THERMISTOR PROBES

GEOKON®

MODEL 3800

Model 3800HT, Model 3800-2-1, and Model 3800-1-1 Thermistor Probes (top to bottom).

APPLICATIONS

The Model 3800 Thermistors are designed for measuring temperature in:

- Rock
- Soil
- Concrete
- Landfills
- Permafrost

Model 3800HT-SS Thermistor Probe shown with 316 stainless steel sheathed cable.

OPERATING PRINCIPLE

Model 3800 Thermistor Probes are supplied inside a housing at the end of a cable ready to be attached to a structure, installed in concrete, or buried in the ground. The housing is made from PVC (Models 3800-1 and 3800-3), or stainless steel (Model 3800-2). For OEM applications, thermistors are potted in epoxy and covered with a clear heat shrink (Model 3800-1-1-1 and 3800-1-2-1). Thermistor Probes are particularly well suited for measuring the heat of hydration in concrete and RCC dams.

Standard temperature range is –20 °C to +80 °C. The Model 3800HT is a high temperature version in a stainless steel housing for use up to 230 °C. Other ranges available on request.

Thermistors are semiconductors, which behave as thermal resistors—that is, resistors with a high (usually negative) temperature coefficient of resistance. Thermistor beads are made from a mixture of metal oxides encased in epoxy or glass. The beads are small in size and extremely robust with a high degree of stability over a long life span. Because their resistance change is so great, it is unusual for cable effects to be significant. However, where absolute temperatures are required (as opposed to changes in temperature) and/or where long cables are used, cable resistance must be taken into account using remote sense techniques (contact GEOKON for details). Alternatively, the use of another type of temperature sensor, such as the Model 4700 Vibrating Wire Temperature Gauge, should be considered.

ADVANTAGES AND LIMITATIONS

Thermistors have a negative temperature coefficient (NTC) where their resistance decreases with increasing temperature. The NTC can be as large as several percent per degree C, which allows the thermistor to detect minute changes in temperature. Thermistors are very small, which means they will respond quickly to temperature changes.

Thermistors have a non-linear output that can be represented by the Steinhart-Hart Equation:

$$T_C = \frac{1}{A + B(\ln R) + C(\ln R)^3} - 273.15$$

Where T is the temperature in degrees Centigrade and R is the resistance in ohms.

Thermistors are selected at the factory, which conform with this equation, either to a standard accuracy of ±0.5 °C or, by a more discriminating selection, to an accuracy of ±0.2°.

The correspondence between the resistance output in ohms and the equivalent temperature in degrees Celsius is presented in tabular form.

The high resistance of the thermistor affords it a distinct measurement advantage inasmuch as a four-wire resistance measurement to compensate for cable effects is not required, as may be the case with RTDs (Resistance Temperature Detectors). Standard thermistor output is nominally 3000 ohms at 25 °C (10,000 ohms for Model 3800HT) and around this temperature the rate of change of resistance is approximately 130 ohms per °C (450 ohms for Model 3800HT).

READOUT

Thermistors can be read using either a GK-404 or GK-406 Readout, which both display the temperature directly in degrees Celsius. Alternatively, a digital ohmmeter can be used in conjunction with the look-up tables provided in the product manual. For remote unattended applications, thermistors can be connected to the Model 8600 Series Dataloggers (via the Model 8032 Multiplexer) or Model 8900 GeoNet Wireless Data Hosting System to provide automatic data collection at pre-determined intervals, and data transmission via wireless methods. For these applications, connectors can be attached to the thermistor strings to facilitate rapid connection.

CABLE

The Model 3800 Thermistor Probes are available with a variety of cable options to complement the choice of sensor and for optimum performance in the application in which it is to be used. In addition to the standard PVC jacketed cables, conductors encased in annealed 316 stainless steel, Duplex 2205® stainless steel or Inconel® tubing are also available.

The choice of cable is largely dependent on the chemical composition of the water in the area of study and the materials through which the cables are to be routed.

A number of Chemical Resistance Guides can be found on the internet to aid in the selection of the most appropriate cable, but users are reminded that the chemical resistance of metals, plastics and elastomers used in the cable construction can be affected by chemical concentration, chemical combinations and temperature. The most suitable cable will generally be determined after consultation with the resident ground-water chemist or geologist, and/or with metallurgists with relevant experience, on a case-by-case basis.

TECHNICAL SPECIFICATIONS

Thermistor Probes	3800-1-1, 3800-1-1-3, 3800-3-1	3800-1-1-1	3800-1-2, 3800-1-2-3, 3800-3-2	3800-1-2-1	3800-2-1 3800-2-1-3	3800-2-2 3800-2-2-3	3800HT
Range[1]	–20 °C to +80 °C	–20 °C to +80 °C	–20 °C to +80 °C	–20 °C to +80 °C	–20 °C to +80 °C	–20 °C to +80 °C	–30 °C to +230 °C
Resolution	0.1 °C	0.1 °C	0.1 °C	0.1 °C	0.1 °C	0.1 °C	0.1 °C
Accuracy[2]	±0.5 °C	±0.5 °C	±0.2 °C	±0.2 °C	±0.5 °C	±0.2 °C	±0.5 °C
Housing	PVC	Potted in heat shrink	PVC	Potted in heat shrink	Stainless Steel	Stainless Steel	Stainless Steel
Length × Diameter[3]	50 × 12 mm	15 × 9 mm	50 × 12 mm	15 × 9 mm	50 × 12 mm	50 × 12 mm	75 × 19 mm
Thermal Time Constant[4]	63 seconds	33 seconds	63 seconds	33 seconds	26 seconds	26 seconds	84 seconds
Time for Thermal Equilibrium to be obtained[5]	225 seconds	135 seconds	225 seconds	135 seconds	150 seconds	150 seconds	335 seconds

[1] Other ranges available on request.
[2] Stated accuracy is for the thermistor sensor only, between 0 °C and 70 °C. The cable used to connect the thermistor to the readout adds resistance and measurement error.
[3] See manual for Model 3800-3 diameter
[4] 63.2% of an instantaneous temperature change.
[5] 99% of temperature change.

CABLE SPECIFICATIONS

Model	Conductors	Conductor Insulation	Drain Wire	Cable Jacket[1]	Nominal O.D.	Temperature Range
02-187V3	4-conductor, 2 twisted pairs, 22 AWG 7/30	8 mil HDPP	24 AWG	Red PVC	4.75 mm (±0.25 mm)	–20 °C to +80 °C
02-250V6	4-conductor, 2 twisted pairs, 22 AWG 7/30	10 mil HDPP	24 AWG	Blue PVC	6.35 mm (±0.25 mm)	–20 °C to +80 °C
02-250PEP-2205	4-conductor, 24 AWG Solid	8 mil PTFE	N/A	Duplex 2205	6.35 mm (±0.13 mm)	–150 °C to +300 °C
02-250PEP-316	4-conductor, 24 AWG Solid	8 mil PTFE	N/A	316 SS	6.35 mm (±0.13 mm)	–150 °C to +300 °C
02-250T	4-conductor, 2 twisted pairs, 22 AWG 19/34	10 mil FEP	22 AWG	White Teflon with aluminum polyester foil shielding	5.20 mm (±0.25 mm)	–80 °C to +200 °C

[1] All outer cable jackets are pressure extruded. In addition, other cable jackets are available for special applications. HDPP = High Density Polypropylene | PTFE = Polytetrafluoroethylene | FEP = Fluorinated Ethylene Propylene (Teflon™)

ORDERING INFORMATION

3800-1-1: Thermistor in PVC housing, ±0.5 °C accuracy.
3800-1-1-1: Thermistor Bead only, ±0.5 °C accuracy, potted in heat shrink.
3800-1-2: Thermistor in PVC housing, ±0.2 °C accuracy.
3800-1-2-1: Thermistor Bead only, ±0.2 °C accuracy, potted in heat shrink.
3800-2-1: Thermistor in stainless steel housing, ±0.5 °C accuracy.
3800-2-2: Thermistor in stainless steel housing, ±0.2 °C accuracy.
3800-3-1: Thermistor in surface mount PVC housing, ±0.5 °C accuracy.
3800-3-2: Thermistor in surface mount PVC housing, ±0.2°C accuracy.
02-187V3: Red PVC Cable, 4.75 mm (±0.25 mm) [0.187"] Ø, 2 twisted pairs, for the above.
3800-1-1-3: Thermistor in PVC housing, ±0.5 °C accuracy.
3800-1-2-3: Thermistor in PVC housing, ±0.2 °C accuracy.
3800-2-1-3: Thermistor in stainless steel housing, ±0.5 °C accuracy.
3800-2-2-3: Thermistor in stainless steel housing, ±0.2 °C accuracy.
02-250V6: Blue PVC Cable, 6.35 mm (±0.25 mm) [0.250"] Ø, 2 twisted pairs, for the above.
THERM-100: Thermistor Bead Only, ±0.5 °C accuracy, bulk, no cable attached.
3800HT: High Temperature Thermistor (-30 to + 230 °C) in stainless steel housing, ±0.5 °C accuracy.
02-250T: White Teflon cable with aluminum polyester foil shielding, 5.20 mm (±0.25 mm) [0.156"] Ø, 2 twisted pairs, for the above.
3800HT-SS: High Temperature Thermistor (–30 to + 230 °C) in stainless steel housing, ±0.5 °C accuracy. Configured for use with stainless steel encapsulated cable.
02-250PEP-316: 316 stainless steel encapsulated cable, 6.35 mm (±0.13 mm) [0.250"] Ø, 1 mm wall, 4-conductor, 24 AWG (300 °C).
02-250PEP-2205: Duplex 2205 stainless steel encapsulated cable, 6.35 mm (±0.13 mm) [0.250"] Ø, 1 mm wall, 4-conductor, 24 AWG (300 °C).

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