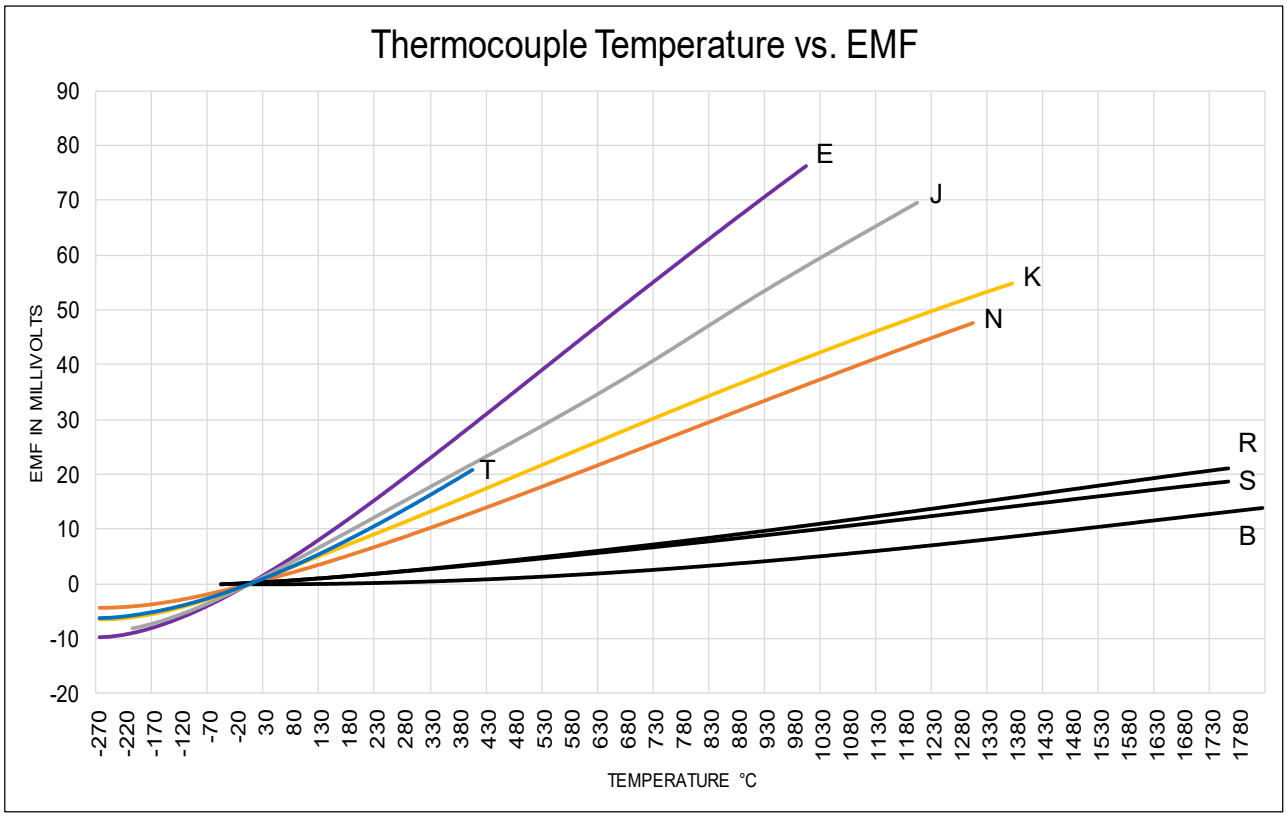
Thermocouples

The thermocouple is a temperature sensor created by joining two dissimilar metals together to form a sensing junction. The output is a very small EMF, which has a predictable value to the temperature of the sensing junction in reference to a reference junction. This technology was discovered in the 1800's and today, widely used in the measurement industry. Thermocouples are defined by the dissimilar metals used and designated with a letter which is known as the thermocouple type. Colour coding has also been standardized for distinguishing thermocouple types when examining thermocouple wire.

Aircom contributes to the thermocouple technology by manufacturing it into usable temperature devices such as sensor probes and assemblies for commercial and industrial purposes. The primary factor in selecting a thermocouple for a given application is the temperature range it will be exposed. The graph below offers a reference for this purpose. Other important factors to consider in thermocouple temperature sensor design are the process conditions the sensor will experience. This includes things such as the pressure rating and process media itself. Further information is provided in this catalog to assist with thermocouple temperature sensor design.



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Thermocouple Tolerance

Type	Material	Wire Colour Indicator	Temperature Range (°C)	Tolerances (which ever is greater)	
				Standard Limits	Special Limits
B	Platinum 30% Rhodium Platinum 6% Rhodium	Grey (+) Red (-)	870 to 1700	±0.5%	±0.25%
E	Chromel Constantan	Purple (+) Red (-)	0 to 870	±1.7°C or ±0.5%	±1°C or ±0.4%
J	Iron Constantan	White (+) Red (-)	0 to 760	±2.2°C or ±0.75%	±1.1°C or ±0.4%
K	Chromel Alumel	Yellow (+) Red (-)	0 to 1260	±2.2°C or ±0.75%	±1.1°C or ±0.4%
N	Nicrosil Nisil	Orange (+) Red (-)	0 to 1260	±2.2°C or ±0.75%	±1.1°C or ±0.4%
R	Platinum 13% Rhodium Platinum	Black (+) Red (-)	0 to 1480	±1.5°C or ±0.25%	±0.6°C or ±0.1%
S	Platinum 10% Rhodium Platinum	Black (+) Red (-)	0 to 1480	±1.5°C or ±0.25%	±0.6°C or ±0.1%
T	Copper Constantan	Blue (+) Red (-)	0 to 350	±1.0°C or ±1.5%	±0.5°C or ±0.4%
Cryrogenic Ranges					
E	Chromel Constantan	Purple (+) Red (-)	-200 to 0	±1.7°C or ±1%	±1.0°C or ±0.5%
K	Chromel Alumel	Yellow (+) Red (-)	-200 to 0	±2.2°C or ±2.0%	-
T	Copper Constantan	Blue (+) Red (-)	-200 to 0	±1.0°C or ±1.5%	±0.5°C or ±0.8%

The tolerances given in the table above are in accordance with ASTM E230. More detailed information on thermocouples can be found within the published standards. Tolerances indicated do not factor in system and installation error. Additionally, process factors such as the heating of the materials and environment can affect initial tolerances.

Not listed above are Tungsten - Rhenium thermocouples (WR, W3 &W5). Aircom has the ability to manufacture these thermocouple types not identified in the standard.

Standards met by Aircom and related thermocouple material suppliers:

-ATSM E230: Standard Specification and Temperature-Electromotive Force (emf) Tables for Standardized Thermocouples / Temperature Measurement Thermocouples
-ASTM E585: Specification for Compacted Mineral-Insulated, Metal Sheathed, Base Metal Thermocouple Cable

-ASTM E220: Standard Test Method for Calibration of Thermocouples By Comparison Techniques
-NIST Monograph 175: Temperature-Electromotive Force Referenced Functions and Tables for Letter Designated Thermocouple Types Based on the ITS-90. *The International Temperature Scale of 1990.*

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Thermocouple Junctions and Response Time

The Thermocouple Junction is located in the tip of the sensor. This is where the temperature sensing takes place. In mineral insulated sheathed thermocouples, there are three thermocouple junction styles available:

Grounded junctions are common to the sensor sheath, providing no electrical isolation and fast response time.

Ungrounded junctions are isolated from the sensor sheath, providing electrical isolation from the sheath and reasonable response time.

Exposed junctions are created outside the sensor sheath, providing the fastest response time with no isolation.

Thermocouple size and response time (seconds) Based on the time to indicate 63.2% of value from room temperature to boiling water.

Probe OD (Inches)	Conductor Size (AWG)	Response Time	
		Grounded	Ungrounded
0.4	33	0.1	0.3
0.0625	29	0.2	0.5
0.0625 Dual	31	0.2	0.5
0.125	23	0.6	1.5
0.125 Dual	25	0.6	1.5
0.187	19	1.1	2.2
0.187 Dual	21	1.1	2.2
0.250	17	2.0	4.5
0.250 Dual	19	2.0	4.5
0.375	14	2.9	8.2
0.375 Dual	15	3.9	8.2

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