

# Temperature - Electromotive Force (EMF) Tables for Standardized Thermocouples <sup>1</sup>

This reference manual consists of reference tables that give temperature-electromotive force (emf) relationships for Types B, E, J, K, R, S, and T thermocouples. These are the thermocouple types most commonly used in industry.

These tables give emf values to three decimal places (1  $\mu\text{V}$ ) for each degree of temperature. Such tables are satisfactory for most industrial uses but may not be adequate for computer and similar applications. If greater precision is required, the reader should refer to the NIST reference noted below which also includes tables giving emf values to four decimal places (0.1  $\mu\text{V}$ ) as well as equations which permit easy and unique generation of the temperature-emf relationship.

<sup>1</sup> All temperature - electromotive force data in Tables 3 to 18 have been extracted from "Temperature-Electromotive Force Reference Functions and Tables for the Letter-Designated Thermocouple Types Based on the ITS-90" *National Institute of Standards and Technology Monograph 175*.

## List of Tables

Following is a list of the thermocouple tables included in this reference manual.

Table	Type	Range
1	Limits of error	
2	Recommended upper temperature limits for protected thermocouples	
3	B	(0 to 1820) °C
4	B	(32 to 3308) °F
5	E	(-270 to 1000) °C
6	E	(-454 to 1832) °F
7	J	(-210 to 1200) °C
8	J	(-346 to 2192) °F
9	K	(-270 to 1372) °C
10	K	(-454 to 2500) °F
11	N	(-270 to 1300) °C
12	N	(-454 to 2372) °F
13	R	(-50 to 1768) °C
14	R	(-58 to 3214) °F
15	S	(-50 to 1768) °C
16	S	(-58 to 3214) °F
17	T	(-270 to 400) °C
18	T	(-454 to 752) °F

**Table 1 — Initial Limits of Error for Thermocouples**

Type	Temperature Range		Tolerances-Reference Junction 0 °C [32 °F]			
	°C	°F	Standard Tolerances		Special Tolerances	
	°C	°F	°C	°F	°C	°F
T	0 to 370	32 to 700	$\pm 1.0$ or $\pm 0.75$ %	Note 1	$\pm 0.5$ or $0.4$ %	Note 1
J	0 to 760	32 to 1400	$\pm 2.2$ or $\pm 0.75$ %		$\pm 1.1$ or $0.4$ %	
E	0 to 870	32 to 1600	$\pm 1.7$ or $\pm 0.5$ %		$\pm 1.0$ or $\pm 0.4$ %	
K or N	0 to 1260	32 to 2300	$\pm 2.2$ or $\pm 0.75$ %		$\pm 1.1$ or $\pm 0.4$ %	
R or S	0 to 1480	32 to 2700	$\pm 1.5$ or $\pm 0.25$ %		$\pm 0.6$ or $\pm 0.1$ %	
B	870 to 1700	1600 to 3100	$\pm 0.5$ %		$\pm 0.25$ %	
T <sup>A</sup>	-200 to 0	-328 to 32	$\pm 1.0$ or $\pm 1.5$ %		B	
E <sup>A</sup>	-200 to 0	-328 to 32	$\pm 1.7$ or $\pm 1$ %		B	
K <sup>A</sup>	-200 to 0	-328 to 32	$\pm 2.2$ or $\pm 2$ %		B	

<sup>A</sup> If materials are required to meet the tolerances stated for temperatures below 0 °C the purchase order must so state.

<sup>B</sup> Special tolerances for temperatures below 0°C are difficult to justify, values for Type E and T thermocouples are suggested as a guide.

Type E (-200 to 0) °C  $\pm 1$  °C or  $\pm 0.5$  %

Type T (-200 to 0) °C  $\pm 0.5$  °C or  $\pm 0.8$  %

Note 1 — The Fahrenheit tolerance is 1.8 times larger than the °C tolerance at the equivalent °C temperature. Note particularly that percentage tolerance apply only to temperature that are expressed in °C

**Table 2 — Recommended Upper Temperature Limits for Protected Thermocouples**

Upper Temperature limit for Various Wire Gage Sizes (Awg). °C [°F]						
Type	8 Gage	14 Gage	20 Gage	24 Gage	28 Gage	30 Gage
T		370 [700]	260 [500]	200 [400]	200 [400]	150 [300]
J	760 [1400]	590 [1100]	480 [900]	370 [700]	370 [700]	320 [600]
E	870 [1600]	650 [1200]	540 [1000]	430 [800]	430 [800]	370 [700]
K and N	1260 [2300]	1090 [2000]	980 [1800]	870 [1600]	870 [1600]	760 [1400]
R and S				1480 [2700]	1480 [2700]	
B				1700 [3100]	1700 [3100]	