White paper: A Practical Energy Efficiency Solution for Life Science Utilizing Industry 4.0
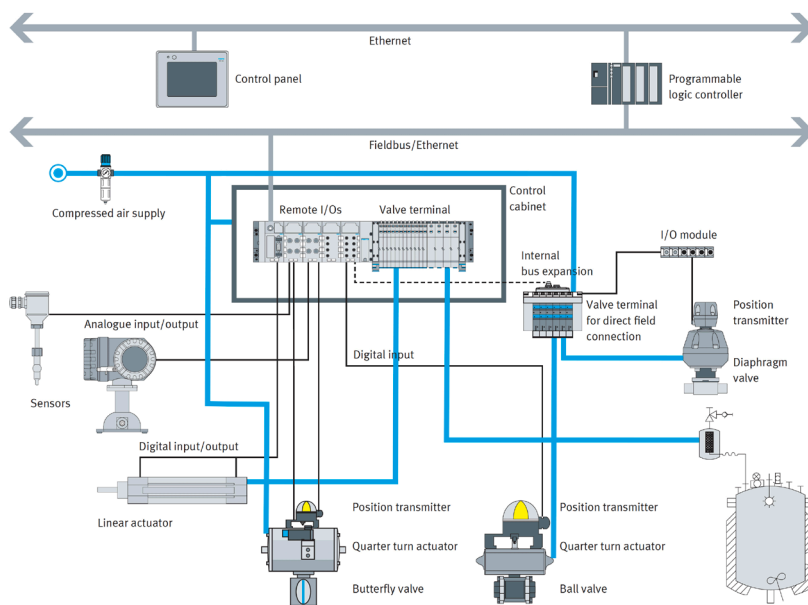
FESTO

"Internet of Things" (IoT) and "Industry 4.0" (I4.0) are buzzwords in the process manufacturing and automation world, with far-reaching benefits understood by most at a high level. But, what relevant and practical data and understanding can I4.0 bring your company in everyday operations, such as monitoring compressed air consumption, process optimization, enabling energy efficiencies, and providing preventative diagnostics?

This article will examine simple installation of IoT in a pharmaceutical production environment that will help with energy conservation efforts, provide predictive analytics for machine and manufacturing processes, and help pharma companies reach ISO50001 targets.

Compressed Air's Role In Automation And Manufacturing

Compressed air is a necessary component of automation in a modern pharmaceutical facility that end users need to carefully manage. It is considered a clean, safe, and readily available source of energy for automation and as such is commonly used in pharmaceutical, biological, and cosmetic production. From an environmental standpoint, electricity is required to generate compressed air and therefore contributes to the environmental footprint. Responsibly utilizing compressed air only as necessary, when necessary, is a best practice for "green" operations.

Typical Pneumatic Schematic

> **Scharnhausen Technology Plant**
> This is an actual example of the principle in action; many of the aspects of Industry 4.0 are already a reality in the technology plant. For example, employees cooperate in safe interaction with a flexible robot, which takes over assembly tasks that are ergonomically disadvantageous. A holistic energy transparency system will mean that all energy flows and consumption in the factory can be tracked in the future. And for service engineers, alongside their usual tools, the tablet represents the principal working tool: with the help of an app, they are able to detect and rectify machine faults as soon as possible and directly on-site.
>
> Visit the link here: http://bit.ly/scharnhausen

From a revenue standpoint, compressed air generation does have an impact on utility costs. Efficiency and benchmarking usage ensure control of future utility requirements over a facility's lifetime, which is financially responsible.

Further savings can be found in ensuring there are no compressed air leaks in your systems that lead to wasted air, equipment maintenance and downtime, and drops in productivity — more on this in a moment.

The standard convention for monitoring compressed air has been with pressure sensors on the air preparation units. When the compressed air pressure drops below levels required, the unit sends an alert to the programmable logic controller (PLC or DCS) letting the end user know a problem exists. From there, the system reacts and often shuts down; engineering or maintenance departments examine the equipment, diagnose the problem, and perform corrective actions. From there, production can resume.

However, measuring air pressure only addresses part of the equation. Air flow rates and volumetric consumption have been widely ignored within the industry. A new component, the E2M module from Festo, brings air flow monitoring and measuring capabilities to process manufacturers, furthering current proficiencies and delivering new opportunities for efficiency, as well as enhanced energy and revenue savings.

Two Innovations Combine For Smarter Use And Monitoring

E2M Module

The E2M seamlessly integrates with any existing or new manufacturing equipment requiring compressed air to operate. The unit serves as both a pressure sensor and flow sensor for compressed air, measuring the real-time flow rate and the volumetric consumption over a defined period. Over time, this data can be used to enhance machine efficiency and reduce compressed air consumption.

Festo E2M Module

For instance, in a given manufacturing setting, the E2M shows a system uses 27 liters of compressed air at standard atmospheric pressure for a specific, repeatable process, establishing a baseline. Down the road, the E2M shows the same process using 33 liters of compressed air per minute. Though the system hasn't failed, it's easy to deduce that the compressed air circuit has been compromised, the system is leaking air, and this is also an excellent indicator for predictive maintenance. Often leaks are hidden, causing inefficiencies that worsen over time, which can eventually become an unplanned equipment shutdown. The E2M provides the data required for predictive diagnostics regarding air flow and consumption, stopping manufacturing inefficiencies from growing into catastrophes.

The E2M is also capable of performing leak checks downstream between cycles. The unit will pressurize the pneumatic circuit and measure pressure degradation to determine if air is leaking and the rate of the leak. Further, while the system is idle or shut down, the E2M acts as a master on/off valve, preventing air loss through trickling.
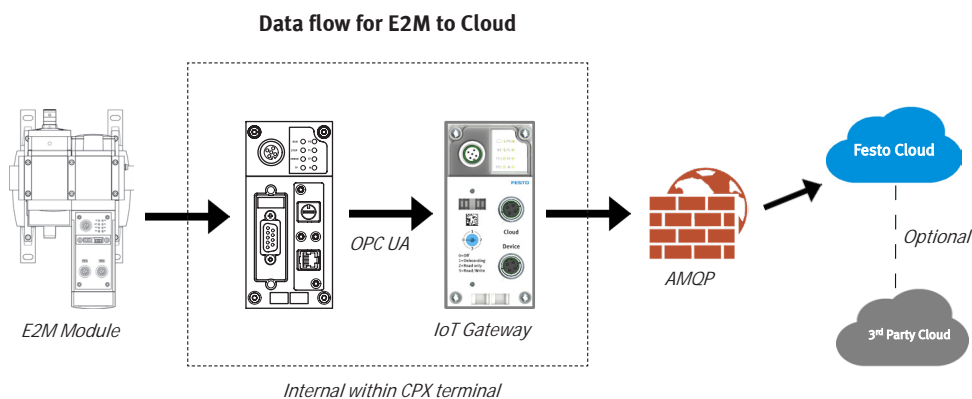
CPX IoT Gateway

The IoT Gateway integrates into the Festo CPX electrical terminal and brings the data from the E2M module, as well as other components and modules, onto a standardized, cloud-based dashboard for easy monitoring and benchmarking. Trends can be analyzed, early warnings can be issued, and incident notifications can be set up.

Festo IoT Gateway

The dashboards can be securely accessed in a web browser from any device with internet access. Simple traffic light indications, as well as graphic depictions of energy use, performance figures, and historical data are available on standard predesigned dashboards.

Data flow for E2M to Cloud

E2M Module *OPC UA* *IoT Gateway* *AMQP* Festo Cloud *Optional* 3rd Party Cloud

Internal within CPX terminal

The Gateway will automatically discover the E2M on the ethernet network. Safeguards for security are taken, such as a manual switch to control data flow to using secure protocols. It will aggregate the data and send it to the Festo cloud using the industry standard AMQP protocol. The dashboard is available by subscription from the Festo cloud and can be shared further to other dashboards.

It should be noted that the Festo E2M module can also directly interface with other third-party clouds, such as Siemens Mindsphere and Rockwell's Factory Talk/Shelby platform.

The result is a true I4.0 solution that can bring immediate benefits to a pharmaceutical, biological, or cosmetic facility.
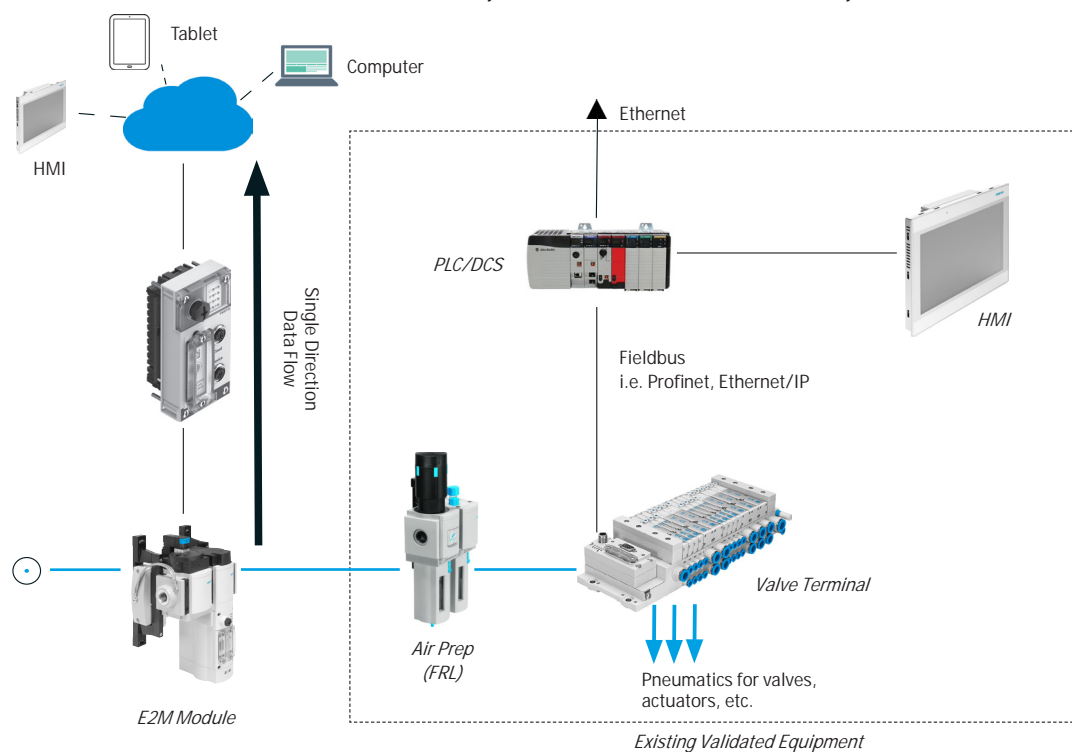
Two Practical Installation Concepts

An important attribute of the IoT Gateway for pharmaceutical installations is that it does not receive inputs from the cloud. It is pushing data only, so there is no risk to a validated process or skid. Based upon this, there are two installation concepts:

A Stand-alone Installation – outside the existing PLC/DCS, just gathering and pushing information to the cloud. This is ideal to realize the energy efficiency and preventative diagnostic benefits with no impact to an existing validated process.
In this case, the E2M is installed in front of the process, skid, or plant, usually directly before the air preparation unit responsible for the pressure regulation and filtration of the compressed air.

It can be powered directly and is connected to the IoT Gateway (GW) via Modbus/TCP, which will automatically recognize the E2M and configure the data to be pushed to the cloud. The IoT Gateway is installed in a stand-alone CPX terminal operating in an autonomous mode.

Example of Stand Alone Installation Concept

Tablet
Computer
HMI
Ethernet
PLC/DCS
HMI
Single Direction Data Flow
Fieldbus
i.e. Profinet, Ethernet/IP
Air Prep (FRL)
Valve Terminal
Pneumatics for valves, actuators, etc.
E2M Module
Existing Validated Equipment

In this scenario, because it is not connected to the PLC or DCS, some benefits of the E2M are not fully realized. The air leakage function that measures the air loss between processes cannot be triggered and the automatic air shutoff when the equipment is idle will not be realized.

The benefits are in the simplicity of the installation, which does not impact the validated processes and equipment, and it provides an organization with a risk-free way to evaluate data collection on operational efficiencies. There are no programming or commissioning changes required at the PLC/DCS.

A Fully Integrated Installation – connecting to the PLC/DCS, this brings additional functionality to the E2M and, in addition to the cloud dashboard, data is available at the PLC/DCS for local processing and analysis.

Ideal for new designs, this can be set up with an autonomous CPX electrical terminal or with a full-featured CPX terminal that includes operational modules for things like electrical I/O, IO Link, or pneumatic valves. In the latter case, it is connected to the PLC/DCS using standard industrial ethernet protocols like Ethernet/IP, Profinet, and EtherCAT. Function blocks (FBs) and Add-On Instructions (AOIs) are also available to quickly access E2M data and capabilities in the control software.

For plants with a decentralized automation concept, having these electrical terminals close to the process is very common. The integration of the IoT Gateway in a new design is not very complicated.

Example of Fully Integrated Installation Concept
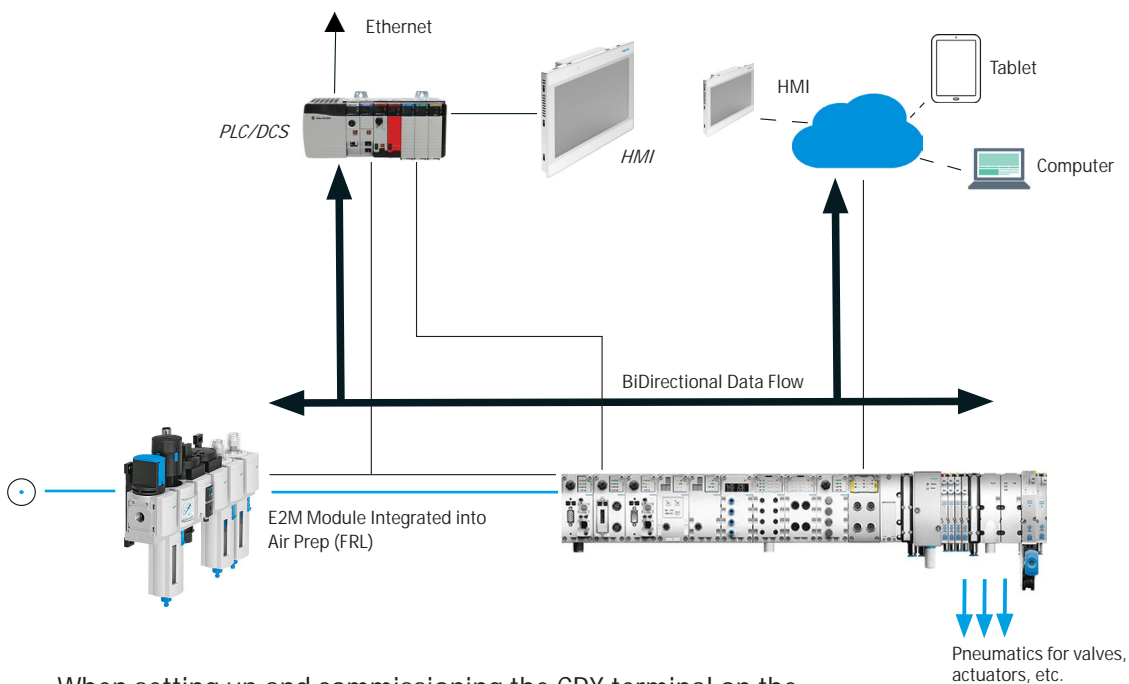
When setting up and commissioning the CPX terminal on the network, considerations must be made for the IoT solutions. Walk-through guidelines for this are available from the Festo website. Installing this into an existing facility would require validation review, so this needs to be considered.

The benefits are the same as the autonomous installation, with some additions: measurement of pressure changes and automatic shutdown when the system is not in production or process. These are configurable parameters, accessible from the FB or AOI, that allow customization for process requirements. The HMI can also have access to all the energy and diagnostic data for local dashboards and fault handling.

IComparing E2M/IoT Features for both Installation Concepts

Benefit	Installation Concept	
	Stand Alone	**Fully Integrated with PLC/DCS**
Ease of installation in existing validated equipment, no PLC/DCS changes. Pushes data only.	Yes	
Data viewable on cloud via Festo predesigned dashboard	Yes, with subscription	Yes, with subscription
Raw data suppled to PLC/DCS via fieldbus		Yes
Data viewable on cloud via Rockwell FactoryTalk predesigned dashboard		Yes, with Rockwell subscription and Hardware
Data viewable on cloud via Siemens MindSphere predesigned dashboard		Yes, with Siemens subsciption and hardware.
Supply data to other 3rd party cloud	Yes, with subscription	Yes, with subscription
Paramaterization E2M via Festo software	Yes	Yes
Paramaterization of E2M via PLC/DCS over fieldbus		Yes
View Asset Management Data (model, revision, serial number) on dashboard	Yes, with subscription	Yes, with subscription
Access historical information with time stamp on dashboard	Yes, with subscription	Yes, with subscription
Access historical information with time stamp at PLC/DCS		Yes
Measure current flow rate	Yes	Yes
Measure current pressure	Yes	Yes
Monitor pressure change	Yes	Yes
Measure volumetric consumption for a define period/cycle	Yes	Yes
Measure volumetric consumption for a day	Yes	Yes
Limit monitoring of pressure, pressure change, and flow rate	Yes	Yes
Detect standby condition and shut off air supply automatically.		Yes
Automatic detection and notification of leakages		Yes
Will replace airline pressure sensors and electrical on/off valve	Yes	Yes
Supports IoT protocols AMQP and MQTT	Yes	Yes
Connect other Festo devices via OPC-UA	Yes	Yes
Will support digitalization strategy of company	Yes	Yes
Will support energy conservation strategy of company	Yes	Yes

Industry Trends Driving The Solution

Monitoring and measuring compressed air is a relevant and practical avenue for using IoT/I4.0 in pharmaceutical manufacturing. Many large pharma companies' production initiatives — generating and using data for GMP, energy consumption and conservation improvements, operational productivity and efficiency, and improving revenues and margins — directly correlate to compressed air use.
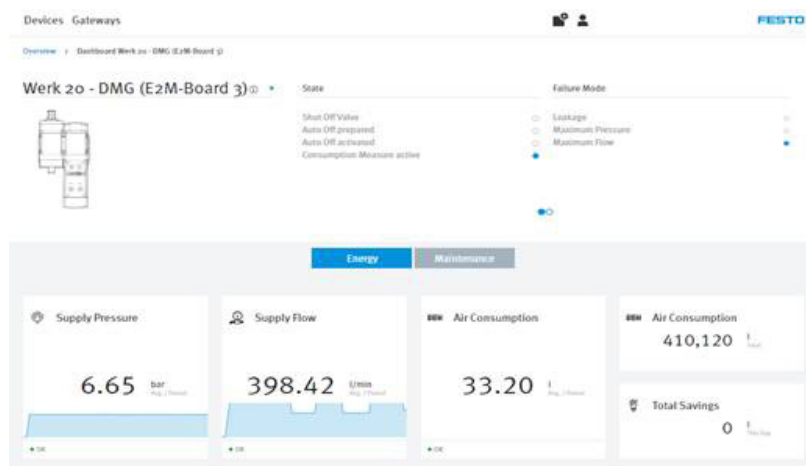
Sample Festo E2M Dashboard

ISO50001 is a recent standard that defines requirements, with guidance, for an energy management system. The standard is based on establishing, maintaining, and improving energy usage. This is being adopted and integrated into most major pharmaceutical companies. The ability to measure, detect, and report air consumption trends and losses is a critical part of achieving this standard and improving the energy performance of a company.

The Benefit Is Easy To Achieve

The E2M fits directly into existing air preps and filtration units of both new and existing process manufacturing equipment. The IoT Gateway module fits directly into valve terminals, the Festo I/O module, or a combination of both. Both products work over fieldbus, HMI, local networks, Festo cloud, and third-party clouds, and in unison to address manufacturing inefficiencies while providing useful and meaningful data.

Easy and real-time access to compressed air consumption data paves a smooth path to improving environmental footprints, lowering energy costs, improving efficiency through predictive maintenance, and, ultimately, bolstering bottom lines. Another long-term benefit is that this is a simple I4.0 application for data collection to understand operations holistically. It will help organizations identify and quantify real value and allow further digitalization strategies and investments to be effectively defined.

> **A Successful Implementation of ISO50001**
> Vetoquinol is the ninth largest veterinary pharmaceutical company in the world. It has completed a successful implementation of ISO50001 in its Lure, France facility. Read this press release to learn more about the social and economic benefits realized from its efforts in 2019.
>
> http://bit.ly/vetoquinol
>
> For details on ISO50001 Energy Management program, please visit
>
> https://www.iso.org/iso-50001-energy-management.html

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