Analog, Discrete RIDE Device-Level Bus

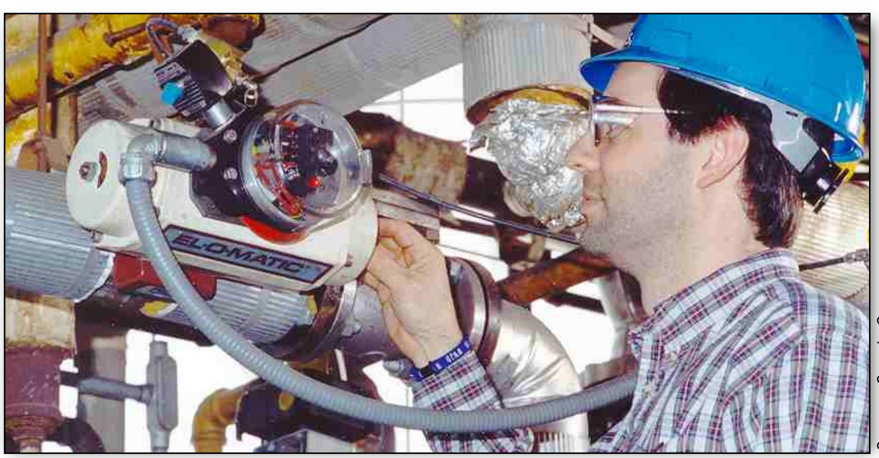
By James A. Mitchell

Disparate batch-chemical controls integrated through AS-i

At a small, batch chemical plant across the Hudson River from New York City, in Hoboken, N.J.—home of Frank Sinatra and the Stevens Institute of Technology—Cognis Corp. engineers wanted to tie analog and discrete devices into one easy-to-configure system to automate its plant in several phases.

But they found that at least 80% of the plant's total I/O was discrete. Analog and discrete control logic had resided in separate controllers as long as anyone could remember. The controllers didn't communicate with one another very well and sometimes didn't talk at all.

Engineers considered integrating all discrete devices into the Fieldbus Foundation's (FF's) H1 bus, something already used at the plant, but costs were excessive, and few discrete devices would be foundation registered initially.



Source: Cognis Corp.

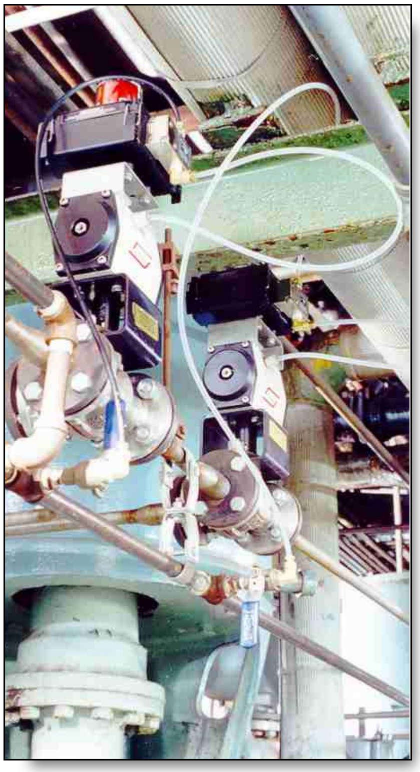
So Cognis investigated open, industry-standard, device-level buses for discrete equipment. Because such buses have their roots in discrete manufacturing and onboard electronics, the company had to ask about their suitability for process control. After evaluation, AS-Interface (AS-i) won out over DeviceNet.

Split Platform Cumbersome

In chemical manufacturing, most automation systems' analog devices were individually wired to a distributed control system that resided in a nonhazardous area. But discrete devices such as solenoid-actuated valves, motor starters, and switches are still normally tied to programmable logic controllers (PLCs).

These separate analog and discrete platforms were eventually tied together through a gateway linking their dissimilar control networks or, at a lower level, through serial links or even hard wiring. And this split-platform model for chemical plant automation worked, but it was complex, costly, and slow to engineer and install, and it didn't provide efficient communications.

The company didn't seriously consider incorporating both discrete and analog functions in a hybrid PLC and human-



Source: Cognis Corp.

Typical Class 1, Division 2 solenoid valve controlled by AS-i bus communications.

machine interface control system. That was because the engineering group didn't have the staff or time to develop such a system from scratch, as a large amount of development and programming work would have been required.

Cognis also lacked a global database and therefore would have needed to do extensive mapping. Such a system wouldn't have had the preengineered functions and scaling that make process controllers so analog friendly.

The engineers did consider integrating all discrete devices into FF H1. But they surmised that the cost would be excessive and that few discrete devices would be registered by the foundation, at least initially.

Discrete Climbs Aboard

Cognis began investigating open, industry-standard, device-level buses for discrete equipment. The goal was to cost-effectively and seamlessly integrate both analog and discrete buses into a scalable control system to automate its plant in several phases.

The company evaluated DeviceNet and AS-i bus and chose the latter. It is a two-wire, master/slave bus organized in a tree topology that engineers believed would provide the best combination of cost, performance, and features for the plant's batch processes. Reportedly, AS-i detects single and double faults with a certainty of 100% and all threefold and fourfold faults to 99.999%.

The engineering team started small, automating just one new process expansion. The implementation included control valves, transmitters, on/off valves, and starter relays. The plant planned to do later upgrades that would include additional fieldbus devices and 25 AS-i slaves on one network each. The controller would also handle hard-wired 4–20 mA analog devices and discrete devices that don't support FF H1 or AS-i bus.

For space and other reasons, Cognis engineers placed the process controller in a cabinet in a motor-control center (MCC) room. Although the controller itself was certified for hazardous areas, other electrical and electronic components in the cabinet were not.

Because bus cards take much less space than hard-wired I/O modules and termination blocks for an equivalent point count, the controller, when fully loaded, was relatively modest in physical size—and the cabinet relatively clean—for the degree of control involved.

For ease in troubleshooting and to avoid clutter, Cognis engineers terminated FF H1

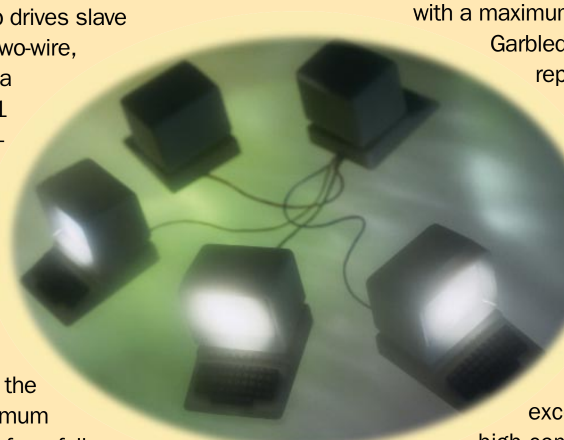
AS-i Offers Simplicity

AS-I bus is based on CENELEC standard EN 50 295. AS-i is less sophisticated than the FF H1 bus and most other discrete buses, which explains its lower cost. This robust digital bus was primarily designed for on/off switching.

An application-specific microchip drives slave logic and communications for this two-wire, master/slave bus. It's organized in a tree topology with a maximum of 31 slaves per network. Each slave handles up to four sensors or actuators, giving a total of 124 I/O points. The device interface has four configurable data ports (inputs, outputs, or bidirectional), four parameter outputs, and two control outputs (strobe).

AS-i bus also provides power for the sensors and actuators, with a maximum current of 8 A, or 258 mA per slave for a fully loaded segment. This will drive low-power, solenoid-actuated valves. If substantially more power is needed, AS-i bus can drive a remote AS-i relay module to switch an auxiliary power circuit typically rated at 2 A, 24 VDC per output, which is sufficient to operate motor contactors.

The master automatically assigns an address in sequence on start-up unless slaves have been preaddressed using a programming tool. The master polls slaves in order, with each slave's traffic in both directions completed before the next slave is polled. Message structure is compact and transmission fast: 4 bits (net) per slave and message (plus status), with a maximum cycle time of 5 ms for 31 slaves. Garbled messages are identified and repeated.



One of AS-i bus's advantages for process control is its acceptance for classified areas. Discrete valve communications manufacturers have been quick to introduce Class 1, Division 2 AS-i slave communications packages that typically control the solenoid and two limit switches.

The network floats, so it has excellent noise resistance, enabling high common-mode rejection.

The primary limitation of AS-i bus is its maximum drop length of 100 meters, although a repeater can extend that reach. Plants can avoid the short bus length problem if a Class 1, Division 2–rated controller can be placed near the process. Also, discrete devices such as valve manifolds are often grouped together.

and AS-i segments in dedicated boxes, even though both segments were carried in the same conduit. The other segment simply passed through the box. If the analog or discrete devices served were nearby, a flexible oil-tight conduit typically routed the spurs from the junction boxes. The company did not connect devices in a daisy chain, for maintenance and troubleshooting reasons.

New Vs. Old

Cognis saw changes or savings in several areas after combining the analog and discrete systems.

Less wire required. In a traditional hard-wired system, the number of control points handled by these digital buses would have required four to six 1¼-inch or 1½-inch conduits, with analog and discrete wiring separated.

The AS-i standard allows for a special molded cable, but Cognis didn't use it, opting instead for electrical conduit. AS-i bus doesn't require shielded twisted-pair wire and can be run in conduit with other control circuits. So the company pulled all wire—two twisted-shielded FF H1 pairs, four AS-i bus conductors (two networks), two AS-i auxiliary power conductors, and a 16-pair traditional control cable for future 4–20 mA use—through one 2-inch sealed conduit from the MCC room to a junction box in the manufacturing area.

Engineers noticed no signal degradation or cross talk in either of the buses, even with the wires carried in the same conduit.

Drawings consolidated. In the past, each device required a loop diagram. This time the engineering team used a single diagram for 25 AS-i slaves and 16 FF H1 devices. They didn't need maps of marshaling cabinets and termination boxes, and there were no wire pair numbers to assign and record.

Fast installation and commissioning. The Cognis team members found that fewer wires and terminations helped speed up the process. They also saved time by not needing to trace or ring out pairs. And with digital buses, inadvertent cross pairing can't occur. The control system autorecognized FF H1 devices and AS-i bus slaves.

Higher initial cost. Even though AS-i is a low-cost discrete bus, the cost to connect the first device is higher than the cost of conventional hard wiring and the first discrete I/O module. This is true for most digital bus applications. But as more slave units are added, the cost per device goes down. Cognis estimated that the hardware cost curves for hard-wired and AS-i bus intersected at about 10 AS-i slaves per bus.

The company's initial installation has worked perfectly since start-up. The plant collects large amounts of data from the FF H1 devices and uses the data to monitor and manage its instrumentation assets. The system detects problems with discrete devices because failure of any function in an AS-i device can be alarmed.

The engineering team's success in applying both analog and discrete buses has encouraged it to automate the entire plant using this architecture. The Hoboken plant's success is also of great interest to other Cognis plants around the world. **IC**

ABOUT THE AUTHOR
James A. Mitchell, P.E., is principal process engineer at Cognis Corp.'s Hoboken, N.J., plant. Contact him c/o editors at IC@isa.org.

Getting Automation Nearer

The introduction of digital fieldbuses and scalable, field-distributable process controllers has begun changing the architecture of process automation.

Controllers and analog I/O cards rated for Class 1, Division 2 environments now permit automation to be located near the equipment controlled. This minimizes conduit seals between hazardous and nonhazardous areas. One pair of the FF H1 can serve 16 analog instruments, carrying a wealth of data. Windows-based configuration enables autosensing as devices are installed, reducing commissioning time.

Digital Control Changes Plant Ops

Just as digital data communications changed the way organizations perform business, digital communications are changing the way goods are manufactured.

Less wiring is the most obvious argument for digital control networks, but the greatest advantage comes through utilizing the wealth of information digital control networks provide. "Once you go digital, you add equipment health data into your system," said Jim Gray, director of advanced development for The Foxboro Co. "You also get more precise data for process analysis."

Systems prioritize equipment health data so that the most important problems are taken care of first. Staffers then use asset management software packages to order parts and generate work orders before a sensor or valve fails. "One of our customers reduced its maintenance workload by two-thirds after going from a hard-wired to a digital system," Gray said.

Low-cost device buses for discrete control offer a significant advantage in maintenance costs. "The biggest paycheck is in preventing valve-related breakdowns," he said. "You can use a higher-level discrete bus like Profibus-DP or simpler, lower-cost buses like DeviceNet or AS-Interface."

And equipment health isn't the only advantage.

With digital communications, plant maintenance staffers can make many instrument adjustments from safe environments that would require going into hazardous areas with a traditional system.

For process design and control, more precise process data brings statistical process control to a higher level, allowing control and process engineers to boost efficiency through tuning and process changes.

Equipment manufacturers use newfound data to improve their products. "Since digital transmitters came out, we've seen great improvements in mean time between failure," stated Gray.

—Matthew G. Lamoreaux