FOUR-WIRE RTD CURRENT-LOOP TRANSMITTER:
Four-Wire Connections to an RTD Allow the RTD to be Remotely Located from Active Circuitry, Yet Maintain Accuracy

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Platinum Resistance Temperature Detectors (RTD)s are favored for demanding temperature measurement applications, such as process control, because of their excellent accuracy and sensor interchangeability. Combining an RTD with a Burr-Brown XTR105 forms a complete precision temperature to 4-to-20mA current-loop transmitter solution. Current-mode transmission gives superior noise rejection and is immune to errors resulting from series line resistance. XTR105 is a two-wire transmitter that uses the same wire-pair for both signal and power supply, which reduces expensive wiring cost and simplifies installation.

XTR105 is an application-specific IC containing onboard transducer excitation, signal conditioning instrumentation amplifier, linearization circuitry, and two-wire current-loop output on a single chip. Excitation consists of two on-chip current sources. One current source excites the RTD and a second current source drives a reference resistor to set system "zero."

When the RTD is located near the XTR105, a basic "two-wire" solution can be implemented, as shown in Figure 1. Errors due to wiring resistance are minimal and the XTR105 will provide good accuracy. However, when the RTD is
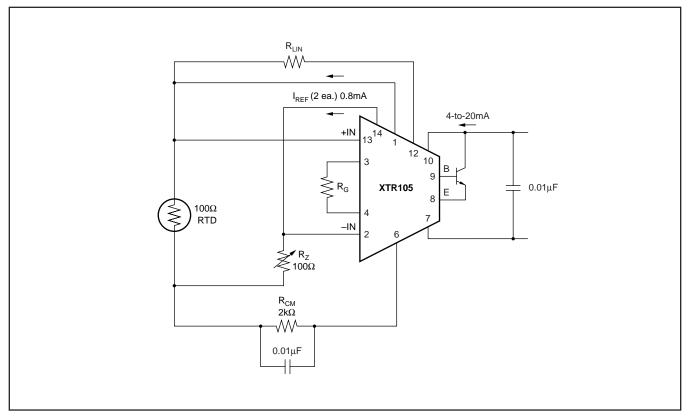

FIGURE 1. Basic RTD to 4-to-20mA Two-Wire Tansmitter Using XTR105. Internal 0.8mA current sources excite the RTD and zero-setting resistor. R_{CM} provides additional voltage drop to set the XTR105 inputs within their valid common-mode input range. Optional resistor, R_{LIN} can be used for linearization of the RTD. See the XTR105 data sheet for additional details.

located remotely, wiring resistance adds to the RTD impedance and can cause significant error. The "three-wire" connection (shown in Figure 2) mitigates the problem, but depends on matching wiring resistance in R_{W1} and R_{W2} to achieve best accuracy. Applications where matching wiring resistance is not practical can use the "four-wire" connection shown in Figure 3.

In the "four-wire" solution, the RTD is connected remotely through four wires, designated R_{W1} to R_{W4}. RTD excitation current from XTR105 (pin 1) flows to the RTD through R_{W1} and R_{W4}. Since excitation is derived from a high impedance current source, voltage drops in the wiring do not substantially affect the accuracy of the current delivered to the RTD.

The voltage across the RTD is accurately measured through R_{W2} and R_{W3}. Since these connect to high-impedance amplifier inputs, the small bias currents flowing in these connections produce little error. Buffer amplifier, A1, drives the zero- set resistor, R_Z, which is excited by the second current source at XTR105 (pin 14). Power to A1 is provided by a 5.1V voltage regulator, internal to the XTR105. All currents return through pin 6, assuring current-loop accuracy.

System span is determined by R_G. Adjust R_Z and R_G to set system zero and span according to the procedures described in the XTR105 data sheet. If linearization is desired, use the calculations described in the data sheet and subtract the wire resistance, R_{W1}, from the external linearization resistor.
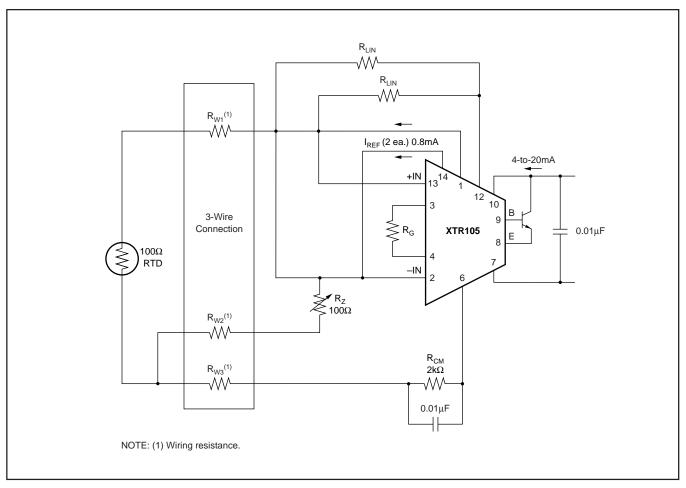

FIGURE 2. Three-Wire RTD to 4-to-20mA, Two-Wire Transmitter using XTR105. When the RTD is located remotely, this "three-wire" solution can improve accuracy. For linearization, a second resistor is required with this solution. See the XTR105 data sheet for additional details.
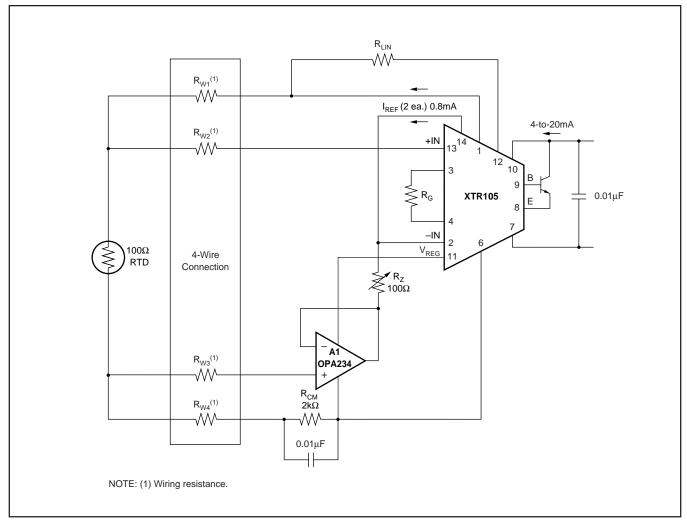
FIGURE 3. Four-Wire RTD to 4-to-20mA, Two-Wire Transmitter using XTR105. When remote location distances are great and wiring resistance mismatch can be substantial, better precision is possible with a "four-wire" solution.

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