Who really needs RF process monitoring?

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Automated RF testing is finding favour with semiconductor manufacturers the world over, thanks to its short calibration times and ease of use.

IC manufacturers have traditionally taken s-parameter data only in device modelling labs due to the measurement complexity and associated cost. However, RF parameters are extracted from the s-parameter data and included in the simulation models design engineers use during product development. Several leading manufacturers have now attempted to migrate this measurement capability from their modelling labs to manufacturing operations. They have had little success.

RF testing began in product development to describe device performance in terms of familiar transmission-line characteristics. The instruments used for microwave device testing were then added to DC test racks to allow measurements from DC to RF frequencies. However, these systems require multiple probe insertions on the wafer. Several individual measurements are needed to characterise a device fully at DC and RF frequencies, resulting in long test times. The initial system calibration can take several hours to complete.

The delays associated with these systems result from manual methods that involve substantial operator intervention. A PhD-level practitioner may be required to obtain accurate results, and a full battery of tests can take several days. While tolerable during initial device characterisation, this is impractical for process monitoring.

The benefits of automation

Fortunately, there are no fundamental impediments to automating RF parametric test algorithms. Appropriate instruments, probe hardware and test executive software can shorten calibration and test times dramatically and make RF parameter extraction practical.

With an automated calibration algorithm in the test executive, a system-level calibration can take just two minutes. Calibrating the instruments, interconnects, probe card, probe card adapter and calibration substrate as a complete system ensures the highest overall accuracy and eliminates the need to recalibrate for changes in test frequency or the number of data points.

The DC/RF wafer probe.

A vector network analyser (VNA) is at the heart of an s-parameter measurement system. A VNA can provide high precision in auto-reversing s-parameter measurements of active and passive multi-port devices at microwave frequencies. If the test executive contains a library of RF macros, the VNA s-parameters can be used to extract corrected RF parameters quickly. US company Keithley has developed merged DC/RF testers based on this design approach. Features include:

- Keithley S600 and S400 DC test systems with a solid-state transfer switch and Anritsu VNA technology for fast RF measurements, stable auto-calibration, and a modular upgrade path from 13.5–40GHz
- Anritsu VNA with integrated fast sweeping source, auto-reversing s-parameter test set and a four-channel receiver
- GGB or Cascade probe technology support for measurements from DC to RF

This design can be used with any automatic probe, and provides fully automated single-pass calibration that is quickly executed during testing without human verification. The calibration, which takes about two minutes, includes automatic de-embedding of probe pad/interconnect impedance that would impair data integrity.

With the user library of RF macros provided, even novices can extract RF parameters quickly. This shortens development time with true statistical RF device models, improving yield with production-ready process monitoring and reduced costs with a standard solution that has worldwide support. With better measurement speed and fast automatic calibration, overall system throughput can be increased. ■

Author & Company

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