Introduction to Thermocouples and Thermocouple Assemblies

What is a thermocouple?

A thermocouple is a temperature sensor consisting of two dissimilar metal wires, joined at one end, and connected to a thermocouple thermometer or other thermocouple-capable device at the other end. When properly configured, thermocouples can provide temperature measurements over wide range of temperatures.

What are the different thermocouple types?

Thermocouples are available in different combinations of metals or "calibrations". The most common are the "Base Metal" thermocouples known as Types J, K, T, E and N. There are also some special thermocouple types known as Noble Metal thermocouples, these are Types R, S and B. The highest temperature thermocouple types are the Refractory Type thermocouples which include types C, G and D.

How do I choose a thermocouple type?

Thermocouples are typically selected based on the following conditions:

- Temperature range
- Accuracy
- Process Compatibility (Chemical and Mechanical)
- Instrument Compatibility

How do I know which junction type to choose?

Sheathed thermocouple types are available in three junction styles, grounded, ungrounded and exposed.

Operating Atmosphere—Typical Sheath Materials

Material	Maximum Temperature	Application Atmosphere			
		Oxidizing	Hydrogen	Vacuum	Inert
304, 310, 316, and 321 SS	900°C (1650°F)	Very Good	Good	Very Good	Very Good
Inconel® 600	1150°C (2100°F)	Very Good	Good	Very Good	Very Good
Super OMEGACLAD® XL	1335°C (2440°F)	Excellent	Good	Very Good	Very Good
Platinum-Rhodium Alloy	1650°C (3000°F)	Very Good	Poor	Poor	Poor
Molybdenum	2200°C (4000°F)	Not Rec.	Fair	Good	Fair
Tantalum	2300°C (4200°F)	Not Rec.	Not Rec.	Good	Not Rec.

OMEGACLAD® Specifications

Diameters: Standard diameters: 0.25 mm (0.010"), 0.5 mm (0.020"), 0.75 mm (0.032"), 1 mm (0.040"), 1.5 mm (1/16"), 3 mm (1/8"), 4.5 mm (3/16"), and 6 mm (1/4"), 8 mm (0.313") and 9.5 mm (0.375").
Length: Standard OMEGA® thermocouples have 300 mm (12") immersion lengths. Other lengths are available.
Sheaths: 304 SS and Inconel® are standard. Other sheath materials are available; call for price and availability.
Insulation: High-purity magnesium oxide is standard. Minimum insulation resistance wire to wire or wire to sheath is 1000 MΩ at 500 Vdc in diameters above 1.5 mm (1/16")
Calibration: Iron-constantan (J), CHROMEGA®-ALOMEGA® (K), copper-constantan (T), and CHROMEGA®-constantan (E) are standard calibrations.
Bending: Easily bent and formed. Bend radius should be not less than twice the diameter of the sheath.
Delivery: Off-the-shelf. Other sheaths are available; call for price and delivery.
Dual Elements: Thermocouples with a sheath diameter of 1 mm (0.040") through 6 mm (1/4") are available in dual element.
Accuracy: The wires used in OMEGA® thermocouples are selected and matched to meet ANSI Limits of Error. Special limits of error thermocouples can be made from 0.25 mm (0.010") OD to 9.5 mm (0.375") OMEGACLAD® thermocouple wire.
ANSI Polarity*: In the thermocouple industry, standard practice is to color the negative lead red. Other standards that OMEGA® uses are: the negative lead of bare wire thermocouple is approximately 6 mm (1/4") shorter than the positive lead, and the large pin on a thermocouple connector is always the negative conductor. *IEC polarity–standard practice is to color the negative lead white.
Extension Wire: Thermocouple alloy wire must always be used to connect a thermocouple sensor to the instrumentation to ensure accurate measurements.

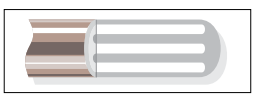
Room Temperature Insulation Resistance		
Nominal Sheath mm (inch)	Applied DC Voltage Min	Insulation Resistance Min
<0.80 (0.03)	50 V	100 MΩ
0.80 to 1.5 (0.030 to 0.059)	50 V	500 MΩ
>1.5 (0.059)	500 V	1000 MΩ

(Place the existing grounded, ungrounded and exposed junction diagrams and text here, add insulation resistance table within the ungrounded section)

What is response time?

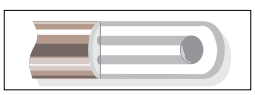
Response time, also known as the sensor time constant, is the time required for a sensor to respond to a step change in temperature. This is normally defined under a set of conditions such as "the 63.2% response in water flowing at 3 feet per second". The 63.2% value (also known as the primary time constant) is the most common, but 50% and 90% values may also used. The response time is a comparison measure of how quickly a sensor will indicate a change in temperature conditions, and is usually a component in determining a system response time. See Page Z-52 for typical thermocouple response times.

Grounded Junction, OMEGACLAD® Probes



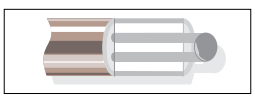
A **grounded junction** is recommended for the measurement of static or flowing corrosive gas and liquid temperatures and for high-pressure applications. The junction of a grounded thermocouple is welded to the protective sheath, giving faster response than the ungrounded junction type.

Ungrounded Junction, OMEGACLAD® Probes



An **ungrounded junction** is recommended for measurements in corrosive environments it is desirable to have the thermocouple electronically isolated from and shielded by the sheath. The welded wire thermocouple is physically insulated from the thermocouple sheath by MgO powder (soft).

Exposed Junction, OMEGACLAD® Probes



An **exposed junction** is recommended for the measurement of static or flowing non-corrosive gas temperatures where fast response time is required. The junction extends beyond the protective metallic sheath to give accurate, fast response. The sheath insulation is sealed where the junction extends to prevent penetration of moisture or gas, which could cause errors.