MINCO Temptran[TM]

Field and Bench Calibration

- Applies to Temptran models: **TT110, TT111, TT115, TT160, TT176, TT210, TT211, and TT220**.

- Applies to matched-calibrated Temptran models: **TT150, TT151, TT155, TT200, TT676, TT710, TT711, and TT720**. These have been calibrated to individual sensors to remove the sensor tolerances, resulting in higher system accuracies.

Depending upon accuracy requirements, two calibration procedures are described in this manual. The first method described improves the accuracy of the Temptran at a single temperature within the temperature range, while possibly degrading accuracy at the zero and/or span temperatures.[1] Accuracies of 0.2% of span or better are possible, but are very dependent on the accuracies of the equipment and measurement techniques used.

The second method, bench calibration, will enable you to calibrate your Temptran to within 0.2% of span over the full Temptran range. This method takes into account the basic accuracy of the Temptran, and its warm-up drift. Total system accuracy is the sum of the Temptran's accuracy and the RTD's[2] accuracy. The RTD's accuracy must include the RTD's tolerance and drift specifications. However, calibrating a Temptran to a specific RTD effectively removes RTD tolerance from system accuracy specifications, resulting in a better system accuracy.

In the calibration instructions below, be aware that getting good accuracy is very difficult.
BE ABSOLUTELY POSITIVE THAT THE TEMPTRAN NEEDS CALIBRATION.   The accuracy specifications of voltmeters, current meters, and temperature meters may be as poor as ±0.5% of reading, which is five times worse than the Temptran's ±0.1% factory calibration accuracy. It is best to calibrate using instruments whose accuracies are five to ten times better than that of the Temptran's. This should minimize the cumulative errors.

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[1]   The zero and span temperatures are, respectively, the lowest and highest temperatures of the Temptran range. They are denoted as T_{ZERO} and T_{SPAN}. These have a different meaning from the term temperature span. Temperature span is the number of degrees, or the difference, between the span and zero temperatures.

[2]   RTD – Resistance Temperature Detector. An RTD is a resistor whose resistance changes with temperature.

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MINOR CALIBRATION OF A TEMPTRAN WITH A FEW DEGREES OF ERROR

Equipment needed:
- Portable temperature meter.
- A Hewlett Packard 3468A 5½ Digit multimeter or equivalent.
- A small screwdriver to make adjustments to the zero and span screws.

Procedure:
1. Connect a current meter in series with the 4-20 mA loop. See Figure 1.
2. Measure the temperature at the sensor and calculate what the current from the transmitter should be using the following formula:

$$\text{Current at } T_{SENSOR} = \left(\frac{T_{SENSO} - T_{ZERO}}{T_{SPAN} - T_{ZERO}} * 16mA \right) + 4mA$$

Example calculation:
Temptran range is 40 to 90°F. You measure the room temperature as 72°F.

Temperature span	= 90° - 40°	= 50 °F
Current span	= 20° - 4	= 16 mA

$$\text{Current at } 72° F = \left(\frac{72° - 40°}{90° - 40°} \right) + 4\,mA = 14.24\,mA$$

Turn the Zero pot of the Temptran (it is marked on the label, or see Figure 1) until the transmitter's current reading matches what you calculated.

Notes:
1) The zero pot's adjustment is limited to about ±5% of span.
2) A change in the Zero setting affects the whole temperature range; that is, if you increase the Zero by 2 degrees, you have increased every other reading by approximately 2 degrees.

BENCH CALIBRATION TO HIGHER ACCURACY OF ±0.2% OF SPAN

Equipment needed:
- A small screwdriver to make adjustments to the zero and span screws.
- Two decade boxes with milliohm resolution.
- A Hewlett Packard 3468A 5½ Digit multimeter or equivalent.
- DC power supply.
- R_{SENSE} resistor, see text for accuracy and value.

Procedure:

1. Set up the measurement system as follows:
   a. The current loop sensing resistor, R_{SENSE}, should be a 100Ω precision resistor to

eliminate tolerance and temperature drift errors. The resistor should have a tolerance of ±0.01% and a temperature coefficient (TC) of 10 ppm/°C or less. Use the 4-wire measurement mode (Kelvin connection) on your ohmmeter to verify that the resistor is within the range of 100Ω ± 0.010Ω (99.990 to 100.010Ω).

b. It is best to use a supply voltage that the Temptran will see during normal operation (typically, 24 VDC). This will minimize self-heating and supply voltage effects. However, make sure there is sufficient supply voltage so the current loop functions properly.

c. Set each decade box to one of the two resistances printed on the side of the Temptran. Measure the resistance from the ends of the leadwires attached to the decade box using a Kelvin connection. Adjust the decade boxes as necessary to achieve the correct resistances. The setting numbers may not match the exact resistance, so make a note of the box settings if necessary.

Notes:
1) Models **TT110, TT111, TT115, TT160, TT176, TT210, TT211,** and **TT220** use nominal RTD resistances. The two resistance values are printed on the Temptran's label or found in a resistance vs. temperature table available from Minco. When using nominal (ideal) resistance figures, your calibration ignores the interchangeability tolerance from one RTD to the next.

2) Models **TT150, TT151, TT155, TT200, TT676, TT710, TT711,** and **TT720** use each RTD's unique zero and span resistances which are printed on the Temptran's label. Because each transmitter of this type has been factory-calibrated to one specific RTD sensor, the RTD's are not interchangeable. Make sure to keep the same transmitter with the same sensor. To assist you, a matching number has been placed on both the Temptran and the RTD.

Option:
Instead of using the resistances printed on the side of the Temptran, you can measure the resistance of the RTD in a temperature bath at the Zero and Span temperatures. Then, use these resistances where you would have used the label resistances. The temperature of the bath and the resistance readings of the RTD's must be made carefully and exactly.

2. Wire up the calibration setup as shown in Figure 1.

3. Switch to the decade box which is providing the 4 mA (Zero) resistance and adjust the Temptran's Zero adjustment screw. The location of the two screws is marked on the label on the side of the transmitter. Adjust the screw until the voltmeter reads 0.40000 ±0.00320 volts (0.39680 to 0.40320 volts).

4. Switch to the decade box which is providing the 20 mA (Span) resistance and adjust the Temptran's Span adjustment screw until the voltmeter reads:

2.00000 ±0.00320 volts (1.99680 to 2.00320 volts).

5. Repeat these steps two or three times until unit is calibrated at both points.

6. Give the unit a light rap on the table to seat the pots. Check both the zero and span again; repeat calibration as necessary
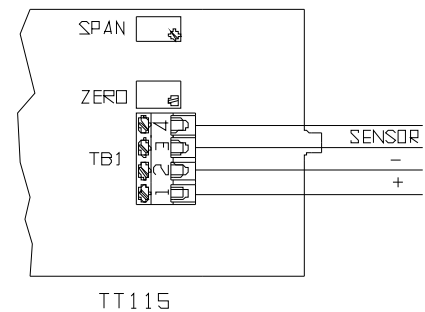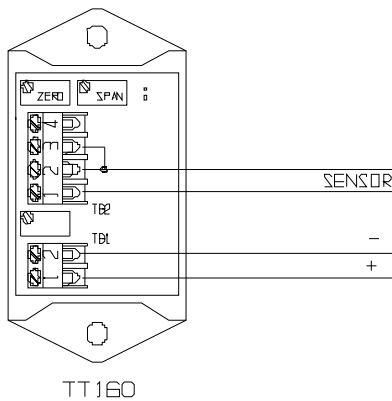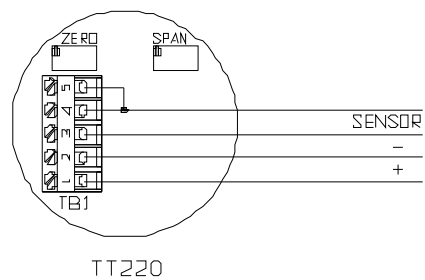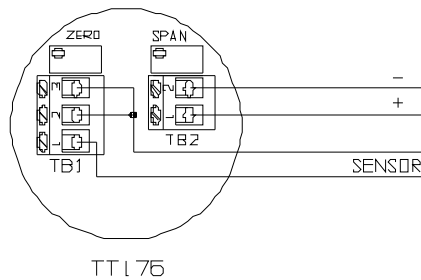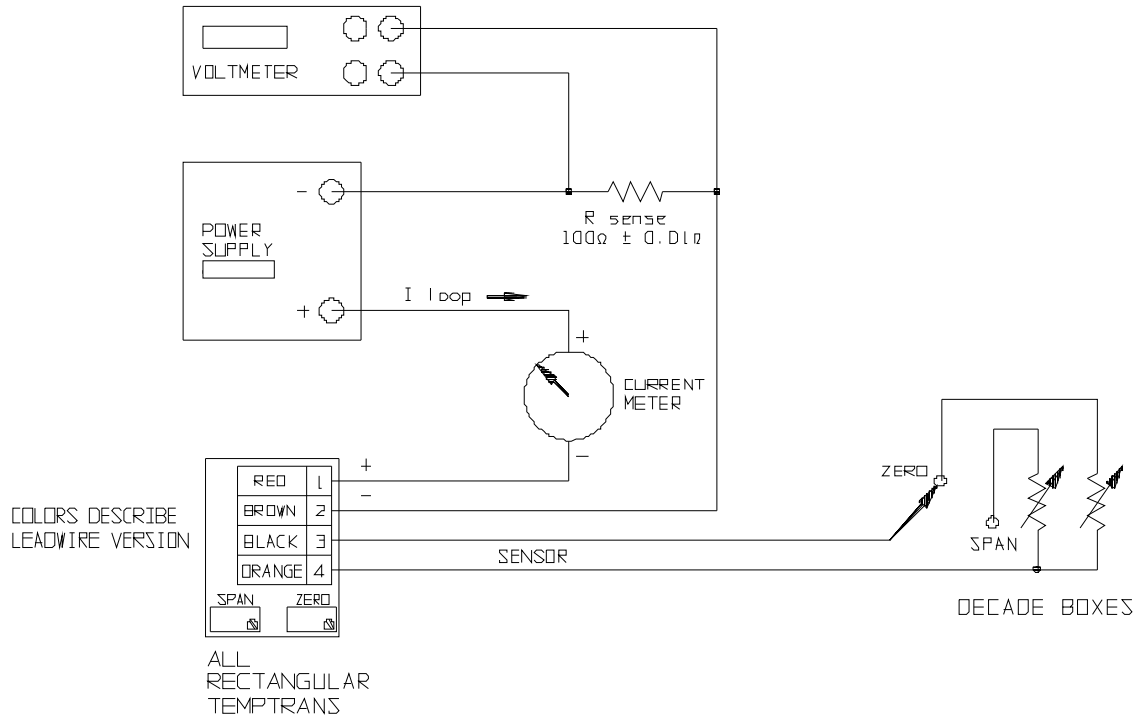
Figure 1 Wiring Diagram

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