Certificate of Calibration
Report Number: 1361265

Sensor Model: CX-1050-SD-HT-1.4L	Serial Number: X189328
Sensor Type: Cernox Resistor	Calibration Date: October 28, 2022
Sensor Excitation: see *Test Data* page of report	Calibration Due:
Temperature Range: 1.40 K to 325 K	

Traceability and Calibration Method

This temperature sensor has been calibrated to the International Temperature Scale of 1990 (ITS-90) or the Provisional Low Temperature Scale (PLTS-2000) as appropriate. The calibrations are traceable to the National Institute of Standards and Technology (NIST, United States), the National Physical Laboratory (NPL, United Kingdom), the Physikalisch-Technische Bundesanstalt (PTB, Germany), or natural physical constants.

Lake Shore Cryotronics maintains ITS-90 and PLTS-2000 on standard platinum (PRT), rhodium-iron (RIRT), and germanium (GRT) resistance thermometers that have been calibrated directly by an internationally recognized national metrology institute (NIST, NPL, PTB) for T < 330 K or an ISO 17025 accredited metrology laboratory for 330 K < T < 800 K. A nuclear orientation thermometer is also used for temperatures less than 50 mK. These standards are routinely intercompared to verify consistency and accuracy of the temperature scale.

The sensor calibrations are performed by comparison to laboratory standard resistance thermometers and tested in accordance with Lake Shore Cryotronics, Inc. Quality Assurance Manual (QP-4220). The quality system of Lake Shore Cryotronics is registered to ISO 9001.

Procedures used: 021-97-02, 099-00-00, 121-96-02, 029-95-02

Notes
The calibration results in this report apply only to the specific sensor specified above.

Unless stated otherwise, the uncertainties in this report are based on an approximate 95% confidence level with a coverage factor k=2.

Reported by: Matt Vance
Calibration Engineer/Technician

Approved by: Carlos Segovia
Metrology

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DATA PLOT

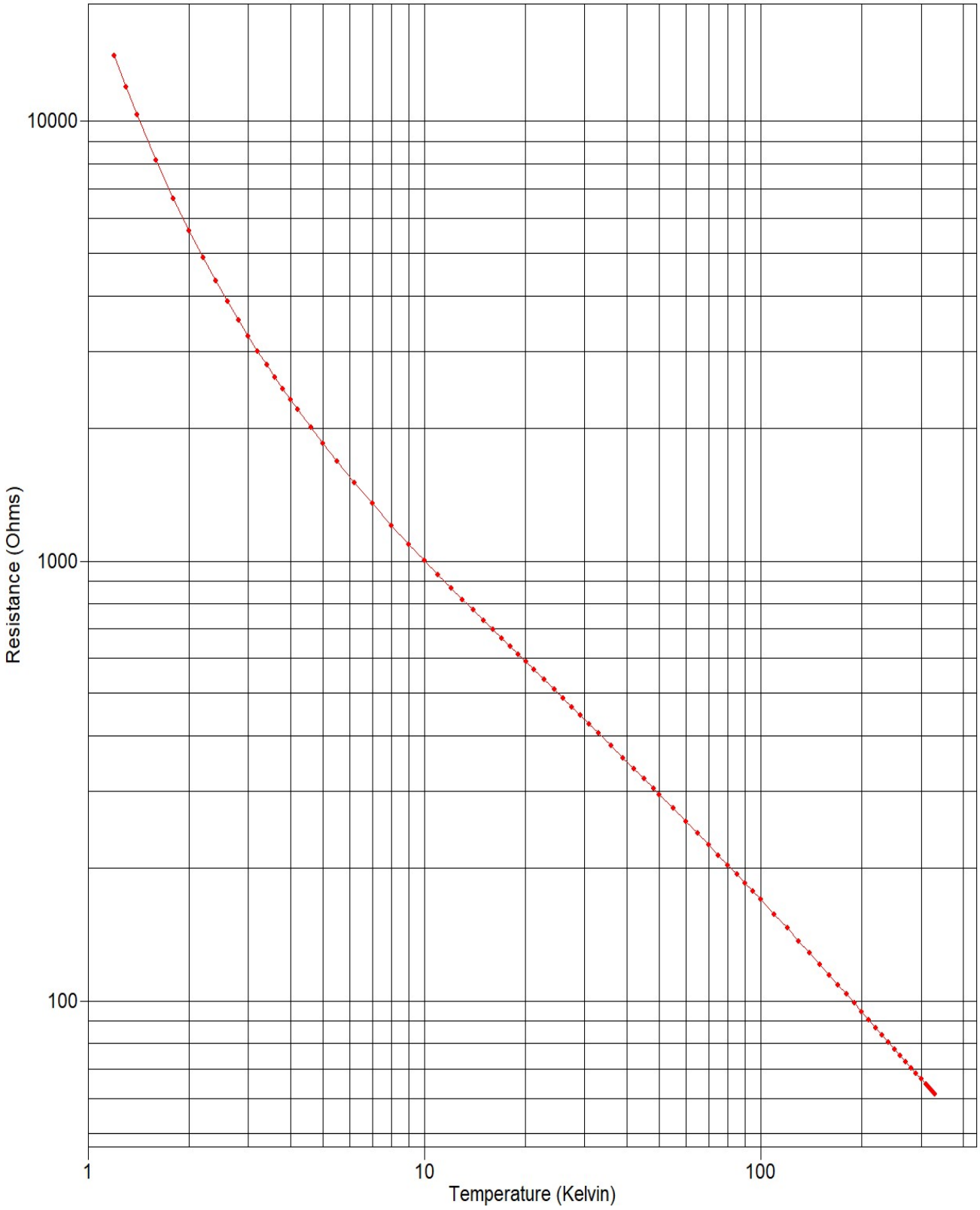
Calibration Report: 1361265

Sensor Model: CX-1050-SD-HT-1.4L

Serial Number: X189328

Sensor Type: Cernox Resistor

Temperature Range: 1.40 K to 325 K



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TEST DATA

Calibration Report: 1361265

Sensor Model: CX-1050-SD-HT-1.4L Serial Number: X189328

Sensor Type: Cernox Resistor Temperature Range: 1.40 K to 325 K

Index	Temp. (K)	Resistance (Ω)	Excitation	Index	Temp. (K)	Resistance (Ω)	Excitation
1	1.19689	14082.0	2mV±25%	46	41.9860	336.830	2mV±25%
2	1.29791	11945.3	2mV±25%	47	44.9766	319.427	2mV±25%
3	1.39929	10328.3	2mV±25%	48	47.9791	303.837	2mV±25%
4	1.59625	8126.24	2mV±25%	49	49.9733	294.378	2mV±25%
5	1.79896	6649.75	2mV±25%	50	54.9730	273.306	2mV±25%
6	2.00025	5633.18	2mV±25%	51	59.9677	255.339	2mV±25%
7	2.20115	4890.43	2mV±25%	52	64.9610	239.767	2mV±25%
8	2.40099	4326.85	2mV±25%	53	69.9485	226.170	2mV±25%
9	2.60128	3883.87	2mV±25%	54	74.9375	214.132	2mV±25%
10	2.80016	3530.37	2mV±25%	55	79.9350	203.388	2mV±25%
11	2.99973	3237.88	2mV±25%	56	84.9363	193.742	2mV±25%
12	3.20230	2992.98	2mV±25%	57	89.9325	185.019	2mV±25%
13	3.40292	2787.41	2mV±25%	58	94.9286	177.085	2mV±25%
14	3.60315	2611.38	2mV±25%	59	99.9263	169.836	2mV±25%
15	3.80307	2458.78	2mV±25%	60	109.904	157.079	2mV±25%
16	4.00318	2325.47	2mV±25%	61	119.914	146.127	2mV±25%
17	4.20288	2207.87	2mV±25%	62	129.908	136.654	2mV±25%
18	4.60185	2009.41	2mV±25%	63	139.892	128.364	2mV±25%
19	5.00254	1848.17	2mV±25%	64	149.894	121.032	2mV±25%
20	5.50009	1685.77	2mV±25%	65	159.897	114.521	2mV±25%
21	6.20063	1507.46	2mV±25%	66	169.896	108.689	2mV±25%
22	7.00620	1351.50	2mV±25%	67	179.890	103.445	2mV±25%
23	8.00298	1204.87	2mV±25%	68	189.886	98.7020	2mV±25%
24	9.00673	1091.81	2mV±25%	69	199.886	94.3912	2mV±25%
25	10.0040	1002.56	2mV±25%	70	209.891	90.4619	2mV±25%
26	11.0023	929.455	2mV±25%	71	219.896	86.8699	2mV±25%
27	12.0015	868.259	2mV±25%	72	229.902	83.5583	2mV±25%
28	13.0017	816.254	2mV±25%	73	239.904	80.5341	2mV±25%
29	14.0033	771.226	2mV±25%	74	249.906	77.7274	2mV±25%
30	15.0021	731.951	2mV±25%	75	259.926	75.1294	2mV±25%
31	16.0016	697.176	2mV±25%	76	269.949	72.7173	2mV±25%
32	17.0033	666.151	2mV±25%	77	279.964	70.4823	2mV±25%
33	18.0014	638.264	2mV±25%	78	289.975	68.3990	2mV±25%
34	19.0030	612.944	2mV±25%	79	299.991	66.4518	2mV±25%
35	20.0862	588.023	2mV±25%	80	310.013	64.6322	2mV±25%
36	21.1533	565.795	2mV±25%	81	315.044	63.7657	2mV±25%
37	22.7203	536.381	2mV±25%	82	320.060	62.9244	2mV±25%
38	24.3230	509.736	2mV±25%	83	326.058	61.9584	2mV±25%
39	25.9067	486.155	2mV±25%	84	330.072	61.3301	2mV±25%
40	27.4933	464.983	2mV±25%				
41	29.0898	445.598	2mV±25%				
42	30.8966	425.745	2mV±25%				
43	32.9881	405.090	2mV±25%				
44	35.9880	379.085	2mV±25%				
45	38.9883	356.554	2mV±25%				

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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)												
	GR	Cernox (CX)					RX			Platinum		RF-800	Diode
		1010	1030	1050	1070	1080	102A	103A	202A	100 Ω	25 Ω	27 Ω	
1.4	4	4	4	4			4	4	4			5	7
4.2	4	4	4	4	4		4	6	5			5	5
10	4	5	5	4	4		10	15	12			7	6
20	8	10	9	8	8	8	35	35	28	9	10	13	9
30	9	13	11	9	9	9	76	61	46	9	9	14	31
50	11	18	14	12	12	11				10	10	13	37
100	20	29	22	17	16	14				11	12	12	32
300		78	60	46	45	36				24	24	25	35
400		124	94	74	72	60				45	45	45	49
500										51	51		54

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:

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

where

σ_{fit} = standard deviation of the fit
T_i = measured temperature for point i
T_{icalc} = the temperature calculated from the polynomial equation for point i
N = number of data points in fit range
n = number of fit coefficients
ΔT_{RMS} = root mean square deviation of fit

A value of ΔT_{RMS} is given for each range of fit.

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POLYNOMIAL EQUATION

Calibration Report: 1361265
Sensor Model: CX-1050-SD-HT-1.4L
Serial Number: X189328
Sensor Type: Cernox Resistor
Temperature Range: 1.40 K to 325 K

Polynomial Type: Chebychev
Useful Range of Fit:

1.40 K	to	14.0 K
1.031e+4 ohms	to	771.2 ohms

Lower and Upper limits of Log(Resistance) used in computing Chebychev coefficients:
ZL = 2.84334238169 ZU = 4.14866501287

Order	Coefficient	Std. Deviation of Coefficient	Ratio (Coeff./Std Dev.)
0	5.571487	1.2678E-04	43945.40
1	-6.388558	2.0374E-04	-31356.51
2	2.750689	1.7901E-04	15365.78
3	-0.955339	1.8361E-04	-5203.14
4	0.270645	1.7371E-04	1558.02
5	-0.059402	1.6120E-04	-368.49
6	0.007658	1.5878E-04	48.23
7	0.000646	1.5849E-04	4.08
8	-0.001037	1.6038E-04	-6.47

Z = Log(Resistance)

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

Temp. (K) = ΣA_i* COS(i * ARCCOS(k)), where 0 <= i <= 8
and the A_i's are the coefficients in the table above.

POLYNOMIAL EQUATION

Calibration Report: 1361265
Sensor Model: CX-1050-SD-HT-1.4L
Serial Number: X189328
Sensor Type: Cernox Resistor
Temperature Range: 1.40 K to 325 K

Polynomial Type: Chebychev
Temp. (K) vs. Log(Resistance)

	R Meas. (Ω)	T Meas. (K)	T Eq. (K)	T diff. (mK)
1	14082.02	1.19689	1.19679	0.10
2	11945.31	1.29791	1.29839	-0.48
3	10328.28	1.39929	1.39872	0.57
4	8126.241	1.59625	1.59623	0.02
5	6649.749	1.79896	1.79947	-0.51
6	5633.185	2.00025	2.00041	-0.16
7	4890.433	2.20115	2.20076	0.39
8	4326.854	2.40099	2.40057	0.42
9	3883.874	2.60128	2.60097	0.31
10	3530.368	2.80016	2.80002	0.14
11	3237.877	2.99973	3.00086	-1.13
12	2992.979	3.20230	3.20268	-0.38
13	2787.407	3.40292	3.40295	-0.03
14	2611.381	3.60315	3.60298	0.17
15	2458.777	3.80307	3.80303	0.04
16	2325.475	4.00318	4.00269	0.49
17	2207.867	4.20288	4.20224	0.63
18	2009.415	4.60185	4.60186	-0.01
19	1848.165	5.00254	5.00260	-0.06
20	1685.770	5.50009	5.50080	-0.70
21	1507.461	6.20063	6.20139	-0.76
22	1351.503	7.00620	7.00516	1.03
23	1204.866	8.00298	8.00296	0.02
24	1091.814	9.00673	9.00663	0.10
25	1002.557	10.00401	10.00373	0.28
26	929.4552	11.00226	11.00238	-0.12
27	868.2587	12.00147	12.00261	-1.14
28	816.2540	13.00169	13.00145	0.24
29	771.2263	14.00326	14.00280	0.46
30	731.9509	15.00213	15.00157	0.56
31	697.1759	16.00161	16.00210	-0.49

Order of Fit = 8 RMS error of fit = 0.50 mK
Largest absolute error = -1.14 mK at data point no. 27

POLYNOMIAL EQUATION

Calibration Report: 1361265
Sensor Model: CX-1050-SD-HT-1.4L
Serial Number: X189328
Sensor Type: Cernox Resistor
Temperature Range: 1.40 K to 325 K

Polynomial Type: Chebychev
Useful Range of Fit:

14.0 K	to	79.9 K
771.2 ohms	to	203.4 ohms

Lower and Upper limits of Log(Resistance) used in computing Chebychev coefficients:
ZL = 2.2672173739 ZU = 2.93864915083

Order	Coefficient	Std. Deviation of Coefficient	Ratio (Coeff./Std Dev.)
0	42.072590	3.3853E-04	124280.25
1	-37.715521	5.5279E-04	-68227.69
2	8.763109	5.0324E-04	17413.27
3	-1.246077	4.7318E-04	-2633.41
4	0.137608	4.5383E-04	303.21
5	-0.004021	4.2698E-04	-9.42
6	-0.005790	4.2544E-04	-13.61

Z = Log(Resistance)

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

Temp. (K) = ΣA_i* COS(i * ARCCOS(k)), where 0 <= i <= 6
and the A_i's are the coefficients in the table above.

POLYNOMIAL EQUATION

Calibration Report: 1361265
Sensor Model: CX-1050-SD-HT-1.4L
Serial Number: X189328
Sensor Type: Cernox Resistor
Temperature Range: 1.40 K to 325 K

Polynomial Type: Chebychev
Temp. (K) vs. Log(Resistance)

	R Meas. (Ω)	T Meas. (K)	T Eq. (K)	T diff. (mK)
27	868.2587	12.00261	12.00190	0.71
28	816.2540	13.00145	13.00259	-1.13
29	771.2263	14.00280	14.00371	-0.91
30	731.9509	15.00213	15.00173	0.40
31	697.1759	16.00161	16.00135	0.25
32	666.1506	17.00333	17.00115	2.18
33	638.2638	18.00141	18.00049	0.92
34	612.9445	19.00301	19.00250	0.50
35	588.0230	20.08624	20.08915	-2.90
36	565.7946	21.15326	21.15372	-0.47
37	536.3815	22.72034	22.72134	-1.00
38	509.7363	24.32301	24.32297	0.04
39	486.1552	25.90672	25.90919	-2.47
40	464.9827	27.49334	27.49031	3.04
41	445.5978	29.08977	29.08795	1.82
42	425.7451	30.89662	30.89523	1.38
43	405.0899	32.98806	32.98828	-0.23
44	379.0852	35.98801	35.98987	-1.85
45	356.5544	38.98831	38.98961	-1.30
46	336.8295	41.98597	41.98633	-0.35
47	319.4272	44.97663	44.97515	1.49
48	303.8369	47.97913	47.97854	0.59
49	294.3783	49.97326	49.97392	-0.66
50	273.3062	54.97302	54.97435	-1.33
51	255.3390	59.96765	59.96532	2.33
52	239.7669	64.96101	64.96254	-1.53
53	226.1699	69.94848	69.94686	1.62
54	214.1325	74.93746	74.93840	-0.94
55	203.3883	79.93501	79.93664	-1.62
56	193.7416	84.93626	84.93424	2.02
57	185.0194	89.93254	89.93314	-0.59

Order of Fit = 6 RMS error of fit = 1.47 mK
Largest absolute error = 3.04 mK at data point no. 40

POLYNOMIAL EQUATION

Calibration Report: 1361265
Sensor Model: CX-1050-SD-HT-1.4L
Serial Number: X189328
Sensor Type: Cernox Resistor
Temperature Range: 1.40 K to 325 K

Polynomial Type: Chebychev
Useful Range of Fit:

79.9 K	to	325 K
203.4 ohms	to	62.13 ohms

Lower and Upper limits of Log(Resistance) used in computing Chebychev coefficients:
ZL = 1.78767388768 ZU = 2.35443477358

Order	Coefficient	Std. Deviation of Coefficient	Ratio (Coeff./Std Dev.)
0	176.782531	1.4885E-03	118764.23
1	-126.776790	2.2992E-03	-55138.39
2	22.607937	2.2074E-03	10241.94
3	-3.162273	2.0944E-03	-1509.87
4	0.599700	1.9952E-03	300.58
5	-0.118392	2.0007E-03	-59.18
6	0.017784	1.9756E-03	9.00
7	-0.005044	1.9083E-03	-2.64

Z = Log(Resistance)

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

Temp. (K) = ΣA_i* COS(i * ARCCOS(k)), where 0 <= i <= 7
and the A_i's are the coefficients in the table above.

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POLYNOMIAL EQUATION

Calibration Report: 1361265

Sensor Model: CX-1050-SD-HT-1.4L Serial Number: X189328

Sensor Type: Cernox Resistor Temperature Range: 1.40 K to 325 K

Polynomial Type: Chebychev

Temp. (K) vs. Log(Resistance)

	R Meas. (Ω)	T Meas. (K)	T Eq. (K)	T diff. (mK)
53	226.1699	69.94686	69.94545	1.41
54	214.1325	74.93840	74.94140	-3.00
55	203.3883	79.93664	79.93807	-1.44
56	193.7416	84.93626	84.93280	3.47
57	185.0194	89.93254	89.92932	3.23
58	177.0854	94.92860	94.92948	-0.88
59	169.8356	99.92626	99.93008	-3.82
60	157.0791	109.90381	109.90447	-0.66
61	146.1275	119.91396	119.91238	1.58
62	136.6537	129.90830	129.90549	2.81
63	128.3643	139.89242	139.89365	-1.23
64	121.0319	149.89389	149.90091	-7.02
65	114.5207	159.89716	159.89361	3.54
66	108.6890	169.89629	169.89435	1.93
67	103.4454	179.89027	179.88753	2.74
68	98.70196	189.88609	189.88453	1.56
69	94.39122	199.88598	199.88883	-2.84
70	90.46188	209.89063	209.89183	-1.20
71	86.86990	219.89551	219.88659	8.92
72	83.55830	229.90239	229.92765	-25.26
73	80.53409	239.90360	239.88911	14.49
74	77.72744	249.90605	249.90401	2.05
75	75.12936	259.92630	259.92420	2.10
76	72.71733	269.94909	269.95618	-7.09
77	70.48229	279.96390	279.95830	5.60
78	68.39901	289.97484	289.96840	6.45
79	66.45182	299.99118	299.99563	-4.45
80	64.63222	310.01308	310.02014	-7.06
81	63.76569	315.04396	315.03707	6.88
82	62.92438	320.05990	320.06901	-9.11
83	61.95843	326.05771	326.05322	4.49
84	61.33013	330.07226	330.07045	1.81

Order of Fit = 7 RMS error of fit = 6.69 mK

Largest absolute error = -25.26 mK at data point no. 72

INTERPOLATION TABLE

Calibration Report: 1361265

Sensor Model: CX-1050-SD-HT-1.4L Serial Number: X189328

Sensor Type: Cernox Resistor Temperature Range: 1.40 K to 325 K

Temp (K)	Res. (Ω)	dR/dT (Ω/K)	dlogR/dlogT	Temp (K)	Res. (Ω)	dR/dT (Ω/K)	dlogR/dlogT
1.400	10310.3	-14037	-1.9060	15.50	714.100	-34.759	-0.75447
1.500	9071.07	-10932	-1.8077	16.00	697.220	-32.794	-0.75257
1.600	8093.08	-8756.4	-1.7311	16.50	681.276	-31.010	-0.75105
1.700	7300.42	-7169.4	-1.6695	17.00	666.184	-29.380	-0.74973
1.800	6646.59	-5961.8	-1.6145	17.50	651.873	-27.887	-0.74865
1.900	6099.06	-5025.6	-1.5656	18.00	638.277	-26.517	-0.74780
2.000	5634.95	-4285.5	-1.5210	18.50	625.338	-25.256	-0.74717
2.100	5237.09	-3692.1	-1.4805	19.00	613.005	-24.092	-0.74672
2.200	4892.86	-3209.0	-1.4429	19.50	601.232	-23.014	-0.74642
2.300	4592.44	-2811.8	-1.4082	20.00	589.978	-22.014	-0.74626
2.400	4328.27	-2481.8	-1.3761	21.00	568.883	-20.218	-0.74633
2.500	4094.30	-2205.3	-1.3466	22.00	549.465	-18.651	-0.74678
2.600	3885.79	-1971.4	-1.3191	23.00	531.517	-17.275	-0.74754
2.700	3698.85	-1772.3	-1.2937	24.00	514.863	-16.057	-0.74847
2.800	3530.39	-1601.3	-1.2700	25.00	499.358	-14.973	-0.74960
2.900	3377.82	-1453.7	-1.2480	26.00	484.880	-14.002	-0.75082
3.000	3239.02	-1325.3	-1.2275	27.00	471.322	-13.129	-0.75210
3.100	3112.23	-1213.0	-1.2083	28.00	458.594	-12.340	-0.75344
3.200	2995.96	-1114.3	-1.1902	29.00	446.618	-11.624	-0.75478
3.300	2888.98	-1027.2	-1.1733	30.00	435.324	-10.972	-0.75612
3.400	2790.21	-949.75	-1.1573	31.00	424.655	-10.376	-0.75746
3.500	2698.75	-880.76	-1.1423	32.00	414.556	-9.8298	-0.75877
3.600	2613.82	-818.99	-1.1280	33.00	404.981	-9.3277	-0.76007
3.700	2534.74	-763.50	-1.1145	34.00	395.887	-8.8648	-0.76134
3.800	2460.93	-713.46	-1.1017	35.00	387.239	-8.4364	-0.76251
3.900	2391.89	-668.18	-1.0895	36.00	379.004	-8.0402	-0.76371
4.000	2327.16	-627.08	-1.0778	37.00	371.150	-7.6725	-0.76488
4.200	2209.11	-555.58	-1.0563	38.00	363.650	-7.3301	-0.76596
4.400	2104.16	-495.64	-1.0364	39.00	356.482	-7.0112	-0.76704
4.600	2010.24	-444.97	-1.0182	40.00	349.621	-6.7135	-0.76809
4.800	1925.67	-401.81	-1.0016	42.00	336.745	-6.1741	-0.77006
5.000	1849.11	-364.69	-0.98612	44.00	324.881	-5.6995	-0.77191
5.200	1779.46	-332.56	-0.97182	46.00	313.910	-5.2798	-0.77369
5.400	1715.82	-304.54	-0.95843	48.00	303.732	-4.9061	-0.77534
5.600	1657.41	-280.08	-0.94631	50.00	294.259	-4.5727	-0.77698
5.800	1603.60	-258.42	-0.93467	52.00	285.418	-4.2731	-0.77852
6.000	1553.88	-239.21	-0.92368	54.00	277.147	-4.0031	-0.77997
6.500	1444.53	-200.00	-0.89994	56.00	269.388	-3.7594	-0.78150
7.000	1352.38	-169.90	-0.87942	58.00	262.094	-3.5379	-0.78293
7.500	1273.54	-146.35	-0.86186	60.00	255.223	-3.3365	-0.78438
8.000	1205.24	-127.54	-0.84659	65.00	239.658	-2.9052	-0.78795
8.500	1145.40	-112.32	-0.83354	70.00	226.034	-2.5564	-0.79167
9.000	1092.47	-99.781	-0.82201	75.00	213.993	-2.2689	-0.79519
9.500	1045.27	-89.344	-0.81201	77.35	208.801	-2.1512	-0.79691
10.00	1002.86	-80.547	-0.80318	80.00	203.262	-2.0312	-0.79942
10.50	964.500	-73.068	-0.79546	85.00	193.618	-1.8313	-0.80395
11.00	929.614	-66.642	-0.78857	90.00	184.902	-1.6599	-0.80794
11.50	897.713	-61.088	-0.78256	95.00	176.979	-1.5131	-0.81219
12.00	868.406	-56.255	-0.77735	100.0	169.739	-1.3859	-0.81652
12.50	841.361	-52.004	-0.77262	105.0	163.092	-1.2750	-0.82083
13.00	816.324	-48.218	-0.76788	110.0	156.967	-1.1775	-0.82515
13.50	793.070	-44.873	-0.76384	115.0	151.299	-1.0912	-0.82943
14.00	771.382	-41.945	-0.76126	120.0	146.039	-1.0144	-0.83356
14.50	751.073	-39.330	-0.75930	125.0	141.141	-0.94570	-0.83755
15.00	732.015	-36.937	-0.75688	130.0	136.570	-0.88386	-0.84134

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INTERPOLATION TABLE

Calibration Report: 1361265

Sensor Model: CX-1050-SD-HT-1.4L Serial Number: X189328

Sensor Type: Cernox Resistor Temperature Range: 1.40 K to 325 K

Temp (K)	Res. (Ω)	dR/dT (Ω/K)	dlogR/dlogT	Temp (K)	Res. (Ω)	dR/dT (Ω/K)	dlogR/dlogT
135.0	132.293	-0.82799	-0.84493	235.0	81.9877	-0.30325	-0.86919
140.0	128.282	-0.77730	-0.84830	240.0	80.5018	-0.29125	-0.86832
145.0	124.512	-0.73114	-0.85144	245.0	79.0741	-0.27992	-0.86728
150.0	120.964	-0.68896	-0.85434	250.0	77.7016	-0.26919	-0.86610
155.0	117.617	-0.65031	-0.85700	255.0	76.3813	-0.25903	-0.86476
160.0	114.455	-0.61478	-0.85941	260.0	75.1105	-0.24939	-0.86329
165.0	111.464	-0.58204	-0.86159	265.0	73.8865	-0.24025	-0.86168
170.0	108.631	-0.55180	-0.86353	270.0	72.7072	-0.23157	-0.85994
175.0	105.943	-0.52380	-0.86523	273.15	71.9860	-0.22632	-0.85878
180.0	103.389	-0.49782	-0.86671	275.0	71.5701	-0.22332	-0.85808
185.0	100.961	-0.47367	-0.86795	280.0	70.4733	-0.21547	-0.85611
190.0	98.6498	-0.45118	-0.86898	285.0	69.4148	-0.20801	-0.85402
195.0	96.4470	-0.43020	-0.86979	290.0	68.3927	-0.20089	-0.85183
200.0	94.3456	-0.41059	-0.87039	295.0	67.4053	-0.19411	-0.84954
205.0	92.3390	-0.39223	-0.87079	300.0	66.4510	-0.18765	-0.84716
210.0	90.4213	-0.37503	-0.87099	305.0	65.5283	-0.18148	-0.84469
215.0	88.5869	-0.35888	-0.87099	310.0	64.6358	-0.17559	-0.84214
220.0	86.8309	-0.34370	-0.87081	315.0	63.7720	-0.16996	-0.83951
225.0	85.1485	-0.32941	-0.87045	320.0	62.9357	-0.16458	-0.83682
230.0	83.5354	-0.31595	-0.86990	325.0	62.1258	-0.15944	-0.83406

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THERMAL CYCLE TESTING

Calibration Report: 1361265
Sensor Model: CX-1050-SD-HT-1.4L Serial Number: X189328
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 295 K:	66.3 Ω
Liquid Nitrogen:	209 Ω
Liquid Helium:	2207 Ω

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 Lake Shore, 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 CUBIC SPLINE FORMAT

Calibration Report: 1361265

Sensor Model: CX-1050-SD-HT-1.4L Serial Number: X189328

Sensor Type: Cernox Resistor Temperature Range: 1.40 K to 325 K

Sensor Model: CX-1050-SD-HT-1.4L
Serial Number: X189328
Data Format: 7 (Ohms/Kelvin)
Setpoint Limit: 325

Measurement (ohms)	Temp (K)	Curvature	Measurement (ohms)	Temp (K)	Curvature
6.13301E+01	3.30070E+02	2.60757E-01	7.71226E+02	1.40028E+01	7.63089E-05
6.19584E+01	3.26053E+02	2.51007E-01	8.16254E+02	1.30015E+01	6.24464E-05
6.29244E+01	3.20069E+02	2.36017E-01	8.68259E+02	1.20026E+01	5.06874E-05
6.37657E+01	3.15037E+02	2.24174E-01	9.29455E+02	1.10024E+01	4.00297E-05
6.46322E+01	3.10020E+02	2.12515E-01	1.00256E+03	1.00037E+01	3.07411E-05
6.64518E+01	2.99996E+02	1.90845E-01	1.09181E+03	9.00663E+00	2.27540E-05
6.83990E+01	2.89968E+02	1.70963E-01	1.20487E+03	8.00296E+00	1.59999E-05
7.04823E+01	2.79958E+02	1.52699E-01	1.35150E+03	7.00516E+00	1.06286E-05
7.27173E+01	2.69956E+02	1.35978E-01	1.50746E+03	6.20139E+00	7.21702E-06
7.51294E+01	2.59924E+02	1.20653E-01	1.68577E+03	5.50080E+00	4.85496E-06
7.77274E+01	2.49904E+02	1.06710E-01	1.84817E+03	5.00260E+00	3.52835E-06
8.05341E+01	2.39889E+02	9.40529E-02	2.00941E+03	4.60186E+00	2.62160E-06
8.35583E+01	2.29928E+02	8.26431E-02	2.20787E+03	4.20224E+00	1.88873E-06
8.68699E+01	2.19887E+02	7.22538E-02	2.32547E+03	4.00269E+00	1.58937E-06
9.04619E+01	2.09892E+02	6.29427E-02	2.45878E+03	3.80303E+00	1.30690E-06
9.43912E+01	1.99889E+02	5.45721E-02	2.61138E+03	3.60298E+00	1.06275E-06
9.87020E+01	1.89885E+02	4.70777E-02	2.78741E+03	3.40295E+00	8.49727E-07
1.03445E+02	1.79888E+02	4.03943E-02	2.99298E+03	3.20268E+00	6.66925E-07
1.08689E+02	1.69894E+02	3.44523E-02	3.23788E+03	3.00086E+00	5.11132E-07
1.14521E+02	1.59894E+02	2.91842E-02	3.53037E+03	2.80002E+00	3.82320E-07
1.21032E+02	1.49901E+02	2.45404E-02	3.88387E+03	2.60097E+00	2.77973E-07
1.28364E+02	1.39894E+02	2.04577E-02	4.32685E+03	2.40057E+00	1.94187E-07
1.36654E+02	1.29905E+02	1.68983E-02	4.89043E+03	2.20076E+00	1.29652E-07
1.46127E+02	1.19912E+02	1.38063E-02	5.63318E+03	2.00041E+00	8.16686E-08
1.57079E+02	1.09904E+02	1.11238E-02	6.64975E+03	1.79947E+00	4.79489E-08
1.69836E+02	9.99301E+01	8.84842E-03	8.12624E+03	1.59623E+00	2.57291E-08
1.77085E+02	9.49295E+01	7.85092E-03	1.03283E+04	1.39872E+00	1.25648E-08
1.85019E+02	8.99293E+01	6.89575E-03	1.19453E+04	1.29839E+00	8.19259E-09
1.93742E+02	8.49328E+01	5.97910E-03	1.40820E+04	1.19679E+00	2.41520E-09
2.03388E+02	7.99366E+01	5.16945E-03			
2.14132E+02	7.49384E+01	4.44403E-03			
2.26170E+02	6.99469E+01	3.75388E-03			
2.39767E+02	6.49625E+01	3.13436E-03			
2.55339E+02	5.99653E+01	2.57421E-03			
2.73306E+02	5.49744E+01	2.07533E-03			
2.94378E+02	4.99739E+01	1.64161E-03			
3.03837E+02	4.79785E+01	1.48930E-03			
3.19427E+02	4.49751E+01	1.26644E-03			
3.36830E+02	4.19863E+01	1.06857E-03			
3.56554E+02	3.89896E+01	8.89672E-04			
3.79085E+02	3.59899E+01	7.30199E-04			
4.05090E+02	3.29883E+01	5.90779E-04			
4.25745E+02	3.08952E+01	5.05052E-04			
4.45598E+02	2.90880E+01	4.36784E-04			
4.64983E+02	2.74903E+01	3.81631E-04			
4.86155E+02	2.59092E+01	3.31354E-04			
5.09736E+02	2.43230E+01	2.85281E-04			
5.36381E+02	2.27213E+01	2.42890E-04			
5.65795E+02	2.11537E+01	2.05522E-04			
5.88023E+02	2.00891E+01	1.82265E-04			
6.12944E+02	1.90025E+01	1.59850E-04			
6.38264E+02	1.80005E+01	1.40682E-04			
6.66151E+02	1.70011E+01	1.22589E-04			
6.97176E+02	1.60014E+01	1.06237E-04			
7.31951E+02	1.50017E+01	8.89767E-05			

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BREAKPOINTS 340 FORMAT

Calibration Report: 1361265

Sensor Model: CX-1050-SD-HT-1.4L Serial Number: X189328

Sensor Type: Cernox Resistor Temperature Range: 1.40 K to 325 K

Name: CX-1050-SD-HT-1.4L
Serial Number: X189328
Format: 4 ;Log Ohms/Kelvin
Limit: 325.0
Coefficient: 1 ;Negative

Point 1: 1.79326,325.000	Point 51: 2.26498, 90.500	Point 101: 2.88488, 14.100
Point 2: 1.80003,319.000	Point 52: 2.27480, 88.000	Point 102: 2.89804, 13.550
Point 3: 1.80636,313.500	Point 53: 2.28488, 85.500	Point 103: 2.91054, 13.050
Point 4: 1.81283,308.000	Point 54: 2.29523, 83.000	Point 104: 2.92360, 12.550
Point 5: 1.81944,302.500	Point 55: 2.30587, 80.500	Point 105: 2.93727, 12.050
Point 6: 1.82619,297.000	Point 56: 2.31681, 78.000	Point 106: 2.95161, 11.550
Point 7: 1.83309,291.500	Point 57: 2.32581, 76.000	Point 107: 2.96669, 11.050
Point 8: 1.84014,286.000	Point 58: 2.33502, 74.000	Point 108: 2.98098, 10.600
Point 9: 1.84735,280.500	Point 59: 2.34446, 72.000	Point 109: 2.99599, 10.150
Point 10: 1.85472,275.000	Point 60: 2.35416, 70.000	Point 110: 3.01183, 9.700
Point 11: 1.86226,269.500	Point 61: 2.36411, 68.000	Point 111: 3.02858, 9.250
Point 12: 1.86997,264.000	Point 62: 2.37435, 66.000	Point 112: 3.04437, 8.850
Point 13: 1.87786,258.500	Point 63: 2.38488, 64.000	Point 113: 3.06102, 8.450
Point 14: 1.88593,253.000	Point 64: 2.39572, 62.000	Point 114: 3.07871, 8.050
Point 15: 1.89420,247.500	Point 65: 2.40690, 60.000	Point 115: 3.09753, 7.650
Point 16: 1.90266,242.000	Point 66: 2.41727, 58.200	Point 116: 3.11510, 7.300
Point 17: 1.91054,237.000	Point 67: 2.42794, 56.400	Point 117: 3.13375, 6.950
Point 18: 1.91859,232.000	Point 68: 2.43894, 54.600	Point 118: 3.15367, 6.600
Point 19: 1.92682,227.000	Point 69: 2.45029, 52.800	Point 119: 3.17504, 6.250
Point 20: 1.93524,222.000	Point 70: 2.46201, 51.000	Point 120: 3.19806, 5.900
Point 21: 1.94385,217.000	Point 71: 2.47414, 49.200	Point 121: 3.22076, 5.580
Point 22: 1.95267,212.000	Point 72: 2.48669, 47.400	Point 122: 3.24530, 5.260
Point 23: 1.96170,207.000	Point 73: 2.49970, 45.600	Point 123: 3.27025, 4.960
Point 24: 1.97094,202.000	Point 74: 2.51170, 44.000	Point 124: 3.29549, 4.680
Point 25: 1.98042,197.000	Point 75: 2.52410, 42.400	Point 125: 3.32288, 4.400
Point 26: 1.99013,192.000	Point 76: 2.53695, 40.800	Point 126: 3.35066, 4.140
Point 27: 2.00008,187.000	Point 77: 2.55029, 39.200	Point 127: 3.37501, 3.930
Point 28: 2.01030,182.000	Point 78: 2.56328, 37.700	Point 128: 3.39733, 3.750
Point 29: 2.02078,177.000	Point 79: 2.57676, 36.200	Point 129: 3.41989, 3.580
Point 30: 2.03046,172.500	Point 80: 2.59079, 34.700	Point 130: 3.44402, 3.410
Point 31: 2.04037,168.000	Point 81: 2.60539, 33.200	Point 131: 3.46998, 3.240
Point 32: 2.05053,163.500	Point 82: 2.61961, 31.800	Point 132: 3.49632, 3.080
Point 33: 2.06096,159.000	Point 83: 2.63441, 30.400	Point 133: 3.52292, 2.930
Point 34: 2.07165,154.500	Point 84: 2.64988, 29.000	Point 134: 3.55160, 2.780
Point 35: 2.08263,150.000	Point 85: 2.66490, 27.700	Point 135: 3.58271, 2.630
Point 36: 2.09392,145.500	Point 86: 2.68060, 26.400	Point 136: 3.61432, 2.490
Point 37: 2.10552,141.000	Point 87: 2.69705, 25.100	Point 137: 3.64872, 2.350
Point 38: 2.11745,136.500	Point 88: 2.71299, 23.900	Point 138: 3.68368, 2.220
Point 39: 2.12974,132.000	Point 89: 2.72971, 22.700	Point 139: 3.72187, 2.090
Point 40: 2.14100,128.000	Point 90: 2.74732, 21.500	Point 140: 3.76397, 1.960
Point 41: 2.15255,124.000	Point 91: 2.76435, 20.400	Point 141: 3.80696, 1.840
Point 42: 2.16444,120.000	Point 92: 2.77735, 19.600	Point 142: 3.85448, 1.720
Point 43: 2.17669,116.000	Point 93: 2.78829, 18.950	Point 143: 3.90306, 1.610
Point 44: 2.18931,112.000	Point 94: 2.79961, 18.300	Point 144: 3.95206, 1.510
Point 45: 2.20234,108.000	Point 95: 2.81135, 17.650	Point 145: 4.00685, 1.410
Point 46: 2.21581,104.000	Point 96: 2.82356, 17.000	Point 146: 4.01327, 1.400
Point 47: 2.22799,100.500	Point 97: 2.83527, 16.400	
Point 48: 2.23693, 98.000	Point 98: 2.84744, 15.800	
Point 49: 2.24605, 95.500	Point 99: 2.86013, 15.200	
Point 50: 2.25540, 93.000	Point 100: 2.87225, 14.650	

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BREAKPOINTS 91C/93C/330 FORMAT

Calibration Report: 1361265

Sensor Model: CX-1050-SD-HT-1.4L | Serial Number: X189328

Sensor Type: Cernox Resistor | Temperature Range: 1.40 K to 325 K

Interpolation Method: Lagrangian
Limit: 325.0 (Kelvin)
Format: 4 (Log Ohms/Kelvin)
Number of Breakpoints: 53

No.	Units	Temperature (K)	No.	Units	Temperature (K)
1	1.79327	325.0	31	2.95611	11.4
2	1.79439	324.0	32	3.00830	9.8
3	1.81165	309.0	33	3.05896	8.5
4	1.82995	294.0	34	3.11005	7.4
5	1.84936	279.0	35	3.15973	6.5
6	1.86998	264.0	36	3.21218	5.7
7	1.89194	249.0	37	3.25851	5.1
8	1.91536	234.0	38	3.31301	4.5
9	1.94040	219.0	39	3.35533	4.1
10	1.96723	204.0	40	3.40393	3.7
11	1.99609	189.0	41	3.44564	3.4
12	2.02722	174.0	42	3.49307	3.1
13	2.06098	159.0	43	3.54782	2.8
14	2.09777	144.0	44	3.58948	2.6
15	2.13818	129.0	45	3.63631	2.4
16	2.18298	114.0	46	3.68956	2.2
17	2.23334	99.0	47	3.71909	2.1
18	2.29108	84.0	48	3.75089	2.0
19	2.35912	69.0	49	3.78526	1.9
20	2.40977	59.5	50	3.82260	1.8
21	2.46873	50.0	51	3.86335	1.7
22	2.50419	45.0	52	3.95766	1.5
23	2.54360	40.0	53	4.01327	1.4
24	2.58798	35.0			
25	2.63881	30.0			
26	2.69324	25.4			
27	2.74589	21.6			
28	2.79964	18.3			
29	2.85165	15.6			
30	2.90427	13.3			

Temperature for Resistance Decades:

Res. (Ohms)	Temp. (K)
100	187.050
1000	10.035
10000	1.423

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BREAKPOINTS 234 FORMAT

Calibration Report: 1361265

Sensor Model: CX-1050-SD-HT-1.4L Serial Number: X189328

Sensor Type: Cernox Resistor Temperature Range: 1.40 K to 325 K

Maximum Temperature Error:

1.4 - 10 K:	0.014 K
10 - 20 K:	0.006 K
20 - 40 K:	0.010 K
40 - 100 K:	0.021 K
> 100 K:	0.084 K

BP #	Temp. (K)	Res. (W)	Log10 Res.	BP #	Temp. (K)	Res. (W)	Log10 Res.
1	319.031	63.09573	1.800	46	24.878	501.1872	2.700
2	302.048	66.06934	1.820	47	23.394	524.8075	2.720
3	286.118	69.18310	1.840	48	21.996	549.5409	2.740
4	271.143	72.44360	1.860	49	20.680	575.4399	2.760
5	257.037	75.85776	1.880	50	19.442	602.5596	2.780
6	243.725	79.43282	1.900	51	18.280	630.9573	2.800
7	231.142	83.17638	1.920	52	17.189	660.6934	2.820
8	219.230	87.09636	1.940	53	16.166	691.8310	2.840
9	207.940	91.20108	1.960	54	15.208	724.4360	2.860
10	197.226	95.49926	1.980	55	14.311	758.5776	2.880
11	187.050	100.0000	2.000	56	13.472	794.3282	2.900
12	177.376	104.7129	2.020	57	12.687	831.7638	2.920
13	168.174	109.6478	2.040	58	11.955	870.9636	2.940
14	159.416	114.8154	2.060	59	11.271	912.0108	2.960
15	151.077	120.2264	2.080	60	10.632	954.9926	2.980
16	143.133	125.8925	2.100	61	10.036	1000.000	3.000
17	135.566	131.8257	2.120	62	8.960	1096.478	3.040
18	128.357	138.0384	2.140	63	8.023	1202.264	3.080
19	121.489	144.5440	2.160	64	7.207	1318.257	3.120
20	114.948	151.3561	2.180	65	6.495	1445.440	3.160
21	108.720	158.4893	2.200	66	5.873	1584.893	3.200
22	102.792	165.9587	2.220	67	5.329	1737.801	3.240
23	97.155	173.7801	2.240	68	4.851	1905.461	3.280
24	91.797	181.9701	2.260	69	4.430	2089.296	3.320
25	86.707	190.5461	2.280	70	4.059	2290.868	3.360
26	81.876	199.5262	2.300	71	3.730	2511.886	3.400
27	77.290	208.9296	2.320	72	3.438	2754.229	3.440
28	72.942	218.7762	2.340	73	3.179	3019.952	3.480
29	68.823	229.0868	2.360	74	2.947	3311.311	3.520
30	64.923	239.8833	2.380	75	2.739	3630.781	3.560
31	61.231	251.1886	2.400	76	2.553	3981.072	3.600
32	57.738	263.0268	2.420	77	2.385	4365.158	3.640
33	54.434	275.4229	2.440	78	2.234	4786.301	3.680
34	51.310	288.4032	2.460	79	2.097	5248.075	3.720
35	48.356	301.9952	2.480	80	1.973	5754.399	3.760
36	45.565	316.2278	2.500	81	1.860	6309.573	3.800
37	42.926	331.1311	2.520	82	1.756	6918.310	3.840
38	40.434	346.7369	2.540	83	1.662	7585.776	3.880
39	38.078	363.0781	2.560	84	1.575	8317.638	3.920
40	35.853	380.1894	2.580	85	1.496	9120.108	3.960
41	33.751	398.1072	2.600	86	1.423	10000.00	4.000
42	31.766	416.8694	2.620	87	1.265	12589.25	4.100
43	29.892	436.5158	2.640				
44	28.122	457.0882	2.660				
45	26.453	478.6301	2.680				

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