Electronics Components

Introduction to the Basic components

What is a Capacitor ?

- CAPACITATORS consist of two metal plates or metal films separated by an insulator. In larger capacitors these are in the form of long ribbons wound into a cylinder.
- The bigger the plates the bigger the capacitance. To stop capacitors becoming too large to be practical however they are often rolled up like Swiss rolls.

Here is a picture of one!

- This is a polarised capacitor. It has a positive and negative leg.
- The positive leg is the longer one.

Here is another Capacitor

- This is a nonpolarised capacitor.
- It can be connected either way round.
- These tend to be smaller capacitors.

What They Do?

- Capacitors store charge for a period of time.
- A capacitor stores up charge till it is full then discharges in one pulse. The speed at which it fills up is dependant on the resistor allowing the charge in.
- A large capacitor, when charged, can supply enough current to run an LED for a few seconds.

In Depth Capacitor Theory

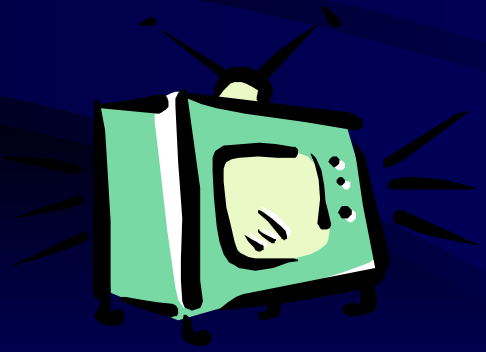
- Capacitors come in two flavours, **electrolytic** and **non-electrolytic**. Electrolytic capacitors use a special liquid or paste which is formed into a very thin dielectric in the factory. Non-electrolytic capacitors have ordinary dielectrics.
- Electrolytic capacitors can store more charge than non-electrolytic capacitors but there are a couple of problems. They must be connected the right way around in a circuit or they won't work. They also slowly leak their charge, and they have quite large tolerances. A 47uF capacitor might actually be as high as 80uF or as low as 10uF

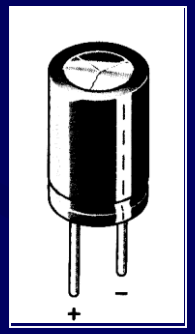
Capacitor Charging Theory

- When a capacitor is connected to a battery it begins to charge.
- The current flows rapidly at first.
- Charge builds up on the two plates, negative charge on one plate and the same amount of positive charge on the other.
- The positive charge results from electrons leaving one of the plates and leaving positively-charged protons behind. But as the capacitor fills with charge it starts to oppose the current flowing in the circuit. It is as if another battery were working against the first. The current decreases and the capacitor charges more slowly. The plates become full of charge and it takes practically forever to squeeze the last drop in

Where They Are Used ?

- Most electronic circuits including radios, televisions and calculators.





Where you can used them

- As a component to store Charge.
- In timing circuits.
- To control the frequency of pulse in a timer circuit.

Capacitance Measurement

- The capacitance is measured in units called farads(the symbol is F)
- The Farad is a very large unit so capacitors used in electronics circuits are often rated in :
  - Micro (µf) 1000 in a F
  - Nano (nf) 10000 0in a F
  - Pico (pf) 10000000 in a F

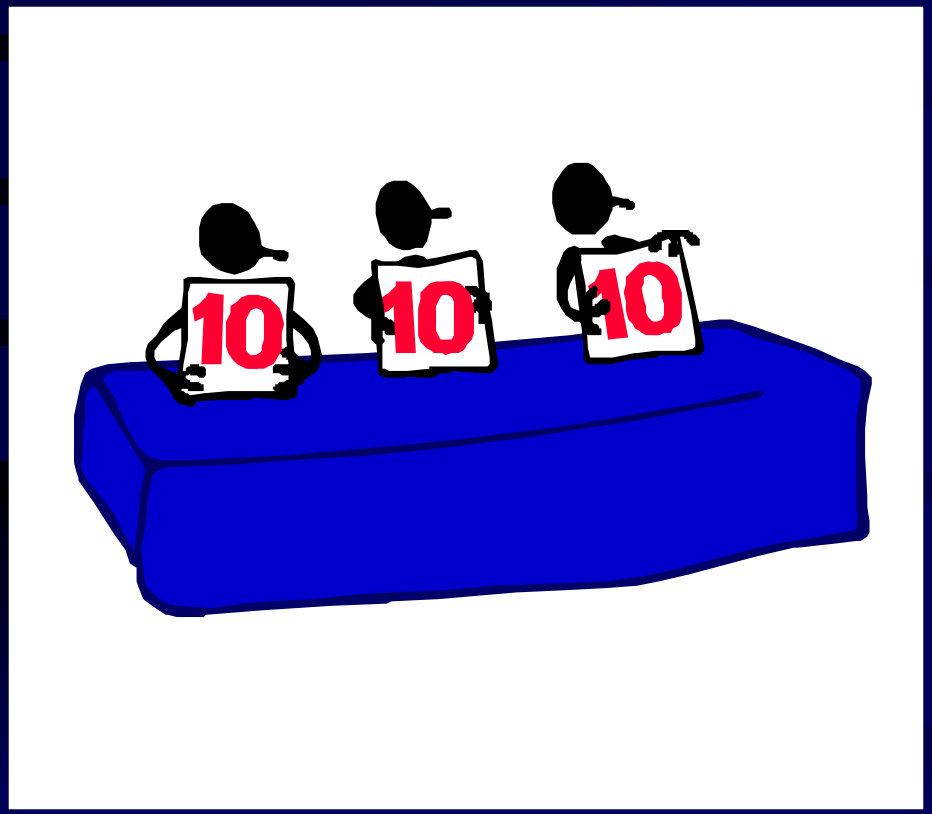
Questions on Capacitors

- What are the two types?
- What are they measured in?
- What do they do?
- How do they work?
- Where can you find them?
- Draw a picture of a polarised capacitor.

Answers to the questions.

- Polarised & Nonpolarised
- Farads (F)
- Capacitors store charge for a period of time.
- They gradually fill up with power until they are completely full and then charge in one pulse.
- Most electronic circuits including radios, televisions and calculators.

How did you do?



- 6/6 excellent you deserve a merit.
- 5/6 Great
- 4/6 Well Done
- 3/6 Not bad
- 2/6 Try harder
- 1/6 Please try again.

Resistors

Theory & Practice

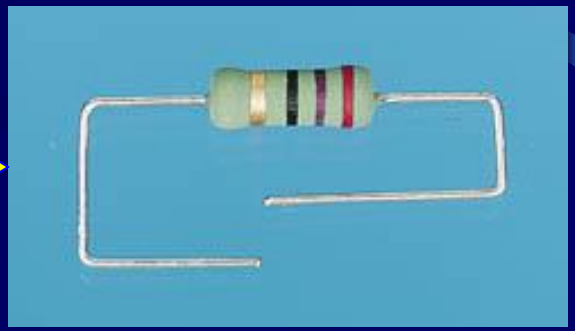
Introduction to Resistors

- Resistance is a property of materials which determines how easily charge can flow through them at a particular voltage.
- Resistance is measured in units called ohms. (Ω)

Fixed Resistor

- Most of the fixed resistors you are likely to use will only be suitable for use with small currents. They are likely to be 0.25W or 0.5W resistors.
- This is a measure of the maximum power-handling capacity.

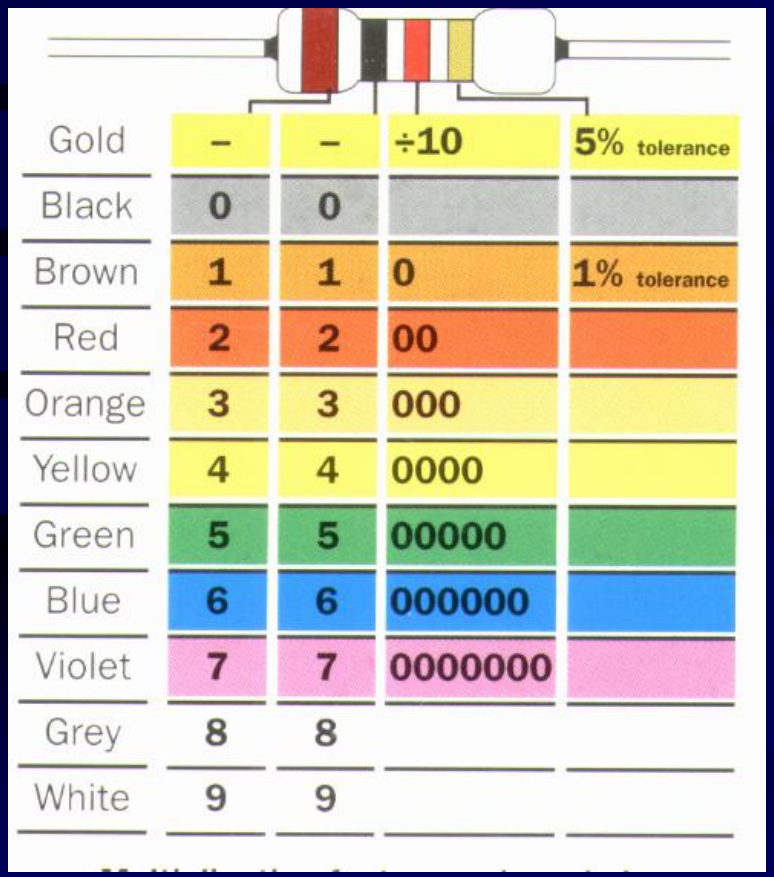
A fixed resistor



Resistor Colour Codes

- Most resistors are labelled with four coloured bands to show the resistance value and tolerance.
- This is known as the resistor colour code.
- You should know how to use it to check resistor values.

Resistor Colour Codes

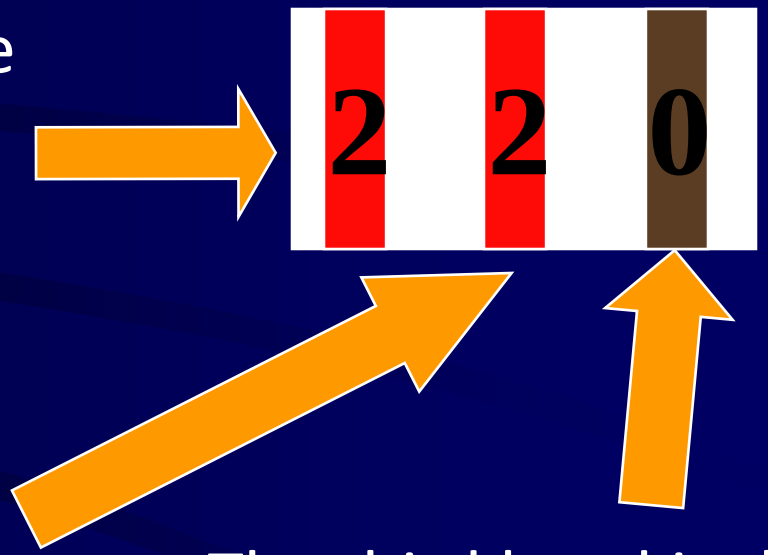


Gold	–	–	÷10	5% tolerance
Black	0	0		
Brown	1	1	0	1% tolerance
Red	2	2	00	
Orange	3	3	000	
Yellow	4	4	0000	
Green	5	5	00000	
Blue	6	6	000000	
Violet	7	7	0000000	
Grey	8	8		
White	9	9		

- Here is a copy of the resistor codes.
- The first band is a number
- The second a number
- The third the number of 0's

How to work out Colour Codes

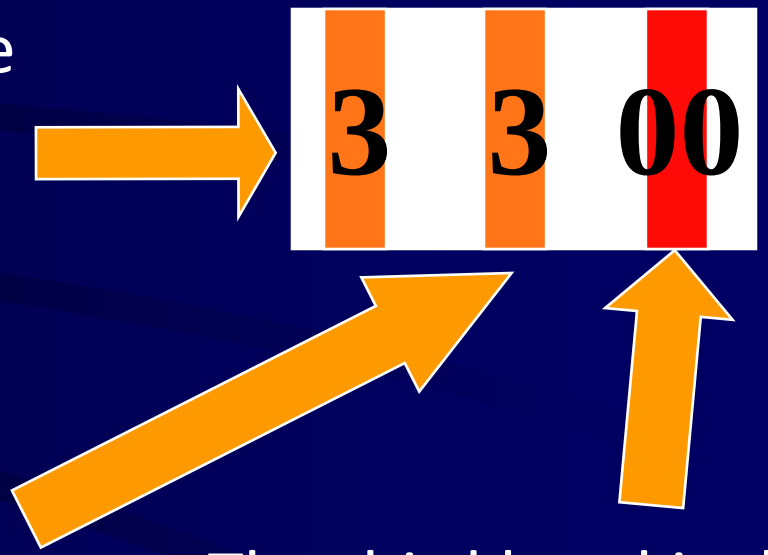
- To work out the code the first band is a number



- The second band is also a number
- The third band is the number of 0's added on the end.

Colour Codes Example 2

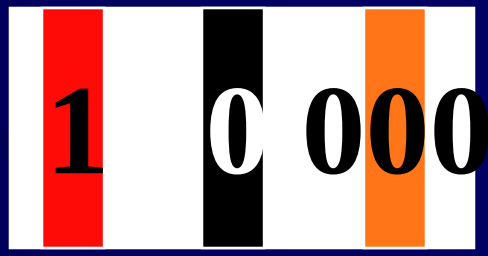
- To work out the code the first band is a number



- The second band is also a number
- The third band is the number of 0's added on the end.

Colour Codes Example 3

- You should now understanding how to work them out.
- Follow this last example.



- This is a 1000Ω resistor. Or 1KΩ
- AS 1000Ω = 1KΩ

Now its your turn to try?

- Here come some colour codes
- Have a go
- Answer them.
- Please draw a rectangle.
- Then draw on the stripes
- In the correct colours

Work Out These Colour Codes

- 220Ω 
- 35KΩ 
- 230Ω 
- 330Ω 
- 180Ω 
- 1000Ω 
- 1.2KΩ 

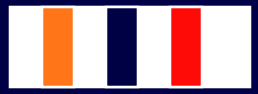
- 3300Ω 
- 1KΩ 
- 10KΩ 

How did you do?

- 10 Excellent : Merit.
- 8-9 Great
- 6-7 Well Done
- 5 Not bad
- 3-4 Try harder
- 1-3 Listen up and try again.

Now work out the numbers

- 33kΩ



- 27kΩ

- 470kΩ

- 15Ω

- 180Ω

- 560Ω

- 8.2kΩ

- 35Ω

- 810Ω

- 24Ω

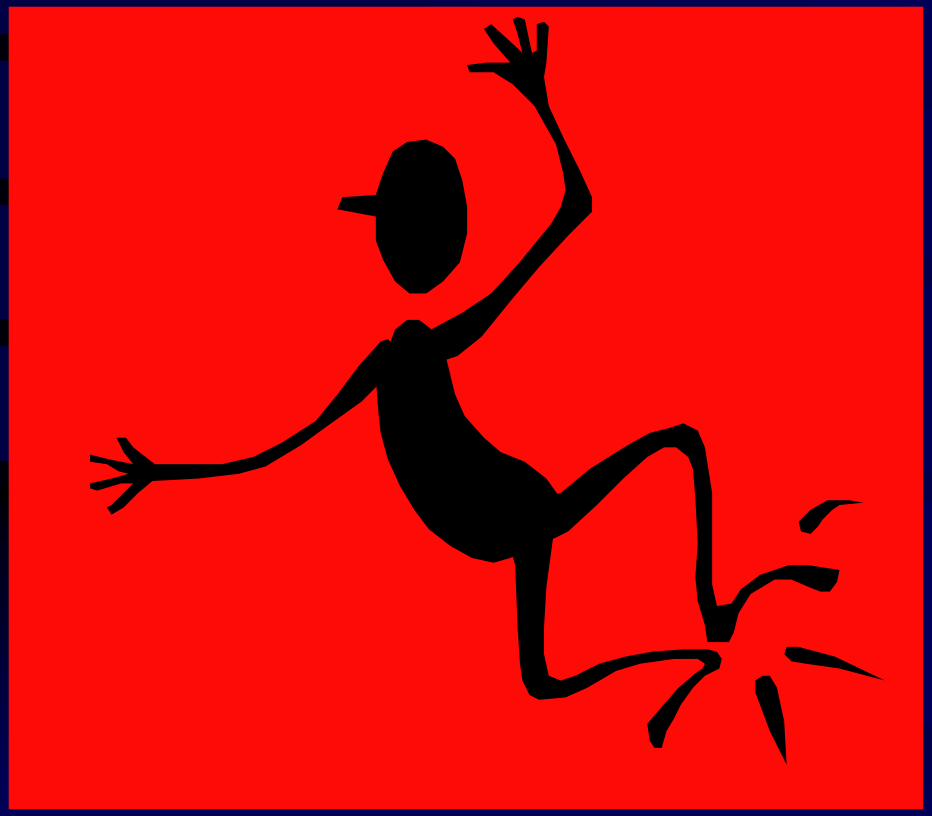
- 330Ω

- 160Ω

- 1000Ω

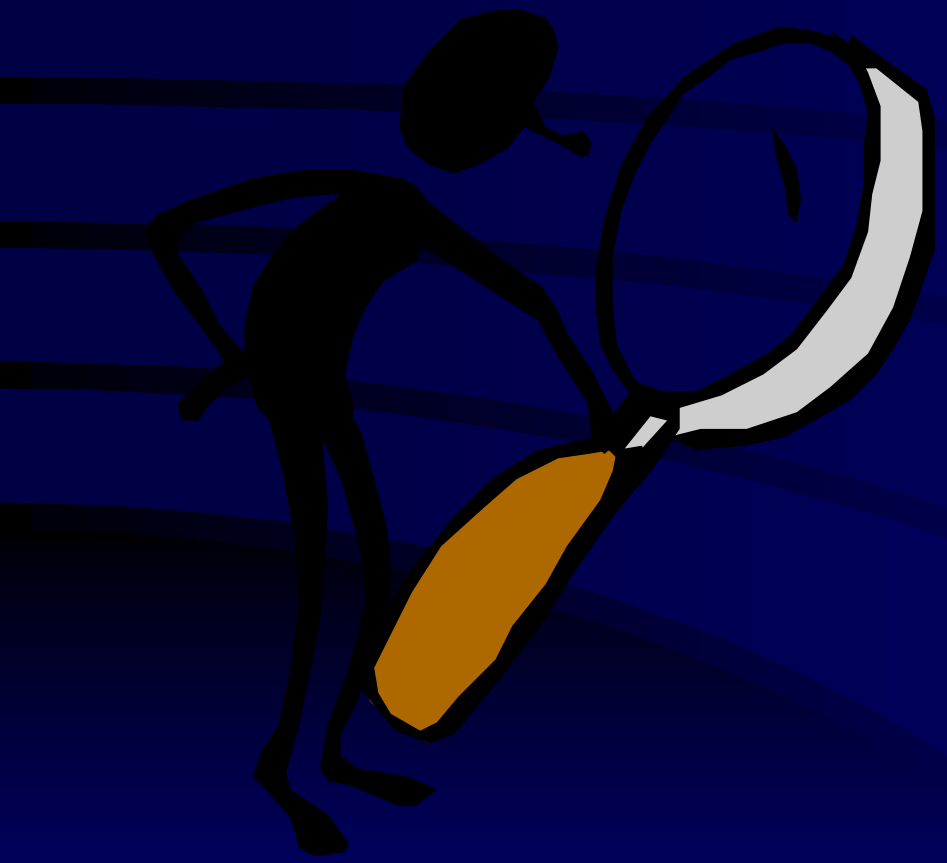
- 1200Ω

How did you do?



- 14 Excellent
- 10-13 Great work
- 7-9 Good
- 4-6 Not bad
- 0-3 Try again

Tolerance



- Tolerance is a measure of the accuracy of the colour coding in indicating the actual resistance of the resistor.
- For example, a 1k gold band resistor - 5% tolerance could have a resistance of 1000 ohms +or - 50 Ω (that is 950Ω to 1050Ω)

Variable Resistors (Potentiometer)

- The resistance value is changed by moving the wiper along the resistance track.
- The maximum resistance is marked on the outside of the casing or stamped on to the resistor.

Ohms Law

The Theory & Practice.

Ohm's Law

- Ohm's Law is actually very simple.
- It says that the more voltage applied to a resistor the more current flows through it.
- If the voltage is doubled then the current doubles, if the voltage is trebled then the current trebles, and so on.
- There is always a constant ratio between the voltage and current for a particular resistor. This value is the resistance measured in ohms. (Ω)

Ohms Law 2

- To work out the resistance of something, simply measure the voltage across it and the current through it. Divide the first figure by the second and you have the resistance.
- If you know the resistance and the voltage you can work out the current. Or if you know the resistance and the current you can work out the voltage. That makes Ohm's Law very useful

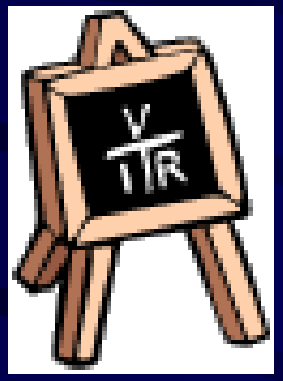
Ohms Law Examples

Ohms Law Calculations

V=IR

I=V/R

R=V/I



Simple Substitution

See Example

$$V = IR$$

$$V = 2A \times 2\Omega$$

$$V = 4V$$

Resistance Using Ohms Law

$$R = \frac{V}{I}$$

$$R = \frac{12V}{2A}$$

$$R = 6\Omega$$

- To work out the resistance we can use Ohms law this way round.
- I = 12volts
- V= 2 amps
- Therefore R = 6Ω

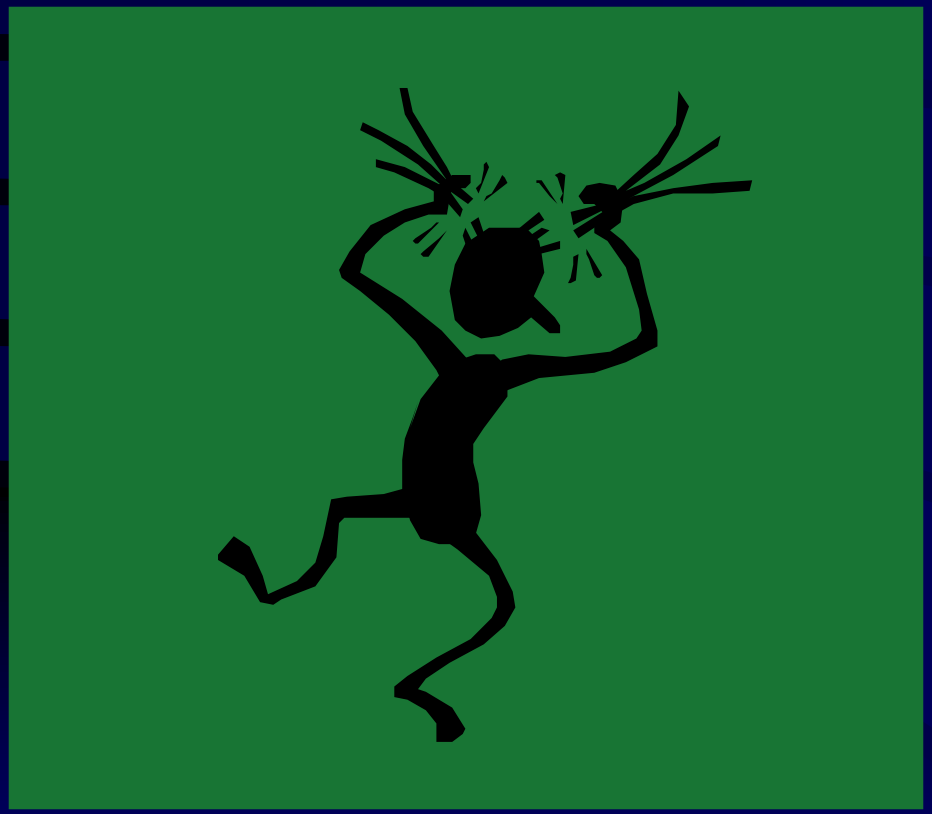
Ohms Law -Your Turn?

- Here come some Calculations
- Have a go
- Answer them.
- Please write out the full equation.
- Show all working out
- Use correct unit in the answers.

Now You Try? Ohms law Calcs

V	I	R
660v	2A	330Ω
6v	3A	2Ω
12V	2A	**6Ω**
24V	**48A**	2Ω
135V	3A	45Ω
15V	**0.31A**	47Ω

How did you score?



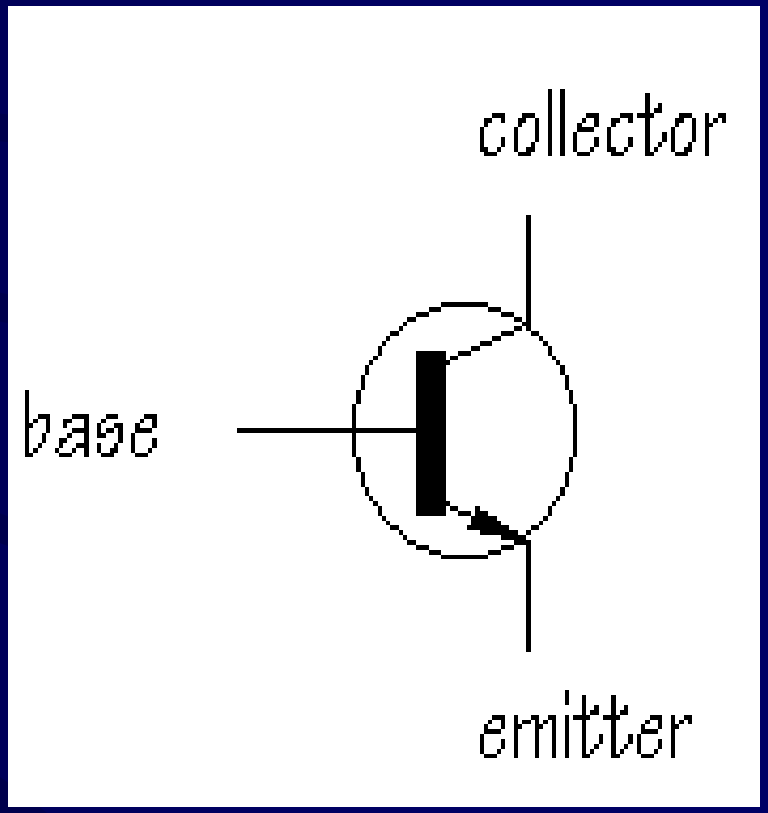
- 6 - Top work.
- 5 - Great work
- 4 - Well Done
- 3 - Not bad
- 2 - Try harder
- 1 - Listen harder and then try again.

Transistors

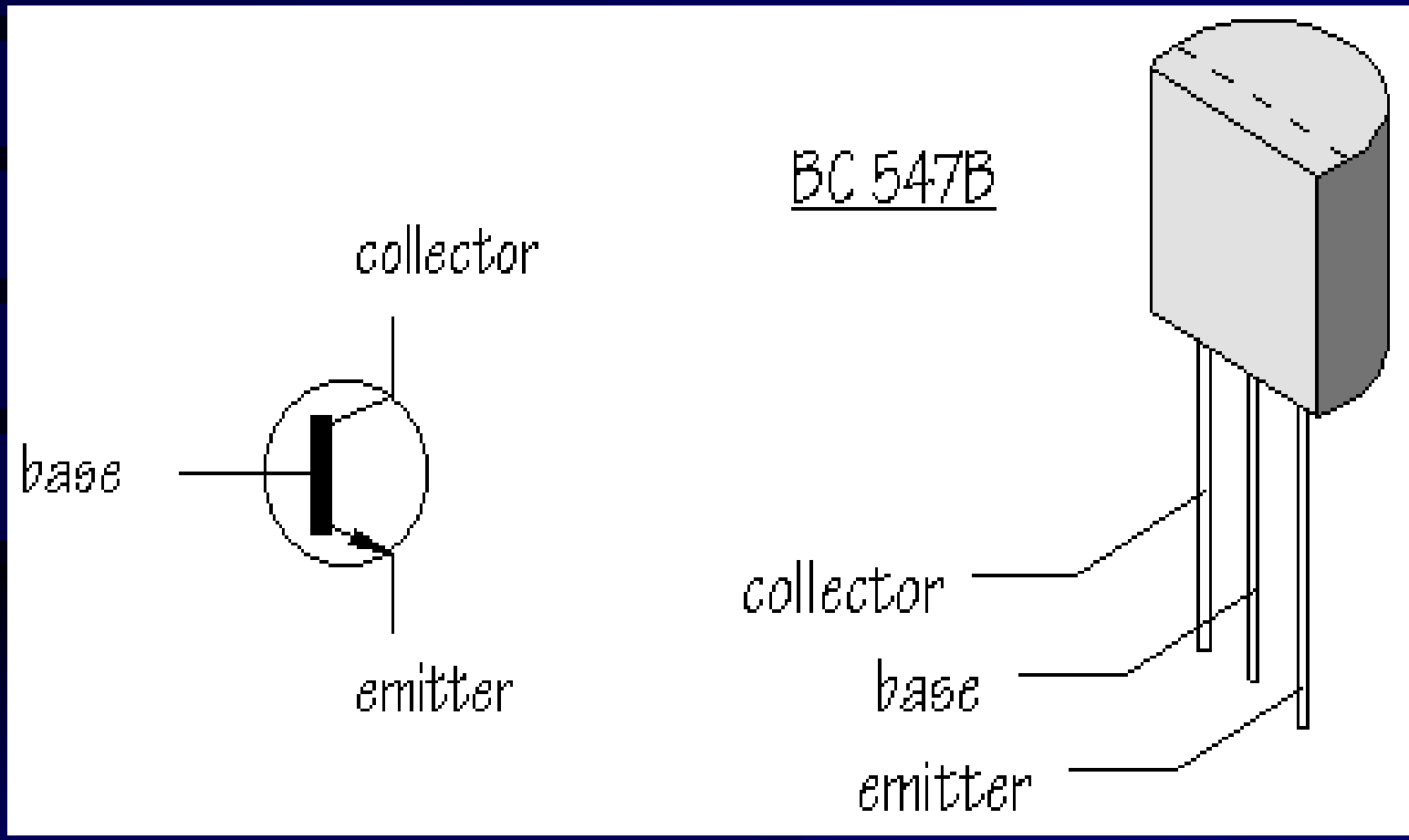
Theory & Practice

Transistor Basics

- Here is the symbol and picture for the BC547B transistor
- It is the cheap replacement for the BC108
- Look at the three legs and learn their names



Here is the Transistor



Transistor Theory

- Transistors underpin the whole of modern electronics. They are found everywhere - in watches, calculators, microwaves, hi-fi's. A Pentium(tm) computer chip contains over a million transistors!
- Transistors work in two ways. They can work as switches (turning currents on and off) and as amplifiers (making currents bigger). We'll only be looking at them as switches here. To understand them as amplifiers would involve a little mathematics.
- Transistors are sandwiches of three pieces of semiconductor material. A thin slice of n-type or p-type semiconductor is sandwiched between two layers of the opposite type. This gives two junctions rather than the one found in a diode. If the thin slice is n-type the transistor is called a p-n-p transistor, and if the thin slice is p-type it is called a n-p-n transistor. The middle layer is always called the **base**, and the outer two layers are called the **collector** and the **emitter**.

Technical Terms

Electronics Technical Terms

Technical Terms

- CURRENT - Symbolised by I (Intensity). The movement of electrons or ions through a conductor. Measured in "amperes", symbolised by A. One ampere is the flow of one coulomb per second passed a given point in a circuit.

- VOLTAGE - Electrical pressure, measured in volts, i.e., the force which causes current to flow through an electrical conductor. Symbolised by E (standing for Electromotive force). E represents the greatest difference of potential between any two conductors of a circuit. This usually winds up being the voltage source itself (such as a battery).

Technical Terms

- RESISTANCE - a property of conductors, measured in ohms, which - depending on their dimensions, material, and temperature - determines the current produced by a given difference of potential; that property of a substance which impedes current and results in the dissipation of power in the form of heat.

- POWER - The rate at which work is done. Units of power are the: watt, joule, and kilowatt.

The Prefix Multipliers

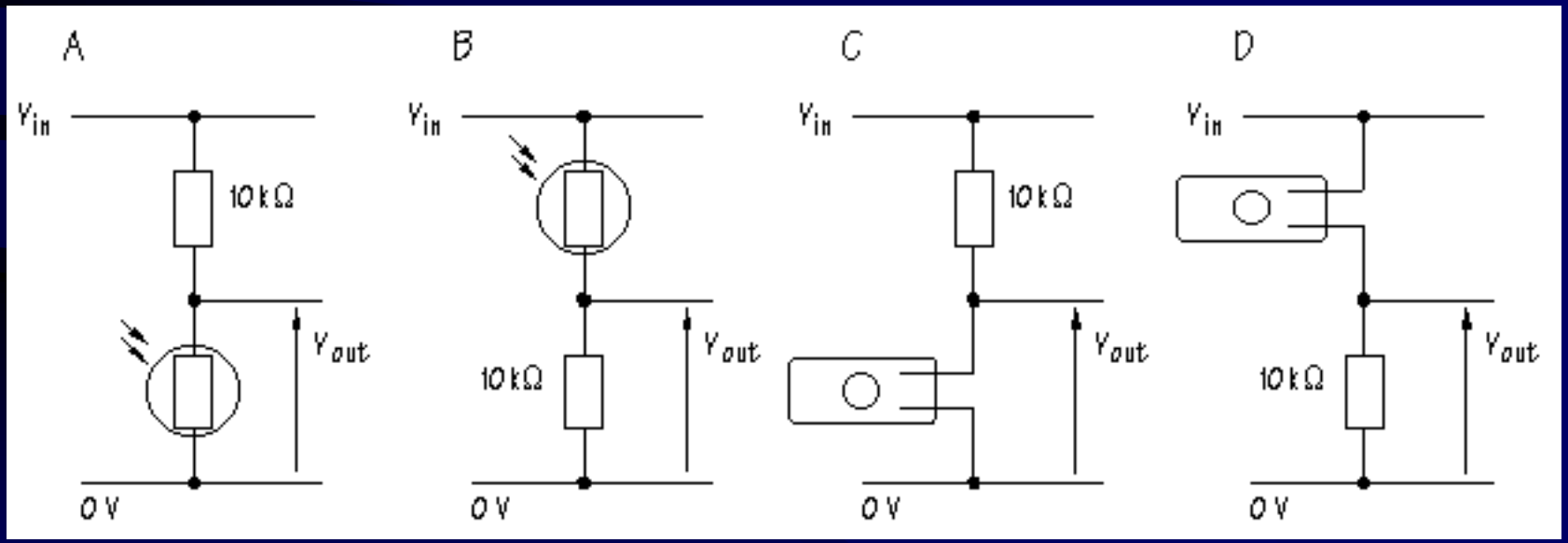
ower	Value	Prefix	Symbol
10^9	one billion	giga	G
10^6	one million	mega	M
10^3	one thousand	kilo	k
10^-3	one-thousandth	milli	m
10^-6	one-millionth	micro	u
10^-9	one-billionth	nano	n
10^-12	one trillionth	pico	p

Sensors

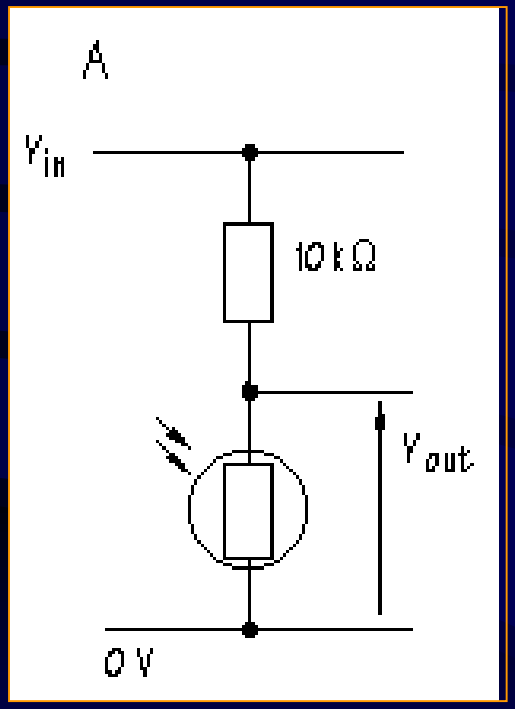
Potential Divider Circuits
& their applications

Sensor Circuits

- Here are 4 sensor circuits that work as potential divider circuits.

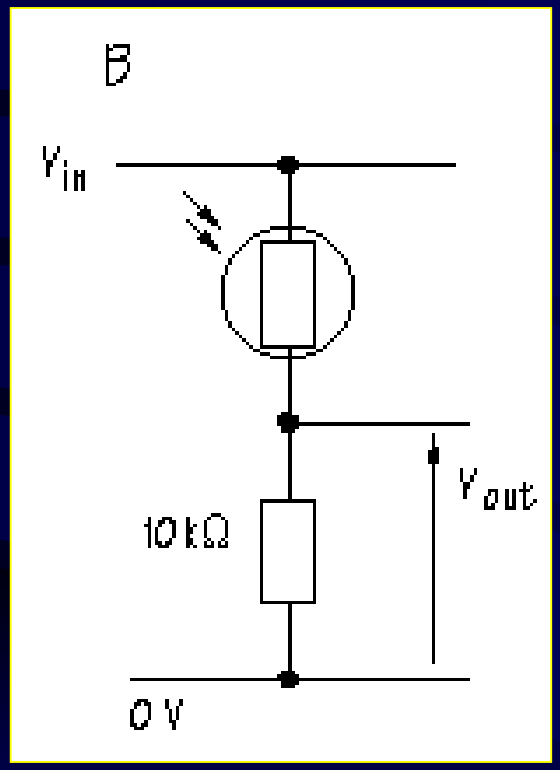


Example 1 : Sensor A



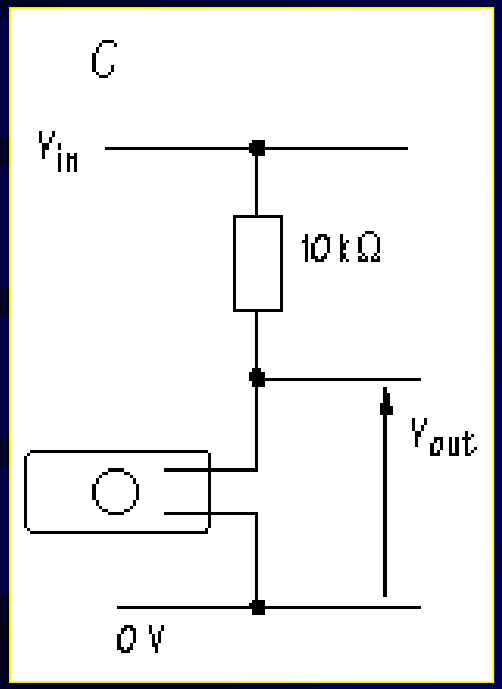
- Circuit A show an LDR sensor circuit.
- Which is a dark sensor.

Example 2 : Sensor B



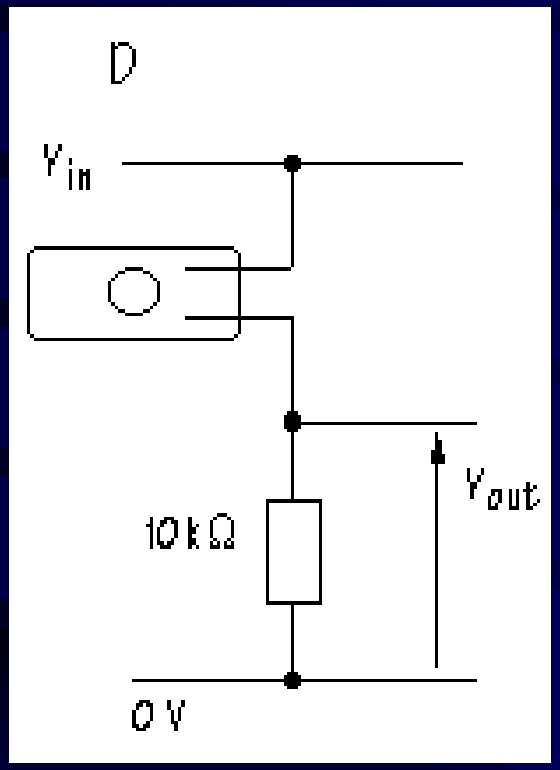
- Circuit B show an LDR sensor circuit.
- Which is a light sensor.

Example 3 : Sensor C



- Circuit C show an moisture sensor circuit.
- Which is a dry sensor.

Example 4 : Sensor D



- Circuit D show an Moisture sensor circuit.
- Which is a Wet sensor.

Potential Divider Circuits

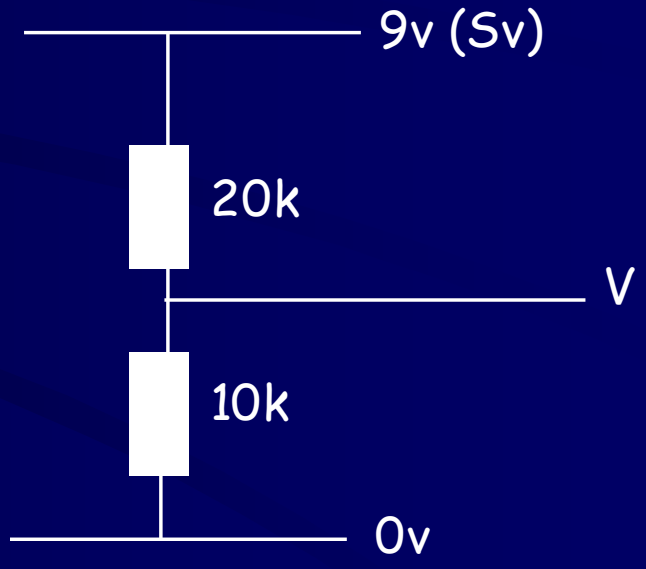
The Theory & Practical Application.

Potential Divider Circuits

- Potential Dividers are a way of adjusting the sensitivity of a circuit
- They are made of resistors connected in series between the +ve and the -ve rails of the circuit.
- Most commonly used in sensing circuits to control the sensitivity

Potential Divider Circuits

- This is how you work out Potential Divider Circuits.
- V= Sv x R2/R1+R2
- V= Output Voltage
- Sv= Supply Voltage
- R1 is top Resistor
- R2 is Bottom Resistor



Next Stage PD Calculations

Sv = 9volts

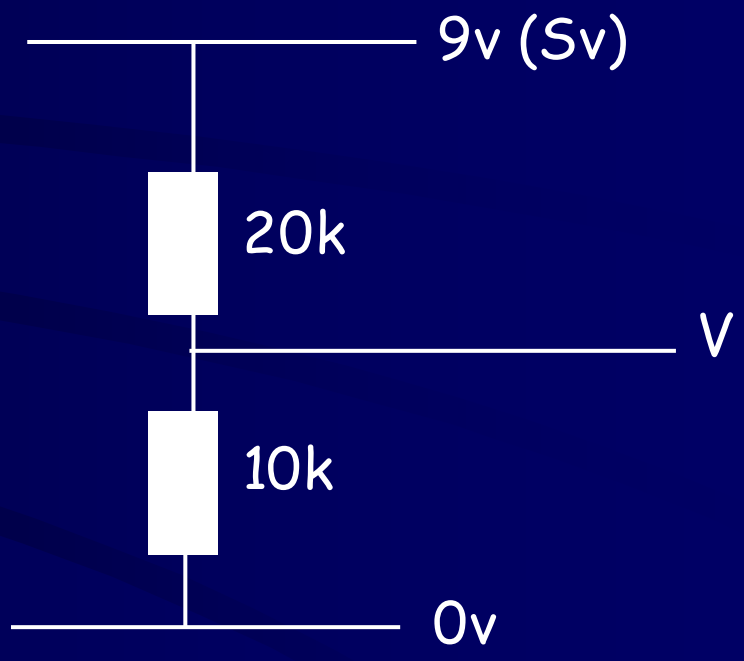
R1 = 20KΩ

R2 = 10KΩ

$$V = 9v \times \frac{10}{20+10}$$

$$V = 9v \times \frac{1}{3}$$

$$V = 3v$$



PD circuits -Your Turn?

- Here are a few potential divider Calculations
- Have a go
- Answer them.
- Please write out the full equation.
- Show all working out
- Use the correct units in the answers.

Now You Try? PD Calcs

	SV	R1	R2
4.5v	9v	10Ω	10Ω
3.6v	6v	20Ω	30Ω
3v	**3.6v**	10Ω	50Ω
3.6v	6v	20Ω	30Ω
5.14v	12v	40kΩ	30000Ω
14.4v	24v	10kΩ	15kΩ

How did you score?

- 6 - Top work.
- 5 - Great work
- 4 - Well Done
- 3 - Not bad
- 2 - Try harder
- 1 - Listen harder and then try again.

Potential Dividers Key Points

- Potential Dividers are made from two resistors in series with a power supply.
- The input to many electronic circuits is from a potential divider circuit.
- Sensors such as thermistors and LDR’s are used in the pd circuit to control the sensitivity at which the switching action takes place

Electronics Glossary A-B

AMPERE.

* This is the unit of electrical current, often shortened to Amp. It is given the symbol 'I' in calculations and can be found by dividing VOLTS with OHMS.

ANODE.

* This is the POSITIVE ELECTRODE in a circuit. It is commonly linked with DIODES and things like television sets. It is the opposite of CATHODE.

BASE.

* One of the pins of a TRANSISTOR. This pin is the 'trigger' which will switch the transistor on when an electric current, usually greater then 0.6 volt, is applied. If there is little or no current, the transistor is off. The base is also known as the GATE.

Electronics Glossary

Manyof the important electronics terms explained in detail.

Electronics Glossary C

CAPACITOR.

* A capacitor can store small amounts of electrical charge. It consists of two ELECTRODES with a non-conducting layer in between them. If you think of the capacitor as a small reservoir of electricity that will be released later, you will have a rough idea of how it works.

CATHODE.

* This is the NEGATIVE ELECTRODE in a circuit. It is commonly linked with DIODES and things like television sets. It is the opposite of ANODE.

COLLECTOR.

* One of the pins of a TRANSISTOR. This is the pin which is connected to the main voltage. Think of it as the 'entry' point.

Electronics Glossary C-D

COMPARATOR.

* A particular type of OPERATIONAL AMPLIFIER which has an output that is either on or off. It is a type of switch, but has two inputs, one for what is being measured and the other being a reference point. The comparator will normally switch on when the input is less than the reference. An example would be in a thermostat. Then input would be given by a THERMISTOR and the reference would come from a VARIABLE RESISTOR. This allows the actual switching temperature to be altered.

DIODE.

* A diode will allow electrical current to flow in one direction only. They are SOLID STATE devices and typically need more than 0.6 VOLTS to operate. In a normal diode, current flows from the positive ANODE to the negative CATHODE. There are several special types including LEDs, PHOTODIODES and ZENER DIODES.

Electronics Glossary E

EARTH.

* This is another name for the GROUND, or zero VOLT connection of a circuit. Sometimes called neutral, though this can cause confusion with NEGATIVE supply.

ELECTRODE.

* An electrical terminal, normally left unconnected at one end. Electrical connection between electrodes is often made by electric arcing or holding them in salt solutions.

EMITTER.

* One of the pins of a TRANSISTOR. This pin is where the high voltage side leaves the transistor. You could think of it as the 'exit' for electricity.

Electronics Glossary G

GAIN.

* Gain is often quoted in the specification of TRANSISTORS. it is the ratio of the current in AMPS between the COLLECTOR and the BASE of the transistor. Typically this can be a ratio several hundred to one, since the current needed to switch the transistor on is very small compared with what can be passed through the collector and out of the EMITTER. This is why transistors are used to amplify currents in music and radio equipment.

GATE

* One of the pins of a TRANSISTOR. This pin is the 'trigger' which will switch the transistor on when an electric current, usually greater then 0.6 volt, is applied. If there is little or no current, the transistor is off. The gate is also known as the BASE.

Electronics Glossary I-L

INTEGRATED CIRCUIT.

* An integrated circuit (IC) is a complete, very compact circuit made up from tiny RESISTORS, CAPACITORS, DIODES and TRANSISTORS. Each IC can contain hundreds of these components, and the circuits themselves are very complicated. However, we do not need to know the exact details, just what the IC needs as inputs and what we can expect as outputs.

L.D.R.

* Light Dependant Resistor. This is a special type of RESISTOR and is sometimes called a PHOTOCONDUCTOR. LDRs are made so that their resistance decreases as the level of light falling on them increases.

L.E.D.

* Light Emitting Diode. These DIODES emit light when current flows from ANODE to CATHODE. They normally emit red light, but other colours are available. They conduct current in one direction only, but can be damaged by reverse voltages.

Electronics Glossary N

NEGATIVE SUPPLY.

* Any supply which has a voltage less than zero VOLTS. Some circuits, particularly OPERATIONAL AMPLIFIERS, need a negative supply to work reliably. This can be obtained using special equipment, or by using a VOLTAGE DIVIDER set to split the voltage in half and connecting the halfway voltage to the circuits EARTH point. The first method is preferred.

N.P.N.

* This refers to TRANSISTORS, which usually have three pins. The three letters correspond to the pins, with the middle one being the BASE. The 'P' in this case means that the base must be 0.6 volts higher than then EMITTER before the transistor will switch on. It is the opposite of PNP.

Electronics Glossary O

OHM.

- This is the unit of electrical resistance and is often shortened to ''. It is given the symbol 'R' in calculations and can be found by dividing VOLTS with AMPERES.

OPERATIONAL AMPLIFIER.

* This is a small INTEGRATED CIRCUIT and is known as an Op-Amp for short. Depending on the connections used and the values of CAPACITORS and RESISTORS in the circuit, the Op-Amp behaves like a COMPARATOR or DIFFERENTIAL AMPLIFIER.

Electronics Glossary P

PARALLEL.

* A way of connecting components so they each have the same voltage difference across them. On a circuit diagram, you would draw the components parallel to each other and connect them all back to the same point. Compare with SERIES.

PHOTOCONDUCTOR.

* This is a special type of RESISTOR and is sometimes called an LDR. Photoconductors are made so that their resistance decreases as the level of light falling on them increases.

PHOTODIODE.

* This type of DIODE reacts to light. It is mounted so that the CATHODE is more 'positive' than the ANODE. It relies on the fact that all diodes leak a small amount of current back out of the anode. The amount of current leaking through depends on the amount of light falling onto the diode.

Electronics Glossary P

POSITIVE SUPPLY.

* Any supply which has a voltage greater than zero VOLTS. Normally used to refer to the original power source.

PROPORTIONAL AMPLIFIER.

* A particular type of OPERATIONAL AMPLIFIER where the output voltage is in proportion to the difference between it's inputs. Unlike the COMPARATOR, which can based on exactly the same INTEGRATED CIRCUIT, the Op-Amp has two individual inputs instead of one input and one reference value. This use is sometimes called a DIFFERENTIAL AMPLIFIER or SUBTRACTOR.

Electronics Glossary R

RELAY.

* These are very useful but expensive electrical switches that can control very large amounts of electrical energy. A relay consists of a switch that is operated by an electrical magnet. There are several types, including normally-open (NO) and normally-closed (NC). In an NO relay, when the magnet is on the metal parts of the switch are pulled together. When the magnet is off the metal parts of the switch are pushed apart. The action is the opposite way around for an NC relay. This is an example of a switch containing moving parts, compared to SOLID STATE devices.

RESISTOR.

* Resistors are used to restrict the amount of CURRENT flowing through a circuit. They are often used to protect other delicate devices, such as LEDs, from damaging high voltages. The value of a resistor is measured in OHMS and we can use this to calculate how much current will pass through it.

Electronics Glossary S

SERIES.

* A method of connecting components so that they follow on one after another, in a queue. Compare with PARALLEL.

SOLID STATE.

* A switch which has no moving parts is known as solid state. TRANSISTORS and DIODES are examples of these devices.

SUBTRACTOR.

* A particular type of OPERATIONAL AMPLIFIER where the output voltage is in proportion to the difference between it's inputs. Unlike the COMPARATOR, which can based on exactly the same INTEGRATED CIRCUIT, the Op-Amp has two individual inputs instead of one input and one reference value. This use is sometimes called a DIFFERENTIAL or PROPORTIONAL AMPLIFIER.

Electronics Glossary T

THERMISTOR.

* This is a special type of RESISTOR. The resistance of all resistors changes slightly as they get hotter. Thermistors are usually made so that their resistance falls noticeably as the temperature around them rises. They can be used to detect temperatures very accurately when used with a simple COMPARATOR circuit. The resistance of a thermistor is specified at a certain temperature, for instance 47K at 25C.

TRANSISTOR.

* A transistor is a SOLID STATE switch and is cheaper than a RELAY. The current being controlled enters at the COLLECTOR, but will not go any further until the GATE opens, after which it leaves at the EMITTER. Many different types of transistor exist, including special types like PHOTOTRANSISTORS, but the most common are 'NPN bi-polar' types. A transistor can amplify an output signal, often by several hundred times. This is called GAIN.

Electronics Glossary V

VARIABLE RESISTOR.

* This is an adjustable RESISTOR. They can normally be set to give anything from zero resistance to whatever is the maximum design value. Most have three pins so that they can also be used as a VOLTAGE DIVIDER.

VOLTAGE DIVIDER.

* By connecting two or more resistors in SERIES between the positive and negative supplies, you can split the voltage down into a series of steps. The size of these steps depends on the resistor values used. VARIABLE RESISTORS can be use - in this case, the middle pin gives the divided voltage, normally any value in between the voltage difference across the other two pins.

VOLTS.

* This is the unit of potential difference, which is basically a way of talking about total power. It is given the symbol 'V' in calculations and can be found by multiplying AMPS and OHMS together.