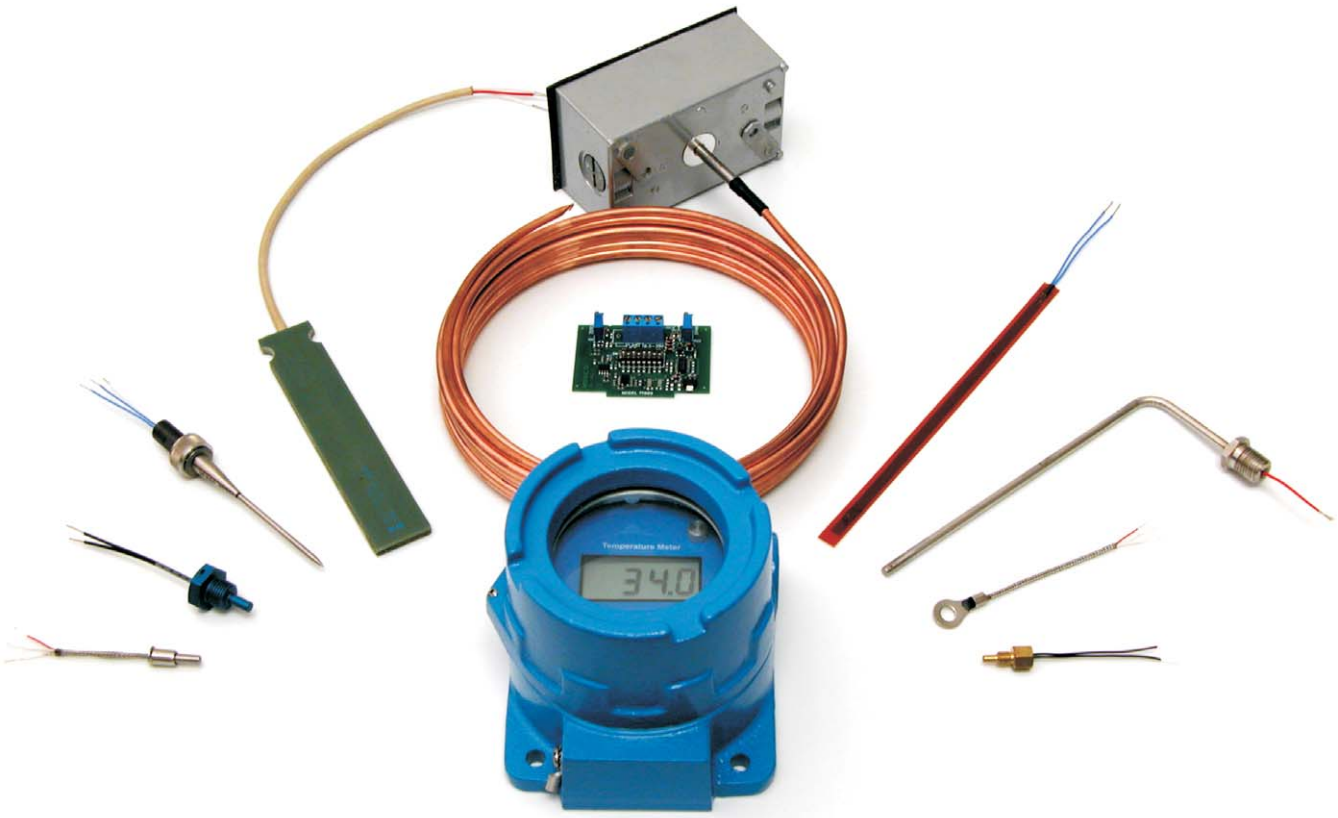
*Bulletin TS-103*

# Temperature Sensors & Instruments


**Resistance Temperature Detectors • Thermocouples**
**Thermistors • Transmitters • Monitors • Controllers**
**Precision sensing for process control, industrial equipment, science and aerospace**
**Stock, standard and custom**

MINCO
PRODUCTS, INC.




# Minco: Your Source For Sensors

Minco has designed and manufactured RTDs for more than 45 years. We have the capabilities and experience to put together a proven sensing solution, at a cost-effective price, for your application.

## The right sensor

No sensor manufacturer offers more styles and variations. From miniature detectors to 100 foot averaging thermometers, from flexible Thermal-Ribbons to heavy duty probe assemblies, our selection lets you choose the best model for your needs. We can supply platinum, nickel, nickel-iron, and copper RTDs with curves to match any instrumentation. And Minco also offers thermocouples and thermistors mechanically interchangeable with RTD models to help you standardize installations.

## Single source manufacturing

Minco builds sensors from start to finish. We manufacture our own sensing elements, machine our own cases and fittings, and assemble finished parts. That gives us complete control over product quality, plus flexibility in adapting designs to customer requirements.

## Custom design

Stock solutions aren't always the best solutions. Minco has designed over 7000 custom sensors, each with unique features for better performance at a lower price. Let our engineers suggest innovative ideas to tailor a sensor to your application.

## Quality above all

Minco sensors have proven their reliability in the most critical areas. The Space Shuttle uses our RTDs. So do nuclear plant safety systems, rocket motors, power generators, missiles, and calibration labs. Quality comes first at Minco. Documented and audited procedures, continuous quality improvement goals, and employee involvement programs set a high standard throughout the company. Minco is certified to ISO 9001: 2000.

## Credit cards

Minco accepts MasterCard, Visa, and American Express.

## Extensive stock for urgent needs

When you need it right now, this is the right place. Minco stocks more than 250 different types of sensors. Cut-to-length probes are one example. We can take a probe from the shelf, trim it to the proper size, add fittings, connection head, transmitter, and thermowell, and ship it to you overnight. Look for this symbol:

**IN STOCK**

## To order stock items:

Minco Order Desk:

Phone: 763-571-3123
FAX: 763-571-0942

Saturday-Sunday emergency beeper:
612-580-4659

## For technical assistance and non-standard items:

Minco Sales Department:

Phone: 763-571-3121
FAX: 763-571-0927

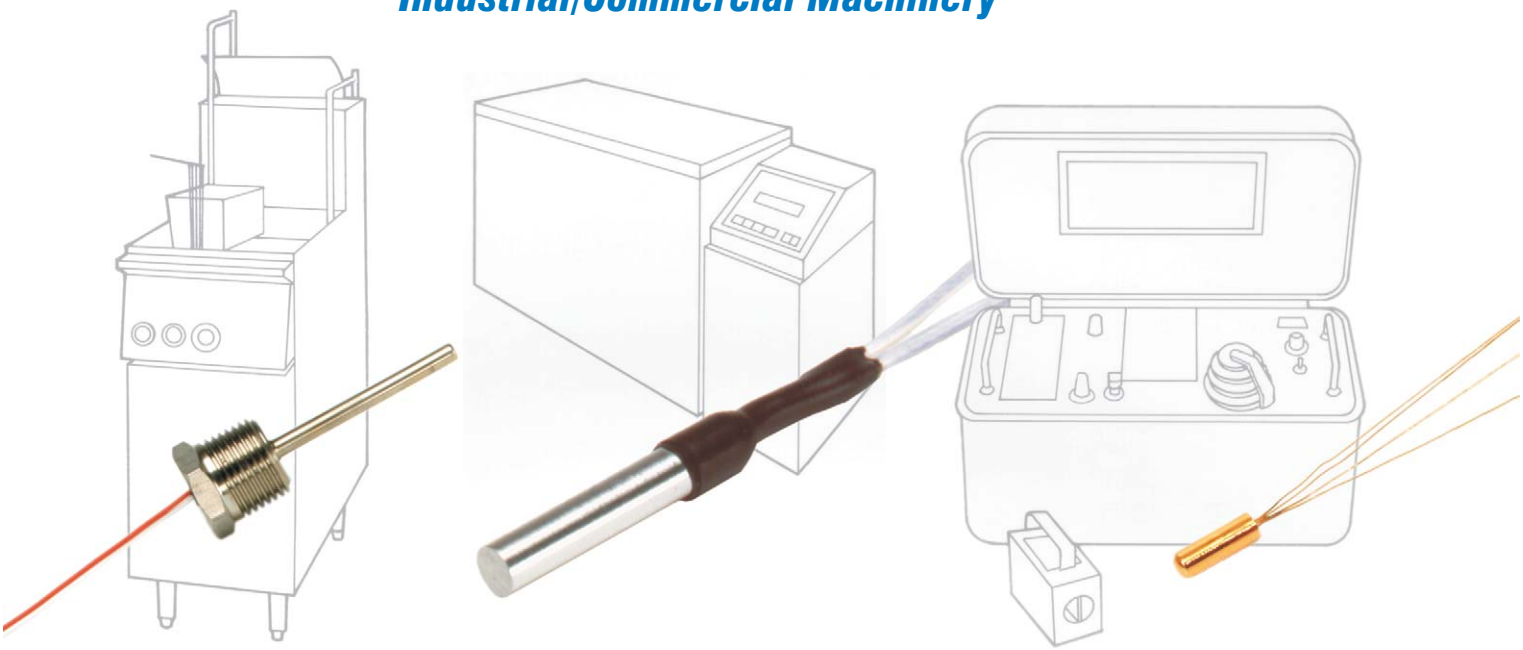
Or visit www.minco.com to find your local sales representative's phone number.

**MINCO PRODUCTS, INC.**
*7300 Commerce Lane • Minneapolis, MN 55432-3177 U.S.A.*

# Contents

# Typical Applications

## Industrial/Commercial Machinery



### Restaurant fryer

A fast response RTD monitors oil temperature for perfect cooking results.

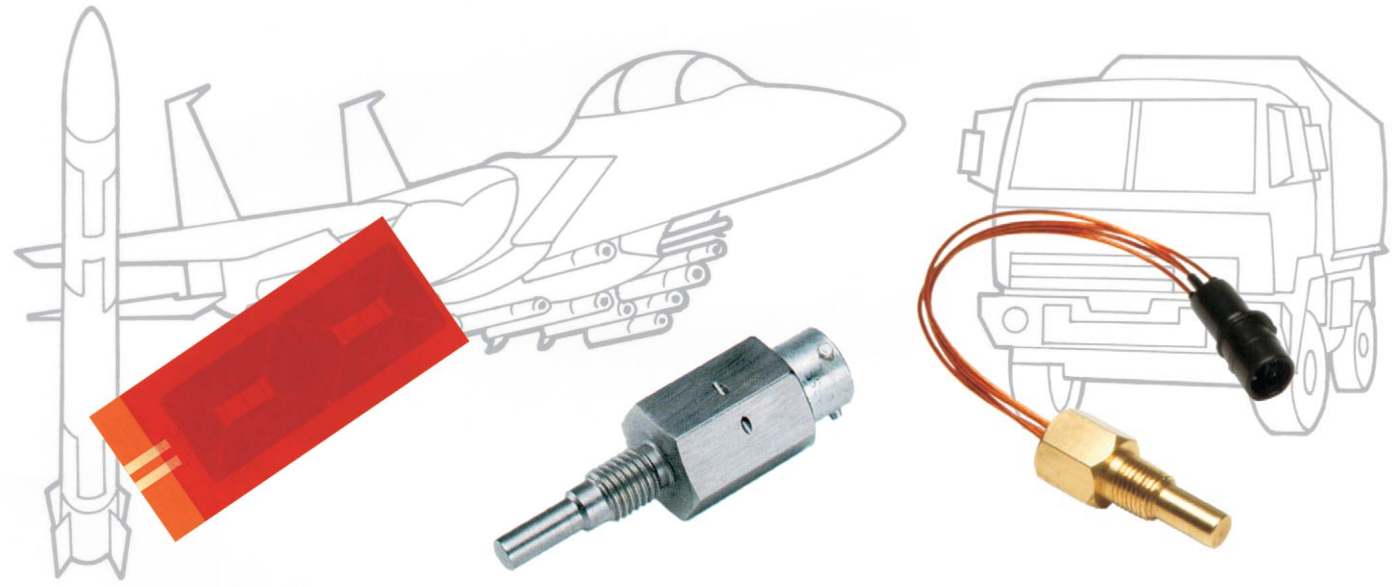
### Medical freezer

RTDs monitor temperatures as low as -269°C in freezers used to store biological and pharmaceutical materials. Close control and sensor reliability are essential.

### Humidity calibration

A wet bulb/dry bulb humidity standard contains two gold-plated precision platinum thermometers.

## Aerospace/Defense



### Wing de-icing system

This flexible Thermal-Ribbon mounts on the leading edge as part of a system to control wing surface icing.

### Hydraulic systems

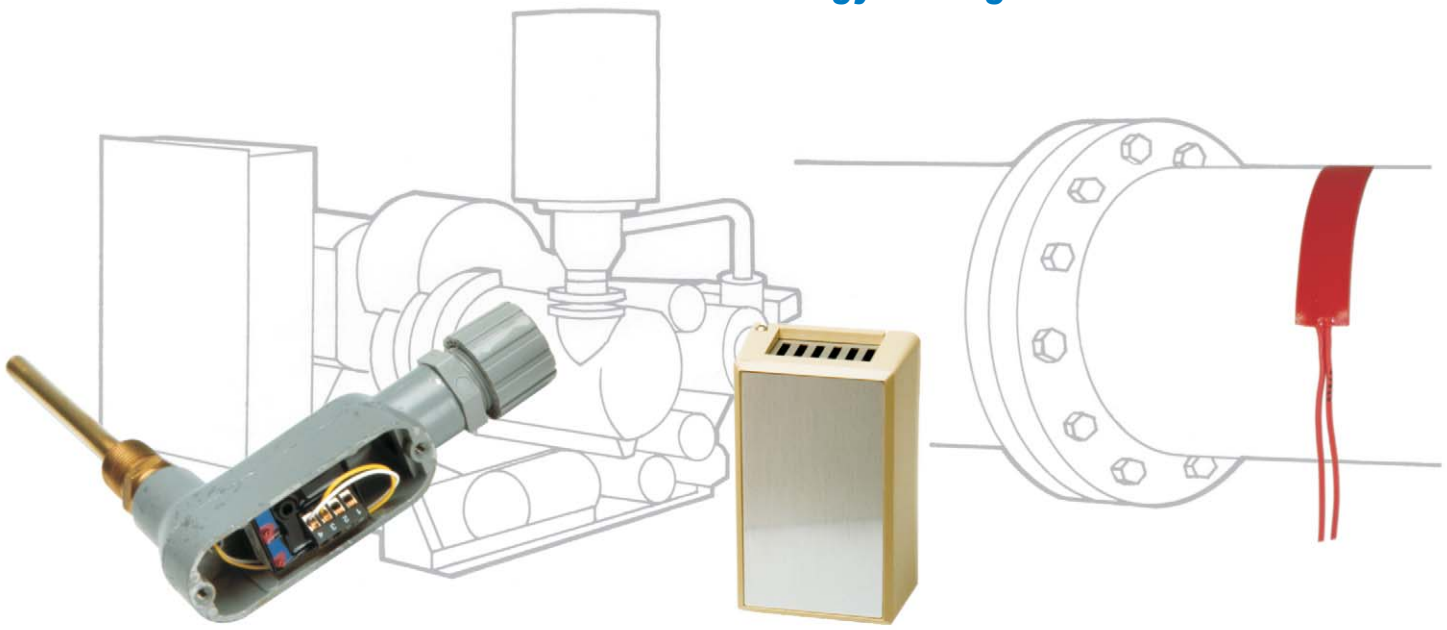
Installed in hydraulic lines, this RTD monitors oil temperatures to prevent overheating.

### Military vehicles

This RTD contains an integral Wheatstone bridge. It monitors engine temperatures for computerized diagnostics.

# Typical Applications

## Process Control and Energy Management



### Centrifugal compressor

This assembly includes an RTD probe, thermowell, and 2-wire Temptran™ transmitter. It monitors the air outlet stream.

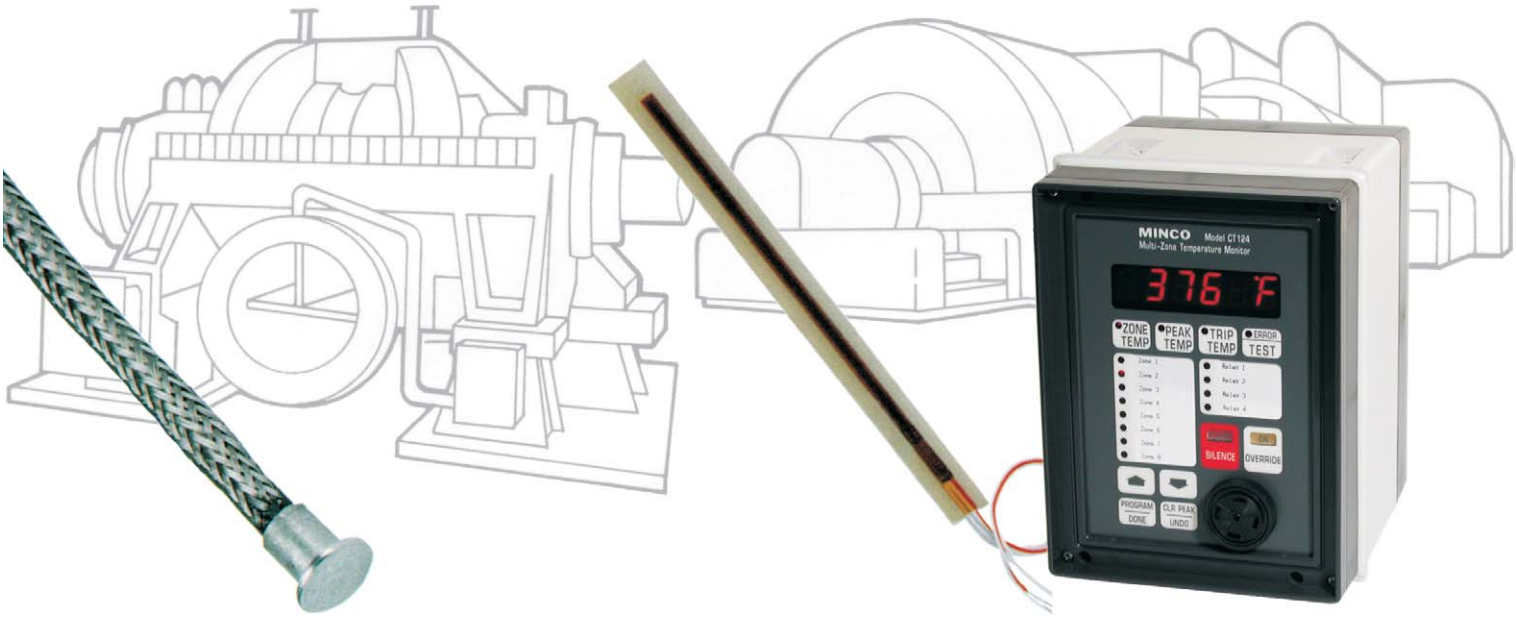
### Room air sensing

Minco's sensor/transmitter is specially designed to reduce self-heating effects for accurate readings.

### Pipe surface measurement

A flexible Thermal-Ribbon™, taped to a pipe surface, eliminates the need for thermowell installation.

## Motor/Machinery Protection




### Bearings

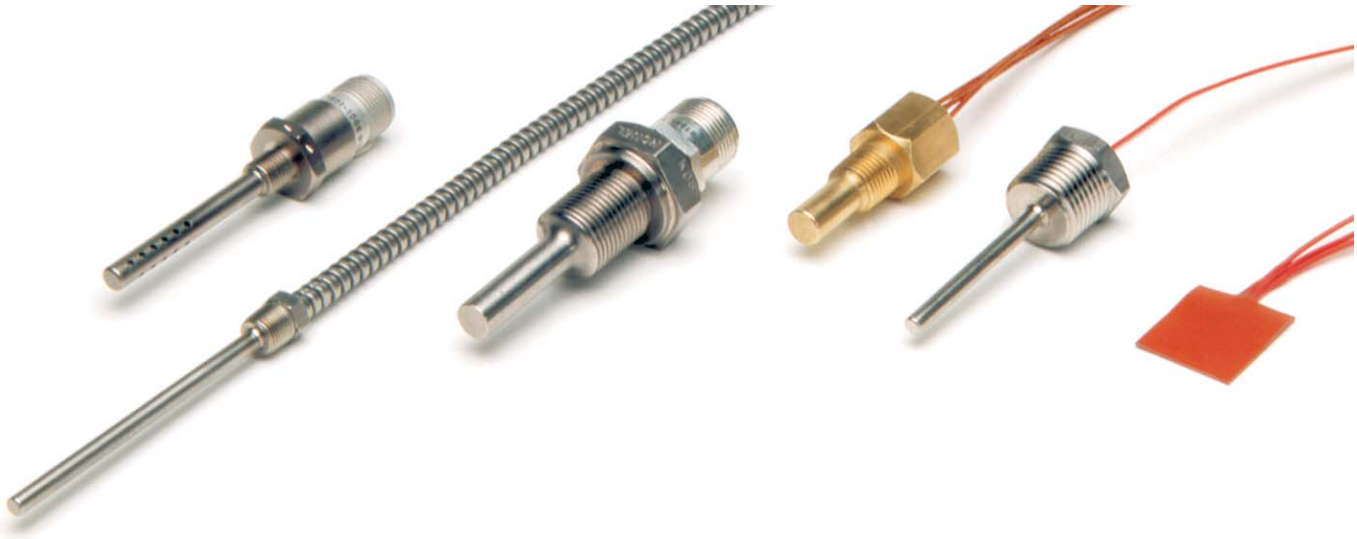
Miniature detectors fit beneath the babbitt surface of bearing shoes to provide early warning of failure.

### Stator windings

Flat "stick" RTDs track winding temperatures to prevent motor burnout.

### Temperature alarm

Minco's programmable monitor tracks up to eight sensing points and automatically activates relays and an audible alarm.



# Custom Design For Better Performance

This bulletin contains a wide array of sensor styles to fit most applications. But if you have special requirements — or will purchase sensors in quantity for an OEM design — a custom sensor can improve accuracy and reduce cost at the same time. And no one offers more custom design possibilities than Minco.

## Elements to match any curve

We can supply sensors to work with nearly any type of instrument input:

- Platinum RTDs with TCRs from 0.00375 to 0.003927
- Nickel, copper, and nickel-iron RTD elements
- Non-standard curves
- Base resistances up to thousands of ohms
- Thermistors or thermocouples
- Linearizing transmitters with 4 to 20 mA, 1 to 5 VDC, or other voltage/current outputs

## Machining and materials

A sensor's case construction determines its thermal response and resistance to corrosive media. Minco has an advanced machine shop with CAD/CAM capability for economic production of cases and fittings.

Select from a variety of materials:

- Stainless steel in various grades
- Brass
- Copper
- Monel
- Hastelloy
- Titanium
- Rubber, PTFE, plastics

We can plate with nickel, gold, and other metals. Additional services include electropolishing, passivating, and pressure testing.

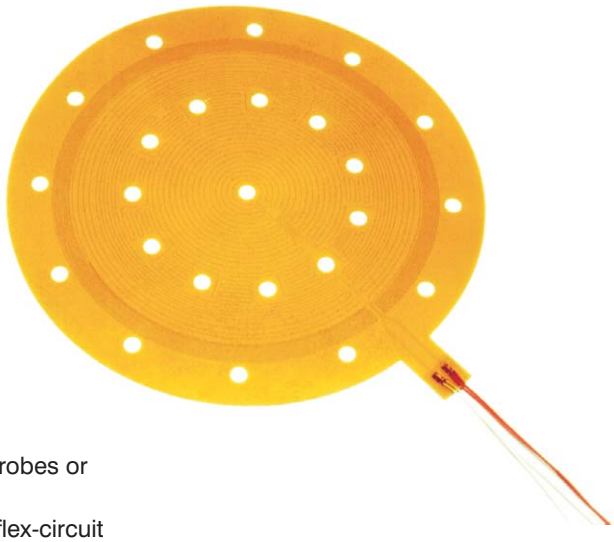
## Leadwires

RTDs, thermocouples, and thermistors may be furnished with many different types of leadwire and cables to meet application parameters:

- PTFE, silicone rubber, polyimide, mica/glass, and glass braid insulation
- Stainless steel overbraid or flexible armor
- UL recognized wire
- Integral feedthroughs
- Connectors assembled to probes or leadwires
- Flat ribbon leads or sensor/flex-circuit hybrids

## Lamination

Minco's winding and lamination technology enables manufacture of flat, flexible sensors in any size or shape. The custom Thermal-Ribbon below has a wire element to average temperatures over its entire area.



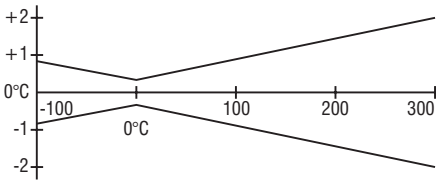
## Testing

Minco has complete in-house testing and metrology equipment to meet stringent quality requirements:

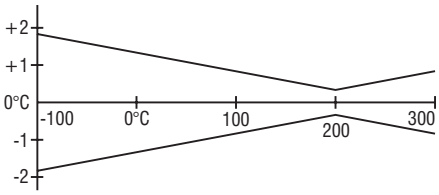
- NIST traceable calibrations
- Hydrostatic testing of thermowells
- Helium leak testing for nuclear requirements
- Automated resistance measurement
- Humidity testing

## Critical point calibration

Here's a simple idea to improve accuracy with little additional cost. Suppose you want RTDs interchangeable within 0.5°C at a critical control point of 200°C. The interchangeability for a typical RTD (EN60751, Class B) is ±0.3°C at 0°C, ±1.3°C at 200°C. The tolerance band looks like this:




You could specify a tighter overall calibration in order to get the desired tolerance at 200°C, but that would increase sensor cost. Instead, Minco can calibrate the sensor to have its narrowest tolerance at the critical temperature:




You now have a sensor with ±0.3°C tolerance at 200°C. And the cost is no more than a standard sensor in volume.

## Sensor/instrument systems

Minco manufactures transmitters, readouts, controllers, and alarms in addition to sensors. Ordering sensors and instruments in sets offers many benefits:

- Transmitters can be calibrated to individual sensors rather than nominal curves. That way, overall accuracy is not dependent on sensor tolerance.
- There are no worries about sensor and instrument compatibility.
- Entire systems can be custom designed with the best feature/price package for the intended application.
- You can combine Thermofoil™ heaters with sensors and controllers for ready-to-use thermal systems.

## Designing for accuracy

How accurate is a temperature sensor? To many, the answer to this question is the sensor's interchangeability specification. For example, 100 Ω platinum RTDs are typically interchangeable within 0.1 Ω (0.3°C) at 0°C.

But interchangeability only tells how closely the electrical characteristics of a sensor conform to its published tables. What you really want to know is how much the temperature seen at your readout or controller deviates from the actual temperature of the material you are sensing. Interchangeability is only one of the potential sources of error in the system, and it is usually not the largest. Following are some other error modes along with suggested solutions.

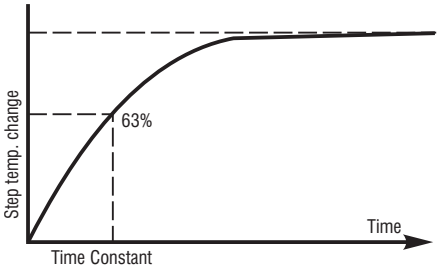
**Repeatability/stability:** Repeatability tells how well the sensor repeats subsequent readings at the same temperature. Stability is the absence of long term drift. In many cases, the user is less concerned with absolute accuracy than with the ability of a sensor to maintain a process at the same point once properly set.

**Solution:** Platinum RTDs are the most stable sensor in common use and are used to interpolate over the standard temperature scale from -260 to 962°C. Ordinary industrial models will drift less than 0.1°C per year in normal use.

**Time lag:** When temperatures change rapidly, sensors may not keep up.

**Solution:** Minco specializes in fast response RTDs. Most models in this catalog have a time constant of 2 seconds or less. Certain custom designed models are faster yet.

Time constant is defined as the time it takes a sensor to reflect 63% of a step temperature change:




**Conduction errors:** Heat conducted into sensors from ambient air alters the temperature of the sensing tip.

**Solution:** Use smaller sensors or tip-sensitive probes, and be sure they are sufficiently immersed or embedded in the sensed medium.

**Point sensing errors:** In places where temperatures are stratified or gradients are large, the temperature at a single point may be unrepresentative or misleading.

**Solution:** Use temperature averaging probes or Thermal-Ribbons.

**Leadwire resistance:** Resistance in the leads between RTDs and control points elevates apparent readings.

**Solutions:**

- Specify sensors with higher resistances.
- Use 3 or 4-wire compensating circuits (see page 13-3).
- Eliminate leadwire effects with a 4 to 20 mA transmitter (Section 5).

**Self-heating:** The measuring current through an RTD can raise its temperature above the true value.

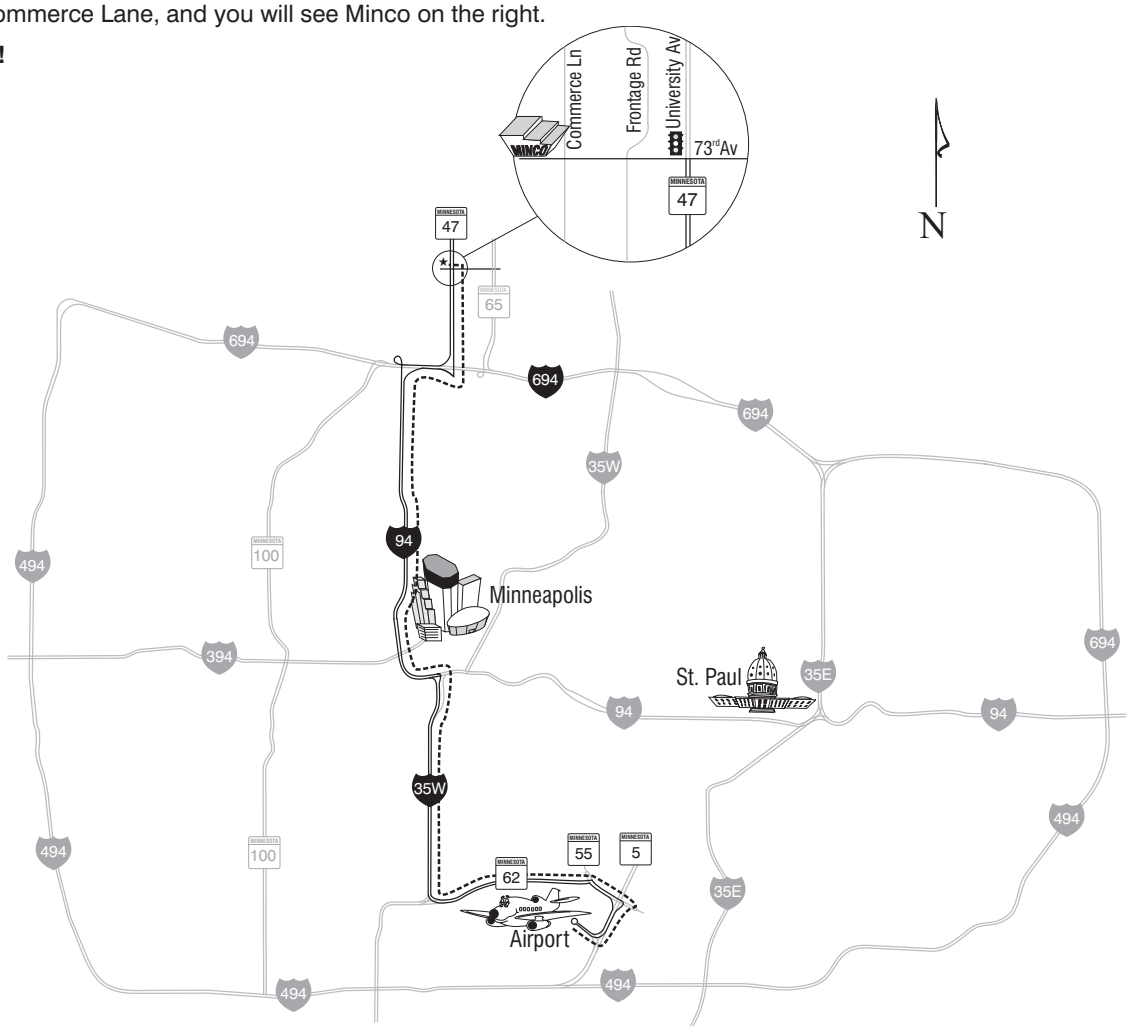
**Solution:** As a general rule, limit current to 5 mA for industrial applications. Most Minco RTDs, and especially Thermal-Ribbons, have a large surface area to dissipate heat and reduce self-heating effects.

## Directions to Minco

Located just 30 minutes from the Twin Cities International Airport, Minco welcomes customer visits.

From the airport, follow the signs to Hwy. 55 West.
Follow Hwy. 55 to Hwy. 62 Crosstown West.
Follow Hwy. 62 West to I-35W North.
Follow I-35W to I-94 West around downtown Minneapolis.
From I-94, take I-694 East across the Mississippi River.
Exit University Ave. (Hwy. 47) North.
Follow University Ave. to 73rd Ave.
Turn left on 73rd Ave.
Go two blocks to Commerce Lane, and you will see Minco on the right.

**Welcome to Minco!**

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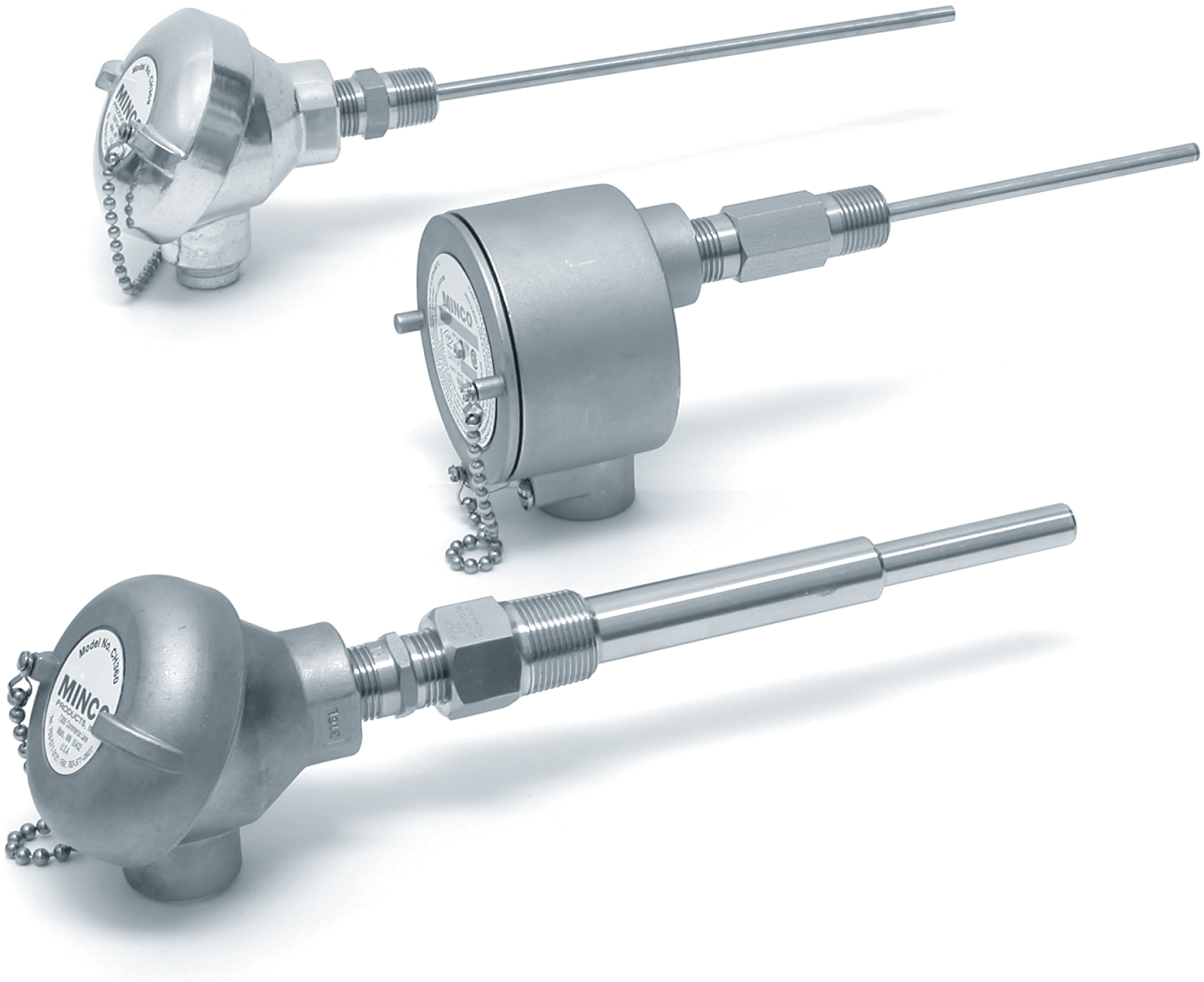
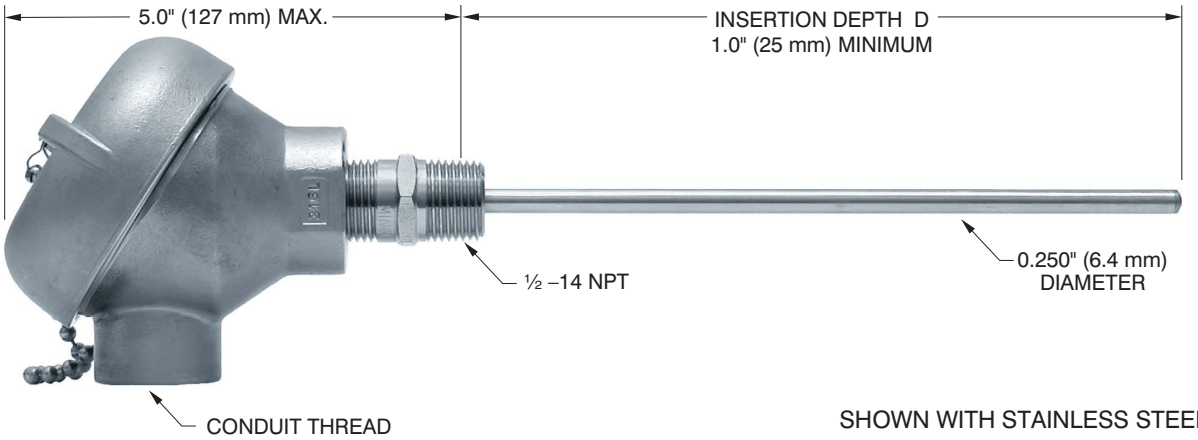


# Section 2: Temperature Sensor Assemblies

- Standard, easy-to-order assemblies to fit a variety of applications
- RTDs, thermocouples, and transmitters
- Fittings, connection heads, and thermowells included
- Tip-sensitive, high temperature, explosionproof, and flameproof versions

To specify custom assemblies see:

| | |
|---|---|
| Probes: | Section 3 |
| Accessories: | Section 4 |
| Transmitters: | Section 5 |




SHOWN WITH STAINLESS STEEL HEAD

# Tip-Sensitive Spring-Loaded RTDs

- Tip-sensitive RTD probe for use to 260°C (500°F)
- Spring-loaded holder with fluid seal
- Cast iron, stainless steel, or aluminum connection head

Get fast and accurate readings from bearings, blocks, and other solids. Minco's spring-loaded holder ensures solid contact in drilled holes and has a built-in oil seal. The sensing probe features a copper alloy tip for quick response to temperature changes.

## Specifications

**Temperature range:**
-50 to 260°C (-58 to 500°F).
**Material:**
Probe: Stainless steel with copper alloy tip.
Holder: Stainless steel with Viton O-ring.
Connection head: Cast iron, aluminum, or stainless steel.
**Pressure rating:** 50 psi (3.4 bar).
**Insulation resistance:** 100 megohms min. at 100 VDC, leads to case.
**Connection:** Terminal block for wires to 14 AWG.
**Time constant:** Typical value in moving water:
Single element: 2.0 seconds.
Dual element: 3.0 seconds.

| Sensing element | | Code |
|---|---|---|
| Platinum 392 | 100 Ω ±0.5% at 0°C | PA |
| Platinum 385 (Meets EN60751, Class B) | 100 Ω ±0.1% at 0°C | PD |
| Platinum 385 | 100 Ω ±0.5% at 0°C | PE |
| Copper | 10 Ω ±0.2% at 25°C | CA |
| (dual) | 10 Ω ±0.5% at 25°C | CC |
| Nickel | 120 Ω ±0.5% at 0°C | NA |

## Transmitters

Minco's Temptran™ transmitters provide a 4 to 20 mA signal that can be sent over long distances with a simple 2-wire system. Add any Minco model transmitter (except electrically isolated models). See Section 5 for complete details and ordering information.

TT211, TT711
miniature transmitter

TT176, TT676
standard transmitter

## Special high-accuracy calibration

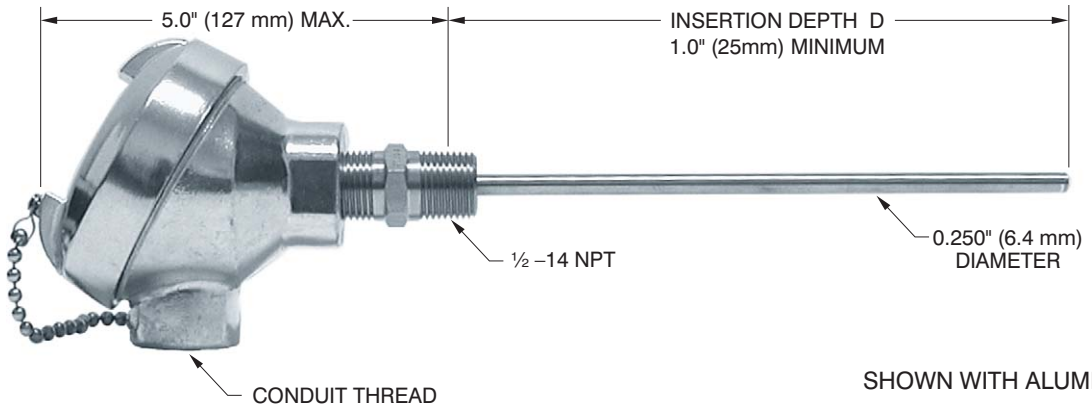
For guaranteed system accuracy of ± 0.75% of temperature span, specify transmitters with high-accuracy calibration as shown on page 5-13. Calibration data traceable to NIST will also be provided.

**IN STOCK**

Single element models (except PE)
Contact Minco for currently available Temptran models and ranges

## How to order

| | |
|---|---|
| AS5004 | **Assembly number:**<br>AS5004: Single element RTD<br>AS5005: Dual element RTD |
| PA | **Sensing element from table** |
| 67 | **Insertion depth D:**<br>Specify in 0.1" increments<br>(Ex: 67 = 6.7 inches) |
| Z | **Leads per sensing element:**<br>Y = 2 leads<br>Z = 3 leads (required for CA and CC copper elements)<br>X = 4 leads (PD elements only) |
| 2 | **Conduit thread:**<br>1 = ½ - 14 NPT<br>2 = ¾ - 14 NPT |
| C | **Connection head:**<br>C = Cast iron<br>A = Aluminum<br>S = Stainless steel |
| **To order standard assembly, stop here. To order with transmitters (single platinum element only, 2 or 3 leads) add:** | |
| 211 | **Temptran model:**<br>211 = TT211: 2-lead RTDs<br>176 = TT176: 3-lead RTDs<br>711 = TT711: 2-lead RTDs, match calibrated<br>676 = TT676: 3-lead RTDs, match calibrated |
| A | **Temperature range code:**<br>See page 5-10 for a list of codes |
| AS5004PA67Z2C211A ← Sample P/N | |




SHOWN WITH ALUMINUM HEAD

# Tip-Sensitive Spring-Loaded Thermocouples

- Tip-sensitive Thermocouple for use to 260°C (500°F)
- Spring-loaded holder with fluid seal
- Cast iron, stainless steel or aluminum connection head

Get fast and accurate readings from bearings, blocks, and other solids. Minco's spring-loaded holder ensures solid contact in drilled holes and has a built-in oil seal. The sensing probe features a copper alloy tip for quick response to temperature changes.

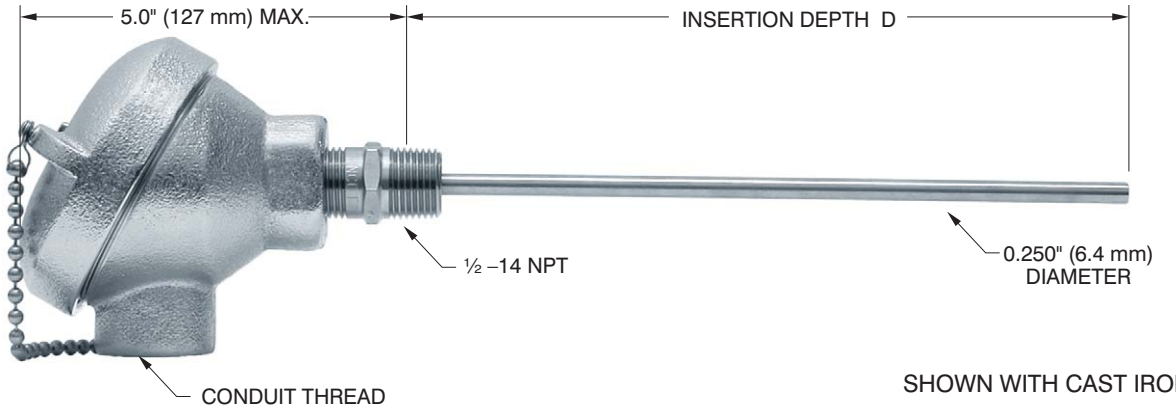
## Specifications

**Temperature range:**
-50 to 260°C (-58 to 500°F).
**Material:**
Probe: Stainless steel with copper alloy tip.
Holder: Stainless steel with Viton O-ring.
Connection head: Cast iron, aluminum, or stainless steel.
**Pressure rating:** 50 psi (3.4 bar).
**Insulation resistance:** 10 megohms min. at 100 VDC, leads to case. Ungrounded junctions only.
**Connection:** Terminal block for wires to 14 AWG.
**Time constant:** Typical value in moving water:
Grounded junction: 1.5 seconds.
Ungrounded junction: 7 seconds.

## How to order

| | |
|---|---|
| AS5192 | **Assembly number:**<br>AS5191: Single junction<br>AS5192: Dual junction |
| E | **Junction type:**<br>E = Chromel-Constantan<br>J = Iron-Constantan<br>K = Chromel-Alumel<br>T = Copper-Constantan |
| U | **Junction grounding:**<br>G = Grounded<br>U = Ungrounded |
| 133 | **Insertion depth D:**<br>Specify in 0.1" increments<br>(Ex: 133 = 13.3 inches) |
| P | |
| 1 | **Conduit thread:**<br>1 = ½ - 14 NPT<br>2 = ¾ - 14 NPT |
| C | **Connection head:**<br>C = Cast iron<br>A = Aluminum<br>S = Stainless steel |
| AS5192EU133P1C ← Sample P/N | |

**⚠ Thermocouple transmitters are available in section 5.**




SHOWN WITH CAST IRON HEAD

# Direct Immersion RTDs

- RTD probe for use to 260°C (500°F)
- Adjustable fluid seal fitting
- Cast iron, stainless steel, or aluminum connection head

Mount sensors directly in fluid flow for fast response. Probes are rated to 100 psi (6.9 bar). For non-corrosive fluids only.

## Specifications

**Temperature range:**
-50 to 260°C (-58 to 500°F).
**Material:**
Probe: Stainless steel.
Fitting: Stainless steel, silicone rubber O-ring.
Connection head: Cast iron, aluminum, or stainless steel.
**Pressure rating:** 100 psi (6.9 bar).
**Insulation resistance:** 100 megohms min. at 100 VDC, leads to case.
**Connection:** Terminal block for wires to 14 AWG.
**Time constant:** Typical value in moving water:
Single element: 2.0 seconds.
Dual element: 3.0 seconds.

| Sensing element | | Code |
|---|---|---|
| Platinum 392 | 100 Ω ±0.5% at 0°C | PA |
| Platinum 385 (Meets EN60751, Class B) | 100 Ω ±0.1% at 0°C | PD |
| Platinum 385 | 100 Ω ±0.5% at 0°C | PE |
| Copper | 10 Ω ±0.2% at 25°C | CA |
| (dual) | 10 Ω ±0.5% at 25°C | CC |
| Nickel | 120 Ω ±0.5% at 0°C | NA |

## Transmitters

Minco's Temptran™ transmitters provide a 4 to 20 mA signal that can be sent over long distances with a simple 2-wire system. Add any Minco model transmitter (except electrically isolated models). See Section 5 for complete details and ordering information.

TT211, TT711
miniature transmitter

TT176, TT676
standard transmitter

## Special high-accuracy calibration

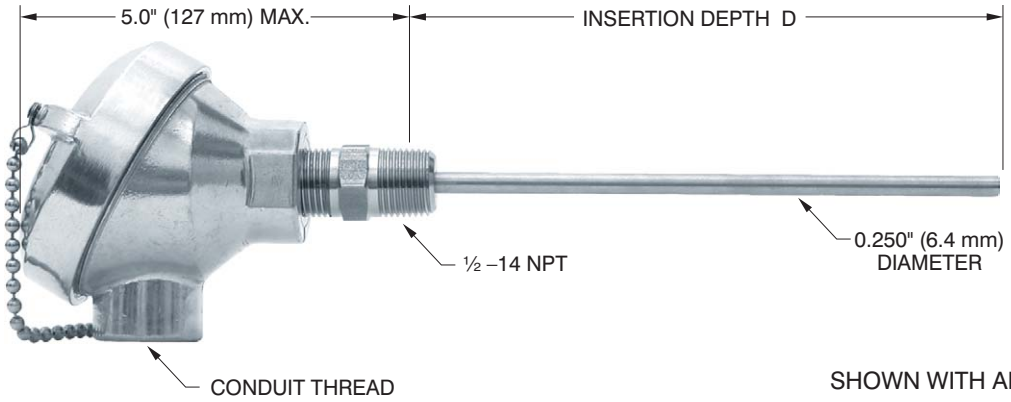
For guaranteed system accuracy of ± 0.75% of temperature span, specify transmitters with high-accuracy calibration as shown on page 5-13. Calibration data traceable to NIST will also be provided.

**IN STOCK**

Single element models (except PE)
Contact Minco for currently available Temptran models and ranges

## How to order

| | |
|---|---|
| AS5200 | **Assembly number:**<br>AS5200: Single element<br>AS5201: Dual element |
| PD | **Sensing element from table** |
| 100 | **Insertion depth D:**<br>Specify in 0.1" increments<br>(Ex: 100 = 10.0 inches) |
| Z | **Number of leads per sensing element:**<br>Y = 2 leads<br>Z = 3 leads (required for CA and CC copper elements)<br>X = 4 leads (PD elements only) |
| 2 | **Conduit thread:**<br>1 = ½ - 14 NPT<br>2 = ¾ - 14 NPT |
| C | **Connection head:**<br>C = Cast iron<br>A = Aluminum<br>S = Stainless steel |
| **To order standard assembly, stop here. To order with transmitters (single platinum element only, 2 or 3 leads) add:** | |
| 211 | **Temptran model:**<br>211 = TT211: 2-lead RTDs<br>176 = TT176: 3-lead RTDs<br>711 = TT711: 2-lead RTDs, match calibrated<br>676 = TT676: 3-lead RTDs, match calibrated |
| A | **Temperature range code:**<br>See page 5-10 for a list of codes |
| AS5200PD100Z2C211A ← Sample P/N | |




SHOWN WITH ALUMINUM HEAD

# Direct Immersion Thermocouples

- Thermocouple for use to 260°C (500°F)
- Adjustable fluid seal fitting
- Cast iron, stainless steel or aluminum connection head

Mount sensors directly in fluid flow for fast response. Probes are rated to 100 psi (6.9 bar). For non-corrosive fluids only.

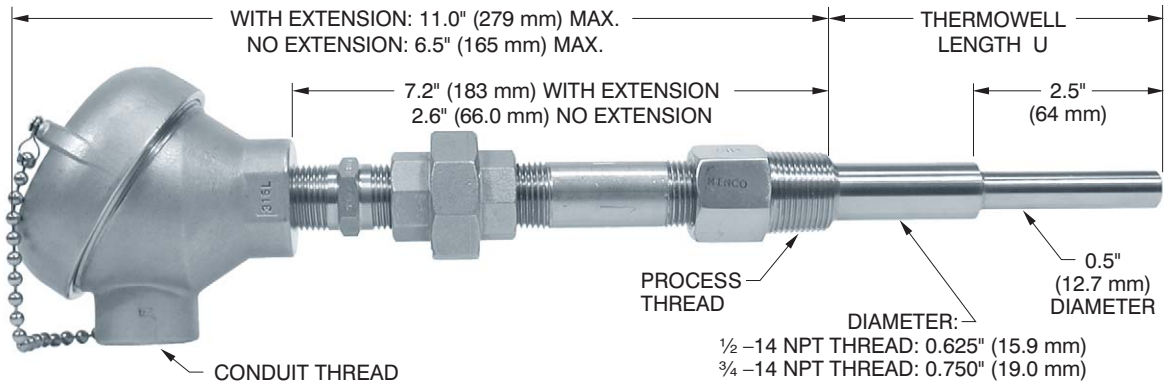
## Specifications

**Temperature range:**
-50 to 260°C (-58 to 500°F).
**Material:**
Probe: Stainless steel.
Fitting: Stainless steel, silicone rubber O-ring.
Connection head: Cast iron, aluminum, or stainless steel.
**Pressure rating:** 100 psi (6.9 bar).
**Insulation resistance:** 10 megohms min. at 100 VDC, leads to case. Ungrounded junctions only.
**Connection:** Terminal block for wires to 14 AWG.
**Time constant:** Typical value in moving water:
Grounded junction: 1.5 seconds.
Ungrounded junction: 7 seconds.

## How to order

| | |
|---|---|
| AS5206 | **Assembly number:**<br>AS5205: Single junction<br>AS5206: Dual junction |
| E | **Junction type:**<br>E = Chromel-Constantan<br>J = Iron-Constantan<br>K = Chromel-Alumel<br>T = Copper-Constantan |
| U | **Junction grounding:**<br>G = Grounded<br>U = Ungrounded |
| 215 | **Insertion depth D:**<br>Specify in 0.1" increments<br>(Ex: 215 = 21.5 inches) |
| P | |
| 1 | **Conduit thread:**<br>1 = ½ - 14 NPT<br>2 = ¾ - 14 NPT |
| C | **Connection head:**<br>C = Cast iron<br>A = Aluminum<br>S = Stainless steel |
| AS5206EU215P1C ← Sample P/N | |

**⚠ Thermocouple transmitters are available in section 5.**




SHOWN WITH STAINLESS STEEL HEAD AND UNION/NIPPLE EXTENSION

# Tip-Sensitive RTDs With Thermowells

- 316 stainless steel thermowell
- Tip-sensitive RTD probe for use to 260°C (500°F)
- Spring-loaded probe
- Cast iron, stainless steel, or aluminum connection head

Thermowells protect sensors from the effects of fluid flow and pressure. These assemblies are spring-loaded for positive probe contact against the bottom of the thermowell. The probe's copper alloy tip provides superior time response and reduces error from stem conduction.

## Specifications

**Temperature range:**
-50 to 260°C (-58 to 500°F).
**Material:**
Probe: Stainless steel with copper alloy tip.
Connection head: Cast iron, aluminum, or stainless steel.
Thermowell: 316 stainless steel.
Extension: Stainless steel.
**Pressure rating:** 7000 psi (483 bar) at 21°C, reducing to 6300 psi (433 bar) at 260°C.
**Standard U dimensions:** 2.5, 4.5, 6.0, 7.5, 8.0, 10.5, 13.5, 16.5, and 22.5".
**Insulation resistance:** 100 megohms min. at 100 VDC, leads to case.
**Connection:** Terminal block for wires to 14 AWG.
**Time constant:** 17 seconds typical in moving water.

| Sensing element | | Code |
|---|---|---|
| Platinum 392 | 100 Ω ±0.5% at 0°C | PA |
| Platinum 385 (Meets EN60751, Class B) | 100 Ω ±0.1% at 0°C | PD |
| Platinum 385 | 100 Ω ±0.5% at 0°C | PE |
| Copper | 10 Ω ±0.2% at 25°C | CA |
| (dual) | 10 Ω ±0.5% at 25°C | CC |
| Nickel | 120 Ω ±0.5% at 0°C | NA |

## Transmitters

Minco's Temptran™ transmitters provide a 4 to 20 mA signal that can be sent over long distances with a simple 2-wire system. Add any Minco model transmitter (except electrically isolated models). See Section 5 for complete details and ordering information.

TT211, TT711
miniature transmitter

TT176, TT676
standard transmitter

## Special high-accuracy calibration

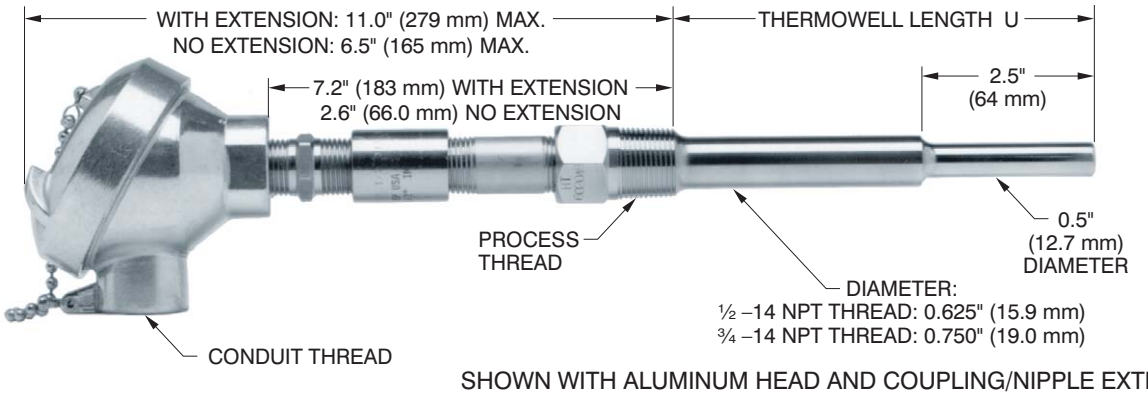
For guaranteed system accuracy of ± 0.75% of temperature span, specify transmitters with high-accuracy calibration as shown on page 5-13. Calibration data traceable to NIST will also be provided.

**IN STOCK**

Standard thermowell lengths to 8.0"
Single element models (except PE)
Contact Minco for currently available Temptran models and ranges

## How to order

| | |
|---|---|
| AS5140 | **Assembly number:**<br>AS5140: Single element RTD<br>AS5141: Dual element RTD |
| CA | **Sensing element from table** |
| 60 | **Thermowell length U:**<br>Specify in 0.1" increments<br>(Ex: 60 = 6.0 inches) |
| Z | **Leads per sensing element:**<br>Y = 2 leads<br>Z = 3 leads (required for CA and CC copper elements)<br>X = 4 leads (PD elements only) |
| 2 | **Conduit thread:**<br>1 = ½ - 14 NPT<br>2 = ¾ - 14 NPT |
| C | **Connection head:**<br>C = Cast iron<br>A = Aluminum<br>S = Stainless steel |
| 1 | **Thermowell process thread:**<br>1 = ½ - 14 NPT<br>2 = ¾ - 14 NPT |
| U | **Extension option:**<br>P = Coupling/nipple extension<br>N = No extension<br>U = Union/Nipple extension |
| **To order standard assembly, stop here. To order with transmitters (single platinum element only, 2 or 3 leads) add:** | |
| 211 | **Temptran model:**<br>211 = TT211: 2-lead RTDs<br>176 = TT176: 3-lead RTDs<br>711 = TT711: 2-lead RTDs, match calibrated<br>676 = TT676: 3-lead RTDs, match calibrated |
| A | **Temperature range code:**<br>See page 5-10 for a list of codes |
| AS5140CA60Z2C1U211A ← Sample P/N | |




SHOWN WITH ALUMINUM HEAD AND COUPLING/NIPPLE EXTENSION

# Tip-Sensitive Thermocouples With Thermowells

- 316 stainless steel thermowell
- Tip-sensitive thermocouple for use to 260°C (500°F)
- Spring-loaded probe
- Cast iron, stainless steel, or aluminum connection head

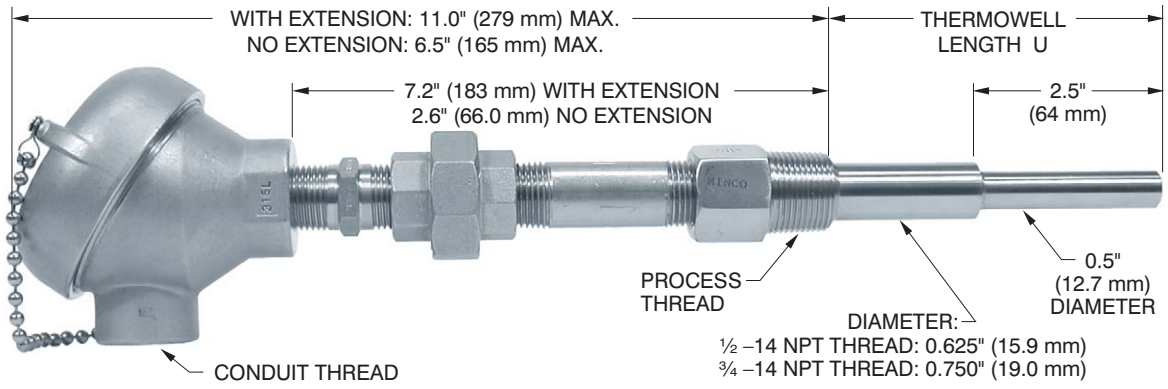
## Specifications

**Temperature range:**
-50 to 260°C (-58 to 500°F).
**Material:**
Probe: Stainless steel with copper alloy tip.
Connection head: Cast iron, aluminum, or stainless steel.
Thermowell: 316 stainless steel.
Extension: Stainless steel.
**Pressure rating:** 7000 psi (483 bar) at 21°C, reducing to 6300 psi (433 bar) at 260°C.
**Standard U dimensions:** 2.5, 4.5, 6.0, 7.5, 8.0, 10.5, 13.5, 16.5, and 22.5".
**Insulation resistance:** 10 megohms min. at 100 VDC, leads to case. Ungrounded junctions only.
**Connection:** Terminal block for wires to 14 AWG.
**Time constant:** Typical value in moving water.
Grounded junction: 17 seconds.
Ungrounded junction: 22 seconds.

## How to order

| | |
|---|---|
| AS5145 | **Assembly number:**<br>AS5145: Single junction TC<br>AS5146: Dual junction TC |
| E | **Junction type:**<br>E = Chromel-Constantan<br>J = Iron-Constantan<br>K = Chromel-Alumel<br>T = Copper-Constantan |
| G | **Junction Grounding:**<br>G = Grounded<br>U = Ungrounded |
| 135 | **Thermowell length U:**<br>Specify in 0.1" increments<br>(Ex: 135 = 13.5 inches) |
| P | |
| 1 | **Conduit thread:**<br>1 = ½ - 14 NPT<br>2 = ¾ - 14 NPT |
| C | **Connection head:**<br>C = Cast iron<br>A = Aluminum<br>S = Stainless steel |
| 1 | **Thermowell process thread:**<br>1 = ½ - 14 NPT<br>2 = ¾ - 14 NPT |
| U | **Extension option:**<br>P = Coupling/nipple extension<br>N = No extension<br>U = Union/Nipple extension |
| AS5145EG135P1C1U ← Sample P/N | |

**Thermocouple transmitters are available in section 5.**




SHOWN WITH STAINLESS STEEL HEAD AND UNION/NIPPLE EXTENSION

# 550°C RTDs With Thermowells

- 316 stainless steel thermowell
- RTD probe for use to 550°C (1022°F)
- Spring-loaded probe
- Cast iron, stainless steel, or aluminum connection head

Sense temperature in high-pressure fluids and gases. These assemblies are spring-loaded for positive probe contact against the bottom of the thermowell.

Note: For temperatures less than 260°C (500°F), assemblies using tip-sensitive sensors are recommended.

## Specifications

**Temperature range:**
Thermowell and sensor:
-100 to 550°C (-148 to 1022°F).
Connection head:
Cast iron: 260°C (500°F) max.
Aluminum: 316°C (600°F) max.
Stainless steel: 121°C (250°F) max.
**Material:**
Probe: 316 stainless steel.
Connection head: Cast iron, aluminum, or stainless steel.
Thermowell: 316 stainless steel.
Extension: Stainless steel.
**Pressure rating:** 7000 psi (483 bar) at 21°C, reducing to 2500 psi (172 bar) at 550°C.
**Standard U dimensions:** 2.5, 4.5, 6.0, 7.5, 8.0, 10.5, 13.5, 16.5, and 22.5".
**Insulation resistance:** 10 megohms min. at 100 VDC, leads to case.
**Connection:** Terminal block for wires to 14 AWG.
**Time constant:**
23 seconds typical in moving water.

| Sensing element | Code |
|---|---|
| Platinum 391 100 Ω ±0.1% at 0°C | PB |
| Platinum 385 100 Ω ±0.1% at 0°C (Meets EN60751, Class B) | PD |

## Transmitters

Minco's Temptran™ transmitters provide a 4 to 20 mA signal that can be sent over long distances with a simple 2-wire system. Add any Minco model transmitter (except electrically isolated models). See Section 5 for complete details and ordering information.

TT211, TT711 miniature transmitter

TT176, TT676 standard transmitter

## Special high-accuracy calibration

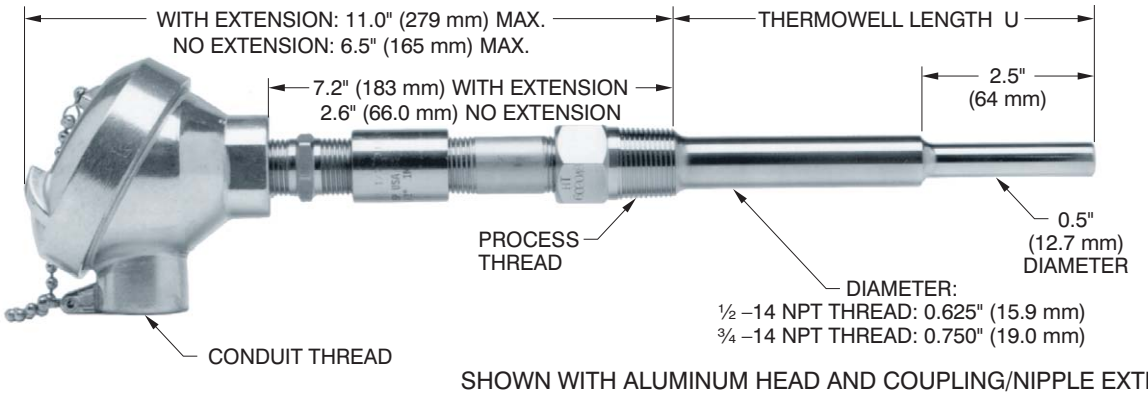
For guaranteed system accuracy of ± 0.75% of temperature span, specify transmitters with high-accuracy calibration as shown on page 5-13. Calibration data traceable to NIST will also be provided.

**IN STOCK**

Standard thermowell dimensions 2.5, 4.5, 6.0, 7.5, 8.0"
Single element models (except PE)
Contact Minco for currently available Temptran models and ranges

## How to order

| | |
|---|---|
| AS5160 | **Assembly number: AS5160** |
| PB | **Sensing element from table** |
| 105 | **Thermowell length U:** Specify in 0.1" increments (Ex: 105 =10.5 inches) |
| Z | **Number of leads:** Y = 2 leads<br>Z = 3 leads<br>X = 4 leads (PD elements only) |
| 2 | **Conduit thread:** 1 = ½ - 14 NPT<br>2 = ¾ - 14 NPT |
| C | **Connection head:** C = Cast iron<br>A = Aluminum<br>S = Stainless steel |
| 1 | **Thermowell process thread:** 1 = ½ - 14 NPT<br>2 = ¾ - 14 NPT |
| U | **Extension option:** P = Coupling/nipple extension<br>N = No extension<br>U = Union/Nipple extension |
| **To order standard assembly, stop here. To order with transmitters (2 or 3 leads), add:** | |
| 211 | **Temptran model:** 211 = TT211: 2-lead RTDs<br>176 = TT176: 3-lead RTDs<br>711 = TT711: 2-lead RTDs, match calibrated<br>676 = TT676: 3-lead RTDs, match calibrated |
| A | **Temperature range code:** See page 5-10 for a list of codes |
| AS5160PB105Z2C1U211A ← Sample P/N | |




SHOWN WITH ALUMINUM HEAD AND COUPLING/NIPPLE EXTENSION

# 550°C Thermocouples With Thermowells

- 316 stainless steel thermowell
- Thermocouple probe for use to 550°C (1022°F)
- Spring-loaded probe
- Cast iron, aluminum or stainless steel connection head

Sense temperature in high-pressure fluids and gases. These assemblies are spring-loaded for positive probe contact against the bottom of the thermowell.

Note: For temperatures less than 260°C (500°F), assemblies using tip-sensitive sensors are recommended.

## Specifications

**Temperature range:**
Thermowell and sensor:
-100 to 550°C (-148 to 1022°F).
Connection head:
Cast iron: 260°C (500°F) max.
Aluminum: 316°C (600°F) max.
Stainless steel: 121°C (250°F) max.
**Material:**
Probe: 316 stainless steel.
Connection head: Cast iron, aluminum, or stainless steel.
Thermowell: 316 stainless steel.
Extension: Stainless steel.
**Pressure rating:** 7000 psi (483 bar) at 21°C, reducing to 2500 psi (172 bar) at 550°C.
**Standard U dimensions:** 2.5, 4.5, 6.0, 7.5, 8.0, 10.5, 13.5, 16.5, and 22.5".
**Insulation resistance:** 10 megohms min. at 100 VDC, leads to case. Ungrounded junctions only.
**Connection:** Terminal block for wires to 14 AWG.
**Time constant:** 60 seconds typical in moving water.

## How to order

| | |
|---|---|
| AS5165 | **Assembly number: AS5165** |
| K | **Junction type:**<br>E = Chromel-Constantan<br>J = Iron-Constantan<br>K = Chromel-Alumel |
| U | **Junction grounding:**<br>G = Grounded<br>U = Ungrounded |
| 135 | **Thermowell length U:**<br>Specify in 0.1" increments<br>(Ex: 135 = 13.5 inches) |
| P | |
| 1 | **Conduit thread:**<br>1 = ½ - 14 NPT<br>2 = ¾ - 14 NPT |
| C | **Connection head:**<br>C = Cast iron<br>A = Aluminum<br>S = Stainless steel |
| 1 | **Thermowell process thread:**<br>1 = ½ - 14 NPT<br>2 = ¾ - 14 NPT |
| U | **Extension option:**<br>P = Coupling/nipple extension<br>N = No extension<br>U = Union/Nipple extension |
| AS5165KU135P1C1U ← Sample P/N | |

**⚠ Thermocouple transmitters are available in section 5.**

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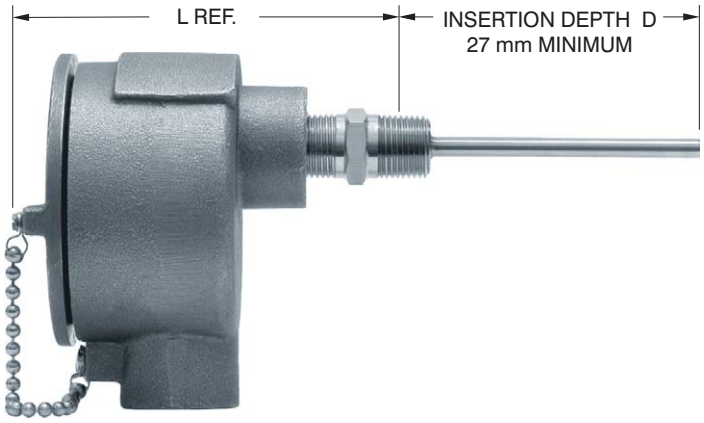


# Flameproof/Explosionproof Sensors

- Tip sensitive, all stainless or MgO filled probes available
- RTD or thermocouple sensors
- Hazardous area rated

## Specifications

**Temperature range:**
-50 to 260°C (-58 to 500°F).
**Material:**
Probe: Stainless steel (tip sensitive models have copper alloy tip).
Holder: Stainless steel.
Connection head:
Copper free aluminum alloy (CH104)
316L stainless steel (CH106).
**Pressure rating:** See table on facing page.
**Insulation resistance:** 10 megohms min. at 100 VDC, leads to case. Ungrounded junctions only on thermocouples.
**Connection:** Terminal block for wires to 14 AWG.
**Time constant:** Typical value in moving water.
Tip sensitive: 3 seconds.
All stainless and MgO filled: 10 seconds.
**Explosionproof and flameproof ratings:**
National and Canadian Electrical Code:
Class I, Divisions 1 and 2, Groups B, C, and D,
Class II, Groups E, F, and G,
T6 (Ta = 40°C),
T2 (Ta = 260°C). Ta limited to 160°C for CSA Class II locations.
National Electrical Code (Article 505):
Class I, Zones 1 and 2, AEx d IIC,
T6 (Ta =40°C), T2 (Ta = 260°C).
Canadian Electrical Code (IEC 60079):
Class 1, Zones 1 and 2, Ex d IIC,
T6 (Ta = 40°C), T2 (Ta = 260°C).

## How to order RTDs

| | |
|---|---|
| AS720 | **Assembly number:** (see table on facing page) |
| 4 | **Connection head/fitting:** (see table on facing page) |
| PD | **Sensing element:** (see table on facing page) |
| 100 | **Insertion depth D (in mm):** (43–1219 mm) |
| X | **Number of leads:** Y = 2 leads (n/a for copper) Z = 3 leads X = 4 leads (n/a for dual models) |
| 3 | **Conduit thread:** 3 = ½ - 14 NPT 4 = ¾ - 14 NPT |

AS7204PD100X3 ← Sample P/N

## How to order thermocouples

| | |
|---|---|
| AS706 | **Assembly number:** (see table on facing page) |
| 4 | **Connection head/fitting:** (see table on facing page) |
| E | **Junction type:** (see table on facing page) |
| U | **Junction Grounding:** G = Grounded U = Ungrounded |
| 100 | **Insertion depth D (in mm):** (27–3000 mm) |
| P | |
| 3 | **Conduit thread:** 3 = ½ - 14 NPT 4 = ¾ - 14 NPT |

AS7064EU100P3 ← Sample P/N

## Hazardous Area Requirements

Request Application Aid #19 for information on how to classify a hazardous area, methods of protection, and the various standards and agencies (including FM, CSA, CENELEC and ATEX).

# Flameproof/Explosionproof Sensors

## RTDs

| Probe diameters | 0.215" (5.5 mm) | | 0.236" (6.0 mm) | | 0.250" (6.4 mm) | |
|---|---|---|---|---|---|---|
| **Number of elements** | Single | Dual | Single | Dual | Single | Dual |
| Tip-sensitive | AS760 | AS761 | AS700 | AS701 | AS720 | AS721 |
| All stainless | AS762 | AS763 | AS702 | AS703 | AS722 | AS723 |
| MgO filled (platinum only) | | | AS704 | | AS724 | |

| Sensing element | | Code | |
|---|---|---|---|
| | | Single | Dual |
| Platinum 392 | 100 Ω ±0.5% at 0°C | PA | PAPA |
| Platinum 385 (Meets EN60751, Class B) | 100 Ω ±0.1% at 0°C | PD | PDPD |
| Platinum 385 | 100 Ω ±0.5% at 0°C | PE | PEPE |
| Copper | 10 Ω ±0.2% at 25°C | CA | |
| (dual) | 10 Ω ±0.5% at 25°C | | CCCC |
| Nickel 672 | 120 Ω ±0.5% at 0°C | NA | NANA |
| Nickel 618 | 100 Ω ±0.22% at 0°C | NB | NBNB |

## Thermocouples

| Probe diameters | 0.215" (5.5 mm) | | 0.236" (6.0 mm) | | 0.250" (6.4 mm) | |
|---|---|---|---|---|---|---|
| **Number of elements** | Single | Dual | Single | Dual | Single | Dual |
| Tip-sensitive | AS766 | AS767 | AS706 | AS707 | AS726 | AS727 |
| MgO filled | | | AS708 | AS709 | AS728 | AS729 |

| Thermocouple Junction | Code | |
|---|---|---|
| | Single | Dual |
| Chromel-Constantan | E | EE |
| Iron-Constantan | J | JJ |
| Chromel-Alumel | K | KK |
| Copper-Constantan | T | TT |

## Connection head and fitting options

CH104: Aluminum IP65, Type 3 and 4.
CH106: 316L stainless steel IP66, Type 3, 4, and 4X.

| Fitting | Process thread | Pressure Rating | L REF. | Head | Code |
|---|---|---|---|---|---|
| Welded | ½ - 14 NPT | 200 psi (13.8 bar) | 4.4" (112 mm) | CH104 | 0* |
| Welded | ½ - 14 NPT | 200 psi (13.8 bar) | 4.2" (106 mm) | CH106 | 1* |
| Welded | G½ | 200 psi (13.8 bar) | 4.2" (107 mm) | CH104 | 2* |
| Welded | G½ | 200 psi (13.8 bar) | 4.0" (101 mm) | CH106 | 3* |
| Spring-loaded holder | ½ - 14 NPT | 50 psi (3.4 bar) | 5.7" (144 mm) | CH104 | 4 |
| Spring-loaded holder | ½ - 14 NPT | 50 psi (3.4 bar) | 5.4" (138 mm) | CH106 | 5 |
| Spring-loaded holder | G½ | 50 psi (3.4 bar) | 5.7" (144 mm) | CH104 | 6 |
| Spring-loaded holder | G½ | 50 psi (3.4 bar) | 5.4" (138 mm) | CH106 | 7 |

* 0.250 diameter only for all stainless and MgO probes.

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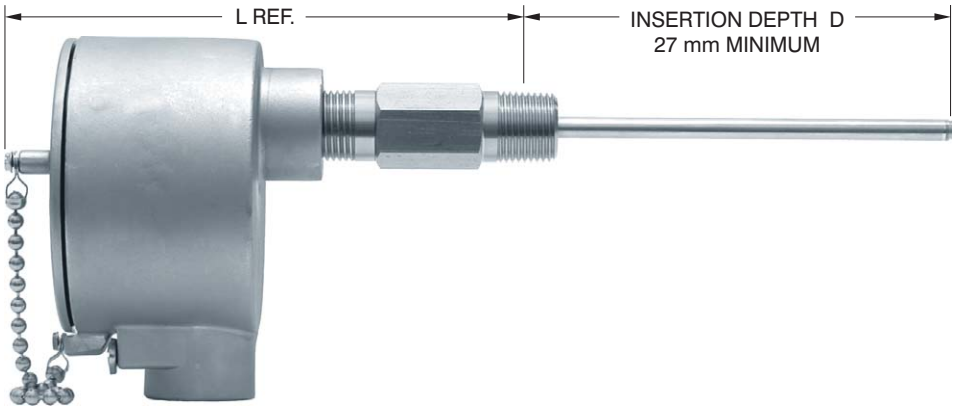


# Flameproof/Explosionproof RTDs With Transmitters

- Tip sensitive, all stainless or MgO filled RTD probe
- Temptran transmitter for long signal path
- Hazardous area rated

## Specifications

**Temperature range:**
-50 to 260°C (-58 to 500°F).
**Material:**
Probe: Stainless steel (tip sensitive models have copper alloy tip).
Holder: Stainless steel.
Connection head:
Copper free aluminum alloy (CH104)
316L stainless steel (CH106).
**Pressure rating:** See table on facing page.
**Insulation resistance:** 10 megohms min. at 100 VDC, leads to case.
**Connection:** Terminal block for wires to 14 AWG.
**Time constant:** Typical value in moving water.
Tip sensitive: 3 seconds.
All stainless and MgO filled: 10 seconds.
**Explosionproof and flameproof ratings:**
National and Canadian Electrical Code:
Class I, Divisions 1 and 2, Groups B, C, and D,
Class II, Groups E, F, and G,
T6 (Ta = 40°C),
T2 (Ta = 260°C). Ta limited to 160°C for CSA Class II locations.
National Electrical Code (Article 505):
Class I, Zones 1 and 2, AEx d IIC,
T6 (Ta =40°C), T2 (Ta = 260°C).
Canadian Electrical Code (IEC 60079):
Class 1, Zones 1 and 2, Ex d IIC,
T6 (Ta = 40°C), T2 (Ta = 260°C).

## Transmitters

**Output:** 4 to 20 mA over specified range, linear with temperature.
**Calibration accuracy:** ±0.1% of span.
**Linearity:** 0.1% of span.
**Adjustments:** Zero and span, ±5% of span. Factory calibrated to nominal R/T curve.
**Ambient operating temperature:**
TT211, TT711: -25 to 85°C (-13 to 185°F).
TT176, TT676: -40 to 85°C (-40 to 185°F).
**Supply voltage:** 10 to 35 VDC.
**Maximum load resistance:**

$$R_{loop\ max} = \frac{V_{supply} - 10}{0.020\ \text{amps}}$$

**Leadwires:**
TT211, TT711: 2-lead RTD.
TT176, TT676: 3-lead RTD for resistance compensation.
**Physical:** Epoxy potted for moisture resistance.
**Mounting:** Transmitter mounts in connection head.

TT211, TT711
miniature transmitter

TT176, TT676
standard transmitter

## Special high-accuracy calibration

For guaranteed system accuracy of ± 0.75% of temperature span, specify transmitters with high-accuracy calibration as shown on page 5-13. Calibration data traceable to NIST will also be provided.

## How to order

| | |
|---|---|
| AS710 | **Assembly number:** (see table on facing page) |
| 4 | **Connection head/fitting:** (see table on facing page) |
| TT176 | **Temptran model number:** TT211: 2-lead RTDs<br>TT176: 3-lead RTDs<br>TT711: 2-lead RTDs, match calibrated<br>TT676: 3-lead RTDs, match calibrated |
| N | **Code for temperature range:** (see table on facing page) |
| 100 | **Insertion depth D (in mm):** (27 – 3000 mm) |
| PD | **Sensing element** |
| 3 | **Conduit thread:** 3 = ½ - 14 NPT<br>4 = ¾ - 14 NPT |
| AS7104TT176N100PD3 ← Sample P/N | |

## Hazardous Area Requirements

Request Application Aid #19 for information on how to classify a hazardous area, methods of protection, and the various standards and agencies (including FM, CSA, CENELEC and ATEX).

# Flameproof/Explosionproof RTDs With Transmitters

## RTD with Transmitter

| Probe diameters | 0.215" (5.5 mm) | 0.236" (6.0 mm) | 0.250" (6.4 mm) |
|---|---|---|---|
| Tip-sensitive | AS770 | AS710 | AS730 |
| All stainless | AS772 | AS712 | AS732 |
| MgO filled | | AS714 | AS734 |

## Transmitters:

**Popular ranges:**

| Code | Range | |
|---|---|---|
| EO | -50 to 100°C | -58 to 212°F |
| BC | -30 to 30°C | -22 to 86°F |
| S | -17.8 to 37.8°C | 0 to 100°F |
| AC | -17.8 to 93.3°C | 0 to 200°F |
| AN | -17.8 to 148.9°C | 0 to 300°F |
| AG | -17.8 to 260°C | 0 to 500°F |
| AP | -6.7 to 21.1°C | 20 to 70°F |
| A | -6.7 to 48.9°C | 20 to 120°F |
| N | 0 to 50°C | 32 to 122°F |
| C | 0 to 100°C | 32 to 212°F |
| J | 0 to 150°C | 32 to 302°F |
| K | 0 to 200°C | 32 to 392°F |
| V | 10 to 65.6°C | 50 to 150°F |
| P | 37.8 to 179.4°C | 100 to 355°F |
| BH | 50 to 150°C | 122 to 302°F |

⚠ Complete range table is on page 5-10.

## Connection head and fitting options

CH104: Aluminum IP65, Type 3 and 4.
CH106: 316L stainless steel IP66, Type 3, 4, and 4X.

| Fitting | Process thread | Pressure Rating | L REF. | Head | Code |
|---|---|---|---|---|---|
| Welded | ½ - 14 NPT | 200 psi (13.8 bar) | 4.4" (112 mm) | CH104 | 0* |
| Welded | ½ - 14 NPT | 200 psi (13.8 bar) | 4.2" (106 mm) | CH106 | 1* |
| Welded | G½ | 200 psi (13.8 bar) | 4.2" (107 mm) | CH104 | 2* |
| Welded | G½ | 200 psi (13.8 bar) | 4.0" (101 mm) | CH106 | 3* |
| Spring-loaded holder | ½ - 14 NPT | 50 psi (3.4 bar) | 5.7" (144 mm) | CH104 | 4 |
| Spring-loaded holder | ½ - 14 NPT | 50 psi (3.4 bar) | 5.4" (138 mm) | CH106 | 5 |
| Spring-loaded holder | G½ | 50 psi (3.4 bar) | 5.7" (144 mm) | CH104 | 6 |
| Spring-loaded holder | G½ | 50 psi (3.4 bar) | 5.4" (138 mm) | CH106 | 7 |

* 0.250 diameter only for all stainless and MgO probes.

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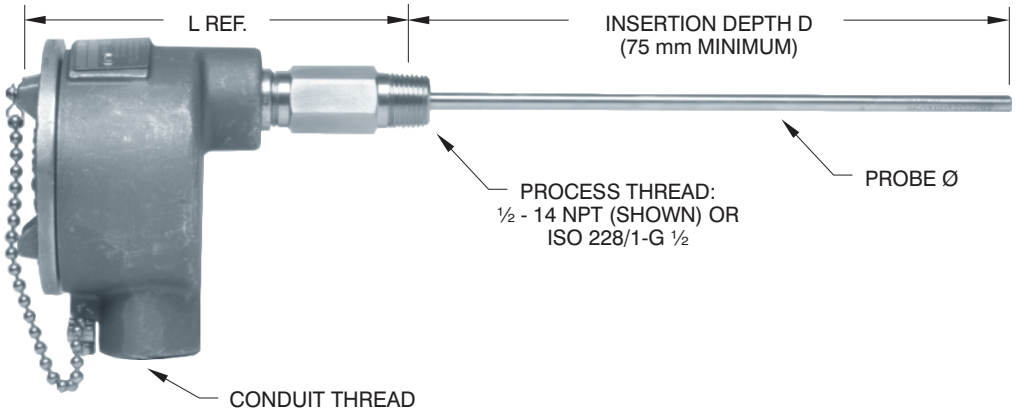



# Flameproof Sensors

- Approved for use in hazardous locations defined by CENELEC EN50014 and EN50018, ATEX directive 94/4/EC (KEMA 03 ATEX 2389)
- Features tip-sensitive, all stainless or MgO filled RTD or thermocouple probe for fast response
- Spring-loaded holder ensures good probe contact
- U.S. or European threads

Flameproof sensors are designed to contain an explosion, and prevent the transmission of the explosion to the surrounding atmosphere. These sensors are suitable for use in Zone 1 or Zone 2.

## Specifications

**Temperature range:**
-50 to 260°C (-58 to 500°F).
**Material:**
Tip-sensitive probe: Stainless steel with copper alloy tip.
All stainless RTD: Stainless steel.
MgO filled RTD: Inconel.
MgO filled thermocouple: Stainless steel.
Fittings: Stainless steel.
Connection head:
CH357: Copper free aluminum alloy; IP65.
CH358: Epoxy coated copper free; IP66.
**Pressure rating:** Spring-loaded holder: 50 psi (3.4 bar). Fluid seal fitting: 100 psi (6.9 bar).
**Insulation resistance:** 100 megohms min. at 100 VDC, leads to probe case. Ungrounded junction models only on thermocouples.
**Connection:** Terminal block for wires up to AWG 14.

## How to order RTDs

| | |
|---|---|
| MAS600 | **Assembly number:** (see table on facing page) |
| 4 | **Connection head/fitting:** (see table on facing page) |
| CA | **Sensing element:** (see table on facing page) |
| 100 | **Insertion depth D (in mm):** (75 – 1219 mm) |
| X | **Number of leads:** Y = 2 leads (n/a for copper) Z = 3 leads X = 4 leads (n/a for dual models) |
| 3 | **Conduit thread:** 3 = ½ - 14 NPT 4 = ¾ - 14 NPT |

MAS6004CA100X3 ← Sample P/N

## How to order thermocouples

| | |
|---|---|
| MAS607 | **Assembly number:** (see table on facing page) |
| 5 | **Connection head/fitting:** (see table on facing page) |
| EE | **Junction type:** (see table on facing page) |
| U | **Junction Grounding:** G = Grounded U = Ungrounded |
| 450 | **Insertion depth D (in mm):** (75 – 1219 mm) |
| P | |
| 3 | **Conduit thread:** 3 = ½ - 14 NPT 4 = ¾ - 14 NPT |

MAS6075EEU450P3 ← Sample P/N

## Hazardous Area Requirements

Request Application Aid #19 for information on how to classify a hazardous area, methods of protection, and the various standards and agencies (including FM, CSA, CENELEC and ATEX).

# Flameproof Sensors

## RTDs

| Probe diameters | 0.236" (6.0 mm) | | 0.250" (6.4 mm) | |
|---|---|---|---|---|
| **Number of elements** | Single | Dual | Single | Dual |
| Tip-sensitive | MAS600 | MAS601 | MAS620 | MAS621 |
| All stainless | MAS602 | MAS603 | MAS622 | MAS623 |
| Platinum, MgO filled* | MAS604 | | MAS624 | |

*MAS604_ and MAS624_, not available with head/fitting options “8” or “9”.

| Sensing element | | Code | |
|---|---|---|---|
| | | Single | Dual |
| Platinum 392 | 100 Ω ±0.5% at 0°C | PA | PAPA |
| Platinum 385 (Meets EN60751, Class B) | 100 Ω ±0.1% at 0°C | PD | PDPD |
| Platinum 385 | 100 Ω ±0.5% at 0°C | PE | PEPE |
| Copper | 10 Ω ±0.2% at 25°C | CA | |
| (dual) | 10 Ω ±0.5% at 25°C | | CCCC |
| Nickel 672 | 120 Ω ±0.5% at 0°C | NA | NANA |
| Nickel 618 | 100 Ω ±0.22% at 0°C | NB | NBNB |

## Thermocouples

| Probe diameters | 0.236" (6.0 mm) | | 0.250" (6.4 mm) | |
|---|---|---|---|---|
| **Number of elements** | Single | Dual | Single | Dual |
| Tip-sensitive | MAS606 | MAS607 | MAS626 | MAS627 |
| MgO filled | MAS608 | MAS609 | MAS628 | MAS629 |

| Thermocouple Junction | Code | |
|---|---|---|
| | Single | Dual |
| Chromel-Constantan | E | EE |
| Iron-Constantan | J | JJ |
| Chromel-Alumel | K | KK |
| Copper-Constantan | T | TT |

## Connection head and fitting options

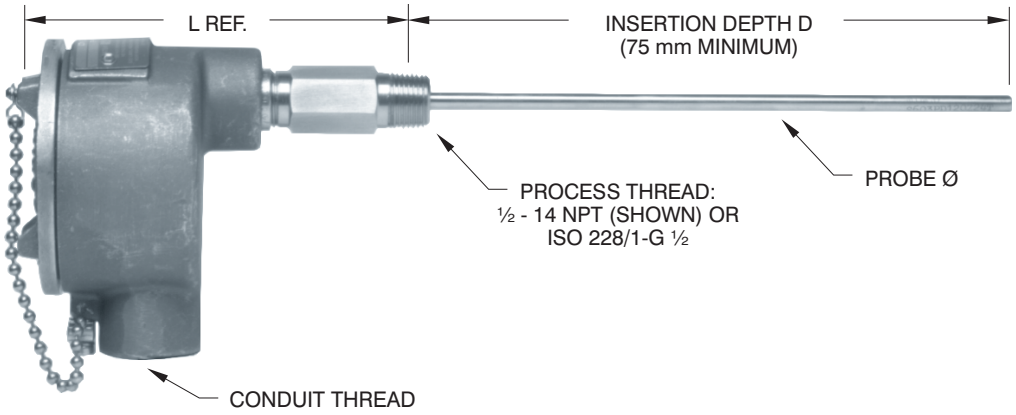
CH357: Aluminum alloy; meets IP65.
CH358: Epoxy coated; meets IP66.

| Fitting | Process thread | L REF. | Head | Code |
|---|---|---|---|---|
| Fluid seal | ½ - 14 NPT | 4.6" (117 mm) | CH357 | 0 |
| Fluid seal | ½ - 14 NPT | 4.6" (117 mm) | CH358 | 1 |
| Fluid seal | G½ | 4.4" (111 mm) | CH357 | 2 |
| Fluid seal | G½ | 4.4" (111 mm) | CH358 | 3 |
| Set screw spring-loaded holder | ½ - 14 NPT | 5.6" (143 mm) | CH357 | 4 |
| Set screw spring-loaded holder | ½ - 14 NPT | 5.6" (143 mm) | CH358 | 5 |
| Set screw spring-loaded holder | G½ | 5.4" (136 mm) | CH357 | 6 |
| Set screw spring-loaded holder | G½ | 5.4" (136 mm) | CH358 | 7 |
| Release knob spring-loaded holder | ½ - 14 NPT | 5.7" (144 mm) | CH357 | 8* |
| Release knob spring-loaded holder | ½ - 14 NPT | 5.7" (144 mm) | CH358 | 9* |

*MAS604_ and MAS624_, not available with head/fitting options “8” or “9”.

CE 0344

II 2 G EEx d IIC T6




# Flameproof RTDs With Transmitters

- Approved for use in hazardous locations defined by CENELEC EN50014 and EN50018, ATEX directive 94/4/EC (KEMA 03 ATEX 2389)
- Features tip-sensitive RTD probe for fast response
- Spring-loaded holder ensures good probe contact
- U.S. or European threads
- Temperature transmitters for 2-lead RTDs or 3-lead RTDs

Flameproof sensors are designed to contain an explosion, and prevent the transmission of the explosion to the surrounding atmosphere. These sensors are suitable for use in Zone 1 or Zone 2.

## Specifications

**Temperature range:**
-50 to 260°C (-58 to 500°F).
**Material:**
Tip-sensitive probe: Stainless steel with copper alloy tip.
All stainless RTD: Stainless steel.
MgO filled RTD: Inconel.
MgO filled thermocouple: Stainless steel.
Fittings: Stainless steel.
Connection head:
CH357: Aluminum alloy; meets IP65.
CH358: Epoxy coated; meets IP66.
**Pressure rating:** Spring-loaded holder: 50 psi (3.4 bar). Fluid seal fitting: 100 psi (6.9 bar).
**Insulation resistance:** 100 megohms min. at 100 VDC, leads to probe case.
**Connection:** Terminal block for wires up to AWG 14.

## Transmitters

**Output:** 4 to 20 mA over specified range, linear with temperature.
**Calibration accuracy:** ±0.1% of span.
**Linearity:** 0.1% of span.
**Adjustments:** Zero and span, ±5% of span. Factory calibrated to nominal R/T curve.
**Ambient operating temperature:**
TT211, TT711: -25 to 85°C (-13 to 185°F).
TT176, TT676: -40 to 85°C (-40 to 185°F).
**Supply voltage:** 10 to 35 VDC.
**Maximum load resistance:**

$$R_{loop\ max} = \frac{V_{supply} - 10}{0.020\ \text{amps}}$$

**Leadwires:**
TT211, TT711: 2-lead RTD.
TT176, TT676: 3-lead RTD for resistance compensation.
**Physical:** Epoxy potted for moisture resistance.
**Mounting:** Transmitter mounts in connection head.

TT211, TT711
miniature transmitter

TT176, TT676
standard transmitter

## Special high-accuracy calibration

For guaranteed system accuracy of ± 0.75% of temperature span, specify transmitters with high-accuracy calibration as shown on page 5-13. Calibration data traceable to NIST will also be provided.

## How to order

| | |
|---|---|
| MAS624 | **Assembly number:** (see table on facing page) |
| 7 | **Connection head/fitting:** (see table on facing page) |
| TT676 | **Temptran model number:** TT211: 2-lead RTDs<br>TT176: 3-lead RTDs<br>TT711: 2-lead RTDs, match calibrated<br>TT676: 3-lead RTDs, match calibrated |
| N | **Code for temperature range:** (see table on facing page) |
| 500 | **Insertion depth D (in mm):** (75–1219 mm) |
| PD | **Sensing element:** (see table on facing page) |
| 4 | **Conduit thread:** 3 = ½ - 14 NPT<br>4 = ¾ - 14 NPT |

MAS6247TT676N500PD4 ← Sample P/N

## Hazardous Area Requirements

Request Application Aid #19 for information on how to classify a hazardous area, methods of protection, and the various standards and agencies (including FM, CSA, CENELEC and ATEX).

# Flameproof RTDs With Transmitters

## RTDs

| Probe diameters | 0.236" (6.0 mm) | 0.250" (6.4 mm) |
|---|---|---|
| **Number of elements** | Single | Single |
| Tip-sensitive | MAS600 | MAS620 |
| All stainless | MAS602 | MAS622 |
| Platinum, MgO filled* | MAS604 | MAS624 |

*MAS604_ and MAS624_, not available with head/fitting options “8” or “9”.

| Sensing element | Code |
|---|---|
| Platinum 392 100 Ω ±0.5% at 0°C | PA |
| Platinum 385 100 Ω ±0.1% at 0°C (Meets EN60751, Class B) | PD |
| Platinum 385 100 Ω ±0.5% at 0°C | PE |

## Transmitters:

**Popular ranges:**

| Code | Range | |
|---|---|---|
| EO | -50 to 100°C | -58 to 212°F |
| BC | -30 to 30°C | -22 to 86°F |
| S | -17.8 to 37.8°C | 0 to 100°F |
| AC | -17.8 to 93.3°C | 0 to 200°F |
| AN | -17.8 to 148.9°C | 0 to 300°F |
| AG | -17.8 to 260°C | 0 to 500°F |
| AP | -6.7 to 21.1°C | 20 to 70°F |
| A | -6.7 to 48.9°C | 20 to 120°F |
| N | 0 to 50°C | 32 to 122°F |
| C | 0 to 100°C | 32 to 212°F |
| J | 0 to 150°C | 32 to 302°F |
| K | 0 to 200°C | 32 to 392°F |
| V | 10 to 65.6°C | 20 to 150°F |
| P | 37.8 to 179.4°C | 100 to 355°F |
| BH | 50 to 150°C | 122 to 302°F |

⚠ **Complete range table is on page 5-10.**

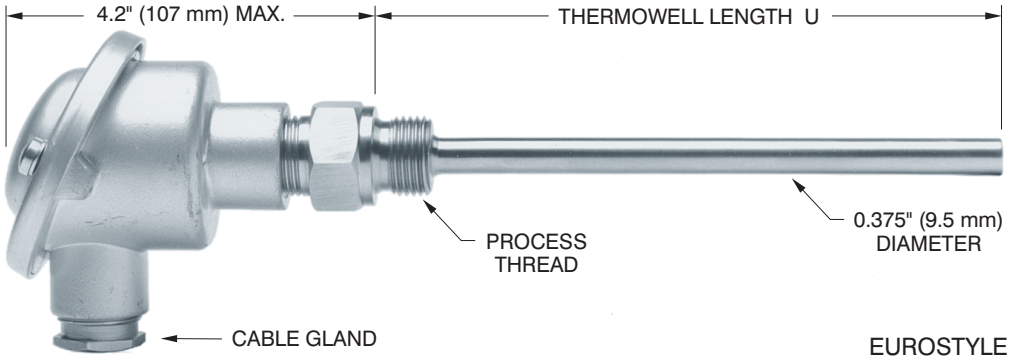
## Connection head and fitting options

CH357: Aluminum alloy; meets IP65.
CH358: Epoxy coated; meets IP66.

| Fitting | Process thread | L REF. | Head | Code |
|---|---|---|---|---|
| Fluid seal | ½ - 14 NPT | 4.6" (117 mm) | CH357 | 0 |
| Fluid seal | ½ - 14 NPT | 4.6" (117 mm) | CH358 | 1 |
| Fluid seal | G½ | 4.4" (111 mm) | CH357 | 2 |
| Fluid seal | G½ | 4.4" (111 mm) | CH358 | 3 |
| Set screw spring-loaded holder | ½ - 14 NPT | 5.6" (143 mm) | CH357 | 4 |
| Set screw spring-loaded holder | ½ - 14 NPT | 5.6" (143 mm) | CH358 | 5 |
| Set screw spring-loaded holder | G½ | 5.4" (136 mm) | CH357 | 6 |
| Set screw spring-loaded holder | G½ | 5.4" (136 mm) | CH358 | 7 |
| Release knob spring-loaded holder | ½ - 14 NPT | 5.7" (144 mm) | CH357 | 8* |
| Release knob spring-loaded holder | ½ - 14 NPT | 5.7" (144 mm) | CH358 | 9* |

*MAS604_ and MAS624_, not available with head/fitting options “8” or “9”.

# Temperature Sensor Assemblies




EUROSTYLE HEAD SHOWN.

## Eurostyle Sensors

- Compact, economical RTD or thermocouple assembly
- Metric straight thread or U.S. tapered thread
- Tip-sensitive probe for use to 260°C (500°F)
- Optional European Form B connection head to DIN 43729
- Stainless steel thermowell

These low-priced assemblies come complete with thermowells, spring-loaded probes, and connection heads. They provide accurate sensing and quick response in liquid or air streams. Specify U.S. or metric thread for global compatibility.

### Specifications

**Temperature range:**
-50 to 260°C (-58 to 500°F).
**Material:**
Probe: Stainless steel with copper alloy tip.
Connection head: Cast aluminum.
Thermowell: 300 series stainless steel.
**Pressure rating:** 2755 psi (190 bar) at 25°C, reducing to 493 psi (34 bar) at 600°C.
**Insulation resistance:** 10 megohms min. at 100 VDC, leads to case. Ungrounded junctions only on thermocouples.
**Connection:** Terminal block for wires to 14 AWG.
**Time constant:** Typical in moving water:
RTD: 35 seconds.
Thermocouple: 27 seconds.

### Transmitters

Minco's Temptran™ transmitters provide a 4 to 20 mA signal that can be sent over long distances with a simple 2-wire system. See Section 5 for complete details and ordering information.

For guaranteed system accuracy of ± 0.75% of temperature span, specify transmitters with high-accuracy calibration as shown on page 5-13. Calibration data traceable to NIST will also be provided.

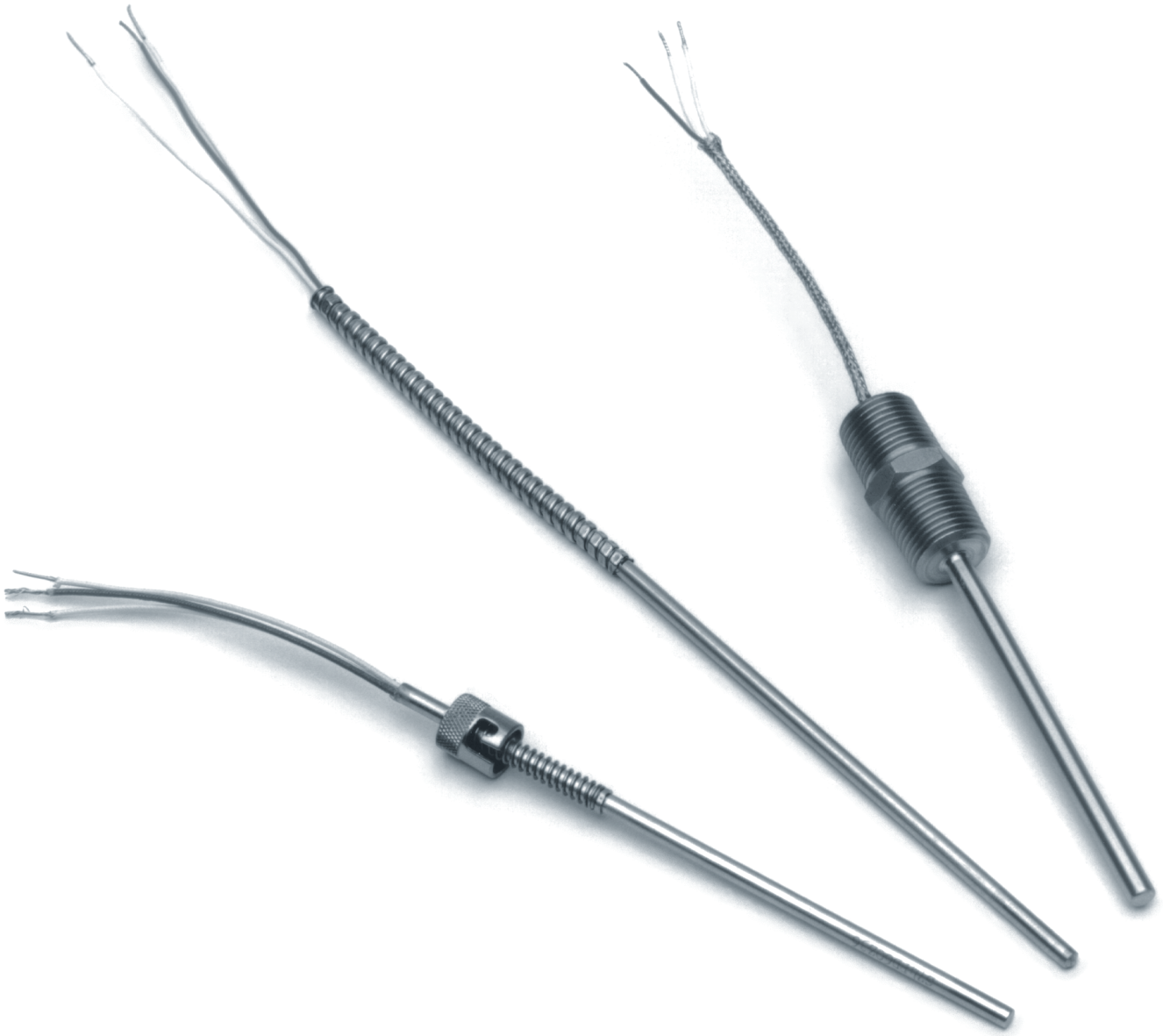
### How to order RTDs

| Sensing element | | Code |
|---|---|---|
| Platinum 392 | 100 Ω ±0.5% at 0°C | PA |
| Platinum 385 (Meets EN60751, Class B) | 100 Ω ±0.1% at 0°C | PD |
| Platinum 385 | 100 Ω ±0.5% at 0°C | PE |
| Copper | 10 Ω ±0.2% at 25°C | CA |
| (dual) | 10 Ω ±0.5% at 25°C | CC |
| Nickel | 120 Ω ±0.5% at 0°C | NA |

| | |
|---|---|
| AS5240 | **Assembly number:**<br>AS5240: Single element RTD<br>AS5241: Dual element RTD |
| PD | **Sensing element from table:** |
| 40 | **TW length U in 0.1" increments**<br>[Ex: 40 = 4.0 inches (102 mm)] |
| Z | **Leads per sensing element:**<br>Y = 2 leads<br>Z = 3 leads (required for CA/CC)<br>X = 4 leads (single element only) |
| 2 | **Conduit thread:**<br>1 = ½ - 14 NPT<br>2 = ¾ - 14 NPT<br>3 = PG cable gland (Eurostyle only) |
| A | **Connection head:**<br>A = Standard aluminum head<br>E = Eurostyle aluminum head |
| 1 | **TW process thread:**<br>1 = ½ - 14 NPT<br>2 = ¾ - 14 NPT<br>3 = ISO 228/1 - G½ |
| **To order standard assembly, stop here. To order with transmitters, add:** | |
| TT176 | **Temptran model:**<br>TT176: 3-lead RTDs<br>TT676: 3-lead RTDs, match calibrated |
| A | **Temperature range code:**<br>See page 5-10 for a list of codes |
| AS5240PD40Z2A1TT176A ← Sample P/N | |

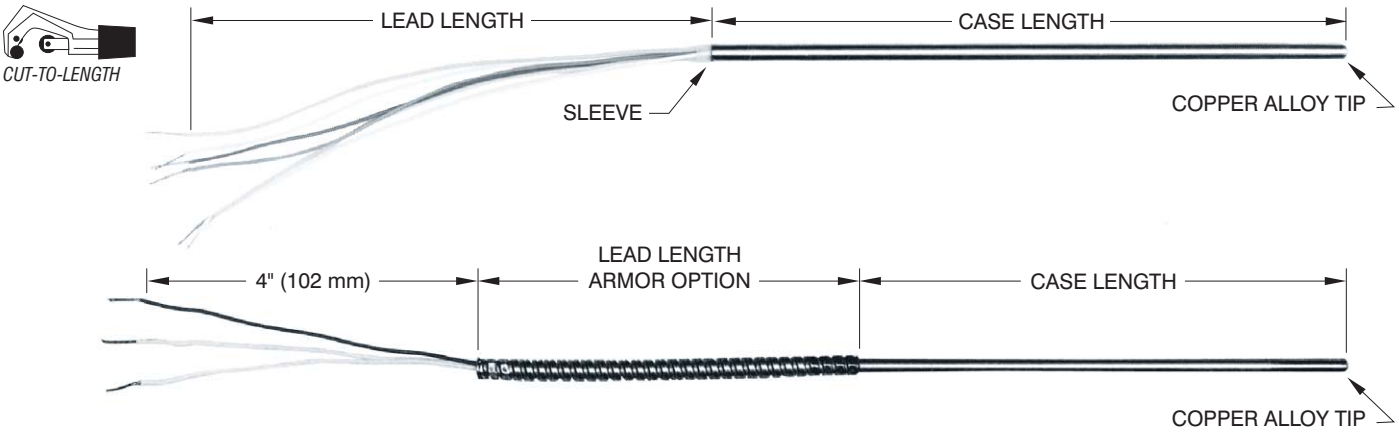
### How to order Thermocouples

| | |
|---|---|
| AS5245 | **Assembly number:**<br>AS5245: Single junction TC<br>AS5246: Dual junction TC |
| E | **Junction type:**<br>E = Chromel-Constantan<br>J = Iron-Constantan<br>K = Chromel-Alumel<br>T = Copper-Constantan |
| G | **Junction grounding:**<br>G = Grounded<br>U = Ungrounded |
| 135 | **Thermowell length U:**<br>Specify in 0.1" increments<br>[Ex: 135 = 13.5 inches (343 mm)] |
| P | |
| 3 | **Conduit thread:**<br>1 = ½ - 14 NPT<br>2 = ¾ - 14 NPT<br>3 = PG cable gland (Eurostyle head only) |
| E | **Connection head:**<br>A = Standard aluminum head<br>E = Eurostyle aluminum head |
| 3 | **Thermowell process thread:**<br>1 = ½ - 14 NPT<br>2 = ¾ - 14 NPT<br>3 = ISO 228/1 - G½ |
| AS5245EG135P3E3 ← Sample P/N | |



# Section 3: RTD and Thermocouple Probes

- Tip-sensitive, high temperature, and fast response versions
- Single and dual elements
- Cut-to-length models are marked with  (see page 3-11 for instructions)




# Tip-Sensitive RTDs

- Copper alloy tip for fast response
- Accurate sensing to 260°C (500°F)
- Non armor models can be user-shortened

The sensing tip of these probes is constructed of copper alloy, twenty times more conductive than stainless steel. Sensors react more quickly to changes and indicate tip temperature instead of stem temperature. The result: Better accuracy in thermowells, bearings, and other installations.

0.250" diameter is recommended for use in thermowells.

## Specifications

**Temperature range:**
-50 to 260°C (-58 to 500°F).
**Case:** Stainless steel with copper alloy tip.
Minimum case length:
Single element probes: 2.8" (71.1 mm).
Dual element probes: 4.0" (101.6 mm).
Maximum case length:
48" (1220 mm), longer on special order.
**Leads:** 2, 3, or 4 leadwires, stranded copper with PTFE insulation. AWG 22, except 0.188" diameter dual probes AWG 24. For 2-lead RTDs add 0.03 Ω per foot (0.05 Ω per foot for 0.188" diameter dual probes) of combined case and lead length to element tolerance. Copper (CA, CC) models must have 3 leads.
**Time constant:** 2.0 seconds typical in moving water. 3.0 seconds for dual element models.
**Pressure rating:** 100 psi (6.9 bar).
**Insulation resistance:**
Single element probes: 1000 megohms min. at 500 VDC, leads to case.
Dual element probes: 100 megohms min. at 100 VDC, between elements and leads to case.
**Vibration:** Withstands 10 to 2000 Hz at 20 G's min. per MIL-STD-202, Method 204, Test Condition D.
**Shock:** Withstands 100 G's min. sine wave shock of 8 milliseconds duration.

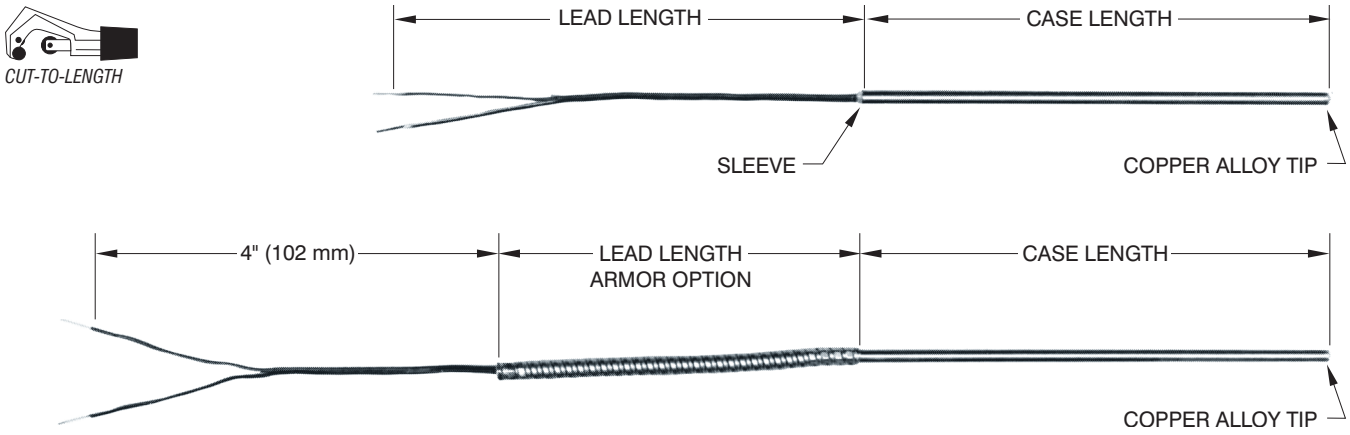
| Element | TCR Ω/Ω/°C | Model number for probe diameter: 0.188" (4.8 mm) | 0.215" (5.5 mm) | 0.250" (6.4 mm) |
|---|---|---|---|---|
| **Single element RTDs: No armor over leads** | | | | |
| Platinum, 100 Ω ±0.5% at 0°C | 0.00392 | S54PA | S51PA | S53PA |
| Platinum, 100 Ω ±0.1% at 0°C (meets EN60751, Class B) | 0.00385 | S854PD | S851PD | S853PD |
| Platinum, 100 Ω ±0.5% at 0°C | 0.00385 | S884PE | S881PE | S883PE |
| Copper, 10 Ω ±0.2% at 25°C | 0.00427 | S54CA | S51CA | S53CA |
| Nickel, 120 Ω ±0.5% at 0°C | 0.00672 | S54NA | S51NA | S53NA |
| **Single element RTDs with armor over leads** | | | | |
| Add element code (Ex: S154NA, S153CA) | | S154__ | S151__ | S153__ |
| **Dual element RTDs: No armor over leads** | | | | |
| Platinum, 100 Ω ±0.5% at 0°C | 0.00392 | S59PA | S56PA | S57PA |
| Platinum, 100 Ω ±0.1% at 0°C (meets EN60751, Class B) | 0.00385 | S859PD | S856PD | S857PD |
| Platinum, 100 Ω ±0.5% at 0°C | 0.00385 | S889PE | S886PE | S887PE |
| Copper, 10 Ω ±0.5% at 25°C | 0.00427 | N/A | S56CC | S57CC |
| Nickel, 120 Ω ±0.5% at 0°C | 0.00672 | S59NA | S56NA | S57NA |
| **Dual element RTDs with armor over leads** | | | | |
| Add element code (Ex: S159NA, S157CC) | | S159__ | S156__ | S157__ |

## How to order

| | |
|---|---|
| S56NA | **Model number from table** |
| 125 | **Case length:** Specify in 0.1" increments (Ex: 125 = 12.5 inches) |
| Y | **Number of leads per sensing element:** Y = 2 leads, Z = 3 leads, X = 4 leads (PD only) |
| 36 | **Lead length in inches** |
| S56NA125Y36 ← Sample P/N | |

**IN STOCK**

Single element models (except PE), lengths from 4" to 24", without armor
Dual models: S859 to 18", S857 to 24"




# Tip-Sensitive Thermocouples

- Copper alloy tip for fast response
- Accurate sensing to 260°C (500°F)
- Non armor models can be user-shortened

The sensing tip of these probes is constructed of copper alloy, twenty times more conductive than stainless steel. Sensors react more quickly to changes and indicate tip temperature instead of stem temperature. The result: Better accuracy in thermowells, bearings, and other installations.

0.250" diameter is recommended for use in thermowells.

## Specifications

**Temperature range:**
-184 to 260°C (-300 to 500°F).
**Case:** Stainless steel with copper alloy tip.
Minimum case length: 2.5" (63.5 mm).
Maximum case length: 48" (1220 mm), longer on special order.
**Leads:** Solid thermocouple wire, AWG 20 (except AWG 24 on model TC355). Specify PTFE insulation, stainless steel overbraid, or stainless steel armor.
**Time constant:** Typical value in moving water:
Grounded junction: 1.5 seconds.
Ungrounded junction: 7 seconds.
**Pressure rating:** 100 psi (6.9 bar).
**Insulation resistance:** 10 megohms min. at 100 VDC, leads to case, ungrounded junctions only.
**Vibration:** Withstands 10 to 2000 Hz at 20 G's min. per MIL-STD-202, Method 204, Test Condition D.
**Shock:** Withstands 100 G's min. sine wave shock of 8 milliseconds duration.

## Thermocouple model numbers

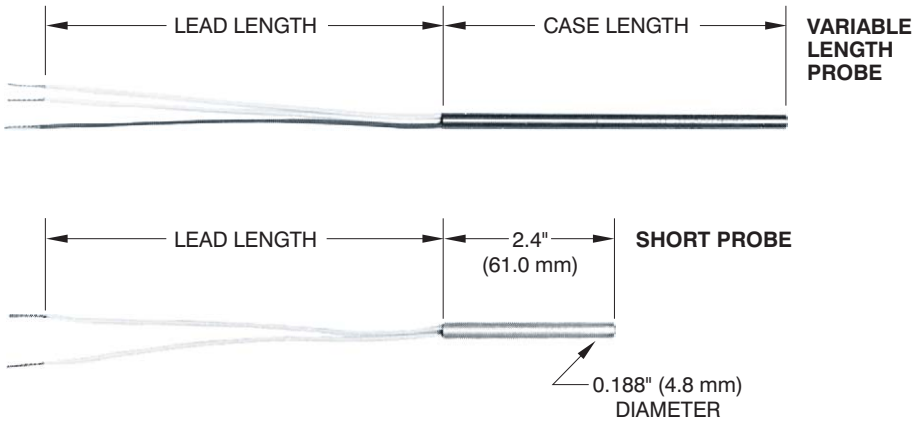
| | Model | | |
|---|---|---|---|
| | Ø 0.188" (4.8 mm) | Ø 0.215" (5.5 mm) | Ø 0.250" (6.4 mm) |
| **Single junction** | TC354 | TC356 | TC358 |
| **Dual junction** | TC355 | TC357 | TC359 |

## How to order

| | |
|---|---|
| TC356 | **Model number from table** |
| T | **Junction type:**<br>E = Chromel-Constantan<br>J = Iron-Constantan<br>K = Chromel-Alumel<br>T = Copper-Constantan |
| G | **Junction grounding:**<br>G = Grounded<br>U = Ungrounded |
| 200 | **Case length:**<br>Specify in 0.1" increments:<br>Ex: 200 = 20.0 inches |
| S | **Covering over leadwires:**<br>T = PTFE only<br>G = Glass braid only<br>S = Stainless steel overbraid<br>A = Stainless steel armor |
| 24 | **Lead length in inches** |
| TC356TG200S24 ← Sample P/N | |

*CUT-TO-LENGTH*

S601: 0.215" (5.5 mm) Ø
S602: 0.125" (3.2 mm) Ø
S603: 0.250" (6.4 mm) Ø
S604: 0.188" (4.8 mm) Ø




# Fast Response RTDs

- All-stainless steel probes for use to 260°C (500°F)
- Unique low mass element reacts quickly to temperature changes

These probes have rugged stainless steel cases for use in high pressures or corrosive fluids. Yet their time constants are comparable to copper-tipped probes at 2 to 4 seconds, compared to 8 to 10 seconds for other all-stainless probes.

## Specifications

**Temperature range:**
-269 to 260°C (-452 to 500°F).
**Case material:**
S601, S602, S603, S604: 316 stainless steel.
S614: 304/305 stainless steel.
**Case length:**
Minimum case length:
S602, S604: 2.0" (50.8 mm) with PTFE insulated leads; 3.0" (76.2 mm) with SS braid over leads.
S601, S603: 3.0" (76.2 mm).
Maximum case length:
48" (1220 mm), longer on special order.
**Time constant:** Typical in moving water:
S602, S604, S614: 2 seconds.
S601: 3 seconds.
S603: 4 seconds.
**Pressure rating:** 1500 psi (103 bar).
**Leads:** 2, 3, or 4 leadwires, AWG 22, stranded copper with PTFE insulation, stainless steel braid, or stainless steel armor. For 2-lead RTDs add 0.03 Ω per foot of combined case and lead length to element tolerance (model S602 has AWG 26; add 0.08 Ω per foot for 2-lead).
**Insulation resistance:** 1000 megohms min. at 500 VDC, leads to case.
**Vibration:** Withstands 10 to 2000 Hz at 20 G's min. per MIL-STD-202, Method 204, Test Condition D.
**Shock:** Withstands 100 G's min. sine wave shock of 8 milliseconds duration.

**Sensing elements:**

| Element | Code |
|---|---|
| Platinum 392, 100 Ω ±0.5% at 0°C | PA |
| Platinum 385, 100 Ω ±0.1% at 0°C (Meets EN60751, Class B) | PD |
| Platinum 385, 100 Ω ±0.5% at 0°C | PE |
| Platinum 385, 1000 Ω ±0.1% at 0°C (N/A for model S602) | PF |
| Copper, 10 Ω ±0.2% at 25°C | CA |
| Nickel, 120 Ω ±0.5% at 0°C | NA |

## How to order variable length probes

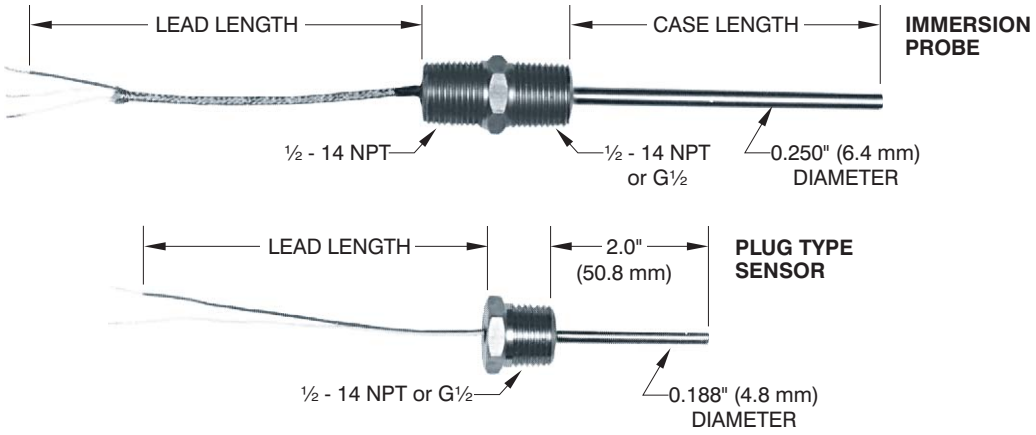
Specify 0.125" or 0.188" for fastest response, 0.250" or 0.215" for greater strength and cut-to-length capability (PTFE and SS braid models).

| | |
|---|---|
| S604 | **Model number:**<br>S601: Ø 0.215" (5.5 mm)<br>S602: Ø 0.125" (3.2 mm)<br>S603: Ø 0.250" (6.4 mm)<br>S604: Ø 0.188" (4.8 mm) |
| PD | **Sensing element from table** |
| 140 | **Case length:**<br>Specify in 0.1" increments<br>(Ex: 140 = 14.0 inches) |
| X | **Number of leadwires:**<br>Y = 2 leads<br>Z = 3 leads<br>X = 4 leads (PD only) |
| 36 | **Lead length in inches** |
| T | **Covering over leadwires:**<br>T = PTFE only<br>S = Stainless steel braid<br>A = Stainless steel armor<br>(S, A not available on S602) |
| S604PD140X36T ← Sample P/N | |

## How to order short probes

This model has a case with fixed length of 2.4" (61 mm). Use it as an all-purpose sensing element.

| | |
|---|---|
| S614 | **Model number: S614** |
| PA | **Sensing element from table** |
| Z | **Number of leadwires:**<br>Y = 2 leads<br>Z = 3 leads<br>X = 4 leads (PD only) |
| 12 | **Lead length in inches** |
| S | **Covering over leadwires:**<br>T = PTFE only<br>S = Stainless steel braid |
| S614PAZ12S ← Sample P/N | |






# Fast Response Immersion RTDs

- Stainless steel probes for use to 260°C (500°F)
- Pressure rating 1500 psi (103 bar)
- Quick reaction to changing fluid and gas temperatures
- NPT (U.S.) or metric threads

You can mount these probes directly in fluid streams for accurate, reliable sensing. Time constant is just 2 seconds, compared to 10 seconds for an ordinary stainless probe or up to 50 seconds for a thermowell. The result: More accurate monitoring of dynamic processes.

## Specifications

**Temperature range:**
-269 to 260°C (-452 to 500°F).
**Case material:**
S623, S628: 316 stainless steel.
S634, S639: 304/305 stainless steel.
**Case length:**
Minimum case length: 1.5" (38.1 mm).
Maximum case length: 48" (1220 mm), longer on special order.
**Time constant:** Typical value in moving water:
S623, S628: 4 seconds.
S634, S639: 2 seconds.
**Pressure rating:** 1500 psi (103 bar).
**Leads:** 2, 3, or 4 leadwires, AWG 22, stranded copper with PTFE insulation, stainless steel braid, or stainless steel armor. For 2-lead RTDs add 0.03 Ω per foot of combined case and lead length to element tolerance.
**Insulation resistance:** 1000 megohms min. at 500 VDC, leads to case.
**Vibration:** Withstands 10 to 2000 Hz at 20 G's min. per MIL-STD-202, Method 204, Test Condition D.
**Shock:** Withstands 100 G's min. sine wave shock of 8 milliseconds duration.

**Sensing elements:**

| Element | Code |
|---|---|
| Platinum 392, 100 Ω ±0.5% at 0°C | PA |
| Platinum 385, 100 Ω ±0.1% at 0°C (Meets EN60751, Class B) | PD |
| Platinum 385, 100 Ω ±0.5% at 0°C | PE |
| Platinum 385, 1000 Ω ±0.1% at 0°C (N/A for model S602) | PF |
| Copper, 10 Ω ±0.2% at 25°C | CA |
| Nickel, 120 Ω ±0.5% at 0°C | NA |

## How to order immersion probes

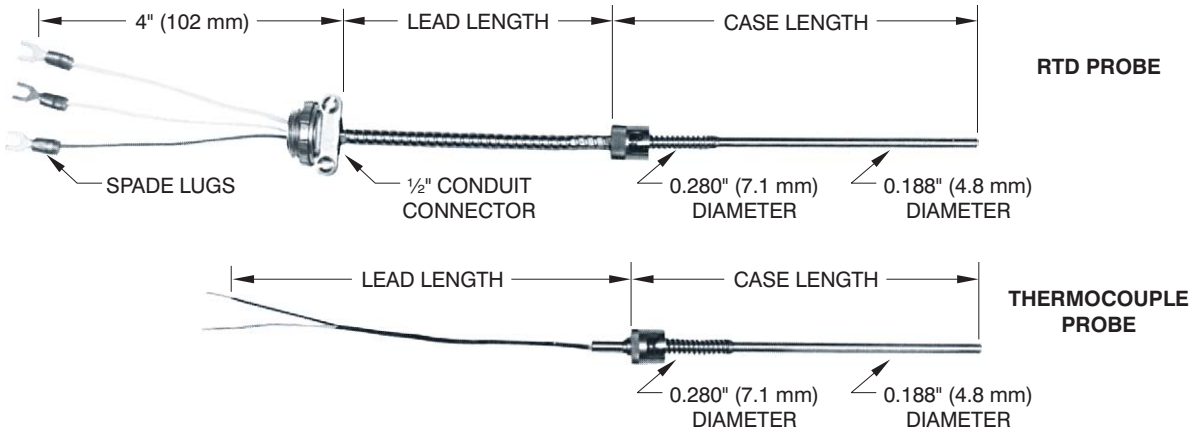
These probes have welded fittings to mount directly into fluid vessels. Add a connection head for termination of extension leads.

| | |
|---|---|
| S623 | **Model number:**<br>S623: ½ - 14 NPT thread [2]<br>S628: ISO 228/1-G½ process thread<br>(½ - 14 NPT on leads end) |
| PF | **Sensing element from table** |
| 60 | **Case length:**<br>Specify in 0.1" increments<br>(Ex: 60 = 6.0 inches) |
| Y | **Number of leads:**<br>Y = 2 leads<br>Z = 3 leads<br>X = 4 leads (PD only) |
| 72 | **Lead length in inches** |
| A | **Covering over leadwires:**<br>T = PTFE only<br>S = Stainless steel braid<br>A = Stainless steel armor |
| S623PF60Y72A ← Sample P/N | |

## How to order plug type sensors

Save space and get accurate readings with this compact, easy-to-install probe.

| | |
|---|---|
| S634 | **Model number:**<br>S634: ½ - 14 NPT thread<br>S639: ISO 228/1-G½ thread |
| NA | **Sensing element from table** |
| Y | **Number of leads:**<br>Y = 2 leads<br>Z = 3 leads<br>X = 4 leads (PD only) |
| 24 | **Lead length in inches** |
| T | **Covering over leadwires:**<br>T = PTFE only<br>S = Stainless steel braid |
| S634NAY24T ← Sample P/N | |




# Bayonet Mount Tip-Sensitive Probes

- Lockcap and spring for twist-and-release spring loading
- Accurate sensing to 260°C (500°F)

Bayonet mounting provides easy and inexpensive spring loaded installation of probes into solids. All models have a copper alloy tip for fast time response and increased tip sensitivity.

See page 4-9 for bayonet fittings.

## Specifications

**Temperature range:**
-50 to 260°C (-58 to 500°F).
**Case:** Stainless steel with copper alloy tip.
Minimum case length: 3.0" (76.2 mm).
Maximum case length: 48" (1220 mm), longer on special order.
**Vibration:** Withstands 10 to 2000 Hz at 20 G's min. per MIL-STD-202, Method 204, Test Condition D.
**Shock:** Withstands 100 G's min. sine wave shock of 8 milliseconds duration.

**⚠ See compatible fittings on pages 4-9 and 4-10.**

## RTDs

| Element | Model |
|---|---|
| Platinum 392, 100 Ω ±0.5% at 0°C | S44PA |
| Platinum 385, 100 Ω ±0.1% at 0°C (Meets EN60751, Class B) | S844PD |
| Platinum 385, 100 Ω ±0.5% at 0°C | S874PE |
| Copper, 10 Ω ±0.2% at 25°C | S44CA |
| Nickel, 120 Ω ±0.5% at 0°C | S44NA |

**Leads:** 2, 3, or 4 leadwires, AWG 22, stranded copper with PTFE insulation, stainless steel armor, and ½" conduit connector. For 2-lead RTDs add 0.03 Ω per foot of combined case and lead length to element tolerance.
**Time constant:** 2 seconds typical in moving water.
**Insulation resistance:** 1000 megohms min. at 500 VDC, leads to case.

## How to order

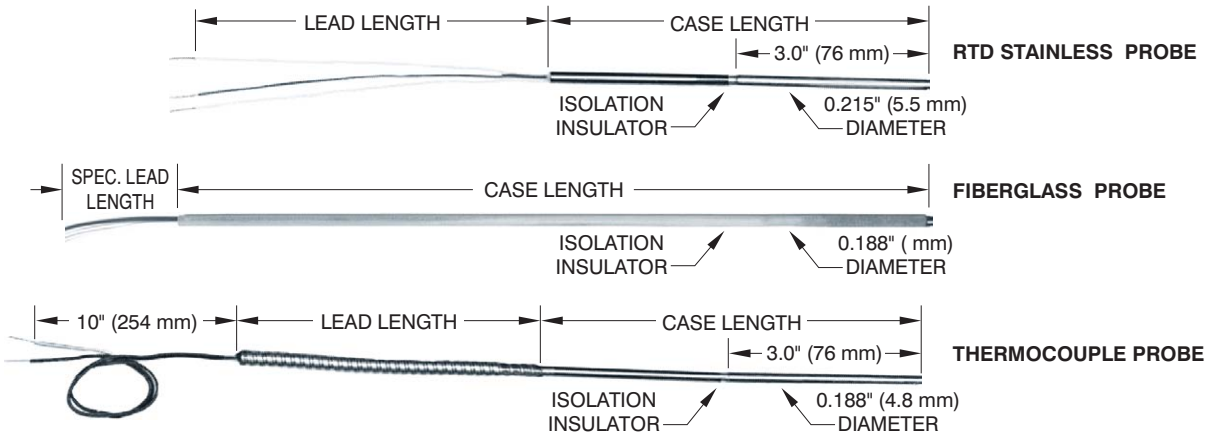
| | |
|---|---|
| S874PE | **Model number from table** |
| 110 | **Case length:** Specify in 0.1" increments (Ex: 110 = 11.0 inches) |
| Y | **Number of leads:** Y = 2 leads, Z = 3 leads, X = 4 leads (PD only) |
| 36 | **Lead length in inches** |
| S874PE110Y36 ← Sample P/N | |

## Thermocouples

**Leads:** Solid thermocouple wire, AWG 20 (single) or AWG 24 (dual). Specify PTFE insulation, glass braid insulation, stainless steel braid over glass braid, or stainless steel armor over PTFE.
**Time constant:** Typical value in moving water:
Grounded junction: 1.5 seconds.
Ungrounded junction: 7 seconds.
**Insulation resistance:** 10 megohms min. at 100 VDC, leads to case, ungrounded junctions only.

## How to order

| | |
|---|---|
| TC360 | **Model number:** TC360 = Single junction, TC361 = Dual junction |
| E | **Junction type:** E = Chromel-Constantan, J = Iron-Constantan, K = Chromel-Alumel, T = Copper-Constantan |
| G | **Junction grounding:** G = Grounded, U = Ungrounded |
| 95 | **Case length:** Specify in 0.1" increments (Ex: 95 = 9.5 inches) |
| A | **Covering over leadwires:** T = PTFE only, G = Glass braid, A = Stainless steel armor, S = Stainless steel overbraid |
| 12 | **Lead length in inches** |
| TC360EG95A12 ← Sample P/N | |






# Electrically Isolated Probes

- Electrically isolated sensing tip for "hot" bearings
- Accurate sensing to 260°C (500°F), 155°C (311°F) for fiberglass probes.
- Copper alloy tip for fast time response and increased tip sensitivity.

## Specifications

**Dielectric strength of isolation insulator:** 1000 volts RMS at 60 Hz for 30 seconds, between case sections, 1 mA max. leakage current.
**Pressure rating:** 30 psi (2.1 bar).
**Vibration:** Withstands 10 to 2000 Hz at 20 G's min. per MIL-STD-202, Method 204, Test Condition D.
**Shock:** Withstands 100 G's min. sine wave shock of 8 milliseconds duration.

## Fiberglass sheath RTDs

| Element | Model |
|---|---|
| Platinum 392, 100 Ω ±0.5% at 0°C | S101659PA |
| Platinum 385, 100 Ω ±0.12% at 0°C (Meets EN60751, Class B) | S101659PD |
| Platinum 385, 100 Ω ±0.5% at 0°C | S101659PE |
| Copper, 10 Ω ±0.2% at 25°C | S101659CA |
| Nickel, 120 Ω ±0.5% at 0°C | S101659NA |

**Temp. Range:** -50 to 155°C (-58 to 311°F).
**Case:** Filament braided glass/epoxy tubing with copper alloy tip.
Minimum case length: 3.0" (101.6 mm).
Maximum case length: 40" (1220 mm).
**Leads:** 2 (not available with CA element models), 3, or 4 leadwires, AWG 22, stranded copper with PTFE insulation. For 2-lead RTDs add 0.03Ω per foot of combined case and lead length to element tolerance.
**Time constant:** 2.5 seconds typical in moving water.
**Insulation resistance:** 1000 megohms min. at 500 VDC, leads to tip.

## Isolated tip RTDs

| Element | Model |
|---|---|
| Platinum 392, 100 Ω ±0.5% at 0°C | S52PA |
| Platinum 385, 100 Ω ±0.1% at 0°C (Meets EN60751, Class B) | S852PD |
| Platinum 385, 100 Ω ±0.5% at 0°C | S882PE |
| Copper, 10 Ω ±0.2% at 25°C | S52CA |
| Nickel, 120 Ω ±0.5% at 0°C | S52NA |

**Temp. Range:** -50 to 260°C (-58 to 500°F).
**Case:** Stainless steel with copper alloy tip.
Minimum case length: 4.0" (101.6 mm).
Maximum case length: 48" (1220 mm), longer on special order.
**Leads:** 2, 3, or 4 leadwires, AWG 22, stranded copper with PTFE insulation. For 2-lead RTDs add 0.03 Ω per foot of combined case and lead length to element tolerance.
**Time constant:** 2 seconds typical in moving water.
**Insulation resistance:** 1000 megohms min. at 500 VDC, leads to case.

## How to order

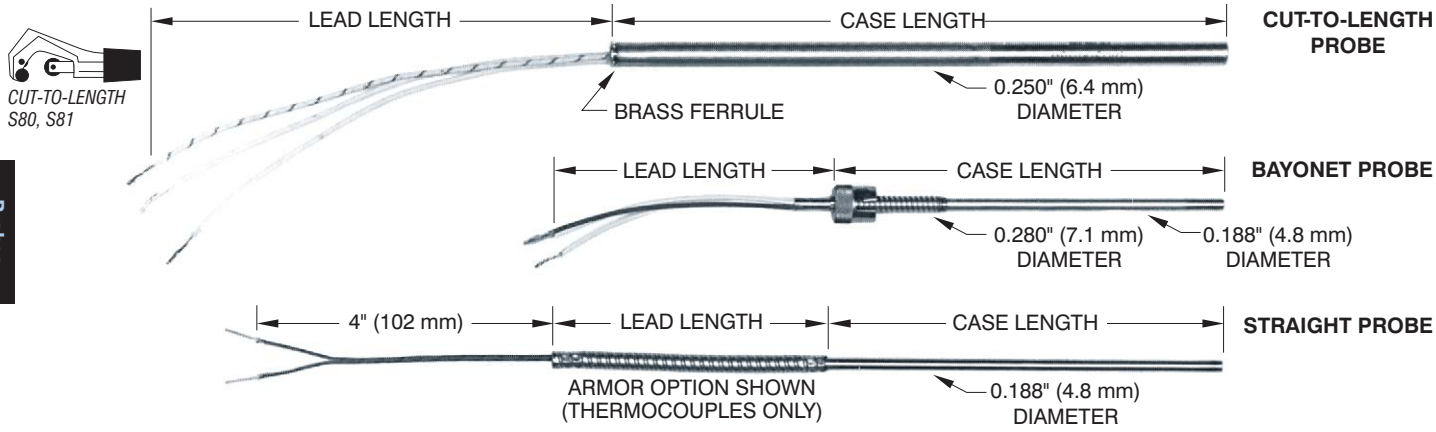
| | |
|---|---|
| S52CA | **Model number from isolated tip or fiberglass sheath table** |
| 355 | **Case length:** Specify in 0.1" increments (Ex: 355 = 35.5 inches) |
| Z | **Number of leads:** Y = 2 leads, Z = 3 leads, X = 4 leads (PD only) |
| 36 | **Lead length in inches** |
| S52CA355Z36 ← Sample P/N | |

## Thermocouples

**Temp. Range:** -50 to 260°C (-58 to 500°F).
**Case:** Stainless steel with copper alloy tip.
Minimum case length: 4.0" (101.6 mm).
Maximum case length: 48" (1220 mm), longer on special order.
**Leads:** Solid thermocouple wire, AWG 20 (AWG 24 for stainless steel braid option). Specify PTFE insulation or PTFE with stainless steel armor and shrink tubing over all.
**Time constant:** Typical value in moving water: Grounded junction: 1.5 seconds. Ungrounded junction: 7 seconds.
**Insulation resistance:** 10 megohms min. at 100 VDC, leads to case, ungrounded junctions only.

## How to order

| | |
|---|---|
| TC2198 | **Model number: TC2198** |
| E | **Junction type:** E = Chromel-Constantan, J = Iron-Constantan, K = Chromel-Alumel, T = Copper-Constantan |
| U | **Junction grounding:** G = Grounded, U = Ungrounded |
| 225 | **Case length:** Specify in 0.1" increments (Ex: 225 = 22.5 inches) |
| T | **Covering over leadwires:** T = PTFE only, A = Stainless steel armor plus shrink tubing, S = SS braid over PTFE (5" min. case length) |
| 48 | **Lead length in inches** |
| TC2198EU225T48 ← Sample P/N | |




# 550°C RTD and Thermocouple Probes

- 0.250" diameter cut-to-length RTDs
- 0.188" diameter straight and bayonet RTDs and thermocouples.

Install these probes in steam lines, exhaust gases, wherever you need precise readings of elevated temperatures. RTD probes feature high temperature ceramic elements, assembled into stainless steel cases in a configuration that provides long-term reliable service.

Models S80 and S81 are user shortenable. You can stock standard lengths and cut them to the size required with an ordinary tubing cutter.

Bayonet style probes have a lockcap and spring for spring-loaded installation. See page 4-9 for bayonet fittings.

## Specifications

**Temperature range:**
-100 to 550°C (-148 to 1022°F).
Leadwires: 500°C (932°F) max.
**Case:** 316 stainless steel.
Minimum case length:
0.250" diameter: 4.0" (101.6 mm).
0.188" diameter:
S71, S72: 2.0" (50.8 mm)
S73, S74: 3.0" (76.2 mm).
Maximum case length: 48" (1220 mm), longer on special order.
**Pressure rating:** 1500 psi (103 bar).
**Vibration:** Withstands 10 to 2000 Hz at 20 G's min. per MIL-STD-202, Method 204, Test Condition D.
**Shock:** Withstands 100 G's min. sine wave shock of 8 milliseconds duration.

**IN STOCK**

S80 and S81, lengths from 4" to 24"

## RTDs

| Element 100 Ω ±0.1% at 0°C | Ø 0.188" (4.8 mm) Straight probe | Ø 0.188" (4.8 mm) Bayonet probe | Ø 0.250" (6.4 mm) Cut-to-length |
|---|---|---|---|
| Platinum 391 | S71PB | S73PB | S80PB |
| Platinum 385, (Meets EN60751, Class B) | S72PD | S74PD | S81PD |

**Leads:** 2 or 3 leadwires, AWG 22, stranded copper with mica/glass insulation. For 2-lead RTDs add 0.04 Ω per foot of combined case and lead length to element tolerance.
**Time constant:** 10 seconds typical in moving water.
**Insulation resistance:** 10 megohms min. at 100 VDC, leads to case.

### How to order

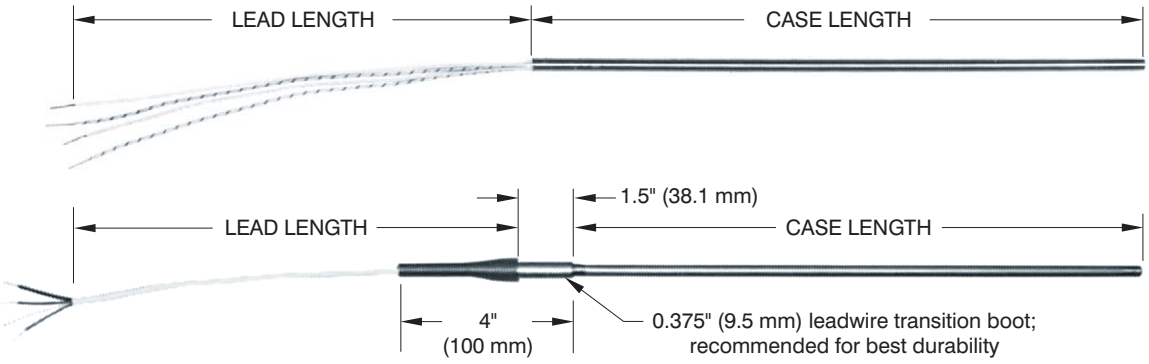
| | |
|---|---|
| S74PD | **Model number from table** |
| 145 | **Case length:** Specify in 0.1" increments (Ex: 145 = 14.5 inches) |
| Z | **Number of leads:** Y = 2 leads Z = 3 leads |
| 6 | **Lead length in inches** |
| S74PD145Z6 ← Sample P/N | |

## Thermocouples

**Leads:** Solid thermocouple wire, AWG 20. Specify glass braid insulation, stainless steel overbraid, or stainless steel armor.
**Time constant:** 7 seconds typical in moving water.
**Insulation resistance:** 10 megohms min. at 100 VDC, leads to case, ungrounded junctions only.

### How to order

| | |
|---|---|
| TC173 | **Model number:** TC173: Straight probe TC171: Bayonet mount |
| J | **Junction type:** E = Chromel-Constantan J = Iron-Constantan K = Chromel-Alumel |
| U | **Junction grounding:** G = Grounded U = Ungrounded |
| 45 | **Case length:** Specify in 0.1" increments (Ex: 45 = 4.5 inches) |
| G | **Covering over leadwires:** G = Glass braid only S = Stainless steel overbraid A = Stainless steel armor |
| 24 | **Lead length in inches** |
| TC173JU45G24 ← Sample P/N | |






# 600°C and 850°C RTDs

- Accurate sensing of extreme high and low temperatures
- Platinum elements to EN60751, Class A or B
- English and metric diameters

These RTDs cover the full temperature scale of the international standard EN60751. Precision sensing elements and nickel alloy sheaths are capable of measurements from -200 to 850°C with typical ice point drift less than ±0.05°C.

600°C models have stainless steel sheaths for reduced cost. They use the same element structure as 850°C models for excellent accuracy and stability.

## Specifications

**Element:** Platinum, 100 Ω at 0°C, TCR = 0.00385 Ω/Ω/°C.
**Tolerance:** EN60751 Class A or B.
Class A: ± 0.06%
Class B: ± 0.12%
**Repeatability:** Meet IEC requirements. Typical shift less than 0.05°C (0.02 Ω) at 0°C after ten cycles over range.
**Stability:** Meet IEC stability specifications after 250 hours exposure to extremes of temperature range. Typical drift is less than 0.05°C (0.02 Ω) at 0°C.
**Vibration:** Will withstand 10 to 5000 Hz at 2 G's minimum per EN60751.
**Shock:** Will withstand 250 mm drop onto 8 mm thick steel plate (approximately 1400 G's for 0.08 ms).
**Time constant:** 10 seconds typical in moving water.
**Pressure rating:** 1000 psi (69 bar) at 25°C.
**Insulation resistance:** 10 megohms min. at 100 VDC, leads to case.

## 600°C probes

| Probe diameter | Model number |
|---|---|
| 0.188" (4.8 mm) | S914 |
| 0.236" (6.0 mm) | S912 |
| 0.250" (6.4 mm) | S913 |

**Temperature range:** -200 to 600°C (-328 to 1112°F). Reduced temperature rating for leads and last 2" (50 mm) of case; see leadwire chart.
**Case:** 316 stainless steel.
Minimum case length: 2.0" (50.8 mm).
Maximum case length: 48.0" (1220 mm), longer on special order.

## 850°C probes

| Probe diameter | Model number |
|---|---|
| 0.157" (4.0 mm) | S926 |
| 0.236" (6.0 mm) | S922 |
| 0.250" (6.4 mm) | S923 |

**Temperature range:** -200 to 850°C (-328 to 1582°F). Reduced temperature rating for leads and last 2" (50 mm) of case; see leadwire chart.
**Case:** Nickel alloy.
Minimum case length: 6.0" (150 mm).
Maximum case length: 18.0" (460 mm), longer on special order.

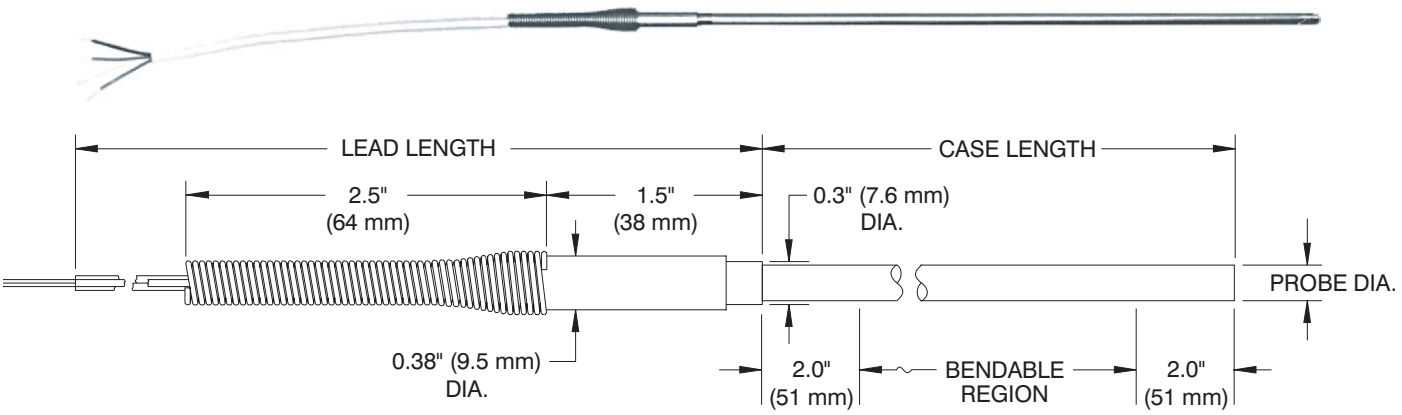
## Leadwire options:

| Code | Description | Max. temp* |
|---|---|---|
| G | Mica/glass insulated stranded copper, AWG 22. | 600°C 1112°F |
| T | PTFE insulated stranded copper, AWG 22. | 260°C 500°F |
| C | AWG 24, PTFE insulated, stranded copper wires with silver-plated copper braid and PTFE over all (4 leads only). | 260°C 500°F |

* Temp. rating for leads and last 2" of case.

## How to order

| | |
|---|---|
| S914 | **Model number from table** |
| PD | **100 Ω Platinum, 0.00385 TCR** |
| 06 | **Tolerance at 0°C:**<br>06 = ±0.06%, EN60751 Class A<br>12 = ±0.12%, EN60751 Class B |
| G | **Leadwire code from table** |
| 120 | **Case length:**<br>Specify in 0.1" increments<br>(Ex: 120 = 12.0 inches) |
| X | **Number of leads:**<br>Z = 3 leads<br>X = 4 leads |
| 24 | **Lead length in inches** |
| BS | **Probe termination:**<br>BS = Boot and spring<br>B = Boot only<br>(Boot required on S926)<br>N = No boot or spring |
| S914PD06G120X24BS ← Sample P/N | |




# Mineral-Insulated RTDs

- Mineral MgO packing protects element from shock and contamination
- Field bendable
- Inconel or stainless steel sheath
- High precision RTD elements for stable, repeatable measurements

Mineral-insulated RTDs provide excellent performance, even when exposed to high levels of shock and vibration in tough industrial environments. Typical applications include process control and steam turbine efficiency measurement.

Probes can be bent around a mandrel diameter at least 3 times the probe diameter without kinking.

Custom designed RTDs and thermocouples are available.

| Probe diameter | Max. temperature | Case material | Model |
|---|---|---|---|
| 0.236" (6.0 mm) | 550°C (1022°F) | 316 stainless steel | S942 |
| 0.236" (6.0 mm) | 650°C (1202°F) | Inconel 600 | S932 |
| 0.250" (6.4 mm) | 550°C (1022°F) | 316 stainless steel | S943 |
| 0.250" (6.4 mm) | 650°C (1202°F) | Inconel 600 | S933 |
| 0.188" (4.8 mm) | 550°C (1022°F) | 316 stainless steel | S944 |

## Specifications

**Element:** Platinum, 100 Ω at 0°C, TCR=0.00385 Ω/Ω/°C.
**Temperature range:**
Inconel case: -200 to 650°C (-328 to 1202°F).
Stainless steel case: -200 to 550°C (-328 to 1022°F). Reduced to 260°C (500°F) for leadwires and potting.
**Tolerance:** EN60751 Class B (±0.12 Ω = ±0.3°C) or Class A (±0.06 Ω = ±0.15°C)
**Repeatability:** Meets EN60751 requirements. Typical shift less than 0.05°C (0.1°F) when cycled over temperature range.
**Stability:** Meets EN60751 specifications after 250 hours exposure to extremes of temperature range. Typical drift of less than 0.05°C (0.1°F) at 0°C.
**Vibration:** Withstands 10 to 5000 Hz at 2 G's per EN60751. Also withstands 50 to 250 Hz at 50 G's at 500°C.
**Shock:** Withstands a 1 meter drop onto an 8 mm steel plate (1 meter is 4 times the EN60751 height requirement of 250 mm).
**Time constant:** 10 seconds typical in moving water.
**Pressure rating:** 69 bar (1000 psi) at 25°C.
**Insulation resistance:** 10 megohms min. at 100 VDC.

## How to order

| | |
|---|---|
| S933 | **Model number from table** |
| PD | **100 Ω platinum, 0.00385 TCR** |
| 06 | **Tolerance at 0°C:**<br>06 = ±0.06%, EN60751 Class A<br>12 = ±0.12%, EN60751 Class B |
| T | **Leadwire insulation:**<br>T = PTFE leadwires<br>C = PTFE cable (4 lead only) |
| 120 | **Case length:**<br>Specify in 0.1" increments<br>(Ex: 120 = 12.0 inches) |
| X | **Number of leadwires:**<br>Z = 3 leads<br>X = 4 leads |
| 36 | **Lead length in inches** |
| BS | **Lead exit configuration:**<br>(B or BS option recommended for best lead exit strength)<br>BS = Potting boot and strain relief spring<br>B = Potting boot<br>N = No potting boot or spring |
| S933PD06T120X36BS ← Sample P/N | |

## Cut-to-length probes

Many probe models in section 3 can be cut to the required length using an ordinary tubing cutter. Cut-to-length models are marked with 

Benefits are:

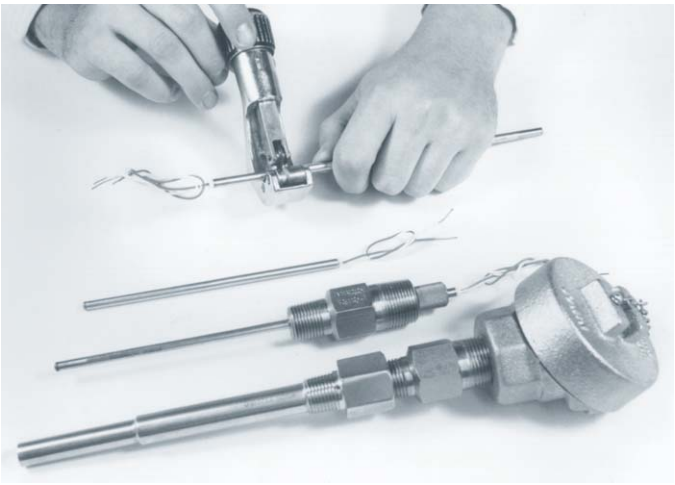
- You can keep standard lengths in inventory, and shorten them as needed for urgent requirements
- Stocking and shortening probes, instead of ordering a few pieces at a time, may let you take advantage of quantity discounts
- Minco stocks most cut-to-length probes and can trim and ship them within 24 hours of your call

## How to shorten probes

Remove the PTFE or brass ferrule from the lead exit end of the probe. Mark the proper length, then cut, going slowly to avoid crimping the case or damaging the leads. Use a good quality tubing cutter that is intended to cut stainless steel tubing or conduit. The cutter must have a sharp blade to prevent “rolling in” during cutting of the tubing. Suitable models are available from Imperial Eastman and Sears Industrial.

After cutting, discard the hollow tube section, carefully deburr the cut end, and replace the ferrule. You can slit the PTFE ferrule for easier installation.

If you use many cut-to-length probes consider the AC101248 probe cutting system. It includes an electric Dremel™ tool, flexible shaft and accessories to allow clean, precise cuts. The system includes a convenient carrying case and comes with easy to follow instructions.



Shorten probes easily with a tubing cutter.

The AC101248 probe cutting system makes clean, precise cuts.

## Protect probes from chemical attack

### AC100375 PFA or FEP encapsulation tubing

The tube is sealed at one end and can be easily shrunk onto any probe. Supplied separately.

**Temperature range:**
PFA = -70 to 260°C (-94 tp 500°F).
FEP = -70 to 200°C (-94 to 392°F).

**IN STOCK**

6" and 12" lengths

### How to order

| | |
|---|---|
| AC100375 | **Model number** |
| L60 | **Length in 0.1" increments** |
| P | **Encapsulation type:**<br>P = clear PFA<br>F = clear FEP |
| 188 | **Probe diameter:**<br>125 = 0.125" (3.2 mm)<br>188 = 0.188" (4.8 mm)<br>215 = 0.215" (5.5 mm)<br>250 = 0.250" (6.4 mm) |

AC100375L60P188 ← Sample P/N

# Specifying Custom Assemblies

The standard assemblies in Section 2 will fit a wide variety of installations. For more versatility you can create new assemblies from the probes, accessories, and transmitters in the pages listed.

Follow these steps:

## 1. Choose a probe

Select an RTD or thermocouple from Section 3. The section includes tip-sensitive, high temperature, and fast response models. Some have integral fittings or bayonet lockcaps.

Factors to consider are:

- Temperature rating
- Compatibility with receiving instruments
- Probe style and diameter
- Accuracy vs. cost

## 2. Add a fitting

See Section 4 for probe mounting fittings. Adjustable fittings, combined with cut-to-length probes, allow instant fabrication of assemblies to any length required. Included are spring-loaded holders, pressure fittings, and bayonet-style fittings.

Factors to consider are:

- Temperature rating
- Probe diameter
- Correct NPT threads
- Pressure ratings
- Compatibility with environment

## 3. Select a thermowell

Thermowells isolate sensors from the effects of fluid flow and pressure. See Section 4 for a variety of well styles and materials.

Factors to consider are:

- Pressure rating
- Compatibility with fluid media
- Insertion depth
- Correct NPT thread

## 4. Attach a connection head

Finish off your assembly with a connection head for termination to remote extension wires. See pages 4-2 to 5-14.

Factors to consider are:

- Connection head size
- Temperature rating
- Correct pipe threads for fitting and conduit
- Number of terminals or wire nuts
- Hazardous area requirements

## 5. Install a transmitter

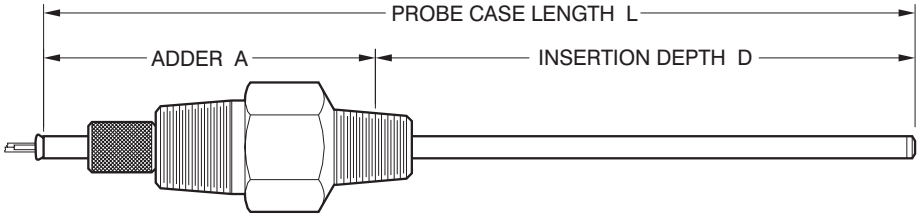
Transmitters convert sensor output to a 4 to 20 mA current signal, immune to leadwire resistance. See Section 5 for RTD and thermocouple transmitters.

Factors to consider are:

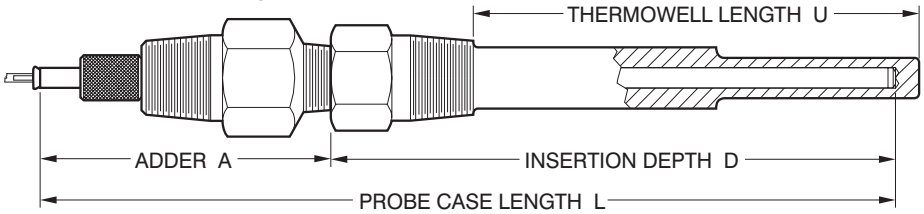
- Transmitter accepts sensor input
- Transmitter fits connection head
- Ambient temperature range acceptable

## 6. How to calculate probe length

All fittings listed in this catalog have probe length adders to help you determine total probe length. Total length L is the insertion depth D plus the adder A.



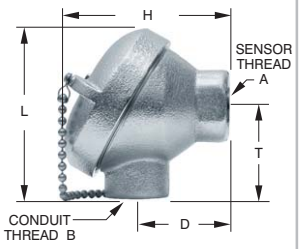
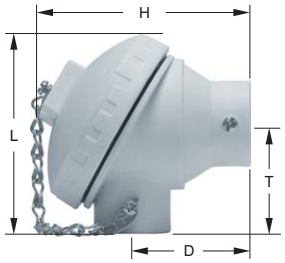
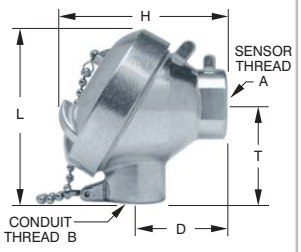
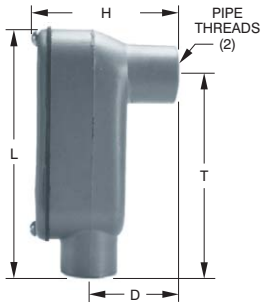
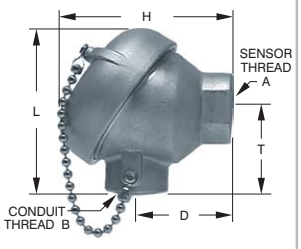
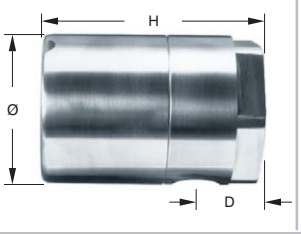

Thermowell drawings show an adder to convert thermowell length U to insertion depth D. Then use D plus the fitting adder A to find total probe length L.



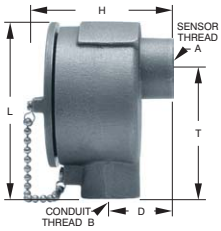
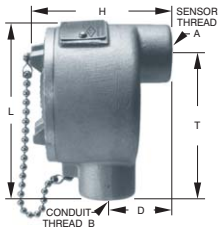
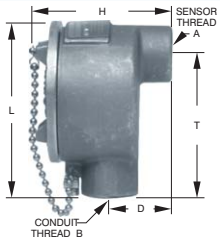

# Section 4: Accessories

- A wide selection of fittings and accessories adapt sensors to any installation
- Adjustable fittings combine with cut-to-length probes for off-the-shelf versatility
- Choose from a variety of materials for severe environments

# Connection Heads

| Dimensions in inches (mm) | Body/gasket material | IP/NEMA Rating | Max. Temp. | Pipe thread codes | Temptran™ models | Approx. weight | Model |
|---|---|---|---|---|---|---|---|
| CH103<br>3.5 (89) H<br>3.5 (89) L<br>1.9 (48) D<br>1.9 (48) T<br>  | Nickel-plated cast iron with SS chain/ silicone gasket | IP55<br>Type 3 and 4 | 316°C (600°F) | P1, P2, P3, P4 | All models except isolated | 2.0 lbs. (0.9 kg.) | CH103 |
| CH366<br>3.0 (76) H<br>3.7 (94) L<br>1.37 (35) D<br>1.9 (48) T<br>  | White polypropylene (FDA approved)/ neoprene gasket | IP55<br>Type 3 and 4 | 110°C (230°F) | P3 only | All models except isolated | 0.2 lbs. (0.1 kg.) | CH366 |
| CH359<br>3.5 (89) H<br>3.5 (89) L<br>2.0 (51) D<br>1.75 (44) T<br>  | Aluminum/ silicone gasket | IP55<br>Type 3 and 4 | 316°C (600°F) | P1, P2, P3, P4 | All models except isolated | 0.8 lbs. (0.4 kg.) | CH359 |
| CH301<br>2.33 (59.2) H<br>4.25 (108) L<br>1.25 (31.8) D<br>3.60 (91.4) T<br>CH302<br>2.60 (66.0) H<br>5.20 (132) L<br>1.50 (38.1) D<br>4.25 (108) T<br>  | Aluminum/ neoprene gasket | IP55<br>Type 3 and 4 | 115°C (240°F) | CH301: P3 only<br>CH302: P2 only | Miniature TT110 and TT111 models | 0.5 lbs. (0.2 kg.) | CH301<br>CH302 |
| CH360<br>3.5 (89) H<br>3.5 (89) L<br>2.0 (51) D<br>1.75 (44) T<br>  | 316 SS with silicone gasket | IP56<br>Type 3, 4 and 4X | 316°C (600°F) | P1, P2, P3, P4 | All models except isolated | 1.8 lbs. (0.8 kg.) | CH360 |
| CH335/CH339<br>2.5 (64) Ø<br>3.5 (89) H<br>0.95 (20) D<br>  | 300 series SS with Buna N O-ring | IP56<br>Type 3, 4 and 4X | 121°C (250°F) | P3 only | All models except isolated | 2.6 lbs. (1.2 kg.) | CH335 |
| | 300 series SS with Buna N O-ring and chain | IP56<br>Type 3, 4 and 4X | 121°C (250°F) | P3 only | All models except isolated | 2.6 lbs. (1.2 kg.) | CH339 |

## Explosionproof and flameproof

| Dimensions in inches (mm) | Body/gasket material | Hazardous location rating | IP/NEMA Rating | Max. Temp. | Approx. weight | Model |
|---|---|---|---|---|---|---|
| **Explosionproof/flameproof heads FM/CSA approved** | | | | | | |
| CH104<br>4.60 (116.8) L<br>3.50 (88.9) H<br>1.63 (41.4) D<br>3.35 (85.1) T<br>CH106<br>4.20 (106.7) L<br>3.50 (88.9) H<br>1.35 (34.3) D<br>3.22 (81.8) T<br>  | Copper-free aluminum/Buna-N O-ring | Division 1; Class I, Groups B, C, D; Class II, Groups E, F, G; Class I, Zone 1, AEx d IIC; Class I, Zone 1, Ex d IIC; T6 (Ta = 40°C), T2 (Ta = 260°C) | IP65 Type 3 and 4 | 121°C* (250°F) | 1.5 lbs. (0.7 kg.) | CH104 |
| | Stainless steel/Buna-N O-ring | | IP66 Type 4X | 121°C* (250°F) | 2.4 lbs. (1.1 kg.) | CH106 |
| **Explosionproof heads FM/CSA approved** | | | | | | |
| 4.60 (116.8) L<br>3.60 (91.4) H<br>1.63 (41.4) D<br>3.70 (96.0) T<br>  | Copper-free aluminum | Division 1; Class I, Groups A, B, C, D; Class II, Groups E, F, G; Class III (FM approved only) | IP54, Type 3 | 260°C (500°F) | 1.4 lbs. (0.6 kg.) | CH405 |
| | Copper-free aluminum/Buna-N O-ring | | IP65 Type 3 and 4 | 121°C (250°F) | | CH407 |
| | Copper-free aluminum, gray epoxy coat, no chain/ Buna-N O-ring | Division 1; Class I, Groups B, C, D; Class II, Groups E, F, G | IP66 Type 4X | | | CH342 |
| | Copper-free aluminum, gray epoxy coat, with chain/Buna-N O-ring | | | | | CH343 |
| **Note: The following models have lower cost but no FM/CSA approval or label.** | | | | | | |
| | Aluminum/Buna-N O-ring | Division 1; Class I, Groups B, C, D; Class II, Groups E, F, G; Class III | IP65 Type 3 and 4 | 121°C (250°F) | 1.4 lbs. (0.6 kg.) | CH330 |
| | Aluminum with FDA approved white epoxy coat, no chain/Buna-N O-ring | | IP66 Type 4X | | | CH328 |
| **Flameproof heads CENELEC/ATEX approved** ⟨Ex⟩ **II 2G EEx d IIC** | | | | | | |
| 4.49 (114) L<br>3.60 (91.4) H<br>1.63 (41.4) D<br>3.78 (96.0) T<br>  | Copper-free aluminum/ Buna-N O-ring | Zone 1, Group IIC | IP65 | 40°C (104°F) | 1.4 lbs. (0.6 kg.) | CH357 |
| | Copper-free aluminum, epoxy coated/Buna-N O-ring | Zone 1, Group IIC | IP66 | | | CH358 |

*Maximum temperature increases to 500°F (260°C) if O-ring is removed. Environmental rating drops to Type 3, IP54.

⚠ All Temptran™ models may be used with all models on this page.

## How to order connection heads

| | | | |
|---|---|---|---|
| CH104 | **Model number:** | | |
| P2 | **Pipe thread code:** | **Thread A** | **Thread B** |
| | P1 = | ¾ - 14 | ½ - 14 |
| | P2 = | ¾ - 14 | ¾ - 14 |
| | P3 = | ½ - 14 | ½ - 14 |
| | P4 = | ½ - 14 | ¾ - 14 |
| T | **Connection type:** T = Terminal board for wires AWG 14 or smaller<br>W = Wire nuts for wires AWG 14 to 22 | | |
| 4 | **Number of terminal posts or wire nuts:** 0, 4 or 6<br>T0: transmitter mounting hardware<br>W0: empty enclosure<br>T4: N/A on CH103, CH331, CH335, CH339, CH359, CH360 | | |

CH104P2T4 ← Sample P/N

## How to order replacement terminal boards

| Model | 4-position board | 6-position board |
|---|---|---|
| CH103 | | AC100427 |
| CH104 | AC1048 | AC1039 |
| CH106 | AC1048 | AC1039 |
| CH301 | AC101377T4 | AC101377T6 |
| CH302 | AC101377T4 | AC101377T6 |
| CH328 | AC1048 | AC1039 |
| CH330 | AC1048 | AC1039 |
| CH331 | | AC100427 |
| CH335 | | AC100427 |
| CH339 | | AC100427 |
| CH342 | AC1048 | AC1039 |
| CH343 | AC1048 | AC1039 |

| Model | 4-position board | 6-position board |
|---|---|---|
| CH357 | AC1048 | AC1039 |
| CH358 | AC1048 | AC1039 |
| CH359 | | AC100427 |
| CH360 | | AC100427 |
| CH405 | AC1048 | AC1039 |
| CH407 | AC1048 | AC1039 |

### 8 position terminal boards

These are available on some models. Contact Minco for details.

# Spring-Loaded Holders

Spring-loaded holders provide a quick and simple installation of probe sensors – pull out and twist the knob, insert the probe until it bottoms out, and release the knob. Spring pressure holds the probe tip in contact with the measuring surface for faster response and more reliable measurements. Many models feature a rubber O-ring that doesn't crimp the probe but prevents oil leakage to 50 psi (3.4 bar) at up to 260°C. High temperature models are usable to 450°C. Nylon versions provide electrical insulation.

**Fluoroelastomer O-ring seal: 50 psi pressure rated fluid seal**

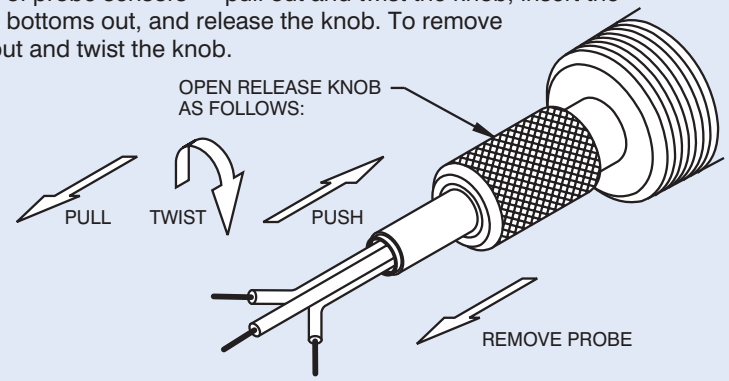
| | Body material | Temperature range | Thread "CH" | Process thread | Hex size | Adder "A" (Total length) | Probe Ø | Model |
|---|---|---|---|---|---|---|---|---|
|  | 300 series stainless steel | -40 to 260°C (-40 to 500°F) | ¾ - 14 NPT | ½ - 14 NPT | 1⅛" (29 mm) | 3.6" (91 mm) | 0.188" | FG114-1 |
| | | | | | | | 0.215" | FG110-1 |
| | | | | | | | 0.250" | FG113-1 |
|  | 316 stainless steel | -40 to 260°C (-40 to 500°F) | ¾ - 14 NPT | ½ - 14 NPT | 1⅛" (29 mm) | 3.6 (91 mm) | 0.188" | FG914 |
| | | | | | | | 0.215" | FG912 |
| | | | | | | | 0.250" | FG911 |
|  | Nylon | -40 to 120°C (-40 to 248°F) | ¾ - 14 NPT | ½ - 14 NPT | 1" (25 mm) wrench flats | 3.6" (91 mm) | 0.188" | FG314 |
| | | | | | | | 0.215" | FG310 |
| | | | | | | | 0.250" | FG313 |
|  | 300 series stainless steel | -40 to 260°C (-40 to 500°F) | ½ - 14 NPT | ½ - 14 NPT | ⅞" (22 mm) | 2.6" (66 mm) | 0.125" | FG216 |
| | | | | | | | 0.188" | FG214 |
| | | | | | | | 0.215" | FG210 |
| | | | | | | | 0.250" | FG213 |
| | | | | | | | 6.0 mm | FG215 |
|  | 300 series stainless steel | -40 to 260°C (-40 to 500°F) | None | ⅛ - 27 NPT | ⅝" (16 mm) | 2.8" (71 mm) | 0.125" | FG116 |
| | | | | | | 3.6" (91 mm) | 0.188" | FG112 |
| | | | | | | | 0.215" | FG111 |
| | | | | | | | 0.250" | FG117 |
|  | 300 series stainless steel | -40 to 260°C (-40 to 500°F) | None | ¼ - 18 NPT | ⅝" (16 mm) | 1.9" (48 mm) | 0.188" | FG101072 |
| | | | | | | | 0.215" | FG101078 |
| | | | | | | | 0.250" | FG101080 |

**High temperature: No pressure rating or fluid seal**

| | Body material | Temperature range | Thread "CH" | Process thread | Hex size | Adder "A" (Total length) | Probe Ø | Model |
|---|---|---|---|---|---|---|---|---|
|  (Set screw installation) | 300 series stainless steel | -40 to 450°C (-40 to 842°F) | ½ - 14 NPT | ½ - 14 NPT | ⅞" (22 mm) | 2.3" (58 mm) | 0.188" | FG801 |
| | | | | | | | 0.215" | FG802 |
| | | | | | | | 0.250" | FG810 |

## Exclusive Minco user-friendly design!

Minco offers spring-loaded holders to provide a quick and simple installation and removal of probe sensors — pull out and twist the knob, insert the probe until it bottoms out, and release the knob. To remove probe, pull out and twist the knob.




**IN STOCK**

All fittings shown

# Fluid Immersion Fittings

Install probes directly into fluid streams and pressure vessels. Simply position the fitting on the probe and tighten the sealing nut.

Fluid seal fittings are best for moderate temperatures and pressures. Pressure fittings, constructed of stainless steel, can withstand corrosive media and greater extremes of pressure and temperature.

Be sure to check the pressure ratings of probes intended for direct immersion.

## Fluid seal fittings to 260°C (500°F)

| | Body material | Thread "CH" | Process thread | Adder "A" (Total length) | Probe Ø | Model |
|---|---|---|---|---|---|---|
|  | Brass | None | ⅛ -27 NPT | 1.2" min. (31 mm) | 0.188" | FG143 |
| | | None | ¼ -18 NPT | | | FG140 |
| | | None | ⅛ -27 NPT | | 0.215" | FG126 |
| | | None | ¼ -18 NPT | | | FG120 |
| | | None | ⅛ -27 NPT | | 0.250" | FG151 |
| | | None | ¼ -18 NPT | | | FG130 |
|  | Stainless steel | ½ -14 NPT | ½ -14 NPT | 2.4" (61 mm) | 0.188" | FG142 |
| | | | | | 0.215" | FG122 |
| | | | | | 0.250" | FG132 |

⚠ Fluid seal fittings are rated to 200 psi (17 bar) when using the repositionable silicone rubber O-ring. They are rated to 500 psi (34 bar) when using the non-repositionable compression ring. These fittings come with both the O-ring and the compression ring.

## Pressure fittings to 871°C (1600°F)

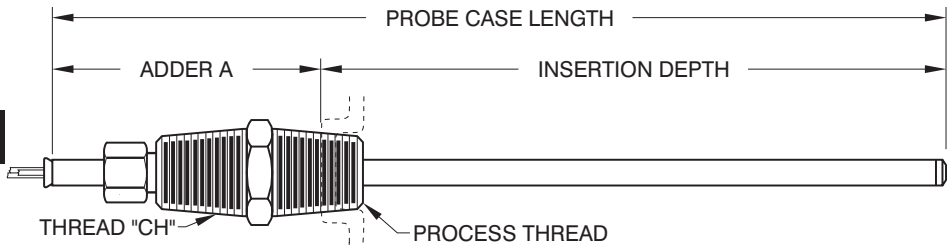
| | Body material | Thread "CH" | Process thread | Adder "A" (Total length) | Probe Ø | Model |
|---|---|---|---|---|---|---|
|  | 316 stainless steel | None | ⅛ -27 NPT | 1.5" (39 mm) | 0.188" | FG141T3P2 |
| | | None | ¼ -18 NPT | | | FG141T3P4 |
| | | None | ½ -14 NPT | | | FG141T3P8 |
| | | None | ⅛ -27 NPT | | 0.250" | FG141T4P2 |
| | | None | ¼ -18 NPT | | | FG141T4P4 |
| | | None | ½ -14 NPT | | | FG141T4P8 |
|  | | ½ -14 NPT | ½ -14 NPT | 2.4" (61 mm) | 0.250" | FG145T4 |

⚠ Pressure fittings are rated to 1500 psi (103 bar) at 25°C/77°F, reducing to 500 psi (34 bar) at 630°C/1166°F. The probe cannot be repositioned after installation.

To determine the ideal probe length add the insertion depth to the adder A for the fitting you will use.

**IN STOCK**

All fittings shown





# Economy Thermowells

Thermowells protect probes from pressure, flow, and corrosion. The models on this page have integral fittings for probe and connection head mounting.

Immerse the thermowell at least 2.5" (65 mm) for accurate readings. The well should extend beyond the center of the fluid stream without touching the opposite wall. Installation in an elbow or tee may be necessary for sufficient immersion in small pipes.

For fastest time response, Minco can furnish thermowells with heat sink compound in the tip. This eliminates the air gap between the probe and inside wall of the well and can reduce time constant by as much as 50%. Order AC101750.

## Economy thermowells

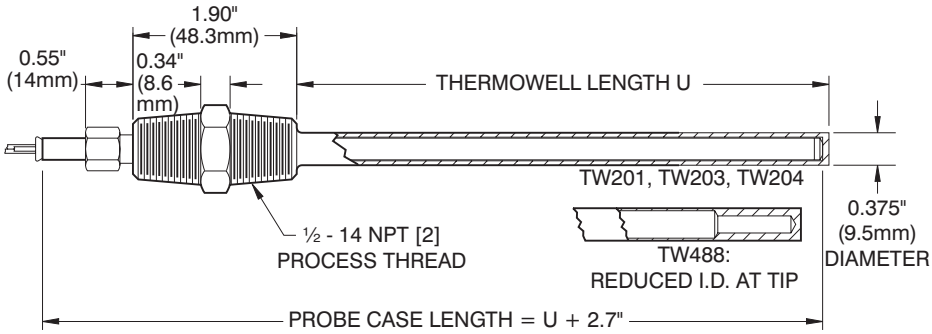
| Use with tip-sensitive probes from section 3 | Body material | Temp limit | Pressure rating | Thread "CH" | Process thread | Hex size | Standard U dimension | Probe Ø | Model |
|---|---|---|---|---|---|---|---|---|---|
| | 300 series stainless steel Nickel-plated brass sealing nut w/ brass compression ring | 260°C (500°F) | 1000 psi (69.9) bar | ½ -14 NPT | ½ -14 NPT | ⅞" (22 mm) | 0.1" increments to 48" | 0.188" | TW204 |
| | | | | | | | | 0.215" | TW201 |
| | | | | | | | | 0.250" | TW203 |

## HVAC thermowells

| Use with HVAC probes on page 9-7 | Body material | Temp limit | Pressure rating | Thread "CH" | Process thread | Hex size | Standard U dimension | Model |
|---|---|---|---|---|---|---|---|---|
| | 316 stainless steel Nickel-plated brass sealing nut w/silicone rubber O-ring | 260°C (500°F) | 1880 psi (129.7) bar | ½ -14 NPT | ½ -14 NPT | ⅞" (22 mm) | 3.0, 6.0, 12.0, and 18.0". Other lengths are available. | TW488 |

## How to order

| | |
|---|---|
| TW203 | **Model number** |
| U | |
| 60 | **Thermowell length U:** Specify in 0.1" increments (Ex: 60 = 6.0 inches) |
| TW203U60 ← Sample P/N | |




**IN STOCK**

TW488: 3.0, 6.0"

REDUCED TIP

TAPERED



# Heavy Duty Thermowells

Protect probes from pressure, flow, and corrosive fluids. Thermowells on this page are machined from solid bar stock. Specify reduced tip style for fast response, tapered style for maximum rigidity in high flow conditions.

Immerse the thermowell at least 2.5" (65 mm) for accurate readings. The well should extend beyond the center of the fluid stream without touching the opposite wall. Installation in an elbow or tee may be necessary for sufficient immersion in small pipes.

Spring-loaded probe installation is recommended, using either spring-loaded holders or bayonet mount probes. 0.250" diameter probes provide the best fit.

For fastest time response, Minco can furnish thermowells with heat sink compound in the tip. This eliminates the air gap between the probe and inside wall of the well and can reduce time constant by as much as 50%. Order AC101750.

Contact Minco for other well styles and materials.

## Reduced tip thermowells

**Temperature limit:**
Stainless steel: 900°C (1650°F).
Monel: 538°C (1000°F).
**Standard U dimensions:** 2.5, 4.5, 6.0, 7.5, 8.0, 10.5, 13.5, 16.5, and 22.5". Other dimensions available.

| Material | Process thread (NPT) | | |
|---|---|---|---|
| | ½ - 14 | ¾ - 14 | 1 - 11½ |
| 304 SS | TW239 | TW228 | TW238 |
| 316 SS | TW222 | TW248 | TW234 |
| Monel | TW1204 | TW447 | TW1231 |
| **Dia. Q** | 0.625" (16 mm) | 0.750" (19 mm) | 0.875" (22 mm) |
| **Hex** | 1 ⅛" (29 mm) | | 1⅜" (35 mm) |

**IN STOCK**

TW222: 2.5, 4.5, 6.0, 7.5, 8.0, 10.5"
TW248: 2.5, 4.5, 6.0, 7.5, 8.0, 10.5"

## Tapered thermowells

**Temperature limit:**
Stainless steel: 900°C (1650°F).
**Standard U dimensions:** 2.5, 4.5, 6.0, 7.5, 8.0, 10.5, 13.5, 16.5, and 22.5". Other dimensions available.

| Material | Process thread (NPT) | |
|---|---|---|
| | ¾ - 14 | 1 - 11½ |
| 304 SS | TW477 | TW252 |
| 316 SS | TW1218 | TW1237 |
| **Dia. Q** | 0.875" (22 mm) | 1.06" (27 mm) |
| **Hex** | 1 ⅛" (29 mm) | 1⅜" (35 mm) |

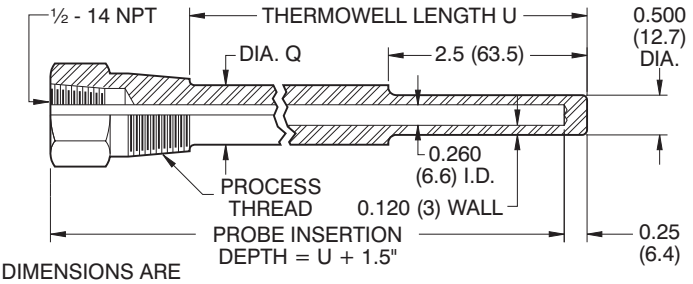
## Pressure rating

| Material | Temperature | | |
|---|---|---|---|
| | 21°C 70°F | 538°C 1000°F | 650°C 1200°F |
| 304 SS | 7000 psi 483 bar | 4500 psi 310 bar | 1650 psi 114 bar |
| 316 SS | 7000 psi 483 bar | 5100 psi 352 bar | 2500 psi 172 bar |
| Monel | 6500 psi 448 bar | 1500 psi 103 bar | |

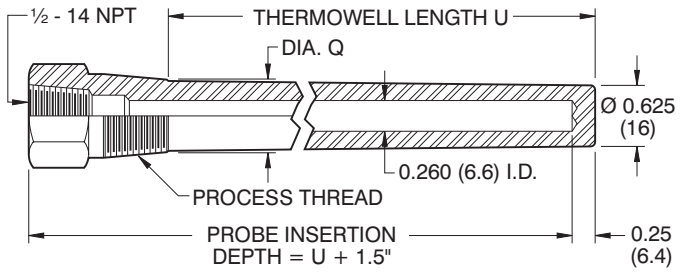
## How to order

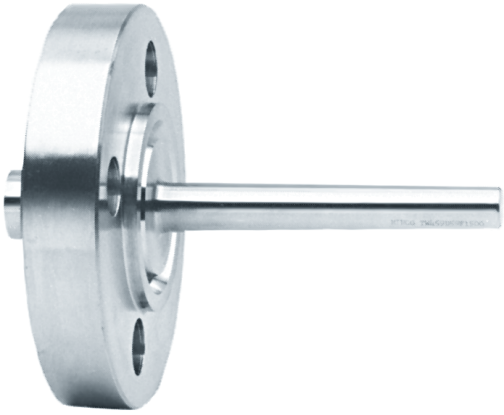
| | |
|---|---|
| TW222 | **Model number from table** |
| U | |
| 45 | **Thermowell length U:** Specify in 0.1" increments (Ex: 45 = 4.5 inches) |

TW222U45 ← Sample P/N




DIMENSIONS ARE IN INCHES (MM)





# Flanged Thermowells

Flanged thermowells are available in three standard flange sizes: 1.0", 1.5", and 2.0" per ANSI B16.5. Specify U dimension and pressure rating.

Immerse the thermowell at least 2.5" (65 mm) for accurate readings. The well should extend beyond the center of the fluid stream without touching the opposite wall. Installation in an elbow or tee may be necessary for sufficient immersion in small pipes.

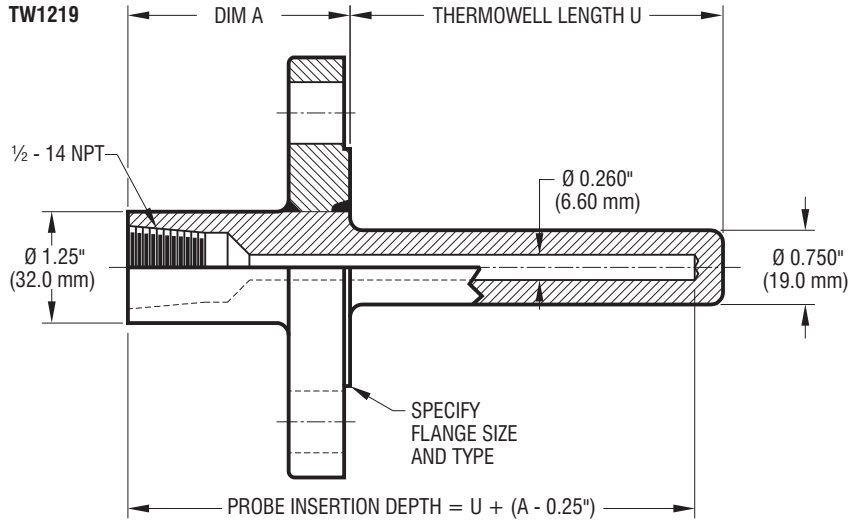
## TW1219, TW1220 thermowells

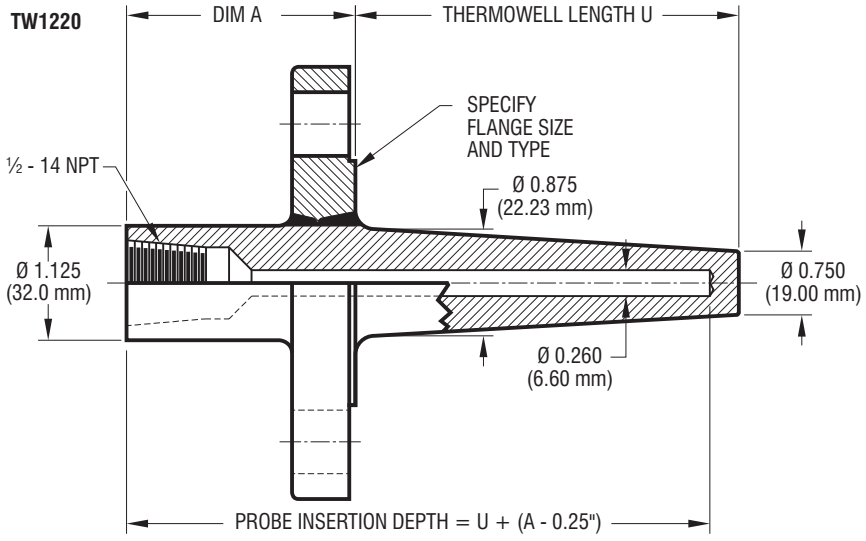
**Material:** 316 stainless steel.
**Thread:** ½ - 14 NPT internal thread.
**Temperature limit:** 607°C (1125°F).
**Pressure limit:** Specify flange pressure rating. Standard ratings: 150, 300, 400, 600, 900, 1500, 2500 psi (1 bar = 14.5 psi).
**Standard U dimensions:** 2.5, 4.5, 6.0, 7.5, 8.0, 10.5, 13.5, 16.5, and 22.5". Other dimensions available.

| Pressure rating | Dimension A |
|---|---|
| 150-600 | 2.25" |
| 900-2500 | 3.25" |

## How to order

| | |
|---|---|
| TW1219 | **Model number:**<br>TW1219 = Straight<br>TW1220 = Tapered |
| U | |
| 105 | **Thermowell length U:**<br>Specify in 0.1" increments<br>(Ex: 105 = 10.5 inches) |
| S | |
| 10 | **Flange size:**<br>10 = 1.0"<br>15 = 1.5"<br>20 = 2.0" |
| F | |
| 300 | **Pressure rating in pounds per square inch** |
| RF | **Flange type:**<br>RF = Raised face<br>RTJ = Ring type joint |
| TW1219U105S10F300RF ← Sample P/N | |



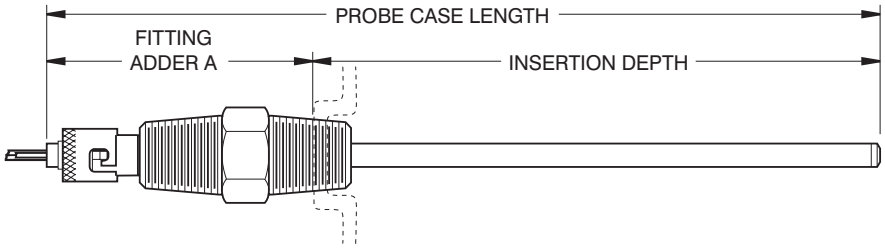
# Bayonet Fittings, Extensions

Bayonet fittings are for spring-loaded installation of probes equipped with springs and lockcaps. Insert the probe, hook the lockcap over the pin on the fitting, and release.

Extensions in assemblies serve to isolate connection heads from process connections in order to clear pipe insulation or limit heat conduction into the head. Choose from galvanized or stainless steel nipples, couplings, and unions.

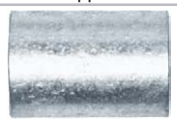
| Bayonet adapter style | Body material | Thread "CH" | Process thread | Hex size | Adder "A" | Probe Ø | Model |
|---|---|---|---|---|---|---|---|
|  | 303 stainless steel | None | ⅛ - 27 NPT | None | 1.2" min. (31 mm) | 0.188" (4.8 mm) | FG180 |
|  | 316 stainless steel | ½ - 14 NPT | ½ - 14 NPT | ⅞" (22 mm) | 2.4" (61 mm) | 0.188" (4.8 mm) | FG144T3 |

⚠ Temperature limit: 871°C (1600°F)

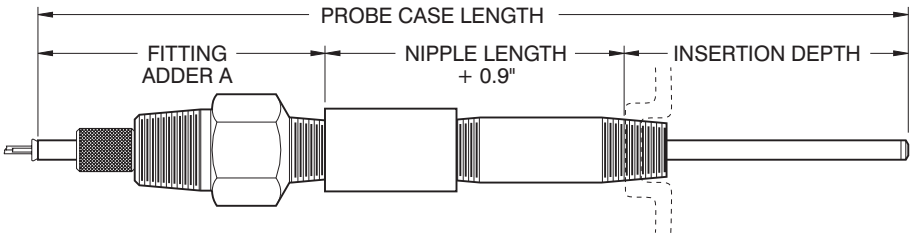



## Extension nipples, couplings, unions

Nipples are short lengths of pipe to extend connection heads away from processes. Couplings and unions have two ½ -14 NPT female threads to join nipples to other fittings. Unions allow installation without rotating the connection head.
**Note: FG709 does not provide a fluid seal.**

| Style | Length | Galvanized steel to 260°C (500°F) | Stainless steel to 871°C (1600°F) |
|---|---|---|---|
|  Nipple | 1.38" (35 mm) | FG563 | FG537 |
| | 2.0" (51 mm) | FG556L20 | FG579L20 |
| | 3.0" (76 mm) | FG556L30 | FG579L30 |
| | 6.0" (152 mm) | FG556L60 | FG579L60 |
|  Coupling | 1.7" (43 mm) | FG602 | FG854 |
|  Union | 1.56" (40 mm) | FG709 1⅜" (35 mm) hex | FG714 1½" (38 mm) hex |

⚠ All threads are ½ -14 NPT [2].




**IN STOCK**

All models except FG579L60
Other accessories listed at
www.minco.com/support

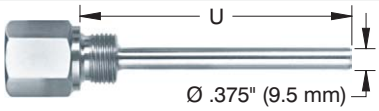
# Metric Accessories

Metric fittings and thermowells help you design your equipment to meet global standards. Use these fittings to install Minco sensors in process lines, rotating machinery, and all types of industrial equipment destined for Europe and other continents.

Special threads and accessories are available. Also see the Eurostyle assemblies on page 2-18.

**Spring-loaded holders** provide fast installation and simple adjustment or removal of probes. Minco's unique designs work with straight probes and provide sealing for the typical oil pressures found in rotating machines.
**Fluid seal fittings** are a low cost solution where a connection head is not required.
**Bayonet adapters** work with Minco's spring-loaded bayonet fitted probes on pages 3-6 and 3-8.

**Adapter bushings** allow fitting ½ - 14 NPT fittings into metric threaded process connections.
**Thermowells** provide high pressure protection and allow probe replacement without opening the system.

| | Body material | Temp. limit | Pressure rating | Thread "CH" | Process thread | Hex size | Probe Ø | Model |
|---|---|---|---|---|---|---|---|---|
|  Fluid seal spring-loaded holder<br>Probe length adder A: 3.6" (91 mm) | 303 stainless steel | 260°C (500°F) | 3.4 bar (50 psi) | ¾ - 14 NPT | G½ | 1 1/16" (27 mm) | 0.188" (4.8 mm) | MFG812P477 |
| | | | | | | | 0.215" (5.5 mm) | MFG812P546 |
| | | | | | | | 0.250" (6.4 mm) | MFG812P635 |
|  Fluid seal fitting<br>Probe length adder A: 1.1" min. (28 mm) | Brass | 260°C (500°F) | Silicone rubber O-ring: 17.2 bar (250 psi). Brass compression ring: 34.5 bar (500 psi). | None | R¼ | 9/16" (14 mm) | 0.250" (6.4 mm) | MFG816 |
|  Bayonet adapter<br>Probe length adder A: 1.2" (31 mm) | 303 stainless steel | 871°C (1600°F) | No fluid seal | None | R⅛ | None | 0.188" (4.8 mm) | MFG817 |
|  Adapter bushing<br>Probe length adder A: 1.2" (31 mm) | 303 stainless steel | 871°C (1600°F) | No fluid seal | ½ - 14 NPT (Female) | G½ | 1 1/16" (27 mm) | All | MFG811 |
|   Thermowell<br>Probe length = U + 30 mm + fitting adder A<br>(U= 13 mm min./1200 mm max.) | 303 stainless steel | 871°C (1600°F) | 190 bar (2755 psi) at 25°C, reducing to 34 bar (493 psi) at 600°C. | ½ - 14 NPT (Female) | G½ | 1 1/16" (27 mm) | 0.250" (6.4 mm) | MTW1208 |

⚠ 303 stainless steel per DIN 1.4300, AISI 303.
G thread is defined by ISO 288/1 parallel.
R thread is defined by ISO 7/1 tapered.

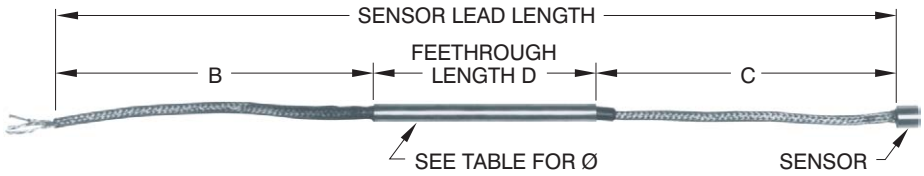
**IN STOCK**

All metric fittings

## How to order Thermowells

| | |
|---|---|
| MTW1208 | **Model number** |
| U | |
| 100 | **Thermowell length U:**<br>Specify in millimeters<br>Minimum: 13 mm<br>Maximum: 1200 mm |

MTW1208U100 ← Sample P/N






# Feedthroughs

Feedthroughs provide an oil tight seal where a cable exits a machine housing. The stainless steel tube is epoxy filled and each wire is sealed to the individual conductor. This prevents wicking of oil inside the wires as well as leakage around the wire insulation. The pressure rating to 25 psi (1.7 bar) is suitable for most oil and coolant pump systems.

They can be ordered as an accessory to any sensor in this catalog. When ordering feedthroughs with case style B bearing sensors, the spring and retaining ring are automatically included. Fluid seal fittings allow easy installation of feedthroughs into standard NPT threaded machine housings. Use fluid seal fittings on page 4-4 or FG1015 and FG3015 on page 4-12 for transitions through housings.

## Specifications

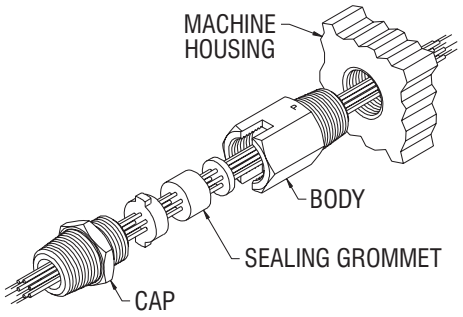
**Material:** Stainless steel with epoxy potting.
**Temperature limit:** 149°C (300°F).
**Pressure limit:** 25 psi (1.7 bar).

| Sheath Ø | Max. Cable Ø | Model |
|---|---|---|
| 0.188" (4.8 mm) | 0.12" (3.0 mm) | AC958 |
| 0.215" (5.5 mm) | 0.14" (3.6 mm) | AC717 |
| 0.250" (6.4 mm) | 0.17" (4.3 mm) | AC718 |
| 0.375" (9.5 mm) | 0.26" (6.6 mm) | AC961 |

## How to order

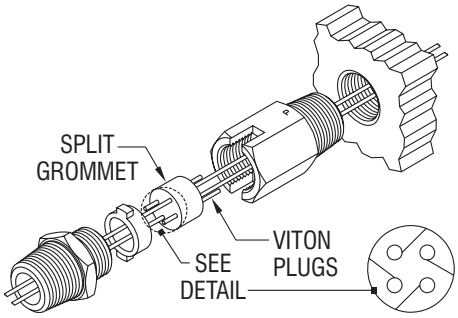
| | |
|---|---|
| AC717 | **Model number from table** |
| B6 | **Lead length B or C in inches:**<br>Specify one:<br>B = Lead end<br>C = Sensor end |
| D250 | **Feedthrough length D in 0.01" increments:**<br>Min. length: 1.6" (40.6 mm)<br>(Ex: 250 = 2.50") |

AC717B6D250 ← Sample P/N



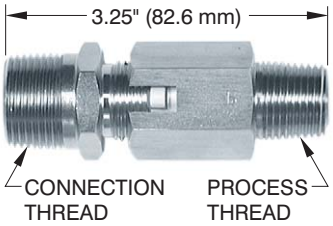

FG1015

Seal around 2, 3, or 4 probes or feedthroughs...




FG3015

or up to 6 wires.




# Leadwire and cable seal

Stop oil seepage! The FG1015 and FG3015 seal RTD or thermocouple leadwires where they exit oil-filled bearing housings of rotating equipment.

Both versions include a grommet that provides the seal and allows adjustment of the wire or cable position. With the FG1015 the wire or cable ends must be threaded through the grommet holes. The FG3015 features a split grommet so it can be fitted over the wire or cable where access to the wire ends isn't practical.

Order the 6-hole version to seal around PTFE-insulated wires. Order the 2-, 3-, or 4-hole version to allow multiple feedthroughs or cables to exit to a single connection head.

**⚠ Viton plugs are provided for unused holes on 6 hole and split grommets.**

| Number of holes | FG3015 split grommet | FG1015 | Grommet hole Ø | Cable/tube Ø range |
|---|---|---|---|---|
| 1 | | • | 0.130" (3.30 mm) | 0.100" to 0.130" (2.54 to 3.30 mm) |
| | | • | 0.160" (4.06 mm) | 0.130" to 0.160" (3.30 to 4.06 mm) |
| | | • | 0.220" (5.59 mm) | 0.190" to 0.220" (4.83 to 5.59 mm) |
| 2 | | • | 0.130" (3.30 mm) | 0.100" to 0.130" (2.54 to 3.30 mm) |
| | | • | 0.160" (4.06 mm) | 0.130" to 0.160" (3.30 to 4.06 mm) |
| | | • | 0.190" (4.83 mm) | 0.160" to 0.190" (4.06 to 4.83 mm) |
| | • | • | 0.220" (5.59 mm) | 0.190" to 0.220" (4.83 to 5.59 mm) |
| | | • | 0.257" (6.53 mm) | 0.227" to 0.257" (5.77 to 6.53 mm) |
| 3 | | • | 0.130" (3.30 mm) | 0.100" to 0.130" (2.54 to 3.30 mm) |
| | | • | 0.160" (4.06 mm) | 0.130" to 0.160" (3.30 to 4.06 mm) |
| | • | • | 0.220" (5.59 mm) | 0.190" to 0.220" (4.83 to 5.59 mm) |
| 4 | • | | 0.100" (2.54 mm) | 0.080" to 0.100" (2.03 to 2.54 mm) |
| | • | • | 0.130" (3.30 mm) | 0.100" to 0.130" (2.54 to 3.30 mm) |
| | • | • | 0.160" (4.06 mm) | 0.130" to 0.160" (3.30 to 4.06 mm) |
| 6 | • | • | 0.050" (1.27 mm) | 0.035" to 0.050" (0.76 to 1.27 mm) |

## Specifications

**Material:** Stainless steel.
**Temperature:** -40 to 150°C (-40 to 320°F).
**Pressure:** 50 psi (3.4 bar) at 20°C.

| Connection thread | Process thread | Pipe thread code |
|---|---|---|
| ½ - 14 NPT | ¾ - 14 NPT | P1 |
| ¾ - 14 NPT | ¾ - 14 NPT | P2 |
| ½ - 14 NPT | ½ - 14 NPT | P3 |
| ¾ - 14 NPT | ½ - 14 NPT | P4 |

## How to order

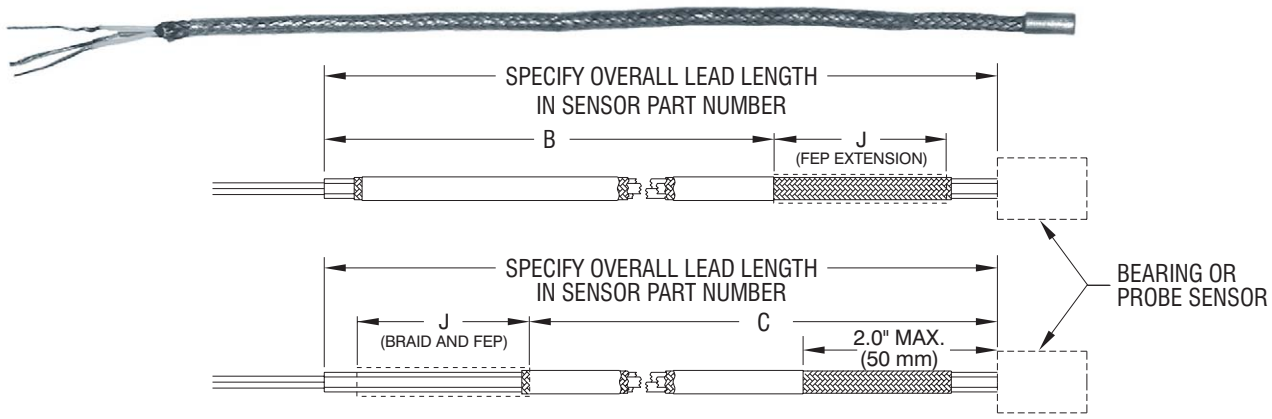
| | |
|---|---|
| FG1015 | **Model number:**<br>FG1015: Cable seal<br>FG3015: Cable seal with split grommet |
| P2 | **Thread code (table at left)** |
| SS | **Fitting material:**<br>SS = Stainless steel |
| 2 | **Number of holes (table at left)** |
| V | **Grommet material:**<br>V = Viton |
| 220 | **Hole diameter in 0.001" increments (table above)**<br>(Ex: 220 = 0.220") |
| FG1015P2SS2V220 ← Sample P/N | |

## Replacement grommet/washer kits

For replacement grommet/washer kits order model AC1015 or AC3015 (split grommet). Specify the number of holes and hole diameter required from the table above.

**IN STOCK**

FG1015 (most versions), AC1015
FG3015 (most versions), AC3015






# Elastomer Rubber Filled Cable

Model AC100324 is a sensor cable with elastomer fill between the wires, stainless steel braid, and outer jacket. This fill can extend along the entire length of the cable, or a specified portion. The outside of the cable can be sealed with an FG1015 or FG3015 fitting.

While the AC100324 provides a good seal, a minuscule amount of oil may escape inside the individual wires.

## Using the AC100324 with FG1015/FG3015 oil seal fittings

When selecting the FG1015 or FG3015 for use with silicone filled cable use the grommet hole size from the table below.

| Lead size AWG | Number of leads | Grommet hole Ø |
|---|---|---|
| 20 | 2 | 0.160 |
| 24 | 2 | 0.130 |
| 24 | 3 and 4 | 0.160 |
| 24 | 6 | 0.190 |
| 26-28 | 2,3,4, and 6 | 0.130 |
| 30 | 4 and 6 | 0.130 |

| Number of sensing elements | Case style | Grommet hole ø | |
|---|---|---|---|
| | | Leads/RTD | |
| | | 2 | 3 |
| 1 | A | .130 | .160 |
| | B | .130 | .160 |
| | C | .130 | .130 |
| | D | .100 | .100 |
| 2 | A | .160 | .190 |
| | B | .160 | .190 |
| | C | .130 | .130 |

## Specifications

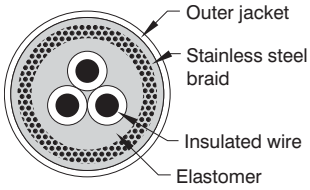
**Temperature range:** -50° C to 125°C (-58°F to 257°F).
**Tolerance on lead length:** +1/-0" (+25/-0mm) for lead lengths 24" or less; +5/-0% for lead length greater than 24".
**B length:** Cable is filled starting at leadwire end of cable. Tubing ends at B length; stainless steel braid extends to case.
**C length:** Cable is filled starting 2" from case. If J length is specified, stainless steel braid extends to lead end.
**J length:** Unfilled FEP extension length.

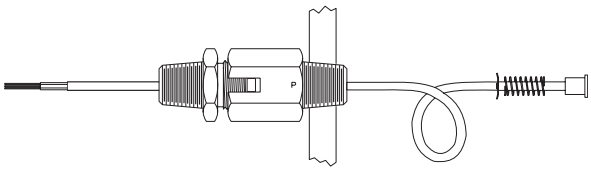
## How to order

| | |
|---|---|
| AC100324 | **Elastomer filled cable model number** |
| B24 | **Elastomer filled length B or C in inches** (if not specified, entire length will be filled)<br>B = Lead end<br>C = Sensor end<br>(Max fill length = 144") |
| **To order standard filled cable, stop here. To order an optional jacket extension add:** | |
| J | **Jacket extension** |
| AC100324B24J ← Sample P/N | |

Note: the sensor model number dictates all specifications other than the elastomer filled length B or C and optional extension J. You must specify sensor model including SS braid covering over the leadwires when ordering. Some sensor models do not include the option for SS braid lead covering; contact Minco for assistance with these sensors.

Cross section of typical cable



# Extension Wire

Use the wire and cable on this page to connect sensor leadwires to remote instrumentation. Thermocouple wire meets standard limits of error per ANSI MC96.1-1982.

Unless Minco informs you otherwise, wire and cable will be supplied in continuous lengths. Ends are not stripped.



## Copper wire for RTDs

Choose single conductor copper wire or cable.

### How to order

| | |
|---|---|
| WS122R | **Model number from table** |
| 10 | **Length in feet** |
| WS122R10 ← Sample P/N | |

| Description | Temperature limit | Color | Model number for AWG | |
|---|---|---|---|---|
| | | | 22 | 26 |
| Single conductor wire, stranded copper, PTFE insulation | 260°C (500°F) | White | WS122W | WS126W |
| | | Red | WS122R | WS126R |
| | | Blue | WS122B | WS126B |
| | | Yellow | WS122Y | WS126Y |
| Single conductor wire, stranded, mica/glass insulation | 550°C (1022°F) | White | WS222W | |
| | | Red tracer | WS222R | |
| 3 conductor cable, PTFE insulation, stainless steel braid over all | 260°C (500°F) | Red/White/ White | WS322S | WS326S |
| 6 conductor cable, PTFE insulation, stainless steel braid over all | 260°C (500°F) | Red/White/ White/Blue/ Yellow/ Yellow | | WS426S |
| 3 conductor cable, PTFE insulation, copper shield and PTFE jacket over all | 260°C (500°F) | Red/White/ White | WS522T | |

## Thermocouple cable

All cable is single pair, solid wire, color coded per ANSI MC96.1-1982.

### How to order

| | |
|---|---|
| WT120S | **Model number from table** |
| J | **Junction type:** E, J, K, or T |
| 25 | **Length in feet** |
| WT120SJ25 ← Sample P/N | |

| Description | Temperature limit | Model number for AWG | |
|---|---|---|---|
| | | 20 | 24 |
| Single pair thermocouple cable, glass braid insulation | 482°C (900°F) | WT120G | WT124G |
| Single pair thermocouple cable, PTFE insulation | 260°C (500°F) | WT120T | WT124T |
| Single pair thermocouple cable, glass braid insulation with stainless steel braid over all | 482°C (900°F) | WT120S | WT124S |

**IN STOCK**

All wire shown, in moderate lengths


# Section 5: Temperature Instruments

- RTD and thermocouple Temptran™ transmitters give accurate signals over thousands of feet. Select fixed range or field rangeable; miniature,"hockey puck," and isolated versions
- Microprocessor based controllers with optional alarm features
- Miniature DC temperature controller



**www.minco.com**

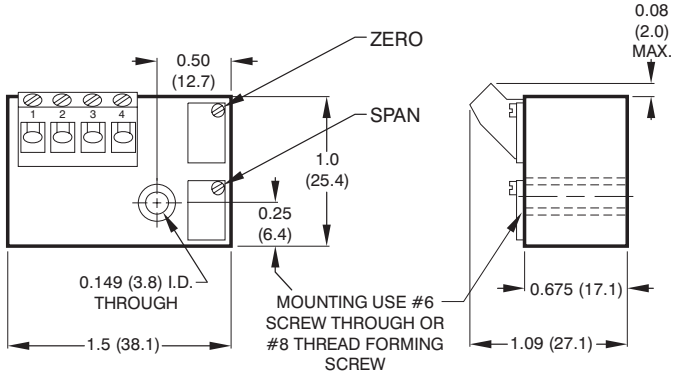
Note: Dozens of other instruments are listed at www.minco.com

TT110, TT111 only

TT210, TT211 only

TT110, TT210

TT111, TT211




DIMENSIONS IN INCHES (mm)
SEE PAGE 5-14 FOR WIRING DIAGRAM



# Miniature RTD Transmitters

- Small size, low cost
- Four models:
  TT110, TT111: UL recognized component for Canada and United States.
  TT210, TT211: Wider ambient rating; FM approved intrinsically safe and nonincendive
- Optional match calibration to Minco RTDs for improved accuracy

## Specifications

**Output:** 4 to 20 mA over specified range, linear with temperature.
**Calibration accuracy:** ±0.1% of span.
**Linearity:** Referenced to actual sensor temperature.
Platinum RTD input: ±0.1% of span.
Nickel and nickel-iron RTD input:
±0.25% of span for spans less than 100°C.
±0.25% of span per 100°C of span for spans greater than 100°C.
**Adjustments:** Zero and span, ±5% of span. Factory set.
**Ambient temperature:**
TT110, TT111: 0 to 50°C (32 to 122°F).
TT210, TT211: -25 to 85°C (-13 to 185°F).
Storage: -55 to 100°C (-67 to 212°F).
**Ambient temperature effects:**
±0.013% of span per °C.
±0.025% of span per °C for spans less than 55°C.
**Warmup drift:** ±0.1% of span max., with $V_{supply} = 24$ VDC and $R_{loop} = 250\ \Omega$. Stable within 30 minutes.
**Supply voltage:** 8.5 to 35 VDC. Voltage effect ±0.001% of span per volt. Reverse polarity protected.
**Maximum load resistance:** The maximum allowable resistance of the signal carrying loop is:

$$R_{loop\ max} = \frac{V_{supply} - 8.5}{0.020\ \text{amps}}$$

Example: With supply voltage 24 VDC, maximum loop resistance is 775 Ω.
**Minimum span:** 27.8°C (50°F).
**Hazardous atmospheres:** All models may be used with Minco flameproof/explosionproof connection heads. Models TT210 and TT211 are Factory Mutual approved intrinsically safe for Class I, Division 1 areas (requires approved barrier) and nonincendive for use in Class I, Division 2 areas. Transmitter entity parameters: $V_{max} = 35$ volts; $I_{max} = 150$ mA; $C_i = 0\ \mu F$ and $L_i = 0$ mH.
**Connections:**
TT110, TT210: Four AWG 22 leads, 5" (127 mm).
TT111, TT211: Terminal block for wires AWG 22 to AWG 14.
**Physical:** Polycarbonate case, epoxy potted for moisture resistance.
**Weight:** 1.1 oz. (30 g).

**IN STOCK**

Contact Minco for currently available transmitter ranges and models

## RTD input types

2-wire resistance thermometer:

| Element | Code |
|---|---|
| Platinum 392, 100 Ω at 0°C | PA |
| Platinum 391, 100 Ω at 0°C | PB |
| Platinum 385, 100 Ω at 0°C | PD, PE |
| Platinum 385, 1000 Ω at 0°C | PF |
| Platinum 375, 1000 Ω at 0°C | PW |
| Nickel-iron, 604 Ω at 0°C | FA |
| Nickel-iron, 1000 Ω at 70°F | FB |
| Nickel-iron, 2000 Ω at 70°F | FC |
| Nickel, 120 Ω at 0°C | NA |

## How to order

| | |
|---|---|
| TT111 | **Model number: TT110, TT111, TT210, or TT211** |
| PD | **RTD element code from table** |
| 1 | **Output: 4 to 20 mA DC** |
| C | **Temperature range code from table on page 5-10** [Ex: C = 0 to 100°C (32 to 212°F)] |
| TT111PD1C ← Sample P/N | |

See page 5-13 for high-accuracy calibration option.

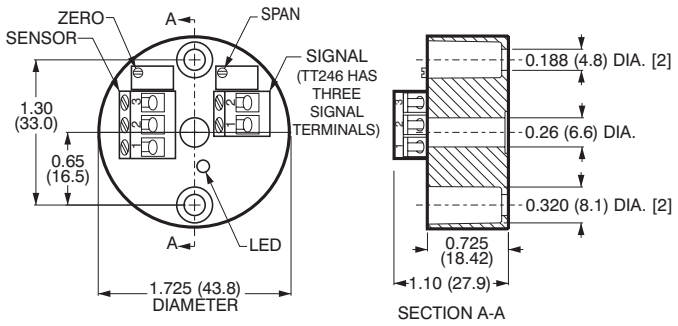
### Hazardous Area Requirements

Request Application Aid #19 for information on how to classify a hazardous area, methods of protection, and the various standards and agencies (including FM, CSA, CENELEC and ATEX).

FM APPROVED
TT176 only

TT176 CURRENT OUTPUT

TT246 VOLTAGE OUTPUT




DIMENSIONS IN INCHES (mm)
SEE PAGE 5-14 FOR WIRING DIAGRAM

# TT176, TT246 RTD Transmitters



- "Hockey puck" style industrial transmitters
- TT176: 4 to 20 mA current signal
  TT246: 1 to 5 VDC voltage signal
- 2 or 3-wire RTD input
- Intrinsically safe, nonincendive for hazardous locations
- Ambient rated to 85°C (185°F)
- Fits DIN "B" style connection heads
- Optional match calibration to Minco RTDs for improved accuracy

Specify these rugged, accurate transmitters for process control and other industrial applications.

Model TT176 provides a linearized 4 to 20 mA current signal for long distance transmission. It has a built-in LED indicator to monitor operation.

TT246 outputs 1 to 5 VDC proportional to temperature. It draws only 3 mA of quiescent current, making it ideal for solar or battery powered systems.

## Specifications

**Output:** Linear with temperature over specified range.
TT176: 4 to 20 mA.
TT246: 1 to 5 VDC.
**Calibration accuracy:** ±0.1% of span (0.2% of span for spans less than 10 Ω).
**Linearity:** 0.1% of span, referenced to actual sensor temperature.
**Adjustments:** Zero and span, ±5% of span, non-interacting. Factory set.
**Ambient temperature:**
Operating: -40 to 85°C (-40 to 185°F).
Storage: -55 to 100°C (-67 to 212°F).
**Ambient temperature effects:**
±0.009% of span per °C.
±0.014% of span per °C for spans less than 10 Ω.
**Warmup drift:** ±0.1% of span max., with $V_{supply} = 24\ VDC\ and\ R_{loop} = 250\ \Omega$.
Stable within 15 minutes.
**Supply voltage:**
TT176: 10 to 35 VDC.
TT246: 7.5 to 35 VDC.
Voltage effect ±0.001% of span per volt.
Reverse polarity protected.
**Supply current (TT246):** 3 mA max. with no load.
**Maximum load resistance (TT176):** The maximum allowable resistance of the signal carrying loop is:

$$R_{loop\ max} = \frac{V_{supply} - 10}{0.020\ \text{amps}}$$

Example: With supply voltage 24 VDC, maximum loop resistance is 700 Ω.
**Minimum span:** 10°C (18°F).
**Minimum output current:** 2.2 mA (TT176).
**Maximum output current:** 28 mA (TT176).
**Leadwire compensation:** (3-wire RTD) ±0.05% of span per Ω up to 25 Ω in each leg.
**Hazardous atmospheres:** Both models may be used with Minco explosionproof connection heads. Model TT176 is Factory Mutual approved intrinsically safe for Class I, Division 1 areas (requires approved barrier) and nonincendive for use in Class I, Division 2 areas. Transmitter entity parameters: $V_{max} = 35\ volts;$ $I_{max} = 150\ mA;\ C_i = 0\ \mu F\ and\ L_i = 0\ mH.$
Request Application Aid #19 for information on how to classify a hazardous area, methods of protection, and the various standards and agencies (including FM, CSA, CENELEC and ATEX).
**Connections:** Terminal block for wires AWG 22 to AWG 14.
**Physical:** Polycarbonate case, epoxy potted for moisture resistance.
**Weight:** 2.0 oz. (57 g).

## RTD input types

2 or 3-wire resistance thermometer:

| Element | Code |
|---|---|
| Platinum 392, 100 Ω at 0°C | PA |
| Platinum 391, 100 Ω at 0°C | PB |
| Platinum 385, 100 Ω at 0°C | PD, PE |
| Platinum 385, 1000 Ω at 0°C | PF |
| Platinum 375, 1000 Ω at 0°C | PW |
| Copper, 10 Ω at 25°C | CA |
| Nickel-iron, 604 Ω at 0°C | FA |
| Nickel-iron, 1000 Ω at 70°F | FB |
| Nickel-iron, 2000 Ω at 70°F | FC |
| Nickel, 120 Ω at 0°C | NA |

## How to order

| | |
|---|---|
| TT176 | **Model number:**<br>TT176: 4 to 20 mA<br>TT246: 1 to 5 VDC |
| PB | **RTD element code from table** |
| 1 | |
| K | **Temperature range code from table on page 5-10**<br>[Ex: K = 0 to 200°C (32 to 392°F)] |
| TT176PB1K ← Sample P/N | |

See page 5-13 for high-accuracy calibration option.

**IN STOCK**

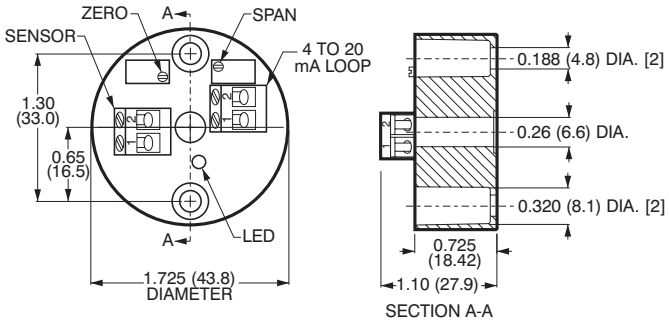
Contact Minco for currently available transmitter ranges and models

FM APPROVED
TT190 only

TT190

TT205

DIMENSIONS SAME AS ON PAGE 5-2




DIMENSIONS IN INCHES (mm)
SEE PAGE 5-14 FOR WIRING DIAGRAM



# TT190, TT205 Thermocouple Transmitters

- TT190: "Hockey puck" style industrial transmitter TT205: Miniature economy version
- Thermocouple input
- Intrinsically safe, nonincendive for hazardous locations
- Fits DIN "B" style connection heads

Model TT190 interfaces with thermocouples for use in process control and other industrial applications. It has a built-in LED indicator to help troubleshoot signal loops. A dark LED signals loss of current loop power or an open thermocouple.

Model TT205 offers performance and economy over a reduced ambient temperature range. Its compact size takes up little space.

## Specifications

**Output:** 4 to 20 mA over specified range.
**Accuracy:** ±0.2% of span.
**Linearity:** Voltage linear.
**Adjustments:** Zero and span, ±5% of span, non-interacting. Factory set.
**Warmup drift:** ±0.2% of span max., with $V_{supply} = 24\ VDC$ and $R_{loop} = 250\ \Omega$. Stable within 15 minutes.
**Supply voltage:**
TT190: 10 to 35 VDC.
TT205: 8.5 to 35 VDC.
Voltage effect ±0.001% of span per volt.
Reverse polarity protected.
**Maximum load resistance:** The maximum allowable resistance of the signal carrying loop is:

$$R_{loop\ max} = \frac{V_{supply} - V_{min}}{0.020\ \text{amps}}$$

Example: With a TT190 ($V_{min} = 10$) operated at 24 VDC, maximum loop resistance is 700 Ω.
**Minimum output current:** 1.5 mA.
**Maximum output current:** 28 mA.
**Burnout:** Downscale burnout standard; upscale optional.

**Hazardous atmospheres:** Both models may be used with Minco explosionproof connection heads. Model TT190 is Factory Mutual approved intrinsically safe for Class I, Division 1 areas (requires approved barrier) and nonincendive for use in Class I, Division 2 areas. Transmitter entity parameters: $V_{max} = 35\ volts;$ $I_{max} = 150\ mA;\ C_i = 0\ \mu F$ and $L_i = 0\ mH.$
**Connections:** Terminal block for wires AWG 22 to AWG 14.
**Physical:** Polycarbonate case, epoxy potted for moisture resistance.
**Weight:** 1.8 oz. (52 g).

## TT190

**Ambient temperature:**
Operating: -40 to 85°C (-40 to 185°F).
Storage: -55 to 100°C (-67 to 212°F).
**Ambient temperature effects:**
±0.018% of span per °C.
**Cold junction compensation drift:**
±0.03°C per °C, -25 to 70°C.
±0.06°C per °C, -40 to -25°C and 70 to 85°C.
**Minimum span:** 100°C (180°F).

## TT205

**Ambient temperature:**
Operating: -10 to 60°C (14 to 140°F).
Storage: -55 to 100°C (-67 to 212°F).
**Ambient temperature effects:**
±0.036% of span per °C.
**Cold junction compensation drift:**
±0.05°C per °C.
**Minimum span:** 150°C (270°F).

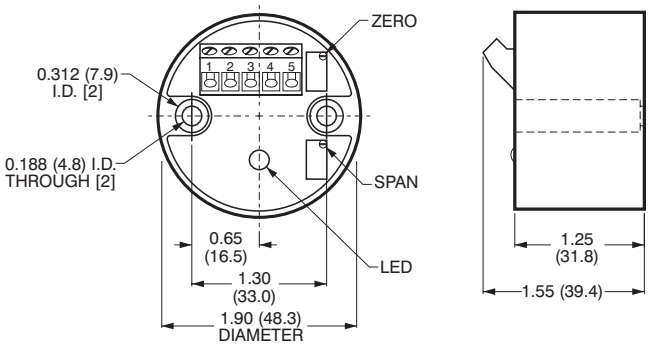
## How to order

| | |
|---|---|
| TT190 | **Model number:** TT190: Round TT205: Rectangular |
| J | **TC junction type:** E = Chromel-Constantan J = Iron-Constantan K = Chromel-Alumel T = Copper-Constantan |
| U | **U = Ungrounded junction (required)** |
| 1 | **Output: 4 to 20 mA DC** |
| GX | **Temperature range code from table on page 5-10** [Ex: GX = 93.3 to 760°C (200 to 1400°F)] |
| TT190JU1GX ← Sample P/N | |

## Hazardous Area Requirements

Request Application Aid #19 for information on how to classify a hazardous area, methods of protection, and the various standards and agencies (including FM, CSA, CENELEC and ATEX).

FM APPROVED




DIMENSIONS IN INCHES (mm)
SEE PAGE 5-14 FOR WIRING DIAGRAM

# TT220 Isolated RTD Transmitter



- 2 or 3-wire RTD input
- Input/output isolated to 600 VRMS
- Factory Mutual approved intrinsically safe, nonincendive for hazardous locations
- Ambient rated to 85°C (185°F)
- Optional match calibration to Minco RTDs for improved accuracy

Model TT220 is a rugged industrial transmitter designed for process control and other applications. It provides electrical isolation to 600 VRMS between the input and output.

The TT220 has a built-in LED indicator to help troubleshoot signal loops. A very bright LED indicates an open sensor; a dark LED signals a shorted sensor or loss of current loop power.

## Specifications

**Output:** 4 to 20 mA over specified range, linear with temperature.
**Calibration accuracy:** ±0.1% of span (0.2% of span for spans less than 10 Ω).
**Linearity:** 0.1% of span, referenced to actual sensor temperature.
**Adjustments:** Zero and span, ±5% of span, non-interacting. Factory set.
**Ambient temperature:**
Operating: -40 to 85°C (-40 to185°F).
Storage: -55 to 100°C (-67 to 212°F).
**Ambient temperature effects:** ±0.018% of span per °C.
**Warmup drift:** ±0.1% of span max., with $V_{supply} = 24\ VDC$ and $R_{loop} = 250\ \Omega$. Stable within 15 minutes.
**Input/output isolation:** 600 VRMS.
**Supply voltage:** 13 to 45 VDC. Voltage effect ±0.001% of span per volt. Reverse polarity protected.

**Maximum load resistance:** The maximum allowable resistance of the signal carrying loop is:

$$R_{loop\ max} = \frac{V_{supply} - 13}{0.020\ \text{amps}}$$

Example: With supply voltage 24 VDC, maximum loop resistance is 550 Ω.
**Minimum span:** 10°C (18°F).
**Minimum output current:** 2.5 mA.
**Maximum output current:** 28 mA.
**Leadwire compensation:** (3-wire RTD) ±0.05% of span per Ω up to 25 Ω in each leg.
**Hazardous atmospheres:** Model TT220 may be used with Minco explosionproof connection heads. This model is Factory Mutual approved intrinsically safe for Class I, Division 1 areas (requires approved barrier) and nonincendive for use in Class I, Division 2 areas. Transmitter entity parameters: $V_{max} = 35\ volts;$ $I_{max} = 150\ mA;\ C_i = 0\ \mu F$ and $L_i = 0\ mH.$
**Connections:** Terminal block for wires AWG 22 to AWG 14.
**Physical:** Polycarbonate case, epoxy potted for moisture resistance.
**Weight:** 3.0 oz. (85 g).

## RTD input types

2 or 3-wire resistance thermometer:

| Element | Code |
|---|---|
| Platinum 392, 100 Ω at 0°C | PA |
| Platinum 391, 100 Ω at 0°C | PB |
| Platinum 385, 100 Ω at 0°C | PD, PE |
| Platinum 385, 1000 Ω at 0°C | PF |
| Platinum 375, 1000 Ω at 0°C | PW |
| Copper, 10 Ω at 25°C | CA |
| Nickel-iron, 604 Ω at 0°C | FA |
| Nickel-iron, 1000 Ω at 70°F | FB |
| Nickel-iron, 2000 Ω at 70°F | FC |
| Nickel, 120 Ω at 0°C | NA |

## How to order

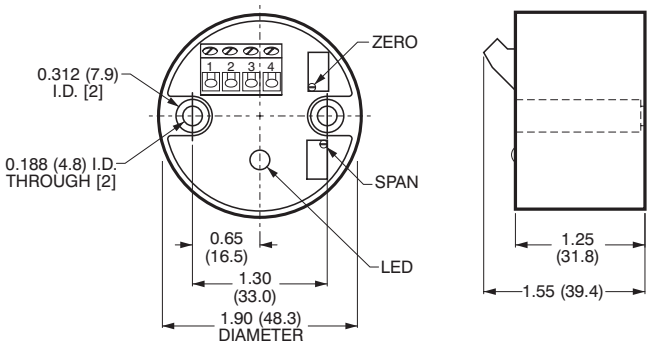
| | |
|---|---|
| TT220 | **Model number** |
| PA | **RTD element code from table** |
| 1 | **Output: 4 to 20 mA DC** |
| GH | **Temperature range code from table on page 5-10** [Ex: GH = -40 to 100°C (-40 to 212°F)] |
| TT220PA1GH ← Sample P/N | |

See page 5-13 for high-accuracy calibration option.

## Hazardous Area Requirements

Request Application Aid #19 for information on how to classify a hazardous area, methods of protection, and the various standards and agencies (including FM, CSA, CENELEC and ATEX).

FM APPROVED




DIMENSIONS IN INCHES (mm)
SEE PAGE 5-14 FOR WIRING DIAGRAM



# TT221 Isolated Thermocouple Transmitter

- Thermocouple input
- Input/output isolated to 600 VRMS
- Factory Mutual approved intrinsically safe, nonincendive for hazardous locations
- Ambient rated to 85°C (185°F)

Model TT221 is a rugged thermocouple transmitter designed for process control and other applications. It provides electrical isolation to 600 VRMS between the input and output. You can use thermocouples with either grounded or ungrounded junctions.

The TT221 has a built-in LED indicator to help troubleshoot signal loops. A dark LED signals loss of loop power or an open sensor.

## Specifications

**Output:** 4 to 20 mA over specified range.
**Accuracy:** ±0.2% of span.
**Linearity:** Voltage linear.
**Adjustments:** Zero and span, ±5% of span, non-interacting. Factory set.
**Ambient temperature:**
Operating: -40 to 85°C (-40 to185°F).
Storage: -55 to 100°C (-67 to 212°F).
**Ambient temperature effects:**
±0.036% of span per °C.
**Cold junction compensation drift:**
±0.03°C per °C, -25 to 70°C.
±0.06°C per °C, -40 to -25°C and 70 to 85°C.
**Warmup drift:** ±0.2% of span max., with $V_{supply} = 24$ VDC and $R_{loop} = 250\ \Omega$.
Stable within 15 minutes.
**Supply voltage:** 13 to 45 VDC. Voltage effect ±0.001% of span per volt. Reverse polarity protected.

**Maximum load resistance:** The maximum allowable resistance of the signal carrying loop is:

$$R_{loop\ max} = \frac{V_{supply} - 13}{0.020\ \text{amps}}$$

Example: With supply voltage 24 VDC, maximum loop resistance is 550 Ω.
**Minimum span:** 100°C (180°F).
**Minimum output current:** 2.5 mA.
**Maximum output current:** 28 mA.
**Burnout:** Downscale burnout standard; upscale optional.
**Hazardous atmospheres:** Model TT221 may be used with Minco explosionproof connection heads. This model is Factory Mutual approved intrinsically safe for Class I, Division 1 areas (requires approved barrier) and nonincendive for use in Class I, Division 2 areas. Transmitter entity parameters: $V_{max} = 35$ volts; $I_{max} = 150$ mA; $C_i = 0\ \mu F$ and $L_i = 0$ mH.
**Connections:** Terminal block for wires AWG 22 to AWG 14
**Physical:** Polycarbonate case, epoxy potted for moisture resistance.
**Weight:** 3.0 oz. (85 g).

## How to order

| | |
|---|---|
| TT221 | **Model number** |
| J | **TC junction type (may be grounded or ungrounded):**<br>E = Chromel-Constantan<br>J = Iron-Constantan<br>K = Chromel-Alumel<br>T = Copper-Constantan |
| 1 | **Output: 4 to 20 mA DC** |
| BW | **Temperature range code from table on page 5-10**<br>[Ex: BW = 0 to 250°C (32 to 482°F)] |
| TT221J1BW ← Sample P/N | |

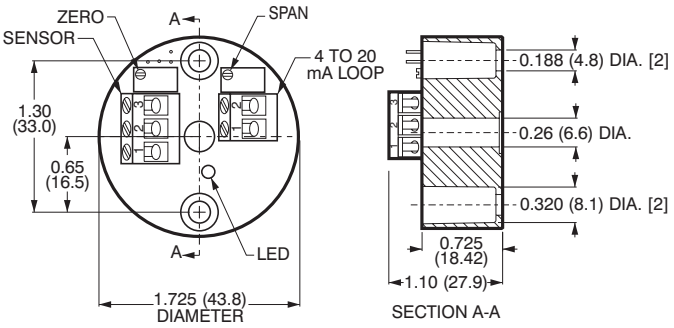
## Hazardous Area Requirements

Request Application Aid #19 for information on how to classify a hazardous area, methods of protection, and the various standards and agencies (including FM, CSA, CENELEC and ATEX).

FM APPROVED

TT216

TT230




DIMENSIONS IN INCHES (mm)
SEE PAGE 5-14 FOR WIRING DIAGRAM

# Field Rangeable Transmitters



- Wide ranging zero and span adjust to desired temperature range
- LED indicates status of current loop

Rangeable transmitters let you stock standard models, then calibrate to the exact range when a need arises. There are three broad range codes for platinum RTDs, one for copper RTDs, and two for thermocouples. Each range code contains three intervals for temperature span. You select the desired interval by making a solder link between two pins atop the transmitter. Zero and span potentiometers give fine adjustments.

## Specifications

**Output:** 4 to 20 mA over specified range.
**Adjustments:** See temperature range chart at right. Normally shipped uncalibrated; factory calibration available.
**Ambient temperature:**
Operating: -40 to 85°C (-40 to 185°F).
Storage: -55 to 100°C (-67 to 212°F).
**Supply voltage:** 10 to 35 VDC. Voltage effect ±0.001% of span per volt. Reverse polarity protected.
**Maximum load resistance:** The maximum allowable resistance of the signal carrying loop is:

$$R_{loop\ max} = \frac{V_{supply} - 10}{0.020\ \text{amps}}$$

Example: With supply voltage 24 VDC, maximum loop resistance is 700 Ω.
**Hazardous atmospheres:** Factory Mutual approved intrinsically safe for Class I, Division 1 areas (requires approved barrier) and nonincendive for use in Class I, Division 2 areas. Transmitter entity parameters: $V_{max} = 35$ volts; $I_{max} = 150$ mA; $C_i = 0\ \mu F$ and $L_i = 0$ mH. Request Application Aid #19 for information on hazardous area classifications.
**Connections:** Terminal block for wires AWG 22 to AWG 14.
**Physical:** Polycarbonate case, epoxy potted for moisture resistance.
**Weight:** 2.0 oz. (57 g).

**Temperature range:** The range code determines which values of zero and span are available on the transmitter you order. The actual values are chosen by shorting two pins on top the transmitter, then adjusting the two potentiometers.

| Zero ($T_{4\ mA}$) | | Span ($T_{20mA}$ - $T_{4mA}$) | | RTD code | Thermocouple input type | Range code |
|---|---|---|---|---|---|---|
| Minimum | Maximum | Minimum | Maximum | | | |
| -25°C | 25°C | 25°C | 100°C | PX | | RA |
| -50°C | 50°C | 50°C | 200°C | PX | | RB |
| -100°C | 200°C | 150°C | 600°C | PX | E, J, K, T | RC |
| -100°C | 100°C | 100°C | 300°C | CA | | RD |
| -100°C | 500°C | 300°C | 1200°C | | K | RE |

## TT216 RTD transmitter

**Calibration accuracy:** ±0.2% of span when factory calibrated.
**Linearity:** 0.2% of span, referenced to actual sensor temperature.
**Ambient temperature effects:** ±0.013% of span per °C.
**Warmup drift:** ±0.1% of span max., with $V_{supply} = 24$ VDC and $R_{loop} = 250\ \Omega$. Stable within 15 minutes.
**Minimum output current** 2.2 mA.
**Maximum output current:** 28 mA.
**Leadwire compensation:** (3-wire RTD) ±0.05% of span per Ω up to 25 Ω in each leg.
**RTD input types:**
2 or 3-wire resistance thermometer:

| Element | Code |
|---|---|
| Platinum, 100 Ω at 0°C (Includes all TCRs) | PX |
| Copper, 10 Ω at 25°C | CA |

## How to order

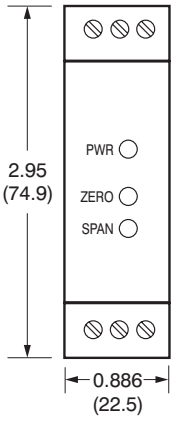
| | |
|---|---|
| TT216 | **Model number** |
| PX | **RTD element code from table** |
| 1 | **Output: 4 to 20 mA DC** |
| RB | **Range code from table** |
| TT216PX1RB ← Sample P/N | |

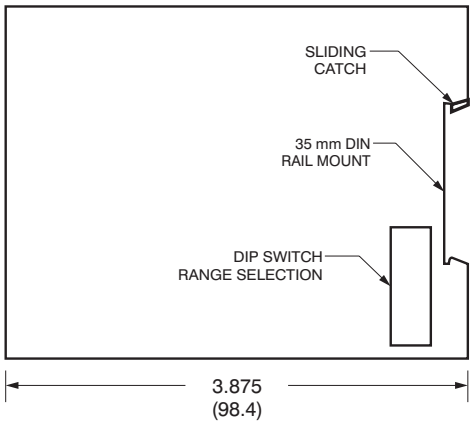
## TT230 thermocouple transmitter

**Calibration accuracy:** ±0.3% of span when factory calibrated.
**Linearity:** Voltage linear.
**Ambient temperature effects:**
±0.025% of span per °C.
**Cold junction compensation drift:**
±0.03°C per °C, -25 to 70°C.
±0.06°C per °C, -40 to -25°C and 70 to 85°C.
**Minimum output current:** 1.5 mA.
**Maximum output current:** 28 mA.
**Burnout:** Downscale burnout standard; upscale optional.

## How to order

| | |
|---|---|
| TT230 | **Model number** |
| T | **TC junction type:** E = Chromel-Constantan, J = Iron-Constantan, K = Chromel-Alumel, T = Copper-Constantan |
| U | **Ungrounded junction (required)** |
| 1 | **Output: 4 to 20 mA DC** |
| RC | **Range code from table above** |
| TT230TU1RC ← Sample P/N | |


DIMENSIONS IN INCHES (mm)

SEE PAGE 5-14 FOR WIRING DIAGRAMS



# TT273 RTD Temperature Transmitter

- Accurate, stable 4 to 20 mA signal
- Fits standard 35 mm DIN rail
- Field-calibrate to your temperature range
- Optional match calibration to Minco RTDs for improved accuracy
- Optional Input/Output isolation to 600 VRMS

The Model TT273 is a 2-wire temperature transmitter for 2 or 3-lead 100 Ω platinum RTDs. The transmitter converts the RTDs temperature into a linearized 4 to 20 mA DC current signal. Because this current signal is immune to leadwire and electrical noise, the TT273 lets you obtain accurate temperature readings from RTDs thousands of feet away. An ordinary twisted pair of wires carries both the temperature signal and power for the transmitter's electronics.

An LED conveniently indicates the status of the control loop. The brightness is directly proportional to the loop current. A very bright LED indicates an open RTD; a dark LED signals a shorted RTD or loss of current loop power.

## Specifications

**Output:** 4 to 20 mA DC over specified range.
**Calibration accuracy:** ±0.2% of span.
**Linearity:** ±0.2% of span, reference to actual sensor temperature.
**Adjustments:**
Zero: -50°C to 150°C (-58°F to 302°F).
Span: 50°C to 600°C (122°F to 1112°F).
**Ambient temperature:**
Operating: -40 to 85°C (-40 to 185°F).
Storage: -55 to 100°C (-67 to 212°F).
**Ambient temperature effects:**
±0.018% of span/°C (±0.01% of span/°F).
**Warmup drift:** ±0.1% of span max., assuming $V_{supply} = 24\ VDC\ and\ R_{loop} = 250\ \Omega$.
Stable within 15 minutes.
**Input/output isolation (optional):**
600 VRMS, 1 minute.
**Supply voltage:**
Non-Isolated: 10 to 45 volts DC with no load.
Isolated: 13 to 45 volts DC with no load.
Reverse polarity protected.
**Voltage effect:** ±0.001% of span per volt.
**Lead wire compensation:** (3-wire RTD) ±0.05% of span per Ω, up to 25 Ω in each leg.
**Maximum load resistance:** The maximum allowable resistance of the signal-carrying loop is given by this formula:

Non-Isolated: $$R_{loop\ max} = \frac{V_{supply} - 10}{0.020\ \text{amps}}$$

Isolated: $$R_{loop\ max} = \frac{V_{supply} - 13}{0.020\ \text{amps}}$$

**Maximum output current:** 28 mA.
**Connections:** Terminal block accepts wires from AWG 22 to AWG 14.
**Physical:** Polycarbonate, DIN rail enclosure.
**Weight:** 4.2 oz. (119 grams).

## RTD input types

2 or 3-wire 100 Ω platinum RTD.

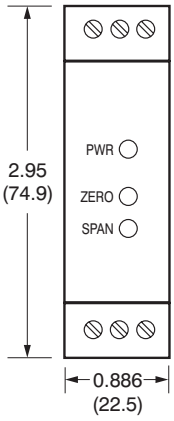
| Element | Code |
|---|---|
| Platinum 392, 100 Ω at 0°C | PA |
| Platinum 391, 100 Ω at 0°C | PB |
| Platinum 385, 100 Ω at 0°C | PD, PE |

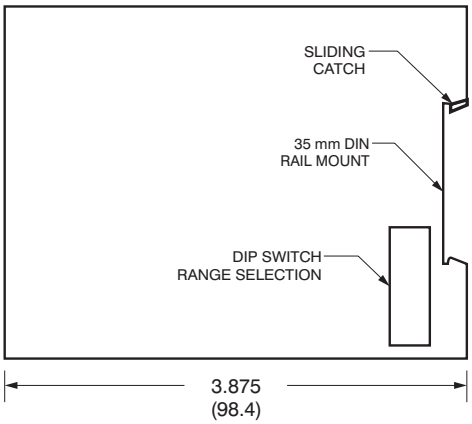
## How to order:

| | |
|---|---|
| TT273 | **Model number** |
| PD | **RTD element code from table** |
| 1 | **Output: 4 to 20 mA DC** |
| N | **Input/Output:** N = Non-isolated, I = Isolated |
| (-25/+50) | **Factory preset temp. range:** (4 mA/20 mA temperature) Range is user adjustable. Refer to the Zero and Span specifications at left. |
| C | **Temperature scale:** F = Fahrenheit, C = Celsius |
| TT273PD1N(-25/+50)C ← Sample P/N | |

See page 5-13 for high-accuracy calibration option.


SEE PAGE 5-14 FOR WIRING DIAGRAMS




DIMENSIONS IN INCHES (mm)

# TT274 Thermocouple Temperature Transmitter

- Accurate, stable 4 to 20 mA signal
- Fits standard 35 mm DIN rail
- Field-calibrate to your thermocouple type and temperature range
- Optional Input/Output isolation to 600 VRMS

The Model TT274 is a 2-wire temperature transmitter for types J and K thermocouples. The transmitter converts the thermocouple's millivolt signal to a 4 to 20 mA DC current signal. Because this current signal is immune to leadwire and electrical noise, the TT274 lets you obtain accurate temperature readings from thermocouples thousands of feet away. An ordinary twisted pair of wires carries both the temperature signal and power for the transmitter's electronics.

With the isolation option, the mV input signal from the thermocouple is electrically isolated from the 4 to 20 mA output, allowing use of grounded thermocouples with multiple TT274s operating from the same power supply.

An LED conveniently indicates the status of the control loop. The brightness is directly proportional to the loop current. A dark LED signals an open sensor or loss of current loop power.

The output signal of the TT274 is voltage linear (not temperature linear) and is intended for use with instruments which compensate for the nonlinear signal output of the thermocouple sensor.

## Specifications

**Input:** Type J or K thermocouple.
**Output:** 4 to 20 mA DC over specified range.
**Accuracy:** ±0.2% of span.
**Linearity:** Voltage linear.
**Adjustments:**
Zero: -50°C to 150°C (-58°F to 302°F)
Span: Type J: 125 to 850°C (257 to 1562°F)
Type K: 150 to 1200°C (302 to 2192°F)
**Ambient temperature:**
Operating: -40 to 85°C (-40 to 185°F).
Storage: -55 to 100°C (-67 to 212°F).
**Ambient temperature effects:** ±0.036% of span/°C (±0.02% of span/°F).
**Cold junction compensation drift:** ±0.03°C/°C for -25 to 70°C ambients. ±0.06°C/°C for -40 to -25°C and 70 to 85°C ambients.
**Warmup drift:** ±0.1% of span max., assuming $V_{supply} = 24\ VDC\ and\ R_{loop} = 250\ \Omega$.
Stable within 15 minutes.
**Input/output isolation (optional):**
600 VRMS, 1 minute.
**Supply voltage:**
Non-Isolated: 10 to 45 volts DC with no load.
Isolated: 13 to 45 volts DC with no load.
Reverse polarity protected.
**Voltage effect:** ±0.001% of span per volt.
**Maximum load resistance:** The maximum allowable resistance of the signal-carrying loop is given by this formula:

Non-Isolated: $$R_{loop\ max} = \frac{V_{supply} - 10}{0.020\ \text{amps}}$$

Isolated: $$R_{loop\ max} = \frac{V_{supply} - 13}{0.020\ \text{amps}}$$

**Maximum output current:** 28 mA.
**Connections:** Terminal block accepts wires from AWG 22 to AWG 14.
**Physical:** Polycarbonate, DIN rail enclosure.
**Weight:** 4.2 oz. (119 grams).

## How to order:

| | |
|---|---|
| TT274 | **Model number** |
| K | **T/C element code:**<br>J = Type J thermocouple<br>K = Type K thermocouple |
| 1 | **Output: 4-20 mA DC** |
| N | **Input/Output:**<br>N = Non-isolated<br>I = Isolated |
| (-25/+200) | **Factory preset temp. range:**<br>(4 mA/20 mA temperature) Range is user adjustable. Refer to the Zero and Span specifications at left. |
| C | **Temperature scale:**<br>F = Fahrenheit<br>C = Celsius |
| TT274K1N(-25/+200)C ← Sample P/N | |

# Temptran™ Temperature Ranges

The endpoints of the temperature range correspond to the Temptran's 4 and 20 mA signals. Choose the smallest possible span for best accuracy. Be sure to check the temperature limits of the sensor you specify.

New ranges are available for a small setup charge.

Minco sets the range for each Temptran using high-quality fixed resistors, then finely calibrates them with high resolution multi-turn zero and span potentiometers. Because the potentiometers represent only 5% of span, Minco Temptrans are much less susceptible than other transmitters to drift caused by vibration and temperature change.



| Range Code | Temperature range | | | | | | Sensor input types for Temptran model: | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | °F | | | °C | | | TT110, TT111, TT115, TT210, TT211 | TT176, TT246, TT220 | TT190, TT221 | TT205 |
| | 4 mA | | 20mA | 4mA | | 20mA | | | | |
| MH | -328 | to | -148 | -200.0 | to | -100.0 | PA PB PD PE | | | |
| LC | -328 | to | -58 | -200.0 | to | -50.0 | | | | T |
| MC | -328 | to | 149 | -200.0 | to | 65.0 | PF PW | PA PB PD PE | | |
| DH | -328 | to | 212 | -200.0 | to | 100.0 | PA PB PD PE | PA PB PD PE | | |
| HG | -325 | to | 100 | -198.3 | to | 37.8 | PA PB PD PE PF PW | | J T | |
| QS | -300 | to | 150 | -184.4 | to | 65.6 | | PA PB PD PE | | |
| AT | -148 | to | -40 | -100.0 | to | -40.0 | PA PB PD PE PF PW | | | |
| EZ | -148 | to | 32 | -100.0 | to | 0.0 | PA PB PD PE PF PW | PA PB PD PE | | |
| TK | -148 | to | 122 | -100.0 | to | 50.0 | PA PB PD PE PF PW | | | |
| LN | -148 | to | 212 | -100.0 | to | 100.0 | PA PB PD PE | | | |
| EB | -120 | to | 60 | -84.4 | to | 15.6 | PA PB PD PE | | | |
| UL | -103 | to | 752 | -75.0 | to | 400.0 | | | K | |
| ET | -85 | to | 32 | -65.0 | to | 0.0 | PA PB PD PE PF PW | | | |
| AR | -60 | to | 10 | -51.1 | to | -12.2 | PA PB PD PE FB | PA PB PD PE | | |
| BO | -60 | to | 120 | -51.1 | to | 48.9 | PA PB PD PE | PA PB PD PE | | |
| M | -58 | to | 122 | -50.0 | to | 50.0 | PA PB PD PE PF PW | PA PB PD PE | | |
| EO | -58 | to | 212 | -50.0 | to | 100.0 | PA PB PD PE NA | PA PB PD PE | T | E T |
| JD | -58 | to | 302 | -50.0 | to | 150.0 | PA PB PD PE | PA PB PD PE | J | |
| MR | -58 | to | 500 | -50.0 | to | 260.0 | | PA PB PD PE CA NA | | |
| Y | -50 | to | 50 | -45.6 | to | 10.0 | PA PB PD PE PF PW FB FC | PA PB PD PE | | |
| MI | -50 | to | 150 | -45.6 | to | 65.6 | PA PB PD PE | PA PB PD PE | T | |
| AI | -50 | to | 275 | -45.6 | to | 135.0 | PA PB PD PE PF PW FB FC FL NA | PA PB PD PE | | |
| DG | -40 | to | 85 | -40.0 | to | 29.4 | PA PB PD PE FB FC | PA PB PD PE | | |
| MU | -40 | to | 86 | -40.0 | to | 30.0 | PA PB PD PE | | | |
| AD | -40 | to | 120 | -40.0 | to | 48.9 | PA PB PD PE FB FC | PA PB PD PE | | |
| AK | -40 | to | 140 | -40.0 | to | 60.0 | PA PB PD PE PU | PA PB PD PE | | |
| BE | -40 | to | 160 | -40.0 | to | 71.1 | PA PB PD PE FB | PA PB PD PE | | |
| GH | -40 | to | 212 | -40.0 | to | 100.0 | PA PB PD PE | PA PB PD PE | | |
| TY | -40 | to | 248 | -40.0 | to | 120.0 | PA PB PD PE PF PW | | | |
| WB | -40 | to | 257 | -40.0 | to | 125.0 | PF PW | | | |
| EX | -40 | to | 482 | -40.0 | to | 250.0 | PA PB PD PE | PF | | |
| L | -30 | to | 120 | -34.4 | to | 48.9 | PA PB PD PE PF PW FB FC | | | |
| AS | -30 | to | 130 | -34.4 | to | 54.4 | PA PB PD PE PF PW FB | PA PB PD PE | | |
| R | -30 | to | 150 | -34.4 | to | 65.6 | PA PB PD PE FB FC | PA PB PD PE | | |
| DR | -30 | to | 212 | -34.4 | to | 100.0 | PA PB PD PE FC | | | |
| LJ | -30 | to | 240 | -34.4 | to | 115.6 | PA PB PD PE FC | | T | |
| BG | -30 | to | 500 | -34.4 | to | 260.0 | PA PB PD PE PF PW | | | |
| MT | -25 | to | 125 | -31.7 | to | 51.7 | PA PB PD PE | PA PB PD PE | | |
| BC | -22 | to | 86 | -30.0 | to | 30.0 | PA PB PD PE | PA PB PD PE | | |
| DN | -22 | to | 122 | -30.0 | to | 50.0 | PA PB PD PE | PA PB PD PE | | |
| TQ | -22 | to | 158 | -30.0 | to | 70.0 | PA PB PD PE | | | |
| ES | -22 | to | 212 | -30.0 | to | 100.0 | PA PB PD PE | PA PB PD PE | | |
| EE | -22 | to | 302 | -30.0 | to | 150.0 | PA PB PD PE | PA PB PD PE | | |
| DO | -20 | to | 120 | -28.9 | to | 48.9 | PA PB PD PE PF PW ND | PA PB PD PE | | |
| EN | -20 | to | 140 | -28.9 | to | 60.0 | PA PB PD PE PF PW FB | PA PB PD PE | | |
| B | -20 | to | 180 | -28.9 | to | 82.2 | PA PB PD PE FB FC NA | PA PB PD PE CA | | |
| UB | -20 | to | 350 | -28.9 | to | 176.7 | | | | T |
| G | -10 | to | 40 | -23.3 | to | 4.4 | PA PB PD PE PF PW | PA PB PD PE | | |

**⚠ Additional ranges are available. Call Minco for details.**

| Range Code | Temperature range | | | | | | Sensor input types for Temptran model: | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | °F | | | °C | | | TT110, TT111, TT115, TT210, TT211 | TT176, TT246, TT220 | TT190, TT221 | TT205 |
| | 4 mA | | 20mA | 4mA | | 20mA | | | | |
| JX | -10 | to | 250 | -23.3 | to | 121.1 | PA PB PD PE | | | K |
| BP | -4 | to | 104 | -20.0 | to | 40.0 | PA PB PD PE FC | PA PB PD PE | | |
| SH | -4 | to | 122 | -20.0 | to | 50.0 | PA PB PD PE | | | |
| DB | -4 | to | 212 | -20.0 | to | 100.0 | PA PB PD PE | PA PB PD PE | | |
| JZ | 0 | to | 65 | -17.8 | to | 18.3 | PA PB PD PE | PA PB PD PE | | |
| S | 0 | to | 100 | -17.8 | to | 37.8 | PA PB PD PE PF PG PW FB | PA PB PD PE PW | | |
| JH | 0 | to | 120 | -17.8 | to | 48.9 | PA PB PD PE PF PW FC | PA PB PD PE | | |
| HD | 0 | to | 130 | -17.8 | to | 54.4 | PA PB PD PE PF PW | PA PB PD PE | | |
| DV | 0 | to | 150 | -17.8 | to | 65.6 | PA PB PD PE FB | PA PB PD PE | | |
| EI | 0 | to | 160 | -17.8 | to | 71.1 | PA PB PD PE | | | |
| AC | 0 | to | 200 | -17.8 | to | 93.3 | PA PB PD PE PF PW FB NA | PA PB PD PE CA | E J K T | T |
| KJ | 0 | to | 240 | -17.8 | to | 115.6 | PA PB PD PE PF PW | PA PB PD PE CA | | |
| EY | 0 | to | 250 | -17.8 | to | 121.1 | PA PB PD PE PF PW NA | PA PB PD PE | J K | J K T |
| KA | 0 | to | 255 | -17.8 | to | 123.9 | PA PB PD PE | | | |
| AN | 0 | to | 300 | -17.8 | to | 148.9 | PA PB PD PE PF PW FB FC NA | PA PB PD PE CA NA | E J K T | K |
| JA | 0 | to | 350 | -17.8 | to | 176.7 | PA PB PD PE | PA PB PD PE | K J | |
| DS | 0 | to | 400 | -17.8 | to | 204.4 | PA PB PD PE NA | PA PB PD PE CA NA | J K | |
| AG | 0 | to | 500 | -17.8 | to | 260.0 | PA PB PD PE PF PW NA | PA PB PD PE CA | E J T | J K T |
| QN | 0 | to | 550 | -17.8 | to | 287.8 | PA PB PD PE | PA PB PD PE | | |
| AB | 0 | to | 600 | -17.8 | to | 315.6 | PA PB PD PE PF PW NA | PA PB PD PE | E J K | J |
| AA | 0 | to | 800 | -17.8 | to | 426.7 | PA PB PD PE PF PW | PA PB PD PE | J | J K |
| BZ | 0 | to | 1000 | -17.8 | to | 537.8 | PA PB PD PE | PA PB PD PE | J K | E J |
| HU | 0 | to | 1300 | -17.8 | to | 704.4 | | | K | |
| JT | 0 | to | 1400 | -17.8 | to | 760.0 | | | J K | J |
| JC | 0 | to | 1500 | -17.8 | to | 815.6 | PA PB PD PE | PA PB PD PE | K | |
| KC | 0 | to | 1750 | -17.8 | to | 954.4 | | | K | K |
| KZ | 0 | to | 2000 | -17.8 | to | 1093.3 | | | K | |
| LV | 0 | to | 2400 | -17.8 | to | 1315.6 | | | K | |
| BM | 10 | to | 60 | -12.2 | to | 15.6 | PA PB PD PE | PA PB PD PE | | |
| HB | 10 | to | 70 | -12.2 | to | 21.1 | PA PB PD PE PF PW | PA PB PD PE | | |
| BY | 14 | to | 104 | -10.0 | to | 40.0 | PA PB PD PE | PA PB PD PE | | |
| AJ | 14 | to | 122 | -10.0 | to | 50.0 | PA PB PD PE | PA PB PD PE | | |
| EA | 15 | to | 65 | -9.4 | to | 18.3 | PA PB PD PE PF PW | | | |
| AP | 20 | to | 70 | -6.7 | to | 21.1 | PA PB PD PE PF PW | PA PB PD PE | | |
| KW | 20 | to | 80 | -6.7 | to | 26.7 | PA PB PD PE | PA PB PD PE | | |
| GV | 20 | to | 100 | -6.7 | to | 37.8 | PA PB PD PE PF PW | PA PB PD PE | | |
| A | 20 | to | 120 | -6.7 | to | 48.9 | PA PB PD PE PF PW FA FB FC NA | PA PB PD PE PF | | |
| ST | 20 | to | 170 | -6.7 | to | 76.7 | PA PB PD PE | | | |
| HE | 20 | to | 240 | -6.7 | to | 115.6 | PA PB PD PE | | | |
| AF | 20 | to | 320 | -6.7 | to | 160.0 | PA PB PD PE FA FB | | | |
| QE | 22 | to | 122 | -5.6 | to | 50.0 | PA PB PD PE | | | |
| GW | 23 | to | 131 | -5.0 | to | 55.0 | PA PB PD PE | | | |
| U | 30 | to | 80 | -1.1 | to | 26.7 | PA PB PD PE PF PW FB FC | PA PB PD PE | | |
| DA | 30 | to | 90 | -1.1 | to | 32.2 | PA PB PD PE PF PW FC | PA PB PD PE | | |
| DP | 30 | to | 100 | -1.1 | to | 37.8 | PA PB PD PE PF PW | | | |
| HC | 30 | to | 120 | -1.1 | to | 48.9 | PA PB PD PE PF PW | | | |
| BI | 30 | to | 130 | -1.1 | to | 54.4 | PA PB PD PE PF PW | PA PB PD PE PF PW | | |
| DQ | 30 | to | 150 | -1.1 | to | 65.6 | PA PB PD PE FB | PA PB PD PE | | |
| KK | 30 | to | 180 | -1.1 | to | 82.2 | PA PB PD PE | | | |
| EV | 30 | to | 230 | -1.1 | to | 110.0 | PA PB PD PE | PA PB PD PE | | |
| BN | 30 | to | 240 | -1.1 | to | 115.6 | PA PB PD PE PF PW FB | PA PB PD PE | | |
| BJ | 30 | to | 250 | -1.1 | to | 121.1 | PA PB PD PE PF PW NA | PA PB PD PE FA | | |
| GQ | 32 | to | 100 | 0.0 | to | 37.8 | PA PB PD PE PF PW | PA PB PD PE | | |
| EG | 32 | to | 104 | 0.0 | to | 40.0 | PA PB PD PE PF PW | PA PB PD PE | | |
| N | 32 | to | 122 | 0.0 | to | 50.0 | PA PB PD PE PF PW FB FC | PA PB PD PE | | |
| HL | 32 | to | 167 | 0.0 | to | 75.0 | PA PB PD PE | PA PB PD PE | | |
| C | 32 | to | 212 | 0.0 | to | 100.0 | PA PB PD PE PF PW FB FC NA | PA PB PD PE CA NA | J T | |
| MQ | 32 | to | 248 | 0.0 | to | 120.0 | | PA PB PD PE | | |

⚠ **Additional ranges are available. Call Minco for details.**

| Range Code | Temperature range | | | | | | Sensor input types for Temptran model: | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | °F | | | °C | | | TT110, TT111, TT115, TT210, TT211 | TT176, TT246, TT220 | TT190, TT221 | TT205 |
| | 4 mA | | 20mA | 4mA | | 20mA | | | | |
| QR | 32 | to | 257 | 0.0 | to | 125.0 | PA PB PD PE | | | |
| DL | 32 | to | 280 | 0.0 | to | 137.8 | PA PB PD PE | PA PB PD PE | | |
| J | 32 | to | 302 | 0.0 | to | 150.0 | PA PB PD PE PF PU PW FC NA | PA PB PD PE CA | J | J |
| LK | 32 | to | 350 | 0.0 | to | 176.7 | | | K | |
| K | 32 | to | 392 | 0.0 | to | 200.0 | PA PB PD PE PU NA | PA PB PD PE CA | J K | J |
| LX | 32 | to | 400 | 0.0 | to | 204.4 | PA PB PD PE | | | |
| BW | 32 | to | 482 | 0.0 | to | 250.0 | PA PB PD PE NA | PA PB PD PE | E J K T | J |
| LF | 32 | to | 572 | 0.0 | to | 300.0 | PA PB PD PE | PA PB PD PE | J T | |
| EU | 32 | to | 662 | 0.0 | to | 350.0 | PA PB PD PE | PA PB PD PE | J | |
| GE | 32 | to | 752 | 0.0 | to | 400.0 | PA PB PD PE PF PW | PA PB PD PE | J K | |
| JW | 32 | to | 932 | 0.0 | to | 500.0 | PA PB PD PE | PA PB PD PE | J K | K |
| HA | 32 | to | 1112 | 0.0 | to | 600.0 | PA PB PD PE PF PW | | K | |
| GF | 32 | to | 1472 | 0.0 | to | 800.0 | PA PB PD PE | PA PB PD PE | K | K |
| MG | 32 | to | 2100 | 0.0 | to | 1148.9 | | | | K |
| SG | 33.8 | to | 123.8 | 1.0 | to | 51.0 | PA PB PD PE | | | |
| HJ | 35 | to | 65 | 1.7 | to | 18.3 | | PA PB PD PE | | |
| MF | 35 | to | 120 | 1.7 | to | 48.9 | PA PB PD PE | | | |
| ME | 40 | to | 85 | 4.4 | to | 29.4 | | | | |
| H | 40 | to | 90 | 4.4 | to | 32.2 | PA PB PD PE PF PW FB | PA PB PD PE | | |
| BU | 40 | to | 100 | 4.4 | to | 37.8 | PA PB PD PE PF PW | | | |
| BK | 40 | to | 140 | 4.4 | to | 60.0 | PA PB PD PE PF PW FB | PA PB PD PE | | |
| KG | 40 | to | 150 | 4.4 | to | 65.6 | PA PB PD PE | | | |
| MX | 40 | to | 200 | 4.4 | to | 93.3 | FB | | | |
| LT | 40 | to | 210 | 4.4 | to | 98.9 | PA PB PD PE | PA PB PD PE | | |
| KH | 40 | to | 240 | 4.4 | to | 115.6 | PA PB PD PE PF PW | PA PB PD PE | | |
| KP | 42 | to | 92 | 5.6 | to | 33.3 | PA PB PD PE | | | |
| DU | 45 | to | 95 | 7.2 | to | 35.0 | PA PB PD PE | PA PB PD PE | | |
| WY | 50 | to | 70 | 10.0 | to | 21.1 | | PA PB PD PE | | |
| DX | 50 | to | 100 | 10.0 | to | 37.8 | PA PB PD PE PF PW | PA PB PD PE | | |
| AH | 50 | to | 110 | 10.0 | to | 43.3 | PA PB PD PE FB | PA PB PD PE | | |
| ED | 50 | to | 120 | 10.0 | to | 48.9 | PA PB PD PE PF PW FB | | | |
| V | 50 | to | 150 | 10.0 | to | 65.6 | PA PB PD PE PF PW FA FB NA | PA PB PD PE | | |
| KQ | 50 | to | 200 | 10.0 | to | 93.3 | PA PB PD PE | PA PB PD PE | | |
| AV | 50 | to | 230 | 10.0 | to | 110.0 | PA PB PD PE PF PW | PA PB PD PE | J | |
| BF | 50 | to | 250 | 10.0 | to | 121.1 | PA PB PD PE PF PW | PA PB PD PE PF PW | E T | |
| AO | 50 | to | 300 | 10.0 | to | 148.9 | PA PB PD PE | PA PB PD PE CA FA | | |
| KM | 50 | to | 350 | 10.0 | to | 176.7 | PA PB PD PE PF PW | PA PB PD PE | | |
| KF | 50 | to | 400 | 10.0 | to | 204.4 | PA PB PD PE | PA PB PD PE | | |
| DW | 50 | to | 550 | 10.0 | to | 287.8 | PA PB PD PE | PA PB PD PE | K | |
| EH | 50 | to | 1200 | 10.0 | to | 648.9 | | | | J |
| AU | 55 | to | 105 | 12.8 | to | 40.6 | PA PB PD PE | | | |
| KO | 60 | to | 110 | 15.6 | to | 43.3 | PA PB PD PE | PA PB PD PE | | |
| WX | 68 | to | 176 | 20.0 | to | 80.0 | PA PB PD PE | | | |
| DZ | 70 | to | 120 | 21.1 | to | 48.9 | PA PB PD PE | | | |
| DM | 70 | to | 130 | 21.1 | to | 54.4 | PA PB PD PE | PA PB PD PE | | |
| D | 70 | to | 220 | 21.1 | to | 104.4 | PA PB PD PE PF PW FB FC | PA PB PD PE | | |
| AM | 70 | to | 550 | 21.1 | to | 287.8 | FB | PA PB PD PE | | |
| W | 100 | to | 200 | 37.8 | to | 93.3 | PA PB PD PE | PA PB PD PE | | |
| Z | 100 | to | 250 | 37.8 | to | 121.1 | PA PB PD PE PF PW FB | PA PB PD PE | | |
| P | 100 | to | 355 | 37.8 | to | 179.4 | PA PB PD PE PF PW | PA PB PD PE | | |
| JO | 100 | to | 400 | 37.8 | to | 204.4 | PA PB PD PE | PA PB PD PE | | |
| E | 100 | to | 500 | 37.8 | to | 260.0 | PA PB PD PE PF PW | PA PB PD PE | | |
| QZ | 122 | to | 212 | 50.0 | to | 100.0 | PA PB PD PE | | | |
| AQ | 125 | to | 275 | 51.7 | to | 135.0 | PA PB PD PE PF PW | PA PB PD PE | | |
| BS | 200 | to | 400 | 93.3 | to | 204.4 | PA PB PD PE | PA PB PD PE | | |
| BL | 200 | to | 500 | 93.3 | to | 260.0 | PA PB PD PE PF PW | | K | |
| GX | 200 | to | 1400 | 93.3 | to | 760.0 | | | J K E | K |

⚠ **Additional ranges are available. Call Minco for details.**

# Why Use Temptrans?

## Long distance accuracy

Temptran transmitters amplify the low-level signals from RTDs or thermocouples to an industry-standard 4 to 20 mA current signal proportional to temperature. Unlike resistance or voltage, current signals are immune to resistance in extension wires and stray electrical noise. This lets you receive accurate signals from a sensor located thousands of feet away.

The 4 to 20 mA output signal and DC power share the same wire pair. You don't need to run power wires to every sensor location.

RTD transmitters also linearize the signal to temperature, making them excellent low cost signal conditioners.

## Engineered for reliability

Over 500,000 Minco transmitters are currently giving trouble-free service in installations around the world. Two factors behind Temptrans' exceptional stability and longevity are:

- Minco encapsulates all electronics in epoxy to exclude contaminants and protect components.
- Standard fixed-range transmitters feature ±5% adjustability using 20 turn trimpots. Because a complete rotation of the trimpot represents only 0.25% of the span, slight movements from mechanical shock cause only negligible output change. In contrast, many competitive transmitters have wide ranging zero and span. Some even use single-turn potentiometers. With zero and span far more sensitive to potentiometer shifts, a minor bump can void the transmitter's calibration.

## Easy to install

Compact Temptrans fit nearly anywhere. You can install most models in standard electrical utility boxes and elbows. Or Minco offers a complete selection of complementary connection heads (pages 4-2, 4-3 and 5-14).

For DIN rail mounting inside instrument cabinets, see the mounting accessories on page 5-14.

## Intrinsic safety

Most Temptrans are rated intrinsically safe by Factory Mutual (FM), a recognized testing authority for safety in hazardous areas. Installations must include a suitable barrier. Contact Minco for a list of barriers FM approved under the system concept for use with Temptrans.

Request Application Aid #19 to learn more about the use of sensors in hazardous areas.



# Special High-Accuracy Calibration

Standard transmitters are calibrated to the *nominal* resistance values of the RTD at the zero and span points. Total system error includes the tolerance of both the transmitter and the RTD sensor.

If you order Minco Temptrans calibrated to the *actual* resistance of the RTD (traceable to NIST), this effectively subtracts the sensor tolerance from system accuracy specifications.

For example, consider a transmitter with a range of 0 to 500°C. The transmitter itself is accurate to ±1.0°C (±0.2% of span, including calibration accuracy and linearity). The RTD interchangeability contributes an additional error of ±0.3°C at 0°C and ±2.8°C at 500°C. Total system error would be ±1.3°C at 0°C and ±3.8°C at 500°C. Calibration of the sensor and transmitter as a set cancels the sensor error, reducing system error to ±1.0°C over the full range — all for a nominal extra cost.

## NIST traceability at no cost

With each matched sensor/transmitter set, Minco sends you calibration data traceable to the National Institute of Standards & Technology. This helps your process comply with ISO 9000 and other quality standards.

## How to order special calibration

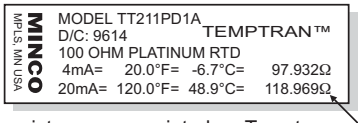
To specify a specially calibrated transmitter, substitute the model number at right in the Temptran part number:

| Standard model | Special calibration |
|---|---|
| TT110 | TT150 |
| TT111 | TT151 |
| TT115 | TT155 |
| TT176 | TT676 |
| TT210 | TT710 |
| TT211 | TT711 |
| TT220 | TT720 |
| TT246 | TT746 |
| TT273 | TT773 |

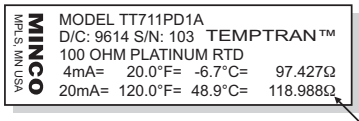
## Recalibration

Minco prints RTD resistance values right on the Temptran label to simplify recalibration. You simply connect a resistance decade box or "RTD simulator" in place of the RTD, dial in the correct values, and adjust zero and span.

Because Minco platinum RTDs are extremely stable in typical installations (0.1°C or better), you can trust the printed values for many years without recalibration of the sensor.




RTD resistances are printed on Temptran labels for easy recalibration of zero and span. A standard Temptran shows nominal values.




A specially calibrated Temptran shows *actual* resistance of the serialized, connected RTD.

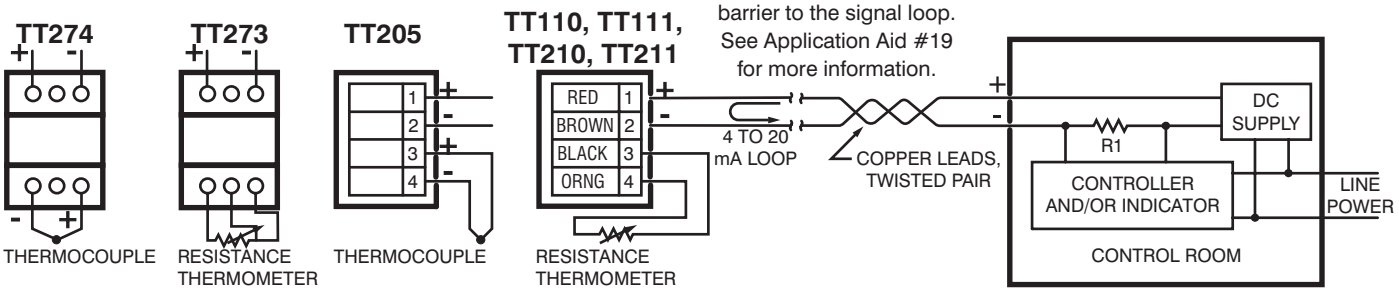
# Temptran Wiring Diagrams

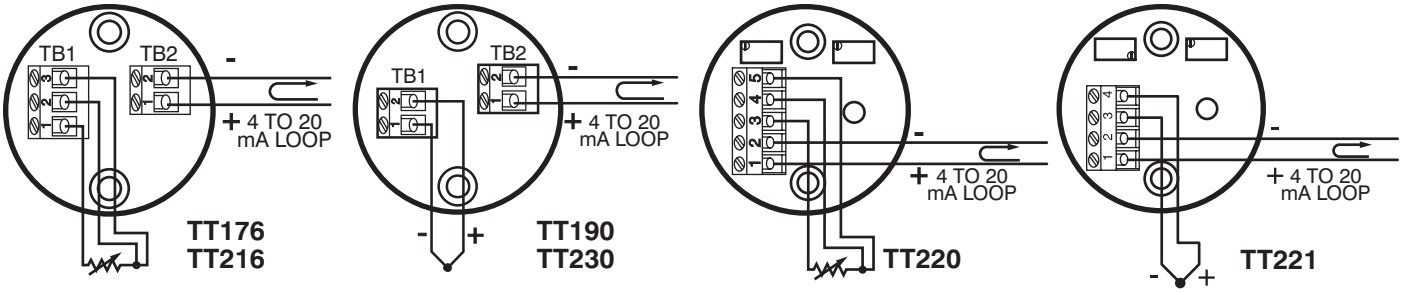
Shown below are schematics of the transmitter signal loop. R1 is a fixed load resistor, typically part of the input instrument, to convert the current signal to voltage. Total resistance of R1, signal wires, and any stray resistances such as contacts, must be less than the maximum allowable resistance for the transmitter. An R1 value of 250 Ω will produce a voltage drop of 1 to 5 VDC from 4 to 20 mA.

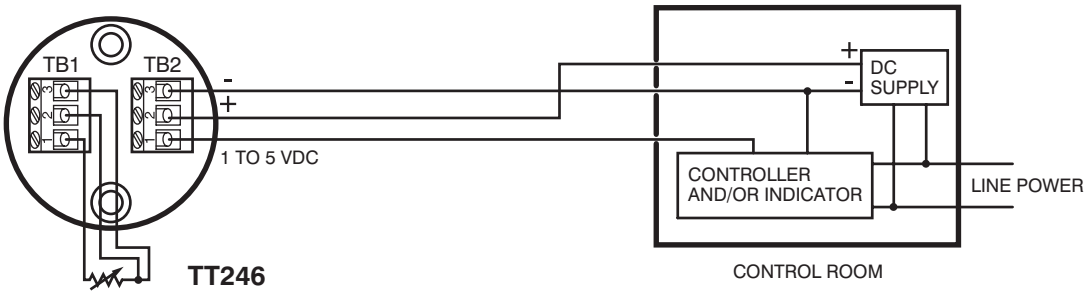
**www.minco.com/support**

Note: Wiring diagrams, literature and application aids are available at www.minco.com/support

**Intrinsically safe** installations require the addition of a safety barrier to the signal loop. See Application Aid #19 for more information.



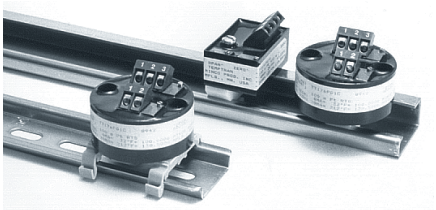



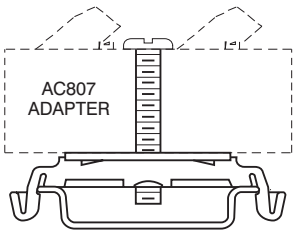

## DIN rail mounting

For easy installation in instrument cabinets. Adapters fit all Temptran models. Specify length when ordering rails.

| Model | Description |
|---|---|
| AC805 | DIN EN50022 Rail |
| AC807 | Adapter for EN50022 |



Temptrans mounted to DIN rail.

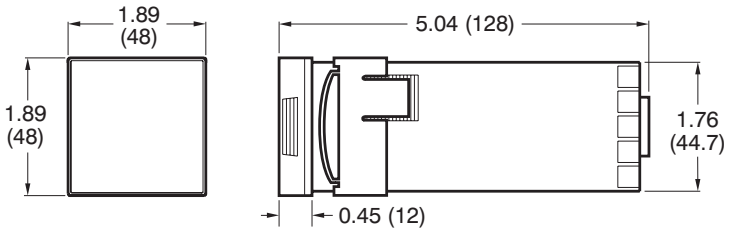



AC805 RAIL

## AC781 dual mounting kit

The AC781 mounting kit fits connection head models CH104, CH106, and CH330 on page 4-3. It holds two miniature Temptrans in a single head for use with dual RTDs.


Compact 1/16 DIN size




PANEL CUTOUT: 1.775" × 1.775" (45 mm × 45 mm)
MAXIMUM PANEL THICKNESS: 0.25" (6.35 mm)
DIMENSIONS IN INCHES (mm)



# CT15 Temperature Controller & Alarm

An easy to use controller with sophisticated PID control. It can also be a single or 2-stage alarm (using alarm feature plus control relay): monitor motors and generators for overheating.

## Features

- RTD or thermocouple input
- Control modes: Self-Tune, pre-set or programmable PID, or On/Off
- Bright red LED display
- Ramp to setpoint
- Digital sensor input correction
- Digital input filter adjustable for noisy or jittery processes
- 4 security levels
- Setpoint limits
- Non-volatile memory needs no battery backup
- Input fault timer
- Alarms at one or two temperatures
- Alarm Relay option is programmable for high, low, absolute, or deviation, can be reset manually or automatically, and it controls a single electromechanical relay with voltage-free contacts

## Specifications

**Selectable inputs:**
RTD: 2 or 3-wire, Minco types PD or PE (100 Ω EN60751 platinum).
Thermocouple: Type J (factory default), K, T (selectable).
**Input impedance:**
Thermocouple: 3 megohms minimum.
RTD current: 200 μA maximum.
**Sensor break or short protection:** De-energizes control outputs to protect system.
**Loop break protection:** Error message is initiated and output is turned off in case of shorted sensor or open heater circuit. Break time adjustable from OFF to 99 minutes.
**Cycle rate:** 1 to 80 seconds.
**Setpoint range:** Selectable from -212 to 1371°C (-350 to 2500°F), input dependent.
**Display:** One: 4 digit, 7 segment 0.3" high LEDs. Display shows the measured temperature, unless a control key is pressed, then it will display the item value.
**Control action:** Reverse (usually heating) or Direct (usually cooling), selectable.
**Ramp/Soak:** One ramp, 0 to 100 hours.
**Accuracy:** ±0.25% of span ±1 count.
**Resolution:** 1° or 0.1°, selectable.
**Line voltage stability:** ±0.05% over supply voltage range.
**Temperature stability:** 4 μV/°C (2.3 μV/°F) typical, 8 μV/°C (4.5 μV/°F) max. (100 ppm/°C typical, 200 ppm/°C max.).
**Isolation:** Relay and SSR outputs are isolated. Pulsed voltage output must not share a common ground with the input.
Supply voltage: 100 to 240 VAC nom., +10/-15%, 50 to 400 Hz, single phase; 132 to 240 VDC, nom., +10/-20%. 5 VA maximum.
*Note:* Do not confuse controller power with heater power. The controller does not supply power to the heater, but only acts as a switch. For example, the controller could be powered by 115 VAC, but controlling 12 VDC to the heater.
**Operating temperature range:**
-10 to 55°C (14 to 131°F).
**Memory backup:** Non-volatile memory (no batteries required).

**Control output ratings:**
AC SSR (SPST): 3.5 A @ 250 VAC @ 25°C (77°F); derates to 1.25 A @ 55°C (130°F). An SSR is recommended for longer life than a mechanical relay.
Mechanical relay, SPST Form A (Normally Open): 3 A resistive, 1.5 A inductive @ 250 VAC; pilot duty: 250 VA; 2 A @ 125 VAC or 1 A @ 250 VAC.
Switched voltage (non-isolated): 5 VDC @ 25 mA.
Alarm relay, SPST Form A (Normally Open): 3 A resistive, 1.5 A inductive @ 250 VAC; pilot duty: 250 VA; 2 A @ 125 VAC or 1 A @ 250 VAC.
**Weight:** 227 g (8 oz.).
**Agency approvals:** UL & CSA.
**Front panel rating:** Type 4X (IP66).

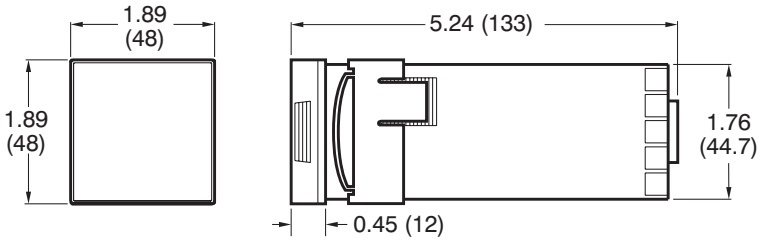
## How to order

| | |
|---|---|
| CT15 | **Model number** |
| 1 | **Alarm:**<br>0 = No<br>1 = Yes |
| 2 | **Input:**<br>1 = J, K, or T thermocouple<br>2 = 100 W platinum RTD, type PD or PE |
| 1 | **Output:**<br>1 = Built-in AC SSR<br>2 = Pulsed voltage (5 VDC)<br>3 = Mechanical relay |
| CT15121 ← Sample P/N | |

**IN STOCK**

Contact Minco for currently available models


Compact 1/16 DIN size




PANEL CUTOUT: 1.775" × 1.775" (45 mm × 45 mm)
MAXIMUM PANEL THICKNESS: 0.25" (6.35 mm)
DIMENSIONS IN INCHES (mm)



# CT16A Temperature Controller

This economical controller packs sophisticated PID control into a compact 1/16 DIN enclosure. A wide range of control modes, sensor input types, and relay or SSR outputs give versatile control of Thermofoil™ heaters and lets you easily connect to other electronics.

## Features

- Dual displays continuously show the set point and the actual temperature reading in resolutions of 1°, 0.1°, or engineering units
- Universal Input fits any sensor: Select from 10 thermocouple types, 4 RTD types, voltage, and current signals
- Isolated Outputs for safe, easy wiring
- Loop Break protection handles sensor or heater failure
- Peak / Valley records the maximum and minimum temperatures
- Front panel is waterproof and corrosion-resistant, making it ideal for sanitary applications. Illuminated keypad for easy operation
- Limit the temperatures which the operator can set via four password-protected Security Levels
- Controller can Self-Tune for best PID control
- Control modes: Self-Tune, pre-set or adjustable PID values, simple On/Off control, and open loop
- Fuzzy Logic provides better response time and reduces overshoot in processes with unpredictable inputs
- Alarms at one or two temperatures
- Alarm Relay option is programmable for high, low, absolute, or deviation, can be reset manually or automatically, and it controls a single electromechanical relay with voltage-free contacts
- Ramp & Soak option handles complex heating profiles of 16 segments with front-panel activation and a selectable time base (CT16A3)
- Auto / Manual option easily switches to manual control for set up or experiments (CT16A3)
- RS-232 or RS-485 Serial Communications access the temperature readings and all control parameters (optional)
- Retransmit either the sensed temperature or the set point as a voltage or current signal to a computer or recorder (optional)
- Vary the Set Point using a potentiometer, a voltage, or a current signal (optional)
- 4-Stage Set Point to quickly switch from one temperature to the next (optional)

## Specifications

**Selectable inputs:**
RTD: 2 or 3-wire, Minco types
PD or PE (100 Ω EN60751 platinum),
PA (100 Ω NIST platinum),
PF (1000 Ω EN60751 platinum), or
NA (120 Ω Nickel).
Thermocouple: Type J (factory default), K, T, L, E, R, S, B, C, or N.
DC current: 0-20 mA or 4-20 mA (use with Temptran™ transmitters).
DC voltage: 0-10 or 2-10 VDC, -10 to 10 mVDC, scalable.
**Input impedance:**
Voltage: 5000 Ω.
Thermocouple: 3 megohms minimum.
Current: 10 Ω.
RTD current: 200 μA.
**Sensor break or short protection:**
Selectable output: disabled, average output before fault, or preprogrammed output.
Adjustable delay: 0.0 to 540.0 minutes.
**Loop break protection:** Error message is initiated and output is turned off in case of shorted sensor or open heater circuit. Break time adjustable from OFF to 9999 seconds.
**Cycle rate:** 1 to 80 seconds.
**Setpoint range:** Selectable from -212 to 2320°C (-350 to 4208°F), input dependent.
**Displays:** Two 4 digit, 7 segment 0.3" high LED's. Process Value red, Setpoint Value green. °C or °F.
**Control action:** Reverse (usually heating) or Direct (usually cooling), selectable.
**Ramp/soak:** (CT16A3 only) 16 separate ramp and soak times are adjustable in minutes or seconds from 0 to 9999. When the program has ended, you may choose to repeat, hold, revert to local setpoint, or turn the outputs off.
**Accuracy:** ±0.25% of span ±1 count.
**Resolution:** 1° or 0.1°, selectable.
**Line voltage stability:** ±0.05% over supply voltage range.
**Temperature stability:** 4 μV/°C (2.3 μV/°F) typical, 8 μV/°C (4.5 μV/°F) max. (100 ppm/°C typical, 200 ppm/°C max.).
**Isolation:**
Relay and SSR: 1500 VAC to all other inputs and outputs.
SP1 and SP2 current and voltage: 500 VAC to all other inputs and outputs, but not isolated from each other.
Process output (options 934, 936): 500 VAC to all other inputs and outputs.
**Supply voltage:** 100 to 240 VAC nom., +10/-15%, 50 to 400 Hz, single phase; 132 to 240 VDC, nom., +10/-20%. 5 VA maximum. 12 & 24 volt AC/DC optional.
*Note*: Do not confuse controller power with heater power. The controller does not supply power to the heater, but only acts as a switch. For example, the controller could be powered by 115 VAC, but controlling 12 VDC to the heater.
**Operating temperature range:**
-10 to 55°C (14 to 131°F).

**Memory backup:** Non-volatile memory (no batteries required).
**Control output ratings:**
AC SSR (SPST): 2.0 A combined outputs
A & B @ 240 VAC @ 25°C (77°F);
derates to 1.0 A @ 55°C (130°F).
An SSR is recommended for longer life than a mechanical relay.
Mechanical relay, SPST Form A (Normally Open) or Form B (Normally Closed):
3 A resistive, 1.5 A inductive @ 240 VAC;
pilot duty: 240 VA; 2 A @ 120 VAC or
1 A @ 240 VAC.
Switched voltage (isolated): 15 VDC @ 20 mA.
Proportional current (isolated):
0 to 20 mA, 600 Ω max.
DC SSR: 1.75 A @ 32 VDC max.
Alarm relay, SPST Form A (Normally Open):
3 A @ 240 VAC resistive;
1/10 HP @ 120 VAC.
**Weight:** 227 g (8 oz.).
**Agency approvals:** UL & CE.
**Front panel rating:** Type 4X (IP66).

## Additional options for CT16A (board level)

**924: Analog remote setpoint:** (0 to 10 VDC) Vary the setpoint using a voltage signal.
**926: Analog remote setpoint:** (4 to 20 mADC) Vary the setpoint using a current signal.
**928: Analog remote setpoint:** (0 to10,000 Ω) Vary the setpoint using a potentiometer.
**934: Analog retransmission of Process Variable or Set Variable:** (4 to 20 mADC) For use as recorder, transmitter or computer A/D input. Linearized 4 to 20 mA DC signal follows the Process or Set variable. Scaleable.
**936: Analog retransmission of Process Variable or Set Variable:** (0 to 10 VDC) Similar to option 934, but output signal is linearized 0 to 10 VDC.
**948: 4-Stage setpoint.** Four preset setpoints may be selected by external contacts. Each set point has its own set of PID values giving controller 4 distinct "recipes" for different process situations.
**992: RS-485 Computer communication link:** Allows remote computer to read and write all control parameters.
**993: RS-232 Computer communication link:** Allows remote computer to read and write all control parameters.
**9502: 12 to 24 VDC / VAC power option:** Controller is powered by low voltage instead of line voltage.
*Note:* Only option 9502 can be combined with another board level option.

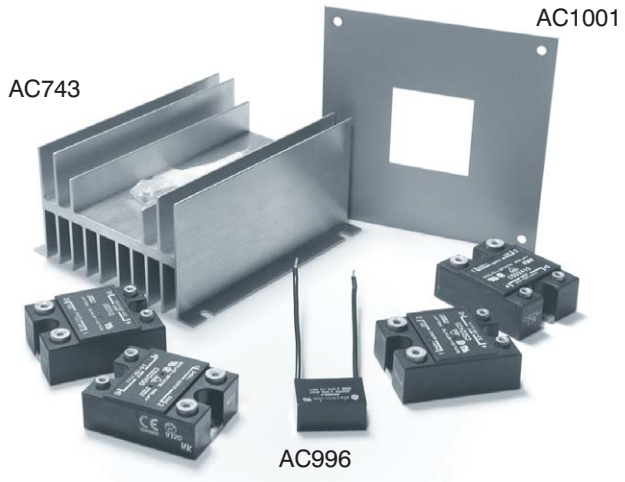


## How to order CT16A

| | |
|---|---|
| CT16A | **Model number** |
| 2 | **Feature set:**<br>2 = Standard<br>3 = Enhanced (ramp & soak, Auto/manual) |
| 1 | **Alarm relay:**<br>0 = No<br>1 = Yes |
| 1 | **Output A:**<br>1 = Built-in AC SSR<br>2 = Pulsed voltage (15 VDC) for external SSR<br>3 = Mechanical relay, SPST (normally open)<br>4 = Mechanical relay, SPST (normally closed)<br>5 = Current<br>8 = DC SSR |
| 0 | **Output B:**<br>0 = None<br>1 = Built-in AC SSR<br>2 = Pulsed voltage (15 VDC) for external SSR<br>3 = Mechanical relay, SPST (normally open)<br>4 = Mechanical relay, SPST (normally closed)<br>5 = Current<br>8 = DC SSR |
| -948 | **Options (leave blank for none)** |
| CT16A2110-948 ← Sample P/N | |

## Accessories

**AC744:** 1-10 A, 24 to 280 VAC SSR
**AC745:** 1-25 A, 24 to 280 VAC SSR
**AC746:** 1-50 A, 24 to 280 VAC SSR
**AC1009:** 1-20 A, 0 to 100 **VDC** SSR
**AC743:** SSR heatsink for high current or ambient temperature
**AC996 R/C Snubber:** Highly recommended to prolong relay contact life, if using the mechanical relay or SSR output to drive a relay or solenoid. Also, for the CT16A AC SSR output, make sure that the coil HOLDING current is greater than 100 mA and voltage is minimum 48 VDC.
**AC1001:** Steel 1/16 to 1/4 DIN adapter plate. 127×127 mm gray steel with 45×45 mm centered hole.




**IN STOCK**

AC743, AC744, AC745, AC746, AC1009
Call Minco for CT16A models in stock

# CT124 8-channel Temperature Monitor



- Protect motors, generators, transformers, other equipment
- Monitor 1 to 8 resistance temperature detectors (RTDs)
- 4 internal relays and audible alarm with independent trip points
- Overtemperature or undertemperature protection
- Microprocessor based; fully programmable
- Large, bright LED display shows °F or °C
- Stores high and low temperature peaks
- Trip points, programs, peaks stored in non-volatile memory
- Programmable silence button
- Versatile override switch permits manual relay toggling
- Rugged enclosure with sealed front panel

The CT124 8-channel Temperature Monitor offers flexible protection and control of temperature-critical equipment and processes. It scans up to eight RTDs and activates four relays plus a built-in audible alarm.

In a typical application, the CT124 provides early warning of possible large machine failure by monitoring the temperature of bearings, stators, transformer coils, and oil outlets. You can configure the CT124 to many other situations such as on/off control or undertemperature alarms. The CT124 can even monitor and control several loops at one time since you can group input zones with output relays in any combination.

## Operation

The CT124 continuously scans all RTD inputs. The display normally shows the highest, lowest, or any other zone temperature according to your instructions. Press up and down arrows to display other zones, Peak Temp to recall high and low peaks, and Trip Temp to indicate trip temperatures.

Each relay has its own trip temperature, either high or low, and may be programmed to react to any or all scanned input zones. Relays may control cooling fans, remote alarms, contactors, or programmable controller inputs. You can set the audible alarm to sound when certain relays trip, and also at its own setpoint. The silence button quiets the alarm for a programmed length of time.

## Programming

In the CT124's program mode you simply step through the included setup worksheet, change each parameter with the up and down arrows, and press Done to proceed. The CT124 retains all program data and setpoints with power off.


## Installation

The CT124 fits in a standard ¾ DIN panel cutout. Plug-in terminal blocks at the rear let you remove the unit without disconnecting wires. Front panel keys and indicators are sealed against dust and moisture.

## Special features

Override: The programmable Override button manually toggles a selected set of relays on and off. With it you can bypass automatic functions to assume direct control. For example, you could turn on fans or shut a machine down at temperatures below the trip point.

Sensor failure protection: If any scanned RTD circuit shorts or opens the CT124 sounds its alarm and locks out that zone. Other zones continue to scan normally. The Error light stays on until the faulty input is repaired and the self-test run.

Self-test: Press the Test button to test all panel lights and inputs. You can also program the Test button to trip relays connected to external alarms, fans, etc.

## Specifications

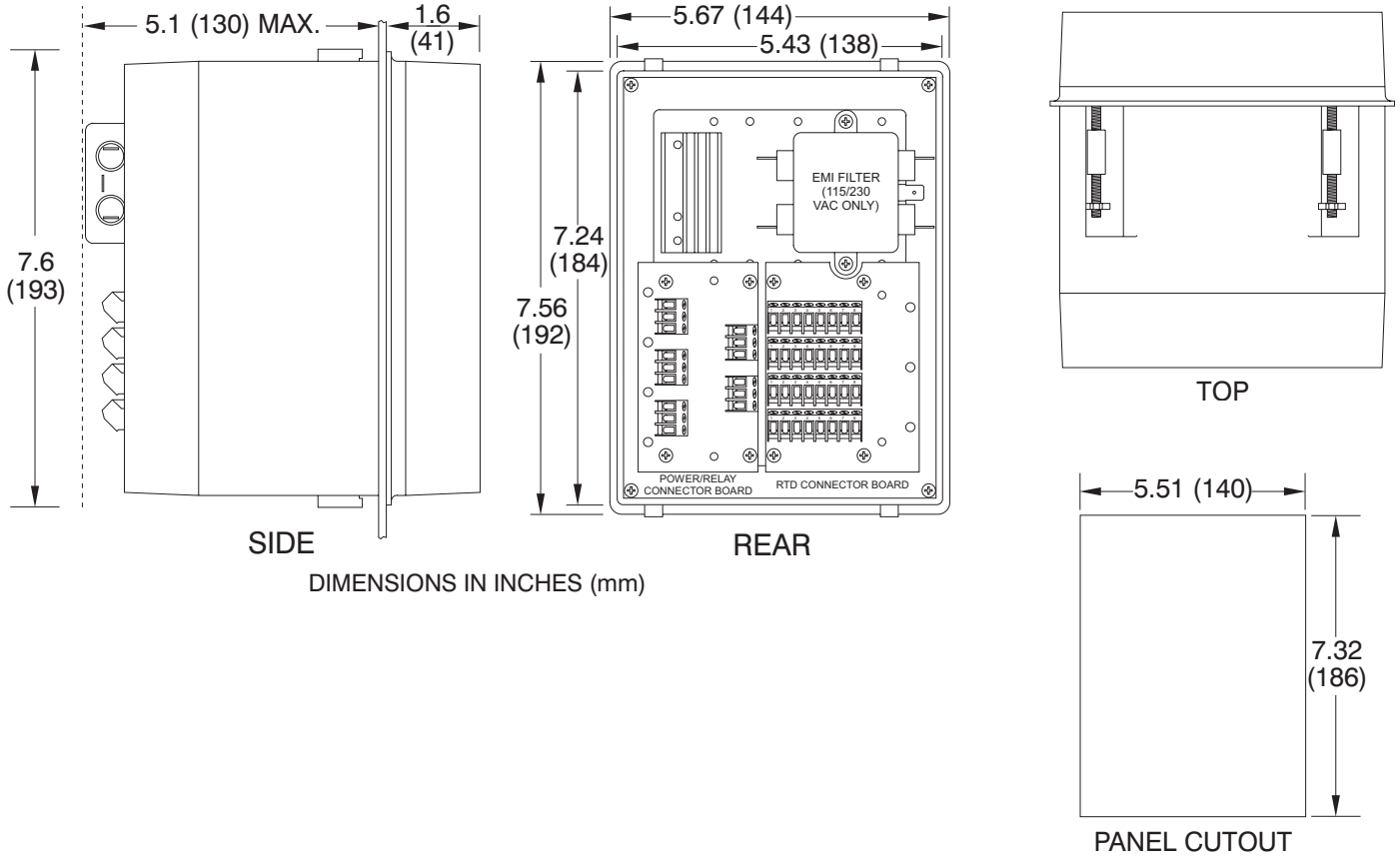
**Range:** Platinum input: -40 to 530°C or -40 to 986°F
Copper or nickel input: -40 to 250°C or -40 to 500°F.
**Input:** 1 to 8 RTDs (Resistance Temperature Detectors), 2 or 3 wire.

| Code | Element | TCR (Ω/Ω/°C) |
|---|---|---|
| PA | Platinum, 100 Ω at 0°C | 0.00392 |
| PB | Platinum, 100 Ω at 0°C | 0.00391 |
| PD | Platinum, 100 Ω at 0°C | 0.00385 |
| PF | Platinum, 1000 Ω at 0°C | 0.00385 |
| CA | Copper, 10 Ω at 25°C | 0.00427 |
| NA | Nickel, 120 Ω at 0°C | 0.00672 |

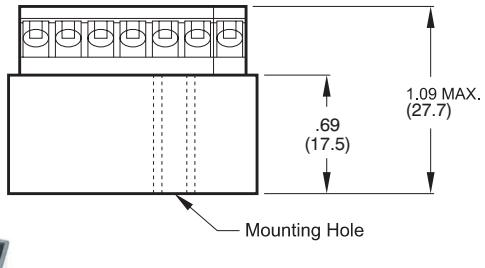
**Input scan rate:** 8 readings per second.
**Input fault detection:** Open or shorted circuit sounds alarm and locks out faulty zone. Other zones unaffected.
**Input protection:** ±30 VDC continuous, any input to ground.
**Output:** 5 independent trip points: 4 relays and one audible alarm. Alarm may be programmed to sound when selected relays trip.
**Relays:** Form C, SPDT, 10 Amps at 250 VAC resistive load, ¼ HP at 120 VAC.
**Trip point hysteresis (deadband):** Programmable from 2 to 20°C or °F.
**Display:** 0.56" (14 mm) LED, 1°C or 1°F resolution. 16 LED indicators.
**Accuracy:** ±2°C (3°F) at 10 to 30°C (50 to 86°F) ambient. ±3°C (5°F) at 0 to 55°C (32 to 131°F) ambient.
**Zone and relay labels:** Replaceable from rear for custom labeling.
**Supply power:** 115 or 230 VAC ±10%, 50/60 Hz. 15 W max. Selection switch inside enclosure. 24 VDC factory option.
**Power loss protection:** Trip points, peaks, and program parameters stored in non-volatile memory. Normal operation resumes when power is restored.
**Keyboard:** 10 membrane type keys with audible feedback.
**Programming:** Programmable from front panel. Access to program mode requires special key sequence.
**Program fault protection:** Watchdog circuit resets microprocessor if it fails to perform program sequence.
**Enclosure:** ABS case, water and dust resistant front panel.
**Ambient temperature rating:** 0 to 55°C (32 to 131°F).
**Connections:** Plug-in terminal boards at rear accept wires to 14 AWG.
**Mounting:** ¾ DIN (DIN 43700). Panel-mounted in 5.51" × 7.32" (140 × 186 mm) opening. Extends behind panel 5.1" (130 mm) max.
**Instructions:** Instruction manual and setup worksheets furnished with each unit.
**Weight:** 4 lb. (1.8 kg).

## How to order:

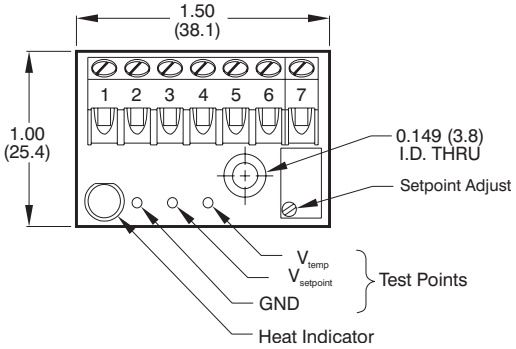
| | |
|---|---|
| CT124 | **Model number CT124** |
| PA | **RTD type:**<br>CA = 10 Ω copper<br>NA = 120 Ω nickel<br>PA = 100 Ω platinum, TCR = 0.00392<br>PB = 100 Ω platinum, TCR = 0.00391<br>PD = 100 Ω platinum, TCR = 0.00385<br>PF = 1000 Ω platinum, TCR = 0.00385 |
| 1 | **Supply power:**<br>1 = 115/230 VAC<br>2 = 24 VDC |
| CT124PA1 ← Sample part number | |




DIMENSIONS IN INCHES (mm)


DIMENSIONS IN INCHES (mm)






# CT325 Miniature DC Temperature Controller

- Tight control with ±0.1°C (0.2°F) deadband!
- Miniature package 1 × 1 × 1.5"
- Solid state on/off control with adjustable setpoint
- Uses standard 100 Ω or 1000 Ω platinum RTD or 50 kΩ thermistor sensor input
- Single DC power source provides power to the controller and heater up to 240 watts
- Simple setup with voltage output pins for process and setpoint temperatures
- 3-wire RTD connection cancels lead resistance

The CT325 Miniature DC Temperature Controller is designed for use with Minco Thermofoil™ heaters and RTD or thermistor sensors. It offers inexpensive on/off temperature control of your process or equipment with accuracy many times better than bimetal thermostats.

You can control temperatures up to 200°C (RTD sensor) or 75°C (thermistor). Easily read and adjust the set point temperature using your voltmeter, then monitor the actual signal temperature at the other end.

Operating from your 4.75 to 60 volt DC power supply, the controller can switch up to 4 amps power to the heater. A bright LED indicates when power is applied to the heater.

The entire unit is epoxy filled for moisture resistance, with a through-hole for a mounting bolt. A terminal block provides the power input, sensor input and heater output connections.

## Custom design options

Minco can customize the design of the CT325 for special applications. Specific temperature ranges, other sensor options, and special packaging are possible for volume OEM applications. Proportional controllers are available in a slightly larger package.

## Specifications

**Input:** 100 Ω or 1000 Ω platinum RTD, 0.00385 Ω/Ω/°C, 2 or 3-leads, or 50 kΩ NTC thermistor, 2-lead.
**Setpoint range:** 2 to 200°C (36 to 392°F) for platinum RTD input. 25 to 75°C (77 to 167°F) for thermistor input. Consult factory for other ranges.
**Setpoint stability:** ±0.02% of span/°C.
**$V_{temp}$ signal:** 0.010 V/°C over specified range.

**Platinum RTD sensor**

| | |
|---|---|
| 2°C | 0.02 V |
| 50°C | 0.50 V |
| 100°C | 1.00 V |
| 200°C | 2.00 V |

Accuracy: ±1% of span
Linearity: ±0.1% of span

**Thermistor sensor**

| | |
|---|---|
| 25°C | 0.25 V |
| 50°C | 0.50 V |
| 75°C | 0.75 V |

Accuracy: ±2% of span
Linearity: ±2% of span

**Deadband:** 0.1°C.
**Input power:** 4.75 to 60 VDC.
**Output:** Open drain, 4 amps max. DC.
**Leadwire compensation:** (3-wire RTD) ±0.06°C/Ω for 100 Ω or 1000 Ω platinum up to 25 Ω per leg.
**Fault protection:** Heater disabled on RTD short or thermistor open. No heater protection; external fuse is recommended.

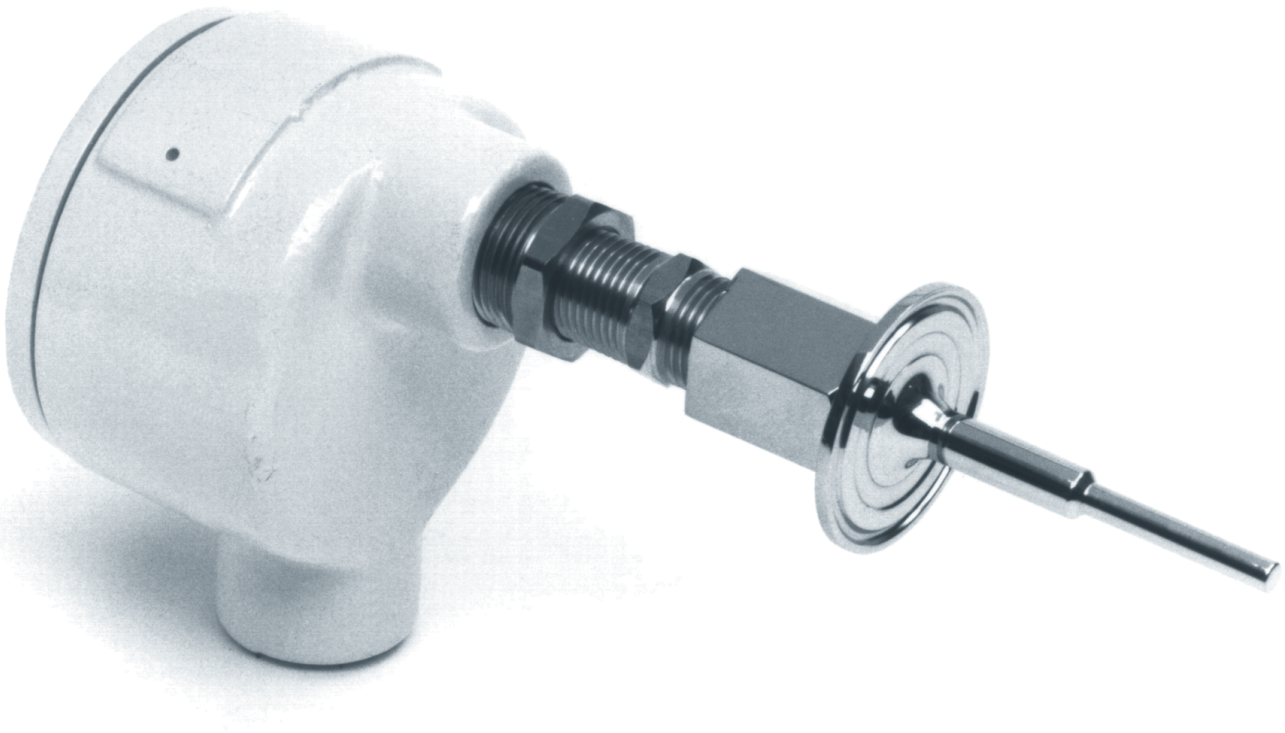
**Operating ambient temperature range:** -40 to 70°C (-40 to 158°F).
**Relative humidity:** 0 to 95% non-condensing.
**Physical:** Polycarbonate case, epoxy sealed for moisture resistance.
**Weight:** 1 oz. (28g).
**Connections:** Terminal block for wires AWG 22 to AWG 14.
**Mounting:** Mounting hole for #6 screw through or #8 thread forming screw.

| Code | Sensor type |
|---|---|
| PD | 100 Ω platinum RTD |
| PF | 1000 Ω platinum RTD |
| TF | 50 kΩ thermistor |

## How to order:

| | |
|---|---|
| CT325 | **Model number** |
| PD | **Sensor type from table** |
| 1 | **Power supply:**<br>1 = 4.75 to 10 VDC<br>2 = 7.5 to 60 VDC |
| C | **Temperature range:**<br>A = 25 to 75°C (thermistor only)<br>C = 2 to 200°C (RTD only) |
| 1 | **Dead band:**<br>1 = 0.1°C |
| CT325PD1C1 ← Sample P/N | |

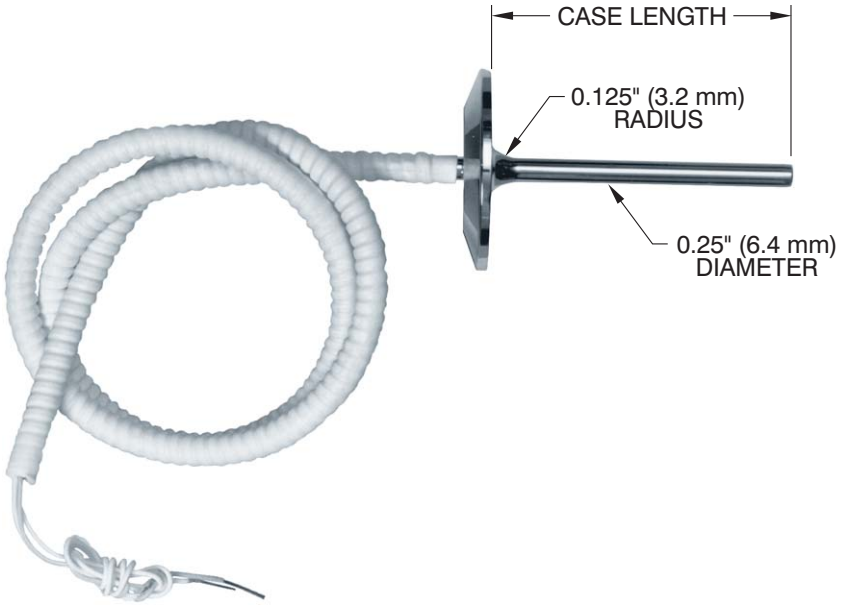
**⚠ 50kΩ thermistor sensor TS665TF is available on page 10-5.**





# Section 6: Sanitary Sensors

- 3-A certified for sanitary clean-in-place applications
- Food, beverage, pharmaceutical processing
- Fast response design
- 100 Ω platinum elements, single or dual
- Three styles: Probe, connection head assembly, thermowell assembly






# Sanitary RTD Probes

Install directly into process lines for fast response. Cases, made of polished 316 stainless steel, are free of cracks and crevices that might shelter bacteria. External cables will withstand washdown; optional stainless steel armor prevents abrasion wear.

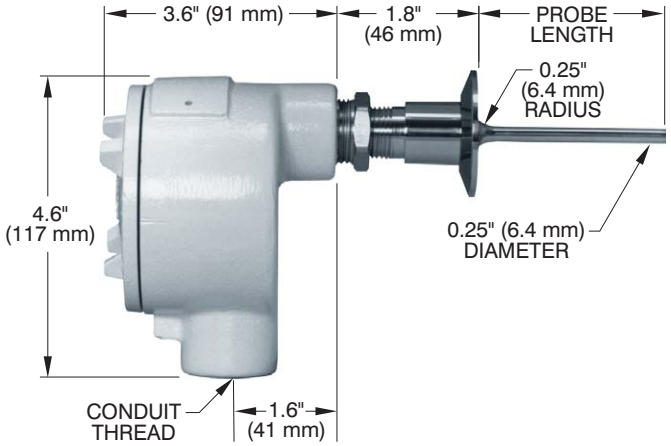
Tri-clamp caps are standard. Contact Minco for other styles. Note that clamp and O-ring are not part of the assembly.

## Specifications

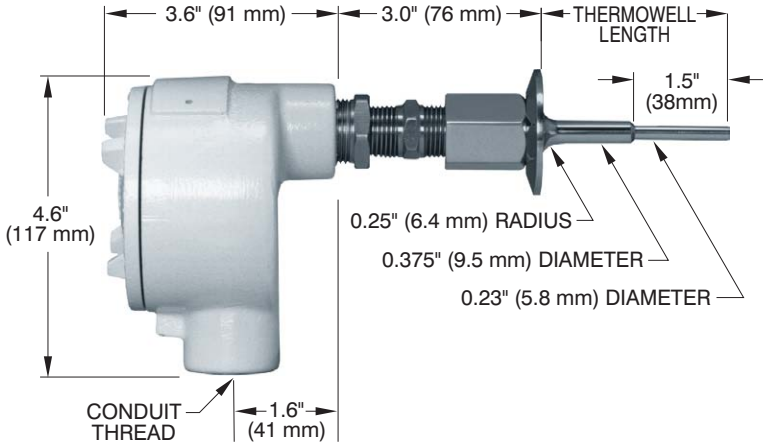
**Sensing element:** Platinum RTD, 100 Ω ±0.1% at 0°C, TCR = 0.00385 Ω/Ω/°C (Meets EN60751, Class B).
**Temperature range:**
Probe: -100 to 200°C (-148 to 392°F).
External leadwires: -100 to 121°C (-148 to 250°F).
**Material:** 316 stainless steel.
**Finish:**
Standard: #4 finish per 3-A standard 09-08, 32 microinches max.
Pharmaceutical (optional): Polished to mirror finish and passivated. 10 microinches typical.
**Pressure rating:** 500 psi (34.5 bar).
**Leadwires:** AWG 22, polyimide insulation; optional stainless steel armor. Polyolefin shrink tubing wrap standard over either option.
**Time constant:** 2 seconds.
**Self-heating:** 50 mW/°C typical in moving water.
**Insulation resistance:**
Single element probes: 1000 megohms min. at 500 VDC, leads to case.
Dual element probes: 100 megohms min. at 100 VDC, between elements and leads to case.

## How to order

| | |
|---|---|
| S5020PD | **Model number:**<br>S5020PD: Single element<br>S5022PD: Dual element |
| Z | **Number of leads per sensing element:**<br>Y = 2 leads<br>Z = 3 leads |
| 30 | **Case length in 0.1" increments:**<br>Standard lengths:<br>30 = 3.0"<br>40 = 4.0"<br>50 = 5.0" |
| A | **Lead covering:**<br>T = Tubing<br>A = Armor |
| 60 | **Lead length in inches** |
| TC | **Sanitary cap style:**<br>TC = Tri-Clamp |
| 20 | **Pipe diameter:**<br>10 = 1.0"<br>15 = 1.5"<br>20 = 2.0" |
| P | **Case finish:**<br>S = Standard finish<br>P = Pharmaceutical finish |
| S5020PDZ30A60TC20P ← Sample P/N | |




**PROBE ASSEMBLY**




**THERMOWELL ASSEMBLY**

CH328 EPOXY-COATED ALUMINUM HEAD SHOWN. SEE PAGES 4-2, 4-3, 5-14 FOR OTHER MODELS.
CAST IRON: MODEL CH103; POLYPROPYLENE: MODEL CH366; STAINLESS STEEL: MODEL CH306, CH335, CH360

# Sanitary RTD Assemblies

These assemblies include a connection head for terminating RTD leads to external wiring. The fast-response thermowell assembly lets you remove the RTD probe without breaking into process lines. Cases and thermowells, made of polished 316 stainless steel, are free of cracks and crevices that might shelter bacteria.

Connection head options include 304 stainless steel, cast iron, FDA approved white polypropylene, and aluminum with FDA approved epoxy coating.

Tri-Clamp caps are standard. Contact Minco for other styles.

Note that clamp and O-ring are not part of the assembly.

## Transmitters

Minco's Temptran™ transmitters provide a 4 to 20 mA signal that can be sent over long distances with a simple 2-wire system. Add any Minco model transmitter (except electrically isolated models). See Section 5 for complete details and ordering information.

TT211, TT711
miniature transmitter

TT176, TT676
standard transmitter

## Specifications

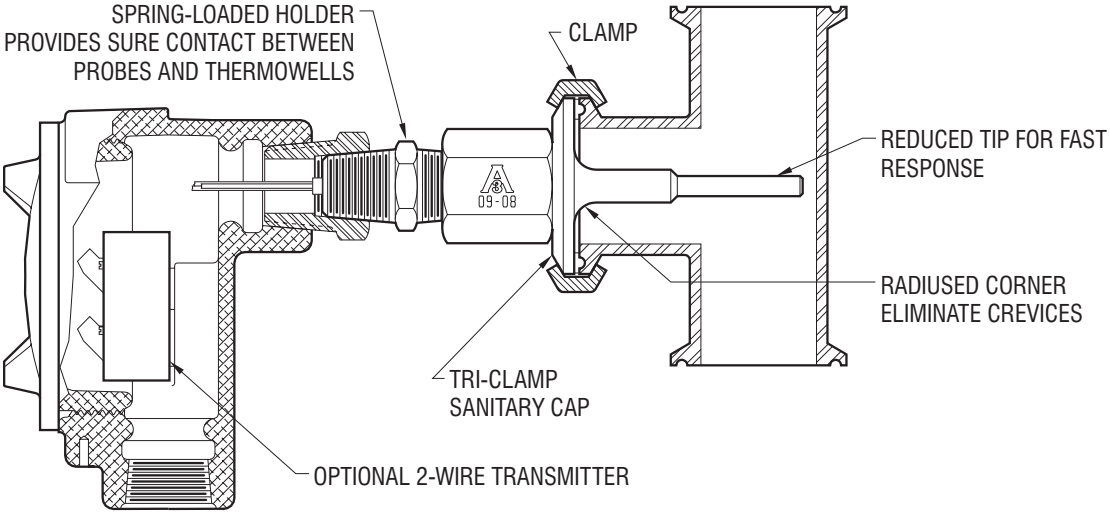
**Sensing element:** Platinum RTD, 100 Ω ±0.1% at 0°C, TCR = 0.00385 Ω/Ω/°C (Meets EN60751, Class B).
**Temperature range:**
-100 to 200°C (-148 to 392°F).
**Material:**
Probe: 316 stainless steel.
Spring-loaded holder on thermowell version: 300 series stainless steel.
**Finish:**
Standard: #4 finish per 3-A standard 09-08, 32 microinches max.
Pharmaceutical (optional): Polished to mirror finish and passivated. 10 microinches typical.
**Pressure rating:** 500 psi (34.5 bar).
**Leadwires:** Polyimide insulated leads, 4" (102 mm) long.
**Time constant:**
Probe assembly: 2 seconds.
Thermowell assembly: 4 seconds.
**Self-heating:** Typical value in moving water.
Probe assembly: 50 mW/°C
Thermowell assembly: 25 mW/°C.
**Insulation resistance:**
Single element probes: 1000 megohms min. at 500 VDC, leads to case.
Dual element probes: 100 megohms min. at 100 VDC, between elements and leads to case.

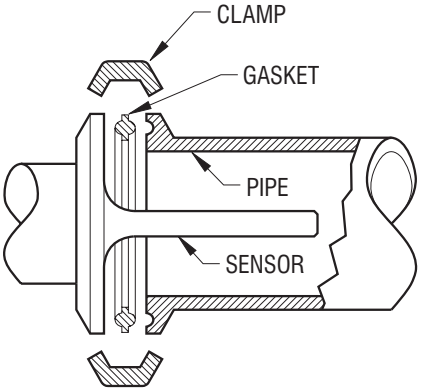
## How to order

| | |
|---|---|
| AS5000PD | **Model number:**<br>**Probe assembly:**<br>AS5010PD: Single element<br>AS5012PD: Dual element<br>**Thermowell assembly:**<br>AS5000PD: Single element<br>AS5002PD: Dual element |
| Z | **Number of leads per element:**<br>Y = 2 leads<br>Z = 3 leads |
| 50 | **Probe or thermowell length in 0.1" increments:**<br>Standard lengths: 30 (3.0"), 40 (4.0"), 50 (5.0") |
| TC | **Sanitary cap style:**<br>TC = Tri-Clamp |
| 15 | **Pipe diameter:**<br>10 = 1.0"<br>15 = 1.5"<br>20 = 2.0" |
| E | **Connection head:**<br>C = Cast iron<br>E = Epoxy coated alum.<br>N = White polypropylene<br>S = Stainless steel (CH335)<br>SL = Stainless steel (CH306)<br>SS = Stainless steel (CH360) |
| 3 | **Conduit thread:**<br>3 = ½ - 14 NPT<br>4 = ¾ - 14 NPT (N/A with N or S connection heads) |
| S | **Case finish:**<br>S = Standard finish<br>P = Pharmaceutical finish |

AS5000PDZ50TC15E3S ← Sample P/N

# Installation



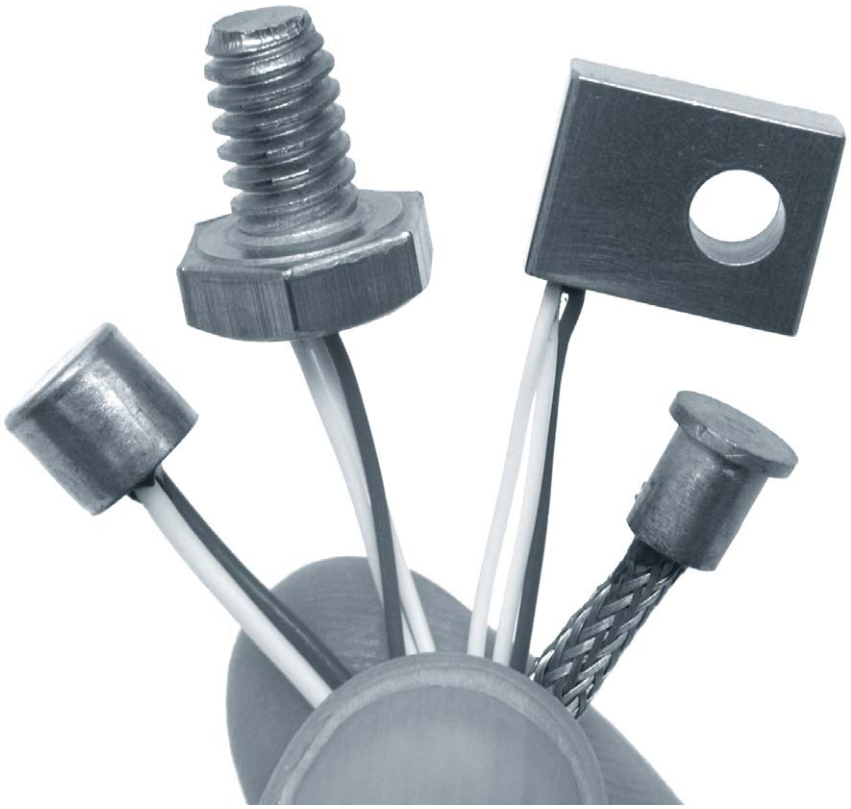

# Accessories

Tri-Clamp fittings, manufactured by Tri-Clover, consist of two identical pipe faces with a gasket between them. A hinged clamp holds the two flanges together.

3-A has established standard probe lengths for installation in Tri-Clamp tee fittings. These lengths are for reference only; you can order Minco RTDs in any case length desired.

| Pipe diameter | Standard case length | Clamp part # |
|---|---|---|
| 1.5" | 3.0" | AC101656 |
| 2.0" | 4.0" | AC101657 |

CLAMP FOR SANITARY FITTING





# Section 7: Miniature Sensors

- Small, rugged RTDs and thermocouples
- Install in bearings for early warning of overheating
- Bolt-on designs for easy installation
- Single or dual elements
- Wide variety of leadwire options

# Embedment RTDs

| Element | TCR Ω/Ω/°C |  Case style A<br>Case L: 0.250" (6.4 mm)<br>Case Ø: 0.275" (7.0 mm) | |  Case style B<br>Case L: 0.250" (6.4 mm)<br>Case Ø: 0.188" (4.8 mm)<br>Flange Ø: 0.250" (6.4 mm) | |  Case style C<br>Case L: 0.300" (7.6 mm)<br>Case Ø: 0.125" (3.2 mm) | |  Case style D<br>Case L: 0.300" (7.6 mm)<br>Case Ø: 0.080" (2.0 mm) | |
|---|---|---|---|---|---|---|---|---|---|
| | | Single | Dual | Single | Dual | Single | Dual | Single | Dual |
| Platinum, 100 Ω ±0.36% at 0°C | .00392 | S325PA<br>S11636PA* | S4026PA | S331PA | S7792PA | S341PA | S14320PA | S12414PA | |
| Platinum, 100 Ω ±0.12% at 0°C (Meets EN60751, Class B) | .00385 | S304PD | S309PD | S306PD | S14405PD | S308PD | S14455PD | S13282PD | |
| Platinum, 100 Ω ±0.36% at 0°C | .00385 | S7304PE | S305PE | S7746PE | S307PE | S7908PE | S14456PE | S13282PE | |
| Platinum, 1000 Ω ±0.12% at 0°C | .00385 | S101907PF | S101911PF | S101908PF | S101912PF | S101909PF | S101913PF | S101910PF | |
| Copper, 10 Ω ±0.2% at 25°C | .00427 | S324CA | S4026CA | S332CA | | S342CA | | | |
| Nickel, 120 Ω ±0.5% at 0°C | .00672 | S326NA<br>S11636NA* | S4026NA | S330NA | S7792NA | S340NA | | | |

*MIL-T-24388C qualified models.

Install miniature sensors in or beneath the babbitt layer of bearing shoes. They monitor metal temperature — the most reliable indicator of bearing condition — to give early warning of oil film breakdown. Machines can then be shut down and the problem corrected before catastrophic failure occurs.

While no larger than many bare ceramic elements, these RTDs have metal cases and insulated leads to withstand rough handling and harsh environments. They're easy to install in drilled holes for general purpose sensing.



## Specifications

**Temperature range:**
-50 to 260°C (-58 to 500°F).
**Case:** Tin plated copper alloy. Models S12414, S13282 and S101910: Stainless steel.
**Babbitt tip:** Factory applied babbitt tip, available on case style A or B, reduces the danger of overheating the sensor when installed in babbitt layer.
**Leads:** Stranded copper with PTFE insulation; stainless steel overbraid optional (one sleeve covers all leads). Polyimide insulation on S11636.
**Leadwire size (AWG):**

| Case style | Number of leads | | | |
|---|---|---|---|---|
| | 2 | 3 | 4 | 6 |
| A | 24 | 24 | 24 | 24 |
| B | 24 | 24 | 28 | 28 |
| C | 24 | 26 | 30 | 30 |
| D | 30 | 30 | 34 | |

**Time constant:** 3.0 seconds (case style A) to 1.5 seconds (case style D), typical value in moving water.
**Insulation resistance:** 10 megohms min. at 100 VDC, leads to case.
**MIL-T-24388C qualified models:**
PRT-EM-E2: Order S11636PA3K36B1.
NRT-EM-E1: Order S11636NA3K36B1.

## How to order

| | |
|---|---|
| S325PA | **Model number from table** |
| 3 | **Number of leads per sensing element (2 or 3):**<br>CA or PD elements must have 3 leads per element |
| S | **Covering over leadwires:**<br>T = PTFE only<br>K = Polyimide; available only on S331, S340, S101913, S11636, S13282 and S14455<br>S = Stainless steel overbraid |
| 36 | **Lead length in inches** |
| | **(Stop here for case style C or D; no babbitt option)** |
| B0 | **Optional babbitt tip:**<br>B0 = No babbitt metal<br>B1 = Babbitt metal applied |
| S325PA3S36B0 ← Sample P/N | |

**IN STOCK**

Most models on this page are stocked

# Embedment Thermocouples

| Leadwire |  Case style A<br>Case L: 0.250" (6.4 mm)<br>Case Ø: 0.275" (7.0 mm) | |  Case style B<br>Case L: 0.250" (6.4 mm)<br>Case Ø: 0.188" (4.8 mm)<br>Flange Ø: 0.250" (6.4 mm) | |  Case style C<br>Case L: 0.300" (7.6 mm)<br>Case Ø: 0.125" (3.2 mm) | |  Case style D<br>Case L: 0.300" (7.6 mm)<br>Case Ø: 0.080" (2.0 mm) | |
|---|---|---|---|---|---|---|---|---|
| | Single | Dual | Single | Dual | Single | Dual | Single | Dual |
| AWG 20 stranded | TC311 | TC312 | TC333 | | | | | |
| AWG 24 stranded | TC2162 | TC2303 | TC2084 | TC2096 | TC344 | TC2623 | | |
| AWG 24 stranded with single SS braid over both wire pairs | | TC2698 | | TC2520 | | TC2837 | | |
| AWG 30 solid | | | | | | | TC2741 | |

Install miniature thermocouples in or beneath the babbitt layer of bearing shoes. They monitor metal temperature — the most reliable indicator of bearing condition — to give early warning of oil film breakdown. Machines can then be shut down and the problem corrected before catastrophic failure occurs.

These thermocouples are mechanically interchangeable with the RTDs on the previous page.

## Specifications

**Temperature range:**
-184 to 260°C (-300 to 500°F).
Copper-Constantan (Type T):
AWG 24: 200°C (392°F) maximum,
AWG 30: 150°C (302°F) maximum.
**Time constant:** Typical value in moving water:
Grounded junction: 0.3 seconds.
Ungrounded junction: 6 seconds (case style A) to 1 second (case style C).
**Insulation resistance:** 10 megohms min. at 100 VDC, leads to case, ungrounded junctions only.
**Case:** Tin plated copper alloy. Model TC2741: Stainless steel.
**Babbitt tip:** Factory applied babbitt tip, available on case styles A and B, reduces the danger of overheating the sensor when installed in babbitt layer.
**Leads:** Thermocouple wire; see table for sizes and options. Dual element models with AWG 24 stranded leadwires are available with a single stainless steel braid over all four wires. This option is recommended for use with integral feedthroughs. See inset below for details.

## How to order

| | |
|---|---|
| TC311 | **Model number from table** |
| E | **Junction type:**<br>E = Chromel-Constantan<br>J = Iron-Constantan<br>K = Chromel-Alumel<br>T = Copper-Constantan |
| U | **Junction grounding:**<br>G = Grounded<br>U = Ungrounded |
| 24 | **Lead length in inches** |
| T | **Covering over leadwires:**<br>T = PTFE only<br>S = Stainless steel overbraid |
| | **(Stop here for case style C or D; no babbitt option)** |
| B0 | **Optional babbitt tip:**<br>B0 = No babbitt metal<br>B1 = Babbitt metal applied |
| TC311EU24TB0 ← Sample P/N | |

⚠ Single SS braid over both wire pairs is preferred with integral feedthroughs.



## Stop Oil Seepage!

**Feedthroughs** provide an oil tight seal where a cable exits a machine housing. The stainless steel tube is epoxy filled and each wire is sealed to the individual conductor. This prevents wicking of oil inside the wires as well as leakage around the wire insulation. Pressure rating to 25 psi (1.7 bar.) See page 4-11 for details.

**Leadwire and cable seal** models FG1015 and FG3015 seal RTD or thermocouple leadwires where they exit oil-filled bearing housings of rotating equipment. Both versions include a grommet that provides the seal and allows adjustment of the wire or cable position. See page 4-12 for details.

**Elastomer rubber filled cable** model AC100324 is a sensor cable with elastomer fill between the wires, stainless steel braid, and outer jacket. This fill can extend along the entire length of the cable, or a specified portion. The outside of the cable can be sealed with an FG1015 or FG3015 fitting. See page 4-13 for details.

Request Application Aid #27 for discussion on the problems of oil seepage and various solutions.

# Bolt-On Temperature Sensors

| | Dimensions W × L × T (max.) | Temperature range | Element options | Case material | Leadwire | Model |
|---|---|---|---|---|---|---|
|  | 0.50 × 1.00 × 0.188" (12.7 × 25.4 × 4.8 mm) with 0.161" (4.1 mm) diameter hole | -70 to 500°C (-94 to 932°F) | PD, PF, PW | Stainless steel | AWG 22, Mica-glass insulated | S101730 |
|  | 0.29 × 1.25 × 0.188" (7.4 × 31.8 × 4.8 mm) with 0.161" (4.1 mm) hole | -70 to 500°C (-94 to 932°F) | PD, PF, PW | Stainless steel | AWG 22, Mica-glass insulated | S101731 |
|  | 0.265" (6.7 mm) ID ring lug | -50 to 260°C (-58 to 500°F) | PD, PE, PF, NB | Nickel plated copper | 2 lead: AWG 24, 3 lead: AWG 26, PTFE insulated | S101732 |
|  | 0.50 x 0.375 x 0.188" (12.7 × 9.5 × 4.8 mm) with 0.166" (4.2 mm) hole | -50 to 260°C (-58 to 500°F) | PD, PE, PF, NB | Stainless steel | 2 lead: AWG 24, 3 lead: AWG 26, PTFE insulated with SS braid cover | S101733 |
|  | ¼ - 20 × ⅜" long thread with 7/16" hex head | -50 to 260°C (-58 to 500°F) | PD, PE, PF, NB | Stainless steel | | S101734 |
| | M6 × 1 thread, 10 mm long, with 10 mm hex | | | | | S101797 |
|  | 0.51 × 1.97 × 0.079" (13 × 50 × 2 mm) with Ø 0.130" (3.3 mm) holes spaced 1.47" (37.3 mm) apart | -50 to 180°C (-58 to 356°F) | PD, PF, PW, PS, NB, NA, NJ | High temperature epoxy glass | AWG 22, PTFE insulated, SS braid option | S100722 |



- Removable and reusable
- Wide temperature range
- Configurations to fit most applications
- Standard 100 Ω platinum, 1000 Ω platinum and 100 Ω nickel elements

Bolt-on temperature sensors are designed for easy installation in industrial and commercial environments. The sensors can be mounted on machines, against process pipes, or embedded directly into a machined part. Threaded fasteners install in seconds and can be easily removed for installation at another location.

These sensors are ideal for process control measurements, test and verification of existing systems, and retrofitting existing machines. Standard designs allow prototyping without high setup costs, while significant discounts are available for OEM quantities.

Standard platinum and nickel RTD elements provide stable and reliable output compatible with most control and monitoring systems. Physically interchangeable designs allow you to easily customize your installation to different instrumentation. Minco can also provide custom RTD, thermistor or thermocouple elements in these packages, or specialized case designs to meet your application needs.

## Specifications

**Time constant:** Less than 10 seconds in moving water.
**Insulation resistance:** 10 megohms minimum at 100 VDC, leads to case.
**Vibration:** Withstands 10 to 2000 Hz at 20 G's minimum per MIL-STD-202. Method 204, test condition D.

| Sensing element specifications* | Code |
|---|---|
| Platinum 385, 100 Ω ±0.12% at 0°C (EN60751, Class B) | PD |
| Platinum 385, 100 Ω ±0.36% at 0°C | PE |
| Platinum 385, 1000 Ω ±0.12% at 0°C | PF |
| Platinum 375, 1000 Ω ±0.12% at 0°C | PW |
| Platinum 385, 10,000 Ω ±0.12% at 0°C | PS |
| Nickel 618, 100 Ω ±0.22% at 0°C (DIN43760 NI100, Class B) | NB |
| Nickel 672, 120 Ω ±0.50% at 0°C | NA |
| Nickel 618, 1,000 Ω ±0.22% at 0°C | NJ |

* See table for element options on each model.

## How to order

| | |
|---|---|
| S101732 | **Model number from table above** |
| PD | **RTD element code** |
| 3 | **Number of leads:** 2 or 3: 2 leads not recommended for PD models |
| S | **Leadwire covering:** G = Mica-glass (S101730 and S101731) T = PTFE (S100722, S101732, S101733, S101734, and S101797) S = Stainless steel braid over PTFE insulated leads (S100722, S101732, S101733, S101734, and S101797) |
| 40 | **Leadwire length in inches:** 40" (1000 mm) standard |
| S101732PD3S40 ← Sample P/N | |

# Economy Sensors

| | Dimensions | Temp. range | Element options | Case material | Leadwire | Model |
|---|---|---|---|---|---|---|
|  | .050" × 0.065" (1.3 × 1.7 mm) Thin-Film with insulated leads | -50 to 150°C (-58 to 302°F) | PD, PF, | Ceramic | AWG 32, solid enamel insulated | S102404 |
|  | Ø .125" × .90" (Ø 3.2 × 22.9 mm) | -50 to 260°C (-58 to 500°F) | PD, PF, PW | Stainless steel | AWG 24, PTFE insulated | S102409 |
|  | Ø .140" × .40" (Ø 3.6 × 10.2 mm) | -70 to 500°C (-94 to 932°F) | PD, PF, PW | Ceramic | AWG 27, solid glass insulated nickel | S102410 |
|  | Ø .188" × .90" (Ø 4.8 × 22.9 mm) | -50 to 150°C (-58 to 302°F) | PD, PF, PW | Silicone rubber | AWG 24, silicone rubber insulated | S102406 |
|  | Ø .188" × 1.25" (Ø 4.8 × 31.8 mm) | -50 to 230°C (-58 to 446°F) | PD, PF, PW | PTFE | AWG 24, PTFE with PTFE jacket | S102405 |
|  | Ø .188" × 1.25" (Ø 4.8 × 31.8 mm) | -50 to 260°C (-58 to 500°F) | PD, PF, PW, NA | Aluminum | AWG 22, PTFE insulated | S102407 |
|  | Ø .188" × 2.38" (Ø 4.8 × 60.5 mm) | -70 to 550°C (-94 to 1022°F) | PD, PF, PW | Stainless steel | AWG 22, glass braid insulated | S102408 |

- Insulated leads of variable length, installed and strain relieved
- Wide temperature range
- Configurations to fit most applications
- Standard 100 Ω platinum, 1000 Ω platinum and 120 Ω nickel elements

Economy sensors are designed to be a component of your final assembly. With insulated leads preattached and strain relieved, final construction is easy and reliable.

## Specifications

**Time constant:** Less than 10 seconds in moving water.
**Insulation resistance:** 10 megohms minimum at 100 VDC, leads to case.
**Vibration:** Withstands 10 to 2000 Hz at 20 G's minimum per MIL-STD-202. Method 204, test condition D.

| Sensing element specifications* | Code |
|---|---|
| Platinum 385, 100 Ω ±0.12% at 0°C (EN60751, Class B) | PD |
| Platinum 385, 100 Ω ±0.36% at 0°C | PE |
| Platinum 385, 1000 Ω ±0.12% at 0°C | PF |
| Platinum 375, 1000 Ω ±0.12% at 0°C | PW |
| Nickel 672, 120 Ω ±0.50% at 0°C | NA |

* See table for element options on each model.

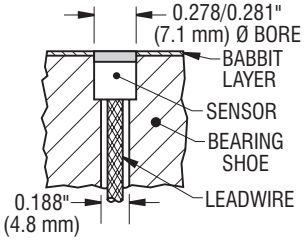
## How to order

| | |
|---|---|
| S102408 | **Model number from table above** |
| PD | **RTD element code from table above** |
| 3 | **Number of leads:**<br>2 leads (not recommended for PD models) or<br>3 leads (only option for S102410PD) |
| G | **Leadwire covering:**<br>E = Enamel (S102404)<br>G = Glass (S102408 and S102410)<br>R = Silicone rubber (S102406)<br>T = PTFE (S102405, S102407, S102409) |
| 40 | **Leadwire length in inches:**<br>40" (1000 mm) standard |
| S102408PD3G40 ← Sample P/N | |

# Installation and Accessories

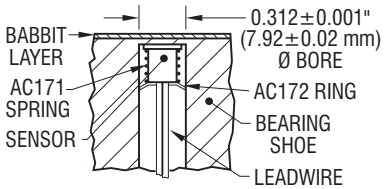
## Case style A

Install case style A sensor just below the babbitt layer, then puddle the babbitt metal over the sensor tip and smooth. Request Engineering Instructions 164 and 167 for complete details. Case styles C and D can be bonded with epoxy near the babbitt face for best readings. Request Engineering Instruction 184.



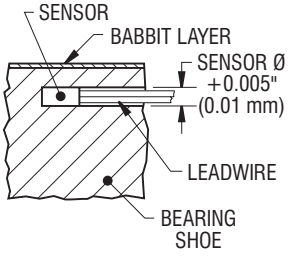

## Case style B

The "top hat" flange shape allows spring loading with the AC171 spring and AC172 or AC915 retaining ring (order separately). Choose the economical AC172 style for lowest cost. The AC915 style allows removal and reinstallation. Slide the spring and ring over the leads, insert the sensor tip into a milled hole, and push down on the retaining ring to compress the spring and secure the sensor. Request Engineering Instructions 180 and 181.




## Case styles C and D

Pot with epoxy inside small bearing shoes. Locate near the babbitt face for best readings. Request Engineering Instruction 184.

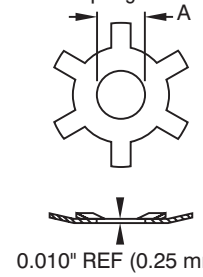



## AC171 spring for case style B

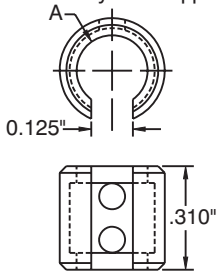
Stainless steel. Outside diameter 0.240" (6.1 mm). Compressed length 0.22" (5.6 mm). To be used in conjunction with AC172 or AC915 for spring loading case style B.

## AC172 and AC915 retaining ring for case style B

AC172: Spring steel




AC915: Beryllium copper




| Model | "A" diameter | Hole I.D. |
|---|---|---|
| AC172 | sized to fit leadwires | 0.312" (7.92 mm) |
| AC172-3 | 0.175" (4.45 mm) | 0.375" (9.53 mm) |
| AC915-2 | 0.213" (5.4 mm) | 0.312" (7.92 mm) |

## AC190 terminal block

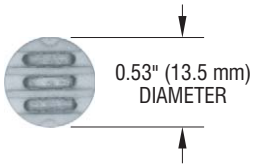
Two tin-plated brass terminals. PTFE body. Meets MIL-T-17600. Request Engineering Instruction #107 for instructions.


## AC191 terminal block

Two tin-plated brass terminals. PTFE body. Meets MIL-T-17600. Request Engineering Instruction #121 for instructions.


## AC192 terminal block

Three tin-plated brass terminals. Glass-filled PTFE body.

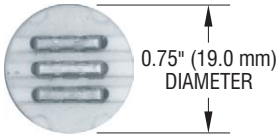



## AC195 terminal block

Same as AC192 except polyamide-imide body for radiation resistance to $10^9$ rads.

## AC197 terminal block

Three tin-plated brass terminals. Glass-filled PTFE body.




## AC196 terminal block

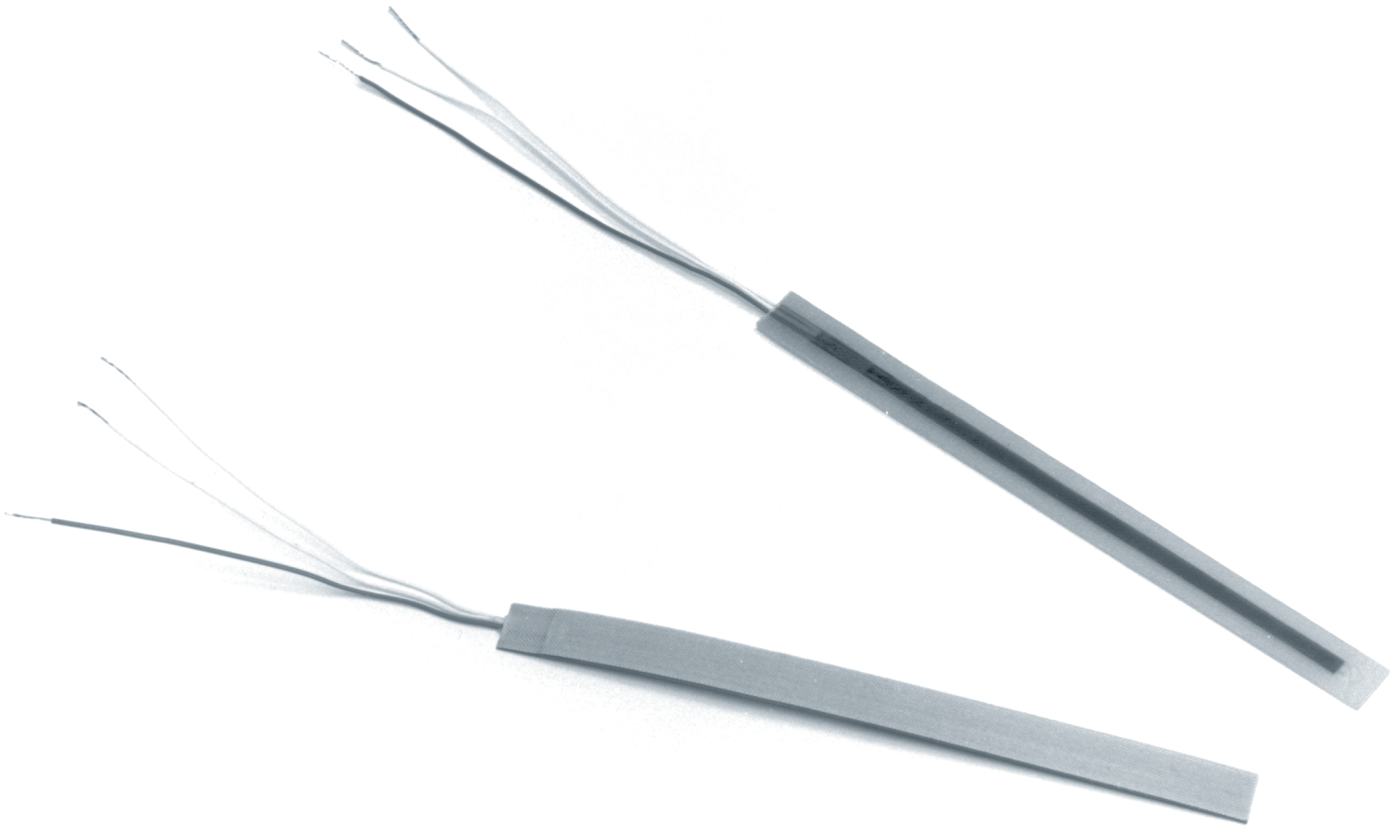
Same as AC197 except polyamide-imide body for radiation resistance to $10^9$ rads.

**www.minco.com/support**

Note: Engineering Instructions (E.I.'s) are available for download at www.minco.com/support .

### Feedthroughs

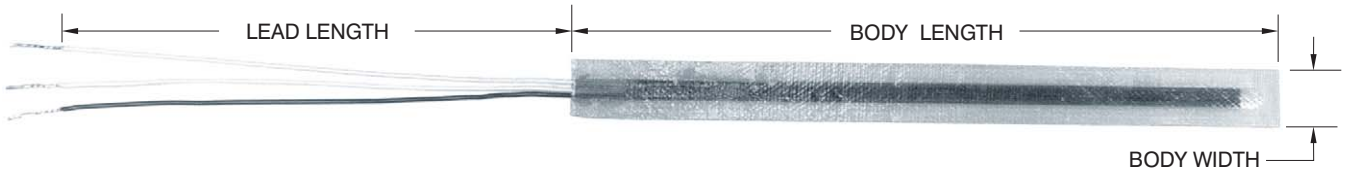
Feedthroughs provide an oil tight seal where a cable exits a machine housing. The stainless steel tube is epoxy filled and each wire is sealed to the individual conductor. This prevents wicking of oil inside the wires as well as leakage around the wire insulation. Pressure rating to 25 psi (1.7 bar). See page 4-11 for details.





# Section 8: Stator Winding Detectors

- Install between stator windings for continuous protection of motors and generators
- Single and dual element RTDs
- Class F or Class H
- Dimensions to fit any machine
- Extensive stock inventory for urgent requirements




# Single Element Stator Winding RTDs

| Element | TCR Ω/Ω/°C | Class F (155°C) RTDs | | | | Class H (180°C) RTDs | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | 0.125" thick | 0.078" thick | 0.050" thick | 0.030" thick* | 0.125" thick | 0.078" thick | 0.050" thick | 0.030" thick* |
| Platinum, 100 Ω ±0.5% at 0°C | .00392 | S8015PA | S11PA | S7682PA | S1320PA | S8016PA | S13PA | S7401PA | S1420PA |
| Platinum, 100 Ω ±0.12% at 0°C (Meets EN60751, Class B) | .00385 | S8015PD | S8011PD | S8013PD | S8009PD | S8016PD | S11016PD | S8014PD | S8010PD |
| Platinum, 100 Ω ±0.5% at 0°C | .00385 | S8015PE | S8011PE | S8013PE | S8009PE | S8016PE | S8012PE | S8014PE | S8010PE |
| Copper, 10 Ω ±0.2% at 25°C | .00427 | S8015CA | S3CA | S23CA | S1120CA | S8016CA | S18CA | S7401CA | S1220CA |
| Nickel, 120 Ω ±0.5% at 0°C | .00672 | S8015NA | S4NA | S24NA | S1140NA | S8016NA | S15NA | S7401NA | S1240NA |

* These models have a lead bulge 0.045" thick, extending into the body a maximum of 0.62".

Flat, laminated "stick" RTDs fit in slots between stator windings to monitor temperature rise and prevent overheating. The National Electrical Manufacturers Association (NEMA) recognizes embedded detectors as a standard protection for motor and generator insulation. Unlike on-off devices, RTDs provide continuous sensing for earlier warning without unnecessary tripouts.

The sensing elements of stator RTDs extend through most of the body length to provide an average temperature reading. This eliminates the danger of a point-type sensor missing a localized hot spot. Six sensors are recommended for each motor, two per phase. Locate sensors near the hottest point of the windings for best performance.

Minco stator RTDs meet the specifications of ANSI C50.10-1990, general requirements for synchronous motors.

**IN STOCK**

Most models available from stock in a variety of sizes

## Specifications

**Temperature limit:**
Class F: 155°C (311°F).
Class H: 180°C (356°F).
**Body material:** Class F: Epoxy glass.
Class H: High temperature epoxy glass.
**Standard sizes (others available):**

| | | | | |
|---|---|---|---|---|
| **Thickness (inches)** | 0.030 | 0.050 | 0.078 | 0.125 |
| **Length (inches)** | 6.0 | 10.0 | 11.0 | 12.0 |
| **Standard body width* (inches)** | 0.219<br>0.344<br>0.563<br>1.000 | 0.260<br>0.406<br>0.656 | 0.305<br>0.455<br>0.750 | 0.315<br>0.500<br>0.875 |

*4 lead models: 0.320 minimum width

**⚠ Custom order any width from 0.219" to 2.500"**

**Leadwires:** 2, 3, or 4, stranded copper with PTFE or polyimide insulation. Other leadwire coverings available.
0.125" thick: AWG 18.
0.078" thick: AWG 22.
0.050" thick: AWG 26.
0.030" thick: AWG 30.
**Dielectric strength:** 3200 VRMS at 60 Hz, tested between the leads and external flat body surface for 1 to 5 seconds.

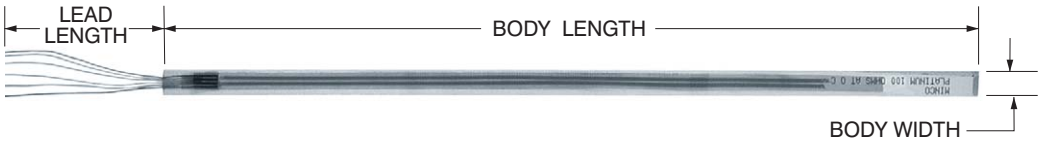
## How to order

| | |
|---|---|
| S3CA | **Model number from table** |
| 110 | **Body length:** Specify in 0.1" increments (Example: 110 = 11.0 inches) |
| T | **Leadwire insulation:** T = PTFE, K = Polyimide |
| 344 | **Body width:** Specify in 0.001" increments (Example: 344 = 0.344 inches) |
| Z | **Number of leads:** Y = 2 leads (PA, PE, NA only), Z = 3 leads, X = 4 leads (0.320" min. width) |
| 36 | **Lead length in inches** |
| S3CA110T344Z36 ← Sample P/N | |

## CENELEC approved/ATEX compliant sensors

Request Bulletin STD-5 for stator RTDs certified to European CENELEC/ATEX standards for increased safety in hazardous areas.

**Ex II 2 G EEx e II**




# Dual Element Stator Winding RTDs

Dual element stator winding RTDs provide extra protection for motors and generators. The second element can be a back up in case of damage, or use one element for input to a temperature display at the machine and the other for control room monitoring.

Standard models are available with thickness options of 0.030 to 0.125", with sensing elements to match most instrumentation.

## Custom designs

Minco designs and builds custom models for many applications. Because we control all steps of the production from element to finished product we have unmatched capabilities. Examples of special options we can make include:

- Thermocouple elements
- Thermistor elements (PTC or NTC)
- Dual sensors with different elements (for example, one copper and one platinum element)
- EEx rated sensors for equipment in hazardous areas. Request bulletin STD-5 for information on these sensors
- Electrically conductive coating
- Special leadwire or cable

Call Minco for the exact solution to your sensing problem.

| Element | TCR Ω/Ω/°C | Class H (180°C) RTDs | | | |
|---|---|---|---|---|---|
| | | 0.125" thick | 0.078" thick | 0.050" thick | 0.030" thick* |
| Platinum, 100 Ω ±0.5% at 0°C | .00392 | S9125PAPA | S9078PAPA | S9050PAPA | S9030PAPA |
| Platinum, 100 Ω ±0.12% at 0°C (Meets EN60751, Class B) | .00385 | S9125PDPD | S9078PDPD | S9050PDPD | S9030PDPD |
| Platinum, 100 Ω ±0.5% at 0°C | .00385 | S9125PEPE | S9078PEPE | S9050PEPE | S9030PEPE |
| Copper, 10 Ω ±0.2% at 25°C | .00427 | S9125CACA | S9078CACA | S9050CACA | S9030CACA |
| Nickel, 120 Ω ±0.5% at 0°C | .00672 | S9125NANA | S9078NANA | S9050NANA | S9030NANA |

*Model has a lead bulge 0.045" thick, extending into the body a maximum of 0.62".

## Specifications

**Temperature limit:** 180°C (356°F), class H.
**Body material:** High temperature epoxy glass.
**Standard sizes:**

| | | | | |
|---|---|---|---|---|
| **Thickness (inches)** | 0.030 | 0.050 | 0.078 | 0.125 |
| **Length (inches)** | 2.0 to 35.0" (51 to 899 mm) | | | |
| **Body width (inches)** | Models S9078 and S9125: 0.425 to 2.500 (10.8 to 63.5 mm)<br>Models S9030 and S9050: 0.425 to 1.065 (10.8 to 27.0 mm) | | | |

**Leadwires:** 2 or 3 (per element) stranded copper with PTFE or polyimide insulation. Other leadwire coverings available.
0.125" thick: AWG 18.
0.078" thick: AWG 22.
0.050" thick: AWG 26.
0.030" thick: AWG 30.
**Dielectric strength:** 3200 VRMS at 60 Hz, tested between the leads and external flat body surface for 1 to 5 seconds.

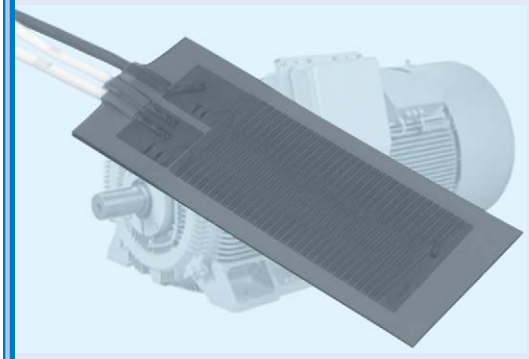
## How to order

| | |
|---|---|
| S9078PAPA | **Model number from table** |
| 120 | **Body length:** Specify in 0.1" increments (Example: 120 = 12.0") |
| T | **Leadwire insulation:** T = PTFE, K = Polyimide |
| 500 | **Body width:** Specify in 0.001" increments (Example: 500= 0.500") |
| Z | **Number of leads per element:** Y = 2 leads (PA, PE, NA only), Z = 3 leads |
| 36 | **Lead length in inches** |
| S9078PAPA120T500Z36 ← Sample P/N | |

# Stator Detectors

## End turn RTD

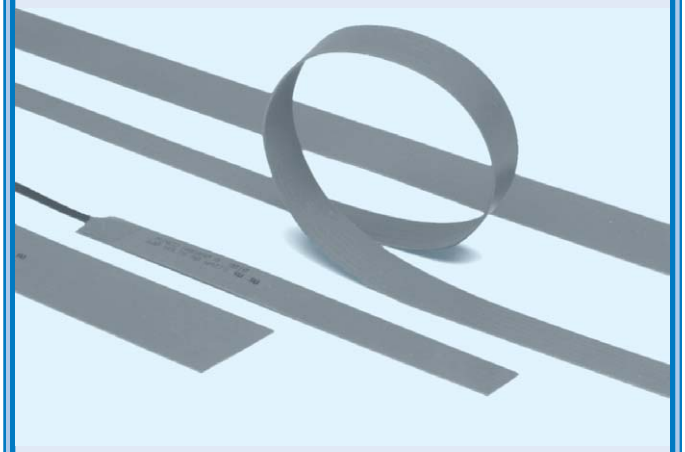
Model S3238 Thermal-Ribbon is designed to sense stator temperatures in motors and generators. With an alternative installation method to the “stick-type” sensors in this section, S3238 is used on the end turns of stator windings and provides an easy way to add overtemperature protection when the stator is not being rewound.



See page 10-4 for details.

## Anti-condensation space heaters

- Flexible silicone rubber insulation
- Mount on windings or housings to prevent moisture buildup
- 2.5 to 10 watts per square inch at 120 or 240 volts
- Variety of sizes to 60" (1.5 m)
- UL component recognition
- Available from stock



Request Bulletin HS-202 for more information.



## CT124 8-channel temperature alarm


- Monitor 1 to 8 platinum, nickel, or copper RTDs
- 4 internal relays and audible alarm with independent trip points
- Microprocessor based, fully programmable
- Large, bright LED shows °C or °F
- Stores high and low temperature peaks
- Programs and parameters stored in non-volatile memory
- Rugged enclosure with sealed front panel

The CT124 alarm offers flexible and reliable protection of large rotating equipment. It scans up to eight points in stators and bearings. Independently programmable trip points let you configure your system for fan control, audible alarms, and shutdown. The CT124 is the perfect companion to Minco sensors for safeguarding of valuable equipment.

See page 5-18 for details.

## CT15 temperature alarm


- Alarm shuts down motor on over-temperature to prevent catastrophic failure
- Monitors single 100 Ω platinum RTD (PD or PE)
- 1 or 2 relays with independent trip points for warning and shutdown
- Microprocessor-based
- Front panel programmable with four security levels
- 100 to 240 VAC supply power
- Compact DIN case with water resistant front panel

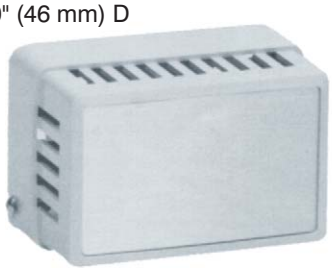
See page 5-15 for details.




# Section 9: HVAC/R Temperature Sensors

- Complete range of sensors for Building Automation Systems
- RTDs, thermistors, and transmitters
- Accurate and stable sensing ensures maximum energy efficiency
- Optional high accuracy calibration of transmitters and sensors
- 3-day shipment for most items

DIMENSIONS:
3.12" (79 mm) W
2.09" (54 mm) H
1.80" (46 mm) D



**COMPACT WALL-MOUNT SENSOR**

DIMENSIONS:
2.75" (70 mm) W
4.50" (114 mm) H
1.56" (40 mm) D

**FULL SIZE WALL-MOUNT SENSOR**

DIMENSIONS:
1.60" (41 mm) W
5.55" (141 mm) H
2.05 (52 mm) D

**EXPLOSIONPROOF WALL-MOUNT SENSOR**

DIMENSIONS:
2.75" (70 mm) W
4.50" (114 mm) H
0.18" (5 mm) D

**FLUSH WALL-MOUNT SENSOR**

# Room Air Temperature Sensors

Room air sensors are designed for wall mounting. Choose from two plastic enclosure styles with brushed aluminum faceplates or a flushmount stainless steel model.

The full-size enclosure and flushmount fit over standard junction boxes. The full size enclosure has optional knockouts for Wiremold raceway surface wiring. Just remove knockouts with pliers.

The compact room air sensor mounts directly on drywall.

See page 9-8 for 4 to 20 mA transmitters.

The explosionproof sensor is UL listed and CSA approved for Class I, Groups C and D; Class II, Groups E, F, and G; and Class III. Request Application Aid #19 for more hazardous area information and the various standards and agencies (including FM, CSA, CENELEC and ATEX).

## Specifications

**Temperature range:**
-45.5 to 100°C (-50 to 212°F).
**Leadwires:**
Full size and compact: AWG 22,
PTFE insulated, 4" (100 mm) long.
Explosionproof and flush mount: AWG 26,
PTFE insulated, 6" (150 mm) inside cover.
**Moisture resistance:** Meets MIL-STD-202, Method 104, Test Condition B.

**IN STOCK**

Three day shipment standard for RTDs (Room air sensors stocked only with 4" lead length)

## How to order room air sensors

| | |
|---|---|
| S472PB | **Model number from table** |
| Y | **Number of leads:**<br>Y = 2 leads<br>Z = 3 leads |
| 4 | **Lead length in inches:**<br>(stocked only in 4") |
| K0 | **Knockouts (full size only):**<br>K0 = No knockouts<br>K1 = Knockouts for Wiremold raceway |
| S472PBY4K0 ← Sample P/N | |

For replacement cover only, order part AC692K0 or AC692K1 for full size, AC551 for compact.

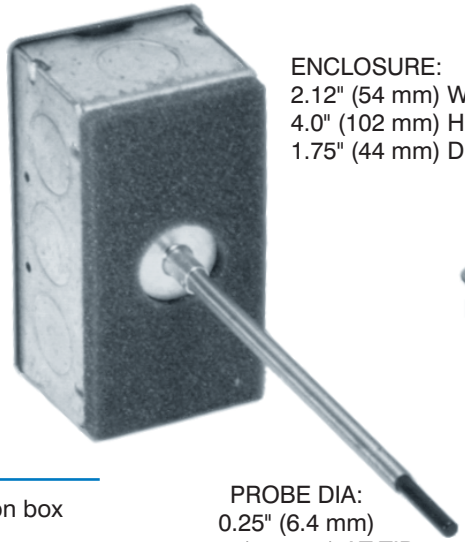
## How to order explosionproof wall-mount sensors and flush wall-mount sensors

| | |
|---|---|
| S100147PD | **Model number from table** |
| Y | **Number of leads:**<br>Y = 2 leads<br>Z = 3 leads |
| S100147PDY ← Sample P/N | |

Transmitters must be installed in a separate enclosure.

| Element | | TCR Ω/Ω/°C | Compact room air sensors | Full size room air sensors | Explosion-proof wall-mount sensors | Flush mount room air sensors |
|---|---|---|---|---|---|---|
| RTDs | | | | | | |
| Platinum, | 100 Ω ±0.1% at 0°C | 0.00391 | S405PB | S472PB | | |
| Platinum, | 100 Ω ±0.1% at 0°C (Meets EN60751, Class B) | 0.00385 | S448PD | S473PD | S100147PD | S101456PD |
| Platinum, | 1000 Ω ±0.1% at 0°C | 0.00385 | S449PF | S474PF | S100148PF | S101456PF |
| Platinum, | 1000 Ω ±0.1% at 0°C | 0.00375 | S483PW | S489PW | S101608PW | S101456PW |
| Nickel-iron, | 1000 Ω ±0.12% at 70°F | 0.00527 | S403FB | S470FB | | |
| Nickel-iron, | 2000 Ω ±0.12% at 70°F | 0.00527 | S404FC | S471FC | | |
| HW, | 3000 Ω at -30.2°C | 0.00262 | S100064PX | S100063PX | | |
| Thermistors | | $R_{25}/R_{125}$ | | | | |
| Thermistor, | 2,252 Ω ±1% at 25°C | 29.2 | TS426TA | TS424TA | TS100149TA | TS101769TA |
| Thermistor, | 10,000 Ω ±1% at 25°C | 23.5 | TS427TB | TS425TB | TS100150TB | TS101769TB |

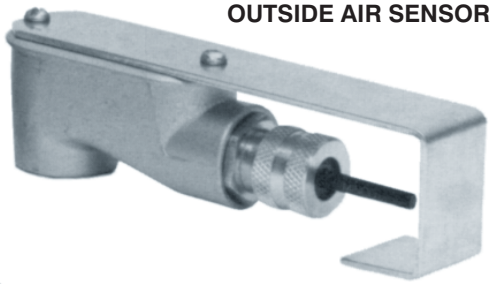
DUCT POINT SENSOR



ENCLOSURE:
2.12" (54 mm) W
4.0" (102 mm) H
1.75" (44 mm) D

PROBE DIA:
0.25" (6.4 mm)
0.188" (4.8 mm) AT TIP

OUTSIDE AIR SENSOR



DIMENSIONS:
5.6" (142 mm) L
1.6" (41 mm) H
1.3" (33 mm) W

### Special options:

- Weatherproof connection box
- All stainless steel probe

# Duct and Outside Air Temperature Sensors

Sense temperature of air streams in ducts and plenums. Sensors include a junction box with gasket to prevent leakage and vibration noise.

These point-sensing thermometers feature a fast-responding aluminum sensing tip.

Custom options include a NEMA 4 weatherproof connection box and an all stainless steel probe.

Outside air sensors are designed to mount on conduit outside your building. They include an elbow type enclosure and sun shield.

See page 9-8 for 4 to 20 mA transmitters.
See page 9-4 for duct averaging sensors.

### Specifications

**Temperature range:**
Probe: -45.5 to 135°C (-50 to 275°F).
Gasket: 100°C (212°F) max.
**Leadwires:** AWG 22, PTFE insulated, 4" (100 mm) long.
**Moisture resistance:** Point sensors meet MIL-STD-202, Method 104, Test Condition B.

### How to order tip-sensitive duct thermometers

| | |
|---|---|
| S450PD | **Model number from table** |
| Y | **Number of leads:** Y = 2 leads, Z = 3 leads |
| 12 | **Insertion depth in inches:** 1 inch = 25.4 mm. Standard lengths: 3, 6, 12, 18". Minimum: 3" |

S450PDY12 ← Sample P/N

### How to order outside air sensors

| | |
|---|---|
| S414PB | **Model number from table** |
| Z | **Number of leads:** Y = 2 leads, Z = 3 leads |

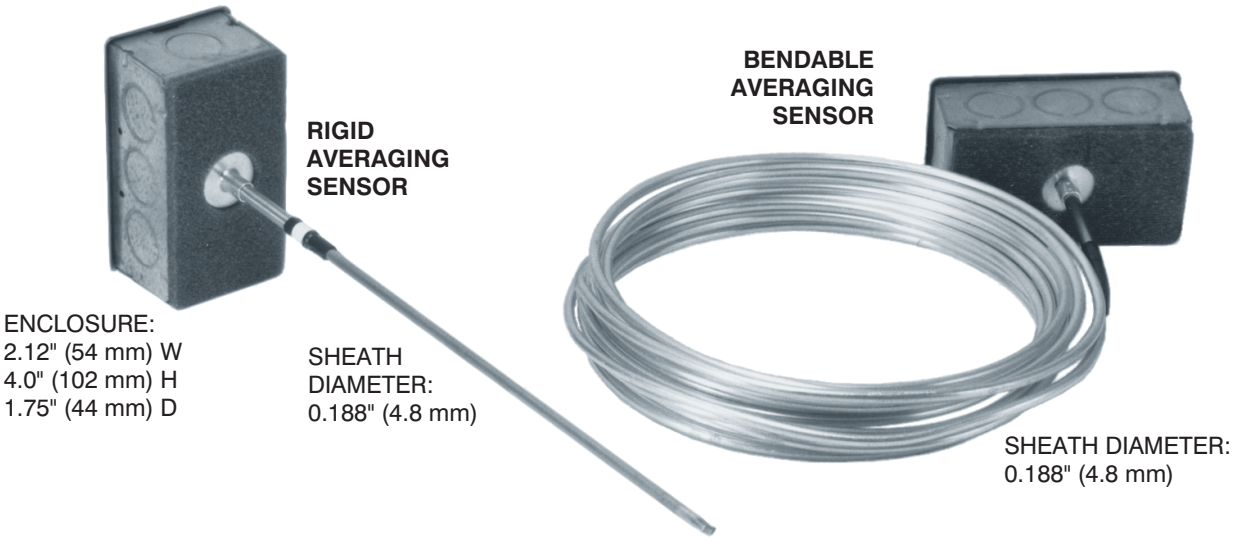
S414PBZ ← Sample P/N

**⚠ Transmitters must be installed in a separate location from outside air sensors.**

| Element | | TCR Ω/Ω/°C | Duct point sensors | Outside air sensors |
|---|---|---|---|---|
| RTDs | | | | |
| Platinum, | 100 Ω ±0.1% at 0°C | 0.00391 | S408PB | S414PB |
| Platinum, | 100 Ω ±0.1% at 0°C (Meets EN60751, Class B) | 0.00385 | S450PD | S454PD |
| Platinum, | 1000 Ω ±0.1% at 0°C | 0.00385 | S451PF | S455PF |
| Platinum, | 1000 Ω ±0.1% at 0°C | 0.00375 | S484PW | S486PW |
| Nickel-iron, | 1000 Ω ±0.12% at 70°F | 0.00527 | S406FB | S412FB |
| Nickel-iron, | 2000 Ω ±0.12% at 70°F | 0.00527 | S407FC | S413FC |
| HW, | 3000 Ω at -30.2°C | 0.00262 | S100060PX | S100062PX |
| Thermistors | | $R_{25}/R_{125}$ | | |
| Thermistor, | 2,252 Ω ±1% at 25°C | 29.2 | TS430TA | TS428TA |
| Thermistor, | 10,000 Ω ±1% at 25°C | 23.5 | TS431TB | TS429TB |

**IN STOCK**

Three day shipment standard for RTDs




# Averaging Temperature Sensors
## True continuous elements

Sense temperature of air streams in ducts and plenums. Sensors include a junction box with gasket to prevent leakage and vibration noise.

These sensors have a continuous element to sense true average temperature along their entire length. They provide accurate composite readings in locations where air may be stratified into hot and cold layers.

Rigid averaging sensors have a brass case. Bendable models have aluminum sheaths (copper on special order), formable to a radius of 4". Bendable sensors can criss-cross ducts to average temperatures in two dimensions.



### Specifications

**Temperature range:**
Probe: -45.5 to 135°C (-50 to 275°F).
Gasket: 100°C (212°F) max.
**Leadwires:** AWG 22, PTFE insulated, 8" (200 mm) long.
**Moisture resistance:** Meet MIL-STD-202, Method 104, Test Condition B.

### Special options:

- Weatherproof connection box
- Sensor only, no box
- Lengths to 100 feet (30 m)
- Thermistor averaging sensors

These averaging sensors do not actually contain platinum. They use a proprietary sensing element that closely matches the platinum curve over the specified range, at a much lower cost.

### How to order rigid averaging sensors

| | |
|---|---|
| S456PE | **Model number from table** |
| Y | **Number of leads:** Y = 2 leads, Z = 3 leads |
| 12 | **Insertion depth in inches:** 1 inch = 25.4 mm. Standard lengths: 12, 18, 24, 36, 48, 60, 72" |

S456PEY12 ← Sample P/N

### How to order bendable averaging sensors

| | |
|---|---|
| S457PE | **Model number from table** |
| Z | **Number of leads:** Y = 2 leads, Z = 3 leads |
| 24 | **Insertion length in feet:** 1 foot = 0.3 m. Standard lengths: 6, 12, 24 feet |

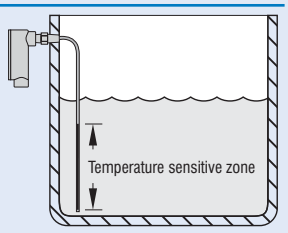
S457PEZ24 ← Sample P/N

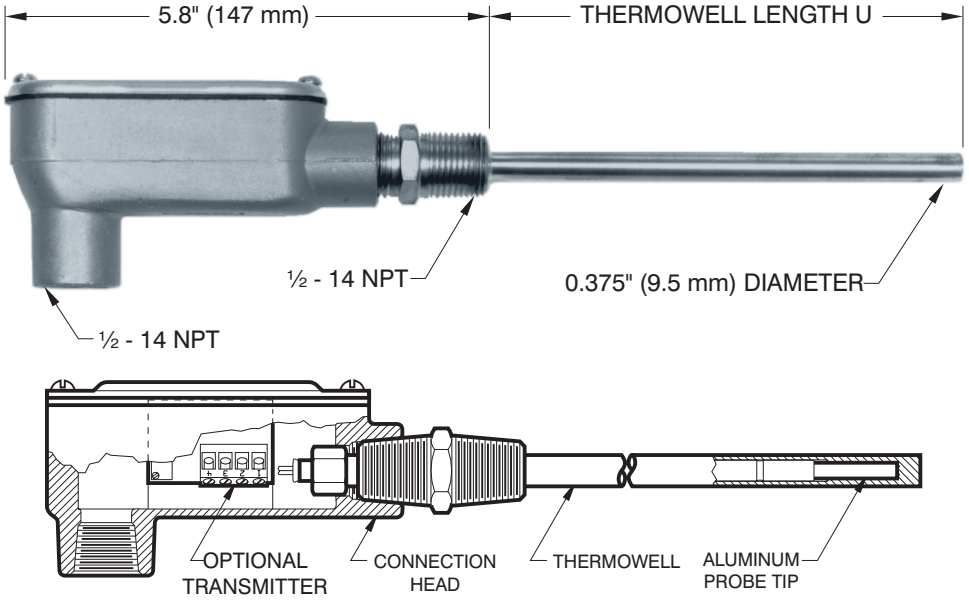
| RTDs (Tolerance: ±0.25% at 70°F) | | TCR Ω/Ω/°C | Rigid averaging sensors | Bendable averaging sensors |
|---|---|---|---|---|
| Platinum, | 100 Ω at 0°C | 0.00391 | S423PB | S447PB |
| Platinum, | 100 Ω at 0°C | 0.00385 | S456PE | S457PE |
| Platinum, | 1000 Ω at 0°C | 0.00385 | S493PF | S475PF |
| Platinum, | 1000 Ω at 0°C | 0.00375 | S492PW | S488PW |
| Nickel-iron, | 1000 Ω at 70°F | 0.00527 | S421FB | S445FB |
| Nickel-iron, | 2000 Ω at 70°F | 0.00527 | S422FC | S446FC |
| HW, | 3000 Ω at -30.2°C | 0.00262 | S20080PX | S15215PX |

### Sump sensors

A sump averaging sensor (S100479) lets you define the temperature sensitive zone to match tank fluid levels (see drawing at right).

**For more information, call Minco and request bulletin RT-13 or go to www.minco.com/support**






# Fluid Immersion Temperature Sensors

Sense temperature of heated/chilled water or other fluids in pipes or tanks.

Immersion sensors include stainless steel thermowells for insertion directly into fluid streams. The sensing probe may be removed without breaking the fluid seal. Brass thermowells are also available.

See page 9-8 for 4 to 20 mA transmitters.

## Specifications

**Temperature range:**
-45.5 to 260°C (-50 to 500°F).
**Leadwires:** AWG 22, PTFE insulated, 4" (100 mm) long.
**Thermowell pressure rating:**
1880 psi (130 bar).
**Moisture resistance:** Meets MIL-STD-202, Method 104, Test Condition B.

## How to order

| | |
|---|---|
| S479PD | **Model number from table** |
| Y | **Number of leads:** Y = 2 leads, Z = 3 leads |
| 60 | **Thermowell length U:** Specify in 0.1" increments (Ex: 60 = 6.0 inches) Standard thermowell lengths are 3" and 6", contact factory for other lengths |

S479PDY60 ← Sample P/N

## How to order replacement stainless steel thermowells

| | |
|---|---|
| TW488 | **Model number** |
| U | |
| 60 | **Thermowell length U:** Specify in 0.1" increments (Ex: 60 = 6.0 inches) Standard thermowell lengths are 3" and 6", contact factory for other lengths |

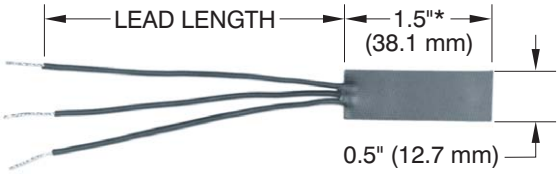
TW488U60 ← Sample P/N

| Element | | TCR Ω/Ω/°C | Model number |
|---|---|---|---|
| Platinum, | 100 Ω ±0.1% at 0°C | 0.00391 | S478PB |
| Platinum, | 100 Ω ±0.1% at 0°C (Meets EN60751, Class B) | 0.00385 | S479PD |
| Platinum, | 1000 Ω ±0.1% at 0°C | 0.00385 | S480PF |
| Platinum, | 1000 Ω ±0.1% at 0°C | 0.00375 | S490PW* |
| Nickel-iron, | 1000 Ω ±0.12% at 70°F | 0.00527 | S476FB* |
| Nickel-iron, | 2000 Ω ±0.12% at 70°F | 0.00527 | S477FC* |
| HW, | 3000 Ω at -30.2°C | 0.00262 | S100061PX* |

* Maximum temperature is 266°F (130°C).

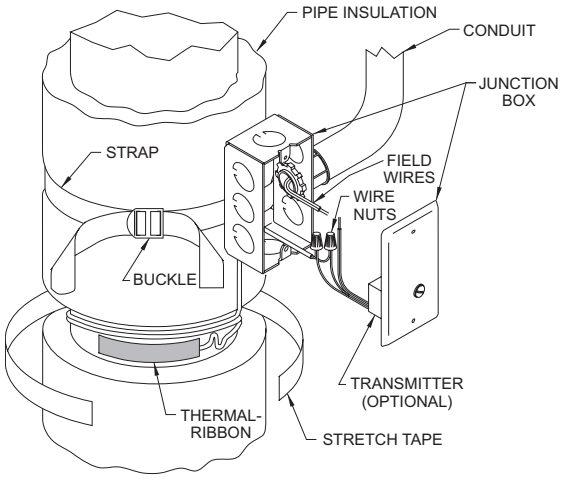
**IN STOCK**

Three day shipment for standard lengths of 3" or 6"




THICKNESS: 0.045" (1.2 mm) over element
*MODEL S468PF IS 3.0" (76.2 mm) LONG

A Thermal-Ribbon accurately senses fluid through pipe walls. No draining, welding, drilling, or tapping — just tape the Thermal-Ribbon in place beneath a layer of insulation. Shown with AC766 Mounting Kit.




# Flexible Thermal-Ribbon™ Pipe Sensors

Flexible Thermal-Ribbon™ sensors mount on the pipe surface — saving time and money during installation. There's no expense of a pipefitter to drain, drill, and tap the pipe for a thermowell because there is no thermowell! When properly installed and insulated, the accuracy and response of a Thermal-Ribbon equals an immersed thermowell assembly.

Options include stainless steel braid over leadwires to prevent abrasion damage, and pressure-sensitive adhesive for easier mounting (flat surfaces only).

See page 9-8 for 4 to 20 mA transmitters.

## Specifications

**Body material:** Silicone rubber with polyimide backing.
**Temperature range:**
RTD: -62 to 200°C (-80 to 392°F).
Thermistor: -45.5 to 135°C (-50 to 275°F).
**Leadwires:** AWG 24, silicone rubber.
**Moisture resistance:** Meets MIL-STD-202, Method 104, Test Condition B.

## How to order Thermal-Ribbons

| | |
|---|---|
| S467PD | **Model number from table** |
| Z | **Number of leads:**<br>Y = 2 leads<br>Z = 3 leads<br>YS = 2 leads, stainless steel braid<br>ZS = 3 leads, stainless steel braid |
| 36 | **Lead length in inches** |
| A | **Adhesive backing:**<br>A = No adhesive<br>B = Pressure-sensitive adhesive |
| S467PDZ36A ← Sample P/N | |

## Mounting accessories:

### AC766 mounting kit
See drawing above. Provides a pipe-mounted enclosure for transmitters and connections. Kit includes junction box, 5 ft. nylon strap, buckle, 4 wire nuts, and 6 ft. of #20 stretch tape.

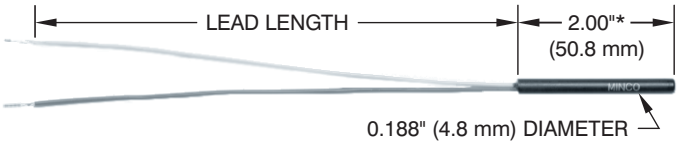
### #20 stretch tape
High temperature self-fusing silicone rubber tape for mounting Thermal-Ribbons to pipes. 1" wide rolls, 6 or 36 foot lengths.

### #6 RTV adhesive
Room temperature vulcanizing adhesive for attaching Thermal-Ribbons to surfaces. 3 oz. (89 ml) tube.

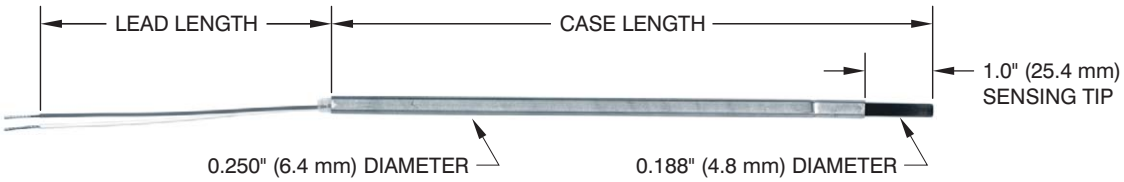
| Element | | TCR Ω/Ω/°C | Model number |
|---|---|---|---|
| RTDs | | | |
| Platinum, | 100 Ω ±0.1% at 0°C | 0.00391 | S464PB |
| Platinum, | 100 Ω ±0.1% at 0°C (Meets EN60751, Class B) | 0.00385 | S467PD |
| Platinum, | 1000 Ω ±0.1% at 0°C | 0.00385 | S468PF |
| Nickel-iron, | 1000 Ω ±0.12% at 70°F | 0.00527 | S462FB |
| Nickel-iron, | 2000 Ω ±0.12% at 70°F | 0.00527 | S463FC |
| HW, | 3000 Ω at -30.2°C | 0.00262 | S100001PX |
| Thermistors | | $R_{25}/R_{125}$ | |
| Thermistor, | 2,252 Ω ±1% at 25°C | 29.2 | TS436TA |
| Thermistor, | 10,000 Ω ±1% at 25°C | 23.5 | TS437TB |

**IN STOCK**

S462, S463, S464, S467




*MODEL S482PW IS 2.4" (60.3 mm) LONG




# Elements & Probes

Elements feature fast-responding RTD or thermistor elements in aluminum cases (except stainless steel on S482PW), with PTFE insulated leadwires. They can be assembled into probes or used separately as all-purpose sensors.

Probes consist of elements assembled into stainless steel extension tubes. They are not suitable for direct fluid immersion but may be used with the thermowells on page 4-6.

See page 9-8 for 4 to 20 mA transmitters.

## Specifications

**Temperature range:**
-45.5 to 135°C (-50 to 275°F).
**Leadwires:** AWG 22, PTFE insulated. Standard lengths are 4", 12" and 18".
**Moisture resistance:** Meets MIL-STD-202, Method 104, Test Condition B.
**Insulation resistance:** 1000 megohms min. at 500 VDC, leads to case.

## How to order elements

| | |
|---|---|
| S458PD | **Model number from table** |
| Z | **Number of leads:**<br>Y = 2 leads<br>Z = 3 leads (platinum only) |
| 4 | **Lead length in inches** |
| S458PDZ4 ← Sample P/N | |

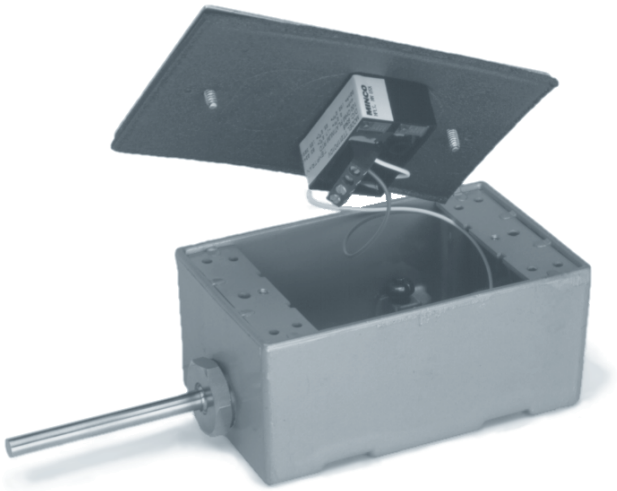
## How to order probes

| | |
|---|---|
| S411PB | **Model number from table** |
| 60 | **Case length:**<br>Specify in 0.1" increments<br>(Ex: 60 = 6.0 inches)<br>Minimum length is 3" |
| Z | **Number of leads:**<br>Y = 2 leads<br>Z = 3 leads (platinum only) |
| 4 | **Lead length in inches** |
| S411PB60Z4 ← Sample P/N | |

| Element | | TCR Ω/Ω/°C | Elements | Probes |
|---|---|---|---|---|
| RTDs | | | | |
| Platinum, | 100 Ω ±0.1% at 0°C | 0.00391 | S402PB | S411PB |
| Platinum, | 100 Ω ±0.1% at 0°C (Meets EN60751, Class B) | 0.00385 | S458PD | S460PD |
| Platinum, | 1000 Ω ±0.1% at 0°C | 0.00385 | S459PF | S461PF |
| Platinum, | 1000 Ω ±0.1% at 0°C | 0.00375 | S482PW | S485PW |
| Nickel-iron, | 1000 Ω ±0.12% at 70°F | 0.00527 | S400FB | S409FB |
| Nickel-iron, | 2000 Ω ±0.12% at 70°F | 0.00527 | S401FC | S410FC |
| HW, | 3000 Ω at -30.2°C | 0.00262 | S100057PX | S100837PX |
| Thermistors | | $R_{25}/R_{125}$ | | |
| Thermistor, | 2,252 Ω ±1% at 25°C | 29.2 | TS438TA | TS440TA |
| Thermistor, | 10,000 Ω ±1% at 25°C | 23.5 | TS439TB | TS441TB |

**IN STOCK**

Three day shipment standard for RTDs



# Refrigeration & Freezer Temperature System

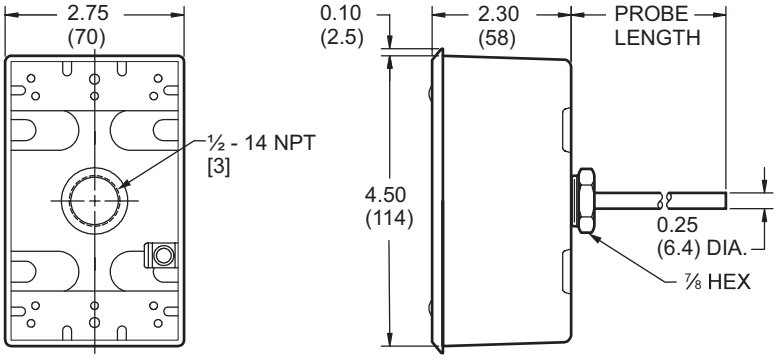
- Ideal for refrigerated rooms, freezers, cold storage facilities, laboratories — anywhere an accurate, rugged, weatherproof temperature sensor is needed.
- 100 Ω platinum RTD probe is constructed of 316 stainless steel to be resistant to most chemicals, including ammonia. Operates to -452°F (-269°C).
- 4-20 mA transmitter is epoxy potted to protect circuitry from condensation and ice. Operates in ambient temperatures down to -13°F (-25°C).
- Transmitter is match calibrated to RTD for 0.75% system accuracy; free NIST certificate.
- Enclosure is gasketed and moisture resistant.
- RTD probe is available in lengths ranging from 2 inches to 48 inches, and the probe can be center-mounted for through-the-wall installation, or end-mounted for flush-to-the-wall mounting.

## Specifications

**Temperature range:**
Probe:-269 to 260°C (-452 to 500°F).
Transmitter:-25 to 85°C (-13 to 185°F).
**RTD probe:** 100 Ω platinum, 0.00385 TCR.
**Transmitter:** 4-20 mA output, 8.5 to 35 VDC loop powered.

## How to order

| | |
|---|---|
| AS100279 | **Assembly number** |
| PD | **100 Ω platinum RTD** |
| 67 | **Probe length:**<br>Specify in 0.1" increments<br>(Ex: 67 = 6.7 inches) |
| M | **Temperature range for 4-20 mA output:**<br>M = -50 to 50°C (-58 to 122°F)<br>AD = -40 to 48.9°C (-40 to 120°F)<br>DN = -30 to 50°C (-22 to 122°F)<br>S = -18 to 37.8°C (0 to 100°F)<br>BY = -10 to 40°C (14 to 104°F)<br>Other ranges are available.<br>See page 5-10. |
| AS100279PD67M ← Sample P/N | |




DIMENSIONS IN INCHES (mm)


STANDARD CONSTRUCTION


WASHDOWN COMPATIBLE

# Thermal Vial™ Temperature Sensing System

- Ideal for ultralow freezers, laboratories, blood banks, walk-in freezers and refrigerators, even incubators — anywhere accurate sensing of the contents instead of the air is a vital concern.
- Sealed polyethylene Thermal Vial™ virtually eliminates spillage and contamination. Simply fill with fluid such as ethylene glycol, alcohol, water, or a cryopreservative to accurately emulate the material being stored or processed.
- Large (50 mm × 50 mm) footprint provides stability on a shelf or rack. Holds 175 ml (6 oz) of fluid.
- 100 Ω Platinum RTD probe is constructed of 316 Stainless Steel and operates to -269°C (-452°F).
- Cable is reinforced with stainless steel braid for ruggedness.
- 4-20 mA transmitter is match calibrated to the RTD for ±0.75% of span system accuracy.
- NIST certificate and calibration data supplied at no additional cost.

## Specifications

**Temperature range:**
Probe and vial: -269 to 120°C (-452 to 248°F).
Transmitter: -25 to 85°C (-13 to 185°F).
**RTD probe:** 100 Ω Platinum;
TCR = 0.00385.
**Transmitter:** 4 to 20 mA output;
8.5 to 35 VDC loop powered.

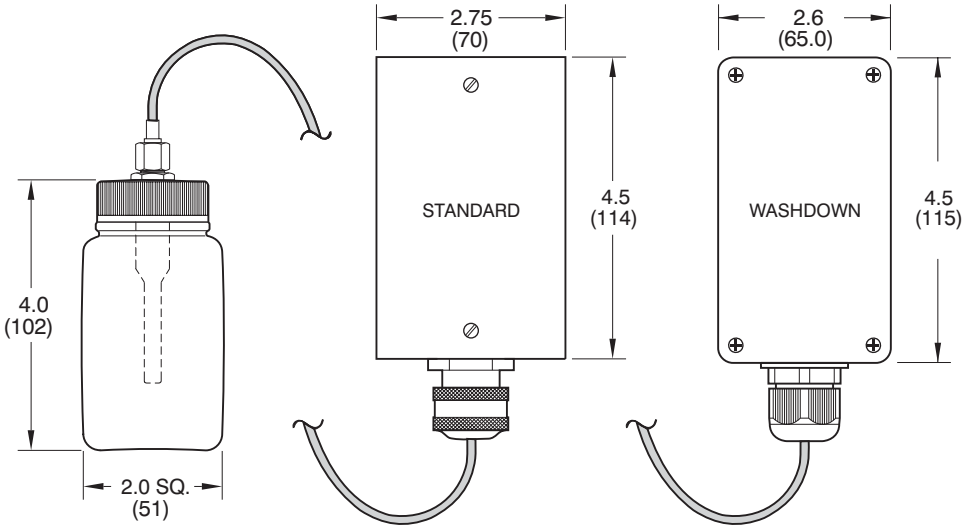
## How to order

| | |
|---|---|
| AS101436 | **Assembly number:**<br>AS101436: Standard construction<br>AS102437: Washdown compatible |
| PD | **100 Ω platinum RTD** |
| 72 | **Cable length in inches** |
| M | **Temperature range for 4-20 mA output:**<br>AT = -100 to 40°C (-148 to -40°F)<br>EZ = -100 to 0°C (-148 to 32°F)<br>LN = -100 to 100°C (-148 to 212°F)<br>M = -50 to 50°C ( -58 to 122°F)<br>BC = -10 to 30°C ( -22 to 86°F)<br>N = 0 to 50°C ( 32 to 122°F)<br>Other ranges are available.<br>See page 5-10. |

AS101436PD72M ← Sample P/N

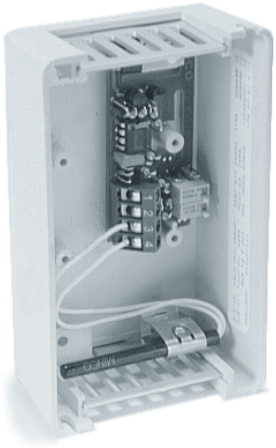
### Washdown compatibility

The washdown compatible Thermal Vial includes a polycarbonate housing and PTFE sensor cable for compatibility with the chemicals commonly used.




DIMENSIONS IN INCHES (mm)

BOX DEPTH APPROXIMATELY 2.2 (55.9)



Full size wall mount thermometers use the TT115 circuit-board style Temptran. The enclosure is thermally designed to minimize heating of the sensor by transmitter

Transmitters are mounted in the junction box on duct sensors, or in the connection head of fluid immersion sensors.

Outside air thermometers and Thermal-Ribbons: Transmitters are furnished separately. Install in an enclosure near the sensor, but away from excessive ambient temperatures.

# Temptran™ 4 to 20 mA Transmitters

All HVAC RTDs are available with companion 4 to 20 mA transmitters. See page 5-2 for suitable models. (Room air thermometers use model TT115, which has the same specifications as TT111). Temptrans convert low-level RTD output to a standard current signal, immune to lead resistance and electrical noise. You can get accurate readings from points thousands of feet away.

## How to order transmitters

To order HVAC/R sensors with integral transmitters, specify both the RTD and the Temptran part numbers.
**Example**: S450PDY12 / TT111PD1A = Platinum duct RTD and 20 to 120°F transmitter.

## Special calibration

Standard transmitters are calibrated to the nominal resistance values of the RTD at the zero and span points. Total system error includes the tolerance of both the transmitter and the RTD sensor.

If you order Minco Temptrans calibrated to the actual resistance of the RTD (as measured in Minco's metrology lab), this effectively subtracts the sensor tolerance from system accuracy specifications.

For example, consider a transmitter with a range of 0 to 500°C. The transmitter itself is accurate to ±1.0°C (±0.2% of span, including calibration accuracy and linearity). The RTD interchangeability contributes an additional error of ±0.3°C at 0°C and ±2.8°C at 500°C. Total system error would be ±1.3°C at 0°C and ±3.8°C at 500°C. When you calibrate the sensor and transmitter as a set, the sensor error disappears, reducing system error to ±1.0°C over the full range — all for a nominal extra cost.

## 0.75% guaranteed accuracy

Minco guarantees a system accuracy (current signal vs temperature) of 0.75% of span when you order specially calibrated Temptrans with any RTD in this section. (An RTD with standard transmitter will deviate about 1-2% of span.) Tighter accuracies are available on special order.

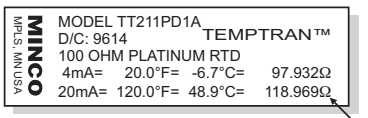
| Standard model | Special calibration |
|---|---|
| TT110 | TT150 |
| TT111 | TT151 |
| TT115 | TT155 |
| TT210 | TT710 |
| TT211 | TT711 |

## Free NIST traceability

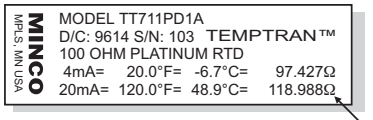
With each matched sensor/transmitter set, Minco sends you calibration data traceable to the National Institute of Standards & Technology. This helps you comply with ISO 9001 and other quality standards.

## Recalibration

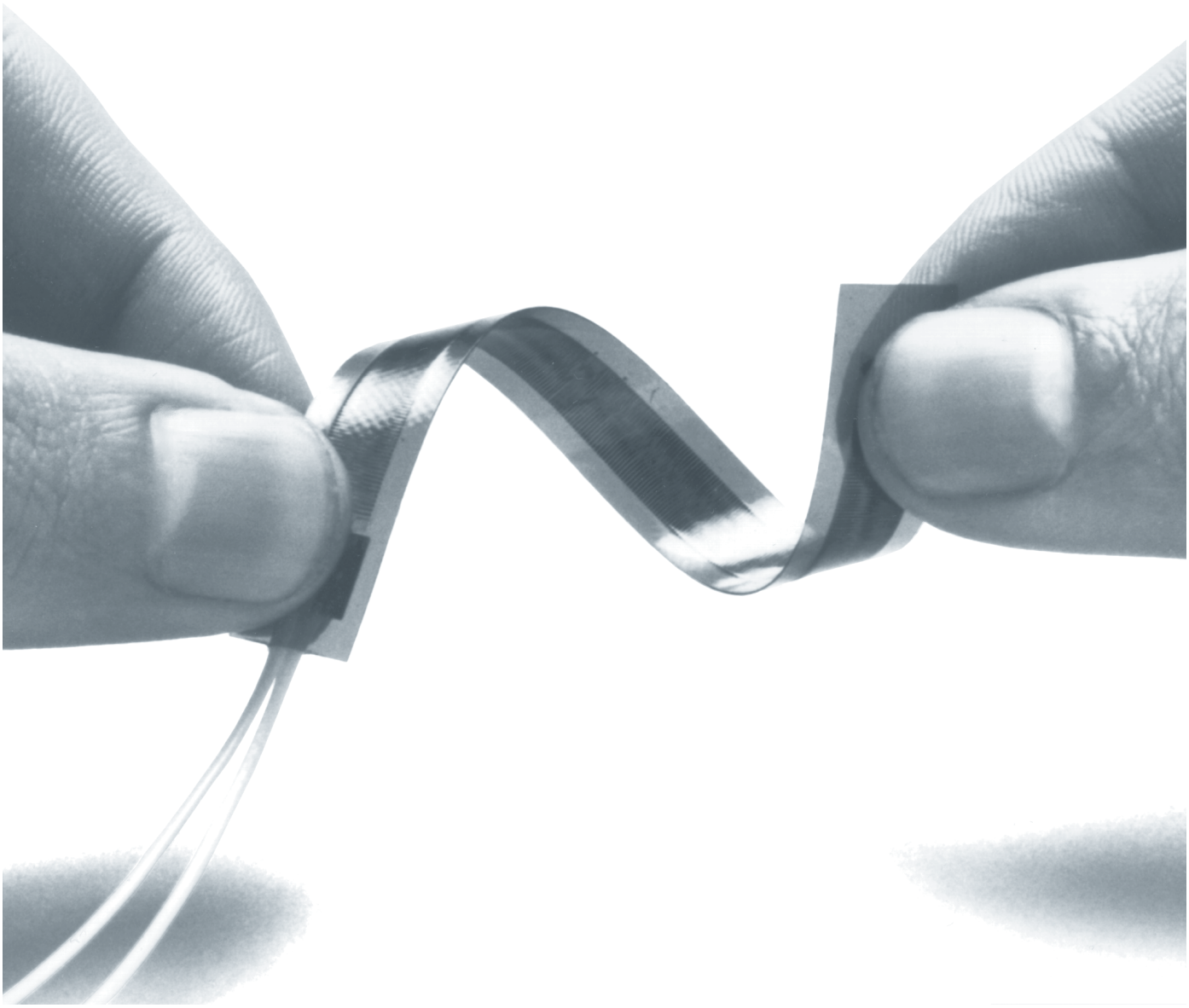
Minco prints RTD resistance values right on the Temptran label to simplify recalibration. You simply connect a resistance decade box or "RTD simulator" in place of the RTD, dial in the correct values, and adjust zero and span. Because Minco RTDs shift less than 0.05°F per year in a typical HVAC installation, the printed values remain valid for many years.




RTD resistances are printed on Temptran labels for easy recalibration of zero and span. A standard Temptran shows nominal values.




A specially calibrated Temptran shows *actual* resistance of the serialized, connected RTD.

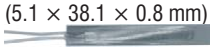
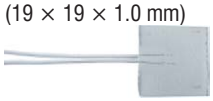
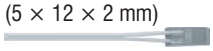
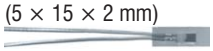
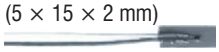
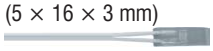
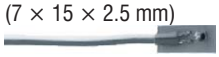
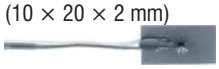
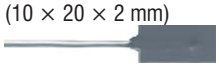


# Section 10: Thermal-Ribbons™

- Thin, flexible RTDs and thermocouples
- Fast response surface sensing in aerospace, medical, and industrial devices
- Rugged laminated construction
- Kapton™, silicone rubber, Mylar™ insulation
- All models available from stock
- See page 9-6 for Thermal-Ribbons designed for pipe mounting.

# Thermal-Ribbons and Thermal-Tabs

Install these compact sensors anywhere for accurate point sensing and fast response. All Thermal-Ribbon models conform to EN60751 Class B tolerance when ordered with a PD platinum element. Thermal-Tab models use a thin-film RTD element.

| Dimensions W × L × T (max.) | Element options | Insulation | Temp. range | Leadwires | Time constant* | Features | Model |
|---|---|---|---|---|---|---|---|
| **Thermal-Ribbons** | | | | | | | |
| 0.20 × 1.50 × 0.030" (5.1 × 38.1 × 0.8 mm)  | FA | Kapton | -200 to 200°C -328 to 392°F | AWG 34, PTFE insulated | 0.15 sec. | Wire-wound nickel-iron for high resistance in small package | S38 |
| 0.30 × 0.30 × 0.025" (7.6 × 7.6 × 0.7 mm)  | PD, PF, PW, PS, NB, NA, NJ | Kapton with foil backing | -200 to 200°C -328 to 392°F | AWG 28, PTFE insulated | 0.15 sec. | Wire-wound element | S651 |
| 0.75 × 0.75 × 0.04" (19 × 19 × 1.0 mm)  | FA | Mylar | -200 to 150°C -328 to 302°F | AWG 30, PTFE insulated | 0.3 sec. | Wire-wound nickel-iron flat element for high resistance | S25 |
| **Thermal-Tabs** | | | | | | | |
| 0.20 × 0.50 × 0.08" (5 × 12 × 2 mm)  | PD, PF, PW | Kapton with elastomer cover coat | -50 to 155°C -58 to 311°F | AWG 26, PTFE insulated | 0.8 sec. | Stocked for immediate shipment | S665 |
| 0.20 × 0.60 × 0.08" (5 × 15 × 2 mm)  | PD, PF, PW, PS, NB, NA, NJ | Kapton | -50 to 200°C -58 to 392°F | AWG 26, PTFE or Polyimide insulated | 1.0 sec. | Platinum models in stock | S17624 |
| 0.20 × 0.60 × 0.08" (5 × 15 × 2 mm)  | PD, PF, PW | Polyimide film | -50 to 260°C -58 to 500°F | AWG 26, PTFE or Polyimide insulated | 0.4 sec. | Highest temperature capability | S100820 |
| 0.20 × 0.60 × 0.12" (5 × 16 × 3 mm)  | PD, PF, PW | Silicone rubber with elastomer cover and foil backing | -50 to 155°C -58 to 311°F | AWG 24, Silicone insulated | 1.3 sec. | Waterproof; suitable for continuous immersion | S667 |
| 0.20 × 0.60 × 0.07" (5 × 15 × 1.7 mm)  | PD, PF, PW | Polyimide film | -50 to 200°C -58 to 392°F | AWG 26, PTFE or Polyimide insulated | 0.6 sec. | Thinnest profile | S100725 |
| 0.30 × 0.60 × 0.10" (7 × 15 × 2.5 mm)  | PD, PF, PW, PS, NB, NA, NJ | Polyimide film | -50 to 200°C -58 to 392°F | AWG 22, PTFE or Polyimide insulated | 1.2 sec. | Heavier leadwire for applications requiring ruggedized design | S100724 |
| 0.40 × 0.80 × 0.08" (10 × 20 × 2 mm)  | PD, PF, PW, PS, NB, NA, NJ | Polyimide film | -50 to 200°C -58 to 392°F | AWG 26, PTFE or Polyimide insulated | 0.9 sec. | Larger surface area for easier handling and max. adhesive bond | S100723 |
| 0.40 × 0.80 × 0.08" (10 × 20 × 2 mm)  | PD, PF, PW, PS, NB, NA, NJ | Silicone rubber | -50 to 220°C -58 to 428°F | AWG 26, PTFE or Polyimide insulated | 1.5 sec. | High temperature rating, available with wide range of element options | S100721 |

* In water at 1 m/sec.

**⚠ T (max.) is over the lead bulge.**

**See next page for information on how to order.**

→ → → → → → → → → → →

## Waterproof model

Model S667 is waterproof and suitable for continous immersion. Use it to monitor the temperature of water in a tank or container, or on equipment that must withstand wash-down or immersion.

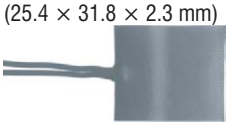
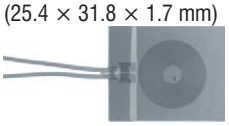
Check with Minco for suitability in other liquids.

## IN STOCK

All models in the following lead lengths:
24": S651
36": S38, S25
40": S100721, S100722, S100723, S100724, S100725, S100820, S17624
40" with 60" max.: S665, S667

# Discoil™ Thermal-Ribbons

Discoil RTD elements are wound in a single plane for faster time response.

| Dimensions W × L × T (max.) | Element options | Insulation | Temp. range | Leadwires | Time constant* | Features | Model |
|---|---|---|---|---|---|---|---|
| 0.79 × 1.87 × 0.055" (20 × 47.5 × 1.4 mm) solder pad version shown  | PD, PE | Kapton (Clear polyester available) | -73 to 200°C -100 to 392°F | (Optional) AWG 24, PTFE insulated | 0.10 sec. | Only 0.010" thick over element, fast time response, platinum PD accuracy available | S17422 |
| 1.00 × 1.25 × 0.090" (25.4 × 31.8 × 2.3 mm)  | PB11, PB22 | Silicone rubber with Kapton backing | -62 to 220°C -80 to 428°F | AWG 24, silicone rubber insulated | 0.2 sec. | High temperature rating, platinum PD accuracy available | S32 |
| | PD12, PE22 | | | | | | S385 |
| 1.00 × 1.25 × 0.065" (25.4 × 31.8 × 1.7 mm)  | FA | Kapton | -200 to 200°C -328 to 392°F | AWG 26, PTFE insulated | 0.15 sec. | High resistance nickel-iron element | S39 |

* In water at 1 m/sec.

| Sensing element specifications** | Code |
|---|---|
| Platinum 391, 100 Ω ±0.11% at 0°C | PB11 |
| Platinum 391, 100 Ω ±0.22% at 0°C | PB22 |
| Platinum 385, 100 Ω±0.12% at 0°C (EN60751, Class B) | PD, PD12 |
| Platinum 385, 100 Ω ±0.36% at 0°C | PE |
| Platinum 385, 100 Ω ±0.22% at 0°C | PE22 |
| Platinum 385, 1000 Ω ±0.12% at 0°C | PF |
| Platinum 375, 1000 Ω ±0.12% at 0°C | PW |
| Platinum 385, 10,000 Ω ±0.12% at 0°C | PS |
| Nickel-iron 518, 604 Ω ±0.26% at 0°C | FA |
| Nickel 618, 100 Ω±0.22% at 0°C (DIN43760 NI100, Class B) | NB |
| Nickel 672, 120 Ω±0.50% at 0°C | NA |
| Nickel 618, 1,000 Ω±0.22% at 0°C (DIN43760 NI1000, Class B) | NJ |

** See tables for element options on each model.

## How to order Thermal-Ribbons and Thermal-Tabs

| | |
|---|---|
| S17624 | **Model number from table on previous page** |
| PD | **Sensing element from table on previous page** |
| Z | **Number of leads:**<br>Y = 2 leads<br>Z = 3 leads (N/A on S25, S38 or S667)<br>X = 4 leads (N/A on S25, S38 or S665/S667) |
| T | **S17624 only, otherwise blank:**<br>T = PTFE insulated wires<br>K = Polyimide insulated wires |
| 24 | **Lead length in inches:**<br>S665/S667: 60" max. |
| A | **Adhesive backing:**<br>A = No adhesive<br>B = Pressure-sensitive adhesive (PSA) |
| S17624PDZT24A ← Sample P/N | |

**⚠ PSA reduces temperature range to -20 to 177°C (-4 to 350°F) and adds 0.005" (0.1 mm) to thickness.**

## IN STOCK

All models in the following lead lengths:
36": S32, S39, S385
40": S17422

## Custom Thermal-Ribbon designs

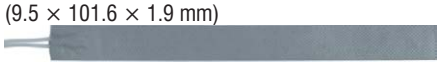
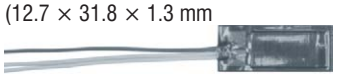
Minco can custom-wind elements in virtually any shape and size. One Thermal-Ribbon model measures 2 feet square and averages temperature readings over its entire surface. We can even profile elements to give more weight to temperature readings in selected zones. Look to Minco for custom design solutions to unique temperature sensing problems.

## How to order Discoil Thermal-Ribbons

| | |
|---|---|
| S32 | **Model number from table above** |
| PB22 | **Sensing element from table above** |
| Z | **Number of leads:**<br>Y = 2 leads<br>Z = 3 leads (Platinum only)<br>X = 4 leads (PD only)<br>W = Solder pads (S17422 only) |
| 36 | **Lead length in inches**<br>(Specify 0 for solder pads, optional on S17422 only) |
| A | **Adhesive backing:**<br>A = No adhesive<br>B = Pressure-sensitive adhesive (PSA) |
| S32PB22Z36A ← Sample P/N | |

# Strip Sensing Thermal-Ribbons

These models average temperatures along their length to eliminate point measurement errors. Wrap them around cylinders or adhere them to flat surfaces.

| Dimensions W × L × T (max.) | Element options | Insulation | Temp. range | Leadwires | Time constant* | Features | Model |
|---|---|---|---|---|---|---|---|
| 0.375 × 4.00 × 0.075" (9.5 × 101.6 × 1.9 mm)  | PB22 | Silicone rubber with Kapton backing | -62 to 220°C -80 to 428°F | AWG 26, PTFE insulated | 0.6 sec. | Platinum PD accuracy | S34 |
| | PD12, PE22 | | | | | | S386 |
| 0.375 × 4.00 × 0.065" (9.5 × 101.6 × 1.7 mm)  | FA | Kapton | -200 to 200°C -328 to 392°F | | 0.2 sec. | Wire-wound nickel-iron for high resistance, thin element | S35 |
| | FA | Mylar | -100 to 150°C -148 to 302°F | | 0.3 sec. | Wire-wound nickel-iron, low cost | S2 |
| 0.50 × 1.25 × 0.050" (12.7 × 31.8 × 1.3 mm  | PA, PE, CA, NA | Kapton | -73 to 200°C -100 to 392°F | | 0.17 sec. | Easy motor installations | S3238 |

| Sensing element specifications** | Code |
|---|---|
| Platinum 392, 100 Ω ±0.5% at 0°C | PA |
| Platinum 391, 100 Ω ±0.22% at 0°C | PB22 |
| Platinum 385, 100 Ω±0.12% at 0°C (EN60751, Class B) | PD12 |
| Platinum 385, 100 Ω ±0.5% at 0°C | PE |
| Platinum 385, 100 Ω ±0.22% at 0°C | PE22 |
| Nickel-iron 518, 604 Ω ±0.26% at 0°C | FA |
| Copper 427, 10 Ω ±0.20% at 25°C | CA |
| Nickel 672, 120 Ω ±0.3% at 0°C | NA |

** See table for element options on each model.

## How to order

| | |
|---|---|
| S34 | **Model number from table (except S3238)** |
| PB22 | **Sensing element from table at top** |
| Y | **Number of leads:**<br>Y = 2 leads<br>Z = 3 leads (required on CA)<br>X = 4 leads (PD only) |
| 36 | **Lead length in inches:**<br>36" stocked |
| A | **Adhesive backing:**<br>A = No adhesive<br>B = Pressure-sensitive adhesive (PSA) |

S34PB22Y36A ← Sample P/N

## Model S3238

Model S3238 is specially designed to sense stator temperatures in motors and generators. An alternative to the "stick" sensors in Section 8, the S3238 mounts on the end turns of stator windings and provides an easy way to add overtemperature protection when the stator is not being rewound.

## How to order

| | |
|---|---|
| S3238 | **Model number S3238** |
| PA | **Sensing element from table above** |
| Y | **Number of leads:**<br>Y = 2 leads<br>Z = 3 leads (required on CA) |
| T | **Lead insulation:**<br>T = PTFE<br>K = polyimide<br>TS = SS braid over PTFE |
| 36 | **Lead length in inches**<br>36" stocked (42" on S2) |
| U | **Lead configuration:**<br>T = Twisted<br>U = Untwisted |
| A | **Adhesive backing:**<br>A = No adhesive<br>B = Pressure-sensitive adhesive (PSA) |

S3238PAYT36UA ← Sample P/N

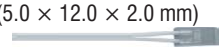
**⚠ PSA reduces temperature range to -20 to 177°C (-4 to 350°F) and adds 0.005" (0.1 mm) to thickness.**

**IN STOCK**

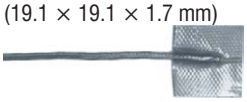
All models in stock with 36" leads, except 42" leads on S2FA

# Thermistor and Thermocouple Thermal-Ribbons

## Thermistor Thermal-Ribbon

| Dimensions W × L × T (max.) | Element options | Insulation | Temp. range | Leadwires | Time constant* | Features | Model |
|---|---|---|---|---|---|---|---|
| 0.20 × 0.47 × 0.079" (5.0 × 12.0 × 2.0 mm)  | TF, TK | Kapton with elastomer cover coat | -50 to 125°C (-58 to 257°F) | AWG 26, PTFE insulated | 0.8 sec. | Small, low-cost, waterproof | TS665 |

## Thermocouple Thermal-Ribbon

| Dimensions W × L × T (max.) | Junction type | Insulation | Temp. range | Leadwires | Time constant* | Features | Model |
|---|---|---|---|---|---|---|---|
| 0.75 × 0.75 × 0.065" (19.1 × 19.1 × 1.7 mm)  | E, J, K, or T | Kapton | -200 to 200°C (-328 to 392°F) | AWG 24, solid PTFE insulated | 0.6 sec. | Surface mounting | TC40 |

## Thermistor TS665

Model TS665 offers extremely sensitive NTC thermistors for applications with small temperature changes.

| Sensing element specifications* | Code |
|---|---|
| NTC thermistor, 50k Ω ±1% at 25°C | TF |
| NTC thermistor, 10k Ω ±1% at 25°C | TK |

* See table for element options.

### How to order

| | |
|---|---|
| TS665 | **Model number from table** |
| TF | **Element from table** |
| Y | **Number of leads:**<br>Y = 2 leads |
| 40 | **Lead length in inches:**<br>40" stocked, 60" maximum |
| A | **Adhesive backing:**<br>A = No adhesive<br>B = Pressure-sensitive adhesive (PSA) |
| TS665TFY40A ← Sample P/N | |

## Thermocouple TC40

TC40 is a patch-style thermocouple that adheres to all types of surfaces for quick and easy mounting.

### How to order

| | |
|---|---|
| TC40 | **Model number** |
| J | **Junction type:**<br>E, J, K, or T |
| T | **Covering over leadwires:**<br>T = PTFE only<br>S = Stainless steel braid |
| 36 | **Lead length in inches:**<br>36" stocked for type J, K, T |
| A | **Adhesive backing:**<br>A = No adhesive<br>B = Pressure-sensitive adhesive (PSA) |
| TC40JT36A ← Sample P/N | |

**⚠ PSA reduces temperature range to -20 to 177°C (-4 to 350°F) and adds 0.005" (0.1 mm) to thickness.**

**IN STOCK**

TS665 stocked in 40" lead length
TC40 types J, K, T stocked in 36" lead length

# Installation and Accessories

Thermal-Ribbons lend themselves to a variety of installation methods. You should avoid repeated bending during the installation process, and Thermal-Ribbons should not flex in use unless they are specifically designed to do so. Take care to secure leadwires so they do not pull against sensor bodies. Leadwires should be routed along the sensed surface a short distance so that they do not sink heat away from the sensing element.

Listed below are some standard installation methods.

## Pressure sensitive adhesive

PSA (option B in part number) is the simplest mounting method, but it is restricted to flat surfaces and temperatures below 177°C (350°F). PSA is usually factory applied to the mounting surface of the Thermal-Ribbon. To install, just remove the backing paper and press in place.

## #6 RTV cement

Room temperature vulcanizing cement for mounting silicone rubber Thermal-Ribbons to flat or curved surfaces. It is available in 3 oz. (89 ml) tubes. Contact Minco for other adhesives usable with Kapton™ or Mylar™ Thermal-Ribbons.

## #21 Polyimide tape

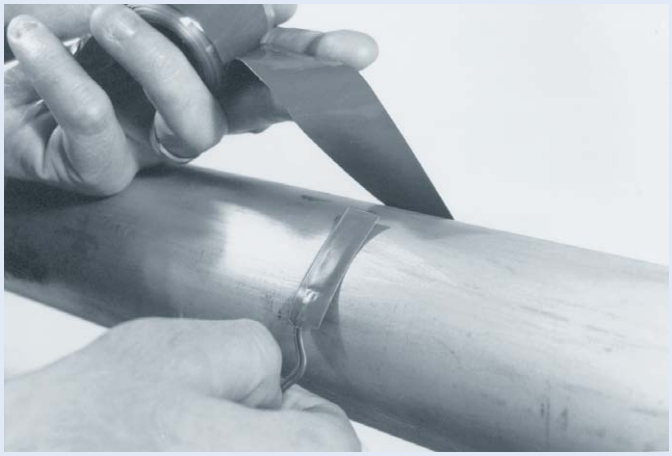
High temperature tape with silicone based adhesive. Useful for quick mounting of Thermal-Ribbon or Thermal-Tab sensors to flat surfaces. Makes a strong but removable bond to most smooth and clean surfaces. Maximum operating temperature is 150°C. 0.5 inch wide × 108 ft. long roll.

## #20 stretch tape

High temperature silicone rubber tape for mounting Thermal-Ribbons to pipes or other cylinders as shown below. It comes in 1" wide rolls, 6 or 36 feet long.

## Shrink bands

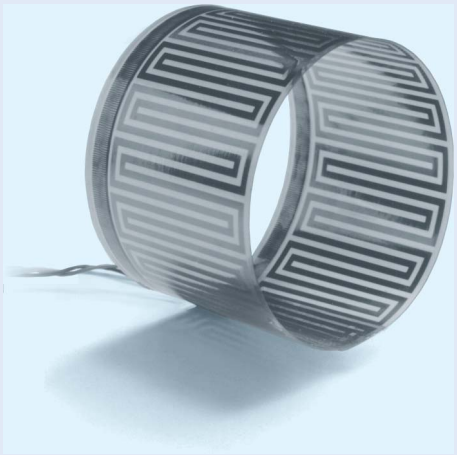
Minco shrink bands are pre-stretched plastic strips with adhesive at both ends. Use them to mount Thermal-Ribbons to cylinders. Simply wrap the band around the sensor and cylinder, secure the ends, and heat to shrink in place. To order, specify band width and cylinder diameter.



## Thermal-Ribbons for fluid sensing

Need to monitor temperature of liquids in pipes or tanks? Thermal-Ribbons make a practical, economical alternative to traditional immersed sensors. They mount directly on pipe surfaces, so there's no need to drain systems and install thermowells. And tests show that Thermal-Ribbons respond as quickly and as accurately as invasive sensors. Request Minco Application Aid #16 for a comparison of Thermal-Ribbons versus thermowells.

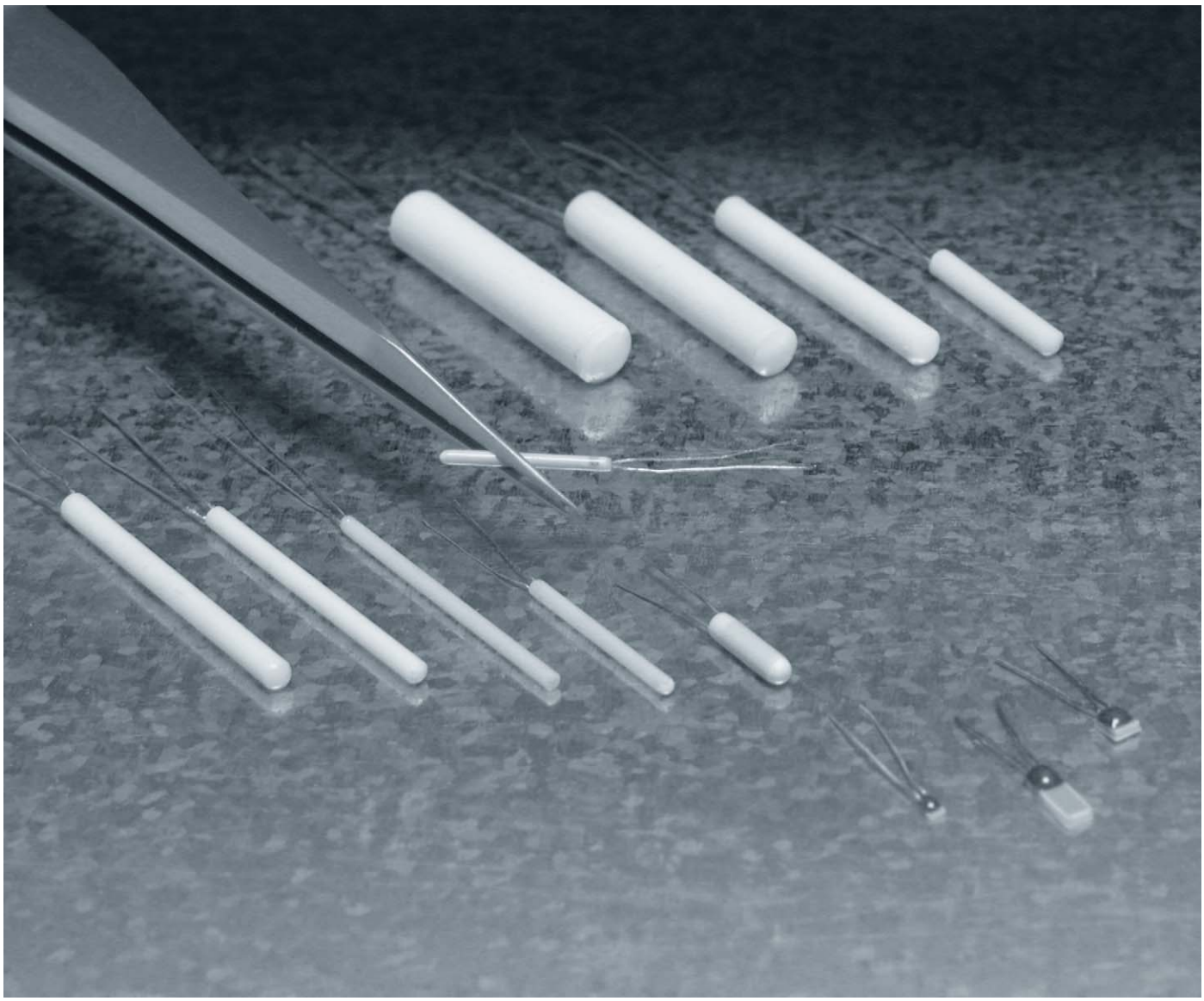
See page 9-6 to order Thermal-Ribbon models designed specifically for pipe mounting.



## Thermofoil™ heater-sensors

Minco manufactures flexible etched-foil heaters for precision temperature control of aerospace, medical, and industrial devices. We can build combination heater-sensors containing Thermal-Ribbons integral to the heating element. We can also etch Thermal-Ribbon RTDs from resistive foil.

Request Bulletin HS-202 for complete heater and heater-sensor information.



# Section 11: Ceramic Elements

- Low cost thin-film elements
- Wire wound elements
- Accurate sensing from -200 to 850°C (-328 to 1582°F)
- Wide choice of sizes and styles for application versatility
- Available from stock

# Wire-Wound and Thin-Film Elements

| Dimensions in inches (mm) | R (0°C) | Temperature range | Leads | Model |
|---|---|---|---|---|
| **550°C wire-wound elements** | | | | |
| 0.040 ø (1.020) — 0.45 (11.4) — 0.75 (19) | 100 Ω | -20 to 550°C (-4 to 1022°F) | 0.006" (0.15 mm) ø Platinum | S200PD |
| 0.058 ø (1.47) — 0.40 (10.2) — 0.75 (19) | 100 Ω | -100 to 550°C (-148 to 1022°F) | 0.010" (0.25 mm) ø Platinum alloy | S201PD |
| 0.077 ø (1.96) — 0.30 (7.6) — 0.75 (19) | 100 Ω | -100 to 550°C (-148 to 1022°F) | 0.010" (0.25 mm) ø Platinum alloy | S202PD |
| 0.100 ø (2.54) — 0.40 (10.2) — 0.75 (19) | 100 Ω | -100 to 550°C (-148 to 1022°F) | 0.014" (0.35 mm) ø Platinum alloy | S203PD |
| 0.135 ø (3.43) — 0.40 (10.2) — 0.75 (19) | 100 Ω | -100 to 550°C (-148 to 1022°F) | 0.014" (0.35 mm) ø Platinum | S204PD |
| 0.077 ø (1.96) — 1.00 (25.4) — 0.75 (19) | 500 Ω | -100 to 550°C (-148 to 1022°F) | 0.010" (0.25 mm) ø Platinum alloy | S212PG |
| 0.135 ø (3.43) — 1.20 (30.5) — 0.75 (19) | 500 Ω | -100 to 550°C (-148 to 1022°F) | 0.014" (0.35 mm) ø Platinum | S214PG |
| **400°C and 600°C thin-film elements** | | | | |
| 0.05 (1.3) — 0.07 (1.7) — 0.025 (0.7) THICK, Lead length: 0.4 (10) | 100 Ω | -50 to 400°C (-58 to 752°F) | 0.010" (0.25 mm) ø Ag .0004 Ω/mm/lead | S100144PD12 |
| | 1,000 Ω | | | S101503PF12 |
| 0.08 (2.0) — 0.09 (2.3) — 0.055 (1.4) THICK, Lead length S245: 0.6 (15) S249: 0.4 (10) | 100 Ω | -70 to 400°C (-94 to 752°F) | 0.010" (0.25 mm) ø Ag .0004 Ω/mm/lead | S245PD12 |
| | | -70 to 600°C (-94 to 1112°F) | 0.008" (0.20 mm) ø Pt/Ni 0.003 Ω/mm/lead | S249PD12 |
| 0.08 (2.0) — 0.20 (5.0) — 0.055 (1.4) THICK, Lead length S247: 0.6 (15) S251: 0.4 (10) | 1,000 Ω | -70 to 400°C (-94 to 752°F) | 0.010" (0.25 mm) ø Ag .0004 Ω/mm/lead | S247PF12 |
| | | -70 to 600°C (-94 to 1112°F) | 0.008" (0.20 mm) ø Pt/Ni 0.003 Ω/mm/lead | S251PF12 |
| 0.10 (2.5) — 0.20 (5.0) — 0.050 (1.3) THICK, Lead length: 0.6 (15) | 10,000 Ω | -50 to 400°C (-58 to 752°F) | 0.010" (0.25 mm) ø Ag .0004 Ω/mm/lead | S19827PS12 |

**Other standard models:**
- Class A tolerance = ±0.15°C at 0°C
- R(0°C) = 500 Ω
- Dimensions: 1.6 × 5 mm, 2 × 10 mm
- Nickel, TCR = 0.00618 Ω/Ω/°C, -50 to 150°C

**Custom models:**
- Special dimensions or shapes
- Longer leadwires (to 100 mm)
- Insulated extension leads (see page 11-4)
- Special R(0°C), TCR, or tolerance

## 550°C wire-wound elements

Use these elements for general purpose sensing in probes or equipment. PD models meet EN60751, Class B.
**Order by model number.**
**Temperature range:** See table above. Some elements may be used down to -269°C in certain applications. Contact factory for advice on cryogenic use.
**Material:** Glass-coated ceramic.
**Tolerance:** ±0.1% at 0°C.
**TCR:** 0.00385 /Ω/°C. Models with 0.00391 TCR, the U.S. industrial standard, are: S201PB, S202PB, S203PB, S204PB, S212PP, S214PP. All 0.00391 TCR models use 0.010" (0.25 mm) diameter 0.5" (13mm) long platinum leads.
**Diameter tolerance:** ±0.005" (0.13 mm).
**Length tolerance:** ±0.06" (1.5 mm).
**Repeatability:** ±0.1°C or better.
**Stability:** Drift less than 0.1°C/year in normal use.
**Vibration:** Withstands 20 G's minimum at 10 to 2,000 Hz.
**Shock:** Withstands 100 G's minimum sine wave shock of 8 milliseconds duration.

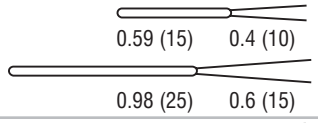
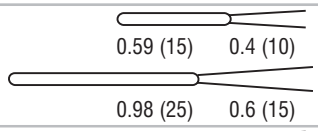
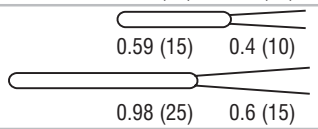
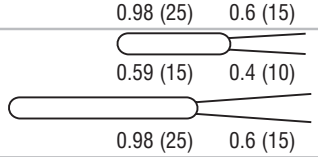
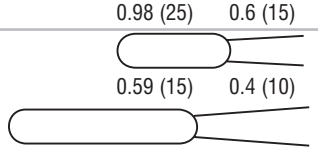
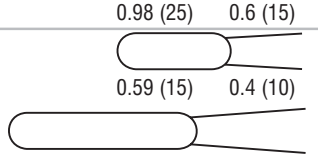
**IN STOCK**

All 0.00385 TCR models

## Thin-film elements

Thin film elements offer low cost and resistances to 10k Ω. See page 10-2 for the S17624 thin-film Thermal-Ribbon™.
**Order by model number.**
**Optional Class A tolerance:** Change 12 to 06 for ±0.06% (EN60751 Class A). Not available with S19827PS.
**Material:** Aluminum oxide substrate with fused glass cover.
**Dimensional tolerance:** ±0.02" (0.5 mm).
**Repeatability:** ±0.1°C or better.
**Stability:** Drift less than 0.1°C/year in normal use.
**Vibration:** Withstands 20 G's minimum at 10 to 2,000 Hz.
**Shock:** Withstands 100 G's minimum sine wave shock of 8 milliseconds duration.

# 850°C Precision Elements

| Dimensions in inches (mm) | Leads | Response time in seconds | | | | Self-Heating Water, 1 m/s °C/mW | Model |
|---|---|---|---|---|---|---|---|
| | | Water, 0.4 m/s | | Air, 1.5 m/s | | | |
| | | 50% | 90% | 50% | 90% | | |
| 0.047 ø (1.2)  0.59 (15) 0.4 (10) 0.98 (25) 0.6 (15) | 0.006" (0.15 mm) ø Platinum Resistance: 0.0055 Ω/mm/lead | 0.06 | 0.15 | 3.5 | 12.5 | 0.100 | S270* |
| | | 0.07 | 0.20 | 6.0 | 20.0 | 0.040 | S271* |
| 0.062 ø (1.6)  0.59 (15) 0.4 (10) 0.98 (25) 0.6 (15) | 0.010" (0.25 mm) ø Platinum Resistance: 0.002 Ω/mm/lead | 0.07 | 0.30 | 6.6 | 25.4 | 0.029 | S272 |
| | | 0.08 | 0.35 | 7.0 | 25.0 | 0.020 | S273 |
| 0.079 ø (2.0)  0.59 (15) 0.4 (10) 0.98 (25) 0.6 (15) | | 0.08 | 0.35 | 7.0 | 24.0 | 0.012 | S274 |
| | | 0.09 | 0.45 | 7.5 | 25.3 | 0.008 | S275 |
| 0.110 ø (2.8)  0.59 (15) 0.4 (10) 0.98 (25) 0.6 (15) | | 0.13 | 0.55 | 9.3 | 30.0 | 0.014 | S276 |
| | | 0.16 | 0.70 | 10.5 | 34.1 | 0.011 | S277 |
| 0.155 ø (3.9)  0.59 (15) 0.4 (10) 0.98 (25) 0.6 (15) | 0.014" (0.36 mm) ø Platinum Resistance: 0.001 Ω/mm/lead | 0.29 | 1.24 | 14.3 | 43.3 | 0.011 | S278 |
| | | 0.35 | 1.55 | 16.0 | 48.0 | 0.010 | S279 |
| 0.177 ø (4.5)  0.59 (15) 0.4 (10) 0.98 (25) 0.6 (15) | | 0.31 | 1.50 | 17.0 | 51.0 | 0.012 | S280 |
| | | 0.41 | 1.60 | 18.0 | 54.0 | 0.008 | S281 |
| 0.188 ø (4.8)  0.59 (15) 0.4 (10) 0.98 (25) 0.6 (15) | | 0.32 | 1.58 | 17.3 | 52.1 | 0.012 | S282 |
| | | 0.43 | 1.65 | 18.4 | 54.8 | 0.008 | S283 |

*Not available with factory installed extension leads AC887/AC888/AC889/AC101828

Obtain accurate measurements over a wide temperature range. A proprietary fill material supports the element wire without straining it, giving exceptional resistance to shock, vibration, and temperature-induced hysteresis.

**IN STOCK**

All models

## Specifications

**Element:** Platinum, 100 Ω at 0°C, TCR = 0.00385 Ω/Ω/°C.
**Tolerance:** EN60751 Class A (± 0.06%) or Class B (± 0.12%). Calibrated 1 mm from ends of leads.
**Temperature range:** -200 to 850°C (-328 to 1562°F).
**Diameter tolerance:** ±0.005" (0.13 mm).
**Length tolerance:** ±0.06" (1.5 mm).
**Repeatability:** Meet IEC requirements. Typical shift less than 0.05°C (0.02 Ω) at 0°C after ten cycles from -200 to 850°C.
**Stability:** Meet IEC stability specifications after 250 hours exposure to extremes of temperature range. Typical drift is less than 0.05°C (0.02 Ω) at 0°C.
**Vibration:** Will withstand 10 to 5000 Hz at 2 G's. minimum.
**Shock:** Will withstand 250 mm drop onto 8 mm thick steel plate (approximately 1400 G's for 0.08 ms).
**Immersion:** Elements are not hermetically sealed.

## How to Order 850°C Elements

| | |
|---|---|
| S276 | **Model number from table** |
| PD | **100 Ω Platinum, 0.00385 TCR** |
| 12 | **Tolerance at 0°C:** 06 = ±0.06%, EN60751 Class A 12 = ±0.12%, EN60751 Class B Other tolerances are available |
| S276PD12 ← Sample P/N | |

# Installation and Accessories

Ceramic elements can be assembled into probes or potted inside holes in heat sinks and platens. Ceramic cement is recommended for high temperature potting. Epoxy is recommended for intermediate temperatures.

Round elements will provide the best time response in round sheaths and holes. Flat thin film elements can be bonded to surfaces.

Elements are calibrated at the end of their leads. The leads have resistances ranging from 0.6 to 2.4 Ω per foot, so you should connect extension leads as close as possible to the end of the element leads to maintain tolerance.

Minco can supply elements with extension leadwires welded onto the sensor leads. Use the standard models below or contact us for a quote on your custom design.

One final note: Ceramic elements are fragile and can suffer damage or loss of accuracy from improper installations. In many cases, the best alternative is to buy a complete encased probe assembly from Minco. Take advantage of our expertise and equipment for best overall performance and value.

## #8 high temperature cement

#8 comes as a powder in 1 oz. packages. Just add water to form a potting compound rated to 850°C (1562°F).

## Extension leads

All elements are available with factory-welded extension leads insulated with PTFE, polyimide, or mica/glass.

| Insulation | Max. temp. | Lead AWG | Max. diameter over lead bundle in inches (mm) | | | Model |
|---|---|---|---|---|---|---|
| | | | 2 leads | 3 leads | 4 leads | |
| PTFE, PTFE tubing over connections | 200°C (392°F) | 22 | 0.136 (3.45) | 0.143 (3.63) | 0.157 (3.99) | AC887 |
| | | 24 | 0.122 (3.10) | 0.124 (3.15) | 0.147 (3.73) | |
| | | 26 | 0.113 (2.87) | 0.119 (3.02) | 0.123 (3.12) | |
| | | 28 | 0.110 (2.79) | 0.116 (2.95) | 0.118 (3.00) | |
| | | 30 | 0.100 (2.54) | 0.101 (2.57) | 0.103 (2.62) | |
| Mica/glass, glass braid over connections | 550°C (1022°F) | 22 | 0.157 (3.99) | 0.192 (4.88) | 0.195 (4.95) | AC888 |
| Polyimide, PTFE tubing over connections | 200°C (392°F) | 22 | 0.123 (3.12) | 0.141 (3.58) | 0.148 (3.76) | AC889 |
| | | 26 | 0.116 (2.95) | 0.131 (3.33) | 0.132 (3.35) | |
| | | 30 | 0.095 (2.41) | 0.102 (2.59) | 0.107 (2.72) | |
| Glass braid, glass braid over connections | 550°C (1022°F) | 27 solid leads | 0.100 (2.54) | 0.117 (2.97) | 0.130 (3.30) | AC101828 |

## How to order extension leads

| | |
|---|---|
| AC887 | **Model Number** |
| Z | **Number of leads:** Y = 2 leads, Z = 3 leads, X = 4 leads |
| 26 | **Lead gauge (AWG)** |
| L | |
| 48 | **Lead length in inches** |

AC887Z26L48 ← Sample P/N

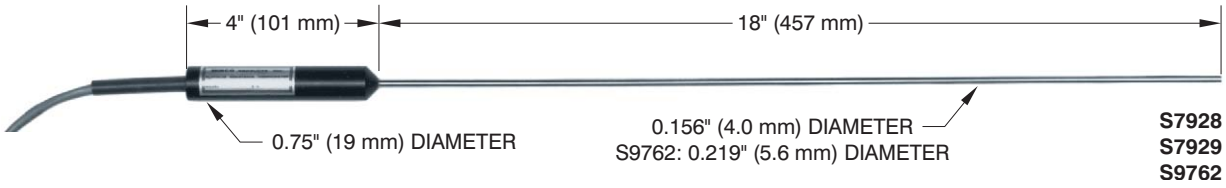
## Custom elements

Shown below are examples of custom design:

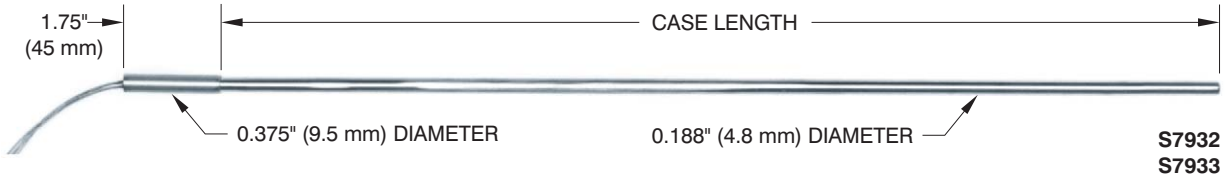
- A dual ceramic sensor used for air flow sensing
- Two resistor-style RTDs

# Section 12: Precision Reference Thermometers

- Laboratory accuracy from -260 to 660°C (-436 to 1220°F)
- True strain-free elements
- Reference grade accuracy at affordable prices
- Traceable to NIST (National Institute of Standards and Technology)




Leads: Shielded cable, 4 wires plus ground, 6 ft. (1.8 m) long




# Laboratory Standards

| Stability | Repeatability after cycling | Temperature range | Sheath | Maximum temperature at leads | Insulation resistance (100 VDC) | Time response (water; 3ft/sec) | Self-heating (water; 3ft/sec) | Model |
|---|---|---|---|---|---|---|---|---|
| **Reference standards (air filled element)** | | | | | | | | |
| 0.005°C/yr. | 0.005°C | -189 to 500°C (-308 to 932°F) | SS | 60°C (140°F) | 1000 MΩ | 10 sec. | 12.5 mW/°C | S7929PA S7928PJ |
| 0.010°C/yr. | 0.010°C | -50 to 250°C (-58 to 482°F) | SS | 60°C (140°F) | 100 MΩ | 10 sec. | 12.5 mW/°C | S7932PA S7932PJ |
| **Ruggedized standards (powder filled element)** | | | | | | | | |
| 0.050°C/yr. | 0.025°C | -189 to 660°C (-308 t0 1220°F) | Inconel | 150°C (302°F) | 1000 MΩ | 9 sec. | 80 mW/°C | S9762PA S9762PJ |
| 0.030°C/yr. | 0.020°C | -50 to 250°C (-58 to 482°F) | SS | 60°C (140°F) | 100 MΩ | 8 sec. | 80 mW/°C | S7933PA S7933PD |

## Reference standards

- Air filled strain-free element
- S7928, S7929: 0.005°C stability from -189 to 500°C (-308 to 932°F)
- S7932: Reduced range for lower cost

Maintain an NIST-traceable secondary temperature reference in your calibration lab. These PRTs offer precision approaching that of primary standards at a fraction of the cost.

Thermometers are shipped in padded carrying cases. Like all temperature standards, they must be handled with extreme caution to avoid calibration shifts.

## Ruggedized standards

- Powder filled strain-free element
- S9762: 0.01°C stability to 600°C
- S7933: Reduced range for low cost

Ruggedized PRTs have a powder filled element to better withstand rough handling, at the cost of slightly reduced stability. They make excellent working standards for transferring calibrations in production environments. Model S9762 features an Inconel sheath for high temperature use.

## Platinum element options

| Code | R(0°C) | TCR (Ω/Ω/°C) |
|---|---|---|
| PA | 100 Ω | 0.003925 min. |
| PD | 100 Ω | 0.003850 |
| PJ | 25.5 Ω | 0.003925 min. |

## How to order

| | |
|---|---|
| S7928PJ | **Model number from table** |
| 1 | **1 = ±0.1% at 0°C** |
| L | |
| 180 | **Case length:** Specify in 0.1" increments (Ex:180 = 18.0") 18" min. required for custom calibration |
| S | **Leadwire termination:** S = 5 spade lugs G = 5 gold plated banana plugs C = 5-pin DIN connector |
| S7928PJ1L180S ← Sample P/N | |

See page 12-6 for calibration.


# Cryogenic Capsule PRT

- Helium filled strain-free element
- 0.0025°C stability
- -260 to 260°C (13 to 533K)

Model S1059 is a miniature thermometer designed to cover a wide temperature range. It provides reference grade precision for cryogenics, calibration, and calorimetry.

Construction features include a strain-free element, gold-plated copper case, all-platinum internal components, dry helium backfill, and a platinum-to-glass internal seal. All materials are non-magnetic.

Select ice point resistance of 25.5 or 100 Ω. The higher resistance is recommended to reduce heat dissipation into cryostats.

## Specifications

| Element | Model |
|---|---|
| Platinum, 25.5 Ω at 0°C | S1059PJ |
| Platinum, 100 Ω at 0°C | S1059PA |

**Temperature coefficient:**
0.003925 Ω/Ω/°C min.
**Case:** Gold-plated copper, helium filled, hermetically sealed. External lead connections epoxy potted.
**Leadwires:** True 4-wire lead construction. Four AWG 30 leads, polyimide insulation. 6" (150 mm) standard.
**Time constant:**
4 seconds typical in water moving at 3 ft/sec.
**Self-heating:** Measuring power of 10 microwatts or less recommended to limit temperature rise to less than 0.6 mK.
**Repeatability:** ±0.0005°C typical after 20 cycles down to 4K.
**Stability:** ±0.0025°C/year at 0°C typical.
**Residual resistance:**

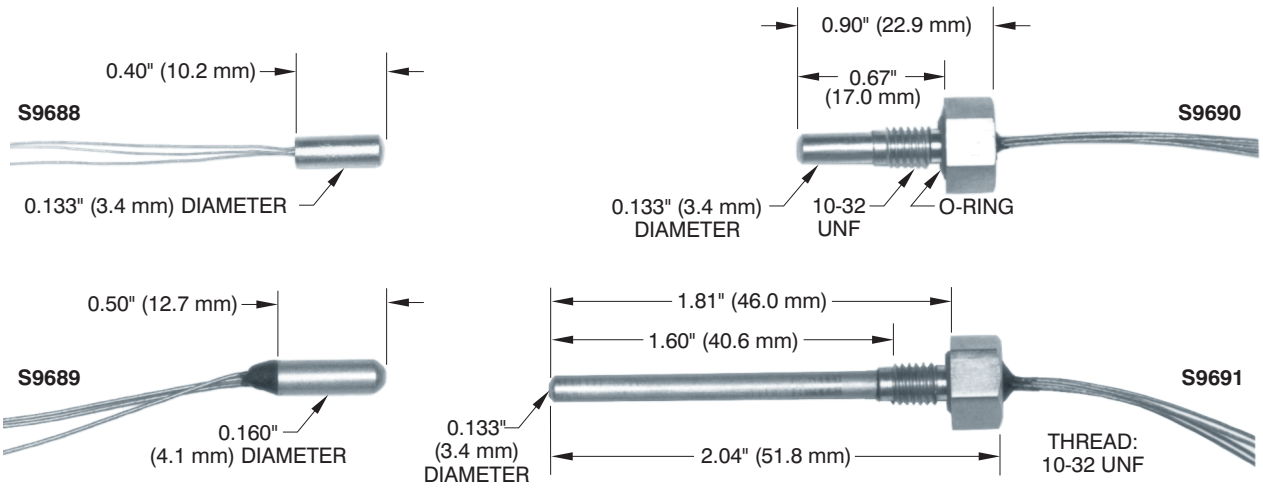
$$\frac{R_{4.2K}}{R_{273.15K}} = 4 \times 10^{-4} \ typical$$

**Insulation resistance:** 1000 megohms min. at 100 VDC, leads to case, at 25°C.

## How to order

| | |
|---|---|
| S1059PA | **Model number from table** |
| 5 | **5 = ±0.5% at 0°C** |
| X | **X = 4 leads** |
| 6 | **Lead length in inches:** 6" is standard |
| S1059PA5X6 ← Sample P/N | |

See page 12-6 for calibration.




# Oil Filled Thermometers

- Oil filled strain-free element
- 0.02°C stability
- -60 to 204°C (-76 to 400°F)

The PRTs on this page use the same element construction as our laboratory thermometers but have an oil-filled, hermetically sealed case. The oil dampens vibrations to protect the sensing wire from stress and shocks. It also improves time response. You can obtain high precision measurements even in harsh industrial and aerospace environments.

## Specifications

**Elements:**

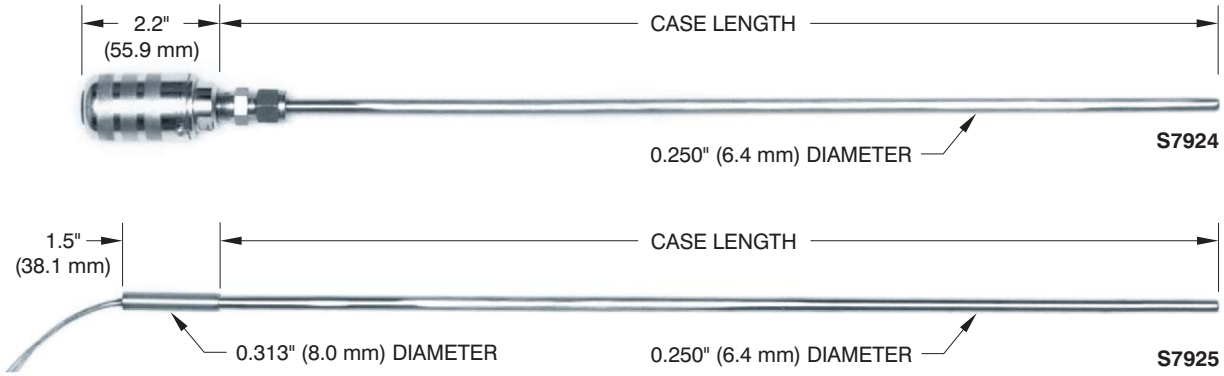
| Element | Code |
|---|---|
| Platinum, 100 Ω at 0°C | PA |
| Platinum, 470 Ω at 0°C | PL |

**Temperature coefficient:** 0.00392 Ω/Ω/°C min.
**Case:** Gold-plated brass, oil filled, glass-to-metal hermetic seal, ⅜" (10 mm) hex. External lead connections epoxy potted.
**Pressure rating:** 500 psi (34.5 bar) for threaded models.
**Leadwires:** Three or four leads, stranded copper, AWG 30, polyimide insulation. 12" (305 mm) standard.
**Time constant:** 1.6 seconds typical in water moving at 3 ft/sec.
**Self-heating:** 30 mW/°C typical in water moving at 3 ft/sec.
**Repeatability:** ±0.01°C after repeated cycling.
**Stability:** ±0.02°C/year at 0°C typical.
**Vibration:** Withstands 10 to 2000 Hz at 20 G's min. per MIL-STD-202, Method 204, Test Condition D.
**Shock:** Withstands 100 G's min. sine wave shock of 8 milliseconds duration.
**Insulation resistance:** 1000 megohms min. at 100 VDC, leads to case, at 25°C.

## How to order

| | |
|---|---|
| S9689 | **Model number (shown above):**<br>S9688<br>S9689<br>S9690<br>S9691 |
| PA | **Element code from table** |
| 5 | **Calibration tolerance at 0°C:**<br>1 = ±0.1%<br>5 = ±0.5% |
| X | **Number of leads:**<br>Z = 3 leads<br>X = 4 leads |
| 12 | **Lead length in inches:**<br>12" is standard<br>Specify 0 for S9688 |
| S9689PA5X12 ← Sample P/N | |

See page 12-6 for calibration.




# Powder Filled Probes & Elements

- Powder filled strain-free element
- 0.05°C stability

Models S7924 and S7925 probes offer laboratory precision in rugged industrial environments. Use them for *in situ* process checks, calibration, and critical process control.

Model S7924 has a miniature connection head for termination of extension wires or cables. S7925 has built-in leadwires.

Field tests of the S7924 have shown performance superior to other commercially available thermometers. When used for side-by-side calibration of thermocouples in power plant equipment, the S7924 typically maintained stability within 0.01 to 0.03°C at 0°C, even after simultaneous exposure to high temperature and vibration.

Specify S215PA and S220PH powder-filled elements for 0.05°C stability at temperatures ranging from -250 to 650°C. Also see the 850°C elements on page 11-3.

Calibration options for these PRTs are on page 12-6.

## S7924, S7925 probes

| Element | Model |
|---|---|
| Platinum, 100 Ω ±0.1% at 0°C | S7924PD |
| Platinum, 100 Ω ±0.1% at 0°C | S7925PD |

**Temperature coefficient:** 0.00385 Ω/Ω/°C.
**Temperature range:**
-189 to 540°C (-308 to 1004°F).
**Case:** 316 stainless steel, hermetically sealed. 4" minimum immersion recommended for best accuracy.
**Pressure rating:** 1000 psi (69 bar) at 20°C.
**Leadwire terminations:**
True 4-wire lead construction.
S7924: Steel terminal head with 4 screw posts for wires to AWG 14. Neoprene grommet and O-ring seal.
S7925: 36" (914 mm) AWG 26 leadwires, polyimide insulated.
**Time constant:** 9 seconds typical in water moving at 3 ft/sec.
**Self-heating:** 80 mW/°C typical in water moving at 3 ft/sec.
**Repeatability:** ±0.025°C after repeated cycling.
**Stability:** ±0.05°C/year at 0°C typical.
**Vibration:** Withstands 10 to 2000 Hz at 20 G's min. per MIL-STD-202, Method 204, Test Condition D.
**Shock:** Withstands 100 G's min. sine wave shock of 8 milliseconds duration.
**Insulation resistance:** 200 megohms min. at 25°C, 2 megohms min. at 500°C, 500 VDC, leads to case.

## How to order

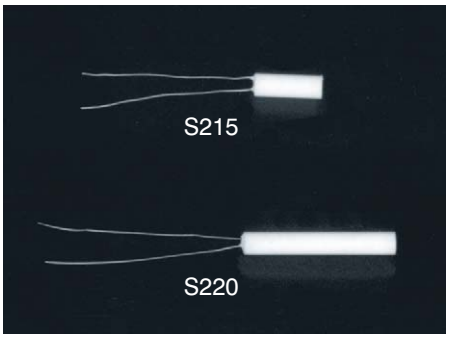
| | |
|---|---|
| S7924PD | **Model number** |
| 120 | **Case length:**<br>60 = 6.0" 120 = 12.0"<br>180 = 18.0" 240 = 24.0"<br>18" min. required for custom calibration |
| S7924PD120 ← Sample P/N | |

## S215PA, S220PH elements

| Element | Model |
|---|---|
| Platinum, 100 Ω ±0.1% at 0°C | S215PA |
| Platinum, 500 Ω ±0.1% at 0°C | S220PH |

**Temperature coefficient:** 0.00392 Ω/Ω/°C.
**Temperature range:**
-250 to 650°C (-418 to 1202°F).
**Body material:** Ceramic.
**Leads:** 0.010" (0.25 mm) diameter platinum (S215) or platinum alloy (S220), 1" (25 mm) long.
**Repeatability:** ±0.05°C typical.
**Stability:** Drift less than 0.05°C/year in normal use.

| Dimensions in inches (mm) | | Model |
|---|---|---|
| Length | Diameter | |
| 0.40 (10.2) | 0.140 (3.56) | S215PA |
| 0.90 (22.9) | 0.140 (3.56) | S220PH |



# Calibration

Minco's fully equipped standards lab can calibrate and furnish individual tables for any thermometer in this bulletin. All temperatures are based on ITS-90. There are two types of calibration:

## Fixed point calibrations

These calibrations use measurements taken at points derived from physical constants, such as the triple point of water or the freezing point of tin. The observed values are used to calculate coefficients for the interpolating equations of ITS-90. In addition to the complete R vs T table, Minco furnishes the actual fixed point values and the resulting coefficients.

## Comparison calibrations

Used for oil filled thermometers, comparison calibrations match the thermometer to be measured against an NIST traceable standard, rather than fixed points.

## Absolute vs ratio tables

Tables may list either absolute resistance values ($R_T$ vs T) or resistance ratios ($R_T/R_0$ vs T) indexed to 1. For example, if the absolute values of a thermometer are 177.47 Ω at 200°C and 100.08 Ω at 0°C, the ratio table reads 1.77328 at 200°C. A ratio like this tends to remain more stable over time than an absolute resistance. You can periodically recheck $R_{0°C}$ in an ice bath and use the latest value for ratio calculation.

## RTD calculations

Minco offers “SensorCalc”, an on-line tool for creating, printing and saving RTD tables available at www.minco.com/support.

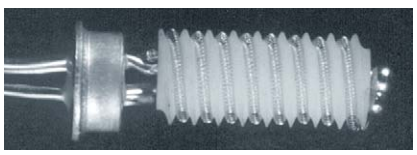
| | Thermometer model (accuracy specifications may vary for other models) | | | | | | |
|---|---|---|---|---|---|---|---|
| | S7928 | S7929 | S9762 | S1059 | | S9688-S9691 S7932-S7933 | S7924, S7925[3] |
| **Type of calibration** | Fixed point | Fixed point | Fixed point | Fixed point | | Comparison | Fixed point |
| **Temperature range** | -189 to 500°C | -189 to 500°C | -189 to 660°C | -269 to 260°C | -189 to 260°C | -100 to 200°C | -189 to 540°C |
| **Ordering number for tables** | | | | | | | |
| **$R_T$ vs T, 1°C increments** | RT05 | RT05 | RT16 | | RT01 | RT09 | RT12 |
| **$R_T/R_0$ vs T, 1°C increments** | RT06 | RT06 | RT17 | | RT02 | RT10 | RT13 |
| **$R_T$ vs T, 0.1°C increments** | | RT07 | RT18 | RT11[1] | RT03 | | RT14 |
| **$R_T/R_0$ vs T, 0.1°C increments** | | RT08 | RT19 | | RT04 | | RT15 |
| **Table accuracy** | ±0.025°C | ±0.025°C | ±0.025°C | ±0.025°C | ±0.025°C | ±0.035°C | ±0.025°C |
| **Data points supplied** | | | | | | | |
| **-268.95°C (4.2K): BP helium** | | | | | • | | |
| **-189.34°C : TP of argon[2]** | • | • | • | | • | | • |
| **-50°C, -25°C, 175°C[2]** | | | | | | • | |
| **-38.83°C : TP of mercury[2]** | • | • | • | | • | | |
| **0.01°C : Triple Point of water** | • | • | • | | • | • | • |
| **100°C: BP water[2]** | | | | | • | • | |
| **231.928°C : FP tin** | • | • | • | | • | | • |
| **419.527°C : FP zinc** | • | • | • | | | | • |
| **660.323°C : FP aluminum[2]** | | | (±0.05°C) | | | | |

[1] Cryogenic calibrations available on special order.
[2] Comparison calibration measurement.
[3] S7924, S7925 calibrations based on EN60751, not ITS-90



## The Minco strain-free element

Minco precision thermometers rely on a unique element design for superior precision. It consists of a helical coil of platinum wire, spiraled onto a grooved ceramic bobbin. This construction gives more support to the coils than “birdcage” designs, but does not stress the element during thermal expansion. The result is stable and repeatable measurements under a variety of conditions.



# RTD, Thermocouple, or Thermistor?

## Resistance temperature detectors (RTDs)

An RTD sensing element consists of a wire coil or deposited film of pure metal. The element's resistance increases with temperature in a known and repeatable manner. RTDs exhibit excellent accuracy over a wide temperature range and represent the fastest growing segment among industrial temperature sensors. Their advantages include:

- Temperature range: Models in this bulletin cover temperatures from -260 to 850°C (-436 to 1582°F).
- Repeatability and stability: The platinum resistance thermometer is the primary interpolation instrument used by the National Institute of Standards and Technology from -260 to 962°C. Minco offers laboratory models stable within 0.0025°C per year. Even ordinary industrial RTDs typically drift less than 0.1°C/year.
- Sensitivity: The voltage drop across an RTD provides a much larger output than a thermocouple.
- Linearity: Platinum and copper RTDs produce a more linear response than thermocouples or thermistors. RTD non-linearities can be corrected through proper design of resistive bridge networks.
- Low system cost: RTDs use ordinary copper extension leads and require no cold junction compensation.
- Standardization: Manufacturers offer RTDs to industry standard curves, most commonly 100 Ω platinum to EN60751 (Minco element code PD or PE).

## Thermocouples

A thermocouple consists of two wires of dissimilar metals welded together into a junction. At the other end of the signal wires, usually as part of the input instrument, is another junction called the reference junction. Heating the sensing junction generates a thermoelectric potential (emf) proportional to the temperature difference between the two junctions. This millivolt-level emf, when compensated for the known temperature of the reference junction, indicates the temperature at the sensing tip. Published millivolt tables assume the reference junction is at 0°C.

Thermocouples are simple and familiar. Designing them into systems, however, is complicated by the need for special extension wires and reference junction compensation. Thermocouple advantages include:

- Extremely high temperature capability: Thermocouples with precious metal junctions may be rated as high as 1800°C (3272°F).
- Ruggedness: The inherent simplicity of thermocouples makes them resistant to shock and vibration.
- Small size/fast response: A fine-wire thermocouple junction takes up little space and has low mass, making it suitable for point sensing and fast response. Note, however, that many Minco RTDs have time constants faster than equivalent thermocouples.

## Thermistors

A thermistor is a resistive device composed of metal oxides formed into a bead and encapsulated in epoxy or glass. A typical thermistor shows a large negative temperature coefficient. Resistance drops dramatically and non-linearly with temperature. Sensitivity is many times that of RTDs but useful temperature range is limited. Some manufacturers offer thermistors with positive coefficients. Linearized models are also available.

There are wide variations of performance and price between thermistors from different sources. Typical benefits are:

- Low sensor cost: Basic thermistors are quite inexpensive. However, models with tighter interchangeability or extended temperature ranges often cost more than RTDs.
- High sensitivity: A thermistor may change resistance by tens of ohms per degree temperature change, versus a fraction of an ohm for RTDs.
- Point sensing: A thermistor bead can be made the size of a pin head for small area sensing.

| Sensor type | Temperature range | Sensor cost | System cost | Stability | Sensitivity | Linearity | Specify for: |
|---|---|---|---|---|---|---|---|
| RTD | -260 to 850°C (-436 to 1562°F) | Moderate | Moderate | Best | Moderate | Best | • General purpose sensing<br>• Highest accuracy<br>• Temperature averaging |
| Thermocouple | -270 to 1800°C (-454 to 3272°F) | Low | High | Low | Low | Moderate | • Highest temperatures |
| Thermistor | -80 to 150°C (-112 to 302°F) (typical) | Low | Moderate | Moderate | Best | Poor | • Best sensitivity<br>• Narrow ranges (e.g. medical)<br>• Point sensing |

# Choosing Sensor Elements

## RTD element types

Platinum is the most widely specified RTD element type, due to its wide temperature range, stability, and standardization between manufacturers. Copper, nickel, and nickel-iron can offer comparable accuracy at lower cost in many applications.

| Element material | Temperature range | Resistivity (Ω per circular mil foot at 20°C) | Benefits | Typical base resistance | Sensitivity (Avg. Ω/°C, 0 to 100°C) | TCR Ω/Ω/°C |
|---|---|---|---|---|---|---|
| Platinum | -260 to 850°C<br>(-436 to 1562°F) | 63.8 | •Greatest range<br>•Best stability<br>•Good linearity | 100 Ω at 0°C<br>1000 Ω at 0°C | 0.39<br>3.90 | 0.00375 to<br>0.003927 |
| Copper | -100 to 260°C<br>(-148 to 500°F) | 10.7 | •Best linearity | 10 Ω at 25°C | 0.04 | 0.00427 |
| Nickel | -100 to 260°C<br>(-148 to 500°F) | 41.5 | •Low cost<br>•High sensitivity | 120 Ω at 0°C | 0.81 | 0.00672 |
| Nickel-iron | -100 to 204°C<br>(-148 to 400°F) | 120.0 | •Low cost<br>•Highest sensitivity | 604 Ω at 0°C<br>1000 Ω at 70°F<br>2000 Ω at 70°F | 3.13<br>4.79<br>9.58 | 0.00518 to<br>0.00527 |

## RTD and thermistor interchangeability

The tables below show temperature tolerance — the allowable deviation from nominal curves — for RTDs and thermistors in this catalog. Minco can supply sensors with tighter overall tolerance, or with the narrowest tolerance at a point other than 0°C.

| Temperature °C | Interchangeability | | | | | | |
|---|---|---|---|---|---|---|---|
| | Platinum RTD | | | | | | |
| | 0.06% at 0°C | 0.1% at 0°C | 0.22% at 0°C | 0.36% at 0°C | 0.5% at 0°C | 0.1% at 70°F | 0.24% at 70°F |
| -200 | ±0.55°C | ±1.3°C | | | ±2.1°C | | |
| -100 | ±0.35°C | ±0.8°C | ±1.3°C | | ±1.7°C | | |
| 0 | ±0.15°C | ±0.3°C | ±0.5°C | ±0.9°C | ±1.3°C | ±0.3°C | ±0.7°C |
| 20 | ±0.19°C | ±0.4°C | ±0.7°C | ±1.3°C | ±1.6°C | ±0.3°C | ±0.6°C |
| 100 | ±0.35°C | ±0.8°C | ±1.8°C | ±2.3°C | ±2.9°C | ±0.7°C | ±1.1°C |
| 200 | ±0.55°C | ±1.3°C | ±3.1°C | ±3.7°C | ±4.4°C | ±1.3°C | ±1.8°C |
| 260 | ±0.67°C | ±1.6°C | ±3.7°C | ±4.6°C | ±5.5°C | | |
| 300 | ±0.75°C | ±1.8°C | | | | | |
| 400 | ±0.95°C | ±2.3°C | | | | | |
| 500 | ±1.15°C | ±2.8°C | | | | | |
| 600 | ±1.35°C | ±3.3°C | | | | | |
| 700 | | ±3.8°C | | | | | |
| 800 | | ±4.3°C | | | | | |
| 850 | | ±4.6°C | | | | | |

| Temperature °C | Interchangeability | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Copper RTD | | Nickel RTD | | Nickel-iron RTD | | | | | Thermistor |
| | ±0.2% at 25°C | ±0.5% at 25°C | ±0.3% at 25°C | ±0.5% at 0°C | ±0.26% at 0°C | ±0.5% at 0°C | ±0.5% at 25°C | ±0.12% at 70°F | ±0.25% at 70°F | ±0.1% at 0°C |
| -100 | ±1.5°C | ±2.2°C | | | | ±2.5°C | ±2.9°C | | | |
| 0 | ±0.7°C | ±1.5°C | ±0.5°C | ±0.8°C | ±0.6°C | ±1.1°C | ±1.4°C | ±0.5°C | ±1.4°C | ±0.2°C |
| 20 | ±0.5°C | ±1.3°C | ±0.8°C | ±1.2°C | ±0.8°C | ±1.4°C | ±1.2°C | ±0.3°C | ±0.7°C | ±0.2°C |
| 100 | ±1.5°C | ±2.5°C | ±1.8°C | ±2.2°C | ±1.7°C | ±2.4°C | ±2.2°C | ±1.1°C | ±2.0°C | ±0.3°C |
| 150 | ±2.2°C | ±3.3°C | ±2.5°C | ±3.0°C | ±2.3°C | ±3.1°C | ±2.9°C | ±1.6°C | ±2.9°C | ±1.0°C |
| 200 | ±2.8°C | ±4.1°C | ±3.1°C | ±3.7°C | ±2.9°C | ±3.8°C | ±3.6°C | ±2.1°C | ±3.8°C | |
| 260 | ±3.6°C | ±5.1°C | ±3.4°C | ±4.0°C | | | | | | |

## Thermocouple limits of error per ANSI-MC96.1-1982

| Junction type: | E (Chromel-Constantan) | J (Iron-Constantan) | K (Chromel-Alumel) | T (Copper-Constantan) |
|---|---|---|---|---|
| Limits of error: | ±1.7°C or ±0.5%<br>0 to 900°C | ±2.2°C or ±0.75%<br>0 to 750°C | ±2.2°C or ±0.75%<br>0 to 1250°C | ±1.0°C or ±0.75%<br>0 to 350°C |

# RTD Connections: 2-Wire, 3-Wire, 4-Wire?

Because an RTD is a resistance type sensor, resistance introduced by connecting extension wires between the RTD and control instrument will add to readings. Furthermore, this additional resistance is not constant but increases with ambient temperature. To estimate leadwire error in 2-wire circuits, multiply the total length of the extension leads times the resistance per foot in the table below. Then divide by the sensitivity of the RTD, given in the next two pages, to obtain an error figure in °C. For example, assume you have connected 100 feet of AWG 22 wires to a 100 Ω platinum RTD (PD element). Lead resistance is:

$$R = (200\,ft.) \times (0.0165\,\Omega\ /\ ft.) = 3.3\,\Omega$$

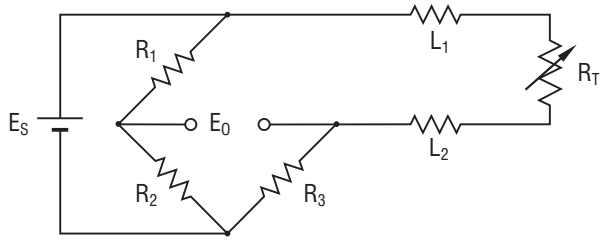
Approximate error is:

$$E = \frac{3.3\,\Omega}{0.385\,\Omega/°C} = 8.6°C$$

| Leadwire AWG | Ohms/ft. at 25°C |
|---|---|
| 12 | 0.0016 |
| 14 | 0.0026 |
| 16 | 0.0041 |
| 18 | 0.0065 |
| 20 | 0.0103 |
| 22 | 0.0165 |
| 24 | 0.0262 |
| 26 | 0.0418 |
| 28 | 0.0666 |
| 30 | 0.1058 |

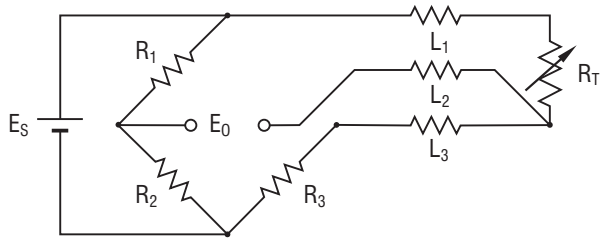
You can reduce leadwire error by:

- Using larger gauge extension wires.
- Specifying an RTD with greater sensitivity; 1000 Ω instead of 100 Ω, for example.
- Employing a 3 or 4-wire resistance canceling circuit as shown at right. Common leads, connected to the same end of the sensing element, are the same color.
- Using a 2-wire current transmitter. Its linearized signal is immune to electrical noise as well as resistance and can maintain accuracy over runs of several thousand feet. See Section 5 for transmitters.



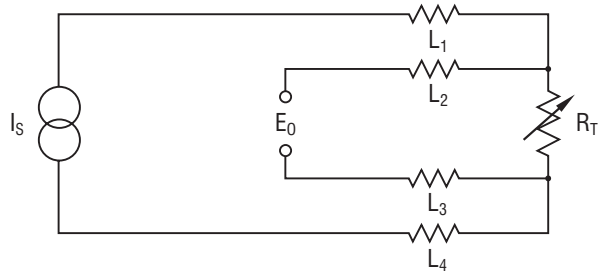

## 2-wire circuit

Shown above is a 2-wire RTD connected to a typical Wheatstone bridge circuit. $E_S$ is the supply voltage; $E_O$ is the output voltage; $R_1$, $R_2$, and $R_3$ are fixed resistors; and $R_T$ is the RTD. In this uncompensated circuit, lead resistances $L_1$ and $L_2$ add directly to $R_T$.



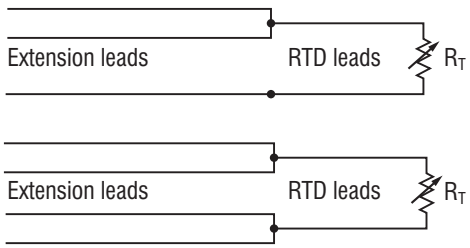

## 3-wire circuit

In this circuit there are three leads coming from the RTD instead of two. $L_1$ and $L_3$ carry the measuring current while $L_2$ acts only as a potential lead. No current flows through it while the bridge is in balance. Since $L_1$ and $L_3$ are in separate arms of the bridge, resistance is canceled. This circuit assumes high impedance at $E_O$ and close matching of resistance between wires $L_1$ and $L_3$. Minco matches RTD leads within 5%.




## 4-wire circuit

4-wire RTD circuits not only cancel leadwires but remove the effects of mismatched resistances such as contact points. A common version is the constant current circuit shown above. $I_S$ drives a precise measuring current through $L_1$ and $L_4$. $L_2$ and $L_3$ measure the voltage drop across the RTD element. $E_O$ must have high impedance to prevent current flow in the potential leads. 4-wire circuits may be usable over longer distances than 3-wire, but you should consider using a transmitter in electrically noisy environments.




If necessary you can connect a 2-wire RTD to a 3-wire circuit or 4-wire circuit, as shown above. As long as the junctions are near the RTD, as in a connection head, errors are negligible.

# Resistance/Temperature Tables

Complete tables in 1°C or 1°F increments are available from Minco at www.minco.com/sensorcalc.

| Platinum elements | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Element code** | **PJ** | **PA** | **PB** | **PD, PE** | **PN** | **PL** | **PH** | **PP** | **PG** | **PF** | **PW** | **PS** |
| **Resistance at 0°C** | **25.5 Ω** | **100 Ω** | **100 Ω** | **100 Ω** | **200 Ω** | **470 Ω** | **500 Ω** | **500 Ω** | **500 Ω** | **1000 Ω** | **1000 Ω** | **10k Ω** |
| **TCR (Ω/Ω/°C)** | **.00392** | **.00392** | **.00391** | **.00385** | **.00385** | **.00392** | **.00392** | **.00391** | **.00385** | **.00385** | **.00375** | **.00385** |
| **Sensitivity (Average Ω/°C)** | 0.100 | 0.392 | 0.391 | 0.385 | 0.770 | 1.845 | 1.963 | 1.955 | 1.925 | 3.850 | 3.750 | 38.50 |
| **Temperature (°C)** | **Resistance (ohms)** | | | | | | | | | | | |
| -200 | 4.33 | 17.00 | 17.26 | 18.52 | 37.04 | 79.88 | 84.98 | 86.30 | 92.60 | 185.20 | | 1,852 |
| -180 | 6.56 | 25.72 | 25.97 | 27.10 | 54.19 | 120.88 | 128.59 | 129.84 | 135.48 | 270.96 | | 2,710 |
| -160 | 8.75 | 34.31 | 34.54 | 35.54 | 71.09 | 161.28 | 171.57 | 172.72 | 177.72 | 355.43 | | 3,554 |
| -140 | 10.91 | 42.80 | 43.01 | 43.88 | 87.75 | 201.15 | 213.99 | 215.03 | 219.38 | 438.76 | | 4,388 |
| -120 | 13.05 | 51.19 | 51.37 | 52.11 | 104.22 | 240.57 | 255.93 | 256.83 | 260.55 | 521.10 | | 5,211 |
| -100 | 15.17 | 59.49 | 59.64 | 60.26 | 120.51 | 279.58 | 297.43 | 298.19 | 301.28 | 602.56 | | 6,026 |
| -80 | 17.27 | 67.71 | 67.83 | 68.33 | 136.65 | 318.23 | 338.55 | 339.17 | 341.63 | 683.25 | | 6,833 |
| -60 | 19.35 | 75.87 | 75.96 | 76.33 | 152.66 | 356.57 | 379.53 | 379.80 | 381.64 | 763.28 | | 7,633 |
| -40 | 21.41 | 83.96 | 84.03 | 84.27 | 168.54 | 394.63 | 419.82 | 420.13 | 421.35 | 842.71 | 846.57 | 8,427 |
| -20 | 23.46 | 92.01 | 92.04 | 92.16 | 184.32 | 432.43 | 460.03 | 460.19 | 460.80 | 921.60 | 923.55 | 9,216 |
| 0 | 25.50 | 100.00 | 100.00 | 100.00 | 200.00 | 470.00 | 500.00 | 500.00 | 500.00 | 1000.00 | 1000.00 | 10,000 |
| 20 | 27.53 | 107.95 | 107.92 | 107.79 | 215.59 | 507.35 | 539.73 | 539.58 | 538.96 | 1077.94 | 1075.96 | 10,779 |
| 40 | 29.54 | 115.85 | 115.78 | 115.54 | 231.08 | 544.47 | 579.23 | 578.92 | 577.70 | 1155.41 | 1151.44 | 11,554 |
| 60 | 31.54 | 123.70 | 123.60 | 123.24 | 246.48 | 581.38 | 618.49 | 618.02 | 616.21 | 1232.42 | 1226.44 | 12,324 |
| 80 | 33.53 | 131.50 | 131.38 | 130.90 | 261.79 | 618.06 | 657.51 | 656.90 | 654.48 | 1308.97 | 1300.96 | 13,090 |
| 100 | 35.51 | 139.26 | 139.11 | 138.51 | 277.01 | 654.53 | 696.31 | 695.54 | 692.53 | 1385.06 | 1375.00 | 13,851 |
| 120 | 37.48 | 146.97 | 146.79 | 146.07 | 292.14 | 690.77 | 734.86 | 733.94 | 730.34 | 1460.68 | 1448.56 | 14,607 |
| 140 | 39.43 | 154.64 | 154.42 | 153.58 | 307.17 | 726.79 | 773.18 | 772.11 | 767.92 | 1535.84 | 1521.63 | 15,358 |
| 160 | 41.37 | 162.25 | 162.01 | 161.05 | 322.11 | 762.59 | 811.27 | 810.05 | 805.27 | 1610.54 | 1594.22 | 16,105 |
| 180 | 43.31 | 169.82 | 169.55 | 168.48 | 336.96 | 798.18 | 849.12 | 847.75 | 842.39 | 1684.78 | 1666.33 | 16,848 |
| 200 | 45.22 | 177.35 | 177.04 | 175.86 | 351.71 | 833.54 | 886.74 | 885.22 | 879.28 | 1758.56 | 1737.96 | 17,586 |
| 220 | 47.13 | 184.82 | 184.49 | 183.19 | 366.38 | 868.68 | 924.12 | 922.46 | 915.94 | 1831.88 | 1809.11 | 18,319 |
| 240 | 49.02 | 192.25 | 191.89 | 190.47 | 380.95 | 903.59 | 961.27 | 959.46 | 952.36 | 1904.73 | 1879.78 | 19,047 |
| 260 | 50.91 | 199.64 | 199.24 | 197.71 | 395.42 | 938.29 | 998.18 | 996.22 | 988.56 | 1977.12 | 1949.96 | 19,771 |
| 280 | 52.78 | 206.97 | 206.55 | 204.91 | 409.81 | 972.77 | 1034.86 | 1032.76 | 1024.52 | 2049.05 | 2019.67 | 20,490 |
| 300 | 54.64 | 214.26 | 213.81 | 212.05 | 424.10 | 1007.03 | 1071.31 | 1069.06 | 1060.26 | 2120.52 | 2088.89 | 21,205 |
| 320 | 56.48 | 221.50 | 221.02 | 219.15 | 438.30 | 1041.06 | 1107.51 | 1105.12 | 1095.76 | 2191.52 | 2157.63 | 21,915 |
| 340 | 58.32 | 228.70 | 228.19 | 226.21 | 452.41 | 1074.88 | 1143.49 | 1140.95 | 1131.03 | 2262.06 | 2225.89 | 22,621 |
| 360 | 60.14 | 235.85 | 235.31 | 233.21 | 466.43 | 1108.47 | 1179.23 | 1176.55 | 1166.07 | 2332.14 | 2293.67 | 23,321 |
| 380 | 61.95 | 242.95 | 242.38 | 240.18 | 480.35 | 1141.85 | 1214.73 | 1211.91 | 1200.88 | 2401.76 | 2360.96 | 24,018 |
| 400 | 63.75 | 250.00 | 249.41 | 247.09 | 494.18 | 1175.00 | 1250.00 | 1247.04 | 1235.46 | 2470.92 | 2427.78 | 24,709 |
| 420 | 65.54 | 257.01 | 256.39 | 253.96 | 507.92 | 1207.93 | 1285.03 | 1281.94 | 1269.81 | 2539.62 | 2494.11 | 25,396 |
| 440 | 67.31 | 263.97 | 263.32 | 260.79 | 521.57 | 1240.64 | 1319.83 | 1316.60 | 1303.92 | 2607.85 | 2559.96 | 26,078 |
| 460 | 69.07 | 270.88 | 270.21 | 267.56 | 535.12 | 1273.14 | 1354.40 | 1351.03 | 1337.81 | 2674.62 | 2625.33 | 26,756 |
| 480 | 70.83 | 277.75 | 277.04 | 274.29 | 548.59 | 1305.41 | 1388.73 | 1385.22 | 1371.46 | 2742.93 | 2690.22 | 27,429 |
| 500 | 72.56 | 284.57 | 283.84 | 280.98 | 561.96 | 1337.46 | 1422.83 | 1419.18 | 1404.89 | 2808.78 | 2754.63 | 28,098 |
| 520 | 74.29 | 291.34 | 290.58 | 287.62 | 575.23 | 1369.28 | 1456.69 | 1452.91 | 1438.08 | 2876.16 | | 28,762 |
| 540 | 76.01 | 298.06 | 297.28 | 294.21 | 588.42 | 1400.89 | 1490.31 | 1486.40 | 1471.04 | 2942.08 | | 29,421 |
| 560 | 77.71 | 304.74 | 303.93 | 300.75 | 601.51 | 1432.28 | 1523.70 | 1519.66 | 1503.77 | 3007.54 | | 30,075 |
| 580 | 79.40 | 311.37 | 310.54 | 307.25 | 614.51 | 1463.45 | 1556.86 | 1552.68 | 1536.27 | 3072.54 | | 30,725 |
| 600 | 81.08 | 317.96 | 317.09 | 313.71 | 627.42 | 1494.39 | 1589.78 | 1585.47 | 1568.54 | 3137.08 | | 31,371 |
| 620 | 82.75 | 324.49 | 323.60 | 320.12 | 640.23 | 1525.12 | 1622.47 | 1618.02 | 1600.58 | 3201.16 | | |
| 640 | 84.40 | 330.98 | 330.07 | 326.48 | | 1555.62 | 1654.92 | 1650.35 | | | | |
| 660 | 86.04 | 337.43 | 336.49 | 332.79 | | 1585.91 | 1687.14 | 1682.43 | | | | |
| 680 | 87.67 | 343.82 | 342.86 | 339.06 | | 1615.97 | 1719.12 | 1714.29 | | | | |
| 700 | 89.29 | 350.17 | 349.18 | 345.28 | | 1645.81 | 175 0.87 | 1745.91 | | | | |
| 720 | | | | 351.46 | | | | | | | | |
| 740 | | | | 357.59 | | | | | | | | |
| 760 | | | | 363.67 | | | | | | | | |
| 780 | | | | 369.71 | | | | | | | | |
| 800 | | | | 375.70 | | | | | | | | |
| 820 | | | | 381.65 | | | | | | | | |
| 840 | | | | 387.55 | | | | | | | | |
| 850 | | | | 390.48 | | | | | | | | |

| | Copper | Nickel | Nickel-iron | | | Thermistors | |
|---|---|---|---|---|---|---|---|
| **Element code** | **CA** | **NA** | **FA** | **FB** | **FC** | **TA** | **TB** |
| **Base resistance** | 10 Ω at 25°C | 120 Ω at 0°C | 604 Ω at 0°C | 1000 Ω at 70°F | 2000 Ω at 70°F | 2252 Ω at 25°C | 10K Ω at 25°C |
| **TCR (Ω/Ω/°C)** | .00427 | .00672 | .00518 | .00527 | .00527 | $\frac{R_{25}}{R_{125}} = 29.2$ | $\frac{R_{25}}{R_{125}} = 23.5$ |
| **Sensitivity (Average Ω/°C)** | 0.039 | 0.806 | 3.133 | 4.788 | 9.576 | -72 | -287 |
| **Temperature (°C)** | **Resistance (ohms)** | | | | | | |
| -100 | 5.128 | | 372.79 | | | | |
| -80 | 5.923 | 66.60 | 410.73 | | | 1660 K | 3558 K |
| -60 | 6.712 | 79.62 | 452.82 | | | 316.5 K | 845.9 K |
| -40 | 7.490 | 92.76 | 499.06 | | | 75.79 K | 239.8 K |
| -20 | 8.263 | 106.15 | 549.46 | 826.90 | 1653.81 | 21.87 K | 78.91 K |
| 0 | 9.035 | 120.00 | 604.00 | 908.40 | 1816.81 | 7355 | 29.49 K |
| 20 | 9.807 | 134.52 | 660.97 | 995.04 | 1990.09 | 2814 | 12.26 K |
| 40 | 10.580 | 149.79 | 720.79 | 1086.49 | 2172.99 | 1200 | 5592 |
| 60 | 11.352 | 165.90 | 783.45 | 1182.50 | 2365.01 | 560.3 | 2760 |
| 80 | 12.124 | 182.84 | 848.97 | 1282.83 | 2565.66 | 282.7 | 1458 |
| 100 | 12.897 | 200.64 | 917.33 | 1387.21 | 2774.44 | 152.8 | 816.8 |
| 120 | 13.669 | 219.29 | 988.54 | 1495.42 | 2990.84 | 87.7 | 481.8 |
| 140 | 14.442 | 238.85 | 1062.60 | 1607.18 | 3214.37 | 53.0 | 297.2 |
| 160 | 15.217 | 259.30 | 1139.50 | 1722.26 | 3444.54 | | |
| 180 | 15.996 | 280.77 | 1219.26 | 1840.41 | 3680.84 | | |
| 200 | 16.776 | 303.46 | 1301.86 | 1961.38 | 3922.77 | | |
| 220 | 17.555 | 327.53 | | | | | |
| 240 | 18.335 | 353.14 | | | | | |
| 260 | 19.116 | 380.31 | | | | | |

## Resistance/temperature calculations

Most RTD tables follow the Callendar-Van Dusen equation or some variation thereof:

$$R_t = R_0\left[1 + At + Bt^2 + Ct^3\right]$$

where $R_t$ is the resistance at temperature $t$, $R_0$ is the ice point resistance, and $A$, $B$, and $C$ are coefficients describing a given thermometer.

Request Application Aid #18 for a complete set of equations and coefficients for numerical calculation of resistance vs temperature.

## SensorCalc program

RTD and thermocouple tables are available on-line at www.minco.com/sensorcalc. You can create and store tables in a variety of formats. You can also enter resistances and coefficients for custom tables, using Callendar-Van Dusen or ITS-90 equations.

## Thermocouples

| **Junction type:** | **E** Chromel-Constantan (+ Purple, − Red) | **J** Iron-Constantan (+ White, − Red) | **K** Chromel-Alumel (+ Yellow, − Red) | **T** Copper-Constantan (+ Blue, − Red) |
|---|---|---|---|---|
| **Sensitivity (mV/°C):** | 0.063 | 0.053 | 0.041 | 0.043 |
| **Temperature (°C)** | **Millivolts** | | | |
| -200 | -8.824 | -7.890 | -5.891 | -5.603 |
| -150 | -7.279 | -6.499 | -4.912 | -4.648 |
| -100 | -5.237 | -4.632 | -3.553 | -3.378 |
| -50 | -2.787 | -2.431 | -1.889 | -1.819 |
| 0 | 0.000 | 0.000 | 0.000 | 0.000 |
| 50 | 3.047 | 2.585 | 2.022 | 2.035 |
| 100 | 6.317 | 5.268 | 4.095 | 4.277 |
| 150 | 9.787 | 8.008 | 6.137 | 6.702 |
| 200 | 13.419 | 10.777 | 8.137 | 9.286 |
| 250 | 17.178 | 13.553 | 10.151 | 12.011 |
| 300 | 21.033 | 16.325 | 12.207 | 14.860 |
| 350 | 24.961 | 19.089 | 14.292 | 17.816 |
| 400 | 28.943 | 21.846 | 16.395 | 20.869 |
| 450 | 32.960 | 24.607 | 18.513 | |
| 500 | 36.999 | 27.388 | 20.640 | |
| 550 | 41.045 | 30.210 | 22.772 | |

# Specifications for Temperature Sensors

Listed below are national and international specifications for RTDs and thermocouples.

## ANSI-MC96.1-1982

**Issued by:** Instrument Society of America
**Date:** 1982
Sets general standards for thermocouples, including millivolt tables, limits of error, and color coding of wires. All Minco thermocouples conform to this specification.

## BS 1904: 1984

**Issued by:** British Standards Institution
**Date:** 1984
Identical to EN60751.

## DIN 43760

**Issued by:** Deutsches Institut für Normung (Germany)
**Date:** 1987
Specifies resistance curves and tolerance for nickel RTDs. Platinum curves are now covered under EN60751.

## IEC Publication EN60751 (IEC 751)

**Issued by:** International Electrotechnical Commission
**Date:** 1983
IEC 751 has the widest international scope of any RTD standard. It calls for platinum RTDs, 100 Ω at 0°C, TCR 0.00385 Ω/Ω/°C, in one of two tolerance classes:
Class A: ±0.06% at 0°C.
Class B: ±0.12% at 0°C.
All Minco RTDs with PD element code meet Class B. Selected models have Class A as an option.

## ISO 9001: 2000 certified compliant by TÜV Management Services

Minco's Quality assurance system has been audited and certified compliant with this internationally recognized standard.

## ITS-90

**Issued by:** Comité International des Poids et Mesures
**Date**: 1990
ITS-90 is the fundamental definition of temperature itself. It specifies the temperature in Kelvins of various physical constants such as the triple point of water. ITS-90 also names the interpolating instruments to be used between the fixed points. Minco laboratory thermometers in Section 12 meet ITS-90 requirements for resistance ratio and calibration, but do not have the stability required for primary standards. They are suitable, however, for use as secondary transfer standards.

## JIS C 1604-1989

**Issued by:** Japanese Standards Association
**Date:** 1989
Specifies 100 Ω 0.00385 platinum thermometers in accordance with EN60751, but also makes provision for 0.003916 TCR. Minco can supply RTDs to either curve.

## MIL-T-24388C(SH)

**Issued by:** U.S. Naval Sea Systems Command
**Date:** 1990
RTDs and thermocouples for shipboard use. Included are platinum RTDs with 0.00392 TCR and nickel models with 0.00672 TCR. See Section 7 for bearing embedment RTD's qualified to this specification. Minco does not currently offer probe and thermowell models to MIL-T-24388.

## SAMA RC21-4-1966

**Issued by:** Scientific Apparatus Makers Association
**Date:** 1966
Specifies various curves for platinum, nickel, and copper RTDs. The platinum curve, available from Minco, has a resistance of 98.129 Ω at 0°C and TCR of 0.003923. Placing a fixed resistor of 1.871 Ω in series with this element makes it fit the EN60751 curve.

## Quality standards

Minco's quality and inspection systems meet MIL-Q-9858 and MIL-I-45208.

# What is Temperature Coefficient of Resistance (TCR)?

Temperature coefficient differentiates between resistance/temperature curves of RTDs. It is also called alpha ( $\alpha$ ) and may be specified in various ways by different manufacturers.

In this bulletin TCR is the RTD's resistance change from 0 to 100°C, divided by the resistance at 0°C, divided by 100°C:

$$TCR(\Omega/\Omega/^\circ C) = \frac{R_{100^\circ C} - R_{0^\circ C}}{R_{0^\circ C} \times 100^\circ C}$$

For example, a platinum thermometer measuring 100 Ω at 0°C and 139.11 Ω at 100°C has TCR 0.00391 Ω/Ω/°C:

$$TCR = \frac{139.11\,\Omega - 100\,\Omega}{100\,\Omega \times 100^\circ C} = 0.003911$$

For a copper RTD, 10 Ω at 25°C, TCR is:

$$TCR = \frac{12.897\,\Omega - 9.035\,\Omega}{9.035\,\Omega \times 100^\circ C} = 0.00427$$

Stated another way, TCR is the average resistance increase per degree of a hypothetical RTD measuring 1 Ω at 0°C.

The most common use of TCR is to distinguish between curves for platinum, which is available with TCRs ranging from 0.00375 to 0.003927. The highest TCR indicates the highest purity platinum, and is mandated by ITS-90 for standard platinum thermometers.

There are no technical advantages of one TCR versus another in practical industrial applications. 0.00385 platinum is the most popular worldwide standard and is available in both wire-wound and thin-film elements.

In most cases, all you need to know about TCR is that it must be properly matched when replacing RTDs or connecting them to instruments.

# Material Selection Guide

This guide lists the least expensive materials compatible with various corrosive media. The user should also consider unusual temperatures or levels of concentration. Consult Minco for assistance.

| Medium | (°F) | Material |
|---|---|---|
| Acetic acid | 212 | Monel |
| Acetic anhydride | 300 | Nickel |
| Acetone | 212 | 304 SS |
| Acetylene | 400 | 304 SS |
| Alcohols | 212 | 304 SS |
| Alum. (Potassium or sodium) | 300 | Hastelloy C |
| Aluminum chloride | 212 | Hastelloy B |
| Aluminum sulfate | 212 | 316 SS |
| Ammonia, dry | 212 | 316 SS |
| Ammonium hydroxide | 212 | 316 SS |
| Ammonium chloride 50% | 300 | Monel |
| Ammonium nitrate | 300 | 304 SS |
| Ammonium sulfate | 212 | 316 SS |
| Amyl acetate | 300 | 304 SS |
| Aniline | 25 | Monel |
| Asphalt | 250 | 304 SS |
| Atmosphere (industrial and marine) | | 304 SS |
| Barium compounds | *See calcium* | |
| Beer | 70 | 304 SS |
| Benzene | 212 | Steel |
| Benzoic acid | 212 | 316 SS |
| Bleaching powder 15% | 70 | Monel |
| Borax | 212 | Brass |
| Bordeaux mixture | 200 | 304 SS |
| Boric acid | 400 | 316 SS |
| Bromine, dry | 125 | Monel |
| Butane | 400 | Steel |
| Butyric acid | 212 | Hastelloy C |
| Calcium bisulphite | 75 | Hastelloy C |
| Calcium chloride | 212 | Hastelloy C |
| Calcium hydroxide 20% | 300 | Hastelloy C |
| Calcium hypochlorite | *See bleaching powder* | |
| Carbolic acid | *See phenol* | |
| Carbon dioxide, dry | 800 | Brass |
| Carbonated water | 212 | 304 SS |
| Carbonated beverages | 212 | 304 SS |
| Carbon disulfide | 200 | 304 SS |
| Carbon tetrachloride | 125 | Monel |
| Chlorine, dry | 100 | Monel |
| Chlorine, moist | 100 | Monel |
| Chloracetic acid | 212 | Monel |
| Chloroform, dry | 212 | Monel |
| Chromic acid | 300 | Hastelloy C |
| Cider | 300 | 304 SS |
| Citric acid | 212 | Hastelloy C |
| Copper (10) chloride | 212 | Hastelloy C |
| Copper (10) nitrate | 300 | 316 SS |
| Copper (10) sulfate | 300 | 316 SS |
| Copper plating solution (cyanide) | 180 | 304 SS |
| Copper plating solution (acid) | 75 | 304 SS |
| Corn oil | 200 | 304 SS |
| Creosote | 200 | 304 SS |
| Crude oil | 300 | Monel |
| Ethyl acetate | *See lacquer thinner* | |
| Ethyl chloride, dry | 500 | Steel |
| Ethylene glycol (uninhibited) | 212 | 304 SS |
| Ethylene oxide | 75 | Steel |
| Fatty acids | 500 | 316 SS |
| Ferric chloride | 75 | Hastelloy C |
| Ferric sulphate | 300 | 304 SS |
| Formaldehyde 40% | 212 | 316 SS |
| Formic acid | 300 | 316 SS |
| Freon | 300 | Steel |
| Fluorine, anhydrous | 100 | 304 SS |
| Furfural | 450 | 316 SS |
| Gasoline | 300 | Steel |
| Glucose | 300 | 304 SS |
| Glue, pH 6-8 | 300 | 304 SS |
| Glycerine | 212 | Brass |
| Hydrobromic acid | 212 | Hastelloy C |
| Hydrochloric acid 37-38% | 225 | Hastelloy B |
| Hydrogen chloride, dry | 500 | 304 SS |
| Hydrocyanic acid | 212 | 304 SS |
| Hydrofluoric acid 60% | 212 | Monel |
| Hydrogen fluoride, dry | 175 | Steel |
| Hydrofluogilicic acid 40% | 212 | Monel |
| Hydrogen peroxide 10-100% | 125 | 304 SS |
| Kerosene | 300 | Steel |
| Lacquers & thinners | 300 | 304 SS |
| Lactic acid | 300 | 316 SS |
| Lime | 212 | 316 SS |
| Linseed oil | 75 | Steel |
| Magnesium chloride 50% | 212 | Nickel |
| Magnesium hydroxide (or oxide) | 75 | 304 SS |
| Magnesium sulphate 40% | 212 | 304 SS |
| Mercuric chloride 10% | 75 | Hastelloy C |
| Mercury 100% | 700 | Steel |
| Methylene chloride | 212 | 304 SS |
| Methyl chloride, dry | 75 | Steel |
| Milk, fresh or sour | 180 | 304 SS |
| Molasses | *See glucose* | |
| Natural gas | 70 | 304 SS |
| Nitric acid | 75 | 304 SS |
| Nitric acid | 300 | 316 SS |
| Oxygen | 75 | Steel |
| Oleic acid | *See fatty acids* | |
| Oxalic acid | 212 | Monel |
| Photographic bleaching | 100 | 304 SS |
| Palmitic acid | *See fatty acids* | |
| Phosphoric acid | 212 | 316 SS |
| Phenol | 212 | 316 SS |
| Potassium compounds | *See sodium compounds* | |
| Propane | 300 | Steel |
| Rosin 100% | 700 | 316 SS |
| Sea water | 75 | Monel |
| Soap & detergents | 212 | 304 SS |
| Sodium bicarbonate 20% | 212 | 316 SS |
| Sodium bisulphite 20% | 212 | 304 SS |
| Sodium bisulphate 20% | 212 | 304 SS |
| Sodium carbinate 40% | 212 | 316 SS |
| Sodium chloride 30% | 300 | Monel |
| Sodium chromate | 212 | 316 SS |
| Salt or brine | *See sodium chloride* | |
| Sodium cyanide | 212 | 304 SS |
| Sodium hydroxide 30% | 212 | 316 SS |
| Sodium hypochlorite 10% | 75 | Hastelloy C |
| Sodium nitrate 40% | 212 | 304 SS |
| Sodium nitrite 20% | 75 | 316 SS |
| Sodium phosphate 10% | 212 | Steel |
| Sodium silicate 10% | 212 | Steel |
| Sodium sulfide 30% | 212 | 316 SS |
| Sodium sulfite 10% | 212 | 316 SS |
| Sodium sulfate 30% | 212 | 304 SS |
| Sodium thiosulfate | 212 | 304 SS |
| Steam | | 304 SS |
| Stearic acid | *See fatty acids* | |
| Sugar solution | *See glucose* | |
| Sulfur | 500 | 304 SS |
| Sulfur chloride, dry | 75 | 316 SS |
| Sulfur dioxide, dry | 500 | 316 SS |
| Sulfur trioxide, dry | 500 | 316 SS |
| Sulfuric acid 10% | 212 | 316 SS |
| Sulfuric acid 10-90% | 212 | Hastelloy B |
| Sulfuric acid 90-100% | 212 | 316 SS |
| Sulfuric acid, fuming | 175 | Hastelloy C |
| Sulfurous acid 20% | 75 | 316 SS |
| Titanium tetrachloride | 75 | 316 SS |
| Tannic acid 40% | 75 | Hastelloy B |
| Toluene | 75 | Steel |
| Trichloracetic acid | 75 | Hastelloy B |
| Trichloroethylene, dry | 300 | Monel |
| Turpentine | 75 | 316 SS |
| Varnish | 150 | Steel |
| Zinc chloride | 212 | Hastelloy B |
| Zinc sulfate | 212 | 316 SS |

# Sensor Selection Guide

| Sensor Type | Description | Temperature Range* | RTD Element | | | | Thermocouple Junction | | | | Thermistors |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Platinum | Copper | Nickel | Nickel-Iron | E | J | K | T | |
| Assemblies | Probes supplied complete with fittings, connection heads, thermowells, and optional transmitters | -269 to 550°C (-452 to 1022°F) | ● | ● | ● | | ● | ● | ● | ● | |
| Probes | Industrial probe type sensors: tip-sensitive, fast response, and high temperature models | -269 to 850°C (-452 to 1562°F) | ● | ● | ● | | ● | ● | ● | ● | |
| Sanitary RTDs | 3-A certified for clean-in-place installations | -100 to 200°C (-148 to 392°F) | ● | | | | | | | | |
| Bearing Detectors & Miniature RTDs | Miniature encased sensing elements | -184 to 260°C (-300 to 500°F) | ● | ● | ● | | ● | ● | ● | ● | |
| Stator Winding Detectors | Flat, laminated "stick" sensors | 180°C (356°F) max. | ● | ● | ● | | ● | ● | ● | ● | |
| HVAC Thermometers | Sensors and transmitters designed for HVAC systems | -45.5 to 135°C (-50 to 275°F) | ● | | | ● | | | | | ● |
| Thermal-Ribbons™ | Flat, flexible sensors for surface mounting | -200 to 200°C (-328 to 428°F) | ● | ● | ● | ● | ● | ● | ● | ● | ● |
| Ceramic Elements | Wire-wound and thin-film elements | -200 to 850°C (-328 to 1582°F) | ● | | | | | | | | |
| Precision Laboratory Thermometers | Reference grade platinum thermometers | -260 to 660°C (-436 to 1220°F) | ● | | | | | | | | |

* Temperature range of individual models may vary.

# Miscellaneous specifications and codes

## Thread specifications

| Thread | Applicable specifications |
|---|---|
| ISO 228/1 - G½ | •DIN 259<br>•BS 2779<br>•JIS B0202 |
| ISO 7/1 R¼<br>ISO 7/1 R⅛ | •DIN 2999<br>•BS 21<br>•JIS B0203 |

## Wire gauge conversion

| Wire Gauge Number AWG | Cross Sectional Area mm² | | Resistance Ω/ft. at 25°C |
|---|---|---|---|
| | Stranded | Solid | |
| 30 | 0.057 | 0.051 | 0.1058 |
| 28 | 0.089 | 0.080 | 0.0666 |
| 26 | 0.141 | 0.128 | 0.0418 |
| 24 | 0.227 | 0.205 | 0.0262 |
| 22 | 0.355 | 0.324 | 0.0165 |
| 20 | 0.563 | 0.519 | 0.0103 |
| 18 | 0.897 | 0.823 | 0.0065 |

## Ingress Protection (IP) Codes

| | First Number<br>Protection against solid bodies | Second Number<br>Protection against liquid |
|---|---|---|
| 0 | No protection | No protection |
| 1 | Objects > 50 mm | Vertically dripping water |
| 2 | Objects > 12 mm | 75° to 90° dripping water |
| 3 | Objects > 2.5 mm | Sprayed water |
| 4 | Objects > 1 mm | Splashed water |
| 5 | Dust-protected | Water jets |
| 6 | Dust-tight | Heavy seas |
| 7 | | Effects of immersion |
| 8 | | Indefinite immersion |

| Approximate US Enclosure Type Equivalent to IPXX | | | | | |
|---|---|---|---|---|---|
| Type | IP | Type | IP | Type | IP |
| 1 | 10 | 3S | 54 | 6 & 6P | 67 |
| 2 | 11 | 4 & 4X | 55 | 12 & 12K | 52 |
| 3 | 54 | 5 | 52 | 13 | 54 |
| 3R | 14 | | | | |

# Related Literature

## Temperature sensors

**Application Aid #16**
"Use of Thermal-Ribbons for Pipe Fluid Temperature Sensing"

Compares surface-mounted Thermal-Ribbons to traditional thermowell assemblies. 4 pages.

**Application Aid #18**
"Resistance Thermometry"

Discusses theory and application of RTDs and thermistors. Includes information on 3 and 4-wire circuits, plus equations for calculating resistance from temperature. 16 pages.

**Application Aid #19**
"Use of Temperature Sensors In Hazardous Areas"

Classification of hazardous atmospheres and specification of Minco sensors for explosion-proof, intrinsically safe, and non-incendive installations. 8 pages.

**Application Aid #20**
"Installation Guidelines: Resistance Thermometers and Temptran Thermometers for Energy Management and Control Systems"

Installation drawings and procedures for HVAC sensors. 8 pages.

**Application Aid #27**
"Sealing Sensor Leads Against Oil Leakage"
Discusses the problems of oil seepage and various solutions. 2 pages.

**Bulletin STD-5**
"Increased Safety Stator Winding Temperature Sensors"
CENELEC/ATEX approved stator sensors for use in hazardous areas. 2 pages.

**SensorCalc program**
"SensorCalc" is Minco's on-line program for calculating, printing and saving resistance vs. temperature or millivolt vs. temperature tables. It provides standard RTD and thermocouple choices, with the option of customizing the table to meet your specific needs. Print the table directly or convert it to an Adobe Acrobat .pdf file for storage or sending by e-mail. Go to www.minco.com/sensorcalc.

## Temperature instruments

**Bulletin CT124**
The CT124 8-channel alarm, a programmable monitor for protection of large machinery. 4 pages.

**Bulletin CT198**
CT198 Heaterstat sensorless temperature controller for use with Thermofoil heaters. 4 pages.

**Bulletin CT325**
Miniature DC temperature controller for use with Thermofoil heaters and RTD or thermistor sensors. 2 pages.

## Thermofoil heaters

**Bulletin HS-202**
Flexible, etched-foil and wire-wound precision heating elements, as well as controllers and accessories. Includes listing of standard models and specifications, plus a custom design guide. 60 pages.

**Bulletin HS-2**
Thermal-Clear transparent heaters and heater/sensors for LCD's and other applications. 4 pages.

**Bulletin HR-2**
Wire-wound silicone rubber heaters for condensation prevention and other applications. 6 pages.

**Application Aid #22**
Recommended Adhesives for Thermofoil Heater Installation describes many alternatives for mounting Minco Thermofoil heaters to optimize the heat transfer, life and efficiency of the heating system. 4 pages.

## Flex-Circuits

**Bulletin FC-301**
Flex-circuits and rigid-flex circuits for high-reliability, high density electronics packaging. 8 pages.

**Application Aid #24**
The "Flex-Circuit Design Guide" assists in the design of reliable, producible flexible circuits. 28 pages.

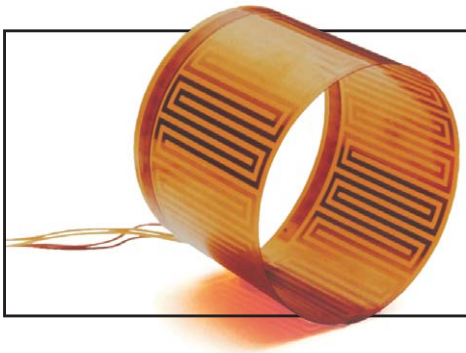
**Bulletin FC-1**
"Flex Coils" describes Minco's unique laminated coils for high reliability telemetry in implantable medical devices, guidance systems and other applications. 4 pages.

**Bulletin FC-4**
"Minco/Omnetics flex-circuit interconnect solutions" describes the fusion of Minco's state-of-the-art flex-circuit production with high reliability, high density connectors from Omnetics. 1 page.

# Part Number Index

# Subject Index

# Other Minco Products

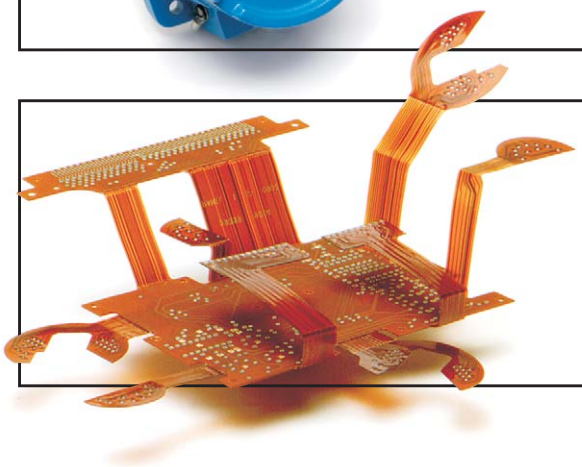


## Thermofoil™ heaters

- Flexible etched-foil heating elements
- Polyimide, polyester, silicone rubber, mica insulation
- Precise heat, uniform or profiled
- UL, NASA qualified models
- Complete subassemblies with heat sinks, temperature sensors, thermostats, and connectors


## Temperature instruments

- PID, proportional, and on/off controllers
- Handheld and panel mount readouts
- Programmable temperature alarms
- Custom instruments for OEM's
- Loop-powered indicators



## Flex-circuits

- Single, double, multilayer, and rigid-flex
- MIL-P-50884C qualified, Types 1 through 5
- High density: 0.003" lines and spaces
- Stiffeners, integral wire wound coils

### A history of meeting needs

Minco was established in 1956 as an engineering firm manufacturing electromechanical instruments. In 1958 the company began to develop precision wire-wound temperature sensors for aerospace guidance systems, followed by the world's first etched-foil heating elements in 1960. Minco soon expanded from aerospace into industrial markets and gained a large customer base. The 1970's saw the introduction of flex-circuits, first used in medical devices, and temperature instruments for use with sensors and heaters.

### Minco today

Minco now has more than 700 employees serving 3000 customers worldwide, while 50 sales representative offices in the U.S. provide field assistance. Annual sales exceed $60 million. Facilities include three plants in Minnesota totaling 230,000 square feet plus a manufacturing center in France and a technical support office in Switzerland.

Minco is the nation's leading producer of such diverse products as temperature sensors for machinery protection, transmitters for energy management, heaters for avionics, and flex-circuits for medical implants.

### People make the difference

Minco's most important asset is an informed and involved work force. Personnel turnover is low, and the company sponsors both in-plant and outside training programs to foster personal growth and job knowledge. Incentive programs and open communications encourage efficiency and continuous improvement of product quality. You'll find that all Minco employees – in customer service, production, engineering, and quality assurance – have the knowledge and desire to serve your needs.

**MINCO**
**ISO 9001: 2000**

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