Improving Calibration Accuracy of Wafer-Level Measurement System for Confident Over-Temperature RF Device Characterization

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Presented: Michael Harz

Motivation

- Device characterization and modeling require measurements at multiple temperatures
- Conventional procedure:
  - Calibration at room temperature
  - Temperature gradient reduces measurement accuracy
- Challenges when calibrating at measurement temperature:
  - Calibration and measurement accuracy depends on calibration standards
  - Standards' properties change with temperature

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Achieved Results

- Proved statement: for accurate results, calibration at measurement temperatures is the must
- Thermal stability of calibration standards was measured
- Method compensating for the thermal instability of standards was developed
- 150ºC calibration accuracy comparable to the room temperature calibration was achieved

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Motivation (1)

- Calibration and measurement accuracy depends on calibration standards
- Standards' properties change with temperature
- Traceability of planar standards is difficult

Challenge: alternative verification procedures

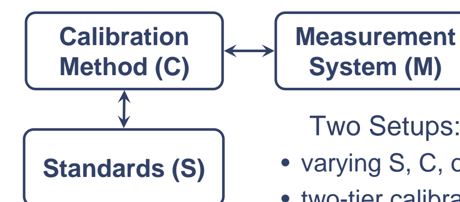
Experimental Setup (2)

- Thermal probe system
  - 150 ºC capability
- Agilent 8510C VNA (50 GHz)
- 50 GHz GSG 150 um pitch probes
  - Probe 'Z'+
  - Probe 'P'++
- Calibration standards:
  - Substrate 'A'*
  - Substrate 'B'**
- Software packages:
  - MultiCal from NIST
  - SussCal Professional from SUSS MicroTec

+|Z| Probe from SUSS MicroTec
++RF probe from alternate vendor

*CSR-8 from SUSS MicroTec
**ISS from alternate vendor

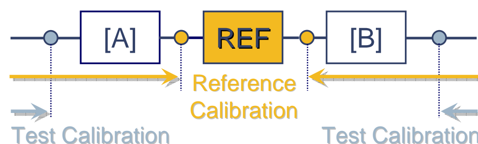
Verification Method (3)



Two Setups:

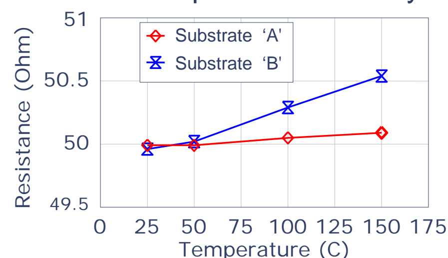
- varying S, C, or M
- two-tier calibration (reference, test)

Verification Method (4)

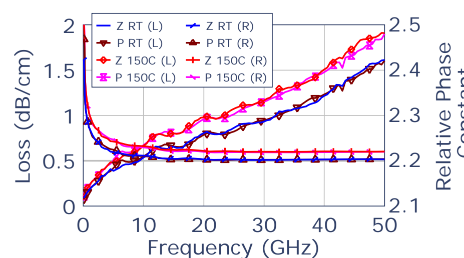


[A] and [B] quantitatively describe the difference in Setup 1 and Setup 2

Load Temperature Stability (5)

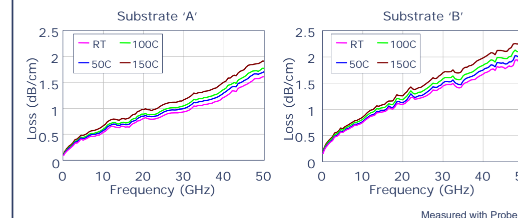


Temperature Stability of CSR-8 Lines (6)



Comparison of CPW Lines (7)

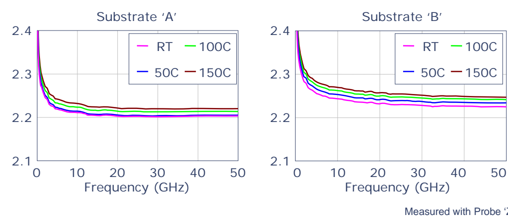
Attenuation Constant



Measured with Probe 'Z'

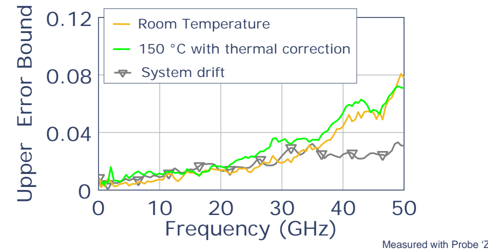
Comparison of CPW Lines (8)

Relative Phase Constant



Measured with Probe 'Z'

LRM+ Calibration Accuracy (9)



Measured with Probe 'Z'

Conclusion (10)

- Calibration at high temperatures is the must
- Thermal stability of calibration standards:

Substrate / Parameter	ΔR, %	Δα @50GHz,%	Δβ @50GHz, %
Substrate 'A'	0.2	18.6	0.86
Substrate 'B'	1.0	19.7	1.00

- 150ºC calibration accuracy comparable to the room temperature calibration was achieved

Acknowledgement (11)

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References (selected)

[1] A. Rumiantsev and R. Doerner, "Verification of wafer-level calibration accuracy at high temperatures " in ARFTG Microwave Measurements Conference-Spring, 71st, 2008, pp. 103-106.

[2] A. Rumiantsev, R. Doerner, and S. Thies, "Calibration standards verification procedure using the calibration comparison technique," in 36th European Microwave Conference, 2006, pp. 489-491.

[3] A. Rumiantsev, R. Doerner, and P. Sakalas, "Verification of wafer-level calibration accuracy at cryogenic temperatures," in ARFTG Microwave Measurements Conference-Fall, 68th, 2006.

[4] D. F. Williams and R. B. Marks, "Transmission line capacitance measurement," IEEE Microwave and Guided Wave Letters, vol. 1, pp. 243-245, 1991.

[5] R. Doerner and A. Rumiantsev, "Verification of the wafer-level LRM+ calibration technique for GaAs applications up to 110 GHz," in ARFTG Microwave Measurements Conference-Spring, 65th, 2005.