# Grounded or ungrounded *T/C* Sensor?

This question must always be answered when designing a thermal system. It's not always as simple as it appears and a few different design characteristics must be understood and considered. Cost, thermal response, ground loops and reliability are a few of the considerations, but lets take a look at each individually.

A grounded thermocouple, by definition, is formed when the sensor allows are welded to the sheath at the junction. The introduction of the third metal does not cause measurement errors because the temperature gradients at the junction are insignificant. The actual grounding occurs when the sensor is mounted to the vessel via the fitting.

Ungrounded junctions are constructed by welding the sensor alloys together but isolating the connection from the sheath. This design will cost more (due to additional labor) to insulate the alloys. Typically, the price for ungrounding is $2 to $20 per unit depending on the diameter of the sensor. Small diameters require specialized equipment and a natural talent for microscopic welding. Also, the thermal time response will be longer since the insulation material's thermal transfer characteristics are not as good as the sheath materials. Grounded junctions will typically transfer heat about 40% faster than ungrounded junctions. Special high thermal transfer insulators can be used like boron nitride; this increases costs and delivery.

Ground loops can occur when the sensor is grounded and the instrument does not have an isolated input. The ground loop is an unwanted conductive path from the sensor to the instrument and is "read" by the instrument as the sensor output. Also keep in mind, that at the higher temperatures, MgO insulation properties drop and an ungrounded sensor may "look grounded. Use caution when using ungrounded sensors as the only means of isolation.

Another consideration is the temperatures that the sensor will be operated in and the cost for failure. Grounded junctions will be prone to thermal stress due to the expansion of different materials. Ungrounded junctions are less susceptible since they are not "fixed" to the sheath. Thermal expansion is usually not a problem under 2000 "F but never less it is a consideration when designing a sensor used in high performance applications.

All of the above factors must be considered and the tradeoffs evaluated. A few basic rules to follow:

1) Select the ungrounded thermocouple if your budget allows and fast response is not essential.
2) If ungrounded is your choice, make sure the instrument has isolation. If not, isolation can be achieved by using a Watlow Richmond isolated signal conditioner and converting the signal to 4 to 20mA. The 5702 or the 5800 will do this.
3) Do not depend on the insulation of the sensor to perform the isolation - especially at the higher temperatures. You might want to consider using a Teflon mounting fitting to "unground" the sensor if you cannot sacrifice the response time.


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