Experiment No 2

STM32 GPIO Port familiarization using blinking LED example

Objectives:

To learn about Input/output pins/ports programming of STM-32 using C language.

I/O Port Programming in STM:

The STM32 family of microcontrollers from STMicroelectronics is based on the ARM Cortex- M4 32-bit processor core. The STM32 series are some of the most popular microcontrollers used in a wide variety of products. They also have an excellent support base from multiple microcontroller development forums. STM32 microcontrollers offer a large number of serial and parallel communication peripherals which can be interfaced with all kinds of electronic components including sensors, displays, cameras, motors, etc. All STM32 variants come with internal Flash memory and RAM. Software used for programming STM32 is KEIL UVision5 IDE.

General-purpose input/outputs (GPIOs):

Each of the GPIO pins can be configured by software as output (push-pull or open-drain, with or without pull-up or pull-down), as input (floating, with or without pull-up or pull-down) or as peripheral alternate function. Most of the GPIO pins are shared with digital or analog alternate functions. All GPIOs are high-current-capable and have speed selection to better manage internal noise, power consumption and electromagnetic emission. The I/O configuration can be locked if needed by following a specific sequence in order to avoid spurious writing to the I/Os registers. Fast I/O handling allowing maximum I/O toggling up to 72 MHz.

Procedure for KEIL Simulation

Proceed as follows to program STM Microprocessor.

1. Run KEIL uVision5 IDE.
2. Select Project/new uVision Project from Project Menu.
3. Give a name to your project then click OK.

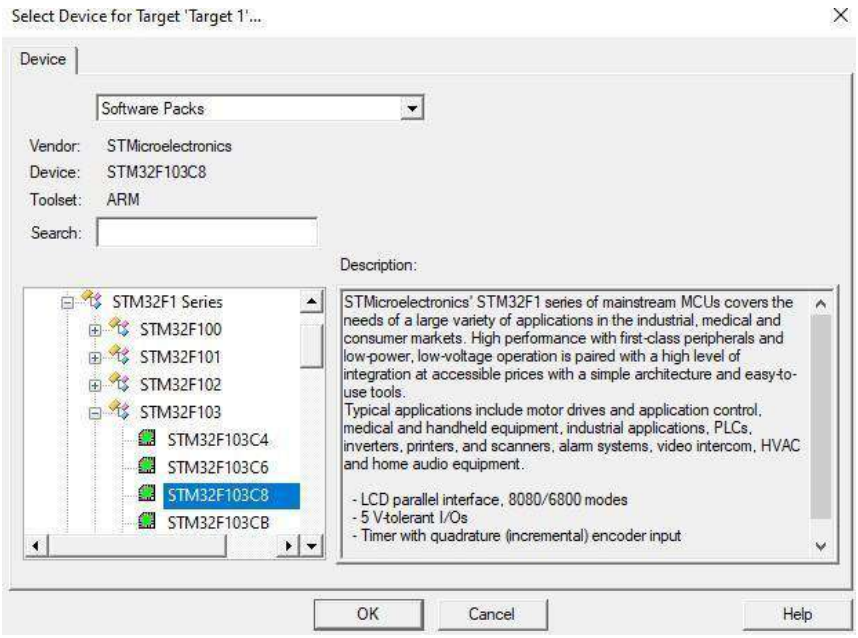


Figure 1

4. Click on STMicroelectronics, different variant just appeared select STM32F103 and then select on STM32F103C8 MCU and click OK.
5. After selecting MCU windows appears just like figure2. Click CMSIS and select CORE, then click driver from software component than select startup and click on resolve Tab after that Click OK.

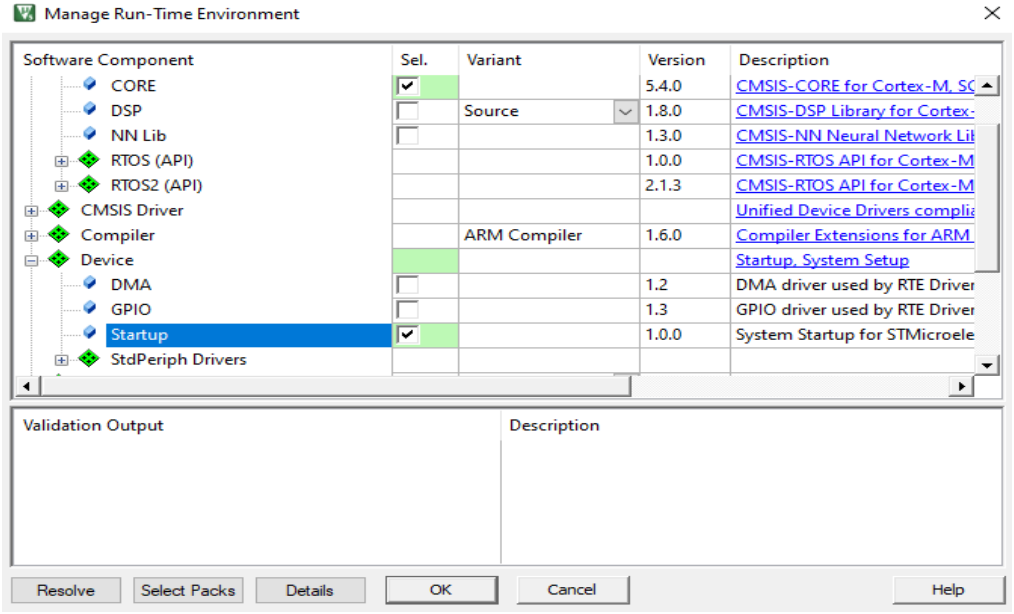


Figure 2

6. Now add new item to group from source group1. Select file type C and give it a name main.
7. First thing to start STM coding is to include STM32 library ("#include <stm32f10x.h>").

8. Now Initialize GPIO pins, whether they act as INPUT or OUTPUT by creating object such as GPIO_InitTypeDef myLED; .
   In STM32 there are two modes to configure

   GPIOS, input and output. In input mode we have,

   - Analog mode
   - Floating Input
   - Input with pull-up/pull-down

   In output mode,

   - General purpose output push-pull
   - General purpose output Open-drain
   - Alternate function output push-pull
   - Alternate function output Open-drain.

```
20  /* GPIOC Peripheral clock enable */
21  RCC_APB2PeriphClockCmd(RCC_APB2Periph_GPIOC, ENABLE);
22  RCC_APB2PeriphClockCmd(RCC_APB2Periph_GPIOB, ENABLE);
23  /* Configure PC13 in output pushpull mode */
24  GPIO_InitStructure.GPIO_Pin = GPIO_Pin_13;
25  GPIO_InitStructure.GPIO_Speed = GPIO_Speed_2MHz;
26  GPIO_InitStructure.GPIO_Mode = GPIO_Mode_Out_PP;
27  GPIO_Init(GPIOC, &GPIO_InitStructure);
28    /* Configure PB5 in Input mode */
29  GPIO_InitStructure.GPIO_Pin = GPIO_Pin_5;
30  GPIO_InitStructure.GPIO_Speed = GPIO_Speed_2MHz;
31  GPIO_InitStructure.GPIO_Mode =  GPIO_Mode_IN_FLOATING;
32  GPIO_Init(GPIOB, &GPIO_InitStructure);
```

Figure 3

9. Now complete the main function by calling relevant function as seen in figure4.

/

```
33  while (1)
34  {
35    if(GPIO_ReadInputDataBit(GPIOB, GPIO_Pin_5) == 0)
36    {
37    /* Write high to on board LED */
38    GPIO_ResetBits(GPIOC,GPIO_Pin_13);
39    }
40    else
41    {
42    /* Write LOW to on board LED */
43    GPIO_SetBits(GPIOC,GPIO_Pin_13);
44    }
45  }
46 }
```

Figure 4

10. Now build the target file.

11. Now click on option for target menu and set the following settings

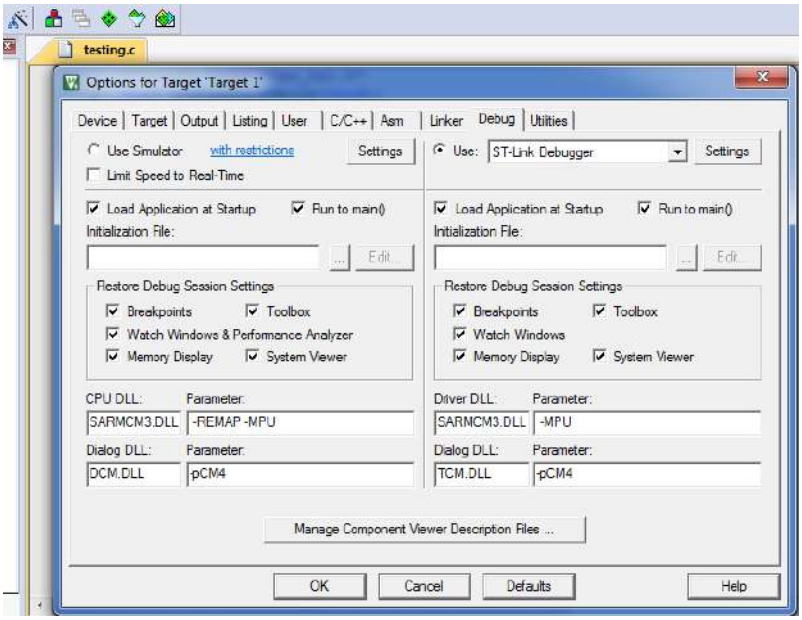


Figure 5

12. Final step is to Load the code in STM by click Load Menu.

Lab Task (Psychomotor)

Activity 01:

Use the PUSH Button of to turn ON four external LEDs on the Trainer.

Activity 02:

Implement two Traffic Signal Indicators displaying the traffic signals on a Highway and a Subway. Traffic signals will operate in DAY and Night Mode. Use an external button to switch between the day and night mode

Day Mode:

- **When RED Light of Highway is turned ON, RED Light of Subway will be turned OFF and GREEN Light of Subway will be ON.**
- **After 5 seconds, YELLOW Light of both Highway and Subway will be turned ON and all other lights will be turned OFF.**
- **After 3 seconds, RED Light of Subway is turned ON, RED Light of Highway will be turned OFF and GREEN Light of Highway will be ON.**
- **After 5 seconds, display YELLOW light both on the Highway and**

Subway Night Mode:

- **YELLOW Light of both Highway and Subway will blink with 1 second delay**

and all other lights will be turned OFF.

Lab Task (Cognitive)

Question 1:

An LED is connected through a resistor to pin PA5 (active-high). The core clock is 16 MHz and one iteration of the software delay loop takes 4 clock cycles.

a) State the sequence of configuration steps required before pin PA5 can be driven as an output. **[3 Marks]**

b) Determine the values (in hexadecimal) that must be written to the BSRR register to set PA5 and to reset PA5. **[3 Marks]**

c) Determine the loop count N required to generate a 500 ms software delay. **[2 Marks]**

d) If the LED is toggled once every 500 ms, determine the blinking period and frequency. **[2 Marks]**

Lab Exercise and Summary

Summary should cover Introduction, Procedure, Data Analysis and Evaluation.

Student's Signature: _____ Date: _____

LABORATORY SKILLS ASSESSMENT (Cognitive)

Obtained Marks	**/10**

Instructor's Signature: _____ Date: _____

LABORATORY SKILLS ASSESSMENT (Psychomotor)

Psychomotor Activity 1: Experimental Setup

S. No	Criteria	Performance	Description	Marks
1	**GPIO Hardware & Software Setup (4)**	Level 4	Correctly prepares the required GPIO hardware and software setup for the experiment independently and according to the laboratory requirements.	4
		Level 3	Correctly prepares the required GPIO hardware and software setup with minor errors or assistance.	3
		Level 2	Partially prepares the required GPIO hardware and software setup and requires considerable assistance.	2
		Level 1	Shows limited ability to prepare the required GPIO hardware and software setup and requires substantial assistance.	1
2	**Pin & Clock Configuration (4)**	Level 4	Correctly prepares the required pin and clock configuration for the experiment independently and according to the laboratory requirements.	4
		Level 3	Correctly prepares the required pin and clock configuration with minor errors or assistance.	3
		Level 2	Partially prepares the required pin and clock configuration and requires considerable assistance.	2
		Level 1	Shows limited ability to prepare the required pin and clock configuration and requires substantial assistance.	1
3	**Build & Debug Parameters (2)**	Level 2	Correctly sets the required build and debug parameters for the experiment.	2
		Level 1	Sets the basic build and debug parameters with minor errors or assistance.	1
Total Obtained				**/10**

If a student is absent:

Criteria	Description	Marks
Absent	Student is absent from the laboratory activity.	**0**

Instructor's Signature: _____ Date: _____

Psychomotor Activity 2: Implementation + Results

S. No	Criteria	Performance	Description	Marks
1	**GPIO C Program & Safe Working Practice (4)**	Level 4	Correctly implements the assigned GPIO C program independently while following appropriate laboratory practices.	4
		Level 3	Implements the assigned GPIO C program with minor errors or assistance and generally follows proper laboratory practices.	3
		Level 2	Partially implements the assigned GPIO C program and requires considerable assistance or repeated guidance.	2
		Level 1	Implementation of the assigned GPIO C program is largely incomplete, requires substantial assistance, or shows poor adherence to proper laboratory and safety practices.	1
2	**Execution & Debugging (2)**	Level 2	Correctly performs the required build, execution and debugging and verifies the expected operation.	2
		Level 1	Performs the basic build, execution and debugging with minor errors or assistance.	1
3	**LED Operation & Output Analysis (4)**	Level 4	Obtains correct LED operation and output analysis and appropriately verifies and interprets the required experimental results.	4
		Level 3	Obtains mostly correct LED operation and output analysis with minor errors in verification or interpretation.	3
		Level 2	Obtains partially correct LED operation and output analysis with noticeable errors or omissions.	2
		Level 1	LED operation and output analysis is largely incorrect or incomplete and requires substantial assistance.	1
Total Obtained				**/10**

If a student is absent:

Criteria	Description	Marks
Absent	Student is absent from the laboratory activity.	**0**

Instructor's Signature: _____ **Date: _____**

LABORATORY SKILLS ASSESSMENT (Affective)

Affective Activity: Lab Report + Viva Voce

S. No	Criteria	Performance	Description	Marks
1	**Lab Report Completeness & Organization (4)**	Level 4	Report is complete, well-organized, properly presented, and demonstrates responsible completion of the assigned laboratory work.	4
		Level 3	Report is complete with minor omissions or organizational issues and demonstrates satisfactory responsibility for the assigned work.	3
		Level 2	Report is partially complete with several omissions and demonstrates limited responsibility for the assigned work.	2
		Level 1	Report has major omissions or poor organization and demonstrates minimal responsibility for the assigned work.	1
2	**GPIO Output & Conclusion (2)**	Level 2	The GPIO output and conclusion are correctly presented and discussed, demonstrating ownership of the assigned work.	2
		Level 1	The GPIO output and conclusion are presented with minor errors or omissions.	1
3	**Viva Voce (4)**	Level 4	Clearly explains the assigned experiment, GPIO configuration, program explanation, working, and results, demonstrating individual responsibility, participation, and effective communication.	4
		Level 3	Explains most of the assigned experiment and results correctly, with minor difficulty, and demonstrates good individual participation.	3
		Level 2	Explains basic aspects of the assigned experiment with some prompting and demonstrates basic participation.	2
		Level 1	Demonstrates limited understanding or involvement and requires substantial prompting to explain the assigned work.	1
Total Obtained				**/10**

The student has not submitted the report and has not appeared in the Viva Voce.

Criteria	Description	Marks
Lab Report and Results Not Submitted	Student has not submitted the report and results file.	**0**
Absent in Viva Voce	Student is absent from the viva voce.	**0**

Instructor's Signature: _____ Date: _____