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Harnessing the power of traceability in the electronics manufacturing and semiconductor industries

Three trends, three challenges, and numerous technological solutions

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Introduction

The electronics manufacturing and semiconductor industries face numerous challenges. Companies strive to control costs while demand for new technologies – particularly consumer electronics devices – rises at a rapid rate, forcing manufacturers to innovate and push their operations to the limit. Under pressure to produce energy-efficient and high performance electronics, companies seek to develop new designs that consume less energy without sacrificing performance. All of this innovation is taking place in an industry that struggles with low profit margins and long, drawn-out production processes.

Consider semiconductor fabrication. This is a capital-intensive process with more than a hundred different steps, lengthy testing requirements and very expensive raw materials. At the same time, semiconductor manufacturers tend to experience low yields. Data-driven traceability systems that read information-packed codes at every step of the way have helped companies squeeze profits out of an extremely competitive industry. These systems play a key role in internal processes that help with quality monitoring, production optimization and security.

This white paper delves into a few of the key trends and challenges that currently shape traceability in the digital and semiconductor industries and describes several technological solutions that can help manufacturers overcome barriers to success.

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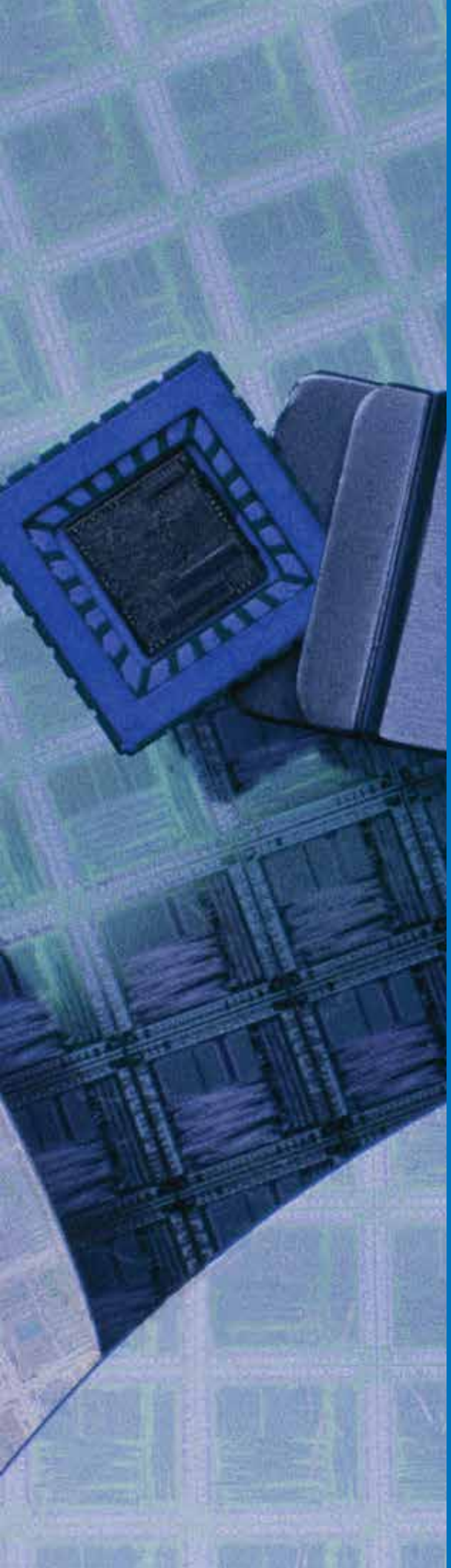

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A peek into the industry's latest trends in traceability

The technology in this industry has long been in a state of rapid change, and it can be difficult for companies to maintain consistent quality in the face of changing requirements. It can also be a challenge for them to build enduring relationships with customers.

Traceability systems provide a way to put process changes in context and analyze the effects they have on the quality of the resulting product. They help identify risks, reduce their impact, and generally maintain a state of constant vigilance. The more automated a traceability system is with real-time decision tracking, the better it is at analyzing the production process and rooting out problem steps.

Although traceability may seem complex, its underlying structure is relatively simple. By affixing barcodes to works-in-progress and scanning these codes throughout the assembly process, manufacturers can gather and store significant amounts of data on the whereabouts of each item at each point in time. This is the basis upon which traceability works its magic.

Trend #1: Analyzing traceability data to determine which machines and processes work best

Low margins are one of the major forces spurring semiconductor manufacturers and electronic manufacturing service (EMS) companies to implement real-time traceability systems. Manufacturers use the immense amounts of data these systems provide to discover the source of bottlenecks and increase velocity through the factory. Different processes can be isolated and compared to determine which ones are working the fastest and/or producing results of the best quality. Traceability also helps minimize the number of items that need to be recalled in the case of faulty production by precisely identifying the affected items.

If a particular machine is consistently producing flawed electronic boards, it would be extremely difficult to pinpoint this machine without a traceability system. However, it's a relatively simple task if electronic boards are consistently tracked throughout the surface-mount technology (SMT) lines that assemble them, and there are several options for integrating traceability solutions into SMT equipment.

One of these is Omron's unique PanelScan technology, which allows the production line to capture barcode data from multi-array printed circuit boards (PCBs) in a single step. User-friendly and easy to integrate, PanelScan replaces error-prone manual scanning (or automated scanning where the scanner needs to be readjusted for each product) with an in-motion reading solution that keeps production lines moving quickly. Capable of decoding and verifying both one-dimensional and two-dimensional codes across the entire length and width of any PCB array, the imaging system is a cost-effective way to take care of traceability needs for high-mix electronics manufacturing.

Trend #2: Scanning barcodes to follow production "recipes" and enable lights-out manufacturing

Traceability can help streamline production by automatically directing the system to route works-in-progress to the appropriate stations. In a sense, it helps the assembly equipment automatically follow "recipes" for production. Manufacturers can make this work by including specific directions – or steps in the "recipe" – in barcodes alongside the basic component identification data.

Introducing more automation into digital and semiconductor manufacturing makes it possible for companies to take advantage in the current trend toward "dark" or "lights-out" manufacturing. Without human workers, lights-out factories are able to be more productive while keeping the costs of upkeep – including heating, lighting and cooling – much lower than they would be otherwise. Work cells can also be smaller when they don't need to accommodate a human presence.

Of course, some lighting is necessary even in a lights-out system – for example, the illumination built into barcode scanners that makes it possible for imaging systems to locate and capture codes on PCBs. Optimal lighting is essential for reading codes with low contrast, which is often the case in the digital and semiconductor industry. When space is limited, it isn't possible to put a large, black-and-white code on an item, so EMS manufacturers generally need to make do with tiny codes on various backgrounds, including green, red and blue.

To ensure that these tiny, low-contrast codes can be read with ease, Omron equipped its MicroHAWK ID-45 industrial barcode reader with an impressive array of 24 LEDs. The reader's advanced illumination works in tandem with state-of-the-art decoding algorithms to extract information from codes that are located under shrink wrap or within metal cavities. The algorithms can even read damaged codes and successfully capture their data. By minimizing the likelihood of no-reads, the MicroHAWK ID-45 helps digital and semiconductor manufacturers keep their production lines going at top speed without interruption.

Trend #3: Using traceability to streamline testing processes

Printed circuit boards undergo a rigorous testing process. Each one is logged, inspected and thoroughly tested to make sure that its quality is near perfect before going out into the market. To make matters even more complex, different PCBs need to be tested in different ways.

Just as barcodes can contain information on which production steps need to be run, they can also indicate which tests should be run on a given PCB. In many manufacturing environments, a tiny, two-dimensional Data Matrix symbol encapsulates this data along with a unique identifier for each individual board. Inside test adapters, these symbols indicate which tests are required to ensure that a given PCB is fully functional.

The patent for the Data Matrix symbology belongs to Omron. The two-dimensional format is preferred by many manufacturers because it can hold a large amount of information. In addition, the symbology contains enough redundancy to ensure that a Data Matrix can be successfully read even if nearly half the code is damaged.

Omron MicroHAWK ID-45 miniscule industrial reader with embedded Ethernet, liquid lens auto-focus and 24-high-intensity LEDs including white, red, blue and optional IR.

Traceability challenges and how to overcome them

A traceability system doesn't build itself. Like other upgrades to manufacturing processes, it's a deliberate investment in the future. When companies expect track and trace capabilities to simply grow out of their existing practices, they remain stuck in the past with cumbersome and error-prone manual record-keeping systems.

Even fully automated, real-time traceability systems come in varying degrees of effectiveness. When manufacturers choose to wait until a product is finished to stamp it with an identifying barcode, they lose large quantities of valuable process data that they could be using to strengthen their operations. Generally, the sooner companies start collecting data on their assembly line processes, the better.

Challenge #1: Not knowing where to begin

Many manufacturers desire the increased flexibility and improved quality control that a complete traceability system can provide, and yet they struggle with figuring out how to implement one. For one thing, there are several choices to make before initiating the process, such as which marking method to use and where to place the marks. Oftentimes, however, the problem is simply that they lack a big-picture understanding of traceability.

To help simplify the concept, Omron came up with the acronym "MVRC" that summarizes the four main actions that must be taken to get the most out of traceability. Short for "Mark, Verify, Read and Communicate," the MVRC concept illustrates the sequential phases of traceability, starting with marking identifying information on parts and verifying that those marks are readable, then using scanners and imagers to capture the data and feed this information back into the manufacturing engineering system (MES) for further analysis.

Omron also keeps things as easy as possible for manufacturers new to the concept by providing all-in-one solutions that take care of every traceability need. From marking to verifying to aggregating data, Omron has a way to seamlessly integrate every component into a complete system.

Challenge #2: Transitioning from a homemade MES to a robust, automated traceability system

Many companies have a homegrown manufacturing execution system (MES) that might make it difficult to integrate traceability data. Real-time traceability adds the challenge of setting up software that can retrieve all the collected data and work with it. The MES needs to have the right interface to integrate the traceability data and make sense of it.

Controllers often act as data aggregators, collecting and sending traceability data to the MES. Omron has optimized several of its controllers, such as those in the NX/NJ series, to efficiently handle this information transfer without hampering machine

Many companies have a homegrown manufacturing execution system (MES) that might make it difficult to integrate traceability data.

control performance. By choosing intelligently designed controllers that enable secure data transfer via OPC UA or direct connection to SQL databases via built-in SQL clients, manufacturers can maintain a high level of productivity while transitioning to a fully automated traceability system.

Another way that manufacturers can facilitate the transition from basic traceability with a homegrown MES to a fully-fledged, real-time system is to implement a packaged solution that's designed with seamless, flexible integration in mind. Omron's traceability technologies, including the above-mentioned PanelScan, make easy integration a priority.

Challenge #3: Dealing with space constraints on works-in-progress and within assembly equipment

Insufficient space is often an issue in digital and semiconductor manufacturing, and it's also a major hurdle for companies seeking to implement a new traceability system or upgrade their existing one. Traceability-related space constraints show up in a variety of ways. For one thing, the individual items that need to be marked – such as PCBs and sometimes even a few of the tiny electronic components that go on PCBs – don't offer much room for barcodes. For another, the equipment on most SMT lines doesn't easily accommodate the addition of new technologies like barcode scanners.

Omron has made miniaturization a key component of its product design. To make it as easy as possible for manufacturers to embed barcode readers in machines, Omron created the MicroHAWK industrial barcode readers, which are the smallest in their class. Despite their small size, the MicroHAWKs are exceptionally powerful, reliable and fast. They also boost flexibility thanks to their liquid lens auto-focus feature that allows them to accurately read codes at a variety of distances.

Omron's fiber laser markers address the problem of fitting detailed barcodes onto tiny PCBs and even tinier components. Laser marking is an excellent way to produce a high-resolution mark that can weather the environmental challenges of the factory. With this technology, manufacturers can create durable barcodes with a cell size of just a few thousandths of an inch.

Of course, markings are useless if they can't be read. All of Omron's MicroHAWK readers are equipped with high-density reading technology that can accurately capture data from the tiniest of codes. Omron has also upgraded several of its barcode verification solutions, including the LVS-9580 and LVS-9585 hand-held verifiers, with ultra-high-density capabilities so that they can grade these miniscule markings to international quality standards.

Omron's LVS-9585 high-performance hand-held verifier for 1D/2D and direct part mark (DPM) verification to ISO/IEC and GS1 standards. Includes red dome, 30 degree and white dome lighting. Ultra-HD model for 2 mil codes.

Summary

The electronics manufacturing and semiconductor industries pose several challenges for manufacturers seeking to implement comprehensive, real-time traceability systems, including a lack of space for barcodes and the devices that read them and the difficulty of moving beyond a homemade MES to a fully-fledged system that collects, analyzes and reports data.

Fortunately, many trends in the latest industrial automation solutions – such as minimization, integration support and enhanced ease of use – are lowering the barriers to getting a robust traceability system up and running so that manufacturers can reap the benefits of better quality, more streamlined operations and deeper insight into the overall effectiveness of processes and machinery.

Omron MicroHAWK with weblink software for precision traceability and inspection solutions.

Omron's NJ series is an scalable machine controller for logic sequence and motion control that includes options for advanced functions such as robotics and database connection. Omron's NX7 series is a high performance machine controller that includes two synchronized motion cores controlling up to 256 axes.

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