

Designation: E879 - 01 (Reapproved 2007)

## Standard Specification for Thermistor Sensors for Clinical Laboratory Temperature Measurements<sup>1</sup>

This standard is issued under the fixed designation E879; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon ( $\varepsilon$ ) indicates an editorial change since the last revision or reapproval.

## 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.

1.3 This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

### 2. Referenced Documents

2.1 ASTM Standards:<sup>2</sup>

- E344 Terminology Relating to Thermometry and Hydrometry
- **E563** Practice for Preparation and Use of an Ice-Point Bath as a Reference Temperature
- F29 Specification for Dumet Wire for Glass-to-Metal Seal Applications

## 3. Terminology sitch ai/catalog/standards/sist/b97bff36-1

3.1 *Definitions*—The definitions given in Terminology E344 shall apply to this specification.

3.2 Definitions of Terms Specific to This Standard:

3.2.1 *dissipation constant*,  $\delta$ , *n*—the ratio of the change in energy dissipated per unit time (power) in a thermistor,  $\Delta P = P_2 - P_1$ , to the resultant temperature change of the thermistor,  $\Delta T = T_2 - T_1$ .

$$\delta = \frac{\Delta P}{\Delta T} \tag{1}$$

The dimensions of the dissipation constant are W/K.

For this specification,  $T_1$  is in the range from 20 to 38 °C and  $\Delta T = 10$  °C.

3.2.2 *dumet*, *n*—round, copper-coated 42 % nickel-iron wire intended primarily for sealing to soft glass. Also known as CuNiFe in some communities.

3.2.3 *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.

3.2.4 *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.

3.2.5 *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 zeropower resistances when the sensor is subjected to a step function change in temperature.

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

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

3.2.7.1 *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

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<sup>&</sup>lt;sup>1</sup> This specification is under the jurisdiction of ASTM Committee E20 on Temperature Measurement and is the direct responsibility of Subcommittee E20.03 on Resistance Thermometers.

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<sup>&</sup>lt;sup>2</sup> For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

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measurements at a single power level adjusted such that the power is not greater than one-fifth the product of the dissipa-

tion constant specified in Table 1 (see 3.2.1 and 7.3) and the

TABLE 1 Specification for ASTM Clinical Laboratory Thermistor Se	ensors
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ASTM No.	E879 S B1N	E879 E B1N	E879 S B2N	E879 E 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 Accuracies for other Temperatures Within Specified Temperature Range	–10 to 60 °C	–10 to 60 °C	–10 to 60 °C	–10 to 60 °C
	Non-interchangeable	Non-interchangeable	Non-interchangeable	Non-interchangeable
Ao	-4.4495078	-4.4495078	-4.4495078	-4.4495078
<i>A</i> <sub>1</sub>	3614.7764	3614.7764	3614.7764	3614.7764
A <sub>2</sub>	88190.906	88190.906	88190.906	88190.906
<i>A</i> <sub>3</sub>	-22328247 0.11766716 × 10 <sup>-2</sup>	-22328247 0.11766716 $ imes$ 10 <sup>-2</sup>	-22328247 0.11766716 × 10 <sup>-2</sup>	-22328247 0.11766716 × 10 <sup>-2</sup>
a <sub>o</sub> a <sub>1</sub>	$0.28173082 \times 10^{-3}$	$0.28173082 \times 10^{-3}$	$0.28173082 \times 10^{-3}$	$0.28173082 \times 10^{-3}$
a <sub>2</sub>	$-0.23285292 \times 10^{-5}$	$-0.23285292 \times 10^{-5}$	$-0.23285292 \times 10^{-5}$	$-0.23285292 \times 10^{-5}$
a <sub>3</sub>	$0.24131652  imes 10^{-6}$	$0.24131652  imes 10^{-6}$	$0.24131652  imes 10^{-6}$	$0.24131652  imes 10^{-6}$
Type of Immersion Fluid	water, air	water, oil, air	water, air	water, oil, air
Nominal R <sub>0</sub> at 25 °C	2.5 κΩ	2.5 κΩ	2.5κΩ	2.5 κΩ
Dissipation Constant	3.5 ± 0.9 mW/K	5.0 ± 1.2 mW/K	3.5± 0.9 mW/K	5.0 ± 1.2 mW/K
63.2 % Response Time	$0.55 \pm 0.16 \text{ s}$	0.45 ± 0.11 s	0.55 ± 0.16 s	$0.45 \pm 0.11 \text{ s}$
Ratio of 95 % to 63.2 % Response Times	2.5 ± 0.6	2.1 ± 0.5	$2.5 \pm 0.6$	$2.1 \pm 0.5$
Design and Construction	Fig. 2	Fig. 3	Fig. 2	Fig. 3
ASTM No.	E879 S A2N	E879 E A2N	E879 G B1N	E879 H B1N
Description	Silicone Rubber Coated Glass	ient previe	5κ $Ω$ -4-Wire	5κ $Ω$ -2-Wire
	Probe	Frank Orated Olars Deaks	Non-interchangeable Sensor	
		Epoxy Coated Glass Probe	in S.S. Housing	Sensor
Major Application	General Purpose Clinical	General Purpose Clinical	in S.S. Housing General Purpose Clinical	Sensor in S.S. Housing General Purpose Clinical
Major Application https://standards.iteh.ai/ca	Laboratory Temperature	General Purpose Clinical Laboratory Temperature	in S.S. Housing General Purpose Clinical Z Laboratory Temperature	Sensor in S.S. Housing General Purpose Clinical Laboratory Temperature
https://standards.iteh.ai/ca	Laboratory Temperature 597 Measurement	General Purpose Clinical Laboratory Temperature Measurement	in S.S. Housing General Purpose Clinical Laboratory Temperature Measurement	Sensor in S.S. Housing General Purpose Clinical Laboratory Temperature Measurement
https://standards.iteh.ai/ca Operating Temperature Range	Laboratory Temperature 697 Measurement -10 to 105 °C	General Purpose Clinical Laboratory Temperature Measurement -10 to 105 °C	in S.S. Housing General Purpose Clinical Laboratory Temperature Measurement -10 to 60 °C	Sensor in S.S. Housing General Purpose Clinical Laboratory Temperature Measurement -10 to 60 °C
https://standards.iteh.ai/ca Operating Temperature Range Accuracy Class Temperatures for Accuracy Class Accuracies for other Temperatures Within Specified Temperature	Laboratory Temperature 597 Measurement	General Purpose Clinical Laboratory Temperature Measurement	in S.S. Housing General Purpose Clinical Laboratory Temperature Measurement	Sensor in S.S. Housing General Purpose Clinical Laboratory Temperature Measurement
https://standards.iteh.ai/ca Operating Temperature Range Accuracy Class Temperatures for Accuracy Class Accuracies for other Temperatures	Laboratory Temperature 697 Measurement -10 to 105 °C 2 (±0.02 °C)	General Purpose Clinical Laboratory Temperature Measurement -10 to 105 °C 2 (±0.02 °C)	in S.S. Housing General Purpose Clinical Laboratory Temperature Measurement -10 to 60 °C 1 (±0.01 °C)	Sensor in S.S. Housing General Purpose Clinical Laboratory Temperature Measurement -10 to 60 °C 1 (±0.01 °C)
https://standards.iteh.ai/ca Operating Temperature Range Accuracy Class Temperatures for Accuracy Class Accuracies for other Temperatures Within Specified Temperature Range Calibration Type Nominal $R$ -T Characteristic $R = \exp[A_0 + A_1/T + A_2/T^2 + A_3/T^3]$ $T(°C) = [a_0 + a_1LnR + a_2(LnR)^2 + a_3(LnR)^3]^{-1} - 273.15$	Laboratory Temperature 697 Measurement -10 to 105 °C 2 (±0.02 °C) -10 to 105 °C Non-interchangeable	General Purpose Clinical Laboratory Temperature Measurement -10 to 105 °C 2 (±0.02 °C) -10 to 105 °C Non-interchangeable	in S.S. Housing General Purpose Clinical Laboratory Temperature Measurement -10 to 60 °C 1 (±0.01 °C) -10 to 60 °C Non-interchangeable	Sensor in S.S. Housing General Purpose Clinical - Laboratory Temperature Measurement -10 to 60 °C 1 (±0.01 °C) -10 to 60 °C Non-interchangeable
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https://standards.iteh.ai/ca Operating Temperature Range Accuracy Class Temperatures for Accuracy Class Accuracies for other Temperatures Within Specified Temperature Range Calibration Type Nominal <i>R</i> - <i>T</i> Characteristic $R = \exp[A_0 + A_1/T + A_2/T^2 + A_3/T^3]$ $T(°C) = [a_0 + a_1LnR + a_2(LnR)^2 + a_3(LnR)^3]^{-1} - 273.15$ $A_0$ $A_1$	Laboratory Temperature 697 Measurement -10 to 105 °C 2 (±0.02 °C) -10 to 105 °C Non-interchangeable	General Purpose Clinical Laboratory Temperature Measurement -10 to 105 °C 2 (±0.02 °C) -10 to 105 °C Non-interchangeable	in S.S. Housing General Purpose Clinical Laboratory Temperature Measurement -10 to 60 °C 1 (±0.01 °C) -10 to 60 °C Non-interchangeable	Sensor in S.S. Housing General Purpose Clinical - Laboratory Temperature Measurement -10 to 60 °C 1 (±0.01 °C) -10 to 60 °C Non-interchangeable
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https://standards.iteh.ai/ca Operating Temperature Range Accuracy Class Temperatures for Accuracy Class Accuracies for other Temperatures Within Specified Temperature Range Calibration Type Nominal <i>R</i> - <i>T</i> Characteristic $R = \exp[A_0 + A_1/T + A_2/T^2 + A_3/T^3]$ $T(\ ^{\circ}C) = [a_0 + a_1LnR + a_2(LnR)^2 + a_3(LnR)^3]^{-1} - 273.15$ $A_0$ $A_1$ $A_2$	Laboratory Temperature / 997 Measurement -10 to 105 °C 2 (±0.02 °C) -10 to 105 °C Non-interchangeable -4.3332974 4440.1603 -104525.78 -4581329.78 0.98667965 × 10 <sup>-3</sup>	General Purpose Clinical Laboratory Temperature Measurement -10 to 105 °C $2 (\pm 0.02 °C)$ -10 to 105 °C Non-interchangeable -4.3332947 4440.1603 -104525.78 -4581329.78 0.98667965 $\times 10^{-3}$	in S.S. Housing General Purpose Clinical -4 Laboratory Temperature Measurement -10 to 60 °C 1 (±0.01 °C) -10 to 60 °C Non-interchangeable -3.7563605 3614.7764 88190.906 -22328247 0.98019160 × 10 <sup>-3</sup>	Sensor in S.S. Housing General Purpose Clinical - Laboratory Temperature Measurement -10 to 60 °C 1 ( $\pm$ 0.01 °C) -10 to 60 °C Non-interchangeable -3.75636005 3614.7764 88190.906 -22328247 0.98019160 × 10 <sup>-3</sup>
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https://standards.iteh.ai/ca Operating Temperature Range Accuracy Class Temperatures for Accuracy Class Accuracies for other Temperatures Within Specified Temperature Range Calibration Type Nominal <i>R</i> - <i>T</i> Characteristic $R = \exp[A_0 + A_1/T + A_2/T^2 + A_3/T^3]$ $T(\ ^{\circ}C) = [a_0 + a_1LnR + a_2(LnR)^2 + a_3(LnR)^3]^{-1} - 273.15$ $A_0$ $A_1$ $A_2$ $A_3$ $a_0$ $a_1$ $a_2$ $a_3$	Laboratory Temperature / 9 7 Measurement -10 to 105 °C 2 (±0.02 °C) -10 to 105 °C Non-interchangeable -4.3332974 4440.1603 -104525.78 -4581329.78 0.98667965 × 10 <sup>-3</sup> 0.24329879 × 10 <sup>-3</sup> -0.59584872 × 10 <sup>-6</sup> 0.97166167 × 10 <sup>-7</sup>	General Purpose Clinical Laboratory Temperature Measurement -10 to 105 °C 2 (±0.02 °C) -10 to 105 °C Non-interchangeable -4.3332947 4440.1603 -104525.78 -4581329.78 0.98667965 × 10 <sup>-3</sup> 0.24329879 × 10 <sup>-3</sup> -0.59584872 × 10 <sup>-6</sup> 0.97166167 × 10 <sup>-7</sup>	in S.S. Housing General Purpose Clinical -4 Laboratory Temperature, Measurement -10 to 60 °C 1 (±0.01 °C) -10 to 60 °C Non-interchangeable -3.7563605 3614.7764 88190.906 -22328247 0.98019160 × 10 <sup>-3</sup> 0.28530667 × 10 <sup>-3</sup> -0.28303328 × 10 <sup>-5</sup> 0.24131652 × 10 <sup>-6</sup>	Sensor in S.S. Housing General Purpose Clinical - Laboratory Temperature Measurement -10 to 60 °C 1 ( $\pm$ 0.01 °C) -10 to 60 °C Non-interchangeable -3.7563605 3614.7764 88190.906 -22328247 0.98019160 × 10 <sup>-3</sup> 0.28530667 × 10 <sup>-3</sup> -0.28303328 × 10 <sup>-5</sup> 0.24131652 × 10 <sup>-6</sup>
https://standards.iteh.ai/ca Operating Temperature Range Accuracy Class Temperatures for Accuracy Class Accuracies for other Temperatures Within Specified Temperature Range Calibration Type Nominal $R$ - $T$ Characteristic $R = \exp[A_0 + A_1/T + A_2/T^2 + A_3/T^3]$ $T(\ ^{\circ}C) = [a_0 + a_1LnR + a_2(LnR)^2 + a_3(LnR)^3]^{-1} - 273.15$ $A_0$ $A_1$ $A_2$ $A_3$ $a_0$ $a_1$ $a_2$ $a_3$ Type of Immersion Fluid	Laboratory Temperature $697$ Measurement -10 to 105 °C 2 (±0.02 °C) -10 to 105 °C Non-interchangeable -4.3332974 4440.1603 -104525.78 -4581329.78 0.98667965 × 10 <sup>-3</sup> 0.24329879 × 10 <sup>-3</sup> -0.59584872 × 10 <sup>-6</sup> 0.97166167 × 10 <sup>-7</sup> water, air	General Purpose Clinical Laboratory Temperature Measurement -10 to 105 °C $2 (\pm 0.02 °C)$ -10 to 105 °C Non-interchangeable -4.3332947 4440.1603 -104525.78 -4581329.78 0.98667965 × 10 <sup>-3</sup> 0.98667965 × 10 <sup>-3</sup> -0.59584872 × 10 <sup>-6</sup> 0.97166167 × 10 <sup>-7</sup> water, air	in S.S. Housing General Purpose Clinical -4 Laboratory Temperature Measurement -10 to 60 °C 1 ( $\pm$ 0.01 °C) -10 to 60 °C Non-interchangeable -3.7563605 3614.7764 88190.906 -22328247 0.98019160 × 10 <sup>-3</sup> 0.28530667 × 10 <sup>-3</sup> -0.28303328 × 10 <sup>-5</sup> 0.24131652 × 10 <sup>-6</sup> all fluids compatible with Type 304 S.S.	Sensor in S.S. Housing General Purpose Clinical - Laboratory Temperature Measurement -10 to 60 °C 1 ( $\pm$ 0.01 °C) -10 to 60 °C Non-interchangeable -3.7563605 3614.7764 88190.906 -22328247 0.98019160 × 10 <sup>-3</sup> 0.28530667 × 10 <sup>-3</sup> -0.28303328 × 10 <sup>-5</sup> 0.24131652 × 10 <sup>-6</sup> all fluids compatible with Type 304 S.S.
https://standards.iteh.ai/ca Operating Temperature Range Accuracy Class Temperatures for Accuracy Class Accuracies for other Temperatures Within Specified Temperature Range Calibration Type Nominal <i>R</i> -T Characteristic $R = \exp[A_0 + A_1/T + A_2/T^2 + A_3/T^3]$ $T(°C) = [a_0 + a_1LnR + a_2(LnR)^2 + a_3(LnR)^3]^{-1} - 273.15$ $A_0$ $A_1$ $A_2$ $A_3$ $a_0$ $a_1$ $a_2$ $a_3$ Type of Immersion Fluid $R_0$ at 25 °C Dissipation Constant 63.2 % Response Time	Laboratory Temperature $b^{-1}$ Measurement -10 to 105 °C 2 (±0.02 °C) -10 to 105 °C Non-interchangeable -4.3332974 4440.1603 -104525.78 -4581329.78 0.98667965 × 10 <sup>-3</sup> 0.24329879 × 10 <sup>-3</sup> -0.59584872 × 10 <sup>-6</sup> 0.97166167 × 10 <sup>-7</sup> water, air 10κΩ	General Purpose Clinical Laboratory Temperature Measurement -10 to 105 °C $2 (\pm 0.02 °C)$ -10 to 105 °C Non-interchangeable -4.3332947 4440.1603 -104525.78 -4581329.78 0.98667965 × 10 <sup>-3</sup> 0.24329879 × 10 <sup>-3</sup> -0.59584872 × 10 <sup>-6</sup> 0.97166167 × 10 <sup>-7</sup> water, air 10 κΩ 5.0 ± 1.2 mW/K 0.45 ± 0.11 s	in S.S. Housing General Purpose Clinical -4 Laboratory Temperature, Measurement -10 to 60 °C 1 ( $\pm$ 0.01 °C) -10 to 60 °C Non-interchangeable Non-interchangeable -3.7563605 3614.7764 88190.906 -22328247 0.98019160 × 10 <sup>-3</sup> 0.28330667 × 10 <sup>-3</sup> -0.28303328 × 10 <sup>-5</sup> 0.24131652 × 10 <sup>-6</sup> all fluids compatible with Type 304 S.S. 5 $\kappa\Omega$ 4.8 $\pm$ 1.2 mW/K 4.5 $\pm$ 1.1 s	Sensor in S.S. Housing General Purpose Clinical - Laboratory Temperature Measurement -10 to 60 °C 1 (±0.01 °C) -10 to 60 °C Non-interchangeable -3.7563605 3614.7764 88190.906 -22328247 0.98019160 $\times 10^{-3}$ 0.28530667 $\times 10^{-3}$ 0.28303328 $\times 10^{-5}$ 0.24131652 $\times 10^{-6}$ all fluids compatible with Type 304 S.S. 5 κΩ 4.8 $\pm 1.2$ mW/K 4.5 $\pm 1.1$ s
https://standards.iteh.ai/ca Operating Temperature Range Accuracy Class Temperatures for Accuracy Class Accuracies for other Temperatures Within Specified Temperature Range Calibration Type Nominal <i>R</i> - <i>T</i> Characteristic $R = \exp[A_0 + A_1/T + A_2/T^2 + A_3/T^3]$ $T(\ ^{\circ}C) = [a_0 + a_1LnR + a_2(LnR)^2 + a_3(LnR)^3]^{-1} - 273.15$ $A_0$ $A_1$ $A_2$ $A_3$ $a_0$ $a_1$ $a_2$ $a_3$ Type of Immersion Fluid $R_0$ at 25 °C Dissipation Constant 63.2 % Response Time	Laboratory Temperature (b.9.7 Measurement -10 to 105 °C 2 ( $\pm$ 0.02 °C) -10 to 105 °C Non-interchangeable -4.3332974 4440.1603 -104525.78 -4581329.78 0.98667965 × 10 <sup>-3</sup> 0.24329879 × 10 <sup>-3</sup> -0.59584872 × 10 <sup>-6</sup> 0.97166167 × 10 <sup>-7</sup> water, air 10κΩ 3.5 ± 0.9 mW/K	General Purpose Clinical Laboratory Temperature Measurement -10 to 105 °C $2 (\pm 0.02 °C)$ -10 to 105 °C Non-interchangeable -4.3332947 4440.1603 -104525.78 -4581329.78 0.98667965 × 10 <sup>-3</sup> 0.24329879 × 10 <sup>-3</sup> -0.59584872 × 10 <sup>-6</sup> 0.97166167 × 10 <sup>-7</sup> water, air 10 κΩ 5.0 ± 1.2 mW/K	in S.S. Housing General Purpose Clinical -4 Laboratory Temperature Measurement -10 to 60 °C 1 ( $\pm$ 0.01 °C) -10 to 60 °C Non-interchangeable -3.7563605 3614.7764 88190.906 -22328247 0.98019160 × 10 <sup>-3</sup> 0.28530667 × 10 <sup>-3</sup> -0.28303328 × 10 <sup>-5</sup> 0.24131652 × 10 <sup>-6</sup> all fluids compatible with Type 304 S.S. 5 $\kappa\Omega$ 4.8 $\pm$ 1.2 mW/K	Sensor in S.S. Housing General Purpose Clinical - Laboratory Temperature Measurement -10 to 60 °C 1 ( $\pm$ 0.01 °C) -10 to 60 °C Non-interchangeable -3.7563605 3614.7764 88190.906 -22328247 0.98019160 × 10 <sup>-3</sup> 0.28530667 × 10 <sup>-3</sup> -0.28303328 × 10 <sup>-5</sup> 0.24131652 × 10 <sup>-6</sup> all fluids compatible with Type 304 S.S. 5 $\kappa \Omega$ 4.8 $\pm$ 1.2 mW/K

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## TABLE 1 (continued)

ASTM NO.         E879 0 RM         E879 H B1N         E879 0 A2N         E879 H A2N           Description         10 44 We Non- meterbangable Senor in S.3. Housing of Application         10 a12 With Non- meterbangable Senor in S.3. Housing S.3. Housing			TABLE 1(continued)		
Interchangeable Sensor In S.S. Housing General Purpose Chical Mage Application         Interchangeable Sensor In S.S. Housing General Purpose Chical Magaryment         Interchangeable Magaryment           Comments Finance Magery Chine General Purpose Chical Magaryment         Interchangeable         Non-Interchangeable         Non-Interchangeable         Non-Interchangeable           Nommal P.7 Charschereter R = ext[A, 4, 4, 7, 4, 7, 7 4, 4, 2, 2, 7, 7, 7, 7, 7, 7, 7, 7, 7, 7, 7, 7, 7,	ASTM No.	E879 G B1N	E879 H B1N	E879 G A2N	E879 H A2N
Accuracy Class         1 (±0.01 *C)         1 (±0.01 *C)         2 (±0.02 *C)         -10 to 105 *C           Class         Accuracy for Accuracy         -10 to 80 *C         -10 to 80 *C         -10 to 105 *C           Class         Morning AF Characteristic         Non-interchangeable         Non-interchangeable         Non-interchangeable           Within Spacing         Total (Labor *C)         -35684419         -37191550         -37191550           A accuracy (Labor *C)         -3997 7965         3367 7955         -3464 1960         -494 1960           A accuracy (Labor *C)         -18066997         -1806997         -14472122         -14472122           A accuracy (Labor *C)         -201733335 × 10 <sup>-3</sup> 0.28158041 × 10 <sup>-3</sup> 0.28859144 × 10 <sup>-3</sup> 0.28859144 × 10 <sup>-3</sup> A accuracy (Labor *C)         -18066997         -1806997         -14472122         -14472122         -1447212           A accuracy (Labor *C)         -0.28169100 × 10 <sup>+5</sup> -0.28169100 × 1	·	interchangeable Sensor in S.S. Housing General Purpose Clinical Laboratory Temperature	interchangeable Sensor in S.S. Housing General Purpose Clinical Laboratory Temperature	interchangeable Sensor in S.S. Housing General Purpose Clinical Laboratory Temperature	interchangeable Sensor in S.S. Housing General Purpose Clinical Laboratory Temperature
Temperatures for Accuracy Case Accuracies for other Accuracies for other Response Nominal Re, at 25 °C         -10 to 80 °C         -10 to 80 °C         -10 to 105 °C<					
Class Recuracies for other Temperatures Manual R- Characteristic R = exp(A, +, A/T + A/T + A/T)         Non-interchangeable         Non-interchangeable <td>-</td> <td>. ,</td> <td></td> <td>. ,</td> <td>. ,</td>	-	. ,		. ,	. ,
Acuration for other Timporatures Within Specified Temperatures Parage         Non-interchangeable         -37191520         -37191520         -37191520         -37191520         -37191520         -40451106 <td></td> <td>-10 to 60 °C</td> <td>-10 to 60 °C</td> <td>–10 to 105 °C</td> <td>–10 to 105 °C</td>		-10 to 60 °C	-10 to 60 °C	–10 to 105 °C	–10 to 105 °C
Calibration Type Nominal PT Characteristic R = sort (A + A/T + A/T + A/T)         Non-interchangeable         Non-interchangeable         Non-interchangeable         Non-interchangeable           Nominal PT Characteristic R = sort (A + A/T)         -3.5684019         -3.5684019         -3.7191520         -3.7191520         -3.7191520           A, A, A, A, A, A, A, A, A, A, A, A, A, A	Accuracies for other Temperatures Within Specified Temperature	9			
Nominal R-1 Characteristic R = exp(A_+ + 1/4)T <sup>2</sup> + A_1T <sup>2</sup> T	5	Non-interchangeable	Non-interchangeable	Non-interchangeable	Non-interchangeable
$ a_{4} (m^{3})^{-1} - 273.15 \\ A_{5} \\ 3907.7065 \\ 3907.7065 \\ 3907.7065 \\ 3907.7065 \\ 3907.7065 \\ 3907.7065 \\ 4045.1666 \\ 4045.166 \\ 4$	Nominal <i>R</i> - <i>T</i> Characteristic $R = \exp[A_0 + A_1/T + A_2/T^2 + A_3/T^3]$ <i>T</i> (	, , , , , , , , , , , , , , , , , , ,	Non merchangeable	Non meteraligeable	non meronangeable
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$					
$ \begin{array}{cccccc} A_{2} & 33480.382 & 33480.382 & -1011.100 & -1017.100 \\ A_{3} & -16866997 & -16866997 & -14472122 & -14472122 & -14472122 \\ a_{4} & 0.26734335 \times 10^{-3} & 0.26866997 & -1447212 & -14472122 & -14472122 \\ a_{5} & 0.26867428 \times 10^{-3} & 0.28898144 \times 10^{-3} & 0.28989144 \times 10^{-3} \\ -2.2089100 \times 10^{-6} & 0.2687428 \times 10^{-6} & 0.2685208 \times 10^{-3} & 0.2685208 \times 10^{-3} \\ -2.2089100 \times 10^{-6} & 0.2087428 \times 10^{-6} & 0.97837898 \times 10^{-6} & 0.97837898 \times 10^{-6} \\ -2.2089100 \times 10^{-6} & 0.2087428 \times 10^{-6} & 0.97837898 \times 10^{-6} & 0.97837898 \times 10^{-6} & 0.97837898 \times 10^{-6} & 0.97837898 \times 10^{-6} \\ -2.2089100 \times 10^{-6} & 0.9847428 \times 10^{-6} & 0.9898144 \times 10^{-3} & 0.2812828 \times 10^{-6} & 0.9847428 \times 10^{-6} & 0.98488 \times 10^{-6} & 0.984888 \times 10^{-6} & 0.98488 \times 10^{-6} & 0.984888 \times 10^{-$					
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$					
$ \begin{array}{c} a_{0} \\ a_{1} \\ 0.26972495 \times 10^{-3} \\ 0.26972495 \times 10^{-9} \\ 0.26975495 \times 10^{-9} \\ 0.26975495 \times 10^{-9} \\ 0.26975495 \times 10^{-9} $					
$a_1^{-1}$ 0.27133335 × 10 <sup>-3</sup> 0.2815206 × 10 <sup>-3</sup> 0.2615206 × 10 <sup>-3</sup> 0.2615206 × 10 <sup>-3</sup> $a_2^{-1}$ 0.20648100 × 10 <sup>-5</sup> 0.20547429 × 10 <sup>-6</sup> 0.37537969 × 10 <sup>-6</sup> 0.37537969 × 10 <sup>-6</sup> $T_{Pe}$ of Immersion Fuld       Ilbuids compatible with Type       all fluids compatible with Type       all fluids compatible with Type         Nominal $R_{g}$ at 25 °C       10 × 10       -0.45       -0.46       -0.46         0.62 % Response Time       4.8 ± 1.2 mWK       4.8 ± 1.2 mWK       4.8 ± 1.2 mWK       4.8 ± 1.2 mWK         6.2 % Response Time       5.2 ± 1.1 s       4.5 ± 1.1 s       4.5 ± 1.1 s       4.5 ± 1.1 s         Besign and Construction       Fig. 4       Fig. 5       Fig. 4       Fig. 5       Fig. 4         Description       Interchangeable Sensor Enclosed in 1.17 mm Plastic Tube       Cuvette Thermometry Cuvette Thermometry       Cuvette Thermometry         Operating Temperatures float       10 to 3C °C       -10 to 60 °C       -01 to 60 °C         Accuracy Class       3 (± 0.0 5 °C)       3 (± 0.0 5 °C)       -01 to 60 °C         Acuracy Class       3 (± 0.0 5 °C)       -3 (± 0.0 5 °C)       -01 to 60 °C         Class Class       -10 to 64 °C : ± 0.1 °C       -10 to 60 °C       -10 to 60 °C         Acuracy Class					
$a_8$ -0.2068100 \times 10^{-6}       -0.2068100 \times 10^{-6}       -0.27537960 \times 10^{-6}       -0.27537960 \times 10^{-6}         Type of Immersion Fluid       all fluids compatible with Type       304 S.S.       10 s.1       0.16613282 \times 10^{-9}       all fluids compatible with Type         Shows and the set 1.2 mWK       4.8 ± 1.2 mWK       4.5 ± 1.1 s       <					
Type of Immersion Fluid       all fluids compatible with Type       a					
$\begin{array}{cccccccccccccccccccccccccccccccccccc$					
$ \begin{array}{l c c c c c c c c c c c c c c c c c c c$	Type of Immersion Fluid		1 21		
Dissipation Constant Basize Arageonse Time Ratio of 95 % to 63.2 % Response Times Design and Construction Table 2.6 $\pm$ 0.3 ASTM No. E379 V B3I Construction Fig. 4 ASTM No. E379 V B3I Construction Fig. 4 ASTM No. E379 V B3I Construction Fig. 4 ASTM No. E379 V B3I Construction Fig. 4 ASTM No. E379 V B3I Construction Fig. 4 Fig. 5 Fig. 4 Fig. 4 Fig. 5 Fig. 4 Fig. 4 Fig. 5 Fig. 4 Fig. 4 Fig. 5 Fig. 4 Fig. 4	Nominal <i>B</i> <sub>2</sub> at 25 °C				
Ratio of 95 % to 63.2 % mass       2.6 $\pm$ 0.3       2.6 $\pm$ 0.3       2.6 $\pm$ 0.3       2.6 $\pm$ 0.3         Design and Construction       Fig. 4       Fig. 5       Fig. 4       Fig. 5         ASTM No.       E879 V B31       E879 W B3N       Fig. 4       Fig. 5         Description       Interchangeable Sensor Enclosed in 1.17 mm Plastic Tube       Non-interchangeable Sensor Enclosed in 0.52 mm Plastic       Fig. 4       Fig.					
Response Times         Fig. 4         Fig. 4         Fig. 4         Fig. 5           Description         Interchangeable Sensor Enclosed in 1.17 mm Plastic Tube         E879 V B3N         E879 V B3N           Operating Temperature Range Accuracy Class         Interchangeable Sensor Enclosed in 0.52 mm Plastic         Tube         Tube           Accuracy Class         3 (±0.05 °C)         -10 to 60 °C         -01 to 60 °C         -01 to 60 °C           Accuracy Class         3 (±0.05 °C)         -10 to 60 °C         -10 to 60 °C         -10 to 60 °C           Accuracy Class         -10 to 24 °C: ±0.1 °C         -10 to 60 °C         -10 to 60 °C         -10 to 60 °C           Accuracy Class         -10 to 24 °C: ±0.1 °C         -10 to 60 °C         -10 to 60 °C         -10 to 60 °C           Accuracy Class         -10 to 24 °C: ±0.1 °C         -10 to 60 °C         -10 to 60 °C         -10 to 60 °C           Calibration Type         Interchangeable         Non-interchangeable         Non-interchangeable         Non-interchangeable           Nominal <i>R-T</i> Characteristic         -3.1645305         -3.0612396         -3.1645305         -3.0612396           Ag         -10323203         -22380305         -0.30427027 × 10^-3         -22880305         -3.0812396           Ag         -0.281287604 × 10^-3         0.280858	•	4.5 ± 1.1 s	4.5 ± 1.1 s	4.5± 1.1 s	4.5 ± 1.1 s
$\begin{tabular}{ c c c c c c c c c c c c c c c c c c c$	Response	2.6 ± 0.3 10 S://S	2.6 ± 0.3 0 arcis.	2.6 ± 0.3	2.6 ± 0.3
DescriptionInterchangeable Sensor Enclosed in 1.17 mm PlasticNon-interchangeable Sensor Enclosed in 0.92 mm PlasticMajor ApplicationCuvette Thermometry $0$ perating Temperature RangeOverte Thermometry $3 (\pm 0.05  ^{\circ}C)$ Cuvette Thermometry $4.56 - 8.492 - 4310414650 e/a stm - e8.79 - 012007$ Operating Temperature Range $-10 to 60  ^{\circ}C$ $3 (\pm 0.05  ^{\circ}C)$ $3 (\pm 0.05  ^{\circ}C)$ $3 (\pm 0.05  ^{\circ}C)$ $3 (\pm 0.05  ^{\circ}C)$ Temperatures $24 to 45  ^{\circ}C$ $2 (\pm 0.45  ^{\circ}C)$ $-10 to 60  ^{\circ}C$ Accuracy Class $-10 to 24  ^{\circ}C : \pm 0.1  ^{\circ}C$ MargeCalibration Type Calibration TypeInterchangeableNon-interchangeableAg-3.1645305-3.0612396Ag-0.2	Design and Construction	Fig. 4	Fig. 5 Drov	Fig. 4	Fig. 5
Enclosed in 1.17 mm Plastic TubeEnclosed in 0.92 mm Plastic TubeMajor Application Operating Temperature Range Accuracy ClassCuvette Thermometry $-10 to 60 °C$ $-10 to 60 °CAccuracy Class3 (± 0.05 °C)3 (\pm 0.05 °C)Cuvette Thermometry-10 to 60 °CCalssA (± 0.05 °C)-10 to 60 °C-10 to 60 °CAccuracy Class41 to 45 °C-10 to 24 °C: \pm 0.1 °CTemperaturesmange45 to 60 °C: \pm 0.1 °CCalibration TypeRangeInterchangeableNominal R-T CharacteristicR = exp(A, A, I, T A_2/T^2 + A, I, A, I, I A_2/T^2 + A, I, A, I, I A_2/T^2 + $	ASTM No.	E879 V B3I	E879 W B3N		
$\begin{array}{l c c c c c c c c c c c c c c c c c c c$	Description	Enclosed in 1.17 mm Plastic	Enclosed in 0.92 mm Plastic		
$ \begin{array}{llllllllllllllllllllllllllllllllllll$					
Temperatures for Accuracy       24 to 45 °C       -10 to 60 °C         Class       -10 to 24 °C: $\pm 0.1$ °C         Accuracies for other       -10 to 24 °C: $\pm 0.1$ °C         Temperatures       45 to 60 °C: $\pm 0.1$ °C         Within Specified Temperature       -10 to 60 °C         Range       -10 to 60 °C         Calibration Type       Interchangeable         Nominal <i>R</i> -7 Characteristic       Non-interchangeable <i>R</i> = exp[A <sub>0</sub> + A <sub>1</sub> / <i>T</i> + A <sub>2</sub> / <i>T</i> ° +        -4 <i>A</i> <sub>1</sub> /T <sup>2</sup> -10 to 60 °C         T(       -0.10 to 24 °C: $\pm 0.1$ °C         ***       -10 to 60 °C         A <sub>0</sub> -3.1645305         -3.0612396       -3.0612396         A <sub>1</sub> 3763.4399         3613.0051       -23.0612396         A <sub>2</sub> 47616.278         A <sub>3</sub> -1833203         -22380305       -23.0612396         A <sub>3</sub> 0.2886784 × 10 <sup>-3</sup> A <sub>2</sub> 47616.278         A <sub>3</sub> 0.2886784 × 10 <sup>-3</sup> A <sub>2</sub> 0.2886784 × 10 <sup>-3</sup> A <sub>3</sub> 0.2886784 × 10 <sup>-3</sup> A <sub>3</sub> 0.2085292 × 10 <sup>-5</sup> A <sub>3</sub> 0.2085292 × 10 <sup>-5</sup> A <sub>3</sub>					
$\begin{array}{llllllllllllllllllllllllllllllllllll$	-	. ,			
Temperatures       45 to 60 °C: ±0.1 °C         Within Specified Temperature       Non-interchangeable         Range       Interchangeable         Calibration Type       Interchangeable         Norninal <i>R</i> - <i>T</i> Characteristic       Range $R = exp[A_0 + A_1/T + A_2/T^2 + A_3/T^2]$ - $T($ °C) = [a_0 + a_1LR + a_2(LnR)^2 + a_3(LnR)^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 $a_0$ 0.7866094 × 10^{-3}       0.78068958 × 10^{-3} $a_1$ 0.28128740 × 10^{-3}       0.28967541 × 10^{-3} $a_1$ 0.28128740 × 10^{-3}       0.28967541 × 10^{-3} $a_1$ 0.28052922 × 10^{-6}       0.241696589 × 10^{-3} $a_1$ 0.28052922 × 10^{-6}       0.2416971 × 10^{-6}         Type of Immersion Fluid       water       water         Nornial $R_0$ at 25 °C       11 $\kappa \Omega$ 10 $\kappa \Omega$ Dissipation Constant       11 $\kappa \Omega$ 0.24 MW/K         063.2 % Response Time       0.5 $\pm 0.12$ s       0.26 $\pm 0.06$ s         Ratio of 95 % to 63.2 % <t< td=""><td></td><td>10 1- 01 00- 101 00</td><td></td><td></td><td></td></t<>		10 1- 01 00- 101 00			
Within Specified Temperature Range         Vithin Specified Temperature Range           Calibration Type         Interchangeable         Non-interchangeable           Nominal $R$ - $T$ Characteristic         Image Range					
Calibration Type         Interchangeable         Non-interchangeable           Nominal $R$ -T Characteristic         R = exp[A_0 + A_1/T + A_2/T^2 + A_3/T^2]         Non-interchangeable $A_0/T^2$ ]         R = exp[A_0 + A_1/T + A_2/T^2 + A_3/T^2]         Non-interchangeable           T(         r         r $\alpha_0(LR)^3$ ] <sup>-1</sup> - 273.15         -3.1645305         -3.0612396 $A_1$ 3763.4399         3613.0051 $A_2$ 47816.278         88718.122 $A_3$ -18332303         -22380305 $a_0$ 0.78686094 × 10 <sup>-3</sup> 0.78069589 × 10 <sup>-3</sup> $a_1$ 0.28128740 × 10 <sup>-3</sup> 0.28067541 × 10 <sup>-3</sup> $a_2$ -0.25226292 × 10 <sup>-6</sup> 0.24169639 × 10 <sup>-6</sup> Nominal $R_0$ at 25 °C         11 $\kappa \Omega$ 10 $\kappa \Omega$ Dissipation Constant         1.1 $\pm 0.3$ mW/K         0.8 $\pm 0.2$ mW/K           63.2 % Response Time         0.5 $\pm 0.12$ s         0.26 $\pm 0.06$ s           Ratio of 95 % to 63.2 %         3.0 $\pm 0.3$ 3 $\pm 0.3$	Within Specified Temperature				
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	Calibration Type Nominal <i>R</i> - <i>T</i> Characteristic $R = \exp[A_0 + A_1/T + A_2/T^2 + A_3/T^3]$	Interchangeable	Non-interchangeable		
$A_1$ 3763.43993613.0051 $A_2$ 47816.27888718.122 $A_3$ -18332303-22380305 $a_0$ 0.78686094 × 10 <sup>-3</sup> 0.78069589 × 10 <sup>-3</sup> $a_1$ 0.28128740 × 10 <sup>-3</sup> 0.28957541 × 10 <sup>-3</sup> $a_2$ -0.25226292 × 10 <sup>-5</sup> -0.38427027 × 10 <sup>-5</sup> $a_3$ 0.20852922 × 10 <sup>-6</sup> 0.24169639 × 10 <sup>-6</sup> Type of Immersion FluidwaterwaterNominal $R_0$ at 25 °C11 $\kappa \Omega$ 10 $\kappa \Omega$ Dissipation Constant1.1 ± 0.3 mW/K0.8 ± 0.2 mW/K63.2 % Response Time0.5 ± 0.12 s0.26 ± 0.06 sRatio of 95 % to 63.2 %3.0 ± 0.33 ± 0.3Response TimesTimes					
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$					
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$					
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	<i>A</i> <sub>1</sub>	3763.4399	3613.0051		
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	$A_1$ $A_2$	3763.4399 47816.278	3613.0051 88718.122		
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	A <sub>1</sub> A <sub>2</sub> A <sub>3</sub>	3763.4399 47816.278 −18332303 0.78686094 × 10 <sup>-3</sup>	3613.0051 88718.122 -22380305 0.78069589 × 10 <sup>-3</sup>		
$ \begin{array}{cccccc} \hline Type \mbox{ of Immersion Fluid} & water & water \\ \hline Nominal $R_0$ at 25 °C & 11 $\kappa\Omega & 10 $\kappa\Omega$ \\ \hline Dissipation Constant & 1.1 $\pm 0.3 $mW/K$ & 0.8 $\pm 0.2 $mW/K$ \\ \hline 63.2 % \mbox{ Response Time} & 0.5 $\pm 0.12 $s$ & 0.26 $\pm 0.06 $s$ \\ \hline Ratio of 95 % to 63.2 % & 3.0 $\pm 0.3$ & 3 $\pm 0.3$ \\ \hline Response & \\ \hline Times & \\ \end{array} $	A <sub>1</sub> A <sub>2</sub> A <sub>3</sub> a <sub>0</sub> a <sub>1</sub>	$\begin{array}{l} 3763.4399 \\ 47816.278 \\ -18332303 \\ 0.78686094 \times 10^{-3} \\ 0.28128740 \times 10^{-3} \end{array}$	$\begin{array}{c} 3613.0051 \\ 88718.122 \\ -22380305 \\ 0.78069589 \times 10^{-3} \\ 0.28967541 \times 10^{-3} \end{array}$		
Nominal $R_0$ at 25 °C         11 κΩ         10 κΩ           Dissipation Constant         1.1 ± 0.3 mW/K         0.8 ± 0.2 mW/K           63.2 % Response Time         0.5 ± 0.12 s         0.26 ± 0.06 s           Ratio of 95 % to 63.2 %         3.0 ± 0.3         3 ± 0.3           Response         Times	A <sub>1</sub> A <sub>2</sub> A <sub>3</sub> a <sub>0</sub> a <sub>1</sub> a <sub>2</sub>	$\begin{array}{l} 3763.4399 \\ 47816.278 \\ -18332303 \\ 0.78686094 \times 10^{-3} \\ 0.28128740 \times 10^{-3} \\ -0.25226292 \times 10^{-5} \end{array}$	$\begin{array}{c} 3613.0051 \\ 88718.122 \\ -22380305 \\ 0.78069589 \times 10^{-3} \\ 0.28967541 \times 10^{-3} \\ -0.38427027 \times 10^{-5} \end{array}$		
Dissipation Constant       1.1 ± 0.3 mW/K       0.8 ± 0.2 mW/K         63.2 % Response Time       0.5 ± 0.12 s       0.26 ± 0.06 s         Ratio of 95 % to 63.2 %       3.0 ± 0.3       3 ± 0.3         Response       Times       V	A <sub>1</sub> A <sub>2</sub> A <sub>3</sub> a <sub>0</sub> a <sub>1</sub> a <sub>2</sub> a <sub>3</sub>	$\begin{array}{c} 3763.4399\\ 47816.278\\ -18332303\\ 0.78686094\times 10^{-3}\\ 0.28128740\times 10^{-3}\\ -0.25226292\times 10^{-5}\\ 0.20852922\times 10^{-6} \end{array}$	$\begin{array}{c} 3613.0051 \\ 88718.122 \\ -22380305 \\ 0.78069589 \times 10^{-3} \\ 0.28967541 \times 10^{-3} \\ -0.38427027 \times 10^{-5} \\ 0.24169639 \times 10^{-6} \end{array}$		
Ratio of 95 % to 63.2 %     3.0 ± 0.3     3 ± 0.3       Response     Times	A <sub>1</sub> A <sub>2</sub> A <sub>3</sub> a <sub>0</sub> a <sub>1</sub> a <sub>2</sub> a <sub>3</sub> Type of Immersion Fluid	$\begin{array}{c} 3763.4399 \\ 47816.278 \\ -18332303 \\ 0.78686094 \times 10^{-3} \\ 0.28128740 \times 10^{-3} \\ -0.25226292 \times 10^{-5} \\ 0.20852922 \times 10^{-6} \\ water \end{array}$	$\begin{array}{c} 3613.0051 \\ 88718.122 \\ -22380305 \\ 0.78069589 \times 10^{-3} \\ 0.28967541 \times 10^{-3} \\ -0.38427027 \times 10^{-5} \\ 0.24169639 \times 10^{-6} \\ water \end{array}$		
Response Times	$A_1$ $A_2$ $A_3$ $a_0$ $a_1$ $a_2$ $a_3$ Type of Immersion Fluid Nominal $R_0$ at 25 °C	3763.4399 47816.278 -18332303 0.78686094 × 10 <sup>-3</sup> 0.28128740 × 10 <sup>-3</sup> -0.25226292 × 10 <sup>-5</sup> 0.20852922 × 10 <sup>-6</sup> water 11 κΩ	$\begin{array}{c} 3613.0051 \\ 88718.122 \\ -22380305 \\ 0.78069589 \times 10^{-3} \\ 0.28967541 \times 10^{-3} \\ -0.38427027 \times 10^{-5} \\ 0.24169639 \times 10^{-6} \\ water \\ 10 \ \kappa\Omega \end{array}$		
Design and Construction Fig. 6 Fig. 7	$\begin{array}{c} A_1 \\ A_2 \\ A_3 \\ a_0 \\ a_1 \\ a_2 \\ a_3 \\ Type of Immersion Fluid \\ Nominal R_0 at 25 \ ^{\circ}C \\ Dissipation Constant \\ 63.2 \ \% \ Response Time \end{array}$	$\begin{array}{l} 3763.4399 \\ 47816.278 \\ -18332303 \\ 0.78686094 \times 10^{-3} \\ 0.28128740 \times 10^{-3} \\ -0.25226292 \times 10^{-5} \\ 0.20852922 \times 10^{-6} \\ \text{water} \\ 11 \ \kappa\Omega \\ 1.1 \ \pm \ 0.3 \ \text{mW/K} \\ 0.5 \ \pm \ 0.12 \ \text{s} \end{array}$	$\begin{array}{l} 3613.0051 \\ 88718.122 \\ -22380305 \\ 0.78069589 \times 10^{-3} \\ 0.28967541 \times 10^{-3} \\ -0.38427027 \times 10^{-5} \\ 0.24169639 \times 10^{-6} \\ water \\ 10 \ \kappa\Omega \\ 0.8 \ \pm \ 0.2 \ mW/K \\ 0.26 \ \pm \ 0.06 \ s \end{array}$		
	$\begin{array}{c} A_1 \\ A_2 \\ A_3 \\ a_0 \\ a_1 \\ a_2 \\ a_3 \\ Type of Immersion Fluid \\ Nominal R_0 at 25 \ ^{\circ}C \\ Dissipation Constant \\ 63.2 \ ^{\circ}{\circ} Response Time \\ Ratio of 95 \ ^{\circ}{\circ} to 63.2 \ ^{\circ}{\circ} \\ Response \\ Times \end{array}$	$\begin{array}{l} 3763.4399 \\ 47816.278 \\ -18332303 \\ 0.78686094 \times 10^{-3} \\ 0.28128740 \times 10^{-3} \\ -0.25226292 \times 10^{-5} \\ 0.20852922 \times 10^{-6} \\ \text{water} \\ 11 \ \kappa\Omega \\ 1.1 \ \pm \ 0.3 \ \text{mW/K} \\ 0.5 \ \pm \ 0.12 \ \text{s} \end{array}$	$\begin{array}{l} 3613.0051 \\ 88718.122 \\ -22380305 \\ 0.78069589 \times 10^{-3} \\ 0.28967541 \times 10^{-3} \\ -0.38427027 \times 10^{-5} \\ 0.24169639 \times 10^{-6} \\ water \\ 10 \ \kappa\Omega \\ 0.8 \ \pm \ 0.2 \ mW/K \\ 0.26 \ \pm \ 0.06 \ s \end{array}$		

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.

4.2.1 *Type Designation*—The type designation shall be a letter symbol to indicate the design and construction of the thermistor sensor.

4.2.1.1 *Type S*—Silicone rubber-coated glass probe with tinned Dumet extension leads (see Fig. 2).

4.2.1.2 *Type E*—Epoxy-coated glass probe with silverplated copper extension leads (see Fig. 3).

4.2.1.3 *Type G*—General purpose four wire sensor in stainless steel housing (see Fig. 4).

4.2.1.4 *Type H*—General purpose two-wire sensor in stainless steel housing (see Fig. 5).

4.2.1.5 *Type V*—Interchangeable sensor enclosed in 1.2-mm vinyl tube (see Fig. 6).

4.2.1.6 *Type W*—Non-interchangeable sensor enclosed in 0.9-mm vinyl tube (see Fig. 7).

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

#### 5. Requirements

5.1 *Specifications*—Sensors shall comply with the general 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 2 Equivalent Temperature Tolerances for Different Class Sensors (See 4.1 and 4.4)

Accuracy	Temperature
Class	Tolerance, °C
1	±0.02
2	±0.03
3	±0.05
4	±0.1

can be obtained from that relationship and have an uncertainty no greater than one-tenth the specified tolerance in Table 2. When tested in accordance with 7.2, the zero-power resistance versus temperature relationship for interchangeable parts shall comply to within the tolerance specified in Table 2. The manufacturer of the sensor shall, for non-interchangeable parts, supply this relationship with each part shipped.

5.2.1 Accuracy—The resistance-temperature relationship, provided in Table 1, or with the sensor, or both, shall not differ from that obtained from measurements made in accordance with 7.2 by more than the tolerances specified in Table 2 for the applicable intervals specified in Table 1.

5.3 Thermal Requirements:

5.3.1 *Dissipation Constant*—When tested in accordance with 7.3, the dissipation constant shall be as specified in the detailed specification.

5.3.2 *Response Time*—When tested in accordance with 7.4, the response time or time constant, or both, shall be as specified in the detailed specification.

5.4 Environmental Requirements:

5.4.1 *Operating Temperature Range*—The operating temperature range shall be as specified in the type designation code (see 4.1 and 4.3).

5.4.2 Storage Temperature Range—Sensors shall be capable of meeting all requirements specified herein as well as those listed in the applicable detailed specification after storage at any temperature (or combination thereof) in the range from -40 to 60 °C for a period of 1 year.

5.4.3 *Humidity Requirement*—Sensors shall be capable of being operated or stored at relative humidity from 0 to 95 % without condensation.

5.5 *Stability*:

5.5.1 Short-Term Stability (10 days)—When tested in accordance with 7.5.1, the equivalent temperature shift shall be no greater than 10 % of the tolerance shown in Table 2 for the accuracy class specified.

5.5.2 Long-Term Stability (120 days)—When tested in accordance with 7.5.2, the equivalent temperature shift shall be no greater than 25 % of the tolerance shown in Table 2 for the accuracy class specified.

5.6 *Low-Temperature Storage*—When tested in accordance with 7.6, there shall be no evidence of mechanical damage and the sensor shall comply with the accuracy requirements of 5.2.

5.7 *Thermal Shock*—When tested in accordance with 7.7, there shall be no evidence of mechanical damage and the sensor shall comply with the accuracy requirements of 5.2.

5.8 Insulation Resistance:

5.8.1 *Dry Test*—This requirement shall apply to sensors that have exposed metallic surfaces, but are not designed for immersion in conductive fluids. When tested in accordance with 7.8.1, there shall be no evidence of mechanical damage and the insulation resistance shall be sufficiently high that its shunting effect will not prevent the unit from complying with the accuracy requirement of Table 2. In no case shall the insulation resistance be less than  $10^8$  ohms.

5.8.2 *Wet Test*—This requirement shall apply to sensors that are designed for use in conductive solutions. When tested in

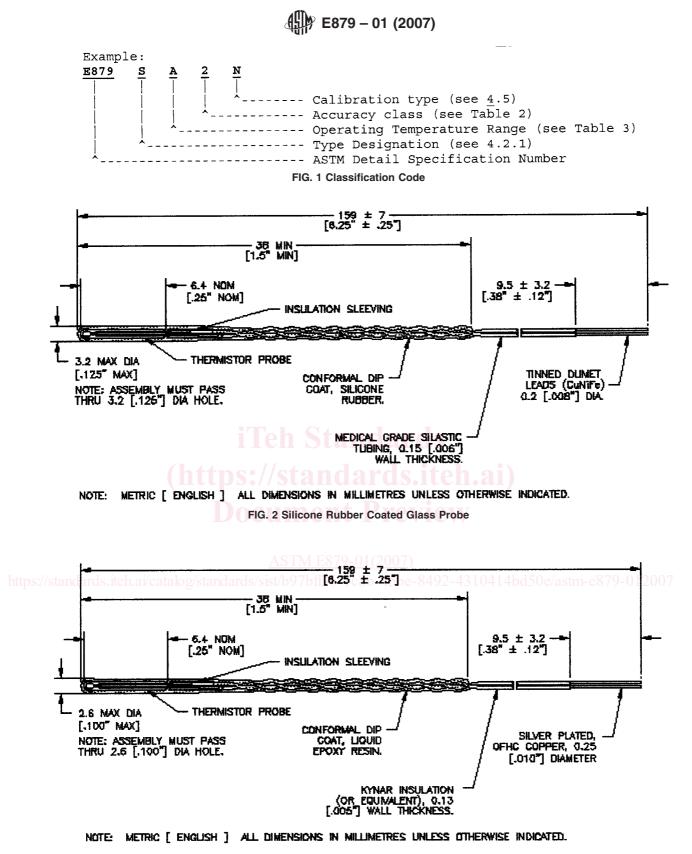
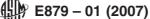
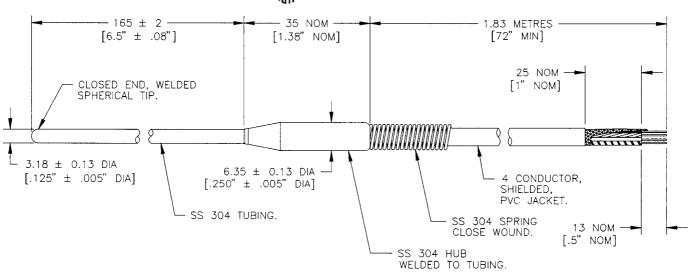


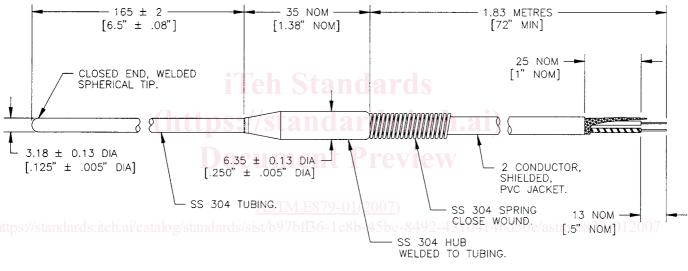
FIG. 3 Epoxy Coated Glass Probe

accordance with 7.8.2, there shall be no evidence of mechanical damage and the insulation resistance shall be sufficiently high that its shunting effect will not prevent the unit from





Note 1—Metric (English) All dimensions in millimetres unless otherwise indicated. FIG. 4 General Purpose Four-Wire Sensor in Stainless Steel Housing



Note 1—Metric (English) All dimensions in millimetres unless otherwise indicated. FIG. 5 General Purpose Two-Wire Sensor in Stainless Steel Housing

complying with the accuracy requirement of Table 2. In no case shall the insulation resistance be less than  $10^8$  ohms.

## 6. Quality Assurance Provisions

6.1 *General*—The methods of examination and tests contained in Section 7 are to be used to determine the conformance of sensors to the requirements of this specification. Each manufacturer or distributor who represents his products as conforming to this specification may, as agreed upon between the purchaser and seller, use statistically based sampling plans that are appropriate for each inspection lot. Records shall be kept as necessary to document the claim that all of the requirements of this specification are met. The tests specified in this section are intended as minimum requirements. Additional sampling and testing of the product, as may be agreed upon between the purchaser and the seller, are not precluded by this section.

## 6.2 Classification of Inspection:

6.2.1 *Qualification Tests*—Qualification tests shall be performed for each basic design manufactured in accordance with this specification. The sample size required for the tests conducted shall be in accordance with Table 4. In order for a design to qualify, there shall be no failures resulting from any of the tests.

6.2.2 *Responsibility for Qualification Testing*—The manufacturer shall perform qualification testing, at least once, for each basic design for which this specification applies. If a basic design incorporates more than one resistance value of a specific