THERMISTOR STRINGS

GEOKON®

MODEL 3810, 3810B

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

APPLICATIONS

Thermistor strings are designed for profiling temperatures in:

- Boreholes
- Glaciers
- Landfills
- Dam embankments
- Levees

OPERATING PRINCIPLE

The Model 3810 Thermistor String comprises a number of Model 3800 Thermistor 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 3810B is a variation of the 3810 which uses temperature sensors installed on a 2-pair cable. This configuration allows up to 248* sensors to be installed on a single, 8 mm diameter cable up to 2000 m in length.

Armored versions of the Model 3810 Thermistor String are available on request. Armored thermistor strings are ideal for offshore temperature profiling, installations in horizontal boreholes, and for monitoring heap leach pads, tailings, and landfills. The thermistors are interconnected by 24/26 AWG solid nickel-plated conductors rated to 150 °C. Both the thermistors and conductors are encapsulated inside 316 stainless steel, 2205 Duplex, or Inconel capillary tubing, and are shipped on a wooden spool to facilitate installation. (Contact GEOKON for more information.)

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 3810B 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 Celsius, which allows the thermistor to detect minute changes in temperature. Thermistors are very small, which means they will respond quickly to temperature changes.

The correspondence between the resistance output in ohms and the equivalent temperature in degrees Celsius is presented in tabular form, or can be determined using the Steinhart-Hart Equation:

$$T = \frac{1}{A + B(\mathrm{Ln}R) + C(\mathrm{Ln}R)^3} - 273.15$$

Where T is the temperature in degrees Celsius 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. This same accuracy is achieved with the Model 3810B Digital Temperature Sensor. The high resistance of the thermistor gives it a distinct measurement advantage over RTDs (Resistance Temperature Detectors), which may require a four-wire resistance measurement to compensate for cable effects. Thermistor output is nominally 3000 ohms at 25 °C and around this temperature the rate of change of resistance is approximately 130 ohms / °C.

Model 3810B Digital Temperature Sensor, shown with 3 sensors.

Close-up showing the encapsulated sensor of a Model 3810B.

Armored Thermistor String.

READOUT

Model 3810 Thermistors Strings can be connected to the Model 8600 Series Dataloggers[1] to provide automatic data collection at pre-determined intervals, and data transmission via wireless methods. For these applications, connectors can be attached to the temperature strings to facilitate rapid connection.

Model 3810B sensor strings can be read using Model 8900 GeoNet Wireless Data Hosting System or any logger that has a half-duplex RS-485 communication interface and support for Modbus® RTU.

Readings are reported as a 32-bit floating point number directly in degrees Celsius (4 bytes, 2-registors). Readout can be accomplished using a Model 8020-38 USB to RS-485 converter and a PC.

[1]Requires Model 8032 Multiplexer.

MODEL 3810 TECHNICAL SPECIFICATIONS

Thermistor Strings	3810-1	3810-2
Range[1]	–20 °C to +80 °C	–20 °C to +80 °C
Resolution	0.1 °C	0.1 °C
Accuracy[2]	±0.5 °C	±0.2 °C
Pressure Rating	3.5 MPa[1]	3.5 MPa[1]
Length × Diameter (sensor)	45 × 16 mm (9.5 mm Ø cable) 64 × 22 mm (12.5 mm Ø cable)	45 × 16 mm (9.5 mm Ø cable) 64 × 22 mm (12.5 mm Ø cable)

Cables	Measurement Points	Minimum Spacing	Cable diameter	Cable Jacket	Temperature Range
17-375V7	1-16	127 mm	9.5 mm	PVC	–20 °C to +80 °C
17-375P13	1-16	127 mm	9.5 mm	Polyurethane	–40 °C to +80 °C
33-500V4	1-32	127 mm	12.5 mm	PVC	–20 °C to +80 °C
33-500P6	1-32	127 mm	12.5 mm	Polyurethane	–20 °C to +80 °C

MODEL 3810B TECHNICAL SPECIFICATIONS

Range[1]	–40 °C to +80 °C	Baud Rate	115,200 bits/second
Accuracy	±0.02 °C	Maximum Cable Length	2000 m
Resolution	14-bit	Working Load[3]	9.1 kg
Supply Voltage	12V ±20%	Breaking Strength	22.7 kg
Minimum Spacing	200 mm	Pressure Rating	1 MPa[4]
Sensors (Wired)	up to 248	Housing	PVC, Nylon
Sensors (Wireless)	up to 30	Length × Diameter (Sensor)	146 x 22 mm (Sensor) 158 x 22 mm (Terminal Sensor)
Interface	RS–485, Half-duplex		

Cable	Conductors	Conductor Insulation	Drain Wire	Cable Jacket	Nominal O.D.	Temperature Range
02-313P9LTD	4-conductor, 2 twisted pairs: 1st: 24 AWG 7/32; 2nd: 22 AWG 7/30	1st pair 20 mil FPE, 2nd pair 10 mil SRPVC	24 AWG	Violet PU	8 mm	–40 °C to +80 °C

[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] Some configurations require an additional mechanical support cable. Please contact GEOKON for more details.
[4] Please contact GEOKON for other ranges.
[5] Dependent upon number of measurement points
FPE = Foamed Polyethylene
SRPVC = Semi-Rigid PVC

ORDERING INFORMATION

3810-1: Thermistor String (several thermistors spaced along a multi-conductor cable), ±0.5 °C accuracy. Minimum sensor spacing is 127 mm.
3810-2: Thermistor String (several thermistors spaced along a multi-conductor cable), ±0.2 °C accuracy. Minimum sensor spacing is 127 mm.
3810-4-1: Thermistor string end terminator for 17-375 cable. 1 required per string.
3810-3-1: Thermistor string end terminator for 33-500 cable. 1 required per string.
17-375V7: Orange PVC Cable, 9.53 mm (0.375") Ø, 17 conductor. For strings of 16 thermistors or less.
17-375P13: Brown Polyurethane Cable, 9.53 mm (0.375") Ø, 17 conductor. For strings of 16 thermistors or less.
33-500V4: Green PVC Cable, 12.7 mm (0.500") Ø, 33 conductor. For strings of 32 thermistors or less.
33-500P6: Blue Polyurethane Cable, 12.7 mm (0.500") Ø, 33 conductor. For strings of 32 thermistors or less.
3810B: Digital Temperature Sensor String (several sensors spaced along a 2-pair cable), Minimum sensor spacing is 204 mm.
3810AT: Addressable Thermistor Terminal Node with integral thermistor. One required per string.
02-313P9LTD: Violet Polyurethane Cable, 8 mm (0.313") Ø, 2 twisted pairs.
3810A-1: TTL to Half Duplex RS-485 Converter. For devices that do not have an RS-485 interface. (Logger must have TTL UART available.)
8020-38: USB to RS-485 converter. Used when PC is to interface directly with a 3810B string.
3810-16: Jumper Assembly, for connectig Model 3810 Thermistor Strings with 16 thermistors or less to Model 8600 dataloggers.
3810-32: Jumper Assembly, for connectig Model 3810 Thermistor Strings with 17-32 thermistors to Model 8600 dataloggers.

GEOKON | TRUSTED MEASUREMENTS

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