Assuring measurement traceability to ATE systems for MEMS temperature sensors testing and calibration

Denis Smorgon
Istituto Nazionale di Ricerca Metrologica
INRIM
Torino, Italy
d.smorgon@inrim.it

Vito Fernicola
Istituto Nazionale di Ricerca Metrologica
INRIM
Torino, Italy
v.fernicola@inrim.it

João A. Sousa
Portuguese Institute for Quality
IPQ,
Caparica, Portugal
jasousa@ipq.pt

Luís Ribeiro
Portuguese Institute for Quality
IPQ,
Caparica, Portugal
LRibeiro@ipq.pt

Enrico Tamburini
SPEA
Volpiano, Italy
enrico.tamburini@spea.com

Michele Catto
SPEA
Volpiano, Italy
michele.catto@spea.com

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I. Abstract

In the framework of an EMPIR joint research project (MET4FoF - Metrology for Factory of Future), a facility is being developed to provide in-situ measurement traceability to next-generation of Automated Test Equipment (ATE) systems used in MEMS temperature sensors testing and calibration.

The above measurement traceability concepts are demonstrated in a testbed developed by SPEA in collaboration with INRIM and IPQ. The experimental work comprises both the factory-side implementation and the laboratory-side developments of a special calibration facility, to cover the temperature range between approximately -60 °C and 200 °C.

On the factory side, SPEA develops a novel ATE prototype system, based on the concepts of good metrology practice, with the possibility to calibrate/validate in-situ the electronic circuitry and the on-board reference temperature sensors. The novel ATE prototype implements:

- An improved temperature control system, with a new design of heaters, temperature sensors and MEMS temperature conditioning features.
- A CPU software/firmware improvements to store sensors' calibration coefficients and allow a "one-touch calibration" feature (i.e. a fully automatic process able to perform a comparison calibration of the ATE on-board reference temperature sensors).
- An assessment of thermal conditions (homogeneity, heat losses, boundary effects) to estimate temperature calibration uncertainty.
- A so-called "reference fixture", i.e. an instrumented sensor socket equipped with a network of laboratory-calibrated reference sensors.

On the laboratory side, INRIM develops calibration facilities and measurements methods to provide traceable temperature and electrical measurements to the above ATE systems. A custom equipment is developed to accommodate the sensors belonging to the reference fixture in order to calibrate them by comparison in a thermostatic bath. IPQ deals with the numerical simulation, by means of a 3D model of the temperature uniformity of the thermal chuck i.e. the ATE component providing the thermal stimulus to the MEMS under test. The simulation data will be used to help the SPEA hardware designer to improve the type, number and position of reference sensors on the thermal chuck to provide a more reliable and metrologically characterized thermal stimulus.

The final paper will describe how an ATE machine works and in which parts it consists and how it is modified to reach the final goal. Furthermore, simulation data will be cross-compared with experimental data coming from metrological characterization before and after the ATE improvements in order to demonstrate their effectiveness. Also the method to assure traceability in large-scale temperature MEMS testing will be detailed and an example of application will be reported.

Finally, it is expected that the outcome of this work will impact the quality and reliability of the MEMS sensors largely used in consumer electronics and will extend the calibration capability provided by INRIM to such an expanding industrial sector.

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