CHOOSING THE RIGHT TEMPERATURE READOUT

When you're performing temperature calibrations, the right choice of readout for your reference probe and units under test is critical. Consider the following:

Accuracy

Most readout devices for resistance thermometers provide a specification in parts per million (ppm), ohms, and/or temperature. Converting ohms or ppm to temperature depends on the thermometer being used. For a 100Ω probe, 0.001Ω equals 0.0025°C at 0°C. One ppm would be the same as 0.1 mΩ or 0.25 mK. You should note whether the specification is "of reading" or "of full range." One ppm of reading at 100Ω is 0.1 mΩ. However, 1 ppm of full range, where full range is 400Ω, is 0.4 mΩ.

When reviewing accuracy specifications, remember the readout uncertainty can be a small contribution to total uncertainty and that it may not make economic sense to buy the lowest uncertainty readout. A 0.1 ppm bridge may cost $40,000, whereas a 1 ppm Super-Thermometer costs less than $16,000. Yet the bridge offers very little improvement—in this case, 0.000006°C (see below).

Measurement Errors

When making high-accuracy resistance measurements, be sure the readout is eliminating thermal EMF errors within the measurement system. A common technique for removing EMF errors uses a switched DC or low-frequency AC current supply.

Resolution

Having 0.001° resolution does not mean the unit is accurate to 0.001°. In general, a readout accurate to 0.01° should have a resolution of at least 0.001°. Display resolution is important when detecting small temperature changes—for example, when monitoring the stability of a calibration bath.

Linearity

Most manufacturers provide an accuracy specification at one temperature (typically 0°C), but it's important to know the accuracy over your working range. If the readout were perfectly linear, its accuracy would be the same across its entire range. However, all readouts have some non-linearity component. Be sure the manufacturer provides an accuracy specification over your working range or at least a linearity specification for you to include in your uncertainty.

Stability

Stability is important, since you'll be making measurements in a wide variety of ambient conditions and over varying lengths of time. Be sure to review the temperature coefficient and long-term stability specifications. Make sure the variations in your ambient conditions will not affect the readout's accuracy. Be wary of the supplier who quotes "zero drift" specifications. Every readout has at least one drift component.

Calibration

Some readout specifications state "no recalibration necessary." However, ISO guides require the calibration of all measuring equipment. Look for a readout that can be calibrated through its front panel without special software, and avoid readouts that still use manual potentiometer adjustments. Most DC readouts are calibrated using high-stability DC standard resistors. Calibration of AC readouts is more complicated, requiring a reference inductive voltage divider and accurate AC standard resistors.

Traceability

Traceability of DC readout measurements is extremely simple through well-established DC resistance standards. Traceability of measurements from AC readouts and bridges is more problematic. Many countries have no established AC resistance traceability. Most countries that have traceable AC measurements rely on AC resistors calibrated with 10 times the uncertainty of the readout or bridge, which significantly increases the system measurement uncertainty.

Convenience Features

Because the push for increased productivity is endless, you'll need a readout with as many time-saving features as possible. Some important ones to look for are direct display in temperature rather than just raw resistance or voltage, acceptance of a wide variety of thermometer types, ease of use for a short learning curve, channel expansion capability through multiplexers, and digital interface (and software) options that allow for automation of measurements and calibrations.

Sources of Uncertainty - Comparison Calibration of PRTs from –196°C to 420°C		
SPRT	0.001000°C	0.001000°C
1 ppm Super-Thermometer (1 ppm)	0.000250°C	
0.1 ppm Bridge		0.000025°C
Bath Uniformity / Stability	0.005000°C	0.005000°C
Estimated Total Uncertainty (k=2)*	**0.005105°C**	**0.005099°C**
*RSS, assuming uncertainty components were statistically evaluated.		

So, for an additional $30,000 you can buy a bridge and improve your system uncertainty by 0.000006°C.

Thermometry