Advanced high-frequency on-wafer capacitance measurement solution

Why is Cascade Microtech introducing this solution?

With the ever-increasing integration of semiconductors, new leading-edge processes rely on aggressively scaled devices with ultra-thin gate dielectrics, high-k materials, and short channel lengths. During R&D, these new devices and process must be characterized thru a variety of on-wafer electrical DC and capacitance measurements. However, these aggressively scaled devices are now pushing the limits of conventional low-frequency on-wafer capacitance measurements. In order to measure capacitance with the necessary resolution and accuracy, high-frequency measurements are now often required. But with typical on-wafer measurement systems capacitance measurements above 10-15 MHz can be troublesome. New 110 MHz auto balancing-bridge(ABB) measurement instruments are now available – but to reach their full potential they require a new system approach with new accessories. Cascade Microtech, the innovator and leader in high frequency probing systems now offers a very practical and complete probing solution specifically designed to support high frequency on-wafer capacitance measurements to 110 MHz.

What is the solution architecture?

- **Semi-automatic 300mm or 200mm wafer prober** with a number of optimized features that assure high-resolution, higher accuracy on-wafer electrical measurements. (see below)

- **Short-Open-Load (SOL) Standards**: calibration to the wafer probe tip. Accurate capacitance measurements with the cable terminated ABB rely on accurate system calibration to the wafer probe tip. This eliminates parasitics related to system cabling and probes. In the past, low-frequency calibration with Open-Short only calibration may have been adequate. But high frequency ABB’s with their 50 W output impedance rely on 50 W load calibration above 5 MHz. Cascade Microtech calibration standards provide precision 50 W calibration standards accurate to within ±0.3%. Further, Cascade provides convenient off-wafer calibration standard mounting locations. The off-wafer location supports the standards without exposure to the heating and cooling of the wafer thermal chuck. This assures consistent calibration reference values without thermally related drift in the standard values.

- **High Frequency Accessories**: Cascade provides unique high-frequency accessories that reduce inductance related error, phase error, location dependent capacitance variation, resonance and stray capacitance.

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### Solution elements cont’d.

- **Convenient off-wafer 60 fF reference capacitors:** In addition to calibration structures the off-wafer impedance standards have reference capacitors which can be used to quickly verify system operation and to check for drift.

- **Stored off-wafer calibration locations:** By storing SOL calibration locations the system software allows quick probe movement to ISS standards when a re-calibration is needed. Stored locations also eliminate operator probe placement uncertainty which results in more consistent calibrations.

- **Microchamber measurement enclosure:** Faraday shield – A metal localized enclosure that surrounds the wafer and calibration locations provides necessary dark and dry measurements environment. It also shields the probes and devices from external electrostatic and electromagnetic interference.

- **AttoGuard integrated guard shield:** By extending the ABB guard over much of the wafer, the AttoGuard reduces position dependent capacitance variation, providing more accurate capacitance measurements.

This solution saves valuable lab time and enhances lab productivity in several ways:

- **No need to manually measure or trim on-wafer standards:** known precision 50 Ω load standards are provided.

- **Faster measurements:** with the AttoGuard there is no need to spend time re-nulling or zeroing the ABB to eliminate position dependent stray capacitance

- **Faster ABB Calibrations:** move to off-wafer SOL calibration locations in <1 second by using stored calibration locations.

- **No waiting for thermal chuck cool-down before calibration:** the thermally isolated auxiliary chuck and calibration standard ensures that accuracy and integrity are maintained during an over temperature test.

- **Quick detection of system or calibration problem:** independent off-wafer reference capacitors are a quick way to confirm overall system functionality

- **Immediate access to probe positioners and microscope viewing:** without reaching inside a cumbersome dark box.

- **Accurate and repeatable capacitance measurements:** results in better device models, reduced design cycle time and time-to-market.

### How does this solution increase productivity in semiconductor R&D labs?

- **How does this solution help semiconductor companies meet their strategic objectives?**

This solution increases lab productivity while providing the best possible semiconductor characteristic data. This results in reduced design cycle times, shorter time-to-market, more robust designs which translate to higher profitability.

- **How does Agilent Technologies test instrumentation complement this solution?**

Agilent Technologies has recently introduced the 4294A ABB Impedance Analyzer to support characterization of advanced semiconductor processes. This new product covers a broad impedance range to 110 MHz and has proven to be a valuable tool in characterization of new ultra-thin gate oxides. Cascade Microtech and Agilent Technologies have worked together to assure that the entire probing system and its accessories allow the customer access to the full measurement range of the new impedance analyzer.

- **What kinds of companies can benefit from this solution?**

This solution is well suited to companies that:

- Are pushing the scaling limits of advanced CMOS processes
- May be fabless but want to develop in-house characterization capability
- Have a critical need to reduce time-to-market, shorten design cycles

- **Who do I contact for information?**

Those interested in an advanced high frequency capacitance solution should contact Cascade Microtech. See the contact information at the end of this document.
Cascade Microtech and Agilent Technologies have partnered to introduce a complete measurement solution that supports advanced capacitance to 110 MHz. Cascade Microtech is the world leader in on-wafer probing systems. Agilent Technologies is the world leader in advanced test and measurement instrumentation for the semiconductor industry. Cascade Microtech is Agilent Technologies’ largest channel partner and both companies have worked together for over 20 years to provide leading edge on-wafer solutions.

Cascade Microtech, Inc. is the worldwide leader in providing high-frequency and parametric on-wafer test solutions. Engineers use our solutions to test and characterize integrated circuits (ICs) and photonic devices. These devices are then used in semiconductor applications, such as personal computers, servers, cell phones, consumer and automotive electronics, fiber-optics, PDAs, and other wireless products. Cascade Microtech also produces thin-film probe cards for production-level on-wafer testing of fine pitch, high-speed IC devices for broadband communications and networking, wireless and cell phones as well as other market applications. For more information visit www.cascademicrotech.com.

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