

MODEL 3810, 3810A



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 3810A is a variation of the 3810 which uses addressable thermistor 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 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.

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:

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

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 °C or up to ±0.07 °C with the Model 3810A.

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.



Model 3810A Addressable Thermistor String, shown with 3 sensors.



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



Armored Thermistor String

READOUT

Model 3810 Thermistors Strings can be connected to the Model 8600 Series Dataloggers¹ 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 3810A addressable 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 raw digital conversion results in 16-bits (2 bytes). Readout can also be accomplished using a Model 3810A-2 USB to RS-485 converter and a PC.

¹Requires 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 3810A TECHNICAL SPECIFICATIONS

Range ¹	-20 °C to +80 °C	Sensors (Wired)	up to 248
Accuracy	±0.35 °C @ -20 °C to -10 °C	Sensors (Wireless)	up to 30
	±0.15 °C @ -10 °C to 0 °C	Interface	RS-485, Half-duplex
	±0.07 °C @ 0 °C to +50 °C	Baud Rate	115,200 bits/second
	±0.12 °C @ +50 °C to +65 °C	Maximum Cable Length	2000 m
	±0.16 °C @ +65 °C to +80 °C	Working Load ³	9.1 kg
Resolution (Non-linear)	0.002 °C (0 °C to +50 °C) 0.005 °C (-20 °C to +80 °C)	Breaking Strength	22.7 kg
Supply Voltage	12V ±20%	Pressure Rating	1 MPa ⁴
Current Per Sensor: Idle / Read	1.0 mA / 8.7 mA	Housing	PVC, Nylon
Read Time	266 mS	Length × Diameter (Sensor)	146 x 22 mm (Sensor) 158 x 22 mm (Terminal Sensor)
Minimum Spacing	200 mm		

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

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.

3810A: Addressable Thermistor String (several thermistors 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.)

3810A-2: USB to RS-485 converter. Used when PC is to interface directly with a 3810A string.

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