Scan-Based Testing: The only Practical Solution for Testing ASIC/Consumer Products

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Over the last 2-3 years, there has been a major change in the IC industry from being predominantly "functional-based testing" to being predominantly "scan-based testing" (for new design starts). As recently as 2-3 years ago, the topic of panels was *"Is scan-based testing feasible for all products?"* The question has now changed to *"Can we completely avoid functional testing?"*

I believe **the same trends that are driving companies toward scan-based testing will also drive them to completely avoid functional-based testing**. The advantages of structural testing cannot be fully exploited unless at-speed functional testing is avoided.

The issues that are driving companies away from functional testing include:

- ***Cost of the ATE required to apply at-speed functional tests.*** *(full speed, full-pincount) The motivation to use "cheap, DFT testers" is quickly growing and is tightly linked to scan-based testing. Additionally, multi-DUT testing (enabled by scan testing) can dramatically reduce the cost of testing.*
- ***Test development time & effect.*** *It may take months of test development activity to fully debug and optimize functional tests. Most products cannot accept this time-to-market impact.*
- ***Lack of a migration path to built-in self-test (BIST).*** *Some companies are moving toward logic BIST and would like test methods (like scan testing) that can be extended to provide a BIST solution.*
- ***Functional testing often requires empirical learning (often based on feedback from the field) that takes months to develop.*** *For many products, this long development time is not acceptable.*
- ***Lack of fast/accurate fault diagnostics.*** *In the future, all test methods MUST provide support for defect localization.*

Many companies that have experience with scan-based testing have found that the vast majority of defects can be detected with structural testing – but there are still a small percentage of faults that apparently require functional test. In order to completely avoid functional testing, the industry will develop a suite of structural test methods that enable scan-based testing to meet product quality and reliability requirements. In the future, **the number of faults detectable only with functional testing will be driven so low so that the additional cost of functional test will not longer be justified.**

Scan-based test methods must become better accepted before functional test can be completely avoided – including:

- *Alternative methods for testing inputs/outputs.*
- *Practical methods for detecting delay defects.*
- *High coverage of all types of circuits.*
- *Methods for embedded analog cores. (may take longer)*

The move away from functional testing will happen in stages. Some companies are already avoiding functional test for some test insertions – but not all. For example, some products are currently tested with scan-based, reduced pincount testing at wafer level – but still require full pincount, scan+functional testing at package test.

ASIC and consumer electronic products are often driven by time-to-market pressures and development cost. Thus, **supporting functional test has a major negative impact and will not be acceptable**. Within IBM, structural testing has reached the level where functional testing is not required for standard ASIC designs and high-reliability, high-end mainframe applications.

It should also be noted that this position paper is written from the view of an IC supplier (e.g., wafer & package-level testing). Clearly functional testing will be used to test components at the system level.

Functional test may still be required for some applications. For example, performance sorting of high-volume products may require functional testing of critical paths -- the additional cost may be justified. Product verification will also require functional testing.

Some products will continue to use some form of functional testing in manufacturing for a few years -- but the functional testing methods must change. The cost of functional testing is driven up by the cost of at-speed performance required across many tester channels. Functional testing will only be feasible if it can be performed on slow-speed testers through a reduced number of IO pins.

 0-7803-7542-4/02 $17.00 © 2002 IEEE