu-EVB-NUC240 V2.1 NuEdu-Basic01 V2.1

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1 功能介绍

1.1 简介

此范例程序将示范如何在 NuMicro® NUC240 系列 MCU 上运行 RTX 系统，并透过 PDMA 来存取 SPI Flash。

1.2 原理

Keil RTX 是一套专为 ARM 和 Cortex-M 硬件装置设计的免付费版本的实时操作系统。这套系统允许开发者可创建同时执行多个功能的程序，并帮助创建结构更好且更易于维护的应用程序。Keil RTX 的详细功能和优点可参考官网，http://www.keil.com/arm/rl-arm/kernel.asp。

此示例代码实现了使用 NuMicro® NUC240 MCU 在 NuEdu-EVB-NUC240 V2.1 电路板上移植 Keil RTX，并创建了一个 RTX 任务，以便在 NuEdu-Basic01 V2.1 电路板上使用 PDMA 读取外部 SPI Flash。
NuEdu-Basic01 V2.1 板的相关驱动程序位于 BSP\Library\NuEdu 文件夹内。

下列 图 1-1 展示了此示例代码的操作流程。

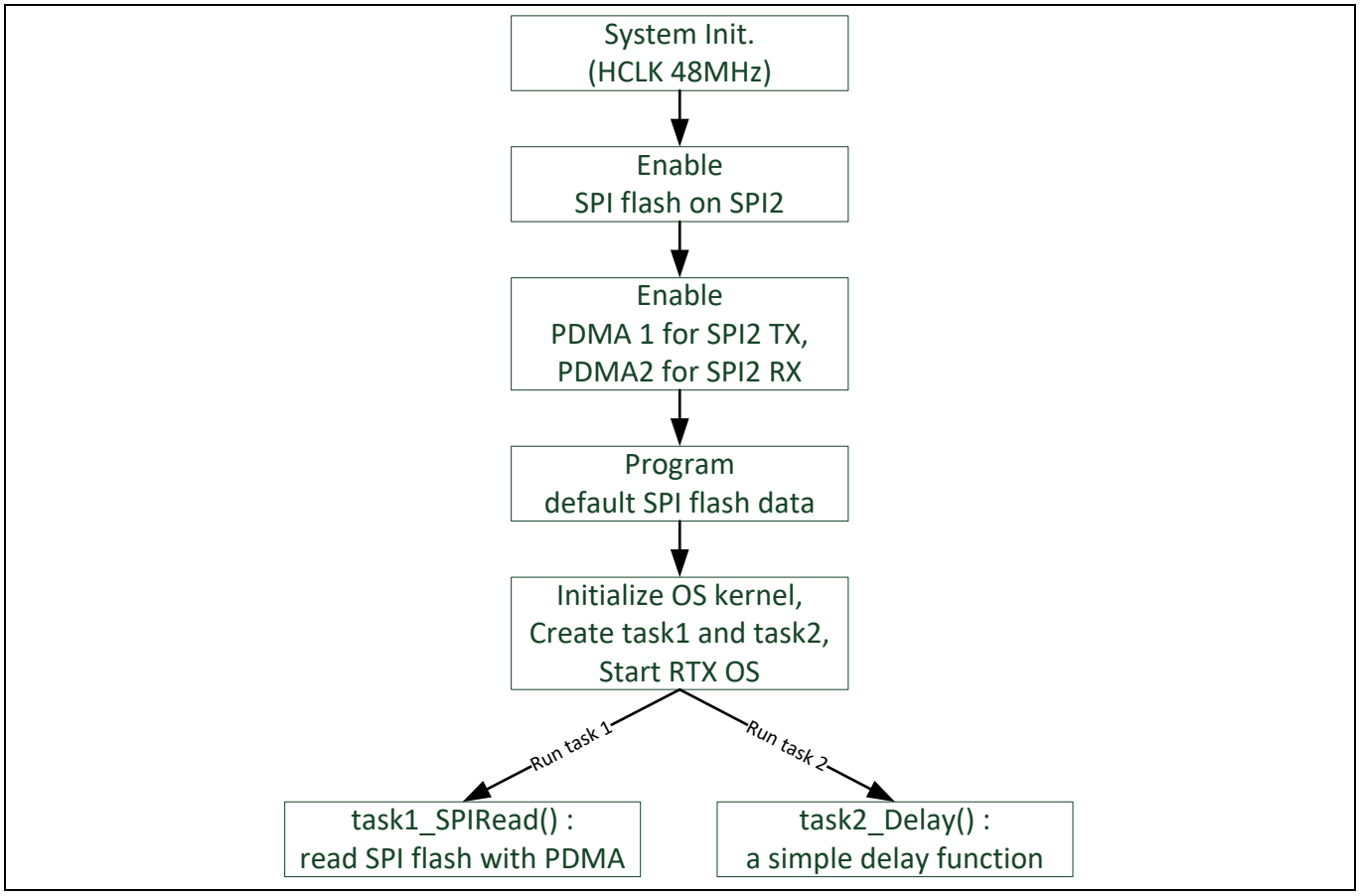

图 1-1 操作流程图

1.3 执行结果

程序执行结果可经由串口鲍率 115200 的输出到 PC 做显示，如下图 1-2 所示。

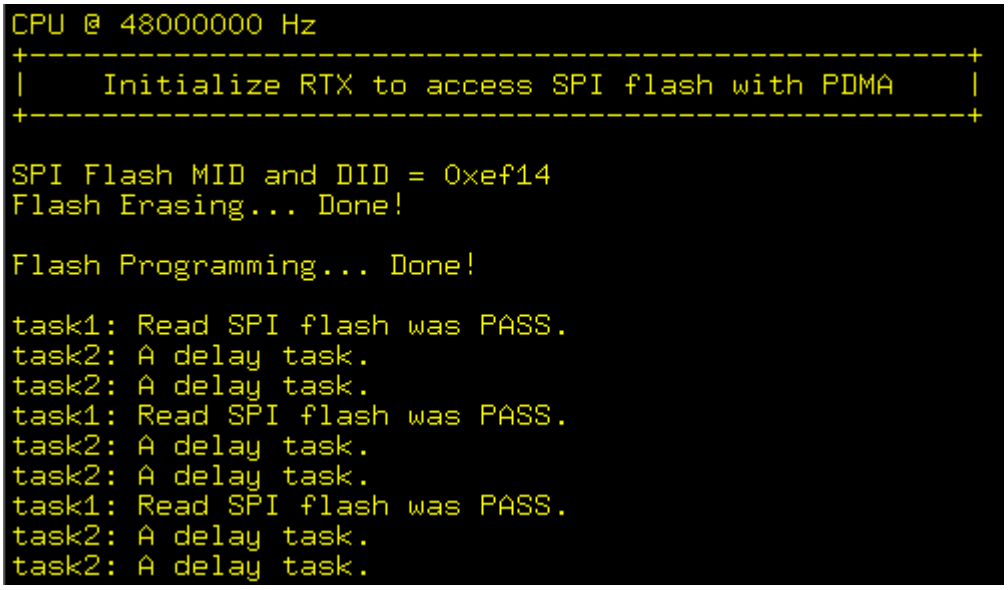

图 1-2 串口执行结果

2 代码介绍

在 main.c 内和 RTC 系统有关的变量和函式说明。

```
osThreadId  t_task1; /* thread ID of task 1 */
osThreadId  t_task2; /* thread ID of task 2 */

void task1_SPIRead(void const *argument); /* thread function of task 1 */
void task2_Delay(void const *argument);   /* thread function of task 2 */

/* Thread Definition with function, priority, and stack requirements */
osThreadDef(task1_SPIRead, osPriorityNormal, 1, 0);
osThreadDef(task2_Delay, osPriorityNormal, 1, 0);

/*-------------------------------------------------------------------------------------
-----------------*/
/* task 1 function: read SPI flash with PDMA
*/
/*-------------------------------------------------------------------------------------
-----------------*/
void task1_SPIRead(void const *argument)
{
    ……
}

/*-------------------------------------------------------------------------------------
-----------------*/
/* task 2 function: a simple delay function
*/
/*-------------------------------------------------------------------------------------
-----------------*/
void task2_Delay(void const *argument)
{
    ……
}
```

在 main.c 内初始化 PDMA 和 SPI 功能，并写入 SPI Flash 的默认数据。

大部分在函式 InitSPIFlashDataAndPDMA( ) 内被调用的 API 是直接引用 NuEdu 驱动程序库内的 NuEdu-Basic01_SPI_Flash_w_PDMA.c。

```
void InitSPIFlashDataAndPDMA(PDMA_T *pdma)
{
    unsigned int u32ByteCount;
```

```
    unsigned int u32MidDid;

    /* Initial PDMA Channels */
    Init_PDMA_CH1_for_SPI2_TX((uint32_t)gau32SrcArray);
    Init_PDMA_CH2_for_SPI2_RX((uint32_t)gau32DestArray);

    /* Enable PDMA IRQ */
    NVIC_EnableIRQ(PDMA_IRQn);

    /* Read MID & DID */
    u32MidDid = SpiFlash_w_PDMA_ReadMidDid();
    printf("\nSPI Flash MID and DID = 0x%x", u32MidDid);

    /* Erase SPI Flash */
    SpiFlash_w_PDMA_ChipErase();
    printf("\nFlash Erasing... ");

    /* Wait ready */
    SpiFlash_w_PDMA_WaitReady();
    printf("Done!");

    /* Fill the Source Data and clear Destination Data Buffer */
    for (u32ByteCount = 0; u32ByteCount < 256; u32ByteCount++)
        gau32SrcArray[u32ByteCount] = ((u32ByteCount+0x10)&0xFF);

    /*=== Program SPI Flash ===*/
    printf("\n\nFlash Programming... ");

    /* Trigger PDMA specified Channel */
    pdma->CSR |= (PDMA_CSR_TRIG_EN_Msk | PDMA_CSR_PDMACEN_Msk);

    /* Page Program */
    SpiFlash_w_PDMA_PageProgram(0x0, 256);
    SpiFlash_w_PDMA_WaitReady();
    printf("Done!\n\n");
}
```

初始化 RTOS，创建任务并启动 RTOS 以运行 main.c 中的所有任务。

```
    /* Initialize RTOS */
```

```
    osKernelInitialize();


    /* Create task1 to read SPI flash with PDMA channel 2, and task 2 as a simple delay
loop */
    t_task1 = osThreadCreate(osThread(task1_SPIRead), PDMA_CH2);
    t_task2 = osThreadCreate(osThread(task2_Delay), NULL);


    /* Start the RTOS */
    osKernelStart();
```

3 软件与硬件环境

- 软件环境
  - BSP 版本
    - NUC230/240 Series BSP CMSIS v3.01.002
  - IDE 版本
    - Keil uVersion 5.28
- 硬件环境
  - 电路组件
    - NuEdu-EVB-NUC240 V2.1
    - NuEdu-Basic01 V2.1
  - 示意图
    - 将 NuEdu-Basic01 V2.1 板上的 NUC240 UART TX (PB.1) 引脚连接到 PC UART RX，以在 PC 上显示示例代码的执行结果。

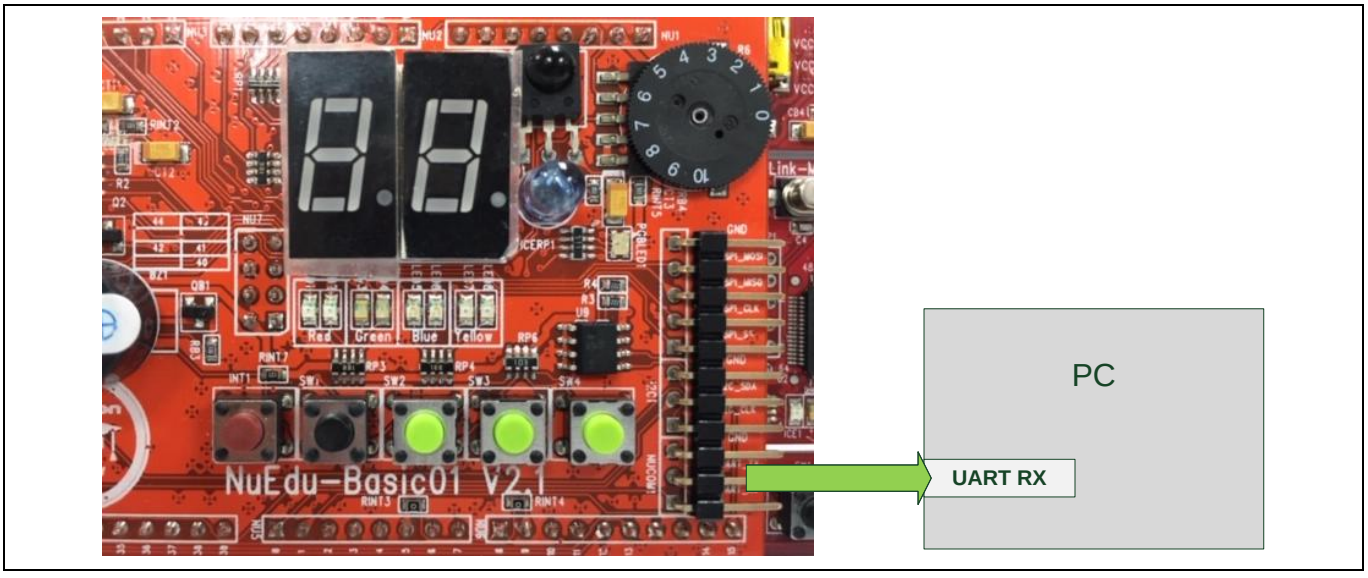

图 3-1 NUC240 UART TX 和 PC UART RX 连接

- 将 NuEdu-EVB-NUC240 V2.1 板上的 NUC240 SPI2 引脚连接到 NuEdu-Basic01 V2.1 板上的外部 SPI Flash。

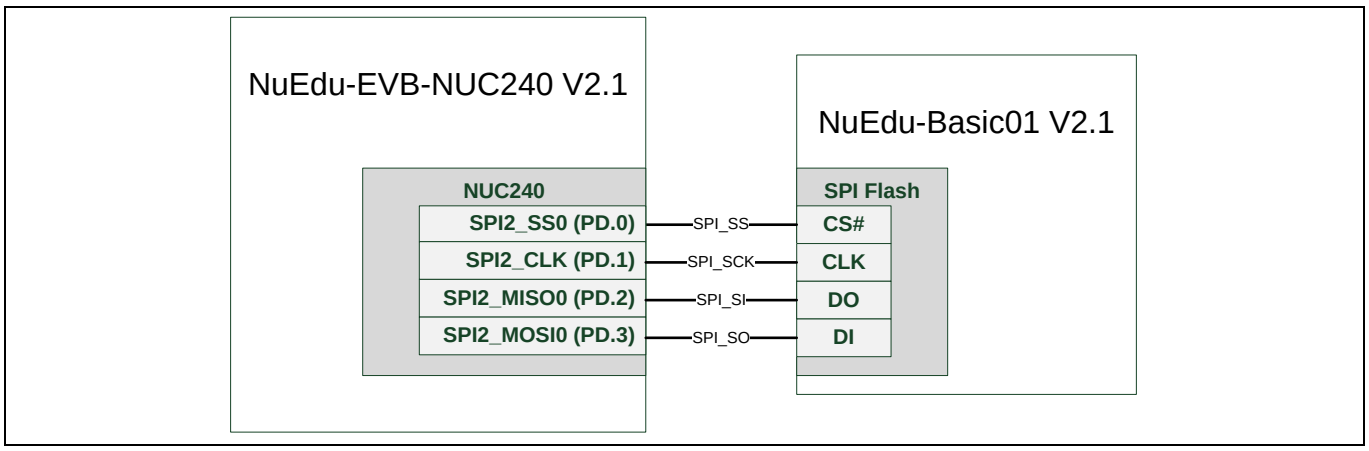

图 3-2 NUC240 SPI2 和 外部 SPI Flash 连接

4 目录信息

- EC_NUC240_RTX_SPI_Flash_wPDMA_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
    - NuEdu — Library for NuEdu-SDK-xxxx board
    - 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 RTX_SPI_Flash_wPDMA.uvprojx。
2. 进入编译模式接口
   a. 编译
   b. 下载代码至内存
   c. 进入 / 离开除错模式
3. 进入除错模式接口
   a. 执行代码

6 修订纪录

Date	Revision	Description
Aug 21, 2019	1.00	1. 初始发布。

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