SUMMER INSTITUTE FOR ENGINEERING AND TECHNOLOGY EDUCATION

ELECTRICAL ENGINEERING - TEACHER MODULE 4

PRINTED CIRCUIT BOARD DEVELOPMENT

CONCEPT

This unit introduces the process of developing a Printed Circuit Board (PCB).

OBJECTIVES

At the completion of this unit, you will be able to do the following:

- Expose the photoresist of a PCB using a circuit mask and Ultraviolet Light
- Develop the exposed PCB with photoresist developer
- Etch a developed PCB
- Prepare the PCB for use and drill the PCB
- Solder electronic components onto a PCB

Materials List

- Unexposed printed circuit board(positive photoresist PCB)
- Approximately 50 grams of developing solution
- Approximately 115 grams of dry concentrated etchant (Ferric Chloride)
- Circuit transparency mask

Tools List

- UV exposer setup
- Drill with appropriate drill bit
- Soldering iron and solder
- A medium strength scrub pad
- Plastic (preferred) or glass container large enough to immerse the PCB
- Glass stirrer
- Paper towels

SAFETY PRECAUTIONS

- ALWAYS wear rubber gloves, a disposable apron and eye goggles when developing and etching the board.
- Follow all instructions on the chemical packages.

THE JOB

You will be given an unexposed PCB and a circuit mask. The unexposed PCB should be kept in its packet until it is ready to be exposed. Make sure all your equipment is clean before starting this lab.

UV expose positive photoresist PCB

1) Prepare the UV exposer for use, make sure there is as little light as possible in the room.
2) When you are ready to expose the unexposed PCB, remove the PCB from its packet; slowly and steadily peel the protectant film from the PCB.
3) Set the unexposed PCB down on the UV exposer, taking care not to touch the copper side of the board, and place the circuit trace on top of the PCB. Make sure the circuit trace is oriented correctly and not upside down.
4) Close the UV exposer and turn the UV light on.
5) At exactly 10 minutes, turn off the UV light and open the UV exposer.
6) Remove the circuit trace and place the exposed PCB in its original packet.

Develop an exposed PCB with PCB Developer

1) Put on your rubber gloves, disposable apron and eye goggles; do it now.
2) Pour 1,000 ml. of warm water (25 - 30^{o}C) into the plastic container.
3) Pour the developing solution into the plastic container and stir it with the glass stirrer until there are no more solid's left in the container.
4) Remove the exposed PCB from its package, taking care not to touch the surface of the PCB, and slowly place the PCB (copper side up) in the plastic container.
5) Gently rock the plastic container from side to side, taking care not to splash the developing solution.
6) Rock the container until the blue smoke film stops floating from the PCB. This procedure should last between 0.5 to 2.0 minutes. Exceeding 2.0 minutes might cause the photoresist film to be over exposed thus making the board unusable.
7) When this is done, remove the PCB from the container and wash the PCB under cold running water. If possible, use gentle flowing water to wash off any remaining developer from the PCB; this stops the developing process from continuing.
8) Gently dab the PCB dry with a dry paper towel and put it aside.
9) Store the remaining developing solution in a plastic container for later use. Clean the plastic container, with water, thoroughly. You are now ready to etch the PCB.

Etch a developed PCB

1) Spread some paper towels or old newspaper around the area you will place the plastic container on, this is to facilitate easier cleanup later.
2) Make sure you have your gloves, apron and eye goggles on before proceeding.
3) Pour 455 ml. of warm water (up to 55^{o}C) in the plastic container.

4) Slowly pour 115 grams of dry concentrated etchant into the warm water. You will see fumes coming out, this is normal but try not to inhale the fumes.
5) Make sure the concentrated etchant is properly dissolved before proceeding with this lab; this can be done by stirring the solution with the glass stirrer.
6) Place the developed PCB, copper side up, in the plastic container and slowly rock the container from side to side; avoid splashing the etchant.
7) Continue rocking the container while watching the unprotected copper traces being etched.
8) The process of etching the PCB can take anywhere from a few minutes to 2 hours; the key idea is to etch the unprotected copper from the PCB.
9) This process should ultimately take about 10 - 30 minutes; over-etching the PCB will cause broken copper traces on the PCB, possibly rendering the board unusable.
10) When the unprotected copper on the PCB seems to be all gone, remove the PCB from the container and verify that this is the intended circuit.
11) Clean the PCB under flowing water, ensuring that all the etching solution is removed from the board. Dry the board with clean paper towels and set the board aside.
12) Store the leftover etching solution in a plastic container and clean up the plastic container with lots of water. Dispose the newspaper or paper towels around the area.

Prepare the PCB for use and drill the PCB

1) Pour the earlier saved developing solution into the plastic container.
2) Put the etched PCB into the container until the copper traces are clearly visible on the PCB.
3) Remove the PCB, rinse it under running water and dry it. The PCB is now ready for drilling.
4) Return the developing solution into its container and clean up the plastic container.
5) Using the appropriate drill bit, drill the white "bubbles" on the PCB. Place the drill bit up to the PCB (copper side up) and start the drill, firmly push the drill bit through the PCB. Continue doing so for all the "bubbles".
6) Once all the "bubbles" are drilled, wash the PCB under running water and dry it well. If the PCB is not fully dried, soldering will not work well on the PCB. The PCB is now ready to be soldered.

Solder onto a PCB

1) Place the component to be soldered into the holes drilled in the board.
2) Refer to the enclosed sheet on how to solder.
3) Once you are done soldering, check the solder joints under a magnifying glass to ensure proper solder joints.
4) Once you are done soldering all the components, check to make sure there are no short circuits on the traces; i.e. no solder has flowed between two pins.
5) As a rule, you should solder the more "resistant" components first, leaving the more sensitive components for later; i.e. solder the I.C. mounts and resistors before soldering the LED's or transistors.

BIBLIOGRAPHY

[1] HOROWITZ, PAUL AND WINFIELD HILL, *The Art of Electronics*, Second Edition, Cambridge University Press : New York, NY, 1989.

OTHER SOURCES

Sources for chemicals and printed circuit boards are:

Circuit Specialists, Inc.
P.O. Box 3047
Scottsdale, AZ 85271-3047
1-800-528-1417
(602) 464-2485

Radio Shack
Fort Worth, TX 76102
Also, look for a Radio Shack Associate Store near you.