

Thermocouple types

ANSI Calibration Code	Positive Leg	Negative Leg	Recommended Temp. Range °F(°C)of Prot. TC**	Application Information
J	Iron ThermoKanthal JP*	Constantan* Cupron* Advance* ThermoKanthal JN*	32 to 1400 (0 to 760)	Suitable for vacuum, reducing, or inert atmospheres, oxidizing atmospheres with reduced life. Iron oxidizes rapidly above 1000°F (538°C) so only heavy gauge wire is recommended for high temperature. Bare elements should not be exposed to sulphurous atmospheres above 1000°F (538°C).
K	Chromel* Tophel* T1* ThermoKanthal KP*	Alumel* Nial* T2* ThermoKanthal KN*	32 to 2300 (0 to 1260)	Recommended for continuous oxidizing or neutral atmospheres. Mostly used above 1000°F (530°C). Subject to failure if exposed to sulphur. Preferential oxidation of chromium in positive leg at certain low oxygen concentrations causes "green rot" and large negative calibration drifts most serious in the 1500 - 1900°F range (816 — 1038°C). Ventilation or inert-sealing of the protection tube can prevent this.
T	Copper	Constantan* Cupron* Advance*	—300 to + 700 (—184 to +371)	Useable in oxidizing, reducing, or inert atmospheres as well as vacuum. Not subject to corrosion in moist atmospheres. Limits of error published for sub-zero temperature ranges.
E	Chromel* Tophel* T1* ThermoKanthal KP*	Constantan* Cupron* Advance* ThermoKanthal JN*	32 to 1600 (0 to 871)	Recommended for continuously oxidizing or inert atmospheres. Sub-zero limits of error not established. Highest thermoelectric output of common calibrations.
R	Platinum— 13% Rhodium	Platinum	100 to 2700 (538 to 1482)	Recommended for high temperature. Must be protected with non-metallic protection tube and ceramic insulators. Continued high temperature usages causes grain growth which can lead to mechanical failure. Negative calibration drift caused by rhodium diffusion to pure leg as well as from rhodium volatilization. Type R is used in industry; type S in the laboratory
S	Platinum— 10% Rhodium	Platinum		
B	Platinum— 30% Rhodium	Platinum— 6% Rhodium	1600 to 3100 (871 to 1705)	Similar as R & S but output is lower. Also less susceptible to grain growth and drift.
M	Nickel	Nickel— 18% Molybdenum	32 to 2250 (0 to 1287)	High temperature applications in inert or vacuum atmosphere. Useful in many hydrogen applications. Continuous cycling causes excessive grain growth.
C	Tungsten- 5% Rhenium(W-5Re)	Tungsten- 26% Rhenium (W-26Re)	32 to 4200 (0 to 2315)	Very high temperature applications in inert or vacuum. Preferred over Tungsten/Tungsten—26% Rhenium because less brittle at low temperatures.
W	Tungsten- 3% Rhenium (W-3Re)	Tungsten- 25% Rhenium (W-25Re)	32 to 4200 (0 to 2315)	The ductility of the W3Re leg is superior to pure Tungsten, but not as good as W5Re. This combination has highest output of the 3 common Tungsten Rhenium calibrations from 1860 to 4200°F.
N	Nicrosil*** 14.5% Chromium 1.4% Silicon .1% Magnesium Balance Nickel	Nisil*** 4.2% Silicon .1% Magnesium Balance Nickel	32 to 2300 (0 to 1260)	Can be used in applications where Type K elements have shorter life and stability problems due to oxidation and the development of "Green Rot"
None	Platinel* 5355	Platinel* 7674	32 to 2300 (0 to 1260)	Noble metal combination which approximates Type K curve but has much improved oxidation resistance. Should be treated as any noble metal calibration.

*Trade names. Chromel, Alumel: Hoskins Mfg. Co.; T1, T2, Advance: Driver-Harris Co.; Nial, Tophel: Wilbur B. Driver Co.; ThermoKanthal KP and KN: The Kanthal Corp.; Platinel; Engelhard Industries.

**The Recommended Temperature Range is that temperature range for which limits of error have been established.

***Trade Name: Amax Specialty Metals Corp.

Thermocouple Types

ANSI Limits of Error Thermocouples Reference Junction °C (32°F). Published in ANSI Circular MC 96.1 - 1982

NOTE: 1/4 limits available on request

Type	Temperature Range °C(°F) for Standard Limits of Error	Standard Limits of Error	Temperature Range °C (°F) for Special Limits of Error	Special Limits of Error
J	0 to 293 (32 to 559)	± 2.2°C (+4.0°F)	0 to 275 (32 to 527)	± 1.1 °C (+ 2°F)
	293 to 760 (559 to 1400)	± 0.75%	275 to 760 (527 to 1400)	± 0.4%
K	-200 to -110 (-328 to -166)	± 2%*		**
	-110 to 0 (-166 to 32)	± 2.2°C (+ 4°F)*	0 to 275 (32 to 527)	**
	0 to 293 (32 to 559)	± 2.2°C (+ 4°F)		± 1.1 °C (+ 2°F)
T	293 to 1250 (559 to 2282)	± 0.75%	275 to 1250 (527 to 2282)	± 0.4%
	-200 to -67 (-328 to -89)	± 1.5 % *		**
	-67 to 0 (-89 to 32)	± 1°C (+ 1.8°F)*	0 to 125 (32 to 257)	**
E	0 to 133 (32 to 271)	± 1 °C (+ 1.8 °F)		± 0.5°C (+ 0.9°F)
	133 to 350 (271 to 662)	± 0.75%	125 to 350 (257 to 662)	± 0.4%
	-200 to -170 (-328 to -274)	± 1%*		**
R	-170 to 0 (-274 to 32)	± 1.7°C (+ 3.1°F)*	0 to 250 (32 to 482)	**
	0 to 340 (32 to 644)	± 1.7°C (+ 3.1°F)		± 1 °C (+ 1.8°F)
	340 to 900 (644 to 1652)	± 0.5%	250 to 900 (482 to 1652)	± 0.4%
S	0 to 600 (32 to 1112)	± 1.5°C (+ 2.7°F)	0 to 600 (32 to 1112)	± 0.6°C (+ 1.1 °F)
	600 to 1450 (1112 to 2642)	± 0.25%	600 to 1450 (1112 to 2642)	± 0.1%
B	0 to 600 (32 to 1112)	± 1.5°C (+ 2.7°F)	0 to 600 (32 to 1112)	± 0.6°C (+ 1.1°F)
	600 to 1450 (1112 to 2642)	± 0.25%	600 to 1450 (1112 to 2642)	± 0.1%
B	800 to 1700 (1472 to 3092)	± 0.5%	800 to 1700 (1472 to 3092)	----

*Thermocouples and thermocouple materials are supplied to meet the Limits of error specified for temperatures above 0°C. A thermocouple material may not conform to the published sub-zero limits of error for that material when purchased,

unless conformance is agreed to.

**Special limits of error for sub-zero temperatures have not yet been established. The following limits for calibrations E and T are useful to start discussion.

-200 to 0°C
Type E + 1°C or +0.5%, whichever is greater
Type T +0.5°C or +0.8%, whichever is greater.

Sub-zero limits of error for Type J and sub-zero special limits of error for Type K are not considered because of the characteristics of the materials.

Non-ANSI Limits of Error Thermocouples

Pyro Type	Type	Temperature Range, °C (°F)	Limits of Error
G	W-W, 26%, Re	0 to 427 (32 to 800)	±4.4°C (+ 8°F)
		427 to 2316 (800 to 4200)	± 1%
C	W, 5% Re-W, 26% Re	0 to 427 (32 to 800)	± 4.4°C (+ 8°F)
		427 to 2316 (800 to 4200)	± 1%
M	Nickel - Nickel, 18% Moly	0 to 1287 (32 to 2250)	± .75%
N	Nicrosil - Nisil	0 to 1250 (32 to 2282)	± 2.2°C (+ 4°F)
		0 to 427 (32 to 800)	± .75%
D	W, 3% Re-W, 25% Re	0 to 427 (32 to 800)	± 4.4°C (+ 8°F)
		427 to 2316 (800 to 4200)	± 1%
P	Platinel II (Platinel 5355/Platinel 7674)	0 to 600 (32 to 1112)	± 0.10mV
		600 to 700 (1112 to 1292)	± 0.15mV
		700 to 1300 (1292 to 2372)	± 0.20mV

Recommended Temperature Limits for Protected Thermocouples

Maximum Temperature

Thermocouple Type	Minimum Temperature		11 ga. (Type M Only)									
	°C	°F	8 ga.	14 ga. (All Others)	20 ga.	24 ga.	30 ga.	°C	°F	°C	°F	
Type T (Copper-Constantan)	-184°	-300°	---	---	---	---	---	---	260°	500°	204°	400°
Type J (Iron-Constantan)	-18°	-0°	760°	1400°	593°	1100°	482°	900°	371°	700°	371°	700°
Type E (Chromel-Constantan)	-184°	-300°	871°	1600°	649°	1200°	538°	1000°	427°	800°	427°	800°
Type K (Chromel-Alumel)	-18°	-0°	1260°	2300°	1093°	2000°	982°	1800°	871°	1600°	871°	1600°
Type M (Nickel-Nickel, 18% Moly)	-18°	-0°	---	---	1287°	2250°	---	---	---	---	---	---
Type N (Nicrosil-Nisil)	-18°	-0°	---	---	1093°	2000°	982°	1800°	---	---	---	---
Type R and Type S	-18°	-0°	---	---	---	---	---	---	1482°	2700°	---	---
Type B	-18°	-0°	---	---	---	---	---	---	1705°	3100°	---	---
40% Iridium 600% Rhodium-Iridium	-18°	-0°	---	---	---	---	---	---	1985°	3600°	---	---
Type C Tungsten 5% Rhenium-	-18°	-0°	---	---	---	---	---	---	2330°	4200°	---	---
Type C Tungsten 26% Rhenium	-18°	-0°	---	---	---	---	---	---	---	---	---	---