



2000-Series Low Resistance Standards Instruction Manual



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1) General

Ohm-Labs' 2000 series Low Resistance Standards are designed as laboratory references for maintaining and disseminating resistance at levels below one ohm. Based on recent advances in materials and processing, these standards are designed to provide long term stability.

Models 2000 through 2003 (1 ohm through 1 milli-ohm) use nickel-chromium (Evanohm) elements, carefully heat treated for low temperature coefficients of resistance (TCR). These models may be used in oil at 25.0 °C or in air at 23 °C with little degradation in accuracy.

Models 2004 and 2005 (100 and 10 micro-ohm) are made with copper-manganese (Manganin) elements, housed in a perforated can for improved dissipation of heat. These models are recommended for use in stirred oil at 25.0 °C. Models 2004 and 2005 include a thermistor temperature sensor bonded to the resistance element for monitoring and applying temperature corrections.

All models are supplied with an ISO17025 accredited report of calibration, including temperature coefficient data. The 2000 series are offered in decade values. Intermediate values are available by special order.

2) Specifications

Model Number	Nominal Resistance	Tolerance in ppm	100 mW Current	1 W Current	Max Current	Typical Coefficients	Physical
2000	1 Ohm	<5	0.3 Amp	1 Amp	2 A	$\alpha < 1 \text{ ppm} / ^\circ\text{C}$ $\beta < 0.1 \text{ ppm} / ^\circ\text{C}$	127 mm dia. x 165 mm high (5" x 6.5"); 4.5 kg (10 #)
2001	0.1	<10	1	3	5		89 mm dia. X 159 mm high (3.5" x 6.25"); 2 kg (5 #)
2002	0.01	<15	3	10	20		
2003	0.001	<20	10	30	50	$\alpha < 2 \text{ ppm} / ^\circ\text{C}$ $\beta < 0.2 \text{ ppm} / ^\circ\text{C}$	267 mm dia. X 305 mm high (10.5" x 12"); 14 kg (28 #)
2004	0.000 1	<100	30	100	500	$\alpha < 20 \text{ ppm} / ^\circ\text{C}$	
2005	0.000 01	<500	100	300	1000	$\beta < 2 \text{ ppm} / ^\circ\text{C}$	

Notes:

Tolerance is accuracy at time of manufacture, measured at reference current

Temperature coefficient is 18 - 30 °C

12 month drift (initial) < 5 ppm, long term < 2

Environmental Limits

Use: 18-30 °C, 10-90 %RH

Storage: 0-40 °C, 0-95 %RH non-condensing

Protect from shock or excessive vibration

3) Use

On receipt, inspect the standard for physical damage. If damaged, please immediately contact the carrier. We will assist with any damage claims and/or necessary repair.

Review the Report of Calibration accompanying the standard. The measured value is reported at either 23.0 (+/- 0.1) or 25.0 (+/- 0.02) °C.

These standards must be used as four-terminal resistors to realize their stated accuracy. Make current and potential connections to the 'C' and 'P' binding posts on the top of the standard. The left current terminal (C1) corresponds to the left potential terminal (P1). Insure that lead wires are rated for the applied current.

On models 2004 and 2005 (100 and 10 micro-ohm standards), use current cables terminated with either copper lugs. Connect lugs, in line with the resistor, to both top and bottom of the bus bars with silicon bronze nuts and bolts. Torque to 15-20 nm.

Potential connection may be made with bare or silver plated copper wire, bare or gold plated copper spade lugs or gold plated 4 mm banana plugs. Wire may be passed through the hole in the binding posts or wrapped around the post. Do not over tighten the binding posts; a snug finger tight pressure is adequate. The rotating barrels on the binding posts will reduce wire deformation.

An optional 10 K thermistor (standard on models 2004 and 2005) is bonded to the resistance element to assist with characterization of the standard's temperature coefficients of resistance. Alternate temperature sensors are 100 ohm RTD or type T thermocouple. Models 2003, 2004 & 2005 are supplied with thermometer wells for monitoring the internal temperature of the standard. Thermometer wells are available as an option on other models.

Allow 24 hours for the standard to acclimatize to temperature.

For best measurement accuracy, use the standard at its 100 milliwatt or 1 watt power levels. Do not exceed the maximum rated current.

Reverse current through the standard, averaging the forward and reverse readings. Averaging of current reversals reduces errors caused by thermoelectric emf (Peltier or thermocouple effects).

Caution: Application of constant current in excess of three times the reference current value may overheat and permanently shift the resistance of these standards.

4) Measured Value and Temperature Coefficients of Resistance

The Report of Calibration includes a measured value at 23.0 or 25.0 °C and alpha and beta temperature coefficients of resistance. Barring damage, the temperature coefficients of resistance will not change over the life of the standard.

The alpha (α) coefficient is the change in resistance with temperature at 23 or 25 °C; the beta (β) coefficient is the curvature of this change. Within a temperature range around ambient (18 – 30 °C), the resistance of a standard may be accurately expressed as:

$$R_t = R_{25}[1 + \alpha(t-25) + \beta(t-25)^2]$$

Where:

R_t	=	Resistance at temperature 't'
R_{25}	=	Resistance at 23.0 or 25.0 °C reference temperature
t	=	Temperature of resistor

Each resistor is supplied with a table of resistance versus temperature. As a visual aid, this data is also presented in a graph.

5) Maintenance and Repair

Other than occasional cleaning, no maintenance is required. Repairs must be performed by the manufacturer.

6) Calibration

Periodically recertify the resistance of the standard at its reference temperature and at several current levels. The calibration cycle will depend on the user's needs. To develop drift history on the resistor, a useful cycle is every three months for the first year, every six months for the second year, and annually thereafter. As the resistor settles into its long term behavior, the calibration cycle may be extended to two, three or five years. The standard may be returned to the manufacturer or sent to another qualified laboratory for calibration.

The recommended calibration method is comparison against a reference resistance standard using a current comparator bridge and high current range extender.

7) Storage and Shipment

Do not expose the standard to temperatures above 40 °C or below 0 °C; exposure to high or low temperatures can permanently shift the resistance of a standard. Protect from shock and extreme vibration. Handle as you would any other precision instrument. Do not use expanding foam to package the resistor, as the heat generated by the foam may permanently shift its value. Shipment during cooler months is recommended.

8) Warrantee

These standards are warranted for five years from the date of shipment. Please see Ohm-Labs' Terms & Conditions for additional information.