Cernox® RTDs

Cernox® features

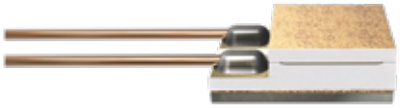
- Low magnetic field-induced errors
- Temperature range of 100 mK to 420 K (model dependent)
- High sensitivity at low temperatures and good sensitivity over a broad range
- Excellent resistance to ionizing radiation
- Bare die sensor with fast characteristic thermal response times: 1.5 ms at 4.2 K, 50 ms at 77 K
- Broad selection of models to meet your thermometry needs
- Excellent stability
- Variety of packaging options

Cernox® thin film resistance temperature sensors offer significant advantages over comparable bulk or thick film resistance sensors. The smaller package size of these thin film sensors makes them useful in a broader range of experimental mounting schemes, and they are also available in a chip form. They are easily mounted in packages designed for excellent heat transfer, yielding a characteristic thermal response time much faster than possible with bulk devices requiring strain-free mounting. Additionally, they have been proven very stable over repeated thermal cycling and under extended exposure to ionizing radiation.

Packaging options

AA, BC, BG, BO, BR, CD, CO, CU, ET, LR, MT, SD

CX-SD



CX-BR



CAUTION: These sensors are sensitive to electrostatic discharge (ESD). Use ESD precautionary procedures when handling, or making mechanical or electrical connections to these devices in order to avoid performance degradation or loss of functionality.

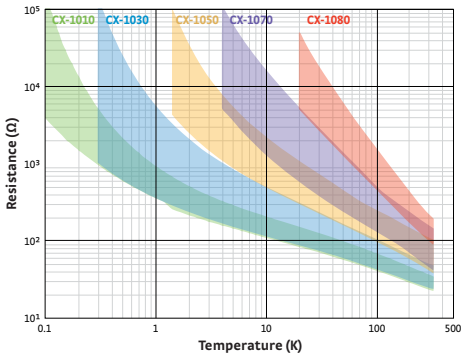
CX-1010—the ideal replacement for germanium RTDs

The CX-1010 is the first Cernox® designed to operate down to 100 mK, making it an ideal replacement for Germanium RTDs. Unlike Germanium, all Cernox models have the added advantage of being able to be used to room temperature. In addition, Cernox is offered in the incredibly robust Lake Shore SD package, giving researchers more flexibility in sensor mounting.

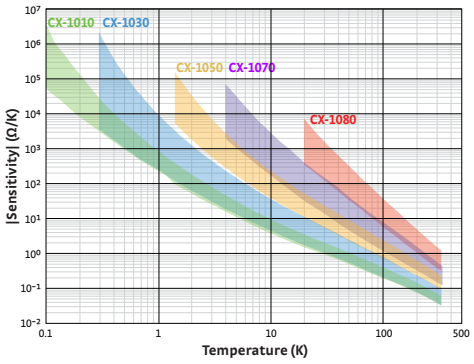
The Lake Shore SD package — the most rugged, versatile package in the industry

The SD package, with direct sensor-to-sapphire base mounting, hermetic seal, and brazed Kovar leads, provides the industry's most rugged, versatile sensors with the best sample to chip connection. Designed so heat coming down the leads bypasses the chip, it can survive several thousand hours at 500 K (depending on model) and is compatible with most ultra high vacuum applications. It can be indium soldered to samples without shift in sensor calibration. If desired, the SD package is also available without Kovar leads.

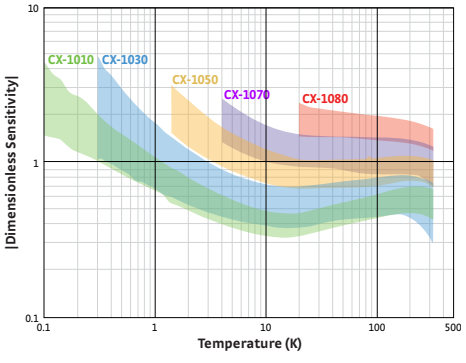
Typical Cernox® resistance



Typical Cernox® sensitivity



Typical Cernox® dimensionless sensitivity



Specifications

Standard curve Not applicable

Recommended excitation[1] 20 µV (0.1 K to 0.5 K); 63 µV (0.5 K to 1 K); 10 mV or less for T > 1.2 K

Dissipation at recommended excitation Typical 10^{-5} W at 300 K, 10^{-7} W at 4.2 K, 10^{-13} W at 0.3 K (model and temperature dependent)

Thermal response time BC, BR, BG: 1.5 ms at 4.2 K, 50 ms at 77 K, 135 ms at 273 K; SD: 15 ms at 4.2 K, 0.25 s at 77 K, 0.8 s at 273 K; AA: 0.4 s at 4.2 K, 2 s at 77 K, 1.0 s at 273 K

Use in radiation Recommended for use in radiation environments—see Appendix B

Use in magnetic field Recommended for use in magnetic fields at low temperatures. The magnetoresistance is typically negligibly small above 30 K and not significantly affected by orientation relative to the magnetic field—see Appendix B

Reproducibility[2] ±3 mK at 4.2 K

Soldering standard J-STD-001 Class 2

[1] 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

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

Range of use

	Minimum limit[3]	Maximum limit
Cernox®	0.10 K	325 K
Cernox® HT	0.10 K	420 K[4]

[3] Model dependent

[4] HT bare chip devices (BG, BC) only for use in vacuum 325 K to 420 K

Calibrated accuracy[5]

	Typical sensor accuracy[6]	Long-term stability[7]
1.4 K	±5 mK	±3 mK
4.2 K	±5 mK	±3 mK
10 K	±6 mK	±6 mK
20 K	±9 mK	±12 mK
30 K	±10 mK	±18 mK
50 K	±13 mK	±30 mK
77 K	±16 mK	±46 mK
300 K	±60 mK	±180 mK
400 K	±65 mK	—

[5] Bare chip sensors can only be calibrated after attaching gold wire leads—the user must remove the ball bonded leads if they are not desired (the bond pads are large enough for additional bonds)

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

[7] Long-term stability data is obtained by subjecting sensor to 200 thermal shocks from 305 K to 77 K

Typical magnetic field-dependent temperature errors[8] ΔT/T (%) at B (magnetic induction)

	Cernox® 1050			
	2.5 T	8 T	14 T	19 T
2 K	1.3	3.1	3.9	5
4.2 K	0.1	-0.15	-0.85	-0.8
10 K	0.04	-0.4	-1.1	-1.5
20 K	0.04	0.02	-0.16	-0.2
30 K	0.01	0.04	0.06	0.11
77 K	0.002	0.022	0.062	0.11
300 K	0.003	0.004	0.004	0.006

[8] Excellent for use in magnetic fields, depending on temperature range (>2 K)

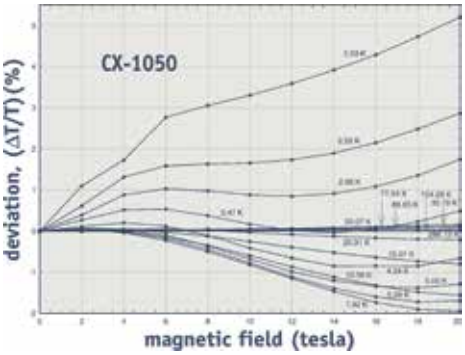
Temperature response data table (typical)[9]

	CX-1010			CX-1030			CX-1050			CX-1070			CX-1080		
	R[10](Ω)	dR/dT (Ω/K)	(T/R)·(dR/dT)	R[10] (Ω)	dR/dT (Ω/K)	(T/R)·(dR/dT)	R[10] (Ω)	dR/dT (Ω/K)	(T/R)·(dR/dT)	R[10] (Ω)	dR/dT (Ω/K)	(T/R)·(dR/dT)	R[10] (Ω)	dR/dT (Ω/K)	(T/R)·(dR/dT)
4.2	277.32	-32.209	-0.49	574.20	-97.344	-0.71	3507.2	-1120.8	-1.34	5979.4	-2225.3	-1.56	—	—	—
10	187.11	-8.063	-0.43	331.67	-19.042	-0.57	1313.5	-128.58	-0.98	1927.2	-214.11	-1.11	—	—	—
20	138.79	-3.057	-0.44	225.19	-6.258	-0.56	692.81	-30.871	-0.89	938.93	-46.553	-0.99	6157.5	-480.08	-1.56
30	115.38	-1.819	-0.47	179.12	-3.453	-0.58	482.88	-14.373	-0.89	629.90	-20.613	-0.98	3319.7	-165.61	-1.50
77.35	70.837	-0.510	-0.56	101.16	-0.820	-0.63	205.67	-2.412	-0.91	248.66	-3.150	-0.98	836.52	-15.398	-1.42
300	30.392	-0.065	-0.65	41.420	-0.088	-0.64	59.467	-0.173	-0.87	66.441	-0.201	-0.91	129.39	-0.545	-1.26
400 (HT)	—	—	—	34.779	-0.050	-0.57	46.782	-0.093	-0.79	51.815	-0.106	-0.81	91.463	-0.261	-1.14
420 (HT)	—	—	—	33.839	-0.045	-0.55	45.030	-0.089	-0.77	49.819	-0.094	-0.80	86.550	-0.231	-1.12

[9] See Appendix G for expanded response table

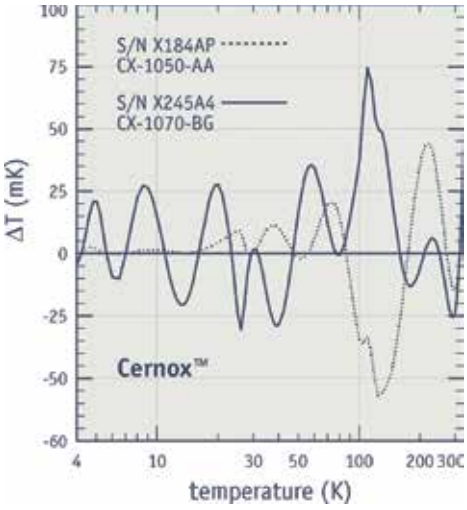
[10] Cernox sensors do not follow a standard response curve — the listed resistance ranges are typical, but can vary widely; consult Lake Shore to choose a specific range

Magnetic field dependence data for sample CX RTDs

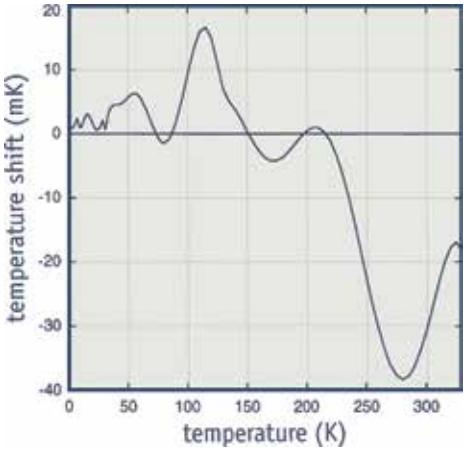


Typical temperature reading errors for operation of CX-1050 sensors in magnetic fields at temperatures from 2.03 K to 286 K. “Low temperature thermometry in high magnetic fields VII. Cernox® sensors to 32 T,” B. L. Brandt, D. W. Liu and L. G. Rubin; Rev. Sci. Instrum., Vol. 70, No. 1, 1999, pp 104-110.

Neutrons and gamma rays

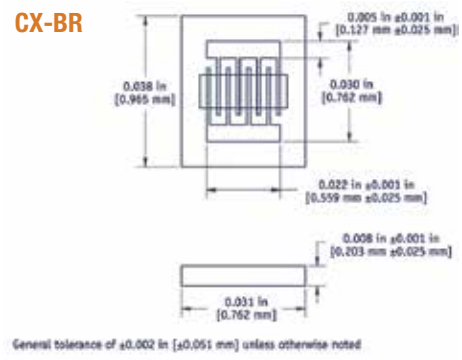


Typical calibration shifts

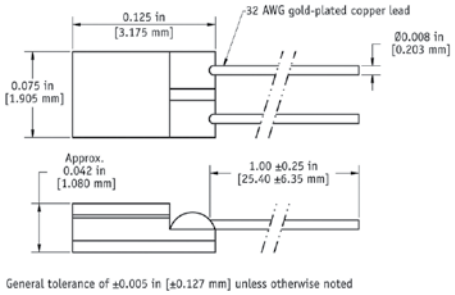


Typical calibration shift after 200 thermal shocks from 305 K to 77 K for a Model CX-1030 temperature sensor (ΔT = 1 mK at 4.2 K and 10 mK at 100 K).

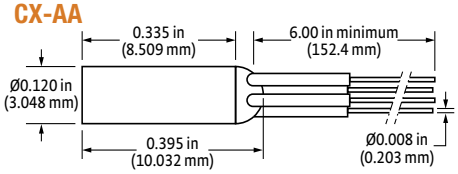
CX-BR



CX-SD



CX-AA



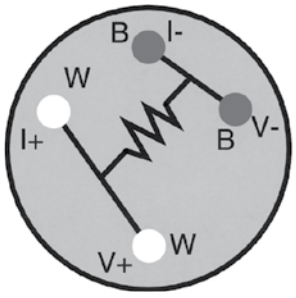
General tolerance of ±0.005 in (±0.127 mm) unless otherwise noted

Physical specifications

	Mass	Lead type	Internal atmosphere
Bare chip (BC), (BG), (BR)	≤ 3.0 mg	BR: none BG: two 2 mil (44 AWG) bare gold 25 mm long wires BC: two 2.5 mil (42 AWG) bare copper 25 mm long wires	NA
Hermetic ceramic package (SD)	≈ 40 mg	2 gold-plated copper	Vacuum
Copper canister package (AA)	≈ 390 mg	4 phosphor bronze with HML heavy build insulation attached with epoxy strain relief at sensor	Helium 4 (^{4}He) is standard

AA package

Wires with the same color code are connected to the same side of the sensor (looking at epoxy seal with leads toward user)



Ordering information

Uncalibrated sensor—Specify the model number in the left column only, for example CX-1050-CD.
Calibrated sensor—Add the calibration range suffix code to the end of the model number, for example CX-1050-CD-1.4L.

Cernox® RTD	Calibration range suffix codes Numeric figure is the low end of the calibration Letters represent the high end: L=325 K, M=420 K										
	Uncal	0.1L	0.1M	0.3L	0.3M	1.4L	1.4M	4L	4M	20L	20M
CX-1010-AA, -BC, -BO, -CD, -ET, -LR, -MT	■	■				■					
CX-1010-BG-HT, -BR-HT	■										
CX-1010-CO-HT, -CU-HT, SD-HT	■	■	■			■	■				
CX-1030-AA, -BC, -BO, -CD, -ET, -LR, -MT	■			■		■					
CX-1030-BG-HT, -BR-HT	■										
CX-1030-CO-HT, -CU-HT, -SD-HT	■			■	■	■	■				
CX-1050-AA, -BC, -BO, -CD, -ET, -LR, -MT	■					■					
CX-1050-BG-HT, -BR-HT	■										
CX-1050-CO-HT, -CU-HT, -SD-HT	■					■	■				
CX-1070-AA, -BC, -BO, -CD, -ET, -LR, -MT	■							■			
CX-1070-BG-HT, -BR-HT	■										
CX-1070-CO-HT, -CU-HT, -SD-HT	■							■	■		
CX-1080-AA, -BC, -BO, -CD, -ET, -LR, -MT	■									■	
CX-1080-BG-HT, -BR-HT	■										
CX-1080-CO-HT, -CU-HT, -SD-HT	■									■	■

ADD -P Add spot-welded platinum leads to the SD package for Cernox® sensors only

Accessories available for sensors

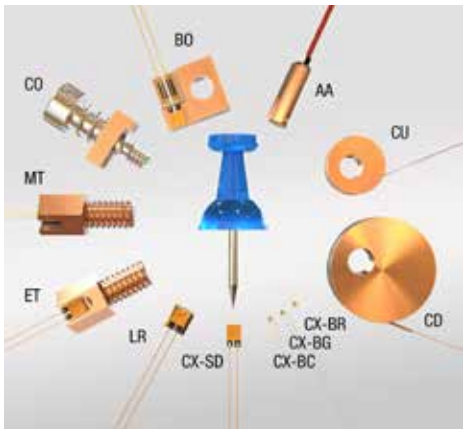
SN-CO-C1	SD package sensor clamp, qty 1
SN-CO-C10	SD package sensor clamp, qty 10
8000-CD	Calibration report on CD-ROM
8000-USB	Calibration report on USB
COC-SEN	Certificate of conformance

Accessories suggested for installation—see Accessories section for full descriptions

Stycast® epoxy	VGE-7031 varnish
Apiezon® grease	Phosphor bronze wire
90% Pb, 10% Sn solder	Manganin wire
Indium solder	CryoCable™

Packaging options

For more information on sensor packages and mounting adapters, see page 20.





CO adapter — spring loaded clamp for easy sensor interchangeability

See the appendices for a detailed description of:
Installation
Uncalibrated sensors
SoftCal™
Calibrated sensors
CalCurve™
Sensor packages

To add length to sensor leads, see page 25.