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AMERICAN SOCIETY FOR TESTING AND MATERIALS
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Standard Specification for Thermistor Sensors for Clinical Laboratory Temperature Measurements¹

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1. Scope

1.1 This specification covers the general requirements for negative temperature coefficient thermistor-type sensors intended to be used for clinical laboratory temperature measurements or control, or both, within the range from -10 to 105°C.

1.2 This specification also covers the detailed requirements for ASTM designated sensors.

2. Referenced Documents

2.1 ASTM Standards:

E 344 Terminology Relating to Thermometry and Hydrometry²

E 563 Practice for Preparation and Use of Freezing Point Reference Baths²

3. Terminology

3.1 *Definitions*—The definitions given in Terminology E 344 shall apply to this specification.

3.2 Definitions of Terms Specific to This Standard:

3.2.1 *dissipation constant, δ, n*—the ratio of the change in energy dissipated per unit time (power) in a thermistor, $\Delta\dot{Q} = \dot{Q}_2 - \dot{Q}_1$, to the resultant temperature change of the thermistor, $\Delta t = t_2 - t_1$.

$$\delta = \frac{\Delta\dot{Q}}{\Delta t} \quad (1)$$

The dimensions of the dissipation constant are W/°C. For this specification, t_1 is in the range from 20 to 38°C and $\Delta t = 10^\circ\text{C}$.

3.2.2 *insulation resistance, dc, n*—the resistance at a specified direct-current voltage between the insulated leads of a thermistor sensor and the metallic enclosure of the sensor, if such an enclosure is present, or else between the sensor leads and a conductive medium in which the sensor is immersed.

3.2.3 *qualification test, n*—a series of tests conducted by the procuring agency or an agent thereof to determine conformance of thermistor sensors to the requirements of a specification, normally for the development of a qualified products list

under the specification.

3.2.4 *response time, n*—the time required for a sensor to change a specified percentage of the total difference between its initial and final temperatures as determined from zero-power resistances when the sensor is subjected to a step function change in temperature.

3.2.5 *time constant, n*—the 63.2 % response time of a sensor that exhibits a single-exponential response.

3.2.6 *zero-power resistance, n*—the dc resistance of a device, at a specified temperature, calculated for zero-power.

3.2.6.1 *Discussion*—Accurate zero-power resistance is obtained by extrapolating to zero-power the resistance values obtained from measurements at three or more levels of power with the sensor immersed in a constant temperature medium. For the purpose of this specification, this is obtained from measurements at a single power level adjusted such that the power is not greater than one-fifth the product of the dissipation constant specified in Table 1 (see 3.2.1 and 7.3) and the appropriate tolerance requirement of Table 2. When making stability measurements, the power shall be kept constant.

4. Classification

4.1 Thermistor sensors covered by this specification shall be classified with a type designation code that includes the ASTM detailed specification number followed by a descriptive code. See Fig. 1.

4.2 *ASTM Specification Number*—The ASTM specification number specifies uniquely the design and construction of the sensor including the type designation if more than one type appears in the same specification.

4.3 *Operating Temperature Range*—The operating temperature range shall be designated by a letter symbol (see Table 3).

4.4 *Accuracy Class*—The accuracy class shall be designated by a single-digit number (see Table 2).

4.5 *Calibration Type*—The calibration type shall be designated by a letter symbol. The letter *I* shall be used to denote units that are interchangeable with respect to a single resistance-temperature relationship. The letter *N* shall be used to denote noninterchangeable units for which resistance-temperature information must be furnished for each unit. For *N*-type sensors, serial number identification must be provided.

5. Requirements

5.1 *Specifications*—Sensors shall comply with the general

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² Annual Book of ASTM Standards, Vol 14.03.

TABLE 1 Specification for ASTM Clinical Laboratory Thermistor Sensors

ASTM No.	B1N	B1N	B2N	B2N
Description	Silicone Rubber Coated Glass Probe	Epoxy Coated Glass Probe	Silicone Rubber Coated Glass Probe	Epoxy Coated Glass Probe
Major Application	General Purpose Clinical Laboratory Temperature Measurement	General Purpose Clinical Laboratory Temperature Measurement	General Purpose Clinical Laboratory Temperature Measurement	General Purpose Clinical Laboratory Temperature Measurement
Operating Temperature Range	−10 to 60°C	−10 to 60°C	−10 to 60°C	−10 to 60°C
Accuracy Class	1 (±0.01°C)	1 (±0.01°C)	2 (±0.02°C)	2 (±0.02°C)
Temperatures for Accuracy Class	−10 to 60°C	−10 to 60°C	−10 to 60°C	−10 to 60°C
Accuracies for other Temperatures Within Specified Temperature Range				
Calibration Type	Non-interchangeable	Non-interchangeable	Non-interchangeable	Non-interchangeable
Nominal R - T Characteristic				
$R = \exp[A_0 + A_1/T + A_2/T^2 + A_3/T^3]$ (T in kelvins)				
$T(^{\circ}\text{C}) = [a_0 + a_1 \ln R + a_2 (\ln R)^2 + a_3 (\ln R)^3]^{-1} - 273.15$				
A_0	−4.4495078	−4.4495078	−4.4495078	−4.4495078
A_1	3614.7764	3614.7764	3614.7764	3614.7764
A_2	88190.906	88190.906	88190.906	88190.906
A_3	−22328247	−22328247	−22328247	−22328247
a_0	$0.11766716 \times 10^{-2}$	$0.11766716 \times 10^{-2}$	$0.11766716 \times 10^{-2}$	$0.11766716 \times 10^{-2}$
a_1	$0.28173082 \times 10^{-3}$	$0.28173082 \times 10^{-3}$	$0.28173082 \times 10^{-3}$	$0.28173082 \times 10^{-3}$
a_2	$−0.23285292 \times 10^{-5}$	$−0.23285292 \times 10^{-5}$	$−0.23285292 \times 10^{-5}$	$−0.23285292 \times 10^{-5}$
a_3	$0.24131652 \times 10^{-6}$	$0.24131652 \times 10^{-6}$	$0.24131652 \times 10^{-6}$	$0.24131652 \times 10^{-6}$
Type of Immersion Fluid	water, air	water, oil, air	water, air	water, oil, air
Nominal R_0 at 25°C	2.5 kΩ	2.5 kΩ	2.5 kΩ	2.5 kΩ
Dissipation Constant	3.5 ± 0.9 mW/°C	5.0 ± 1.2 mW/°C	3.5 ± 0.9 mW/°C	5.0 ± 1.2 mW/°C
63.2 % Response Time	0.55 ± 0.16 s	0.45 ± 0.11 s	0.55 ± 0.16 s	0.45 ± 0.11 s
Ratio of 95 % to 63.2 % Response Times	2.5 ± 0.6	2.1 ± 0.5	2.5 ± 0.6	2.1 ± 0.5
Design and Construction	Fig. 2	Fig. 3	Fig. 2	Fig. 3
ASTM No.	A2N	A2N	B1N	B1N
Description	Silicone Rubber Coated Glass Probe	Epoxy Coated Glass Probe	5kΩ -4-Wire Non-interchangeable Sensor in S.S. Housing	5kΩ -2-Wire Non-interchangeable Sensor in S.S. Housing
Major Application	General Purpose Clinical Laboratory Temperature Measurement	General Purpose Clinical Laboratory Temperature Measurement	General Purpose Clinical Laboratory Temperature Measurement	General Purpose Clinical Laboratory Temperature Measurement
Operating Temperature Range	−10 to 105°C	−10 to 105°C	−10 to 60°C	−10 to 60°C
Accuracy Class	2 (±0.02°C)	2 (±0.02°C)	1 (±0.01°C)	1 (±0.01°C)
Temperatures for Accuracy Class	−10 to 105°C	−10 to 105°C	−10 to 60°C	−10 to 60°C
Accuracies for other Temperatures Within Specified Temperature Range				
Calibration Type	Non-interchangeable	Non-interchangeable	Non-interchangeable	Non-interchangeable
Nominal R - T Characteristic				
$R = \exp[A_0 + A_1/T + A_2/T^2 + A_3/T^3]$				
$T(^{\circ}\text{C}) = [a_0 + a_1 \ln R + a_2 (\ln R)^2 + a_3 (\ln R)^3]^{-1} - 273.15$				
A_0	−4.3332974	−4.3332947	−3.7563605	−3.7563605
A_1	4440.1603	4440.1603	3614.7764	3614.7764
A_2	−104525.78	−104525.78	88190.906	88190.906
A_3	−4581329.78	−4581329.78	−22328247	−22328247
a_0	$0.98667965 \times 10^{-3}$	$0.98667965 \times 10^{-3}$	$0.98019160 \times 10^{-3}$	$0.98019160 \times 10^{-3}$
a_1	$0.24329879 \times 10^{-3}$	$0.24329879 \times 10^{-3}$	$0.28530667 \times 10^{-3}$	$0.28530667 \times 10^{-3}$
a_2	$−0.59584872 \times 10^{-6}$	$−0.59584872 \times 10^{-6}$	$−0.28303328 \times 10^{-5}$	$−0.28303328 \times 10^{-5}$
a_3	$0.97166167 \times 10^{-7}$	$0.97166167 \times 10^{-7}$	$0.24131652 \times 10^{-6}$	$0.24131652 \times 10^{-6}$
Type of Immersion Fluid	water, air	water, air	all fluids compatible with Type 304 S.S.	all fluids compatible with Type 304 S.S.
R_0 at 25°C	10kΩ	10 kΩ	5 kΩ	5 kΩ
Dissipation Constant	3.5 ± 0.9 mW/°C	5.0 ± 1.2 mW/°C	4.8 ± 1.2 mW/°C	4.8 ± 1.2 mW/°C
63.2 % Response Time	0.55 ± 0.16 s	0.45 ± 0.11 s	4.5 ± 1.1 s	4.5 ± 1.1 s
Ratio of 95 % to 63.2 % Response Times	2.5 ± 0.6	2.1 ± 0.5	2.6 ± 0.3	2.6 ± 0.3
Design and Construction	Fig. 2	Fig. 3	Fig. 4	Fig. 5

requirements specified herein as well as with the applicable detailed specifications of Table 1. In the event of conflict between this requirement paragraph and the detailed specification of Table 1, Figs. 2-7 the latter shall govern.

5.2 Zero-Power Resistance versus Temperature Relationship—The zero-power resistance versus temperature relationship shall be presented in a form such that any temperature within the specified operating temperature range

TABLE 1 (continued)

ASTM No.	B1N	B1N	A2N	A2N
Description	10 $\kappa\Omega$ 4-Wire Non-interchangeable Sensor in S.S. Housing	10 $\kappa\Omega$ 2-Wire Non-interchangeable Sensor in S.S. Housing	10 $\kappa\Omega$ 4-Wire Non-interchangeable Sensor in S.S. Housing	10 $\kappa\Omega$ 2-Wire Non-interchangeable Sensor in S.S. Housing
Major Application	General Purpose Clinical Laboratory Temperature Measurement	General Purpose Clinical Laboratory Temperature Measurement	General Purpose Clinical Laboratory Temperature Measurement	General Purpose Clinical Laboratory Temperature Measurement
Operating Temperature Range	-10 to 60°C	-10 to 60°C	-10 to 105°C	-10 to 105°C
Accuracy Class	1 ($\pm 0.01^\circ\text{C}$)	1 ($\pm 0.01^\circ\text{C}$)	2 ($\pm 0.02^\circ\text{C}$)	2 ($\pm 0.02^\circ\text{C}$)
Temperatures for Accuracy Class	-10 to 60°C	-10 to 60°C	-10 to 105°C	-10 to 105°C
Accuracies for other Temperatures				
Within Specified Temperature Range				
Calibration Type	Non-interchangeable	Non-interchangeable	Non-interchangeable	Non-interchangeable
Nominal R - T Characteristic				
$R = \exp[A_0 + A_1/T + A_2/T^2 + A_3/T^3]$				
$T(^{\circ}\text{C}) = [a_0 + a_1 \ln R + a_2 (\ln R)^2 + a_3 (\ln R)^3]^{-1} - 273.15$				
A_0	-3.5684919	-3.5684919	-3.7191520	-3.7191520
A_1	3907.7065	3907.7065	4045.1666	4045.1666
A_2	33480.382	33480.382	-8181.7100	-8181.7100
A_3	-18666997	-18666997	-14472122	-14472122
a_0	$0.86972495 \times 10^{-3}$	$0.86972495 \times 10^{-3}$	$0.89898144 \times 10^{-3}$	$0.89898144 \times 10^{-3}$
a_1	$0.27135335 \times 10^{-3}$	$0.27135335 \times 10^{-3}$	$0.26152805 \times 10^{-3}$	$0.26152805 \times 10^{-3}$
a_2	$-0.20689100 \times 10^{-5}$	$-0.20689100 \times 10^{-5}$	$-0.97537969 \times 10^{-6}$	$-0.97537969 \times 10^{-6}$
a_3	$0.20547429 \times 10^{-6}$	$0.20547429 \times 10^{-6}$	$0.16613292 \times 10^{-6}$	$0.16613292 \times 10^{-6}$
Type of Immersion Fluid	all fluids compatible with Type 304 S.S.	all fluids compatible with Type 304 S.S.	all fluids compatible with Type 304 S.S.	all fluids compatible with Type 304 S.S.
Nominal R_0 at 25°C	10 $\kappa\Omega$	10 $\kappa\Omega$	10 $\kappa\Omega$	10 $\kappa\Omega$
Dissipation Constant	$4.8 \pm 1.2 \text{ mW}/^{\circ}\text{C}$	$4.8 \pm 1.2 \text{ mW}/^{\circ}\text{C}$	$4.8 \pm 1.2 \text{ mW}/^{\circ}\text{C}$	$4.8 \pm 1.2 \text{ mW}/^{\circ}\text{C}$
63.2 % Response Time	$4.5 \pm 1.1 \text{ s}$	$4.5 \pm 1.1 \text{ s}$	$4.5 \pm 1.1 \text{ s}$	$4.5 \pm 1.1 \text{ s}$
Ratio of 95 % to 63.2 % Response Times	2.6 ± 0.3	2.6 ± 0.3	2.6 ± 0.3	2.6 ± 0.3
Design and Construction	Fig. 4	Fig. 5	Fig. 4	Fig. 5

ASTM No.	B3I	B3N
Description	Interchangeable Sensor Enclosed in 1.17 mm Plastic Tube	Non-interchangeable Sensor Enclosed in 0.92 mm Plastic Tube
Major Application	Cuvette Thermometry	Cuvette Thermometry
Operating Temperature Range	-10 to 60°C	-10 to 60°C
Accuracy Class	3 ($\pm 0.05^\circ\text{C}$)	3 ($\pm 0.05^\circ\text{C}$)
Temperatures for Accuracy Class	24 to 45°C	-10 to 60°C
Accuracies for other Temperatures	-10 to 24°C: $\pm 0.1^\circ\text{C}$ 45 to 60°C: $\pm 0.1^\circ\text{C}$	
Within Specified Temperature Range		
Calibration Type	Interchangeable	Non-interchangeable
Nominal R - T Characteristic		
$R = \exp[A_0 + A_1/T + A_2/T^2 + A_3/T^3]$		
$T(^{\circ}\text{C}) = [a_0 + a_1 \ln R + a_2 (\ln R)^2 + a_3 (\ln R)^3]^{-1} - 273.15$		
A_0	-3.1645305	-3.0612396
A_1	3763.4399	3613.0051
A_2	47816.278	88718.122
A_3	-18332303	-22380305
a_0	$0.78686094 \times 10^{-3}$	$0.78069589 \times 10^{-3}$
a_1	$0.28128740 \times 10^{-3}$	$0.28967541 \times 10^{-3}$
a_2	$-0.25226292 \times 10^{-5}$	$-0.38427027 \times 10^{-5}$
a_3	$0.20852922 \times 10^{-6}$	$0.24169639 \times 10^{-6}$
Type of Immersion Fluid	water	water
Nominal R_0 at 25°C	11 $\kappa\Omega$	10 $\kappa\Omega$
Dissipation Constant	$1.1 \pm 0.3 \text{ mW}/^{\circ}\text{C}$	$0.8 \pm 0.2 \text{ mW}/^{\circ}\text{C}$
63.2 % Response Time	$0.5 \pm 0.12 \text{ s}$	$0.26 \pm 0.06 \text{ s}$
Ratio of 95 % to 63.2 % Response Times	3.0 ± 0.3	3 ± 0.3
Design and Construction	Fig. 6	Fig. 7