

### General Instructions

Temperature Sensor Assemblies are available for a range of industrial applications. These instructions provide information for installation, mounting, wiring, and storage of Temperature Sensors and Assemblies.



In most process applications the temperature sensor is inserted into a thermowell or protection tube. This protects the sensor from its environment and facilitates easy removal and replacement. These assemblies generally consist of a head, nipple-union-nipple and thermowell. Smart industrial thermocouples and RTDs are available in virtually any calibration and resistance temperature coefficient.

#### Principle of Operation

A resistance temperature detector (RTD) operates on the principle that electrical resistance of metal changes as its temperature changes. The resistance of the sensing element increases as the temperature rises.

A Thermocouple operates on the principle that two dissimilar metals connected at two separate junctions will produce a current when one of the junctions is hotter than the other.

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*Design and specifications are subject to change without notice.*

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## Installation

Maintain the Assemblies in their original shipping containers until installation. DO NOT STACK shipping containers upon themselves. Maintain shipping containers in an indoor environment. Keep containers elevated off of the ground and cover with waterproof tarp, or equal, until ready for installation.

Unpack the Temperature Assembly. Mount the Assembly and Thermowell (if provided) to the appropriate process connection. See Thermocouple Wiring mounting details on page 5.



*This product should only be installed by trained and competent personnel.*

## Mounting and Wiring

Ensure that wiring conforms to all applicable local and national electrical codes and install assemblies according to safety codes.

RTD and Thermocouple assemblies (with or without well) will be factory wired at time of shipment.

## Commissioning and Set Up

These Temperature Assemblies are shipped factory wired and if ordered with a Temperature Transmitter: they will be configured and programmed. No additional adjustments should be required. If a problem occurs with this assembly – isolate and test the 2 main components of the package as follows:

### REQUIRED TOOLS

- RTDs - Digital Ohm Meter with test current not exceeding 1mA test current at the 100 thru 1K Ohms settings. Applying test current exceeding 1mA to the RTD sensor will cause damage to the sensor and will not be covered under the warranty..
- Thermocouples - Digital Ohm Meter

### PROCEDURE (RTD Checkout)

- The RTD assemblies can be tested for functionality and continuity at the connecting block and/or at the instrument panel end of the RTD assembly's extension wire.  
RTD Element: Disconnect the RTD leads at the terminal block. Using a Ohm Meter – measure the resistance of the RTD (1 Red, 1 White wire) at ambient Temp. A functioning RTD should read approximately 108 ohms @ 21°C (70°F). (100 ohms @ 0°C (32°F) and 138.51 ohms @ 100°C (212°F).

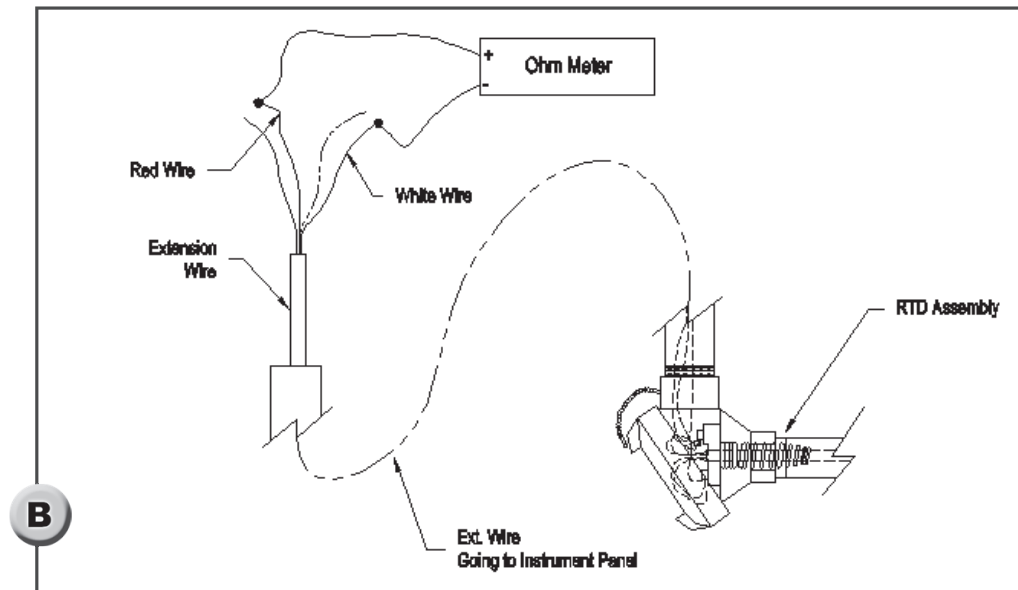
Using **A** below, lookup the ambient temperature's ohms conversion then set the digital ohm meter at the correct ohm reading setting. This ambient temperature ohm value will be compared against your ohm value readings in the following steps.

Resistance in Ohms

| <b>A</b> °F | 0      | 1      | 2      | 3      | 4      | 5      | 6      | 7      | 8      | 9      |
|-------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| -40         | 84.27  | 84.05  | 83.83  | 83.61  | 83.39  | 83.17  | 82.95  | 82.73  | 82.51  | 82.29  |
| -30         | 86.47  | 86.25  | 86.03  | 85.81  | 85.59  | 85.37  | 85.15  | 84.93  | 84.71  | 84.49  |
| -20         | 88.66  | 88.44  | 88.22  | 88.00  | 87.78  | 87.56  | 87.34  | 87.13  | 86.91  | 86.69  |
| -10         | 90.85  | 90.63  | 90.41  | 90.19  | 89.97  | 89.75  | 89.54  | 89.32  | 89.10  | 88.88  |
| 0           | 93.03  | 92.82  | 92.60  | 92.38  | 92.16  | 91.94  | 91.72  | 91.50  | 91.29  | 91.07  |
| 0           | 93.03  | 93.25  | 93.47  | 93.69  | 93.91  | 94.12  | 94.34  | 94.56  | 94.78  | 95.00  |
| 10          | 95.21  | 95.43  | 95.65  | 95.87  | 96.09  | 96.30  | 96.52  | 96.74  | 96.96  | 97.17  |
| 20          | 97.39  | 97.61  | 97.83  | 98.04  | 98.26  | 98.48  | 98.70  | 98.91  | 99.13  | 99.35  |
| 30          | 99.57  | 99.78  | 100.00 | 100.22 | 100.43 | 100.65 | 100.87 | 101.09 | 101.30 | 101.52 |
| 40          | 101.74 | 101.95 | 102.17 | 102.39 | 102.60 | 102.82 | 103.04 | 103.25 | 103.47 | 103.69 |
| 50          | 103.90 | 104.12 | 104.34 | 104.55 | 104.77 | 104.98 | 105.20 | 105.42 | 105.63 | 105.85 |
| 60          | 106.07 | 106.28 | 106.50 | 106.71 | 106.93 | 107.15 | 107.36 | 107.58 | 107.79 | 108.01 |
| 70          | 108.23 | 108.44 | 108.66 | 108.87 | 109.09 | 109.30 | 109.52 | 109.73 | 109.95 | 110.17 |
| 80          | 110.38 | 110.60 | 110.81 | 111.03 | 111.24 | 111.46 | 111.67 | 111.89 | 112.10 | 112.32 |
| 90          | 112.53 | 112.75 | 112.96 | 113.18 | 113.39 | 113.61 | 113.82 | 114.04 | 114.25 | 114.47 |
| 100         | 114.68 | 114.90 | 115.11 | 115.33 | 115.54 | 115.76 | 115.97 | 116.18 | 116.40 | 116.61 |
| 110         | 116.83 | 117.04 | 117.26 | 117.47 | 117.68 | 117.90 | 118.11 | 118.33 | 118.54 | 118.76 |
| 120         | 118.97 | 119.18 | 119.40 | 119.61 | 119.82 | 120.04 | 120.25 | 120.47 | 120.68 | 120.89 |
| 130         | 121.11 | 121.32 | 121.53 | 121.75 | 121.96 | 122.18 | 122.39 | 122.60 | 122.82 | 123.03 |
| 140         | 123.24 | 123.46 | 123.67 | 123.88 | 124.09 | 124.31 | 124.52 | 124.73 | 124.95 | 125.16 |
| 150         | 125.37 | 125.59 | 125.80 | 126.01 | 126.22 | 126.44 | 126.65 | 126.86 | 127.08 | 127.29 |
| 160         | 127.50 | 127.71 | 127.93 | 128.14 | 128.35 | 128.56 | 128.78 | 128.99 | 129.20 | 129.41 |
| 170         | 129.62 | 129.84 | 130.05 | 130.26 | 130.47 | 130.68 | 130.90 | 131.11 | 131.32 | 131.53 |
| 180         | 131.74 | 131.96 | 132.17 | 132.38 | 132.59 | 132.80 | 133.01 | 133.23 | 133.44 | 133.65 |
| 190         | 133.86 | 134.07 | 134.28 | 134.50 | 134.71 | 134.92 | 135.13 | 135.34 | 135.55 | 135.76 |
| 200         | 135.97 | 136.19 | 136.40 | 136.61 | 136.82 | 137.03 | 137.24 | 137.45 | 137.66 | 137.87 |
| 210         | 138.08 | 138.29 | 138.51 | 138.72 | 138.93 | 139.14 | 139.35 | 139.56 | 139.77 | 139.98 |

Deg. °F to Ohms Conversion (100 Ohm Platinum RTD, .00385 Alpha)

If testing at the instrument panel location, connect the ohm meter test leads across the extension wire leads corresponding to any of the red and white wires of the RTD assembly. See **B**.



*The ohm readings you get will be higher than the ambient temperature ohm value from the table due to the added resistance from the extension wire. The extension wire will increase the resistance about 0.02 Ohms per foot. This added resistance will be eliminated from the loop by the device/instrument where the sensor output will be connected.*

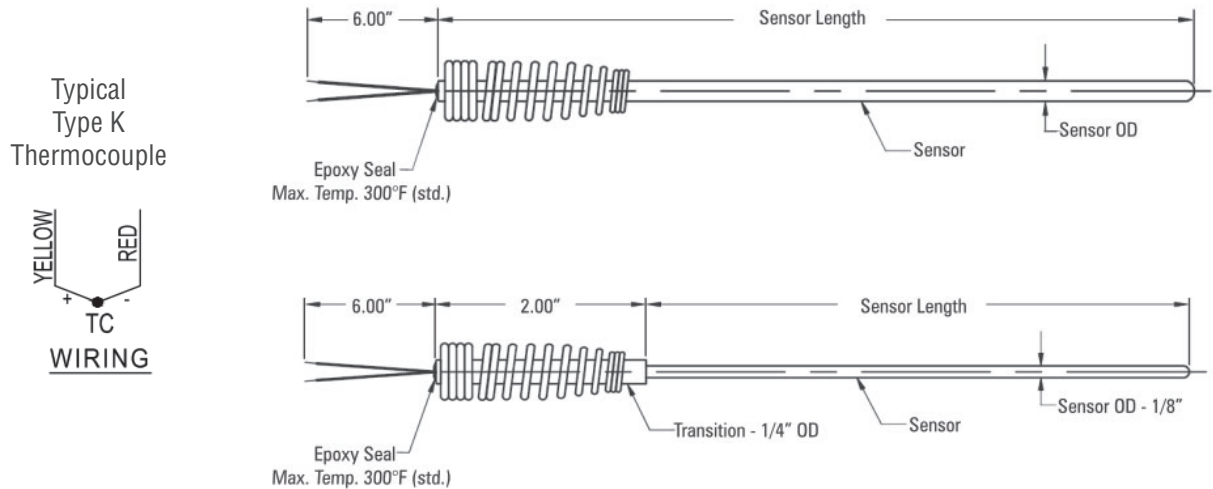
If testing at the RTD assembly connecting block, connect the ohm meter as shown in **C** on page 6.

## Wiring

### Typical Thermocouple Wiring – M.I. Cable Thermocouple Elements

All industrial thermocouples are manufactured using a high purity mineral oxide insulation and a metallic sheath. The standard sheath material unless otherwise noted is 316SS. The ODs found in this section are those that are typically used when an element is housed in a well or protection tube. Each industrial thermocouple is supplied with a heavy duty spring.

**Wire Gauge:** 20 Gauge solid teflon insulated



### Typical RTD Wiring – Industrial RTDs

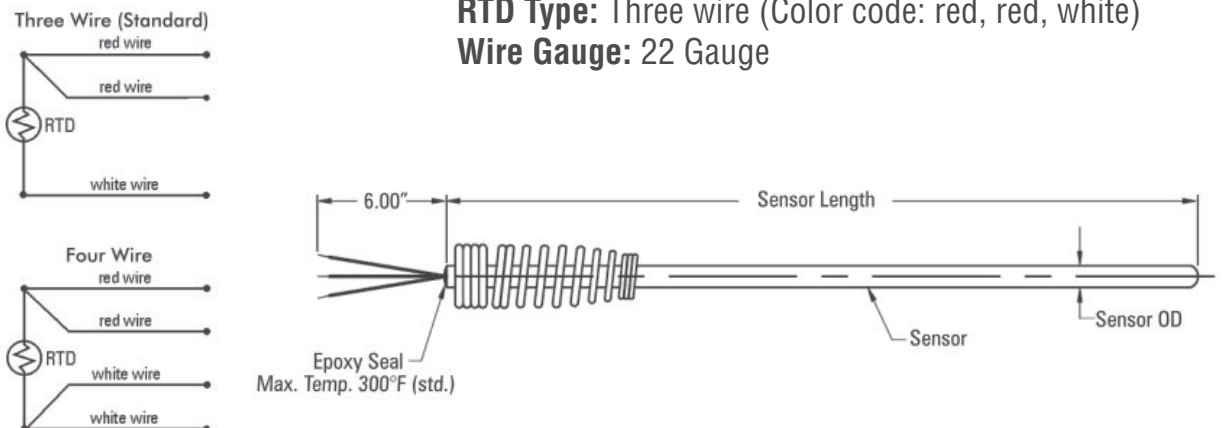
All RTDs are 100% tested to insure that the accuracy and the continuity of the product have not been affected by the manufacturing process. The standard sheath material on all RTDs is 316SS. Other sheath materials and coatings are available. Elements are either thin film or wire wound, depending on the style RTD selected. Thin film elements are used in all constructions unless otherwise specified. Each RTD is supplied with a heavy duty spring.

**Standard RTD Specifications: Element Material:** Platinum

**Element Type:** 100 ohms @ 0C, .00385 DIN Curve

**RTD Type:** Three wire (Color code: red, red, white)

**Wire Gauge:** 22 Gauge



## Troubleshooting

| Resistance Reading   | Possible Problem   | Corrective Action<br>Follow-Up Check  |
|----------------------|--|---|
| Infinite Resistance  | Damaged Sensor<br><br>Faulty Extension Wire Connection     | Check sensor at RTD assemblyhead if possible and confirm reading. See <b>C</b>  |
| Between 0 and 1 Ohms | Short Circuit At Sensor<br>Faulty Extension Wire (Shorted) | Disconnect extension wire at sensor head and test the sensor at the terminal block. If sensor checks out, problem is with the extension wire, replace extension wire. |

**C** Resistance measurement at RTD assembly head across red and white wires

TEMPERATURE TRANSMITTER TROUBLESHOOTING STEPS: (If supplied)

- 1 Confirm that you have a working power supply with a voltage between 10 and 42 VDC.
- 2 Connect the power supply, a milliamp meter and a 100 Ohm resistor to the transmitter input terminals. Consult the Manufacturers wiring instructions per the transmitters O&M manual. You should get a reading of approximately 4 milliamps on the milliamp meter display if the transmitter is scaled 4-20 mA with 4 mA being 0C.



## THERMOCOUPLE TROUBLESHOOTING STEPS:

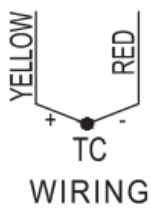
There are many factors that can give a thermocouple sensor an erroneous reading, such as electrical “noise” ground loops and damaged/broken thermocouple leads and conductors.

How to test a T/C that has been used in a process? Usually to test, a replacement sensor needs to be installed in the process the suspect sensor removed for evaluation. A quick check can be comparing the reading of the “new sensor” vs the “defective sensor”. Used thermocouples that have been in a process may no longer be electrically the same as when first installed.

Use a thermocouple meter and set it to match the calibration (J, K, T, E, N, etc...) of the thermocouple being tested.

- ❶ Check the polarity of all connections. The positive colored leg (wire) should be connected to the positive side of the instrument. The negative leg (wire) (Always RED) should be connected to the negative side of the instrument.
- ❷ If the polarity and connections all check out, the next step is to check the Sensor. The Thermocouple can be checked by comparing its reading against those obtained with a test thermocouple of known accuracy (Reference standard) or by placing the sensor in a known temperature bath such as an Ice Bath (32°F/0°C) or boiling water (212°F/100°C). If the sensor reading does not agree within the accuracy specifications at either of these test temperatures – then the sensor should be replaced. If the sensor reads within the allowable tolerance – then move to checking the extension wire and input device module that is reading the mV output from the Thermocouple.

## Thermocouples



| Standard Calibration |   | Material   | Temperature Range | Accuracy    | Premium Grade | Accuracy    |
|----------------------|---|------------|-------------------|-------------|---------------|-------------|
| "J"                  | + | Iron       | 32° F             | ± 4° F      | "JJ"          | ± 2° F      |
|                      | - | Constantan | to<br>1400° F     | or<br>0.75% |               | or<br>0.40% |
| "K"                  | + | Chromel    | 32° F             | ± 4° F      | "KK"          | ± 2° F      |
|                      | - | Alumel     | to<br>2300° F     | or<br>0.75% |               | or<br>0.40% |
| "T"                  | + | Copper     | -320° F           | ± 2° F      | "TT"          | ± 1° F      |
|                      | - | Constantan | to<br>700° F      | or<br>0.75% |               | or<br>0.40% |
| "E"                  | + | Chromel    | 32° F             | ± 3° F      | "EE"          | ± 1.8° F    |
|                      | - | Constantan | to<br>1600° F     | or<br>0.75% |               | or<br>0.40% |
| "N"                  | + | Nicrosil   | 32° F             | ± 4° F      | "NN"          | ± 2° F      |
|                      | - | Nisil      | to<br>2300° F     | or<br>0.75% |               | or<br>0.40% |

- ③ Thermocouple Inspection – Severely corroded or oxidized thermocouples are always a source of trouble. Changes in wire composition can result from corrosion and contamination by foreign elements. Impurities such as sulfur and iron plus other factors picked up from the environment/atmosphere at the cold junction can contaminate the conductors and result in errors. Remember the millivolt readings per the ANSI/ASTME Charts are based on referenced purities of the (+) & (-) conductors. Any contamination or degradation will affect the mV/degree output.
- ④ Meter and Extension Wires – To check the working meter and extension wires, connect the extension wires to the test thermocouple of known accuracy and observe the temperature reading. If the reading is different from that obtained with the test meter, the trouble is either in the extension wires or in the working meter.
- ⑤ Extension Wire Resistance – If the working meter is the millivolt type, it will have been calibrated for a certain external resistance. Accordingly, the extension wire loop should be checked to make sure that it meets the established external resistance required.

The above checks are intended only as elementary guides in trying to pinpoint the possible cause of erroneous readings. If the cause of erroneous readings can be traced to the thermocouple itself, it should be removed and replaced. It is always more economical to replace the thermocouple element than to risk loss of productivity, product, or safety through inaccurate temperature measurement.



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