CGEO INTERNATIONAL LIMITED

CGEO-TEM2

Resistance Temperature Sensor

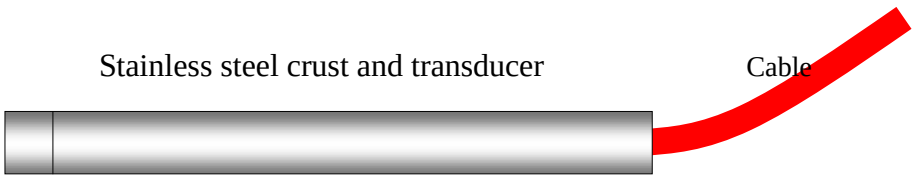
Installation Manual

（REV A）

Contents

1. Brief Introduction

CGEO-TEM2 Thermometer is composed of a stainless steel crust, thermo-resistance, and the CGEO-4-SCT special cable with the outstanding water-proof capability and signal stability. It is widely used in temperature controlling and monitoring of high technology, industrial production and science research and other areas. The temperature of the measured environment can be read out directly by CGEO-PR-VW Readout .



Structure of CGEO-TEM2 Temperature Gauge

The features of CGEO-TEM2 Temperature Gauge as follows:

• Good long-time stability

• Stainless steel structure, which is adaptable to all kinds of atrocious environment

• Good water-proof capability

• Long working life

• High sensitivity

• Applicable to the measuring of the temperature of liquid, solid or gas in the non-strong-acid, non-strong-alkali or non-strong-corrosive environment.

2. Main Specifications

• Temperature Range: -30℃～+70℃

• Accuracy: standard ±0.5℃（Option： ±0.2℃， ±0.1℃）

• Resistance in normal temperature: 3KΩ（At 25℃）

• Insulated resistance: ≥50MΩ

• withstanding voltage: 1500V

• Outer Size: Φ11×110mm

• Color of the lead of cable: green/white (temperature transducer), shield (grounded)

3. Cable Welding Lengthening

A standard CGEO-TEM2 model temperature gauge equips with 1m cable in ex-factory, cable model is CGEO-4-SCT. For cable lengthening adopted is CGEO-4-SCT dedicated cable, and BSIL-4-SC cable as well as. Proceed lengthening basing on the field circumstance before installation. Avoid connection as possible as in the cable buried in soil. If cable connection is inevitable, should adopt waterproof connection, recommend using ES-3 model dedicated heat-shrinkable connector, and also epoxy connector, like 3M ScotchcastTM 82-A1 dedicated cable connector, those connector devices can be ordered from Beijing SOIL.

As following details introduction of connection method of using ES-3 model dedicated heat-shrinkable connector.

Measure the resistance between cores of transducer with millimeter and note it before welding. Thereinto, the resistance between green and white core should be 3kΩ at room temperature 25℃. As to CGEO-TEM2 model temperature gauge, the resistance between red and black core leads is the same as green and white.

Before welding divest the outer leather of cable end part, length about 8cm, and expose the core leads, roughen rest cable outer leather part with emery cloth or sandpaper, length about 3 cm. Sleeve Φ12mm heat-shrinkable tube onto outside cable (length about 14cm). Strip outer skin of cores 0.5~0.8 cm with stripping pliers, jacket Φ2mm heat-shrinkable tube onto core leads. After twisting core leads together corresponding to colors, solder tin with electric soldering iron. Should avoid poor soldering and remove burrs during soldering process. 5 pieces of cores all are needed to solder, please note: 1). Stagger each core connector; 2). Ensure every core lead length same and ensure each core uniformly forced when cable is pulled. After soldering, naked core line length about 7 cm, push Φ2mm outer heat-shrinkable tube onto core leads connector part, and make it shrunk in connector part with heat wind gun. At last push Φ12mm heat-shrinkable tube unto cable connector and heat-shrunk in connector part with heat wind gun. Φ12mm heat-shrinkable tube should be pressed 3 cm over each end of cable outer skin. Should control the temperature when using heat-wind gun so that heat-shrinkable tube internal in transparent, fluid status, and fully filled with connector internal. But too high temperature will melt core lead outer skin and cause

core lead short, cause heat-shrinkable tube carbonization and brittle.

Note: after core leads welding work finishing, you must check the reading measurement with readout, and examine the resistance between cores of cable with millimeter in case welding work causes connector part short and cut

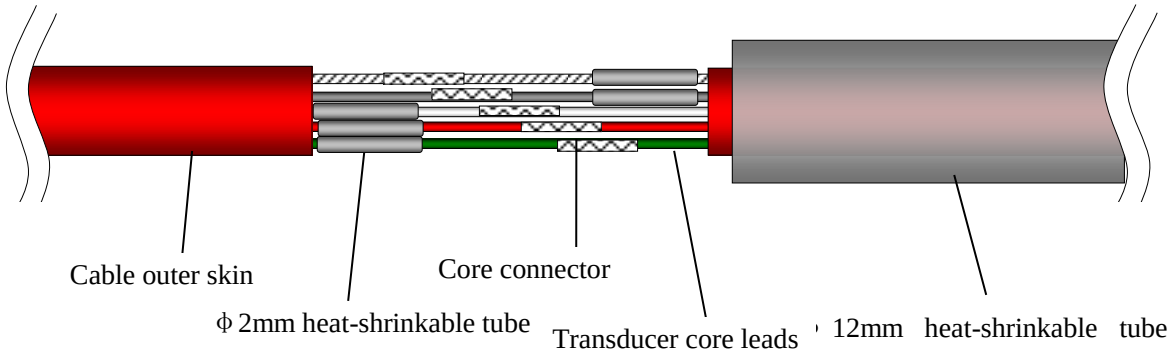


Figure 5 Cable welding splice diagram

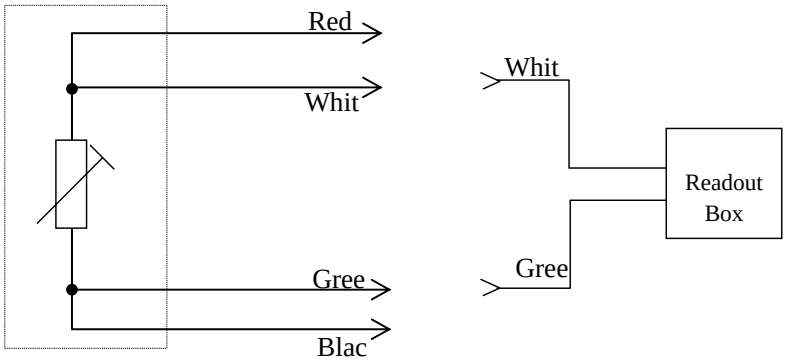
4. Using Surroundings & Installation Notice

Though the CGEO-TEM2 Temperature Transducer can be used in all atrocious environments, it is still necessary to avoid using in the area which is over the standard range (with the exception of the customized), and avoid long-time using in strong acid and alkaline areas.

The CGEO-TEM2 Temperature Transducer can be installed directly inside concrete, soil or borehole. But what is needed to do is to protect the cable and meet all the standard requirements.

5. Operation & Data Process

The signal cable of CGEO-TEM2 Temperature Gauge adopts 4-core shielded cable, the colors of cable core wires are Black, Red, Green, and White respectively and another naked wire is shield wire to ground. Among them, red and white are in parallel connected, so do green and Black, when measuring, you can connect at discretion black, red core wires or green, white core wires. You also can twist together red, white core wires or green, black core wires of temperature gauge and then connect with green, white wires of readout box to measure.



CGEO-TEM2 thermometer wiring schematic diagram

When measuring, connect the green and white nips of CGEO-PR-VW to the black, red wires of the transducers to read out directly, or connect green, white nips to black, red wire of thermometer, and then the thermistor readings can be displayed directly in °C.

Note，please do not connect 4 colors nips of readout box to 4 core wires of thermometer simultaneously, that is, it is just allowed to connect two wires every time to measure temperature, otherwise it will result in readings error.

There are no polarity difference in signal lines of CGEO-TEM2 thermometer, green, white wire are changeable.

6. Temperature Calculation Formula

$$\mathbf{T} = \frac{\mathbf{1}}{\mathbf{A} + \mathbf{B}(\mathbf{LnR}) + \mathbf{C}(\mathbf{LnR})^{3}} - \mathbf{273.2}$$

where:

T = Temperature in °C.

R = Resistance of the temperature transducers in Ω.

LnR = Natural Log of Thermistor Resistance

A = 1.4051×10^{-3} (coefficient is effective in range -50℃~+150℃)

B = 2.369×10^{-4}

C = 1.019×10^{-7}

If there is no special readout, the thermistor can be read by using a digital ohmmeter in conjunction with the above equation, or get the temperature by Appendix A.

7. Trouble Shooting

When troubles occur, a millimeter is usually used to check core wire resistance and examine the breakdown phenomena.

When checking, connect the digital millimeter to the cores of the transducer, the normal condition is that the resistance matches the environment temperature (check Appendix A). In 25°C, the resistance should be 3000Ω. If the resistance deviates from the norms, it is caused normally by cable open or short, should focus on inspecting the cable for damage.

If the cable is damaged or affected with damp, the reading will be fuzzy, a bit bigger than the correct reading. What should be noticed is that, if the cable is too long and under the high-temperature environment, the resistance of cable core should be taken into consideration during calculating, to gain a higher precision. This resistance will not be taken into consideration under low-temperature environment. The resistance of matched cable core is about 50Ω/1000m, and doubled when in two-direction.

Appendix A: Resistance versus Temperature Table

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
								55.6	150

CGEO-TEM2 Semiconductor Thermometer Control Table of Resistance - Temperature