microK Frequently Asked Questions

Do I need a Standard Resistor for use with the microK and does it improve the accuracy?

The instrument has internal reference resistors allowing a wide range of resistance thermometers to be used with microK without the need for an external resistor.

The use of an external or internal resistor depends on the mode of use. In a secondary laboratory comparing one thermometer against another in a comparison bath would not require an external resistor.

The device under test can be compared directly to the standard thermometer without the need to use a reference resistor, be it internal or external.

Uniquely by using one of the internal standards microK can be programmed to display either the temperature or resistance of the standard probe along with the ratio of the DUT to the standard.

Again in this application an external resistor is not required. The value of the reference resistor is not important when comparing thermometers as long as it is stable during the period of the measurement, which is just a few seconds. As long as the thermometers all have the same shape of resistance to temperature curve any change in the reference resistor from its original calibration are negated as the shift in the DUT will be equivalent to the shift in the standard.

In the primary laboratory, when making sub mK measurements in fixed point cells then in line with good laboratory practise an external temperature controlled resistor should be used.

Which Reference Resistor Should I Use?

Choose a value close to the resistance of the probe at the maximum temperature of interest. E.g, 25.5Ohm SPRT being used at 660°C, equivalent resistance a nominal 91 Ohms, select 100 Ohm Resistor.

The performance up to 660C will then be within ±0.4ppm for microK 400 or ±0.8ppm for microK 800.

What is the maximum value for an external standard resistor?

500KΩ, useful when using thermistors.

Which Model of Resistor Should I select?

A resistor of the “Wilkins” design, available from Isotech.

Is the microK an AC or DC Bridge?

The sense current used in the microK’s bridge circuit is a square wave AC signal. This measurement system is usually referred to as a switched DC bridge (the term AC bridge is normally reserved for bridges that use a sinusoidal sense current). The fast ADC used in the microK allows the current to reverse at 6Hz, which avoids the 1/f flicker noise of many conventional switched DC systems. This means that the microK has all the benefits normally only achievable with AC bridge technology (low noise, complete immunity to thermal EMFs).

What is the Benefit of the Substitution Topology?

With the substitution technique, the SPRT and reference resistor are switched alternately into the same measurement position in the bridge. The two measurements are then used to calculate the resistance ratio. This means that the instrument is inherently accurate at unity ratio (two identical resistors will always produce a unity ratio result) and stable with time. Conventional measurement systems in which the SPRT and reference resistor are connected in series are prone to drift in the common-mode rejection ratio of their amplifiers, leading to drift with time.

How is it that 0.4ppm Equates to 0.4mK, 0.0004°C?

Take an example, a 25.5 Ohm SPRT being used with a 100 Ohm Standard Resistor.

For the standard resistor of 100 Ohms an error of 0.4ppm equates to 40µΩ, for a 25.5 Ohm SPRT that is equivalent in temperature of 400µK (0.4mK).

Note that this is *over the whole range*, right up to 100 Ohms.

If we specify the accuracy just at the water triple point (a 25.5 Ohm SPRT used with a 25 Ohm Standard Resistor); then an error of 0.4ppm is equivalent to a resistance of 10 µΩ, for a 25.5 Ohm SPRT that is equivalent to in temperature to 100 µK (in fact the error would be much less than this with microK since it has negligible errors at zero and unity ratio). This is the correct, but it is expressing the performance only at one temperature, 0.01C and as the temperature rises the measurement uncertainty will increase.

We believe it would be misleading to express the performance *only* in this way and on the data sheet are stating the performance over the whole range, not just at the water triple point.

Another company however specifies for their instrument the accuracy not over the range but just at 0.01°C. When comparing specifications be careful not to be misled and ask for the accuracy over the whole range.

What Uncertainties can be expected with an SPRT and external resistor?

Expanding on the above point and giving examples for different configurations,

For a 25.5 Ohm SPRT used with a 25 Ohm Standard Resistor having calibration to ±0.05ppm.

For the microK 400, 0.4ppm of 25 Ohms is 10 µΩ, equivalent to 100µK (0.1mK).
For the Standard Resistor ±0.05ppm of 25 Ohms is equivalent to 13 µK

Combining the uncertainties using the Root Sum of Squares, RSS

$$\sqrt{100^2 + 13^2} = \pm 101\ \mu K$$

Since microK non linearity is close to zero at resistance ranges close the to the standard resistor the uncertainties over the range from Mercury TP to Gallium MP will actually be better than ±100 µK

With a Standard Resistor calibrated to ±0.05ppm the performance can be summarised,

From the Hg TP, -38.834°C to 29.7646°C, 25.5 Ohm SPRT and 25 Ohm Standard Resistor < ±0.1mK
From 29.7646°C to 660°C, 25.5 Ohm SPRT and 100 Ohm Standard Resistor < ±0.4mK

From the Hg TP, -38.834°C to 29.7646°C, 100 Ohm SPRT and 100 Ohm Standard Resistor < ±0.1mK
From 29.7646°C to 660°C, 100 Ohm SPRT and 400 Ohm Standard Resistor < ±0.4mK

What are the advantages of microK over some other conventional ratio bridges?

Can work with thermocouples as well as resistance thermometers

In built PC with easy to use interface and data logging options

Can connect, USB Memory Stick, Keyboard, Mouse (USB)

Warns if calibration dates exceeded.

Built in database for all your thermometers and reference resistors

Easy to use via large colour touch screen

The microK does not use tapped transformers restricting its measurement range

Wide range of resistance, measure low resistance SPRTs to high resistance thermistors

No Mechanical Parts

Low Noise, High Accuracy

Displays Temperature, Resistance and Ratio

Statistical Mode

Chart Display

Keep Warm Currents

Three Channel

High Resolution direct temperature display (or ratio)

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