Electronic Basics

When you are dealing with data acquisition products, there are a few basic electronic concepts which, when understood, can be very useful. Most electronic products take an analog voltage value as the input signal. This signal may represent a temperature, level, flow, pressure value, etc. The instrument takes the input signal, conditions it, and usually displays the value in "engineering units" (that is, in terms which are easily understood, *e.g.,* 75°F). Figure 1 identifies the symbols one might encounter in reading a schematic. Also given are some of the key fundamental electrical equations.

When sensors are at an extended distance from the instrument, it is common to use a 4 to 20 mA (milli-ampere) current loop to transmit the signal.

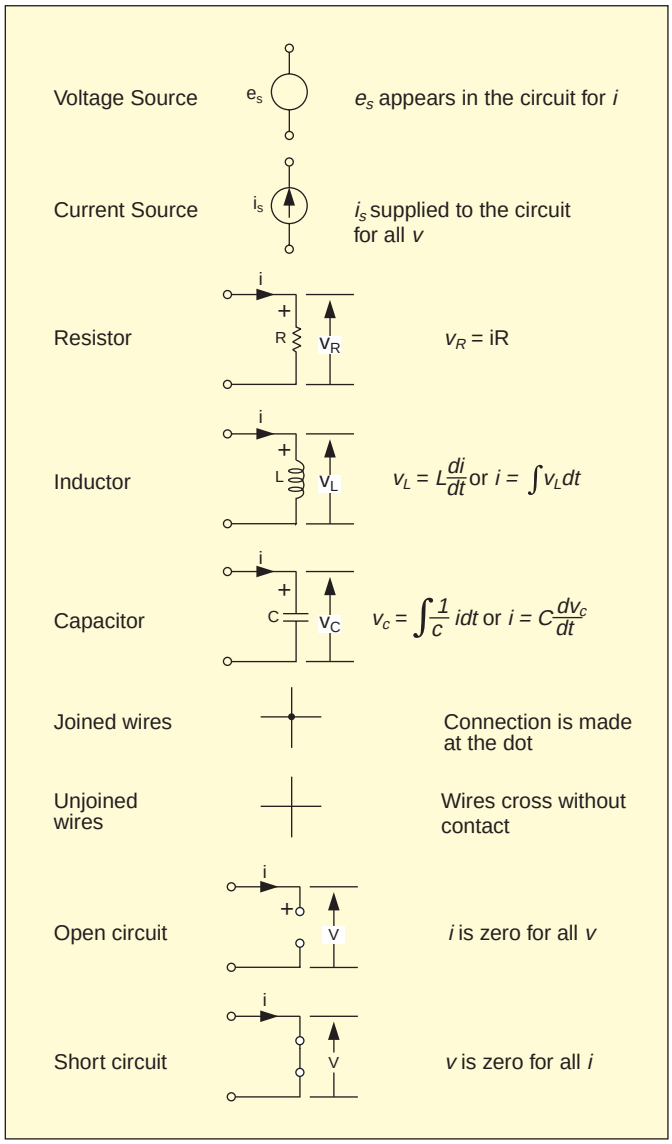

Figure 1. Symbols for Elementary Circuits

Voltage signals are very common and work well over short distances. In addition, a voltage signal usually can be paralleled to go to two instruments. For a high level voltage signal, such as 0 to 5 volts (note: this does not apply to thermocouples), the sending device typically can drive several instruments, because generally the input impedance is very high and will not load down the signal. When extended distances are involved between the sensor and the instrument, the resistance in the cable and electrical noise "picked up" by the cable become significant. Current loops are commonly used when this distance is 100 feet or more.

A 4 to 20 mA signal can easily be converted to a voltage signal for instruments that accept only voltage input. If an instrument accepts only 1 to 5 volt inputs, a 250 ohm dropping resistor placed in the loop will generate the desired voltage. Other voltage levels may be obtained by following the basic electronic law, Voltage = Current x Resistance. The resistor selected should be of high precision. Also, when adding a resistor to the current loop, one must be careful that the instrument does not introduce a second ground point in the loop. Figure 2 identifies the color codes, to help in choosing a resistor. The color band closest to the end identifies the first digit. The next band gives the second digit. The third band gives the multiplier in powers of 10. The fourth band, if shown, identifies the tolerance.

Resistor Value in ohms =
(1st band) and (2nd band) $10^{(3rd\ band)}$

Color	Value of		
	(1st & 2nd bands)	(3rd band)	(4th band)
Black	0	0	±20%
Brown	1	1	
Red	2	2	±2%
Orange	3	3	
Yellow	4	4	
Green	5	5	
Blue	6	6	
Violet	7	7	
Gray	8	8	
White	9	9	
Gold		-1	±5%
Silver		-2	±10%
No color			±20%

Figure 2. Color Code for Resistors

When selecting a resistor, know that not all resistor values are available. Figure 3 identifies the standard resistance values that typically are available. Obviously, these numbers represent all values with different powers of 10 (*e.g.,* 1.0, 10, 100, 1k, etc.)

1.0	1.1	1.2	1.3	1.5	1.6
1.8	2.0	2.2	2.4	2.7	3.0
3.3	3.6	3.9	4.3	4.7	5.1
5.6	6.2	6.8	7.5	8.2	9.1

Figure 3. Standard Resistance Values

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