UNDERSTANDING TRUE

THERMOCOUPLE ACCURACY

TEMPCO

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ANSI type K thermocouple accuracy is specified as follows:

Class	Accuracy Tolerance (Whichever is greater)	Temperature Range
Standard Limits	±2.2°C or ±.75%	0°C to 1250°C
Special Limits (SLE)	±1.1°C or ±0.4%	0°C to 1250°C

This is not an absolute and many things can affect the accuracy of a thermocouple. Some examples are contamination & oxidation, electromagnetic interference, cold junction compensation and sensor drift (hysteresis).

Often referred to as drift or aging, hysteresis is a change in the thermocouple's temperature reading after it is heated to a certain temperature. The reason this occurs is due to metallurgical changes in the grain structure of the thermocouple material.

While this can happen with many types of thermocouples, it is most prevalent with type K thermocouples. Since different thermocouple types use different metals, they experience hysteresis in different temperature ranges and to varying degrees.

For type K thermocouples, they can start to drift about an extra 1-2°C when heated in the 200°C to 600°C range. The highest drift in temperature readings will occur around 400°C. This drift or change in the metallurgical structure can become permanent if the thermocouple is rapidly cooled to room temperature.

This situation can be avoided by using a type K thermocouple outside of the 200°C to 600°C temperature range. If the application needs a thermocouple and is within that range, you may want to consider another calibration type.

A Standard Thermocouple from Tempco

There is a way to heat treat or condition the type K thermocouple to minimize the effect of hysteresis. The thermocouple must be heated to 500°C and allow it to soak at that temperature for 3-4 hours. It then must be gradually cooled back to room temperature and calibrated in order to determine the new accuracy of the thermocouple. This heat treating could be reversed if the thermocouple see temperatures above 600°C. If that occurs, the process previously mentioned would have to be completed again.

Below is a reference table with thermocouple calibration types and what kind of drift is possible and the reasons why they drift in application.

Type	General Drift Behavior	Common Drift Mechanisms	Notes
Type K	Moderate to high drift at elevated temperatures	Oxidation, chromium depletion, "green rot," short-range ordering	Very common, but not ideal for long-term high-temperature stability in reducing or low-oxygen atmospheres.
Type N	Lower drift than Type K	Improved resistance to oxidation and short-range ordering	Often chosen as a more stable replacement for Type K in high-temperature applications.
Type J	Moderate drift; can become unreliable at higher temperatures	Iron oxidation, rusting, embrittlement	Best in reducing, vacuum, or inert atmospheres; poor choice where the iron leg oxidizes.
Type T	Low drift at low/cryogenic temperatures	Copper oxidation at higher temperatures	Very stable for low-temperature measurement, but limited upper temperature range.
Type E	Moderate drift	Nickel-chromium oxidation, contamination	High output signal, good sensitivity, but not the most stable for prolonged high-temperature exposure.
Type R	Low to moderate drift at high temperatures	Rhodium migration, contamination, grain growth	More stable than base-metal types, but contamination from insulation or process atmosphere can still cause drift.
Type S	Low drift at high temperatures	Platinum contamination, grain growth	Common reference/high-temperature type; accuracy depends strongly on keeping the platinum clean.
Type B	Low drift at very high temperatures	Platinum-rhodium contamination, grain growth	More stable at extremely high temperatures; less sensitive at lower temperatures.