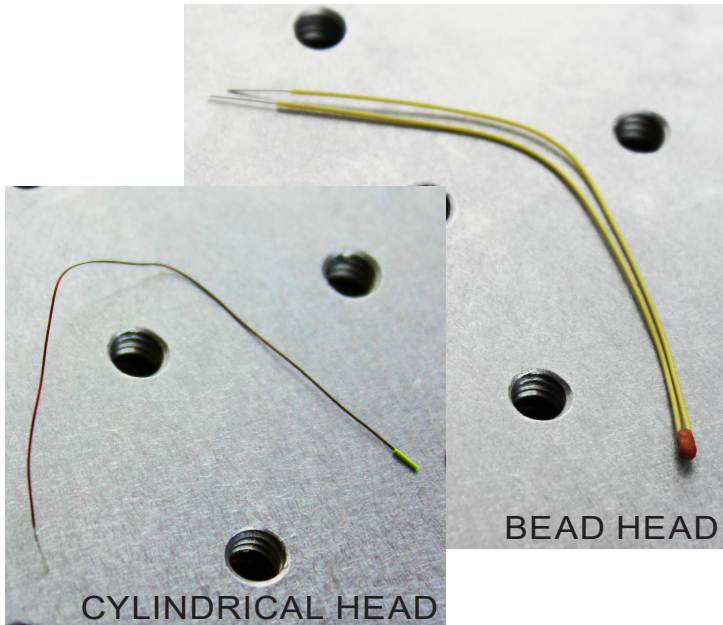


DATASHEET AND OPERATING GUIDE

TCS Series Thermistors



FEATURES AND BENEFITS

- Low Cost
- 1% Tolerance
- Cylindrical Head
 - » Ideal for Optical or Thin Surfaces & Small Laser Packages
 - » 3" Nickel Bifilar Leads
 - » Isolated Leads Provide Isolation from Metal Housing
- Bead Head
 - » Small Size - Conformally Coated
 - » Wide Resistance Range
 - » Available in Five Different R-T Curves
 - » 3" Solid Nickel Wire Leads
 - » Teflon® Insulation Provides Isolation from Metal Housing

CYLINDRICAL HEAD THERMISTOR

This $\pm 1\%$ thermistor is encapsulated in a polyimide tube, for assemblies where surface mounting or embedding the thermistor is required. Ideal for tight mounting spaces with 38 AWG nickel bifilar leads and a diameter of 0.5 mm by 3 mm.

Thermal Resistance or Dissipation Constant is 0.2 mW / °C.

Thermal Time Constant is 200 msec.

BEAD HEAD THERMISTOR

These $\pm 1\%$ thermistors are conformally coated, two-lead thermistors for applications where embedding the thermistor is required. The coating is baked on phenolic for durability and long term stability. They have solid nickel wires with Teflon® insulation to provide isolation when assembled in metal housings.

Thermal Resistance or Dissipation Constant is 2-3 mW / °C.

Thermal Time Constant is 6-14 seconds.

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ORDERING INFORMATION

PART NO	DESCRIPTION
TCS10K5	10 k Ω Thermistor, Cylindrical Head
TCS610	10 k Ω Thermistor, Bead Head
TCS620	20 k Ω Thermistor, Bead Head
TCS650	50 k Ω Thermistor, Bead Head
TCS651	100 k Ω Thermistor, Bead Head

THERMISTOR SELECTION GUIDE

Thermistors allow for precise temperature measurements across a wide range of temperatures. As seen below, temperatures from -45°C up to 114°C can be measured.

For a given thermistor, to accurately measure the voltage (which is related to the temperature, see the charts on the following pages), a bias current must be provided. Since the resistance of a thermistor varies as temperature changes, the bias current must be stable and consistent. In general, there are two commercially available bias current ranges, 10 or 100 µA.

Choose the bias current and thermistor combination such that the sensor voltage remains above 0.3 V for the temperature range under consideration. When the sensor voltage falls below 0.3 V, the sensitivity of the measurement is decreased. For more information, see [AN-TC14: Calibration Coefficients and Thermistor Selection](#).

For optimum performance, system operating temperature should fall in the middle of the thermistor operating range, and within a single bias current range.

Use the chart below to select the thermistor model best suited to your application.

The following pages include complete resistance vs. temperature response charts for each thermistor model, as well as the Steinhart-Hart coefficients for each bias current range.

Additional information about thermistors can be found in [AN-TC11: Thermistor Basics](#). Techniques for installing thermistors can be found in [AN-TC08: Mounting and Soldering Nickel-Lead Thermistors](#).

THERMISTOR SELECTION GUIDE

MODEL	R @ 25°C	10 µA BIAS CURRENT RANGE	100 µA BIAS CURRENT RANGE
TCS10K5 *	10 kΩ	-45 to +13 °C	-8 to +50 °C
TCS610	10 kΩ	-45 to +13 °C	-8 to +50 °C
TCS620	20 kΩ	-35 to +28 °C	+6 to +69 °C
TCS650	50 kΩ	-18 to +49 °C	+25 to +92 °C
TCS651	100 kΩ	-6 to +67 °C	+41 to +114 °C

* Cylindrical Head

STEINHART-HART CALCULATION

You can approximate the response of a thermistor with the Steinhart-Hart Equation. The A, B, and C values listed in the charts for each model apply to the following equation. The coefficients are optimized for the ranges covered by the reference currents.

$$\frac{1}{T} = A + B \times \ln R + C \times (\ln R)^3, \text{ where } R \text{ is in ohms and } T \text{ is in Kelvin}$$

TCS10K5 10 k Ω Cylindrical Head Thermistor @ 25°C

RESISTANCE VERSUS TEMPERATURE RESPONSE

10 μ A Bias Current Temperature Range: -45 to +13°C100 μ A Bias Current Temperature Range: -8 to +50°C

Steinhart-Hart Coefficients			
10 μ A BIAS CURRENT RANGE		100 μ A BIAS CURRENT RANGE	
A	1.1235E-03	A	1.1279E-03
B	2.3500E-04	B	2.3429E-04
C	8.4538E-08	C	8.7298E-08

TEMP (°C)	R _T (Ω)	VOLT (V) (10 μ A)	VOLT (V) (100 μ A)	TEMP (°C)	R _T (Ω)	VOLT (V) (10 μ A)	VOLT (V) (100 μ A)	TEMP (°C)	R _T (Ω)	VOLT (V) (10 μ A)	VOLT (V) (100 μ A)
-45	473200	4.732		-13	65260	0.652		19	13070		1.307
-44	441800	4.418		-12	61750	0.617		20	12490		1.249
-43	412600	4.126		-11	58450	0.584		21	11940		1.194
-42	385600	3.856		-10	55340	0.553		22	11420		1.142
-41	360500	3.605		-9	52420	0.524		23	10920		1.092
-40	337200	3.372		-8	49670	0.496	4.967	24	10450		1.045
-39	315500	3.155		-7	47080	0.470	4.708	25	10000		1.000
-38	295400	2.954		-6	44640	0.446	4.464	26	9572		0.957
-37	276700	2.767		-5	42340	0.423	4.234	27	9165		0.916
-36	259300	2.593		-4	40170	0.401	4.017	28	8777		0.877
-35	243100	2.431		-3	38120	0.381	3.812	29	8408		0.840
-34	228000	2.280		-2	36200	0.362	3.620	30	8056		0.805
-33	213900	2.139		-1	34380	0.343	3.438	31	7721		0.772
-32	200800	2.008		0	32660	0.326	3.266	32	7402		0.740
-31	188600	1.886		1	31040	0.310	3.104	33	7098		0.709
-30	177200	1.772		2	29510	0.295	2.951	34	6808		0.680
-29	166500	1.665		3	28060	0.280	2.806	35	6531		0.653
-28	156600	1.566		4	26690	0.266	2.669	36	6267		0.626
-27	147300	1.473		5	25400	0.254	2.540	37	6015		0.601
-26	138600	1.386		6	24180	0.241	2.418	38	5774		0.577
-25	130500	1.305		7	23020	0.230	2.302	39	5545		0.554
-24	122900	1.229		8	21920	0.219	2.192	40	5326		0.532
-23	115800	1.158		9	20890	0.208	2.089	41	5116		0.511
-22	109200	1.092		10	19900	0.199	1.990	42	4916		0.491
-21	103000	1.030		11	18970	0.189	1.897	43	4725		0.472
-20	97130	0.971		12	18090	0.180	1.809	44	4543		0.454
-19	91660	0.916		13	17260	0.172	1.726	45	4368		0.436
-18	86540	0.865		14	16470		1.647	46	4201		0.420
-17	81730	0.817		15	15710		1.571	47	4041		0.404
-16	77220	0.772		16	15000		1.500	48	3888		0.388
-15	72980	0.729		17	14320		1.432	49	3742		0.374
-14	69000	0.690		18	13680		1.368	50	3602		0.360

TCS610 10 kΩ Bead Head Thermistor @ 25°C

RESISTANCE VERSUS TEMPERATURE RESPONSE

10 μA Bias Current Temperature Range: -45 to +13°C

100 μA Bias Current Temperature Range: -8 to +50°C

Steinhart-Hart Coefficients			
10 μA BIAS CURRENT RANGE		100 μA BIAS CURRENT RANGE	
A	1.1235E-03	A	1.1279E-03
B	2.3500E-04	B	2.3429E-04
C	8.4538E-08	C	8.7298E-08

TEMP (°C)	R _T (Ω)	VOLT (V) (10 μA)	VOLT (V) (100 μA)	TEMP (°C)	R _T (Ω)	VOLT (V) (10 μA)	VOLT (V) (100 μA)	TEMP (°C)	R _T (Ω)	VOLT (V) (10 μA)	VOLT (V) (100 μA)
-45	473200	4.732		-13	65260	0.652		19	13070		1.307
-44	441800	4.418		-12	61750	0.617		20	12490		1.249
-43	412600	4.126		-11	58450	0.584		21	11940		1.194
-42	385600	3.856		-10	55340	0.553		22	11420		1.142
-41	360500	3.605		-9	52420	0.524		23	10920		1.092
-40	337200	3.372		-8	49670	0.496	4.967	24	10450		1.045
-39	315500	3.155		-7	47080	0.470	4.708	25	10000		1.000
-38	295400	2.954		-6	44640	0.446	4.464	26	9572		0.957
-37	276700	2.767		-5	42340	0.423	4.234	27	9165		0.916
-36	259300	2.593		-4	40170	0.401	4.017	28	8777		0.877
-35	243100	2.431		-3	38120	0.381	3.812	29	8408		0.840
-34	228000	2.280		-2	36200	0.362	3.620	30	8056		0.805
-33	213900	2.139		-1	34380	0.343	3.438	31	7721		0.772
-32	200800	2.008		0	32660	0.326	3.266	32	7402		0.740
-31	188600	1.886		1	31040	0.310	3.104	33	7098		0.709
-30	177200	1.772		2	29510	0.295	2.951	34	6808		0.680
-29	166500	1.665		3	28060	0.280	2.806	35	6531		0.653
-28	156600	1.566		4	26690	0.266	2.669	36	6267		0.626
-27	147300	1.473		5	25400	0.254	2.540	37	6015		0.601
-26	138600	1.386		6	24180	0.241	2.418	38	5774		0.577
-25	130500	1.305		7	23020	0.230	2.302	39	5545		0.554
-24	122900	1.229		8	21920	0.219	2.192	40	5326		0.532
-23	115800	1.158		9	20890	0.208	2.089	41	5116		0.511
-22	109200	1.092		10	19900	0.199	1.990	42	4916		0.491
-21	103000	1.030		11	18970	0.189	1.897	43	4725		0.472
-20	97130	0.971		12	18090	0.180	1.809	44	4543		0.454
-19	91660	0.916		13	17260	0.172	1.726	45	4368		0.436
-18	86540	0.865		14	16470		1.647	46	4201		0.420
-17	81730	0.817		15	15710		1.571	47	4041		0.404
-16	77220	0.772		16	15000		1.500	48	3888		0.388
-15	72980	0.729		17	14320		1.432	49	3742		0.374
-14	69000	0.690		18	13680		1.368	50	3602		0.360

TCS620 20 kΩ Bead Head Thermistor @ 25°C

RESISTANCE VERSUS TEMPERATURE RESPONSE

10 μA Bias Current Temperature Range: -35 to +28°C

100 μA Bias Current Temperature Range: +6 to +69°C

Steinhart-Hart Coefficients			
10 μA BIAS CURRENT RANGE		100 μA BIAS CURRENT RANGE	
A	9.7142E-04	A	9.6542E-04
B	2.3268E-04	B	2.3356E-04
C	8.0591E-08	C	7.7781E-08

TEMP (°C)	R _T (Ω)	VOLT (V) (10 μA)	VOLT (V) (100 μA)	TEMP (°C)	R _T (Ω)	VOLT (V) (10 μA)	VOLT (V) (100 μA)	TEMP (°C)	R _T (Ω)	VOLT (V) (10 μA)	VOLT (V) (100 μA)
-35	486200	4.862		0	65320	0.653		35	13062		1.306
-34	456000	4.560		1	62080	0.620		36	12534		1.253
-33	427800	4.278		2	59020	0.590		37	12030		1.203
-32	401600	4.016		3	56120	0.561		38	11548		1.154
-31	377200	3.772		4	53380	0.533		39	11090		1.109
-30	354400	3.544		5	50800	0.508		40	10652		1.065
-29	333000	3.330		6	48360	0.483	4.836	41	10232		1.023
-28	313200	3.132		7	46040	0.460	4.604	42	9832		0.983
-27	294600	2.946		8	43840	0.438	4.384	43	9450		0.945
-26	277200	2.772		9	41780	0.417	4.178	44	9086		0.908
-25	261000	2.610		10	39800	0.398	3.980	45	8736		0.873
-24	245800	2.458		11	37940	0.379	3.794	46	8402		0.840
-23	231600	2.316		12	36180	0.361	3.618	47	8082		0.808
-22	218400	2.184		13	34520	0.345	3.452	48	7776		0.777
-21	206000	2.060		14	32940	0.329	3.294	49	7484		0.748
-20	194260	1.942		15	31420	0.314	3.142	50	7204		0.720
-19	183320	1.833		16	30000	0.300	3.000	51	6936		0.693
-18	173080	1.730		17	28640	0.286	2.864	52	6680		0.668
-17	163460	1.634		18	27360	0.273	2.736	53	6434		0.643
-16	154440	1.544		19	26140	0.261	2.614	54	6198		0.619
-15	145960	1.459		20	24980	0.249	2.498	55	5974		0.597
-14	138000	1.380		21	23880	0.238	2.388	56	5756		0.575
-13	130520	1.305		22	22840	0.228	2.284	57	5550		0.555
-12	123500	1.235		23	21840	0.218	2.184	58	5350		0.535
-11	116900	1.169		24	20900	0.209	2.090	59	5160		0.516
-10	110680	1.106		25	20000	0.200	2.000	60	4978		0.497
-9	104840	1.048		26	19144	0.191	1.914	61	4802		0.480
-8	99340	0.993		27	18330	0.183	1.833	62	4634		0.463
-7	94160	0.941		28	17554	0.175	1.755	63	4472		0.447
-6	89280	0.892		29	16816		1.681	64	4316		0.431
-5	84680	0.846		30	16112		1.611	65	4168		0.416
-4	80340	0.803		31	15442		1.544	66	4024		0.402
-3	76240	0.762		32	14804		1.480	67	3888		0.388
-2	72400	0.724		33	14196		1.419	68	3756		0.375
-1	68760	0.687		34	13616		1.361	69	3628		0.362

TCS650 50 kΩ Bead Head Thermistor @ 25°C

RESISTANCE VERSUS TEMPERATURE RESPONSE

10 μA Bias Current Temperature Range: -18 to +49°C

100 μA Bias Current Temperature Range: +25 to +92°C

Steinhart-Hart Coefficients			
10 μA BIAS CURRENT RANGE		100 μA BIAS CURRENT RANGE	
A	9.5346E-04	A	9.6911E-04
B	2.1233E-04	B	2.1014E-04
C	8.1509E-08	C	8.8019E-08

TEMP (°C)	R _T (Ω)	VOLT (V) (10 μA)	VOLT (V) (100 μA)	TEMP (°C)	R _T (Ω)	VOLT (V) (10 μA)	VOLT (V) (100 μA)	TEMP (°C)	R _T (Ω)	VOLT (V) (10 μA)	VOLT (V) (100 μA)
-18	489000	4.890		19	66500	0.665		56	13205		1.320
-17	460500	4.605		20	63350	0.633		57	12695		1.269
-16	434000	4.340		21	60400	0.604		58	12210		1.221
-15	409000	4.090		22	57600	0.576		59	11740		1.174
-14	385500	3.855		23	54950	0.549		60	11295		1.129
-13	364000	3.640		24	52400	0.524		61	10870		1.087
-12	343500	3.435		25	50000	0.500	5.000	62	10460		1.046
-11	324000	3.240		26	47725	0.477	4.772	63	10070		1.007
-10	306000	3.060		27	45565	0.455	4.556	64	9695		0.969
-9	289000	2.890		28	43510	0.435	4.351	65	9335		0.933
-8	273000	2.730		29	41565	0.415	4.156	66	8990		0.899
-7	258000	2.580		30	39710	0.397	3.971	67	8660		0.866
-6	244000	2.440		31	37950	0.379	3.795	68	8345		0.834
-5	231000	2.310		32	36280	0.362	3.628	69	8040		0.804
-4	218500	2.185		33	34690	0.346	3.469	70	7750		0.775
-3	206500	2.065		34	33180	0.331	3.318	71	7475		0.747
-2	195500	1.955		35	31740	0.317	3.174	72	7205		0.720
-1	185500	1.855		36	30370	0.303	3.037	73	6950		0.695
0	175500	1.755		37	29070	0.290	2.907	74	6705		0.670
1	166500	1.665		38	27830	0.278	2.783	75	6465		0.646
2	157500	1.575		39	26650	0.266	2.665	76	6240		0.624
3	149500	1.495		40	25525	0.255	2.552	77	6020		0.602
4	142000	1.420		41	24455	0.244	2.445	78	5815		0.581
5	134500	1.345		42	23430	0.234	2.343	79	5610		0.561
6	127500	1.275		43	22460	0.224	2.246	80	5420		0.542
7	121500	1.215		44	21530	0.215	2.153	81	5235		0.523
8	115000	1.150		45	20645	0.206	2.064	82	5055		0.505
9	109500	1.095		46	19805	0.198	1.980	83	4885		0.488
10	103900	1.039		47	19000	0.190	1.900	84	4720		0.472
11	98800	0.988		48	18230	0.182	1.823	85	4560		0.456
12	93900	0.939		49	17495	0.175	1.749	86	4410		0.441
13	89350	0.893		50	16795		1.679	87	4260		0.426
14	85000	0.850		51	16125		1.612	88	4120		0.412
15	80850	0.808		52	15490		1.549	89	3985		0.398
16	77000	0.770		53	14880		1.488	90	3855		0.385
17	73300	0.733		54	14295		1.429	91	3730		0.373
18	69800	0.698		55	13740		1.374	92	3605		0.360

TCS651 100 kΩ Bead Head Thermistor @ 25°C

RESISTANCE VERSUS TEMPERATURE RESPONSE

10 μA Bias Current Temperature Range: -6 to +67°C

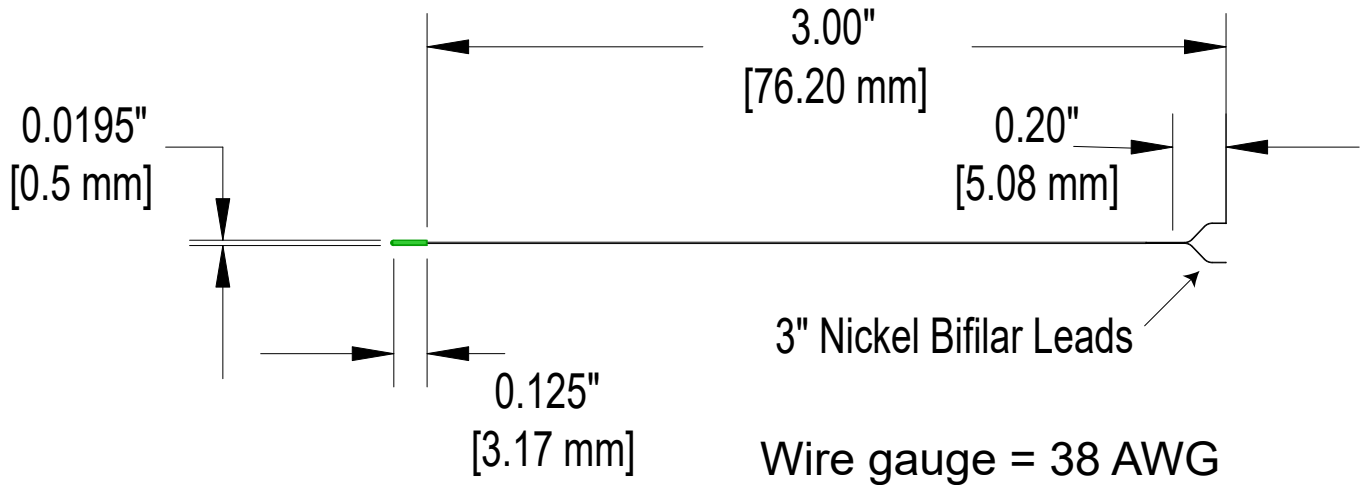
100 μA Bias Current Temperature Range: +41 to +114°C

Steinhart-Hart Coefficients			
10 μA BIAS CURRENT RANGE		100 μA BIAS CURRENT RANGE	
A	8.2458E-04	A	8.47031E-04
B	2.0913E-04	B	2.0561E-04
C	7.9780E-08	C	9.2670E-08

TEMP (°C)	R _T (Ω)	VOLT (V) (10 μA)	VOLT (V) (100 μA)	TEMP (°C)	R _T (Ω)	VOLT (V) (10 μA)	VOLT (V) (100 μA)	TEMP (°C)	R _T (Ω)	VOLT (V) (10 μA)	VOLT (V) (100 μA)
-6	488000	4.880		34	66360	0.665		74	13410		1.341
-5	462000	4.620		35	63480	0.633		75	12930		1.293
-4	437000	4.370		36	60740	0.604		76	12480		1.248
-3	413000	4.130		37	58140	0.576		77	12040		1.204
-2	391000	3.910		38	55660	0.549		78	11630		1.163
-1	371000	3.710		39	53300	0.524		79	11220		1.122
0	351000	3.510		40	51050	0.500		80	10840		1.084
1	333000	3.330		41	48910	0.477	4.891	81	10470		1.047
2	315000	3.150		42	46860	0.455	4.680	82	10110		1.011
3	299000	2.990		43	44920	0.435	4.492	83	9770		0.977
4	284000	2.840		44	43060	0.415	4.306	84	9440		0.944
5	269000	2.690		45	41290	0.397	4.129	85	9120		0.912
6	255000	2.550		46	39610	0.379	3.960	86	8820		0.882
7	243000	2.430		47	38000	0.362	3.800	87	8520		0.852
8	230000	2.300		48	36460	0.346	3.640	88	8240		0.824
9	219000	2.190		49	34990	0.331	3.499	89	7970		0.797
10	207800	2.078		50	33590	0.317	3.359	90	7710		0.771
11	197600	1.976		51	32250	0.303	3.225	91	7460		0.746
12	187800	1.878		52	30980	0.290	3.098	92	7210		0.721
13	178700	1.787		53	29760	0.278	2.976	93	6980		0.698
14	170000	1.700		54	28590	0.266	2.859	94	6760		0.676
15	161700	1.617		55	27480	0.255	2.748	95	6540		0.654
16	154000	1.540		56	26410	0.244	2.641	96	6330		0.633
17	146600	1.466		57	25390	0.234	2.539	97	6130		0.613
18	139600	1.396		58	24420	0.224	2.442	98	5940		0.594
19	133000	1.330		59	23480	0.215	2.348	99	5750		0.575
20	126700	1.267		60	22590	0.206	2.259	100	5570		0.557
21	120800	1.208		61	21740	0.198	2.174	101	5400		0.540
22	115200	1.152		62	20920	0.190	2.092	102	5230		0.523
23	109900	1.099		63	20140	0.182	2.014	103	5070		0.507
24	104800	1.048		64	19390	0.175	1.939	104	4910		0.491
25	100000	1.000		65	18670		1.867	105	4760		0.476
26	95450	0.954		66	17980		1.798	106	4620		0.462
27	91130	0.911		67	17320		1.732	107	4480		0.448
28	87020	0.870		68	16690		1.669	108	4340		0.434
29	83130	0.831		69	16080		1.608	109	4210		0.421
30	79420	0.794		70	15500		1.550	110	4080		0.408
31	75900	0.759		71	14950		1.495	111	3960		0.396
32	72560	0.725		72	14410		1.441	112	3840		0.384
33	69380	0.693		73	13900		1.390	113	3730		0.373
								114	3620		0.362

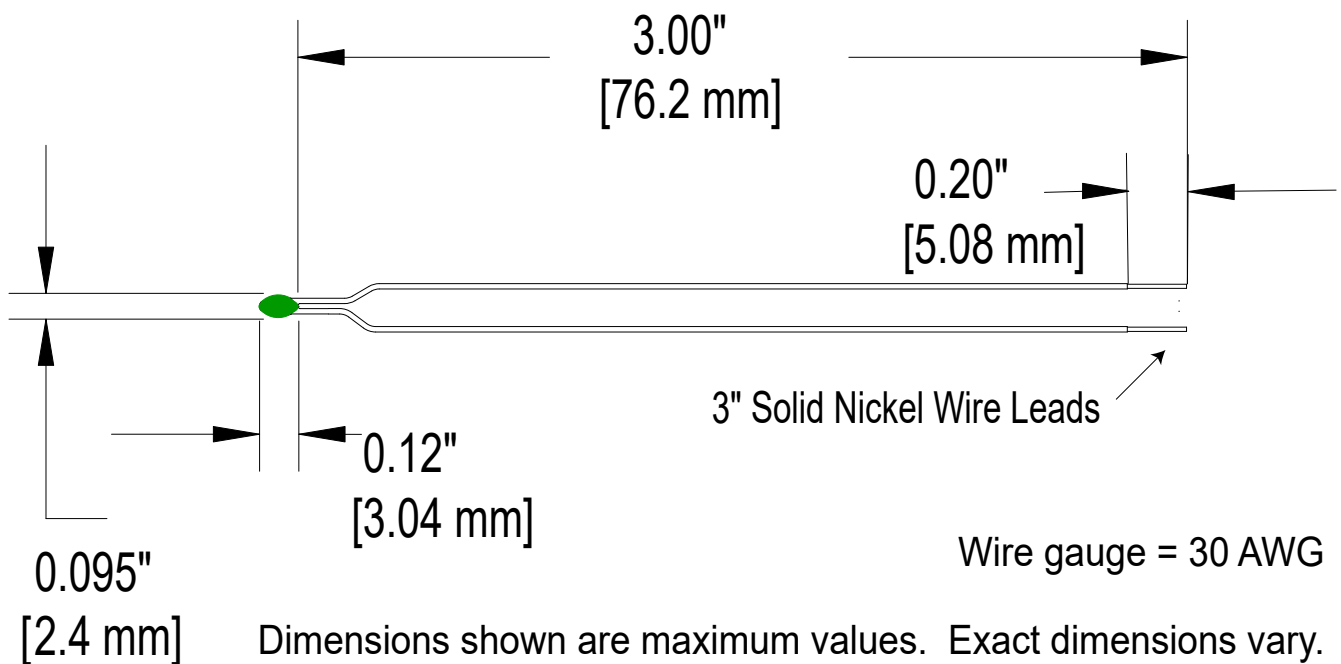
MECHANICAL SPECIFICATIONS

TCS10K5 CYLINDRICAL HEAD THERMISTOR



Dimensions shown are maximum. Exact dimensions vary.

TCS BEAD HEAD THERMISTORS



CERTIFICATION AND WARRANTY

CERTIFICATION

Wavelength Electronics, Inc. (Wavelength) certifies that this product met its published specifications at the time of shipment. Wavelength further certifies that its calibration measurements are traceable to the United States National Institute of Standards and Technology, to the extent allowed by that organization's calibration facilities, and to the calibration facilities of other International Standards Organization members.

WARRANTY

This Wavelength product is warranted against defects in materials and workmanship for a period of one (1) year from date of shipment. During the warranty period, Wavelength will, at its option, either repair or replace products which prove to be defective.

WARRANTY SERVICE

For warranty service or repair, this product must be returned to the factory. An RMA is required for products returned to Wavelength for warranty service. The Buyer shall prepay shipping charges to Wavelength and Wavelength shall pay shipping charges to return the product to the Buyer upon determination of defective materials or workmanship. However, the Buyer shall pay all shipping charges, duties, and taxes for products returned to Wavelength from another country.

LIMITATIONS OF WARRANTY

The warranty shall not apply to defects resulting from improper use or misuse of the product or operation outside published specifications. No other warranty is expressed or implied. Wavelength specifically disclaims the implied warranties of merchantability and fitness for a particular purpose.

EXCLUSIVE REMEDIES

The remedies provided herein are the Buyer's sole and exclusive remedies. Wavelength shall not be liable for any direct, indirect, special, incidental, or consequential damages, whether based on contract, tort, or any other legal theory.

REVERSE ENGINEERING PROHIBITED

Buyer, End-User, or Third-Party Reseller are expressly prohibited from reverse engineering, decompiling, or disassembling this product.

NOTICE

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SAFETY

There are no user-serviceable parts inside this product. Return the product to Wavelength Electronics for service and repair to ensure that safety features are maintained.

LIFE SUPPORT POLICY

This important safety information applies to all Wavelength electrical and electronic products and accessories:

As a general policy, Wavelength Electronics, Inc. does not recommend the use of any of its products in life support applications where the failure or malfunction of the Wavelength product can be reasonably expected to cause failure of the life support device or to significantly affect its safety or effectiveness. Wavelength will not knowingly sell its products for use in such applications unless it receives written assurances satisfactory to Wavelength that the risks of injury or damage have been minimized, the customer assumes all such risks, and there is no product liability for Wavelength. Examples of devices considered to be life support devices are neonatal oxygen analyzers, nerve stimulators (for any use), auto-transfusion devices, blood pumps, defibrillators, arrhythmia detectors and alarms, pacemakers, hemodialysis systems, peritoneal dialysis systems, ventilators of all types, and infusion pumps as well as other devices designated as "critical" by the FDA. The above are representative examples only and are not intended to be conclusive or exclusive of any other life support device.

REVISION HISTORY

DOCUMENT NUMBER: TCS-00400

REV.	DATE	CHANGE
A	January 2019	Initial Release



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