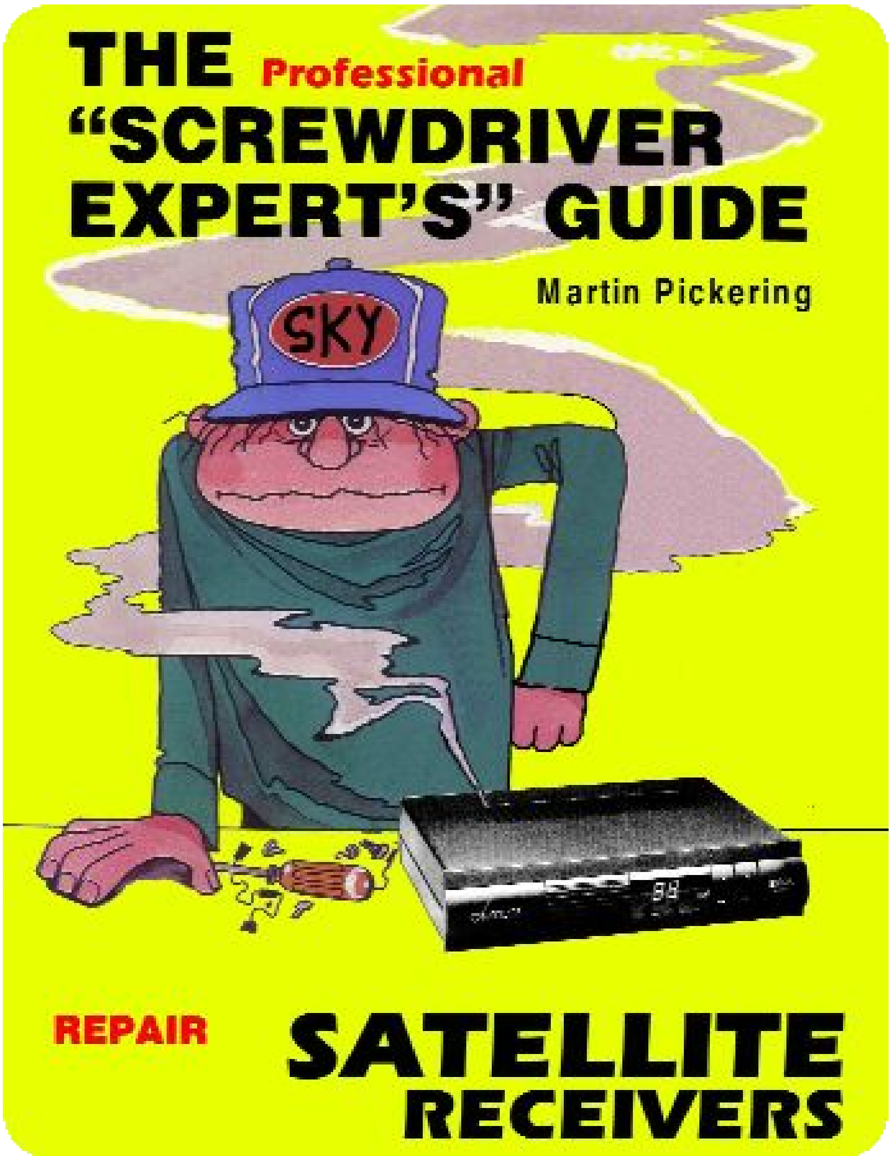


Repairs for Beginners

By M.T. Pickering B.Eng.

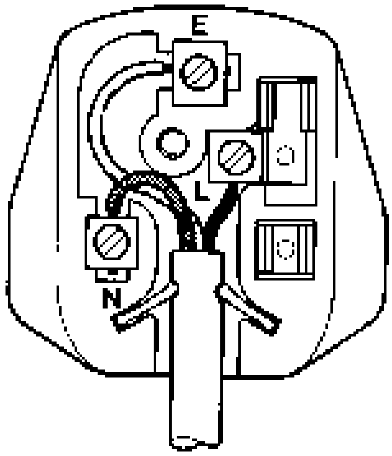
This edition last revised on November 7, 2001

Mains Plugs in the U.K.

No book about satellite receivers could be complete without a mention of mains plugs and I make no apology for including this section.

Mains plugs have been responsible for many, many receiver faults and have also contributed to death and injury.

Some years ago, a friend was drilling a hole in his kitchen wall when the metal casing of his old power drill became "live". The shock he received caused his muscles to contract and he fell from the metal step ladder, still clutching the whirring drill.



The continuing shock made him dance like a puppet, leaving a trail of gouges around the kitchen, until finally he managed to kick the switch on the plug socket. It transpired that the earth wire inside the plug had come loose and touched the live pin, thus passing the live mains through the "earth" wire to the drill body.

You may laugh at this little anecdote because my friend survived, but the story serves to illustrate the importance of correct and secure mains plug wiring. So, even if you *think* you know how to wire a plug, please read on.

Your choice of plug is very important from the point of view of safety and ease of fitting. There are several cheap plugs on the market which are at best fiddly to assemble and, at worst, downright dangerous. The plugs which have been approved as safely designed and manufactured now carry the designation BS1363 (or BS1363A for the type which will withstand knocks), so avoid those which do not.

Don't be ashamed to take a plug apart in the shop to inspect it. Ask to borrow a screwdriver, if necessary, and tell the shopkeeper where to put his plug if he is unhelpful. (However, if he is serving someone who is buying a £500 electrical gizmo, be patient and wait a couple of minutes). The features to look for in a plug are as follows:

1. Fuse clips which are rivetted or welded securely to the other metal parts. Beware flimsy rivets and screws which can work loose and cause serious overheating. Fuse clips which are silver plated will be more reliable than those which are not.

2. Cable sheath clamp which will hold the cable firmly. The best ones use a springy plastic flap which bites into the cable sheath and prevents it from pulling out. The worst are those with a thin fibre bridge held with two screws. Bridges moulded from plastic with tubular ends for the screws are good but fiddly; they are often reversible – to cater for thick or thin cable. Be sure to fit them correctly.

3 A captive cover screw. While this feature is not essential, it saves much scrabbling on the floor!

4 Correct value fuse. Sometimes the shop will swap the fuse for a more suitable value. (Sometimes they will offer to sell you a pack of ten).

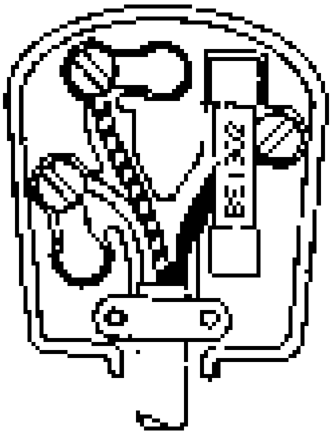
Fitting the Plug

Use a knife to remove about 40mm of sheath from the end of the cable. Do not saw with the blade but bend the cable over your finger so that when you touch it with the blade the stretched sheath splits. Continue the split around the circumference by turning and bending the sheath while touching it with the blade. Avoid nicking the individual coloured wires, or your own pinkies!

Once the end portion of sheath is removed, fit the cable into the plug, securing the remaining sheath with the clamp. Allow 10mm extra for connection and cut the brown and blue wires to reach the Live and Neutral terminals, respectively.

Any green-yellow wire should be cut with at least 25mm to spare.

Use pliers or wire strippers to remove 10mm of insulation from the end of each wire. (You may need to remove the cable from the plug while you do this).
The strands of each wire should be twisted tightly and doubled over to fit into those brass pins with a hole and clamp screw or else hooked clockwise around terminals which use a screw and clamping washer.



The green-yellow earth wire (if present) is deliberately left long so that, if someone should trip on the cable or tug at it in such a way as to pull the sheath out of the clamp, the safety earth will always be the *last* wire to be disconnected, thus ensuring that the appliance is earthed while there is a possibility of its becoming “live”.

Ensure that no loose strands of wire are left, fit the fuse and replace the cover.

Since many appliances are “double insulated” you will find that only two core cable is used, with no green-yellow. Wiring the plug is simpler but do still make sure that the brown wire goes to the live pin via the fuse and the blue wire goes to the neutral pin. Since the cable will be thinner than three-wire cable, be sure to check that the clamp is tight and holds the sheath firmly.

Britain (& parts of Ireland) is the only country in the world which uses mains plugs fitted with a fuse. Other countries rely on the fuses at the main fuse-box or, sometimes, on a fuse in the socket. The fuse in the mains plug, therefore, while not being absolutely essential, does give an added degree of protection from the risk of fire. If the appliance itself has a fuse then the fuse in the plug will prevent the mains lead from catching fire in the event of a short circuit in the lead. It is also a useful backup in case the appliance fuse does not melt quickly when a fault occurs.

Fuses for use in mains plugs are manufactured to a British Standard BS1362 which should *always* be printed on the fuse cartridge.

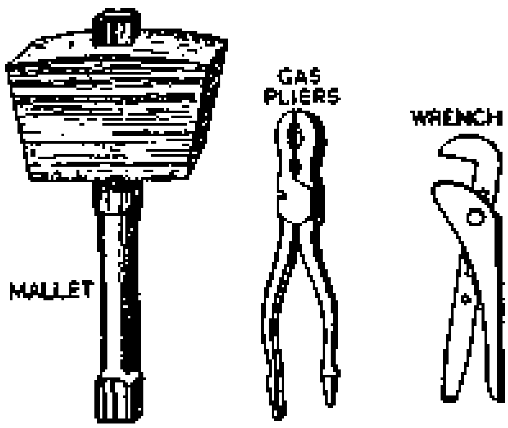
Some appliances are now fitted with moulded plugs. The fuse is accessible for replacement but the wires are not. You should not remove this plug unless it is essential to do so. If you do need to remove the plug, take it out of the mains socket and cut the cable as close to the plug as possible. Remove the fuseholder and fuse. Destroy the fuseholder clip and dispose of the plug so that no child might plug it into a mains socket and receive an electric shock.

Basic Tools

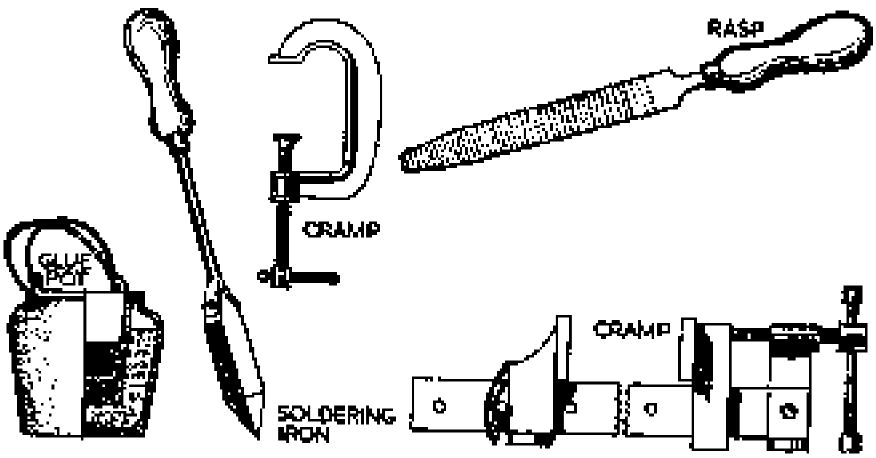
Here are some of the tools which are commonly used for satellite receiver repair.

The heavy mallet is ideal for bending the wires of components after insertion in the holes.

Gas pliers can be used to remove components without the need to de-solder.



Use a wrench to undo stubborn tuner nuts, when a spanner is unavailable, and a rasp to smooth the threads.



A heavy duty soldering iron is ideal for use with surface mount components.

(Get it nice and hot over a gas burner).

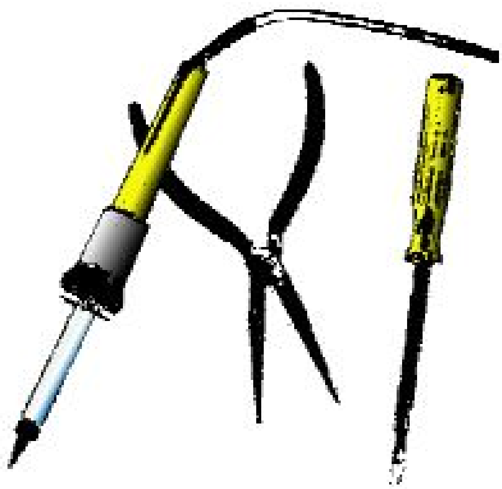
A variety of cramps will be needed to secure the board during hammering and soldering operations.

Finally, no tool kit would be complete without a glue pot. Absolutely indispensable for fixing those lifted pads and tracks after somebody else messed it up!

No, I'm not serious, but some people do actually appear to use these tools when attempting repairs!

The Proper Tools

Before you embark upon any repair or modification work you should have an understanding of the basic use of tools used in electronics.



You really can not do better than to take an electronics course at college, if only to get accustomed to using the tools and terminology used in electronics.

DANGER!

Once you remove the cover screws on a satellite receiver you expose yourself to a real danger of electric shock or burns. The intention of this section is to make you aware of some of the methods by which receivers can be repaired and modified and, while you might be encouraged to “have a go” yourself, please consider the risks involved – not only to yourself but to others if you are doing a “favour” for a friend.

Inside the receiver is a section which carries mains voltages. That is the good news. In a receiver which uses a “switch mode power supply” there are even higher voltages present. This power supply is extremely dangerous. Keep your fingers and tools away from it! You will find that it is almost always marked with a warning notice or symbol.

You are recommended to take the receiver to a time-served repair engineer if you are in any doubt at all. ⚠

First, you need a set of basic tools. You are definitely *not* going to be successful if you use hedge cutters for cutting wires and a poker for soldering!

Screwdrivers

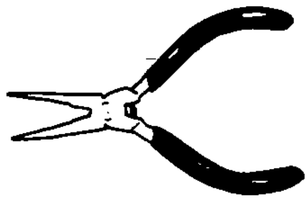
The most common screwdriver is the flat-blade one used for slot-head screws. People don't seem to realise, however, that this comes in different sizes. Use the one which fits the slot exactly. The blade should be square-ended – NOT sharpened to a chisel point or rounded off because you tried to use it on a cross-head screw!

Cross-head screwdrivers come in two different types and several sizes. One type is called "Phillips" and the other is called "Pozidriv™". If you use the wrong one it will slip and damage the slots. The two most useful sizes are #1 and #2, although you might also need #0 for very small screws.

An unusual type of screwdriver is needed for receivers manufactured by Nokia. It is called a "Torx" driver and has a star shaped end. It is almost impossible to remove Torx head screws with anything other than the correct size Torx driver. The most useful size is a number 10 but some receivers used a number 9.

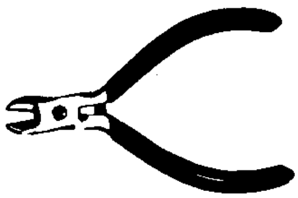
Pliers

Pliers come in all shapes and sizes. For handling electronic components you will need a very small pair of needle-nosed pliers. A larger pair of snub-nosed pliers will be useful for holding a nut while you tighten the screw.



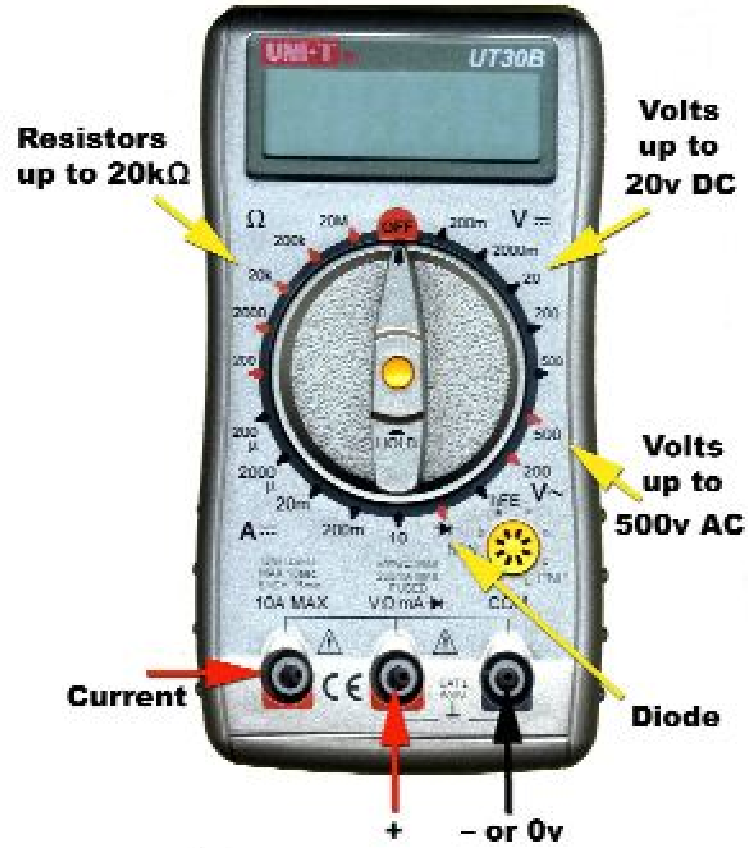
Cutters

One of the tools most people think they can do without – until complaints arise from your spouse regarding misuse of the kitchen scissors! For cutting leads on components you need very small cutters. However, DO NOT use these for cutting thick cable or fence wire.



Meters

The basic meter is called a “**multimeter**”. Most have a digital number display but some have an “analogue” moving needle display. The digital type is more accurate but the analogue type can be useful for seeing the approximate measurement “at a glance”. The analogue type is also better able to indicate if a voltage is pulsing slowly.



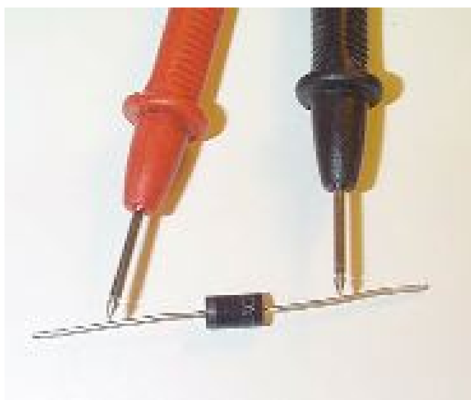
A multimeter has a selection of “ranges”. The most commonly used ranges are indicated here by yellow arrows. Most **DC voltages** in electronic equipment are below 40 volts (for safety). This particular meter has a choice of ranges for measuring up to 200 milliVolts (thousandths of a volt), up to 2 volts, up to 20 volts, up to 200 and up to 500 volts. Of these, the 20 volt DC range is the most useful one. If the actual voltage is between 2 volts and 20 volts then this range will give the most accurate reading. If the measured voltage is higher, you will have to switch to the 200v or 500v range. For DC voltages, the black probe is always connected to either negative or common zero volts - usually the chassis or metalwork. The red probe is used for measuring the actual voltage. Occasionally, you will come across a circuit where the voltage is negative with respect to zero, in which case reverse the probes.

In a switch-mode power supply, the mains input capacitor will have the highest DC voltage of 300 to 350 volts and you must use a 400v DC or 500v DC range to measure this. Be very careful as this voltage is more than enough to kill you!

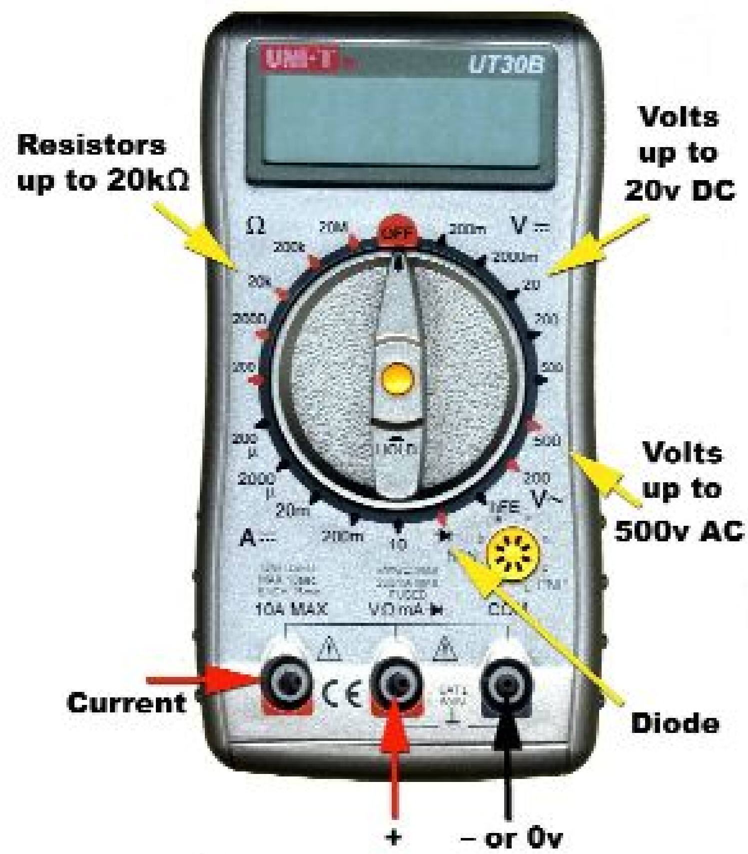
On the low voltage output side of the power supply you will find diodes feeding electrolytic capacitors. The negative lead of each capacitor is usually indicated by a stripe along the body so you must put your red probe on the *other* lead to measure the voltage. At this point, the voltage will be rather "noisy". In other words, it will not be pure DC because it has a lot of little "spikes" which might cause the meter reading to be higher than you expect. Some circuits feed this voltage through a small bobbin inductor (coil) to get rid of the spikes.

On the output side of the power supply, the most common voltage rails you will see are 5.0 volts and 12 volts. In digital equipment there is likely to be a 3.3 volt supply rail as well. In a satellite receiver there will be a (approximately) 30 volt supply for the tuner and a switchable 13v / 18v supply for the LNB. Sometimes these are separate supplies and sometimes a voltage regulator is used to produce one or the other from, say, a 20 volt supply.

The only **AC voltage** you are likely to want to measure is the 230 volt mains supply. Again, measure this with care as it can kill!
Select a range of not les than 300 volts AC, otherwise you might damage the meter. For AC measurements, it doesn't matter which way round you connect the red and black probes.



The **diode test** range can be used to check diodes in or out of the Printed Circuit Board. However, if the reading indicates a fault, remove the diode from the PCB and measure it again. Most meters require you to put the black probe on the cathode (coloured band) end of the diode in order to measure the forward voltage drop in milliVolts. The reading will lie somewhere between 0.2 and 0.7 volts, dependent on the type of diode. More importantly, with the probes reversed, the reading should indicate infinity because no current should flow in the reverse direction. If the diode gives a low reading in both directions then it is no longer a diode!



Yes, it's the same picture, just so you can see it while you read this.

Resistor Test

Resistors are likely to read lower than their expected value when measured in-situ, because other components connected in the circuit will effectively be in parallel when you make the measurement. If the value is correct or low, the resistor is probably OK. If the reading is high then the resistor is definitely faulty.

Never measure resistance while power is applied! You may damage the meter and other components in the circuit as well. Also note that electrolytic capacitors may hold a charge for hours or even weeks after switch-off so it's best to connect a 10Ω resistor across any capacitors of value higher than, say, 10µF, before making measurements. The resistor will remove any residual charge without damaging the capacitor. If the capacitor is to be replaced anyway, then you can short-circuit its leads with pliers but look out for the spark!

Finally, **current** can be measured with this meter. You have to move the red probe from its normal socket to the one marked "10A MAX". The meter can then be set to a suitable current range and connected into one leg of a circuit. You won't often need to do this so I'm not going into detail, here. Suffice to say that, if you set the meter to its 10 Amp range, you can measure the current consumption of an LNB, bulb etc. If the reading is very low, change the range switch to 200mA for better accuracy.

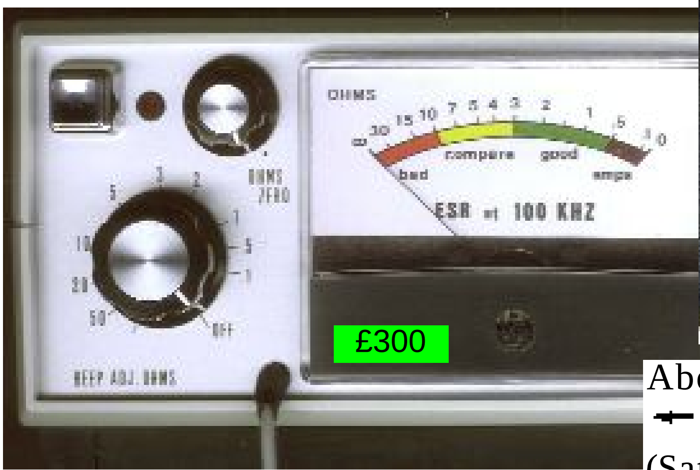
Capacitance and ESR

Capacitors used in power supplies are often stressed to the limit by heat and high current pulses. It's necessary to be able to measure them.
The first type of meter used in any workshop is a capacitance meter.

These used to be quite expensive but, with the advent of modern I.C. technology and Liquid Crystal Displays, the price has fallen to as little as £30. The one on the left was bought from Maplin Electronics.

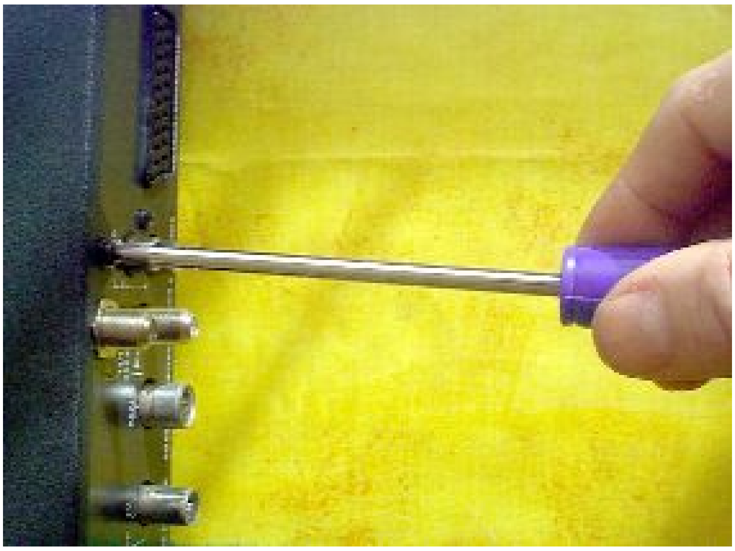
If the capacitance value is significantly lower than it ought to be, the capacitor is clearly faulty. Unfortunately, if the capacitance measurement appears to be correct, that does not verify that an electrolytic capacitor is OK. To do that, you need an ESR meter - Effective Series Resistance.

This factor is measured by applying a fairly high frequency waveform to the capacitor - usually 100kHz. The measurement can usually be made with the capacitor still soldered in place and the measurement is in Ohms. The lower the ESR measurement, the better the capacitor. A look-up table is used to determine whether the capacitors is still OK.



Above - medium price ESR meter
← Left - an expensive ESR meter
(SatCure supplies a low cost one)

Dismantling



Most receivers are held together with cross-head screws. dependent on where they were assembled, these screws could be either “Philips” or “Posidrive”. It’s most important that you select the correct screwdriver, otherwise you may damage the slots and make the screw difficult to remove.

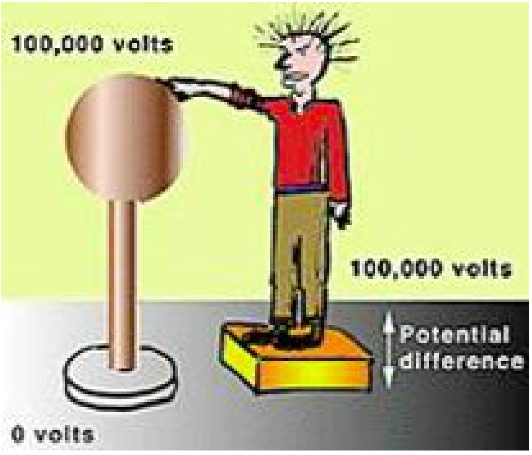
One trick that I use with a damaged screw is to grip the head tightly with a pair of old wire cutters (not new ones!) and rotate the screw that way.

Once the cover is off you have the problem of removing the board assembly. Screws are usually obvious but some manufacturers use two-piece plastic rivets. The trick is to lift the “mushroom” head of the rivet up with cutters. You can then grip the lower body of the rivet and lift it out.

You’ll also come across the bifurcated plastic mounting pillar. Use the cutters or pliers to squeeze the split ends together while you pull the board gently upwards.

Static Electricity

Before handling electronic components, it's important to realise that semiconductors can be damaged by high voltage "static electricity" carried on your body. The explanation I shall give is not quite technically correct but it will give you the general idea and allow you to understand the problems much better than a more involved discussion might.



You have probably all seen a Van de Graaf generator at school or at science fairs. It has a moving rubber belt which transfers electrons from its base to a metal globe. If you touch the globe you will receive an electric shock because your feet are on the ground at zero voltage and your hand is touching the globe (not for long!) at 100,000 volts. The potential difference between your feet and hand is 100,000 volts. However, if you first stand on an insulating block, your whole body will be charged to 100,000 volts when you touch the globe. You feel no painful shock because the potential difference is now between you and the ground - and unless you touch the ground, no current can flow. Your body remains charged to 100,000 volts and your hair tries to escape!

If you are wearing shoes with insulating soles or standing on an insulator such as a nylon carpet, your body can hold a charge for a long time. How does it become charged if you don't have a Van de Graaf generator? There are many ways and here are just a few:

1. Run down stairs with your hands sliding along the bannisters. If the bannisters have a nylon coating or are of varnished wood or of plastic then you will wipe electrons off and transfer them to your body which then holds them as an electrostatic charge.

2. Take a piece of clothing out of a plastic bag. Unroll a plastic dustbin liner bag. Remove a nylon garment. Handle expanded polystyrene packing material. All of these items carry a charge which you will "wipe off" onto yourself.

3. Get into a car and shuffle about on the nylon seat cover. Have the air conditioning blow air at you (full of charged particles). Now step out of the car and touch it. (Sorry, it hurts, doesn't it!)

4. Go into a dark room with a roll of adhesive tape. Wait until your eyes become accustomed to the dark. Now peel a length of tape off the roll. Can you see the blue light as the tape separates from the roll? Separating any pieces of plastic like this will usually produce a discharge of static electricity.

5. Wear two layers of clothing made of synthetic fibres. Move around a lot so the layers move against each other. This movement will build up a static charge on YOU. Now touch a large metal object. Ouch!

OK, you get the general idea. It's easy to charge yourself up.

How do we protect vulnerable components?

Integrated circuits and transistors have several connections. If ALL of these connections are at the same voltage, there is NO potential difference across them and no damage will result. However, if just one of the connections sees a different voltage from the rest, damage may occur.

Some components can be damaged by just a few volts. We protect them by connecting ALL of the pins together. This is quite easy to do. We can wrap them in aluminium foil, for example, or we can press the pins into a conductive material such as black, carbon-filled plastic foam.

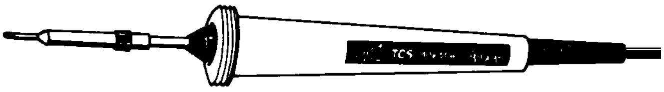
What we should NOT do is expose these components to charge-carrying materials such as plastic bags, expanded polystyrene, polythene, self-adhesive tape or labels being peeled off or *ourselves* unless we are at the same voltage as the components. (Safe bags are pink, blue or black).

The safest way is to make sure that the component is placed onto a conductive surface before removing it from its protective foam or bag. Then we should touch the same conductive surface before touching the component. Now everything is at the same voltage. There is no potential difference between the component and anything touching it.

Soldering

You can buy a very low-cost soldering iron which will be satisfactory if you seldom use it. Such irons usually take a long time to reach the usable temperature and lose their heat rapidly when used to heat up anything other than the smallest solder joint.

A better choice is a high wattage, thermostatically-controlled iron. The one which I have used for twenty years is rated at 45 Watts and I use a number 8 tip which keeps the temperature above 400°C. The tip is iron-coated and lasts a long time. (Iron-coated tips must not be cleaned with anything other than a damp sponge or the iron will peel off and the tip will be useless). The tip size you choose should be tiny – about 1mm.



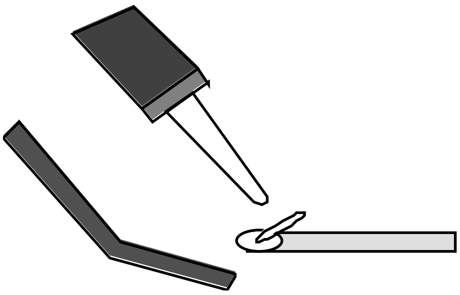
Solder

You need fine solder of 0.7mm diameter *or less* for soldering modern electronic components. The solder should contain cores of flux.
The percentage of flux will be marked on the solder bobbin. You will see that the solder is a mix of tin and lead in 60/40 proportion and the flux percentage should be about 5%. A higher percentage might make soldering a little easier but leaves a residue on the printed circuit board which looks messy and makes it difficult to inspect your work. A lower percentage may be acceptable and leaves virtually no visible residue but is not recommended for a beginner. (I use 2.2% rosin cored flux class 5A, grade KP, 0.7mm diameter 60/40 tin/lead solder from Maplin).

The reason for having flux is that it melts and flows over the metal which you are soldering. In doing so it excludes air and prevents the metal from oxidising (which would make it impossible for the solder to stick to the metal). Flux also has a slightly acidic action and dissolves any oxidation which is already present.

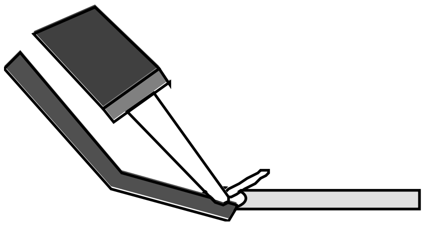
The most common flux is a resin called “rosin” which comes from trees. However, a number of synthetically manufactured fluxes (such as X32 made by Multicore) are also used. These fluxes leave either less residue or a clear residue, which makes inspection of the solder joint easier and may result in a more reliable circuit, since flux is known to cause problems if left on the board. However, your eventual choice may be influenced by the *smell* of the flux and its action on your nose and eyes!

Soldering

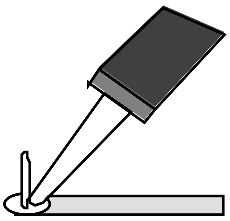


To remove a suspect or faulty component from a printed circuit board is easy – once you know how!

Many people swear by pump-action **solder-suckers**. These are like miniature bicycle pumps with an internal spring. You prime the sucker by pushing the plunger down until it locks. Pressing a button releases the spring-loaded plunger and it sucks up anything close to its nozzle. Great for zits! Not so great for printed circuits. The usual effect is that it sucks the copper pad right off the board, leaving you with nothing to solder the new component lead to.

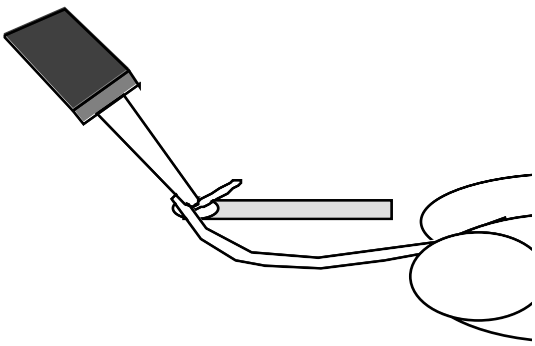


By far the best method is to use a product which goes under various names such as “**Solder wick**” or “Desoldering braid”.
This is very fine braid – like the screening braid found inside coaxial cable. The difference is that it is impregnated with flux.
Simply place the braid on top of the solder joint and press the tip of the iron onto it. When the braid is hot it will melt the solder which will be drawn up the braid by capillary action, aided by the flux.



Sometimes you will need to “prime” the braid by melting a spot of solder into it – called “tinning” – just to get it started.

When the solder is gone, use the tip of the iron to heat the component lead and push it upright so that it can be removed easily from the hole.



In the case of “plated through holes”, where the copper goes all the way through the circuit board, you must make sure that ALL of the solder has come out of the hole.

If it hasn't, resolder the joint with fresh solder then use the desoldering braid again.

Repeat this process for every lead or leg of the component then lift it out of the holes.

To solder a new component in, bend the leads (if necessary) to match the hole centres. Push the leads through the board, taking care not to lift the copper pads off the board. Bend each lead in the direction of the copper track, making sure that the component is flat on the board (unless the original was spaced higher to dissipate heat). Hold the end of the solder on the copper pad and press the tip of the iron onto the solder. Rotate the tip left and right while pressing and feed more solder in as it melts.

Common Soldering Problems

Amateurs tend to put too much solder on the joint (and everywhere else, too!) and leave nasty big stains of flux so they can't see the track breaks which they have left.

A common mistake of the amateur is to melt the solder on to the tip of the iron then carry it to the joint.

It is easy for an expert to tell when an amateur has attempted a repair!

Broken copper pads and tracks are common. Amateurs tend to put too much solder on the joint (and everywhere else, too!) and leave nasty big stains of flux so they can't see the track breaks which they have left.

The solder joint should have a bright, shiny appearance and the component lead should stick out of it and not be submerged. The solder meniscus around the lead should be concave (curved inward) like a volcano. It should *not* look like a ball. If it does, then the solder has probably not made a good connection to the component lead.

Components should sit flat against the board, or be pushed down as far as they will go. Otherwise, when you touch them, the copper pads to which they are soldered will snap away from their copper tracks to leave an open circuit or an intermittent (on / off) connection. Even if you do not touch the badly mounted component, there is every possibility that vibration or a knock will cause it to move and damage the copper track. The only exception is that a component which may run hot, either normally or under fault conditions, may be required to be spaced away from the board. In such a case, the component legs should be kinked to hold it in place or heat-resistant sleeves or beads should be fitted to the leads. Always copy the mounting method of the original component.

When you bend a component wire underneath the board it should always lie along the attached copper track, if possible – never away from the track. This position ensures that, if you need to desolder it, the copper pad will not be damaged.

A common mistake of the amateur is to melt the solder on to the tip of the iron then carry it to the joint. The problem is that the flux has evaporated by the time the solder gets there so a bad joint is inevitable.

Always put the iron tip onto the component lead and copper pad then apply the solder to the opposite side of the pad, forcing the solder on to the component wire and around the copper pad.

Feed in just enough additional solder to encircle the joint then take the tip away immediately. Hold the component still for a few seconds until the solder has solidified.

Movement of the component lead while the solder is still molten will cause a “**dry joint**”. The solder will be greyish rather than shiny silver and the connection may be no good. If this should happen, remove the solder with braid and re-solder the joint, carefully.

The problem is that, by the time the solder carried on the tip is applied to the joint, the flux has evaporated and a bad joint will result.

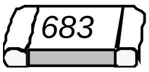
When you bend a component wire underneath the board it should always lie along the attached copper track.

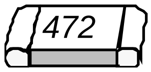
Movement of the component lead while the solder is still molten will cause a “dry” joint.

Always press the iron tip against the component lead and the copper pad then apply the solder to the opposite side of the pad.

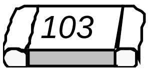
Surface Mount Components

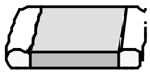
Here is a brief summary of the components you will see. The most common component is the **resistor**. Made by depositing a film of conductive material on a little chip of ceramic, the resistor has tinned ends and the value printed on one surface in ordinary numerals. The first two digits represent the numerical resistance value and the third digit gives the number of noughts to be added.



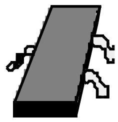


The left hand example, above, is 68000 Ohms or 68k while the right hand one is 4700 or 4k7. There is no way to determine the tolerance or the Wattage. The uncoated part of the ceramic body is usually white.





The resistor shown on the left is 10k. On the right is a **capacitor**. These have no markings so the only way to determine the value is to measure it. Capacitors are usually uniformly coloured brown or green. Unlike the resistor, the capacitor has no coating on the surface. If you break one in half and examine it under a magnifying glass you will see that it is constructed like a multi-layer sandwich. Layers of metal (silver or lead) are separated by layers of insulating ceramic. Odd layers of metal are connected to one end and even layers to the other.



Transistors and diodes are usually found in the SOT23 type package which is small and fiddly to handle, even with tweezers. To add to the difficulty, the legs are usually made of tinned iron which is attracted to metal tweezers if these become magnetised.

The device is too small to accommodate the part number so the manufacturer prints his own code on the top surface — usually a single letter and a number only.

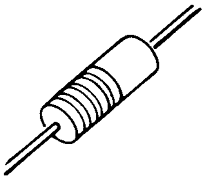
In the case of a diode, the middle leg is usually the **cathode** (striped on conventional diodes) and the other two legs are both connected to the **anode**. In the case of a transistor the middle leg is the **collector**, top right (in the picture) is the **emitter** and bottom right is the **base**.

The end terminations of resistors and capacitors are very delicate. Most manufacturers recommend a maximum cumulative soldering time of 5 seconds. When you come to remove one from a PCB, remember that 3 seconds were used up to put it there in the first place! Don’t expect to remove one of these devices and to re-use it. Always fit a new one.

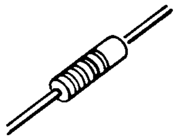
Remove the existing component by applying the soldering iron tip to each end alternately, several times in quick succession, and flicking the component away. This is not always easy because the component is often glued to the board. Get rid of the solder from the copper pads by using desoldering braid. Blob a tiny amount of new solder on the right hand pad (or left if you are left handed). With a pair of tweezers, position the new component and melt the solder blob to secure it. Solder the opposite end.

Use a 1.6mm tip (or smaller) and 26 gauge solder (0.5mm). Thicker solder or tips give enormous problems. Do the soldering as quickly as possible to avoid separating the end contact from the component. Don't worry about what the solder joint looks like. The strength of joint is unimportant.

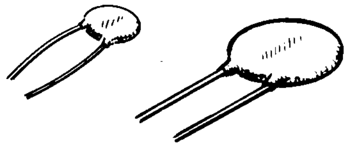
Recognising Components

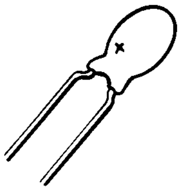


Resistors come in various sizes but usually look like the illustrations, with three or more coloured bands to indicate the resistance value and tolerance (accuracy %).

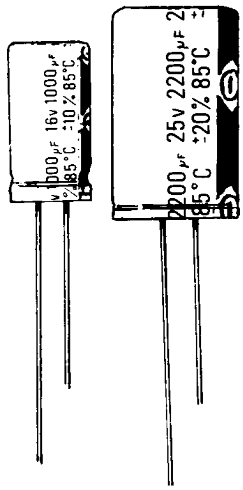


Capacitors come in all shapes and sizes. One of the most common is the ceramic disc.

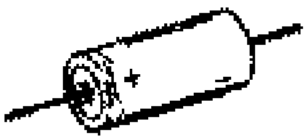




Some capacitors may be fitted only one way round. This Tantalum Bead capacitor has its positive lead marked.

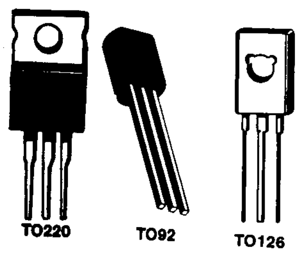


Electrolytic capacitors usually have the negative lead marked with a stripe. Or the positive with a "+". The ones on the right are called "Radial lead" electrolytics. The one below is an "Axial lead" electrolytic.

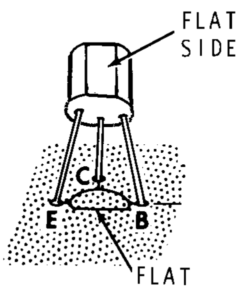


Transistors may be recognised by their black bodies and three legs – a bit like my mother-in-law!

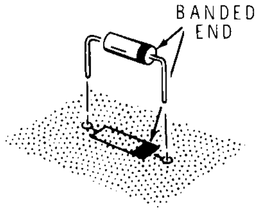
The sketch shows three common types: The TO92 type is a low-power device and you will see lots of these everywhere. The TO220 is designed to cope with fairly high power and is often bolted to a piece of metal which helps to keep it cool (a "heat sink").



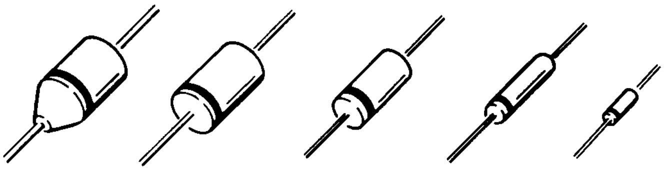
It is important to fit transistors the right way round. the three legs have names – Emitter, Base and Collector. The Collector is usually the middle leg on Japanese transistors but, with European made ones, the centre leg is often the Base. Amstrad receivers use some transistors where the middle leg is the Emitter so you *must* replace a transistor with an identical type.



This trimming potentiometer is a variable resistor. Its slider can be rotated to alter its resistance. NEVER adjust a trimmer without:
1. marking its original position and
2. understanding its function.



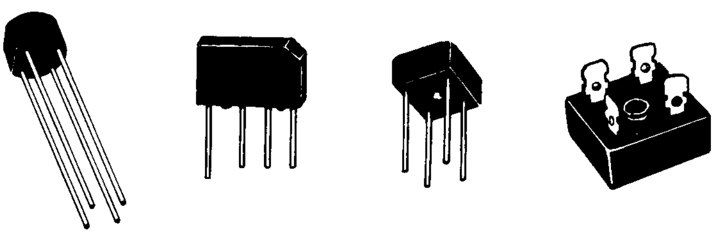
Diodes almost always have one end marked with a band. This end is called the "cathode". The diode will pass current only when this end is more negative than the "anode" end, so it is important to fit diodes the correct way round.

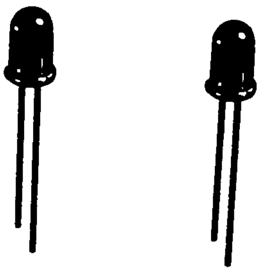


Higher power diodes are called "rectifier diodes" and are usually found in power supplies where they convert alternating current from the mains into direct current (D.C.) which the circuitry needs.

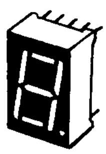
Another type of diode which looks identical is the **Zener diode**. This is used to prevent a voltage in the circuit from rising higher than a particular value. The value is often marked on the diode. For instance a BYX88C5V6 is a zener diode which works at 5.6 volts.

You will often see "**bridge rectifiers**" in power supply circuits. The "bridge rectifier" is simply a convenient way to house four rectifier diodes all connected together.



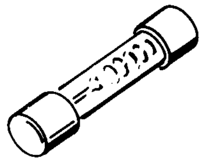


Although they do not look much like ordinary diodes, these **Light Emitting Diodes** (**LEDs**) work in much the same way and must be connected the right way round. In this case, the "cathode" can be seen inside the LED as an anvil shaped wire.



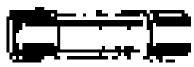
The seven-segment displays used to indicate the channel number often contain LEDs.
Hopefully, you can recognise a **Fuse**!

What you may not recognise is that there are several different types of fuse. The fuse rating is marked on the end cap or, in the form of coloured bands, around the body.

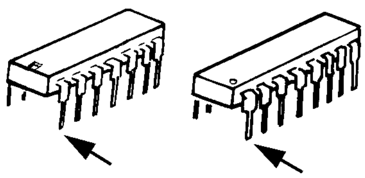


A fuse marked “T1A” is a one amp fuse with a Time-delay action.
A fuse marked “F1A” is a one amp fuse with a Fast action.

You must not substitute one for the other!

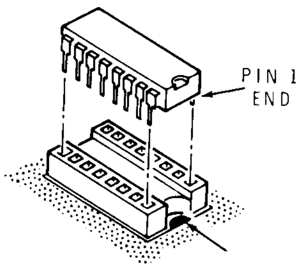


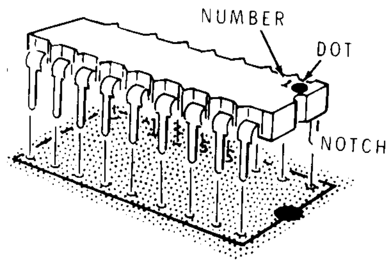
Always replace a fuse with one of an identical rating and type.
The rating should be marked next to the fuse holder (this is a safety requirement which most manufacturers observe) so there should never be a problem in determining what fuse to buy.



An **Integrated Circuit** (**I.C.**) can have any number of pins. Pin 1 is indicated by various methods – usually by a dot or notch near it.

The pins are counted anti-clockwise from pin 1.





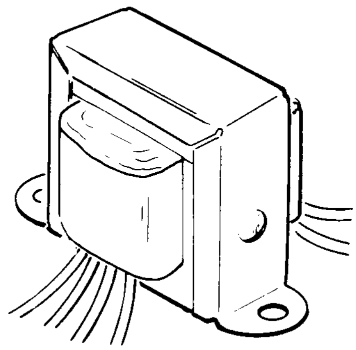
The printed circuit board is marked to indicate the position of either pin 1 or of the notch near pin 1.

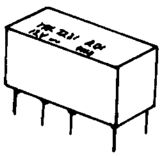
If you ever need to replace an I.C. it is a good idea to fit a socket, just in case you need to put the old I.C. back in; much easier than desoldering all over again!

Sockets can be unreliable, however, so beware of intermittent faults caused by them. Always ensure that every I.C. pin is inserted correctly and pushed fully home. It is worth paying a little extra for a high quality socket.

I.C.s are prone to damage by static electricity. You should make sure that the receiver is disconnected from the mains. Touch the receiver metalwork, to ensure that you are at the same voltage potential, before removing an I.C.

A mains **transformer** converts high voltage mains to safer low voltage which is required by the satellite receiver. It has one or more “primary” windings (hundreds of turns of fine insulated copper wire) connected to the mains and one or more secondary windings (thicker wire) which are isolated from the mains and should (in theory!) be safe to touch.

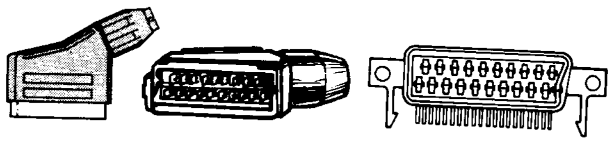




Some receivers use a switching **relay** to switch current from one point to another. A small coil of wire forms an electromagnet and pulls the switch contacts together when the coil is energised by an applied voltage.

Because relays have moving parts, it is not uncommon for them to fail in old age. Sometimes the contacts stick open and sometimes closed.
A click from the relay indicates that the coil is working but does *not* guarantee that the contacts are all right.

SCART connectors (also called PERITEL) are used to make connections between the receiver and external equipment. Amongst other connections, the SCART carries video-in and video-out signals.
It also carries left- and right-audio channels in and out.



Quick Diagnosis

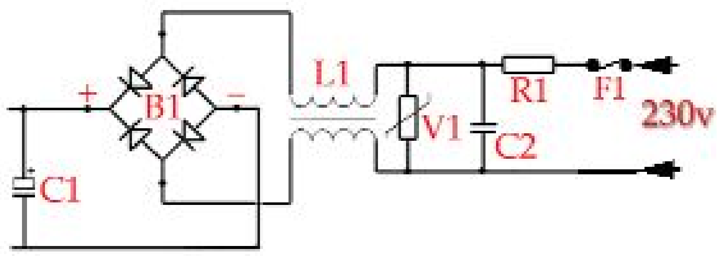
This book gives general fault-finding advice to those with some technical knowledge. You will need a multimeter which can be used to measure fuses, diodes, voltage and resistance. A good fuse will measure short-circuit (almost zero Ohms on the resistance scale).

Digital or Analogue

Most of the information in this book refers to analogue receivers. Digital receivers are much more like computers and there is no "video-" or "audio-path" until the very last stage where the digital signals are converted to analogue and passed to the outputs. Consequently, video and audio faults can not be traced in the normal with with an oscilloscope. Since most of you won't have an oscilloscope anyway, this probably doesn't matter! However, you can still repair power supply faults and replace major items such as tuner modules and minor items such as crystals, capacitors and resistors.

A receiver which is apparently "dead"

Check the fuse in the mains plug and all fuses in the receiver. If an internal fuse has melted then something is probably short circuit. If the fuse is intact (measure it!) then look for broken copper tracks or bad solder joints — often found under a board-mounted mains transformer or any component which is heavy (e.g. heatsink) or any components which can be subjected to strain (e.g. connector).



The sketch shows a typical power supply mains input section. 230 volt AC mains comes in via R1 (a resistor to limit voltage surges. C2 removes both incoming and outgoing interference, as does the double filter L1. V1 is a "varistor" which is sometimes fitted. It looks like a "smartie" or "M&M" and normally has no effect. However, if a high voltage surge comes from the mains supply, the varistor conducts heavily, causing the fuse F1 to melt and, hopefully, protecting the equipment from excessive damage. B1 is a “rectifier bridge” which often comprises four individual high-voltage diodes. These convert the alternating input voltage into pulsing direct current which is then “smoothed” and stored by the large value electrolytic capacitor C1. This is often a 47µF/400v capacitor, although 68µF or 100µF may be used.

R1 is usually 4R7Ω or 10Ω in value. A high wattage wirewound resistor may be used or, alternatively, an anti-surge type. Be sure to use exactly the right type or you could make the equipment unsafe. The fuse type and rating is also critical. Always use exactly the same type. If the rating is too low then it will melt as soon as power is applied. Too high a rating and the fuse will survive but the power supply might explode if there’s a fault!

The method of test is simple but care is needed to avoid electric shock. Set your multimeter to a suitable voltage range of more than 350 volts DC. Measure the voltage across C1 when power is applied. The voltage will be between 320 and 350 volts DC, dependent on mains voltage at your location (it may be slightly more or less than 230 volts AC). If the voltage is present then this input circuit is OK. If it is not then disconnect the power and measure the fuse, which should have almost zero resistance. Measure the resistor R1. Measure each of the two coils in L1, which will be low value (probably less than 2 Ohms). Measure the actual copper tracks in this area to make sure none has cracked. Check solder joints - especially on the power input socket.

If the fuse or the resistor R1 have gone open-circuit, this usually indicates a fault in the power supply, although occasionally these can fail if a mains voltage surge occurs, as they are designed to do. If either of them has failed, it’s usually NOT a good idea to replace them until you’ve found the cause, otherwise the new ones will fail again and other parts may get damaged which were OK till now.

If the voltage across C1 measures rather lower than 320 volts but the other components are all right then it’s likely that C1 is faulty. Remove it from circuit, being sure to discharge it first by connecting a 10Ω resistor across it. 300 volts across your fingers will hurt! Sometimes it is held with glue but if there is any damp liquid beneath it, that’s electrolyte which has leaked and C1 should be replaced. Likewise if its capacitance is less than 45µF or its **ESR** is more than 2Ω.

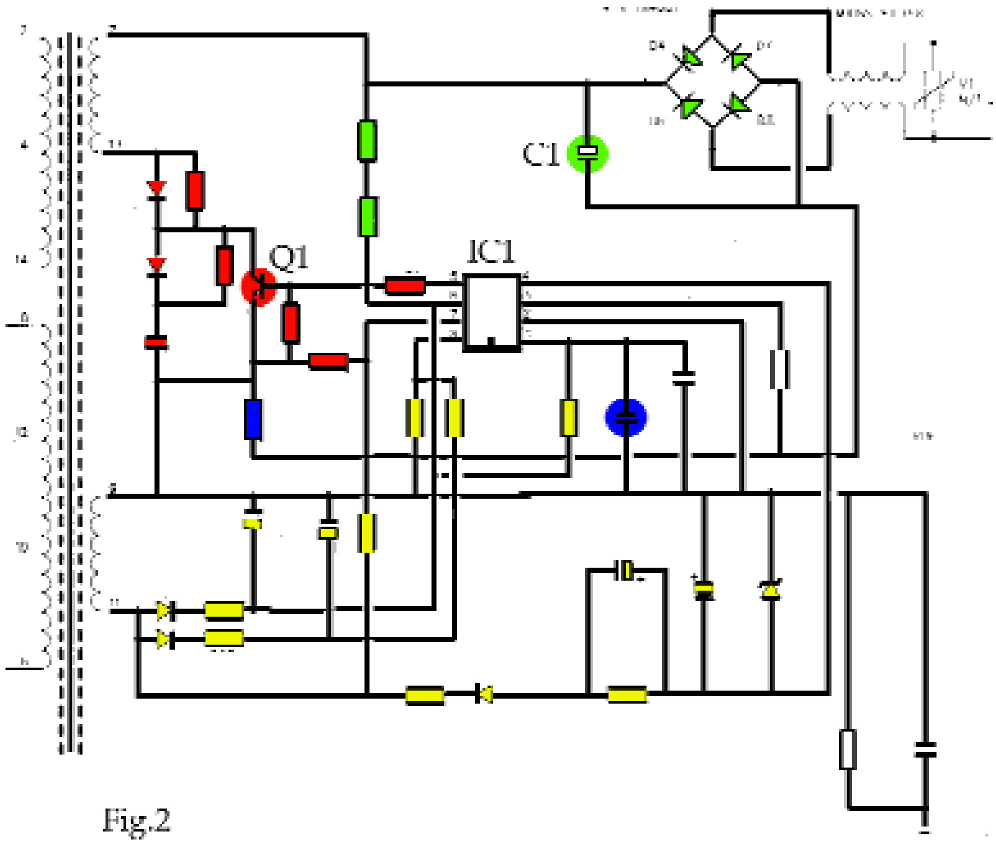


Fig.2

“ESR” is “**Effective Series Resistance**” and is an important measurement in the case of electrolytics. A special “ESR” meter is needed to measure it. No professional would be without one.

Once the input section is working and you have the correct voltage across C1, the power supply may still not function. It’s NOT a good idea to make any more measurements while power is applied and you should not need to.

Fig.2 shows the active part of a typical **SMPSU** (Switch Mode Power Supply Unit). The switching I.C. (IC1) is supplied with a voltage via the green resistors. These are dropping the voltage from around 350 volts to about 9 volts so they have to have a high voltage rating. You’ll often find two resistors connected in series from C1 (as shown) in order to share the high voltage between them. Sometimes a single high voltage resistor is used alone. The resultant low voltage is used to power IC1 during start-up. If one of the resistors is open circuit or too high in value, the I.C. will not receive enough power and will be unable to start. The same effect can be caused by failure of the (yellow) electrolytic used to smooth the voltage. The result may be an audible ticking or an output voltage which pulses once or twice each second. You should be able to see this if you measure the voltage on the cathode of any of the low voltage output diodes (fig.3) If the resistors (yellow) have failed you will notice that C1 holds its charge for several minutes or even hours - normally it will discharge in less than 1 minute. If a capacitor has failed, the resistors will discharge C1 as usual. This is a useful clue.

Another cause of “ticking” or “tripping” is a short-circuit on the low voltage output side of the SMPSU. This may be caused by a shorted output diode (measure each one out of circuit. With a diode tester, a diode should measure low in one direction and infinity in the other.
It may also be caused by a short circuit in the circuit that the SMPSU is feeding.

Brief explanation of the SMPSU

High voltage on C1 is connected to the switching transistor, Q1. IC1 switches its output pin high and low very rapidly (usually more than 25,000 a second). This in turn causes Q1 to switch pulses of current through the Transformer input winding. The output windings of the transformer (Fig.3) have a lot less turns than the input winding so they feed only relatively low voltage pulses into the output diodes. The pulses are stored or “smoothed” by the electrolytic capacitors connected to the output diodes.

To ensure that the output voltages are correct and constant, another transformer winding produces a low voltage which is fed back to the yellow components (Fig.2) This voltage is “smoothed” and fed to IC1 which compares it with a steady reference voltage generated by the Zener diode (yellow, far right, Fig.2) IC1 widens or narrows the pulses to Q1 to increase or decrease the output voltage, thus keeping it constant and correct.

The red components in Fig.2 are mostly for protection of Q1 which has to handle very high voltage and current pulses. The blue resistor connected in line with Q1’s emitter is a **fusible resistor** which will go open-circuit if Q1 is held “on” for more than a few milliseconds. This would occur if IC1 stopped oscillating for any reason. The capacitor encircled in blue (Fig.2) is responsible for setting the oscillating frequency of IC1. It is important that this frequency is correct or Q1 could overheat and burn out.

Fault finding of this part of the circuit (Fig.2) is best done without power connected. **Replace all electrolytics as a matter of course.** They have a limited life so it is false economy to try to prolong their useful life. If this doesn't cure the fault, measure each of the resistors (make sure all capacitors are discharged and C1 is removed first!) and diodes. If Q1 has failed, the fusible resistor (blue in Fig.2) will also have failed so there is seldom any doubt.

It is most important to be sure that ALL faulty parts have been replaced before applying mains power again. If you leave one faulty part, the whole lot may blow up again.

If you are colour blind I apologise for using colours but it's easier to give a general explanation this way. In fig.2 the "red" components are clustered around Q1, to the left of IC1. The "yellow" components you can probably recognise because this is the lightest colour. The two "green" resistors are positioned vertically, above and to the right of Q1 and joined to the 350 volt connection from C1. The "blue" fusible resistor is directly below Q1.

It is very unusual for a transformer to fail, although it happened occasionally with some makes and models. However, if the transformer core is cracked and loose, the transformer will not work. You *might* be able to repair it with "super glue" but replacement is usually the only answer.

Fig.3 shows the low voltage output side of the transformer. Each winding is connected to a diode which feeds an electrolytic capacitor that "stores" the pulses. The resultant "noisy DC" is fed through an inductor ("A choke coil") which gets rid of some of the "noise" pulses. More capacitors in the circuit following will smooth out any remaining "ripple" to leave almost pure DC.

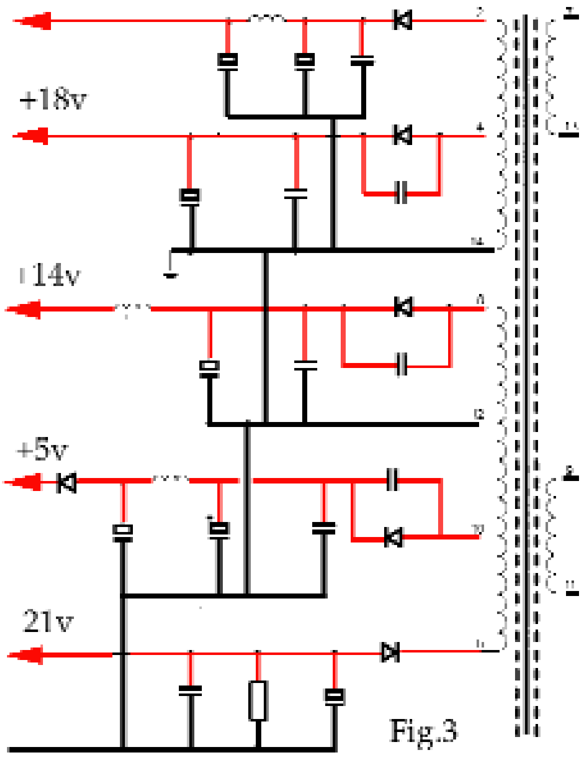


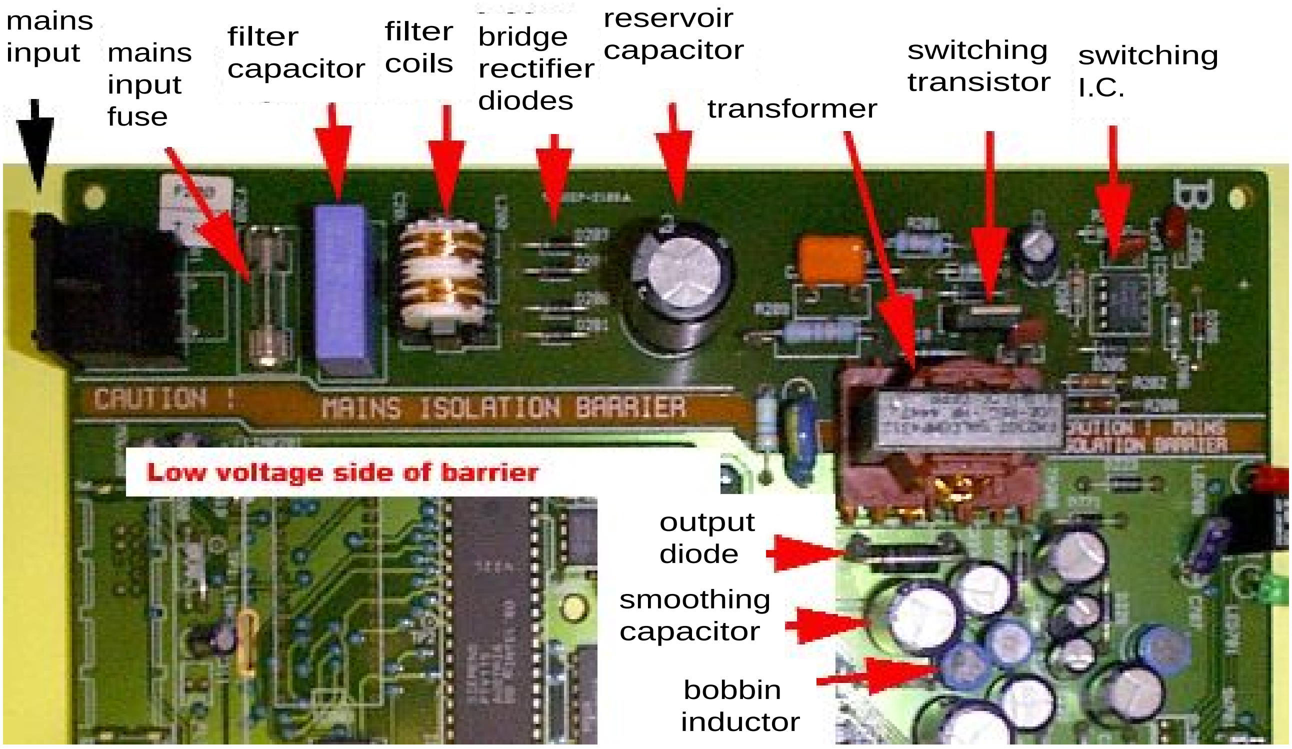
Fig.3

Some diodes have tiny capacitors connected across them to protect the diodes from **fast-risetime pulses**. Some electrolytics also have low value **ceramic capacitors** connected across them to remove fast-risetime pulses.

Electrolytic capacitors are filled with a liquid “**electrolyte**” which can evaporate over a number of years. As this happens, the ability of the capacitor to remove the “ripple” from the supply will decrease, resulting in any one of several effects, from a simple hum or buzz on audio to ripples on the picture or complete loss of sound and / or picture. The voltage may even appear to measure correctly because **voltmeters** tend to ignore small “ripples”. Bear this in mind when making measurements!

If a diode goes short-circuit, it can cause the associated electrolytic capacitor to bulge or even explode. However, overstressed electrolytics can do this in any case as they age. They will also do so if you connect them the wrong way round!

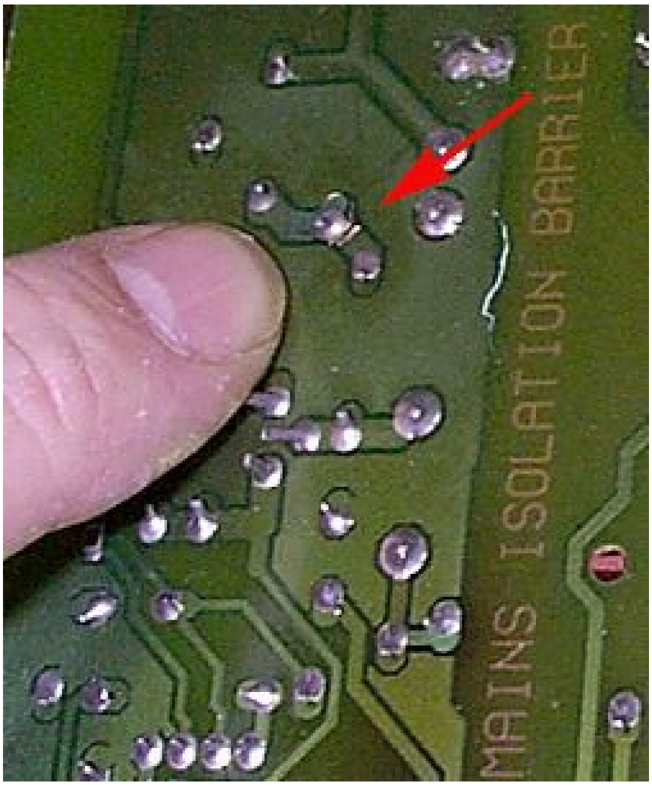
OK, enough of the theory. Let’s look at a **practical example**.



Here’s the power supply end of a “mother board”. I’ve marked the main features. Notice, in particular, the brown stripe labelled “protection barrier”. Above this is the mains voltage circuit where voltages up to

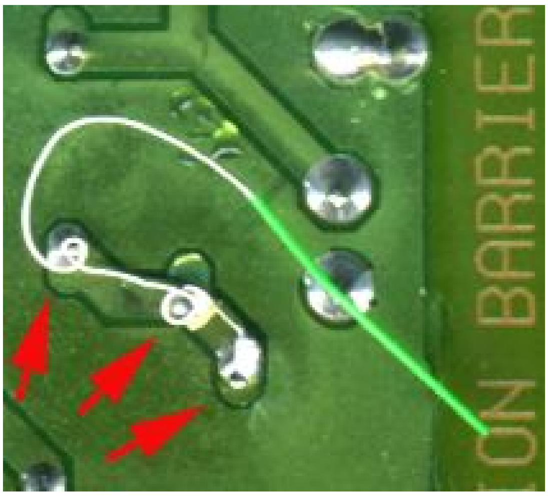
350v are found. Below it is the low voltage section which is isolated by the transformer. As described previously, there should never be any need to make measurements of the “live” section, except to check that the voltage across the high voltage reservoir capacitor is present. Be sure to measure that no voltage remains in the capacitor before you handle the board! I advise the use of the multimeter set to DC volts. This is less painful than putting your tongue across the capacitor terminals!

All other measurements can be carried out *without* mains power connected. If the power supply is “dead”, look at the fuse. If it’s black, the wire inside has melted. If it looks all right, don’t believe your eyes. Measure it. It should read almost short-circuit - after all, it’s only a piece of thin wire inside a tube.



Look for signs of obvious damage. The picture shows a track which has cracked. This one has cracked adjacent to a solder pad which secures a large resistor. Someobody has carelessly banged the assembly upside-down on a hard surface. The resultant knock to the resistor did the damage. Quite often such a crack will be invisible until you move the component so hold the board upside down and brush the parts lightly with your fingers.

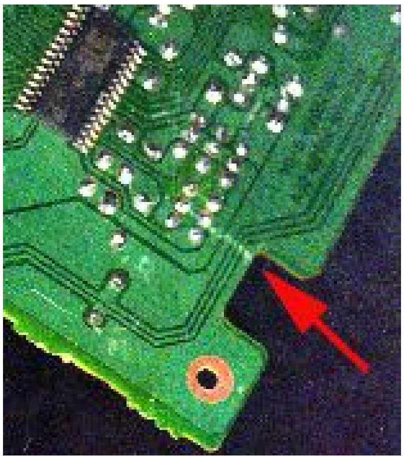
Cracks can be repaired with wire as shown. Put a tiny loop at the end of the wire and solder it to the nearest pad. loop it around the next and solder it, so the crack is bridged. In a case like this where the crack is next to the pad, it’s wise to wrap the wire around a third pad so the broken one is supported on



both sides. If possible, kink the component lead above the board to minimise movement. If there is no solder pad near the break, use a sharp blade to scrape the green solder-resist varnish off the copper track. apply a little solder, quickly, to tin the bare copper track. Now solder the wire along the track so the crack is bridged and cut off any excess wire.

If the wire has to cross any other tracks, use PTFE insulated wire. PTFE won't melt so there's less risk of a short-circuit and it's easier to solder.

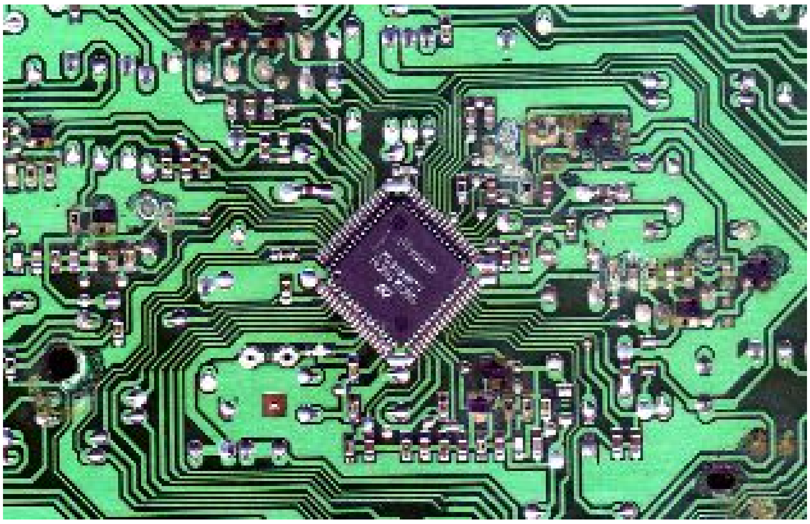
Cracks sometimes occur "naturally" due to poor design. Any sharp-cornered cut-out in the printed circuit board can develop a crack, which may propogate through several copper tracks. If you suspect that a crack is present, put your meter on the diode test range or "bleep" range and put the probes on solder pads, one on each side of the suspected crack - or use a sharp blade to scrape away the green resin to expose bare copper. Some cracks will give a good continuity reading until the board is flexed or warmed up with a hair dryer. Some cracks show up only when you use a freezer spray aerosol.



Repair the tracks as described and apply epoxy resin such as "Araldite" at the end of the track to prevent its going any further.

Corrosion

Moisture can get into equipment by spillage, cat pee or down the TV aerial cable. Corrosion such as this (picture) is normally fatal. However, there's nothing to lose by trying to clean it. Rinse with warm water and detergent, using a soft brush. Flush with Isopropyl alcohol or de-icer aerosol. Blast warm air with a hairdryer then leave in a warm cupboard for 24 hours.



Fault Symptoms

A receiver which “lights up” but produces no output.

Bear in mind that most TV sets are designed to mute the audio unless a recognisable picture is present. Use the RF output and put the Test Signal or Menu on. If audio is then present the fault is limited to the video section or decoder (but the tuner module is probably all right). Make sure that you have not selected an external loop-through video path in the menu or, in very old receivers, an internal selection link.

If the TV screen is blank, you can check to see if the video is being sent *out* to a decoder socket by connecting video out and video in with a suitable connector on the back panel of the analogue satellite receiver.

Sometimes the video sockets are labelled “Baseband out” and “Baseband in”. Sometimes there is just one socket labelled “Decoder”. If this is a SCART socket, connect pins 19 and 20 together with a piece of wire. If it is not a SCART then you will have to check your handbook to find the video in / out connections.
For analogue receivers, bypass any internal decoder by means of a wire link. Some receivers automatically bypass when the decoder board is removed (e.g. Pace) and some need a physical link wire (e.g. Amstrad). Where a link is used, the picture may flicker because the video signal is “unclamped”. If the video appears when the decoder is no longer in line then the decoder is often at fault.

If no audio is present then check the Video output. A signal here indicates a faulty RF modulator or a disconnection to the modulator unit. No signal at the Video output often indicates a faulty tuner or a faulty circuit controlling the tuner. Check the voltages on the tuner pins. Make sure that the tuning voltage (VT) steps up as the frequency is increased (by pressing tune or channel buttons while you measure it).

If a picture is available at the decoder socket but not at the TV socket then the tuner is obviously OK and the fault lies in circuitry inbetween. Check *all* available outputs to pinpoint the fault.

Picture but no sound.

Audio circuits *can* be traced by using just an audio amplifier, provided that you have a circuit diagram and can read it. However, without an oscilloscope, you have very little chance of tracing the fault.
Some common audio fault causes are listed and you may be successful in curing the fault by replacing components without any testing knowledge whatsoever.

Horizontal "fuzzy" bar moves slowly up or down the picture — sometimes accompanied by buzzing on the audio.
One bar indicates mains frequency interference which is almost always caused by a faulty bridge rectifier. If there are *two* bars visible then 100Hz interference is present. This can indicate a healthy bridge rectifier and is usually caused by a faulty electrolytic capacitor on the DC output side of the bridge. The problem can also be caused by a faulty transformer or by mains voltage which is too low (e.g. a UK model used on the continent). The third possibility is a partial short circuit which draws excessive current from the power supply.
Similar interference can be caused by a problem with the DC supply to the **LNB**.

No horizontal or no vertical channels

In receivers which use a 13/17 volt switching LNB then, if the LNB itself is OK (check by substitution), the receiver is not switching the voltage which it sends up the cable to power the LNB. You need to measure the voltage coming out of the LNB input port on the receiver. A short cable with an "F" connector on one end and a resistor connected to the other end is useful in order to simulate the load presented by an LNB. Use a 100Ω resistor rated at 3 Watts (or more) which will draw 150mA with 17 volts applied. (Resistor gets HOT!) This is about the worst case that a receiver will see with a single LNB (but a twin output LNB can draw twice as much current). Measure the DC voltage across the resistor when first vertical (13v) then horizontal (17v) channels are selected. Take care not to short circuit the receiver input. If either voltage measurement is incorrect, the receiver is faulty. Note that most LNBs switch at 14.8 volts so the 13v or 17v setting is not very critical and +/- 0.5 volts is generally acceptable. Also note that most LNBs draw less than 180mA.
Some channels can also go missing if there is **no 22kHz signal** when there should be (or vice-versa) or if the LNB does not respond to the signal correctly by switching hi/lo band as it ought to.

In older analogue receivers which use a **magnetic polariser** you will need to measure the current through the polariser by connecting a milliameter in series with one of the wires. Alternatively, you can connect a 100Ω 1 Watt resistor across the polariser terminals on the receiver and measure the *voltage* across the resistor. The voltage should vary as the skew is adjusted. Since each make and model of receiver gives a different reading, you should compare your reading with that of a known good receiver but *no* voltage change indicates a fault.

If the receiver polariser output appears to be OK then measure the resistance of the polariser itself and compare the reading with that of a known good polariser.

The reading may be anywhere in the range 47 to 110Ω but two identical polarisers should give the same resistance measurement +/- no more than 5Ω (see list of polariser resistances in the appendix).

In receivers which use a mechanical polarotor you will need to connect a polariser interface to the receiver and connect the test resistor to the interface output in order to carry out the checks, above.

The control pulses may be viewed with an oscilloscope. Some receivers provide the control pulses for just long enough to move the mechanical polarotor then cease. In addition, the 5 volt supply may be provided only for a short period before it is turned off.

Bear this in mind when you use an interface (most of which are designed to store the pulse information and continue to supply the current after the pulses have stopped but may not cope with the disappearance of the 5 volt supply!).

A final word of caution

The dangers of working on satellite receivers must be emphasised:
There is a risk of electric shock and a risk of burns from hot components. There is also some risk of cuts from sharp edges.

There is a very real risk that you will nullify your warranty if you poke about inside your receiver. There is a risk that, in attempting to repair it by yourself, you will eliminate all hope of repair by a qualified engineer.

IF IN DOUBT, DON'T ATTEMPT TO REPAIR IT.
Simply use the information to learn about the possible cause and cure, in order to estimate the likely cost of repair, *then take it to a shop.*

After you've fitted a kit

Most kits include a basic check list but it does no harm to check again.
Look for components inserted the wrong way round.
It never fails to amaze me just how often I fit an electrolytic capacitor the wriong way round! Look at other electrolytic capacitors and make sure the ones you fit match the orientation of the others. The stripe on the capacitor body represents the negative end but manufacturers use several different board markings to indicate either positive or negative!

Diodes and zener diodes also need to be the right way round.
The "cathode" end is denoted by a band which, if there is more than one, is always the *widest* band. It may be any colour but is often silver on a black-body diode and black or red on a glass-body diode.

Check your soldering carefully to ensure that you have left NO splashes or whiskers of solder anywhere on the board. It's worthwhile brushing the board with a toothbrush and isopropyl alcohol to remove all traces of flux and solder powder. Give it time to dry before applying power.

Finally, inspect your own work and also make sure that you haven't disturbed anything else - perhaps by resting the board upside down.

END

There are lots of other Virtual Books available, including:-

"Understanding Sky Digital TV"
"Installing Sky Digital TV"
"Installing a Motorised Dish"
"Piping TV Around the House"
"Repairing Sky Digital Receivers"

Which you can download from:-
http://www.satcure-focus.com/books