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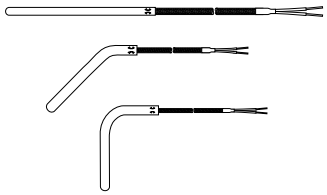
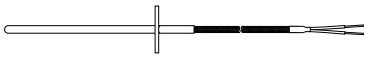
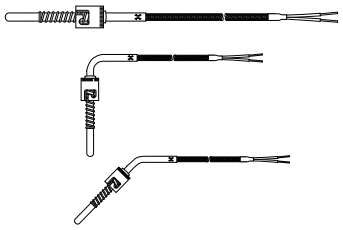
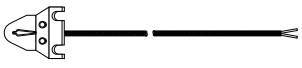
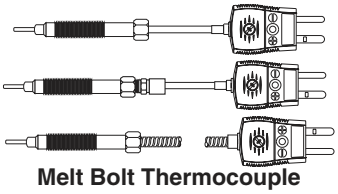
Thermocouples

Style	Temperature Range	Page	Style	Temperature Range	Page
 Adjustable Spring Style	0 to 480°C (32 to 900°F)	45	 Ring Terminal Style	0 to 480°C (32 to 900°F)	55
 Adjustable Armour Style	0 to 480°C (32 to 900°F)	46	 Nozzle Style	0 to 480°C (32 to 900°F)	56
 Rigid Sheath Style	0 to 480°C (32 to 900°F)	47, 52	 Pipe Clamp Style	0 to 480°C (32 to 900°F)	57
 Rigid Sheath with Threaded Fitting	0 to 480°C (32 to 900°F)	48	 Grommet Style	0 to 480°C (32 to 900°F)	58
PFA Encapsulated Style	0 to 260°C (32 to 500°F)	49	Brass Shim Style	0 to 260°C (32 to 500°F)	59
 Flange Style	0 to 480°C (32 to 900°F)	50	 Stainless Steel Shim Style	0 to 480°C (32 to 900°F)	60
 Rigid Sheath Fixed Bayonet Style	0 to 480°C (32 to 900°F)	51	 Kapton® Bracket Style	0 to 200°C (32 to 400°F)	61
			 Low Profile Kapton® Peel and Stick Style	0 to 200°C (32 to 400°F)	61
 Flexible Extensions	0 to 480°C (32 to 900°F)	53	 Newberry Nozzle Style	0 to 480°C (32 to 900°F)	61
Insulated Wire	0 to 480°C (32 to 900°F)	54	 Melt Bolt Thermocouple	0 to 260°C (32 to 500°F)	62

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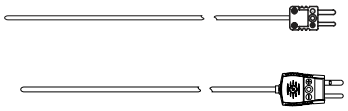
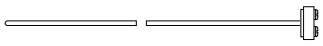
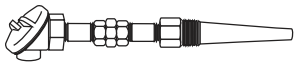
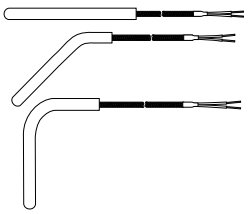
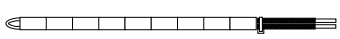
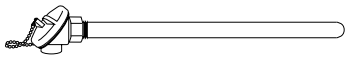
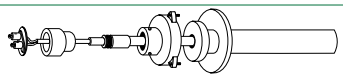
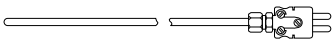
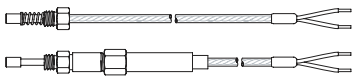
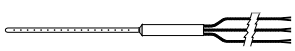
Style	Temperature Range	Page
Cut and Stripped	0 to 1200°C (32 to 2200°F)	64
 Plug or Jack Termination	0 to 1200°C (32 to 2200°F)	65, 66
Metal Transitions with Spring Strain Relief	0 to 1200°C (32 to 2200°F)	68
Miniature Transitions	0 to 1200°C (32 to 2200°F)	67
 Connection Head	0 to 1200°C (32 to 2200°F)	70
 Wafer Head	0 to 1200°C (32 to 2200°F)	71
 For use with Thermowells	0 to 1200°C (32 to 2200°F)	72
 With Thermowell	0 to 1200°C (32 to 2200°F)	73
 High Vibration	0 to 1200°C (32 to 2200°F)	74

Style	Temperature Range	Page
 Base Metal Elements with Insulators	0 to 1200°C (32 to 2200°F)	76
 Immersion Tips	0 to 1200°C (32 to 2200°F)	77
 Base Metal with Protection Tubes	0 to 1200°C (32 to 2200°F)	78
 Noble Metal Elements with Insulators	0 to 1700°C (32 to 3100°F)	80
 Noble Metal Elements with Protection Tube	0 to 1700°C (32 to 3100°F)	81
 High Temperature Plug or Jack Termination	0 to 2315°C (32 to 4200°F)	87
 High Temperature Metal Transitions	0 to 2315°C (32 to 4200°F)	88
 MICROCOIL™	0 to 700°C (32 to 1292°F)	91
 TR Thermocouple	0 to 500°C (32 to 932°F)	92
 TRUE SURFACE Thermocouple (TST)	0 to 200°C (32 to 400°F)	94
 Multipoints	0 to 1200°C (32 to 2200°F)	96

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RTD

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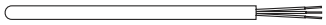
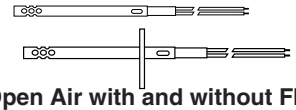
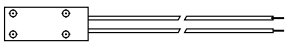
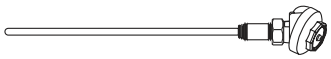
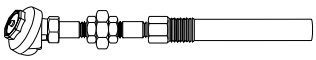
 Standard Industrial Insulated Leads	-50 to 260°C (-58 to 500°F)	100	 Adjustable Spring Style	-50 to 260°C (-58 to 500°F)	107
 Plug or Jack Termination	-50 to 260°C (-58 to 500°F)	101	 Adjustable Armor Style	-50 to 260°C (-58 to 500°F)	107
 Metal Transitions	-200 to 650°C (-328 to 1200°F)	102	 Cartridge with Flange	-50 to 260°C (-58 to 500°F)	107
 Emergency Use Cut-to-Length	-50 to 260°C (-58 to 500°F)	103	 Open Air with and without Flange	-50 to 260°C (-58 to 500°F)	107
 Connection Head/Optional Transmitter	-200 to 650°C (-328 to 1200°F)	104	 Surface Mount	-50 to 260°C (-58 to 500°F)	107
 For use with Thermowells	-200 to 650°C (-328 to 1200°F)	105	 ENVIROSEAL™-HD Sensor	-40 to 200°C (-40 to 392°F)	110
 With Thermowell	-50 to 260°C (-58 to 500°F)	106			

Thermistors

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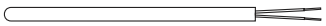
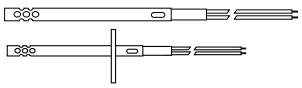
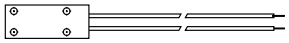
 Standard Industrial Thermistor with Insulated Leads	-60 to 260°C (-75 to 500°F)	109	 Cartridge with Flange	-60 to 260°C (-75 to 500°F)	107
 Adjustable Spring Style	-60 to 260°C (-75 to 500°F)	107	 Open Air with and without Flange	-60 to 260°C (-75 to 500°F)	107
 Adjustable Armor Style	-60 to 260°C (-75 to 500°F)	107	 Surface Mount	-60 to 260°C (-75 to 500°F)	107

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Infrared/Transmitters/ Signal Conditioners

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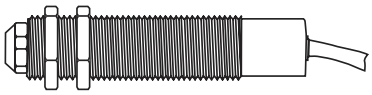
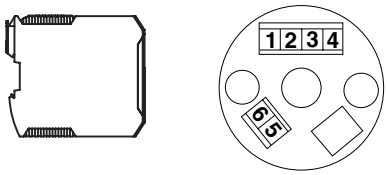
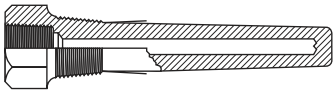
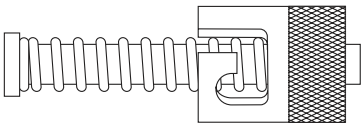
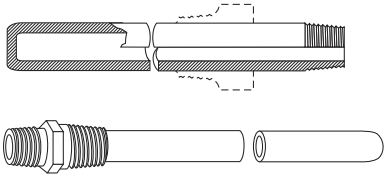
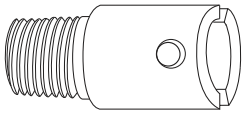
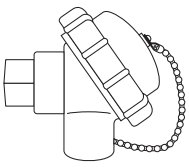
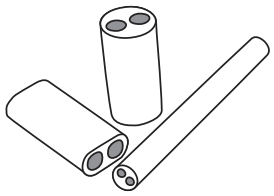
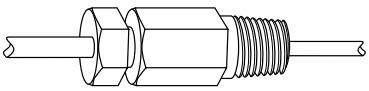
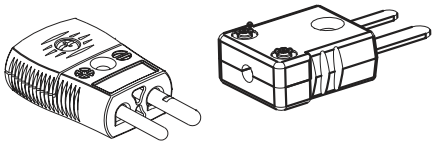
 IR Sensors	113	 Transmitters/Signal Conditioners	129

Accessories

Product	Page	Product	Page
 Thermowells	137	 Fittings	160
 Protecting Tubes	149	 Bayonet Adapters	161
 Connection Heads	156	 Insulators	163
 Compression Fittings	158	 Connectors	166

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Wire and Cable

Style	Construction	Temperature Range	Page
PVC: SERIES 502	Parallel pair	-20 to 105°C (-20 to 220°F)	192
PVC: SERIES 505	Ripcord	-20 to 105°C (-20 to 220°F)	194
PVC: SERIES 510/510UL®	Twisted and shielded pair	-20 to 105°C (-20 to 220°F)	201
PVC: SERIES 701	RTD wire	-20 to 105°C (-20 to 220°F)	210
PVC: SERIES 900/900UL®	Multipair overall shield	-20 to 105°C (-20 to 220°F)	208
PVC: SERIES 1000/1000UL®	Multipair individual shield	-20 to 105°C (-20 to 220°F)	209
FEP: SERIES 506	Parallel pair small gauges	-240 to 204°C (-400 to 400°F)	195
FEP: SERIES 507	Parallel pair	-240 to 204°C (-400 to 400°F)	196
FEP: SERIES 509/509UL®	Twisted and shielded pair	-240 to 204°C (-400 to 400°F)	199
FEP: SERIES 704	RTD wire	-240 to 204°C (-400 to 400°F)	210
PFA: SERIES 516	Parallel pair	-240 to 260°C (-400 to 500°F)	206
TFE Tape: SERIES 508	Parallel pair	-240 to 260°C (-400 to 500°F)	198
Polyimide Tape: SERIES 511	Twisted pair	-240 to 315°C (-400 to 600°F)	203
Polyimide Tape: SERIES 512	Parallel pair	-240 to 315°C (-400 to 600°F)	203
Polyimide Tape: SERIES 513	Parallel pair double taped	-240 to 315°C (-400 to 600°F)	203
SERVTEX: SERIES 155	Parallel pair	-73 to 260°C (-100 to 500°F)	184
SERVTEX: SERIES 157	Parallel pair with TFE tape	-73 to 260°C (-100 to 500°F)	185
Fiberglass - Standard: SERIES 304	Parallel pair	-73 to 480°C (-100 to 900°F)	187
Fiberglass - Standard: SERIES 305	Double wrapped parallel pair	-73 to 480°C (-100 to 900°F)	188
Fiberglass - Standard: SERIES 705	RTD wire	-73 to 480°C (-100 to 900°F)	210
Fiberglass - High Temp.: SERIES 314	Twisted pair	-73 to 705°C (-100 to 1300°F)	189
Fiberglass - High Temp.: SERIES 321	Parallel pair	-73 to 705°C (-100 to 1300°F)	190
Vitreous Silica: SERIES 301/365	Parallel pair	-73 to 980°C (-100 to 1800°F)	186
Ceramic: SERIES 350/355	Parallel pair	0 to 1205°C (32 to 2200°F)	191
Metal Sheathed: XACTPAK	Mineral insulated	0 to 1177°C (32 to 2150°F)	224

General Information

Application Hints

Answering your most frequently asked questions about industrial temperature sensors.

This section gathers in one spot the most commonly requested information on industrial temperature sensors. People of all experience levels will gain a better understanding in the application of temperature sensors from this information. Although we cannot possibly address every question in a few short pages, Watlow provides complete product support through our customer service, sales engineers and distribution network.

General Information

Application Hints

Which temperature sensor is the best choice for my application?

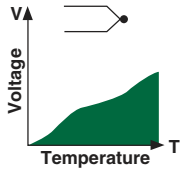
Thermocouples are best suited to high temperatures, environmental extremes or applications requiring microscopic size sensors. They are also recommended for high vibration environments.

RTDs are best for most industrial measurements over a wide temperature range, especially when sensor stability is essential for proper control.

Thermistors are best for low temperature applications over limited temperature ranges.

Thermocouples

Sensors generating varying voltage signals are thermocouples. Thermocouples combine dissimilar metallic elements or alloys to produce a voltage. Using specific combinations of metals and alloys in the thermocouple's legs produces a predictable change in voltage based on a change in temperature.

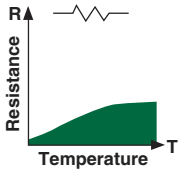
Thermocouples	Advantages	Disadvantages
	• No resistance lead wire problems • Fastest response to temperature changes • Simple, rugged • Inexpensive • High temperature operation • Point temperature sensing	• Non-linear • Low voltage • Least stable, repeatable • Least sensitive to small temperature changes

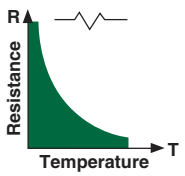
RTDs and Thermistors

Sensors generating varying resistance values are resistance temperature detectors (RTDs). RTDs are further divided into two types:

- RTD - resistive metallic wire or film
- Thermistor (thermally sensitive metal oxide resistor)

A variation of the thermistor not covered in this section is the integrated circuit (IC). It is a thermistor that has a computer chip to condition and amplify its signal. The computer chip limits the IC's use to a narrow temperature range.

RTDs	Advantages	Disadvantages
	• Most stable, accurate • Contamination resistant • More linear than thermocouple • Area temperature sensing • Most repeatable temperature measurement	• Expensive • Current source required • Self-heating • Slow response time • Low sensitivity to small temperature changes

Thermistors	Advantages	Disadvantages
	• High output, fast • Two-wire ohms measurement • Economical • Point temperature sensing • High resistance • High sensitivity to small temperature changes	• Non-linear • Limited temperature range • Fragile • Current source required • Self-heating

General Information

Application Hints

What do thermocouple letter designations mean?

Thermocouples are classified by calibration type because they have differing EMF (electromotive force) versus temperature curves. Some generate considerably more voltage at lower temperatures, while others do not begin to develop a significant voltage until subjected to high temperatures. Also, calibration types are designed to deliver as close to a straight line voltage curve inside their temperature application range as possible. This makes it easier for an instrument or temperature controller to correctly correlate the received voltage to a particular temperature.

Additionally, thermocouple calibration types have different levels of compatibility with different atmospheres. Chemical reaction between certain thermocouple alloys and the application atmosphere could cause metallurgy degradation, making another calibration type more suitable for sensor life and accuracy requirements.

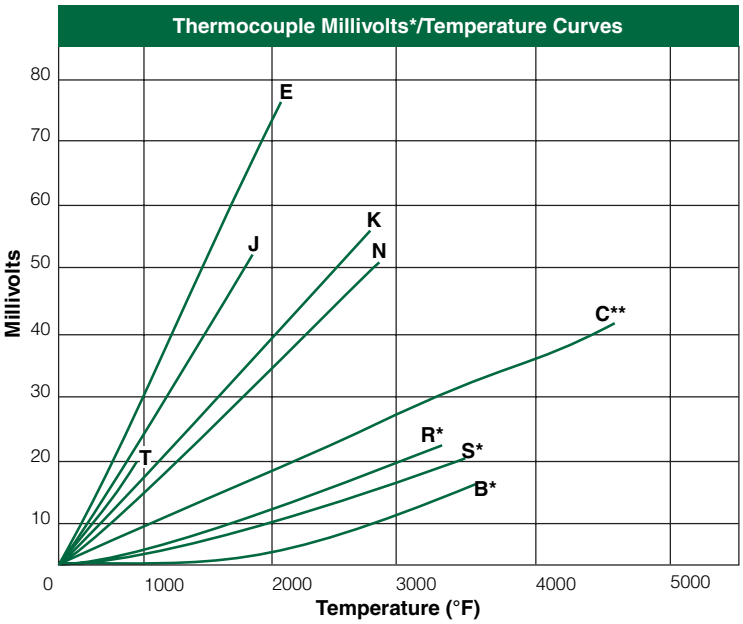
Thermocouple Types

Calibration types have been established by the American Society for Testing and Materials (ASTM) according to their temperature versus EMF characteristics in accordance with ITS-90, in standard or special tolerances.

Additionally, there are non-ASTM calibration types. These thermocouples are made from tungsten and tungsten-rhenium alloys. Generally used for measuring higher temperatures, they're a more economical alternative to the platinum and platinum alloy based noble metal thermocouples, but limited to use in inert and non-oxidizing atmospheres.

Thermocouple Type	Useful/General Application Range
B	1370-1700°C (2500-3100°F)
C*	1650-2315°C (3000-4200°F)
E**	95-900°C (200-1650°F)
J	95-760°C (200-1400°F)
K**	95-1260°C (200-2300°F)
N	95-1260°C (200-2300°F)
R	870-1450°C (1600-2640°F)
S	980-1450°C (1800-2640°F)
T**	0-350°C (32-660°F)

*Not an ASTM E 230 symbol
**Also suitable for cryogenic applications from -200 to 0°C (-328 to 32°F)



*Millivolt values shown for C, R, S and B calibrations pertain to thermocouple calibrations only. RX, SX and BX constructions described in this catalog section are intended for use as **extension wire only** and will not exhibit the millivolt outputs shown.

**Not an ASTM E 230 Symbol—Tungsten 5 percent Rhenium/Tungsten 26 percent Rhenium.

General Information

Application Hints

What are thermocouple color codes?

United States and International Color Coding

Standard ASTM E 230 color coding (United States) is used on all insulated thermocouple wire and extension wire when type of insulation permits. In color coding, the right is reserved to include a tracer to identify the ASTM E 230 type. Thermocouple grade wire normally has a brown overall jacket. For Types B, R and S the color codes relate to the compensating cable normally used. Various national and international standard agencies have adopted color codes for the identification of thermocouple products. These generally differ from those specified in ASTM E 230. Additionally, the overall extension color code is used to identify connectors to specific thermocouple types.

Thermocouple and Extension Wire Color Codes

Overall/Positive (+)/Negative (-)

T/C Type	ASTM E 230 T/C	ASTM E 230 Extension	UK BS 1843	Germany DIN 43710	Japan JIS C1610-1981	IEC 584-3
B (overall)	—	Grey	—	Grey	Grey	—
BP	—	+Grey	—	+Red	+Red	—
BN	—	-Red	—	-Grey	-White	—
E (overall)	Brown	Purple	Brown	Black	Purple	Violet
EP	+Purple	+Purple	+Brown	+Red	+Red	+Violet
EN	Red-	-Red	-Blue	-Black	-White	-White
J (overall)	Brown	Black	Black	Blue	Yellow	Black
JP	+White	+White	+Yellow	+Red	+Red	+Black
JN	-Red	-Red	-Blue	-Blue	-White	-White
K (overall)	Brown	Yellow	Red	Green	Blue	Green
KP	+Yellow	+Yellow	+Brown	+Red	+Red	+Green
KN	-Red	-Red	-Blue	-Green	-White	-White
N (overall)	Brown	Orange	—	—	—	—
NP	+Orange	+Orange	—	—	—	—
NN	-Red	-Red	—	—	—	—
R (overall)	—	Green	Green	—	Black	Orange
RP	—	+Black	+White	—	+Red	+Orange
RN	—	-Red	-Blue	—	-White	-White
S (overall)	—	Green	Green	White	Black	Orange
SP	—	+Black	+White	+Red	+Red	+Orange
SN	—	-Red	-Blue	-White	-White	-White
T (overall)	Brown	Blue	Blue	Brown	Brown	Brown
TP	+Blue	+Blue	+White	+Red	+Red	+Brown
TN	-Red	-Red	-Blue	-Brown	-White	-White

See color version on the inside back cover.

General Information

Application Hints

What letter of calibration should I use?

Type K thermocouples usually work in most applications since they are nickel based and have good corrosion resistance. It is the most common sensor calibration type providing the widest operating temperature range.

Type J is the second most common calibration and a good choice for general purpose applications where moisture is not present.

Type E
The Type E thermocouple is suitable for use at temperatures up to 900°C (1650°F) in a vacuum, inert, mildly oxidizing or reducing atmosphere. At cryogenic temperatures, the thermocouple is not subject to corrosion. This thermocouple has the highest EMF output per degree of all the commonly used thermocouples.

Type J
The Type J may be used, exposed or unexposed, where there is a deficiency of free oxygen. For cleanliness and longer life, a protecting tube is recommended. Since JP (iron) wire will oxidize rapidly at temperatures over 540°C (1000°F), it is recommended that larger gauge wires be used to compensate. Maximum recommended operating temperature is 760°C (1400°F).

Type K
Due to its reliability and accuracy, Type K is used extensively at temperatures up to 1260°C (2300°F). It's good practice to protect this type of thermocouple with a suitable metal or ceramic protecting tube, especially in reducing atmospheres. In oxidizing atmospheres, such as electric furnaces, tube protection is not always necessary when other conditions are suitable; however, it is recommended for cleanliness and general mechanical protection. Type K will generally outlast Type J because the JP (iron) wire rapidly oxidizes, especially at higher temperatures.

Type N
This nickel-based thermocouple alloy is used primarily at high temperatures up to 1260°C (2300°F). While not a direct replacement for Type K, Type N provides better resistance to oxidation at high temperatures and longer life in applications where sulfur is present. It also outperforms Type K in K's aging range.

Type T
This thermocouple can be used in either oxidizing or reducing atmospheres, though for longer life, a protecting tube is recommended. Because of its stability at lower temperatures, this is a superior thermocouple for a wide variety of applications in low and cryogenic temperatures. It's recommended operating range is -200° to 350°C (-330° to 660°F), but it can be used to -269°C (-452°F) (boiling helium).

Types S, R and B
Maximum recommended operating temperature for Type S or R is 1450°C (2640°F); Type B is recommended for use at as high as 1700°C (3100°F). These thermocouples are easily contaminated. Reducing atmospheres are particularly damaging to the calibration. Noble metal thermocouples should always be protected with a gas-tight ceramic tube, a secondary tube of porcelain, and a silicon carbide or metal outer tube as conditions require.

Type C (W-5 Percent Re/W-26 Percent Re)
This refractory metal thermocouple may be used at temperatures up to 2315°C (4200°F). Because it has no resistance to oxidation, its use is restricted to vacuum, hydrogen or inert atmospheres.

General Information

Application Hints

What is the initial accuracy of temperature sensors?

Industry specification have established the accuracy limits of industrial temperature sensors. These limits define initial sensor performance at time of manufacture. Time, temperature and environment operating conditions may cause sensors to change during use. Also, keep in mind that overall system accuracy will depend on the instrument and other installation parameters.

Thermocouples
Tolerances on Initial Values of EMF vs. Temperature

Reference Junction 0°C (32°F)

Calibration Type	Temperature Range °C	(°F)	Tolerances (whichever is greater) Standard °C	(°F)	Special °C	(°F)
Thermocouples ① ③						
B	870 to 1700	(1600 to 3100)	±0.5%	(②)	±0.25%	(②)
E	0 to 870	(32 to 1600)	±1.7 or ±0.5%	(②)	±1.0 or ±0.4%	(②)
J	0 to 760	(32 to 1400)	±2.2 or ±0.75%	(②)	±1.1 or ±0.4%	(②)
K or N	0 to 1260	(32 to 2300)	±2.2 or ±0.75%	(②)	±1.1 or ±0.4%	(②)
R or S	0 to 1480	(32 to 2700)	±1.5 or ±0.25%	(②)	±0.6 or ±0.1%	(②)
T	0 to 370	(32 to 700)	±1.0 or ±0.75%	(②)	±0.5 or ±0.4%	(②)
E④	-200 to 0	(-328 to 32)	±1.7 or ±1%	(②)	⑤	②
K④	-200 to 0	(-328 to 32)	±2.2 or ±2%	(②)	⑤	②
T④	-200 to 0	(-328 to 32)	±1.0 or ±1.5%	(②)	⑤	②
Extension Wires ⑥ ⑦						
EX	0 to 400	(32 to 400)	±1.7	(±3.0)	±1.8	(±1.0)
JX	0 to 400	(32 to 400)	±2.2	(±4.0)	±2.0	(±1.1)
KX or NX	0 to 400	(32 to 400)	±2.2	(±4.0)	±2.0	(±1.1)
TX	0 to 200	(32 to 200)	±1.0	(±1.8)	±0.9	(±0.5)
Compensating Extension Wires ⑧ ⑨						
BX⑩	0 to 200	(32 to 400)	±4.2	(±7.6)	*	*
CX	0 to 260	(32 to 500)	±6.8	(±12.2)	*	*
RX, SX	0 to 200	(32 to 400)	±5.0	(±9.0)	*	*

① Tolerances in this table apply to new essentially homogeneous thermocouple wire, normally in the size range 0.25 to 3 mm in diameter (No. 30 to No. 8 AWG) and used at temperatures not exceeding the recommended limits above. If used at higher temperatures these tolerances may not apply.

② At a given temperature that is expressed in °C, the tolerance expressed in °F is 1.8 times larger than the tolerance expressed in °C. Note: Wherever applicable, percentage-based tolerances must be computed from temperatures that are expressed in °C.

③ **Caution**: Users should be aware that certain characteristics of thermocouple materials, including the EMF vs. temperature relationship may change with time in use; consequently, test results and performance obtained at time of manufacture may not necessarily apply throughout an extended period of use. Tolerances given above apply only to new wire as delivered to the user *and do not allow for changes in characteristics with use*. The magnitude of such changes will depend on such factors as wire size, temperature, time of exposure and environment. It should be further noted that due to possible changes in homogeneity, attempting to recalibrate *used* thermocouples is likely to yield irrelevant results, and is not recommended. However, it may be appropriate to compare used thermocouples *in-situ* with new or known good ones to ascertain their suitability for further service under the conditions of the comparison.

④ Thermocouples and thermocouple materials are normally supplied to meet the tolerances specified in the table for temperatures above 0°C. The same materials, however, may not fall within the tolerances given for temperatures below °C in the second section of the table. If materials are required to meet the tolerances stated for temperatures below 0°C the purchase order must so state. Selection of materials usually will be required.

⑤ Special tolerances for temperatures below 0°C are difficult to justify due to limited available information. However, the following values for Types E and T thermocouples are suggested as a guide for discussion between purchaser and supplier: *Type E*: -200 to 0°C ±1.0°C or ±0.5 percent (whichever is greater);
Type T: -200 to 0°C ±0.5 or±0.8 percent (whichever is greater).

Initial values of tolerance for Type J thermocouples at temperatures below 0°C and special tolerances for Type K thermocouples below 0°C are not given due to the characteristics of the materials.

⑥ Tolerances in the table represent the maximum error contribution allowable from new and essentially homogeneous thermocouple extension wire when exposed to the full temperature range given above. Extension grade materials are not intended for use outside the temperature range shown.

⑦ Thermocouple extension wire makes a contribution to the total thermoelectric signal that is dependent upon the temperature difference between the extreme ends of the extension wire length. The actual magnitude of any error introduced into a measuring circuit by homogeneous and correctly connected extension wires is equal to the algebraic difference of the deviations at its two end temperatures, as determined for that extension wire pair.

⑧ Tolerances in the table apply to new and essentially homogeneous thermocouple compensating extension wire when used at temperatures within the range given above.

⑨ Thermocouple compensating extension wire makes a contribution to the total thermoelectric signal that is dependent upon the temperature difference between the extreme ends of the compensating extension wire length.

⑩ Special compensating extension wires are not necessary with Type B over the limited temperature range 0 to 50°C (32 to 125°F), where the use of non-compensated (copper/copper) conductors introduces no significant error. For a somewhat larger temperature gradient of 0 to 100°C (32 to 210°F) across the extension portion of the circuit, the use of non-compensated (copper/copper) extension wires may result in small errors, the magnitude of which will not exceed the tolerance values given in the table above for measurements above 1000°C (1800°F). Proprietary alloy compensating extension wire is available for use over 0 to 200°C (32 to 400°F) temperature range.

* Special tolerance grade compensating extension wires are not available.

General Information

Application Hints

What is the initial accuracy of temperature sensors?

(Continued)

Generally speaking, if accuracy is your most important concern and the application temperature is between 140°C and 650°C (284°F and 1202°F), RTDs are probably the best choice. Three-wire is the most common but four-wire provides higher system accuracy.

Resistance Temperature Detectors—RTDs

Table of Tolerance Values

Temperature °C	Resistance Value Ω	Tolerance DIN-IEC-751 Class A °C (Ω)	Tolerance DIN-IEC-751 Class B °C (Ω)
-200	18.52	±0.55 (±0.24)	±1.3 (±0.56)
-100	60.26	±0.35 (±0.14)	±0.8 (±0.32)
0	100.00	±0.15 (±0.06)	±0.3 (±0.12)
100	138.51	±0.35 (±0.13)	±0.8 (±0.30)
200	175.86	±0.55 (±0.20)	±1.3 (±0.48)
300	212.05	±0.75 (±0.27)	±1.8 (±0.64)
400	247.09	±0.95 (±0.33)	±2.3 (±0.79)
500	280.98	±1.15 (±0.38)	±2.8 (±0.93)
600	313.71	±1.35 (±0.43)	±3.3 (±1.06)
650	329.64	±1.45 (±0.46)	±3.6 (±1.13)

Where **t** is the actual temperature, in °C, of the platinum elements.

RTD Tolerance Class Definitions

DIN class A: ±[0.15 + 0.002 |t|]°C

DIN class B: ±[0.30 + 0.005 |t|]°C

Thermistors are a cost effective choice when working with a narrow range of temperatures.

Thermistors

- Resistance at 25°C (77°F) and ranges:

Epoxy Bead Tolerance ±1%Ω (+0.3°C)		
#11	1000Ω	-60 to 150°C (-76 to 302°F)
#12	3000Ω	-60 to 150°C (-76 to 302°F)

Glass Bead Tolerance ±15%Ω (+3°C)		
#16	100,000Ω	-60 to 260°C (-76 to 500°F)

*Other thermistors available on request.

General Information

Application Hints

How does Watlow check for thermocouple accuracy?

Watlow uses a verification process at selected temperature points to assure wire and XACTPAK® products conform to ASTM error limits. Samples are taken to our calibration laboratory and verified for accuracy against NIST traceable standards. Conformance to error limits is required at all test temperatures. When test temperature exceeds the rating of wire insulation or sheath, Watlow will perform calibration to the highest test point below materials rating. Calibration at intermediate temperatures can be performed on a per order basis. The following charts provide the standard test temperatures by thermocouple type.

XACTPAK® and MI Insulated Thermocouple

Calibration	Standard Calibration Points °F*
E	200, 600, 1000, 1600
J	200, 600, 1000, 1400
K	600, 1000, 1600, 2000
N	600, 1000, 1600, 2000
T	200, 400

* Calibration not made when temperature exceeds sheath rating.

SERV-RITE® Insulated Wire and General Application Thermocouples

Calibration	Standard Calibration Points °F*
E	300, 500, 1000, 1600
J	200, 500, 1000, 1400
K	300, 500, 1000, 1600, 2000
N	300, 500, 1000, 1600, 2000
T	200, 500
BX	212, 400
CX	200, 300, 400, 500
EX	200, 400
JX	200, 400
KX	200, 300, 400
NX	200, 300, 400
RX	400
SX	400
TX	200, 400

* Calibration not made when temperature exceeds wire insulation rating.

Is there a maximum length for thermocouples and thermocouple wiring?

The length of a thermocouple has no effect on its measurement accuracy or its ability to transfer the signal to the instrument. In other words, thermocouples do not experience "voltage drops" or power loss along its length as a high current power line might possess. The reason for this is due to the very low current and voltages associated with temperature measurements and that the thermocouple wire becomes the voltage source. In reality the sensor can be inches or thousands of feet long and the accuracy will not be affected.

In practical applications where the thermocouple is a substantial distance from the instrument, electrical noise can be induced and the sensor selected should be shielded and grounded at one end. In severe environments, or when the distance is in excess of 150 feet, a 4-20mA signal conditioner is suggested.

Additional information is available in the ASTM Manual on the ***Use of Thermocouples in Temperature Measurement.***

General Information

Application Hints

What sheath material is the best for my application?

In mild corrosive environments and general purpose applications, 304 SS and 316 SS are usually the best choice when considering cost versus performance. Choose Alloy 600 over 304 SS or 316 SS when temperatures exceed 899°C (1650°F).

When using acids at temperatures below 250°C (482°F) PFA coatings should be used.

Use the chart provided as a quick reference for determining the best sheath material for your application or consult a corrosion guide for the best choice based on your environmental conditions.

Sheath Materials

Sheath Material	Description	
304 SS	Maximum temperature: 899°C (1650°F). Most widely used low temperature sheath material. Extensively used in food, beverage, chemical and other industries where corrosion resistance is required. Subject to damaging carbide precipitation in 482-871°C (900-1600°F) range. Lowest cost corrosion resistant sheath material available.	304 SS suits most applications and is readily available.
316 SS	Maximum temperature: 899°C (1650°F). Best corrosion resistance of the austenitic stainless steel grades. Good corrosion resistance in H_2S. Widely used in the food and chemical industry. Subject to damaging carbide precipitation in 482-871°C (900-1600°F) range.	316 SS has more nickel than 304 SS and is used for food applications.
Alloy 600	Maximum temperature: 1176°C (2150°F). 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.	Alloy 600 has the most nickel and the highest temperature rating.
310 SS	Maximum temperature: 1150°C (2100°F). Mechanical and corrosion resistance, similar to but better than 304 SS. Very good heat resistance. This alloy contains 25 percent Cr, 20 percent Ni. Not as ductile as 304 SS.	310 SS has a higher temperature than 304 SS or 316 SS but is not very common.
PFA over 304 SS Coating*	Maximum temperature: 250°C (482°F) continuous. Thermocouple sheath O.D. is encapsulated in a black PFA, allowing the thermocouple to be used in applications where corrosive fluids and gases, strong mineral, oxidizing and organic acids and alkalies are present. **Examples:** food and beverage, pharmaceutical, labs, electroplating, semiconductor processing. Nominal wall thickness of the PFA is 0.010 inch.	PFA over 304 SS works well in most acid environments. Strong bases can corrode PFA.

General Information

Application Hints

What are the maximum temperatures of thermocouples?

The diameter of the sensor wires determines the upper most operating temperature. The larger the diameter, the higher the temperature rating.

Choose alloy 600 over 304 SS or 316 SS when higher temperatures are expected.

The environment is another critical factor when determining the best material. Consult the manual on ***The Use of Thermocouples in Temperature Measurement***, published by ASTM for further details.

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Recommended Upper Temperature Limit for Protected Thermocouple Wire

Thermocouple Type	No. 8 Gauge °C (°F)	No. 14 Gauge °C (°F)	No. 20 Gauge °C (°F)	No. 24 Gauge °C (°F)	No. 28 Gauge °C (°F)
B				3100 (1700)	
E	870 (1600)	650 (1200)	540 (1000)	430 (800)	430 (800)
J	760 (1400)	590 (1100)	480 (900)	370 (700)	370 (700)
K and N	1260 (2300)	1090 (2000)	980 (1800)	870 (1600)	870 (1600)
R and S				2700 (1480)	
T		370 (700)	260 (500)	200 (400)	200 (400)

① This table gives the recommended upper temperature limits for the various thermocouples and wire sizes. These limits apply to protected thermocouples, that is, thermocouples in conventional closed-end protecting tubes. They do not apply to sheathed thermocouples having compacted mineral oxide insulation.

② The temperature limits given here are intended only as a guide to the user and should not be taken as absolute values nor as guarantees of satisfactory life or performance. These types and sizes are sometimes used at temperatures above the given limits, but usually at the expense of stability or life or both. In other instances, it may be necessary to reduce the above limits in order to achieve adequate service. ASTM MNL-12 (Manual on the *Use of Thermocouples in Temperature Measurement*, ASTM MNL-12, 1993) and other literature sources should be consulted for additional application information.

Mineral Insulated Sensors by Diameter and Sheath

Sheath Diameter in.	Calibration	Sheath Material	Maximum Recommended Operating Temperature °C	(°F)
0.032	K	304 SS/Alloy 600	871	(1600)
0.032	J	304 SS	816	(1500)
0.040	K	304 SS/316 SS/Alloy 600	871	(1600)
0.040	J	304 SS	816	(1500)
0.040	T	304 SS	350	(662)
0.040	E	304 SS	871	(1600)
0.063	K or N	Alloy 600	1093	(2000)
0.063	S	Alloy 600	1093	(2000)
0.063	J	304 SS/316 SS	816	(1500)
0.063	E	304 SS	871	(1600)
0.063	K	304 SS/316 SS	871	(1600)
0.063	K	Hastelloy® X	1204	(2200)
0.125	K or N	Alloy 600	1177	(2150)
0.125	T	304 SS/316 SS/Alloy 600	350	(662)
0.125	E	Alloy 600	871	(1600)
0.125	S	Alloy 600	1177	(2150)
0.125	J	304 SS/316 SS	816	(1500)
0.125	K	304 SS	871	(1600)
0.250	K or N	Alloy 600	1177	(2150)
0.250	J	304 SS/310 SS/316 SS	816	(1500)
0.250	K	304 SS	871	(1600)
0.250	T	304 SS	350	(662)
0.250	E	304 SS/316 SS	871	(1600)
0.250	K	310 SS	1093	(2000)
0.250	K	316 SS	871	(1600)
0.250	T	316 SS	350	(662)
0.250	K	446 SS	1149	(2100)

General Information

Application Hints

What type of junction should I use?

Generally speaking, the **grounded junction** offers the best compromise of performance and reliability. It is the best choice for general purpose measurements.

Select **ungrounded** if the lead wire will be shielded and attached to the sheath. Also select the ungrounded junction to avoid ground loops between instruments, power supplies and the sensor.

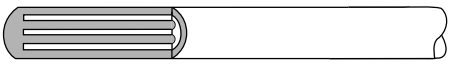
Junction Styles

Listed below are the junction styles offered by Watlow.

Exposed Junction

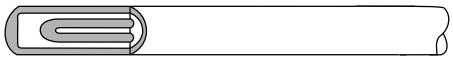
Thermocouple wires are butt welded, and insulation is sealed against liquid or gas penetration. This junction style provides the fastest possible response time but leaves the thermocouple wires unprotected against corrosive or mechanical damage.

Grounded Junction



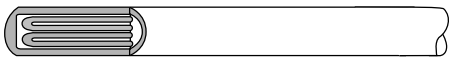
The sheath and conductors are welded together, forming a completely sealed integral junction. Recommended in the presence of liquids, moisture, gas or high pressure. The wire is protected from corrosive or erosive conditions. Response time with this style approaches that of the exposed junction.

Ungrounded Junction



On this type the thermocouple junction is fully insulated from the welded sheath end. The ungrounded junction is excellent for applications where stray EMFs would affect the reading and for frequent or rapid temperature cycling. Response time is longer than for the grounded junction.

Ungrounded Dual Isolated Junction



Two separate thermocouples are encased in a single sheath. The isolation would prevent ground loop errors if wired to separate instruments. Only available as ungrounded junctions.

General Information

Application Hints

What is the response time of mineral insulated thermocouples?

The smaller the diameter, the faster the thermocouple will respond. Grounding the junction will also improve the response time by approximately 50 percent. This is based on the sensor achieving 63.2 percent of the final reading, or to the first time constant. It will take about five time constants to obtain steady state readings.

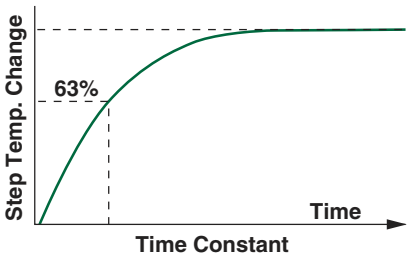
Since you are actually interested in the temperature of the surrounding medium, accuracy depends on the ability of the sensor to conduct heat from its outer sheath to the element wire.

Several factors come into play. The most commonly noted is "time constant" (thermal response time). Time constant, or thermal response time, is an expression of how quickly a sensor responds to temperature changes. As expressed here, time response is defined as how long it takes a sensor to reach 63.2 percent of a step temperature change (see graph to the right).

Response is a function of the mass of the sensor and its efficiency in transferring heat from its outer surfaces to the wire sensing element. A rapid time response is essential for accuracy in a system with sharp temperature changes. Time response varies with the probe's physical size and design.

The response times indicated are representative of standard industrial probes.

Time Constant (Thermal Response Time)



Thermocouple Time Response

Sheath Diameter	Average Response Time Still Water (seconds)*	
	Grounded Junction	Ungrounded Junction
0.010 in.	<0.02	<0.02
0.020 in.	<0.02	0.03
0.032 in.	0.02	0.07
0.040 in.	0.04	0.13
0.063 in.	0.22	0.40
0.090 in.	0.33	0.68
0.125 in.	0.50	1.10
0.188 in.	1.00	2.30
0.250 in.	2.20	4.10
0.313 in.	5.00	7.00
0.375 in.	8.00	11.00
0.500 in.	15.00	20.00
0.5 mm	<0.02	0.03
1.0 mm	0.04	0.13
1.5 mm	<0.15	0.35
2.0 mm	0.25	0.55
3.0 mm	0.40	0.90
4.5 mm	0.95	2.00
6.0 mm	2.00	3.50
8.0 mm	5.00	7.00

*Readings are to 63 percent of measured temperatures.

General Information

Application Hints

What should the thermocouple resistance measure?

Although resistance cannot confirm the alloy has the correct thermoelectric specifications, it will check to see if other undesirable characteristics like opens, poor welds, or corrosion of the wires are present. Always measure the resistance of the thermocouple out of the application so the EMF output is not in conflict with the resistance meter.

Ohms per Double Feet

Long lead wire runs, or the use of analog based instrumentation, make conductor resistance an important consideration in selecting the wire gauge best suited for your application. The table below lists the nominal ohms per double feet for thermocouple and thermocouple extension wire. Ohms per double feet is the total resistance, in ohms, for both conductors, per foot.

Nominal Resistance for Thermocouple Alloys in Ohms per Double Feet at 20°C

AWG Gauge	Diameter in.	Diameter (mm)	Calibration Type BX	CX*	E	J	K	N	RX,SX	T
2	0.258	(6.543)			0.011	0.006	0.009	0.012		
4	0.204	(5.189)			0.017	0.009	0.014	0.019		
6	0.162	(4.115)			0.028	0.014	0.023	0.030		
8	0.129	(3.264)			0.044	0.023	0.036	0.048		
10	0.102	(2.588)			0.070	0.036	0.058	0.077		
12	0.081	(2.053)	0.015	0.058	0.111	0.057	0.092	0.123	0.006	0.048
14	0.064	(1.630)	0.024	0.093	0.177	0.091	0.147	0.195	0.010	0.076
16	0.051	(1.290)	0.039	0.147	0.281	0.145	0.233	0.310	0.016	0.120
18	0.040	(1.020)	0.063	0.238	0.453	0.234	0.376	0.500	0.025	0.194
20	0.032	(0.813)	0.098	0.372	0.709	0.367	0.589	0.783	0.040	0.304
22	0.025	(0.645)	0.156	0.592	1.129	0.584	0.937	1.245	0.063	0.483
24	0.020	(0.508)	0.248	0.941	1.795	0.928	1.490	1.980	0.100	0.768
26	0.016	(0.406)	0.395	1.495	2.853	1.476	2.369	3.148	0.159	1.221
28	0.013	(0.320)	0.628	2.378	4.537	2.347	3.767	5.006	0.253	1.942
30	0.010	(0.254)	0.999	3.781	7.214	3.731	5.990	7.960	0.402	3.088
32	0.008	(0.203)	1.588	6.012	11.470	5.933	9.524	12.656	0.639	4.910
34	0.006	(0.152)	2.525	9.560	18.239	9.434	15.145	20.126	1.016	7.808
36	0.005	(0.127)	4.015	15.200	29.000	15.000	24.080	32.000	1.615	12.415
14 Stranded	0.076	(1.930)	0.022	0.085	0.161	0.083	0.134	0.178	0.009	0.069
16 Stranded	0.060	(1.520)	0.035	0.134	0.256	0.133	0.213	0.283	0.014	0.110
18 Stranded	0.048	(1.220)	0.056	0.214	0.408	0.211	0.338	0.450	0.023	0.174
20 Stranded	0.038	(0.965)	0.090	0.340	0.648	0.335	0.538	0.715	0.036	0.277
22 Stranded	0.030	(0.762)	0.143	0.540	1.031	0.533	0.856	1.137	0.057	0.441
24 Stranded	0.024	(0.610)	0.227	0.859	1.639	0.848	1.361	1.808	0.091	0.701

*Not an ASTM E 230 symbol

Note: BX, CX, RX and SX indicates compensating thermocouple materials.

Conductor Sizes

Wire Size AWG Gauge	Solid Diameter in.	Solid Diameter (mm)	Stranded Diameter in.	Stranded Diameter (mm)	Stranded Number of Strands	Stranded Strand Gauge
14	0.064	(1.630)	0.076	(1.930)	7	22
16	0.051	(1.290)	0.060	(1.520)	7	24
18	0.040	(1.020)	0.048	(1.220)	7	26
20	0.032	(0.813)	0.038	(0.965)	7	28
22	0.025	(0.635)	0.030	(0.762)	7	30
24	0.020	(0.508)	0.024	(0.610)	7	32
26	0.016	(0.406)				
28	0.013	(0.330)				
30	0.010	(0.254)				
32	0.008	(0.203)				
34	0.006	(0.152)				
36	0.005	(0.127)				

General Information

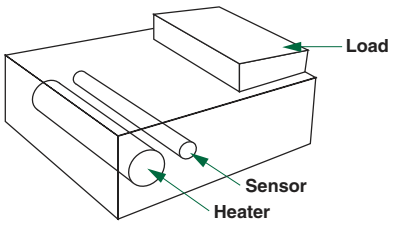
Application Hints

Where should my sensor be placed?

Placement of the sensor in relationship to the work load and heat source can compensate for various types of energy demands from the work load. Sensor placement can limit the effects of thermal lags in the heat transfer process. The controller can only respond to the temperature changes it "sees" through feedback from the sensor location. Thus, sensor placement will influence the ability of the controller to regulate the temperature about a desired set point.

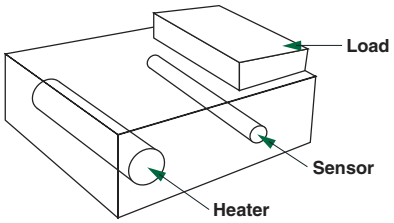
Be aware sensor placement cannot compensate for inefficiencies in the system caused by long delays in thermal transfer. Realize also that inside most thermal systems, temperature will vary from point-to-point.

Sensor in a Static System



We call a system "static" when there is slow thermal response from the heat source, slow thermal transfer and minimal changes in the work load. When the system is static, placing the sensor closer to the heat source will keep the heat fairly constant throughout the process. In this type of system the distance between the heat source and the sensor is small (minimal thermal lag); therefore, the heat source will cycle frequently, reducing the potential for overshoot and undershoot at the work load. With the sensor placed at or near the heat source, it can quickly sense temperature changes, thus maintaining tight control.

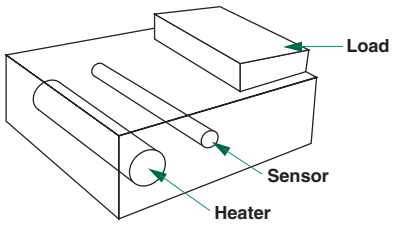
Sensor in a Dynamic System



We call a system "dynamic" when there is rapid thermal response from the heat source, rapid thermal transfer and frequent changes in the work load. When the system is dynamic, placing the sensor closer to the work load will enable the sensor to "see" the load temperature change faster, and allow the controller to take the appropriate output action more quickly. However, in this type of system the distance between the heat source and the sensor is notable, causing thermal lag or delay. Therefore, the heat source cycles will be longer, causing a wider swing between the maximum (overshoot) and minimum (undershoot) temperatures at the work load.

We recommend that the electronic controller selected for this situation include the PID features (anticipation and offset ability) to compensate for these conditions. With the sensor at or near the work load, it can quickly sense temperature rises and falls.

Sensor in a Combination Static/ Dynamic System



When the heat demand fluctuates and creates a system between static and dynamic, place the sensor halfway between the heat source and work load to divide the heat transfer lag times equally. Because the system can produce some overshoot and/ or undershoot, we recommend the electronic controller selected for this situation include the PID features (anticipation and offset ability) to compensate for these conditions. This sensor location is most practical in the majority of thermal systems.

General Information

Application Hints

How does electrical noise get in?

The sensor input and power output lines as well as the power source line, all have the potential to couple or link the control circuit to a noise source.

Depending on its intensity, noise can be coupled to the sensor circuit by any one or combination of the following ways:

Common Impedance Coupling

Common impedance coupling occurs when two circuits share a common conductor or impedance (even common power sources).

Magnetic Inductive Coupling

Magnetic inductive coupling generally appears where there are wires running parallel or in close vicinity to each other. This happens when the wires from several different circuits are bundled together in order to make the system wiring appear neat.

Electrostatic Capacitive Coupling

Electrostatic capacitive coupling appears where wires run parallel to each other, similar to magnetic coupling. That is where the similarities end. Electrostatic, or capacitive, coupling is a function of the distance the wires run parallel to each other, the distance between the wires and wire diameters.

Electromagnetic Radiation Coupling

Electromagnetic radiation coupling occurs when the sensor is very close to a high energy source like TV or radio broadcasting towers.

Helpful Wiring Guidelines

A quick review shows electrical noise can enter the sensor circuit through different paths:

1. Controller output signal lines
2. Power input lines
3. Radiation (least likely to be a problem)

The sensitivity or susceptibility to noise coupling will be different among the three paths and may even vary on the same path, depending on the type of electrical noise and its intensity.

Following simple wiring techniques will greatly decrease the sensor circuit's sensitivity to noise.

- Physical separation and wire routing must be given careful consideration in planning the layout. AC power supply lines should be bundled together and kept physically separate from sensor signal lines. If lines must cross, do so at right angles.
- Another important practice is to look at the system layout and identify electrical noise sources such as solenoids, relay contacts, or motors, and where they are physically located. Then use as much caution as possible to route the sensor lead wires away from these noise sources.
- Whenever possible, sensor signal leads should be run unbroken from sensor to the control.
- Shielded cables should be used for all signal lines to protect from magnetic and electrostatic coupling of noise. Some simple pointers are as follows:

  1. Connect the shield to the control circuit common end only. Never leave the shield unconnected at both ends. Never connect both ends of the shield to a common.

  2. If the shield is broken at a terminal and the line continues, the shield must be reconnected to maintain shield continuity.

  3. If the shield is used as a signal return (conductor), no electrostatic shielding can be assumed. If this must be done, use a triaxed cable (electrostatically shielded coaxial cable).

  4. Twisted wire should be used any time sensor circuit signals must travel over two feet, or when they are bundled in parallel with other wires.

General Information

Application Hints

The sensor appears to be reading incorrectly. What might be wrong?

1. Sensor and Control Agreement—Verify the instrument settings are correct for the type of sensor being utilized. Many instruments require the user to indicate or instruct which type of sensor will be used. Agreement between sensor and instrument allows correct temperature interpretation of the resistance or voltage.

2. Check Instrument—A quick test can indicate that an instrument is functional.

- **Thermocouples**
  Disconnect and place a jumper wire across the input connections. Instrument should indicate room temperature.
- **RTDs**
  Disconnect and place a known resistance value across input terminals. Instrument should indicate the temperature corresponding to resistor used. As an example a 100Ω resistor would indicate 0°C for a 100Ω RTD.

3. Check Instrument Connection—Verify the sensor has been attached to the correct instrument terminals. For thermocouples check that the polarity is correct. The negative conductor of thermocouples colored coded to ASTM standards is red. Other international standards use different color codes to identify thermocouple calibration and conductor polarity. The inside back cover shows many of these international color code standards. Most industrial controllers will accept a two- or three-wire RTD inputs. A two-wire RTD may or may not have the wires color coded differently and can be connected to either input terminal. A three-wire RTD generally will have two leads of one color and the third lead of a different color. The resistive element is wired in series with the leads of different colors. The instrument wiring diagram will indicate location of resistive element.

4. Sensor Wiring—The distance between sensor and instrument can be many feet. Often multiple pieces of wire are joined to complete the circuit. Examine terminal blocks, connectors, connection heads and any other connection points for loose wires, corrosion or electrical isolation. Examine circuit wire insulation for any damage. Replace any insulation that shows cracks, wear spots or heat deterioration with new wiring. Verify that circuit polarity and wire orientation have been maintained throughout the system.

5. Compatible Sensor and Connection Wire—Thermocouples require the connection wire conductors be of the same calibration type as the sensor. If the calibration does not match or copper conductors are used, serious errors can occur. The calibration type of thermocouple wire products can usually be identified by the color of insulation. The chart on the inside back cover of this catalog shows common color codes used for thermocouple wire products. For RTDs the sensor to instrument connections are made using wire with copper conductors. Wire should be of same gauge size, copper material and length for each sensor lead.

6. Verifying Sensor Electrical Continuity (Resistance)—Sensors require a continuous electrical circuit be formed through the resistance element or thermocouple junction. Sensor resistance can be checked with a standard multimeter. Resistance value of a RTD will be nominal resistance at temperature of sensor plus the resistance of lead when checking between the leads of differing colors. Between leads of the same color resistance value is equal to lead resistance. Thermocouples should have resistance measurements taken out of application. Measurement

Application Hints

The sensor appears to be reading incorrectly. What might be wrong?

(Continued)

requires thermocouple to be at uniform temperature and best results are obtained at room temperature. This prevents the voltage generated by thermocouples at temperature from conflicting with multimeter resistance measurement function. The resistance value will vary by calibration and can be approximated by values given in the chart on page 24. For thermistors, resistance measurement at room temperature should equal nominal resistance value.

7. Immersion Depth—Heat can be conducted away from sensors that are not sufficiently immersed into the process being measured. The result will be a reading lower than actual temperature of the system. As a rule of thumb thermocouples should be immersed to a minimum depth of 10 times the sensor diameter. RTDs and thermistors should be immersed a minimum of 10 times the diameter plus ½ inch to provide proper heat transfer in most applications.

8. Changing of Thermocouple Immersion Depths—Thermocouples can develop inhomogeneities due to oxidization, corrosion, contamination and metallurgical changes under some process conditions. If the sensor depth is changed to shift the inhomogeneities into steep temperature gradient zone, the output can be greatly altered. It is suggested that thermocouples not be repositioned once they are placed in a process.

9. Sensor Life—Every system exposes sensors to a wide varying range of operational environments. Selection of sheath materials, protection tubes, temperature cycles and sensor type influence overall usable life. Experience provides the method of determining the need to examine, test and replace sensors. Watlow recommends that each customer establish a preventative maintenance program for periodic inspection and replacement of all sensors.

General Information

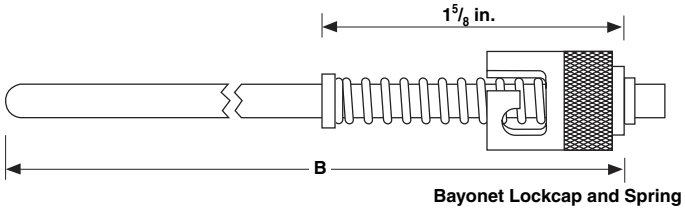
Application Hints

How do I install a sensor with spring loaded bayonet cap?

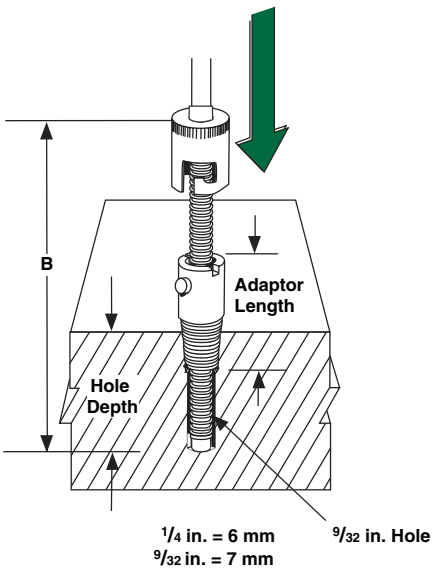
The bayonet adapter is used in conjunction with the spring loaded bayonet cap attached to the sensor sheath. The part to be measured is drilled and tapped for the installation of the bayonet adapter. After placing the sensor through the adapter, the spring is compressed and locked with the bayonet cap. This allows the sensing zone to be pushed tightly against the surface for increased accuracy and faster response time.

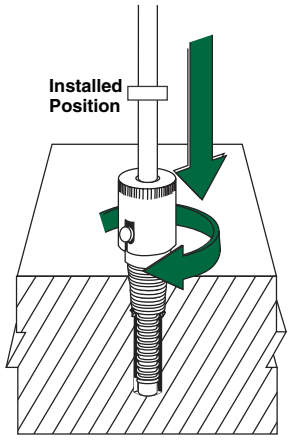
Hole Depth

"B" Dimension	Adapter Length				
	0.875	1	1.5	2	2.5
2.0	0.500	0.375	2		
2.5	0.875	0.750	0.375		
3.0	1.375	1.250	0.750	0.375	
3.5	1.875	1.750	1.250	0.750	0.375
4.0	2.375	2.250	1.750	1.250	0.750
4.5	2.875	2.750	2.250	1.750	1.250
5.0	3.375	3.250	2.750	2.250	1.750
5.5	3.875	3.750	3.250	2.750	2.250
6.0	4.375	4.250	3.750	3.250	2.750
6.5	4.875	4.750	4.250	3.750	3.250
7.0	5.375	5.250	4.750	4.250	3.750
7.5	5.875	5.750	5.250	4.750	4.250
8.0	6.375	6.250	5.750	5.250	4.750
8.5	6.875	6.750	6.250	5.750	5.250
9.0	7.375	7.250	6.750	6.250	5.750
9.5	7.875	7.750	7.250	6.750	6.250
10.0	8.375	8.250	7.750	7.250	6.750
10.5	8.875	8.750	8.250	7.750	7.250
11.0	9.375	9.250	8.750	8.250	7.750
11.5	9.875	9.750	9.250	8.750	8.250
12.1	10.375	10.250	9.750	9.250	8.750



Bayonet Lockcap and Spring





General Information

Lab Services

Prototype Testing and Quality Certification

Watlow lab services start at the front end of product design by assisting you through a battery of tests to research and develop the optimum sensor for your application. Our certification processes can verify your finished product is built to specifications set forth by the world's leading standards agencies.

These in-house services are available also for testing your own temperature sensing products, not just the sensors, wire or cable we design and manufacture for you.

Product Development and Prototype Test Lab

Our prototype testing evaluates new sheath materials, new configurations and new manufacturing processes. Watlow is always stretching the limits and always searching for the better way to handle unique applications. We offer testing for:

Time response
- Measures sensor output relative to a step change in temperature from ambient up to 70°C (160°F) per ASTM

Vibration
- Sine and random electrodynamic excitation

High temperatures
- Up to 1700°C (3090°F)

Cryogenic temperatures
- Up to -195°C (-320°F) for liquid nitrogen; -80°C (-110°F) continuously variable up to 0°C (32°F)

Tensile and compression
- Testing to 500 kg (1,000 lb)

Humidity
- To 95°C/95 percent RH (200°F/95 percent RH)

Life testing
- In molten aluminum and corrosive liquids

Cycle and drift
- Testing up to 1700°C (3090°F)

Wire insulation abrasion testing
- Repeated scrape and wire to wire

Micro-hardness
- Vicker's scale or conversion to other common scales.

Dielectric breakdown testing
- Capabilities to 5000V⎓(dc)

General Information

Lab Services

Product Development and Prototype Test Lab
(Continued)

A lab service technician performs a helium leak test to verify fitting integrity.

Customized Testing to Your Application

Watlow can provide testing during all phases of product development.

To guarantee Watlow temperature sensors retain their quality after long term use, we maintain a variety of custom designed furnaces and baths for long term drift and cycle testing at temperatures up to 1700°C (3090°F).

We can customize any number of standardized tests to meet your needs:

- To verify the quality and stability of our RTDs a recent test cycled the sensors from 93°C (200°F) to 260°C (500°F) for over 80,000 cycles.
- During initial product development for a turbine application, the customer requested performance information on Watlow RTD probes under various conditions. Vibration testing was carried out on several diameters and probe configurations providing the customer with resonance frequencies to 2000Hz and corresponding dB levels.
- Vibration testing was provided for a prototype sensor mounted on the shaft bearings of a large diesel engine. Watlow product and field engineers worked with the customer to develop a vibration dampening design.
- Watlow engineers selected materials and developed several configurations to answer a customer's need for a 20 meter (60 ft) long sheathed sensor capable of handling 1400°C (2550°F). The conditions were reproduced in the product test lab and a successful design selected.

Your Watlow sales engineer is your key to successful temperature monitoring. He/she can assure that your sensor is tested under your conditions.

General Information

Lab Services

Quality Certification Lab

All tested sensors and wire are tagged with deviations and accompanied by a calibration report.

Today's demand for world class products that perform better, last longer, are more accurate and withstand harsher environments has led to an increased demand for certified compliance with manufacturing standards. Many high-tech industries demand certificates of compliance and traceability in the manufacturing process of the components they buy from you, their vendors. Watlow is able to meet this demand with our complete testing and certification services.

Watlow provides certification to verify the finished sensor is built to allow initial calibration tolerances as established by ASTM Standard E 230. This standard is based on the thermodynamic temperature scale of ITS 90, succeeding IPTS 68.

These are initial tolerances as supplied by Watlow. All sensors are susceptible to change during use due to environmental factors such as contamination, temperature, furnace gradient and physical abuse.

Watlow has the advanced capabilities to calibrate your sensors over a broad range of temperatures, from cryogenic -195°C (-320°F) to 1700°C (3090°F).

ISO 10012 is used as the guide for all sensor and instrument calibration making all results traceable to the National Institute of Standards and Technology—NIST. Standard methods and specifications for sensor calibration used are:

- ASTM E 207
- ASTM E 220
- ASTM E 230
- ASTM E 644
- AMS 2750C

We will test and certify any temperature sensing product—whether made by Watlow, or not. Our objective is to provide you with a comprehensive service for determining compliance with established standards.

We will perform the tests and calibrations required and provide all necessary documentation for an additional cost.

We offer:

Calibration testing
- For thermocouples, thermistors and RTDs traceable to NIST standards

End-to-end calibration
- For thermocouple conductors

Insulation resistance testing

Dielectric testing
- Measures an insulation's performance in the presence of electrical discharges

Helium leak testing
- Verifies sheath integrity

Radiographic (X-ray) inspection
- Detects internal defects, dimensional compliance and inclusions

Liquid penetrant testing
- Detects surface defects

Metallographic examination
- Evaluates constituents and structures of alloys

Compaction density testing
- Determines compaction of mineral insulation in metal sheathed cables

Thermal cycling
- Assures ruggedness under thermal transients

Micro-hardness
- Vicker's scale destructive test used to determine sheath hardness.

General Information

Lab Services

Quality Certification Lab

Calibration and Certification

SERV-RITE thermocouple wire and elements can be factory calibrated and certified at an extra charge. Each thermocouple, coil, reel or spool of wire is then tagged to show the individual departure from curve. Once calibrated, their exact departure from the standard curve at any specified temperature is known and can be taken into account. Thermocouples and wire samples sent to the factory for calibrating must be at least 36 inches long.

The standard calibrating temperature points range from 0 to 1260°C (32 to 2300°F), depending on calibration, gauge size and insulation. Sub-zero and cryogenic calibration is available at fixed points, such as boiling helium, nitrogen and sublimated carbon dioxide, including temperatures down to -80°C (-110°F).

A certificate of calibration is furnished for all calibrated items. Each item calibrated is also tagged with the results.

Common Certifications

The following standard certifications are available from Watlow. Requirements for these certifications must be stated on the order.

Certificate #1 - Certificate of Compliance/Conformity

This certification states that product being supplied meets the requirements of the purchase order.

Certificate #2 - Certificate of Compliance to ASTM E 230 Tolerance

This certification states that product being supplied meets the requirements of the purchase order, including the correct calibration type and tolerance. This certification is also used when conformance to ASTM E 230 must be documented.

Certificate #3 - Certificate of Conformance to ISO 10012

This certificate is used to certify that our calibration system is in accordance with ISO 10012.

Certificate #4 - Certificate of Traceability to NIST

This certification is used to certify that the materials they receive is traceable to NIST via calibration data of the thermoelements used to manufacture the product.

Certificate #6 - Certificate of Calibration at Standard Calibration Points

This is a calibration certification offering the preproduction calibration values of the insulated wire product at the standard calibration check points.

Certificate #7 - Chemical Composition of Tubing and Insulation in XACTPAK® Metal Sheathed Cable Products

Our tubing and insulator vendors supply certification on the chemical composition and physical characteristics of their products (material certs) with each lot received. When requested, these certs are duplicated (proprietary information is blocked out) and sent to our customers.

Certificate #7A - Chemical and Physical Analysis of Conductors in Insulated Wire Products

This certification offers the nominal chemical composition of the alloy used in the insulated wire products.

Certificate #8 - Certificate of Calibration at Specified Temperatures

This is a calibration certification when post-production calibration data is desired. Calibration is performed in the Watlow calibration laboratory with NIST traceable calibration standards. In addition to the calibration data, the test standard, equipment, NIST traceability, and reference to applicable calibration procedures are stated.

Note: Custom certifications are available upon request.

General Information

Lab Services

Quality Certification Lab
Continued

A lab service technician uses a metallurgical microscope to examine the microstructure of the metallic components in our mineral insulated metal sheathed cable, XACTPAK.

See the Application Hints section for Tolerances on Initial Values of EMF vs. Temperature for Thermocouples chart on page 17.

Recommended Sensor Straight Length Required for Calibration

Temperature °C (°F)	Length in. (mm)			
	Thermocouples		RTDs	
	Minimum	Maximum	Minimum	Maximum
-195 only (-320 only)	6 (150)	60 (1525)	6 (150)	60 (1525)
-80 to 290 (-110 to 550)	6 (150)	60 (1525)	6 (150)	60 (1525)
290 to 1090* (550 to 2000*)	15 (380)	10 ft (3 m)	15 (380)	10 ft (3 m)
Above 1090 (Above 2000)	18 (455)	10 ft (3 m)	NA	NA

*In this temperature range some sensors longer than 6 in. (150 mm), but shorter than the stated length minimum of 15 in. (380 mm) can be calibrated. Please call Lab Services to see if your sensor meets the necessary criteria.

Thermocouple Calibration

Watlow offers testing for application temperatures other than the standard points in a range from -195 to 1700°C (-320 to 3092°F), depending on material. We do not recommend use outside of the temperature limits of ASTM E 230.

Existing EMF data is available from initial testing of base metal thermoelements and from sample testing of manufactured lots of finished products. Data is at specific standard test temperatures for each thermocouple type, but may not be available on all lots.

Calibration* (Thermocouple Type)	Temperature °C (°F)	Specifications
E, K, J, N, T	0 to 1260 (32 to 2300)	ASTM E 207 ASTM E 220 ASTM E 230
B, R, S	0 to 1650 (32 to 3000)	
E, K, N, T	-195 plus -80 to 0 (-320 plus -110 to 32)	

*Maximum temperatures vary depending on thermocouple type.

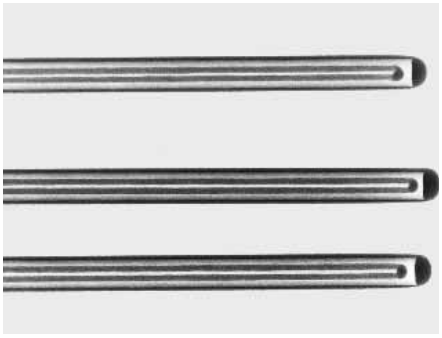
RTD Calibration

Watlow RTD calibration is useful for defining the exact temperature coefficient of the sensor. Coefficients are obtained by calibrating the RTD at a cryogenic temperature, 0°C, 100°C and a high temperature that cannot exceed the maximum temperature capability of the RTD. Through the use of the coefficients, a resistance output table in one degree (°C or °F) increments can be generated for the entire temperature range of the RTD.

General Information

Lab Services

Quality Certification Lab
Continued



X-rays of the sensor verify the nonexistence of cracks at weld points that could let in humidity or gas and potentially shorten the life of the thermocouple.

Certification Testing

Service	Description	Specifications
End-to-End Calibration	Comparison of each end of a length of thermocouple wire by utilizing a common junction measurement test. This is a requirement to verify homogeneity requirements.	ASTM E 207, E 220, E 230
Dielectric Testing	Performance levels of wire insulations in the presence of high, local fields caused by electrical discharges. Routinely used in Watlow quality control testing.	ASTM D 149
Helium Leak Test	Verifies the sheath integrity in metal-sheathed cable and sensors to 70 kg/cm^2 (1000 psi) in specially designed pressure chambers.	ASTM E 235
Radiographic Inspection	Determines dimensions, and detects and evaluates cracks, voids, inclusions and discontinuities. Technicians qualified under SNT-TC-1A.	ASTM E 94, E 142,
Metallographic Examination	Reveals the constituents and structures of metals. Photomicrographs are also available to determine and document average grain size and structure of prepared specimens.	ASTM E 3, E 112, E 235
Compaction Density Test	Determines the compaction of insulating materials in metal-sheathed cable.	ASTM D 2771
Drift Test	Determines long-term stability and drift characteristics.	ASTM E 601, E 644
Thermal Cycle Test	Individual sensors subjected to repeated cycling through a temperature range.	ASTM E 235
Insulation Resistance	Measures the electrical insulation resistance properties between the thermoelements and the sheath at ambient as well as elevated temperatures to determine the presence of moisture or impurities which could affect sensor performance.	ASTM E 780, E 235, E 644
Spurious EMF	Determines the homogeneity of the thermoelements. Performed at high temperatures on the entire length of XACTPAK mineral insulated, metal-sheathed cable.	Watlow
Micro-Hardness	Determines the hardness of sheath or conductors used to measure a material's resistance to penetration (hardness) as a predictor of strength, machinability, brittleness, ductility and wear resistance.	Vicker's

General Information

Tolerances

Sheath Tolerances

Length and diameter are important features for proper installation of temperature sensors. The tables provide the tolerances on these key dimensions of Watlow catalog sensor products.

Sheath Tolerances

General Application & RTD Sheath Tolerances		
Sheath Diameter (in.)	Diameter Tolerance (in.)	Length Tolerance (in.)
1/8	± 0.003	± 0.125
3/16	± 0.003	± 0.125
1/4	± 0.003	± 0.125
3/8	± 0.003	± 0.250

MI Thermocouple Sheath Tolerances			
		Length Tolerance (in.)	
Diameter (in.)	Diameter Tolerance (in.)	up to 24 in.	over 24 in.
0.020	+ 0.001 - 0.0005	± 0.25	± 1%
0.032	+ 0.001 - 0.0005	± 0.25	± 1%
0.040	+ 0.001 - 0.0005	± 0.25	± 1%
0.063	+ 0.001 - 0.0001	± 0.125	± ½%
0.125	+ 0.002 - 0.0001	± 0.125	± ½%
0.188	+ 0.002 - 0.0001	± 0.125	± ½%
0.250	+ 0.003 - 0.0001	± 0.125	± ½%
0.375	+ 0.003 - 0.0001	± 0.125	± ½%
0.500	+ 0.003 - 0.0001	± 0.125	± ½%

Flexible Lead Tolerances

General Application, MI Thermocouple & RTD Lead	
Lead Length (in.)	Tolerance (in.)
Under 6	+ 1 - 0
6 to 24	+ 2 - 0
Over 24 to 120	+ 6 - 0
Over 120	+ 5% - 0

Sheath Configuration

Standard shipping methods and element strength require long length mineral insulated sensors to be shipped in coil format. This chart provides the standard sheath configuration by diameter.

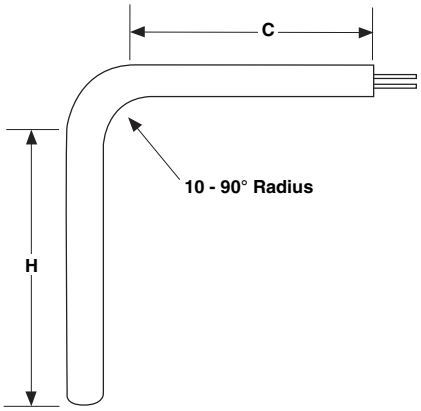
MI Thermocouple Standard Sheath Configuration

Sheath Diameter in.	Standard Length in.	Configuration
0.020 0.032	Up to 20 From 20 to 170 170 to 300 greater than 300	Straight 3 in. coil 6 in. coil 9-10 in. coil
0.040	Up to 20 From 20 to 120 120 to 200 Greater than 200	Straight 3 in. coil 6 in. coil 9-10 in. coil
0.063	Up to 50 50 to 540 (45 feet) Greater than 540 (45 feet)	Straight 9-10 in. coil 24 in. coil
0.125 0.188 0.250	Up to 96 Greater than 96	Straight 24 in. coil

General Information

Bends

Watlow custom bends sensors for a precise fit in many applications. The charts to the right list Watlow's standard radius by sensor type with minimum length requirements. Customers also form many sensor items at their own facility. Mineral insulated sensors should not be bent on a radius smaller than twice the sheath outside diameter. General application thermocouples and standard industrial RTDs should not be bent with radius smaller than indicated in the charts to the right. Support should also be given to these items as not to collapse the protecting sheath and damage internal sensor wiring and insulation. For all sensor types the minimum "H" dimension should be maintained.



Bend Radius For 10 to 90 Degree Bends

General Application Thermocouples

Diameter in.	Standard Bend Radius in.	Minimum "H" Dimension in.	Minimum "C" Dimension in.
0.125	⅜	1	2
0.188	⅜	1	2
0.250	½	2	2
0.375	¾	3	2

Mineral Insulated Thermocouples

Diameter in.	Standard Bend Radius in.	Minimum "H" Dimension in.	Minimum "C" Dimension in.
0.063	3⁄16	½	1 ½
0.090	¼	¾	1 ½
0.125	⅜	1*	2
0.188	½	1*	2
0.250	¾	2	2
0.313	1 ¼	2	2
0.375	1 ½	3	2
0.500	2	4	2

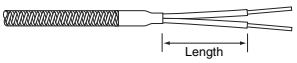
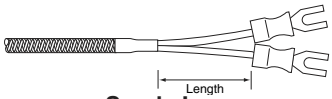
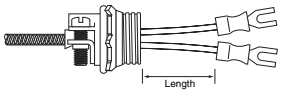
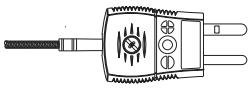
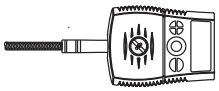
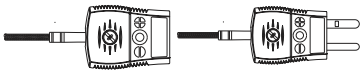
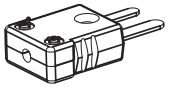
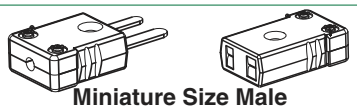
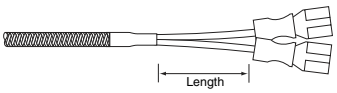
*For RTDs a minimum of 2 inches.

RTDs and Thermistors

Diameter in.	Standard Bend Radius in.	Minimum "H" Dimension in.	Minimum "C" Dimension in.
0.125	⅜	1	2
0.188	⅜	1	2
0.250	½	2	2

General Information

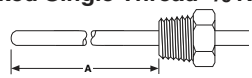
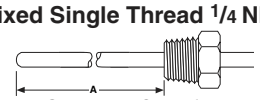
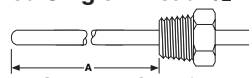
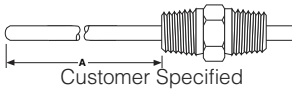
Lead Terminations Options

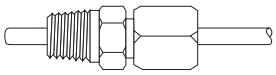
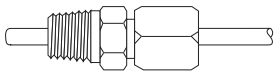
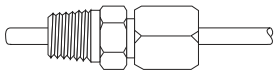
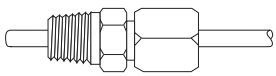
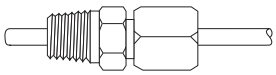
Termination	General Applications		MI Thermocouple		RTD	
	Ordering Code	Length	Ordering Code	Length	Ordering Code	Length
 **Split Leads**	A	2 1/2	T	1 1/2	T	*1 1/2
 **Spade Lugs**	B	2 1/2	U	1 1/2	U	*1 1/2
 **1/2 inch BX Connector Lugs**	C	2 1/2	W	1 1/2	W	1 1/2
 **Standard Size Male**	D	-	A	-	A	-
 **Standard Size Female**	E	-	B	-	B	-
 **Standard Size Male with Mating Connector**	-	-	C	-	C	-
 **Miniature Size Male**	F	-	F	-	J	-
 **Miniature Size Female**	G	-	G	-	K	-
 **Miniature Size Male with Mating Connector**	-	-	H	-	L	-
 **1/4 inch Push on Female Disconnect**	H	2 1/2	-	-	-	-

* When style contains jacketed wire.

General Information

Fitting Options

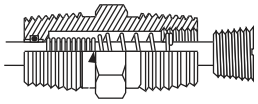
Fitting Type	Material	Sheath Sizes (in.)	NPT Thread Size (in.)	HEX Size (in.)	Length (in.)	Order Code
Fixed Single Thread 1/8 NPT  Customer Specified	303 SS	0.063 to 0.250	1/8	7/16	11/16	A
Fixed Single Thread 1/4 NPT  Customer Specified	303 SS	0.125 to 0.250	1/4	9/16	7/8	B
Fixed Single Thread 1/2 NPT  Customer Specified	303 SS	0.125 to 0.250	1/2	7/8	1	D
Fixed Double Thread 1/2 NPT  Customer Specified	303 SS	0.125 to 0.250	1/2	7/8	1 3/4	F

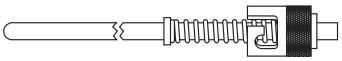
Fitting Type	Material	Sheath Sizes (in.)	NPT Thread Size (in.)	HEX Size (in.)	Length (in.)	Order Code
Non-Adjustable Compression Brass 	Brass	0.125	1/8	1/2	1	J
		0.188	1/8	1/2	1 1/8	J
		0.250	1/8	1/2	1 3/16	J
Non-Adjustable Compression SS 	303 SS	0.063	1/8	1/2	1 1/4	L
		0.125	1/8	1/2	1 1/4	L
		0.188	1/8	1/2	1 5/16	L
		0.250	1/8	1/2	1 5/16	L
Adjustable Compression Neoprene Gland 	303 SS	0.063	1/8	1/2	1 1/4	N
		0.125	1/8	1/2	1 1/4	N
		0.188	1/8	1/2	1 1/4	N
		0.250	1/4	7/8	2 7/16	P
Adjustable Compression TFE Gland 	303 SS	0.063	1/8	1/2	1 1/4	G
		0.125	1/8	1/2	1 1/4	G
		0.188	1/8	1/2	1 1/4	G
		0.250	1/4	7/8	2 7/16	X
Adjustable Compression Lava Gland 	303 SS	0.063	1/8	1/2	1 1/4	Q
		0.125	1/8	1/2	1 1/4	Q
		0.188	1/8	1/2	1 1/4	Q
		0.250	1/4	7/8	2 7/16	V

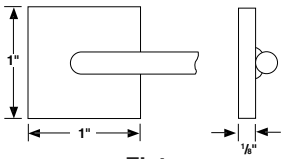
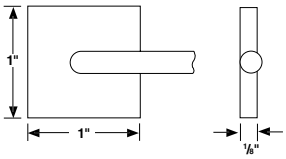
Compression Fittings: Compression fittings are shipped finger-tight on the sheath allowing field installation. Once non-adjustable fittings are deformed, they cannot be relocated. Adjustable fittings come with neoprene, TFE or lava sealant glands.

General Information

Fittings

Fitting Type	Material	Sheath Sizes (in.)	NPT Thread Size (in.)	HEX Size (in.)	Length (in.)	Order Code
Adjustable Spring Loaded 	316 SS	0.250	1/2	7/8	2	H

Fitting Type	Material	Sheath Sizes (in.)	Length (in.)	Order Code
Bayonet Lockcap and Spring 	Plated Steel	0.125	1⅝	W
	Plated Steel	0.188	1⅝	W

Weld Pad Type	Material	Order Code
 **Flat**	304 SS*	2
 **Milled Slot**	304 SS	5

*Alloy 600 available on special order and recommended for use with alloy 600 sheath.

Smart Sensing

Product Overview

Watlow's new line of smart temperature sensors saves operating and maintenance costs by reducing the variation in your process and by utilizing longer life materials.

Using a simple calibration code, Watlow's new INFOSENSE™ technology doubles the sensor's accuracy when used with SERIES SD controllers. Watlow's new INFOSENSE-P™ plug and play technology provides automated error-proof linking of your application to Watlow's NIST-traceable calibration lab. INFOSENSE-P also enables virtually any sensor to reach its furthest accuracy limits, while the new WATCOUPLE™ thermocouple achieves entirely new levels of performance. WATCOUPLE thermocouples save you money with state of the art accuracy and the ability to outlast a Type K thermocouple three times over. Watlow's new SERIES DX DeviceNet™ temperature transmitter brings IEEE 1451.4 plug and play technology to sensor networks. Hundreds of temperature sensors can now be networked together on a single wire.

SERIES DX DeviceNet™ Temperature Transmitter

- Provides high accuracy and flexibility
- Allows hundreds of sensors to be linked on a single network
- Accessible to most PLCs, networks and LabVIEW™ applications
- Can be used in any combination of standard or Plug and Play IEEE 1451.4 smart sensors (thermocouples and RTDs)
- Network and rotary switch configurable

WATCOUPLE™ Thermocouples

- Improves accuracy four times that of Type K special limit thermocouples in applications
- Last three times as long as Type K thermocouples
- Provides three times less drift as Type K thermocouples
- Eliminates aging effects and green rot
- Compatible with IEEE 1451.4 electronics

INFOSENSE™-P Thermocouples, RTDs

- Improves accuracy ten times that of RTDs at 600°C
- Improves initial accuracy three times that of Type K thermocouples
- Stores information about the sensor with an internal EEPROM
- Automatically communicates calibration, identification and traceability
- Compatible with IEEE 1451.4 electronics

INFOSENSE™ Thermocouples, RTDs

- Doubles the original sensor accuracy
- Incorporates four easy-to-use calibration codes or a scanable barcode
- Works with RTDs and thermocouples
- Standard input option with Watlow SERIES SD controllers

To determine the smart sensing solution that best meets your needs, please call your local Watlow distributor, sales engineer or factory technical support.

DeviceNet™ is a trademark of the Open DeviceNet Vendors Association.

LabVIEW™ is a trademark of National Instruments Corporation.

Notes

Thermocouples

General Applications

Over 90 years of manufacturing, research and design makes Watlow a world class supplier of temperature measurement products. We have designed and manufactured millions of thermocouples for industrial and commercial equipment. People involved in critical process control of food, plastics and metal rely on our sensors.

We are ready to meet your sensing needs with our extensive offering of thermocouples. However, if the variations listed in this catalog are unable to satisfy your requirements, Watlow can custom manufacture sensors to your exacting specifications. Contact your Watlow representative for details.

Performance Capabilities

- Fiberglass insulated thermocouples are capable of temperatures up to 480°C (900°F) for continuous operation.

Features and Benefits

"Custom-tailored" standard products including:

- 32 standard sheath lengths
- Lead lengths from six to 360 inches
- Stainless steel braid or hose protection
- J, K, T and E calibrations
- Grounded, ungrounded and exposed junctions
- Flat and drill point
- Epoxy sealed cold ends
- Adjustable depths
- Flexible extensions
- Washers, nozzles and clamp bands
- Custom diameters
- PFA coated and stainless steel sheaths
- Straight, 45° bend or 90° bend
- Locking bayonet caps in standard, 12 mm and 15 mm

Custom manufactured thermocouples

- Units designed and built to your specifications

Applications

- Plastic injection molding machinery
- Food processing equipment
- Deicing
- Plating baths
- Industrial processing
- Medical equipment
- Pipe tracing control
- Industrial heat treating
- Packaging equipment
- Liquid temperature measurement
- Refrigerator temperature control
- Oven temperature control

Thermocouples

General Applications

Construction and Tolerances

Construction

Thermocouples feature flexible SERV-RITE® wire insulated with woven fiberglass or high temperature engineered resins. For added protection against abrasion, products can be provided with stainless steel wire braid and flexible armor. ASTM E 230 color-coding identifies standard catalog thermocouple types (see reference chart on inside back cover).

The addition of a metal sheath over the thermocouple provides rigidity for accurate placement and added protection of the sensing junction. Mounting options include springs, ring terminals, specialized bolts, pipe style clamps and shims.

How to Order

- Determine style of thermocouple required
- Complete the eleven digit part number as determined by the following parameters:
  - Construction
  - Diameter
  - Calibration
  - Lead protection
  - Junction
  - Sheath length
  - Lead length
  - Terminations/options

Note: All eleven spaces must be filled in.

Availability

Rapid Ship sensors are available for same or next day shipment.

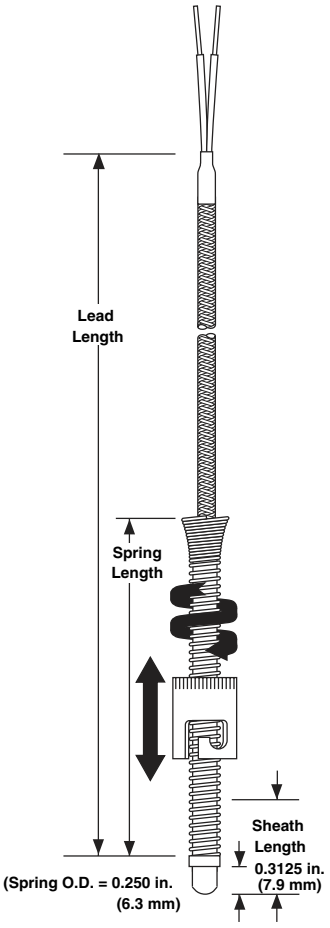
Preferred sensor options are available for shipment in approximately three days.

For **custom built** products consult factory for approximate shipment time.

Thermocouples

General Applications

Adjustable Spring Style



Adjustable spring style thermocouple fits a large range of hole depths. Bends to any angle, eliminating the requirement to stock numerous styles.

Rapid Ship Sensors

Rapid Ship sensors come with 24 gauge stranded fiberglass lead with stainless steel overbraid and grounded junction.

Calibration	Spring Length in. (mm)	Lead Length in. (mm)	Termination	
			Split Leads	Standard Connector
J	6 (152)	24 (610)	10DJSGB024A	10DJSGB024D
		48 (1219)	10DJSGB048A	10DJSGB048D
		72 (1829)	10DJSGB072A	10DJSGB072D
		96 (2438)	10DJSGB096A	10DJSGB096D
	12 (305)	24 (610)	11DJSGB024A	11DJSGB024D
		48 (1219)	11DJSGB048A	11DJSGB048D
		72 (1829)	11DJSGB072A	11DJSGB072D
		96 (2438)	11DJSGB096A	11DJSGB096D

Custom Ordering Information—Items in **Bolded Green Type** are preferred with shorter lead times.

1	2	3	4	5	6	7	8	9	10	11
		D				B				

1-2. Construction Style
10 = Standard cap - 6 inch spring
11 = Standard cap - 12 inch spring
14 = 12 mm cap - 6 inch spring
15 = 15 mm cap - 6 inch spring
16 = 12 mm cap - 12 inch spring
17 = 15 mm cap - 12 inch spring

3. Sheath Diameter (inch), 316 SS
D = 3/16

4. Calibration
J = Type J T = Type T
K = Type K E = Type E

5. Lead Protection
F = Fiberglass (24 gauge stranded)
S = Fiberglass with stainless steel overbraid (24 gauge stranded)
P = Fiberglass (20 gauge stranded)
B = Fiberglass with stainless steel overbraid (20 gauge stranded)
T = PFA (24 gauge stranded)
U = PFA with stainless steel overbraid (24 gauge stranded)
V = PFA (20 gauge stranded)
W = PFA with stainless steel overbraid (20 gauge stranded)

6. Junction
F = Grounded, flat tip
G = Grounded, round tip
D = Grounded, drill point
R = Ungrounded, flat tip
U = Ungrounded, round tip
P = Ungrounded, drill point
H = Grounded, round tip, dual element
S = Ungrounded, round tip, dual element

7. Sheath Length (inch)
B = 1

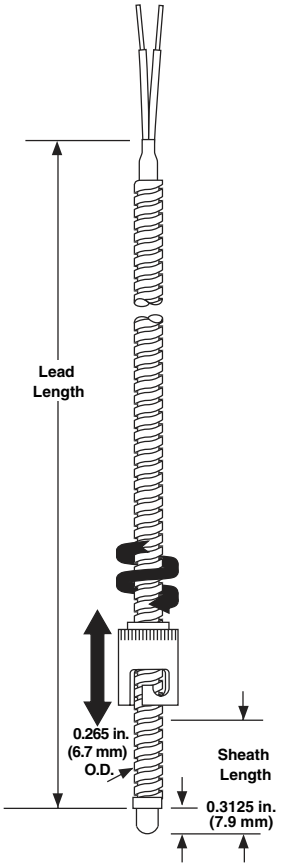
8-10. Lead Length (whole inches)
012, 024, 036, 040, 048, 060, 072, 079, 096 and 120
Available lengths: 006 to 360, over 360 consult factory

11. Terminations/Options
A = Standard, 2 ½ inch split leads
B = 2 ½ inch split leads with #6 spade lugs
C = 2 ½ inch split leads with #6 spade lugs and BX connector
D = Standard male plug, quick disconnect
E = Standard female jack, quick disconnect
F = Miniature male plug, quick disconnect
G = Miniature female jack, quick disconnect
H = ¼ inch push-on connector

Thermocouples

General Applications

Adjustable Armor Style



Adjustable armor thermocouple fits a large range of hole depths. Bends to any angle, eliminating the requirement to stock numerous styles. Stainless steel hose offers additional lead protection in demanding applications.

Rapid Ship Sensors

Rapid Ship sensors come with 24 gauge stranded fiberglass lead with stainless steel armor and grounded junction.

Calibration	Lead Length in.	(mm)	Termination: Split Leads	Termination: Standard Connector
J	48	(1219)	12DJHGB048A	12DJHGB048D
	60	(1524)	12DJHGB060A	12DJHGB060D
	72	(1829)	12DJHGB072A	12DJHGB072D
	96	(2438)	12DJHGB096A	12DJHGB096D
	120	(3048)	12DJHGB120A	12DJHGB120D

Custom Ordering Information—Items in **Bolded Green Type** are preferred with shorter lead times.

1	2	3	4	5	6	7	8	9	10	11
1	2	D				B				

1-2. Construction Style
12 = Adjustable armor thermocouple, standard cap

3. Sheath Diameter (inch), 316 SS
D = 3/16

4. Calibration
J = Type J
K = Type K
T = Type T
E = Type E

5. Lead Protection
H = Fiberglass with stainless steel hose (24 gauge stranded)
C = Fiberglass with stainless steel hose (20 gauge stranded)
K = PFA with stainless steel hose (24 gauge stranded)
Y = PFA with stainless steel hose (20 gauge stranded)

6. Junction
F = Grounded, flat tip
G = Grounded, round tip
D = Grounded, drill point
U = Ungrounded, round tip
P = Ungrounded, drill point
R = Ungrounded, flat tip
H = Grounded, round tip, dual element
S = Ungrounded, round tip, dual element

7. Sheath Length (inch)
B = 1

8-10. Lead Length (inches)
012, 024, 036, 040, 048, 060, 072, 079, 096 and 120
Available lengths: 006 to 360, over 360 consult factory

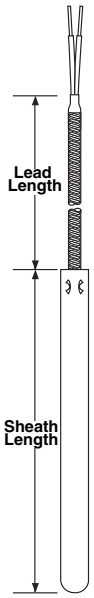
11. Terminations/Options
A = Standard, 2 ½ inch split leads
B = 2 ½ inch split leads with #6 spade lugs
C = 2 ½ inch split leads with #6 spade lugs and BX connector
D = Standard male plug, quick disconnect
E = Standard female jack, quick disconnect
F = Miniature male plug, quick disconnect
G = Miniature female jack, quick disconnect
H = ¼ inch push-on connector

Thermocouples

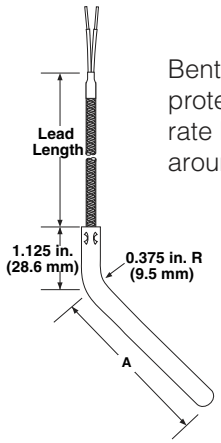
General Applications

Rigid Sheath

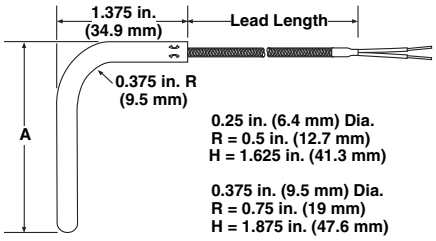
⅛ and 3⁄16 inch Diameter



Rigid sheath provides protection and accurate placement through bulkheads or platens. Use with a compression fitting for water tight immersion application.



Bent rigid tube offers protection and accurate lead placement around machinery.



*Not available with ⅛ inch diameter sheath.

Metric sizes available for made-to-order units, consult factory. Minimum order quantity may apply.

Rapid Ship Sensors

Rapid Ship sensors come with 3⁄16 inch diameter sheath, 24 gauge stranded fiberglass lead with stainless steel overbraid, grounded junction and split lead termination.

Calibration	Sheath Length in.	Sheath Length (mm)	Lead Length in.	Lead Length (mm)	Part Number
J	1	(25)	48	(1219)	20DJSGB048A
			96	(2438)	20DJSGB096A
	2	(51)	48	(1219)	20DJSGD048A
			96	(2438)	20DJSGD096A
	4	(102)	48	(1219)	20DJSGH048A
			96	(2438)	20DJSGH096A

Custom Ordering Information—Items in **Bolded Green Type** are preferred with shorter lead times.

1 2 3 4 5 6 7 8 9 10 11

1-2. Construction Style
20 = Plain sheath, straight
21 = Plain sheath, 45° bend
22= Plain sheath, 90° bend

3. Sheath Diameter (inch), 316 SS
C = ⅛ S = ⅛ epoxy sealed 149°C (300°F)
D = 3⁄16 T = 3⁄16 epoxy sealed 149°C (300°F)

4. Calibration
J = Type J T = Type T
K = Type K E = Type E

5. Lead Protection
F = Fiberglass (24 gauge stranded)
S = Fiberglass with stainless steel overbraid (24 gauge stranded)
H = Fiberglass with stainless steel hose (24 gauge stranded)
*P = Fiberglass (20 gauge stranded)
*B = Fiberglass with stainless steel overbraid (20 gauge stranded)
*C = Fiberglass with stainless steel hose (20 gauge stranded)
O = Plug or jack termination on sheath fiberglass (24 gauge stranded)
T = PFA (24 gauge stranded)
U = PFA with stainless steel overbraid (24 gauge stranded)
K = PFA with stainless steel hose (24 gauge stranded)
*V = PFA (20 gauge stranded)
*W = PFA with stainless steel overbraid (20 gauge stranded)
*Y = PFA with stainless steel hose (20 gauge stranded)

6. Junction
F = Grounded, flat tip P = Ungrounded, drill point
G = Grounded, round tip E = Exposed
D = Grounded, drill point *H = Grounded, round tip, dual element
R = Ungrounded, flat tip *S = Ungrounded, round tip, dual element
U = Ungrounded, round tip

7. Sheath Length (inches)
A = ½ **D = 2** G= 3 ½ K = 5 N = 6 ½ R = 8 U = 9 ½ Z = 12
B = 1 E = 2 ½ **H= 4** L = 5 ½ P = 7 S = 8 ½ W= 10
C = 1 ½ F = 3 J = 4 ½ M = 6 Q = 7 ½ T = 9 Y = 11

8-10. Lead Length (inches)
012, 024, 036, 040, 048, 060, 072, 079, 096 and 120
Available lengths: 006 to 360, over 360 consult factory

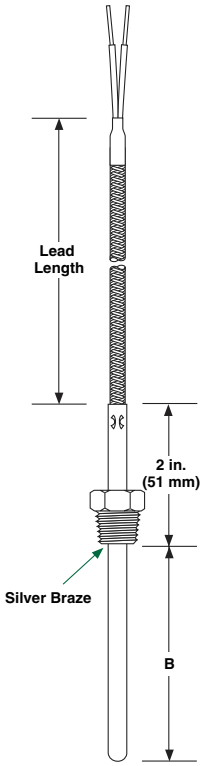
11. Terminations/Options
A = Standard, 2 ½ inch split leads
B = 2 ½ inch split leads with #6 spade lugs
C = 2 ½ inch split leads with #6 spade lugs and BX connector
D = Standard male plug, quick disconnect
E = Standard female jack, quick disconnect
F = Miniature male plug, quick disconnect
G = Miniature female jack, quick disconnect
H = ¼ inch push-on connector

Thermocouples

General Applications

Rigid Sheath with Threaded Fitting

⅛ and 3⁄16 inch Diameter



Rigid sheath with threaded fitting provides accurate placement in process applications.

*Not available with ⅛ inch diameter sheath.

Metric sizes available for made-to-order units, consult factory. Minimum order quantity may apply.

Custom Ordering Information—Items in **Bolded Green Type** are preferred with shorter lead times.

1	2	3	4	5	6	7	8	9	10	11

1-2. Construction Style

23 = Straight sheath with ⅛" NPT SS fitting

24 = Straight sheath with ½" NPT SS fitting

3. Sheath Diameter (inch), 316 SS

C = ⅛ S = ⅛ epoxy sealed 149°C (300°F)

D = 3⁄16 T = 3⁄16 epoxy sealed 149°C (300°F)

4. Calibration

J = Type J T = Type T

K = Type K E = Type E

5. Lead Protection

F = Fiberglass (24 gauge stranded)

S = Fiberglass with stainless steel overbraid (24 gauge stranded)

H = Fiberglass with stainless steel hose (24 gauge stranded)

*P = Fiberglass (20 gauge stranded)

*B = Fiberglass with stainless steel overbraid (20 gauge stranded)

*C = Fiberglass with stainless steel hose (20 gauge stranded)

T = PFA (24 gauge stranded)

U = PFA with stainless steel overbraid (24 gauge stranded)

K = PFA with stainless steel hose (24 gauge stranded)

*V = PFA (20 gauge stranded)

*W = PFA with stainless steel overbraid (20 gauge stranded)

*Y = PFA with stainless steel hose (20 gauge stranded)

6. Junction

F = Grounded, flat tip

G = Grounded, round tip

D = Grounded, drill point

R = Ungrounded, flat tip

U = Ungrounded, round tip

P = Ungrounded, drill point

E = Exposed

*H = Grounded, round tip, dual element

*S = Ungrounded, round tip, dual element

7. "B" Dimension (inches)

A = ½	**D = 2**	G = 3 ½	K = 5	N = 6 ½	R = 8	U = 9 ½	Z = 12
B = 1	E = 2 ½	**H = 4**	L = 5 ½	P = 7	S = 8 ½	W = 10	
C = 1 ½	**F = 3**	J = 4 ½	**M = 6**	Q = 7 ½	T = 9	Y = 11	

8-10. Lead Length (inches)

012, 024, 036, 040, 048, 060, 072, 079, 096 and 120

Available lengths: 006 to 360, over 360 consult factory

11. Terminations/Options

A = Standard, 2 ½ inch split leads

B = 2 ½ inch split leads with #6 spade lugs

C = 2 ½ inch split leads with #6 spade lugs and BX connector

D = Standard male plug, quick disconnect

E = Standard female jack, quick disconnect

F = Miniature male plug, quick disconnect

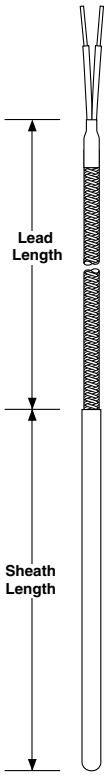
G = Miniature female jack, quick disconnect

H = ¼ inch push-on connector

Thermocouples

General Applications

PFA Encapsulated Style



The rigid sheath is covered with a 0.010 inch (25 mm) wall of PFA for corrosion resistance in acid environments. An epoxy seal improves moisture resistance of sensor and provides a barrier for migrating fumes in corrosive applications.

Custom Ordering Information—Items in **Bolded Green Type** are preferred with shorter lead times.

1	2	3	4	5	6	7	8	9	10	11
6	5									

1-2. Construction Style
65 = PFA coated sheath

3. Diameter (inch) under covering
C = ⅛ epoxy seal 149°C (300°F)
D = 3⁄16 epoxy seal 149°C (300°F)
E = ¼ epoxy seal 149°C (300°F)

4. Calibration
J = Type J T = Type T
K = Type K E = Type E

5. Lead protection
T = PFA (24 gauge stranded)
***R = PFA (20 gauge stranded)**

6. Junction
U = Ungrounded, round tip
G = Grounded, round tip

7. Sheath Length (inches)

B = 1	J = 4 ½	R = 8
C = 1 ½	K = 5	S = 8 ½
D = 2	L = 5 ½	T = 9
E = 2 ½	**M = 6**	U = 9 ½
F = 3	N = 6 ½	W = 10
G = 3 ½	P = 7	Y = 11
H = 4	Q = 7 ½	Z = 12

8-10. Lead Length (inches)
012, 024, 036, 040, 048, 060, 072, 079, 096 and 120
Available lengths: 006 to 360, over 360 consult factory

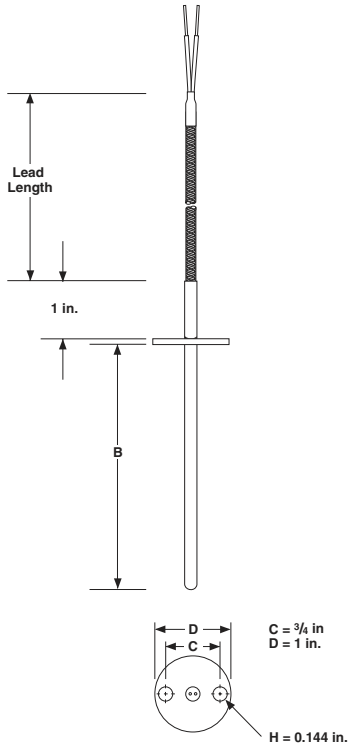
11. Terminations/Options
A = Standard, 2 ½ inch split leads
B = 2 ½ inch split leads with #6 spade lugs
C = 2 ½ inch split leads with #6 spade lugs and BX connector
D = Standard male plug, quick disconnect
E = Standard female jack, quick disconnect
F = Miniature male plug, quick disconnect
G = Miniature female jack, quick disconnect
H = ¼ inch push-on connector

*Not available in ⅛ inch diameter.

Thermocouples

General Applications

Flange Style



The flanged thermocouple allows rapid assembly and low profile when going through bulkheads.

*Not available with ⅛ inch diameter sheath.

Metric sizes available for made-to-order units, consult factory. Minimum order quantity may apply.

Rapid Ship Sensors

Rapid Ship sensors come with 3⁄16 inch diameter sheath, 24 gauge stranded fiberglass lead with stainless steel overbraid, grounded junction and a split lead termination.

Calibration	"B" Dimension in.	(mm)	Lead Length in.	(mm)	Part Number
J	2	(51)	48	(1219)	25DJSGD048A
			96	(2438)	25DJSGD096A
	4	(102)	48	(1219)	25DJSGH048A
			96	(2438)	25DJSGH096A

Custom Ordering Information—Items in **Bolded Green Type** are preferred with shorter lead times.

1	2	3	4	5	6	7	8	9	10	11
2	5									

1-2. Construction Style
25 = Thermocouple with flange

3. Sheath Diameter (inch), 316 SS
C = ⅛ S = ⅛ epoxy sealed 149°C (300°F)
D = 3⁄16 T = 3⁄16 epoxy sealed 149°C (300°F)

4. Calibration
J = Type J T = Type T
K = Type K E = Type E

5. Lead Protection
F = Fiberglass (24 gauge stranded)
S = Fiberglass with stainless steel overbraid (24 gauge stranded)
H = Fiberglass with stainless steel hose (24 gauge stranded)
*P = Fiberglass (20 gauge stranded)
*B = Fiberglass with stainless steel overbraid (20 gauge stranded)
*C = Fiberglass with stainless steel hose (20 gauge stranded)
T = PFA (24 gauge stranded)
U = PFA with stainless steel overbraid (24 gauge stranded)
K = PFA with stainless steel hose (24 gauge stranded)
*V = PFA (20 gauge stranded)
*W = PFA with stainless steel overbraid (20 gauge stranded)
*Y = PFA with stainless steel hose (20 gauge stranded)

6. Junction
F = Grounded, flat tip P = Ungrounded, drill point
G = Grounded, round tip E = Exposed
D = Grounded, drill point *H = Grounded, round tip, dual element
R = Ungrounded, flat tip *S = Ungrounded, round tip, dual element
U = Ungrounded, round tip

7. "B" Dimension (inches)
D = 2 **H = 4** M = 6 R = 8 W = 10
E = 2 ½ J = 4 ½ N = 6 ½ S = 8 ½ Y = 11
F = 3 K = 5 P = 7 T = 9 Z = 12
G = 3 ½ L = 5 ½ Q = 7 ½ U = 9 ½

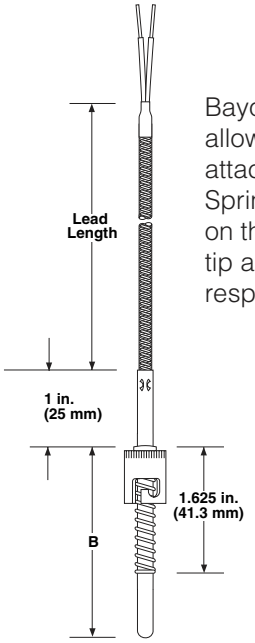
8-10. Lead Length (inches)
012, 024, 036, 040, 048, 060, 072, 079, 096 and 120
Available lengths: 006 to 360, over 360 consult factory

11. Terminations/Options
A = Standard, 2 ½ inch split leads
B = 2 ½ inch split leads with #6 spade lugs
C = 2 ½ inch split leads with #6 spade lugs and BX connector
D = Standard male plug, quick disconnect
E = Standard female jack, quick disconnect
F = Miniature male plug, quick disconnect
G = Miniature female jack, quick disconnect
H = ¼ inch push-on connector

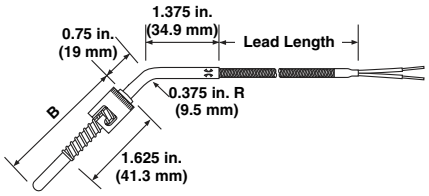
Thermocouples

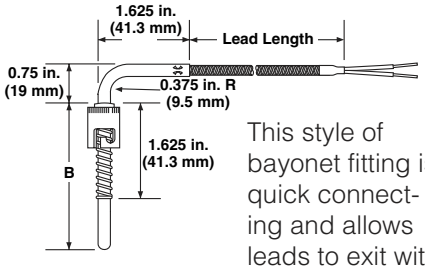
General Applications

Rigid Sheath
Fixed Bayonet Style



Bayonet fittings allow rapid attachment. Spring pressure on the junction tip assures fast response time.





This style of bayonet fitting is quick connecting and allows leads to exit with a protective sheath.

① Reference page 29 to calculate "B" dimension.

*Not available with ⅛ inch diameter sheath.

Metric sizes available for made-to-order units, consult factory. Minimum order quantity may apply.

Rapid Ship Sensors

Rapid Ship sensors come with 3/16 inch diameter sheath, 24 gauge stranded fiberglass lead with stainless steel overbraid, grounded junction and a split lead termination.

Calibration	"B" Dimension in.	(mm)	Lead Length in.	(mm)	Part Number
J	2	(51)	48	(1219)	30DJSGD048A
			96	(2438)	30DJSGD096A
	3	(76)	48	(1219)	30DJSGF048A
			96	(2438)	30DJSGF096A
	4	(102)	48	(1219)	30DJSGH048A
			96	(2438)	30DJSGH096A

Custom Ordering Information—Items in **Bolded Green Type** are preferred with shorter lead times.

1 2 3 4 5 6 7 8 9 10 11

1-2. Construction Style
30 = Bayonet cap with spring, straight
31 = Bayonet cap with spring, 45° bend
32 = Bayonet cap with spring, 90° bend

3. Sheath Diameter (inch), 316 SS
C = ⅛ S = ⅛ epoxy sealed 149°C (300°F)
D = 3/16 T = 3/16 epoxy sealed 149°C (300°F)

4. Calibration
J = Type J T = Type T
K = Type K E = Type E

5. Lead Protection
F = Fiberglass (24 gauge stranded)
S = Fiberglass with stainless steel overbraid (24 gauge stranded)
H = Fiberglass with stainless steel hose (24 gauge stranded)
*P = Fiberglass (20 gauge stranded)
***B = Fiberglass with stainless steel overbraid (20 gauge stranded)**
***C = Fiberglass with stainless steel hose (20 gauge stranded)**
O = Plug or jack termination on sheath fiberglass (24 gauge stranded)
T = PFA (24 gauge stranded)
U = PFA with stainless steel overbraid (24 gauge stranded)
K = PFA with stainless steel hose (24 gauge stranded)
*V = PFA (20 gauge stranded)
*W = PFA with stainless steel overbraid (20 gauge stranded)
*Y = PFA with stainless steel hose (20 gauge stranded)

6. Junction
F = Grounded, flat tip P = Ungrounded, drill point
G = Grounded, round tip E = Exposed
D = Grounded, drill point *H = Grounded, round tip, dual element
R = Ungrounded, flat tip *S = Ungrounded, round tip, dual element
U = Ungrounded, round tip

7. "B" Dimension① (inches)
D = 2 G = 3 ½ K = 5 N = 6 ½ R = 8 U = 9 ½ Z = 12
E = 2 ½ **H = 4** L = 5 ½ P = 7 S = 8 ½ W = 10
F = 3 J = 4 ½ M = 6 Q = 7 ½ T = 9 Y = 11

8-10. Lead Length (inches)
012, 024, 036, 040, 048, 060, 072, 079, 096 and 120
Available lengths: 006 to 360, over 360 consult factory

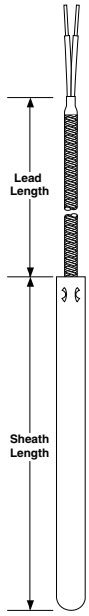
11. Terminations/Options
A = Standard, 2 ½ inch split leads
B = 2 ½ inch split leads with #6 spade lugs
C = 2 ½ inch split leads with #6 spade lugs and BX connector
D = Standard male plug, quick disconnect
E = Standard female jack, quick disconnect
F = Miniature male plug, quick disconnect
G = Miniature female jack, quick disconnect
H = ¼ inch push-on connector
R = Double slotted 12 mm bayonet cap, split end leads
S = Double slotted 15 mm bayonet cap, split end leads

Thermocouples

General Applications

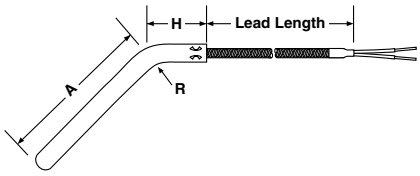
Large Diameter Rigid Sheath Style

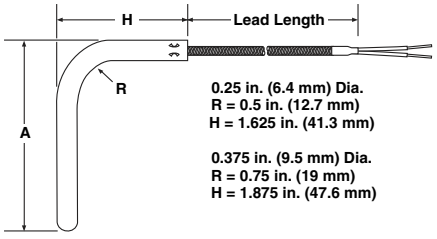
¼ and ⅜ inch Diameter



Rigid sheath provides protection and accurate placement through bulkheads or platens. Use with a compression fitting for water tight immersion application.

Bent rigid tube offers protection and accurate lead placement around machinery.





Metric sizes available for made-to-order units, consult factory. Minimum order quantity may apply.

Rapid Ship Sensors

Rapid Ship sensors come with ¼ inch diameter sheath, 20 gauge stranded fiberglass lead with stainless steel overbraid, grounded junction and a split lead termination.

Calibration	Sheath Length in.	Sheath Length (mm)	Lead Length in.	Lead Length (mm)	Part Number
J	4	(102)	48	(1219)	40EJBGD048A
			96	(2438)	40EJBGD096A
	6	(152)	48	(1219)	40EJBGF048A
			96	(2438)	40EJBGF096A

Custom Ordering Information—Items in **Bolded Green Type** are preferred with shorter lead times.

1 2 3 4 5 6 7 8 9 10 11

1-2. Construction Style

40= Plain sheath, straight, large, diameter

41 = Plain (45°) large diameter

42= Plain (90°) large diameter

3. Sheath Diameter (inch), 316 SS

E = ¼ U = ¼ epoxy sealed 149°C (300°F)

G = ⅜ V = ⅜ epoxy sealed 149°C (300°F)

4. Calibration

J = Type J T = Type T

K = Type K E = Type E

5. Lead Protection

F = Fiberglass (24 gauge stranded)

S = Fiberglass with stainless steel overbraid (24 gauge stranded)

H = Fiberglass with stainless steel hose (24 gauge stranded)

P = Fiberglass (20 gauge stranded)

B = Fiberglass with stainless steel overbraid (20 gauge stranded)

C = Fiberglass with stainless steel hose (20 gauge stranded)

T = PFA (24 gauge stranded)

U = PFA with stainless steel overbraid (24 gauge stranded)

K = PFA with stainless steel hose (24 gauge stranded)

V = PFA (20 gauge stranded)

W = PFA with stainless steel overbraid (20 gauge stranded)

Y = PFA with stainless steel hose (20 gauge stranded)

6. Junction

F = Grounded, flat tip E = Exposed

G = Grounded, round tip H = Grounded, round tip, dual element

R = Ungrounded, flat tip S = Ungrounded, round tip, dual element

U = Ungrounded, round tip

7. Sheath Length (inches)

A = 1 **D = 4** G = 7 K = 10 N = 13 R = 16 U = 19 Z = 24

B = 2 E = 5 H = 8 L = 11 P = 14 S = 17 W = 20

C = 3 **F = 6** J = 9 M = 12 Q = 15 T = 18 Y = 22

8-10. Lead Length (inches)

012, 024, 036, 040, 048, 060, 072, 079, 096 and 120

Available lengths: 006 to 360, over 360 consult factory

11. Terminations/Options

A = Standard, 2 ½ inch split leads

B = 2 ½ inch split leads with #6 spade lugs

C = 2 ½ inch split leads with #6 spade lugs and BX connector

D = Standard male plug, quick disconnect

E = Standard female jack, quick disconnect

F = Miniature male plug, quick disconnect

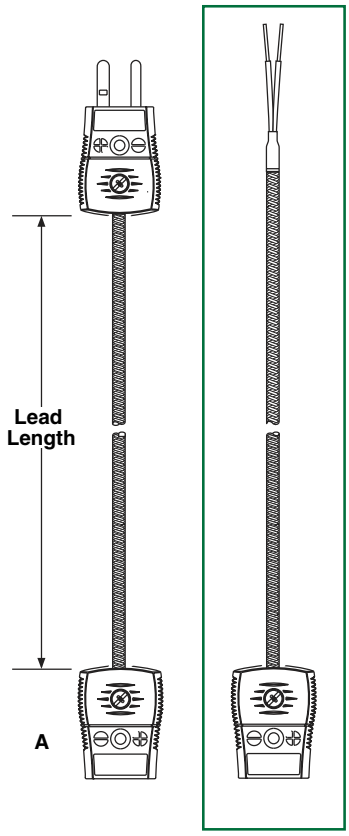
G = Miniature female jack, quick disconnect

H = ¼ inch push-on connector

Thermocouples

General Applications

Flexible Extensions



Flexible extensions allow the disconnecting of thermocouples from a system without disturbing the remaining wiring.

Rapid Ship Sensors

Rapid Ship sensors come with standard female connector and a split lead termination.

Calibration	Lead Protection	Lead Length in.	(mm)	Part Number
J	Fiberglass with SS overbraid	48	(1219)	60XJBXE048A
		96	(2438)	60XJBXE096A
	Fiberglass with SS hose	48	(1219)	60XJCXE048A
		96	(2438)	60XJCXE096A
K	Fiberglass with SS overbraid	48	(1219)	60XKBXE048A
		96	(2438)	60XKBXE096A
	Fiberglass with SS hose	48	(1219)	60XKCXE048A
		96	(2438)	60XKCXE096A

Custom Ordering Information—Items in **Bolded Green Type** are preferred with shorter lead times.

1	2	3	4	5	6	7	8	9	10	11
6	0	X			X					

1-2. Construction Style
60 = Flexible extension

3. Diameter
X = Not applicable

4. Calibration
J = Type J T = Type T
K = Type K E = Type E

5. Lead Protection
F = Fiberglass (24 gauge stranded)
S = Fiberglass with stainless steel overbraid (24 gauge stranded)
P = Fiberglass (20 gauge stranded)
B = Fiberglass with stainless steel overbraid (20 gauge stranded)
C = Fiberglass with stainless steel hose (20 gauge stranded)
T = PFA (24 gauge stranded)
U = PFA with stainless steel overbraid (24 gauge stranded)
K = PFA with stainless steel hose (24 gauge stranded)
V = PFA (20 gauge stranded)
W = PFA with stainless steel overbraid (20 gauge stranded)
Y = PFA with stainless steel hose (20 gauge stranded)

6. Junction
X = Not applicable

7. Termination "A"
A = Standard, 2 ½ inch split leads
B = 2 ½ inch split leads with spade lugs
C = 2 ½ inch split leads with spade lugs and BX Connector
D = Standard male plug, quick disconnect
E = Standard female jack, quick disconnect
*F = Miniature male plug, quick disconnect
*G = Miniature female jack, quick disconnect
H = ¼ inch push-on connector

8-10. Lead Length (inches)
012, 024, 036, 040, 048, 060, 072, 079, 096 and 120
Available lengths: 006 to 360, over 360 consult factory

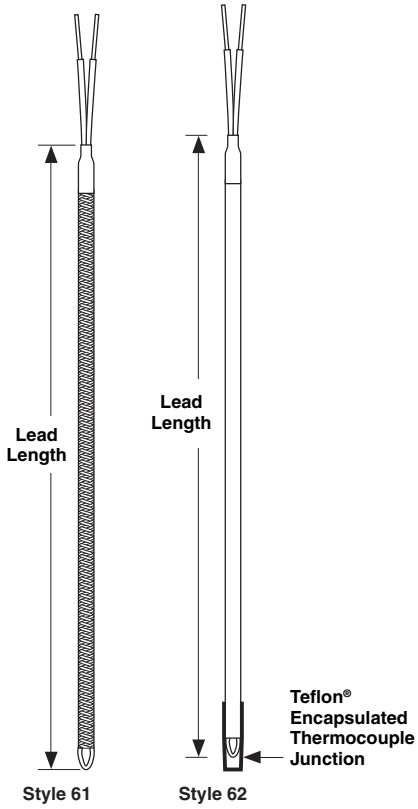
11. Termination "B"
A = Standard, 2 ½ inch split leads
B = 2 ½ inch split leads with #6 spade lugs
C = 2 ½ inch split leads with #6 spade lugs and BX connector
D = Standard male plug, quick disconnect
E = Standard female jack, quick disconnect
F = Miniature male plug, quick disconnect
G = Miniature female jack, quick disconnect
H = ¼ inch push-on connector

* Not available with SS hose.

Thermocouples

General Applications

Insulated Wire Thermocouple Style 61 and Style 62



Rapid Ship Sensors

Rapid Ship sensors come with 24 gauge solid FEP insulated lead and a split lead termination.

Calibration	Lead Protection	Lead Length in.	(mm)	Part Number
K	Extruded FEP	48	(1219)	61XKTEX048A
		96	(2438)	61XKTEX096A
T	Extruded FEP	48	(1219)	61XTTEX048A
		96	(2438)	61XTTEX096A

Custom Ordering Information—Items in **Bolded Green Type** are preferred with shorter lead times.

1	2	3	4	5	6	7	8	9	10	11
		X			E	X				

1-2. Construction Style
61 = SERIES 61
*62= SERIES 62

3. Diameter
X = Not applicable

4. Calibration
J = Type J
K = Type K
T = Type T

5. Lead Protection
P = Fiberglass (20 gauge solid)
B = Fiberglass with stainless steel overbraid (20 gauge solid)
J = Extruded FEP (20 gauge solid)
F = Fiberglass (24 gauge solid)
S = Fiberglass with stainless steel overbraid (24 gauge solid)
T = Extruded FEP (24 gauge solid)

6. Junction
E = Exposed

7. Exter X

8-10. Lead Length (inches)
048 and 096
Available lengths: 006 to 600, over 600 consult factory

11. Terminations/Options
A = Standard, 2 ½ inch split leads
B = 2 ½ inch split leads with spade lugs
D = Standard male plug, quick disconnect
E = Standard female jack, quick disconnect
F = Miniature male plug, quick disconnect
G = Miniature female jack, quick disconnect
H = ¼ inch push-on connector

* Only available with wire (lead protection) options J or T (5th digit).

Constructed with SERV-RITE® insulated thermocouple wire Styles 61 and 62 are economical and versatile thermocouples with the option of an exposed or protected measuring junction. Style 61 has an exposed junction and is suitable for most general purpose applications, such as measuring air, gas and surface temperatures. Style 62 has an encapsulated measuring junction that is ideal for corrosive fluids and gases such as sulfuric acid, hydrofluoric acid, strong mineral acids and oils.

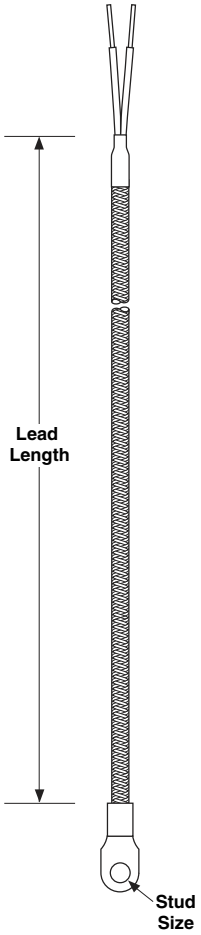
Styles 61 and 62 are available with fiberglass insulated lead wire (SERIES 304 construction), with continuous temperature ratings of 480°C (900°F). Or, order it with FEP insulated lead wire (SERIES 507), rated to 200°C (400°F) continuous temperature.

For additional mechanical strength and abrasion resistance, a stainless steel overbraid is available.

Thermocouples

General Applications

Ring Terminal Style



The nickel terminal can be placed beneath existing screws or bolts to permit surface temperature measurement.

* Only available with 24 gauge wire.

Rapid Ship Sensors

Rapid Ship sensors come with 24 gauge stranded fiberglass lead with stainless steel overbraid, grounded junction and a split lead termination.

Calibration	Stud Size	Lead Length in. (mm)	Part Number
J	No. 10	48 (1219)	70XJSGC048A
		96 (2438)	70XJSGC096A
	¼	48 (1219)	70XJSGD048A
		96 (2438)	70XJSGD096A

Custom Ordering Information—Items in **Bolded Green Type** are preferred with shorter lead times.

1	2	3	4	5	6	7	8	9	10	11
7	0	X								

1-2. Construction Style
70 = Ring terminal thermocouple

3. Diameter
X = Not applicable

4. Calibration
J = Type J T = Type T
K = Type K E = Type E

5. Lead Protection
F = Fiberglass (24 gauge stranded)
S = Fiberglass with stainless steel overbraid (24 gauge stranded)
P = Fiberglass (20 gauge stranded)
B = Fiberglass with stainless steel overbraid (20 gauge stranded)
T = PFA (24 gauge stranded)
U = PFA with stainless steel overbraid (24 gauge stranded)
V = PFA (20 gauge stranded)
W= PFA with stainless steel overbraid (20 gauge stranded)

6. Junction
G = Grounded
*U = Ungrounded

7. Stud Size—Hole Diameter (inches)
***A = No. 6** 0.144
***B = No. 8** 0.169
***C = No. 10** 0.196
D = ¼ 0.266
E = ⅜ 0.390

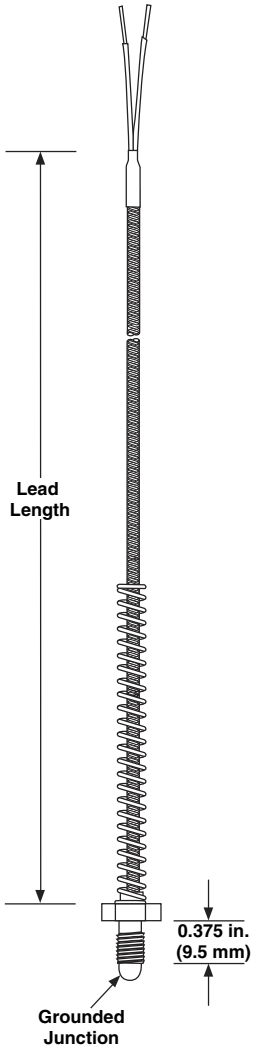
8-10. Lead Length (inches)
012, 024, 036, 040, 048, 060, 072, 079, 096 and 120
Available lengths: 006 to 360, over 360 consult factory

11. Terminations/Options
A = Standard, 2 ½ inch split leads
B = 2 ½ inch split leads with #6 spade lugs
C = 2 ½ inch split leads with #6 spade lugs and BX connector
D = Standard male plug, quick disconnect
E = Standard female jack, quick disconnect
F = Miniature male plug, quick disconnect
G = Miniature female jack, quick disconnect
H = ¼ inch push-on connector

Thermocouples

General Applications

Nozzle Style



The nozzle thermocouple has a short installation depth and a low profile thus allowing control of thin sections of platens.

* Only available with 24 gauge wire.

Rapid Ship Sensors

Rapid Ship sensors come with 24 gauge stranded fiberglass lead with stainless steel overbraid, grounded junction and a split lead termination.

Calibration	Bolt Size	Lead Length in.	(mm)	Part Number
J	¼ in. x 28 UNF	48	(1219)	71XJSGA048A
		96	(2438)	71XJSGA096A
	M6 x 1	48	(1219)	71XJSGM048A
		96	(2438)	71XJSGM096A

Custom Ordering Information—Items in **Bolded Green Type** are preferred with shorter lead times.

1	2	3	4	5	6	7	8	9	10	11
7	1	X			G					

1-2. Construction Style
71 = Nozzle thermocouple

3. Diameter
X = Not applicable

4. Calibration
J = Type J T = Type T
K = Type K E = Type E

5. Lead Protection
F = Fiberglass (24 gauge stranded)
S = Fiberglass with stainless steel overbraid (24 gauge stranded)
P = Fiberglass (20 gauge stranded)
B = Fiberglass with stainless steel overbraid (20 gauge stranded)
T = PFA (24 gauge stranded)
U = PFA with stainless steel overbraid (24 gauge stranded)
V = PFA (20 gauge stranded)
W = PFA with stainless steel overbraid (20 gauge stranded)

6. Junction
G = Grounded

7. 304 SS, Bolt size
A = ¼ inch x 28 UNF, ⅜ inch thread depth
B = 8-32 thread
*C = 10-32 thread
***M = M6 x 1**

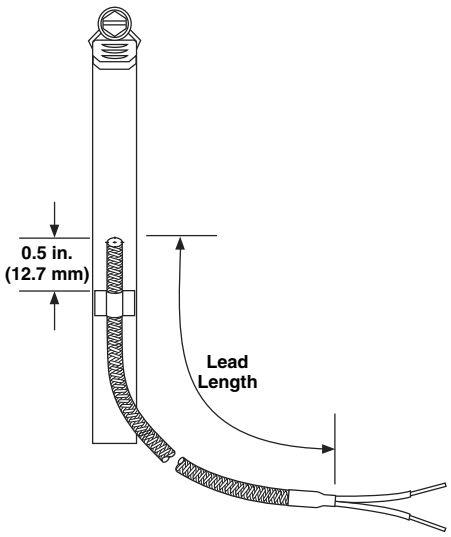
8-10. Lead Length (inches)
012, 024, 036, 040, 048, 060, 072, 079, 096 and 120
Available lengths: 006 to 360, over 360 consult factory

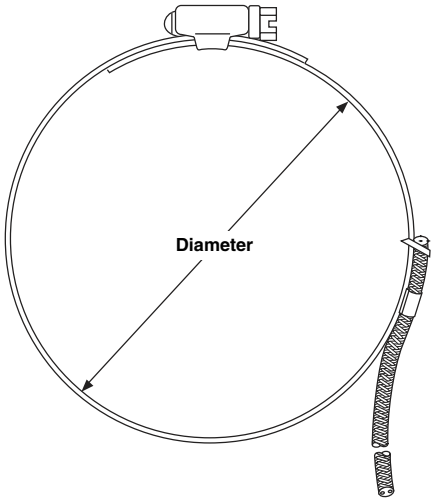
11. Terminations/Options
A = Standard, 2 ½ inch split leads
B = 2 ½ inch split leads with #6 spade lugs
C = 2 ½ inch split leads with #6 spade lugs and BX connector
D = Standard male plug, quick disconnect
E = Standard female jack, quick disconnect
F = Miniature male plug, quick disconnect
G = Miniature female jack, quick disconnect
H = ¼ inch push-on connector

Thermocouples

General Applications

Pipe Clamp Style





The stainless steel clamp allows temperature measurement without drilling or tapping. Ideal for measuring pipe temperatures.

Rapid Ship Sensors

Rapid Ship sensors come with 24 gauge stranded fiberglass lead with stainless steel overbraid, grounded junction and a split lead termination.

Calibration	Clamp Size	Lead Length in.	(mm)	Part Number
J	1/16 to 1 ¼	48	(1219)	72XJSGA048A
		96	(2438)	72XJSGA096A
	1 ¼ to 2 ¼	48	(1219)	72XJSGB048A
		96	(2438)	72XJSGB096A

Custom Ordering Information—Items in **Bolded Green Type** are preferred with shorter lead times.

1	2	3	4	5	6	7	8	9	10	11
7	2	X			G					

1-2. Construction Style
72 = Pipe clamp thermocouple

3. Diameter
X = Not applicable

4. Calibration
J = Type J T = Type T
K = Type K E = Type E

5. Lead Protection
S = Fiberglass with stainless steel overbraid (24 gauge stranded)
B = Fiberglass with stainless steel overbraid (20 gauge stranded)
U = PFA with stainless steel overbraid (24 gauge stranded)
W = PFA with stainless steel overbraid (20 gauge stranded)

6. Junction
G = Grounded

7. Clamp Band Diameter Range (inches)
A = 1/16 to 1 ¼ E = 4 ¼ to 5
B = 1 ¼ to 2 ¼ F = 5 to 6
C = 2 ¼ to 3 ¼ G = 6 to 7
D = 3 ¼ to 4 ¼

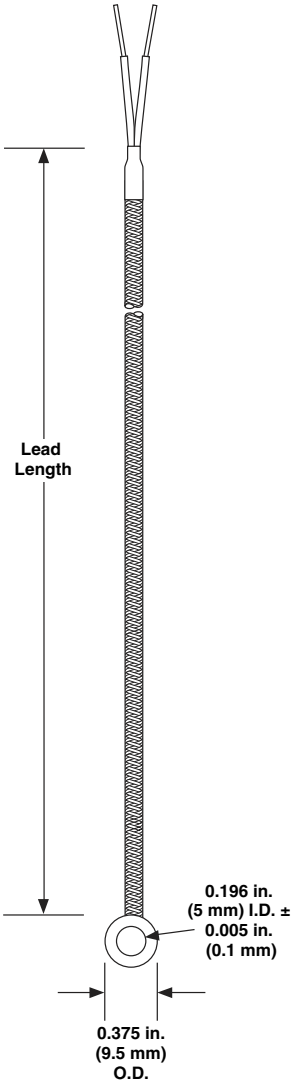
8-10. Lead Length (inches)
012, 024, 036, 040, 048, 060, 072, 079, 096 and 120
Available lengths: 006 to 360, over 360 consult factory

11. Terminations/Options
A = Standard, 2 ½ inch split leads
B = 2 ½ inch split leads with #6 spade lugs
C = 2 ½ inch split leads with #6 spade lugs and BX connector
D = Standard male plug, quick disconnect
E = Standard female jack, quick disconnect
F = Miniature male plug, quick disconnect
G = Miniature female jack, quick disconnect
H = ¼ inch push-on connector

Thermocouples

General Applications

Grommet Style



Extremely low profile of the stainless steel grommet provides fast response time.

Rapid Ship Sensors

Rapid Ship sensors come with 24 gauge solid fiberglass lead with stainless steel overbraid, grounded junction and a split lead termination.

Calibration	Lead Length in.	(mm)	Part Number
J	48	(1219)	73XJFGA048A
	96	(2438)	73XJFGA096A

Custom Ordering Information—Items in **Bolded Green Type** are preferred with shorter lead times.

1	2	3	4	5	6	7	8	9	10	11
7	3	X			G	A				

1-2. Construction Style
73 = Grommet thermocouple

3. Diameter
X = Not applicable

4. Calibration
J = Type J T = Type T
K = Type K E = Type E

5. Lead Protection
F = Fiberglass (24 gauge solid)
T = PFA (24 gauge solid)

6. Junction
G = Grounded

7. Grommet Size (inch)
A = 0.195 inch I.D. x 0.375 inch O.D. x 0.035 inch thick

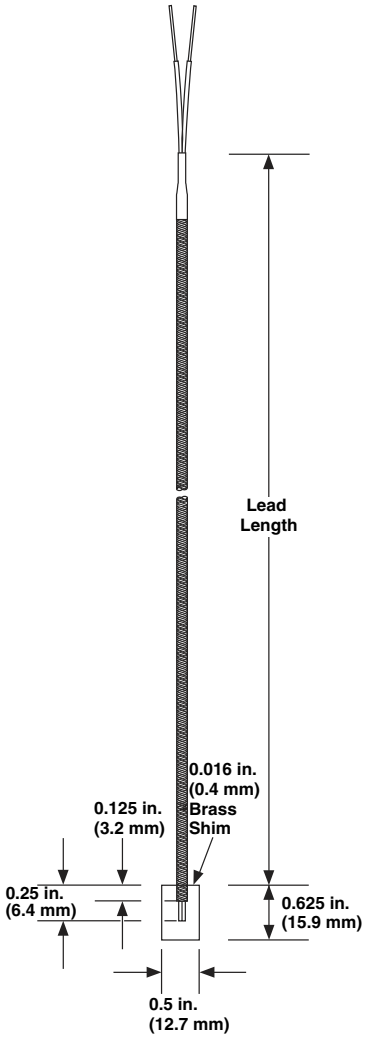
8-10. Lead Length (inches)
012, 024, 036, 040, 048, 060, 072, 079, 096 and 120
Available lengths: 006 to 360, over 360 consult factory

11. Terminations/Options
A = Standard, 2 ½ inch split leads
B = 2 ½ inch split leads with #6 spade lugs
C = 2 ½ inch split leads with #6 spade lugs and BX connector
D = Standard male plug, quick disconnect
E = Standard female jack, quick disconnect
F = Miniature male plug, quick disconnect
G = Miniature female jack, quick disconnect
H = ¼ inch push-on connector

Thermocouples

General Applications

Brass Shim Style



The shim stock thermocouple has low profile and can be placed between components for measurement of surface temperature.

Available in other shim dimensions. Contact your Watlow sales representative for details.

Custom Ordering Information—Items in **Bolded Green Type** are preferred with shorter lead times.

1	2	3	4	5	6	7	8	9	10	11
7	4	X			G	A				

1-2. Construction Style
74 = Shim stock thermocouple

3. Diameter
X = Not applicable

4. Calibration
J = Type J
K = Type K
T = Type T
E = Type E

5 Lead Protection
F = Fiberglass (24 gauge solid)
T = PFA (24 gauge solid)

6. Junction
G = Grounded

7. Shim Size (inch)
A = ½ inch x ⅝ inch x 0.016 inch, brass

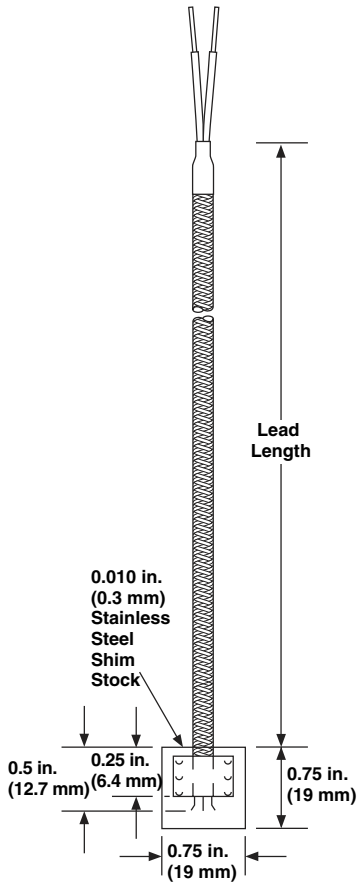
8-10. Lead Length (inches)
012, 024, 036, 040, 048, 060, 072, 079, 096 and 120
Available lengths: 006 to 360, over 360 consult factory

11. Terminations/Options
A = Standard, 2 ½ inch split leads
B = 2 ½ inch split leads with #6 spade lugs
C = 2 ½ inch split leads with #6 spade lugs and BX connector
D = Standard male plug, quick disconnect
E = Standard female jack, quick disconnect
F = Miniature male plug, quick disconnect
G = Miniature female jack, quick disconnect
H = ¼ inch push-on connector

Thermocouples

General Applications

Stainless Steel Shim Style



The shim stock thermocouple has low profile and can be placed between components for measurement of surface temperature.

Available in other shim dimensions. Contact your Watlow sales representative for details.

Rapid Ship Sensors

Rapid Ship sensors come with 24 gauge solid fiberglass lead with stainless steel overbraid, grounded junction and a split lead termination.

Calibration	Lead Length in.	(mm)	Part Number
J	48	(1219)	75XJSGA048A
	96	(2438)	75XJSGA096A

Custom Ordering Information—Items in **Bolded Green Type** are preferred with shorter lead times.

1	2	3	4	5	6	7	8	9	10	11
7	5	X			G	A				

1-2. Construction Style
75 = Stainless steel shim stock thermocouple

3. Diameter
X = Not applicable

4. Calibration
J = Type J
K = Type K
T = Type T
E = Type E

5. Lead Protection
F = Fiberglass (24 gauge stranded)
S = Fiberglass with stainless steel overbraid (24 gauge stranded)
T = PFA (24 gauge stranded)
U = PFA with stainless steel overbraid (24 gauge stranded)

6. Junction
G = Grounded

7. Shim Size (inch)
A = ¾ inch x ¾ inch x 0.010 inch, 304 stainless steel

8-10. Lead Length (inches)
012, 024, 036, 040, 048, 060, 072, 079, 096 and 120
Available lengths: 006 to 360, over 360 consult factory

11. Terminations/Options
A = Standard, 2 ½ inch split leads
B = 2 ½ inch split leads with #6 spade lugs
C = 2 ½ inch split leads with #6 spade lugs and BX connector
D = Standard male plug, quick disconnect
E = Standard female jack, quick disconnect
F = Miniature male plug, quick disconnect
G = Miniature female jack, quick disconnect
H = ¼ inch push-on connector

Thermocouples

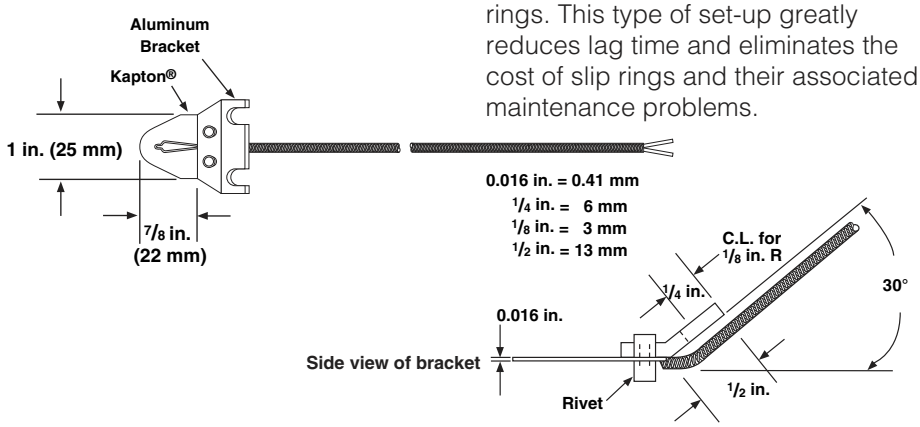
General Applications

Kapton® Bracket Style

The Kapton® thermocouple, when used with the aluminum bracket, has been designed primarily to measure roller temperature. By putting a light pressure on the roller, the Kapton® thermocouple measures roller surface temperature without using slip rings. This type of set-up greatly reduces lag time and eliminates the cost of slip rings and their associated maintenance problems.

It can also be used to measure conveyor belt temperatures or any other moving part by riding gently on the part surface.

- Continuous use at 200°C (400°F), 260°C (500°F) for limited periods
- Low mass
- Fast response
- Totally insulated construction
- Available in Type J or K

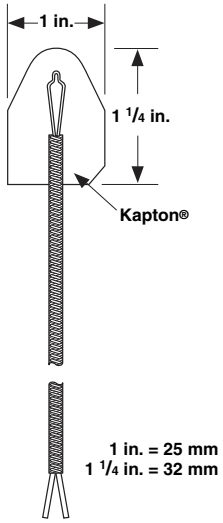


Kapton® Thermocouple with Bracket

Rapid Ship sensors with 30 gauge solid thermocouple wire, with fiberglass insulation and split lead termination.

Calibration	Lead Length in.	(cm)	Part No.
J	48	(122)	**OKJ30B4A**
	96	(244)	OKJ30B4B
K	48	(122)	**OKK30B4A**
	96	(244)	OKK30B4B

Low Profile Kapton® Peel and Stick Style



Low Profile Kapton® Thermocouple (without Bracket)

When used without the bracket it can be placed between heated parts for accurate temperature measurement. At the thermocouple junction, the overall thickness is only 0.016 in. (0.4 mm), so that it does not interfere with fit or thermo conductivity.

Rapid Ship sensors with 30 gauge solid thermocouple wire, with fiberglass insulation and split lead termination.

Calibration	Lead Length in.	(cm)	Part No.
J	48	(122)	**OKJ30B2A**
	96	(244)	OKJ30B2B
K	48	(122)	**OKK30B1A**
	96	(244)	OKK30B1B

Kapton® Peel and Stick

This sensor needs no bracket and no special mounting. Simply peel away the backing and this self-adhesive film will bond to almost any surface. Temperature ratings for continuous use is 200°C (400°F).

Rapid Ship sensors with 30 gauge solid thermocouple wire, with fiberglass insulation and split lead termination.

Calibration	Lead Length in.	(cm)	Part No.
J	48	(122)	**OKJ30B11A**
	96	(244)	**OKJ30B11B**
K	48	(122)	**OKK30B10A**
	96	(244)	**OKK30B10B**
T	48	(122)	OKK30B12A
	96	(244)	OKK30B12B

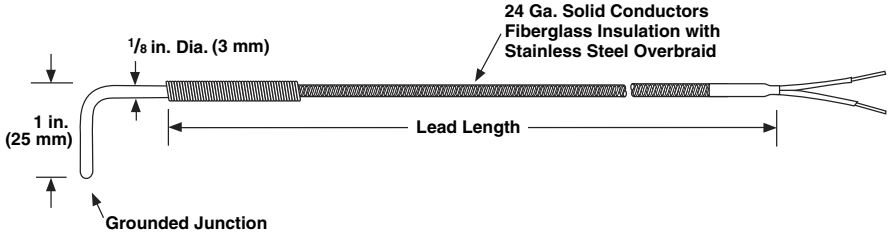
Newbury Nozzle Style

A direct replacement for OEM Type J nozzle thermocouples held in place with a set screw. The sheath is ⅛ inch diameter with a 90 degree bend and a spring strain relief.

Ordering Information

With 48 inch metal braided leads part no. **125J2A23D**

With 60 inch metal braided leads part no. **125J2A23E**



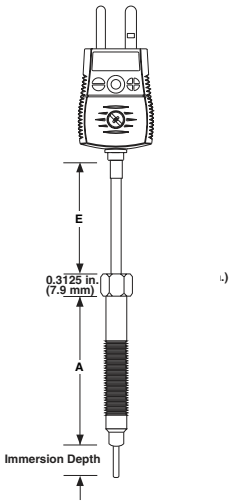
Kapton® is a registered trademark of E.I. du Pont de Nemours & Company.

Thermocouples

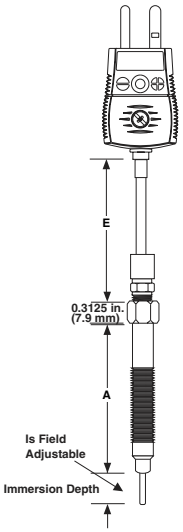
General Applications

Melt Bolt Thermocouple

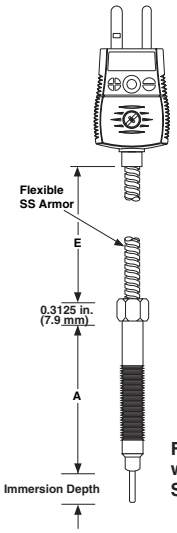
Watlow plastic melt bolt thermocouples are designed so that the sensitive closed end portion of the tip can be inserted directly into the plastic stream of an extruder or injection molding machine. The measuring junction is thermally isolated from the metal bolt mass, assuring accurate reading of the melt temperature up to 260°C (500°F) continuous. Bolt is 300 series stainless steel.



Fixed Immersion Style M1



One Time Adjustable Immersion Style M2



Fixed Immersion with Flexible Extension Style M3

Custom Ordering Information—Items in **Bolded Green Type** are preferred with shorter lead times.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
M						A	0							

2. Style
1 = Fixed immersion
2 = Adjustable immersion
3 = Fixed immersion with flex armor

3. Sheath O.D. (inch)
G = 0.125

4. Lead Wire Construction
O = No flex armor (M1 and M2)
R = S.S. flex armor (M3 only)

5. Melt Bolt Length "A" (inch)
1 = 3
2 = 6

6. Cold End Terminations
A = Standard male plug
B = Standard female jack
C = Standard plug with mating connector
T = Standard 1 ½ inch split leads (Style M3 only)
U = 1 ½ inch split leads with spade lugs (Style M3 only)
W = 1 ½ inch split leads with BX connector and spade lugs (Style M3 only)

7. Probe Construction
A = Mineral insulated with 304 SS sheath

8. Enter "0"

9. Immersion Length "I" (inch)
1 = 1

10. Immersion Length "I" (fractional inch)

1 = ⅛		5 = ⅝	
2 = ¼		6 = ¾	
3 = ⅜		7 = ⅞	
4 = ½		0 = Flush	

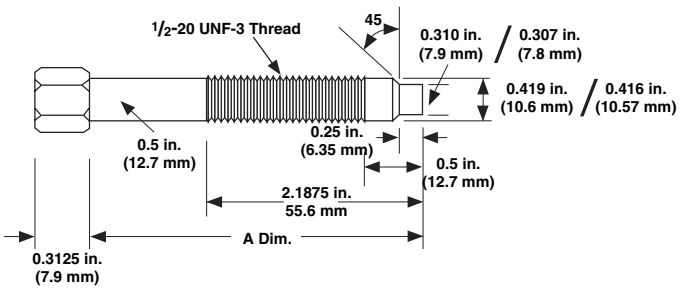
11. Junction
U = Ungrounded
G = Grounded

12. Calibration

Standard limits	**J**	K
Special limits	3	4

13-14. Extension Length "E"
03, 06
Whole inches: 02 to 99

15. Special Requirements
If none, enter "0". If required, consult factory



Standard Dimensions For M1, M2, and M3 Melt Bolts

Thermocouples

Mineral Insulated

Watlow's mineral insulated thermocouples are fast-responding, durable, and capable of handling high temperatures.

These thermocouples are manufactured with best-in-class XACTPAK®, Watlow's trademark for metal sheathed, mineral insulated (MI) thermocouple material. XACTPAK responds fast because the protective metal outer sheath allows the use of smaller diameter thermocouple conductors. The rock hard compacted MgO insulation further enhances the sensor's ability to "read" temperature by transferring heat quickly to the measuring junction.

The XACTPAK protecting sheath and compacted insulation outperforms bare wire thermocouples in most applications.

Performance Capabilities

- Easily handles temperatures up to 1200°C (2200°F)
- Meets or exceeds initial calibration tolerances per ASTM E 230

Features and Benefits

Special mineral insulation
- Protects thermocouple from moisture and thermal shock
- Permits operation in high temperature, high pressure environments

Diameters as small as 0.010 in. (0.25 mm)
- Ideal when physical space or extremely fast response are critical

Flexibility of the XACTPAK material
- Allows you to form and bend the thermocouple, without risk of cracking, to meet your design requirements

Outer sheath
- Protects the wires from oxidation and hostile environments

Wide range of sheath materials, diameters, and calibrations
- Meet specific requirements

In-house manufacturing of XACTPAK material
- Rigid quality control procedures
- Assures high standards are met
- Single source reliability

Custom capabilities
- Include options such as special lead lengths, lead wires and terminations

Applications

- Heat treating
- Furnaces/kilns
- Turbines
- Bearing temperature
- Power stations
- Steam generators
- Diesel engines
- Nuclear reactors
- Atomic research
- Jet engines and test cells
- Rocket engines
- Semiconductor manufacturing
- Refineries/oil processing
- Catalytic reformers
- Food processing

Thermocouples

Mneral Insulated

Cut and Stripped Style AB

The main feature of Watlow's Style AB thermocouple is it allows you to terminate the thermocouple yourself. Style AB is simply a section of XACTPAK material, junctioned and stripped. It is the most basic of all the mineral insulated thermocouple styles.

Because it is constructed with XACTPAK mineral insulation, the thermocouple is protected from moisture, thermal shock, high temperatures and high pressure.

Performance Capabilities

- Maximum temperature depends on sheath material, calibration, and other variables

Features and Benefits

Cold end stripped and sealed with epoxy

- Inhibits moisture penetration

Dual element style

- Allows you to run two instruments off the same element, reducing your costs

Custom Ordering Information—Items in **Bolded Green Type** are preferred with shorter lead times.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
A	B		0		0									

3. Sheath O.D. (inch)

A = 0.010	**E = 0.063**	L = 0.375
B = 0.020	**G = 0.125**	M = 0.500
C = 0.032	**H = 0.188**	
D = 0.040	**J = 0.250**	

4. Enter "0"

5. Fittings, Weld Pads

If required, enter order code from pages 39-40. If none, enter **"0".**

6. Enter "0"

7. Sheath Material

A = 304 SS **Q = Alloy 600 (Type K)**
F = 316 SS

8-9. Sheath Length "L" (whole inches)

01 to 99
Lengths over 99 inches consult factory.

10. Sheath Length "L" (fractional inch)

0 = 0	4 = ½
1 = ⅛	5 = ⅝
2 = ¼	6 = ¾
3 = ⅜	7 = ⅞

11. Junction

	Grounded	Ungrounded	Exposed
Single	**G**	**U**	E
Dual	H	W (isolated)	D (isolated)

12. Calibration

	E	J	K	N	T
Standard limits	E	**J**	**K**	N	**T**
Special limits	2	3	4	—	8

13. Strip Length "S" (whole inches)

0, **1**, 2 and 3 - 1 inch maximum on 0.040 and smaller

14. Strip Length "S" (fractional inch)

0 = 0	4 = ½
1 = ⅛	5 = ⅝
2 = ¼	6 = ¾
3 = ⅜	7 = ⅞

15. Special Requirements

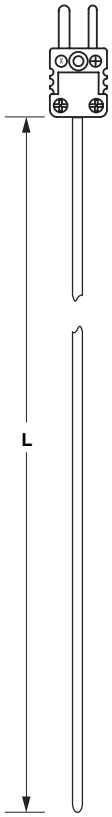
0 = None
X = Special requirements, consult factory

Thermocouples

Mneral Insulated

Mini Plug or Jack Termination

Style AC



Rapid Ship Sensors

Rapid Ship sensors come with mini male thermocouple connector directly attached to sheath, Type J or K, ungrounded junction, 0.063 or 0.125 inch sheath diameter and six or 12 inch sheath length.

Calibration	Sheath Material	Sheath Diameter in.	(mm)	Sheath Length in. (mm) 6 (152)	12 (305)
J	316 SS	0.063	(1.6)	ACEF00F060UJ000	ACEF00F120UJ000
		0.125	(3.2)	ACGF00F060UJ000	ACGF00F120UJ000
K	Alloy 600	0.063	(1.6)	ACEF00Q060UK000	ACEF00Q120UK000
		0.125	(3.2)	ACGF00Q060UK000	ACGF00Q120UK000

Custom Ordering Information—Items in **Bolded Green Type** are preferred with shorter lead times.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
A	C				0							0	0	

3. Sheath O.D. (inch)
A = 0.010 D = 0.040
B = 0.020 **E = 0.063**
C = 0.032 **G = 0.125**

4. Connector Type
Miniature Plugs and Jacks 200°C (400°F)
(0.125 inch maximum O.D.)
F = Miniature plug
G = Miniature jack
H = Miniature plug with mating connector

5. Fittings, Weld Pads
If required, enter order code from pages 39-40.
If none, enter **"0"**.

6. Enter "0"

7. Sheath Material
A = 304 SS **Q = Alloy 600 (Type K)**
F = 316 SS
C = PFA coated over SS (available on G diameter)

8-9. Sheath Length "L" (whole inches)
04, 06, 12, 18, 24
Available lengths: 01 to 99, over 99 consult factory
Maximum length for PFA coating is 48 inches.

10. Sheath Length "L" (fractional inch)
0 = 0 2 = ¼ 4 = ½ 6 = ¾
1 = ⅛ 3 = ⅜ 5 = ⅝ 7= ⅞

11. Junction

	Grounded	Ungrounded	Exposed
Single	**G**	**U**	E

12. Calibration

	E	J	K	N	T
Standard limits	E	**J**	**K**	N	**T**
Special limits	2	3	4	—	8

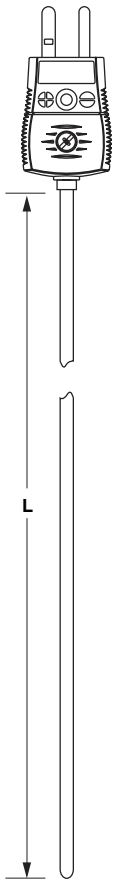
13-14. Enter "00"

15. Special Requirements
0 = None
X = Special requirements, consult factory

Thermocouples

Mineral Insulated

Standard Plug or Jack Termination
Style AC



Rapid Ship Sensors

Rapid Ship sensors come with standard male thermocouple connector directly attached to sheath, Type J or K, ungrounded junction, 0.125, 0.188 or 0.250 inch diameter and six or 12 inch sheath length.

Calibration	Sheath Material	Sheath Diameter in.	(mm)	Sheath Length in. (mm) 6 (152)	12 (305)
J	316 SS	0.125	(3.2)	ACGA00F060UJ000	ACGA00F120UJ000
		0.188	(4.8)	ACHA00F060UJ000	ACHA00F120UJ000
		0.250	(6.4)	ACJA00F060UJ000	ACJA00F120UJ000
K	Alloy 600	0.125	(3.2)	ACGA00Q060UK000	ACGA00Q120UK000
		0.188	(4.8)	ACHA00Q060UK000	ACHA00Q120UK000
		0.250	(6.4)	ACJA00Q060UK000	ACJA00Q120UK000

Custom Ordering Information—Items in **Bolded Green Type** are preferred with shorter lead times.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
A	C				0							0	0	

3. Sheath O.D. (inch)
D = 0.040 **H = 0.188**
E = 0.063 **J = 0.250**
G = 0.125

4. Connector Type
Standard Plugs and Jacks 218°C (425°F)
A = Standard plug
B = Standard jack
C = Standard plug with mating connector

High Temperature Plugs and Jacks 540°C (1000°F)
(0.250 inch maximum O.D.)
L = High temperature plug
M = High temperature jack
N = High temperature plug with mating connector

5. Fittings, Weld Pads
If required, enter order code from pages 39-40.
If none, enter **"0".**

6. Enter "0"

7. Sheath Material
A = 304 SS **Q = Alloy 600 (Type K)**
F = 316 SS
C = PFA coated over SS (available on G, H, J diameters)

8-9. Sheath Length "L" (whole inches)
04, 06, 12, 18, 24
Available lengths: 01 to 99, over 99 consult factory
Maximum length for PFA coating is 48 inches.

10. Sheath Length "L" (fractional inch)
0 = 0 2 = ¼ 4 = ½ 6 = ¾
1 = ⅛ 3 = ⅜ 5 = ⅝ 7= ⅞

11. Junction

	Grounded	Ungrounded	Exposed
Single	**G**	**U**	E
Dual	H	W (isolated)	D (isolated)

12. Calibration

	E	J	K	N	T
Standard limits	E	**J**	**K**	N	**T**
Special limits	2	3	4	—	8

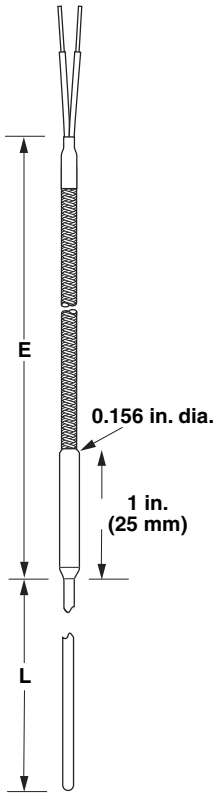
13-14. Enter "00"

15. Special Requirements
0 = None
X = Special requirements, consult factory

Thermocouples

Mneral Insulated

Miniature Transitions
Style AQ



Note: 149°C (300°F) potting standard.

Rapid Ship Sensors

Rapid Ship sensors come with three feet FEP insulated flexible extension, split lead termination, ungrounded junction. See page 166 to order additional connector hardware.

Calibration	Sheath Material	Sheath Diameter in.	(mm)	Sheath Length in. (mm) 3 (76)	6 (152)
J	316 SS	0.040	(1.0)	AQDC0TF030UJ030	AQDC0TF060UJ030
		0.063	(1.6)	AQEC0TF030UJ030	AQEC0TF060UJ030
K	Alloy 600	0.040	(1.0)	AQDC0TQ030UK030	AQDC0TQ060UK030
		0.063	(0.9)	AQEC0TQ030UK030	AQEC0TQ060UK030

Custom Ordering Information—Items in **Bolded Green Type** are preferred with shorter lead times.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
A	Q			0										

2. Style
Q = Miniature metal transition with 149°C (300°F) potting

3. Sheath O.D. (inch)
B = 0.020 **D = 0.040**
C = 0.032 **E = 0.063**

4. Lead Wire Construction

		Standard
Fiberglass	Solid	A
FEP	Solid	**C**

5. Enter "0"

6. Lead Wire Termination
A = Standard male plug
B = Standard female jack
C = Standard plug with mating connector
F = Miniature male plug
G = Miniature female jack
H = Miniature plug with mating connector
T = Standard, 1 ½ inch split leads
U = 1 ½ inch split leads with spade lugs

7. Sheath Material
A = 304 SS
F = 316 SS
Q = Alloy 600 (Type K)

8-9. Sheath Length "L" (whole inches)
03, 06, 12
Available lengths: 01 to 99, over 99 consult factory

10. Sheath Length "L" (fractional inch)
0 = 0 3 = ⅜ 6 = ¾
1 = ⅛ 4 = ½ 7= ⅞
2 = ¼ 5 = ⅝

11. Junction

	Grounded	Ungrounded
Single	**G**	**U**

12. Calibration

	J	K
Standard limits	**J**	**K**
Special limits	3	4

13-14. Lead Wire Length "E" (whole feet)
03, 06
Available lengths: 01 to 30

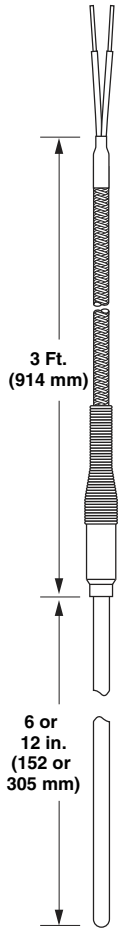
15. Special Requirements
0 = None
M = 260°C (500°F) potting
X = Special requirements, consult factory

Thermocouples

Mineral Insulated

Metal Transitions with Spring Strain Relief

Styles AF



Rapid Ship Sensors

Rapid Ship sensors come with three feet of stranded conductor FEP insulated flexible lead, split lead termination, ungrounded junction, 149°C (300°F) potting. See page 166 to order additional connector hardware.

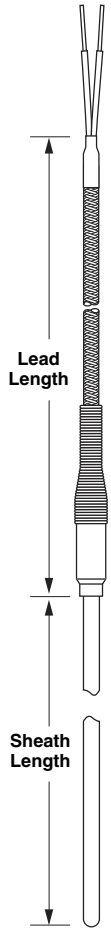
Calibration	Sheath Material	Sheath Diameter in.	(mm)	Sheath Length in. (mm) 6 (152)	12 (305)
J	316 SS	0.063	(1.6)	AFED0TF060UJ030	AFED0TF120UJ030
		0.125	(3.2)	AFGD0TF060UJ030	AFGD0TF120UJ030
		0.188	(4.8)	AFHD0TF060UJ030	AFHD0TF120UJ030
		0.250	(6.4)	AFJD0TF060UJ030	AFJD0TF120UJ030
K	Alloy 600	0.063	(1.6)	AFED0TQ060UK030	AFED0TQ120UK030
		0.125	(3.2)	AFGD0TQ060UK030	AFGD0TQ120UK030
		0.188	(4.8)	AFHD0TQ060UK030	AFHD0TQ120UK030
		0.250	(6.4)	AFJD0TQ060UK030	AFJD0TQ120UK030

See next page for custom ordering information.

Thermocouples

Mneral Insulated

Metal Transitions with Spring Strain Relief
Styles AF (Con't)



①Stranded lead wire available only for sheath O.D. 0.063 to 0.500 inch.

②1000°F potting not recommended with FEP insulated wire.

Note: 149°C (300°F) potting standard

Custom Ordering Information—Items in **Bolded Green Type** are preferred with shorter lead times.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
A	F													

2. Style

F = Metal transition with strain relief and 149°C (300°F) potting

3. Sheath O.D. (inch)

A = 0.010 **E = 0.063**
B = 0.020 **G = 0.125**
C = 0.032 **H = 0.188**
D = 0.040 **J = 0.250**

4. Lead Wire Construction

		Stan-dard	Over-braid	Flex Armor
Fiberglass	Solid	A	J	R
FEP	Solid	C	L	T
Fiberglass	Stranded①	**B**	**K**	S
FEP	Stranded①	**D**	M	U

5. Fittings, Weld Pads

If required, enter order code from pages 39-40.
If none, enter **"0"**.

6. Lead Wire Termination

A = Standard male plug
B = Standard female jack
C = Standard plug with mating connector
F = Miniature male plug
G = Miniature female jack
H = Miniature plug with mating connector
T = Standard, 1 ½ inch split leads
U = 1 ½ inch split leads with spade lugs
W = 1 ½ inch split leads with BX connector and spade lugs

7. Sheath Material

A = 304 SS **Q = Alloy 600 (Type K)**
F = 316 SS
C = PFA coated over SS (available on G, H and J diameter)

8-9. Sheath Length "L" (whole inches)

03, 06, 12, 18, 24
Available lengths: 01 to 99, over 99 consult factory
Maximum length for PFA coating is 48 inches.

10. Sheath Length "L" (fractional inch)

0 = 0 1 = ⅛ 2 = ¼ 3 = ⅜ 4 = ½ 5 = ⅝ 6 = ¾ 7 = ⅞

11. Junction

	Grounded	Ungrounded	Exposed
Single	**G**	**U**	E
Dual	H	W (isolated)	D (isolated)

12. Calibration

	E	J	K	N	T
Standard limits	E	**J**	**K**	N	**T**
Special limits	2	3	4	—	8

13-14. Lead Wire Length "E" (whole feet)

03, 04, 06, 08, 10
Available lengths: 01 to 30, over 30 consult factory

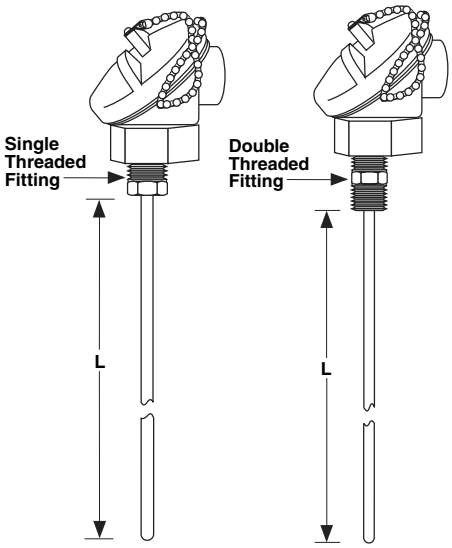
15. Special Requirements

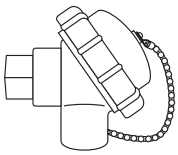
0 = None
H = High temperature 538°C (1000°F) potting
M = 260°C (500°F) potting
X = Special requirements, consult factory

Thermocouples

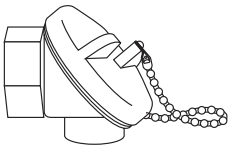
Mneral Insulated

Connection Head
Style AR

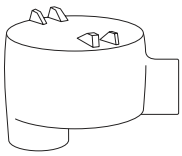




Type C (Polypropylene)



Type D (Small Cast Iron) or
E (Small Aluminum)



Type H (Explosion Proof)

Rapid Ship Sensors

Rapid Ship sensors come double threaded ½ inch NPT mounting fitting, ungrounded junction, 0.250 inch sheath diameter and small aluminum (E) connection head.

Calibration	Sheath Material	Sheath Length in. (mm)		
		6 (152)	12 (305)	18 (457)
J	316 SS	ARJEF0F060UJ000	ARJEF0F120UJ000	ARJEF0F180UJ000
K	Alloy 600	ARJEF0Q060UK000	ARJEF0Q120UK000	ARJEF0Q180UK000

Custom Ordering Information—Items in **Bolded Green Type** are preferred with shorter lead times.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
A	R				0							0	0	

3. Sheath O.D. (inch)
E = 0.063 **J = 0.250**
G = 0.125 L = 0.375
H = 0.188 M = 0.500

4. Connection Head
C = Polypropylene
D = Small cast iron
E = Small aluminum
H = Explosion proof

5. Head Mounting Fittings
0 = Single threaded 303 SS
F = Double threaded 303 SS ½" NPT
*H = Spring loaded double threaded 316 SS ½" NPT

6. Enter "0"

7. Sheath Material
A = 304 SS
F = 316 SS
Q = Alloy 600 (Type K)

8-9. Sheath Length "L" (whole inches)
03, 06, 12, 18, 24
Available lengths: 01 to 99, over 99 consult factory

10. Sheath Length "L" (fractional inch)
0 = 0 2 = ¼ 4 = ½ 6 = ¾
1 = ⅛ 3 = ⅜ 5 = ⅝ 7= ⅞

11. Junction

	Grounded	Ungrounded	Exposed
Single	**G**	**U**	E
Dual	H	W (isolated)	D (isolated)

12. Calibration

	E	J	K	N	T
Standard limits	E	**J**	**K**	N	T
Special limits	2	3	4	—	8

13-14. Enter "00"

15. Special Requirements
0 = None
X = Special requirements, consult factory

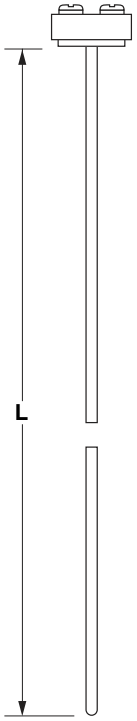
*0.250 inch diameter only.

Metric sizes available for made-to-order units. Consult factory.

Thermocouples

Mneral Insulated

Wafer Head
Style AS



The Style AS thermocouple features a “wafer” head, which allows quick access to terminal screws for wiring. This thermocouple is an economical choice because the termination is attached directly to the XACTPAK sheath.

Performance Capabilities

Cold end termination temperature rating up to 540°C (1000°F).

Features

Termination directly to sheath

- Allows quick hookup and disassembly

Terminal head

- Available in a wide range of materials in both single and dual configurations

Custom Ordering Information—Items in **Bolded Green Type** are preferred with shorter lead times.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
A	S		C		0							0	0	

3. Sheath O.D. (inch)
G = 0.125 **J = 0.250**
H = 0.188

4. Cold End Termination
C = Ceramic 540°C (1000°F)
1 ⅛ inch diameter x ⅝ inch thick

5. Fittings, Weld Pads
If required, enter order code from pages 39-40. If none, enter **“0”**.

6. Enter “0”

7. Sheath Material
A = 304 SS F = 316 SS
Q = Alloy 600 (Type K)

8-9. Sheath Length “L” (whole inches)
04, 06, 12, 18, 24
Available lengths: 01 to 99, over 99 consult factory

10. Sheath Length “L” (fractional inch)
0 = 0 3 = ⅜ 6 = ¾
1 = ⅛ 4 = ½ 7= ⅞
2 = ¼ 5 = ⅝

11. Junction

	Grounded	Ungrounded	Exposed
Single	**G**	**U**	E
Dual	H	W (isolated)	D (isolated)

12. Calibration

	E	J	K	N	T
Standard limits	E	**J**	**K**	N	T
Special limits	2	3	4	—	8

13-14. Enter “00”

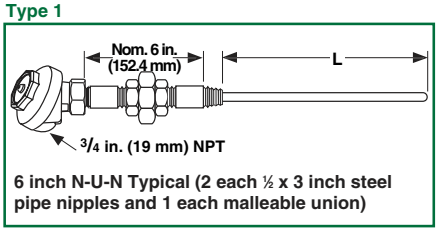
15. Special Requirements
0 = None
X = Special requirements, consult factory

Thermocouples

Mneral Insulated

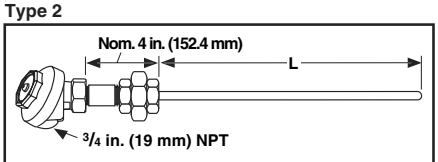
For Use With Thermowells
Style AT

Type 1



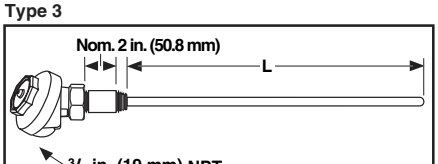
6 inch N-U-N Typical (2 each ½ x 3 inch steel pipe nipples and 1 each malleable union)

Type 2



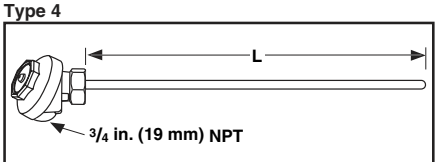
4 inch N-U typical (1 each ½ x 3 inch steel pipe nipple and 1 each malleable union)

Type 3



½ X 3 inch long steel pipe nipple typical

Type 4



Note: For a complete sensor, add thermowell part number to the 15-digit AT part number. For sheath length use "AR" (as required) and factory will determine correct length.
See thermowell section, pages 144 to 146.

See the hardware section, pages 156 to 157, for a complete description of Watlow connection heads.

Custom Ordering Information—Items in **Bolded Green Type** are preferred with shorter lead times.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
A	T	J			0							0		

3. Sheath O.D. (inch)
J = 0.250

4. Connection Head
C = Polypropylene (½ inch NPT thermocouple opening only)
D = Small cast iron
E = Small aluminum
H = Explosion proof (½ inch NPT and ¾ inch NPT thermocouple opening only)

5. Cold End Configuration
1 = Type 1, six inch nipple-union-nipple
2 = Type 2, four inch nipple-union
3 = Type 3, three inch nipple
4 = Type 4, no extensions
Note: Steel nipple and unions are standard.

6. Enter "0"

7. Sheath Material
A = 304 SS
F = 316 SS
Q = Alloy 600 (Type K)

8-9. Sheath Length "L" (whole inch)
Available lengths: 01 to 99, over 99 consult factory

10. Sheath Length "L" (fractional inch)
0 = Not required, complete assembly
1 = ⅛ 3 = ⅜ 5 = ⅝ 7 = ⅞
2 = ¼ 4 = ½ 6 = ¾

11. Junction

	Grounded	Ungrounded
Single	**G**	**U**
Dual, isolated	—	W

12. Calibration

	E	J	K	N	T
Standard limits	E	**J**	**K**	N	T
Special limits	2	3	4	—	8

13. Enter "0"

14. Spring-Loading
Y = Yes
N = No

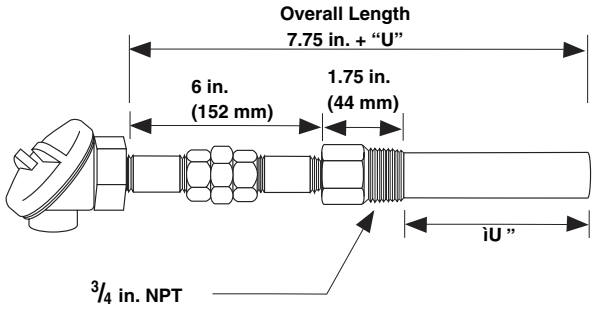
15. Special Requirements
0 = None
X = Special requirements, consult factory

Thermocouples

Mneral Insulated

Style AT With Thermowells

Straight Well

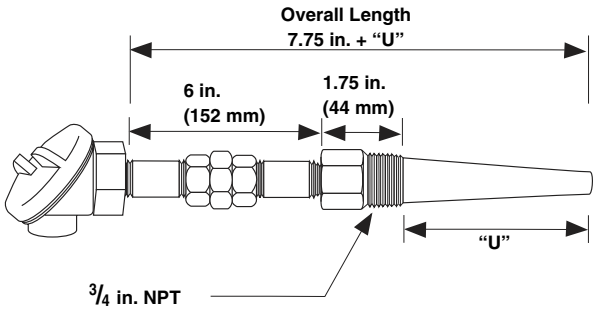


Rapid Ship Sensors

Rapid Ship sensors come with 316 SS straight well, nipple-union-nipple, 0.250 inch diameter spring loaded element, small aluminum connection head and ungrounded junction.

Calibration	“U” in.	“U” (mm)	Overall Length in.	Overall Length (mm)	Part Number
J	2.5	(64)	10.25	261	ATJE1SF024UJ0Y0
	4.5	(114)	12.25	312	ATJE1SF044UJ0Y0
	7.5	(191)	15.25	388	ATJE1SF074UJ0Y0
	10.5	(267)	18.25	465	ATJE1SF104UJ0Y0
K	2.5	(64)	10.25	261	ATJE1SF024UK0Y0
	4.5	(114)	12.25	312	ATJE1SF044UK0Y0
	7.5	(191)	15.25	388	ATJE1SF074UK0Y0
	10.5	(267)	18.25	465	ATJE1SF104UK0Y0

Tapered Well



Rapid Ship Sensors

Rapid Ship sensors come with 316 SS tapered well, nipple-union-nipple, 0.250 inch diameter spring loaded element, small aluminum connection head and ungrounded junction.

Calibration	“U” in.	“U” (mm)	Overall Length in.	Overall Length (mm)	Part Number
J	2.5	(64)	10.25	261	ATJE1TF024UJ0Y0
	4.5	(114)	12.25	312	ATJE1TF044UJ0Y0
	7.5	(191)	15.25	388	ATJE1TF074UJ0Y0
	10. 5	(267)	18.25	465	ATJE1TF104UJ0Y0
K	2.5	(64)	10.25	261	ATJE1TF024UK0Y0
	4.5	(114)	12.25	312	ATJE1TF044UK0Y0
	7.5	(191)	15.25	388	ATJE1TF074UK0Y0
	10.5	(267)	18.25	465	ATJE1TF104UK0Y0

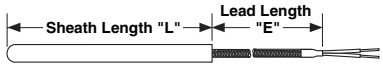
Thermocouples

High Vibration

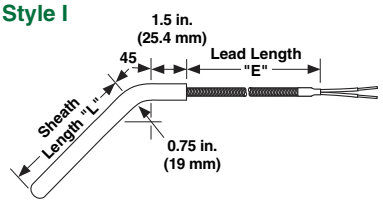
Styles H, I and J

Watlow's patented high vibration thermocouples are a totally new approach to producing vibration and moisture resistant temperature sensors. These qualities make them ideally suited for diesel and turbine exhaust gas temperature sensing, marine applications, laboratory furnaces and R & D test stands and chemical processing.
The patented continuous, homogenous thermoelement design, with high temperature compacted MgO insulation, ensures long life where severe vibration and shock are present at elevated temperatures.
Highly adaptable to confined areas, the vibration tolerant thermocouple's integrally mounted hermetic seal prevents moisture infiltration while "spliceless" construction eliminates calibration errors normally caused by non-uniformity in other construction styles.

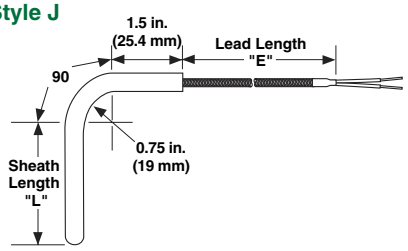
Style H



Style I



Style J



Custom Ordering Information—Items in **Bolded Green Type** are preferred with shorter lead times.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
C		J		0		Q					K			

2. Style
H = Straight J = 90° angle
I = 45° angle

3. Sheath O.D. (inch)
J = 0.250

4. Lead Wire Construction
M = Stranded conductor PFA insulation with stainless steel overbraid

5. Fittings
0 = None available

6. Terminations
For reference, see terminations chart on page 38.
A = Standard plug
B = Standard jack
C = Standard plug with mating connector
T = Standard—1 ½ inch split leads

7. Sheath Material
Q = Alloy 600

8-9. Sheath Length "L" (inch)
Whole inches: 02 to 15

10. Sheath Length "L" (fractional inch)
0 = 0 2 = ¼ 4 = ½ 6 = ¾
1 = ⅛ 3 = ⅜ 5 = ⅝ 7 = ⅞

11. Junction

	Ungrounded	Grounded
Single	U	G

12. Calibration
Standard limits K

13-14. Lead Wire Length "E" (feet)
Whole feet: 01 to 05 (01 foot standard)

15. Special Requirements
0 = None
X = Special requirements, consult factory

Thermocouples

Industrial Base/ Noble Metal

Watlow offers two basic types of base metal thermocouples: bare and ceramic insulated elements and thermocouples with protection tubes. Many variations of each type are available to meet your application needs.

Performance Capabilities

- 1260°C (2300°F) maximum temperature

Features and Benefits

Insulated wire thermocouples

- Suitable for most general purpose applications

Bare and ceramic insulated elements

- Available in ASTM E 230 Types K and J, can be twisted or butt welded
- Choices include straight or angle types, two-or four-hole insulators and single or dual element

Protected thermocouples

- Supplied complete with head, block and protection tube
- Several styles available

Applications

- Metal processing such as aluminum, zinc, brass (with appropriate protection tube)
- Chemical
- Petrochemical
- Industrial storage tanks

Thermocouples

Base Metal

Rapid Ship Sensors

Rapid Ship Type K calibration, standard limits, 8 AWG gauge with two-hole ceramic insulators, twisted and welded junction.

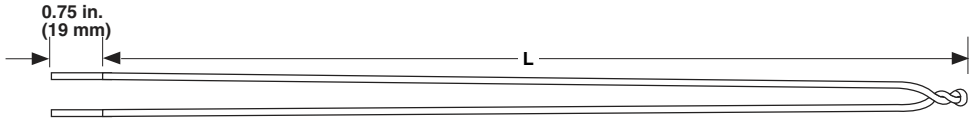
Lead Length in. (mm)	Part Number
12 (305)	1409-12
18 (457)	1409-18
24 (610)	1409-24
36 (914)	1409-36
48 (1219)	1409-48

Bare Elements

To order, specify:

Part number-length.

Example: 1402-36 or 1432-BW-24



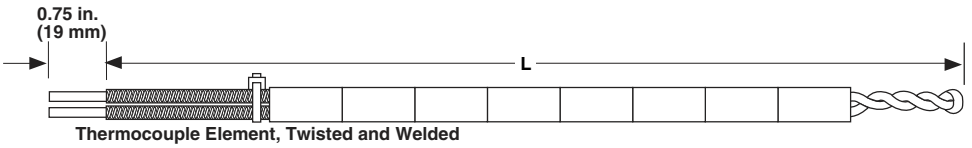
Bare Thermocouple Element, Twisted and Welded

Straight Elements with Two-Hole Insulators

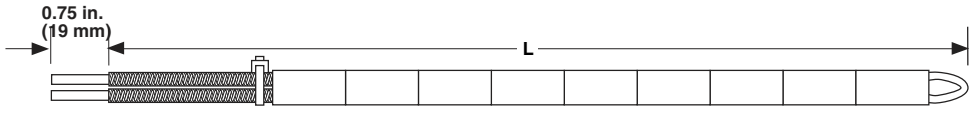
To order, specify:

Part number-length.

Example: 1409-48 or 1436-BW-18



Thermocouple Element, Twisted and Welded



Thermocouple Element, Butt Welded

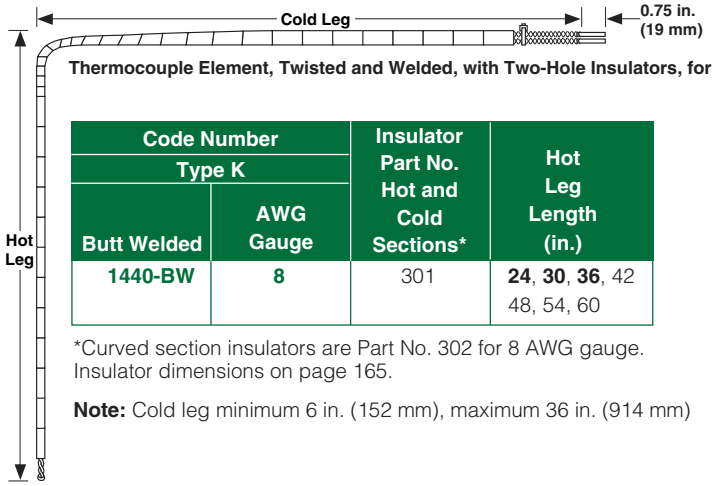
Code Number				AWG Gauge	Insulator Part No.	Length (in.)
Type K		Type J				
Twisted and Welded	Butt Welded	Twisted and Welded	Butt Welded			
1402	**1432-BW**	—	—	**8**	BARE	12, 18,
1403	1433-BW	—	—	11	BARE	24, 30,
1404	1434-BW	1503	1576-BW	14	BARE	36, 42,
1409	**1436-BW**	1507	1578-BW	**8**	301	48, 54,
1410	1437-BW	—	—	11	304	60, 66,
1411	1438-BW	1509	1579-BW	14	304	72
1412	1439-BW	1510	1580-BW	20	328	

Angle Type with Two-Hole Insulators

To order, specify:

Part number-cold leg length-hot leg length.

Example: 1440-BW-12-24



Thermocouple Element, Twisted and Welded, with Two-Hole Insulators, for Angle Assembly.

Code Number		Insulator Part No. Hot and Cold Sections*	Hot Leg Length (in.)
Type K			
Butt Welded	AWG Gauge		
1440-BW	**8**	301	**24**, **30**, **36**, 42 48, 54, 60

*Curved section insulators are Part No. 302 for 8 AWG gauge. Insulator dimensions on page 165.

Note: Cold leg minimum 6 in. (152 mm), maximum 36 in. (914 mm)

Note: Items in **Bolded Green Type** are preferred with shorter lead times.

Thermocouples

Base Metal

Rapid Ship Sensors

Rapid Ship dual Type K calibration, standard limits, 14 AWG gauge with four-hole ceramic insulators and butt-welded junction.

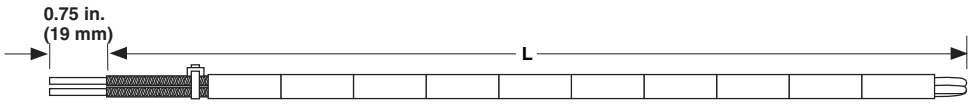
Lead Length in.	(mm)	Part Number	Insulator Part No.
12	(305)	1442-BW-12	360
18	(457)	1442-BW-18	360
24	(610)	1442-BW-24	360

Dual Element with Four-Hole Insulators

To order, specify:

Part number-length.

Example: 1442-BW-36



Thermocouple Element, Butt Welded

Code Number (Butt Welded Only)		AWG Gauge	Insulator Part No.	Length
Type K	Type J			
1442-BW	1584-BW	**14**	360	12, 18, 24, 30, 36, 42, 48,
1443-BW	1585-BW	20	378	54, 60, 66, 72 Inches

Immersion Tips

SERV-RITE immersion tips are superior thermocouples for nonferrous molten metals. The hot junction is forged into the 446 stainless steel sheath for maximum sensitivity. Available in Type K calibration only.

To order, specify:

Part number-tip length-lance length.

Example: 1449-501-T-8-43
1449-M-12-43

Length of Tip in.	(mm)	Length of Leads in.	(mm)	Part Number
8	(203)	31	(787)	**1449-501-T-8-31**
		43	(1092)	1449-501-T-8-43
		55	(1397)	1449-501-T-8-55
12	(305)	31	(787)	**1449-M-12-31**
		43	(1092)	1449-M-12-43
		55	(1397)	1449-M-12-55
15	(381)	31	(787)	**1449-M-15-31**
		43	(1092)	**1449-M-15-43**
		55	(1397)	1449-M-15-55
20	(508)	31	(787)	1449-M-20-31
		43	(1092)	1449-M-20-43
		55	(1397)	1449-M-20-55

Note: Items in **Bolded Green Type** are preferred with shorter lead times.

Thermocouples

Base Metal

Standard Thermocouple with Protection

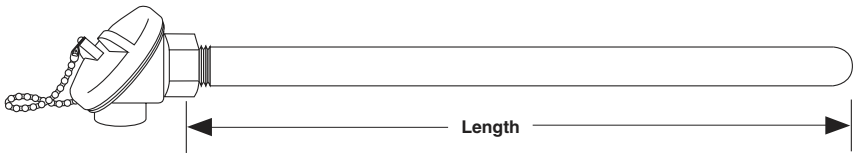
Straight Type

To order, specify:

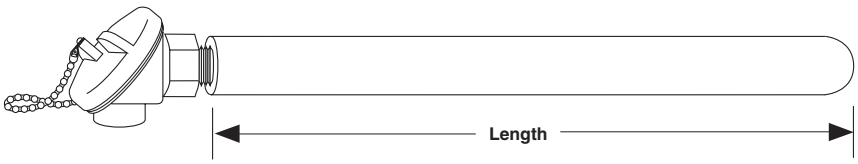
Part number-length.

Example: 1409-1308-24

Metal Tube



Cast Iron Tube



Code Number		AWG	Protection Tube		Pipe			
Type K	Type J	Gauge	Material	NPT Size in.	Diameter in.	Construction	Cast Iron Head	Length in.
1409-1395	1507-1395	**8**	**Alloy 601**	½	**0.840**	**Seamless**	**70900203**	
1409-1396	1507-1396	8	Alloy 601	¾	1.050	Seamless	70900202	
1409-1341	1507-1341	**8**	**304 SS**	½	**0.840**	**Welded**	**70900203**	
1409-1342	1507-1342	8	304 SS	¾	1.050	Welded	70900202	12, 18, 24, 30,
1409-1307	1507-1307	**8**	**446 SS**	½	**0.840**	**Seamless**	**70900203**	36, 42, 48, 54,
1409-1308	1507-1308	8	446 SS	¾	1.050	Seamless	70900202	60
1409-1309	1507-1309	8	446 SS	1	1.315	Seamless	70900201	
1409-1375	1507-1375	8	Cast Iron	¾ int	1.625	Cast	70900202	

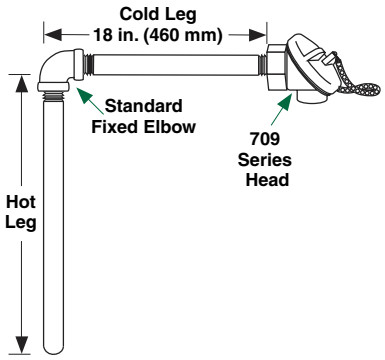
Note: Items in **Bolded Green Type** are preferred with shorter lead times.

Thermocouples

Base Metal

Standard Thermocouple with Protection

90 Degree Angle Type



To order, specify:

Part number-cold leg length hot leg length.

Example: 1414-1395-18-24

Standard Thermocouple with Protection — 90 Degree Angle

Code Number		AWG Gauge	Protection Tube (Hot Leg)			Cast Iron Head	Hot Leg Length in.
Type K	Type J		Material	NPT Size in.	Construction		
1414-1307-18	1517-1307-18	**8**	**446 SS**	**½**	**Seamless**	**70900203**	
1414-1328-18	1517-1328-18	**8**	**Black Steel**	**1**	**Welded**	**70900201**	
1414-1375-18	1517-1375-18	8	Cast Iron	¾ int	Cast	70900202	12, 18,
1414-1395-18	1517-1395-18	**8**	**Alloy 601**	**½**	**Seamless**	**70900203**	24, 30,
1415-1307-18	1518-1307-18	14	446 SS	½	Seamless	70900203	36
1415-1326-18	1518-1326-18	14	Black Steel	½	Welded	70900203	
1415-1328-18	1518-1328-18	14	Black Steel	1	Welded	70900201	
1415-1375-18	1518-1375-18	14	Cast Iron	¾ int	Cast	70900202	
1415-1395-18	1518-1395-18	14	Alloy 601	½	Seamless	70900203	

Pipe Diameters

Cast iron = 1 ⅝ inch

½ in. NPT = 0.840 inch

¾ in. NPT = 1.050 inch

1 in. NPT = 1.315 inch

Notes: Items in **Bolded Green Type** are preferred with shorter lead times.

Standard cold leg is 18 inches.

Thermocouples

Noble Metal

Watlow's noble metal thermocouples offer the advantages of handling higher temperatures and providing greater accuracy than base metal thermocouples. Depending on your temperature and tolerance requirements choose from ASTM E 230 Types S, R or B.

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

Performance Capabilities

- Platinum assemblies can handle temperatures to 1700°C (3100°F)

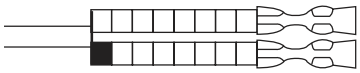
Applications

- Heat treating and control sensors
- Semiconductor: CVD processing, control spikes
- Glass manufacturing
- Ferrous and non-ferrous metals

Type S, R, or B
24 AWG

To order, specify:

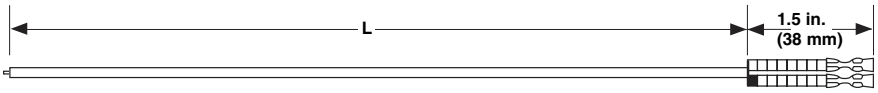
Part number-calibration-length.
Example: 2114-R-24-MC



Enlarged picture of copper sleeves

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

① Insulation consists of a one-piece two-hole alumina (0.125 diameter) insulator. For lengths over 24 in. (610 mm), a single piece alumina 3⁄16 inch diameter insulator is used.



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

Calibration	Length in.	Part Number Bare T/C	Part Number T/C With Alumina Insulator①
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

Thermocouples

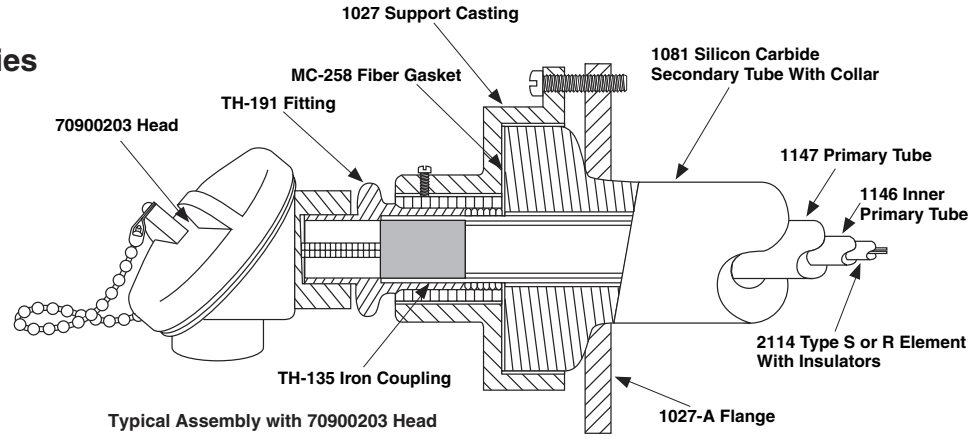
Noble Metal

Thermocouple Assemblies

To order, specify:

Part no.-calibration-length of tube.

Examples: 2144-S-12
2147-R-36

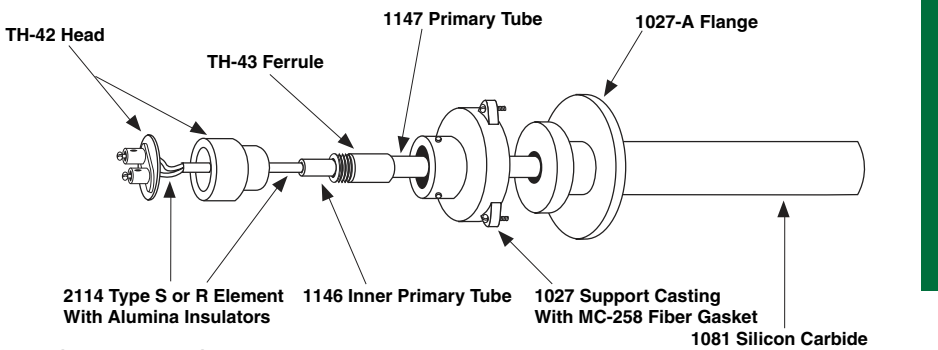


Typical Assembly with 70900203 Head

70900203 Head* and Alumina Ceramics

Code No.*	Calibration	AWG Gauge	Protecting Tubes	Size I.D. x O.D. in.	Length in.
2144	B, R, S	24	1147 Alumina Primary only	7/16 x 11/16	12, 18, 24 30, 36, 42, 48
2145	B, R, S	24	1147 Primary 1146 Alumina Inner Primary	1/4 x 11/16	
2147	B, R, S	24	1147 Alumina Primary 1146 Alumina Inner Primary 1081 Secondary	1/4 x 1 3/4	

Examples: 2140-B-18
2141-R-24



Typical Assembly with TH-42 Head

TH-42 Head and Alumina Ceramics

Code No.*	Calibration	AWG Gauge	Protecting Tubes	Size I.D. X O.D. in.	Length in.
2140	B, R, S	24	1147 Alumina Primary only	7/16 x 11/16	12, 18, 24 30, 36, 42, 48
2141	B, R, S	24	1147 Alumina Primary 1146 Alumina Inner Primary	1/4 x 11/16	

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

Thermocouples

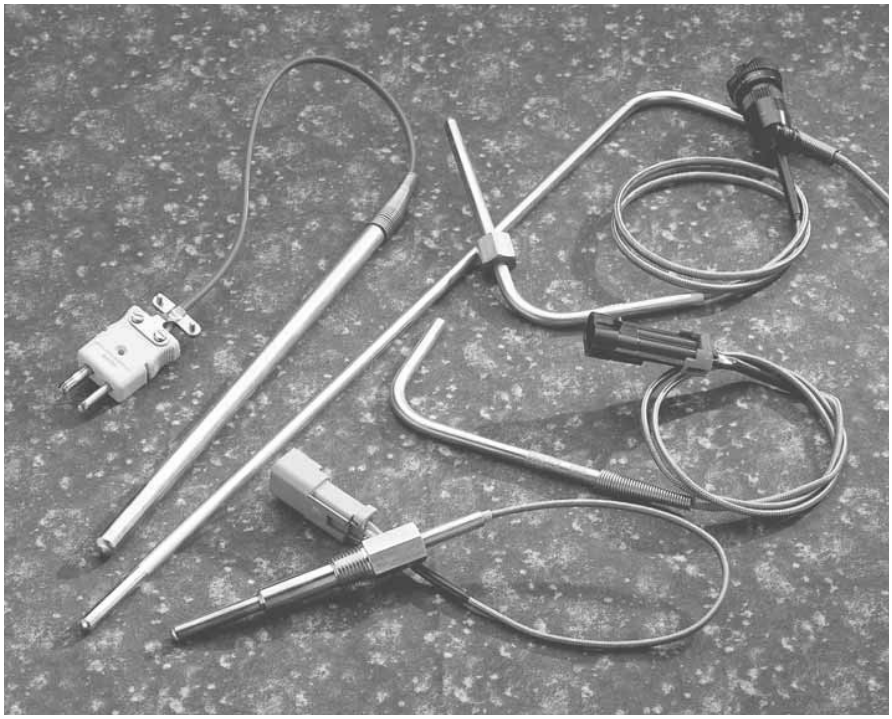
High Temperature

For Demanding Applications

Technological advances have created a demand for thermocouple materials with unusually high performance characteristics and superior quality. Watlow has kept pace with these demands. A long time leader in the field of temperature measurement, we have the modern facilities necessary to comply with today's complex specifications, standards and industrial or governmental regulatory requirements. We also provide testing and certification services to document compliance with agency standards. Our products are proof that we meet the challenge of reliability and high performance.

Performance Capabilities

- Compliance with recognized agency tolerances and specifications
- Temperature ranges up to 2315°C (4200°F)
- 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
- Meet specific application requirements

Insulation materials
- Meet demanding application temperatures

Grounded and ungrounded junctions
- Meet electrical configurations

Testing and certification services
- Ideal for demanding applications

Applications

- Semiconductor manufacturing
- Diesel engines
- Jet engines
- Laboratory research
- Nuclear environments
- Power stations and steam generators
- Rocket engines
- Turbines
- Vacuum furnaces
- Exhaust gas sensing

*Not ASTM symbols

Thermocouples

High Temperature

Materials Data

Exotic Metal Sheathed Thermocouples

The specification tables shown on the following pages outline 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 2315°C (4200°F); others can be used in unusually corrosive environments. Pressure, atmosphere and other process variables all affect service life and operating maximums.

Unless otherwise noted, the components listed in the tables can be combined into either compacted or uncompacted constructions.

Compacted constructions are manufactured by loading conductors and crushable ceramic insulators into the sheath. This subassembly is then drawn and/or swaged down to the required O.D., uniformly compacting the insulation around the conductors. Some combinations of materials that cannot be drawn or swaged are available only in uncompacted constructions.

Uncompacted constructions use 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. Consult factory for special pre-bent sensors.

Thermocouples

High Temperature

High Temperature Sheath Materials

Sheath Material	Approximate Melting Point	Maximum Recommended Temperature	Environment	Available Stock Constructions inch			
				0.063	0.125	0.188	0.250
Platinum-20% Rhodium (Pt-20% Rh)	1870°C (3400°F)	1650°C (3000°F)	Oxidizing, inert, vacuum	*	*	N/A	N/A
Molybdenum (Mo)	2620°C (4750°F)	1900°C (3450°F)	Inert, vacuum, reducing	N/A	LP	LP	LP
Tantalum (Ta)	2995°C (5425°F)	2400°C (4350°F)	Inert, vacuum	C	C	*	*
Titanium (Ti)	1725°C (3135°F)	Oxidizing 315°C (600°F)	Oxidizing to 315°C (600°F), inert, vacuum	N/A	*	*	*
Alloy 600	1345°C (2470°F)	1175°C (2150°F)	Inert, vacuum, reducing, oxidizing	N/A	LP	N/A	LP

C = Compacted LP = Loose pack NA = Not available *Available as a special.

Sheath Material	Remarks
Platinum-10% Rhodium (Pt-10% Rh)	Used primarily in oxidizing environments to 1550°C (2825°F). Applications include semiconductor manufacturing, research and gas turbine probes. Silicon, sulfur and carbon are contaminants of platinum and should be avoided.
Platinum-20% Rhodium (Pt-20% Rh)	Same uses as platinum-10% rhodium; except usable to 1650°C (3000°F) with increased high temperature strength.
Molybdenum (Mo)	Molybdenum is a refractory metal that is brittle and available in uncompacted styles only. Do not use in oxidizing environments above 400°C (750°F). Vacuum at <10(-2) torr to 1700°C (3100°F). Vacuum <10(-4) torr to 1870°C (3400°F). Stable in inert gases to 1900°C (3450°F). Avoid contamination with graphite, carbon and hydrocarbons.
Tantalum (Ta)	Refractory metal that is very ductile. Use only in inert atmospheres or very good vacuums. <10(-3) torr. Hydrogen and nitrogen will react with tantalum above 400°C (750°F) resulting in nitride and hydride formation that will affect life.
Titanium (Ti)	Lightweight, excellent strength in the 150 to 425°C (300 to 800°F) temperature range. Excellent resistance to oxidizing agents such as nitric or chromic acids. Resistant to inorganic chloride solutions, chlorinated organic compounds and moist chlorine gas. Resistant to salt water spray and sea water.
Alloy 600	Maximum temperature 1175°C (2150°F). 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

High Temperature Insulation Material

Insulation	Approximate Upper Useful Temperature	Approximate Melting Point	Remarks
Magnesium Oxide (MgO)	1370°C (2500°F)	2800°C (5070°F)	Used primarily with platinum sheathing in compacted constructions only.
Alumina Oxide (Al_2O_3)	1540°C (2800°F)	2015°C (3660°F)	Compacted constructions to 1540°C (2800°F). Uncompacted constructions with vitrified insulators to 1650°C (3000°F).
Hafnia Oxide (HfO_2)	4530°F (2500°C)	2760°C (5000°F)	Available in compacted and uncompacted constructions.

Insulation	Properties
Magnesium Oxide (MgO) (99.4% min. purity)	Low impurity levels make this insulation very useful for all thermocouple calibrations up to 1370°C (2500°F). Above 1370°C (2500°F) we recommend using beryllium oxide insulation because of MgO's low resistivity at these elevated temperatures. This material meets the requirements established in ASTM E 235.
Alumina Oxide (Al_2O_3) (99.6% min. purity)	Comparable electrical properties to MgO. Used primarily in loose pack constructions because of availability and low cost.
Hafnia Oxide (HfO_2)	Hafnia is replacing BeO in applications where BeO cannot be used because of safety concerns. Hafnia can be used up to 2500°C (4530°F).

Thermocouples

High Temperature

High Temperature Sensing Wire

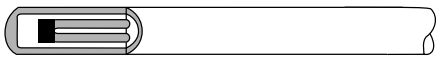
Conductors	ASTM Designation	Approx. Upper Useful Temperature	Melting Point	Remarks
Pt-10% Rh vs. Pt Pt-13% Rh vs. Pt	S R	1480°C (2700°F)	1760°C (3200°F)	Some decalibration at continued use over 1095°C (2000°F) due to rhodium volatilization. This effect is accelerated in compacted construction.
Pt-30% Rh vs. Pt-6% Rh	B	1700°C (3100°F)	1790°C (3250°F)	Less subject to decalibration by rhodium volatilization than Types S or R.
W-5% Re vs. W-26% Re	C*	2315°C (4200°F)	3095°C (5600°F)	Brittle; avoid flexing.

Calibration Type	Remarks
ASTM Type R	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 0 to 1480°C (32 to 2700°F). Type R is available in standard limits and special limits ITS-90 scale.
ASTM Type S	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 0 to 1480°C (32 to 2700°F). Type S has a lower EMF output than Type R and is available in standard limits and special limits ITS-90 scale.
ASTM Type B	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 870 to 1700°C (1600 to 3100°F). Type B is available in standard limits and special limits ITS-90 scale.
Type C*	Type C is composed of a positive leg (CP) which is approximately 95% tungsten, 5% rhenium and a negative leg (CN) which is approximately 74% tungsten, 26% rhenium. When protected by mineral insulation and appropriate outer sheath, Type C is usable from 0 to 2315°C (32 to 4200°F). Type C calibrations are used most often with hafnia oxide insulation and either molybdenum or tantalum sheath. These combinations can only be used in an inert or vacuum environment.

*Not an ASTM symbol

Basic Hot Or Measuring Junctions Available

Ungrounded Junction (U)

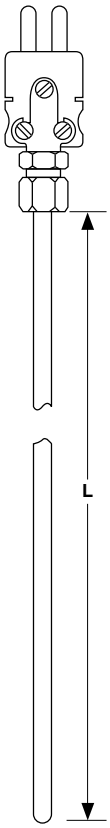


The thermocouple junction is fully insulated from welded sheath end. Excellent for electrical applications where stray EMFs and EMIs would affect the reading and for frequent or rapid temperature cycling.

Thermocouples

High Temperature

High Temperature Plug or Jack Termination



- Features noble or refractory metal sheaths
- ASTM Type R, S, B, W-5 percent Re/W-26 percent Re (Type C*) thermocouple calibrations
- High temperature insulations
- Compacted and loose pack assemblies
- Plug or jack cold end terminations

Ordering Information—To order, complete the part number on the right with the information below:

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
H	C			0								0	0	

3. Sheath O.D. (inch)
E = 0.063 H = 0.188
G = 0.125 J = 0.250

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

5. Enter "0"

6. Insulation

	MgO	Al_2O_3	HfO_2
** Compacted	1	2	4
Loose pack	—	B	D

7. Sheath Material
2 = Pt- 20% Rh 4 = Tantalum
3 = Molybdenum 5 = Titanium Q = Alloy 600

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

10. Sheath Length "L" (fractional inch)
0 = 0 2 = ¼ 4 = ½ 6 = ¾
1 = ⅛ 3 = ⅜ 5 = ⅝ 7 = ⅞

11. Junction

	Ungrounded
Single	U
Dual	Consult factory

12. Calibration

	B	R	S	C*
Std. limits	B	R	S	C
Spc. limits	Consult factory			

13-14. Enter "00"

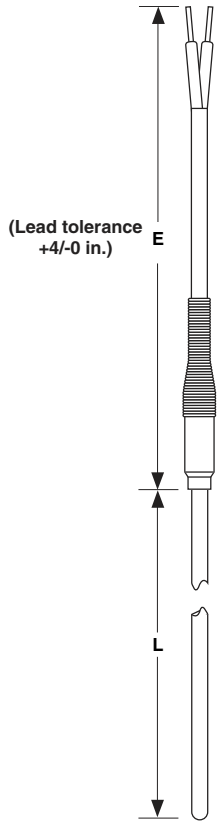
15. Special Requirements
If none, enter "0".
If required, consult factory

* Not an ASTM symbol.
**Not available with molybdenum sheath.

Thermocouples

High Temperature

High Temperature Metal Transitions



- Features noble or refractory metal sheaths
- ASTM Type R, S, B, W-5 percent Re/W-26 percent Re (Type C*) thermocouple calibrations
- High temperature insulations
- Compacted and loose pack assemblies
- Transition with lead wire termination
- Standard maximum continuous operating temperature of 260°C (500°F) for the transition.

Ordering Information—To order, complete the part number on the right with the information below:

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
H	F													

3. Sheath O.D. (inch)

E = 0.063 H = 0.188
G = 0.125 J = 0.250

4. Lead Wire Construction

		Standard	Overbraid
Fiberglass	Solid	**A**	**J**

5. Lead Wire Termination

A = Standard plug
B = Standard jack
C = Standard plug with mating connector
F = Miniature plug
G = Miniature jack
H = Miniature plug with mating connector
T = Standard—1 ½ inch split leads
U = 1 ½ inch split leads with spade lugs
W = 1 ½ inch split leads with BX connector and spade lugs

6. Insulation

	MgO	Al_2O_3	HfO_2
** Compacted	1	2	4
Loose pack	—	B	D

7. Sheath Material

2 = Pt 20% Rh 4 = Tantalum
3 = Molybdenum 5 = Titanium Q = Alloy 600

8-9. Sheath Length "L" (inch)

Whole inches: 01 to 60

10. Sheath Length "L" (fractional inch)

0 = 0 2 = ¼ 4 = ½ 6 = ¾
1 = ⅛ 3 = ⅜ 5 = ⅝ 7 = ⅞

11. Junction

	Ungrounded
Single =	U
Dual =	Consult factory

12. Calibration

	B	R	S	C*
Std. limits	B	R	S	C
Spc. limits	Consult factory			

13-14. Lead Wire Length "E" (feet)

Whole feet: 01 to 25
(01 foot standard)

15. Special Requirements

M = Standard 260°C (500°F) potting
If others required, consult factory

* Not an ASTM symbol, Consult factory for availability.
** Not available with molybdenum sheath.

Thermocouples

Surface Temperature Measurement

Watlow's MICROCOIL™, Radio Frequency Thermocouple Probe (TR), Tapered Thermocouple Probe and True Surface Thermocouple (TST) all incorporate isothermal physical principles to achieve superior surface temperature measurement. The isothermal design provides accurate sensing because the areas of the sensor that are exposed to normal process variances are positioned outside the thermal gradient.

These four sensor technologies are now available as standard products that can be ordered in a variety of options. Proven standard technologies will help to shorten design cycles on next generation tool and process technologies.

MICROCOIL™

MICROCOIL surface sensors are ideal for measuring chuck, internal wall, chip, heat sinks and circuit temperatures. The flexible probe design positions the sensor tip for optimal surface contact and isothermal response and accuracy.

Radio Frequency Thermocouple Probe (TR)

TR immersion sensors are designed to reduce transient 13.56 MHz signals from being transmitted on the sensor leads in plasma environments. This results in a more stable and accurate measurement of chuck temperature.

TRUE SURFACE Thermocouple (TST)

TST is a surface sensor designed to reduce error in atmospheric applications where air currents can cause instability in temperature accuracy. A winner of *Control Engineering's* 2000 Editor's Choice Award, the TST achieves superior accuracy through a combination of isothermal design and shielding.

Thermocouples

Surface Temperature Measurement

MICROCOIL™

Accurate, Repeatable, Fast Response in Perpendicular Surface Measurement

Watlow's MICROCOIL miniature thermocouple provides surface temperature measurements with an unparalleled degree of accuracy. This patented technology achieves critical isothermal surface temperature measurement and offers superior design flexibility. Typical sensor-to-sensor repeatability of one to two percent (DT) can be achieved with the MICROCOIL because the areas of the sensor that are vulnerable to normal production variances are not in the thermal gradient. Weld location, insulation thickness and welded tip thickness no longer impact measurement in an isothermal environment. Therefore, the inherent challenges of measuring surface temperatures are no longer a problem with the MICROCOIL.
The MICROCOIL thermocouple utilizes Watlow's XACTPAK® mineral insulated thermocouple cable, which with an ungrounded junction, will electrically isolate the sensor from the surface being measured. For higher voltage applications, the aluminum nitride sensor disc option can be used for additional protection.
The helix design of the MICROCOIL demonstrates a faster response time because the surface temperature needs to conduct only through the diameter of the cable and the thickness of the sensor disk.

The thermal analysis demonstrates the superior performance of the MICROCOIL technology. This patented method achieves the critical isothermal area for a long length of the very small cable, therefore insuring accurate and repeatable measurement. Standard straight sensors exhibit problems including poor accuracy response time and non-repeatable results as well as errors of 20, 30 percent or more.

Features and Benefits

Miniature size

- Allows for precision measurement in tight spaces

XACTPAK mineral insulated thermocouple cable

- Electronically isolated and shielded

700°C (1292°F) maximum continuous temperature

- Offers exact measurement for demanding applications

Self leveling and loading

- Provides superior repeatability of measurement for a wide variety of surfaces

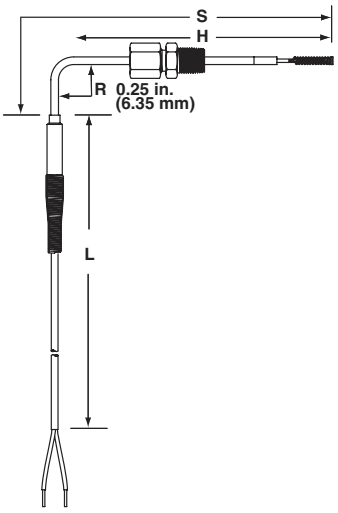
Applications

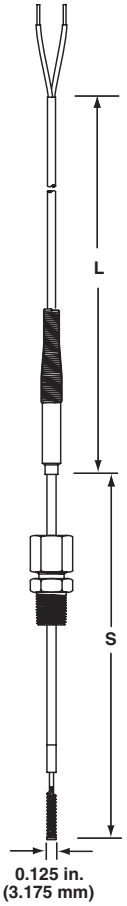
- Environmental chambers
- Chip cases
- Heat sinks
- Packaging
- Platens

Thermocouples

Surface Temperature Measurement

MICROCOIL™





150˚C standard surface calibration supplied.

Ordering Information—To order, complete the part number on the right with the information below:

1	2	3	4	5	6	7	8	9	10	11	12
M	C										

Type K Calibration
0.020 inch diameter Alloy 718 thermocouple sheath
0.125 inch coil diameter
12.5 oz approx. spring force for 0.050 inch compression

3. Temperature Rating
C = Copper tip 350°C (662°F) max
N = Aluminum nitride 700°C (1292°F) max

4. Junction Type
G = Grounded single junction
U = Ungrounded single junction

5-6. Sheath Length "S"
XX = 02 to 18 inch

7. Hot Leg Length "H", if 90˚ bend (inch)

0	=	n/a, straight sheath			
A	=	1.125	J	=	2.125
B	=	1.250	K	=	2.250
C	=	1.375	L	=	2.375
D	=	1.500	M	=	2.500
E	=	1.625	N	=	2.625
F	=	1.750	P	=	2.750
G	=	1.875	R	=	2.875
H	=	2.000	S	=	3.000

Notes: Bend radius is 0.25 inch
Cold leg length (1.0 inch minimum) = S - H - 0.4 inch
If a fitting is ordered, it will be installed hand tightened onto the hot leg
If a fitting is ordered, the minimum hot leg length "H" is 2.500 in.

8. Fitting, Optional
0 = None
C = Compression fitting, adjustable, ⅛ inch NPT, TFE gland

9. Lead Length Construction, solid conductors

1	=	24 Ga. Fiberglass	3	=	26 Ga. FEP with shield and ground not common to sheath
2	=	26 Ga. FEP with shield and drain not attached	4	=	26 Ga. FEP with shield and ground common to sheath
			5	=	24 Ga. FEP with stainless steel overbraid

10-11. Lead Length "L"
XX = 03 to 99 inch

12. Lead Wire Terminations
A* = Standard male plug
B* = Standard female jack
C* = Standard plug with mating connector
F = Miniature male plug
G = Miniature female jack
H = Miniature plug with mating connector
T = Standard, 1.5 inch split leads
U = 1.5 inch split leads with spade lugs

* Not available with lead wire construction options 3 and 4.

Thermocouples

Surface Temperature Measurement

Radio Frequency Thermocouple Probe (TR)

Watlow's TR thermocouple probe is designed for use in plasma generation. Radio frequency energy can cause serious temperature measurement errors through radiation or conduction. Traditional sensors are ineffective against the induced noise associated with such environments. The TR probe is ideal for reading temperatures through such interference.

The construction of the TR probe utilizes a unique combination of high performance materials. The sensor tip is made from high thermal conductivity materials, providing a quick response time. High dielectric insulation is used to electrically insulate the sensor from capacitive coupling. Additionally, the lead wires are twisted to improve common mode rejection and reduce induced EMI.

Options

- Type E, J or K calibration
- Drill point or flat tip designs
- 0.875 inch (22.23 mm) to 1.5 inch (38.10 mm) immersion depths
- 5/16 - 18 or M8 threaded fitting

Features and Benefits

3000V⎓(dc) dielectric rating

- Allows thermocouple to be used in platens with dc bias

High thermal conductivity design

- Ensures accurate, repeatable measurements

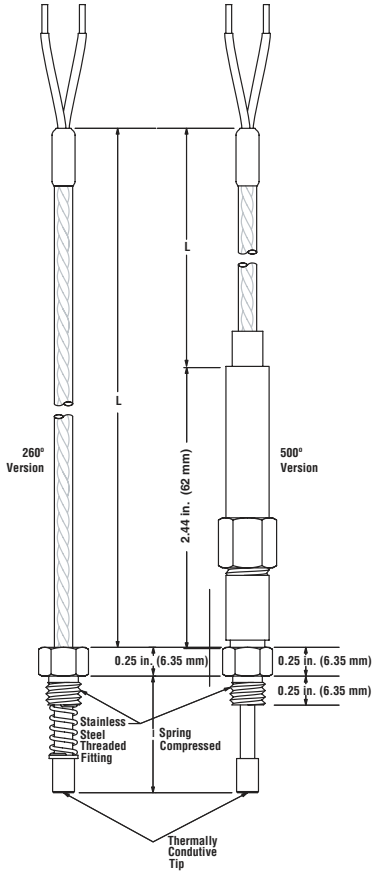
High CMMR lead wire design

- Reduces induced error from EMI

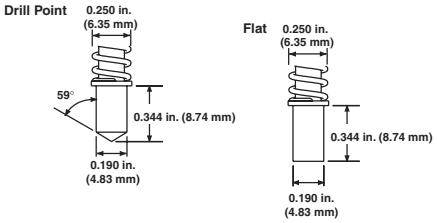
Thermocouples

Surface Temperature Measurement

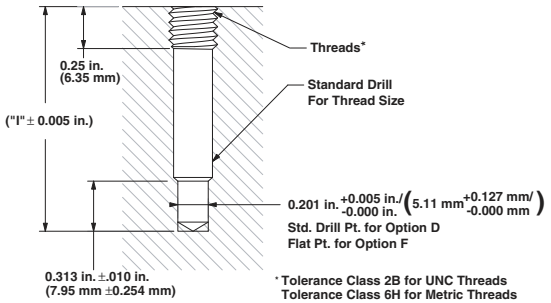
TR Thermocouple



Tip Shape



Platen Modification Detail



Ordering Information—To order, complete the part number on the right with the information below:

1	2	3	4	5	6	7	8	9	10	11	12
T	R										

TR Thermocouple

3. Maximum Temperature
- C = 260°C silver-plated copper tip
- N = 500°C aluminum nitride tip (AIN)

4. Tip Shape
- D = Drill point (260°C tip only)
- F = Flat

5-6. Immersion Depth "I" (inch)
(from tip to top of threads, spring compressed)
- 08 = 0.875
- 10 = 1.000
- 11 = 1.125
- 12 = 1.250
- 13 = 1.375
- 15 = 1.500

7. Threaded Fitting Size
- 5 = 5/16-18 UNC-2A
- 8 = M8 x 1.25-6g

8. Junction Type
- U = Ungrounded single

9. Calibration
- E = Special limits E (±1.0°C or ±0.4%)
- J = Special limits J (±1.1°C or ±0.4%)
- K = Special limits K (±1.1°C or ±0.4%)

10-11. Lead Length "L"
- XX = 01 to 96 inch

12. Lead Wire Terminations
- A = Standard male plug
- B = Standard female jack
- C = Standard plug with mating connector
- F = Miniature male plug
- G = Miniature female jack
- H = Miniature plug with mating connector
- T = Standard, 1.5 in. (38.10 mm) split leads
- U = 1.5 in. (38.10 mm) split leads with spade lugs

Thermocouples

Surface Temperature Measurement

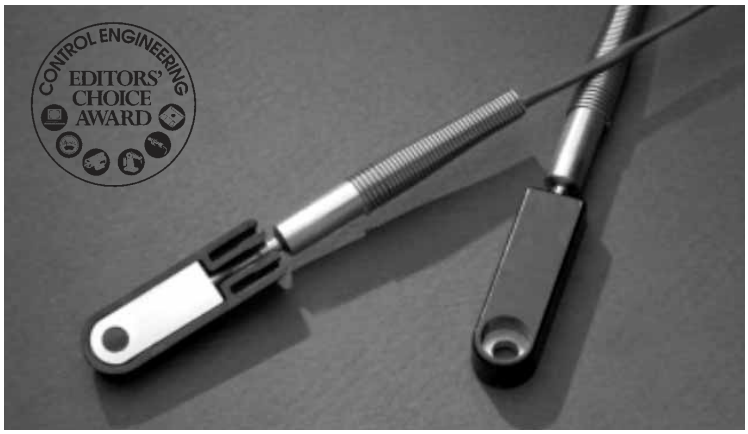
TRUE SURFACE Thermocouple (TST)

Increase Surface Temperature Accuracy with Improved Thermocouple Design

Watlow's award winning TST offers superior accuracy for measuring flat surface temperatures. This compact, highly accurate sensor isolates the thermocouple junction from ambient airflow. The TST typically achieves accuracy and repeatability of one to two percent (ΔT).
The TST, with its removable molded cover, fits into corners and other tight locations. TSTs are easy to install with a variety of commonly used screw types.
Watlow's TST sensor is ideal for many applications including semiconductor chambers, platens, packaging, cleaning and food preparation.

Options

- Dual, isolated thermocouples in the same sensor
- Ungrounded or grounded junction(s)
- Type J or K calibrations
- Shielded lead wire with drain, either isolated from or connected to the sensor sheath (availability limited with dual junctions)



Steady State Temperature Measurement Test

- **Purpose:** To determine and compare the steady state error of the Watlow TST and a common "washer"-style thermocouple at several temperature settings with and without ambient airflow.
- **Test Description:** Each sensor was attached to a brass hot plate and allowed to reach equilibrium before temperature readings were taken. Room temperature air was then blown onto the hot plate and the sensors. Temperature readings were taken after the system reached the new equilibrium point. The test was performed with a 20, 40, 60 and 80°C differential between the hot plate temperature and ambient.
- **Results:** Ambient temperature = 25°C.

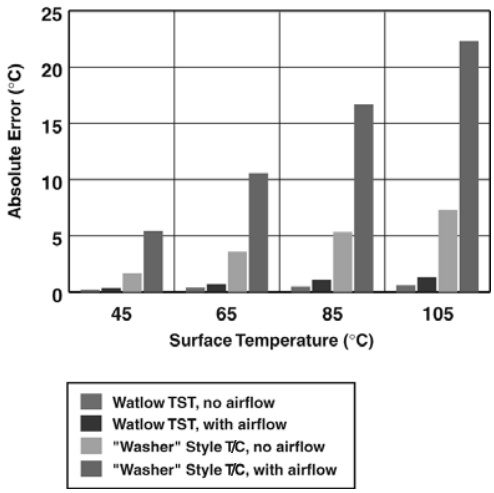
Features and Benefits

Isothermal measuring junction
- Offers excellent thermal conductivity for the measuring junction

Molded insulator
- Isolates the isothermal measuring block from ambient airflow

Compact, universal package
- Fits into corners and other tight locations easily (0.44 inch (11.88 mm) side by 0.24 inch (6.10 mm) high)
- Molded insulator is removable for applications where an even smaller package is needed

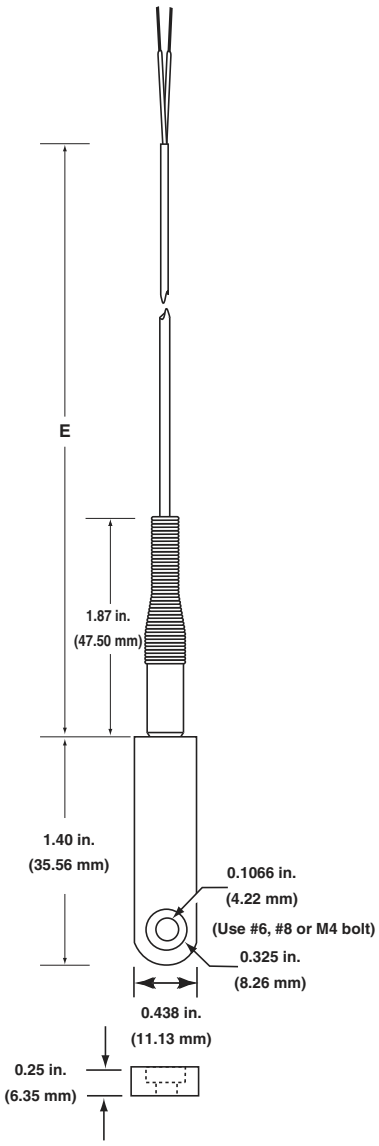
Temperature rating of 200°C (400°F)
- Offers superior application flexibility for a wide variety of surfaces



Thermocouples

Surface Temperature Measurement

TRUE SURFACE Thermocouple (TST)



Ordering Information—To order, complete the part number on the right with the information below:

1	2	3	4	5	6	7	8	9
T	S	T						

TRUE SURFACE Thermocouple

4. Lead Wire Construction

2 = FEP 26 gauge solid
3 = FEP 26 gauge solid with shield and ground, not continuous to sheath

5. Lead Wire Termination

A = Standard male plug
B = Standard female jack
C = Standard plug with mating connector
F = Miniature male plug
G = Miniature female jack
H = Miniature plug with mating connector
T = Standard, 1.5 inch (38.1 mm) split leads
U = 1.5 inch (38.1 mm) split leads with spade lugs

6. Junction

	Ungrounded	Grounded
Single	U	G
Dual (Type K only)	W	H

7. Calibration

	Type J	Type K
Std. limits	J	K
Spc. limits	3	4

8-9. Lead Length "E"

01 to 99 feet

Thermocouples

Multipoint Sensor

Temperature variances exist in all systems, regardless of materials, working fluid or system design. There is no process that involves heating a particular medium where temperature of that medium is the same throughout—temperature gradients will always exist. Sensing the temperature at just one location in a process is acceptable for many applications because temperature gradients are often insignificant. However, there is a need in many applications to monitor the temperature in multiple locations to ensure a safe, accurate and cost efficient process. Installing multiple independent, temperature sensors may be impractical due to cost or space limitations.

Multipoint temperature sensors are capable of accurately measuring temperatures at various locations along its length. They are used in a broad range of processes and installations—predominately applications involving a large or complex process where close temperature control is necessary.

Multipoint temperature sensors are designed to meet the requirements of the specific application; i.e., temperature, pressure, chemical environment, time response and number of points required. Sensors are constructed from a variety of protecting tube materials, with

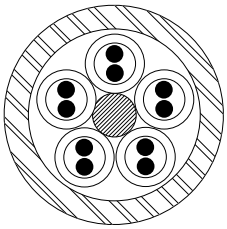
XACTPAK® mineral insulated, metal-sheathed cable. Multipoint temperature sensors are available in either standard or special ASTM thermocouple calibration tolerances. For applications requiring extreme accuracy, special constructions can be made with platinum RTDs.

Applications

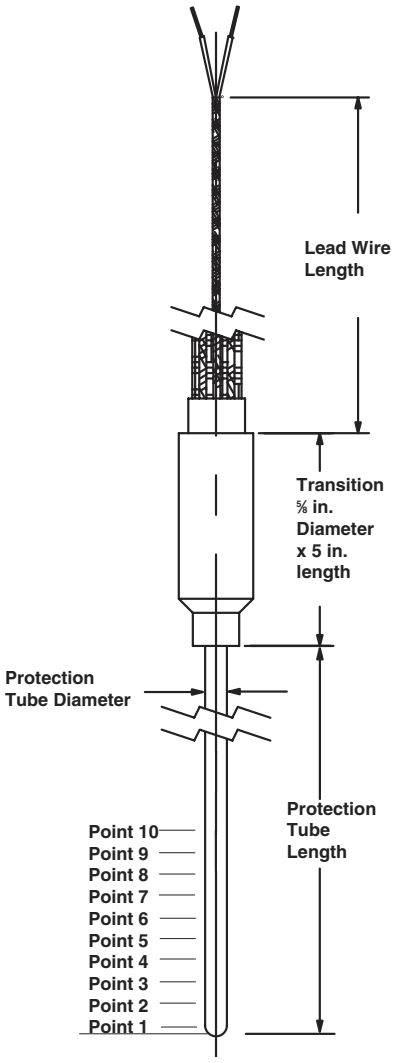
- Chemical processing
- Petroleum distillation towers
- Semiconductor manufacturing
- Profiles of furnaces and kilns
- Combustion research
- Storage tanks
- Air flow ducts

Thermocouples

Multipoint Sensor



Thermocouple sensors made from mineral insulated, metal-sheathed cable are positioned inside the overall protection sheath.



Note: Sensor point locations are measured from protection tube tip. Please specify point location when ordering.

Ordering Information—To order, complete the part number on the right with the information below:

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
A	W													

1-2. Style
AW = Multipoint

3. Protection Tube Diameter (inch)
G = 0.125 **J = 0.250**
H = 0.188

4-5. Number of Points
02 - 10

6. Protection Tube Material
F = 316 SS **Q = Alloy 600**

7. Calibration
J = J Standard Limits 3 = J Special Limits
K = K Standard Limits 4 = K Special Limits

8. Junction
G = Grounded
U = Ungrounded

9-11. Protection Tube Length (inch)
006-144

12. Lead Wire Construction
A = Fiberglass solid wire
C = FEP solid wire

13-14. Lead Wire Length (feet)
01-25

15. Lead Wire Termination
A = Standard male plug
B = Standard female jack
C = Standard plug with mating connector
F = Miniature male plug
G = Miniature female jack
H = Miniature plug with mating connector
T = Standard, 1½ inch split leads

Notes

RTDs and Thermistors

Resistance Temperature Sensing

RTDs

Watlow's platinum resistance elements are specially designed to ensure precise and repeatable temperature versus resistance characteristics. The sensors are made with controlled purity platinum, have high purity ceramic components and constructed in a unique strain-free manner.

Performance Capabilities

- Ceramic elements are extremely precise and stable within the wide temperature range of -200 to 650°C (-328 to1200°F).

Features and Benefits

Patented, strain-free construction

- Provides dependable, accurate readings
- Allows elements from different lots to be substituted without recalibration

High signal-to-noise output

- Increases accuracy of data transmission
- Permits greater distances between sensor and measuring equipment

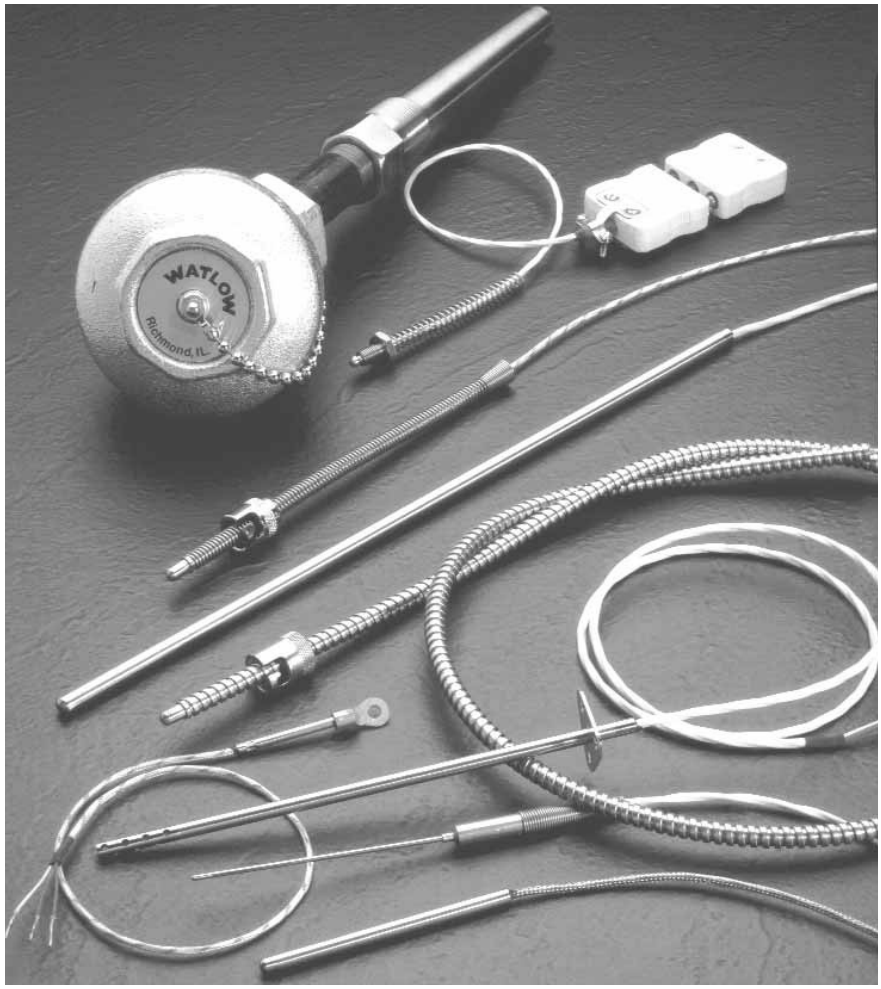
Temperature coefficient (alpha) carefully controlled while insulation resistance values exceed DIN-IEC-751 standards

- Ensures sensor sensitivity
- Minimizes self heating
- Allows precise measurement
- Repeatable

Highly controlled manufacturing process

- Ensures wide temperature range
- Stabilizes physical and chemical attributes

Metric diameters and fittings are available, please consult factory

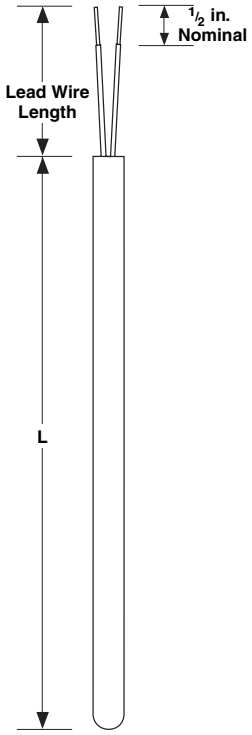


Applications

- Air conditioning and refrigeration servicing
- Furnace servicing
- Stoves and grills
- Textile production
- Plastics processing
- Petrochemical processing
- Micro electronics
- Air, gas and liquid temperature measurement
- Exhaust gas temperature measurement

RTD Style RB

Standard Industrial Insulated Leads



Features and Benefits

High accuracy

- Dependable readings

Customized diameters

- From 0.125 to 0.250 inch

Epoxy sealed

- Resist moisture and pull out
- Standard 260°C (500°F) potting

Durable rigid sheath

- 316 stainless steel -50 to 260°C (-58 to 500°F)

Internal heat transfer paste

- Quick time response

① Certain option combinations must be furnished with a transition between the sheath and lead wire, consult factory if transition is unacceptable.

② May require transition.

③ Requires two- or three-wire, single element only.

* One inch sheath length for 0.188 diameter requires a crimp tube within the last half inch of the tube.

Rapid Ship Sensors

Rapid Ship sensors come with 100Ω DIN 0.00385 curve, 316 stainless steel, 0.188 inch diameter,TFE three-wire, four foot leads, temperature rating -50 to 260°C (-58 to 500°F), standard split end lead termination and no mounting fittings. See page 166 to order additional connector hardware.

Class Accuracy	Sheath Length in. (mm)	Part Number 4 foot (102 mm) Leads
A	2 (51)	RBHB0TA020BA040
	4 (102)	RBHB0TA040BA040
	6 (152)	RBHB0TA060BA040
	9 (229)	RBHB0TA090BA040
	12 (305)	RBHB0TA120BA040

Custom Ordering Information—Items in **Bolded Green Type** are preferred with shorter lead times.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
R	B					A								

3. Sheath O.D. (inch)
G = 0.125
H = 0.188
J = 0.250

4. Lead Wire Construction①

	Standard	Overbraid	Flex Armor
Fiberglass Stranded	**A**	J②	R②
PFA or TFE Stranded	**B**	L②	T②

5. Fittings
If required, enter order code from pages 39 to 40.
If none, enter "0".

6. Lead Wire Termination
A③ = Standard male plug 200°C (400°F)
B③ = Standard female plug
C③ = Standard plug with mating connector
J③ = Male miniature plug
K③ = Female miniature jack
L③ = Male/female mini set
T = Standard leads
U = Leads with spade lugs

7. Sheath Construction
A = 316 SS

8-9. Sheath Length "L" (inch)
02, 04 and 06
Whole inches: 01* to 99
Metric lengths and lengths over 99 inches consult factory.

10. Sheath Length "L" (fractional inch)
0 = No fraction, whole inches
1 = ⅛ 3 = ⅜ 5 = ⅝ 7 = ⅞
2 = ¼ 4 = ½ 6 = ¾

11. Element

	2-wire	3-wire	4-wire
100Ω Single	A	**B**	C

12. Temperature Coefficient
DIN 0.00385
A = Class A
B = Class B

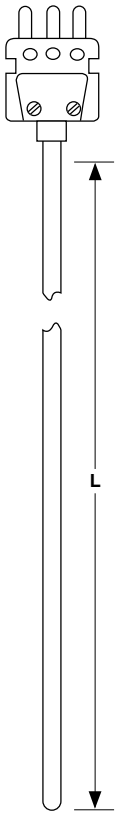
13-14. Lead Wire Length (foot)
02 and 04
Whole feet: 01 to 99

15. Special Requirements
0 = None
X = Special requirements, consult factory

RTDs and Thermistors

RTD Style RC

Plug or Jack Termination



Custom Ordering Information—Items in **Bolded Green Type** are preferred with shorter lead times.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
R	C				0	A						0	0	

3. Sheath O.D. (inch)
G = 0.125
H = 0.188
J = 0.250

4. Cold End Termination
Standard plugs and jacks 200°C (400°F)
A = Standard plug
C = Standard plug with mating connector

5. Fittings
If required, enter order code from pages 39 to 40.
If none, enter "0".

6. Enter "0"

7. Sheath Construction
A = 316SS

8-9. Sheath Length "L" (inch)
02, 04 and 06
Whole inches: 02 to 36

10. Sheath Length "L" (fractional inch)
0 = No fraction, whole inches
1 = 1/8 3 = 3/8 5 = 5/8 7 = 7/8
2 = 1/4 4 = 1/2 6 = 3/4

11. Element

	2-wire	3-wire
100Ω Single	A	**B**

12. Temperature Coefficient
DIN 0.00385
A = Class A
B = Class B

13-14. Enter "00"

15. Special Requirements
0 = None
X = Special requirements, consult factory

Features and Benefits

Durable rigid sheath

- 316 stainless steel -50 to 260°C (-58 to 500°F)

Durable connectors with copper pins

- 200°C (400°F) temperature rating
- Provide simple connection to extension leads

Brazed adapter

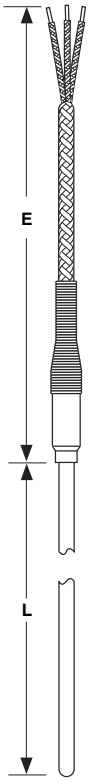
- Provides superior connector attachment

High accuracy

- Dependable readings

RTD Style RF

Metal Transitions



Features and Benefits

Stainless steel transitions

- Crimped to sheath and filled with 260°C (500°F) epoxy
- Optional brazing available

Coiled spring strain relief

- Protects lead wire against sharp bends in the transition area

Flexible mineral insulated construction

- Provides a bendable and highly durable sensor

Temperature rating

- -200 to 650°C (-328 to 1200°F)

High accuracy

- Dependable readings

Diameters available

- 0.125 to 0.250 inch O.D.

② Requires two- or three-wire only, single element only

Rapid Ship Sensors

Rapid Ship sensors come with 100Ω DIN 0.00385 curve, 316 stainless steel, 0.188 inch diameter, 24 AWG stranded Teflon® three-wire, four foot leads, temperature rating -200 to 650°C (-328 to 1200°F), standard split end lead termination and no mounting fittings. See page 166 to order additional connector hardware.

Class Accuracy	Sheath Length in. (mm)	Part Number 4 foot (102 mm) Leads
A	3 (76)	RFHB0TK030BA040
	6 (152)	RFHB0TK060BA040
	9 (229)	RFHB0TK090BA040
	12 (305)	RFHB0TK120BA040

Custom Ordering Information—Items in **Bolded Green Type** are preferred with shorter lead times.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
R	F													

1-2. Style
F = Metal transition with strain relief

3. Sheath O.D. (inch)
G = 0.125
H = 0.188
J = 0.250

4. Lead Wire Construction

	Standard	Overbraid	Flex Armor
Fiberglass Stranded	**A**	J	R
PFA or TFE Stranded	**B**	L	T

5. Fittings
If required, enter order code from pages 39 to 40.
If none, enter "0".

6. Lead Wire Termination
A② = Standard male plug
B② = Standard female plug
C② = Standard plug with mating connector
J② = Male miniature plug
K② = Female miniature jack
L② = Male/female mini set
T = Standard leads
U = Leads with spade lugs

7. Sheath Construction

	316 SS	Alloy 600
Mineral Insulated	**K**	**L**

8-9. Sheath Length "L" (inch)
03, 06 and 12
Whole inches: 03 to 99
Metric lengths and lengths over 99 inches consult factory.

10. Sheath Length (fractional inch)
0 = No fraction, whole inches
1 = ⅛ 3 = ⅜ 5 = ⅝ 7 = ⅞
2 = ¼ 4 = ½ 6 = ¾

11. Element

	2-wire	3-wire
100Ω Single	A	**B**

12. Temperature Coefficient
DIN 0.00385
A = Class A
B = Class B

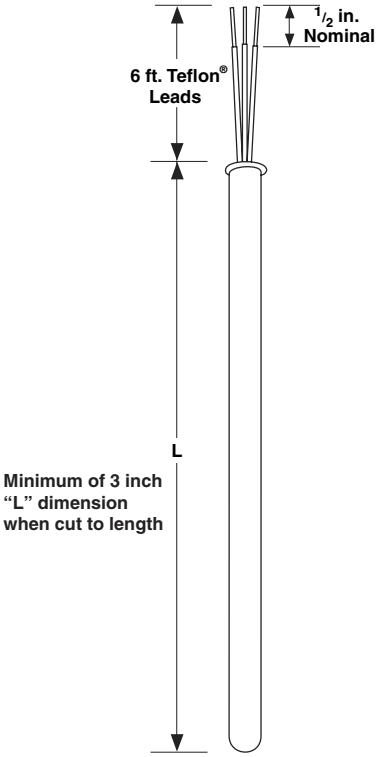
13-14. Lead Wire Length "E" (foot)
02 and 04
Whole feet: 01 to 99

15. Special Requirements
0 = None
X = Special requirements, consult factory

RTDs and Thermistors

RTD Style RK

Emergency Use Cut-to-Length RTD



Rapid Ship Sensors

Rapid Ship sensors come with 100Ω DIN, 0.00385 curve, 316 stainless steel, 0.188 and 0.250 inch diameter, 24 AWG stranded Teflon® three-wire, temperature rating -50 to 260°C (-58 to 500°F), standard split end leads and no mounting fittings.

Class Accuracy	Diameter	"L" Dimension in.	(mm)	Part Number (Contains Bag of Five Sensors)
A	0.188	12	(305)	RKH12A-05
	0.188	24	(610)	RKH24A-05
	0.250	12	(305)	RKJ12A-05
	0.250	24	(610)	RKJ24A-05

Adjustable C-Frame Tube Cutter	RK-Cutter

NEW: Cut-to-length emergency RTD kit is a bag of five adjustable RTD sensors. Keep a bag of these items on your shelf for immediate, emergency replacement of RTDs to 24 inches in length.

Features and Benefits

Cut-to-length features

- Avoids need to stock several RTD lengths

Probes can be shortened

- To three inches minimum using a tubing cutter

High accuracy

- Dependable reading, three-wire, Class A DIN 0.00385 curve

Internally sealed

- Prevent moisture penetration

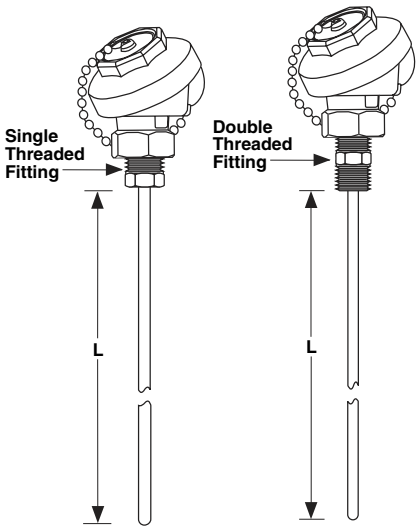
316 SS sheath

- -50 to 260°C (-58 to 500°F)

Teflon® is a registered trademark of E.I. du Pont de Nemours & Company.

RTD Style RR

Connection Head/ Optional Transmitter



Features and Benefits

Connection heads

- Provide superior dust and moisture resistance

Weatherproof plastic heads

- Resist weak acids, organic solvents, alkalies, sunlight and dust

Standard bottom mounting

- Side mounting available upon request

Complete assembly available

- Head-mounted 4-20mA transmitter, two- or three-wire input and non-isolated

① Units with transmitter, buyer to specify range and degree C or F, as well as temperature span.

For further details on Watlow connection heads see the hardware section of this catalog, pages 156 to 157.

Rapid Ship Sensors

Rapid Ship sensors come with 100Ω DIN 0.00385 curve, 316 stainless steel, 0.250 inch diameter, cast aluminum industrial head, double threaded stainless steel fitting for head mount with 0.5 inch NPT process mount, three-wire configuration and a temperature rating of -50 to 260°C (-58 to 500°F).

Class Accuracy	Sheath Length in. (mm)	Part Number
A	3 (76)	RRJEF0A030BA000
	6 (152)	RRJEF0A060BA000
	18 (457)	RRJEF0A180BA000

Custom Ordering Information—Items in **Bolded Green Type** are preferred with shorter lead times.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
R	R				0							0	0	

3. Sheath O.D. (inch)
G = 0.125 **J = 0.250**
H = 0.188

4. Connection Head
C = Polypropylene
D = Cast iron
E = Cast aluminum
H = Explosion proof
U① = E head with 5750 transmitter
V① = C head with 5750 transmitter
W① = H head with 5750 transmitter

5. Head Mounting Fittings
O = Single threaded, 303 SS
F = Double threaded, 303 SS ½" NPT
* H = Spring loaded, double threaded, 316 SS ½" NPT

6. Enter "0"

7. Sheath Construction

	-50 to 260°C (-58 to 500°F) 316 SS	-200 to 650°C (-328 to 1200°F) 316 SS
Standard Industrial (0.125-0.250 inch O.D.)	**A**	—
Mineral Insulated (0.125-0.250 inch O.D.)	—	K

8-9. Sheath Length "L" (inches)
03, 06 and 18
Whole inches: 02 to 99
Metric lengths and lengths over 99 inches consult factory.

10. Sheath Length "L" (fractional inch)
0 = No fraction, whole inches
1 = ⅛ 2 = ¼ 3 = ⅜ 4 = ½ 5 = ⅝ 6 = ¾ 7 = ⅞

11. Element

	2-wire	3-wire	4-wire
100Ω Single	A	**B**	C

12. Temperature Coefficient
DIN 0.00385
A = Class A
B = Class B

13-14. Enter "00"

15. Special Requirements
0 = None
X = Special requirements, consult factory

* 0.250 inch diameter only.

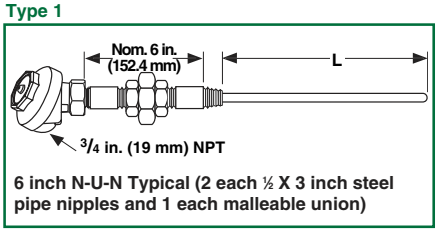
For a complete RTD assembly, add thermowell part number. See thermowell section, pages 144 to 146.

RTDs and Thermistors

RTD Style RT

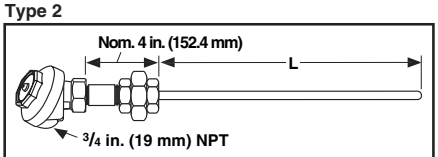
For Use with Thermowells

Type 1



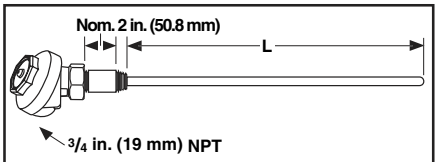
6 inch N-U-N Typical (2 each ½ X 3 inch steel pipe nipples and 1 each malleable union)

Type 2



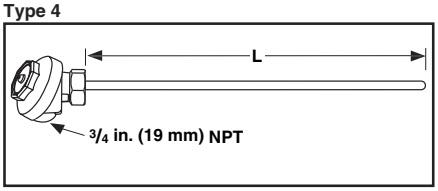
4 inch N-U typical (1 each ½ X 3 inch steel pipe nipple and 1 each malleable union)

Type 3



½ X 3 inch long steel pipe nipple typical

Type 4



Features and Benefits

High quality thermowells and pipe wells

- Protect sensor

Mineral insulated construction

- Available in 0.125 to 0.250 inch O.D.

Available with spring-loading

- Ensures positive contact

Complete assembly available

- Head mounted 4-20mA transmitter, two- or three-wire input and non-isolated

Variety of connection head options

- Meet your application requirements

Custom Ordering Information—Items in **Bolded Green Type** are preferred with shorter lead times.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
R	T				0							0		

3. Sheath O.D. (inch)
G = 0.125 **J = 0.250**
H = 0.188

4. Connection Head
C = Polypropylene
D = Cast iron
E = Cast aluminum
H = Explosion proof
U① = E head with 5750 transmitter
V① = C head with 5750 transmitter
W① = H head with 5750 transmitter

5. Cold End Configuration②
Type 1 Type 2 Type 3 Type 4

6. Enter "0"

7. Sheath Construction

	-50 to 260°C (-58 to 500°F) 316 SS	-200 to 650°C (-328 to 1200°F) 316 SS
Standard Industrial	**A**	—
Mineral Insulated	—	K

8-9. Sheath Length "L" (see drawings at left)
When ordering a complete assembly with thermowell, specify "AR" as required. Otherwise, specify the "L" dimension in whole inches.

10. Sheath Length "L" (fractional inch)
0 = No fraction, whole inches
1 = ⅛ 3 = ⅜ 5 = ⅝ 7 = ⅞
2 = ¼ 4 = ½ 6 = ¾

11. Element

	2-wire	3-wire	4-wire
100Ω Single	A	**B**	C

12. Temperature Coefficient
DIN 0.00385
A = Class A
B = Class B

14. Spring-Loading
Y = Yes N = No

15. Special Requirements
0 = None
X = Special requirements, consult factory

① Units with transmitter, buyer to specify range and degree C or F, as well as temperature span.

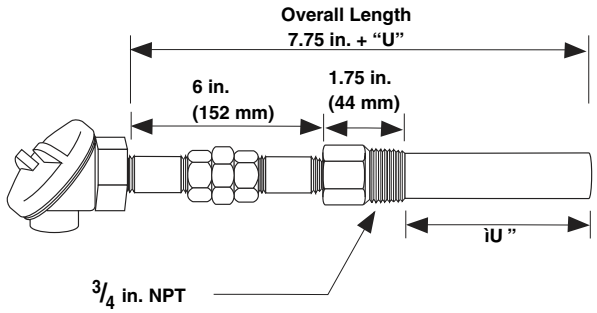
② Other sizes, lengths and materials available. Consult factory.

For further details on Watlow connection heads see the hardware section of this catalog, pages 156 to 157.

RTDs and Thermistors

Style RT with Thermowell

Straight Well

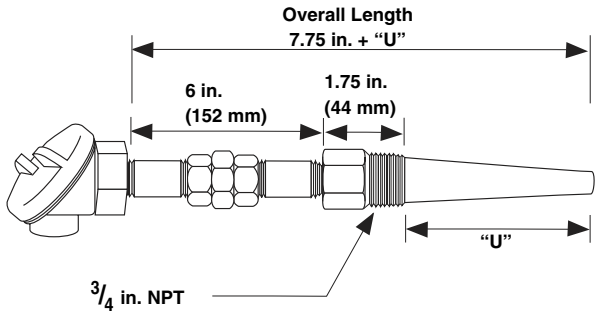


Rapid Ship Sensors

Rapid Ship sensors come with 316 SS straight well, nipple-union-nipple, 0.250 inch diameter spring loaded element, 100Ω DIN 0.00385 curve, Class A and three-wire RTD. Temperature rating -50 to 260ºC (-58 to 500ºF).

Calibration	"U" in.	"U" (mm)	Overall Length in.	Overall Length (mm)	Part Number
A	2.5	(64)	10.25	261	RTJE1SF024BA0Y0
	4.5	(114)	12.25	312	RTJE1SF044BA0Y0
	7.5	(191)	15.25	388	RTJE1SF074BA0Y0
	10.5	(267)	18.25	465	RTJE1SF104BA0Y0

Tapered Well



Rapid Ship Sensors

Rapid Ship sensors come with 316 SS tapered well, nipple-union-nipple, 0.250 inch diameter spring loaded element, 100Ω DIN 0.00385 curve, Class A and three-wire RTD. Temperature rating -50 to 260ºC (-58 to 500ºF).

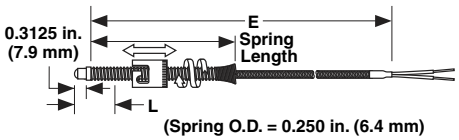
Calibration	"U" in.	"U" (mm)	Overall Length in.	Overall Length (mm)	Part Number
A	2.5	(64)	10.25	261	RTJE1TF024BA0Y0
	4.5	(114)	12.25	312	RTJE1TF044BA0Y0
	7.5	(191)	15.25	388	RTJE1TF074BA0Y0
	10. 5	(267)	18.25	465	RTJE1TF104BA0Y0

RTDs and Thermistors

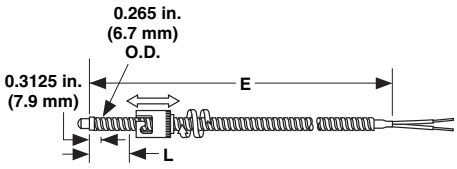
Speciality RTDs and Thermistors

Construction Styles

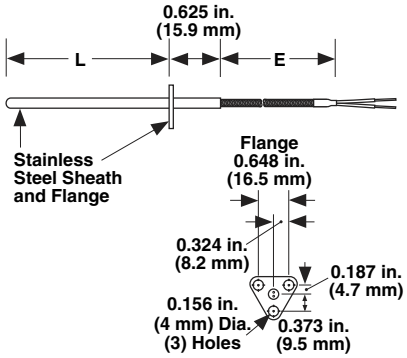
10 = 6 in. Adjustable Spring Style
11 = 12 in. Adjustable Spring Style



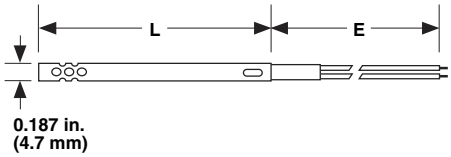
12 = Adjustable Armor Style



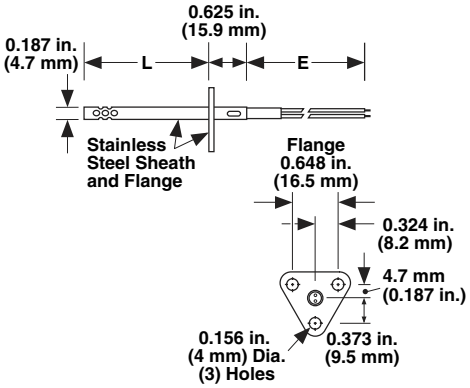
25 = Cartridge with Flange



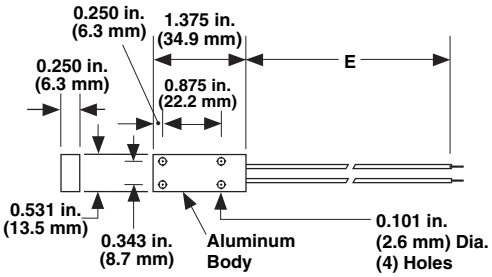
50 = Open Air



55 = Open Air with Flange



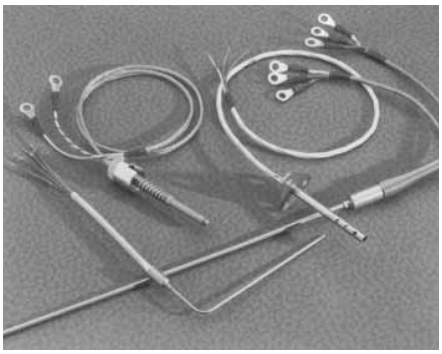
80 = Surface Mount



See next page for Rapid Ship sensors and ordering instructions.

RTDs and Thermistors

Speciality RTDs and Thermistors



Rapid Ship Sensors

Rapid Ship sensors come with 100Ω DIN 0.00385 curve RTD sensor, 24 AWG stranded three-wire leads, temperature rating -50 to 260°C (-58 to 500°F), standard split end lead termination and no mounting fittings.

	Part Number	
	4 Foot (102 mm) Leads	6 Foot (152 mm) Leads
Construction 10 with Fiberglass and SS overbraid leads	S10DDN4C048A	S10DDN4C072A
Construction 80 with Teflon® leads	S80ADT2A048A	S80ADT2A072A

Custom Ordering Information—Items in **Bolded Green Type** are preferred with shorter lead times.

1	2	3	4	5	6	7	8	9	10	11	12
S											

Specifications: RTD

- Two- or three-wire
- Resistance: 100Ω at 0°C
- Alpha curve: 0.00385Ω/Ω/°C
- Tolerance at 0°C: ±0.12% (±0.25°C)
- Range: -50 to 260°C (-58 to 500°F)

Specifications: Thermistor

- Metal oxide, sintered and encapsulated
- Negative temperature coefficient
- Non-linear temperature/resistance curve
- Resistance at 25°C (77°F) and ranges:

Epoxy Bead Tolerance ±1%Ω +0.3°C (37°F)		
#11	1000Ω	-60 to 150°C (-76 to 302°F)
#12	3000Ω	-60 to 150°C (-76 to 302°F)

Glass Bead Tolerance ±15%Ω +0.3°C (37°F)		
#16	100,000Ω	-60 to 260°C (-76 to 500°F)

*Other thermistors available on request. Consult factory. See Style TB thermistor on page 109.

2-3. Construction

10 = 6 inch adjustable spring style
11 = 12 inch adjustable spring style
12 = Adjustable armor style
25 = Cartridge with flange
50 = Open air
55 = Open air with flange
80 = Surface mount

4. Diameter (inch)

D = 0.188
A = Not applicable: surface mount

***5. Element Type**

C = RTD 2-wire No. 3850
D = RTD 3-wire No. 3850
M = Thermistor No. 11
N = Thermistor No. 12
P = Thermistor No. 16

6-7. Lead Type

L4 = Fiberglass and SS armor
M4 = Fiberglass
N4 = Fiberglass and SS overbraid
T2 = PFA or TFE

8. Sheath Length "L" (inches)

A = Not applicable
C = 1.5 (required for VAT construction: No. 10, 11, 12)

D = 2.0	L = 5.5	T = 9.0
E = 2.5	**M = 6.0**	U = 9.5
F = 3.0	N = 6.5	W = 10.0
G = 3.5	P = 7.0	Y = 11.0
H = 4.0	Q = 7.5	Z = 12.0
J = 4.5	R = 8.0	
K = 5.0	S = 8.5	

9-11. Lead Wire Length "E" (foot)

012 = 1	084 = 7
024 = 2	096 = 8
036 = 3	108 = 9
048 = 4	120 = 10
060 = 5	180 = 15
072 = 6	

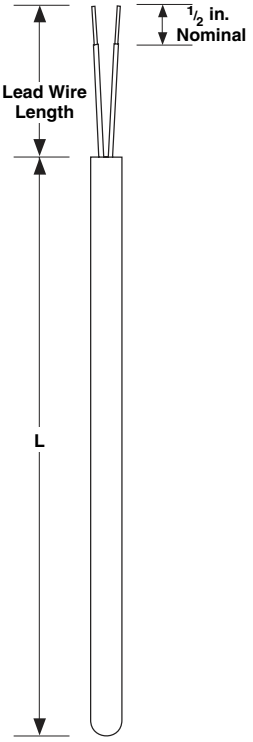
12. Terminations

A = 1.5 inch stripped split leads, no terminals
B = No. 8 spade terminals
H = 0.25 inch female quick connect terminals

RTDs and Thermistors

Speciality RTDs and Thermistors

Style TB Standard Industrial Thermistor with Insulated Leads



Features and Benefits

Rigid 316 stainless steel sheath

- Ideal for industrial applications

Cold end epoxy seal

- Rated to 260°C (500°F)

Internal heat transfer paste

- Quick time response

Custom Ordering Information—Items in **Bolded Green Type** are preferred with shorter lead times.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
T	B		B								O			

3. Sheath O.D. (inch)
H = 0.188
J = 0.250

4. Lead Wire Construction

	Standard
PFA or TFE Stranded	**B**

5. Fittings
If required, enter order code from pages 39 to 40.
If none, enter "0".

6. Lead Wire Termination
T = Standard leads
U = Leads with spade lugs

7. Temperature Rating and Accuracy
A① = -60 to 150°C (-75 to 302°F) ±1% (±.3°C) Accuracy @ 25°C
B② = -60 to 260°C (-75 to 500°F) ±15% (±.3°C) Accuracy @ 25°C

8-9. Sheath Length "L" (inches)
02, 04 and 06
Whole inches: 02 to 24

10. Sheath Length "L" (fractional inch)
0 = No fraction, whole inches

1 = 1/8	5 = 5/8
2 = 1/4	6 = 3/4
3 = 3/8	7 = 7/8
4 = 1/2	

11. Element/Resistance at 25°C (77°F)
E = 1,000Ω
G = 3,000Ω
T = 100,000Ω

12. Sheath
O = Standard sheath

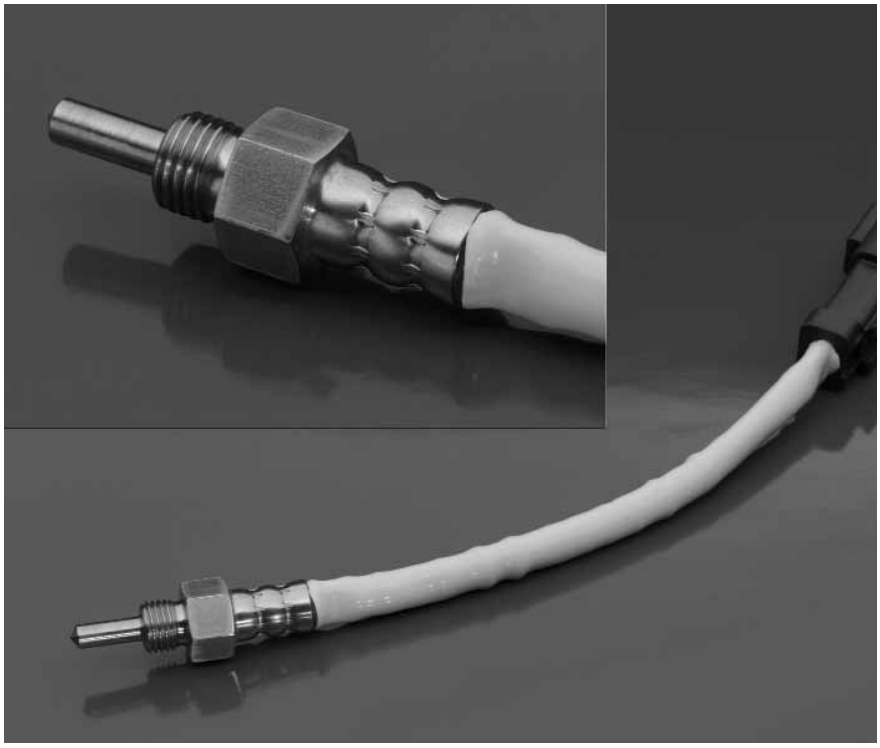
13-14. Lead Wire Length "E" (foot)
02 and 04
Whole feet: 01 to 15

15. Special Requirements
0 = None
X = Special requirements, consult factory

① Only available with 1,000Ω or 3,000Ω.
⑤ Only available with 100,000Ω.

ENVIROSEAL™ HD Sensor

Watlow's ENVIROSEAL™-HD temperature sensor keeps out moisture, oil and contaminants in all of your heavy-duty applications including those outside applications exposed to harsh weather, oils and other extreme moisture environments. The ENVIROSEAL-HD sensor is also designed to provide accurate, dependable measurements in high-vibration environments.



Features and Benefits

Submersible and 1200psi pressure wash rated seal (not including connector area)

- Protects the sensor from washdown or other extreme moisture environments

Oil Resistant Materials

- Sensors maintain a long life even when exposed to oil, gasoline, or diesel fuel

Vibration resistant design, 25 lb pull out force rating

- Tough, rugged design to hold up to the roughest applications

-40 to 200°C (-40 to 392°F) sensor temperature rating

- Offers superior application flexibility

Time response of two seconds

- Fast response will measure 63.2 percent (first order) of the temperature change in two seconds or less

250psi threaded fitting pressure rating

- Suitable for most rugged applications

Applications

- Engine coolant or oil
- Refrigeration or condensation units
- Industrial equipment
- Heat exchangers
- Gear boxes
- Hydraulic fluid
- Marine

RTDs and Thermistors

ENVIROSEAL™ HD Sensor

Ordering Information—To order, complete the part number on the right with the information below:

1	2	3	4	5	6	7	8	9	10
H	D								

3. Sensor Type

A = 100Ω DIN 0.00385 RTD Class A element, 2-wire
B = 100Ω DIN 0.00385 RTD Class B element, 2-wire
C = 1000Ω DIN 0.00385 RTD Class A element, 2-wire
D = 1000Ω DIN 0.00385 RTD Class B element, 2-wire
K = Ungrounded standard limits Type K thermocouple

4-5. Sheath Length "S"

07 = 0.75 in. (19.05 mm)
15 = 1.50 in. (38.1 mm)
30 = 3.00 in. (76.2 mm)

6. Threaded Fitting

4 = 0.25 in. (6.35 mm) NPT male threads
"F" = 1.4 in. (35.56 mm)
8 = 0.125 in. (3.18 mm) NPT male threads
"F" = 1.2 in. (30.48 mm)

7. Fitting Material

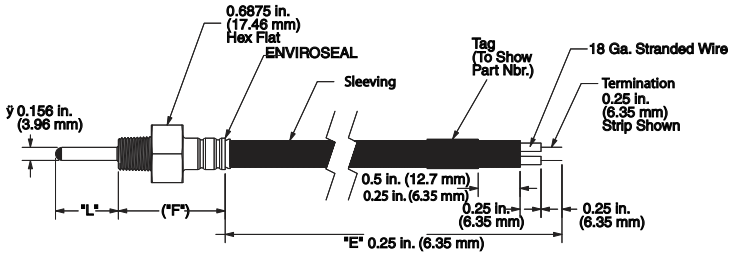
B = Brass
S = 316 stainless steel

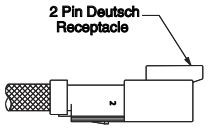
8-9. Lead Length "L" (whole inches)
(18 gauge stranded conductor lead wire)

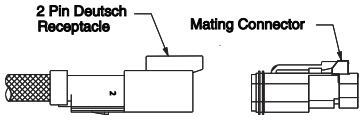
06 = 6 in. (152.4 mm)
12 = 12 in. (304.8 mm)
24 = 24 in. (609.6 mm)

10. Lead Wire Terminations

T = Standard 0.25 in. (6.35 mm) stripped ends
2 = 2-pin receptacle Deutsch connector 125°C (257°F)
4 = 2-pin receptacle Deutsch connector 125°C (257°F) with mating connector







Notes