NUC240 Use ADC to Measure AV_{DD}

Example Code Introduction for 32-bit NuMicro® Family

Information

Application	This example code use ADC to measure internal Bandgap voltage(V_{BG}) and use V_{BG} to calculate AV_{DD}
BSP Version	NUC230_240_Series_BSP_CMSIS_V3.01.001
Hardware	NuEdu-EVB-NUC240 v1.0

1 Function Description

1.1 Introduction

A temperature independent voltage reference circuit inside microcontroller can produce a constant voltage called internal bandgap voltage (V_{BG}). V_{BG} is one of the ADC reference voltages.

In this example code, we use ADC channel 7 to measure the V_{BG}. We then use the measured value to calculate AV_{DD} value by using below formula. This method requires the V_{REF} pin connects to AV_{DD} pin.

1.2 Principle

V_{BG}: Internal bandgap voltage. The NUC240 series V_{BG} typical value is 1.25 V.

V_{BGM}: Built-in band-gap A/D conversion result

$V_{REF} = AV_{DD}$

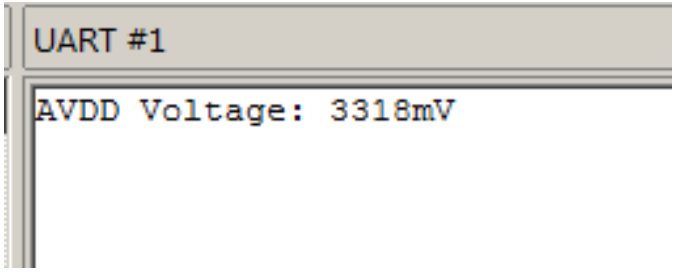
We can get the AV_{DD} voltage by using the formula:

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

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

1.3 Demo Result

Compile the project and enter debug mode, the serial window UART #1 displays the AV_{DD} voltage in debug mode.



2 Code Description

2.1 Get ADC conversion result

Use GetAVDDCodeByADC () function to get ADC conversion result.

```
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 Calculate AVDD voltage

GetAVDDVoltage() function use formula $V_{BGM} = \frac{V_{BG} \times 4096}{V_{REF}}$ to calculate current AV_{DD} voltage.

```
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 Software and Hardware Environment

Software Environment

- BSP version
  - NUC230_240 Series BSP CMSIS v3.01.001
- IDE version
  - Keil uVersion 4.74

Hardware Environment

- Circuit components
  - NuEdu-EVB-NUC240 V1.0

4 Directory Information

- 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 How to Execute Example Code

1. Browsing into sample code folder by Directory Information (section 4) and double click NUC240_ADC_Measure_AVDD.uvproj.
2. Enter Keil compile mode
   a. Build
   b. Download
   c. Start/Stop debug session
3. Enter debug mode
   a. Run

6 Revision History

Date	Revision	Description
Nov. 1, 2019	1.00	1. Initially issued.

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