A03.01

Summary:

Students will practice soldering components onto printed circuit boards. Students will learn the visible characteristics of a properly soldered connection and how to inspect printed circuit connections.

Expected Outcomes:

Students should become proficient in making electrically and mechanically sound solder connections without taking so much time, or applying so much solder, as to overheat the components or form solder bridges.

Materials:

Each student(s) should have the following materials, equipment, and supplies:
(*) indicates materials supplied as part of LaACES kit

1. Soldering iron or temperature-controlled solder station
2. Small diameter rosin core solder
3. *Collection of sample components
4. *Small piece of copper clad perfboard or etched circuit board
5. *Short lengths (10 cm or so) of insulated wire, about AWG #22, and shielded cable
6. Small hand magnifier (optional but useful for inspection)
7. Flush-cutting wire nippers
8. Wire stripper or hobby knife
9. **SAFETY GLASSES or GOGGLES**

The laboratory should also be equipped with the following:

1. Flat work tables sufficient to seat all students with plenty of work space.
2. Sufficient light for soldering.

Procedure:

Students will start with through-hole soldering and move onto surface mount soldering. There is no rush, practice makes perfect. It cannot be emphasized enough that one must wear SAFETY GLASSES. Molten solder can splash and clipped wires can fly. Also, solder can contain up to 40% lead so wash your hands well after this activity. Most beginning solderers use too much solder and not enough heat. It is stressed that the **SOLDER PAD** melts the solder, not the iron tip. Only enough solder should be applied to flow onto the pad. Finally, when soldering insulated wire or shielded cable, take care not to overheat the insulation, which will cause it to soften and distort.

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1. **PUT ON YOUR SAFETY GLASSES**

2. Prepare soldering iron. Allow it to heat up to operating temperature, then use a *slightly* damp sponge to clean the tip. “Tin the tip” by applying a small amount of solder and then clean again with the sponge. ***Repeat this cleaning and tinning operation before every joint***.

3. Find a through-hole resistor. Use the lead bending tool to form the leads. Secure the resistor flat against the board, then solder on the reverse side. Make sure the solder is touching the pad, not just the iron. Trim the leads.

4. Inspect each solder joint. A good joint will look like a small, shiny Hershey Kiss. Also, make sure that no solder has formed a bridge to an adjacent connection; this bridge is known as “a short”. Do a few more connections until you are consistently making good joints.

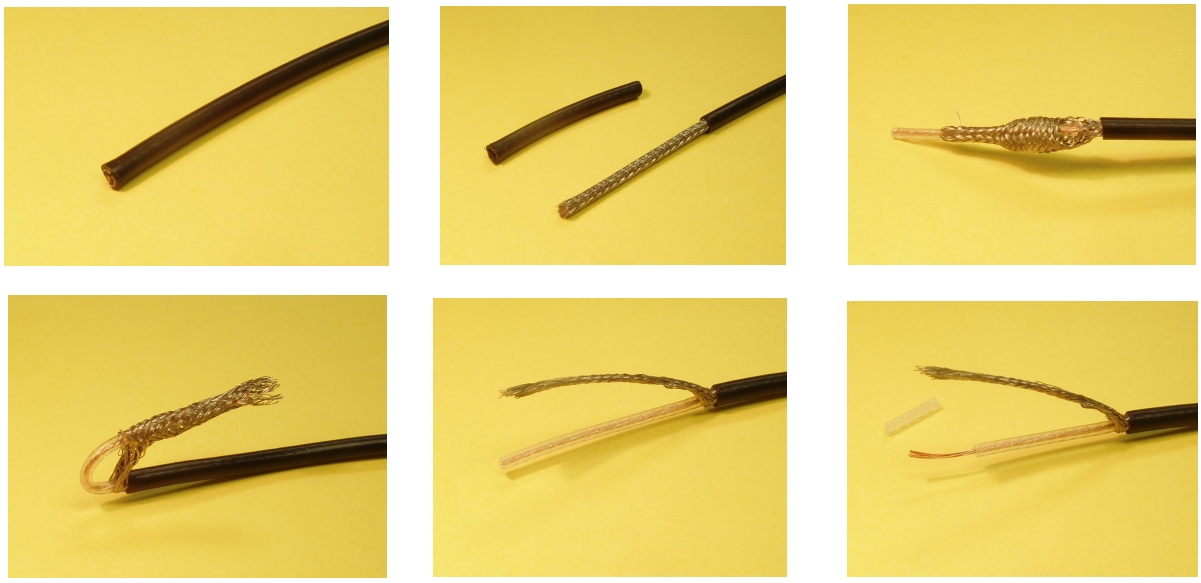
5. Install and solder an integrated circuit (IC) chip. You may have to bend the leads inward slightly to get them to fit into the board. Press the chip flat against the board and then turn the board over. To secure the chip, solder two corner pins diagonally adjacent from eachother. Try not to leave the iron in contact with the joint for more than two or three seconds. Some chips are temperature sensitive.

6. Inspect the chip again and make sure it is flat against the board. If not, re-heat each corner while gently pressing the chip down onto the board.

7. Solder the remaining pins. Practice getting the iron on and off quickly, while still making good shiny joints. DO NOT clip off excess lead length, it's not necessary.

8. Install and solder wire leads. Strip off about 5 mm of insulation from the wire. If the wire is stranded, twist the strands together. Insert the bare end of the wire through a hole in the perfboard and solder on the reverse side. Trim the excess lead length.

9. Prepare a short length of shielded wire (supplied in your LaACES parts assortment) Follow the steps pictured below to prepare the wire, then solder it onto the perfboard.



Note that the braided shield is not unraveled, but rather bunched up and separated so that the inner conductor can be pulled through the opening. Both the braid and the inner conductor should be "tinned" before soldering to the board.

Now it is time to move on to surface mount soldering. In general, tweezers are your friend when handling surface mount devices (SMD). They are usually tiny, and can be lost easily. A clean, well-lit workstation is vital to not losing SMDs. Keep all SMDs in their original packaging and remove them only as need. Also, placing SMDs on top of a plain-white piece of paper when they are out of the packaging helps prevent them from disappearing.

10. Tin the tip of your iron and place a small amount of solder on *one* of the two pads on the board. It will cool and solidify quickly and that's ok.

11. *Carefully*, remove the two-terminal SMD resistor from its packaging by pealing back the plastic with a pair of tweezers. If the SMD is going to be lost, it will most likely occur during this step.

12. Tweezers will help you considerably with this part. Align the resistor on the pads on the board. Once the resistor is aligned, hold it down firmly while you use the iron to re-melt the solder on the pad, and the resistor should become flush with the board. ***Keep holding the resistor down while the solder cools.***

13. Once the solder is cool, apply solder to the other side and inspect your work. It should be flush with the board and free of excess solder. Continue soldering more surface mount resistors until you feel comfortable and then move on to soldering multi-terminal IC.

14. If available, applying flux to the pads on the board will greatly assist in soldering of a multi-terminal IC.

15. Use tweezers to remove the IC from the packaging and align it with the pads of the board (no need to put solder down beforehand like you did for the surface mount resistor).

16. While holding the IC down, tac down one of the corner pins with solder, and then check for proper alignment of the remaining pins. If they are not aligned, remove the solder tac and try again.

17. If you have used flux, jump to the next step. Otherwise, carefully apply a *small* amount of solder to the remaining leads. The motion and rhythm of this process will be similar to tapping each pad/pin connection with the solder and iron briefly as you move down the line of pins. Many ICs are temperature sensitive so practice giving the component a break from the iron heat after each side is done.

18. If you have used flux you can try the fallowing technique with the remaining pins: tin you tip and then “brush” the remaining pins as if you were painting. Use a gentle, brief stroke of the tinned tip on the one side of the IC’s pins and the solder should flow into each pad/pin connection without effort. Wipe away excess flux when done.