Excellence in Resistance

100-Series High Resistance Standards
Instruction Manual

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100-Series Guarded High Resistance Standards
Instruction Manual

1. General

Ohm-Labs' 100-Series High Resistance Standards are designed as transportable or laboratory references for maintaining the ohm at levels between one megohm and ten teraohms. Based on recent advances in measurement and design, each standard is individually manufactured from selected, custom manufactured resistance elements which have been processed for long term stability. Internal guarding and electrical isolation of terminals reduce errors caused by leakage currents. The internal guard resistance is nominally equal to the resistance of the standard, allowing use in any measurement system without the need for external components. Hermetically sealed, these standards are highly immune from changes in barometric pressure and relative humidity. All models are supplied with a traceable report of calibration at two voltages. These standards are recommended for use at an ambient temperature near 23 °C. A thermistor in close proximity to the internal resistance element is provided for monitoring purposes. This thermistor is electrically isolated from both the case and the internal element.

The 100-Series High Resistance Standards are offered in decade values. Non-decade values are available by special order.

2. Specifications

Model Number	Nominal Resistance	Tolerance in ppm	Internal Guard	Temperature Coefficient	Voltage Coefficient	12 month Stability	Recom. Voltage	Max. Voltage
106	1 Meg	5	1 Meg	1 ppm / °C	0.1 ppm / V	<5 ppm	10	300
107	10 Meg	10	10 M	3	0.1	10	20	1000
108	100 Meg	20	100 M	10	0.1	20	50	1000
109	1 Gig	35	1 G	30	0.1	25	100	1000
110	10 Gig	50	10 G	35	0.1	50	100	1000
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111	100 Gig	200	100 G	50	0.2	100	200	3000
112	1 Tera	500	1 T	50	1	200	500	3000
113	10 Tera	1000	10 T	300	10	500	500	3000

Options: Type N connectors, specify –N in model number (example: 110-N)
BNC connectors, specify –B in model number (example: 110-B)
Grounded triax connectors, specify –T in model number (example: 110-T)
No internal guard (or binding posts for external guard)

Notes:
Tolerance is accuracy at time of manufacture, stated within the absolute accuracy listed.
Temperature coefficient is at 23 °C +/-5 °C.
Voltage coefficient is at recommended voltage –50 % / +100 %.
Internal thermistor = 10,000 ohms (nominal) at 25 °C

Physical:
106-110: 178 x 75 x 100 mm / 7" x 3" x 4"; 1.5 kG / 3 #
111-113: 228 x 125 x 125 mm / 9" x 5" x 5"; 2.5 kG / 5 #

Accessories and options available:
BPO to BNC adaptor (specify EL4302 for BNC male or EL4303 for BNC female)
1 m cables: BPO to BNC male (EL4305); BPO to BPO (EL4306)
1 m thermistor cables: 2 mm dual banana to spades (EL4111), to 4 mm banana plug (EL4112)
Protective caps for BPO connectors (EL4320)
Transit case (for four standards)

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 reported value is at 23 °C. Allow 24 hours for the standard to acclimatize at ambient temperature (23 °C nominal). To monitor the internal temperature of the standard, connect a thermistor thermometer to the 2 mm banana jack in the lid of the resistor. If using an ohmmeter, refer to a thermistor table showing temperature versus resistance for a 10 K (at 25 °C) thermistor.

These standards must be used in a guarded measurement system to realize their stated accuracy. An internal resistor connects the coaxial shields to provide a return path for the guard circuit current. This resistor is nominally equal to the value of the standard.

Connections are made with silver plated BPO (British Post Office) type coaxial connectors. Protective caps should be left in place when the standard is not in use. Optional type N, BNC or triaxial connectors may also be ordered. Use shielded, low noise cables. The low (voltage) shield should be connected to ground (or to the low point corresponding to the junction of the standard). The high (voltage) shield should be driven at measurement voltage. For added protection, triaxial or twin-ax cable may be used, with the outer-most shield at ground potential.

Connect the green resistor ground terminal to a ground to reduce measurement noise. Connect the measurement low (voltage) to the left connector (closest to ground terminal); connect the measurement high (voltage) to the right terminal. Although either terminal may be high, to best match the factory calibration conditions, the left terminal (closest to ground terminal) should be at low potential, and the right terminal at high potential.

Due to coaxial cable capacitance and triboelectric currents in high resistance measurement systems, rapid voltage reversals may cause errors proportional with resistance; these errors increase with increasing resistance (decreasing measurement currents). Improved measurements, particularly above 10 G, will be obtained by allowing the standard to ‘soak’ at applied voltage for a period of time (120 seconds or more) before measuring.

After connecting the standard to the measuring system, apply positive voltage. Allow 2 to 5 minutes stabilization (discard these measurements); take a series of measurements and average this forward voltage reading. Apply negative voltage. Allow 2 to 5 minutes stabilization (discard these measurements); take a series of measurements and average this reverse reading. Finally, average the forward and reverse readings.

High resistance measurements are susceptible to interference from electrical signal noise; to reduce noise, measurement in a low traffic area, or at times of reduced activity, is recommended.

For best measurement accuracy, do not exceed the maximum voltage rating of the standard.

Caution: Application of voltage in excess of three times the rated maximum may damage these standards.

4. Temperature and Voltage Coefficients of Resistance

Each high resistance standard's report of calibration includes its measured value at two voltages, and a determination of the temperature coefficients of resistance (TCR) at 23 °C (nominal). Barring damage, the voltage coefficient and TCR will not change significantly over the life of the standard and do not need to be re-determined.

The difference between the two voltage values, divided by the voltage difference between the two measurements, gives the standard's voltage coefficient (in microvolts / volt).

Measurements at three temperatures are performed to determine the TCR. The alpha (α) temperature coefficient of resistance is the change in resistance with temperature at 23 °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:

$$R_t = R_{23}[1+\alpha(t-23)+\beta(t-23)^2]$$

Where:

R_t	=	Resistance at temperature 't'
R_{23}	=	Resistance at 23 °C
t	=	Temperature of resistance standard

5. Maintenance and Repair

No maintenance is required. The fluoropolymer mounts around the BPO plugs should be kept free from oil and other contaminants. These mounts may be occasionally cleaned with ethanol. To slow tarnishing of the silver plated BPO plugs, keep the protective caps in place when not in use. The plugs may be cleaned with a silver polishing cloth. Repairs must be performed by the manufacturer.

6. Calibration

The recommended calibration method is comparison against a known resistance standard using a dual source bridge. The calibration cycle will depend on the user's needs. Annual calibration is recommended. Ohm-Labs can provide calibration service.

7. Storage and Shipment

Never use expanding foam fill around resistance standards; the heat generated can permanently shift the resistance. Do not expose the standard to temperatures above 40 °C. Protect from shock and extreme vibration. Handle as you would any other precision instrument.

8. Warrantee

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

9. Application Notes

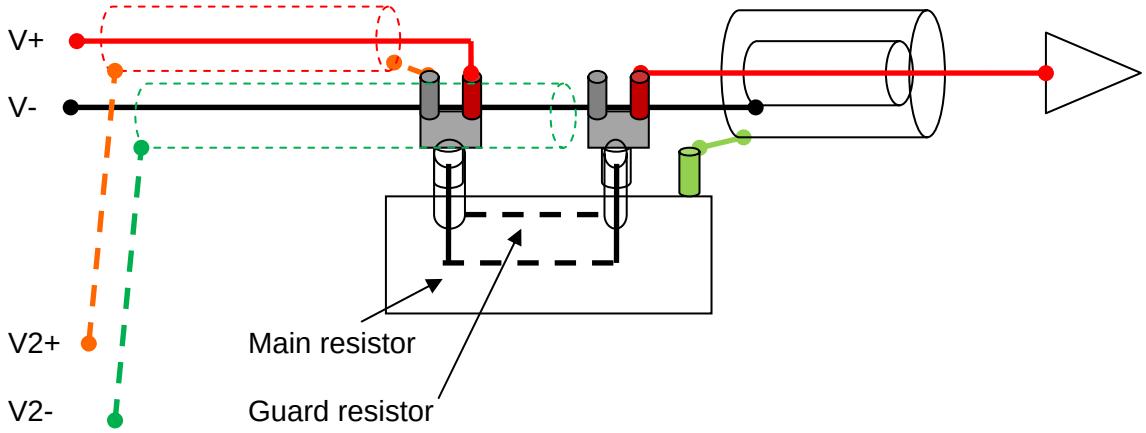
9.1. Electrometer Calibration

To use Ohm-Labs guarded high resistance standards for calibrating electrometers, apply a known voltage and calculate the current using Ohm's Law: I = E/R

Using coax to dual banana plug adaptors, connect voltage calibrator high output to center pin of one resistor terminal; connect center pin of second resistor terminal to electrometer input. Connect voltage calibrator low output to electrometer low (return). Connect electrometer ground to resistor ground.

To reduce noise, use short cable lengths and always ground the resistor case.

Application of 1 volt through 1 GΩ will produce 1 μA; 2 V through 1 TΩ will be 2 pA, etc.



To reduce leakage, connect a second voltage source to the resistor guard high and low as shown in the dotted lines. Generally, the V2- will be at ground potential. Set the V2+ guard voltage to equal the V+ measurement voltage.

External Guard Terminal Option:

100-series high resistance standards are available with high and low guard terminals. These terminals are connected to the shell of the coaxial connectors, and through coaxial shield leads to the internal housing of the internal resistance element.

No internal guard resistor is supplied with these models.

An external guard resistor may be connected between the two external guard binding posts.

Factory calibration is performed with no guard resistor, or with a guard resistor nominally equal to the value of the standard.