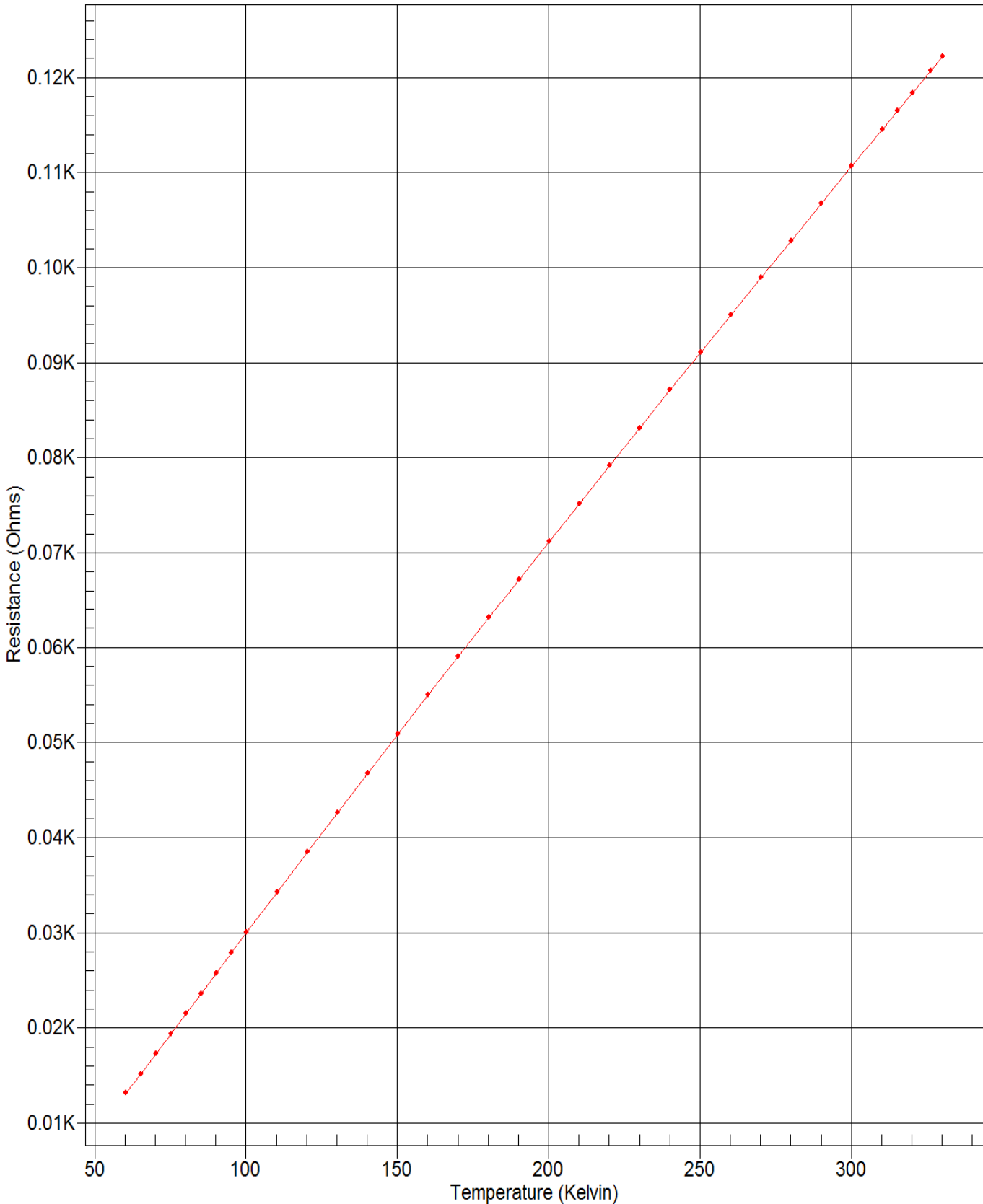


DATA PLOT

Calibration Report: 564123
Sensor Model: PT-103-AM-70L
Sensor Type: Platinum Resistor

Sales Order: 50282
Serial Number: P15334
Temperature Range: 70.0K to 325K



TEST DATA

Calibration Report: 564123
Sensor Model: PT-103-AM-70L
Sensor Type: Platinum Resistor

Sales Order: 50282
Serial Number: P15334
Temperature Range: 70.0K to 325K

Index	Temp. (K)	Resistance (Ω)	Excitation	Index	Temp. (K)	Resistance (Ω)	Excitation
1	60.3290	13.1631	0.50mA \pm 5%	21	220.194	79.1689	0.50mA \pm 5%
2	65.3144	15.2008	0.50mA \pm 5%	22	230.190	83.1449	0.50mA \pm 5%
3	70.3096	17.2843	0.50mA \pm 5%	23	240.195	87.1118	0.50mA \pm 5%
4	75.2975	19.3915	0.50mA \pm 5%	24	250.186	91.0590	0.50mA \pm 5%
5	80.2877	21.5137	0.50mA \pm 5%	25	260.184	94.9979	0.50mA \pm 5%
6	85.2804	23.6442	0.50mA \pm 5%	26	270.186	98.9248	0.50mA \pm 5%
7	90.2712	25.7754	0.50mA \pm 5%	27	280.185	102.839	0.50mA \pm 5%
8	95.2642	27.9055	0.50mA \pm 5%	28	290.190	106.744	0.50mA \pm 5%
9	100.266	30.0341	0.50mA \pm 5%	29	300.196	110.636	0.50mA \pm 5%
10	110.249	34.2613	0.50mA \pm 5%	30	310.197	114.516	0.50mA \pm 5%
11	120.244	38.4635	0.50mA \pm 5%	31	315.208	116.454	0.50mA \pm 5%
12	130.235	42.6338	0.50mA \pm 5%	32	320.206	118.385	0.50mA \pm 5%
13	140.227	46.7763	0.50mA \pm 5%	33	326.198	120.697	0.50mA \pm 5%
14	150.220	50.8934	0.50mA \pm 5%	34	330.206	122.239	0.50mA \pm 5%
15	160.216	54.9884	0.50mA \pm 5%				
16	170.212	59.0618	0.50mA \pm 5%				
17	180.209	63.1167	0.50mA \pm 5%				
18	190.199	67.1503	0.50mA \pm 5%				
19	200.202	71.1735	0.50mA \pm 5%				
20	210.204	75.1812	0.50mA \pm 5%				



UNCERTAINTY ANALYSIS

Calibration Report: 564123
 Sensor Model: PT-103-AM-70L
 Sensor Type: Platinum Resistor

Sales Order: 50282
 Serial Number: P15334
 Temperature Range: 70.0K 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 ≤ 100	X ≥ 250	Y ≤ 1030	Y ≥ 1050		-102	-103	100 Ω	25 Ω	27 Ω	100 Ω	
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
- σ_{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
 - ΔT_{RMS} = root mean square deviation of fit

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

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



POLYNOMIAL EQUATION

Calibration Report: 564123
Sensor Model: PT-103-AM-70L
Sensor Type: Platinum Resistor

Sales Order: 50282
Serial Number: P15334
Temperature Range: 70.0K to 325K

Polynomial Type: Chebychev
Useful Range of Fit:

70.0 K to 325. K
17.15 Ohms to 120.2 Ohms

Lower and Upper limits of Resistance used in computing Chebychev coefficients:
ZL = 13.16307996021 ZU = 122.23909110794

Order	Coefficient	Std. Deviation of Coefficient	Ratio (Coeff./Std Dev.)
0	193.501681	1.8861E-04	1025909.93
1	134.893277	2.9008E-04	465023.47
2	1.910583	2.7804E-04	6871.54
3	-0.080624	2.7644E-04	-291.65
4	-0.071656	2.6724E-04	-268.13
5	0.088581	2.5964E-04	341.17
6	-0.057255	2.5578E-04	-223.84
7	0.030116	2.5231E-04	119.36
8	-0.013812	2.4945E-04	-55.37
9	0.005633	2.5124E-04	22.42
10	-0.002265	2.5353E-04	-8.93
11	0.000820	2.5264E-04	3.25

Z = Resistance

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

Temp. (K) = $\sum A_i \cdot \text{COS}(i \cdot \text{ARCCOS}(k))$, where $0 \leq i \leq 11$
and the A_i 's are the coefficients in the table above.



POLYNOMIAL EQUATION

Calibration Report: 564123
Sensor Model: PT-103-AM-70L
Sensor Type: Platinum Resistor

Sales Order: 50282
Serial Number: P15334
Temperature Range: 70.0K to 325K

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

	R Meas. (Ω)	T Meas. (K)	T Eq. (K)	T diff. (mK)
1	13.16308	60.32904	60.32947	-0.43
2	15.20078	65.31445	65.31329	1.16
3	17.28431	70.30957	70.30958	-0.01
4	19.39154	75.29746	75.29910	-1.64
5	21.51373	80.28771	80.28783	-0.11
6	23.64424	85.28040	85.27961	0.80
7	25.77538	90.27119	90.27001	1.18
8	27.90553	95.26418	95.26428	-0.11
9	30.03409	100.26603	100.26682	-0.79
10	34.26130	110.24912	110.24938	-0.26
11	38.46354	120.24423	120.24438	-0.14
12	42.63377	130.23511	130.23494	0.16
13	46.77633	140.22740	140.22701	0.39
14	50.89336	150.22037	150.21994	0.42
15	54.98844	160.21598	160.21659	-0.61
16	59.06180	170.21196	170.21205	-0.09
17	63.11672	180.20878	180.20960	-0.82
18	67.15031	190.19906	190.19804	1.02
19	71.17355	200.20193	200.20145	0.48
20	75.18119	210.20378	210.20442	-0.65
21	79.16888	220.19399	220.19411	-0.11
22	83.14492	230.19007	230.18962	0.44
23	87.11182	240.19522	240.19600	-0.79
24	91.05903	250.18608	250.18528	0.80
25	94.99785	260.18433	260.18498	-0.66
26	98.92483	270.18635	270.18566	0.69
27	102.8394	280.18532	280.18565	-0.33
28	106.7436	290.18959	290.18987	-0.28
29	110.6360	300.19607	300.19510	0.97
30	114.5159	310.19671	310.19897	-2.26
31	116.4536	315.20833	315.20684	1.50
32	118.3846	320.20564	320.20466	0.99
33	120.6966	326.19759	326.19906	-1.47
34	122.2391	330.20564	330.20508	0.56

Order of Fit = 11 RMS error of fit = 0.85 mK
Largest absolute error = -2.26 mK at data point no. 30



INTERPOLATION TABLE

Calibration Report: 564123
Sensor Model: PT-103-AM-70L
Sensor Type: Platinum Resistor

Sales Order: 50282
Serial Number: P15334
Temperature Range: 70.0K to 325K

<u>Temp (K)</u>	<u>Res. (Ω)</u>	<u>dR/dT (Ω/K)</u>	<u>dlogR/dlogT</u>	<u>Temp (K)</u>	<u>Res. (Ω)</u>	<u>dR/dT (Ω/K)</u>	<u>dlogR/dlogT</u>
70.00	17.1543	0.41978	1.7130	215.0	77.0973	0.39921	1.1133
75.00	19.2647	0.42400	1.6507	220.0	79.0915	0.39850	1.1085
77.35	20.2627	0.42527	1.6234	225.0	81.0823	0.39781	1.1039
80.00	21.3910	0.42625	1.5941	230.0	83.0696	0.39713	1.0995
85.00	23.5248	0.42707	1.5431	235.0	85.0536	0.39646	1.0954
90.00	25.6601	0.42692	1.4974	240.0	87.0342	0.39581	1.0915
95.00	27.7929	0.42613	1.4566	245.0	89.0117	0.39517	1.0877
100.0	29.9207	0.42494	1.4202	250.0	90.9859	0.39454	1.0841
105.0	32.0420	0.42355	1.3880	255.0	92.9571	0.39392	1.0806
110.0	34.1561	0.42205	1.3592	260.0	94.9251	0.39330	1.0773
115.0	36.2625	0.42051	1.3336	265.0	96.8901	0.39269	1.0740
120.0	38.3612	0.41898	1.3106	270.0	98.8520	0.39209	1.0709
125.0	40.4523	0.41748	1.2900	273.15	100.087	0.39171	1.0690
130.0	42.5360	0.41603	1.2715	275.0	100.811	0.39148	1.0679
135.0	44.6127	0.41464	1.2547	280.0	102.767	0.39088	1.0650
140.0	46.6825	0.41331	1.2395	285.0	104.720	0.39027	1.0621
145.0	48.7459	0.41204	1.2257	290.0	106.670	0.38967	1.0594
150.0	50.8030	0.41083	1.2130	295.0	108.616	0.38906	1.0567
155.0	52.8543	0.40968	1.2014	300.0	110.560	0.38846	1.0541
160.0	54.8999	0.40859	1.1908	305.0	112.501	0.38786	1.0515
165.0	56.9403	0.40756	1.1810	310.0	114.439	0.38726	1.0490
170.0	58.9756	0.40657	1.1719	315.0	116.374	0.38667	1.0466
175.0	61.0061	0.40562	1.1636	320.0	118.306	0.38608	1.0443
180.0	63.0319	0.40472	1.1558	325.0	120.234	0.38547	1.0419
185.0	65.0533	0.40385	1.1485				
190.0	67.0705	0.40302	1.1417				
195.0	69.0836	0.40221	1.1353				
200.0	71.0927	0.40143	1.1293				
205.0	73.0979	0.40067	1.1237				
210.0	75.0994	0.39993	1.1183				



BREAKPOINTS 340 FORMAT

Calibration Report: 564123

Sensor Model: PT-103-AM-70L

Sensor Type: Platinum Resistor

Sales Order: 50282

Serial Number: P15334

Temperature Range: 70.0K to 325K

Name: PT-103-AM-70L

Serial number: P15334

Format: 3 ;Ohms/Kelvin

Limit: 325.0

Coefficient: 2 ;Positive

Point 1: 3.82000, 30.000

Point 2: 4.23481, 32.000

Point 3: 5.14601, 36.000

Point 4: 6.17000, 40.000

Point 5: 6.72621, 42.000

Point 6: 7.90899, 46.000

Point 7: 9.92364, 52.000

Point 8: 12.1800, 58.000

Point 9: 15.0154, 65.000

Point 10: 17.1510, 70.000

Point 11: 19.6873, 76.000

Point 12: 24.5904, 87.500

Point 13: 28.2211, 96.000

Point 14: 33.5267, 108.500

Point 15: 38.7837, 121.000

Point 16: 44.2019, 134.000

Point 17: 49.9849, 148.000

Point 18: 56.1288, 163.000

Point 19: 62.6310, 179.000

Point 20: 69.4896, 196.000

Point 21: 76.7019, 214.000

Point 22: 84.0658, 232.500

Point 23: 91.5813, 251.500

Point 24: 99.2478, 271.000

Point 25: 106.868, 290.500

Point 26: 114.443, 310.000

Point 27: 120.236, 325.000

Point 28: 131.616, 355.000

Point 29: 148.652, 400.000

Point 30: 165.457, 445.000

Point 31: 182.035, 490.000

Point 32: 198.386, 535.000

Point 33: 216.256, 585.000

Point 34: 232.106, 630.000

Point 35: 247.714, 675.000

Point 36: 261.391, 715.000

Point 37: 276.566, 760.000

Point 38: 289.830, 800.000

Note: Breakpoints outside of the calibration range were added from the standard curve. These extra points conform to reduced accuracy specifications and are added as a convenience to the customer.



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BREAKPOINTS 91C/93C/330 FORMAT

Calibration Report: 564123
Sensor Model: PT-103-AM-70L
Sensor Type: Platinum Resistor

Sales Order: 50282
Serial Number: P15334
Temperature Range: 70.0K to 325K

Interpolation Method: Straight Line
Limit: 325.0 (Kelvin)
Format: 3 (Ohms/Kelvin)
Number of Breakpoints: 29

No.	Units	Temperature (K)	No.	Units	Temperature (K)
1	3.82000e-02	30.0	16	0.929710	255.0
2	4.23481e-02	32.0	17	1.08631	295.0
3	5.14601e-02	36.0	18	1.20239	325.0
4	6.17000e-02	40.0	19	1.31616	355.0
5	6.72621e-02	42.0	20	1.48652	400.0
6	7.90899e-02	46.0	21	1.65457	445.0
7	9.92364e-02	52.0	22	1.82035	490.0
8	0.121800	58.0	23	1.98387	535.0
9	0.150154	65.0	24	2.16256	585.0
10	0.171350	70.0	25	2.32106	630.0
11	0.235230	85.0	26	2.47714	675.0
12	0.341690	110.0	27	2.61391	715.0
13	0.467030	140.0	28	2.76566	760.0
14	0.610240	175.0	29	2.89830	800.0
15	0.771160	215.0			

Note: Breakpoints outside of the calibration range were added from the standard curve. These extra points conform to reduced accuracy specifications and are added as a convenience to the customer.

