Institute of Information and Communication Technology
M. Sc. Engineering Program, April 2023

ICT 6641	***Advanced Embedded System Design Lab***
Expt. #3	***Ultrasonic Sensor (Input Capture) and Analog to digital Converter (ADC)***

Course Teacher: Prof. S. M. Lutful Kabir

Introduction: First of all, an application of the input capture feature of timers will be demonstrated by exploring the technique of measuring the distance of an object using an Ultrasonic Sensor. Secondly, with the ADC of STM32, the technique of measuring analog voltage will be demonstrated. In this experiment we shall discuss their use of ADC in poling and interrupt mode of operation.

Lab components required: STM32 blue pill board, ST-Link V2 utility, one LED, one Potentiometer, USB to TTL converter, one 220 ohms, power supply, Ultrasonic Sensor and one oscilloscope.

Part#3A: Ultrasonic Sensor (Input Capture)

The objective of this experiment is to use Ultrasonic Sensor and measure the distance. Connect your Blue pill and Ultrasonic sensor and USB to TTL converter module according to the following diagram.

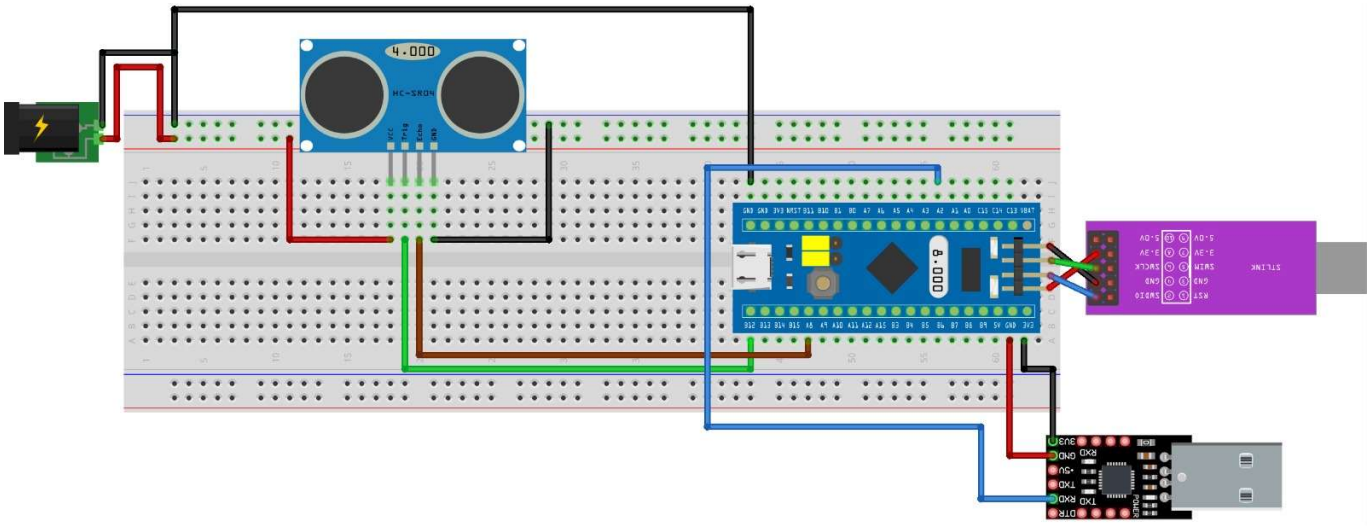

Fig 1: Connection Diagram for Part#3A.

Procedure:

1. Open STM32 CubeIDE and create a project.
2. Set PB12 at GPIO_OUTPUT pin.
3. Set The RCC External Clock Source and Set the system clock to be 72MHz
4. In the configuration screen set Timer 1 (TIM1) as shown in the figure in the next page.
5. Set the following parameters:
    a. Internal clock: internal clock
    b. Prescalar: 71
    c. Counter Period: 65535
    d. auto-reload preload: Disable

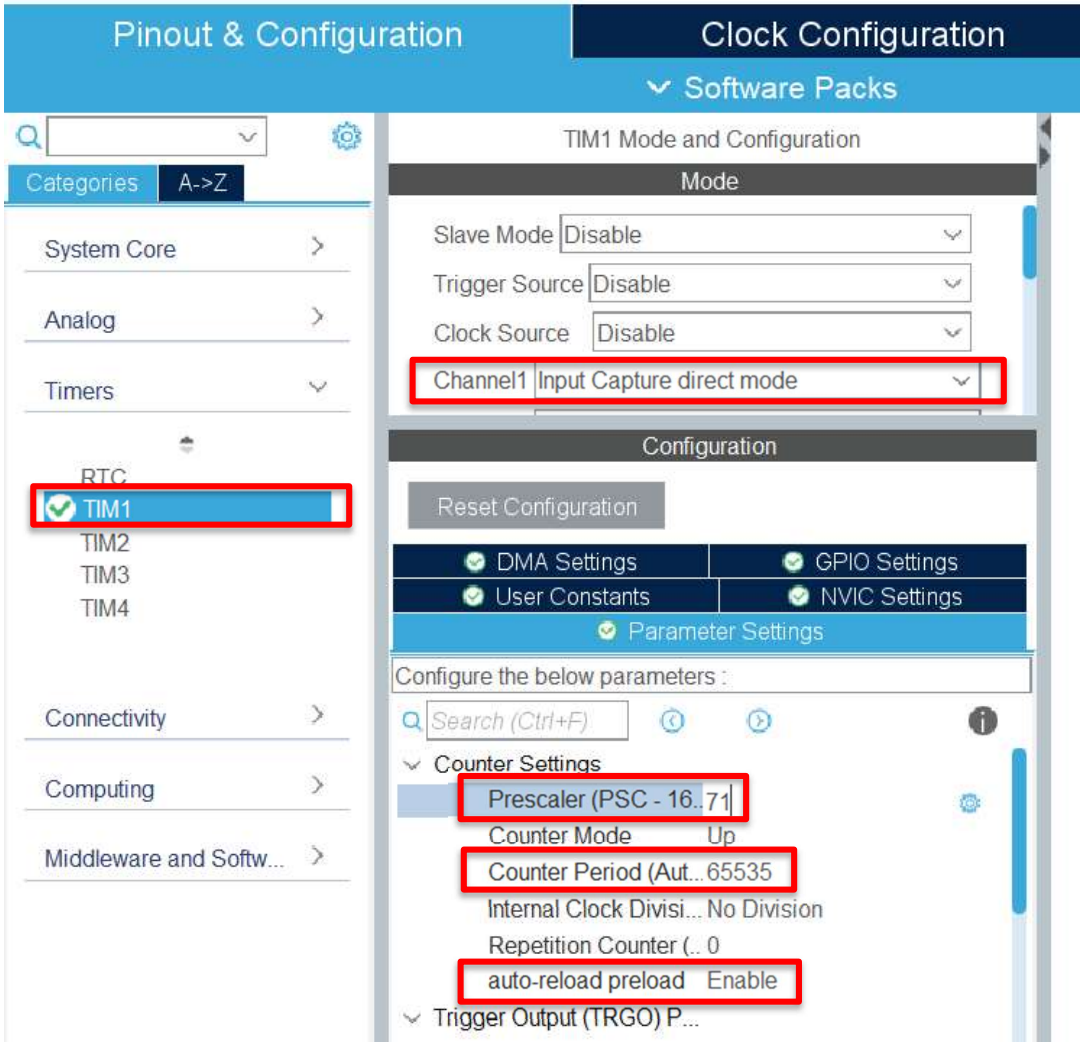

Fig. 2: Timer1 (TIM1) settings

6. The above settings are in the “Parameter Settings”, Now check all the interrupt boxes.

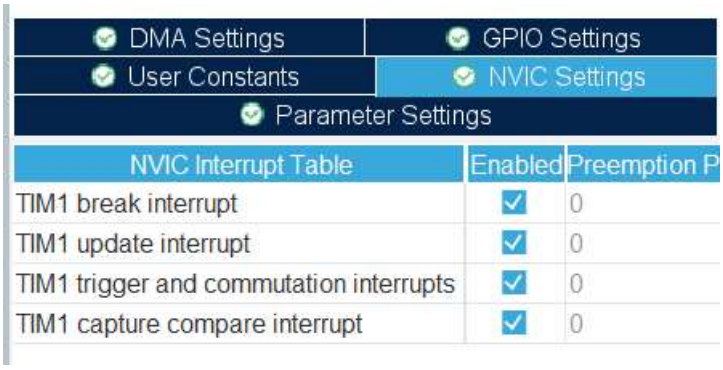

Fig. 3: Timer Interrupt settings

7. Then set the UART setting for serial print.
8. Set UART2 and the settings should be as follows:
9. The values in the “Parameter Settings” tab, set Mode->Asynchronous, Baud Rate->9600
10. There should not be any interrupt settings for UART.

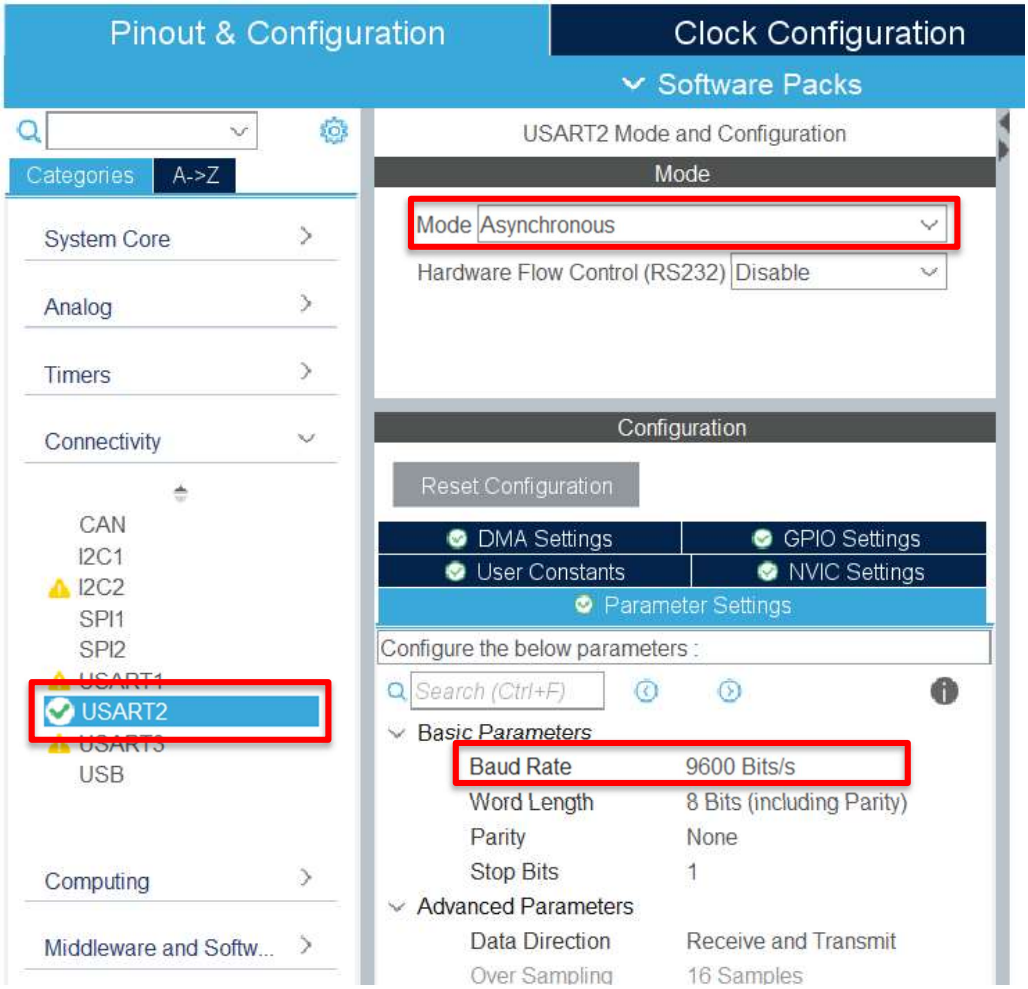

Fig 3: UART settings

11. Save the project (Ctrl+S) and the initialization code will be generated.
12. Add the appropriate portions from the supplementary document.
13. Compile the code and check if there is any error. If any try to correct it.
14. Run the Proteus file and see the effect. [check the name and path and name of the Hex file]
15. Power up the setup (CONNECT THE EXTERNAL SUPPLY IN APPROPRIATE POINTS).
16. Run and download the program to the Bluetooth Module using ST-Link module.
17. Disconnect the ST-LINK module, connect USB-TTL converter and switch on the external power supply.
18. Create a terminal and set the baud rate at 9600.
19. Observe the distance output against the actual distance.
20. Vary the distance and note down the distances.

====

Part#3B: ADC in Poling and Interrupt Mode of operation

3B(i) ADC in polling mode

For Polling mode, connect your Blue Pill module, USB to TTL converter, LED, resistor and ST-Link as shown below:

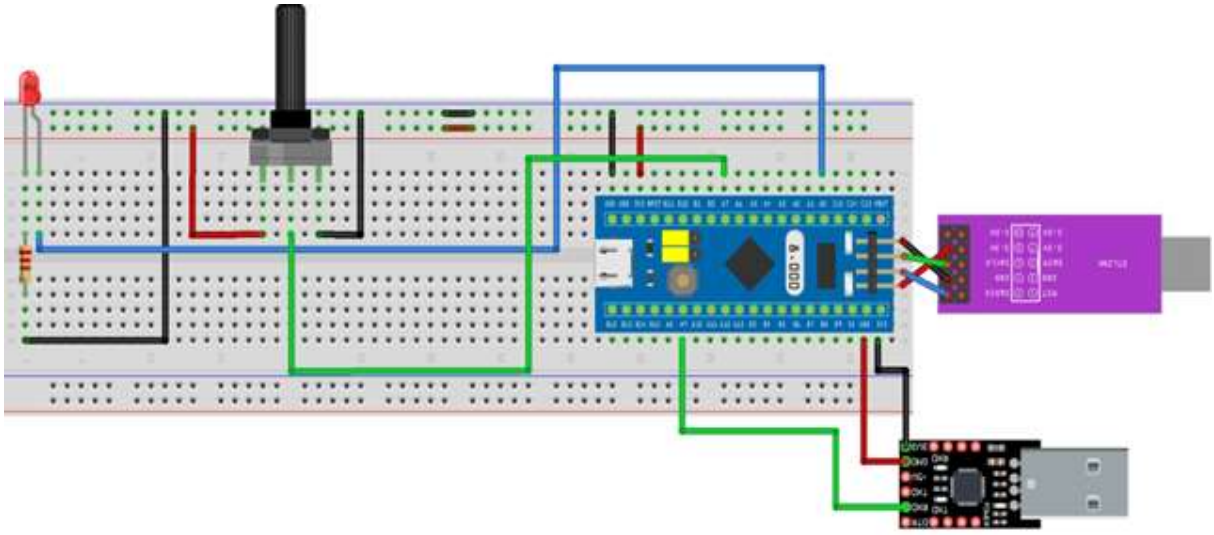

Fig.1: Connection Diagram for Part#3B

Procedure 3B(i):

1. Open STM32 CubeIDE & create a Project.
2. Set The RCC External Clock Source and Set the system clock to be 72MHz
3. Configure The ADC1 Peripheral.
4. The settings are-> Channel: IN7, Mode: Independent mode, Data Alignment: Right alignment.

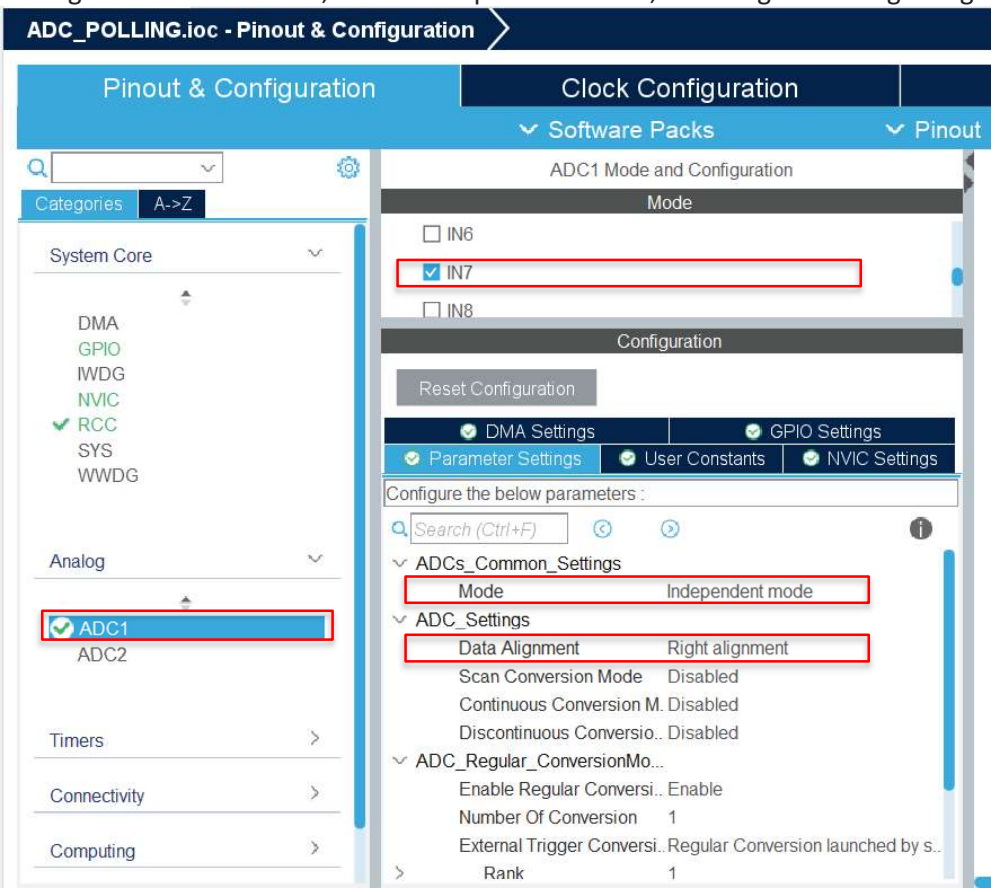

Fig 5: ADC Settings

5. Configure Timer 2 (TIM2) peripheral.
6. The settings are-> Clock Source: Internal Clock, Channel 1: PWM Generation CH1, Prescalar:0, Counter Period: 65535 and auto-reload preload: Enable.

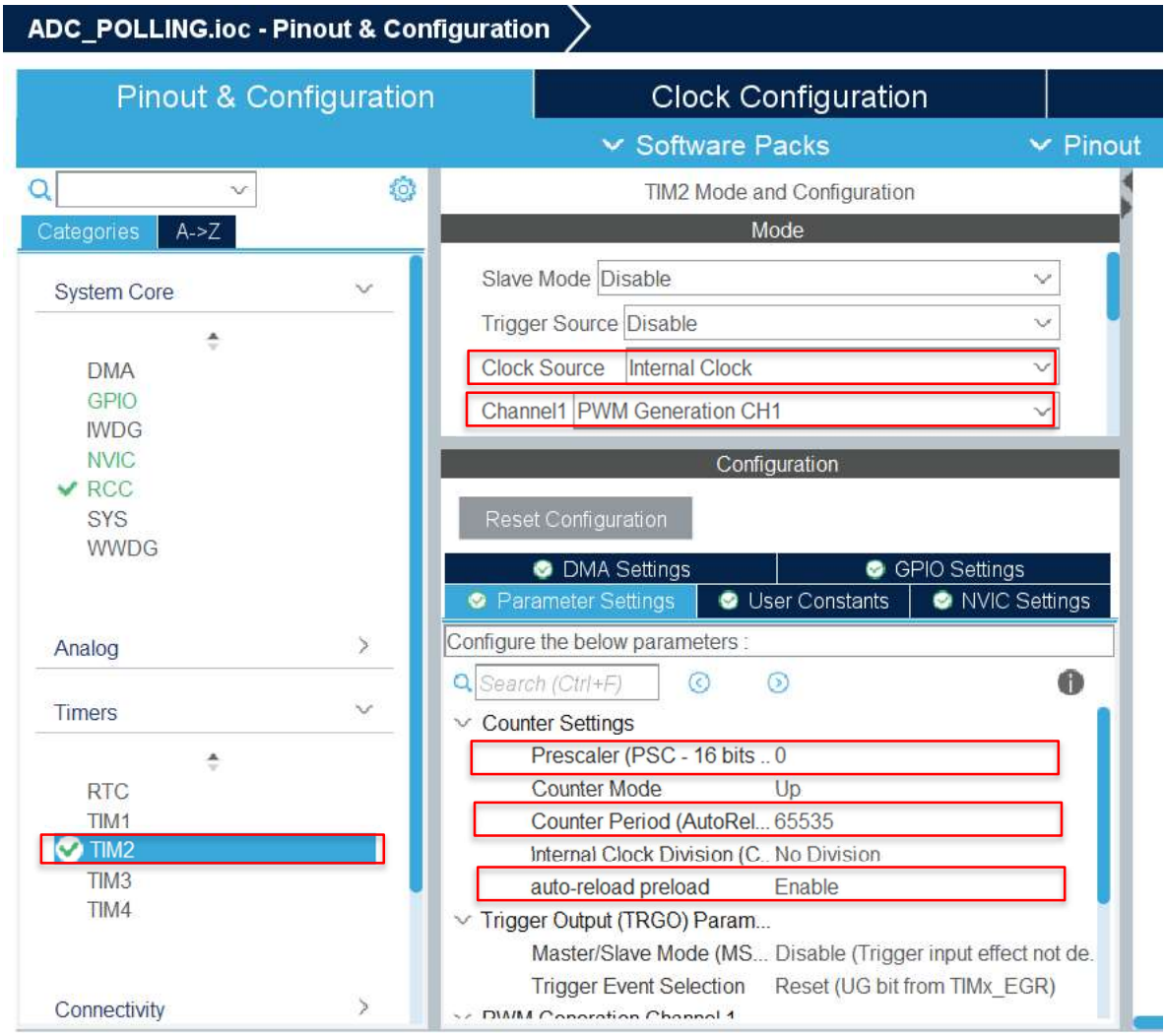

Fig 5: Timer 1 (TIM1)

7. Configure UART1 as shown in the figure in the next page.
8. The settings are-> Mode: Asynchronous, Baud Rate: 9600.
9. Save the project (Ctrl+S) and the initialization code will be generated.
10. Add the appropriate portions from the supplementary document.
11. Compile the code and check if there is any error. If any try to correct it.
12. Run the Proteus file and see the effect. [check the name and path and name of the Hex file]
13. Power up the setup.
14. Run and download the program to the Bluetooth Module using ST-Link module.
15. Disconnect the ST-LINK module, connect USB-TTL converter.
16. Create a terminal and set the baud rate at 9600.
17. Observe the output of duty cycle against the actual value obtained from the wave shape.
18. Vary the potentiometer and note down the duty cycle.
19. Verify the output in the serial port against calculated value from the wave shape.

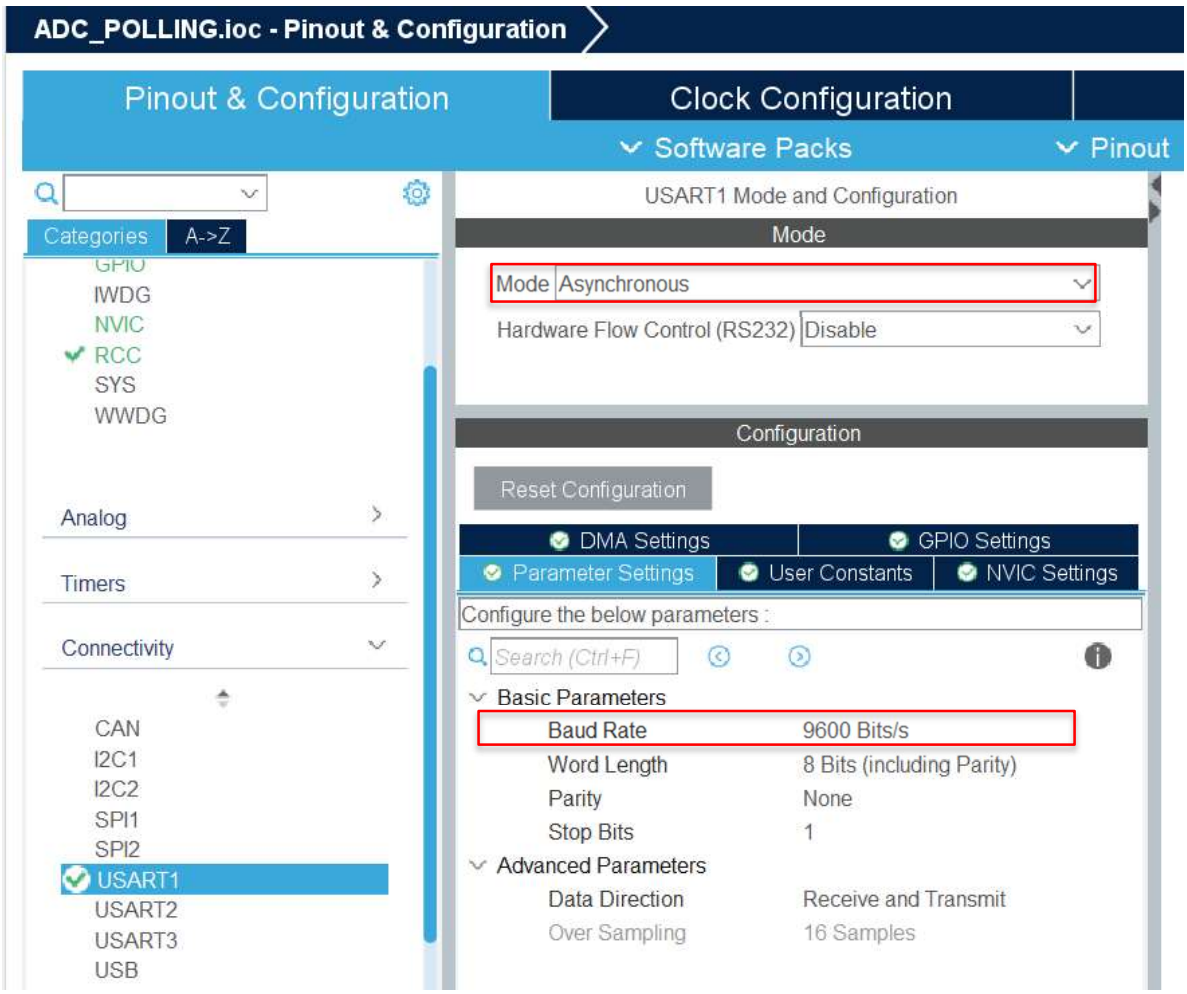

Fig. 6: UART Settings

=====

3B(ii) ADC in interrupt mode

Use the same circuit shown for 3B(i).

Procedure 3B(ii)

1. Repeat Step 1 to 4 of Part 3B(i). All ADC settings will remain the same but we'll need to enable the interrupt from the NVIC controller tab. This is shown in the Fig. below.
2. Repeat rest of the steps 5 to 18. [the code is given separately in the supplementary document]
3. Compile the code and check if there is any error. If any try to correct it.
4. In step 12, Run the Proteus file (use the same Proteus file) and see the effect. [check the name and path and name of the Hex file]

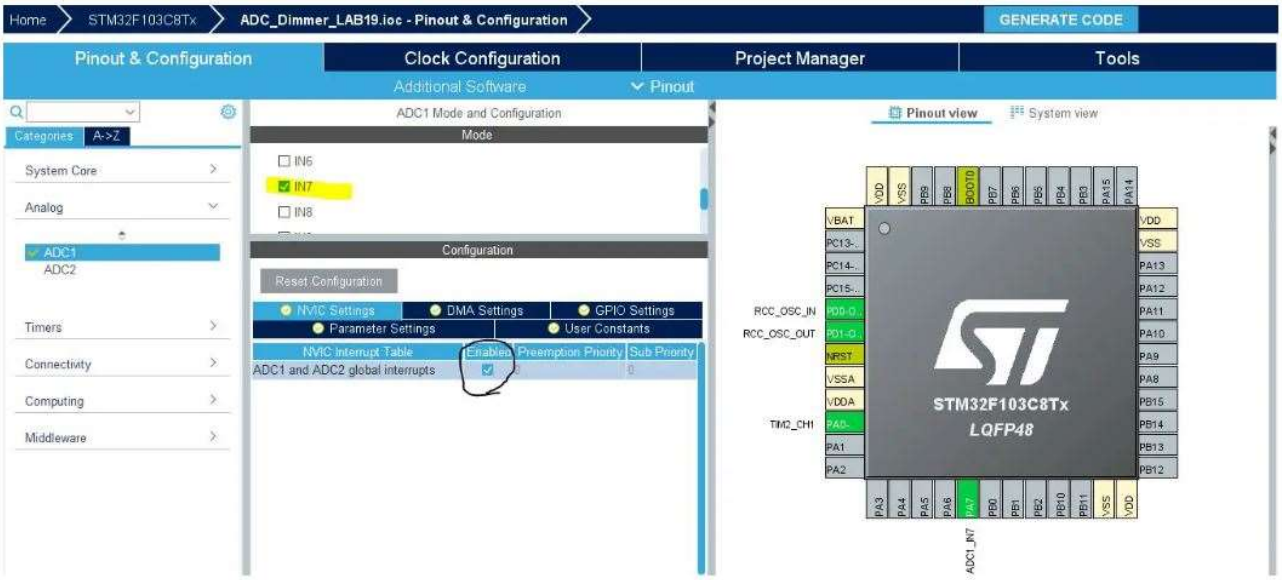

Fig. 7: Interrupt setting for ADC