Electronic systems

SECTION 3.4

Electronic systems

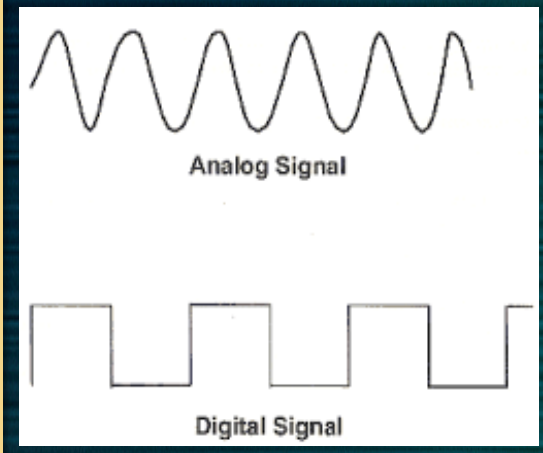
These systems add functionality and intelligence to engineering products

Analogue and digital signals

Electronic systems and sub systems collect, transmit, alter and output both Analogue and Digital signals.

Analogue signs are signals that vary and change continuously over time. They take any value within a given range. Examples include sound waves, light levels and continuously varying voltages or electrical currents.

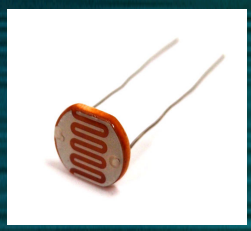
Digital signals are sent as pulses of information that are either high (1) or low (0)
They are able to carry more information per second and maintain the quality better, An example of the use of digital signals is the information contained on CD's and MP3 files.



Sensor inputs

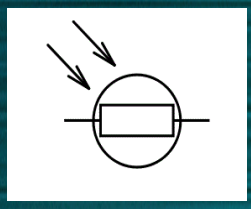
Sensors are used as inputs, they allow the system to gather info about the environment e.g. changes in lighting, heating etc.
This is then changed into an electronic signal that can be acted on by a process sub-system.

These sensors can be analogue or digital, two that are commonly used are LDR's and Thermistors.



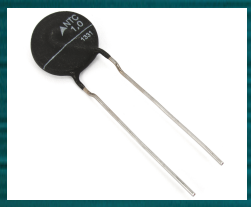
Light-dependent resistors

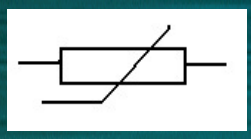
This is a special type of resistor which changes the light level detected into resistance so as the light increases the resistance decreases.
LDR's are relatively cheap to buy and readily available.
Example: sensing circuit for a garden lamp that lights up when it gets dark.



Thermistors

This is a special type of variable resistor which change the temperature level into resistance, so as the temperature increases the resistance decreases.
Example: sensing circuit for a system that needs to keep a room at a particular temperature.





Process devices

This is like the brain of the electronic circuit. This works by responding to the electrical signals sent from the input stage and then changing it in some way. This altered sign is then used to control the output stage of the system.
Process devices are usually IC's (integrated circuits) which is a small complete circuit inside a microchip. They have the rest of circuit built around them to achieve the outcome desired. Most common forms of processors are timing and counting.

Timers

These are used to turn an Output high or low for a certain time. This is in response to a switch or sensor being activated / pressed. One way this can be done is by using a 555 timer

Counter

These circuits are used to count how many times an event happens. For instance each time a point is scored I a sport event.

Electronic systems

SECTION 2.1

What do Electronic systems add to products?

What is the difference between an Analogue and Digital signals?

Draw diagram to explain the difference

Describe the purpose of a Sensor in an Electronic system

Draw down the symbol for a LDR and explain what it does

Drawn down the symbol for a Thermistor and explain what it does

What action does a Process device do in an electronic product

What form do they usually take?

Name a couple of examples where process devices can be used in Electronic devices and explain them

Electronic systems

SECTION 3.4

Comparators

These compare two input voltage signals and decide which one is the greater.
An operational amplifier (op-amp) is often used as a processing block The result can then be indicated using either a buzzer or LED's.

The op-amp has two inputs:
An inverting input (-)
A Non inverting input (+)

It compares the inverting input voltage with the Non inverting inut voltage. If the Non inverting voltage is higher, the op-amp output goes high (LED 1 lights up). If the inverting input voltage is higher the output goes low (LED 2 lights up).

In the schematic diagram above an LDR (R1) and a Variable resistor (VR1) are being used to adjust the input voltages.

The sensors can be changed to detect different environmental changes. E.g. change the LDR with a thermistor and you would have a control devise for making sure a room was at a precise temperature.

Logic gates

These gates respond to and output digital signals

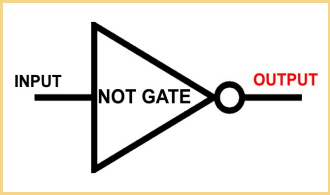
You need to be aware of three Logic gates:
- NOT gate
- AND gate
- OR gate

Truth tables are used to show what the output signal is for different possible combinations.

NOT gate

NOT Gate

A	Q
0	1
1	0

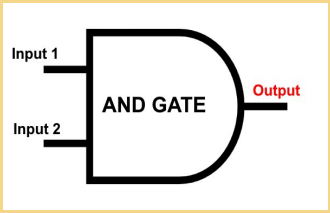


NOT gates can be used to turn an output device off when a switch is turned on e.g. emergency stop button.

AND Gate

These only produce an Output of 1 when both inputs are 1.

A	B	Q
0	0	0
0	1	0
1	0	0
1	1	1

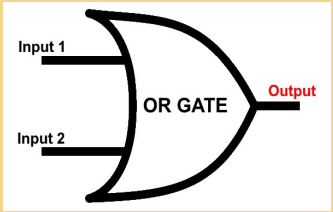


Example is an elevator where the button has been pushed and doors have closed.

OR Gate

This gate produces an Output of 1 when either A or B or both have an Output on 1.

A	B	Q
0	0	0
0	1	1
1	0	1
1	1	1



An example is in a home alarm where one of switches is broken

Electronic systems

SECTION 2.1

Draw down and describe how a Comparator circuit works

Explain the purpose of logic gates

Drawn down the symbols and explain each of there truth tables

NOT Gate

AND Gate

OR Gate

Electronic systems

SECTION 3.4

Programmable devices

These can be used to perform more complex operations than IC's. They are replace IC's for timing, counting and comparing circuits. However, a program must be written and downloaded onto the chip for it to function.

Microcontrollers

These are programmable devices which are like small computers that have different pins that various input and outputs can be connected to.

Peripheral interface controller (PIC)

A PIC is a type of microcontroller that is common in both schools and industry. The simplest of the chips has 8 pins but more complex ones can go up to 40.

Advantages of PICs

- Can be programmed and reprogrammed loads of times – flexible and adaptable
- Can replace loads of IC's saving space on the PCB
- Multiple input and output devices connected.

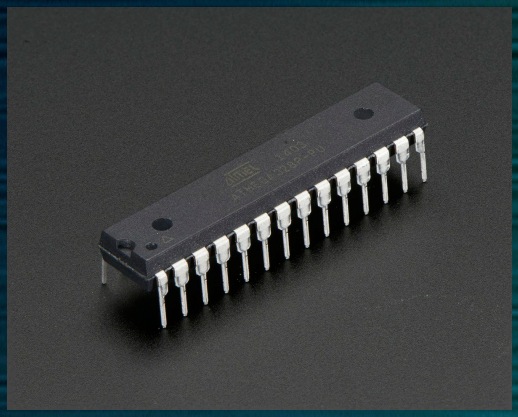
Disadvantages of PICs

- Expensive
- Access to software and hardware costs

Programming PICs

PIC chips can be programmed using block based editors, flowchart software or text based programming (BASIC or C).

Example PIC program to the right, simple on off lighting circuit.



Analogue to digital conversion (ADC) in a programmable device

Microcontrollers only understand digital signals (1 and 0), however some input devices produce analogue signals so modern microcontrollers have a built in analogue to digital converter that can convert an analogue voltage to a digital value. To make use of this the input device must be connected to an input port with ADC.

Programming for an analogue input

Most flow chart programming software has a dedicated analogue input command that can be used to read a signal from an analogue sensor and then convert it to a digital output signal with the aid of a simple supporting program.

The flow chart below shows how an analogue signal can be incorporated into a flowchart. In the diagram below, if the signal falls outside of the range given (100 to 255) then the G0 goes High (or On) otherwise G0 remains Low (or off).

Electronic systems

SECTION 2.1

What is the purpose of a Programmable devise?

What is a Microcontroller?

What can be done with a Peripheral interface controller?

What advantages does this give over IC's?

How can these be Programmed?

Draw down some of the programming blocks

Can these chips only be used in a digital way (on / off)

Yes / no

How can they be converted?

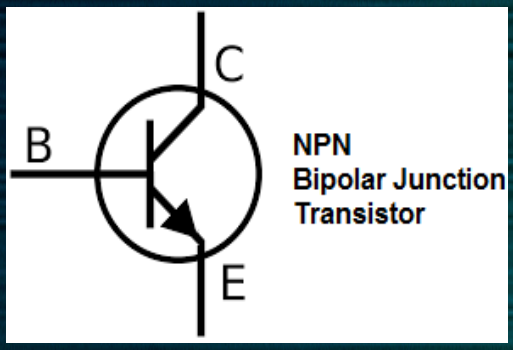
Explain how an Analogue input can be put into a Programmable devise

Electronic systems

SECTION 3.4

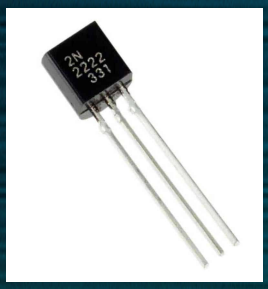
Interfacing components

These devices boost the output signal going from the process block of an electronic system to the output stage. This is necessary because some output devices require a larger current or voltage than can be provided by the process block alone. This is particularly the case with PIC microcontrollers as they only output small current values.



Transistors

These are current amplifiers, they can provide enough current for outputs that require a small to medium current boost such as lamps or buzzers.



The Transistor has three legs

- Base
- Collector
- Emitter

The diagram below shows a Transistor driver circuit, When voltage between the Base and the emitter is below 0.6 the buzzer will not sound. But when it is above 0.6 a larger current will flow between the Collector and emitter making the buzzer sound.

Field effect transistors (FETs)

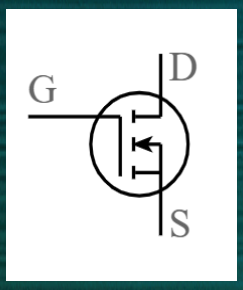
These components are voltage amplifiers, these are different from Transistors because Transistors are analogue while FETs are digital.

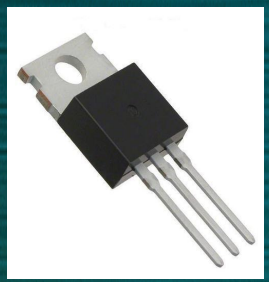
The FET has three legs called the:

- Gate
- Drain
- Source

FETs can provide an output signal high enough for motors and solenoids to work correctly.

The diagram below shows a simple circuit using a FET, when the Gate is 2Volts or higher the FET switches on and the motor turns on.





Electronic systems

SECTION 2.1

Explain what an Interfacing component does

Draw down the symbol of a Transistor and state what it does

What is a Field effect transistor?

Drawn down its symbol

Drawn down an example of a FET circuit

Explain how a field effect transistor works

Electronic systems

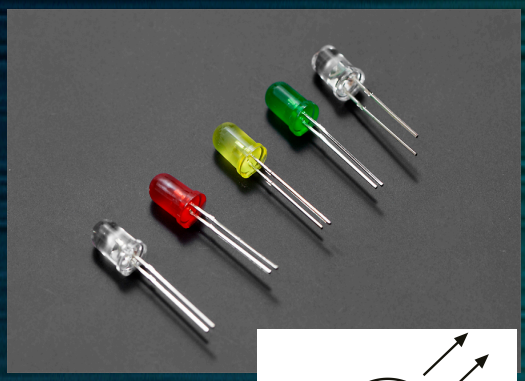
SECTION 3.4

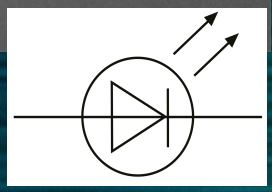
Output components

These components turn an electronic signal into a real world signal such as light, sound or movement,

LED's (Light emitting diodes)

These output devices produce light when current flows from the anode to the cathode. The LED has two legs, the longer leg is the anode and the shorter leg is the cathode.



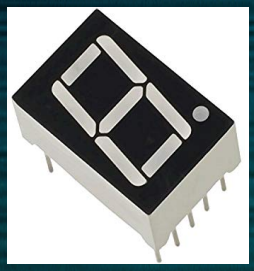


LED's are used as light indicators and help to show if a product is on or off. But they are being used in lamps and other lights as they are more energy efficient than filament light bulbs. Also they come in a range of colours and in a flashing or rotating colour form.

LED's can be damaged from too much voltage so a protective resistor is needed to protect it from burning out. These are connected in series.

Seven segment display

This is a package of LED's arranged so that numbers ranging from 0 to 9 can be displayed by parts of the display lighting up and others remaining dark representing numbers.



There are two types of Seven segment displays:

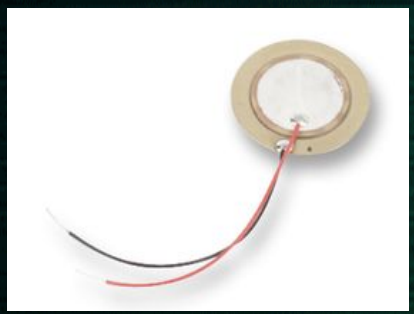
- Common Cathode – light when receive high signals
- Common Anode – light when receive low signals

When a seven segment display is used a suitable driver is needed such as a 4511 binary coded decimal (BCD) IC.

These displays can also replace LED's in counting circuits.

Piezo sounder

These output components convert electrical signal into sound using piezo-electric effect. They are able to produce a range of tones making them ideal for playing musical tunes in cards or toys. A microcontroller can be used to provide the required signals for the different tones and most pic programming software has commands designed for this purpose.



Electronic systems

SECTION 2.1

Describe what an Output component does

Draw down the symbol for an LED

What does an LED do?

Why are LED always held in series with a Resistor?

What is a Seven Segment display?

Draw down the symbol for a Seven Segment display

What is a Piezo sounder?

Why are they different from a Buzzer?

What product could these be used in?

Electronic systems

SECTION 3.4

Discrete Components within a circuit

These components are not inputs or outputs but are required to make the circuit work. Resistors, capacitors and diodes are all passive components that don't require a power source to perform their function.

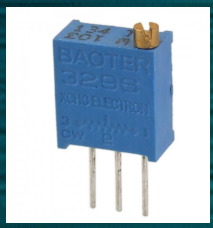
Resistors

The purpose of a resistor is to control the flow of current around a circuit and protects components from burning out e.g. LED's need to be protected by a 330 Resistor.

The value of a Resistor is given in Ohms, the higher the number the greater the resistance, 1000 ohms is shown as 1KΩ and 1,000,000 is shown as 1MΩ. On a circuit diagram the Resistor is shown by using the letter R followed by the value of the resistor e.g. 330R.

There are two main types of resistors:

- Fixed
- Variable



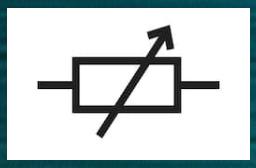
Fixed resistors

These have a set value within a tolerance (+ or – 5% or 10%) so it is sometimes required to combine resistors in series to achieve a certain number.

Total resistance in series = R1 + R2 + R3 (just add all the resistors up but watch out for any that are K or M!)

Variable resistors

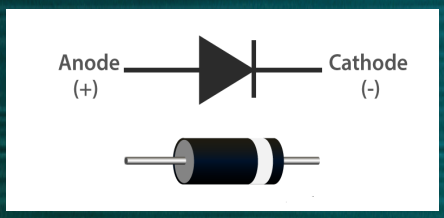
These type of resistors are variable and their resistance can be changed by turning a small dial or set by turning a screw with a screw driver. Example is on an electric guitar amp.



LDR's and thermistors are special types of variable resistors who resistance changed with the environment.

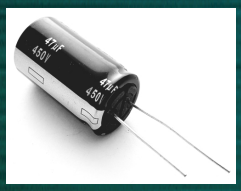
Diodes

These are components in a circuit which only allow current to flow in a single direction. Like LED's it has two legs, the anode and cathode and current flows from the anode (+) to the cathode (-).

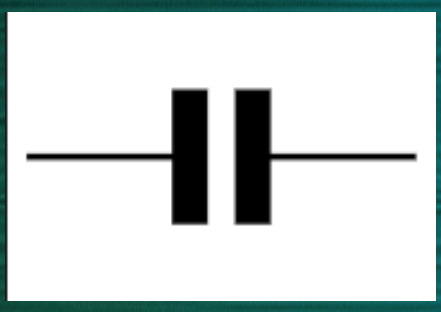


Capacitors

These components store electrical charge and are measured in Farads or F. A standard 1F capacitor used to quite large in size so for practicality most capacitor values used to be in micro Farads. Super Capacitors where developed to get around this issue and their internal design allows them to have much higher capacitance values but in a small package making them suitable for use as power supplies.



Capacitors can be polarised or non polarised meaning that they have to go the right way round in a circuit, non polarised ones can go any way round while Polarised need to have the anode on the positive side and cathode on the negative side.



Electronic systems

SECTION 2.1

Name three examples of Discrete components withi a circuit

.
.
.

Drawn down the symbol for a Resistor

Explain what a Resistor does in a circuit

_____
_____

_____
_____

Complete the following Sentence:

The higher the number the _____ the resistance.

What is the difference between a fixed and variable Resisotr?

_____
_____

_____
_____

How would a 1,000,000 ohm resistor be written down?

_____
_____

Using the following Equation: Total R =R1 + R2. Calculate the total resistance of R1 = 3K, R2 = 12K and R3 = 200
Show all working

Draw down the symbol for a Diode

Explain what a diode does within an electronic circuit

_____
_____

_____
_____

Draw down the symbol for a Capacitor

Explain what a Capacitor does

_____
_____