

Featured Article - Testing Digital Designs – The Boundary-scan Balance

As several industry pundits have expressed in recent years: “the era of ‘one test method fits all’ seems well behind us.” For most test managers with even a modest mix of products, trying to formulate a test policy/philosophy has become a tricky balancing act at the best of times. James Stanbridge, Sales Manager UK for JTAG Technologies, and Steve Lees Managing Director of ATE Solutions look at the options.

For those who have previously invested heavily in In-Circuit Test (ICT) equipment there is a natural reluctance to abandon this method in spite of the fact that available test points are frequently far exceeded by the number of circuit nets.

Also, commercial managers are often found asking the question why equipment that cost £250,000 (or more) a couple of years ago cannot now test the designer’s or OEM’s latest circuits?



For many test managers facing this quandary the answer is not to abandon their current test method but simply to augment it with additional capability.

A hot favourite in this capacity is boundary-scan test which overcomes the need for physical test (certainly on most digital designs) and is therefore ideal for testing the buried interconnect between BGAs.

In addition, spin-off benefits of boundary-scan (a.k.a. **JTAG**) include the ability to program devices such as CPLDs and serial PROMs ‘in-system’. Even non-boundary-scan parts such as NOR and NAND flash devices respond to the JTAG treatment and the more capable hardware can provide an efficient programming solution for these too.

Through the addition of boundary-scan testing, conventional ICT can be retained for fault coverage across mixed signal and/or passive circuit elements. Also, fixture complexity and consequently price can be greatly reduced.

What’s more, using boundary-scan for complex digital testing often negates the requirement for sophisticated IC modelling and/or fixtures which support non-contact methods, such as **TestJet™** or **Q-Test™** - which all add cost.

Boundary-scan is not just a viable complement to ICT though. Other test and inspection methods can benefit too. For example, automatic optical inspection (AOI) and flying-

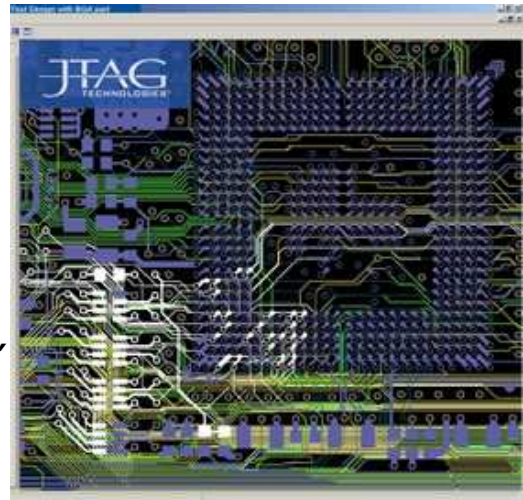
probe testers (which are now sometimes combined) can offer good coverage (albeit slow) on circuit joint integrity and device orientation.

In fact they test virtually any element you can either 'touch' or 'see'. Adding boundary-scan/JTAG plus the necessary PSUs in these systems then extends the test coverage to the parts you cannot 'see' (e.g. under BGAs, CSPs etc...).

The beauty about boundary-scan test is its versatility in terms of how it can be integrated into any stage in production, and there are tools to make it easy for you to do so. Also, compared to ICT and functional test, boundary-scan works out at a fraction of the cost per node covered.

Some have argued that the net-level fault reporting offered by boundary-scan is not as concise as the device level fault reporting that ICTs traditionally offer.

However with the advent of powerful, graphical board layout viewers - such as **JTAG Technologies' Visualizer** - faulting interconnects can be viewed in an instant and tracked through the board layers to determine the most obvious position of failure.



Indeed, just within JTAG Technologies' product range, there are integration products – **JTAG Technologies' Symphony Systems** – which allow test engineers to retrofit high-performance **Boundary-scan Test and In-System Programming (ISP)** capabilities into **In-Circuit Testers (ICTs)** and **Flying Probe Test systems**.

Symphony Systems are currently available for **Agilent's** 3070 ICTs, **Teradyne's** 228x and 12x **TestStations** and **Takaya** flying probe stations.

JTAG Technologies also has many OEM partners that offer a choice of in-circuit and flying probe systems with built-in JTAG Technologies products. The upshot: all the benefits of an integrated solution (less floor space, reduced board handling, single user interface, less training requirements) plus the reassurance that genuine JTAG Technologies hardware and software are driving the boundary-scan performance.

These OEM products include: **Aeroflex's 4220** and **5800 Advanced Manufacturing Test Systems**, **DigitalTest's MTSxxx series** products, and **Seica** and **Spea flying probe stations**.

Similarly if your philosophy eschews structural test in favour of a functional test approach, boundary-scan can once again bridge the gap between the two techniques.

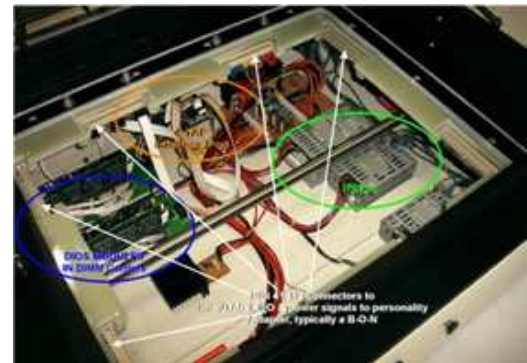


By offering boundary-scan test controllers in PXI, PCI, Ethernet and USB form factors, plus drivers for the popular **National Instrument's** software tools such as **LabView** and **TestStand**, JTAG Technologies' boundary-scan tests can be applied in conjunction with analogue tests.

Indeed, a boundary-scan structural interconnect test is a sensible pre-cursor to boundary-scan cluster testing, device/board configuration (via CPLD and flash device programming) and finally unit functional test.

For example, **ATE Solutions** recently assisted a telecommunications company by building a custom test fixture to test an entire range of boards. Inside the fixture were housed PSU resources, JTAG-compliant digital I/O test channels plus the JTAG controller Test Access Ports – all mapped to generic resource connectors which could be routed to the UUT by custom personality interfaces.

For functional applications that include boundary-scan requirements ATE Solutions also offers test programs based around LabView, and one company with which ATE solutions deals builds machines for sorting foodstuffs, such as peanuts, and has quite different requirements to the telecom industry.



On the one hand, the company's [test] system still requires stimuli and measurements via analogue instruments, and on the other hand, the high-density signal processing side must be tested using boundary-scan.

A combined functional and boundary-scan test system powered by LabView was therefore the perfect solution.'

In short, if you are looking to recover a shortfall in test coverage of your digital designs then boundary-scan test could well provide the solution. As has been observed above, once designed-in it's simple to develop test programs using off-the-shelf tools from JTAG Technologies or by using the expertise of a bureau like ATE Solutions.

Once developed, tests can be executed in isolation or when integrated into an ICT or functional test system. What's more, boundary-scan is relatively low cost (systems available from £5K =>£20K) and its portability make it the ideal partner to most existing test strategies.