Thermistor Probes & Thermistor Strings

Applications

The Model 3800 Thermistors are designed for measuring temperatures in rock, soil and concrete dams.

The Model 3810 Thermistor String is designed for profiling temperatures in…

- **Boreholes**
- **Glaciers**
- **Landfills**
- **Dam embankments**
- **Levees**

Model 3800-1-1, Model 3800-2-1 and Model 3800HT Thermistor Probes.

Model 3810A (Addressable) Thermistor String, shown with 5 sensors.

Close-up of an encapsulated sensor from the Model 3810A (Addressable) Thermistor String.

Model 3810 Thermistor String (inset shows a close-up of an encapsulated sensor).

Operating Principle

The Model 3800-1-1, 3800-2-1 and 3800HT Thermistor Probes are supplied inside a housing at the end of a cable ready to be attached to a structure, or buried in concrete or in the ground. The housing is made from PVC (Model 3800-1-1) or from stainless steel (Model 3800-2-1, 3800HT). Thermistor Probes are particularly well suited for measuring the heat of hydration in concrete and RCC dams. The Model 3800HT is a high temperature version for use up to 230°C.

The Model 3810 Thermistor String comprises a number of individual 3800 sensors encapsulated in a rugged, direct burial, multiconductor cable for multiple measurements in a single borehole. Thermistor strings are manufactured according to customer requirements for overall length, number of sensors and accuracy. Thermistor strings are typically used for profiling temperatures in boreholes, landfills and glaciers.

The Model 3810A is a variation of the 3810 which uses addressable thermistor sensors installed on a 2-pair cable. This configuration allows up to 255* sensors to be installed on a single, 6 mm diameter cable up to 2000 m in length.

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, for high accuracy work, and when long cables are used, the cable resistance must be taken into account, unless the Model 3810A is used. Standard temperature range is –20°C to +80°C (other ranges available on request).

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:

$$T_C = \frac{1}{A + B(\ln R) + C(\ln R)^3} - 273.2$$

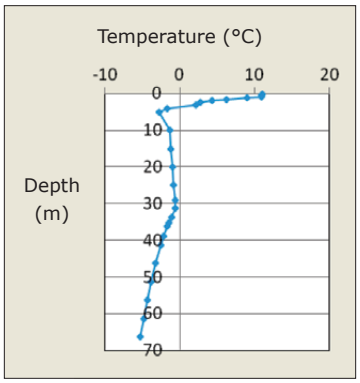
Where T is the temperature in degrees Centigrade and R is the resistance in ohms.

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°C or ±0.05°C with the Model 3810A.

The number of sensors that can be supported depends on the overall length of the cable. Please contact **GEOKON, INCORPORATED for details.*

- *Summer view of the **GEOKON**® Model 8025 Data Acquisition Station measuring a 70 m deep Thermistor String in mine tailings, located in northern Canada.**

- *Winter view of the above installation.**



- *Sample temperature plot taken from the above installation.**

**Plot and photos courtesy of GKM Consultants, Inc. (www.gkmconsultants.com).*

The correspondence between the resistance output in ohms and the equivalent temperature in degrees Celsius is presented in tabular form with each thermistor or thermistor string. 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).Thermistor output is nominally 3000 ohms at 25°C and around this temperature the rate of change of resistance is approximately 130 ohms / °C. For greater accuracy the resistance of the cable leading to the thermistor can be taken into account (with non-addressable sensors).

Readout

Thermistors can be read using either a GK-404 or GK-405 Readout, which both display the temperature directly in degrees Celsius. Alternatively, a digital ohmmeter can be used in conjunction with look-up tables. For remote unattended applications, thermistors can be connected to the Model 8600 Series Dataloggers (via the Model 8032 Multiplexer) 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.

Model 3810A addressable sensor strings can be read using any logger that has a half-duplex RS-485 communication interface and support for **Modbus®** RTU. Readings are reported as raw digital conversion results in 16-bits (2 bytes). Readout can also be accomplished using a USB to RS-485 converter and a PC or the same FPC-1 Field PC as used in the GK-405 and GK-604D Readouts.

Technical Specifications

Thermistor Probes	3800-1-1	3800-1-2	3800-2-1	3800-2-2	3800HT
Range[1]	–20° to +80°C	–20° to +80°C	–20° to +80°C	–20° to +80°C	–30° to +230°C
Resolution	0.1°C	0.1°C	0.1°C	0.1°C	0.1°C
Accuracy[2]	±0.5°C	±0.2°C	±0.5°C	±0.2°C	±0.5°C
Housing	PVC	PVC	Stainless Steel	Stainless Steel	Stainless Steel
Length × Diameter	50 × 12 mm	50 × 12 mm	50 × 12 mm	50 × 12 mm	75 × 19 mm

Thermistor Strings	3810-1	3810-2
Range[1]	–20° to +80°C	–20° to +80°C
Resolution	0.1°C	0.1°C
Accuracy[2]	±0.5°C	±0.2°C
Waterproof[1]	3.5 MPa	3.5 MPa
Length × Diameter (Sensor)	45 × 16 mm (1-7 and 1-16 measurement points)	64 × 22 mm (1-32 measurement points)

Cables	17-375V7	17-375P13	33-500V4	33-500P6
Measurement Points	1-16	1-16	1-32	1-32
Minimum Spacing	127 mm	127 mm	127 mm	127 mm
Cable Diameter	9.5 mm	9.5 mm	12.5 mm	12.5 mm
Cable Jacket	PVC	Polyurethane	PVC	Polyurethane

Addressable Thermistor Strings	3810A		
Range	–40° to +70°C	Read Time	75 ms/sensor
Accuracy	±0.605°C *(–40° to –20°C)*	Sensors	1-255
	±0.303°C *(–20° to –10°C)*	Minimum Spacing	127 mm
	±0.102°C *(–10° to 0°C)*	Interface	Half-duplex RS-485
	±0.052°C *(0° to 50°C)*	Data Rate	9600 baud (bits/S)
	±0.403°C *(+50° to +70°C)*	Maximum Cable Length	2000 m
Resolution (Non-Linear)	< 0.01°C	Housing	Stainless Steel
Supply Voltage	5 V to 16 V	Length × Diameter (Sensor)	56 × 16 mm
Supply Current (Idle)	600 µA/Sensor	Breaking Strength	50 kg (110 lbs)
Supply Current (Read)	1 mA/Sensor	Waterproof[2]	3.5 MPa

[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.*

GEOKON The World Leader in Vibrating Wire Technology®

GEOKON, INCORPORATED
48 Spencer Street
Lebanon, NH 03766 · USA

phone: 1 · 603 · 448 · 1562
email: info@geokon.com
web: www.geokon.com

***GEOKON** is an*
ISO 9001:2008
registered company