

How to Solder

Overview: What is soldering and when should you use it?

- Soldering is a process in which two or more metal items are joined together by melting and then allow flowing a filler metal into the joint—the filler metal having a relatively low melting point.
- Soldering is used to form a permanent connection between electronic components.
- The metal to be soldered is heated with a soldering iron and then solder is melted into the connection.
 - ❖ Only the solder melts, not the parts that are being soldered.
 - ❖ Solder is metallic "glue" that holds the parts together and forms a connection that allows electrical current to flow.
- You can use a solderless breadboard to make test circuits, but if you want your circuit to last for more than a few days, you will want to solder the components together.

Materials and Equipment

- A soldering iron
 - ❖ A soldering iron is used to heat the connections to be soldered.
 - ❖ For electronic circuits, you should use a 25- to 40-watt (W) soldering iron.
 - ❖ Higher wattage soldering irons are not necessarily hotter; they are just able to heat larger components. A 40-W soldering iron makes joints faster than a 25-W soldering iron does.
 - ❖ A soldering iron can be purchased at hardware stores and at most large department stores.
- Rosin core solder
 - ❖ Solder has a lower melting point than the metals that are being connected do. The solder melts when it is heated by the soldering iron, but the metals being joined will not melt.
 - ❖ The rosin core acts as a *flux*. It prevents oxidation of the metals that are being connected, and enhances the ability of the solder to "wet" the surfaces that are being joined.

- ❖ Solder that is used to join copper pipes has an acid core, which is appropriate for pipes, but will corrode electronic connections. Use solder that has a rosin core.
- ❖ For most electronics work, a solder with a diameter of 0.75 millimeters (mm) to 1.0 mm is best. Thicker solder might make soldering small joints difficult and also increases the chances of creating *solder bridges* between copper pads that are not meant to be connected.
- ❖ An alloy of 60/40 (60% tin, 40% lead) is used for most electronics work, but lead-free solders are available as well.
- Stand on which to hold the hot soldering iron
 - ❖ There are a variety of stands available. It is important to always keep the hot iron in its stand when not in use.
- Sponge
 - ❖ The damp sponge is used to clean the tip of the iron.

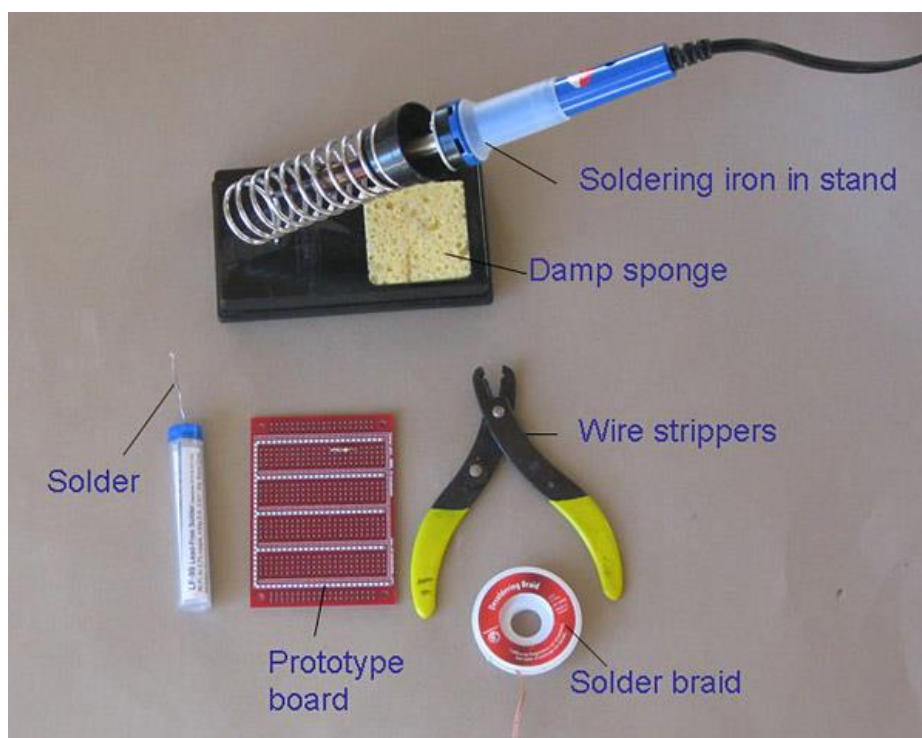


Figure 1. Soldering equipment and materials. The solder in this picture is coiled inside a plastic tube; it is pulled through the top as needed. The spring on the stand holds the hot soldering iron. The damp sponge is used to clean the tip of the iron. Solder braid is used to remove solder; solder is "soaked up" into the braid when it is heated by the soldering iron. The wire strippers can be adjusted to strip the plastic covering off of various thicknesses of wire. The prototype board is used to connect electronic components in a circuit.

- Solder braid
 - ❖ This is used to remove solder.

- ❖ To use the braid, place it over the solder to be removed and heat it from above with the iron. The solder will flow into the braid.
- ❖ Solder braid is used to extract an electronic component that is soldered onto a board.
- ❖ It is also used to reduce the amount of solder on a connection.

- Prototype board
 - ❖ A prototype board is used to assemble the circuit. The board shown is from www.protostack.com, but www.radioshack.com also supplies prototype boards.
 - ❖ Prototype boards have copper tracks or pads for connecting components.

- Steel wool or fine sandpaper
 - ❖ This is used to clean connections prior to soldering.
 - ❖ Solder will *not* flow over a dirty connection.

- Crocodile clips
 - ❖ These can be used as heat sinks, if needed.

Safety Precautions

1. **Caution:** A soldering iron can heat to around 400°C, which can burn you or start a fire, so use it carefully.
2. Unplug the iron when it is not in use.
3. Keep the power cord away from spots where it can be tripped over.
4. Take great care to avoid touching the tip of the soldering iron on a power line. If a power cord is touched by a hot iron, there is a serious risk of burns and electric shock.
5. Always return the soldering iron to its stand when it is not in use.
6. Never put the soldering iron down on your work bench, even for a moment!
7. Work in a well-ventilated area.
8. The smoke that will form as you melt solder is mostly from the flux and can be quite irritating. Avoid breathing it by keeping your head to the side of, not above, your work.
9. Solder contains lead, which is a poisonous metal. Wash your hands after using solder.

Tips

Reliable operation of a circuit with soldered connections depends on good soldering practices. Here are some tips for successful soldering.

1. Plan before you start to solder. Identify all the parts that you will be using.

2. It is helpful to attach each part to a piece of paper and write what it is and its value (for example, resistor #1: 100 ohms).
3. Some components, such as LED's, must be placed the correct way around in order to function.
4. The following is a suggested order for the installation of various components:
 - ❖ Integrated circuit (IC) holders (note the orientation). The IC will be added later.
 - ❖ Resistors
 - ❖ Capacitors, less than 1 micro farad
 - ❖ Large capacitors, 1 micro farad or greater, note the orientation.
 - ❖ Diodes, note the orientation.
 - ❖ LED's, note the orientation.
 - ❖ Transistors, note the orientation.
 - ❖ Solid wire connections between components on the board
 - Solid wire is fairly rigid, so it will stay in place once attached.
 - ❖ Stranded wire to parts that are connected by wire to the circuit
 - Stranded wire is more flexible than solid wire.
 - ❖ Integrated circuits
 - Connect them the correct way around.
 - Many IC's are static sensitive.
 - Leave IC's in their antistatic packaging until you need them, then ground your hands by touching a metal water pipe or window frame before touching the IC's.
 - Carefully insert IC's in their holders. Make sure all the pins are lined up with the socket, then push down firmly with your thumb.

Preparing the Soldering Iron: Tinning the Tip

1. Place the soldering iron in its stand and plug it in.
2. Wait for the soldering iron to heat up.
3. Moisten the sponge.
4. Wipe the tip of the iron on the damp sponge. This will clean the tip.
5. Melt a little solder on the tip of the iron.
 - ❖ This is called *tinning* and it will help the heat flow from the iron's tip to the joint.
 - ❖ The solder should flow onto the tip, producing a bright shiny surface.

- ❖ If the solder will not flow onto the tip, clean it by wiping it on the wet sponge.
 - ❖ When tinned, wipe excess solder off on the wet sponge.
 - ❖ You do not need to tin the tip before every joint, but you should re-tin it if it has gone dull when the soldering iron has not been used for a few minutes.
 - ❖ Check the manufacturer's instructions related to tinning the tip.
6. The tip of the soldering iron should be a shiny silver color. If it is black and pitted, replace it with a new one.

Soldering

1. Solder needs a clean surface on which to adhere.
 - ❖ Buff the copper foil of a PC board with steel wool before soldering.
 - ❖ Remove any oil, paint, wax, etc. with a solvent, steel wool, or fine sandpaper.
2. To solder, heat the connection with the tip of the soldering iron for a few seconds, then apply the solder.
 - ❖ Heat the connection, *not* the solder.
 - ❖ Hold the soldering iron like a pen, near the base of the handle.
 - ❖ Both parts that are being soldered have to be hot to form a good connection.

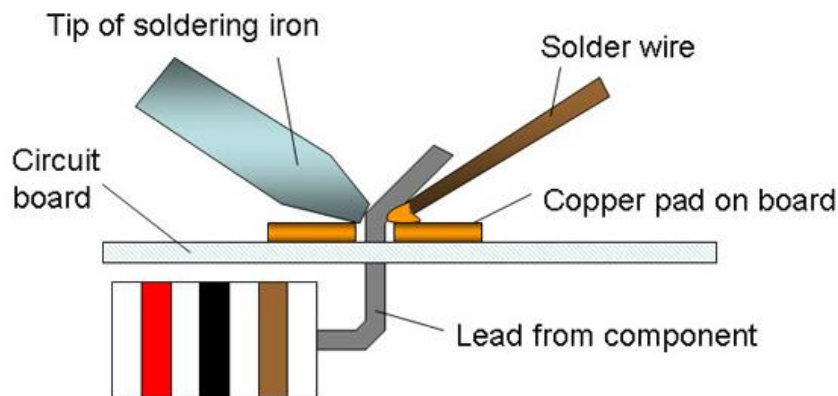


Figure 2. The tip of the soldering iron heats both the copper pad and the lead from the electronic component. Solder melts when placed in contact with the hot metals to be joined.

3. Keep the soldering tip on the connection as the solder is applied.
 - ❖ Solder will flow into and around well-heated connections.
 - ❖ Use just enough solder to form a strong connection.
4. Remove the tip from the connection as soon as the solder has flowed where you want it to be. Remove the solder, then the iron.
5. Don't move the connection while the solder is cooling.
6. Don't overheat the connection, as this might damage the electrical component you are soldering.
 - ❖ Transistors and some other components can be damaged by heat when soldering. A crocodile clip can be used as a heat sink to protect these components.

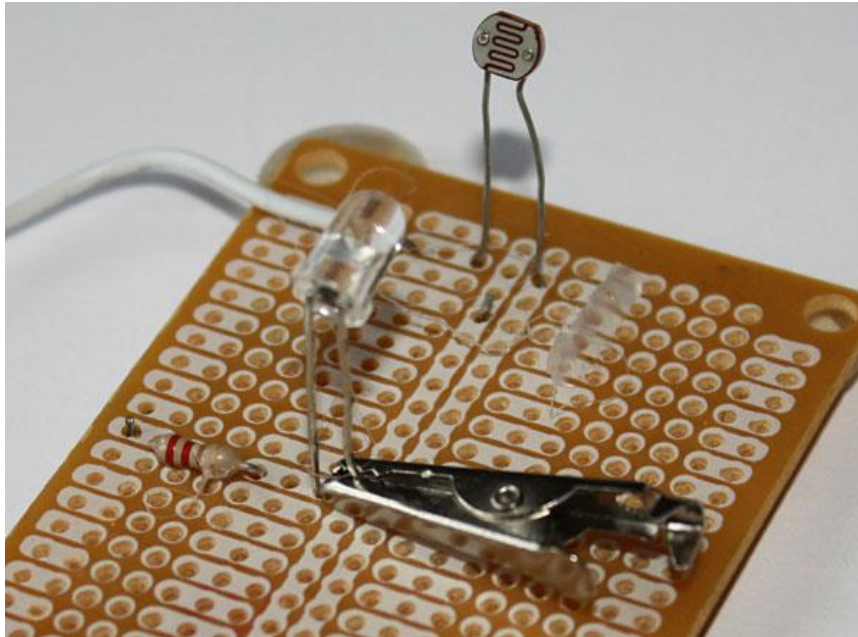


Figure 3. By absorbing heat, the crocodile clip will reduce the heat that flows to the component, helping to prevent damage.

7. Soldering a connection should take just a few seconds.
 - ❖ If it is taking longer, see the troubleshooting section below.
8. Inspect the joint closely. It should look shiny.
 - ❖ If you are soldering a wire (called the *lead*) onto a PC board (on the *track*), it should have a volcano shape. See Figure 3.
 - ❖ If the connection looks bad, reheat it and try again.

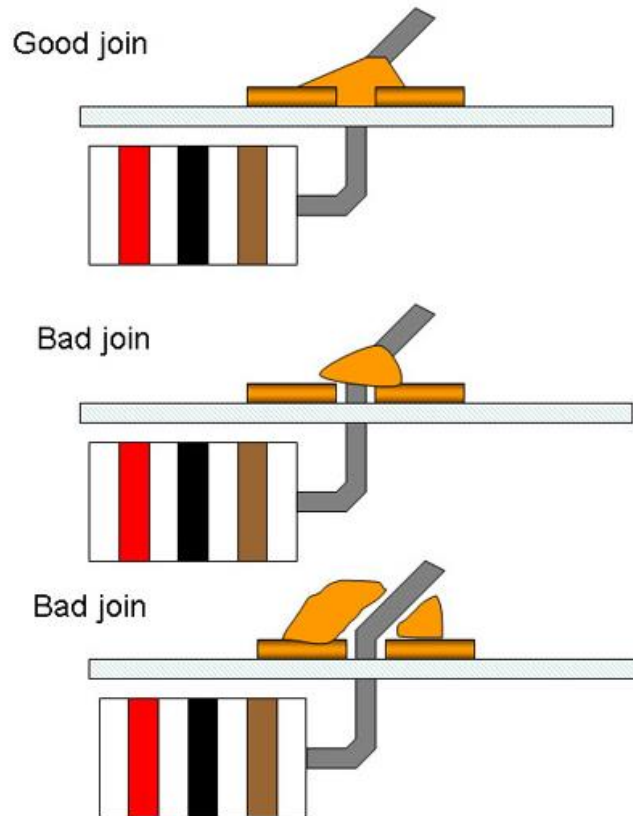


Figure 4. The solder in a good joint will be shaped like a cone, with solid contact between the solder and all surfaces to be joined. Bad joints (also called *dry joints*) should be melted and remade.

9. Wipe the tip of the iron on a damp sponge to clean it. The tip should now be shiny.
10. Unplug the soldering iron when it is not in use.

Common Problems and Troubleshooting

1. Solder will not flow.
 - ❖ The parts to be joined may be dirty. Remove the solder and clean the parts.
2. The connection looks grainy or crystalline.
 - ❖ Parts were moved before the solder was allowed to cool.
 - ❖ Reheat to form a good joint. You may need a larger soldering iron to heat connections adequately.
3. The tip is oxidized.
 - ❖ Soldering is much easier with a shiny, clean tip.
 - ❖ Clean the tip with a damp synthetic sponge while the iron is hot.
 - ❖ To avoid oxidizing the tip, do not leave the iron plugged in when not in use.
 - ❖ Do not use the iron at a higher temperature than is necessary to melt solder.
 - ❖ Clean the tip of the iron on a damp synthetic sponge as soon as it starts to change from a silver color.
4. There is too much or too little solder.
 - ❖ Using too much solder can cause a solder bridge, which means that two adjacent joints are accidentally connected.
 - ❖ Using too little solder might result in poor electrical continuity between the board and component. The connection should be smooth, shiny, and rigid