CMPE 443 PRINCIPLES OF EMBEDDED SYSTEMS DESIGN

PRELAB #004

"General purpose I/O (GPIO) and Data Structures"

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 a push button as an input device and a 7-Segment Display as an output device.

In this experiment, you will learn

- to describe inputs and outputs of an embedded system with a system-level structural diagram (block diagram)
- to access the registers of a pin to configure, read data and write data
- to define pin signals to obtain different patterns in the 7-Segment Display
- to define pin signals to detect the state of a push button
- develop and use data structures for the GPIO module

1) Problem Description

In this lab, you will use the 7 Segment Display with a Push Button. At the start, the display will show the 0 number and wait. After the push button is pressed, the numbers on the display will change with the 0 - 1 - 2 - 3 - 4 - 5 - 6 - 7 - 8 - 9 - 0 - 1 … sequence. The change interval is approximately 1 second. When the push button is pressed, the display will go to the initial state which is in the waiting state with only showing the 0 number (The push button can be pressed any time). When the push button is pressed again, it will start the sequence again.

2) Block Diagram

Show the inputs and outputs of this system with a System-Level Structural Diagram. (Answer in Moodle)

3) Using Struct for Port Definition

Data types are necessary for writing the readable codes. Therefore you will use that structure in the code. In the moodle, GPIO_TypeDef is defined incorrectly (Use the name in the datasheet for the variables).

- Correctly define GPIO_TypeDef struct. (Answer in Moodle) _____

In this lab, you will use the 8 pins. Therefore, you need to access all of the ports' DIR and PIN registers.

- Define each PORT of the GPIO with data structure. (Answer in Moodle)

_____

The PCONP registers allow turning off selected peripheral functions for the purpose of saving power. In order to use GPIO, you should enable GPIO from the PCONP register.

- Which bit of PCONP register is used for enabling GPIO? (Answer in Moodle)

_____

- Define PCONP register. (Answer in Moodle) _____
- Enable GPIO in **init** method.

You will use P1.5, P1.6, P1.7, P1.11, P1.3, P1.23, P1.24, pins for the 7-Segment Display. You will use P0.25 for the push button.

- Define IOCON registers for these pins. (Answer in Moodle) _____
- Change the IOCON registers FUNC field with 0 in **init** method.

4) Using 7-Segment Display *4 pts*

In this part, you will use 7-Segment Display. There are two types of 7-Segment Display which are common Anode and common Cathode. Your 7-Segment Display is a common Anode.

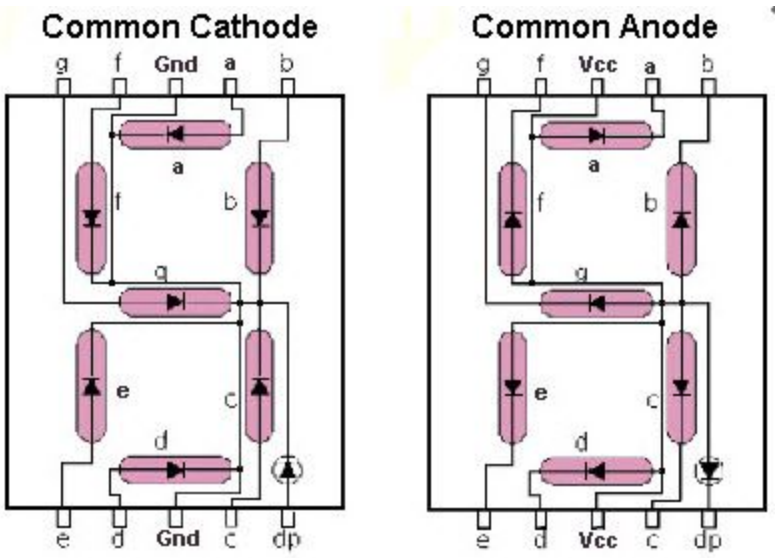


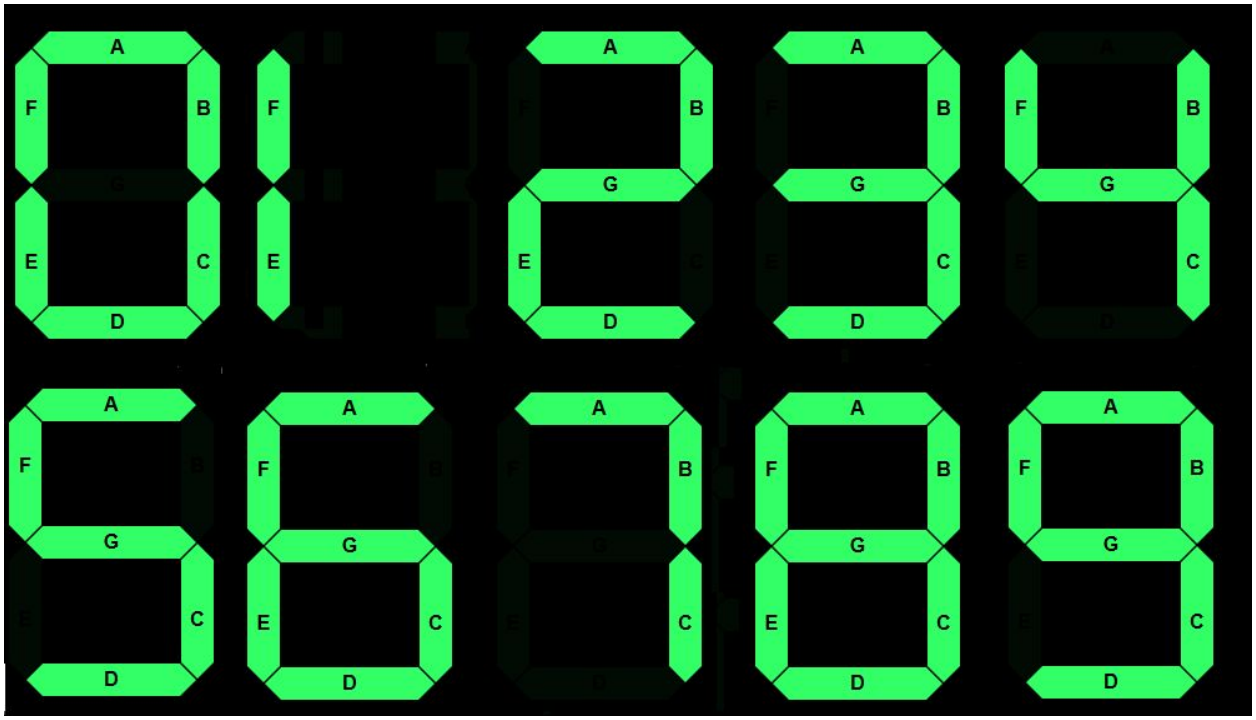
Figure: 7- Segment Display Configuration[1]

The Vcc of the 7-Segment display will be connected to 3.3V via the 1 KΩ resistor. The a,b,c,d,e,f,g pins of the 7-Segment display will be connected to P1.5, P1.6, P1.7, P1.11, P1.3, P1.23, P1.24 pins.

In the **init** method:

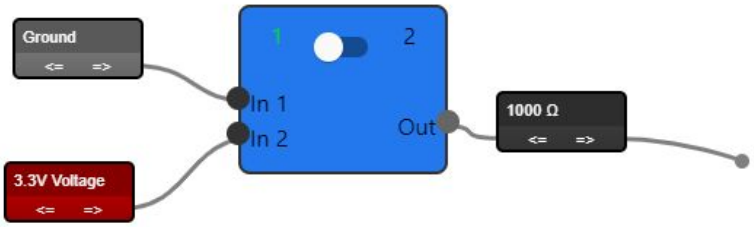
- Change the GPIO direction as output for 7-Segment display.
- At the start 7-Segment Display should show 0.

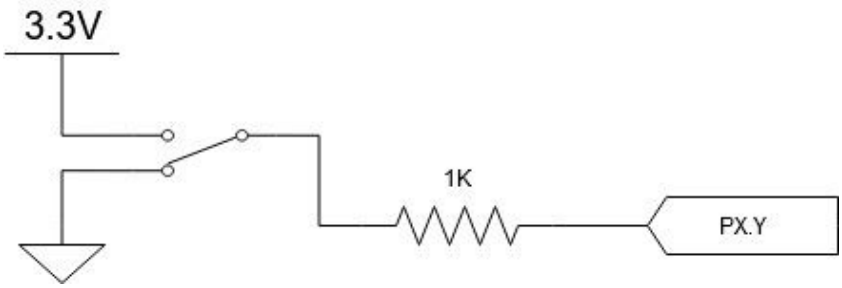
[1] "Types of Seven Segment Displays and Controlling Methods." https://www.elprocus.com/types-of-7-segment-displays-and-controlling-ways/. Accessed 10 Dec. 2020.



5) Push Button

You will use Push Button as an input device. On LPC4088_Visualizer, you will use Switch component as shown on image:





When switch is at 1, the pin will be connected to the ground and when switch is at 2, the 3.3V will be connected to the pin.

In the **init** method:

- Change the GPIO direction as input for the push button.

6) Changing Numbers

In the update method, change the shown number of 7-Segment Display 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 on your computer.

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

7) 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**)