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Global fluid technologies provider integrates analog instrumentation and FOUNDATION fieldbus with smart I/O

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The Lubrizol Corporation, a global provider of specialty additives and fluid technologies that was founded in 1928, owns and operates 36 manufacturing plants in 16 countries. Its three research centers are located in Wickliffe, Ohio, Hazelwood, England, and Kinuura, Japan. In 2002, the company had revenues of $1.98 billion and earnings of $118.5 million.

Lubrizol's high-performance technologies focus on chemicals, systems, and services for transportation and industry. Its customers use this technology to enhance a wide variety of end-use products, including: engine lubricants and fuel; gear oils and other vehicle-related fluids; hydraulic fluids and emission control systems; greases and industrial fluids; personal care products and industrial cleaners; paints, coatings and inks; and mining chemicals.

Two years ago, Lubrizol's Deer Park, Texas facility elected to replace a portion of our legacy (installed in the 1980s) distributed control system (DCS) with a new, advanced process automation system based on FOUNDATION® fieldbus technology. The system, a DeltaV®, is a core technology of Emerson Process Management's PlantWeb® digital plant architecture. The project was undertaken in part to leverage advances in technology such as the FOUNDATION fieldbus to improve product quality, increase product throughput, and substantially lower our overall installation and operating costs. Existing analog instrumentation was to be migrated to the fieldbus network in a phased approach.

Our traditional approach to leveraging the advantages of hybrid/digital technology for analog field instrumentation has relied on HART® technology. However, a new generation of smart I/O instruments are providing cost-effective options to integrate existing analog instrumentation with the all-digital FOUNDATION fieldbus—maximizing the use of existing analog-instrumentation-based assets.

Project specifics

During the installation, we wanted to use existing plant assets such as plant wiring and cabinet space, wherever possible, but without sacrificing many of the benefits offered by our system. Figure 1 (below) illustrates a representative wiring diagram connecting our existing analog field instrumentation to the con-

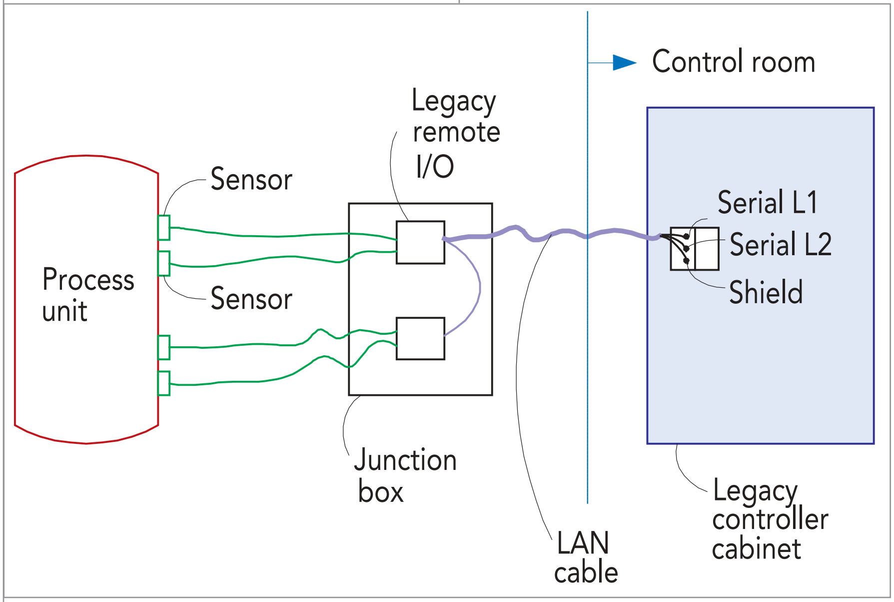

FIG. 1: Existing wiring shows analog connections from sensors to legacy I/O.

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trol room via dedicated local area network (LAN) cables.

To integrate the existing analog instrumentation with our new automation system, we evaluated three options:

1. Install new home run wiring,
2. Consider new remote I/O in place of the existing I/O, or
3. Use the existing cabinets and plant wiring by placing controllers of our new system in the existing remote I/O cabinets.

Obviously, the third option was the most desirable since it would generate the most cost savings compared to the other options. However, finding a solution to use the existing cabinets and plant wiring was challenging.

The smart I/O-based solution

We determined that the most cost-effective way to integrate existing analog instrumentation with our new control system was via the FOUNDATION fieldbus network. All we needed were smart I/O multiplexer (i.e., "smart mux") devices to:

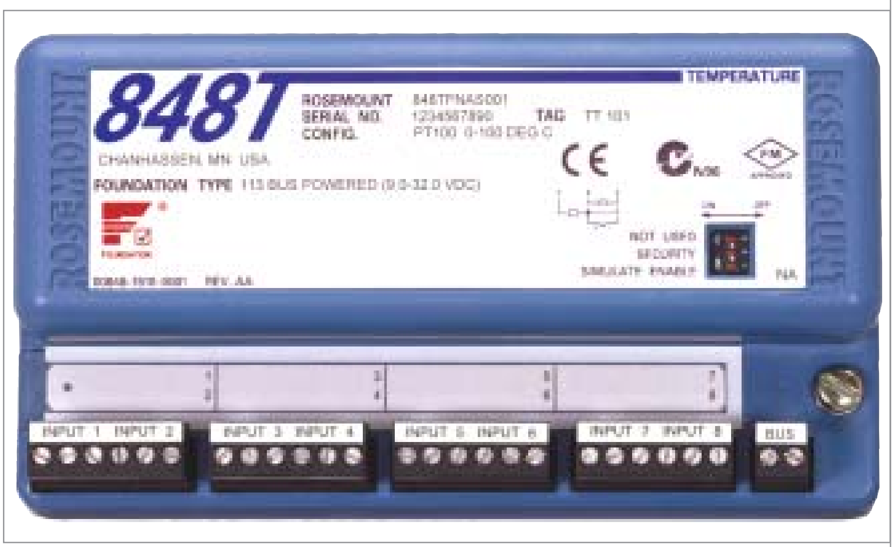

FIG. 2: The 848 temperature transmitter accepts up to eight analog inputs using the FOUNDATION fieldbus standard.

1. Receive multiple inputs from traditional 4-20 mA sensors (internally and externally powered) and convert them to corresponding FOUNDATION fieldbus outputs, and
2. Generate traditional 4-20 mA outputs in response to receiving corresponding FOUNDATION fieldbus inputs.

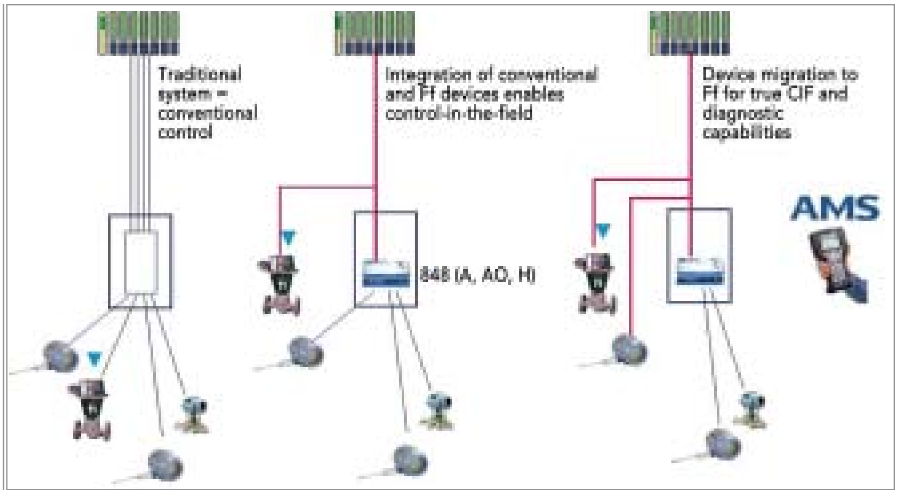

FIG. 3: A phased approach called for integrating analog instrumentation with the FOUNDATION fieldbus network.

Emerson's Rosemount 848 temperature transmitter (848T) based on FOUNDATION fieldbus turned out to be the smart mux device we were looking for. This device (Fig. 2) provided a cost-effective means to communicate up to eight analog measurements per transmitter using the FOUNDATION fieldbus standard. Up to eight analog input (AI) function blocks are available to communicate individual measurements with alarming. A multiple analog input (MAI) function block is available to communicate all eight measurements at once, if desired. In addition, four input selector (ISEL) function blocks may be used for selecting average, minimum, maximum, midpoint, or first good status temperatures.

The smart mux accepts eight independently-configurable RTD, thermocouple, ohm, and millivolt inputs. It may be mounted in the field, including in a hazardous area, close to the process equipment. The smart mux device is also suitable for mounting in intrinsically safe Class I/Div 1/Zone 0 environments.

The next step was to determine if the smart mux was capable of supporting our closed-loop control requirements. During the evaluation phase, we generated a dump of the legacy control system's database to determine the loop tuning requirements. Scan rates and loop execution rates were reviewed on the existing control loops and this data was used to verify that all the fieldbus devices under consideration would be suitable for our process.

To convert FOUNDATION fieldbus inputs to analog outputs, we selected the Smar FI302 smart output device (FI302). This unit is capable of generating three analog output signals.

The smart mux based migration plan

Based on our technical and economic project analyses, we are confident that we have a cost-effective integration/migration plan. It is based largely on the Rosemount 848 temperature transmitter, which is used to integrate our analog instrumentation with the FOUNDATION fieldbus network in a phased approach, as shown in Figure 3. In the intermediate phase, all existing analog instrumentation is received as inputs by this smart mux. In the final phase, selective analog instrumentation is removed from the smart mux device and replaced by a FOUNDATION fieldbus-based field instrument. The ultimate goal is to distribute control-in-the-field (CIF) by using FOUNDATION fieldbus.

As a potential future bonus, according to our vendor, the smart mux will be adding support for 4-20 mA/HART input. With this planned feature, we will be able to access HART diagnostic data over a FOUNDATION fieldbus network with access to the asset management system (AMS) capabilities.

Sizing and performance considerations for smart I/O and FOUNDATION fieldbus-based systems

Compared with handling automation projects in an analog world, the implementation of digital FOUNDATION fieldbus based automation projects requires new configuration, sizing, and performance considerations. For example, process performance may require that a control loop response time be less than or equal to one second. Like any other communications network, the H1 fieldbus network also has inherent communication throughput limitations such as handling up to 25 virtual communication relationships (VCR's) per H1 segment. Thus, process performance requirements may limit the number of devices present on each H1 segment.

In our case, we configured each H1 fieldbus segment to include no more than two smart mux devices and one smart output device to maintain a 1-second loop response. The number of smart mux devices that may be placed on each H1 segment may be increased for processes requiring a slower response.

To insure success, it is imperative that the following factors receive adequate attention, especially during the early phases of the project development cycle:

1. Configuration strategy,
2. Loop execution/scan rate requirements,
3. VCR limitations, and
4. Location of PID control— that is, PID execution in a controller or in a FOUNDATION fieldbus device.

About the author

Bruce L. Johnson is the I & E controls manager at The Lubrizol Corporation's Deer Park, Texas manufacturing facility. Bruce graduated with a B.S. degree in electrical engineering from the Tuskegee University in Tuskegee, Alabama, USA. He may be reached via e-mail at: bjoh@lubrizol.com