PML goes to Mars: far-out thermal calibration

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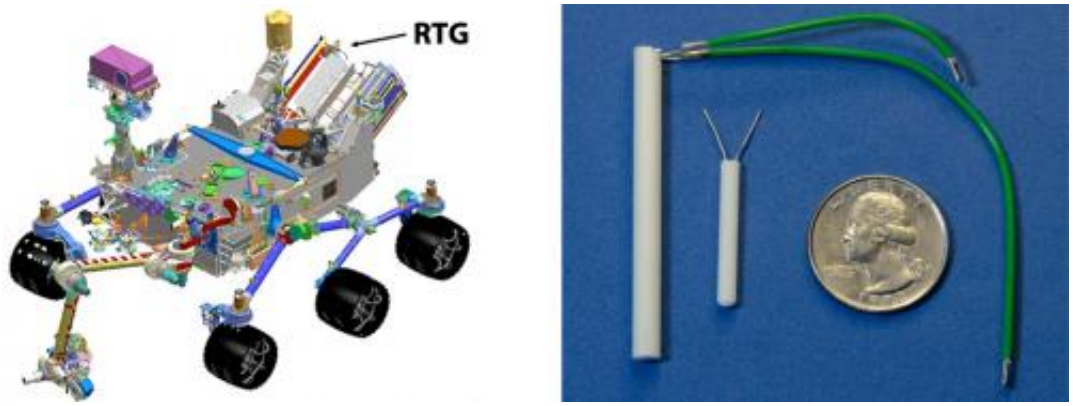

At left: Diagram of the Curiosity rover now on Mars, showing location of the radioisotope thermoelectric generator (RTG). At right: Duplicates of two of the NIST-traceable temperature sensors mounted in the RTG unit.

(Phys.org)—Sometimes the chain of measurement traceability – the unbroken series of links between a calibrated instrument and the official NIST standard – can get pretty long. But 250 million kilometers is remarkable, even for NIST.

That's the current distance between the Curiosity rover on Mars and the temperature labs in Gaithersburg, MD, where the calibration process began for several small but critically important temperature sensors that monitor the rover's power generator.

"They're all hand-made and hand-customized," says Chris Albert of Sensing Devices Inc. (SDI) in Lancaster, PA, who designed the sensors to NASA contractor Teledyne Energy Systems specifications. "Each one has to be calibrated, and each one has to have NIST traceability."

So Albert brought the company's master reference thermometer to PML's Temperature & Humidity (T&H) Group to have it calibrated according to the International Temperature Scale of 1990, the worldwide standard for equipment calibration. For Albert, it was a familiar process. He and his colleagues have been getting calibration services from NIST's thermometry experts for almost 22 years, and Albert has worked with Gregory Strouse, T&H group leader in PML's Sensor Science Division, for 20 of those years.

SDI makes platinum resistance thermometers (PRTs) for applications that range from regulating commercial English muffin ovens here on Earth to monitoring environmental living conditions on the International Space Station.

PRTs work because the electrical resistance of platinum (like various other metals) varies in a linear way with temperature. Measuring the change in resistance is a straightforward and highly accurate way of measuring temperature. The platinum is typically formed into a coil to maximize its resistance per unit length, and covered by protective layers of ceramic and glass. Different PRT designs have different resistance values which can be characterized at two or more well-defined calibration points, usually 0 °C and 100 °C.

Four SDI PRTs, based on three of Albert's designs, are used on Curiosity , and range from 100 ohms to 500 ohms at 0 °C. "The higher the ohmic value," he says, "the easier it is for the electronics to use less power and still get the same precision." The SDI sensors are used to track the temperature inside the rover's Multi-Mission Radioisotope

Thermoelectric Generator, which uses thermocouples to convert the heat from radioactive plutonium-238 into about 125 watts of electrical power.

The SDI PRTs, which measure a temperature range from – 200 °C up to 661 °C, had to be made very small to fit the specifications for insertion into the generator. The longest is about the size of a wooden matchstick, and each contains 490 windings of 0.18 mm platinum wire over a 15 mm length. The windings and electrical leads are enclosed in tubes of 99.8% pure alumina ceramic.

When Albert first began working with PRTs, "I had no background in thermometry. NIST trained me back in 1991," he says, "and I've been coming there ever since. That relationship has been, by far, the deciding factor in our being able to satisfy our customer's requirements."

Not that he always knows immediately whether the customer is satisfied. In the case of the rover sensors, "they were designed and sold in 2006 to Teledyne Energy Systems, which was making the rover generator," Albert says, "and of course we moved on to numerous other things and never thought much more about it. Then on Aug. 15 of this year, I got an e-mail from a contact at Teledyne that caught us by surprise. He said something like, 'By the way, thank you, your sensors are working on Mars.' And our reaction was, um, what was that again? I'm glad he included the part number, because we had to look it up."

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