

CMPE 443 PRINCIPLES OF EMBEDDED SYSTEMS DESIGN

PRE LAB #003

“Introduction to General purpose I/O (GPIO) programming”

Motivation

General Purpose Input/Output (GPIO) pins of a microcontroller are used for simple I/O devices, sensors and actuators. In this experiment, we introduce LEDs as an output device.

In addition, you will be designing your first embedded system. First steps will be taken to draw the related diagrams

In this experiment, you will learn:

- to describe inputs and outputs of an embedded system with a system-level structural diagram (block diagram)
- to configure a microcontroller's pins according to the hardware which is connected to those pins.
- to access the registers of a pin to configure it as an output and write data

1) Problem Description

In this lab and the next lab, you will use the 3 LEDs as outputs. The On and Off states of the LEDs will change according to time. Start state of the LEDs is the Off state, except LED1. LED1 will start with the On state and LEDs will light up with the LED1 - LED2 - LED3 - LED1 - ... sequence. Only one LED will be at a given time. (ex. Once LED2 lights up, LED1 must be in the Off state) The LED state change interval is approximately 1 second.

2) Block Diagram

Show the inputs and outputs of this system with a Block Diagram. (Answer in Moodle)

3) GPIO

In order to use GPIO Pins as input or output, Direction Control Register is used. When the Direction Control Register bit value is 0, the pin which is connected to that bit works as input, if value is 1, it works as output.

- What is the address range of the GPIO registers? (Answer in Moodle)

4) Initializing Registers of LEDs

In order to get the value from the input pins or set the value of the output pins, PIN Value Register is used. On the QuickStart Board, there are 4 LEDs with 2 different colors. On the Schematic of QuickStart Board (*LPC4088 QuickStart Board revB* on the moodle), find followings (Answer in Moodle):

- What is the port of LED1?
- What is the pin number of LED1 at that port?
- What is the port of LED2?
- What is the pin number of LED2 at that port?
- What is the port of LED3?
- What is the pin number of LED3 at that port?
- What is the port of LED4?
- What is the pin number of LED4 at that port?

You will use LED1, LED2 and LED3 in the prelab. So you should define the addresses of the DIR and PIN registers as **LED1_GPIO_DIR, LED1_GPIO_PIN**

5) Building LED Circuit

Until now, you built circuits of the LED for turning on at HIGH value. However, you can turn on some of the LEDs on the board by giving LOW value. You should analyze the QuickStart Board and build your circuits according to schematic. (You can use 3.3V, Resistor and LED for building these circuits on LPC4088_Visualizer. *Note: Be careful about + and - terminals of the LED*)

6) Initializing LEDs

At init state, only LED1 is at On state and the other LEDs should be turned off.

- Create a **LED_Init** method, configure the LED pins as output. (For example, You can change the 5th pin value to 1, by using **LEDX_GPIO_DIR |= (1 << 5)** or you can change the 10th pin value to 0, by using **LEDX_GPIO_DIR &= ~(1 << 10)**)
- In **LED_Init**, turn on LED1 and turn off the other LEDs.

7) Playing with LEDs

In the update method, change the on or off state of LEDs as described in the problem definition.

Note: You will use the QEMU emulator on your computers and the speed of the code execution will be different for every machine. You need a 1 second delay operation in this lab too. So find a number for the empty loop to make the approximately 1 second delay.

Note: Use O0 and Optimize for the Space options for optimization.

8) Submission

The file name for the submissions should be (ex: PRE001_2020000000):

PRE<exp num>_<StudentID1>.axf (This will be generated **.axf** file)

PRE<exp num>_<StudentID1>.lpc_vcf (This will be exported circuit file)

PRE<exp num>_<StudentID1>.zip (This will be **source files of project**, not the whole project)