Use Nano112 ACMP Slope Measures PT1000

Example Code Introduction for 32-bit NuMicro® Family

Information

Application	This sample code uses the ACMP slope of Nano112 to measure the temperature of PT1000.
BSP Version	Nano102_112_Series_BSP_CMSIS_v3.03.000
Hardware	NuTiny-SDK-Nano112V

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1 Function Description

1.1 Introduction

The Single Slop ADC mode is an analog-to-digital conversion technique to measure unknown resistance and can be implemented with a comparator rather than a standalone ADC module. The technique is using known and unknown resistor to discharge a capacitor. While the capacitor is discharged, the number of clock cycles counted by timer indicates resistance ratio. Larger counting number indicates Larger resistance value. The unknown resistance can be calculated based on the discharge time and known resistance.

Only the comparator ACMP0 has Single Slope ADC mode which can implement a low-cost but high resolution ADC function by using just a little additional external components. The external components include a thermistor (e.g. PT1000), a reference resistor, and a capacitor.

1.2 Principle

Calculating Resistance Value of Thermistor：

$$\frac{Tcap_temp}{R_temp} = \frac{Tcap_ref}{R_ref}$$

Tcap_ref：Discharge time captured by reference resistance discharge timer.

R_ref ： Reference resistance.

Tcap_temp：Discharge time captured by thermistor discharge timer.

R_temp ： Thermistor resistance (calculated from the first three values).

Pt1000 temperature calculate：

$$t = \frac{39083 - \sqrt{175848089 - 231000 * R_t}}{11.55}$$

Rt：Resistance value of platinum thermistor at temperature.

t：Temperature.

2 Code Description

Calculate the temperature value：

```
            for (u32cnt = 0; u32cnt < 0x100000; u32cnt++);


            PE->DOUT   &= ~0x40 ;
            ACMP_SetSlopeConv(ACMP_TIMER01, ACMP_MODCR0_TMR_TRI_LV_FALLING,
ACMP_CR_CPP0SEL_PA4, ACMP_MODCR0_CH_DIS_PINSEL_PA14);
            ACMP_ENABLE(ACMP, 0);


            for (u32cnt = 0; u32cnt < 0x50000; u32cnt++);


            ACMP_START_CONV(ACMP);


            while (!i32Tmr0_cap_complete);
            i32Tmr0_cap_complete = 0;


            ACMP_DISABLE(ACMP, 0);
            u32Tcap_ref = TIMER0->TCAP;    //about 0.2mS


            ACMP_SetSlopeConv(ACMP_TIMER01, ACMP_MODCR0_TMR_TRI_LV_FALLING,
ACMP_CR_CPP0SEL_PA4, ACMP_MODCR0_CH_DIS_PINSEL_PA3);
            ACMP_ENABLE(ACMP, 0);


            for (u32cnt = 0; u32cnt < 0x50000; u32cnt++);


            ACMP_START_CONV(ACMP);


            while (!i32Tmr0_cap_complete);
            i32Tmr0_cap_complete = 0;


            ACMP_DISABLE(ACMP, 0);
            u32Tcap_temp = TIMER0->TCAP;


            u32R_temp = (u32Tcap_temp * 119370 / u32Tcap_ref + u32R_temp) / 2;
            u32C_temp = ((39083 - _sqrt(1758480890 - 231 * u32R_temp)) * 1000 / 1155 +
u32C_temp) / 2;
            PE->DOUT   |= 0x40 ;
```

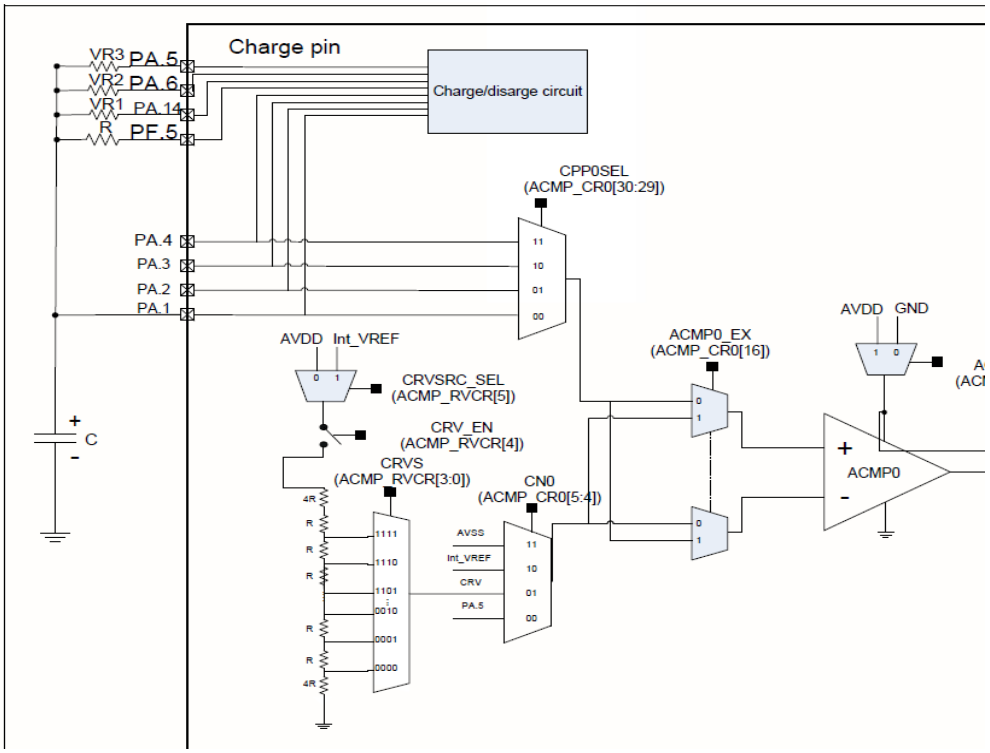
3 Software and Hardware Environment

Software Environment

- BSP version
  - Nano102_112_Series_BSP_CMSIS_v3.03.000
- IDE version
  - Keil uVersion 5.26

Hardware Environment

- Circuit components
  - NuTiny-SDK-Nano112V
  - PT1000
- Diagram



4 Directory Information

- EC_Nano112_ACMP_Slope_PT1000_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
    - LCDLib — LCD library source code
  - SampleCode
    - ExampleCode — Source file of example code
    - NUTINY-EVB-NANO112 — LCD Panel source code

5 How to Execute Example Code

1. Browsing into sample code folder by Directory Information (section 4) and double click Nano112_ACMP_Slope_PT1000.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
Sept. 17, 2019	1.00	1. Initially issued.

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