Lab 5

Keypad Interfacing Using Digital I/O Ports

Objectives

- Using digital I/O ports of AVR microcontroller for digital Inputs.
- Use I/O ports to interface matrix keypad with microcontroller.

Software

- Microchip Studio (Version 7)
- Proteus ISIS (Version 8.4)
- AVRDUDE

Hardware

- Arduino Nano x 1
- 4X4 Keypad x 1
- 16 x 2 LCD x 1
- Resistors 470 Ω x 8

Theory

4x4 Membrane Keypad:

The 4x4 Keypad features 16 push buttons arranged in a 4x4 matrix to form a standard alphanumeric keypad.

Underneath each key is a pushbutton, with one end connected to one row, and the other end connected to one column. A keypad provides a useful human interface component for microcontroller projects.

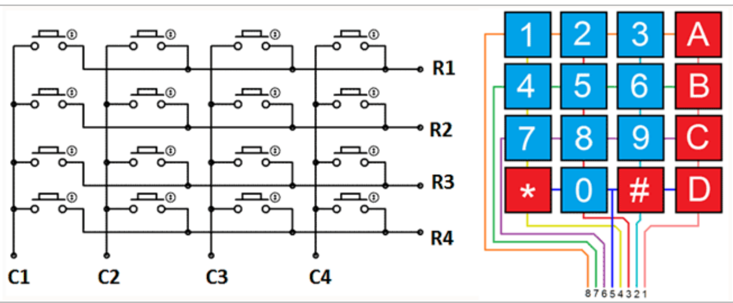


Figure 5.1 – Standard 4x4 Keypad

This keypad can be used for menu selection and data entry for embedded systems and various other applications.

Key Specifications

- Maximum rating: 24 VDC, 30 mA
- Interface: 8-pin access to 4x4 matrix
- Operating temperature: 32 to 122 °F (0 to 50°C)
- Dimensions: Keypad, 6.9 x 7.6 cm Cable: 2.0 x 8.8 cm

As can be seen in Figure 5.1, the buttons consist of 16 switches that are normally open. When one button is pressed, a pair of pins are connected, as seen in Figure 5.2. As shown in the Figure, the R2 and C2 pins will help determine the button that is pressed.

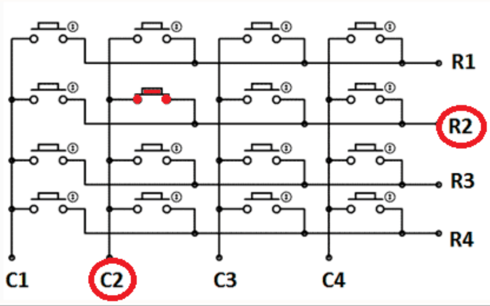


Figure 5.2 – Standard 4x4 Keypad

To use a keypad with a microcontroller, its rows and column pins should be connected to digital IO pins (port pins) of the microcontroller. Rows may be connected to port pins configured as output, while the columns are connected to outputs (or vice-versa). Suggested connections are shown in Figure 5.3. To determine whether a key is pressed or not, logical 0s are asserted on the output pins (rows in our case) and the input as read at the columns. If a key is pressed, one of the inputs will read logical 0, while the rest will read logical 1.

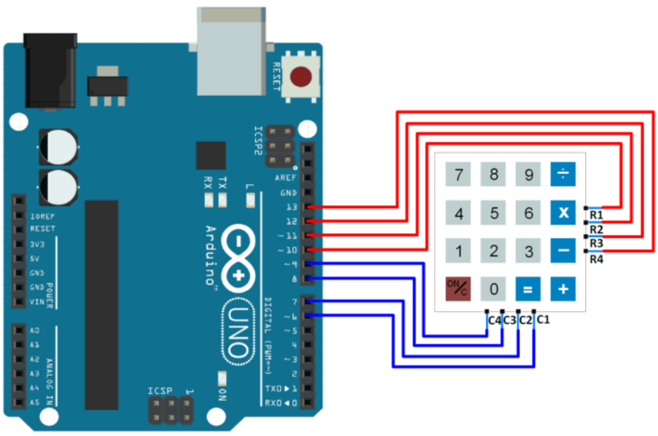


Figure 5.3 – Connection between Keypad and Arduino Uno

You should remember the role of IO-registers in the ATmega328p as illustrated in Figure 5.4. Assume all the 4 rows are initially set as input (by virtue of DDRx register). The programmer will have to scan the rows to determine if a button is pressed. Normally, the values on the row would be all 1 i.e. R4-R1 == 1111. When the button is pressed as shown in Figure 5.2, the value would change to R4-R1 == 11**0**1.

The fundamental idea is that the program keeps scanning the rows as long as no button is pressed. However, as soon as a button is pressed, invert the rows to outputs and the columns to input. This would happen so fast that the button will still be pressed. So, on scanning the columns, C4-C1 == 11**0**1. This way one can identify the button that is pressed, which in this case is '5'. *[hint: the sequence 1101-1101 could signify '5']*

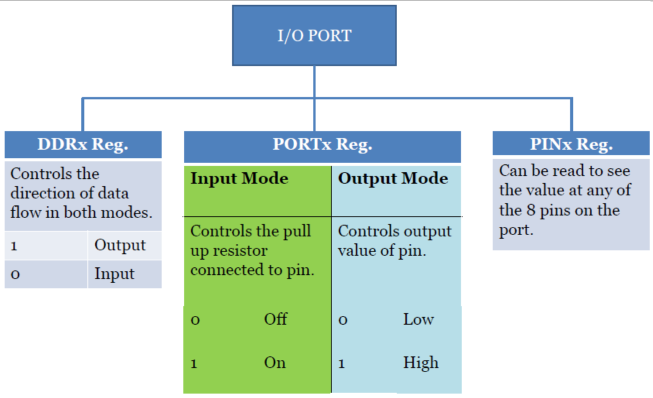


Figure 5.4 – ATmega328p port registers roles

Pre-Lab Tasks

Task-1

Interface an LCD with Atmega328p (Nano/Uno) in the 4-bit mode. Bring the breadboard implementation to the Lab.

Task-2

Write a C function that reads an 8-bit value from a DIP switch and displays it on the LCD. Configure the port as input with pull-ups activated. Model and simulate the task shown in Figure 5.5 on Proteus.

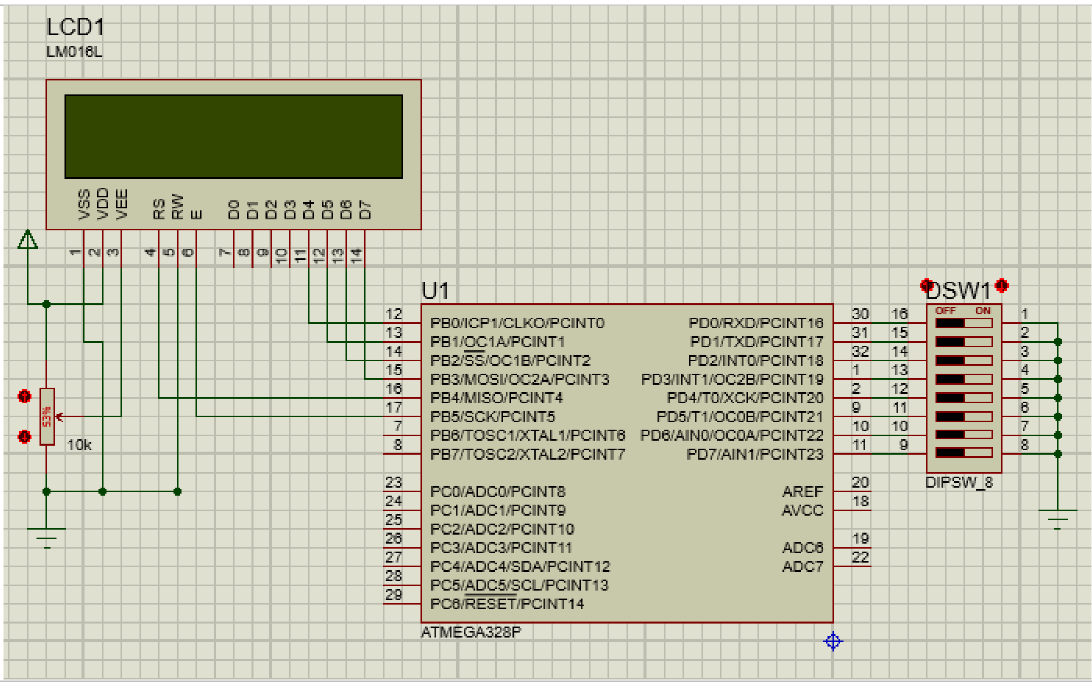
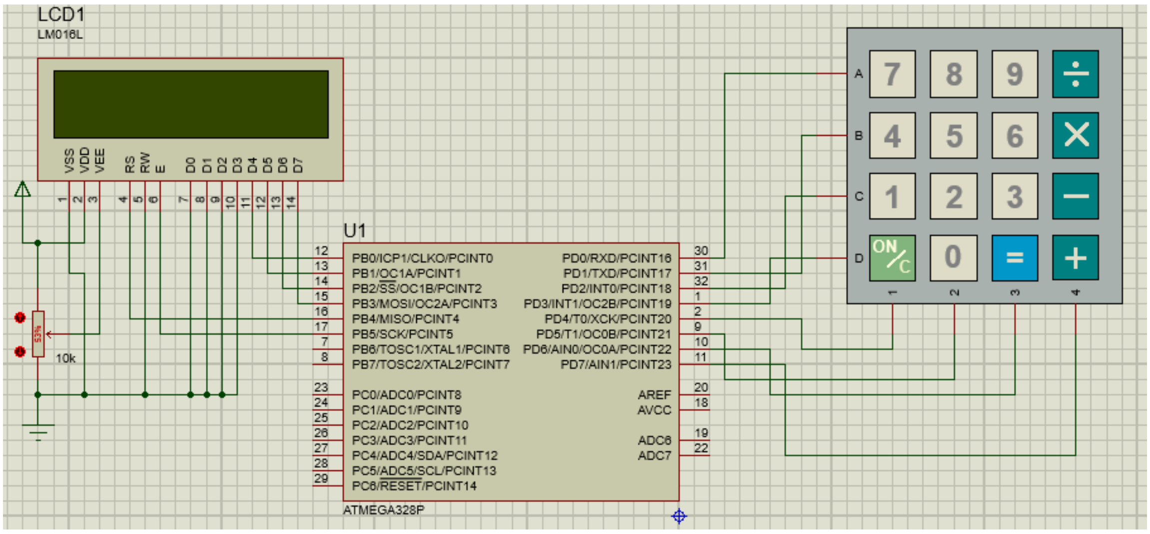


Figure 5.5 – Pre-Lab task 2

In-Lab Tasks

Task-1

For this task, you will need to display the key pressed on the keypad on a 16 x 2 LCD interfaced in the 4-bit mode. You may use the LCD interface software from the previous task.



Task-2

Download the hex file from the previous task and implement the hardware shown in the figure above.

Post Lab

Task-1

Make a basic calculator with numeric addition, subtraction, multiplication and division. The user should be able to enter the operands and the operation using the keypad and the process and the results should be displayed on the LCD.

Critical Analysis / Conclusion (To be filled in by the student)

Lab Assessment (To be filled by the lab-instructor)		
Pre-Lab	/5	/25
In-Lab	/5	
Results	/5	
Viva	/5	
Critical Analysis	/5	

Comments:

Instructor Name

Instructor Signature