Abstract

Functional test (FT) coverage exposure risks continue to increase on printed circuit boards. Coverage risks are partially due to defect detection shortcomings at pre-functional test stages causing a defect migration to FT. Board interconnect technology advancements have expanded the manufacturing defect spectrum producing additional functional test coverage gaps. Historical FT techniques are ill-equipped to adequately address these issues requiring fresh innovation.

1. Assembly Defects migrating to FT

More and more manufacturing (Mfg) assembly defects are becoming undetectable by in-circuit test (ICT). Inspection techniques (which include vision technology like AXI or AOI) close the gap somewhat but still do not address subtle solder defects effectively. The undetected defects naturally migrate into FT. FT is ill-equipped to effectively detect and isolate such defects creating yet another obstacle to shipping quality platform products.

ICT has historically addressed 95% or more of the platform manufacturing fault spectrum. This situation is fundamentally changing due to the inability to apply critical board testability (testpoints). This is largely due to increased electrical sensitivities and lack of physical real estate at the board level. Further, decreasing discrete component sizes and values exceed in-circuit fixture probing and measurement capabilities in many cases. Consequently, significant in-circuit test coverage gaps have surfaced. The result in part is a migration of assembly defects into the FT testing stage.

Advanced vision system testing (i.e. AXI or AOI) addresses ICT coverage gaps to some extent although its BGA (Ball Grid Array) level test coverage is suspect. AXI/AOI are respectable in finding gross opens/shorts. More subtle solder quality issues like “micro-cracks” are largely undetectable and migrate to the FT testing stage.

The ability of FT to adequately address the migration of assembly defects is bounded by its inherent lack of test program control and observability.

2. Expanding Mfg Defect spectrum

The “expanded” Mfg defect spectrum associated with high speed system interconnects represents additional FT coverage holes. Defects types expand beyond simple opens/shorts due to limited system tolerances to transmission line loss, impedance discontinuities, and crosstalk. The increased sensitivities at the board level require advanced test pattern delivery and methods to substantiate bit error rate specifications of performance interfaces. Both of which exceed current functional test capabilities.

Coverage gaps caused by fundamental limits of FT

Since functional testing methods necessitate some level of operating system bring-up the tests must be transaction based. The inability to control system buses directly impedes the test application’s ability to manage electrical behavior. OS based tests lack determinism which impacts test time radically (i.e. test application’s software overhead requires many more machine cycles to provide bus stimulus, chipset limitations may throttle burst lengths/break up cycles, etc.). Further, OS hosting abstracts and interferes with test algorithms due to process scheduling and caching issues. It is nearly impossible to precisely control bus transactions (synchronization and arbitrations) let alone the electrical behavior (ground bounce, resonance, etc.). As a result, resource contentions reduce test coverage since the exact flow of the transactions is beyond test software's realm of control.

Micro-Kernel Based Tests better but still insufficient

Although tests executed within an micro-kernel based environment provide better control than applications written for the OS level, micro-kernels lack multiprocessor concurrency; thus system interactions cannot be stressed and still depend on a nearly fully functional system (i.e. full interconnect integrity). Finally, a major concern associated with micro-kernel based testing (as well as OS based testing) is their innate limitation to isolate failures. Moving forward, the complexities associated with high performance IO amplifies the fundamental limits making it nearly impossible to isolation defects beyond the field replaceable unit level.

Key Message: Use of current OS based functional testing methods are inadequate for meeting platform testing needs moving forward.