Keysight Technologies
Comparing Boundary Scan Methods

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KEYSIGHT TECHNOLOGIES

Comparing Boundary Scan Methods

The need for reusable tests is driving standalone boundary scan-ICT integration.

MANUFACTURERS FACE SIMULTANEOUS trends: ever-increasing high-speed signal technology and diminishing test access. Currently, in-circuit test (ICT) remains the major, if not the sole, electrical test strategy on most manufacturing lines. The reason: It covers the entire manufacturing fault spectrum. Within the electrical process test itself, there are a few alternative electrical testing methodologies (**FIGURE 1**):

Flying probe. These use moving mechanical probes to make contact with a component lead or testpoint. They are used primarily on prototype boards because they permit fast program development and debug without the need for a fixture. However, due to slower test execution and limited coverage, they are typically not adopted for mainstream production testing.

Manufacturing defect analyzer. After ICT, MDA is one of the most commonly used high-volume test systems. The main benefit is the lower cost compared to ICT, as well as the lower cost of the fixtures used. The main drawback is it lacks the ability to test assemblies in a more complex powered mode such as digital test, mixed test, functional analog test, flash programming and boundary scan testing.

Functional test. Although it has been around the high-volume manufacturing line for a while, functional test is not meant to replace ICT. It is not designed to capture specific component faults or pinpoint the actual failure sources, such as shorted pins or resistors with wrong values.

Standalone boundary scan. This tool was built to support the IEEE 1149.1 standard and includes functionality such as memory testing and programming. The main benefit is the low cost of implementing it across the product cycle from prototype to functional test, down to field repair, without the need to redevelop the test program at every stage (**FIGURE 2**).

Standalone boundary scan has proven to be the best alternative to ICT because of its flexibility of implementation and ability to deal with limited access challenge on an assembly. The typical setup involves a PC connected to a boundary scan controller box via a LAN/USB interface that can be easily deployed to any part of the manufacturing line. By contrast, ICT systems, which have a bigger footprint, are normally fixed in one location between the wave solder station and functional testing stage. The need for ICT bed-of-nails (fixture) also prohibits ICT testing from being implemented during the early stages of prototype and design/engineering validation.

What about ICT with built-in or native boundary scan capabilities? How can manufacturers weigh this option opposite standalone boundary scan tools on the manufacturing floor? Even before standalone boundary scan tools gained popularity, many ICT systems had their own native boundary scan software to support the IEEE 1149.1 requirements.

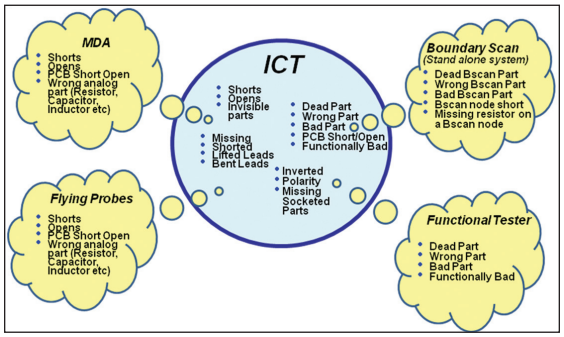

FIGURE 1. ICT fault coverage and equivalent fault coverage of other test systems.

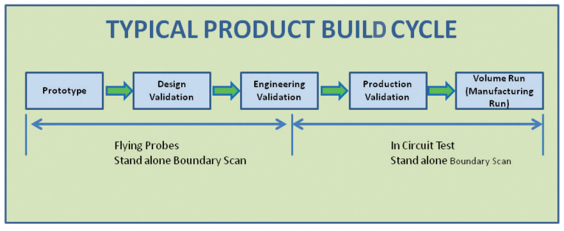

FIGURE 2. Typical product build cycle.

TABLE 1. Boundary Scan Comparison

		ICT Native BS	Remarks
Interconnect test	X	X	
Memory test	X	X	Via BS
Flash/serial EEPROM	X	X	Via BS
Connect test		X	BS test on nailed BS nodes
Powered short test		X	Short between BS nodes and nailed non-BS node
Vectorless powered test		X	Vectorless testing using VTEP and BS test
Flash programming	X		Via BS
IBIST	X		Intel-developed technology

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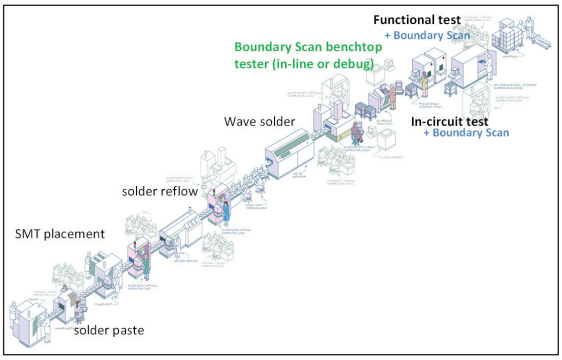

FIGURE 3. Typical manufacturing line.

TABLE 1 shows the boundary scan tests available between an ICT system and standalone boundary scan tools. In general, ICT offers the advantage of more manufacturing test options compared to standalone tests, as a result of its ability to access nodes using the conventional bed of nails. However, the standalone boundary scan tool can offer capabilities closer to functional testing, such as flash programming using boundary scan and iBIST. The only barrier so far for standalone boundary scan is its limited ability for integration into high-volume manufacturing areas such as that for computer motherboards, where there are minimal boundary scan interconnects, and where more than 50% of the nodes are still either in analog, mixed signal or non-boundary scan digital signal modes (**TABLE 2**).

TABLE 2. Testable Boundary Scan Nodes

	Board A (Low Volume)	Board B (High Volume)
Total BS device in chain	14	2
BS Interconnect	1199	710
Other BS test	364	0
Total BS tested nodes	1563	710
Total nodes	3406	689
Percentage node coverage	45.89%	42.04%

Use of standalone boundary scan tools on a manufacturing line continues to be confined to areas such as assembly prototyping, debugging and diagnostics for volume manufacturing, while ICT with native boundary scan software will remain the preferred method of manufacturing testing because of its ability to test the rest of the shorts, opens, analog components and digital devices at speeds that match the throughput of the manufacturing line (**FIGURE 3**). ICT system providers also have been increasing their native boundary scan capability via vectorless powered tests, which integrate vectorless testing technologies such as VTEP and boundary scan testing to increase test coverage on connectors, sockets and non-boundary scan devices. **CA**