

# Thermocouples

## High Temperature

As a long time leader in the field of temperature measurement, Watlow continues to meet the demands of technological advances by developing thermocouples using materials with unusually high performance characteristics and superior quality.

Watlow's modern facilities are built to ensure that products meet compliance with today's complex specifications, standards and industrial or governmental regulatory requirements. Thermocouples are tested and certified to meet document compliance with agency standards—proof that Watlow products meet reliability and high performance standards.

### Performance Capabilities

- Compliance with recognized agency tolerances and specifications
- Temperature ranges up to 3100°F (1700°C)
- NIST traceable calibration certificates
- Thermocouple limits set to ITS-90 reference standards

### Features and Benefits

#### Thermocouple conductors

- Ideal for all temperature applications

#### Wide selection of sheath materials

- Meets specific application temperatures

#### Insulation materials

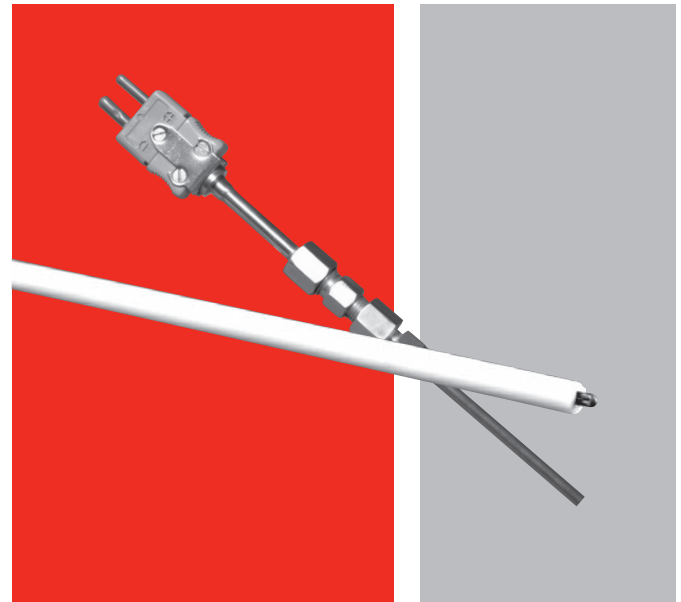
- Meets demanding application temperatures

#### Grounded and ungrounded junctions

- Meets electrical configurations

#### Testing and certification services

- Ideal for demanding applications



### Typical Applications

- Semiconductor: CVD processing, control spikes
- Diesel engines
- Jet engines
- Laboratory research
- Nuclear environments
- Power stations and steam generators
- Rocket engines
- Turbines
- Vacuum furnaces
- Exhaust gas sensing
- Glass manufacturing
- Heat treating and control sensors
- Ferrous and non-ferrous metals

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### Noble Metal

Watlow's noble metal thermocouples tolerate higher temperatures and provide greater accuracy than base metal thermocouples. Choose from ASTM E230 Types B, R or S, depending on temperature and tolerance requirements.

Thermocouples can be ordered as bare elements, elements with insulators or as assemblies. A typical assembly includes a head, alumina insulators and a protecting tube. A variety of hardware choices are available.

### Type B, R or S, 24 AWG

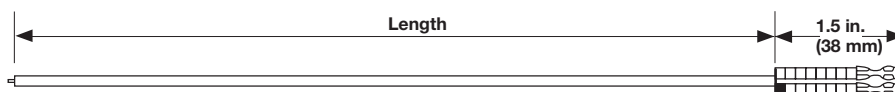
**To order, specify:** Part number-calibration-length

**Example:** 2114-R-24-MC



Enlarged picture of copper sleeves

For use with standard, general purpose heads; platinum assemblies can be furnished with MC-124 copper sleeves at no additional charge. Add the suffix "-MC" to part number.



Elements with Insulators; Shown with Optional MC-124 Copper Sleeves

Calibration	Length in.	Part Number Bare T/C	Part Number T/C with Alumina Insulator*
B	12	2110-B-12	2114-B-12
	18	2110-B-18	2114-B-18
	24	2110-B-24	2114-B-24
	30	2110-B-30	2114-B-30
	36	2110-B-36	2114-B-36
	42	2110-B-42	2114-B-42
	48	2110-B-48	2114-B-48
R	12	2110-R-12	2114-R-12
	18	2110-R-18	2114-R-18
	24	2110-R-24	2114-R-24
	30	2110-R-30	2114-R-30
	36	2110-R-36	2114-R-36
	42	2110-R-42	2114-R-42
	48	2110-R-48	2114-R-48
S	12	2110-S-12	2114-S-12
	18	2110-S-18	2114-S-18
	24	2110-S-24	2114-S-24
	30	2110-S-30	2114-S-30
	36	2110-S-36	2114-S-36
	42	2110-S-42	2114-S-42
	48	2110-S-48	2114-S-48

\*Insulation consists of a one-piece two-hole alumina (0.125 diameter) insulator. For lengths over 24 in. (610 mm), a single piece alumina <sup>3</sup>/<sub>16</sub> inch diameter insulator is used.

# Thermocouples

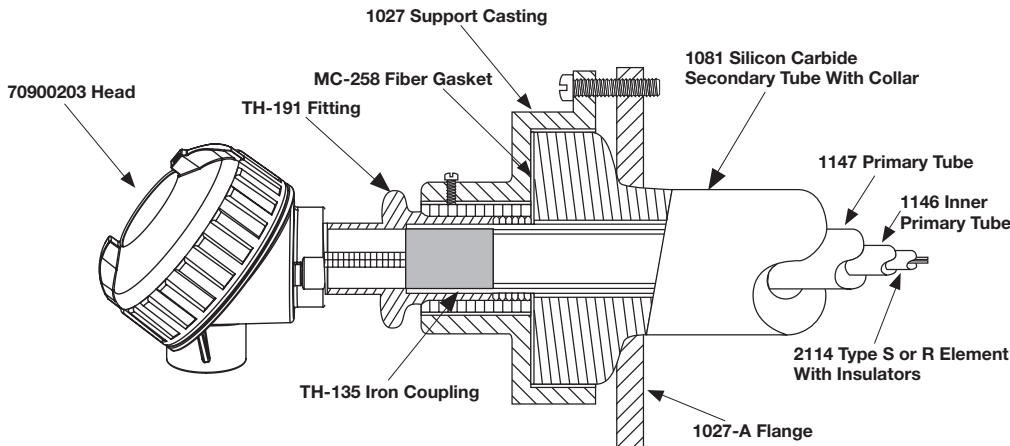
## High Temperature

### Noble Metal

### Thermocouple Assemblies

**To order, specify:** Part number-calibration-length of tube

**Example:** 2144-S-24  
2147-R-36



Typical Assembly with 70900203 Head

### 70900203 Head\* and Alumina Ceramics

Part Number*	Calibration	AWG Gauge	Protecting Tubes	Size I.D. x O.D. in.	Length in.
2144	B, R, S	24	1147 Alumina Primary only	$\frac{7}{16} \times \frac{11}{16}$	12, 18, 24, 30, 36, 42, 48
2145	B, R, S	24	1147 Primary only 1146 Alumina Inner Primary	$\frac{1}{4} \times \frac{11}{16}$	
2147	B, R, S	24	1147 Alumina Primary 1146 Alumina Inner Primary 1081 Secondary	$\frac{1}{4} \times 1\frac{3}{4}$	

\*Specify Type B, R or S by adding -B, -R or -S after the part number. Types B, R and S thermocouples and the thermoelements are provided in accordance with ITS-90.

# Thermocouples

## High Temperature

### Exotic Metal Sheath

The specification tables shown on the following pages detail Watlow's highly specialized line of metal sheathed thermocouple configurations. Some combinations of noble or refractory metal sheaths, high temperature insulations and compatible thermocouple conductors can withstand temperatures as high as 3100°F (1700°C); others can be used in unusually corrosive environments. Pressure, atmosphere and other process variables all affect service life and operating maximums.

These sensors are constructed with hard-fired ceramic insulators strung onto the thermocouple conductors and inserted into the sheath with minimum practical clearance. This type of "loose pack" assembly cannot be bent or formed in the field. Contact the factory for special pre-bent sensors.

### High Temperature Insulation Materials

All of our most common exotic sheathed thermocouples are produced using hard-fired ceramic insulators strung onto the thermocouple conductors and inserted into the sheath with minimum practical clearance.

This type of "loose pack" assembly cannot be bent or formed in the field. Please contact the factory for special pre-bent assemblies.

Part Number	Insulation	Approximate Upper Useful Temperature	Approximate Melting Point	Remarks
<b>B</b>	Alumina Oxide (Al <sub>2</sub> O <sub>3</sub> ) (99.6% min. purity)	2800°F (1540°C)	3660°F (2015°C)	Comparable electrical properties to MgO. Used primarily in loose pack constructions because of availability and low cost.
<b>D</b>	Hafnia Oxide (HfO <sub>2</sub> )	4530°F (2500°C)	5000°F (2760°C)	Hafnia is replacing BeO in applications where BeO cannot be used because of safety concerns. Hafnia can be used up to 4530°F (2500°C)

### High Temperature Sheath Materials

Below is a table with our most common sheath materials.

Sheath Material	Approximate Melting Point	Max. Recommended Temperature	Environment	Available Constructions (in.)				Remarks
				0.063	0.125	0.188	0.250	
Molybdenum (mo)	4750°F (2620°C)	3450°F (1900°C)	Inert, vacuum, reducing	N/A	LP	N/A	N/A	Molybdenum is a refractory metal that is brittle and available in uncompacted styles only. Do not use in oxidizing environments above 750°F (400°C). Vacuum at <10(-2) torr to 3100°F (1700°C). Vacuum <10(-4) torr to 3400°F (1870°C). Stable in inert gases to 3450°F (1900°C). Avoid contamination with graphite, carbon and hydrocarbons.
Alloy 600	2470°F (1345°C)	2150°F (1175°C)	Inert, vacuum, reducing, oxidizing	N/A	LP	N/A	LP	Maximum temperature 2150°F (1175°C). Most widely used thermocouple sheath material. Good high temperature strength, corrosion resistance, resistance to chloride ion stress corrosion cracking and oxidation resistance to high temperatures. Do not use in sulfur bearing environments. Good in nitriding environments.

# Thermocouples

## High Temperature Exotic Metal Sheath

### High Temperature Sensing Wire

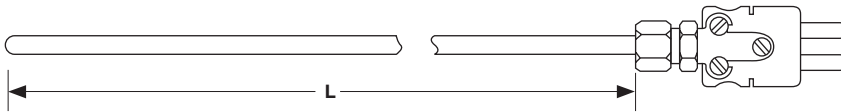
Calibration Type	Conductors	Approximate Upper Useful Temperature	Melting Point	Remarks
ASTM Type B	PT-30% Rh vs. Pt-6% Rh	3100°F (1700°C)	3250°F (1790°C)	Type B is composed of a positive leg (BP) which is approximately 70% platinum and 30% rhodium and a negative leg (BN) which is approximately 94% platinum and 6% rhodium. When protected by compacted mineral insulation and appropriate outer sheath, Type B is usable from 1600 to 3100°F (870 to 1700°C). Type B is available in standard limits and special limits ITS-90 scale.
ASTM Type R	PT-13% Rh vs. Pt	2700°F (1480°C)	3200°F (1760°C)	Type R is composed of a positive leg (RP) which is 87% platinum and 13% rhodium, and a negative leg (RN) which is 100% platinum. When protected by compacted mineral insulation and appropriate outer sheath, Type R is usable from 32 to 2700°F (0 to 1480°C). Type R is available in standard limits and special limits ITS-90 scale.
ASTM Type S	PT-10% Rh vs. Pt	2700°F (1480°C)	3200°F (1760°C)	Type S is composed of a positive leg (SP) which is 90% platinum and 10% rhodium, and a negative leg (SN) which is 100% platinum. When protected by compacted mineral insulation and appropriate outer sheath, Type S is usable from 32 to 2700°F (0 to 1480°C). Type S has a lower EMF output than Type R and is available in standard limits and special limits ITS-90 scale.

# Thermocouples

## High Temperature

### Exotic Metal Sheath

### Plug or Jack Termination



- High temperature insulations
- Loose pack assemblies
- Plug or jack cold end terminations

## Ordering Information

### Part Number

① ②	③	④	⑤	⑥	⑦	⑧ ⑨	⑩	⑪	⑫	⑬ ⑭	⑮
HC	Sheath O.D.	Connector Type	0	Insulation	Sheath Material	Sheath Length "L" (in.)	Sheath Length "L" (fract. in.)	Junction	Calibration	00	Special Rqmts.

③	Sheath O.D. (in.)
G =	0.125
H* =	0.188
J* =	0.250
* Not available with molybdenum sheath, see chart on page 74.	

④	Connector Type
A =	Standard plug
B =	Standard jack
C =	Standard plug with mating connector
<b>Note:</b> Standard plugs and jacks 400°F (205°C), 0.250 in. max. O.D.	

⑥	Insulation
B =	Loose pack Al <sub>2</sub> O <sub>3</sub>
D =	Loose pack HfO <sub>2</sub>

⑦	Sheath Material
3 =	Molybdenum
Q =	Alloy 600

⑧ ⑨	Sheath Length "L" (in.)
Whole inches: 01 to 60	

⑩	Sheath Length "L" (fractional in.)
0 =	0
4 =	1/2

⑪	Junction
U =	Ungrounded - Single
Contact Factory	Ungrounded - Dual

⑫	Calibration
B =	ASTM Type B - Standard limits
R =	ASTM Type R - Standard limits
S =	ASTM Type S - Standard limits
<b>Note:</b> For special limits contact the factory.	

⑮	Special Requirements
0 =	None
<b>Note:</b> If required, contact the factory.	