利用TIMER抓取信號上升緣和下降緣

NuMicro® 32 位系列微控制器範例代碼介紹

文件資訊

代碼簡述	本範例代碼利用 TIMER 抓取外部信號的上升緣和下降緣
BSP 版本	M0518 Series BSP CMSIS V3.00.002
開發平台	NuTiny-M0518S-V1.1

The information described in this document is the exclusive intellectual property of Nuvoton Technology Corporation and shall not be reproduced without permission from Nuvoton.

Nuvoton is providing this document only for reference purposes of NuMicro microcontroller based system design. Nuvoton assumes no responsibility for errors or omissions.

All data and specifications are subject to change without notice.

For additional information or questions, please contact: Nuvoton Technology Corporation.

www.nuvoton.com

1 功能介紹

1.1 簡介

本範例代碼利用TIMER抓取外部信號的上升緣和下降緣，並配合TIMER clock計算出高電平持續時間。

1.2 原理

TIMER可以設定由外部信號觸發中斷，而且可以選擇是上升緣觸發，下降緣觸發，或是兩者都觸發中斷。本範例代碼會示範如何利用上升緣和下降緣皆可觸發中斷的功能，來抓取當時的TIMER counter，並配合TIMER clock進一步計算出高電平持續時間。

為了方便示範，範例代碼會自行產生一組信號並經由GPIO PB.14輸出，來代替真正的外部信號。執行範例代碼前，請先將PB.14和PB.15用跳線連接。實際運用時，可以不用跳線，將真正的外部信號直接接PB.15即可。

1.3 執行結果

執行結果，以及打印資料。

```
CPU @ 50000000 Hz
+----------------------------------------+
|    TIMER0 Capture Counter Sample Code    |
+----------------------------------------+

  * Please connect PB14 and PB15 by wire.
TIMER0 clock @ 25000000 Hz
Capture counter for rising edge: 0x2 (2)
Capture counter for falling edge: 0x61D2 (25042)

Capture counter for high level duration: 0x61D0 (25040)
The high level duration time should be about (TIMER0 clock) * 25040
                                            = 1001 us
```

2 代碼介紹

設定 TIMER0 為 capture 模式，TIMER0 clock 為 HCLK/2，並且上升緣和下降緣皆可觸發中斷：

```
    /*----- Initial TIMER0 -----*/

    SYS_ResetModule(TMR0_RST);
    TIMER_Open(TIMER0, TIMER_CONTINUOUS_MODE, 1);

    /* Configure TIMER0 setting for external counter input and capture function */
    /* Set TIMER0 clock to HCLK/(1+1) */
    TIMER_SET_PRESCALE_VALUE(TIMER0, 1);
    /* Reset TIMER0 counter value */
    TIMER_SET_CMP_VALUE(TIMER0, 0xFFFFFF);
    /* Set TIMER0 to capture both edges */
    TIMER_EnableCapture(TIMER0, TIMER_CAPTURE_FREE_COUNTING_MODE,
TIMER_CAPTURE_FALLING_AND_RISING_EDGE);
    /* Enable TIMER0 capture interrupt */
    TIMER_EnableCaptureInt(TIMER0);
    NVIC_EnableIRQ(TMR0_IRQn);
```

設定 TIMER0 中斷處理程式，在上升緣和下降緣時抓取 TIMER0 counter：

```
void TMR0_IRQHandler(void)
{
    if (TIMER_GetCaptureIntFlag(TIMER0) == 1)
    {
        /* Clear TIMER0 capture interrupt flag */
        TIMER_ClearCaptureIntFlag(TIMER0);

        if (PB15)
        {
            /* Save the capture counter for PB15 rising edge */
            g_au32TMRCapCountRise = TIMER_GetCaptureData(TIMER0);
        }
        else
        {
            /* Save the capture counter for PB15 falling edge */
            g_au32TMRCapCountFall = TIMER_GetCaptureData(TIMER0);
            g_u32TimerCapFlag = 1;
        }
    }
}
```

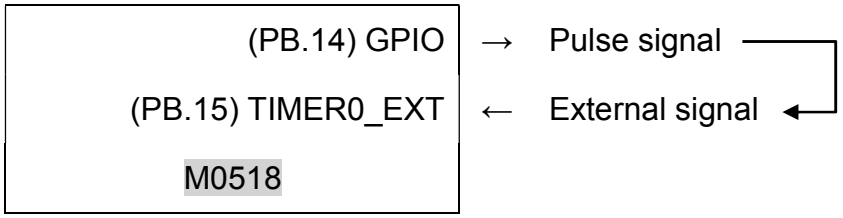
實際執行時，在 PB.14 產生一組信號，製造出上升緣和下降緣，中斷處理程式就可以抓取 TIMER0 counter，並配合 TIMER clock 進一步計算出高電平持續時間。

```
    /*---- Begin to test -----*/
    g_au32TMRCapCountRise = g_au32TMRCapCountFall = g_u32TimerCapFlag = 0;

    /* Start TIMER0 counting */
    TIMER_Start(TIMER0);

    /* Generate a pulse with both rising edge and falling edge to PB14 */
    PB14 = 1;   /* Rising edge */

    /* Delay to keep high level of pulse. */
    /* Change the delay counter will get different capture counter value */
    for (u32delayCounter = 0; u32delayCounter < 10000; u32delayCounter++);

    PB14 = 0;   /* Falling edge */

    /* Wait a rising edge and a falling edge from PB15 */
    /* TIMER0 interrupt handler will set g_u32TimerCapFlag to 1 when received */
    /*      external capture signal from PB15 */
    while (g_u32TimerCapFlag == 0);

    /* Got the counter value for external capture signal */
    if (g_au32TMRCapCountFall > g_au32TMRCapCountRise)
        u32CAPValue = g_au32TMRCapCountFall - g_au32TMRCapCountRise;
    else
        /* In the case that TIMER0 counter overflowed */
        u32CAPValue = 0xffffff - g_au32TMRCapCountRise + g_au32TMRCapCountFall;

    printf("Capture counter for rising edge: 0x%X (%d)\n", g_au32TMRCapCountRise,
g_au32TMRCapCountRise);
    printf("Capture counter for falling edge: 0x%X (%d)\n", g_au32TMRCapCountFall,
g_au32TMRCapCountFall);
    printf("\n");
    printf("Capture counter for high level duration: 0x%X (%d)\n", u32CAPValue,
u32CAPValue);
    printf("The high level duration time should be about (TIMER0 clock) * %d\n",
u32CAPValue);
    printf("                                                = %d us\n", u32CAPValue /
(SystemCoreClock / 2 / 1000000));
```

3 軟體與硬體環境

- **軟體環境**
  - BSP 版本
    - M0518 Series BSP CMSIS V3.00.002
  - IDE 版本
    - Keil uVersion 4.74
- **硬體環境**
  - 電路元件
    - NuTiny-M0518S-V1.1
  - 示意圖

M0518 設定 PB.15 為 TIMER0 外部信號輸入腳位。範例代碼則選用 PB.14 來自行產生一組信號。執行範例代碼前，請先將 PB.14 和 PB.15 用跳線連接。硬體外部線路連接如下。



4 目錄資訊

- EC_M0518_TIMER_Capture_Both_Edge_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 M0518_TIMER_Capture_Both_Edge.uvproj。
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. 17, 2019	1.00	1. 初始發布.

Important Notice

Nuvoton Products are neither intended nor warranted for usage in systems or equipment, any malfunction or failure of which may cause loss of human life, bodily injury or severe property damage. Such applications are deemed, "Insecure Usage".

Insecure usage includes, but is not limited to: equipment for surgical implementation, atomic energy control instruments, airplane or spaceship instruments, the control or operation of dynamic, brake or safety systems designed for vehicular use, traffic signal instruments, all types of safety devices, and other applications intended to support or sustain life.

All Insecure Usage shall be made at customer's risk, and in the event that third parties lay claims to Nuvoton as a result of customer's Insecure Usage, customer shall indemnify the damages and liabilities thus incurred by Nuvoton.

Please note that all data and specifications are subject to change without notice.
All the trademarks of products and companies mentioned in this datasheet belong to their respective owners.