CALIBRATION CERTIFICATE
Report Number: 940802

Sensor Model: DT-670-CU-1.4L	Serial Number: D6068043
Sensor Type: Silicon Diode	Sales Order: 113657
Sensor Excitation: see *Test Data* page of report	Date: January 10, 2017
Temperature Range: 1.40 K to 325 K	Due: January 10, 2018

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 9001:2008.

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: John Krause
Metrology

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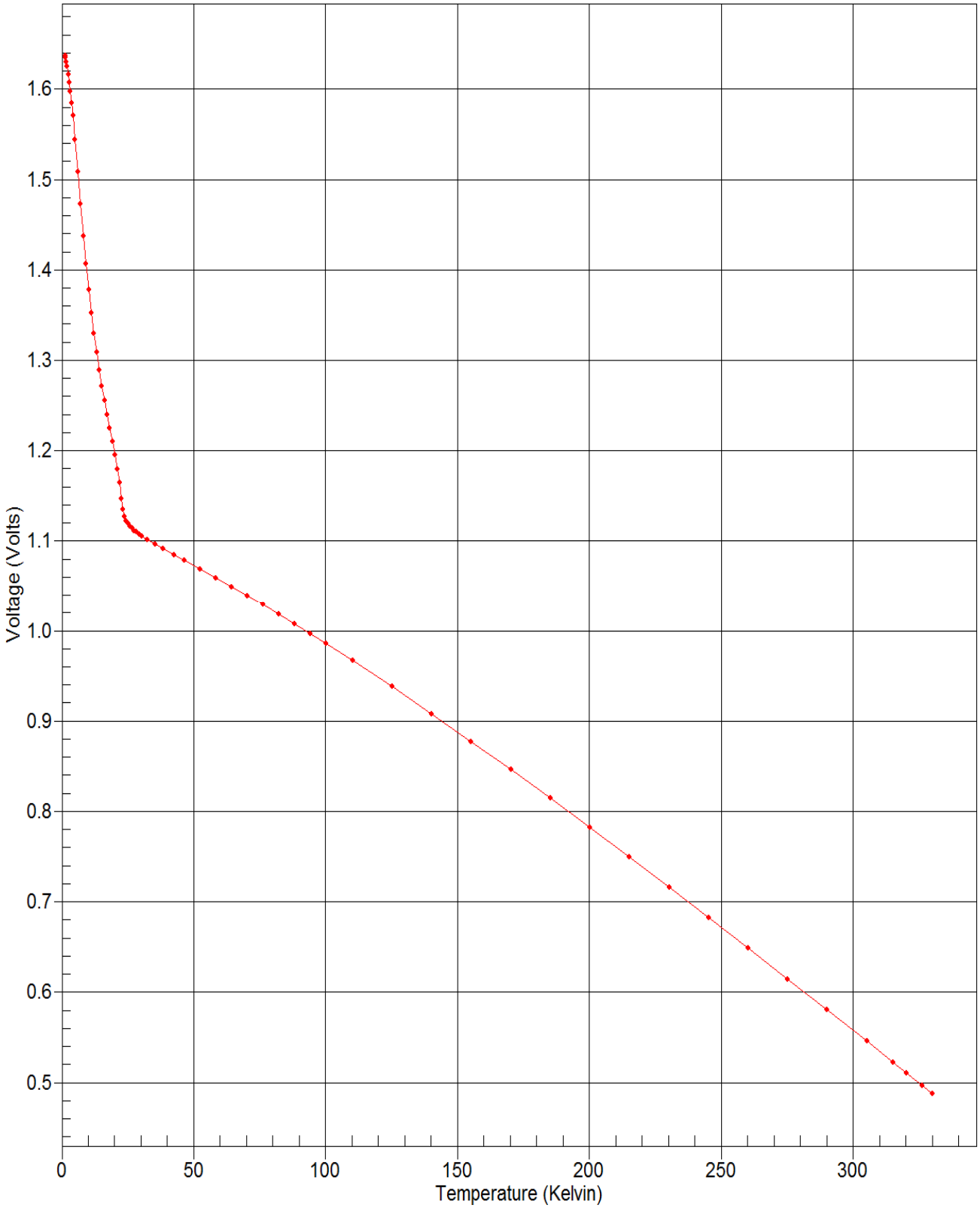
DATA PLOT

Calibration Report: 940802
Sensor Model: DT-670-CU-1.4L
Sensor Type: Silicon Diode

Sales Order: 113657
Serial Number: D6068043
Temperature Range: 1.40 K to 325 K



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TEST DATA

Calibration Report: 940802 Sales Order: 113657

Sensor Model: DT-670-CU-1.4L Serial Number: D6068043

Sensor Type: Silicon Diode Temperature Range: 1.40 K to 325 K

Index	Temp. (K)	Voltage (V)	Excitation	Index	Temp. (K)	Voltage (V)	Excitation
1	1.20068	1.63725	10μA±0.1%	41	35.3753	1.09643	10μA±0.1%
2	1.29985	1.63616	10μA±0.1%	42	38.3845	1.09146	10μA±0.1%
3	1.40183	1.63489	10μA±0.1%	43	42.4059	1.08501	10μA±0.1%
4	1.69955	1.63045	10μA±0.1%	44	46.3981	1.07866	10μA±0.1%
5	1.99908	1.62504	10μA±0.1%	45	52.3861	1.06905	10μA±0.1%
6	2.39925	1.61663	10μA±0.1%	46	58.3641	1.05932	10μA±0.1%
7	2.80058	1.60735	10μA±0.1%	47	64.3448	1.04943	10μA±0.1%
8	3.20037	1.59770	10μA±0.1%	48	70.3330	1.03934	10μA±0.1%
9	3.70391	1.58478	10μA±0.1%	49	76.3158	1.02907	10μA±0.1%
10	4.20812	1.57032	10μA±0.1%	50	82.3092	1.01858	10μA±0.1%
11	5.01006	1.54426	10μA±0.1%	51	88.2945	1.00790	10μA±0.1%
12	6.03333	1.50858	10μA±0.1%	52	94.2824	0.997030	10μA±0.1%
13	7.05980	1.47244	10μA±0.1%	53	100.276	0.985959	10μA±0.1%
14	8.10305	1.43748	10μA±0.1%	54	110.258	0.967136	10μA±0.1%
15	9.12524	1.40634	10μA±0.1%	55	125.251	0.938040	10μA±0.1%
16	10.1611	1.37796	10μA±0.1%	56	140.243	0.908087	10μA±0.1%
17	11.1934	1.35240	10μA±0.1%	57	155.221	0.877429	10μA±0.1%
18	12.2166	1.32931	10μA±0.1%	58	170.211	0.846129	10μA±0.1%
19	13.2288	1.30837	10μA±0.1%	59	185.208	0.814270	10μA±0.1%
20	14.2331	1.28925	10μA±0.1%	60	200.195	0.781956	10μA±0.1%
21	15.2232	1.27173	10μA±0.1%	61	215.185	0.749210	10μA±0.1%
22	16.2082	1.25535	10μA±0.1%	62	230.183	0.716061	10μA±0.1%
23	17.1833	1.23987	10μA±0.1%	63	245.173	0.682569	10μA±0.1%
24	18.1565	1.22490	10μA±0.1%	64	260.172	0.648731	10μA±0.1%
25	19.1262	1.21016	10μA±0.1%	65	275.171	0.614593	10μA±0.1%
26	20.0993	1.19517	10μA±0.1%	66	290.161	0.580199	10μA±0.1%
27	21.0695	1.17930	10μA±0.1%	67	305.158	0.545545	10μA±0.1%
28	21.8533	1.16459	10μA±0.1%	68	315.152	0.522336	10μA±0.1%
29	22.6459	1.14704	10μA±0.1%	69	320.154	0.510691	10μA±0.1%
30	23.2462	1.13497	10μA±0.1%	70	326.141	0.496722	10μA±0.1%
31	23.8580	1.12675	10μA±0.1%	71	330.154	0.487349	10μA±0.1%
32	24.4797	1.12187	10μA±0.1%				
33	25.1104	1.11868	10μA±0.1%				
34	25.7401	1.11630	10μA±0.1%				
35	26.5748	1.11378	10μA±0.1%				
36	27.4135	1.11163	10μA±0.1%				
37	28.2371	1.10974	10μA±0.1%				
38	29.2633	1.10757	10μA±0.1%				
39	30.2903	1.10554	10μA±0.1%				
40	32.3315	1.10174	10μA±0.1%				

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Calibration Report: 940802 Sales Order: 113657
Sensor Model: DT-670-CU-1.4L Serial Number: D6068043
Sensor Type: Silicon Diode Temperature Range: 1.40 K to 325 K

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: 940802 | Sales Order: 113657
Sensor Model: DT-670-CU-1.4L | Serial Number: D6068043
Sensor Type: Silicon Diode | Temperature Range: 1.40 K to 325 K

Polynomial Type: Chebychev
Useful Range of Fit:

1.40 K	to	12.2 K
1.635 volts	to	1.329 volts

Lower and Upper limits of Voltage used in computing Chebychev coefficients:
ZL = 1.289251987 ZU = 1.637251892

Order	Coefficient	Std. Deviation of Coefficient	Ratio (Coeff./Std Dev.)
0	7.612338	2.6242E-03	2900.79
1	-6.095342	3.8347E-03	-1589.52
2	0.221498	3.9013E-03	56.77
3	-0.366965	3.6353E-03	-100.94
4	-0.075888	3.4582E-03	-21.94
5	-0.029530	3.3796E-03	-8.74
6	-0.013395	3.3382E-03	-4.01
7	-0.009489	3.3474E-03	-2.83
8	-0.008657	3.4600E-03	-2.50
9	-0.008645	3.6632E-03	-2.36
10	-0.013279	3.6618E-03	-3.63

Z = Voltage

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

Temp. (K) = ΣA_i* COS(i * ARCCOS(k)), where 0 <= i <= 10
and the A_i's are the coefficients in the table above.

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POLYNOMIAL EQUATION

Calibration Report: 940802 Sales Order: 113657
Sensor Model: DT-670-CU-1.4L Serial Number: D6068043
Sensor Type: Silicon Diode Temperature Range: 1.40 K to 325 K

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

	V Meas. (V)	T Meas. (K)	T Eq. (K)	T diff. (mK)
1	1.637252	1.20068	1.21265	-11.97
2	1.636156	1.29985	1.29870	1.14
3	1.634889	1.40183	1.39337	8.46
4	1.630454	1.69955	1.69030	9.25
5	1.625044	1.99908	1.99858	0.50
6	1.616630	2.39925	2.40740	-8.15
7	1.607348	2.80058	2.80790	-7.32
8	1.597697	3.20037	3.19820	2.17
9	1.584782	3.70391	3.69317	10.74
10	1.570323	4.20812	4.20716	0.95
11	1.544259	5.01006	5.02214	-12.08
12	1.508579	6.03333	6.02362	9.71
13	1.472440	7.05980	7.06199	-2.19
14	1.437482	8.10305	8.10868	-5.64
15	1.406339	9.12524	9.11816	7.07
16	1.377963	10.16111	10.16178	-0.67
17	1.352404	11.19339	11.19946	-6.07
18	1.329312	12.21659	12.21008	6.51
19	1.308374	13.22884	13.23181	-2.96
20	1.289252	14.23312	14.23259	0.53

Order of Fit = 10 RMS error of fit = 6.92 mK
Largest absolute error = -12.08 mK at data point no. 11

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POLYNOMIAL EQUATION

Calibration Report: 940802 Sales Order: 113657
Sensor Model: DT-670-CU-1.4L Serial Number: D6068043
Sensor Type: Silicon Diode Temperature Range: 1.40 K to 325 K

Polynomial Type: Chebychev
Useful Range of Fit:

12.2 K	to	25.1 K
1.329 volts	to	1.119 volts

Lower and Upper limits of Voltage used in computing Chebychev coefficients:
ZL = 1.113775352 ZU = 1.377962894

Order	Coefficient	Std. Deviation of Coefficient	Ratio (Coeff./Std Dev.)
0	17.239054	9.2951E-03	1854.64
1	-7.717599	1.6926E-02	-455.96
2	0.508998	1.4231E-02	35.77
3	-0.048156	1.0978E-02	-4.39
4	0.230422	7.2688E-03	31.70
5	-0.289395	6.1357E-03	-47.17
6	0.234633	8.5617E-03	27.41
7	-0.122876	1.1947E-02	-10.29
8	0.106857	1.2969E-02	8.24
9	-0.024376	1.2459E-02	-1.96
10	0.043660	9.5482E-03	4.57

Z = Voltage

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

Temp. (K) = ΣA_i* COS(i * ARCCOS(k)), where 0 <= i <= 10
and the A_i's are the coefficients in the table above.

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POLYNOMIAL EQUATION

Calibration Report: 940802
Sensor Model: DT-670-CU-1.4L
Sensor Type: Silicon Diode

Sales Order: 113657
Serial Number: D6068043
Temperature Range: 1.40 K to 325 K

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

	V Meas. (V)	T Meas. (K)	T Eq. (K)	T diff. (mK)
16	1.377963	10.16178	10.16122	-0.11
17	1.352404	11.19946	11.19208	1.31
18	1.329312	12.21008	12.22267	-6.08
19	1.308374	13.22884	13.21596	12.89
20	1.289252	14.23312	14.24242	-9.31
21	1.271731	15.22318	15.23046	-7.28
22	1.255346	16.20819	16.19933	8.86
23	1.239866	17.18330	17.17411	9.20
24	1.224895	18.15645	18.16182	-5.37
25	1.210158	19.12624	19.13928	-13.04
26	1.195172	20.09929	20.09813	1.15
27	1.179305	21.06946	21.05102	18.43
28	1.164594	21.85327	21.85787	-4.60
29	1.147044	22.64589	22.67120	-25.31
30	1.134972	23.24617	23.22089	25.28
31	1.126748	23.85800	23.84465	13.35
32	1.121871	24.47970	24.49586	-16.17
33	1.118677	25.11039	25.12458	-14.18
34	1.116302	25.74013	25.73794	2.19
35	1.113775	26.57480	26.56603	8.77

Order of Fit = 10 RMS error of fit = 12.39 mK
Largest absolute error = -25.31 mK at data point no. 29

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POLYNOMIAL EQUATION

Calibration Report: 940802 Sales Order: 113657
Sensor Model: DT-670-CU-1.4L Serial Number: D6068043
Sensor Type: Silicon Diode Temperature Range: 1.40 K to 325 K

Polynomial Type: Chebychev
Useful Range of Fit:

25.1 K	to	88.3 K
1.119 volts	to	1.008 volts

Lower and Upper limits of Voltage used in computing Chebychev coefficients:

ZL = 0.9859585795 ZU = 1.126747869

Order	Coefficient	Std. Deviation of Coefficient	Ratio (Coeff./Std Dev.)
0	60.361692	7.3888E-03	8169.40
1	-39.958754	1.3180E-02	-3031.77
2	0.911711	1.2356E-02	73.79
3	1.444713	8.9269E-03	161.84
4	0.826147	6.3751E-03	129.59
5	0.326113	2.9039E-03	112.30
6	0.072017	3.3786E-03	21.32
7	-0.010958	6.3366E-03	-1.73
8	-0.052376	8.8903E-03	-5.89
9	-0.011028	9.6527E-03	-1.14
10	-0.033326	9.7810E-03	-3.41
11	0.000413	7.6605E-03	0.05
12	-0.019043	5.2914E-03	-3.60

Z = Voltage

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

Temp. (K) = ΣA_i* COS(i * ARCCOS(k)), where 0 <= i <= 12
and the A_i's are the coefficients in the table above.

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POLYNOMIAL EQUATION

Calibration Report: 940802
Sensor Model: DT-670-CU-1.4L
Sensor Type: Silicon Diode

Sales Order: 113657
Serial Number: D6068043
Temperature Range: 1.40 K to 325 K

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

	V Meas. (V)	T Meas. (K)	T Eq. (K)	T diff. (mK)
31	1.126748	23.84465	23.85732	0.68
32	1.121871	24.49586	24.48621	-6.51
33	1.118677	25.12458	25.09987	10.52
34	1.116302	25.74013	25.73617	3.97
35	1.113775	26.57480	26.58084	-6.05
36	1.111627	27.41346	27.42137	-7.91
37	1.109736	28.23711	28.24223	-5.12
38	1.107572	29.26327	29.26048	2.78
39	1.105539	30.29035	30.28182	8.53
40	1.101736	32.33149	32.32468	6.80
41	1.096431	35.37525	35.38189	-6.64
42	1.091455	38.38446	38.39198	-7.52
43	1.085013	42.40586	42.39976	6.10
44	1.078660	46.39805	46.39334	4.71
45	1.069047	52.38613	52.39346	-7.34
46	1.059323	58.36410	58.36154	2.56
47	1.049432	64.34481	64.34200	2.81
48	1.039343	70.33296	70.33754	-4.58
49	1.029068	76.31582	76.31254	3.28
50	1.018576	82.30923	82.31067	-1.44
51	1.007902	88.29446	88.29406	0.40
52	0.9970298	94.28241	94.28248	-0.07
53	0.9859586	100.27633	100.27632	0.00

Order of Fit = 12 RMS error of fit = 5.45 mK
Largest absolute error = 10.52 mK at data point no. 33

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POLYNOMIAL EQUATION

Calibration Report: 940802 | Sales Order: 113657
Sensor Model: DT-670-CU-1.4L | Serial Number: D6068043
Sensor Type: Silicon Diode | Temperature Range: 1.40 K to 325 K

Polynomial Type: Chebychev
Useful Range of Fit:

88.3 K	to	325 K
1.008 volts	to	0.4994 volts

Lower and Upper limits of Voltage used in computing Chebychev coefficients:
ZL = 0.4873488418 ZU = 1.029067901

Order	Coefficient	Std. Deviation of Coefficient	Ratio (Coeff./Std Dev.)
0	207.406033	1.6232E-04	1277737.02
1	-125.944226	2.3498E-04	-535981.46
2	-3.907099	2.2989E-04	-16995.70
3	-0.892581	2.3755E-04	-3757.51
4	-0.246232	2.3537E-04	-1046.14
5	-0.079879	2.2596E-04	-353.52
6	-0.018216	2.1833E-04	-83.43
7	-0.002968	2.1829E-04	-13.60

Z = Voltage

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: 940802
Sensor Model: DT-670-CU-1.4L
Sensor Type: Silicon Diode

Sales Order: 113657
Serial Number: D6068043
Temperature Range: 1.40 K to 325 K

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

	V Meas. (V)	T Meas. (K)	T Eq. (K)	T diff. (mK)
49	1.029068	76.31254	76.31483	0.99
50	1.018576	82.31067	82.31065	-1.42
51	1.007902	88.29406	88.29495	-0.49
52	0.9970298	94.28241	94.28190	0.51
53	0.9859586	100.27633	100.27608	0.25
54	0.9671360	110.25835	110.25774	0.62
55	0.9380401	125.25098	125.25112	-0.13
56	0.9080869	140.24279	140.24305	-0.26
57	0.8774292	155.22141	155.22200	-0.59
58	0.8461286	170.21075	170.21048	0.27
59	0.8142703	185.20804	185.20750	0.54
60	0.7819562	200.19543	200.19550	-0.07
61	0.7492105	215.18549	215.18584	-0.35
62	0.7160615	230.18329	230.18286	0.43
63	0.6825693	245.17338	245.17365	-0.27
64	0.6487311	260.17152	260.17223	-0.71
65	0.6145929	275.17138	275.17032	1.06
66	0.5801988	290.16079	290.16093	-0.15
67	0.5455447	305.15848	305.15891	-0.43
68	0.5223360	315.15184	315.15226	-0.42
69	0.5106911	320.15411	320.15297	1.14
70	0.4967222	326.14071	326.14139	-0.68
71	0.4873488	330.15430	330.15414	0.16

Order of Fit = 7 RMS error of fit = 0.62 mK
Largest absolute error = -1.42 mK at data point no. 50

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INTERPOLATION TABLE

Calibration Report: 940802 Sales Order: 113657

Sensor Model: DT-670-CU-1.4L Serial Number: D6068043

Sensor Type: Silicon Diode Temperature Range: 1.40 K to 325 K

Temp (K)	Volts (V)	dV/dT (mV/K)	Temp (K)	Volts (V)	dV/dT (mV/K)
1.400	1.63491	-13.072	15.50	1.26703	-16.828
1.500	1.63354	-14.324	16.00	1.25874	-16.372
1.600	1.63205	-15.492	16.50	1.25065	-15.995
1.700	1.63045	-16.576	17.00	1.24273	-15.683
1.800	1.62874	-17.595	17.50	1.23495	-15.437
1.900	1.62693	-18.567	18.00	1.22728	-15.271
2.000	1.62503	-19.490	18.50	1.21967	-15.188
2.100	1.62303	-20.342	19.00	1.21208	-15.198
2.200	1.62096	-21.097	19.50	1.20445	-15.323
2.300	1.61882	-21.756	20.00	1.19673	-15.618
2.400	1.61661	-22.319	21.00	1.18050	-17.105
2.500	1.61436	-22.793	22.00	1.16147	-21.670
2.600	1.61206	-23.183	23.00	1.13955	-19.883
2.700	1.60972	-23.490	24.00	1.12539	-8.9431
2.800	1.60736	-23.713	25.00	1.11916	-4.4904
2.900	1.60498	-23.907	26.00	1.11546	-3.1359
3.000	1.60258	-24.124	27.00	1.11265	-2.5510
3.100	1.60016	-24.364	28.00	1.11026	-2.2510
3.200	1.59771	-24.629	29.00	1.10811	-2.0676
3.300	1.59523	-24.943	30.00	1.10610	-1.9571
3.400	1.59272	-25.334	31.00	1.10419	-1.8807
3.500	1.59016	-25.801	32.00	1.10234	-1.8209
3.600	1.58755	-26.346	33.00	1.10054	-1.7747
3.700	1.58489	-26.966	34.00	1.09879	-1.7350
3.800	1.58216	-27.630	35.00	1.09707	-1.7013
3.900	1.57936	-28.297	36.00	1.09538	-1.6731
4.000	1.57650	-28.968	37.00	1.09372	-1.6494
4.200	1.57057	-30.320	38.00	1.09208	-1.6299
4.400	1.56438	-31.577	39.00	1.09046	-1.6146
4.600	1.55795	-32.610	40.00	1.08885	-1.6030
4.800	1.55135	-33.418	42.00	1.08566	-1.5909
5.000	1.54460	-34.001	44.00	1.08248	-1.5902
5.200	1.53776	-34.427	46.00	1.07929	-1.5940
5.400	1.53084	-34.776	48.00	1.07610	-1.6007
5.600	1.52385	-35.050	50.00	1.07289	-1.6074
5.800	1.51682	-35.248	52.00	1.06967	-1.6141
6.000	1.50976	-35.369	54.00	1.06644	-1.6211
6.500	1.49206	-35.326	56.00	1.06319	-1.6289
7.000	1.47452	-34.774	58.00	1.05992	-1.6376
7.500	1.45736	-33.772	60.00	1.05663	-1.6469
8.000	1.44080	-32.410	65.00	1.04834	-1.6723
8.500	1.42500	-30.817	70.00	1.03991	-1.6992
9.000	1.40998	-29.262	75.00	1.03134	-1.7267
9.500	1.39573	-27.776	77.35	1.02727	-1.7397
10.00	1.38218	-26.409	80.00	1.02264	-1.7543
10.50	1.36930	-25.159	85.00	1.01380	-1.7817
11.00	1.35701	-24.014	90.00	1.00483	-1.8089
11.50	1.34527	-22.966	95.00	0.995714	-1.8355
12.00	1.33403	-21.987	100.0	0.986473	-1.8607
12.50	1.32327	-21.070	105.0	0.977109	-1.8845
13.00	1.31295	-20.200	110.0	0.967629	-1.9075
13.50	1.30306	-19.381	115.0	0.958036	-1.9295
14.00	1.29356	-18.637	120.0	0.948336	-1.9503
14.50	1.28441	-17.969	125.0	0.938535	-1.9699
15.00	1.27558	-17.366	130.0	0.928638	-1.9885

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INTERPOLATION TABLE

Calibration Report: 940802 Sales Order: 113657

Sensor Model: DT-670-CU-1.4L Serial Number: D6068043

Sensor Type: Silicon Diode Temperature Range: 1.40 K to 325 K

Temp (K)	Volts (V)	dV/dT (mV/K)	Temp (K)	Volts (V)	dV/dT (mV/K)
135.0	0.918651	-2.0062	235.0	0.705337	-2.2302
140.0	0.908578	-2.0229	240.0	0.694167	-2.2379
145.0	0.898424	-2.0388	245.0	0.682959	-2.2454
150.0	0.888192	-2.0538	250.0	0.671714	-2.2526
155.0	0.877887	-2.0679	255.0	0.660434	-2.2594
160.0	0.867514	-2.0814	260.0	0.649120	-2.2660
165.0	0.857075	-2.0942	265.0	0.637774	-2.2725
170.0	0.846573	-2.1065	270.0	0.626395	-2.2789
175.0	0.836010	-2.1183	273.15	0.619210	-2.2829
180.0	0.825391	-2.1296	275.0	0.614985	-2.2853
185.0	0.814716	-2.1404	280.0	0.603542	-2.2916
190.0	0.803988	-2.1508	285.0	0.592070	-2.2974
195.0	0.793209	-2.1608	290.0	0.580569	-2.3028
200.0	0.782380	-2.1704	295.0	0.569042	-2.3079
205.0	0.771505	-2.1797	300.0	0.557490	-2.3130
210.0	0.760584	-2.1887	305.0	0.545912	-2.3180
215.0	0.749618	-2.1974	310.0	0.534310	-2.3225
220.0	0.738610	-2.2058	315.0	0.522689	-2.3258
225.0	0.727560	-2.2141	320.0	0.511050	-2.3303
230.0	0.716469	-2.2223	325.0	0.499386	-2.3348

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Calibration Report: 940802
Sales Order: 113657
Sensor Model: DT-670-CU-1.4L
Serial Number: D6068043
Sensor Type: Silicon Diode

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

Approximately 305 K:	0.546 V
Liquid Nitrogen:	1.027 V
Liquid Helium:	1.571 V

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 diode sensors calibrated by Lake Shore, the current is maintained at the constant values listed on the Test Data page. In order to minimize calibration offsets due to the nonlinear voltage-current relationship in the diode sensor, these same guidelines should be followed in using the sensor.

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BREAKPOINTS CUBIC SPLINE FORMAT

Calibration Report: 940802 Sales Order: 113657
Sensor Model: DT-670-CU-1.4L Serial Number: D6068043
Sensor Type: Silicon Diode Temperature Range: 1.40 K to 325 K

Sensor Model: DT-670-CU-1.4L
Serial Number: D6068043
Data Format: 6 (Volts/Kelvin)
Setpoint Limit: 325

Measurement (V)	Temp (K)	Curvature	Measurement (V)	Temp (K)	Curvature
4.87349E-01	3.30154E+02	2.78134E+01	1.37796E+00	1.01611E+01	1.44738E+02
4.96722E-01	3.26141E+02	-2.39181E+01	1.40634E+00	9.12524E+00	1.26170E+02
5.10691E-01	3.20154E+02	-1.01012E+02	1.43748E+00	8.10305E+00	9.51051E+01
5.22336E-01	3.15152E+02	-4.40262E+01	1.47244E+00	7.05980E+00	3.95542E+01
5.45545E-01	3.05158E+02	-7.96604E+01	1.50858E+00	6.03333E+00	-8.69263E+00
5.80199E-01	2.90161E+02	-8.48801E+01	1.54426E+00	5.01006E+00	-5.13772E+01
6.14593E-01	2.75171E+02	-1.07565E+02	1.57032E+00	4.20812E+00	-2.25725E+02
6.48731E-01	2.60172E+02	-1.10564E+02	1.58478E+00	3.70391E+00	-3.45102E+02
6.82569E-01	2.45173E+02	-1.29035E+02	1.59770E+00	3.20037E+00	-1.96396E+02
7.16061E-01	2.30183E+02	-1.46775E+02	1.60735E+00	2.80058E+00	-1.34406E+02
7.49210E-01	2.15185E+02	-1.60239E+02	1.61663E+00	2.39925E+00	-4.21421E+02
7.81956E-01	2.00195E+02	-1.84327E+02	1.62504E+00	1.99908E+00	-1.15783E+03
8.14270E-01	1.85208E+02	-2.14977E+02	1.63045E+00	1.69955E+00	-2.08417E+03
8.46129E-01	1.70211E+02	-2.55653E+02	1.63489E+00	1.40183E+00	-5.25893E+03
8.77429E-01	1.55221E+02	-3.08172E+02	1.63616E+00	1.29985E+00	-8.62661E+03
9.08087E-01	1.40243E+02	-3.90761E+02	1.63725E+00	1.20068E+00	-1.15390E+04
9.38040E-01	1.25251E+02	-4.92828E+02			
9.67136E-01	1.10258E+02	-6.44579E+02			
9.85959E-01	1.00276E+02	-7.49835E+02			
9.97030E-01	9.42824E+01	-8.57368E+02			
1.00790E+00	8.82945E+01	-9.29889E+02			
1.01858E+00	8.23092E+01	-9.92908E+02			
1.02907E+00	7.63158E+01	-1.06365E+03			
1.03934E+00	7.03330E+01	-1.11143E+03			
1.04943E+00	6.43448E+01	-1.13468E+03			
1.05932E+00	5.83641E+01	-1.05596E+03			
1.06905E+00	5.23861E+01	-7.90238E+02			
1.07866E+00	4.63981E+01	-8.39805E+02			
1.08501E+00	4.24059E+01	2.37581E+02			
1.09146E+00	3.83845E+01	3.74599E+03			
1.09643E+00	3.53753E+01	6.02089E+03			
1.10174E+00	3.23315E+01	8.13943E+03			
1.10554E+00	3.02903E+01	1.11032E+04			
1.10757E+00	2.92633E+01	1.43566E+04			
1.10974E+00	2.82371E+01	1.96732E+04			
1.11163E+00	2.74135E+01	2.18575E+04			
1.11378E+00	2.65748E+01	2.62819E+04			
1.11630E+00	2.57401E+01	2.69662E+04			
1.11868E+00	2.51104E+01	2.53887E+04			
1.12187E+00	2.44797E+01	1.85423E+04			
1.12675E+00	2.38580E+01	8.10294E+03			
1.13497E+00	2.32462E+01	1.92172E+03			
1.14704E+00	2.26459E+01	2.79524E+02			
1.16459E+00	2.18533E+01	-7.06423E+02			
1.17930E+00	2.10695E+01	-5.45350E+02			
1.19517E+00	2.00993E+01	-2.16167E+02			
1.21016E+00	1.91262E+01	-4.86271E+01			
1.22490E+00	1.81565E+01	5.86951E+01			
1.23987E+00	1.71833E+01	1.37669E+02			
1.25535E+00	1.62082E+01	1.80925E+02			
1.27173E+00	1.52232E+01	2.18995E+02			
1.28925E+00	1.42331E+01	2.18656E+02			
1.30837E+00	1.32288E+01	2.12862E+02			
1.32931E+00	1.22166E+01	1.82193E+02			
1.35240E+00	1.11934E+01	1.60607E+02			

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BREAKPOINTS 340 FORMAT

Calibration Report: 940802 Sales Order: 113657
Sensor Model: DT-670-CU-1.4L Serial Number: D6068043
Sensor Type: Silicon Diode Temperature Range: 1.40 K to 325 K

Name: DT-670-CU-1.4L
Serial Number: D6068043
Format: 2 ;Volts/Kelvin
Limit: 325.0
Coefficient: 1 ;Negative

Point 1: 9.06000e-02,500.000
Point 2: .110239,491.000
Point 3: .136555,479.500
Point 4: .179181,461.500
Point 5: .265393,425.500

Point 6: .349522,390.000
Point 7: .452797,346.000
Point 8: .499413,325.000
Point 9: .542454,306.500
Point 10: .579439,290.500

Point 11: .613863,275.500
Point 12: .646875,261.000
Point 13: .678486,247.000
Point 14: .707587,234.000
Point 15: .735320,221.500

Point 16: .762793,209.000
Point 17: .788904,197.000
Point 18: .813667,185.500
Point 19: .836029,175.000
Point 20: .857094,165.000

Point 21: .876871,155.500
Point 22: .895380,146.500
Point 23: .912635,138.000
Point 24: .928655,130.000
Point 25: .943464,122.500

Point 26: .958055,115.000
Point 27: .971451,108.000
Point 28: .984628,101.000
Point 29: .994804, 95.500
Point 30: 1.00302, 91.000

Point 31: 1.01113, 86.500
Point 32: 1.01913, 82.000
Point 33: 1.02702, 77.500
Point 34: 1.03480, 73.000
Point 35: 1.04246, 68.500

Point 36: 1.05002, 64.000
Point 37: 1.05829, 59.000
Point 38: 1.06612, 54.200
Point 39: 1.07483, 48.800
Point 40: 1.08981, 39.400

Point 41: 1.09371, 37.000
Point 42: 1.09706, 35.000
Point 43: 1.10000, 33.300
Point 44: 1.10269, 31.800
Point 45: 1.10513, 30.500

Point 46: 1.10729, 29.400
Point 47: 1.10916, 28.500
Point 48: 1.11094, 27.700
Point 49: 1.11264, 27.000
Point 50: 1.11425, 26.400

Point 51: 1.11576, 25.900
Point 52: 1.11713, 25.500
Point 53: 1.11870, 25.100
Point 54: 1.12010, 24.800
Point 55: 1.12173, 24.500

Point 56: 1.12373, 24.200
Point 57: 1.12538, 24.000
Point 58: 1.12734, 23.800
Point 59: 1.12969, 23.600
Point 60: 1.13247, 23.400

Point 61: 1.13575, 23.200
Point 62: 1.14152, 22.900
Point 63: 1.16365, 21.900
Point 64: 1.17164, 21.500
Point 65: 1.18228, 20.900

Point 66: 1.19522, 20.100
Point 67: 1.20060, 19.750
Point 68: 1.21439, 18.850
Point 69: 1.22955, 17.850
Point 70: 1.24349, 16.950

Point 71: 1.25545, 16.200
Point 72: 1.26617, 15.550
Point 73: 1.27642, 14.950
Point 74: 1.28708, 14.350
Point 75: 1.29728, 13.800

Point 76: 1.30792, 13.250
Point 77: 1.31905, 12.700
Point 78: 1.33071, 12.150
Point 79: 1.34293, 11.600
Point 80: 1.35458, 11.100

Point 81: 1.36675, 10.600
Point 82: 1.37951, 10.100
Point 83: 1.39291, 9.600
Point 84: 1.40701, 9.100
Point 85: 1.42187, 8.600

Point 86: 1.43752, 8.100
Point 87: 1.45561, 7.550
Point 88: 1.47794, 6.900
Point 89: 1.52951, 5.440
Point 90: 1.55074, 4.820

Point 91: 1.56380, 4.420
Point 92: 1.57362, 4.100
Point 93: 1.58079, 3.850
Point 94: 1.58678, 3.630
Point 95: 1.59325, 3.380

Point 96: 1.60115, 3.060
Point 97: 1.60998, 2.690
Point 98: 1.61596, 2.430
Point 99: 1.62056, 2.220
Point 100: 1.62426, 2.040

Point 101: 1.62732, 1.880
Point 102: 1.62979, 1.740
Point 103: 1.63191, 1.610
Point 104: 1.63370, 1.490
Point 105: 1.63492, 1.400

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: 940802 Sales Order: 113657
Sensor Model: DT-670-CU-1.4L Serial Number: D6068043
Sensor Type: Silicon Diode Temperature Range: 1.40 K to 325 K

Interpolation Method: Straight Line
Limit: 325.0 (Kelvin)
Format: 2 (Volts/Kelvin)
Number of Breakpoints: 36

No.	Units	Temperature (K)	No.	Units	Temperature (K)
1	0.147030	475.0	21	1.10808	29.0
2	0.218700	445.0	22	1.11261	27.0
3	0.326000	400.0	23	1.11546	26.0
4	0.490260	330.0	24	1.11916	25.0
5	0.499490	325.0	25	1.12539	24.0
6	0.569080	295.0	26	1.13955	23.0
7	0.637860	265.0	27	1.16147	22.0
8	0.705430	235.0	28	1.18050	21.0
9	0.771610	205.0	29	1.26658	15.5
10	0.825470	180.0	30	1.31234	13.0
11	0.867570	160.0	31	1.36839	10.5
12	0.908660	140.0	32	1.43946	8.0
13	0.948430	120.0	33	1.56541	4.4
14	0.977150	105.0	34	1.61080	2.7
15	1.00489	90.0	35	1.63259	1.6
16	1.03141	75.0	36	1.63483	1.4
17	1.05670	60.0			
18	1.08254	44.0			
19	1.09366	37.0			
20	1.10228	32.0			

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.

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