Wrong Thermocouple Type Reading Error

Temperature an instrument shows when a thermocouple of one type is read as another type (for example J read as K), from the NIST ITS-90 reference functions.

Method: NIST ITS-90 thermocouple reference functions (NIST Monograph 175)

Input parameters

Unit system: SI

Parameter	Value	Unit
Thermocouple actually fitted	Type J (Iron / Constantan)	
Type the instrument is set for	Type K (Chromel / Alumel)	
True temperature at the hot junction	300.00	°C

Calculated results

Parameter	Value	Unit
EMF produced by the fitted thermocouple (cold junction 0 °C)	16.327	mV
Temperature shown by the instrument	398.34	°C
Error (shown − true)	98.344	K

Notes for this case

• Cold junction taken at 0 °C. A real instrument compensates with the set type's function at its terminal temperature, so the shown value shifts by the difference between the two types' EMF at the terminals (a few kelvin for common pairs near room temperature).

Formula and method

$$T_{ind} = E_{set}^{-1}(E_{act}(T))$$

Variables

sensor	Thermocouple actually fitted	-
set	Type the instrument is set for	-
T	True temperature at the hot junction	K
E	EMF produced by the fitted thermocouple (cold junction 0 °C)	V
T_{ind}	Temperature shown by the instrument	K
ΔT	Error (shown − true)	K

Method and standards

Forward NIST function of the fitted type, inverse function of the set type.

Assumptions and limits

- A real instrument adds E_set(T_terminal) for cold-junction compensation while the fitted sensor delivers E_act(T) − E_act(T_terminal); the shown value then differs from this 0 °C result by roughly the mismatch of the two types' EMF at terminal temperature.
- Cold junction at 0 °C.

References

• NIST ITS-90 thermocouple reference functions (NIST Monograph 175)

Report details

Report reference	FCC-6RMX-WDJ8 (the same inputs always give the same reference)
Generated	17 November 2026, 19:48 UTC
Calculator	Wrong Thermocouple Type Reading Error
Method last reviewed	12 November 2026
Software release	FireCAD Calc, release of 17 November 2026
Release checks	3 reference cases of this calculator, computed independently, are checked on every release

Results are for engineering estimation. Verify critical designs against the referenced standards and your own data.

This calculator online

https://calc.firecad.com/instrumentation/temperature/thermocouple-type-mismatch-error

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.