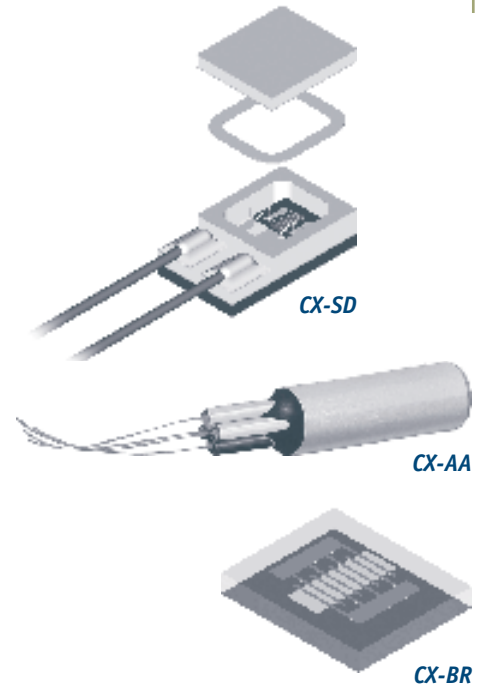


**Features**

- 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™ RTDs\*

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-1010 – the Ideal Replacement for Germanium RTDs**

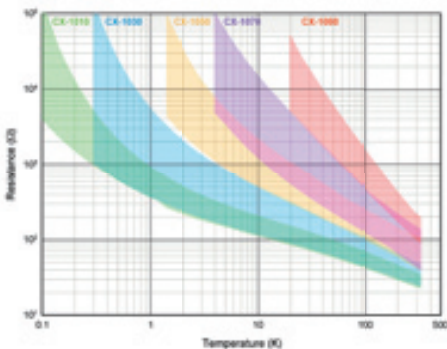
The CX-1010 is the first Cernox™ designed to operate down to 100 mK, making it an ideal replacement for Germanium RTDs. Unlike Germanium, all Cernox models have the added advantage of being able to be used to room temperature. In addition, Cernox is offered in the incredibly robust Lake Shore SD package,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

**The Lake Shore SD Package – The Most Rugged, Versatile Package in the Industry**

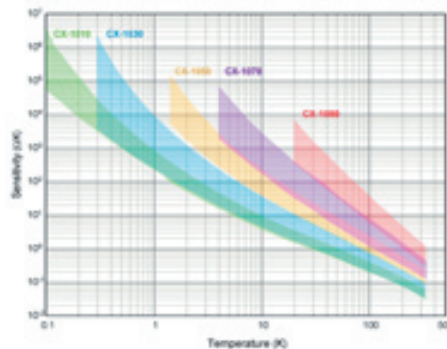
The SD package, with direct sensor-to-sapphire base mounting, hermetic seal, and soldered copper leads, provides the industry's most rugged, versatile sensors with the best sample to chip connection. Designed so heat coming down the leads bypasses the chip, it can survive several thousand hours at 420 K (depending on model) and is compatible with most ultra high vacuum applications. It can be indium soldered to samples without sensor calibration shift.

\*Patent #5,363,084, Nov. 1994, "Film Resistors Having Trimmable Electrodes" and #5,367,285, Nov. 1994, "Cernox™", "Metal Oxy-nitride Resistance Films and Methods of Making the Same," Lake Shore Cryotronics, Inc.

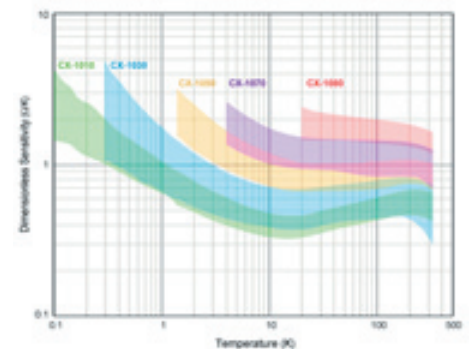
**Typical Cernox™ Resistance**



**Typical Cernox™ Sensitivity**



**Typical Cernox™ Dimensionless Sensitivity**



## Specifications

**Standard curve** Not applicable

**Recommended excitation**<sup>1</sup> 20  $\mu$ V (0.1 K to 0.5 K); 63  $\mu$ V (0.5 K to 1 K); 10 mV or less for T > 1.2 K

**Dissipation at recommended excitation**

Typical 10<sup>-5</sup> W at 300 K, 10<sup>-7</sup> W at 4.2 K, 10<sup>-13</sup> 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**<sup>2</sup>  $\pm$ 3 mK at 4.2 K

<sup>1</sup> 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

<sup>2</sup> 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	Maximum Limit
Cernox™	0.10 K <sup>3</sup>	325 K
Cernox™ HT	0.10 K <sup>3</sup>	420 K

<sup>3</sup> Model dependent

## Calibrated Accuracy<sup>4</sup>

	Typical sensor accuracy <sup>5</sup>	Long-term stability <sup>6</sup>
1.4 K	$\pm$ 5 mK	$\pm$ 25 mK
4.2 K	$\pm$ 5 mK	$\pm$ 25 mK
10 K	$\pm$ 6 mK	$\pm$ 25 mK
20 K	$\pm$ 9 mK	$\pm$ 25 mK
30 K	$\pm$ 10 mK	$\pm$ 25 mK
50 K	$\pm$ 13 mK	$\pm$ 25 mK
77 K	$\pm$ 16 mK	$\pm$ 25 mK
300 K	$\pm$ 40 mK	$\pm$ 153 mK
400 K	$\pm$ 65 mK	—

<sup>4</sup> 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)

<sup>5</sup> [(Calibration uncertainty)<sup>2</sup> + (reproducibility)<sup>2</sup>]<sup>0.5</sup>

for more information see Appendices B, D, and E

<sup>6</sup> 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<sup>7</sup> $\Delta$ T/T (%) at B (magnetic induction)

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

<sup>7</sup> Excellent for use in magnetic fields, depending on temperature range (>2 K)

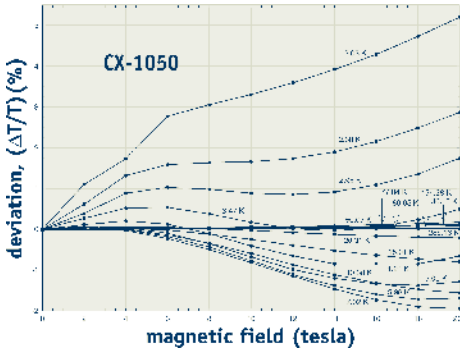
## Temperature Response Data Table (typical)

	CX-1010			CX-1030			CX-1050			CX-1070			CX-1080		
	R <sup>8</sup> ( $\Omega$ )	dR/dT ( $\Omega$ /K)	(T/R)·(dR/dT)	R <sup>8</sup> ( $\Omega$ )	dR/dT ( $\Omega$ /K)	(T/R)·(dR/dT)	R <sup>8</sup> ( $\Omega$ )	dR/dT ( $\Omega$ /K)	(T/R)·(dR/dT)	R <sup>8</sup> ( $\Omega$ )	dR/dT ( $\Omega$ /K)	(T/R)·(dR/dT)	R <sup>8</sup> ( $\Omega$ )	dR/dT ( $\Omega$ /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

See Appendix G for expanded response table

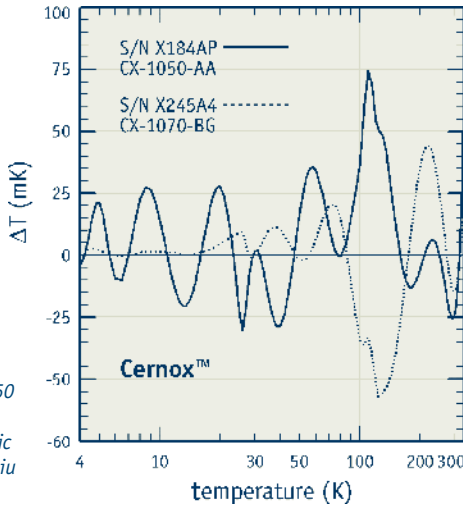
<sup>8</sup> Cernox sensors do not follow a standard response curve — the listed resistance ranges are typical, but can vary widely; consult Lake Shore to choose a specific range

**Magnetic Field Dependence Data for Sample CX RTDs**

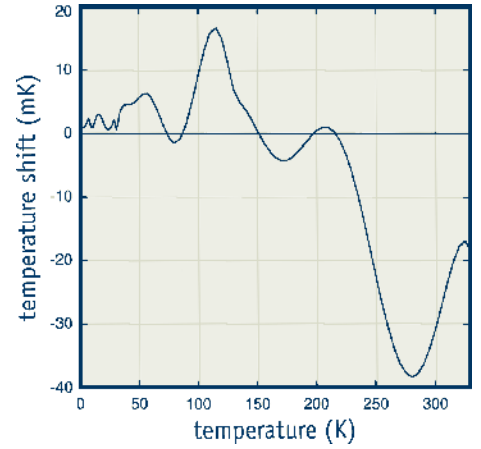


Typical temperature reading errors for operation of CX-1050 sensors in magnetic fields at temperatures from 2.03 K to 286 K. "Low temperature thermometry in high magnetic fields VII. Cernox™ sensors to 32 T," B. L. Brandt, D. W. Liu and L. G. Rubin; Rev. Sci. Instrum., Vol. 70, No. 1, 1999, pp 104-110.

**Neutrons and Gamma Rays**



**Typical Calibration Shifts**

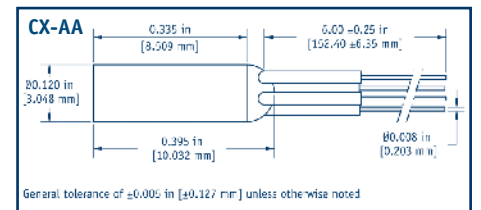
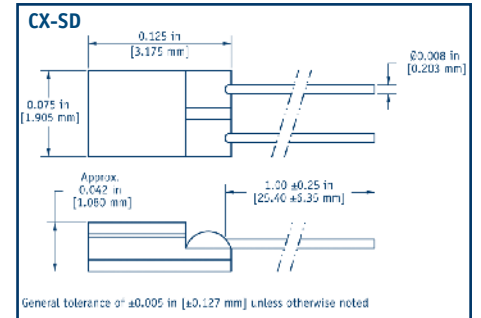
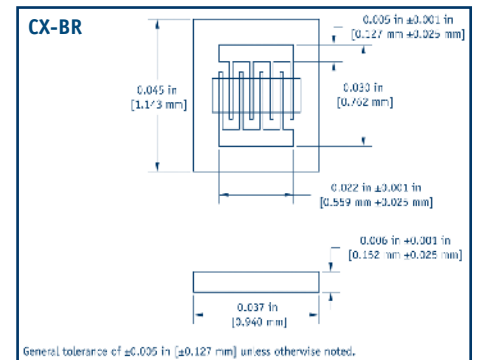
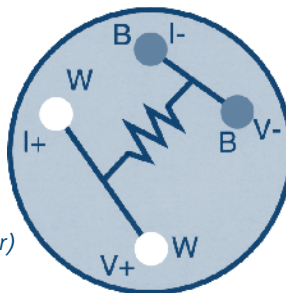


Typical calibration shift after 200 thermal shocks from 305 K to 77 K for a Model CX-1030 temperature sensor ( $\Delta T = 1$  mK at 4.2 K and 10 mK at 100 K).

**Physical Specifications**

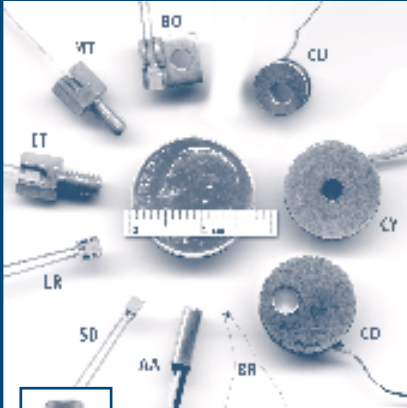
	Mass	Lead type	Internal atmosphere	Sensor materials used
<b>Bare Chip</b> (BC), (BG), (BR)	≤ 3.0 mg	BR: none BG: two 2 mil (44 AWG) bare gold 25 mm long wires BC: two 2.5 mil (42 AWG) bare copper 25 mm long wires	NA	Ceramic oxynitride, gold pads and sapphire substrate with Au Pt Mo back (chip in all models)
<b>Hermetic Ceramic Package</b> (SD)	≈ 40 mg	2 gold-plated copper	Vacuum	Chip mounted on sapphire base with alumina body and lid, Mo/Mn with nickel and gold plating on base and lid, gold-tin solder as hermetic lid seal, 60/40 SnPb solder used to attach leads
<b>Copper Canister Package</b> (AA)	≈ 390 mg	4 phosphor bronze with HML heavy build insulation attached with epoxy strain relief at sensor	Helium 4 ( <sup>4</sup> He) is standard	Chip mounted in a gold plated cylindrical copper can

**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)



**PACKAGING  
OPTIONS**

For information on the packages and mounting adapters available for Cernox™ sensors, see page 25.



CO adapter – SD package adapter is a spring loaded clamp allowing easy sensor interchangeability

To add length to sensor leads (SMOD), see page 28.



See the appendices for a detailed description of:

- Installation
- Uncalibrated sensors
- SoftCal™
- Calibrated sensors
- CalCurve™
- Sensor packages

## Ordering Information



**Uncalibrated sensor**—Specify the model number in the left column only, for example CX-1050-SD.

**Calibrated sensor**—Add the calibration range suffix code to the end of the model number, for example CX-1050-SD-1.4L.

**Cernox™ RTD** Calibration Range Suffix Codes  
 Numeric figure is the low end of the calibration  
 Letters represent the high end: B=40 K, D=100 K, L=325 K, M=420 K

Model number	Uncal	0.1B	0.1L	0.3B	0.3D	0.3L	0.3M	1.4B	1.4D	1.4L	1.4M	4B	4D	4L	4M	20L	20M
CX-1010-AA	■	■	■	■	■	■		■	■	■							
CX-1010-BC, -BG, -BR	■							■	■	■							
CX-1010-BO, -CD, -CO, -CU, -LR, -ET, -MT, -SD	■	■	■	■	■	■		■	■	■							
CX-1030-AA	■			■	■	■		■	■	■		■	■	■			
CX-1030-BC	■							■	■	■		■	■	■			
CX-1030-BG, -BR	■																
CX-1030-BO, -CD, -CO, -CU, -LR, -ET, -MT, -SD	■			■	■	■		■	■	■		■	■	■			
CX-1050-AA, -BC, -BO, -CD, -CO, -CU, -LR, -ET, -MT, -SD	■							■	■	■		■	■	■			
CX-1050-BG, -BR	■																
CX-1070-AA, -BC, -BO, -CD, -CO, -CU, -LR, -ET, -MT, -SD	■											■	■	■			
CX-1070-BG, -BR	■																
CX-1080-AA, -BC, -BO, -CD, -CO, -CU, -LR, -ET, -MT, -SD	■																■
CX-1080-BG, -BR	■																

<b>Cernox™ HT RTD</b>																	
Model number	Uncal	0.1B	0.1L	0.3B	0.3D	0.3L	0.3M	1.4B	1.4D	1.4L	1.4M	4B	4D	4L	4M	20L	20M
CX-1010-BG/BR-HT	■																
CX-1010-CO/CU/SD-HT	■	■	■			■	■			■	■						
CX-1030-BG/BR-HT	■																
CX-1030-CO/CU/SD-HT	■					■	■			■	■			■	■		
CX-1050-BG/BR-HT	■																
CX-1050-CO/CU/SD-HT	■									■	■			■	■		
CX-1070-BG/BR-HT	■																
CX-1070-CO/CU/SD-HT	■													■	■		
CX-1080-BG/BR-HT	■																
CX-1080-CO/CU/SD-HT	■																■

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

**Accessories available for sensors**

- SN-CO-C1 CO style sensor clamps for SD package
- ECRIT Expanded interpolation table
- 8000 Calibration report on CD-ROM
- COC-SEN Certificate of conformance

**Accessories suggested for installation – see Accessories section for full descriptions**

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