

Rox™ Ruthenium Oxide

- Useful to below 50 mK
- Model RX-202A is monotonic to room temperature
- Interchangeable to a standard curve
- Good radiation resistance
- Low magnetic field-induced errors

Ruthenium oxide temperature sensors are thick-film resistors used in applications involving magnetic fields. These sensors are composite materials consisting of bismuth ruthenate, ruthenium oxides, binders, and other compounds to obtain the necessary temperature and resistance characteristics.

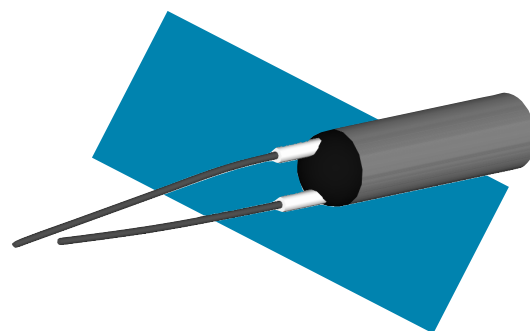
Ruthenium oxide temperature sensors have some unique advantages over other temperature resistors. Each model of the Lake Shore Rox™ temperature sensor adheres to a single resistance versus temperature curve. The RX-102A and RX-202A are useful temperature sensors to below 50 mK.

Rox™ Model RX-202A

(2000 Ω at room temperature) is a unique ruthenium oxide temperature sensor, with specific advantages over other ruthenium oxide temperature sensors. The RX-202A is a factor of four (4) improvement in magnetic field-induced errors over other commercially available ruthenium oxide temperature sensors with similar resistances and sensitivities. Most ruthenium oxide sensors have a maximum useful temperature limit well below room temperature where the sensitivity changes from negative to positive. The RX-202A however, is designed to have a monotonic response from 0.05 K up to 300 K.

Rox™ Model RX-103A

(10,000 Ω at room temperature) has a unique resistance and temperature response curve. The RX-103A is the best choice for interchangeability from 1.4 K to 150 K combined with low magnetic field-induced errors.



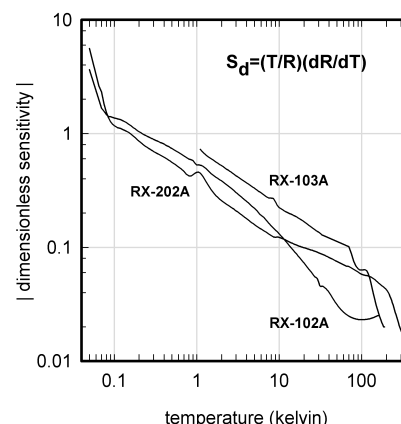
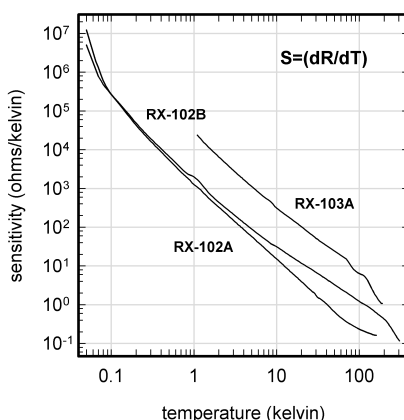
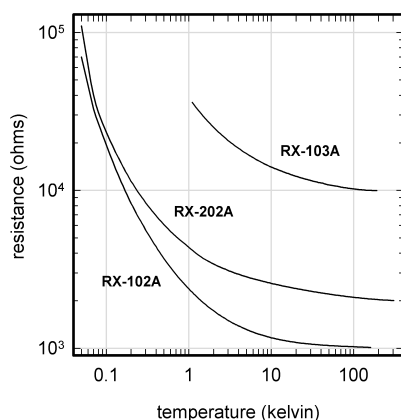
Rox™ Model RX-102A

(1000 Ω at room temperatures) is useful down to 50 mK and has better interchangeability than the Model RX-202A in addition to low magnetic field-induced errors.

Packaging

All models are available in Lake Shore's standard copper A-can (3 mm diameter by 8.5 mm long). Two of the models are available as bare chips for applications requiring a physically smaller sensor or a faster response time. The Model RX-102A-BR is a bare chip version of the Model RX-102A. Dimensions for this bare chip version are 1.4 mm long by 1.27 mm wide by 0.25 mm thick. This bare chip features wrap-around noble metal contacts which can be soldered to using standard lead/tin solder. The Model RX-103A-BR is a bare chip version of the Model RX-103A. This bare chip has wrap-around pretinned contacts which can be soldered to using standard lead/tin solder. Dimensions for the bare chip version are 1.45 mm long by 1.25 mm wide by 0.25 mm thick. The pretinned contacts increase the sensor thickness from 0.25 mm to 0.41 mm. Leads are not attached to these models, so they are not available as matched or calibrated sensors.

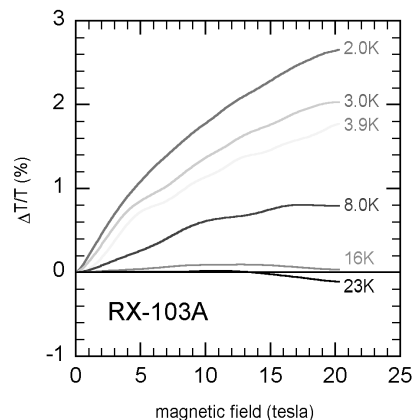
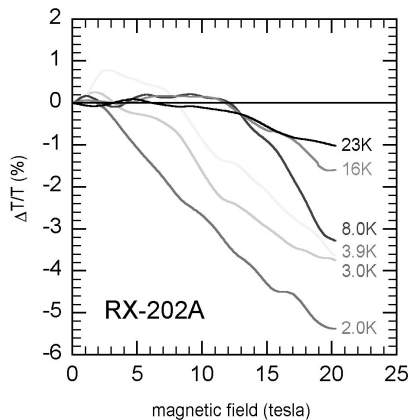
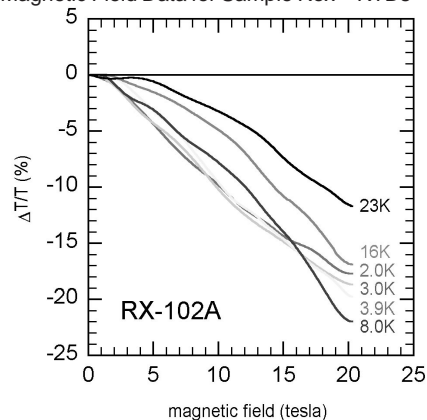
Typical Resistance and Sensitivity values for Rox™ RTDs. See page A-56 for tabular data.



Specifications

	RX-102A-AA	RX-202A-AA	RX-103A-AA
Temperature			
Useful range			
Minimum	0.05 K	0.05 K	1.2 K
Maximum	40 K	40 K	40 K
Maximum storage temperature	300 K	300 K	300 K
Standard curve	Yes (0.05 K to 20 K)	Yes (0.05 K to 20 K)	Yes (1.2 K to 100 K)
Resistance (typical)	See plots on previous page	See plots on previous page	See plots on previous page
Sensitivity (typical)	See plots on previous page	See plots on previous page	See plots on previous page
Dimensionless sensitivity (typical)	See plots on previous page	See plots on previous page	See plots on previous page
Accuracy (interchangeability)			
Matched	See table	See table	See table
Unmatched	See table	See table	See table
Accuracy (SoftCal™)	± 40 mK at 4.2 K, ± 300 mK at 20 K	± 60 mK at 4.2 K, ± 400 mK at 20 K	± 30 mK at 4.2 K, ± 150 mK at 20 K
Accuracy (calibrated)	± 5 mK at 0.05 K, ± 6 mK at 1.4 K ± 15 mK at 4.2 K, ± 110 mK at 20 K	± 5 mK at 0.05 K, ± 7 mK at 1.4 K, ± 13 mK at 4.2 K, 77 mK at 20 K	± 7 mK at 1.4 K, ± 11 mK at 4.2 K, ± 65 mK at 20 K
Stability			
Short-term	± 15 mK at 4.2 K	± 13 mK at 4.2 K	± 10 mK at 4.2 K
Long-term	± 30 mK/yr at 4.2 K	± 50 mK/yr at 4.2 K	± 15 mK/yr at 4.2 K
Thermal response time (A-can)	0.5 seconds at 4.2 K, 2.5 seconds at 77 K	0.5 seconds at 4.2 K, 2.5 seconds at 77 K	0.5 seconds at 4.2 K, 2.5 seconds at 77 K
Recommended recalibration schedule	Annual	Annual	Annual
Excitation			
Recommended	10 mV or less for $T > 1$ K, 30 μ V with AC bridge, 50 mK to 1 K	10 mV or less for $T > 1$ K, 30 μ V with AC bridge, 50 mK to 1 K	10 mV or less (1.2 K to 175 K)
Maximum power before damage	10^5 W, 0.1 mA or 1 V, whichever is less	10^5 W, 0.1 mA or 1 V, whichever is less	10^5 W, 0.1 mA or 1 V, whichever is less
Dissipation at rated excitation	7.5×10^{-8} W at 4.2 K	7.5×10^{-8} W at 4.2 K	3.2×10^{-9} W at 1.4 K, 5.5×10^{-9} W at 4.2 K, 9.6×10^{-9} W at 77 K
Units range (volts or ohms)	1000 Ω at 273 K to 70,000 Ω at 0.05 K	2000 Ω at 300 K to 100,000 Ω at 0.05 K	10,000 Ω at 273 K to 31,000 Ω at 1.4 K
Lead wire configuration	Two lead, no polarity	Two lead, no polarity	Two lead, no polarity
Physical Specifications			
Materials in the sensor/construction	Thick ruthenium dioxide and bismuth ruthenate films with palladium silver contacts, indium solder, aluminum oxide substrate, sapphire header and copper canister with epoxy seal.		
Size in millimeters	3 mm diameter x 8.5 mm long	3 mm diameter x 8.5 mm long	3 mm diameter x 8.5 mm long
Mass	-350 milligrams	-350 milligrams	-350 milligrams
Leads			
Size	0.24 mm diameter x 15 cm long	0.24 mm diameter x 15 cm long	0.24 mm diameter x 15 cm long
Number	Two; user should branch to four wires	Two; user should branch to four wires	Two; user should branch to four wires
Material	Copper	Copper	Copper
Insulation	Heavy build Formvar™	Heavy build Formvar™	Heavy build Formvar™
Internal atmosphere	Air	Air	Helium-4
Environmental			
Radiation effects	Recommended	Recommended	Recommended
Magnetic fields	Recommended	Recommended	Recommended
ESD sensitivity	Not applicable	Not applicable	Not applicable
Noise sensitivity	Not applicable	Not applicable	Not applicable

Magnetic Field Data for Sample Rox™ RTDs



Temperature (kelvin)	RX-102A-AA-M Matched	RX-102A-AA Unmatched	RX-202A-AA-M Matched	RX-202A-AA Unmatched	RX-103A-AA-M Matched	RX-103A-AA Unmatched
0.05 K	±5 mK	±10 mK	±10 mK	±15 mK		
0.3 K	±15 mK	±20 mK	±20 mK	±25 mK		
0.5 K	±20 mK	±25 mK	±25 mK	±30 mK		
1.4 K	±25 mK	±50 mK	±50 mK	±100 mK	±50 mK	±150 mK
4.2 K	±75 mK	±125 mK	±150 mK	±250 mK	±100 mK	±400 mK
20 K	±500 mK	±1.25 K	±1 K	±2.5 K	±700 mK	±2 K
40 K	±1.5 K	±4 K	±2 K	±5 K	±1.5 K	±4 K

Ordering Information

Rox™ RTD

Calibration Range Suffix Codes

Numeric figure is the low end of the calibration; alpha character corresponds to high end.

B = 40 K; D = 100 K; M = Matched (Calibration of matched sensors are available - consult factory)

Model number	Uncal	0.05B	0.3B	1.4B
RX-202A-AA, CD	✓	✓	✓	✓
RX-202A-AA-M	✓			
RX-102A-AA, CD		✓	✓	✓
RX-102A-AA-M	✓			
RX-103A-AA, CD				✓
RX-103A-AA-M	✓			

Other packaging available through special order. Consult Lake Shore.

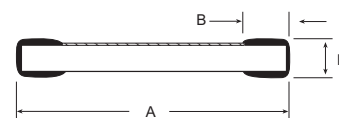
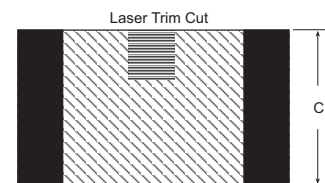


Accessories suggested for installation
(see Section 3):

Stycast® Epoxy
Apiezon® Grease
IMI-7031 Varnish
Indium Solder
90% Pb, 10% Sn Solder
Phosphor-Bronze Wire
Manganin Wire
CryoCable™

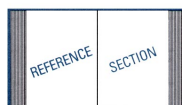
Bare Chip Models

Models	A (chip length)	B (pad width)	C (chip width)	D (thickness)
RX-102A-BR	1.45 mm (0.057")	0.30 mm (0.012")	1.27 mm (0.050")	0.65 mm (0.022")
RX-103A-BR	1.40 mm (0.070")	0.21 mm (0.010")	1.23 mm (0.060")	0.41 mm (0.016")



For information on Packages for Sensor Installation, see pages 1-40 to 1-42.

Adding lead length to sensors - see page 1-43.



See the Reference Section for a detailed description of

Self-heating
Installation
Uncalibrated sensors
Calibrated sensors
CalCurve™
Sensor packages