Laboratory 06 – Area of Interest

ANALOG TO DIGITAL CONVERTER

CpE 185 / EEE 174 Lab Section 02

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INTRODUCTION

This laboratory will introduce the Analog to Digital converter in which converts analog (continuous) data to digital (discrete) data. The way to accomplish this is through the use of method called quantization in which a process of mapping input values from a large set to output values in a smaller set, which usually a finite number. The student will be using the topics learned from the previous laboratory such as the basic use of microcontrollers and UART. In order to test the analog to digital converter, the student must have the STM32 board and a potentiometer.

LABORATORY

Before the actual measurements, the student setup the whole board shown in figure 1. We can see that the potentiometer is facing left side in which the ground pin on top, output in the middle and the VCC at the bottom.

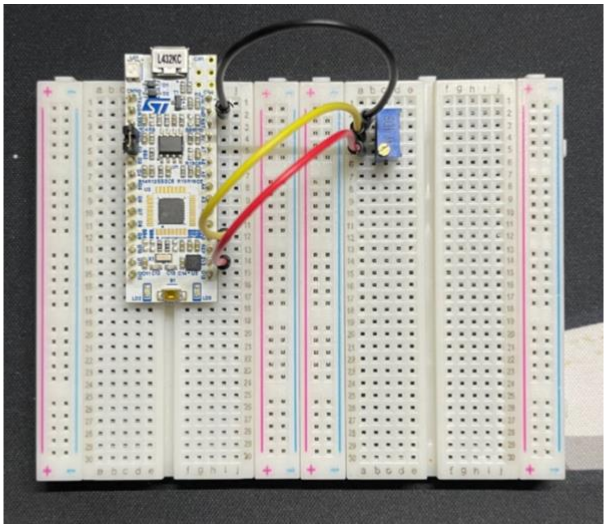
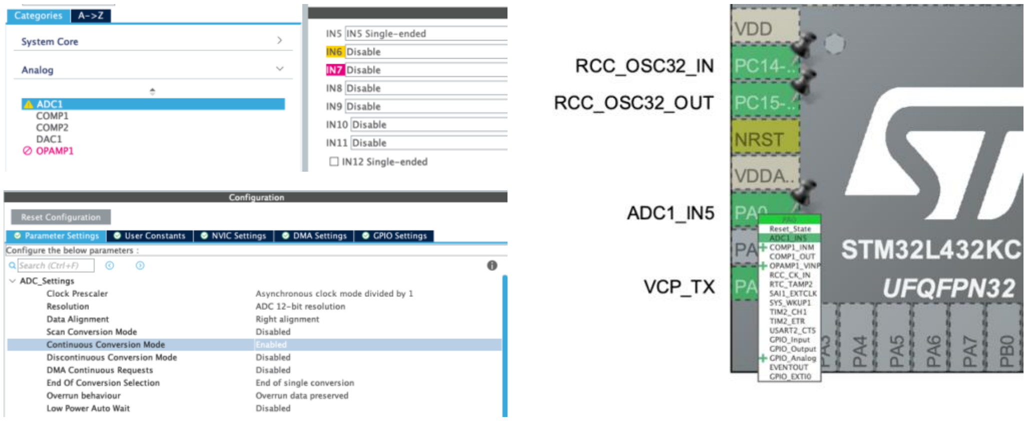


Figure 1. actual wiring of the potentiometer

After, the student moved to the next step which to setup the STM32 using the NUCLEO-L432KC as the board. The student also identified the Baud Rate which is 115200 Bits/s. On the hand, the student set the PA0 pin to ADC1_IN5 and configure the IN1 with Single-ended and enable continuous conversion mode under ADC1. The full configuration shown below.



IN5	IN5 Single-ended
IN6	Disable
IN7	Disable
IN8	Disable
IN9	Disable
IN10	Disable
IN11	Disable

☐ IN12 Single-ended

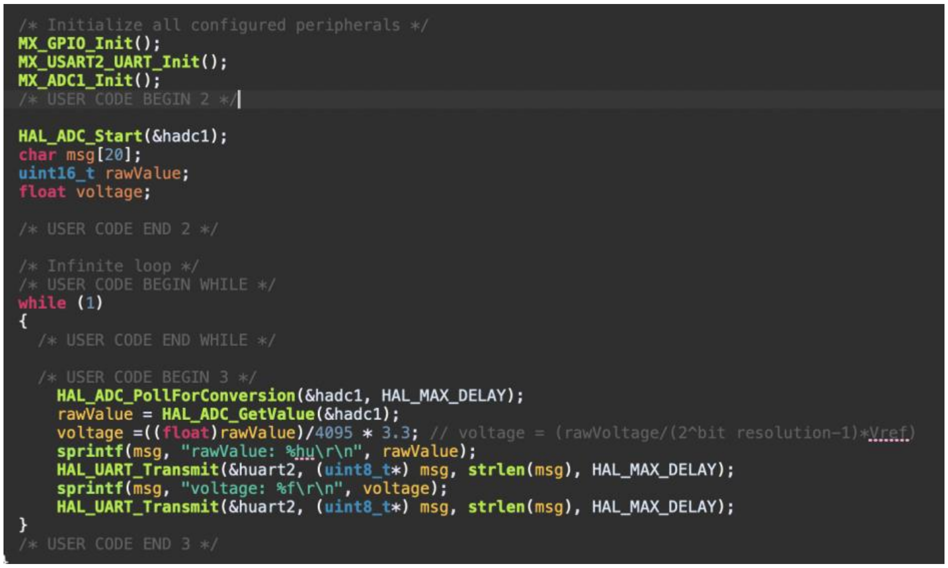
Configure the below parameters :

ADC_Settings

Clock Prescaler	Asynchronous clock mode divided by 1
Resolution	ADC 12-bit resolution
Data Alignment	Right alignment
Scan Conversion Mode	Disabled
Continuous Conversion Mode	Enabled
Discontinuous Conversion Mode	Disabled
DMA Continuous Requests	Disabled
End Of Conversion Selection	End of single conversion
Overrun behaviour	Overrun data preserved
Low Power Auto Wait	Disabled

Figure 2. STM32 IDE full pinout setup & configuration

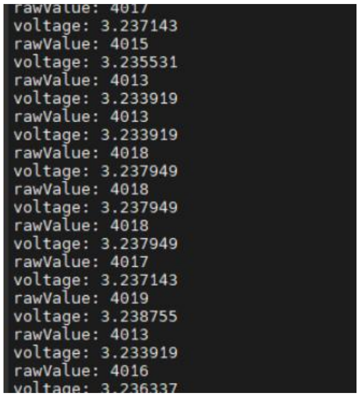
After that, the student checked the clock configuration then generate the code. Then, the student added the following code to the designated places. The whole code shown below.



```
/* Initialize all configured peripherals */
MX_GPIO_Init();
MX_USART2_UART_Init();
MX_ADC1_Init();
/* USER CODE BEGIN 2 */

HAL_ADC_Start(&hadc1);
char msg[20];
uint16_t rawValue;
float voltage;

/* USER CODE END 2 */

/* Infinite loop */
/* USER CODE BEGIN WHILE */
while (1)
{
  /* USER CODE END WHILE */

  /* USER CODE BEGIN 3 */
    HAL_ADC_PollForConversion(&hadc1, HAL_MAX_DELAY);
    rawValue = HAL_ADC_GetValue(&hadc1);
    voltage =((float)rawValue)/4095 * 3.3; // voltage = (rawVoltage/(2^bit resolution-1)*Vref)
    sprintf(msg, "rawValue: %hu\r\n", rawValue);
    HAL_UART_Transmit(&huart2, (uint8_t*) msg, strlen(msg), HAL_MAX_DELAY);
    sprintf(msg, "voltage: %f\r\n", voltage);
    HAL_UART_Transmit(&huart2, (uint8_t*) msg, strlen(msg), HAL_MAX_DELAY);
}
/* USER CODE END 3 */
```

Figure 3. STM32 IDE code

After completing the code, the student connected the STM32 board and debug the code. Then, the student opens the terminal and look for the serial port with the baud rate the student noted. After that, the student then run or continue the STM32 IDE in which the output shows below. In addition, adjusting the dial in the potentiometer will result to voltage value change.



```
rawValue: 4017
voltage: 3.237143
rawValue: 4015
voltage: 3.235531
rawValue: 4013
voltage: 3.233919
rawValue: 4013
voltage: 3.233919
rawValue: 4018
voltage: 3.237949
rawValue: 4018
voltage: 3.237949
rawValue: 4018
voltage: 3.237949
rawValue: 4017
voltage: 3.237143
rawValue: 4019
voltage: 3.238755
rawValue: 4013
voltage: 3.233919
rawValue: 4016
voltage: 3.236337
```

Figure 4. Terminal Session Output

CONCLUSION

For this laboratory, the student learned about Analog to Digital Converter using the STM32 board. We learned that besides using the Analog Discovery 2, we can use STM32 board as replacement to check voltages. On the other hand, using this method requires coding to make the STM32 board and the output work.