省電模式喚醒中斷

NuMicro® 32 位系列微控制器範例代碼介紹

文件資訊

代碼簡述	本範例代碼在 POWER DOWN 模式之下，使用 GPIO 喚醒 MCU，進入 POWER DOWN WAKEUP 中斷。
BSP 版本	NUC230_240 Series BSP CMSIS V3.01.001
開發平台	NuTiny-EVB-NUC240 V1.2

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1 功能介紹

1.1 簡介

在Power Down Wakeup中斷來源是從周邊過來的，如果中斷優先權是同一層，周邊硬體中斷會先執行。若希望Power Down Wakeup中斷先發生，可以將Power Down Wakeup中斷優先權提高。

1.2 原理

NUC240支援系統核心產生的中斷和32個可由周邊產生的中斷。中斷的優先權可由向量中斷控制器(NVIC)的中斷優先控制暫存器(NVIC_IPR0~7) 設定。除了Reset，NMI，HardFault的優先權固定為最高，其他的都可以做配置。

名稱	向量號碼	優先權
Reset	1	-3
NMI	2	-2
HardFault	3	-1
保留	4~10	保留
SVCall	11	可配置
保留	12~13	保留
PendSV	14	可配置
SysTick	15	可配置
Interrupt (IRQ0~IRQ31)	16~47	可配置

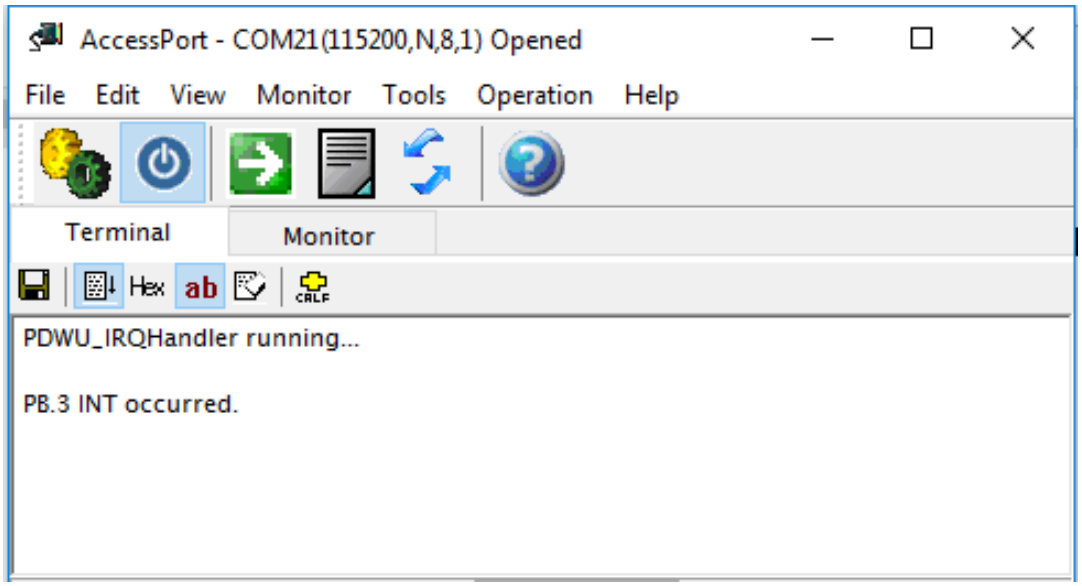
一個中斷的優先權設定有8個位元，只有最高兩個位元的設定有效，因此優先權可以設定為0~3，數字越小的優先權越高，設定為0的優先權最高，設定為3的優先權最低。

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2		Bit 1	Bit 0
用於優先權設定			沒有實現功能，讀回零					

1.3 執行結果

使用NUC240開發板，PB.0(UART RX)及PB.1(UART TX)連接到連接至Nubridge，從UART0打印訊息。

當PB.3接地時，MCU會被喚醒，之後進PDWU 中斷，再進GPIO中斷。



2 代碼介紹

2.1 GPIO 中斷設定

設定 GPIO (PB.3) 為輸入模式，下降邊緣觸發中斷，開啟NVIC中斷功能。

```
    /* Configure PB.3 as Input mode and enable interrupt by falling edge trigger */
    GPIO_SetMode(PB, BIT3, GPIO_PMD_INPUT);
    GPIO_EnableInt(PB, 3, GPIO_INT_FALLING);
    NVIC_EnableIRQ(GPAB_IRQn);
```

在GPIO中斷裡清除PB.3中斷旗標，以及打印訊息。

```
void GPAB_IRQHandler(void)
{
    /* To check if PB.3 interrupt occurred */
    if(GPIO_GET_INT_FLAG(PB, BIT3)) {
        GPIO_CLR_INT_FLAG(PB, BIT3);
        printf("PB.3 INT occurred.\n");
    } else {
        /* Un-expected interrupt. Just clear all PA, PB interrupts */
        PA->ISRC = PA->ISRC;
        PB->ISRC = PB->ISRC;
        printf("Un-expected interrupts.\n");
    }
}
```

為了讓喚醒中斷比GPIO中斷早產生，設定GPIO中斷的優先權為3(最低)。

```
    /* Set PA and PB interrupt priority as 3(lowest) */
    NVIC_SetPriority(GPAB_IRQn,3);
```

2.2 喚醒中斷設定

開啟喚醒中斷功能。

```
    /* Enable wake-up interrupt source */
    CLK->PWRCON |= CLK_PWRCON_PD_WU_INT_EN_Msk;

    /* Enable IRQ request for PDWU interrupt */
    NVIC_EnableIRQ(PWRWU_IRQn);
```

在喚醒中斷裡清除喚醒中斷旗標，以及打印訊息。

```
void PWRWU_IRQHandler(void)
{
    printf("PDWU_IRQHandler running...\n");

    /* Clear interrupt */
    CLK->PWRCON  |= CLK_PWRCON_PD_WU_STS_Msk;
}
```

為了讓喚醒中斷先產生，設定喚醒中斷的優先權為0(最高)。

```
    /* Set Power-down wake-up interrupt priority as 0(highest) */
    NVIC_SetPriority(PWRWU_IRQn,0);
```

2.3 進入省電模式

呼叫CLK_PowerDown API後進入省電模式。

```
    /* Enter to Power-down mode and wait for PB.3 falling edge interrupt event */
    UART_WAIT_TX_EMPTY(UART0);
    CLK_PowerDown();
```

3 軟體與硬體環境

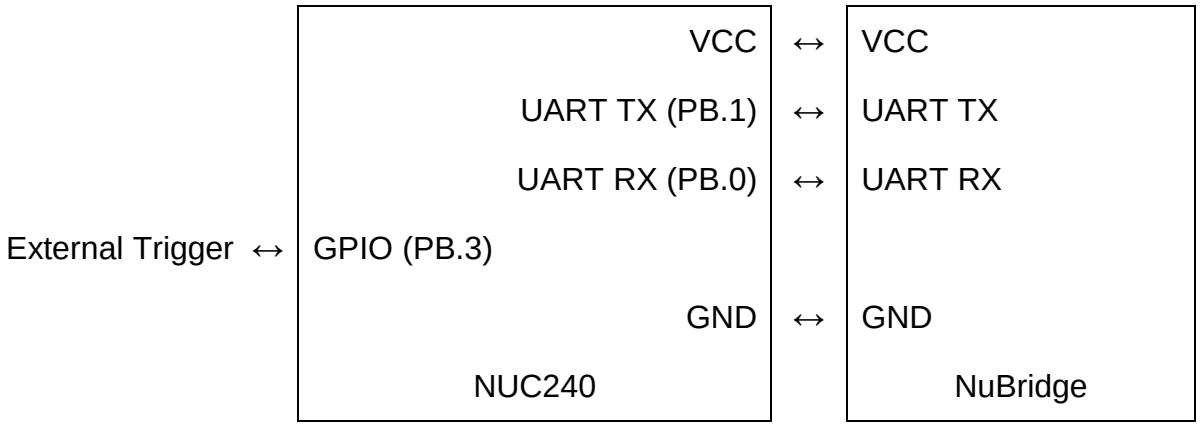
● 軟體環境

- ■ 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
  - ◆ NuTiny-EVB-NUC240 V1.2
  - ◆ NuBridge
- ■ 示意圖

NUC240 使用 GPIO(PB.3) 腳位為喚醒來源。



4 目錄資訊

- EC_NUC240_PDWK_INT_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_PDWK_INT.uvproj。
2. 進入編譯模式介面
   a. 編譯
   b. 下載代碼至記憶體
3. 按開發版上的重置按鈕讓程式開始執行

6 修訂紀錄

Date	Revision	Description
Jul. 31, 2019	1.00	1. 初始發布.

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