利用PDMA搬運EADC的轉換數據

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 PDMA 搬運 EADC 的轉換數據到 RAM 中存放
BSP 版本	M451 Series BSP CMSIS V3.01.003
開發平台	NuTiny-EVB-M451-LQFP100 V1.3

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1 功能介紹

1.1 簡介

本範例代碼利用PDMA搬運EADC的轉換數據到RAM中。範例中會示範如何用軟體觸發ADC，或用中斷觸發ADC，以及EADC如何觸發PDMA開始搬運資料。

1.2 原理

EADC有多種來源可以觸發ADC開始轉換，包括軟體觸發以及中斷觸發。本範例代碼會示範如何用軟體觸發EADC module 4，再用module 4 轉換完成的中斷來觸發module 5, 6, 7 做ADC轉換。

PDMA也有多種來源可以觸發PDMA開始搬運資料，包括EADC轉換完成的中斷。本範例代碼會示範如何設定PDMA去同時搬運 4 個EADC module的轉換數據到RAM buffer中。

1.3 執行結果

執行結果，以及打印資料。

```
System clock rate: 72000000 Hz
+------------------------------------------------------+
|    M453 Series EADC and PDMA Transfer Sample Code    |
+------------------------------------------------------+
PDMA interrupt !!
Conversion result of channel 0: 0xCB9, PDMA transfer data :0xCB9
Conversion result of channel 1: 0x7D9, PDMA transfer data :0x7D9
Conversion result of channel 2: 0x000, PDMA transfer data :0x000
Conversion result of channel 3: 0xFFF, PDMA transfer data :0xFFF
Conversion result of channel 0: 0xBC3, PDMA transfer data :0xBC3
Conversion result of channel 1: 0xA9F, PDMA transfer data :0xA9F
Conversion result of channel 2: 0x000, PDMA transfer data :0x000
Conversion result of channel 3: 0xFFF, PDMA transfer data :0xFFF
Exit EADC sample code
```

EADC得到的轉換值要符合外部的輸入電壓，而且要和PDMA搬運出來的值完全相同才對。

2 代碼介紹

設定 EADC module 4 為軟體觸發，module 5 ~ 7 為中斷觸發：

```
    /* Set the ADC internal sampling time, input mode as single-end and enable the A/D
converter */
    EADC_Open(EADC, EADC_CTL_DIFFEN_SINGLE_END);
    EADC_SetInternalSampleTime(EADC, 6);


    /* Configure the sample 4 module for analog input channel 0 and enable software trigger
source */
    EADC_ConfigSampleModule(EADC, 4, EADC_SOFTWARE_TRIGGER, 0);
    /* Configure the sample 5 module for analog input channel 1 and enable ADINT0 trigger
source */
    EADC_ConfigSampleModule(EADC, 5, EADC_ADINT0_TRIGGER, 1);
    /* Configure the sample 6 module for analog input channel 2 and enable ADINT0 trigger
source */
    EADC_ConfigSampleModule(EADC, 6, EADC_ADINT0_TRIGGER, 2);
    /* Configure the sample 7 module for analog input channel 3 and enable ADINT0 trigger
source */
    EADC_ConfigSampleModule(EADC, 7, EADC_ADINT0_TRIGGER, 3);


    /* Clear the A/D ADINT0 interrupt flag for safe */
    EADC_CLR_INT_FLAG(EADC, EADC_STATUS2_ADIF0_Msk);
    /* Enable the interrupt 0 */
    EADC_ENABLE_INT(EADC, BIT0);
    /* Enable sample module 4 to use interrupt 0 */
    EADC_ENABLE_SAMPLE_MODULE_INT(EADC, 0, (BIT0 << 4));


    /* Clear the A/D ADINT1 interrupt flag for safe */
    EADC_CLR_INT_FLAG(EADC, EADC_STATUS2_ADIF1_Msk);
    /* Enable the interrupt 1 */
    EADC_ENABLE_INT(EADC, BIT1);
    /* Enable sample module 7 to use interrupt 1 */
    EADC_ENABLE_SAMPLE_MODULE_INT(EADC, 1, (BIT0 << 7));


    NVIC_EnableIRQ(ADC01_IRQn);
```

設定 PDMA 去搬運 8 筆 EADC 的轉換數據，每筆數據有 32 bits：

```
    /* Reset PDMA module */
    SYS_ResetModule(PDMA_RST);
    /* Open PDMA channel */
    PDMA_Open(BIT0 << PDMA_CH);
    /* PDMA transfer width is one word (32 bit) and transfer count 8 */
    PDMA_SetTransferCnt(PDMA_CH, PDMA_WIDTH_32, 8);
    /* PDMA transfer data from ADC to buffer g_au32DestArray*/
    PDMA_SetTransferAddr(PDMA_CH, (uint32_t) & (EADC->CURDAT), PDMA_SAR_FIX,
(uint32_t)g_au32DestArray, PDMA_DAR_INC);
    PDMA_SetTransferMode(PDMA_CH, PDMA_ADC_RX, FALSE, 0);


    PDMA_SetBurstType(PDMA_CH, PDMA_REQ_SINGLE, PDMA_BURST_128);


    g_u32IsPDMATestOver = 0;
    PDMA_EnableInt(PDMA_CH, PDMA_INT_TRANS_DONE);
    NVIC_EnableIRQ(PDMA_IRQn);


    PDMA_Trigger(PDMA_CH);


    /* Enable PDMA transfer */
    EADC_ENABLE_PDMA(EADC);
```

用軟體觸發 EADC module 4 開始做 ADC 轉換。Module 4 轉換完成後會發出中斷觸發 module 5, 6, 7 也開始做 ADC 轉換，所以一輪會產生 4 筆轉換數據。

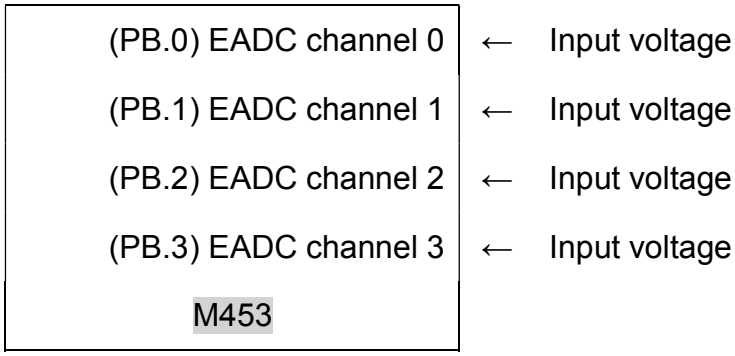
```
    /* Reset the ADC indicator and trigger sample module 4 to start A/D conversion */
    g_u32AdcIntFlag = 0;
    g_u32IsADCChannel7Over = 0;

    /* Start EADC module 4 conversion */
    EADC_START_CONV(EADC, (BIT0 << 4));

    /* Wait EADC interrupt (g_u32AdcIntFlag will be set at IRQ_Handler function) */
    while (g_u32IsADCChannel7Over == 0);

    /* Get the conversion result of the sample module 4 ~ 7 */
    for (u32ModuleCount = 4, u32SampleCount = 0;
            u32ModuleCount < 8;
            u32ModuleCount++, u32SampleCount++)
        g_au32ConversionData[u32SampleCount] = EADC_GET_CONV_DATA(EADC, u32ModuleCount);
```

因為已經設定 PDMA 要搬運 8 筆數據，所以相同的過程要做兩輪，產生 8 筆數據讓 PDMA 搬運，PDMA 才能完成任務。

3 軟體與硬體環境

- **軟體環境**
  - BSP 版本
    - M451 Series BSP CMSIS V3.01.003
  - IDE 版本
    - Keil uVersion 4.74
- **硬體環境**
  - 電路元件
    - NuTiny-EVB-M451-LQFP100 V1.3
  - 示意圖

M453 設定 EADC module 4 使用 channel 0，EADC module 5 使用 channel 1，EADC module 6 使用 channel 2，EADC module 7 使用 channel 3。硬體外部線路連接如下。



4 目錄資訊

- EC_M453_Move_EADC_Data_by_PDMA_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 M453_Move_EADC_Data_by_PDMA.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. 16, 2019	1.00	1. 初始發布.

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