

Temperature Transmitters V

Here are seven reasons you should consider using a temperature transmitter instead of directly wiring your temperature sensor to the control system.

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When making temperature measurements, two methods traditionally have been employed to carry process readings to a readout/control system. The first is sensor extension wires, which carry low-level (Ω or mV) signals generated by field-mounted thermocouples or RTDs (figure 1). The second is a temperature transmitter installed at or near the measurement point. The transmitter amplifies and conditions the primary sensor signal, then carries it over twisted pair wiring to the control room (figure 2).

In the past, direct wiring strategies were considered less expensive and sometimes easier to use. Because of cost considerations, transmitter use often was reserved for important loops and applications where signal and loop integrity were musts. Today, though, functional yet affordable micro-processor-based field-mount temperature transmitters

are comparable in price to direct-wiring strategies. When the additional benefits of using transmitters are considered, many users will find that transmitters can save them time and reduce their maintenance headaches, especially if the measurement point is located some distance from the readout and control system.

Here are seven reasons why you should think about using temperature transmitters in place of direct-wiring strategies.

1 Protect Signals from Plant Noise

Common in nearly every environment, electromagnetic interference (EMI) and radio frequency interference (RFI) can negatively affect process signals. Before you rule out EMI/RFI as possible causes of erratic signals in your operation, consider some common sources:

- ◆ Mobile and stationary radio, television and hand-held walkie-talkies.
- ◆ Radio-controlled overhead cranes.
- ◆ Radar.
- ◆ Induction heating systems.
- ◆ Static discharge.
- ◆ High speed power-switching elements.
- ◆ High AC current conductors.
- ◆ Large solenoids and relays.
- ◆ Transformers.
- ◆ AC and DC motors.
- ◆ Welders.
- ◆ Fluorescent lighting.

If you have one or more of these items in your plant, you may have an EMI/RFI problem. Their effects may cause just a minor inconvenience or problems as serious as a costly plant shutdown.

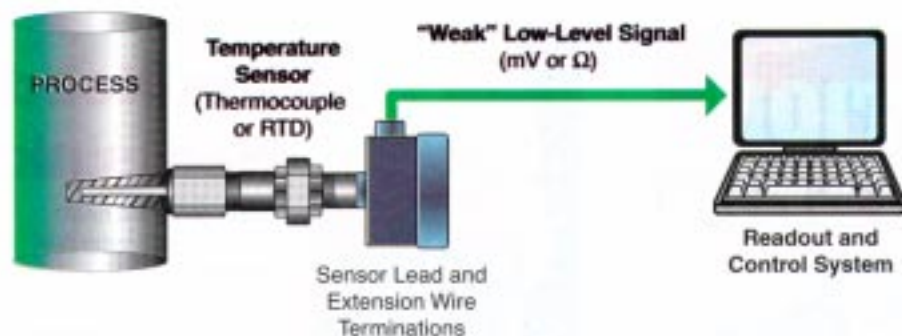


Figure 1. Sensor extension wires carry low-level (Ω or mV) signals generated by field-mounted thermocouple or RTD sensors.

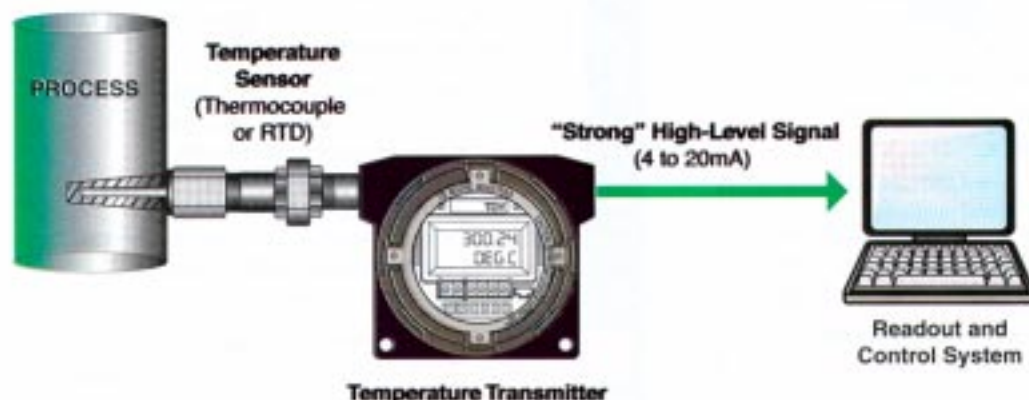


Figure 2. A temperature transmitter amplifies and conditions the primary sensor signal, then carries it over a twisted pair wire to the control room.

S. Direct Wiring

In a direct-wiring scheme, the high-impedance, low-level signals generated by an RTD (Ω) or thermocouple (mV) are particularly susceptible to the signal-degrading effects of EMI/RFI. Compounding the problem, sensor extension wires can behave much like an EMI/RFI antenna, actually drawing plant "noise" to the wires and affecting weak, low-level signals.

A temperature transmitter negates the effects of incoming RFI noise by converting the sensor's low-level signal to a low-impedance, high-level analog signal (typically 4 to 20 mA). This amplified signal is resistant to EMI/RFI and can accurately withstand long-distance transmission from the field, through a noisy plant, to the control room. When selecting a temperature transmitter, always check to be sure it provides EMI/RFI protection. If it is not specified, the transmitter may not be designed to resist noise and may not perform well in noisy plant environments.

Also, if you use ungrounded thermocouples, be sure to choose an isolated transmitter. In most applications, the ungrounded sensor's insulation eventually will break down. If it does, the transmitter's input/output/power signal isolation will protect the process against signal inaccuracies caused by ground loops. Common mode noise rejection — a feature that allows a transmitter to reject interference appearing as a common mode signal — is another option to consider specifying, especially for electric heating processes.

2 Enhance Accuracy and Long-Term Stability

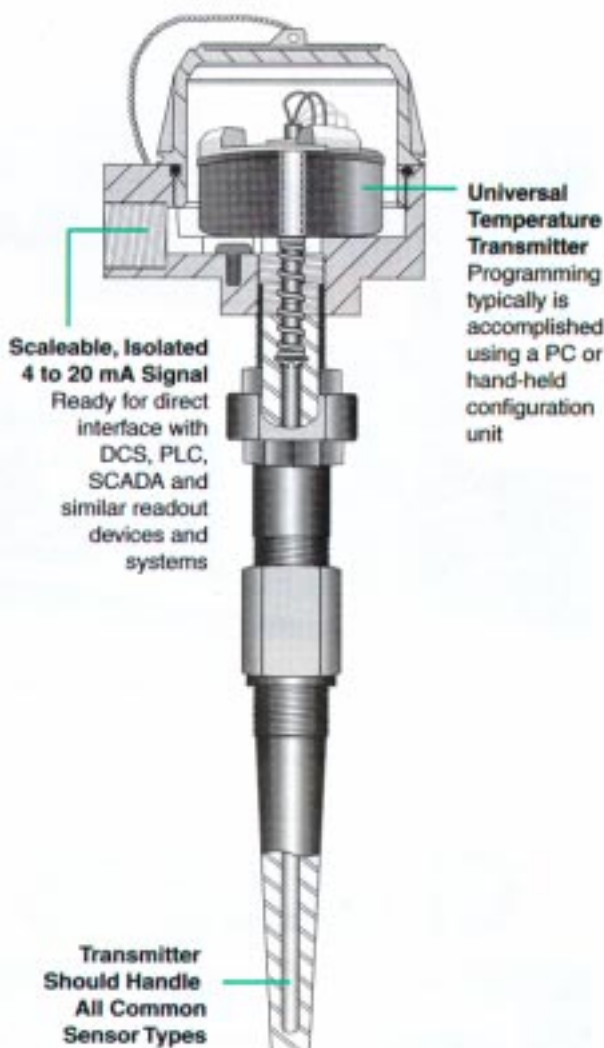
Using temperature transmitters can enhance measurement accuracy. A distributed control system (DCS) and programmable logic controls (PLCs) measure readings over a sensor's entire range, which can be thousands of degrees. Yet, it is well-known that measuring a narrower temperature range produces far more accurate readings. Transmitters can be calibrated to any range within a sensor's overall capabilities, and their measurements are more precise than is possible with most direct-wiring strategies.

Where feasible, use four-wire RTDs and specify a temperature transmitter that can accept a true four-wire RTD input. Using the fourth wire in a RTD circuit cancels out errors due to resistance imbal-

ances between the leads. Every ohm of imbalance in a RTD's lead wires can produce as much as 2.5°C error in the measurement. Typical causes of resistance imbalances include manufacturing variances, lead length differences, loose connections, terminal block corrosion, and work-hardening from bending and other stresses.

Temperature transmitters capable of accepting true four-wire RTD inputs provide a constant current source to the RTD's outer leads. With this setup, the voltage drop is measured across the inner leads (a high impedance loop). Essentially no current flows in the voltage loop, so voltage is directly proportional to resistance. Lead resistance is ignored. This arrangement will provide an accurate measurement as long as the RTD's resistance value, plus corrosion, plus wire resistance, is less than 2,000 Ω (typically). Three- and four-wire RTDs cost nearly the same, so this protection can be added without much expense. And, with a four-wire RTD, smaller gauge wire can be run without concern for added resistance.

A word of caution: Some transmitters use a common terminal for two of the sensor's compensation leads or have a dummy terminal where the fourth lead wire is connected. Both methods are essentially a three-wire hookup and do not cancel out resistance imbalances as a true four-wire transmitter does.



Universal transmitters are configurable to accept all common temperature sensor types and temperature ranges.

Temperature Transmitters VS. Direct Wiring

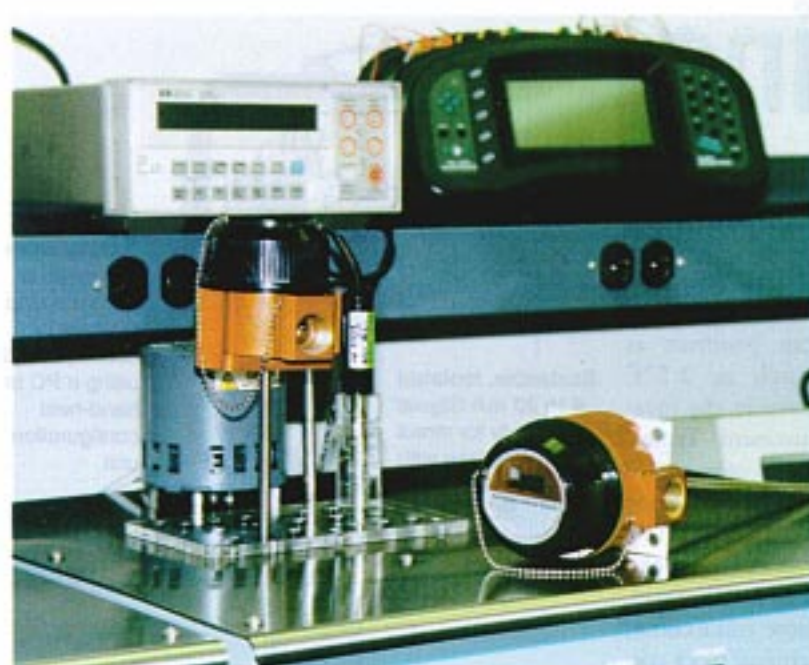


Figure 3. To trim a sensor, connect the transmitter to a sensor and immerse it in a calibration bath maintained at stabilized temperatures. The transmitter will capture two or more actual outputs from the sensor and use those to compensate for the sensor's deviations from the standard curve.

3 High Accuracy Is the Rage

Some control systems experts may argue that installing transmitters adds another possible source of signal inaccuracies to a loop. But, with the current generation of instruments, this concern is not valid, once you consider the accuracy pitfalls that can result from not using them. When paired with quality RTDs, transmitter accuracy ratings of $\pm 0.1^\circ\text{C}$ are common, and many manufacturers are pushing the envelope even further.

In addition, the latest transmitters can be trimmed to precisely match a particular sensor to further enhance measurement accuracy. Although sensors are designed to have a high degree of conformance to an established curve, each one can vary slightly from the stated specification. In the past, transmitters assumed that the sensor supplied an accurate measurement and processed it accordingly. Trimming each transmitter to match the measurement actually being made by the individual sensor ensures process accuracy.

Called sensor-to-transmitter trimming, the transmitter is connected to the sensor and the assembly is immersed in calibration baths maintained at stabilized temperatures (figure 3). The transmitter

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captures two or more actual outputs from the sensor, then compensates for that sensor's deviations from the standard curve.

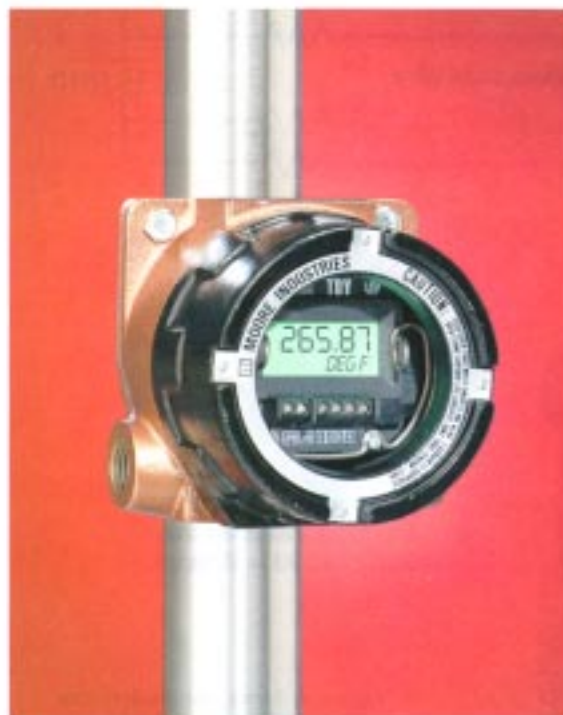
4 Cut Wiring Costs

Fragile and expensive extension wires must be used to directly wire sensors to a control system. By contrast, a temperature transmitter uses common shielded copper wire to carry the 4 to 20 mA signal. The ability to use less expensive wires offsets the costs to purchase the transmitters.

In retrofit situations, some users are reluctant to add transmitters because they believe new copper wire must be run to carry the 4 to 20 mA signal. This is not the case. The existing RTD or thermocouple extension wires can be used to transmit the 4 to 20 mA signal to the control system.

5 Ease Future Upgrades

Throughout its lifetime, process equipment is enhanced to accommodate the manufacture of upgraded or completely new products. Process changes may require different temperature measurement ranges or greater temperature accuracy than was previously needed. Either of these conditions



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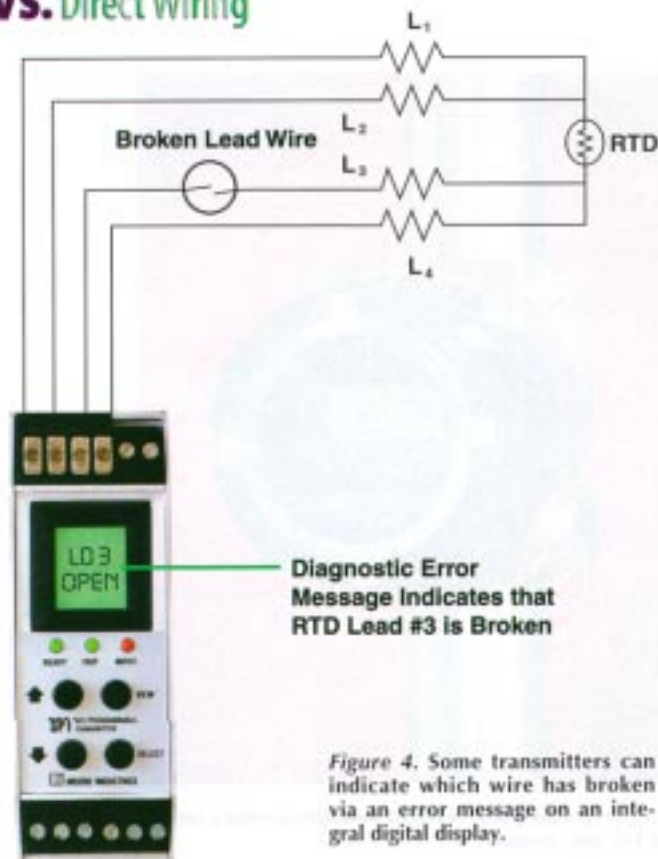


Figure 4. Some transmitters can indicate which wire has broken via an error message on an integral digital display.

may necessitate a change in the type of sensors used.

If the process equipment employs direct wiring, changing sensor requirements often necessitate removal of the existing wire and installation of new extension wire. Because extension wire must be matched to the sensor type, retrofitting a direct-wired system can be cost- and labor-intensive. Additional costs are incurred if the control system's input boards are sensor-type dependent; if so, they also must be replaced to accommodate the new sensors.

By contrast, if temperature transmitters are installed, process changes are simplified: The user changes the sensor and reconfigures the transmitter to the new sensor type. The control loop's twisted pair wiring and existing 4 to 20 mA input boards do not require attention. Configurable transmitters accept all common temperature ranges and sensor types — Types J, K, E, T, R, S, B, N, and C thermocouples; and platinum, copper and nickel RTDs with 10 to 1,000 Ω impedance.

6 Reduce Maintenance Time and Expense

Temperature transmitters have come a long way since the days of fixed-range, inflexible instruments.



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Current designs can provide continuous monitoring and incorporate powerful sensor diagnostic capabilities. These functions can help you track sensor operation and quickly find and diagnose sensor failures. For example, if a wire breaks or otherwise stops sending a signal during operation, the transmitter sends the output upscale or downscale to warn of sensor burnout and other unwanted conditions. In addition, some transmitters can indicate which wire has broken via an error message on an integral digital display. Specific fault messages eliminate the need to remove the sensor or check each lead wire to diagnose the problem (figure 4).

7 Minimize Stocking And Documentation

With direct wiring, it is necessary to match the sensor type to input-specific DCS and PLC cards. Many different sensor types commonly are used in a plant, so a large number of different cards must be specified and stocked as spares. This can be expensive and lead to confusion when installing, maintaining and replacing equipment.

Temperature transmitters incorporate micro-processors that allow them to be configured to

accept many sensor input types, and the 4 to 20 mA output signal is control-system ready. This allows the user to standardize his stock using 4 to 20 mA DCS and PLC input cards. When replacement or change is necessary, the user simply matches the type of sensor to a particular process point using existing materials.

Documentation also is reduced. Instead of numerous sensor lead-wire and DCS/PLC input board combinations, engineering designs and drawings only need to show one wire type and input board. This one-wire/one-input-board approach simplifies maintenance and minimizes the chances of loop miswiring.

The enhanced functionality provided by modern temperature transmitters can provide more accurate results than direct wiring, which translates to a more efficient and reliable process. [PH]

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