CONTROL ENGINEERING
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New day for wireless control

Wireless control technology will be available to more users than previously. With this simple, secure, and reliable wireless control solution, it's a new day for process operations.

A new day has dawned for wireless control applications. With modifications to the proportional-integral-derivative (PID) algorithm, the ability to use wireless devices for most process industry applications has emerged. This new approach makes it possible to achieve control performance comparable to using traditional wired transmitters and wired valves.

The movement toward wireless began with the drive to improve plant operations. Plant managers saw opportunities for significant gains by accessing information about process operating conditions in remote areas. Wireless devices were the most cost-effective way to get access to remote areas, given that the cost of wireless installations is a fraction of the cost of a wired installation using traditional transmitters. Once plants gain experience using wireless measurements, next consideration is often looking for a way to incorporate these wireless measurements in closed loop control.

Wireless technology challenge

Manufacturing facilities have found that slow measurement updates and nonperiodic measurement updates present technical challenges to using wireless measurements in control applications.

The underlying assumption in process control has always been that control is executed on a periodic basis and that a new measurement value is available for each execution. That approach works when power consumption is not a factor. However, power consumption is a factor for wireless devices. To achieve a 5-year battery life, a communication update rate of 8 or 16 seconds is typically required in wireless control applications, as a chart with the online version of this article shows.

As a result, when using traditional PID control, the calculated reset and derivative action may not be appropriate in many applications.

Two communication techniques are most appropriate when implementing control using a wireless transmitter. When continuous (periodic) update is selected, the device wakes up at a configured update period, senses the measurement, and then communicates the value. For the window technique, the device wakes up at a configured update period, senses the measurement, and then communicates the measurement if the change in value since the last communication exceeds a specified limit or if the time since the last communication exceeds a default update time. Window communications is the preferred method since for the same update period less power is required.

In spite of the technical challenge presented by a slow measurement update rate, there are a limited number of applications where the standard PID can be used with wireless transmitters. For controlling very slow processes, such as level or temperature, the standard PID available in most distributed control systems is a viable option. Closed loop control with wireless transmitters that use slow communications update rates (8 or 16 seconds) will work as long as the process response time is at least 4 times slower than the communication rate. The reliability of most networks is better than 99.9% when using standard PID in wireless control. However, it is prudent to add logic to switch the control to manual in case communications are lost.

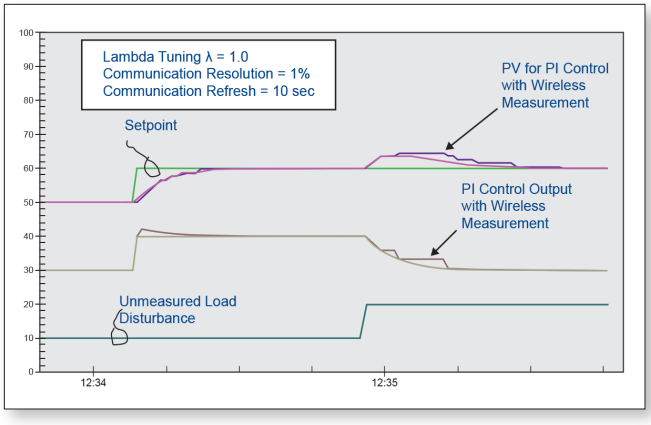

Figure 1: *Control for wireless measurement is shown. All figures courtesy: Emerson Process Management from "Using Wireless Measurement in Control Applications," ISA 2013*

Wireless control applications

From the beginning of WirelessHART standard development, the vision was that someday wireless devices would be used for control as well as for monitoring. In anticipation of the issues ahead, engineers began working on solving the problem by challenging previous assumptions about control.

What they discovered opens up the possibility of using wireless devices for the vast majority of applications in the process industry. The PID algorithm can be modified to correctly work with slow measurement updates, nonperiodic measurement

updates, and loss of communication to achieve wireless control performance that is comparable to that obtained using traditional wired transmitters and wired valves. The key is to understand that when the PID reset is implemented using a positive-feedback network, the time constant of the filter used in this network is a direct reflection of the process dynamic response. Based on this, the reset calculation of the PID may be modified for wireless control.

Positive feedback

In the PIDPlus implementation, the positive feedback network used to create the reset contribution is modified to maintain the last calculated filter output until a new measurement is communicated. When a new measurement is received, the reset contribution uses the new filter output as the positive feedback contribution. For those processes that require derivative (rate) action, the derivative contribution to the PID output is recomputed and updated only when a new measurement is received. The derivative calculation uses the elapsed time since the last new measurement.

Using PIDPlus, the reset calculation automatically compensates for setpoint change and measurement update rate. The derivative component accounts for a new measurement value not being available for each execution of the PID. Thus, there is no need to modify tuning for wireless control, that is, PIDPlus tuning is determined only by progress gain and dynamics.

Communications/Control	Number of Communications	IAE
Periodic/standard PI controller	692	123
Update using communication Rules/PI controller for Wireless	25	159

Figure 2: *Table compares communications and control comparison and improvement using PID algorithms.*

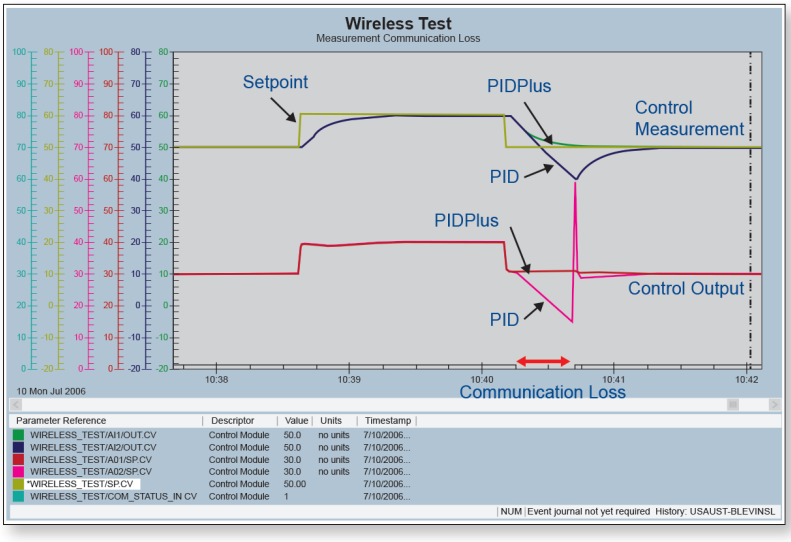

Figure 3: *Response for measurement loss is shown. For the past four years, PIDPlus has been a standard feature of the DeltaV distributed control system. Emerson DeltaV users can select the PIDPlus capability as one of the control parameter options. Starting in fall 2014, Emerson is offering it free to WirelessHART users through the HART Communication Foundation.*

When the PIDPlus is used with a wireless transmitter in a control application, the performance is comparable to that achieved using a wired transmitter. The closed loop response of the PIDPlus was tested for changes and unmeasured process disturbances where the wireless transmitter used window communications as illustrated in Figure 1. In these tests, the performance was compared to a standard PI controller where the wired measurement value is communicated as frequently as the PI control algorithm executes. In the example, window communications reduced the number of communications by over 96% when compared to the number of new measurement values used in control using the wired transmitter. The table, Figure 2, shows the difference in control performance with integral absolute error (IAE) for periodic measurement update vs. nonperiodic.

Traditional PID typically provides poor dynamic response; PIDPlus improves the dynamic response under these conditions. Figure 3 shows that PIDPlus provides improved dynamic response compared to the PID for the same conditions since the PIDPlus reset and derivative contribution are automatically maintained at last value on loss of communication.

A field trial was conducted as part of the Separations Research Program at the J.J. Pickle Research campus. WirelessHART transmitters were installed for pressure and steam flow control as part of a focus project on CO_2 removal from stack gas.

Using the original plant PID tuning, the same dynamic control response was observed for setpoint changes for both steam flow and column pressure.

PIDPlus is available in a commercially available distributed control system; users can select the PIDPlus capability as one of the control parameter options. From life sciences to specialty chemicals, users have successfully implemented reliable, real-time control with wireless devices.

Free licenses available

In fall 2014, Emerson Process Management will offer licenses for the PIDPlus wireless PID controller at no charge. The licenses will be available through the HART Communication Foundation to plants that use WirelessHART field devices, expanding use of wireless control. With this simple, secure, reliable wireless control solution, it's a new day for process operations. **ce**

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www.controleng.com/archives September, this article has more info and links. See chart: updates vs. battery life.