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Research on CPU Internal Temperature Measurement Method

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***Abstract*—In the embedded control system, the CPU temperature will continue to rise because the program will continue to run. Therefore, it is necessary to measure the internal temperature of the CPU. For STM32F103 series processors, there is a A/D acquisition channel inside, which can be used to collect the internal temperature of CPU. The design has certain practical value.**

Keywords—CPU, internal temperature, A/D acquisition

I. Introduction

In engineering practice, a large number of embedded chips will be used, because of the continuous operation of the program, the internal temperature of the CPU will continue to rise. Therefore, some necessary measures should be taken to detect the temperature inside the CPU. When it reaches a certain level, it is necessary to start the fan to cool it down.

For the STM32 series microprocessor, the 12-bit ADC with 16 channels can measure the internal temperature accurately.

II. Hardware Design

The hardware circuit design is shown in Figure 1. The sequence diagram of ADC data acquisition is described in detail in the figure. The highest clock frequency of ADC_CLK is 1MHz. The data is collected at the descending edge of AET_ADON, and the analog is converted into digital. After the conversion, the EOC outputs high level. At this time, the CPU can read the data.

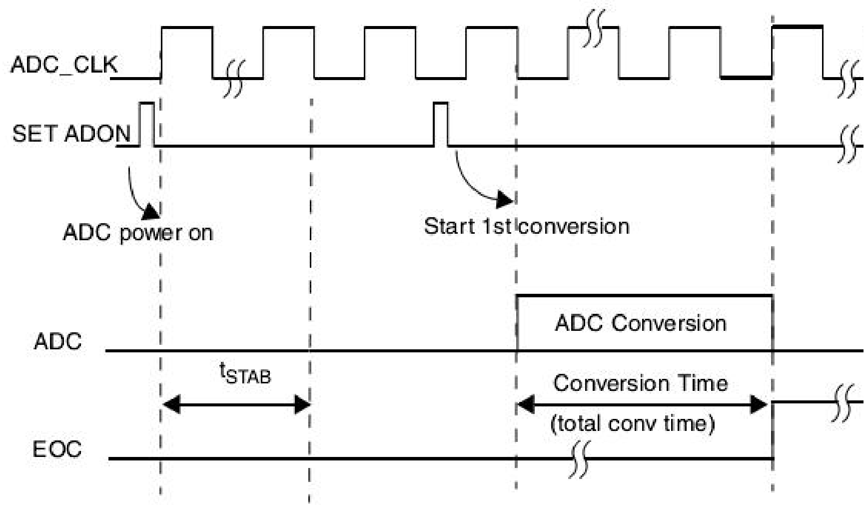

Fig 1 ADC Timing Diagram

Software Program

In this design, KEIL 5 is programmed in C language. It mainly completes the initialization and data acquisition of ADC. The following code is given:

```
void  Adc1_temp_Init(void)
{
  RCC->APB2ENR|=1<<2;
  GPIOA->CRL&=0XFFFF0000
  RCC->APB2ENR|=1<<9;
  RCC->APB2RSTR|=1<<9;
  RCC->APB2RSTR&=~(1<<9);
```

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```
  RCC->CFGR&=~(3<<14);
  RCC->CFGR|=2<<14;    // 10：
  ADC1->CR1&=0XF0FFFF;
  ADC1->CR1|=0<<16;
  ADC1->CR1&=~(1<<8);
  ADC1->CR2&=~(1<<1);         ADC1->CR2&=~(7<<17);
  ADC1->CR2|=7<<17;

  ADC1->CR2|=1<<20;
  ADC1->CR2&=~(1<<11);
  ADC1->CR2|=1<<23;

   ADC1->SQR1&=~(0XF<<20);
  ADC1->SQR1|=0<<20;

  ADC1->SMPR1&=~(7<<18);
  ADC1->SMPR1|=7<<18;

  ADC1->CR2|=1<<0;
  ADC1->CR2|=1<<3;
  while(ADC1->CR2&1<<3);
  ADC1->CR2|=1<<2;
  while(ADC1->CR2&1<<2);
}
u16 Get_Adc1_Average(u8 ch,u8 times)
{
  u32 temp_val=0;
  u8 t;
  for(t=0;t<times;t++)
  {
        temp_val+=Get_Adc1(ch);
        delay_ms(5);
  }
  return temp_val/times;
}
u16 Get_Adc2(u8 ch)
{
  ADC2->SQR3&=0XFFFFFFE0;
  ADC2->SQR3|=ch;
  ADC2->CR2|=1<<22;
  while(!(ADC2->SR&1<<1));
  return ADC2->DR;
```

```
}
void ADC1_2_IRQHandler(void)
{
  adcval=ADC2->DR;
  //adcval=ADC1->DR;

  ADC2->SR&=~(1<<1);
  cnt++;
  if(cnt%2==0)
  {
        printf("ADC9:%d\r\n",adcval);
        //Get_Adc2(8);
        //ADC2->SQR3|=0x09<<5;            //SQ1[4:0]:
//      GUI_sprintf_nu(40, 279,(adcval)/1000,BLUE,WHITE);
//      GUI_sprintf_nu(50, 279,((adcval)%1000)/100,BLUE,WHITE);
//      GUI_sprintf_nu(60, 279,(((adcval)%1000)%100)/10,BLUE,WHITE);
//      GUI_sprintf_nu(70, 279,((((adcval)%1000)%100)%10),BLUE,WHITE);
  }
  else
  {
        //Get_Adc2(9);
        //ADC2->SQR3|=0x08<<0;
        printf("ADC8:%d\r\n",adcval);
//      GUI_sprintf_nu(40, 262,(adcval)/1000,BLUE,WHITE);
//      GUI_sprintf_nu(50, 262,((adcval)%1000)/100,BLUE,WHITE);
//      GUI_sprintf_nu(60, 262,(((adcval)%1000)%100)/10,BLUE,WHITE);
//      GUI_sprintf_nu(70, 262,((((adcval)%1000)%100)%10),BLUE,WHITE);
  }
}
```

III. SUMMARY

This paper expounds the working principle and method of collecting internal CPU temperature by STM32, gives the hardware circuit design diagram, describes the timing of ADC acquisition in detail, and writes the driver program in C language under KEIL, which can accurately collect internal temperature and meet the design requirements. It has certain practical value.

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