TROUBLESHOOTING: VISUAL INSPECTION

Many students build a complex experimental circuit and have trouble getting it to work because they didn't stop to check things along the way. It is human nature to rush to completion of a project, thinking that such checks are a waste of valuable time. However, more time will be wasted in troubleshooting a malfunctioning circuit than would be spent checking the operation of subsystems throughout the process of construction. Not checking increases the chance of damage to components and wastes valuable time.

It's always easier begin the design and construction process in little steps, leading to larger and larger steps, rather than to build the whole thing at once and try to troubleshoot it as a whole.

CHECKING:

If the components are not working correctly turn off the power immediately and check the following:

- ☐ Compare a working PCB to yours.
- ☐ Check that components are not touching each other.
- ☐ That the +ve (red) and –ve (black) from the battery connectors go to the correct positions on PCB.
- ☐ Check that the batteries are properly inserted in the battery holder.
- ☐ Check that the batteries have adequate charge.
- ☐ Is wiring connected as per instructions (wiring diagram).
- ☐ Look for water or foreign objects anywhere on the circuit board.
- ☐ Components soldered the wrong way.
- ☐ Components soldered in incorrect position.
- ☐ Missing components.
- ☐ Signs of overheating.
- ☐ Swollen, burnt or discoloured components.
- ☐ Inspect soldering for poor soldering.
- ☐ Check that there are no solder bridges (short circuits).
- ☐ Make sure there are no dry joints - the soldering may look dry or lumpy or you may notice the solder does not actually connect to the wire. This will look like a dark ring around the wire: try pulling the wire to see if the lead comes out or moves (a magnifying glass or eye piece will help).
- ☐ If the LEDs do not light, check orientation of the LEDs. If they are correct and the LEDs don't light check the PCB leads. Negative and positive must connect the correct way around to the power supply.
- ☐ If a LED only glows dimly, check that the resistors are in the correct position.
- ☐ If the LED does not illuminate: Check that the batteries have adequate charge (low battery voltage can cause erratic performance); Check that the batteries are properly inserted in the battery holder; Check that the LED is the right way around.
- ☐ Check the wiring against the wiring diagram.
- ☐ Look for cracks on the circuit board. A hairline crack may not look too damaging but it will prevent the correct operation of the circuit.

GENERAL HINTS

- ☐ Don't drink beverages while you are working on circuit boards. You could spill your beverage into the workings and cause problems.
- ☐ Check and identify all the components for the PCB before commencing assembly. The location of the components is as printed on the PCB. The copper tracks are on the underside of the PCB, and the outline of the tracks is visible through the PCB. These will act as a guide to help locate the components onto the PCB.
- ☐ Begin by placing the components that sit lowest on to the PCB.
- ☐ When all the components are in place, but before soldering, check them carefully against the printed circuit board or drawings.
- ☐ Take care in the orientation of IC sockets, Diodes, LED and electrolytic capacitor.
- ☐ Once all the components are correctly located, turn the circuit board over and bend the component leads outwards, away from the component's body (about 15 degrees from vertical). This will prevent the components from slipping down while soldering them in position. (Don't bend them too far or you will have considerable trouble removing them if it becomes necessary later on).
- ☐ Many electric devices, such as motors, draw large current. For this reason, alkaline batteries are recommended, as low battery voltage can cause erratic performance.

WIRING HINTS

- ☐ For wiring, use different coloured wires to assist in tracing wires during fault finding. When soldering wires, strip a short piece of insulation from the end of the wire, twist the strands and "tin" them with solder.
- ☐ CONVENTION: It is best to follow standard wiring conventions for all battery connections. That is RED for POSITIVE (+ve) and BLACK for NEGATIVE (-ve).
- ☐ Check all wiring thoroughly BEFORE connecting the batteries

SOLDERING HINTS

- ☐ A good quality soldering iron, with a fine tip and the use of 0.71mm 60/40 solder is recommended.
- ☐ Soldering with a clean tip and having a damp sponge to clean the tip of the iron ensures a better result.
- ☐ Turn over the PCB and slightly bend the leads of the components outwards, to prevent them from slipping out.
- ☐ Solder components onto the PCB in the suggested order with lower components soldered first.
- ☐ Apply the soldering iron tip to the lead and track pad at the same time. Heat the joint for 2-3 seconds and then apply the solder to the heated lead and pad on the opposite side to the soldering iron tip. Melt the solder onto the hot pad and lead, not onto the soldering iron.
- ☐ When soldering, hold the wire still while the solder cools, otherwise the solder may fracture, causing a dry joint. (the soldering may look dry or lumpy). A dry joint may

look OK, but it is a poor electrical connection. This could cause your model to not work, or not work properly.

- ☐ During soldering, do not overheat the PCB and components.
- ☐ Once all the components have been soldered, use a pair of side cutters to cut off the ends of the leads as close as possible to the solder.
- ☐ When soldering multi-strand wires, strip a short length of insulation from the end of the wire, twist the strands and then "tin" them. This is done by using a hot soldering iron to apply solder to the end of the wire. If required, solder flux may also be used.
- ☐ Solder bridges are most likely to occur between tracks that are close together. Solder bridges must be removed before connecting power to the PCB. Failure to do so may result in damage to the circuit due to short circuits.
- ☐ If you experience solder blobs between the terminals, carry out the following: Hold the PCB track side facing down. Heat the solder blob with the tip of the soldering iron until it melts. Then lower the soldering iron away from the component (gravity should pull the solder away with the soldering iron). After that, very carefully re-solder the component.
- ☐ Unsoldering and replacing damaged or wrongly positioned components will waste time, so check all components for their correct position and orientation.
- ☐ Switches should be clamped when connecting wires to them (a PCB holder is ideal). Alternatively a small vice or a pair of pliers, with an elastic band around the handles, may be suitable - but be careful not to damage the switch.
- ☐ When soldering wires to the switches, take care not to overheat the switch terminals (overheating could cause the plastic part of the switch to melt).
- ☐ A desoldering iron, “Solder Sucker”, can be used to correct improper connections and also remove circuit components that are positioned incorrectly on the PCB.
- ☐ SAFETY WARNING: Soldering irons and molten solder are very hot and can burn you.
- ☐ SAFETY WARNING: Never leave the irons unattended and allow them to cool off properly before storing.
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FAULT	CAUSE	REMEDY
Dry joint	Iron not touching one part of the joint. Melting solder onto the soldering iron and not the heated wire and pad.	Reheat making sure that both parts are hot.
Solder will not flow	Dirt on one or both parts of the joint.	Clean with steel wool, fine emery paper or abrasive ink rubber.
Solder on both parts but joint not made	Gap too large	Bend component leg to touch pad
Tip of iron will not tin	Contamination on tip	Use tinning compound
Iron not hot enough	Tip has moved along the element or tip not tightly screwed on.	Wait for iron to cool and tighten tip

Disturbed joint - Solder has a dry appearance	Joint has moved during cooling	Reheat, make sure both parts are hot apply a small amount of additional solder. You can avoid disturbing joints by stabilizing the board with, for example, a vice.
Cold joint – lumped or rough surface	Solder didn't melt completely. Iron not hot enough.	Reheat joint with the soldering iron until the solder begins to flow. Apply a small amount of additional solder.
Solder has "blobbed"	Too much solder fed in	Use a solder-sucker tool to remove excess and resolder
Bridged joint	Too much solder fed in	Wipe dry iron across joint or use a solder-sucker tool.
Overheated joint	The solder fails to flow so the flux burns. The soldering iron may not be clean.	Carefully scrape the joint with the tip of a knife to remove the burnt flux.