A Flexible Cost-Effective Solution for Deploying Boundary-Scan Applications into Production
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Introduction

- Boundary-Scan has become an essential test method for complex digital Printed Circuit Boards (PCB’s) with limited physical nodal access.
- Although a Boundary-Scan production system is low cost, adding a system to every automated flow line of a large manufacturing floor would accumulate into a substantial investment.
- This presentation will describe a hardware solution to aid in cost-effectively adding Boundary-Scan to the manufacturing floor whilst maintaining interchangeability of the automated flow lines.
In order to avoid introduction of an additional stop in fully automated flow lines, Boundary-Scan applications can be integrated within existing ATE.
Boundary-Scan Production System Cost

- Execution and Diagnostic software is approximately $12,000.
- Top of the line hardware with flash optimizations is approximately $8,000.
- With a ballpark price tag of $20,000, a Boundary-Scan production system is still a fraction of the cost of previously mentioned ATE.

Example Case

- Manufacturing floor with 10 Automated Flow Lines.
  - Each line with in-line ICT and FBT.
- Three Boundary-Scan testable designs.
  - Kit-A, B-Scan integrated within ICT.
  - Kit-B, B-Scan integrated within ICT.
  - Kit-C, B-Scan integrated within FBT.
- Boundary-Scan required at ICT and FBT.
  - How should this be handled on the manufacturing floor?
The Problem

- Although Boundary-Scan production systems are relatively inexpensive, the addition of 20 production systems (for every ICT and FBT) to test three products is probably not an acceptable solution.
- The alternative is to purchase only the necessary number of systems which will result in loss of flexibility of the manufacturing floor as lines must be designated as Boundary-Scan capable.

Kit-A or Kit-B
Kit-A or Kit-B
Kit-C

The Problem Compounded

- In the case of Contract Equipment Manufacturers (CEM’s) it may be necessary to support multiple tool vendors.
  - Kit-A tested with Vendor-X’s tools
  - Kit-B tested with Vendor-Y’s tools
  - Kit-C tested with Vendor-Z’s tools
- This further restricts the flexibility of the manufacturing floor.
The Software Solution

- The use of Floating Licensing alleviates the need for an unnecessary number of execution/diag software packages.
- The necessary number of seats can be purchased and checked out for use by all systems on the network.
- What about H/W?

A H/W Solution is Needed

- The Boundary-Scan controller can comprise 50+% of the cost of a production station.
- Adding a Boundary-Scan controller to all 10 ICT’s and FBT’s to maintain interchangeability can be of significant cost (20 cont. @ $8K per = $160k)
- Ideally, Boundary-Scan controllers would be shared by all ATE as with floating license S/W.
The Solution

- UpLink and DownLink based on Gigabit Ethernet (IEEE Std. 802.3z – 1998).
- Virtually no distance limitations.
- Other wired and/or wireless communication protocols can be supported upon request.
  
  - Programmable voltage levels and thresholds.
  - Programmable TCK frequencies.
  - Supports Boundary-Scan controller optimizations.
    - Control of flash WE_.
    - Flash image memory.

The Solution (Cont.)

- TapCommunicator based on TapSpacer™ technology developed by Patria Advanced Solutions, Finland.
- At the controller, the TAP signals are coded to the communication protocol and transmitted via the communication link to the target.
- UpLink at the controller.
- DownLink at the target.
Parallel Testing

- Can support gang testing of multiple targets (4-up fixtures).
- Supports targets with multiple chains.

Operation Principle

- To allow TCK to run at the optimum frequency, a virtual component consisting of a number of virtual cells is appended to the chain.
- The latency of the communication channel and the TCK frequency will dictate the number of virtual cells.
**Operation Principle (Cont.)**

- TDO is loaded in the FIFO asynchronously in respect to TCK.
- The UpLink will store TDO data and the Virtual Cell Counter will be preset to the number of virtual cells.
- Virtual Cell Counter is decremented per TCK.

When the Virtual Cell Counter reaches zero, relevant TDO data will be transferred to the Boundary-Scan controller.

**Testing in a Networked Environment**

- Single U/L can communication with any number of D/Links.
Multi-Vendor Support

- Protocol conversion is IEEE Std. 1149.1 to intermediate data format. Therefore Boundary-Scan vendor independent.
- With a low cost DownLink at every ICT and FBT, any vendor’s Boundary-Scan applications can be executed.
- Automated Flow Lines are fully interchangeable.

Software Requirements

- No modification to COTS Boundary-Scan execution S/W.
- Utility to establish UpLink to DownLink connection, set TCK frequency and set voltage levels and thresholds.
- Utility to query communication channel and add virtual cells to application (ideal but not necessary).
- Controller management software
  - Must be able to manage a pool of controllers
  - Check out controller when request received
  - Add back to pool when released
  - Queue requests if controller is unavailable
Conclusion

- The solution is ideal for large manufacturing environments.
- Solves the multi-vendor support problem of CEM's.
- Enables Boundary-Scan throughout the manufacturing environment with minimal incurred cost.
- Virtually unlimited distance from controller to target while still maintaining high TCK frequencies (40MHz with 1GbE).
- Retention of controller optimizations (flash image memory, flash WE, gang testing, etc...).
- Original intent of TapCommunicator is embedded remote access applications. See paper entitled “A Transparent Solution for Providing Remote Wired or Wireless Communication to Board and System Level Boundary-Scan Architectures” presented by Pete Collins at ITC 2005.