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How To Use This Catalog

This catalog is divided into:

- Temperature Sensors and Components
- Wire and Cable Products

The forward portion of this catalog includes a Customer Assistance section that lists the full address, and fax and phone numbers for your Watlow representative as well as all other Watlow plant location information. A short overview of the entire Watlow organization and philosophy follows.

Also included is a description of our Lab Services, both prototype testing and our certification lab.

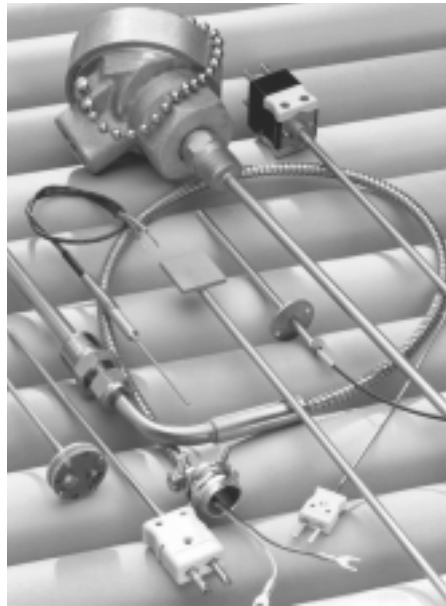
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Temperature Sensors and Components



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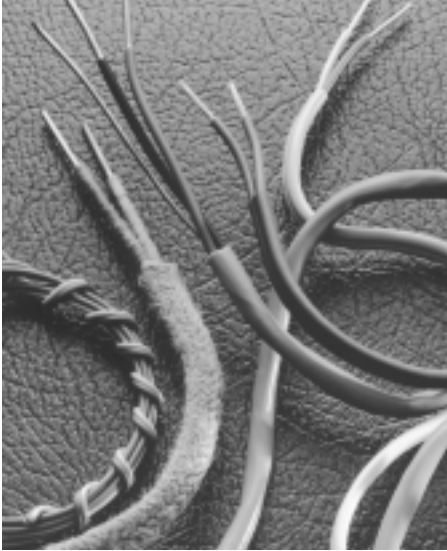
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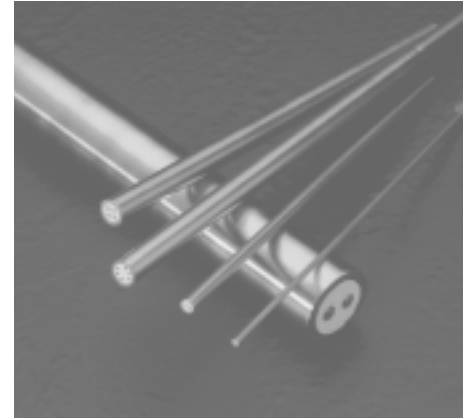
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Responsible Engineering

Think Safety

Safety

When specifying any sensor or designing any sensor/instrumentation circuit, caution must always be exercised to comply with safety requirements, local and/or national electrical codes, agency standards, considerations for use in toxic or explosive environments and sound engineering practices. Integrity and suitability of any specification for use is ultimately the responsibility of those making the specification decisions. This section will deal with safety as it relates to dangers presented by catastrophic failures, fault conditions and hazardous environments.

Operational Safety— Don't Make It Dangerous

The actual performance of a temperature sensor must take into account a failure that could cause serious product, plant or user safety problems.

If a sensor is used in a medical application, with life or death consequences, careful attention must be paid to fitness for application with appropriate redundancies and/or alarms built into the product.

If the sensor is used in an industrial environment where hazards exist, attention must be paid to protection methods (isolating sensors and wiring from explosive or flammable substances) to prevent failures or short circuits from becoming dangerous to personnel and property.

It is a good engineering practice to always consider the consequences of a catastrophic failure and the affect it would have on people and property. Please institute the appropriate safeguards to limit any danger.

Designing Intrinsic Safety Circuits

When installing temperature sensors in hazardous areas, circuits should be made intrinsically safe with "barriers" that prevent sparks and excessive heat on the "safe" side from reaching explosive gases or flammable materials.

Many devices exist on the market to meet this need. Some cost more than others, but they have in common the use of a "buffer," or "barrier" device located in the sensor circuit, between the sensor and instrument or temperature controller. If a fault condition should develop, it prevents current, in sufficient amounts, from reaching the hazardous area and causing sparks.

All barrier devices have parameters that will effect how it works and its effect on the sensor circuit. These include:

- Polarity, whether rated for AC or DC signals
- Rated voltage, or working voltage of the signal the device is designed to carry before it senses a fault
- Internal resistance, as the amount of resistance the barrier device inherently has will affect the strength of the current signal it's allowing to pass.

Limit Sensors

Most heated thermal systems have:

- A heat source, either fuel fired or electrical resistance
- A temperature controller
- A temperature sensor

The sensor produces a signal value based on the temperature it is exposed to. The temperature controller interprets that signal into a value that is either above, below or on its predetermined set point. The

controller will, in turn, create an output signal to command some device to turn the heat source on or off.

As with any such heated thermal system, a failure in the sensor, temperature controller or heat-source controlling device will create an over- or under-temperature condition. These conditions can ruin product in process or pose a danger to personnel and property.

Limit circuits are used to avoid these over- and under-temperature conditions. When they sense either condition, they may be programmed to sound an alarm, and/or shut the heated thermal system down. Whatever its application, the limit control system must be totally independent from the primary control system. Its only connection to the primary control system is the ability to override it and:

- Turn off the heat source in an over-temperature condition
- Sound an alarm in an under-temperature condition

Generally, the sensor used in a limit control system need not be as accurate as the primary sensor. Its only function is to create a temperature signal that will allow a controller to determine if a preprogrammed over- or under-temperature condition exists. Sensor longevity and aging must be taken into account if they will have an unacceptable impact on the limit control system's ability to accurately determine an under- or over-temperature condition.

Again, like with enclosures, there are agency standards for the design and construction of limit control systems, and their suitability for use.

Quick Reference Guide

Thermocouples

General Applications

Temperature Range:
32°F (0°C) to
900°F (480°C)

Product Descriptions:



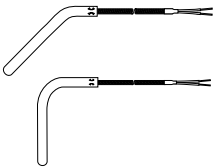
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Adjustable Armour Style
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Rigid Sheath Style
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Rigid Sheath with Threaded Fitting
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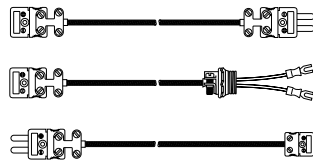
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Flange Style
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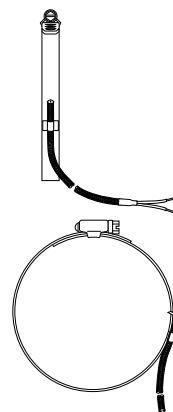
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Ring Terminal Style
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Nozzle Style
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Pipe Clamp Style
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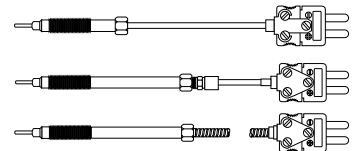
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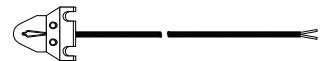
Brass Shim Style
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Stainless Steel Shim Style
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Melt Bolt Thermocouple
Page 58-59



Kapton® Bracket Style
Page 60



Low Profile Kapton® Peel and Stick Style
Page 60



Newbury Nozzle Style
Page 60

Typical 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

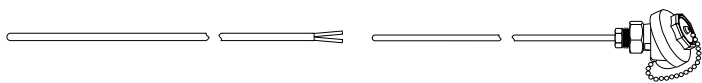
Quick Reference Guide

Thermocouples

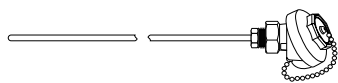
Mineral Insulated (MI)

Temperature Range:
32°F (0°C) to
2200°F (1200°C)

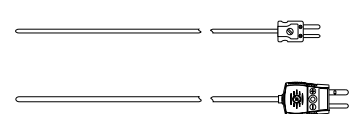
Product Descriptions:



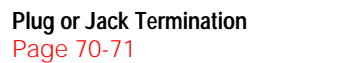
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Wafer Head
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Plug or Jack Termination
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Metal Transitions with Spring Strain Relief
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Metal Transitions
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Minature Transitions
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Use with Thermowells
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Typical Applications:

- Metal heat treating
- Power generation
- Engine testing
- Chemical and oil processing
- Semiconductor manufacturing
- Food processing

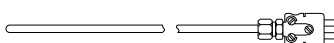
Special Applications

Temperature Range:
32°F (0°C) to
4200°F (2315°C)

Product Descriptions:



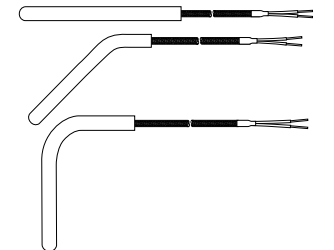
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High Temperature Metal Transitions
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Vibration Tolerant (Hybrid)
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Multipoints
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True Surface Thermocouple (TST)
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Typical Applications:

- Semiconductor manufacturing
- Diesel engines
- Jet engines
- Laboratory research
- Nuclear environments

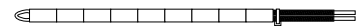
Base and Noble Metals

Temperature Range:
32°F (0°C) to
2300°F (1260°C)

Product Descriptions:



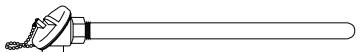
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Base Metal Elements with Insulators
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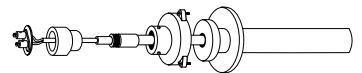
Immersion Tips
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Base Metal with Protection Tubes
Page 103-106



Noble Metal Elements with Insulators
Page 107



Noble Metal Elements with Protection Tube
Page 108

Typical Applications:

- Metal processing
- Incinerators
- Glass and ceramic manufacturing

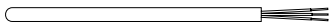
Quick Reference Guide

RTDs and Thermistors

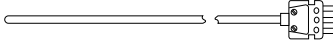
RTDs

Temperature Range:
-328°F (-200°C) to
1200°F (650°C)

Product Descriptions:



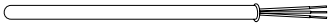
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Plug or Jack Termination
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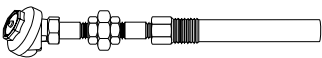
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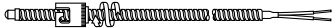
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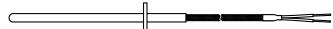
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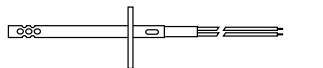
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Adjustable Armor Style
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Open Air with and without Flange
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Surface Mount
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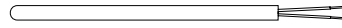
Typical Applications:

- Air conditioning and refrigeration
- Food equipment
- Industrial ovens
- Textile production
- Plastics processing
- Electronic manufacturing

Thermistors

Temperature Range:
-75°F (-60°C) to
508°F (260°C)

Product Descriptions:



Standard Industrial Thermistor with Insulated Leads
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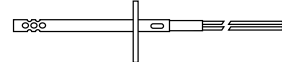
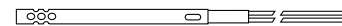
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Open Air with and without Flange
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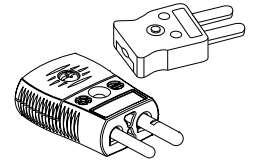
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Typical Applications:

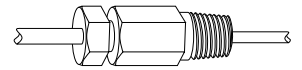
- Medical devices
- Food preparation
- Laboratory equipment

Accessories

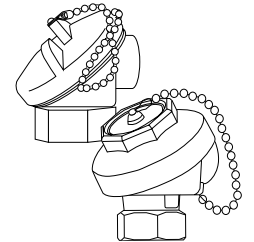
Product Descriptions:



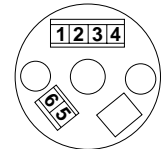
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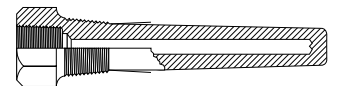
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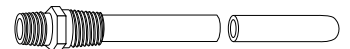
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Protecting Tubes
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Quick Reference Guide

Wire and Cable

Extruded Insulations

PVC

-20°F to 220°F (-29°C to 105°C)

Series 502*:	PVC insulated wire	<i>Page 195 & 210</i>
Series 505:	PVC "ripcord" wire	<i>Page 197</i>
Series 510*:	PVC insulated and shielded wire	<i>Page 202 & 212</i>
Series 701:	PVC insulated RTD wire	<i>Page 215</i>
Series 900*:	PVC insulated multipair cable with overall shield	<i>Page 208 & 213</i>
Series 1000*:	PVC insulated multipair cable with individual pairs shielded	<i>Page 209 & 214</i>

Nylon

-85°F to 300°F (-65°C to 150°C)

Series 504:	Nylon insulated wire	<i>Page 196</i>
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ETFE (Tefzel®)

-150°F to 300°F (-101°C to 150°C)

Series 514:	ETFE insulated wire	<i>Page 206</i>
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FEP

-400°F to 400°F (-240°C to 204°C)

Series 506:	FEP insulated wire, small gauges	<i>Page 198</i>
Series 507*:	FEP insulated wire	<i>Page 199</i>
Series 509*:	FEP insulated and shielded wire	<i>Page 201 & 211</i>
Series 704*:	FEP insulated RTD wire	<i>Page 216</i>

PFA

-400°F to 500°F (-240°C to 260°C)

Series 516:	PFA insulated wire	<i>Page 207</i>
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Taped Insulations

TFE Tape

-400°F to 500°F (-240°C to 260°C)

Series 508:	TFE taped wire	<i>Page 200</i>
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Polyimide Tape

-400°F to 600°F (-240°C to 315°C)

Series 511:	Polyimide taped and twisted wire	<i>Page 203</i>
Series 512:	Polyimide taped wire	<i>Page 204</i>
Series 513:	Polyimide double taped wire	<i>Page 205</i>

Braided Insulations

SERVTEX

-100°F to 550°F (-73°C to 290°C)

Series 155:	SERVTEX braided wire	<i>Page 184</i>
Series 157:	SERVTEX braided wire with TFE tape	<i>Page 185</i>

E-glass

-100°F to 900°F (-73°C to 480°C)

Series 302:	E-glass double braided wire	<i>Page 187</i>
Series 304:	E-glass braided wire	<i>Page 188</i>
Series 305:	E-glass double wrapped wire	<i>Page 189</i>
Series 307:	E-glass braided with TFE taped wire	<i>Page 190</i>
Series 313:	E-glass heavy insulated wire	<i>Page 191</i>
Series 705:	E-glass braided RTD wire	<i>Page 217</i>

S-glass

-100°F to 1300°F (-73°C to 705°C)

Series 314:	S-glass braided and twisted wire	<i>Page 192</i>
Series 321:	S-glass braided wire	<i>Page 193</i>

Vitreous Silica

-100°F to 1800°F (-73°C to 980°C)

Series 301:	Vitreous Silica braided wire	<i>Page 186</i>
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Ceramic

0°F to 2200°F (-18°C to 1205°C)

Series 350:	Ceramic fiber braided wire	<i>Page 194</i>
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Metal Sheathed Cable

32°F to 2150°F (0°C to 1177°C)

XACTPAK®:	Mineral insulated	<i>Page 221-235</i>
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* These constructions also available with 300 Volt UL® PLTC rating

Note: All temperatures listed above represent insulation material capabilities, as defined by the insulation manufacturer. Acceptable wire product performance may not be achieved in all applications at all temperatures. Please consult factory for individual application suitability.

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Customer Assistance

Watlow Manufacturing Facilities

United States Manufacturing Facilities

Anaheim, California

Watlow AOV

Manufactures:

- Silicone Rubber Heaters

4545 East LaPalma Avenue
Anaheim, California 92807

Phone: 714-779-2252

FAX: 714-777-9626

Batavia, Illinois

Watlow Batavia

Manufactures:

- Heated Parts
- K-Ring Heaters

1310 Kingsland Drive
Batavia, Illinois 60510

Phone: 630-879-2696

FAX: 630-879-1101

Chesterfield, Missouri

Watlow Engineering

Manufactures:

- Capitol Equipment

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Chesterfield, Missouri 63005

Phone: 636-530-0288

FAX: 636-530-0395

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Watlow Columbia

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- Flexible Heaters

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FAX: 573-474-5859

Columbia, Missouri

Watlow Ceramic Fiber Heaters

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- Ceramic Fiber Heaters

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FAX: 573-443-8818

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- Duct Heaters
- Circulation Heaters
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FAX: 573-221-3723

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- RTDs Thermistors
- Thermistors

Watlow Gordon

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FAX: 815-678-3961

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- Strip Heaters
- Radiant Heaters
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St. Louis, Missouri 63146

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FAX: 314-878-6814

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- Control Panels

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- High Level Software

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- Control Consoles
- Custom Electronic Controllers
- Power Controllers
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1241 Bundy Boulevard
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Phone: 507-454-5300

FAX: 507-452-4507

Winona, Minnesota

Watlow Polymer Technologies

Manufactures:

- Polymer Heaters

1265 East Sanborn Street
Winona, Minnesota 55987

Phone: 507-457-9797

FAX: 507-457-9736

Customer Assistance

Watlow Manufacturing Facilities

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Manufactures:

- Cartridge Heaters
- Temperature Controllers
- Thermocouples

Blk. 55, Ayer Rajah Crescent, #3-23
Ayer Rajah Industrial Estate
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Phone: 65-777-5488

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Watlow France, S.A.R.L.

Manufactures:

- Cartridge Heaters

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Cergy Pontoise Cedex, France 95307

Phone: 33-1-3073-2425

FAX: 33-1-3073-2875

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- Cartridge Heaters
- Silicone Rubber Heaters
- K-RING Heaters
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Postfach 1165

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Phone: 49-7253-9400-50

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Manufactures:

- Thermocouples

Via Meucci 14
20094 Corsico
Milano, Italy 20135

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FAX: 39-02-4586-9954

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Watlow Limited

Manufactures:

- Band Heaters
- Cartridge Heaters
- Flexible Heaters
- Thermocouples

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Watlow de Mexico S.A. de C.V.

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- Ceramic Knuckle Heaters
- Band Heaters
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Tucker, Georgia 30084
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Phone: 512-249-1900
FAX: 512-249-0082

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FAX: 704-541-3852

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FAX: 847-458-1515

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Mason, Ohio 45040
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FAX: 513-398-7575

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FAX: 330-467-1659

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FAX: 972-423-1759

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FAX: 317-575-9478

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Lenexa, Kansas 66285
Phone: 913-897-3973
FAX: 913-897-4085

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Orange, California 92868
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FAX: 714-935-2990

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1394 Alison Court
Westminster, Maryland 21158
Phone: 410-840-8034
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Phone: 603-882-1330
FAX: 603-882-1524

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Doylestown, Pennsylvania 18901
Phone: 215-345-8130
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Portland, Oregon 97223
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10413 Lightner Bridge Drive
Tampa, Florida 33626
Phone: 813-926-3600
FAX: 813-926-3500

Tulsa

4444 East 66th Street, Suite 101
Tulsa, Oklahoma 74136
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Winston Salem/Raleigh

8425 Maeve Court
Clemmons, North Carolina 27012
Phone: 336-766-9659
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Sales Territory: China, including
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Watlow Korea

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Seoul, Korea 135-090
Phone: 82-2-563-5777
FAX: 82-2-563-5779

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Watlow Singapore Pte. Ltd.

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Ayer Rajah Industrial Estate
Singapore 0513
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FAX: 65-778-0323

Sales Territory: Southeast Asia

Taiwan

Watlow Taiwan

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Chi-Shen 2nd Road
Kaohsiung, Taiwan, ROC
Phone: 886-7-261-8397
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Sales Territory: Taiwan

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France 95307
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76709 Kronau, Germany
Phone: 49-7253-9400-50
FAX: 49-7253-9400-99

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Watlow Italy, s. r. l.

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Milano, Italy 39-02135
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FAX: 39-02-4586-9954

Sales Territory: Italy

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Watlow Limited

Robey Close
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Linby, Nottingham, England
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Phone: 44-115-964-0777
FAX: 44-115-964-0071

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Latin American Sales Office

Mexico

Watlow de Mexico, S.A. de C.V.

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Col. Parques Industriales
Queretaro, Qro., Mexico CP-76130
Phone: 011-52-42-17-6235
FAX: 011-52-42-17-6403

Sales Territory: Latin America and
Puerto Rico

Corporate Headquarters

Watlow

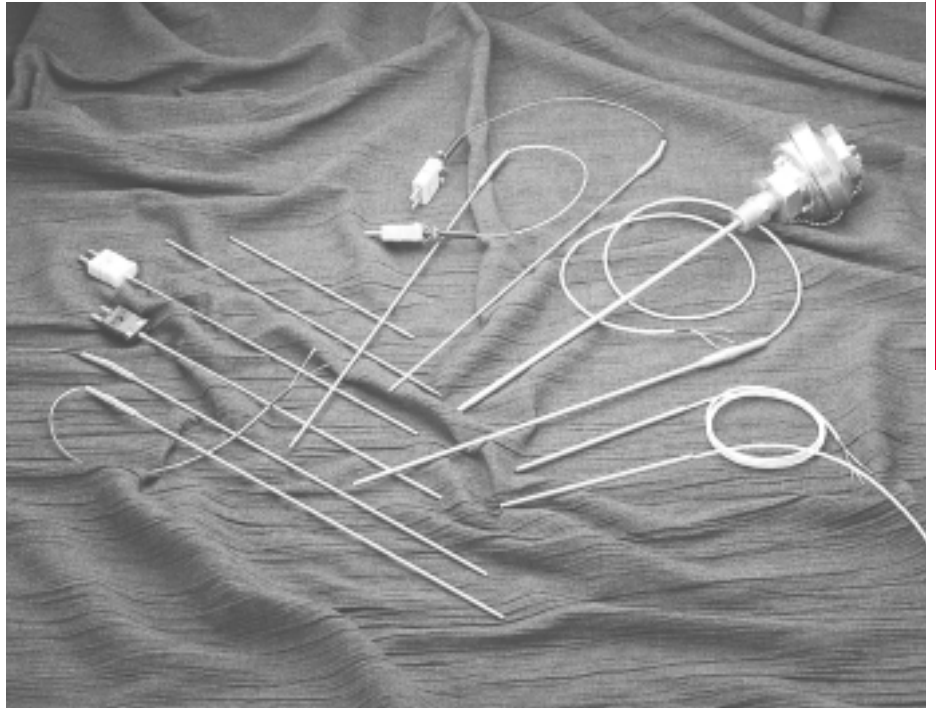
12001 Lackland Road
St. Louis, Missouri 63146
Phone: 314-878-4600
FAX: 314-878-6814

Sales Territory: All countries and
Canadian provinces not specified in
U.S. sales office list.

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 can not possibly address every question in a few short pages, Watlow provides complete product support through our customer service, sales engineers and distribution network.



- **Which temperature sensor is the best choice for my application?14**
- **What sheath material is the best for my application?15**
- **What is the initial accuracy of temperature sensors?16-17**
- **What do thermocouple letter designations mean?18**
- **What letter of calibration should I use?19**
- **What are the maximum temperatures of thermocouples?20**
- **What type of junction should I use?21**
- **What is the response time of mineral insulated thermocouples?22**
- **Can I bend sensors to fit in my application?23**
- **Is there a maximum length for thermocouples and thermocouple wiring?24**
- **What should the thermocouple resistance measure?24**
- **Where should my sensor be placed?25**
- **How does electrical noise get in26**
- **The sensor appears to be reading incorrectly, what might be wrong?27-28**

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.

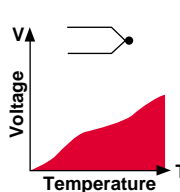
RTDs are best for most industrial measurements over a wide temperature range, especially when sensor stability is essential for proper control.

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.

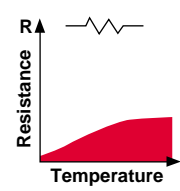
Thermocouples	Advantages	Disadvantages
	<ul style="list-style-type: none"> No resistance leadwire problems Fastest response to temperature changes Simple, rugged Inexpensive High temperature operation Point temperature sensing 	<ul style="list-style-type: none"> Non-linear Low voltage Least stable, repeatable Least sensitive to small temperature changes

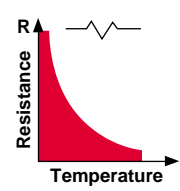
RTDs and Thermistors

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

A variation of the thermistor not covered in this section is the integrated circuit (IC). It's 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.

- Resistance wire RTD
- Thermistor (thermally sensitive resistor)

RTDs	Advantages	Disadvantages
	<ul style="list-style-type: none"> Most stable, accurate Contamination resistant More linear than thermocouple Area temperature sensing Most repeatable Most accurate temperature measurement 	<ul style="list-style-type: none"> Expensive Current source required Self-heating Slow response time Low sensitivity to small temperature changes

Thermistors	Advantages	Disadvantages
	<ul style="list-style-type: none"> High output, fast Two-wire ohms measurement Economic Point temperature sensing High resistance High sensitivity to small temperature changes 	<ul style="list-style-type: none"> Non-linear Limited temperature range Fragile Current source required Self-heating

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 vs. performance. Choose Alloy 600 over 304 SS or 316 SS when temperatures exceed 1650°F (899°C).

When using acids at temperatures below 482°F (250°C) 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	Comments
304 SS	Maximum temperature: 1650°F (899°C). 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 900°-1600°F (482°-871°C) range. Lowest cost corrosion resistant sheath material available.	304 SS suits most applications and is readily available.
316 SS	Maximum temperature: 1650°F (899°C). Best corrosion resistance of the austenitic stainless steel grades. Good corrosion resistance in H ₂ S. Widely used in the food and chemical industry. Subject to damaging carbide precipitation in 900°-1600°F (482°-871°C) range.	316 SS has more nickel than 304 SS and is used for food applications.
Alloy 600	Maximum temperature: 2150°F (1176°C). Most widely used thermocouple sheath material. Good high temperature strength, corrosion resistance, resistance to chloride ion stress corrosion cracking and oxidation resistance to high temperatures. Do not use in sulfur bearing environments. Good in nitriding environments.	Alloy 600 has the most nickel and the highest temperature rating.
310 SS	Maximum temperature: 2100°F (1150°C). Mechanical and corrosion resistance, similar to but better than 304 SS. Very good heat resistance. This alloy contains 25% Cr, 20% 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: 482°F (250°C) 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 alkalis 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.

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 32°F (0°C)

Calibration Type	Temperature Range °F (°C)		Tolerances (whichever is greater)			
			Standard (°C)		Special (°C)	
Thermocouples ^{① ③}						
B	1600 to 3100	(870 to 1700)	②	(±0.5%)	②	(±0.25%)
E	32 to 1600	(0 to 870)	②	(±1.7 or ±0.5%)	②	(±1.0 or ±0.4%)
J	32 to 1400	(0 to 760)	②	(±2.2 or ±0.75%)	②	(±1.1 or ±0.4%)
K or N	32 to 2300	(0 to 1260)	②	(±2.2 or ±0.75%)	②	(±1.1 or ±0.4%)
R or S	32 to 2700	(0 to 1480)	②	(±1.5 or ±0.25%)	②	(±0.6 or ±0.1%)
T	32 to 700	(0 to 370)	②	(±1.0 or ±0.75%)	②	(±0.5 or ±0.4%)
E ^④	-328 to 32	(-200 to 0)	②	(±1.7 or ±1%)	②	⑤
K ^④	-328 to 32	(-200 to 0)	②	(±2.2 or ±2%)	②	⑤
T ^④	-328 to 32	(-200 to 0)	②	(±1.0 or ±1.5%)	②	⑤
Extension Wires ^{⑥ ⑦}						
EX	32 to 400	(0 to 200)	±3.0	(±1.7)	±1.8	(±1.0)
JX	32 to 400	(0 to 200)	±4.0	(±2.2)	±2.0	(±1.1)
KX or NX	32 to 400	(0 to 200)	±4.0	(±2.2)	±2.0	(±1.1)
TX	32 to 200	(0 to 100)	±1.8	(±1.0)	±0.9	(±0.5)
Compensating Extension Wires ^{⑧ ⑨}						
BX ^⑩	32 to 400	(0 to 200)	±7.6	(±4.2)	*	*
CX	32 to 500	(0 to 260)	±12.2	(±6.8)	*	*
RX, SX	32 to 400	(0 to 200)	±9.0	(±5.0)	*	*

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 on page 20. 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 0°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% (whichever is greater); Type T: -200 to 0°C ±0.5 or ±0.8% (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 32 to 125°F (0 to 50°C), where the use of non-compensated (copper/copper) conductors introduces no significant error. For a somewhat larger temperature gradient of 32 to 210°F (0 to 100°C) 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 1800°F (1000°C). Proprietary alloy compensating extension wire is available for use over 32 to 400°F (0 to 200°C) temperature range.

* Special tolerance grade compensating extension wires are not available.

Application Hints

What is the initial accuracy of temperature sensors?

Generally speaking, if accuracy is your most important concern and the application temperature is between 284°F and 1202°F (140°C and 650°C), **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)	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: $\pm[0.15 + 0.002 |t|]^{\circ}\text{C}$

DIN class B: $\pm[0.30 + 0.005 |t|]^{\circ}\text{C}$

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

Thermistors

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

Epoxy Bead Tolerance ±1%Ω (+0.3°C)			Glass Bead Tolerance ±15%Ω (+3°C)	
#10	300Ω	-76 to 212°F (-60 to 100°C)	#16	100,000Ω -76 to 500°F (-60 to 260°C)
#11	1000Ω	-76 to 302°F (-60 to 150°C)		
#12	3000Ω	-76 to 302°F (-60 to 150°C)		

*Other thermistors available on request.

Application Hints

What do thermocouple letter designations mean?

Thermocouples are classified by *calibration type* because they have differing EMF (electromotive force) vs. temperature curves. Some generate considerably more voltage at lower temperatures, while others don't 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 vs. 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	Popular Generic and Tradenames
B	2500-3100°F (1370-1700°C)	Platinum 30% Rhodium (BP) Platinum 6% Rhodium (BN)
C*	3000-4200°F (1650-2315°C)	W5Re (Tungsten 5% Rhenium) (CP) W26Re (Tungsten 26% Rhenium) (CN)
E**	200-1650°F (95-900°C)	Chromel®, Tophel®, HAI-KP® (EP) Constantan, Cupron®, Advance® (EN)
J	200-1400°F (95-760°C)	Iron (JP) Constantan, Cupron®, Advance® (JN)
K**	200-2300°F (95-1260°C)	Chromel®, Tophel®, HAI-KP® (KP) Alumel®, Nial®, HAI-KN® (KN)
N	1200-2300°F (650-1260°C)	Nicrosil (NP) Nisil (NN)
R	1600-2640°F (870-1450°C)	Platinum 13% Rhodium (RP) Pure Platinum (RN)
S	1800-2640°F (980-1450°C)	Platinum 10% Rhodium (SP) Pure Platinum (SN)
T**	32-660°F (0-350°C)	Copper (TP) Constantan, Cupron®, Advance® (TN)

*Not an ASTM E 230 symbol

**Also suitable for cryogenic applications from -328 to 32°F (-200 to 0°C)

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Cupron®, Nial®, and Tophel® are registered trademarks of Carpenter Technology.

Advance®, HAI-KP® and HAI-KN® are registered trademarks of Harrison Alloys Company.

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 1650°F (900°C) 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 1000°F (540°C), it is recommended that larger gauge wires be used to compensate. Maximum recommended operating temperature is 1400°F (760°C).

Type K

Due to its reliability and accuracy, Type K is used extensively at temperatures up to 2300°F (1260°C). 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 2300°F (1260°C). 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—330° to 660°F (-200° to 350°C), but it can be used to -452°F (-269°C) (boiling helium).

Types S, R and B

Maximum recommended operating temperature for Type S or R is 2640°F (1450°C); Type B is recommended for use at as high as 3100°F (1700°C). 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% Re/W-26% Re)

This refractory metal thermocouple may be used at temperatures up to 4200°F (2315°C). Because it has no

resistance to oxidation, its use is restricted to vacuum, hydrogen or inert atmospheres.

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.

Recommended Upper Temperature Limit for Protected Thermocouple Wire

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

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

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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 leadwire 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



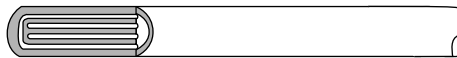
On this type, the thermocouple junction is fully insulated from the welded sheath end. The ungrounded junction is excellent for applications where stray EMFs would affect the reading and for frequent or rapid temperature cycling. Response time is longer than for the grounded junction.

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.

Ungrounded Dual Common Junction



Two sensors in one sheath but the junctions are welded together. Available in both grounded or ungrounded junctions.

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're 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.

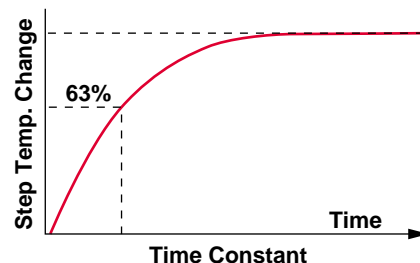
Several factors come into play. The most commonly noted is "time constant" (thermal response time). Time constant, or thermal response time, is an expression of how quickly a sensor responds to temperature changes. As expressed here, time response is defined as how long it takes a sensor to reach 63.2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

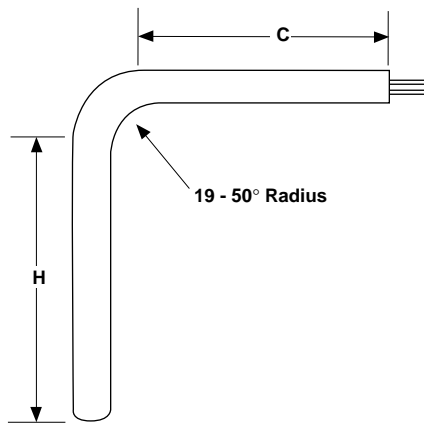
*Readings are to 63% of measured temperatures.

Application Hints

Can I bend sensors to fit in my application?

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 can 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 RTD's 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



Customer Assistance

Mineral Insulated Thermocouples

Diameter inch	Standard Bend Radius inches	Minimum "H" Dimension inches	Minimum "C" Dimension inches
0.063	3/16	1/2	1 1/2
0.090	1/4	3/4	1 1/2
0.125	3/8	1*	2
0.188	1/2	1*	2
0.250	3/4	2	2
0.313	1 1/4	2	2
0.375	1 1/2	3	2
0.500	2	4	2

*For RTDs a minimum of 2 inches.

General Application Thermocouples

Diameter inch	Standard Bend Radius inches	Minimum "H" Dimension inches	Minimum "C" Dimension inches
0.125	3/8	1	2
0.188	3/8	1	2
0.250	1/2	2	2
0.375	3/4	3	2

RTDs and Thermistors

Diameter inch	Standard Bend Radius inches	Minimum "H" Dimension inches	Minimum "C" Dimension inches
0.125	3/8	1	2
0.188	3/8	1	2
0.250	1/2	2	2

Application Hints

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**.

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 leadwire 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

B & S Gauge	Diameter inch (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.

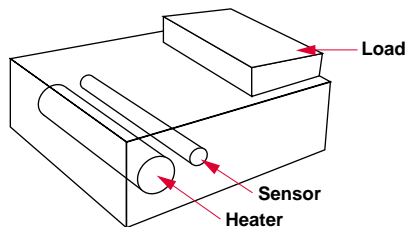
Application Hints

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 that 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.

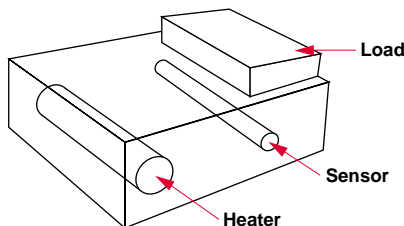
Sensor in a Static System



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

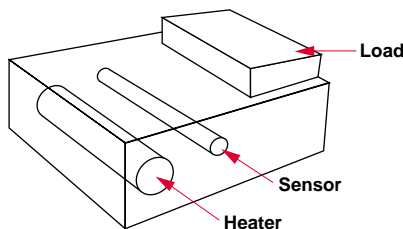


We call a system "dynamic" when there is rapid thermal response from the heat source, rapid thermal transfer and frequent changes in the work load. When the system is dynamic, placing the sensor closer to the work load will enable the sensor to "see" the load temperature change faster, and allow

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 half-way 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 that 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.

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's 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 that 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 leadwires 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.

Application Hints

The sensor appears to be reading incorrectly, what might be wrong?

1. Sensor and Control

Agreement—Verify that 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. For:

- **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 100 Ω resistor would indicate 0°C for a 100 Ω RTD.

3. Check Instrument Connection

Verify that 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 that 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 RTD's 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 that 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

Application Hints

The sensor appears to be reading incorrectly, what might be wrong?

Continued

sensor plus the resistance of lead resistance 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 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 $\frac{1}{2}$ 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.

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. At the back end, 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; always stretching the limits, always searching for the better way to handle unique applications. We offer testing for:

- **Time response** to measure 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** to 1700°C (3090°F).
- **Cryogenic temperatures** 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% RH (200°F/95% 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 $\overline{=}$ (dc).



A lab service technician calibrates sensors to verify that they meet NIST standards.

Lab Services

Prototype Testing and Quality Certification

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.

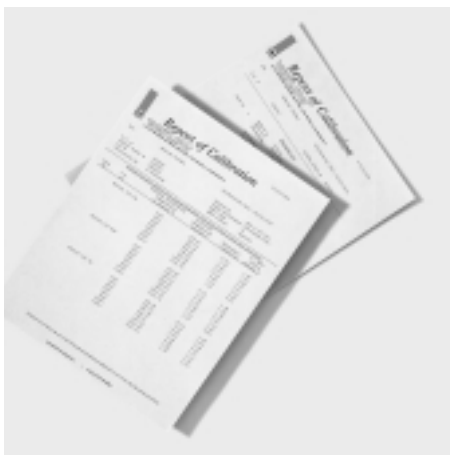
- Vibration testing was provided for a prototype sensor mounted on the shaft bearings of a large diesel engine. Watlow product and field engineers worked with the customer to develop a vibration dampening design.
- Watlow engineers selected materials and developed several configurations to answer a customer's 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.

Lab Services

Prototype Testing and Quality Certification

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. We at Watlow are able to meet this demand with our complete testing and certification services.

Watlow provides certification to verify the finished sensor is built to allowable 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).

MIL-STD-45662 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'll 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.

At an additional cost, we'll perform the requisite tests and calibrations, and provide all necessary documentation.

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** to measure an insulation's performance in the presence of electrical discharges.
- **Helium leak testing** to verify sheath integrity.
- **Radiographic (X-ray) inspection** for internal defects, dimensional compliance and inclusions.
- **Liquid penetrant testing** for surface defects.
- **Metallographic examination** to evaluate constituents and structures of alloys.
- **Compaction density testing** to determine compaction of mineral insulations in metal sheathed cables.
- **Thermal cycling** to assure ruggedness under thermal transients.
- **Micro-hardness:** Vicker's scale destructive test used to determine sheath hardness.



For ASTM Standard E 230 tables, based on the ITS 90 scale, see Watlow's Thermocouple Temperature vs. EMF Outputs Reference Guide.

Lab Services

Prototype Testing and Quality Certification

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 16.

Recommended Sensor Straight Length Required for Calibration

Temperature °C (°F)	Length inch (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 inch (150 mm), but shorter than the stated length minimum of 15 inch (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 thermo-elements 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)	

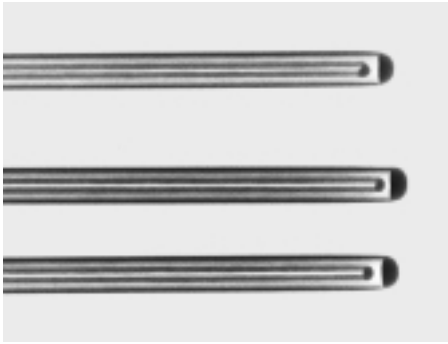
*Maximum temperatures vary depending on thermocouple type.

Lab Services

Prototype Testing and Quality Certification

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.

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.

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,
Liquid Penetrant Test	Detection of small surface defects using fluorescent post-emulsification methods. Technicians qualified under SNT-TC-1A.	ASTM E 165,
Metallographic Examination	Reveals the constituents and structures of metals. Also available: photomicrographs to determine and document average grain size and structure of prepared specimens.	ASTM E 3, E 112, E 235

CONTINUED

Lab Services

Prototype Testing and Quality Certification

Quality Certification Lab

Continued

Certification Testing

Service	Description	Specifications
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

Custom Engineered Sensors

Solving the Industries Most Difficult Application Problems

Watlow has been servicing the demands of the temperature measurement market since 1914. Over 85 years of experience has propelled us to become a leader in the design and manufacturing of custom temperature sensors. We bring a long history of innovation, technical experience and the dedicated need to solve the industries most difficult and demanding applications.

Our staff of engineers, along with our in-house testing, calibration and manufacturing capabilities is prepared to design the most accurate and reliable sensor possible.



Accurate sensing in radio frequency environments.



High temperature ribbon surface sensing.



Durable engine exhaust gas probes.



Fast responding small mass sensors.

Custom Engineered Sensors



Use Form 434 on page 37 to fax us your sensor application information.

Custom Engineered Sensors

Technical Data

Quality Assurance

Watlow's Quality Assurance System for sensor products is ISO 9001 certified. Our process begins at the very source of our raw materials.

With your order we can provide documentation certifying the traceability of the materials used and attesting to their quality.

In-process inspection and testing is performed throughout the manufacturing cycle and verified by our technicians' system of "checks and balances."

While observing the most rigid specifications and quality surveillance criteria, we retain the flexibility and capability to supply our customers with considerable economy.

Watlow adheres to the many standard specifications that govern the manufacture of high-grade thermocouples and mineral insulated, metal-sheathed cable. Additional customer requirements often call for compliance with one or more of the following specifications:

Number	Title
ASTM E 2	Metallurgical examination
ASTM E 3 E 112	Procedures and requirements
ASTM E 94 E 142 E 165	Non-destructive testing procedures and requirements
ASTM E 207 E 220 E 230	Calibration of thermocouples
ASTM E 585-88	Standard specification for sheathed base-metal thermocouple material
ASTM E 839-89	Standard test methods for sheathed thermocouples and sheathed thermocouple material
ASTM E 235	Nuclear grade thermocouple materials and assemblies

Manufacturing Capabilities

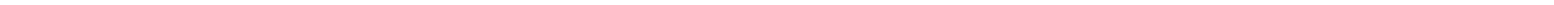
- Special tube cleaning facilities.
- Insulation baking to 2000°F (1090°C).
- A controlled near-clean room environment for the assembly of tubes, insulators and wire.
- Swaging machines to reduce materials to various diameters.
- Draw machines for effective sheath reductions from 0.500 to 0.010 inches O.D.
- Special constructions—dual element and dual diameter thermocouples.
- Annealing furnaces for heat treating and quenching in reducing or inert atmospheres.
- Induction brazing and annealing.
- A controlled environment for assembly and other fabricating processes. Highlights of these operations include:
 - TIG and plasma welding of "G" grounded or Class 1 and 3 junctions; "U" ungrounded or Class 2 and 4 junctions; "E" exposed junctions; plus numerous variations of these: caps, seals and special weldments such as pads, ferrules, etc. Watlow welders are qualified to perform special welding procedures required for aerospace thermocouples.
 - End seals of various types and techniques, with time-cycled auto-curing of epoxies, etc.
- In-process testing, including polarity, continuity, insulation resistance, wire resistance, visual and metallurgical examination, dimensional checks, etc.
- Miscellaneous fitting and adapter applications.
- Special storage and in-process facilities to prevent moisture and contaminants from entering the insulation.
- Straightening and coiling machines and complete packaging equipment.

Custom Engineered Sensors

Form 434

Customer (Name, Address, Phone)			Dimensioned Sketch				Number PR						
Application													
Qty.	Date	Annual Usage											
Territory	Item CL	Product Code											
Thermocouple (Circle one) B E J K N R S T													
Junction: Grounded Ungrounded Exposed			0.00385 0.003916 Ohm/Ohm/°C										
Error Limits: Standard Special			Class: Spec:				Tolerance and Curve:						
Wall Thickness	Wire Diam.	Single Dual	2 3 4 Leadwire		Single Dual								
Wire Watlow Code No (if any):					Length:	Feet	Gauge:	# Conductors:					
Insulation: Singles:					Overall:								
Solid Stranded		Special Requirements:											
Color Code: ASTM Other													
Sheath Material: 316SS Inc 600 Other:								# Conductors:					
Insulation: MgO Al ₂ O ₃ Other:				Compacted		Loosepack		Wire		O.D.: In.			
Testing													
Terminations/Hardware (Fittings, Tubes, Wells, Plugs, etc.)						Additional Information							
Environment Pressure:			psi	Vibration		Shock							
Temperature: Low °F °C		High °F °C		Continuous °F °C									
Atmosphere: Inert Oxidizing			Reducing		Vacuum								
						Please attach drawings, specifications							
Office Use		Product Mgr:			<input type="checkbox"/> Approved <input type="checkbox"/> Disapproved		Engineer:						
		Customer RFQ:			Gordon Quote:		M.O.		G.O.				
Comments:													

Custom Engineered Sensors



Thermocouples

General Applications

Over 85 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 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 stock 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 900°F (480°C) for continuous operation.

Features and Benefits

- **Fast delivery.** Over 5,000,000 thermocouple variations are available for next day shipment.
- **“Custom-tailored” stock products.** Our program includes:
 - 32 standard sheath lengths
 - Lead lengths from six to 999 inches
 - Stainless steel braid or hose protection
 - J, K, T and E calibrations
 - Grounded, ungrounded and exposed junctions
 - Flat and drill point
 - SAE and metric sizes
 - 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.** Watlow can design and build units to meet 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.

Bayonet Cap and Retaining Ring Dimensions

Style	Length	O.D.	I.D.
Standard Cap	0.70 in	0.570/0.530 in	0.453 in
15 mm Cap	17.8 mm	17.5 mm	15 mm
12 mm Cap	17.8 mm	15 mm	12.7 mm
Retaining Ring	NA	0.250 in (6.35 mm)	NA

Tolerances

Tube diameters:

±0.003 inch (0.08 mm)

Hose lengths:

+2 inch/-0 (+51 mm/-0)

Leadwire lengths:

+2 inch/-0 (+51 mm/-0)

Tube lengths:

¾ inch O.D. ±¼ inch
(10 mm O.D. ±6 mm)

all others ±½ inch
(all others ±3 mm)

How to Order

- Determine style of thermocouple required
- Complete the eleven digit code 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

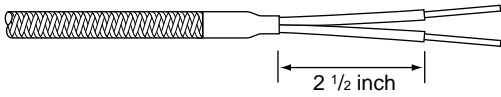
Most thermocouples listed in this section are available for next day shipment.

Thermocouples

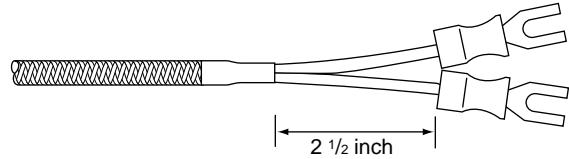
General Applications

Termination Options

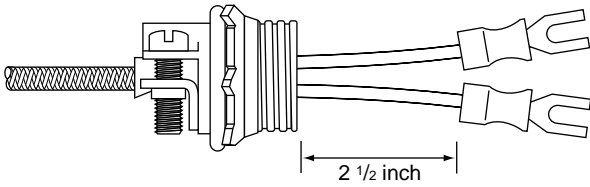
Style A, 2 1/2 inch Split Leads



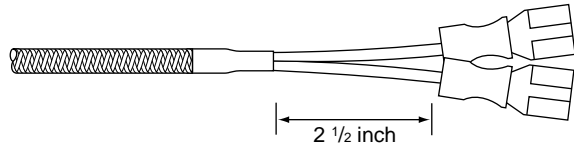
Style B, Spade Lugs



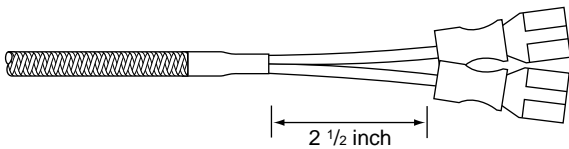
Style C, 1/2 inch BX Connector and Lugs



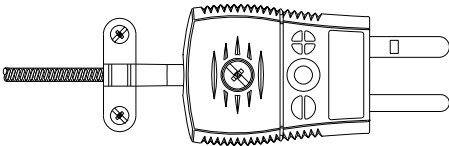
Style H, 1/4 inch Push on Female Disconnect



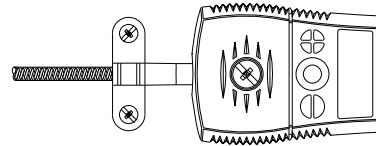
Style J, 3/16 inch Push on Female Disconnect



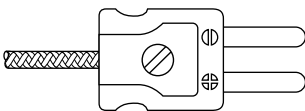
Style D, Standard Size Male



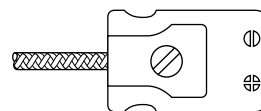
Style E, Standard Size Female



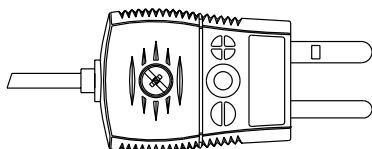
Style F, Miniature Size Male



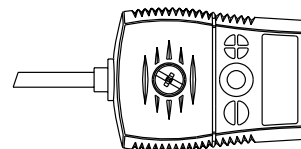
Style G, Miniature Size Female



Style L, Standard Plug on Sheath

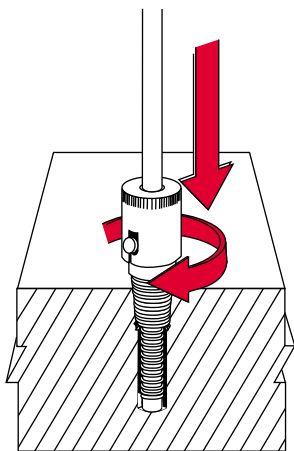
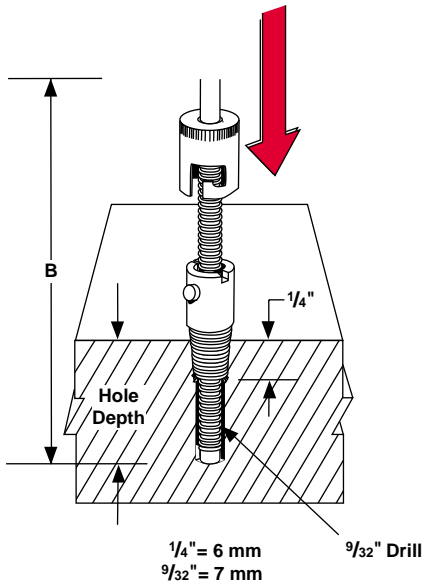


Style M, Standard Jack on Sheath



Thermocouples

General Applications Bayonet Adapters



Installation Procedures for Thermocouples with Bayonet Fittings

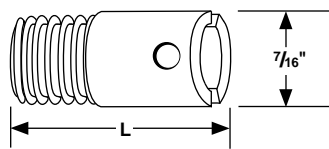
The bayonet adaptor is used in conjunction with the spring loaded bayonet cap attached to the thermocouple sheath. The part to be measured is drilled and tapped

for the installation of the bayonet adaptor. After placing the thermocouple through the adaptor, the spring is compressed and locked with the bayonet cap. This allows the sensing junction to be pushed tightly against the surface for increased accuracy and faster response time.

Hole Depth (inch)	"B" Dimension Adaptor Length inches				
	0.875	1.000	1.500	2.000	2.500
0.25 to 0.49	1.875	2.000	2.500	3.000	3.500
0.50 to 0.99	2.375	2.500	3.000	3.500	4.000
1.00 to 1.49	2.875	3.000	3.500	4.000	4.500
1.50 to 1.99	3.375	3.500	4.000	4.500	5.000
2.00 to 2.49	3.875	4.000	4.500	5.000	5.500
2.50 to 2.99	4.375	4.500	5.000	5.500	6.000
3.00 to 3.49	4.875	5.000	5.500	6.000	6.500
3.50 to 3.99	5.375	5.500	6.000	6.500	7.000
4.00 to 4.49	5.875	6.000	6.500	7.000	7.500
4.50 to 4.99	6.375	6.500	7.000	7.500	8.000
5.00 to 5.49	6.875	7.000	7.500	8.000	8.500
5.50 to 5.99	7.375	7.500	8.000	8.500	9.000
6.00 to 6.49	7.875	8.000	8.500	9.000	9.500

Note: For each additional 1/2 inch of hole depth, add 1/2 inch to "B" dimension.

Bayonet Adapter

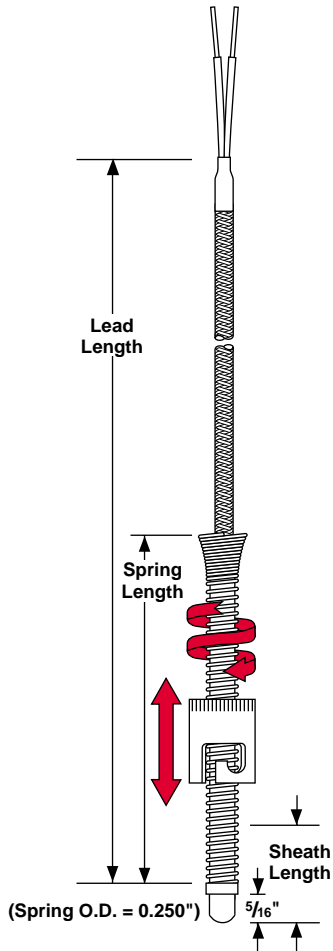


Code No.	Description	L Length inches (mm)	Thread inches
TH-295-1	Bayonet Adapter	3/8 22	1/8 NPT
TH-295-2		1 25	1/8 NPT
TH-295-3		1 1/2 38	1/8 NPT
TH-295-4		2 51	1/8 NPT
TH-295-5		2 1/2 64	1/8 NPT
TH-298-1	3/8 22	3/8 - 24	
TH-298-2	1 1/2 38	3/8 - 24	

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.

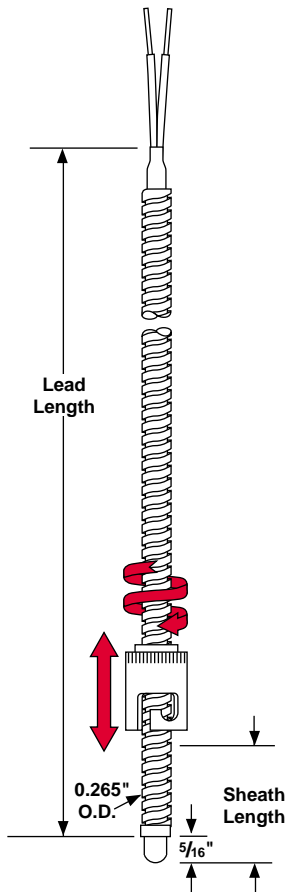
Ordering Information—To order, complete the code number on the right with the information below:

	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), 304 SS	_____										
D = 3/16											
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)											
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 (inches)	_____										
Whole inches: 006 to 999											
Lengths over 999 inches, consult factory											
11. Terminations/Options	_____										
A = Standard, 2 1/2 inch split leads											
B = 2 1/2 inch split leads with #6 spade lugs											
C = 2 1/2 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 = 1/4 inch push-on connector											
J = 3/16 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.

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

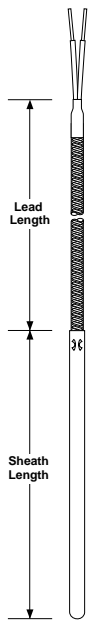
	1	2	3	4	5	6	7	8	9	10	11
1-2. Construction Style 12 = Adjustable armor thermocouple, standard cap	1	2	D				B				
3. Sheath Diameter (inch), 304 SS D = 3/16											
4. Calibration J = Type J K = Type K T = Type T E = Type E											
5. Lead Protection H = Fiberglass with stainless steel hose (24 gauge 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) Whole inches: 006 to 999 Lengths over 999 inches, consult factory											
11. Terminations/Options A = Standard, 2 1/2 inch split leads B = 2 1/2 inch split leads with #6 spade lugs C = 2 1/2 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 = 1/4 inch push-on connector J = 3/16 inch push-on connector											

Thermocouples

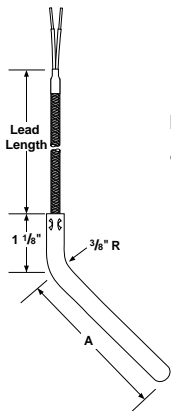
General Applications

Rigid Sheath

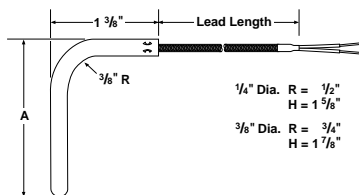
1/8 and 3/16 inch Diameter



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 1/8 inch diameter sheath.

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

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

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), 304 SS

- C = 1/8 S = 1/8 epoxy sealed 300°F
- D = 3/16 T = 3/16 epoxy sealed 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
- 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. Sheath Length (inches)

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

8-10. Lead Length (inches)

Whole inches: 006 to 999
000 = Termination Styles "L" and "M", Lengths over 999 inches, consult factory

11. Terminations/Options

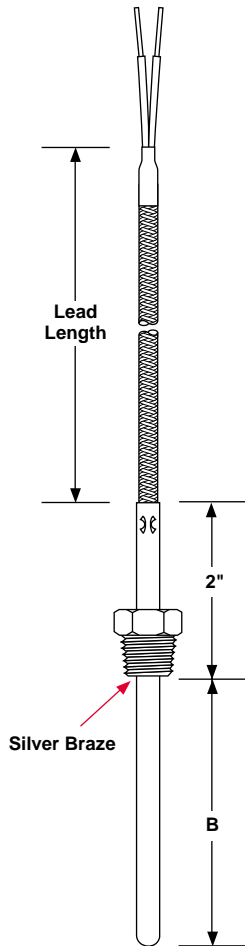
- A = Standard, 2 1/2 inch split leads
- B = 2 1/2 inch split leads with #6 spade lugs
- C = 2 1/2 inch split leads with #6 spade lugs and BX connector
- D = Standard male plug, quick disconnect
- E = Standard female jack, quick disconnect
- F = Miniature male plug, quick disconnect
- G = Miniature female jack, quick disconnect
- H = 1/4 inch push-on connector
- J = 3/16 inch push-on connector
- L = Plug mounted directly on sheath
- M = Jack mounted directly on sheath

Thermocouples

General Applications

Rigid Sheath with Threaded Fitting

1/8 and 3/16 inch Diameter



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

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

1 2 3 4 5 6 7 8 9 10 11

1-2. Construction Style

- 23 = Straight sheath with 1/8" NPT SS fitting
- 24 = Straight sheath with 1/2" NPT SS fitting

3. Sheath Diameter (inch), 304 SS

- C = 1/8" S = 1/8" epoxy sealed 300°F
- D = 3/16" T = 3/16" epoxy sealed 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 = 1/2" D = 2" G = 3 1/2" K = 5" N = 6 1/2" R = 8" U = 9 1/2" Z = 12"
- B = 1" E = 2 1/2" H = 4" L = 5 1/2" P = 7" S = 8 1/2" W = 10"
- C = 1 1/2" F = 3" J = 4 1/2" M = 6" Q = 7 1/2" T = 9" Y = 11"

8-10. Lead Length (inches)

- Whole inches: 006 to 999
- Lengths over 999 inches, consult factory

11. Terminations/Options

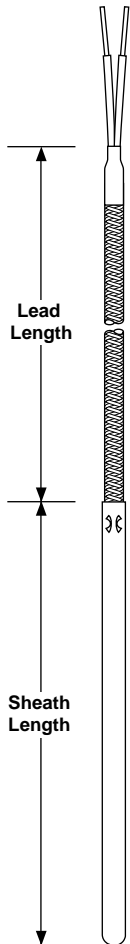
- A = Standard, 2 1/2 inch split leads
- B = 2 1/2 inch split leads with #6 spade lugs
- C = 2 1/2 inch split leads with #6 spade lugs and BX connector
- D = Standard male plug, quick disconnect
- E = Standard female jack, quick disconnect
- F = Miniature male plug, quick disconnect
- G = Miniature female jack, quick disconnect
- H = 1/4 inch push-on connector
- J = 3/16 inch push-on connector

*Not available with 1/8 inch diameter sheath.

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

Thermocouples

General Applications PFA Encapsulated Style



The rigid sheath is covered with a 0.010 inch (0.25 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.

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

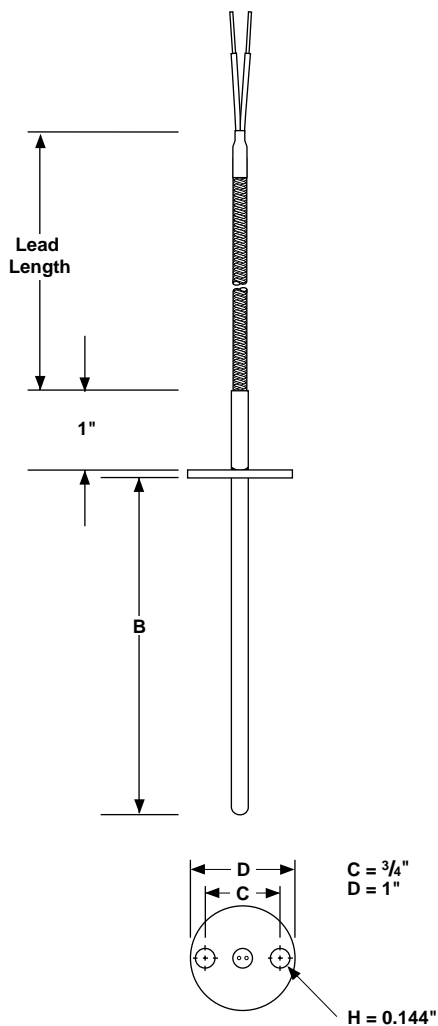
	1	2	3	4	5	6	7	8	9	10	11
1-2. Construction Style	6	5									
65 = PFA coated sheath											
3. Diameter (inch) under covering											
C = 1/8 epoxy seal 300°F											
D = 3/16 epoxy seal 300°F											
E = 1/4 epoxy seal 300°F											
4. Calibration											
J = Type J T = Type T											
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 1/2 R = 8											
C = 1 1/2 K = 5 S = 8 1/2											
D = 2 L = 5 1/2 T = 9											
E = 2 1/2 M = 6 U = 9 1/2											
F = 3 N = 6 1/2 W = 10											
G = 3 1/2 P = 7 Y = 11											
H = 4 Q = 7 1/2 Z = 12											
8-10. Lead Length (inches)											
Whole inches: 006 to 999											
000 = Termination Styles L and M											
Lengths over 999 inches, consult factory											
11. Terminations/Options											
A = Standard, 2 1/2 inch split leads											
B = 2 1/2 inch split leads with #6 spade lugs											
C = 2 1/2 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 = 1/4 inch push-on connector											
J = 3/16 inch push-on connector											

*Not available in 1/8 inch diameter.

Thermocouples

General Applications

Flange Style



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

*Not available with 1/8 inch diameter sheath.

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

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

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), 304 SS

C = 1/8 S = 1/8 epoxy sealed 300°F

D = 3/16 T = 3/16 epoxy sealed 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)

D = 2 H = 4 M = 6 R = 8 W = 10

E = 2 1/2 J = 4 1/2 N = 6 1/2 S = 8 1/2 Y = 11

F = 3 K = 5 P = 7 T = 9 Z = 12

G = 3 1/2 L = 5 1/2 Q = 7 1/2 U = 9 1/2

8-10. Lead Length (inches)

Whole inches: 006 to 999

Lengths over 999 inches, consult factory

11. Terminations/Options

A = Standard, 2 1/2 inch split leads

B = 2 1/2 inch split leads with #6 spade lugs

C = 2 1/2 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

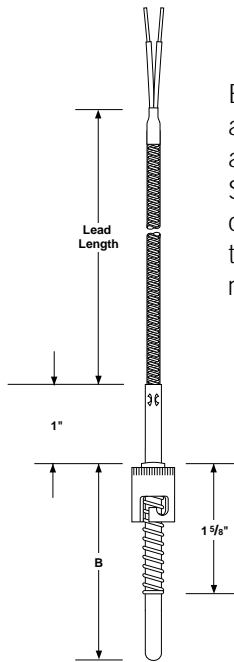
H = 1/4 inch push-on connector

J = 3/16 inch push-on connector

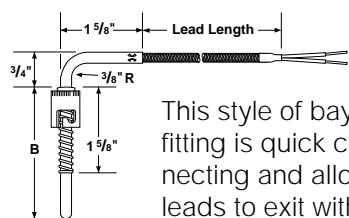
Thermocouples

General Applications

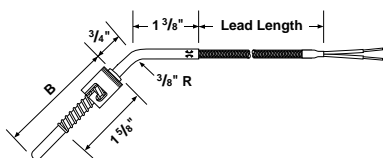
Rigid Sheath Fixed Bayonet Style



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 42 to calculate "B" dimension.

*Not available with 1/8 inch diameter sheath.

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

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

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), 304 SS

- C = 1/8 S = 1/8 epoxy sealed 300°F
- D = 3/16 T = 3/16 epoxy sealed 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" Dimension^① (inches)

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

8-10. Lead Length (inches)

Whole inches: 006 to 999
000 = Termination Styles "L" and "M", Lengths over 999 inches, consult factory

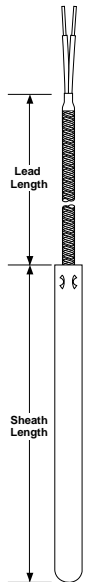
11. Terminations/Options

- A = Standard, 2 1/2 inch split leads
- B = 2 1/2 inch split leads with #6 spade lugs
- C = 2 1/2 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 = 1/4 inch push-on connector
- J = 3/16 inch push-on connector
- L = Plug mounted directly on sheath
- M = Jack mounted directly on sheath
- R = Double slotted 12 mm bayonet cap, split end leads
- S = Double slotted 15 mm bayonet cap, split end leads

Thermocouples

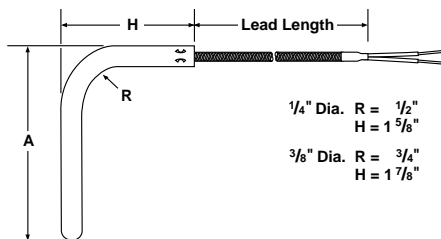
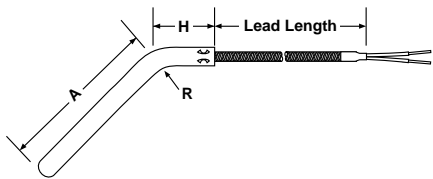
General Applications

Large Diameter Rigid Sheath Style 1/4 and 3/8 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.

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

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), 304 SS

- E = 1/4" U = 1/4" epoxy sealed 300°F
- G = 3/8" V = 3/8" epoxy sealed 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
- R = Ungrounded, flat tip
- U = Ungrounded, round tip
- E = Exposed
- H = Grounded, round tip, dual element
- S = Ungrounded, round tip, dual element

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)

- Whole inches: 006 to 999
- Lengths over 999 inches, consult factory

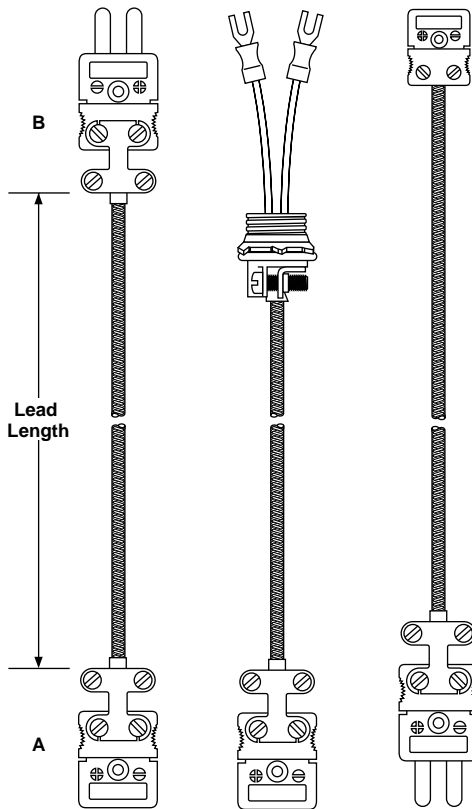
11. Terminations/Options

- A = Standard, 2 1/2 inch split leads
- B = 2 1/2 inch split leads with #6 spade lugs
- C = 2 1/2 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 = 1/4 inch push-on connector
- J = 3/16 inch push-on connector

Thermocouples

General Applications

Flexible Extensions



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

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

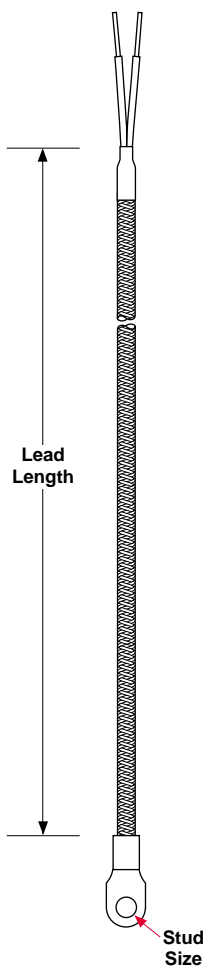
	1	2	3	4	5	6	7	8	9	10	11
1-2. Construction Style 60 = Flexible extension	6	0	X								
3. Diameter X = Not applicable											
4. Calibration J = Type J K = Type K T = Type T E = Type E											
5. Lead Protection F = Fiberglass (24 gauge stranded) S = Fiberglass with stainless steel overbraid (24 gauge stranded) 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							X				
7. Termination "A" A = Standard, 2 1/2 inch split leads B = 2 1/2 inch split leads with spade lugs C = 2 1/2 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 = 1/4 inch push-on connector J = 3/16 inch push-on connector											
8-10. Lead Length (inches) Whole inches: 006 to 999 Lengths over 999 inches, consult factory											
11. Termination "B" A = Standard, 2 1/2 inch split leads B = 2 1/2 inch split leads with #6 spade lugs C = 2 1/2 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 = 1/4 inch push-on connector J = 3/16 inch push-on connector											

* Not available with SS hose.

Thermocouples

General Applications

Ring Terminal Style



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

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

	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

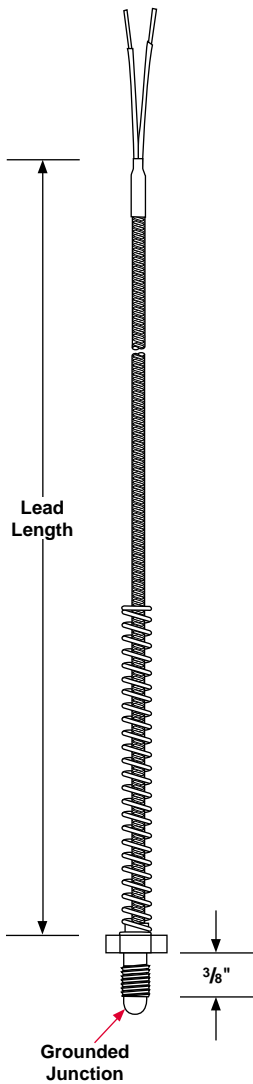
8-10. Lead Length (inches) _____
Whole inches: 006 to 999
Lengths over 999 inches, consult factory

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
J = ⅜ inch push-on connector

* Only available with 24 gauge wire.

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.

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

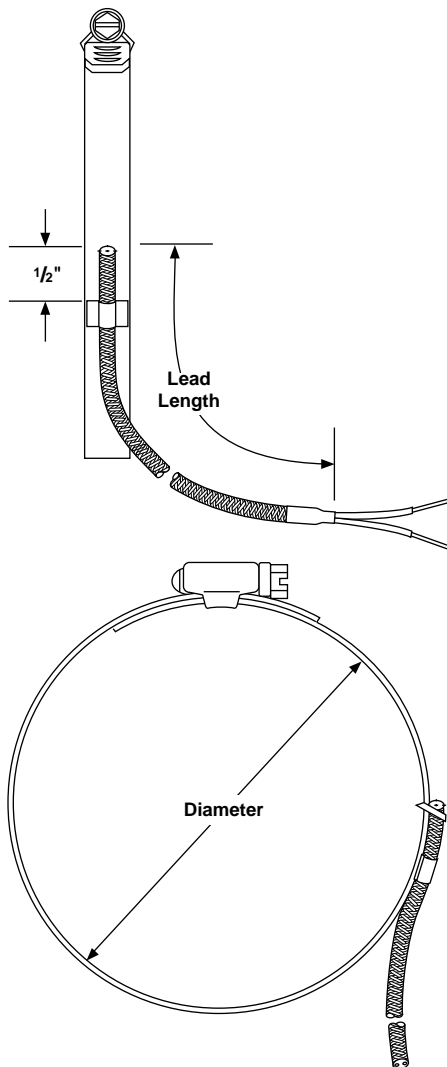
	1	2	3	4	5	6	7	8	9	10	11
	7	1	X			G					
1-2. Construction Style	_____										
71 = Nozzle thermocouple											
3. Diameter	_____										
X = Not applicable											
4. Calibration	_____										
J = Type J T = Type T											
K = Type K E = Type E											
5. Lead Protection	_____										
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 = 1/4 inch X 28 UNF, 3/8 inch thread depth											
* B = 8-32 thread											
* C = 10-32 thread											
M = M6 X 1											
8-10. Lead Length (inches)	_____										
Whole inches: 006 to 999											
Lengths over 999 inches, consult factory											
11. Terminations/Options	_____										
A = Standard, 2 1/2 inch split leads											
B = 2 1/2 inch split leads with #6 spade lugs											
C = 2 1/2 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 = 1/4 inch push-on connector											
J = 3/16 inch push-on connector											

* Only available with 24 gauge wire.

Thermocouples

General Applications

Pipe Clamp Style



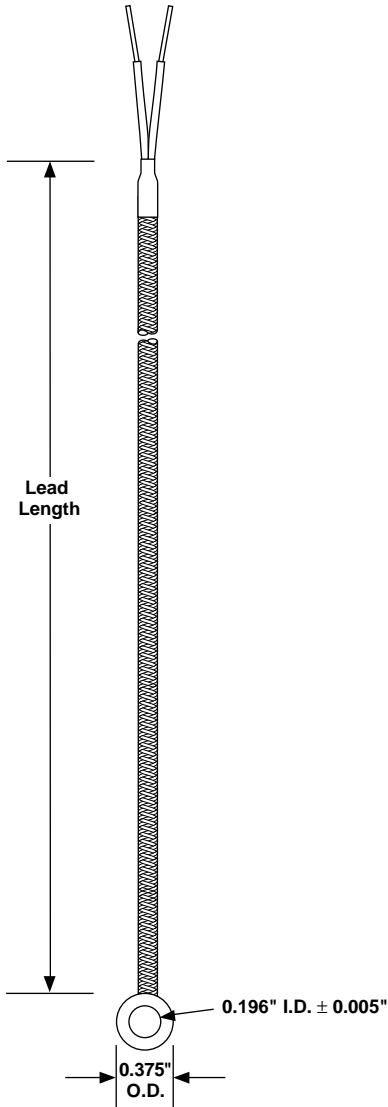
Ordering Information—To order, complete the code number on the right with the information below:

	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 1/4 E = 4 1/4 to 5											
B = 1/4 to 2/4 F = 5 to 6											
C = 2/4 to 3/4 G = 6 to 7											
D = 3/4 to 4 1/4											
8-10. Lead Length (inches)	_____										
Whole inches: 006 to 999											
Lengths over 999 inches, consult factory											
11. Terminations/Options	_____										
A = Standard, 2 1/2 inch split leads											
B = 2 1/2 inch split leads with #6 spade lugs											
C = 2 1/2 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 = 1/4 inch push-on connector											
J = 3/16 inch push-on connector											

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

Thermocouples

General Applications Grommet Style



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

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

	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

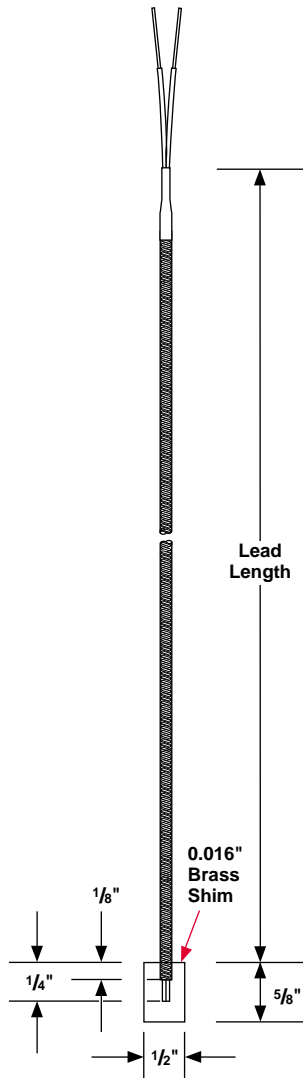
8-10. Lead Length (inches) _____
Whole inches: 006 to 999
Lengths over 999 inches, consult factory

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
J = ⅜ inch push-on connector

Thermocouples

General Applications

Brass Shim Style



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

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 = 1/2 inch X 3/8 inch X 0.016 inch, brass

8-10. Lead Length (inches)

Whole inches: 006 to 999

Lengths over 999 inches, consult factory

11. Terminations/Options

A = Standard, 2 1/2 inch split leads

B = 2 1/2 inch split leads with #6 spade lugs

C = 2 1/2 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 = 1/4 inch push-on connector

J = 3/16 inch push-on connector

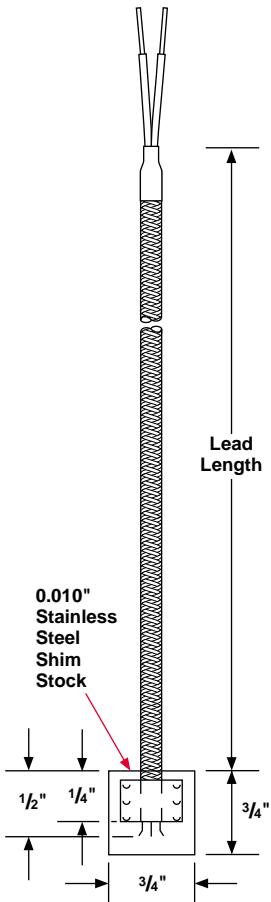
The shim stock thermocouple has low profile and can be placed between components for measurement of surface temperature.

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

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.

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

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

6. Junction
G = Grounded

7. Shim Size (inch)
A = 3/4 inch X 3/4 inch X 0.010 inch, 304 stainless steel

8-10. Lead Length (inches)
Whole inches: 006 to 999
Lengths over 999 inches, consult factory

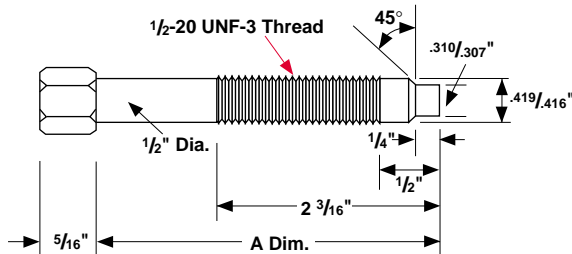
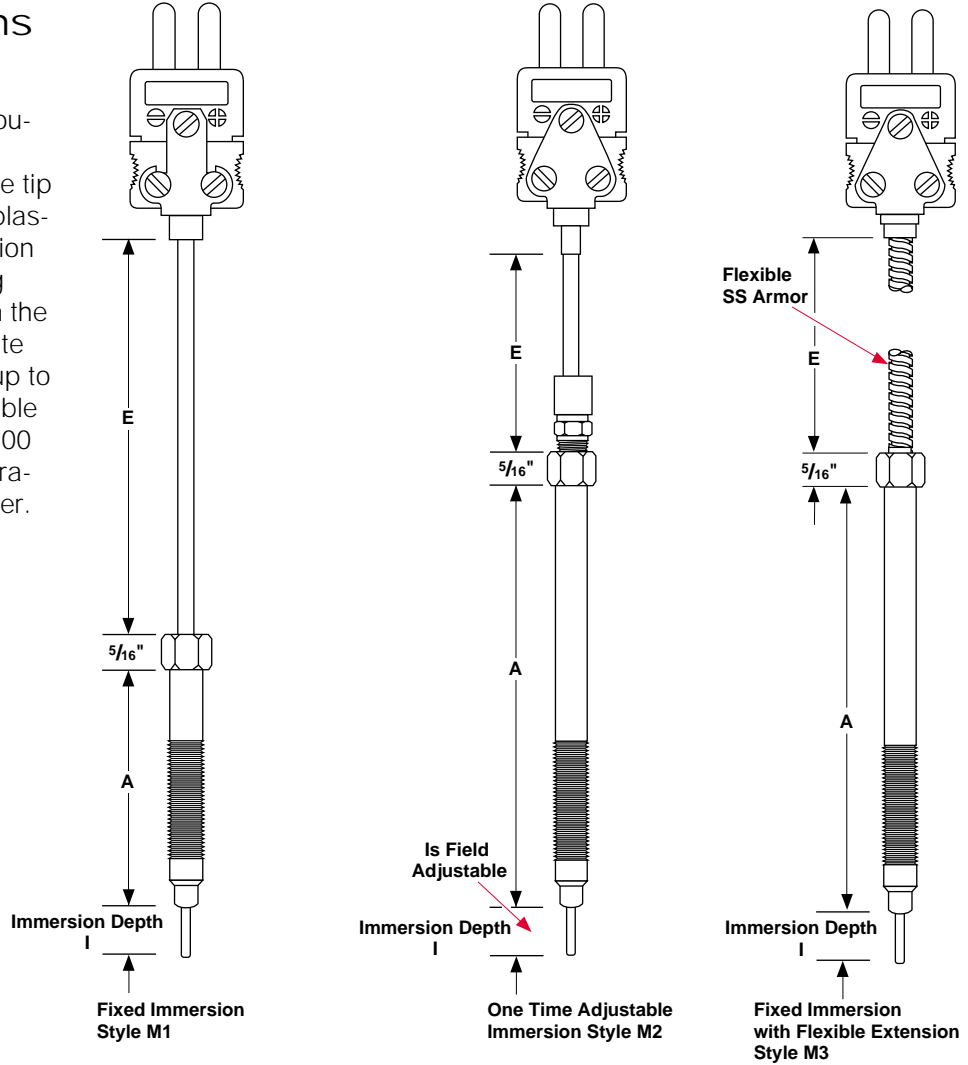
11. Terminations/Options
A = Standard, 2 1/2 inch split leads
B = 2 1/2 inch split leads with #6 spade lugs
C = 2 1/2 inch split leads with #6 spade lugs and BX connector
D = Standard male plug, quick disconnect
E = Standard female jack, quick disconnect
F = Miniature male plug, quick disconnect
G = Miniature female jack, quick disconnect
H = 1/4 inch push-on connector
J = 3/16 inch push-on connector

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 500°F (260°C) continuous. Available in J or K calibration only. Bolt is 300 series stainless steel. Other calibrations are available on special order.



Thermocouples

General Applications

Melt Bolt Thermocouple

Continued

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

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
M															
2. Style															
1 = Fixed immersion															
2 = Adjustable immersion															
3 = Fixed immersion with flex armor															
3. Sheath O.D. (inch)															
G = 0.125															
H = 0.188															
4. Leadwire 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															
X = Other, please specify															
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 5 = 5															
2 = 2 6 = 6															
3 = 3 X = Other															
4 = 4 0 = Flush															
10. Immersion Length "I" (fractional inch)															
1 = 1/8 5 = 5/8															
2 = 1/4 6 = 3/4															
3 = 3/8 7 = 7/8															
4 = 1/2 0 = Flush															
11. Junction															
U = Ungrounded															
G = Grounded															
12. Calibration															
Standard Limits J K															
Special Limits 3 4															
13-14. Extension Length "E"															
Whole inches: 02 to 99															
15. Special Requirements															
If none, enter "0". If required, consult factory															

Thermocouples

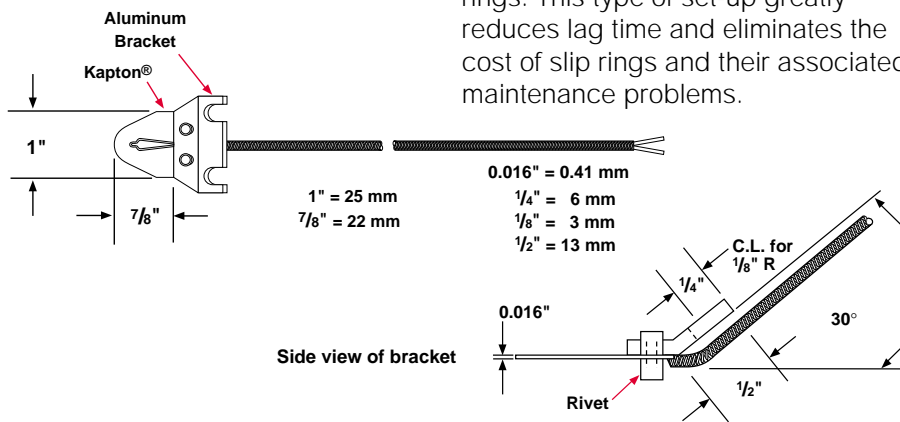
General Applications

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.

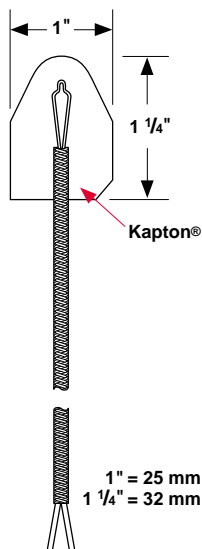
- Continuous use at 400°F (200°C), 500°F (260°C) for limited periods
- Low mass
- Fast response
- Totally insulated construction
- Available in Type J or K



Kapton® Thermocouple with Bracket

Code No.	Calibration	Lead Length inches (cm)	
OKJ30B4A	J	48	122
OKJ30B4B	J	96	244
OKK30B2A	K	48	122
OKK30B2B	K	96	244

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 inch (0.4 mm), so that it doesn't interfere with fit or thermo conductivity.

Code No.	Calibration	Lead Length inches (cm)	
OKJ30B2A	J	48	122
OKJ30B2B	J	96	244
OKK30B1A	K	48	122
OKK30B1B	K	96	244

All units stocked with 30 gauge solid thermocouple wire, with fiberglass insulation and split leads.

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 400°F (200°C).

Code No.	Calibration	Lead Length inches (cm)	
OKK30B10A	K	48	122
OKK30B10B	K	96	244
OKJ30B11A	J	48	122
OKJ30B11B	J	96	244
OKT30B12A	T	48	122
OKT30B12B	T	96	244

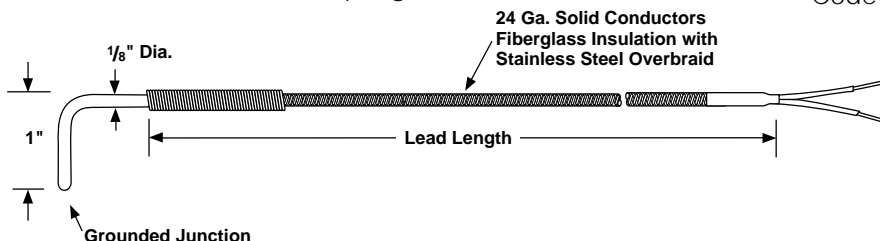
Newbury Nozzle Style

A direct replacement for OEM Type J nozzle thermocouples held in place with a set screw. The sheath is 1/8 inch diameter with a 90° bend and a spring strain relief.

Ordering Information

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

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



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

Thermocouples

Mineral Insulated

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

These thermocouples are manufactured with 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 2200°F (1200°C)
- Meets or exceeds initial calibration tolerances per ASTM E 230

Features and Benefits

- **Special mineral insulation** protects thermocouple from moisture and thermal shock, and permits operation in high temperature, high pressure environments.
- **Small diameters**—as little as 0.010 inch (0.25 mm)—are an excellent choice when physical space or extremely fast response are critical.
- **Rigid quality control procedures** assure high standards are met consistently in the manufacturing of XACTPAK.
- **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.
- **A wide range of sheath materials, diameters, and calibrations** are available to meet your specific requirements.
- **In-house manufacturing** of XACTPAK material assures single source reliability and permits faster turnaround times.
- **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

Mineral Insulated

Applications and Technical Data

Sheath Materials

Virtually any malleable metal can be used as XACTPAK sheath material. Unless otherwise specified, XACTPAK is annealed in a protective atmosphere.

Listed at right are some of the more commonly used materials and their maximum continuous operating temperatures in an oxidizing atmosphere. For temperatures exceeding 2200°F (1200°C), noble or refractory metals are used for sheathing. See the Special Applications section of this catalog, [pages 83 to 98](#).

Sheath Material	Ordering Code (7th digit in code number)	Description
304 SS	A	Maximum temperature: 1650°F (899°C). 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 900°-1600°F (482°-871°C) range. Lowest cost corrosion resistant sheath material available.
316 SS	F	Maximum temperature: 1650°F (899°C). Best corrosion resistance of the austenitic stainless steel grades. Good corrosion resistance in H ₂ S. Widely used in the food and chemical industry. Subject to damaging carbide precipitation in 900°-1600°F (482°-871°C) range.
Alloy 600	Q	Maximum temperature: 2150°F (1176°C). Most widely used thermocouple sheath material. Good high temperature strength, corrosion resistance, resistance to chloride ion stress corrosion cracking and oxidation resistance to high temperatures. Do not use in sulfur bearing environments. Good in nitriding environments.
310 SS	D	Maximum temperature: 2100°F (1150°C). Mechanical and corrosion resistance, similar to but better than 304 SS. Very good heat resistance. This alloy contains 25% Cr, 20% Ni. Not as ductile as 304 SS.
PFA over 304 SS Coating*	C	Maximum temperature: 482°F (250°C) 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 alkalis are present. Examples: food and beverage, pharmaceutical, labs, electroplating, semiconductor processing. Nominal wall thickness of the PFA is 0.010 inch.



See pages 225-226 for a complete list of all the sheath materials that are available.

Calibration Tolerances

The thermocouple material used meets or surpasses initial calibration tolerances as defined by ASTM E 230 Table 1.

Insulation

The insulation used in XACTPAK is high purity or standard purity magnesium oxide with other insulation types available on request. During the manufacturing process, the insulation is highly compacted, which excludes air from the sheath, retards moisture absorption and prevents "powdering

out." The high degree of compaction also ensures high thermal conductivity and maximum dielectric strength.

Forming

Because XACTPAK sheath material is dead soft and bright annealed, it can be formed or shaped to any contour without risk of cracking. As a rule of thumb, it can be formed on a mandrel twice the outside diameter of the sheath. For example, a 0.125 inch (3.0 mm) thermocouple can be wound around a 0.250 inch (6.35 mm) mandrel.

Welding

Welding, such as to a vessel or pipe, should be made in an inert atmosphere to prevent oxidation of the sheath. When working with XACTPAK extreme caution should be used not to burn through the sheath.



For more information on initial calibration tolerances, turn to page 16.

Thermocouples

Mineral Insulated Assembly Length Tolerances

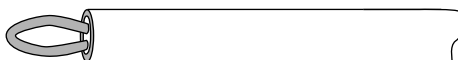
Standard Length Tolerance		
Sheath Diameter inches	Element Length	
	Up to 24 in	Over 24 in
Up to 0.056	$\pm\frac{1}{4}$	$\pm 1\%$
0.057 and larger	$\pm\frac{1}{8}$	$\pm\frac{1}{2}\%$

Flexible Lead Length Tolerance	
Length (inches)	Tolerance (inches)
under 6	+1, -0
6 to 24	+2, -0
Over 24 to 120 (10 feet)	+6, -0
Over 120	+5%, -0

Junction Styles

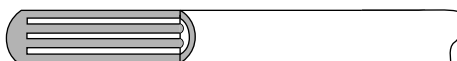
Watlow offers three types of measuring junctions; exposed, grounded and ungrounded. The letters indicate the ordering code.

Exposed Junction (E)



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 (G)



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 (U)



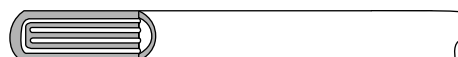
On this type, the thermocouple junction is fully insulated from the welded sheath end. The ungrounded junction is excellent for applications where stray EMFs would affect the reading and for frequent or rapid temperature cycling. Response time is longer than for the grounded junction.

Ungrounded Dual Isolated Junction (W)



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.

Ungrounded Dual Common Junction (V)



Two sensors in one sheath but the junctions are welded together.

Thermocouples

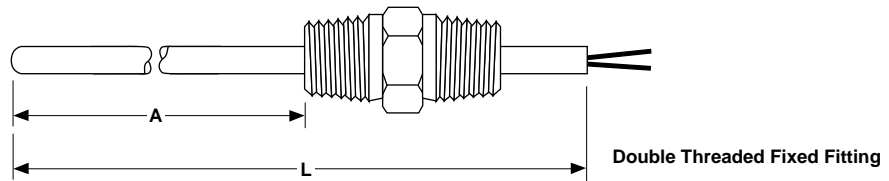
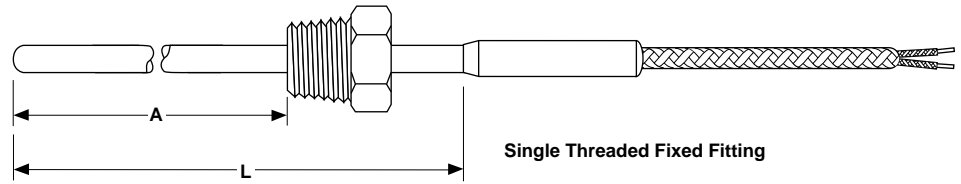
Mineral Insulated

Optional Features

Consult factory for price and availability for all features without an ordering code.

Fixed Fittings

Fixed fittings must be brazed to the sheath and are suitable where the exact immersion depth "A" is known in advance.



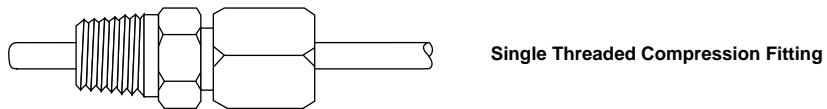
Fixed

Thread	Material	Sheath O.D. inch	NPT inch	Hex inch	Length inches	Order Code
Single	303 SS	0.063 to 0.250	1/8	7/16	1 1/16	—
Single	303 SS	0.250 to 0.375	1/4	7/8	7/8	—
Single	Mild Steel	0.125 to 0.375	1/2	7/8	1	—
Single	303 SS	0.125 to 0.375	1/2	7/8	1	—
Double	Mild Steel	0.125 to 0.375	1/2	7/8	1 3/4	—
Double	303 SS	0.125 to 0.375	1/2	7/8	1 3/4	—

When ordering fixed fittings as part of a sensor, specify the distance "A" in inches from the tip of the measuring junction to the start of threads.

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.



Non-Adjustable

Thread	Material	Sheath O.D. inch	NPT inch	Hex inch	Order Code
Single	Brass	0.125 to 0.250	1/8	1/2	J
Single	303 SS	0.063 to 0.250	1/8	1/2	L

Adjustable

Thread	Material	Sheath O.D. inch	NPT inch	Hex inch	Order Code		
					Neoprene	TFE	Lava
Single	303 SS	0.063 to 0.188	1/8	1/2	N	G	Q
Single	303 SS	0.250 to 0.375	1/4	7/8	P	X	V

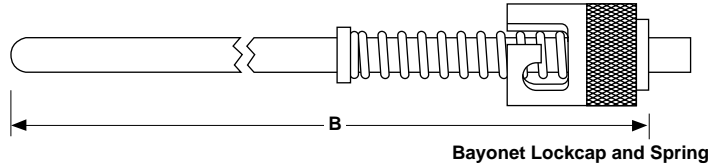
Thermocouples

Mineral Insulated

Optional Features

Continued

Consult factory for price and availability for all features without an ordering code.



Fixed

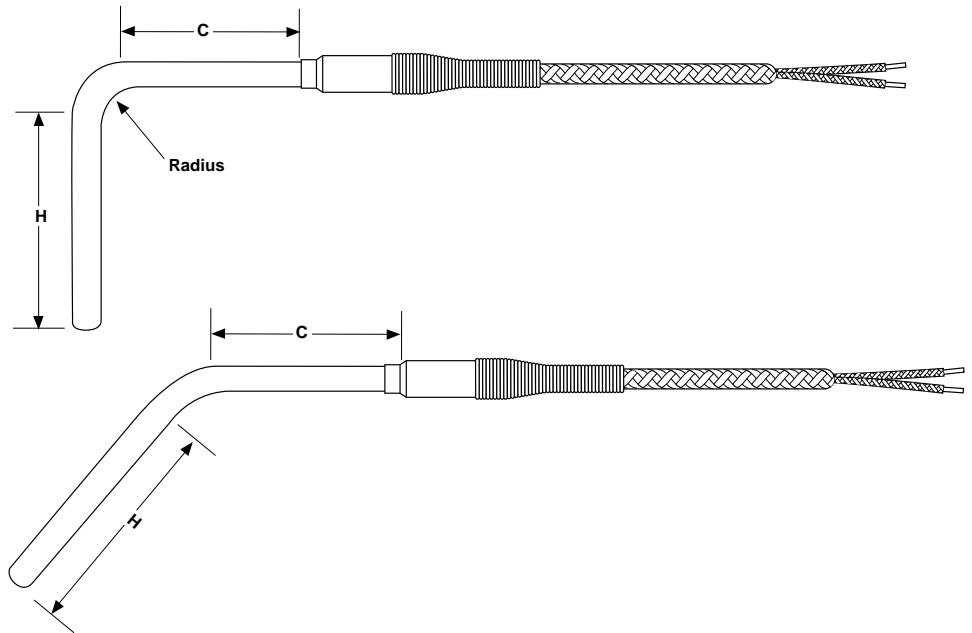
Type	Material	Sheath O.D. inch	Order Code
Fixed	Plated Steel	0.063 to 0.188	—

Bayonet Fittings

When used together, a bayonet fitting and adaptor bottom a sensor in a hole.

Bends

Watlow can provide mineral insulated thermocouples with bends from 15 to 180 degrees. Standard radius are listed with other bends provided upon request. Specify cold leg "C", hot leg "H" and bend angle.



Thermocouple Diameter inch	Standard Bend Radius inches	Minimum "H" Dimension inches	Minimum "C" Dimension inches
0.063	3/64	1/2	1 1/2
0.090	1/4	3/4	1 1/2
0.125	3/8	1	2
0.188	1/2	1	2
0.250	3/4	2	2
0.313	1 1/4	2	2
0.375	1 1/2	3	2
0.500	2	4	2

Thermocouples

Mineral Insulated

Optional Features

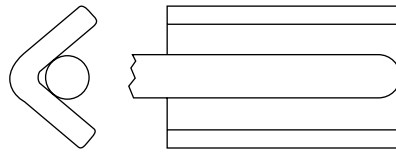
Continued

Consult factory for price and availability for all features without an ordering code.

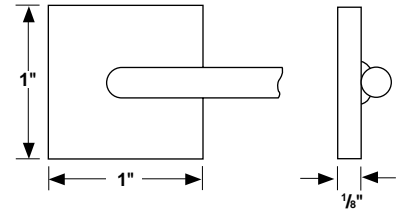
Weld Pads

To facilitate field welding of XACTPAK thermocouples to surfaces such as pipes or tubes, the measuring junction can be fitted with a weld pad. For sheath diameter $\frac{1}{8}$ inch and larger. Weld pads can be formed for improved fit with pipes. Provide factory with required radius.

Series 1

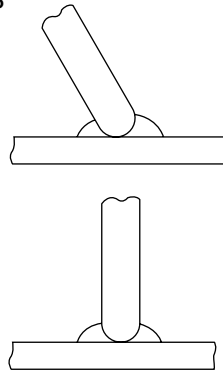


Series 2 — Flat



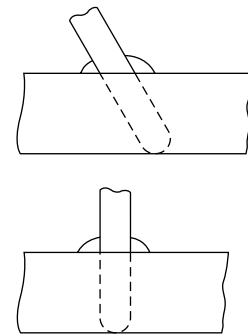
Series 3

0° to 90° ±5°

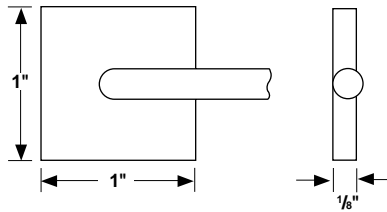


Series 4

0° to 90° ±5°



Series 5 — Milled Slot



	Material	Weld Pad Size	Order Code						
			Series 1	Series 2	Series 3 (45°)	Series 3 (90°)	Series 4 (45°)	Series 4 (90°)	Series 5
SAE (inch)	304 SS*	1 X 1 X $\frac{1}{8}$	—	2	—	—	—	—	5
Metric (mm)	304 SS	2.5 X 2.5 X 3.17	—	2	—	—	—	—	5

* Alloy 600 pads are also available on special order. They are recommended for use with Alloy 600 sheath material.

Thermocouples

Mineral Insulated

Optional Features

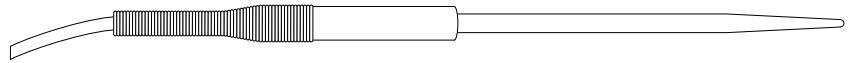
Continued

Consult factory for price and availability for all features without an ordering code.

Tapered Tips

XACTPAK thermocouples can be tapered to a smaller diameter at the measuring junction for faster response. A typical tapered construction is pictured below.

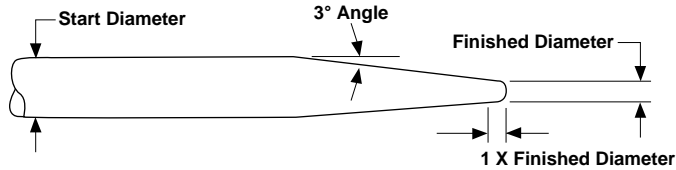
A wide range of possible tapering combinations are available. Consult factory for other combinations and to order tapered tip sensors.



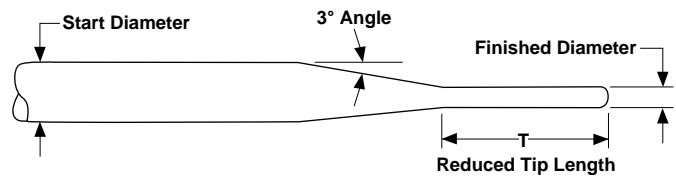
Typical Style AF thermocouple with tapered tip at hot junction for extra fast response.

Taper Styles

Style A



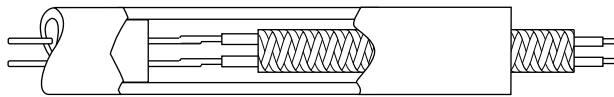
Style B



SAE Outside Diameter (inch)	
From:	To:
0.250	0.188
0.188	0.125
0.125	0.063
0.063	0.040
0.040	0.020

Smooth Transition Thermocouple

With certain installations it is desirable to have the transition from sheath to leads no larger than the sheath diameter. This allows the mounting fitting to be installed on the sheath over the leads. Minimum sheath diameter is 0.188 inch O.D.



Thermocouples

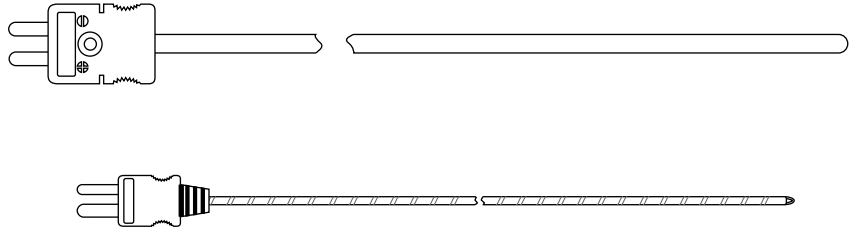
Mineral Insulated

Optional Features

Continued

Consult factory for price and availability for all features without an ordering code.

Molded Plugs



- **Fully molded on plug** withstands extreme vibration, eliminating the problem of intermittent thermocouple signals.
- **Tamper proof molded plug** cannot be disassembled, preventing people from removing the plug and reversing the polarity.
- **ASTM E 230 color coded plugs** allow quick identification of the thermocouple calibration.
- **Available in standard and miniature sizes.**

Molded Transition

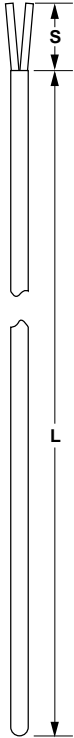


- **Excellent moisture resistance.**
- **Coiled spring strain relief** prevents wire damage due to overflexing.
- **Custom designs** for large range of XACTPAK sheath diameters.

Thermocouples

Mineral Insulated

Cut and Stripped Style AB



The main feature of Watlow's Style AB thermocouple is that 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

- **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.

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

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

3. Sheath O.D. (inch) _____
 A = 0.010 E = 0.063 K = 0.313
 B = 0.020 G = 0.125 L = 0.375
 C = 0.032 H = 0.188 M = 0.500
 D = 0.040 J = 0.250

4. Enter "0" _____

5. Fittings, Weld Pads _____
 If required, enter order code from pages 64-66. If none, enter "0".

6. Enter "0" _____

7. Sheath Material _____
 A = 304 SS Q = Alloy 600
 F = 316 SS D = 310 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 = 1/2
 1 = 1/8 5 = 5/8
 2 = 1/4 6 = 3/4
 3 = 3/8 7 = 7/8

11. Junction _____

	Grounded	Ungrounded	Exposed
Single	G	U	E
Dual, common	H	V	F
Dual, isolated	—	W	D

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 to 3
 1 inch maximum on 0.040 and smaller

14. Strip Length "S" (fractional inch) _____
 0 = 0 4 = 1/2
 1 = 1/8 5 = 5/8
 2 = 1/4 6 = 3/4
 3 = 3/8 7 = 7/8

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

Thermocouples

Mineral Insulated Plug or Jack Termination Style AC



Featuring plug or jack terminations, Style AC thermocouples can be quickly connected or disconnected. Besides saving time, this thermocouple style offers the advantage of ease of use, even by inexperienced personnel. In addition, the thermocouples are color coded per ASTM E 230 specifications so you can easily determine the calibration.

On all Style AC thermocouples except ASTM E 230 Type R and S, the pins and contacts are of the same alloy as the thermocouple, resulting in higher accuracy. This technique eliminates errors due to temperature gradients across the connector. Type R and S connectors have compensating alloys.

Performance Capabilities

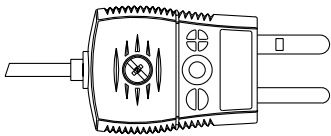
- Ambient rating of 400°F (200°C) on standard and miniature connectors
- High temperature connectors perform to 1000°F (540°C)

Features

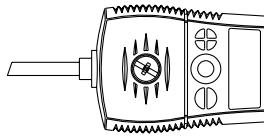
- **Plugs and jacks** are easy to connect and disconnect, saving you time.
- **ASTM color coded connectors** allow quick identification of the thermocouple calibration.
- **Miniature connectors**, available with thermocouple diameters up to 0.125 inch (metric size 3.0 mm), can be used in locations where space is minimal. The miniature plug permits quick connection to portable instrumentation.
- **Matching thermocouple alloys** provide higher accuracy.
- **An adapter** assures the connector is mounted rigidly to the sheath, preventing the connector from turning or twisting.

Connector Types

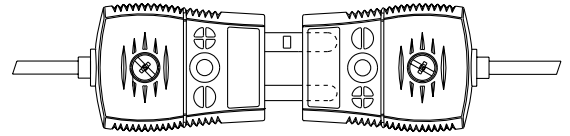
Standard Plug



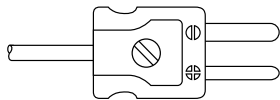
Standard Jack



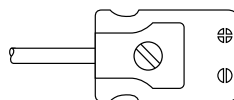
Standard Plug with Mating Connector



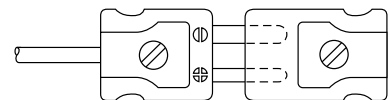
Miniature Plug



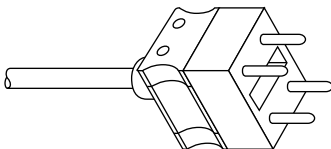
Miniature Jack



Miniature Plug with Mating Connector



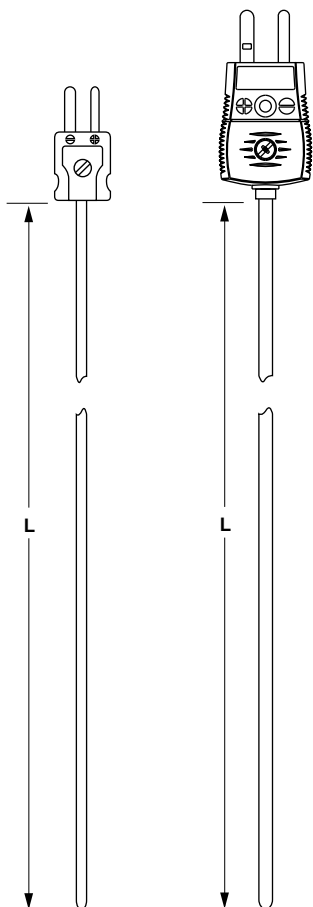
Dual Thermocouple Connector



For a complete description of Watlow plugs and jacks, see the Connectors section, pages 143 to 152.

Thermocouples

Mineral Insulated Plug or Jack Termination Style AC



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

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 H = 0.188
B = 0.020 E = 0.063 J = 0.250
C = 0.032 G = 0.125 K = 0.313

Note: PFA coating only available on E, G, H, J.

4. Connector Type

Standard Plugs and Jacks 400°F (200°C)
(0.313 inch maximum O.D.)

A = Standard plug
B = Standard jack
C = Standard plug with mating connector

Miniature Plugs and Jacks 400°F (200°C)
(0.125 inch maximum O.D.)

F = Miniature plug
G = Miniature jack
H = Miniature plug with mating connector

High Temperature Plugs and Jacks 1000°F (540°C)
(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 64-66](#).
If none, enter "0".

6. Enter "0"

7. Sheath Material

A = 304 SS D = 310 SS
F = 316 SS Q = Alloy 600
C = PFA coated over 304 SS

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

01 to 99
Lengths over 99 inches 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 = ⅙ 3 = ⅓ 5 = ⅝ 7 = ⅞

11. Junction

	Grounded	Ungrounded	Exposed
Single	G	U	E
Dual, common	H	V	F
Dual, isolated	—	W	D

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

If none, enter "0". If required, consult factory.

Thermocouples

Mineral Insulated

Metal Transitions Styles AF, AG and AM



Metal transitions are the distinguishing feature of Styles AF and AG thermocouples. The transition provides a durable, potted connection between the XACTPAK sheathed thermocouple material and the flexible SERV-RITE® insulated wire.

On Style AF, the transition is crimped to the sheath (0.040 inch (1 mm) and larger). Crimping is a quick, reliable method of attachment.

Brazing is typically used on Style AG thermocouples. This transition type helps provide a moisture tight seal.

The Style AM miniature transition thermocouple is designed for limited space applications where size and/or response time are critical. It is designed to give instant readings in various mediums. More accurate readings are possible because of its small size and fast response.

A patented fitting allows visual inspection of the transition area prior to potting for increased reliability.

Performance Capabilities

- Standard maximum continuous operating temperature of 300°F (150°C) for the transition
- High temperature potting compounds are available in 500° and 1000°F (260° and 540°C) ranges for high temperature applications.

Features

- **The transition body** is filled with a potting compound which insulates and strengthens the splice.
- **Coiled spring strain relief** on Style AF protects the wire against sharp bends in the transition area.
- **Custom leadwire terminations** include plug-in jacks, spade lugs, plugs with mating connectors and more.
- **Many made-to-order options** are available in leadwire construction, length, and sheath material.
- **Stranded leadwire construction** is an ideal choice for applications where the lead wire is subjected to continuous flexing.

Applications and Technical Data

How to Select the Right Potting Compound

Watlow offers many different potting compounds for use in filling transition bodies. The standard potting is an epoxy rated at 300°F (150°C). Another epoxy-based compound is available that can handle temperatures up to 500°F (240°C).

Because the epoxy-based compounds provide superior moisture resistance, they are useful in applications where moisture is a problem. However, they should not be used if the transition is in a hot zone where the maximum temperature could be exceeded.

A ceramic based potting rated at 1000°F (540°C) is a popular choice,

but it should not be used in high moisture areas. Even though a sealer is placed over the ceramic potting, this burns off when it is put into use, allowing moisture to penetrate the transition.

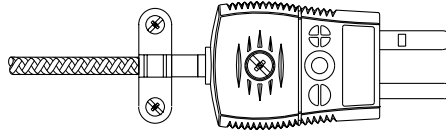
The ceramic potting is recommended for applications where the temperature is high enough to keep moisture from accumulating and the temperature will remain constant.

The use of high temperature potting with FEP leadwire is of questionable value, since the FEP wires are only rated to 400°F. Rather than using the 1000°F potting, specify a 300 or 500°F potting.

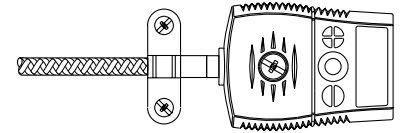
Thermocouples

Mineral Insulated
Styles AF, AG and AM
Leadwire Termination Options

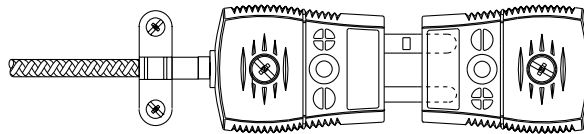
Style A, Standard Male Plug



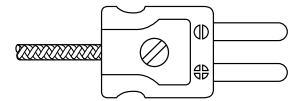
Style B, Standard Female Jack



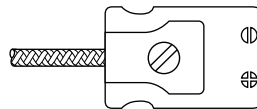
Style C, Standard Plug with Mating Connector



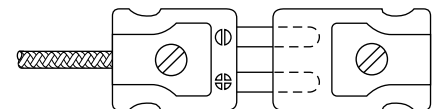
Style F, Miniature Male Plug



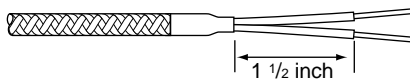
Style G, Miniature Female Jack



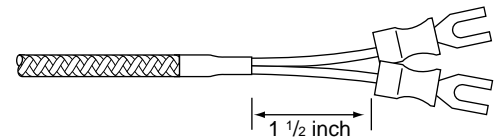
Style H, Miniature Plug with Mating Connector



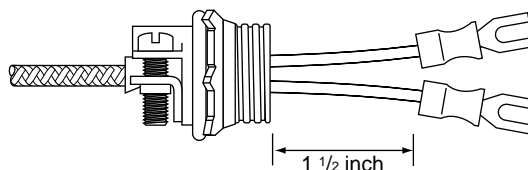
Style T, Standard: 1 1/2" (3.8 cm) Split Leads



Style U, 1 1/2" Split Leads with Spade Lugs



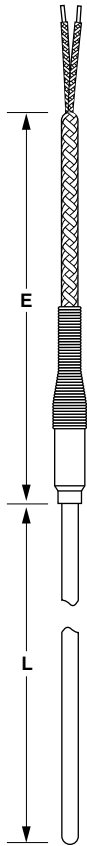
Style W, 1 1/2" Split Leads with BX Connector and Spade Lugs



Thermocouples

Mineral Insulated

Metal Transitions with Spring Strain Relief Styles AF



*Note: PFA coating only available on sheath O.D. E, G, H, J.

®Stranded leadwire available only for sheath O.D. 0.063 to 0.500 inch.

®1000°F potting not recommended with FEP insulated wire.

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

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

2. Style _____

F = Metal transition with strain relief and 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. Leadwire Construction _____

		Stan- dard	Over- braid	Flex Armor
Fiberglass	Solid	A	J	R
FEP	Solid	C	L	T
Fiberglass	Stranded [®]	B	K	S
FEP	Stranded [®]	D	M	U

5. Fittings, Weld Pads _____

If required, enter order code from pages 64-66.

If none, enter "0".

6. Leadwire 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 F = 316 SS D = 310 SS

* C = PFA coated over 304 SS sheath

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

01 to 99 (Lengths over 99 inches consult factory.)

Maximum length for PFA coating is 48 inches.

10. Sheath Length "L" (fractional inch) _____

0 = 0 1 = 1/8 2 = 1/4 3 = 3/8 4 = 1/2 5 = 5/8 6 = 3/4 7 = 7/8

11. Junction _____

	Grounded	Ungrounded	Exposed
Single	G	U	E
Dual, common	H	V	F
Dual, isolated	—	W	D

12. Calibration _____

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

13-14. Leadwire Length "E" (whole feet) _____

01 to 99 (01 foot standard)

15. Special Requirements _____

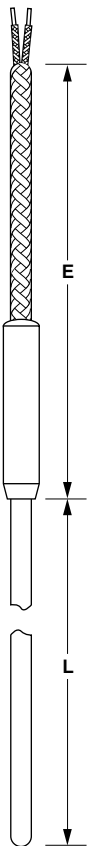
H = High temperature 1000°F potting[®]

M = 500°F potting. If none, enter "0". If others required, consult factory.

Thermocouples

Mineral Insulated

Metal Transition Styles AG



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

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

2. Style _____

G = Metal transition

3. Sheath O.D. (inch) _____

- H = 0.188
- J = 0.250
- K = 0.313
- L = 0.375
- M = 0.500

4. Leadwire Construction _____

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

5. Fittings, Weld Pads _____

If required, enter order code from [pages 64-66](#).

If none, enter "0".

6. Leadwire Termination _____

- A = Standard male plug
- B = Standard female jack
- C = Standard 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 F = 316 SS D = 310 SS

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

01 to 99 (Lengths over 99 inches consult factory.)

Maximum length for PFA coating is 48 inches.

10. Sheath Length "L" (fractional inch) _____

0 = 0 1 = 1/8 2 = 1/4 3 = 3/8 4 = 1/2 5 = 5/8 6 = 3/4 7 = 7/8

11. Junction _____

	Grounded	Ungrounded
Single	G	U
Dual, common	H	V
Dual, isolated	—	W

12. Calibration _____

	E	J	K
Standard Limits	E	J	K
Special Limits	2	3	4

13-14. Leadwire Length "E" (whole feet) _____

01 to 99 (01 foot standard)

15. Special Requirements _____

H = High temperature 1000°F potting®

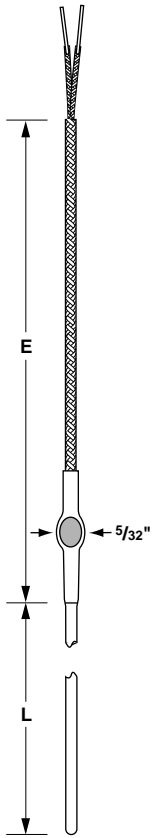
M = 500°F potting. If none, enter "0". If others required, consult factory.

MI Thermocouples

®1000°F potting not recommended with FEP insulated wire.

Thermocouples

Mineral Insulated Miniature Transitions Style AM



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

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	A	M			0										0
3. Sheath O.D. (inch)	_____														
A = 0.010 D = 0.040															
B = 0.020 E = 0.063															
C = 0.032															
4. Leadwire Construction	_____														
Standard															
Fiberglass Solid A															
FEP Solid C															
5. Enter "0"	_____														
6. Leadwire 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															
8-9. Sheath Length "L" (whole inches)	_____														
01 to 99															
Lengths over 99 inches consult factory.															
10. Sheath Length "L" (fractional inch)	_____														
0 = 0 3 = ¾ 6 = ¾															
1 = ¼ 4 = ½ 7 = ¾															
2 = ¼ 5 = ⅝															
11. Junction	_____														
Single															
Grounded G															
Ungrounded U															
Exposed E															
12. Calibration	_____														
Standard Limits E J K															
Special Limits 2 3 4															
13-14. Leadwire Length "E" (whole feet)	_____														
01 to 99															
(01 foot standard)															
15. Special Requirements	_____														
M = 500°F (260°C) potting															
H = 1000°F (540°C) potting®															
If none, enter "0".															
If others required, consult factory.															

®1000°F potting not recommended with FEP insulated wire.

Thermocouples

Mineral Insulated Connection Head Style AR



Featuring connection heads, Style AR mineral insulated thermocouples are resistant to dust and moisture, ensuring continuous long term reliability. This is possible because the covers keep the connection to the extension wire clean.

The connection heads are designed for mating to a conduit, allowing permanent installation. A variety of head styles are available, including plastic, cast iron, aluminum and explosion proof.

Features

- **Connection head** provides superior dust and moisture resistance.
- **Eight different head styles** are available to meet various application requirements.

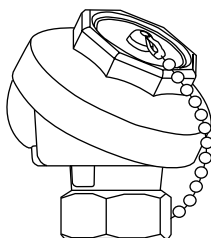
- **Lugs on covers** allow tightening with either a screwdriver or wrench.
- **Plastic heads** are weather resistant and can be exposed to weak acids, organic solvents, alkalis, sunlight and dust. Bottom mounting is standard; side mounting is available on request.
- **Cast iron heads**, available in standard and miniature sizes, are suitable for demanding high temperature environments, such as heavy industrial and process applications.
- **Optional head-mounted transmitter**, 4-20mA, reduces electrical noise. The transmitter is available on connection head styles A, B, C, D, E and H.



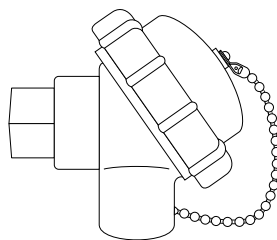
For more information on transmitter options see page 165-170.

Style AR Connection Head Connection Head Styles

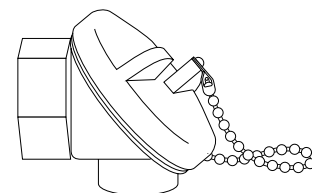
Type A (Universal Cast Iron) or B (Universal Cast Aluminum)



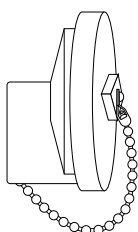
Type C (Polypropylene)



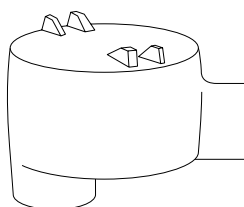
Type D (Small Cast Iron) or E (Small Aluminum)



Type F (Miniature Plastic)



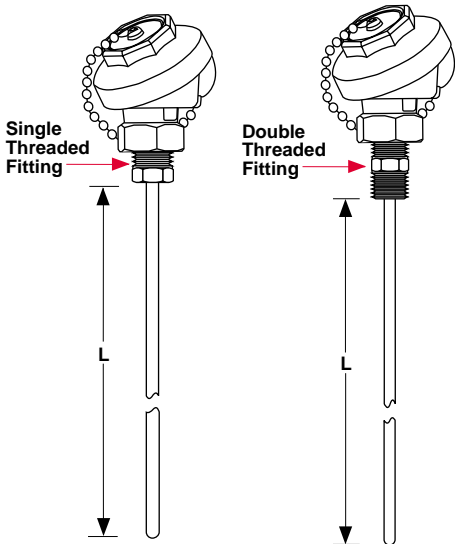
Type H (Explosion Proof)



For a complete description of the connection head styles, see pages 153 to 155.

Thermocouples

Mineral Insulated Connection Head Style AR



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

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 M = 0.500
G = 0.125 K = 0.313
H = 0.188 L = 0.375

4. Connection Head

A = Universal cast iron
B = Universal cast aluminum
C = Polypropylene
D = Small cast iron
E = Small aluminum
F = Miniature plastic
H = Explosion proof

***5. Head Mounting Fittings and
Optional Weld Pads**

0 = Single threaded 303 SS
E = Double threaded mild steel 1/2" NPT
F = Double threaded 303 SS 1/2" NPT
H = Spring loaded double threaded 316 SS 1/2" NPT
2 = Single threaded 303 SS with series 2 weld pad
5 = Single threaded 303 SS with series 5 weld pad

6. Enter "0"

7. Sheath Material

A = 304 SS F = 316 SS
Q = Alloy 600 D = 310 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 2 = 1/4 4 = 1/2 6 = 3/4
1 = 1/8 3 = 3/8 5 = 5/8 7 = 7/8

11. Junction

	Grounded	Ungrounded	Exposed
Single	G	U	E
Dual, common	H	V	F
Dual, isolated	—	W	D

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

If none, enter "0". If required, consult factory.

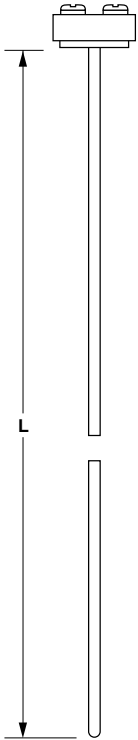
* Double threaded fitting options are not available with miniature plastic head.

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

Thermocouples

Mineral 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 brazed directly to the XACTPAK sheath.

Three different termination materials are available. All mounting plates are 304 SS except on the glass cloth/phenolic type which are brass.

Performance Capabilities

Cold end termination temperature rating up to 1000°F (540°C) on ceramic mounting plate

Features

- **Termination** directly to sheath allows quick hookup and disassembly.
- **The terminal head** is available in a wide range of materials in both single and dual configurations.

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

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	A	S				0							0	0	0
3. Sheath O.D. (inch)	E = 0.063 H = 0.188		G = 0.125 J = 0.250												
4. Cold End Termination															
Sheath Material															
O.D. (inch)															
A = 0.063	Glass cloth/		250°F (120°C)												
0.125	Phenolic		1 1/8 inch dia. X												
			7/16 inch thick												
*B = 0.125	Glass cloth/		350°F (175°C)												
0.188	Silicon		1 inch dia. X												
0.250			1/2 inch thick												
C = 0.125	Ceramic		1000°F (540°C)												
0.188			1 1/8 inch dia. X												
0.250			5/8 inch thick												
5. Fittings, Weld Pads															
If required, enter order code from pages 64-66. If none, enter "0".															
6. Enter "0"															
7. Sheath Material															
A = 304 SS F = 316 SS															
Q = Alloy 600															
8-9. Sheath Length "L" (whole inches)															
01 to 99															
Lengths over 99 inches consult factory.															
10. Sheath Length "L" (fractional inch)															
0 = 0 3 = 3/8 6 = 3/4															
1 = 1/8 4 = 1/2 7 = 7/8															
2 = 1/4 5 = 5/8															
11. Junction															
	Grounded	Ungrounded	Exposed												
Single	G	U	E												
Dual, common	H	V	F												
Dual, isolated	—	W	D												
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															
If none, enter "0". If required, consult factory.															

* Not available in dual element.

Thermocouples

Mineral Insulated

For Use With Thermowells Style AT



Style AT thermocouple is an energy and process temperature sensor that features XACTPAK metal-sheathed mineral insulation, enhancing the sensor's ability to "read" temperature by transferring heat quickly to the measuring junction.

This thermocouple style is ideal for process petrochemical and power applications where a sensor-thermowell assembly is typically used. Thermowells protect the thermocouple and allow you to replace the sensor without shutting down the process, saving valuable downtime.

Features

- **Designed for use with thermowells**, Style AT is ideal for process industry applications.
- **Compliance with specifications such as ASTM** assures high quality sensor products.

- **Manufacturing capabilities** include special tube cleaning processes, insulation baking to 2000°F (1095°C) and much more.
- **Four standard sheath material choices** are available to meet varying application requirements.
- **Connection heads** come in five different styles.
- **Spring-loading option** allows the thermocouple to maintain contact against the bottom of the thermowell, assuring rapid heat transfer to the sensor.

Applications

- Petrochemical
- Refineries
- Power stations
- Blast furnaces
- Incinerators

Thermocouples

Mineral Insulated

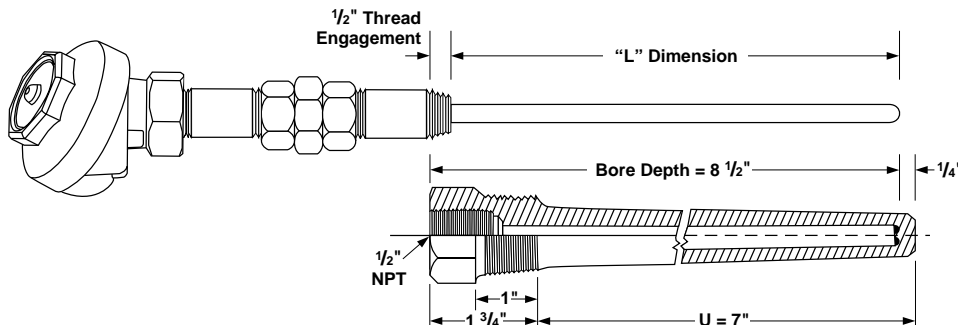
For Use With Thermowells Style AT

Manufacturing Capabilities

While observing the most rigid specifications and quality surveillance criteria, Watlow still retains the flexibility to serve the varying needs of our customers with considerable economy. Our capabilities include:

- Special tube cleaning processes and facilities.
- Insulation baking to 2000°F (1095°C).
- A controlled near-clean room environment in the XACTPAK assembly area.
- Swaging and drawing machines suitably sized for effective sheath reduction from 0.500 inch to 0.010 inch O.D., as well as special constructions, dual element and dual diameter sensors.
- Annealing furnaces for heat treating and quenching in reducing or inert atmospheres.
- Induction brazing and annealing.
- TIG and plasma welding of measuring junctions.
- Straightening and coiling machines.

Calculating "L" Dimension



Non-Spring-Loaded Sensors

To determine the "L" dimension to fit existing thermowells, take the existing bore depth—which is equal to the overall length of the thermowell minus the tip thickness (typically 1/4 inch)—and subtract 3/4 inch for thread engagement and tolerance variation. In the pictured example, if the "U" dimension equals seven inches, the bore depth would equal 8 1/2 inches. Thus the "L" dimension would be 7 3/4 inches.

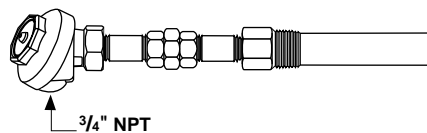
Due to the variation in pipe thread engagement, the sensor may not hit bottom inside the thermowell. To assure that it does hit bottom, spring loading is recommended.

Spring-Loaded Sensors

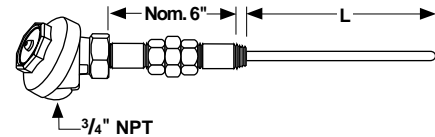
To calculate this "L" dimension, add an additional 1/2 inch to the "L" dimension calculated for a non-spring loaded sensor. This dimension may require field adjustment due to variation in pipe thread engagement.

Cold End Configurations

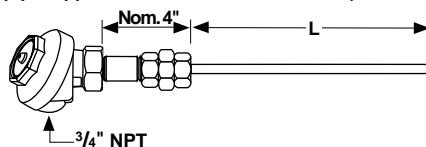
Types 1-4 With Well
Sheath length does not need to be specified (Type 1 with thermowell is shown)



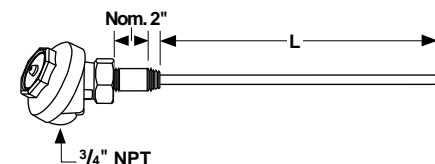
Type 1 Without Well
6 inch N-U-N typical (2 each 1/2 X 3 inch long steel pipe nipples and 1 each malleable union)*



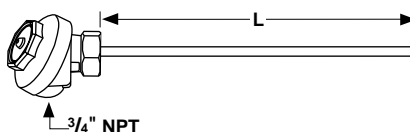
Type 2 Without Well
4 inch N-U typical (1 each 1/2 X 3 inch long steel pipe nipple and 1 each malleable union)*



Type 3 Without Well
1/2 X 3 inch long steel pipe nipple typical*



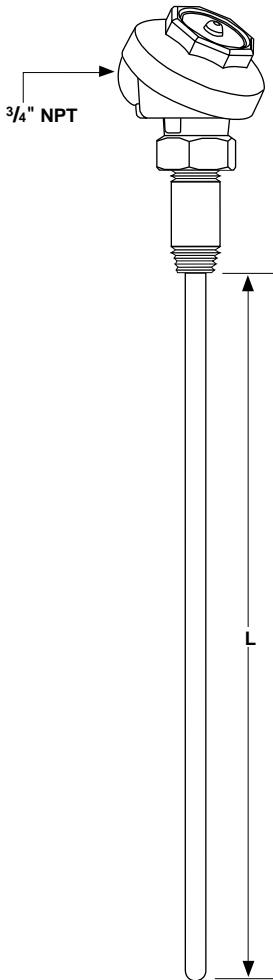
Type 4 Without Well



* Other sizes, lengths, and materials are available. Consult factory.

Thermocouples

Mineral Insulated For Use With Thermowells Style AT



Note: For a complete sensor, add thermowell part number to the 15-digit AT part number. See thermowell section, pages 125 to 136.

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

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

3. Sheath O.D. (inch)

- G = 0.125
- H = 0.188
- J = 0.250

4. Connection Head

- A = Universal cast iron
- B = Universal cast aluminum
- C = Polypropylene (½ inch NPT thermocouple opening only)
- D = Small cast iron
- H = Explosion proof (½ inch NPT and ¾ inch NPT thermocouple opening only)

5. Cold End Configuration

- 1 = Type 1, 6-inch nipple-union-nipple
- 2 = Type 2, 4-inch nipple-union
- 3 = Type 3, 3-inch nipple
- 4 = Type 4, no extensions

Note: Steel nipple and unions are standard.

6. Enter "0"

7. Sheath Material

- A = 304 SS
- Q = Alloy 600
- F = 316 SS

8-9. Sheath Length "L" (see drawings)

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 = Not required, complete assembly
- 1 = ¼ 3 = ¾ 5 = 5/8 7 = 7/8
- 2 = 1/8 4 = 1/2 6 = 3/4

11. Junction

	Grounded	Ungrounded
Single	G	U
Dual, common	H	V
Dual, isolated	—	W

12. Calibration

	E	J	K	N	T
Std. 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

If none, enter "0". If required consult factory.



See the hardware section, pages 153 to 155, for a complete description of Watlow connection heads.

Thermocouples

Special Applications For Demanding Applications

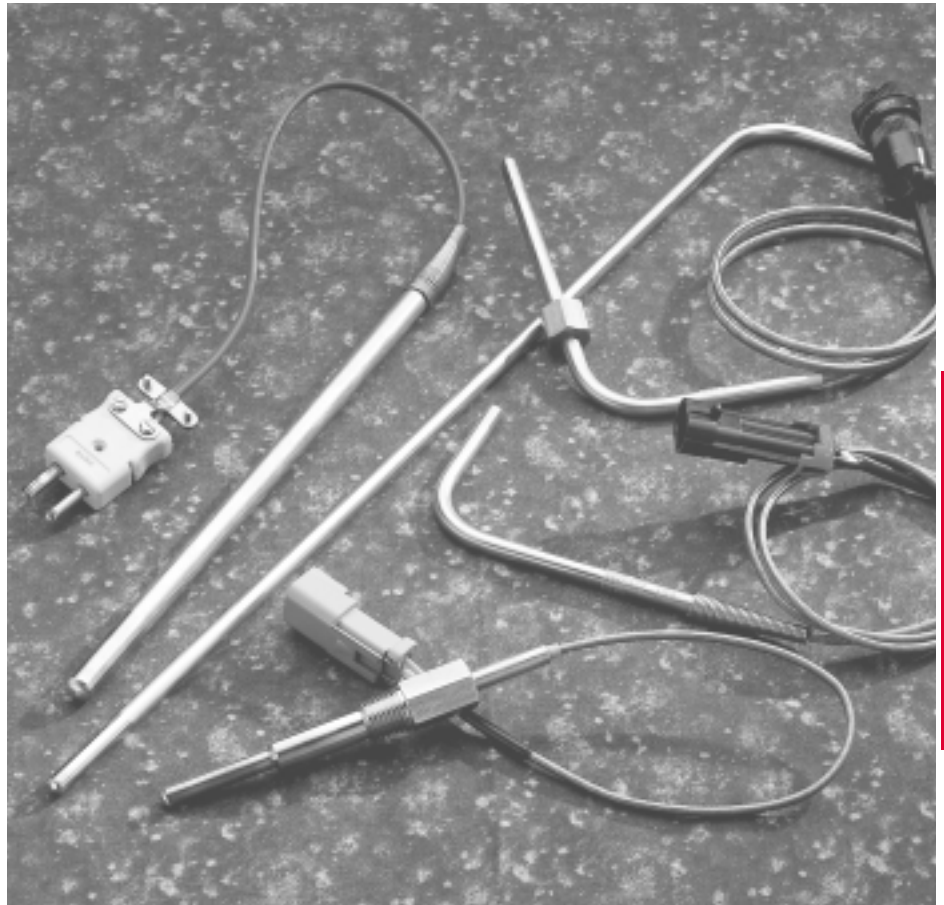
Technological advances in industry have created a demand for thermocouple materials with unusually high performance characteristics and superior quality. We, at Watlow, have kept pace with these demands. A long time leader in the field of temperature measurement, we have the modern facilities necessary 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 4200°F (2315°C)
- NIST traceable calibration certificates
- Thermocouple limits set to ITS-90 reference standards

Features and Benefits

- **Thermocouple conductors** for all temperature applications.
- **Wide selection of sheath materials** to meet specific application requirements.
- **Insulation materials** to meet demanding application temperatures.



- **Grounded and ungrounded junctions** to meet electrical configurations.
- **Multipoint temperature sensor assemblies** measure temperature gradients without multiple, individual sensors.
- **Vibration tolerant (hybrid) thermocouples** withstand environments of extreme vibration and humidity.
- **True surface thermocouple (TST)** with isolating cover.
- **Testing and certification services** 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

Special Applications Materials Data

Exotic Metal Sheathed Thermocouples

The specification tables shown on the following pages outline a highly specialized line of metal sheathed thermocouple configurations offered by Watlow. Using noble or refractory metal sheaths, high temperature insulations and compatible thermocouple conductors, some combinations can withstand temperatures as high as 4200°F (2315°C); 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 sub-assembly 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

Special Applications

High Temperature Sheath Materials

Sheath Material	Approximate Melting Point	Maximum Recommended Temperature	Environment	Available Stock Constructions inch				
				0.040	0.063	0.125	0.188	0.250
Platinum-10% Rhodium (Pt-10% Rh)	3360°F (1850°C)	2825°F (1550°C)	Oxidizing, inert, vacuum	C	C	C	*	*
Platinum-20% Rhodium (Pt-20% Rh)	3400°F (1870°C)	3000°F (1650°C)	Oxidizing, inert, vacuum	C	C	C	*	*
Molybdenum (Mo)	4750°F (2620°C)	3450°F (1900°C)	Inert, vacuum, reducing	NA	*	LP	LP	LP
Tantalum (Ta)	5425°F (2995°C)	4350°F (2400°C)	Inert, vacuum	C	C	C LP	*	*
Titanium (Ti)	3135°F (1725°C)	Oxidizing 600°F (315°C)	Oxidizing to 600°F (315°C), inert, vacuum	*	C	LP	*	*
Niobium- (Nb) 1% Zirconium	4525°F (2495°C)	2400°F (1315°C)	Inert, vacuum	*	*	*	*	*
Tungsten (W)	6170°F (3410°C)	4500°F (2480°C)	Inert, vacuum, reducing	*	*	*	*	*
Alloy 600	2470°F (1345°C)	2150°F (1175°C)	Inert, vacuum, reducing, oxidizing	C	C	C LP	C LP	C 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 2825°F (1550°C). 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 3000°F (1650°C) 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 750°F (400°C). Vacuum at <10(-2) torr to 3100°F (1700°C). Vacuum <10(-4) torr to 3400°F (1870°C). Stable in inert gases to 3450°F (1900°C). Avoid contamination with graphite, carbon and hydrocarbons.
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 750°F (400°C) resulting in nitride and hydride formation that will affect life.
Titanium (Ti)	Lightweight, excellent strength in the 300 to 800°F (150 to 425°C) 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.

CONTINUED

Thermocouples

Special Applications

High Temperature Sheath Materials, continued

Sheath Material	Remarks
Niobium (Nb)-1% Zirconium (Zr)	Good resistance to sulfuric, nitric and hydrochloric acids within defined limits. Also used in liquid metals such as lithium, sodium, potassium, sodium potassium, lead, mercury and bismuth providing oxygen is less than 40 ppm.
Tungsten (W)	Tungsten has the highest melting point of any metal. Available only in loose pack constructions due to its brittle nature. Good wet and abrasion resistance. Lowest vapor pressure of all metals. Can be used in hydrogen at all temperatures.
Alloy 600	Maximum temperature 2150°F (1175°C). Most widely used thermocouple sheath material. Good high temperature strength, corrosion resistance, resistance to chloride ion stress corrosion cracking and oxidation resistance to high temperatures. Do not use in sulfur bearing environments. Good in nitriding environments.

High Temperature Insulation Material

Insulation	Approximate Upper Useful Temperature	Approximate Melting Point	Remarks
Magnesium Oxide (MgO)	2500°F (1370°C)	5070°F (2800°C)	Used primarily with platinum sheathing in compacted constructions only.
Alumina Oxide (Al ₂ O ₃)	2800°F (1540°C)	3660°F (2015°C)	Compacted constructions to 2800°F (1540°C). Uncompacted constructions with vitrified insulators to 3000°F (1650°C).
Hafnia Oxide (HfO ₂)	4530°F (2500°C)	5000°F (2760°C)	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 2500°F (1370°C). Above 2500°F (1370°C) 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 ₂ O 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 4530°F (2500°C).

Thermocouples

Special Applications

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	2700°F (1480°C)	3200°F (1760°C)	Some decalibration at continued use over 2000°F (1095°C) due to rhodium volatilization. This effect is accelerated in compacted construction.
Pt-30% Rh vs. Pt-6% Rh	B	3100°F (1700°C)	3250°F (1790°C)	Less subject to decalibration by rhodium volatilization than Types S or R.
W-5% Re vs. W-26% Re	C*	4200°F (2315°C)	5600°F (3095°C)	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 32 to 2700°F (0 to 1480°C). 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 32 to 2700°F (0 to 1480°C). Type S has a lower EMF output than Type R and is available in standard limits and special limits ITS-90 scale.
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 1600 to 3100°F (870 to 1700°C). 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 32 to 4200°F (0 to 2315°C). 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

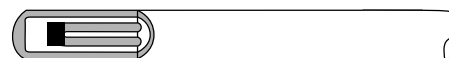
Basic Hot Or Measuring Junctions Available

Grounded Junction (G)



Thermocouple conductors are welded to the sheath, producing excellent time response. Caution should be taken to avoid electrical fields. Not available with molybdenum sheath or platinum conductors in sheathing other than platinum.

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

Special Applications

High Temperature Cut and Stripped



- Features noble or refractory metal sheaths
- ASTM Type R, S, B, W-5% Re/W-26% Re (Type C*) thermocouple calibrations
- High temperature insulations
- Compacted and loose pack assemblies
- Cold end stripped and sealed with epoxy

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

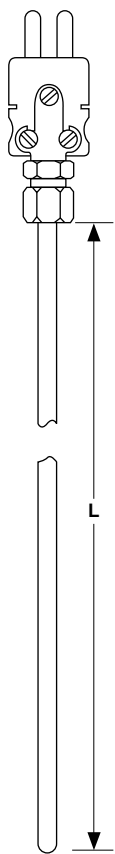
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	H	B		0	0										0
3. Sheath O.D. (inch)	_____														
D = 0.040 G = 0.125 J = 0.250															
E = 0.063 H = 0.188															
4-5. Enter "00"	_____														
6. Insulation	_____														
	MgO	Al ₂ O ₃	HfO ₂												
** Compacted	1	2	4												
Loose pack	—	B	D												
7. Sheath Material	_____														
1 = Pt-10% Rh 4 = Tantalum															
2 = Pt-20% Rh 5 = Titanium															
3 = Molybdenum Q = Alloy 600															
8-9. Sheath Length "L" (inch)	_____														
Whole inches: 01 to 99															
Metric lengths consult factory															
10. Sheath Length "L" (fractional inch)	_____														
0 = 0 2 = ¼ 4 = ½ 6 = ¾															
1 = ⅙ 3 = ⅓ 5 = ⅕ 7 = ⅞															
11. Junction	_____														
	Ungrounded	Grounded													
Single [Ⓣ]	U	G													
12. Calibration	_____														
	B	R	S	C*											
Std. limits	B	R	S	C											
Spc. limits	1	6	7	NA											
13. Strip Length "S" (inch)	_____														
Whole inches: 0 to 3															
14. Strip Length "S" (fractional inch)	_____														
0 = 0 2 = ¼ 4 = ½ 6 = ¾															
1 = ⅙ 3 = ⅓ 5 = ⅕ 7 = ⅞															
15. Special Requirements	_____														
If none, enter "0".															
If required, consult factory.															

* Not an ASTM symbol.
 **Not available with molybdenum sheath.
 Ⓣ Dual element available, consult factory.

Thermocouples

Special Applications

High Temperature Plug or Jack Termination



- Features noble or refractory metal sheaths
- ASTM Type R, S, B, W-5% Re/W-26% 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 code 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) _____
 D = 0.040 G = 0.125 J = 0.250
 E = 0.063 H = 0.188

4. Connector Type _____
 Standard plugs and jacks 400°F (205°C)
 (0.250 in. max. O.D.)
 A = Standard plug
 B = Standard jack
 C = Standard plug with mating connector
 Miniature plugs and jacks 400°F (205°C)
 (0.125 in. max. O.D.)
 F = Miniature plug
 G = Miniature jack
 H = Miniature plug with mating connector
 High temperature plugs and jacks 1000°F (540°C)
 (0.250 in. max. O.D.)
 L = High temperature plug
 M = High temperature jack
 N = High temperature plug with mating connector

5. Enter "0" _____

6. Insulation _____

	MgO	Al ₂ O ₃	HfO ₂
** Compacted	1	2	4
Loose pack	—	B	D

7. Sheath Material _____
 1 = Pt-10% Rh 3 = Molybdenum 5 = Titanium
 2 = Pt- 20% Rh 4 = Tantalum Q = Alloy 600

8-9. Sheath Length "L" (inch) _____
 Whole inches: 01 to 99
 For metric lengths, consult factory

10. Sheath Length "L" (fractional inch) _____
 0 = 0 2 = ¼ 4 = ½ 6 = ¾
 1 = ⅙ 3 = ⅓ 5 = ⅕ 7 = ⅞

11. Junction _____

	Ungrounded	Grounded
Single [Ⓣ]	U	G

12. Calibration _____

	B	R	S	C*
Std. limits	B	R	S	C
Spc. limits	1	6	7	NA

13-14. Enter "00" _____

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

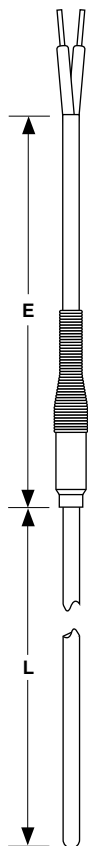
* Not an ASTM symbol.
 ** Not available with molybdenum sheath.
[Ⓣ] Consult factory for dual element.

Special Applications

Thermocouples

Special Applications

High Temperature Metal Transitions



(Lead tolerance +4/-0 in.)

- Features noble or refractory metal sheaths
- ASTM Type R, S, B, W-5% Re/W-26% Re (Type C*) thermocouple calibrations
- High temperature insulations
- Compacted and loose pack assemblies
- Transition with leadwire termination
- Standard maximum continuous operating temperature of 300°F (150°C) for the transition. High temperature (1000°F/540°C) potting compound available. Order option "H" in the last digit of code number.

Ordering Information—To order, complete the code 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)

D = 0.040 G = 0.125 J = 0.250
E = 0.063 H = 0.188

4. Leadwire Construction

Standard Overbraided
Fiberglass Solid **A** **J**

5. Leadwire 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 ₂ O ₃	HfO ₂
** Compacted	1	2	4
Loose pack	—	B	D

7. Sheath Material

1 = Pt 10% Rh 3 = Molybdenum 5 = Titanium
2 = Pt 20% Rh 4 = Tantalum Q = Alloy 600

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

Whole inches: 01 to 99
For metric lengths 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

Ungrounded Grounded
Single[Ⓣ] **U** **G**

12. Calibration

	B	R	S	C*
Std. limits	B	R	S	C
Spc. limits	1	6	7	NA

13-14. Leadwire Length "E" (feet)

Whole feet: 01 to 99
(01 foot standard)

15. Special Requirements

O = Standard 300°F (150°C) potting
M = Standard 500°F (260°C) potting
H = Standard 1000°F (540°C) potting
If others required, consult factory

* Not an ASTM symbol

**Not available with molybdenum sheath.

[Ⓣ] Dual element available, consult factory.

Thermocouples

Special Applications

Vibration Tolerant (Hybrid) Thermocouples Styles H, I and J

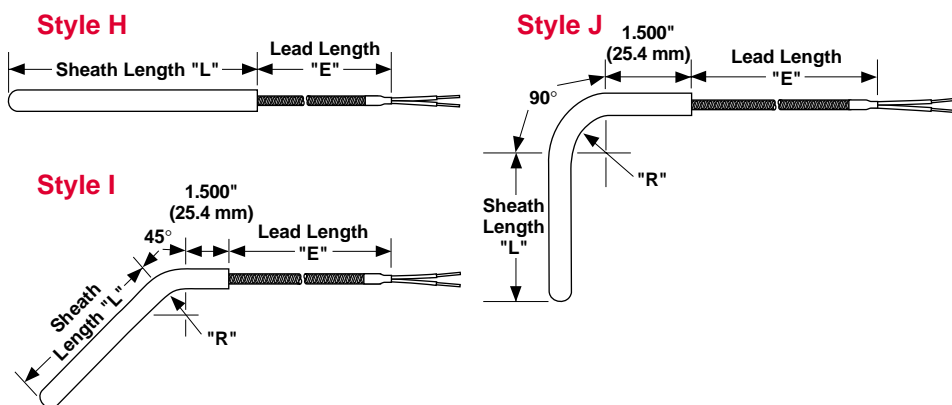
Available in three styles, Watlow vibration tolerant thermocouples are configured to straight, 45° and 90° constructions, making them readily adaptable to limited space applications.

The following illustrations and table show the acceptable bend radius ("R" dimension).

Watlow's patented* vibration tolerant 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, homogeneous 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.



Outside Diameter inches (mm)	Minimum "L" dimension inches (mm)	Standard Bend Radius "R" inches (mm)
0.250 (6.35)	2.000 (50.80)	0.750 (19.05)

Note: For Styles I and J, the sheath length "L" will be measured from the tip of the thermocouple to the start of the bend, unless otherwise specified.

Standard Leadwire Construction

Leadwires are standard ASTM color coded, standard limits, stranded or solid thermocouple conductors. This insulation system consists of a primary insulation of color coded FEP

and an overall layer of the same extruded FEP with a stainless steel overbraid.

The following table lists the leadwire gauge available.

Sheath diameter inch (mm)	Leadwire B & S Gauge	Leadwire Diameter inch (mm)
0.250 (6.35)	18	0.040 (1.02)

*United States Patent Number 4,934,831.

Thermocouples

Special Applications

Vibration Tolerant (Hybrid) Thermocouples

Styles H, I and J

Continued

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

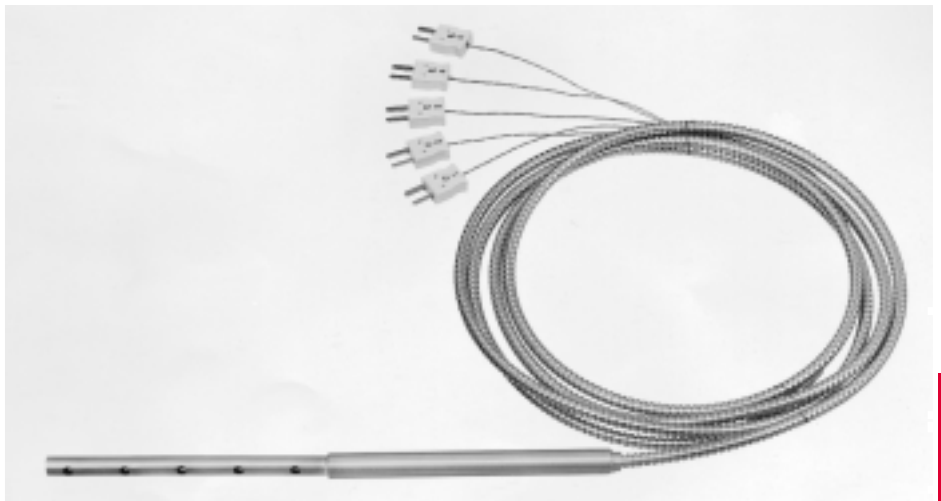
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	C		J		0		Q					K			
2. Style	_____														
H = Straight	J = 90° angle														
I = 45° angle															
3. Sheath O.D. (inch)	_____														
J = 0.250															
*4. Leadwire Construction	_____														
L = Solid conductor FEP insulation with SS overbraid															
M = Stranded conductor FEP insulation with SS overbraid															
5. Fittings	_____														
0 = None available															
6. Terminations	_____														
For reference, see terminations chart on page 97 in the Multipoint portion of this catalog section.															
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															
Metric lengths, consult factory															
10. Sheath Length "L" (fractional inch)	_____														
0 = 0	2 = ¼	4 = ½	6 = ¾												
1 = ⅙	3 = ⅓	5 = ⅕	7 = ⅞												
11. Junction	_____														
	Ungrounded							Grounded							
Single	U							G							
12. Calibration	_____														
	K														
Standard limits	K														
13-14. Leadwire Length "E" (feet)	_____														
Whole feet: 01 to 05 (01 foot standard)															
15. Special Requirements	_____														
If none, enter "0".															
If required, consult factory															

*Leadwire gauge size determined by sheath diameter. Refer to standard leadwire construction chart on the preceding page.

Thermocouples

Special Applications

Multipoint Sensor Assemblies



Multipoint thermocouple sensor with stagnation tube for air duct monitoring.

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 insure a safe, accurate and cost efficient process. Installing multiple independent, temperature sensors may be impractical due to cost or space limitations.

Multipoint temperature sensor assemblies 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.

Applications include:

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

Multipoint temperature sensor assemblies are designed to meet the requirements of the specific application; i.e., temperature, pressure, chemical environment, time response and number of points required. The styles depicted in this section are general constructions.

These sensors are constructed from a variety of protecting tube materials, with XACTPAK® mineral insulated, metal-sheathed cable. Multipoint temperature sensor assemblies are available in either standard or special ASTM thermocouple calibration tolerances. For applications requiring extreme accuracy, special constructions can be made with platinum RTDs.

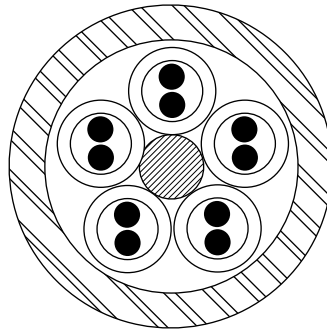
Thermocouples

Special Applications

Multipoint Sensor Assemblies

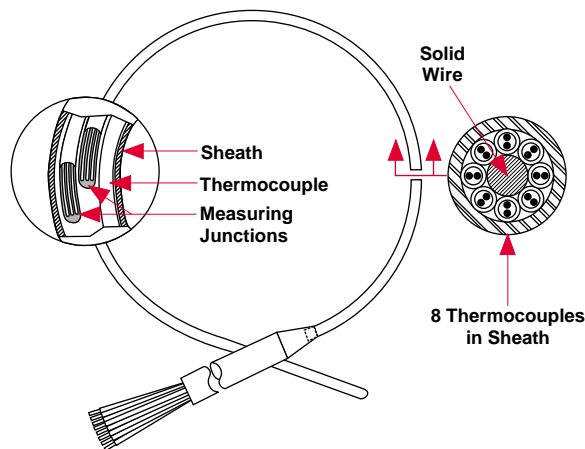
Continued

Style A—Loose-Pack



The Style A loose-pack multipoint is the most widely used industrial multiple sensor assembly. Thermocouple sensors, made from mineral insulated, metal-sheathed cable are positioned inside the overall protection sheath. This is the lowest cost multipoint sensor assembly construction. Style A is not bendable and time response is not as good as a Style B multipoint sensor assembly.

Style B—Multi-Pack



Multi-pack multipoint temperature sensor assemblies are similar to Style A multipoint assemblies, except that the sensors have intimate contact with the outer sheath which provides faster time response and greater strength. The multi-pack can be bent without damage to the outer sheath or movement of the thermocouple junctions along its length.

Thermocouples

Special Applications

Multipoint Sensor Assemblies

Continued

Multipoint Sensor Comparisons

Characteristic	Loose-Pack Style A	Multi-Pack Style B
Response	Fair	Excellent
Bendable	No	Yes
Individual sensor replacement	No	No
Maximum length	50 feet	25 feet
Maximum temperature*	2150°F (1175°C)	2150°F (1175°C)

*Depending on sensor diameter and materials

Protecting Tube and Sensor Limitations

The number of individual sensors that can be placed inside the protecting tube is restricted by the protecting tube's inside diameter and the outside diameter of the individual

sensors used to create the sensor pack. The following chart outlines the number of sensors permitted in standard multipoint designs. Please consult the factory if your application requires specifications differing from our standard constructions.

Protecting Tube Diameter and Number of Sensor Limitations

Protecting Tube O.D. (in)	Loose-Pack Style A	Multi-Pack Style B
E = 0.063	4	NA
G = 0.125	13	10
H = 0.188	20	15
J = 0.250	20	15
K = 0.313	20	18
L = 0.375	20	20
1 = ½ Sch. 40	NA	NA
2 = ¾ Sch. 40	NA	NA
3 = 1 Sch. 40	NA	NA

Thermocouples

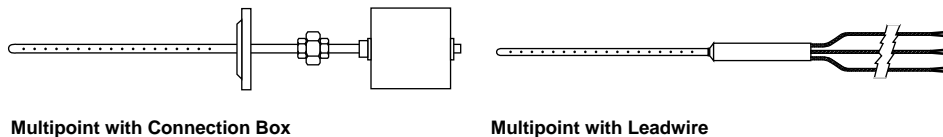
Special Applications

Multipoint Sensor Assemblies

Continued

How-to-Order

The following two pages include all the necessary information for Watlow to provide a multipoint sensor assembly to meet your application. Please fill in the boxes, as required, and submit to your local Watlow representative.

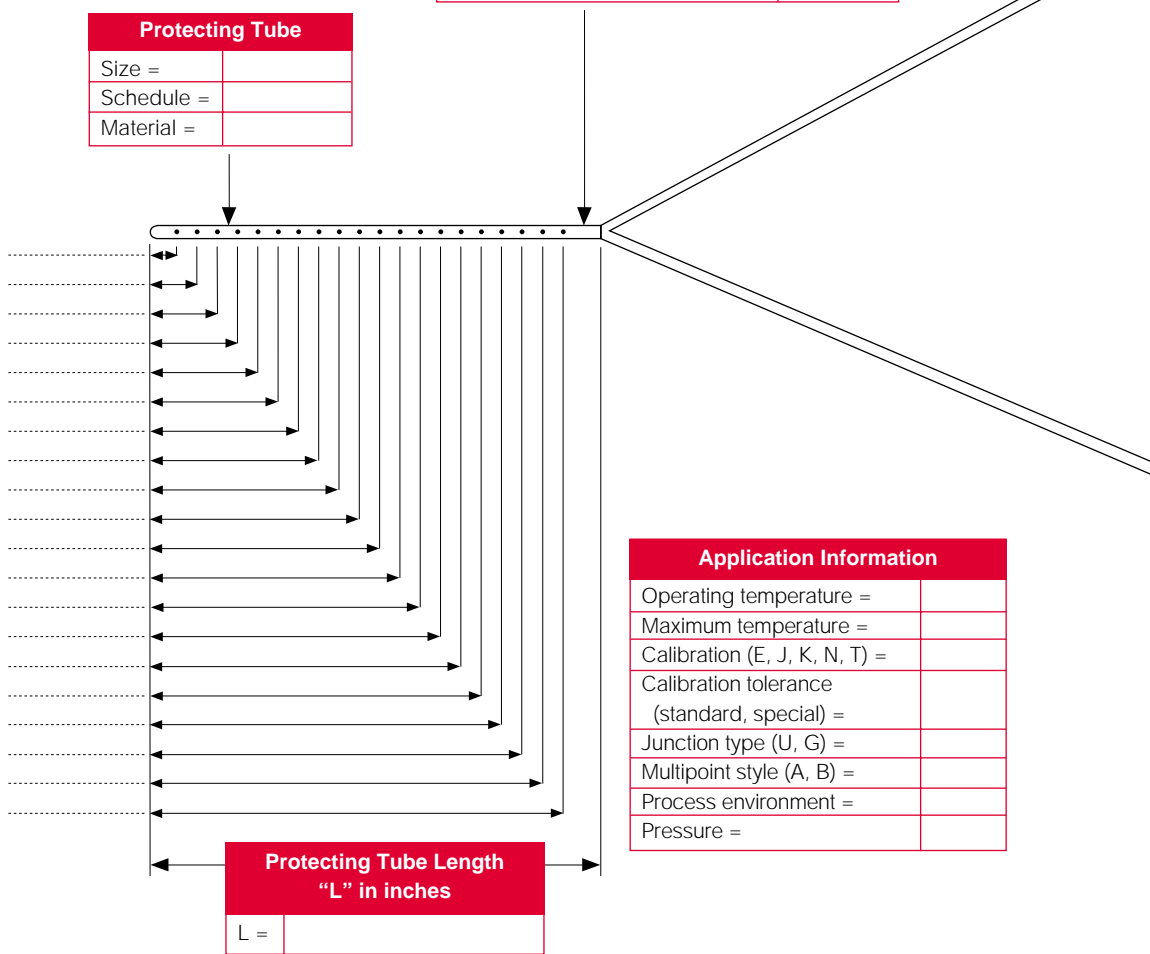


Point Locations in inches	
Point 1 =	
Point 2 =	
Point 3 =	
Point 4 =	
Point 5 =	
Point 6 =	
Point 7 =	
Point 8 =	
Point 9 =	
Point 10 =	
Point 11 =	
Point 12 =	
Point 13 =	
Point 14 =	
Point 15 =	
Point 16 =	
Point 17 =	
Point 18 =	
Point 19 =	
Point 20 =	

Point Location: Point location is the distance each sensor is spaced from the protecting tube's tip. This illustration shows how to determine the point location for each sensor. For more than 20 sensor points, consult factory.

Protecting Tube	
Size =	
Schedule =	
Material =	

Sheath Fittings (If Required)	
Enter order code from table on page 64 under Fittings in the Mineral Insulated Thermocouples section of this catalog =	



Application Information	
Operating temperature =	
Maximum temperature =	
Calibration (E, J, K, N, T) =	
Calibration tolerance (standard, special) =	
Junction type (U, G) =	
Multipoint style (A, B) =	
Process environment =	
Pressure =	

Protecting Tube Length "L" in inches	
L =	

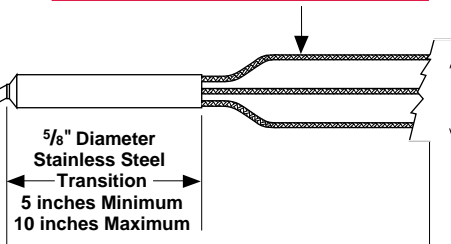
Thermocouples

Special Applications

Special Applications

Leadwire Construction

Fiberglass =	
Extruded FEP =	



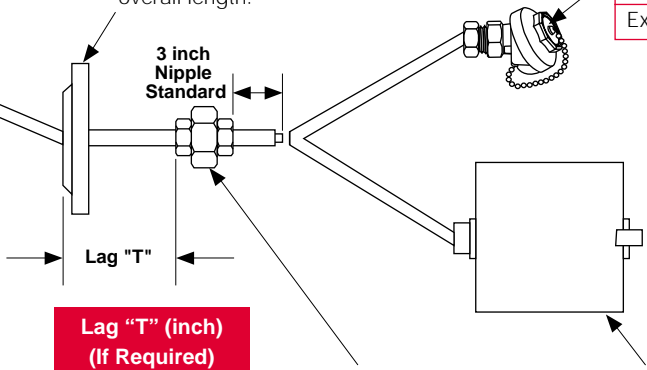
Leadwire Length "E" (feet)

E =	
-----	--

Flange (If Required)

Size =	
Rating =	
Face type =	
Material =	

If no flange, "L" is the overall length.



Lag "T" (inch) (If Required)

T =	
-----	--

Union (If Required)

Rating =	
Material =	

If no union, connection head/box is mounted onto protecting tube.

Connection Head (3 Sensors Max.)

Material =	
Explosion proof =	

Connection Box

Size =	
NEMA rating =	
Material =	
Conduit connection size =	

Termination Style	Description	Selection
	A = Standard plug	
	B = Standard jack	
	C = Standard male plug with mating connector	
	F = Miniature plug	
	G = Miniature jack	
	H = Miniature plug with mating connector	
	T = Standard—1 1/2 inches split leads	
	U = 1 1/2 inches split leads with spade lugs	
	W = 1 1/2 inches split leads with spade lugs and BX connector	

Additional Considerations

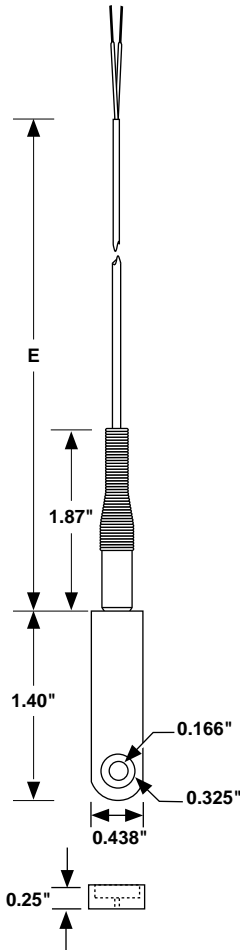
After you've reviewed your sensor requirements, as discussed above, it will help if you also supply the following:

- A complete description of the application and environment (maximum temperature, operating pressure, atmosphere—corrosive and explosive agents and humidity, etc.)
- A description of special requirements (accuracy, instrumentation/control devices involved, leadwire run length, etc.)
- A drawing or sketch of the application showing all relevant factors
- The specific "L" dimensions involved
- A completed order code number sequence
- Quantity

Thermocouples

Special Applications

True Surface Thermocouple (TST)



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

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

4. Leadwire Construction

- 2 = FEP 26 gauge solid
- 3 = FEP 26 gauge solid with shield and ground

5. Leadwire 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

6. Junction

	Ungrounded	Grounded
Single	U	G
Dual	W	H

7. Calibration

	J	K
Std. limits	J	K
Sp. limits	3	4

8-9. Leadwire Length "E" (feet)

Whole feet: 01 to 99
(01 foot standard)

Watlow's True Surface Thermocouple (TST) offers superior accuracy for measuring flat surface temperatures. This compact, highly accurate sensor isolates the thermocouple junction from ambient airflow.

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 design** fits easily into corners and other tight locations (0.44" wide by 0.24" high). The molded insulator is removable for applications where an even smaller package is needed.
- **Temperature rating of 400°F (200°C)** offers superior application flexibility for a wide variety of surfaces.

Thermocouples

Base Metal

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

Performance Capabilities

- 2300°F (1260°C) maximum temperature

Features and Benefits

- **Insulated wire thermocouples** are 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.
- **Thermocouples with protection** comes complete with head, block and protection tube. Several styles are available.

Applications

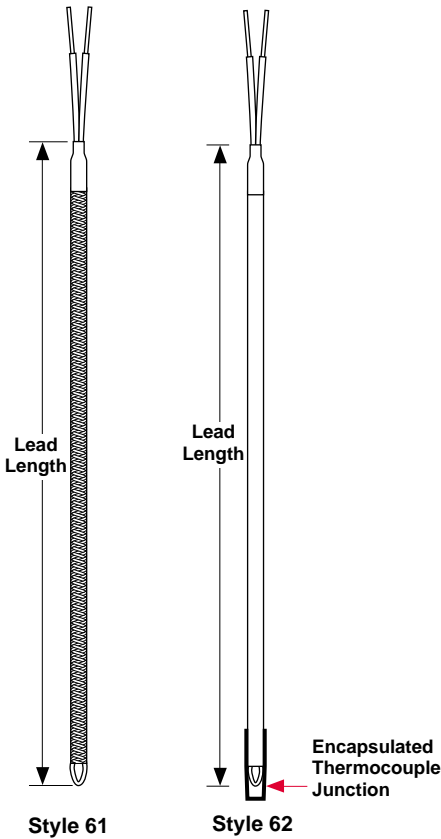
- Metal processing such as aluminum, zinc, brass (with appropriate protection tube)
- Chemical
- Petrochemical
- Industrial storage tanks



Thermocouples

Base Metal

Insulated Wire Thermocouple Style 61 and Style 62



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

	1	2	3	4	5	6	7	8	9	10	11
1-2. Construction Style			X			E	X				
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 SS overbraid (20 gauge solid) J = Extruded FEP (20 gauge solid) F = Fiberglass (24 gauge solid) S = Fiberglass with SS overbraid (24 gauge solid) T = Extruded FEP (24 gauge solid)											
6. Junction											
E = Exposed											
7. Enter X											
8-10. Lead Length (inches)											
Whole inches: 006 to 999											
11. Terminations (see illustrations on page 41)											
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 J = ⅜ 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 leadwire (Series 304 construction), with continuous temperature ratings of 900°F (480°C). Or, order it with FEP insulated leadwire (Series 507), rated to 400°F (200°C) continuous temperature.

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



For more information on Series 304 and Series 507 thermocouple wire, see pages 188 and 199.

Thermocouples

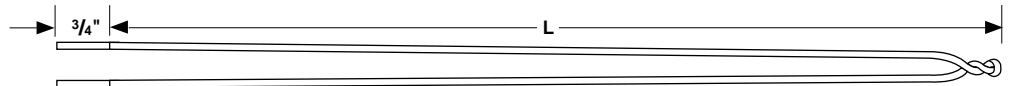
Base Metal

Bare Elements

To order, specify:

Code number-length.

Example: 1402-36



Bare Thermocouple Element, Twisted and Welded

Code Number				B & S Gauge	Length
Type K		Type J			
Twisted and Welded	Butt Welded	Twisted and Welded	Butt Welded		
1401	—	—	—	6	12 inches
1402	1432-BW	1501	1575-BW	8	(305 mm) and
1403	1433-BW	—	—	11	over in 6 inch
1404	1434-BW	1503	1576-BW	14	(152 mm)
1405	1435-BW	1504	1577-BW	20	increments

Straight Elements with Two-Hole Insulators

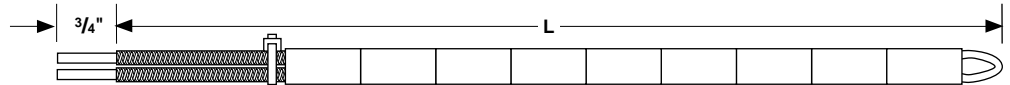
To order, specify:

Code number-length.

Example: 1409-48



Thermocouple Element, Twisted and Welded



Thermocouple Element, Butt Welded

Code Number				B & S Gauge	Insulator Code No.	Length
Type K		Type J				
Twisted and Welded	Butt Welded	Twisted and Welded	Butt Welded			
1408	1444-BW	—	—	6	300	12 inches
1409	1436-BW	1507	1578-BW	8	301	(305 mm) and
1410	1437-BW	—	—	11	304	over in 6 inch
1411	1438-BW	1509	1579-BW	14	304	(152 mm)
1412	1439-BW	1510	1580-BW	20	328	increments

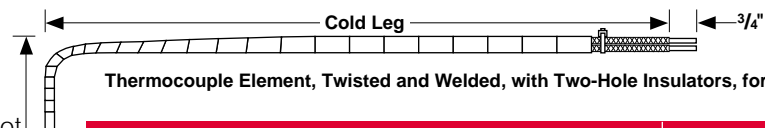
Base Metal

Angle Type with Two-Hole Insulators

To order, specify:

Code number-cold leg length-hot leg length.

Example: 1414-12-24



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

Code Number				B & S Gauge	Insulator Code No. Hot and Cold Sections*	Length
Type K		Type J				
Twisted and Welded	Butt Welded	Twisted and Welded	Butt Welded			
1414	1440-BW	1517	1581-BW	8	301	24 inches
1415	1441-BW	1518	1582-BW	14	304	(610 mm) and
—	—	1519	1583-BW	20	328	over in 6 inch
						(152 mm)
						increments

*Curved section insulators are Code No. 302 for 8 gauge and Code No. 311 for 14 gauge and 20 gauge.

Note: cold leg minimum 6 inches (152 mm).

Thermocouples

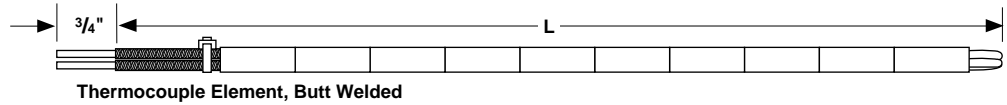
Base Metal

Dual Element with Four-Hole Insulators

To order, specify:

Code number-length.

Example: 1442-BW-36



Code Number (Butt Welded Only)		B & S Gauge	Insulator Code No.	Length
Type K	Type J			
1442-BW	1584-BW	14	360	12 inches (305 mm) and over in 6 inch (152 mm) increments
1443-BW	1585-BW	20	378	

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:

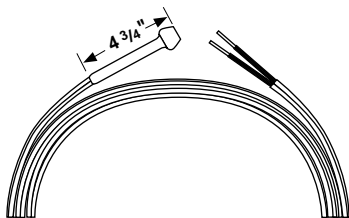
Code number-tip length-lance length.

Example: 1449-501-T-8-43



Code No.	Length of Tip inches	Length of Lance inches
1449-501-T	8	
1449-M-12	12	31, 43, 55,
1449-M-15	15	72, 96
1449-M-18	18	and 120
1449-M-20	20	inches only
1449-M-24	24	
1449-M-30	30	

Plasti-Immersion Thermocouples



Type	Code No.	B & S Gauge	Length
K	1470	14	10 ft (3 m) and over in 1 ft (30.5 cm) increments
	1471	16	
	1472	20	
J	1570	14	
	1571	16	
	1572	20	
T	1771	16	
	1772	20	

Economical SERV-RITE plasti-immersion thermocouples are designed for low-temperature measurement (maximum 221°F/105°C) of low concentration acid baths. The measuring junction of this PVC-insulated thermocouple is encapsulated in plastic for protection.

To order, specify:

Code number-length.

Example: 1470-15

Thermocouples

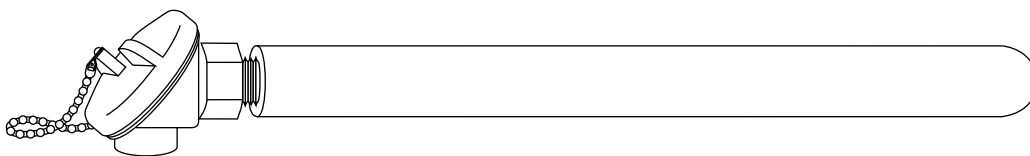
Base Metal

Standard Thermocouple with Protection
Straight Type

Metal Tube



Cast Iron Tube



Code Number		B & S Gauge	Protection Tube		Construction	Head*	Length
Type K	Type J		Material	NPT Size inch			
1411-1395	1509-1395	14	Alloy 601	½	Seamless	70900203	12 inches
1409-1395	1507-1395	8	Alloy 601	½	Seamless	70900203	and over
1409-1396	1507-1396	8	Alloy 601	¾	Seamless	70900202	in 6 inch
1409-1397	1507-1397	8	Alloy 601	1	Seamless	70900201	increments
1409-1341	1507-1341	8	304 SS	½	Welded	70900203	12 inches and
1409-1342	1507-1342	8	304 SS	¾	Welded	70900202	over in 6 inch
1409-1343	1507-1343	8	304 SS	1	Welded	70900201	increments
1409-1307	1507-1307	8	446 SS	½	Seamless	70900203	12 inches and
1409-1308	1507-1308	8	446 SS	¾	Seamless	70900202	over in 6 inch
1409-1309	1507-1309	8	446 SS	1	Seamless	70900201	increments
1409-1375	1507-1375	8	Cast Iron	¾ int	Cast	70900202	12 inches through 72 inches in 6 inch increments

Base Metal

To order, specify:

Code number-length.

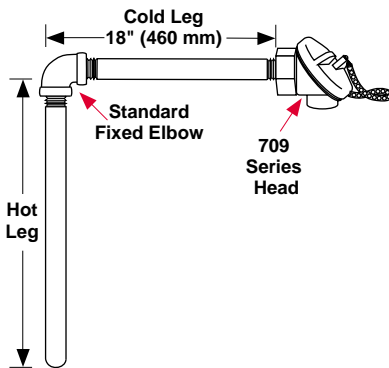
Example: 1409-1308-24

*Universal aluminum heads may be substituted.

Thermocouples

Base Metal

Standard Thermocouple with Protection 90° Angle Type



To order, specify:

Code number-cold leg length
hot leg length.

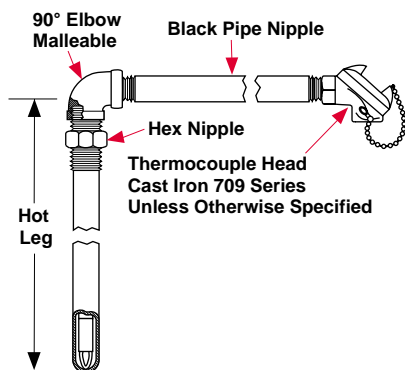
Example: 1414-1395-18-24

Standard Thermocouple with Protection — 90° Angle

Code Number		B & S Gauge	Protection Tube (Hot Leg)			Head*	Hot Leg Length
Type K	Type J		Material	NPT Size inch	Construction		
1415-1375	1518-1375	14	Cast Iron	3/4 int	Cast	70900202	12 inches through
1414-1375	1517-1375	8	Cast Iron	3/4 int	Cast	70900202	72 inches in 6 inch increments
1415-1326	1518-1326	14	Black Steel	1/2	Welded	70900203	12 inches and
1415-1328	1518-1328	14	Black Steel	1	Welded	70900201	over in 6 inch increments
1414-1328	1517-1328	8	Black Steel	1	Welded	70900201	
1415-1307	1518-1307	14	446 SS	1/2	Seamless	70900203	12 inches and
1414-1307	1517-1307	8	446 SS	1/2	Seamless	70900203	over in 6 inch increments
1414-1308	1517-1308	8	446 SS	3/4	Seamless	70900202	
1414-1309	1517-1309	8	446 SS	1	Seamless	70900201	
1415-1395	1518-1395	14	Alloy 601	1/2	Seamless	70900203	12 inches and
1414-1395	1517-1395	8	Alloy 601	1/2	Seamless	70900203	over in 6 inch increments
1414-1396	1517-1396	8	Alloy 601	3/4	Seamless	70900202	
1414-1397	1517-1397	8	Alloy 601	1	Seamless	70900201	

*Cold leg lengths over 18 inches long; universal elbow or flanged elbow; and universal heads may be substituted on request.

Hexoloy® Protection 90° Angle Type



Recommended for use in molten aluminum, zinc, lead, tin and gold. Hexoloy® protection tubes provide excellent corrosion/erosion resistance. Hexoloy® is also impermeable which makes it ideal for strong acids and alkalis.

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

	1	2	3	4	5	6	7	8	9	10	11	12
	B	M										
3. Beaded Element Size	_____											
4 = 14 AWG single element butt welded												
2 = 20 AWG single element butt welded												
4. Calibration	_____											
K = Type K												
J = Type J												
5-8. Hexoloy® Protection Tube	_____											
Number	O.D. X I.D. (ref.)	NPT (ref.)										
1042	3/4 X 1/2 inch	3/4										
1043	1 X 1/2 inch	1										
9-10. Cold Leg	_____											
Whole inches:	12 to 48											
11-12. Hot Leg	_____											
Whole inches:	12 to 48											

Hexoloy® is a registered trademark of Carborundum Company.

Thermocouples

Base Metal

Standard Thermocouple with Protection

Style AT—For Use with Pipe Type Thermowells



Style AT “beaded element” thermocouples are energy and process temperature sensors manufactured using ceramic insulators and base metal thermoelements, butt welded, in single or dual element.

This thermocouple style is ideal for metal processing and incineration applications where a sensor-thermowell assembly is typically used. Pipe type thermowells protect the thermocouple and allow you to replace the sensor without shutting down the process, saving valuable downtime.

Features

- **Designed for use with pipe type thermowells**, Style AT is ideal for process industry applications.
- **Compliance with specifications** such as ASTM assures high quality sensor products.

Applications

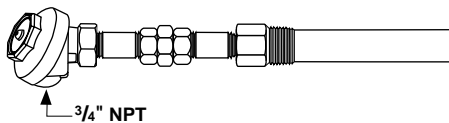
- Metal processing
- Incineration



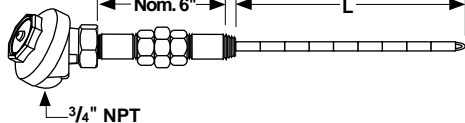
For more demanding applications, consider Watlow XACTPAK® metal-sheathed, mineral insulated thermocouples in Style AT or other styles (see pages 80 to 82).

Cold End Configurations

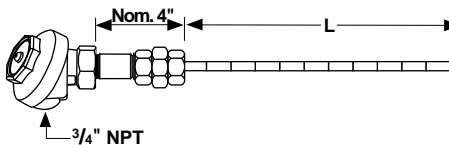
Types 1-4 With Well
Sheath length does not need to be specified (Type 1 with thermowell is shown)



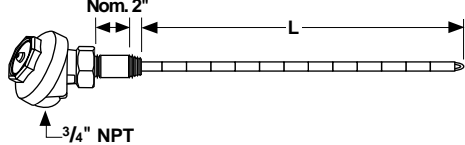
Type 1 Without Well
6 inch N-U-N typical (2 each 1/2 X 3 inch long steel pipe nipples and 1 each malleable union)*



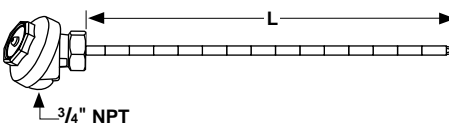
Type 2 Without Well
4 inch N-U typical (1 each 1/2 X 3 inch long steel pipe nipple and 1 each malleable union)*



Type 3 Without Well
1/2 X 3 inch long steel pipe nipple typical*



Type 4 Without Well



*Other sizes, lengths, and materials are available. Consult factory.



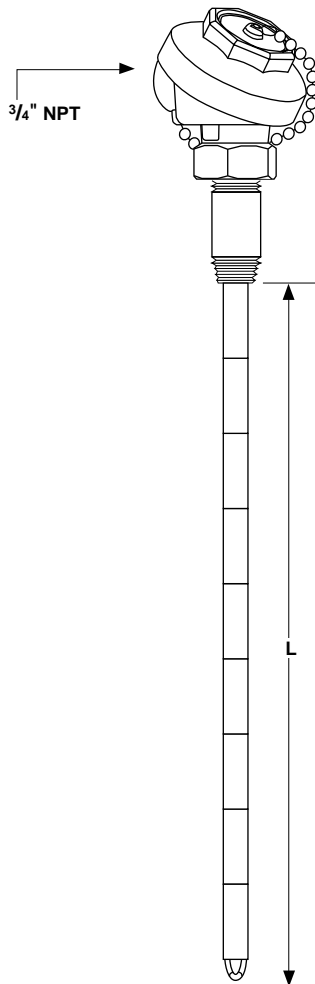
For information on calculating the “L” dimension to fit existing thermowells, please see page 81.

Thermocouples

Base Metal

Standard Thermocouple with Protection

Style AT



Note: For a complete sensor, add thermowell part number. See thermowell section, pages 126 to 136.

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

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

4. Connection Head

A = Universal cast iron
B = Universal cast aluminum
H = Explosion proof (1/2 inch NPT and 3/4 inch NPT thermocouple opening only)

5. Cold End Configuration

1 = Type 1
2 = Type 2
3 = Type 3
4 = Type 4

Note: 6 inch N-U-N, 4 inch N-U or 3 inch nipple typical (standard is steel).

6. Enter "0"

7. Sheath Material
0 = Beaded element

8-9. Sheath Length "L" (see drawings)

When ordering a complete assembly with thermowell, specify "AR" as required. Otherwise, specify the "L" dimension in whole inches (max. 24 inches; consult factory for longer lengths).

10. Sheath Length "L" (fractional inch)

0 = Not required, complete assembly
1 = 1/8 4 = 1/2 7 = 7/8
2 = 1/4 5 = 5/8
3 = 3/8 6 = 3/4

11. Junction

	Grounded	Ungrounded
Single	G	U
Dual, common	H	—
Dual, isolated	—	W

12. Calibration

	E	J	K	T
Std. Limits	E	J	K	T
Special Limits	2	3	4	8

13. Beaded Element Size

2 = 20 gauge single-butt welded
4 = 14 gauge single-butt welded
B = 20 gauge dual-butt welded
D = 14 gauge dual-butt welded

14. Enter "N"

15. Special Requirements

If none, enter "0". If required consult factory.



See the hardware section, pages 153 to 155, for a complete description of Watlow connection heads.

Thermocouples

Noble Metal

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

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 3100°F (1700°C)

Applications

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

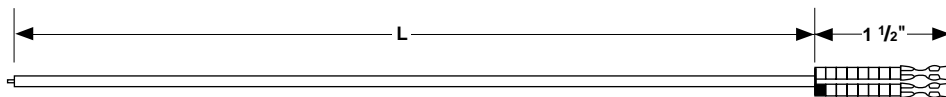


Type S, R, or B

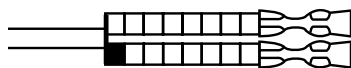
To order, specify:

Code number-calibration-length.

Example: 2114-R-24



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



Enlarged picture of copper sleeves

Code No.*	Diameter	Length
2110	0.0201 inch (0.511 mm)—24 B&S gauge bare	12 to 48 inches (305 to 1220 mm) in 6 inch (152 mm) increments
2112	0.0225 inch (0.573 mm)—23 B&S gauge bare	
2114**	0.0201 inch (0.511 mm)—24 B&S gauge alumina insulated [Ⓢ]	
2115**	0.0225 inch (0.573 mm)—23 B&S gauge alumina insulated [Ⓢ]	
2117**	0.0100 inch (0.255 mm)—30 B&S gauge alumina insulated [Ⓢ]	

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

Note: Type B is available from stock in 24 gauge only.

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

[Ⓢ] Insulation consists of a one-piece two-hole alumina (Watlow code number 391) insulator. For lengths over 24 inches (610 mm), a single piece alumina 3/16 inch diameter insulator is used.

Thermocouples

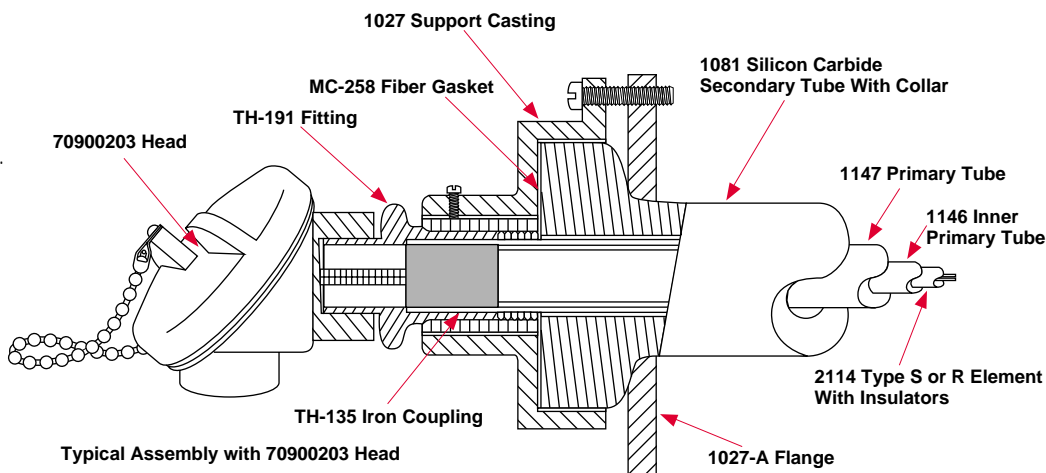
Noble Metal

Thermocouple Assemblies

To order, specify:

Code no.-calibration-length of tube.

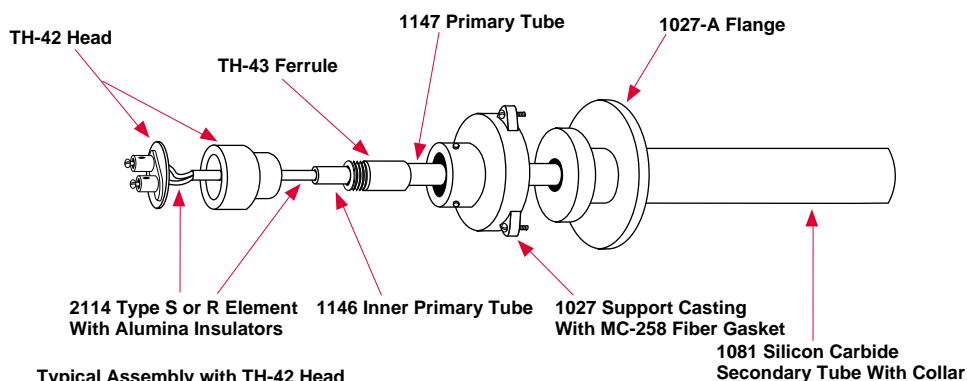
Example: 2143-S-12



Typical Assembly with 70900203 Head

70900203 Head* and Alumina Ceramics

Code No.**	B & S Gauge	Protecting Tubes	Size I.D. X O.D. inches	Length
2144	24	1147 Alumina Primary only	$\frac{7}{16} \times 1\frac{1}{16}$	12 to 48 inches in 6 inch increments
2145	24	1147 Primary 1146 Alumina Inner Primary	$\frac{1}{4} \times 1\frac{1}{16}$	
2147	24	1147 Alumina Primary 1146 Alumina Inner Primary 1081 Secondary	$\frac{1}{4} \times 1\frac{3}{4}$	



Typical Assembly with TH-42 Head

TH-42 Head and Alumina Ceramics

Code No.**	B & S Gauge	Protecting Tubes	Size I.D. X O.D. inch	Length
2140	24	1147 Alumina Primary only	$\frac{7}{16} \times 1\frac{1}{16}$	12 to 48 inches in 6 inch increments
2141	24	1147 Alumina Primary 1146 Alumina Inner Primary	$\frac{1}{4} \times 1\frac{1}{16}$	
2142	24	1147 Alumina Primary 1146 Alumina Inner Primary 1081 Secondary	$\frac{1}{4} \times 1\frac{3}{4}$	
2143	24	1147 Alumina Primary 1081 Secondary	$\frac{7}{16} \times 1\frac{3}{4}$	

*Universal aluminum heads may be substituted on request.

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

RTDs and Thermistors

Resistance Temperature Sensing

RTDs

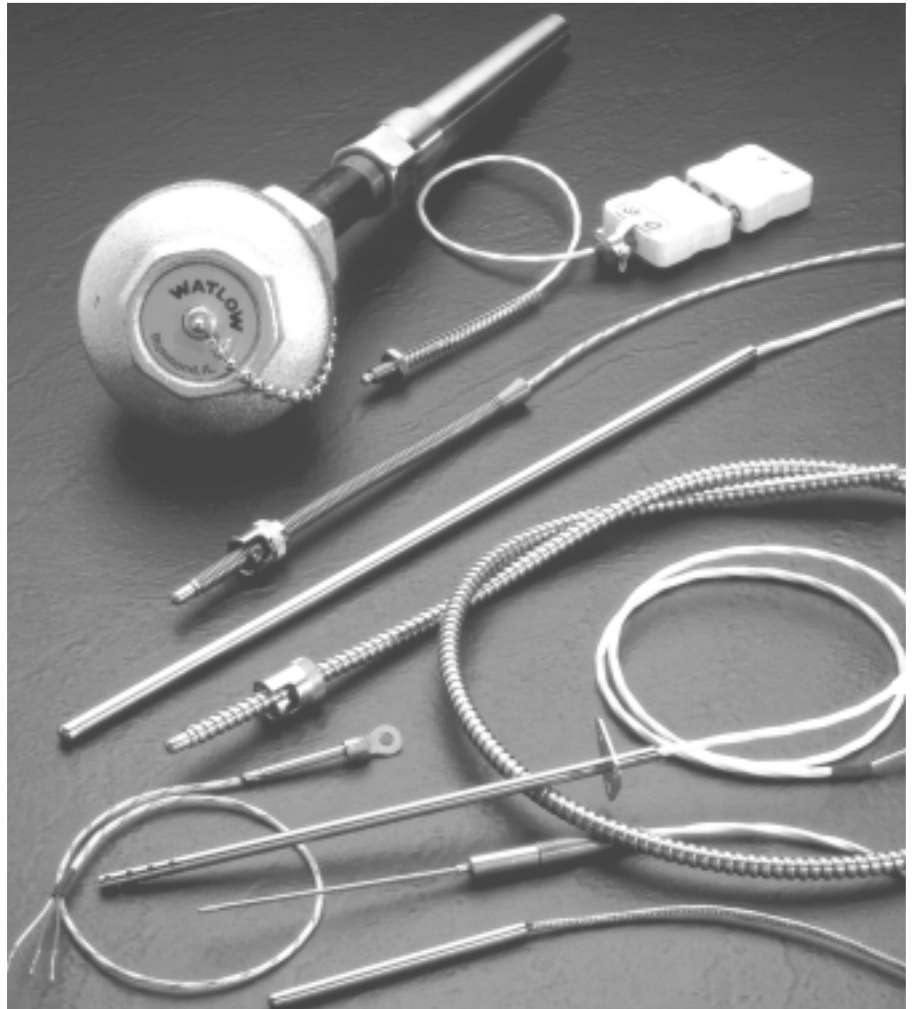
Watlow's platinum resistance elements are specially designed to ensure precise and repeatable temperature versus resistance characteristics. The sensors are made with controlled purity platinum wire and high purity ceramic components, and constructed in a unique strain-free manner.

Performance Capabilities

- Wire-wound ceramic elements are extremely precise and stable within the wide temperature range of -200°C (-328°F) to 650°C (1200°F).
- Laboratory grade platinum wire-wound elements recognized in the international temperature standard from 13.8K (hydrogen point) to 630.74°C (antimony point).

Features and Benefits

- **Accuracy.** A special patented process combines strain-free construction with full winding support for dependable, accurate readings.
- **High signal-to-noise output** increases the accuracy of data transmission and permits greater distances between the sensor and the measuring equipment.
- **Interchangeability.** Strain-free construction and precision trimming allow elements from different lots to be substituted without recalibration.
- **Sensitivity.** Self-heating is minimized, allowing precise measurement. The temperature coefficient (α) is carefully controlled at the industry standard while insulation resistance values exceed DIN-IEC-751 standards.



- **Standardization.** Elements are available to meet or exceed the requirements of various standardization agencies. DIN-IEC-751 standard tolerance classes A and B respectively are very well suited for industrial applications.
- **Physical and chemical stability over a wide temperature range** is ensured by Watlow's highly controlled manufacturing process. Elements are also built to resist mechanical vibration and shock.
- **Repeatability.** All elements exceed DIN-IEC-751 repeatability values even after long exposure to temperatures within the operating range.

- **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

RTDs and Thermistors

Comparison of RTDs and Thermistors

When to Use RTDs

- When accuracy and stability are the foremost goals of an application.
- When accuracy must extend over a wide temperature range.
- When area, rather than point, sensing improves control.
- When a high degree of standardization is desirable.

RTDs

Advantages

- Linear over wide operating range
- Wide temperature operating range
- High temperature operating range
- Interchangeability over wide range
- Better stability at high temperature

Disadvantages

- Low sensitivity
- Higher cost
- No point sensing
- Affected by shock and vibration
- Requires three or four-wire operation
- Can be affected by contact resistance

When to Use Thermistors

- When the application requires high resolution over a narrow span.
- When low cost is a primary consideration.
- When point sensing or miniaturization is desirable.

Thermistors

Advantages

- Fast response
- Small size
- High resistance eliminates most lead resistance problems
- Rugged, not affected by shock or vibration
- Lower cost

Disadvantages

- Nonlinear
- Narrow span for any single unit
- Interchangeability is limited unless matched pairs are used

Table of Tolerance Values

Temperature °C	Resistance Value Ω	Tolerance DIN-IEC-751	
		Class A °C (Ω)	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)

RTD Tolerance Class Definitions

DIN class A: $\pm [0.15 + 0.002 |t|]^\circ\text{C}$

DIN class B: $\pm [0.30 + 0.005 |t|]^\circ\text{C}$

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

RTDs and Thermistors

Resistance Temperature Sensing

Application and Technical Data



See Watlow's Application Guide for RTD time constant (time response).

DIN Specifications

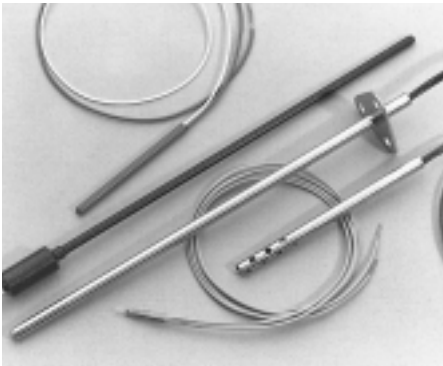
Elements conform to DIN-IEC-751 specifications. Other resistance values and temperature coefficients

are available on special request. Watlow supplies 500Ω and 1000Ω elements.

Element Type	Temperature Range	Base Resistance	TCR(Ω/Ω/°C)
*Platinum DIN	-200 to 650°C (-330 to 1200°F)	100Ω at 0°C	0.00385
Copper	-100 to 260°C (-150 to 500°F)	10Ω at 25°C	0.00427
Nickel	-100 to 205°C (-150 to 400°F)	120Ω at 0°C	0.00672

*Thin film element -50 to 500°C (-58 to 932°F).

Thermistor Sensors



A thermistor operates through an electrical resistance change in semi-conductors rather than pure metal. Thermistor beads are coated with epoxy or glass to suit a variety of applications.

Performance Capabilities

- Epoxy beads rated up to 150°C (300°F).
- Glass beads rated up to 300°C (570°F).

Features

- **Low cost.** The sensing bead itself is a very low cost component, typically one-tenth that of a platinum RTD element.
- **High resistance.** Base resistance of thermistors may be several thousand ohms. This provides a larger signal than RTDs with the same measuring current, negating leadwire resistance problems.
- **Point sensing.** Thermistor beads may be pinhead in size.
- **Interchangeability** within a specific range.
- **Rugged.** The packaged thermistor bead is vibration resistant.

- **Variety of sheath configurations.** The subassembly can be inserted into a closed end tube, machined housing, bolt, ring terminal or many other configurations.
- **Multiple termination options** include spade lugs, molded miniature male connector or universal head.

Applications

- Fever thermometers and respirators
- Fast food processing
- Coffee makers
- Thermostats
- Emission controls
- Photo processing
- Hot glue dispensing equipment
- Laboratory equipment
- Processes requiring high resolution over a narrow band
- Processes requiring miniaturization

Typical Properties of Thermistors

The thermistor exhibits very large resistance changes in comparison to an RTD sensor. One main difference is its negative temperature coefficient (NTC). As temperature increases, resistance decreases.

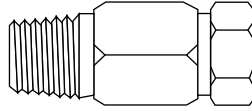
Base resistances are commonly specified at 25°C (75°F). Resistance values at this temperature can vary from thousands to millions of ohms. Thermistors tend to drift more than RTDs, but will eventually stabilize.

Self heating can present problems with error. High resistance generates more internal heat. This coupled with the relatively small diameters of the bead leaves little surface area for heat dissipation.

RTDs and Thermistors

Resistance Temperature Sensing

Optional Features



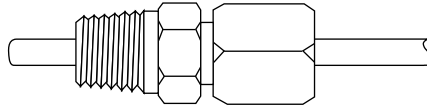
Shown in hardware section as TH-2747 or TH-2748 (single) and TH-2751 or TH-2752 (double)

Adjustable

Thread	Material	Sheath O.D. inch	NPT inch	Hex inch	Order Code			Length
					Neoprene	Teflon®	Lava	
Single	303 SS	0.063 to 0.188	1/8	1/2	N	G	Q	1 1/4
Single	303 SS	0.250 to 0.375	1/4	3/8	P	X	V	2 7/8

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.



Shown in hardware section as TH-185 (brass), TH-2745 (stainless steel single) or TH-2749 (stainless steel double)

Non-Adjustable

Thread	Material	Sheath O.D. inch	NPT inch	Hex inch	Order Code	Length
Single	Brass	0.125 to 0.250	1/8	1/2	J	1 3/8 max.
Single	Brass	0.250 to 0.375	1/4	1/2	K	1 3/4 max.
Single	303 SS	0.063 to 0.250	1/8	1/2	L	1 5/8 max.



See pages 156 to 162 for a complete description of all mounting fittings.

RTDs and Thermistors

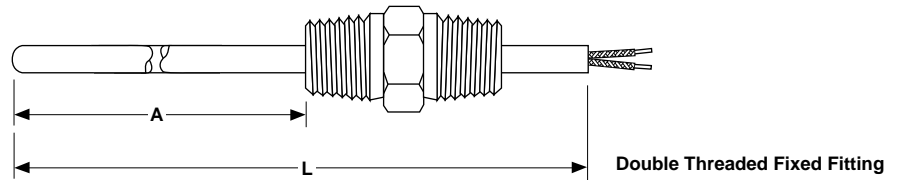
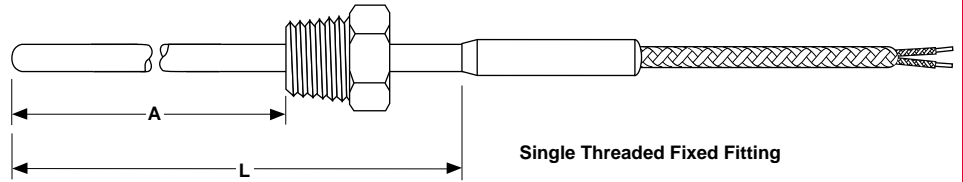
Resistance Temperature Sensing

Optional Features

Continued

Fixed Fittings

Fixed fittings must be brazed to the sheath and are suitable where the exact immersion depth "A" is known in advance.



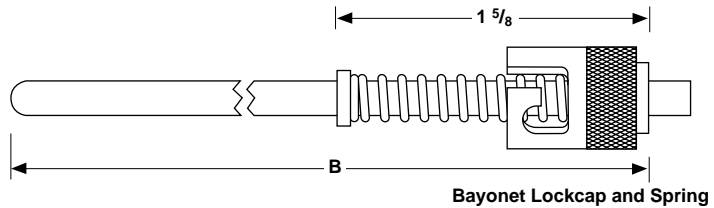
Fixed

Thread	Material	Sheath O.D. inch	NPT inch	Hex inch	Length inches	Order Code
Single	303 SS	0.063 to 0.250	1/8	3/16	1 1/16	—
Single	303 SS	0.250 to 0.375	1/4	9/16	7/8	—
Single	Mild Steel	0.125 to 0.375	1/2	7/8	1	—
Single	303 SS	0.125 to 0.375	1/2	7/8	1	—
Double	Mild Steel	0.125 to 0.375	1/2	7/8	1 3/4	—
Double	303 SS	0.125 to 0.375	1/2	7/8	1 3/4	—

When ordering fixed fittings as part of an assembly, specify the distance "A" in inches from the tip of the measuring junction to the start of threads.

Bayonet Fittings

When used together, a bayonet fitting and adaptor bottom a sensor in a hole.



Fixed

Type	Material	Sheath O.D. inch	Order Code
Fixed	Plated Steel	0.063 to 0.188	—

RTDs and Thermistors

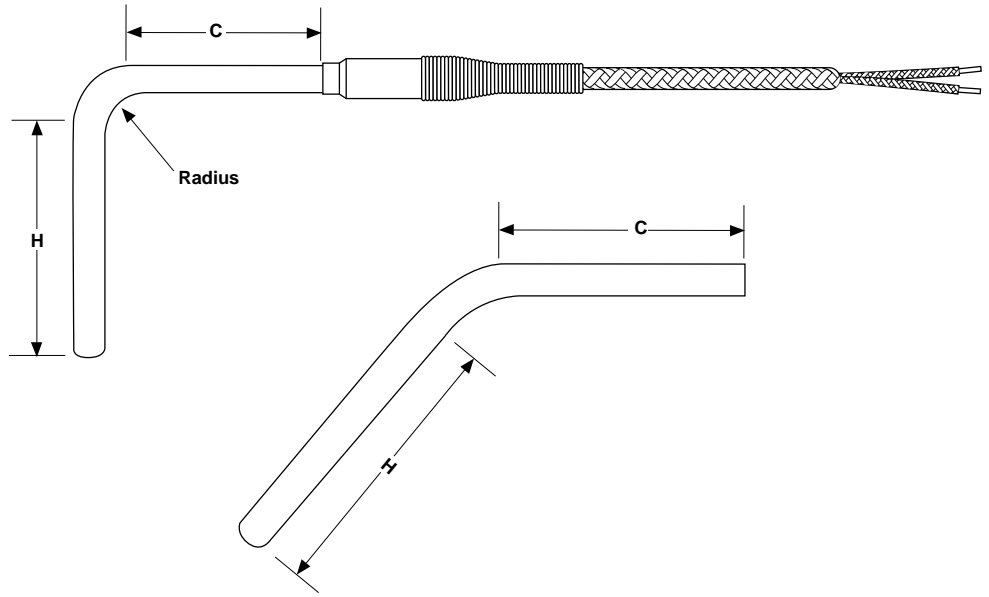
Resistance Temperature Sensing

Optional Features

Continued

Bends

Watlow can provide RTDs with bends from 15 to 180 degrees. Standard radius are listed with others provided upon request. Specify cold leg "C", hot leg "H" and bend angle.



Thermocouple Diameter inch	Standard Bend Radius inches	Minimum "H" Dimension inches	Minimum "C" Cold Leg inches
0.125	$\frac{3}{8}$	1	2
0.188	$\frac{3}{8}$	1	2
0.250	$\frac{1}{2}$	2	2

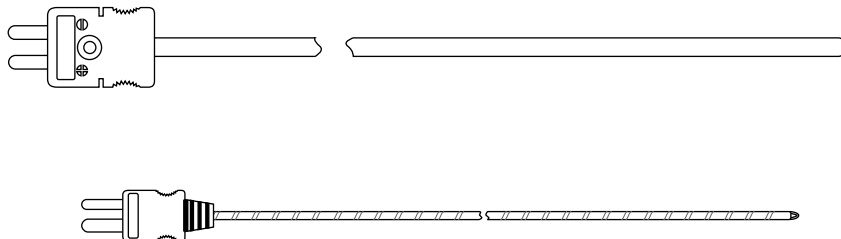
RTDs and Thermistors

Resistance Temperature Sensing

Optional Features

Continued

Molded Plugs



- **Fully molded on plug** withstands extreme vibration, eliminating the problem of intermittent thermocouple signals.
- **Tamper proof molded plug** cannot be disassembled, preventing people from removing the plug and reversing the polarity.
- **Consult factory for availability.**

Molded Transition

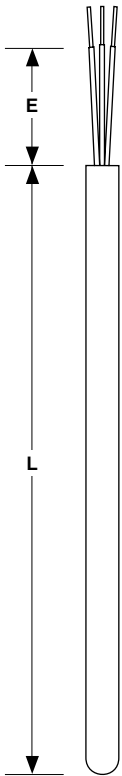


- **Excellent moisture resistance.**
- **Coiled spring strain relief** prevents wire damage due to overflexing.
- **Custom designs** for large range of sheath diameters.
- **Consult factory for availability.**

RTDs and Thermistors

Style RB

Standard Industrial Insulated Leads



Features and Benefits

- **High accuracy** for dependable readings.
- **Customized diameters** from 0.125 to 0.375 inch.
- **Epoxy sealed** to resist moisture and pullout. Standard 500°F potting.
- **Durable rigid sheath** made of corrosion resistant materials.
- **Larger diameters** for demanding applications.

① Certain option combinations must be furnished with a transition between the sheath and leadwire, consult factory if transition is unacceptable.
 ② May require transition.
 ③ Requires two- or three-wire, single element only.

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

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

3. Sheath O.D. (inch) _____
 G = 0.125 K = 0.313
 H = 0.188 L = 0.375
 J = 0.250

4. Leadwire Construction^① _____
 Standard Overbraid Flex Armor
 Fiberglass Stranded **A** **J**^② **R**^②
 PFA or TFE Stranded **B** **L**^② **T**^②

5. Fittings _____
 If required, enter order code from [pages 112 to 113](#).
 If none, enter "0".

6. Leadwire Termination _____
 A^③ = Standard male plug 200°C (400°F)
 B^③ = Standard female plug
 C^③ = Standard plug with mating connector
 J^③ = Male miniature plug
 K^③ = Female miniature jack
 L^③ = Male/female mini set
 T = Standard leads
 U = Leads with spade lugs
 W = 1 ½ inch with BX connector and spade lugs

7. Sheath Construction _____
 -50 to 260°C
 (-58 to 500°F)
 316 SS
A
 Standard Industrial*

8-9. Sheath Length "L" (inch) _____
 Whole inches: 02 to 99
 Metric lengths and lengths over 99 inches consult factory.

10. Sheath Length "L" (fractional inch) _____
 0 = Not required, complete assembly
 1 = 1/8 5 = 5/8
 2 = 1/4 6 = 3/4
 3 = 3/8 7 = 7/8
 4 = 1/2

11. Element _____
 2-Wire 3-Wire 4-Wire
 100Ω Single **A** **B** **C**

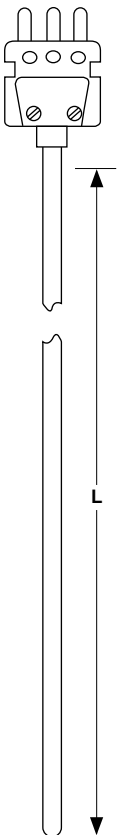
12. Temperature Coefficient _____
 DIN 0.00385
 Class A **A**
 Class B **B**

13-14. Leadwire Length (foot) _____
 Whole feet: 01 to 99

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

RTDs and Thermistors

Style RC Plug or Jack Termination



Features and Benefits

- **Durable connectors with copper pins** have a 200°C (400°F) temperature rating and provide simple connection to extension leads.
- **Brazed adaptor** provides superior connector attachment.
- **Available in rigid sheath** or mineral insulated constructions.
- **High accuracy** for dependable readings.

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

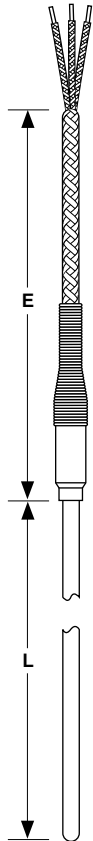
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
	R	C				0							0	0	0	
3. Sheath O.D. (inch)	_____		_____		_____		_____		_____		_____		_____		_____	
G = 0.125																
H = 0.188																
J = 0.250																
4. Cold End Termination	_____		_____		_____		_____		_____		_____		_____		_____	
Standard plugs and jacks 200°C (400°F)																
A = Standard plug																
B = Standard jack																
C = Standard plug with mating connector																
5. Fittings	_____		_____		_____		_____		_____		_____		_____		_____	
If required, enter order code from pages 112 to 113 .																
If none, enter "0".																
6. Enter "0"	_____		_____		_____		_____		_____		_____		_____		_____	
7. Sheath Construction	_____		_____		_____		_____		_____		_____		_____		_____	
			-50 to 260°C				-200 to 650°C									
			(-58 to 500°F)				(-328 to 1200°F)									
			316 SS				316 SS								Alloy 600	
Standard Industrial	A		—				—								—	
Mineral Insulated	—				K										L	
8-9. Sheath Length "L" (inch)	_____		_____		_____		_____		_____		_____		_____		_____	
Whole inches: 02 to 99																
Metric lengths and lengths over 99 inches consult factory.																
10. Sheath Length "L" (fractional inch)	_____		_____		_____		_____		_____		_____		_____		_____	
0 = Not required, complete assembly																
1 = 1/8 5 = 5/8																
2 = 1/4 6 = 3/4																
3 = 3/8 7 = 7/8																
4 = 1/2																
11. Element	_____		_____		_____		_____		_____		_____		_____		_____	
			2-Wire				3-Wire									
100Ω Single	A						B									
12. Temperature Coefficient	_____		_____		_____		_____		_____		_____		_____		_____	
DIN 0.00385																
Class A	A															
Class B	B															
13-14. Enter "00"	_____		_____		_____		_____		_____		_____		_____		_____	
15. Special Requirements	_____		_____		_____		_____		_____		_____		_____		_____	
If none, enter "0". If required, consult factory.																

RTDs and Thermistors

RTDs and Thermistors

Style RF

Metal Transitions



Features and Benefits

- **Stainless steel transitions** are crimped to sheath and filled with 500°F epoxy. Optional brazing available.
- **Coiled spring strain relief** protects leadwire against sharp bends in the transition area.
- **Flexible mineral insulated construction** provides a bendable and highly durable sensor.
- **High accuracy** for dependable readings.
- **Available in diameters** 0.125 to 0.313 inch O.D. Consult factory.

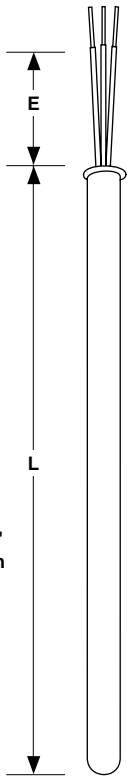
② Requires two- or three-wire only, single element only

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

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	R	F													0
1-2. Style	_____														
F = Metal transition with strain relief															
3. Sheath O.D. (inch)	_____														
G = 0.125 K = 0.313															
H = 0.188															
J = 0.250															
4. Leadwire Construction	_____														
	Standard	Over-braid	Flex Armor												
Fiberglass Stranded	A	J	R												
PFA or TFE Stranded	B	L	T												
5. Fittings	_____														
If required, enter order code from pages 112 to 113 .															
If none, enter "0".															
6. Leadwire Termination	_____														
A ^② = Standard male plug															
B ^② = Standard female plug															
C ^② = Standard plug with mating connector															
J ^② = Male miniature plug															
K ^② = Female miniature jack															
L ^② = Male/female mini set															
T = Standard leads															
U = Leads with spade lugs															
W = 1 ½ inch leads with BX connector and spade lugs															
7. Sheath Construction	_____														
-200°C to 650°C															
(-328 to 1200°F)															
316 SS Alloy 600															
Mineral Insulated	K	L													
(0.125-0.375 inch O.D.)															
8-9. Sheath Length "L" (inches)	_____														
Whole inches: 03 to 99															
Metric lengths and lengths over 99 inches consult factory.															
10. Sheath Length (fractional inch)	_____														
0 = Not required, complete assembly															
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															
Class A	A														
Class B	B														
13-14. Leadwire Length "E" (foot)	_____														
Whole feet: 01 to 99															
15. Special Requirements	_____														
If none, enter "0". If required, consult factory.															

RTDs and Thermistors

Style RK Cut-to-Length RTD



Minimum of 3" "L" Dimension

Features and Benefits

- **Cut-to-length features** avoids the need to stock several RTD lengths.
- **Probes can be shortened** to three inches minimum using a tubing cutter.
- **High accuracy** for dependable reading.
- **Internally sealed** to prevent moisture penetration.

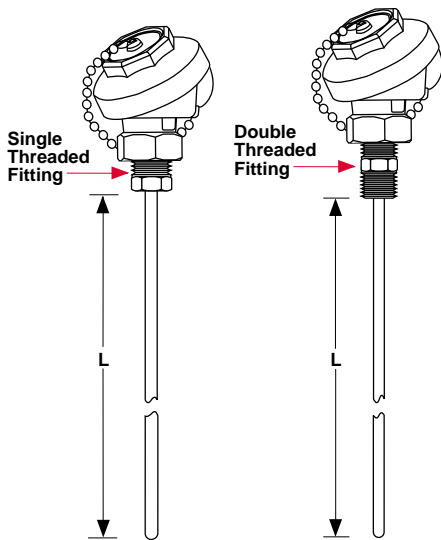
Ordering Information—To order, complete the code number on the right with the information below:

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	R	K				T									0
1-2. Style	_____														
K = Cut-to-length RTD															
3. Sheath O.D. (inch)	_____														
H = 0.188															
J = 0.250															
4. Leadwire Construction	_____														
Standard															
Fiberglass Stranded A															
PFA or TFE Stranded B															
5. Fittings	_____														
If required, enter order code from pages 112 to 113 .															
If none, enter "0".															
6. Leadwire Termination	_____														
T = Standard leads															
7. Sheath Construction	_____														
-50 to 260°C															
(-58 to 500°F)															
316 SS															
Standard Industrial A															
8-9 Sheath Length "L" (inches)	_____														
Whole inches: 03 to 60															
Metric lengths and lengths over 60 inches consult factory.															
10. Sheath Length "L" (fractional inch)	_____														
0 = Not required, complete assembly															
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 4-Wire															
100Ω Single A B C															
12. Temperature Coefficient	_____														
DIN 0.00385															
Class A A															
Class B B															
13-14. Leadwire Length "E" (foot)	_____														
Whole feet: 01 to 99															
15. Special Requirements	_____														
If none, enter "0". If required, consult factory.															

RTDs and Thermistors

Style RR

Connection Head/ Optional Transmitter



Features and Benefits

- **Connection heads** provide superior dust and moisture resistance.
- **Plastic heads are weatherproof** and resist weak acids, organic solvents, alkalis, sunlight and dust.
- **Bottom mounting is standard.** Side mounting available upon request.
- **Available complete** with a head-mounted 4-20mA transmitter, two- or three-wire input, non-isolated.

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

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 K = 0.313

4. Connection Head

A = Universal cast iron-maximum temperature 315°C (600°F)
B = Universal cast aluminum
C = Polypropylene
D = Small cast iron
E = Small cast aluminum
F = Miniature plastic-maximum temperature 175°C (350°F)
G = Canister-maximum temperature 115°C (240°F)
H = Explosion proof
P = Epoxy coated aluminum
T[Ⓞ] = A head with 5751 transmitter
U[Ⓞ] = B head with 5751 transmitter
V[Ⓞ] = C head with 5751 transmitter
W[Ⓞ] = H head with 5751 transmitter

5. Head Mounting Fittings

O = Single threaded, 303 SS
E = Double threaded, mild steel ½" NPT
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 Inc 600
Standard Industrial (0.125-0.375 inch O.D.)	A	—
Mineral Insulated (0.125-0.375 inch O.D.)	—	K L

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

Whole inches: 02 to 99
Metric lengths and lengths over 99 inches consult factory.

10. Sheath Length "L" (fractional inch)

0 = Not required, complete assembly
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
Class A A
Class B B

13-14. Enter "00"

15. Special Requirements

If none, enter "0". If required, consult factory.

[Ⓞ] Units with transmitter, buyer to specify range and degree C or F.



For further details on Watlow connection heads see the hardware section of this catalog, pages 153 to 155.

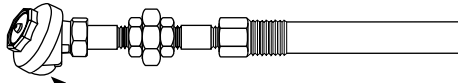


For a complete RTD assembly, add thermowell part number. See thermowell section, pages 125 to 136.

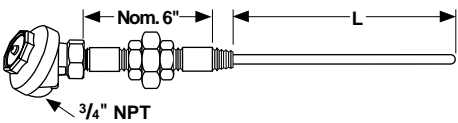
RTDs and Thermistors

Style RT

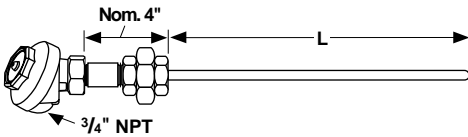
For Use with Thermowells



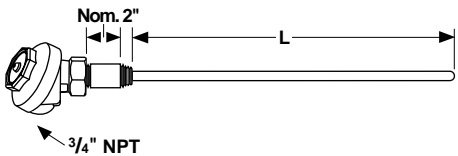
Type 1 With Well
(Sheath length does not have to be specified)



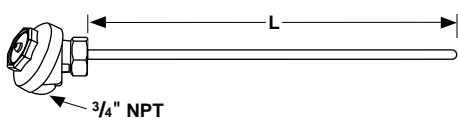
Type 1 Without Well
6 inch N-U-N Typical (2 each 1/2 X 3 inch steel pipe nipples and 1 each malleable union)[Ⓟ]



Type 2 Without Well
4 inch N-U typical (1 each 1/2 X 3 inch steel pipe nipple and 1 each malleable union)[Ⓟ]



Type 3 Without Well
1/2 X 3 inch long steel pipe nipple typical[Ⓟ]



Type 4 Without Well

Features and Benefits

- **Protect sensor** with high quality thermowells and pipe wells.
- **Mineral insulated construction** available in 0.125 to 0.313 inch O.D., up to four-wire single or two-wire dual element.
- **Available with spring-loading** for positive contact.
- **Available complete** with a head mounted 4-20mA transmitter, two or three-wire input, non-isolated.
- **Variety of connection head options** to meet your application requirements.
- **Larger diameters** for demanding applications.

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

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
R	T				0							0		0
3. Sheath O.D. (inch)														
G = 0.125 J = 0.250														
H = 0.188 K = 0.313														
4. Connection Head														
A = Universal cast iron														
B = Universal cast aluminum														
C = Polypropylene														
D = Small cast iron														
H = Explosion proof														
P = Epoxy coated aluminum														
T [Ⓟ] = A head with 5751 transmitter														
U [Ⓟ] = B head with 5751 transmitter														
V [Ⓟ] = C head with 5751 transmitter														
W [Ⓟ] = H head with 5751 transmitter														
5. Cold End Configuration[Ⓟ]														
Type 1 Type 2 Type 3 Type 4														
6. Enter "0"														
7. Sheath Construction														
		-50 to 260°C			-200 to 650°C									
		(-58 to 500°F)			(-328 to 1200°F)									
		316 SS			316 SS			Alloy 600						
Standard Industrial		A			—									
Mineral Insulated		—			K			L						
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 = Not required, complete assembly														
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			4-Wire						
100Ω Single		A			B			C						
12. Temperature Coefficient														
		DIN 0.00385												
Class A		A												
Class B		B												
14. Spring-Loading														
Y = Yes N = No														
15. Special Requirements														
If none, enter "0". If required, consult factory.														

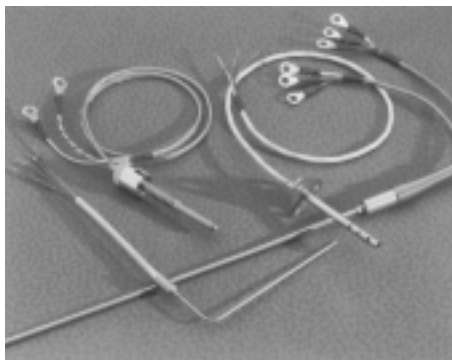
[Ⓟ] Units with transmitter, buyer to specify range and degree C or F.
[Ⓢ] Other sizes, lengths and materials available. Consult factory.



For further details on Watlow connection heads see the hardware section of this catalog, pages 153 to 155.

RTDs and Thermistors

Speciality RTDs and Thermistors



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 and ranges:

Epoxy Bead Tolerance ±1%Ω (+0.3°C)		
#10	300Ω	-60 to 100°C (-76 to 212°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 (+3°C)		
#16	100,000Ω	-60 to 260°C (-76 to 500°F)

*Other thermistors available on request. Consult factory. See Style TB thermistor on [page 124](#).

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

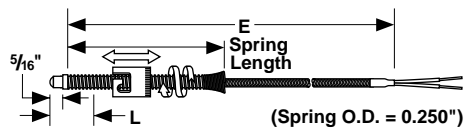
1	2	3	4	5	6	7	8	9	10	11	12
S											
2-3. Construction											
10 = 6 inch adjustable spring style											
11 = 12 inch adjustable spring style											
12 = Adjustable armor style											
25 = Cartridge with flange											
50 = Open air											
55 = Open air with flange											
80 = Surface mount											
4. Diameter (inch)											
D = 0.187											
A = Not applicable: surface mount											
*5. Element Type											
C = RTD 2-wire No. 3850 M = Thermistor No. 11											
D = RTD 3-wire No. 3850 N = Thermistor No. 12											
L = Thermistor No. 10 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. Leadwire 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

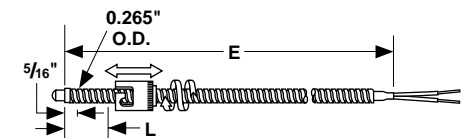
Speciality RTDs and Thermistors

Construction Styles

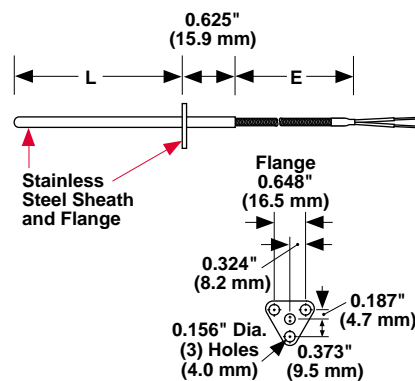
10 = 6 inch Adjustable Spring Style
 11 = 12 inch Adjustable Spring Style



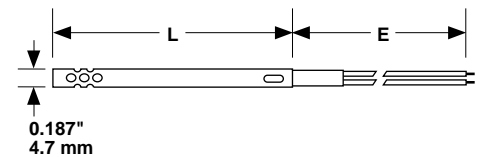
12 = Adjustable Armor Style



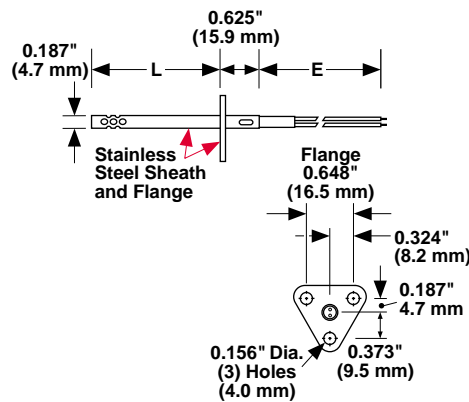
25 = Cartridge with Flange



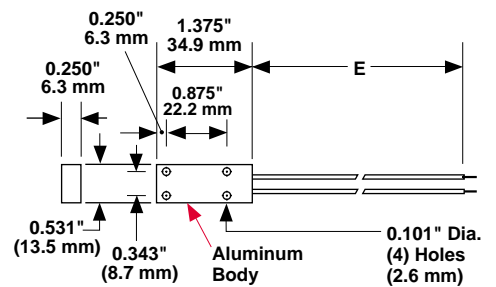
50 = Open Air



55 = Open Air with Flange



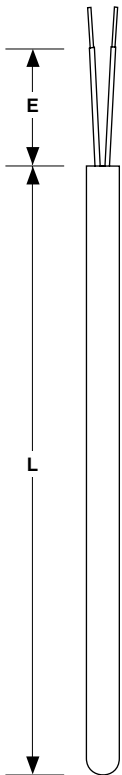
80 = Surface Mount



RTDs and Thermistors

Style TB

Standard Industrial Thermistor with Insulated Leads



Features and Benefits

- **Rigid 316 stainless steel sheath** for industrial applications.
- **Rated to 260°C (500°F) cold end epoxy seal.**
- **Optional PFA covered sheath materials,** can handle variety of corrosive environments.
- **Sheath material 316 stainless steel.**
- **Wide assortment** of resistance bases.

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

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
	T	B										O			0	
3. Sheath O.D. (inch) H = 0.188 J = 0.250																
4. Leadwire Construction																
5. Fittings If required, enter order code from pages 112 to 113 . If none, enter "0".																
6. Leadwire Termination T = Standard leads U = Leads with spade lugs W = 1 ½ inch with BX connector and spade lugs																
7. Temperature Rating A = -60 to 150°C (-75 to 302°F) ±1% (±.3°C) Accuracy @ 25°C B = -60 to 260°C (-75 to 500°F) ±15% (±.3°C) Accuracy @ 25°C																
8-9. Sheath Length "L" (inches) Whole inches: 02 to 99 Metric lengths and lengths over 99 inches consult factory.																
10. Sheath Length "L" (fractional inch) 0 = Not required, complete assembly 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) D ^① = 300Ω E ^① = 1000Ω G ^① = 3000Ω T = 100,000Ω																
12. Sheath O = Standard sheath																
13-14. Leadwire Length "E" (foot) Whole feet: 01 to 99																
15. Special Requirements If none, enter "0". If required, consult factory.																

① Only available in -60 to 150°C temperature range.

② Requires transition.

Accessories

Thermowells and Protecting Tubes

Watlow offers a full line of thermowells and protecting tubes to meet varying requirements. While both types are designed to protect your sensor in an application, the two are different in terms of their construction and capabilities.

Thermowells

Manufactured from drilled bar stock, Watlow thermowells provide a pressure-tight connection at the point of installation. With thick walls, thermowells are sturdy enough to handle high pressure, high velocity and corrosive environments. They are frequently used in petrochemical and power plant applications.

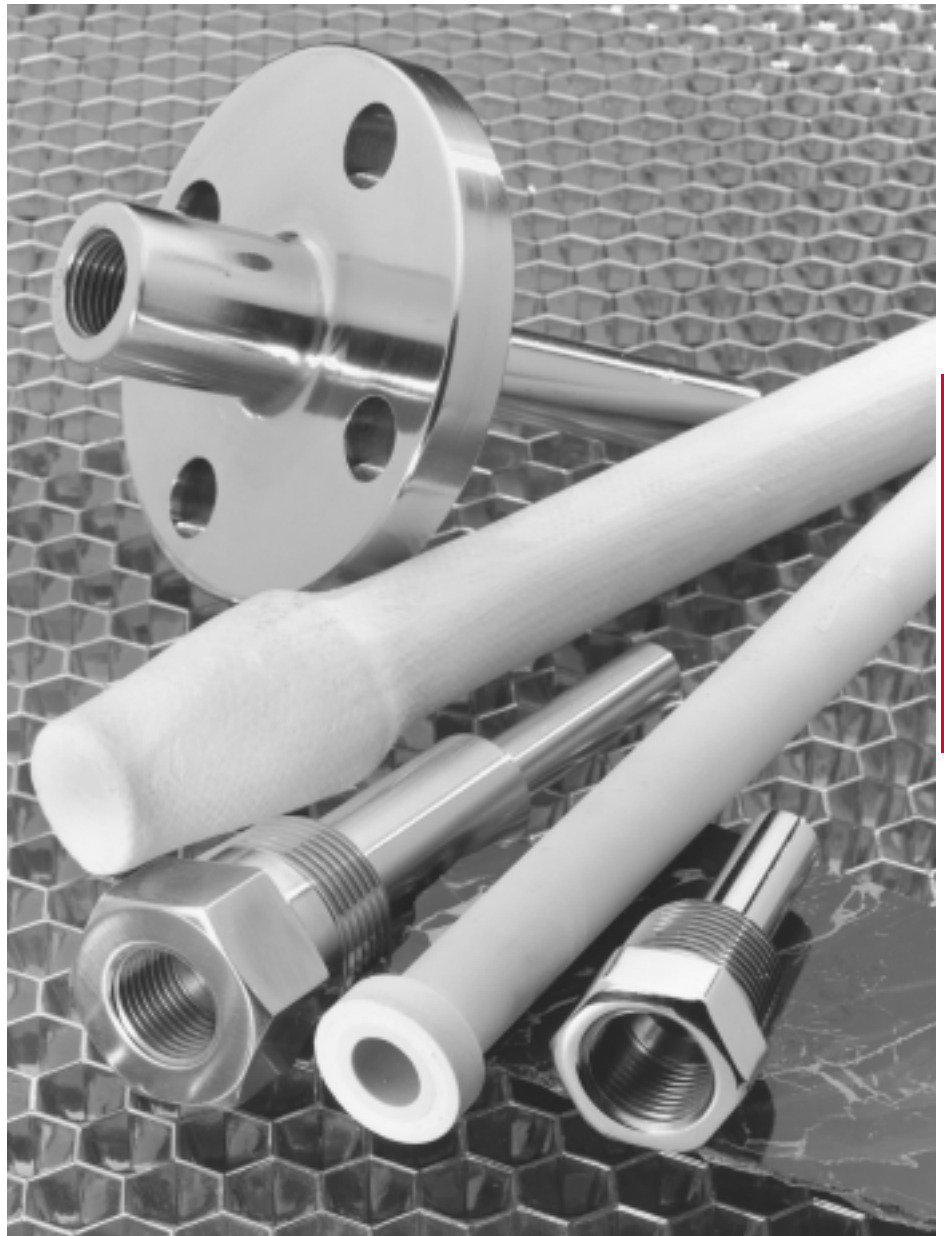
Highly critical or demanding applications may require thermowells not only for protection of the temperature sensor, but also to withstand high pressure or erosion or both, caused by material flows through vessels.

Watlow offers numerous standard thermowell constructions, and special configurations can be designed on request.

Protecting Tubes

Both ceramic and metal (pipe type) protecting tubes serve the purpose of protecting the temperature sensor from harsh environments. Unlike thermowells, they are not primarily designed for pressure tight applications. Protection tubes are often used in heat treatment furnaces, ovens, open containers, flues and ducts.

Construction styles of protecting tubes are more limited than thermowells, but the tubes offer the advantages of economy, corrosion resistance, and, in some cases, higher temperature capabilities.



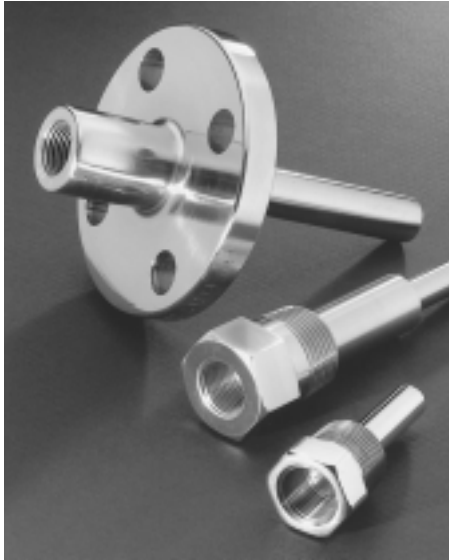
Thermowells



**For more information on
Watlow's protecting tubes
see pages 137 to 142.**

Accessories

Thermowells



Watlow designs and manufactures all types of thermowells. The thermowell designs shown in this catalog section are representative of the types of basic styles in popular usage throughout the industry. Special designs as well as modifications of our standard offerings are also available.

Drilled from solid bar stock, the thermowell protects the temperature sensor from corrosion, high pressure and high velocity environments.

Features and Benefits

- **Numerous standard thermowell constructions** are available, and special configurations can be designed on request.

- **The bar stock** used to manufacture our thermowells is hex stock when available. Round bar with wrench flats is substituted when hex is not available.
- **A plug and chain** are available for an additional charge. Specify brass or stainless steel.

Applications

- Petrochemical
- Chemical
- Oil refineries
- Power plants
- Storage tanks and lines

Manufacturing Standards

Bar Stock	Mill Standards (± 0.010 inch approximately)
Process Connection	Threaded: Inspected with Standard Ring Gauge Flanged: Front "J" groove welds are $\frac{1}{4}$ inch wide by $\frac{1}{4}$ inch deep. Welds are machined, leaving $\frac{1}{8}$ inch radius. Rear welds are $\frac{1}{8}$ inch wide by $\frac{1}{8}$ inch deep "V". Welds are machined, leaving $\frac{1}{4}$ inch radius. Full penetration welds are available upon request. Must be specified.
Stem O.D.	Straight: ± 0.015 inch Tapered: ± 0.015 inch (Minor dimension)
U Dimension	$\pm \frac{1}{8}$ inch
Overall Dimension	$\pm \frac{1}{8}$ inch
End Thickness	$\frac{1}{4}$ inch $\pm \frac{1}{16}$ inch
Finish	63 RMS
Bore	+0.005 inch -0.003 inch
Tapered Wells	The maximum taper on all thermowells is 16 inches +0.5 - 1.0.

These specifications listed are for standard thermowells, or for thermowells manufactured where no other specifications prevail.

Accessories

Thermowells

Thermowell Material Selection Guide

Application	Protecting Tube Material
Heat treating	
Annealing Up to 1300°F (704°C) Over 1300°F (704°C)	Black steel Inconel® 600, Type 446 SS
Carburizing hardening Up to 1500°F (816°C) 1500 to 2000°F (816 to 1093°C) Over 2000°F (1093°C) Nitriding salt baths Cyanide	Black steel, Type 446 SS Inconel® 600, Type 446 SS Ceramic* Type 446 SS Nickel (CP)
Neutral	Type 446 SS
High speed	Ceramic*
Iron and steel	
Blast furnaces Downcomer Stove dome Hot blast main Stove trunk Stove outlet flue	Inconel® 600, Type 446 SS Silicon carbide Inconel® 600 Inconel® 600 Black steel
Open hearth Flues and stack Checkers Waste heat boiler	Inconel® 600, Type 446 SS Inconel® 600, Cermets Inconel® 600, Type 446 SS
Billet heating slab heating and butt welding Up to 2000°F (1093°C) Over 2000°F (1093°C)	Inconel® 600, Type 446 SS Silicon ceramic carbide*
Bright annealing batch Top work temperature Bottom work temperature	Not required (use bare Type J thermocouple) Type 446 SS
Continuous furnace section	Inconel® 600, ceramic*
Forging	Silicon carbide, ceramic*
Soaking pits Up to 2000°F (1093°C) Over 2000°F (1093°C)	Inconel® 600 Silicon ceramic carbide*
Nonferrous metals	
Aluminum Melting Heat treating	Hexoloy® Black steel
Brass or bronze	Not required (use dip-type thermocouple)
Lead	Type 446 SS, black steel
Magnesium	Black steel, cast iron
Tin	Extra heavy carbon steel
Zinc	Extra heavy carbon steel
Pickling tanks	Chemical lead
Cement	
Exit flues Kilns, heating zone	Inconel® 600, Type 446 SS Inconel® 600
Ceramic	
Kilns	Ceramic* and silicon carbide*
Dryers	Silicon carbide, black steel
Vitreous enamelling	Inconel® 600, Type 446 SS
Barium chloride, all concentration, 70°F (21°C)	Monel®, Hastelloy C®

Inconel® and Monel® are registered trademarks of the Inco family of companies.

Hexoloy® is a registered trademark of Carborundum Company.

Hastelloy C® is a registered trademark of Haynes International.

* Due to susceptibility to cracking, sudden thermal shocks should be avoided.

Accessories

Thermowells

Thermowell Material Selection Guide

Continued

Application	Protecting Tube Material
Barium hydroxide, all concentration, 70°F (21°C)	Low carbon steels
Barium sulphite	Nichrome®, Hastelloy C®
Brines	Monel®
Bromine	Tantalum, Monel®
Butadiene	Type 304 SS
Butane	Type 304 SS
Butylacetate	Monel®
Butyl alcohol	Type 304 SS
Calcium chlorate, dilute, 70 to 150°F (21 to 66°C)	Type 304 SS
Calcium hydroxide 10 to 20%, 212°F (100°C) 50%, 212°F (100°C)	Type 304 SS, Hastelloy C® Type 316 SS, Hastelloy C®
Carbolic acid, all, 212°F (100°C)	Type 316 SS
Carbon dioxide, wet or dry	2017-T4 aluminum, Monel®, nickel
Chlorine gas Dry, 70°F (21°C) Moist, 20 to 212°F (-7 to 100°C)	Type 316 SS, Monel® Hastelloy C®
Chromic acid, 10 to 50% 212°F (100°C)	Type 316 SS, Hastelloy C® (all concentrations)
Citric acid 15%, 70°F (21°C) 15%, 212°F (100°C) Concentrated, 212°F (100°C)	Type 304 SS, Hastelloy C® (all concentrations) Type 316 SS, Hastelloy C® (all concentrations) Type 316 SS, Hastelloy C® (all concentrations)
Copper nitrate	Types 304 SS, 316 SS
Copper sulphate	Types 304 SS, 316 SS
Cresols	Type 304 SS
Cyanogen gas	Type 304 SS
Dow therm®	Low carbon steels
Ether	Type 304 SS
Ethyl acetate	Monel®, Type 304 SS
Ethyl chloride, 70°F (21°C)	Type 304 SS, low carbon steel
Ethyl sulphate, 70°F (21°C)	Monel®
Ferric chloride, 5%, 70°F (21°C) to boiling	Tantalum, Hastelloy C®
Ferric sulphate, 5%, 70°F (21°C)	Type 304 SS
Ferrous sulphate, dilute, 70°F (21°C)	Type 304 SS
Formaldehyde	Types 304 SS, 316 SS
Formic acid, 5%, 70 to 150°F (21 to 66°C)	Type 316 SS
Freon	Monel®
Gallic acid, 5%, 70 to 150°F (21 to 66°C)	Monel®
Gasoline, 70°F (21°C)	Type 304 SS, low carbon steel
Glucose, 70°F, (21°C)	Type 304 SS
Glycerine, 70°F (21°C)	Type 304 SS
Glycerol	Type 304 SS
Hydrobromic acid, 98%, 212°F (100°C)	Hastelloy B®
Hydrochloric acid 1%, 5% 70°F (21°C) 1%, 5% 212°F (100°C) 25%, 70 to 212°F (21 to 100°C)	Hastelloy C® Hastelloy B® Hastelloy B®
Hydrofluoric acid, 60%, 212°F (100°C)	Hastelloy C®, Monel®
Hydrogen peroxide, 70 to 212°F (21 to 100°C)	Types 316 SS, 304 SS
Hydrogen sulphide, wet and dry	Type 316 SS

Nichrome® is a registered trademark of the Driver-Harris Co.

Dow therm® is a registered trademark of the Dow Chemical Corporation.

* Due to susceptibility to cracking, sudden thermal shocks should be avoided.

CONTINUED

Accessories

Thermowells

Thermowell Material Selection Guide

Continued

Application	Protecting Tube Material
Glass	
Fore hearths and feeders	Platinum thimble
Lehrs	Black steel
Tanks Roof and wall Flues and checkers	Ceramic* Inconel® 600, Type 446 SS
Paper	
Digesters	Type 316 SS, Type 446 SS
Petroleum	
Dewaxing	Types 304, 310, 316, 321, 347 SS, carbon steel
Towers	Types 304, 310, 316, 321, 347 SS, carbon steel
Transfer lines	Types 304, 310, 316, 321, 347 SS, carbon steel
Fractioning column	Types 304, 310, 316, 321, 347 SS, carbon steel
Bridgewall	Types 304, 310, 316, 321, 347 SS, carbon steel
Power	
Coal-air mixtures	304 SS
Flue gases	Black steel, Type 446 SS
Preheaters	Black steel, Type 446 SS
Steel lines	Types 347 or 316 SS
Water lines	Low carbon steels
Boiler tubes	Types 304, 309, or 310 SS
Gas producers	
Producer gas	Type 446 SS
Water gas	
Carburetor	Inconel® 600, Type 446 SS
Superheater	Inconel® 600, Type 446 SS
Tar stills	Low carbon steels
Incinerators	
Up to 2000°F (1093°C)	Inconel® 600, Type 446 SS
Over 2000°F (1093°C)	Ceramic (primary) Hexoloy® (secondary)*
Food	
Baking ovens	Black steel
Charretort, sugar	Black steel
Vegetables and fruit	Type 304 SS
Chemical	
Acetic acid 10 to 50%, 70°F (21°C) 50%, 212°F (100°C) 99%, 70 to 212°F (21 to 100°C)	Type 304, Hastelloy C®, Monel® Type 316, Hastelloy C®, Monel® Type 430, Hastelloy C®, Monel®
Alcohol, ethyl, methyl 70 to 212°F (21 to 100°C)	Type 304
Ammonia All concentration 70°F (21°C)	Types 304, 316 SS
Ammonium chloride All concentration 212°F (100°C)	Types 316 SS, Monel®
Ammonium nitrate All concentration 70 to 212°F (21 to 100°C)	Type 316 SS
Ammonium sulphate, 10% to saturated 212°F (100°C)	Type 316 SS

* Due to susceptibility to cracking, sudden thermal shocks should be avoided.

CONTINUED

Accessories

Thermowells

Thermowell Material Selection Guide

Continued

Application	Protecting Tube Material
Iodine, 70°F (21°C)	Tantalum
Lactic acid 5%, 70°F (21°C) 5%, 150°F (66°C) 10%, 212°F (100°C)	Type 304 SS, 316 SS Type 316 SS Tantalum
Magnesium chloride 5%, 70°F (21°C) 5%, 212°F (100°C)	Monel®, nickel Nickel
Magnesium sulphate, hot and cold	Monel®
Muriatic acid, 70°F (21°C)	Tantalum
Naptha, 70°F (21°C)	Type 304 SS
Natural gas, 70°F (21°C)	Types 304 SS, 316 SS, 317 SS
Nickel chloride, 70°F (21°C)	Type 304 SS
Nickel sulphate, hot and cold	Type 304 SS
Nitric acid 5%, 70°F (21°C) 20%, 70°F (21°C) 50%, 70°F (21°C) 50%, 212°F (100°C) 65%, 212°F (100°C) Concentrated, 70°F (21°C) Concentrated, 212°F (100°C)	Types 304 SS, 316 SS Types 304 SS, 316 SS Types 304 SS, 316 SS Types 304 SS, 316 SS Type 316 SS Types 304 SS, 316 SS Tantalum
Nitrobenzene, 70°F (21°C)	Type 304 SS
Oleic acid, 70°F (21°C)	Type 316 SS
Oleum, 70°F (21°C)	Type 316 SS
Oxalic acid 5% hot and cold 10%, 212°F (100°C)	Type 304 SS Monel®
Oxygen 70°F (21°C)	Steel
Liquid	SS
Elevated temperatures	SS
Palmitic acid	Type 316 SS
Pentane	Type 340 SS
Phenol	Types 304 SS, 316 SS
Phosphoric acid 1%, 5%, 70°F (21°C) 10%, 70°F (21°C) 10%, 212°F (100°C) 30%, 70 to 212°F (21 to 100°C) 85%, 70 to 212°F (21 to 100°C)	Type 304 SS Type 316 SS Hastelloy C® Hastelloy B® Hastelloy B®
Picric acid, 70°F (21°C)	Type 304 SS
Potassium bromide, 70°F (21°C)	Type 316 SS
Potassium carbonate, 1%, 70°F (21°C)	Types 304 SS, 316 SS
Potassium chlorate, 70°F (21°C)	Type 304 SS
Potassium hydroxide 5% 70°F (21°C) 25% 212°F (100°C) 60% 212°F (100°C)	Type 304 SS Type 304 SS Type 316 SS
Potassium nitrate 5%, 70°F (21°C) 5%, 212°F (100°C)	Type 304 SS Type 304 SS

* Due to susceptibility to cracking, sudden thermal shocks should be avoided.

CONTINUED

Accessories

Thermowells

Thermowell Material Selection Guide

Continued

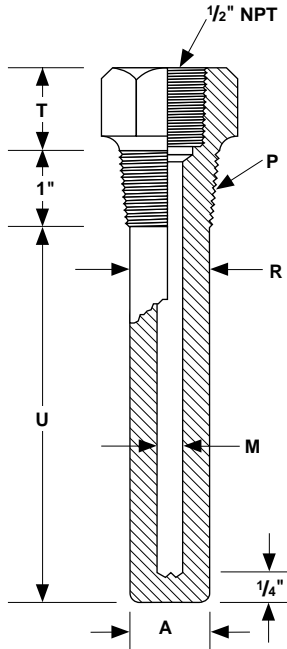
Application	Protecting Tube Material
Potassium permanganate, 5%, 70°F (21°C)	Type 304 SS
Potassium sulphate, 5%, 70°F (21°C)	Types 304 SS, 316 SS
Potassium sulphide, 70°F (21°C)	Types 304 SS, 316 SS
Propane	Type 304 SS, low carbon steel
Pyrogalllic acid	Type 304 SS
Quinine bisulphate, dry	Type 316 SS
Quinine sulphate, dry	Type 304 SS
Seawater	Monel® or Hastelloy C®
Salicylic acid	Nickel
Sodium bicarbonate All concentration, 70°F (21°C) 5%, 150°F (66°C)	Type 304 SS Types 304 SS, 316 SS
Sodium carbonate, 5%, 70 to 150°F (21 to 66°C)	Types 304 SS, 316 SS
Sodium chloride 5%, 70 to 150°F (21 to 66°C) Saturated, 70 to 212°F (21 to 100°C)	Type 316 SS Type 316 SS, Monel®
Sodium fluoride, 5%, 70°F (21°C)	Monel®
Sodium hydroxide	Types 304 SS, 316 SS, Hastelloy C®
Sodium hypochlorite, 5% still	Type 316 SS, Hastelloy C®
Sodium nitrate, fused	Type 316 SS
Sodium peroxide	Type 304 SS
Sodium sulphate, 70°F (21°C)	Types 304 SS, 316 SS
Sodium sulphide, 70°F (21°C)	Type 316 SS
Sodium sulphite, 30%, 150°F (66°C)	Type 304 SS
Sulphur dioxide Moist gas, 70°F (21°C) Gas, 575°F (302°C)	Type 316 SS Types 304 SS, 316 SS
Sulphur Dry molten Wet	Type 304 SS Type 316 SS
Sulphuric acid 5%, 70 to 212°F (21 to 100°C) 10%, 70 to 212°F (21 to 100°C) 50%, 70 to 212°F (21 to 100°C) 90%, 70°F (21°C) 90%, 212°F (100°C)	Hastelloy B®, 316 SS Hastelloy B® Hastelloy B® Hastelloy B® Hastelloy D®
Tannic acid 70°F (21°C)	Type 304 SS, Hastelloy B®
Tartaric acid 70°F (21°C) 150°F (66°C)	Type 304 SS Type 316 SS
Toluene	2017-T4 aluminum, low carbon steel
Turpentine	Types 304 SS, 316 SS
Whiskey and wine	Type 304 SS, nickel
Xylene	Copper
Zinc chloride	Monel®
Zinc sulphate 5%, 70°F (21°C) Saturated, 70°F (21°C) 25%, 212°F (100°C)	Types 304 SS, 316 SS Types 304 SS, 316 SS Types 304 SS, 316 SS

Reference charts and tables on pages 127 to 131 courtesy of the American Society for Testing and Materials. Taken from publication MNL 12, ***“Manual on the Use of Thermocouples in Temperature Measurement.”***

Accessories

Thermowells

Threaded Type—Straight



Standard Bore Size: 0.385 inch

Standard Materials: 304 SS, 316 SS, Monel®, Hastelloy C®

Typical Dimensions

Process Conn. NPT P inch	A inch	R inch	T inch
1	$\frac{49}{64}$	$\frac{49}{64}$	$\frac{3}{4}$
$\frac{3}{4}$	$\frac{49}{64}$	$\frac{49}{64}$	$\frac{3}{4}$

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

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

2. Thermowell Style

T = Threaded

3. Stem Configuration

S = Straight

4-5. "U" Dimension (inches)

Whole inches: 00 to 99

6. "U" Dimension (fractional inch)

0 = 0

1 = $\frac{1}{8}$

2 = $\frac{1}{4}$

3 = $\frac{3}{8}$

4 = $\frac{1}{2}$

5 = $\frac{5}{8}$

6 = $\frac{3}{4}$

7 = $\frac{7}{8}$

7. Thermowell Material

A = 304 SS

C = 316 SS

H = Monel®

M = Hastelloy C-276®

X = Other

8. Process Connection Size "P" (inch)

D = $\frac{3}{4}$ NPT

E = 1 NPT

X = Other

9. Flange Rating

0 = No flange

10. Flange Face Type

0 = No flange

11. Flange Material

0 = No flange

12. Lag "T" (inches)

Whole inches: 0 to 9

13. Lag "T" (fractional inch)

0 = 0

1 = $\frac{1}{8}$

2 = $\frac{1}{4}$

3 = $\frac{3}{8}$

4 = $\frac{1}{2}$

5 = $\frac{5}{8}$

6 = $\frac{3}{4}$ STD

7 = $\frac{7}{8}$

14. Bore Diameter "M" (inch)

A = 0.260

B = 0.385

X = Other

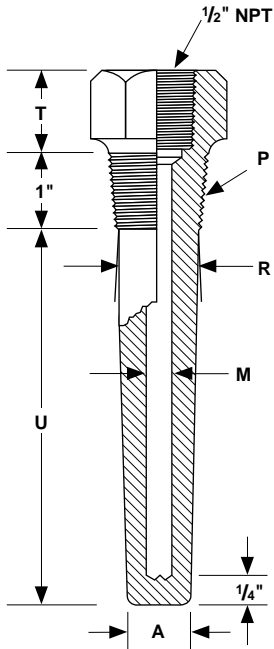
15. Special Options

0 = Standard options—consult factory

Accessories

Thermowells

Threaded Type—Tapered



Standard Bore Size: 0.260 inch and 0.385 inch

Standard Materials: 304 SS, 316 SS, Monel®, Hastelloy C®

Typical Dimensions

Process Conn. NPT P inch	A inch	M inch	R inch	T inch
1	$\frac{49}{64}$	0.385	$1 \frac{1}{16}$	$\frac{3}{4}$
$\frac{3}{4}$	$\frac{49}{64}$	0.385	$\frac{7}{8}$	$\frac{3}{4}$
1	$\frac{5}{8}$	0.260	$1 \frac{1}{16}$	$\frac{3}{4}$
$\frac{3}{4}$	$\frac{5}{8}$	0.260	$\frac{7}{8}$	$\frac{3}{4}$

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

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	T	T	T												
2. Thermowell Style	_____														
T = Threaded															
3. Stem Configuration	_____														
T = Standard taper															
X = Special															
4-5. "U" Dimension (inches)	_____														
Whole inches: 00 to 99															
6. "U" Dimension (fractional inch)	_____														
0 = 0															
1 = $\frac{1}{8}$															
2 = $\frac{1}{4}$															
3 = $\frac{3}{8}$															
4 = $\frac{1}{2}$															
5 = $\frac{5}{8}$															
6 = $\frac{3}{4}$															
7 = $\frac{7}{8}$															
7. Thermowell Material	_____														
A = 304 SS															
C = 316 SS															
H = Monel®															
M = Hastelloy C-276®															
X = Other															
8. Process Connection Size "P" (inch)	_____														
D = $\frac{3}{4}$ NPT															
E = 1 NPT															
X = Other															
9. Flange Rating	_____														
0 = No flange															
10. Flange Face Type	_____														
0 = No flange															
11. Flange Material	_____														
0 = No flange															
12. Lag "T" (inches)	_____														
Whole inches: 0 to 9															
13. Lag "T" (fractional inch)	_____														
0 = 0															
1 = $\frac{1}{8}$															
2 = $\frac{1}{4}$															
3 = $\frac{3}{8}$															
4 = $\frac{1}{2}$															
5 = $\frac{5}{8}$															
6 = $\frac{3}{4}$ STD															
7 = $\frac{7}{8}$															
14. Bore Diameter "M" (inch)	_____														
A = 0.260															
B = 0.385															
X = Other															
15. Special Options	_____														
0 = Standard options—consult factory															

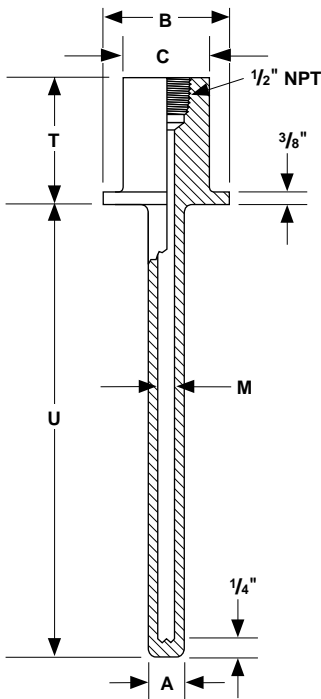
Accessories

Thermowells

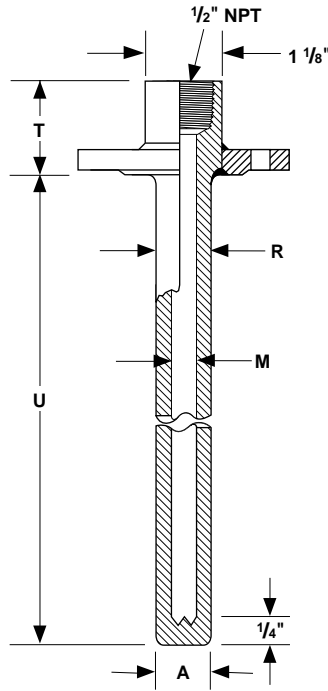
Other Available Thermowells

Consult factory for availability and pricing.

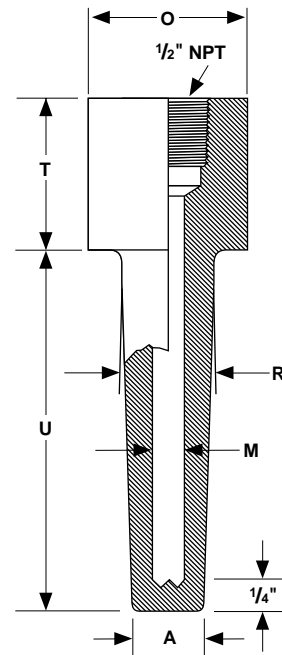
Van Stone Type (TVS)



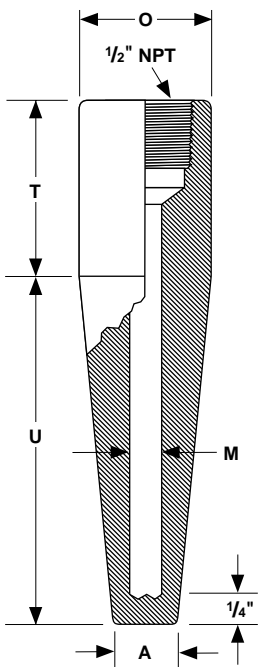
Welded Flange Well (TFS, TFT)



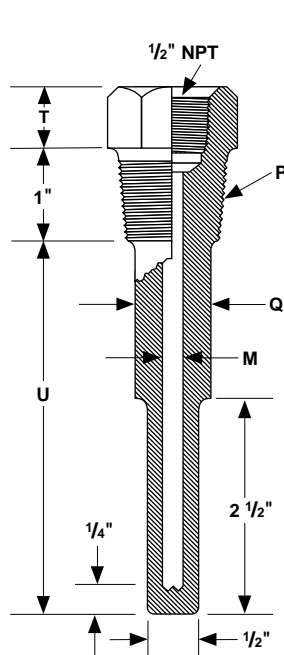
Socket Weld Type (TST)



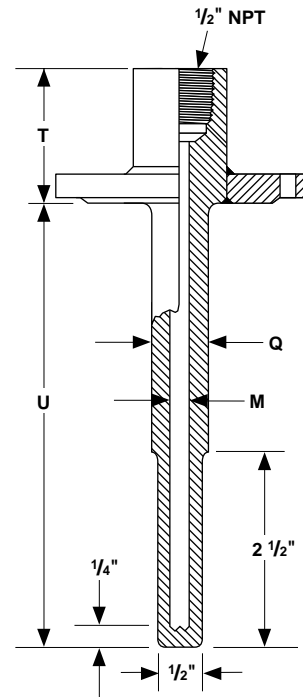
Weld-In Type (TWT)



Bimetallic Thermometer Wells—Threaded Type (TBD)



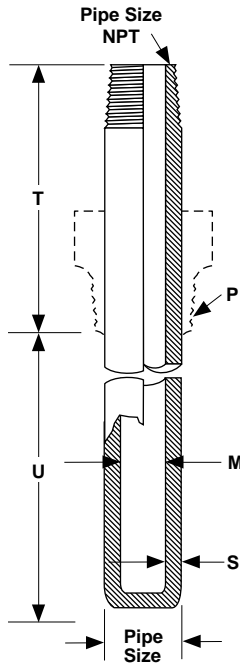
Bimetallic Thermometer Well—Flanged Type (TFD)



Accessories

Thermowells

Pipe Type



Pipe Available: Stocked

Standard Materials: 304 SS and 316 SS, 446 SS and Alloy 601

Note: When no bushing or flange is required, "U" becomes the overall length.

Typical Dimensions

T inch
3

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

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
	P	N														
2. Pipe Size (inch) C = ½ E = 1 D = ¾																
3. Pipe Type "S" N = Schedule 40																
4-5. "U" Dimension (inches) Whole inches: 00 to 99																
6. "U" Dimension (fractional inch) 0 = 0 2 = ¼ 4 = ½ 6 = ¾ 1 = ⅙ 3 = ⅓ 5 = ⅕ 7 = ⅞																
7. Pipe Material A = 304 SS W = Alloy 601 C = 316 SS K = 446 SS																
8. Process Connection Size "P" (inch) * Nonflanged or with Mounting Bushing Flanged: Flange Size D = ¾ NPT 1 = ¾ E = 1 NPT 2 = 1 F = 1 ¼ NPT 3 = 1 ½ G = 1 ½ NPT 4 = 2 H = 2 NPT 5 = 3 X = Other 0 = No flange or mounting bushing required																
9. Flange Rating (lbs.) 0 = No flange D = 900 A = 150 E = 1500 B = 300 F = 2500 C = 600																
10. Flange Face Type 0 = No flange 3 = Ring joint 1 = Raised face 4 = Lap joint 2 = Flat face																
11. Flange or Bushing Alloy 0 = No flange or bushing K = 446 SS A = 304 SS W = Alloy 601 C = 316 SS G = Carbon steel																
12. Lag "T" (inches) Whole inches: 0 to 9																
13. Lag "T" (fractional inch) 0 = 0 4 = ½ 1 = ⅙ 5 = ⅕ 2 = ¼ 6 = ¾ 3 = ⅓ 7 = ⅞																
14. Bore Diameter "M" (inch) J = Per pipe size																
15. Special Options 0 = Standard options—consult factory																

*Must be at least one size larger than pipe size

Accessories

Thermowells

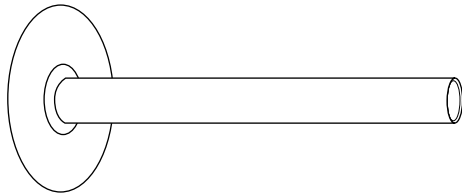
Pipe Type

Continued

Dimensions of Welded and Seamless Pipe

Nominal Pipe Size	O.D.	Nominal Wall Thickness		
		SCH 40	SCH 80	SCH 160
1/8	0.405	0.068	0.095	—
1/4	0.540	0.088	0.119	—
3/8	0.675	0.091	0.126	—
1/2	0.840	0.109	0.147	0.187
3/4	1.050	0.113	0.154	0.218
1	1.315	0.133	0.179	0.250
1 1/4	1.660	0.140	0.191	0.250
1 1/2	1.900	0.145	0.200	0.281
2	2.375	0.154	0.218	0.344
2 1/2	2.875	0.203	0.276	0.375
3	3.50	0.216	0.300	0.438
3 1/2	4.00	0.226	0.318	—
4	4.50	0.237	0.337	0.531

Options



Tantalum Oversheaths for Thermowells

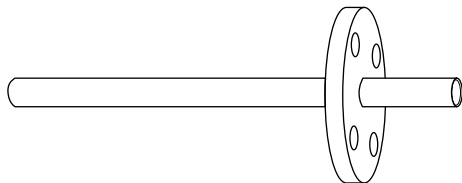
Tantalum oversheaths provide protection to thermowells with unequaled efficiency. In applications of corrosive processes such as chlorine, bromine, hydrochloric, nitric and sulphuric acids, oversheaths withstand product contamination without measurable deterioration.

Tantalum oversheaths are designed with thin walls. This has the advantages of economy and efficiency. Tantalum's high thermal conductivity and thin-wall design make rapid heat transfer possible, and its low fouling factor extends the operational life of

the oversheath and the thermowell. Since corrosion and metal loss are not problems with the use of tantalum, it is best suited for thermowells immersed directly into the corrosive process.

Standard oversheaths are designed for thermowell sizes of 1/2, 3/4, 7/8 and 1 inch stem O.D.s up to 60 inches in length; and for 1, 1 1/2, 2, 3 and 4 inch flanges. Standard oversheaths are constructed with 0.013 inch thin-wall welded and redrawn tubing with a 0.013 inch tantalum formed cup at the bottom of the well (0.015 inch is also available.)

Note: To ensure proper fit, please order with thermowell.



Coated Thermowells

Coated thermowells are recommended in applications of severe abrasion, corrosion, impact, high temperature and oxidation. The purpose of coated thermowells is to achieve longer

thermowell life, better thermowell performance, and both hardness and strength. We offer coatings of Stellite® No. 1, Stellite® No. 6, chromium carbide, Teflon®, Kynar®, glass and ceramic.

Stellite® is a trade name of Cabot Corporation.

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

Kynar® is a registered trademark of Pennwalt Corporation.

Accessories

Protecting Tubes

Protecting Tube Application Data

Material	Grade	Max. Use Air	Flexural Strength (X10 ³ psi)	Thermal Conduct. W/m.K 1475°K	Thermal Shock Resistance	Remarks	Typical Applications
Hexoloy SA® <i>See page 142</i>	Sintered	3000°F (1650°C)	67	54.0	Excellent	Maintains strength to 3000°F, exceptional corrosion resistance, does not creep, attacked by halides, fused caustics and ferrous metals	Incineration, molten aluminum and non-ferrous metals, flue gas, hydrofluoric and sulfuric acids, bauxite calcining
Silicon Carbide <i>See page 139</i>	Oxide Bonded	3000°F* (1650°C)		15-20	Good	Permeable	Non-ferrous metals
Alumina <i>See page 138</i>	99.9%	3450°F (1900°C)	50	6.3	Fair—preheating to 900°F recommended	Creeps (sags) at 2900°F ferrous metals, dry H ₂	Barium, crown glass; non-ferrous metals; gas-tight protection for noble metal thermocouples in excess of 2400°F (1316°C)
	96%	3100°F (1700°C)	49	5.4	Same as above	Creeps at 2900°F	
Mullite <i>See page 138</i>	—	3100°F (1700°C)	12	2.1	Poor—must be preheated to 900°F	Creeps at 2642°F, attacked by halides—contains silica	Non-ferrous metals; gas-tight protection for base metal thermocouples to 2400°F (1316°C)
Metal Ceramic <i>See page 140</i>	LT-1	2500°F (1400°C)	45	29.0 (R.T.)	Must be preheated to 900°F before immersion into molten metal at 2000°F or higher	Not recommended in carburizing, nitrogen atmospheres, high vacuum or in molten aluminum	Molten non-ferrous metals; calcining kilns, oxidizing atmospheres up to 2500°F
Coated Protection Tubes (1100 Series) <i>See page 140</i>		1400°F (760°C)			Excellent	Do not exceed 1400°F	Molten aluminum, zinc and galvanizing; maximum operating temperature 1400°F (745°C)

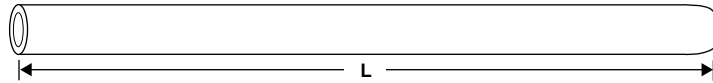
* Hot face temperature

Note: Other mounting fittings available; please consult factory.

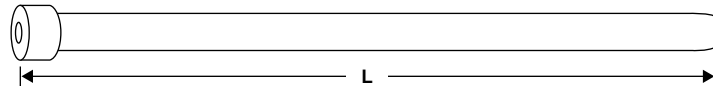
Accessories

Protecting Tubes

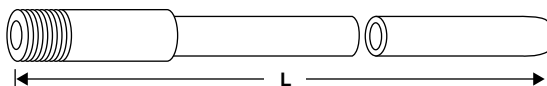
Ceramic Protecting Tubes



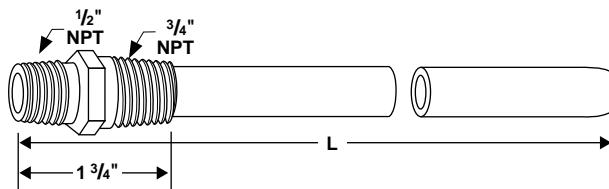
Mullite or Alumina Protecting Tube, Plain End



Mullite Protecting Tube with Collar



Mullite or Alumina Protecting Tube with TH-43 or TH-50 Ferrule



Mullite or Alumina Protecting Tube with TH-190 or TH-191 Fitting (1/4 inch of Tube Enters Fitting)

Mullite Protecting Tubes*

Code No.	I.D. X O.D. inch	Construction	Length inch
1152-"L"	1/4 X 3/8	Plain end	12 through 60 inches in 6 inch increments
1153*-"L"	7/16 X 1 1/16	Plain end	
1155-"L"	3/4 X 1	Plain end	
1154-"L"	1 X 1 1/4	Plain end	
1152-N-"L"	1/4 X 3/8	With TH-50 ferrule 7/8 - 27 threads	12 through 60 inches in 6 inch increments
1153-N-"L"	7/16 X 1 1/16	With TH-43 ferrule 7/8 - 27 threads	
1155-N-"L"	3/4 X 1	Close steel nipple 1 1/2 inch long, 1 NPT	
1154-N-"L"	1 X 1 1/4	Close steel nipple, 1 5/8 inch long, 1 1/4 NPT	

* Available with TH-190 brass reducing fitting (add -190 to code no.); or with TH-191 steel reducing fitting (add -191 to code no.). Example: 1153-191-12

Alumina (99% Minimum Purity) Protecting Tubes

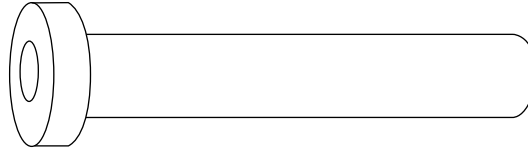
Code No.	I.D. X O.D. inch	Construction	Length inch
1146-"L"	1/4 X 3/8	Plain end	12 through 48 inches in 6 inch increments
1147*-"L"	7/16 X 1 1/16	Plain end	12 through 60 inches in 6 inch increments
1148-"L"	3/4 X 1	Plain end	12 through 72 inches in 6 inch increments
1149-"L"	1 X 1 1/4	Plain end	12 through 72 inches in 6 inch increments
1146-N-"L"	1/4 X 3/8	TH-50 ferrule 7/8-27 threads	12 through 48 inches in 6 inch increments
1147-N-"L"	7/16 X 1 1/16	TH-43 ferrule 7/8-27 threads	12 through 60 inches in 6 inch increments
1148-N-"L"	3/4 X 1	Close Steel Nipple 1 1/2" long, 1" NPT	12 through 72 inches in 6 inch increments
1149-N-"L"	1 X 1 1/4	Close Steel Nipple 1 5/8" long, 1 1/4" NPT	12 through 72 inches in 6 inch increments

Dimension Tolerance: Up to 1 inch, ±5% or 0.025 inch, whichever is greater; over 1 inch, ±4% or 0.050 inch, whichever is greater.

Accessories

Protecting Tubes

Silicon Carbide and Cast Iron Protecting Tubes



Silicon Carbide Protecting or Target Tube

Silicon Carbide Protecting Tubes—Oxide Bonded

Code No.	I.D. X O.D. inch	Construction	Length inch	Weight per inch
1080	1 X 1 3/4	Plain end	12 through 48 inches in 6 inch increments	0.15 lbs
1081	1 X 1 3/4	Collar, 3 inch dia.*		0.17 lbs

*Back edge of flange rounded.

Cast Iron

Code No.	I.D. X O.D. inch	NPT Thread	Construction	Length inch
1375	7/8 X 1 1/2	3/4 Int.*	Cast	12 through 72 inches in 6 inch increments
1377-36	7/8 X 1 1/2	1 Ext.	Cast	36 inches

*1 inch NPT external thread available on special order.



Typical Cast Iron Protecting Tube

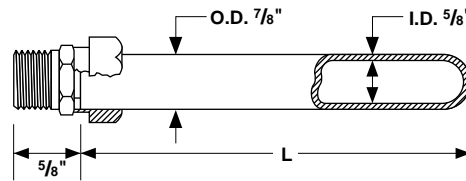
Protecting Tubes

Accessories

Protecting Tubes

Special Application Protecting Tubes

Metal-Ceramic Protecting Tube



Watlow's SERV-RITE® metal-ceramic protecting tube is composed of metallic chromium and aluminum oxide. The metal imparts shock resistance and high thermal conductivity for fast, precise readings; the stable ceramic resists deformation, corrosive attack, abrasion and oxidizing atmospheres over 2200°F (1205°C).

Thermocouples can be installed directly, eliminating the expense of multi-tube assemblies. Metal-ceramics resist surface deformation below the maximum recommended operating temperature of 2500°F (1355°C). They are useful in calcining kilns; for preheat temperature control of open hearth furnaces; for continuous immersion in molten brass, bronze, copper, zinc and lead; and in sulphurous gases.

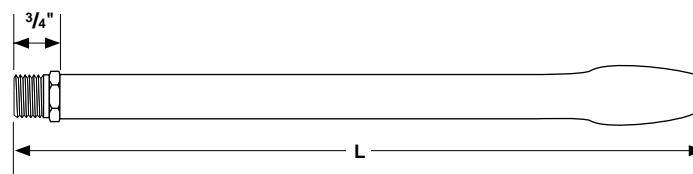
In use, excess thermal or mechanical shock should be avoided. Though superior to ceramics, metal-ceramic tubes are not as shock resistant as metal alloys, and may require preheating for certain applications.

Note: Not recommended in molten aluminum.

Code No.	I.D. X O.D. inch	Construction	Length inch
1161	5/8 X 7/8	Std. 3/4 inch conduit connector	12 through 48 inches in 6 inch increments

Coated Protecting Tubes for Molten Aluminum, Zinc and Galvanizing Applications

Series 1100 Protecting Tube



With a tough refractory laminated coating, Series 1100 protecting tubes resist erosion from molten aluminum, zinc or galvanizing baths. They stay strong, even at higher temperatures, and require no washing or maintenance to prolong their service life. A special protective cap at the tip provides fast response time, while

permitting thermal expansion without damage to the refractory laminate.

The 0.493 inch I.D. easily accommodates up to an 8-gauge beaded thermocouple. Stocked for immediate shipment. The maximum operating temperature for the 1100 Series is 1400°F (745°C).

Code No.	I.D. inch	Nominal O.D. inch	Fitting inch	Tube Length inch
1100	0.493	1 1/2 Max.	3/4 NPT	12 through 48 inches in 6 inch increments

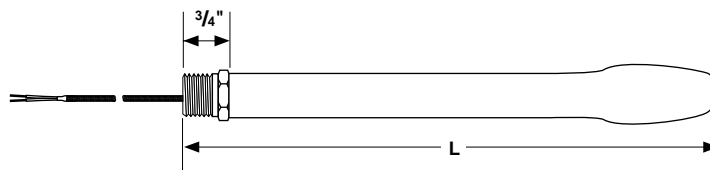
Accessories

Protecting Tubes

Coated Protecting Tubes for Molten Aluminum, Zinc and Galvanizing Applications

Continued

Series 1101 Protected Thermocouple



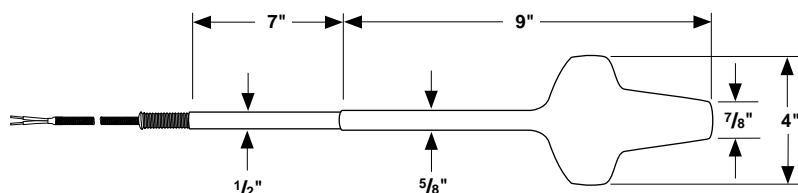
Watlow's Series 1101 protected thermocouple assemblies incorporate a mineral-insulated stainless steel sheathed XACTPAK® thermocouple hermetically sealed within a refractory laminated Series 1100 protecting tube. Standard calibration is Type K (code no. 402-2107),

complete with 36 inches of high temperature insulated thermocouple wire.

Like the 1100, the 1101 assembly requires no washing or maintenance to prolong its service life, yet gives fast, accurate readings in molten aluminum, zinc and galvanizing baths.

Code No.	Calibration	Nominal O.D. inch	Fitting inch	Lead Length inch	Tube Length inch
1101	K	1 1/2 Max.	3/4 NPT	36	12 through 48 inches in 6 inch increments

Series 1102 Floating Protected Thermocouple



A thermocouple that floats! It contains a 0.125 inch O.D. XACTPAK ASTM E 230 Type K stainless steel sheathed thermocouple for quick, accurate temperature indication approximately three inches below the surface of the melt or bath—where control is needed most. This trouble-free unit gives you continuous temperature indication at dip-out depth—regardless of metal level! Chances of breakage are minimized, thanks to a patented buoyant fiber collar that absorbs shock if struck by ladles or

skimmers. The Series 1102 floats easily aside to permit unobstructed skimming.

High temperature, 36 inch insulated thermocouple wire is standard (optional stainless steel overbraid, code no. 1112). A metal sleeve with strain relief spring at the top protects against molten metal splash and wire abrasion. The thick, rugged refractory laminated thermocouple protecting cone provides rapid heat transfer and full physical protection.

Code No.	Calibration	Nominal O.D. inch	Lead Length inch	Stem Length inch
1102-12	K	4 Max.	36	12
1112-12*	K	4 Max.	36	12

*Lead wire with SS overbraid

Accessories

Protecting Tubes

Hexoloy SA® Tubes



* Composition code: Si = Free Silicon Metal; C = Free Graphite; SiC = Silicon Carbide; TiB = Titanium Diboride

** Test Bar Size: 1/8 X 1/4 X 2 inch (3.2 X 6.4 X 50.8 mm), Outer Span = 1.5 inch; Inner Span = 0.75 inch

① Dependent upon dopants in Hexoloy SA® SiC which will decrease electrical resistivity to a desired range

Physical Properties of Hexoloy® Materials—Technical Data

Typical Values	Hexoloy® Grade
Physical Properties	SA
Composition* (Phases)	SiC
Density kg/m ³ (g/cm ³)	3100 (3.10)
Hardness-Knopp (Kg/mm ²)	2800
Flexural Strength 4 pt. @ RT** MPa (X 103 lb/in ²)	460 (67)
Flexural Strength 3 pt. @ RT** MPa (X 103 lb/in ²)	550 (80)
Compressive Strength RT MPa (X 103 lb/in ²)	3900 (560)
Modulus of Elasticity RT GPa (X 106 lb/in ²)	410 (59)
Weibull Modulus (2 Parameter)	10
Poisson Ratio	0.14
Fracture Toughness @ RT Double Torsion and SENB MPa/√m (X 103 lb/in ² /√in)	4.60 (4.20)
Coefficient of Thermal Expansion RT-700°C (68°-1,292°F) X 10 ⁻⁶ mm/mmK (X 10 ⁻⁶ in/in°F)	4.02 (2.20)
Maximum Service Temp. (Air) °F (°C)	3000 (1650)
Mean Specific Heat @ RT (J/gm K)	0.67
Thermal Conductivity @ RT W/m K (BTU/ft h °F)	125.6 (72.6)
Thermal Conductivity 200°C W/m K (BTU/ft h °F)	102.6 (59.3)
Thermal Conductivity 400°C W/m K (BTU/ft h °F)	77.5 (44.8)
Electrical Resistivity ¹ RT, ohm-cm	0.2 to 300 ^①
1000°C, ohm-cm	0.01 to 0.2 ^①
Emissivity	0.9
Max Warpage	0.005/inch

How to Order

Watlow stocks a wide variety of Hexoloy® tubes for immediate shipment. To order, specify the following code numbers and lengths required for your application.

Ex: 1040-12 (Code no.-length, inch)

Cemented mounting fittings are available for most tubes. Contact the factory or your local Watlow sales representative or distributor for further information.

Code No.	O.D./I.D. inch	Lengths inches
1040	3/8 X 1/4	From 6 to 48 inches
1041	5/8 X 3/8	
1042	3/4 X 1/2	

For other lengths, consult factory.

Mounting Fittings

Tube Code No.	Head Mount	Process Mount	Type Ordering	Code
1040	1/2 NPT	1/2 NPT	Cemented hex nipple	L
1041	3/4 NPT	3/4 NPT	Cemented hex nipple	M
1042	3/4 NPT	3/4 NPT	Cemented hex nipple	P

Example: 1041-M-24 is a 5/8 X 3/8 inch Hexoloy® tube 24 inches long with a single 3/4 inch NPT cemented hex fitting.

Note: Maximum recommended temperature rating of cemented fitting is 1000°F continuous.

Accessories

Connector Systems

Many varieties of thermocouple connectors and jack panels are available from Watlow. Whether you're looking for high impact strength, fast installation, or high temperature capabilities, you'll find the right connector system for your application at Watlow.

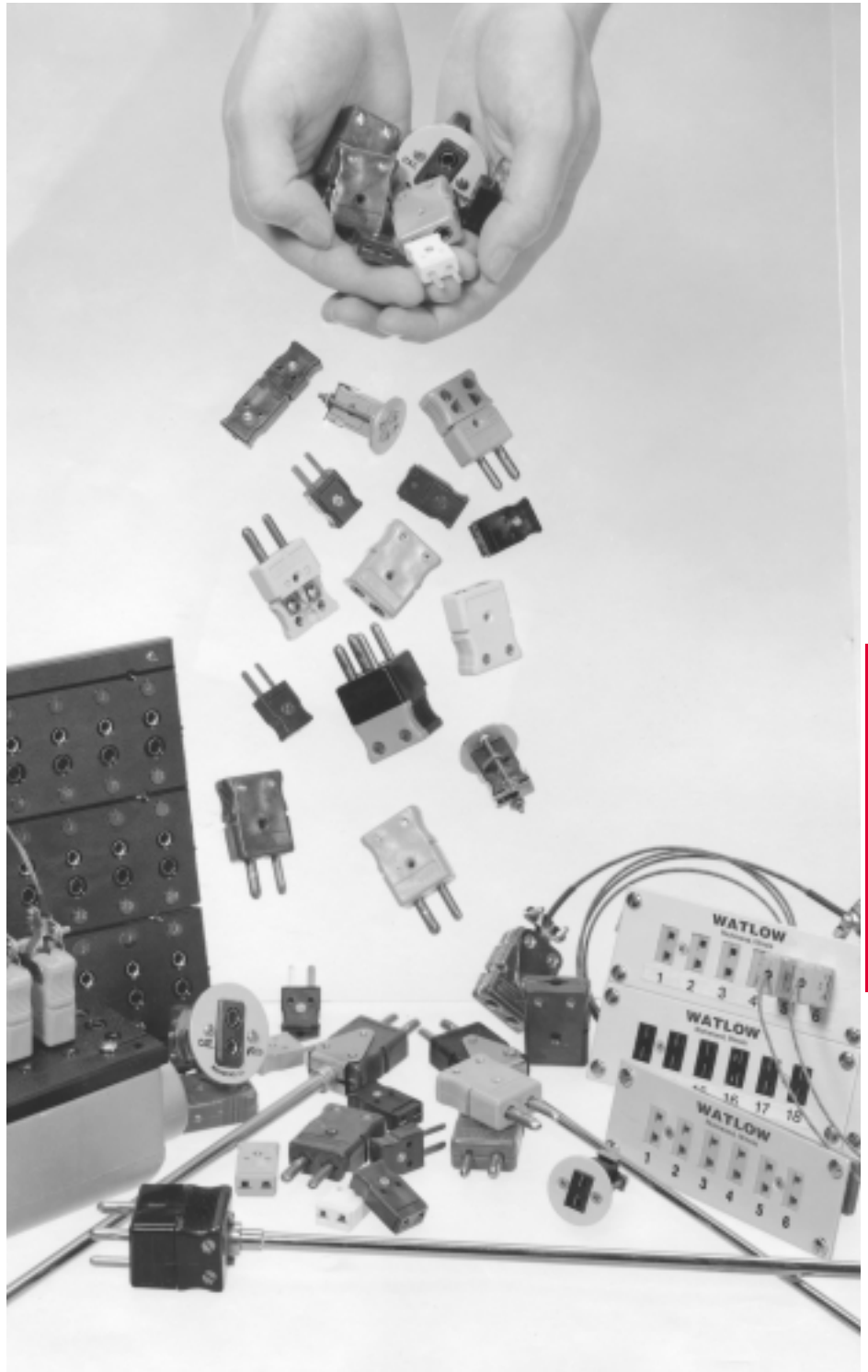
Listed below are the various connectors and systems from which to choose:

- Standard thermocouple connectors
- Quick-attach thermocouple connectors
- High temperature connectors
- Three-pole connectors for RTD applications
- Dual thermocouple connectors
- Miniature thermocouple connectors
- Jack panels: multi-circuit, multi-circuit for FS box mounting, and miniature multiple jack panels

Applications and Technical Data

To eliminate measuring errors, all Watlow connectors are made exclusively of matching metal alloys. If the connector material had different thermal EMF characteristics from the thermocouple or lead wire, a uniform temperature would have to be maintained across the connector. This is not always easily obtainable, nor is it practical.

If a temperature gradient did exist across the connector made of a third metal, unwanted EMFs generated between the thermoelectric materials and the extremities of the connectors would cause an error appearing at the thermocouple output. The larger the gradient the larger the error. In some cases and depending on the calibration, net errors may occur that are even larger than the gradient.

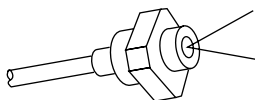
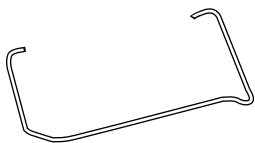
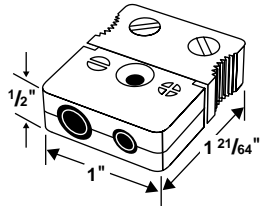
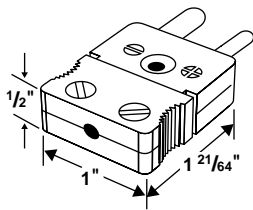


Accessories

Connector Systems

Standard Thermocouple Connectors

Lightweight, rugged, and accurate, the standard connectors also feature quick positive wiring hookup. The exclusive channel design isolates all wire for clean, strong signals.



Additional Features and Benefits

- **Matching thermocouple materials** throughout (except Types R/S, which are compensated).
- **Hollow pins** minimize weight.
- **Standard 7/16 inch** pin spacing.
- **Positive pin diameter** 5/32 inch, negative pin diameter 3/16 inch.
- **Glass-filled thermoplastic** provides high impact strength.
- **Fully visible connections.**
- **ASTM color coded** for easy identification.
- **Handles high temperature** thermocouple applications; 400°F (200°C) ambient temperature rating.
- **Molded-in** threaded inserts.
- **Captive cap screws** won't fall out.

Code Number	Description
900	Connector plug with Watlow name (specify calibration*)
910**	Connector plug without Watlow name** (specify calibration*)

Code Number	Description
901	Connector jack (specify calibration*)
911**	Connector jack without Watlow name** (specify calibration*)

Code Number	Description
924	Connector lock

Code Number	Description
923-020	Small XACTPAK® brazing adapter for plug or jack (0.020 inch sheath O.D.)
923-032	Small XACTPAK® brazing adapter for plug or jack (0.032 inch sheath O.D.)
923-040	Small XACTPAK® brazing adapter for plug or jack (0.040 inch sheath O.D.)
923-063	Small XACTPAK® brazing adapter for plug or jack (0.063 inch sheath O.D.)
923-125	Small XACTPAK® brazing adapter for plug or jack (0.125 inch sheath O.D.)
923-188	Small XACTPAK® brazing adapter for plug or jack (0.188 inch sheath O.D.)

Note: Nominal dimensions of plug or jack 1 3/8 X 1 X 1/2 inch

* Available in ASTM E 230 calibration Types J, K, T, R/S, E, Cu/Cu and N.

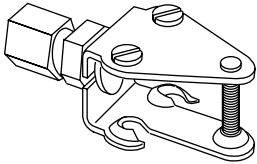
** Can be imprinted with customer's own logo (minimum order and tooling charge applies).

Accessories

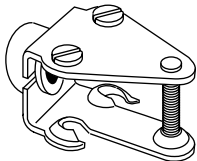
Connector Systems

Standard Thermocouple Connectors

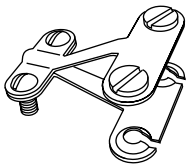
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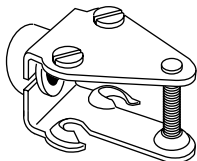
Code Number	Description
933-063	Compression type adapter for plug or jack (0.063 inch sheath O.D.)
933-125	Compression type adapter for plug or jack (0.125 inch sheath O.D.)
933-188	Compression type adapter for plug or jack (0.188 inch sheath O.D.)
933-250	Compression type adapter for plug or jack (0.250 inch sheath O.D.)
933-313	Compression type adapter for plug or jack (0.313 inch sheath O.D.)



Code Number	Description
934-125	Large XACTPAK brazing adapter for plug or jack (0.125 inch sheath O.D.)
934-188	Large XACTPAK brazing adapter for plug or jack (0.188 inch sheath O.D.)
934-250	Large XACTPAK brazing adapter for plug or jack (0.250 inch sheath O.D.)



Code Number	Description
921	Cable clamp for plug or jack



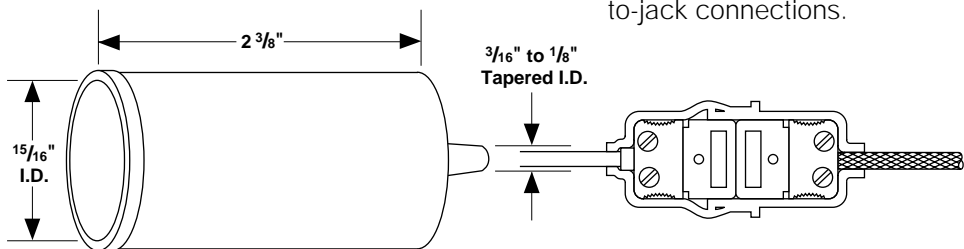
Code Number	Description
934-265	Large brazing adapter for flexible stainless steel tubing (0.265 inch O.D.)

Connector Systems

Weatherproof Boots

Code No. 943

Used in pairs as illustrated, these flexible neoprene rubber boots add moisture protection to standard plug-to-jack connections.



Accessories

Connector Systems

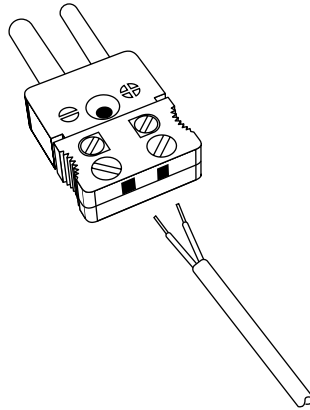
Quick-Attach Thermocouple Connectors

Watlow's time-saving thermocouple connectors are fast and convenient to use. No loose parts, no cap removal, no need to wrap wires around terminal screws. Simply insert stripped wire ends into plug or jack, tighten down two terminal screws, and you're finished. There is no need to remove Watlow cable clamp, either.

Accepts solid or stranded wires to 16 gauge. Available in J, K and T calibrations, ASTM E 230 color-coded. The connector is made of a high impact strength, 400°F (200°C) rated glass filled thermocouplastic with matching thermocouple materials throughout. Other features and specifications are identical to standard Watlow 900 Series quick-disconnect connectors.

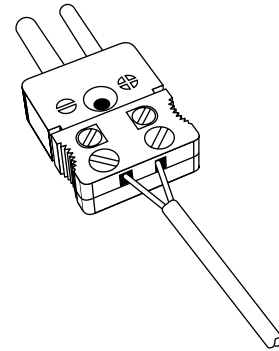
Step 1.

Simply insert stripped wires into connector.



Step 2.

Tighten down two terminal screws, and you're finished.



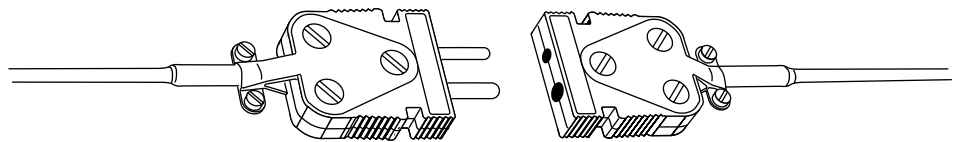
Code Number	Description
916	Connector plug with Watlow name (specify J, K or T calibration)
917	Connector jack with Watlow name (specify J, K or T calibration)
918	Connector plug without Watlow name* (specify J, K or T calibration)
919	Connector jack without Watlow name* (specify J, K or T calibration)

*Can be imprinted with customer's own logo (minimum order and tooling charge applies).

High Temperature Connectors

The ASTM E 230 color-coded bodies of these high temperature ceramic connectors are practical for temperatures up to 1000°F (540°C). Colors are permanent and will not fade even after exposure to temperature. The positive-locking screw type terminals are captive for easy assembly. Solid plug pins and collet inserts are made of thermocouple alloys (except Types R/S which are compensated).

Calibration must be specified when ordering. Both plug and jack are marked for polarity. Standard 3/16 inch pin spacing.



Code Number	Description
912	Ceramic plug (specify calibration J, K, R/S or E)
913	Ceramic jack (specify calibration J, K, R/S or E)
925-125	XACTPAK adapter for plug or jack (0.125 inch sheath O.D.)
925-188	XACTPAK adapter for plug or jack (0.188 inch sheath O.D.)
925-250	XACTPAK adapter for plug or jack (0.250 inch sheath O.D.)
926	Cable clamp for ceramic plug or jack

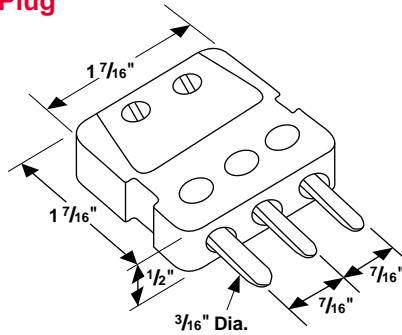
Accessories

Connector Systems

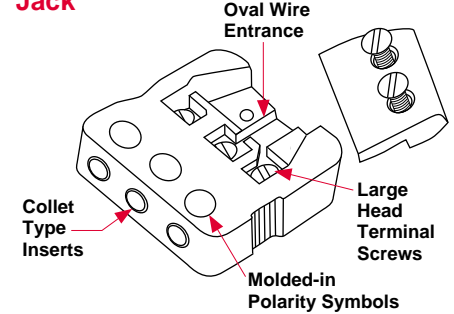
Three-Pole Connectors for RTD Applications

- Three pins to accommodate most RTD sensor applications
- Rated to 400°F (200°C) continuous
- Jacks have spring-loaded inserts for positive contact
- Larger diameter negative pin prevents user from reversing polarity

Plug



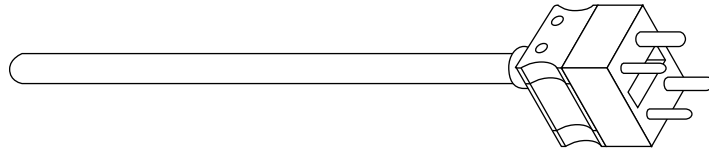
Jack



Code Number	Description
TH-335	3-pole connector plug with copper pins
TH-336	3-pole connector jack with copper inserts
TH-337-125	Compression-type adapter for 0.125 inch tube
TH-337-188	Compression-type adapter for 0.188 inch tube
TH-337-250	Compression-type adapter for 0.250 inch tube
80701201	Cable clamp for 3-pole connector

Dual Thermocouple Connectors

- High impact molded plugs and jacks
- Mate with standard jack panels or two single connectors
- ASTM E 230 color-coded caps
- Matching thermocouple materials throughout (except Types R/S, which are compensated)
- Firm, positive connections—fast!
- Captive screws for efficient assembly
- Full line of hardware fittings
- Exclusive internal channel design isolates all conductors for clean, strong signals
- Ambient temperature rating 300°F (150°C)
- Standard 7/16 inch pin spacing with 3/4 inch between circuits
- Positive pin diameter 5/32 inch, negative pin diameter 3/16 inch.



Code Number	Description
914	Connector plug (specify calibration*)
915	Connector jack (specify calibration*)
927-125	Compression type adapter for plug or jack (0.125 inch sheath O.D.)
927-188	Compression type adapter for plug or jack (0.188 inch sheath O.D.)
927-250	Compression type adapter for plug or jack (0.250 inch sheath O.D.)
928-063	Brazing adapter for plug or jack (0.063 inch sheath O.D.)
928-125	Brazing adapter for plug or jack (0.125 inch sheath O.D.)
928-188	Brazing adapter for plug or jack (0.188 inch sheath O.D.)
928-250	Brazing adapter for plug or jack (0.250 inch sheath O.D.)
928-265	Adapter for Watlow's TH-195 stainless flex armor (0.265 inch sheath O.D.)

*Available in ASTM E 230 calibration Types J, K, T, R/S, E, Cu/Cu and N.

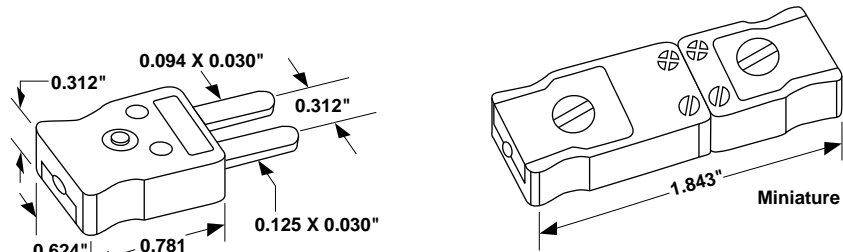
Accessories

Connector Systems

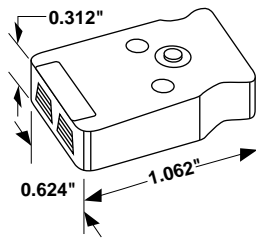
Miniature Thermocouple Connector System

- Miniature design—mates with other miniature size thermocouple connectors
- Molded-in pin contacts assure precise alignment (no loose, wobbly parts)
- Rugged, high quality, high performance connectors
- Employ matching thermocouple alloy materials
- Available in all standard calibrations and copper-copper, ASTM E 230 color-coded
- Exclusive channel design isolates the wires for clean, strong signals.

Miniature Connectors Compared with Standard Connectors



Lightweight and space-saving, they complement modern miniature instrumentation.

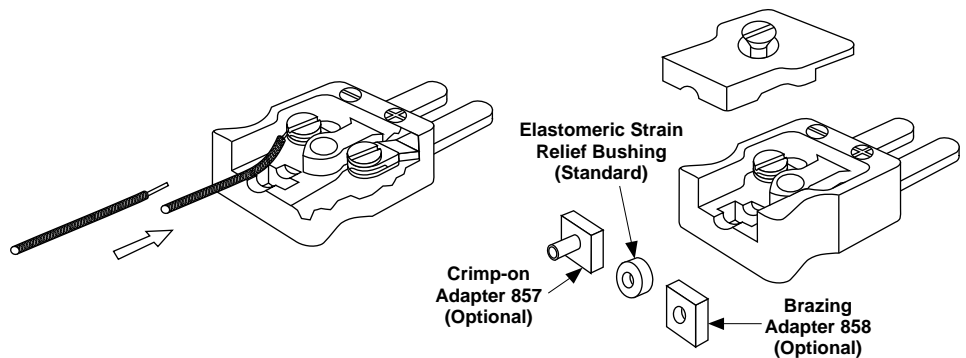


Connection Method

Simply insert the stripped ends of your thermocouple wire between contact base and washer, tighten down the two terminal screws and you're finished. There are no loose parts to contend with. Do not wrap conductors around the terminal screws.

Watlow miniature connectors can accommodate wire sizes up to 20 AWG, 20 ga. solid, 22 ga. stranded. The connector is made of high impact strength, 400°F (200°C) rated, glass-filled thermoplastic. To maintain the highest measurement accuracy, matching thermocouple alloy materials are employed throughout. The same fine features and high quality performance characteristics found in Watlow's standard connectors also apply with the miniature connectors.

To order, simply indicate the code number, calibration and specify the quantity. Elastomeric strain relief bushings are standard, but brazing and crimp-on accessories are also available as options.



Code Number	Description
850-Specify calibration letter	Plug with Watlow name
851-Specify calibration letter	Jack with Watlow name
852-Specify calibration letter	Plug without Watlow name*
853-Specify calibration letter	Jack without Watlow name*
857-000	Crimp-on adapter - undrilled
857-040	Crimp-on adapter - 0.040 inch sheath diameter
857-063	Crimp-on adapter - 0.063 inch sheath diameter
858-000	Brazing adapter - undrilled
858-040	Brazing adapter - 0.040 inch sheath diameter
858-063	Brazing adapter - 0.063 inch sheath diameter
858-125	Brazing adapter - 0.125 inch sheath diameter

Note: Available in ASTM E 230 calibration Types J, K, T, R/S, E, Cu/cu.

*Can be imprinted with customer's own logo (minimum order and tooling charge applies.)

Accessories

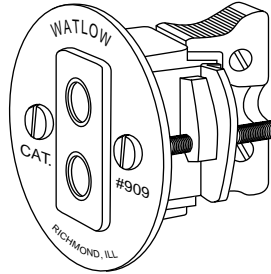
Connector Systems

Panel Mount Hardware

Single Panel Mount Hardware

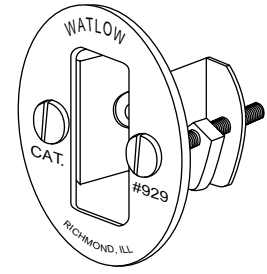
Designed for use with Watlow's standard thermocouple connectors, these units fit panels up to $\frac{7}{16}$ inch thick. Panel cutout: $1 \frac{1}{8}$ inch to $1 \frac{5}{32}$ inch hole. Units fit into standard $\frac{3}{4}$ inch knockouts.

Code No. 909



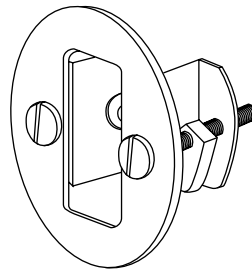
Single circuit panel mount with quick-disconnect jack included. Available calibrations J, K, N, T, R/S & Cu/cu.

Code No. 929



Panel mount hardware only.

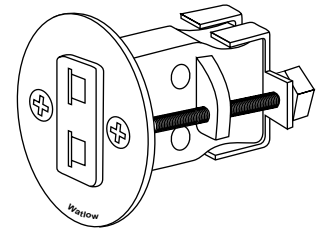
Code No. 930



Panel mount hardware only without Watlow name.*

Miniature Single Jack Panel Mount

- Easy $\frac{3}{4}$ inch diameter "knock-out" installation
- Attractive frosted aluminum finish
- Rear clearance $1 \frac{1}{2}$ inch
- All installation can be accomplished from the front of the panel



Jack not included.
(See page 148 for code number 851 or 853)

Code Number	Description
861	Single jack panel mount less jack; with Watlow name.
863	Single jack panel mount less jack; without Watlow name.*

*Can be imprinted with customer's own logo (minimum order and tooling charge applies).

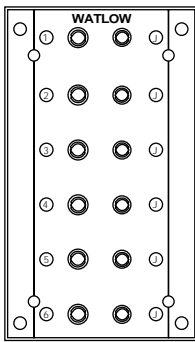
Accessories

Connector Systems

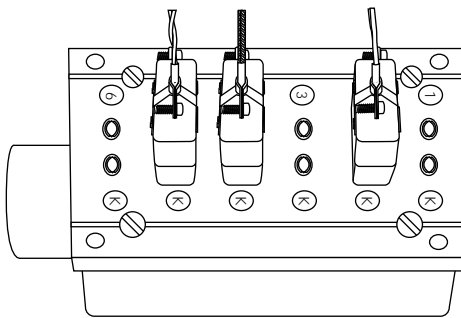
Jack Panels

Multi-Circuit Thermocouple Jack Panels

Continued



Multi-Circuit Thermocouple Jack Panels for FS Box Mounting



940 multi-circuit jack panel mounted in 942 FS box. Nominal dimensions: 940 panel 4 3/4 in X 2 3/4 in X 1 in, 942 box 4 3/8 in X 2 13/16 in X 2 1/8 in.

Code No.	Calibration*	Single Module Mounting Position	No. of Circuits	Numbering Sequence**	No. of Modules Left to Right	X	No. of Modules Top to Bottom
941	J, K, T	H-Horizontal V-Vertical	4, 5, 6	R-Row C-Column	1	X	1

*All circuits in any given module must be the same calibration.

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

4 5 6 7 8 9 10
9 4 1 — — — — — 1 X 1

4. Calibration

- J = Type J
- K = Type K
- T = Type T

5. Mounting position

- H = Horizontal
- V = Vertical

6. Number of circuits

- 4 = 4 circuits
- 5 = 5 circuits
- 6 = 6 circuits

7. Numbering sequence

- R = Row (horizontal)
- C = Column (vertical)

These multi-circuit thermocouple jack panels are lightweight, yet sturdy. Their many outstanding features include:

- Thermocouple alloy contacts (except Types R/S which are compensated)
- Standard 3/16 inch pin spacing with 3/8 inch between circuits
- 250°F (120°C) ambient temperature rating

- Choice of four, five or six circuits per panel

Code number 940 jack panels are designed for mounting in special Watlow FS boxes (Code no. 942), which can accommodate panels with four, five or six circuits.

To order: Specify 940—ASTM E 230 calibration—Number of circuits, i.e., 940-K-6.

Code No.	Description	Calibration	No. of Circuits
940	Jack Panel	J, K, T, N, R/S, E and Cu/Cu	4, 5 or 6
942	FS Box	—	—

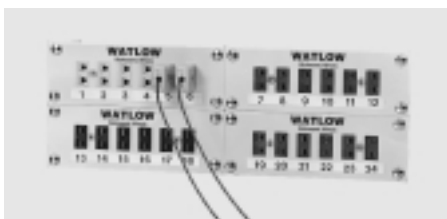
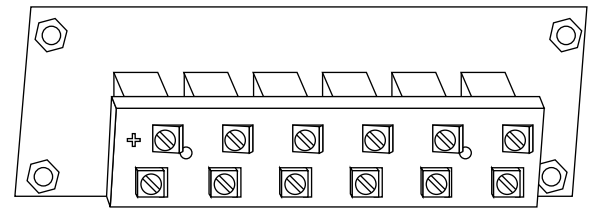
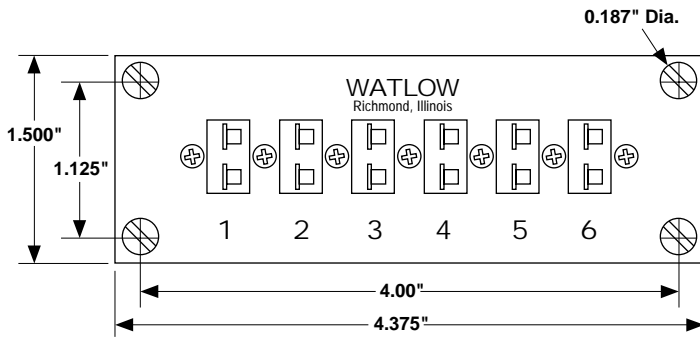
Accessories

Connector Systems

Jack Panels

Miniature Multiple Jack Panels

- For use with Watlow miniature connectors
- Each multiple jack panel compactly holds six jacks
- Color-coding of connectors is clearly visible for easy identification of calibration
- Modular building blocks in multiples of six circuits
- Panel has attractive frosted aluminum finish
- Cutout dimensions 3 ½ X 1 inch
- Rear clearance 1 ½ inch
- Comes fully assembled
- Specially modified jacks with terminal screw extenders are used for easy rear terminal connections
- Thermocouple alloys are used throughout jacks, including extenders
- Polarity is clearly indicated on the insulating back plate
- Connections are easy to make with exposed screw terminals



Miniature Multiple Jack Panel Connectors

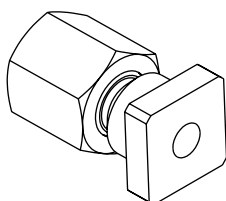
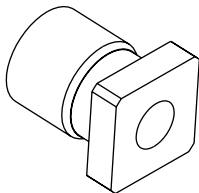
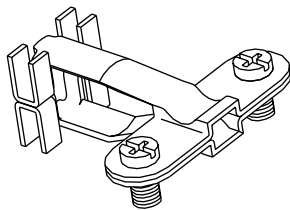
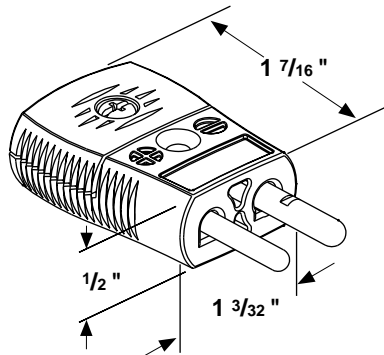
Code No.	Description
871 Specify calibration letter	Panel with mounting hardware and jacks, with Watlow name (J, K, T, E, Cu/Cu)
873 Specify calibration letter	Panel with mounting hardware and jacks, without Watlow name* (J, K, T, E, Cu/Cu)
874	Back strap and four screws (only necessary when four panels are used in rectangular configuration)
871-SPL-6, -12, etc. Specify calibration letter	Special panel with mounting hardware and jacks, with Watlow name, using decal numbering
873-SPL-6, -12, etc. Specify calibration letter	Special panel with mounting hardware and jacks, without Watlow name, using decal numbering
9-136 Specify calibration letter	Replacement jack for use with miniature multiple jack panels only. Calibration numeral code: 1-K; 2-J; 3-T; 4-R/S; 5-E; 6-Cu/Cu.

*Can be imprinted with customer's own logo (minimum order and tooling charge applies).

Accessories

Connector Systems

"S" Series Standard Connectors



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

1 2 3 4 5 6 7
S C - - - -

1-2. "S" Series Standard Connector, 425°F

3. Style

- M = Male (plug)
- F = Female (jack)

4. Calibration

- E = Type E
- J = Type J
- K = Type K
- S = Type S/Type R
- T = Type T
- U = Uncompensated

5. Name Plate

- W = With Watlow name
- N = Without name label

6. Color Code

- AT = ASTM E 230 color code/uncompensated-white

Cable Clamp Style

**Ordering Information:
Specify SAC-300**

Crimp/Braze Style

1 2 3 4 5 6
S A B - - -

4-6. Sheath size

- 040 = 0.040 inches
- 063 = 0.063 inches
- 090 = 0.090 inches
- 125 = 0.125 inches
- 188 = 0.188 inches
- 250 = 0.250 inches
- 30M = 3.0 mm
- 60M = 6.0 mm

Compression Style

1 2 3 4 5 6
S A P - - -

4-6. Sheath size

- 063 = 0.063 inches
- 125 = 0.125 inches
- 188 = 0.188 inches
- 250 = 0.250 inches
- 30M = 3.0 mm
- 60M = 6.0 mm

Accessories

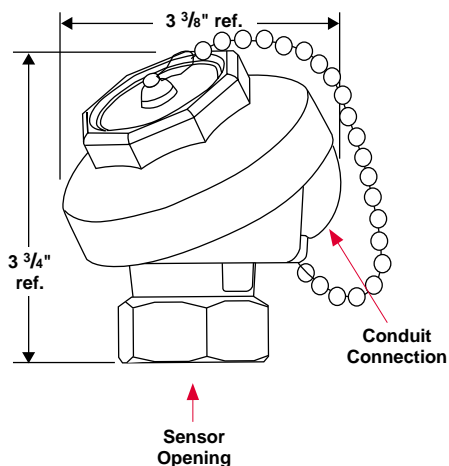
Hardware

Watlow offers a variety of hardware components for use with our thermocouples (see picture at right). These include:

- Thermocouple heads
- Connector blocks
- Open terminations
- Terminal boxes, swamping boxes and switch boxes
- Thermocouple mounting fittings
- Thermocouple insulators and accessories

Thermocouple Heads and Connector Blocks

MI Thermocouples Option A or B



The universal head is designed for heavy industrial and process applications. The high temperature connector blocks, both single element (TH-2730-S) and dual element (TH-2730-D), are designed to handle up to 8 ga. thermocouple wire, and both incorporate a center access hole for spring loading XACTPAK® elements up to 0.313 inch O.D.

The **XL Series** heads have an O-ring seal and are available in 1, 3/4 or 1/2 inch NPT thermocouple connections, and 3/4 or 1/2 inch conduit connections.

Universal Thermocouple Heads

(Assembly Ordering Options A or B)

Universal Aluminum Thermocouple Head Code No.	Universal Iron Thermocouple Head Code No.	Thermocouple Connection (NPT) inches	Conduit Code No. Connection inches
XL-4200	XL-3200	1	3/4
XL-4100	XL-3100	3/4	3/4
XL-4000	XL-3000	1/2	3/4
XL-4500	XL-3500	1	1/2
XL-4400	XL-3400	3/4	1/2
XL-4300	XL-3300	1/2	1/2

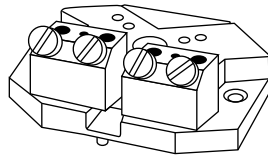
Note: Multiple sizes are obtained using reducers which may lengthen sensor and conduit lengths. A ground screw, identified with green coating, is standard on XL Series connection heads.

Accessories

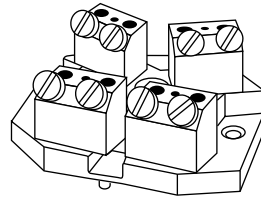
Hardware

Thermocouple Heads and Connector Blocks

Continued



Code No. TH-2730-S



Code No. TH-2730-D

Terminal Blocks for Universal Heads

Code No.	Description
TH-2730-S*	Single element, maximum operating temperature 1000°F (540°C)
TH-2730-D*	Dual element, maximum operating temperature 1000°F (540°C)

*Spring loading options are compatible with both connector blocks. Fits our universal heads. Materials are porcelain with brass terminals and stainless steel screws.

4-20mA Transmitter Mounting Kit

The mounting kit is essentially a mounting plate that is 2.1 inches long X 1 ½ inches wide X ¼ inch thick.

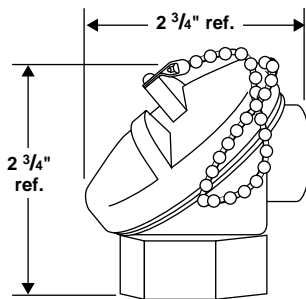
Code No.	Description
81500601	For universal heads
81500101	PT Heads
81500401	Explosion proof heads

Standard Thermocouple Heads

(Assembly Ordering Options D or E)

Watlow's standard heads are made of cast iron or aluminum. A plated chain attaches the gasketed cover to the body. Flats are provided for tightening. The connector block, held

in place with two screws, can be a single, duplex or triplex. These heads have 1, ¾ or ½ inch NPT openings for protecting tubes or drilled wells. The conduit outlet is ¾ inch NPT. Epoxy coating is available on the aluminum head. Maximum operating temperature is 825°F (441°C)

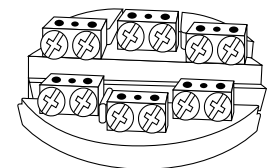
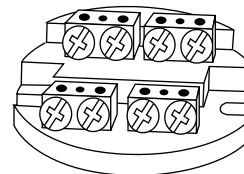
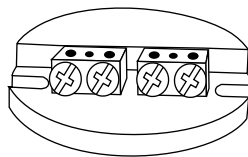


Approximate Assembled Dimensions:
2 ⅜" H X 2 ¾" L X 2 ¾" W

Cast Iron Head Only Code No.	Aluminum Head Only Code No.	Sensor Opening (NPT) inches	Conduit Connection inches
70900201	—	1	¾
70900202	—	¾	¾
70900203	70900301*	½	¾

*Available with epoxy coating (70900302)

Terminal Blocks for Standard Heads



Code No.	Description
50500401	Single element, maximum operating temperature 1000°F (540°C)
50500501	Dual, maximum operating temperature 1000° (540°C)
50500601	Triplex, maximum operating temperature 1000° (540°C)

Accessories

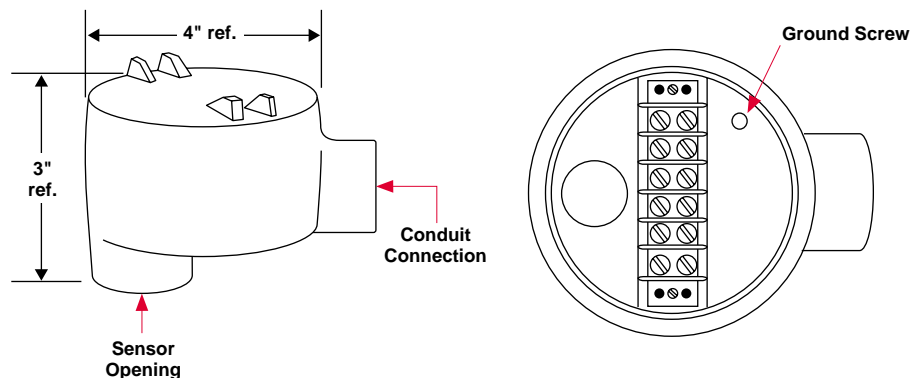
Hardware

Thermocouple Heads and Connector Blocks

Continued

Explosion Proof Thermocouple Heads

(Assembly Ordering Option H)



Approximate Assembled Dimensions:
4" H X 2 1/4" L X 3" W

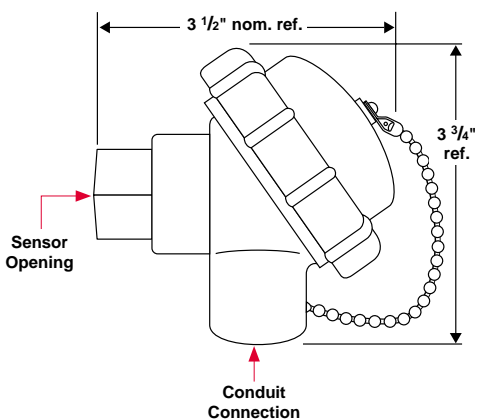
XP Head Shown with TH-615 Block

Code No.	Sensor Opening inches	Conduit Connection inches
XP-11	3/4	3/4
XP-12	1/2	3/4

For hazardous locations. Underwriter's Laboratories Listed Class 1, Groups C, D; Class 2, Groups E, F, G; Class 3, all Groups.

All XP explosion-proof heads use a TH-615 (six terminal) block. **Order separately.**

Also approved for CSA Class I, Groups C and D; Class II, Groups E and F; and Class III.



PT Polypropylene Head and Connector Blocks

(Assembly Ordering Option C)

PT Polypropylene Heads

Code No. Head Only	Sensor Opening inches	Conduit Connection inches
PT-20	1/2	1/2
PT-30	1/2	3/4
RT-30-WHT	1/2	3/4

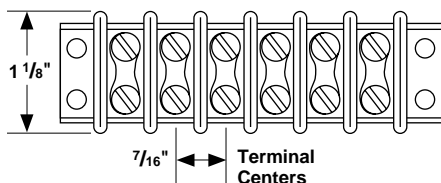
The polypropylene head is the answer to many of the corrosion problems facing connection heads. The U.V. stabilized polypropylene head is impervious to practically all corrosive media and is rated for continuous operation up to 220°F (105°C). The PT-20 and PT-30 are black and the RT-30-WHT is white in color.

Terminal Blocks for PT Heads

Code No.	Description
50500701	Single element block
50500801	Dual element block

4-20mA Transmitter Mounting Kit for PT Heads

Code No.
81500101



Barrier Type Terminal Strips

Standard barrier type terminal strips made of molded phenolic blocks with nickel plated brass terminals are available with two to 18 terminals. Terminal strips using thermocouple material also are available. **Note:** Two terminals required for each thermocouple.

Ordering Information: Specify 4201-____-BR

Insert the number of terminals desired (two to 18) in the blank. For terminals of thermocouple material, insert thermocouple calibration symbol in place of BR (K, J, E, T and R/S). Terminal strips then will be supplied with alternate positive and negative strips, e.g., Chromel®-Alumel®.

Chromel® and Alumel® are registered trademarks of Hoskins Manufacturing Co.

Accessories

Hardware

Sensor Mounting Fittings

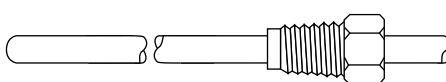
Mounting fittings can be applied at any point along the sheath. They are used to mount a sensor at a given depth, or for sensor to connection head attachment. Double threaded fittings can be used for both purposes simultaneously.

Mounting fittings are generally available in three basic types: fixed type, non-adjustable compression type and adjustable compression type. Various spring-loading features can be added to any of these basic types.

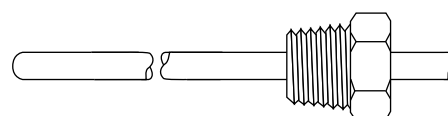
Fixed Type

Fixed type fittings must be brazed to the sheath. They are therefore suitable only where the exact immersion

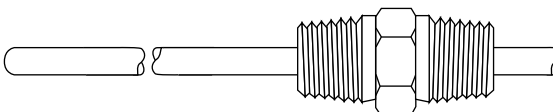
length of the thermocouple is known in advance and subsequent adjustments are unnecessary.



Typical TH-184



Typical MC-100151-C or MC-100155-G



Typical MC-100156-G or MC-100157-G

Code No.	Sheath O.D. inches	Material	Bore + 0.10, -0.000 inches	Male NPT inches	Hex Across Flats inches	Length inches
TH-184-1*	0.063	303 SS	0.065	1/8	3/16	1 1/8
TH-184-2*	0.125	303 SS	0.130	1/8	3/16	1 1/8
TH-184-3*	0.188	303 SS	0.192	1/8	3/16	1 1/8
TH-184-4*	0.250	303 SS	0.256	1/8	3/16	1 1/8
TH-184-5*	0.250	303 SS	0.256	1/4	3/16	7/8
TH-184-6*	0.313	303 SS	0.318	1/4	3/16	7/8
TH-184-7*	0.375	303 SS	0.380	1/4	3/16	7/8
MC-100151-C*	0.125 or larger	Mild Steel	Drilled to size	1/2	7/8	1
MC-100155-G*	0.125 or larger	303 SS	Drilled to size	1/2	7/8	1
MC-100156-G*	0.125 or larger	Mild Steel	Drilled to size	1/2	7/8	1 3/4
MC-100157-G*	0.125 or larger	303 SS	Drilled to size	1/2	7/8	1 3/4

*When ordering fixed fittings as part of an assembly, specify the distance "A" in inches from tip of the measuring junction to the start of threads.

Non-Adjustable Compression Type

Non-adjustable compression type fittings allow the exact immersion length to be set in the field at the time the sensor is installed. However, because the compression sleeve and sheath are deformed in application,

the fitting cannot be relocated along the sheath after tightening. When ordered as a part of a sensor for mounting the thermocouple, all compression type fittings are shipped finger-tight on the sheath.

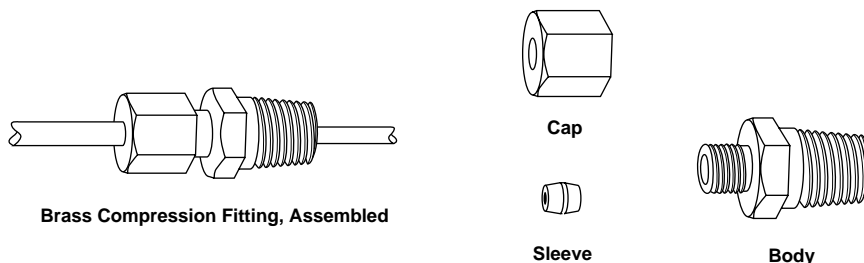
Accessories

Hardware

Sensor Mounting Fittings

Continued

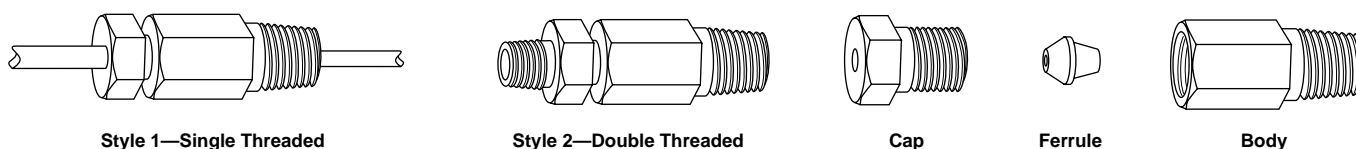
Brass Compression Fitting, Non-Adjustable



Code No.	Sheath O.D. inches	Material	Bore +0.10, -0.000 inches	Male NPT inches	Length inches
TH-185-2	0.125	Brass	0.130	1/8	1
TH-185-3	0.188	Brass	0.192	1/8	1 1/8
TH-185-4	0.250	Brass	0.256	1/8	1 1/4
TH-185-5	0.250	Brass	0.256	1/4	1 1/2
TH-185-6	0.313	Brass	0.318	1/4	1 1/2
TH-185-7	0.375	Brass	0.380	1/4	1 3/4
TH-185-9	0.250	Brass	0.256	1/2	1 3/4

Stainless Steel Compression Fitting, Non-Adjustable

Made entirely of 303 stainless steel.



Style 1—Single Threaded		Style 2—Double Threaded		Sheath O.D. inches	Bore ±0.001 inches	Male NPT inches	Hex Across Flats inches
Code No.	Length in	Code No.	Length in				
TH-2745-063	1 1/4	TH-2749-063	1 1/8	0.063	0.067	1/8	1/2
TH-2745-125	1 1/4	TH-2749-125	1 1/8	0.125	0.129	1/8	1/2
TH-2745-188	1 5/8	TH-2749-188	1 1/8	0.188	0.194	1/8	1/2
TH-2745-250	1 5/8	TH-2749-250	1 1/8	0.250	0.257	1/8	1/2

Adjustable Compression Type

Adjustable compression type fittings can be relocated at different positions along the sheath whenever changes in the immersion length are necessary. To relocate an adjustable compression fitting simply loosen the cap, slide the fitting to the new

location and retighten the cap. It is recommended that lava sealant glands be replaced after each tightening. Neoprene and TFE sealant glands should withstand several relocations before replacement is necessary.

Accessories

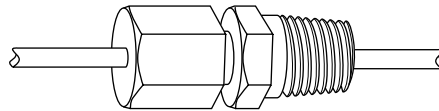
Hardware

Sensor Mounting Fittings

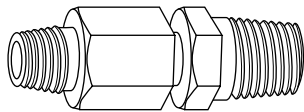
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Stainless Steel Adjustable Compression Fitting

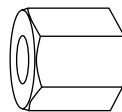
Except for their sealant glands, these fittings are made entirely of 303 stainless steel. Sealant glands are available in neoprene, -40 to 200°F (-40 to 95°C); lava, -300 to 1000°F (-184 to 540°C); TFE, -300 to 500°F (-184 to 260°C). Unless otherwise specified*, neoprene sealant glands will be furnished. Depending on temperature and sheath diameter, the fittings are pressure rated up to 3,000 psi.



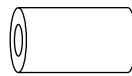
Style 1—Single Threaded



Style 2 - Double Threaded



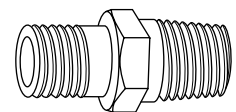
Cap



Follower



Sealant Gland

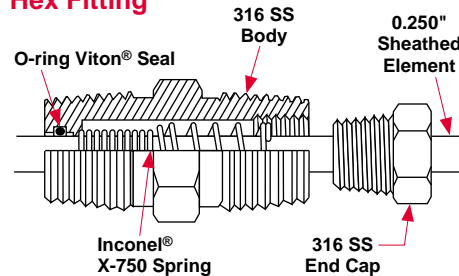
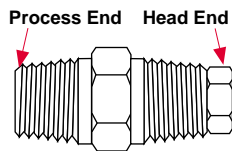


Body

Style 1—Single Threaded		Style 2—Double Threaded		Sheath O.D. inches	Bore +0.002 inches	Male NPT inches	Hex Across Flats inches	Replacement Sealant Glands, Neoprene
Code No.	Length in	Code No.	Length in					
TH-2747-N-063	1 ¼	TH-2751-N-063	1 ⅝	0.063	0.067	⅛	½	TH-279-N-063
TH-2747-N-125	1 ¼	TH-2751-N-125	1 ⅝	0.125	0.136	⅛	½	TH-279-N-125
TH-2747-N-188	1 ¼	TH-2751-N-188	1 ⅝	0.188	0.193	⅛	½	TH-279-N-188
TH-2748-N-250	2 ⅞	TH-2752-N-250	3 ¼	0.250	0.257	¼	⅞	TH-280-N-250
TH-2748-N-313	2 ⅞	TH-2752-N-313	3 ¼	0.313	0.316	¼	⅞	TH-280-N-313
TH-2748-N-375	2 ⅞	TH-2752-N-375	3 ¼	0.375	0.386	¼	⅞	TH-280-N-375

*If lava or TFE sealant glands are desired, substitute L or T in place of the N in the code number.

Adjustable Spring-Loaded Hex Fitting



The adjustable spring-loaded fitting has a stainless steel body and end cap, an Inconel® X-750 spring, and a high temperature, fluid-tight seal pressure rated at 50 psi ambient. Designed for use with 0.250 inch O.D. sheath thermocouples and RTDs.

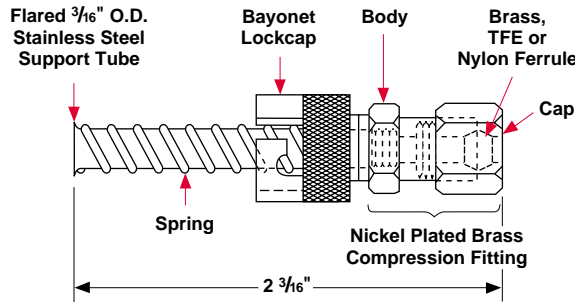
Code No.	Sheath			Male NPT inches	Hex Across Body Flats inches	Hex Across Cap Flats inches
	Length inches	O.D. inches	Material			
6555-250	2	0.250	316 SS	⅛	⅞	⅞

Viton® is a registered trademark of the E.I. du Pont de Nemours & Company. Inconel® is a registered trademark of the Inco family of companies.

Accessories

Hardware Bayonet Fittings

Adjustable Bayonet Compression Fitting

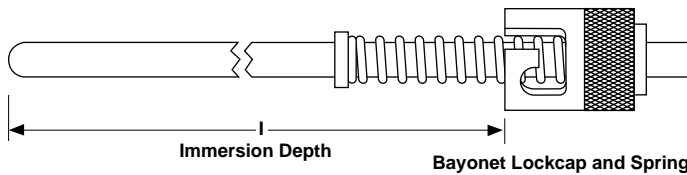


This fitting combines the features of the fixed bayonet fitting in a compact unit which does not require brazing to assemble.

The fitting is designed for 0.125 inch O.D. sensor and is available with either brass, TFE or nylon ferrules. With either the TFE or nylon ferrules, this fitting may be relocated at different positions along the sheath whenever changes in the immersion length are necessary. Brass ferrules cannot be relocated once they are set.

Code No.	Description
TH-2762-BR	Adjustable bayonet fitting with brass ferrule
TH-2762-NY	Adjustable bayonet fitting with nylon ferrule
TH-2762-T	Adjustable bayonet fitting with TFE ferrule

Fixed Bayonet Fitting



0.188 inch O.D. sensor but, by means of a brazed-on sleeve, 0.063 inch and 0.125 inch O.D. sensor can be built up to 0.188 inch O.D. to accept it. The TH-2760 includes the lockcap, spring and spring stop, which require brazing for assembly.

The adapter requires a tapped 1/8 inch NPT or 3/8 24 hole for mounting. All components are nickel plated steel.

When used together, a bayonet fitting and bayonet adapter act as a spring-loading device for bottoming a thermocouple hot junction in a hole. The fitting is designed for use on

Code No.	Description
TH-2760	Lockcap, spring and spring stop

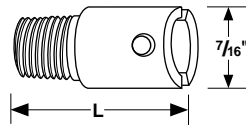
Accessories

Hardware

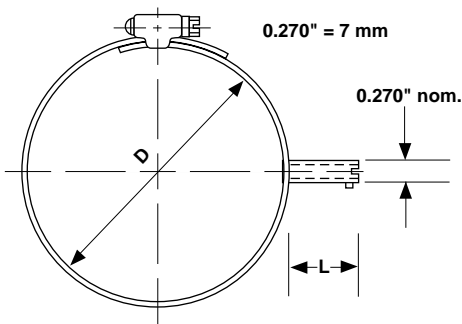
Bayonet Fittings

Continued

Bayonet Adapter



Code No.	Description	L Length inches	Thread inches
TH-295-1	Bayonet Adapter	$\frac{7}{8}$	$\frac{1}{8}$
TH-295-2		1	$\frac{1}{8}$
TH-295-3		$1\frac{1}{2}$	$\frac{1}{8}$
TH-295-4		2	$\frac{1}{8}$
TH-295-5		$2\frac{1}{2}$	$\frac{1}{8}$
TH-298-1		$\frac{7}{8}$	$\frac{3}{8}$ -24
TH-298-2		$1\frac{1}{2}$	$\frac{3}{8}$ -24



The pipe clamp band with bayonet adapter is designed for use in conjunction with a bayonet style thermocouple. It allows temperature measurement without drilling or tapping. Thermocouple replacement is extremely fast and simple and is accomplished without disturbing the surroundings, such as pipe insulation.

Pipe Clamp with Bayonet Adapter

1 2 3 4
9 0

1-2. Construction Code

90 = Pipe clamp band with bayonet adapter

3. "D" Clamp Band Diameter Range (inch)

- A = $1\frac{1}{8}$ to $1\frac{1}{4}$
- B = $1\frac{1}{4}$ to $2\frac{1}{4}$
- C = $2\frac{1}{4}$ to $3\frac{1}{4}$
- D = $3\frac{1}{4}$ to $4\frac{1}{4}$
- E = $4\frac{1}{4}$ to 5
- F = 5 to 6
- G = 6 to 7

4. "L" Bayonet Adapter Length inches

- 1 = 1 (use with thermocouple that has "B" dimension = 2 inch)
- 2 = 2 (use with thermocouple that has "B" dimension = 3 inch)

All combinations are available for next day shipment.

Accessories

Hardware

Transition Fittings and Accessories

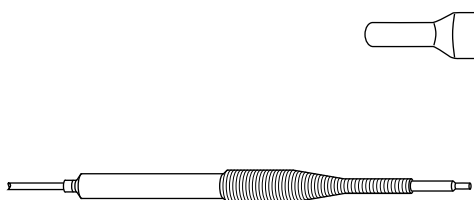
Watlow's complete line of stainless steel transition fittings offers durable, potted connections between XACTPAK® type sheathed thermocouple material and insulated wire. When the distance between the thermocouple and the instrument is known in advance, this type of assembly can be connected directly to your instrument, minimizing field installation time.

When making a sensor with a transition fitting, the thermocouple and connecting wires are first securely brazed together. The appropriate transition body is then positioned over the splice and either crimped or brazed to the sheath material. The transition body is then filled with a potting compound which effectively insulates and strengthens the splice.

Unless otherwise specified, standard potting compounds are used. The maximum continuous operating tem-

perature of these compounds is 200°F (95°C) in the TH-2780 series and 300°F (150°C) in all other transition fittings. High temperature (1000°F/540°C) potting compound is available on request.

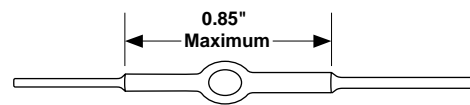
A coiled spring strain relief on the 700 and 701 protects the connecting wire against sharp bends at the transition area. The TH-2780 fitting allows for visual inspection after the necessary joints are made prior to potting.



700 or 701 Transition Fitting, Assembled
U.S. Patent Number 3,811,958



702 Transition Fitting



TH-2780 Transition Fitting. U.S. Patent Number 3,324,321. 0.165" Maximum Width at Eye.



703 Heavy Duty Transition

Code No.	Sheath O.D. inches	Transition Body inches		Spring Strain Relief	Length Including Spring inches	Max. Dia. Extension Wire inches	Method of Attachment to Sheath
		O.D.	Length Less Spring (if any)				
700-010*	0.010	1/4	1 3/16	yes	2 1/4	0.136	Braze
702-010*	0.010	5/32	1	no	—	0.100	Braze
700-020*	0.020	1/4	1 3/16	yes	2 1/4	0.136	Braze
702-020*	0.020	5/32	1	no	—	0.100	Braze
TH-2780-020	0.020	5/32	5/16	no	—	0.064	Braze
700-032*	0.032	1/4	1 3/16	yes	2 1/4	0.136	Braze
702-032	0.032	5/32	1	no	—	0.100	Braze
TH-2780-032	0.032	5/32	5/16	no	—	0.064	Braze
700-040*	0.040	1/4	1 3/16	yes	2 1/4	0.136	Crimp or braze**
702-040	0.040	5/32	1	no	—	0.100	Braze
TH-2780-040	0.040	5/32	5/16	no	—	0.064	Braze
700-063	0.063	1/4	1 3/16	yes	2 1/4	0.136	Crimp or braze**
701-063	0.063	3/8	1 3/16	yes	2 1/2	0.210	Crimp or braze**
702-063	0.063	5/32	1	no	—	0.100	Braze
TH-2780-063	0.063	5/32	5/16	no	—	0.064	Braze
700-125	0.125	1/4	1 3/16	yes	2 1/4	0.136	Crimp or braze**
701-125	0.125	3/8	1 3/16	yes	2 1/2	0.210	Crimp or braze**
701-188	0.188	3/8	1 3/16	yes	2 1/2	0.210	Crimp or braze**
701-250	0.250	3/8	1 3/16	yes	2 1/2	0.210	Crimp or braze**
703-188	0.188	1/2	2	no	—	0.320	Braze
703-250	0.250	1/2	2	no	—	0.320	Braze
703-313	0.313	1/2	2	no	—	0.320	Braze
703-375	0.375	1/2	2	no	—	0.320	Braze
TH-2743-500	0.500	3/4	2	no	—	0.400	Braze

*Sleeved down from larger size to accept smaller O.D. sheath material.

**Crimp standard; braze available.

Accessories

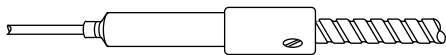
Hardware

Transition Fittings and Accessories

Continued



TH-195 Stainless Steel Flexible Tubing



TH-213 or TH-249 Screw on Adapter Ferrule



TH-524 Crimp on Adapter Ferrule

Flexible Tubing and Adapter Ferrule

When it is desirable to protect the connection wire, either for a short distance at a connector or transition fitting, or for the full length, this stainless steel flexible tubing may be used. It can

be used with either 700 or 701 series transition fittings. An adapter ferrule is used in place of the coiled spring strain relief to firmly secure the flexible tubing to the transition body.

Code No.	Description
TH-195	Stainless steel flexible tubing, 0.188 inch I.D. X 0.265 inch O.D. (0.175 inch maximum wire size)
TH-195-PVC	Same as the TH-195 with extruded PVC overall
TH-213	Screw on adapter ferrule for code no. 701 transition
TH-249	Screw on adapter ferrule for code no. 700 transition
TH-524	Crimp on adapter ferrule for code no. 700 transition (may be used as a combination transition fitting and adapter ferrule on 0.250 inch O.D. XACTPAK)

Thermocouple Insulators and Accessories



Thermocouple insulators are usually selected for their ability to withstand elevated temperatures or to resist thermal shock. This listing groups SERV-RITE® thermocouple insulators in these classifications for convenient selection. Some sizes and lengths are available in more than one classification. The thermocouple insulators listed below are generally carried in stock for quick delivery. Other sizes can be made to suit individual requirements. Prices and delivery quoted upon request.

Mullite Insulators

- High temperature
- Low thermal expansion
- Good mechanical strength
- Maximum continuous temperature 2640°F (1450°C)
- Maximum intermittent temperature 3000°F (1650°C)

Oval—Double Hole

Code No.	B & S Gauge	Dimensions inches*			
		Width	Thickness	Bore	Length
372	8	0.468	0.281	0.156	3
373	12	0.385	0.218	0.093	1

Round—Double Hole

Code No.	B & S Gauge	Dimensions inches*		
		Diameter	Bore	Length
376-1	18	0.156	0.046	1
376-3	18	0.156	0.046	3
331	16	0.250	0.062	24
377-12	16	0.250	0.062	12
333-2	22	0.125	0.031	2
333-12	22	0.125	0.031	12
333-18	22	0.125	0.031	18
333-24	22	0.125	0.031	24

*Nominal

Accessories

Hardware

Thermocouple Insulators and Accessories

Mullite Insulators

Continued

Round—Four Hole

Code No.	B & S Gauge	Dimensions inches*		
		Diameter	Bore	Length
360	12	0.312	0.093	1
378	18	0.187	0.046	1

Accessories

Code No.	Description	Dimensions inches*	
		I.D.	O.D.
339	Mullite hot junction cup	0.375	0.687

Steatite Insulators

- Excellent physical strength
- Poor heat shock resistance
- Good electrical properties
- Maximum continuous temperature 1830°F (1000°C)
- Maximum intermittent temperature 2370°F (1300°C)

Oval—Double Hole

Code No.	B & S Gauge	Dimensions inches*			
		Width	Thickness	Bore	Length
380	8	0.500	0.284	0.156	1
381-¼	14	0.313	0.187	0.080	¼
381-1	14	0.313	0.187	0.080	1
382-1	20	0.172	0.118	0.042	1
383-1	24	0.144	0.091	0.028	1

Round—Double Hole

Code No.	B & S Gauge	Dimensions inches*		
		Diameter	Bore	Length
385-1	14	0.245	0.073	1
385-2	14	0.245	0.073	2
385-3	14	0.245	0.073	3
386	18	0.150	0.046	2

Ball and Socket Insulators—Fish Spine

Code No.	B & S Gauge	Dimensions inches*			No. Per Lb.
		Width	Bore	Length	
349	4	0.54	0.240	0.54	160
344	8	0.26	0.156	0.26	1720
342	14	0.20	0.092	0.20	3100
341	16	0.17	0.068	0.17	5200
340-1	17	0.11	0.056	0.11	18160

*Nominal

Accessories

Hardware

Thermocouple Insulators and Accessories

Continued

Cordierite Insulators

- Excellent thermal shock resistance
- Fair physical strength and electrical properties
- Maximum continuous temperature 2280°F (1250°C)
- Maximum intermittent temperature 2370°F (1300°C)

Round—Single Hole

Code No.	B & S Gauge	Dimensions inches*		
		Diameter	Bore	Length
316	8	0.250	0.156	3

Round—Double Hole

Code No.	B & S Gauge	Dimensions inches*		
		Diameter	Bore	Length
321	6	0.505	0.188	1
327	8	0.375	0.140	3
384	8	0.490	0.156	1
323	14	0.281	0.080	1
326	14	0.250	0.080	2 ½
328	16	0.187	0.062	1

Oval—Double Hole

Code No.	B & S Gauge	Dimensions inches*			
		Width	Thickness	Bore	Length
300	4	0.718	0.412	0.218	1
306	6	0.531	0.281	0.170	3
301	6	0.531	0.281	0.170	1
302	6	0.531	0.281	0.170	¾
303	8	0.437	0.250	0.156	1
311	8	0.437	0.250	0.156	¾
304	11	0.375	0.217	0.110	1
305	11	0.375	0.217	0.110	5
309	12	0.313	0.187	0.090	3

*Nominal

Alumina Insulators

- Excellent high temperature insulation
- Good electrical and mechanical properties
- Maximum continuous temperature 3000°F (1650°C)
- Maximum intermittent temperature 3300°F (1815°C)

Round—Double Hole

Code No.	B & S Gauge	Dimensions inches*		
		Diameter	Bore	Length
391-12	22	0.125	0.031	12
391-18	22	0.125	0.031	18
391-24	22	0.125	0.031	24

*Nominal

Transmitters/ Signal Conditioners

System Components

Two-Wire Transmitters

Watlow offers several different thermal-head mounted two-wire transmitters.

The 5900 Series two-wire signal conditioner is constructed using surface mount technology and utilizes digital technology with non-volatile memory. It is designed to fit directly into universal aluminum or universal iron connection heads with a separate mounting kit.

The transmitter is programmed via a separate connection cable along with an easy-to-use Windows®-based software program. There is no need to use a separate thermocouple/RTD calibrator; nor are individual resistors required.

The 5900 Series is isolated to 1500V~(ac) and features full linearization between temperature sensor input signal and the 4-20mA output signal.

The 5800 Series signal conditioners are constructed using a single oval shaped circuit board. This unit is designed to fit directly into the universal, small cast iron or small cast aluminum connection heads without a mounting kit. They use a ½ inch stand-off. The 5801 is isolated to 500V≡(dc) and fully linearized between temperature and signal output.

In addition, the 5800 Series features improved noise rejection and RFI/EMI immunity due to the filtering of the miniature isolation transformers.

The 5701 and 5751 Series are non-isolated, non-linearized two-wire transmitters. They generate a 4-20mA output current in response to a change in input conditions (the output curve will follow the input curve). The transmitters offer performance and versatility with the advantage of a low price.

Windows® is a registered trademark of Microsoft Corporation.



The new Series 5900 is pictured mounted into the universal head.

On 5800, 5751 and 5701 Series, range is determined by a set of internally mounted resistors and can be changed in a matter of minutes. In addition they can be ranged for all known types of thermocouples. The units provide three-wire compensation for Pt-100 and ice point reference compensation for thermocouples.

Features and Benefits

- **User selectable input type** accommodates all thermocouple types, mV, and Pt-100 RTD (JIS or DIN).
- **Field rangeable** for greater convenience.

- **Full isolation from input to output** eliminates ground loops for high data integrity.
- **Universal input capabilities** reduce the required inventory levels for both inplant users and distributors.
- **CE marked** for compliance to electromagnetic interference.

Applications

- Power stations
- Chemical processing
- Refrigeration warehouses
- Energy management

Transmitters/ Signal Conditioners

System Components

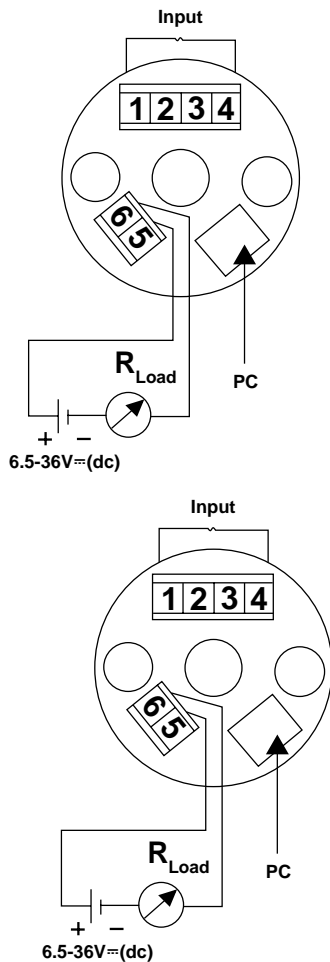
5900 Series



Specifications for 5900

- **Isolation:** 1500V~(ac) for one minute
- **Operating voltage:** 6.5 to 36 volts (the 5900 is protected against voltage surges and reverse polarity)
- **Sensor burn out protection:** A pulsed current is continuously checking all sensor leads for disconnect. The output will go upscale or downscale.
- **Minimum input signal:** RTDs: 10C, Thermocouples: 2mV
- **Operating temperature:** -40 to +85°C
- **Response time appr.:** 0.5 sec.
- **RFI sensitive:** 20 - 1000 MHz, 10V/m typical <0.1% (of end value)
- **Permissible ripple of supply:** 4V p-p
- **Long term stability:** 0.1% per year
- **Calibration inaccuracy, thermocouples:** max of 20μ volts or 0.01%
- **Temperature effect:** cold junction compensation 0.02% C/C
- **Housing:** PC, ABS/VO connection polyamid / V2
- **Mounting:** DIN B
- **CE marked**

5900, 5901 and 5902 Series Pinout



Ordering Information—To order, complete the code number to the right with the information below.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	_____				_____	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____
1-4. Series	_____														
5900 = Isolated, linearized T/C or RTD															
5901 = 1000Ω RTD															
5902 = Isolated, linearized with insulation resistance monitoring															
5. Sensor Type	_____														
B = Type B T/C	R = Type R T/C														
C = Type C T/C	S = Type S T/C														
E = Type E T/C	T = Type T T/C														
J = Type J T/C	O = 3-Wire RTD														
K = Type K T/C	1 = 2-Wire RTD														
N = Type N T/C	2 = 4-Wire RTD														
6. Low Temperature Sign	_____														
(Enter + or - sign)															
7-9. Low Temperature	_____														
10. High Temperature Sign	_____														
(Enter + or - sign)															
11-14. High Temperature	_____														
15. Unit of Measure (°C/°F)	_____														

Program cable and software part #5900-CABLE
(Necessary only if changing the original factory range)

See connection head mounting options on [page 170](#).

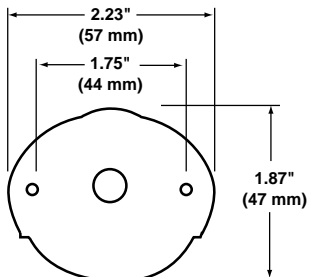
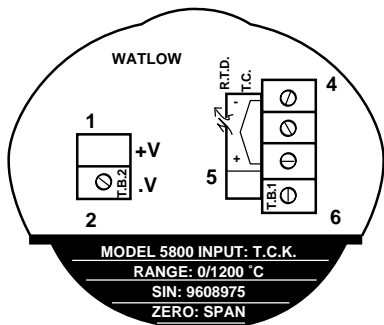
Transmitters/ Signal Conditioners

System Components

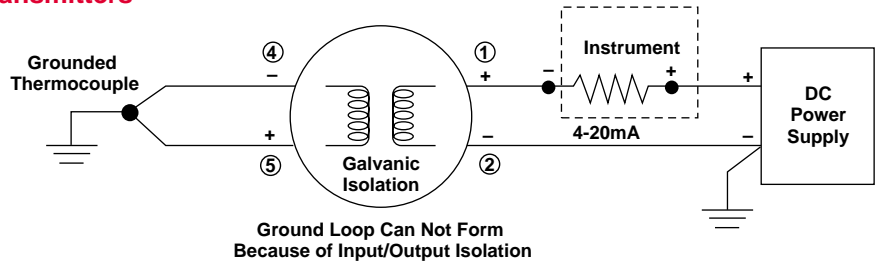
5800 Series Two-Wire Transmitters (Isolated)



5800 and 5801 Series Pinout



Application Sketch for Isolated Transmitters



Specifications for 5800 and 5801

- **Isolation (I/O):** 500V \approx (dc) or peak ac
- **Output span:** 4-20mA, limiting @ <28mA
- **Input: RTD:** Pt-100, 2- or 3-wire;
Thermocouple: all known types
- **Input span:** RTD: 50°F min.;
T/C: 5mV min. span (appr. 200°F)
- **Adjustability:** \pm 25% for both zero and span
- **Burnout detection:** upscale—standard
- **Supply voltage:** 10-40V \approx (dc) polarity protected
- **Maximum load:** $R_{max} = (V_{supply} - 10V) \div 20mA$
- **Ambient temperature:** -4 to +150°F (-20 to +70°C)
- **Humidity:** 0 - 95% RH, non-condensing
- **Stability:** Pt-100 (100°C span): 0.02% of span/°C (for both zero and span) T/C/mV (25mV span): 0.02 % of span/°C
- **Thermocouple CJC:** <0.05°C/°C of ambient temperature

Ordering Information—To order, complete the code number to the right with the information below.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1-4. Series	_____														
5800 = Isolated T/C or RTD non-linearized (oval shape)															
5801 = Isolated T/C linearized (oval shape)															
5. Sensor Type	_____														
B = Type B T/C	R = Type R T/C														
C = Type C T/C	S = Type S T/C														
E = Type E T/C	T = Type T T/C														
J = Type J T/C	0 = 3-Wire RTD														
K = Type K T/C	1 = 2-Wire RTD														
N = Type N T/C															
6. Low Temperature Sign	_____														
(Enter + or - sign)															
7-9. Low Temperature	_____														
10. High Temperature Sign	_____														
(Enter + or - sign)															
11-14. High Temperature	_____														
15. Unit of Measure (°C/°F)	_____														

See connection head mounting options on [page 170](#).

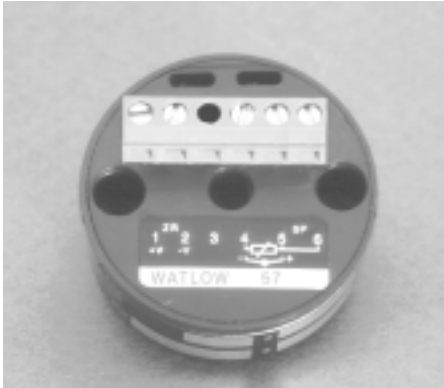
Transmitters/ Signal Conditioners

System Components

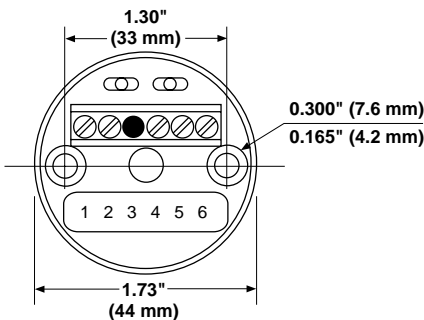
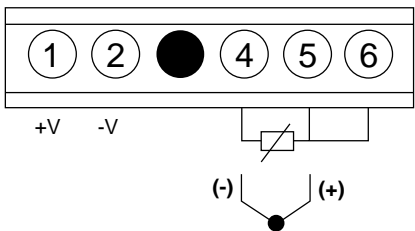
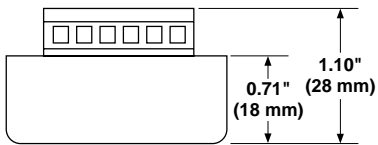
5700 Series

Two-Wire Transmitters

(Non-Isolated and Non-Linearized)



5701 and 5751 Series Pinout



Specifications for 5701 and 5751

- **Output span:** 4-20mA limiting at 28mA
- **Supply voltage:** 10-38V $\overline{=}$ (dc)
- **Maximum load resistance:**
 $R_{max} = (V \text{ supply} - 10V) \div 20mA$
- **Supply voltage variation effect:** negligible
- **Operating temperature:** -4 to +150°F (-20 to +70°C)
- **Humidity:** 0 - 95% non-condensing
- **Typical zero span adjustment accuracy:** $\pm 0.2\%$

- **Minimum span:** 5mV
- **Stability (for 25mV span):** better than 0.015% of span/°C plus 0.007% of reading/°C plus 0.05°C/°C
- **Burnout protection:** upscale
- **Ungrounded junction recommended.**

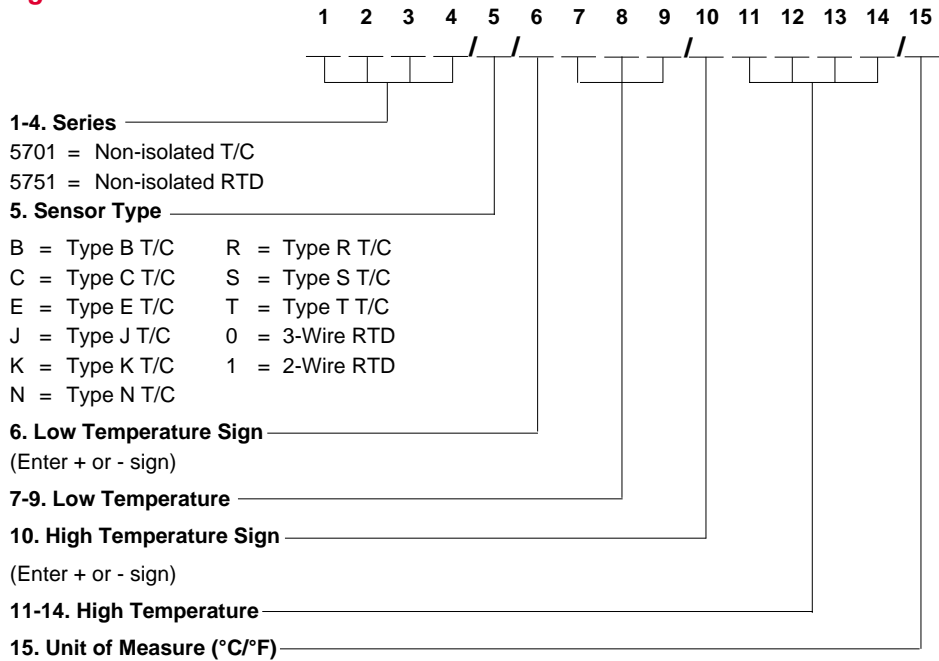
5751 Series

5701 Series

- **Input:** Thermocouple Types E, J, K, R, S, T, C and N

- **Input:** Pt-100 2- or 3-wire
- **Sensor excitation:** 1.0mA
- **Stability (for 100°C span):** better than 0.007% of span/°C plus 0.007% of reading/°C
- **CE marked**

Ordering Information—To order, complete the code number to the right with the information below.



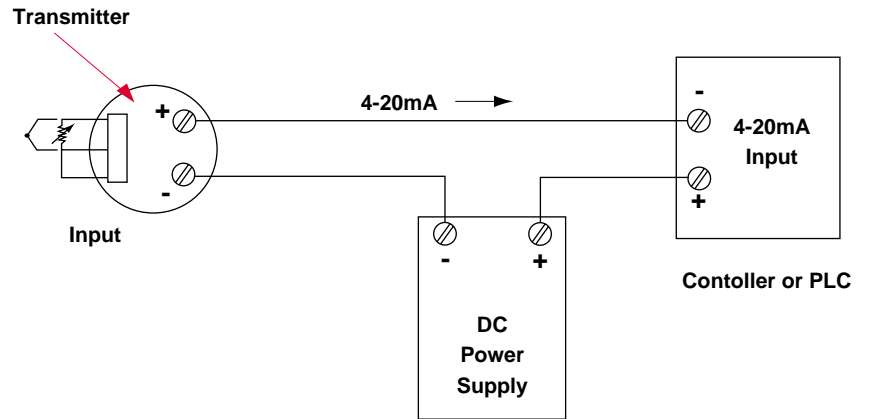
See connection head mounting options on [page 170](#).

Transmitters/ Signal Conditioners

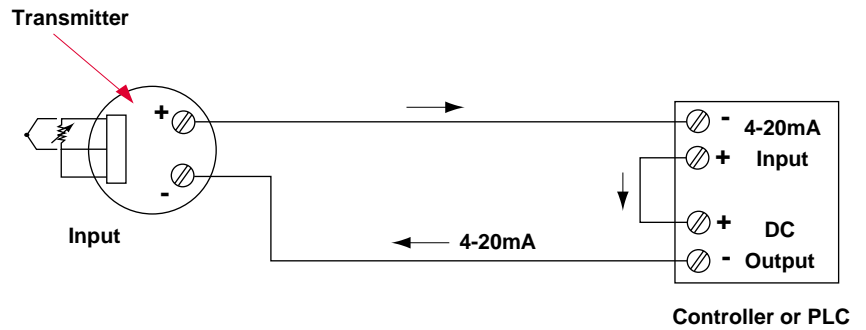
System Components

Typical Wiring Diagrams for Two-Wire Signal Conditioners

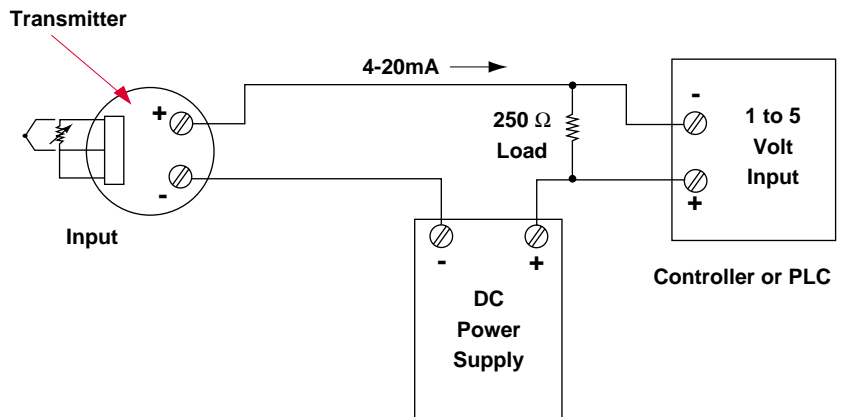
Controller or PLC with 4-20mA Input



Controller or PLC with Intergal Power Supply



Controller or PLC with 1 to 5 Volt Input



Transmitters/ Signal Conditioners

System Components

Transmitter and Connection Head Mounting Options

Signal Conditioner Model and Description	Connection Heads			
	Small Cast Aluminum and Iron	Universal Aluminum and Iron	Explosion XP Series	Poly Heads Pt Series
5701 and 5751, Non-isolated, Non-linearized	Does not fit	Mount with kit 81500601	Mount with kit 81500401	Mount with kit 81500101
5800, Isolated, Oval	Direct mount	Direct mount	Direct mount	Direct mount
5801, Isolated, Linearized, Oval	Does not fit	Direct mount	Direct mount	Direct mount
5900, 5901 and 5902, Isolated, Linearized	Does not fit	Mount with kit 81500601	Mount with kit 81500401	Mount with kit 81500101

SERV-RITE® Wire and Cable

Thermocouple and Thermocouple Extension Wire

Manufactured to Exacting Specifications

Since 1914, SERV-RITE® thermocouple wire and thermocouple extension wire have been known for premium performance and reliability. All stock and custom wire is manufactured in our plant where careful selection of materials, latest type of special machines and quality controls assure superior uniformity.

While this section presents available stock wire products, Watlow Gordon can custom manufacture wire using alloys and insulation types to meet your specific application demands.

All SERV-RITE thermocouple wire and thermocouple extension wire is manufactured under rigid quality controls. Watlow Gordon's wire products are manufactured following ISO 9001 standards. In addition, all EMF vs. temperature calibration procedures follow one or more of the following standards:

- ASTM E 207
- ASTM E 220
- AMS 2750

All testing has NIST (formerly NBS) traceability. Unless otherwise specified, all SERV-RITE thermocouple wire and extension wire are supplied to meet Standard Tolerances of ASTM E 230. Special Tolerances are also available.

Performance Capabilities

- Compliance with recognized agency tolerances
- Insulation temperature ranges from -328 to 2350°F (-200 to 1290°C)
- Tolerances from $\pm 0.5^\circ\text{C}$ or $\pm 0.4\%$
- NIST calibration certificates



SERV-RITE Wire and Cable

Features and Benefits

- **Type E, J, K, N and T thermocouple wire** for virtually all applications.
- **Type EX, JX, KX, NX, TX extension wire** to match thermocouple type.
- **Compensating extension wire for Type B, C*, R and S thermocouples** permit fine tuning of temperature measuring circuit.
- **Solid or stranded wire constructions** to meet specific application requirements.
- **Wide selection of insulation types** to meet temperature, chemical, moisture and abrasion resistance objectives.
- **Color coding** available to comply with United States, United Kingdom, German, Japanese and IEC standards.
- **Select metallic overbraids and wraps** to enhance abrasion resistance.
- **UL® listed PLTC wire and cable** for applications requiring agency compliance.
- **Stock RTD lead wire** to meet virtually all industrial RTD applications.

*Not an ASTM E 230 symbol.

UL® is a registered trademark of Underwriter's Laboratories, Inc.

SERV-RITE Wire and Cable

Thermocouple and Thermocouple Extension Wire

Technical Data

The following pages contain SERV-RITE wire technical data. This information covers ASTM E 230 letter designations and tolerances, color coding, stranded and solid constructions, selection considerations, how to read SERV-RITE wire product code numbers, metallic overbraid and wrap options, insulation or "Series," constructions and characteristics.

If you are unable to locate the stock product specifications required by your application, Watlow Gordon can custom manufacture a wire to meet your needs.

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 32 to 2300°F (0 to 1260°C), 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 -110°F (-80°C).

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

Common Certifications for Wire

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

Certificate #1 - Certificate of Compliance/Conformity

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

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

This certification states that product is being supplied which 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 MIL Standard 45662A

This certificate is used to certify that our calibration system is in accordance with MIL-STD 45662A.

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 #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.

SERV-RITE Wire Standard Calibration Temperatures

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.

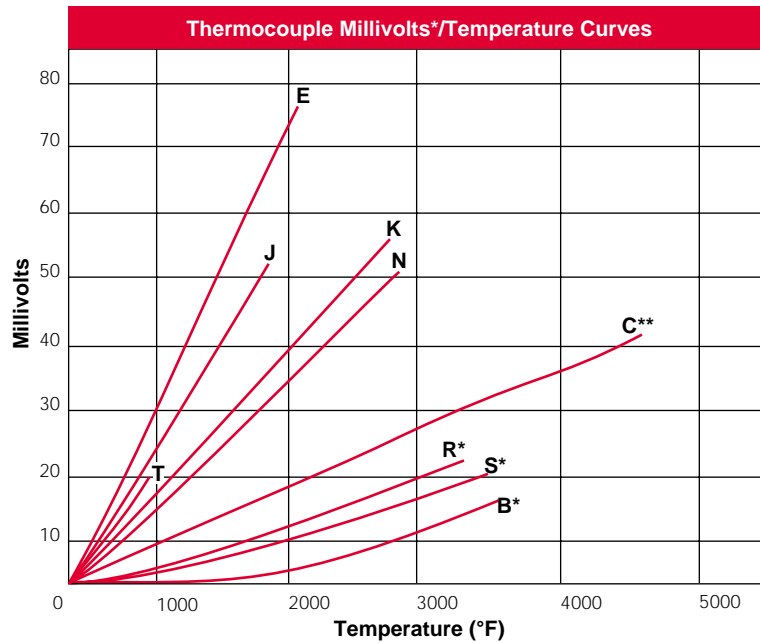
SERV-RITE Wire and Cable

Thermocouple and Thermocouple Extension Wire

Technical Data

Calibration and Certification

Continued



ASTM E 230
Symbol
B*
C**
E
J
K
N
R*
S*
T

*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% Rhenium/Tungsten 26% Rhenium.

ASTM E 230 Letter Designations

Thermocouple and extension wires are generally ordered and specified by ASTM E 230 letter designations for wire type. Positive and negative legs are identified by the appropriate letter suffixes P and N, respectively.

ASTM E 230 Letter	Description	Thermocouple Grade Alloys	Extension or Compensating Grade Alloys
B	BP BN	Platinum 30% Rhodium Platinum 6% Rhodium	BPX-PCLW-30-6 Copper
C*	CP CN	W5Re (Tungsten 5% Rhenium) W26Re (Tungsten 26% Rhenium)	Alloy 405 Alloy 426
E	EP EN	Chromel® Constantan	Chromel® Constantan
J	JP JN	Iron Constantan	Iron Constantan
K	KP KN	Chromel® Alumel®	Chromel® Alumel®
N	NP NN	Nicrosil Nisil	Nicrosil Nisil
R	RP RN	Platinum 13% Rhodium Pure Platinum	Copper #11 Alloy
S	SP SN	Platinum 10% Rhodium Pure Platinum	Copper #11 Alloy
T	TP TN	Copper Constantan	Copper Constantan

* Not an ASTM E 230 symbol.

Note: Watlow Gordon reserves the right to substitute equivalent materials.

Chromel® and Alumel® are registered trademarks of Hoskins Manufacturing Company.

SERV-RITE Wire and Cable

Thermocouple and Thermocouple Extension Wire

Technical Data

Continued

ASTM E 230 Tolerances

Unless otherwise specified, all SERV-RITE thermocouple wire and extension wire is supplied to meet Standard Tolerances of ASTM E 230. Special Tolerances are also available. The standard and special tolerances for thermocouple and extension wires are given in the accompanying tables. Where tolerances are given in percent, the percentage applies to the temperature being measured.

Initial Calibration Tolerances for SERV-RITE Wire And Cable

Reference Junction 32°F (0°C)

Calibration Type	Temperature Range °F (°C)		Tolerances (whichever is greater)			
			Standard (°C)		Special (°C)	
Thermocouples ^{① ③}						
B	1600 to 3100	(870 to 1700)	②	(±0.5%)	②	(±0.25%)
E	32 to 1600	(0 to 870)	②	(±1.7 or ±0.5%)	②	(±1.0 or ±0.4%)
J	32 to 1400	(0 to 760)	②	(±2.2 or ±0.75%)	②	(±1.1 or ±0.4%)
K or N	32 to 2300	(0 to 1260)	②	(±2.2 or ±0.75%)	②	(±1.1 or ±0.4%)
R or S	32 to 2700	(0 to 1480)	②	(±1.5 or ±0.25%)	②	(±0.6 or ±0.1%)
T	32 to 700	(0 to 370)	②	(±1.0 or ±0.75%)	②	(±0.5 or ±0.4%)
E ^④	-328 to 32	(-200 to 0)	②	(±1.7 or ±1%)	②	⑤
K ^④	-328 to 32	(-200 to 0)	②	(±2.2 or ±2%)	②	⑤
T ^④	-328 to 32	(-200 to 0)	②	(±1.0 or ±1.5%)	②	⑤
Extension Wires ^{⑥ ⑦}						
EX	32 to 400	(0 to 200)	±3.0	(±1.7)	±1.8	(±1.0)
JX	32 to 400	(0 to 200)	±4.0	(±2.2)	±2.0	(±1.1)
KX or NX	32 to 400	(0 to 200)	±4.0	(±2.2)	±2.0	(±1.1)
TX	32 to 200	(0 to 100)	±1.8	(±1.0)	±0.9	(±0.5)
Compensating Extension Wires ^{⑧ ⑨}						
BX [®]	32 to 400	(0 to 200)	±7.6	(±4.2)	*	*
CX	32 to 500	(0 to 260)	±12.2	(±6.8)	*	*
RX, SX	32 to 400	(0 to 200)	±9.0	(±5.0)	*	*

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 on page 177. 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 0°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% (whichever is greater); *Type T:* -200 to 0°C ±0.5 or ±0.8% (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 32 to 125°F (0 to 50°C), where the use of non-compensated (copper/copper) conductors introduces no significant error. For a somewhat larger temperature gradient of 32 to 210°F (0 to 100°C) 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 1800°F (1000°C). Proprietary alloy compensating extension wire is available for use over 32 to 400°F (0 to 200°C) temperature range.

* Special tolerance grade compensating extension wires are not available.

SERV-RITE Wire and Cable

Thermocouple and Thermocouple Extension Wire

Technical Data

Continued

International Standards

SERV-RITE wire and cable complies with international standards and tolerances in both standard and special limits.

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. Additionally, various national and international standard agencies have adopted color codes for the identification of thermocouple wire and products. These generally differ from those used by ASTM E 230.

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

SERV-RITE Wire and Cable



See colored version on the inside back cover.

SERV-RITE Wire and Cable

Thermocouple and Thermocouple Extension Wire

Technical Data

Continued

Solid and Stranded Conductors

Thermocouple wire and extension wire are usually solid conductors. When greater flexibility is required, either may be ordered in stranded construction.

Stranded wire is specified when flexibility is a major concern. It is manufactured by using several smaller gauge strands grouped together to form the desired gauge size. This is accomplished by twisting the smaller gauge wires together. The twisting also adds to the flexibility of the wire.

The most widely used stranding combination consists of seven small strands. This yields a fairly round construction and allows the use of various connection systems that are designed for round solid wires. SERV-RITE wire's standard items use this seven strand construction.

While most stranded wire is specified for its flexibility, there is another less common reason for its use. When a very specific resistance is required, the stranded conductors allow "fine tuning" the finished conductor's resistance. By replacing fine wires with slightly larger wires, the conductor's resistance can be adjusted to within a few percent of any given target resistance.

When flexibility or resistance are of prime concern, SERV-RITE wire or cable can be designed for your particular application.

Conductor Sizes

Wire Size B & S Gauge	Solid		Stranded			
	Diameter		Diameter		Number of Strands	Strand Gauge
inch	(mm)	inch	(mm)			
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)				

Ohms per Double Feet

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

B & S Gauge	Diameter		BX	CX*	E	J	K	N	RX,SX	T
	inch	(mm)								
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

SERV-RITE Wire and Cable

Thermocouple and Thermocouple Extension Wire

Technical Data

Continued

How to Select Wire to Suit Your Requirements

The following information will acquaint you with some of the nomenclature involved with thermocouple wire and thermocouple extension wire. By spending a few minutes reading this information orders can be placed quickly and accurately.

Thermocouple Wire or Thermocouple Extension Wire

There are some significant differences between the wire used to actually measure temperature and the wire used to carry the millivoltage signal to an instrument.

The most obvious difference is the color-code used to identify the wire itself. In most cases, thermocouple grade wire is identified by its overall brown color. The exceptions in the SERV-RITE wire product line are the very high temperature yarns such as those used in the Series 301 and 350. Of course, the overall color code is not used when there is no overall covering as in SERV-RITE wire Series 505, 511 and 314.

The working differences between the two wires is that the thermocouple "extension" wire is not calibrated above 400°F (204°C). The temperature rating of the insulations used on some extension grade wire exceeds this 400°F temperature. This is to allow the wire to survive occasional contact with hot parts or furnace walls.

This catalog lists certain specific insulations for thermocouple and extension grade wire. However, virtually any of SERV-RITE wire insulation systems can be applied to either thermocouple or extension wire.

The following explains the meanings of the terms used in the tables of this section.

Single Conductor Insulation

This item identifies the type of insulation used on the individual thermoelements. Certain part numbers use a combination of insulations. When there is a combination, the insulations are listed in their order of application.

Duplex Conductor Insulation

This item lists the overall insulation when one is used. Some constructions which have no overall insulation use this area to describe the duplexing method—i.e. twisting, "ripcord", etc.

Temperature Rating

Most constructions are rated for both continuous use and for single reading applications. The continuous use temperature is considered to be the highest temperature at which that particular construction will survive indefinitely. The single reading temperature has been determined by actual tests. Each insulation system will perform differently when exposed to this temperature. Generally, the construction will perform at this temperature and produce an accurate reading. However, after exposure to this temperature, the wire will exhibit less flexibility and/or abrasion resistance. Because of this, it is unlikely that the wire could be removed from the application and then replaced after exposure to the "single reading temperature."

Recommended Upper Temperature Limit for Protected Thermocouple Wire

Thermocouple Type	No. 8 Gauge °F (°C)	No. 14 Gauge °F (°C)	No. 20 Gauge °F (°C)	No. 24 Gauge °F (°C)	No. 28 Gauge °F (°C)
E	1600 (870)	1200 (650)	1005 (540)	805 (430)	805 (430)
J	1400 (760)	1095 (590)	895 (480)	700 (370)	700 (370)
K and N	2300 (1260)	1995 (1090)	1795 (980)	1600 (870)	1600 (870)
T		700 (370)	500 (260)	395 (200)	395 (200)

Table courtesy of ASTM.

SERV-RITE Wire and Cable

Thermocouple and Thermocouple Extension Wire

Technical Data

How to Select Wire to Suit Your Requirements

Continued

ASTM E 230 Color Code

Generally, SERV-RITE wire has color codes wherever possible. The exceptions are the high temperature yarn constructions such as the 301 and 350 Series. Color coding of the 511 and 512 Series is accomplished by including a colored thread or "tracer" under the tape.

Physical Properties

Abrasion Resistance is rated fair, good, or excellent and is based on the wall thickness of the construction and how well it survives with other insulations of similar thicknesses. The 511 Series receives an excellent rating because the thin wall of polyimide tape will survive better than almost any other insulation applied in the same wall thickness.

The "absolute" abrasion resistance of a construction will depend not only on the type of insulation but on thickness at which it is applied.

Moisture Resistance ratings are given for the wire in the "as received" condition. In the case of fiberglass insulated wire, the moisture resistance is achieved by the use of impregnations or spirally applied tapes called moisture barriers. The impregnations and/or tapes will burn off at temperatures below the upper useful operating temperatures of the fiberglass. The thermoplastic insulations (PVC and the fluoroplastics) and the polyimide insulated constructions will maintain their moisture resistance up to their "continuous" temperature rating.

Chemical Resistance ratings are given as they relate to most common chemicals. These ratings apply to the insulation types and not necessarily to the type of impregnation used. Consult factory for specific applications.

UL® Listed PLTC Wire And Cable

Watlow Gordon offers UL® listed SERV-RITE thermocouple and extension wire and cable for PLTC (Power Limited Tray Cable) applications. The following insulation Series have these approvals:

- 502
- 507
- 509
- 510
- 900
- 1000

All these insulation Series have the following physical characteristics:

- UL® listed Type PLTC—300 Volt
- Passes IEEE 383 70,000 BTU/Hr flame test
- Passes VW-1 flame test
- UL® listed under Subject 13
- Non-propagating
- Flame retardant
- UV light resistant

How to Read SERV-RITE Wire Code Numbers

Product code numbers for SERV-RITE wire are made up of three sets of figures separated by slashes. These figures convey the following data:

- The first set consists of a letter and two numerals. The letter is the ASTM E 230 Type designation for wire type. The numerals signify the wire B&S gauge.
- The second set consists of a single number. For thermocouple wire, 1 indicates solid, while 3 indicates stranded. For extension wire, 5 indicates solid, while 7 indicates stranded. The use of ODD numbers also indicates that the wire is manufactured to Standard Tolerances. If Special

Tolerances are desired, this figure MUST be changed to the next higher EVEN digit when ordering.

- The third set consists of three numerals signifying SERV-RITE wire insulation type or "Series."

Example:

1 2 3 4 5 6 7
K 2 0 / 1 / 3 0 4

1. ASTM E 230 Letter Designation (Calibration)

2-3. B & S Gauge

4. Conductor Type/Tolerance

- 1 = Thermocouple grade, solid wire, standard tolerance
- 2 = Thermocouple grade, solid wire, special tolerance
- 3 = Thermocouple grade, stranded wire, standard tolerance
- 4 = Thermocouple grade, stranded wire, special tolerance
- 5 = Extension grade, solid wire, standard tolerance
- 6 = Extension grade, solid wire, special tolerance
- 7 = Extension grade, stranded wire, standard tolerance
- 8 = Extension grade, stranded wire, special tolerance

5-7. Insulation Type (Series)

SERV-RITE Wire and Cable

Thermocouple and Thermocouple Extension Wire

Technical Data Metallic Overbraids and Wraps

Continued

Although standard SERV-RITE wire products are designed to yield a high degree of abrasion resistance, it is sometimes necessary to add an additional metallic covering to further enhance this property. The following are the available overbraids and wraps.

Stainless Steel Wire Braid (S)

This, the most popular of the overbraids, uses 300 series stainless steel and is available on virtually all standard SERV-RITE wire offerings. It is an economical method of extending the life of thermocouple and extension wire. Several of our standard wire items are available from stock with a stainless overbraid. Non-stock items are available on a special order basis.

Alloy 600 Wire Braid (N)

Most commonly specified on high temperature SERV-RITE wire yarn insulations, the Inconel braid offers a higher operating temperature than the series 300 stainless steel overbraid. When this braid is specified on SERV-RITE's Series 350 the performance of the material is only surpassed by metal-sheathed cables. Consult factory for availability on specific wire items.

Tinned Copper Wire Overbraid (C)

When there is a possibility of electrical interference in the area of the thermocouple installation, it may be necessary to shield the wire from electrical "noise." Several of our standard products use aluminized tapes as an intrinsic shield. However, when shielding is needed on other constructions, a tinned copper shield can be specified on special order.

Half Oval Galvanized Wrap and Stainless Steel Spiral Wrap (G) or (W)

Certain constructions are available with a spirally applied galvanized or stainless steel wrap. The wrap yields a tough mechanical coating that survives well in most outdoor applications. Consult factory for the availability on specific catalog items. To add a metallic overbraid or wrap, insert the letter designator as follows:

How to Select Wire

Code Number

1. ASTM E 230 Calibration[Ⓛ]

B J S
C* K T
E N

2-3. B & S Gauge

14 to 36

4. Conductor Type/Tolerance[Ⓜ]

- 1 = Thermocouple grade, solid wire, standard tolerance
- 2 = Thermocouple grade, solid wire, special tolerance
- 3 = Thermocouple grade, stranded wire, standard tolerance
- 4 = Thermocouple grade, stranded wire, special tolerance
- 5 = Extension grade, solid wire, standard tolerance
- 6 = Extension grade, solid wire, special tolerance
- 7 = Extension grade, stranded wire, standard tolerance
- 8 = Extension grade, stranded wire, special tolerance

5. Metallic Overbraids (optional)

S = Stainless steel
N = Alloy 600
C = Tinned copper

6-8. Insulation Series

Refer to Insulation chart below.

9-11. Color Code

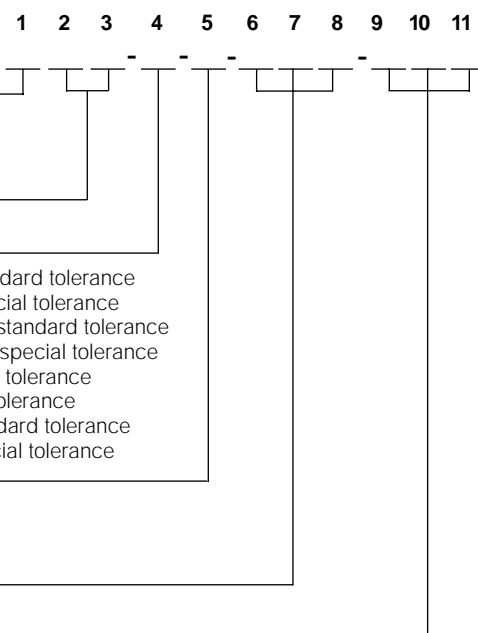
Blank = ASTM E 230 (formally ANSI MC96.1)
BSC = BS 1843
DIN = DIN 43710
JIS = JIS C 1610-1981
IEC = IEC 584-3

*Not an ASTM E 230 symbol.

[Ⓛ] Color coding will be to ASTM E 230 standards, unless specified.

[Ⓜ] Stranded conductors will be seven strand constructions. Consult factory for other configurations.

Note: Product normally shipped in 1,000 foot spools. However, random lengths may be shipped, if not specified. Consult factory for special packaging.



SERV-RITE Wire and Cable

Made-to-order

If you are unable to locate the stock SERV-RITE wire product that meets your unique application, Watlow Gordon can manufacture the exact wire product that does. With short lead times, Watlow Gordon can make-to-order any combination of wire type and insulation with metallic

overbraids, wraps or shielding, in designated standards. Simply review "How to Order," at the end of this section, define your requirements and call your Watlow representative to place your order and confirm specifications.

SERV-RITE Wire and Cable

Thermocouple and Thermocouple Extension Wire

Technical Data

Construction and Characteristics

The following table lists the available SERV-RITE wire insulation series for thermocouple and extension wire. Further construction and characteristic explanations are contained in the pages referenced in the extreme right column of this table.

Temperature Rating [®]		Series	Single Conductor		Duplex Conductors		ASTM Color Coded	Physical Properties			Notes	Page No.
Continuous Reading	Single Reading		Insulation	Impregnation	Insulation	Impregnation		Abrasion Resistance	Moisture Resistance	Chemical Resistance		
Thermocouple and Thermocouple Extension Wire Constructions												
190°F (88°C)	190°F (80°C)	308- 002	Double Cotton Wrap	—	Twisted, with Double Cotton Braid	Light Lacquer Coating	Yes	Fair	Fair	Poor		NA
220°F (105°C)	220°F (105°C)	502 or 502/UL	PVC	—	PVC	—	Yes	Good	Excellent	Good		195, 210
220°F (105°C)	220°F (105°C)	503	PVC	—	PVC Twisted W/Cotton	—	Yes	Good	Excellent	Good		NA
220°F (105°C)	220°F (105°C)	505	PVC	—	Ripcord	—	Yes	Good	Excellent	Good		197
220°F (105°C)	220°F (105°C)	510 or 510/UL	PVC	—	PVC Twisted	—	Yes	Good	Excellent	Good	Aluminum/ Polyester shield with Drain Wire	202, 212
220°F (105°C)	220°F (105°C)	900 or 900/UL	PVC	—	PVC Twisted/ Cabled	—	Yes	Good	Excellent	Good	Aluminum/ Polyester shield with Drain Wire	208, 213
220°F (105°C)	220°F (105°C)	1000 or 1000/UL	PVC	—	PVC Twisted/ Cabled	—	Yes	Good	Excellent	Good	Aluminum/ Polyester shield with Drain Wire [®]	209, 214
300°F (150°C)	300°F (150°C)	504	Nylon	—	Nylon	—	Yes	Excellent	Fair	Good	Overall Jacket is clear	196
300°F (150°C)	390°F (200°C)	514	Tefzel [®]	—	Tefzel [®]	—	Yes	Excellent	Excellent	Excellent		206
300°F (150°C)	390°F (200°C)	515	Tefzel [®]	—	Tefzel [®] Twisted	—	Yes	Excellent	Excellent	Excellent	Aluminum/ Polyester shield with Drain Wire	NA
400°F (204°C)	500°F (260°C)	506	FEP Extr.	—	FEP Extr.	—	Yes	Excellent	Excellent	Excellent		198
400°F (204°C)	500°F (260°C)	507 or 507/UL	FEP Extr.	—	FEP Extr.	—	Yes	Excellent	Excellent	Excellent		199, NA

CONTINUED

Tefzel[®] is a registered trademark of E.I. du Pont de Nemours & Company.

SERV-RITE Wire and Cable

Thermocouple and Thermocouple Extension Wire

Technical Data

Construction and Characteristics

Continued

Temperature Rating [®]		Series	Single Conductor		Duplex Conductors		ASTM Color Coded	Physical Properties			Notes	Page No.
Continuous	Single Reading		Insulation	Impregnation	Insulation	Impregnation		Abrasion Resistance	Moisture Resistance	Chemical Resistance		
Thermocouple and Thermocouple Extension Wire Constructions Continued												
400°F (204°C)	500°F (260°C)	509 or 509/UL	FEP Extr.	—	FEP Extr. Twisted	—	Yes	Excellent	Excellent	Excellent	Aluminum/Polyester shield with Drain Wire	201, 211
400°F (204°C)	500°F (260°C)	1900	FEP Extr.	—	FEP Extr. Twisted/Cabled	—	Yes	Excellent	Excellent	Excellent	Aluminum/Polyester shield with Drain Wire	NA
400°F (204°C)	500°F (260°C)	2000	FEP Extr.	—	FEP Extr. Twisted/Cabled	—	Yes	Excellent	Excellent	Excellent	Aluminum/Polyester shield with Drain Wire [®]	NA
500°F (260°C)	600°F (315°C)	508	TFE Tape Fused	—	TFE Tape Fused	—	Yes	Good	Excellent	Excellent		200
500°F (260°C)	550°F (290°C)	516	PFA	—	PFA	—	Yes	Good	Excellent	Excellent		207
500°F (260°C)	550°F (290°C)	517	PFA	—	PFA Twisted	—	Yes	Good	Excellent	Excellent	Aluminum/Polyester shield with Drain Wire	NA
550°F (290°C)	650°F (340°C)	155	Glass Braid	Modified Resin	SERVTEX [®] Braid	Modified Resin	Yes	Good	Good	Good	Impregnation retained to 400°F (204°C)	184
550°F (290°C)	650°F (340°C)	157	TFE Tape (not fused) Glass Braid	Modified Resin	SERVTEX Braid	Modified Resin	Yes	Good	Good	Good	Impregnation retained to 400°F (204°C); TFE good to 500°F (260°C)	185
600°F (315°C)	800°F (430°C)	511	Fused Polyimide Tape	—	None Twisted	—	Both legs have tracer	Excellent	Excellent	Excellent	FEP binder melts at approx. 500°F (260°C)	203

SERV-RITE Wire and Cable

CONTINUED

SERV-RITE Wire and Cable

Thermocouple and Thermocouple Extension Wire

Technical Data

Construction and Characteristics

Continued

Temperature Rating [®]		Series	Single Conductor		Duplex Conductors		ASTM Color Coded	Physical Properties			Notes	Page No.
Continuous	Single Reading		Insulation	Impregnation	Insulation	Impregnation		Abrasion Resistance	Moisture Resistance	Chemical Resistance		
Thermocouple and Thermocouple Extension Wire Constructions Continued												
600°F (315°C)	800°F (430°C)	512	Fused Polyimide Tape	—	Fused Polyimide Tape	—	Both legs have tracer	Excellent	Excellent	Excellent	FEP binder melts at approx. 500°F (260°C)	204
600°F (315°C)	800°F (430°C)	513	Fused Polyimide Tape	—	Fused Polyimide Tape	—	Yes	Excellent	Excellent	Excellent	FEP binder melts at approx. 500°F (260°C)	205
900°F (480°C)	1000°F (540°C)	302	Double Glass Braid	Modified Resin	Glass Braid	Modified Resin	Yes	Good	Good	Good	Impregnation retained to 400°F (204°C)	187
900°F (480°C)	1000°F (540°C)	303	Enameled Conductors/ Glass Braid	Modified Resin	Glass Braid	Modified Resin	Yes	Fair	Good	Good	Impregnation retained to 400°F (204°C)	NA
900°F (480°C)	1000°F (540°C)	304	Glass Braid	Modified Resin	Glass Braid	Modified Resin	Yes	Fair	Good	Good	Impregnation retained to 400°F (204°C)	188
900°F (480°C)	1000°F (540°C)	305	Double Glass Wrap	Modified Resin	Glass Braid	Modified Resin	Yes	Fair	Good	Good	Impregnation retained to 400°F (204°C)	189
900°F (480°C)	1000°F (540°C)	306	Glass Braid	—	Glass Braid	—	No	Fair	Fair	Good		NA
900°F (480°C)	1000°F (540°C)	307	TFE Tape (not fused) TFE coated glass	—	TFE Coated Glass Braid	—	Yes	Good	Excellent	Excellent	TFE good to 500°F (260°C)	190
900°F (480°C)	1000°F (540°C)	313	Glass Braid	Modified Resin	Glass Braid	Modified Resin	Yes	Good	Good	Good	Impregnation retained to 400°F (204°C)	191

CONTINUED

SERV-RITE Wire and Cable

Thermocouple and Thermocouple Extension Wire

Technical Data

Construction and Characteristics

Continued

Temperature Rating ^①		Series	Single Conductor		Duplex Conductors		ASTM Color Coded	Physical Properties			Notes	Page No.
Continuous	Single Reading		Insulation	Impregnation	Insulation	Impregnation		Abrasion Resistance	Moisture Resistance	Chemical Resistance		
Thermocouple and Thermocouple Extension Wire Constructions Continued												
900°F (480°C)	1000°F (540°C)	315	Glass Braid	Modified Resin	Twisted	—	Yes	Good	Good	Good	Impregnation retained to 400°F (204°C)	NA
1300°F (705°C)	1600°F (870°C)	309	High Temp. Glass Braid	—	High Temp. Glass Braid	Modified Resin	Both legs have tracer	Good	Fair	Good	Impregnation retained to 400°F (204°C)	NA
1300°F (705°C)	1600°F (870°C)	311	High Temp. Glass Braid	—	High Temp. Glass Braid	Modified Resin	No	Fair	Fair	Good	Coating retained to 300°F (149°C)	NA
1300°F (705°C)	1600°F (870°C)	314	High Temp. Glass Braid	Modified Resin	Twisted	—	Yes	Good	Good	Good	Impregnation retained to 400°F (204°C)	192
1300°F (705°C)	1600°F (870°C)	321	High Temp. Glass Braid	Modified Resin	High Temp. Glass Braid	Modified Resin	Yes	Good	Good	Good	Impregnation retained to 400°F (204°C)	193
1800°F (980°C)	2000°F (1095°C)	301	Vitreous Silica Fiber	—	Vitreous Silica Fiber	—	No	Fair	Fair	Good		186
1800°F (980°C)	2000°F (1095°C)	365	Vitreous Silica Fiber	—	Vitreous Silica Fiber	—	No	Fair	Fair	Good		NA
2200°F (1205°C)	2600°F (1430°C)	350	Ceramic Fiber	—	Ceramic Fiber	—	No	Good	Fair	Good		194
2200°F (1205°C)	2600°F (1430°C)	355	Ceramic Fiber	—	Ceramic Fiber	—	No	Good	Fair	Good		NA
RTD Leadwire Constructions												
220°F (105°C)	220°F (105°C)	701	PVC	—	PVC	—	Yes**	Good	Excellent	Good	RTD Leadwire	215
400°F (204°C)	500°F (260°C)	704	FEP Extr.	—	FEP Extr. Twisted	—	Yes**	Excellent	Excellent	Excellent	RTD Leadwire	216
900°F (480°C)	1000°F (540°C)	705	Glass Braid	Modified Resin	Glass Braid	Modified Resin	Yes**	Fair	Good	Good	RTD Leadwire	217

①Thermocouple extension grade wire is only calibrated up to 400°F (204°C).

②Individual and overall

**Not an ASTM E 230 color code.

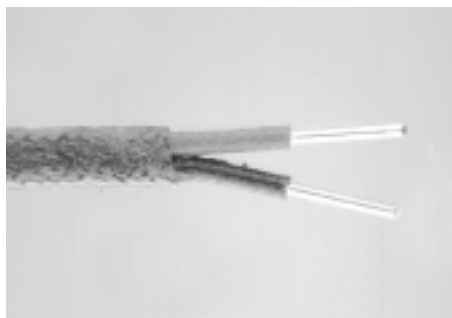
**STOCKED FOR
SAME DAY
SHIPMENT**

- K16/5/155
- K16/7/155

SERV-RITE Wire and Cable

SERVTEX Insulated Extension Wire

Series 155



Temp.	Resistance Properties		
	Moisture	Chemical	Abrasion
550°F (290°C)	Good	Good	Good

The Series 155 is a tough wire especially suited to applications involving momentary contact with molten metals.

Conductors are insulated with braided fiberglass and then impregnated with a resin. Insulated conductors are then laid parallel and a SERVTEX braid is woven over them and a final impregnation is applied.

Construction Combinations

1. ASTM E 230 Calibrations

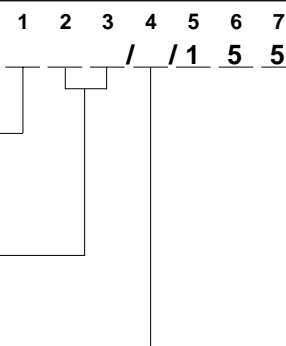
E N
J S
K T

2-3. B & S Gauge

20 16 14
20 stranded (7/28) 16 stranded (7/24) 14 stranded (7/22)

4. Conductor Type/Tolerance

5 = Extension grade, solid wire, standard tolerance
6 = Extension grade, solid wire, special tolerance
7 = Extension grade, stranded wire, standard tolerance
8 = Extension grade, stranded wire, special tolerance



Performance Capabilities

- Continuous temperature rating: 550°F (290°C)
- Single reading: 650°F (340°C)

Features and Benefits

- **Braided fiberglass single conductor insulation** impregnated for moisture resistance.
- **SERVTEX braid duplex insulation** for superior abrasion resistance.
- **Impregnation retained to 400°F (204°C).**
- **ASTM E 230 color code** for easy identification.

- **Good abrasion and chemical resistance, good moisture resistance.**
- **Additional abrasion resistance** with optional stainless steel, tinned copper and alloy 600 wire overbraids, or flat stainless steel spiral and half oval galvanized steel spiral wraps.
- **Custom constructions available, consult factory.**

Applications

- Heat treating
- Steel and aluminum plants
- Glass, ceramic and brick manufacturing

Wire Specifications

B & S Gauge	Nominal Conductor Size inches (mm)		Nominal Insulation Thickness		Nominal Overall Size inches (mm)		Approximate Shipping Weight lbs/1000 ft (kg/km)	
			Conductor inches (mm)	Overall inches (mm)				
20	0.032	(0.813)	0.015 (0.381)	0.030 (0.762)	0.136 X 0.178	(3.45 X 4.52)	15	(22.4)
20 S* (7/28)	0.038	(0.965)	0.015 (0.381)	0.030 (0.762)	0.144 X 0.196	(3.66 X 4.98)	16	(23.8)
16	0.051	(1.290)	0.015 (0.381)	0.030 (0.762)	0.158 X 0.226	(4.01 X 5.74)	29	(43.2)
16 S* (7/24)	0.060	(1.524)	0.015 (0.381)	0.030 (0.762)	0.170 X 0.244	(4.32 X 6.20)	31	(46.2)
14	0.064	(1.628)	0.015 (0.381)	0.030 (0.762)	0.180 X 0.252	(4.57 X 6.40)	40	(59.6)
14 S* (7/22)	0.076	(1.930)	0.015 (0.381)	0.030 (0.762)	0.205 X 0.270	(5.21 X 6.86)	46	(68.5)

*"S" denotes stranded wire: e.g., "20 S (7/28)" is seven strands of 28 gauge wire to make a 20 gauge stranded conductor.

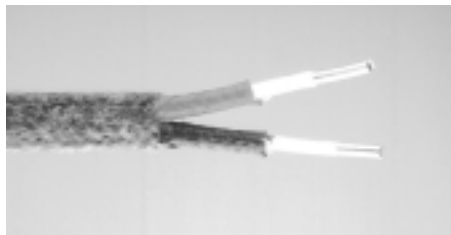


- K16/5/157
- S16/5/157

SERV-RITE Wire and Cable

SERVTEX and TFE Tape Extension Wire

Series 157



Temp.	Resistance Properties		
	Moisture	Chemical	Abrasion
550°F (290°C)	Good	Good	Good

The Series 157 is an improved version of Series 155. The Series 157 uses tape over the conductors to improve moisture resistance.

The Series 157 conductors are first wrapped with a TFE tape, braided with fiberglass, and then impregnated with a resin. The insulated single conductors are then laid parallel and braided with SERVTEX yarn. The final coat is a resin impregnation.

The excellent abrasion resistance of the Series 157 can be further improved by the addition of metallic braids or wraps.

Construction Combinations

1. ASTM E 230 Calibrations

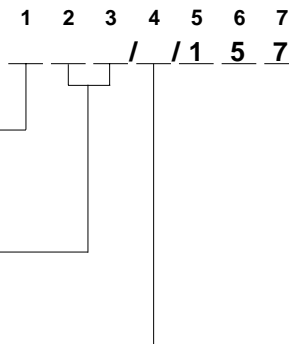
E N
J S
K T

2-3. B & S Gauge

20 16 14
20 stranded (7/28) 16 stranded (7/24) 14 stranded (7/22)

4. Conductor Type/Tolerance

- 5 = Extension grade, solid wire, standard tolerance
- 6 = Extension grade, solid wire, special tolerance
- 7 = Extension grade, stranded wire, standard tolerance
- 8 = Extension grade, stranded wire, special tolerance



Performance Capabilities

- Continuous temperature rating: 550°F (290°C)
- Single reading: 650°F (340°C)

Features and Benefits

- **Non-fused TFE tape and braided fiberglass single conductor insulation** impregnated with modified resin to provide moisture resistance.
- **SERVTEX braid duplex insulation** impregnated for additional moisture resistance.
- **Impregnation retained to 400°F (204°C), TFE good to 500°F (260°C).**
- **ASTM E 230 color code** for easy identification.
- **Good abrasion, moisture and chemical resistance.**

- **Additional abrasion resistance** with optional stainless steel, tinned copper and alloy 600 wire overbraids, or flat stainless steel spiral and half oval galvanized steel spiral wraps.
- **Custom constructions available, consult factory.**

Applications

- Heat treating
- Steel and aluminum plants
- Glass, ceramic and brick manufacturing

Wire Specifications

B & S Gauge	Nominal Conductor Size inches (mm)		Nominal Insulation Thickness		Nominal Overall Size inches (mm)		Approximate Shipping Weight lbs/1000 ft (kg/km)	
			Conductor inches (mm)	Overall inches (mm)				
20	0.032	(0.813)	0.020 (0.508)	0.030 (0.762)	0.146 X 0.192 (3.71 X 4.87)	16	(23.8)	
20 S* (7/28)	0.038	(0.965)	0.020 (0.508)	0.030 (0.762)	0.154 X 0.210 (3.91 X 5.33)	17	(25.3)	
16	0.051	(1.290)	0.020 (0.508)	0.030 (0.762)	0.168 X 0.240 (4.27 X 6.10)	30	(44.7)	
16 S* (7/24)	0.060	(1.524)	0.020 (0.508)	0.030 (0.762)	0.180 X 0.258 (4.57 X 6.55)	32	(47.7)	
14	0.064	(1.628)	0.020 (0.508)	0.030 (0.762)	0.019 X 0.266 (4.83 X 6.76)	42	(62.6)	
14 S (7/22)	0.076	(1.930)	0.025 (0.508)	0.030 (0.762)	0.225 X 0.302 (5.72 X 7.67)	48	(71.5)	

* "S" denotes stranded wire: e.g., "20 S (7/28)" is seven strands of 28 gauge wire to make a 20 gauge stranded conductor.



- K20/1/301
- K20/2/301

SERV-RITE Wire and Cable

High Temperature Vitreous Silica Braided Thermocouple Wire

Series 301



Temp.	Resistance Properties		
	Moisture	Chemical	Abrasion
1800°F (980°C)	Fair	Good	Fair

Series 301 uses vitreous silica yarn as the insulation on both the conductors and duplex. This yarn retains its flexibility after exposure to high temperatures.

The vitreous silica yarn's greater purity performs better at high temperatures than other fibrous glass products. Testing has indicated that "contamination" will compromise this material's upper use temperature. For this reason, our standard offering is supplied without color coding or impregnations.

For higher temperatures consider Series 350.

Construction Combinations



Performance Capabilities

- Continuous temperature rating: 1800°F (980°C)
- Single reading: 2000°F (1095°C)

Features and Benefits

- **Braided vitreous silica yarn* single conductor and duplex insulation** provides high temperature performance.
- **Good chemical resistance, fair abrasion and moisture resistance.**

- **Additional abrasion resistance** with optional stainless steel and alloy 600 wire overbraids.
- **Custom constructions available, consult factory.**

Applications

- Furnace survey work
- Heat treating load thermocouples

Wire Specifications

B & S Gauge	Nominal Conductor Size inches (mm)		Nominal Insulation Thickness		Nominal Overall Size inches (mm)		Approximate Shipping Weight lbs/1000 ft (kg/km)	
			Conductor inches (mm)	Overall inches (mm)				
20	0.032	(0.813)	0.018 (0.457)	0.015 (0.381)	0.098 X 0.154	(2.49 X 3.91)	15	(22.4)
18	0.040	(1.020)	0.018 (0.457)	0.015 (0.381)	0.110 X 0.180	(2.79 X 4.57)	19	(28.3)
16	0.051	(1.290)	0.016 (0.406)	0.015 (0.381)	0.118 X 0.198	(3.00 X 5.03)	25	(37.3)

* Lack of binders or impregnations may cause insulation to "flower" when stripped.

SERV-RITE Wire and Cable

Fiberglass Double Braided Thermocouple and Extension Wire

Series 302



Temp.	Resistance Properties		
	Moisture	Chemical	Abrasion
900°F (480°C)	Good	Good	Good

Series 302 is a heavy duty version of the popular Series 304. The construction uses a double fibrous glass braid over each single conductor. These double insulated single conductors are then laid parallel and covered with a braided glass. Each braid is impregnated to add abrasion resistance and minimize fraying of the fibrous glass. Due to additional layers of glass, this Series can be expected to survive longer and at higher temperatures than its single braided counterparts. For higher temperature applications consider Series 321.

Construction Combinations

1. ASTM E 230 Calibrations

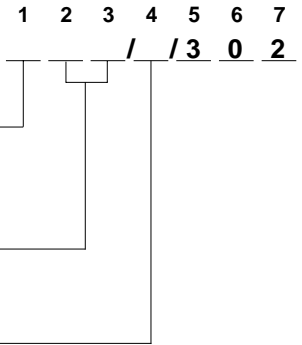
E N
J S
K T

2-3. B & S Gauge

24 20
24 stranded (7/32) 20 stranded (7/28)

4. Conductor Type/Tolerance

- 1 = Thermocouple grade, solid wire, standard tolerances
- 2 = Thermocouple grade, solid wire, special tolerances
- 3 = Thermocouple grade, stranded wire, standard tolerances
- 4 = Thermocouple grade, stranded wire, special tolerances
- 5 = Extension grade, solid wire, standard tolerance
- 6 = Extension grade, solid wire, special tolerance
- 7 = Extension grade, stranded wire, standard tolerance
- 8 = Extension grade, stranded wire, special tolerance



Performance Capabilities

- Continuous temperature rating: 900°F (480°C)
- Single reading: 1000°F (540°C)

Features and Benefits

- **Double fiberglass braid single conductor insulation** impregnated with modified resin to provide abrasion resistance.
- **Fiberglass braid duplex insulation** impregnated with modified resin for added abrasion resistance.
- **Impregnation retained to 400°F (204°C).**
- **ASTM E 230 color code** for easy identification.

- **Good abrasion, moisture and chemical resistance.**
- **Additional abrasion resistance** with optional stainless steel, tinned copper and alloy 600 wire overbraids.
- **Custom constructions available, consult factory.**

Applications

- Steel and aluminum plants
- Heat treating
- Foundries
- Glass, ceramic and brick plants
- Plastic processing equipment

Wire Specifications

B & S Gauge	Nominal Conductor Size inches (mm)		Nominal Insulation Thickness		Nominal Overall Size inches (mm)		Approximate Shipping Weight lbs/1000 ft (kg/km)	
			Conductor inches (mm)	Overall inches (mm)				
24	0.020	(0.508)	0.008 (0.203)	0.006 (0.152)	0.048 X 0.084 (1.22 X 2.13)	7	(10.4)	
24 S* (7/32)	0.024	(0.610)	0.008 (0.203)	0.006 (0.152)	0.054 X 0.094 (1.37 X 2.39)	7	(10.4)	
20	0.032	(0.813)	0.008 (0.203)	0.006 (0.152)	0.060 X 0.108 (1.52 X 2.74)	10	(14.9)	
20 S* (7/28)	0.038	(0.965)	0.008 (0.203)	0.006 (0.152)	0.068 X 0.122 (1.73 X 3.10)	10	(14.9)	

* "S" denotes stranded wire: e.g., "24 S (7/32)" is seven strands of 32 gauge wire to make a 24 gauge stranded conductor.

SERV-RITE Wire and Cable



- B20/5/304
- J24/1/304
- K24/1/304
- C24/5/304
- J24/2/304
- K24/2/304
- E20/1/304
- J24/3/304
- K24/3/304
- J20/1/304
- K20/1/304
- S24/5/304
- J20/2/304
- K20/2/304
- T20/1/304
- J20/3/304
- K20/3/304
- T24/1/304
- J20/1/S/304
- K20/1/S/304
- J20/3/S/304
- K20/3/S/304

Fiberglass Braided Thermocouple and Extension Wire

Series 304



Temp.	Resistance Properties		
	Moisture	Chemical	Abrasion
900°F (480°C)	Good	Good	Fair

The uniform quality and availability of the Series 304 make it the ideal wire for general applications requiring moderate abrasion and moisture resistance, wide temperature capabilities and economy.

Each conductor is covered with a color coded glass braid. This braid is impregnated to enhance abrasion resistance and reduce fraying. The insulated single conductors are laid parallel and covered with another layer of woven glass. A final impregnation is then applied to the glass.

For better moisture resistance, consider Series 307. For higher temperatures, consider Series 321. For better abrasion resistance, use Series 302 or choose an item with a stainless steel overbraid.

Construction Combinations

1. ASTM E 230 Calibrations

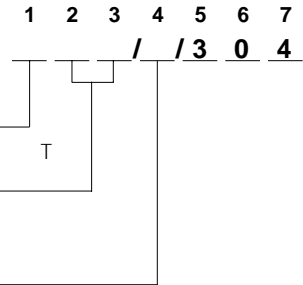
B C E J K N S T

2-3. B & S Gauge

30 24 20
28 24 stranded (7/32) 20 stranded (7/28)

4. Conductor Type/Tolerance

- 1 = Thermocouple grade, solid wire, standard tolerances
- 2 = Thermocouple grade, solid wire, special tolerances
- 3 = Thermocouple grade, stranded wire, standard tolerances
- 4 = Thermocouple grade, stranded wire, special tolerances
- 5 = Extension grade, solid wire, standard tolerance
- 6 = Extension grade, solid wire, special tolerance
- 7 = Extension grade, stranded wire, standard tolerance
- 8 = Extension grade, stranded wire, special tolerance



Performance Capabilities

- Continuous temperature rating: 900°F (480°C)
- Single reading: 1000°F (540°C)

Features and Benefits

- **Fiberglass braided single conductor and duplex insulation** impregnated with modified resin to enhance abrasion resistance.
- **Impregnation retained to 400°F (204°C).**
- **ASTM E 230 color code** for easy identification.
- **Good moisture and chemical resistance, fair abrasion resistance.**

- **Additional abrasion resistance** with optional stainless steel, tinned copper and alloy 600 wire overbraids, or flat stainless steel spiral wrap.
- **Custom constructions available, consult factory.**

Applications

- Steel and aluminum plants
- Heat treating
- Foundries
- Glass, ceramic and brick plants

Wire Specifications

B & S Gauge	Nominal Conductor Size inches (mm)	Nominal Insulation Thickness		Nominal Overall Size inches (mm)	Approximate Shipping Weight lbs/1000 ft (kg/km)
		Conductor inches (mm)	Overall inches (mm)		
30	0.010 (0.254)	0.007 (0.178)	0.008 (0.203)	0.043 X 0.064 (1.09 X 1.63)	3 (4.5)
28	0.013 (0.320)	0.007 (0.178)	0.008 (0.203)	0.043 X 0.070 (1.09 X 1.78)	3 (4.5)
24	0.020 (0.508)	0.005 (0.127)	0.006 (0.152)	0.045 X 0.072 (1.14 X 1.83)	7 (10.4)
24 S* (7/32)	0.024 (0.610)	0.005 (0.127)	0.006 (0.152)	0.048 X 0.080 (1.22 X 2.03)	8 (11.9)
20	0.032 (0.813)	0.005 (0.127)	0.006 (0.152)	0.056 X 0.096 (1.42 X 2.44)	9 (13.4)
20 S* (7/28)	0.038 (0.965)	0.006 (0.152)	0.006 (0.152)	0.064 X 0.112 (1.63 X 2.84)	10 (14.9)

* "S" denotes stranded wire: e.g., "24 S (7/32)" is seven strands of 32 gauge wire to make a 24 gauge stranded conductor.



- J28/1/305
- J28/2/305
- J30/1/305
- J30/2/305
- K28/2/305
- K30/1/305
- K30/2/305

SERV-RITE Wire and Cable

Fiberglass Wrapped Thermocouple and Extension Wire

Series 305



Temp.	Resistance Properties		
	Moisture	Chemical	Abrasion
900°F (480°C)	Good	Good	Fair

Series 305 is specifically constructed for light duty applications where size is a critical factor. The single conductors are insulated using a specialized yarn wrapped on the conductors in layers. This yarn is then impregnated to add abrasion resistance and enhance electrical properties. The insulated single conductors are then laid parallel and covered with a layer of braided glass. A final impregnation is applied to the braid.

For higher temperature applications, use Series 321.

For applications where resistance to abrasion is important, consider Series 302 or choose an item with a stainless steel overbraid.

Construction Combinations

1. ASTM E 230 Calibrations

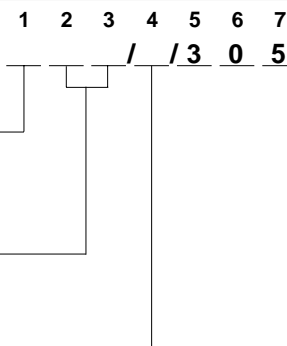
B	J	S
C	K	T
E	N	

2-3. B & S Gauge

30	24	20
28	24 stranded (7/32)	20 stranded (7/28)

4. Conductor Type/Tolerance

- 1 = Thermocouple grade, solid wire, standard tolerances
- 2 = Thermocouple grade, solid wire, special tolerances
- 3 = Thermocouple grade, stranded wire, standard tolerances
- 4 = Thermocouple grade, stranded wire, special tolerances
- 5 = Extension grade, solid wire, standard tolerance
- 6 = Extension grade, solid wire, special tolerance
- 7 = Extension grade, stranded wire, standard tolerance
- 8 = Extension grade, stranded wire, special tolerance



Performance Capabilities

- Continuous temperature rating: 900°F (480°C)
- Single reading: 1000°F (540°C)

Features and Benefits

- **Double fiberglass wrap single conductor insulation**, impregnated with modified resin to add abrasion resistance and enhance electrical properties.
- **Fiberglass braided duplex insulation** impregnated with modified resin to enhance abrasion resistance.
- **Impregnation retained to 400°F (204°C).**
- **ASTM E 230 color code** for easy identification.

- **Good chemical and moisture resistance, fair abrasion resistance.**
- **Additional abrasion resistance** with optional stainless steel, tinned copper and alloy 600 wire overbraids, or flat stainless steel spiral wrap.
- **Custom constructions available, consult factory.**

Applications

- Steel and aluminum plants
- Heat treating
- Foundries
- Glass, ceramic and brick plants

Wire Specifications

B & S Gauge	Nominal Conductor Size inches (mm)		Nominal Insulation Thickness		Nominal Overall Size inches (mm)		Approximate Shipping Weight lbs/1000 ft (kg/km)	
			Conductor inches (mm)	Overall inches (mm)				
30	0.010	(0.254)	0.005 (0.127)	0.008 (0.203)	0.036 X 0.056	(0.914 X 1.42)	3	(4.5)
28	0.013	(0.320)	0.005 (0.127)	0.008 (0.203)	0.040 X 0.062	(1.02 X 1.57)	3	(4.5)
24	0.020	(0.508)	0.005 (0.127)	0.006 (0.152)	0.042 X 0.072	(1.07 X 1.83)	7	(10.4)
24 S* (7/32)	0.024	(0.610)	0.005 (0.127)	0.006 (0.152)	0.048 X 0.080	(1.22 X 2.03)	8	(11.9)
20	0.032	(0.813)	0.005 (0.127)	0.006 (0.152)	0.054 X 0.096	(1.37 X 2.44)	9	(13.4)
20 S* (7/28)	0.038	(0.965)	0.005 (0.127)	0.006 (0.152)	0.060 X 0.108	(1.52 X 2.74)	10	(14.9)

* "S" denotes stranded wire: e.g., "24 S (7/32)" is seven strands of 32 gauge wire to make a 24 gauge stranded conductor.

SERV-RITE Wire and Cable

TFE Fiberglass with TFE Tape Thermocouple and Extension Wire Series 307



Temp.	Resistance Properties		
	Moisture	Chemical	Abrasion
900°F (480°C)	Excellent	Excellent	Good

Series 307 is designed for applications where a possibility of moisture along the unheated portion exists. While fiberglass has little moisture resistance, the use of TFE tape on the conductors provides moisture protection—even after short term exposure to temperatures of 600°F (315°C).

The Series 307 is constructed by first wrapping each conductor with TFE tape. Each taped conductor is then braided with TFE impregnated fiberglass. The two insulated conductors are then laid parallel and braided again with TFE impregnated fiberglass. The final operation involves heating the entire construction to fuse the insulations.

When your application involves higher temperatures, specify Series 314 or 321.

Construction Combinations

1. ASTM E 230 Calibrations

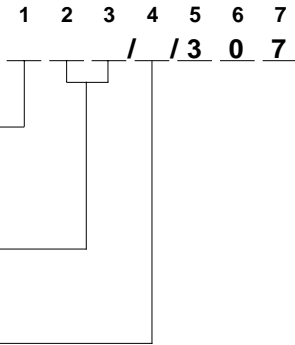
E N
J S
K T

2-3. B & S Gauge

24 16
20

4. Conductor Type/Tolerance

- 1 = Thermocouple grade, solid wire, standard tolerances
2 = Thermocouple grade, solid wire, special tolerances
3 = Thermocouple grade, stranded wire, standard tolerances
4 = Thermocouple grade, stranded wire, special tolerances
5 = Extension grade, solid wire, standard tolerance
6 = Extension grade, solid wire, special tolerance
7 = Extension grade, stranded wire, standard tolerance
8 = Extension grade, stranded wire, special tolerance



Performance Capabilities

- Continuous fiberglass temperature rating: 900°F (480°C)
- Continuous TFE temperature rating: 500°F (260°C)
- Single reading: 1000°F (540°C)

Features and Benefits

- **Non-fused TFE tape and TFE coated fiberglass single conductor insulation** provides excellent moisture and chemical resistance.
- **TFE coated fiberglass braid duplex insulation** adds to moisture and chemical resistance.
- **TFE retained to 600°F (315°C).**
- **ASTM E 230 color code** for easy identification.

- **Excellent moisture and chemical resistance, good abrasion resistance.**
- **Additional abrasion resistance with optional stainless steel, tinned copper and alloy 600 wire overbraids, or flat stainless steel wrap.**
- **Custom constructions available, consult factory.**

Applications

- Steel and aluminum plants
- Heat treating
- Foundries
- Glass, ceramic and brick plants

Wire Specifications

B & S Gauge	Nominal Conductor Size inches (mm)		Nominal Insulation Thickness		Nominal Overall Size inches (mm)		Approximate Shipping Weight lbs/1000 ft (kg/km)	
			Conductor inches (mm)	Overall inches (mm)				
24	0.020	(0.508)	0.012 (0.305)	0.006 (0.152)	0.060 X 0.096	(1.52 X 2.44)	9	(13.4)
20	0.032	(0.813)	0.012 (0.305)	0.006 (0.152)	0.072 X 0.118	(1.83 X 3.00)	12	(17.9)
16	0.051	(1.290)	0.012 (0.305)	0.006 (0.152)	0.085 X 0.158	(2.16 X 4.01)	24	(35.8)



- J16/5/313
- K16/5/313

SERV-RITE Wire and Cable

Heavy Duty Fiberglass Braided Thermocouple and Extension Wire

Series 313



Temp.	Resistance Properties		
	Moisture	Chemical	Abrasion
900°F (480°C)	Good	Good	Good

Series 313 is designed to replace the popular Series 304 in applications requiring a tougher construction. The Series 313 uses a heavier duty fiberglass yarn than the Series 304. The additional yarn enhances abrasion resistance and cut-through resistance.

Each thermoelement is insulated with braided fiberglass and impregnated to improve abrasion resistance. The insulated single conductors are laid parallel and again braided with fiberglass. Finally, another layer of abrasion resistant impregnation is applied to the construction.

For higher temperatures, consider Series 314 or 321.

For better abrasion resistance, specify Series 302 or consider a metallic overbraid.

Construction Combinations

1. ASTM E 230 Calibrations

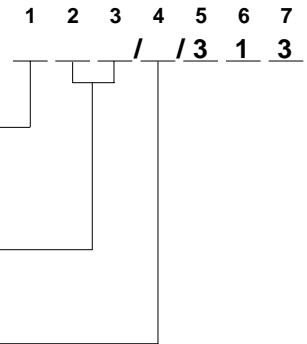
E	N
J	S
K	T

2-3. B & S Gauge

20	18	16
20 stranded (7/28)	18 stranded (7/26)	16 stranded (7/24)

4. Conductor Type/Tolerance

- 1 = Thermocouple grade, solid wire, standard tolerances
- 2 = Thermocouple grade, solid wire, special tolerances
- 3 = Thermocouple grade, stranded wire, standard tolerances
- 4 = Thermocouple grade, stranded wire, special tolerances
- 5 = Extension grade, solid wire, standard tolerance
- 6 = Extension grade, solid wire, special tolerance
- 7 = Extension grade, stranded wire, standard tolerance
- 8 = Extension grade, stranded wire, special tolerance



Performance Capabilities

- Continuous temperature rating: 900°F (480°C)
- Single reading: 1000°F (540°C)

Features and Benefits

- **Thick fiberglass braid single conductor and duplex insulation** impregnated with modified resin for added abrasion resistance.
- **Impregnation retained to 400°F (204°C).**
- **ASTM E 230 color code** for easy identification.
- **Good abrasion, moisture and chemical resistance.**

- **Additional abrasion resistance** with optional stainless steel, tinned copper and alloy 600 wire overbraids, or flat stainless steel spiral wrap.
- **Custom constructions available, consult factory.**

Applications

- Steel and aluminum plants
- Heat treating
- Foundries
- Glass, ceramic and brick plants

Wire Specifications

B & S Gauge	Nominal Conductor Size		Nominal Insulation Thickness		Nominal Overall Size		Approximate Shipping Weight	
			Conductor	Overall				
	inches	(mm)	inches (mm)	inches (mm)	inches	(mm)	lbs/1000 ft	(kg/km)
20	0.032	(0.813)	0.010 (0.254)	0.010 (0.254)	0.074 X 0.124	(1.88 X 3.15)	12	(17.9)
20 S* (7/28)	0.038	(0.965)	0.010 (0.254)	0.010 (0.254)	0.080 X 0.136	(2.03 X 3.45)	13	(19.4)
18	0.040	(1.02)	0.010 (0.254)	0.010 (0.254)	0.082 X 0.140	(2.08 X 3.56)	16	(23.8)
18 S* (7/26)	0.048	(1.22)	0.010 (0.254)	0.010 (0.254)	0.090 X 0.156	(2.29 X 3.96)	17	(25.3)
16	0.051	(1.29)	0.010 (0.254)	0.010 (0.254)	0.093 X 0.162	(2.36 X 4.11)	22	(32.8)
16 S* (7/24)	0.060	(1.52)	0.010 (0.254)	0.010 (0.254)	0.102 X 0.180	(2.59 X 4.57)	24	(35.8)

* "S" denotes stranded wire: e.g., "20 S (7/28)" is seven strands of 28 gauge wire to make a 20 gauge stranded conductor.



- J20/2/314
- K20/2/314

SERV-RITE Wire and Cable

High Temperature Fiberglass Twisted Thermocouple and Extension Wire

Series 314



Temp.	Resistance Properties		
	Moisture	Chemical	Abrasion
1300°F (705°C)	Good	Good	Good

The Series 314 is an economical construction for general, high temperature applications. The braided high temperature yarn is applied in a unique manner that allows Series 314 to be competitively priced with other fiberglass constructions. It produces a finished wire that performs at temperatures to 1600°F (870°C).

The conductors are insulated with braided high strength fiberglass and impregnated to improve abrasion resistance. The impregnation is tinted to impart color coding to primary insulations. The insulated single conductors are then twisted together to yield a construction flexible enough for most any application.

Construction Combinations

1. ASTM E 230 Calibrations

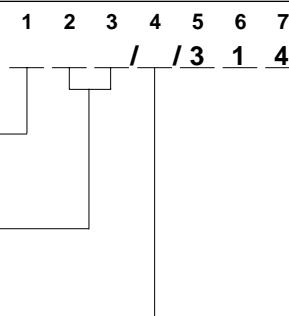
E K T
J N

2-3. B & S Gauge

24 18 14
20 16

4. Conductor Type/Tolerance

- 1 = Thermocouple grade, solid wire, standard tolerances
- 2 = Thermocouple grade, solid wire, special tolerances
- 3 = Thermocouple grade, stranded wire, standard tolerances
- 4 = Thermocouple grade, stranded wire, special tolerances
- 5 = Extension grade, solid wire, standard tolerance
- 6 = Extension grade, solid wire, special tolerance
- 7 = Extension grade, stranded wire, standard tolerance
- 8 = Extension grade, stranded wire, special tolerance



For better abrasion resistance, consider Series 321 or a metallic overbraid.

Consider Series 301 or 350 for higher temperatures.

Performance Capabilities

- Continuous temperature rating: 1300°F (705°C)
- Single reading: 1600°F (870°C)

Features and Benefits

- **High temperature fiberglass braid single conductor insulation** impregnated with modified resin for added abrasion resistance.
- **Impregnation retained to 400°F (204°C).**

- **Duplex construction via twisting single conductors.**
- **ASTM E 230 color code** for easy identification.
- **Good abrasion, moisture and chemical resistance.**
- **Additional abrasion resistance** with optional stainless steel, tinned copper and alloy 600 wire overbraids.
- **Custom constructions available, consult factory.**

Applications

- Heat treating load thermocouples
- Aluminum stress relieving
- Steel annealing

Wire Specifications

B & S Gauge	Nominal Conductor Size		Nominal Conductor Insulation Thickness		Nominal Overall Size		Approximate Shipping Weight	
	inches	(mm)	inches	(mm)	inches	(mm)	lbs/1000 ft	(kg/km)
24	0.020	(0.508)	0.015	(0.381)	0.100	(2.54)	6	(8.9)
20	0.032	(0.965)	0.015	(0.381)	0.124	(3.15)	10	(14.9)
18	0.040	(1.02)	0.018	(0.457)	0.152	(3.86)	16	(23.8)
16	0.051	(1.29)	0.018	(0.457)	0.174	(4.42)	21	(31.3)
14	0.064	(1.63)	0.018	(0.457)	0.200	(5.08)	32	(47.7)



- J20/1/321
- J20/2/321
- K20/1/321
- K20/2/321

SERV-RITE Wire and Cable

High Temperature Braided Fiberglass Thermocouple Wire

Series 321



Temp.	Resistance Properties		
	Moisture	Chemical	Abrasion
1300°F (705°C)	Good	Good	Good

The addition of color coding and impregnation to the high temperature fiberglass make this the logical next step for systems which have exceeded the temperature capabilities of standard glass insulated series.

Each conductor is covered with a color coded high temperature fiberglass braid. This braid is then impregnated to enhance abrasion resistance and reduce fraying. The insulated conductors are laid parallel and covered with another braid of high temperature fiberglass and impregnation.

The Series 321 is available with a full range of metallic coverings for improved abrasion resistance.

When the temperature of the application exceeds the rating of the Series 321, specify Series 301.

Construction Combinations

1. ASTM E 230 Calibrations

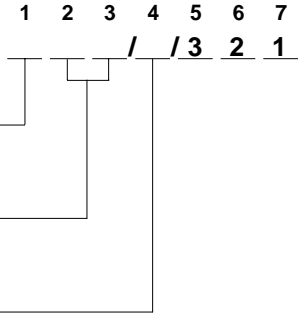
E K T
J N

2-3. B & S Gauge

24 18 14
20 16

4. Conductor Type/Tolerance

- 1 = Thermocouple grade, solid wire, standard tolerances
- 2 = Thermocouple grade, solid wire, special tolerances
- 3 = Thermocouple grade, stranded wire, standard tolerances
- 4 = Thermocouple grade, stranded wire, special tolerances
- 5 = Extension grade, solid wire, standard tolerance
- 6 = Extension grade, solid wire, special tolerance
- 7 = Extension grade, stranded wire, standard tolerance
- 8 = Extension grade, stranded wire, special tolerance



Performance Capabilities

- Continuous temperature rating: 1300°F (705°C)
- Single reading: 1600°F (870°C)

Features and Benefits

- **High temperature fiberglass braid single conductor and duplex insulation** impregnated with modified resin for added abrasion resistance.
- **Impregnation retained to 400°F (204°C).**
- **ASTM E 230 color code** for easy identification.
- **Good abrasion, moisture and chemical resistance.**

- **Additional abrasion resistance** with optional stainless steel, tinned copper and alloy 600 wire overbraids, or flat stainless steel spiral and half oval galvanized steel spiral wraps.
- **Custom constructions available, consult factory.**

Applications

- Steel and aluminum plants
- Heat treating

Wire Specifications

B & S Gauge	Nominal Conductor Size		Nominal Insulation Thickness		Nominal Overall Size		Approximate Shipping Weight	
			Conductor	Overall				
	inches	(mm)	inches (mm)	inches (mm)	inches	(mm)	lbs/1000 ft	(kg/km)
24	0.020	(0.508)	0.015 (0.381)	0.010 (0.254)	0.072 X 0.120	(1.83 X 3.05)	10	(14.9)
20	0.032	(0.965)	0.015 (0.381)	0.010 (0.254)	0.082 X 0.140	(2.08 X 3.56)	13	(19.4)
18	0.040	(1.02)	0.015 (0.381)	0.010 (0.254)	0.090 X 0.156	(2.29 X 3.96)	18	(26.8)
16	0.051	(1.29)	0.015 (0.381)	0.010 (0.254)	0.100 X 0.174	(2.54 X 4.42)	25	(37.3)
14	0.064	(1.63)	0.015 (0.381)	0.010 (0.254)	0.114 X 0.200	(2.90 X 5.08)	34	(50.7)



- K20/1/350
- K20/2/350

SERV-RITE Wire and Cable

High Temperature Ceramic Fiber Thermocouple Wire Series 350



Temp.	Resistance Properties		
	Moisture	Chemical	Abrasion
2200°F (1205°C)	Fair	Good	Good

The Series 350 uses the ultimate high-temperature flexible insulating system. The ceramic fiber yarn's upper temperature limit often exceeds the melting point of the material it's insulating. When an application requires flexible insulation, while pushing Type K or Type N to their extreme limits, ceramic fiber insulation is the only choice.

While Series 350 can be manufactured to your specification, Watlow Gordon supplies standard Series 350 without color coding or impregnations.* This minimizes contaminating the pure ceramic fiber yarn. Laboratory testing indicates the

Construction Combinations

1. ASTM E 230 Calibrations

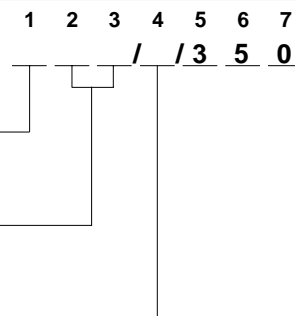
E K
J N

2-3. B & S Gauge

24 18 14
20 16

4. Conductor Type/Tolerance

- 1 = Thermocouple grade, solid wire, standard tolerances
- 2 = Thermocouple grade, solid wire, special tolerances
- 3 = Thermocouple grade, stranded wire, standard tolerances
- 4 = Thermocouple grade, stranded wire, special tolerances



introduction of even small amounts of impregnation can decrease the upper use temperature by as much as 1000°F (540°C). Watlow Gordon's processing assures the ceramic fiber yarn has the longest life and maximum operating temperature.

If application temperatures exceed Series 350 construction, specify XACTPAK® mineral-insulated, metal-sheathed cable.

Performance Capabilities

- Continuous temperature rating: 2200°F (1205°C)
- Single reading: 2600°F (1430°C)

Features and Benefits

- **Ceramic fiber braid single conductor and duplex insulation;** no impregnation for contamination-free operation.
- **Good abrasion and chemical resistance, fair moisture resistance.**
- **Additional abrasion resistance** with optional stainless steel and alloy 600 wire overbraids.
- **Custom constructions available, consult factory.**

Applications

- Steel and aluminum plants
- Heat treating

Wire Specifications

B & S Gauge	Nominal Conductor Size inches (mm)		Nominal Insulation Thickness		Nominal Overall Size inches (mm)		Approximate Shipping Weight lbs/1000 ft (kg/km)	
			Conductor inches (mm)	Overall inches (mm)				
24	0.020	(0.508)	0.016 (0.406)	0.016 (0.406)	0.088 X 0.132	(2.24 X 3.35)	13	(19.4)
20	0.032	(0.965)	0.016 (0.406)	0.016 (0.406)	0.100 X 0.154	(2.54 X 3.91)	16	(23.8)
18	0.040	(1.02)	0.016 (0.406)	0.016 (0.406)	0.108 X 0.170	(2.74 X 4.32)	21	(31.3)
16	0.051	(1.29)	0.016 (0.406)	0.016 (0.406)	0.119 X 0.192	(3.02 X 4.88)	32	(47.7)
14	0.064	(1.63)	0.016 (0.406)	0.016 (0.406)	0.132 X 0.218	(3.35 X 5.54)	44	(65.6)

*Because this insulation has no binders or impregnations, it may "flower" when stripped.

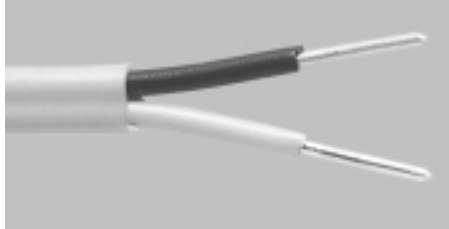


- E20/5/502
- J16/5/502
- J20/5/502
- J20/7/502
- K16/5/502
- K20/5/502
- K20/7/502
- S20/5/502
- T20/5/502
- T20/7/502

SERV-RITE Wire and Cable

PVC Insulated Thermocouple and Extension Wire

Series 502



Temp.	Resistance Properties		
	Moisture	Chemical	Abrasion
220°F (105°C)	Excellent	Excellent	Excellent

Series 502 is an economical wire that's also available in UL® listings for PLTC (Power Limited Tray Cable) applications.

The primary and duplex insulation is PVC. It yields a construction that's inexpensive while performing continuously at temperatures to 220°F (105°C).

Series 502 is often used in conduit and wiring trays where its flexibility allows for easy installation. The Series 502 can be easily stripped using hand tools or mechanical methods.

Performance Capabilities

- Continuous temperature rating: 220°F (105°C)

Construction Combinations

1. ASTM E 230 Calibrations

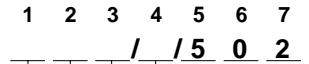
B	J	S
C	K	T
E	N	

2-3. B & S Gauge

24	18	14
24 stranded (7/32)	18 stranded (7/26)	14 stranded (7/22)
20	16	
20 stranded (7/28)	16 stranded (7/24)	

4. Conductor Type/Tolerance

- 1 = Thermocouple grade, solid wire, standard tolerances
- 2 = Thermocouple grade, solid wire, special tolerances
- 3 = Thermocouple grade, stranded wire, standard tolerances
- 4 = Thermocouple grade, stranded wire, special tolerances
- 5 = Extension grade, solid wire, standard tolerance
- 6 = Extension grade, solid wire, special tolerance
- 7 = Extension grade, stranded wire, standard tolerance
- 8 = Extension grade, stranded wire, special tolerance



Features and Benefits

- **Extruded PVC single conductor and duplex insulation** for excellent moisture resistance.
- **Available as UL® Listed PLTC Wire and Cable.**
- **ASTM E 230 color code** for easy identification.
- **Excellent moisture resistance, good abrasion and chemical resistance.**
- **Additional abrasion resistance** with optional stainless steel and tinned copper wire overbraids.

- **Custom constructions available, consult factory.**

Applications

- Laboratories
- Industrial equipment testing
- Automotive

Wire Specifications

B & S Gauge	Nominal Conductor Size inches (mm)		Nominal Insulation Thickness		Nominal Overall Size inches (mm)		Approximate Shipping Weight lbs/1000 ft (kg/km)	
			Conductor inches (mm)	Overall inches (mm)				
24	0.020	(0.508)	0.015 (0.381)	0.015 (0.381)	0.080 X 0.130 (2.03 X 3.30)	10	(14.9)	
24 S* (7/32)	0.024	(0.610)	0.015 (0.381)	0.015 (0.381)	0.084 X 0.138 (2.13 X 3.51)	11	(16.4)	
20	0.032	(0.813)	0.015 (0.381)	0.015 (0.381)	0.092 X 0.154 (2.34 X 3.91)	14	(20.9)	
20 S* (7/28)	0.038	(0.965)	0.015 (0.381)	0.015 (0.381)	0.098 X 0.166 (2.49 X 4.22)	16	(23.8)	
18	0.040	(1.02)	0.020 (0.508)	0.020 (0.508)	0.120 X 0.200 (3.05 X 5.08)	21	(31.3)	
18 S* (7/26)	0.048	(1.22)	0.020 (0.508)	0.020 (0.508)	0.128 X 0.216 (3.25 X 5.49)	23	(34.3)	
16	0.051	(1.29)	0.020 (0.508)	0.020 (0.508)	0.131 X 0.222 (3.33 X 5.64)	28	(41.7)	
16 S* (7/24)	0.060	(1.52)	0.020 (0.508)	0.020 (0.508)	0.140 X 0.240 (3.56 X 6.10)	30	(44.7)	
14	0.064	(1.628)	0.020 (0.508)	0.025 (0.635)	0.144 X 0.248 (3.66 X 6.30)	44	(65.6)	
14 S* (7/22)	0.076	(1.930)	0.020 (0.508)	0.025 (0.635)	0.166 X 0.282 (4.22 X 7.16)	48	(71.5)	

* "S" denotes stranded wire: e.g., "24 S (7/32)" is seven strands of 32 gauge wire to make a 24 gauge stranded conductor.

SERV-RITE Wire and Cable

Nylon Insulated Thermocouple Wire

Series 504



Temp.	Resistance Properties		
	Moisture	Chemical	Abrasion
300°F (150°C)	Fair	Good	Excellent

The Series 504 is a construction that permits reduced amounts of insulation material to produce a rugged, compact wire.

Primary and duplex insulation is extruded nylon that performs continuously at 300°F (150°C). Single conductors are color coded for easy installation.

Series 504 can be easily stripped using hand tools or mechanical methods.

Construction Combinations



Performance Capabilities

- Continuous temperature rating: 300°F (150°C)

Features and Benefits

- **Extruded nylon single conductor and duplex insulation** for exceptional protection.
- **Resistant to chemicals and hydrocarbons**
- **Overall insulation jacket is clear** to ease identification.
- **ASTM E 230 color code** for easy identification.

- **Excellent abrasion resistance, good chemical resistance and fair moisture resistance.**

- **Additional abrasion resistance** with optional stainless steel and tinned copper wire overbraids.
- **Custom constructions available, consult factory.**

Applications

- Laboratories
- Test stands
- Food processing

Wire Specifications

B & S Gauge	Nominal Conductor Size inches (mm)		Nominal Insulation Thickness		Nominal Overall Size inches (mm)		Approximate Shipping Weight lbs/1000 ft (kg/km)	
			Conductor inches (mm)	Overall inches (mm)				
24	0.020	(0.508)	0.008 (0.203)	0.004 (0.102)	0.044 X 0.080 (1.12 X 2.03)	6	(8.9)	
20	0.032	(0.813)	0.008 (0.203)	0.008 (0.203)	0.064 X 0.112 (1.63 X 2.84)	11	(16.4)	



- J24/1/505
- J24/2/505
- K24/1/505
- K24/2/505
- T24/1/505
- T24/2/505

SERV-RITE Wire and Cable

PVC Insulated "RIPCORD" Thermocouple and Extension Wire

Series 505

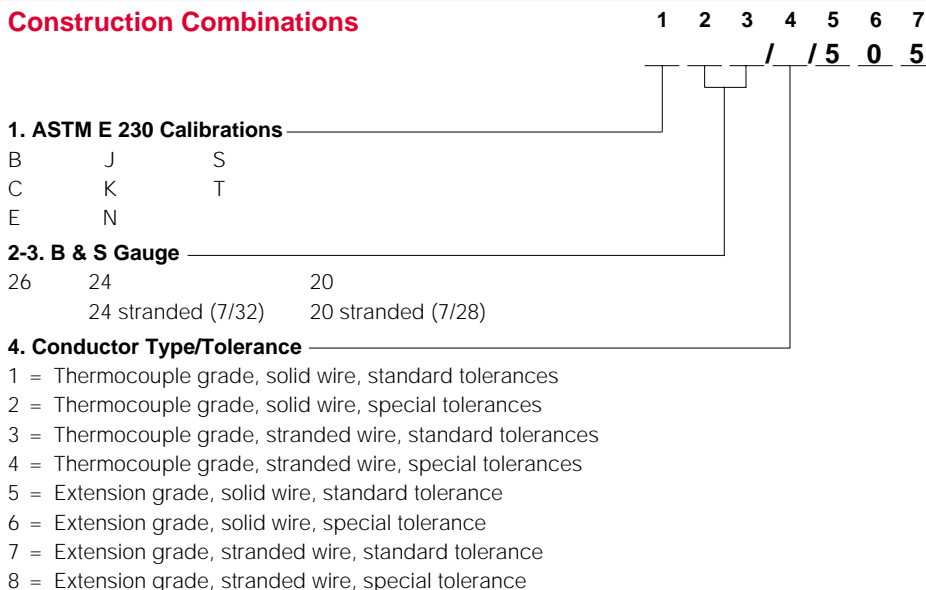


Temp.	Resistance Properties		
	Moisture	Chemical	Abrasion
220°F (105°C)	Excellent	Good	Good

The Series 505 is the most economical wire produced. Unlike some competitive "rip cord" type constructions which use only a stripe to establish polarity, Series 505 single conductors are fully color coded. The conductors are individually insulated with the proper colored PVC and fused into "rip cord" using a proprietary process.

The insulated conductors can be easily separated by hand once the bond between conductors has been slit. As with other PVC insulated products, Series 505 lends itself well to both manual and mechanical stripping methods.

Construction Combinations



For higher temperature applications or enhanced abrasion resistance, consider a fluoroplastic insulated construction such as the Series 507 or 508.

Performance Capabilities

- Continuous temperature rating: 220°F (105°C)

Features and Benefits

- **Extruded PVC single conductor insulation** with fused (rip cord) duplex construction for easy separation and stripping.
- **ASTM E 230 color code** for easy identification.

- **Excellent moisture resistance, good abrasion and chemical resistance.**
- **Additional abrasion resistance** with optional stainless steel and tinned copper wire overbraids.
- **Custom constructions available, consult factory.**

Applications

- Laboratories
- Test stands
- Automotive

SERV-RITE Wire and Cable

Wire Specifications

B & S Gauge	Nominal Conductor Size		Nominal Conductor Insulation Thickness		Nominal Overall Size		Approximate Shipping Weight	
	inches	(mm)	inches	(mm)	inches	(mm)	lbs/1000 ft	(kg/km)
26	0.016	(0.406)	0.015	(0.381)	0.046 X 0.088	(1.17 X 2.24)	4	(6.0)
24	0.020	(0.508)	0.015	(0.381)	0.050 X 0.096	(1.27 X 2.44)	5	(7.5)
24 S* (7/32)	0.024	(0.610)	0.015	(0.381)	0.054 X 0.104	(1.37 X 2.64)	6	(8.9)
20	0.032	(0.813)	0.015	(0.381)	0.062 X 0.120	(1.57 X 3.05)	10	(14.9)
20 S* (7/28)	0.038	(0.965)	0.015	(0.381)	0.068 X 0.132	(1.73 X 3.35)	11	(16.4)

* "S" denotes stranded wire: e.g., "24 S (7/32)" is seven strands of 32 gauge wire to make a 24 gauge stranded conductor.



- J30/2/506
- K30/2/506
- T30/2/506

SERV-RITE Wire and Cable

Small Gauge FEP Insulated Thermocouple and Extension Wire

Series 506



Temp.	Resistance Properties		
	Moisture	Chemical	Abrasion
400°F (204°C)	Excellent	Excellent	Excellent

Series 506 is the smallest standard insulated wire construction. The thin FEP wall on both primary and duplex insulation yields a construction that can operate safely at temperatures far beyond common PVC and nylon insulations.

The Series 506 is fully color coded for ease of installation. Its small size allows use in high density circuits. Response time is minimized by small diameter conductors. Series 506 is available only in gauge sizes of #26 and smaller. For gauge sizes larger than #26 specify Series 507.

Construction Combinations

1. ASTM E 230 Calibrations

E N
J S
K T

2-3. B & S Gauge

36 30
32 28

4. Conductor Type/Tolerance

- 1 = Thermocouple grade, solid wire, standard tolerances
 2 = Thermocouple grade, solid wire, special tolerances
 3 = Thermocouple grade, stranded wire, standard tolerances
 4 = Thermocouple grade, stranded wire, special tolerances
 5 = Extension grade, solid wire, standard tolerance
 6 = Extension grade, solid wire, special tolerance
 7 = Extension grade, stranded wire, standard tolerance
 8 = Extension grade, stranded wire, special tolerance

1 2 3 4 5 6 7
/ / 5 0 6

Performance Capabilities

- Continuous temperature rating: 400°F (204°C)
- Single reading: 500°F (260°C)

Features and Benefits

- **Extruded FEP single conductor and duplex insulation** for excellent protection.
- **ASTM E 230 color code** for easy identification.
- **Excellent abrasion, moisture and chemical resistance.**

- **Additional abrasion resistance** with optional stainless steel and tinned copper wire overbraids.
- **Custom constructions available, consult factory.**

Applications

- Industrial equipment testing

Wire Specifications

B & S Gauge	Nominal Conductor Size inches (mm)		Nominal Insulation Thickness		Nominal Overall Size inches (mm)		Approximate Shipping Weight lbs/1000 ft (kg/km)	
			Conductor inches (mm)	Overall inches (mm)				
36	0.005	(0.127)	0.005	(0.127)	0.025 X 0.040	(0.635 X 1.02)	2	(3.0)
32	0.008	(0.203)	0.005	(0.127)	0.028 X 0.046	(0.711 X 1.17)	2	(3.0)
30	0.010	(0.254)	0.005	(0.127)	0.030 X 0.050	(0.762 X 1.27)	3	(4.5)
28	0.013	(0.330)	0.005	(0.127)	0.033 X 0.056	(0.838 X 1.42)	3	(4.5)

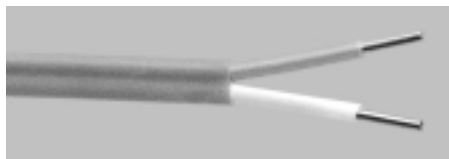
SERV-RITE Wire and Cable



- C24/5/507
- J24/2/507
- K24/2/507
- E20/1/507
- J24/3/507
- K24/3/507
- K24/3/507
- J20/1/507
- K20/1/507
- S20/5/507
- J20/2/507
- K20/2/507
- T20/1/507
- J20/3/507
- K20/3/507
- T20/2/507
- J20/5/507
- K20/5/507
- T20/3/507
- J24/1/507
- K24/1/507
- T24/2/507

FEP Insulated Thermocouple and Extension Wire

Series 507

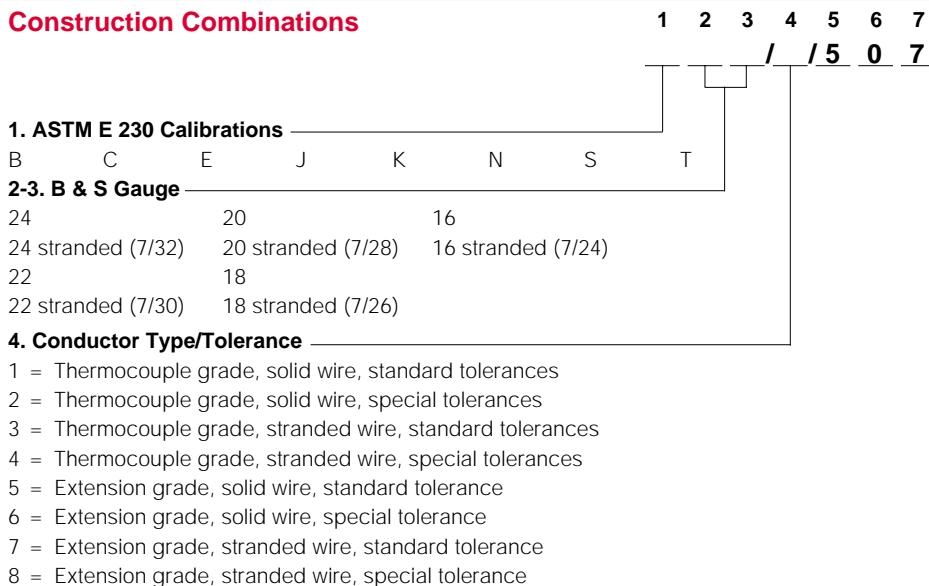


Temp.	Resistance Properties		
	Moisture	Chemical	Abrasion
400°F (204°C)	Excellent	Excellent	Excellent

The Series 507 is the most economical fluoroplastic insulated wire. Series 507 is also available as UL® listed PLTC. Individual conductors are coated with a layer of color coded FEP. The insulated conductors are then parallel duplexed with an additional layer of color coded FEP. The finished construction has a temperature rating of 500°F (260°C). Abrasion, moisture and chemical resistance are far in excess of most other insulations.

This construction is widely used when pulling long lengths of wire through conduit. FEP's low friction coefficient and abrasion resistance make it ideally suited for these applications.

Construction Combinations



For higher abrasion resistance consider Tefzel® insulated constructions, the Series 514.

For higher temperatures specify Series 508 or 516.

Performance Capabilities

- Continuous temperature rating: 400°F (204°C)
- Single reading: 500°F (260°C)

Features and Benefits

- **Extruded FEP single conductor and duplex insulation** for excellent protection.

- **Available as UL® listed PLTC wire and cable.**
- **ASTM E 230 color code** for easy identification.
- **Excellent abrasion, moisture and chemical resistance.**
- **Additional abrasion resistance** with optional stainless steel and tinned copper wire overbraids.
- **Custom constructions available, consult factory.**

Applications

- Aerospace
- Industrial equipment testing

Wire Specifications

B & S Gauge	Nominal Conductor Size		Nominal Insulation Thickness		Nominal Overall Size		Approximate Shipping Weight	
			Conductor	Overall				
	inches	(mm)	inches (mm)	inches (mm)	inches	(mm)	lbs/1000 ft	(kg/km)
24	0.020	(0.508)	0.008 (0.203)	0.010 (0.254)	0.056 X 0.096	(1.42 X 2.44)	8	(11.9)
24 S* (7/32)	0.024	(0.610)	0.008 (0.203)	0.010 (0.254)	0.060 X 0.104	(1.52 X 2.64)	9	(13.4)
22	0.025	(0.635)	0.008 (0.203)	0.010 (0.254)	0.061 X 0.106	(1.55 X 2.69)	10	(14.9)
22 S* (7/30)	0.030	(0.762)	0.008 (0.203)	0.010 (0.254)	0.066 X 0.116	(1.68 X 2.95)	11	(16.4)
20	0.032	(0.813)	0.008 (0.203)	0.010 (0.254)	0.068 X 0.120	(1.73 X 3.05)	12	(17.9)
20 S* (7/28)	0.038	(0.965)	0.008 (0.203)	0.010 (0.254)	0.074 X 0.132	(1.88 X 3.35)	14	(20.9)
18	0.040	(1.02)	0.008 (0.203)	0.010 (0.254)	0.076 X 0.136	(1.93 X 3.45)	18	(26.8)
18 S* (7/26)	0.048	(1.22)	0.008 (0.203)	0.010 (0.254)	0.084 X 0.152	(2.13 X 3.86)	20	(29.8)
16	0.051	(1.29)	0.008 (0.203)	0.012 (0.305)	0.091 X 0.162	(2.31 X 4.11)	28	(41.7)
16 S* (7/24)	0.060	(1.52)	0.008 (0.203)	0.012 (0.305)	0.100 X 0.186	(2.54 X 4.72)	30	(44.7)

* "S" denotes stranded wire: e.g., "24 S (7/32)" is seven strands of 32 gauge wire to make a 24 gauge stranded conductor.

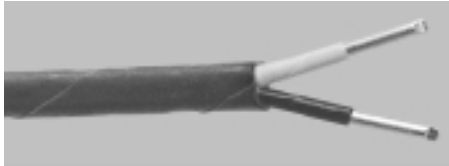


- J20/1/508
- J20/2/508
- J24/1/508
- J24/2/508
- K20/1/508
- K20/2/508
- K24/1/508
- K24/2/508
- T20/2/508
- T24/1/508
- T24/2/508

SERV-RITE Wire and Cable

TFE Tape Insulated Thermocouple and Extension Wire

Series 508



Temp.	Resistance Properties		
	Moisture	Chemical	Abrasion
500°F (260°C)	Excellent	Excellent	Good

The primary and duplex insulation of Series 508 is fused TFE tape. The tape is spirally applied to the conductor and heated. This process, called sintering, forms the tape into a homogeneous layer. When sintered, the tape exhibits all of the advantages of extruded TFE insulation, while eliminating the concentricity problems associated with TFE extrusions.

The Series 508 is fully color coded and capable of continuous operation in excess of 500°F (260°C). Because the fusing process causes the duplex tape to fuse with the primary insulation, Series 508 is not recommended for applications where it's necessary to remove the outer tape while leaving the primary insulation intact.

Construction Combinations

1. ASTM E 230 Calibrations

B	C	E	J	K	N	S	T
26		20					16
							20 stranded (7/28)
24		18					16 stranded (7/24)
							18 stranded (7/26)
24 stranded (7/32)							

4. Conductor Type/Tolerance

- 1 = Thermocouple grade, solid wire, standard tolerances
- 2 = Thermocouple grade, solid wire, special tolerances
- 3 = Thermocouple grade, stranded wire, standard tolerances
- 4 = Thermocouple grade, stranded wire, special tolerances
- 5 = Extension grade, solid wire, standard tolerance
- 6 = Extension grade, solid wire, special tolerance
- 7 = Extension grade, stranded wire, standard tolerance
- 8 = Extension grade, stranded wire, special tolerance

When higher temperature capabilities are required, specify polyimide insulated constructions: Series 511, 512 or 513.

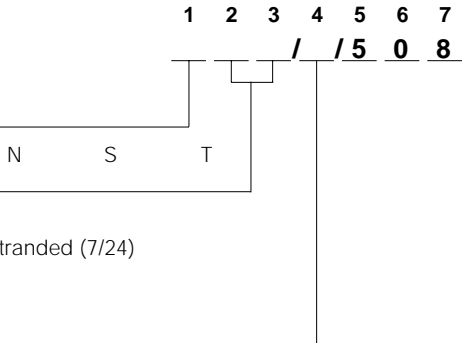
For improved abrasion resistance, consider Series 514 or a stainless steel overbraid.

Performance Capabilities

- Continuous temperature rating: 500°F (260°C)
- Single reading: 600°F (315°C)

Features and Benefits

- **Fused TFE tape single conductor and duplex insulation** to eliminate concentricity problems.



- **ASTM E 230 color code** for easy identification.
- **Excellent moisture and chemical resistance, good abrasion resistance.**
- **Additional abrasion resistance** with optional stainless steel and tinned copper wire overbraids.
- **Custom constructions available, consult factory.**

Applications

- Aircraft composite bonding
- Petroleum plants

Wire Specifications

B & S Gauge	Nominal Conductor Size inches (mm)	Nominal Insulation Thickness		Nominal Overall Size inches (mm)	Approximate Shipping Weight lbs/1000 ft (kg/km)
		Conductor inches (mm)	Overall inches (mm)		
26	0.016 (0.406)	0.006 (0.152)	0.008 (0.203)	0.044 X 0.072 (1.12 X 1.83)	4 (6.0)
24	0.020 (0.508)	0.006 (0.152)	0.008 (0.203)	0.047 X 0.077 (1.19 X 1.95)	5 (7.5)
24 S* (7/32)	0.024 (0.610)	0.006 (0.152)	0.008 (0.203)	0.049 X 0.084 (1.24 X 2.13)	6 (8.9)
20	0.032 (0.813)	0.006 (0.152)	0.008 (0.203)	0.061 X 0.106 (1.55 X 2.69)	11 (16.4)
20 S* (7/28)	0.038 (0.965)	0.006 (0.152)	0.008 (0.203)	0.064 X 0.112 (1.63 X 2.84)	12 (17.9)
18	0.040 (1.02)	0.006 (0.152)	0.008 (0.203)	0.068 X 0.120 (1.73 X 3.05)	16 (23.8)
18 S* (7/26)	0.048 (1.22)	0.006 (0.152)	0.008 (0.203)	0.076 X 0.136 (1.93 X 3.45)	18 (26.8)
16	0.051 (1.29)	0.010 (0.254)	0.008 (0.203)	0.087 X 0.158 (2.21 X 4.01)	25 (37.3)
16 S* (7/24)	0.060 (1.52)	0.010 (0.254)	0.008 (0.203)	0.096 X 0.176 (2.44 X 4.47)	27 (40.2)

* "S" denotes stranded wire: e.g., "24 S (7/32)" is seven strands of 32 gauge wire to make a 24 gauge stranded conductor.

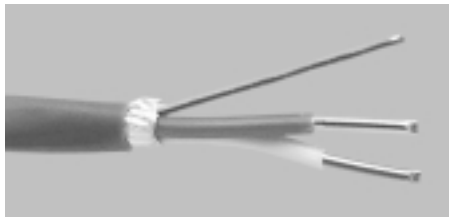
SERV-RITE Wire and Cable



- J16/5/509
- J20/1/509
- J20/5/509
- K16/5/509
- K20/1/509
- K20/2/509
- K20/5/509
- T20/1/509

FEP Insulated and Shielded Thermocouple and Extension Wire

Series 509



Temp.	Resistance Properties		
	Moisture	Chemical	Abrasion
400°F (204°C)	Excellent	Excellent	Excellent

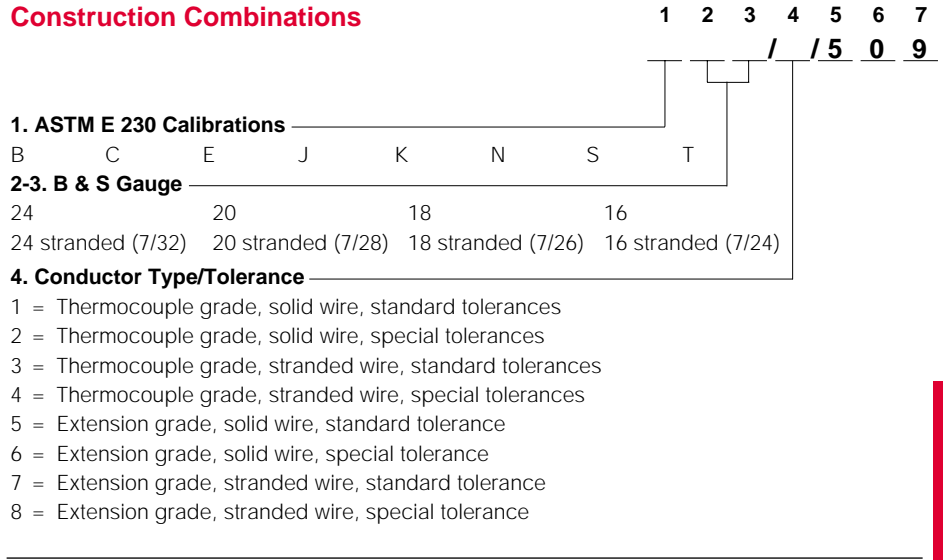
The Series 509 was developed especially for use with microprocessor based systems. Series 509 is also available as UL® listed PLTC.

The conductors are insulated with color coded FEP. They're then twisted with a copper drain wire. An aluminized polyester tape is wrapped around the conductors and drain wire. Finally, FEP is applied.

The finished construction can withstand temperatures in excess of 400°F (204°C). Twisted conductors minimize EMI and the taped shield eliminates most problems associated with AC "noise."

When better abrasion resistance is required, specify an overall metallic braid.

Construction Combinations



Performance Capabilities

- Continuous temperature rating: 400°F (204°C)
- Single reading: 500°F (260°C)

Features and Benefits

- **Extruded FEP single conductor insulation** for excellent protection.
- **Twisted; extruded FEP overall duplex insulation** to minimize electrical interference.
- **Available as UL® listed PLTC wire and cable.**
- **Aluminum/polyester shield with drain wire** reduces electrical noise.
- **ASTM E 230 color code** for easy identification.

- **Excellent abrasion, moisture and chemical resistance.**
- **Additional abrasion resistance** with optional stainless steel and tinned copper wire overbraids.
- **Custom constructions available, consult factory.**

Applications

- Aerospace
- Industrial equipment testing
- Glass manufacture

Wire Specifications

B & S Gauge	Nominal Conductor Size inches (mm)	Nominal Insulation Thickness		Nominal Overall Size		Approximate Shipping Weight	
		Conductor inches (mm)	Overall inches (mm)	inches	(mm)	lbs/1000 ft	(kg/km)
24	0.020 (0.508)	0.008 (0.203)	0.012 (0.305)	0.104	(2.64)	12	(17.9)
24 S* (7/32)	0.024 (0.610)	0.008 (0.203)	0.012 (0.305)	0.112	(2.84)	13	(19.4)
20	0.032 (0.813)	0.008 (0.203)	0.012 (0.305)	0.128	(3.25)	18	(26.8)
20 S* (7/28)	0.038 (0.965)	0.008 (0.203)	0.012 (0.305)	0.140	(3.56)	20	(29.8)
18	0.040 (1.02)	0.008 (0.203)	0.015 (0.381)	0.152	(3.86)	25	(37.3)
18 S* (7/26)	0.048 (1.22)	0.008 (0.203)	0.015 (0.381)	0.168	(4.27)	27	(40.2)
16	0.051 (1.29)	0.008 (0.203)	0.015 (0.381)	0.174	(4.42)	33	(49.2)
16 S* (7/24)	0.060 (1.52)	0.008 (0.203)	0.015 (0.381)	0.192	(4.88)	35	(52.2)

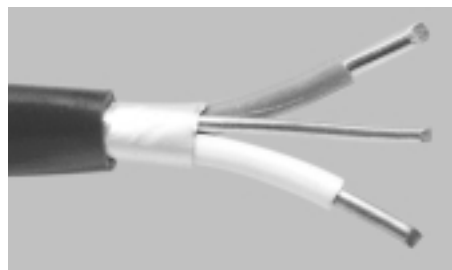
* "S" denotes stranded wire: e.g., "24 S (7/32)" is seven strands of 32 gauge wire to make a 24 gauge stranded conductor.

SERV-RITE Wire and Cable



- E20/5/510
- J16/5/510
- J20/5/510
- J20/7/510
- K16/5/510
- K20/5/510
- K20/7/510
- S20/5/510
- T16/5/510
- T20/5/510

PVC Insulated and Shielded Thermocouple and Extension Wire Series 510



Temp.	Resistance Properties		
	Moisture	Chemical	Abrasion
220°F (105°C)	Excellent	Good	Good

The Series 510 is a PVC insulated, twisted and shielded construction for systems sensitive to induced voltages and "noise." Series 510 is also available as UL® listed PLTC.

The conductors are insulated with color coded PVC. The next operation twists the two insulated conductors with a copper drain wire. An aluminum polyester tape is wrapped around the wires to impart 100 per cent shielding. Lastly, another layer of PVC is applied.

Construction Combinations

1. ASTM E 230 Calibrations

B	E	K	S
C	J	N	T

2-3. B & S Gauge

24	20	18
24 stranded (7/32)	20 stranded (7/28)	18 stranded (7/26)
16	14	
16 stranded (7/24)	14 stranded (7/22)	

4. Conductor Type/Tolerance

- 1 = Thermocouple grade, solid wire, standard tolerances
- 2 = Thermocouple grade, solid wire, special tolerances
- 3 = Thermocouple grade, stranded wire, standard tolerances
- 4 = Thermocouple grade, stranded wire, special tolerances
- 5 = Extension grade, solid wire, standard tolerance
- 6 = Extension grade, solid wire, special tolerance
- 7 = Extension grade, stranded wire, standard tolerance
- 8 = Extension grade, stranded wire, special tolerance

1 2 3 4 5 6 7
/ / 5 1 0

The twisting eliminates most EMI while the shield tape minimizes AC "noise."

For higher temperatures specify Series 509. For improved abrasion resistance consider a metallic overbraid.

Performance Capabilities

- Continuous temperature rating: 220°F (105°C)

Features and Benefits

- **Extruded PVC single conductor insulation** for excellent protection.

- **Twisted; extruded PVC overall duplex insulation.**
- **Available in UL® PLTC.**
- **Aluminum/polyester shield with drain wire.**
- **ASTM E 230 color code.**
- **Excellent moisture resistance, good abrasion and chemical resistance.**
- **Additional abrasion resistance** with optional stainless steel and tinned copper wire overbraids.
- **Custom constructions available, consult factory.**

Wire Specifications

B & S Gauge	Nominal Conductor Size		Nominal Insulation Thickness		Nominal Overall Size		Approximate Shipping Weight	
			Conductor	Overall				
	inches	(mm)	inches (mm)	inches (mm)	inches	(mm)	lbs/1000 ft	(kg/km)
24	0.020	(0.508)	0.015 (0.381)	0.020 (0.508)	0.140	(3.56)	13	(19.4)
24 S* (7/32)	0.024	(0.610)	0.015 (0.381)	0.020 (0.508)	0.148	(3.76)	14	(20.9)
20	0.032	(0.813)	0.015 (0.381)	0.020 (0.508)	0.164	(4.17)	22	(32.8)
20 S* (7/28)	0.038	(0.965)	0.015 (0.381)	0.020 (0.508)	0.176	(4.47)	24	(35.8)
18	0.040	(1.02)	0.020 (0.508)	0.020 (0.508)	0.200	(5.08)	30	(44.7)
18 S* (7/26)	0.048	(1.22)	0.020 (0.508)	0.020 (0.508)	0.216	(5.49)	32	(47.7)
16	0.051	(1.29)	0.020 (0.508)	0.020 (0.508)	0.222	(5.64)	39	(58.1)
16 S* (7/24)	0.060	(1.52)	0.020 (0.508)	0.020 (0.508)	0.240	(6.10)	41	(61.1)
14	0.064	(1.63)	0.020 (0.508)	0.025 (0.635)	0.258	(6.55)	55	(82.0)
14 S* (7/22)	0.076	(1.93)	0.020 (0.508)	0.025 (0.635)	0.282	(7.16)	58	(86.4)

* "S" denotes stranded wire: e.g., "24 S (7/32)" is seven strands of 32 gauge wire to make a 24 gauge stranded conductor.

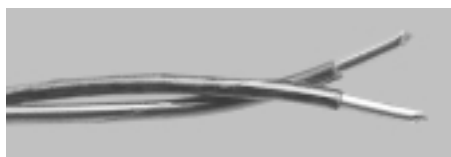
• J24/2/511



SERV-RITE Wire and Cable

Polyimide Insulated and Twisted Thermocouple and Extension Wire

Series 511

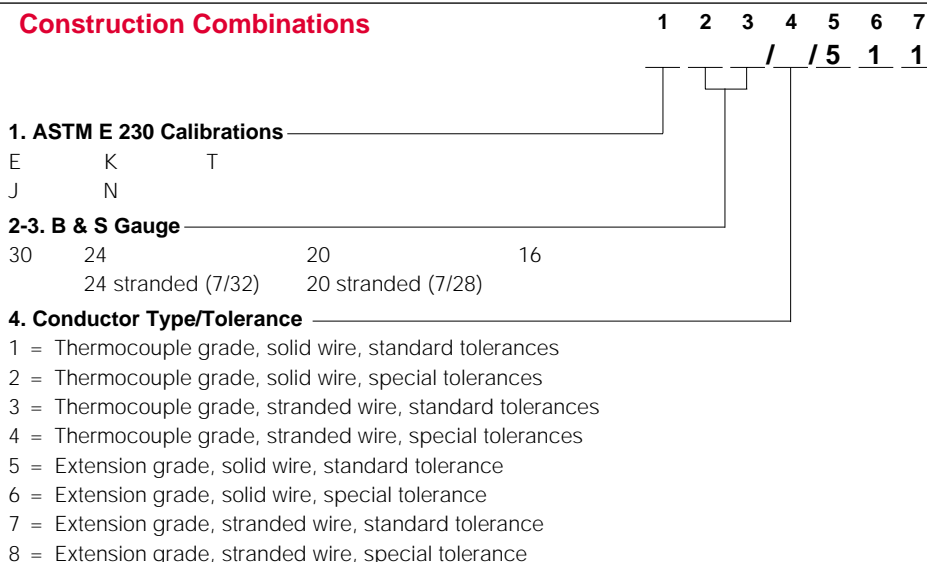


Temp.	Resistance Properties		
	Moisture	Chemical	Abrasion
600°F (315°C)	Excellent	Excellent	Excellent

Series 511 is the most economical polyimide taped construction. The polyimide film applied to the conductors is considered to be the ultimate "soft" insulation. The tape maintains its strength at temperatures to 600°F (315°C). The FEP laminate serves as a moisture barrier and allows the tape to fused with itself. The finished construction will not unravel when cut.

The Series 511 conductors are wrapped with the polyimide tape which is fused to itself. Each conductor is color coded with a colored thread under the tape. The final operation is twisting the insulated conductors into a duplex construction, thereby eliminating the overall duplex insulation and minimizing cost.

Construction Combinations



The Series 512 and 513 use additional polyimide insulation and should be specified when better abrasion resistance is required.

For higher temperatures, consider our fiberglass insulated constructions.

If heavier insulation is needed, refer to Series 512.

Performance Capabilities

- Continuous temperature rating: 600°F (315°C)
- Single reading: 800°F (430°C)

Features and Benefits

- **Fused polyimide tape*** single conductor insulation for excellent protection.
- **Duplex construction via twisted single conductors.**

- **Both legs have ASTM E 230 color coded tracers** for easy identification.
- **Excellent abrasion, moisture and chemical resistance.**
- **Additional abrasion resistance** with optional stainless steel and tinned copper wire overbraids.
- **Custom constructions available, consult factory.**

Applications

- Petrochemical plants
- Glass, ceramic and brick manufacturing
- Electric power plants
- Cryogenic applications
- Aerospace industry

Wire Specifications

B & S Gauge	Nominal Conductor Size		Nominal Insulation Thickness		Nominal Overall Size		Approximate Shipping Weight	
			Conductor					
	inches	(mm)	inches	(mm)	inches	(mm)	lbs/1000 ft	(kg/km)
30	0.010	(0.254)	0.004	(0.102)	0.040	(1.02)	3	(4.5)
24	0.020	(0.508)	0.005	(0.127)	0.060	(1.52)	4	(6.0)
24 S** (7/32)	0.024	(0.610)	0.005	(0.127)	0.068	(1.73)	5	(7.5)
20	0.032	(0.813)	0.005	(0.127)	0.084	(2.13)	8	(11.9)
20 S** (7/28)	0.038	(0.965)	0.005	(0.127)	0.094	(2.39)	9	(13.4)
16	0.051	(1.29)	0.005	(0.127)	0.122	(3.10)	19	(28.3)

* FEP laminate melts at approximately 500°F (260°C). Polyimide tape film may be either Kapton® from E.I. du Pont de Nemours & Company, or Apical® from Allied.

** "S" denotes stranded wire: e.g., "24 S (7/32)" is seven strands of 32 gauge wire to make a 24 gauge stranded conductor.

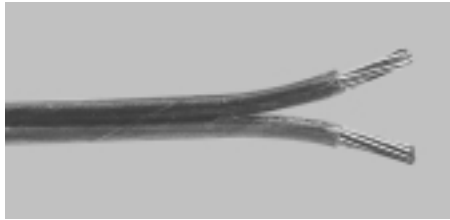


- J20/1/512
- J20/3/512
- K20/3/512

SERV-RITE Wire and Cable

Polyimide Insulated Thermocouple and Extension Wire

Series 512



Temp.	Resistance Properties		
	Moisture	Chemical	Abrasion
600°F (315°C)	Excellent	Excellent	Excellent

The Series 512 is a heavier duty version of Series 511 construction, using the same polyimide insulation. Color coding is accomplished using the same colored thread "tracers". However, the Series 512 has a duplex insulation of polyimide tape. The extra wall of tape yields a construction with increased abrasion resistance.

For higher temperature requirements, choose one of our fiberglass insulated wires.

For improved abrasion resistance, and easier color identification of conductors, specify Series 513.

Construction Combinations

	1	2	3	4	5	6	7
1. ASTM E 230 Calibrations				/	/	5	1 2
E K T							
J N							
2-3. B & S Gauge							
30 24 20 16							
24 stranded (7/32) 20 stranded (7/28) 16 stranded (7/24)							
4. Conductor Type/Tolerance							
1 = Thermocouple grade, solid wire, standard tolerances							
2 = Thermocouple grade, solid wire, special tolerances							
3 = Thermocouple grade, stranded wire, standard tolerances							
4 = Thermocouple grade, stranded wire, special tolerances							
5 = Extension grade, solid wire, standard tolerance							
6 = Extension grade, solid wire, special tolerance							
7 = Extension grade, stranded wire, standard tolerance							
8 = Extension grade, stranded wire, special tolerance							

Performance Capabilities

- Continuous temperature rating: 600°F (315°C)
- Single reading: 800°F (430°C)

Features and Benefits

- **Fused polyimide tape* single conductor and duplex insulation** for excellent protection.
- **Both legs have ASTM E 230 color coded tracers** for easy identification.
- **Excellent abrasion, moisture and chemical resistance.**
- **Additional abrasion resistance** with optional stainless steel and tinned copper wire overbraids.

- **Custom constructions available, consult factory.**

Applications

- Petrochemical plants
- Glass, ceramic and brick manufacturing
- Electric power plants
- Cryogenic applications
- Aerospace industry

Wire Specifications

B & S Gauge	Nominal Conductor Size inches (mm)		Nominal Insulation Thickness		Nominal Overall Size inches (mm)		Approximate Shipping Weight lbs/1000 ft (kg/km)	
			Conductor inches (mm)	Overall inches (mm)				
30	0.010	(0.254)	0.004	(0.102)	0.026 X 0.044	(0.660 X 1.18)	3	(4.5)
24	0.020	(0.508)	0.005	(0.127)	0.036 X 0.064	(0.914 X 1.626)	5	(7.5)
24 S** (7/32)	0.024	(0.610)	0.005	(0.127)	0.043 X 0.066	(1.092 X 1.676)	6	(8.9)
20	0.032	(0.813)	0.005	(0.127)	0.048 X 0.088	(1.219 X 2.235)	8	(11.9)
20 S** (7/28)	0.038	(0.965)	0.005	(0.127)	0.056 X 0.098	(1.42 X 2.490)	9	(13.4)
16	0.051	(1.29)	0.005	(0.127)	0.071 X 0.132	(1.80 X 3.35)	19	(28.3)
16 S** (7/24)	0.060	(1.52)	0.005	(0.127)	0.084 X 0.148	(2.134 X 3.760)	21	(31.3)

* FEP laminate melts at approximately 500°F (260°C). Polyimide tape film may be either Kapton® from E.I. du Pont de Nemours & Company, or Apical® from Allied.

** "S" denotes stranded wire: e.g., "24 S (7/32)" is seven strands of 32 gauge wire to make a 24 gauge stranded conductor.

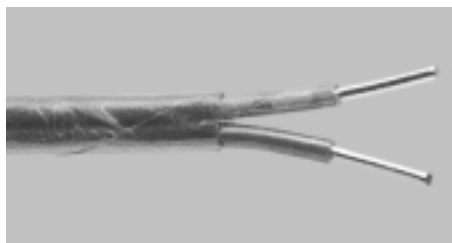


- J20/2/513
- J24/2/513
- K20/2/513
- K24/2/513
- K30/2/513

SERV-RITE Wire and Cable

Double Polyimide Insulated Thermocouple and Extension Wire

Series 513



Temp.	Resistance Properties		
	Moisture	Chemical	Abrasion
600°F (315°C)	Excellent	Excellent	Excellent

The Series 513 is the ultimate polyimide insulated wire. The toughness of multiple polyimide tape layers along with fully color coded conductors make this insulation system the choice for high reliability circuits. Abrasion, moisture and chemical resistance are all enhanced by additional layers of tape and application of polyimide varnish.

The actual construction consists of a double polyimide tape layer applied to each conductor. The tape is fused by heating. Each insulated single conductor is then coated to impart the proper color code. Finally, the insulated conductors are laid parallel and covered by a double, heat fused layer of polyimide tape.

Construction Combinations

1. ASTM E 230 Calibrations

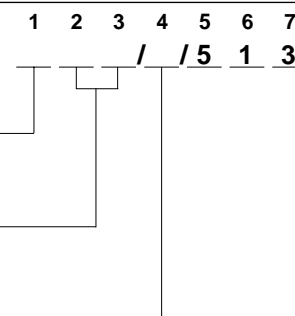
E K T
J N

2-3. B & S Gauge

30 24 20
 24 stranded (7/32) 20 stranded (7/28)

4. Conductor Type/Tolerance

- 1 = Thermocouple grade, solid wire, standard tolerances
- 2 = Thermocouple grade, solid wire, special tolerances
- 3 = Thermocouple grade, stranded wire, standard tolerances
- 4 = Thermocouple grade, stranded wire, special tolerances
- 5 = Extension grade, solid wire, standard tolerance
- 6 = Extension grade, solid wire, special tolerance
- 7 = Extension grade, stranded wire, standard tolerance
- 8 = Extension grade, stranded wire, special tolerance



When applications require higher heat resistance, it is necessary to specify fiberglass insulation.

For applications requiring better abrasion resistance, specify a metallic overbraid.

Performance Capabilities

- Continuous temperature rating: 600°F (315°C)
- Single reading: 800°F (430°C)

Features and Benefits

- **Fused polyimide tape* single conductor insulation** color coded with polyimide enamel for excellent protection.
- **Fused polyimide tape* duplex insulation** for additional protection.

- **Both conductors have ASTM E 230 color code** for easy identification.
- **Excellent abrasion, moisture and chemical resistance.**
- **Additional abrasion resistance** with optional stainless steel and tinned copper wire overbraids.
- **Custom constructions available consult factory.**

Applications

- Petrochemical plants
- Glass, ceramic and brick manufacturing
- Electric power plants
- Cryogenic applications
- Aerospace industry

Wire Specifications

B & S Gauge	Nominal Conductor Size inches (mm)		Nominal Insulation Thickness		Nominal Overall Size inches (mm)		Approximate Shipping Weight lbs/1000 ft (kg/km)	
			Conductor inches (mm)	Overall inches (mm)				
30	0.010	(0.254)	0.006	(0.152)	0.006	(0.152)	3	(4.5)
24	0.020	(0.508)	0.006	(0.152)	0.006	(0.152)	5	(7.5)
24 S** (7/32)	0.024	(0.610)	0.006	(0.152)	0.006	(0.152)	6	(8.9)
20	0.032	(0.813)	0.006	(0.152)	0.006	(0.152)	10	(14.9)
20S** (7/28)	0.038	(0.965)	0.006	(0.152)	0.006	(0.152)	11	(16.4)

* FEP laminate melts at approximately 500°F (260°C). Polyimide tape film may be either Kapton® from E.I. du Pont de Nemours & Company, or Apical® from Allied.

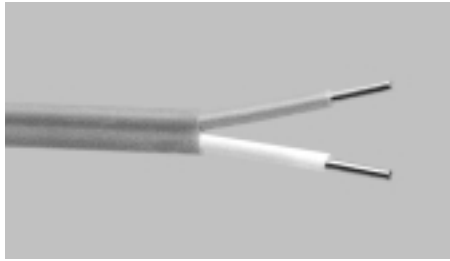
** "S" denotes stranded wire: e.g., "24 S (7/32)" is seven strands of 32 gauge wire to make a 24 gauge stranded conductor.

SERV-RITE Wire and Cable

SERV-RITE Wire and Cable

Tefzel® Insulated Thermocouple and Extension Wire

Series 514



Temp.	Resistance Properties		
	Moisture	Chemical	Abrasion
300°F (150°C)	Excellent	Excellent	Excellent

The Series 514 for applications requiring a higher cut-through resistance than is typically available with the other fluoroplastics. The Tefzel® insulation retains the chemical resistance associated with fluoroplastics but has enhanced physical properties. Its temperature rating, while not as high as the other fluoroplastics, is far higher than nylon or PVC.

The construction consists of bare conductors insulated with a color coded layer of extruded Tefzel®. The insulated conductors are then laid parallel and covered with another layer of Tefzel®.

Construction Combinations

1. ASTM E 230 Calibrations

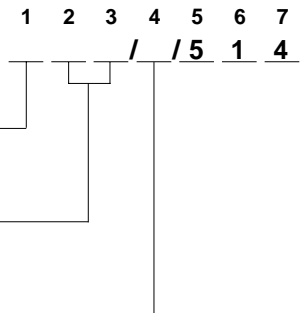
B	E	K	S
C	J	N	T

2-3. B & S Gauge

24	20	16
24 stranded (7/32)	20 stranded (7/28)	16 stranded (7/24)

4. Conductor Type/Tolerance

- 1 = Thermocouple grade, solid wire, standard tolerances
- 2 = Thermocouple grade, solid wire, special tolerances
- 3 = Thermocouple grade, stranded wire, standard tolerances
- 4 = Thermocouple grade, stranded wire, special tolerances
- 5 = Extension grade, solid wire, standard tolerance
- 6 = Extension grade, solid wire, special tolerance
- 7 = Extension grade, stranded wire, standard tolerance
- 8 = Extension grade, stranded wire, special tolerance



Performance Capabilities

- Continuous temperature rating: 300°F (150°C)
- Single reading: 390°F (200°C)

Features and Benefits

- **Extruded Tefzel® (ETFE) single conductor and duplex insulation** for excellent protection.
- **ASTM E 230 color code** for easy identification.
- **Excellent abrasion, moisture and chemical resistance.**

- **Additional abrasion resistance** with optional stainless steel and tinned copper wire overbraids.
- **Custom constructions available, consult factory.**

Applications

- Petrochemical plants
- Power generating plants

Wire Specifications

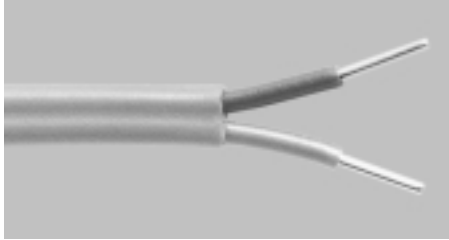
B & S Gauge	Nominal Conductor Size inches (mm)		Nominal Insulation Thickness		Nominal Overall Size inches (mm)		Approximate Shipping Weight lbs/1000 ft (kg/km)	
			Conductor inches (mm)	Overall inches (mm)				
24	0.020	(0.508)	0.010 (0.254)	0.010 (0.254)	0.060 X 0.100 (1.52 X 2.54)	9	(13.4)	
24 S* (7/32)	0.024	(0.610)	0.010 (0.254)	0.010 (0.254)	0.064 X 0.108 (1.63 X 2.74)	10	(14.9)	
20	0.032	(0.813)	0.010 (0.254)	0.012 (0.305)	0.076 X 0.128 (1.93 X 3.25)	12	(17.9)	
20 S* (7/28)	0.038	(0.965)	0.010 (0.254)	0.012 (0.305)	0.082 X 0.140 (2.08 X 3.56)	13	(19.4)	
16	0.051	(1.29)	0.010 (0.254)	0.012 (0.305)	0.095 X 0.166 (2.41 X 4.22)	26	(38.7)	
16 S* (7/24)	0.060	(1.52)	0.010 (0.254)	0.012 (0.305)	0.104 X 0.184 (2.64 X 4.67)	28	(41.7)	

* "S" denotes stranded wire: e.g., "24 S (7/32)" is seven strands of 32 gauge wire to make a 24 gauge stranded conductor.

SERV-RITE Wire and Cable

PFA Insulated Thermocouple and Extension Wire

Series 516



Temp.	Resistance Properties		
	Moisture	Chemical	Abrasion
500°F (260°C)	Excellent	Excellent	Good

A relatively new fluoroplastic, PFA, is the insulation on Series 516. PFA's temperature rating is only slightly less than TFE. However, PFA can be applied using conventional extrusion techniques. This produces a smooth finish, as opposed to the spiral usually associated with TFE tape constructions. This is important in the food industry where taped constructions present cleaning problems. The smooth surface also allows this construction to be pulled through conduits and cut-outs more easily.

Once each conductor has been coated with a color coded PFA layer, they are laid parallel and again coated with PFA.

Construction Combinations

1. ASTM E 230 Calibrations

B	E	K	S
C	J	N	T

2-3. B & S Gauge

36	30	24	20	16
		24 stranded (7/32)	20 stranded (7/28)	16 stranded (7/24)

4. Conductor Type/Tolerance

- 1 = Thermocouple grade, solid wire, standard tolerances
- 2 = Thermocouple grade, solid wire, special tolerances
- 3 = Thermocouple grade, stranded wire, standard tolerances
- 4 = Thermocouple grade, stranded wire, special tolerances
- 5 = Extension grade, solid wire, standard tolerance
- 6 = Extension grade, solid wire, special tolerance
- 7 = Extension grade, stranded wire, standard tolerance
- 8 = Extension grade, stranded wire, special tolerance



For improved abrasion resistance, the Series 516 can be supplied with a metallic braid or wrap.

For higher temperature applications, specify polyimide insulated wire constructions, Series 511, 512, or 513.

Performance Capabilities

- Continuous temperature rating: 500°F (260°C)
- Single reading: 550°F (290°C)

Features and Benefits

- **Extruded PFA single conductor and duplex insulation** for added protection.
- **ASTM E 230 color code** for easy identification.

- **Excellent, moisture and chemical resistance, good abrasion resistance.**
- **Additional abrasion resistance** with optional stainless steel and tinned copper wire overbraids.
- **Custom constructions available, consult factory.**

Applications

- Food processing facilities
- Petrochemical plants

Wire Specifications

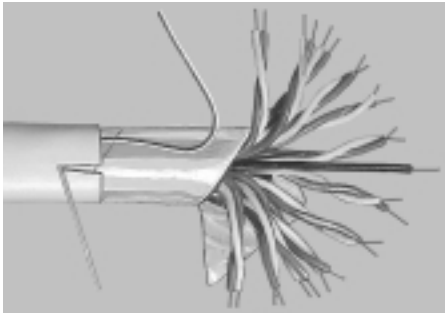
B & S Gauge	Nominal Conductor Size inches (mm)		Nominal Insulation Thickness		Nominal Overall Size inches (mm)		Approximate Shipping Weight	
			Conductor inches (mm)	Overall inches (mm)			lbs/1000 ft	(kg/km)
36	0.005	(0.127)	0.003	(0.076)	0.017 X 0.028	(0.432 X 0.711)	2	(3.0)
30	0.010	(0.254)	0.003	(0.076)	0.022 X 0.038	(0.559 X 0.965)	3	(4.5)
24	0.020	(0.508)	0.008	(0.203)	0.056 X 0.092	(1.42 X 2.34)	8	(11.9)
24 S* (7/32)	0.024	(0.610)	0.008	(0.203)	0.060 X 0.100	(1.52 X 2.54)	9	(13.4)
20	0.032	(0.813)	0.008	(0.203)	0.068 X 0.116	(1.73 X 2.95)	12	(17.9)
20 S* (7/28)	0.038	(0.965)	0.008	(0.203)	0.074 X 0.128	(1.88 X 3.25)	14	(20.9)
16	0.051	(1.29)	0.010	(0.254)	0.095 X 0.166	(2.41 X 4.22)	27	(40.2)
16 S* (7/24)	0.060	(1.52)	0.010	(0.254)	0.104 X 0.184	(2.64 X 4.67)	29	(43.2)

* "S" denotes stranded wire: e.g., "24 S (7/32)" is seven strands of 32 gauge wire to make a 24 gauge stranded conductor.

SERV-RITE Wire and Cable

PVC Insulated Multi-Pair Extension Wire with Overall Shield

Series 900



Temp.	Resistance Properties		
	Moisture	Chemical	Abrasion
220°F (105°C)	Excellent	Good	Good

Series 900 is the classification for our family of overall shielded multipair cables. Series 900 is also available in UL® listings for PLTC (Power Limited Tray Cable) applications.

Series 900 cable starts by insulating conductors with 220°F (105°C) PVC. For identification, one conductor of each pair is numbered and twisted with its counterpart. These “twisted pairs” are cabled with an additional insulated copper wire for communication use. The entire cable is wrapped with clear polyester tape to

Construction Combinations

1. ASTM E 230 Calibrations

E K T
J S

2-3. B & S Gauge

24 20 18 16

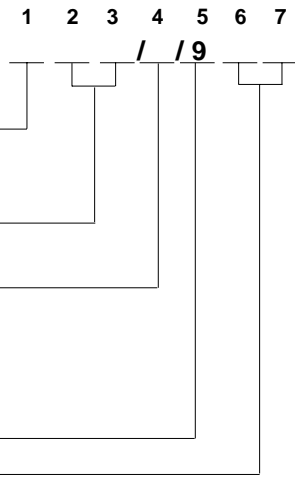
4. Conductor Type/Tolerance

5 = Extension grade, solid wire, standard tolerance
6 = Extension grade, solid wire, special tolerance
7 = Extension grade, stranded wire, standard tolerance
8 = Extension grade, stranded wire, special tolerance

5. Series 900

6-7. Pair Counts

02 04 06 08 10 12 16 20 24



minimize the chance of short circuits to the cable's shield. An aluminized polyester tape shield is then spirally applied. A copper drain wire and heavy ripcord are longitudinally applied under the final jacket of color coded PVC.

For higher temperatures, contact our factory. Multipair constructions, using FEP, Tefzel®, polyimide and fiberglass can be made to meet specific requirements in quantities of not less than 1000 feet (305 m). Specifications should accompany any request for quotation.

Performance Capabilities

- Continuous temperature rating: 220°F (105°C)

Features and Benefits

- **Extruded PVC single conductor and overall insulation.**
- **Available in UL® PLTC.**
- **Aluminum/polyester shield with drain wire** provides “noise” protection.
- **ASTM E 230 color code.**
- **Excellent moisture resistance, good abrasion and chemical resistance.**

Wire Specifications

No. of Pairs	B & S Gauge	Nominal Conductor Size		Nominal Insulation Thickness		Nominal Overall Size		Approximate Shipping Weight	
				Conductor	Overall				
		inches	(mm)	inches (mm)	inches (mm)	inches	(mm)	lbs/1000 ft	(kg/km)
2	20	0.032	(0.813)	0.015	(0.381)	0.290	(7.37)	72	(107.3)
4	20	0.032	(0.813)	0.015	(0.381)	0.350	(8.89)	94	(140.1)
6	20	0.032	(0.813)	0.015	(0.381)	0.405	(10.29)	116	(172.8)
8	20	0.032	(0.813)	0.015	(0.381)	0.440	(11.18)	140	(208.6)
10	20	0.032	(0.813)	0.015	(0.381)	0.490	(12.45)	164	(244.4)
12	20	0.032	(0.813)	0.015	(0.381)	0.535	(13.59)	188	(280.1)
16	20	0.032	(0.813)	0.015	(0.381)	0.610	(15.49)	240	(357.6)
20	20	0.032	(0.813)	0.015	(0.381)	0.650	(16.51)	292	(435.1)
24	20	0.032	(0.813)	0.015	(0.381)	0.710	(18.03)	344	(512.6)

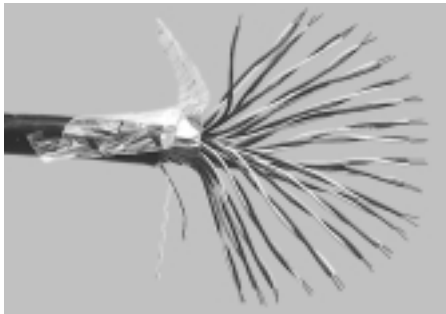


- J20/5/1004
- K20/5/1004
- T20/5/1004
- J20/5/1008
- K20/5/1008
- T20/5/1008

SERV-RITE Wire and Cable

PVC Insulated Multi-Pair Extension Wire with Individual and Overall Shield

Series 1000



Temp.	Resistance Properties		
	Moisture	Chemical	Abrasion
220°F (105°C)	Excellent	Good	Good

Series 1000 is the classification for our extensive family of individually shielded and isolated multipair cables. Series 1000 is also available in UL® listings for PLTC (Power Limited Tray Cable) applications. Series 1000 cables are manufactured the same as Series 900 cables except each pair is spirally wrapped with an aluminized polyester tape and a drain wire. This isolates each pair of conductors in the cable. This eliminates both internal and external "noise" that can exist in a circuit.

Construction Combinations

1. ASTM E 230 Calibrations

E J K S T

2-3. B & S Gauge

24 20 18 16

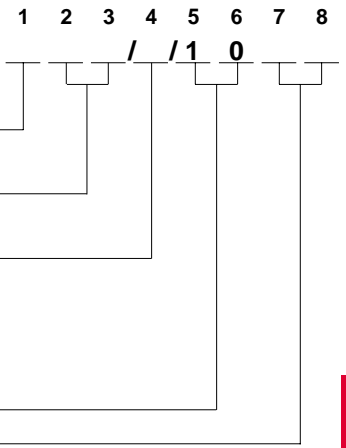
4. Conductor Type/Tolerance

- 5 = Extension grade, solid wire, standard tolerance
- 6 = Extension grade, solid wire, special tolerance
- 7 = Extension grade, stranded wire, standard tolerance
- 8 = Extension grade, stranded wire, special tolerance

5-6. Series 1000

7-8. Pair Counts

02 04 06 08 10 12 16 20 24



These individual pairs are then cabled together and finished the same way as the Series 900 cables. These cables are ideal for computerized data communications.

For higher temperature versions of Series 1000, please contact our factory. Special multipair constructions, using FEP, Tefzel®, polyimide and fiberglass can be manufactured to meet specific requirements or specifications in quantities of not less than 1000 feet (305 m). Specifications should accompany any request for quotation.

Performance Capabilities

- Continuous temperature rating: 220°F (105°C)

Features and Benefits

- **Extruded PVC single conductor and overall insulation** for excellent protection.
- **Available as UL® listed PLTC wire and cable.**
- **Aluminum/polyester shield with drain wire** provides "noise" protection.
- **ASTM E 230 color code** for easy identification.
- **Excellent moisture resistance, good abrasion and chemical resistance.**

Wire Specifications

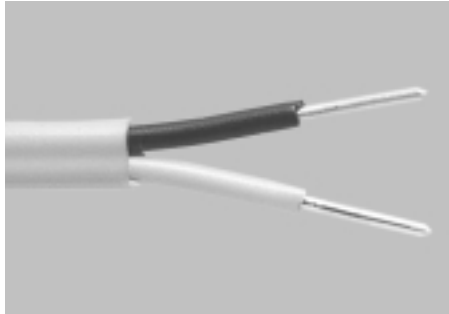
No. of Pairs	B & S Gauge	Nominal Conductor Size		Nominal Insulation Thickness		Nominal Overall Size		Approximate Shipping Weight	
				Conductor	Overall				
		inches	(mm)	inches (mm)	inches (mm)	inches	(mm)	lbs/1000 ft	(kg/km)
2	20	0.032	(0.813)	0.015 (0.381)	0.050 (1.27)	0.305	(7.75)	77	(114.7)
4	20	0.032	(0.813)	0.015 (0.381)	0.050 (1.27)	0.385	(9.78)	104	(155.0)
6	20	0.032	(0.813)	0.015 (0.381)	0.050 (1.27)	0.445	(11.30)	131	(195.2)
8	20	0.032	(0.813)	0.015 (0.381)	0.050 (1.27)	0.490	(12.45)	160	(238.4)
10	20	0.032	(0.813)	0.015 (0.381)	0.050 (1.52)	0.560	(14.22)	189	(281.6)
12	20	0.032	(0.813)	0.015 (0.381)	0.050 (1.52)	0.610	(15.49)	218	(324.8)
16	20	0.032	(0.813)	0.015 (0.381)	0.050 (1.52)	0.640	(16.26)	280	(417.2)
20	20	0.032	(0.813)	0.015 (0.381)	0.050 (1.52)	0.710	(18.03)	342	(509.6)
24	20	0.032	(0.813)	0.015 (0.381)	0.050 (1.52)	0.805	(20.45)	404	(602.0)

SERV-RITE Wire and Cable

SERV-RITE Wire and Cable

PVC Insulated 300V UL® Listed PLTC Extension Wire

UL® Series 502



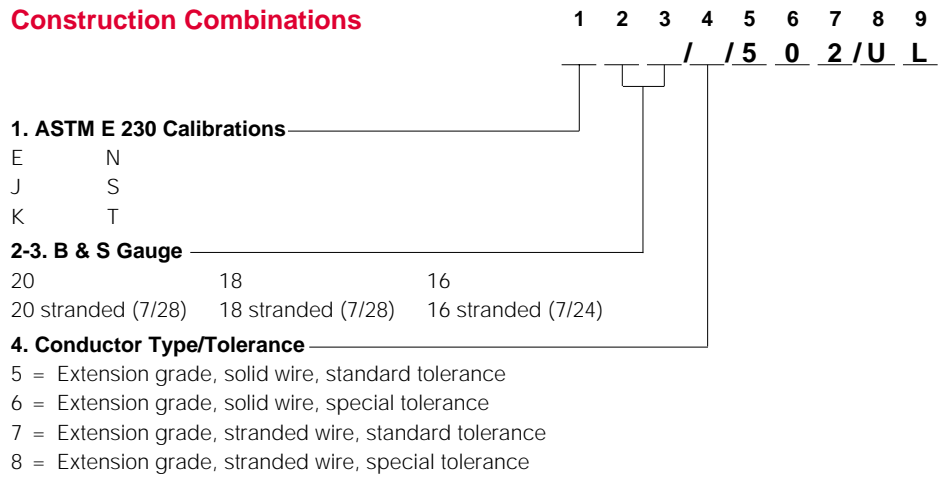
Temp.	Resistance Properties		
	Moisture	Chemical	Abrasion
220°F (105°C)	Excellent	Good	Good

UL® Series 502 is an economical wire available in UL® listings for PLTC (Power Limited Tray Cable) applications.

The primary and duplex insulation is PVC. It yields a construction that's inexpensive while performing continuously at temperatures to 220°F (105°C).

UL® Series 502 is often used in conduit and wiring trays where its flexibility allows for easy installation. The UL® Series 502 can be easily stripped using hand tools or mechanical methods.

Construction Combinations



Performance Capabilities

- Continuous temperature rating: 220°F (105°C)

Features and Benefits

- **UL® listed Type PLTC—300 volt.**
- **Listed under UL® Subject 13, File Number E116321.**
- **Extruded PVC single conductor and duplex insulation** for excellent moisture resistance.
- **Passes IEEE 383 70,000 BTU/hour flame test.**
- **Passes VW-1 flame test.**
- **Non-propagating.**

- **UV light resistant.**

- **ASTM E 230 color code** for easy identification.
- **Excellent moisture resistance, good abrasion and chemical resistance.**
- **Additional abrasion resistance** with optional stainless steel and tinned copper wire overbraids.
- **Custom constructions available, consult factory.**

Applications

- Laboratories
- Industrial equipment
- Hydrocarbon processing plants
- Automotive

Wire Specifications

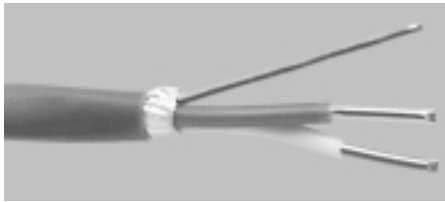
B & S Gauge	Nominal Conductor Size inches (mm)	Nominal Insulation Thickness		Nominal Overall Size inches (mm)	Approximate Shipping Weight lbs/1000 ft (kg/km)
		Conductor inches (mm)	Overall inches (mm)		
20	0.032 (0.813)	0.015 (0.381)	0.035 (0.889)	0.132 X 0.194 (3.35 X 4.93)	23 (34.3)
20 S* (7/28)	0.038 (0.965)	0.015 (0.381)	0.035 (0.889)	0.138 X 0.206 (3.50 X 5.23)	25 (37.3)
18	0.040 (1.02)	0.020 (0.508)	0.035 (0.889)	0.158 X 0.230 (3.81 X 5.48)	31 (46.2)
18 S* (7/26)	0.048 (1.22)	0.020 (0.508)	0.035 (0.889)	0.158 X 0.246 (4.01 X 6.25)	32 (47.7)
16	0.051 (1.29)	0.020 (0.508)	0.035 (0.889)	0.161 X 0.252 (4.09 X 6.40)	38 (56.6)
16 S* (7/24)	0.060 (1.52)	0.020 (0.508)	0.035 (0.889)	0.170 X 0.270 (4.32 X 6.86)	40 (59.6)

* "S" denotes stranded wire: e.g., "20 S (7/28)" is seven strands of 28 gauge wire to make a 20 gauge stranded conductor.

SERV-RITE Wire and Cable

FEP Insulated with Shield and Drain 300V UL® Listed PLTC Extension Cable

UL® Series 509



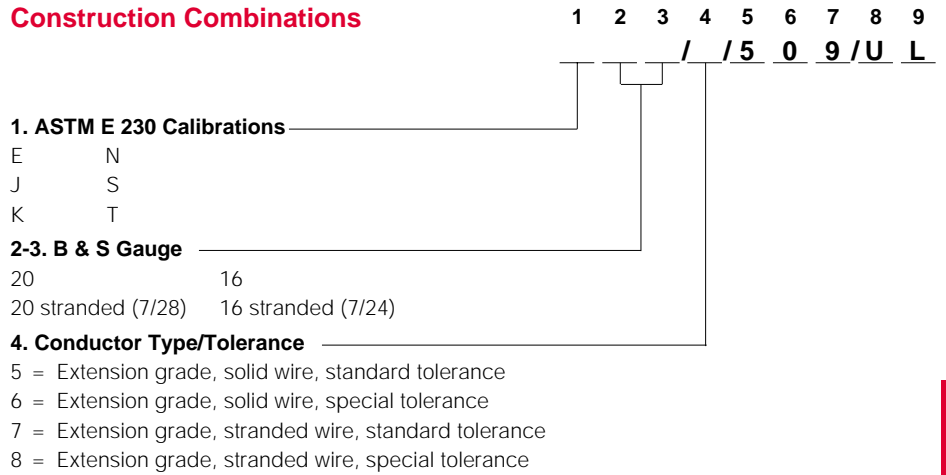
Temp.	Resistance Properties		
	Moisture	Chemical	Abrasion
400°F (204°C)	Excellent	Excellent	Excellent

The Series 509 UL® is one of a family of constructions developed especially for use with microprocessor based systems. Series 509 UL® has UL® listings for PLTC (Power Limited Tray Cable) applications.

The conductors are first insulated with color coded FEP. The conductors are then twisted with a copper drain wire. An aluminized polyester tape is wrapped around the two conductors and drain wire. Finally, an FEP layer is applied over the taped conductors.

The finished construction can withstand temperatures in excess of 400°F (204°C). The twisted conductors minimizes electromagnetic interference and the taped shield

Construction Combinations



eliminates most problems associated with AC “noise” in the sensing circuit. When better abrasion resistance is required, specify an overall metallic braid.

Performance Capabilities

- Continuous temperature rating: 400°F (204°C)
- Single reading: 500°F (260°C)

Features and Benefits

- **Extruded FEP single conductor insulation** for excellent protection.
- **Twisted; extruded FEP overall duplex insulation** to minimize electrical interference.
- **UL® listed Type PLTC—300 volt.**
- **Listed under UL® Subject 13, File Number E116321.**
- **Passes IEEE 383 70,000 BTU/hour flame test.**

- **Passes VW-1 flame test.**
- **Non-propagating.**
- **UV light resistant.**
- **Aluminum/polyester shield with drain wire** reduces electrical noise.
- **ASTM E 230 color code** for easy identification.
- **Excellent abrasion, moisture and chemical resistance.**
- **Additional abrasion resistance** with optional stainless steel and tinned copper wire overbraids.
- **Custom constructions available, consult factory.**

Applications

- Aerospace
- Industrial equipment
- Glass manufacture
- Chemical plants

SERV-RITE Wire and Cable

Wire Specifications

B & S Gauge	Nominal Conductor Size inches (mm)	Nominal Insulation Thickness		Nominal Overall Size inches (mm)	Approximate Shipping Weight lbs/1000 ft (kg/km)
		Conductor inches (mm)	Overall inches (mm)		
20	0.032 (0.813)	0.008 (0.203)	0.018 (0.457)	0.142 (3.61)	22 (32.8)
20 S* (7/28)	0.038 (0.965)	0.008 (0.203)	0.018 (0.457)	0.158 (3.91)	24 (35.8)
16	0.051 (1.29)	0.008 (0.203)	0.018 (0.457)	0.180 (4.57)	38 (56.6)
16 S* (7/24)	0.060 (1.52)	0.008 (0.203)	0.018 (0.457)	0.198 (5.03)	41 (61.1)

* "S" denotes stranded wire: e.g., "20 S (7/28)" is seven strands of 28 gauge wire to make a 20 gauge stranded conductor.

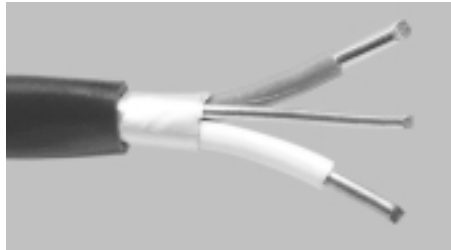


- J16/5/510/UL®
- J20/5/510/UL®
- K16/5/510/UL®
- K20/5/510/UL®

SERV-RITE Wire and Cable

PVC Insulated and Shielded 300V UL® Listed PLTC Extension Cable

UL® Series 510



Temp.	Resistance Properties		
	Moisture	Chemical	Abrasion
220°F (105°C)	Excellent	Good	Good

The UL® Series 510 is UL® listed for PLTC (Power Limited Tray Cable) applications. It's an economical PVC insulated, twisted and shielded construction for microprocessor based systems and others that are sensitive to induced voltages and "noise."

The conductors are first insulated with color coded PVC. The next operation consists of twisting the two insulated conductors with a copper drain wire. An aluminized polyester tape is then wrapped around the wires to impart 100 percent shielding. Lastly, another layer of PVC is applied.

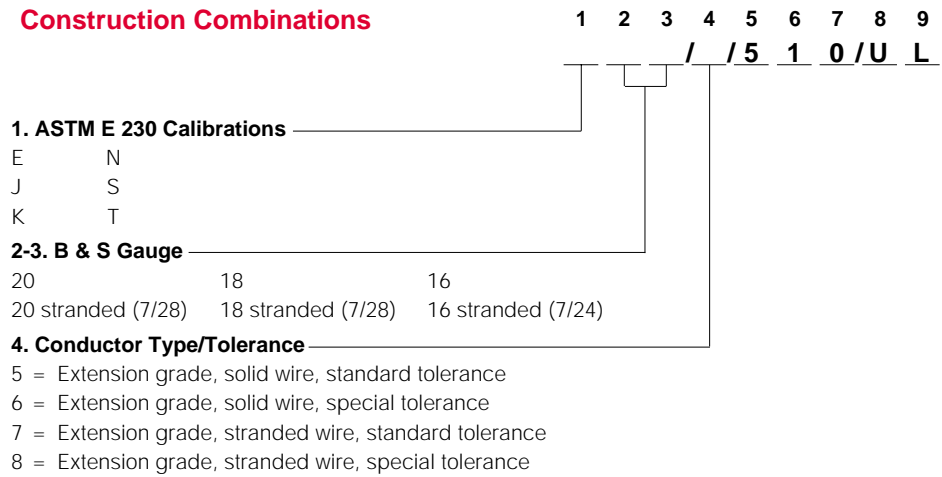
The twisting eliminates most electromagnetic interference while the shield tape minimizes AC "noise" interference.

Wire Specifications

B & S Gauge	Nominal Conductor Size inches (mm)	Nominal Insulation Thickness		Nominal Overall Size inches (mm)	Approximate Shipping Weight lbs/1000 ft (kg/km)
		Conductor inches (mm)	Overall inches (mm)		
20	0.032 (0.813)	0.015 (0.381)	0.035 (0.889)	0.198 (5.03)	27 (40.2)
20 S* (7/28)	0.038 (0.965)	0.015 (0.381)	0.035 (0.889)	0.210 (5.33)	29 (43.2)
18	0.040 (1.02)	0.020 (0.508)	0.035 (0.889)	0.234 (5.94)	35 (52.2)
18 S* (7/26)	0.048 (1.22)	0.020 (0.508)	0.035 (0.889)	0.250 (6.35)	37 (55.1)
16	0.051 (1.29)	0.020 (0.508)	0.035 (0.889)	0.256 (6.50)	48 (71.5)
16 S* (7/24)	0.060 (1.52)	0.020 (0.508)	0.035 (0.889)	0.274 (6.96)	51 (76.0)

* "S" denotes stranded wire: e.g., "20 S (7/28)" is seven strands of 28 gauge wire to make a 20 gauge stranded conductor.

Construction Combinations



For improved abrasion resistance consider a metallic overbraid.

Performance Capabilities

- Continuous temperature rating: 220°F (105°C)

Features and Benefits

- **UL® listed Type PLTC—300 volt.**
- **Listed under UL® Subject 13, File Number E116321.**
- **Extruded PVC single conductor insulation** for excellent protection.
- **Twisted; extruded PVC overall duplex insulation** to minimize electrical interference.
- **Passes IEEE 383 70,000 BTU/hour flame test.**
- **Passes VW-1 flame test.**
- **Non-propagating.**
- **UV light resistant.**

- **Aluminum/polyester shield with drain wire** reduces electrical noise.
- **ASTM E 230 color code** for easy identification.
- **Excellent moisture resistance, good abrasion and chemical resistance.**
- **Additional abrasion resistance** with optional stainless steel and tinned copper wire overbraids.
- **Custom constructions available, consult factory.**

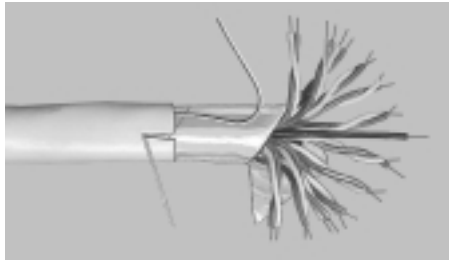
Applications

- Industrial equipment
- Automotive
- Laboratories
- Hydrocarbon processing plants

SERV-RITE Wire and Cable

PVC Insulated Multi-Pair 300V UL® Listed PLTC Extension Cable

UL® Series 900



Temp.	Resistance Properties		
	Moisture	Chemical	Abrasion
220°F (105°C)	Excellent	Good	Good

UL® Series 900 is our family of multi-pair cables* for UL® PLTC applications. Standard UL® Series 900 cables of different pair counts in most calibrations can be shipped quickly.

UL® Series 900 cable starts by insulating conductors with 220°F (105°C) PVC. For identification, one conductor of each pair is numbered and twisted with its counterpart. These “twisted pairs” are cabled with an additional insulated copper wire for communication use. The entire cable is wrapped with clear polyester tape to minimize the chance of short circuits to the

Construction Combinations

1. ASTM E 230 Calibrations

E N
J S
K T

2-3. B & S Gauge

24 20 18 16

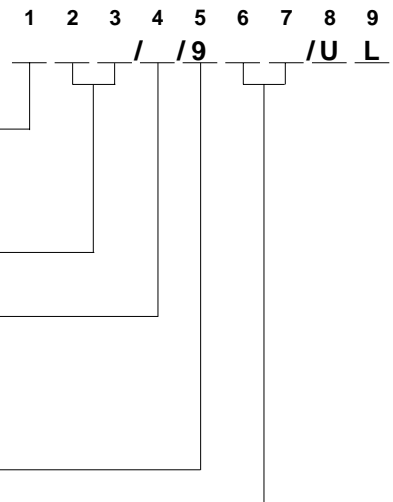
4. Conductor Type/Tolerance

5 = Extension grade, solid wire, standard tolerance
6 = Extension grade, solid wire, special tolerance
7 = Extension grade, stranded wire, standard tolerance
8 = Extension grade, stranded wire, special tolerance

5. Series 900

6-7. Pair Counts

02 04 06 08 10 12 16 20 24



cable's shield. An aluminized polyester tape shield is then spirally applied. A copper drain wire and heavy ripcord are longitudinally applied under the final jacket of color coded PVC.

For higher temperatures, UL® Series 900 can be made with FEP insulation. Multipair constructions are also available to meet specific requirements in quantities of not less than 1000 feet (305 m). Specifications should accompany any request for quotation.

Performance Capabilities

- Continuous temperature rating: 220°F (105°C)

Features and Benefits

- **UL® listed Type PLTC—300 volt.**
- **Listed under UL® Subject 13.**
- **Extruded PVC single conductor and overall insulation.**
- **Passes IEEE 383 70,000 BTU/hour flame test.**
- **Passes VW-1 flame test.**
- **Non-propagating.**
- **UV light resistant.**
- **Aluminum/polyester shield with drain wire.**
- **ASTM E 230 color code.**
- **Excellent moisture resistance, good abrasion and chemical resistance.**

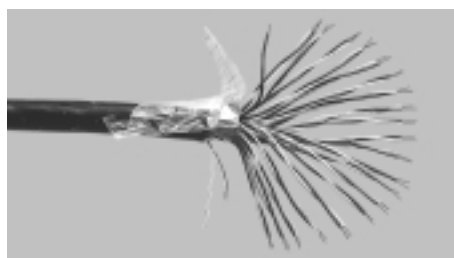
Wire Specifications

No. of Pairs	B & S Gauge	Nominal Conductor Size		Nominal Insulation Thickness		Nominal Overall Size		Approximate Shipping Weight	
				Conductor	Overall				
		inches	(mm)	inches (mm)	inches (mm)	inches	(mm)	lbs/1000 ft	(kg/km)
2	20	0.032	(0.813)	0.015	(0.381)	0.290	(7.37)	72	(107.3)
4	20	0.032	(0.813)	0.015	(0.381)	0.350	(8.89)	94	(140.1)
6	20	0.032	(0.813)	0.015	(0.381)	0.405	(10.29)	116	(172.8)
8	20	0.032	(0.813)	0.015	(0.381)	0.440	(11.18)	140	(208.6)
10	20	0.032	(0.813)	0.015	(0.381)	0.490	(12.45)	164	(244.4)
12	20	0.032	(0.813)	0.015	(0.381)	0.535	(13.59)	188	(280.1)
16	20	0.032	(0.813)	0.015	(0.381)	0.610	(15.49)	240	(357.6)
20	20	0.032	(0.813)	0.015	(0.381)	0.650	(16.51)	292	(435.1)
24	20	0.032	(0.813)	0.015	(0.381)	0.710	(18.03)	344	(512.6)

SERV-RITE Wire and Cable

PVC Insulated Multi-Pair 300V UL® Listed PLTC Extension Cable with Individual and Overall Shield

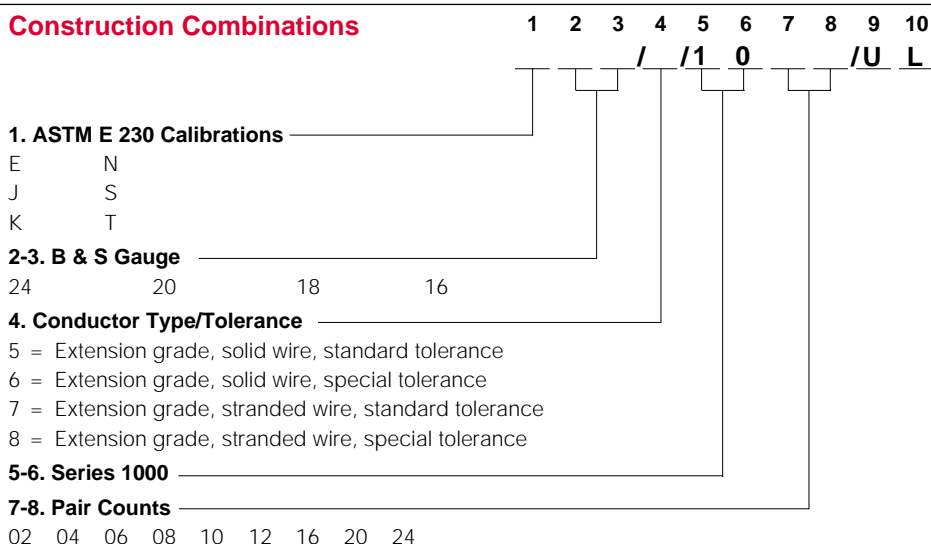
UL® Series 1000



Temp.	Resistance Properties		
	Moisture	Chemical	Abrasion
220°F (105°C)	Excellent	Good	Good

UL® Series 1000 is our family of individually shielded and isolated multipair cables* for UL® PLTC applications. UL® Series 1000 cables are made by insulating conductors with 220°F (105°C) PVC. For identification, one conductor of each pair is numbered and twisted with its counterpart. The pairs are then spirally wrapped with an aluminized polyester tape and drain wire to isolate them in the cable. This eliminates "noise" that can exist in a circuit.

Construction Combinations



Individual pairs are then cabled with an additional insulated copper wire for communication use. These cables are ideal for data signals.

For higher temperature applications, UL® Series 1000 can be made with FEP insulation. Special multipair constructions are also available to meet specific requirements in quantities of not less than 1000 feet (305 m). Specifications should accompany any request for quotation.

Performance Capabilities

- Continuous temperature rating: 220°F (105°C)

Features and Benefits

- UL® listed Type PLTC—300 volt.
- Listed under UL® Subject 13.
- Extruded PVC single conductor and overall insulation.
- Passes IEEE 383 70,000 BTU/hour flame test.
- Passes VW-1 flame test.
- Non-propagating.
- UV light resistant.
- Aluminum/polyester shield with drain wire.
- ASTM E 230 color code.
- Excellent moisture resistance, good abrasion and chemical resistance.

Wire Specifications

No. of Pairs	B & S Gauge	Nominal Conductor Size		Nominal Insulation Thickness		Nominal Overall Size		Approximate Shipping Weight	
				Conductor	Overall				
		inches	(mm)	inches (mm)	inches (mm)	inches	(mm)	lbs/1000 ft	(kg/km)
2	20	0.032	(0.813)	0.015 (0.381)	0.050 (1.27)	0.305	(7.75)	77	(114.7)
4	20	0.032	(0.813)	0.015 (0.381)	0.050 (1.27)	0.385	(9.78)	104	(155.0)
6	20	0.032	(0.813)	0.015 (0.381)	0.050 (1.27)	0.445	(11.30)	131	(195.2)
8	20	0.032	(0.813)	0.015 (0.381)	0.050 (1.27)	0.490	(12.45)	160	(238.4)
10	20	0.032	(0.813)	0.015 (0.381)	0.060 (1.52)	0.560	(14.22)	189	(281.6)
12	20	0.032	(0.813)	0.015 (0.381)	0.060 (1.52)	0.610	(15.49)	218	(324.8)
16	20	0.032	(0.813)	0.015 (0.381)	0.060 (1.52)	0.640	(16.26)	280	(417.2)
20	20	0.032	(0.813)	0.015 (0.381)	0.060 (1.52)	0.710	(18.03)	342	(509.6)
24	20	0.032	(0.813)	0.015 (0.381)	0.060 (1.52)	0.805	(20.45)	404	(602.0)

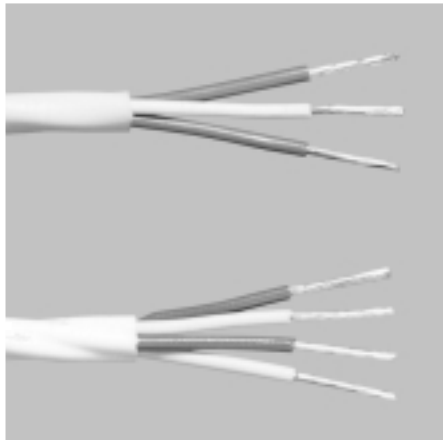


• RT3/22/4/701

SERV-RITE Wire and Cable

PVC Insulated RTD Leadwire

Series 701



Temp.	Resistance Properties		
	Moisture	Chemical	Abrasion
220°F (105°C)	Excellent	Good	Good

Watlow Gordon's quality, experience and versatility carry over from insulated thermocouple and extension wire to RTD leadwire. Series 701 is offered in three- and four-wire constructions, and available from stock to cover many industrial RTD applications.

Construction Combinations

3. Number of Conductors

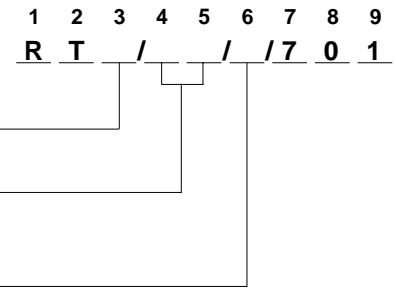
2 3 4

4-5. B & S Gauge

24 22 20
18 16

6. Conductor Type/Tolerance

4 = Stranded tinned copper



Each conductor is insulated and color coded with extruded PVC insulation. The conductors are then twisted for added flexibility and covered with an overall PVC insulation.

Performance Capabilities

- Continuous temperature rating: 220°F (105°C)

Features and Benefits

- **Extruded PVC single conductor and overall insulation** for protection.
- **Twisted conductors for reduced electrical interference.**
- **Color coded conductors** for easy installation.

- **Excellent moisture resistance, good abrasion and chemical resistance.**
- **Additional abrasion resistance** with optional stainless steel and tinned copper wire overbraids.
- **Custom constructions available, consult factory.**

SERV-RITE Wire and Cable

Wire Specifications

Number of Conductors	B & S Gauge*	Nominal Conductor Size		Nominal Insulation Thickness		Nominal Overall Size	Approximate Shipping Weight		
				Conductor	Overall				
		inches	(mm)	inches (mm)	inches (mm)	inches (mm)	lbs/1000 ft	(kg/km)	
2	22 S** (7/30)	0.030	(0.762)	0.015	(0.381)	0.160	(4.06)	17	(25.3)
	20 S** (7/28)	0.038	(0.965)	0.015	(0.381)	0.176	(4.47)	19	(28.3)
	18 S** (7/26)	0.048	(1.22)	0.020	(0.508)	0.226	(5.74)	22	(32.8)
3	22 S** (7/30)	0.030	(0.762)	0.015	(0.381)	0.172	(4.37)	20	(29.8)
	20 S** (7/28)	0.038	(0.965)	0.015	(0.381)	0.190	(4.83)	25	(37.3)
	18 S** (7/26)	0.048	(1.22)	0.020	(0.508)	0.244	(6.20)	30	(44.7)
4	22 S** (7/30)	0.030	(0.762)	0.015	(0.381)	0.184	(4.67)	23	(34.3)
	20 S** (7/28)	0.038	(0.965)	0.015	(0.381)	0.204	(5.18)	30	(44.7)
	18 S** (7/26)	0.048	(1.22)	0.020	(0.508)	0.262	(6.65)	37	(55.1)

* 24 and 16 gauge constructions also available, consult factory for details.

** "S" denotes stranded wire: e.g., "22 S (7/30)" is seven strands of 30 gauge wire to make a 22 gauge stranded conductor.

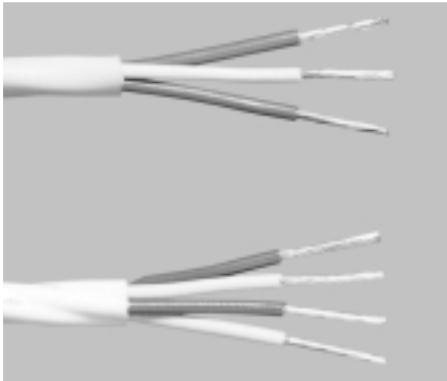


• RT3/22/8/704

SERV-RITE Wire and Cable

FEP Insulated RTD Leadwire

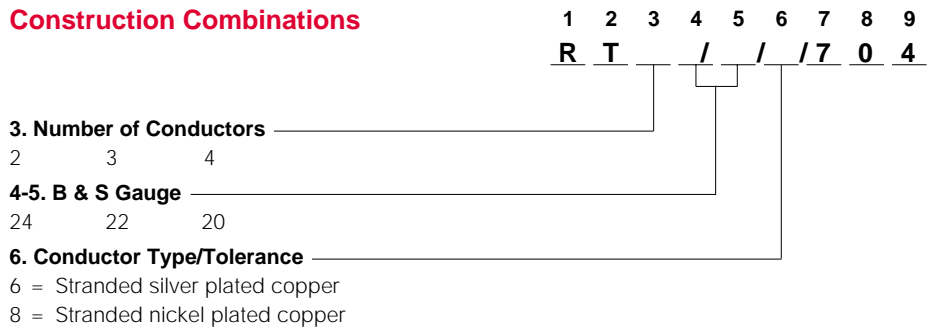
Series 704



Temp.	Resistance Properties		
	Moisture	Chemical	Abrasion
400°F (204°C)	Excellent	Excellent	Excellent

Watlow Gordon's quality, experience and versatility carry over from insulated thermocouple and extension wire to RTD leadwire. Series 704 is offered in two-, three- and four-wire constructions, and available from stock to cover many industrial RTD applications.

Construction Combinations



Each conductor is insulated and color coded with extruded FEP insulation. The conductors are then twisted for added flexibility and covered with an overall FEP insulation.

Performance Capabilities

- Continuous temperature rating: 400°F (204°C)
- Single reading: 500°F (260°C)

Features and Benefits

- **Extruded FEP single conductor and overall insulation** for protection.

- **Twisted conductors for reduced electrical interference.**
- **Color coded conductors** for easy installation.
- **Excellent moisture, abrasion and chemical resistance.**
- **Additional abrasion resistance** with optional stainless steel and tinned copper wire overbraids.
- **Custom constructions available, consult factory.**

Wire Specifications

Number of Conductors	B & S Gauge	Nominal Conductor Size		Nominal Insulation Thickness		Nominal Overall Size		Approximate Shipping Weight	
				Conductor	Overall				
		inches	(mm)	inches (mm)	inches (mm)	inches (mm)	inches (mm)	lbs/1000 ft	(kg/km)
2	24 S* (7/32)	0.024	(0.610)	0.008 (0.203)	0.012 (0.305)	0.118 (3.00)	12	(17.9)	
2	22 S* (7/30)	0.030	(0.762)	0.008 (0.203)	0.012 (0.305)	0.130 (3.30)	14	(20.9)	
2	20 S* (7/28)	0.038	(0.965)	0.008 (0.203)	0.012 (0.305)	0.146 (3.71)	17	(25.3)	
3	24 S* (7/32)	0.024	(0.610)	0.008 (0.203)	0.012 (0.305)	0.126 (3.20)	16	(23.8)	
3	22 S* (7/30)	0.030	(0.762)	0.008 (0.203)	0.012 (0.305)	0.140 (3.56)	20	(29.8)	
3	20 S* (7/28)	0.038	(0.965)	0.008 (0.203)	0.012 (0.305)	0.158 (4.01)	24	(35.8)	
4	24 S* (7/32)	0.024	(0.610)	0.008 (0.203)	0.012 (0.305)	0.136 (3.46)	19	(28.3)	
4	22 S* (7/30)	0.030	(0.762)	0.008 (0.203)	0.012 (0.305)	0.150 (3.81)	23	(34.3)	
4	20 S* (7/28)	0.038	(0.965)	0.008 (0.203)	0.012 (0.305)	0.170 (4.32)	27	(40.2)	

* "S" denotes stranded wire: e.g., "24 S (7/32)" is seven strands of 32 gauge wire to make a 24 gauge stranded conductor.

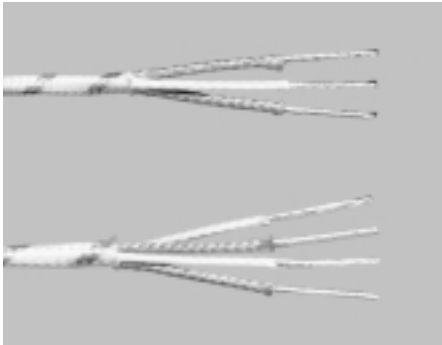
• RT3/24/8/705



SERV-RITE Wire and Cable

Fiberglass Braided RTD Leadwire

Series 705



Temp.	Resistance Properties		
	Moisture	Chemical	Abrasion
900°F (480°C)	Good	Good	Fair

Watlow Gordon's quality, experience and versatility carry over from insulated thermocouple and extension wire to RTD leadwire. Series 705 is offered in three- and four-wire constructions, and available from stock to cover many industrial RTD applications.

Construction Combinations

3. Number of Conductors

2 3 4

4-5. B & S Gauge

24 22 20

6. Conductor Type/Tolerance

6 = Stranded silver plated copper

8 = Stranded nickel plated copper

1 2 3 4 5 6 7 8 9
R T / / / 7 0 5

Each conductor is covered with a color coded fiberglass braid insulation that's impregnated with a modified resin. The conductors are then twisted for added flexibility and covered with a fiberglass braid impregnated with a modified resin.

Performance Capabilities

- Continuous temperature rating: 900°F (480°C)
- Single reading: 1000°F (540°C)

Features and Benefits

- **Fiberglass braid single conductor and overall insulation** impregnated with modified resin for protection.

- **Twisted conductors** for reduced electrical interference.
- **Color coded conductors** for easy installation.
- **Good moisture and chemical resistance, fair abrasion resistance.**
- **Additional abrasion resistance** with optional stainless steel and tinned copper wire overbraids.

SERV-RITE Wire and Cable

Wire Specifications

Number of Conductors	B & S Gauge	Nominal Conductor Size		Nominal Insulation Thickness		Nominal Overall Size		Approximate Shipping Weight	
				Conductor	Overall				
		inches	(mm)	inches (mm)	inches (mm)	inches (mm)	inches (mm)	lbs/1000 ft	(kg/km)
2	24 S* (7/32)	0.024	(0.610)	0.005 (0.127)	0.006 (0.152)	0.080	(2.03)	6	(8.9)
2	22 S* (7/30)	0.030	(0.762)	0.005 (0.127)	0.006 (0.152)	0.092	(2.34)	7	(10.4)
2	20 S* (7/28)	0.038	(0.965)	0.006 (0.152)	0.006 (0.152)	0.112	(2.84)	9	(13.4)
3	24 S* (7/32)	0.024	(0.610)	0.005 (0.127)	0.006 (0.152)	0.086	(2.18)	8	(11.9)
3	22 S* (7/30)	0.030	(0.762)	0.005 (0.127)	0.006 (0.152)	0.098	(2.49)	9	(13.4)
3	20 S* (7/28)	0.038	(0.965)	0.006 (0.152)	0.006 (0.152)	0.120	(3.05)	12	(17.9)
4	24 S* (7/32)	0.024	(0.610)	0.005 (0.127)	0.006 (0.152)	0.092	(2.34)	10	(14.9)
4	22 S* (7/30)	0.030	(0.762)	0.005 (0.127)	0.006 (0.152)	0.106	(2.69)	12	(17.9)
4	20 S* (7/28)	0.038	(0.965)	0.006 (0.152)	0.006 (0.152)	0.130	(3.30)	16	(23.8)

* "S" denotes stranded wire: e.g., "24 S (7/32)" is seven strands of 32 gauge wire to make a 24 gauge stranded conductor.

SERV-RITE Wire and Cable

Bare Thermocouple Alloy

ASTM E 230 Types J, K, T, E and N

Watlow Gordon can provide uninsulated thermocouple alloys for your temperature sensing needs. These are the same quality products used to manufacture our own insulated wire, XACTPAK metal sheathed cable, sensors and specialty components. Many wire products from 2 to 36 AWG may be available for off the shelf shipment in standard or special limits of error.

In addition to the listed products Watlow Gordon can provide other gauge sizes, stranded thermocouple wire, extension grade wire, compensating wire, strip and ribbon items. Consult the factory with your specific requirements for pricing and availability.

Bare Thermocouple Wire—ASTM E 230 Types J and K

B & S Gauge	KP ^① Code No.	Feet per lb	KN ^① Code No.	Feet per lb	JP Code No.	Feet per lb	JN ^② Code No.	Feet per lb
2	1475/2	5	1476/2	5	—	—	—	—
6	1475/6	13	1476/6	13	—	—	—	—
8	1475/8	21	1476/8	21	1565/8	23	1566/8	20
14	1475/14	83	1476/14	83	1565/14	91	1566/14	80
16	1475/16	130	1476/16	130	1565/16	145	1566/16	128
18	1475/18	212	1476/18	212	1565/18	231	1566/18	204
20	1475/20	331	1476/20	331	1565/20	365	1566/20	332
22	1475/22	530	1476/22	530	1565/22	586	1566/22	514
24	1475/24	838	1476/24	838	1565/24	926	1566/24	818
26	1475/26	1340	1476/26	1340	1565/26	1476	1566/26	1300
28	1475/28	2130	1476/28	2130	1565/28	2360	1566/28	2071
30	1475/30	3370	1476/30	3370	1565/30	3740	1566/30	3290
32	1475/32	5260	1476/32	5340	1565/32	5840	1566/32	5185
36	1475/36	13480	1476/36	16480	1565/36	14950	1566/36	13280

① KP and KN 2 ga. to 14 ga. products are oxide finished, all other sizes are bright annealed finish.

② JN must be matched with JP to meet ASTM E 230 Type J calibration. JP and JN must be purchased together as a matched pair only. Order TN (1625) for non-thermocouple applications where constantan alloy is desired.

Bare Thermocouple Wire—ASTM E 230 Types T and E

B & S Gauge	EP Code No.	Feet per lb	TP Code No.	Feet per lb	EN & TN Code No.	Feet per lb
8	1475/8	21	—	—	1625/8	20
14	1475/14	83	1665/14	80	1625/14	80
16	1475/16	130	1665/16	128	1625/16	128
18	1475/18	212	1665/18	204	1625/18	204
20	1475/20	331	1665/20	332	1625/20	332
22	1475/22	530	1665/22	514	1625/22	514
24	1475/24	838	1665/24	818	1625/24	818
26	1475/26	1340	1665/26	1300	1625/26	1300
28	1475/28	2130	1665/28	2071	1625/28	2071
30	1475/30	3370	1665/30	3290	1625/30	3290
32	1475/32	5260	1665/32	5237	1625/32	5155

SERV-RITE Wire and Cable

Bare Thermocouple
Alloy
ASTM E 230
Types B, R, S and C

ASTM E 230 Type B* (6%/30%)—Standard Grade

Size of Wire		BP Code No.	Inches Per Troy Oz. (Approx.)	BN Code No.	Inches Per Troy Oz. (Approx.)
B & S Gauge	O.D. in				
24	0.0201	2330/24	294	2306/24	343
30	0.0100	2330/30	1373	2306/30	1176

*Type B thermocouples and thermoelements meet ITS-90. BP and BN thermoelements must be ordered as a matched pair.

ASTM E 230 Types R and S—Standard Grade ITS-90**

Size of Wire		RN, SN Code No.	Inches Per Troy Oz. (Approx.)	SP Code No.	Inches Per Troy Oz. (Approx.)	RP Code No.	Inches Per Troy Oz. (Approx.)
B & S Gauge	O.D. in						
23	0.0225	2300/23	222	2310/23	241	2313/23	246
24	0.0201	2300/24	282	2310/24	302	2313/24	308
30	0.0100	2300/30	1127	2310/30	1209	2313/30	1234

ASTM E 230 Types R and S—Reference Grade[®], ITS-90**

Size of Wire		RN, SN Code No.	Inches Per Troy Oz. (Approx.)	SP Code No.	Inches Per Troy Oz. (Approx.)	RP Code No.	Inches Per Troy Oz. (Approx.)
B & S Gauge	O.D. in						
24	0.0201	2300/24/SP	282	2310/24/SP	302	2313/24/SP	308
30	0.0100	2300/30/SP	1127	2310/30/SP	1209	2313/30/SP	1234

[®] Accuracy 0.10% from 600 to 1450 °C (1112 to 2642 °F).

** Types R and S thermocouples and thermoelements are provided in accordance with ITS-90.

Type C (Non-ASTM E 230)

Tungsten 5% Rhenium / Tungsten 26% Rhenium. Calibrated accuracy as a matched pair is guaranteed to conform to Part 44 of the 1978 annual book of ASTM standards in the Related Material Section within $\pm 8^\circ\text{F}$ ($\pm 4^\circ\text{C}$) from room temperature to 800°F (425°C) and $\pm 1\%$ from 800°F to 4200°F (425 to 2315°C).

Size of Wire		Code No. Double Inch
B & S Gauge	O.D. inch	
24	0.0201	2556/24
30	0.0100	2556/30
36	0.0050	2556/36

SERV-RITE Wire and Cable

How to Order

When ordering SERV-RITE thermocouple and extension wire, remember to include the following information:

- **Calibration:** B, C*, E, J, K, N, R, S or T
- **Gauge Size:** B & S gauge
- **Solid or Stranded Conductors:** Stranded conductors will be seven strand constructions. If your requirements need other configurations, please consult the factory.
- **Thermocouple or Extension Grade:** Will this be used for the actual sensor or just to “extend” the signal at lower temperatures.
- **Standard or Special Limits of Error:** This will determine the accuracy of your sensor.
- **Insulation on Singles and Duplex:** These are usually the same material which is chosen for the environment in which the sensor will be used. If special designs are required, consult factory for details.
- **Color Coding:** Unless specified, all color coding will be to ASTM E 230 standards.

- **Spool Lengths:** Spool lengths should be specified as to your requirements. Watlow Gordon tries to maintain a policy of shipping 1,000 foot spools, however, if not specified, random lengths may be shipped. If you have special packaging requirements, please consult factory.
- **Variation in Quantity:** Watlow Gordon follows the industry standard of shipping and invoicing at plus or minus 10 percent of any ordered item. If your requirements dictate anything other than plus or minus ten percent, consult factory as there may be additional charges.
- **Overbraid Options:** If an overbraid is required, the options are presented below.
- **Overbraid Selection Code:**
 - S**–Stainless Steel Wire Braid
 - C**–Tinned Copper Wire Braid
 - W**–Flat Stainless Steel Spiral Wrap
 - G**–Half Oval Galvanized Steel Spiral Wrap
 - N**–Alloy 600 Wire Braid

Each Series page lists these options. Special requirements and testing are available at additional cost. Consult factory for details. These include:

- **Shielding:** Some constructions are available with shielding possibilities.
- **Calibration Tests:** If calibration is required, please specify the temperatures.
- **Certificate of Compliance:** These may be provided to various specifications. When ordering, please provide specification requirements.
- **Special Requirements:** Please consult the factory for any requirements not covered above.

Availability

Stock constructions: Same day shipment on orders received before 11:00 am (CST)

Stock constructions with options: Shipment in five working days or less

Stock constructions requiring calibration or other laboratory services: Shipment in five working days or less

Made-to-order: Two to five weeks, consult factory for details

*Not an ASTM E 230 symbol

Mineral Insulated Metal-Sheathed Cable

XACTPAK® Cable

Watlow helped pioneer XACTPAK® mineral insulated, metal-sheathed cable. The unique properties of XACTPAK make it ideally suited to solve a wide variety of problem applications.

The outer sheath can be made from any malleable metal in a wide range of diameters, containing single or multiple wires. Easily formed or bent, it can accommodate virtually any configuration. The outer sheath protects thermocouple or thermocouple extension wires from oxidation and hostile environments that would quickly destroy unprotected wire.

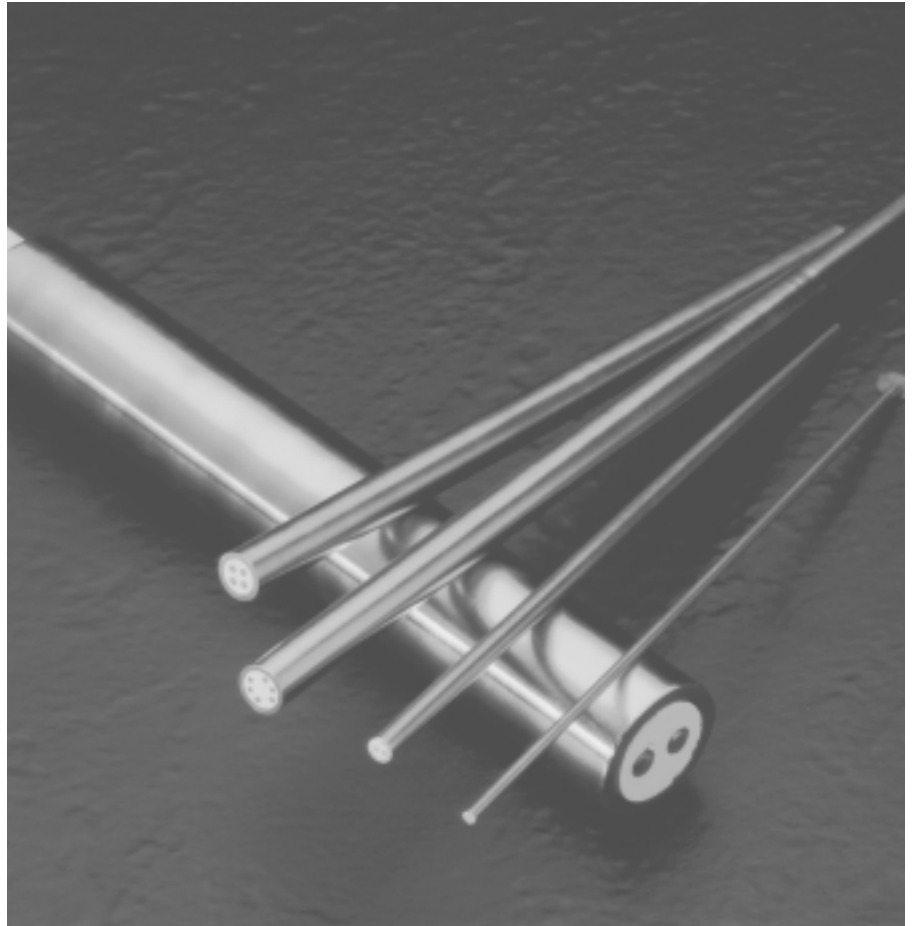
The mineral insulations available provide excellent high temperature dielectric strength to ensure signals are carried faithfully to your instrumentation or controls.

Performance Capabilities

- Available in standard and special calibrations
- Diameters down to 0.010 (0.25 mm)
- Compliance with recognized agency tolerances and specifications
- Sheath materials available to withstand a wide variety of hostile and corrosive environments
- Calibrated for intended temperature range
- Temperature ranges from 32 to 2700°F (0 to 1480°C)
- Cryogenic cable available upon request

Features and Benefits

- **Fireproof** to perform where conventionally insulated wires burn and degrade.
- **Fast, accurate response** for precise temperature measurement.
- **Gas tight and moisture proof** to resist contamination.



- **High pressure rated** for pressure vessel and vacuum applications.
 - **Formable and weldable**, adaptable to virtually any application.
 - **Cold and thermal shock resistant** to withstand thermal cycling.
 - **Corrosion resistant, durable and compact** for long life performance with minimum constraints on applications.
 - **High temperature rated** to meet demanding applications.
- Applications**
- Atomic research
 - Bearing temperature
 - Blast furnaces
 - Catalytic reformers
 - Diesel engines
 - Food and beverage
 - Furnaces
 - Glass and ceramic
 - Heat treating
 - Instrument cabling
 - Jet engines and test cells
 - Kilns
 - Laboratory and research
 - Medical
 - Nuclear reactors
 - Power stations and steam generators
 - Refineries and oil processing
 - Rocket engines
 - Semiconductor processing
 - Turbines
 - Vacuum furnaces

Mineral Insulated Metal-Sheathed Cable

XACTPAK Cable

Technical Data

XACTPAK Calibration Temperatures

Calibration	Standard Calibration Points (°F)
B	1600, 2000, 2200*, 2700*
E	300, 500, 1000, 1600
J	200, 500, 1000, 1500
K	300, 500, 1000, 1600, 2000*, 2200*
N	300, 500, 1000, 1600, 2000*, 2200*
R	1000, 1500, 2000, 2700*
S	1000, 1500, 2000, 2700*
T	200, 500

*These calibration temperatures are checked if the sheath, sheath diameter and insulation are rated to this temperature.

Quality Control and Testing

To maintain quality and consistency, XACTPAK cable is manufactured under carefully controlled procedures and rigid standards of cleanliness. Quality checks are made at critical points throughout the manufacturing process.

All XACTPAK cable is inspected and tested for sheath condition, insulation density, conductor uniformity, electrical continuity, insulation resistance, calibration conformance and physical dimension. Special testing and certification—including helium leak, homogeneity, metallurgical examination, and dye penetrant, among others—are available on request.

Quality Assurance

Every coil of XACTPAK cable is thoroughly tested for continuity, insulation resistance, physical dimensions and physical appearance.

Each lot, or batch of XACTPAK contains raw materials (sheath, insulation, wires) from one production lot which eliminates the need to calibrate every thermocouple cut from a coil because of poor homogeneity.

Samples from each lot are calibrated in our modern calibration laboratory by highly skilled technicians. Unlike some manufacturers who calibrate at a few low temperature calibration points, Watlow calibrates throughout the range that the cable is designed for.



For a more complete discussion of Watlow's advanced technological capabilities, refer to the laboratory services section, pages 29 to 34.

Care, Handling and Fabrication of XACTPAK Cable

To maximize the performance advantages made possible by XACTPAK cable's overall premium quality, the following instructions covering its storage, handling and further fabrication should be observed:

Storage

To prevent moisture from being absorbed by its hygroscopic mineral insulation, both ends of each length of XACTPAK cable are sealed at the factory. To further guard against moisture penetration, it is advisable to store XACTPAK material in a dry place.

Moisture

If XACTPAK cable is not adequately sealed, its insulation will absorb moisture. This will lower its electrical resistance and may prove to be troublesome in subsequent welding. Minor moisture penetration can be remedied by using a blow torch to heat the sheath. Apply the flame six to seven inches from the open end and slowly work the flame to and over the end. Reseal the end after it has cooled to about 180°F. Deep moisture penetration is unlikely, but should it occur the material may be baked at approximately 250°F for 24 hours to bring up its insulation resistance. If baking does not bring the insulation resistance back to acceptable levels, the material should be discarded.

Mineral Insulated Metal-Sheathed Cable

XACTPAK Cable

Technical Data

Care, Handling and Fabrication of XACTPAK Cable

Continued

Cutting

When pieces are cut off a length of XACTPAK cable the exposed ends should immediately be squared and sealed. Squaring and sealing will guard against possible contamination and remove any loosened insulation or distorted wire caused by cutting. A light pressure sanding with a 180-grit belt is the easiest method for rough squaring of 0.040 inch or larger diameter XACTPAK cable. Using hard pressure against the sanding belt will cause excessive heat build-up which may "smear" the soft metal over the insulation. After sanding, a clean fine toothed file should be used to dress the squared ends. Each exposed end should then be sealed with XACTSEAL to prevent moisture absorption.

Inexperienced personnel may find 0.032 inch or smaller diameter XACTPAK cable difficult to handle and will probably prefer to have all cutting, stripping and fabricating done at our factory.

Insulation Resistance

XACTPAK mineral insulated, metal-sheathed cable should have a minimum room temperature insulation resistance of 100 megohms when tested at 50V $\overline{=}$ (dc) both wires to sheath and wire to wire.

All ceramics used in XACTPAK cable will decrease in resistance as temperature increases.

Shipping and Packaging

XACTPAK cable is stocked in random lengths from 20 feet to the "Maximum Stock Lengths" listed in the tables on the following pages. We reserve the right to supply random lengths of our choice unless specific cut lengths are specified on your order.

On request, XACTPAK cable can be furnished in other coil dimensions or shipped in straight form when necessary. Longer lengths are available on special order.

Stripping

A hand stripping tool will readily remove the sheath from 0.010 through 0.125 inch diameter XACTPAK cable. However, due to the difficulty of working with 0.032 inch or smaller diameter material, it is recommended that small diameter material be ordered factory stripped. Material larger than 0.125 inch diameter can be stripped on a lathe with a suitable tool bit or lathe-mounted stripping tool. It is also possible to strip larger sizes of XACTPAK cable by using a hacksaw to make a ring cut through the sheath at the desired distance from the end. Hammering the severed portion of sheath at several places will break up the insulation allowing the sheath to be slipped off. After stripping, the exposed conductors should be sandblasted or cleaned with emery cloth. The exposed ends should be resealed immediately after completion of the stripping operation.

Forming

Because XACTPAK cable's sheath is dead soft and bright annealed, it can be formed and shaped to most contours without risk of cracking. As a rule of thumb, the sheath can be formed around a mandrel twice the sheath diameter without damage. In other words, 0.125 inch diameter XACTPAK cable can be wound around a 0.250 inch diameter mandrel.

Mineral Insulated Metal-Sheathed Cable

XACTPAK Cable

Technical Data

Care, Handling and Fabrication of XACTPAK Cable

Continued

Welding

Because of the delicate nature of the work and to avoid possible contamination, it is recommended that the fabrication of "hot" or "measuring" junctions be done at our factory.

If they are attempted in the field, a welding rod of the same material as the sheath should be used, and the welding method should be by inert

gas. Flux should not be used as it will contaminate the insulation.

Other weldments, such as to a vessel or pipe, should be made in an inert atmosphere to prevent oxidation of the sheath. When working with XACTPAK cable of 0.040 inch outside diameter or less, extreme caution should be used not to burn through the sheath.

How to Select XACTPAK Cable to Suit Your Requirements

Our mineral insulated metal-sheathed cable section has been designed for ease of use so that the right cable is chosen for each application. The following four items must be considered when selecting XACTPAK mineral insulated metal-sheathed cable:

1. Sheath Material

The sheath serves to isolate and protect the wires and insulation from contamination and mechanical damage. There is no sheath material which is appropriate for all conditions so Watlow offers a wide variety to choose from. Temperature, strength, corrosiveness, service life and cost must be considered when selecting a sheath material.

2. Calibration

Watlow stocks all ASTM recognized thermocouple types along with many that have not been recognized, such

as the full line of tungsten rhenium thermocouples. We also manufacture cable with other wire alloys such as nickel, copper, nickel clad copper, 304 SS, Alloy 600 and virtually any malleable metal.

3. Insulation Material

The insulation separates the conductors from each other and the outer sheath. When selecting insulation, temperature rating, environment and cost must be taken into account.

4. Physical Characteristics

The diameter of the sheath and the wall thickness will directly affect the following:

- Time response
- Service life
- Flexibility
- Pressure rating
- Strength

Mineral Insulated Metal-Sheathed Cable

XACTPAK Cable

Sheath Material

The following information is designed to be used as a guide and may not be correct in every application. If in doubt, consult with your Watlow sales engineer or the factory.

Alloy 600

01—Maximum temperature: 2150°F (1175°C). Most widely used thermo-couple 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.

304 SS

02—Maximum temperature: 1650°F (900°C). 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 900 to 1600°F (480 to 870°C) range. Lowest cost *corrosion resistant* sheath material available.

310 SS

03—Maximum temperature: 2100°F (1150°C). Mechanical and corrosion resistance, similar to but better than 304 SS. Very good heat resistance. This alloy contains 25% chromium, 20% nickel. Not as ductile as 304 SS.

316 SS

04—Maximum temperature: 1650°F (900°C). Best corrosion resistance of the austenitic stainless steel grades. Widely used in the food and chemical industry. Subject to damaging carbide precipitation in 900 to 1600°F (482 to 870°C) range.

2-3. Sheath Material

CODE

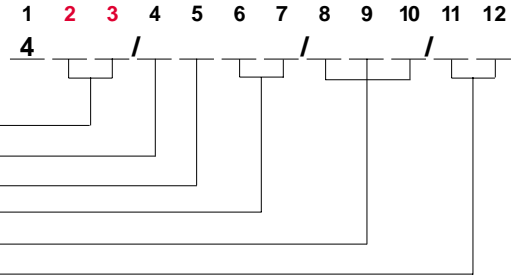
4. Calibration

5. Insulation

6-7. Sheath O.D.

8-10. Variation

11-12. Limits of Error



347 SS

05—Maximum temperature: 1600°F (870°C). Similar to 304 SS except nickel niobium stabilized. This alloy is designed to overcome susceptibility to carbide precipitation in the 900 to 1600°F (480 to 870°C) range. Used in aerospace and chemical applications.

304L

11—Maximum temperature: 1650°F (900°C). Low carbon version of 304 SS (02). Low carbon content allows this material to be welded and heated in the 900 to 1600°F (480 to 870°C) range without damage to corrosion resistance.

Nickel 201

12—Maximum temperature: 2000°F (1095°C). Commercially pure wrought nickel with low carbon. Used in molten salt bath furnaces. Offers good resistance to caustic alkalis and fluorine.

446 SS

13—Maximum temperature: 2100°F (1150°C). Ferritic stainless steel which has good resistance to sulfurous atmospheres at high temperatures. Good corrosion resistance to nitric acid, sulfuric acid and most alkalis. 27 percent chromium content gives this alloy the highest heat resistance of any ferritic stainless steel.

321 SS

16—Maximum temperature: 1600°F (870°C). Similar to 304 SS except titanium stabilized for inter-granular corrosion. This alloy is designed to overcome susceptibility to carbon precipitation in the 900 to 1600°F (480 to 870°C) range. Used in aerospace and chemical applications.

Hastelloy®X

18—Maximum temperature: 2200°F (1205°C). Widely used in aerospace applications. Resistant to oxidizing, reducing and neutral atmospheric conditions. Excellent high temperature strength along with superior oxidation resistance. Resistant to stress corrosion cracking in petrochemical applications.

Inconel® 601

19—Maximum temperature: 2150°F (1175°C) continuous, 2300°F (1260°C) intermittent. Similar to Alloy 600 with the addition of aluminum for outstanding oxidation resistance. Designed for high temperature corrosion resistance. This material is good in carburizing environments, and has good creep rupture strength. *Do not use in vacuum furnaces!* Susceptible to intergranular attack by prolonged heating in 1000 to 1400°F (540 to 760°C) temperature range.

Hastelloy® is a registered trademark of Haynes International.

Inconel® is a registered trademark of the Inco family of companies.

Mineral Insulated Metal-Sheathed Cable

XACTPAK Cable

Sheath Material

Continued

316L

22—Maximum temperature: 1650°F (900°C). Same as 316 SS (04) except low carbon version allows for better welding and fabrication.

Incoloy® 800

23—Maximum temperature: 2000°F (1095°C). Widely used as heater sheath material. Minimal use in thermocouples. Superior to Alloy 600 in sulfur, cyanide salts and fused neutral salts. Susceptible to inter-granular attack in some applications by exposure to the temperature range of 1000 to 1400°F (540 to 760°C).

Inconel® 625

25—Maximum temperature: 1800°F (980°C). Used in many aerospace applications. Excellent high temperature strength. Excellent resistance to pitting and crevice corrosion. Unaffected by radiation embrittlement.

Monel® 400

28—Maximum temperature: 1000°F (540°C) in oxidizing conditions. Nickel-copper alloy with good corrosion resistance. Excellent resistance to sea water, hydrofluoric acid, sulfuric acid, hydrochloric acid and most alkalis.

Alloy 188

30—Maximum temperature 2100°F (1150°C). Cobalt base austenitic alloy. High strength along with oxidation and corrosion resistance to 2100°F (1150°C) make this alloy useful in aerospace, nuclear, chemical and process industries.

2-3. Sheath Material

CODE

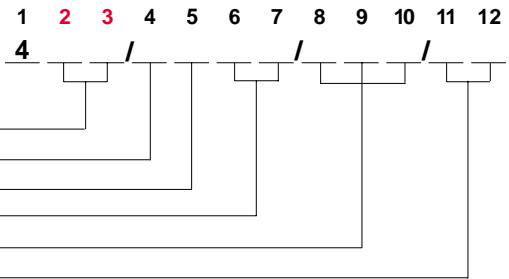
4. Calibration

5. Insulation

6-7. Sheath O.D.

8-10. Variation

11-12. Limits of Error



Haynes® Alloy 230

32—Maximum temperature: 2100°F (1150°C). This alloy offers excellent high temperature strength, oxidation resistance and long term thermal stability. Used in aerospace applications, chemical process industries and high temperature industrial heating applications. This alloy is recommended for use in nitriding environments.

Hastelloy® C-276

33—Maximum temperature: 2000°F (1095°C). Widely used in chemical applications. Excellent corrosion resistance, especially in chlorinated environments. Resistant to ferric and cupric chlorides, solvents, chlorine, formic acids, acetic acids, brine, wet chlorine gas and hypochlorite.

Haynes® Alloy 556

34—Maximum temperature: 2000°F (1095°C). This multipurpose alloy offers good resistance to sulfidizing, carburizing and chlorine-bearing environments. Applications include waste incinerators, petroleum processes where sulfur is present, chloride salt baths, exhaust gas thermocouples, recuperator thermocouples and for process thermocouples in molten zinc applications such as galvanizing.

Inconel® Alloy X-750

36—Maximum temperature 1500°F (815°C). Precipitation hardenable alloy similar to Alloy 600. High tensile and creep rupture properties combined with resistance to corrosion and oxidation. Used in aerospace and petrochemical applications.

Haynes® Alloy HR-160

38—Maximum temperature 2150°F (1175°C). Developed to provide superior sulfidation-resistance at high temperatures. This alloy shows good resistance to corrosion in some salt bath applications. Applications include sulfur furnaces, waste incinerators, coke burners, recuperators, cement kilns and high temperature furnaces.

Incoloy® and Monel® are registered trademarks of the Inco family of companies.

Haynes® is a registered trademark of Haynes International.

Mineral Insulated Metal-Sheathed Cable

XACTPAK Cable

Calibration

ASTM Type J

1—Type J's positive leg (JP) is iron. Its negative leg (JN) is approximately 45 percent nickel-55 percent copper. When protected by compacted mineral insulation and outer sheath, Type J is usable from 32 to 1500°F (0 to 815°C). Type J is not susceptible to short range ordering in the 700 to 1000°F (0 to 538°C) temperature range, (+2 to +4°F drift) which occurs with ASTM Type E and K. This low cost, stable thermocouple calibration is primarily used with 96 percent pure MgO insulation and stainless steel sheath.

ASTM Type K

2—Type K's positive leg (KP) is approximately 90 percent nickel-10 percent chromium. Its negative leg (KN) is approximately 95 percent nickel-2 percent aluminum-2 percent manganese-1 percent silicon. When protected by compacted mineral insulation and outer sheath, Type K is usable from -32 to 2300°F (-35 to 1260°C). If the application is between 600 to 1100°F, we recommend Type J or N because of short range ordering that can cause drift of +2 to +4°F in a few hours time. Type K is relatively stable to radiation transmission in nuclear environments. For applications below 32°F, special alloy selections are usually required.

2-3. Sheath Material

4. Calibration

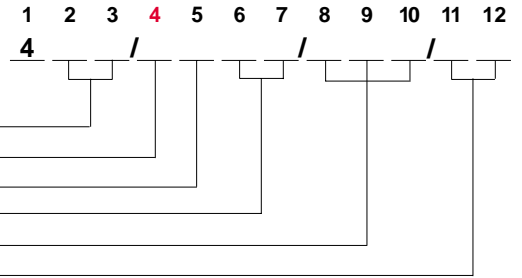
CODE

5. Insulation

6-7. Sheath O.D.

8-10. Variation

11-12. Limits of Error



ASTM Type T

3—Type T's positive leg (TP) is pure copper. Its negative leg (TN) is approximately 45 percent nickel-55 percent copper. When protected by compacted mineral insulation and outer sheath, Type T is usable from 32 to 660°F (0 to 350°C) and very stable in cryogenic and low temperature applications. For applications below 32°F special alloy selections may be required.

ASTM Type E

4—Type E's positive leg (EP) is approximately 90 percent nickel-10 percent chromium. Its negative leg (EN) is approximately 45 percent nickel-55 percent copper. When protected by compacted mineral insulation and outer sheath, Type E is usable from 32 to 1650°F (0 to 900°C) and has the highest EMF output per degree of all ASTM types. If the application temperature is between 600 to 1100°F, we recommend Type J or N because of short range ordering which can cause drift of +1 to +3°F in a few hours time. For applications below 32°F, special alloy selections may be required.

ASTM Type N

8—Type N's positive leg (nicrosil) is approximately 14 percent chromium-1.4 percent silicon-84.6 percent nickel. Its negative leg (nihil) is approximately 4.4 percent silicon-95.6 percent nickel. When protected by compacted mineral insulation and outer sheath, it's usable from 32 to 2300°F (0 to 1260°C). Type N overcomes several problems inherent in Type K. Short range ordering, (+2 to +4°F drift), in the 600 to 1100°F (315 to 590°C) range is greatly reduced, and drift rate at high temperatures is considerably less. Type N is also more stable than Type K in nuclear environments.

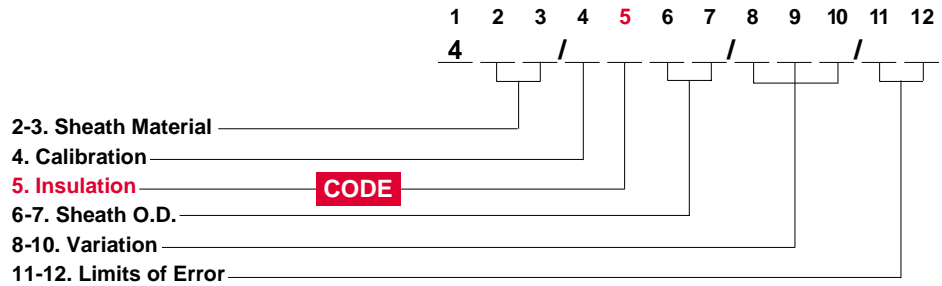
Miscellaneous

9—Consult factory.

Mineral Insulated Metal-Sheathed Cable

XACTPAK Cable

Insulation



High Purity Magnesium Oxide (MgO) 99.4% Minimum Purity

1—Low impurity levels make this insulation very useful for all thermocouple calibrations up to 2500°F (1370°C). Above 2500°F we recommend using hafnia oxide insulation because of MgO's low resistivity. This material meets the requirements established in ASTM E-235.

Alumina Oxide (Al₂O₃) 99.6% Minimum Purity

2—Although this material is comparable to MgO in its electrical properties and cost, it does not compact well and tends to "powder out." This undesirable characteristic has made this insulation unpopular in industry so cable with this type of insulation is available only as a "special."

Magnesium Oxide (MgO) 96% Minimum Purity

5—This low cost insulation is similar to high purity MgO (1) except it should be used in applications below 2000°F (1095°C) because of the impurity levels. This insulation *should not* be used with platinum or in nuclear applications.

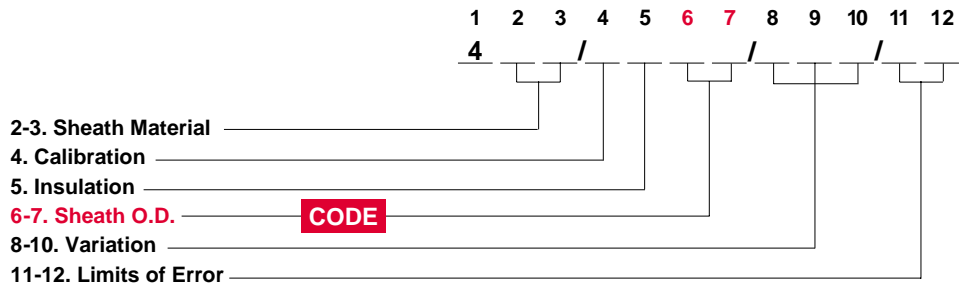
Hafnia Oxide (HfO₂)

7—Hafnia is now being used as a substitute for beryllia oxide because of beryllia's toxicity problem. The temperature limit of hafnia is 4530°F (2500°C) which is higher than BeO.

Mineral Insulated Metal-Sheathed Cable

XACTPAK Cable

Sheath O.D.



Sheath Diameter		Code No.	Approximate Standard Coil	Weight lbs/100 ft.	Average Response Time* Still Water (seconds)	
					G-JCT	U-JCT
0.020 in	+0.001 -0.0005	01	9 inch	0.08	<0.02	0.03
0.032 in	+0.001 -0.0005	02	9 inch	0.20	0.02	0.07
0.040 in	+0.001 -0.0005	03	9 inch	0.32	0.04	0.13
0.063 in	±0.001	04	24 inch	0.74	0.220	0.4
0.090 in	±0.001	05	24 inch	1.5	0.33	0.68
0.114 in	+0.002 -0.001	06	24 inch	2.45	0.38	0.85
0.125 in	+0.002 -0.001	07	24 inch	3.00	0.50	1.1
0.188 in	+0.002 -0.001	08	24 inch	6.65	1.0	2.3
0.250 in	+0.003 -0.001	11	24 inch	11.65	2.2	4.1
0.313 in	+0.003 -0.001	12	24 inch	19.60	5.0	7.0
0.375 in	+0.003 -0.001	13	straight or 40 inch coils	28.10	8.0	11.0
0.430 in	+0.003 -0.001	14	straight or 40 inch coils	35.0	11.0	15.0
0.500 in	+0.003 -0.001	15	straight or 40 inch coils	47.0	15.0	20.0
0.010 in	+0.001 -0.0005	16	9 inch	0.019	<0.02	<0.02
0.011 in	+0.001 -0.0005	17	9 inch	0.022	<0.02	<0.02
0.0126 in	+0.001 -0.0005	18	9 inch	0.029	<0.02	<0.02
0.025 in	+0.001 -0.0005	19	9 inch	0.13	<0.02	0.05
0.5 mm	±0.02	51	23 cm	0.08	<0.02	0.03
1.0 mm	±0.02	52	23 cm	0.32	0.04	0.13
1.5 mm	±0.02	53	61 cm	0.65	<0.15	0.35
2.0 mm	±0.03	54	61 cm	1.13	0.25	0.55
3.0 mm	±0.03	55	61 cm	2.60	0.40	0.90
4.5 mm	±0.03	56	61 cm	6.0	0.95	2.0
6.0 mm	±0.05	57	61 cm	10.5	2.0	3.5
8.0 mm	±0.05	58	61 cm	19.65	5.0	7.0
9.0 mm	±0.05	59	61 cm	25.0	7.5	10.0

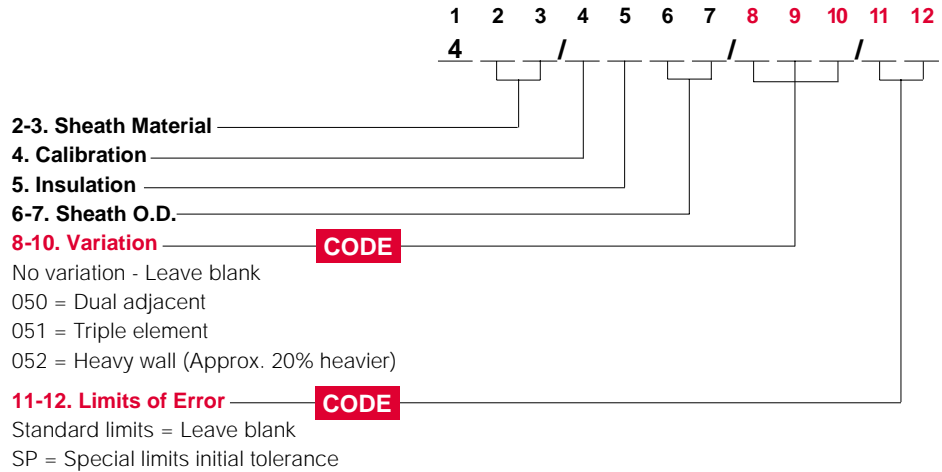
XACTPAK Cable

*Note: First order response time 63.2%.

Mineral Insulated Metal-Sheathed Cable

XACTPAK Cable

Variation/Limits of Error



Single Element

(Normally stocked for off-the-shelf delivery)

Code* No.	Calibration	Sheath Material	Insulation	Nominal B & S Gauge	Nominal Wall Thickness in	Maximum Stock Length ft	Maximum Recommended Operating Temperature °F (°C)
Sheath O.D. 0.020 inches							
+0.001 -0.0005							
Fine diameter, quick time response. Greater availability of calibration types and sheath materials.							
401/2101	K	Alloy 600	99.4% MgO	38	0.003	100	1600 (871)
402/2101	K	304 SS	99.4% MgO	38	0.003	100	1600 (871)
Sheath O.D. 0.032 inches							
+0.001 -0.0005							
Easier to fabricate than 0.020 but faster time response than 0.040.							
401/2102	K	Alloy 600	99.4% MgO	34	0.004	150	1600 (871)
Sheath O.D. 0.040 inches							
+0.001 -0.0005							
Wide range of sheath materials and calibrations. Quick time response.							
401/1103	J	Alloy 600	99.4% MgO	32	0.006	250	1500 (816)
401/2103	K	Alloy 600	99.4% MgO	32	0.006	250	1600 (871)
402/1103	J	304 SS	99.4% MgO	32	0.006	250	1500 (816)
404/2103	K	316 SS	99.4% MgO	32	0.006	250	1600 (871)
Sheath O.D. 0.063 inches							
±0.001							
One of the more common diameters used. Wide range of calibrations, sheath materials, and accessory hardware available.							
401/2104	K	Alloy 600	99.4% MgO	28	0.009	1000	2000 (1093)
401/2504	K	Alloy 600	96% MgO	28	0.009	1000	2000 (1093)
404/1504	J	316 SS	96% MgO	28	0.009	1000	1500 (816)
404/2504	K	316 SS	96% MgO	28	0.009	1000	1600 (871)
Sheath O.D. 0.090 inches							
±0.001							
An unusual diameter used by a limited number of customers.							
401/2505	K	Alloy 600	96% MgO	25	0.012	750	2000 (1093)

CONTINUED

*To specify special limits add to code number: /SP

Mineral Insulated Metal-Sheathed Cable

XACTPAK Cable

Single Element

Continued

Code* No.	Calibration	Sheath Material	Insulation	Nominal B & S Gauge	Nominal Wall Thickness in	Maximum Stock Length ft	Maximum Recommended Operating Temperature °F (°C)
Sheath O.D. 0.125 inches +0.002 -0.001			The most popular size we sell. Widest combination of sheath materials and calibrations. Long life yet surprisingly good time response.				
401/2107	K	Alloy 600	99.4% MgO	22	0.017	900	2150 (1177)
401/2507	K	Alloy 600	96% MgO	22	0.017	900	2000 (1093)
401/8107	N	Alloy 600	99.4% MgO	22	0.017	900	2150 (1177)
402/1507	J	304 SS	96% MgO	22	0.017	900	1500 (816)
402/2107	K	304 SS	99.4% MgO	22	0.017	900	1600 (871)
402/2507	K	304 SS	96% MgO	22	0.017	900	1600 (871)
402/3507	T	304 SS	96% MgO	22	0.017	500	662 (350)
403/2507	K	310 SS	96% MgO	22	0.017	900	2000 (1093)
404/2507	K	316 SS	96% MgO	22	0.017	900	1600 (871)
404/3507	T	316 SS	96% MgO	22	0.017	500	662 (350)
404/4507	E	316 SS	96% MgO	22	0.017	900	1600 (871)
418/2107	K	Hastelloy® X	99.4% MgO	22	0.017	125	2200 (1204)
Sheath O.D. 0.188 inches +0.002 -0.001			Heavier duty, longer life than 0.063 or 0.125, but slower time response is the trade-off.				
401/2108	K	Alloy 600	99.4% MgO	19	0.025	350	2150 (1177)
401/2508	K	Alloy 600	96% MgO	19	0.025	350	2000 (1093)
402/1508	J	304 SS	96% MgO	19	0.025	350	1500 (816)
402/2508	K	304 SS	96% MgO	19	0.025	350	1600 (871)
403/2508	K	310 SS	96% MgO	19	0.025	350	2000 (1093)
404/1508	J	316 SS	96% MgO	19	0.025	350	1500 (816)
404/2508	K	316 SS	96% MgO	19	0.025	350	1600 (871)
Sheath O.D. 0.250 inches +0.003 -0.001			Heavy duty industrial grade with wide availability of calibrations and sheaths as well as accessory items.				
401/1511	J	Alloy 600	96% MgO	16	0.033	220	1500 (816)
401/2111	K	Alloy 600	99.4% MgO	16	0.033	220	2150 (1177)
401/2511	K	Alloy 600	96% MgO	16	0.033	220	2000 (1093)
402/1511	J	304 SS	96% MgO	16	0.033	220	1500 (816)
402/2511	K	304 SS	96% MgO	16	0.033	220	1600 (871)
403/2511	K	310 SS	96% MgO	16	0.033	220	2000 (1093)
404/1511	J	316 SS	96% MgO	16	0.033	220	1500 (816)
404/2511	K	316 SS	96% MgO	16	0.033	220	1600 (871)
Sheath O.D. 0.313 inches +0.003 -0.001			Large diameter material for abusive applications where time response is not the primary consideration.				
401/2512	K	Alloy 600	96% MgO	14	0.041	150	2000 (1093)
Sheath O.D. 0.375 inches +0.003 -0.002			Heavy sheath wall and large diameter conductors make this a workhorse, but don't look for fast time response or flexibility.				
401/2513	K	Alloy 600	96% MgO	13	0.052	100	2000 (1093)

*To specify special limits add to code number: /SP

Mineral Insulated Metal-Sheathed Cable

XACTPAK Cable

Double Element— Adjacent Conductors

Code* No.	Calibration	Sheath Material	Insulation	Nominal B & S Gauge	Nominal Wall Thickness in	Maximum Stock Length ft	Maximum Recommended Operating Temperature °F (°C)
Sheath O.D. 0.125 inches +0.002 -0.001		Double the wall thickness of our 0.063 material and considerably larger conductors. Longer life and easier fabrication.					
401/2507/050	K	Alloy 600	96% MgO	24	0.017	900	2000 (1093)
404/1507/050	J	316 SS	96% MgO	24	0.017	900	1500 (816)
Sheath O.D. 0.188 inches +0.002 -0.001		Heavier duty and a wider range of sheath offerings make this a popular size.					
402/1508/050	J	304 SS	96% MgO	21	0.025	350	1500 (816)
Sheath O.D. 0.250 inches +0.003 -0.001		Our best seller in dual element. Heavy duty for long life.					
401/2511/050	K	Alloy 600	96% MgO	18	0.033	220	2000 (1093)
401/4511/050	E	Alloy 600	96% MgO	18	0.033	220	1600 (871)
404/1511/050	J	316 SS	96% MgO	18	0.033	220	1500 (816)

*To specify special limits add to code number: /SP

XACTSEAL

Watlow developed a premium sealant for sealing the exposed ends of XACTPAK sheathed type material against moisture penetration. At room temperature, thin layers of the sealant air-dry in approximately one hour. It may be baked at up to 250°F (120°C) to accelerate drying. The sealant comes ready to use from its

own container; use G.E. #1500 or equivalent should a thinner be needed. XACTSEAL is a temporary sealant. For long term storage we recommend that the ends of the cable be seal welded.

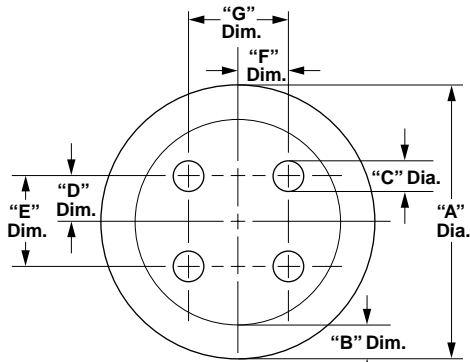
Code No.	Description
8010	4 oz. dispenser can

Mineral Insulated Metal-Sheathed Cable

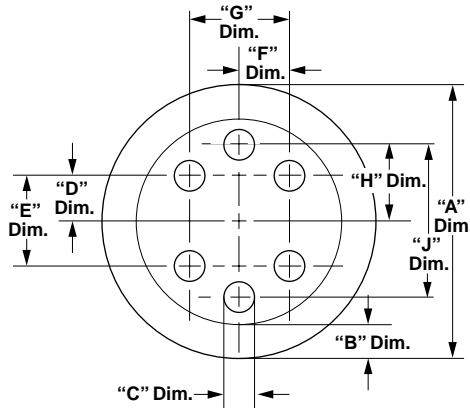
XACTPAK Cable

Mineral Insulated Metal-Sheathed RTD Cable

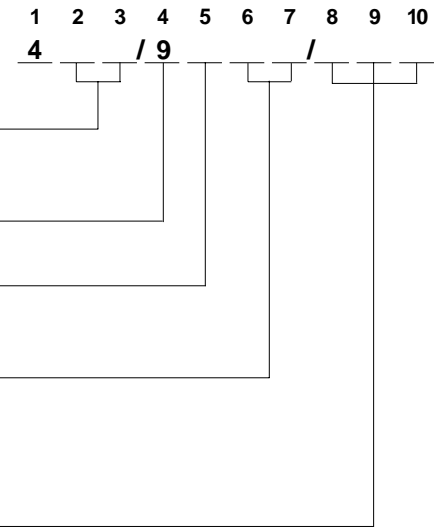
This cable is used for making rugged RTD probes. Special spacing allows room for elements to be placed between conductors. Dimensions are shown below.



4 Conductor RTD MIMS Cable



6 Conductor RTD MIMS Cable



2-3. Sheath Material

- 01 = Alloy 600
- 04 = 316 SS

4. Wire

- 9 = Nickel 201

5. Wire Insulation

- 1 = 99.4% MgO
- 5 = 96% MgO

6-7. Sheath O.D.

- 07 = 0.125 inch diameter
- 08 = 0.188 inch diameter
- 11 = 0.250 inch diameter
- 12 = 0.313 inch diameter

8-10. Variation

- 001 = 6-Wire
- 003 = 4-Wire

A Diameter	B Wall Thickness	C Diameter	Spacing Nominal			
			D Dim.	E Dim.	F Dim.	G Dim.
0.125 +0.002 -0.001	0.015 ± 0.002	0.014 ± 0.002	0.022	0.045	0.025	0.050
0.188 +0.002 -0.001	0.023 ± 0.002	0.020 ± 0.002	0.034	0.068	0.037	0.074
0.250 +0.003 -0.001	0.030 ± 0.005	0.027 ± 0.003	0.045	0.090	0.050	0.100
0.313 +0.003 -0.001	0.038 ± 0.005	0.032 ± 0.003	0.056	0.112	0.062	0.124

A Dim.	B Dim.	C Dim.	D Dim.	E Dim.	F Dim.	G Dim.	H Dim.	J Dim.
0.125 +0.002 -0.001	0.015 ± 0.002	0.014 ± 0.002	0.022	0.045	0.025	0.050	0.034	0.068
0.188 +0.002 -0.001	0.023 ± 0.002	0.020 ± 0.002	0.034	0.068	0.037	0.074	0.052	0.104
0.250 +0.003 -0.001	0.030 ± 0.005	0.027 ± 0.003	0.045	0.090	0.050	0.100	0.068	0.137
0.313 +0.003 -0.001	0.038 ± 0.005	0.032 ± 0.003	0.056	0.112	0.062	0.124	0.085	0.170

XACTPAK Cable

Stock

Code Number	Number of Nickel 201 Conductors	Sheath Material	Insulation	Conductor Size	Nominal Wall Thickness	Maximum Stock Length	Maximum Recommended Operating Temperature
401/9108/001	6	Alloy 600	99.4% MgO	0.020 inches	0.023 inches	75 feet	1400°F
401/9108/003	4	Alloy 600	99.4% MgO	0.020 inches	0.023 inches	75 feet	1400°F
404/9108/001	6	316 SS	99.4% MgO	0.020 inches	0.023 inches	75 feet	1000°F
404/9108/003	4	316 SS	99.4% MgO	0.020 inches	0.023 inches	75 feet	1000°F
404/9508/003	4	316 SS	96% MgO	0.020 inches	0.023 inches	75 feet	1000°F
401/9111/001	6	Alloy 600	99.4% MgO	0.027 inches	0.030 inches	45 feet	1400°F
401/9111/003	4	Alloy 600	99.4% MgO	0.027 inches	0.030 inches	45 feet	1400°F
404/9111/001	6	316 SS	99.4% MgO	0.027 inches	0.030 inches	45 feet	1000°F
404/9511/001	6	316 SS	96% MgO	0.027 inches	0.030 inches	45 feet	1000°F
404/9511/003	4	316 SS	96% MgO	0.027 inches	0.030 inches	45 feet	1000°F

Mineral Insulated, Metal-Sheathed Cable

XACTPAK Cable

Made-to-order Mineral-Insulated (MI) Cable

In addition to our full line of metal-sheathed, mineral-insulated thermocouple cable, we will also manufacture metal-sheathed, mineral-insulated signal cable with copper, stainless steel or other conductor materials to meet many specialized requirements. (MI) cable incorporating one or more conductors can be made from a large variety of sheath and insulation materials. Properly selected combinations of materials provide (MI) cable with these outstanding performance features:

- It is totally impervious to moisture.
- It can withstand extremes of temperature and pressure.
- It can endure highly oxidizing or corrosive conditions.
- It adapts well to nuclear applications because of its low neutron capture cross section which is unaffected by radiation heating. (Selected sheaths and calibrations.)
- It can be easily formed to a radius equal to approximately twice its diameter without insulation breakdown. It maintains its shape after forming.

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

4 / / /

2-3. Sheath Material

00 = Unused	22 = 316L
01 = Alloy 600	23 = Incoloy® 800
02 = 304 SS	25 = Inconel® 625
03 = 310 SS	28 = Monel®-400
04 = 316 SS	30 = Alloy 188
05 = 347 SS	32 = Haynes® Alloy 230
11 = 304L	33 = Haynes® Alloy C276
12 = Nickel 201	34 = Haynes® Alloy 556
13 = 446 SS	36 = Inconel® X-750
16 = 321 SS	38 = Alloy HR-160
18 = Hastelloy® X	99 = Miscellaneous
19 = Inconel® 601	

4. Calibration

0 = 0-Unused	4 = E
1 = J	8 = N
2 = K	9 = Misc.
3 = T	

5. Insulation

0 = Unused	7 = Hafnia oxide
1 = Magnesium oxide 99.4%	8 = Unassigned
2 = Alumina oxide 99.6%	9 = Miscellaneous
5 = Magnesium oxide 96%	

6-7. Sheath O.D. [inch (mm)]

00 = Unassigned	08 = 0.188	16 = 0.010	55 = (3.0 ± 0.03)
01 = 0.020	09 = Unused	17 = 0.011	56 = (4.5 ± 0.03)
02 = 0.032	10 = Unused	18 = 0.0126	57 = (6.0 ± 0.05)
03 = 0.040	11 = 0.250	19 = 0.025	58 = (8.0 ± 0.05)
04 = 0.063	12 = 0.313	51 = (0.5 ± 0.02)	59 = (9.0 ± 0.05)
05 = 0.090	13 = 0.375	52 = (1.0 ± 0.02)	99 = Miscellaneous
06 = 0.114	14 = 0.430	53 = (1.5 ± 0.02)	
07 = 0.125	15 = 0.500	54 = (2.0 ± 0.03)	

8-10. Variation

Leave blank = No variation
 001 = Dual diagonal
 050 = Dual adjacent
 051 = Triple element
 052 = Heavy wall
 (Approximately 20% heavier)

Examples

401/2107
 401/2107/SP
 402/1511/050/SP

11-12. Limits of Error

Standard = Leave blank
 Special limits = SP

Mineral Insulated, Metal-Sheathed Cable

XACTPAK Cable

Made-to-order Mineral-Insulated (MI) Cable

Continued

Be sure to provide the following information when requesting a quotation for special **made-to-order** (MI) cable:

- **Sheath material**
- **Insulation type**
- **Insulation purity**
- **Calibration**
- **Required conductor size**
- **Wall thickness of the sheath**
- **Minimum acceptable lengths**

Availability

Stock including standard calibration points: Same day shipment on orders received before 11:00 am

Stock requiring special calibration: Shipment in three working days or less

Made-to-order: Two to five weeks, consult factory for details

How to Order

This section presents the information you need to specify and order XACTPAK cable. For unique applications, there's also an example on **made-to-order** cables. Simply follow the code number examples to specify the desired sheath material, calibration, insulation, sheath outside diameter, variation (if required) and the desired limits of error. In addition to specifying your XACTPAK cable, you'll need

to also specify quantity, coil lengths and other special requirements. These include packaging, sealing, certificate of compliance to specification and special testing. As with any Watlow product, our extensive laboratory services are able to handle your most unique requirements. If for any reason you need additional help, please contact your nearest Watlow representative for assistance.

1. Select code number.

See [pages 225-230](#) on how to select your code number, based on your specific requirements.

2. Specify quantity.

3. Specify coil lengths. Random—the factory selects for you (20 foot minimum). Special—specify lengths and tolerance.

4. Specify any other requirement such as:

- Packaging
- Sealing
- Certificate of compliance to specification
- Special testing

Terms and Conditions

Quantity and Weights:

Products purchased and sold hereunder shall be those for which Buyer submits an Order which is accepted by Watlow. Watlow's quantities shall govern unless proved to be in error. On Orders for Products carried in stock, Watlow will deliver the ordered quantity specified. However, in the manufacture of Products it is agreed that Watlow will be allowed production losses. Watlow shall have the right to manufacture, deliver and invoice for partial deliveries of Products as stated below:

Quantity Ordered	Delivery Variation
1-4	No variation
5-24	± 1 unit
25-74	± 2 units
75-99	± 3 units
100+	± 3 percent
SERV-RITE® Insulated Wire and Cable	± 10 percent
XACTPAK® Sheathed Wire	± 10 percent

Note: Watlow will deliver exact quantities on Products with a net price of \$100.00 or more. If Buyer expressly requests no variation in delivered quantity of Products with a total net price under \$100.00, a ten percent (10%) surcharge will be added to the net billing on the invoice for such Order.

Delivery:

F.O.B. Watlow's Plant. Risk of loss shall pass to Buyer on delivery at the F.O.B. point. Watlow shall prepay freight, assure the shipment and select the means of transportation unless Buyer provides specific written instructions otherwise with Buyer's order. Watlow shall not be bound to tender delivery of any quantities for which Buyer has not given shipping instructions. Watlow shall be entitled to designate from time to time the locations from which Buyer may receive or pick up Products.

Payment Terms:

Terms are net 30 days upon approved credit. Prices and discounts are subject to change without notice. All quotations are valid for 30 days unless otherwise stated.

Restocking Charges:

Stock heaters, controls, sensors and accessories which have not been used or modified may be returned to the relevant

Watlow Plant for a twenty percent (20%) restocking charge. For Watlow's Hannibal Plant Products only, modified-stock Products may be returned if not permanently modified, for a minimum thirty percent (30%) restocking charge. All stock and modified-stock Products require Watlow's prior authorization to be returned and must be returned within one hundred twenty (120) days from the date of delivery. Controls may not be returned if the packaging seal is broken. Non-stock (custom) heaters, controls, sensors and accessories are not returnable.

Price Revision:

Prices are subject to change without advance notice. If Watlow desires to revise the discounts, prices, points of delivery, service allowances or terms of payment but is restricted to any extent against so doing by reason of any governmental request, law, regulation, order or action, or if the discounts, prices, points of delivery, service allowances or terms of payment then in effect are altered by reason of governmental request, law, regulation, order or action, Watlow shall have the right (i) to terminate this Order by notice to Buyer, (ii) to suspend deliveries for the duration of such restriction or alteration or (iii) to have applied to this Order (as of the effective date of such restriction or alteration) any discounts, prices, points of delivery, service allowances or terms of payment governmentally acceptable. Any delivery suspended under this Section may be canceled without liability.

Return Policy:

Prior approval must be obtained from the relevant Watlow Plant to return any Product. Watlow will assign a return authorization number and record the reason for the return. Watlow will examine returned Product to determine the actual cause, if any, leading to Buyer's return. If Product has a manufacturing defect, Watlow, in its sole discretion, may issue a credit for the returned Product or repair or replace with like Product. If returned Product is not subject to Watlow's warranty, Buyer will be notified of the estimated cost of repair, if possible. Thereafter, Buyer must advise Watlow whether or not Buyer chooses to have Product repaired at Buyer's expense.

Order Changes:

Buyer must notify Watlow in writing of requested changes in the quantity, drawings, designs or specifications for Products which are ordered but not yet in the process of manufacture. After receipt of such notice, Watlow will inform Buyer of any adjustments to be made in price, delivery schedules, etc. resulting from Buyer's requested changes prior to incorporating requested changes into manufactured Products. Control Products require written notice of requested changes not less than sixty (60) days prior to last scheduled shipping date.

Freight and Taxes:

Prices do not include prepaid freight, federal, state or local taxes. Any increase in freight rates paid by Watlow on deliveries covered by this Order and hereafter becoming effective and any tax or governmental charge or increase in same (excluding any franchise or income tax or other tax or charge based on income) (i) increasing the cost to Watlow of producing, selling or delivering Products or of procuring Products used therein or, (ii) payable by Watlow because of the production, sale or delivery of Products, such as Sales Tax, Use Tax, Retailer's Occupational Tax, Gross Receipts Tax, Value Added Tax, and Ways Fees may, at Watlow's option, be added to the prices herein specified and be added to invoices.

Engineering Charge:

On complex Products, systems or control software modifications, an engineering charge shall be applied or included in the price of Prototypes. This charge is not subject to discounts.

Tooling:

All tooling and fixtures are the property of Watlow. Watlow will accept Buyer's special tooling if sent freight prepaid. Watlow will maintain this tooling, exercising reasonable care, in order to produce Buyer's Products. Permanent molds for cast-in Products shall be the property and responsibility of Buyer.

Cancellation Charges:

There will be no cancellation charge for non-modified stock Products. Non-stock and modified-stock Products may be subject to a cancellation charge to be determined by Watlow depending upon the portion of Product completed at the time of such cancellation.

Terms and Conditions

Excuse of Performance:

(A) Deliveries may be suspended by either party in the event of: Act of God, war, riot, fire, explosion, accident, flood, sabotage; lack of adequate fuel, power, raw materials, labor, containers or transportation facilities; compliance with Governmental Requirements (as hereinafter defined); breakage or failure of machinery or apparatus; national defense requirements or any other event, whether or not of the class or kind enumerated herein, beyond the reasonable control of such party; or in the event of labor trouble, strike, lockout or injunction (provided that neither party shall be required to settle a labor dispute against its own best judgment); which event makes impracticable the manufacture, transportation, sale, purchase, acceptance, use or resale of Products or a material upon which the manufacture of Products is dependent.

(B) If Watlow determines that its ability to supply the total demand for Products, or obtain any or a sufficient quantity of any material used directly or indirectly in the manufacture of Products, is hindered, limited or made impracticable, Watlow may allocate its available supply of Products or such material (without obligation to acquire other supplies of any such Products or material) among itself and its purchasers on such basis as Watlow determines to be equitable without liability for any failure of performance which may result therefrom.

(C) Deliveries suspended or not made by reason of this Section shall be canceled without liability, but this agreement and/or Order shall otherwise remain unaffected.

Prototypes:

If Buyer orders and/or Watlow delivers a Product designated as a "Prototype", no guarantees, warranties or representations as to fitness for a particular purpose or merchantability are made with respect to such Prototype. Buyer shall have the duty and sole responsibility to test a Prototype prior to acceptance and/or incorporation into end-use applications. Further, a production Product based on a Prototype design may differ in assembly methods and materials from the Prototype. Buyer, therefore, shall have the duty and sole responsibility for testing and acceptance of production Products which are based on Prototype designs.

Warranty and Limitation of Liability:

Watlow warrants its Products against defects in material and workmanship for at least one (1) year (three (3) years on some controls) from the date of delivery, provided such Product is properly applied, used and maintained. Refer to the express written warranty time period for each individual Product or contact the relevant Watlow plant for such warranty time period information. Watlow does not warrant any Product against damage from corrosion, contamination, misapplication, improper specification or wear and tear and operational conditions beyond Watlow's control. The terms of this Warranty are the exclusive terms available to Buyer and to any other person or entity to whom Products are transferred during the period of this Warranty. No person has authority to bind Watlow to a representation or warranty other than this express Warranty. Watlow shall not be liable for incidental or consequential damages resulting from the use of Products whether a claim for such damages is based upon warranty, contract, negligence or other cause of action. Should any Product fail while subject to this Warranty, such Product shall be repaired or replaced, at Watlow's option, at no charge to Buyer or to any other person or entity to whom Product is transferred during the period of this Warranty. Watlow must be notified of the alleged failure of Product within thirty (30) days of such event and advanced authorization for repair or replacement must be obtained in writing from Watlow.

THIS WARRANTY IS MADE EXPRESSLY IN LIEU OF ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, INCLUDING WITHOUT LIMITATION, ANY WARRANTY ARISING FROM A COURSE OF DEALING OR USAGE OF TRADE, AND ALL OTHER SUCH WARRANTIES ARE SPECIFICALLY EXCLUDED. THE CORRECTION OF ANY DEFECT IN OR FAILURE OF PRODUCTS BY REPAIR OR REPLACEMENT TO THE EXTENT SET FORTH ABOVE, SHALL BE WATLOW'S LIMIT OF LIABILITY AND THE EXCLUSIVE REMEDY FOR ANY AND ALL LOSSES, DELAYS OR DAMAGES RESULTING FROM THE PURCHASE OR USE OF THE PRODUCTS. IN NO EVENT SHALL WATLOW BE LIABLE FOR SPECIAL, INDIRECT, INCIDENTAL OR CONSEQUENTIAL DAMAGES.

WATLOW SHALL NOT BE LIABLE FOR, AND BUYER AND ANY OTHER PERSON OR ENTITY TO WHOM PRODUCTS ARE TRANSFERRED DURING THE PERIOD OF THIS WARRANTY ASSUMES RESPONSIBILITY FOR, ALL PERSONAL INJURY AND PROPERTY DAMAGE RESULTING FROM OR RELATED TO THE HANDLING, POSSESSION OR USE OF PRODUCTS AND PRODUCTS MANUFACTURED AND SOLD BY WATLOW HEREUNDER.

Miscellaneous:

THE VALIDITY, INTERPRETATION AND PERFORMANCE OF THIS AGREEMENT AND/OR ORDER AND ANY DISPUTE CONNECTED HERewith SHALL BE GOVERNED AND CONSTRUED IN ACCORDANCE WITH THE LAWS OF THE STATE OF MISSOURI. These Terms and Conditions constitute the full understanding of the parties, a complete allocation of risks between them and a complete and exclusive statement of the terms and conditions of their agreement and/or Order relating to the subject matter herein. Except as otherwise expressly provided herein, no conditions, usage of trade, course of dealing or performance, understanding or agreement and/or Order purporting to modify, vary, explain or supplement the terms or conditions of this agreement and/or Order shall be binding unless hereafter made in writing and signed by the party to be bound, and no modification shall be effected by the acknowledgment or acceptance of any purchase order or shipping instruction forms containing terms or conditions at variance with or in addition to those set forth herein. No waiver by either party with respect to any breach or default or of any right or remedy and no course of dealing or performance shall be deemed to constitute a continuing waiver of any other breach or default or of any other right or remedy, unless such waiver be expressed in writing signed by the party to be bound. If any term, condition or provision of this agreement and/or Order or the application thereof is judicially or otherwise determined to be invalid or unenforceable, or if the parties mutually agree in writing to any revision of this agreement and/or Order, the remainder of this agreement and/or Order and the application thereof shall not be affected, and this agreement and/or Order shall otherwise remain in full force and effect.

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Watlow

Innovative Solutions For Every Application

Watlow supplies the thermal systems that help solve your demanding application needs. We design and manufacture reliable thermal system components to work together. As your single-source supplier you can count on yielding the following advantages every time you use Watlow products:

- Longer heater life
- More precise control
- Faster response time
- Higher productivity
- Limitless ways of managing processes

Watlow is creating innovative solutions to all of your heating needs by expanding our heater line to meet temperature requirements to 2300°F

(1260°C), while our temperature sensor line manages applications ranging from -328°F (-200°C) to 4200°F (2315°C). Watlow's temperature controllers range from simple on-off, non-indicating devices to the technologically advanced microprocessor-based ramping controllers and multi-loop controllers. Our power controllers range from simple MDRs to the more complex SCRs.

Our 77 years of experience is reflected in our design of over one million different heaters, sensors, controllers, software and system packages.

Watlow products are demanded in a variety of markets including: semiconductor, plastics processing,



food equipment, packaging, medical equipment, aerospace, scientific equipment and nuclear power generation.

Whatever your application, however complex, just call us. We'll provide you with the best thermal solution.

Tradenames and Trademarks

The following tradenames are registered to Watlow Electric Manufacturing Company and its subsidiaries:

Watlow®
Gordon®
Anafaze®

The following logo is registered to Watlow Electric Manufacturing Company and its subsidiaries:



The following registered trademarks belong to Watlow Electric Manufacturing Company and its subsidiaries:

ANASOFT® PC software
ANAWIN® PC software
Control Confidence®
DIN-A-MITE® power controllers
FIREBAR® flat tubular heating elements
FIREROD® cartridge heaters
K-RING® nozzle heaters
LOGICPRO™ integrated software component
MICRODIN™ temperature controllers
MINICHEF® temperature controllers
MODULE-MOUNT® ceramic fiber furnace system
RAYMAX® radiant heaters
SERV-RITE® thermocouple wire and cable
THERMO-DUCER® infrared temperature sensors
THINBAND® band heaters
THINCAST® cast-in heaters

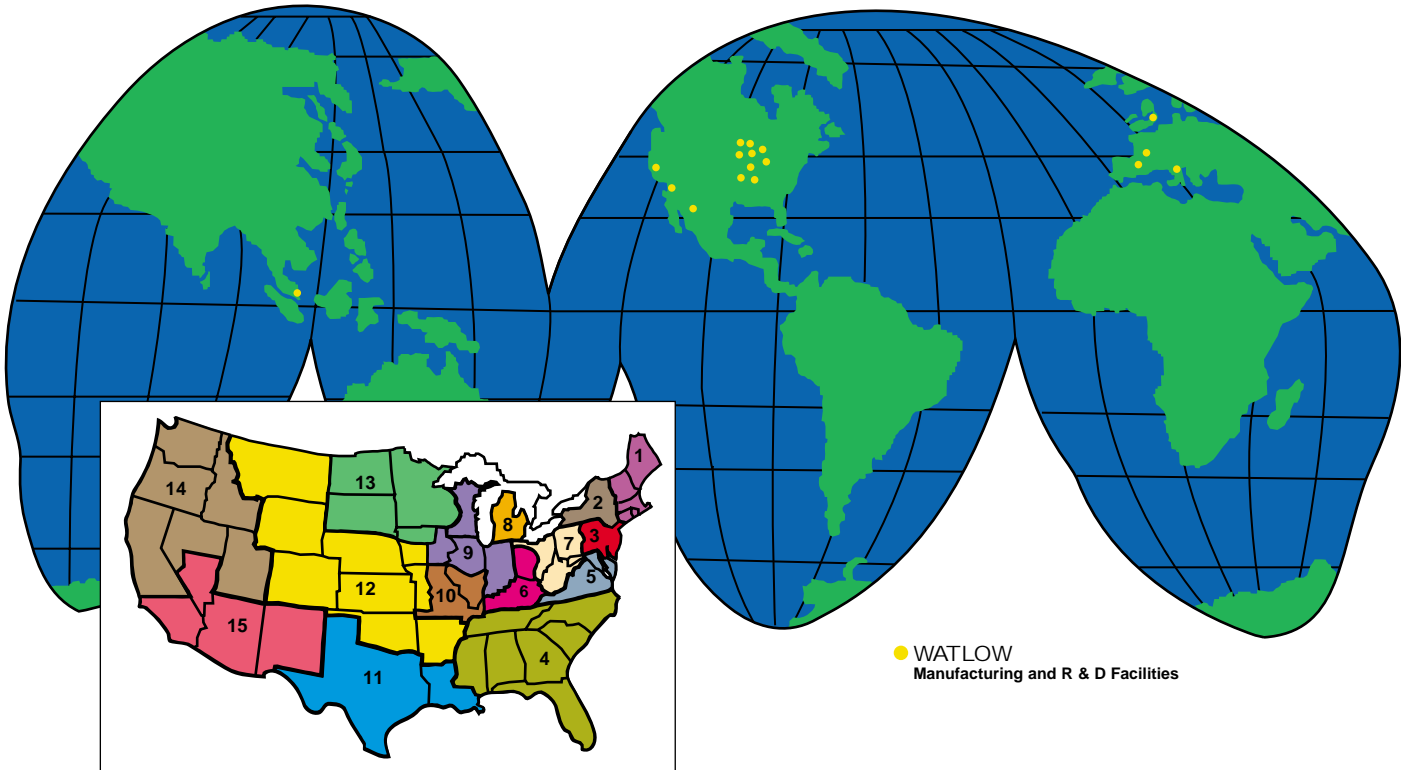
WATVIEW™ PC software
XACTEMP® hand-held temperature probes
XACTPAK® mineral insulated, metal-sheathed cable

The following trademarks are used by Watlow Electric Manufacturing Company and its subsidiaries:

ANASCAN PC software
CARBONSOFT carbon potential software
FREEFLEX heated tubing
LA lead adapter system
MICROCOIL miniature thermocouple
POWER SERIES power controllers
QUICK CLAMP option for THINBAND heaters
TEMPSWITCH thermostats
WATCURVE food application software
WATLUBE cartridge heater release agent
WATROD round tubular heating elements

Thermocouple and Extension Wire Color Codes

ASTM Code	ASTM T/C	ASTM Extension	UK BS 1843	Germany DIN 43710	Japan JIS C1610-1981	IEC 584-3
Type B						
Type E						
Type J						
Type K						
Type N						
Type R						
Type S						
Type T						



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