HARDWIRE VS. WIRELESS FAILSAFE CONTROL SYSTEM

In today's industrial automation world, the debate continues…
Is wire more reliable then wireless?

The answer is No….

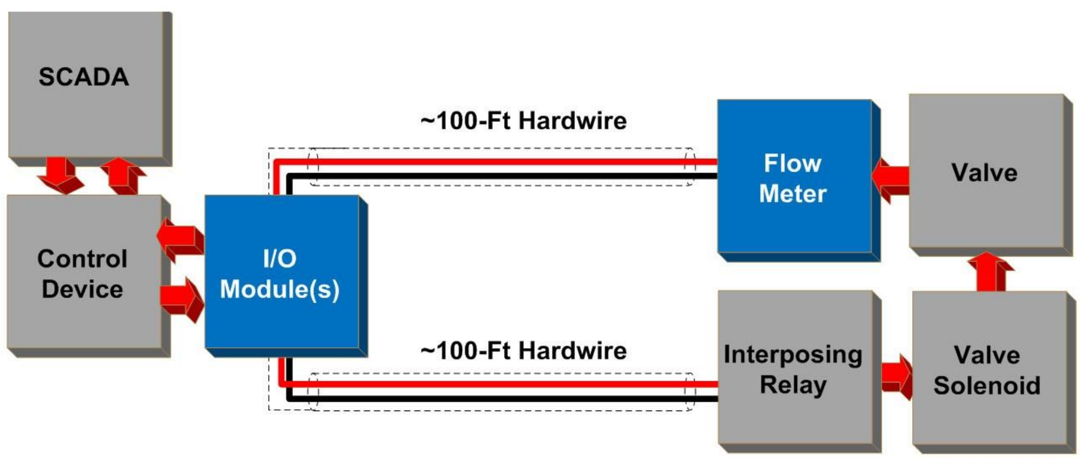
In any industrial control environment, it is imperative to return process conditions to its normal or safe conditions to prevent fires, petro-chemical spills, waste spills, and other preventable disasters when failure within a control loop is detected. Implementation of a "failsafe control system" is required to perform this function.

Prior to wireless technologies, aluminum and copper wires have been the only means to control and monitor remote instrument devices. The advantage of a hardwired system is that it is "reliable." The notion is: I know it's connected so I trust it. The disadvantages are more apparent as the cost of wires, trenching, installation, and technical aspects of operability start to mount. In addition, there are physical drawbacks: environmental factors such as lightning hazards (fire), galvanic corrosion, electrolysis, and other debilitating wear and tear on the wiring over time.

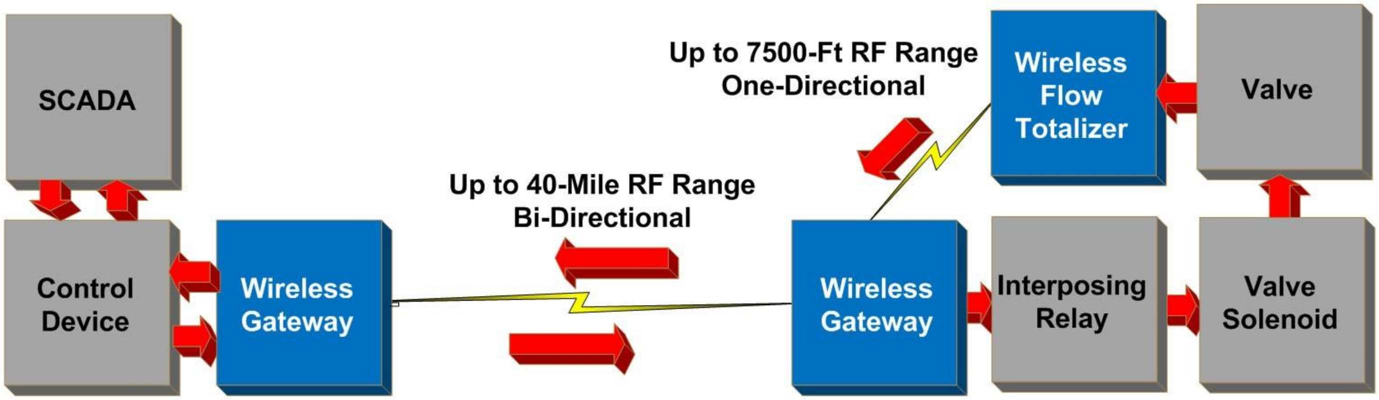
Modern day wireless technology is proven to offer an equally reliable fail safe solution when replacing long distance hardwired applications. Wireless solutions offer additional advantages of the added benefits of lower cost and faster startup and commissioning of new projects.

Wireless solutions eliminate the inevitable costs mentioned of hardwiring. And, when an OleumTech Wireless System is utilized for replacing the hardwire method, it reduces additional cost by completely removing the need for long distance analog (4-20 mA) I/O modules and analog to digital converters from the control instrumentation loop. All inputs and outputs (I/Os) are simply relayed via Serial communication (Modbus) to and from a control device, which further reduces the complexity of wiring and installation time. The block diagrams below depicts a typical hardwire and wireless control loop for valve control with feedback.

HARDWIRED INSTRUMENT CHAIN



WIRELESS INSTRUMENT CHAIN USING OLEUMTECH WIRELESS SYSTEM



Typically a Distributive Control System (DCS), Programmable Logic Controller (PLC), or other Remote Terminal Unit (RTU) is used to control a valve (Control Device). Figure 1 depicts a failsafe control loop that uses an air to open acting actuator to control the valve. This de-energized condition is commonly referred to as an open loop. In general, the use of an interposing relay protects the output I/O circuit of the Control Device that is controlling the solenoid valve. The output of the Control Device drives the interposing relay coil, which in turn switches the valve open or close. The Control Device output is isolated from the solenoid valve coil by the interposing relay. Utilizing this concept is necessary because the voltage ratings between the Control Device I/O and solenoid are often dissimilar, or because the Control Device's output current rating is inadequate to drive the greater current required by the solenoid valve.

Figure 1 depicts a control loop that is in a safe operating condition. The example below shows the valve to be closed because the SCADA system that monitors and controls the Instrument loop has initiated the valve to close, or the logic in the Control Device is reading a no flow rate from the Flow Meter. In either case, the output of the Control Device is de-energized thereby removing the ground source to the interposing relay coil. The valve solenoid is wired to the open contact of the interposing relay. In this condition the valve solenoid coil is de-energized and no instrument air is supplied to the valve actuator diaphragm keeping it closed.

Figure 1: Hardwired - Open Loop Diagram (Valve Closed)

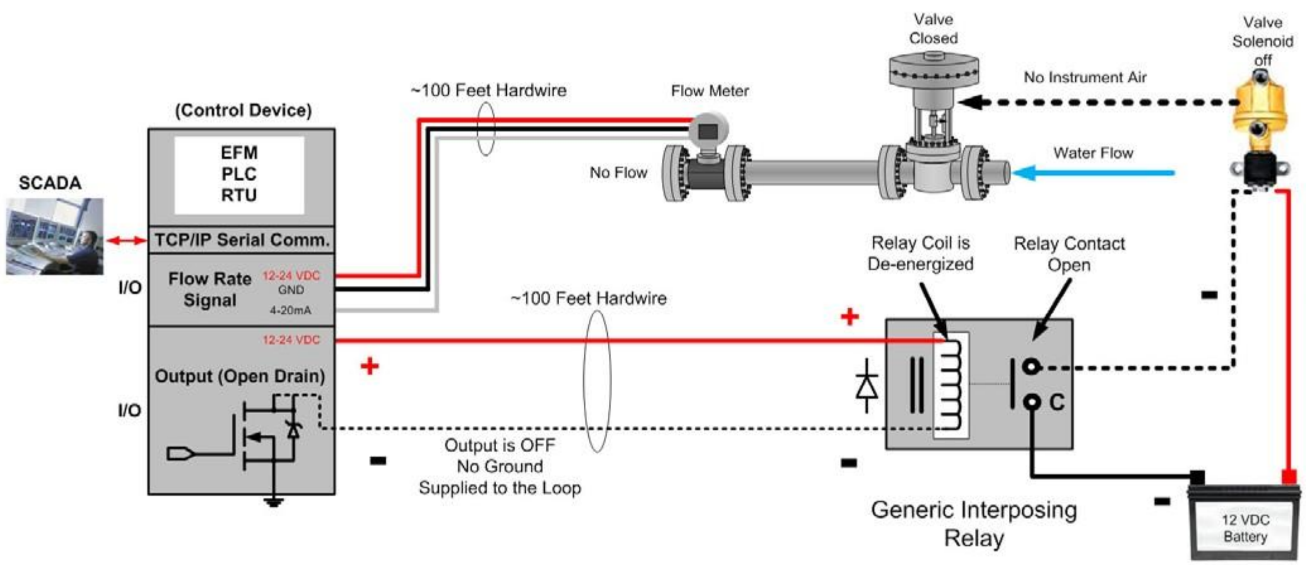
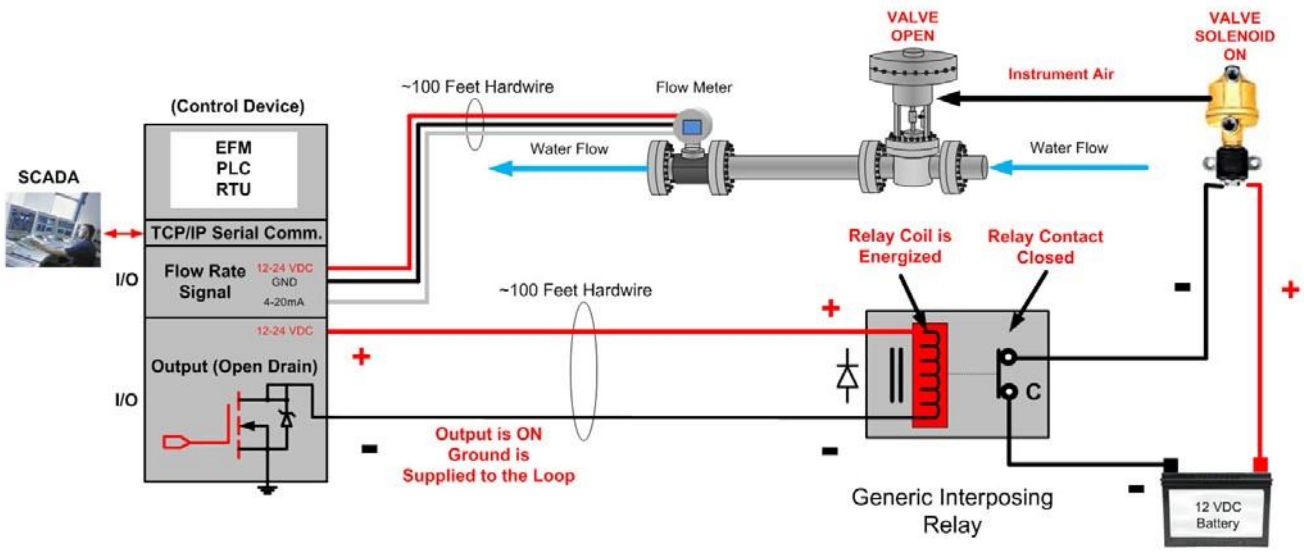
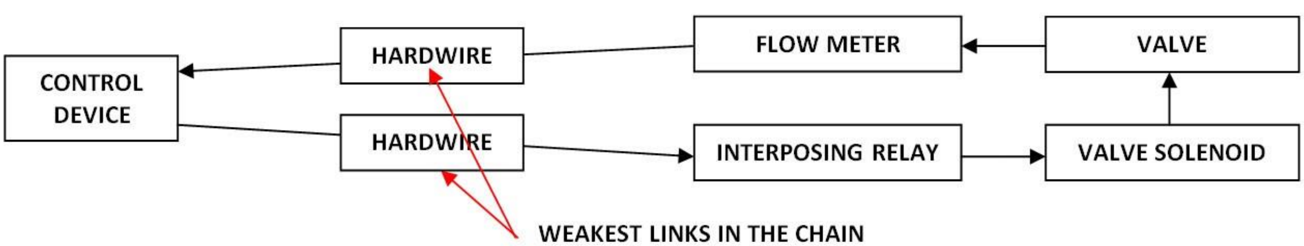


Figure 2 depicts an operating failsafe instrument loop. In this condition the SCADA computer system has initiated the Control Device to open the valve. The Control Device has energized the output and supplied ground to the interposing relay coil. Once the interposing relay coil is energized the contact will switch from open to close. By closing the contact, ground is delivered to the high current solenoid valve. Once the solenoid valve is energized, instrument air pressurizes the valve actuator diaphragm to open, allowing water to flow. The water Flow Meter is monitored by the Control Device for feedback. This condition is operating as a failsafe instrument closed control loop because if any part of the loop fails the valve will close.

Figure 2: Hardwired - Closed Loop Diagram (Valve Opened)



Identifying that the control valve may be a critical part of the described control loop. It would be inaccurate to say that the control valve is the most important part of the loop when using a failsafe concept, because all the components are interrelated and dependent upon each other. Think of the above example control loop as an instrumentation chain. Like any other chain, the whole chain is only as strong as its weakest link as displayed below.



The cable and conduit that links the Control Device to the Flow Meter and Valve become the weakest link in a hardwire application. Control loop wiring and data cabling are usually in conduit or cable trays that age and fail over time. Direct burial cables are costly and time consuming. Additionally, wiring can be damaged in many ways including trenching, flooding and electrolysis. These concerns can be eliminated utilizing wireless technology. OleumTech Wireless System technology provides a low cost solution that eliminates links in the control loop chain providing a robust, reliable system.

Figure 3 depicts the removal of the weak link (wire and conduit) in the instrument chain utilizing the same open loop failsafe control used in Figure 1 and replacing it with the OleumTech Wireless Solution. Utilizing Modbus serial communications from the Wireless Gateway to the Control Device has eliminated costly I/O modules; I/O analog to digital converters are replaced with computer based memory locations containing IEEE floating-point representation of the process variables. Floating-point representation can support a much wider range of values with greater precision. In addition, overall power consumption at the Control Device is lower, making it a cost-effective application in remote locations with limited power.

Figure 3: Wireless - Open Loop Diagram (Valve Closed)

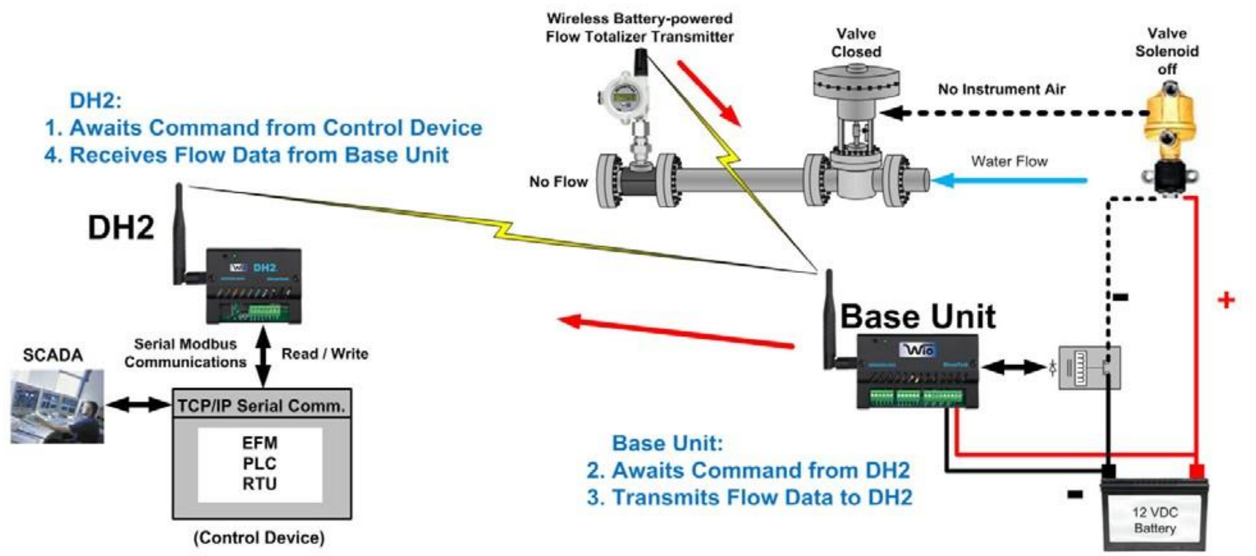
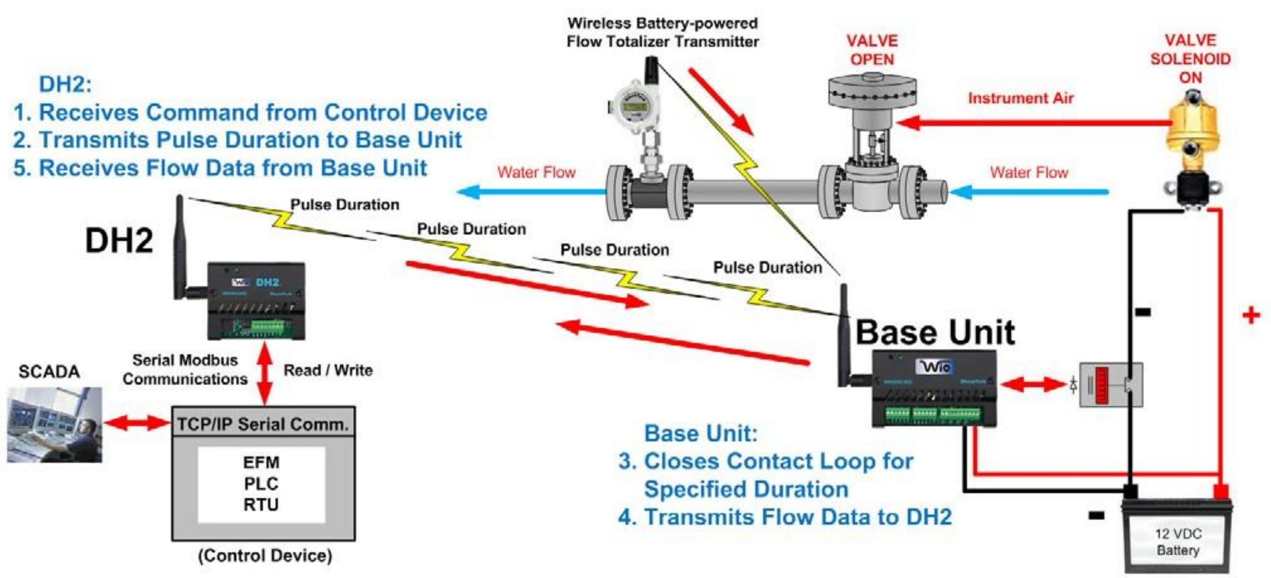


Figure 4 depicts a wireless failsafe closed loop. This wireless application will ensure failsafe protection if the DH2, Control Device or Base Unit electronics fail or loses power. The method behind this application is that all three computer based devices remain in constant communication. This is accomplished using serial Modbus communications between the Control Device and DH2 utilizing the pulsed output function of the Base Unit connected to the valve solenoid equipment.

Figure 4: Wireless – Closed Loop Diagram (Valve Opened)



The wireless fail safe closed loop begins with the Control Device constantly writing timed pulse duration values to a Modbus register in a DH2. Once the DH2 receives the write command, it immediately transmits the data to the Base Unit located at the valve. The solenoid at the valve is constantly energized thus holding the valve open. If the solenoid becomes de-energized, the valve will close and shut off water flow. The solenoid is energized by the open drain discrete output of the Base Unit that energizes the interposing relay. A "normally closed" state will keep the solenoid energized. This state is created by overlapping wireless pulse durations transmitted by the DH2. Consequently, if a pulse duration is missed because of wireless failure, an open state occurs and the valve will close. The same effect will occur if this loop was hardwired and the wire was cut or failed. The Base Unit can pulse an output for up to 25 seconds. When the Base Unit receives a new value, it starts the count over. For example, if the Base Unit receives a pulse value of 25 seconds from the Control Device every 15 seconds, a normally closed state is produced. If the Base Unit does not receive a pulse duration value, the discrete output will open at the end of 25 seconds and remain open until it receives another value. In addition, if the Control Device initiates a valve open and does not receive the wireless Feed-back transmission from the wireless Flow Meter the loop is not closed because of failure.

During normal operations the Control Device receives diagnostic data from the wireless Flow Meter and Base Unit. The Control Device can now monitor the status of the control loop and account for all successful RF transmissions by serially reading diagnostic Modbus registers in the DH2. For example, if the wireless Flow Meter is programmed to transmit data to the DH2 every 1 minute, a diagnostic counter register increments upon receiving a proper RF transmission. If the diagnostic register does not increment because of an RF failure, the Control Device can generate an alarm to the SCADA system just as if the control loop was hardwired and a technician or operator can be dispatched to diagnose the alarm condition.

The following chart illustrates how all parts must be in operation and communication. If any part fails, the valve closes whether it is Hardwired or Wireless.

CONDITION	RESULT
INTERPOSING RELAY FAILS	VALVE CLOSES
BASE UNIT FAILS	VALVE CLOSES
POWER FAILURE AT BASE UNIT	VALVE CLOSES
COMMUNICATION LOSS BETWEEN DH2 AND BASE	VALVE CLOSES
DH2 FAILS	VALVE CLOSES
COMMUNICATION LOSS BETWEEN DH2 AND CONTROL DEVICE	VALVE CLOSES
CONTROL DEVICE FAILS	VALVE CLOSES
POWER FAILURE AT CONTROL DEVICE	VALVE CLOSES

Before the existence of reliable wireless technology, a control manger only had one option: hardwired. With advancement in today's technology, even critical applications such as implementing a failsafe control system can be integrated using wireless technology. There are obvious benefits of hardwired and there are new advantages of wireless. When justifying reliability, cost, and time it takes to commission, it is hard to ignore wireless as a viable option.