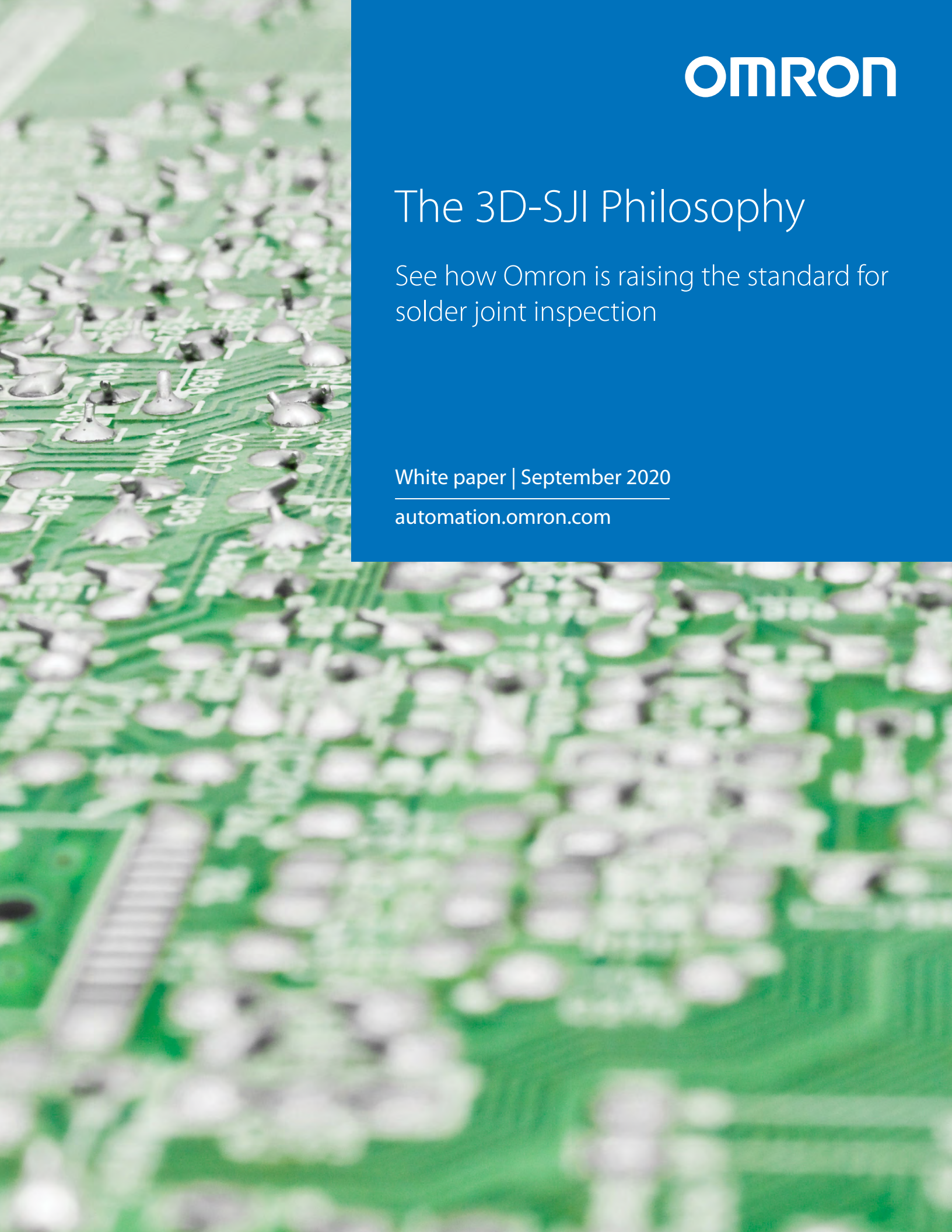

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The 3D-SJI Philosophy

See how Omron is raising the standard for solder joint inspection

White paper | September 2020

automation.omron.com

Introduction

Many industries depend on the rigorous standards put in place for the production of printed circuit boards (PCBs). In the automotive industry, for example, PCBs often come into contact with environmental challenges such as high heat and vibration, and it is essential that these challenges do not cause structural defects. A major factor in ensuring the viability of a PCB is to check that its surface-mount solder joints are all properly formed.

Furthermore, to meet marketplace guidelines for miniaturization, weight reduction and use environment expansion, manufacturers are finding it increasingly difficult to satisfy the requirements for quality control. It is indispensable to establish a quality control system complying with the global quality standard ISO/TS 16949, both at the mother factory as well as at any satellite factories.

Omron has developed an innovative approach to ensuring the quality of solder joints in PCB production. Based on the fact that joint quality can be determined by quantifying the solder shape, this philosophy – known as "3D-SJI" – promotes fast program creation and tuning capability as well as stable inspection results.

This white paper will go into detail about 3D-SJI and how it can help manufacturers simultaneously boost quality and productivity on the SMT line.

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Contents

What is 3D-SJI?

3D-SJI is Omron's unique methodology for solder joint inspection that takes a quantitative approach to assessing the shape of the solder joint. By providing reliable and accurate information without depending on the specialized knowledge of the person overseeing the inspection process, 3D-SJI helps manufacturers meet international standards and the requirements of the marketplace while keeping costs low and maintaining a competitive advantage.

The process of soldering components onto a PCB serves to connect them both mechanically and electrically. The quality of the connections is reflected in the overall appearance of the places where each component's electrode leads are soldered to the substrate. A highly reliable solder joint will satisfy the following conditions:

1. It must be in the correct location on the PCB substrate.
2. It must allow for the appropriate position of the component relative to the electrode leads.
3. It must have the proper shape.

Omron's inspection philosophy takes a uniquely quantitative approach to the third condition, namely the shape of the solder joint itself. To accurately grasp and analyze the solder shape without relying on the specialized knowledge of personnel, Omron's technology uses a combination of optimal principles as a reference. Abnormal lead heights and other unusual characteristics can all indicate a defect in the solder bond.

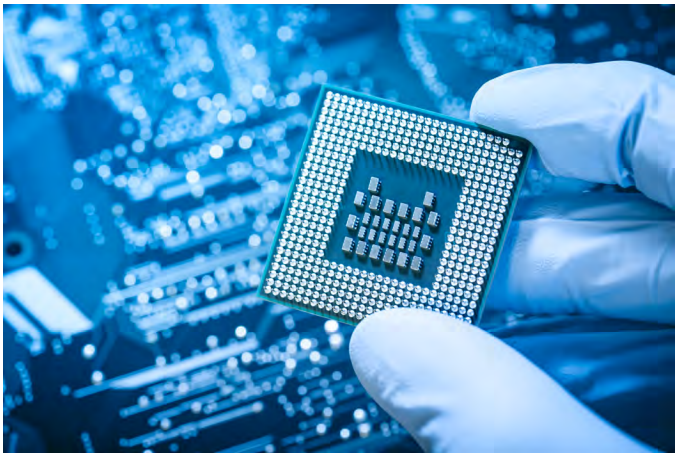
The use of component height data and other easily quantifiable aspects of solder joint shape makes it possible to create stable programs without depending on human capabilities such as specialized knowledge and know-how relating to the soldering process. 3D-SJI also offers a high level of robustness thanks to the fact that its analysis is not affected by variations in component layout or color.

By promoting high-quality solder and consequently high-quality products, the 3D-SJI philosophy creates an improvement cycle that helps manufacturers minimize quality-related costs and sharpen their competitive edge. This cycle can be broken down into three key components:

Diagnose. 3D-SJI points to possible defects in the PCB soldering process, improving the quality control system and helping to produce better products overall.

Detect. 3D-SJI facilitates a restriction-free design to meet the market needs for miniaturization and weight reduction.

Define. 3D-SJI leads to effective quality control initiatives based on the same standards between mother and satellite factories.



What technologies support 3D-SJI?

The 3D-SJI methodology introduces several key technologies to facilitate solder joint inspection and promote excellent connection reliability.

Omron's Color Highlight ™ 3D Shape Reconstruction technology, part of the VT-S730 Post-Reflow Inspection System, uses an optimal principle to enable a stable inspection of a solder joint's reflection surface. Even for high-gloss curved surfaces such as a solder fillet, color highlight 3D shape reconstruction stays within the range of the constant inclination angle and minimizes the software calculation required for the reconstruction range.

Another key technology is a fringe lighting system, also known as oblique light irradiation. Since the light irradiated by the system has a limited spreading angle, the capturable range of a curved fillet is limited. It is necessary to make the light form an image to focus the stripe on the work face. Since the light is reflected in a narrow range this system is not suitable for the measurement of mirror and curved faces such as fillets.

If the system is working with the regular reflection of RGB lights onto a mirror face such as a solder fillet, a color highlight lighting system can help by detecting a specific range of tilt angle to precisely capture the fillet shape. This works because a color highlight dome-shaped illumination – which can irradiate light in a broad angle range of 360 degrees – can broadly irradiate light to a fillet with a curved face almost equal to a mirror face.

Examples of quality control solutions with 3D-SJI

By combining 3D-SJI with before and after inspection, quality control during PCB production results in consistent process improvement with post-reflow quality. The yield rate and actual defect rate can be confirmed in real time to swiftly address quality issues. Following are a few specific examples of tools that manufacturers have at their disposal with Omron's advanced solder joint inspection technologies.

1. Statistical Process Control (SPC)

Using the SPC menu, the administrator can instruct the system to check the production quality by factory, line and model. The pass rate, real defect rate and related values for the designated period can be confirmed in real time.

2. Real defect Pareto analysis/False alarm Pareto analysis

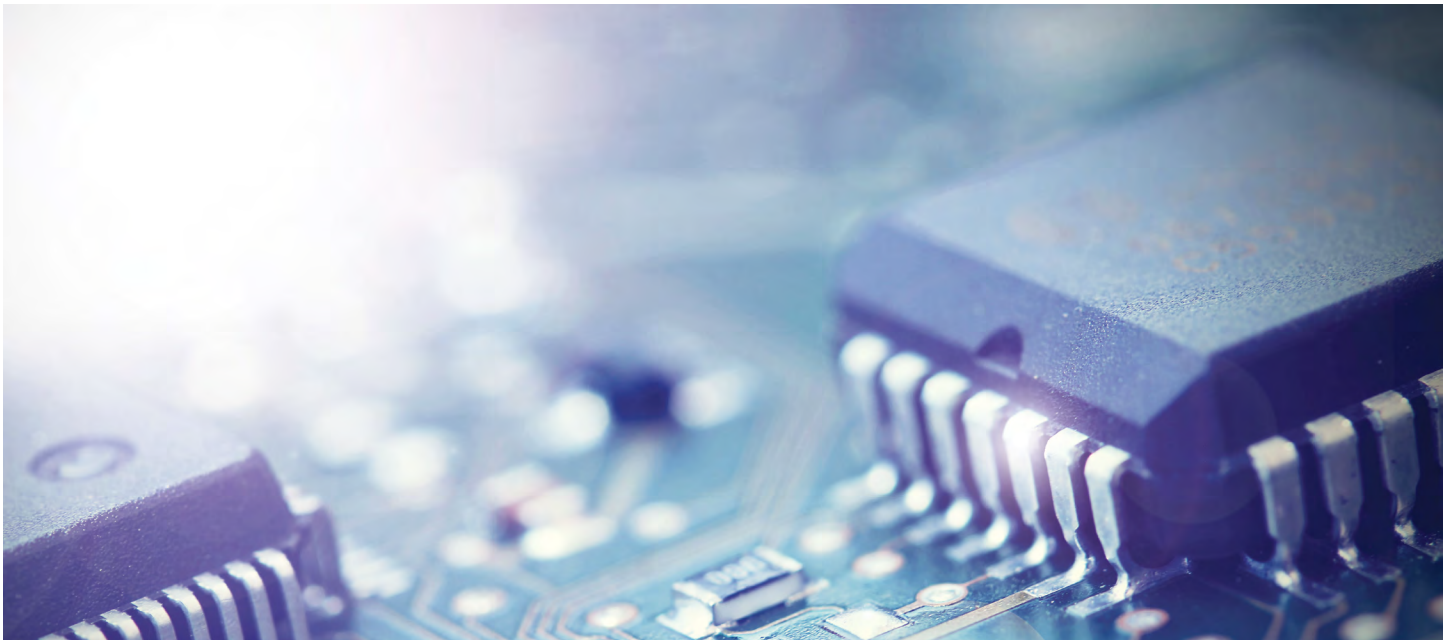
This menu is mainly used by engineers. It allows the priority sequence of improvements to be fixed through "abc" analysis of real defects and false alarms.

3. Production variation analysis (color map)

This menu is also used by engineers. The tendency where production and inspection abnormalities occur can be immediately grasped thanks to a visual presentation of the stability of production and inspection.

4. Process collation

Engineers checking the status in the color map can use the process collation menu to identify the cause of failure by confirming images by printing, mounting and reflow process. Omron's Q-up Navi can indicate the cause of a true defect or a false alarm, help shorten the analysis time, and ensure the proper implementation of the plan-do-check-act (PDCA) cycle for continuous improvement. Any implemented actions can be evaluated again by SPC, and data output to a CSV file and used for reporting.



Summary

Omron's unique 3D-SJI methodology for PCB quality control helps ensure reliable solder joint connections by quantifying the shape of the solder itself. Using 3D shape reconstruction, fringe lighting, color highlight lighting and other key technologies, this solution eliminates the need for human inspectors with specialized knowledge of the soldering process. Thanks to its consistent results, 3D-SJI can help manufacturers meet the requirements of the marketplace and standards set down by international organizations while simultaneously reducing costs and staying competitive.

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