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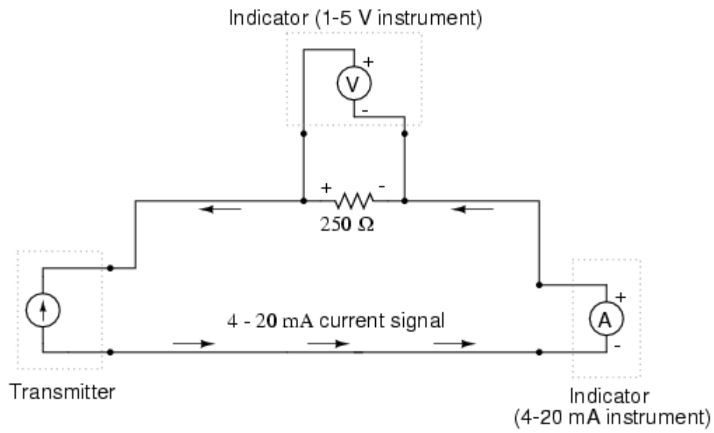
A Brief Description of SCADA System Signals



The most common current signal standard in modern use is the *4 to 20 milliamp* (4-20 mA) loop, with 4 milliamps representing 0 percent of measurement, 20 milliamps representing 100 percent, 12 milliamps representing 50 percent, and so on. The use of a 4 mA reading to indicate zero is known as "live zero." This helps to distinguish a zero reading from a "dead signal" or non-functioning equipment. The range of readings possible for a properly functioning system then is only 16 mA (20 mA – 4 mA). This 16 mA range is known as the "live signal." The actual reading being recorded in mA is called the "process variable." The PV indicates a percentage of a particular measurement being monitored. The table below shows the relationship between various PVs and their corresponding percentages.

Percent of measurement	4 – 20 mA signal (PV)	1 – 5 V signal
0	4.0 mA	1.0 V
10	5.6 mA	1.4 V
20	7.2 mA	1.8 V
25	8.0 mA	2.0 V
30	8.8 mA	2.2 V
40	10.4 mA	2.6 V
50	12.0 mA	3.0 V
60	13.6 mA	3.4 V
70	15.2 mA	3.8 V
75	16.0 mA	4.0 V
80	16.8 mA	4.2 V
90	18.4 mA	4.6 V
100	20.0 mA	5.0 V

A convenient feature of the 4-20 mA standard is the ease in converting these signals to 1-5 volt indicating instruments, as the table on the left shows. A simple 250-ohm precision resistor connected in series with the circuit will produce a range of readings from 1 volt of drop at 4 milliamps to 5 volts of drop at 20 milliamps.

The current loop scale of 4-20 milliamps has not always been the standard for current instruments. In the past, 10-50 milliamp signals were used more frequently. That standard has since become obsolete. The main reason for the eventual supremacy of the 4-20 milliamp loop was safety. Lower circuit voltages and lower current levels (compared to 10-50 mA systems) mean less chance for electrical shock injuries and/or the generation of sparks capable of igniting flammable environments in certain industrial applications.

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An Overview of SCADA Signal Calculations

DEFINITION OF TERMS

Dead signal: A reading from a non-functioning system that can be mistaken for a measurement.

Live signal: The range of possible process variables. In a 4 – 20 mA system, any signal below 4 mA or above 20 mA indicates malfunctioning equipment. The range of useable signals is between 4 & 20 mA. Therefore, the live signal = 16 mA.

Live zero: A reading other than zero used to indicate zero so that a zero reading can be distinguished from a dead signal. In 4 – 20 mA systems, the live zero = 4 mA.

PV: Process variable. The signal reading, in mA, that represents a percentage of a particular measurement.

One of the more common uses for SCADA systems is the monitoring of storage levels. Formulas for making these calculations include:

$$\text{PV, mA} = \left[\left(\frac{\text{Water level, ft}}{\text{Tank SWH, ft}}\right) \times \text{Live signal, mA}\right] + \text{Live zero, mA}$$

$$\text{Water level, ft} = \left(\frac{\text{PV, mA} - \text{Live zero, mA}}{\text{Live signal, mA}}\right) \times \text{Tank SWH, ft}$$

So, given a SWH of 30 ft, and board reading of 14.67 mA, the water level would be calculated as follows:

$$\begin{aligned}
\text{Water level, ft} &= \left(\frac{\text{PV, mA} - \text{Live zero, mA}}{\text{Live signal, mA}}\right) \times \text{Tank SWH, ft} \\
&= \left(\frac{14.67\text{ mA} - 4.0\text{ mA}}{16\text{ mA}}\right) \times 30\text{ ft} \\
&= \left(\frac{10.67\text{ mA}}{16\text{ mA}}\right) \times 30\text{ ft} \\
&= 0.67 \times 30\text{ ft} = 20\text{ ft}
\end{aligned}$$

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