

## **Soldering**

One important method that is used in electronics for connecting circuits permanently is to solder the wires to a printed circuit board. Solder is a special metal that can be melted at a low temperature. We can connect two metal leads together by melting metal across both leads and allowing it to cool. This is the method that is used in your robot kits.

To prepare you for soldering your robot, you will first spend some time learning to make good solder joints on scrap circuit boards. It is important to practice this first, as excessive heating or excessive solder can destroy the robot PC board. There is a soldering iron, a cleaning sponge, and rosin core solder in the lab tool kit. ALWAYS use rosin core solder when soldering electronic components. The acid core solder used by plumbers will corrode delicate electronic components. At the beginning of the lab you should plug in the soldering iron to allow it to warm up fully before attempting to solder. If you plan to purchase your own soldering iron, always use a low wattage (25-40W) soldering iron. High power soldering irons can overheat delicate electronic components. If your soldering iron does not seem to be getting warm, you should check to make sure that the soldering iron is plugged in and that the power switch for your lab bench is turned on. You should also wet the sponge before each soldering session. Each time you are about to use the soldering iron to solder a wire, you should first brush it lightly across the wet sponge. This removes the corrosion that tends to build up on the tip when it is hot. Solder cannot stick to paint, grease, oil, wax, hair, or other organic substances. In addition, solder will not stick to corroded wires, printed circuit board traces, or component leads. Any corroded surfaces should be buffed with steel wool or fine sandpaper in order to remove the corrosion before soldering is attempted. Wires, component leads, and the copper traces on a printed circuit board should always appear shiny.

Wires or components to be soldered should be held in place by bending their leads to keep them fixed in place or by holding the component with a pair of pliers. If you are holding a component with a pair of pliers, you must keep the pliers perfectly still until the solder has cooled, otherwise you will have a poor and unreliable solder joint. It is dangerous to hold a component being soldered in your hand, as heat will be conducted from the point at which it is being soldered throughout the component or wire. Note, the most common error in soldering is to apply the solder to the tip of the soldering iron. A small drop of solder placed on the tip of the iron before it is brought in contact with the wires to be joined can facilitate heat flow from the iron into the wires. This is called "tinning" the tip. However, additional solder applied to the tip will tend to form a ball on the soldering iron rather than flowing into the solder joint.

You should first bring the soldering iron into contact with the wires and/or printed circuit board traces that are to be soldered together. Typically holding the iron at roughly 45° to the printed circuit board surface. Try to have the tip of the iron touching all of the different wires that are to be joined. Wait about two seconds for the wires that are part of the joint to heat up. Then bring the solder in from the opposite side of the joint. It should also approach at roughly 45° to the printed circuit board surface. You should only touch the solder to the wires to be joined. They should be hot enough to melt the solder. NEVER bring the solder in to touch the soldering iron tip. Feed in solder until a smooth fillet appears between the leads being joined and the printed circuit board trace. Too much solder will result in a large ball enclosing the joint. This should be avoided. Too little solder will leave the leads coated in solder but without solder bridging between them and the printed circuit board. This should also be avoided.

## **Unsoldering**

**CAUTION:** The solder joint you just made, and all of the components attached to it will be very hot for several minutes after being soldered. You should use care in touching metal leads, or any component that has been recently soldered. In addition, the tip of a soldering iron is very hot. It will burn you. One dangerous practice is to allow the power cord of the soldering iron to loop off the edge of the lab bench. This is dangerous because passers by might bump it causing the soldering iron to pull free of the holder and injure someone. You should keep the cord of the soldering iron completely on the surface of the lab bench. In addition, you should never leave the soldering iron sitting directly on the lab bench surface as it can easily spin around and burn objects on the bench. Instead always return the soldering iron to its holder.

Because it is possible to make a mistake and solder together the wrong components (though hopefully this is extremely rare), you should also learn how to "unsolder" components. The key job in unsoldering components is removing the solder from the joint without damaging the components or the circuit board. All approaches to removing the solder require reheating the solder joint with the soldering iron to return the solder to a molten state. Just as with soldering, when you are about to use the soldering iron to unsolder a wire, you should first brush it lightly across the wet sponge. This removes the corrosion that tends to build up on the tip when it is hot. In addition, you may find that it helps to place a small drop of solder on the tip of the iron before it is brought into contact with the solder joint to be unsoldered.

Wires or components to be unsoldered should be held using a pair of pliers. Remember, it is dangerous to hold a component being heated by the soldering iron in your hand, as heat will be conducted throughout the component or wire.

You should first bring the soldering iron into contact with the wires and/or printed circuit board traces that are to be unsoldered. Typically holding the iron at roughly  $45^\circ$  to the printed circuit board surface. Wait until the solder joint begins to soften. Usually this is evident as the tip of the soldering iron sinks into the solder joint slightly. At this point, the component being held by the pliers can be removed from the solder joint by gently pulling on the pliers. Do not pull hard or the copper trace may be pulled away from the surface of the printed circuit board.

The solder left on the circuit board can be removed using solder wick or a "solder sucker." Solder wick is a copper braid which absorbs molten solder. First the end of the solder wick is brought into contact with the solder joint. Then the solder joint is heated with the soldering iron until the solder melts at which point it is absorbed into the solder wick. Next remove the solder wick and then the soldering iron from the joint which should have been drained of its solder. The end of the solder wick, which has become matted with solder is then cut off using a pair of diagonal cutters but be careful it is very hot. If there is still solder remaining on the solder joint, this process can be repeated until all of the solder is all removed.

Another approach to removing the solder from a solder joint is to use a "solder sucker" which is a small suction device that actually pulls the solder away from the board using suction. The soldering iron is first used to heat the solder joint until it is molten. Then the tip of the solder sucker is brought into proximity with the solder joint and the solder sucker is triggered. It sucks some of the solder up into its suction chamber. This process is repeated until all of the solder is removed from the joint.

Note, many components are sensitive to prolonged heating with the soldering iron. Therefore, it is a good idea to heat a solder joint, remove the solder, and then let it cool before repeating the process. In addition, extended heating can also cause the copper traces on the printed circuit boards to detach from the surface of the board.

**CAUTION:** The solder joint you just unsoldered, and all of the components you removed will be very hot for several minutes after being unsoldered. You should use care in touching metal leads, or any component, or the printed circuit board that has been recently unsoldered.