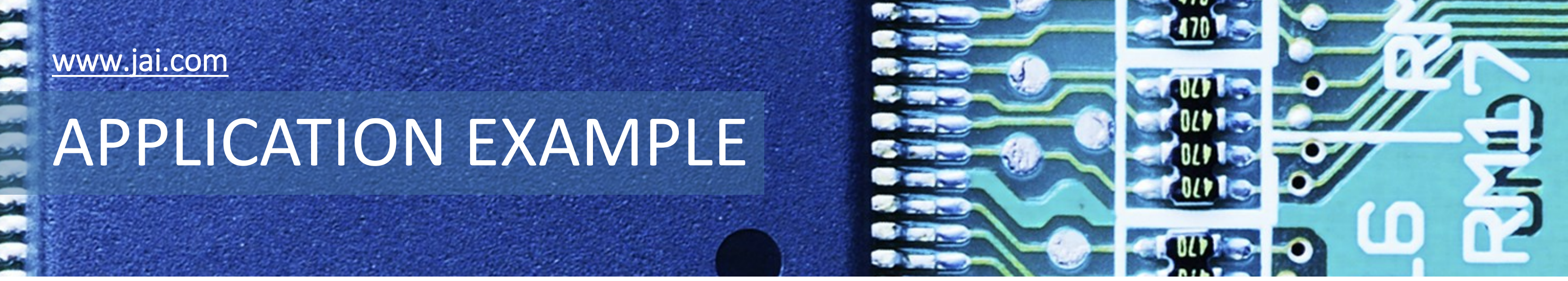

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APPLICATION EXAMPLE

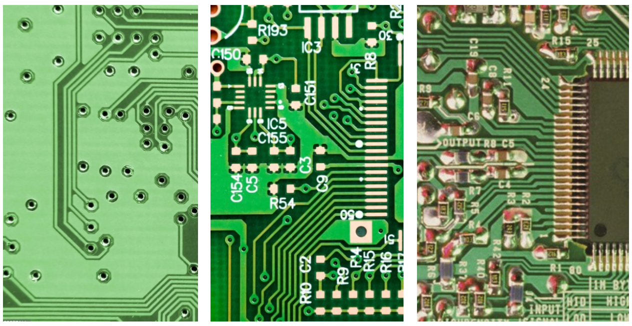
PCB Inspection—Accuracy at Every Layer

Printed Circuit Boards (PCBs) form the backbone of modern electronics, driving functionality in everything from smartphones and EVs to medical and industrial systems. As the demand for smarter, faster, and smaller electronics grows, so does the need for precision in PCB manufacturing and inspection.

Printed Circuit Boards (PCBs) are categorized based on structural complexity into three main types:

- Single-sided boards – featuring copper traces on only one side of the substrate.
- Double-sided boards – with copper circuitry on both the top and bottom layers.
- Multi-layer boards – composed of multiple copper layers laminated with insulating dielectric materials.

Advanced applications such as Differential Scanning Calorimetry (DSC) typically require high-density multi-layer configurations like 1-4-1 and 2-4-2. These stack-ups enable compact, high-performance designs by supporting increased signal routing layers, enhanced thermal performance, and robust interconnect reliability.



From Raw Material to Ready Board: The PCB Production Process

Each step in PCB manufacturing is critical. Below is a simplified overview of the key stages:

1. Cutting the Copper-Clad Laminate
Base materials, typically copper-clad on both sides, are automatically or semi-automatically cut to panel size.

2. Surface Pre-Treatment
Using alkaline and acidic solutions, surfaces are cleaned of oils and oxidized layers, then micro-etched for optimal dry film adhesion.

3. Image Transfer
- Dry Film Lamination: A photosensitive film is applied.
- Exposure: UV light transfers the circuit pattern.
- Development: Unexposed film dissolves in alkali solution.
- Etching: Acid removes unprotected copper traces.
- Film Removal: Residual film is stripped.

4. Inner Layer Inspection (AOI)
Automated Optical Inspection (AOI) checks the etched layers for defects like shorts, opens, residual copper, and missing features—using black-and-white line scan cameras since the copper is still bare.

5. Oxidation/Browning
The surface is roughened (blackened or browned) to enhance interlayer adhesion.

6. Lamination
Multiple layers are fused under high temperature and pressure, ensuring a void-free bond between copper layers and insulating films.

7. Drilling and Post-Drill Cleaning
Mechanical and laser drills form through-holes, buried and blind vias. Post-drill cleaning removes debris to ensure reliable copper plating.

8. Copper Plating
- Electroless plating deposits a base copper layer.
- Electrolytic plating builds up copper thickness.

Inspection Point: PCB Hole Inspection
Dedicated inspection machines verify hole integrity post-drill and post-plating to catch defects early.

See the possibilities

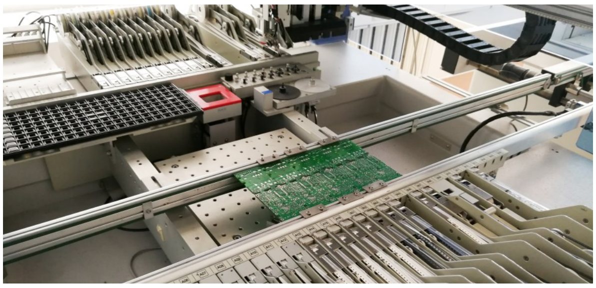
9. Solder Mask and Silkscreen

- Green Oil Coating: Solder mask is applied via stencil printing.
- Silk Screen Printing: Component labels and marks are printed.

10. Final Shaping & Pre-Test Checks

- Contour Cutting: Panels are routed to shape.
- Visual Inspection: Warpage and cosmetic defects are screened.

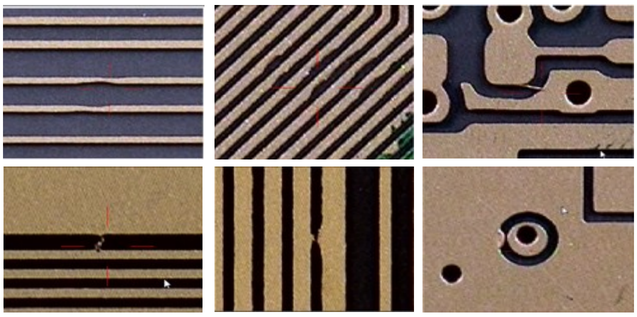
11. Electrical Testing
All connections are tested for continuity and shorts using electrical fixtures.



Advanced Inspection Systems in Action

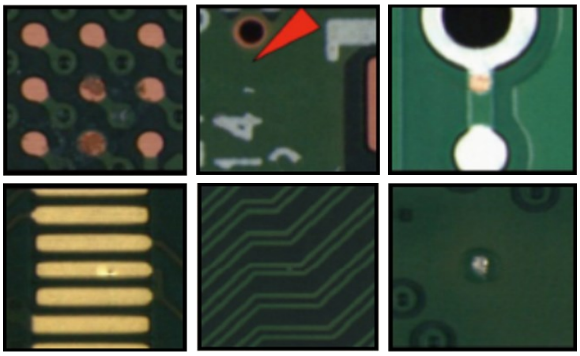
1. AOI (Automated Optical Inspection)

Defect Inspection: After the inner layer process, AOI checks for critical defects such as shorts, opens, copper residue, pinholes, line width and spacing errors, annular ring issues, and missing features.
Camera recommendation: SW-16001M-MCL



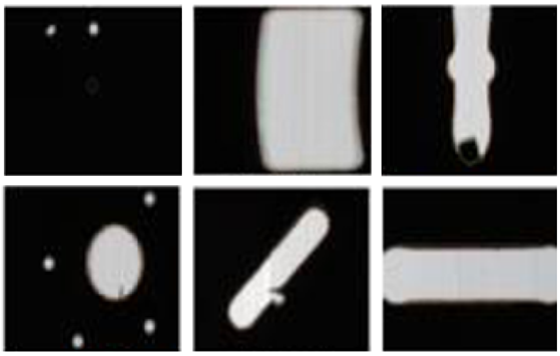
2. AVI (Automated Visual Inspection)

AVI is used to detect cosmetic and surface-level defects, including exposed copper, solder pad issues, concave or protruding surfaces, discoloration, broken solder masks, missing or blurred text, blocked or damaged holes, oxidation, contamination, foreign materials, and irregular board shapes.
Camera recommendation: SW-8001TL-MCL



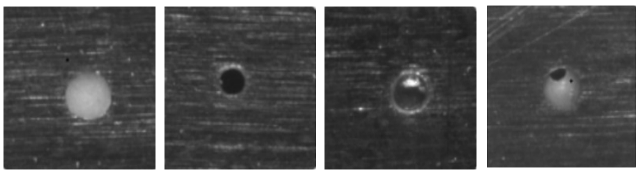
3. Hole Inspection Machine

After drilling copper-clad laminates, this system inspects for defects such as missing, oversized, undersized, or multiple holes, as well as debris in round and slotted holes.
Camera recommendation: SW-16001M-MCL



4. Plugging machine

Detects plugging defects such as leaks, dents, and bubbles after plugging.
Camera recommendation: SW-16001M-MCL



Camera Solutions and Benefits

For inspection tasks such as **inner layer AOI**, **hole inspection**, and **plugging defect detection**, precision and speed are essential.
With trace widths and defect sizes often ranging from **25 µm down to 10 µm**, resolving these features requires high-resolution imaging. Depending on the type of defect and the contrast two pixels/defect or more can be required. For example, to inspect an 80 mm-wide panel with 10 µm resolution, at least an **8k camera** is required—and for even finer features or wider panels, a **16k sensor** becomes necessary.

JAI's new **SW-8001M-MCL** (8k) and **SW-16001M-MCL** (16k) monochrome cameras are designed for such demanding tasks. Their **dual-line TDI functionality** increases signal accumulation during fast scanning, improving image quality without requiring longer exposures or higher-intensity lighting. This is especially beneficial for capturing subtle defects on low-reflectance surfaces, such as **bare copper**, **oxidized layers**, or **browned interlayers**, where conventional line scan cameras may struggle to maintain consistent image quality.

Other defects that occurs during PCB production require differentiation between different colors. This adds an additional layer of information that is critical for detecting issues like **solder mask misalignment**, **contamination**, **oxidation**, **incorrect silkscreen,** or **discoloration from thermal stress**. These are defects that may not be reliably identified in grayscale imaging alone. The **SW-8001TL-MCL** trilinear color model is well suited for this role, offering excellent color fidelity and high sensitivity thanks to its large pixels and accurate color reproduction even at high line speeds.

Together, these high-resolution, high-sensitivity cameras offer the right balance of speed, accuracy, and image quality required to support the evolving needs of modern PCB manufacturing, where both **dimensional precision** and **visual appearance** must be tightly controlled to maintain yield and reliability.

See the possibilities