

# Connected Lock

In this project you will design a connected lock which carries out the following specifications:

- There will be a keypad to enter the password to lock or unlock a door (Figure 1.a) Whenever the correct password is entered, the lock is open or closed.
- The keypad lock can be used both indoors and outdoors. When the environment is dark, backlight should be turned on so as to make the buttons visible (See Figure 1.b)
- Whenever a series of wrong passwords is detected, the lock should send an alarm message to the owner of the lock or to an authority assigned by the user.
- If the user starts entering the password but fails to do so within a predefined time, then the session needs to be initialized. You have to alert the user with a beep.

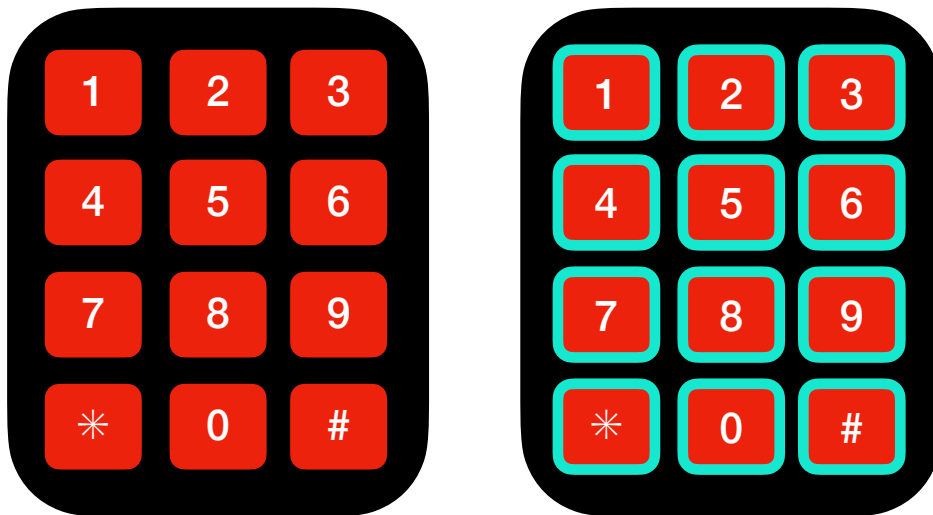


Figure 1. A Keypad (a) the backlight is off (b) the backlight is on.

## DESIGN REQUIREMENTS

### PASSWORD:

- M1: Password will be in N-digits. N will be hardcoded. (What should be N? Propose your solution. Explain your reasoning.)
- M1: The user should be able to change the password. (Explain your mechanism.)
- M1: If the user cannot enter the password in M minutes, then the session needs to be initialized. (Propose a meaningful value for M. Explain your reasoning.)
- M2: When the number of attempts is P, the alarm message is sent to the user or the authority. (Propose a meaningful value for P. Explain your reasoning.)

### LOCK

- M1: The lock mechanism will be activated when it has to lock the door. It will be deactivated when it has to open the door.
- M2: If the user closes the door, the design will detect it and lock the door automatically. (Explain how you can do it.)

### ALERT (BEEP)

- M1: The beep sound should be between 2kHz and 5kHz.
- O1: You can make user program the volume of beep. (If you pick-up this option, then you have to explain how you can do it with the peripherals that are taught in CmpE443.)

### ALARM (USER OR AUTHORITY)

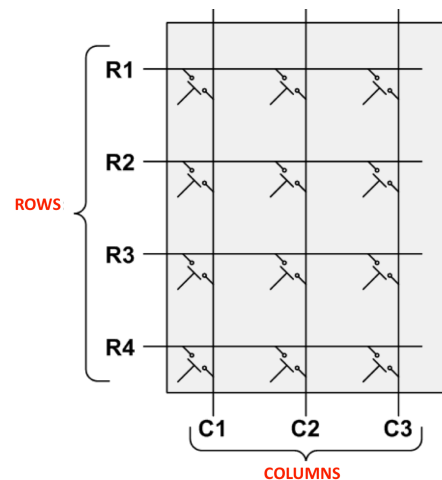
- M2: User or authority message address should be hardcoded.
- O2: You can think of sending messages to multiple parties at once or selectively at specific circumstances. Imagine how you can do it. Note that this device is low cost. Hence avoid using more than one serial communication peripheral. (If you pick-up this option, then you have to explain how you can do it with the peripherals that are taught in CmpE443.)

## SCHEMATIC

Draw the schematic of your design. You need to specify explicitly specify the pin connections, component values on the microcontroller. Here are some components that might be useful for your design:

- Matrix Keypad + Backlight: A basic matrix keypad is shown on the right. For the backlight you can design a LED circuit or select a keypad with backlight. If you choose design a LED circuit, then you have to show the physical placement of the LEDs in order to make the Keypad be entirely lit up. Note that you need to minimize cost at the same time. If you select a keypad with backlight, explain how you use it in your report.

Keypad is a set of switches. The operation of the keypad can be explained as follows: When you press a button, the switch is closed and related row and column wires touch each other. For example, when you press "1" on the keypad, R1 and C1 wires touch each other. While reading keypad, obviously you need to connect some resistors and voltage supply or ground. For this purpose, you have to use pull-up or pull-down configuration on the port that you are reading. If column pins are driven from the outputs of the microcontroller, then pins reading rows should be configured as input with pull-up or pull-down mode.

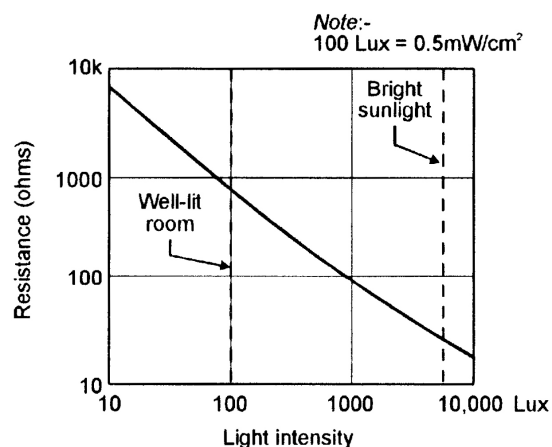
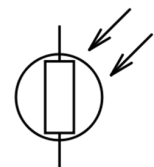


Example: Assume that we configured rows (inputs) with pull-up. Then if columns are driven with HIGH, then you will not be able to read anything (why?). If only two columns are taken to LOW, then you will not be able distinguish which numbers are pressed (why?). Hence, at any time, only one column should be LOW. Then look at the row values. When you see **LOW** value in a row pin input, that means that button which is at the location of that **LOW** valued column and **LOW** valued row is pressed. For keypad scanning, start with 011, then 101, then 110. If you make it fast, then it will obviously read the correct button press. Yet, if you make it extremely fast, then you may have some other problems (what are they?)

- BEEP: You can use a buzzer. Its circuit symbol is shown on the right. Buzzer draws current which is much more than the current supplied from the pin of a microcontroller. So you can use a transistor (Hint: remember the transistor connection to drive multiple seven-segments). Other solutions which do not harm the pin of the microcontroller are also welcome.
- Lock activation/deactivation: You can use a relay. Its circuit symbol is shown on the right. It draws more current than the buzzer. You may use a circuit similar to that you used in buzzer, but you need to place a freewheel diode to protect the switch from the excessive current of inductance when the transistor is switching to off state. Be careful about the direction of the diode. Other solutions which do not harm the pin of the microcontroller are also welcome.
- Environmental light detection: You can use an LDR (light dependent resistor). On the right, there is a typical LDR with its circuit symbol. An LDR is a component that has a variable resistance changing with the light intensity that falls upon it. The most common type of LDR has a resistance that decreases with an increase in the light intensity falling upon the device. A typical LDR resistance vs light intensity graph as shown below. You can find your own graph on the internet.



right.



- Door open/close: You can use a tact switch. Its symbol is on the right.



## YOUR DESIGN (< 25 pts)

This must be a clear report of your work. You have to describe how you interact all these input and output devices, including the communication part. Numerical calculations are necessary for dark/light operations. A bill of materials is required to show the cost of your design. You have to explain how you plan to realize the requirements. Note that there are some codes at the requirements part:

M1: Core Requirements - 50%

M2: Core Requirements - 30%

O1: Core Requirements - 10%

O2: Core Requirements - 10%

## YOUR CODE (< 25 pts)

You have to write a commented code. Your code needs to be linked with the parts of your report.

## HONESTY

This time, you will not find time to object your grades. Hence, we advise you not to take anything from the internet as it is. Give references if you want to take a sensor's behavior from the data sheet. In the same way, we have all the codes of previous years. If you take a piece of code from one of the graduates of BoUn-CmpE, we can directly find it. It will not matter how small it is or how typical it is. So, I suggest you to be straight and present a nice work which will be a pleasure for us to evaluate.

## GOOD LUCK!