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WHITEPAPER

Connecting the Pneumatic Circuit

Basics and benefits of connecting pneumatics to the Industrial Internet of Things

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Connecting the Pneumatic Circuit

Basics and benefits of connecting pneumatics to the Industrial Internet of Things

Pneumatics have gone hand-in-hand with industrial settings for nearly a century. Because it offers a simple and reliable way to get work done using compressed air, many manufacturers depend on pneumatics to this day.

A basic pneumatic circuit operates through the use of compressed air that is cleaned and regulated to the appropriate pressure. Valves are then used to direct the air to move the piston of an actuator, which is what carries out the work that needs to get done, such as moving, gripping, or lifting. Pneumatics are employed in a broad range of industries, including packaging, food and beverage, machinery, and more.

With the arrival of the Fourth Industrial Revolution (or Industry 4.0), pneumatics continue to evolve at a pace previously unseen. And what is powering this revolution are, among other things, advances in smart technology that connect industrial machinery and devices to the internet in an effort to facilitate automation and transmit data in real time. This is commonly referred to as the Industrial Internet of Things (IIoT). In fact, as connectivity becomes increasingly common in everyday life, growing numbers of manufacturers and industry leaders are upgrading their machinery to become part of the IIoT.

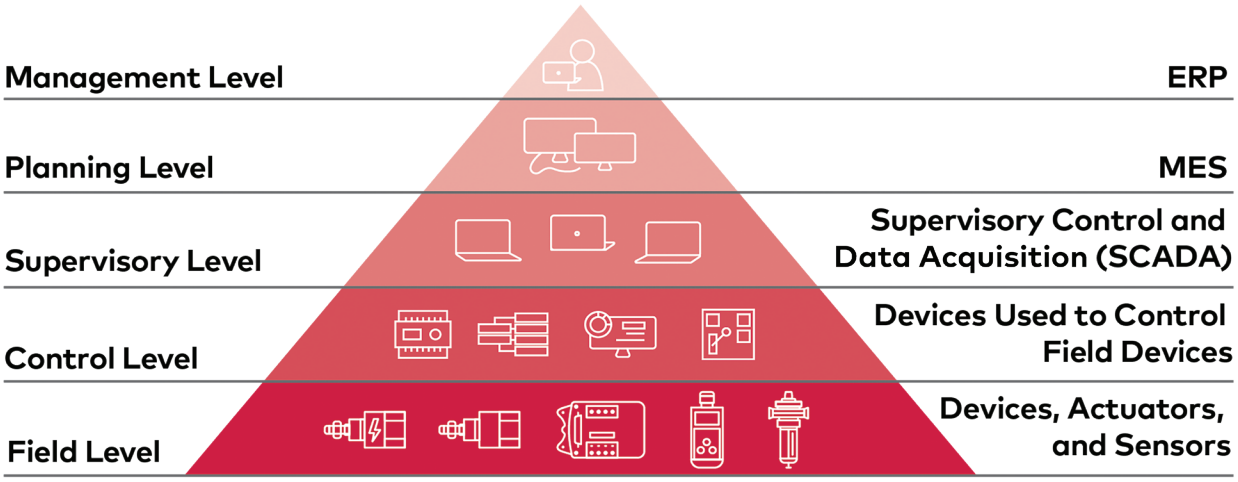
There are very prudent business reasons behind this move: as large numbers of the current workforce reach retirement without enough newer, skilled workers to replace them, finding solutions to maximize productivity and to make things easier for current workers has become paramount. At the same time, manufacturers need to find new and innovative ways to help extend the life of equipment, thereby reducing replacement costs. Investing in digitally connected technologies has the potential to accomplish both. Additionally, the ability to gather more insights from pneumatic equipment enables better decision-making to optimize production, as well as facilitating better environmental sustainability.

However, implementing a digital connected pneumatic circuit can seem complicated and daunting at the outset. To make this process more approachable, this whitepaper will help build a basic understanding of how equipment in the IIoT communicates, what information can be gained from pneumatic components, and the benefits of a connected pneumatic circuit.

How industrial devices communicate

When considering the use of a connected pneumatic system, it is important to first understand how devices communicate digitally with one another in an industrial setting, which is what makes connectivity and automation possible.

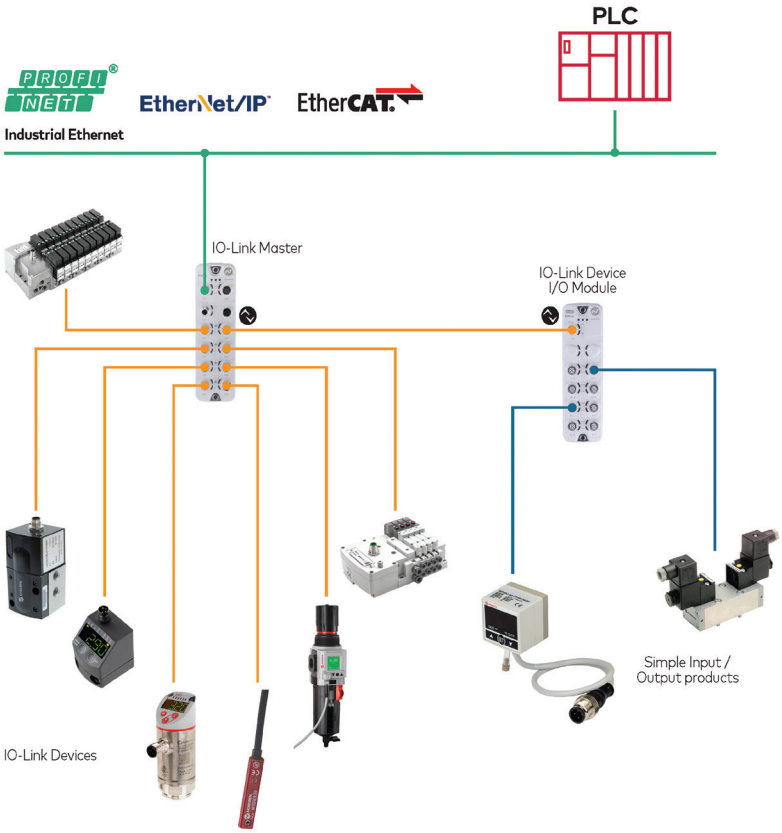
Manufacturing operations are complex, and there are several layers of automation in a factory or organization. A common way of visualizing these layers is in what is referred to as the automation pyramid, which helps to define how various devices relate to one another as they communicate.



At the base is the field level, which refers to the technology that actually does the work, such as sensors, actuators, and the like. Next, comes the control level, which includes the programmable logic controller (PLC) that directly controls the devices and equipment at the field level. Above that is the process management level, where humans typically interface with data being collected, and can control multiple machines. Following that is the planning level, which helps to monitor and make decisions for the manufacturing process as a whole, from raw materials through to the finished product. At the very top is the managing level, which oversees operations for an entire business, including all levels of manufacturing, as well as other departments.

A connected circuit primarily interacts with the first three levels (field, control, and process management), which are linked into a local area network (LAN) that allows them to communicate with other technologies on the network. Communication between various devices takes place through a communication protocol, which is essentially a common language that devices can use to share data. A protocol establishes the requirements and formats for structuring messages between devices. For devices to communicate, they must be able to support the same protocol.

The two most common kinds of industrial network are fieldbus and industrial Ethernet, which each have their own supported communication protocols. Because not all protocols are compatible with one another, it is important to have a PLC and devices that can support the same protocol family, so that they can successfully exchange information.



IO-Link helps standardize the information exchanged between a variety of devices while reducing the number of cables and different interfaces required.

One useful tool to assist in this is IO-Link, a communication system for connecting sensors and many other components – without any complex wiring – to a control system. It integrates into virtually any fieldbus or automation system to standardize information, so that it can be understood between devices and connect to the PLC. Ultimately, the goal is to enable all devices to communicate effectively with one another, so that the data they generate can be put to use.

Collecting data from pneumatic circuits

Within the realm of IIoT technology, exactly what kind of data can pneumatic devices generate, and how can they be used? Traditional pneumatic systems can function perfectly well without connectivity. However, they do not give engineers much detailed insight about their activities. Modern, connected systems, on the other hand, can provide useful data about various aspects of the pneumatic circuit, and how it is functioning.

There are several kinds of data that can be collected. For instance, in the case of an IO-Link connection, there are four basic data types available: (1) process data, which refers to the latest state of a connected device; (2) value status, which indicates the validity of the process data; (3) device data, which includes device parameters and diagnostic information; and (4) event data, which is information such as error messages, warnings and maintenance data.[1]

Additionally, connecting different elements of the pneumatic circuit can provide different information. In order to gather data as part of a connected circuit, a part must be able to support a smart digital connection. Each component of the circuit, as long as it is compatible with smart technology, offers something valuable to learn:

> ***Filter Regulator Lubricator:*** At the start of the circuit is air preparation, or the filter regulator lubricator (FRL). Sensors can gather information about the secondary pressure, which is the pressure of the compressed air that the FRL produces as output. If the pressure is lower than it should be, that can be an indicator that there is something going wrong in the FRL – for example, the filter may be clogged and needs to be replaced.

Using Norgren's Excelon® Plus air preparation equipment with an integrated electronic pressure sensor allows manufacturers to monitor secondary pressures and other application data.

Valve Manifold: For this component, in addition to controlling the valve operation, a variety of data can be gathered. For example: cycle count, voltage and short circuit diagnostics, temperature warnings, and communication error. Each of these data points can be used to diagnose the health of the valve.

Actuator Switches: At the business end of the circuit, actuator switches can detect the position of the piston to keep an accurate cycle count. That cycle count can be used to monitor productivity, and to determine the estimated life of the component, so that manufacturers can predict when the actuator will need to be repaired or replaced. It is also possible to monitor local temperature of the actuator. This can tell you if the actuator is generating too much heat and could fail prematurely or if the temperature in the immediate area may cause quality issues in your application.

Sensors: Additionally, sensors built into a pneumatic circuit can monitor the operating pressure of the system to identify leaks, or monitor temperature levels, which is critical for ensuring optimal productivity.

Input/Output Blocks and IO-Link Master: Analog devices can also be connected to a digital network to provide information. Input/output (I/O) blocks can translate input and output from an analog device into data. These can be connected to an IO-Link master, which, in turn, acts as a gateway, so that enabled devices – such as sensors and valves, and I/O blocks translating for an analog device – can connect to an Ethernet system.

The IO-Link Master acts as a gateway between IO-Link enabled devices and the higher level communication system, and can transmit data over various networks so that it is accessible for immediate action or long-term analysis.

Benefits of a connected pneumatic circuit

Clearly, there is a wealth of knowledge to be gained from enabling connectivity for various components in a pneumatic circuit. And gathering this information can have far-reaching benefits to a manufacturing operation as a whole. While there are many such benefits, this paper will only delve into a few:

Improved Efficiency: With a comparatively small amount of effort, manufacturers can more efficiently automate and monitor the function of their pneumatic systems. For instance, connectivity can help with monitoring compressed air consumption, identifying potential inefficiencies, such as leakages, which account for approximately 20% of total air consumption, and reducing both energy costs and carbon footprint.

Even a small change – such as the addition of an airline sensor to monitor operating pressure – can have a positive impact on operations. By setting it to provide a notification when pressure drops below a certain value, engineers can know exactly when a system is not operating at efficiency, and take measures to remedy the problem, such as changing the filter or repairing a leak.

Establishing connectivity does not need to be difficult, either. With some methods, it can be time-consuming to install or start up a connected component, as well as manually establish sensor parameters. However, this is not true of all sensors and connected devices. For example, a technology, such as IO-Link, only has to be plugged in to be ready to use, and enables users to configure and commission connected equipment quickly by reading and changing device parameters from the IO device description file, through the control system software. In the case of IO-Link, machine setup is also much faster due to manufacturer independent "point-to-point" connection that allows for seamless integration with all established Fieldbus/Ethernet systems.

Optimized Productivity: Connectivity can also meaningfully improve a circuit's performance. Operational and performance metrics can be remotely monitored, as sensors and other connected devices send out data in real time. This data provides insight on how the entire system is working, both as individual parts and as a whole. That information allows users to make adjustments, so that the whole system operates better – for example, maintaining the air pressure that optimizes energy use for the desired productivity. Having data pertaining to operations at the field level gives one the ability to make better decisions at the operational level regarding the best way to maximize productivity.

Reduced Downtime: Data from sensors can facilitate predictive and planned maintenance, notifying maintenance managers of necessary repair or upkeep before an issue becomes urgent or puts a stop to production. For example, by monitoring cycle counts and production levels over time, it is possible to estimate the actuator's life and predict its end of life, thereby enabling its replacement before failure.

Real-time transfer of data and continuous diagnostics make the health status of each device more visible to users. Errors, such as wire breaks or short circuits, are detected immediately, allowing them to be remedied much more quickly and reducing any associated downtime. This diagnostic data can even be accessed during operation.

The M/50 solid state switch, pictured above as installed on a Norgren P-series NFPA Pneumatic Cylinder, is one example of an IO-Link enabled device that can be used with an actuator to monitor local temperature and provide operation cycle counts.

If a component does fail, sensors can help to pinpoint possible sources of the failure to better facilitate the diagnosis and repair of the problem. Therefore, when a system is down for maintenance, it does not take nearly as long, saving manufacturers not only time, but also money.

Additionally, access to data for the entire pneumatic circuit, rather than just a single data point, offers a more comprehensive view of how the circuit is functioning. As a result, engineers can provide more cohesive technical support. And with a system such as IO-Link, even the replacement of sensors is simplified when failures occur — its auto-parameterization means that users only have to plug in the new device for the parameter settings to be imported, so that everything can get up and running more quickly.

Connect to the future with Norgren

While adding connectivity to pneumatic circuits can appear daunting, the benefits to doing so — providing manufacturing efficiency and productivity, while reducing downtime and overall costs — make it a worthwhile endeavor. Connecting with the experts to develop your solution can help you get the most out of the process. With a long history of motion control and fluid technology, Norgren can guide your transition to smart pneumatics, offering a portfolio of products to complete everything from a basic pneumatic circuit to a connected, IO-Link-enabled pneumatic system. No matter where you start – whether it is a single sensor or a completely connected circuit – updating your pneumatic systems is an invaluable way to make sure you are well-positioned to handle the manufacturing challenges in the years ahead.

[1] https://io-link.com/share/Downloads/At-a-glance/IO-Link_System_Description_eng_2018.pdf

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