# NUC240 使用ADC量測 $AV_{DD}$

NuMicro® 32 位系列微控制器範例代碼介紹

## 文件資訊

| | |
|---|---|
| 代碼簡述 | 本範例代碼使用內部 ADC 量測出 Bandgap 電壓，推算出 $AV_{DD}$ 。 |
| BSP 版本 | NUC230_240_Series_BSP_CMSIS_V3.01.001 |
| 開發平台 | NuEdu-EVB-NUC240 v1.0 |

# 1 功能介紹

## 1.1 簡介

IC的內部的Band-Gap(1.25V)電壓是穩定的，可以用來當做ADC的參考電壓。在本範例程式，使用ADC通道7，該通道為測量內部參考電壓，也就是內部Band-Gap電壓。只需要測到Band-Gap電壓對應的ADC值，就可以反推到電源電壓的值$AV_{DD}$。

## 1.2 原理

已知

$V_{BG}$ : 內部 Band-gap 電壓。NUC240系列$V_{BG}$值為 1.25 V。

$V_{BGM}$: Band-gap A/D 轉換結果

$V_{REF} = AV_{DD}$

根據

$$\frac{V_{BGM}}{4096} = \frac{V_{BG}}{V_{REF}}$$

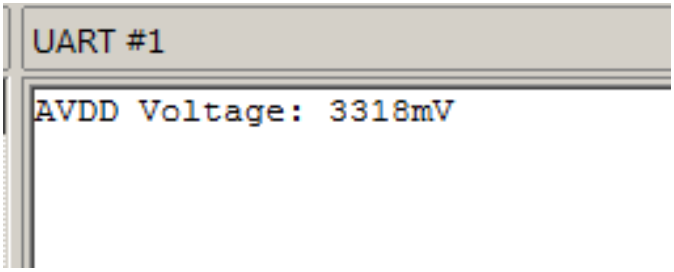
我們可以使用公式

$$AV_{DD} = V_{REF} = \frac{1.25 \times 4096}{V_{BGM}}$$

推算出$AV_{DD}$的電壓。

## 1.3 執行結果

編譯專案並進入除錯模式執行程式，Serial Window UART #1將輸出$AV_{DD}$電壓值。


UART #1
AVDD Voltage: 3318mV

# 2 代碼介紹

## 2.1 讀取 ADC 值

GetAVDDCodeByADC () 函式用來讀取ADC值。

```
uint32_t GetAVDDCodeByADC(void)
{
    uint32_t u32Count, u32Sum, u32Data;

    /* Enable ADC module clock */
    CLK_EnableModuleClock(ADC_MODULE);

    /* ADC clock source is 22.1184MHz, set divider to 7, ADC clock is 22.1184/7 MHz */
    CLK_SetModuleClock(ADC_MODULE, CLK_CLKSEL1_ADC_S_HIRC, CLK_CLKDIV_ADC(22));

    /* Configure ADC: single-end input, single scan mode, enable ADC analog circuit. */
    ADC_Open(ADC, NULL, ADC_ADCR_ADMD_SINGLE, BIT7);

    /* Configure the analog input source of channel 7 as internal band-gap voltage */
    ADC_CONFIG_CH7(ADC, ADC_ADCHER_PRESEL_INT_BANDGAP);

    /* Power on ADC */
    ADC_POWER_ON(ADC);

    /* Clear conversion finish flag */
    ADC_CLR_INT_FLAG(ADC, ADC_ADF_INT);

    /* Enable ADC conversion finish interrupt */
    ADC_EnableInt(ADC, ADC_ADF_INT);
    NVIC_EnableIRQ(ADC_IRQn);

    g_u8ADF = 0;
    u32Sum = 0;

    /* sample times are according to ADC_SAMPLE_COUNT definition */
    for (u32Count = 0; u32Count < ADC_SAMPLE_COUNT; u32Count++)
    {
        /* Delay for band-gap voltage stability */
```

```
        CLK_SysTickDelay(1000);

        /* Start A/D conversion */
        ADC_START_CONV(ADC);

        u32Data = 0;

        /* Wait conversion done */
        while (g_u8ADF == 0);

        g_u8ADF = 0;

        /* Get the conversion result */
        u32Data = ADC_GET_CONVERSION_DATA(ADC, 7);

        /* Sum each conversion data */
        u32Sum += u32Data;
    }

    /* Disable ADC interrupt */
    ADC_DisableInt(ADC, ADC_ADF_INT);

    /* Disable ADC */
    ADC_POWER_DOWN(ADC);

    /* Return the average of ADC_SAMPLE_COUNT samples */
    return (u32Sum >> 7);
}
```

## 2.2 計算 $AV_{DD}$電壓值

GetAVDDVoltage ()函式使用$V_{BGM} = \frac{V_{BG} \times 4096}{V_{REF}}$公式去計算 $AV_{DD}$電壓值。

```
uint32_t GetAVDDVoltage(void)
{
    uint32_t u32ConversionResult;
    uint64_t u64MvAVDD;

    /* Calculate Vref by using conversion result of VBG */
    u32ConversionResult = GetAVDDCodeByADC();
```

```
    /* u32ConversionResult = VBG * 1024 / Vref, Vref = AVDD */
    /* => AVDD = VBG * 4096 / u32ConversionResult */
    u64MvAVDD = (VBG_VOLTAGE << 12) / (uint64_t)u32ConversionResult;

    return (uint32_t)u64MvAVDD;
}
```

# 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 4.74
- **硬體環境**
  - 電路元件
    - NuEdu-EVB-NUC240 V1.0

# 4 目錄資訊

- EC_ NUC240_ADC_Measure_AVDD_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
  - 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_ADC_Measure_AVDD.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 |
|---|---|---|
| Nov. 1, 2019 | 1.00 | 1. 初始發布 |

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