Virtually all test challenges come down to a matter of controlability and observability. In order to properly test a differential signal, the IEEE 1149.1 standard recommends separate control and observation boundary cells on each leg, creating two single ended nets with full testability. In this model, the differential driver and receiver are part of the functional logic. In most cases, this has an unacceptable impact on functional performance.

Alternately, the IEEE 1149.1 standard allows an “analog” model of the differential signal, with a single control cell before the driver, and a single observation cell after the receiver. Due to limited controlability and observability, almost half of the possible board assembly defects are not detected. If the differential signal is capacitively (AC) coupled, almost all defects become undetectable.

Due to the large installed base of IEEE 1149.1 compliant tools and testers, not to mention components, any changes to the Standard must be minimal.

The first change required to the IEEE 1149.1 standard is to allow the inversion inherent between the boundary cell and the inverted output of the differential pair. This will permit the two legs to be independently observed. Many testers already support this.

The second change required is to increase observability on the two legs of the differential signal.

The obvious choice for doing this is to add a single ended receiver on each leg of the receiving chip. However, there are some open questions as to whether single ended receivers can work reliably with differential signals. While they do not have to support high-performance characteristics, they will typically have only half the signal level and must deal with double the noise, as compared to the differential receiver connected to the same nets. There may be differential observer designs capable of detecting common fault syndromes that would work more reliably.

A way to further increase observability is to make the differential signal bidirectional for test, in addition to the single-ended or other observation cells, as shown in the figure. Having both good observability and controlability at each end of the signal should give near optimal testability using the IEEE 1149.1 EXTEST instruction.

For an AC coupled signal, the series capacitor splits each leg into two independent nets. If the bidirectional structure described above exists, then current IEEE 1149.1 compliant static tests should be able to detect all shorts between signals, or to power supply rails. Again, many testers already support this.

The third change required to the standard is a new interconnect test instruction that can pass data through the coupling capacitor. With the bidirectional structure, this is required only to detect open type defects, a simpler problem than having to detect all defects on the AC coupled signals, and may therefore allow a simpler structure.

It may be that the increased controlability and observability offered by the bidirectional structure may be a better use of the chip resources than some of the complex encoding and decoding schemes proposed for solving the more general AC test problem.