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Title:	**Wireless temperature measurements above 500°C using surface acoustic wave sensors**

Abstract:

As demonstrated now for more than 25 years, Surface Acoustic Wave (SAW) devices can be operated without on-board power supply using a dedicated interrogation unit. Using appropriate design considerations, these devices are sensitive to parametric perturbations including temperature, pressure and strain, to name but a few.

The work reported in this presentation has been developed as part of the SAWHOT (NMP Europa/Russia) project, consisting in measuring temperature in harsh environments like high temperature furnace, gas turbine engines and chemical reactors. The consortium researched and developed temperature sensors which operate between room temperature and 700°C. Another aspect of the project was dedicated to the development of very low temperature sensor, capable to operate at liquid nitrogen boiling point.

The first challenge of the project was to adequately chose the sensor material and structure considering the targeted environment. For high temperature applications, SAW resonator-based sensor built on Langasite was found to be the best strategy to operate the measurement system as expected. On the other hand, cryogenic temperature sensing was best achieved with a reflective delay line sensor structure (SAW Tag) using $LiNbO_3$ substrate.

As packaging and antenna assembly are one of the main issues of such a development, a dedicated housing has been designed and implemented for the SAW sensors. Connections of the packaged SAW device with antennas capable to support high and low temperature has been investigated and validated for that purpose. Different methods to connect antennas to the package have been investigated and compared. The preferred one for the demonstration phase imposes a specific strategy when mounting the device in the package, and the packaging sequence has been optimized regarding to that aspect.

Tests at very low temperature have shown that SAW technology was well adapted for such operating conditions. The LiNbO3-based sensors were effectively operated without observable damage and expected reproducibility down to -196°. For high temperature experiments, below 500°C, the use of a Quartz-based differential SAW sensors has allowed for accurate temperature measurements, withstanding the harsh environmental conditions. Above 500°C, Langasite (LGS)-based SAW resonator sensors have been used, allowing for temperature measurements up to 700°C lasting several tens of hours. For the corresponding tests, the operation of the system was demonstrated for several successive cycles of about 10 hours with more than two hours exposition at maximum temperature.

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