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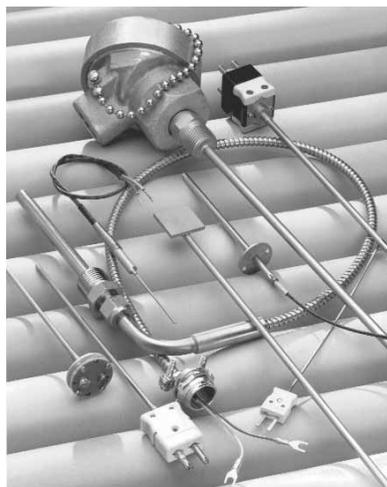
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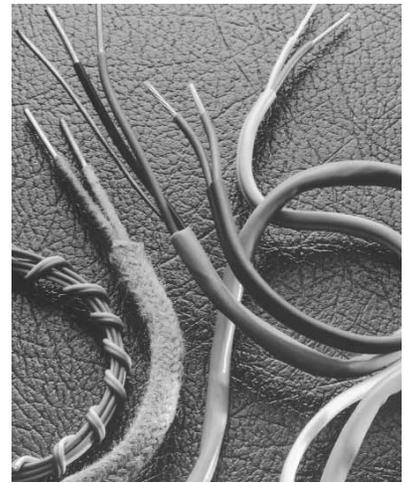
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General Information

Think Safety

When specifying any sensor or designing any sensor/instrumentation circuit, caution must be exercised. It is important 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. This section deals with safety as it relates to the dangers presented by catastrophic failures, fault conditions and hazardous environments.

Operational Safety— Do Not 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 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.

General Information

Customer Assistance

Watlow Manufacturing Facilities

United States Manufacturing Facilities

Batavia, Illinois

Watlow Batavia

Manufactures:

- Cast-In Heaters

1310 Kingsland Drive
Batavia, IL 60510

Phone: 630-879-2696

FAX #1: 630-879-1101

FAX #2: 630-482-2042

Chesterfield, Missouri

Watlow Engineering

Manufactures:

- Machines

636 Goddard Avenue
Chesterfield, MO 63005

Phone: 636-530-0288

FAX: 636-530-0395

Columbia, Missouri

Watlow Columbia/Ceramic Fiber

Manufactures:

- Ceramic Fiber Heaters

2407 Big Bear Court
Columbia, MO 65202

Phone: 573-443-8817

FAX: 573-443-8818

Watlow Columbia/Flexible

Manufactures:

- Flexible Heaters/Polymer
- Silicone Rubber Heaters

2101 Pennsylvania Drive
Columbia, MO 65202

Phone: 573-474-9402

FAX: 573-474-5859

Fenton, Missouri

Single Iteration

An Engineering Services Division
of Watlow

909 Horan Drive
Fenton, MO 63026

Phone: 866-449-6846

FAX: 636-349-5352

Hannibal, Missouri

Watlow Hannibal

Manufactures:

- Circulation Heaters
- Duct Heaters
- Immersion Heaters
- Multicell Heaters
- Process Heating Systems
- Tubular Heaters
- Thick Film Heaters

#6 Industrial Loop Road

P.O. Box 975

Hannibal, MO 63401

Phone: 573-221-2816

FAX: Tubular/Process/Multicell

573-221-3723

FAX: Thick Film

573-221-7578

Richmond, Illinois

Watlow Richmond

Manufactures:

- RTDs, Thermocouples, Thermistors
- Thermocouple Wire and Cable
- Temperature Measurement Devices

5710 Kenosha Street, P.O. Box 500

Richmond, IL 60071

Phone: 815-678-2211

FAX: 815-678-3961

St. Louis, Missouri

World Headquarters and Watlow St. Louis

Manufactures:

- Band Heaters
- Cable Heaters
- FIREROD® Heaters
- Radiant Heaters
- Special Heaters
- Strip Heaters

12001 Lackland Road

St. Louis, MO 63146

Phone: 314-878-4600

FAX: 314-878-6814

Watsonville, California

Watlow Anafaze

Manufactures:

- Multi-Loop Controllers
- High Level Software

Phone: 507-454-5300

FAX: 507-452-4507

Winona, Minnesota

Watlow Winona

Manufactures:

- Custom Electronic Controllers
- Power Controllers
- Safety and Limit Controllers
- Single-Loop Controllers

1241 Bundy Boulevard,

P.O. Box 5580

Winona, MN 55987-5580

Phone: 507-454-5300

FAX: 507-452-4507

Asian Manufacturing Facilities

Singapore

Watlow Asia Engineering

Manufactures:

- FIREROD Heaters
- Thermocouples
- Pump Line Heaters
- Controllers
- Power Controllers

16 Ayer Rajah Crescent, #03-23

Singapore 139949

Phone: +65-6773-9488

FAX: +65-6778-0323

European Manufacturing Facilities

Germany

Watlow GmbH

Manufactures:

- Cable Heaters
- Cartridge Heaters
(FIREROD, EB Cartridge and
Metric FIREROD)
- Silicone Rubber Heaters
- K-RING® Heaters
- Pump Line Heaters
- Electronic Assemblies

Lauchwasenstr. 1

Postfach 1165

D 76709 Kronau, Germany

Phone: +49-7253-94-00-0

FAX: +49-7253-94-00-44

General Information

Customer Assistance

Watlow Manufacturing Facilities

United Kingdom

Watlow Limited

Manufactures:

- Band Heaters
- Cartridge Heaters
- FIREROD Heaters
- Silicone Rubber Heaters
- Thermocouples

Robey Close

Linby Industrial Estate
Linby, Nottingham, England
NG15 8AA

Phone: +44-0-115-964-0777

FAX: +44-0-115-964-0071

Latin American Manufacturing Facilities

Mexico

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

Manufactures:

- FIREROD Heaters
(Cartridge and Metric)
- Ceramic Knuckle Heaters
- THINBAND® Heaters
- HV Band Heaters
- Silicone Rubber Heaters
- Tubular Heaters
- Cable Heaters

Av. Fundicion No. 5
Col. Parques Industriales
Querétaro C.P. 76130
Querétaro, Mexico

Phone: +52-442-217-62-35

FAX: +52-442-217-64-03

Sales Support

United States Sales Offices

Atlanta

Phone: 678-935-1281

Fax: 678-935-3928

Austin

Phone: 512-249-1900

Fax: 512-249-0082

Birmingham

Phone: 205-678-2358

Fax: 205-678-2567

Charlotte

Phone: 704-573-8446

Fax: 866-422-5998

Chicago

Phone: 847-309-3495

Fax: 847-458-1515

Cincinnati

Phone: 513-398-5500

Fax: 513-398-7575

Cleveland

Phone: 330-467-1423

Fax: 330-467-1659

Dallas

Phone: 972-620-6030

Fax: 972-620-8620

Denver

Phone: 303-798-7778

Fax: 303-798-7775

Detroit

Phone: 248-651-0500

Fax: 248-651-6164

Houston

Phone: 281-440-3074

Fax: 281-440-6873

Indianapolis

Phone: 317-575-8932

Fax: 317-575-9478

Kansas City

Phone: 913-897-3973

Fax: 913-897-4085

Los Angeles

Phone: 714-935-2999

Fax: 714-935-2990

Maryland/Virginia

Phone: 215-345-8130

Fax: 215-345-0123

Milwaukee/Appleton

Phone: 920-993-2161

Fax: 920-993-2162

Minneapolis

Phone: 952-892-9222

Fax: 952-892-9223

Nashville

Phone: 615-264-2333

Fax: 615-264-9212

New England

Phone: 603-882-1330

Fax: 603-882-1524

New York/Upstate

Phone: 716-438-0454

Fax: 716-438-0082

Orlando

Phone: 407-351-0737

Fax: 407-351-6563

Philadelphia

Phone: 215-345-8130

Fax: 215-345-0123

Phoenix

Phone: 602-795-7712

Fax: 602-298-6960

Pittsburgh

Phone: 412-322-5004

Fax: 412-322-1322

Portland

Phone: 360-254-1009

Fax: 360-254-2912

For your nearest local sales office call 1-800-WATLOW2.

General Information

Customer Assistance Sales Support Cont.

Sacramento

Phone: 707-425-1155
Fax: 707-425-4455

Saint Louis

Phone: 636-441-5077
Fax: 636-447-8770

San Francisco

Phone: 408-434-1894
Fax: 408-435-5409

Seattle

Phone: 360-668-3438
Fax: 360-668-0959

Tampa/St. Petersburg

Phone: 407-647-9052
Fax: 407-647-5466

Tulsa

Phone: 918-496-2826
Fax: 918-477-2826

Asian Sales Offices

Australia

Watlow Australia Pty. Ltd.

Tullamarine, Australia
Phone: +61-3-9335-6449
FAX: +61-3-9330-3566
Sales Territory: Australia,
New Zealand

China

Watlow China

Shanghai, China
Phone: +86-21-5211-0231
FAX: +86-21-5211-0177
Sales Territory: China

Japan

Watlow Japan Ltd.

Minato-Ku, Tokyo, Japan
Phone: +81-3-5403-4688
FAX: +81-3-5575-3373
Sales Territory: Japan

Korea

Watlow Korea Co., Ltd.

Seoul, Korea
Phone: +82-2-575-9804
FAX: +82-2-575-9831
Sales Territory: Korea

Malaysia

Watlow Malaysia Sdn Bhd

Penang, Malaysia
Phone: +60-3-641-5977
FAX: +60-4-641-5979
Sales Territory: Malaysia

Singapore

Watlow Singapore Pte. Ltd.

Singapore
Phone: +65-677-39488
FAX: +65-677-80323
Sales Territory: Singapore, South
East Asia, Hong Kong, India, China
Sales Support

Taiwan

Watlow Taiwan

Kaohsiung, Taiwan
Phone: +886-7-288-5168
FAX: +886-7-288-5568
Sales Territory: Taiwan

Canadian Sales Offices

Ontario

Watlow Ontario

Mississauga, Ontario Canada
Phone: 905-979-3507
FAX: 905-979-4296

Quebec and Atlantic Canada

Watlow Quebec & Atlantic Canada

Dorval, QC Canada
Phone: 514-884-6834
FAX: 716-438-0082

Western Canada

Watlow Western Canada

Burnaby, British Columbia Canada
Phone: 604-444-4881
Fax: 604-444-4883

European Sales Offices

France

Watlow France, s.a.r.l.

Cergy Pointoise, France
Phone: +33-1-3073-2425
FAX: +33-1-3073-2875
Sales Territory: France

Germany

Watlow GmbH

Kronau, Germany
Phone: +49-7253-9400-0
FAX: +49-7253-9400-900

Sales Territory:

All Other European Countries

Italy

Watlow Italy, S.r.l.

Corsico - MI, Italy
Phone: +39-0-2-4588841
Fax: +39-0-2-45869954
Sales Territory: Italy

United Kingdom

Watlow Limited

Linby Nottingham England
Phone: +44-115-964-0777
FAX: +44-115-964-0071
Sales Territory: Great Britain, Ireland

Latin American Sales Office

Mexico

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

Querétaro, Mexico
Phone: +52-442-217-6235
FAX: +52-442-217-6403
Sales Territory: Mexico and
Latin America

Corporate Headquarters

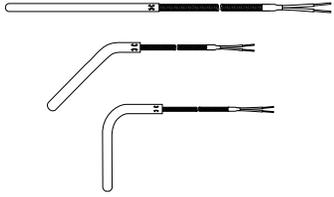
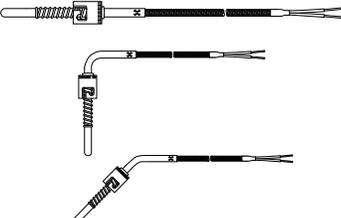
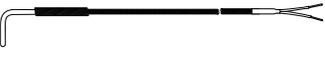
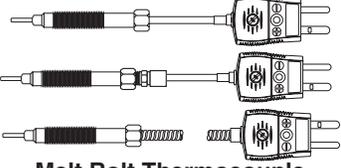
Watlow Electric Manufacturing Company

St. Louis, MO
Phone: 314-878-4600
FAX: 314-434-1020
Sales Territory: All countries and
Canadian provinces not specified.

General Information

Quick Reference Guide

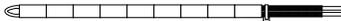
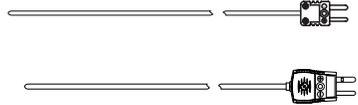
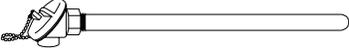
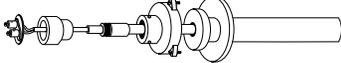
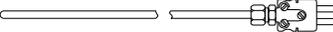
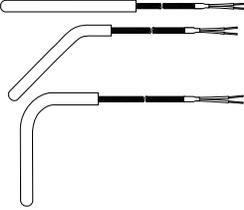
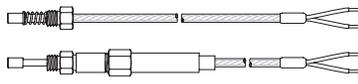
Thermocouples

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

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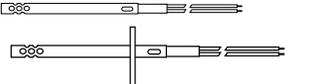
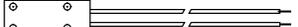
Quick Reference Guide

Thermocouples

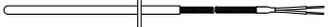
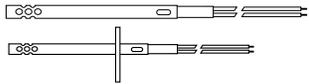
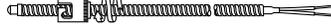
Style	Temperature Range	Page	Style	Temperature Range	Page
 Cut and Stripped	0 to 1200°C (32 to 2200°F)	64	 Base Metal Elements with Insulators	0 to 1200°C (32 to 2200°F)	76
 Plug or Jack Termination	0 to 1200°C (32 to 2200°F)	65, 66	 Immersion Tips	0 to 1200°C (32 to 2200°F)	77
 Metal Transitions with Spring Strain Relief	0 to 1200°C (32 to 2200°F)	68	 Base Metal with Protection Tubes	0 to 1200°C (32 to 2200°F)	78
 Miniature Transitions	0 to 1200°C (32 to 2200°F)	67	 Noble Metal Elements with Insulators	0 to 1700°C (32 to 3100°F)	80
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 Wafer Head	0 to 1200°C (32 to 2200°F)	71	 High Temperature Plug or Jack Termination	0 to 2315°C (32 to 4200°F)	87
 For use with Thermowells	0 to 1200°C (32 to 2200°F)	72	 High Temperature Metal Transitions	0 to 2315°C (32 to 4200°F)	88
 With Thermowell	0 to 1200°C (32 to 2200°F)	73	 MICROCOIL™	0 to 700°C (32 to 1292°F)	91
 High Vibration	0 to 1200°C (32 to 2200°F)	74	 TR Thermocouple	0 to 500°C (32 to 932°F)	92
			 TRUE SURFACE Thermocouple (TST)	0 to 200°C (32 to 400°F)	94
			 Multipoints	0 to 1200°C (32 to 2200°F)	96

General Information

Quick Reference Guide RTD

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

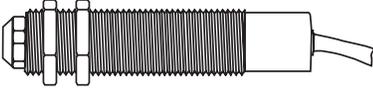
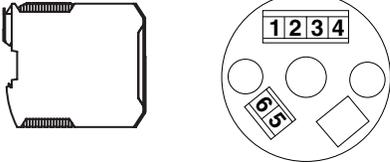
Thermistors

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

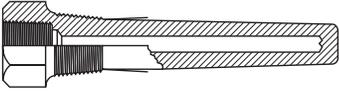
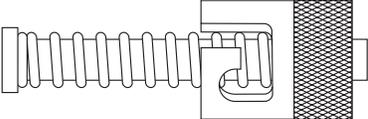
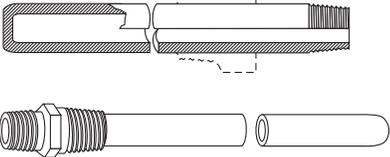
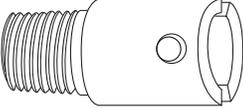
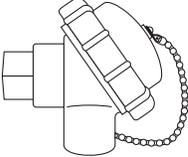
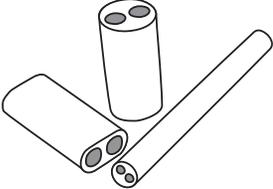
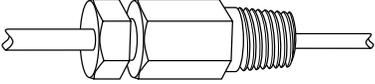
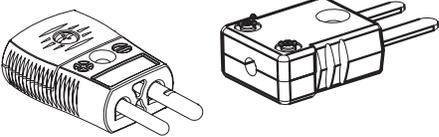
General Information

Quick Reference Guide

Infrared/Transmitters/ Signal Conditioners

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Accessories

Product	Page	Product	Page
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General Information

Quick Reference Guide Wire and Cable

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

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General Information

Application Hints

Answering your most frequently asked questions about industrial temperature sensors.

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



- Which temperature sensor is the best choice for my application?13
- What do thermocouple letter designations mean?14
- What are thermocouple color codes?15
- What letter of calibration should I use?16
- What is the initial accuracy of temperature sensors?17
- How does Watlow check for thermocouple accuracy?19
- Is there a maximum length for thermocouples and thermocouple wiring?19
- What sheath material is the best for my application?20
- What are the maximum temperatures of thermocouples?21
- What type of junction should I use?22
- What is the response time of mineral insulated thermocouples?23
- What should the thermocouple resistance measure?24
- Where should my sensor be placed?25
- How does electrical noise get in?26
- The sensor appears to be reading incorrectly, what might be wrong?27
- How do I install a sensor with spring loaded bayonet cap?29

General Information

Application Hints Which temperature sensor is the best choice for my application?

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

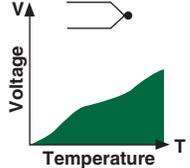
RTDs are best for most industrial measurements over a wide temperature range, especially when sensor stability is essential for proper control.

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

Thermocouples

Sensors generating varying voltage signals are thermocouples. Thermocouples combine dissimilar metallic elements or alloys to produce a

voltage. Using specific combinations of metals and alloys in the thermocouple's legs produces a predictable change in voltage based on a change in temperature.

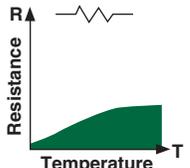
Thermocouples	Advantages	Disadvantages
	<ul style="list-style-type: none"> No resistance lead wire problems Fastest response to temperature changes Simple, rugged Inexpensive High temperature operation Point temperature sensing 	<ul style="list-style-type: none"> Non-linear Low voltage Least stable,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

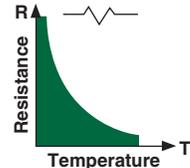
RTDs and Thermistors

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

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

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

RTDs	Advantages	Disadvantages
	<ul style="list-style-type: none"> Most stable, accurate Contamination resistant More linear than thermocouple Area temperature sensing Most repeatable 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 Economical 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

General Information

Application Hints

What do thermocouple letter designations mean?

Thermocouples are classified by calibration type because they have differing EMF (electromotive force) versus temperature curves. Some generate considerably more voltage at lower temperatures, while others do not begin to develop a significant voltage until subjected to high temperatures. Also, calibration types are designed to deliver as close to a straight line voltage curve inside their temperature application range as possible. This makes it easier for an instrument or temperature controller to correctly correlate the received voltage to a particular temperature. Additionally, thermocouple calibration types have different levels of compatibility with different atmospheres. Chemical reaction between certain thermocouple alloys and the application atmosphere could cause metallurgy degradation, making another calibration type more suitable for sensor life and accuracy requirements.

Thermocouple Types

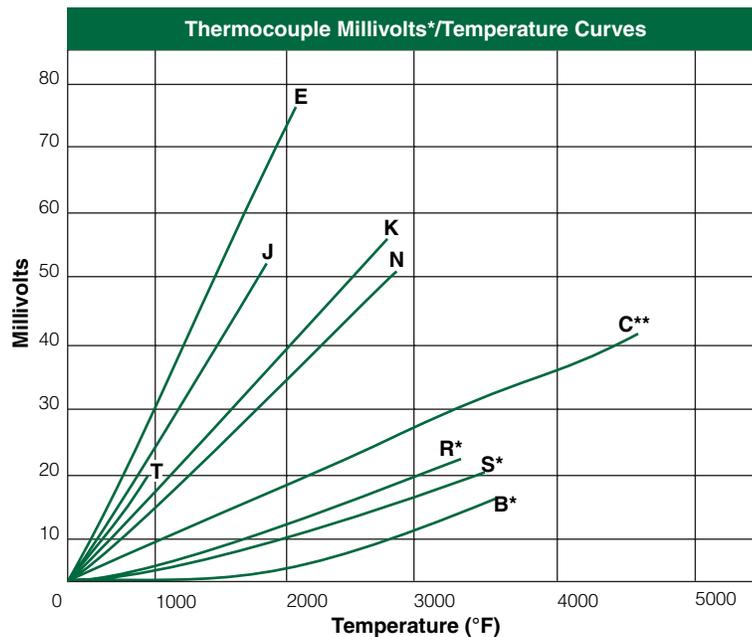
Calibration types have been established by the American Society for Testing and Materials (ASTM) according to their temperature versus EMF characteristics in accordance with ITS-90, in standard or special tolerances.

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

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

*Not an ASTM E 230 symbol

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



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

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

General Information

Application Hints

What are thermocouple color codes?

United States and International Color Coding

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

Thermocouple and Extension Wire Color Codes

Overall/Positive (+)/Negative (-)

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



See color version on the inside back cover.

General Information

Application Hints

What letter of calibration should I use?

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

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

Type E

The Type E thermocouple is suitable for use at temperatures up to 900°C (1650°F) in a vacuum, inert, mildly oxidizing or reducing atmosphere.

At cryogenic temperatures, the thermocouple is not subject to corrosion. This thermocouple has the highest EMF output per degree of all the commonly used thermocouples.

Type J

The Type J may be used, exposed or unexposed, where there is a deficiency of free oxygen. For cleanliness and longer life, a protecting tube is recommended. Since JP (iron) wire will

oxidize rapidly at temperatures over 540°C (1000°F), it is recommended that larger gauge wires be used to compensate. Maximum recommended operating temperature is 760°C (1400°F).

Type K

Due to its reliability and accuracy, Type K is used extensively at temperatures up to 1260°C (2300°F). It's good practice to protect this type of thermocouple with a suitable metal or ceramic protecting tube, especially in reducing atmospheres. In oxidizing atmospheres, such as electric

furnaces, tube protection is not always necessary when other conditions are suitable; however, it is recommended for cleanliness and general mechanical protection. Type K will generally outlast Type J because the JP (iron) wire rapidly oxidizes, especially at higher temperatures.

Type N

This nickel-based thermocouple alloy is used primarily at high temperatures up to 1260°C (2300°F). While not a direct replacement for Type K,

Type N provides better resistance to oxidation at high temperatures and longer life in applications where sulfur is present. It also outperforms Type K in K's aging range.

Type T

This thermocouple can be used in either oxidizing or reducing atmospheres, though for longer life, a protecting tube is recommended. Because of its stability at lower temperatures, this is a superior

thermocouple for a wide variety of applications in low and cryogenic temperatures. It's recommended operating range is -200° to 350°C (-330° to 660°F), but it can be used to -269°C (-452°F) (boiling helium).

Types S, R and B

Maximum recommended operating temperature for Type S or R is 1450°C (2640°F); Type B is recommended for use at as high as 1700°C (3100°F). These thermocouples are easily contaminated. Reducing atmospheres are

particularly damaging to the calibration. Noble metal thermocouples should always be protected with a gas-tight ceramic tube, a secondary tube of porcelain, and a silicon carbide or metal outer tube as conditions require.

Type C (W-5 Percent Re/W-26 Percent Re)

This refractory metal thermocouple may be used at temperatures up to

2315°C (4200°F). Because it has no resistance to oxidation, its use is restricted to vacuum, hydrogen or inert atmospheres.

General Information

Application Hints

What is the initial accuracy of temperature sensors?

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

Thermocouples

Tolerances on Initial Values of EMF vs. Temperature

Reference Junction 0°C (32°F)

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

- Tolerances in this table apply to new essentially homogeneous thermocouple wire, normally in the size range 0.25 to 3 mm in diameter (No. 30 to No. 8 AWG) and used at temperatures not exceeding the recommended limits above. If used at higher temperatures these tolerances may not apply.
 - 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.
 - 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.
 - 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.
 - Special tolerances for temperatures below 0°C are difficult to justify due to limited available information. However, the following values for Types E and T thermocouples are suggested as a guide for discussion between purchaser and supplier: Type E: -200 to 0°C ±1.0°C or ±0.5 percent (whichever is greater); Type T: -200 to 0°C ±0.5 or ±0.8 percent (whichever is greater). Initial values of tolerance for Type J thermocouples at temperatures below 0°C and special tolerances for Type K thermocouples below 0°C are not given due to the characteristics of the materials.
 - 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.
 - 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.
 - Tolerances in the table apply to new and essentially homogeneous thermocouple compensating extension wire when used at temperatures within the range given above.
 - 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.
 - Special compensating extension wires are not necessary with Type B over the limited temperature range 0 to 50°C (32 to 125°F), where the use of non-compensated (copper/copper) conductors introduces no significant error. For a somewhat larger temperature gradient of 0 to 100°C (32 to 210°F) across the extension portion of the circuit, the use of non-compensated (copper/copper) extension wires may result in small errors, the magnitude of which will not exceed the tolerance values given in the table above for measurements above 1000°C (1800°F). Proprietary alloy compensating extension wire is available for use over 0 to 200°C (32 to 400°F) temperature range.
- * Special tolerance grade compensating extension wires are not available.

General Information

Application Hints

What is the initial accuracy of temperature sensors?

(Continued)

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

Resistance Temperature Detectors—RTDs

Table of Tolerance Values

Temperature °C	Resistance Value Ω	Tolerance DIN-IEC-751	
		Class A °C (Ω)	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: $\pm[0.15 + 0.002 |t|]$ °C

DIN class B: $\pm[0.30 + 0.005 |t|]$ °C

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

Thermistors

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

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

*Other thermistors available on request.

General Information

Application Hints

How does Watlow check for thermocouple accuracy?

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

XACTPAK® and MI Insulated Thermocouple

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

* Calibration not made when temperature exceeds sheath rating.

SERV-RITE® Insulated Wire and General Application Thermocouples

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

* Calibration not made when temperature exceeds wire insulation rating.

Is there a maximum length for thermocouples and thermocouple wiring?

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

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

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

General Information

Application Hints

What sheath material is the best for my application?

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

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

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

Sheath Materials

Sheath Material	Description	
304 SS	Maximum temperature: 899°C (1650°F). Most widely used low temperature sheath material. Extensively used in food, beverage, chemical and other industries where corrosion resistance is required. Subject to damaging carbide precipitation in 482-871°C (900-1600°F) range. Lowest cost corrosion resistant sheath material available.	304 SS suits most applications and is readily available.
316 SS	Maximum temperature: 899°C (1650°F). Best corrosion resistance of the austenitic stainless steel grades. Good corrosion resistance in H ₂ S. Widely used in the food and chemical industry. Subject to damaging carbide precipitation in 482-871°C (900-1600°F) range.	316 SS has more nickel than 304 SS and is used for food applications.
Alloy 600	Maximum temperature: 1176°C (2150°F). Most widely used thermocouple sheath material. Good high temperature strength, corrosion resistance, resistance to chloride ion stress corrosion cracking and oxidation resistance to high temperatures. Do not use in sulfur bearing environments. Good in nitriding environments.	Alloy 600 has the most nickel and the highest temperature rating.
310 SS	Maximum temperature: 1150°C (2100°F). Mechanical and corrosion resistance, similar to but better than 304 SS. Very good heat resistance. This alloy contains 25 percent Cr, 20 percent Ni. Not as ductile as 304 SS.	310 SS has a higher temperature than 304 SS or 316 SS but is not very common.
PFA over 304 SS Coating*	Maximum temperature: 250°C (482°F) continuous. Thermocouple sheath O.D. is encapsulated in a black PFA, allowing the thermocouple to be used in applications where corrosive fluids and gases, strong mineral, oxidizing and organic acids and alkalies are present. Examples: food and beverage, pharmaceutical, labs, electroplating, semiconductor processing. Nominal wall thickness of the PFA is 0.010 inch.	PFA over 304 SS works well in most acid environments. Strong bases can corrode PFA.

General Information

Application Hints

What are the maximum temperatures of thermocouples?

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

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

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

Hastelloy® is a registered trademark of Haynes International.

Recommended Upper Temperature Limit for Protected Thermocouple Wire

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

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

General Information

Application Hints

What type of junction should I use?

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

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

Junction Styles

Listed below are the junction styles offered by Watlow.

Exposed Junction



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

Grounded Junction



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

Ungrounded Junction



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

Ungrounded Dual Isolated Junction



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

General Information

Application Hints

What is the response time of mineral insulated thermocouples?

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

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

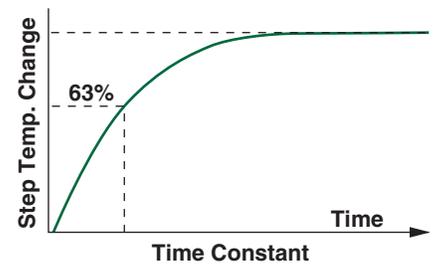
Several factors come into play. The most commonly noted is “time constant” (thermal response time). Time constant, or thermal response time, is an expression of how quickly a sensor responds to temperature changes. As expressed here, time response is defined as how long it takes a sensor to reach 63.2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

Response is a function of the mass of the sensor and its efficiency in transferring heat from its outer surfaces to

the wire sensing element. A rapid time response is essential for accuracy in a system with sharp temperature changes. Time response varies with the probe’s physical size and design.

The response times indicated are representative of standard industrial probes.

Time Constant (Thermal Response Time)



Thermocouple Time Response

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

*Readings are to 63 percent of measured temperatures.

General Information

Application Hints

What should the thermocouple resistance measure?

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

Ohms per Double Feet

Long lead wire runs, or the use of analog based instrumentation, make conductor resistance an important consideration in selecting the wire gauge best suited for your

application. The table below lists the nominal ohms per double feet for thermocouple and thermocouple extension wire. Ohms per double feet is the total resistance, in ohms, for both conductors, per foot.

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

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

*Not an ASTM E 230 symbol

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

Conductor Sizes

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

General Information

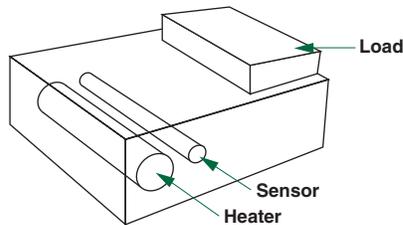
Application Hints

Where should my sensor be placed?

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

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

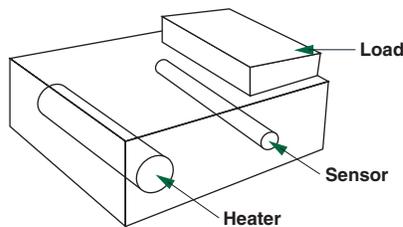
Sensor in a Static System



We call a system “static” when there is slow thermal response from the heat source, slow thermal transfer and minimal changes in the work load. When

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

Sensor in a Dynamic System



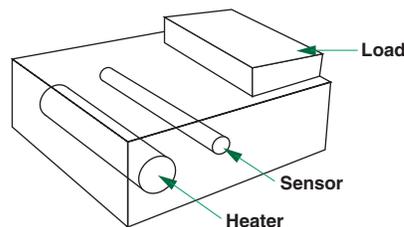
We call a system “dynamic” when there is rapid thermal response from the heat source, rapid thermal transfer and frequent changes in the work load. When the system is dynamic, placing the sensor closer to the work load will enable the sensor to “see” the load temperature change faster, and allow

the controller to take the appropriate output action more quickly.

However, in this type of system the distance between the heat source and the sensor is notable, causing thermal lag or delay. Therefore, the heat source cycles will be longer, causing a wider swing between the maximum (overshoot) and minimum (undershoot) temperatures at the work load.

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

Sensor in a Combination Static/Dynamic System



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

General Information

Application Hints

How does electrical noise get in?

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

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

Common Impedance Coupling

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

Magnetic Inductive Coupling

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

Electrostatic Capacitive Coupling

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

Electromagnetic Radiation Coupling

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

Helpful Wiring Guidelines

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

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

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

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

- Physical separation and wire routing must be given careful consideration in planning the layout. AC power supply lines should be bundled together and kept physically separate from sensor signal lines. If lines must cross, do so at right angles.
- Another important practice is to look at the system layout and identify electrical noise sources such as solenoids, relay contacts, or motors, and where they are physically located. Then use as much caution as possible to route the sensor lead wires away from these noise sources.

- Whenever possible, sensor signal leads should be run unbroken from sensor to the control.
- Shielded cables should be used for all signal lines to protect from magnetic and electrostatic coupling of noise. Some simple pointers are as follows:
 1. Connect the shield to the control circuit common end only. Never leave the shield unconnected at both ends. Never connect both ends of the shield to a common.
 2. If the shield is broken at a terminal and the line continues, the shield must be reconnected to maintain shield continuity.
 3. If the shield is used as a signal return (conductor), no electrostatic shielding can be assumed. If this must be done, use a triaxed cable (electrostatically shielded coaxial cable).
 4. Twisted wire should be used any time sensor circuit signals must travel over two feet, or when they are bundled in parallel with other wires.

General Information

Application Hints

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

1. Sensor and Control

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

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

- **Thermocouples**

Disconnect and place a jumper wire across the input connections. Instrument should indicate room temperature.

- **RTDs**

Disconnect and place a known resistance value across input terminals. Instrument should indicate the temperature corresponding to resistor used. As an example a 100 Ω resistor would indicate 0°C for a 100 Ω RTD.

3. Check Instrument Connection—

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

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

5. Compatible Sensor and Connection Wire—

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

6. Verifying Sensor Electrical Continuity (Resistance)—

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

General Information

Application Hints

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

(Continued)

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

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

8. Changing of Thermocouple Immersion Depths—

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

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

General Information

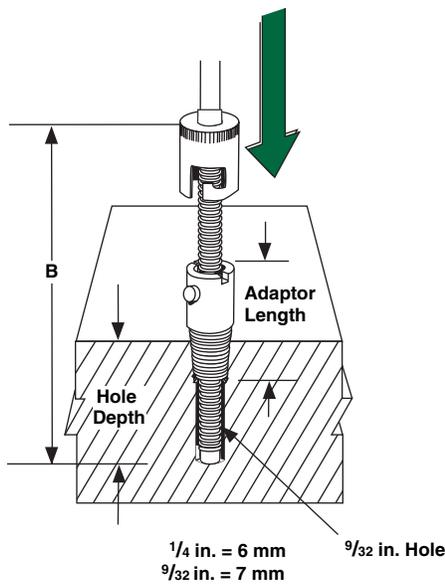
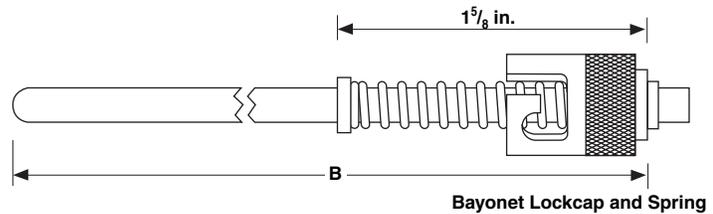
Application Hints

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

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

Hole Depth

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



General Information

Lab Services

Prototype Testing and Quality Certification

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

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

Product Development and Prototype Test Lab

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

Time response

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

Vibration

- Sine and random electrodynamic excitation

High temperatures

- Up to 1700°C (3090°F)

Cryogenic temperatures

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

Tensile and compression

- Testing to 500 kg (1,000 lb)



Humidity

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

Life testing

- In molten aluminum and corrosive liquids

Cycle and drift

- Testing up to 1700°C (3090°F)

Wire insulation abrasion testing

- Repeated scrape and wire to wire

Micro-hardness

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

Dielectric breakdown testing

- Capabilities to 5000V=(dc)

General Information

Lab Services

Product Development and Prototype Test Lab

(Continued)



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

Customized Testing to Your Application

Watlow can provide testing during all phases of product development.

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

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

- To verify the quality and stability of our RTDs a recent test cycled the sensors from 93°C (200°F) to 260°C (500°F) for over 80,000 cycles.
- During initial product development for a turbine application, the customer requested performance information on Watlow RTD probes under various conditions. Vibration testing was carried out on several diameters and probe configurations providing the customer with resonance frequencies to 2000Hz and corresponding dB levels.

- Vibration testing was provided for a prototype sensor mounted on the shaft bearings of a large diesel engine. Watlow product and field engineers worked with the customer to develop a vibration dampening design.
- Watlow engineers selected materials and developed several configurations to answer a customer's need for a 20 meter (60 ft) long sheathed sensor capable of handling 1400°C (2550°F). The conditions were reproduced in the product test lab and a successful design selected.

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

General Information

Lab Services

Quality Certification Lab



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

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

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

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

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

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

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

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

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

We offer:

Calibration testing

- For thermocouples, thermistors and RTDs traceable to NIST standards

End-to-end calibration

- For thermocouple conductors

Insulation resistance testing

Dielectric testing

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

Helium leak testing

- Verifies sheath integrity

Radiographic (X-ray) inspection

- Detects internal defects, dimensional compliance and inclusions

Liquid penetrant testing

- Detects surface defects

Metallographic examination

- Evaluates constituents and structures of alloys

Compaction density testing

- Determines compaction of mineral insulation in metal sheathed cables

Thermal cycling

- Assures ruggedness under thermal transients

Micro-hardness

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

General Information

Lab Services

Quality Certification Lab

Calibration and Certification

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

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

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

Common Certifications

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

Certificate #1 - Certificate of Compliance/Conformity

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

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

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

Certificate #3 - Certificate of Conformance to ISO 10012

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

Certificate #4 - Certificate of Traceability to NIST

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

Certificate #6 - Certificate of Calibration at Standard Calibration Points

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

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

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

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

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

Certificate #8 - Certificate of Calibration at Specified Temperatures

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

Note: Custom certifications are available upon request.

General Information

Lab Services

Quality Certification Lab

Continued



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



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

Recommended Sensor Straight Length Required for Calibration

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

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

Thermocouple Calibration

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

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

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

*Maximum temperatures vary depending on thermocouple type.

RTD Calibration

Watlow RTD calibration is useful for defining the exact temperature coefficient of the sensor. Coefficients are obtained by calibrating the RTD at a cryogenic temperature, 0°C, 100°C and a high temperature that cannot

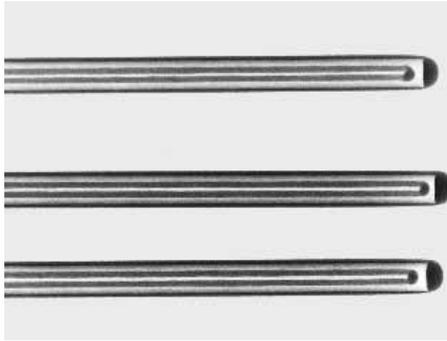
exceed the maximum temperature capability of the RTD. Through the use of the coefficients, a resistance output table in one degree (°C or °F) increments can be generated for the entire temperature range of the RTD.

General Information

Lab Services

Quality Certification Lab

Continued



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

Certification Testing

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

General Information

Tolerances

Sheath Tolerances

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

Sheath Tolerances

General Application & RTD Sheath Tolerances		
Sheath Diameter (in.)	Diameter Tolerance (in.)	Length Tolerance (in.)
1/8	± 0.003	± 0.125
3/16	± 0.003	± 0.125
1/4	± 0.003	± 0.125
5/8	± 0.003	± 0.250

MI Thermocouple Sheath Tolerances			
Diameter (in.)	Diameter Tolerance (in.)	Length Tolerance (in.)	
		up to 24 in.	over 24 in.
0.020	+ 0.001 - 0.0005	± 0.25	± 1%
0.032	+ 0.001 - 0.0005	± 0.25	± 1%
0.040	+ 0.001 - 0.0005	± 0.25	± 1%
0.063	+ 0.001 - 0.0001	± 0.125	± 1/2%
0.125	+ 0.002 - 0.0001	± 0.125	± 1/2%
0.188	+ 0.002 - 0.0001	± 0.125	± 1/2%
0.250	+ 0.003 - 0.0001	± 0.125	± 1/2%
0.375	+ 0.003 - 0.0001	± 0.125	± 1/2%
0.500	+ 0.003 - 0.0001	± 0.125	± 1/2%

Flexible Lead Tolerances

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

Sheath Configuration

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

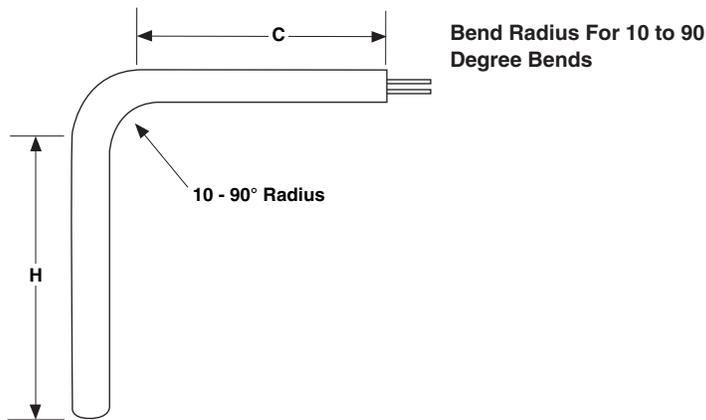
MI Thermocouple Standard Sheath Configuration

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

General Information

Bends

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



General Information

General Application Thermocouples

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

Mineral Insulated Thermocouples

Diameter in.	Standard Bend Radius in.	Minimum "H" Dimension in.	Minimum "C" Dimension in.
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

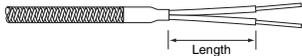
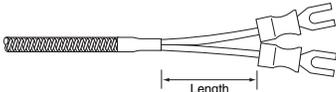
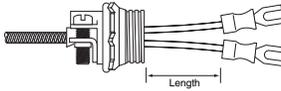
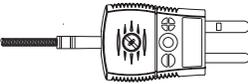
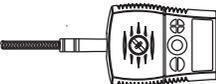
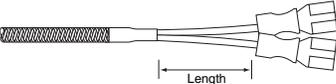
*For RTDs a minimum of 2 inches.

RTDs and Thermistors

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

General Information

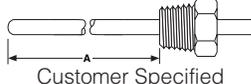
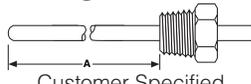
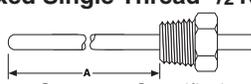
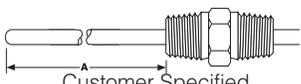
Lead Terminations Options

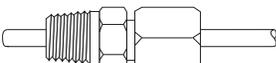
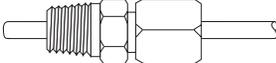
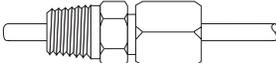
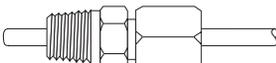
Termination	General Applications		MI Thermocouple		RTD	
	Ordering Code	Length	Ordering Code	Length	Ordering Code	Length
 <p>Split Leads</p>	A	2 ¹ / ₂	T	1 ¹ / ₂	T	*1 ¹ / ₂
 <p>Spade Lugs</p>	B	2 ¹ / ₂	U	1 ¹ / ₂	U	*1 ¹ / ₂
 <p>1/2 inch BX Connector Lugs</p>	C	2 ¹ / ₂	W	1 ¹ / ₂	W	1 ¹ / ₂
 <p>Standard Size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

* When style contains jacketed wire.

General Information

Fitting Options

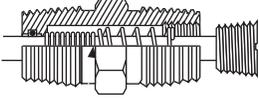
Fitting Type	Material	Sheath Sizes (in.)	NPT Thread Size (in.)	HEX Size (in.)	Length (in.)	Order Code
Fixed Single Thread 1/8 NPT 	303 SS	0.063 to 0.250	1/8	7/16	11/16	A
Fixed Single Thread 1/4 NPT 	303 SS	0.125 to 0.250	1/4	9/16	7/8	B
Fixed Single Thread 1/2 NPT 	303 SS	0.125 to 0.250	1/2	7/8	1	D
Fixed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

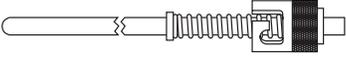
Fitting Type	Material	Sheath Sizes (in.)	NPT Thread Size (in.)	HEX Size (in.)	Length (in.)	Order Code
Non-Adjustable Compression Brass 	Brass	0.125	1/8	1/2	1	J
		0.188	1/8	1/2	1 1/8	J
		0.250	1/8	1/2	1 3/16	J
Non-Adjustable Compression SS 	303 SS	0.063	1/8	1/2	1 1/4	L
		0.125	1/8	1/2	1 1/4	L
		0.188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

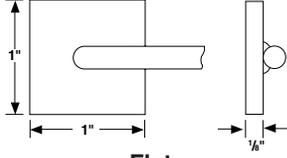
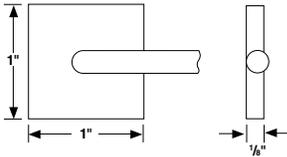
Compression Fittings: Compression fittings are shipped finger-tight on the sheath allowing field installation. Once non-adjustable fittings are deformed, they cannot be relocated. Adjustable fittings come with neoprene, TFE or lava sealant glands.

General Information

Fittings

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

Fitting Type	Material	Sheath Sizes (in.)	Length (in.)	Order Code
Bayonet Lockcap and Spring 	Plated Steel	0.125	1%	W
	Plated Steel	0.188	1%	W

Weld Pad Type	Material	Order Code
 <p>Flat</p>	304 SS*	2
 <p>Milled Slot</p>	304 SS	5

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

Smart Sensing

Product Overview

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

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

SERIES DX DeviceNet™ Temperature Transmitter

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

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

LabVIEW™ is a trademark of National Instruments Corporation.



WATCOUPLE™ Thermocouples

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

INFOSENSE™-P Thermocouples, RTDs

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

INFOSENSE™ Thermocouples, RTDs

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

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

Notes

Thermocouples

General Applications

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

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

Performance Capabilities

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

Features and Benefits

“Custom-tailored” standard products including:

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



Custom manufactured thermocouples

- Units designed and built to your specifications

Applications

- Plastic injection molding machinery
- Food processing equipment
- Deicing
- Plating baths
- Industrial processing
- Medical equipment
- Pipe tracing control
- Industrial heat treating

- Packaging equipment
- Liquid temperature measurement
- Refrigerator temperature control
- Oven temperature control

Thermocouples

General Applications

Construction and Tolerances

Construction

Thermocouples feature flexible SERV-RITE® wire insulated with woven fiberglass or high temperature engineered resins. For added protection against abrasion, products can be provided with stainless steel wire braid and flexible armor. ASTM E 230 color-coding identifies standard catalog

thermocouple types (see reference chart on inside back cover).

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

How to Order

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

Note: All eleven spaces must be filled in.

Availability

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

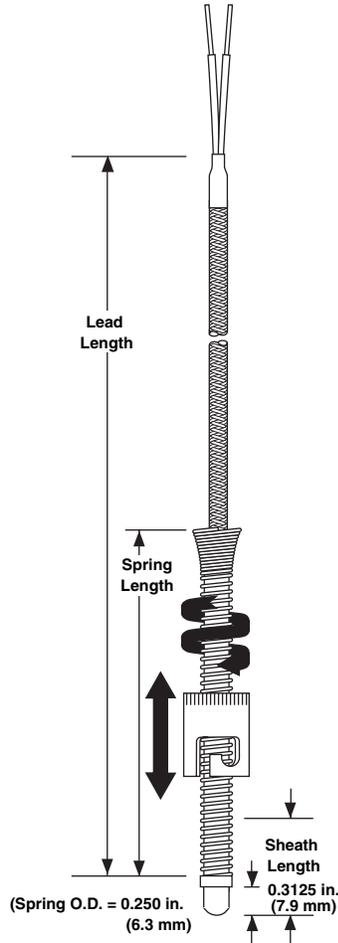
Preferred sensor options are available for shipment in approximately three days.

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

Thermocouples

General Applications

Adjustable Spring Style



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

Rapid Ship Sensors

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

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

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

1 2 3 4 5 6 7 8 9 10 11

D **B**

1-2. Construction Style

- 10 = Standard cap - 6 inch spring**
- 11 = Standard cap - 12 inch spring**
- 14 = 12 mm cap - 6 inch spring
- 15 = 15 mm cap - 6 inch spring
- 16 = 12 mm cap - 12 inch spring
- 17 = 15 mm cap - 12 inch spring

3. Sheath Diameter (inch), 316 SS

D = 3/16

4. Calibration

- J = Type J** T = Type T
- K = Type K** E = Type E

5. Lead Protection

- F = Fiberglass (24 gauge stranded)
- S = Fiberglass with stainless steel overbraid (24 gauge stranded)**
- P = Fiberglass (20 gauge stranded)
- B = Fiberglass with stainless steel overbraid (20 gauge stranded)**
- T = PFA (24 gauge stranded)
- U = PFA with stainless steel overbraid (24 gauge stranded)
- V = PFA (20 gauge stranded)
- W = PFA with stainless steel overbraid (20 gauge stranded)

6. Junction

- F = Grounded, flat tip
- G = Grounded, round tip**
- D = Grounded, drill point
- R = Ungrounded, flat tip
- U = Ungrounded, round tip**
- P = Ungrounded, drill point
- H = Grounded, round tip, dual element
- S = Ungrounded, round tip, dual element

7. Sheath Length (inch)

B = 1

8-10. Lead Length (whole inches)

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

Available lengths: 006 to 360, over 360 consult factory

11. Terminations/Options

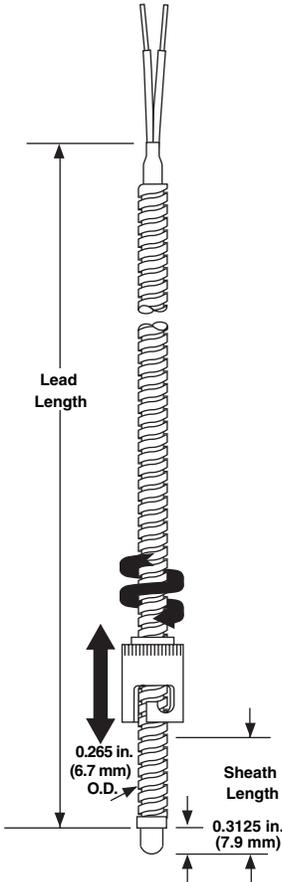
- A = Standard, 2 1/2 inch split leads**
- B = 2 1/2 inch split leads with #6 spade lugs
- C = 2 1/2 inch split leads with #6 spade lugs and BX connector
- D = Standard male plug, quick disconnect**
- E = Standard female jack, quick disconnect
- F = Miniature male plug, quick disconnect
- G = Miniature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

Thermocouples

Thermocouples

General Applications

Adjustable Armor Style



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

Rapid Ship Sensors

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

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

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

1 2 3 4 5 6 7 8 9 10 11

1 2 D B

1-2. Construction Style —————

12 = Adjustable armor thermocouple, standard cap

3. Sheath Diameter (inch), 316 SS —————

D = $\frac{3}{16}$

4. Calibration —————

J = Type J
K = Type K
 T = Type T
 E = Type E

5. Lead Protection —————

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

6. Junction —————

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

7. Sheath Length (inch) —————

B = 1

8-10. Lead Length (inches) —————

012, 024, 036, 040, 048, 060, 072, 079, 096 and 120
 Available lengths: 006 to 360, over 360 consult factory

11. Terminations/Options —————

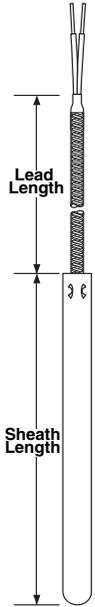
A = Standard, 2 1/2 inch split leads
 B = 2 1/2 inch split leads with #6 spade lugs
 C = 2 1/2 inch split leads with #6 spade lugs and BX connector
D = Standard male plug, quick disconnect
 E = Standard female jack, quick disconnect
 F = Miniature male plug, quick disconnect
 G = Miniature female jack,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

Thermocouples

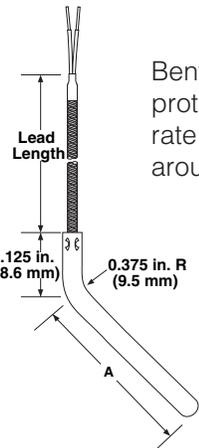
General Applications

Rigid Sheath

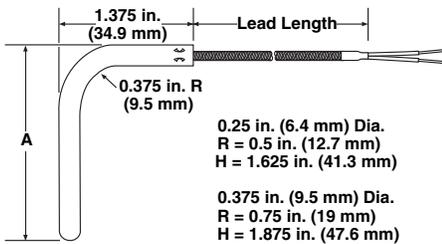
1/8 and 3/16 inch Diameter



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. Minimum order quantity may apply.

Rapid Ship Sensors

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

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

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

1 2 3 4 5 6 7 8 9 10 11

1-2. Construction Style

20 = Plain sheath, straight

21 = Plain sheath, 45° bend

22 = Plain sheath, 90° bend

3. Sheath Diameter (inch), 316 SS

C = 1/8 S = 1/8 epoxy sealed 149°C (300°F)

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

4. Calibration

J = Type J T = Type T

K = Type K E = Type E

5. Lead Protection

F = Fiberglass (24 gauge stranded)

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

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

*P = Fiberglass (20 gauge stranded)

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

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

O = Plug or jack termination on sheath fiberglass (24 gauge stranded)

T = PFA (24 gauge stranded)

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

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

*V = PFA (20 gauge stranded)

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

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

6. Junction

F = Grounded, flat tip P = Ungrounded, drill point

G = Grounded, round tip E = Exposed

D = Grounded, drill point *H = Grounded, round tip, dual element

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

U = Ungrounded, round tip

7. Sheath Length (inches)

A = 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)

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

Available lengths: 006 to 360, over 360 consult factory

11. Terminations/Options

A = Standard, 2 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

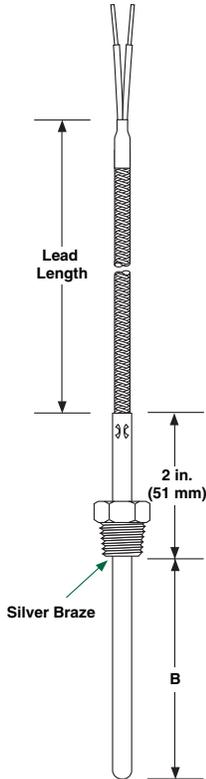
G = Miniature female jack, quick disconnect

H = 1/4 inch push-on connector

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.

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

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

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

3. Sheath Diameter (inch), 316 SS
C = 1/8 S = 1/8 epoxy sealed 149°C (300°F)
D = 3/16 T = 3/16 epoxy sealed 149°C (300°F)

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

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

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

7. "B" Dimension (inches)
 A = 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)
012, 024, 036, 040, 048, 060, 072, 079, 096 and 120
 Available lengths: 006 to 360, over 360 consult factory

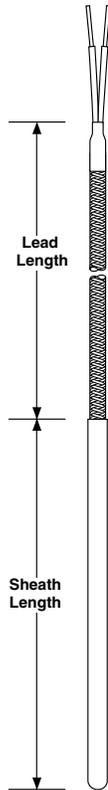
11. Terminations/Options
A = Standard, 2 1/2 inch split leads
 B = 2 1/2 inch split leads with #6 spade lugs
 C = 2 1/2 inch split leads with #6 spade lugs and BX connector
D = Standard male plug, quick disconnect
 E = Standard female jack, quick disconnect
F = Miniature male plug, quick disconnect
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

*Not available with 1/8 inch diameter sheath.

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

Thermocouples

General Applications PFA Encapsulated Style



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

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

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

1-2. Construction Style — 65 = PFA coated sheath

3. Diameter (inch) under covering
 C = 1/8 epoxy seal 149°C (300°F)
D = 3/16 epoxy seal 149°C (300°F)
 E = 1/4 epoxy seal 149°C (300°F)

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

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

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

7. Sheath Length (inches)
 B = 1 J = 4 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)
012, 024, 036, 040, 048, 060, 072, 079, 096 and 120
 Available lengths: 006 to 360, over 360 consult factory

11. Terminations/Options
A = Standard, 2 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

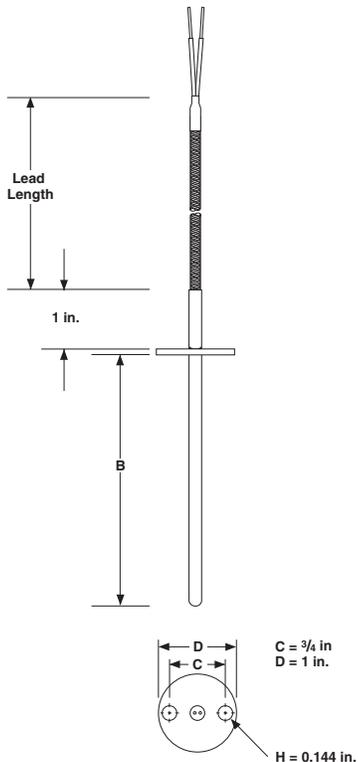
Thermocouples

*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. Minimum order quantity may apply.

Rapid Ship Sensors

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

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

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

1 2 3 4 5 6 7 8 9 10 11

2 5

1-2. Construction Style
25 = Thermocouple with flange

3. Sheath Diameter (inch), 316 SS
C = 1/8 S = 1/8 epoxy sealed 149°C (300°F)
D = 3/16 T = 3/16 epoxy sealed 149°C (300°F)

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

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

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

7. "B" Dimension (inches)
D = 2 H = 4 M = 6 R = 8 W = 10
E = 2 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

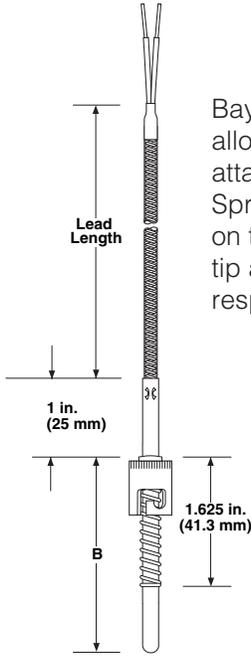
8-10. Lead Length (inches)
012, 024, 036, 040, 048, 060, 072, 079, 096 and 120
Available lengths: 006 to 360, over 360 consult factory

11. Terminations/Options
A = Standard, 2 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

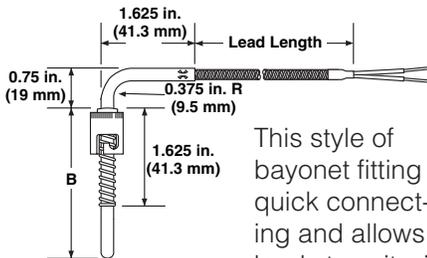
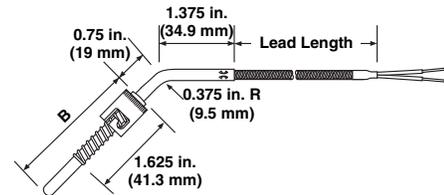
Thermocouples

General Applications

Rigid Sheath Fixed Bayonet Style



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



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

① Reference page 29 to calculate "B" dimension.

*Not available with 1/8 inch diameter sheath.

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

Rapid Ship Sensors

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

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

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

1 2 3 4 5 6 7 8 9 10 11

1-2. Construction Style

30 = Bayonet cap with spring, straight

31 = Bayonet cap with spring, 45° bend

32 = Bayonet cap with spring, 90° bend

3. Sheath Diameter (inch), 316 SS

C = 1/8 S = 1/8 epoxy sealed 149°C (300°F)

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

4. Calibration

J = Type J T = Type T

K = Type K E = Type E

5. Lead Protection

F = Fiberglass (24 gauge stranded)

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

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

*P = Fiberglass (20 gauge stranded)

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

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

O = Plug or jack termination on sheath fiberglass (24 gauge stranded)

T = PFA (24 gauge stranded)

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

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

*V = PFA (20 gauge stranded)

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

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

6. Junction

F = Grounded, flat tip P = Ungrounded, drill point

G = Grounded, round tip E = Exposed

D = Grounded, drill point *H = Grounded, round tip, dual element

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

U = Ungrounded, round tip

7. "B" 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)

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

Available lengths: 006 to 360, over 360 consult factory

11. Terminations/Options

A = Standard, 2 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

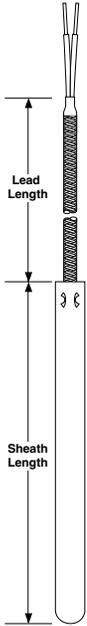
R = Double slotted 12 mm bayonet cap, split end leads

S = Double slotted 15 mm bayonet cap, split end leads

Thermocouples

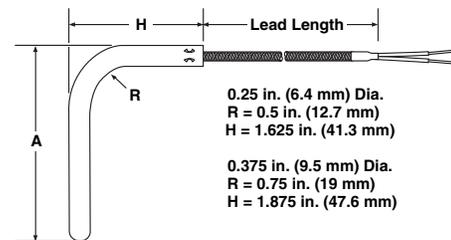
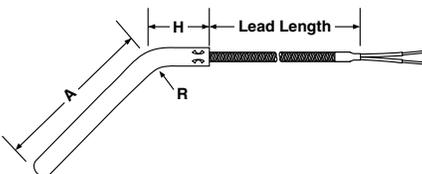
General Applications

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. Minimum order quantity may apply.

Rapid Ship Sensors

Rapid Ship sensors come with 1/4 inch diameter sheath, 20 gauge stranded fiberglass lead with stainless steel overbraid, grounded junction and a split lead termination.

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

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

1 2 3 4 5 6 7 8 9 10 11

1-2. Construction Style

- 40= Plain sheath, straight, large, diameter**
- 41= Plain (45°) large diameter
- 42= Plain (90°) large diameter

3. Sheath Diameter (inch), 316 SS

- E = 1/4** U = 1/4 epoxy sealed 149°C (300°F)
- G = 3/8** V = 3/8 epoxy sealed 149°C (300°F)

4. Calibration

- J = Type J** T = Type T
- K = Type K** E = Type E

5. Lead Protection

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

6. Junction

- F = Grounded, flat tip
- G = Grounded, round tip**
- 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)

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

Available lengths: 006 to 360, over 360 consult factory

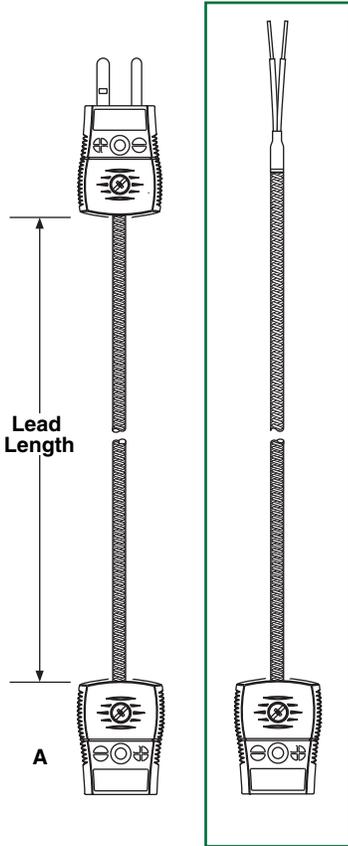
11. Terminations/Options

- A = Standard, 2 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

Thermocouples

General Applications

Flexible Extensions



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

Rapid Ship Sensors

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

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

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

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

1-2. Construction Style _____
60 = Flexible extension

3. Diameter _____
X = Not applicable

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

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

6. Junction _____
X = Not applicable

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

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

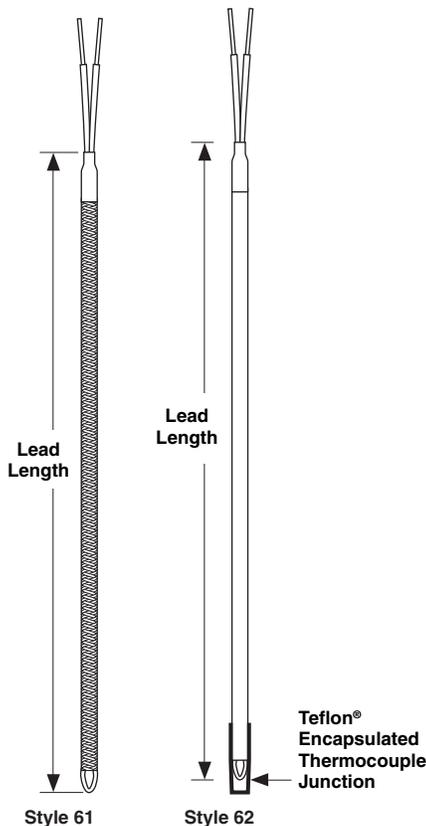
11. Termination "B" _____
A = Standard, 2 ½ inch split leads
B = 2 ½ inch split leads with #6 spade lugs
C = 2 ½ inch split leads with #6 spade lugs and BX connector
D = Standard male plug, quick disconnect
E = Standard female jack, quick disconnect
F = Miniature male plug, quick disconnect
G = Miniature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

* Not available with SS hose.

Thermocouples

General Applications

Insulated Wire Thermocouple Style 61 and Style 62



Rapid Ship Sensors

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

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

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

1 2 3 4 5 6 7 8 9 10 11

X E X

1-2. Construction Style —————

61 = SERIES 61
*62= SERIES 62

3. Diameter —————

X = Not applicable

4. Calibration —————

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

5. Lead Protection —————

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

6. Junction —————

E = Exposed

7. Exter X —————

8-10. Lead Length (inches) —————

048 and 096
Available lengths: 006 to 600, over 600 consult factory

11. Terminations/Options —————

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

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

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

such as sulfuric acid, hydrofluoric acid, strong mineral acids and oils.

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

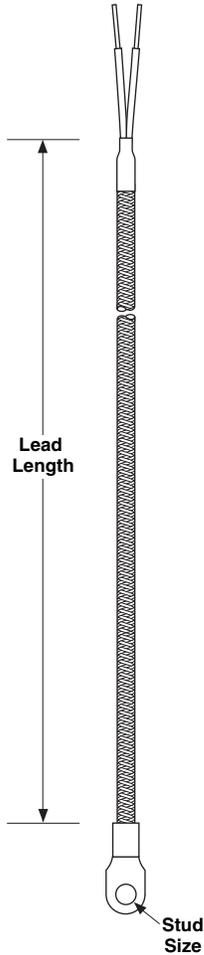
For additional mechanical strength and abrasion resistance, a stainless steel overbraid is available.

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

Thermocouples

General Applications

Ring Terminal Style



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

Rapid Ship Sensors

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

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

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

1 2 3 4 5 6 7 8 9 10 11

7 0 X

1-2. Construction Style — Ring terminal thermocouple

3. Diameter — Not applicable

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

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

6. Junction — **G = Grounded**
*U = Ungrounded

7. Stud Size—Hole Diameter (inches) —

*A = No. 6	0.144
*B = No. 8	0.169
*C = No. 10	0.196
D = ¼	0.266
E = ⅜	0.390

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

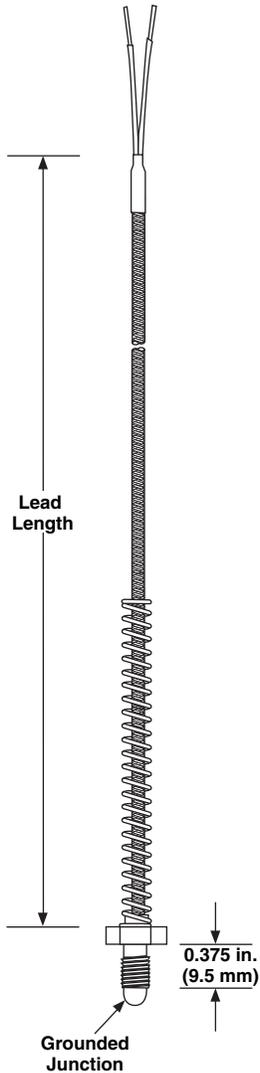
11. Terminations/Options — **A = Standard, 2 ½ inch split leads**
B = 2 ½ inch split leads with #6 spade lugs
C = 2 ½ inch split leads with #6 spade lugs and BX connector
D = Standard male plug, quick disconnect
E = Standard female jack, quick disconnect
F = Miniature male plug, quick disconnect
G =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

* 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.

Rapid Ship Sensors

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

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

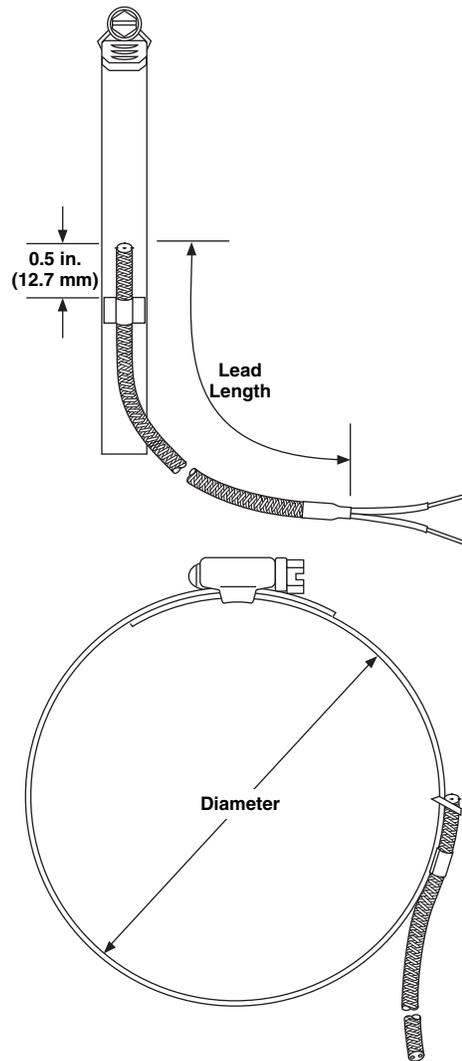
Custom Ordering Information—Items in **Bolded Green Type** are preferred with shorter lead times.

	1	2	3	4	5	6	7	8	9	10	11
	7	1	X			G					
1-2. Construction Style	71 = Nozzle thermocouple										
3. Diameter	X = Not applicable										
4. Calibration	J = Type J T = Type T K = Type K E = Type E										
5. Lead Protection	F = Fiberglass (24 gauge stranded) S = Fiberglass with stainless steel overbraid (24 gauge stranded) P = Fiberglass (20 gauge stranded) B = Fiberglass with stainless steel overbraid (20 gauge stranded) T = PFA (24 gauge stranded) U = PFA with stainless steel overbraid (24 gauge stranded) V = PFA (20 gauge stranded) W = PFA with stainless steel overbraid (20 gauge stranded)										
6. Junction	G = Grounded										
7. 304 SS, Bolt size	A = ¼ inch x 28 UNF, ⅜ inch thread depth B = 8-32 thread * C = 10-32 thread * M = M6 x 1										
8-10. Lead Length (inches)	012, 024, 036, 040, 048, 060, 072, 079, 096 and 120 Available lengths: 006 to 360, over 360 consult factory										
11. Terminations/Options	A = Standard, 2 ½ inch split leads B = 2 ½ inch split leads with #6 spade lugs C = 2 ½ inch split leads with #6 spade lugs and BX connector D = Standard male plug, quick disconnect E = Standard female jack, quick disconnect F = Miniature male plug, quick disconnect G = Miniature female jack, quick disconnect H = ¼ inch push-on connector										

* Only available with 24 gauge wire.

Thermocouples

General Applications Pipe Clamp Style



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

Rapid Ship Sensors

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

Calibration	Clamp Size	Lead Length		Part Number
		in.	(mm)	
J	1/8 to 1 1/4	48	(1219)	72XJSGA048A
		96	(2438)	72XJSGA096A
	1 1/4 to 2 1/4	48	(1219)	72XJSGB048A
		96	(2438)	72XJSGB096A

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

1 2 3 4 5 6 7 8 9 10 11

7 2 X G

1-2. Construction Style _____
72 = Pipe clamp thermocouple

3. Diameter _____
X = Not applicable

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

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

6. Junction _____
G = Grounded

7. Clamp Band Diameter Range (inches) _____
A = 1/8 to 1 1/4 E = 4 1/4 to 5
B = 1 1/4 to 2 1/4 F = 5 to 6
C = 2 1/4 to 3 1/4 G = 6 to 7
D = 3 1/4 to 4 1/4

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

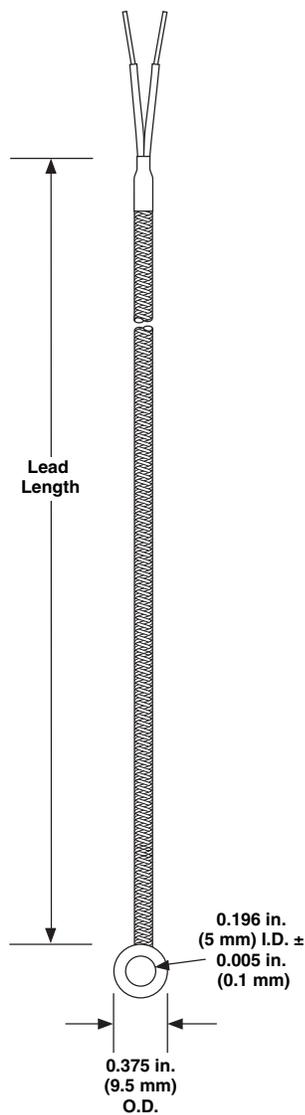
11. Terminations/Options _____
A = Standard, 2 1/2 inch split leads
B = 2 1/2 inch split leads with #6 spade lugs
C = 2 1/2 inch split leads with #6 spade lugs and BX connector
D = Standard male plug, quick disconnect
E = Standard female jack, quick disconnect
F = Miniature male plug, quick disconnect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

Thermocouples

Thermocouples

General Applications

Grommet Style



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

Rapid Ship Sensors

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

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

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

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

1-2. Construction Style _____
73 = Grommet thermocouple

3. Diameter _____
X = Not applicable

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

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

6. Junction _____
G = Grounded

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

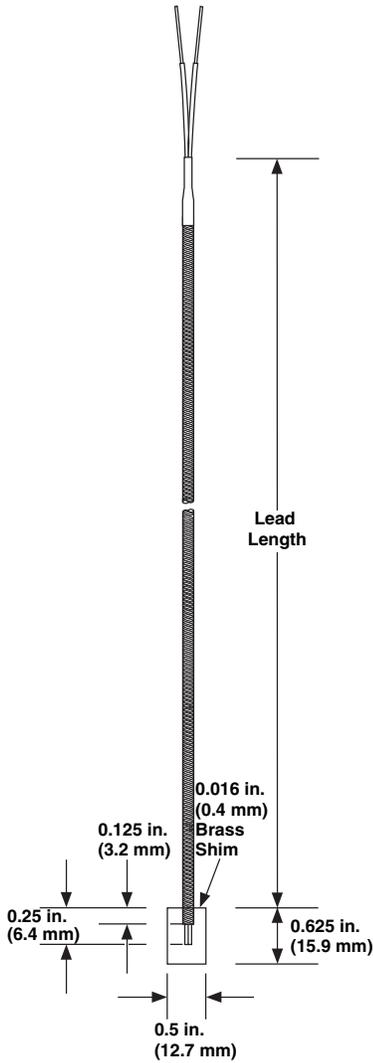
8-10. Lead Length (inches) _____
012, 024, 036, 040, 048, 060, 072, 079, 096 and 120
Available lengths: 006 to 360, over 360 consult factory

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

Thermocouples

General Applications

Brass Shim Style



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

	1	2	3	4	5	6	7	8	9	10	11
	7	4	X			G	A				
1-2. Construction Style	_____										
74 = Shim stock thermocouple											
3. Diameter	_____										
X = Not applicable											
4. Calibration	_____										
J = Type J											
K = Type K											
T = Type T											
E = Type E											
5 Lead Protection	_____										
F = Fiberglass (24 gauge solid)											
T = PFA (24 gauge solid)											
6. Junction	_____										
G = Grounded											
7. Shim Size (inch)	_____										
A = 1/2 inch x 3/8 inch x 0.016 inch, brass											
8-10. Lead Length (inches)	_____										
012, 024, 036, 040, 048, 060, 072, 079, 096 and 120											
Available lengths: 006 to 360, over 360 consult factory											
11. Terminations/Options	_____										
A = Standard, 2 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											

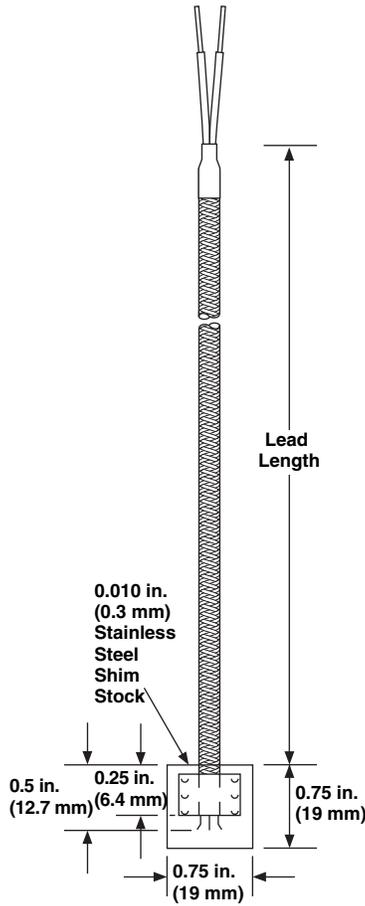
The shim stock thermocouple has low profile and can be placed between components for measurement of surface temperature.

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.

Rapid Ship Sensors

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

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

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

	1	2	3	4	5	6	7	8	9	10	11
	7	5	X			G	A				
1-2. Construction Style	75 = Stainless steel shim stock thermocouple										
3. Diameter	X = Not applicable										
4. Calibration	J = Type J K = Type K T = Type T E = Type E										
5. Lead Protection	F = Fiberglass (24 gauge stranded) S = Fiberglass with stainless steel overbraid (24 gauge stranded) T = PFA (24 gauge stranded) U = PFA with stainless steel overbraid (24 gauge stranded)										
6. Junction	G = Grounded										
7. Shim Size (inch)	A = ¼ inch x ¼ inch x 0.010 inch, 304 stainless steel										
8-10. Lead Length (inches)	012, 024, 036, 040, 048, 060, 072, 079, 096 and 120 Available lengths: 006 to 360, over 360 consult factory										
11. Terminations/Options	A = Standard, 2 ½ inch split leads B = 2 ½ inch split leads with #6 spade lugs C = 2 ½ inch split leads with #6 spade lugs and BX connector D = Standard male plug, quick disconnect E = Standard female jack, quick disconnect F = Miniature male plug, quick disconnect G = Miniature female jack, quick disconnect H = ¼ inch push-on connector										

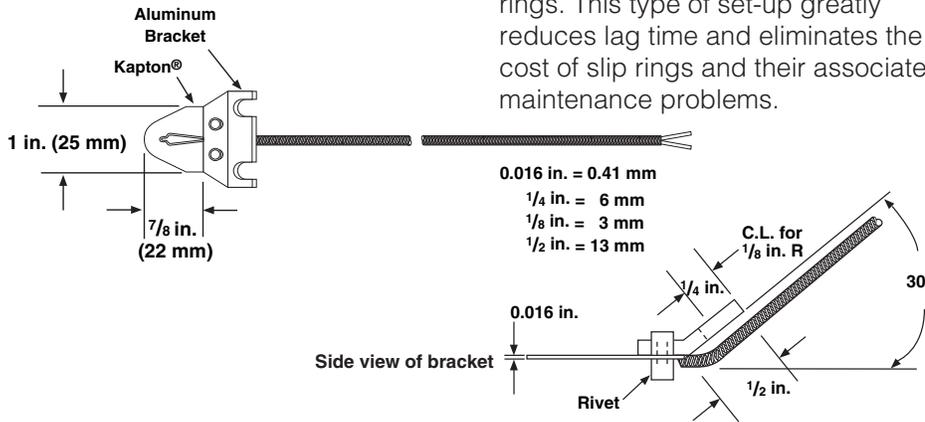
Thermocouples

General Applications Kapton® Bracket Style

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

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

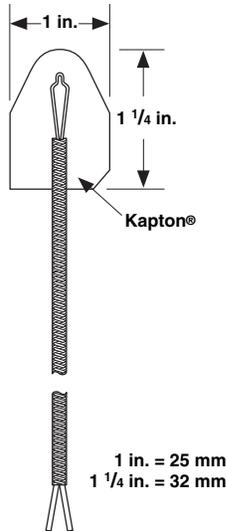
- Continuous use at 200°C (400°F), 260°C (500°F) for limited periods
- Low mass
- Fast response
- Totally insulated construction
- Available in Type J or K



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

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

Low Profile Kapton® Peel and Stick Style



Low Profile Kapton® Thermocouple (without Bracket)

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

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

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

Kapton® Peel and Stick

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

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

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

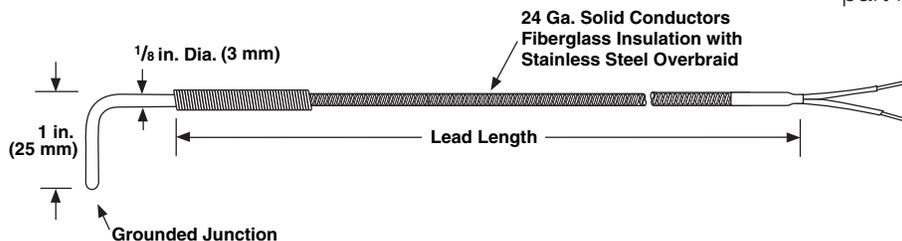
Newbury Nozzle Style

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

Ordering Information

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

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



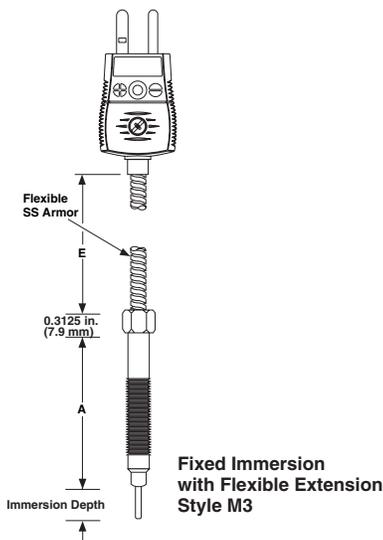
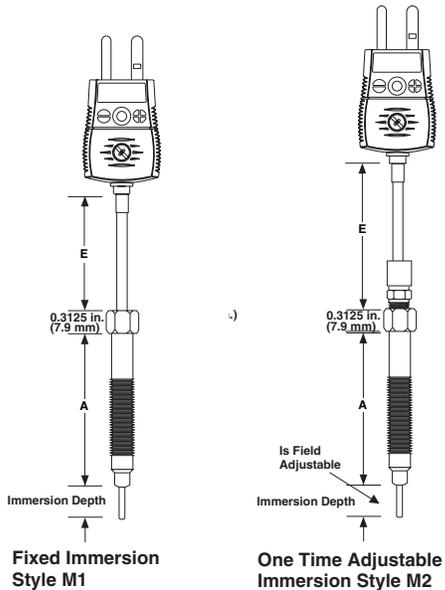
Kapton® is a registered trademark of E. I. du Pont de Nemours & Company.

Thermocouples

General Applications

Melt Bolt Thermocouple

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



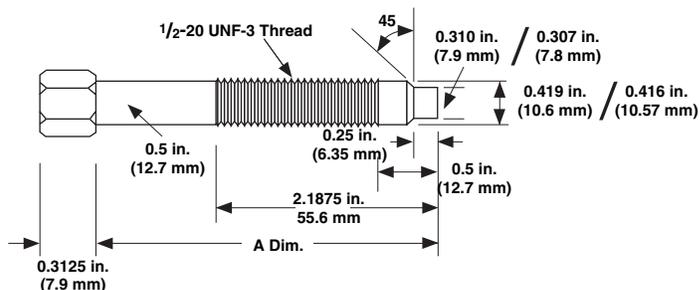
Custom Ordering Information—Items in **Bolded Green Type** are preferred with shorter lead times.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
2. Style	M							A	O						
3. Sheath O.D. (inch)															
4. Lead Wire Construction															
5. Melt Bolt Length "A" (inch)															
6. Cold End Terminations															
7. Probe Construction															
8. Enter "0"															
9. Immersion Length "I" (inch)															
10. Immersion Length "I" (fractional inch)															
11. Junction															
12. Calibration															
13-14. Extension Length "E"															

- 2. Style**
- 1 = Fixed immersion**
- 2 = Adjustable immersion
- 3 = Fixed immersion with flex armor
- 3. Sheath O.D. (inch)**
- G = 0.125
- 4. Lead Wire Construction**
- O = No flex armor (M1 and M2)
- R = S.S. flex armor (M3 only)
- 5. Melt Bolt Length "A" (inch)**
- 1 = 3**
- 2 = 6
- 6. Cold End Terminations**
- A = Standard male plug**
- B = Standard female jack
- C = Standard plug with mating connector
- T = Standard 1 ½ inch split leads (Style M3 only)
- U = 1 ½ inch split leads with spade lugs (Style M3 only)
- W = 1 ½ inch split leads with BX connector and spade lugs (Style M3 only)
- 7. Probe Construction**
- A = Mineral insulated with 304 SS sheath
- 8. Enter "0"**
- 9. Immersion Length "I" (inch)**
- 1 = 1
- 10. Immersion Length "I" (fractional inch)**
- 1 = 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"**

03, 06
Whole inches: 02 to 99

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



Standard Dimensions For M1, M2, and M3 Melt Bolts

Thermocouples

Mineral Insulated

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

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

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

Performance Capabilities

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

Features and Benefits

Special mineral insulation

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

Diameters as small as 0.010 in. (0.25 mm)

- Ideal when physical space or extremely fast response are critical

Flexibility of the XACTPAK material

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



Outer sheath

- Protects the wires from oxidation and hostile environments

Wide range of sheath materials, diameters, and calibrations

- Meet specific requirements

In-house manufacturing of XACTPAK material

- Rigid quality control procedures
- Assures high standards are met
- Single source reliability

Custom capabilities

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

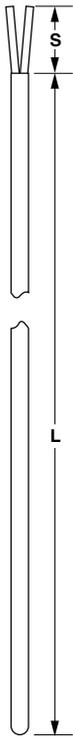
Applications

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

Thermocouples

Mineral Insulated

Cut and Stripped Style AB



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

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

Performance Capabilities

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

Features and Benefits

Cold end stripped and sealed with epoxy

- Inhibits moisture penetration

Dual element style

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

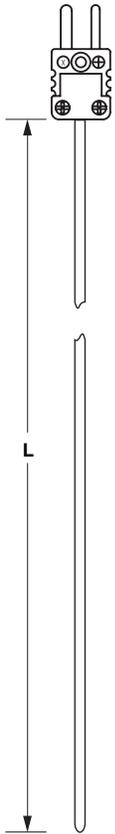
Custom Ordering Information—Items in **Bolded Green Type** are preferred with shorter lead times.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	A	B		0		0									
3. Sheath O.D. (inch)															
A = 0.010	E = 0.063	L = 0.375													
B = 0.020	G = 0.125	M = 0.500													
C = 0.032	H = 0.188														
D = 0.040	J = 0.250														
4. Enter "0"															
5. Fittings, Weld Pads															
If required, enter order code from pages 39-40. If none, enter "0".															
6. Enter "0"															
7. Sheath Material															
A = 304 SS	Q = Alloy 600 (Type K)														
F = 316 SS															
8-9. Sheath Length "L" (whole inches)															
01 to 99															
Lengths over 99 inches consult factory.															
10. Sheath Length "L" (fractional inch)															
0 = 0	4 = 1/2														
1 = 1/8	5 = 3/8														
2 = 1/4	6 = 1/2														
3 = 3/8	7 = 3/4														
11. Junction															
Single	Grounded	Ungrounded	Exposed												
Dual	G	U	E												
	H	W (isolated)	D (isolated)												
12. Calibration															
Standard limits	E	J	K	N	T										
Special limits	2	3	4	—	8										
13. Strip Length "S" (whole inches)															
0, 1, 2 and 3 - 1 inch maximum on 0.040 and smaller															
14. Strip Length "S" (fractional inch)															
0 = 0	4 = 1/2														
1 = 1/8	5 = 3/8														
2 = 1/4	6 = 1/2														
3 = 3/8	7 = 3/4														
15. Special Requirements															
0 = None															
X = Special requirements, consult factory															

Thermocouples

Mineral Insulated

Mini Plug or Jack Termination Style AC



Rapid Ship Sensors

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

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

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

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

A C 0 0 0 0

3. Sheath O.D. (inch) ————

A = 0.010 D = 0.040
 B = 0.020 **E = 0.063**
 C = 0.032 **G = 0.125**

4. Connector Type ————

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

5. Fittings, Weld Pads ————

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

6. Enter "0" ————

7. Sheath Material ————

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

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

04, 06, 12, 18, 24
 Available lengths: 01 to 99, over 99 consult factory
 Maximum length for PFA coating is 48 inches.

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

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

11. Junction ————

Single Grounded Ungrounded Exposed
 G **U** E

12. Calibration ————

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

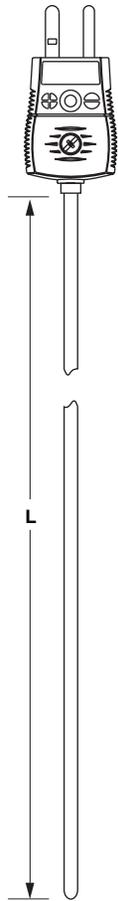
13-14. Enter "00" ————

15. Special Requirements ————

0 = None
 X = Special requirements, consult factory

Thermocouples

Mineral Insulated Standard Plug or Jack Termination Style AC



Rapid Ship Sensors

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

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

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

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

A C **0** **0 0**

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

4. Connector Type _____
 Standard Plugs and Jacks 218°C (425°F)
A = Standard plug
 B = Standard jack
 C = Standard plug with mating connector
 High Temperature Plugs and Jacks 540°C (1000°F)
 (0.250 inch maximum O.D.)
 L = High temperature plug
 M = High temperature jack
 N = High temperature plug with mating connector

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

6. Enter "0" _____

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

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

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

11. Junction _____
 Single Grounded **G** Ungrounded **U** Exposed E
 Dual H W (isolated) D (isolated)

12. Calibration _____
 Standard limits E J K N T
 Special limits E **J K** N **T**
 2 3 4 — 8

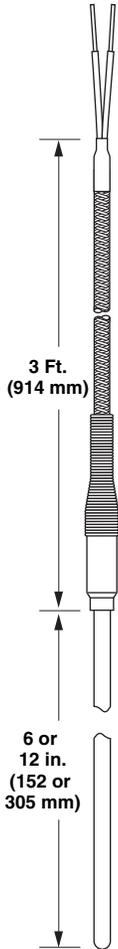
13-14. Enter "00" _____

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

Thermocouples

Mineral Insulated

Metal Transitions with Spring Strain Relief Styles AF



Rapid Ship Sensors

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

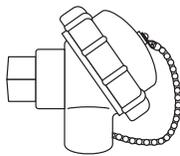
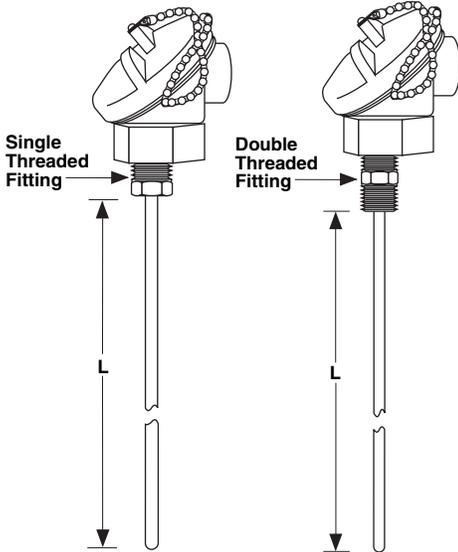
Calibration	Sheath Material	Sheath Diameter		Sheath Length	
				in. (mm)	in. (mm)
J	316 SS	0.063	(1.6)	6 (152)	12 (305)
		0.125	(3.2)	AFGD0TF060UJ030	AFGD0TF120UJ030
		0.188	(4.8)	AFHD0TF060UJ030	AFHD0TF120UJ030
		0.250	(6.4)	AFJD0TF060UJ030	AFJD0TF120UJ030
K	Alloy 600	0.063	(1.6)	6 (152)	12 (305)
	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

See next page for custom ordering information.

Thermocouples

Mineral Insulated

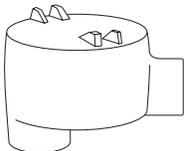
Connection Head Style AR



Type C (Polypropylene)



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



Type H (Explosion Proof)

Rapid Ship Sensors

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

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

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

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

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

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

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

6. Enter "0"

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

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

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

11. Junction

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

12. Calibration

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

13-14. Enter "00"

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

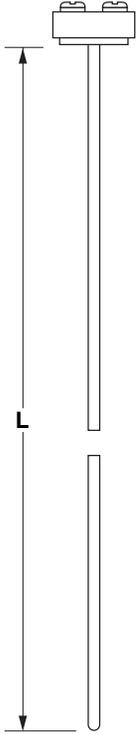
*0.250 inch diameter only.

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

Thermocouples

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 attached directly to the XACTPAK sheath.

Performance Capabilities

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

Features

Termination directly to sheath

- Allows quick hookup and disassembly

Terminal head

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

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

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

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

4. Cold End Termination
C = Ceramic 540°C (1000°F)
1 1/8 inch diameter x 1/8 inch thick

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

6. Enter “0”

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

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

10. Sheath Length “L” (fractional inch)
0 = 0 3 = 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	H	W (isolated)	D (isolated)

12. Calibration

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

13-14. Enter “00”

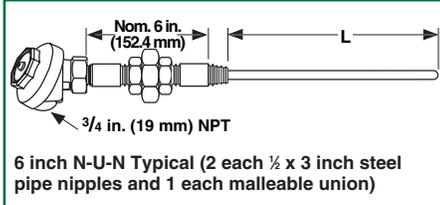
15. Special Requirements
0 = None
X = Special requirements, consult factory

Thermocouples

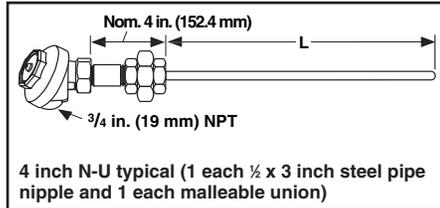
Mineral Insulated

For Use With Thermowells Style AT

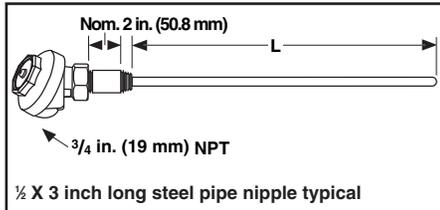
Type 1



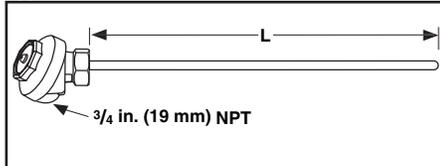
Type 2



Type 3



Type 4



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

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

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	A	T	J			0									0
3. Sheath O.D. (inch) J = 0.250															
4. Connection Head C = Polypropylene (1/2 inch NPT thermocouple opening only) D = Small cast iron E = Small aluminum H = Explosion proof (1/2 inch NPT and 3/8 inch NPT thermocouple opening only)															
5. Cold End Configuration 1 = Type 1, six inch nipple-union-nipple 2 = Type 2, four inch nipple-union 3 = Type 3, three inch nipple 4 = Type 4, no extensions Note: Steel nipple and unions are standard.															
6. Enter "0"															
7. Sheath Material A = 304 SS F = 316 SS Q = Alloy 600 (Type K)															
8-9. Sheath Length "L" (whole inch) Available lengths: 01 to 99, over 99 consult factory															
10. Sheath Length "L" (fractional inch) 0 = Not required, complete assembly 1 = 1/8 3 = 3/8 5 = 5/8 7 = 7/8 2 = 1/4 4 = 1/2 6 = 3/4															
11. Junction Grounded Ungrounded Single G U Dual, isolated — W															
12. Calibration Standard limits E J K N T Special limits 2 3 4 — 8															
13. Enter "0"															
14. Spring-Loading Y = Yes N = No															
15. Special Requirements 0 = None X = Special requirements, consult factory															

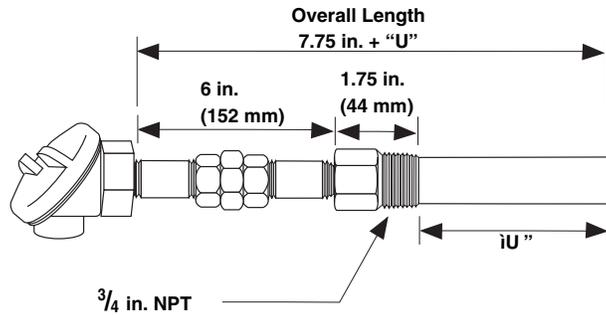


See the hardware section, pages 156 to 157, for a complete description of Watlow connection heads.

Thermocouples

Mineral Insulated Style AT With Thermowells

Straight Well

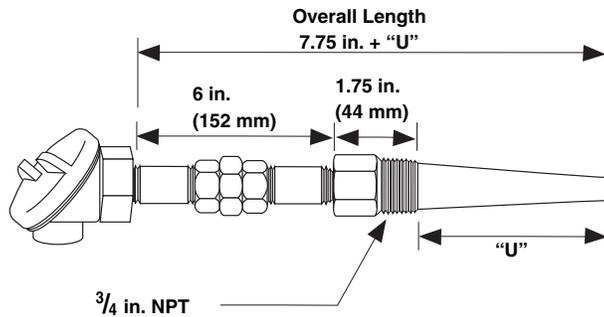


Rapid Ship Sensors

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

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

Tapered Well



Rapid Ship Sensors

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

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

Thermocouples

Industrial Base/ Noble Metal

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

Performance Capabilities

- 1260°C (2300°F) maximum temperature

Features and Benefits

Insulated wire thermocouples

- Suitable for most general purpose applications

Bare and ceramic insulated elements

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

Protected thermocouples

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

Applications

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



Thermocouples

Base Metal

Rapid Ship Sensors

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

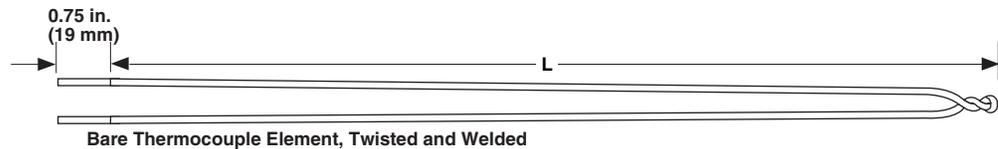
Lead Length		Part Number
in.	(mm)	
12	(305)	1409-12
18	(457)	1409-18
24	(610)	1409-24
36	(914)	1409-36
48	(1219)	1409-48

Bare Elements

To order, specify:

Part number-length.

Example: 1402-36 or
1432-BW-24

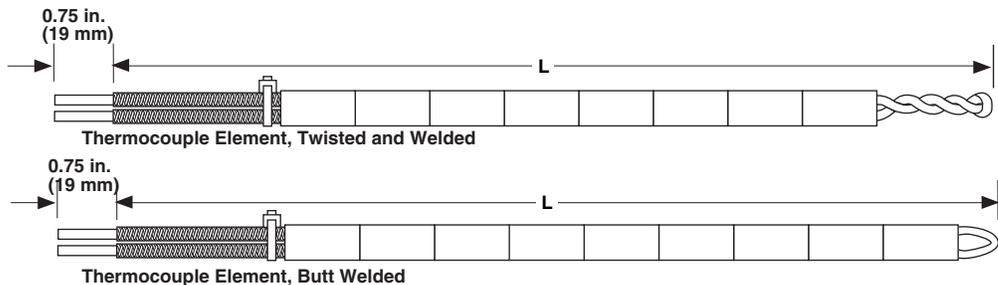


Straight Elements with Two-Hole Insulators

To order, specify:

Part number-length.

Example: 1409-48 or
1436-BW-18



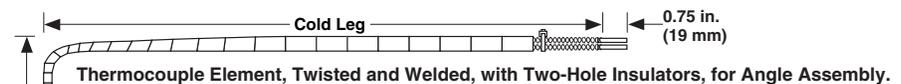
Code Number				AWG Gauge	Insulator Part No.	Length (in.)
Type K		Type J				
Twisted and Welded	Butt Welded	Twisted and Welded	Butt Welded			
1402	1432-BW	—	—	8	BARE	12, 18,
1403	1433-BW	—	—	11	BARE	24, 30,
1404	1434-BW	1503	1576-BW	14	BARE	36, 42,
1409	1436-BW	1507	1578-BW	8	301	48, 54,
1410	1437-BW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

Angle Type with Two-Hole Insulators

To order, specify:

Part number-cold leg length-hot leg length.

Example: 1440-BW-12-24



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

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

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

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

Thermocouples

Base Metal

Rapid Ship Sensors

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

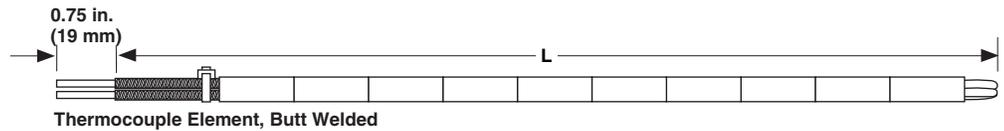
Lead Length in. (mm)	Part Number	Insulator Part No.
12 (305)	1442-BW-12	360
18 (457)	1442-BW-18	360
24 (610)	1442-BW-24	360

Dual Element with Four-Hole Insulators

To order, specify:

Part number-length.

Example: 1442-BW-36



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

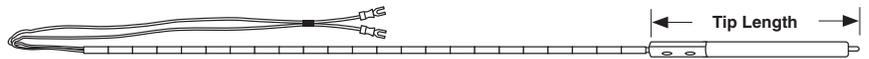
Immersion Tips

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

To order, specify:

Part number-tip length-lance length.

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



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

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

Thermocouples

Thermocouples

Base Metal

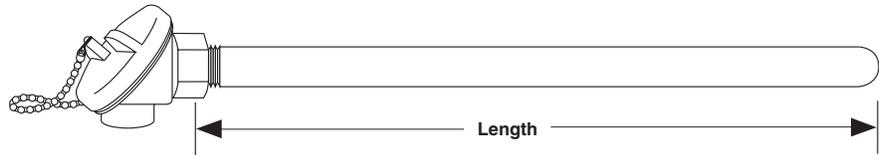
Standard Thermocouple with Protection Straight Type

To order, specify:

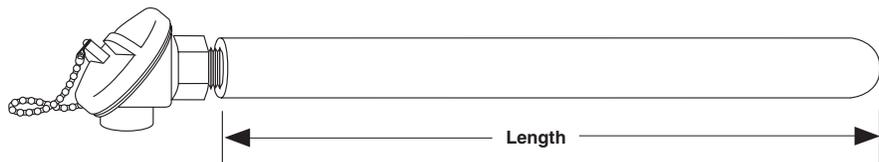
Part number-length.

Example: 1409-1308-24

Metal Tube



Cast Iron Tube



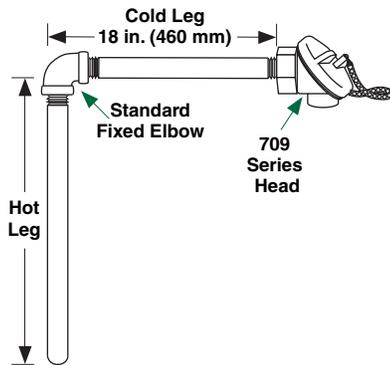
Code Number		AWG Gauge	Protection Tube		Pipe Diameter in.	Construction	Cast Iron Head	Length in.
Type K	Type J		Material	NPT Size in.				
1409-1395	1507-1395	8	Alloy 601	½	0.840	Seamless	70900203	12, 18, 24, 30, 36, 42, 48, 54, 60
1409-1396	1507-1396	8	Alloy 601	¾	1.050	Seamless	70900202	
1409-1341	1507-1341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

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

Thermocouples

Base Metal

Standard Thermocouple with Protection 90 Degree Angle Type



To order, specify:

Part number-cold leg length
hot leg length.

Example: 1414-1395-18-24

Standard Thermocouple with Protection — 90 Degree Angle

Code Number		AWG Gauge	Protection Tube (Hot Leg)			Cast Iron Head	Hot Leg Length in.
Type K	Type J		Material	NPT Size in.	Construction		
1414-1307-18	1517-1307-18	8	446 SS	$\frac{1}{2}$	Seamless	70900203	12, 18, 24, 30, 36
1414-1328-18	1517-1328-18	8	Black Steel	1	Welded	70900201	
1414-1375-18	1517-1375-18	8	Cast Iron	$\frac{3}{4}$ int	Cast	70900202	
1414-1395-18	1517-1395-18	8	Alloy 601	$\frac{1}{2}$	Seamless	70900203	
1415-1307-18	1518-1307-18	14	446 SS	$\frac{1}{2}$	Seamless	70900203	
1415-1326-18	1518-1326-18	14	Black Steel	$\frac{1}{2}$	Welded	70900203	
1415-1328-18	1518-1328-18	14	Black Steel	1	Welded	70900201	
1415-1375-18	1518-1375-18	14	Cast Iron	$\frac{3}{4}$ int	Cast	70900202	
1415-1395-18	1518-1395-18	14	Alloy 601	$\frac{1}{2}$	Seamless	70900203	

Pipe Diameters

- Cast iron = 1 $\frac{5}{8}$ inch
- $\frac{1}{2}$ in. NPT = 0.840 inch
- $\frac{3}{4}$ in. NPT = 1.050 inch
- 1 in. NPT = 1.315 inch

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

Standard cold leg is 18 inches.

Thermocouples

Noble Metal

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

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

Performance Capabilities

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

Applications

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



Type S, R, or B 24 AWG

To order, specify:

Part number-calibration-length.

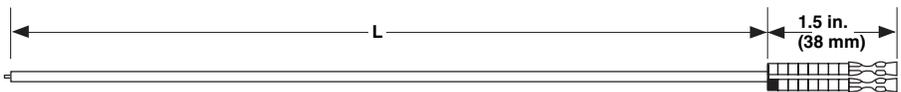
Example: 2114-R-24-MC



Enlarged picture of copper sleeves

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

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



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

Calibration	Length in.	Part Number Bare T/C	Part Number T/C With Alumina Insulator ^①
B	12	2110-B-12	2114-B-12
	18	2110-B-18	2114-B-18
	24	2110-B-24	2114-B-24
	30	2110-B-30	2114-B-30
	36	2110-B-36	2114-B-36
	42	2110-B-42	2114-B-42
R	48	2110-B-48	2114-B-48
	12	2110-R-12	2114-R-12
	18	2110-R-18	2114-R-18
	24	2110-R-24	2114-R-24
	30	2110-R-30	2114-R-30
	36	2110-R-36	2114-R-36
S	42	2110-R-42	2114-R-42
	48	2110-R-48	2114-R-48
	12	2110-S-12	2114-S-12
	18	2110-S-18	2114-S-18
	24	2110-S-24	2114-S-24
	30	2110-S-30	2114-S-30
S	36	2110-S-36	2114-S-36
	42	2110-S-42	2114-S-42
	48	2110-S-48	2114-S-48

Thermocouples

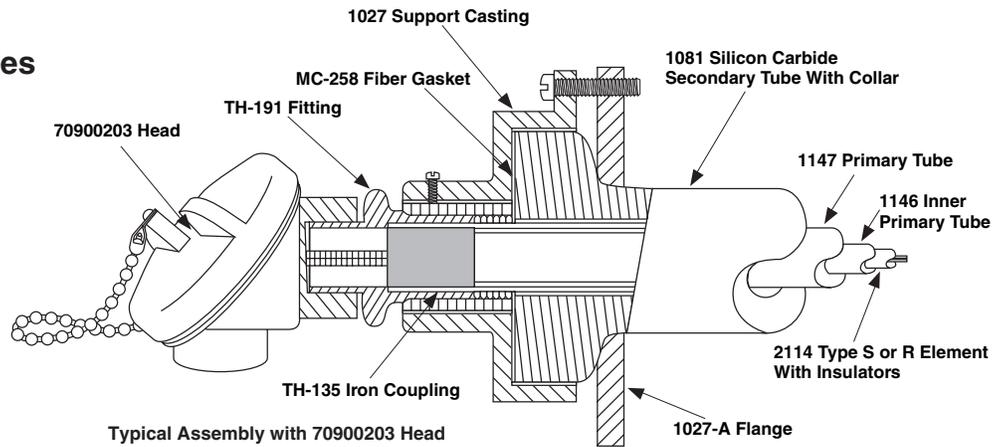
Noble Metal

Thermocouple Assemblies

To order, specify:

Part no.-calibration-length of tube.

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

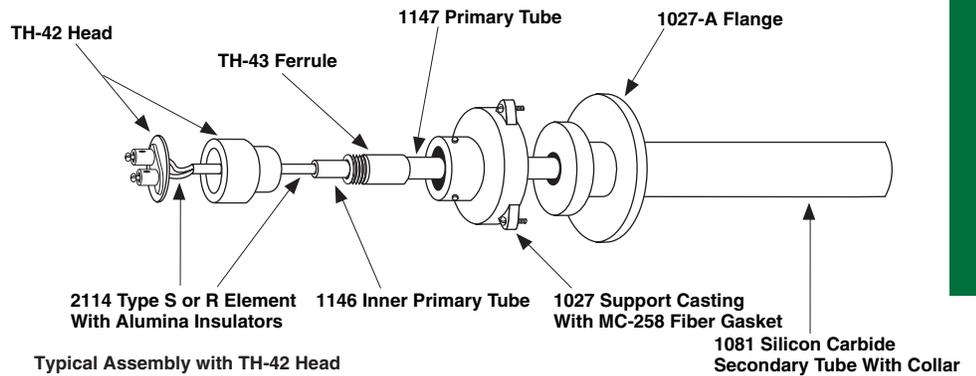


Typical Assembly with 70900203 Head

70900203 Head* and Alumina Ceramics

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

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



Typical Assembly with TH-42 Head

TH-42 Head and Alumina Ceramics

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

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

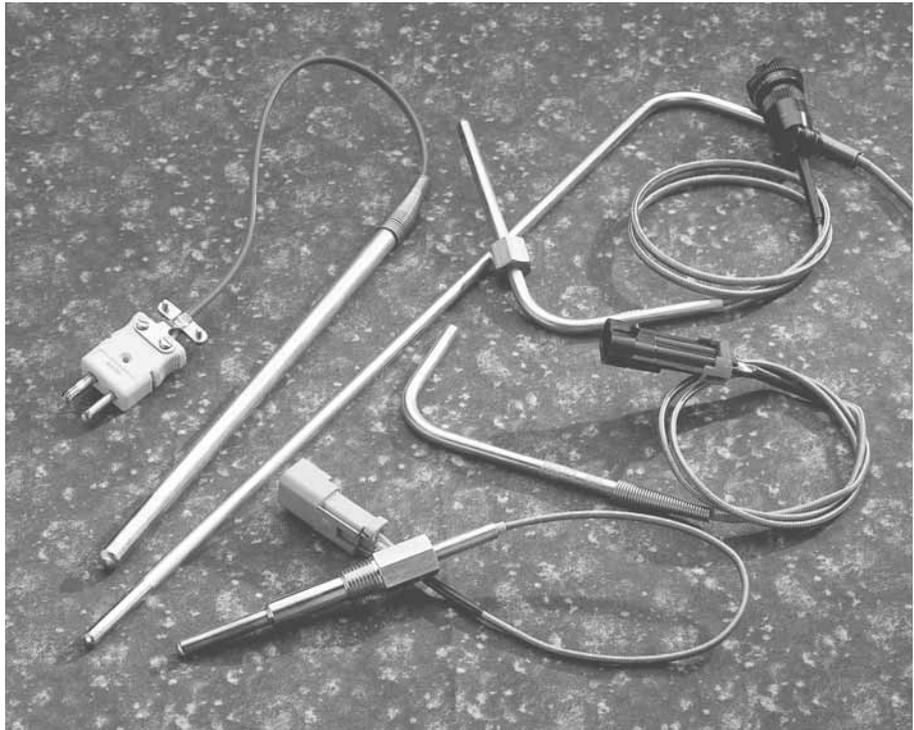
Thermocouples

High Temperature For Demanding Applications

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

Performance Capabilities

- Compliance with recognized agency tolerances and specifications
- Temperature ranges up to 2315°C (4200°F)
- NIST traceable calibration certificates
- Thermocouple limits set to ITS-90 reference standards



Features and Benefits

Thermocouple conductors

- Ideal for all temperature applications

Wide selection of sheath materials

- Meet specific application requirements

Insulation materials

- Meet demanding application temperatures

Grounded and ungrounded junctions

- Meet electrical configurations

Testing and certification services

- Ideal for demanding applications

Applications

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

*Not ASTM symbols

Thermocouples

High Temperature Materials Data

Exotic Metal Sheathed Thermocouples

The specification tables shown on the following pages outline Watlow's highly specialized line of metal sheathed thermocouple configurations. Some combinations of noble or refractory metal sheaths, high temperature insulations and compatible thermocouple conductors can withstand temperatures as high as 2315°C (4200°F); others can be used in unusually corrosive environments. Pressure, atmosphere and other process variables all affect service life and operating maximums.

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

Compacted constructions are manufactured by loading conductors and crushable ceramic insulators into the sheath. This 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

High Temperature

High Temperature Sheath Materials

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

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

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

Thermocouples

High Temperature

High Temperature Insulation Material

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

Insulation	Properties
Magnesium Oxide (MgO) (99.4% min. purity)	Low impurity levels make this insulation very useful for all thermocouple calibrations up to 1370°C (2500°F). Above 1370°C (2500°F) we recommend using beryllium oxide insulation because of MgO's low resistivity at these elevated temperatures. This material meets the requirements established in ASTM E 235.
Alumina Oxide (Al 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 2500°C (4530°F).

Thermocouples

High Temperature

High Temperature Sensing Wire

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

Calibration Type	Remarks
ASTM Type R	Type R is composed of a positive leg (RP) which is 87% platinum and 13% rhodium, and a negative leg (RN) which is 100% platinum. When protected by compacted mineral insulation and appropriate outer sheath, Type R is usable from 0 to 1480°C (32 to 2700°F). Type R is available in standard limits and special limits ITS-90 scale.
ASTM Type S	Type S is composed of a positive leg (SP) which is 90% platinum and 10% rhodium, and a negative leg (SN) which is 100% platinum. When protected by compacted mineral insulation and appropriate outer sheath, Type S is usable from 0 to 1480°C (32 to 2700°F). Type S has a lower EMF output than Type R and is available in standard limits and special limits ITS-90 scale.
ASTM Type B	Type B is composed of a positive leg (BP) which is approximately 70% platinum and 30% rhodium and a negative leg (BN) which is approximately 94% platinum and 6% rhodium. When protected by compacted mineral insulation and appropriate outer sheath, Type B is usable from 870 to 1700°C (1600 to 3100°F). Type B is available in standard limits and special limits ITS-90 scale.
Type C*	Type C is composed of a positive leg (CP) which is approximately 95% tungsten, 5% rhenium and a negative leg (CN) which is approximately 74% tungsten, 26% rhenium. When protected by mineral insulation and appropriate outer sheath, Type C is usable from 0 to 2315°C (32 to 4200°F). Type C calibrations are used most often with hafnia oxide insulation and either molybdenum or tantalum sheath. These combinations can only be used in an inert or vacuum environment.

*Not an ASTM symbol

Basic Hot Or Measuring Junctions Available

Ungrounded Junction (U)

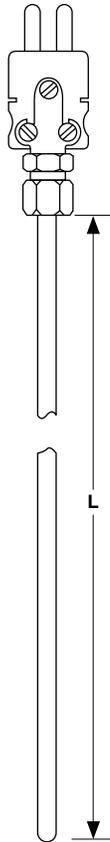


The thermocouple junction is fully insulated from welded sheath end. Excellent for electrical applications where stray EMFs and EMIs would affect the reading and for frequent or rapid temperature cycling.

Thermocouples

High Temperature

High Temperature Plug or Jack Termination



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

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

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

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

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

5. Enter "0" _____

6. Insulation _____

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

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

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

10. Sheath Length "L" (fractional inch) _____
 0 = 0 2 = ¼ 4 = ½ 6 = ¾
 1 = ⅙ 3 = ⅓ 5 = ⅝ 7 = ⅞

11. Junction _____
 Single Ungrounded U
 Dual Consult factory

12. Calibration _____
 Std. limits B R S C*
 Spc. limits Consult factory

13-14. Enter "00" _____

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

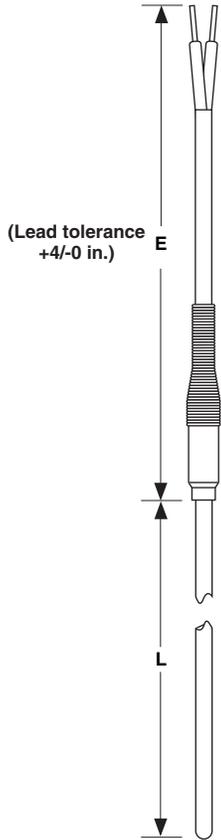
Thermocouples

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

Thermocouples

High Temperature

High Temperature Metal Transitions



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

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

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
	H	F														
3. Sheath O.D. (inch)	_____		_____		_____		_____		_____		_____		_____		_____	
E = 0.063	H = 0.188															
G = 0.125	J = 0.250															
4. Lead Wire Construction	_____		_____		_____		_____		_____		_____		_____		_____	
	Standard		Overbraided													
Fiberglass	Solid		A		J											
5. Lead Wire Termination	_____		_____		_____		_____		_____		_____		_____		_____	
A = Standard plug	B = Standard jack		C = Standard plug with mating connector		F = Miniature plug		G = Miniature jack		H = Miniature plug with mating connector		T = Standard—1 ½ inch split leads		U = 1 ½ inch split leads with spade lugs		W = 1 ½ inch split leads with BX connector and spade lugs	
6. Insulation	_____		_____		_____		_____		_____		_____		_____		_____	
	MgO		Al ₂ O ₃		HfO ₂											
** Compacted	1		2		4											
Loose pack	—		B		D											
7. Sheath Material	_____		_____		_____		_____		_____		_____		_____		_____	
2 = Pt 20% Rh	4 = Tantalum		3 = Molybdenum		5 = Titanium		Q = Alloy 600									
8-9. Sheath Length "L" (inch)	_____		_____		_____		_____		_____		_____		_____		_____	
Whole inches: 01 to 60																
10. Sheath Length "L" (fractional inch)	_____		_____		_____		_____		_____		_____		_____		_____	
0 = 0	2 = ¼		4 = ½		6 = ¾		1 = ⅛		3 = ⅜		5 = ⅝		7 = ⅞			
11. Junction	_____		_____		_____		_____		_____		_____		_____		_____	
	Ungrounded															
Single =	U															
Dual =	Consult factory															
12. Calibration	_____		_____		_____		_____		_____		_____		_____		_____	
	B		R		S		C*									
Std. limits	B		R		S		C									
Spc. limits	Consult factory															
13-14. Lead Wire Length "E" (feet)	_____		_____		_____		_____		_____		_____		_____		_____	
Whole feet: 01 to 25																
(01 foot standard)																
15. Special Requirements	_____		_____		_____		_____		_____		_____		_____		_____	
M = Standard 260°C (500°F) potting																
If others required, consult factory																

* Not an ASTM symbol, Consult factory for availability.

** Not available with molybdenum sheath.

Thermocouples

Surface Temperature Measurement

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

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

MICROCOIL™

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



Radio Frequency Thermocouple Probe (TR)

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

TRUE SURFACE Thermocouple (TST)

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

Thermocouples

Surface Temperature Measurement

MICROCOIL™

Accurate, Repeatable, Fast Response in Perpendicular Surface Measurement

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

The helix design of the MICROCOIL demonstrates a faster response time because the surface temperature needs to conduct only through the diameter of the cable and the thickness of the sensor disk.



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

Features and Benefits

Miniature size

- Allows for precision measurement in tight spaces

XACTPAK mineral insulated thermocouple cable

- Electronically isolated and shielded

700°C (1292°F) maximum continuous temperature

- Offers exact measurement for demanding applications

Self leveling and loading

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

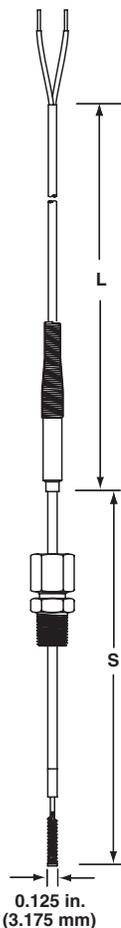
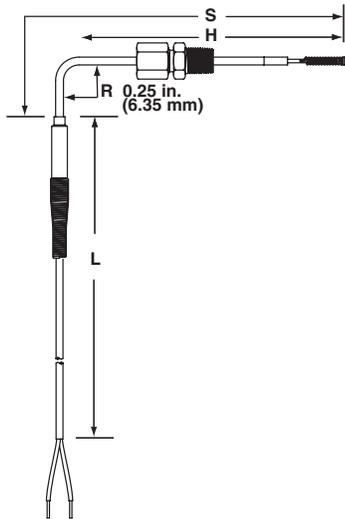
Applications

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

Thermocouples

Surface Temperature Measurement

MICROCOIL™



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

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

M C

Type K Calibration

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

3. Temperature Rating

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

4. Junction Type

G = Grounded single junction
 U = Ungrounded single junction

5-6. Sheath Length “S”

XX = 02 to 18 inch

7. Hot Leg Length “H”, if 90° bend (inch)

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

Notes: Bend radius is 0.25 inch

Cold leg length (1.0 inch minimum) = S - H - 0.4 inch

If a fitting is ordered, it will be installed hand tightened onto the hot leg

If a fitting is ordered, the minimum hot leg length “H” is 2.500 in.

8. Fitting, Optional

0 = None
 C = Compression fitting, adjustable, 1/8 inch NPT, TFE gland

9. Lead Length Construction, solid conductors

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

10-11. Lead Length “L”

XX = 03 to 99 inch

12. Lead Wire Terminations

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

150°C standard surface calibration supplied.

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

MICROCOIL™

Thermocouples

Surface Temperature Measurement

Radio Frequency Thermocouple Probe (TR)

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

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



Options

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

Features and Benefits

3000V $\overline{\text{dc}}$ dielectric rating

- Allows thermocouple to be used in platens with dc bias

High thermal conductivity design

- Ensures accurate, repeatable measurements

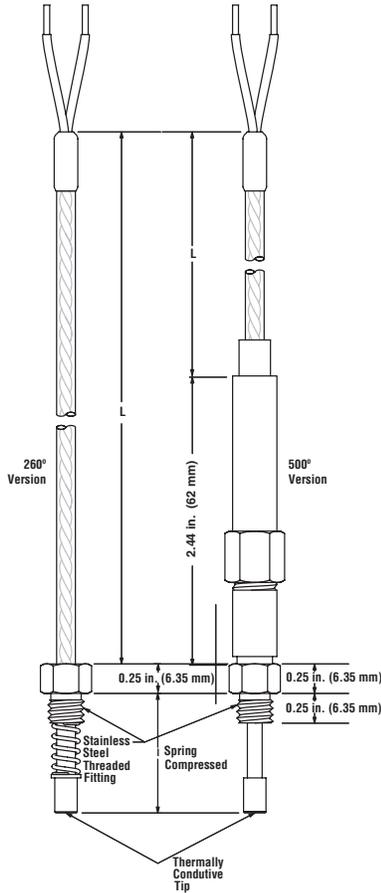
High CMMR lead wire design

- Reduces induced error from EMI

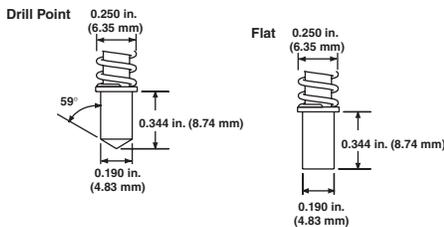
Thermocouples

Surface Temperature Measurement

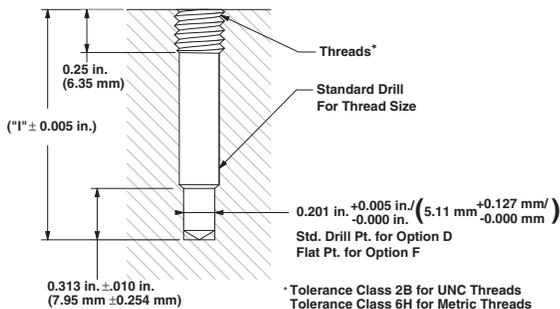
TR Thermocouple



Tip Shape



Platen Modification Detail



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

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

TR Thermocouple

3. Maximum Temperature

- C = 260°C silver-plated copper tip
- N = 500°C aluminum nitride tip (AlN)

4. Tip Shape

- D = Drill point (260°C tip only)
- F = Flat

5-6. Immersion Depth "I" (inch)

(from tip to top of threads, spring compressed)

- 08 = 0.875
- 10 = 1.000
- 11 = 1.125
- 12 = 1.250
- 13 = 1.375
- 15 = 1.500

7. Threaded Fitting Size

- 5 = 5/16-18 UNC-2A
- 8 = M8 x 1.25-6g

8. Junction Type

- U = Ungrounded single

9. Calibration

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

10-11. Lead Length "L"

- XX = 01 to 96 inch

12. Lead Wire Terminations

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

Thermocouples

Surface Temperature Measurement

TRUE SURFACE Thermocouple (TST)

Increase Surface Temperature Accuracy with Improved Thermocouple Design

Watlow's award winning TST offers superior accuracy for measuring flat surface temperatures. This compact, highly accurate sensor isolates the thermocouple junction from ambient airflow. The TST typically achieves accuracy and repeatability of one to two percent (ΔT).

The TST, with its removable molded cover, fits into corners and other tight locations. TSTs are easy to install with a variety of commonly used screw types.

Watlow's TST sensor is ideal for many applications including semiconductor chambers, platens, packaging, cleaning and food preparation.

Options

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



Steady State Temperature Measurement Test

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

Features and Benefits

Isothermal measuring junction

- Offers excellent thermal conductivity for the measuring junction

Molded insulator

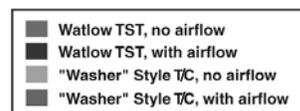
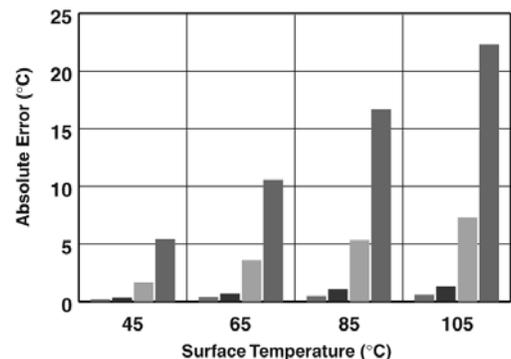
- Isolates the isothermal measuring block from ambient airflow

Compact, universal package

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

Temperature rating of 200°C (400°F)

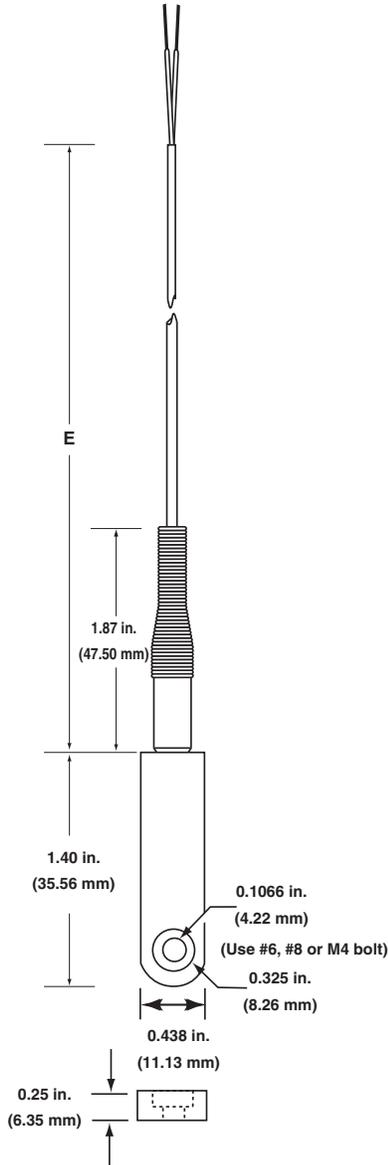
- Offers superior application flexibility for a wide variety of surfaces



Thermocouples

Surface Temperature Measurement

TRUE SURFACE Thermocouple (TST)



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

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

TRUE SURFACE Thermocouple

4. Lead Wire Construction

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

5. Lead Wire Termination

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

6. Junction

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

7. Calibration

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

8-9. Lead Length "E"

01 to 99 feet

Thermocouples

Thermocouples

Multipoint Sensor

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

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

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



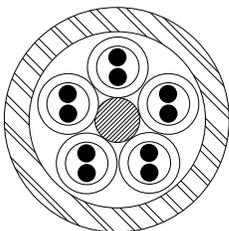
XACTPAK® mineral insulated, metal-sheathed cable. Multipoint temperature sensors are available in either standard or special ASTM thermocouple calibration tolerances. For applications requiring extreme accuracy, special constructions can be made with platinum RTDs.

Applications

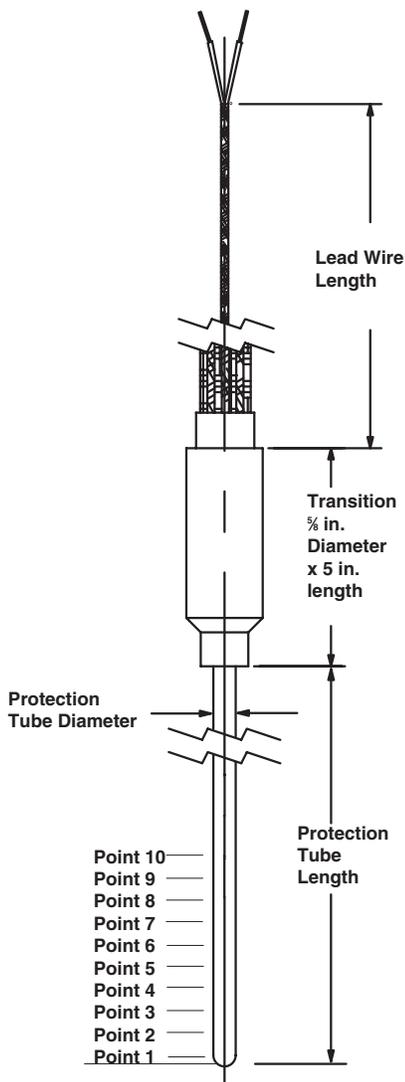
- Chemical processing
- Petroleum distillation towers
- Semiconductor manufacturing
- Profiles of furnaces and kilns
- Combustion research
- Storage tanks
- Air flow ducts

Thermocouples

Multipoint Sensor



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



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

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

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	A W														
1-2. Style	AW = Multipoint														
3. Protection Tube Diameter (inch)															
G = 0.125			J = 0.250												
H = 0.188															
4-5. Number of Points															
02 - 10															
6. Protection Tube Material															
F = 316 SS															
Q = Alloy 600															
7. Calibration															
J = J Standard Limits															
K = K Standard Limits															
3 = J Special Limits															
4 = K Special Limits															
8. Junction															
G = Grounded															
U = Ungrounded															
9-11. Protection Tube Length (inch)															
006-144															
12. Lead Wire Construction															
A = Fiberglass solid wire															
C = FEP solid wire															
13-14. Lead Wire Length (feet)															
01-25															
15. Lead Wire Termination															
A = Standard male plug															
B = Standard female jack															
C = Standard plug with mating connector															
F = Miniature male plug															
G = Miniature female jack															
H = Miniature plug with mating connector															
T = Standard, 1½ inch split leads															

Thermocouples

Notes

RTDs and Thermistors

Resistance Temperature Sensing

RTDs

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

Performance Capabilities

- Ceramic elements are extremely precise and stable within the wide temperature range of -200 to 650°C (-328 to 1200°F).

Features and Benefits

Patented, strain-free construction

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

High signal-to-noise output

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

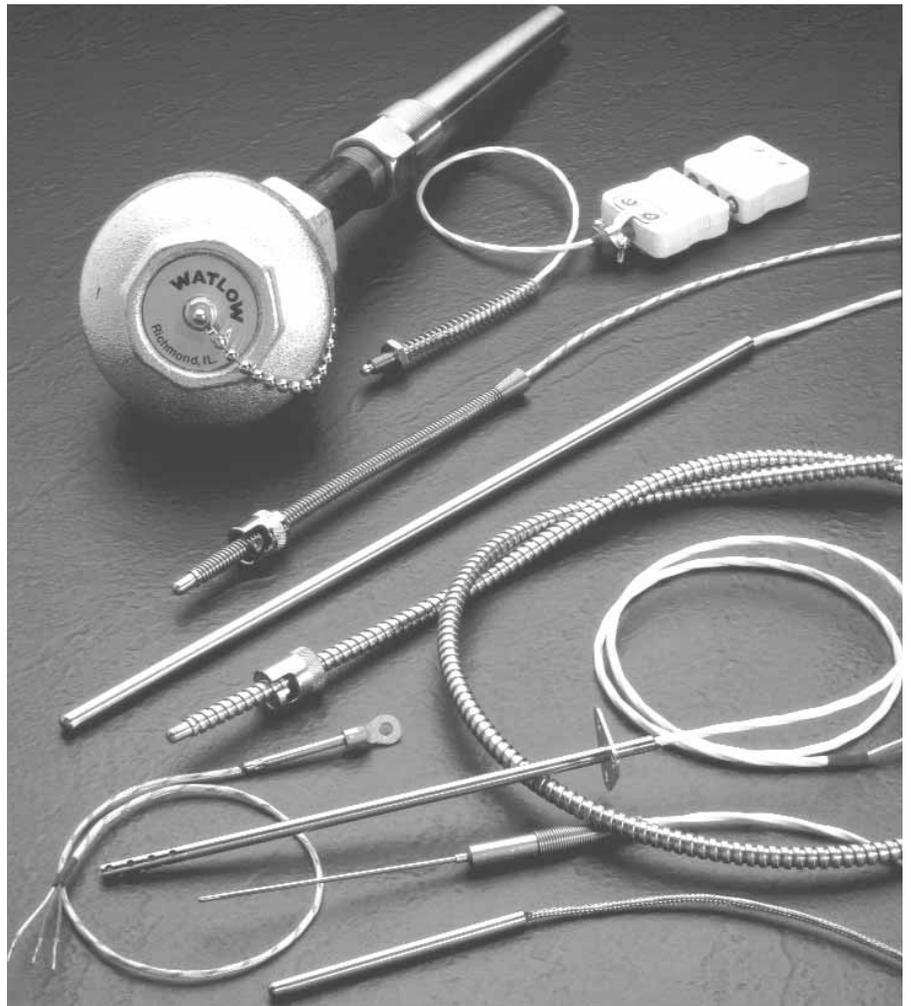
Temperature coefficient (alpha) carefully controlled while insulation resistance values exceed DIN-IEC-751 standards

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

Highly controlled manufacturing process

- Ensures wide temperature range
- Stabilizes physical and chemical attributes

Metric diameters and fittings are available, please consult factory



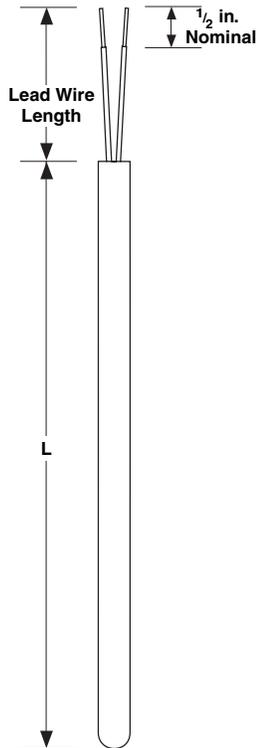
Applications

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

RTDs and Thermistors

RTD Style RB

Standard Industrial Insulated Leads



Features and Benefits

High accuracy

- Dependable readings

Customized diameters

- From 0.125 to 0.250 inch

Epoxy sealed

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

Durable rigid sheath

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

Internal heat transfer paste

- Quick time response

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

② May require transition.

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

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

Rapid Ship Sensors

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

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

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

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

R B A

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

4. Lead Wire Construction^① _____
 Standard Overbraided 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 39 to 40.
If none, enter "0".

6. Lead Wire 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

7. Sheath Construction _____
A = 316 SS

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

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

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

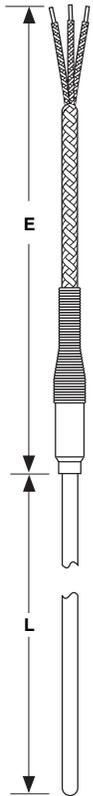
12. Temperature Coefficient _____
 DIN 0.00385
A = Class A
B = Class B

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

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

RTDs and Thermistors

RTD Style RF Metal Transitions



Features and Benefits

Stainless steel transitions

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

Coiled spring strain relief

- Protects lead wire against sharp bends in the transition area

Flexible mineral insulated construction

- Provides a bendable and highly durable sensor

Temperature rating

- -200 to 650°C (-328 to 1200°F)

High accuracy

- Dependable readings

Diameters available

- 0.125 to 0.250 inch O.D.

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

Rapid Ship Sensors

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

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

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

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

R F

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

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

4. Lead Wire Construction _____
 Standard Overbraid Flex Armor
 Fiberglass Stranded **A** J R
 PFA or TFE Stranded **B** L T

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

6. Lead Wire Termination _____
 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

7. Sheath Construction _____
 316 SS Alloy 600
 Mineral Insulated **K** **L**

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

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

11. Element _____
 2-wire 3-wire
 100Ω Single A **B**

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

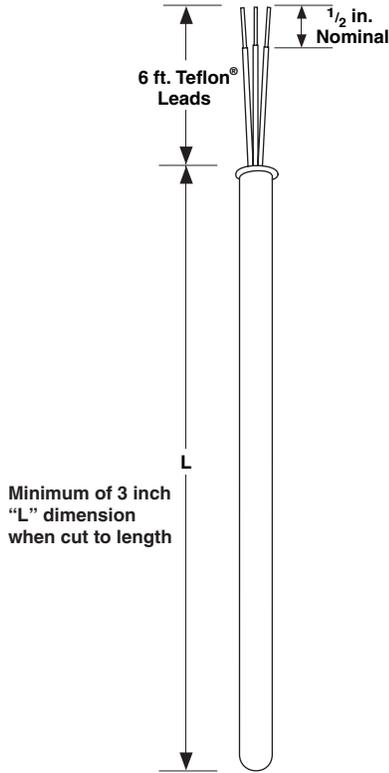
13-14. Lead Wire Length "E" (foot) _____
02 and 04
 Whole feet: 01 to 99

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

RTDs and Thermistors

RTD Style RK

Emergency Use Cut-to-Length RTD



Rapid Ship Sensors

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

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

Adjustable C-Frame Tube Cutter	RK-Cutter
--------------------------------	-----------

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

Features and Benefits

Cut-to-length features

- Avoids need to stock several RTD lengths

Probes can be shortened

- To three inches minimum using a tubing cutter

High accuracy

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

Internally sealed

- Prevent moisture penetration

316 SS sheath

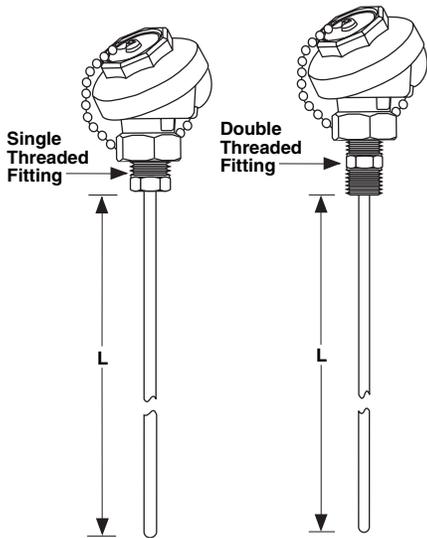
- -50 to 260°C (-58 to 500°F)

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

RTDs and Thermistors

RTD Style RR

Connection Head/ Optional Transmitter



Features and Benefits

Connection heads

- Provide superior dust and moisture resistance

Weatherproof plastic heads

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

Standard bottom mounting

- Side mounting available upon request

Complete assembly available

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

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



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

Rapid Ship Sensors

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

Class Accuracy	Sheath Length in. (mm)	Part Number
A	3 (76)	RRJEFOA030BA000
	6 (152)	RRJEFOA060BA000
	18 (457)	RRJEFOA180BA000

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

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15														
	R	R				0							0	0															
3. Sheath O.D. (inch)	G = 0.125 J = 0.250		H = 0.188																										
4. Connection Head	C = Polypropylene D = Cast iron E = Cast aluminum H = Explosion proof U ^① = E head with 5750 transmitter V ^① = C head with 5750 transmitter W ^① = H head with 5750 transmitter																												
5. Head Mounting Fittings	O = Single threaded, 303 SS F = Double threaded, 303 SS ½" NPT *H = Spring loaded, double threaded, 316 SS ½" NPT																												
6. Enter "0"																													
7. Sheath Construction	<table style="width: 100%; border: none;"> <tr> <td style="text-align: center;">-50 to 260°C (-58 to 500°F) 316 SS</td> <td style="text-align: center;">-200 to 650°C (-328 to 1200°F) 316 SS</td> <td colspan="13"></td> </tr> </table>														-50 to 260°C (-58 to 500°F) 316 SS	-200 to 650°C (-328 to 1200°F) 316 SS													
-50 to 260°C (-58 to 500°F) 316 SS	-200 to 650°C (-328 to 1200°F) 316 SS																												
Standard Industrial (0.125-0.250 inch O.D.)	A																												
Mineral Insulated (0.125-0.250 inch O.D.)			K																										
8-9. Sheath Length "L" (inches)	03, 06 and 18																												
Whole inches: 02 to 99																													
Metric lengths and lengths over 99 inches consult factory.																													
10. Sheath Length "L" (fractional inch)	0 = No fraction, whole inches																												
	1 = ¼ 2 = ½ 3 = ¾ 4 = 1 5 = 1 ¼ 6 = 1 ½ 7 = 1 ¾																												
11. Element	2-wire 3-wire 4-wire 100Ω Single A B C																												
12. Temperature Coefficient	DIN 0.00385																												
	A = Class A																												
	B = Class B																												
13-14. Enter "00"																													
15. Special Requirements	0 = None																												
	X = Special requirements, consult factory																												

* 0.250 inch diameter only.

RTDs and Thermistors

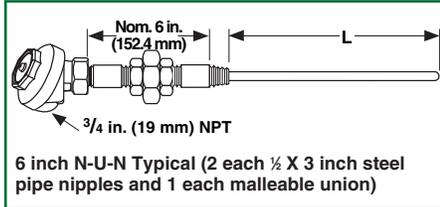


For a complete RTD assembly, add thermowell part number. See thermowell section, pages 144 to 146.

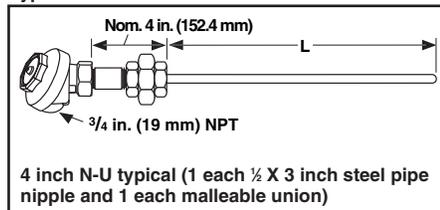
RTD Style RT

For Use with Thermowells

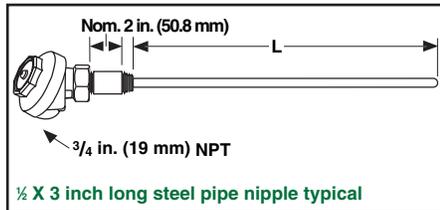
Type 1



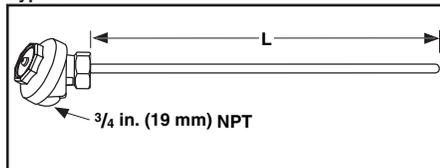
Type 2



Type 3



Type 4



Features and Benefits

High quality thermowells and pipe wells

- Protect sensor

Mineral insulated construction

- Available in 0.125 to 0.250 inch O.D.

Available with spring-loading

- Ensures positive contact

Complete assembly available

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

Variety of connection head options

- Meet your application requirements

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

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	R	T				0									0
3. Sheath O.D. (inch)	_____														
G = 0.125	J = 0.250														
H = 0.188															
4. Connection Head	_____														
C = Polypropylene															
D = Cast iron															
E = Cast aluminum															
H = Explosion proof															
U ^① = E head with 5750 transmitter															
V ^① = C head with 5750 transmitter															
W ^① = H head with 5750 transmitter															
5. Cold End Configuration^②	_____														
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											
Standard Industrial	A			—											
Mineral Insulated	—			K											
8-9. Sheath Length "L" (see drawings at left)	_____														
When ordering a complete assembly with thermowell, specify "AR" as required. Otherwise, specify the "L" dimension in whole inches.															
10. Sheath Length "L" (fractional inch)	_____														
0 = No fraction, whole inches															
1 = 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															
A = Class A															
B = Class B															
14. Spring-Loading	_____														
Y = Yes	N = No														
15. Special Requirements	_____														
0 = None															
X = Special requirements, consult factory															

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

② Other sizes, lengths and materials available. Consult factory.

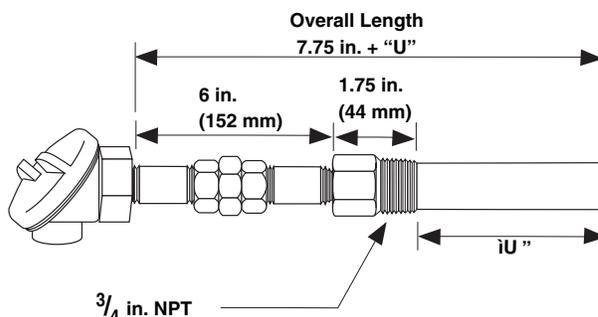


For further details on Watlow connection heads see the hardware section of this catalog, pages 156 to 157.

RTDs and Thermistors

Style RT with Thermowell

Straight Well

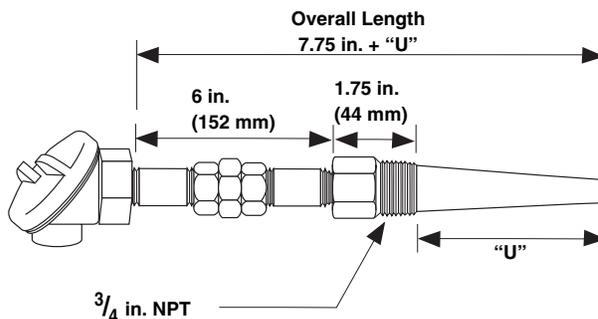


Rapid Ship Sensors

Rapid Ship sensors come with 316 SS straight well, nipple-union-nipple, 0.250 inch diameter spring loaded element, 100Ω DIN 0.00385 curve, Class A and three-wire RTD. Temperature rating -50 to 260°C (-58 to 500°F).

Calibration	"U" in. (mm)	Overall Length in. (mm)	Part Number
A	2.5 (64)	10.25 261	RTJE1SF024BA0Y0
	4.5 (114)	12.25 312	RTJE1SF044BA0Y0
	7.5 (191)	15.25 388	RTJE1SF074BA0Y0
	10.5 (267)	18.25 465	RTJE1SF104BA0Y0

Tapered Well



Rapid Ship Sensors

Rapid Ship sensors come with 316 SS tapered well, nipple-union-nipple, 0.250 inch diameter spring loaded element, 100Ω DIN 0.00385 curve, Class A and three-wire RTD. Temperature rating -50 to 260°C (-58 to 500°F).

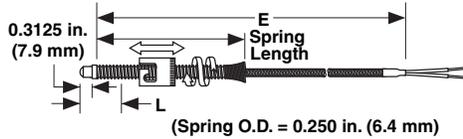
Calibration	"U" in. (mm)	Overall Length in. (mm)	Part Number
A	2.5 (64)	10.25 261	RTJE1TF024BA0Y0
	4.5 (114)	12.25 312	RTJE1TF044BA0Y0
	7.5 (191)	15.25 388	RTJE1TF074BA0Y0
	10.5 (267)	18.25 465	RTJE1TF104BA0Y0

RTDs and Thermistors

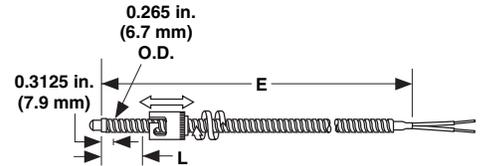
Speciality RTDs and Thermistors

Construction Styles

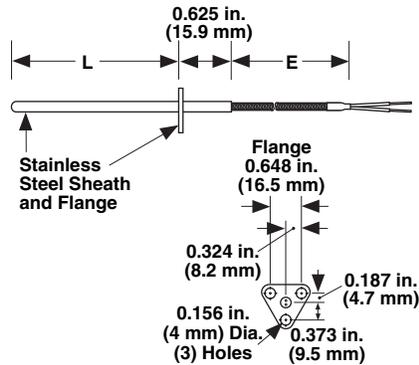
10 = 6 in. Adjustable Spring Style
11 = 12 in. Adjustable Spring Style



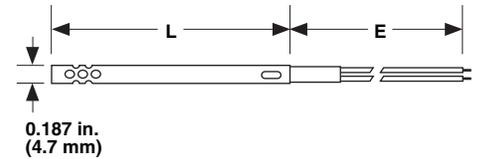
12 = Adjustable Armor Style



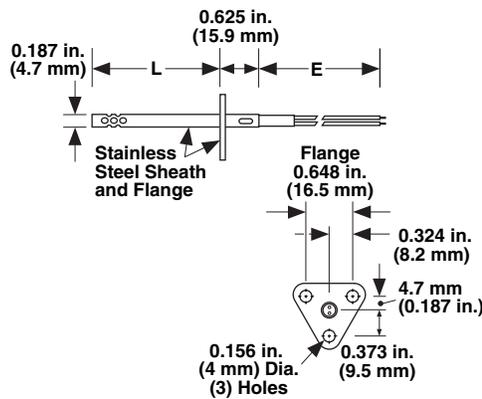
25 = Cartridge with Flange



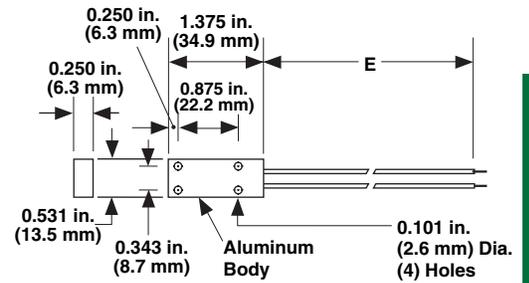
50 = Open Air



55 = Open Air with Flange



80 = Surface Mount



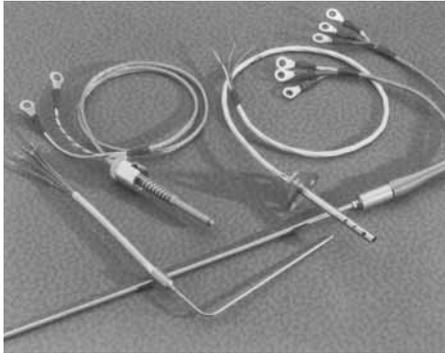
RTDs and Thermistors



See next page for Rapid Ship sensors and ordering instructions.

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 (77°F) and ranges:

Epoxy Bead Tolerance ±1%Ω +0.3°C (37°F)		
#11	1000Ω	-60 to 150°C (-76 to 302°F)
#12	3000Ω	-60 to 150°C (-76 to 302°F)

Glass Bead Tolerance ±15%Ω +0.3°C (37°F)		
#16	100,000Ω	-60 to 260°C (-76 to 500°F)

*Other thermistors available on request. Consult factory. See Style TB thermistor on page 109.

Rapid Ship Sensors

Rapid Ship sensors come with 100Ω DIN 0.00385 curve RTD sensor, 24 AWG stranded three-wire leads, temperature rating -50 to 260°C (-58 to 500°F), standard split end lead termination and no mounting fittings.

	Part Number	
	4 Foot (102 mm) Leads	6 Foot (152 mm) Leads
Construction 10 with Fiberglass and SS overbraid leads	S10DDN4C048A	S10DDN4C072A
Construction 80 with Teflon® leads	S80ADT2A048A	S80ADT2A072A

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

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

S

2-3. Construction —————

10 = 6 inch adjustable spring style
 11 = 12 inch adjustable spring style
 12 = Adjustable armor style
 25 = Cartridge with flange
 50 = Open air
 55 = Open air with flange
80 = Surface mount

4. Diameter (inch) —————

D = 0.188
 A = Not applicable: surface mount

*** 5. Element Type** —————

C = RTD 2-wire No. 3850 N = Thermistor No. 12
D = RTD 3-wire No. 3850 P = Thermistor No. 16
 M = Thermistor No. 11

6-7. Lead Type —————

L4 = Fiberglass and SS armor
 M4 = Fiberglass
 N4 = Fiberglass and SS overbraid
T2 = PFA or TFE

8. Sheath Length "L" (inches) —————

A = Not applicable
 C = 1.5 (required for VAT construction: No. 10, 11, 12)
D = 2.0 L = 5.5 T = 9.0
 E = 2.5 **M = 6.0** U = 9.5
 F = 3.0 N = 6.5 W = 10.0
 G = 3.5 P = 7.0 Y = 11.0
H = 4.0 Q = 7.5 Z = 12.0
 J = 4.5 R = 8.0
 K = 5.0 S = 8.5

9-11. Lead Wire Length "E" (foot) —————

012 = 1 084 = 7
024 = 2 096 = 8
 036 = 3 108 = 9
048 = 4 120 = 10
 060 = 5 180 = 15
 072 = 6

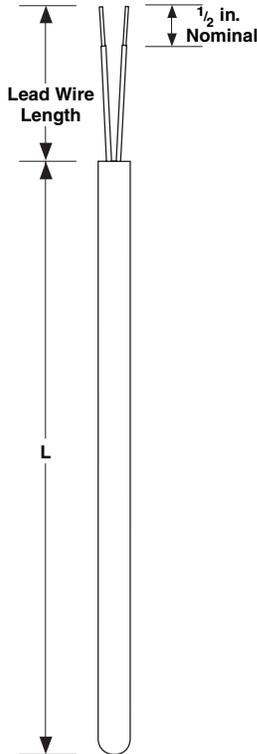
12. Terminations —————

A = 1.5 inch stripped split leads, no terminals
 B = No. 8 spade terminals
 H = 0.25 inch female quick connect terminals

RTDs and Thermistors

Speciality RTDs and Thermistors

Style TB Standard Industrial Thermistor with Insulated Leads



Features and Benefits

Rigid 316 stainless steel sheath

- Ideal for industrial applications

Cold end epoxy seal

- Rated to 260°C (500°F)

Internal heat transfer paste

- Quick time response

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

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	T	B		B								O			
3. Sheath O.D. (inch)	_____														
H = 0.188															
J = 0.250															
4. Lead Wire Construction	_____														
Standard															
PFA or TFE Stranded	B														
5. Fittings	_____														
If required, enter order code from pages 39 to 40.															
If none, enter "0".															
6. Lead Wire Termination	_____														
T = Standard leads															
U = Leads with spade lugs															
7. Temperature Rating and Accuracy	_____														
A ^① = -60 to 150°C (-75 to 302°F) ±1% (±.3°C) Accuracy @ 25°C															
B ^② = -60 to 260°C (-75 to 500°F) ±15% (±.3°C) Accuracy @ 25°C															
8-9. Sheath Length "L" (inches)	_____														
02, 04 and 06															
Whole inches: 02 to 24															
10. Sheath Length "L" (fractional inch)	_____														
0 = No fraction, whole inches															
1 = 1/8 5 = 5/8															
2 = 1/4 6 = 3/4															
3 = 3/8 7 = 7/8															
4 = 1/2															
11. Element/Resistance at 25°C (77°F)	_____														
E = 1,000Ω															
G = 3,000Ω															
T = 100,000Ω															
12. Sheath	_____														
O = Standard sheath															
13-14. Lead Wire Length "E" (foot)	_____														
02 and 04															
Whole feet: 01 to 15															
15. Special Requirements	_____														
0 = None															
X = Special requirements, consult factory															

① Only available with 1,000Ω or 3,000Ω.

② Only available with 100,000Ω.

RTDs and Thermistors

ENVIROSEAL™ HD Sensor

Watlow's ENVIROSEAL™-HD temperature sensor keeps out moisture, oil and contaminants in all of your heavy-duty applications including those outside applications exposed to harsh weather, oils and other extreme moisture environments. The ENVIROSEAL-HD sensor is also designed to provide accurate, dependable measurements in high-vibration environments.

Features and Benefits

Submersible and 1200psi pressure wash rated seal (not including connector area)

- Protects the sensor from washdown or other extreme moisture environments

Oil Resistant Materials

- Sensors maintain a long life even when exposed to oil, gasoline, or diesel fuel

Vibration resistant design, 25 lb pull out force rating

- Tough, rugged design to hold up to the roughest applications

-40 to 200°C (-40 to 392°F) sensor temperature rating

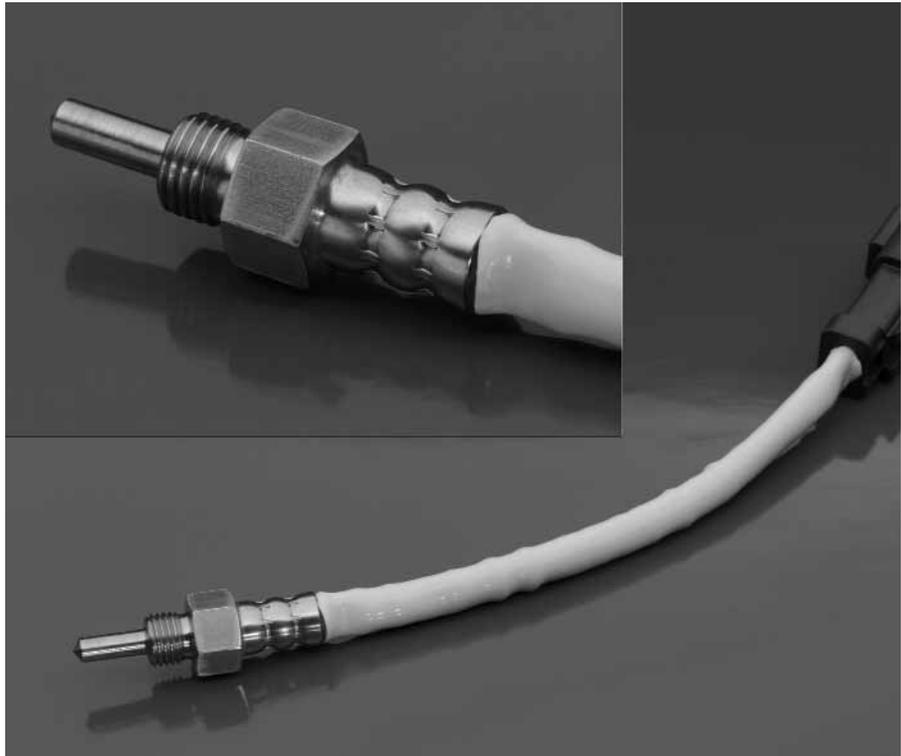
- Offers superior application flexibility

Time response of two seconds

- Fast response will measure 63.2 percent (first order) of the temperature change in two seconds or less

250psi threaded fitting pressure rating

- Suitable for most rugged applications



Applications

- Engine coolant or oil
- Refrigeration or condensation units
- Industrial equipment
- Heat exchangers
- Gear boxes
- Hydraulic fluid
- Marine

RTDs and Thermistors

ENVIROSEAL™ HD Sensor

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

1 2 3 4 5 6 7 8 9 10
H D

3. Sensor Type

- A = 100Ω DIN 0.00385 RTD Class A element, 2-wire
- B = 100Ω DIN 0.00385 RTD Class B element, 2-wire
- C = 1000Ω DIN 0.00385 RTD Class A element, 2-wire
- D = 1000Ω DIN 0.00385 RTD Class B element, 2-wire
- K = Ungrounded standard limits Type K thermocouple

4-5. Sheath Length “S”

- 07 = 0.75 in. (19.05 mm)
- 15 = 1.50 in. (38.1 mm)
- 30 = 3.00 in. (76.2 mm)

6. Threaded Fitting

- 4 = 0.25 in. (6.35 mm) NPT male threads
 "F" = 1.4 in. (35.56 mm)
- 8 = 0.125 in. (3.18 mm) NPT male threads
 "F" = 1.2 in. (30.48 mm)

7. Fitting Material

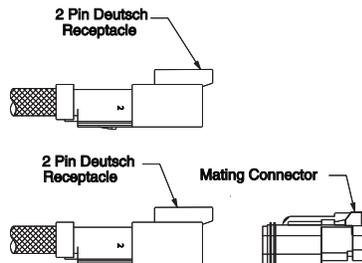
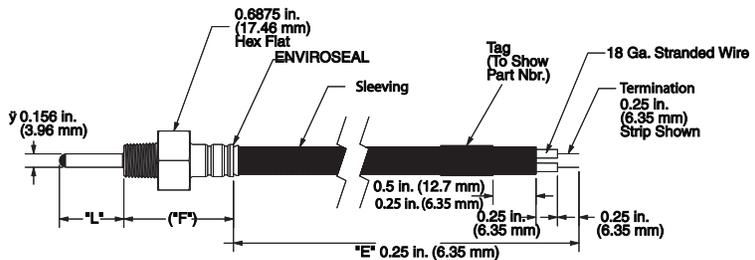
- B = Brass
- S = 316 stainless steel

**8-9. Lead Length “L” (whole inches)
 (18 gauge stranded conductor lead wire)**

- 06 = 6 in. (152.4 mm)
- 12 = 12 in. (304.8 mm)
- 24 = 24 in. (609.6 mm)

10. Lead Wire Terminations

- T = Standard 0.25 in. (6.35 mm) stripped ends
- 2 = 2-pin receptacle Deutsch connector 125°C (257°F)
- 4 = 2-pin receptacle Deutsch connector 125°C (257°F) with mating connector



Notes

Infrared Sensors

Raytek® Family

Noncontact Temperature Measurement

Watlow offers a wide variety of Raytek® infrared thermometers that monitor and control temperature in various manufacturing processes. These thermometers measure temperature of fast moving processes quickly and efficiently. They measure the temperature of the product directly, instead of the oven or the dryer. This allows you to quickly adjust to process parameters to ensure top product quality.

Infrared thermometers are easily integrated into existing process control systems and have the following benefits:

- Non-destructive: the product is never touched or contaminated
- Fast and reliable: moving objects are measured accurately and quickly
- Flexible: temperature measurements can be made of a large area or a small spot

Small Size, Big Features

These products may be compact, but do not compromise on features. Using advanced micro-fabrication techniques, the cost and size of these sensors remain small while retaining sophisticated features such as emissivity, signal conditioning and t-ambient processing. The wide temperature range in each model allows you to detect process variations and monitor start-up performance.

Infrared Thermocouples

If you are looking for a low-maintenance solution for infrared thermocouples, consider the MI™ or CI™. The MI™, a two-piece system with miniature sensing head and separate electronics, features adjustable emissivity and selectable peak hold, valley hold and averaging.

The CI™ is a compact, integrated unit with the same output impedance as a thermocouple. It functions accurately—without offset errors—when used in conjunction with the thermocouple break protection circuitry in most controllers, displays and transmitters.

Both the MI™ and CI™ have rugged stainless steel housings to ensure continuous, long-term performance, even in environments with high ambient temperatures.

An Affordable Solution for Your Process

The miniature size and low cost of the MI™ (shown above) make it an ideal configuration for installation at multiple points along your process. The sensor is isolated from the electronics box which allows it to withstand ambient temperatures up to 200°C (392°F) with cooling accessories.

Whether you choose a modular system based on the GP™ monitor, or the MI™ or CI™, we have a compact, value-priced infrared thermometer to meet your needs. Cooling jackets, air purge collars and other accessories are available to ensure accurate performance regardless of your environment.



Raytek® Service Ensures Long Use

With over 30 years experience, Raytek® knows infrared temperature measurement. Application specialists are available to help answer your technical questions. Each product includes a two year warranty. In addition, maintenance, training, calibration and other customized services are available to ensure that you receive the maximum benefits from your Raytek® infrared, noncontact thermometer. For more information on Raytek® infrared temperature measurement solutions, contact your Watlow sales agent or applications specialist today.

Product	Temperature Range	Accuracy	Signal Processing	Display	Power Supply	Outputs
GP™ Monitor w/ GPR™	-18 to 540°C (0 to 1000°F)	1 percent	Adjustable	Yes	110-220V~(ac)	Thermocouple 4-20mA & 2 Alarms
GP™ Monitor w/ CI™	0 to 500°C (0 to 1000°F) w/ 2 models	2 percent	Adjustable	Yes	110-220V~(ac)	Thermocouple 4-20mA & 2 Alarms
MI™	-40 to 600°C (-40 to 1112°F)	1 percent	Adjustable	No	12-24V=(dc)	4-20mA, J or K T/C, or mV
CI™	0 to 500°C (32 to 932°F) w/ 2 models	2 percent	N/A	No	12-24V=(dc)	*J or K T/C, or mV

*Must specify at time of order.

Raytek® is a registered trademark of the Raytek Corporation. MiniTemp™, ST ProPlus™, GP™, CI™ and MI™ are trademarks of Raytek Corporation.

Infrared Sensors

Raytek® Family

Product Offering

Infrared Thermocouples	Description
Raytek® MI™	
RAYMID10LTCB3	MI electronics and sensing head with 10:1 optics and 9.8 ft (3 m) cable
RAYMID10LTCB8	MI electronics and sensing head with 10:1 optics and 26 ft (8 m) cable
XXXMIACAB	Adjustable bracket for MID
XXXMIACAJ	MI air purge jacket (no cooling)
XXXMIACCJ	MI air cooling and purging system with 2.8 ft (0.8 m) insulated air hose
XXXMIACCJ1	MI air cooling and purging system with 9.2 ft (2.8 m) insulated air hose
XXXMIACFB	MI sensor head fixed mounting bracket
XXXMIACMN	MI sensor head mounting nuts (5)
Raytek® CI™	
RAYCI1A	Type J output sensing head w/1 m cable, ± 3°C accuracy 0 to 115°C (± 5.4°F, 32 to 240°F)
RAYCI1A10L	Type J output sensing head w/3 m cable (MAX 105°C, 220°F), ± 3°C accuracy 0 to 115°C (± 5.4°F, 32 to 240°F)
RAYCI1B	Type J output sensing head w/1m cable, ± 3°C accuracy 100 to 500°C (± 5.4°F, 202 to 932°F)
RAYCI1B10H	Type J output sensing head w/3m high temp cable (MAX 260°C, 500°F), ± 3°C accuracy 100 to 500°C (± 5.4°F, 202 to 932°F)
RAYCI1B10L	Type J output sensing head w/3m cable (MAX 105°C, 220°F), ± 3°C accuracy 100 to 500°C (± 5.4°F, 202 to 932°F)
RAYCI2A	Type K output sensing head w/1m cable, ± 3°C accuracy 0 to 115°C (± 5.4°F, 32 to 240°F)
RAYCI2A10L	Type K output sensing head w/3m cable (MAX 105°C, 220°F), ± 3°C accuracy 0 to 115°C (± 5.4 F, 32 to 240°F)
RAYCI2B	Type K output sensing head w/1m cable, ± 3°C accuracy 100 to 500°C (± 5.4°F, 202 to 932°F)
RAYCI3A10L	Linear voltage output sensing head w/3m cable (MAX 105°C, 220°F), ± 3°C accuracy 0 to 115°C (± 5.4°F, 32 to 240°F)
XXXCIACAP	Air purge collar for CI
XXXCIACFB	Fixed bracket for CI
XXXCIACMN	Mounting nuts (2) for CI
XXXCIADJB	Adjustable bracket for CI
XXXCIAP	Air purge collar (aluminum) for CI
XXXCIDCPS	24V=(dc), 125mA switching power supply (110/220V input)
Temperature Monitoring System	Description
Raytek® GP™	
RAYGPC	GPC panel-mount meter with standard 5V=(dc) alarm outputs, 110/220V~(ac) power input
RAYGPRSF	GPR standard focus sensing head with 8-14 micron spectral response and 35:1 optical resolution
XXXGPACFB	GPC mounting bracket for sub-panel mounting of monitor
XXXGPRCB15	50 ft (15 m) 5 conductor cable with 5-pin bayonet connector
Hand Held IR Thermometers	Description
MiniTemp™	
RAYMT2U	Standard MiniTemp MT2
RAYMT4U	Enhanced MiniTemp MT4 model with class 2 laser sighting
RAYMTAPK	Nylon carrying pouch with belt clip
ST™ Pro	
RAYST20XBUS	ST 20 Pro™ eXtra-Bright
ST™ ProPlus	
RAYST60XBUS	ST 60 ProPlus™ eXtra-Bright
RAYST80XBUS	ST 80 ProPlus™ eXtra-Bright
RAYST80XBUS-IS	ST 80 ProPlus™ eXtra-Bright intrinsically safe

Items in **bolded green** type are stocked for immediate availability.

Infrared Sensors

Hand Held MiniTemp™

The Raytek® MiniTemp™ is pocket-sized and easy to use—just point, shoot and read the temperature on the large backlit display. When you need a fast, easy and safe way to measure surface temperature, you need a MiniTemp™ noncontact thermometer. Use MiniTemp™ at work, at home, anywhere.

Choice of Models

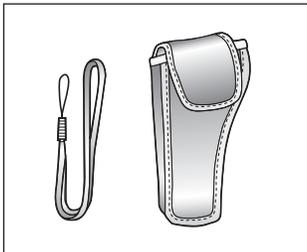
Choose between MiniTemp™ MT2, no laser sighting, or MiniTemp™ MT4, with laser sighting. Both models are powered by a 9V battery and display temperatures in either °C or °F. An accessory pack including a pouch and wrist strap is also available.

Applications

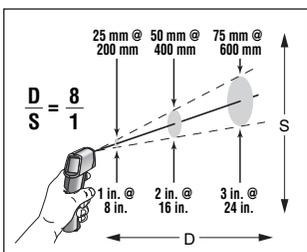
- Blown film extrusion
- Cast film extrusion
- Originally oriented film extrusion
- Sheet extrusion
- Extrusion coating
- Laminating and bossing
- Thermoforming

Options/Accessories

Soft Pouch with Wrist Strap



Target Spot Sizes



D:S = 8:1 at focal point



Specifications

Models	MT2	MT4
Temperature range	-18 to 275°C (0 to 525°F)	
Accuracy	-1 to 275°C (30 to 525°F) ±2% or ±2°C (±3.5°F), whichever is greater, -18 to -1°C (0 to 30°F) ±3°C (±5°F)	
Repeatability	±2% of reading or ±2°C (±3°F), whichever is greater	
Response time	500mSec, 95% response	
Spectral response	7-18 μm	
Emissivity*	Pre-set 0.95	
Ambient operating range	0 to 50°C (32 to 120°F)	
Relative humidity	10-95% RH non-condensing, @ up to 30°C (86°F)	
Storage temperature	-20 to 65°C (-4° to 150°F) without battery	
Weight/dimensions	0.5 lb (227g); 6 X 4 X 1.5 in. (152 X 101 X 38 mm)	
Power	9V Alkaline or NiCd battery (included)	
Battery life (Alkaline)	22 hours	12 hours
Laser Class II	—	√
Distance to spot size	8 : 1	
Typical distance to target (spot)	Up to 4 ft (1.5 m)	
Display hold (7 seconds)	√	√
LCD backlight	√	√
Temperature display	°C or °F selectable	
Display resolution	0.2°C (0.5°F)	
Options/accessories	Nylon holster	
Warranty	1 year**	

*For more information on emissivity for unique applications visit www.raytek.com/emissivity.htm
 **U.S. only. Warranty duration may vary by country.

Infrared Sensors

Hand Held

ST Pro™ 20 XB

Choose the ST Pro™ XB when you need a dependable professional tool for day-to-day applications. You won't find other noncontact thermometers with the temperature range, ability to measure so small an area and comparable laser sighting at this price. Simply point, shoot and read.

With a wide temperature range, MAX temperature display and choice of laser sighting options, the ST Pro™ makes temperature measurement a breeze. The ST20XB features rugged rubber overmolding and the ability to be tripod mounted.

Choose the infrared noncontact thermometer that millions of professionals use worldwide. Call today and discover the advantage—fast, easy and safe temperature measurement backed by over 40 years of experience.

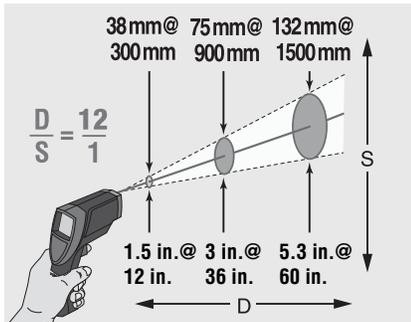


Raytek® Infrared Noncontact Thermometers are the professional's choice for:

- Blown film extrusion
- Cast film extrusion
- Originally oriented film extrusion
- Sheet extrusion
- Extrusion coating
- Laminating and bossing
- Thermoforming
- Hazardous locations (ST80-IS)

Infrared Sensors

Hand Held ST Pro™ 20 XB



ST20XB Target Spot Sizes
D:S = 12:1 at Focus Point

Specifications

Models	ST20 XB
Temperature range	-32 to 535°C (-25 to 999°F)
Accuracy (Assumes ambient operating temperature of 23°C (73°F))	-32 to 26°C (-25 to -15°F): ±3°C (±5°F) -26 to -18°C (-15 to 0°F): ±2.5°C (±4°F) -18 to 23°C (0 to 73°F): ±2°C (±3°F) 23 to 510°C (73 to 950°F): ±1% of reading or ±1°C (±2°F), whichever is greater Above 510°C (950°F): ±1.5% of reading
Repeatability	±0.5% or ≤ ±1°C (±2°F), whichever is greater
Response time	≤ 0.5 second (95% of reading)
Spectral response	8-14 μm
Emissivity*	Pre-set at 0.95
Ambient operating temp.	0 to 50°C (32 to 120°F)
Relative humidity	10-90% RH non-condensing at <30°C (86°F) ambient
Storage temperature	-20 to 60°C (-13 to 158°F) without battery
Weight/dimensions	11 oz (320 g), 8 X 6 X 2 in. (200 X 160 X 55 mm)
Power	9V Alkaline or NiCd battery
Battery life (Alkaline)	10 hours w/laser & backlight on 20 hours w/laser & backlight off
Laser (class II)	Offset single point laser point XB
Typical distance to target	Up to 6 ft (2 m)
Distance to spot (D:S)	12:1 at focus point
MAX temp display	√
Display hold (7 seconds)	√
LCD backlit	√
Temperature display	°C or °F selectable
Display resolution	0.2°C (0.5°F)
Hard carrying case	√
Tripod mounting	√
Warranty*	1 year
Additional options/accessories	Nylon holster NIST/DKD traceable calibration certificate (includes one year warranty)

*U.S. only. Warranty duration may vary by country.

Infrared Sensors

Hand Held

ST ProPlus™ 60/80 XB

When you need more features and higher specifications, choose the ProPlus™ for your most demanding applications. Advanced infrared technology for reading higher temperatures and powerful optics for measuring smaller areas (or from farther back), make the ProPlus™ the professional's choice for noncontact temperature measurement. Whether you choose the ST60 or the ST80, gathering temperature data has never been easier. Simply point, shoot and read.

Innovative features like extra bright laser sighting, adjustable emissivity, a wide temperature range and 12 point data logging, make any temperature measurement application a snap. This rugged unit with rubber overmolding also includes a jack for the optional Raytek® ST RTD temperature probe, and can be tripod mounted for hands-free operation. The ST80 is also available in a model rated "Intrinsically Safe" by Factory Mutual Research for use in hazardous locations.



Raytek® Infrared Noncontact Thermometers are the professional's choice for:

- Blown film extrusion
- Cast film extrusion
- Originally oriented film extrusion
- Sheet extrusion
- Extrusion coating
- Laminating and bossing
- Thermoforming
- Hazardous locations (ST80-IS)

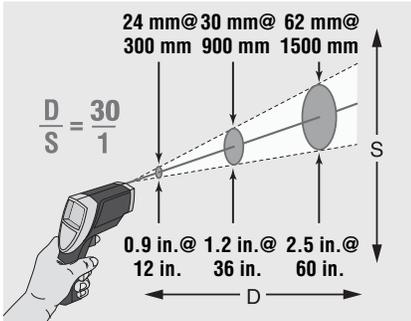
Options/Accessories

- RTD temperature probe
- Nylon holster
- NIST traceable calibration certificate
- Factory Mutual Research Intrinsically Safe Rated ST80-IS, including probe (Intrinsically Safe, Class 1 Division 1 Groups A,B,C,D Class I, Zone 0, AEx ia IIC, T4 at 50°C (122°F) when used with 9V alkaline battery)

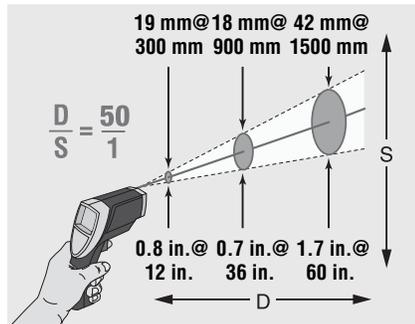
Infrared Sensors

Hand Held

ST ProPlus™ 60/80 XB



ST60 ProPlus™ Target Spot Sizes
D:S = 30:1 at Focus Point



ST80 ProPlus™ Target Spot Sizes
D:S = 50:1 at Focus Point

Specifications

Models	ST60 XB	ST80 XB / ST80 XB-IS*
Temperature range	-32 to 600°C (-25 to 1100°F)	-32 to 760°C (-25 to 1400°F)
Accuracy (Assumes ambient operating temperature of 23°C (73°F))	-32 to 26°C (-25 to -15°F): ±3°C (±5°F) -26 to -18°C (-15 to 0°F): ±2.5°C (±4°F) -18 to 23°C (0 to 73°F): ±2°C (±3°F) For targets above 23°C (73°F): ±1% of reading or ±1°C (±2°F), whichever is greater	
Repeatability	±0.5% or ≤ ±1°C (±2°F), whichever is greater	
Response time	≤ 0.5 second (95% of reading)	
Spectral response	8-14 μm	
Emissivity**	Digitally adjustable emissivity (from 0.1 to 1.0 by 0.01)	
Ambient operating temp.	0 to 50°C (32 to 120°F)	
Relative humidity	10-90% RH non-condensing, at <30°C (86°F) ambient	
Storage temperature	-20 to 60°C (-13° to 158°F) without battery	
Weight/dimensions	11 oz (320 g); 8 X 6 X 2 in. (200 X 160 X 55 mm)	
Power	9V Alkaline or NiCd battery	
Battery life (Alkaline)	20 hours w/laser & backlight on 50% 40 hours w/laser & backlight off	
Laser sighting (class II)	Extra bright laser point	
Typical distance to target	15 ft (5 m)	25 ft (8 m)
Distance to spot (D:S)	30:1 at focus point	50:1 at focus point
MIN, MAX, AVG, DIF temp display	√	
Data logging	12 points	
Probe jack	√	
Display hold (7 seconds)	√	
Hi/Low alarm	√	
LCD backlit	√	
Temperature display	°C or °F selectable	
Display resolution	0.1°C (0.1°F)	
Hard carrying case	√	
Locking trigger	√	
Tripod mounting	0.25 in. (6.35 mm) 20 UNC threading	

*Approved by Factory Mutual Research for use in hazardous locations.

**For more information on emissivity, or for unique applications visit www.raytek.com/emissivity.htm

Infrared Sensors

Fixed Mount

Raytek® GP™ Sensor

The GP™ sensor is a versatile, two-piece temperature monitoring system which combines a compact, value-priced monitor with an infrared sensing head. The heart of the system is the 1/8 DIN GP™ monitor which provides advanced infrared processing capabilities including peak and valley hold, averaging and a user-adjustable offset. The rugged GPR sensor is available with standard- or close-focus optics and provides target temperature readings with one percent accuracy.

Along with its large four-digit LED display, the monitor provides a user-defined 4-20mA or thermocouple output. Two adjustable set points/deadbands control 5V alarm outputs or optional 3A mechanical relays. The GP monitor accepts universal 110-220V~(ac) power and provides a 24V=(dc)/50mA excitation voltage for loop power to external sensors. All monitor functions are configured via the front panel, including °C/°F switching.

The GP™ monitor provides adjustable emissivity when used with the GPR™ infrared sensor. This high performance, eight to 14 micron infrared sensor with detachable cable combines current loop driven signals with 35:1 optics.

The GP™ monitor also works with other Raytek® infrared sensors, including the CI™ and MID™.



Highlights

- Temperature range from -18 to 538°C (0 to 1000°F)
- Compact 1/8 DIN digital monitor with large four-digit display
- Monitor and sensor functions configured on front panel
- Signal processing capabilities typically found on much larger systems
- Adjustable emissivity
- Universal 110-220V~(ac) power
- User-defined 4-20mA or thermocouple output (J,K,E,N,R,S,T)
- Adjustable dual set points and deadband alarm outputs
- Choice of sensing head to match application requirements
- Standard- and close-focus optics available
- Accessories for cooling and air purging
- Field interchangeable sensing heads

Accessories/Options:

- Cooling housings for high ambient conditions
- Air purge fittings for sensing heads
- Adjustable mounting brackets and adapters
- External isolated solid state relays for alarm outputs (10 Amp AC)
- 3A mechanical output relays

Infrared Sensors

Fixed Mount Raytek® GP™ Sensor

Measurement Specifications (Monitor with Sensing Head)

Model	GPR
Temperature range	-18 to 538°C (0 to 1000°F)
Accuracy (mA output)	±1% of measured value or ±1°C (±2°F), whichever is greater, @ 23°C ±5°C (73°F ±9°F)
Repeatability	±0.5% of measured value or ±1°C (2°F), whichever is greater
Response time (95 percent)	700mSec
Spectral response	8-14 μm
Emissivity	0.1 to 1.09 digitally adjustable increments of 0.01
Signal processing	Peak/valley hold (up to 998 sec, 999=infinite hold with external reset) Variable averaging filter (up to 60 seconds) T-ambient: fixed background ambient temperature compensation

GPR Electrical Specifications

Outputs	4-digit, 7 segment LED display, °C/°F selectable. User configurable 4-20mA current or thermocouple output (J, K, E, N, R, S, T). Two adjustable set points with deadbands controlling +5V alarm outputs or optional 3A mechanical relay
Power supply	110/220V~(ac), ±20 percent, 50-60Hz. User configurable inputs for GPR, GPM, any 0.5V or 4-20mA sensor or thermocouple (J, K, E, N, R, S, T). External reset input to reset peak/valley hold 24V=(dc)/50mA excitation voltage

General Specifications

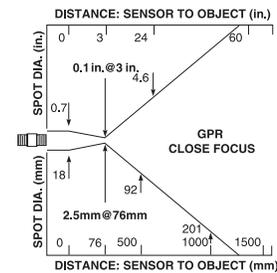
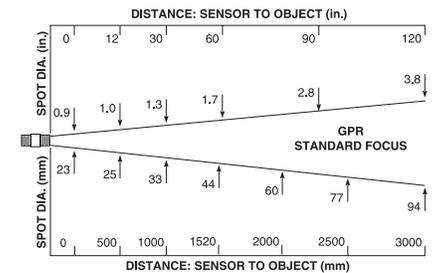
Environmental rating	GP monitor front panel GPR sensing head	IP 54 (IEC 529); NEMA-12 IP 65 (IEC 529); NEMA-4*
Ambient temperature range	GP monitor GPR sensing head with optional water cooling	0 to 50°C (32 to 120°F) 0 to 65°C (32 to 150°F) 0 to 177°C (32 to 350°F)
Storage temperature		-30 to 65°C (-22 to 150°F)
Relative humidity		10 to 95% non-condensing
GP monitor dimensions		1.75 X 3.63 X 4.75 in. (¼ DIN X 120 mm)
GP monitor weight		0.7 lbs (320 g)

*GPR rated with adapter and compression fitting.

Sensing Head — Optical Specifications

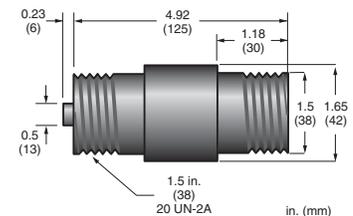
(Note: nominal spot size based on 90 percent energy)

GPR Sensing Head Optical Charts



Dimensions

GPR Sensing Head



Infrared Sensors

Fixed Mount

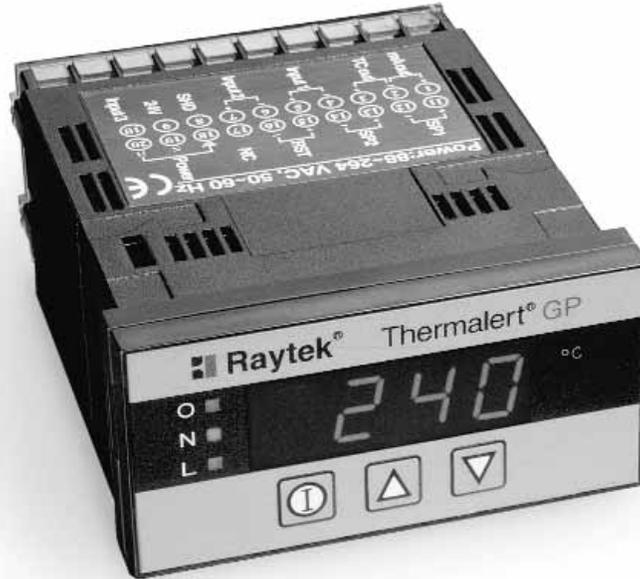
Raytek® GP™ Monitor

The GP™ monitor provides a compact, easy-to-use interface and display for process instruments. This low-cost 1/8 DIN digital panel meter comes standard with features which are optional on other panel meters in this price range. The GP™ monitor accepts inputs from any 0-5V sensor, 4-20mA sensor or thermocouple type J,K,E,N,R,S,T. In addition, the monitor can be used with many Raytek® noncontact, infrared temperature sensors.

Along with its large four-digit LED display, the monitor provides a user-defined 4-20mA or thermocouple output. Two adjustable set points/deadbands control 5V alarm outputs or optional 3A mechanical relays. The GP™ monitor accepts 110-220V~(ac) power and provides a 24V=(dc)/50 mA excitation voltage, capable of providing loop power to external sensors.

For signal processing requirements, the monitor provides peak hold, valley hold and averaging and a user adjustable offset. Best of all, there are no internal jumpers used for setup, as all monitor functions are configured via the front panel.

Versatile. Compact. Value-priced. All reasons to standardize on the GP™ monitor for your process monitoring requirements.



Highlights

- Accepts any 0-5V or 4-20mA sensor input
- Accepts Type J, K, E, N, R, S, T thermocouple inputs
- Compact 1/8 DIN monitor
- Large four-digit LED display
- Universal 110/220V~(ac) power
- Provides 24V=(dc) / 50mA excitation voltage
- User defined 4-20mA or thermocouple output (J,K,E,N,R,S,T)
- Adjustable dual set points and deadband controlling alarm outputs
- Signal processing: peak hold, valley hold, averaging
- User adjustable offset
- External reset input

Infrared Sensors

Fixed Mount

Raytek® GP™ Monitor

Measurement Specifications

Resolution and accuracy	0-5V input resolution 1 mV, accuracy @ ±2 mV. 4-20mA input resolution 0.01mA, accuracy @ ±0.02mA. J, K, E, N, T thermocouple input, ±0.05 percent or ±2°C, whichever is greater. R,S thermocouple input, ±0.5 percent or ±3°C, whichever is greater. 4-20mA output resolution 0.014mA accuracy @ ±0.02mA. J, K, E, N, T thermocouple output, ±0.05 percent or ±2°C, whichever is greater. R,S thermocouple output, ±0.5 percent or ±4°C, whichever is greater.
Repeatability	±0.5% of measured value
Response time (95 percent)	500mSec
Warmup time	5 seconds
Signal Processing	Peak hold, valley hold (up to 998 sec, 999=infinite hold with external reset). Variable averaging filter (up to 60 seconds)

Electrical Specifications

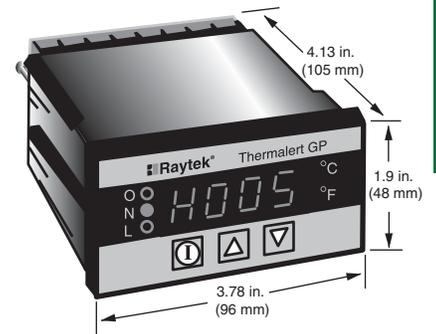
Inputs	User-configurable inputs for 0-5 V or 4-20mA or J, K, E, N, R, S thermocouple. External reset input to reset peak/valley hold circuit.
Outputs selectable	4-digit, 7 segment LED display, °C/°F. User-configurable 4-20mA current or thermocouple output (J, K, E, N, R, S, T). Two adjustable set points with deadbands controlling +5V alarm outputs or optional 3A mechanical relays. 24V=(dc)/50mA excitation voltage for powering external sensors
Power supply	110/220V~(ac), ±20 percent, 50-60Hz

General Specifications

Environmental rating	GP front panel IP54 (IEC 529); NEMA-12
Ambient temperature range	0 to 50°C (32 to 120°F)
Storage temperature	-30 to 65°C (-22 to 150°F)
GP monitor dimensions	1.75 X 3.63 X 4.75 in. (¼ DIN X 120 mm)
GP monitor weight	0.7 lbs (320 g)

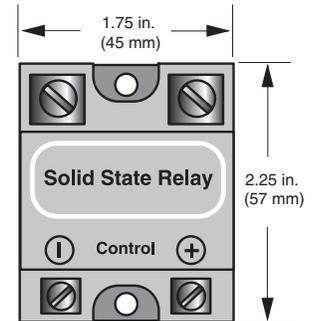
General Dimensions

Panel cut-out: 1.75 in. x 3.63 in. (92 mm x 44 mm)



Accessory — Solid State Relay

External isolated solid state relays for alarm outputs (10 amp AC)



Infrared Sensors

Fixed Mount

Raytek® MI™ Temperature Measurement System

The MI™ product is a two-piece infrared temperature measurement system with miniature sensing head and separate electronics. The sensor is small enough to be installed just about anywhere, yet performs as well as much larger systems. The MI™ electronics include a host of signal processing features which you won't normally find in systems in this price range, including emissivity, peak hold, valley hold and averaging, all of which are adjustable on the five-digit LCD interface.

Designed for applications where the target temperature is in the -40 to 600°C (-40 to 1112°F) range, the sensor is housed in a rugged stainless steel enclosure to ensure long term performance, even in harsh industrial environments with ambient temperatures up to 85°C (185°F) without cooling.

Although the MI™ system is small in size, it still has the features you need, with one percent accuracy and 10:1 optics, with user selectable output signals. And the MI's™ response time is as fast or faster than many high-end systems.

The MI's™ system's miniature size and low cost make it ideal for installation at multiple points along your process. Accurate. Easy to install. Affordable. With the MI™ system, precision infrared temperature measurement is now an economical alternative.



Highlights

- Small sensing head fits where other sensors cannot
- Ambient operating range to 85°C (185°F) without cooling
- Five-digit backlit LCD interface
- Adjustable emissivity, peak hold, valley hold and averaging
- One percent accuracy from -40 to 600°C (-40 to 1112°F)
- 10:1 optics
- Powered by 12-24V=(dc) at 100 mA
- Accessories for cooling and air purging
- Remote electronics box
- User selectable output signals
- Optional RS232 or RS485 communication

Infrared Sensors

Fixed Mount Raytek® MI™ Sensor

Measurement Specifications

Temperature range	-40 to 600°C (-40 to 1112°F); -25 to 600°C for J thermocouple output
Accuracy	±1% of reading or ±1°C (±2°F), whichever is greater @ 23°C ±5°C (73°F ±9°F). Thermocouple output accuracy ±1% of reading or ±2.5°C, whichever is greater @ 23°C ±5°C (73°F ±9°F)
Spectral response	8 to 14 microns
Optical resolution	10:1
Repeatability	±0.5% of reading or ±0.5°C (1°F), whichever is greater
Temperature coefficient	0.15K per K or 0.15% per K, whichever is greater
Temperature resolution	0.3°C (0.5°F)
Response time	150ms (95%)
Emissivity	0.100 to 1.100 digitally adjustable increments of 0.001
Transmission	0.100 to 1.100 digitally adjustable increments of 0.001
Signal processing	Peak hold, valley hold, variable averaging filter, adjustable up to 998 seconds

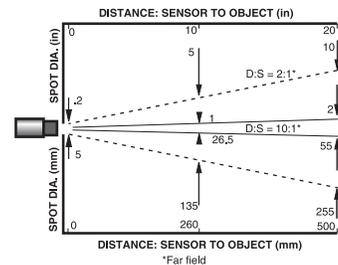
Electrical Specifications

Outputs	Scalable 4-20mA, 0-20mA, 0-5V, J or K thermocouple, 10mV/°C head ambient signal
Cable length	3.2 ft (1 m) standard, 9.8 ft (3 m) optional
Output impedance (T/C output)	20 ohm
Minimum lead impedance (mV output)	100K ohms
Maximum loop impedance (mA output)	500 ohms with 24V=(dc) power supply
Current draw	100mA
Power supply	11-26V=(dc)

General Specifications

Environmental rating	NEMA-4 (IP 65)
Ambient temperature range	
Sensing head	0 to 85°C (32 to 185°F)
With air cooling	-18 to 200°C (0 to 392°F)
Electronics housing	0 to 65°C (32 to 150)
Storage temperature	-18 to 85°C (0 to 185°F)
Relative humidity	10 to 95% non-condensing
Construction	
Sensing head	Stainless steel
Electronics housing	Zinc, die-cast
Weight	
Sensing head (w/1 m cable)	1.75 oz (50 g)
Electronics housing	9.5 oz (270 g)

Nominal Optical Specifications

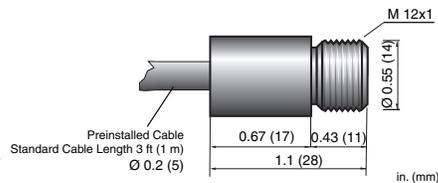


D:S is the optical resolution expressed as a ratio of the distance to the resolution spot divided by the diameter of the spot.

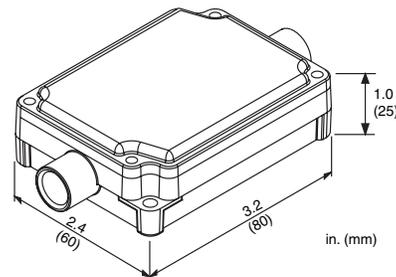
Optical resolution for the MID is 2:1 and 10:1. Nominal spot size based on 90 percent energy.

General Specifications

Sensing Head



Electronics Housing



Accessories/Options*

Each standard MID package includes a sensing head, one mounting nut, 3.2 ft (1 m) of cable, die-cast housing with premounted electronics, and an operator's manual.

- Adjustable or fixed mounting bracket
- Air purge jacket
- Air cooling/purging system
- Longer cable: 9.8 ft (3 m)*
- RS232 or RS485 communication*

*Must be specified at time of order

Infrared Sensors

Fixed Mount

Raytek® CI™ Sensor

The CI™ sensor provides the advantages of infrared temperature measurement in a compact, low cost integrated sensor. Designed for easy integration into a standard four-wire system, the CI™ sensor can easily replace traditional contact probes with a Type J or Type K thermocouple output, or with a 0-5 volt output if your application is susceptible to noise or requires a longer cable run.

The CI™ sensor is designed to measure target temperatures ranging from 0 to 500°C (32 to 932°F). The CI's™ onboard electronics are protected by a rugged IP 65 (NEMA-4) stainless steel housing and the sensor can function in ambient temperatures to 70°C (160°F) without cooling. With water cooling, the CI™ sensor can withstand ambient temperatures to 260°C (500°F).

Because the CI™ sensor has the same 50 ohm output impedance as a thermocouple, it functions accurately—without offset errors—when used in conjunction with the thermocouple break protection circuitry in most controllers, displays, and transmitters.

Compact. Easy to install. Affordable. The CI™ sensor is ideal for both OEM and end-user applications.



Highlights

- Type J or K, or 0-5V output
- Two models cover temperature ranges from 0 to 500°C (32 to 932°F)
- IP 65 (NEMA-4) stainless steel electronics housing
- 4:1 optics at 90 percent energy
- 350 mSec (95 percent) response time
- Powered by 12-24V=(dc) at 20mA
- Accessories for cooling and air purging

Infrared Sensors

Fixed Mount

Raytek® CI™ Sensor

Models and Temperature Ranges

Models	CI1	CI2	CI3
Output	Type J thermocouple	Type K thermocouple	10 mV/°C linear voltage, scaled 0-5V (0-500°C)
Range A	0 to 350°C (32 to 662°F)		
Range B	30 to 500°C (86 to 932°F)		
Accuracy	±2% or ±3°C (±6°F), whichever is greater, btw 0 to 115°C (32 to 240°F); ±5% or ±6°C (±10°F), whichever is greater, btw 30 to 100°C (86 to 212°F)		

Measurement Specifications

Spectral response	7 to 18 microns
System repeatability	±1% of measured value or ±1°C (2°F), whichever is greater
Temperature resolution	<0.5°C (1°F)
Response time (95%)	350mSec
Emissivity	Fixed at 0.95

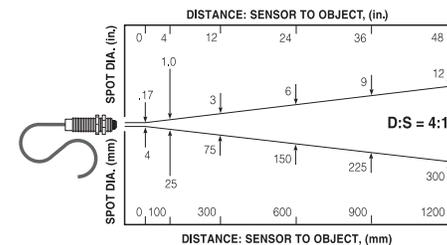
Electrical Specifications

Outputs	User-selectable thermocouple output (model specific, either J or K) or voltage output 10mV/°C
head ambient signal	
Cable length	3 ft (0.9 m) standard, longer cables optional
Output impedance	50 ohm
Minimum lead impedance	50K ohms
Power supply	12-24V=(dc) (±2.5% ripple) @ 20mA

General Specifications

Environmental rating	NEMA-4 (IP 65)
Ambient temperature range	
Sensing head	0 to 70°C (32 to 160°F)
With air cooling	0 to 90°C (32 to 200°F)
With water cooling	0 to 260°C (32 to 500°F)
Storage temperature	-30 to 85°C (-22 to 185°F)
Relative humidity	10 to 95% non-condensing
Shock	IEC 68-2-27 (MIL STD 810D) 50 g's, 11 mSec, any axis
Vibration	IEC 68-2-27 (MIL STD 810D) 3 g's, any axis, 11-200Hz
Dimensions	3.4 L in. X 0.75 in. D (19 mm L X 87 mm D)
Weight	4.5 oz (130 g)

Nominal Optical Specifications

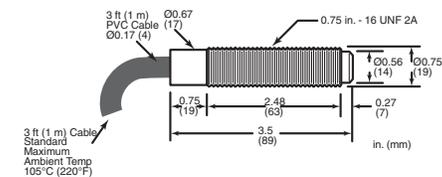


D:S is the optical resolution expressed as a ratio of the distance to the resolution spot divided by the diameter of the spot.

Optical resolution for the CI™ is 4:1.

Nominal spot size based on 90 percent energy

General Dimensions



Accessories/Options*

Sensing head comes with a 3 ft (0.9 m) cable, two mounting nuts, and an operator's manual.

- GP monitor provides display, and 4-20mA output
- Air-/water-cooled housing*
- High temperature cables (standard with air-/water-cooled housing)
- Adjustable or fixed mounting bracket
- Air purge collar
- Longer cables 10 ft (3 m)*

*Must be specified at time of order

Notes

Transmitters/Signal Conditioners

SERIES DX

Watlow's SERIES DX DeviceNet™ four-channel temperature transmitter provides high accuracy and the flexibility of distributed networking in a compact, DIN-mounted package. Hundreds of temperature sensors can now be networked together on a single DeviceNet™ cable. This simplifies the installation process and reduces the cost of wiring labor and input hardware. The new transmitter not only saves on installation costs, but also allows all of the latest temperature sensor technologies based on the IEEE 1451.4 format to be accessible to most PLCs, networks and LabVIEW™ applications.

The DX transmitter inputs can be used in any combination of standard or plug and play IEEE 1451.4 RTDs and thermocouples.

- Thermocouples: Type J, K, T, N, E, R, S, B and nonstandard
- RTDs: 2- or 3-wire platinum, 100Ω, DIN (0.00385 curve)
- INFOSENSE-PT™ high accuracy plug and play IEEE 1451.4 smart sensors (RTD and thermocouple)
- WATCOUPLE thermocouple long-life, high accuracy, high temperature plug and play IEEE 1451.4 smart nonstandard thermocouples



Features and Benefits

Easy installation, use and maintenance

- Network and rotary switch configurable
- Bright, legible status LEDs for channel and network status
- Automatic DIN-rail grounding
- Writable front cover for easy identification
- Hot-swappable without having to remove adjoining transmitters
- No need to install separate power supply

Lower cost installation (significantly lower cost per channel in multi-channel installation)

- Powered from DeviceNet™ network (11 to 25V_{DC}, class 2); no additional cost for additional power supplies and additional cabinet space

- Low power consumption; allows up to 252 sensors to be installed via 63 cascaded transmitters on one DeviceNet™ network run
- Small size enables use of smaller enclosures and lowers the enclosure cost per channel (four sensor inputs in 0.90 in. (22.5 mm) wide package)

Very high accuracy

- 0.5°C (±0.9°F) cold junction compensation accuracy for thermocouples over range of -40 to 70°C (-40 to 158°F)
- ± 0.5°C (±0.9°F) transmitter accuracy with thermocouple
- ± 0.25°C (±0.5°F) transmitter accuracy with RTD

Available Options

- M12 sealed-style metal circular male micro DeviceNet™ connector
- Open-style stripped five-wire DeviceNet™ connector
- Backplane cascade connection

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

LabVIEW™ is a trademark of National Instruments Corporation.

Transmitters/Signal Conditioners

SERIES DX

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

DX4000

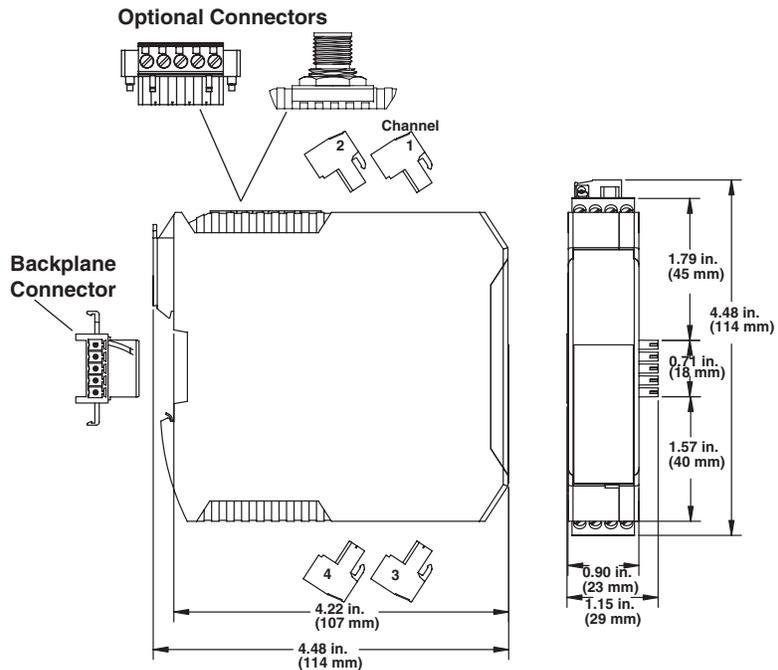
Connector

- B = Backplane connector only
- M = M12 sealed style metal circular male micro DeviceNet™ connector and backplane connector
- S = Open style stripped five-wire DeviceNet™ connector and a backplane connector

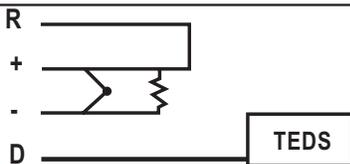
Printed manual 22308101

CD manual and EDS file 22307601

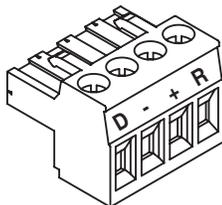
Dimensions



TERMINAL T/C RTD IEEE 1451.4

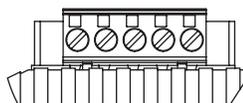
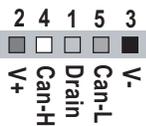


Channel Connector Removable for Easy Wiring

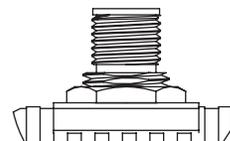
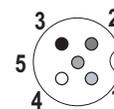


DeviceNet™ Connector Options

Open Style Connector (Option S)



M12 Male Micro Style (Option M)



Transmitters/Signal Conditioners

SERIES 5750

Watlow's SERIES 5750 temperature transmitters offer remarkably accurate temperature measurement and improved reliability which reduces downtime and costs.

The 5750 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 SERIES 5750 provides linearization between temperature sensor input signal and the 4-20 mA output signal, ensuring accurate temperature measurements over a wider range.

Contact our customer service department to integrate this transmitter into a Watlow Style AR or AT thermocouple sensor or a Watlow Style RR or RT RTD sensor.

Features and Benefits

Full temperature to thermocouple signal linearization over the complete operation temperature span

- Ensures signal accuracy

Programmable

- Ensures greater convenience for future changes and inventory efficiency



User selectable input types

- Thermocouple calibration Types B, C, E, J, K, N, R, S and T; RTD Pt100, DIN or JIS

CE marked

- Compliant to electromagnetic interference

NAMUR compliant

- Increased safety

No external power supply needed for ranging

- Ease of use

Specifications

- **Operating voltage:** 8 to 36 volts (the SERIES 5750 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: 10°C, thermocouples: 2mV
- **Operating temperature:** -40 to +85°C

- **Response time appr.:** 0.5 seconds
- **RFI sensitive:** 20 - 1000 MHz, 10V/m typical <0.1 percent (of end value)
- **Permissible ripple of supply:** 4V p-p
- **Long term stability:** 0.2 percent per year
- **Calibration inaccuracy, thermocouples:** max of 20µ volts or 0.01 percent
- **Temperature effect:** cold junction compensation $\pm 0.5^{\circ}\text{C}$
- **Housing:** PC, ABS/VO connection polyamid / V2
- **Mounting:** DIN B or DIN-rail with Part #30413301
- **Non-Isolated**

Windows® is a registered trademark of the Microsoft Corporation.

Transmitters/Signal Conditioners

SERIES 5750

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

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

1-4. SERIES

5750 = Linearized T/C or RTD

5. Sensor Type

- Standard plugs and jacks 200°C (400°F)
- B = Type B T/C N = Type N T/C
 - C = Type C T/C R = Type R T/C
 - E = Type E T/C S = Type S T/C
 - J = Type J T/C T = Type T T/C
 - K = Type K T/C O = 3-wire RTD 100Ω

6. Low Temperature Sign

(Enter + or - sign)

7-9. Low Temperature

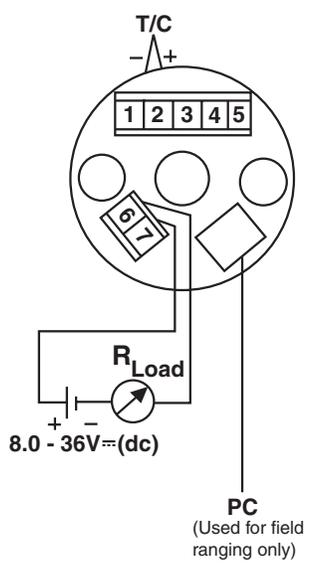
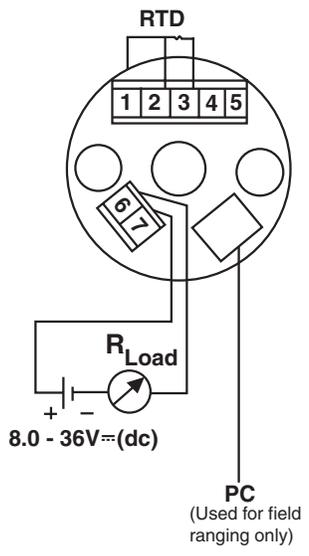
10. High Temperature Sign

(Enter + or - sign)

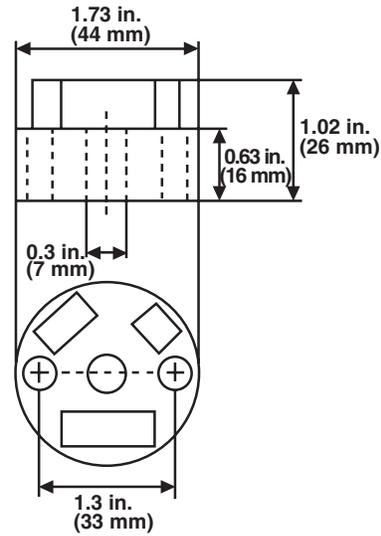
11-14. High Temperature

15. Unit of Measure (°C/°F)

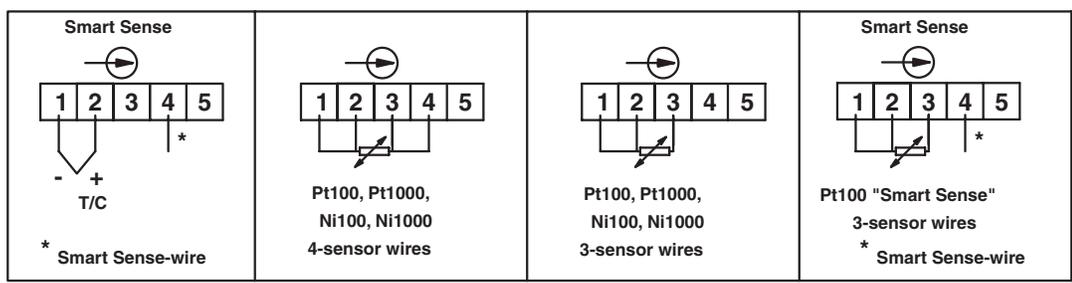
Program cable and software part number 5750-CABLE (Required for optional future changes)



Standard Dimensions



Wiring Diagram



Transmitters/Signal Conditioners

SERIES 5900

Watlow's SERIES 5900 temperature transmitters offer remarkably accurate temperature measurement and improved reliability which reduces downtime and costs.

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 SERIES 5900 is isolated to 1500V~(ac) and features full linearization between temperature sensor input signal and the 4-20 mA output signal. Isolated transmitters provide isolation from input to output thus eliminating ground loops and other related problems to signal integrity.

Additional options include insulation resistance monitoring between sensor and ground to prevent inaccurate measurements due to insulation breakdown.

Contact our customer service department to integrate this transmitter into a Watlow Style AR or AT thermocouple sensor or a Watlow Style RR or RT RTD sensor.

Features and Benefits

Full temperature to thermocouple signal linearization over the complete operation temperature span

- Ensures signal accuracy

Full isolation from input to output

- Eliminates ground loops for high data integrity



Fits directly into connection head

- Easy to install

Programmable

- Insures greater convenience for future changes and inventory efficiency

User selectable input types

- Thermocouple calibration Types B, C, E, J, K, N, R, S and T; RTD Pt100 and Pt1000 including four-wire

Optional insulation resistance monitoring

- Prevents inaccurate measurements due to insulation breakdown

CE marked

- Compliant to electromagnet interference

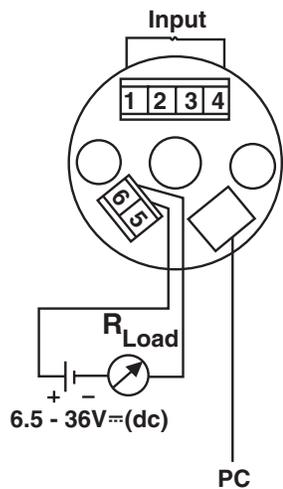
Specifications

- **Isolation:** 1500V~(ac) for one minute
- **Operating voltage:** 6.5 to 36 volts (the 5900 is protected against voltage surges and reverse polarity)

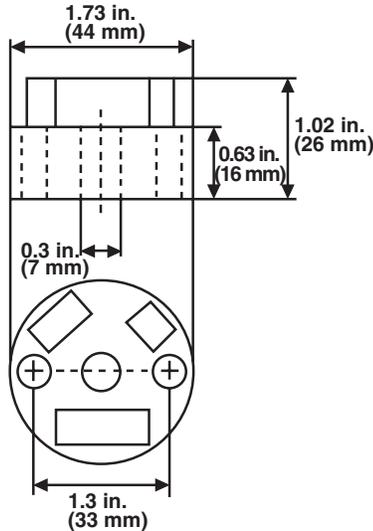
- **Sensor burn out protection:** A pulsed current is continuously checking all sensor leads for disconnect. The output will go upscale or downscale.
- **Minimum input signal:** RTDs: 10°C, thermocouples: 2mV
- **Operating temperature:** -40 to 85°C
- **Response time appr.:** 0.5 seconds
- **RFI sensitive:** 20 - 1000 MHz, 10V/m typical <0.1 percent (of end value)
- **Permissible ripple of supply:** 4V p-p
- **Long term stability:** 0.1 percent per year
- **Calibration inaccuracy, thermocouples:** max of 20μ volts or 0.01 percent
- **Temperature effect:** cold junction compensation 0.02 percent C/C
- **Housing:** PC, ABS/VO connection polyamid / V2
- **Mounting:** DIN B

Transmitters/Signal Conditioners

SERIES 5900



Standard Dimensions

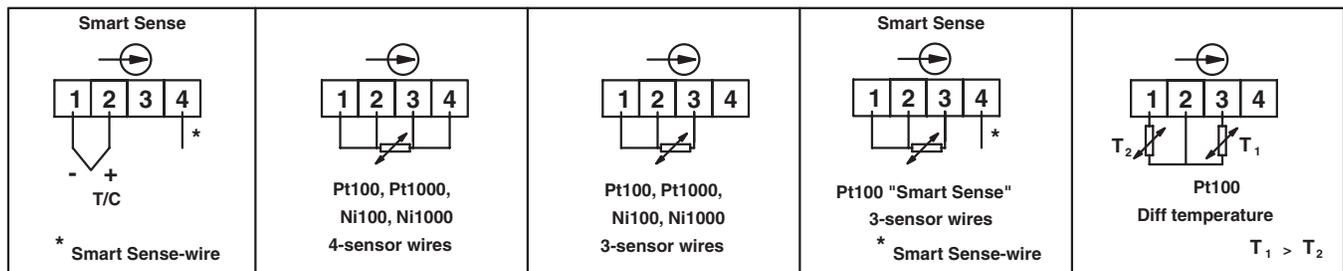


Ordering Information—To order, complete the part number on the right with the information below:

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1-4. SERIES															
5900 = Linearized T/C or RTD															
5901 = 1000 Ω RTD															
5902 = Isolated, linearized with insulation resistance monitoring															
5. Sensor Type															
Standard plugs and jacks 200°C (400°F)															
B = Type B T/C															
C = Type C T/C															
E = Type E T/C															
J = Type J T/C															
K = Type K T/C															
N = Type N T/C															
R = Type R T/C															
S = Type S T/C															
T = Type T T/C															
O = 3-wire RTD															
1 = 2-wire RTD															
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 number 5900-CABLE

Wiring Diagram

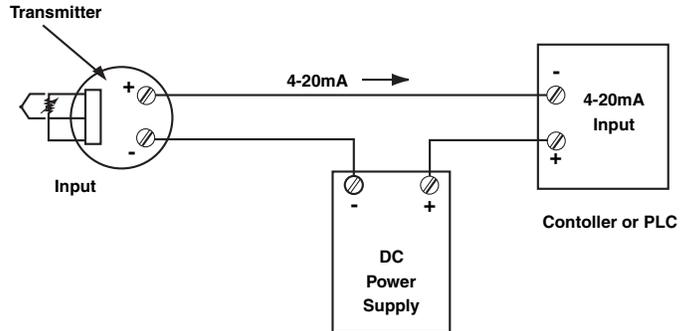


Transmitters/ Signal Conditioners

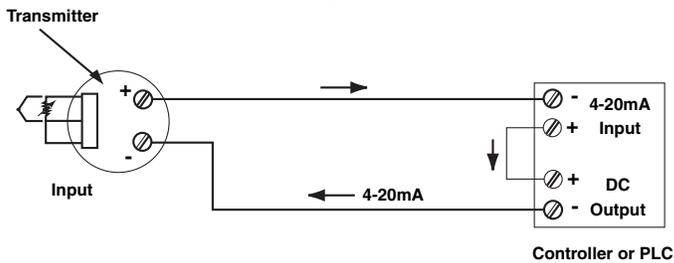
System Components

Typical Wiring Diagrams for Two-Wire Signal Conditioners

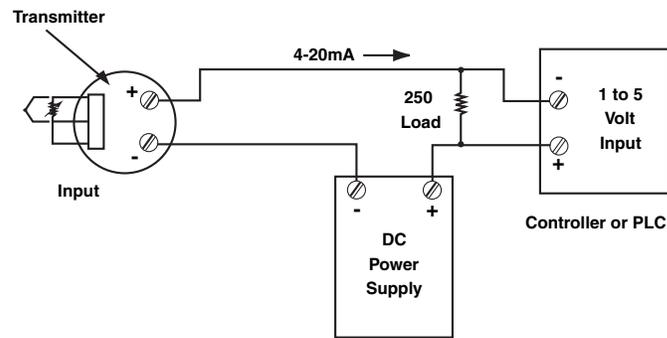
Controller or PLC with 4-20mA Input



Controller or PLC with Internal Power Supply



Controller or PLC with 1 to 5 Volt Input



Transmitter and Connection Head Mounting Options

Signal Conditioner Model and Description	Connection Heads			
	Cast Aluminum	Cast Iron	Explosion XP SERIES	Poly Heads Pt SERIES
5750, Non-isolated, Non-linearized	Mount with kit 81501901	Does not fit	Mount with kit 81501301	Mount with kit 81501201
5900, 5901 and 5902, Isolated, Linearized	Mount with kit 81501901	Does not fit	Mount with kit 81501301	Mount with kit 81501201

Notes

Accessories

Accessory Overview

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.

Protecting tube construction styles are more limited than thermowells. The tubes offer the advantages of economy, corrosion resistance and, in some cases, higher temperature capabilities.



**For more information on
Watlow's protecting tubes
see page 149.**

Note: All accessories subject to minimum purchase quantities.

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 available

- Special configurations can be designed on request

The bar stock used (when available) to manufacture thermowells

- Protection against corrosion
- Round bar with wrench flats is substituted when hex not available

Plug and chain 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.

Note: All accessories subject to minimum purchase quantities.

Accessories

Thermowells

Thermowell Material Selection Guide

Application	Protecting Tube Material
Heat treating	
Annealing Up to 704°C (1300°F) Over 704°C (1300°F)	Black steel Inconel® 600, Type 446 SS
Carburizing hardening Up to 816°C (1500°F) 816 to 1093°C (1500 to 2000°F) Over 1093°C (2000°F) 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 1093°C (2000°F) Over 1093°C (2000°F)	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 1093°C (2000°F) Over 1093°C (2000°F)	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 enameling	Inconel® 600, Type 446 SS
Barium chloride, all concentration, 21°C (70°F)	Monel®, Hastelloy C®

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

Inconel® and Monel® are registered trademarks of the Special Metals Corporation.

Hexoloy® is a registered trademark of Carborundum Company.

Hastelloy C® is a registered trademark of Haynes International.

Note: All accessories subject to minimum purchase quantities.

Accessories

CONTINUED

Accessories

Thermowells

Thermowell Material Selection Guide

Continued

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

CONTINUED

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.

Note: All accessories subject to minimum purchase quantities.

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	Ceramic*
Flues and checkers	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
Factioning 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 1093°C (2000°F)	Inconel® 600, Type 446 SS
Over 1093°C (2000°F)	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%, 21°C (70°F)	Type 304, Hastelloy C®, Monel®
50%, 100°C (212°F)	Type 316, Hastelloy C®, Monel®
99%, 21 to 100°C (70 to 212°F)	Type 430, Hastelloy C®, Monel®
Alcohol, ethyl, methyl	
21 to 100°C (70 to 212°F)	Type 304
Ammonia	
All concentration 21°C (70°F)	Types 304, 316 SS
Ammonium chloride	
All concentration 100°C (212°F)	Types 316 SS, Monel®
Ammonium nitrate	
All concentration 21 to 100°C (70 to 212°F)	Type 316 SS
Ammonium sulphate, 10% to saturated	
100°C (212°F)	Type 316 SS

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

Note: All accessories subject to minimum purchase quantities.

CONTINUED

Accessories

Thermowells

Thermowell Material Selection Guide

Continued

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

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

CONTINUED

Note: All accessories subject to minimum purchase quantities.

Accessories

Thermowells

Thermowell Material Selection Guide

Continued

Application	Protecting Tube Material
Potassium permanganate, 5%, 21°C (70°F)	Type 304 SS
Potassium sulphate, 5%, 21°C (70°F)	Types 304 SS, 316 SS
Potassium sulphide, 21°C (70°F)	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, 21°C (70°F) 5%, 66°C (150°F)	Type 304 SS Types 304 SS, 316 SS
Sodium carbonate, 5%, 21 to 66°C (70 to 150°F)	Types 304 SS, 316 SS
Sodium chloride 5%, 21 to 66°C (70 to 150°F) Saturated, 21 to 100°C (70 to 212°F)	Type 316 SS Type 316 SS, Monel®
Sodium fluoride, 5%, 21°C (70°F)	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, 21°C (70°F)	Types 304 SS, 316 SS
Sodium sulphide, 21°C (70°F)	Type 316 SS
Sodium sulphite, 30%, 66°C (150°F)	Type 304 SS
Sulphur dioxide Moist gas, 21°C (70°F) Gas, 302°C (575°F)	Type 316 SS Types 304 SS, 316 SS
Sulphur Dry molten Wet	Type 304 SS Type 316 SS
Sulphuric acid 5%, 21 to 100°C (70 to 212°F) 10%, 21 to 100°C (70 to 212°F) 50%, 21 to 100°C (70 to 212°F) 90%, 21°C (70°F) 90%, 100°C (212°F)	Hastelloy B®, 316 SS Hastelloy B® Hastelloy B® Hastelloy B® Hastelloy D®
Tannic acid 21°C (70°F)	Type 304 SS, Hastelloy B®
Tartaric acid 21°C (70°F) 66°C (150°F)	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%, 21°C (70°F) Saturated, 21°C (70°F) 25%, 100°C (212°F)	Types 304 SS, 316 SS Types 304 SS, 316 SS Types 304 SS, 316 SS

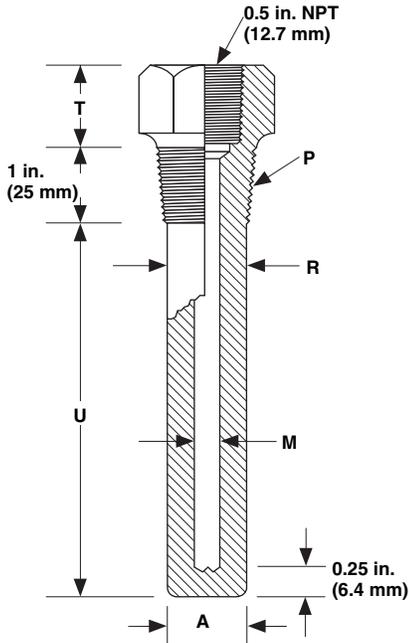
Reference charts and tables on pages 139 to 143 courtesy of the American Society for Testing and Materials. Taken from publication MNL 12, ***“Manual on the Use of Thermocouples in Temperature Measurement.”***

Note: All accessories subject to minimum purchase quantities.

Accessories

Thermowells

Threaded Type—Straight



Standard Bore Size: 0.260 inch

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

Typical Dimensions

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

Rapid Ship Sensors

Rapid Ship straight thermowells come in four lengths in 316 SS with a $\frac{1}{4}$ inch NPT process connection, a $\frac{1}{4}$ inch lag length and a 0.260 bore diameter with a $\frac{1}{2}$ inch NPT connection.

"U" Length		Part Number
in.	(mm)	
2.5	64	TTS024CD00006A0
4.5	114	TTS044CD00006A0
7.5	191	TTS074CD00006A0
10.5	267	TTS104CD00006A0

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

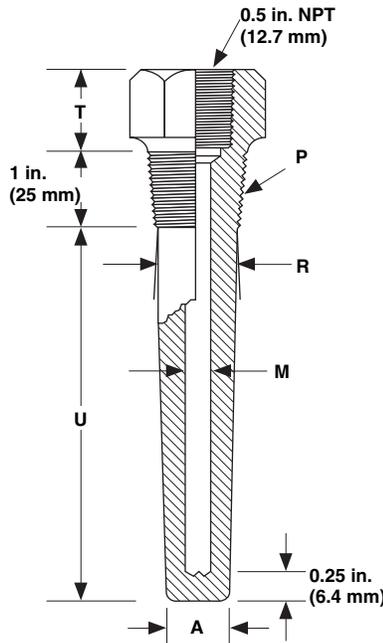
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	T	T	S												
2. Thermowell Style	T = Threaded														
3. Stem Configuration	S = Straight														
4-5. "U" Dimension (inches)	Whole inches: 00 to 99														
6. "U" Dimension (fractional inch)	0 = 0 4 = $\frac{1}{2}$ 1 = $\frac{1}{8}$ 5 = $\frac{3}{8}$ 2 = $\frac{1}{4}$ 6 = $\frac{1}{2}$ 3 = $\frac{3}{8}$ 7 = $\frac{5}{8}$														
7. Thermowell Material	A = 304 SS C = 316 SS H = Monel® M = Hastelloy C-276® X = Other														
8. Process Connection Size "P" (inch)	D = $\frac{1}{4}$ 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 4 = $\frac{1}{2}$ 1 = $\frac{1}{8}$ 5 = $\frac{3}{8}$ 2 = $\frac{1}{4}$ 6 = $\frac{1}{2}$ Industry Standard 3 = $\frac{3}{8}$ 7 = $\frac{5}{8}$														
14. Bore Diameter "M" (inch)	A = 0.260 B = 0.385 X = Other														
15. Special Options	0 = None X = Special requirements, consult factory														

Note: All accessories subject to minimum purchase quantities.

Accessories

Thermowells

Threaded Type–Tapered



Standard Bore Size: 0.260 inch
Standard Materials: 304 SS, 316 SS, Monel®, Hastelloy C®

Typical Dimensions

Process Conn. NPT P in.	A in.	M in.	R in.	T in.
1	4/64	0.385	1 1/16	3/4
3/4	4/64	0.385	7/8	3/4
1	5/8	0.260	1 1/16	3/4
3/4	5/8	0.260	7/8	3/4

Rapid Ship Sensors

Rapid Ship tapered thermowells come in four lengths in 316 SS with a 3/4 inch NPT process connection, a 3/8 inch lag length and a 0.260 bore diameter with a 1/2 inch NPT connection.

"U" Length in.	(mm)	Part Number
2.5	64	TTT024CD00006A0
4.5	114	TTT044CD00006A0
7.5	191	TTT074CD00006A0
10.5	267	TTT104CD00006A0

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

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	T	T	T												
2. Thermowell Style	_____														
T = Threaded															
3. Stem Configuration	_____														
T = Standard taper															
4-5. "U" Dimension (inches)	_____														
Whole inches: 00 to 99															
6. "U" Dimension (fractional inch)	_____														
0 = 0 4 = 1/2															
1 = 1/8 5 = 3/8															
2 = 1/4 6 = 1/2															
3 = 3/8 7 = 3/4															
7. Thermowell Material	_____														
A = 304 SS															
C = 316 SS															
H = Monel®															
M = Hastelloy C-276®															
X = Other															
8. Process Connection Size "P" (inch)	_____														
D = 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 4 = 1/2															
1 = 1/8 5 = 3/8															
2 = 1/4 6 = 1/2 Industry Standard															
3 = 3/8 7 = 3/4															
14. Bore Diameter "M" (inch)	_____														
A = 0.260															
B = 0.385															
X = Other															
15. Special Options	_____														
0 = None															
X = Special requirements, consult factory															

Accessories

Note: All accessories subject to minimum purchase quantities.

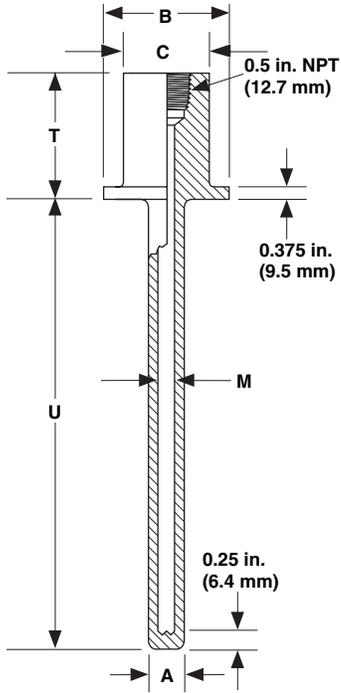
Accessories

Thermowells

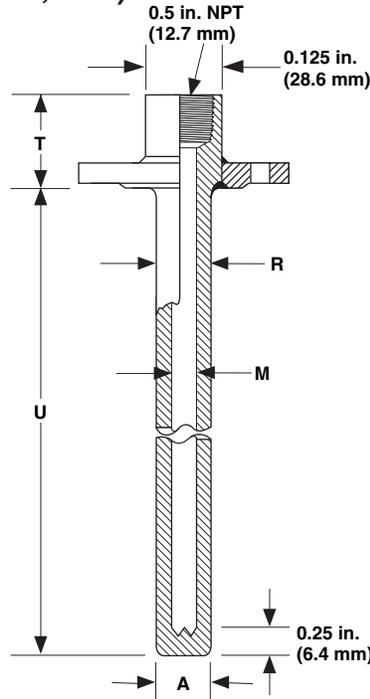
Other Available Thermowells

Consult factory for availability and pricing.

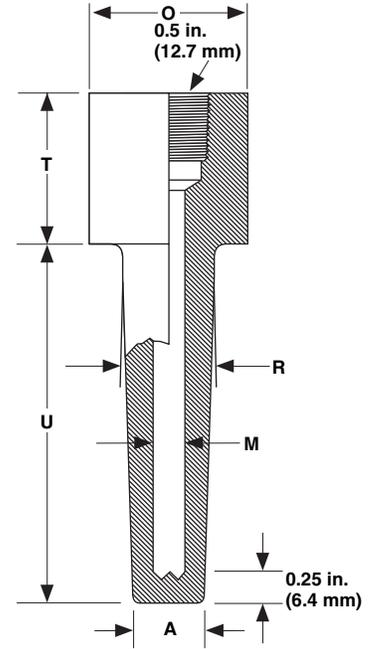
Van Stone Type (TVS)



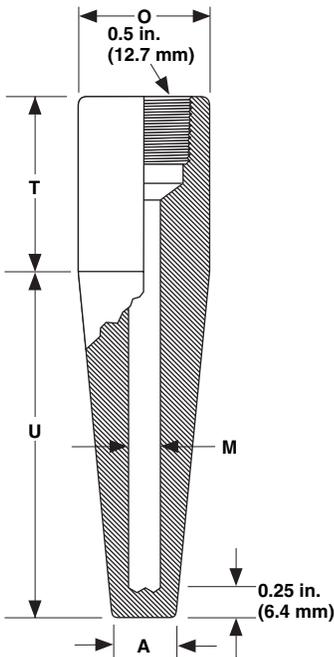
Welded Flange Well (TFS, TFT)



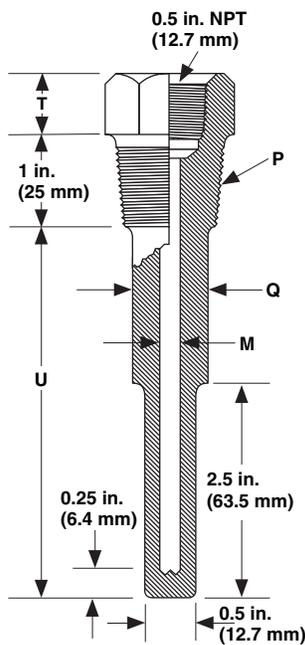
Socket Weld Type (TST)



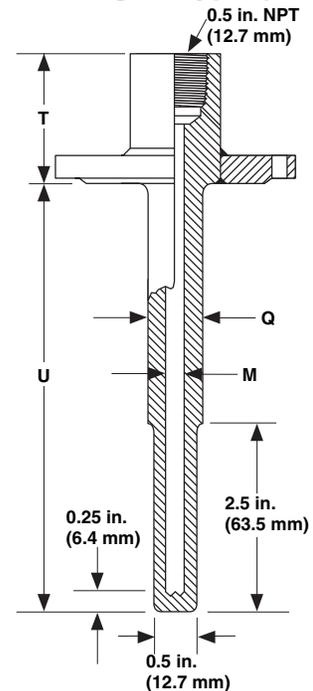
Weld-In Type (TWT)



Bimetallic Thermometer Wells—Threaded Type (TBD)

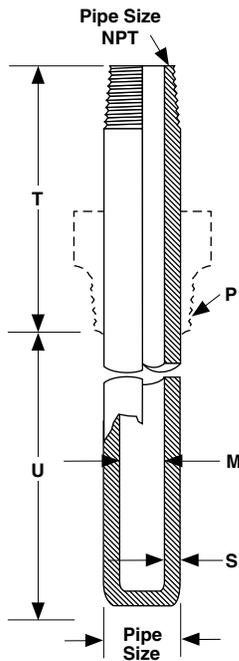


Bimetallic Thermometer Well—Flanged Type (TFD)



Accessories

Thermowells Pipe Type



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.

Standard "T" Dimension: 3 inches

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

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	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 = ⅛ 3 = ⅜ 5 = ⅝ 7 = ⅞															
7. Pipe Material	_____														
A = 304 SS K = 446 SS															
C = 316 SS W = Alloy 601															
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														
0 = No bushing or flange	4 = 2														
	5 = 3														
9. Flange Rating (lbs)	_____														
0 = No flange															
A = 150															
B = 300															
C = 600															
10. Flange Face Type	_____														
0 = No flange															
1 = Raised face															
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 = ⅛ 5 = ⅝															
2 = ¼ 6 = ¾															
3 = ⅜ 7 = ⅞															
14. Bore Diameter "M" (inch)	_____														
J = Per pipe size															
15. Special Options	_____														
0 = None															
X = Special requirements, consult factory															

*Must be at least one size larger than pipe size.

Note: All accessories subject to minimum purchase quantities.

Accessories

Thermowells

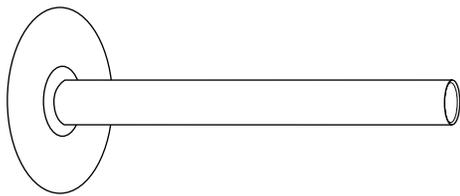
Pipe Type

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

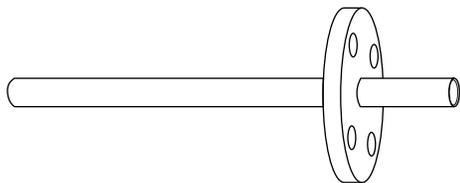
Tantalum oversheaths provide protection to thermowells with unequaled efficiency. In applications of corrosive processes such as chlorine, bromine, hydrochloric, nitric and sulphuric acids, oversheaths withstand product contamination without measurable deterioration.

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 1/8, 1/4, 3/8 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 registered trademark of Cabot Corporation.

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

Kynar® is a registered trademark of Pennwalt Corporation.

Note: All accessories subject to minimum purchase quantities.

Accessories

Protection Tubes and Assemblies

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 154</i>	Sintered	1650°C (3000°F)	67	54.0	Excellent	Maintains strength to 1650°C (3002°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 151</i>	Oxide Bonded	1650°C (3000°F)		15-20	Good	Permeable	Non-ferrous metals
Alumina <i>See page 150</i>	99.9%	1900°C (3450°F)	50	6.3	Fair—preheating to 482°C (900°F) recommended	Creeps (sags) at 1900°C (3452°F) ferrous metals, dry H ₂	Barium, crown glass; non-ferrous metals; gas-tight protection for noble metal thermocouples in excess of 1316°C (2400°F)
	96%	1700°C (3100°F)	49	5.4	Same as above	Creeps at 1900°C (3452°F)	
Mullite <i>See page 150</i>	—	1700°C (3100°F)	12	2.1	Poor—must be preheated to 482°C (900°F)	Creeps at 1700°C (3092°F), attacked by halides—contains silica	Non-ferrous metals; gas-tight protection for base metal thermocouples to 1316°C (2400°F)
Metal Ceramic <i>See page 151</i>	LT-1	1400°C (2500°F)	45	29.0 (R.T.)	Must be preheated to 482°C (900°F) before immersion into molten metal at 1093°C (1999°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 1400°C (2552°F)
Coated Protection Tubes (1100 SERIES) <i>See page 152</i>		760°C (1400°F)			Excellent	Do not exceed 760°C (1400°F)	Molten aluminum, zinc and galvanizing; maximum operating temperature 745°C (1373°F)

* Hot face temperature

Note: Other mounting fittings available; please consult factory.

Note: All accessories subject to minimum purchase quantities.

Accessories

Protection Tubes and Assemblies

Ceramic Protecting Tubes

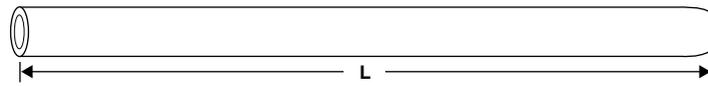
Order - Part No.

Code - Length

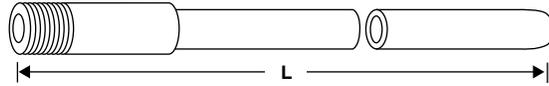
Example: 1152-12

1152-N-12

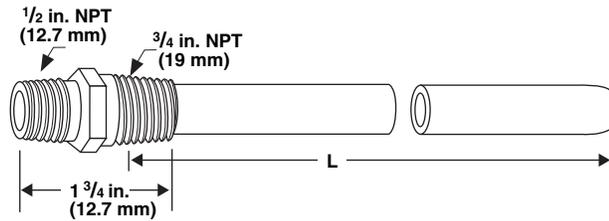
1153-191-24



Mullite or Alumina Protecting Tube, Plain End



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



Mullite or Alumina Protecting Tube with TH-190 or TH-191 Fitting (3/4 inch of Tube Enters Fitting)

Mullite Protecting Tubes*

Code No.	I.D. X O.D. in.	Construction	Length in.
1152-	1/4 x 3/8	Plain end	12, 18, 24, 30, 36, 42, 48, 54, 60
1153-	7/16 x 1/8		
1154-	3/4 x 1		
1155-	1 x 1 1/4		
1152-N-	1/4 x 3/8		
1153-N-	7/16 x 1/8	With TH-43 ferrule 7/8 - 27 threads	
1153-190-	7/16 x 1/8	With TH-190 1/2" x 3/4" brass	
1153-191-		With TH-191 1/2" x 3/4" steel	

Alumina (99% Minimum Purity) Protecting Tubes

Order - Part No.

Code - Length

Example: 1146-18

1146-N-36

1147-190-30

Code No.	I.D. X O.D. in.	Construction	Length in.
1146	1/4 x 3/8	Plain end	12, 18, 24, 30, 36, 42, 48
1147	7/16 x 1/8	Plain end	12, 18, 24, 30, 36, 42, 48, 54, 60
1148	3/4 x 1	Plain end	12, 18, 24, 30, 36, 42, 48, 54, 60, 66, 72
1149	1 x 1 1/4	Plain end	12, 18, 24, 30, 36, 42, 48, 54, 60, 66, 72
1146-N	1/4 x 3/8	TH-50 ferrule 7/8-27 threads	12, 18, 24, 30, 36, 42, 48
1147-N	7/16 x 1/8	TH-43 ferrule 7/8-27 threads	12, 18, 24, 30, 36, 42, 48, 54, 60
1147-190	7/16 x 1/8	With TH-190 1/2" x 3/4" brass	12, 18, 24, 30, 36, 42, 48, 54, 60
1147-191	7/16 x 1/8	With TH-191 1/2" x 3/4" steel	12, 18, 24, 30, 36, 42, 48, 54, 60

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

Note: All accessories subject to minimum purchase quantities.

Accessories

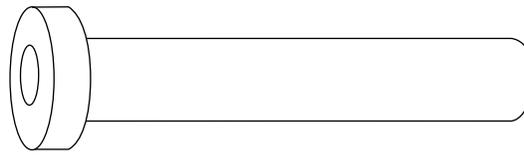
Protection Tubes and Assemblies

Silicon Carbide and Cast Iron Protecting Tubes

Order - Part No.

Code - Length

Example: 1080-18



Silicon Carbide Protecting or Target Tube

Silicon Carbide Protecting Tubes—Oxide Bonded

Code No.	I.D. X O.D. in.	Construction	Length in.	Weight per in.
1080	1 x 1 3/4	Plain end	12, 18, 24, 30, 36	0.15 lbs
1081	1 x 1 3/4	Collar, 3 inch dia.*		0.17 lbs

*Back edge of flange rounded.

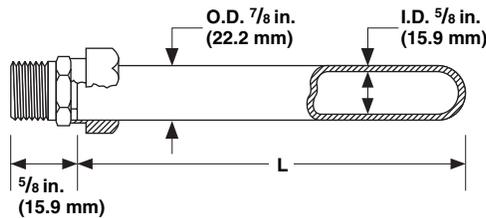
Special Application Protecting Tubes

Order - Part No.

Code - Length

Example: 1161-36

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 1205°C (2200°F).

Thermocouples can be installed directly, eliminating the expense of multi-tube assemblies. Metal-ceramics resist surface deformation below the maximum recommended operating temperature of 1355°C (2500°F). 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. in.	Construction	Length in.
1161	5/8 x 7/8	Std. 3/4 inch conduit connector	12, 18, 24, 30, 36

Note: All accessories subject to minimum purchase quantities.

Accessories

Protection Tubes and Assemblies

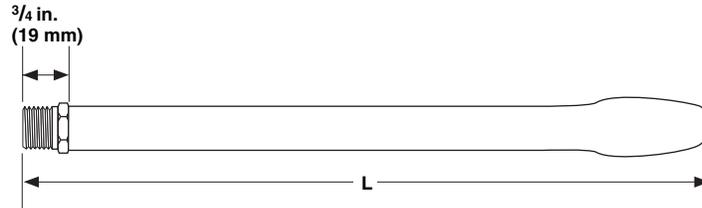
Coated Protecting Tubes for Molten Aluminum, Zinc and Galvanizing Applications

Order - Part No.

Code - Length

Example: 1100-24

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 eight-gauge beaded thermocouple. Stocked for immediate shipment. The maximum operating temperature for the SERIES 1100 is 745°C (1400°F).

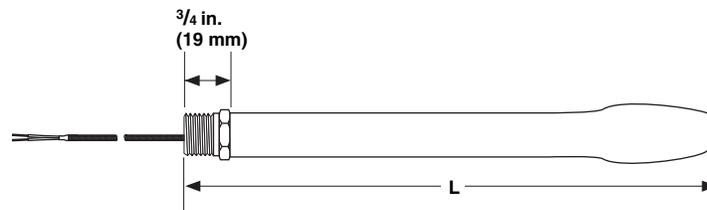
Code No.	I.D. in.	Nominal O.D. in.	Fitting in.	Tube Length in.
1100	0.493	1 ½ Max.	¾ NPT	12, 18, 24, 30, 36, 42, 48

Order - Part No.

Code - Length

Example: 1101-12

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 (part 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. in.	Fitting in.	Lead Length in.	Tube Length in.
1101	K	1 ½ Max.	¾ NPT	36	12, 18, 24, 30, 36, 42, 48

Note: All accessories subject to minimum purchase quantities.

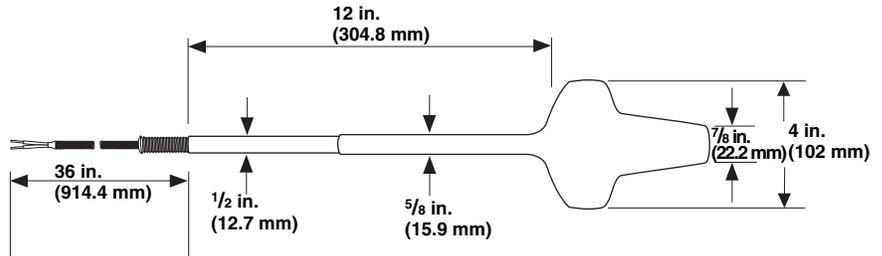
Accessories

Protection Tubes and Assemblies

Coated Protecting Tubes for Molten Aluminum, Zinc and Galvanizing Applications

Continued

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, part 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.

Part No.	Wire Type	Calibration in.	Nominal O.D. in.	Lead Length in.	Stem Length
1102-12	Fiberglass	K	4	36	12
1112-12	Fiberglass with stainless steel overbraid				

Note: All accessories subject to minimum purchase quantities.

Accessories

Protection Tubes and Assemblies

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) °C (°F)	1650 (3000)
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 part numbers and lengths required for your application.

Order - Part No.

Code - Length

Example: 1040-12

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. in.	Lengths in.
1040	3/8 x 1/4	6, 12, 18, 24, 30, 36
1041	5/8 x 3/8	
1042	3/4 x 1/2	

Tubes with Optional Mounting Fittings

Tube Code No.	Head Mount	Process Mount	Fitting Description	Lengths in.
1040-L	1/2 NPT	1/2 NPT	Cemented hex nipple	6, 12,
1041-M	3/4 NPT	3/4 NPT	Cemented hex nipple	18, 24,
1042-P	3/4 NPT	3/4 NPT	Cemented hex nipple	30, 36

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 538°C (1000°F) continuous.

Note: All accessories subject to minimum purchase quantities.

Accessories

Hardware

Watlow offers a variety of hardware components for use with our thermocouples. These include:

- Thermocouple heads
- Connector blocks
- Open terminations
- Thermocouple mounting fittings
- Thermocouple insulators and accessories

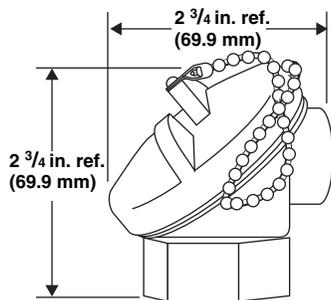


Note: All accessories subject to minimum purchase quantities.

Accessories

Hardware

Thermocouple Heads and Connector Blocks



Approximate Assembled Dimensions:
2 3/16 in. H x 2 3/4 in. L x 2 3/4 in. W

Standard Thermocouple Heads

(Assembly ordering options D or E)

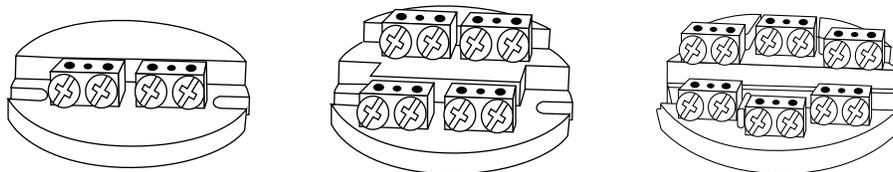
Watlow's standard heads are made of cast iron or aluminum. A plated chain attaches the gasketed cover to the body. Flats are provided for tightening. The connector block, held

in place with two screws, can be a single, duplex or triplex. These heads have 1, 3/4 or 1/2 inch NPT openings for protecting tubes or drilled wells. The conduit outlet is 3/4 inch NPT. Epoxy coating is available on the aluminum head. Maximum operating temperature is 441°C (825°F).

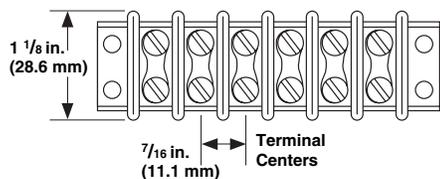
Cast Iron Head Only Part No.	Aluminum Head Only Part No.	Sensor Opening (NPT) in.	Conduit Connection in.
70900201	—	1	3/4
70900202	—	3/4	3/4
70900203	70900301*	1/2	3/4

*Available with epoxy coating (70900302)

Terminal Blocks for Standard Heads



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



Note: All accessories subject to minimum purchase quantities.

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 (02 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.

Accessories

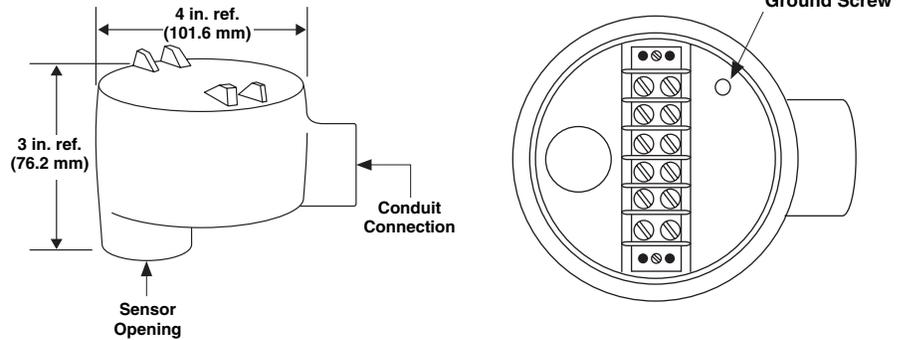
Hardware

Thermocouple Heads and Connector Blocks

Continued

Explosion Proof Thermocouple Heads

(Assembly ordering option H)



Approximate Assembled Dimensions:
4 in. H x 2 1/4 in. L x 3 in. W

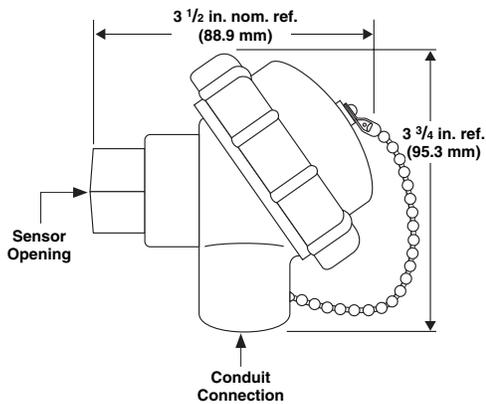
XP Head Shown with TH-615 Block

Part No.	Sensor Opening in.	Conduit Connection in.
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

Part No. Head Only	Sensor Opening in.	Conduit Connection in.
PT-20	1/2	1/2
PT-30	1/2	3/4
RT-30-WHT	1/2	3/4

Terminal Blocks for PT Heads

Part No.	Description
50500701	Single element block
50500801	Dual element block

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 105°C (220°F). The PT-20 and PT-30 are black and the RT-30-WHT is white in color.

Note: All accessories subject to minimum purchase quantities.

Accessories

Hardware

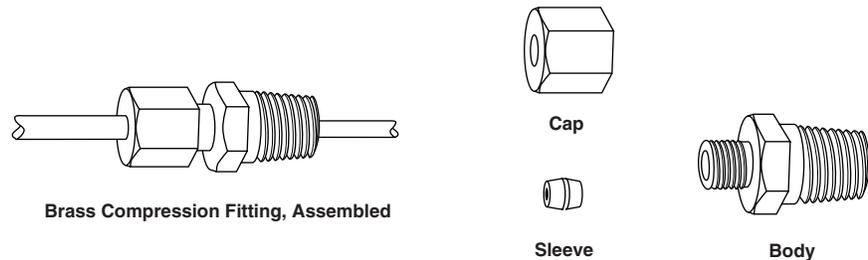
Sensor Mounting Fittings

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.

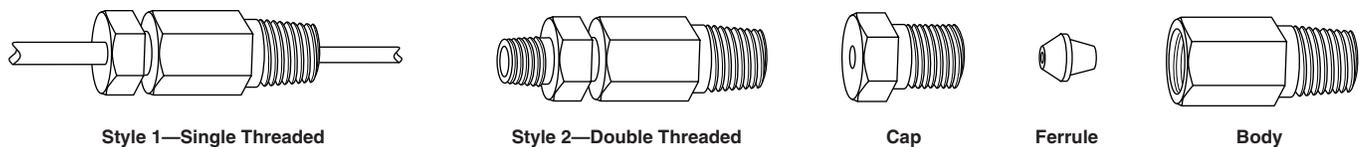
Brass Compression Fitting, Non-Adjustable



Part No.	Sheath O.D. in.	Material	Bore +0.10, -0.000 in.	Male NPT in.	Length in.
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 3/8
TH-185-6	0.313	Brass	0.318	1/4	1 3/8
TH-185-7	0.375	Brass	0.380	1/4	1 7/8
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. in.	Bore ±0.001 in.	Male NPT in.	Hex Across Flats in.
Part No.	Length in.	Part No.	Length in.				
TH-2745-063	1 1/4	TH-2749-063	1 1/16	0.063	0.067	1/8	1/2
TH-2745-125	1 1/4	TH-2749-125	1 1/16	0.125	0.129	1/8	1/2
TH-2745-188	1 1/4	TH-2749-188	1 1/16	0.188	0.194	1/8	1/2
TH-2745-250	1 1/4	TH-2749-250	1 1/16	0.250	0.257	1/8	1/2

Note: All accessories subject to minimum purchase quantities.

Accessories

Hardware

Sensor Mounting Fittings

Continued

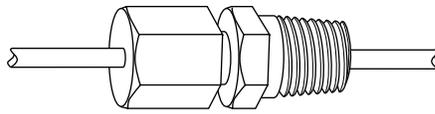
Adjustable Compression Type

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

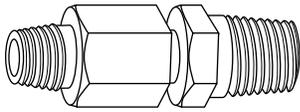
location and retighten the cap. It is recommended that lava sealant glands be replaced after each tightening. Neoprene and TFE sealant glands should withstand several relocations before replacement is necessary.

Stainless Steel Adjustable Compression Fitting

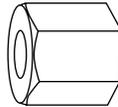
Except for their sealant glands, these fittings are made entirely of 303 stainless steel. Sealant glands are available in neoprene, -40 to 95°C (-40 to 200°F); lava, -184 to 540°C (-300 to 1000°F); TFE, -184 to 260°C (-300 to 500°F). Unless otherwise specified*, neoprene sealant glands will be furnished. Depending on temperature and sheath diameter, the fittings are pressure rated up to 3,000 psi.



Style 1—Single Threaded



Style 2 - Double Threaded



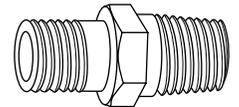
Style 1 Cap Shown



Follower



Sealant Gland

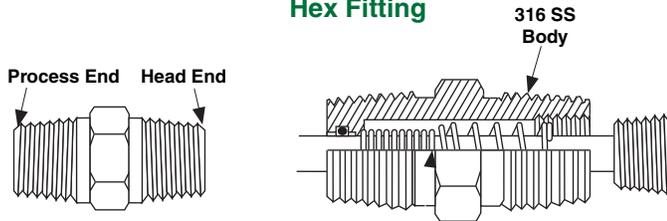


Body

Style 1—Single Threaded		Style 2—Double Threaded		Sheath O.D. in.	Bore +0.002 in.	Male NPT in.	Hex Across Flats in.	Replacement Sealant Glands, Neoprene
Part No.*	Length in.	Part No.*	Length in.					
TH-2747-N-063	1 ¼	TH-2751-N-063	1 ½	0.063	0.067	¼	½	TH-279-N-063
TH-2747-N-125	1 ¼	TH-2751-N-125	1 ½	0.125	0.136	¼	½	TH-279-N-125
TH-2747-N-188	1 ¼	TH-2751-N-188	1 ½	0.188	0.193	¼	½	TH-279-N-188
TH-2748-N-250	2 ⅞	TH-2752-N-250	3 ¼	0.250	0.257	¼	¾	TH-280-N-250
TH-2748-N-313	2 ⅞	TH-2752-N-313	3 ¼	0.313	0.316	¼	¾	TH-280-N-313
TH-2748-N-375	2 ⅞	TH-2752-N-375	3 ¼	0.375	0.386	¼	¾	TH-280-N-375

*If lava or TFE sealant glands are desired, substitute L or T in place of the N in the part number.

Adjustable Spring-Loaded Hex Fitting



Inconel® X-750 Spring

The adjustable spring-loaded fitting has a stainless steel body and end cap, an Inconel® X-750 spring. Designed for use with 0.250 inch O.D. sheath thermocouples and RTDs.

Note: All accessories subject to minimum purchase quantities.

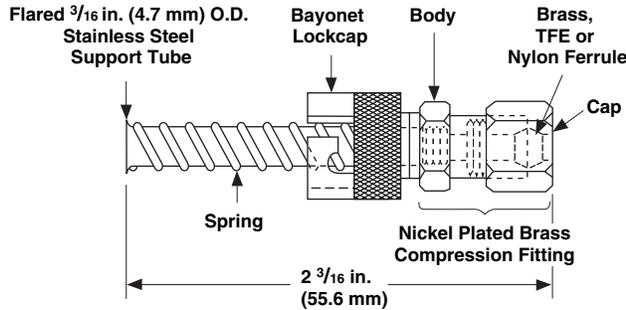
Inconel® is a registered trademark of the Special Metals Corporation.

Part No.	Sheath			Male NPT in.	Hex Across Body Flats in.	Hex Across Cap Flats in.
	Length in.	O.D. in.	Material			
6556-250	2	0.250	316 SS	¼	¾	⅝

Accessories

Hardware Bayonet Fittings

Adjustable Bayonet Compression Fitting



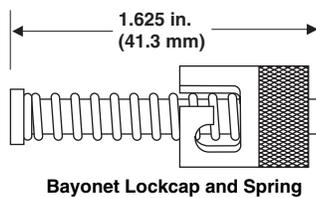
This fitting combines the features of the fixed bayonet fitting in a compact unit which does not require brazing to assemble.

The fitting is designed for 0.125 in. (3 mm) 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.

Part 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



Bayonet Lockcap and Spring

Part No.	Description
TH-2760	Lockcap, spring and spring stop

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 0.188 inch O.D. sensor. 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.

Note: All accessories subject to minimum purchase quantities.

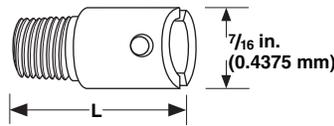
Accessories

Hardware

Bayonet Fittings

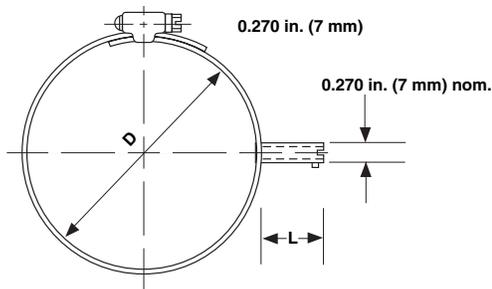
Continued

Bayonet Adapter



Part No.	Description	L Length in.	Thread in.
TH-295-1	Bayonet Adapter	7/8	1/8
TH-295-2		1	1/8
TH-295-3		1 1/2	1/8
TH-295-4		2	1/8
TH-295-5		2 1/2	1/8
TH-298-1		7/8	3/8-24
TH-298-2		1 1/2	3/8-24

Pipe Clamp with Bayonet Adapter



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.

1-2. Construction Code

90 = Pipe clamp band with bayonet adapter

3. "D" Clamp Band Diameter Range (inch)

- A = 1/8 to 1 1/4
- B = 1 1/4 to 2 1/4
- C = 2 1/4 to 3 1/4
- D = 3 1/4 to 4 1/4
- E = 4 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.

1 2 3 4
9 0

Note: All accessories subject to minimum purchase quantities.

Accessories

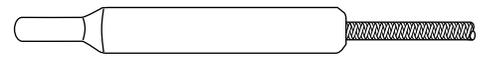
Hardware

Transition Fittings and Accessories

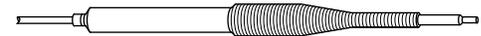
Watlow's complete line of stainless steel transition fittings offers durable, potted connections between XACTPAK® type sheathed thermocouple material and insulated wire. When the distance between the thermocouple and the instrument is known in advance, this type of assembly can be connected directly 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.

A coiled spring strain relief on the 700 and 701 protects the connecting wire against sharp bends at the transition area.



702 Transition Fitting



700 or 701 Transition Fitting, Assembled
U.S. Patent Number 3,811,958



703 Heavy Duty Transition

Part No.	Sheath O.D. in.	Max. Dia. Extension Wire	Transition Body inches		Spring Strain Relief	Length Including Spring in.	Method of Attachment to Sheath
			O.D.	Length Less Spring (if any)			
702-020*	0.020	0.100	$\frac{5}{32}$	1	no	—	Braze
702-032	0.032	0.100	$\frac{5}{32}$	1	no	—	Braze
700-040*	0.040	0.136	$\frac{1}{4}$	$1 \frac{3}{16}$	yes	$2 \frac{1}{4}$	Crimp or braze
702-040	0.040	0.100	$\frac{5}{32}$	1	no	—	Braze
700-063	0.063	0.136	$\frac{1}{4}$	$1 \frac{3}{16}$	yes	$2 \frac{1}{4}$	Crimp or braze
701-063	0.063	0.210	$\frac{3}{8}$	$1 \frac{3}{16}$	yes	$2 \frac{1}{2}$	Crimp or braze
702-063	0.063	0.100	$\frac{5}{32}$	1	no	—	Braze
700-125	0.125	0.136	$\frac{1}{4}$	$1 \frac{3}{16}$	yes	$2 \frac{1}{4}$	Crimp or braze
701-125	0.125	0.210	$\frac{3}{8}$	$1 \frac{3}{16}$	yes	$2 \frac{1}{2}$	Crimp or braze
701-188	0.188	0.210	$\frac{3}{8}$	$1 \frac{3}{16}$	yes	$2 \frac{1}{2}$	Crimp or braze
701-250	0.250	0.210	$\frac{3}{8}$	$1 \frac{3}{16}$	yes	$2 \frac{1}{2}$	Crimp or braze
703-250	0.250	0.320	$\frac{1}{2}$	2	no	—	Braze

*Sleeved down from larger size to accept smaller O.D. sheath material.

Note: All accessories subject to minimum purchase quantities.

Accessories

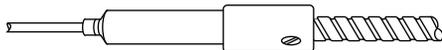
Hardware

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.

Part 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 1450°C (2640°F)
- Maximum intermittent temperature 1650°C (3000°F)

Oval—Double Hole

Part No.	AWG	Dimensions inches*			
		Width	Thickness	Bore	Length
372	8	0.468	0.281	0.156	3

Round—Double Hole

Part No.	AWG	Dimensions inches*		
		Diameter	Bore	Length
376-1	18	0.156	0.046	1
376-3	18	0.156	0.046	3
377-12	16	0.250	0.062	12
333-12	22	0.125	0.031	12
333-24	22	0.125	0.031	24

*Nominal

Note: All accessories subject to minimum purchase quantities.

Accessories

Hardware

Thermocouple Insulators and Accessories

Mullite Insulators

Continued

Round—Four Hole

Part No.	AWG	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 1000°C (1830°F)
- Maximum intermittent temperature 13000°C (2370°F)

Oval—Double Hole

Part No.	AWG	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

Part No.	AWG	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

Part No.	AWG	Dimensions inches*			No. Per lbs
		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

Note: All accessories subject to minimum purchase quantities.

Accessories

Hardware

Thermocouple Insulators and Accessories

Continued

Cordierite Insulators

- Excellent thermal shock resistance
- Fair physical strength and electrical properties
- Maximum continuous temperature 1250°C (2280°F)
- Maximum intermittent temperature 1300°C (2370°F)

Alumina Insulators

- Excellent high temperature insulation
- Good electrical and mechanical properties
- Maximum continuous temperature 1650°C (3000°F)
- Maximum intermittent temperature 1815°C (3300°F)

Round—Single Hole

Part No.	AWG	Dimensions inches*		
		Diameter	Bore	Length
316	8	0.250	0.156	3

Round—Double Hole

Part No.	AWG	Dimensions inches*		
		Diameter	Bore	Length
321	6	0.505	0.188	1
327	8	0.375	0.140	3
384		0.490	0.156	1
323	14	0.281	0.080	1
326		0.250	0.080	2 ½
328	16	0.187	0.062	1

Oval—Double Hole

Part No.	AWG	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		0.531	0.281	0.170	1
302		0.531	0.281	0.170	¾
303		8	0.437	0.250	0.156
311	0.437		0.250	0.156	¾
304	11	0.375	0.217	0.110	1
305		0.375	0.217	0.110	5
309	12	0.313	0.187	0.090	3

*Nominal

Round—Double Hole

Part No.	AWG	Dimensions inches*		
		Diameter	Bore	Length
391-24	22	0.125	0.031	24

*Nominal

Note: All accessories subject to minimum purchase quantities.

Accessories

Connector Systems

Many varieties of thermocouple connectors 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
- Miniature thermocouple connectors

Watlow's standard line of connector systems are lightweight, rugged and accurate and features a clamping mechanism that is unique in the industry.

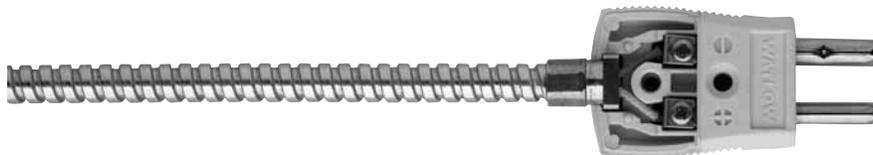
The new, easy-to-use clamping connection will replace the traditional screw and wire wrap. This new device allows a straight-in application, which squeezes the wire and forms a tight connection assuring a clean, strong signal.

US Patent Number D424016, additional patent pending.

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.

Note: All accessories subject to minimum purchase quantities.



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.

Features and Benefits

ASTM color coded

- Assures easy identification

Compensated alloys

- Provides accuracy in readings

Glass-filled thermoplastic

- Provides high impact strength

Captive cap screws

- Secure connection

Connection hardware

- Redesigned to eliminate a number of components

Meets requirements for ASTM E1129

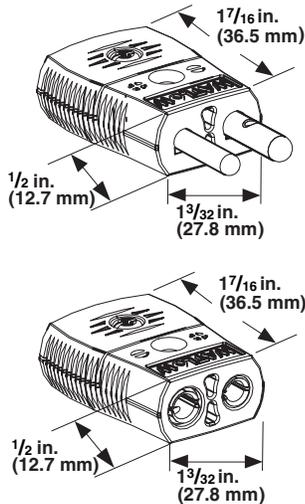
- Ensures adequate pin spacing, dimensions and contact resistance

Rated to 215°C (425°F)

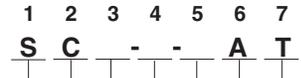
Accessories

Connector Systems

“S” SERIES Standard Connectors, 425°F



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



1-2. “S” SERIES Standard Connector, 215°C (425°F)

3. Style

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

4. Calibration

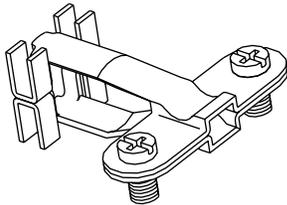
- E = Type E
- J = Type J
- K = Type K
- S = Type S/Type R
- T = Type T
- U = Uncompensated

5. Name Plate

- W = With Watlow name
- N = Without name label (For J and K calibrations only)

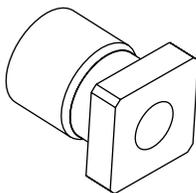
6-7. Color Code

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

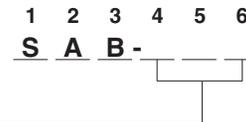


Cable Clamp Style for Male or Female

SAC-220

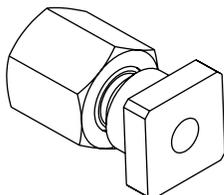


Crimp/Braze Style

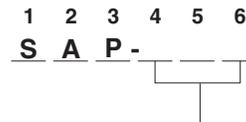


4-6. Sheath size

- 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



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

Note: All accessories subject to minimum purchase quantities.

Accessories

Connector Systems

Quick-Attach Thermocouple Connectors, 425°F

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 Type J, K and T calibrations, ASTM E 230 color-coded. The connector is made of a high impact strength, 215°C (425°F) rated glass filled thermoplastic with matching thermocouple materials throughout. Other features and specifications are identical to standard Watlow "S" SERIES quick-disconnect connectors.

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

1 2 3 4 5 6 7 8 9 10 11
S K - -W A T-A S S Y

1-2. "S" SERIES Standard Connector, 215°C (425°F)

3. Style

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

4. Calibration

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

5. Name Plate

- W = With Watlow name

6-7. Color Code

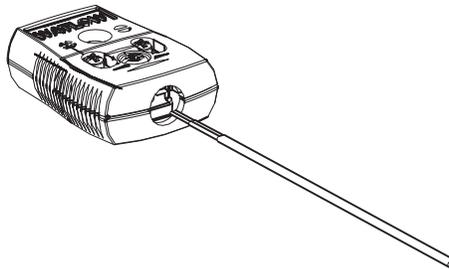
- AT = ASTM E 230 color code

8, 9, 10-11.

- ASSY = Comes with cap assembly on body

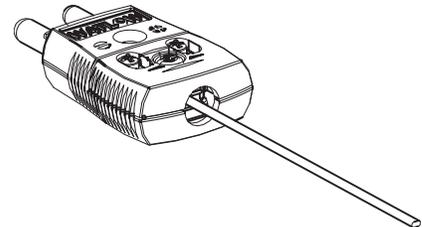
Step 1.

Simply insert stripped wires into connector.



Step 2.

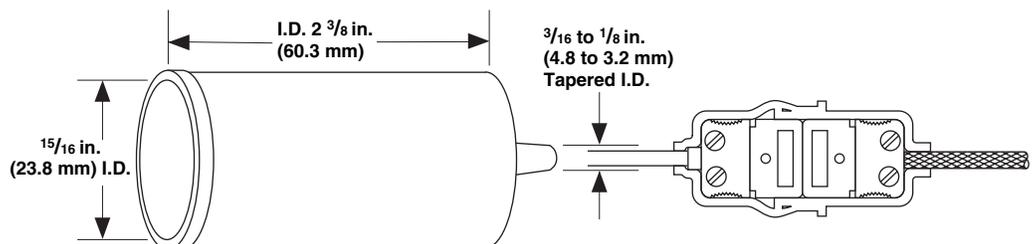
Tighten down two terminal screws, and you are finished.



Weatherproof Boots

Part No. 943

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



Note: All accessories subject to minimum purchase quantities.

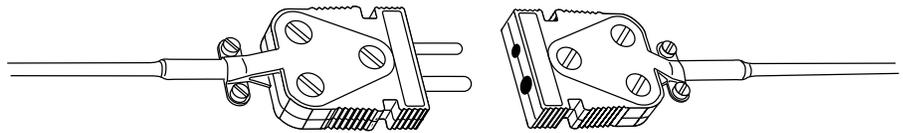
Accessories

Connector Systems

High Temperature Connectors, 1000°F

The ASTM E 230 color-coded bodies of these high temperature ceramic connectors are practical for temperatures up to 540°C (1000°F). 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 7/16 inch pin spacing.

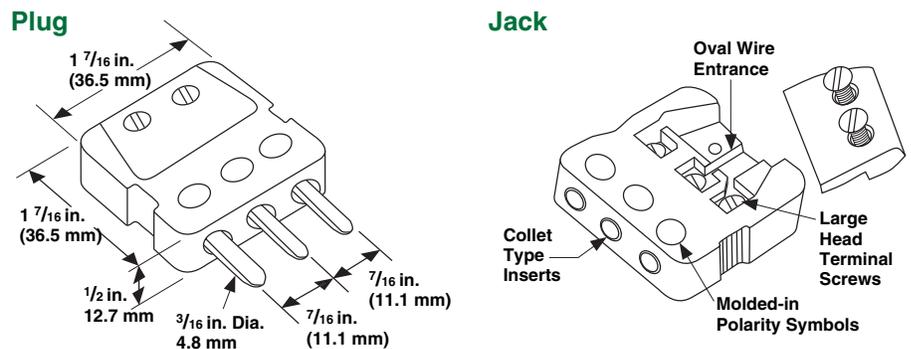


Code Number	Description
912-*	Ceramic plug (specify calibration J, K, R/S or E)
913-*	Ceramic jack (specify calibration J, K, R/S or E)
Part Number	Description
925-125	XACTPAK adapter for plug or jack (0.125 inch sheath O.D.)
925-188	XACTPAK adapter for plug or jack (0.188 inch sheath O.D.)
925-250	XACTPAK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

* Insert calibration letter for full part number 912-J

Three-Pole Connectors for RTD Applications, 400°F

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



Part 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

Note: All accessories subject to minimum purchase quantities.

Accessories

Connector Systems

Miniature Thermocouple Connector System, 400°F

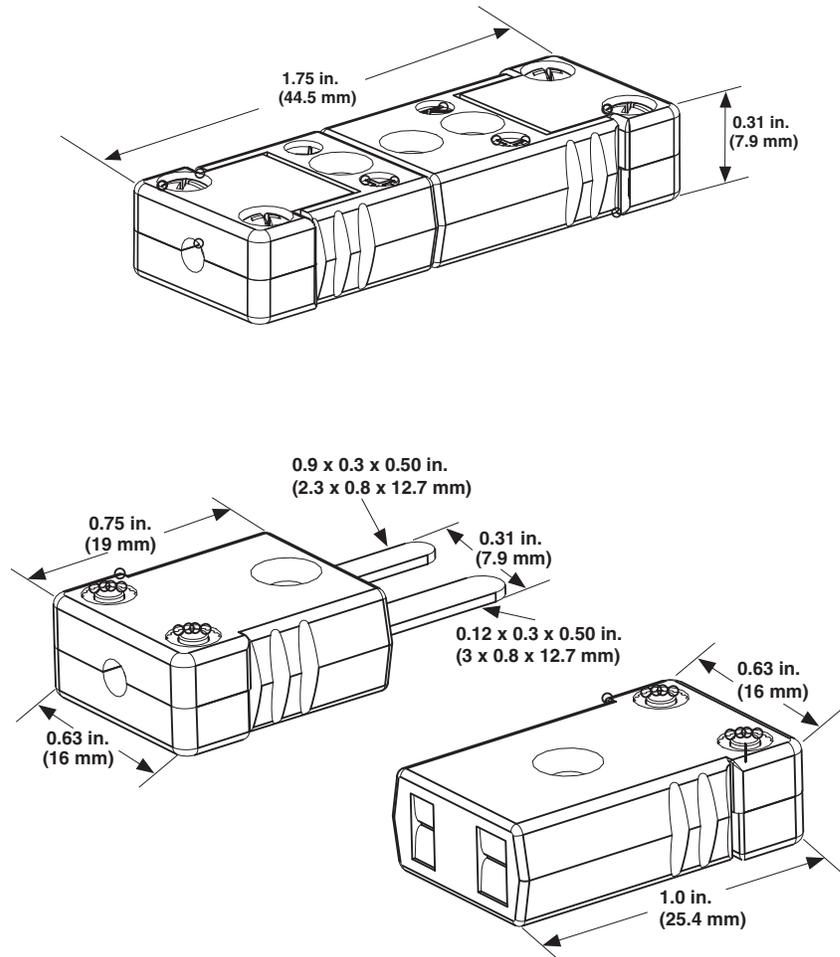
- Miniature design—mates with other miniature size thermocouple connectors
- Molded-in pin contacts assure precise alignment (no loose, wobbly parts)
- Rugged, high quality, high performance connectors
- Employ matching thermocouple alloy materials
- Available in all standard calibrations and copper-copper,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

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, stranded. The connector is made of high impact strength, 200°C (400°F) 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.

Miniature Connectors Compared with Standard Connectors

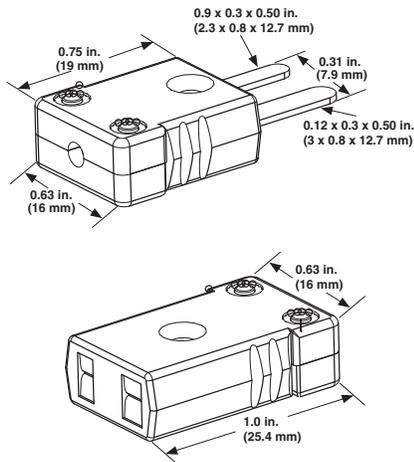


Note: All accessories subject to minimum purchase quantities.

Accessories

Connector Systems

Miniature Thermocouple Connector System, 400°F



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

1 2 3 4 5 6 7
M C - - A T

1-2. "M" SERIES Miniature Connector, 204°C (400°F)

3. Style

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

4. Calibration

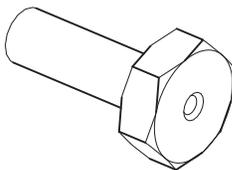
- E = Type E
- J = Type J
- K = Type K
- N = Type N
- R = Type R
- S = Type S
- T = Type T
- U = Uncompensated

5. Name Plate

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

6-7. Color Code

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

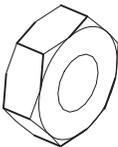


Crimp Style

1 2 3 4 5 6
M B C - - -

4-6. Sheath size

- 040 = 0.040 inches
- 063 = 0.063 inches



Braze Style

1 2 3 4 5 6
M B B - - -

4-6. Sheath size

- 040 = 0.040 inches
- 063 = 0.063 inches
- 125 = 0.125 inches

Note: All accessories subject to minimum purchase quantities.

Accessories

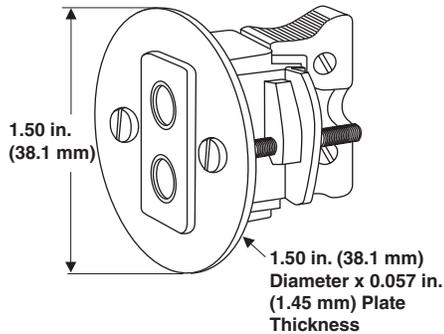
Connector Systems

Panel Mount Hardware

Single Panel Mount Hardware, 425°F

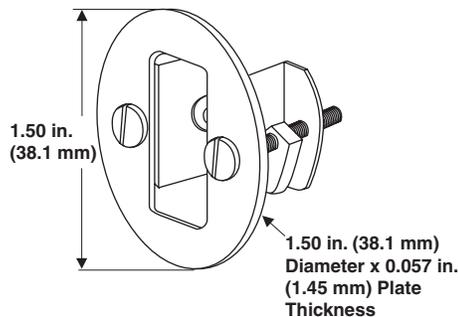
Designed for use with Watlow's "S" standard thermocouple connectors, these units fit panels up to 7/16 inch thick. Panel cutout: 1 1/8 inch to 1 5/32 inch hole. Units fit into standard 3/4 inch knockouts.

SKP Style



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

SNP Style



Panel mount hardware only without Watlow name.*

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

1 2 3 4 5 6 7
S K P - -W A T

1-2-3. "SKP" SERIES Single Panel Mount Standard Connector, 218°C (425°F)

4. Calibration

J = Type J

K = Type K

T = Type T

5. Name Plate

W = With Watlow name

6-7. Color Code

AT = ASTM E 230 color code

Note: All accessories subject to minimum purchase quantities.

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, manufacturing equipment and quality controls assure superior uniformity.

This section presents popular available and custom wire. Watlow 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'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 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 -200 to 1290°C (-328 to 2350°F)
- Tolerances from $\pm 0.5^\circ\text{C}$ or ± 0.4 percent
- NIST calibration certificates



Features and Benefits

Usability

- Flexible Type E, J, K, N and T thermocouple wire can be used for virtually all applications

Compensation extension wire

- Permits fine tuning of temperature measuring circuits

Solid or stranded wire

- Meets specific application requirements

Wide selection of insulation types

- Meet temperature, chemical, moisture and abrasion resistance objectives

Color coding

- Available to comply with United States, United Kingdom, German, Japanese and IEC standards

Metallic overbraids and wraps

- Enhance abrasion resistance

UL® listed PLTC wire and cable

- For applications needing agency compliance

Stock RTD lead wire

- Meets 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



- All stock constructions available in 100, 250, 500 and 1,000 foot spools.

Stock Wire Products By Calibration

Part Number	Limits	Construction/ Description	Max. Rec. Opr. Temp	
			°C	(°F)
B20-5-304	Std.	Brd.Gls./Brd.Gls.	538	(1000*)
E20-1-304	Std.	Brd.Gls./Brd.Gls.	538	(1000)
E20-1-507	Std.	FEP/FEP	260	(500)
E20-5-502	Std.	PVC/PVC	105	(221)
E20-5-510	Std.	PVC/TWS/PVC	105	(221)
J16-5-313	Std.	Brd. Gls./Brd. Gls.	538	(1000*)
J16-5-502	Std.	PVC/PVC	105	(221)
J16-5-509	Std.	FEP/TWS/FEP	260	(500)
J16-5-510	Std.	PVC/TWS/PVC	105	(221)
J16-5-510-UL®	Std.	PVC/TWS/PVC	105	(221)
J16-7-515	Std.	ETFE/TWS/ETFE	199	(390)
J20-1-304	Std.	Brd.Gls./Brd.Gls.	538	(1000)
J20-2-304	Spc.	Brd.Gls./Brd.Gls.	538	(1000)
J20-2-314	Spc.	Brd. HT Gls./TW	871	(1600)
J20-1-321	Std.	Brd. HT Gls./Brd. HT Gls.	871	(1600)
J20-2-321	Spc.	Brd. HT Gls./Brd. HT Gls.	871	(1600)
J20-1-507	Std.	FEP/FEP	260	(500)
J20-2-507	Spc.	FEP/FEP	260	(500)
J20-1-508	Std.	Tp.TFE/Tp. TFE	316	(600)
J20-2-508	Spc.	Tp.TFE/Tp. TFE	316	(600)
J20-1-509	Std.	FEP/TWS/FEP	260	(500)
J20-1-512	Std.	Tp. P-mide/Tp. P-mide	427	(800)
J20-1-S-304	Std.	Brd.Gls./Brd.Gls.	538	(1000)
J20-2-513	Spc.	Tp. P-mide/Tp. P-mide	427	(800)
J20-3-304	Std.	Brd. Gls./Brd. Gls.	538	(1000)
J20-3-507	Std.	FEP/FEP	260	(500)
J20-3-512	Std.	Tp. P-mide/Tp. P-mide	427	(800)
J20-3-S-304	Std.	Brd. Gls./Brd. Gls./SS Brd.	538	(1000)
J20-5-502	Std.	PVC/PVC	105	(221)
J20-5-507	Std.	FEP/FEP	260	(500)
J20-5-509	Std.	FEP/TWS/FEP	260	(500)
J20-5-510	Std.	PVC/TWS/PVC	105	(221)
J20-5-510-UL®	Std.	PVC/TWS/PVC	105	(221)
J20-5-1004	Std.	PVC/TWS pr./PVC Cbl.	105	(221)
J20-5-1008	Std.	PVC/TWS pr./PVC Cbl.	105	(221)
J20-7-502	Std.	PVC/PVC	105	(221)
J20-7-510	Std.	PVC/TWS/PVC	105	(221)
J24-1-304	Std.	Brd.Gls./Brd.Gls.	538	(1000)
J24-2-304	Spc.	Brd.Gls./Brd.Gls.	538	(1000)
J24-1-505	Std.	PVC/Ripcord	105	(221)
J24-2-505	Spc.	PVC/Ripcord	105	(221)
J24-1-507	Std.	FEP/FEP	260	(500)
J24-2-507	Spc.	FEP/FEP	260	(500)
J24-1-508	Std.	Tp.TFE/Tp. TFE	316	(600)
J24-2-508	Spc.	Tp.TFE/Tp. TFE	316	(600)
J24-2-511	Spc.	Tp. P-mide/TW	427	(800)
J24-3-304	Std.	Brd. Gls./Brd. Gls.	538	(1000)
J24-3-507	Std.	FEP/FEP	260	(500)

Part Number	Limits	Construction/ Description	Max. Rec. Opr. Temp	
			°C	(°F)
J24-3-516	Std.	PFA/PFA	288	(550)
J28-1-305	Std.	Wrp. Dbl. Gls./Brd. Gls.	538	(1000)
J28-2-305	Spc.	Wrp. Dbl. Gls./Brd. Gls.	538	(1000)
J30-1-305	Std.	Wrp. Dbl. Gls./Brd. Gls.	538	(1000)
J30-2-305	Spc.	Wrp. Dbl. Gls./Brd. Gls.	538	(1000)
J30-2-308-002	Spc.	Dbl. Wrp. Cot./Brd. Cot.	88	(190)
J30-2-506	Spc.	FEP/FEP	260	(500)
K16-5-155	Std.	Brd. Gls./Brd. Stx.	343	(650*)
K16-5-157	Std.	Tp. TFE, Brd. Gls./Brd.Stx	343	(650*)
K16-5-313	Std.	Brd. Gls./Brd. Gls.	538	(1000*)
K16-5-502	Std.	PVC/PVC	105	(221)
K16-5-509	Std.	FEP/TWS/FEP	260	(500)
K16-5-510	Std.	PVC/TWS/PVC	105	(221)
K16-5-510-UL®	Std.	PVC/TWS/PVC	105	(221)
K16-7-155	Std.	Brd.Gls./Brd. Stx.	343	(650*)
K16-7-515	Std.	ETFE/TWS/ETFE	199	(390)
K18-7-503	Std.	PVC/Cotton/PVC	105	(221)
K20-1-301	Std.	Brd. Sil./Brd. Sil	1093	(2000)
K20-2-301	Spc.	Brd. Sil./Brd. Sil	1093	(2000)
K20-1-304	Std.	Brd.Gls./Brd.Gls.	538	(1000)
K20-2-304	Spc.	Brd.Gls./Brd.Gls.	538	(1000)
K20-2-314	Spc.	Brd. HT Gls./TW	871	(1600)
K20-1-321	Std.	Brd. HT Gls./Brd. HT Gls.	871	(1600)
K20-2-321	Spc.	Brd. HT Gls./Brd. HT Gls.	871	(1600)
K20-1-350	Std.	Brd. C.Fbr./Brd. C.Fbr.	1427	(2600)
K20-2-350	Spc.	Brd. C.Fbr./Brd. C.Fbr.	1427	(2600)
K20-1-355	Std.	Brd. C.Fbr./Brd. C.Fbr.	1427	(2600)
K20-2-355	Spc.	Brd. C.Fbr./Brd. C.Fbr.	1427	(2600)
K20-1-365	Std.	Brd. Sil./Brd. Sil.	1093	(2000)
K20-2-365	Spc.	Brd. Sil./Brd. Sil.	1093	(2000)
K20-1-507	Std.	FEP/FEP	260	(500)
K20-2-507	Spc.	FEP/FEP	260	(500)
K20-1-508	Std.	Tp.TFE/Tp. TFE	316	(600)
K20-2-508	Spc.	Tp.TFE/Tp. TFE	316	(600)
K20-1-509	Std.	FEP/TWS/FEP	260	(500)
K20-2-509	Spc.	FEP/TWS/FEP	260	(500)
K20-1-S-304	Std.	Brd.Gls./Brd.Gls.	538	(1000)
K20-2-513	Spc.	Tp. P-mide/Tp. P-mide	427	(800)
K20-1-517	Std.	PFA/TWS/PFA	288	(550)
K20-3-304	Std.	Brd. Gls./Brd. Gls.	538	(1000)
K20-3-507	Std.	FEP/FEP	260	(500)
K20-3-512	Std.	Tp. P-mide/Tp. P-mide	427	(800)
K20-3-S-304	Std.	Brd. Gls./Brd. Gls./SS Brd.	538	(1000)
K20-5-502	Std.	PVC/PVC	105	(221)
K20-5-507	Std.	FEP/FEP	260	(500)

CONTINUED

* **Note:** Recommended operating temperature limited to the extension grade alloy recommended temperature of 204°C (400°F).

SERV-RITE Wire and Cable



• All stock constructions available in 100, 250, 500 and 1,000 foot spools.

Stock Wire Products By Calibration (con't)

Part Number	Limits	Construction/Description	Max. Rec. Opr. Temp	
			°C	(°F)
K20-5-509	Std.	FEP/TWS/FEP	260	(500)
K20-5-510	Std.	PVC/TWS/PVC	105	(221)
K20-5-510-UL*	Std.	PVC/TWS/PVC	105	(221)
K20-5-1004	Std.	PVC/TWS pr./PVC Cbl.	105	(221)
K20-5-1008	Std.	PVC/TWS pr./PVC Cbl.	105	(221)
K20-7-502	Std.	PVC/PVC	105	(221)
K20-7-510	Std.	PVC/TWS/PVC	105	(221)
K24-1-304	Std.	Brd.Gls./Brd.Gls.	538	(1000)
K24-2-304	Spc.	Brd.Gls./Brd.Gls.	538	(1000)
K24-1-505	Std.	PVC/Ripcord	105	(221)
K24-2-505	Spc.	PVC/Ripcord	105	(221)
K24-1-507	Std.	FEP/FEP	260	(500)
K24-2-507	Spc.	FEP/FEP	260	(500)
K24-1-508	Std.	Tp.TFE/Tp. TFE	316	(600)
K24-2-508	Spc.	Tp.TFE/Tp. TFE	316	(600)
K24-2-306	Spc.	Brd.Gls./Brd.Gls.	538	(1000)
K24-2-513	Spc.	Tp. P-mide/Tp. P-mide	427	(800)
K24-2-516	Spc.	PFA/PFA	288	(550)
K24-3-304	Std.	Brd. Gls./Brd. Gls.	538	(1000)
K24-3-507	Std.	FEP/FEP	260	(500)
K28-2-305	Spc.	Wrp. Dbl. Gls./Brd. Gls.	538	(1000)
K30-1-305	Std.	Wrp. Dbl. Gls./Brd. Gls.	538	(1000)
K30-2-305	Spc.	Wrp. Dbl. Gls./Brd. Gls.	538	(1000)
K30-2-506	Spc.	FEP/FEP	260	(500)
S16-5-157	Std.	Tp. TFE, Brd. Gls./Brd.Stx	343	(650*)
S20-5-304	Std.	Brd.Gls./Brd.Gls.	538	(1000)
S20-5-502	Std.	PVC/PVC	105	(221)
S20-5-507	Std.	FEP/FEP	260	(500)
S20-5-510	Std.	PVC/TWS/PVC	105	(221)
T16-5-510	Std.	PVC/TWS/PVC	105	(221)
T20-1-304	Std.	Brd.Gls./Brd.Gls.	538	(1000)
T20-1-507	Std.	FEP/FEP	260	(500)
T20-2-507	Spc.	FEP/FEP	260	(500)
T20-2-508	Spc.	Tp.TFE/Tp. TFE	316	(600)
T20-1-509	Std.	FEP/TWS/FEP	260	(500)
T20-3-507	Std.	FEP/FEP	260	(500)
T20-5-502	Std.	PVC/PVC	105	(221)
T20-5-510	Std.	PVC/TWS/PVC	105	(221)
T20-5-1004	Std.	PVC/TWS pr./PVC Cbl.	105	(221)
T20-5-1008	Std.	PVC/TWS pr./PVC Cbl.	105	(221)
T20-7-502	Std.	PVC/PVC	105	(221)
T24-1-304	Std.	Brd. Gls./Brd. Gls.	538	(1000)
T24-1-505	Std.	PVC/Ripcord	105	(221)
T24-2-505	Spc.	PVC/Ripcord	105	(221)
T24-2-507	Spc.	FEP/FEP	260	(500)
T24-1-508	Std.	Tp.TFE/Tp. TFE	316	(600)
T24-2-508	Spc.	Tp.TFE/Tp. TFE	316	(600)
T30-2-506	Spc.	FEP/FEP	260	(500)

RTD Lead Wire

Part Number	Construction/Description	Max. Rec. Opr. Temp	
		°C	(°F)
RT3-22-4-701	PVC/TW/PVC	105	(221)
RT3-22-8-704	FEP/TW/FEP	260	(500)
RT3-24-8-705	Brd. Gls./TW/Brd. Gls.	538	(1000)

* **Note:** Recommended operating temperature limited to the extension grade alloy recommended temperature of 204°C (400°F).

Legend:

- Brd. = Braided
- Gls. = Fiberglass
- TWS. = Twisted and shielded
- HT = High temperature
- Tp. = Taped
- P-mide = Polyimide
- Cbl. = Cable
- TW. = Twisted
- Wrp. = Wrapped
- Dbl. = Double
- Cot. = Cotton
- Stx. = SERV TEX synthetic braid
- C.Fbr = Ceramic fiber
- Sil. = Vitreous silica
- pr. = Pair
- Std. = Standard
- Spc = Special

SERV-RITE Wire and Cable



- All stock constructions available in 100, 250, 500 and 1,000 foot spools.

Stock Wire Products By Temperature

Thermocouple Wire Max. Op. Temp.		Insulation	Part Number	Limits of Error	Description	Physical Properties			Page No.
°C	(°F)					Abrasion Resistance	Moisture Resistance	Chemical Resistance	
1427	(2600)	Ceramic	K20-1-350	Standard	Brd. C. Fbr./Brd. C. Fbr. (heavy build)	Good	Fair	Good	191
			K20-1-355	Standard	Brd. C. Fbr./Brd. C. Fbr.	Good	Fair	Good	191
			K20-2-350	Special	Brd.C. Fbr./Brd. C. Fbr. (heavy build)	Good	Fair	Good	191
			K20-2-355	Special	Brd. C. Fbr./Brd. C. Fbr.	Good	Fair	Good	191
1093	(2000)	Vitreous Silica	K20-1-301	Standard	Brd. Sil./Brd.Sil. (heavy build)	Fair	Fair	Good	186
			K20-1-365	Standard	Brd. Sil./Brd.Sil.	Fair	Fair	Good	186
			K20-2-301	Special	Brd. Sil/Brd.Sil. (heavy build)	Fair	Fair	Good	186
			K20-2-365	Special	Brd. Sil./Brd.Sil.	Fair	Fair	Good	186
871	(1600)	High Temp. Fiberglass	J20-1-321	Standard	Brd. HT Gls./Brd. HT Gls.	Good	Good	Good	190
			J20-2-314	Special	Brd. HT Gls./TW	Good	Good	Good	189
			J20-2-321	Special	Brd. HT Gls./Brd. HT Gls.	Good	Good	Good	190
			K20-1-321	Standard	Brd. HT Gls./Brd. HT Gls.	Good	Good	Good	190
			K20-2-314	Special	Brd. HT Gls./TW	Good	Good	Good	189
			K20-2-321	Special	Brd. HT Gls./Brd. HT Gls.	Good	Good	Good	190
538	(1000)	Standard Fiberglass	B20-5-304*	Standard	Brd. Gls./Brd. Gls.	Fair	Good	Good	187
			E20-1-304	Standard	Brd. Gls./Brd. Gls.	Fair	Good	Good	187
			J16-5-313	Standard	Brd. Gls./Brd. Gls.	Good	Good	Good	N/A
			J20-1-304	Standard	Brd. Gls./Brd. Gls.	Fair	Good	Good	187
			J20-1-S-304	Standard	Brd. Gls./Brd. Gls.	Fair	Good	Good	187
			J20-2-304	Special	Brd. Gls./Brd. Gls.	Fair	Good	Good	187
			J20-3-304	Standard	Brd. Gls./Brd. Gls.	Fair	Good	Good	187
			J20-3-S-304	Standard	Brd. Gls./Brd. Gls./SS Brd.	Fair	Good	Good	187
			J24-1-304	Standard	Brd. Gls./Brd. Gls.	Fair	Good	Good	187
			J24-2-304	Special	Brd. Gls./Brd. Gls.	Fair	Good	Good	187
			J24-3-304	Standard	Brd. Gls./Brd. Gls.	Fair	Good	Good	187
			J28-1-305	Standard	Wrp. Dbl. Gls./Brd. Gls.	Fair	Good	Good	188
			J28-2-305	Special	Wrp. Dbl. Gls./Brd. Gls.	Fair	Good	Good	188
			J30-1-305	Standard	Wrp. Dbl. Gls./Brd. Gls.	Fair	Good	Good	188
			J30-2-305	Special	Wrp. Dbl. Gls./Brd. Gls.	Fair	Good	Good	188
			K16-5-313*	Standard	Brd. Gls./Brd. Gls.	Good	Good	Good	N/A
			K20-1-304	Standard	Brd. Gls./Brd. Gls.	Fair	Good	Good	187
			K20-1-S-304	Standard	Brd. Gls./Brd. Gls.	Fair	Good	Good	187
			K20-2-304	Special	Brd. Gls./Brd. Gls.	Fair	Good	Good	187
			K20-3-304	Standard	Brd. Gls./Brd. Gls.	Fair	Good	Good	187
			K20-3-S-304	Standard	Brd. Gls./Brd. Gls./SS Brd.	Fair	Good	Good	187
			K24-1-304	Standard	Brd. Gls./Brd. Gls.	Fair	Good	Good	187
			K24-2-304	Special	Brd. Gls./Brd. Gls.	Fair	Good	Good	187
			K24-2-306	Special	Brd. Gls./Brd. Gls.	Fair	Good	Good	N/A
K24-3-304	Standard	Brd. Gls./Brd. Gls.	Fair	Good	Good	187			

CONTINUED

*Note: Recommended operating temperature limited to the extension grade alloy recommended temperature of 204°C (400°F).

SERV-RITE Wire and Cable



• All stock constructions available in 100, 250, 500 and 1,000 foot spools.

Stock Wire Products By Temperature

Thermocouple Wire Max. Op. Temp.		Insulation	Part Number	Limits of Error	Description	Physical Properties			Page No.
°C	(°F)					Abrasion Resistance	Moisture Resistance	Chemical Resistance	
538	(1000)	Standard Fiberglass	K28-2-305	Special	Wrp. Dbl. Gls./Brd. Gls.	Fair	Good	Good	188
			K30-1-305	Standard	Wrp. Dbl. Gls./Brd. Gls.	Fair	Good	Good	188
			K30-2-305	Special	Wrp. Dbl. Gls./Brd. Gls.	Fair	Good	Good	188
			S20-5-304*	Standard	Brd. Gls./Brd. Gls.	Fair	Good	Good	187
			T20-1-304	Standard	Brd. Gls./Brd. Gls.	Fair	Good	Good	187
			T24-1-304	Standard	Brd. Gls./Brd. Gls.	Fair	Good	Good	187
427	(800)	Polyimide Tape	J20-1-512	Standard	Tp. P-mide/Tp. P-mide	Excellent	Excellent	Excellent	204
			J20-2-513	Special	Dbl. Tp. P-mide/Dbl. Tp. P-mide	Excellent	Excellent	Excellent	205
			J20-3-512	Standard	Tp. P-mide/Tp. P-mide	Excellent	Excellent	Excellent	204
			J24-2-511	Special	Tp. P-mide/TW	Excellent	Excellent	Excellent	203
			K20-2-513	Special	Dbl. Tp. P-mide/Dbl. Tp. P-mide	Excellent	Excellent	Excellent	205
			K20-3-512	Standard	Tp. P-mide/Tp. P-mide	Excellent	Excellent	Excellent	204
343	(650)	SERV TEX	K16-5-155*	Standard	Brd. Gls./Brd. Stx.	Good	Good	Good	184
			K16-5-157*	Standard	Tp. TFE/Brd. Gls./Brd. Stx.	Good	Good	Good	185
			K16-7-155*	Standard	Brd. Gls./Brd. Stx.	Good	Good	Good	184
			S16-5-157*	Standard	Tp. TFE/Brd. Gls./Brd. Stx.	Good	Good	Good	185
316	(600)	TFE Tape	J20-1-508	Standard	Tp. TFE/Tp. TFE	Good	Excellent	Excellent	198
			J20-2-508	Special	Tp. TFE/Tp. TFE	Good	Excellent	Excellent	198
			J24-1-508	Standard	Tp. TFE/Tp. TFE	Good	Excellent	Excellent	198
			J24-2-508	Special	Tp. TFE/Tp. TFE	Good	Excellent	Excellent	198
			K20-1-508	Standard	Tp. TFE/Tp. TFE	Good	Excellent	Excellent	198
			K20-2-508	Special	Tp. TFE/Tp. TFE	Good	Excellent	Excellent	198
			K24-1-508	Standard	Tp. TFE/Tp. TFE	Good	Excellent	Excellent	198
			K24-2-508	Special	Tp. TFE/Tp. TFE	Good	Excellent	Excellent	198
			T20-2-508	Special	Tp. TFE/Tp. TFE	Good	Excellent	Excellent	198
			T24-1-508	Standard	Tp. TFE/Tp. TFE	Good	Excellent	Excellent	198
288	(550)	PFA	J24-3-516	Standard	PFA/PFA	Good	Excellent	Excellent	206
			K20-1-517	Standard	PFA/TWS/PFA	Good	Excellent	Excellent	N/A
			K24-2-516	Special	PFA/PFA	Good	Excellent	Excellent	206
260	(500)	FEP	E20-1-507	Standard	FEP/FEP	Excellent	Excellent	Excellent	196
			J16-5-509	Standard	FEP/TWS/FEP	Excellent	Excellent	Excellent	199
			J20-1-507	Standard	FEP/FEP	Excellent	Excellent	Excellent	196
			J20-1-509	Standard	FEP/TWS/FEP	Excellent	Excellent	Excellent	199
			J20-2-507	Special	FEP/FEP	Excellent	Excellent	Excellent	196
			J20-3-507	Standard	FEP/FEP	Excellent	Excellent	Excellent	196
			J20-5-507	Standard	FEP/FEP	Excellent	Excellent	Excellent	196
			J20-5-509	Standard	FEP/TWS/FEP	Excellent	Excellent	Excellent	199
J24-1-507	Standard	FEP/FEP	Excellent	Excellent	Excellent	196			

CONTINUED

*Note: Recommended operating temperature limited to the extension grade alloy recommended temperature of 204°C (400°F).

SERV-RITE Wire and Cable



• All stock constructions available in 100, 250, 500 and 1,000 foot spools.

Stock Wire Products By Temperature

Thermocouple Wire Max. Op. Temp.		Insulation	Part Number	Limits of Error	Description	Physical Properties			Page No.
°C	(°F)					Abrasion Resistance	Moisture Resistance	Chemical Resistance	
260	(500)	FEP	J24-2-507	Special	FEP/FEP	Excellent	Excellent	Excellent	196
			J24-3-507	Standard	FEP/FEP	Excellent	Excellent	Excellent	196
			J30-2-506	Special	FEP/FEP	Excellent	Excellent	Excellent	195
			K16-5-509	Standard	FEP/TWS/FEP	Excellent	Excellent	Excellent	199
			K20-1-507	Standard	FEP/FEP	Excellent	Excellent	Excellent	196
			K20-1-509	Standard	FEP/TWS/FEP	Excellent	Excellent	Excellent	199
			K20-2-507	Special	FEP/FEP	Excellent	Excellent	Excellent	196
			K20-2-509	Special	FEP/TWS/FEP	Excellent	Excellent	Excellent	199
			K20-3-507	Standard	FEP/FEP	Excellent	Excellent	Excellent	196
			K20-5-507	Standard	FEP/FEP	Excellent	Excellent	Excellent	196
			K20-5-509	Standard	FEP/TWS/FEP	Excellent	Excellent	Excellent	199
			K24-1-507	Standard	FEP/FEP	Excellent	Excellent	Excellent	196
			K24-2-507	Special	FEP/FEP	Excellent	Excellent	Excellent	196
			K24-3-507	Standard	FEP/FEP	Excellent	Excellent	Excellent	196
			K30-2-506	Special	FEP/FEP	Excellent	Excellent	Excellent	195
			S20-5-507	Standard	FEP/FEP	Excellent	Excellent	Excellent	196
			T20-1-507	Standard	FEP/FEP	Excellent	Excellent	Excellent	196
			T20-1-509	Standard	FEP/TWS/FEP	Excellent	Excellent	Excellent	199
			T20-2-507	Special	FEP/FEP	Excellent	Excellent	Excellent	196
			T20-3-507	Standard	FEP/FEP	Excellent	Excellent	Excellent	196
T24-2-507	Special	FEP/FEP	Excellent	Excellent	Excellent	196			
T30-2-506	Special	FEP/FEP	Excellent	Excellent	Excellent	195			
199	(390)	ETFE	J16-7-515	Standard	ETFE/TWS/ETFE	Excellent	Excellent	Excellent	N/A
			K16-7-515	Standard	ETFE/TWS/ETFE	Excellent	Excellent	Excellent	N/A
105	(221)	PVC	E20-5-502	Standard	PVC/PVC	Good	Excellent	Good	192
			E20-5-510	Standard	PVC/TWS/PVC	Good	Excellent	Good	201
			J16-5-502	Standard	PVC/PVC	Good	Excellent	Good	192
			J16-5-510	Standard	PVC/TWS/PVC	Good	Excellent	Good	201
			J16-5-510-UL	Standard	PVC/TWS/PVC	Good	Excellent	Good	202
			J20-5-1004	Standard	PVC/TWS pr./PVC Cbl.	Good	Excellent	Good	209
			J20-5-1008	Standard	PVC/TWS pr./PVC Cbl.	Good	Excellent	Good	209
			J20-5-502	Standard	PVC/PVC	Good	Excellent	Good	192
			J20-5-510	Standard	PVC/TWS/PVC	Good	Excellent	Good	201
			J20-5-510-UL	Standard	PVC/TWS/PVC	Good	Excellent	Good	202
			J20-7-502	Standard	PVC/PVC	Good	Excellent	Good	192
			J20-7-510	Standard	PVC/TWS/PVC	Good	Excellent	Good	201
			J24-1-505	Standard	PVC/Ripcord	Good	Excellent	Good	194
			J24-2-505	Special	PVC/Ripcord	Good	Excellent	Good	194

CONTINUED

*Note: Recommended operating temperature limited to the extension grade alloy recommended temperature of 204°C (400°F).

SERV-RITE
Wire and Cable



• All stock constructions available in 100, 250, 500 and 1,000 foot spools.

Stock Wire Products
By Temperature

Thermocouple Wire Max. Op. Temp.		Insulation	Part Number	Limits of Error	Description	Physical Properties			Page No.
°C	(°F)					Abrasion Resistance	Moisture Resistance	Chemical Resistance	
105	(221)	PVC	K16-5-502	Standard	PVC/PVC	Good	Excellent	Good	192
			K16-5-510	Standard	PVC/TWS/PVC	Good	Excellent	Good	201
			K16-5-510-UL	Standard	PVC/TWS/PVC	Good	Excellent	Good	202
			K20-5-1004	Standard	PVC/TWS pr./PVC Cbl.	Good	Excellent	Good	209
			K20-5-1008	Standard	PVC/TWS pr./PVC Cbl.	Good	Excellent	Good	209
			K20-5-502	Standard	PVC/PVC	Good	Excellent	Good	192
			K20-5-510	Standard	PVC/TWS/PVC	Good	Excellent	Good	201
			K20-5-510-UL	Standard	PVC/TWS/PVC	Good	Excellent	Good	202
			K20-7-502	Standard	PVC/PVC	Good	Excellent	Good	192
			K20-7-510	Standard	PVC/TWS/PVC	Good	Excellent	Good	201
			K24-1-505	Standard	PVC/Ripcord	Good	Excellent	Good	194
			K24-2-505	Special	PVC/Ripcord	Good	Excellent	Good	194
			S20-5-502	Standard	PVC/PVC	Good	Excellent	Good	192
			S20-5-510	Standard	PVC/TWS/PVC	Good	Excellent	Good	201
			T16-5-510	Standard	PVC/TWS/PVC	Good	Excellent	Good	201
			T20-5-1004	Standard	PVC/TWS pr./PVC Cbl.	Good	Excellent	Good	209
			T20-5-1008	Standard	PVC/TWS pr./PVC Cbl.	Good	Excellent	Good	209
			T20-5-502	Standard	PVC/PVC	Good	Excellent	Good	192
T20-5-510	Standard	PVC/TWS/PVC	Good	Excellent	Good	201			
T20-7-502	Standard	PVC/PVC	Good	Excellent	Good	192			
T24-1-505	Standard	PVC/Ripcord	Good	Excellent	Good	194			
T24-2-505	Special	PVC/Ripcord	Good	Excellent	Good	194			
88	(190)	Cotton	J30-2-308-002	Special	Dbl. Wrp. Cot./Brd. Cot.	Fair	Fair	Poor	N/A
RTD Lead Wire									
538	(1000)	Standard Fiberglass	RT3-24-8-705	N/A	Brd. Gls./TW/Brd. Gls.	Fair	Good	Good	210
260	(500)	FEP	RT3-22-8-704	N/A	FEP/TW/FEP	Excellent	Excellent	Excellent	210
105	(221)	PVC	RT3-22-4-701	N/A	PVC/TW/PVC	Good	Excellent	Good	210

*Note: Recommended operating temperature limited to the extension grade alloy recommended temperature of 204°C (400°F).

Legend:

Brd. = Braided
Gls. = Fiberglass
TWS. = Twisted and shielded
HT = High temperature
Tp. = Taped
P-mide = Polyimide

Cbl. = Cable
TW. = Twisted
Wrp. = Wrapped
Dbl. = Double
Cot. = Cotton
Stx. = SERV TEX synthetic braid

C.Fbr = Ceramic fiber
Sil. = Vitreous silica
pr. = Pair
Std. = Standard
Spc. = Special

SERV-RITE® Wire and Cable

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

- AWG 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

- Determine whether this will 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. Limits of error is determined by testing at a pre-defined Watlow standard test point. To guarantee limits of error at other temperature points please contact the factory to arrange special testing.

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 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 follows the industry standard of shipping and invoicing at plus or minus ten 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
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: Many constructions available for same day shipment

Stock constructions with options: Shipment generally in five working days or less

Stock constructions requiring calibration or other laboratory services: Shipment generally in five working days or less

Made-to-order: Consult factory for details

*Not an ASTM E 230 symbol

SERV-RITE Wire and Cable

Thermocouple Wire and Thermocouple Extension Wire

Technical Data

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 204°C (400°F). The temperature rating of the insulations used on some extension grade wire exceeds this 204°C (400°F) temperature. This is to allow the wire to survive occasional contact with hot parts or furnace walls.

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."

SERV-RITE Wire and Cable

Thermocouple Wire and Thermocouple Extension Wire

Technical Data

How to Select Wire to Suit Your Requirements

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 SERIES 301 and 350. Color coding of the SERIES 511 and 512 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 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

Metallic Overbraids and Wraps

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 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.

Stainless Steel Spiral Wrap (W)

Certain constructions are available with a spirally applied 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:

Inconel® is a registered trademark of Special Metals Corporation.

SERV-RITE Wire and Cable

Thermocouple Wire and Thermocouple Extension Wire

Technical Data

How to Select Wire

Code Number

1. ASTM E 230 Calibration^①

B J S
C* K T
E N

2-3. AWG

14 to 36

4. Conductor Type/Tolerance^②

- 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.

^① Color coding will be to ASTM E 230 standards, unless specified.

^② Stranded conductors will be seven strand constructions. Consult factory for other configurations.

1 2 3 4 5 6 7 8 9 10 11

Made-to-order

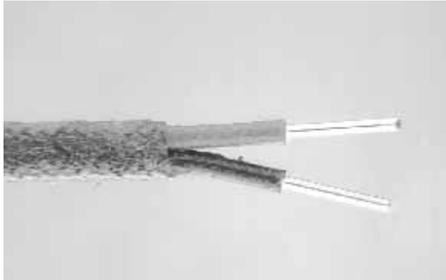
If you are unable to locate the stock SERV-RITE wire product that meets your unique application, Watlow can manufacture the exact wire product that does. With short lead times, Watlow can make-to-order any combination of wire type and insulation with metallic overbraids,

wraps or shielding, in designated standards. Simply review "How to Order," on page 180 of this section, define your requirements and call your Watlow representative to place your order and confirm specifications.

SERV-RITE Wire and Cable

Thermocouple Wire

SERV TEX Insulated Extension Wire SERIES 155



The SERIES 155 is a tough wire especially suited to applications involving momentary contact with molten metals, hot surfaces as found in heat treating, steel, aluminum plants, glass ceramic and brick manufacturing.

The conductors are insulated with braided fiberglass and then impregnated with a resin. Insulated conductors are then laid parallel and a SERV TEX braid is woven over them and a final impregnation is applied.

Continuous Use Temp.	Single Use Temp.
290°C (550°F)	340°C (650°F)
Resin retained to 204°C (400°F)	

Resistance Properties		
Moisture	Chemical	Abrasion
Good	Good	Good

Wire Specifications

AWG	Nominal Conductor Size in. (mm)	Nominal Insulation Thickness		Nominal Overall Size in. (mm)	Approximate Shipping Weight lbs/1000 ft (kg/km)
		Conductor in. (mm)	Overall in. (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)

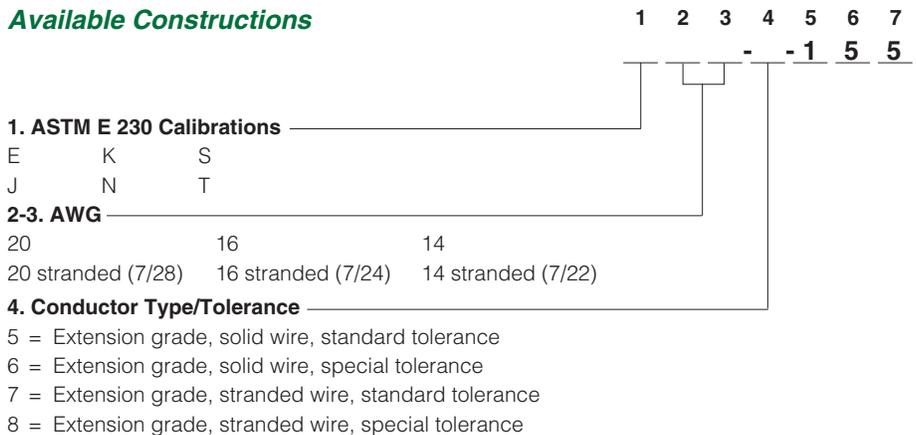
* "S" denotes stranded wire: e.g., "20 S (7/28)" is seven strands of 28 gauge wire to make a 20 gauge stranded conductor.

Popular Constructions

Grade	AWG	Wire Type	Limits of Error	Type K	Type J	Type S
Extension	16	Solid	Standard	K16-5-155	J16-5-155	S16-5-155
		Stranded	Standard	K16-7-155	J16-7-155	S16-7-155

Note: **Bolded** products are stocked and shipped in 100, 250, 500 and 1000 foot spools.

Available Constructions



Note: Minimum order sizes apply for non-stock constructions.

Performance Capabilities

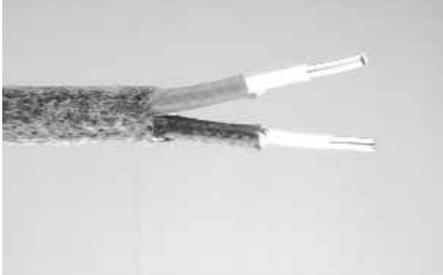
- Continuous temperature rating: 290°C (550°F)
- SERV TEX heavy braided jacket
- Fiberglass braided insulation
- Available with optional metallic overbraid for additional abrasion resistance

Applications

- Heat treating
- Molten metal
- Foundry

SERV-RITE Wire and Cable

Thermocouple Wire SERV TEX and TFE Tape Extension Wire SERIES 157



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 SERV TEX yarn. The final coat is a resin impregnation.

Continuous Use Temp.	Single Use Temp.
290°C (550°F)	340°C (650°F)
Resin retained to 204°C (400°F)	

Resistance Properties		
Moisture	Chemical	Abrasion
Good	Good	Good

Wire Specifications

AWG	Nominal Conductor Size in. (mm)	Nominal Insulation Thickness		Nominal Overall Size in. (mm)	Approximate Shipping Weight lbs/1000 ft (kg/km)
		Conductor in. (mm)	Overall in. (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)	0.190 x 0.266 (4.87 x 6.76)	42 (62.6)
14 S* (7/22)	0.076 (1.930)	0.020 (0.508)	0.030 (0.762)	0.225 x 0.302 (5.72 x 7.67)	48 (71.5)

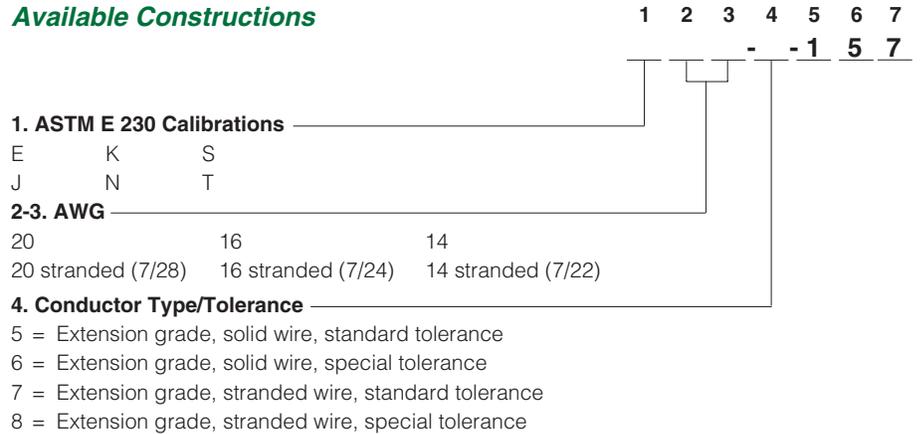
* "S" denotes stranded wire: e.g., "20 S (7/28)" is seven strands of 28 gauge wire to make a 20 gauge stranded conductor.

Popular Constructions

Grade	AWG	Wire Type	Limits of Error	Type K	Type J	Type S
Extension	16	Solid	Standard	K16-5-157	J16-5-157	S16-5-157
		Stranded	Standard	K16-7-157	J16-7-157	S16-7-157

Note: **Bolded** products are stocked and shipped in 100, 250, 500 and 1000 foot spools.

Available Constructions



Note: Minimum order sizes apply for non-stock constructions.

Performance Capabilities

- Continuous temperature rating 290°C (550°F)
- SERV TEX heavy braided jacket
- Fiberglass braided insulation
- TFE taped conductors
- Available with optional metallic overbraid for additional abrasion resistance

Applications

- Heat treating
- Molten metal
- Foundry

SERV-RITE Wire and Cable

Thermocouple Wire High Temperature Vitreous Silica Braided Thermocouple Wire SERIES 301 and 365



Both the SERIES 301 and 365 use 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. The 365 construction is a cost-effective, medium insulation build of the popular heavy duty 301 construction.

For higher temperatures consider SERIES 350 (see page 191).

Continuous Use Temp.	Single Use Temp.
980°C (1800°F)	1093°C (2000°F)

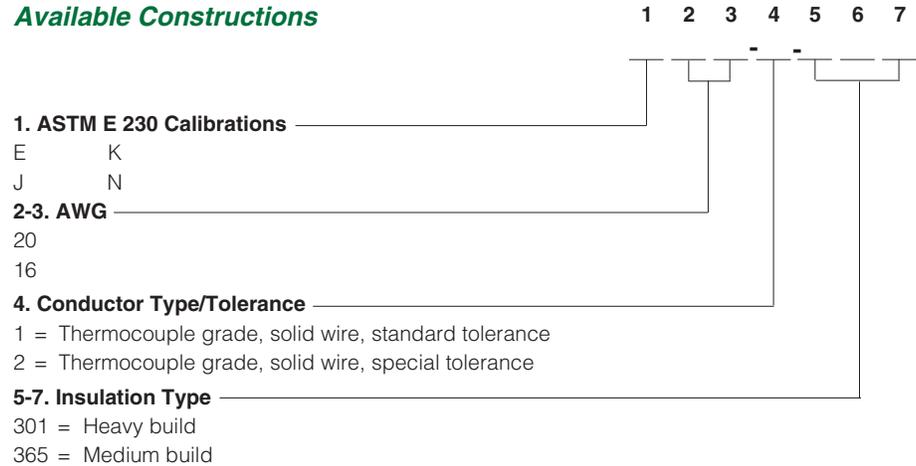
Resistance Properties		
Moisture	Chemical	Abrasion
Fair	Good	Fair

Popular Constructions

Grade	AWG	Wire Type	Insulation	Limits of Error	Type K
Thermocouple	20	Solid	Heavy	Standard	K20-1-301
				Special	K20-2-301
			Medium	Standard	K20-1-365
				Special	K20-2-365

Note: **Bolded** products are stocked and shipped in 100, 250, 500 and 1000 foot spools.

Available Constructions



Note: Minimum order sizes apply for non-stock constructions.

Performance Capabilities

- Continuous temperature rating 982°C (1800°F)
- Vitreous silica braided yarn insulation
- Available with optional metallic overbraid for additional abrasion resistance

Applications

- Heat treating
- Oven and furnace
- Survey and load

Wire Specifications - SERIES 301 and SERIES 365

AWG	Nominal Conductor Size in. (mm)	Nominal Insulation Thickness		Nominal Overall Size in. (mm)	Approximate Shipping Weight lbs/1000 ft (kg/km)
		Conductor in. (mm)	Overall in. (mm)		
20 ^①	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 ^①	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 ^①	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)
20 ^②	0.032 (0.813)	0.015 (0.381)	0.012 (0.305)	0.090 x 0.140 (2.29 x 3.56)	13 (19.4)

^①SERIES 301

^②SERIES 365

* Lack of binders or impregnations may cause insulation to "flower" when stripped.

SERV-RITE Wire and Cable

Thermocouple Wire Fiberglass Braided Thermocouple and Extension Wire SERIES 304



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 higher temperatures, consider SERIES 321 (see page 190).

Continuous Use Temp.	Single Use Temp.
480°C (900°F)	540°C (1000°F)
Resin retained to 204°C (400°F)	

Resistance Properties		
Moisture	Chemical	Abrasion
Good	Good	Fair

Wire Specifications

AWG	Nominal Conductor Size in. (mm)	Nominal Insulation Thickness		Nominal Overall Size in. (mm)	Approximate Shipping Weight lbs/1000 ft (kg/km)
		Conductor in. (mm)	Overall in. (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 (1.508)	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 (1.610)	0.005 (0.127)	0.006 (0.152)	0.048 x 0.080 (1.22 x 2.03)	8 (11.9)
20	0.032 (1.813)	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 (1.965)	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., "20 S (7/28)" is seven strands of 28 gauge wire to make a 20 gauge stranded conductor.

Popular Constructions

Grade	AWG	Wire Type	Limits of Error	Type K	Type J	Type T
Thermocouple	20	Solid	Standard	K20-1-304*	J20-1-304*	T20-1-304
			Special	K20-2-304	J20-2-304	T20-2-304
	Stranded	Standard	K20-3-304*	J20-3-304*	T20-3-304	
		Special	K24-1-304	J24-1-304	T24-1-304	
	24	Solid	Standard	K24-2-304	J24-2-304	T24-2-304
			Special	K24-3-304	J24-3-304	

Grade	AWG	Wire Type	Limits of Error	Type E	Type B
Thermocouple	20	Solid	Standard	E20-1-304	
			Special	E20-2-304	
Extension	20	Stranded	Standard	E20-3-304	
			24	Solid	Standard

Note: Bolded products are stocked and shipped in 100, 250, 500 and 1000 foot spools.

*These constructions stocked with a stainless steel overbraid (order overbraid by adding "-S" in front of construction type (i.e. K20-1-S-304).

Available Constructions

1. ASTM E 230 Calibrations

B	E	K	S
C	J	N	T

2-3. AWG

30	24	20
28	24 stranded (7/32)	20 stranded (7/28)

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

Note: Minimum order sizes apply for non-stock constructions.

Performance Capabilities

- Continuous temperature rating 482°C (900°F)
- Fiberglass braided yarn insulation
- Available with optional metallic

overbraid for additional abrasion resistance

Applications

- Heat treating
- Oven
- General use

SERV-RITE Wire and Cable

Thermocouple Wire

Fiberglass Wrapped Thermocouple and Extension Wire SERIES 305



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 (see page 190).

Continuous Use Temp.	Single Use Temp.
480°C (900°F)	540°C (1000°F)
Resin retained to 204°C (400°F)	

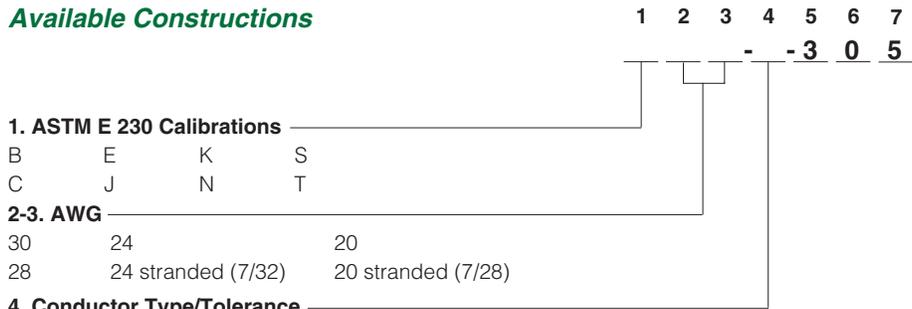
Resistance Properties		
Moisture	Chemical	Abrasion
Good	Good	Fair

Popular Constructions

Grade	AWG	Wire Type	Limits of Error	Type K	Type J
Thermocouple	24	Solid	Standard	K24-1-305	J24-1-305
			Special	K24-2-305	J24-2-305
	28	Solid	Standard	K28-1-305	J28-1-305
			Special	K28-2-305	J28-2-305
	30	Solid	Standard	K30-1-305	J30-1-305
			Special	K30-2-305	J30-2-305

Note: Bolded products are stocked and shipped in 100, 250, 500 and 1000 foot spools.

Available Constructions



- 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

Note: Minimum order sizes apply for non-stock constructions.

Performance Capabilities

- Continuous temperature rating 482°C (900°F)
- Fiberglass braided yarn insulation
- Yarn wrapped conductors for superior coverage on small gauge wires
- Available with optional metallic overbraid for additional abrasion resistance

Applications

- Heat treating
- Oven
- General use

Wire Specifications

AWG	Nominal Conductor Size in. (mm)	Nominal Insulation Thickness		Nominal Overall Size in. (mm)	Approximate Shipping Weight lbs/1000 ft (kg/km)
		Conductor in. (mm)	Overall in. (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

Thermocouple Wire High Temperature Fiberglass Twisted Thermocouple Wire SERIES 314



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 870°C (1600°F).

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.

Continuous Use Temp.	Single Use Temp.
705°C (1300°F)	870°C (1600°F)
Resin retained to 204°C (400°F)	

Resistance Properties		
Moisture	Chemical	Abrasion
Good	Good	Good

Wire Specifications

AWG	Nominal Conductor Size in. (mm)	Nominal Conductor Insulation Thickness		Nominal Overall Size		Approximate Shipping Weight	
		in.	(mm)	in.	(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	(3.56)	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)

Popular Constructions

Grade	AWG	Wire Type	Limits of Error	Type K	Type J
Thermocouple	20	Solid	Standard	K20-1-314	J20-1-314
			Special	K20-2-314	J20-2-314
	24	Solid	Standard	K24-1-314	J24-1-314
			Special	K24-2-314	J24-2-314

Note: **Bolded** products are stocked and shipped in 100, 250, 500 and 1000 foot spools.

Available Constructions



- 1. ASTM E 230 Calibrations**
E K T
J N
- 2-3. AWG**
24 16
20
- 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

Note: Minimum order sizes apply for non-stock constructions.

Performance Capabilities

- Continuous temperature rating 705°C (1300°F)
- Fiberglass braided yarn insulation
- Twisted design has no jacket
- Available with optional metallic overbraid for additional abrasion resistance

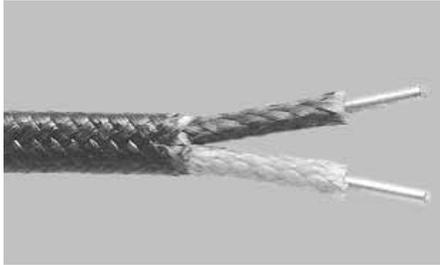
Applications

- Heat treating
- Aluminum stress relieving
- Steel annealing

SERV-RITE® Wire and Cable

SERV-RITE Wire and Cable

Thermocouple Wire High Temperature Braided Fiberglass Thermocouple Wire SERIES 321



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.

Continuous Use Temp.	Single Use Temp.
705°C (1300°F)	870°C (1600°F)
Resin retained to 204°C (400°F)	

Resistance Properties		
Moisture	Chemical	Abrasion
Good	Good	Good

Wire Specifications

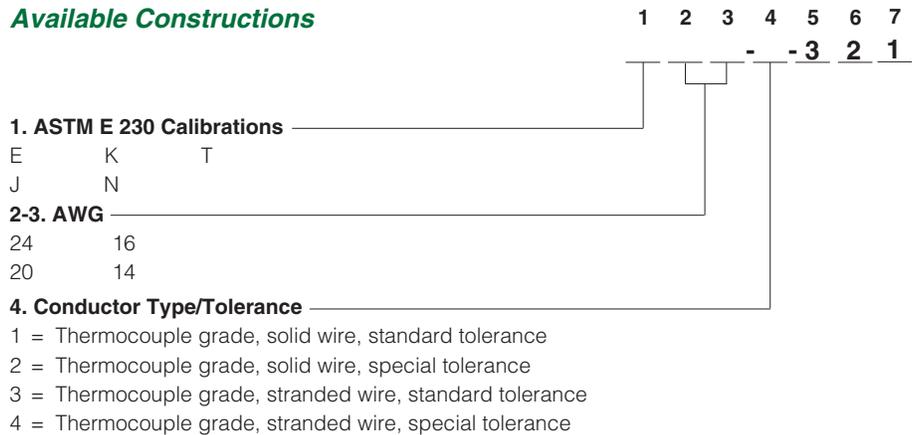
AWG	Nominal Conductor Size in. (mm)		Nominal Insulation Thickness		Nominal Overall Size in. (mm)		Approximate Shipping Weight lbs/1000 ft (kg/km)	
			Conductor in. (mm)	Overall in. (mm)				
24	0.020	(0.508)	0.015 (0.381)	0.010 (0.254)	0.072 x 0.120 (1.83 x 3.05)	10	(14.9)	
20	0.032	(0.965)	0.015 (0.381)	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)	

Popular Constructions

Grade	AWG	Wire Type	Limits of Error	Type K	Type J
Thermocouple	20	Solid	Standard	K20-1-321	J20-1-321
			Special	K20-2-321	J20-2-321
	24	Solid	Standard	K24-1-321	J24-1-321
			Special	K24-2-321	J24-2-321

Note: **Bolded** products are stocked and shipped in 100, 250, 500 and 1000 foot spools.

Available Constructions



Note: Minimum order sizes apply for non-stock constructions.

Performance Capabilities

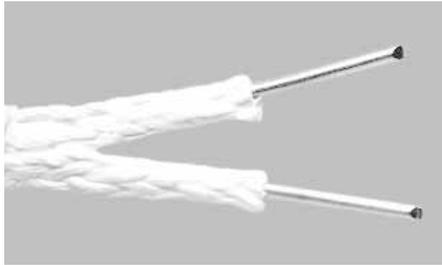
- Continuous temperature rating 705°C (1300°F)
- Heavy fiberglass braided yarn insulation
- Twisted design has no jacket
- Available with optional metallic overbraid for additional abrasion resistance

Applications

- Heat treating
- Aluminum and steel

SERV-RITE Wire and Cable

Thermocouple Wire High Temperature Ceramic Fiber Thermocouple Wire SERIES 350 and 355



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.

Watlow supplies standard SERIES 350 without color coding or impregnations.* This minimizes contaminating the pure ceramic fiber yarn. Laboratory testing indicates the impregnation can decrease the upper use temperature by as much as 540°C (1000°F).

The 355 construction is a cost-effective, medium insulation build of the popular 350 heavy duty construction.

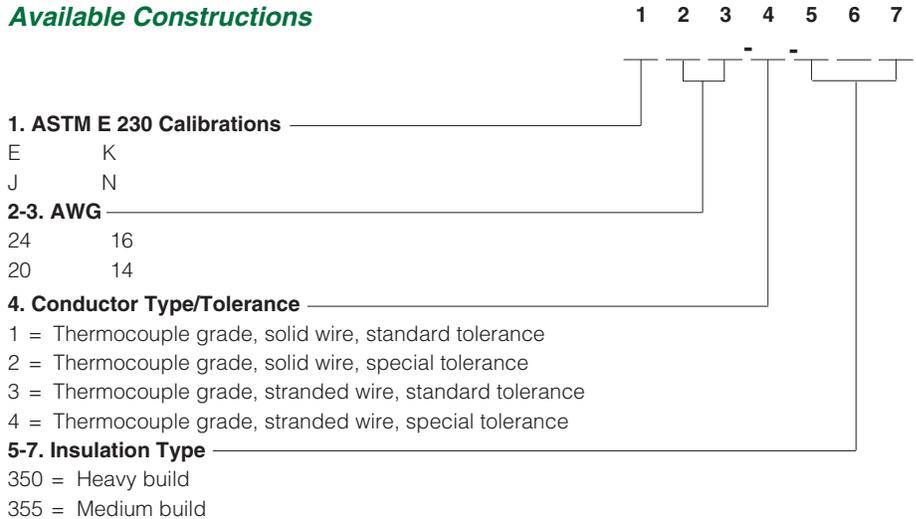
If application temperatures exceed SERIES 350 construction, specify XACTPAK® mineral-insulated, metal-sheathed cable.

Popular Constructions

Grade	AWG	Wire Type	Insulation	Limits of Error	Type K
Thermocouple	20	Solid	Heavy	Standard	K20-1-350
				Special	K20-2-350
			Medium	Standard	K20-1-355
				Special	K20-2-355

Note: **Bolded** products are stocked and shipped in 100, 250, 500 and 1000 foot spools.

Available Constructions



1. ASTM E 230 Calibrations

E K
J N

2-3. AWG

24 16
20 14

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

5-7. Insulation Type

- 350 = Heavy build
- 355 = Medium build

Note: Minimum order sizes apply for non-stock constructions.

Performance Capabilities

- Continuous temperature rating 1205°C (2200°F)
- Ceramic fiber braided yarn insulation
- Available with optional metallic overbraid for additional abrasion resistance

Applications

- Heat treating
- Oven and furnace survey
- Load thermocouple

Continuous Use Temp.	Single Use Temp.
1205°C (2200°F)	1430°C (2600°F)

Resistance Properties		
Moisture	Chemical	Abrasion
Fair	Good	Good

Wire Specifications - SERIES 350 and SERIES 355

AWG	Nominal Conductor Size in. (mm)	Nominal Insulation Thickness		Nominal Overall Size in. (mm)	Approximate Shipping Weight lbs/1000 ft (kg/km)
		Conductor in. (mm)	Overall in. (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)
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)
24 [Ⓜ]	0.020 (0.508)	0.012 (0.305)	0.016 (0.406)	0.078 x 0.116 (1.98 x 2.95)	13 (19.4)
20 [Ⓜ]	0.032 (0.965)	0.012 (0.305)	0.016 (0.406)	0.090 x 0.138 (2.29 x 3.50)	16 (23.8)
16 [Ⓜ]	0.051 (1.29)	0.012 (0.305)	0.016 (0.406)	0.111 x 0.176 (2.82 x 4.47)	32 (47.7)

[Ⓛ]SERIES 350

[Ⓜ]SERIES 355

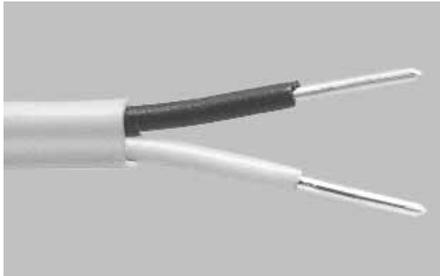
* Because this insulation has no binders or impregnations, it may "flower" when stripped.

SERV-RITE® Wire and Cable

SERV-RITE Wire and Cable

Thermocouple Wire

PVC Insulated Extension Wire SERIES 502



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 105°C (220°F).

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.

The SERIES 502 is also available as a UL® PLTC construction (see page 193).

Continuous Use Temp.	Single Use Temp.
105°C (220°F)	105°C (220°F)

Resistance Properties		
Moisture	Chemical	Abrasion
Excellent	Excellent	Excellent

Wire Specifications

AWG	Nominal Conductor Size in. (mm)	Nominal Insulation Thickness		Nominal Overall Size		Approximate Shipping Weight	
		Conductor in. (mm)	Overall in. (mm)	in. (mm)	(mm)	lbs/1000 ft	(kg/km)
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.

Popular Constructions

Grade	AWG	Wire Type	Limits of Error	Type K	Type J	Type T
Extension	16	Solid	Standard	K16-5-502	J16-5-502	
		Stranded	Standard	K16-7-502	J16-7-502	
	20	Solid	Standard	K20-5-502	J20-5-502	T20-5-502
		Stranded	Standard	K20-7-502	J20-7-502	T20-7-502
	24	Solid	Standard	K24-5-502	J24-5-502	T24-5-502
		Stranded	Standard	K24-7-502	J24-7-502	T24-7-502

Grade	AWG	Wire Type	Limits of Error	Type E	Type S
Extension	20	Solid	Standard	E20-5-502	S20-5-502

Note: Bolded products are stocked and shipped in 100, 250, 500 and 1000 foot spools.

Available Constructions

1. ASTM E 230 Calibrations	2	3	4	5	6	7
B E K S						
C J N T						
2-3. AWG						
24	20	16	14			
24 stranded (7/28)	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						

Note: Minimum order sizes apply for non-stock constructions.

Performance Capabilities

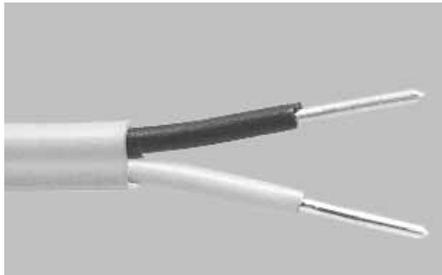
- Continuous temperature rating 105°C (220°F)
- Flexible PVC plastic insulation
- Available with optional metallic overbraid for additional abrasion resistance

Applications

- General use extension wire

SERV-RITE Wire and Cable

Thermocouple Wire PVC Insulated Extension Wire SERIES 502 UL®



UL® SERIES 502 is an economical wire available in UL® listings for Power Limited Tray Cable (PLTC) applications.

The primary and duplex insulation is PVC. It yields a construction that's in-expensive while performing continuously at temperatures to 105°C (220°F).

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.

Continuous Use Temp.	Single Use Temp.
105°C (220°F)	105°C (220°F)

Resistance Properties		
Moisture	Chemical	Abrasion
Excellent	Good	Good

Wire Specifications

AWG	Nominal Conductor Size in. (mm)	Nominal Insulation Thickness		Nominal Overall Size in. (mm)	Approximate Shipping Weight lbs/1000 ft (kg/km)
		Conductor in. (mm)	Overall in. (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.

Popular Constructions

Grade	AWG	Wire Type	Limits of Error	Type K	Type J	Type T
Extension	16	Solid	Standard	K16-5-502-UL®	J16-5-502-UL®	
		Stranded	Standard	K16-7-502-UL®	J16-7-502-UL®	
	20	Solid	Standard	K20-5-502-UL®	J20-5-502-UL®	T20-5-502-UL®
		Stranded	Standard	K20-7-502-UL®	J20-7-502-UL®	T20-7-502-UL®

Available Constructions

1 2 3 4 5 6 7 8 9

— — — — - 5 0 2 - U L

1. ASTM E 230 Calibrations
 E K S
 J N T

2-3. AWG
 20 16
 20 stranded (7/28) 16 stranded (7/28)

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

Note: Minimum order sizes apply for non-stock constructions.

Performance Capabilities

- Continuous temperature rating 105°C (220°F)
- Flexible PVC plastic insulation
- UL® listed 300V PLTC
- 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

- Available with optional metallic overbraid for additional abrasion resistance

Applications

- General Use extension wire

SERV-RITE Wire and Cable

Thermocouple Wire PVC Insulated "RIPCORD" SERIES 505



The SERIES 505 is the most economical wire produced. Unlike some competitive "ripcord" 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 "ripcord" 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.

Continuous Use Temp.	Single Use Temp.
105°C (220°F)	105°C (220°F)

Resistance Properties		
Moisture	Chemical	Abrasion
Excellent	Good	Good

Wire Specifications

AWG	Nominal Conductor Size		Nominal Conductor Insulation Thickness		Nominal Overall Size		Approximate Shipping Weight	
	in.	(mm)	in.	(mm)	in.	(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.

Popular Constructions

Grade	AWG	Wire Type	Limits of Error	Type K	Type J	Type T
Thermocouple	24	Solid	Standard	K24-1-505	J24-1-505	T24-1-505
			Special	K24-2-505	J24-2-505	T24-2-505

Note: **Bolded** products are stocked and shipped in 100, 250, 500 and 1000 foot spools.

Available Constructions

	1	2	3	4	5	6	7
1. ASTM E 230 Calibrations							
B	E	K	S				
C	J	N	T				
2-3. AWG							
26	24		20				
	24 stranded (7/32)		20 stranded (7/28)				
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

Note: Minimum order sizes apply for non-stock constructions.

Performance Capabilities

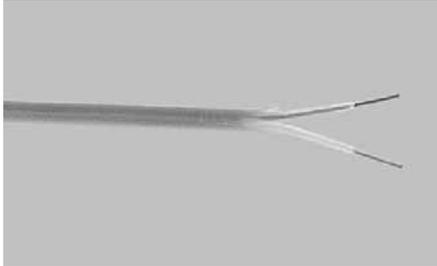
- Continuous temperature rating 105°C (220°F)
- Flexible PVC plastic insulation
- "Ripcord" peelable construction
- Available with optional metallic overbraid for additional abrasion resistance

Applications

- Laboratory
- Test stand
- Automotive

SERV-RITE Wire and Cable

Thermocouple Wire Small Gauge FEP Insulated SERIES 506



The 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 (see page 196).

Continuous Use Temp.	Single Use Temp.
204°C (400°F)	260°C (500°F)

Resistance Properties		
Moisture	Chemical	Abrasion
Excellent	Excellent	Excellent

Wire Specifications

AWG	Nominal Conductor Size in. (mm)	Nominal Insulation Thickness		Nominal Overall Size in. (mm)	Approximate Shipping Weight lbs/1000 ft (kg/km)
		Conductor in. (mm)	Overall in. (mm)		
36	0.005 (0.127)	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)	0.005 (0.127)	0.028 x 0.046 (0.711 x 1.17)	2 (3.0)
30	0.010 (0.254)	0.005 (0.127)	0.005 (0.127)	0.030 x 0.050 (0.762 x 1.27)	3 (4.5)
28	0.013 (0.330)	0.005 (0.127)	0.005 (0.127)	0.033 x 0.056 (0.838 x 1.42)	3 (4.5)

Popular Constructions

Grade	AWG	Wire Type	Limits of Error	Type K	Type J	Type T
Thermocouple	28	Solid	Special	K28-2-506	J28-2-506	T28-2-506
	30	Solid	Special	K30-2-506	J30-2-506	T30-2-506
	36	Solid	Special	K36-2-506	J36-2-506	T36-2-506

Note: Bolded products are stocked and shipped in 100, 250, 500 and 1000 foot spools.

Available Constructions



- 1. ASTM E 230 Calibrations**
E K S
J N T
- 2-3. AWG**
36 30 28
- 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

Note: Minimum order sizes apply for non-stock constructions.

Performance Capabilities

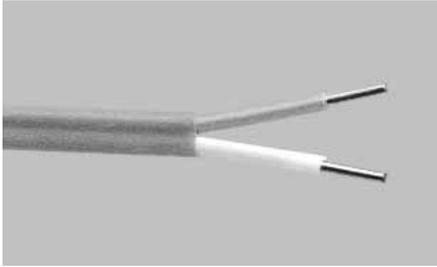
- Continuous temperature rating 204°C (400°F)
- Flexible FEP plastic insulation
- Thin insulation wall for a compact construction
- Available with optional metallic overbraid for additional abrasion resistance

Applications

- Laboratory
- Test stand
- Industrial equipment testing

SERV-RITE Wire and Cable

Thermocouple Wire FEP Insulated Thermocouple and Extension Wire SERIES 507



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 260°C (500°F). 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.

For higher abrasion resistance consider Tefzel® insulated constructions, the SERIES 514.

For higher temperatures specify SERIES 508 (see page 198).

Continuous Use Temp.	Single Use Temp.
204°C (400°F)	260°C (500°F)

Resistance Properties		
Moisture	Chemical	Abrasion
Excellent	Excellent	Excellent

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

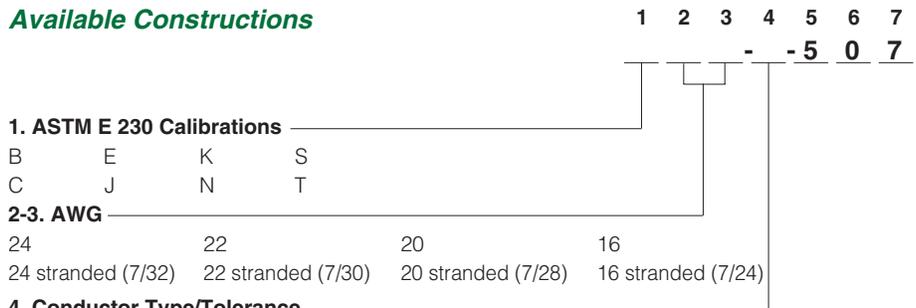
Popular Constructions

Grade	AWG	Wire Type	Limits of Error	Type K	Type J	Type T
Extension	20	Solid	Standard	K20-5-507	J20-5-507	T20-5-507
Thermocouple	20	Solid	Standard	K20-1-507	J20-1-507	T20-1-507
		Stranded	Standard	K20-3-507	J20-3-507	T20-3-507
		Solid	Special	K20-2-507	J20-2-507	T20-2-507
	24	Solid	Standard	K24-1-507	J24-1-507	T24-1-507
		Stranded	Standard	K24-3-507	J24-3-507	T24-3-507
		Solid	Special	K24-2-507	J24-2-507	T24-2-507

Grade	AWG	Wire Type	Limits of Error	Type E	Type S
Extension	20	Solid	Standard	E20-5-507	S20-5-507
Thermocouple	20	Solid	Standard	E20-1-507	
		Stranded	Standard	E20-3-507	
		Solid	Special	E20-2-507	
Extension	24	Solid	Standard		S24-5-507
Thermocouple	24	Solid	Standard	E24-1-507	
		Stranded	Standard	E24-3-507	
		Solid	Special	E24-2-507	

Note: **Bolded** products are stocked and shipped in 100, 250, 500 and 1000 foot spools.

Available Constructions



1. ASTM E 230 Calibrations

B E K S
C J N T

2-3. AWG

24 22 20 16
24 stranded (7/32) 22 stranded (7/30) 20 stranded (7/28) 16 stranded (7/24)

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

Note: Minimum order sizes apply for non-stock constructions.

Performance Capabilities

- Continuous temperature rating 204°C (400°F)
- Flexible FEP plastic insulation
- Available with optional metallic overbraid for additional abrasion resistance

Applications

- General use extension wire

SERV-RITE Wire and Cable

Thermocouple Wire

FEP Insulated Thermocouple and Extension Wire SERIES 507 (con't)

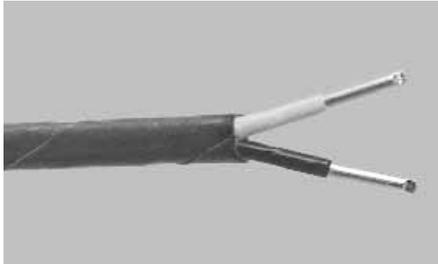
Wire Specifications

AWG	Nominal Conductor Size in. (mm)		Nominal Insulation Thickness		Nominal Overall Size in. (mm)		Approximate Shipping Weight lbs/1000 ft (kg/km)	
			Conductor in. (mm)	Overall in. (mm)				
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.

SERV-RITE Wire and Cable

Thermocouple Wire TFE Insulated SERIES 508



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 260°C (500°F). 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.

Continuous Use Temp.	Single Use Temp.
260°C (500°F)	315°C (600°F)

Resistance Properties		
Moisture	Chemical	Abrasion
Excellent	Excellent	Good

Wire Specifications

AWG	Nominal Conductor Size in. (mm)	Nominal Insulation Thickness		Nominal Overall Size in. (mm)	Approximate Shipping Weight lbs/1000 ft (kg/km)
		Conductor in. (mm)	Overall in. (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.

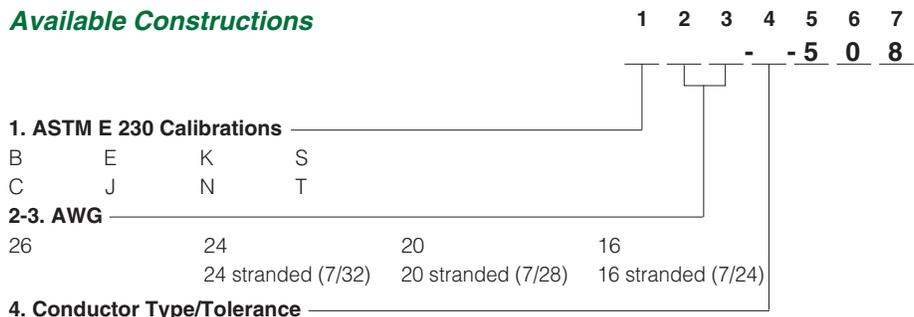
Popular Constructions

Grade	AWG	Wire Type	Limits of Error	Type K	Type J	Type T
Thermocouple	20	Solid	Standard	K20-1-508	J20-1-508	T20-1-508
		Stranded	Standard	K20-3-508	J20-3-508	T20-3-508
		Solid	Special	K20-2-508	J20-2-508	T20-2-508
	24	Solid	Standard	K24-1-508	J24-1-508	T24-1-508
		Stranded	Standard	K24-3-508	J24-3-508	T24-3-508
		Solid	Special	K24-2-508	J24-2-508	T24-2-508

Grade	AWG	Wire Type	Limits of Error	Type E
Thermocouple	20	Solid	Standard	E20-1-508
		Stranded	Standard	E20-3-508
		Solid	Special	E20-2-508
	24	Solid	Standard	E24-1-508
		Stranded	Standard	E24-3-508
		Solid	Special	E24-2-508

Note: Bolded products are stocked and shipped in 100, 250, 500 and 1000 foot spools.

Available Constructions



- 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

Note: Minimum order sizes apply for non-stock constructions.

Performance Capabilities

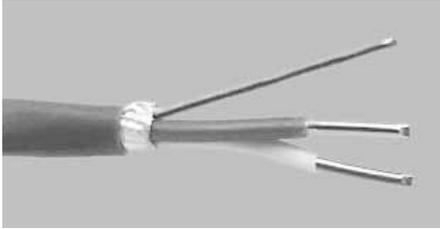
- Continuous temperature rating 260°C (500°F)
- Fused TFE tape insulation
- Available with optional metallic overbraid for additional abrasion resistance

Applications

- Aircraft
- Petroleum processing

SERV-RITE Wire and Cable

Thermocouple Wire FEP Insulated and Shielded Thermocouple and Extension Wire SERIES 509



The SERIES 509 was developed especially for use with microprocessor based systems. SERIES 509 (see page 200) is also available as UL® listed PLTC .

The conductors are insulated with color coded FEP. They are 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 204°C (400°F). Twisted conductors minimize EMI and the taped shield eliminates most problems associated with AC “noise.”

Continuous Use Temp.	Single Use Temp.
204°C (400°F)	260°C (500°F)

Resistance Properties		
Moisture	Chemical	Abrasion
Excellent	Excellent	Excellent

Wire Specifications

AWG	Nominal Conductor Size in. (mm)	Nominal Insulation Thickness		Nominal Overall Size in. (mm)	Approximate Shipping Weight lbs/1000 ft (kg/km)
		Conductor in. (mm)	Overall in. (mm)		
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.

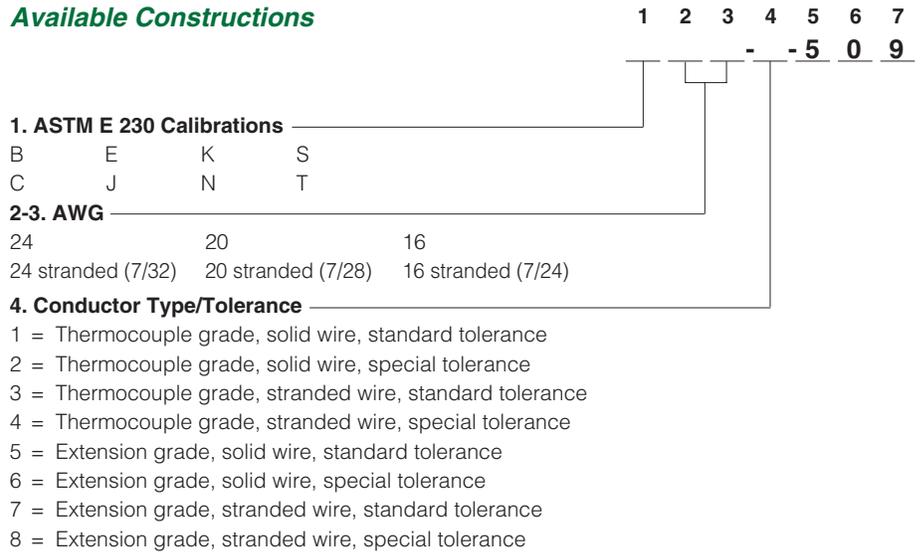
Popular Constructions

Grade	AWG	Wire Type	Limits of Error	Type K	Type J	Type T
Extension	16	Solid	Standard	K16-5-509	J16-5-509	
		Stranded	Standard	K16-7-509	J16-7-509	
	20	Solid	Standard	K20-5-509	J20-5-509	T20-5-509
		Stranded	Standard	K20-7-509	J20-7-509	T20-7-509
Thermocouple	20	Solid	Standard	K20-1-509	J20-1-509	T20-1-509
		Solid	Special	K20-2-509	J20-2-509	T20-2-509
	24	Solid	Standard	K24-1-509	J24-1-509	T24-1-509
		Stranded	Standard	K24-3-509	J24-3-509	T24-3-509

Grade	AWG	Wire Type	Limits of Error	Type E	Type S
Extension	20	Solid	Standard	E20-5-509	S20-5-509

Note: **Bolded** products are stocked and shipped in 100, 250, 500 and 1000 foot spools.

Available Constructions



Note: Minimum order sizes apply for non-stock constructions.

Performance Capabilities

- Continuous temperature rating 204°C (400°F)
- Flexible FEP plastic insulation
- Twisted and shielded construction to reduce electrical noise interference

- Available with optional metallic overbraid for additional abrasion resistance

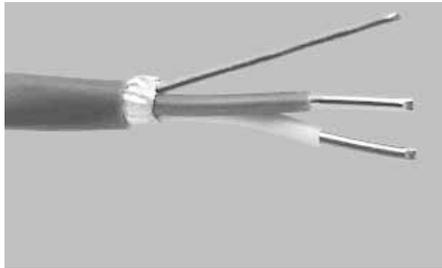
Applications

- General use extension wire

SERV-RITE Wire and Cable

Thermocouple Wire

FEP Insulated with Shield and Drain 300V UL® Listed PLTC Extension Cable SERIES 509 UL®



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 Power Limited Tray Cable (PLTC) applications.

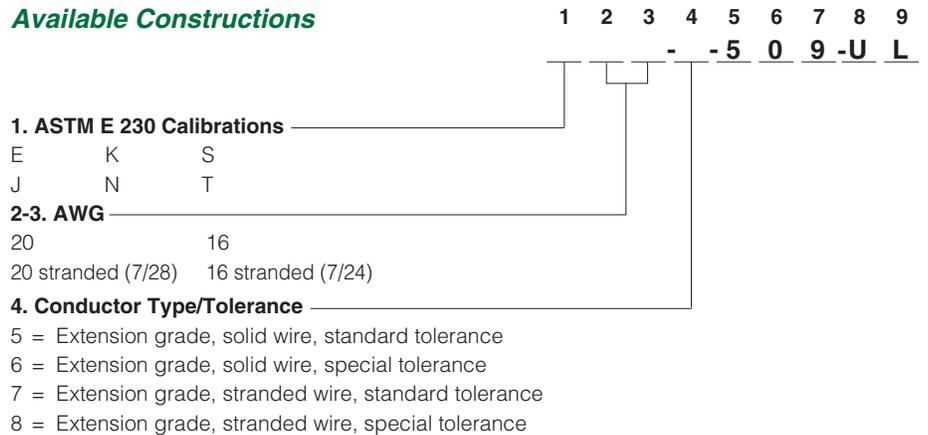
The conductors are first insulated with color coded FEP. The conductors are then twisted with a copper drain wire. An aluminized polyester tape is wrapped around the two conductors and drain wire. Finally, an FEP layer is applied over the taped conductors.

The finished construction can withstand temperatures in excess of 204°C (400°F). The twisted conductors minimize electromagnetic interference and the taped shield eliminates most problems associated with AC “noise” in the sensing circuit.

Popular Constructions

Grade	AWG	Wire Type	Limits of Error	Type K	Type J	Type T
Extension	16	Solid	Standard	K16-5-509-UL®	J16-5-509-UL®	
		Stranded	Standard	K16-7-509-UL®	J16-7-509-UL®	
	20	Solid	Standard	K20-5-509-UL®	J20-5-509-UL®	T20-5-509-UL®
		Stranded	Standard	K20-7-509-UL®	J20-7-509-UL®	T20-7-509-UL®

Available Constructions



1. ASTM E 230 Calibrations

E K S
J N T

2-3. AWG

20 16
20 stranded (7/28) 16 stranded (7/24)

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

Note: Minimum order sizes apply for non-stock constructions.

Performance Capabilities

- UL® listed 300V PLTC
- 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

- Continuous temperature rating 204°C (400°F)
- Flexible FEP plastic insulation
- Twisted and shielded construction to reduce electrical noise interference
- Available with optional metallic overbraid for additional abrasion resistance

Applications

- General use extension wire

Continuous Use Temp.	Single Use Temp.
204°C (400°F)	260°C (500°F)

Resistance Properties		
Moisture	Chemical	Abrasion
Excellent	Excellent	Excellent

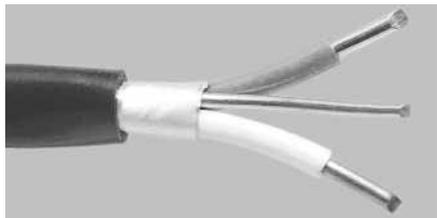
Wire Specifications

AWG	Nominal Conductor Size in. (mm)		Nominal Insulation Thickness		Nominal Overall Size in. (mm)		Approximate Shipping Weight lbs/1000 ft (kg/km)	
			Conductor in. (mm)	Overall in. (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.

SERV-RITE Wire and Cable

Thermocouple Wire PVC Insulated and Shielded Thermocouple and Extension Wire SERIES 510



The SERIES 510 is a PVC insulated, twisted and shielded construction for systems sensitive to induced voltages and “noise.” SERIES 510 (see page 202) 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 percent shielding. Lastly, another layer of PVC is applied.

The twisting eliminates most EMI while the shield tape minimizes AC “noise”.

Continuous Use Temp.	Single Use Temp.
105°C (220°F)	105°C (220°F)

Resistance Properties		
Moisture	Chemical	Abrasion
Excellent	Good	Good

Wire Specifications

AWG	Nominal Conductor Size in. (mm)	Nominal Insulation Thickness		Nominal Overall Size		Approximate Shipping Weight	
		Conductor in. (mm)	Overall in. (mm)	in. (mm)	(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.

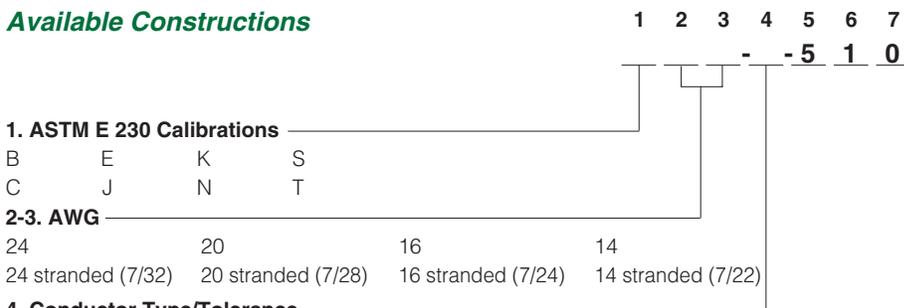
Popular Constructions

Grade	AWG	Wire Type	Limits of Error	Type K	Type J	Type T
Extension	16	Solid	Standard	K16-5-510	J16-5-510	T16-5-510
		Stranded	Standard	K16-7-510	J16-7-510	T16-7-510
	20	Solid	Standard	K20-5-510	J20-5-510	T20-5-510
		Stranded	Standard	K20-7-510	J20-7-510	T20-7-510
	24	Solid	Standard	K24-5-510	J24-5-510	T24-5-510
		Stranded	Standard	K24-7-510	J24-7-510	T24-7-510

Grade	AWG	Wire Type	Limits of Error	Type E	Type S
Extension	20	Solid	Standard	E20-5-510	S20-5-510

Note: Bolded products are stocked and shipped in 100, 250, 500 and 1000 foot spools.

Available Constructions



1. ASTM E 230 Calibrations

B E K S
C J N T

2-3. AWG

24 20 16 14
24 stranded (7/32) 20 stranded (7/28) 16 stranded (7/24) 14 stranded (7/22)

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

Note: Minimum order sizes apply for non-stock constructions.

Performance Capabilities

- Continuous temperature rating 105°C (220°F)
- Flexible PVC plastic insulation
- Twisted and shielded construction to reduce electrical noise interference

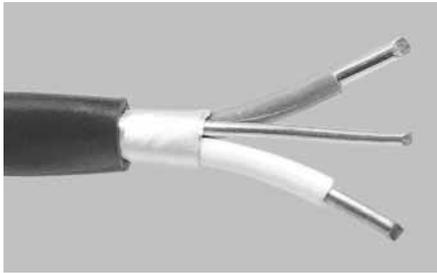
- Available with optional metallic overbraid for additional abrasion resistance

Applications

- General use extension wire

SERV-RITE Wire and Cable

Thermocouple Wire PVC Insulated and Shielded 300 V UL® Listed PLTC Extension Cable SERIES 510 UL®



The SERIES 510 UL® is UL® listed for Power Limited Tray Cable (PLTC) 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.

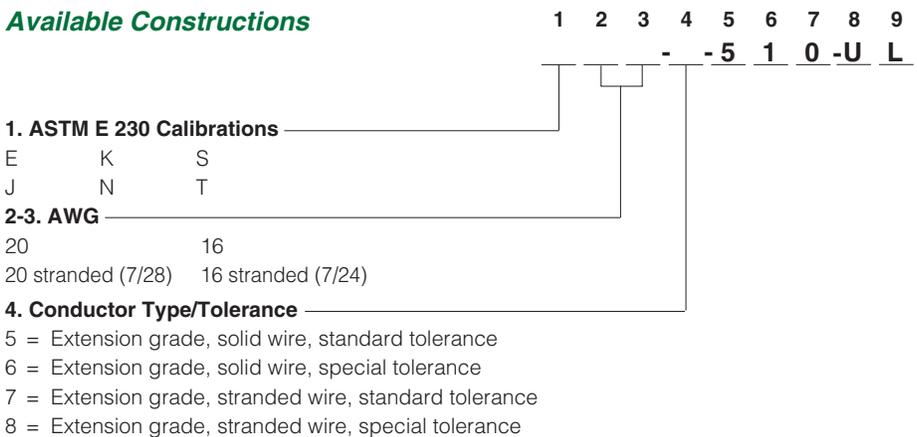
The twisting eliminates most electromagnetic interference while the shield tape minimizes AC "noise" interference.

Popular Constructions

Grade	AWG	Wire Type	Limits of Error	Type K	Type J	Type T
Extension	16	Solid	Standard	K16-5-510-UL®	J16-5-510-UL®	
		Stranded	Standard	K16-7-510-UL®	J16-7-510-UL®	
	20	Solid	Standard	K20-5-510-UL®	J20-5-510-UL®	T20-5-510-UL®
		Stranded	Standard	K20-7-510-UL®	J20-7-510-UL®	T20-7-510-UL®

Note: Bolded products are stocked and shipped in 100, 250, 500 and 1000 foot spools.

Available Constructions



1. ASTM E 230 Calibrations

E	K	S
J	N	T

2-3. AWG

20	16
20 stranded (7/28)	16 stranded (7/24)

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

Note: Minimum order sizes apply for non-stock constructions.

Performance Capabilities

- UL® listed 300V PLTC
- 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
- Continuous temperature rating 105°C (220°F)
- Flexible PVC plastic insulation
- Available with optional metallic overbraid for additional abrasion resistance

Applications

- General use extension wire

Continuous Use Temp.	Single Use Temp.
105°C (220°F)	105°C (220°F)

Resistance Properties		
Moisture	Chemical	Abrasion
Excellent	Good	Good

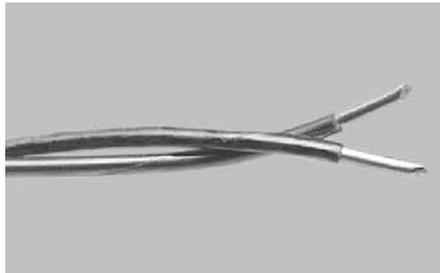
Wire Specifications

AWG	Nominal Conductor Size in. (mm)		Nominal Insulation Thickness		Nominal Overall Size in. (mm)		Approximate Shipping Weight lbs/1000 ft (kg/km)	
			Conductor in. (mm)	Overall in. (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.

SERV-RITE Wire and Cable

Thermocouple Wire Polyimide Insulated and Twisted SERIES 511



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 315°C (600°F). The FEP laminate serves as a moisture barrier and allows the tape to fused with itself. The finished construction will not unravel when cut.

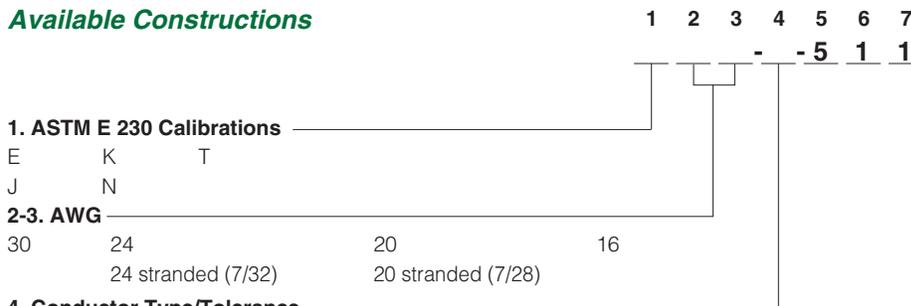
The SERIES 511 conductors are wrapped with the polyimide tape which is fused to itself. Each conductor is color coded with a colored thread under the tape. The final operation is twisting the insulated conductors into a duplex construction, thereby eliminating the overall duplex insulation and minimizing cost.

Popular Constructions

Grade	AWG	Wire Type	Limits of Error	Type K	Type J
Thermocouple	20	Solid	Standard	K20-1-511	J20-1-511
			Special	K20-2-511	J20-2-511
	24	Solid	Standard	K24-1-511	J24-1-511
			Special	K24-2-511	J24-2-511

Note: **Bolded** products are stocked and shipped in 100, 250, 500 and 1000 foot spools.

Available Constructions



1. ASTM E 230 Calibrations

E K T
J N

2-3. AWG

30 24 20 16
24 stranded (7/32) 20 stranded (7/28)

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

Note: Minimum order sizes apply for non-stock construction.

Performance Capabilities

- Continuous temperature rating 315°C (600°F)
- Polyimide fused tape insulation
- Twisted design has no outer jacket
- Colored tracer used to indicate calibration type

- Available with optional metallic overbraid for additional abrasion resistance

Applications

- Aerospace
- Petrochemical
- Plastics

*Continuous Use Temp.	*Single Use Temp.
315°C (600°F)	430°C (800°F)

Resistance Properties		
Moisture	Chemical	Abrasion
Excellent	Excellent	Excellent

Wire Specifications

AWG	Nominal Conductor Size in. (mm)	Nominal Conductor Insulation Thickness		Nominal Overall Size		Approximate Shipping Weight	
		in.	(mm)	in.	(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 260°C (500°F).

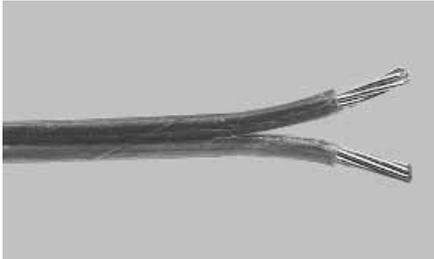
** "S" denotes stranded wire: e.g., "24 S (7/32)" is seven strands of 32 gauge wire to make a 24 gauge stranded conductor.

SERV-RITE® Wire and Cable

SERV-RITE Wire and Cable

Thermocouple Wire

Polyimide Insulated SERIES 512



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 (see page 205) when consulting the factory.

*Continuous Use Temp.	*Single Use Temp.
315°C (600°F)	430°C (800°F)

Resistance Properties		
Moisture	Chemical	Abrasion
Excellent	Excellent	Excellent

Wire Specifications

AWG	Nominal Conductor Size in. (mm)		Nominal Insulation Thickness		Nominal Overall Size in. (mm)		Approximate Shipping Weight lbs/1000 ft (kg/km)	
			Conductor in. (mm)	Overall in. (mm)				
30	0.010	(0.254)	0.004	(0.102)	0.005	(0.127)	3	(4.5)
24	0.020	(0.508)	0.005	(0.127)	0.005	(0.127)	5	(7.5)
24 S** (7/32)	0.024	(0.610)	0.005	(0.127)	0.005	(0.127)	6	(8.9)
20	0.032	(0.813)	0.005	(0.127)	0.005	(0.127)	8	(11.9)
20 S** (7/28)	0.038	(0.965)	0.005	(0.127)	0.005	(0.127)	9	(13.4)
16	0.051	(1.29)	0.005	(0.127)	0.005	(0.127)	19	(28.3)
16 S** (7/24)	0.060	(1.52)	0.005	(0.127)	0.005	(0.127)	21	(31.3)

*FEP laminate melts at approximately 260°C (500°F).

** “S” denotes stranded wire: e.g., “24 S (7/32)” is seven “S” strands of 32 gauge wire to make a 24 gauge stranded conductor.

Popular Constructions

Grade	AWG	Wire Type	Limits of Error	Type K	Type J
Thermocouple	20	Solid	Standard	K20-1-512	J20-1-512
			Special	K20-2-512	J20-2-512
	24	Solid	Standard	K20-3-512	J20-3-512
			Special	K24-1-512	J24-1-512
	24	Solid	Standard	K24-1-512	J24-1-512
			Special	K24-2-512	J24-2-512

Note: **Bolded** products are stocked and shipped in 100, 250, 500 and 1000 foot spools.

Available Constructions

1	2	3	4	5	6	7
1. ASTM E 230 Calibrations						
E	K	T				
J	N					
2-3. AWG						
30	24	20	16			
	24 stranded (7/32)	20 stranded (7/28)	16 stranded (7/24)			
4. Conductor Type/Tolerance						
1	2	3	4	5	6	7
				-5	1	2

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

Note: Minimum order sizes apply for non-stock constructions.

Performance Capabilities

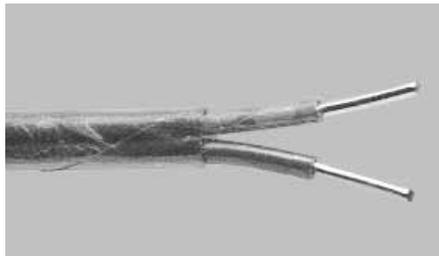
- Continuous temperature rating 315°C (600°F)
- Polyimide fused tape insulation
- Colored tracer used to indicate calibration type
- Available with optional metallic overbraid for additional abrasion resistance

Applications

- Aerospace
- Petrochemical
- Plastics

SERV-RITE Wire and Cable

Thermocouple Wire Double Polyimide Insulated SERIES 513



The SERIES 513 is the ultimate polyimide insulated wire. The 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. When applications require higher heat resistance, it is necessary to specify fiberglass insulation.

Popular Constructions

Grade	AWG	Wire Type	Limits of Error	Type K	Type J
Thermocouple	20	Solid	Standard	K20-1-513	J20-1-513
			Special	K20-2-513	J20-2-513
	Stranded	Standard	K20-3-513	J20-3-513	
		Special	K20-4-513	J20-4-513	
	24	Solid	Standard	K24-1-513	J24-1-513
			Special	K24-2-513	J24-2-513
30	Solid	Special	K30-2-513	J24-2-513	

Note: Bolded products are stocked and shipped in 100, 250, 500 and 1000 foot spools.

Available Constructions

1. ASTM E 230 Calibrations

E K T
J N

2-3. AWG

30 24 20
 24 stranded (7/32) 20 stranded (7/28)

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

Note: Minimum order sizes apply for non-stock constructions.

Performance Capabilities

- Continuous temperature rating 315°C (600°F)
- Double polyimide fused tape insulation
- Colored coated conductors used to indicate calibration type

- Available with optional metallic overbraid for additional abrasion resistance

Applications

- Aerospace
- Petrochemical
- Plastics

*Continuous Use Temp.	*Single Use Temp.
315°C (600°F)	430°C (800°F)

Resistance Properties		
Moisture	Chemical	Abrasion
Excellent	Excellent	Excellent

Wire Specifications

AWG	Nominal Conductor Size in. (mm)	Nominal Insulation Thickness		Nominal Overall Size in. (mm)	Approximate Shipping Weight lbs/1000 ft (kg/km)
		Conductor in. (mm)	Overall in. (mm)		
30	0.010 (0.254)	0.006 (0.152)	0.006 (0.152)	0.038 x 0.058 (0.097 x 1.47)	3 (4.5)
24	0.020 (0.508)	0.006 (0.152)	0.006 (0.152)	0.054 x 0.076 (1.37 x 1.93)	5 (7.5)
24 S** (7/32)	0.024 (0.610)	0.006 (0.152)	0.006 (0.152)	0.056 x 0.084 (1.42 x 2.13)	6 (8.9)
20	0.032 (0.813)	0.006 (0.152)	0.006 (0.152)	0.065 x 0.100 (1.65 x 2.54)	10 (14.9)
20 S** (7/28)	0.038 (0.965)	0.006 (0.152)	0.006 (0.152)	0.070 x 0.112 (1.78 x 2.84)	11 (16.4)

*FEP laminate melts at approximately 260°C (500°F).

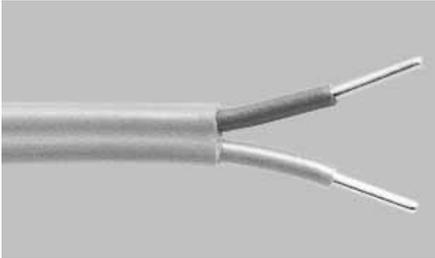
** "S" denotes stranded wire: e.g., "24 S (7/32)" is seven strands of 32 gauge wire to make a 24 gauge stranded conductor.

SERV-RITE® Wire and Cable

SERV-RITE Wire and Cable

Thermocouple Wire

PFA Insulated Thermocouple and Extension Wire SERIES 516



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.

Continuous Use Temp.	Single Use Temp.
260°C (500°F)	105°C (220°F)

Resistance Properties		
Moisture	Chemical	Abrasion
Excellent	Excellent	Good

Popular Constructions

Grade	AWG	Wire Type	Limits of Error	Type K	Type J	Type T
Thermocouple	20	Solid	Standard	K20-1-516	J20-1-516	T20-1-516
		Solid	Special	K20-2-516	J20-2-516	T20-2-516
		Stranded	Standard	K20-3-516	J20-3-516	T20-3-516
	24	Solid	Standard	K24-1-516	J24-1-516	T20-1-516
		Solid	Special	K24-2-516	J24-2-516	T20-2-516
		Stranded	Standard	K24-3-516	J24-3-516	T20-3-516

Grade	AWG	Wire Type	Limits of Error	Type E
Thermocouple	20	Solid	Standard	E20-1-516
		Solid	Special	E20-2-516
		Stranded	Standard	E20-3-516
	24	Solid	Standard	E24-1-516
		Solid	Special	E24-2-516
		Stranded	Standard	E24-3-516

Note: Bolded products are stocked and shipped in 100, 250, 500 and 1000 foot spools.

Available Constructions

1. ASTM E 230 Calibrations

B E K S
C J N T

2-3. AWG

36 24 20 16
30 24 stranded (7/32) 20 stranded (7/28) 16 stranded (7/24)

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

Note: Minimum order sizes apply for non-stock constructions.

Performance Capabilities

- Continuous temperature rating 260°C (500°F)
- Flexible TFE plastic insulation
- Available with optional metallic overbraid for additional abrasion resistance

Applications

- General use extension wire

SERV-RITE Wire and Cable

Thermocouple Wire

PFA Insulated Thermocouple and Extension Wire SERIES 516 (con't)

Wire Specifications

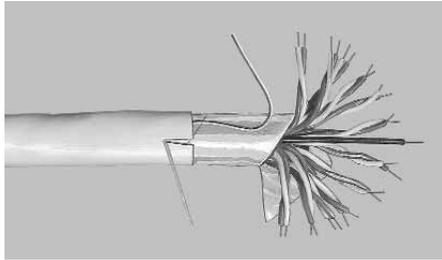
AWG	Nominal Conductor Size in. (mm)	Nominal Insulation Thickness		Nominal Overall Size in. (mm)	Approximate Shipping Weight lbs/1000 ft (kg/km)
		Conductor in. (mm)	Overall in. (mm)		
36	0.005 (0.127)	0.003 (0.076)	0.003 (0.076)	0.017 x 0.028 (0.432 x 0.711)	3.0 (2)
30	0.010 (0.254)	0.003 (0.076)	0.003 (0.076)	0.022 x 0.038 (0.559 x 0.965)	4.5 (3)
24	0.020 (0.508)	0.008 (0.203)	0.010 (0.254)	0.056 x 0.092 (1.42 x 2.34)	11.9 (8)
24 S* (7/32)	0.024 (0.610)	0.008 (0.203)	0.010 (0.254)	0.060 x 0.100 (1.52 x 2.54)	13.4 (9)
20	0.032 (0.813)	0.008 (0.203)	0.010 (0.254)	0.068 x 0.116 (1.73 x 2.95)	17.9 (12)
20 S* (7/28)	0.038 (0.965)	0.008 (0.203)	0.010 (0.254)	0.074 x 0.128 (1.88 x 3.25)	20.9 (14)
16	0.051 (1.29)	0.010 (0.254)	0.012 (0.305)	0.095 x 0.166 (2.41 x 4.22)	40.2 (27)
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)	43.2 (29)

* "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

Multi-Pair Cable

PVC Insulated Multi-Pair 300 V UL® Listed PLTC Extension Cable SERIES 900 UL® and 900



SERIES 900 UL® is our family of multi-pair cables for UL® PLTC applications. Standard SERIES 900 UL® cables of different pair counts in most calibrations can be shipped quickly.

SERIES 900 UL® and 900 cable starts by insulating conductors with 105°C (220°F) 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 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.

Wire Specifications

No. of Pairs	AWG	Nominal Conductor Size in. (mm)	Nominal Insulation Thickness		Nominal Overall Size in. (mm)	Approximate Shipping Weight	
			Conductor in. (mm)	Overall in. (mm)		lbs/1000 ft	(kg/km)
2	20	0.032 (0.813)	0.015 (0.381)	0.050 (1.27)	0.290 (7.37)	72	(107.3)
4	20	0.032 (0.813)	0.015 (0.381)	0.050 (1.27)	0.350 (8.89)	94	(140.1)
6	20	0.032 (0.813)	0.015 (0.381)	0.050 (1.27)	0.405 (10.29)	116	(172.8)
8	20	0.032 (0.813)	0.015 (0.381)	0.050 (1.27)	0.440 (11.18)	140	(208.6)
10	20	0.032 (0.813)	0.015 (0.381)	0.050 (1.27)	0.490 (12.45)	164	(244.4)
12	20	0.032 (0.813)	0.015 (0.381)	0.060 (1.52)	0.535 (13.59)	188	(280.1)
16	20	0.032 (0.813)	0.015 (0.381)	0.060 (1.52)	0.610 (15.49)	240	(357.6)
20	20	0.032 (0.813)	0.015 (0.381)	0.060 (1.52)	0.650 (16.51)	292	(435.1)
24	20	0.032 (0.813)	0.015 (0.381)	0.060 (1.52)	0.710 (18.03)	344	(512.6)

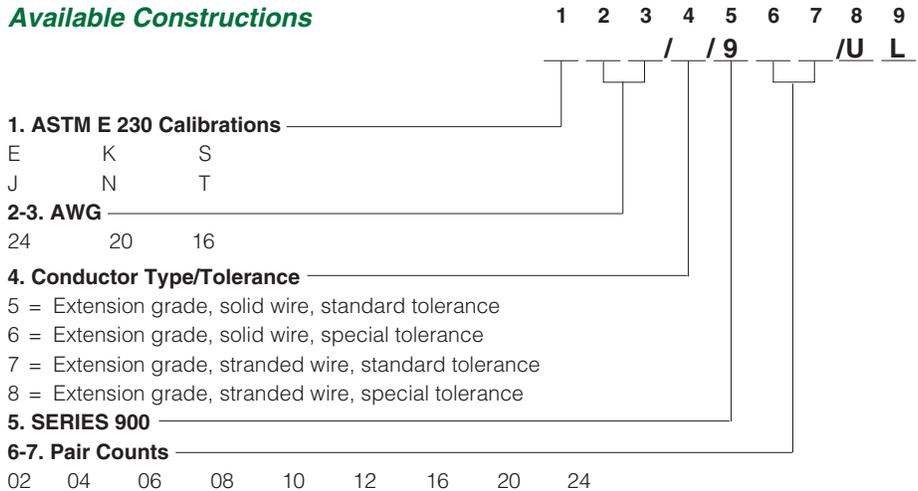
Popular Constructions

Grade	AWG	Wire Type	Limits of Error	Type K	Type J	Type T
Extension (4 pr)	20	Solid	Standard	K20-5-904	J20-5-904	T20-5-904
Extension (8 pr)	20	Solid	Standard	K20-5-908	J20-5-908	T20-5-908
Extension (4 pr)	24	Solid	Standard	K24-5-904	J24-5-904	T24-5-904
Extension (8 pr)	24	Solid	Standard	K24-5-908	J24-5-908	T24-5-908

Popular Constructions UL® Listed

Grade	AWG	Wire Type	Limits of Error	Type K	Type J	Type T
Extension (4 pr)	20	Solid	Standard	K20-5-904-UL®	J20-5-904-UL®	T20-5-904-UL®
Extension (8 pr)	20	Solid	Standard	K20-5-908-UL®	J20-5-908-UL®	T20-5-908-UL®
Extension (4 pr)	24	Solid	Standard	K24-5-904-UL®	J24-5-904-UL®	T24-5-904-UL®
Extension (8 pr)	24	Solid	Standard	K24-5-908-UL®	J24-5-908-UL®	T24-5-908-UL®

Available Constructions



Note: Minimum order sizes apply for non-stock constructions.

Performance Capabilities

- Continuous temperature rating 105°C (220°F)

Continuous Use Temp.	Single Use Temp.
105°C (220°F)	105°C (220°F)

Resistance Properties		
Moisture	Chemical	Abrasion
Excellent	Good	Good

- Flexible PVC plastic insulation
- Multipair cable with overall shield
- Available in UL® listed 300V PLTC design also
- Available with optional metallic overbraid for additional abrasion resistance

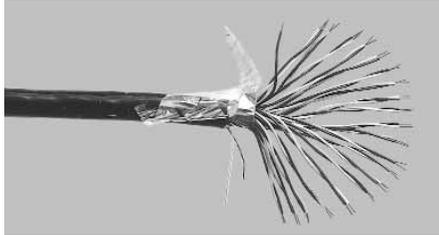
Applications

- General use extension wire

SERV-RITE Wire and Cable

Multi-Pair Cable

**PVC Insulated Multi-Pair
300 V UL® Listed PLTC
Extension Cable with
Individual and Overall Shield
SERIES 1000 UL® and 1000**



SERIES 1000 UL® is our family of individually shielded and isolated multipair cables* for UL® PLTC applications. SERIES 1000 is the non UL® equivalent. SERIES 1000 UL® cables are made by insulating conductors with 105°C (220°F) 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. Individual pairs are then cabled with an additional insulated copper wire for communication use. These cables are ideal for data signals.

Continuous Use Temp.		Single Use Temp.
105°C (220°F)		105°C (220°F)

Resistance Properties		
Moisture	Chemical	Abrasion
Excellent	Good	Good

Wire Specifications

No. of Pairs	AWG	Nominal Conductor Size in. (mm)	Nominal Insulation Thickness		Nominal Overall Size in. (mm)	Approximate Shipping Weight	
			Conductor in. (mm)	Overall in. (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)

Popular Constructions

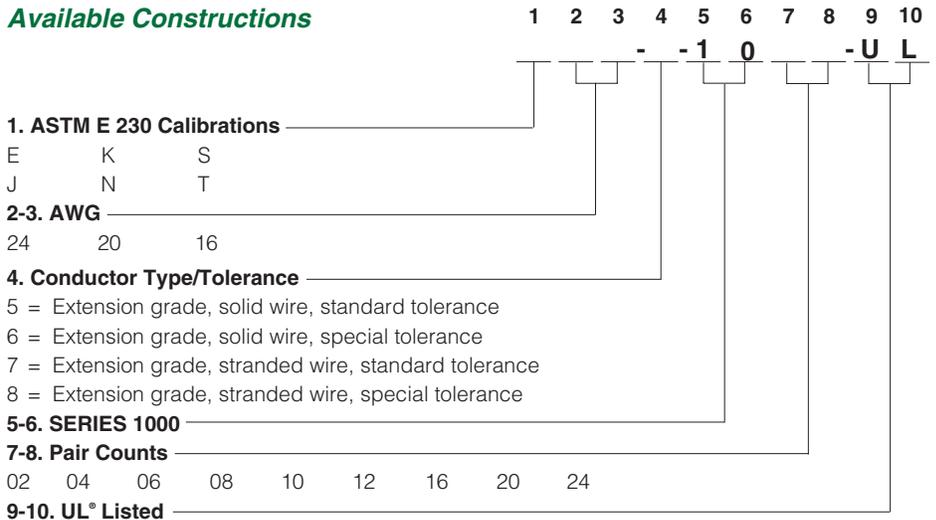
Grade	AWG	Wire Type	Limits of Error	Type K	Type J	Type T
Extension (4 pr)	20	Solid	Standard	K20-5-1004	J20-5-1004	T20-5-1004
Extension (8 pr)	20	Solid	Standard	K20-5-1008	J20-5-1008	T20-5-1008
Extension (4 pr)	24	Solid	Standard	K24-5-1004	J24-5-1004	T24-5-1004
Extension (8 pr)	24	Solid	Standard	K24-5-1008	J24-5-1008	T24-5-1008

Popular Constructions UL® Listed

Grade	AWG	Wire Type	Limits of Error	Type K	Type J	Type T
Extension (4 pr)	20	Solid	Standard	K20-5-1004-UL®	J20-5-1004-UL®	T20-5-1004-UL®
Extension (8 pr)	20	Solid	Standard	K20-5-1008-UL®	J20-5-1008-UL®	T20-5-1008-UL®
Extension (4 pr)	24	Solid	Standard	K24-5-1004-UL®	J24-5-1004-UL®	T24-5-1004-UL®
Extension (8 pr)	24	Solid	Standard	K24-5-1008-UL®	J24-5-1008-UL®	T24-5-1008-UL®

Note: Bolded products are stocked and shipped in 100, 250, 500 and 1000 foot spools.

Available Constructions



Leave blank for no UL®

Note: Minimum order sizes apply for non-stock constructions.

Performance Capabilities

- Continuous temperature rating 105°C (220°F)
- Flexible PVC plastic insulation
- Multipair cable with individual pair and overall shields
- Available in UL® listed 300V PLTC design

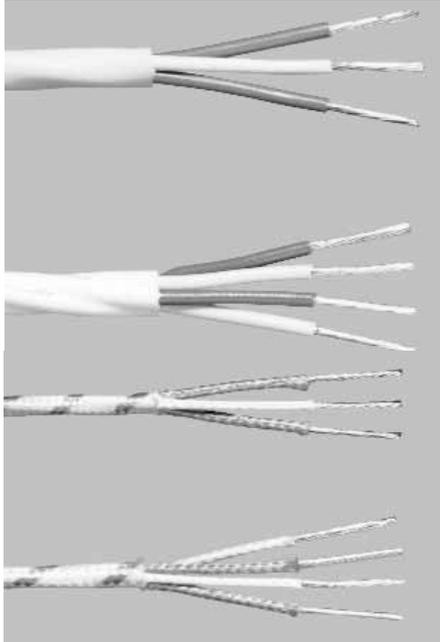
- Available with optional metallic overbraid for additional abrasion resistance

Applications

- General use extension wire

SERV-RITE Wire and Cable

RTD Lead Wire SERIES 701, 704 and 705



Watlow's quality, experience and versatility carry over from insulated thermocouple and extension wire to RTD Lead Wire and fiberglass wire.

PVC

Continuous Use Temp.	Single Use Temp.
105°C (220°F)	105°C (220°F)

Resistance Properties		
Moisture	Chemical	Abrasion
Excellent	Good	Good

FEP

Continuous Use Temp.	Single Use Temp.
204°C (400°F)	260°C (500°F)

Resistance Properties		
Moisture	Chemical	Abrasion
Excellent	Excellent	Excellent

Fiberglass

Continuous Use Temp.	Single Use Temp.
480°C (900°F)	540°C (1000°F)

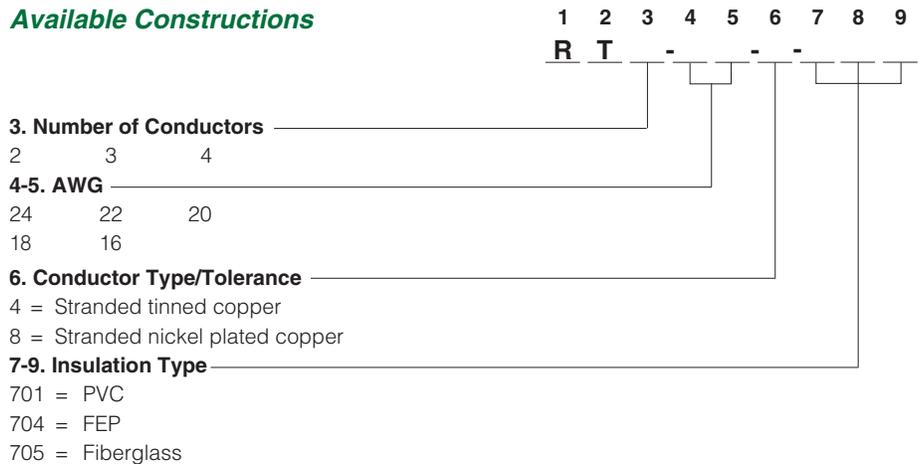
Resistance Properties		
Moisture	Chemical	Abrasion
Good	Good	Fair

Popular Constructions

No. of Conductors	AWG	Wire Type*	Insulation Material		
			PVC (220°F)	FEP (400°F)	Fiberglass (900°F)
2	22	Tinned copper	RT2-22-4-701	RT2-22-4-704	RT2-22-4-705
		Nickel plated copper	RT2-22-8-701	RT2-22-8-704	RT2-22-8-705
	24	Tinned copper	RT2-24-4-701	RT2-24-4-704	RT2-24-4-705
		Nickel plated copper	RT2-24-8-701	RT2-24-8-704	RT2-24-8-705
3	22	Tinned copper	RT3-22-4-701	RT3-22-4-704	RT3-22-4-705
		Nickel plated copper	RT3-22-8-701	RT3-22-8-704	RT3-22-8-705
	24	Tinned copper	RT3-24-4-701	RT3-24-4-704	RT3-24-4-705
		Nickel plated copper	RT3-24-8-701	RT3-24-8-704	RT3-24-8-705
4	22	Tinned copper	RT4-22-4-701	RT4-22-4-704	RT4-22-4-705
		Nickel plated copper	RT4-22-8-701	RT4-22-8-704	RT4-22-8-705
	24	Tinned copper	RT4-24-4-701	RT4-24-4-704	RT4-24-4-705
		Nickel plated copper	RT4-24-8-701	RT4-24-8-704	RT4-24-8-705

Note: Bolded products are stocked and shipped in 100, 250, 500 and 1000 foot spools.

Available Constructions



Note: Minimum order sizes apply for non-stock constructions.

Performance Capabilities

- Continuous temperature rating 105 to 480°C (220 to 900°F) depending upon construction
- Available with optional metallic overbraid for additional abrasion resistance

Applications

- General use RTD sensor wire

SERV-RITE Wire and Cable

RTD Lead Wire

SERIES 701, 704 and 705

Wire Specifications - SERIES 701 - PVC

No. of Conductors	AWG	Nominal Conductor Size		Nominal Insulation Thickness		Nominal Overall Size		Approximate Shipping Weight			
				Conductor	Overall						
		in.	(mm)	in.	(mm)	in.	(mm)	lbs/1000 ft	(kg/km)		
2	22S** (7/30)	0.030	(0.762)	0.015	(0.381)	0.020	(0.508)	0.160	(4.06)	17	(25.3)
	20S** (7/28)	0.038	(0.965)	0.015	(0.381)	0.020	(0.508)	0.176	(4.47)	19	(28.3)
	18S** (7/26)	0.048	(1.22)	0.020	(0.508)	0.025	(0.635)	0.226	(5.74)	22	(32.8)
3	22S** (7/30)	0.030	(0.762)	0.015	(0.381)	0.020	(0.508)	0.172	(4.37)	20	(29.8)
	20S** (7/28)	0.038	(0.965)	0.015	(0.381)	0.020	(0.508)	0.190	(4.83)	25	(37.3)
	18S** (7/26)	0.048	(1.22)	0.020	(0.508)	0.025	(0.635)	0.244	(6.20)	30	(44.7)
4	22S** (7/30)	0.030	(0.762)	0.015	(0.381)	0.020	(0.508)	0.184	(4.67)	23	(34.3)
	20S** (7/28)	0.038	(0.965)	0.015	(0.381)	0.020	(0.508)	0.204	(5.18)	30	(44.7)
	18S** (7/26)	0.048	(1.22)	0.020	(0.508)	0.025	(0.635)	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.

Wire Specifications - SERIES 704 - FEP

No. of Conductors	AWG	Nominal Conductor Size		Nominal Insulation Thickness		Nominal Overall Size		Approximate Shipping Weight			
				Conductor	Overall						
		in.	(mm)	in.	(mm)	in.	(mm)	lbs/1000 ft	(kg/km)		
2	24S* (7/32)	0.024	(0.610)	0.008	(0.203)	0.012	(0.305)	0.118	(3.00)	12	(17.9)
	22S* (7/30)	0.030	(0.762)	0.008	(0.203)	0.012	(0.305)	0.130	(3.30)	14	(20.9)
	20S* (7/28)	0.038	(0.965)	0.008	(0.203)	0.012	(0.305)	0.146	(3.71)	17	(25.3)
3	24S* (7/32)	0.024	(0.610)	0.008	(0.203)	0.012	(0.305)	0.126	(3.20)	16	(23.8)
	22S* (7/30)	0.030	(0.762)	0.008	(0.203)	0.012	(0.305)	0.140	(3.56)	20	(29.8)
	20S* (7/28)	0.038	(0.965)	0.008	(0.203)	0.012	(0.305)	0.158	(4.01)	24	(35.8)
4	24S* (7/32)	0.024	(0.610)	0.008	(0.203)	0.012	(0.305)	0.136	(3.46)	19	(28.3)
	22S* (7/30)	0.030	(0.762)	0.008	(0.203)	0.012	(0.305)	0.150	(3.81)	23	(34.3)
	20S* (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.

Wire Specifications - SERIES 705 - Fiberglass

No. of Conductors	AWG	Nominal Conductor Size		Nominal Insulation Thickness		Nominal Overall Size		Approximate Shipping Weight			
				Conductor	Overall						
		in.	(mm)	in.	(mm)	in.	(mm)	kg/km	(lbs/1000 ft)		
2	24S* (7/32)	0.024	(0.610)	0.005	(0.127)	0.006	(0.152)	0.080	(2.03)	6	(8.9)
	22S* (7/30)	0.030	(0.762)	0.005	(0.127)	0.006	(0.152)	0.092	(2.34)	7	(10.4)
	20S* (7/28)	0.038	(0.965)	0.006	(0.152)	0.006	(0.152)	0.112	(2.84)	9	(13.4)
3	24S* (7/32)	0.024	(0.610)	0.005	(0.127)	0.006	(0.152)	0.086	(2.18)	8	(11.9)
	22S* (7/30)	0.030	(0.762)	0.005	(0.127)	0.006	(0.152)	0.098	(2.49)	9	(13.4)
	20S* (7/28)	0.038	(0.965)	0.006	(0.152)	0.006	(0.152)	0.120	(3.05)	12	(17.9)
4	24S* (7/32)	0.024	(0.610)	0.005	(0.127)	0.006	(0.152)	0.092	(2.34)	10	(14.9)
	22S* (7/30)	0.030	(0.762)	0.005	(0.127)	0.006	(0.152)	0.106	(2.69)	12	(17.9)
	20S* (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

SERV-RITE Wire and Cable

Bare Thermocouple Alloy

ASTM E 230 Types J, K, T, E and N

Watlow can provide matched pairs of 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.

Consult the factory with your specific requirements for pricing and availability.

All thermocouple alloys will be sold as a matched pair (i.e. KP and KN, JP and JN, etc.). For non-thermocouple applications the only alloy available as a single leg will be the TN product (code number 1625-X, where X is the AWG size).

Bare Thermocouple Wire—ASTM E 230 Types J and K

AWG	KP [Ⓞ] Code No.	Feet per lb	KN [Ⓞ] Code No.	Feet per lb	JP Code No.	Feet per lb	JN Code No.	Feet per lb
2	1475-2	5	1476-2	5	—	—	—	—
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
36	1475-36	13480	1476-36	16480	1565-36	14950	1566-36	13280

[Ⓞ] KP and KN 2 gauge to 14 gauge products are oxide finished, all other sizes are bright annealed finish.

Bare Thermocouple Wire—ASTM E 230 Types T and E

AWG	EP Code No.	Feet per lb	EN Code No.	Feet per lb	TP Code No.	Feet per lb	TN Code No.	Feet per lb
8	1474-8	21	1624-8	20	—	—	1625-8	20
14	1474-14	83	1624-14	80	1665-14	80	1625-14	80
16	1474-16	130	1624-16	128	1665-16	128	1625-16	128
18	1474-18	212	1624-18	204	1665-18	204	1625-18	204
20	1474-20	331	1624-20	332	1665-20	332	1625-20	332
22	1474-22	530	1624-22	514	1665-22	514	1625-22	514
24	1474-24	838	1624-24	818	1665-24	818	1625-24	818
26	1474-26	1340	1624-26	1300	1665-26	1300	1625-26	1300
28	1474-28	2130	1624-28	2071	1665-28	2071	1625-28	2071
30	1474-30	3370	1624-30	3290	1665-30	3290	1625-30	3290

SERV-RITE Wire and Cable

Bare Thermocouple Alloy

**ASTM E 230
Types B, R, S and C**

ASTM E 230 Type B* (6 Percent / 30 Percent)—Standard Grade

Size of Wire		BP Code No.	Inches Per Troy Oz (Approx.)	BN Code No.	Inches Per Troy Oz (Approx.)
AWG	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.)
AWG	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^①, 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.)
AWG	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

^① Accuracy 0.10 percent 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 five percent Rhenium / Tungsten 26 percent 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 $\pm 4^{\circ}\text{C}$ ($\pm 8^{\circ}\text{F}$) from room temperature to 425°C (800°F) and ± 1 percent from 425 to 2315°C (800 to 4200°F).

Size of Wire		Code No. Double Inch
AWG	O.D. (in.)	
24	0.0201	2556-24
30	0.0100	2556-30

Notes

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 limits of error accuracy
- Diameters from 0.010 to 0.5 inch (0.25 to 12.7 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 0 to 1480°C (32 to 2700°F)
- Cryogenic cable available upon request

Features and Benefits

Fireproof cable

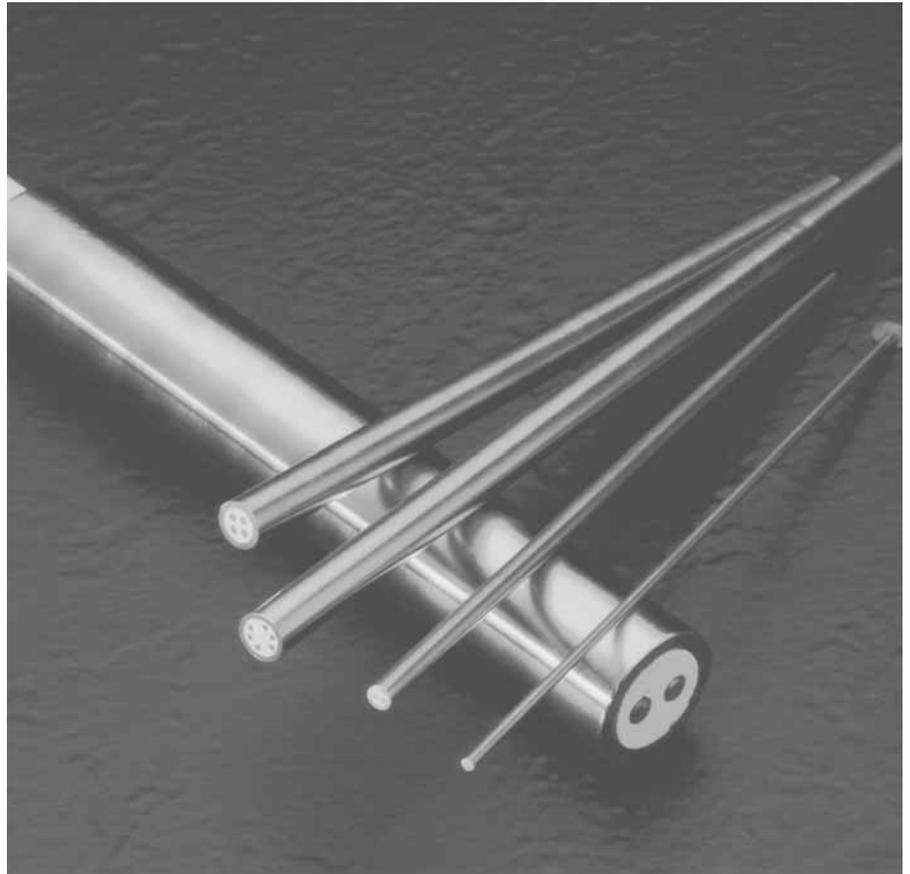
- Perform where conventional insulated wires burn and degrade

Fast and accurate

- Precisely measures temperature for a fast response

Tight moisture and gas seals

- Resists contamination



Mineral Insulated Metal-Sheathed Cable

High pressure rating

- Allows use in pressure vessels and vacuum applications

Form flexibility

- Adapts to virtually any application

Thermal shock resistance

- Withstands thermal cycling

Compact, durable and corrosion resistant

- Long life performance with minimum constraints on applications

High temperature rating

- Meets demanding application needs

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

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 and metallurgical examination, 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 30 to 35.

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 82°C (180°F). Deep moisture penetration is unlikely, but should it occur the material may be baked at approximately 121°C (250°F) for 24 hours to increase 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 from 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_{DC} (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

5. Specify Coil Lengths

Random—the factory selects for you (20 foot minimum). Special—specify lengths and tolerance. Cut to length charges and minimum order quantities may apply.

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: 1175°C (2150°F). Most widely used thermocouple sheath material. Good high temperature strength, corrosion resistance, resistance to chloride ion stress corrosion cracking and oxidation resistance to high temperatures. Do not use in sulfur bearing environments. Good in nitriding environments.

304 SS

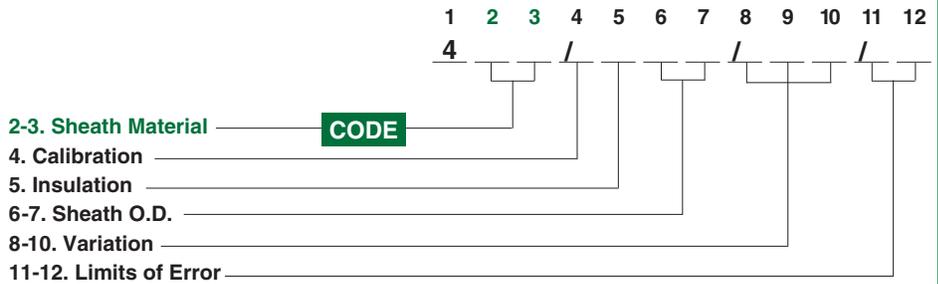
02—Maximum temperature: 900°C (1650°F). Most widely used low temperature sheath material. Extensively used in food, beverage, chemical and other industries where corrosion resistance is required. Subject to damaging carbide precipitation in 480 to 870°C (900 to 1600°F) range. Lowest cost *corrosion resistant* sheath material available.

310 SS

03—Maximum temperature: 1150°C (2100°F). Mechanical and corrosion resistance, similar to but better than 304 SS. Very good heat resistance. This alloy contains 25 percent chromium, 20 percent nickel. Not as ductile as 304 SS.

316 SS

04—Maximum temperature: 900°C (1650°F). Best corrosion resistance of the austenitic stainless steel grades. Widely used in the food and chemical industry. Subject to damaging carbide precipitation in 482 to 870°C (900 to 1600°F) range.



347 SS

05—Maximum temperature: 870°C (1600°F). Similar to 304 SS except nickel niobium stabilized. This alloy is designed to overcome susceptibility to carbide precipitation in the 480 to 870°C (900 to 1600°F) range. Used in aerospace and chemical applications.

446 SS

13—Maximum temperature: 1150°C (2100°F). Ferritic stainless steel which has good resistance to sulfurous atmospheres at high temperatures. Good corrosion resistance to nitric acid, sulfuric acid and most alkalies. 27 percent chromium content gives this alloy the highest heat resistance of any ferritic stainless steel.

321 SS

16—Maximum temperature: 870°C (1600°F). Similar to 304 SS except titanium stabilized for inter-granular corrosion. This alloy is designed to overcome susceptibility to carbon precipitation in the 480 to 870°C (900 to 1600°F) range. Used in aerospace and chemical applications.

Hastelloy® X

18—Maximum temperature: 1205°C (2200°F). 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: 1175°C (2150°F) continuous, 1260°C (2300°F) 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 540 to 760°C (1000 to 1400°F) temperature range.

Hastelloy® is a registered trademark of Haynes International.

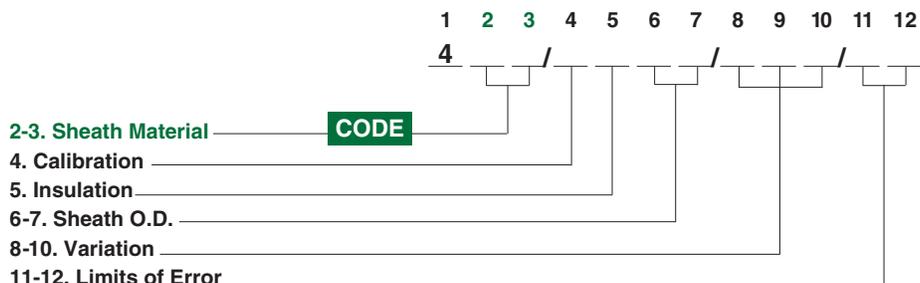
Inconel® is a registered trademark of the Special Metals Corporation.

Mineral Insulated Metal-Sheathed Cable

XACTPAK Cable

Sheath Material

Continued



Inconel® 625

25—Maximum temperature: 980°C (1800°F). Used in many aerospace applications. Excellent high temperature strength. Excellent resistance to pitting and crevice corrosion. Unaffected by radiation embrittlement.

Haynes® Alloy 230

32—Maximum temperature: 1150°C (2100°F). 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.

Haynes® Alloy HR-160

38—Maximum temperature 1175°C (2150°F). 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.

Haynes® Alloy 718

42—Maximum temperature 700°C (1300°F). A precipitation hardenable Inconel® alloy developed for corrosion resistance and excellent weldability. Applications include gas turbine, aerospace, oil and gas production and nuclear.

Mineral Insulated Metal-Sheathed Cable

XACTPAK Cable

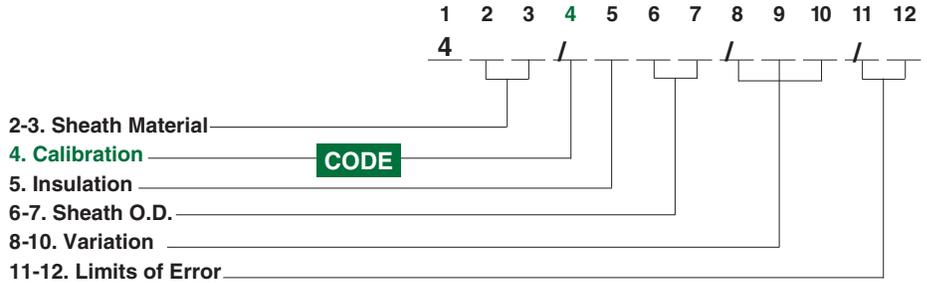
Calibration

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 0 to 815°C (32 to 1500°F). Type J is not susceptible to short range ordering in the 0 to 538°C (700 to 1000°F) 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-two percent aluminum-two percent manganese-one percent silicon. When protected by compacted mineral insulation and outer sheath, Type K is usable from -35 to 1260°C (-32 to 2300°F). 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 0°C (32°F), special alloy selections are usually required.



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 0 to 350°C (32 to 660°F) and very stable in cryogenic and low temperature applications. For applications below 0°C (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 0 to 900°C (32 to 1650°F) 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 0°C (32°F), special alloy selections may be required.

ASTM Type N

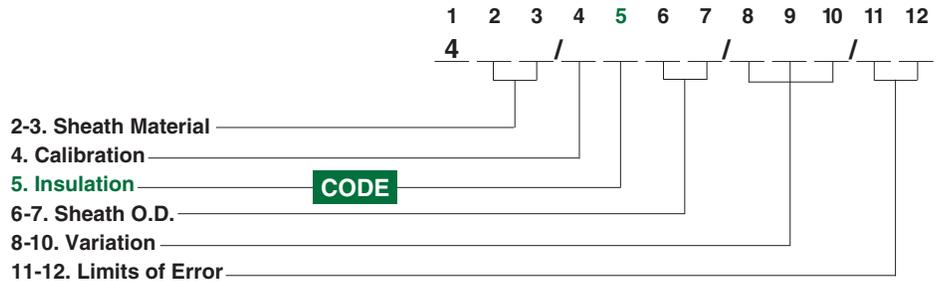
8—Type N's positive leg (nicosil) is approximately 14 percent chromium-1.4 percent silicon-84.6 percent nickel. Its negative leg (nisil) is approximately 4.4 percent silicon-95.6 percent nickel. When protected by compacted mineral insulation and outer sheath, it's usable from 0 to 1260°C (32 to 2300°F). Type N overcomes several problems inherent in Type K. Short range ordering, (+2 to +4°F drift), in the 315 to 590°C (600 to 1100°F) 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 Percent Minimum Purity

1—Low impurity levels make this insulation very useful for all thermocouple calibrations up to 1370°C (2500°F). 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

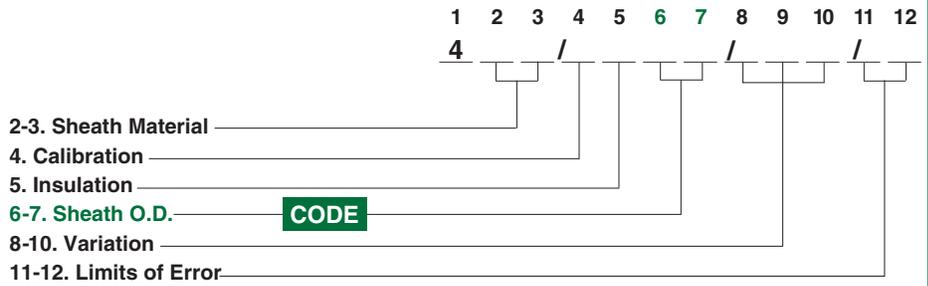
5—This low cost insulation is similar to high purity MgO (1) except it should be used in applications below 1095°C (2000°F) because of the impurity levels. This insulation *should not* be used with platinum or in nuclear applications.

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 2500°C (4530°F), which is higher than BeO.

Mineral Insulated Metal-Sheathed Cable

XACTPAK Cable Sheath O.D.



Mineral Insulated
Metal-Sheathed Cable

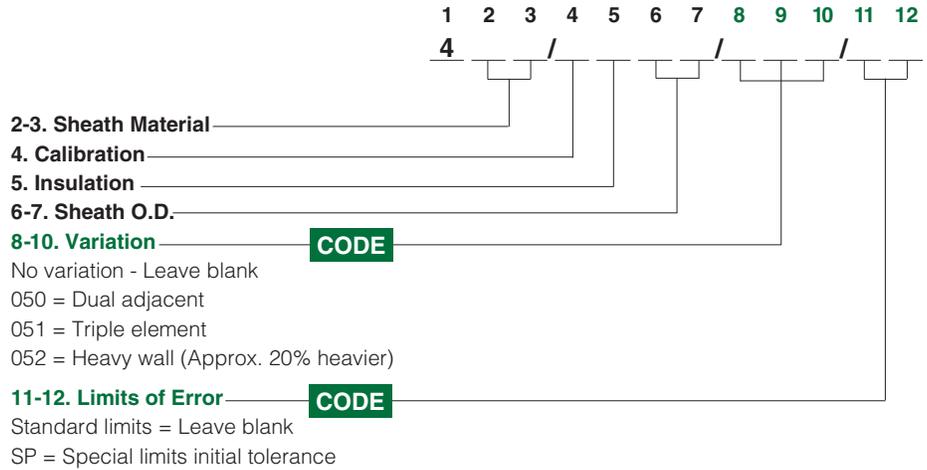
Code No.	Sheath Diameter		Approximate Standard	Weight Coil	Average Response Time* Still Water (seconds)	
	Nominal	Tolerance			lbs/100 ft.	G-JCT
01	0.020 inch	+0.001 -0.0005	9 inch	0.08	<0.02	0.03
02	0.032 inch	+0.001 -0.0005	9 inch	0.20	0.02	0.07
03	0.040 inch	+0.001 -0.0005	9 inch	0.32	0.04	0.13
04	0.063 inch	±0.001	24 inch	0.74	0.220	0.40
05	0.090 inch	±0.001	24 inch	1.50	0.33	0.68
06	0.114 inch	+0.002 -0.001	24 inch	2.45	0.38	0.85
07	0.125 inch	+0.002 -0.001	24 inch	3.00	0.50	1.10
08	0.188 inch	+0.002 -0.001	24 inch	6.65	1.00	2.30
11	0.250 inch	+0.003 -0.001	24 inch	11.65	2.20	4.10
12	0.313 inch	+0.003 -0.001	24 inch	19.60	5.00	7.00
13	0.375 inch	+0.003 -0.001	straight or 40 inch coils	28.10	8.00	11.00
14	0.430 inch	+0.003 -0.001	straight or 40 inch coils	35.0	11.00	15.00
15	0.500 inch	+0.003 -0.001	straight or 40 inch coils	47.0	15.00	20.00
16	0.010 inch	+0.001 -0.0005	9 inch	0.019	<0.02	<0.02
17	0.011 inch	+0.001 -0.0005	9 inch	0.022	<0.02	<0.02
18	0.0126 inch	+0.001 -0.0005	9 inch	0.029	<0.02	<0.02
19	0.025 inch	+0.001 -0.0005	9 inch	0.13	<0.02	0.05
51	0.5 mm	±0.02	23 cm	0.08	<0.02	0.03
52	1.0 mm	±0.02	23 cm	0.32	0.04	0.13
53	1.5 mm	±0.02	61 cm	0.65	<0.15	0.35
54	2.0 mm	±0.03	61 cm	1.13	0.25	0.55
55	3.0 mm	±0.03	61 cm	2.60	0.40	0.90
56	4.5 mm	±0.03	61 cm	6.00	0.95	2.00
57	6.0 mm	±0.05	61 cm	10.50	2.00	3.50
58	8.0 mm	±0.05	61 cm	19.65	5.00	7.00
59	9.0 mm	±0.05	61 cm	25.00	7.50	10.00

*Note: First order response time 63.2%.

Mineral Insulated Metal-Sheathed Cable

XACTPAK Cable

Variation/Limits of Error



Single Element

Code* No.	Sheath Diameter	Sheath Material	Calibration	Insulation	Nominal AWG Gauge	Nominal Wall Thickness in.	Maximum Stock Length ft	Maximum Recommended Operating Temperature °C (°F)
401/2101	0.020	Alloy 600	K	99.4% MgO	38	0.003	100	871 (1600)
402/2101	0.020	304 SS	K	99.4% MgO	38	0.003	100	871 (1600)
401/2102	0.032	Alloy 600	K	99.4% MgO	34	0.004	150	871 (1600)
401/1103	0.040	Alloy 600	J	99.4% MgO	32	0.006	250	816 (1500)
401/2103	0.040	Alloy 600	K	99.4% MgO	32	0.006	250	871 (1600)
402/1103	0.040	304 SS	J	99.4% MgO	32	0.006	250	816 (1500)
404/2103	0.040	316 SS	K	99.4% MgO	32	0.006	250	871 (1600)
401/2104	0.063	Alloy 600	K	99.4% MgO	28	0.009	1000	1093 (2000)
401/2107	0.125	Alloy 600	K	99.4% MgO	22	0.017	900	1177 (2150)
401/2507	0.125	Alloy 600	K	96% MgO	22	0.017	900	1093 (2000)
401/8107	0.125	Alloy 600	N	99.4% MgO	22	0.017	900	1177 (2150)
402/1507	0.125	304 SS	J	96% MgO	22	0.017	900	816 (1500)
402/2107	0.125	304 SS	K	99.4% MgO	22	0.017	900	871 (1600)
402/2507	0.125	304 SS	K	96% MgO	22	0.017	900	871 (1600)
402/3507	0.125	304 SS	T	96% MgO	22	0.017	500	350 (662)
403/2507	0.125	310 SS	K	96% MgO	22	0.017	900	1093 (2000)
404/2507	0.125	316 SS	K	96% MgO	22	0.017	900	871 (1600)
404/3507	0.125	316 SS	T	96% MgO	22	0.017	500	350 (662)
404/4507	0.125	316 SS	E	96% MgO	22	0.017	900	871 (1600)
418/2107	0.125	Hastelloy® X	K	99.4% MgO	22	0.014	125	1204 (2200)
401/2108	0.188	Alloy 600	K	99.4% MgO	19	0.025	350	1177 (2150)
401/2508	0.188	Alloy 600	K	96% MgO	19	0.025	350	1093 (2000)
402/1508	0.188	304 SS	J	96% MgO	19	0.025	350	816 (1500)
402/2508	0.188	304 SS	K	96% MgO	19	0.025	350	871 (1600)
403/2508	0.188	310 SS	K	96% MgO	19	0.025	350	1093 (2000)
404/1508	0.188	316 SS	J	96% MgO	19	0.025	350	816 (1500)

CONTINUED

*To specify special limits add to code number: /SP

Mineral Insulated Metal-Sheathed Cable

XACTPAK Cable

Single Element

Continued

Code* No.	Sheath Diameter	Sheath Material	Calibration	Insulation	Nominal AWG Gauge	Nominal Wall Thickness in.	Maximum Stock Length ft	Maximum Recommended Operating Temperature °C (°F)
404/2508	0.188	316 SS	K	96% MgO	19	0.025	350	871 (1600)
401/1511	0.250	Alloy 600	J	96% MgO	16	0.033	220	816 (1500)
401/2111	0.250	Alloy 600	K	99.4% MgO	16	0.033	220	1177 (2150)
401/2511	0.250	Alloy 600	K	96% MgO	16	0.033	220	1093 (2000)
402/1511	0.250	304 SS	J	96% MgO	16	0.033	220	816 (1500)
402/2511	0.250	304 SS	K	96% MgO	16	0.033	220	871 (1600)
403/2511	0.250	310 SS	K	96% MgO	16	0.033	220	1093 (2000)
404/1511	0.250	316 SS	J	96% MgO	16	0.033	220	816 (1500)
404/2511	0.250	316 SS	K	96% MgO	16	0.033	220	871 (1600)
401/2512	0.313	Alloy 600	K	96% MgO	14	0.041	150	1093 (2000)
401/2513	0.375	Alloy 600	K	96% MgO	13	0.052	100	1093 (2000)

*To specify special limits add to code number: /SP

Double Element—Adjacent Conductors

Code* No.	Sheath Diameter	Sheath Material	Calibration	Insulation	Nominal AWG Gauge	Nominal Wall Thickness in.	Maximum Stock Length ft	Maximum Recommended Operating Temperature °C (°F)
401/2507/050	0.125	Alloy 600	K	96% MgO	24	0.017	900	1093 (2000)
404/1507/050	0.125	316SS	J	96% MgO	24	0.017	900	816 (1500)
402/1508/050	0.188	304 SS	J	96% MgO	21	0.025	350	816 (1500)
401/2511/050	0.188	Alloy 600	K	96% MgO	18	0.033	220	1093 (2000)
401/4511/050	0.250	Alloy 600	E	96% MgO	18	0.033	220	871 (1600)
404/1511/050	0.250	316 SS	J	96% MgO	18	0.033	220	816 (1500)

*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 120°C (250°F) 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.

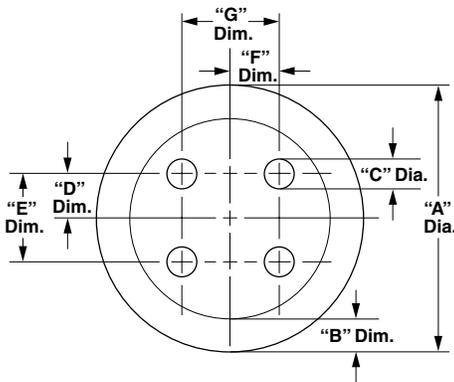
Code No.	Description
8010	4 oz dispenser can

Mineral Insulated Metal-Sheathed Cable

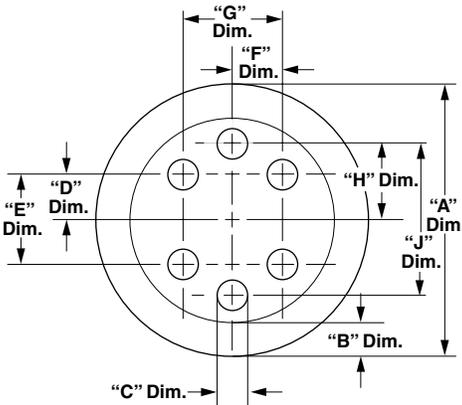
XACTPAK Cable

Mineral Insulated Metal-Sheathed RTD Cable

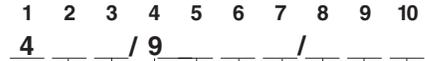
This cable is used for making rugged RTD probes. Special spacing allows room for elements to be placed between conductors. Dimensions are shown below.



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

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

01 = Alloy 600	18 = Hastelloy® X
02 = 304 SS	19 = Inconel® 601
03 = 310 SS	25 = Inconel® 625
04 = 316 SS	32 = Haynes® Alloy 230
05 = 347 SS	38 = Alloy HR-160
13 = 446 SS	42 = Alloy 718
16 = 321 SS	99 = Miscellaneous

4. Calibration

1 = J	4 = E
2 = K	8 = N
3 = T	9 = Misc.

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)]

01 = 0.020	11 = 0.250	19 = 0.025	58 = (8.0 ± 0.05)
02 = 0.032	12 = 0.313	51 = (0.5 ± 0.02)	59 = (9.0 ± 0.05)
03 = 0.040	13 = 0.375	52 = (1.0 ± 0.02)	99 = Miscellaneous
04 = 0.063	14 = 0.430	53 = (1.5 ± 0.02)	
05 = 0.090	15 = 0.500	54 = (2.0 ± 0.03)	
06 = 0.114	16 = 0.010	55 = (3.0 ± 0.03)	
07 = 0.125	17 = 0.011	56 = (4.5 ± 0.03)	
08 = 0.188	18 = 0.0126	57 = (6.0 ± 0.05)	

8-10. Variation

Leave blank = No variation
001 = Dual diagonal
050 = Dual adjacent
051 = Triple element

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

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 aluminum cast-in and Polymer 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 a substitute Product shall be provided, 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.

11/02

Watlow

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“*” Asterisk indicates partial code number.

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