White Paper
Improved Diagnostics from Decentralized Solenoid Valves and I/O Systems
The minute you can get information from all the devices in a plant in real time, you have the ability to operate the plant, and maintain the plant in a significantly different way from the past. Real time operations data enables the plant to be “tuned” to operate in the most efficient or most profitable manner (they are not always the same) and provides the ability to apply the techniques of the other new information technology, Big Data. For maintenance and operations, being able to get information to and from all the devices in the plant in real time makes asset management practical in a whole new dimension.

Benefits of Asset Management

The basic benefits of asset management are clear. Proactive asset management can prevent extremely costly unplanned shutdowns. How costly is “extremely costly”? A catastrophic failure of a master pump in a refinery could cost not only the entire production of the refinery for the length of the downtime, but also additional costs from cascading failures of additional components. A failure of a temperature sensor in a biotech plant could cause the spoilage of literally millions of dollars worth of product. A missing additive in a batch, caused by the failure of a single solenoid valve, could result in scrapping the entire batch, at a cost of possibly millions again.

What you need to do is to see a failure coming, before it occurs. It is necessary to get the data in real time to be able to see those potential failures. The problem is that while that information does exist, getting it to plant operations and maintenance personnel in real time can be truly difficult.
Plant Health Intelligence
Information about the health of a control system, I/O module, even a field device, and sometimes including diagnostic events, is readily available through any DCS or PLC. But the use of diagnostics is only common when the controller and I/O subsystems are from the same manufacturer. In biotech or pharmaceutical installations, not to mention CPI and petrochemical applications this is not often the case.

In biotech and pharma applications, control cabinets, skids and even entire plant units are often procured from different machine builders or integrators. Each of these uses the sensors, valves and controllers that it has selected, unless the end user specifies otherwise. So most OEMs and integrators provide their own preferred sensors, analog valves, solenoid valves and controllers.

Unfortunately, it is not easy to obtain diagnostic information from different control systems and different brands of I/O, a different bus, or different manufacturers of sensors and valves. Because it can be difficult to acquire this information, it is usually underutilized. Sometimes, operators and maintenance personnel don’t even know that this diagnostic information exists.

This is especially true of pneumatically operated solenoid pilot valves. Control systems are optimized today for electronic devices. Pneumatic devices seem sometimes to be relics of another time. Yet solenoid air pilot valves, both centralized on a manifold or decentralized at the media valve, can provide quicker and more reliable control and their electrical brethren.

To be a world-class facility in the 21st century, all the field devices in the plant need to be connected to the control system and from the control system to the asset management software—including the pneumatic field devices like solenoid pilot valves.

Plant Networks and Fieldbus Connections
Plants have moved decisively to a single network using Ethernet. This network can be wired or wireless using IEEE 802.11x. But this kind of network has only recently begun to penetrate to the device level. Instead, there are a number of device networks, called fieldbuses. These include Foundation Fieldbus, HART, Proflbus, Profinet, Modbus, Ethernet/IP, DeviceNet, and several others.

Devices such as analog control valves, pneumatic valve terminals and field sensors and are commonly connected via fieldbus and integrated into the plant controls, the same way I/O terminals and secondary controllers are. The challenge is not all of these devices offer diagnostic feedback or it is not being utilized.

For examples of how to integrate Festo CPX/MPA range and access diagnostic information from your controller, please visit: www.festo.us/biotech/diagnostics

Both PLC and DCS control system vendors such as Emerson Process Management and Rockwell Automation promote diagnostics based asset management systems. It is possible to seamlessly interface any controller, I/O terminal, or pneumatic solenoid manifold into these systems but not all devices offer the same level of diagnostic feedback.

Emerson's CHARM I/O connects HART compatible field devices and communicates diagnostics back to the control system and the asset management system. Other Emerson I/O does the same for Foundation Fieldbus. But CHARMs are not designed to handle control and diagnostics of solenoid pilot valves mainly because for many valve manufacturers that technology is lagging.

Another common platform is Rockwell Automation's RSLogix systems which can connect with various brands of I/O and field devices using Ethernet/IP, but when you start talking about pneumatics valves the same issue arises. Similar to the Emerson example, manufacturer technology in most cases limits the functionality of pneumatic pilot valves to a simple on/off control.

The solution is to specify pneumatic solenoid valves with diagnostic capability, whether used for handling automation or piloting.
Advent of Diagnostics on Solenoid Air Pilot Valves
This is much more important than it may first sound. In a typical Pharma plant doing API production, there may be literally thousands of solenoid pilot valves in control panels, mounted on machines, and mounted on walls. While a typical solenoid lasts seven to ten years in an API plant, if any one of these valves fails, there may be a cascading failure that may ruin the process or batch that is being run. Having predictive diagnostics on these valves may save thousands of dollars, or even more, in the event of failure.

It doesn’t help to keep the plant from going off line if you have all the analog sensors and all the analog control valves producing diagnostic information, but the diagnostics from your plant’s population of solenoid air pilot valves can’t be seen. What inevitably happens is that the solenoid valve will be the point of failure that shuts down the plant or the batch reactor train, or the entire process, because predictive maintenance cannot be applied if the diagnostics from the solenoid valve cannot be seen.

It is good practice, then, to purchase solenoid valves, I/O, and controllers that have rich diagnostics built in. In most control systems a pneumatic solenoid valve appears merely as a digital output and a local LED.

Example of Performance and Value:
Versatile CPX/MPA integrated I/P is able to both pilot process valves and control inert gas flow directly to reactor vessels.

Pneumatic valve terminals are available today which can supply open load or coil current monitoring at the specific valve, pressure monitoring inside the valve terminal and even detect in a manual override has not been reset.
On the electrical side, the CPX terminal has combined five different I/O connection technologies for digital and analog I/O, and multiple I/P transducers can be mounted with the pneumatic valve and electrical I/O. Festo offers an option for IP20 high density digital I/O for cabinet installations, as well as the ability to support redundant bus control with embedded controller and isolated power zones for safety.

Detailed diagnostic functions are needed to locate the causes of errors in the electrical installation and reduce plant downtime. The Festo design begins with optionally color-coding valves and LEDs, which Festo believes simplifies validation and troubleshooting. Festo calls this on-the-spot diagnostics. Further point diagnostics are available from the manifold, or through the bus connection to the control system via explicit messaging. Festo on-the-spot diagnostics include undervoltage monitoring, fieldbus status, controller and I/P transducer status, and module specific diagnostics as well as valve-specific diagnostics and solenoid coil status.

Short circuit detection for sensors, outputs and valves is supported. Open load detection finds missing solenoid coils.

Festo's CPX series terminal also has on-board history, which can store the last 40 causes of errors, along with error start and end times.

Diagnostics can be also retrieved using a hand-held terminal, or by using Festo's maintenance tool software on a laptop, and are capable of being read out on the fieldbus interface and historicized to evaluate the causes of errors and failures. The series offers optional access via the integrated Ethernet interface for remote maintenance using PC or Web applications.

Selecting the Festo CPX series can provide a whole new level of diagnostics when the end user is specifying the I/O and solenoid air pilot valves for a skid or integration project.

Diagnostics and the Connected Plant
As the Internet of Things becomes more of a reality, and penetrates the industrial process and discrete manufacturing operations, the value of diagnostics will increase exponentially. Diagnostics will be critical to the acquisition of process data, and will provide the device health data that is necessary to fully enable predictive maintenance throughout the plant.

Most vendors of control systems have integrated diagnostics for electronic sensors and electronically-actuated control valves. Simple on-off valves, like solenoid air pilot valves, have often been overlooked because it has been a standard assumption that these valves are not as important as control valves, or field sensors. Pneumatic solenoids have been bypassed or ignored for diagnostic purposes for years.

But this will need to change, as all of the sensors and field devices in a plant become connected and smart.

In the pharmaceuticals and biotech industries, validation and GMP issues have increased the demand for real-time diagnostic information. At the same time, the increasing use of skid-mounted production processes has made the use of dissimilar control systems a near certainty. This means that end users must insist on diagnostics in every I/O terminal, in every sensor, and in every final control element on their skid. I/O must have easy diagnostic information transfer using fieldbus. Festo's CPX/MPA series provides a way to produce that as a plant standard.

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Further information is available on the web:
www.festo.us/biotech/diagnostics