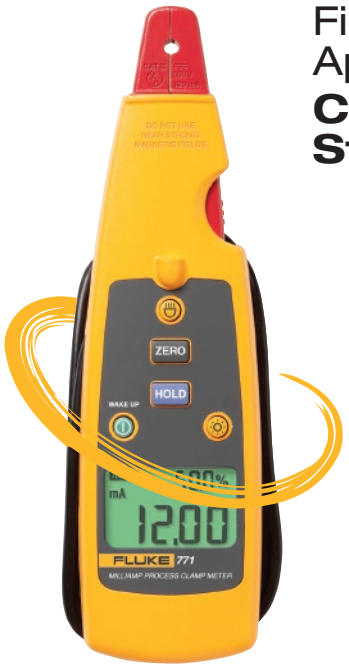
Troubleshooting 4 mA to 20 mA controls, ethanol style

In this operation, downtime is not an alternative

Application Note



Field Applications **Case Study**

Tool: Fluke 771 Miliamp Process Clamp Meter

Profile: Bruce Yenzer, instrumentation technician, Siouxland Energy and Livestock Cooperative

Measurements: Troubleshooting live 4–20 mA controls for temperature, pressure, flow, and pH devices and valves

An ethanol production plant is a storehouse of process control technologies and a great venue for illustrating the enduring benefits of 4 mA to 20 mA technology. Ask Bruce Yenzer, an instrumentation technician at the Siouxland Energy & Livestock Cooperative (Sioux Center, IA). He "keeps the gears oiled" in an ethanol production facility that manufactures 60 million gallons of the alternative fuel annually. Control devices at the plant measure temperature, pressure, flow, pH, "and a whole myriad of parameters," says Yenzer. And what all the control devices have in common is that they output a 4 mA to 20 mA signal—more or less the industry standard of control instrumentation. "I also have a vast array of proportional devices—valves—that are fed a 4 mA to 20 mA signal. 4 mA to 20 mA is our lifeblood."

However, the simplicity of the 4 mA to 20 mA current loop masks the complexity of the challenge to keep a plant running optimally and reveals a basic limitation of conventional electronic measurement tools. Let's look deeper.

Measuring current with a multimeter requires making a connection within the circuit under test, which often requires powering down the circuit. Of course, that could mean shutting down power to a complex, dynamic system in which performance is measured in thousands of dollars of revenue per hour. "In a plant like this, where production is paramount—we're online 24 hours a day—closing a valve or shutting down a device can have far-reaching effects throughout the process and the plant," says Yenzer. "If I were using a multimeter to troubleshoot a circuit, I would have to break the circuit and stop the process, which would cause the valves to slam shut and 'deadhead' the pump. That could cause myriad problems. Taking my measurements while things are running is the best of all possible worlds."

The other limitation of a multimeter or ammeter in Yenzer's application? Inserting the meter within the circuit changes the resistance of the circuit—even if slightly—and can skew a current measurement. Enter the clamp meter (a name derived from "clamp-on ammeter"). Because a clamp meter "clamps" around an individual wire, no disruption to the circuit is required.

"I use the Fluke 771 Milliamp Clamp Meter almost daily. Used to be, I had to break the circuit and insert my meter, which meant I had to shut down the circuit. The 771 allows me to take my measurement and to perform calibration while online, with no interruption of the circuit whatsoever."

Going with the flow

"Ethanol is like other chemical production, says Yenzer. "Using corn fermentation and extracting the alcohol involves, quite literally, thousands of transmitters—constantly taking measurements and reporting back to the DCS." The majority of SELC's operations are controlled from computers that are part of a DCS. The system, he says, can often run automated, with occasional manual intervention from facility operators.

"We know what kind of flow we should be getting through a pipe. If an operator notices that the flow is wrong, but the DCS says the valve is adjusted correctly to 50 % open, I can place the 771 on the signal lines coming in, verify that they are correct, and use that data to verify that the valve is open to the proper position. Typically, the signal is not getting to the valve. We are in a nasty environment for electronics—high moisture and high heat—and that can cause malfunctions in the wiring, in the computers, the terminals, or the connection to the device."

Or, he says, the valve itself might require an adjustment—essentially an impromptu calibration. The 4 mA to 20 mA current-to-pressure transducer at the device would output a 3 psi to 15 psi pressure signal that actually controls the valve. "I could use this signal to get a pneumatic response to control the valve," says Yenzer. "Less frequently, I could have a fuse blown, could have a bad output on my computer card, or could have a bad rack in the card cage."

In the loop

The 4 mA to 20 mA current loop is a common method of transmitting sensor information in many industrial process-monitoring applications—typically in systems monitoring pressure, temperature, pH, flow, or other physical factors. These systems employ the familiar two-wire, 4 mA to 20 mA current loop, in which a single twisted-pair cable supplies power to a module and also carries the output signal.

The loop's operation is straightforward: a sensor's output voltage is first converted to a proportional current, with 4 mA normally representing the sensor's zero-level output and 20 mA representing the sensor's full-scale output. A reading of 20 mA means that a direct-acting valve, for example, is 100 % open, and a reading of 4 mA means that it is closed (and the opposite for a reverse-acting valve). Readings between the maximum and minimum values indicate that the circuit is controlling the valve.

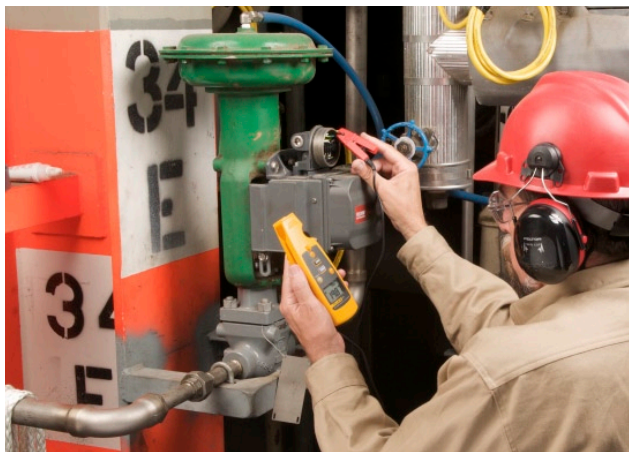
Transmitting sensor information via a current loop is particularly useful when the signal has to be sent over long distances—1,000 feet typically, or more. The use of basic two-wire technology makes the installation both inexpensive and simple to wire, maintain and troubleshoot.

Key among the advantages of 4 mA to 20 mA current loop technology is that the accuracy of the signal is not affected by voltage drop in the interconnecting wiring, and that the loop can supply operating power to the device. Even if there is significant electrical resistance in the line, the current loop transmitter will maintain the proper current, up to its maximum voltage capability.

Back at the plant

"Our team considers this clamp meter indispensable," says Yenzer. "Once I expose a positive or negative lead, all I have to do is clamp on the circuit and take a measurement." The 771 display, he says, provides an Open or Close indication—meaning that, even if the mechanic is not able to diagnose the reading, the tool will tell him, for example, that 8 mA = 25 % open. If the reading doesn't agree with the DCS, it means the mechanic needs to make an adjustment.

"After I received my Fluke 771, I ordered another one. We've cut troubleshooting and device calibration or alignment by 70 % to 80 %. For us, the biggest advantage of a clamp meter is that it allows analysis without interrupting the circuit. And honestly, I have people with little or no electrical background using the Fluke 771. It couldn't be easier."



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Web access: http://www.fluke.com

Printed in U.S.A. 7/2008 3358397 A-EN-N Rev A