

## 4-20mA Current Loop Primer

### Introduction

This application note's primary goal is to provide an easy-to-understand primer for users who are not familiar with 4-20mA current-loops and their applications. Some of the many topics discussed include why, and where, 4-20mA current loops are used; the functions of the four components found in a typical application; the electrical terminology and laws being needed to understand current loop operation. Users looking for product-specific information and/or typical wiring diagrams for DATEL's 4-20mA loop and locally-provided process monitors are referred to DMS Application Note 21, titled "Transmitter Types and Loop Configurations."

Despite the fact that the current (4-20mA) and voltage ( $\pm 12$  to  $\pm 24$ V) present in a typical current loop application are relatively low, please keep in mind that all local and national wiring codes, along with any applicable safety regulations, must be observed. Also, this application note is intended to be used as a supplement to all pertinent equipment manufacturer's published data sheets, including the sensor/transducer, the transmitter, the loop power supply, and the display instrumentation.

### Why Use a Current Loop?

The 4-20mA current loop shown in Figure 1 is a common method of transmitting sensor information in many industrial process-monitoring applications. A sensor is a device used to measure physical parameters such as temperature, pressure, speed, liquid flow rates, etc. Transmitting sensor information via a

current loop is particularly useful when the information has to be sent to a remote location over long distances (1000 feet, or more). The loop's operation is straightforward: a sensor's output voltage is first converted to a proportional current, with 4mA usually representing the sensor's zero-level output, and 20mA representing the sensor's full-scale output. Then, a receiver at the remote end converts the 4-20mA current back into a voltage which in turn can be further processed by a computer or display module.

However, transmitting a sensor's output as a voltage over long distances has several drawbacks. Unless very high input-impedance devices are used, transmitting voltages over long distances produces correspondingly lower voltages at the receiving end due to wiring and interconnect resistances. However, high-impedance instruments can be sensitive to noise-pickup since the lengthy signal-carrying wires often run in close proximity to other electrically-noisy system wiring. Shielded wires can be used to minimize noise pickup, but their high cost may be prohibitive when long distances are involved.

Sending a current over long distances produces voltage losses proportional to the wiring's length. However, these voltage losses—also known as "loop drops"—do not reduce the 4-20mA current as long as the transmitter and loop supply can compensate for these drops. The magnitude of the current in the loop is not affected by voltage drops in the system wiring, since all of the current (i.e., electrons) originating at the negative (-) terminal of the loop power supply has to return back to its positive (+) terminal—fortunately, electrons cannot easily jump out of wires!



Figure 1. Typical Components Used in a Loop Powered Application

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**G. Randy Slone**



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