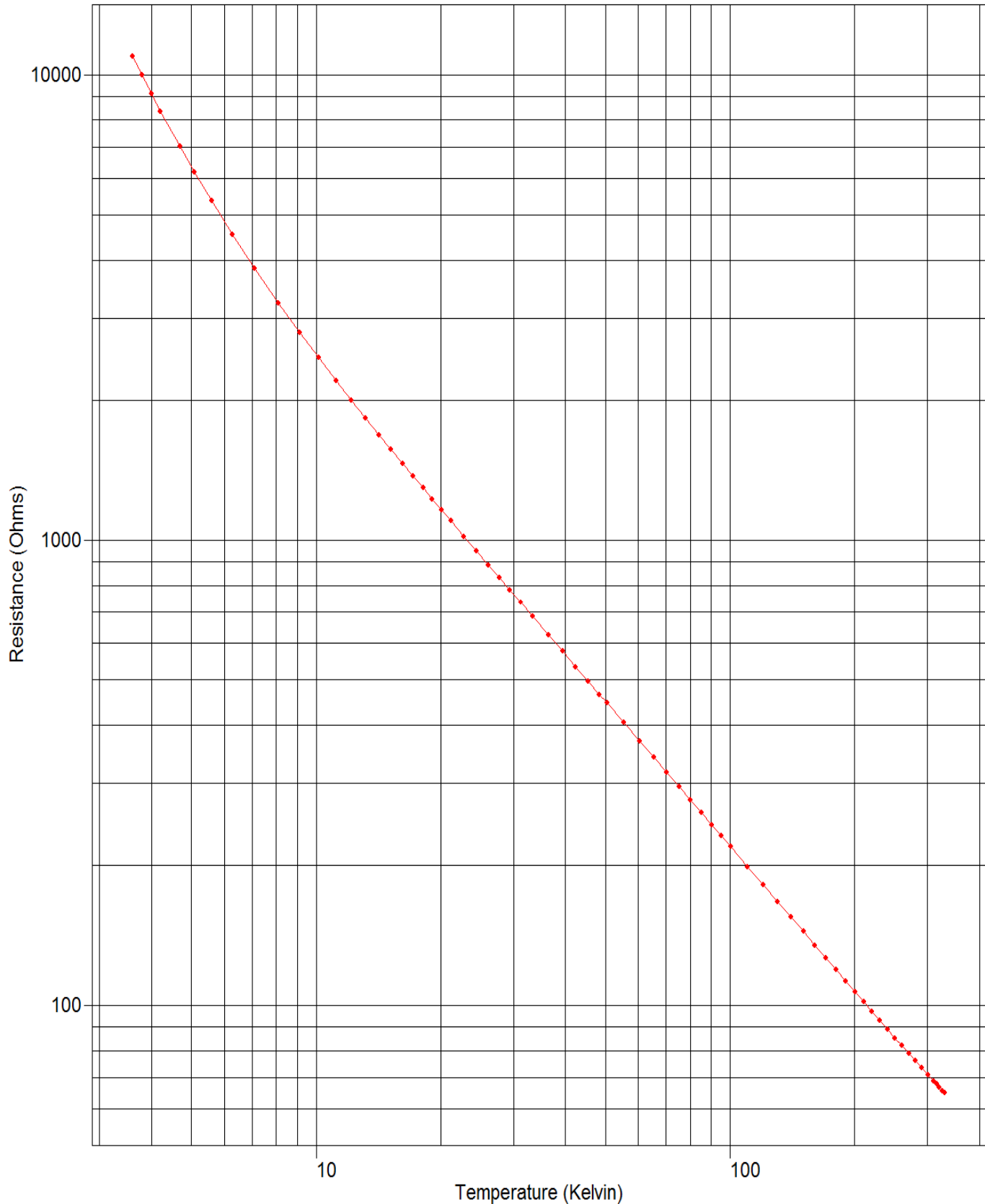


# DATA PLOT

Calibration Report: 582810  
Sensor Model: CX-1070-CU-4L  
Sensor Type: Cernox Resistor

Sales Order: 54828  
Serial Number: X58257  
Temperature Range: 4.00K to 325K



# TEST DATA

Calibration Report: 582810

Sensor Model: CX-1070-CU-4L

Sensor Type: Cernox Resistor

Sales Order: 54828

Serial Number: X58257

Temperature Range: 4.00K to 325K

Index	Temp. (K)	Resistance ( $\Omega$ )	Excitation	Index	Temp. (K)	Resistance ( $\Omega$ )	Excitation
1	3.59861	10978.5	2mV $\pm$ 25%	41	75.3163	294.651	2mV $\pm$ 25%
2	3.79614	9975.35	2mV $\pm$ 25%	42	80.3088	275.786	2mV $\pm$ 25%
3	3.99995	9106.00	2mV $\pm$ 25%	43	85.3027	259.169	2mV $\pm$ 25%
4	4.20672	8357.58	2mV $\pm$ 25%	44	90.2896	244.410	2mV $\pm$ 25%
5	4.68282	7023.37	2mV $\pm$ 25%	45	95.2804	231.214	2mV $\pm$ 25%
6	5.08404	6178.60	2mV $\pm$ 25%	46	100.279	219.330	2mV $\pm$ 25%
7	5.58580	5367.25	2mV $\pm$ 25%	47	110.278	198.803	2mV $\pm$ 25%
8	6.28977	4533.15	2mV $\pm$ 25%	48	120.261	181.749	2mV $\pm$ 25%
9	7.09978	3846.17	2mV $\pm$ 25%	49	130.245	167.330	2mV $\pm$ 25%
10	8.11017	3237.73	2mV $\pm$ 25%	50	140.238	154.963	2mV $\pm$ 25%
11	9.12202	2799.45	2mV $\pm$ 25%	51	150.232	144.263	2mV $\pm$ 25%
12	10.1397	2467.27	2mV $\pm$ 25%	52	160.234	134.923	2mV $\pm$ 25%
13	11.1626	2206.32	2mV $\pm$ 25%	53	170.231	126.702	2mV $\pm$ 25%
14	12.1774	1998.28	2mV $\pm$ 25%	54	180.232	119.411	2mV $\pm$ 25%
15	13.1881	1828.01	2mV $\pm$ 25%	55	190.231	112.910	2mV $\pm$ 25%
16	14.1867	1686.79	2mV $\pm$ 25%	56	200.222	107.100	2mV $\pm$ 25%
17	15.1806	1566.95	2mV $\pm$ 25%	57	210.217	101.858	2mV $\pm$ 25%
18	16.1655	1464.31	2mV $\pm$ 25%	58	220.221	97.1158	2mV $\pm$ 25%
19	17.1416	1375.18	2mV $\pm$ 25%	59	230.215	92.8133	2mV $\pm$ 25%
20	18.1181	1296.35	2mV $\pm$ 25%	60	240.199	88.8904	2mV $\pm$ 25%
21	19.0974	1226.16	2mV $\pm$ 25%	61	250.208	85.2959	2mV $\pm$ 25%
22	20.0702	1163.31	2mV $\pm$ 25%	62	260.195	82.0094	2mV $\pm$ 25%
23	21.1476	1101.18	2mV $\pm$ 25%	63	270.204	78.9784	2mV $\pm$ 25%
24	22.7407	1020.45	2mV $\pm$ 25%	64	280.193	76.1852	2mV $\pm$ 25%
25	24.3633	949.492	2mV $\pm$ 25%	65	290.202	73.5946	2mV $\pm$ 25%
26	26.0328	886.133	2mV $\pm$ 25%	66	300.192	71.2061	2mV $\pm$ 25%
27	27.6991	830.623	2mV $\pm$ 25%	67	310.197	68.9780	2mV $\pm$ 25%
28	29.3557	781.974	2mV $\pm$ 25%	68	315.195	67.9169	2mV $\pm$ 25%
29	31.2084	733.732	2mV $\pm$ 25%	69	320.176	66.9080	2mV $\pm$ 25%
30	33.3463	684.867	2mV $\pm$ 25%	70	326.155	65.7370	2mV $\pm$ 25%
31	36.3723	625.723	2mV $\pm$ 25%	71	330.173	64.9677	2mV $\pm$ 25%
32	39.3831	576.137	2mV $\pm$ 25%				
33	42.3821	533.936	2mV $\pm$ 25%				
34	45.3806	497.375	2mV $\pm$ 25%				
35	48.3753	465.555	2mV $\pm$ 25%				
36	50.3688	446.493	2mV $\pm$ 25%				
37	55.3630	404.848	2mV $\pm$ 25%				
38	60.3542	370.306	2mV $\pm$ 25%				
39	65.3384	341.152	2mV $\pm$ 25%				
40	70.3280	316.249	2mV $\pm$ 25%				



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# UNCERTAINTY ANALYSIS

Calibration Report: 582810  
 Sensor Model: CX-1070-CU-4L  
 Sensor Type: Cernox Resistor

Sales Order: 54828  
 Serial Number: X58257  
 Temperature Range: 4.00K to 325K

## Calibration Data Uncertainty

The uncertainties of the measured calibration data for Lake Shore's sensors are summarized in the table below. The values given are the combined uncertainty of the temperature measurement and the resistance or voltage measurement expressed as an equivalent temperature uncertainty in millikelvin (mK). Note that the values are the calibration uncertainty only and do not include the stability of the temperature sensor. The uncertainty analysis has followed the guidelines for determining measurement uncertainty as outlined in the ISO Guide to the Expression of Uncertainty in Measurement, NIST Technical Note 1297, and ANSI/NCSL Z540-2-1997. Since the uncertainty varies with temperature due to the variation of the sensor sensitivity and excitation, the table gives typical values at several different temperatures throughout the range of the calibration. The uncertainty is based on an approximate 95% confidence level with a coverage factor  $k = 2$ .

T (K)	Uncertainty (+/- mK)											
	Ge (GR-200-X)		Cernox (CX-Y)		CGR	RX		Pt		RhFe		Diode
	$X \leq 100$	$X \geq 250$	$Y \leq 1030$	$Y \geq 1050$		-102	-103	100 $\Omega$	25 $\Omega$	27 $\Omega$	100 $\Omega$	
1.4	4	4	4	4	4	4	4			4	4	7
4.2	4	4	4	4	4	4	6			4	4	5
10	4	4	5	4	4	10	15			4	5	6
20	8	7	9	8	8	34	34	8	10	8	9	9
30	9	8	11	9	9	72	60	8	8	9	9	28
50	12	11	16	12	13			10	10	10	10	34
100	32	18	24	16	27			11	11	11	11	30
300			72	40	100			22	22	22	22	33
400			120	67				43	43	42		47
500								48	48			52

## Polynomial Fit Uncertainty

When a sensor is used to measure temperature, a polynomial fit to the measured calibration data is often used to convert the sensor resistance (R) or voltage (V) to a temperature (T). How well the polynomial represents the sensor calibration data is another source of uncertainty when using the sensor. In the polynomials provided with this set of calibration data, the standard deviation of the fit can be used as an estimate of this additional temperature uncertainty. The standard deviation of fit is determined from the following equation:

$$\sigma_{fit}^2 = \frac{\sum_{i=1}^N (T_i - T_{i,calc})^2}{N - n} = \frac{N}{N - n} (\Delta T_{RMS})^2$$

where  $\sigma_{fit}$  = standard deviation of the fit

$T_i$  = measured temperature for point i

$T_{i,calc}$  = the temperature calculated from the polynomial equation for point i

N = number of data points in fit range

n = number of fit coefficients

$\Delta T_{RMS}$  = root mean square deviation of fit

A value of  $\Delta T_{RMS}$  is given for each range of fit.

F008-04-00 (08/06/04)



## POLYNOMIAL EQUATION

Calibration Report: 582810  
Sensor Model: CX-1070-CU-4L  
Sensor Type: Cernox Resistor

Sales Order: 54828  
Serial Number: X58257  
Temperature Range: 4.00K to 325K

Polynomial Type: Chebychev  
Useful Range of Fit:

4.00 K to 24.4 K  
9106. Ohms to 949.5 Ohms

Lower and Upper limits of Log(Resistance) used in computing Chebychev coefficients:  
ZL = 2.91940388806 ZU = 4.04054290499

Order	Coefficient	Std. Deviation of Coefficient	Ratio (Coeff./Std Dev.)
0	12.003172	1.8907E-04	63486.13
1	-11.263451	2.9234E-04	-38529.13
2	3.536949	2.8253E-04	12518.95
3	-0.781795	2.6614E-04	-2937.52
4	0.109059	2.6109E-04	417.70
5	-0.004531	2.4932E-04	-18.17
6	-0.000296	2.4141E-04	-1.23
7	-0.000605	2.3984E-04	-2.52

$Z = \text{Log}(\text{Resistance})$

$k = ((Z - Z_L) - (Z_U - Z)) / (Z_U - Z_L)$

$\text{Temp. (K)} = \sum A_i \cdot \text{COS}(i \cdot \text{ARCCOS}(k))$ , where  $0 \leq i \leq 7$   
and the  $A_i$ 's are the coefficients in the table above.



# POLYNOMIAL EQUATION

Calibration Report: 582810

Sensor Model: CX-1070-CU-4L

Sensor Type: Cernox Resistor

Sales Order: 54828

Serial Number: X58257

Temperature Range: 4.00K to 325K

Polynomial Type: Chebychev

Temp. (K) vs. Log(Resistance)

	R Meas. ( $\Omega$ )	T Meas. (K)	T Eq. (K)	T diff. (mK)
1	10978.50	3.59861	3.59850	0.10
2	9975.350	3.79614	3.79620	-0.06
3	9106.003	3.99995	3.99996	-0.01
4	8357.578	4.20672	4.20736	-0.63
5	7023.375	4.68282	4.68160	1.22
6	6178.605	5.08404	5.08398	0.06
7	5367.255	5.58580	5.58687	-1.07
8	4533.146	6.28977	6.28971	0.06
9	3846.172	7.09978	7.09931	0.47
10	3237.730	8.11017	8.11065	-0.48
11	2799.452	9.12202	9.12204	-0.02
12	2467.265	10.13969	10.13876	0.93
13	2206.324	11.16263	11.16209	0.54
14	1998.277	12.17741	12.17806	-0.65
15	1828.013	13.18809	13.18872	-0.63
16	1686.793	14.18675	14.18756	-0.81
17	1566.952	15.18060	15.18100	-0.40
18	1464.311	16.16553	16.16474	0.80
19	1375.180	17.14164	17.14089	0.75
20	1296.349	18.11807	18.11820	-0.13
21	1226.156	19.09736	19.09569	1.67
22	1163.310	20.07023	20.07201	-1.77
23	1101.184	21.14761	21.14734	0.27
24	1020.455	22.74072	22.74066	0.06
25	949.4923	24.36327	24.36427	-1.00
26	886.1331	26.03278	26.03185	0.93
27	830.6229	27.69908	27.69927	-0.19

Order of Fit = 7

RMS error of fit = 0.76 mK

Largest absolute error = -1.77 mK at data point no. 22



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## POLYNOMIAL EQUATION

Calibration Report: 582810  
Sensor Model: CX-1070-CU-4L  
Sensor Type: Cernox Resistor

Sales Order: 54828  
Serial Number: X58257  
Temperature Range: 4.00K to 325K

Polynomial Type: Chebychev  
Useful Range of Fit:

24.4 K to 110. K  
949.5 Ohms to 198.8 Ohms

Lower and Upper limits of Log(Resistance) used in computing Chebychev coefficients:

ZL = 2.22357474803      ZU = 3.04185995812

Order	Coefficient	Std. Deviation of Coefficient	Ratio (Coeff./Std Dev.)
0	63.828276	4.9047E-04	130136.98
1	-52.807175	7.9233E-04	-66647.80
2	11.687868	7.2348E-04	16154.98
3	-1.733424	6.5108E-04	-2662.38
4	0.177954	6.2115E-04	286.49
5	-0.006903	6.1915E-04	-11.15
6	0.001121	6.0582E-04	1.85
7	-0.001479	5.8469E-04	-2.53
8	0.001304	5.9473E-04	2.19

$Z = \text{Log}(\text{Resistance})$

$k = ((Z - ZL) - (ZU - Z)) / (ZU - ZL)$

Temp. (K) =  $\sum A_i \cdot \text{COS}(i \cdot \text{ARCCOS}(k))$ , where  $0 \leq i \leq 8$   
and the  $A_i$ 's are the coefficients in the table above.



# POLYNOMIAL EQUATION

Calibration Report: 582810

Sensor Model: CX-1070-CU-4L

Sensor Type: Cernox Resistor

Sales Order: 54828

Serial Number: X58257

Temperature Range: 4.00K to 325K

Polynomial Type: Chebychev

Temp. (K) vs. Log(Resistance)

	R Meas. ( $\Omega$ )	T Meas. (K)	T Eq. (K)	T diff. (mK)
23	1101.184	21.14734	21.14754	-0.20
24	1020.455	22.74066	22.73994	0.71
25	949.4923	24.36427	24.36457	-0.30
26	886.1331	26.03278	26.03301	-0.23
27	830.6229	27.69908	27.70093	-1.85
28	781.9744	29.35573	29.35431	1.42
29	733.7316	31.20842	31.20699	1.42
30	684.8667	33.34633	33.34554	0.80
31	625.7231	36.37227	36.37386	-1.59
32	576.1371	39.38305	39.38475	-1.70
33	533.9358	42.38208	42.38125	0.83
34	497.3749	45.38057	45.38247	-1.90
35	465.5549	48.37528	48.37294	2.34
36	446.4929	50.36879	50.36594	2.85
37	404.8482	55.36298	55.36482	-1.84
38	370.3063	60.35421	60.35411	0.10
39	341.1521	65.33844	65.34263	-4.19
40	316.2489	70.32800	70.32384	4.16
41	294.6513	75.31630	75.31723	-0.92
42	275.7864	80.30876	80.30981	-1.06
43	259.1694	85.30274	85.29992	2.82
44	244.4096	90.28963	90.29088	-1.26
45	231.2139	95.28043	95.28135	-0.92
46	219.3302	100.27900	100.27784	1.17
47	198.8031	110.27776	110.27936	-1.60
48	181.7494	120.26133	120.26002	1.31
49	167.3304	130.24515	130.24550	-0.36

Order of Fit = 8

RMS error of fit = 1.81 mK

Largest absolute error = -4.19 mK at data point no. 39



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## POLYNOMIAL EQUATION

Calibration Report: 582810  
Sensor Model: CX-1070-CU-4L  
Sensor Type: Cernox Resistor

Sales Order: 54828  
Serial Number: X58257  
Temperature Range: 4.00K to 325K

Polynomial Type: Chebychev  
Useful Range of Fit:

110. K to 325. K  
198.8 Ohms to 65.96 Ohms

Lower and Upper limits of Log(Resistance) used in computing Chebychev coefficients:  
ZL = 1.81269740614      ZU = 2.36401397921

Order	Coefficient	Std. Deviation of Coefficient	Ratio (Coeff./Std Dev.)
0	193.830156	2.1039E-03	92127.43
1	-114.835289	3.2546E-03	-35284.11
2	18.478033	2.9173E-03	6334.02
3	-2.551149	2.8443E-03	-896.94
4	0.419104	2.8519E-03	146.96
5	-0.067600	2.8292E-03	-23.89
6	0.008494	2.7283E-03	3.11

$Z = \text{Log}(\text{Resistance})$

$k = ((Z - ZL) - (ZU - Z)) / (ZU - ZL)$

$\text{Temp. (K)} = \sum A_i \cdot \text{COS}(i \cdot \text{ARCCOS}(k))$ , where  $0 \leq i \leq 6$   
and the  $A_i$ 's are the coefficients in the table above.





# POLYNOMIAL EQUATION

Calibration Report: 582810

Sensor Model: CX-1070-CU-4L

Sensor Type: Cernox Resistor

Sales Order: 54828

Serial Number: X58257

Temperature Range: 4.00K to 325K

Polynomial Type: Chebychev

Temp. (K) vs. Log(Resistance)

	R Meas. ( $\Omega$ )	T Meas. (K)	T Eq. (K)	T diff. (mK)
45	231.2139	95.28135	95.28175	-0.40
46	219.3302	100.27784	100.27679	1.05
47	198.8031	110.27936	110.28043	-1.08
48	181.7494	120.26133	120.26207	-0.74
49	167.3304	130.24515	130.24200	3.15
50	154.9627	140.23771	140.23957	-1.87
51	144.2634	150.23204	150.23567	-3.64
52	134.9235	160.23351	160.22973	3.78
53	126.7016	170.23146	170.22697	4.49
54	119.4112	180.23175	180.23184	-0.09
55	112.9101	190.23138	190.24103	-9.65
56	107.1004	200.22225	200.22067	1.58
57	101.8584	210.21721	210.21818	-0.98
58	97.11585	220.22078	220.21794	2.84
59	92.81331	230.21480	230.20764	7.16
60	88.89043	240.19920	240.20054	-1.35
61	85.29593	250.20777	250.21384	-6.06
62	82.00944	260.19522	260.19419	1.03
63	78.97843	270.20359	270.19873	4.86
64	76.18522	280.19326	280.19297	0.29
65	73.59459	290.20199	290.21606	-14.07
66	71.20613	300.19157	300.18296	8.61
67	68.97800	310.19656	310.18742	9.14
68	67.91690	315.19472	315.21572	-21.00
69	66.90798	320.17596	320.16688	9.07
70	65.73696	326.15488	326.13397	20.91
71	64.96769	330.17278	330.18983	-17.04

Order of Fit = 6

RMS error of fit = 8.37 mK

Largest absolute error = -21.00 mK at data point no. 68



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# INTERPOLATION TABLE

Calibration Report: 582810  
Sensor Model: CX-1070-CU-4L  
Sensor Type: Cernox Resistor

Sales Order: 54828  
Serial Number: X58257  
Temperature Range: 4.00K to 325K

<u>Temp (K)</u>	<u>Res. (<math>\Omega</math>)</u>	<u>dR/dT (<math>\Omega/K</math>)</u>	<u>dlogR/dlogT</u>	<u>Temp (K)</u>	<u>Res. (<math>\Omega</math>)</u>	<u>dR/dT (<math>\Omega/K</math>)</u>	<u>dlogR/dlogT</u>
4.000	9105.84	-3915.0	-1.7198	37.00	614.731	-17.252	-1.0384
4.200	8382.10	-3344.0	-1.6755	38.00	597.943	-16.335	-1.0381
4.400	7760.85	-2884.4	-1.6353	39.00	582.037	-15.489	-1.0378
4.600	7222.70	-2509.8	-1.5985	40.00	566.944	-14.707	-1.0376
4.800	6752.38	-2203.1	-1.5661	42.00	538.963	-13.309	-1.0371
5.000	6338.11	-1947.2	-1.5361	44.00	513.582	-12.100	-1.0367
5.200	5970.74	-1732.6	-1.5089	46.00	490.457	-11.049	-1.0362
5.400	5642.95	-1550.1	-1.4834	48.00	469.302	-10.127	-1.0358
5.600	5348.88	-1394.7	-1.4602	50.00	449.877	-9.3155	-1.0353
5.800	5083.64	-1260.8	-1.4385	52.00	431.978	-8.5973	-1.0349
6.000	4843.38	-1144.4	-1.4177	54.00	415.435	-7.9576	-1.0344
6.500	4331.83	-914.49	-1.3722	56.00	400.101	-7.3875	-1.0340
7.000	3918.85	-745.88	-1.3323	58.00	385.847	-6.8756	-1.0335
7.500	3578.87	-619.57	-1.2984	60.00	372.564	-6.4149	-1.0331
8.000	3294.49	-522.18	-1.2680	65.00	343.008	-5.4467	-1.0322
8.500	3053.10	-446.26	-1.2424	70.00	317.758	-4.6821	-1.0314
9.000	2845.71	-385.53	-1.2193	75.00	295.936	-4.0681	-1.0310
9.500	2665.59	-336.57	-1.1995	77.35	286.671	-3.8207	-1.0309
10.00	2507.69	-296.33	-1.1817	80.00	276.887	-3.5679	-1.0308
10.50	2368.10	-263.05	-1.1663	85.00	260.112	-3.1549	-1.0310
11.00	2243.77	-235.08	-1.1524	90.00	245.224	-2.8102	-1.0314
11.50	2132.29	-211.46	-1.1404	95.00	231.921	-2.5193	-1.0320
12.00	2031.75	-191.24	-1.1295	100.0	219.960	-2.2715	-1.0327
12.50	1940.57	-173.88	-1.1200	105.0	209.147	-2.0585	-1.0334
13.00	1857.49	-158.80	-1.1114	110.0	199.327	-1.8740	-1.0342
13.50	1781.45	-145.66	-1.1038	115.0	190.368	-1.7134	-1.0350
14.00	1711.57	-134.10	-1.0969	120.0	182.161	-1.5726	-1.0359
14.50	1647.12	-123.92	-1.0909	125.0	174.614	-1.4484	-1.0368
15.00	1587.47	-114.86	-1.0853	130.0	167.654	-1.3381	-1.0376
15.50	1532.09	-106.80	-1.0805	135.0	161.213	-1.2398	-1.0382
16.00	1480.53	-99.567	-1.0760	140.0	155.238	-1.1518	-1.0387
16.50	1432.40	-93.070	-1.0721	145.0	149.680	-1.0726	-1.0391
17.00	1387.36	-87.199	-1.0685	150.0	144.499	-1.0012	-1.0393
17.50	1345.11	-81.884	-1.0653	155.0	139.658	-0.93644	-1.0393
18.00	1305.39	-77.049	-1.0624	160.0	135.125	-0.87761	-1.0392
18.50	1267.99	-72.643	-1.0599	165.0	130.873	-0.82399	-1.0389
19.00	1232.69	-68.611	-1.0575	170.0	126.877	-0.77497	-1.0384
19.50	1199.32	-64.915	-1.0555	175.0	123.116	-0.73005	-1.0377
20.00	1167.72	-61.515	-1.0536	180.0	119.571	-0.68877	-1.0369
21.00	1109.30	-55.489	-1.0505	185.0	116.223	-0.65075	-1.0358
22.00	1056.46	-50.323	-1.0479	190.0	113.058	-0.61566	-1.0346
23.00	1008.42	-45.857	-1.0459	195.0	110.062	-0.58320	-1.0333
24.00	964.553	-41.964	-1.0441	200.0	107.222	-0.55312	-1.0317
25.00	924.331	-38.555	-1.0428	205.0	104.527	-0.52519	-1.0300
26.00	887.305	-35.561	-1.0420	210.0	101.967	-0.49921	-1.0281
27.00	853.093	-32.912	-1.0417	215.0	99.5323	-0.47502	-1.0261
28.00	821.386	-30.546	-1.0413	220.0	97.2144	-0.45244	-1.0239
29.00	791.921	-28.424	-1.0409	225.0	95.0055	-0.43134	-1.0215
30.00	764.467	-26.516	-1.0406	230.0	92.8987	-0.41160	-1.0190
31.00	738.828	-24.791	-1.0402	235.0	90.8874	-0.39311	-1.0164
32.00	714.831	-23.229	-1.0399	240.0	88.9657	-0.37576	-1.0137
33.00	692.323	-21.809	-1.0395	245.0	87.1281	-0.35947	-1.0108
34.00	671.170	-20.516	-1.0393	250.0	85.3694	-0.34415	-1.0078
35.00	651.255	-19.332	-1.0389	255.0	83.6851	-0.32973	-1.0047
36.00	632.473	-18.247	-1.0386	260.0	82.0708	-0.31614	-1.0015



# INTERPOLATION TABLE

Calibration Report: 582810

Sensor Model: CX-1070-CU-4L

Sensor Type: Cernox Resistor

Sales Order: 54828

Serial Number: X58257

Temperature Range: 4.00K to 325K

<u>Temp (K)</u>	<u>Res. (<math>\Omega</math>)</u>	<u>dR/dT (<math>\Omega/K</math>)</u>	<u>dlogR/dlogT</u>	<u>Temp (K)</u>	<u>Res. (<math>\Omega</math>)</u>	<u>dR/dT (<math>\Omega/K</math>)</u>	<u>dlogR/dlogT</u>
265.0	80.5224	-0.30333	-0.99827	285.0	74.9178	-0.25878	-0.98445
270.0	79.0363	-0.29124	-0.99492	290.0	73.6484	-0.24910	-0.98085
273.15	78.1304	-0.28397	-0.99277	295.0	72.4260	-0.23992	-0.97721
275.0	77.6089	-0.27981	-0.99149	300.0	71.2484	-0.23121	-0.97353
280.0	76.2371	-0.26901	-0.98800	305.0	70.1132	-0.22294	-0.96982
				310.0	69.0183	-0.21509	-0.96609
				315.0	67.9617	-0.20763	-0.96234
				320.0	66.9414	-0.20052	-0.95857
				325.0	65.9558	-0.19377	-0.95479



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## THERMAL CYCLE TESTING

Sensor Model: CX-1070-CU-4L

Serial Number: X58257

Sensor Type: Cernox Resistor

This sensor was tested for repeatability through rapid thermal cycles from room temperature into liquid helium. During this test, the following four lead resistance values were recorded:

Approximately 305 K:	70.0 $\Omega$
Liquid Nitrogen:	286 $\Omega$
Liquid Helium:	8336 $\Omega$

The nitrogen and helium values were recorded in OPEN dewars, so precision comparisons with calibration values or other thermal cycle test values should not be made.

### Recommended Operating Parameters:

For sensors calibrated by LSCI, the current to the sensor is adjusted to maintain the sensor output voltage or power at the values listed on the Test Data page.



# BREAKPOINTS 340 FORMAT

Calibration Report: 582810

Sensor Model: CX-1070-CU-4L

Sensor Type: Cernox Resistor

Sales Order: 54828

Serial Number: X58257

Temperature Range: 4.00K to 325K

Name: CX-1070-CU-4L

Serial number: X58257

Format: 4 ;Log Ohms/Kelvin

Limit: 325.0

Coefficient: 1 ;Negative

Point 1: 1.81923,325.000	Point 56: 2.42579, 83.000	Point 111: 3.35778, 10.850
Point 2: 1.82699,319.000	Point 57: 2.43673, 81.000	Point 112: 3.37917, 10.400
Point 3: 1.83425,313.500	Point 58: 2.44792, 79.000	Point 113: 3.40175, 9.950
Point 4: 1.84167,308.000	Point 59: 2.45940, 77.000	Point 114: 3.42299, 9.550
Point 5: 1.84926,302.500	Point 60: 2.47118, 75.000	Point 115: 3.44536, 9.150
Point 6: 1.85702,297.000	Point 61: 2.48328, 73.000	Point 116: 3.46907, 8.750
Point 7: 1.86495,291.500	Point 62: 2.49572, 71.000	Point 117: 3.49426, 8.350
Point 8: 1.87307,286.000	Point 63: 2.50852, 69.000	Point 118: 3.52111, 7.950
Point 9: 1.88139,280.500	Point 64: 2.52170, 67.000	Point 119: 3.54619, 7.600
Point 10: 1.88990,275.000	Point 65: 2.53528, 65.000	Point 120: 3.57285, 7.250
Point 11: 1.89861,269.500	Point 66: 2.54929, 63.000	Point 121: 3.60137, 6.900
Point 12: 1.90672,264.500	Point 67: 2.56376, 61.000	Point 122: 3.63194, 6.550
Point 13: 1.91501,259.500	Point 68: 2.57871, 59.000	Point 123: 3.66491, 6.200
Point 14: 1.92349,254.500	Point 69: 2.59262, 57.200	Point 124: 3.69956, 5.860
Point 15: 1.93216,249.500	Point 70: 2.60697, 55.400	Point 125: 3.73263, 5.560
Point 16: 1.94104,244.500	Point 71: 2.62181, 53.600	Point 126: 3.76829, 5.260
Point 17: 1.95012,239.500	Point 72: 2.63715, 51.800	Point 127: 3.80706, 4.960
Point 18: 1.95943,234.500	Point 73: 2.65305, 50.000	Point 128: 3.84652, 4.680
Point 19: 1.96896,229.500	Point 74: 2.66954, 48.200	Point 129: 3.88643, 4.420
Point 20: 1.97872,224.500	Point 75: 2.68474, 46.600	Point 130: 3.93000, 4.160
Point 21: 1.98872,219.500	Point 76: 2.70045, 45.000	Point 131: 3.95927, 4.000
Point 22: 1.99898,214.500	Point 77: 2.71675, 43.400	
Point 23: 2.00950,209.500	Point 78: 2.73366, 41.800	
Point 24: 2.02030,204.500	Point 79: 2.75124, 40.200	
Point 25: 2.03138,199.500	Point 80: 2.76838, 38.700	
Point 26: 2.04162,195.000	Point 81: 2.78620, 37.200	
Point 27: 2.05210,190.500	Point 82: 2.80476, 35.700	
Point 28: 2.06285,186.000	Point 83: 2.82281, 34.300	
Point 29: 2.07387,181.500	Point 84: 2.84161, 32.900	
Point 30: 2.08517,177.000	Point 85: 2.86125, 31.500	
Point 31: 2.09678,172.500	Point 86: 2.88030, 30.200	
Point 32: 2.10870,168.000	Point 87: 2.90017, 28.900	
Point 33: 2.12094,163.500	Point 88: 2.92098, 27.600	
Point 34: 2.13354,159.000	Point 89: 2.94280, 26.300	
Point 35: 2.14649,154.500	Point 90: 2.96395, 25.100	
Point 36: 2.15984,150.000	Point 91: 2.98613, 23.900	
Point 37: 2.17204,146.000	Point 92: 3.00951, 22.700	
Point 38: 2.18457,142.000	Point 93: 3.03212, 21.600	
Point 39: 2.19746,138.000	Point 94: 3.05594, 20.500	
Point 40: 2.21072,134.000	Point 95: 3.07422, 19.700	
Point 41: 2.22438,130.000	Point 96: 3.08960, 19.050	
Point 42: 2.23846,126.000	Point 97: 3.10556, 18.400	
Point 43: 2.25298,122.000	Point 98: 3.12215, 17.750	
Point 44: 2.26798,118.000	Point 99: 3.13807, 17.150	
Point 45: 2.28348,114.000	Point 100: 3.15460, 16.550	
Point 46: 2.29750,110.500	Point 101: 3.17183, 15.950	
Point 47: 2.31195,107.000	Point 102: 3.18828, 15.400	
Point 48: 2.32687,103.500	Point 103: 3.20539, 14.850	
Point 49: 2.34008,100.500	Point 104: 3.22325, 14.300	
Point 50: 2.35139, 98.000	Point 105: 3.24192, 13.750	
Point 51: 2.36297, 95.500	Point 106: 3.25969, 13.250	
Point 52: 2.37485, 93.000	Point 107: 3.27825, 12.750	
Point 53: 2.38706, 90.500	Point 108: 3.29771, 12.250	
Point 54: 2.39961, 88.000	Point 109: 3.31814, 11.750	
Point 55: 2.41251, 85.500	Point 110: 3.33749, 11.300	



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# BREAKPOINTS 91C/93C/330 FORMAT

Calibration Report: 582810

Sales Order: 54828

Sensor Model: CX-1070-CU-4L

Serial Number: X58257

Sensor Type: Cernox Resistor

Temperature Range: 4.00K to 325K

Interpolation Method: Lagrangian

Limit: 325.0 (Kelvin)

Format: 4 (Log Ohms/Kelvin)

Number of Breakpoints: 47

No.	Units	Temperature (K)	No.	Units	Temperature (K)
1	1.81925	325.0	26	2.90024	28.9
2	1.82053	324.0	27	2.95157	25.8
3	1.84032	309.0	28	3.00364	23.0
4	1.86134	294.0	29	3.05383	20.6
5	1.88370	279.0	30	3.10561	18.4
6	1.90756	264.0	31	3.15606	16.5
7	1.93306	249.0	32	3.20704	14.8
8	1.96039	234.0	33	3.25794	13.3
9	1.98976	219.0	34	3.30787	12.0
10	2.02142	204.0	35	3.36018	10.8
11	2.05567	189.0	36	3.40967	9.8
12	2.09290	174.0	37	3.46012	8.9
13	2.13356	159.0	38	3.51096	8.1
14	2.17829	144.0	39	3.56133	7.4
15	2.22789	129.0	40	3.61003	6.8
16	2.28352	114.0	41	3.65541	6.3
17	2.34685	99.0	42	3.70617	5.8
18	2.42046	84.0	43	3.75151	5.4
19	2.50854	69.0	44	3.80196	5.0
20	2.57496	59.5	45	3.84385	4.7
21	2.65309	50.0	46	3.90633	4.3
22	2.69355	45.7	47	3.95932	4.0
23	2.74572	40.7			
24	2.79730	36.3			
25	2.84859	32.4			

## Temperature for Resistance Decades:

Res. (Ohms)	Temp. (K)
100	214.021
1000	23.185



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# BREAKPOINTS 234 FORMAT

Calibration Report: 582810

Sensor Model: CX-1070-CU-4L

Sensor Type: Cernox Resistor

Sales Order: 54828

Serial Number: X58257

Temperature Range: 4.00K to 325K

## Maximum Temperature Error:

1.4 - 10K:	0.006K
10 - 20K:	0.011K
20 - 40K:	0.017K
40 - 100K:	0.015K
> 100K:	0.075K

BP #	Temp. (K)	Res. ( $\Omega$ )	Log10 Res.	BP #	Temp. (K)	Res. ( $\Omega$ )	Log10 Res.
1	324.423	66.06934	1.820	46	43.092	524.8075	2.720
2	309.241	69.18310	1.840	47	41.221	549.5409	2.740
3	294.923	72.44360	1.860	48	39.431	575.4399	2.760
4	281.418	75.85776	1.880	49	37.719	602.5596	2.780
5	268.646	79.43282	1.900	50	36.083	630.9573	2.800
6	256.553	83.17638	1.920	51	34.519	660.6934	2.820
7	245.087	87.09636	1.940	52	33.023	691.8310	2.840
8	234.206	91.20108	1.960	53	31.592	724.4360	2.860
9	223.862	95.49926	1.980	54	30.224	758.5776	2.880
10	214.019	100.0000	2.000	55	28.916	794.3282	2.900
11	204.649	104.7129	2.020	56	27.664	831.7638	2.920
12	195.713	109.6478	2.040	57	26.468	870.9636	2.940
13	187.188	114.8154	2.060	58	25.324	912.0108	2.960
14	179.054	120.2264	2.080	59	24.230	954.9926	2.980
15	171.281	125.8925	2.100	60	23.185	1000.000	3.000
16	163.853	131.8257	2.120	61	21.234	1096.478	3.040
17	156.749	138.0384	2.140	62	19.455	1202.264	3.080
18	149.955	144.5440	2.160	63	17.834	1318.257	3.120
19	143.454	151.3561	2.180	64	16.361	1445.440	3.160
20	137.234	158.4893	2.200	65	15.022	1584.893	3.200
21	131.280	165.9587	2.220	66	13.807	1737.801	3.240
22	125.580	173.7801	2.240	67	12.706	1905.461	3.280
23	120.121	181.9701	2.260	68	11.708	2089.296	3.320
24	114.895	190.5461	2.280	69	10.804	2290.868	3.360
25	109.894	199.5262	2.300	70	9.986	2511.886	3.400
26	105.107	208.9296	2.320	71	9.245	2754.229	3.440
27	100.524	218.7762	2.340	72	8.575	3019.952	3.480
28	96.139	229.0868	2.360	73	7.968	3311.311	3.520
29	91.941	239.8833	2.380	74	7.418	3630.781	3.560
30	87.927	251.1886	2.400	75	6.918	3981.072	3.600
31	84.087	263.0268	2.420	76	6.464	4365.158	3.640
32	80.413	275.4229	2.440	77	6.050	4786.301	3.680
33	76.898	288.4032	2.460	78	5.674	5248.075	3.720
34	73.541	301.9952	2.480	79	5.329	5754.399	3.760
35	70.328	316.2278	2.500	80	5.015	6309.573	3.800
36	67.258	331.1311	2.520	81	4.727	6918.310	3.840
37	64.322	346.7369	2.540	82	4.462	7585.776	3.880
38	61.517	363.0781	2.560	83	4.219	8317.638	3.920
39	58.836	380.1894	2.580	84	3.996	9120.108	3.960
40	56.271	398.1072	2.600	85	3.791	10000.00	4.000
41	53.820	416.8694	2.620				
42	51.478	436.5158	2.640				
43	49.238	457.0882	2.660				
44	47.096	478.6301	2.680				
45	45.049	501.1872	2.700				



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