Continuing..

**PRINTED WIRING BOARD TECHNOLOGIES**
MECHANICAL DRILLING OF HOLES FOR PWBs

Why holes?

- Registration during PWB manufacture
- Mounting Holes for assembled PCBs
- Stacking holes during drilling
- Plated through holes to electrically connect different layers

4 MLB

3-4 PCBs stack
Double Sided Plated Through Hole Printed Wiring Board

Interlayer connection..

- Riveting Technology
- Filling with solder
- Filling with conducting polymer paste
- Metal deposition on the hole wall - 1964 – Shipley
Double sided board manufacture

- Design
- Photo-tooling (1:1)
- Drill holes (PTH)
- Plate (electroless)
- Image circuit
- Plate (Cu electroplate)
- Plate (Sn or Sn-Pb electroplate)
- Strip
- Etch
- Strip and Protect before assembly

Fig. source: Wikimedia Commons 2011
Step to Step description of DS PTH Board making

The laminate comes in 1150 mm × 980 mm size

**Step 1**  Panel cutting - Shearing/Circular Saw

Every PWB manufacturer will have a **fixed panel size** which is processed...individual boards are not processed..

Design has to fit into some **COMMON** panel sizes: 600 × 600 mm, 450 × 600 mm, 450 × 450 mm, 450 × 300 mm or 300 × 300 mm

A Panel can carry one or more circuits

Six smaller circuits are **STEP-REPEATED** in a given Panel Size

15 mm border allowance is preferred

Diagram: A 3 × 2 grid of numbers 1 to 6 representing the possible configurations of circuits on a panel.
Step 2 Insertion of Holes

Why holes are required?

a. Component mounting [Through and through/round]
b. Interlayer connection hole [Through and blind - Round]
c. Stack Location holes [Through and through]
d. Registration hole [MLB/Round/Oval]

How to make holes? 

Automate

Drill Bit Material?

Solid Tungsten Carbide (Co inclusions)
Iso-statically Pressed

CNC Drilling machines 30-40 holes
multi-spindle 0.1c 1.5G

Drill Geometry?

1 or 2 times Rebecca
Step 3  **Stacking** for Drilling

Stack of three laminates

Drilling machine table

Entry board ..?  Al

Exit board ..?  Bakelite

bed of CNC M/C

To increase productivity
Manual Drilling machine for PWB application
CNC Drilling for PWBs
Step 4  Deburring

Entry and exit burrs

Burrs are to be removed......they cause plating problems

*This is called as "deburring" operation ... ...note that Cu surface is not touched*
Step 5  Brushing
Cleaning and roughening of Copper surface
Expected increase in surface area - 2 to 4 times

Machine brushing gives best results

parallel axis is important

Step 6  Hole cleaning & Rinse
Hole walls carry a lot of loose dust particles... bad base for copper plating

Cleaned by Slurry blast or Ultrasonic cleaning

Epoxy smear glass fibre

Reduced diameter of hole after plating

0.6mm → 0.5mm
Step 7  Sensitizing
preparing for electroless copper
dip in 30% HCl - halide rich surface.....

Microetch using (NH4)2S2O8
Swell / Etch using alkaline KMnO4

Step 8  Pre-Activation
Dip in a colloid solution of palladium
Adsorption of “embryo” containing colloidal palladium

Agglomerates of palladium atoms encapsulated in
alfa-stannic acid as carrier is adsorbed on the surface
Step 9 - Activation/ Accelerator

Breaking of the “embryo” and spilling of palladium atoms

Palladium atom/catalyst

Step 10 - Cascade Rinse

Step 11 - Electroless copper plating

Palladium atoms “catalyze” copper reduction from a solution containing copper ions... $\text{Cu}^{2+}$ ion source and reducing agent: $\text{N}_2\text{H}_4$

Each “nascent” copper atom formed in itself acts like catalyst and the reaction continues; hence also known as “auto-catalytic” deposition

PTH process ends here
Electroless Copper Plating - Rate of deposition

- Low build electroless copper gives 1 micron/hour
- Medium build electroless copper gives 3 microns/hour
- High build electroless copper gives 6 microns/hour

Electroless Copper thickness is not adequate for “reliability” of the plated barrel......

A minimum of 12-15 microns copper thickness is necessary

Additional copper thickness is added through Electroplating

Two routes are possible in electroplating

- panel plating method - medium dense boards
- pattern plating method - high dense boards
During drilling, drill bits become heated resulting in the melting and smearing of the epoxy-resin base material across the inner-layer copper surfaces within the hole barrel to which subsequent through-hole plating must connect. If not corrected the smear would constitute a dielectric layer between the inner-layer copper surfaces and the plated copper, and the circuit would be defective.
During etchback, in addition to smear removal, the glass fibers themselves are etched back from the hole wall. The goal is to remove about 0.25 mil from the top and bottom of the innerlayer copper so that it will protrude out from the hole wall. This creates three surfaces (also known as a three-point connection) for the copper to bond to during the making holes conductive step. Glass etchants include hydrochloric acid, ammonium bifluoride, and hydrofluoric acid (rarely used). Etchback with plasma can be achieved by varying the type and amount of reactive gases. KMnO$_4$ is also used.
Panel Plating

- Cut Laminate
- Drill the holes
- PTH Plating-Electroless
- Cu Electroplate the Panel
- IMAGE DRY film - Tent the PTH Holes
- Plate TIN AS ETCH Resist
- ETCH-ALKALINE NH₃
- Strip Dry film
- POST Operations

Pattern Plating

- Cut Laminate
- Drill the holes
- PTH Plating-Electroless
- IMAGE DRY FILM - NO TENTING
- Cu Electroplate the PATTERN
- Sn Electroplate - AS ETCH Resist
- ETCH-Alkaline NH₃
- Strip Dry film
- POST Operations

Bare board is complete
PTH Electroless Copper Plating

Video highlights-PTH process sequence- complete steps