NORTH STAR SENSORS, LLC

HELPING YOU NAVIGATE THE WORLD OF SENSORS
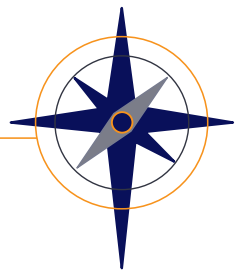
NTC THERMISTORS

NTC Thermistors are small, rugged ceramic semiconductors manufactured from compositions of the oxides of metals. Oxides of manganese, nickel, cobalt, copper, and/or iron are common. Each NTC thermistor composition or mix, has a specific ratio of metal oxides which defines the thermistor's physical dimensions, R/T curve and its resistance at 25 °C.

NTC thermistors exhibit a relatively large change in resistance vs. temperature, typically on the order of -3 % to -6 % per °C, providing a much greater sensitivity or signal response to changes in temperature when compared to other temperature sensors, such as thermocouples and RTD's.

With the variety of physical configurations, R25 values and temperature/resistance tolerances, NTC thermistors are the most versatile temperature sensor available. North Star Sensors manufactures its NTC thermistors from the highest grade raw materials and controls every step of the manufacturing process.
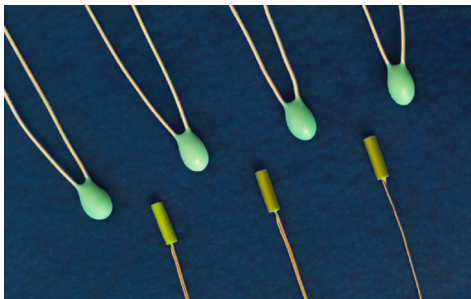
LEADS – Depending on the thermistor configuration, lead styles vary. Typical lead gage varies from 32 AWG to 26 AWG. Leads may be insulated or uninsulated. Common lead materials are copper, copper alloy, and nickel.

COATING/ENCAPSULATION – Epoxy coatings are typical. Some thermistor styles are encapsulated in a polyimide tube or plastic cup.

R25 VALUES – Typical R25 values range from 50 Ω to 100 kΩ. An R25 of 10 kΩ is one of the most common configurations.

POINT-MATCHED TOLERANCE – A point-matched tolerance is a ± % resistance tolerance at specific temperature point. The most common reference temperature point is at 25 °C.

TEMPERATURE TOLERANCE – A temperature tolerance is a ± degree C tolerance specified over a temperature range. Typical temperature tolerances range from ± 0.5 °C to ± 0.1 °C

Consult the factory for other available styles and tolerances. NTC thermistors can be built to meet customers' specific requirements.

NORTH STAR SENSORS ASSEMBLIES
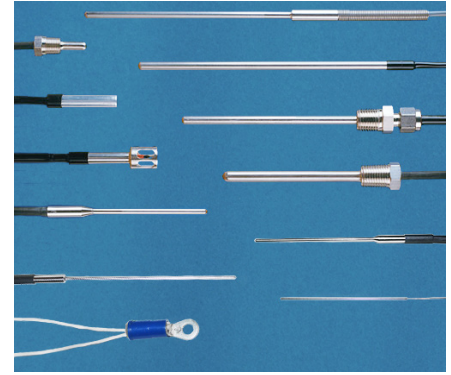
When used in temperature measurement and control applications, it is common for the NTC thermistor to be mounted in some type of assembly. The design of the sensor assembly should enhance applicability, protect the sensor, and appropriately locate the sensor in the target medium for maximum efficiency.

Areas for consideration are:
1. Minimum/maximum storage temperatures
2. Minimum/maximum operating temperatures
3. Temperature cycling
4. Desired response times
5. Shock/vibration exposure
6. Exposure to moisture
7. Exposure to high/low pressure
8. Corrosive environments

North Star Sensors application engineers have decades of experience in working with customers to solve some of the most challenging temperature applications.

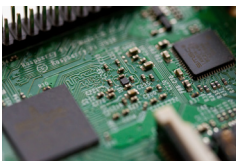## NTC THERMISTOR MARKETS

AUTOMOTIVE/HEAVY EQUIPMENT

AVIATION/AEROSPACE

BUILDING ENERGY MANAGEMENT CHEMICAL/PETROCHEMICAL

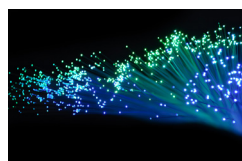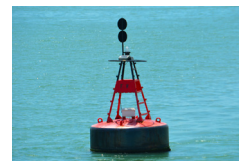FOOD PROCESSING

FACTORY AUTOMATION

ELECTRICAL/ELECTRONICS

COMMUNICATIONS/COMPUTER TECHNOLOGY

CONSUMER PRODUCTS

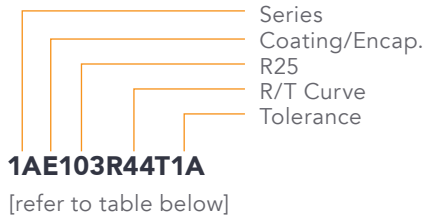METEROLOGY/ENVIRONMENTAL

MEDICAL DEVICES

PART NUMBERING LEGEND

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Series
Coating/Encap.
R25
R/T Curve
Tolerance
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1AE103R44T1A

[refer to table below]

NORTH STAR SENSORS PART NUMBER CODES

Series: Basic Thermistor Style

1A	30 AWG tin-plated copper, 2" L
1B	28 AWG tin-plated copper, 2" L
1C	32 AWG tin-plated copper, 3" L
1D	32 AWG tin-plated Alloy 180, 3" L
3A	38 AWG nickel, insulated bifilar, 3" L

Coating/Encapsulation

E	Epoxy
T	Polyimide tube with epoxy

R25: Resistance at 25 °C

104	10,000 Ω
503	50,000 Ω
303	30,000 Ω
103	10,000 Ω
502	5,000 Ω
222	2,252 Ω

R/T Curve* Typical R25 values

44	1,000 Ω - 100,000 Ω
43	20,000 Ω - 50,000 Ω
38	150 Ω - 1,500 Ω
35	50 Ω - 500 Ω

Tolerance: Temperature Range or Point-matched

T1A	± 0.1 °C from 0 °C to 70 °C
T1B	± 0.1 °C from -20 °C to 50 °C
T1C	± 0.1 °C from 0 °C to 100 °C
T2A	± 0.2 °C from 0 °C to 70 °C
T2B	± 0.2 °C from -20 °C to 50 °C
T2C	± 0.2 °C from 0 °C to 100 °C
T9A	± 1.0 °C from 0 °C to 70 °C
P1	± 1 % resistance tolerance at 25 °C
P2	± 2 % resistance tolerance at 25 °C
P5	± 5 % resistance tolerance at 25 °C

*Curve number matches NTC coefficient at 25 °C. For example, curve 44 has an NTC coefficient of -4.4% at 25 °C.

SERIES – The first two characters indicate the basic thermistor style which would specify parameters such as lead type and over all length.

COATING/ENCAPSULATION – The third character indicates the type of coating/encapsulation.

R25 – The fourth and fifth represent the first significant numbers of the resistance at 25 °C while the sixth number represents the number of trailing zeros. The seventh character "R" represents "resistance."

R/T CURVE – The eighth and ninth character represent the R/T Curve and the NTC characteristic at 25 °C. For example, R/T Curve 44 represents an R/T Curve material with an NTC, or a negative temperature coefficient, of -4.4 %/°C at 25 °C.

TOLERANCE – For temperature tolerances, the tenth character, "T", represents a temperature tolerance while the eleventh and twelfth characters represent a temperature tolerance and a temperature range, respectively.

For point-matched tolerances, the tenth character, "P", represents a point-matched tolerance at 25 °C while the twelfth character represents a ± % resistance tolerance at the given temperature point.

NIST TRACEABILITY

STATEMENT OF TRACEABILITY AND UNCERTAINTY OF TEMPERATURE STANDARDS
North Star Sensors NTC thermistors are manufactured utilizing standards with calibrations that are either traceable to the National Institute of Standards and Technology (NIST) or are derived from the ITS-90 (International Temperature Scale Of 1990) fixed points: TPHg (Triple Point of Mercury), TPH2O (Triple Point of Water), MPGa (Melting Point of Gallium), FPSn (Freezing Point of Tin), and/or FPZn (Freezing Point of Zinc).

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RESISTANCE VS. TEMPERATURE CONVERSION TABLES

°C	CURVE 35 Ω RATI R_T/R_{25}	CURVE 35 NTC (%/°C)	CURVE 35 T9A CODE ±°C TOL.	CURVE 38 Ω RATIO R_T/R_{25}	CURVE 38 NTC (%/°C)	CURVE 38 T5A CODE ±°C TOL	CURVE 43 Ω RATIO R_T/R_{25}	CURVE 43 NTC (%/°C)	CURVE 43 T2A CODE ±°C TOL.	CURVE 44 Ω RATIO R_T/R_{25}	CURVE 44 NTC (%/°C)	CURVE 44 T2A CODE ±°C TOL.
-50	27.54	-5.57	2.32	38.99	-6.18	1.16	56.432	-6.71	0.58	67.012	-7.14	0.58
-45	20.94	-5.39	2.08	28.77	-5.97	1.04	40.570	-6.49	0.53	47.199	-6.89	0.53
-40	16.07	-5.21	1.88	21.45	-5.77	0.94	29.473	-6.29	0.49	33.650	-6.65	0.49
-35	12.44	-5.04	1.70	16.15	-5.58	0.85	21.626	-6.09	0.44	24.269	-6.42	0.44
-30	9.707	-4.87	1.54	12.27	-5.40	0.77	16.021	-5.91	0.39	17.698	-6.21	0.39
-25	7.638	-4.72	1.40	9.411	-5.22	0.70	11.977	-5.73	0.34	13.015	-6.00	0.34
-20	6.056	-4.57	1.28	7.278	-5.06	0.64	9.0322	-5.56	0.30	9.7074	-5.81	0.30
-15	4.837	-4.43	1.18	5.674	-4.90	0.59	6.8689	-5.39	0.26	7.2950	-5.62	0.26
-10	3.891	-4.3	1.10	4.459	-4.75	0.55	5.2658	-5.24	0.23	5.5325	-5.44	0.23
-5	3.151	-4.17	1.04	3.530	-4.60	0.52	4.0680	-5.09	0.21	4.2325	-5.27	0.21
0	2.568	-4.05	1.00	2.815	-4.46	0.50	3.1660	-4.94	0.20	3.2651	-5.11	0.20
5	2.103	-3.94	1.00	2.260	-4.33	0.50	2.4815	-4.80	0.20	2.5393	-4.95	0.20
10	1.732	-3.82	1.00	1.826	-4.20	0.50	1.9583	-4.67	0.20	1.9901	-4.80	0.20
15	1.434	-3.71	1.00	1.485	-4.07	0.50	1.5556	-4.54	0.20	1.5712	-4.66	0.20
20	1.195	-3.61	1.00	1.215	-3.95	0.50	1.2434	-4.42	0.20	1.2493	-4.52	0.20
25	1.000	-3.50	1.00	1.000	-3.84	0.50	1.0000	-4.30	0.20	1.0000	-4.39	0.20
30	0.8413	-3.41	1.00	0.8276	-3.73	0.50	0.80892	-4.18	0.20	0.80567	-4.26	0.20
35	0.7113	-3.31	1.00	0.6885	-3.63	0.50	0.65804	-4.07	0.20	0.65314	-4.14	0.20
40	0.6042	-3.22	1.00	0.5758	-3.53	0.50	0.53820	-3.97	0.20	0.53266	-4.02	0.20
45	0.5155	-3.13	1.00	0.4840	-3.43	0.50	0.44249	-3.87	0.20	0.43689	-3.91	0.20
50	0.4417	-3.05	1.00	0.4087	-3.33	0.50	0.36563	-3.77	0.20	0.36031	-3.81	0.20
55	0.3800	-2.97	1.00	0.3467	-3.24	0.50	0.30357	-3.67	0.20	0.29857	-3.71	0.20
60	0.3282	-2.89	1.00	0.2954	-3.16	0.50	0.25323	-3.58	0.20	0.24869	-3.61	0.20
65	0.2845	-2.82	1.00	0.2528	-3.07	0.50	0.21219	-3.49	0.20	0.20816	-3.51	0.20
70	0.2475	-2.75	1.00	0.2172	-2.99	0.50	0.17858	-3.41	0.20	0.17508	-3.42	0.20
75	0.2161	-2.68	1.06	0.1874	-2.92	0.53	0.15093	-3.32	0.22	0.14793	-3.33	0.22
80	0.1893	-2.62	1.14	0.1622	-2.84	0.57	0.12808	-3.24	0.24	0.12554	-3.24	0.24
85	0.1663	-2.55	1.24	0.1410	-2.77	0.62	0.10912	-3.17	0.28	0.10700	-3.16	0.28
90	0.1466	-2.49	1.36	0.1230	-2.70	0.68	0.09332	-3.09	0.31	0.09156	-3.08	0.31
95	0.1297	-2.43	1.50	0.1076	-2.63	0.75	0.08010	-3.02	0.36	0.07867	-3.00	0.36
100	0.1150	-2.37	1.66	0.0945	-2.57	0.83	0.06900	-2.95	0.40	0.06784	-2.91	0.40
105				0.0832	-2.51	0.92	0.05963	-2.88	0.45	0.05876	-2.84	0.45
110				0.0735	-2.45	1.02	0.05171	-2.82	0.49	0.05107	-2.77	0.49
115				0.0652	-2.39	1.13	0.04499	-2.75	0.54	0.04453	-2.71	0.54
120				0.0579	-2.33	1.25	0.03926	-2.69	0.59	0.03896	-2.64	0.59
125				0.0516	-2.28	1.37	0.03437	-2.63	0.65	0.03419	-2.58	0.65
130							0.03017	-2.57	0.70	0.03010	-2.52	0.70
135							0.02657	-2.52	0.77	0.02657	-2.46	0.77
140							0.02346	-2.46	0.83	0.02352	-2.41	0.83
145							0.02077	-2.41	0.92	0.02088	-2.35	0.92

COLUMN HEADING DEFINITIONS

Ω RATIO- The ratio of the resistance at temperature "T" to the resistance at 25 °C. To determine the resistance of a thermistor at a temperature point other an 25 °C, multiply the given resistance ratio by the resistance at 25 °C.

NTC- The Negative Temperature Coefficient of resistance is the % change in resistance per change in temperature, expressed in units of -%/ °C. To determine the approximate % resistance tolerance of a thermistor at a particular temperature, multiply the given NTC value by the temperature tolerance at that temperature.

"XXX" CODE- An "XXX" code means that a thermistor has a temperature tolerance specified over a temperature range. For example, a "T2A" code indicates a ± 0.2 °C temperature tolerance from 0 °C to 70 °C. Typically, interchangeable thermistors should not cycle or operate continuously above their specified temperature range.