

# THERMISTOR PROBE & STRING

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## 1.0 INTRODUCTION

This manual is intended for all users of Thermistor instruments manufactured by **Geosense**<sup>®</sup> and provides information on their principle, installation, operation and maintenance.



**It is VITAL that personnel responsible for the installation and use of Thermistors READ and UNDERSTAND the manual, prior to working with the equipment.**



### 1.1 General Description

Thermistors provide accurate and reliable long-term temperature measurements and are used widely in the extremely harsh environments found within Geotechnical monitoring.

They are available in two types:

**Probe** – A single point sensor mounted within a PVC or stainless steel housing which is attached to a cable length.

**String** – A series of sensors mounted along a multi-core cable which provide a temperature profile and is manufactured to customer requirements in terms of the number and spacing of each sensor.

Applications such as, but not limited to measuring temperature in the following :-

- Concrete (particularly RCC dams)
- Soil
- Tundra
- Rock
- Ice caps
- Glaciers
- Landfills

Particular features of **Geosense**<sup>®</sup> Thermistors are:-

- Fast response
- High accuracy
- Reliable long term performance
- Suitable for demanding environments
- Waterproof to IP68 (10 bar)

*(Continued from page 3)*

## **1.2 Theory of Operation**

The NTC (negative temperature coefficient ) 3K thermistor sensor has a resistance that decreases with increasing temperature and with a coefficient  $>4\%/^{\circ}\text{C}$  allows it to detect very small changes in temperature.

They have a non-linear output that is represented by the Steinhart–Hart equation.

$$T = (1 / (A + B (\text{Ln}R) + C(\text{Ln}R)^3)) - 273.2$$

Where: T = Temperature in degrees Centigrade

LnR= Natural log of Thermistor resistance in ohms

Readings can be made with a wide range of readout units including the VWR-1, MP12 which display the reading directly in degrees Celsius or resistance Ohms or by an ohmmeter in combination with look-up tables.

Readings can also be automated using an automatic data acquisition unit such as a Linx Logger, WI-SOS VW Node, GeoLogger CR Series



## 2.0 CONFORMITY

### Geosense Ltd

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Email: [info@geosense.co.uk](mailto:info@geosense.co.uk), Web: [www.geosense.co.uk](http://www.geosense.co.uk).

## Declaration of Conformity



We **Geosense**<sup>®</sup> Ltd at above address declare under our sole responsibility that the **Geosense**<sup>®</sup> products detailed below to which this declaration relates complies with protection requirements of the following harmonized EU Directives:-

The Electromagnetic Compatibility Directive 2014/30/EU  
Restriction on the use of certain Hazardous Substances RoHS2 2017/2102/EU  
Waste electrical & electronic equipment WEEE 2012/19/EU

<i>Equipment description</i>	<b>Thermistors, Thermistor Strings</b>
<i>Make/Brand</i>	<b>Geosense</b>
<i>Model Numbers</i>	<b>TP-1, TP-2, TS-1, TS-2, TS-3, TS-4, TS-5, TS-6</b>

Compliance has been assessed with reference to the following harmonised standard:

EN 61326-1:2013 Electrical equipment for measurement, control and laboratory use.  
EMC requirements. General requirements.

A technical file for this equipment is retained at the above address.

A handwritten signature in black ink, appearing to read "Martin Clegg".

Martin Clegg  
**Director**

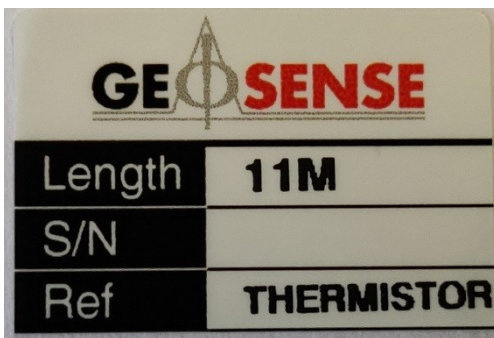
October 2020

### 3.0 MARKINGS

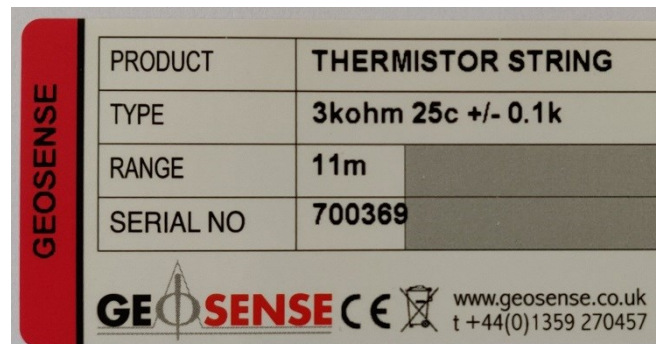
Markings on Geosense® Thermistors varies depending on whether it is a Probe Type or a Thermistor String.

The Probe Type only has a label on the end of the cable identifying its reference S/N - Label A

The Thermistor String has an additional label - label B



**Label A**



**Label B**

**Geosense®** Thermistors are labelled with the following information:-

Product Name

Product Type

Individual Serial Number

Manufacturers Name & Address

CE Mark

## 4.0 DELIVERY

This section should be read by all users of Thermistors manufactured by **Geosense®**.

### 4.1 Packaging

Thermistors are packed for transportation to site. Packaging is suitably robust to allow normal handling by transportation companies. Inappropriate handling techniques may cause damage to the packaging and the enclosed equipment. The packaging should be carefully inspected upon delivery and any damage **MUST** be reported to both the transportation company and **Geosense®**.

### 4.2 Handling

Whilst they are a robust devices, Thermistors piezometers are precision measuring instruments. They, and their associated equipment, should always be handled with care during transportation, storage and installation.

Once the shipment has been inspected (see below), it is recommended that Thermistors remain in their original packaging for storage or onward transportation.

Cable should also be handled with care. Do not allow it to be damaged by sharp edges, rocks for example, and do not exert force on the cable as this may damage the internal conductors and could render an installation useless.

### 4.3 Inspection / functionality check readings

It is important to check all the equipment in the shipment as soon as possible after taking delivery and well before installation is to be carried out. Check that all the components detailed on the documents are included in the shipment. Check that the equipment has not been physically damaged.

**CHECK** the Thermistor readings against the approximate environmental temperature on arrival to ensure they have not been damaged during transportation. This is a basic 'out of the box' functional check.

### 4.4 Storage

All equipment should be stored in an environment that is protected from direct sunlight. It is recommended that cables be stored in a dry environment to prevent moisture migrating along inside them in the event of prolonged submersion of exposed conductors.

Storage areas should be free from rodents as they have been known to damage connecting cables.

No other special requirements are needed for medium or long-term storage although temperature limits should be considered when storing or transporting associated components, such as readout equipment.

## 5.0 INSTALLATION

Geosense Thermistor Strings are manufactured to specific customer requirements with the following variables:-

- Length of cable to the first Thermistor
- Number of Thermistors
- Spacing between each Thermistor

They should be installed in accordance with the specific project requirement.

It is therefore important that the correct reference is made & recorded for each sensor.

Below is the colour coding for multiple Thermistors up to a total of twenty six with Thermistor number one being the nearest to the bare ended cable and from where readings should be taken.

THERMISTOR LOCATION ALONG CABLE	COLOUR CODING	
1	GREEN	WHITE
2	BLACK	RED
3	BLACK	WHITE
4	BLACK	GREEN
5	BLACK	BLUE
6	BLACK	YELLOW
7	BLACK	BROWN
8	BLACK	ORANGE
9	RED	WHITE
10	RED	GREEN
11	RED	BLUE
12	RED	YELLOW
13	RED	BROWN
14	RED	ORANGE
15	GREEN	WHITE
16	GREEN	BLUE
17	GREEN	YELLOW
18	GREEN	BROWN
19	GREEN	ORANGE
20	WHITE	BLUE
21	WHITE	YELLOW
22	WHITE	BROWN
23	WHITE	ORANGE
24	BLUE	YELLOW
25	BLUE	BROWN



## 6.0 DATA HANDLING



The function of an instrument is to provide useful and reliable data. Accurate recording and handling of the data is essential if it is to be of any value.



### 6.1 Taking readings

#### 6.1.1 Portable Readouts

Geosense® offer a range of readout and data logging options which can be used to read Thermistors. Specific operation manuals are supplied with each readout device.

Below is a brief, step-by-step procedure for use with the Geosense® VWR1 portable readout.

1. Connect signal cables from the Thermistor to the GREEN & WHITE terminals
2. Press the 'On/Off' button to switch the unit on. Press it again to acquire a reading from the connected instrument.
3. The readout displays the temperature reading in both resistance (Ohms) and degrees C.

For more details see the VWR-1 readout manual.

4. Press and hold down the On/Off' button to switch the unit off.



**NAN IS DISPLAYED AS NO VW SENSOR IS CONNECTED**

#### 6.1.2 Data Loggers

A number of data loggers are available to automatically excite, interrogate and record the reading from Thermistors. These include the GeoLogger CR Series and GeoLogger Linx

## 6.2 Data Reduction

Where a readout such as the VWR-1 is used the data is obtained directly as degrees Celsius together with the corresponding resistance reading in Ohms.

If another type of readout such as a Multi Meter is used the reading will only be in Ohms and therefore to convert to degrees Celsius the Steinhart & Hart look up table is required (see below)

### Resistance versus temperature table for 3K @25°C Thermistor

Ohms	Temp	Ohms	Temp	Ohms	Temp	Ohms	Temp	Ohms	Temp
201.1K	-50	16.60K	-10	2417	30	525.4	70	153.2	110
187.3K	-49	15.72K	-9	2317	31	507.8	71	149.0	111
174.5K	-48	14.90K	-8	2221	32	490.9	72	145.0	112
162.7K	-47	14.12K	-7	2130	33	474.7	73	141.1	113
151.7K	-46	13.39K	-6	2042	34	459.0	74	137.2	114
141.6K	-45	12.70K	-5	1959	35	444.0	75	133.6	115
132.2K	-44	12.05K	-4	1880	36	429.5	76	130.0	116
123.5K	-43	11.44K	-3	1805	37	415.6	77	126.5	117
115.4K	-42	10.86K	-2	1733	38	402.2	78	123.2	118
107.9K	-41	10.31K	-1	1664	39	389.3	79	119.9	119
101.0K	-40	9796	0	1598	40	376.9	80	116.8	120
94.48K	-39	9310	1	1535	41	364.9	81	113.8	121
88.46K	-38	8851	2	1475	42	353.4	82	110.8	122
82.87K	-37	8417	3	1418	43	342.2	83	107.9	123
77.66K	-36	8006	4	1363	44	331.5	84	105.2	124
72.81K	-35	7618	5	1310	45	321.2	85	102.5	125
68.30K	-34	7252	6	1260	46	311.3	86	99.9	126
64.09K	-33	6905	7	1212	47	301.7	87	97.3	127
60.17K	-32	6576	8	1167	48	292.4	88	94.9	128
56.51K	-31	6265	9	1123	49	283.5	89	92.5	129
53.10K	-30	5971	10	1081	50	274.9	90	90.2	130
49.91K	-29	5692	11	1040	51	266.6	91	87.9	131
46.94K	-28	5427	12	1002	52	258.6	92	85.7	132
44.16K	-27	5177	13	965.0	53	250.9	93	83.6	133
41.56K	-26	4939	14	929.6	54	243.4	94	81.6	134
39.13K	-25	4714	15	895.8	55	236.2	95	79.6	135
36.86K	-24	4500	16	863.3	56	229.3	96	77.6	136
34.73K	-23	4297	17	832.2	57	222.6	97	75.8	137
32.74K	-22	4105	18	802.3	58	216.1	98	73.9	138
30.87K	-21	3922	19	773.7	59	209.8	99	72.2	139
29.13K	-20	3748	20	746.3	60	203.8	100	70.4	140
27.49K	-19	3583	21	719.9	61	197.9	101	68.8	141
25.95K	-18	3426	22	694.7	62	192.2	102	67.1	142
24.51K	-17	3277	23	670.4	63	186.8	103	65.5	143
23.16K	-16	3135	24	647.1	64	181.5	104	64.0	144
21.89K	-15	3000	25	624.7	65	176.4	105	62.5	145
20.70K	-14	2872	26	603.3	66	171.4	106	61.1	146
19.58K	-13	2750	27	582.6	67	166.7	107	59.6	147
18.52K	-12	2633	28	562.8	68	162.0	108	58.3	148
17.53K	-11	2523	29	543.7	69	157.6	109	56.8	149

## 7.0 TROUBLESHOOTING

### RESISTANCE DIAGNOSTICS

Where damage to a sensor or cable is suspected this guide illustrates the way in which simple resistance checks can be taken to identify the possible cause of the problem.

Resistance checks can be made with most types of multi-meter which are readily available in the market.



### RESISTANCE OF THE THERMISTOR

#### STEP 1

Set the range to 20k $\Omega$  (or  $\Omega$  if using a multi-meter which has automatic ranging).

#### STEP 2

Connect the T+ (green) conductor to the red lead on the multi-meter and the T- (white) to the black lead on the multi-meter.

The readings will be dependent on the temperature as below:-

- 10°C ~ 5.971k $\Omega$  (5971 $\Omega$ )
- 15°C ~ 4.714k $\Omega$  (4714 $\Omega$ )
- 20°C ~ 3.478k $\Omega$  (3478 $\Omega$ )
- 25°C ~ 3.000k $\Omega$  (3000 $\Omega$ )

**PLEASE REFER TO THE THERMISTOR LOOK UP TABLE ON THE NEXT PAGE**

## 8.0 SPECIFICATION

### PROBE

Model	TP-1	TP-2
Temperature range*	-50 to +150 °C	-50 to +150 °C
Accuracy	± 0.2 °C	± 0.2 °C
Resolution**	0.1 °C	0.1 °C
Housing	PVC	Stainless steel
Housing diameter (mm)	31	16
Housing length (mm)	85	85
Cable diameter (mm)	7	7
Cable Type	900 - VW Sensor with Foil Screen & Drain Wire String	

### STRINGS

Model	TS-1	TS-2	TS-3	TS-4	TS-5	TS-6
Temp range*	-50 to +150 °C					
Accuracy	± 0.2 °C					
Resolution**	0.1 °C					
Points	1-2	3-4	5-7	8-10	11-15	16-25
Cable diameter	7	8.9	9.8	11.4	12.5	14.8
Cable Type	910 - Multi-Core with Foil Screen & Drain Wire					
Housing diameter (mm)	19, 31	19, 31	31	31	31	31
Housing length (mm)	85	85	85	85	85	85

\* Other temperature ranges available on request

\*\* Readout dependent

## 9.0 SPARE PARTS

As a Thermistor is a sealed unit, it is neither serviceable nor does it contain any replaceable parts.

## 10.0 RETURN OF GOODS

### 10.1 Returns procedure

If goods are to be returned for either service/repair or warranty, the customer should contact **Geosense®** for a **Returns Authorisation Number**, request a **Returned Equipment Report Form QF034** and, where applicable, a **Returned Goods Health and Safety Clearance Form QF038** prior to shipment. Numbers must be clearly marked on the outside of the shipment.

Complete the **Returned Equipment Report Form QF034**, including as much detail as possible, and enclose it with the returned goods.

### 10.2 Inspection & estimate

It is the policy of **Geosense®** that an estimate is provided to the customer prior to any repair being carried out. A set charge for inspecting the equipment and providing an estimate is also chargeable.

### 10.3 Warranty Claim

#### (See Limited Warranty Conditions)

This covers defects which arise as a result of a failure in design or manufacturing. It is a condition of the warranty that the Thermistor must be installed and used in accordance with the manufacturer's instructions and has not been subject to misuse.

In order to make a warranty claim, contact **Geosense®** and request a **Returned Equipment Report Form QF034**. Tick the warranty claim box and return the form with the goods as above. You will then be contacted and informed whether your warranty claim is valid.

### 10.4 Packaging and Carriage

All used goods shipped to the factory **must** be sealed inside a clean plastic bag and packed in a suitable carton. If the original packaging is not available, **Geosense®** should be contacted for advice. **Geosense®** will not be responsible for damage resulting from inadequate returns packaging or contamination under any circumstances.

### 10.5 Transport & Storage

All goods should be adequately packaged to prevent damage in transit or intermediate storage.



## 11.0 LIMITED WARRANTY

The manufacturer, (**Geosense Ltd**), warrants the **Thermistors** manufactured by it, under normal use and service, to be free from defects in material and workmanship under the following terms and conditions:-

Sufficient site data has been provided to **Geosense**<sup>®</sup> by the purchaser as regards the nature of the installation to allow **Geosense**<sup>®</sup> to select the correct type and range of **Thermistors** and other component parts.

The **Thermistors** equipment shall be installed in accordance with the manufacturer's recommendations.

The equipment is warranted for 2 years from the date of shipment from the manufacturer to the purchaser.

The warranty is limited to replacement of part or parts which, are determined to be defective upon inspection at the factory. Shipment of defective part or parts to the factory shall be at the expense of the Purchaser. Return shipment of repaired/replaced part or parts covered by this warranty shall be at the expense of the Manufacturer.

Unauthorised alteration and/or repair by anyone which, causes failure of the unit or associated components will void this **LIMITED WARRANTY** in its entirety.

**The Purchaser warrants through the purchase of the THERMISTORS equipment that he is familiar with the equipment and its proper use. In no event shall the manufacturer be liable for any injury, loss or damage, direct or consequential, special, incidental, indirect or punitive, arising out of the use of or inability to use the equipment sold to the Purchaser by the Manufacturer.**

The Purchaser assumes all risks and liability whatsoever in connection with the Thermistor equipment from the time of delivery to Purchaser.

**NOTES**



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