

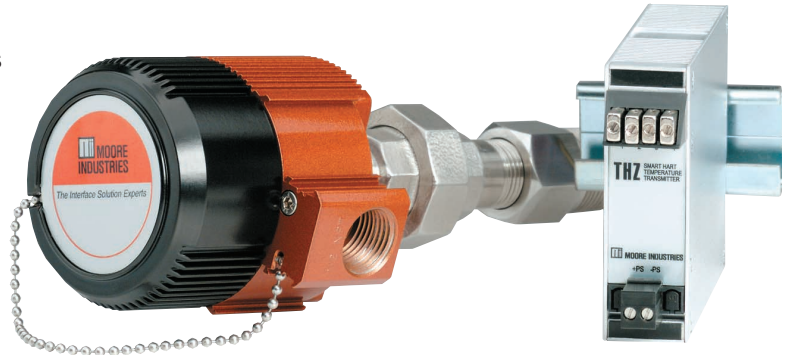
Transmitters vs. Direct Wiring

When making temperature measurements, two ways have traditionally been employed to get process readings back to a monitoring and control system.

One method is to utilize sensor extension wires to carry the low-level signals (ohm or mV) generated by field-mounted RTD or thermocouple sensors (Figure 1). Another is to install temperature transmitters at or near the measurement point. The transmitter amplifies and conditions the sensor signal, and transmits it over a twisted wire pair back to the control room (Figure 2).

Direct wiring strategies have generally been considered less expensive and sometimes easier. Transmitter use, because of cost considerations, was often reserved for important loops and applications where signal and loop integrity was a must.

Today, our highly functional, yet very affordable, microprocessor-based field-mount temperature transmitters are comparable in price to direct wiring strategies. When the additional advantages of using intelligent transmitters are factored in you will, in most applications, also save considerable time and maintenance headaches. This is especially true when the measurement point is located a long distance from the readout and control system.



Here are just some of the reasons why you should use Moore Industries' intelligent temperature transmitters in place of direct wiring strategies:

Cut Wiring Costs

Direct wiring sensors to a control system requires the use of sensor extension wires. Not only are extension wires fragile, they also cost three times more than the common shielded copper wire used for a temperature transmitter's 4-20mA signal. Using the less expensive wires, transmitters can pay for themselves in wire and conduit costs alone. The longer the wire run, the greater the potential savings.

In retrofit situations, you may wish to switch to transmitters, but are reluctant to do so because some mistakenly believe that new copper wires must be run to accommodate the 4-20mA. This is not the case. Temperature transmitters can be installed at the sensor, and the in-place RTD or thermocouple extension wires can be used to transmit the 4-20mA back to the control system. This means no additional installation time or material costs (including conduit) will be needed. And you still get all of the advantages of using temperature transmitters.

Protect Signals from Plant Noise

Common in nearly every industrial environment, RFI (radio frequency interference) and EMI (electromagnetic interference) can negatively affect process signals. Before you eliminate RFI and EMI as a possible culprit of erratic signals, consider just some of the 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; and even fluorescent lighting.

If you have one or more of these in your plant, you may have a RFI/EMI problem. The result is sometimes just a minor inconvenience. Other times it can be as

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

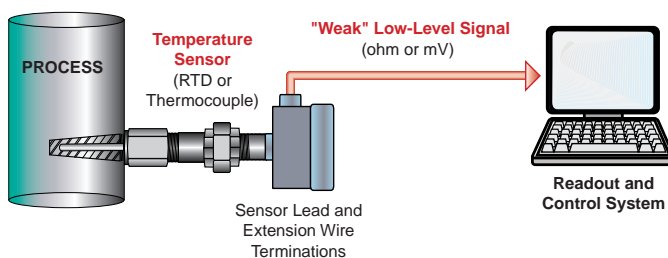
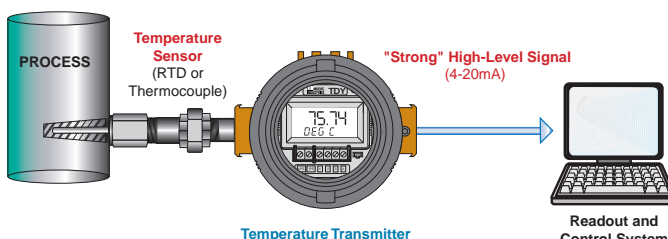


Figure 2. A temperature transmitter amplifies and conditions the primary sensor signal, then carries it over a twisted pair wire to the control room.



Why Use Temperature Transmitters Instead of Direct Wiring?

serious as a costly plant shutdown.

In a direct wiring scheme, the low-level signals generated by an RTD (ohm) or thermocouple (mV) are particularly susceptible to the signal degrading effects of RFI/EMI. Compounding the problem, sensor extension wires can behave much like an RFI/EMI antenna by actually drawing plant "noise" to the wires, and affecting weak, low-level signals. Conversely, a properly designed temperature transmitter effectively negates the effects of incoming RFI noise by converting a sensor's low-level signal to a high-level analog signal (typically 4-20mA). This amplified signal is resistant to RFI/EMI, and can accurately withstand long distance transmission from the field, through a noisy plant, back to the control room. When specifying your transmitter, always check for RFI/EMI protection. If there's no specification given, it's usually because the instrument is not designed to resist noise. It will probably not perform very well in a noisy plant environment.



Stop Ground Loops

Make sure to choose an isolated transmitter (even today, not all are!). Our transmitter's input/output/power signal isolation protects against signal inaccuracies caused by ground loops. This is important even when using ungrounded thermocouples because their insulation will eventually break down.

Reduce Hardware and Stocking Costs

With direct wiring, it is necessary to match the sensor type to input-specific DCS and PLC input cards. Sensor input-specific cards usually cost a lot more per point than a 4-20mA input card. And since numerous sensor types are routinely used in a plant, a large number of different cards must be ordered and kept on hand as spares. This is not only expensive, but can result in a lot of confusion when installing, maintaining, and replacing equipment.

Our temperature transmitters incorporate powerful microprocessors that allow them to be easily configured to accommodate nearly any sensor input type. Their 4-20mA output signal is control-system ready. This allows you to standardize on (and stock) less expensive 4-20mA DCS and PLC input cards.

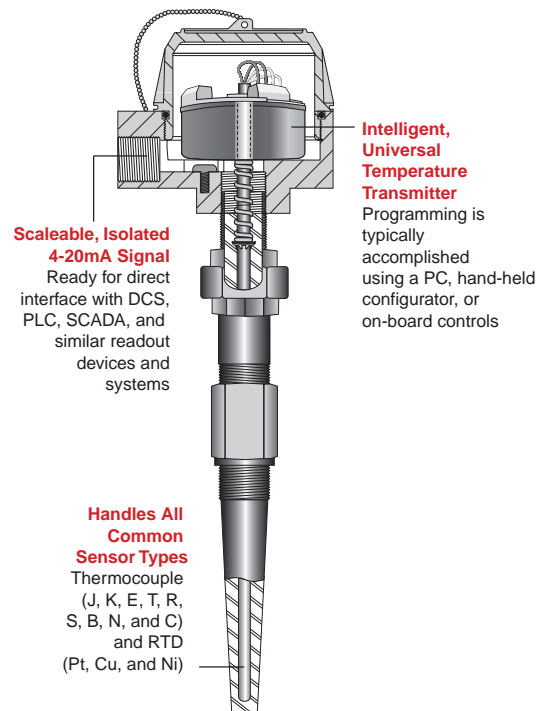
Match the Best Sensor to the Application

In an intelligent temperature transmitter strategy, you simply change out the sensor and reconfigure the transmitter to accommodate the different sensor type. The loop's twisted pair wiring and existing 4-20mA input boards don't even have to be touched. Because you never know what sensor you'll end up with, make sure to go with a universal transmitter that configures to accept all common temperature sensor types and temperature ranges (*Figure 3*).

Enhance Accuracy and Stability

Using temperature transmitters can substantially enhance measurement accuracy. DCS and PLC systems measure readings over the entire (very wide) range of a sensor. It is well known that measuring a narrower range produces far more accurate measurements. Transmitters can be calibrated to any range within a sensor's overall capabilities. Their measurements are more

Figure 3. Our universal temperature transmitters configure to handle nearly every temperature sensor type and temperature range.



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Figure 4. Sensor-to-Transmitter Trimming compensates for deviations in a temperature sensor's established curve.



precise than is possible with most direct wiring strategies. Our transmitters deliver accuracy ratings of $\pm 0.13^{\circ}\text{C}$ ($\pm 0.23^{\circ}\text{F}$) when paired with a common Pt100 RTD sensor over a 200° span.

If you need even better accuracy, you can trim our universal transmitters to precisely match a particular sensor. Even though sensors are designed to have a high degree of conformance to an established curve, each one (even precision sensors) will vary slightly from their stated specification. In the past, transmitters assumed an accurate sensor measurement and processed it accordingly. Our transmitters can be trimmed to match the measurement actually being taken by each individual sensor.

Called Sensor-to-Transmitter Trimming, the transmitter is connected to the sensor and then immersed in calibration baths maintained at stabilized temperatures (Figure 4). The transmitter then “captures” two readings from the sensor representing the upper and lower range values, and stores them in non-volatile memory. The transmitter uses these values to compensate for deviations between the sensor’s stated linearization curve and its actual measurements. When our transmitters are paired with a 1000 ohm RTD, this technique results in amazing measurement accuracy of up to $\pm 0.014^{\circ}\text{C}$ ($\pm 0.025^{\circ}\text{F}$) over a 100° span.

To further enhance measurement accuracy, our transmitters can be trimmed to respond to two data points within the selected zero and span measurement range. This advantage allows a complete range to be monitored, while placing measurement emphasis on a specific segment of the range most critical to the process. For example, in Figure 5, the actual sensor curve is used in place of the ideal RTD curve between 20°C

and 27°C . This provides incredible precision over a portion of span, while measuring the remainder of the span with our transmitter’s usual outstanding accuracy.

Simplify Engineering and Prevent Mis-Wiring

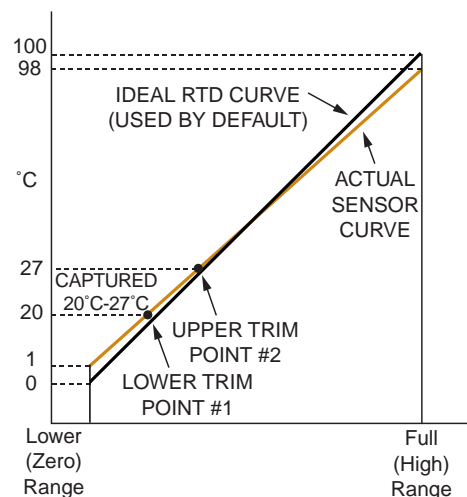
In place of numerous sensor lead-wire and DCS/PLC input board combinations, engineering designs and drawings will only need to show one wire type (twisted wire pair) and one input board type (4-20mA). This one wire and one input board system means maintenance is greatly simplified, and the chances of loop mis-wiring are virtually eliminated.

Ease Future Upgrades

Throughout the lifetime of a process, enhancements are routinely made to accommodate the manufacture of upgraded or even completely new products. Process changes may require different measurement ranges or greater temperature accuracy than was previously required. Either of these conditions may necessitate a change in the type of sensors that are used.

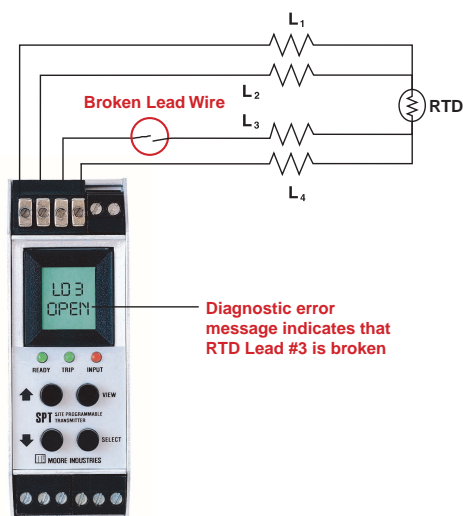
In a direct wired system, changing sensors generally means removing existing, and pulling new extension wire. This is because extension wire must be matched to the sensor type. Additional costs are incurred when the control system’s costly input boards (if also sensor-type dependent) must be replaced to accommodate the new sensors.

Figure 5. Intelligent temperature transmitters can be trimmed to place measurement emphasis on a specific segment of the range most critical to the process.



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Figure 6. Our transmitters can indicate which wire has broken via an error message on their integral digital display.



Lower Maintenance Time and Expense

Temperature transmitters have come a long way since the days of fixed-range, inflexible instruments. Moore Industries transmitters are not only universal in regards to input type and range; they also incorporate powerful sensor diagnostics that save considerable time and money.

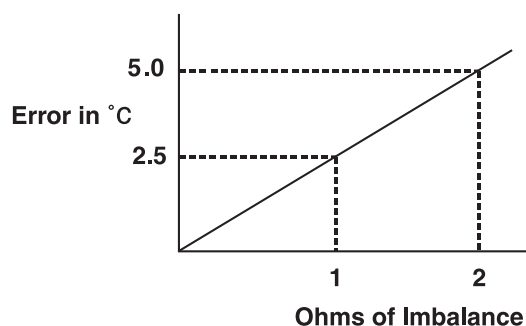
Temperature transmitters with intelligent diagnostic capabilities help you keep track of sensor operation and quickly find and diagnose sensor failures. Capable of continually monitoring the sensor, if a wire breaks or otherwise stops sending a signal during operation, the transmitter sends the output upscale or downscale to warn of sensor burnout and other unwanted conditions. Furthermore, our transmitters can tell you which wire has broken via an error message either on an integral digital display or using their PC configuration software. Specific fault messages eliminate the work of removing the sensor or checking all of the lead wires to diagnose a problem (Figure 6). During startups, in the middle of the night, or in the middle of winter, this can be a huge timesaving advantage.

Avoid Lead Wire Imbalances

Where feasible, use 4-wire RTDs, and specify a temperature transmitter that is able to accept a "true" 4-wire RTD input. The advantage is that the fourth wire in a RTD circuit effectively cancels out errors due to resistance

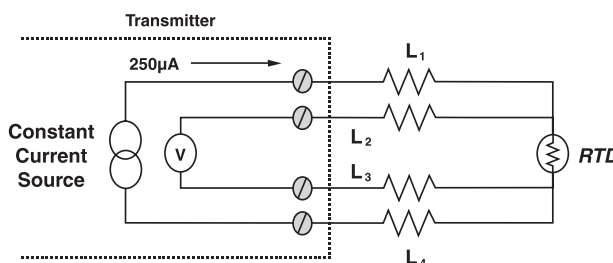
imbalances between the leads. Every ohm of imbalance in a RTD sensor's lead wires can produce as much as a 2.5°C error in the measurement (Figure 7). Serious imbalances may be present from the very first day of commissioning without you even being aware of them. Typical causes include manufacturing variances; lead length differences; loose connections; terminal block corrosion; and work hardening from bending and other stresses.

Figure 7. Every ohm of imbalance in an RTD (100 ohm, Pt3850) sensor's lead wires results in as much as 2.5°C measurement error.



Our intelligent temperature transmitters are capable of accepting "true" 4-wire RTD inputs and provide a constant current source to the outer leads of the RTD (Figure 8). The voltage drop is measured across the inner leads, which is a high impedance loop. There is essentially no current flow in the voltage loop, so voltage is directly proportional to resistance. Lead resistance is ignored. You will get a very accurate measurement providing the resistance value of the RTD plus corrosion, plus wire resistance, is less than 2,000 ohms (typically). A 4-wire RTD costs about the same as a 3-wire and can be used with less expensive, smaller gauge wire without concern for added resistance.

Figure 8. A 4-wire RTD compensates for all resistance imbalances between lead wires.



The Interface Solution Experts • www.miinet.com

United States • info@miinet.com
Tel: (818) 894-7111 • FAX: (818) 891-2816
Australia • sales@mooreind.com.au
Tel: (02) 8536-7200 • FAX: (02) 9525-7296

Belgium • info@mooreind.be
Tel: 03/448.10.18 • FAX: 03/440.17.97
The Netherlands • sales@mooreind.nl
Tel: (0)344-617971 • FAX: (0)344-615920

China • sales@mooreind.com.cn
Tel: 86-21-68406724 • FAX: 86-21-50623585
United Kingdom • sales@mooreind.com
Tel: 01293 514488 • FAX: 01293 536852