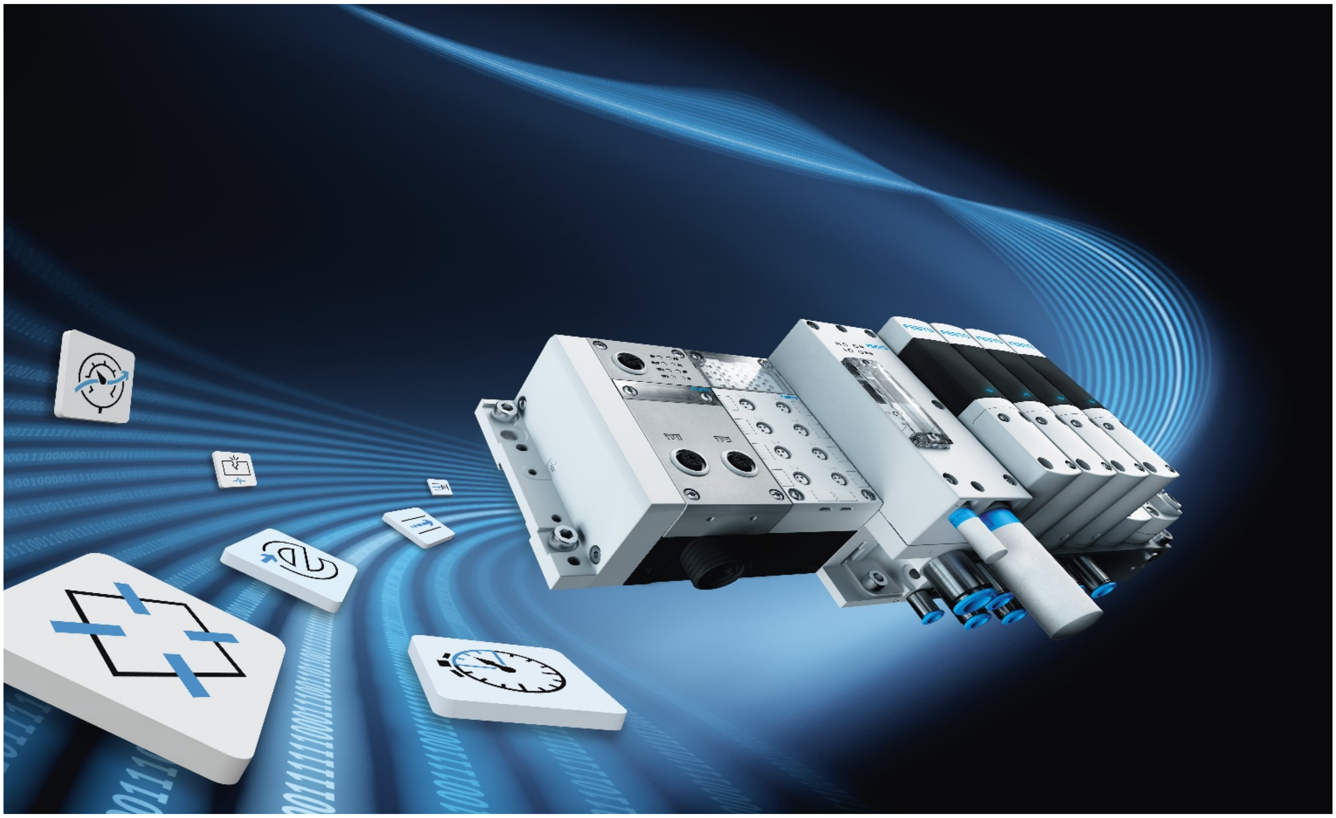
White Paper
Digital pneumatics: breakthrough in fingerboard control, safety, reliability



The advent of digital pneumatics promises to change how machines and processes are designed and managed throughout the industrial world. It's a technological disrupter with exciting potential applications in oil and gas exploration and production. This whitepaper describes a first application: using digital pneumatics to control and monitor latch opening on the fingerboard of an oil exploration platform. The benefits include cost and time savings in installation, a reduced safety risk for employees, lower energy cost and increased reliability through preventive maintenance.

This whitepaper includes information on:

- Digital pneumatics and what it means to industry
- Fingerboard operations – the conventional and digitally managed approaches
- Festo Motion Terminal VTEM – how it works
- Benefits of wire-free, monitored fingerboard operations
- Other benefits of VTEM for oil and gas drilling platforms

The promise of digital pneumatics

Digital pneumatics is a technological breakthrough, the biggest innovation in pneumatics in a generation. Digital pneumatics greatly simplify the planning, installation, operation and maintenance of a pneumatic system. In many automated processes, converting to digital pneumatics can eliminate the need for up to 50 different components – sensors, pressure regulators, flow control and exhaust valves – throughout the compressed air delivery system. All of these functions are performed instead by a radically new type of valve terminal, the Festo Motion Terminal VTEM.

Festo in the lead

Festo launched the age of digital pneumatics last year with the introduction of VTEM. Software in the form of motion apps, combined with new, flexible valve technology – both resident in the Motion Terminal – can perform all of the functions of a conventional valve terminal as well as those other components along the compressed air line to the pneumatic cylinder. A motion app can perfectly synchronize multiple cylinders, continually fine-tuning their performance. By managing the air supply, another motion app can even eliminate the need for damping or end cushioning on pneumatic cylinders. The user can set up, monitor and change processes via these apps, rather than having to adjust or replace valves and other components manually for changes in production. Other motion apps can optimize energy use and perform diagnostics to detect air leakage.

Using motion apps on the fingerboard

Among the Motion Terminal's many innovative features are its integrated, intelligent sensors. This particular aspect is at the heart of the first application using VTEM in the oil and gas sector – employing its motion apps to control and monitor pneumatically-driven latch opening on the fingerboard of an offshore oil drilling platform. Employing VTEM in this application delivers cost and labor savings, improved operational reliability and energy efficiency, and enhanced safety when compared to existing control and monitoring solutions.

Inherent risks with fingerboard control

A majority of large oil drilling platforms worldwide use pneumatics to open and close racking system latches on the fingerboard to store or release lengths of tubular pipe. Latches can be opened manually, but that function is increasingly automated, managed remotely from the control room (drill cabin) below. On large rigs, there can be hundreds of latches on the fingerboard. Since fingerboards are located at 85-90 feet above the main deck, exposed to rapidly changing and often harsh weather and corrosive sea mist, pneumatics are an ideal choice.

Pneumatics outperform alternatives

Both electrical and hydraulic actuation are more expensive alternatives to install and maintain. The great torque provided by a hydraulic actuator is simply not needed to open a latch, but drives up the cost. And electric actuation in such an environment requires a huge investment in hazloc-certified components and wiring. Pneumatics are the most reliable and cost-effective solution. The pneumatic cylinder on the latch presents no ignition risk – thus simplifying hazloc compliance. Typically, Festo uses a specially designed variant of its basic DSNU round cylinder to open and close the latch (Fig 1). The cylinder barrel is made of stainless steel, has a specially coated spring inside and customized end caps to facilitate installation on the latch.

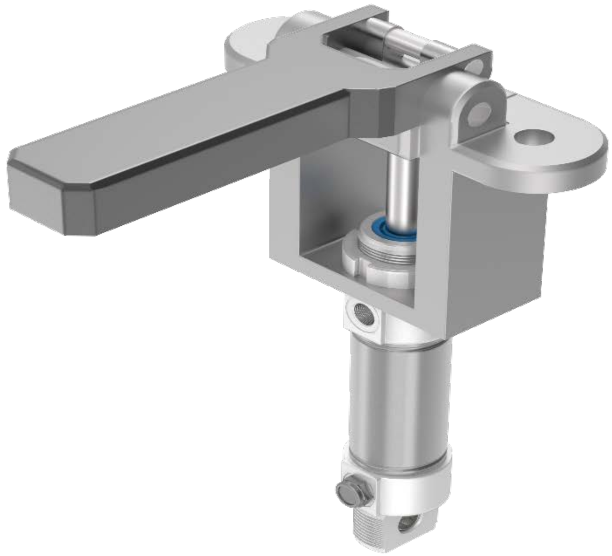


Fig 1. A pneumatic cylinder-latch combination. The extension of the cylinder piston rod under pressure opens the latch, a spring in the cylinder closes it.

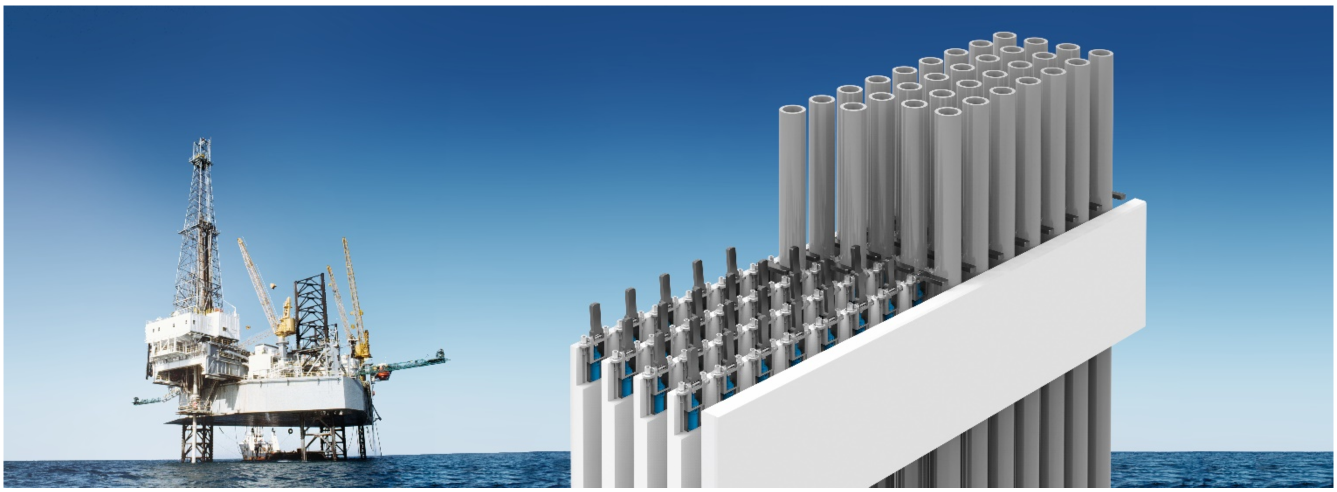
The monitoring alternative: pros and cons

Any automated latch opening control system can be monitored electronically so the control room knows immediately if a latch has failed to open or close, even why. A latch in the wrong position can cause an operational disruption and present a significant added safety risk. Under heavy sea conditions, a latch that has not closed as it should can result in pipes dislodging and crashing. The finger itself could be damaged. If staff know there is a problem, they can halt an operation before it can cause a dangerous or disruptive incident. With a proper monitoring system, they might even get advance warning of a potential problem that would allow them to perform timely, pre-emptive maintenance without halting drilling activity.

Trouble can strike without warning. It can happen when weather conditions for troubleshooting a latch failure are less than ideal. A worker must scale the 85 feet to the fingerboard to locate the frozen latch, identify the problem and fix it. Often, the safety risk inherent in sending a worker up the mast is amplified by the urgency of the situation and prevailing conditions. Fingerboard equipment is exposed to a corrosive atmosphere. Wide temperature fluctuations can make metal shrink or expand. With a pneumatic system, a latch-opening problem could originate anywhere along the compressed air supply route. It could originate with failing tubing or fittings, a malfunctioning sensor or a worn cylinder seal allowing compressed air out or moisture in. Or it could be the pneumatic system is fine but the latch itself is frozen. The longer it takes to locate the problem and make repairs, the longer it may take for normal activities to resume.

Regardless of the automated latch-opening technology used, many rig operators opt for cost reasons to “fly blind” – with no sensor or other indicator to tell them if a latch is open or closed. With pneumatics, creating a monitoring capability has involved placing a sensor on the pneumatic cylinder and wiring it to the control room. The sensor and signal cable must be both robust and hazloc-compliant because of the introduction of an electrical ignition source.

If there are 400 latches on the fingerboard, that means 400 expensive sensors, 800 initial hardwired connections – a lot of work for an installer, with the inherent risk of wiring errors – and as much as 34,000 feet of specialized wiring. (The alternative, optical verification by closed-circuit television, can inform the control room whether a valve is open or closed. However, it doesn't provide an alarm – the TV screen has to be constantly watched during operations – and it doesn't provide any information about the location or nature of the problem.) Rig operators that install a feedback system can expect gains in operational reliability and worker safety. In today's more stringent regulatory environment, and considering insurance liability, that cost is becoming easier for operators to justify.



Festo Motion Terminal: the next generation solution
Still, if there was a more cost-effective and safer solution for providing the control room with monitoring and feedback of latch opening, more companies would consider it. Festo's answer is to deploy the new Motion Terminal for fingerboard latch management. VTEM fulfills the functionality of conventional valve terminals, and is suitable for both new installations and retrofits.

Sensor function internalized
VTEM not only controls and regulates the air flow to the cylinder as does a conventional valve terminal, it internalizes the sensor (feedback) function for each latch opening. That dispenses with the need for placing a sensor on the cylinder, all the associated electrical wiring, the labor of making initial connections and the need to stock replacements for those parts. Removing the sensor and wiring eliminates a potential ignition source; the only link between the VTEM unit and each cylinder is the air supply tubing. In lieu of that hard-wired sensor, VTEM's End Position Detection app calculates the volume of air flow in each compressed air feed to determine the position of the latch, providing the control room with a continuous status for each one. It can signal whether the latch is open or closed, or whether the pneumatic cylinder is blocked in between. The open position is defined when the piston rod in the cylinder reaches the end position. The Motion Terminal also provides new opportunities for preventive maintenance that can be undertaken in ideal conditions to substantially reduce the possibility of a latch failure at an inopportune time. Each time a worker doesn't have to go up the mast under intense time pressure to fix a problem represents a net gain for safety. That makes VTEM an important safety enhancement and part of a good risk management strategy.

How VTEM works
The Motion Terminal embodies a valve design with multiple degrees of freedom for actuation, as well as integrated data acquisition and processing like a true cyber-physical system. It's a bold step into the world of Industry 4.0. Its unique technology includes valve electronics with sensors – the integrated stroke, pressure and temperature sensors that provide optimum control and transparent condition monitoring. It has powerful on-board processors for decentralized intelligence, plus software function elements – the motion apps. VTEM valves are not restricted to performing a single function like standard valves. With the apps, each valve can be used to execute a wide range of functions. Motion apps also can optimize the performance of the pneumatic system through selectable pressure regulation and managing supply and exhaust flow control.

Leakage diagnostics: key to preventive maintenance
Another VTEM app – Leakage Diagnostics – conducts diagnostic cycles that allow operators to detect and locate leaks in the compressed air network. It also promises to reduce energy waste and hence energy expense. The diagnostic and management capabilities of VTEM motion apps also have great promise to help improve the safety and reliability of blowout protectors by ensuring the operational readiness of its pneumatic actuation functions. The Festo Motion Terminal is a more sophisticated piece of equipment than a conventional valve terminal, and hence more expensive, but the benefits it provides – including its internalized control, sensor, optimization and diagnostic capabilities – make it a more cost-effective solution overall for managing pneumatics on the fingerboard.

In conclusion

Employing a Festo Motion Terminal VTEM applies a new technology – digital pneumatics – to controlling and monitoring latch opening and closing on oil rig fingerboards. While performing all the functions of a conventional valve terminal, VTEM also conducts wire-free monitoring of the pneumatic cylinder to provide feedback to the control room on the position of each latch. This eliminates the need for a hazloc-compliant wired sensor on each cylinder, removing that ignition source from the fingerboard and generating significant labor and other cost savings associated with the installation and maintenance of wired monitoring. Motion Terminal software apps also can perform system diagnostics as part of preventive maintenance and increase energy efficiency throughout the pneumatic system. With these potential benefits, VTEM-based pneumatic latch control and monitoring can deliver a lower total cost of ownership, while reducing safety risks and improving operational reliability compared with conventional control and monitoring solutions.

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