LAB: ADC – IR Reflective Sensor

I. Introduction

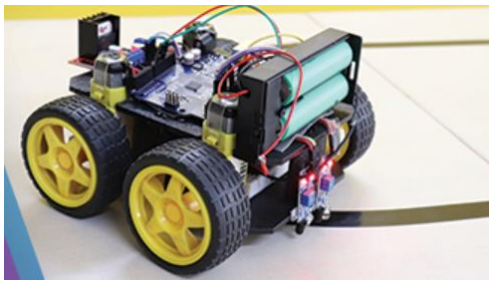
In this lab, you are required to create a simple application that uses ADCs to implement the line tracing mission for an RC car. The analog measurement of reflection values from two IR reflective sensors are used . The ADCs are triggered by a timer of given samping rate.

Hardware

NUCLEO -F411RE, 2x IR Reflective Sensors(TCRT 5000)

Software

Keil uVision IDE, CMSIS, EC_HAL



II. Procedure

A. Create EC_HAL functions

Specific for given Output Pins

Include File	Function	Description

ecTIM.h, c	uint32_t is_UIF(TIM_TypeDef *timx);
	void clear_UIF(TIM_TypeDef *timx);
	void TIM_INT_enable(TIM_TypeDef* timx);
	void TIM_INT_disable(TIM_TypeDef* timx);
		Initialize timer counter period of usec.
		For Timerx= TIM1, TIM2, …

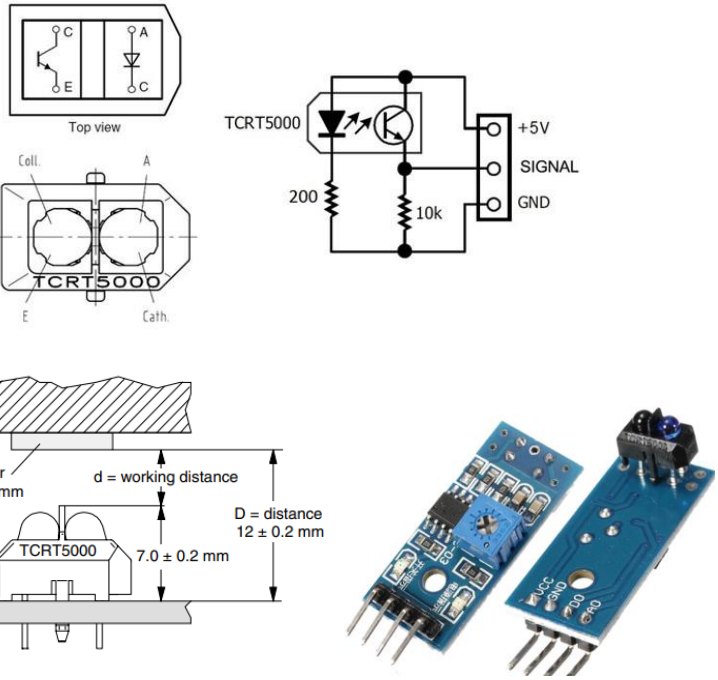
ecADC	void ADC_init(GPIO_TypeDef *port, int pin, int type);
	void ADC_continue(int contmode);
	void ADC_TRGO(TIM_TypeDef* TIMx, int msec,
		// ADC_pinmap() will be provided

	int edge);
	void ADC_sequence(int length, int *seq);
	
	void ADC_start(void);
	uint32_t ADC_read();
	uint32_t ADC_pinmap(GPIO_TypeDef *port, int pin);
	uint32_t is_ADC_EOC(ADC_TypeDef *ADCx);
	uint32_t is_ADC_OVR(ADC_TypeDef *ADCx);
	void clear_ADC_OVR(ADC_TypeDef *ADCx);	

B. IR Reflective Sensor (TCRT 5000)

IR Reflective Sensor(TCRT 5000): Spec Sheet

The TCRT5000 and TCRT5000L are reflective sensors which include an infrared emitter and phototransistor in a leaded package which blocks visible light.



The HC-SR04 Ultrasonic Range Sensor Features:

- Input Voltage: 5V
- Detector type: phototransistor
- Operating range within > 20 % relative collector current: 0.2 mm to 15 mm
- Emitter wavelength: 950 nm

APPLICATIONS

• Position sensor for shaft encoder • Detection of reflective material such as paper, IBM cards, magnetic tapes etc. • Limit switch for mechanical motions in VCR • General purpose - wherever the space is limited

Discussion

C. Configuration

Create a new project named as “**LAB_ADC_IR”.**

Name the source file as “**LAB_ADC_IR.c”**

Configure Input and Output pins

TIMER	
Timer3 Up-Counter, Counter CLK 1kHz OC1M: Output Compare 1 mode (PWM mode 1) MasterModeSelection: (TRGO) OC1REF	
ADC	**GPIO**
ADC_IN8 (1st channel) ADC_IN9 (2nd channel) ADC Clock Prescaler /8 12-bit resolution, right alignment, Single conversation mode Scan mode: Two channels in regular group External trigger(Timer3 TRGO) @ 1kHz Trigger Detection on Rising Edge	PB_0, PB_1: Analog Mode ADC_IN8 (PB_0) ADC_IN9 (PB_1) No Pull-up Pull-down

D. Line Tracing

- Create a logic to trace a dark line on white background surface for your RC car.
- Use 2 IR reflective sensors to detect if the black line is in between the sensors. It should display whether the system needs to move **Left or Right** to keep the line between sensors.
- Set the ADC sampling rate trigger to be 1KHz, to decrease burden to your CPU.
- Determine the threshold value to differentiate dark and white surface of the object.
- Display (1) reflection value of IR1 and IR2 (2) print 'GO LEFT' or 'GO 'RIGHT' on serial monitor of Tera-Term. Print the values every second

ADC_IRSensor_result

Discussion

1) How would you change the code if you need to use 3 Analog sensors?
2) Which registers should be modified if you need to use Injection Groups instead of regular groups for 2 analog sensors?

III. Report

You are required to write a consice lab report and submit the program files.

Lab Report: See sample report.

- Write Lab Title, Date, Your name, Introduction
- For each Part show only main() source file. Also, need to include the external circuit diagram if necessary.
- Show your whole code **in the appendix,**
- Answer **Discussion questions**
- You can write Troubleshooting section
- Link your demo video
- Submit in both PDF and original file (*.docx etc)
- No need to print out. Only the On-Line submission.

Source Code:

- Write description of your functions in github. **(Submit your documentation *.md)**
- Upload the final version of your library in github.
- Zip all the necessary source files(main.c, ecRCC.h, ecGPIO.h etc...).
- Only the source code files. Do not submit project files etc.

Appendix

For ADC Pinmap and GPIO Pinmap. See EC class wiki webpage