Pearson BTEC Level 5 Higher Nationals in Engineering (RQF)

## Unit 46: Embedded Systems

# Unit Workbook 2

in a series of 4 for this unit

Learning Outcome 2

# Microcontroller Interfacing

# Contents

# Simple Digital Interfacing

## Switches

There are a number of ways to connect switches to microcontroller input pins, as depicted in Figure 1.

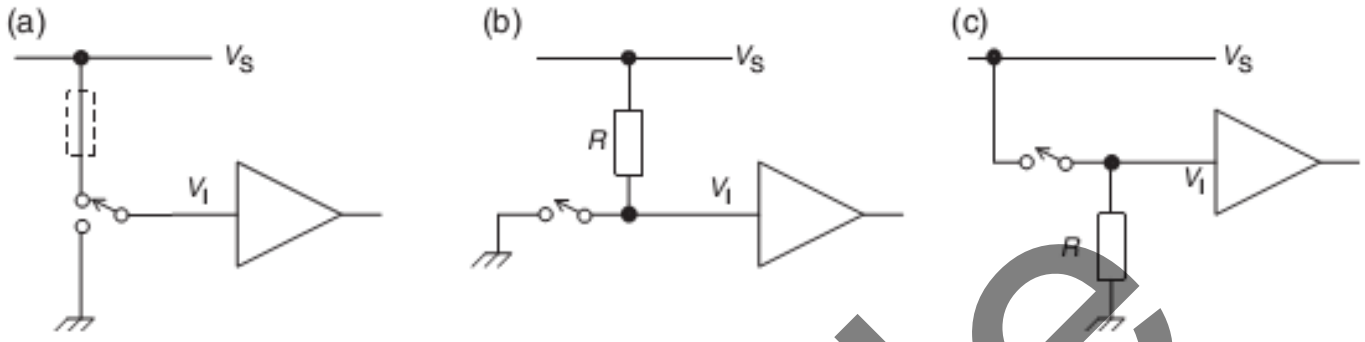


**Figure 1:** *Ways to connect a switch to a microcontroller input pin*

In (a), we see the simplest way to connect a switch to a digital input. If the switch is connected to the top connection, then a logic 1 (high) will be presented to the chip. If the bottom connection is selected, then a logic 0 (low) will be presented to the chip. The problem here is that whilst the switch is moving between the top and bottom connections, there is a point in time when the input to the chip is floating (neither high nor low) which can cause indeterminate states and unpredictable behaviour in the digital circuitry.

Solutions to combat the indeterminate state problem are to use either a pull-up resistor, as in (b), or a pull-down resistor, as in (c). For example, in circuit (b), if the switch is open, the pull-up resistor (perhaps 10 kΩ) raises the chip pin voltage to logic 1. Should the switch be closed then there is a very fast transition of the chip pin down to the ground state, logic 0. If the switch is open in circuit (c), then the pull-down resistor (perhaps 10 kΩ) lowers the chip pin voltage to logic 0. Should the switch be closed, then there is a very fast transition of the chip pin-up to logic 1.

## LEDs

Light Emitting Diodes (LEDs) are prevalent in many microcontroller applications, perhaps to indicate the presence of power, data or a fault.

Concerning Figure 2, we see that in circuit (a), the chip output pin is a source of electrical energy to the resistor-LED combination. Should the chip output logic high (perhaps 5 V), if we use an LED with a forward voltage of say 1.7 V and a current draw of say 10 mA, then the resistor will need to be (5 – 1.7)/0.01 = 330 Ω.

The situation in arrangement (b) sees the chip output acting as a sink of current from the positive supply rail. Here, should the chip output logic 0, then current will flow from the positive supply rail through the resistor-LED combination.

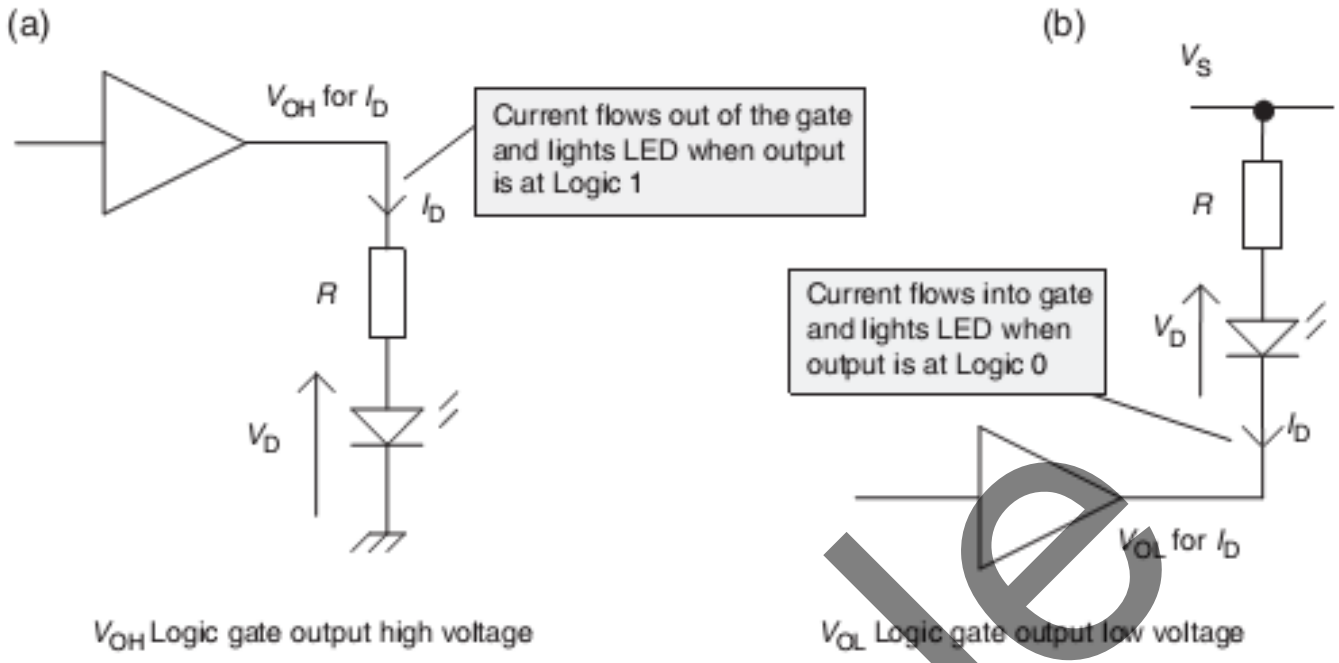


**Figure 2:** *Ways to connect an LED to a microcontroller output pin*

## Keypads

Keypads with four rows and four columns are commonly used with microcontrollers. A typical device and its wiring arrangement are shown in Figure 3.

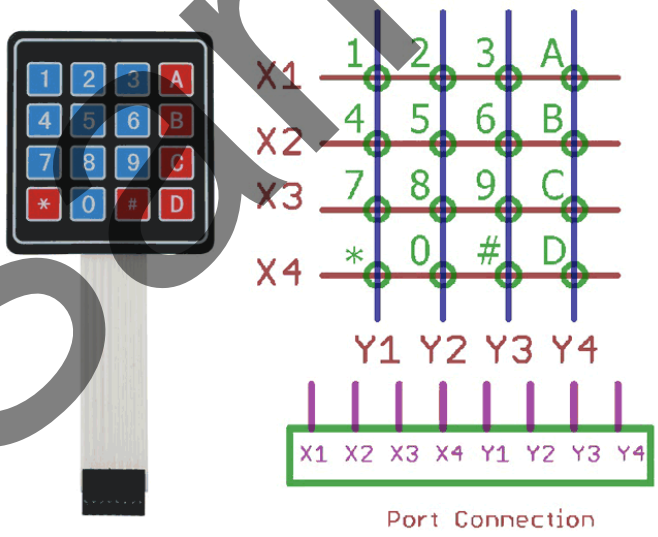


**Figure 3:** *A 4 X 4 keypad and its wiring scheme*

The usual approach is to connect each row line to an output port bit on the microcontroller and each column line on an input port bit on the microcontroller. Then, in turn, each row is activated with a logic high and 4 successive checks are made on each of the column bits. Therefore 16 checks are made repetitively. For example, if button 3 is pressed, then 5 volts supplied to X1 line will be rerouted through switch 3 and be