

Jitter Test in Production for High Speed Serial Links

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With high-end ATE pins going beyond multi-gigahertz, and widely adopted on-chip PRBS BIST, multi-gigahertz at-speed functional test in production is no longer impossible. The most controversial area is now in jitter testing.

1. The new definitions of jitter

In the last few years, more and more serial link standards adopted the concept of separating jitter into deterministic jitter (DJ), periodic jitter (PJ) and random jitter (RJ). The old concept of histogram based peak-to-peak jitter has been replaced by the concept of total jitter (TJ), which is associated with a certain bit-error-rate for the serial link (typically 10^{-12}). This makes the jitter test more meaningful with a direct connection to system performance. It is much harder to perform a proper jitter test directly in production, as it is specified in terms of DJ, PJ, RJ and TJ, rather than a simple peak-to-peak or rms jitter measurement. It means we need to decompose the jitter measured into various types, each having its own budget on the spec sheet.

The trend of separating jitter into different types also applies to the jitter tolerance test. To conduct a jitter tolerance test, jitter must be deliberately injected into the data stream in a controlled fashion. That means we need to mix a certain amount of DJ (including some PJ) with a certain amount of RJ to perform this test to the spec. [1]

In this panel discussion, we need to distinguish jitter test solutions for production between full standard compliant tests and tests providing only partial coverage.

2. Under what circumstances is jitter test required in production?

Philosophically, any test should only be included in production when it is needed to distinguish a bad device from the good. There are certain specs that are declared “guaranteed by design and characterization”. In that case, we can assume the defect rate is so low that ignoring such test will not be a big risk. However, we should not take this approach lightly. For example, we cannot say it is guaranteed by design if we have difficulty testing it in production.

In most cases, 2~12Gb/s serial links are pushing the envelope of the processing technology used. The not so perfect analog design simulation with variation in parasitic extraction makes it very hard to predict jitter performance in design stage, or to use analog BIST. Therefore, “guaranteed by design” is virtually impossible for new designs. That is why “guaranteed by design and characterization” is more realistic. If a certain jitter spec is verified with enough margin in various process, voltage and temperature corners, with statistically significant samples tested, then we can skip the

test in production. In order to achieve that, it almost implies a limited production with the jitter test involved.

If the limited production test indicates a small percentage fall-out in jitter tests, but still higher than the defect rate the customer demands, then a jitter test in production to screen every part is the only solution.

3. Existing Jitter Test Solutions

So no matter if we need jitter tests in final production, or only limited production to justify the label -“guaranteed by design and characterization”, we need jitter test equipment to do that. There are not many choices of ATE right now that do jitter decomposition and jitter injection of various types of jitter. Most these solutions are either lab instrument based or DUT board add-on circuits. This approach is hardly viable for high port-count serial links. Although there are a few pin-card level solutions on the market to handle larger port counts with better throughput up to 3.2Gb/s, some of these pin cards either provide a very limited jitter measurement, or are limited by signal delivery path to do a very accurate measurement.

Because of the lack of proper instruments to perform the test exactly according to the specs, several simple techniques for jitter test are still very popular in high volume production. For example, jitter tolerance test by adding DJ in the loopback path [2], adding latches on the DUT board as a high-speed under-sampling head, some indirect tests that could be related back to jitter performance [3], etc... All these tests are by no means a complete solution, but when used to correctly address a particular device issue, they may be able to effectively solve a jitter problem in product screen.

4. Conclusions

There is an obvious disconnect between what has been specified in serial link standards and what can be practically tested in production. There are no cost-efficient and complete solutions on ATE that can address that as of today. A thorough characterization is critical to identify and isolate the root of the jitter problems, followed by implementing a more focused and cost-effective jitter test in production. In summary, as of today, the best jitter test in production is not necessarily following the standard or data sheet definition.

References:

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