

## Question

Standard 4-20 mA loop power supplies are 24 VDC. What if only a non-standard power supply is available? How low of a voltage can this device tolerate? What can be expected if the minimum requirements are not satisfied?

## Answer

The specifications for the Badger® Series 310 define the power requirements as "Loop Input Voltage 9-35 VDC." Loop powered 4-20 mA devices like the Series 310 derive their power by dropping some of the loop voltage across themselves. For a loop system to be reliable, the sum of the individual component voltage drops must never exceed the supply voltage.

## Example

Assume a loop consisting of a 24 VDC power supply, Model 310, and 4-20 mA input device with a 250-ohm input impedance. In order to insure that the system will operate under all conditions, the voltage drop loop equations must be solved that the maximum current (20 mA) is not exceeded.

(Supply Voltage) - (Series 310 minimum) - (Input Device) = Permitted Wire Loss

(24 VDC) - (9 VDC) - (0.02 A \* 250 Ω) = 10 VDC

If, however, the same loop was attempted with a 12 VDC supply, it should be noted that the loop attempts to exceed the power supply at 12mA. Full scale of 20 mA can never be achieved, even if line loss was 0 VDC.

Maximum Loop Current = (12 VDC – 9 VDC)/250 Ω = 0.012 A = 12 mA

If a Series 310 is operated with an inadequate power supply, it will work properly up to the point where it doesn't receive sufficient voltage (above 12 mA in example above). The Series 310 will track correctly until it starts to run out of voltage. As the voltage across the "+Loop" and "-Loop" terminals starts to drop below 9 VDC, the 4-20 mA output will become non-linear. It will then start to oscillate with currents dropping to 3mA or less. If the flow continues to increase the output will drop to an unstable 3 mA. This condition will continue until the voltage across the "+Loop" and "-Loop" terminals returns to a voltage above 9 VDC.

## Suggestion

If the input device receiving the 4-20 mA signal is not configured with an internal 24 VDC power supply for loop powered devices, you must specify a standard 24 VDC power supply (such as our Model A503). If this is not permitted by system design or availability, use the equations above to confirm reliable operation. If the wire runs are too long, the voltage drop in the wiring can be significant. Wire loss can be computed using the ohm/foot data provided by the wire supplier.

Wire Loss = 2 (Ω/Ft \* Feet of Wire Run) \* (0.02 A)

