Lab 3: Interfacing Keypad
Instructor: Prof. Yifeng Zhu
Spring 2016

Goals

1. Understand I/O matrix technique
2. Be familiar with keypad scanning algorithms
3. Understand software debouncing

Pre-lab Assignment

1. Read Textbook Chapter 14.7 Keypad Scan
2. Complete the register tables listed in the pre-lab

In-lab Assignment

1. Use polling method to scan keypad and display the inputs on LCD
    a. When a key is pressed, its value is then displayed on the LCD. The LCD should be able to display up to six digits or letters.
    b. Software debouncing should be used.
2. Something cool. The following gives a few examples.
    a. When a key is pressed for a long time, two options: either generate one input no matter how long it is pressed, or generate a periodical input with an interval of 2 seconds.
    b. Use the "*" key to delete the previous input. Pressing "*" key again keeps deleting the previous input.
    c. Use the "#" key to repeat the previous inputs.
   d. Detect and recognize if multiple keys are pressed simultaneously.

Keyboard Interface

The 4x4 keypad used in this lab requires 8 pins (four row pins and four column pins). In this lab, the connection between the keypad and the discovery kit is as the following table.

Row	R1 → PE 10	R2 → PE 11	R3 → PE 12	R4 → PE 13
Column	C1 → PA 1	C2 → PA 2	C3 → PA 3	C4 → PA 5

All pins of the input port (C1, C2, C3, and C4) are pulled up to 3V via a 2.2KΩ resistor. Within the processor, each GPIO pin can be pulled up via an internal resistor (between 20 and 55 KΩ, typically 40 KΩ). However, the internal pull-up capability is too weak and thus an external pull-up is required.

When looking at the front size of the keypad, the pins on the back from left to right are:
R1 – R2 – R3 – R4 – C1 – C2 – C3 – C4.
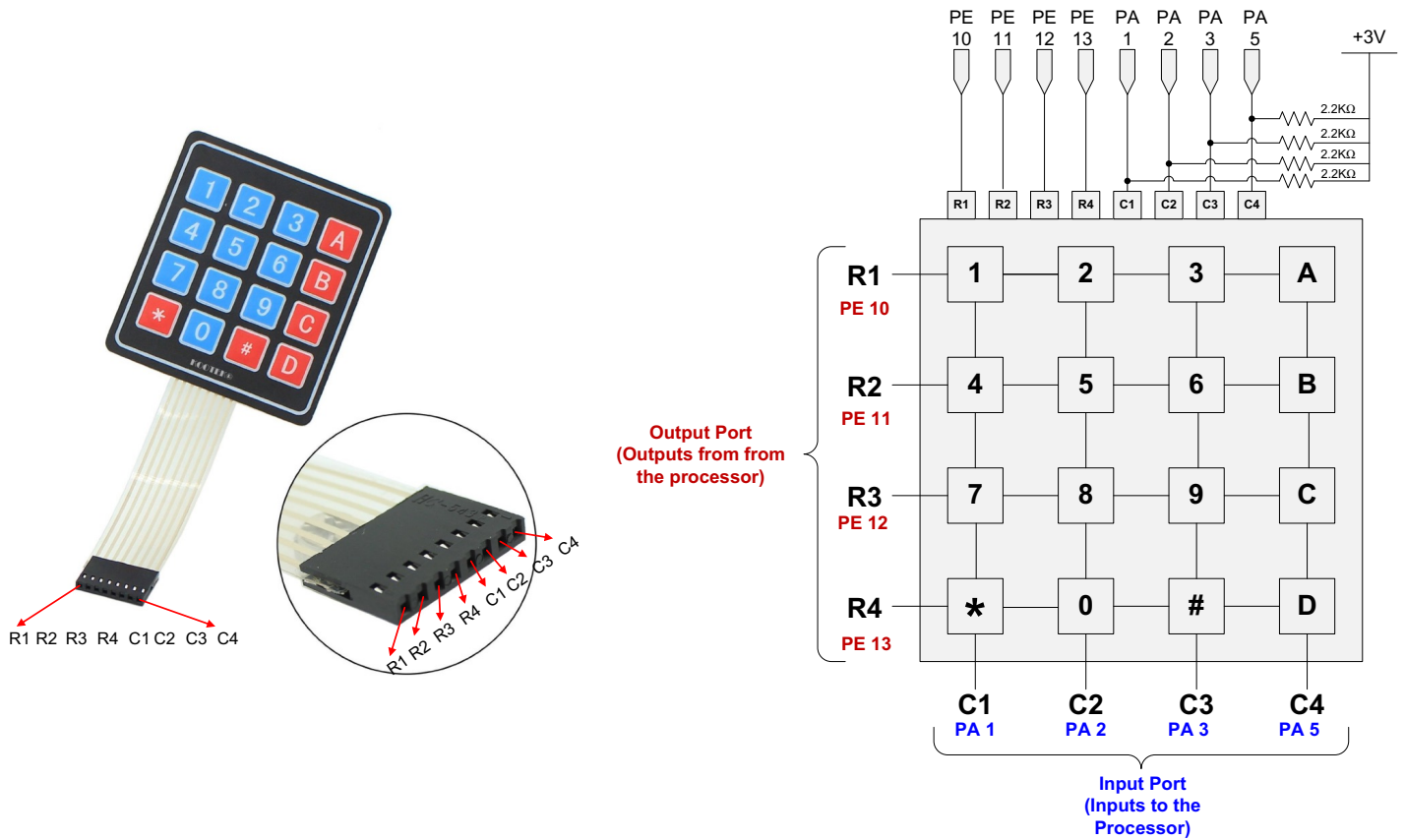
The maximum current a GPIO pin can source or sink is 20 mA. When calculating the value of external pull-up resisters, make sure that the current should not exceed 20 mA.

$$\frac{3V}{2.2K\Omega} = 1.4 \ mA$$

On the STM32L4 board, all pins in the input port (PA1, PA2, PA3, and PA5) are connected to ground via a 100nF capacitor, as shown in the figure below. A very short delay should be added before reading the input port.
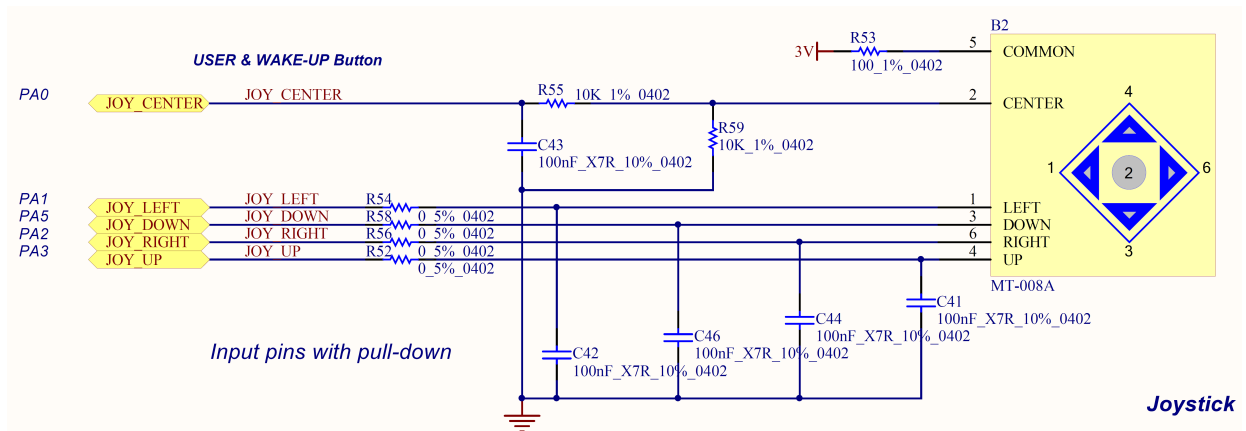
Pre-Lab Assignment
Lab 3: Interfacing Keypad

Student Name: _____
TA: _____
Time & Date: _____

Configure Port E: Pin 10, 11, 12, and 13 as Digital Output

GPIO Mode: Digital Input (00), Digital Output (01), Alternative Function (10), Analog (11)

Register	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
MODER	MODER15[1:0]		MODER14[1:0]		MODER13[1:0]		MODER12[1:0]		MODER11[1:0]		MODER10[1:0]		MODER9[1:0]		MODER8[1:0]		MODER7[1:0]		MODER6[1:0]		MODER5[1:0]		MODER4[1:0]		MODER3[1:0]		MODER2[1:0]		MODER1[1:0]		MODER0[1:0]	
MASK																																
VALUE																																

GPIOA Mode Register MASK Value = 0x_____ (in HEX)
GPIOA Mode Register Value = 0x_____ (in HEX)

2. Configure Port A: Pin 1, 2, 3, and 5 as Digital Input

GPIO Mode: Digital Input (00), Digital Output (01), Alternative Function (10), Analog (11)

Register	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
MODER	MODER15[1:0]		MODER14[1:0]		MODER13[1:0]		MODER12[1:0]		MODER11[1:0]		MODER10[1:0]		MODER9[1:0]		MODER8[1:0]		MODER7[1:0]		MODER6[1:0]		MODER5[1:0]		MODER4[1:0]		MODER3[1:0]		MODER2[1:0]		MODER1[1:0]		MODER0[1:0]	
MASK																																
VALUE																																

GPIOB Mode Register MASK Value = 0x_____ (in HEX)
GPIOB Mode Register Value = 0x_____ (in HEX)

3

Lab Demo
Lab 3: Interfacing Keypad

1. Do all digits (0-9) and letters (A, B, C, and D) show up on the LCD correctly?
2. What is your software-debouncing algorithm? How well does it work?
3. Explain to TA your keypad scanning algorithm
4. We do not use the internal pull-up in this lab. Instead, we pulled the pins up through external resistors. We said the internal pull up is too weak. What does it mean specifically?

Post-Lab Assignment
Lab 3: Interfacing Keypad

Write your answer to the post-lab assignment in the file Readme.MD and submit it to gitlab server.

1. When multiple keys are pressed, can the scan algorithm correctly detect all keys pressed? (Hint: ghosting, or ghost key)
2. What suggestions you would give to improve the experiences of this lab?
3. For the textbook, do you find any typos or have any comments or suggestions?