

Keysight Technologies

The Future of In-Circuit Testing in the High-speed, Complex Electronics Environment

White Paper

Introduction

The effectiveness of in-circuit test (ICT) was never challenged for the past 20 years of its reign as the center of printed circuit board assembly (PCBA) test strategy for many electronics manufacturers. However, the reign of ICT on the manufacturing floor is facing growing threat with the increasing popularity of low voltage differential signaling (LVDS) integrated circuits used for high speed differential signaling, and ball grid array (BGA) devices. And as pin counts increase to try and keep up with Moore's Law predicting that the number of transistors in the integrated circuit will double every two years, ICT capabilities will be stretched even further.

By Jun Balanguie
 Technical Marketing Engineer,
 Keysight Technologies, Inc.

Many electronics designers are switching to high speed differential signal due to its many advantages, such as high speed data transfer in the range of gigabits per second, lower power consumption of about 1.1 mA per pin, immunity to common mode noise and low Electro Magnetic Interference (EMI). However, high speed differential signaling introduces a new set of ICT challenges onto the manufacturing floor.

In-circuit testing relies on having good contact points between the device under test (DUT) and the ICT test resources – the driver/receiver (see Figure 1). However, where LVDS ICs are used, test points are not allowed on the signal traces in order to maintain the integrity of high speed signals.

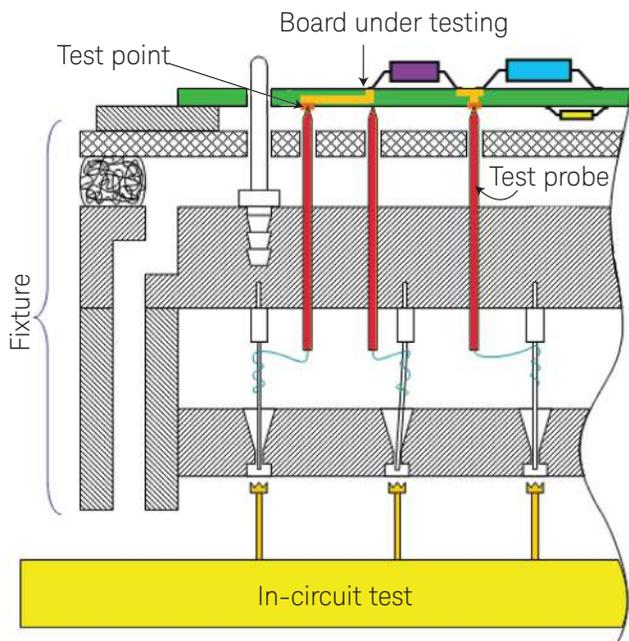


Figure 1. In-circuit test method showing a test point and a fixture test probe used to test a device.

In-Circuit Test Solution on High Speed Differential Signal

In the absence of test points on a trace, the test engineer has to consider the use of limited access solutions, such as the 1149.6 IEEE standard for boundary scan testing of advance digital networks, which provide a guideline on differential signal boundary scan interconnect testing. Some ICT solutions providers are now implementing a native 1149.6 capability on their system or leveraging third-party boundary scan solutions on their systems to overcome this limited access issue.

Another relatively new solution that is gaining popularity is to put 3 to 5 mil bead probes on top of a trace (see Figure 2). These bead probes serve as a substitute to the conventional 50 to 100 mil test points. The bead probes are then targeted with a flat head probe on the fixture to make contact between the in-circuit tester and DUT. Extensive tests by some key electronics OEMs and Keysight Technologies, Inc. which patented this bead probe methodology, has shown that these tiny bead probes do not affect the integrity of high speed differential signals. At the same time, these bead probes have the same contact resistance as conventional test points and pointed test probes.

Importance of High-Speed Connector Ground Pin

Another challenge which test engineers face is ensuring the integrity of high speed connector ground (GND) pin connections, as an open connector GND pin will result in an increased bit error rate (BER). The GND pins on connectors are traditionally not tested with the ICT method as all the GND pins are shorted together; making it difficult for conventional ICT measurement techniques to detect opens on GND pin connectors. A relatively new solution in the form of network parameter measurement has emerged in the industry to effectively detect opens on power and ground pins on connectors. This capability enables coverage that could otherwise escape even functional test.

Increasing Board Density Challenge on In-Circuit Test

The continuous evolution of technology means innovators of new ICT technology need to stay one step ahead of new waves of test access challenges. For instance, the increasing usage of large ball grid array (BGA) devices and multiple CPU's is pushing up the number of node counts which need to be addressed at in-circuit test. A traditional way to solve this is to increase the node count capability of the ICT system to match the requirements of the printed circuit board assembly. However this will also mean an increased cost of test for the ICT system, the accompanying fixture cost, as well as higher operational and maintenance cost for the entire solution. It is always a challenge for the test engineer to balance the cost of test to maintain competitiveness and to achieve optimized test coverage of the product, and in many cases, achieving traditional 100% test access is no longer applicable. In order to get around the increasing board density, test engineers are looking into limited access solutions to lower their cost of test with new paradigms in ICT.

Even in cases where the cost of test is cushioned by high margins for their products, test engineers are also finding it difficult to implement a 100% test point access strategy at in-circuit test due to the fact that test points are not allowed with boards using High Speed Differential Signaling. In addition, more PCB designers are beginning to embed signal traces into the inner layer of the PCB to gain more noise immunity as they push for increase in operating frequency. These will spell new challenges even for latest innovations such as the bead probing technique.

Conclusion

As board complexity and node counts continue to rise and high speed differential signaling continues to grow in popularity, ICT needs to move quickly beyond the traditional realms of short tests, analog measurement and digital testing. The new generation of ICT solutions will need to be able to overcome issues of increasing speed and limited access, and be able to identify component failures down to the device pin level, if it were to continue to be the solution of choice on the manufacturing floor.

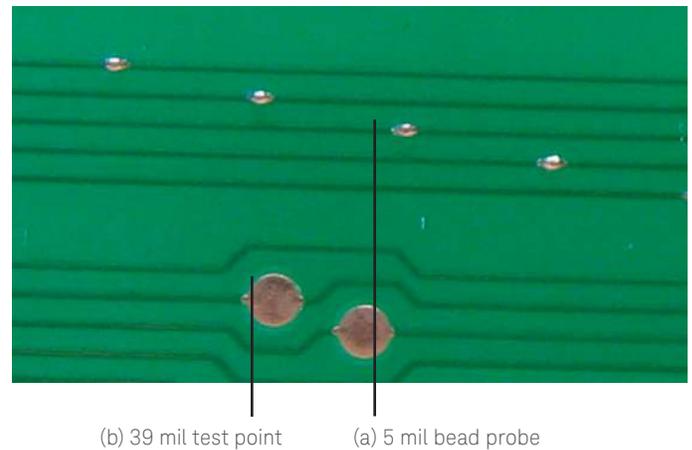


Figure 2. Examples of (a) 5 mil bead probes and (b) 39 mil test points on signal traces

For more information on Keysight Technologies' products, applications or services, please contact your local Keysight office. The complete list is available at: www.keysight.com/find/contactus

Americas

Canada	(877) 894 4414
Brazil	55 11 3351 7010
Mexico	001 800 254 2440
United States	(800) 829 4444

Asia Pacific

Australia	1 800 629 485
China	800 810 0189
Hong Kong	800 938 693
India	1 800 112 929
Japan	0120 (421) 345
Korea	080 769 0800
Malaysia	1 800 888 848
Singapore	1 800 375 8100
Taiwan	0800 047 866
Other AP Countries	(65) 6375 8100

Europe & Middle East

Austria	0800 001122
Belgium	0800 58580
Finland	0800 523252
France	0805 980333
Germany	0800 6270999
Ireland	1800 832700
Israel	1 809 343051
Italy	800 599100
Luxembourg	+32 800 58580
Netherlands	0800 0233200
Russia	8800 5009286
Spain	0800 000154
Sweden	0200 882255
Switzerland	0800 805353
	Opt. 1 (DE)
	Opt. 2 (FR)
	Opt. 3 (IT)
United Kingdom	0800 0260637

For other unlisted countries:
www.keysight.com/find/contactus

(BP-09-04-14)