Certificate of Calibration
Report Number: 1363904

Sensor Model: RX-202A-AA-0.05B	Serial Number: U09912
Sensor Type: Ruthenium Oxide Resistor	Calibration Date: November 09, 2022
Sensor Excitation: see *Test Data* page of report	Calibration Due:
Temperature Range: 0.05 K to 40.0 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: Derick Gillette
Calibration Engineer/Technician

Approved by: Romerero Prince
Metrology

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DATA PLOT

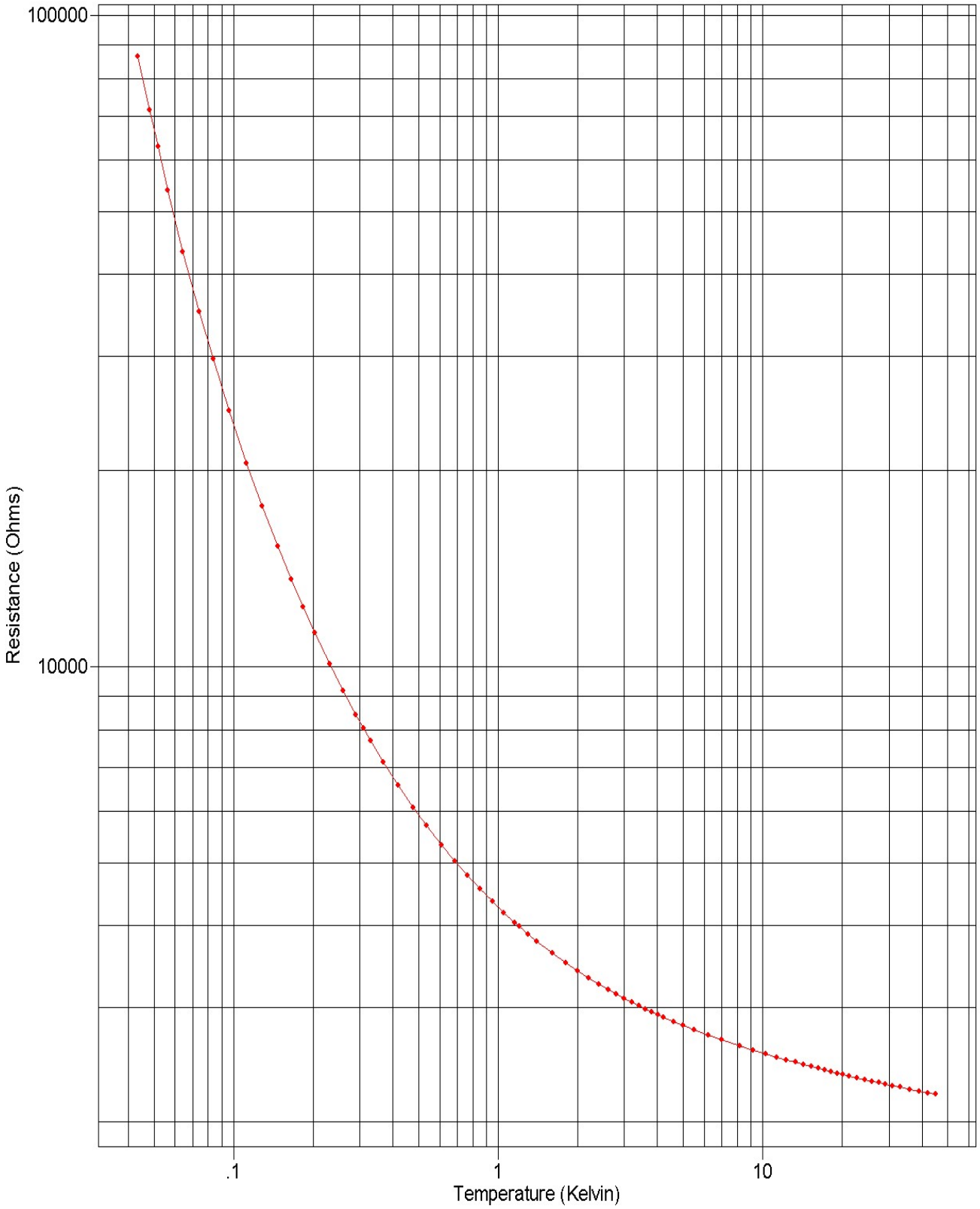
Calibration Report: 1363904

Sensor Model: RX-202A-AA-0.05B

Serial Number: U09912

Sensor Type: Ruthenium Oxide Resistor

Temperature Range: 0.05 K to 40.0 K



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TEST DATA

Calibration Report: 1363904

Sensor Model: RX-202A-AA-0.05B

Serial Number: U09912

Sensor Type: Ruthenium Oxide Resistor

Temperature Range: 0.05 K to 40.0 K

Index	Temp. (K)	Resistance (Ω)	Excitation	Index	Temp. (K)	Resistance (Ω)	Excitation
1	4.34054e-2	86535.0	8.7µV	46	4.00270	2919.14	2mV±25%
2	4.79647e-2	71505.0	7.2µV	47	4.20593	2893.07	2mV±25%
3	5.18796e-2	62921.0	6.3µV	48	4.60301	2848.15	2mV±25%
4	5.64071e-2	53818.0	5.4µV	49	5.00723	2808.64	2mV±25%
5	6.39757e-2	43316.0	13.7µV	50	5.48647	2768.21	2mV±25%
6	7.37624e-2	35082.0	11.1µV	51	6.21015	2717.17	2mV±25%
7	8.37638e-2	29629.9	9.4µV	52	7.00267	2671.29	2mV±25%
8	9.60691e-2	24742.8	7.8µV	53	8.18399	2616.13	2mV±25%
9	0.111847	20545.5	6.5µV	54	9.22446	2576.68	2mV±25%
10	0.128038	17661.6	5.6µV	55	10.2634	2543.34	2mV±25%
11	0.146906	15283.8	15.3µV	56	11.2898	2514.80	2mV±25%
12	0.164424	13634.0	13.6µV	57	12.2984	2490.06	2mV±25%
13	0.183125	12338.3	12.3µV	58	13.2952	2468.21	2mV±25%
14	0.202397	11277.3	11.3µV	59	14.2790	2448.93	2mV±25%
15	0.230016	10099.3	10.1µV	60	15.2482	2431.57	2mV±25%
16	0.259956	9166.10	9.2µV	61	16.2137	2415.74	2mV±25%
17	0.289975	8437.50	8.4µV	62	17.1766	2401.30	2mV±25%
18	0.309927	8035.20	8.0µV	63	18.1394	2388.05	2mV±25%
19	0.329982	7687.50	7.7µV	64	19.1014	2375.66	2mV±25%
20	0.368525	7132.00	7.1µV	65	20.0706	2363.96	2mV±25%
21	0.419887	6568.90	6.6µV	66	21.1422	2351.95	2mV±25%
22	0.478363	6077.00	6.1µV	67	22.7258	2335.81	2mV±25%
23	0.534842	5708.81	18.0µV	68	24.3206	2321.04	2mV±25%
24	0.610130	5326.50	5.3µV	69	25.9135	2307.65	2mV±25%
25	0.684914	5031.69	15.9µV	70	27.5089	2295.20	2mV±25%
26	0.764947	4779.35	15.1µV	71	29.1166	2283.78	2mV±25%
27	0.855029	4551.77	14.4µV	72	30.9173	2271.94	2mV±25%
28	0.950457	4356.48	13.8µV	73	33.0171	2259.35	2mV±25%
29	1.04965	4189.67	13.2µV	74	36.0108	2243.25	2mV±25%
30	1.14994	4048.41	12.8µV	75	39.0166	2228.69	2mV±25%
31	1.19882	3990.52	2mV±25%	76	42.0061	2215.83	2mV±25%
32	1.29834	3882.20	2mV±25%	77	45.0085	2204.23	2mV±25%
33	1.39789	3787.75	2mV±25%				
34	1.59925	3630.06	2mV±25%				
35	1.80049	3505.90	2mV±25%				
36	1.99852	3406.90	2mV±25%				
37	2.19619	3323.96	2mV±25%				
38	2.39928	3251.73	2mV±25%				
39	2.59958	3190.53	2mV±25%				
40	2.79992	3137.22	2mV±25%				
41	3.00001	3090.22	2mV±25%				
42	3.19962	3048.66	2mV±25%				
43	3.39984	3011.19	2mV±25%				
44	3.60363	2977.19	2mV±25%				
45	3.80017	2947.20	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:

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

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: 1363904

Sensor Model: RX-202A-AA-0.05B | Serial Number: U09912

Sensor Type: Ruthenium Oxide Resistor | Temperature Range: 0.05 K to 40.0 K

Polynomial Type: Chebychev

Useful Range of Fit:

5.00e-2 K	to	0.855 K
6.662e+4 ohms	to	4552 ohms

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

ZL = 3.62217985851 ZU = 4.93719180002

Order	Coefficient	Std. Deviation of Coefficient	Ratio (Coeff./Std Dev.)
0	0.284645	8.8993E-05	3198.51
1	-0.376908	1.4211E-04	-2652.29
2	0.203785	1.3406E-04	1520.12
3	-0.099681	1.2497E-04	-797.66
4	0.046699	1.1511E-04	405.68
5	-0.021324	1.0790E-04	-197.62
6	0.009391	1.0978E-04	85.54
7	-0.004199	1.1556E-04	-36.34
8	0.001736	1.1957E-04	14.52
9	-0.000801	1.1519E-04	-6.95

Z = Log(Resistance)

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

Temp. (K) = ΣA_i* COS(i * ARCCOS(k)), where 0 <= i <= 9
and the A_i's are the coefficients in the table above.

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POLYNOMIAL EQUATION

Calibration Report: 1363904
Sensor Model: RX-202A-AA-0.05B
Serial Number: U09912
Sensor Type: Ruthenium Oxide Resistor
Temperature Range: 0.05 K to 40.0 K

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

	R Meas. (Ω)	T Meas. (K)	T Eq. (K)	T diff. (mK)
1	86535.00	0.04341	0.04334	0.06
2	71505.00	0.04796	0.04837	-0.40
3	62921.00	0.05188	0.05140	0.47
4	53818.00	0.05641	0.05627	0.14
5	43316.00	0.06398	0.06447	-0.50
6	35082.00	0.07376	0.07391	-0.15
7	29629.90	0.08376	0.08326	0.50
8	24742.80	0.09607	0.09580	0.27
9	20545.50	0.11185	0.11211	-0.26
10	17661.60	0.12804	0.12834	-0.30
11	15283.80	0.14691	0.14702	-0.11
12	13634.00	0.16442	0.16465	-0.23
13	12338.30	0.18312	0.18282	0.30
14	11277.30	0.20240	0.20196	0.43
15	10099.30	0.23002	0.22998	0.04
16	9166.100	0.25996	0.25974	0.22
17	8437.500	0.28998	0.28990	0.07
18	8035.200	0.30993	0.31015	-0.22
19	7687.500	0.32998	0.33030	-0.32
20	7132.000	0.36853	0.36910	-0.57
21	6568.900	0.41989	0.41986	0.03
22	6077.000	0.47836	0.47819	0.17
23	5708.810	0.53484	0.53448	0.36
24	5326.500	0.61013	0.60979	0.34
25	5031.690	0.68491	0.68467	0.24
26	4779.350	0.76495	0.76518	-0.24
27	4551.770	0.85503	0.85550	-0.47
28	4356.480	0.95046	0.95082	-0.36
29	4189.670	1.04965	1.04917	0.48

Order of Fit = 9 RMS error of fit = 0.32 mK
Largest absolute error = -0.57 mK at data point no. 20

POLYNOMIAL EQUATION

Calibration Report: 1363904
Sensor Model: RX-202A-AA-0.05B
Serial Number: U09912
Sensor Type: Ruthenium Oxide Resistor
Temperature Range: 0.05 K to 40.0 K

Polynomial Type: Chebychev
Useful Range of Fit:

0.856 K	to	6.21 K
4552 ohms	to	2717 ohms

Lower and Upper limits of Log(Resistance) used in computing Chebychev coefficients:
ZL = 3.4176599032 ZU = 3.70171390248

Order	Coefficient	Std. Deviation of Coefficient	Ratio (Coeff./Std Dev.)
0	2.799319	1.6186E-04	17295.12
1	-3.095991	2.6676E-04	-11605.82
2	1.390001	2.4376E-04	5702.31
3	-0.567915	2.0879E-04	-2719.97
4	0.216904	1.9658E-04	1103.40
5	-0.078102	1.8760E-04	-416.32
6	0.025811	1.9855E-04	130.00
7	-0.007655	1.9562E-04	-39.13
8	0.002320	1.9504E-04	11.90

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.

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POLYNOMIAL EQUATION

Calibration Report: 1363904
Sensor Model: RX-202A-AA-0.05B
Serial Number: U09912
Sensor Type: Ruthenium Oxide Resistor
Temperature Range: 0.05 K to 40.0 K

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

	R Meas. (Ω)	T Meas. (K)	T Eq. (K)	T diff. (mK)
25	5031.690	0.68467	0.68469	-0.02
26	4779.350	0.76518	0.76506	0.12
27	4551.770	0.85550	0.85575	-0.25
28	4356.480	0.95046	0.95029	0.17
29	4189.670	1.04965	1.04935	0.30
30	4048.410	1.14994	1.15100	-1.06
31	3990.520	1.19882	1.19839	0.42
32	3882.202	1.29834	1.29772	0.62
33	3787.752	1.39789	1.39764	0.25
34	3630.059	1.59925	1.59997	-0.72
35	3505.898	1.80049	1.80118	-0.69
36	3406.896	1.99852	1.99800	0.51
37	3323.965	2.19619	2.19565	0.54
38	3251.728	2.39928	2.39890	0.39
39	3190.529	2.59958	2.59934	0.24
40	3137.222	2.79992	2.79978	0.14
41	3090.223	3.00001	3.00048	-0.47
42	3048.663	3.19962	3.20018	-0.56
43	3011.187	3.39984	3.40121	-1.37
44	2977.192	3.60363	3.60352	0.11
45	2947.195	3.80017	3.80013	0.04
46	2919.140	4.00270	4.00149	1.22
47	2893.069	4.20593	4.20572	0.21
48	2848.149	4.60301	4.60249	0.52
49	2808.642	5.00723	5.00715	0.08
50	2768.207	5.48647	5.48708	-0.61
51	2717.167	6.21015	6.21066	-0.51
52	2671.294	7.00267	7.00224	0.43
53	2616.134	8.18399	8.18402	-0.03

Order of Fit = 8 RMS error of fit = 0.55 mK
Largest absolute error = -1.37 mK at data point no. 43

POLYNOMIAL EQUATION

Calibration Report: 1363904

Sensor Model: RX-202A-AA-0.05B | Serial Number: U09912

Sensor Type: Ruthenium Oxide Resistor | Temperature Range: 0.05 K to 40.0 K

Polynomial Type: Chebychev

Useful Range of Fit:

6.21 K	to	40.0 K
2717 ohms	to	2224 ohms

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

ZL = 3.34325787885 ZU = 3.44849633647

Order	Coefficient	Std. Deviation of Coefficient	Ratio (Coeff./Std Dev.)
0	18.197567	1.5321E-03	11877.81
1	-18.048711	2.4596E-03	-7337.94
2	6.283249	2.1934E-03	2864.57
3	-1.814820	2.0928E-03	-867.19
4	0.491227	1.9798E-03	248.12
5	-0.125663	1.9392E-03	-64.80
6	0.028249	1.9330E-03	14.61
7	-0.007741	1.8741E-03	-4.13
8	0.004136	1.8077E-03	2.29

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.

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POLYNOMIAL EQUATION

Calibration Report: 1363904
Sensor Model: RX-202A-AA-0.05B
Serial Number: U09912
Sensor Type: Ruthenium Oxide Resistor
Temperature Range: 0.05 K to 40.0 K

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

	R Meas. (Ω)	T Meas. (K)	T Eq. (K)	T diff. (mK)
49	2808.642	5.00715	5.00749	-0.35
50	2768.207	5.48708	5.48581	1.27
51	2717.167	6.21066	6.21245	-1.78
52	2671.294	7.00267	7.00232	0.35
53	2616.134	8.18399	8.18283	1.16
54	2576.683	9.22446	9.22468	-0.22
55	2543.336	10.26341	10.26343	-0.01
56	2514.796	11.28979	11.28926	0.53
57	2490.061	12.29838	12.29844	-0.06
58	2468.207	13.29518	13.29822	-3.05
59	2448.926	14.27901	14.27760	1.41
60	2431.566	15.24820	15.24851	-0.31
61	2415.737	16.21369	16.21710	-3.41
62	2401.301	17.17658	17.17807	-1.49
63	2388.048	18.13939	18.13281	6.57
64	2375.659	19.10138	19.09469	6.70
65	2363.962	20.07058	20.07050	0.08
66	2351.952	21.14224	21.14727	-5.03
67	2335.810	22.72583	22.72733	-1.50
68	2321.044	24.32055	24.32238	-1.82
69	2307.652	25.91352	25.90848	5.04
70	2295.198	27.50888	27.51706	-8.18
71	2283.782	29.11660	29.11780	-1.19
72	2271.937	30.91733	30.92033	-3.00
73	2259.348	33.01707	33.01329	3.78
74	2243.253	36.01077	35.99227	18.49
75	2228.688	39.01658	39.02678	-10.20
76	2215.830	42.00605	42.01701	-10.96
77	2204.235	45.00854	45.00136	7.18

Order of Fit = 8 RMS error of fit = 5.53 mK
Largest absolute error = 18.49 mK at data point no. 74

INTERPOLATION TABLE

Calibration Report: 1363904

Sensor Model: RX-202A-AA-0.05B

Serial Number: U09912

Sensor Type: Ruthenium Oxide Resistor

Temperature Range: 0.05 K to 40.0 K

Temp (K)	Res. (Ω)	dR/dT (Ω/K)	dlogR/dlogT	Temp (K)	Res. (Ω)	dR/dT (Ω/K)	dlogR/dlogT
5.000e-2	66616.0	-2.8215e+6	-2.1178	1.300	3879.90	-1009.1	-0.33810
5.500e-2	55821.1	-1.6491e+6	-1.6248	1.400	3785.67	-880.24	-0.32553
6.000e-2	48564.6	-1.2922e+6	-1.5965	1.500	3703.06	-775.12	-0.31398
6.500e-2	42763.9	-1.0386e+6	-1.5786	1.600	3630.04	-688.19	-0.30333
7.000e-2	38093.3	-8.3677e+5	-1.5376	1.700	3564.95	-615.62	-0.29357
7.500e-2	34333.8	-6.7278e+5	-1.4696	1.800	3506.55	-554.06	-0.28441
8.000e-2	31301.4	-5.4621e+5	-1.3960	1.900	3453.83	-501.61	-0.27594
8.500e-2	28819.3	-4.5113e+5	-1.3306	2.000	3405.98	-456.55	-0.26809
9.000e-2	26752.3	-3.7896e+5	-1.2749	2.100	3362.32	-417.62	-0.26083
9.500e-2	25000.5	-3.2435e+5	-1.2325	2.200	3322.29	-383.72	-0.25410
0.1000	23487.7	-2.8224e+5	-1.2016	2.300	3285.43	-354.03	-0.24785
0.1100	20998.3	-2.1987e+5	-1.1518	2.400	3251.37	-327.87	-0.24202
0.1200	19023.5	-1.7729e+5	-1.1184	2.500	3219.76	-304.70	-0.23659
0.1300	17416.3	-1.4569e+5	-1.0875	2.600	3190.34	-284.05	-0.23149
0.1400	16085.7	-1.2142e+5	-1.0567	2.700	3162.88	-265.57	-0.22671
0.1500	14970.5	-1.0238e+5	-1.0258	2.800	3137.17	-248.95	-0.22220
0.1600	14025.5	-87192	-0.99467	2.900	3113.03	-233.95	-0.21794
0.1700	13216.8	-74978	-0.96440	3.000	3090.33	-220.34	-0.21390
0.1800	12518.3	-65048	-0.93532	3.100	3068.92	-207.97	-0.21008
0.1900	11909.7	-56942	-0.90842	3.200	3048.70	-196.68	-0.20644
0.2000	11374.8	-50250	-0.88353	3.300	3029.55	-186.34	-0.20298
0.2100	10900.9	-44691	-0.86095	3.400	3011.40	-176.85	-0.19968
0.2200	10478.1	-39995	-0.83974	3.500	2994.16	-168.12	-0.19652
0.2300	10098.5	-36042	-0.82087	3.600	2977.75	-160.06	-0.19351
0.2400	9755.36	-32671	-0.80377	3.700	2962.13	-152.61	-0.19063
0.2500	9443.60	-29751	-0.78761	3.800	2947.21	-145.71	-0.18787
0.2600	9159.00	-27231	-0.77302	3.900	2932.97	-139.30	-0.18523
0.2700	8897.91	-25031	-0.75954	4.000	2919.34	-133.34	-0.18269
0.2800	8657.53	-23086	-0.74665	4.200	2893.77	-122.60	-0.17795
0.2900	8435.42	-21372	-0.73474	4.400	2870.21	-113.21	-0.17355
0.3000	8229.45	-19849	-0.72359	4.600	2848.41	-104.94	-0.16948
0.3200	7859.30	-17259	-0.70272	4.800	2828.16	-97.655	-0.16574
0.3400	7535.86	-15154	-0.68372	5.000	2809.29	-91.195	-0.16231
0.3600	7250.77	-13408	-0.66572	5.200	2791.64	-85.414	-0.15910
0.3800	6997.55	-11955	-0.64924	5.400	2775.09	-80.151	-0.15596
0.4000	6771.13	-10719	-0.63321	5.600	2759.55	-75.386	-0.15298
0.4200	6567.56	-9667.2	-0.61823	5.800	2744.91	-71.103	-0.15024
0.4400	6383.46	-8763.1	-0.60402	6.000	2731.07	-67.286	-0.14782
0.4600	6216.26	-7975.3	-0.59017	6.500	2699.46	-59.456	-0.14316
0.4800	6063.76	-7292.0	-0.57722	7.000	2671.42	-52.921	-0.13867
0.5000	5924.03	-6693.1	-0.56491	7.500	2646.37	-47.423	-0.13440
0.5500	5621.12	-5485.4	-0.53672	8.000	2623.84	-42.864	-0.13069
0.6000	5370.59	-4578.2	-0.51148	8.500	2603.36	-39.133	-0.12777
0.6500	5159.64	-3888.6	-0.48988	9.000	2584.62	-35.947	-0.12517
0.7000	4979.16	-3352.6	-0.47133	9.500	2567.34	-33.238	-0.12299
0.7500	4822.76	-2917.5	-0.45370	10.00	2551.32	-30.876	-0.12102
0.8000	4686.07	-2564.5	-0.43780	10.50	2536.41	-28.821	-0.11931
0.8500	4564.90	-2295.5	-0.42744	11.00	2522.46	-26.993	-0.11771
0.9000	4455.62	-2077.5	-0.41963	11.50	2509.38	-25.366	-0.11625
0.9500	4357.02	-1867.7	-0.40723	12.00	2497.07	-23.898	-0.11485
1.000	4268.51	-1678.2	-0.39315	12.50	2485.46	-22.573	-0.11353
1.050	4188.68	-1520.4	-0.38112	13.00	2474.48	-21.366	-0.11225
1.100	4116.07	-1387.0	-0.37066	13.50	2464.07	-20.266	-0.11103
1.150	4049.68	-1271.7	-0.36114	14.00	2454.20	-19.255	-0.10984
1.200	3988.63	-1172.5	-0.35276	14.50	2444.81	-18.328	-0.10870

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INTERPOLATION TABLE

Calibration Report: 1363904

Sensor Model: RX-202A-AA-0.05B

Serial Number: U09912

Sensor Type: Ruthenium Oxide Resistor

Temperature Range: 0.05 K to 40.0 K

Temp (K)	Res. (Ω)	dR/dT (Ω/K)	dlogR/dlogT	Temp (K)	Res. (Ω)	dR/dT (Ω/K)	dlogR/dlogT
15.00	2435.86	-17.472	-0.10759	30.00	2277.86	-6.5734	-8.6574e-2
15.50	2427.32	-16.682	-0.10653	31.00	2271.44	-6.2770	-8.5667e-2
16.00	2419.17	-15.950	-0.10549	32.00	2265.30	-6.0025	-8.4792e-2
16.50	2411.36	-15.271	-0.10449	33.00	2259.42	-5.7478	-8.3949e-2
17.00	2403.89	-14.638	-0.10352	34.00	2253.80	-5.5108	-8.3133e-2
17.50	2396.72	-14.050	-0.10259	35.00	2248.40	-5.2891	-8.2333e-2
18.00	2389.83	-13.501	-0.10169	36.00	2243.21	-5.0825	-8.1566e-2
18.50	2383.21	-12.987	-0.10082	37.00	2238.23	-4.8893	-8.0824e-2
19.00	2376.84	-12.506	-9.9972e-2	38.00	2233.43	-4.7076	-8.0096e-2
19.50	2370.70	-12.055	-9.9159e-2	39.00	2228.81	-4.5373	-7.9395e-2
20.00	2364.78	-11.631	-9.8370e-2	40.00	2224.35	-4.3772	-7.8713e-2
21.00	2353.54	-10.857	-9.6872e-2				
22.00	2343.04	-10.167	-9.5466e-2				
23.00	2333.18	-9.5504	-9.4145e-2				
24.00	2323.92	-8.9948	-9.2893e-2				
25.00	2315.18	-8.4933	-9.1713e-2				
26.00	2306.91	-8.0378	-9.0590e-2				
27.00	2299.09	-7.6226	-8.9518e-2				
28.00	2291.66	-7.2430	-8.8497e-2				
29.00	2284.59	-6.8944	-8.7515e-2				

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THERMAL CYCLE TESTING

Calibration Report: 1363904
Sensor Model: RX-202A-AA-0.05B Serial Number: U09912
Sensor Type: Ruthenium Oxide 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:	2009 Ω
Liquid Nitrogen:	2125 Ω
Liquid Helium:	2892 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: 1363904

Sensor Model: RX-202A-AA-0.05B

Serial Number: U09912

Sensor Type: Ruthenium Oxide Resistor

Temperature Range: 0.05 K to 40.0 K

Sensor Model: RX-202A-AA-0.05B
Serial Number: U09912
Data Format: 7 (Ohms/Kelvin)
Setpoint Limit: 40

Measurement (ohms)	Temp (K)	Curvature	Measurement (ohms)	Temp (K)	Curvature
2.20423E+03	4.50014E+01	2.28709E-03	6.07700E+03	4.78191E-01	8.03124E-08
2.21583E+03	4.20170E+01	2.04015E-03	6.56890E+03	4.19862E-01	5.27562E-08
2.22869E+03	3.90268E+01	1.76631E-03	7.13200E+03	3.69096E-01	3.50476E-08
2.24325E+03	3.59923E+01	1.51794E-03	7.68750E+03	3.30299E-01	2.47594E-08
2.25935E+03	3.30133E+01	1.29180E-03	8.03520E+03	3.10147E-01	2.04307E-08
2.27194E+03	3.09203E+01	1.14575E-03	8.43750E+03	2.89903E-01	1.63481E-08
2.28378E+03	2.91178E+01	1.02612E-03	9.16610E+03	2.59739E-01	1.14358E-08
2.29520E+03	2.75171E+01	9.25793E-04	1.00993E+04	2.29978E-01	7.63594E-09
2.30765E+03	2.59085E+01	8.30079E-04	1.12773E+04	2.01964E-01	4.87698E-09
2.32104E+03	2.43224E+01	7.40861E-04	1.23383E+04	1.82822E-01	3.39956E-09
2.33581E+03	2.27273E+01	6.55852E-04	1.36340E+04	1.64653E-01	2.25045E-09
2.35195E+03	2.11473E+01	5.76580E-04	1.52838E+04	1.47015E-01	1.41216E-09
2.36396E+03	2.00705E+01	5.25252E-04	1.76616E+04	1.28343E-01	8.14537E-10
2.37566E+03	1.90947E+01	4.79963E-04	2.05455E+04	1.12109E-01	4.90429E-10
2.38805E+03	1.81328E+01	4.36924E-04	2.47428E+04	9.58037E-02	2.79040E-10
2.40130E+03	1.71781E+01	3.95694E-04	2.96299E+04	8.32603E-02	1.59614E-10
2.41574E+03	1.62171E+01	3.55773E-04	3.50820E+04	7.39140E-02	8.25563E-11
2.43157E+03	1.52485E+01	3.17252E-04	4.33160E+04	6.44745E-02	3.36540E-11
2.44893E+03	1.42776E+01	2.80548E-04	5.38180E+04	5.62651E-02	2.35624E-11
2.46821E+03	1.32982E+01	2.45697E-04	6.29210E+04	5.14049E-02	2.29960E-11
2.49006E+03	1.22984E+01	2.12738E-04	7.15050E+04	4.83656E-02	5.95478E-12
2.51480E+03	1.12893E+01	1.82475E-04	8.65350E+04	4.33436E-02	-2.38833E-11
2.54334E+03	1.02634E+01	1.55147E-04			
2.57668E+03	9.22468E+00	1.30414E-04			
2.61613E+03	8.18283E+00	1.08593E-04			
2.67129E+03	7.00232E+00	7.89149E-05			
2.71717E+03	6.21066E+00	6.38019E-05			
2.76821E+03	5.48708E+00	4.89491E-05			
2.80864E+03	5.00715E+00	4.04072E-05			
2.84815E+03	4.60249E+00	3.34073E-05			
2.89307E+03	4.20572E+00	2.71969E-05			
2.91914E+03	4.00149E+00	2.42650E-05			
2.94720E+03	3.80013E+00	2.14540E-05			
2.97719E+03	3.60352E+00	1.88915E-05			
3.01119E+03	3.40121E+00	1.64237E-05			
3.04866E+03	3.20018E+00	1.41563E-05			
3.09022E+03	3.00048E+00	1.20848E-05			
3.13722E+03	2.79978E+00	1.01867E-05			
3.19053E+03	2.59934E+00	8.47320E-06			
3.25173E+03	2.39890E+00	6.93384E-06			
3.32396E+03	2.19565E+00	5.54546E-06			
3.40690E+03	1.99800E+00	4.35185E-06			
3.50590E+03	1.80118E+00	3.30955E-06			
3.63006E+03	1.59997E+00	2.39543E-06			
3.78775E+03	1.39764E+00	1.66935E-06			
3.88220E+03	1.29772E+00	1.39162E-06			
3.99052E+03	1.19839E+00	1.14083E-06			
4.04841E+03	1.15100E+00	1.03406E-06			
4.18967E+03	1.04935E+00	8.25195E-07			
4.35648E+03	9.50290E-01	6.00218E-07			
4.55177E+03	8.55498E-01	4.00957E-07			
4.77935E+03	7.65183E-01	3.29392E-07			
5.03169E+03	6.84673E-01	2.35101E-07			
5.32650E+03	6.09791E-01	1.69427E-07			
5.70881E+03	5.34483E-01	1.13400E-07			

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BREAKPOINTS 340 FORMAT

Calibration Report: 1363904

Sensor Model: RX-202A-AA-0.05B

Serial Number: U09912

Sensor Type: Ruthenium Oxide Resistor

Temperature Range: 0.05 K to 40.0 K

Name: RX-202A-AA-0.05B
Serial Number: U09912
Format: 4 ;Log Ohms/Kelvin
Limit: 40.0
Coefficient: 1 ;Negative

Point 1: 3.34720, 40.000	Point 51: 3.44531, 5.240	Point 101: 3.81107, 0.430
Point 2: 3.34843, 38.600	Point 52: 3.44914, 4.960	Point 102: 3.82254, 0.412
Point 3: 3.34962, 37.300	Point 53: 3.45331, 4.680	Point 103: 3.83477, 0.394
Point 4: 3.35087, 36.000	Point 54: 3.45754, 4.420	Point 104: 3.84787, 0.376
Point 5: 3.35218, 34.700	Point 55: 3.46217, 4.160	Point 105: 3.86192, 0.358
Point 6: 3.35345, 33.500	Point 56: 3.46627, 3.950	Point 106: 3.87533, 0.342
Point 7: 3.35478, 32.300	Point 57: 3.46982, 3.780	Point 107: 3.88966, 0.326
Point 8: 3.35618, 31.100	Point 58: 3.47363, 3.610	Point 108: 3.90506, 0.310
Point 9: 3.35765, 29.900	Point 59: 3.47773, 3.440	Point 109: 3.92166, 0.294
Point 10: 3.35920, 28.700	Point 60: 3.48189, 3.280	Point 110: 3.93845, 0.279
Point 11: 3.36070, 27.600	Point 61: 3.48637, 3.120	Point 111: 3.95662, 0.264
Point 12: 3.36228, 26.500	Point 62: 3.49091, 2.970	Point 112: 3.97503, 0.250
Point 13: 3.36395, 25.400	Point 63: 3.49582, 2.820	Point 113: 3.99499, 0.236
Point 14: 3.36571, 24.300	Point 64: 3.50115, 2.670	Point 114: 4.01683, 0.222
Point 15: 3.36741, 23.300	Point 65: 3.50657, 2.530	Point 115: 4.03909, 0.209
Point 16: 3.36921, 22.300	Point 66: 3.51246, 2.390	Point 116: 4.06354, 0.196
Point 17: 3.37112, 21.300	Point 67: 3.51845, 2.260	Point 117: 4.08849, 0.184
Point 18: 3.37315, 20.300	Point 68: 3.52499, 2.130	Point 118: 4.11601, 0.172
Point 19: 3.37465, 19.600	Point 69: 3.53219, 2.000	Point 119: 4.14665, 0.160
Point 20: 3.37600, 19.000	Point 70: 3.53952, 1.880	Point 120: 4.17798, 0.149
Point 21: 3.37740, 18.400	Point 71: 3.54761, 1.760	Point 121: 4.21275, 0.138
Point 22: 3.37873, 17.850	Point 72: 3.55660, 1.640	Point 122: 4.25168, 0.127
Point 23: 3.38013, 17.300	Point 73: 3.56580, 1.530	Point 123: 4.29132, 0.117
Point 24: 3.38158, 16.750	Point 74: 3.57605, 1.420	Point 124: 4.33565, 0.107
Point 25: 3.38309, 16.200	Point 75: 3.58759, 1.310	Point 125: 4.38631, 0.097
Point 26: 3.38468, 15.650	Point 76: 3.59945, 1.210	Point 126: 4.43612, 0.089
Point 27: 3.38634, 15.100	Point 77: 3.60148, 1.195	Point 127: 4.48743, 0.081
Point 28: 3.38792, 14.600	Point 78: 3.60604, 1.160	Point 128: 4.54360, 0.074
Point 29: 3.38956, 14.100	Point 79: 3.61158, 1.120	Point 129: 4.61452, 0.067
Point 30: 3.39129, 13.600	Point 80: 3.61743, 1.080	Point 130: 4.70285, 0.059
Point 31: 3.39310, 13.100	Point 81: 3.62364, 1.040	Point 131: 4.77287, 0.053
Point 32: 3.39501, 12.600	Point 82: 3.63024, 1.000	Point 132: 4.82283, 0.050
Point 33: 3.39701, 12.100	Point 83: 3.63641, 0.965	
Point 34: 3.39891, 11.650	Point 84: 3.64295, 0.930	
Point 35: 3.40090, 11.200	Point 85: 3.65091, 0.890	
Point 36: 3.40300, 10.750	Point 86: 3.65940, 0.850	
Point 37: 3.40521, 10.300	Point 87: 3.66726, 0.815	
Point 38: 3.40755, 9.850	Point 88: 3.67561, 0.780	
Point 39: 3.40976, 9.450	Point 89: 3.68457, 0.745	
Point 40: 3.41208, 9.050	Point 90: 3.69421, 0.710	
Point 41: 3.41456, 8.650	Point 91: 3.70461, 0.675	
Point 42: 3.41719, 8.250	Point 92: 3.71422, 0.645	
Point 43: 3.41964, 7.900	Point 93: 3.72452, 0.615	
Point 44: 3.42225, 7.550	Point 94: 3.73562, 0.585	
Point 45: 3.42504, 7.200	Point 95: 3.74765, 0.555	
Point 46: 3.42804, 6.850	Point 96: 3.76072, 0.525	
Point 47: 3.43126, 6.500	Point 97: 3.77016, 0.505	
Point 48: 3.43474, 6.150	Point 98: 3.77959, 0.486	
Point 49: 3.43828, 5.820	Point 99: 3.79017, 0.466	
Point 50: 3.44178, 5.520	Point 100: 3.80031, 0.448	

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BREAKPOINTS 234 FORMAT

Calibration Report: 1363904

Sensor Model: RX-202A-AA-0.05B

Serial Number: U09912

Sensor Type: Ruthenium Oxide Resistor

Temperature Range: 0.05 K to 40.0 K

Maximum Temperature Error:	
1.4 - 10 K:	0.181 K
10 - 20 K:	1.286 K
20 - 40 K:	1.629 K
40 - 100 K:	-
> 100 K:	-

BP #	Temp. (K)	Res. (W)	Log10 Res.	BP #	Temp. (K)	Res. (W)	Log10 Res.
1	28.109	2290.868	3.360	16	0.261	9120.108	3.960
2	11.402	2511.886	3.400	17	0.233	10000.00	4.000
3	5.671	2754.229	3.440	18	0.179	12589.25	4.100
4	3.352	3019.952	3.480	19	0.142	15848.93	4.200
5	2.229	3311.311	3.520	20	0.115	19952.62	4.300
6	1.599	3630.781	3.560	21	0.095	25118.86	4.400
7	1.206	3981.072	3.600	22	0.079	31622.78	4.500
8	0.946	4365.158	3.640	23	0.068	39810.72	4.600
9	0.763	4786.301	3.680	24	0.059	50118.72	4.700
10	0.628	5248.075	3.720	25	0.051	63095.73	4.800
11	0.527	5754.399	3.760	26	0.046	79432.82	4.900
12	0.449	6309.573	3.800				
13	0.387	6918.310	3.840				
14	0.337	7585.776	3.880				
15	0.296	8317.638	3.920				

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