From Functional To Embedded Test: A Manufacturing Test Paradigm Shift

Stephen Pateras
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It is of no surprise that the growing complexity of chip designs continues to provide huge challenges to manufacturing test. In particular, the demands on test equipment are driving incredibly complex and expensive solutions. The growing costs of this equipment are beginning to seriously effect the viability of silicon products. For example, Intel projected at the keynote speech at last year’s International Test Conference that if nothing changes, it will cost more to test a microprocessor in 2003 than it will to manufacture it. Even if cost is not an issue, growing technical challenges will soon make it virtually impossible for external test equipment to possess the speed and accuracy required to adequately test silicon devices. Clearly, revolutionary and not evolutionary changes are needed to address these serious problems.

A shift to embedded test represents such a revolutionary change. The concept itself is rather simple. Move part of the test equipment functionality into the device under test. In particular move the high bandwidth portion of the functionality into the device, leaving only low bandwidth communication requirements between the tester and the device. A number of important advantages over functional testing result from this new approach:

Test Equipment Cost Reduction

A large portion of the cost of a tester resides in the high speed pin electronics. Since only low speed pins are needed to interact with the embedded test blocks, the cost of the tester can be greatly reduced. Also, if embedded I/O testing is used, the number of tester pins can be greatly reduced. This not only further reduces the cost of the tester, but also greatly reduces the cost of other test hardware such as DUT boards and probe cards.

Test Development Cost Reduction

The time needed to develop functional test patterns continues to grow as chips become more complex. Dozens of man

months of effort are not uncommon for large chips. Virtually no test development is required with embedded testing. Only a small number of patterns are typically needed to initialize the embedded test blocks and extract the test results. These patterns can be automatically generated through automation tools.

Test Quality Enhancement

Since the embedded test functionality is created using the same silicon technology as the rest of the device, it is always capable of running as fast as the circuitry under test. A full at-speed test is therefore always possible. Functional patterns require a tester that can apply them at speed. Even with such a tester, functional patterns typically do not provide the same level of fault coverage that can be achieved with embedded test techniques such as random pattern logic test.

Diagnostic Enhancement

Diagnosing defects detected with functional patterns can be very difficult. Spending hours or even days on diagnosing a functional failure is not unheard of. Because embedded testing is structural in nature, faults can typically be diagnosed within seconds. In addition, since embedded tests are run at-speed, even speed related defects can be accurately diagnosed. At-speed failures are especially difficult to diagnose within a functional test environment.

In addition to all of the manufacturing test advantages described above, embedded test represents other important advantages. Embedded tests can be reused for board and system level testing, decreasing the cost and increasing the quality of testing at those levels. Embedded tests can also be reused in the field for diagnosis and repair.

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