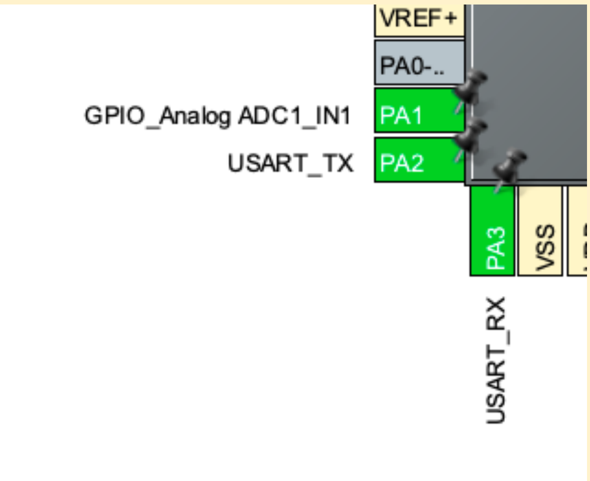
Mark	/11

Team name:	*A1*		
Homework number:	*HOMEWORK 06*		
Due date:	28/10/24		
Contribution	NO	Partial	Full
Piombo			*x*
Fumagalli			*x*
Pierfederici			*x*
Zenoni			*x*
Ferraro			*x*
Notes:			

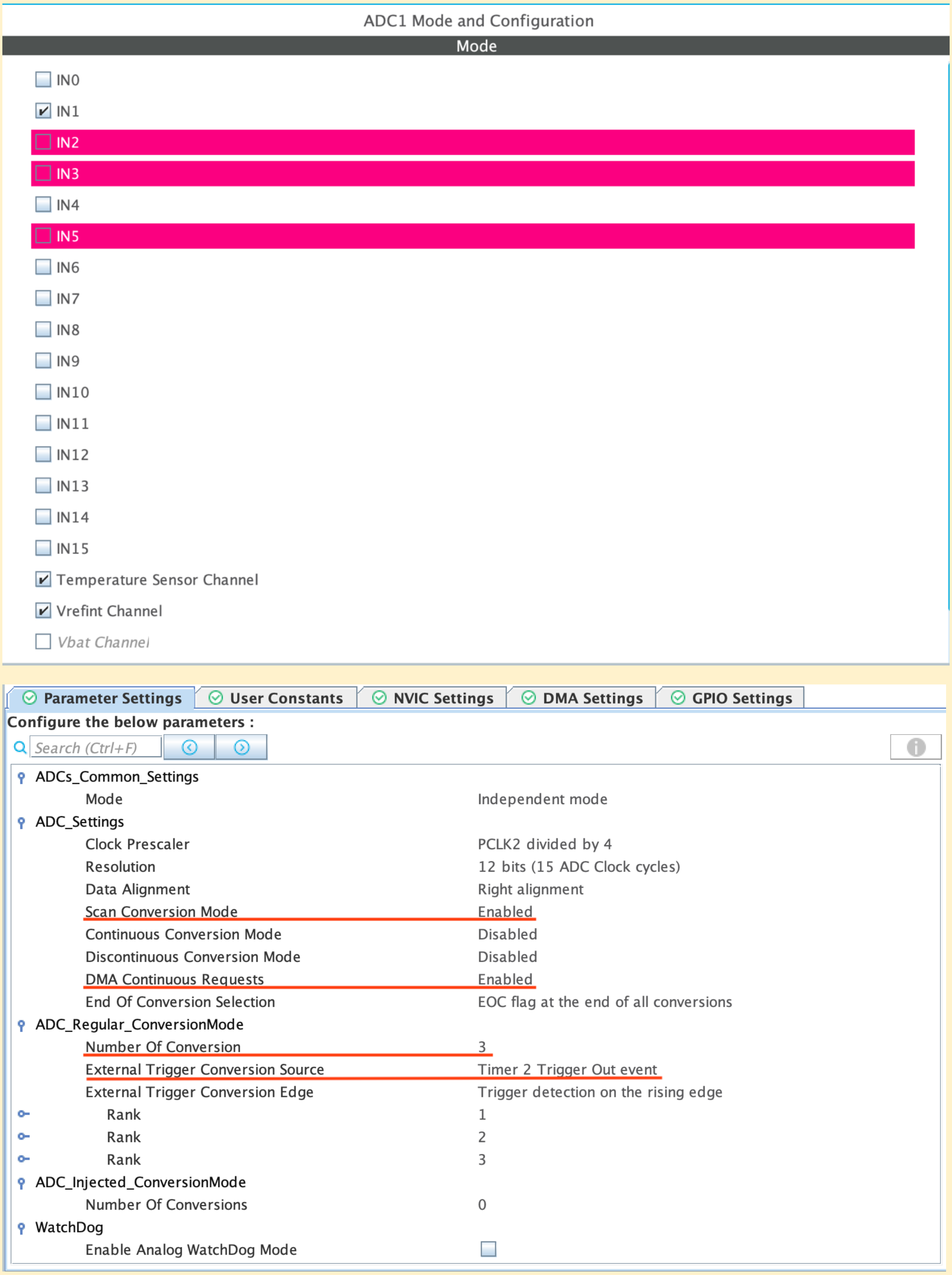
Project name	ADC DMA + LDR		
Not done	Partially done (major problems)	Partially done (minor problems)	Completed
			x

Part 1:

First of all, we set the potentiometer pin (PA1) as analog input (ADC1) and we checked the UART pins



We configured the ADC as below in order to scan the 3 channels in sequence (scanning mode), operating it in DMA mode, with the conversion started by the timer (TIM2)



This is the scanning order operated by the ADC

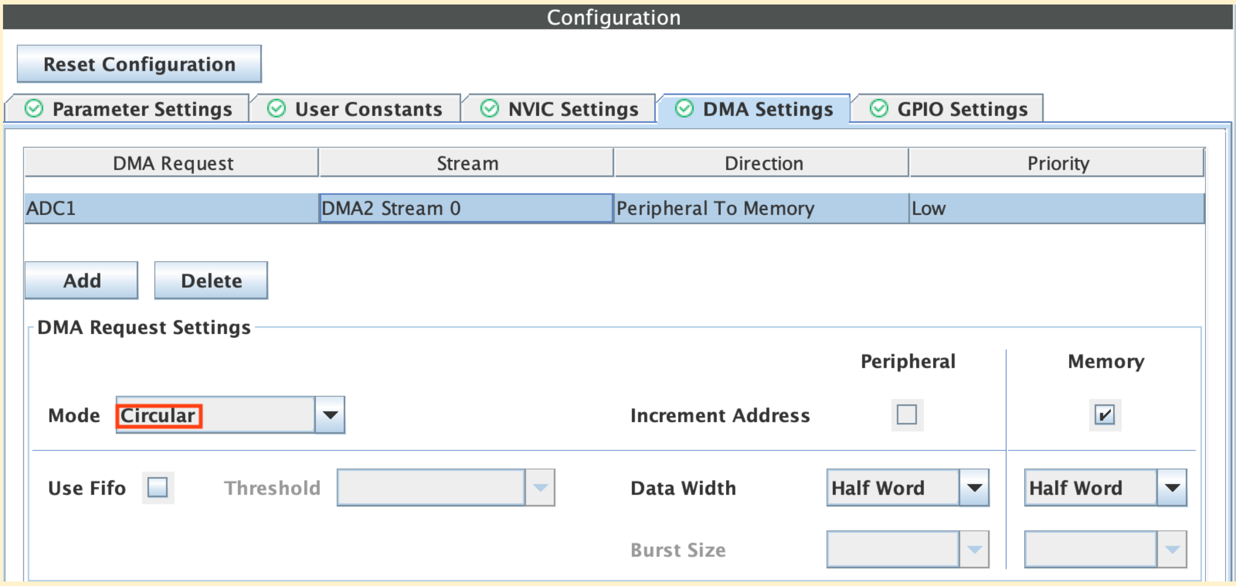
Rank	1
Channel	Channel 1
Sampling Time	480 Cycles
Rank	2
Channel	Channel Temperature Sensor
Sampling Time	480 Cycles
Rank	3
Channel	Channel Vrefint
Sampling Time	480 Cycles

We needed the ADC interrupt enabled

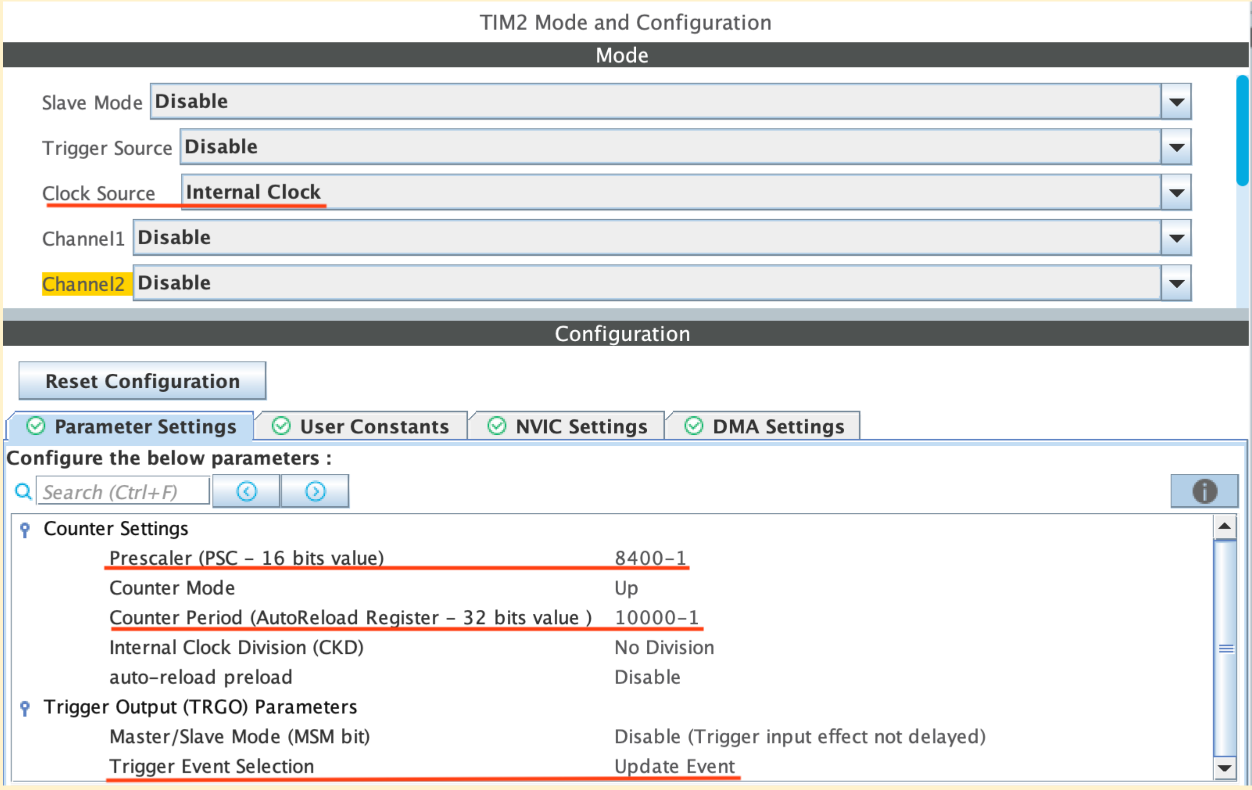
Parameter Settings | User Constants | NVIC Settings | DMA Settings | GPIO Settings

NVIC Interrupt Table	Enabled	Preemption Priority	Sub Priority
ADC1 global interrupt	☑	0	0
DMA2 stream0 global interrupt	☑	0	0

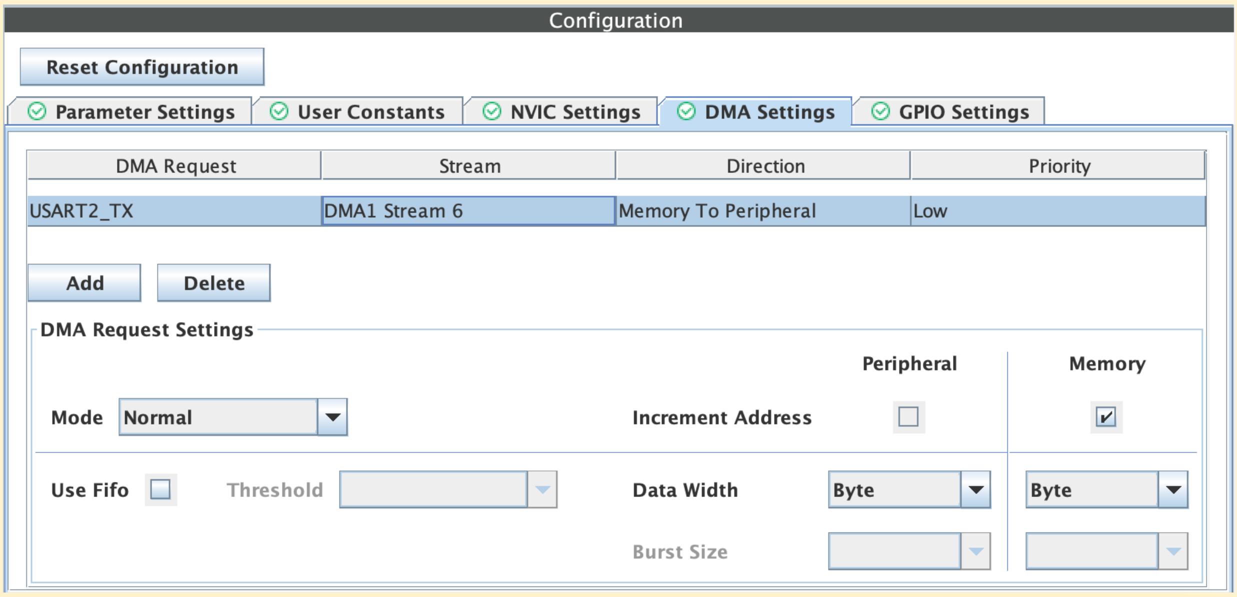
This is the configuration of the DMA of the ADC (circular mode)



This is the timer 2 configuration (start the ADC conversion every second)



In order to send data to the PC we used UART in DMA mode (we also enabled UART interrupt)



These are the variables used in our code

```
/* USER CODE BEGIN PV */

uint16_t digital_data[BUF_LEN];      //store the 3 channel's digital values from ADC
float analog_voltage[BUF_LEN];       //store the 3 channel's analog values
float temperature;
char string[STR_LEN];
int length;

/* USER CODE END PV */
```

In our main function we configured the ADC in DMA mode and started our timer

```
HAL_ADC_Start_DMA(&hadc1, digital_data, BUF_LEN);     //properly configure the ADC in DMA mode
HAL_TIM_Base_Start(&htim2);                           // start timer
```

When the ADC conversion is finished, this function is called: the data are elaborated and sent to the PC console (LSB is defined as 3.3/4096.0)

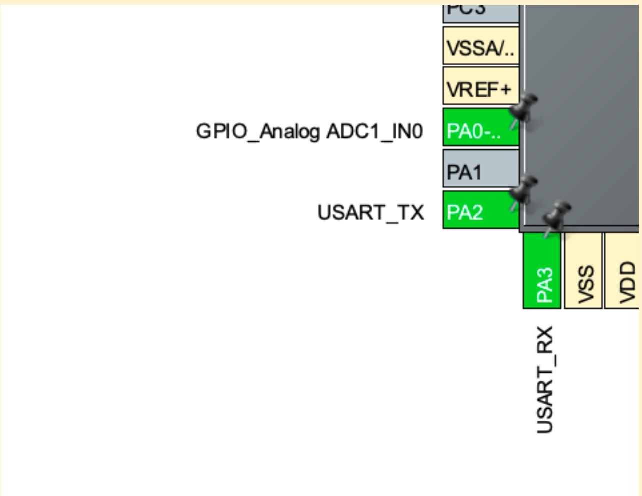
```
void HAL_ADC_ConvCpltCallback (ADC_HandleTypeDef *hadc) {
    if (hadc == &hadc1) {
        for (int i = 0; i < BUF_LEN; i++) {
            analog_voltage[i] = LSB*digital_data[i];
        }
        temperature = ((analog_voltage[1]-V_25)/AVG_SLOPE) + 25;    // conversion V -> °C
        length = snprintf(string, sizeof(string), "POT: %.3fV  TMP: %.3f°C  VREF: %.3fV\n", analog_voltage[0], temperature, analog_voltage[2]);
        HAL_UART_Transmit_DMA(&huart2, string, length);
    }
}
```

We computed the temperature with the provided formula

$$Temperature(in\ °C) = \frac{V_{sense} - V_{25}}{Avg\_Slope} + 25$$

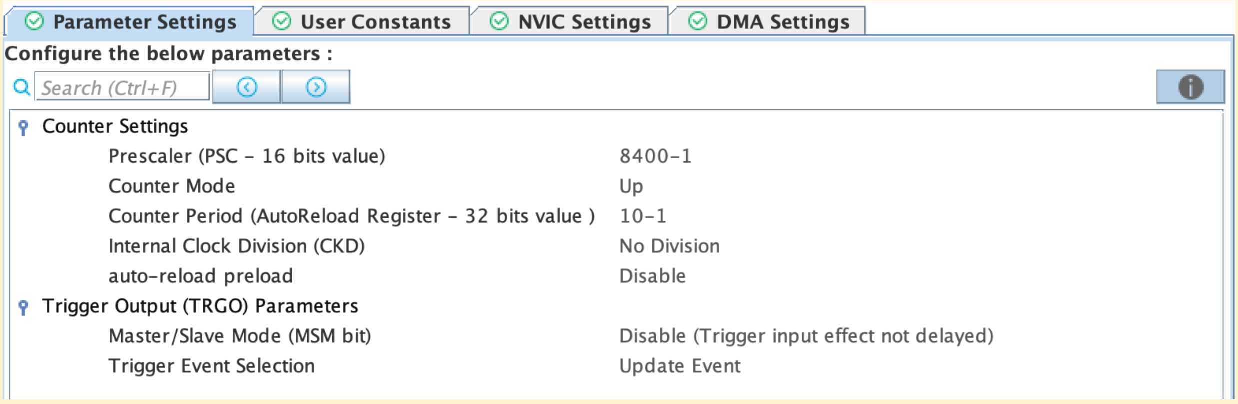
Part 2:

We set the light sensor pin (PA0) as analog input (ADC1) and we checked the UART pins



We configured the ADC as the part 1 (DMA **circular mode**, started by timer 2, ADC interrupt enabled). The only difference is that now we operate on a single channel.

This is timer 2 configuration, in order to start the ADC conversion every ms



Then we configured UART in DMA mode as part 1, to send our data to the PC.

We needed to acquire 1000 samples from the LDR and average them. In order to be as fast as possible to avoid the DMA buffer (digital_data) being overwritten while we still have to process our data, we exploited also the half DMA callback, in which we processed the first 500 samples. In this way the ADC with DMA can collect data in parallel to the data elaboration performed by the CPU, avoiding data corruption.

These are our variables (NUM_OF_SAMPLES is defined as 1000)

```
/* USER CODE BEGIN PV */

uint16_t digital_data[NUM_OF_SAMPLES];      //store all ldr values sampled every ms
uint32_t digital_sum1 = 0;                  //store sum of 1st 500 samples
uint32_t digital_sum2 = 0;                  //store sum of 2nd 500 samples
uint32_t digital_average = 0;               //store ldr average value
float analog_voltage = 0;                   //store analog voltage value (average)
float ldr = 0;   // in kOhm
float lux = 0;   // in lx
char string[STR_LEN];
int length;

/* USER CODE END PV */
```

We configured the ADC and started the timer in the main function

```
HAL_ADC_Start_DMA(&hadc1, digital_data, NUM_OF_SAMPLES);      //properly configure ADC in DMA mode
HAL_TIM_Base_Start(&htim2);                                   // start timer
```

These are our callbacks (LSB is defined as 3.3/4096.0)

```c
void HAL_ADC_ConvHalfCpltCallback (ADC_HandleTypeDef *hadc) {
    if (hadc == &hadc1) {
        digital_sum1 = 0;
        for (int i = 0; i < NUM_OF_SAMPLES/2; i++) {    //process here the 1st 500 samples
            digital_sum1 += digital_data[i];
        }
    }
}

void HAL_ADC_ConvCpltCallback (ADC_HandleTypeDef *hadc) {
    if (hadc == &hadc1) {
        digital_sum2 = 0;
        for (int i = 500; i < NUM_OF_SAMPLES; i++) {    //process here the 2nd 500 samples
            digital_sum2 += digital_data[i];
        }
        digital_average = (digital_sum1 + digital_sum2)/NUM_OF_SAMPLES; //compute the average
        analog_voltage = LSB*digital_average;
        ldr = (analog_voltage*100)/(3.3-analog_voltage);    //conversion V -> kOhm
        lux = 10*powf(100/ldr, 1.25);                       //conversion kOhm -> lx
        length = snprintf(string, sizeof(string), "LDR: %.3fkOhm  LUX: %.3flx\n", ldr, lux);
        HAL_UART_Transmit_DMA(&huart2, string, length);
    }
}
```

We calculated resistance value and lux value with the provided formulas

$$LDR = (V_{ADC} \times 100\ k\Omega)/(3.3\ V - V_{ADC})$$

$$LUX \simeq 10\times(100\ k\Omega/LDR)^{1.25}$$