ELECTRICAL ENGINEERING DEPARTMENT

EE143 California Polytechnic State University Lab #8

Assembly & Electrical Testing of Continuity-Tester PCB

VIDEOS:

Experiment #8 Playlist at
https://www.youtube.com/playlist?list=PLkooZoxYRwMgdUwuDtI4RH7pI0MSl0e4Y

PRELAB:

1. To begin manually soldering one of your PCBs before attending lab. Soldering can be completed during lab followed by electrical testing and troubleshooting if necessary.

PURPOSE:

- To understand how to electrically test a PCB design, such as a continuity-tester.

This experiment relates to the following **course learning objectives**:

1. Ability to electrically test a PCB design successfully.
2. To be able to troubleshoot a protype design.

STUDENT PROVIDED EQUIPMENT:

1 Continuity-Tester PCB (not assembled or partially assembled)
1 Soldering Kit
1 Soldering Iron (with sponge)
1 Roll of 60/40 Solder or Roll of Lead-Free Solder
1 Safety Glasses
1 Solder Sucker
1 Tweezer
1 Wire Cutter
1 Arduino (only for use of 5V supply)
1 Digital Multi-meter (and its User's Guide) for troubleshooting if necessary

EXPERIMENTAL SECTIONS:

1) Reflow Soldering (background info provided only, will not be able to be done remotely)
2) Electrical Test of Continuity-Tester
3) Troubleshooting (if necessary)

BACKGROUND:

Reflow Soldering

Reflow soldering is the process where solder (usually in paste form) is placed on solder pads before heat is applied. In contrast to, manual soldering or wave soldering where solder and heat are applied simultaneously.

The melting of solder is accomplished by either forced-convection (same as a high-quality pizza oven) or by IR (infrared energy). A third method, vapor-phase is no longer used due to environmental concerns, the release of aerosol gases that adversely affect the atmosphere.

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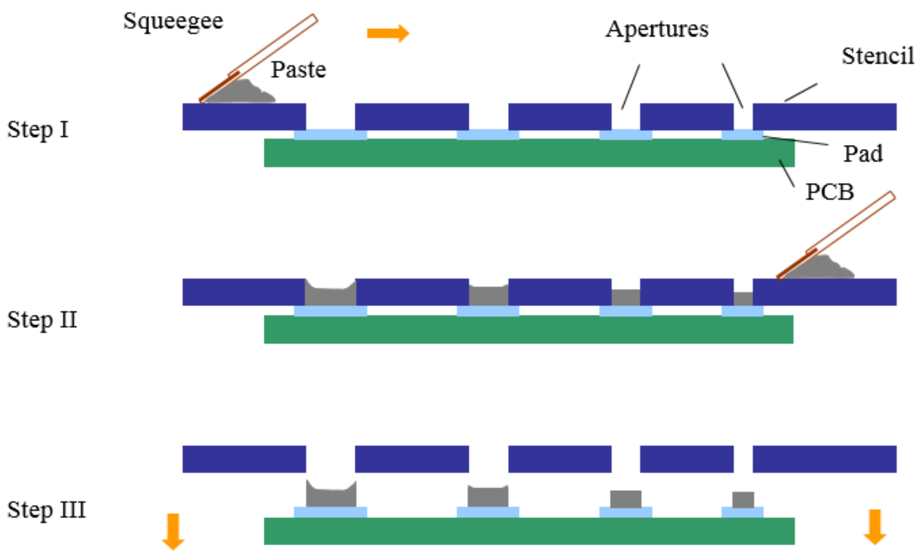
The placement of the solder paste onto the PCB solder pads can be done manually (typically using a syringe) or using a stencil. Stencils are templates made of metal or plastic with apertures (openings) corresponding to solder pad locations. A squeegee is used to spread the solder paste over the stencil thereby forcing the paste through the apertures onto the pads as illustrated below.



Applying heat to the solder paste and then removing heat after reflow has occurred is done in stages referred to as a thermal profile. There are four thermal profile stages; pre-heat, soak, reflow and cool down.

During the pre-heat stage heat is applied gradually so as not to “thermally-shock” PCB components. Applying heat too quickly can physically damage components, especially components made of semiconductors; such as integrated circuits, transistors and diodes. Also, during this phase, flux contained within the solder paste liquefies. The liquefied flux removes oxide from surfaces to be soldered to enhance the heat transfer between the soldering surfaces thereby increasing the probability of a good solder joint.

The next stage, soak, brings the temperature of all components and PCB areas to an equal temperature. Differences in components’ “thermal signature” cause components to heat up at different rates (thermal signature refers to the color, thermal co-efficient and reflectivity of a component). This is especially true for IR heating. The temperature during the soak stage is held constant or at a slow gradual incline to allow the time for all components and PCB areas to heat up to the same temperature.

After soak is finished, comes reflow. During reflow heat is increased until the solder paste melting temperature is exceeded. Typically, the peak oven temperature will be 25°C above the solder paste melting temperature. During this stage the highest temperature is reached. Solder flows to the surfaces to be soldered.

The last stage is cool down. Temperature is gradually decreased as to not “thermally-shock” components. Removing heat too quickly can damage components (especially semiconductor components). Also, gradually removing heat leads to better quality solder joints. Of course, cool down is necessary to safely remove boards from the reflow oven.

A typical thermal profile with the four stages illustrated is shown below.

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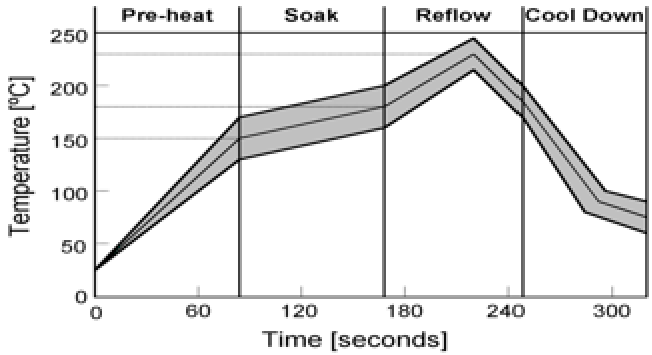

PROCEDURE:

Section2) Electrical Test of Continuity-Tester

a) Testing:

Connect 5V and ground of Arduino to continuity-tester PCB. Solder wire directly to PCB connector pads. If using stranded wire, tin wires with light coat of solder before inserting into PCB holes.

Be alert to overheating of components. Gently touch IC package (black plastic), if hot (or very warm), disconnect 5V immediately. Of course, if there's smoke, unplug 5V!!

Solder wire directly to X and Y PCB pads. If using stranded wire, tin wires with light coat of solder before inserting into PCB holes.

LED should not be lit when X and Y wires are not connected.

LED should be lit when X and Y are connected.

If the continuity-tester is not working, go to the next section

Section3) Troubleshooting (if necessary)

a) Troubleshooting tips:

i. Measure 5V on both the PCB and on the Arduino board with a DMM. If when 5V is connected to PCB, DMM reads voltage < 5V disconnect 5V from PCB and measure 5V on Arduino board. If DMM reads 5V on Arduino board but reads < 5V when 5V is connected to PCB, most likely there is a short (most likely solder bridge) on PCB.

ii. Check to make sure traces on PCB agree with schematic. Easiest way to do this is to look at the traces on one the unassembled PCBs to clearly see where traces connect.

iii. Make sure components are in their correct locations and if a polarized component, make sure of correct orientation.

iv. After steps i through iii, consult ISA or instructor for assistance.

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DISCUSSION:

Section 2

1) Insert pictures of your completed continuity-tester board here, both topside and bottom side.

Section 3

1) If you had to troubleshoot your project, what problem did you find? How could of the problem been prevented?