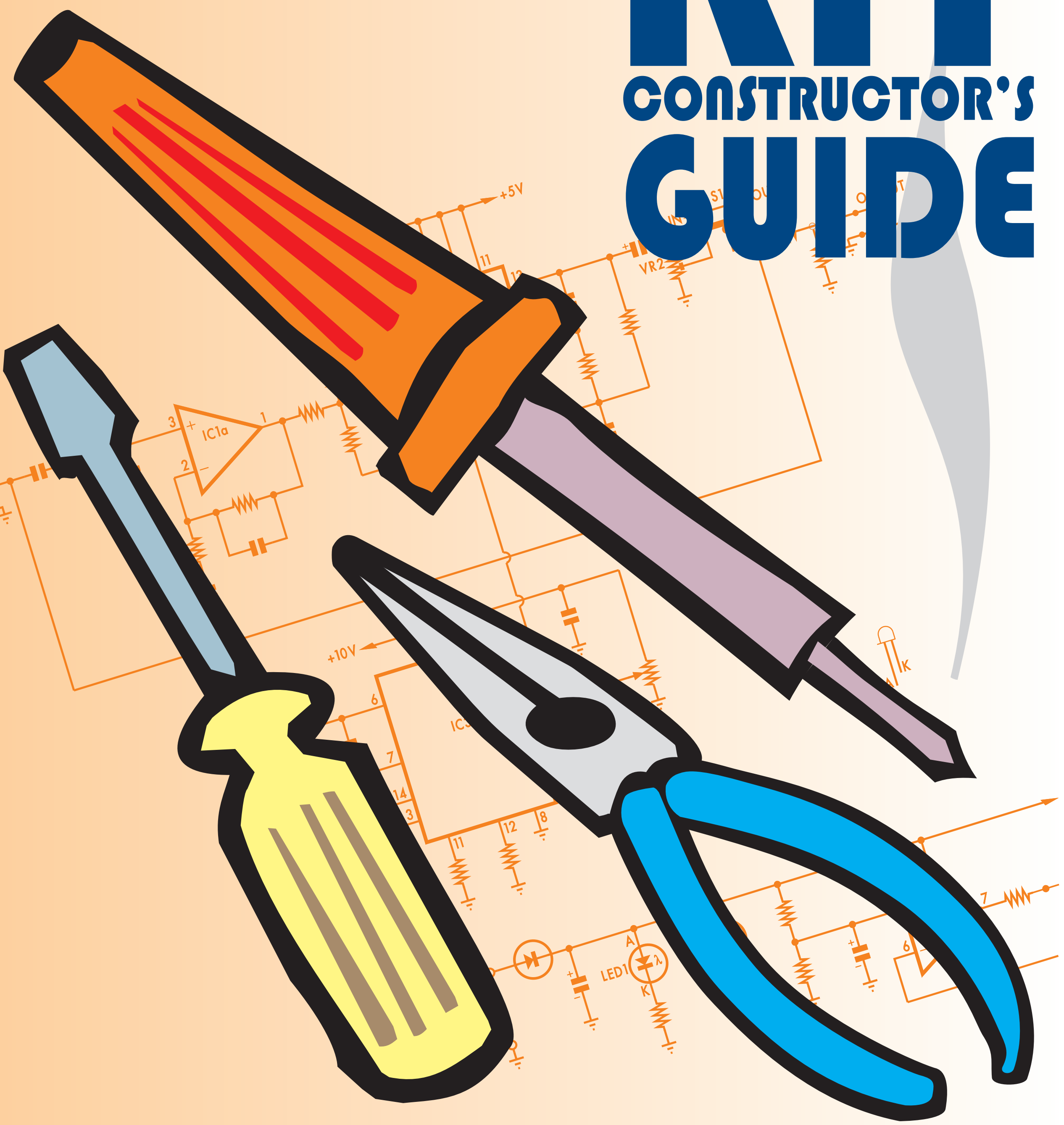
• GUIDE FOR BOTH BEGINNERS AND EXPERIENCED • SAFETY • SOLDERING •

jaycar
TECH, ELECTRONICS & MORE

No 1 for Kits

KIT CONSTRUCTOR'S GUIDE



COMPONENT IDENTIFICATION • TOOLS REQUIRED • HANDLING SEMICONDUCTORS • FAULT FINDING

TRANSFORMERS • TECHNICAL TERMS EXPLAINED • COMPONENT ORIENTATION • CONSTRUCTION TIPS

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• SOLDERING TECHNIQUES • PARTS IDENTIFICATION • GLOSSARY OF TERMS •

GETTING STARTED

INTRODUCTION

This kit constructors guide is designed to assist newcomers to kit construction. It covers topics such as soldering, component identification and fault finding. Your project will be more likely to work first time by following the construction information listed throughout this guide. We encourage you to read this guide cover to cover before attempting your first kit.

TOOLS

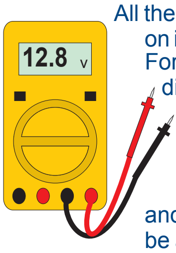
A few basic tools are necessary before you start your first electronic project. These include:

- Soldering iron & solder
- Assorted screwdrivers
- Long nose pliers
- Side cutters and wire strippers

Once you get started constructing projects you might also need the following:

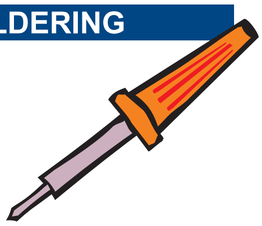
- Power drill
- Drill bits
- Centre punch
- Hacksaw
- Larger screwdrivers
- Tapered hand reamer
- Nibbling Tool
- Small Hammer
- Vice
- Steel ruler

TEST EQUIPMENT



All these tools are extremely useful, especially for working on instrument cases or metal chassis mounts.
For checking and testing, a multimeter is essential. A digital multimeter is recommended, for its ease of use and accuracy. Digital multimeters can be purchased from as little as $15 up to several hundred dollars. General kit construction will require functions to measure Resistance, Voltage and Current. A multimeter with a continuity buzzer will be a benefit while fault finding. See further in this guide for details on how to use a multimeter.

SOLDERING IRON & SOLDERING



Soldering could well be the deciding factor as to whether your kit works or not. The biggest problem with kits not working is the quality of the soldering. Take time practising before you start on a project.
Your soldering iron should be between 10 and 30 watts. It can be either an iron which runs on 240V mains or a low voltage iron which runs from a special stepdown transformer.
The tip should always be kept clean. Use a damp sponge to clean it whilst working. Solder should be 60/40 multicore, 60% tin and 40% lead with inbuilt resin flux. Solder is designed to set quickly, so no movement should occur during the setting period. All irons are fitted with removable tips, which eventually need to be replaced. The tip

SOLDERING HINTS

A properly made soldering joint is important to prevent kit failure. In a reliable solder joint the solder will adhere strongly. It cannot be prised loose, nor can it be drained off by heating. The structure of the bond is quite complex, but it is important to know what constitutes a good reliable joint.

There are two basic requirements:

1. The metal surfaces must be clean and shiny

2. The temperature of the metal surfaces must be raised to that of molten solder.

When these requirements are satisfied, the molten solder will 'wet' the metal surfaces and flow freely over them. The ability to recognise the 'wetting' action' is part of the skill to be learnt. Also, from the 'wetting' concept comes the opposite term 'dry joint'.

A 'dry joint' is a poorly soldered one. Rather than being smooth and shiny, it will be dull and frosted.

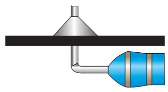
SOLDERING HINTS con't

Some causes of a 'dry joint' are:

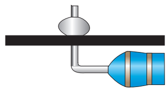
1. The component leg could have moved during soldering
2. The solder failed to flow correctly
3. Either the PC board track or component lead are oxidised or dirty
4. Either the PC board or component lead were not heated sufficiently.

A bad habit, when using resin cored solder is to carry molten solder to the job on the tip of the soldering iron. When using cored solder, most, or all of the flux can be vaporised in the time needed to convey the solder to the job.

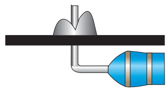
In the event that a PC board does not 'take' immediately, do not continue to apply heat to force the situation. The result will almost certainly be a damaged board. Stop and determine what has gone wrong. If it is a dirty lead, clean it, then tin it and try again.
It is very important not to rush the job. Take your time, read the instruction manual thoroughly and take care putting each component in the correct way. Check each step when completed.
Regularly refer to the kits instruction manual, checking each step as it is completed. Use a coloured high lighter or marker to check off each component on the circuit overlay diagram as it is soldered into the PC board. This way you will know which components you have installed.



Good Solder Joint - The solder has properly joined to the circuit board track and the component leg.



Poor Solder Joint - The solder has not joined to the circuit board track properly because the track was not hot enough. Solution - Apply more heat to the track.



Poor Solder Joint - The solder has not joined to the component leg properly because the component leg was not hot enough. Solution - Apply more heat to the component leg.

CONTENTS

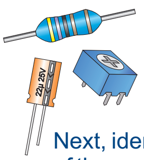
KIT CONSTRUCTION

WHERE TO BEGIN

1. The first decision you need to make before commencing construction on a kit is to make sure you have the ability to complete it. Most Jaycar kits have a difficulty rating, these are:

We encourage all newcomers to kit construction to start with a 'simple' kit. This gives you practice at component identification, soldering and sometimes faultfinding. If you are constructing a 'Complex' kit for the first time then you should have somebody else check your work before you power the project up. We do stress that beginners should not build any kits that require 240V mains wiring (see page 6).

An important thing to do first is to thoroughly read the instructions of the kit you are about to construct. This will give you a good idea on what construction is necessary, what tools are needed and what special requirements are involved.
The second thing you need to do is prepare a clean work area. Have a clean bench with all your tools at hand. Good lighting will be required and anti-static procedures considered (see Antistatic procedures on page 4).



Next, prepare all of the components that need to be soldered into the PCB. These should be put into small containers and kept divided as supplied in the pre-sealed kit component bag.

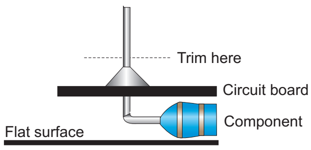
Next, identify all of the components. The best way is to tick off all of the components on the kit parts list found in the kit instructions. Identify the resistors and capacitors using the chart on the back page of this guide. If you can't identify any of the components after checking in this kit construction guide and the kit instruction's then you can get assistance from any Jaycar store or the Jaycar production department. email:kits@jaycar.com.au

STEP BY STEP

Taking into account any construction advice in the kit instructions the basic way to construct the kit is as follows:

1. Wire links, if any, should be soldered into the PCB (Printed Circuit Board) first. Make sure these links lie flat on the PCB and are perfectly straight. If they are not inserted tightly they may bend and possibly short on other wire links or components. Low profile components should be soldered in next.

2. Low profile components. These include resistors, diodes and IC sockets. Starting with the lower profile components, supported by a flat surface, ensures that they solder in flush on the circuit board. Double check that you have inserted the correct component and the right value. Polarised components will only work if installed the right way.



Trim each leg off the soldered component just above the solder joint (*see trim line*).

3. PC Pins (see page 7). These can be soldered into place. Solder them into place before any higher profile components, otherwise it may be difficult to solder them into place without them constantly falling out.

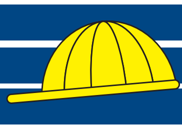
4. Solder in all remaining components.

5. Perform any other construction in the kit instructions.

6. Read any details in your kit instructions regarding powering of your project.

7. Double check you work before power up. Have an electrician check any mains wiring if applicable. Cross your fingers and power up. If there are any problems see 'fault finding' on page 9.

SAFETY FIRST!



FIRST AID

Care must be taken when using a soldering iron and solder, both of which could reach temperatures up to 400°C. If you are unlucky to sustain a burn which requires treatment, here's what to do:

1. Immediately run cold water over the burnt area for at least ten minutes.
2. Remove any jewellery from the area before swelling starts.
3. Apply a sterile dressing to protect against infection.
4. Do not apply lotions, ointments etc.
5. Seek professional medical advice if necessary.

240VAC MAINS WIRING

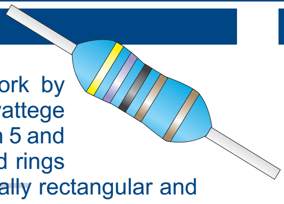
Any kits that are connected to the electric supply authority, "the mains", are dangerous in that personal contact with the mains power can cause death. Always keep this in mind.

Being careful is much smarter than being dead.

Each single phase supply has three wires for connection as they appear at the wall socket.
1. Active 2. Neutral 3. Earth.
1. The active cable is the live cable and has a potential of 240 volts between it and the Neutral wire.
2. The Neutral wire is theoretically at zero potential as it is linked to the earth terminal at a switchboard within the system. (The "MEN", mains-earth-neutral link).
3. The Earth wire is literally connected to a conductor driven into the ground, often connected to the metal water pipes in a residence which are buried in the ground for a large part of their length.
Mains cables that are used by the hobbyist will have a colour coding that indicates which wire is which. The present standard is for earth to be Yellow with a Green stripe, Active is Brown and Neutral is Blue.
PLEASE NOTE that the mains supply is dangerous.
When fitting mains cables to a piece of equipment it is essential that where the cable passes through any metal cover or wall an approved method is used to secure the cable and prevent any possibility of the insulation of the cable being cut into. The ends of the cables should be terminated into an approved junction block and then routed to fuse holders, switches or other components. A fuse may be fitted to the active circuit to limit the effect of a short circuit on the cable or to fail if the device draws excessive current through the cable.
Using approved components ensures that the possibility of touching a live part is reduced and any terminal or lug that carries mains potential should be covered with shrink material or some cover as the equipment is built.
The electrical industry is one of the few that encourages you to keep your hands in your pockets while you work, and this is a good habit to get into. While the hobbyist may not work in the same area of danger as a power house person, you can be made just as dead with 240 volt in a toaster as anywhere else .Be sure to unplug a piece of mains equipment while any adjustment is being carried out, don't just turn it off at the switch. If working on equipment with large power supply capacitors, temporarily attach an appropriate size bleeder resistor across the capacitors to discharge them in a short time. This can save a nasty shock, multimeter damage or ends bitten off soldering irons by the charge, which sometimes can lurk within a filter capacitor for many minutes.
When a new piece of equipment is to be tested or run for the first time, check the earth pin of the plug is really connected to the earth of the equipment and the path is a very low resistance. If there is no connection find out why, and fix it before applying power. Make sure the active pin is not connected to the metal of the equipment! Yes it can and has happened, and is nasty in that the metal is alive at 240 volt waiting for a grounded hand to touch.
Obtain the power for your workbench through an approved residual current device adjacent to the work area. Then if there is some kind of slip up this RCD will most likely trip, but not cause the main breaker to trip and plunge the whole building into darkness and dump off line the computers in the next room.

PASSIVE COMPONENTS

RESISTORS



Resistors are one of the most common components that you will use. Resistors work by resisting the current flow in the circuit. Low wattege resistors are generally round devices between 5 and 40mm long. They are recognised by coloured rings around them. Large wattage types are generally rectangular and have their value written on them.

Resistance is measured in ohms, which is abbreviated to Ω or R. Thousands of ohms is abbreviated to k and millions of ohms to M.

Eg. 10,000Ω is 10k, 15,000,000Ω is 15M

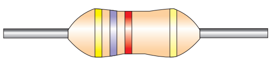
The coloured rings around the resistor determine its value. Generally you will use 4 band or 5 band resistors. A colour reference chart is on the back page to help identify the resistance.

TOLERANCE

%

Resistors are manufactured to different tolerances. For example a 100Ω 5% resistor may actually measure as low as 95Ω or as high as 105Ω. The tolerance of a colour coded resistor is indicated by the last colour band. A 5% tolerance resistor has a silver band, a 10% is a gold band and a 1% is a Brown band. You will notice that 1% resistors have five coloured bands instead of four. The colour coding is basically the same except that 5 band resistors have three bands indicating the significant values, the fourth band is the multiplier and the fifth is the tolerance.

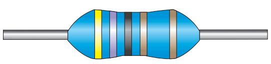
4 BAND RESISTORS



The first three bands determine the resistance, the fourth band indicates its tolerance. Tolerance is how much the resistance varies from its specified value. This is given as a percentage: e.g. 5% tolerance is indicated by a gold fourth band. This means that a 100Ω resistor could actually be between 95-105Ω. To determine the resistance, the first two rings are the significant value, the third ring is the number of zeros following (multiplier).

E.g. 82Ω 5% is grey-red-black-gold
1KΩ 5% is brown-black-red-gold

5 BAND RESISTORS



The first four bands determine the resistance, the fifth indicates the tolerance. Generally these are a 1% tolerance resistor, which means that a 100W resistor would actually be between 99-101Ω. Much more accurate than a 5% resistor.

To determine the resistance, the first three rings are the significant value, the fourth ring is the number of zeros following (multiplier).

E.g. 82Ω 1% is grey-red-black-gold-brown
1KΩ 1% is brown-black-black-brown-brown

OHM'S LAW

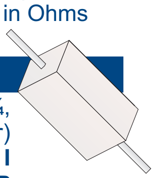
The most basic law in electronics. The relationship between resistance, voltage and current is determined by Ohm's Law (Ω). If you know two out of the three values you can work out the third.

V= IxR
I= V/R
R= V/I

The formulas are:

V is Voltage
I is Current in Amps and
R is resistance in Ohms

WATTAGE



Resistors will come in various wattages including 1/8th, ¼, ½, 1, 2, 5 and10 Watts. Wattage (also known as Power) equals Voltage (V) multiplied by Current (I). **P = V x I** Therefore, substituting V or R for Ohm's law, **P = I² R** and **P = V²/ R** respectively.

LIGHT DEPENDANT RESISTORS

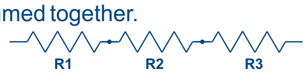
A LDR (light-dependent resistor) is a component that changes its resistance depending on the strength of light shining on it.

RESISTOR BASICS

See back cover for resistor colour code.

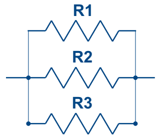
SERIES - all resistors are summed together.

R TOTAL = R1 + R2 + R3 + ...

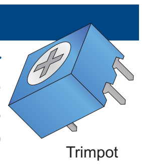


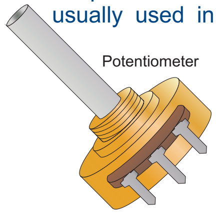
PARALLEL

$$\frac{1}{R\ TOTAL} = \frac{1}{R1} + \frac{1}{R2} + \frac{1}{R3} + \ldots$$



VARIABLE RESISTORS

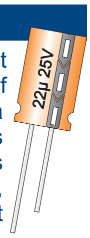




Variable resistors are also known as potentiometers or trimpots. Potentiometers, also referred to as Pots, are usually used in circuits where regular adjustment is required, volume or bass on a stereo for example.

Trimpots on the other hand are smaller and used where a once off setup or calibration is required, calibrating a multimeter for example.

CAPACITORS



A capacitor is a component that stores an electrical charge. It consists of two plates separated by an insulator. The amount of capacitance is measured in Farads but as this is too large a unit for everyday electronics we use smaller units such as microfarads (µ) 1/1,000,000 of a farad and smaller. Capacitors come in many types including electrolytic, polyester, polypropylene, ceramic, paper and mica (the latter two not commonly used now days).

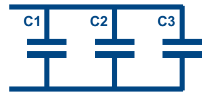
SERIES/PARALLEL

SERIES

$$\frac{1}{C\ total} = \frac{1}{C1 + C2 + C3 \ldots}$$

PARALLEL

C total = C1 + C2 + C3 ....



CAPACITOR CODE SYSTEM

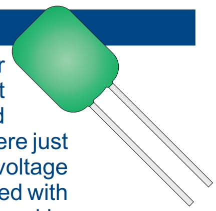
Microfarad (µF) -1 / 1,000,000 of a Farad - used for electrolytics.

Nanofarads (nf)-1 / 1,000,000,000 Farad - used for polyester,etc

Picofarads (pF) -1 / 1,000,000,000,000 Farad - used for ceramics

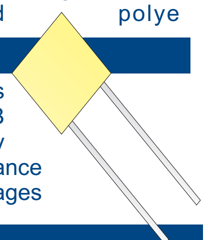
Capacitors are marked with their value depending on their type and size and manufacturer. A chart is on the back page which shows you the conversions between values and labelling conventions. eg. a greencap marked 100N (nF) could also be marked .1 (µF)

GREENCAPS



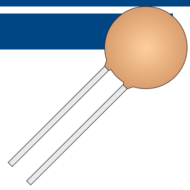
So called because of the common green colour (can now be found in other colours), these cost effective units have a fair tolerance, electrical and mechanical. Usually used in non critical places where just a "capacitor" is needed. Most popular in low voltage circuits with ratings around 100VDC. Usually marked with the capacitance in "n" (nanofarads) and the working voltage, eg: 100n/100v. Made of metallised polye

M.K.T. CAPACITORS



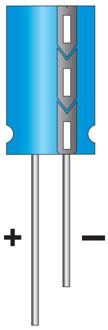
A more expensive capacitor with a case size that is made to precise standards to suit automatic PCB loading and quality assembly. Generally clearly marked with the value on the top showing capacitance and voltage. Comes in sizes from pF to µF and voltages

CERAMIC CAPACITORS



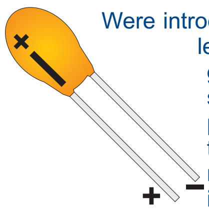
More suited to high frequency work and usually made as small as possible because of this. Comes in sizes pF to uF and used in voltages from 100's to 1000's.

ELECTROLYTIC CAPACITORS



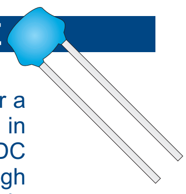
In the early days of electronic part manufacture most capacitors were made with a paper and oil dielectric placed between the active plates. The physical size of capacitors of microfarad value produced components that could be measured with a metre rule so the dielectric and insulation between the metallic plates was made very thin to save space. The dielectric was "formed" on the active plate area by an "electrolytic" process with chemical and voltage similar to plating or anodising procedures. Early electrolytics were very "leaky", they had a fair effective parallel resistance and also tended to dry up and lose capacitance value. 100 years later they are much smaller in physical size and available in far greater values, but still tend to leak and dry up losing capacitance.

TANTALUM CAPACITORS



Were introduced to obtain values in the uF range with low leakage , but in a small package. They are generally more stable than an electrolytic of the same value and the main application is for non power supply usage. They are polarised and easy to damage if reverse connected. They have a marking system somewhat similar to resistors, or if big enough, the value and voltage are marked on them.

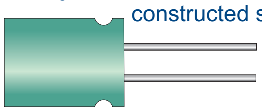
STROSEAL/POLYSTYRENE



A more expensive and generally more accurate capacitor where value and stability are important over a wide range of temperature and humidity. They come in values pF to nF and a good voltage range up to 630VDC and generally are found in timing circuits and high impedance circuits where low leakage is important in

NON-POLARISED ELECTROLYTICS

Were developed to enable large values in the uF range to be obtained in reasonable size packages and where a low voltage rating and leakage is not so critical. Although they are electrolytic they are constructed so the applied polarity is not important and can handle AC as well as DC current. Found mostly in low impedance circuits like speaker cross over networks.



VOLTAGE RATINGS

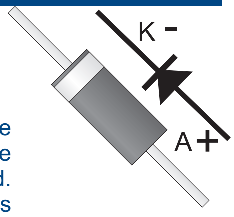
It is really important that voltage ratings are not exceeded and polarity markings are adhered to. Failure to do this may actually cause a capacitor to explode and distribute loads of tin foil and gunk inside your new piece of equipment. In some cases it is also detrimental to a polarised capacitor to run it under voltage. Electrolytic and tantalum benefit by being run at a good proportion of the rating. Without this "bias" some units may cease to exhibit capacitance and cause the circuit to malfunction.

TOLERANCE

You may see capacitors marked with a ± so many percent (%). Some capacitor manufacturing processes do not lend them selves to gaining a constant value of capacitance, some finish over value, some under. In a lot of applications this is no problem so a wide tolerance capacitor may be in order. Another circuit may involve matching with a calibration mark on a dial or a timed process and a close value of capacitance may be required to get repeat ability in a batch of PC assemblies of the same circuit.

SEMICONDUCTORS

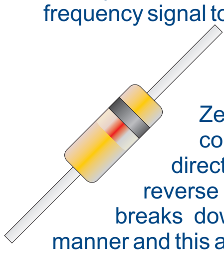
SIGNAL, ZENER & RECTIFIER DIODES

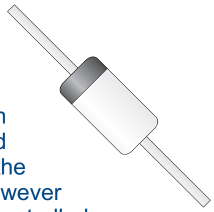


The name "diode" as the word suggests has two poles or terminals. The diode is the family name for a range of devices that basically are directional when presented with a current flow. They may allow current to flow easily in one direction but impede current flow, where the current reverses or the diode is turned around. The word diode is usually used for small devices that are used in low power and signal circuits. In power supplies and circuits that carry large current the term "rectifier" is commonly used. Hence "power rectifier" and "rectifier bridge".

There are quite a few types of diodes that have specific functions but the main types the hobbyist will see are "signal diodes" "Rectifier diodes" and "Zener diodes". Most of these nowadays are based on silicon and have a forward voltage drop of about 0.5 volt. This is the reason why the diode heats up from the product of current times voltage drop.

Signal diodes that work at high frequencies as part of a radio receiver, may still be made from germanium in some cases. They usually form the rectifier in the circuit which converts the radio frequency signal to audio frequency.

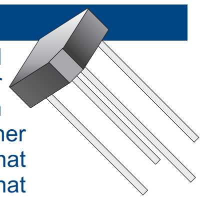




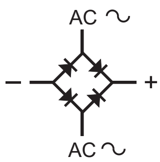
Zener diodes are types which conduct current in the forward direction and block current in the reverse direction. This blocking however breaks down at a certain voltage in a controlled manner and this allows the diode to be used as a voltage reference. You may see a Zener diode in a circuit to provide a reference voltage or the Zener diode may be used to clamp an unregulated supply to allow a steady rail voltage for other devices to work from.

Rectifier diodes are made to handle alternating current AC, and to convert this into direct current, that is direct current DC. They are designed to cope with the stress of charging filter capacitors on power up and to dissipate wattage as current flows through them. They are generally distinguished by physical size and hang around power transformers and invertor coils.

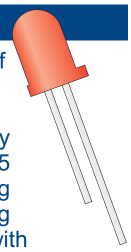
BRIDGE RECTIFIERS



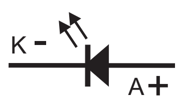
For convenience, rectifiers are available configured as a "bridge". This is the name for 4 diodes or rectifiers connected so they accept AC current on two terminals and output plus and minus DC on anther two. Bridges come in small sizes that handle milli-amps to large sizes that handle hundreds of amps. Bridges can be found in plastic or metal packages. Larger types can be fixed to a chassis or heatsink or may have their own heatsink or cooling system. The common bridge rectifiers in hobby equipment are seen in power



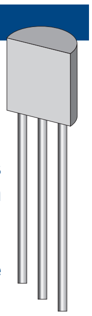
LEDS



These are diodes that emit light and took the place of filament lamps as indicator devices. LEDs once came in basic red colour but now come in various colours and sizes. And can be continuous lit or flashing. They generally operate from 1 to 100 ma (milli-amp) current and from 0.5 to 3v volts. Unless fitted with an internal current limiting resistor they need this fitted externally to set the running current from the circuit voltage supply. Also available with infra red output for transmit and use with a matched infra red receiver unit. These are used as code transmitters over a short distance as in a TV remote control. For depiction of letters and numbers displays are available in seven segment assemblies up to 50mm in size.

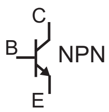


TRANSISTORS

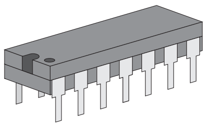


Transistors were developed to succeed the Vacuum valve as the device to perform electronic amplification and control, without the usage of a red heated internal surface to promote electron flow. All other things being equal the first transistors should have been called "triodes" as they had three terminals and performed the same functions as the triode Vacuum valve. Industry had to coin another name and so settled on an abbreviation of "Transfer Resistor". This came about as in some ways early transistors were likened to a resistance which had the capability of varying its value by using a third control terminal.
The transistor has the ability to conduct a current between its two main terminals, and the level of this current can be controlled by a much smaller current being injected via the third terminal. In a gesture to Vacuum valve terms the terminal that the load current flows from was termed the "emitter", the terminal that current flows in is termed the "collector" and the control terminal was called the "base" (which gives no clue at all to what it does).

The name transistor stuck as the basic label for all germanium and silicon devices that exhibit a transfer characteristic and had three terminals.
Transistors are made in two polarities called PNP and NPN, this allows them to be used in circuits which are "mirror image" around a zero volt rail, or used in reverse along side each other. Typically you will see this arrangement in audio amplifier circuits where the power supply is arranged to have positive, zero and negative rails and the various amplifiers, drivers, and power devices spread to either side according to the voltage and transistor polarity.

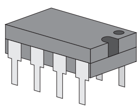


INTERGRATED CIRCUITS (IC'S)



IC's were developed as blocks that would contain whole circuits with repeatable characteristics. This would save a lot of space and enable very complex devices to be assemble out of these blocks. The growing miniaturisation of computers and military hardware forced the development of these blocks and in the same way as valve types became common between manufactures, families of IC's with known characteristics and common type numbers evolved. The most famous in general use is the 555 timer IC and operational amplifier 741. As different manufacturing techniques became available different types of "chips" came on the market, that is "TTL", "CMOS" and so on. Each of these families have logic blocks, analog amplifiers, functional blocks, specific purpose blocks, in a seemingly infinite number. The physical sizes of blocks standardised between manufacturers and for decades the "DIL" package in 8, 14 and 16 pin forms was most prevalent. More sophisticated chips appeared in 20 and 40 pin "DIL" cases and in the last decade increasing miniaturisation and manufacturing processes forced the advent of the "mini" DIL surface mount cases and really special packages with many pins, as you will see on computer boards.

OPERATIONAL AMPLIFIERS



The broadest of categories of electronic circuits can be divided into two groups, linear (audio) and digital (computer).
The first group of IC's perform linear functions. "OP" amp is short for "operational" and usually meant an amplifier that has a linear change of output with linear change of input. The gain and frequency response of this amplifier may be set internally or sufficient points may be made accessible to enable the designer to adjust these externally. The most famous of these amps and still used today is the "741" amplifier. The 741comes in a classic 8 pin case with access to two inputs + and - , the output, and power rail terminals. The gain and bandwidth could be manipulated externally and this basic block was used in many analog circuits for measuring and control and in audio applications in domestic and industrial amplifiers. Each drawback of this basic block, when used in applications, spawned better models with higher gain, wider bandwidth, better external controllability and better stability, precision and reliability.

TTL

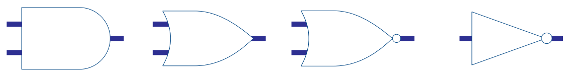
The first of the popular types in general electronics, and most generally suited to tightly controlled 5v power rails. Do not like over-voltage at all.
Generally came in digital logic blocks and the most used type numbers settled on the "7400" series, example 7401.
Not used in manufacturing or new equipment and available only for replacement purposes, if at all.

CMOS

These allowed the use of different voltage rails and were much more tolerant in the manner of drive and loading. Earlier families were susceptible to failure from voltage spikes caused by static discharges from handling. In general they still must be handled and inserted onto boards with care to avoid damage. Read 'Anti-static procedure' below.
The most recognised family in general use is the "4000" series , example 4001.

LOGIC GATES

The second broad group of IC's are logic gates. Simply put, the output of a logic gate changes state when a set of input conditions are met. This is the whole fundamental point of a logic block. You will see terms such as "AND" and "OR" being used. These are literal meanings, a two input AND gate will have its output change when number one input, AND, number two input are satisfied. A two input "OR" gate will have its output change state when either number one input , OR, number two input is satisfied. Thus you will have a logic gate waiting, and not allowing a part of circuit to operate until all its input functions are satisfied.



ANTI-STATIC PROCEDURES

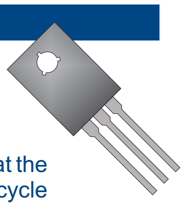
In the process of building a piece of equipment, static charges build up on the body of an operator and these charges will discharge somewhere in the course of moving around. Most of the time you don't notice this phenomena. It is only when you receive a "belt" that a static charge is noticed. Sliding out of a car seat and getting bitten on the hand by the door frame is the most common experience. The clothes worn and the surrounding furniture are the main controlling factors in developing a charge. Remember the high school experiment where you pull a plastic ruler through a silk cloth and then the ruler can suck up loose pieces of paper by its static charge? Now think of sitting in a plastic chair wearing a silk shirt, turn this way and that, build up a nice charge, and then pick up your nice new expensive memory chip by its bare legs. The static discharge then zaps down the legs and blows out every circuit in the chip like a bolt of lighting!
Two main ways of defeating this static problem can be used, one is to use materials in the environment that are least likely to develop static charges, the other to provide equipment that tends to discharge any static on a continuing basis.
In an industrial soldering station the operator will wear non static clothing, the floor and bench surface will be made of conductive covering and the operators soldering wrist, soldering iron, and work will be connected together by a conductive cable and tethers. The hobbyist does not have to go to such extremes, but a few simple procedures can reduce the risk of damage particularly to CMOS devices.
Work in a non static producing area, wear non static producing clothes. Before picking up devices and inserting or soldering, ground any built up charge by placing your hands from time to time on some mass which is grounded. Remove chips from their antistatic wrap or tubes and plug them straight into sockets, or, if soldering, identify the rail pins and solder these first after inserting.

MISCELLANEOUS SEMICONDUCTORS

FETS

Further developments created another broad class of three terminal devices called "field effect" transistors. These control the current between the two main terminals not by direct injection of current into the control terminal but by the potential of the control element "squeezing" the path of the current flow to reduce, or "relaxing" the path of the current flow to increase it.
Among the advantages with this system is that the input impedance of the device is much higher that a current controlled transistor and the FET device can exhibit a natural thermal limiting effect. With rising temperature, the squeezing effect increases and tends to limit current flow tending to limit an overdrive situation from becoming a burn out.
You will see FETs used in the front end of amplifiers where the high input impedance is handy in not loading surrounding circuits and in the output stages of audio amplifiers where the natural thermal limiting effect helps to make them bullet proof to hard usage.

TRIACS/SCRs



While rectifiers are two terminal devices it was found that a rectifier could be controlled with a third terminal called a gate. This is called triggering the SCR or Triac. When not triggered, the SCR or Triac will not conduct in either direction. When triggered by a pulse at the gate the device will then conduct for the rest of the AC cycle applied and shut off when the AC cycle passes through zero volts. . In the case of the SCR it will then act as a rectifier and in the case of the Triac will conduct in both directions and act as a switch.
As a point of history and naming, in the valve era a two terminal device was called a diode and a three terminal device a triode. The diode name transferred to the solid sate equivalent but the system fell down with the three terminal devices and different terms were coined. Industry settled on SCR, "Silicon Controlled Rectifier" and Triac, "Three terminal AC ".
SCRs and Triacs are used mainly in AC circuits to control voltages and currents, a simple application is a lighting dimmer or pistol drill speed control.

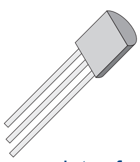
UJTS

This is an interesting three terminal transistor which was developed initially to provide a simple timing and triggering device for SCR gate circuits. It has mainly been replaced by integrated circuit devices but it still interesting to use when simplicity and demonstration is required. It is a silicon device which is not an amplifier but has the characteristic of being open circuit until its control terminal has its voltage raised to a certain percentage of the voltage applied across the outer terminals. Once the control voltage exceeds the set point the device conducts heavily exhibiting a "negative resistance" until it saturates. This characteristic made it ideal for producing the pulse required to perform SCR gate triggering. With a few surrounding components a UJT can be a phase control device for a SCR power controller , or a timer element within a circuit. Just to confuse everybody the control terminal was termed the "emitter" and the other terminals the "Base1" and "Base2". This alone was enough to confuse anybody as to how the device works.

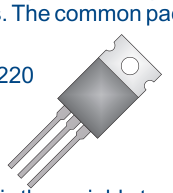
VOLTAGE REGULATORS

Voltage regulators are three pin devices that deliver a fixed voltage output from a higher voltage input. For example, to get 6 volts from a 12 volt supply you can use a 6 volt regulator. These devices only require a filtered DC voltage input. Various packages are available for different current capabilities. The common packages are:

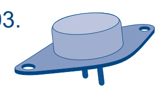
TO-92



TO-220



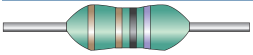
T-03.

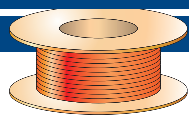


Another variety of regulator is the variable type which allows you to set the output voltage by a few external components.

MISCELLANEOUS

INDUCTORS





The inductor is one of the basic elements of electrical circuits. Its main function is to present a restriction to the flow of Alternating electrical current.
An inductor may take the form of a tuning coil in an RF circuit, a "filter choke" in a power supply or a curved piece of track on a PCB layout. The one common feature of all inductors is the at there is a "winding" or coil of conducting material present about a core, which may be air, or may be a material
The size of an inductor is expressed in terms of "Henrys" and given the symbol "L".
The "resistance" of an inductor to alternating current is expressed by the word "reactance" and this is given the symbol, XL. The relationship tying these terms together is best remembered in the formula XL = 2 x 3.14 x f x L (XL equals two pie fL!) The most important point to appreciate here, is the reactance varies with frequency and this is the basis of tuned circuits used in channel selectors or speaker cross over networks.
The overall impedance of an inductance at a fixed frequency is termed "Z" and is the sum of the DC resistance in OHMS, "R" , and the AC reactance, XL. The formula tying these terms together is simplest put as Z = (square root of)[Rsquared + XLsquared].
Then, and again in a simple form, AC circuits may be treated to a form of "OHM'S LAW" where a three terminal relationship may be expressed as, Z = E / I, E = I x Z, and I = E / Z similar to the DC ohm's law.

COPPER

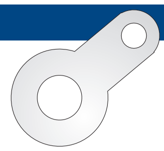
Cu

Copper is the common metal used in general purpose electrical wires. It is interesting to know that other metals are used for specific applications such as aluminium, gold and mixtures of alloy to give high temperature or special resistance characteristics.
For some wiring, plain uninsulated wire of a single strand may be used. This is usually plated to make it look pretty and reduce the effect of tarnish making electrical contact easier. Inductive windings such as tuning coils or power transformers may be wound with single core copper wire and as the turns are piled on top of each other the wire is covered with an insulation. There is an unending number of insulations to meet circumstances and most of these are some kind of varnish with differing characteristics of voltage rating, temperature of operation mechanical strength and so on..

PCB PINS

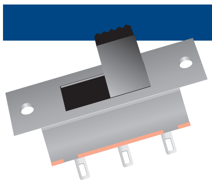
When assembling a printed circuit a convenient means of attaching wires from the component side of the board to the copper side is by the use of PCB pins. This allows connection of a wire or cable to the component side without having to turn the board over and is handy when batches of boards are being made and the copper side of the board is fully soldered and sealed off.

SOLDER LUGS



These are used to attach wires to a nut and bolt termination. The ring part of the solder lug acts as a flat washer when part of the threaded assembly and provides the best type of contact for electrical flow.
The wire is preferably soldered onto the tag part of the solder lug before assembly to minimise time to heat up the components and reduce risk of damage to the assembly.

SWITCHES

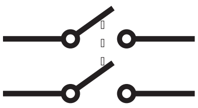


Switches are devices for interrupting or guiding the passage of electrical current. They may be mechanically operated like a wall light switch, electrically operated like a relay, a solid state device like a Triac or a radio operated remote control device.

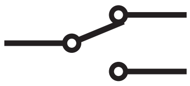
Simple switches are commonly use on the front panel of equipment to switch circuits, indicate functions, and may have one or more sections. The number of sections are called “poles” and each pole may have a “normally closed” or “normally open” contact. The operating handle of the switch may have one or more positions. A complex switch may have dozens of poles and many positions of operation. A good example of this is the rotary TV tuner station selector switch you see on older TV sets. These have many poles with open and closed contacts and as many positions of operation as TV channels.

Switch (SPST)

Push Button Switch(SPST)



Switch (DPDT)



Changeover Switch (SPDT)

SP - Single pole, DP - Double pole
ST - Single throw, DT - Double throw

Thank you for taking the time to read our first volume of the Improved 'Kit Constructor's Guide'.

We welcome any comments, corrections or feedback you may have with this volume.

Please send any correspondence to either:

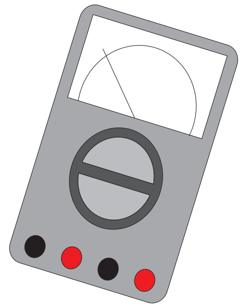
kits@jaycar.com.au

Production Department
PO Box 6424
Silverwater, NSW, 1811

Please note that this 'Kit Constructor's Guide' should be treated as a guide only. We encourage you to consult our Production department, a qualified technician or electrician if you are uncertain with any details or instructions.

MULTIMETERS

The multimeter is the most basic and general purpose tool available to a hobbyist. As all electrical circuits contain values of amps, volts ,and ohms, the multimeter is there to measure these values to find out what level they are at.



Always refer to the handbook supplied with the multimeter to gain the best out of any measurement, but the normal way of measuring most values is to anticipate what the quantity to be measured may be, set the range of the multimeter to the highest value available of the quantity and make a test measurement.

Where the application of the meter is in parallel with a circuit, as in measuring a voltage, the equipment may be powered and the measurement made.

Other measurements may be current, where the meter may have to be connected with the equipment whilst not powered, then powered up to take a measurement, or a measurement where a component may have to be partly removed from the circuit , such as a resistor or capacitor.

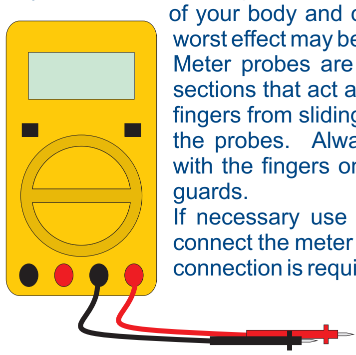
The most common faults in measurement that may cause an error or destruction, are:

1. Selecting the wrong range. The classic fault is to measure Voltage with the meter switched for Amps, or, Ohms. The consequences of doing this can range from bitten off ends of probes, blown fuses in equipment and meter, or worse, a written off meter and the equipment that is being tested. Keep firmly in mind that a meter set to the amps scale is a short circuit between the measuring probes in your hands!

2. Ignoring the effect of the loading of the meter while measuring a value. However slight it may be, the meter can present a parallel loading to a voltage circuit, or, a series resistance to a current circuit and this introduction of the meter to the circuit under test may change the values in the circuit. Be aware of what the characteristic of your meter is and how it may relate to the circuit under test.

3. Ignoring the effect of surrounding components on the assembly when measuring values. When measuring components that are part of an assembled board, remember that a resistor rectifier, or transistor junction may have other parts connected in parallel with it that will reduce or mask the apparent value. You may have to lift at least one leg of a device to avoid this problem.

4. Holding the metallic part of the probes. The least effect this may have is to shunt the part under test with the internal resistance of your body and cause a measuring error. The worst effect may be that you will kill yourself.



Meter probes are usually provided with raised sections that act as finger guards to prevent the fingers from sliding too close to the metal part of the probes. Always hold the probes correctly with the fingers on the “right” side of the finger guards.

If necessary use an alternative clip type lead to connect the meter to the circuit if a semi permanent connection is required.

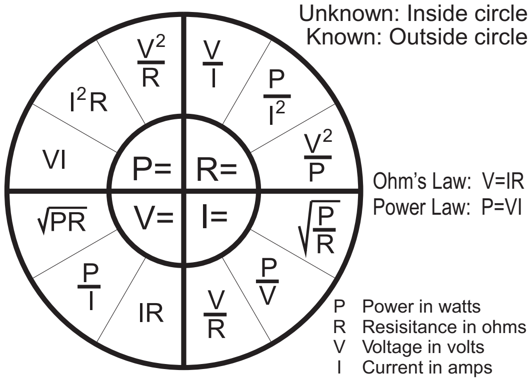
FAULT FINDING

This is the most frustrating but in the end the most satisfying and rewarding aspect of kit construction, after actually using the kit for what it is intended to do.
When something doesn't work, the way to find out why, is to have a clear understanding of why it should work in the first place.
Any device has a function. From some sort of understanding of what the operational requirement is, and armed with clues such as a circuit diagram and technical data on the components used, it is then possible to decipher how a circuit should react, observe what it is doing, and then to deduce why it will not do the correct thing.
In the very best instance, one may have a fully comprehensive handbook with all the information gathered together and indexed in a way to gain easy access. In the real world one may be extremely lucky to have a badly faxed mud map of what last years model circuit diagram was and you nut it out from there, assisted by your technical training.
When constructing a kit from Jaycar, you are well on the way to having at least part of all this, as the constructional articles have a circuit diagram and pictures of a working model and a lot of information on how the device works and what it is supposed to do.
Assuming you have built a kit and at least have visually checked the assembly and have determined that the assembly is complete and all wires, parts and cables are attached.
1. Do not turn the kit on again, until, you have checked each component position and verified that the part there is the right part, the right value, and is inserted the right way around!
Time and time again Jaycar have had distressed hobbyists unable to get a kit to work, hit a blank wall mentally, and finally when a fresh third person has checked the kit out has found IC's, transistors, diodes connected or inserted the wrong way around, parts inserted that are not the right value, and wiring looms connected back to front to panel switches or terminal strips. Get a friend to check your work.
Taking this step will fix 98% of faulty kits! Being able to perceive that a part is incorrectly inserted is one of the most valuable tools that a hobbyist can acquire.
To narrow the area where the trouble lies so you can recognise the “faulty” part is an important part of the process.
The first step is to power up the kit and assuming clouds of smoke do not pour out of it, note whether the kit operates partly and what does work, and not work.
One can measure whether voltage rails are present and make a check of the current draw from the power supply and whether any part is getting hot.
With this first information and comparing this with the constructional article you may be able to ascertain that a particular section is not receiving rail voltage or a chip function is not working.
Then with the focus on that suspect section you closely investigate the circuit values about that section or individual transistor or chip and look for a value of voltage, or signal that is wrong or absent.
With circuits that have a clearly defined path of logic, isolating a faulty section may not be too hard. When you really start working for your money is when a bunch of sections are interrelated, depending on each other for rail or bias voltages or are looped together to provide a function as a whole. With these, when one part does not work then the whole does not work, and restoring correct working may get down to detecting a wrong value or faulty part rather and replacing it rather than deducing by logic what may be wrong.
Most kits can be fixed by observation, deduction and some test instruments. The most basic piece of test equipment is a multimeter (see 'how to use a multimeter' on page page 8).
Your testing process may begin with voltage and power consumption measurement and may continue to temporarily provide a missing rail voltage to bypass some open circuit feed.
What processes you use are sometimes limited by the type of kit being tested, it may be hard to reproduce the actual operating conditions of the kit on the bench. You may have to make a replacement or adjustment then refit the kit to its operating area and see if correct functioning has been achieved.

POWER WHEEL

Ohms Law and the Power Law all in one place.

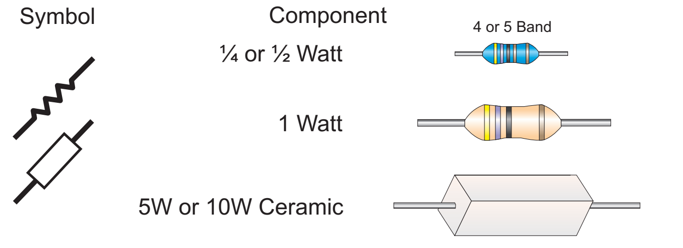
Determine the unknown variable in the inner circle by using the parameters shown in the outer circle.



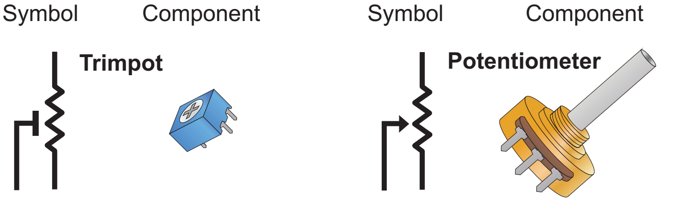
COMPONENT IDENTIFICATION

This section will help you to match some of the symbols used in schematics (electronic circuit diagrams) to the physical component used in the actual product. You will see the symbol on the left and the component on the right.

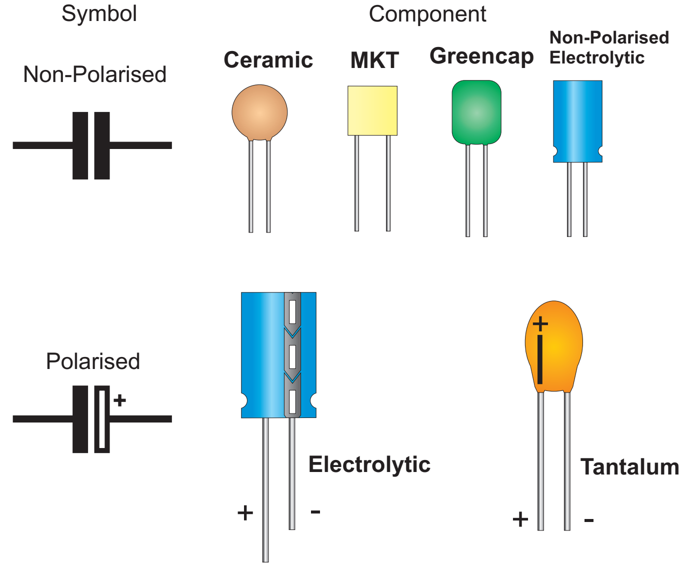
RESISTORS



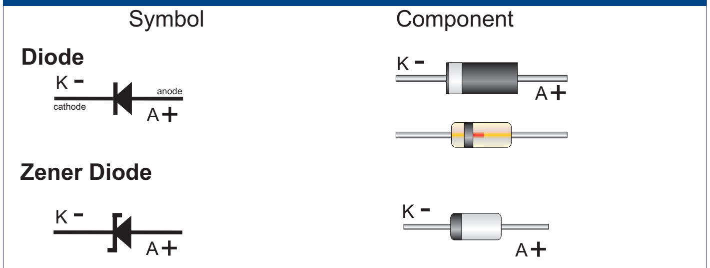
VARIABLE RESISTORS



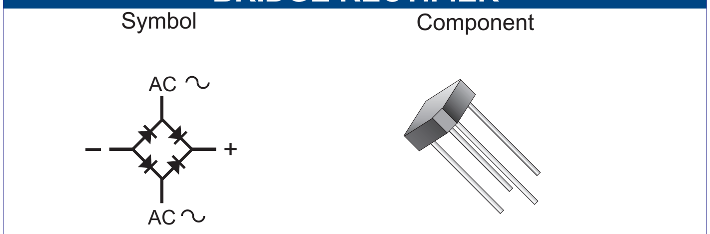
CAPACITORS



DIODE / ZENER DIODE

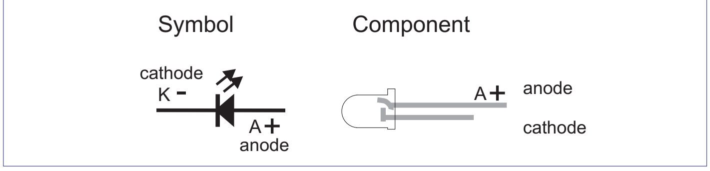


BRIDGE RECTIFIER

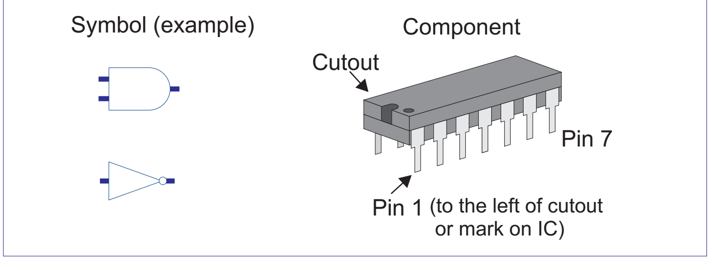


COMPONENT IDENTIFICATION

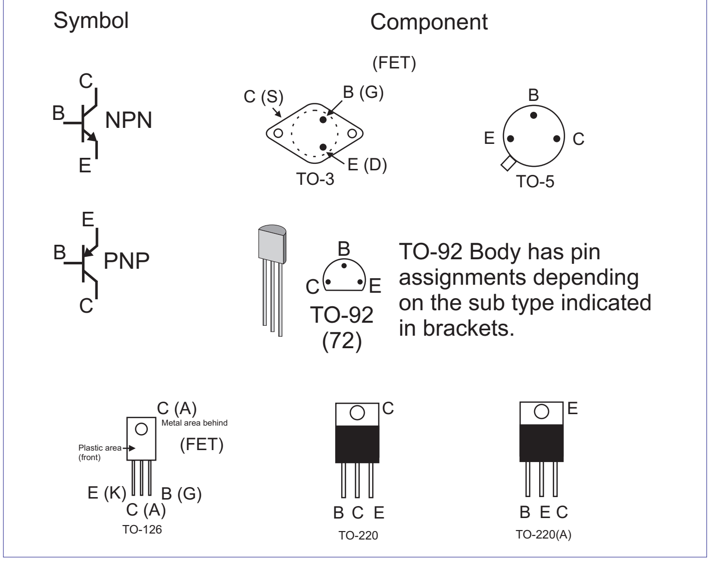
LED's



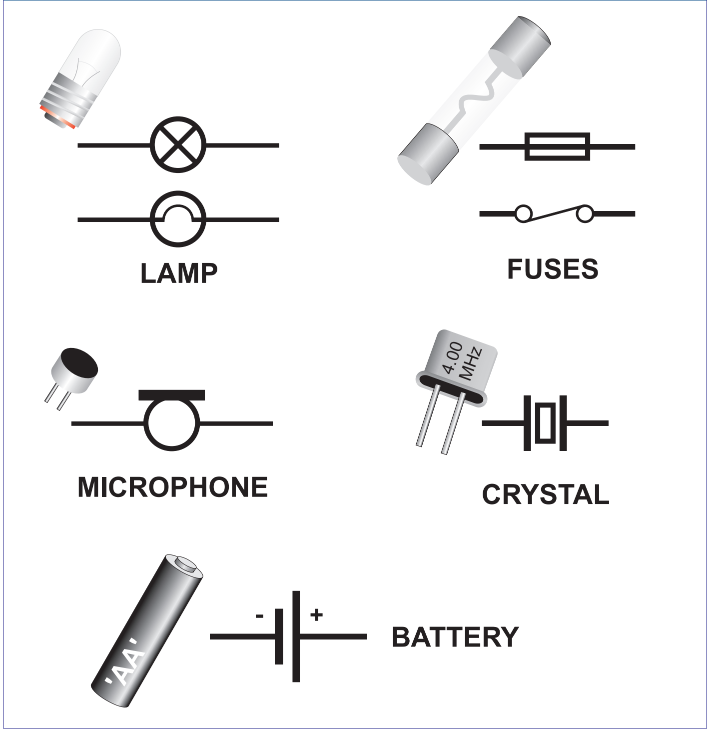
INTEGRATED CIRCUIT (IC)



TRANSISTORS



COMPONENT IDENTIFICATION

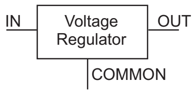


COMPONENT IDENTIFICATION

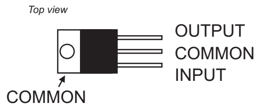
VOLTAGE REGULATORS

VOLTAGE REGULATORS

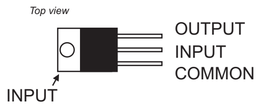
Symbol



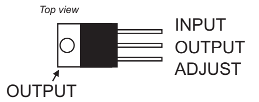
Component



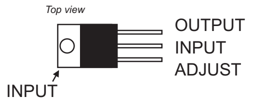
POSITIVE REGULATOR
TO-220 PACKAGE
78XX, LM340, LM2940



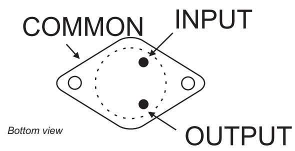
NEGATIVE REGULATOR
TO-220 PACKAGE
79XX, LM320



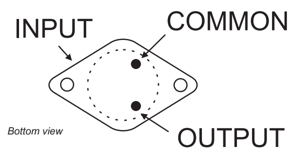
POSITIVE ADJUSTABLE REGULATOR
TO-220 PACKAGE
LM317, LM350



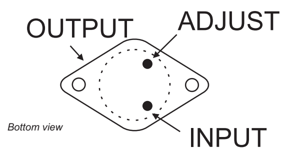
NEGATIVE ADJUSTABLE REGULATOR
TO-220 PACKAGE
LM337



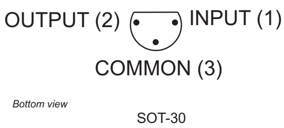
POSITIVE REGULATOR
TO-3 PACKAGE
78XX, LM340



NEGATIVE REGULATOR
TO-3 PACKAGE
79XX, LM320

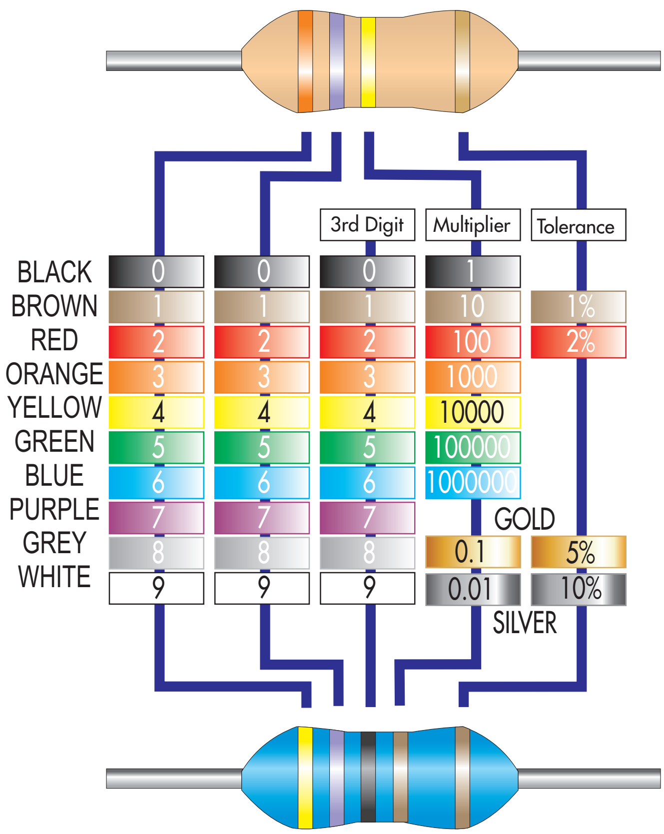


ADJUSTABLE REGULATOR
TO-3 PACKAGE
LM317, LM350

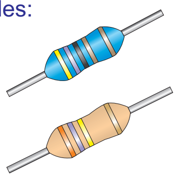


POSITIVE REGULATOR
TO-92 PACKAGE
78LXX

RESISTOR COLOUR CODES



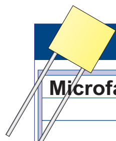
Examples:



(5 BAND)
yellow-purple-black-brown-brown
= 4 - 7 - 0 - 1 - 1% = 4k7 1%

(4 BAND)
orange-purple-yellow-gold
= 3 - 7 - 4 - 10% = 370k 10%

CAPACITOR CODES



Microfarads (u)	Nanofarads (n)	Picofarads (p)	EIA code
-	-	100pF	101
-	0.22nF	220pF	221
0.001uF	1nF	1000pF	102
0.0047uF	4.7nF	4700pF	472
0.01uF	10nF	-	103
0.047uF	47nF	-	473
0.1uF	100nF	-	104
0.47uF	470nF	-	474
1uF	1000nF	-	105

ZENER DIODES (1 WATT UNLESS SPECIFIED)

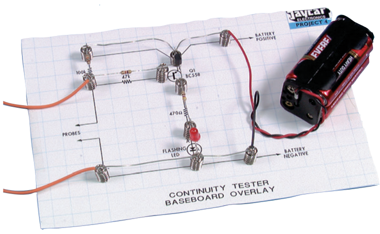
Part no.	Voltage	Part no.	Voltage
1N4728	3V3	1N4744	15V
1N4729	3V6	1N4745	16V
1N4730	3V9	1N4746	18V
1N4731	4V3	1N4747	20V
1N4732	4V7	1N4748	22V
1N4733	5V1	1N4749	24V
1N4734	5V6	1N4750	27V
1N4735	6V2	1N4751	30V
1N4736	6V8	1N4752	33V

“Short Circuits” What it's all about…
Since it's inception, the Short Circuits learning system has become the preferred platform from which students can confidently tackle the various levels of modern electronics. The system consists of the Short Circuits books and their own series of construction projects. Although written with beginners in mind, the books are incredibly thorough without being intimidating and, most importantly, they're written with an emphasis on FUN! All books in the series are geared towards specific levels of electronics knowledge.

SHORT CIRCUITS

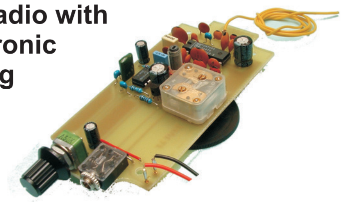
LEARNING SYSTEM FOR ELECTRONICS

Short Circuits Volume 1
Our first book in the series uses a leaning system designed around a baseboard, which you use to mount your projects. All components are connected together by our exclusive spring terminals. They are extremely easy to use, and don't even require a screwdriver. At the back of the book is a paper template for each project, which you attach to the baseboard. The springs are then inserted into the baseboard according to the locations shown on the template. The template then shows you EXACTLY where each component goes, making project success almost a certainty. The projects are fun to build and, more importantly, are very relevant to today's electronics. Each of the 20+ projects is powered from batteries and requires absolutely no soldering, making this learning system safe for ages 8+. We guarantee that you will be delighted with this fun and unique learning system.

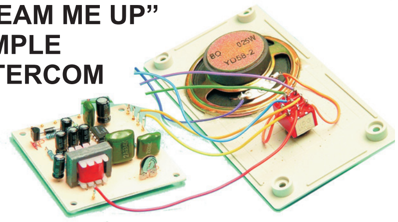


Short Circuits Volume 2
Once you have the basic skills and knowledge either from a School Design and Technology course, or tackling Short Circuits Vol 1, you can now have some real fun! With this book (and associated project packs available separately) you can make such things as; a mini strobe light, police siren, mini organ, a couple of powerful radio transmitters, an FM radio - even a 'Knight Rider' scanner!! All components are fully described and explained, along with tutorials on soldering iron and multimeter use. All projects are safe and battery powered.

FM Radio with Electronic Tuning

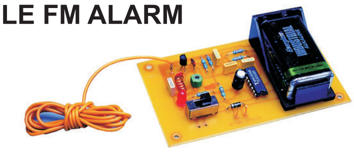


“BEAM ME UP” SIMPLE INTERCOM



Short Circuits Volume 3
This is the definitive electronics training manual and is far more than the weekend "fun-type", superficial approach to electronics. This volume presents more than 30 individual printed circuit board-based construction projects, which are purchased separately. Naturally, soldering techniques are discussed in detail, as is the proper use of a digital multimeter. We describe projects that take from just 20 minutes to make (such as project 2, "Ding Dong Doorbell"), to a fully fledged "Guitar Sustain" which may take several hours to complete, but will give you a music accessory that could last a lifetime. Each project contains a full technical description, with experimental changes to each circuit also explained. After you have built any - or all of the described projects, there is no reason why you would not be able to successfully tackle any of the construction projects published in the electronics magazines; this book will end up giving you the knowledge and skill that will elevate you into a fully fledged constructor!

SIMPLE FM ALARM



VOX - SOUND SWITCH