Five Critical Factors for Selecting Fieldbus Valve Manifolds

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Introduction

In today's highly automated machines, fieldbus valve manifolds are replacing conventional hardwired solutions. They more easily perform vital functions by integrating communication interfaces to pneumatic valve manifolds with input/output (I/O) capabilities. This allows programmable logic controllers (PLCs) to more efficiently turn valves on and off and to channel I/O data from sensors, lights, relays, individual valves, or other I/O devices via various industrial networks. The resulting integrated control packages can also be optimized to allow diagnostic benefits not previously available.

Fieldbus valve manifolds from manufacturers such as Festo, SMC, and Numatics find wide utility in packaging, automotive/tire, and material handling applications, as well as in the pharmaceutical, chemical, water, and wastewater industries. They are specified for purchase by controls engineers at original equipment manufacturers (OEMs) who design and develop industrial automation solutions — as well as by end users in relevant industries.

This paper presents controls engineers, specifiers, and buyers with new insights into five crucial factors they must consider before selecting pneumatic fieldbus valve manifolds — commissioning, distribution, modularity, diagnostics, and recovery — while also outlining some shortcomings of conventional approaches. Finally, it highlights new designs that offer substantial improvements in the application, performance, and maintenance of these valve manifolds from the end users' and OEMs' points of view.

Factor 1 Commissioning: down with DIP switches

After purchasing a fieldbus manifold, the OEM's controls team must commission the manifold: mounting it on its specified automated machine; connecting network and I/O cables, power, and compressed-air supplies; configuring its parameters; and testing it.

On the connection front, when hundreds or thousands of connections are involved, time, difficulty, and costs quickly add up. Specifiers and buyers should consider innovative alternatives to mitigate commissioning costs. A few manufacturers now offer SPEEDCON M12

connectors, which need only a half-turn instead of the usual five or six turns to gain a secure connection, while still being fully compatible with conventional M12x1 connector threads. Buyers should also look for I/O layouts that do not space connectors too closely, so an average-sized hand is not impeded when installing multiple I/O connectors. Allowing free play for fingers will minimize the time needed to connect all necessary cables.

Connections are tedious, but configuration can be worse. Settings for communication protocols (e.g., DeviceNet, Ethernet, PROFIBUS DP, etc.), distribution options, I/O mapping, and other configuration parameters may well be the chief pain points in the entire commissioning process. A prime reason: the dreaded DIP switch.

Manipulating these tiny, often inaccessible 1960s-era switches is an exercise in frustration. The user must constantly consult cryptic instructions in unfriendly user manuals to identify each switch's function and settings. Visual feedback is limited to subtle positioning of the switch itself. (Does DIP stand for "dual inline package" or "damned invisible plastic"?) And on many projects, the aggravation is repeated across multiple switches on many different modules. Software configuration may sometimes be an option, but it usually requires proprietary software and hardware.

At least one manufacturer has adopted a 21st-century solution. Users should look for pneumatic fieldbus valve manifolds that actually embed a small graphic display on each module. This offers plain-language messaging that clearly identifies network addresses, baud rates, and other parametric data. The display is paired with pushbuttons that enable navigation through intuitive menus. Users receive instant visual feedback of set values with error-proof selections (i.e., inapplicable settings are disallowed).

This simple system represents a revolution in pneumatic fieldbus manifold interfaces. OEM controls engineers can now simplify and greatly speed up complex operations, including time-consuming and expensive configuration, parameterization, and commissioning of fieldbus communication modules (nodes) such as DeviceNet, PROFIBUS DP, Industrial Ethernet, and more.

Thankfully, this cutting-edge interface should also signal the imminent demise of those detested DIP switches.

Factor 2 Distribution: flexibility for sizable savings

Historically, conventional pneumatic fieldbus valve manifolds with integrated I/O modules have been designed within a relatively rigid architecture.

Dedicated fieldbus I/O modules would handle either valves or I/O — one or the other, but not both. So the OEM engineer would specify different modules for each task. He or she would also install multiple dedicated communication nodes on the machine's industrial network — each having high hardware and associated commissioning expenses (i.e., mounting, cabling, power distribution, etc.), while contributing to network throughput degradation.

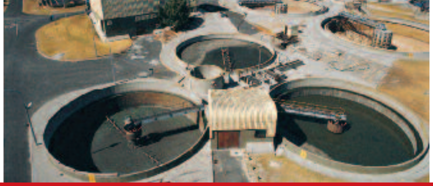
However, newer designs offer more flexible, significantly more cost-effective architectures. These provide fieldbus nodes that can handle both valves and I/O as well as the mutual distribution of I/O and valve manifold functionality around a given machine. Therefore, this allows a large number of I/O distribution options that optimize the physical layout of the machine while using only a few basic multifunctional modules.

Optimizing distribution lets the user lower network hardware investment, save time, and decrease the number of nodes on the network — thus optimizing network traffic and enhancing topology opportunities for network and power distribution.

These new systems take advantage of sub-bus technology that allows the same modules that traditionally were part of a centralized manifold to be detached and used in a distributed architecture. Engineers can now configure the pneumatic fieldbus manifold(s) and I/O the way the machine is laid out, without adding more communication modules (nodes). Since sub-bus modules don't show up as network nodes, the need for multiple PLC scanner cards is eliminated, while still allowing substantial I/O capacity.

Perhaps more importantly, on Industrial Ethernet applications, this architecture enables a reduction in the number of Ethernet switches and communication nodes. This directly decreases overall cost and system complexity.

For instance, a conventional design might require the use of four pneumatic fieldbus valve manifolds arranged with four EtherNet/IP network nodes. Instead, users should look for a system that allows optimal distribution. The user specifies only one main EtherNet/IP pneumatic fieldbus valve manifold, along with three sub-bus manifolds. Each sub-bus module is less pricey than an EtherNet/IP module — and requires no costly commissioning. In this example, the costs could be as much as 22% below those for a system requiring four conventional EtherNet/IP fieldbus manifolds. In addition, the main and sub-bus units utilize the same common I/O module components, simplifying ordering and inventory for both OEM and end user. Finally, only one port of the Ethernet switch is used instead of four — allowing for a reduction in the number of Ethernet switches.



Thus, new distribution designs offer the potential for substantial reductions in the combined costs of hardware, commissioning, and inventory. They can also accommodate and optimize various machine topology and application requirements.

Factor 3 Modularity: progress at a fast clip

Traditional fieldbus valve manifolds suffer from a fairly low degree of modularity. This presents challenges for OEMs and end users alike.

For instance, testing or usage may indicate that a particular I/O module is malfunctioning, or a late change order during assembly may require making an alteration. Conventional non-modular designs force the user to dismantle the entire assembly to get access, dismount the offending module, replace it, and then reassemble the whole fieldbus manifold or system.

By contrast, some new fieldbus manifold systems offer modular designs that simply connect together via easily removable clips and screws.

This allows easy assembly and effortless last-minute changes for OEMs. In another example, a given set of I/O cables may turn out to be too short to reach their associated manifold. With a conventional manifold, the user would be forced to order a whole new assembly. With the new modular designs, the user simply unclips the I/O module from the main pneumatic fieldbus valve manifold, positions it on the machine within reach of the cables, and connects it back to the main module via a sub-bus cable. All without disrupting the I/O mapping!

For the end user, modularity permits quick, trouble-free field changes. I/O modules can be removed and replaced without forcing the user to dismantle the entire pneumatic fieldbus valve manifold system. Further flexibility is provided by allowing the same module to be used in either centralized or distributed applications, reducing inventory requirements.

Factor 4 Diagnostics: get the LED out

If something should go wrong with the network or with a pneumatic fieldbus valve manifold on the plant floor, diagnostic indicators play a key role in locating the problem and identifying its cause to get the machine up and running quickly. Unfortunately, conventional pneumatic fieldbus manifold designs have given diagnostics short shrift.

Today, most fieldbus manifolds allow diagnostic data to be signaled to a human/machine interface (HMI), often located in a control room some distance from the machine or on a different part of the machine, away from the problem area. Moreover, this option requires programming at setup, and is considered too expensive by many users.

Another option allows the pneumatic fieldbus valve manifold to interface with a proprietary handheld HMI device. Simply plug this unit into a manifold module, interact via pushbuttons, and read diagnostic data off a small screen. But this optional handheld represents an extra expense over the manifold cost. It takes training to utilize properly. Its use often necessitates an extensive blind search — the user must plug in and read off data on numerous suspect modules before finally finding the culprit. And when needed most, the handheld always seems to be hidden in somebody else's toolbox — or in a locked drawer in an unknown office at the far end of the plant, during the third shift.

Finally, most fieldbus manifold designs offer diagnostic LEDs on the manifold system itself, right at the point of use. Unfortunately, this may be the worst choice of all. Many users carry painful memories of consulting cryptic instruction manuals while peering past tangled coils of cables and connectors at dim, diminutive LEDs: Are they on? Are they red or green? Are they blinking fast or slow?

Fortunately, new designs offer more functional alternatives. Most innovative is the module-integrated graphic display with plain-language messaging mentioned earlier. It provides users and OEMs with a wealth of point-of-use status and diagnostic information, plus setup and version tracking data at both the I/O-module and communication-node levels.

This arrangement places visual status and alarm indication away from tangled cables, in a clearly visible display area at one end of each module. It involves no programming or extra cost, and takes no training to use. Error messages are generated and cleared automatically, and blink to draw the viewer's eye immediately to the problem module. The display's associated pushbuttons allow the user to navigate quickly through intuitive menus for easy and effective troubleshooting. Some systems even log errors for future or remote analysis.

Factor 5 Recovery: do away with do-overs

A final topic closely related to diagnostics is recovery. In a conventional pneumatic fieldbus valve manifold, this is usually difficult and time-consuming. Once the user has finally isolated a fault to a particular module, he or she must then disassemble the entire system, remove the old part, and then start consulting manuals and determining DIP switch settings to enable the replacement part to operate properly. In effect, the new part must be commissioned from scratch, reloading all configuration settings. Once these have been finally set and rechecked, the new module can then be replaced and the fieldbus manifold system reassembled. Again, this is not a process for an untrained user — and it virtually guarantees substantial machine downtime.

However, the latest advancements in fieldbus valve manifold designs include an auto-recovery module option. During a critical failure, this module stores and protects all commissioning or configuration parameters originally input. When a new communication or I/O module has been clipped into place, this device recognizes it as a replacement unit and reloads all settings, configuration parameters, and other pertinent information into it.

The technology works automatically and transparently, without user interaction. It's part of the system, always available when needed; there's no removable memory device to misplace or lose and no batteries to maintain. There's also no need for a laptop or handheld configurator, no tedious reading of manuals, no parameter re-entries, and no recommissioning. It requires no special training. And it should greatly speed up repair, ensuring greater machine availability. Once the replacement communication or I/O module has been automatically recommissioned, the auto-recovery module electrically disconnects itself from the system. This ensures that external electrical spikes and other electrical noise influences can't corrupt its stored data. Safety and availability are maximized.

Solutions: winning new combinations

This report has highlighted several problem areas for conventional pneumatic fieldbus valve manifolds and pointed to innovative solutions now available to improve the experience of controls engineers, buyers, and specifiers with these products. A number of these improvements are combined in models such as G3 fieldbus valve manifolds from Numatics.

This new class of electronics platform for fieldbus applications helps address commissioning and diagnostic concerns by banishing the dreaded DIP switch and the equally ineffective status LED. Instead, these systems integrate a plain-language graphic display on every module, with accessible pushbuttons and intuitive menus for easy configuration, status checking, and point-of-use diagnostics. They also offer half-turn SPEEDCON connectors for even faster cable connections. They replace rigid architectures with a wide range of flexible — and cost-effective — I/O distribution possibilities, making the same components available for either centralized (main manifold) or distributed (sub-bus manifold) use. They provide simple clip-together modularity, eliminating the need for wholesale dismantling for changes or replacements. They offer an optional auto-recovery module to safeguard configuration data during a critical failure. Certain models even allow configuration and diagnostic monitoring online via standard Web browsers.

Conclusion

Choosing the best pneumatic fieldbus valve manifold for a given automated machine application presents several challenges. Of special concern are the problems that many conventional pneumatic fieldbus valve manifolds exhibit in the areas of commissioning, distribution, modularity, diagnostics, and recovery. Controls engineers, specifiers, and buyers should consider newly available designs that apply proven technology in innovatively simple ways to resolve these problems. Users report these solutions are delivering greater cost efficiency and wider application opportunities while considerably improving commissioning, use, and maintenance.

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