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Dealing with Ground Loop

Have you ever had problems with process controls and electrical instrumentation?
The source may be ground loops. What is this?
"Potentially detrimental loop formed when two or more points in an electrical system normally at ground potential are connected by a conducting path such that either or both points are not at the same ground potential."

Unwanted ground loops can cause inaccurate sensor readings by negatively affecting instrumentation signals.

In layman's terms, a ground loop exists when a circuit is connected to earth ground at two or more points. Because the potential of the earth varies from point to point, two or more connections to ground cause currents to flow. If the current flows through a signal carrying wire, the result is a noisy, offset signal. The classic symptom of a ground loop is a sensor that reads correctly in buffers, but gives a reading grossly in error when placed in the process liquid.

In a typical process measurement, the pH sensor is connected through the process liquid and piping to earth ground. If the circuitry in the pH analyzer becomes connected to a second earth ground, current will flow through the reference electrode.

A voltage proportional to the current and the electrode resistance develops across the reference electrode. Because the voltage is in series with the other cell voltages, the ground loop current causes the pH reading to be substantially different from the expected value. The currents created by ground loops are often unstable, so pH readings affected by ground loops are often noisy.

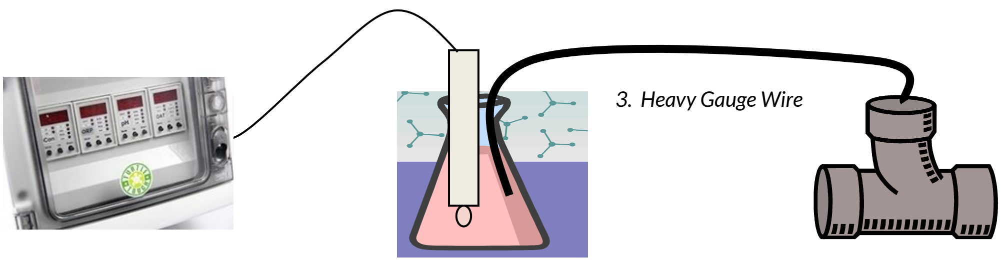
Checking for a Ground Loop!

If an instrumentation system starts acting strangely or erratically, make sure you eliminate all unintended ground connections. Or if your readings fluctuate when you touch a cable or move the sensor.

These can occur when you – add or change a motor or agitator. Any electrical item that is worked on – may upset the balance and needs to be checked once more.

To Check for Ground Loop – we recommend following the steps –

1. Remove the pH sensor from the process liquid.
2. Calibrate the sensor in buffers. Be sure there is no direct electrical connection between the container holding the buffer and the process liquid or piping.
3. Strip back the ends of a heavy gauge wire. Connect one end of the wire to the process piping or, better, place it in the process liquid. Place the other end of the wire in the container with the buffer and sensor. The wire makes an electrical connection between the process and sensor.
4. If the pH reading changes or becomes noisy after making the connection, a ground loop exists. If no symptoms develop a ground loop probably does not exist.



2. pH 4 buffer solution

3. Process Liquid / Process Pipe

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What is Next?

- It is *much* easier to avoid ground loops during installation and project planning
    - Rather than to diagnose and resolve them in the field after installation.
- Often not the same ground and Often separated by distance
- Not always just in the 4-20 mA loop
- Consider non-isolated RS-485 of signal wires
- Consider non-isolated power/output input power grounds
- The ground potentials are NOT equal
- RGND caused by multiple factors
    - Noise
    - Resistance of ground path
    - Poor initial power rail installations

So if you can't eliminate the conditions for ground loops, what's your next step? You can use signal isolators. These devices break the galvanic path (DC continuity) between all grounds while allowing the analog signal to continue throughout the loop. An isolator can also eliminate the electrical noise of AC continuity (common-mode voltage).

There are a couple of ways to do this – but regardless of the isolation method you choose, an isolator must provide input, output, and power isolation. If you don't have this three-way isolation, then an additional ground loop can develop between the isolator's power supply and the process input and/or output signal.

Stopping Ground Loops in the Future!

To minimize the danger of introducing these loops into a complicated network, you should use a dedicated instrumentation system ground bus and connect grounds from the signal common, cabinet ground, and instrumentation AC power ground to it. The bus is tied to earth via the building ground and plant ground grid.

But, this can be much more complicated than it appears. For example, you will rarely have just one instrumentation loop. In fact, you could have hundreds or even thousands.

Many are packaged together in vendor-supplied instrumentation system cabinets. Generally, these contain a DC signal common bus and power supply common bus. The manufacturer normally ties these busses together within the cabinets at a master ground bus. The cabinet ground is a safety ground that protects equipment and personnel from accidental shock hazards. It also provides a direct drain line for any static charges or electromagnetic interference (EMI) that may affect the cabinets. This cabinet ground remains separate from the DC signal ground until it terminates at the master ground bus.

The AC service ground is a single-point ground termination of the system AC power. This ground connects to the neutral-to-ground bond at the main AC power isolation transformer. It also terminates at a single point on the plant ground grid (usualy the grounding electrode).

For all your extreme liquid analysis needs
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