

## Troubleshooting process loops

Tracking down problems within a process loop can be a difficult challenge. However, properly applying the right tools will allow you to resolve most problems efficiently. This application note will demonstrate some practical applications of process meters, loop calibrators, and digital multimeters (DMMs) to troubleshoot process loop problems.

### Loop calibrators

Loop calibrators, such as the Fluke 705, 715, 707 and the intrinsically safe 707Ex can temporarily replace the power source in a current loop. With the calibrator in control of the current, you can accurately set the current between 4 and 20 mA. This allows you to control the loop

and the devices connected to it – which means you can control and calibrate actuators and indicators in that loop. For example, you can supply a 20 mA signal to a valve positioner and observe the valve respond – it will move to a fully open or fully closed position (depending on the configuration). Or, you can supply a 12 mA signal to a panel-mounted level indicator and see if it indicates 50 % of scale.

But, you can do far more than single-point checks. For example, suppose you want to calibrate a control valve and positioner. Typically, you would first calibrate the positioner for proper output at each step, then use the positioner to drive and calibrate the valve. You can use the calibrator to provide positioner input current corresponding to the typical 0 %, 25 %, 50 %, 75 %, and 100 % control valve calibration positions. At each of these step inputs, you can check the position of the valve and make any needed adjustments. You can also determine if the valve is opening properly, rather than jumping off its seat. And, you can determine if it is seating properly to begin with.

Suppose you want to simulate an output from a signal conditioner that has a voltage input (from, for example, a thermocouple). You can use a calibrator to simulate that input and calibrate the signal conditioner. You can also simulate the signal conditioner itself, regardless of whether it operates with voltage or with current. If it operates with voltage, you can use a precision resistor with the calibrator to generate accurate voltages.

## Application Note

There's far more you can do, but let's look more closely at the precision resistor technique.

Placing a precision resistor across the output leads of a loop calibrator creates a voltage across the resistor. You can control this voltage by varying the output of the calibrator. For example, placing a 250  $\Omega$  resistor across the source output jacks and driving it with a 4 to 20 mA current will produce 1 to 5 V across the resistor. Place this voltage on the input of a signal conditioner, and you create a test system to set linearity as well as the zero and span points. With a DMM or ProcessMeter™ (e.g., the Fluke 789), you can measure the output of the signal conditioner and ensure it correctly matches the corresponding input voltage.

### ProcessMeter™

The Fluke 789 is a loop calibrator and true-rms DMM in one package. Although not as accurate as other Fluke loop calibrators, the 789 works well as a current source in most troubleshooting situations. You can still control devices on a current loop to see if they are functioning, and set them to various levels to aid in locating problems.

The DMM measurement capabilities within the 789 make it a valuable tool in troubleshooting process loops. You can use the basic DMM measurement functions like volts ac and dc, current ac and dc, resistance, and frequency at different stages of troubleshooting.



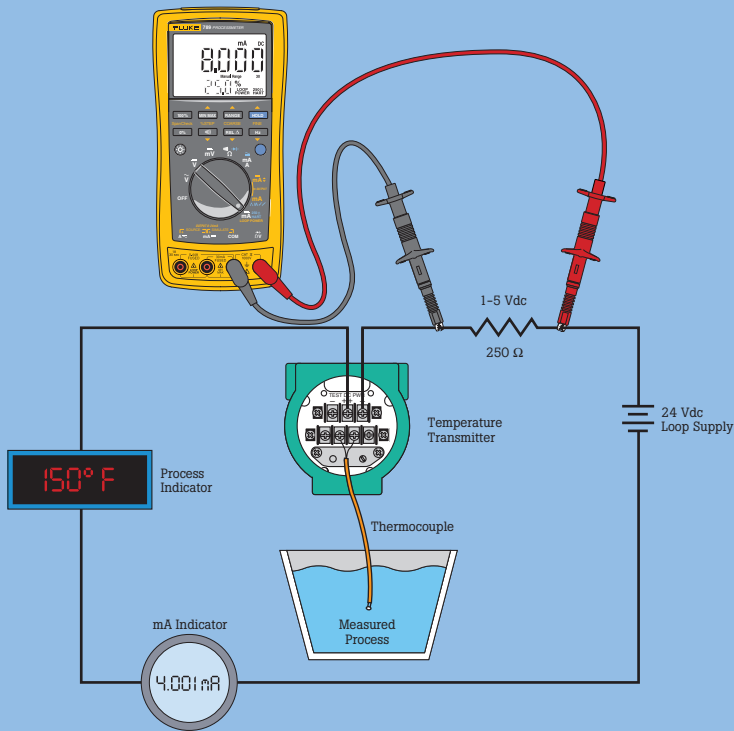


Figure 1. Meter across dropping resistor.

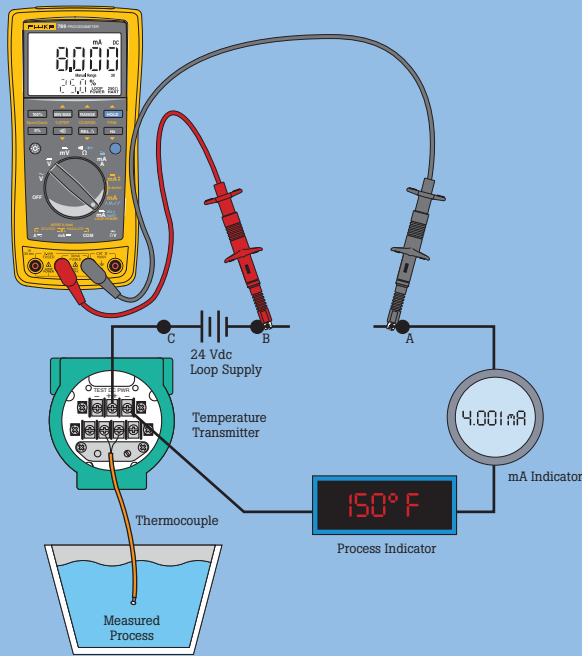


Figure 2. Meter in series with loop.

Another feature of the 789 that comes in handy is the min/max function, which can be used to determine the range of values a current loop experiences over a period of time. If the current loop has a dropping resistor across which we can make a voltage measurement, place the 789 in volts dc and connect the leads across the dropping resistor (Figure 1). This will give you a voltage reading that will vary in proportion to loop current. If a dropping resistor is not available, you can open the current loop and use the ProcessMeter's current jacks to close the loop (Figure 2).

With the Fluke 789 in the proper function and connected to the circuit, press the mix/max button to activate the mode. The Fluke 789 will look at each measurement and test whether it is higher than the highest reading it has measured so far, or lower than the lowest measurement. If it detects a new high or low, the meter will store that value. This process continues until the meter is shut off or another function selected. While in the min/max mode, selecting the min/max button will cycle the display through the high, low, and average readings stored in the ProcessMeter.

The Fluke 789 has an on-board loop power supply. This allows a device to be powered independently of the in-house supply. That way, you can either eliminate it in troubleshooting or power and test a device when a loop supply isn't available. In Figure 2, by moving the test lead from B to C and enabling the transmitter 24 V supply, the 789 will measure the mA output of the transmitter.

## Digital multimeters

The Fluke 189, besides being an extremely accurate DMM, has the capability to store time stamped measurements taken periodically, or in a series. These readings can then be used for future analysis, reference, and process documentation. Like the min/max mode of the Fluke 789, this can be helpful in looking for values on a loop that are unexpected and that occur intermittently. However, this DMM takes the min/max record method to the next level.

**Logging**

The Fluke 189 can be set to record a series of intervals instead of a single interval of high and low readings. In addition, these intervals are time stamped in real time so you can tell exactly when a min/max period took place. However, to view all the data from these logged measurements, you must have access to a PC and use software to transfer and view the data.

The Fluke 189's logging feature gathers and records high and low readings over a period of time which will be referred to simply as a period. The beginning and ending of this period can be triggered in two different ways; either by a set time period (interval logging), or by one of two events (event logging).

**Interval logging**

Through the Fluke 189's setup feature, you can set the time interval, or period that high-low data is to be collected, from 1 second to 99 minutes and 59 seconds. If, for instance, you set the logging interval to five minutes, from the instant you start the logging process, the highest and lowest readings over the next five minutes are recorded. The average of all readings taken during that five-minute period is calculated and recorded as well. At the end of that period, another five-minute period starts recording. This continues until the DMM has no more memory to store data or the logging process is terminated. After the logging session, data is downloaded to a PC for storage and analysis.

**Event logging**

As mentioned earlier, two events control the measurement period for event logging. One is a "stable" measurement and the other is an "unstable" measurement.

A stable period will continue to be stable if the input signal does not vary more than  $\pm 4$  percent from the input signal amplitude at the beginning of a stable period. If during this time the input signal jumps or drifts outside the  $\pm 4$  percent window and is detected by the meter as

being outside the window, the meter will end that stable period and log (record) the input signal's high, low, and average values for that stable period of time.

The meter will then attempt to start another stable period. If the meter finds the input signal cannot stay within the  $\pm 4$  percent window after trying to start a new stable period, it then defines a period of time as unstable.

**Logging a process loop**

As before, we can either place the Fluke 189 across a dropping resistor placed in the current loop, or break the circuit and place the DMM's current jacks in series with the current loop, making sure to select the voltage or current function as appropriate. If we want to conduct interval logging, we use logging interval through the DMM's setup function to set the desired time interval. If we are only interested in event logging, then we simply turn off the interval logging by setting the interval to 00:00, and activate the logging session by starting the logging function.

At this point we can leave the DMM running and come back at a later time to retrieve the logged data. With interval logging, the DMM can store up to 288 periods. Of course, how long that is will depend on the interval. For instance, an interval of five minutes gives 24 hours of logging, while 15 minute intervals allows for 72 hours. Event logging capability is determined by the number of stable and unstable periods detected.

**FlukeView® Forms**

With FlukeView Forms loaded on a PC, you can transfer logging and measurement data from the DMM to the PC and display that data in a graphical as well as tabular form. This software package is ideal for documenting measurements taken by the Fluke 180 Series DMMs.

Shown in Figure 3 is the tabular presentation of a five-minute logging session on a current loop. For this session, interval logging was used and the interval period was set to ten seconds. You will see that each recorded period has a start time, duration, high value, average value, low value, a description, and a stop time. The recorded times are in real time or time-of-day, not elapsed time.

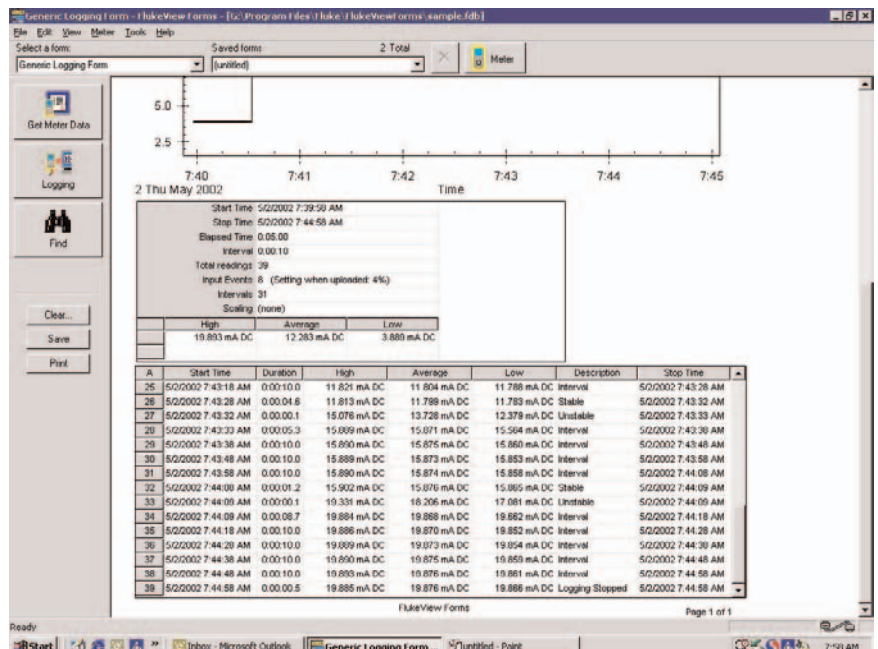


Figure 3. Five-minute logging session on a current loop.

FlukeView Forms creates a graph of the recorded data as well. The graph is a series of rectangles strung together with each rectangle representing a period. The top of each rectangle represents the maximum value while the bottom is the minimum value. A bar across the inside of a rectangle represents the average value. This gives us a visual approximation of the data collected by the DMM and makes it easy to spot any anomalies in the current loop measurement.

The graph in Figure 4 is set up to show just the “interval” periods. You’ll see that the value changes very little with the exception of the time period around the 2:35:58 mark. That period had a large variation occur which is not typical of a temperature measurement loop. By adding the “events” logging periods, we see that the anomaly is very short in duration. Looking at the event in the tabular form (Figure 5) shows the transition happened in a 3.1 second period.

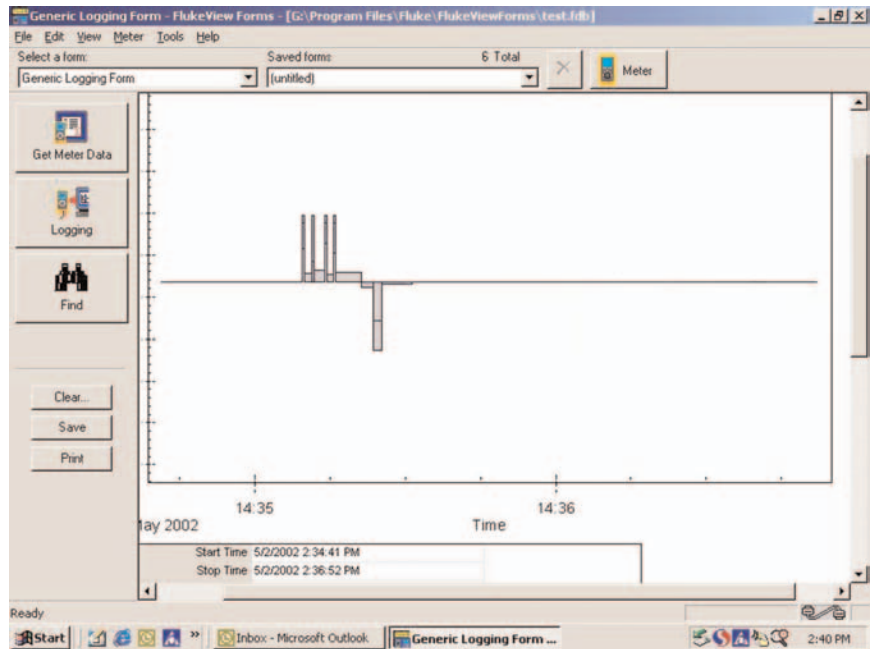


Figure 4. Graphical representation of logging.

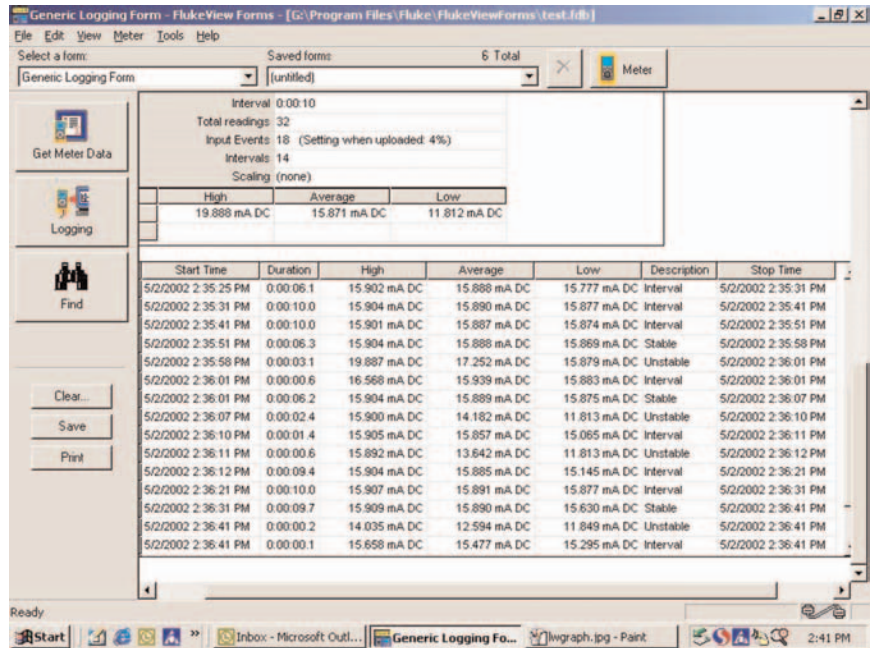


Figure 5. Tabular representation of logging.

### **AC and DC readings**

The Fluke 189 has the ability to display both the ac and dc components of a signal simultaneously. In addition, this DMM will combine the two components and display the result as a true-rms value. This gives us the capability of measuring exactly what a device on a process loop sees for a signal. This can be handy when we're looking for noise or current loop interference.

As before, you either measure across a dropping resistor or insert the meter into the current loop. Now you switch the DMM to either dc volts or dc amps as appropriate. The DMM now shows the current flowing in the loop (if measuring across dropping resistor, the voltage represents the current in the loop). Next, you press the blue function button to switch the function to ac + dc. The display of the DMM now shows two separate readings. The large, or primary, digital display indicates the dc measurement while the smaller, or secondary, display is the true-rms ac measurement riding on the dc signal.

Pressing the blue function button again swaps the two digital displays. Pressing it a third time, combines the two voltages into a true-rms value of the total signal.

The ac + dc feature of the Fluke 189 can help us track down noise or EMI signals on the current loop. As long as the ac signal stays relatively small in comparison to the dc signal, all works well. If the ac signal starts approaching .5 mA, then you may have a noise or interference problem to resolve.

### **Summary**

As this application note has demonstrated, you can use several different tools to troubleshoot process loops. Calibrators are handy for calibrating process loops, and they can help you troubleshoot typical problems. An advanced DMM brings your troubleshooting abilities to the next level. The ProcessMeter gives you both the calibrator and the DMM in one instrument.

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