LAB NOTE

Subject: Hardware/Software Interfacing

Lab 3: ADC

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1. Objectives

- Using STM32F411 board and STM32CubeIDE in Windows, create code to:
  - Read a voltage from one or more ADC-configured STM32 pins
  - Show use in a simple application

Advance:

- Code created that:
  - Uses 3 ADC pins for input on different channels
    - The different channels will need sampling one at a time, as there is only one physical ADC on the F411 board.
  - Using the ADC conversion complete interrupt that signals conversion completion and triggers.
    - Update on the terminal the raw value of the 3 ADCs.
    - Displays the converted raw ADC values in voltage to 1 decimal place accurately.
    - You may optionally use DMA as well.

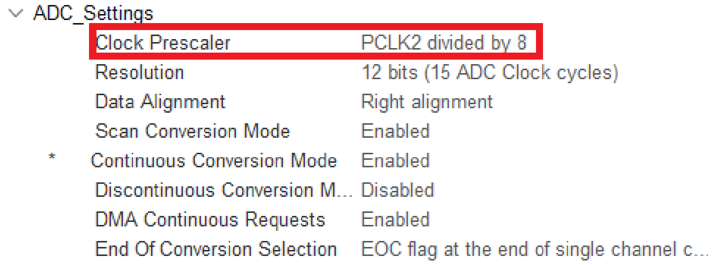
2. Problems and Solutions

2.1 Problems

- Using interrupt with ADC somehow interrupt got execute too often lead to the main while loop can't be executed.

2.2 Solutions

- So far, there are 3 ways to change how frequent the conversion occur:
    - Changing the Clock Prescale



ADC_Settings

Clock Prescaler	PCLK2 divided by 8
Resolution	12 bits (15 ADC Clock cycles)
Data Alignment	Right alignment
Scan Conversion Mode	Enabled
* Continuous Conversion Mode	Enabled
Discontinuous Conversion M...	Disabled
DMA Continuous Requests	Enabled
End Of Conversion Selection	EOC flag at the end of single channel c...

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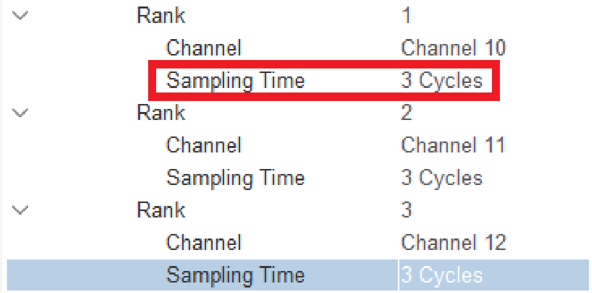
Figure 2-1: Changing Clock Prescaler

- Changing the sampling time



Rank	1
Channel	Channel 10
Sampling Time	3 Cycles
Rank	2
Channel	Channel 11
Sampling Time	3 Cycles
Rank	3
Channel	Channel 12
Sampling Time	3 Cycles

Figure 2-2: Changing the sampling time

- Changing the frequency of PCLK2

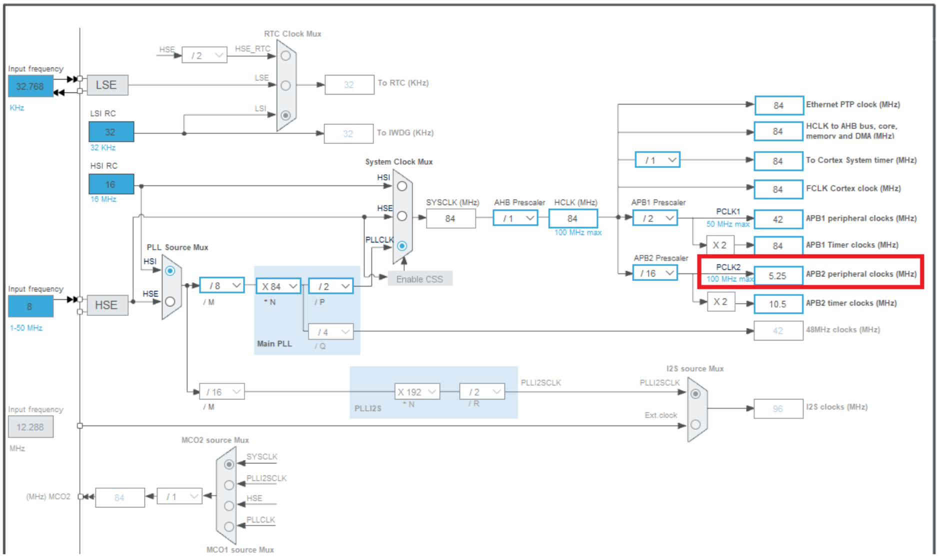


Figure 2-3: Changing PCLK2

3. Software Design

3.1 List of function

- This function is used to convert the adcValue (12 bits value) to voltage value.

```
float adcConvertVoltage(uint32_t adcVal)
{
      return adcVal * 3.3 / 4095;
}
```

- This function is used to get the internal temperature of the Nucleo board, the formula to calculate is: ((Vsense - V25)/AVG_SLOPE) + 25 (refer STM32F411 reference manual p222)
- V25 and AVG_SLOPE value refers to STM32F411CE datasheet p120

```
flofloat getTemp(float Vsense)
{
      return ((Vsense - V25)/AVG_SLOPE) + 25;
}
```

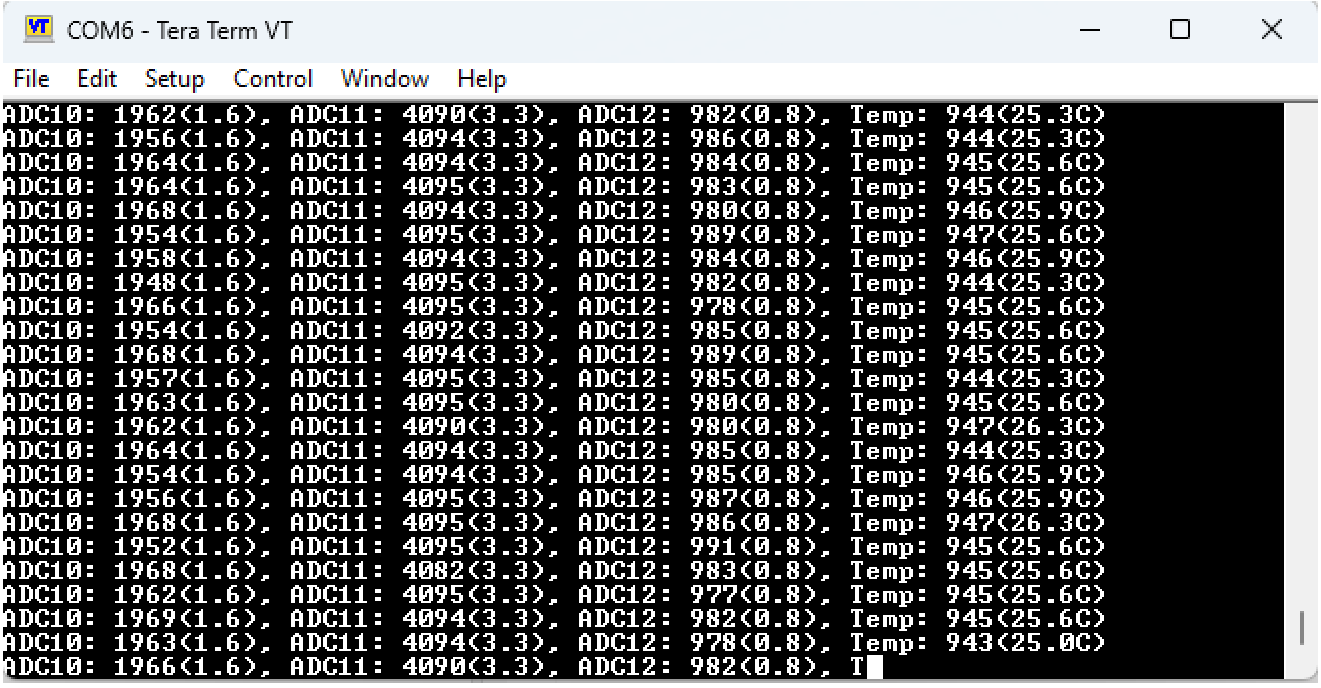
- This function is used to get the ADC value and convert to Voltage value whenever conversion occur.

```
void HAL_ADC_ConvCpltCallback(ADC_HandleTypeDef *hadc)
{
      // Get ADC value from DMA and convert the value to Voltage
      adc1Val = buffer[0];
      adc1Vol = adcConvertVoltage(adc1Val);

      adc2Val = buffer[1];
      adc2Vol = adcConvertVoltage(adc2Val);

      adc3Val = buffer[2];
      adc3Vol = adcConvertVoltage(adc3Val);

      tempVal = buffer[3];
      tempVol = adcConvertVoltage(tempVal);
}
```

3.2 While loop

```
  while (1)
  {
        temp = getTemp(tempVol); // get temperature value
        printf("ADC10: %lu(%.1f), ADC11: %lu(%.1f), ADC12: %lu(%.1f), Temp:
%lu(%.1fC)\r\n",  adc1Val, adc1Vol,

                  adc2Val, adc2Vol,

                  adc3Val, adc3Vol,

                  tempVal, temp);

        HAL_Delay(100);  // Send every 100ms
  }
```

4. Result



```
ADC10: 1962(1.6), ADC11: 4090(3.3), ADC12: 982(0.8), Temp: 944(25.3C)
ADC10: 1956(1.6), ADC11: 4094(3.3), ADC12: 986(0.8), Temp: 944(25.3C)
ADC10: 1964(1.6), ADC11: 4094(3.3), ADC12: 984(0.8), Temp: 945(25.6C)
ADC10: 1964(1.6), ADC11: 4095(3.3), ADC12: 983(0.8), Temp: 945(25.6C)
ADC10: 1968(1.6), ADC11: 4094(3.3), ADC12: 980(0.8), Temp: 946(25.9C)
ADC10: 1954(1.6), ADC11: 4095(3.3), ADC12: 989(0.8), Temp: 947(25.6C)
ADC10: 1958(1.6), ADC11: 4094(3.3), ADC12: 984(0.8), Temp: 946(25.9C)
ADC10: 1948(1.6), ADC11: 4095(3.3), ADC12: 982(0.8), Temp: 944(25.3C)
ADC10: 1966(1.6), ADC11: 4095(3.3), ADC12: 978(0.8), Temp: 945(25.6C)
ADC10: 1954(1.6), ADC11: 4092(3.3), ADC12: 985(0.8), Temp: 945(25.6C)
ADC10: 1968(1.6), ADC11: 4094(3.3), ADC12: 989(0.8), Temp: 945(25.6C)
ADC10: 1957(1.6), ADC11: 4095(3.3), ADC12: 985(0.8), Temp: 944(25.3C)
ADC10: 1963(1.6), ADC11: 4095(3.3), ADC12: 980(0.8), Temp: 945(25.6C)
ADC10: 1962(1.6), ADC11: 4090(3.3), ADC12: 980(0.8), Temp: 947(26.3C)
ADC10: 1964(1.6), ADC11: 4094(3.3), ADC12: 985(0.8), Temp: 944(25.3C)
ADC10: 1954(1.6), ADC11: 4094(3.3), ADC12: 985(0.8), Temp: 946(25.9C)
ADC10: 1956(1.6), ADC11: 4095(3.3), ADC12: 987(0.8), Temp: 946(25.9C)
ADC10: 1968(1.6), ADC11: 4095(3.3), ADC12: 986(0.8), Temp: 947(26.3C)
ADC10: 1952(1.6), ADC11: 4095(3.3), ADC12: 991(0.8), Temp: 945(25.6C)
ADC10: 1968(1.6), ADC11: 4082(3.3), ADC12: 983(0.8), Temp: 945(25.6C)
ADC10: 1962(1.6), ADC11: 4095(3.3), ADC12: 977(0.8), Temp: 945(25.6C)
ADC10: 1969(1.6), ADC11: 4094(3.3), ADC12: 982(0.8), Temp: 945(25.6C)
ADC10: 1963(1.6), ADC11: 4094(3.3), ADC12: 978(0.8), Temp: 943(25.0C)
ADC10: 1966(1.6), ADC11: 4090(3.3), ADC12: 982(0.8), T
```

Figure 4-1: Lab3's result

REFERENCES