在Keil RTX下以多工的方式存取EEPROM

NuMicro® 32 位系列微控制器範例代碼介紹

文件資訊

代碼簡述	本代碼示範在 Keil RTX 程式下以多工的方式存取 EEPROM。
BSP 版本	NUC230_240 Series BSP CMSIS V3.01.001
開發平台	NuEdu-EVB-NUC240 V2.1 NuEdu-Basic01 V2.1

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1 功能介紹

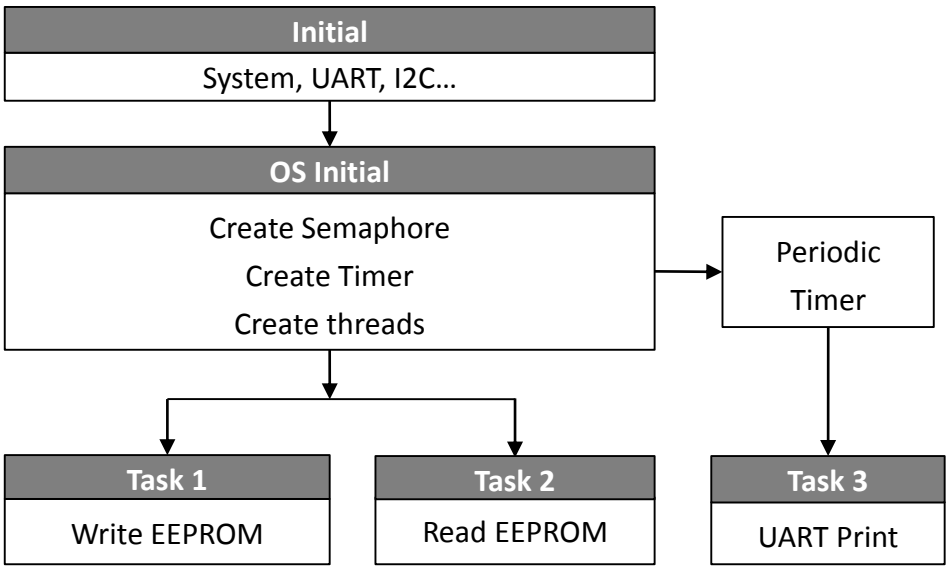
1.1 簡介

當微控制器程式需同時執行許多任務時，可使用實時操作系統(real-time operating system，RTOS)來管理這些任務。RTOS將CPU的處理時間切割成許多時隙 (time slots)，每個時隙進行不同的任務，並且在每個時隙之間進行任務的切換。因為任務間的切換在一秒鐘內可以達到上百次，整體看起來像是這些任務是同時在執行。當程式比較複雜需要許多任務同時執行，就可使用RTOS協助建立和管理這些任務。

Keil MDK (Microcontroller Development Kit) 內建的CMSIS-RTOS，為底層 RTOS和上層應用程式提供一套標準API，包括Keil免費的RTX (Real-Time eXecutive) 核心。當其他RTOS也支援CMSIS-RTOS，透過共同標準的API，則可輕易將程式移植到其他RTOS平台。本範例代碼利用Keil裡提供的CMSIS-RTOS建立RTX核心的系統，進行EEPROM的讀寫。

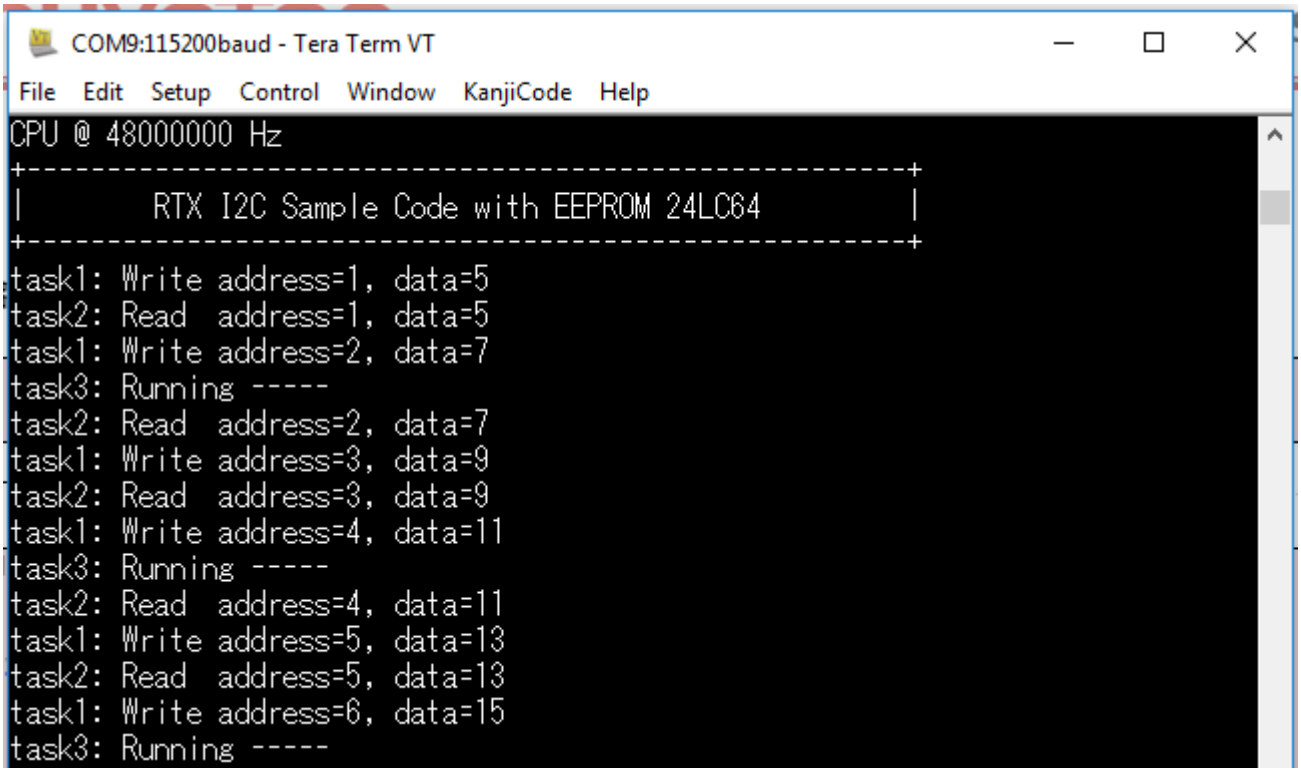
1.2 原理

程式首先做初始化，包括打印訊息的UART和存取EEPROM的I2C。建立一個Semaphore、一個Timer和兩個Thread。兩個Thread分別是對EEPROM的讀寫：其中一個 Thread先寫入資料，釋放一個Semaphore token；另外一個任務則等待完成EEPROM寫入的Semaphore token，再讀取EEPROM的資料。設定週期性的Timer，定時觸發UART打印訊息。

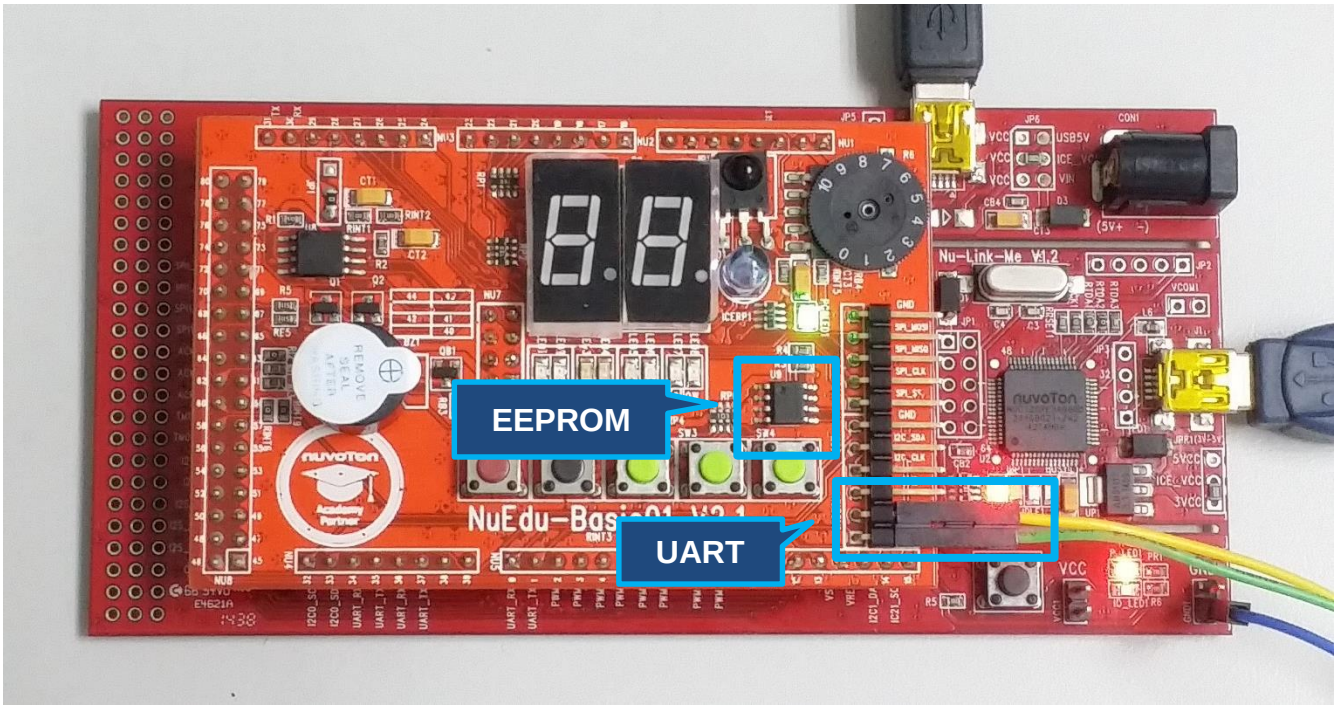


1.3 執行結果

NUC240開發板透過NuBridge連接到電腦，開啟電腦終端機，顯示UART打印的訊息。



下圖為NUC240開發版上EEPROM和UART的位置。



2 代碼介紹

2.1 RTX

Thread

本範例代碼有兩個平行處理的任務，分別宣告其函式原型，並為每個任務宣告各自的ID(t_task1和t_task2)。使用osThreadDef宣告每個任務為thread，也可以用來設定任務的優先等級。

```
/* Thread IDs */
osThreadId t_task1;     // Declare a thread ID for task 1 (EEPROM Write)
osThreadId t_task2;     // Declare a thread ID for task 2 (EEPROM Read)

/* Function Declaration */
void task1_EEPROMwrite(void const *argument);
void task2_EEPROMread(void const *argument);

/* Thread Definition with function, priority, and stack requirements */
osThreadDef(task1_EEPROMwrite, osPriorityNormal, 1, 0);
osThreadDef(task2_EEPROMread, osPriorityNormal, 1, 0);
```

在主程式中使用osThreadCreate函式為每個任務建立新的thread，傳回值指定給該任務的ID。

```
    /* Create task and assign thread IDs */
    t_task1 = osThreadCreate(osThread(task1_EEPROMwrite), NULL);
    t_task2 = osThreadCreate(osThread(task2_EEPROMread), NULL);
```

Semaphore

宣告作為任務之間內部互相溝通的Semaphore，名字為Sem_Arrive，以及宣告其ID變數，Sem_Arrive_id。

```
/* Semaphore ID */
osSemaphoreId Sem_Arrive_id;

/* Semaphore Declaration */
osSemaphoreDef(Sem_Arrive);
```

主程式中呼叫osSemaphoreCreate函式建立新的Semaphore，並將傳回值指定給該Semaphore的ID (Sem_Arrive_id)，設定可用的token數目為1。

```
    /* Create Semaphore without token */
```

```
    Sem_Arrive_id = osSemaphoreCreate(osSemaphore(Sem_Arrive), 1);
```

Timer

宣告一個Timer ID名字為Timer_Delay_id。定義這個Timer的名字為Timer_Delay，time-out時會觸發task3_UARTprint函式。

```
/* Timer ID */
osTimerId Timer_Delay_id;

/* osTimer Declaration */
osTimerDef(Timer_Delay, task3_UARTprint);
```

主程式中呼叫osTimerCreate函式建立新的Timer，操作在週期的模式，沒有傳入參數，並將傳回值指定給該Timer的ID(Timer_Delay_id)。呼叫osTimerStart函式開始Timer的計數，時間為50ms。每50ms就會觸發task3_UARTprint函式執行。

```
    /* Create Timer in periodic mode and without argument */
    Timer_Delay_id = osTimerCreate(osTimer(Timer_Delay), osTimerPeriodic, (void *)NULL);

    /* Start Timer with period 50ms */
    osTimerStart(Timer_Delay_id, 50);
```

task3_UARTprint函式打印程式執行中訊息。

```
void task3_UARTprint(void const *argument)
{
    /* UART print message */
    printf("task3: Running -----\n");
}
```

OS Kernel 初始化和執行

呼叫osKernelInitialize函式，開始進行OS Kernel初始化。

```
    /* Initialize RTOS */
    osKernelInitialize();
```

呼叫osKernelStart函式開始執行OS Kernel以及任務切換。

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

2.2 EEPROM

開啟I2C，設定多功能管腳、時鐘、傳輸速率和中斷。

```
    /* Initial I2C */
    I2C_EEPROM_Init();
```

第一個任務裡等有空的Semaphore token，呼叫I2C_EEPROM_Write函式寫入資料，然後釋出一個Semaphore token。

```
void task1_EEPROMwrite(void const *argument)
{
    while(1) {

        /* Wait for semaphore token */
        osSemaphoreWait(Sem_Arrive_id, osWaitForever);

        /* Delay 10 msec */
        osDelay(10);

        /* Access EEPROM address from 0~10 */
        u32Addr++;
        if (u32Addr>10)
            u32Addr=0;

        /* Write data */
         printf("task1: Write address=%d, data=%d \n\r",u32Addr,(u32Addr*2+3));
         I2C_EEPROM_Write(u32Addr,(u32Addr*2+3));

        /* Release semaphore token */
        osSemaphoreRelease(Sem_Arrive_id);
    }
}
```

第二個任務，等有空的Semaphore token，呼叫I2C_EEPROM_Read函式讀取資料，檢查資料數值，然後釋出Semaphore token。

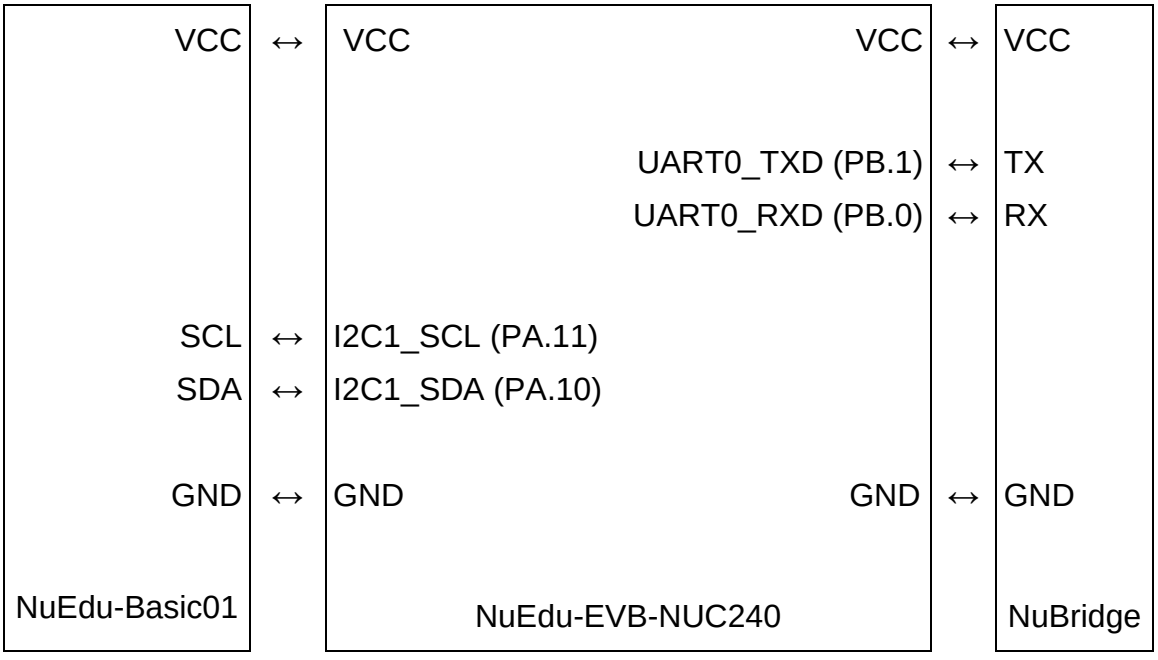
```
void task2_EEPROMread(void const *argument)
{
    uint32_t u32Data;

    while(1)
```

```
    {
        /* Wait for semaphore token */
        osSemaphoreWait(Sem_Arrive_id, osWaitForever);

        /* Read data */
        u32Data = I2C_EEPROM_Read(u32Addr);
        printf("task2: Read  address=%d, data=%d \n\r",u32Addr,u32Data);

        /* Check data is correct or not */
         if(u32Data!=(u32Addr*2+3)){
             printf("I2C Byte Write/Read Failed, Data 0x%x\n", u32Data);
             while(1);
         }

        /* Release semaphore token */
        osSemaphoreRelease(Sem_Arrive_id);

    }
}
```

3 軟體與硬體環境

- **軟體環境**
  - BSP 版本
    - NUC230_240 Series BSP CMSIS V3.01.001
  - IDE 版本
    - Keil uVersion 5.28
- **硬體環境**
  - 電路元件
    - NuEdu-EVB-NUC240 V2.1
    - NuEdu-Basic01 V2.1
    - NuBridge
  - 示意圖

NuEdu-EVB-NUC240 開發版上接 NuEdu-Basic01 版子和 NuBridge。



4 目錄資訊

- EC_NUC240_RTX_EEPROM_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-NUC240 board
    - StdDriver — All peripheral driver header and source files
  - SampleCode
    - ExampleCode — Source file of example code

5 如何執行範例程式

1. 根據目錄資訊章節進入 ExampleCode 路徑中的 KEIL 資料夾，雙擊 NUC240_RTX_EEPROM.uvprojx。
2. 進入編譯模式介面
   a. 編譯
   b. 下載代碼至記憶體
   c. 進入 / 離開除錯模式
3. 進入除錯模式介面
   a. 執行代碼

6 修訂紀錄

Date	Revision	Description
Sep. 30, 2019	1.00	1. 初始發布.

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