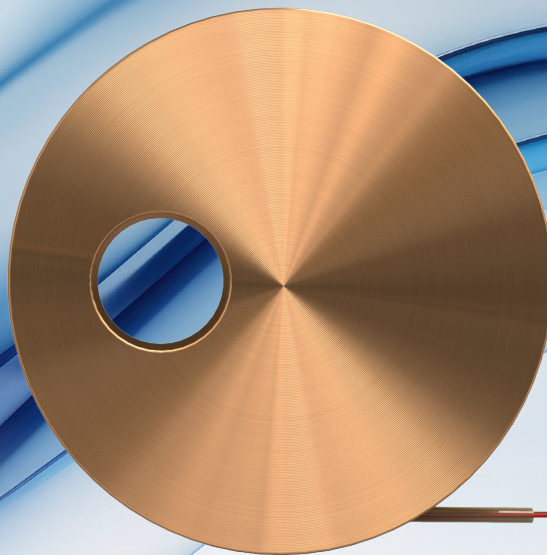


Interchangeable Rox™

Cryogenic Temperature Sensor



Product Features

Temperature range: 50 mK to 300 K

Resistance range: 1 k Ω to 20 k Ω

Calibration curve: Interchangeable

Accuracy: ± 1.4 mK at 16 mK

Short-term stability: ± 15 mK at 4.2 K

Magnetic fields: Recommended

Radiation: Recommended

Packages: AA, CD, BR

Temperature controller: 372

Product Overview

Interchangeable Rox sensors are designed for use in moderate magnetic fields and enable ultra-low temperature measurements down to 50 mK. These sensors are optimized for low magnetic field-induced errors and are available with different resistance values to suit various temperature ranges, from 50 mK up to 300 K. Interchangeable packaging options allow for soldering, bolting, or insertion into a hole, with gold-plated copper bobbins available for effective lead thermalization.

Accuracies

Interchangeable Rox™ sensors use a single resistance versus temperature calibration curve and are offered in two accuracy bands: band A (highest accuracy) and band B. Because they share a standard calibration curve, the same curve can be applied across all sensors of the same model. This makes them ideal for high-volume applications where a single curve can be hard-coded into the measurement system. Interchangeable sensors are not individually calibrated, but each undergoes a quality control check to ensure it meets the specified accuracy requirements.

For applications requiring maximum precision, individually calibrated sensors are also available. These provide the best accuracy but are not interchangeable, each sensor requires its own unique calibration curve. Among the models, RX-102A delivers the highest accuracy, followed by RX-103A (but limited to >1.4 K), and then RX-202A. For measurements extending to room temperature, RX-202A offers a monotonic response up to 300 K enabling measurements up to room temperature. However, accuracy starts to decrease significantly above 40 K.

	Calibrated ¹ (not interchangeable)			Interchangeable					
	RX-102A	RX-202A	RX-103A	RX-102A		RX-202A		RX-103A	
	Cal 0.05 to 40 K	Cal 1.4 to 40 K		Band A	Band B	Band A	Band B	Band A	Band B
50 mK	—	—	—	±5 mK	±10 mK	±10 mK	±15 mK	—	—
300 mK	—	—	—	±15 mK	±20 mK	±20 mK	±25 mK	—	—
500 mK	—	—	—	±20 mK	±25 mK	±25 mK	±30 mK	—	—
1.4 K	±16 mK	±16 mK	±16 mK	±25 mK	±50 mK	±50 mK	±100 mK	±50 mK	±150 mK
4.2 K	±16 mK	±16 mK	±17 mK	±75 mK	±125 mK	±150 mK	±250 mK	±100 mK	±400 mK
10 K	±18 mK	±18 mK	±22 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

¹ [(Calibration uncertainty)² + (reproducibility)²]^{0.5} for more information see Appendices B, D, and E

Performance specifications

	RX-102A	RX-202A	RX-103A
Operational temperature range	5 mK to 40 K	5 mK to 300 K ⁴	1.4 K to 40 K
Resistance at room temperature	1 kΩ	2 kΩ	10 kΩ
Recommended excitation	20 μV (0.05 K to 0.1 K) 63 μV (0.1 K to 1.2 K) 10 mV or less for T > 1 K		10 mV or less for T > 1 K
Short-term stability ²	±15 mK at 4.2 K	±15 mK at 4.2 K	±15 mK at 4.2 K
Long-term stability ³	±30 mK at 4.2 K	±50 mK at 4.2 K	±15 mK at 4.2 K
Thermal response time	0.5 s at 4.2 K 2.5 s at 77 K	0.5 s at 4.2 K 2.5 s at 77 K	0.5 s at 4.2 K 2.5 s at 77 K
Dissipation at rated excitation (typical)	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
Magnetic field use	T > 2 K, and B ≤ 10 T	T > 2 K, and B ≤ 10 T	T > 2 K, and B ≤ 10 T
Radiation	Recommended		
Maximum vacuum	High (to 10 ⁻⁴ Pa)		

² Recommended excitation for T < 1 K based on Lake Shore calibration procedures using an AC resistance bridge—for more information refer to Appendix D and Appendix E

³ Short-term reproducibility data is obtained by subjecting sensor to repeated thermal shocks from 305 K to 4.2 K

⁴ Above 40 K significantly decreases accuracy

Typical sensitivity

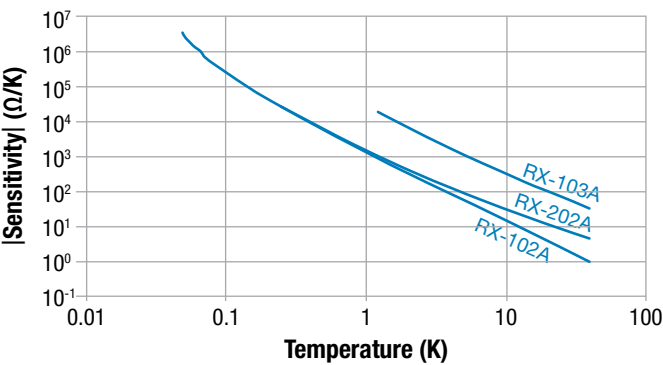


Figure 1
Typical Interchangeable Rox sensitivity

Typical resistance

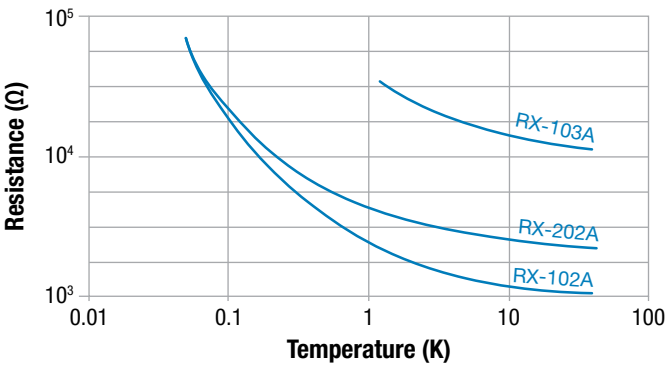


Figure 2
Typical Interchangeable Rox resistance

Temperature response

RX-102A				RX-202A			RX-103A		
T (K)	R (Ω)	dR/dT (Ω/K)	(T/R)-(dR/dT)	R (Ω)	dR/dT (Ω/K)	(T/R)-(dR/dT)	R (Ω)	dR/dT (Ω/K)	(T/R)-(dR/dT)
0.05	70020	-5090000	-3.6	110000	-12300000	-5.6	—	—	—
0.1	19390	-266000	-1.4	23340	-274000	-1.2	—	—	—
0.2	8278	-43000	-1.0	11420	-49000	-0.86	—	—	—
0.3	5615	-16600	-0.89	8364	-19400	-0.69	—	—	—
0.5	3701	-5478	-0.74	6069	-6791	-0.56	—	—	—
1	2381	-1260	-0.53	4366	-2000	-0.46	—	—	—
1.4	2005	-667	-0.47	3797	-935	-0.34	30750	-13570	-0.62
2	1726	-331	-0.38	3420	-440	-0.26	25090	-6550	-0.52
3	1502	-152	-0.30	3112	-218	-0.21	20710	-2940	-0.43
4.2	1370	-80.3	-0.25	2918	-121	-0.17	18150	-1560	-0.36
6	1267	-40.5	-0.19	2757	-66.6	-0.15	16130	-811	-0.3
10	1167	-15.3	-0.13	2579	-31.6	-0.12	14060	-315	-0.22
20	1089	-3.96	-0.07	2390	-11.9	-0.10	12290	-103	-0.17
30	1063	-1.75	-0.05	2300	-6.88	-0.09	11550	-52.4	-0.14
40	1049	-1.06	-0.04	2244	-4.58	-0.08	11150	-21.7	-0.08

Radiation effects

Interchangeable Rox sensors are engineered to withstand ionizing radiation, maintaining calibration stability even under exposure to gamma rays and neutron radiation. While radiation can cause temporary or permanent shifts in calibration, sensors demonstrate consistent behavior and minimal temperature drift across a wide range of doses and conditions. This radiation resistance makes them well-suited for use in high-energy physics, space applications, and other environments where exposure to ionizing radiation is expected.

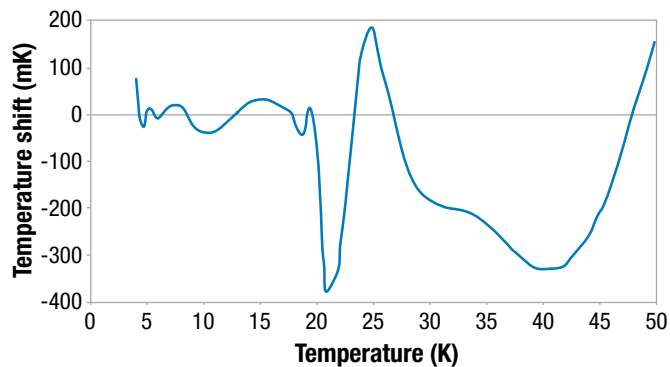
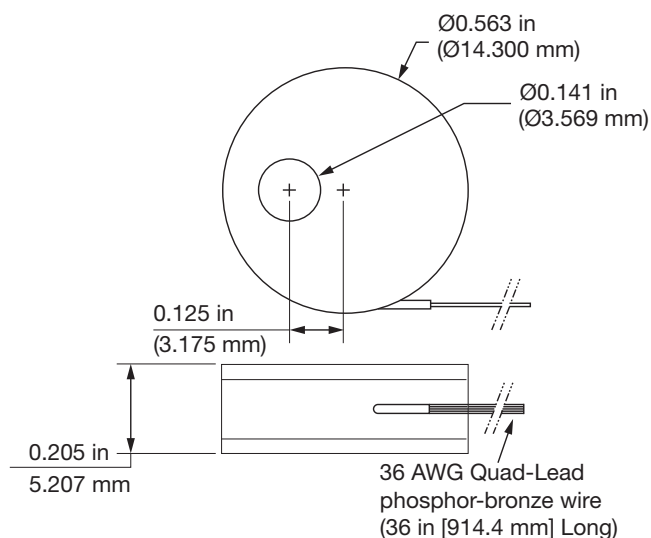


Figure 3
Temperature shift for a 1 K Ω RuO₂ sensor after exposure to 10 kGy (1 Mrad) gamma radiation from a Co-60 source; irradiation performed at 4.2 K

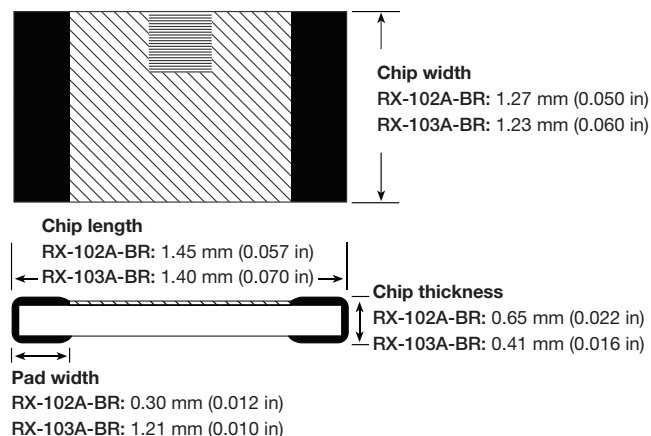
Physical specifications

	RX-102A	RX-202A	RX-103A
Lead wire	2-lead, no polarity – user should branch to 4		
Package options	CD, AA, BR	CD, AA	CD, AA, BR
Mass	3.3 g	3.28 g	3.36 g
Wire	32 AWG copper leads with heavy build Formvar® attached with epoxy strain relief at sensor		
Soldering standard	J-STD-001 Class 2		
Internal atmosphere	Air		
Maximum vacuum	High (to 10 ⁻⁴ Pa)		

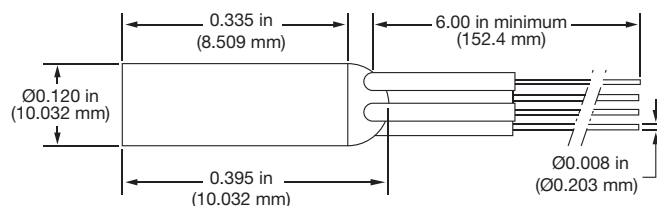
CD



BR



AA



Magnetic field dependence

For low to mid-range magnetic fields, the RX-202A provides the most accurate temperature response above 1 K, while at high magnetic fields, the RX-103A exhibits the greatest resistance to field-induced errors. For measurements below 1 K, the RX-102A delivers the lowest magnetic field-induced errors.

		RX-102A	RX-202A	RX-103A
Temperature (K)	Magnetic field (T)	$\frac{\Delta T}{T}$ (%)	$\frac{\Delta T}{T}$ (%)	$\frac{\Delta T}{T}$ (%)
2	2.5	-1.4	-0.13	0.58
	8	-7.9	-2.2	1.5
	14	-13	-3.9	2.2
	19	-17	-5.2	2.6
3	2.5	-1.5	0.18	0.44
	8	-7	-0.68	1.1
	14	-14	-2.7	1.7
	19	-18	-3.7	2.0
4	2.5	-0.56	0.77	0.27
	8	-6.7	0.046	0.95
	14	-14	-1.8	1.4
	19	-18	-3.2	1.7
8	2.5	-1.3	-0.023	0.11
	8	-6.1	0.16	0.49
	14	-13	-0.65	0.71
	19	-21	-3.0	0.80
16	2.5	-0.40	0.03	0.018
	8	-3.4	0.16	0.076
	14	-9.6	-0.48	-0.089
	19	-16	-1.5	0.040
23	2.5	-0.31	-0.05	0.0051
	8	-2.2	-0.08	0.0058
	14	-6.2	-0.39	-0.006
	19	-11	-0.92	-0.095

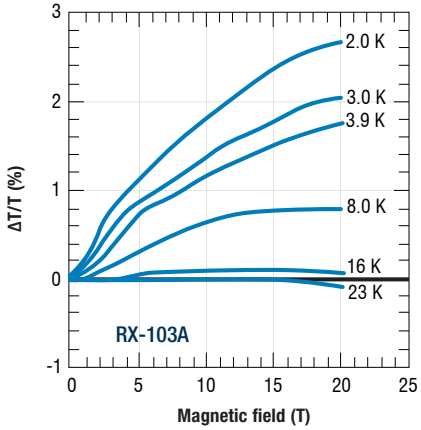
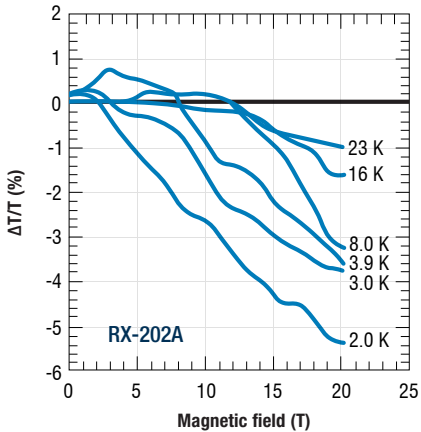
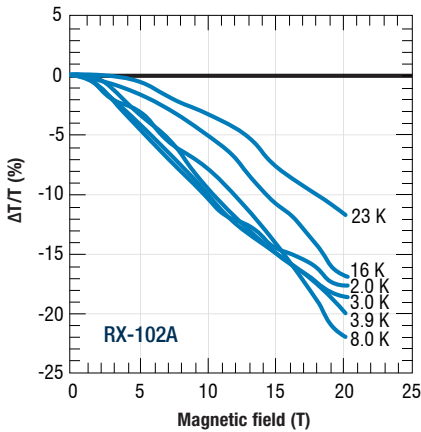
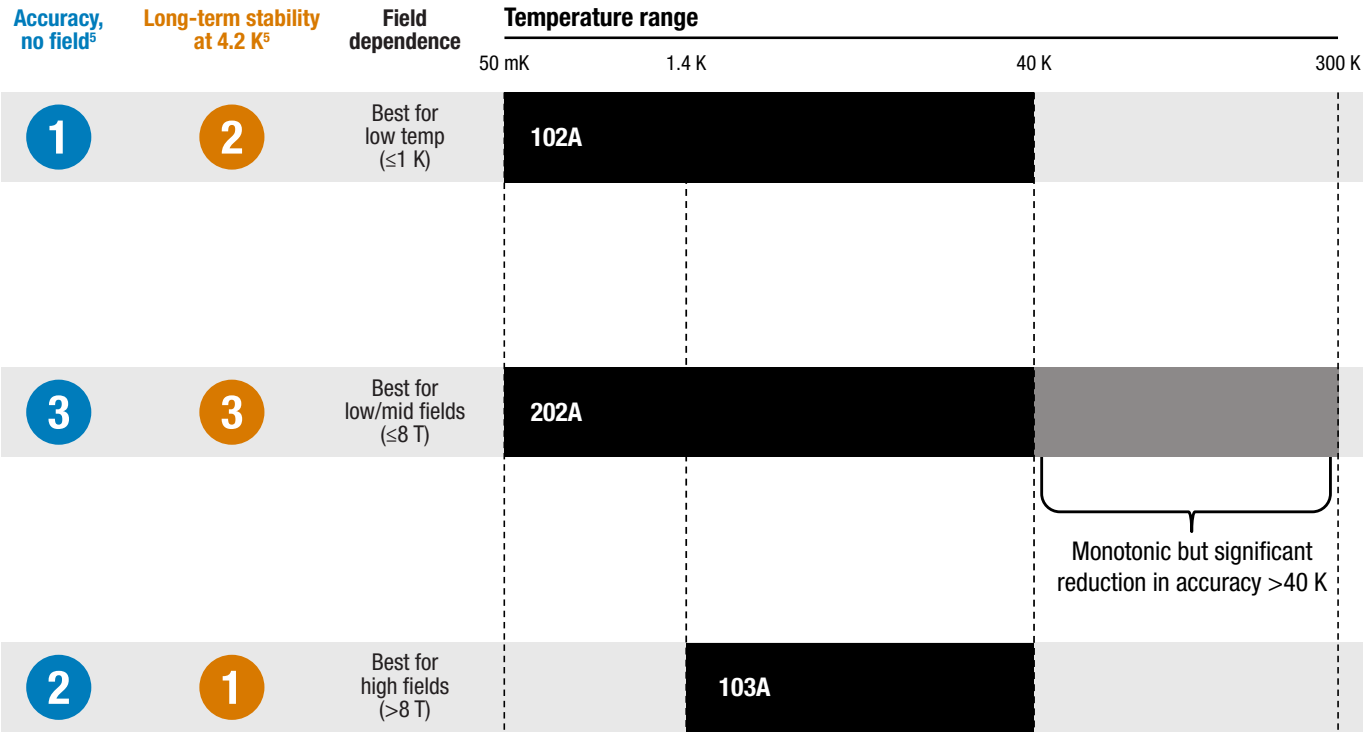


Figure 4, 5, and 6
Magnetic field dependence of
RX-102A, 202A, and RX-103A

Interchangeable Rox selection

The RX-102A is the most popular choice for applications below 1 K, offering the highest accuracy and excellent magnetic field performance in this range. The RX-202A is typically selected for measurements extending up to room temperature, though accuracy decreases significantly above 40 K. The RX-103A is preferred for operation above 1.4 K and in very high magnetic fields. It also provides the best long-term stability at 4.2 K, with the RX-102A a very close second.



⁵ Relative comparison between 102A, 202A, and 103A; 1 = best

Ordering information

Rox sensors

Part number	Package	Type
RX-102A-CD		Interchangeable — band B
RX-102A-CD-0.05B		Calibrated 50 mK to 40 K
RX-102A-AA		Interchangeable — band B
RX-102A-AA-M		Interchangeable — band A
RX-102A-AA-0.05B		Calibrated 50 mK to 40 K
RX-102A-BR		Interchangeable — band B
RX-202A-CD		Interchangeable — band B
RX-202A-CD-0.05B		Calibrated 50 mK to 40 K
RX-202A-AA		Interchangeable — band B
RX-202A-AA-M		Interchangeable — band A
RX-202A-AA-0.05B		Calibrated 50 mK to 40 K
RX-103A-CD		Interchangeable — band B
RX-103A-CD-1.4B		Calibrated 1.4 K to 40 K
RX-103A-AA		Interchangeable — band B
RX-103A-AA-M		Interchangeable — band A
RX-103A-AA-1.4B		Calibrated 1.4 K to 40 K
RX-103A-BR		Interchangeable — band B

Temperature controller



A 372 temperature controller is required to take readings down to 50 mK. Add a 3726 scanner card to increase the number of channels from 2 to 17 and provide a fully guarded signal path.

372N	AC resistance bridge temperature controller
372S	AC resistance bridge temperature controller with 3726 scanner

Lead extensions

Extensions can be added to your device down to (1 in) to extend lead length, with a variety of wire types available to suit your application. Below are the most common configurations.

Refer to the [Lead Extensions datasheet](#) for the complete list.

-QT	Quad-Twist™, 36 AWG, 2 m
-QT	Quad-Twist™, 36 AWG, 2 m



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