



Striving for Perfection, Zero Tolerance for Errors

In the electronic era characterized by high speed, high density, and high reliability, PCB (Printed Circuit Board) has become the core carrier that determines the performance, stability, and service life of electronic products.

POE Takes You Deep into PCB Processes and Error Control

From consumer electronics to industrial control, and even to the aerospace field, the requirements for PCB precision are becoming increasingly stringent. This article will explain how POE ensures each circuit board is accurate and meets high-end application needs through advanced technologies and strict systems.

Part 1 Core PCB Manufacturing Processes and Key Error Control

1. Pattern Transfer

Process Overview :

Pattern transfer is a key process that accurately replicates the pattern information (such as circuits and pads) from PCB design drawings onto copper-clad laminates. It directly affects the fineness and accuracy of circuits.

Key Errors and Control Measures :

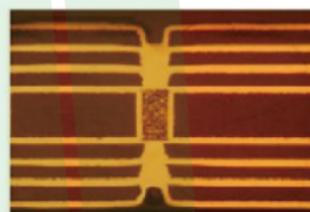
- **Alignment Accuracy:** Misalignment of circuits between layers in multi-layer PCBs can lead to connection failure and signal crosstalk. POE adopts a Laser Direct Imaging (LDI) system to eliminate film deformation and manual alignment errors. The alignment accuracy reaches $\pm 3\mu\text{m}$, which is suitable for high-density products with circuit spacing less than 0.1mm. It also supports rapid engineering changes and complies with environmental standards.



LDI

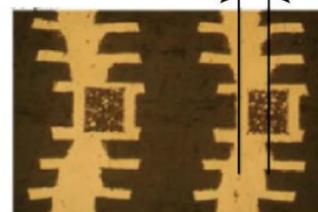
Alignment Performance Comparison :

Alignment accuracy reaches $\pm 3\mu\text{m}$



LDI exposure

Offset between layers 80 μm



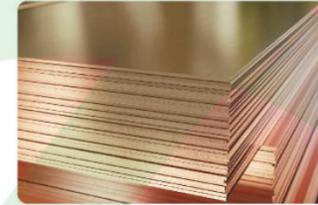
Film exposure

- **Line Width/Spacing Control:** Deviations will affect current carrying capacity, signal transmission, and anti-interference ability. POE achieves precise etching through triple control: real-time monitoring of etching solution parameters (Cu^{2+} concentration: 180-220g/L, data collected every 30 seconds), precise proportioning of additives as required by suppliers, and equipping with a "breakpoint detection" system to control etching time and avoid "over-etching" or "under-etching".

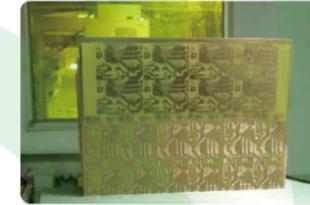


Etching Line

Etching Comparison :



Copper-Clad Laminate (CCL) / Full Copper Foil



Etched Circuit Pattern

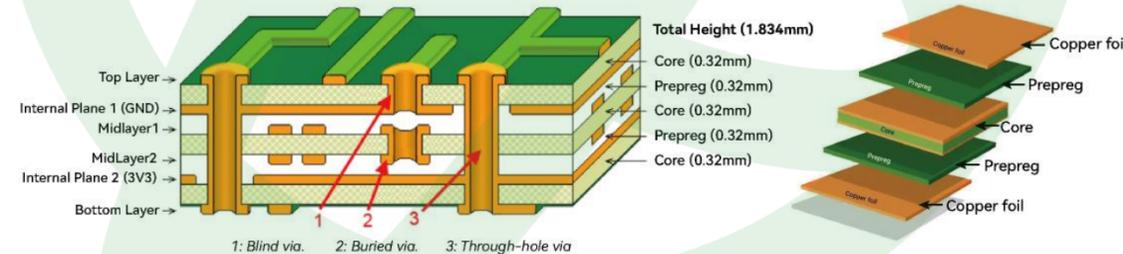
2. Lamination

Process Overview :

Lamination is the process of pressing multiple inner core boards and prepregs into an integrated multi-layer substrate according to the designed stacking sequence under specific temperature and pressure. It is crucial for the uniformity of substrate thickness, impedance consistency, and structural stability.

Key Errors and Control Measures :

- **Alignment Accuracy:** Dielectric thickness deviation causes impedance fluctuation, impairing high-speed signal transmission. POE ensures PCB quality through multi-level controls, including: employing next-generation automated lamination systems with precision, reliability, and advanced control to meet multilayer PCB stacking requirements; and verifying each substrate using automated laser thickness gauges (accuracy: $\pm 1\mu\text{m}$) with ≥ 20 measurement points.



Structure of Multilayer PCB

Structure of Multilayer PCB

3. Drilling

Process Overview :

Drilling is the process of using CNC drilling machines to process through-holes, blind holes, and buried holes. It is used to realize the electrical connection of circuits between layers, and its quality affects the effect of hole metallization and interconnection reliability.

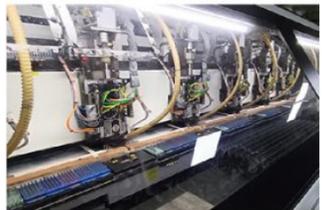


CNC drilling machines

Key Errors and Control Measures :

- **Hole Position Accuracy:** Deviations will lead to misalignment between holes and circuits. POE selects Japanese Fanuc CNC drilling machines (positioning accuracy $\pm 0.01\text{mm}$, repeat positioning accuracy $\pm 0.005\text{mm}$) and calibrates the equipment monthly. The drilling machines are placed in a constant temperature and humidity workshop, and a "zoned drilling" strategy is adopted to prevent thermal deformation.

- **Hole Wall Quality:** Issues such as burrs and slag adhesion will cause poor hole metallization. POE selects drill bits according to the substrate conditions (service life: 500-800 holes per bit), determines the optimal drilling speed and feed rate through DOE (burr height $\leq 5\mu\text{m}$), and uses compressed air to blow away debris.



4. Plating

Process Overview :

Plating is the process of depositing a uniform copper layer on the substrate surface and the hole walls of drilled holes, including surface plating and hole metallization. High-density PCBs require blind hole filling plating.

Key Errors and Control Measures :

- **Copper Thickness Uniformity:** To prevent uneven current distribution and signal delay variations, POE utilizes horizontal electroless plating lines with a "double spray" system. This maintains a plating solution pressure deviation within 0.05MPa, guaranteeing full contact across the entire substrate surface.



Electroplating

5. PCB Key Dimensional Tolerance Control Table

Process Link	Control Item	Control Range (Tolerance)	Testing Equipment	Standard Basis
Pattern Transfer	Line Width /Spacing	$\pm 0.02\text{mm}$ (line width $\leq 0.1\text{mm}$); $\pm 0.03\text{mm}$ (line width $> 0.1\text{mm}$)	Laser Line Width Measuring Instrument (accuracy $\pm 1\mu\text{m}$)	IPC-6012 Class 3
Lamination	Total Substrate Thickness	$\pm 10\%$ (e.g., 1.6mm substrate: 1.44-1.76mm)	Fully Automatic Laser Thickness Gauge (accuracy $\pm 1\mu\text{m}$)	IPC-6012 Class 3
Lamination	Dielectric Layer Thickness	$\pm 8\%$ (e.g., 0.2mm dielectric layer: 0.184-0.216mm)	Metallographic Microscope (400x)	IPC-4101
Drilling	Hole Position Accuracy	$\pm 0.05\text{mm}$ (hole diameter $\leq 0.5\text{mm}$); $\pm 0.08\text{mm}$ (hole diameter $> 0.5\text{mm}$)	Coordinate Measuring Machine (CMM, accuracy $\pm 0.002\text{mm}$)	IPC-6012 Class 3
Drilling	Hole Diameter	$\pm 0.05\text{mm}$ (hole diameter $\leq 0.5\text{mm}$); $\pm 0.05\text{mm}$ (hole diameter $> 0.5\text{mm}$)	Hole Diameter Measuring Instrument (accuracy $\pm 1\mu\text{m}$)	IPC-6012 Class 3

Process Link	Control Item	Control Range (Tolerance)	Testing Equipment	Standard Basis
Plating	Surface Copper Thickness	±10% (e.g., 35µm copper thickness: 31.5-38.5µm)	Copper Thickness Tester (accuracy ±1µm)	IPC-6012 Class 3
Plating	Inner-hole Copper Thickness	≥20µm (hole diameter ≤ 0.5mm); ≥25µm (hole diameter > 0.5mm)	Metallographic Microscope (400x)	IPC-6012 Class 3
Profile Processing	Substrate Profile Dimension	±0.1mm (length ≤ 100mm); ±0.15mm (length > 100mm)	2D Image Measuring Instrument (accuracy ±0.005mm)	IPC-4101
Profile Processing	Warpage	≤0.5% (substrate diagonal length)	Warpage Tester (accuracy ±0.01mm)	IPC-6012 Class 3

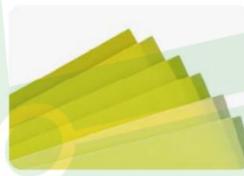
Part 2 POE's Core Error Control System

1. Impedance Control – The Cornerstone of Signal Integrity

In high-speed applications like 5G base stations and autonomous driving chips, PCB impedance mismatch degrades performance. POE's end-to-end control system, covering design, manufacturing, and verification, ensures stable signal transmission.

2. Dimensional Stability – Full-process "Anti-deformation" Management

POE employs a three-tiered management approach to ensure dimensional stability: utilizing high-Tg (≥150°C) and low-CTE materials; implementing pre-lamination baking (120-130°C, 2-4 hours), optimized lamination profiles, and a "rough milling + laser finishing" process; and conducting post-process 2D dimensional inspection with parameter adjustment triggered by deviations exceeding the 5% warning threshold.



High-Tg material



Pre-lamination baking

3. Automation and Intelligent Monitoring – Reducing Human Errors

To mitigate human error in production, POE has implemented a digital quality ecosystem. This includes an MES for full-process tracking, AOI to replace manual inspection after key steps, and an industrial Internet platform that integrates data to trigger predictive alerts, thereby minimizing human intervention.



AOI



Inner circuit X-ray



Automatic E-test



Probe-flying test

"Design-Manufacturing" Collaboration Solution

PCB manufacturing precision is closely related to the design scheme. POE provides support for designers to achieve perfect collaboration between the two parties.

- Free DFM analysis: Provide a report within 24 hours after receiving the design file.
- Impedance calculation support: Assist in determining impedance design parameters.
- Material selection suggestions: Recommend substrate materials according to the application scenario and provide samples for testing.



1. Counselling

Send gerber file to sales@poe-pcba.com



2. Quotation

Get a free quote within 24 hours



3. Confirm an order

Confirm PO from customer



4. DFM analysis

Free DFM checking and send engineering questions

POE delivers precision PCBs through expert micron-level process control. We partner with you to mitigate design risks, ensure product consistency, and guarantee quality—enabling your success in HDI, high-speed, and high-reliability applications. Contact us to solve your technical challenges.

“ POE ,
Precision
On
Excellence!



POE MANUFACTURING
YOUR GLOBAL TECHNOLOGY
PARTNER



POE Takes You Deep into
PCB Processes
and Error Control

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