Leaving Certificate

Technology

Applied Control Technology

PIC Theory Notes

PIC – Peripheral Interface Controllers

Contents

Introduction
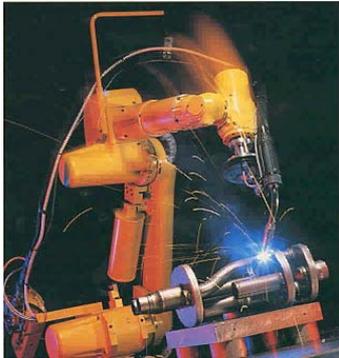
PICs are commonly used in a host of different applications mainly due to their low cost and flexibility. Costing upwards of €1 they allow us to automate many of the repetitive processes which would otherwise require expensive labour. An automated welder or a traffic barrier control system are often found to have a PIC at their core.
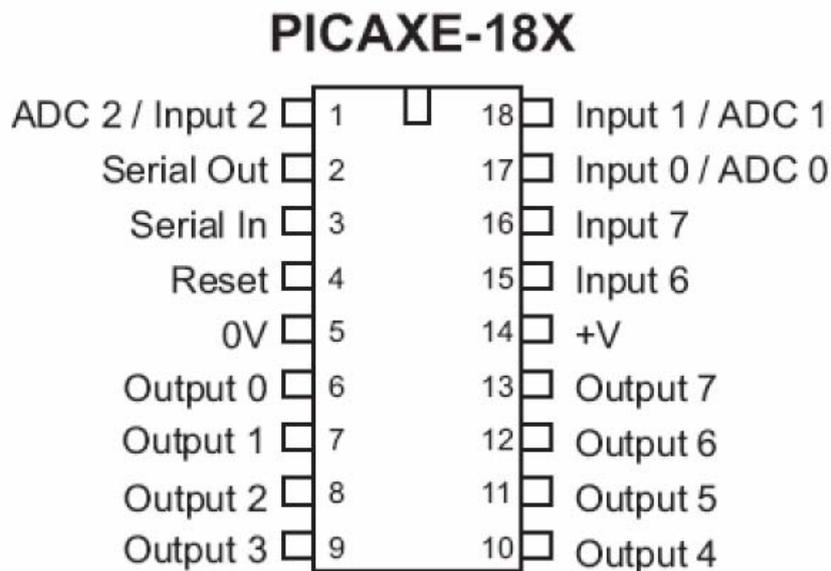
There are many types of PIC available for use but many are sourced and supplied by a US company called Microchip. Visit their website to see the variety of ICs available and the range of solutions to which they can be put.

Our PIC of choice for this syllabus is the PIC16F88 also known as the PICAXE 18X. Why the difference in name? Well, if we were working at industrial standards we would probably choose the PIC16F88 but programming it is not at all easy, requiring knowledge of a low level language such as assembler. The PICAXE 18X on the other hand when purchased already contains a tiny piece of code known as a bootstrap program. It is the inclusion of this code that allows us to use a more high level and easily understood language such as PIC Logicator. The bootstrap program means that terms such as wait are interpreted and run acordingly. For school based solutions this is a much better way to proceed.

IC Arrangement

The PICAXE 18X is an 18 pin IC (Integrated Circuit).

PICAXE-18X

|		
ADC 2 / Input 2	1 — 18	Input 1 / ADC 1
Serial Out	2 — 17	Input 0 / ADC 0
Serial In	3 — 16	Input 7
Reset	4 — 15	Input 6
0V	5 — 14	+V
Output 0	6 — 13	Output 7
Output 1	7 — 12	Output 6
Output 2	8 — 11	Output 5
Output 3	9 — 10	Output 4

The main features are as follows:

- Pin 5 is connected to the 0V rail

- Pin 14 is connected to the 5 Volt supply

- Pin 4 is used to reset a programme at any stage

- There are eight outputs (Pins 6-13)

- There are 5 inputs (Pins 1-3 and Pins 17/18)

- As with all ICs pin 1 is identifies as being to the left of the notch found at one end of the chip

- The PICAXE 18X is very flexible in that it has three analogue channels (ADC) that can be used to detect light, heat or moisture levels. The three pins used are 18, 17 and 1.

On Board Power Supply

The PIC requires a steady 5V supply and this is sometimes more problematic than it appears. Using the arrangement above creates two main problems:

- ➢ Batteries tend to have a short shelf life
- ➢ As shown the arrangement will supply 6V, one volt more than required.
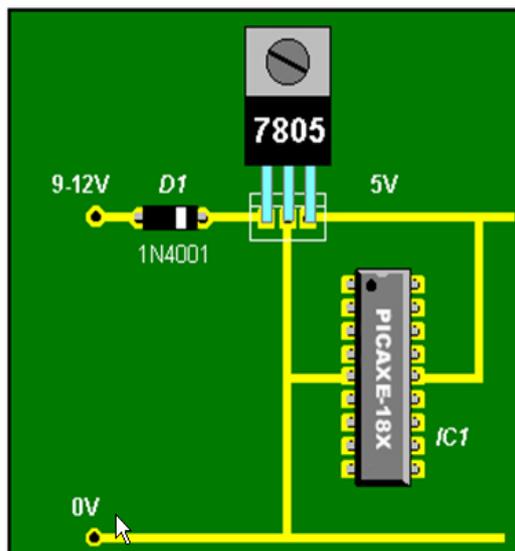
This arrangement uses a mains operated 9-12 volt power supply. A 7805 voltage regulator reduces the voltage to a suitable 5 volts. A diode is included to ensure the power is not connected the wrong way around to the circuit thus damaging some of the components. Pin 5 is connected to 0V and pin 14 to the 5 volt supply. The diode is also useful as it drops 0.7 volts across itself. Referring back to our batteries in series above this means we effectively lose 0.7V and our output voltage is 5.3V, more suitable for our purpose.

Adding Capacitors

In order to work correctly the PICAXE 18X must have a continuous steady 5 volt supply. There are two main things that might affect the circuit and cause further problems.
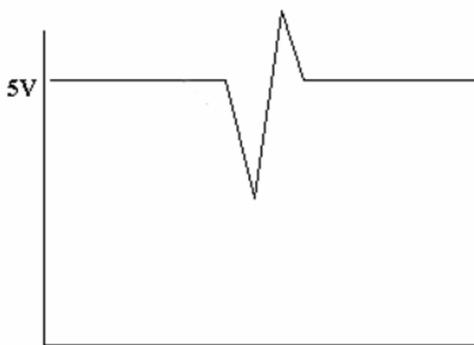
The first of these is electrical noise. This can either be radiated noise or is resultant from an active component in an electronic component. ICs themselves are particularly prone to producing noise. In any event it causes a fluctuation in the 5V supply. This can often cause the PIC to reset.
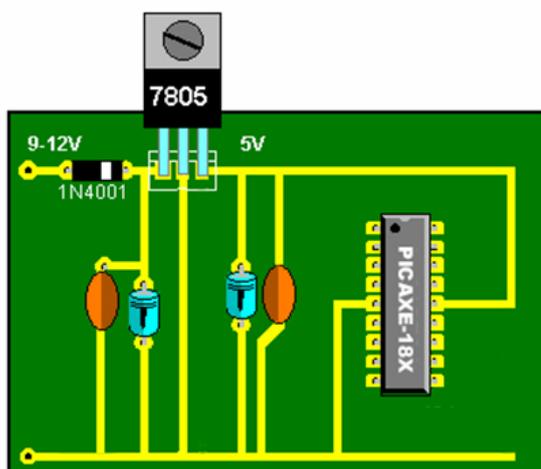

To overcome this problem we use two 0.1µF capacitors which filter out any unwanted noise from the circuit. This filtering works on the basis that capacitors block DC but allow AC (noise) to pass through. The larger 100µF/220µF capacitors are used to solve the second problem which is to stabilise the voltage and keep it steady. This is useful when dealing with motors and other high current devices which have a tendency to pull down the voltage and may result in a PIC reset.

Reset Switch

A 4700Ω (4.7K) resistor is used to form a potential divider with a push to make switch. With the switch in the open position we observe that the voltage is 5V. In PIC terminology this is seen as a 1. The mid-point of the potential divider is fed to pin 4 which is the reset pin.
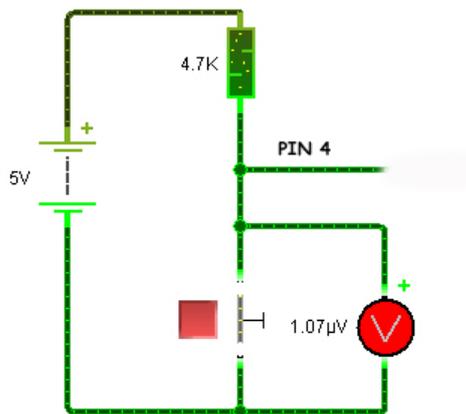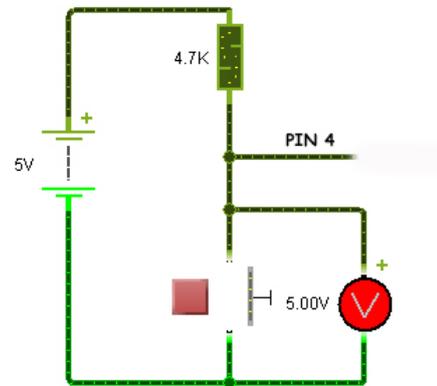
When the switch is pressed the voltage drops to a value very close to 0V. This is what we should expect to happen. In this case we say the PIC sees the value on Pin 4 as a 0.

With a 0 value on pin 4 four the program stored in the PIC is forced to reset. In other words to run correctly pin 4 should normally be at 5V, the switch has not been pressed. On pressing the switch closed we cause a RESET. On the PCB board we can see the resistor and switch are connected to pin 4.
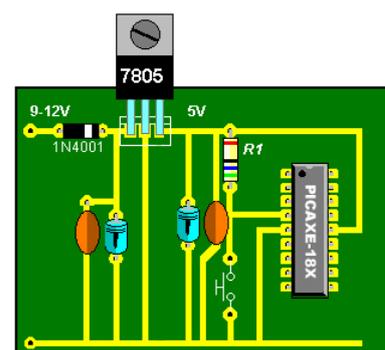
Resonator
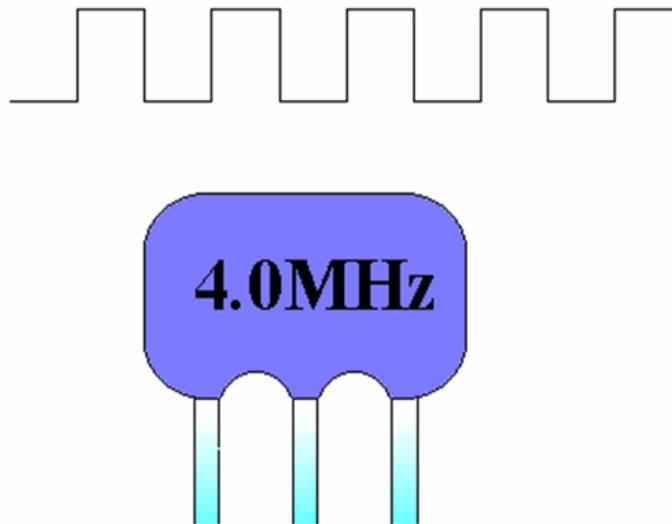
The resonator is a central component in any PIC based circuit. There are two types of resonator used, a mechanical crystal arrangement or more commonly a resistor capacitor network housed in a ceramic. In both cases an astable output results and this is essentially a clock but not as we might commonly understand it. Unlike the hours, minutes and seconds used for everyday timing the resonator creates a series of very high frequency pulses, usually in the order of 4MHz or 4 million pulses every second.

This gives us a means to check and test for events very quickly indeed and makes PICs very effective devices for use in industrial applications. Essentially when we use a term like 'WAIT 1' this means the circuitry counts down 4,000,000 pulses. 'WAIT 0.1' counts down 400,000 pulses and so on.

Note however that the shortest time we can measure using PIC Logicator is in fact 0.001s. Unlike other PICs the resonator in the PICAXE 18X is internal and therefore is not visible.

Using Ouputs
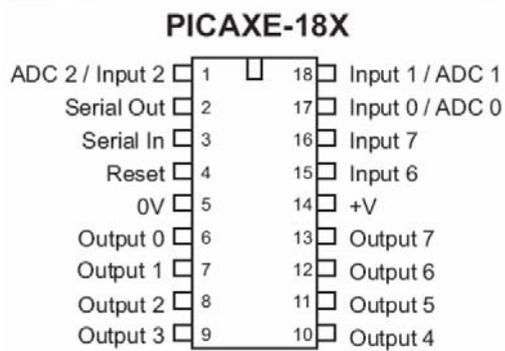
Remember that the PIC has 8 outputs, pin 6 through to 13. These outputs are forced high and low by setting them using appropriate software.
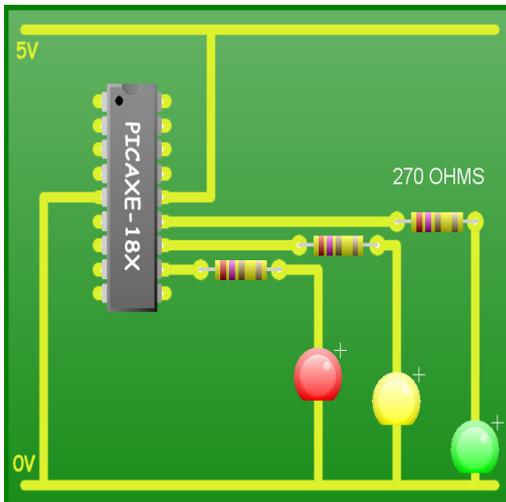
The circuit used to turn LEDs on and off is relatively simple. Since LEDs only require a small current (10mA) to operate then we can connect these components directly to the PIC. Note however that this is the exception rather than the rule. As it can only source or give out a small current, the only other device that can be switched directly is a piezo buzzer/sounder.

Identify the outputs which will turn on: -

Red LED: ☐   Yellow LED: ☐   Green LED: ☐

To drive other devices that draw larger currents, including light bulbs, will require further circuitry.

To switch these more high current devices will require some type of buffer circuit. In this case a buzzer / motor can be controlled by the PIC and a BC337/40 transistor. Note the diode to protect against Back EMF