Position Measurement & Control - Issue 35

TECHNICAL FOCUS

A Look at Analog Signal Types

Voltage and Current Loop Outputs

Editor's note: This article familiarizes novice transducer users with voltage versus current outputs, both of which are available on the Series 6 position transducers.

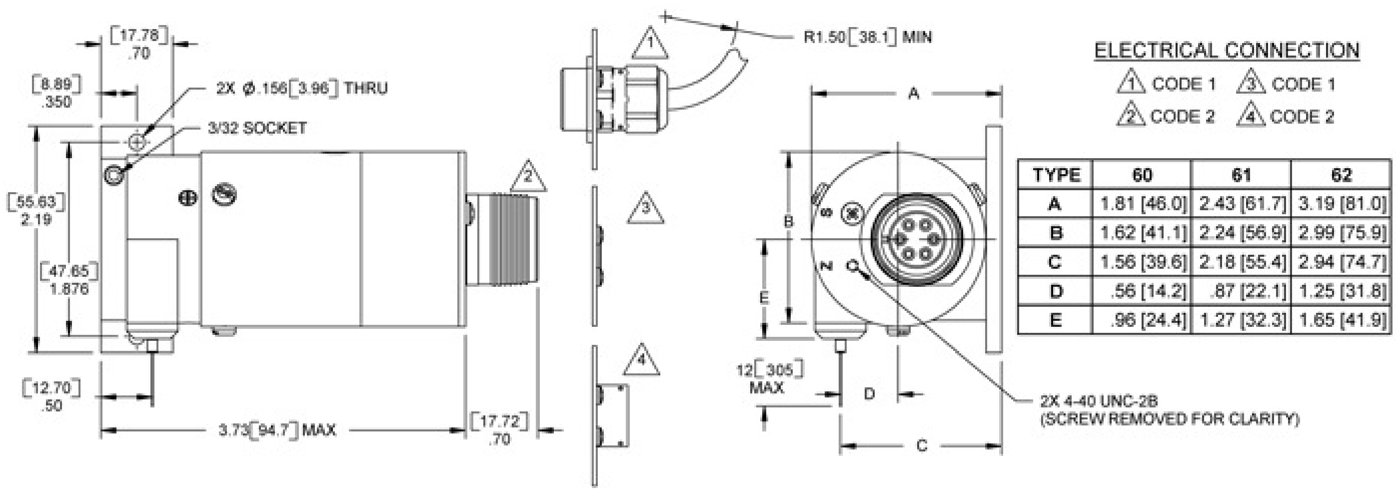

Figure A0 - The Series 6 position transducer comes with a variety of flexible factory-set outputs including voltage conditioned and current loop (4-20 mA).

Analog position transducers are often provided with one of two basic signal types: DC voltage and DC current. Voltage or V (expressed in volts (V) and also known as "potential") is the difference in electric charge between two points, similar to water pressure. Current or I (expressed in amps (A)) is the rate of electron flow between two points, similar to water flow rate. Resistance or R (expressed in ohms) is similar to friction in water pipes. One form of Ohm's law shows the relationship of voltage, current, and resistance:

Voltage = Current x Resistance (V = I x R)

Common voltage outputs are 0-5 V and 0-10 V. The most common current output is 4-20 mA. Block diagrams for these two output types are shown below in Figure A1. A current or milliamp output has some advantages over a voltage output. A voltage output is more susceptible to line noise caused by external electrical devices. In addition, resistance inherent in the signal cable causes a voltage drop that is proportional to cable length. The voltage signal can sometimes diminish significantly between the transducer and the location of the signal reading when the resistance in the data acquisition device/controller and power source are far from the transducer. Current output transducers supply a constant current, regardless of the resistance. Therefore, transducers with mA outputs are preferred.

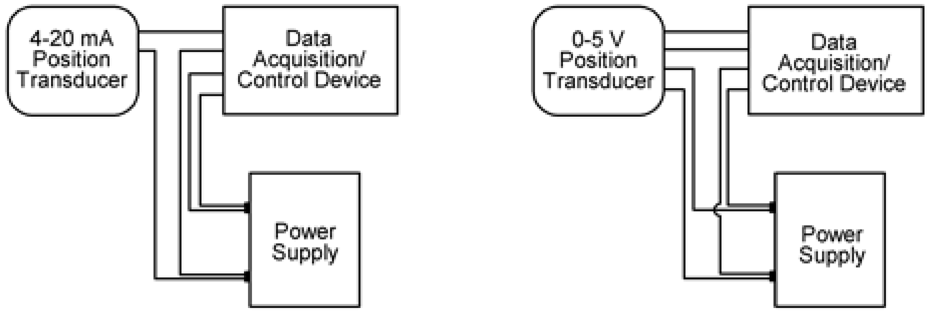

Figure A1 - Current (4-20 mA) and voltage (0-5 VDC) sensor setups showing connection to a power source and control/acquisition device.

Most data acquisition and control devices read voltage and not current. To obtain a voltage signal, 4-20 mA and other current signals are dropped across a precision resistor. The voltage across this resistor is what is actually measured. Most data aquisition and control devices that can read voltage signals can be modified externally to read current signals. A 250-ohm resistor converts 4-20 mA to 1-5 V if connected per Figure A2 below. From Ohm's Law above, (0.004 A) x (250 ohms) = (1 V) and (0.020 A) x (250 ohms) = (5 V). Similarly, a 4-20 mA signal can be converted to a 0.4-2.0 V signal with a 100-ohm resistor, or a 200-1000 mV signal with a 50-ohm resistor. The resistor should be installed at the data acquisition or control device so the voltage signal path is short and the voltage drop is insignificant.

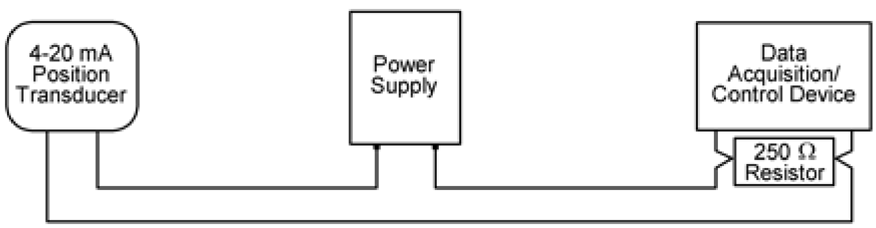

Figure A2 - Inserting a 250-ohm precision resistor across the controller/acquisition device will convert a 4-20 mA signal to a 1-5 V signal.

High-quality resistors required to obtain an accurate signal are not easily located from electronics distributors. Precision, low-temperature-coefficient, 0.1% or lower tolerance resistors should be used. Precision resistor sources include Charcroft, Riedon, TTI, Micro-Ohm, and Precision Resistive Products.

POTENTIOMETER USE TIP

Power Rating Explained

Excess Power Can Be Life-Limiting

Our analog position transducer data sheets specify a power rating. What is a "power rating"?

Power rating is the maximum heat that can be dissipated by a potentiometer under specified conditions with certain performance requirements. Heat (or power) dissipation is the result of current passing through a resistance. Mathematically:

$$P = (I \times I) \times R = (V \times V) / R$$

where P is the power dissipation in watts, R is the total resistance in ohms, I is the total current in amps flowing through the resistance R, and V is the total voltage drop expressed in volts across the resistance, R.

The useful life of a given potentiometer is directly related to the maximum temperature allowed in the interior of the transducer. Above a certain internal temperature, insulating materials begin to degrade. A maximum power rating indicates to the circuit designer just how much power may be safely dissipated without harm to the device.

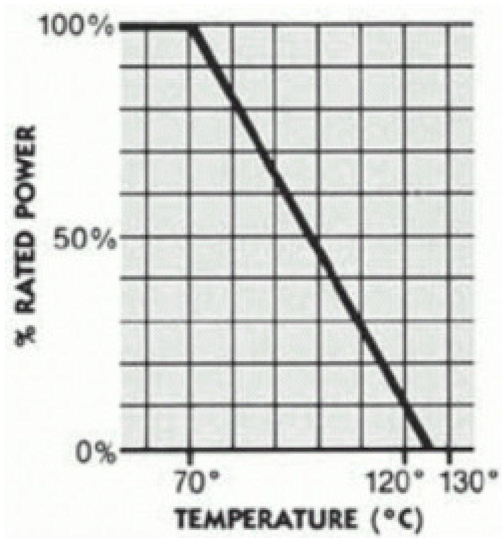

Figure C1 - Power ratings are generally based on a specific temperature with the power rating reduced with increased temperature via a process known as "derating".

Source: C.D. Todd, P.E. 1975. The Potentiometer Handbook, McGraw Hill.

APPLICATION CORNER

Truth in Accuracy

Q. What is the accuracy of your products?

A. We do not generally state the accuracy of our products due to these reasons:

- The term "accuracy" has evolved to where it has several meanings.
- "Accuracy" needs to be defined in regards to a specific environment: temperature range, shock and vibration, duration, pressure, and other variables. A simple one-line entry on a data sheet does not allow for this information.
- "Accuracy" is seldom an important criteria when making sensor purchasing decisions. In the broad majority of situations, linearity, repeatability, and hysteresis are far more important than is accuracy.

If you would like us to help characterize the accuracy of our products for your specific application, please contact us. To learn more about accuracy and contributors to accuracy, consider reading these Web documents:

- Accuracy - Know What You're Getting - Part 1 of 2
- Accuracy - Know What You're Getting - Part 2 of 2
- Introduction to Sensor Terminology
- Errors in Physical Measurements

NEWS YOU CAN USE

Previous Issue (Issue 34)

- 4-20 mA / 0-5 VDC / ±10 VDC / More
- DARPA Grand Challenge Teams Gain Unfair Advantage
- Using A Calculator Is Not Cheating
- Latest Poll: What lifetime requirement do you have for your displacement sensors?

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