

Calibration-Resistance Ratio's

How do you interpret a calibration report listing resistance ratio's and inverse differences?

The resistance ratio is the ratio of the resistance of the thermometer at some temperature (t) to the resistance of the thermometer at the ice point (t₀).

Example

If the resistance of a platinum resistance thermometer is 25.51548 ohms at the ice point, what is the temperature when its resistance is 26.53035?

The Resistance ratio (RR) is expressed as:

$$RR = R_T / R_0$$

The resistance ratio is found as follows:

$$26.53035 / 25.51548$$

$$RR = 1.03977467$$

The table indicates that this ratio corresponds to + 10°C.

SAMPLE PRT TABLE		
R ₀ = 25.51548 ohms		
Temp	Resistance Ratio	Inverse Difference
0°C	.9999601	
10°C	1.03977467	251.5103

The inverse difference column is provided as an aid to interpolation. The inverse difference listed in the table is the reciprocal of the difference between the resistance ratios at that temperature and the next lower temperature.

If the resistance ratio (RR) does not result in a whole number on the temperature scale, linear interpolation may be used to find the temperature using the following expression: $t = t_2 + [(RR - RR_2) \times ID]$

Where:

T = the measurement temperature

T2 = the lower of the two temperatures in the table which bracket the resistance ratio computed

RR = the resistance ratio computed in the measurement

RR2 = the resistance ratio at t2

ID = the inverse difference for the temperature which has the resistance ratio which is just greater than RR

Example: The ice point resistance of a thermometer is 25.51548 ohms. The resistance of the thermometer at some temperature is measured as 25.84327 ohms. What is the temperature? The resistance ratio is found as follows:

$$RR = R_T / R_0$$

$$25.84327 / 25.51548$$

$$RR = 1.01284671$$

The chart indicates this ratio lies between 3°C and 4°C. The inverse difference for 4°C is 251.0493, and the resistance ratio for 3°C is 1.01191728.

Substituting these values into equation yields:

$$t = t_2 + [(RR - RR_2) \times ID]$$

$$t = 3^\circ\text{C} + (1.01284671 - 1.01191728) \times 251.0493$$

$$3^\circ\text{C} + (.00092943) \times 251.0493$$

$$3^\circ\text{C} + .2333327$$

$$\text{or: } t = 3.2333327^\circ\text{C}$$

SAMPLE PRT TABLE

Ro = 25.51548 ohms

Temp	Resistance Ratio	Inverse Difference
0°C	.9999601	
1°C	1.00394706	250.8190
2°C	1.00793278	250.8957
3°C	1.01191728	250.9725
4°C	1.01590056	251.0493
5°C	1.01988262	251.1263
6°C	1.02386346	251.2033
7°C	1.02784309	251.2796
8°C	1.03182152	251.3554
9°C	1.03579869	251.4351

If the table is given in 1°C increments, the precision of the mathematical computations for determine the measurement temperatures using linear interpolation is .0001°C. This does not imply that the precision of the Platinum Resistance Thermometer is .0001°C. If the precision of the measuring instrument used to measure the thermometer resistance (Mueller bridge) is compatible to the thermometer, the uncertainty of the system is about 0.01°C.

Temp Calibration-Ice Point

APPARATUS

Measurements shall be made on an apparatus suitable for the characteristic of the component to be measured as follows;

Ice point temperature resistance measurements may be taken using a digital multimeter with an accuracy of +/- .01%.

ICE POINT TEMPERATURE RESISTANCE

In a Dewar flask, place distilled water, and shaved or crushed clear ice (<2mm pieces) made from distilled water. The bath should have enough water to provide good thermal contact with the thermometers, but not enough to float the ice. The spaces between ice particles must be filled with water (no air pockets) and the ice must extend all the way to the bottom of the Dewar flask. Left to itself, a cavity may form as the conducted heat melts the ice, hence stirring is required every few minutes. The tool used for stirring should not be removed from the Dewar flask during the test, to avoid introducing heat sources.

Thoroughly clean the Standard Thermometer and Test Instrument with distilled water and insert them into the bath, leaving a minimum of 1" of ice at the bottom of the Dewar Flask.

Note: In general, when you push down on the ice pack, the water should rise only ¼" above the ice pack.

Refer to the Job Card Instruction form 4.9 and or the drawing to determine the allowable tolerance at the ice point temperature.

Measure the ice point resistance of the sensor.

Note: The ice point bath is the most widely used and simplest fixed point. The ice bath may be realized with an error of less than 0.01°C. Contamination of any surfaces and or touching the ice with your hands, may be jeopardize the accuracy of the ice point. Wipe down the Dewar flask and ice crusher with distilled water prior to performing this test. Immersion Error may occur if the thermometers are not immersed at least 2 to 3 inches into the bath. To avoid this error, place small thermometers into quartz tubes filled with Magnesium Oxide (MgO) to enable full immersion. Allow the temperatures to stabilize for at least ½ hour, stirring the ice frequently, and draining off excess water. Add ice as necessary. Galvanic Error may occur if water is allowed to touch element or extension wires, especially dissimilar metals in thermocouples. A galvanic cell may be set up, causing voltages that alter thermometers output in millivolts or resistance.