CALIBRATION CERTIFICATE
Report Number: 874105

Sensor Model: DT-670-CU-1.4L	Serial Number: D6059358
Sensor Type: Silicon Diode	Sales Order: 108148
Sensor Excitation: see *Test Data* page of report	Date: February 01, 2016
Temperature Range: 1.40 K to 325 K	Due: January 31, 2017

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: Derick Gillette
Calibration Engineer/Technician

Approved by: John Krause
Metrology

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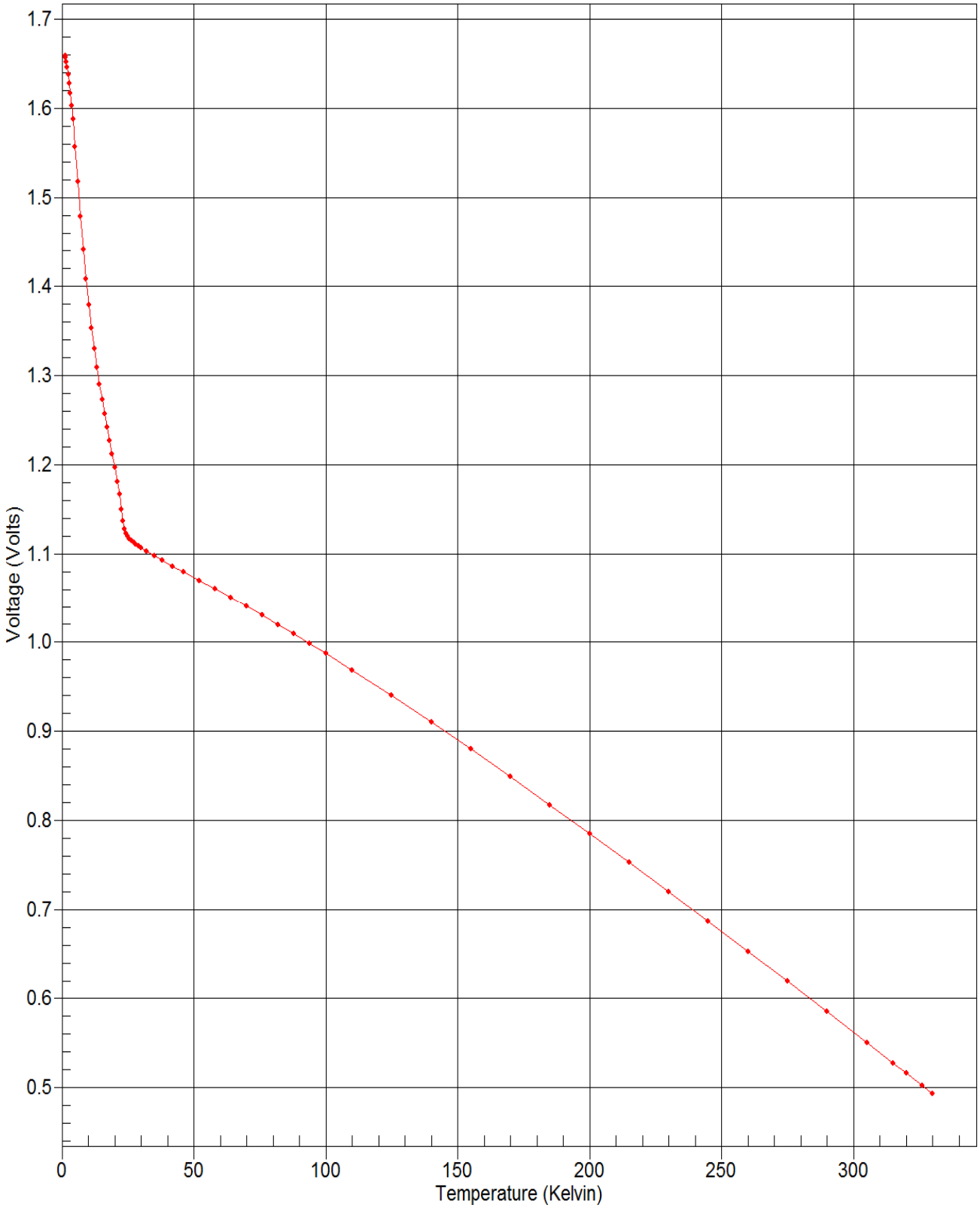
DATA PLOT

Calibration Report: 874105
Sensor Model: DT-670-CU-1.4L
Sensor Type: Silicon Diode

Sales Order: 108148
Serial Number: D6059358
Temperature Range: 1.40 K to 325 K



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TEST DATA

Calibration Report: 874105 Sales Order: 108148
Sensor Model: DT-670-CU-1.4L Serial Number: D6059358
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	1.20268	1.65931	10μA±0.1%	41	35.0251	1.09732	10μA±0.1%
2	1.30430	1.65813	10μA±0.1%	42	38.0187	1.09238	10μA±0.1%
3	1.40301	1.65686	10μA±0.1%	43	42.0159	1.08601	10μA±0.1%
4	1.70060	1.65223	10μA±0.1%	44	46.0175	1.07966	10μA±0.1%
5	2.00553	1.64639	10μA±0.1%	45	52.0165	1.07007	10μA±0.1%
6	2.40049	1.63751	10μA±0.1%	46	58.0152	1.06035	10μA±0.1%
7	2.79906	1.62749	10μA±0.1%	47	64.0092	1.05049	10μA±0.1%
8	3.20027	1.61673	10μA±0.1%	48	70.0049	1.04046	10μA±0.1%
9	3.69966	1.60242	10μA±0.1%	49	76.0049	1.03023	10μA±0.1%
10	4.17942	1.58739	10μA±0.1%	50	81.9984	1.01983	10μA±0.1%
11	5.05096	1.55657	10μA±0.1%	51	87.9985	1.00923	10μA±0.1%
12	6.07321	1.51768	10μA±0.1%	52	93.9962	0.998440	10μA±0.1%
13	7.10379	1.47824	10μA±0.1%	53	99.9927	0.987479	10μA±0.1%
14	8.13911	1.44129	10μA±0.1%	54	109.995	0.968816	10μA±0.1%
15	9.17112	1.40839	10μA±0.1%	55	124.995	0.939996	10μA±0.1%
16	10.2067	1.37917	10μA±0.1%	56	139.991	0.910324	10μA±0.1%
17	11.2370	1.35319	10μA±0.1%	57	154.993	0.879912	10μA±0.1%
18	12.2498	1.33011	10μA±0.1%	58	170.001	0.848858	10μA±0.1%
19	13.2505	1.30934	10μA±0.1%	59	184.995	0.817294	10μA±0.1%
20	14.2416	1.29048	10μA±0.1%	60	199.998	0.785228	10μA±0.1%
21	15.2207	1.27320	10μA±0.1%	61	215.006	0.752728	10μA±0.1%
22	16.1922	1.25708	10μA±0.1%	62	230.007	0.719849	10μA±0.1%
23	17.1622	1.24171	10μA±0.1%	63	245.007	0.686612	10μA±0.1%
24	18.1305	1.22683	10μA±0.1%	64	260.006	0.653044	10μA±0.1%
25	19.0981	1.21215	10μA±0.1%	65	275.013	0.619156	10μA±0.1%
26	20.0716	1.19715	10μA±0.1%	66	290.021	0.584999	10μA±0.1%
27	21.0486	1.18120	10μA±0.1%	67	305.035	0.550599	10μA±0.1%
28	21.8286	1.16683	10μA±0.1%	68	315.065	0.527502	10μA±0.1%
29	22.6298	1.14943	10μA±0.1%	69	320.060	0.515963	10μA±0.1%
30	23.2251	1.13661	10μA±0.1%	70	326.046	0.502119	10μA±0.1%
31	23.8258	1.12770	10μA±0.1%	71	330.034	0.492884	10μA±0.1%
32	24.4274	1.12257	10μA±0.1%				
33	25.0249	1.11934	10μA±0.1%				
34	25.6211	1.11696	10μA±0.1%				
35	26.4174	1.11445	10μA±0.1%				
36	27.2232	1.11231	10μA±0.1%				
37	28.0201	1.11045	10μA±0.1%				
38	29.0218	1.10830	10μA±0.1%				
39	30.0226	1.10630	10μA±0.1%				
40	32.0259	1.10255	10μA±0.1%				

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Calibration Report: 874105 Sales Order: 108148
Sensor Model: DT-670-CU-1.4L Serial Number: D6059358
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: 874105 Sales Order: 108148
Sensor Model: DT-670-CU-1.4L Serial Number: D6059358
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
1.657 volts	to	1.330 volts

Lower and Upper limits of Voltage used in computing Chebychev coefficients:
ZL = 1.290475511 ZU = 1.659306976

Order	Coefficient	Std. Deviation of Coefficient	Ratio (Coeff./Std Dev.)
0	7.543724	2.2410E-03	3366.30
1	-6.065620	3.2214E-03	-1882.90
2	0.293390	3.3212E-03	88.34
3	-0.393920	3.1171E-03	-126.37
4	-0.069180	2.9779E-03	-23.23
5	-0.029924	2.9278E-03	-10.22
6	-0.017540	2.8998E-03	-6.05
7	-0.014001	2.8890E-03	-4.85
8	-0.011029	2.9481E-03	-3.74
9	-0.009874	3.0964E-03	-3.19
10	-0.011620	3.1023E-03	-3.75

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: 874105 Sales Order: 108148
Sensor Model: DT-670-CU-1.4L Serial Number: D6059358
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	1.659307	1.20268	1.21440	-11.72
2	1.658134	1.30430	1.30296	1.34
3	1.656860	1.40301	1.39446	8.55
4	1.652231	1.70060	1.69155	9.05
5	1.646387	2.00553	2.00698	-1.45
6	1.637512	2.40049	2.40813	-7.65
7	1.627486	2.79906	2.80353	-4.47
8	1.616730	3.20027	3.19709	3.18
9	1.602416	3.69966	3.69291	6.74
10	1.587388	4.17942	4.17904	0.37
11	1.556570	5.05096	5.06023	-9.27
12	1.517684	6.07321	6.06397	9.24
13	1.478242	7.10379	7.10820	-4.40
14	1.441295	8.13911	8.14161	-2.50
15	1.408386	9.17112	9.16526	5.85
16	1.379171	10.20672	10.20881	-2.09
17	1.353194	11.23703	11.24112	-4.09
18	1.330109	12.24980	12.24420	5.60
19	1.309336	13.25054	13.25338	-2.84
20	1.290476	14.24163	14.24108	0.55

Order of Fit = 10 RMS error of fit = 6.01 mK
Largest absolute error = -11.72 mK at data point no. 1

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POLYNOMIAL EQUATION

Calibration Report: 874105 Sales Order: 108148
Sensor Model: DT-670-CU-1.4L Serial Number: D6059358
Sensor Type: Silicon Diode Temperature Range: 1.40 K to 325 K

Polynomial Type: Chebychev
Useful Range of Fit:

12.3 K	to	25.0 K
1.330 volts	to	1.119 volts

Lower and Upper limits of Voltage used in computing Chebychev coefficients:
ZL = 1.114445223 ZU = 1.379170971

Order	Coefficient	Std. Deviation of Coefficient	Ratio (Coeff./Std Dev.)
0	17.252717	9.0613E-03	1904.00
1	-7.686077	1.6578E-02	-463.64
2	0.473583	1.3854E-02	34.18
3	-0.005546	1.0541E-02	-0.53
4	0.206222	6.8308E-03	30.19
5	-0.270515	5.8213E-03	-46.47
6	0.222145	8.3575E-03	26.58
7	-0.114474	1.1670E-02	-9.81
8	0.107068	1.2554E-02	8.53
9	-0.023707	1.1916E-02	-1.99
10	0.045413	9.0830E-03	5.00

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: 874105
Sensor Model: DT-670-CU-1.4L
Sensor Type: Silicon Diode

Sales Order: 108148
Serial Number: D6059358
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	1.379171	10.20881	10.20683	-0.11
17	1.353194	11.24112	11.23571	1.32
18	1.330109	12.24420	12.25600	-6.20
19	1.309336	13.25054	13.23738	13.15
20	1.290476	14.24163	14.25090	-9.27
21	1.273198	15.22070	15.22834	-7.64
22	1.257081	16.19223	16.18369	8.54
23	1.241713	17.16218	17.15256	9.61
24	1.226833	18.13050	18.13542	-4.92
25	1.212147	19.09810	19.11083	-12.74
26	1.197152	20.07165	20.07125	0.40
27	1.181197	21.04865	21.03192	16.73
28	1.166831	21.82857	21.82982	-1.25
29	1.149433	22.62983	22.65423	-24.40
30	1.136606	23.22514	23.20600	19.14
31	1.127699	23.82579	23.80964	16.14
32	1.122573	24.42742	24.44091	-13.49
33	1.119342	25.02492	25.03942	-14.50
34	1.116964	25.62109	25.62155	-0.46
35	1.114445	26.41740	26.40747	9.93

Order of Fit = 10 RMS error of fit = 11.63 mK
Largest absolute error = -24.40 mK at data point no. 29

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POLYNOMIAL EQUATION

Calibration Report: 874105 Sales Order: 108148
Sensor Model: DT-670-CU-1.4L Serial Number: D6059358
Sensor Type: Silicon Diode Temperature Range: 1.40 K to 325 K

Polynomial Type: Chebychev
Useful Range of Fit:

25.0 K	to	88.0 K
1.119 volts	to	1.009 volts

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

ZL = 0.9874793278 ZU = 1.12769885

Order	Coefficient	Std. Deviation of Coefficient	Ratio (Coeff./Std Dev.)
0	60.025768	8.4436E-03	7109.04
1	-39.889254	1.4915E-02	-2674.38
2	1.071408	1.4137E-02	75.79
3	1.519060	1.0137E-02	149.85
4	0.855917	7.3590E-03	116.31
5	0.334585	3.3825E-03	98.92
6	0.065139	3.8376E-03	16.97
7	-0.027618	7.1512E-03	-3.86
8	-0.061598	1.0119E-02	-6.09
9	-0.019771	1.0951E-02	-1.81
10	-0.031432	1.1233E-02	-2.80
11	-0.000876	8.7742E-03	-0.10
12	-0.016365	6.1877E-03	-2.64

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: 874105
Sensor Model: DT-670-CU-1.4L
Sensor Type: Silicon Diode

Sales Order: 108148
Serial Number: D6059358
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	1.127699	23.80964	23.82496	0.82
32	1.122573	24.44091	24.43565	-8.23
33	1.119342	25.03942	25.01186	13.07
34	1.116964	25.62109	25.61577	5.32
35	1.114445	26.41740	26.42450	-7.10
36	1.112314	27.22323	27.23345	-10.23
37	1.110446	28.02013	28.02590	-5.77
38	1.108299	29.02179	29.01904	2.75
39	1.106295	30.02262	30.01378	8.85
40	1.102547	32.02589	32.01638	9.51
41	1.097318	35.02515	35.03149	-6.34
42	1.092381	38.01867	38.02848	-9.82
43	1.086008	42.01587	42.00999	5.88
44	1.079665	46.01752	46.01163	5.88
45	1.070066	52.01645	52.02356	-7.11
46	1.060348	58.01519	58.01346	1.73
47	1.050490	64.00918	64.00612	3.06
48	1.040456	70.00488	70.00896	-4.08
49	1.030231	76.00493	76.00229	2.63
50	1.019829	81.99840	81.99946	-1.06
51	1.009226	87.99855	87.99828	0.27
52	0.9984402	93.99624	93.99628	-0.04
53	0.9874793	99.99271	99.99271	0.00

Order of Fit = 12 RMS error of fit = 6.34 mK
Largest absolute error = 13.07 mK at data point no. 33

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POLYNOMIAL EQUATION

Calibration Report: 874105 Sales Order: 108148
Sensor Model: DT-670-CU-1.4L Serial Number: D6059358
Sensor Type: Silicon Diode Temperature Range: 1.40 K to 325 K

Polynomial Type: Chebychev
Useful Range of Fit:

88.0 K	to	325 K
1.009 volts	to	0.5045 volts

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

ZL = 0.4928843026 ZU = 1.030231274

Order	Coefficient	Std. Deviation of Coefficient	Ratio (Coeff./Std Dev.)
0	207.224245	2.7657E-04	749269.81
1	-126.031964	3.9950E-04	-315475.36
2	-3.947970	3.9089E-04	-10099.94
3	-0.904517	4.0396E-04	-2239.13
4	-0.242129	4.0225E-04	-601.93
5	-0.077915	3.8438E-04	-202.70
6	-0.016675	3.7190E-04	-44.84
7	-0.000293	3.7148E-04	-0.79
8	0.001244	3.7614E-04	3.31

Z = Voltage

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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Sensor Model: DT-670-CU-1.4L Serial Number: D6059358
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)
49	1.030231	76.00229	76.00403	0.90
50	1.019829	81.99946	81.99922	-0.82
51	1.009226	87.99828	87.99923	-0.68
52	0.9984402	93.99624	93.99723	-0.99
53	0.9874793	99.99271	99.99222	0.49
54	0.9688156	109.99499	109.99224	2.75
55	0.9399957	124.99470	124.99547	-0.77
56	0.9103243	139.99071	139.99273	-2.03
57	0.8799117	154.99276	154.99277	0.00
58	0.8488577	170.00143	170.00021	1.22
59	0.8172936	184.99484	184.99356	1.28
60	0.7852276	199.99850	199.99929	-0.79
61	0.7527276	215.00587	215.00699	-1.12
62	0.7198487	230.00740	230.00774	-0.34
63	0.6866118	245.00737	245.00646	0.91
64	0.6530445	260.00552	260.00487	0.65
65	0.6191559	275.01279	275.01320	-0.41
66	0.5849993	290.02139	290.02208	-0.70
67	0.5505993	305.03465	305.03446	0.19
68	0.5275016	315.06483	315.06390	0.93
69	0.5159635	320.06032	320.06073	-0.41
70	0.5021186	326.04578	326.04641	-0.63
71	0.4928843	330.03376	330.03340	0.36

Order of Fit = 8 RMS error of fit = 1.02 mK
Largest absolute error = 2.75 mK at data point no. 54

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INTERPOLATION TABLE

Calibration Report: 874105 Sales Order: 108148
Sensor Model: DT-670-CU-1.4L Serial Number: D6059358
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	1.65690	-13.547	15.50	1.26847	-16.774
1.500	1.65548	-14.897	16.00	1.26020	-16.320
1.600	1.65392	-16.194	16.50	1.25214	-15.948
1.700	1.65224	-17.437	17.00	1.24424	-15.645
1.800	1.65044	-18.611	17.50	1.23648	-15.411
1.900	1.64852	-19.700	18.00	1.22882	-15.248
2.000	1.64650	-20.704	18.50	1.22122	-15.166
2.100	1.64438	-21.631	19.00	1.21364	-15.187
2.200	1.64218	-22.489	19.50	1.20601	-15.334
2.300	1.63989	-23.280	20.00	1.19828	-15.649
2.400	1.63752	-24.003	21.00	1.18203	-17.059
2.500	1.63509	-24.650	22.00	1.16331	-20.962
2.600	1.63260	-25.212	23.00	1.14116	-21.384
2.700	1.63005	-25.689	24.00	1.12591	-9.4244
2.800	1.62746	-26.081	25.00	1.11946	-4.5874
2.900	1.62484	-26.437	26.00	1.11570	-3.1612
3.000	1.62217	-26.803	27.00	1.11287	-2.5554
3.100	1.61947	-27.178	28.00	1.11049	-2.2438
3.200	1.61674	-27.564	29.00	1.10834	-2.0647
3.300	1.61396	-27.969	30.00	1.10634	-1.9508
3.400	1.61114	-28.405	31.00	1.10443	-1.8695
3.500	1.60828	-28.869	32.00	1.10259	-1.8093
3.600	1.60537	-29.364	33.00	1.10081	-1.7630
3.700	1.60241	-29.887	34.00	1.09907	-1.7228
3.800	1.59939	-30.445	35.00	1.09736	-1.6888
3.900	1.59632	-31.041	36.00	1.09569	-1.6603
4.000	1.59318	-31.675	37.00	1.09404	-1.6364
4.200	1.58671	-33.055	38.00	1.09241	-1.6173
4.400	1.57996	-34.366	39.00	1.09080	-1.6025
4.600	1.57298	-35.459	40.00	1.08921	-1.5919
4.800	1.56579	-36.334	42.00	1.08603	-1.5830
5.000	1.55846	-36.991	44.00	1.08287	-1.5845
5.200	1.55101	-37.468	46.00	1.07969	-1.5898
5.400	1.54348	-37.862	48.00	1.07651	-1.5969
5.600	1.53587	-38.178	50.00	1.07331	-1.6035
5.800	1.52821	-38.416	52.00	1.07009	-1.6097
6.000	1.52051	-38.575	54.00	1.06687	-1.6161
6.500	1.50121	-38.512	56.00	1.06363	-1.6233
7.000	1.48213	-37.638	58.00	1.06037	-1.6312
7.500	1.46368	-36.133	60.00	1.05710	-1.6398
8.000	1.44604	-34.379	65.00	1.04884	-1.6636
8.500	1.42933	-32.466	70.00	1.04046	-1.6887
9.000	1.41357	-30.594	75.00	1.03196	-1.7144
9.500	1.39872	-28.804	77.35	1.02791	-1.7268
10.00	1.38473	-27.201	80.00	1.02332	-1.7408
10.50	1.37149	-25.779	85.00	1.01455	-1.7671
11.00	1.35893	-24.489	90.00	1.00565	-1.7934
11.50	1.34698	-23.319	95.00	0.996618	-1.8183
12.00	1.33560	-22.233	100.0	0.987466	-1.8424
12.50	1.32474	-21.226	105.0	0.978195	-1.8661
13.00	1.31436	-20.285	110.0	0.968806	-1.8892
13.50	1.30444	-19.413	115.0	0.959304	-1.9113
14.00	1.29493	-18.628	120.0	0.949695	-1.9321
14.50	1.28580	-17.930	125.0	0.939985	-1.9517
15.00	1.27699	-17.312	130.0	0.930180	-1.9701

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INTERPOLATION TABLE

Calibration Report: 874105 Sales Order: 108148

Sensor Model: DT-670-CU-1.4L Serial Number: D6059358

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	0.920286	-1.9876	235.0	0.708825	-2.2120
140.0	0.910306	-2.0042	240.0	0.697746	-2.2197
145.0	0.900245	-2.0199	245.0	0.686628	-2.2273
150.0	0.890108	-2.0349	250.0	0.675473	-2.2346
155.0	0.879897	-2.0492	255.0	0.664283	-2.2417
160.0	0.869617	-2.0628	260.0	0.653057	-2.2485
165.0	0.859270	-2.0757	265.0	0.641798	-2.2551
170.0	0.848861	-2.0879	270.0	0.630507	-2.2613
175.0	0.838392	-2.0997	273.15	0.623377	-2.2651
180.0	0.827865	-2.1110	275.0	0.619185	-2.2673
185.0	0.817283	-2.1219	280.0	0.607834	-2.2731
190.0	0.806647	-2.1323	285.0	0.596455	-2.2786
195.0	0.795960	-2.1423	290.0	0.585048	-2.2839
200.0	0.785224	-2.1519	295.0	0.573616	-2.2890
205.0	0.774442	-2.1611	300.0	0.562159	-2.2937
210.0	0.763613	-2.1702	305.0	0.550679	-2.2982
215.0	0.752740	-2.1790	310.0	0.539177	-2.3027
220.0	0.741824	-2.1876	315.0	0.527651	-2.3075
225.0	0.730865	-2.1959	320.0	0.516103	-2.3114
230.0	0.719865	-2.2040	325.0	0.504539	-2.3141

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Calibration Report: 874105
Sales Order: 108148
Sensor Model: DT-670-CU-1.4L
Serial Number: D6059358
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:	0.551 V
Liquid Nitrogen:	1.028 V
Liquid Helium:	1.587 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: 874105 Sales Order: 108148
Sensor Model: DT-670-CU-1.4L Serial Number: D6059358
Sensor Type: Silicon Diode Temperature Range: 1.40 K to 325 K

Sensor Model: DT-670-CU-1.4L
Serial Number: D6059358
Data Format: 6 (Volts/Kelvin)
Setpoint Limit: 325

Measurement (V)	Temp (K)	Curvature	Measurement (V)	Temp (K)	Curvature
4.92884E-01	3.30034E+02	-3.35634E+01	1.37917E+00	1.02067E+01	1.52951E+02
5.02119E-01	3.26046E+02	-3.85166E+01	1.40839E+00	9.17112E+00	1.35733E+02
5.15963E-01	3.20060E+02	-4.59428E+01	1.44129E+00	8.13911E+00	9.72677E+01
5.27502E-01	3.15065E+02	-8.08340E+01	1.47824E+00	7.10379E+00	5.32531E+01
5.50599E-01	3.05035E+02	-7.14102E+01	1.51768E+00	6.07321E+00	-9.38735E+00
5.84999E-01	2.90021E+02	-8.73039E+01	1.55657E+00	5.05096E+00	-4.09395E+01
6.19156E-01	2.75013E+02	-1.00226E+02	1.58739E+00	4.17942E+00	-1.90613E+02
6.53044E-01	2.60006E+02	-1.17580E+02	1.60242E+00	3.69966E+00	-2.08183E+02
6.86612E-01	2.45007E+02	-1.35300E+02	1.61673E+00	3.20027E+00	-1.88147E+02
7.19849E-01	2.30007E+02	-1.49264E+02	1.62749E+00	2.79906E+00	-1.93093E+02
7.52728E-01	2.15006E+02	-1.68257E+02	1.63751E+00	2.40049E+00	-4.64926E+02
7.85228E-01	1.99998E+02	-1.87158E+02	1.64639E+00	2.00553E+00	-1.01273E+03
8.17294E-01	1.84995E+02	-2.23567E+02	1.65223E+00	1.70060E+00	-2.06741E+03
8.48858E-01	1.70001E+02	-2.61078E+02	1.65686E+00	1.40301E+00	-5.06401E+03
8.79912E-01	1.54993E+02	-3.22371E+02	1.65813E+00	1.30430E+00	-7.59704E+03
9.10324E-01	1.39991E+02	-3.98555E+02	1.65931E+00	1.20268E+00	-9.92773E+03
9.39996E-01	1.24995E+02	-5.05782E+02			
9.68816E-01	1.09995E+02	-6.72113E+02			
9.87479E-01	9.99927E+01	-7.68150E+02			
9.98440E-01	9.39962E+01	-8.12311E+02			
1.00923E+00	8.79985E+01	-9.34081E+02			
1.01983E+00	8.19984E+01	-9.76199E+02			
1.03023E+00	7.60049E+01	-1.04165E+03			
1.04046E+00	7.00049E+01	-1.04749E+03			
1.05049E+00	6.40092E+01	-1.09180E+03			
1.06035E+00	5.80152E+01	-9.60297E+02			
1.07007E+00	5.20165E+01	-7.20055E+02			
1.07966E+00	4.60175E+01	-9.10505E+02			
1.08601E+00	4.20159E+01	7.77743E+01			
1.09238E+00	3.80187E+01	4.06286E+03			
1.09732E+00	3.50251E+01	6.49955E+03			
1.10255E+00	3.20259E+01	8.57169E+03			
1.10630E+00	3.00226E+01	1.26326E+04			
1.10830E+00	2.90218E+01	1.56240E+04			
1.11045E+00	2.80201E+01	2.01432E+04			
1.11231E+00	2.72232E+01	2.42725E+04			
1.11445E+00	2.64174E+01	2.70616E+04			
1.11696E+00	2.56211E+01	2.72411E+04			
1.11934E+00	2.50249E+01	2.44181E+04			
1.12257E+00	2.44274E+01	1.73581E+04			
1.12770E+00	2.38258E+01	7.03484E+03			
1.13661E+00	2.32251E+01	1.48841E+03			
1.14943E+00	2.26298E+01	-9.51558E+01			
1.16683E+00	2.18286E+01	-6.43827E+02			
1.18120E+00	2.10486E+01	-4.76766E+02			
1.19715E+00	2.00716E+01	-2.21001E+02			
1.21215E+00	1.90981E+01	-5.66885E+01			
1.22683E+00	1.81305E+01	6.29358E+01			
1.24171E+00	1.71622E+01	1.32650E+02			
1.25708E+00	1.61922E+01	1.81275E+02			
1.27320E+00	1.52207E+01	2.21377E+02			
1.29048E+00	1.42416E+01	2.30149E+02			
1.30934E+00	1.32505E+01	2.24926E+02			
1.33011E+00	1.22498E+01	1.96169E+02			
1.35319E+00	1.12370E+01	1.70737E+02			

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BREAKPOINTS 340 FORMAT

Calibration Report: 874105 Sales Order: 108148
Sensor Model: DT-670-CU-1.4L Serial Number: D6059358
Sensor Type: Silicon Diode Temperature Range: 1.40 K to 325 K

Name: DT-670-CU-1.4L
Serial number: D6059358
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: .504561,325.000
Point 9: .546103,307.000
Point 10: .585070,290.000

Point 11: .620340,274.500
Point 12: .653078,260.000
Point 13: .683306,246.500
Point 14: .712162,233.500
Point 15: .739656,221.000

Point 16: .765803,209.000
Point 17: .790617,197.500
Point 18: .814117,186.500
Point 19: .836310,176.000
Point 20: .857212,166.000

Point 21: .876839,156.500
Point 22: .895204,147.500
Point 23: .912326,139.000
Point 24: .928225,131.000
Point 25: .943900,123.000

Point 26: .958365,115.500
Point 27: .971651,108.500
Point 28: .984715,101.500
Point 29: .994805, 96.000
Point 30: 1.00296, 91.500

Point 31: 1.01101, 87.000
Point 32: 1.01896, 82.500
Point 33: 1.02680, 78.000
Point 34: 1.03453, 73.500
Point 35: 1.04216, 69.000

Point 36: 1.04968, 64.500
Point 37: 1.05809, 59.400
Point 38: 1.06623, 54.400
Point 39: 1.07524, 48.800
Point 40: 1.08446, 43.000

Point 41: 1.09015, 39.400
Point 42: 1.09403, 37.000
Point 43: 1.09718, 35.100
Point 44: 1.10010, 33.400
Point 45: 1.10277, 31.900

Point 46: 1.10518, 30.600
Point 47: 1.10732, 29.500
Point 48: 1.10917, 28.600
Point 49: 1.11093, 27.800
Point 50: 1.11261, 27.100

Point 51: 1.11420, 26.500
Point 52: 1.11568, 26.000
Point 53: 1.11703, 25.600
Point 54: 1.11856, 25.200
Point 55: 1.11992, 24.900

Point 56: 1.12149, 24.600
Point 57: 1.12342, 24.300
Point 58: 1.12500, 24.100
Point 59: 1.12688, 23.900
Point 60: 1.12918, 23.700

Point 61: 1.13194, 23.500
Point 62: 1.13522, 23.300
Point 63: 1.14108, 23.000
Point 64: 1.16130, 22.100
Point 65: 1.17137, 21.600

Point 66: 1.18211, 21.000
Point 67: 1.19519, 20.200
Point 68: 1.20910, 19.300
Point 69: 1.23185, 17.800
Point 70: 1.24578, 16.900

Point 71: 1.25773, 16.150
Point 72: 1.26844, 15.500
Point 73: 1.27870, 14.900
Point 74: 1.28847, 14.350
Point 75: 1.29865, 13.800

Point 76: 1.30931, 13.250
Point 77: 1.31946, 12.750
Point 78: 1.33007, 12.250
Point 79: 1.34118, 11.750
Point 80: 1.35284, 11.250

Point 81: 1.36508, 10.750
Point 82: 1.37797, 10.250
Point 83: 1.39019, 9.800
Point 84: 1.40303, 9.350
Point 85: 1.41659, 8.900

Point 86: 1.43090, 8.450
Point 87: 1.44598, 8.000
Point 88: 1.46361, 7.500
Point 89: 1.48395, 6.950
Point 90: 1.54279, 5.420

Point 91: 1.56514, 4.820
Point 92: 1.58003, 4.400
Point 93: 1.59133, 4.060
Point 94: 1.60003, 3.780
Point 95: 1.60773, 3.520

Point 96: 1.61538, 3.250
Point 97: 1.62327, 2.960
Point 98: 1.63084, 2.670
Point 99: 1.63658, 2.440
Point 100: 1.64106, 2.250

Point 101: 1.64483, 2.080
Point 102: 1.64815, 1.920
Point 103: 1.65082, 1.780
Point 104: 1.65311, 1.650
Point 105: 1.65504, 1.530

Point 106: 1.65664, 1.420
Point 107: 1.65690, 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: 874105 Sales Order: 108148
Sensor Model: DT-670-CU-1.4L Serial Number: D6059358
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	1.10831	29.0
2	0.218700	445.0	22	1.11283	27.0
3	0.326000	400.0	23	1.11570	26.0
4	0.490260	330.0	24	1.11946	25.0
5	0.504640	325.0	25	1.12591	24.0
6	0.573650	295.0	26	1.14116	23.0
7	0.641880	265.0	27	1.16331	22.0
8	0.708920	235.0	28	1.18203	21.0
9	0.763670	210.0	29	1.27613	15.0
10	0.817370	185.0	30	1.32415	12.5
11	0.859320	165.0	31	1.38358	10.0
12	0.900320	145.0	32	1.46201	7.5
13	0.940070	125.0	33	1.58141	4.4
14	0.968850	110.0	34	1.63373	2.6
15	0.996680	95.0	35	1.65443	1.6
16	1.02338	80.0	36	1.65683	1.4
17	1.04891	65.0			
18	1.07337	50.0			
19	1.09399	37.0			
20	1.10253	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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