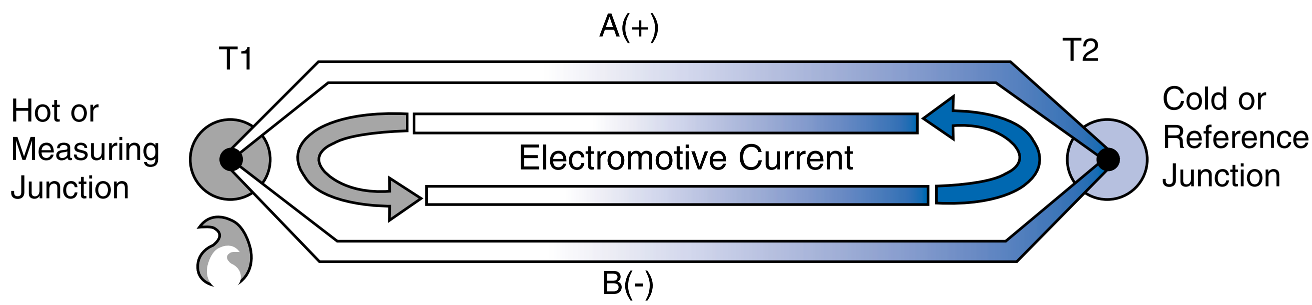
Thermocouple
General Specifications

Seebeck Effect

Thermocouples were discovered in 1821 when Thomas J. Seebeck observed the phenomenon of thermoelectricity - the Seebeck Effect. When two dissimilar metals are joined creating two junctions and those "sensing junctions" are at different temperatures - an electric current flows through the created circuit. The emf is proportional to the temperature difference and is measured in mV.

Thermocouple measurements are deduced from the millivolt reading and the known reference junction temperature. A signal converter must make the millivolt reading and compare the millivolt value of the reference junction at a known temperature to be able to make the temperature measurement.



Standard Thermocouples

Any combination of dissimilar metals will create the Seebeck Effect; however eight wire combinations are predominately used in thermocouples in the United States. They are types: J, K, T, E, R, S, B & N.

Refer to the chart on the following page for characteristics of each type.

Thermocouples are designated by capital letters that refer to their composition according to the American National Standards Institute (ANSI). They have been chosen for stability of EMF, ability to be replicated, mechanical and chemical properties, and costs.

Selection of a Thermocouple

Factors to consider when selecting a thermocouple:

- Temperature Range
- Media
- Required Response Time
- Accuracy
- Measurement System Installation
- Cold Junction Compensation
- Leadwire Compatibility

Standard Thermocouple Characteristics

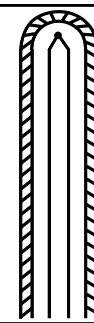
Type	Wire Materials	Wire Insulation Coloring	Recommended Atmosphere	Features
J	Iron (+) Constantan (-)	White Red	Vacuum, Inert, Oxidizing or Reducing	Most commonly used. Iron wire may rust or become brittle at sub-zero temperatures. If unprotected, iron wire may be attacked by ammonia, nitrogen and hydrogen atmospheres. Type J should not be used in sufurous atmospheres about 540°C.
K	Chromel (+) Alumel (-)	Yellow Red	Inert or Oxidizing	Generally used to measure high temperatures to 2300°F. Should not be used for accurate measurement to below 900°F or after prolonged exposure above 1400°F. Short life in alternately oxidizing and reducing atmospheres.
T	Copper (+) Constantan (-)	Blue Red	Vacuum, Inert, Oxidizing or Reducing	Commonly used for sub-zero to 700°F temperature. Superior corrosion resistance. Preferred to type J for sub-zero applications due to copper's higher moisture resistance, as compared to iron.
E	Chromel (+) Constantan (-)	Purple Red	Inert, Oxidizing or Reducing	Highest EMF output of any standard metallic thermocouple. Wires are not subject to corrosion at sub-zero temperatures.
N	Nicrosil (+) Nisil (-)	Orange Red	Inert or Oxidizing	Developed for oxidation resistance and EMF stability superior to those of type K thermocou ples at elevated temperatures. Popular in Europe.
R	Platinum-13%/ Rhodium (+)	Black Red	Inert or Oxidizing	Good linearity at high temperatures. Should always be protected from contamination - insulation should be silica free.
S	Platinum-10%/ Rhodium (+) Platinum (-)	Black Red	Inert or Oxidizing	Widely used in laboratories as a standard for calibration of base metal thermocouples and other temperature sensing instruments.
B	Platinum-30%/ Rhodium (+) Platinum (-)	Grey Red	Inert or Oxidizing	For use between 1000 and 3175°F. As with other platinum thermocouples, protection from contamination with silica-free insulation is required.

Typical Response Time for MgO Constructed Thermocouples

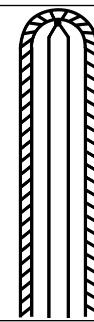
Thermocouple O.D. (inch)	Measuring Junction	Typical Response (seconds)
1/50	Grounded	0.05
1/50	Ungrounded	0.15
1/25	Grounded	0.1
1/25	Ungrounded	0.3
1/16	Grounded	0.2
1/16	Ungrounded	0.5
1/8	Grounded	0.7
1/8	Ungrounded	1.3
3/16	Grounded	1.1
3/16	Ungrounded	2.2
1/4	Grounded	2.0
1/4	Ungrounded	4.5
1/4	Exposed	0.1

Junction Type/Description

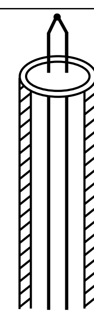
Ungrounded Junction
Thermocouple junction is insulated from sheath and ground. Provides better performance under noisy conditions. Slower response time than grounded junction thermocouples.



Grounded Junction
Thermocouple junction is an integral part of the sheath. Provides fast response time and is least expensive construction. Susceptible to ground loops and noise interference.



Exposed Junction
Thermocouple junction extends beyond sheath. Provides fastest response. Not suitable for pressurized or corrosive environments. Moisture will affect performance.



Initial Thermocouple Tolerances

Thermocouple	Range	ANSI Standard Limits of Error (Whichever is greater)	ANSI Special Limits of Error (Whichever is greater) *Weed Standard*
J	32 to 1400°F	±4.0°F or 0.75%	±2.0°F or 0.40%
K	-328 to 2300°F	±4.0°F or 0.75%	±2.0°F or 0.40%
T	-328 to 700°F	±1.8°F or 0.75%	±0.9°F or 0.40%
E	-328 to 1600°F	±3.0°F or 0.50%	±1.8°F or 0.40%
N	-454 to 2372°F	±4.0°F or 0.75%	±2.0°F or 0.40%
R	32 to 2700°F	±2.7°F or 0.25%	±1.1°F or 0.10%
S	32 to 2700°F	±2.7°F or 0.25%	±1.1°F or 0.10%
B	32 to 3100°F	±0.50%	±0.25%

Weed Instrument Company uses only ANSI Special Limits of Error in its manufacturing of thermocouples.