



**TT176, TT216, and TT676  
2-wire Temperature Transmitters  
Installation and Operation Instructions**



**INTRINSICALLY SAFE  
NON-INCENDIVE**



## **Description**

Models TT176, TT216, and TT676 are 2-wire temperature transmitters for RTD (resistance temperature detector) thermometers. These transmitters are FM-approved for use in Class I, Divisions 1 & 2, Groups A, B, C, and D hazardous locations and appear in the approval guide as IS/I/1/ABCD and NI/I/2/ABCD. The Temptran™ converts the RTD's signal into a 4 to 20 mA current. The current changes according to the range marked on the Temptran: 4 mA at the lowest temperature of the range, rising to 20 mA at the top of the range. The leads that supply power also carry the current signal.

## Installation

If installing the Temptran in a hazardous location, the installer must adhere to installation requirements as set forth by the National Electrical Code (NEC) and any other applicable codes and standards. Refer to pages 3-7 for further information on installing these transmitters in a hazardous location.

Locate the Temptran near the RTD, in an area where the ambient temperature stays between -40 and 85°C (-40 and 185°F). Mount with #8 machine screws using the two mounting holes provided in the transmitter case.

Connect the Temptran as shown in Figure 1, observing the +/- polarity of the current loop. Maximum DC supply voltage = 35 VDC. The RTD connections for the Temptran in the wiring diagram below must be connected as shown or the transmitter will not function properly.

For models TT176 and TT676, the Temptran has been factory-calibrated for its marked temperature range or else for a specific RTD. Do not change its zero and span adjustments.

## Wiring Diagram

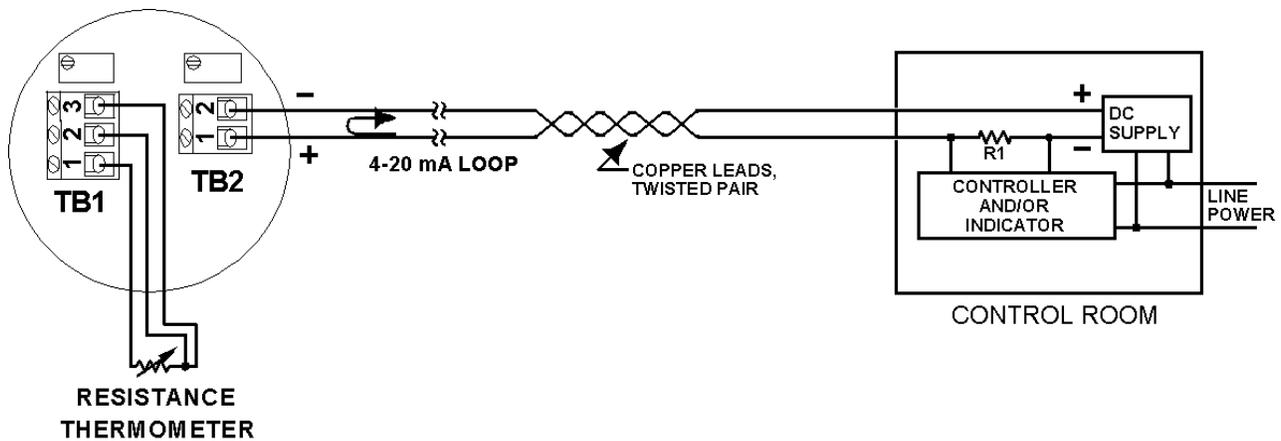


Figure 1

**Installation** of TT176, TT216, and TT676 Temptrans™ in Class I, Divisions 1 or 2, Groups A, B, C, and D hazardous locations.

Read these instructions thoroughly before installing transmitters in a hazardous area.

Per Factory Mutual,

- 1) Installation shall be in accord with these instructions and the National Electric Code.
- 2) If installing transmitters in a Class I, Division 1 hazardous area, then refer to Minco INST. 704, "Control Document, System Approvals For Intrinsically Safe Transmitters" on pages 5-7 of this manual. The Simple Apparatus referenced in these pages is the RTD temperature sensor.
- 3) If installing transmitters in a Class I, Division 2 hazardous area, then the transmitters must be mounted in a vent-free enclosure, meeting the "Electrical Utilization Enclosure Requirements" stated below with which only the Approved equipment will be installed. All unused openings should be sealed.
- 4) Tampering and replacement with non-factory components may adversely affect the safe use of the system.

## Electrical Utilization Enclosure Requirements (Required for Division 2 areas only)

1. Each of the transmitters must be mounted within an enclosure to prevent personal injury resulting from accessibility to live parts. This enclosure must comply with the requirements listed below. Further details of the enclosure requirements may be found in ANSI/ISA Standards S82.01, S82.02, and S82.03.
  - 1.1 Accessibility - The transmitters must be installed within the enclosure so that its circuits are accessible by the use of a tool only. A part is accessible when a) the IEC articulate accessibility probe applied in every possible position to the exterior or exposed surfaces, including the bottom, or b) the IEC rigid accessibility probe applied with a maximum force of 30 Newtons (6.75 lbs force) in every possible position to the exterior or exposed surface, including the bottom, touches the part.
  - 1.2 Protection From Fire - If the enclosure is non-metallic, it shall have the proper flammability rating as detailed within ANSI/ISA Standard S82.01.
  - 1.3 Grounding - A metallic enclosure must have a protective grounding terminal and be marked as such. The size of the ground terminal is to be equivalent to the size of the supply circuit conductor terminals. All accessible non-current conductive parts must be bonded to the protective grounding terminal.
  - 1.4 General Construction - The equipment enclosure, or parts of the enclosure, required to be in place to comply with the requirements for protection from electric shock, personal injury, protection from internal parts and wiring, and external cord and cable assembly strain relief shall comply with the following tests for mechanical strength:
    - a. Impact Tests - The equipment shall be held firmly against a rigid support and shall be subjected to sets of three blows from a spring-operated impact hammer. The hammer shall be applied to any external part that when broken is likely to expose live parts. A window of an indicating device shall withstand an impact of 0.085 Newton-meter (0.753 pound force-inch) from a hollow steel impact sphere 50.8 mm (2 inches) in diameter and an approximate mass of 113.4 grams (4 ounces).
    - b. Pressure Tests - A force of 90 Newtons (20 pounds) shall be applied from a metal rod 12.7 mm (.50 inch) in diameter, the end of which is rounded. The force shall be applied for one minute to any point on the overall enclosure except the bottom. The bottom shall sustain a force of 65 Newtons (15 pounds).
    - c. Tip Stability Test - Equipment having a weight of 11 kilograms (24 pounds) or more shall not tip over when placed at the center of an inclined plane that makes an angle of 10 degrees with the horizontal and then turned to the position (with all doors, drawers and other openable and sliding parts in the least stable position) most likely to cause tip-over.
    - d. Sharp Edges - An accessible edge, projection, or corner of an enclosure, opening, frame, guard, handle, or the like shall be smooth and well rounded, and shall not cause a cut-type injury during normal use of the equipment.

**REVISIONS**

REV.	DESCRIPTION	DATE	ECO	APP.
A	Added notes 2-8, was INST 702(-), added "simple apparatus" notes	6/14/93	10344	MWG

**INST. 704(A)**

**Control Document, System Approvals for Intrinsically Safe Transmitters**

The approved entity parameters specified are for Class I, Div. 1 Groups A, B, C, and D hazardous locations.

Models TT210, TT211, <u>TT710, TT711</u> Vmax = 35 volts Imax = 150 mA Ci = 0 µF Li = 0 mH	Models TT176, TT216, TT676 <u>TT190, TT230</u> Vmax = 35 volts Imax = 150 mA Ci = 0 µF Li = 0 mH	Models <u>TT220, TT221, TT720</u> Vmax = 35 volts Imax = 150 mA Ci = 0 µF Li = 0 mH
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ANY CHANGES TO THIS  
DRAWING MUST BE  
PREAPPROVED BY FACTORY  
MUTUAL PER INST. 695

1. The selected associated apparatus and intrinsically safe apparatus must meet the following conditions for single channel operation:

$$\begin{aligned} V_{oc} &\leq V_{max} \\ I_{sc} &\leq I_{max} \\ C_a &\geq C_i \\ L_a &\geq L_i \end{aligned}$$

2. The selected associated apparatus and intrinsically safe apparatus must meet the following conditions for dual channel or multiple single channel operation:

$$\begin{aligned} V_t &\leq V_{max} \\ I_t &\leq I_{max} \\ C_a &\geq C_i \\ L_a &\geq L_i \end{aligned}$$

3. Voc, Vt, Isc, It, Ca and La are parameters of the associated apparatus where:

Voc, Vt = maximum open circuit voltage  
Isc, It = maximum short circuit current  
Ca = maximum allowable connected capacitance  
La = maximum allowable connected inductance

4. Vmax, Imax, Ci and Li are parameters of the intrinsically safe apparatus where:

Vmax = maximum safe input voltage  
Imax = maximum safe input current  
Ci = maximum unprotected internal capacitance  
Li = maximum unprotected internal inductance

5. Installation must be in accordance with the barrier manufacturers instructions, ANSI/ISA RP12.6 and the National Electrical Code (ANSI/NFPA 70).

6. Control room equipment connected to the associated apparatus must not contain a source of potential with respect to earth in excess of 250 Vrms or 250 Vdc.

7. Associated apparatus is not required for operation in Division 2 hazardous (classified) locations.

8. For Division 2 installations, the transmitters must be mounted within an enclosure meeting the requirements of ANSI/ISA S82.

DR: <u>TPB</u>	CHK: <u>MWG</u>	APP: <u>DKS</u>
DATE: <u>05/04/93</u>	DATE: <u>05/05/93</u>	DATE: <u>05/05/93</u>
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Any of the listed intrinsic safety barriers are Factory Mutual approved under the system concept (single barrier only) for use with any of the following Minco Tempran™ 4-20mA transmitter models:

TT176, TT190, TT210, TT211, TT216, TT220, TT221, TT230, TT676, TT710, TT711, TT720

For use in Class I, Division 1, Groups A, B, C, D hazardous locations.

Barrier Manufacturer

Barrier Model

MTL  
(Manassas, VA  
703-361-0111)

702+, 706+, 787S+, 788+, 2441,  
3041, 3046B, 4041

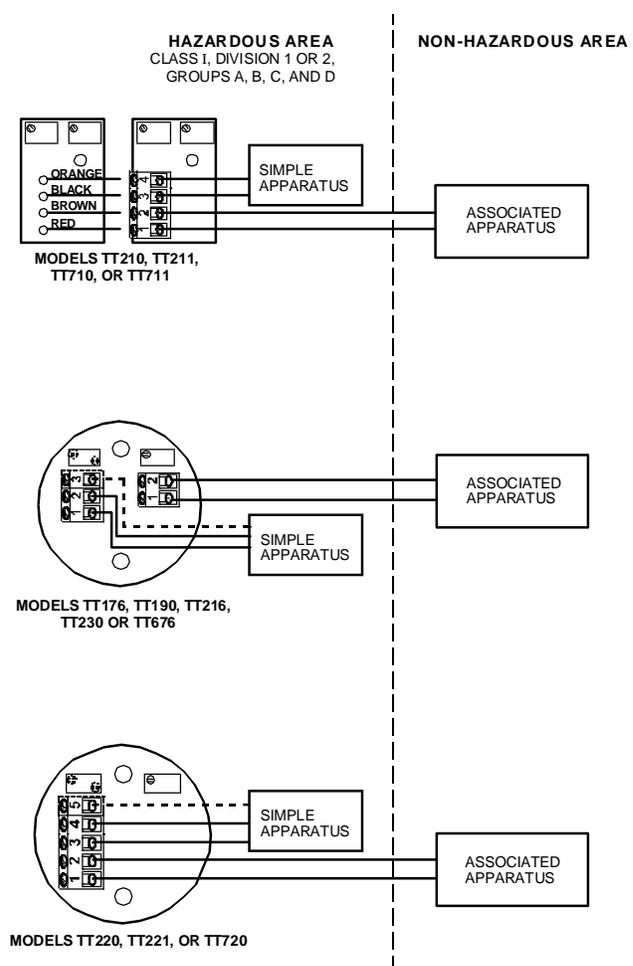
R. Stahl  
(Woburn, MA  
800-782-4357)

9001/01-280-100-10, 9001/51-280-091-14,  
9001/51-280-110-14, 9002/13-280-110-00

Pepperl & Fuchs  
(Twinsburg, OH  
216-425-3555)

KHD3-ICR/EX130 200, KHD3-ICR/EX130 240, KHP-103/EX-1A,  
KHP-104/EX-2A, KHP-105/EX-2A, KHZ-428/EX3, KHZ-487/EX3,  
KHZ-907/EX, Z130/EX, Z428/EX, Z479/EX, Z487/EX

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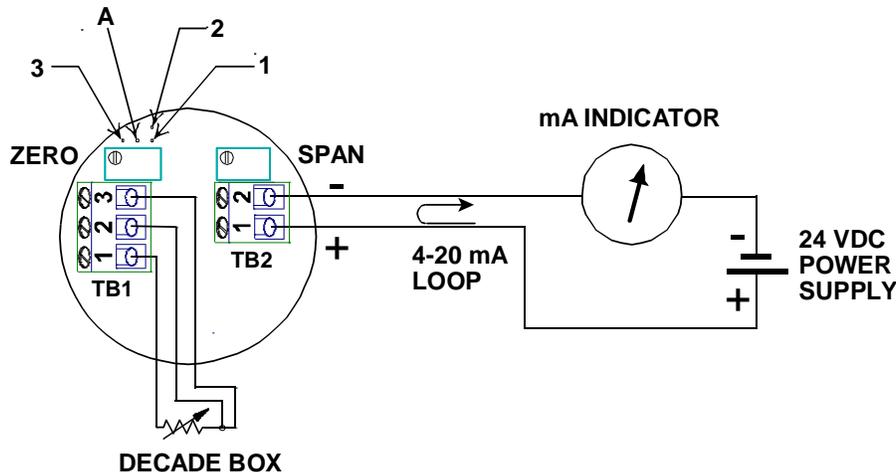
## Calibration

**NOTE: Steps 1 - 3 are only required if calibrating model TT216. If calibrating models TT176 or TT676, then skip to Step 4.**

1. Desired Zero (4 mA) temperature must be within the limits specified in table below for the temperature range (RA, RB, RC, or RD) being calibrated.
2. Select desired span from the table. Temperature Span equals the desired temperature at 20 mA minus the desired temperature at 4 mA. For example, if a range of -50 to 200 °C is desired, then span = 200 - (-50) = 250 °C. Assuming a 100 ohm Platinum RTD input, calibration to this temperature range requires a model TT216PX1RC (last 2 letters of model number designate the temperature range), since RC is the only range that will handle a 250 °C temperature span.

Temperature Span				
Sensor:	100 ohm Platinum			10 ohm Copper
Connect:	RA range	RB range	RC range	RD range
1 – A	25 to 35°C	50 to 70°C	150 to 200°C	100 to 150°C
2 – A	35 to 50°C	70 to 100°C	200 to 300°C	150 to 300°C
3 – A	50 to 100°C	100 to 200°C	300 to 600°C	
Zero (4mA):	-25 to 25°C	-50 to 50°C	-100 to 200°C	-100 to 100°C

3. Bend over the lead designated 1, 2, or 3, depending on selection from table, to the A lead and solder. See Figure 2 below. For the above example, lead 2 should be soldered to lead A.



**Figure 2**

4. Connect a power supply of 24 VDC, and a digital milliammeter (5-1/2 digit preferred) as shown in Figure 1, or use a loop calibrator instead of the DC supply and milliammeter.

**NOTE:** For the TT176 and TT676, Zero and Span resistance values are printed on the transmitter's label. For model TT216, refer to an R vs. T chart for the desired element type.

5. Connect a resistance decade box with a resolution of at least .01 ohms to the input of the transmitter. If unsure or concerned about the decade box's accuracy, measure the zero and span

resistance settings using a known-accurate ohmmeter and record decade box settings before connecting decade box to the transmitter.

6. Set decade box resistance to simulate the 4 mA temperature. For the given example, the decade box resistance should be set to simulate -50 °C.
7. Adjust ZERO potentiometer on the transmitter until the meter reads 4 mA.
8. Set decade box resistance to simulate the 20 mA temperature. For the given example, the decade box resistance should be set to simulate 200 °C.
9. Adjust SPAN potentiometer on the transmitter until the meter reads 20 mA.
10. For model TT216, repeat steps 6 - 9 until no further adjustment is necessary. Models TT176 and TT676 have non-interacting Zero and Span adjustments; therefore, Steps 6 - 9 should not have to be repeated. However, it is recommended that Step 6 be repeated to check that the meter still reads 4 mA to ensure proper calibration

### How to Order

TT176	<b>Model Number:</b> TT176 RTD Temptran TT676 Temptran calibrated to a specific RTD TT216 Rangeable RTD Temptran
PD	<b>Calibrated to match RTD Element Code:</b> <b>TT176/TT676 only</b> CA = 10 Ω copper (.00427) PA = 100 Ω platinum RTD (.00392) PB = 100 Ω platinum RTD (.00391) PD = 100 Ω platinum RTD (.00385, meets DIN 43760, Class B) PE = 100 Ω platinum RTD (.00385) <b>TT216 only</b> CA = 10 Ω copper (.00427) PX = 100 Ω platinum (.00392 (PA), .00391 (PB), and .00385 (PD, PE) TCRs)
1	<b>Output:</b> 1 = 4 to 20 mA DC.
C	<b>Temperature Range:</b> Use one of the over 175 range codes in the Minco Temptran sales bulletin. Note: A range that is available for a particular Temptran model is not automatically available for the TT176/TT216/TT676; there may be a nominal charge.
TT176PD1C ← Sample Part Number	

## Specifications

<b>Input:</b>	10 ohm copper or 100 ohm platinum RTDs.
<b>Output:</b>	4 to 20 mA DC over specified range.
<b>Accuracy:</b>	TT176: $\pm 0.1\%$ of span. TT216: $\pm 0.2\%$ of span when factory calibrated.
<b>Linearity:</b>	TT176: $\pm 0.1\%$ of span. TT216: $\pm 0.2\%$ of span.
<b>Ambient temperature:</b>	Operating: $-40$ to $85$ °C ( $-40$ to $185$ °F). Storage: $-55$ to $100$ °C ( $-67$ to $212$ °F).
<b>Ambient temperature effects:</b>	TT176/TT676: $\pm 0.009\%$ of span/°C. $\pm 0.018\%$ of span/°C for spans less than 10 ohms. TT216: $\pm 0.013\%$ of span/°C.
<b>Adjustments:</b>	TT176/TT676: Zero and Span, $\pm 5\%$ of span. TT216: Depends on temperature range selected.
<b>Warmup drift:</b>	$\pm 0.1\%$ of span max., assuming $V_{\text{supply}} = 24$ VDC and $R_{\text{loop}} = 250$ ohms. Stable within 30 minutes.
<b>Supply voltage:</b>	10 to 35 volts DC with no load. Reverse polarity protected.
<b>Voltage effect:</b>	$\pm 0.001\%$ of span per volt.
<b>Maximum load resistance:</b>	The maximum allowable resistance of the signal-carrying loop is given by this formula: $R_{\text{loop max}} = (V_{\text{supply}} - 10) / .02$ amps.
<b>Maximum output current:</b>	27 mA.
<b>Connections:</b>	Terminal blocks for wires from AWG 22 to AWG 14.
<b>Physical:</b>	Epoxy potted for moisture resistance.
<b>Weight:</b>	1.8 oz. (58 grams).

## Warranty

Items returned within one year from the date of sale, transportation prepaid, which Minco Products, Inc. (The "Seller") reasonably determines to be faulty by reason of defective materials or faulty workmanship will be replaced or repaired at the Seller's discretion, free of charge.

This remedy is to be the sole and exclusive remedy available to the buyer in the event of a breach by the Seller. Items that show evidence of mishandling or misapplication may be returned by the Seller at the customer's expense.

Furthermore, the Seller is not to be held responsible for consequential damages caused by its product except as required under Minnesota Statutes, Section 336.1-719 (3).

This warranty is expressly in lieu of any other expressed warranty or implied warranty of merchantability or fitness for a particular purpose, and of any other obligations or liability on the part of the Seller or its employees or agents.

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