REPORT

Outperforming traditional Valve design meets smart monitoring system for pneumatic and hydraulic valve actuators

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Unexpected or unscheduled downtime of a critical valve in a chemical or oil & gas site will lead to high costs. A newly developed integrated solution helps detect failures before they occur. This technical report presents a smart monitoring system for a fluid-powered actuator on top of best-in-class Tripple Offset Valve.

Safety Instrumented System (SIS) play a key role in predictive maintenance. Safety requirements are a must in every plant, more so in critical processes applications and this is when engineers, planners, operators and EPCs strive to find the best solutions for their sites. These also helps protect the personnel and the plant from hazardous conditions.

SIL ANALYSIS AS BASIS

The Safety Integrity Level (SIL) serves as a method for identifying the potential risk to humans, systems, devices, and processes in the event of a malfunction. As part of a risk assessment and SIL analysis in accordance with IEC 61511/61508, the operators having safety-related functions define the safety integrity level for that particular safety function.
The calculated data determine the default rates (**Figure 2**). These characteristics helps assess the level of safety integrity according to the standards. An actuated valve package can guarantee the corresponding SIL capacity for a certain time. This requires actuation controls that can be used to generate advanced diagnostics.

ELECTRIC VALVE ACTUATORS

Electric valve actuators offer many advantages—such as enabling preventive maintenance, partial stroke tests, time-stamped event logs, and communications via standard protocols—and have been successfully implemented in a range of applications and industries. Thus, many greenfield projects are equipped directly with electrics, such as Emerson's Bettis XTE3000, rather than conventional air-powered actuators with a control unit.

SIL requirements are no longer a problem barrier for adopting electrics due to the integration of a SIL module into the control of the electric actuator. If an alarm is triggered in

Source: Emerson

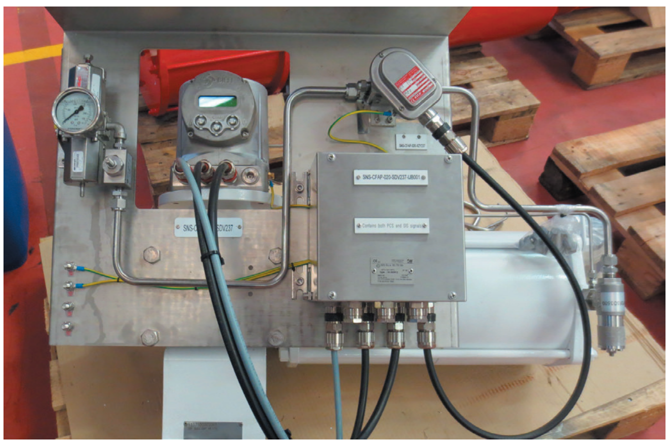


Figure 1: Control Panel Low Pressure

Source: Emerson

SIL-Level	Risk-Factor
SIL-4	100.000 - 10.000
SIL-3	10.000 - 1.000
SIL-2	1.000 - 100
SIL-1	100 - 10

Figure 2: SIL- failure rates

the ongoing process with a downstream safety function, it is immediately and primarily executed.

PNEUMATIC AND HYDRAULIC VALVE ACTUATORS

But what if the requirements include compressed air or hydraulic energy? The safety function of the pneumatic actuator is usually to take the desired position of the actuator when the alarm is triggered to shut off or release a volume flow so that they are single channel (1-ch) up to SIL2 or redundant configuration SIL3 or SIL4 with redundant systems.

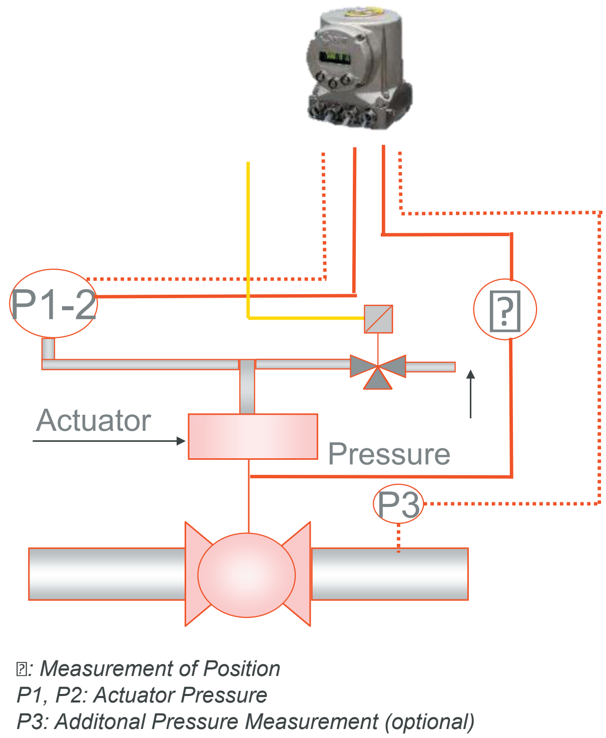
Pneumatic low-pressure actuators and especially hydraulic high-pressure solutions are often used as emergency shutdown (ESD) devices designed to stop the flow of a hazardous fluid upon the detection of a dangerous event. These devices are usually used to control the functions of a control unit using additional smart valve positioners and analog limit switch boxes, with a smart electric valve actuator added to gain benefits from it.

ESD functionality is usually only tested during planned maintenance events (STOs) by a full stroking test (FST), in which the valve is completely opened or closed. This is because the system cannot be tested during operation, as it would disrupt the process and prevent the maximum production capacity from being reached. The ESD mode typically switches the solenoid valve off from the power source, and the valve moves into its emergency position. However, this would mean a disruption of the process.

INTEGRATION IN CONTROL SYSTEMS

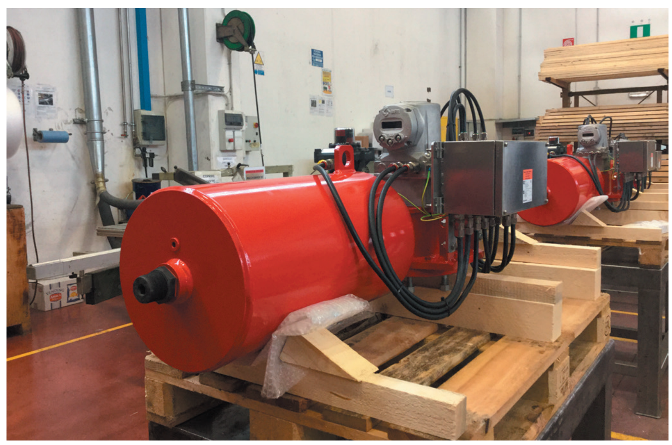
What are the existing possibilities for integrating the actuator into a control system? For this purpose, it is strongly recommended to use an actuator that helps to ensure the functional safety standards, without disturbing the production process during test verification. This is an intelligent, integrated, manufacturer-independent monitoring system for fluid-powered (pneumatic and hydraulic) valve actuators—Emerson's Smart Integrated Valve Monitoring Device, or IMVS—an intelligent partial lifting device particularly suitable for preventive diagnostics in valve solutions that use compressed air or mineral oil as a working medium.

The sensor-integrated, electromechanical IMVS is operated on single (spring close/open) or double-acting pneumatics, as well as hydraulic actuators, mounted analogously to a limit switch box, and controlled by a separate single or redundant solenoid valve. Diagnostics, operational insights, and safety functions are thus guaranteed. The SOVs (solenoid valves) used are explicitly tested for each partial stroke test, as they



Source: Emerson

Figure 3: Simplified function diagram of the IMVS



Source: Emerson

Figure 4: IMVS mounted on a Scotch-Yoke Actuator

are switched voltage-free at the same time at the start of the test. Still, it is also possible to test the functionality of each SOV separately without a partial stroke test.

During the partial or full stroke test, the integrated IMVS controls the SOV, which is used to control the actuator as a combination of valve and actuator. This ensures that the actual dynamics of the automated valve package are detected, and that the solenoid valve is fundamentally checked in parallel. The partial stroke describes a movement at an angle of 10 to 15 degrees (with a 90°-fitting) to avoid possible effects on the process. The Partial Stroke Test (PST) angle is settable in the intuitive device menu.

Thus, it is very clear that the device represents more than a modified electro-pneumatic five-point controller, which typically detects the current position of the actuator via a potentiometer and compares it with position control (target vs. actual values). The IMVS mounted on the actuator (**Figure 4**) can be used for reference operation during the entire service life of the automated valve and thus detect real-time deviations directly or report potential errors (predictive maintenance).

Source: Emerson

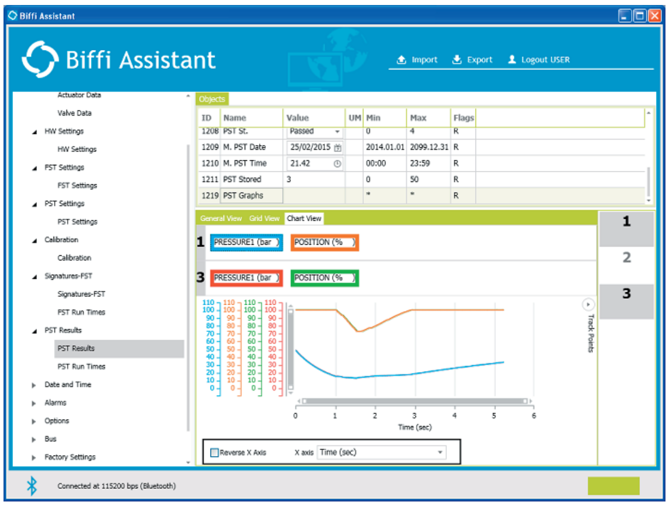


Figure 5: The IMVS is not only suitable for partial stroke tests

Source: Emerson

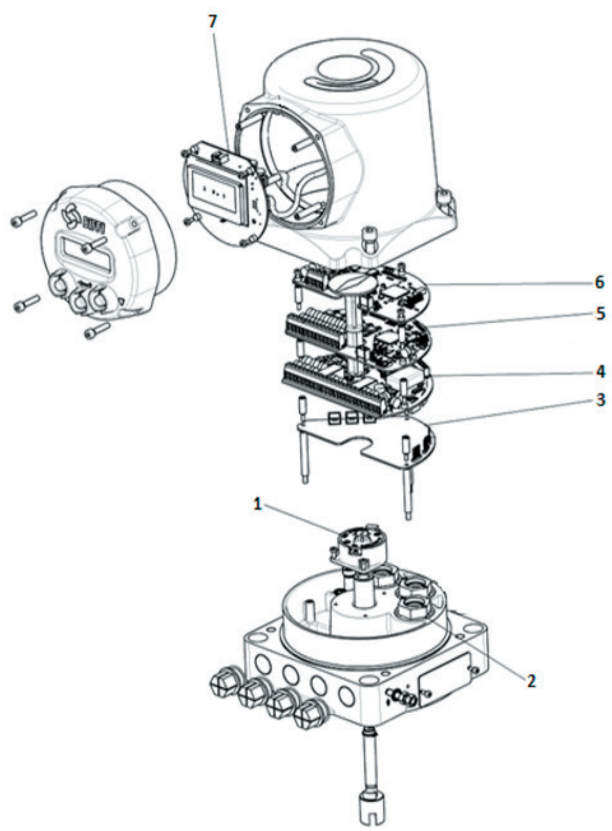


Figure 6: Explosive presentation IMVS

SMART MONITORING SYSTEM FITTED ON A PREMIUM PROCESS VALVE

The IMVS is a sensor-integrated electromechanical system that provides diagnostic, operating, and safety functions via a single or double-acting quarter turn, linear, (independent of manufacturer) which is mounted on top of the housing like a limit switch box and is driven by an external single or redundant solenoid to enable a partial stroke test, hydraulic or pneumatic solution.

The latest software packages, with HART® 7 (wireless), Modbus®, or Bluetooth® connectivity, are available for this purpose (**Figure 5**). The IMVS is not part of the SIL loop; the ESD action works independently and the ESD configuration determine the SIL level and the emergency capability. During the partial stroke test, two integrated half-conductor relays ensure potential-free switching and thus a very long minimum service life (from 107 at 300 cycles per minute).

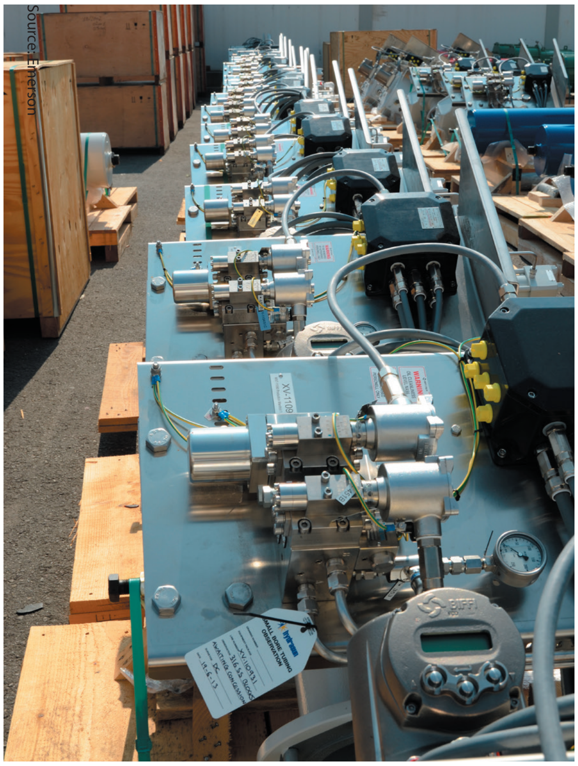
The exploded view (**Figure 6**) clearly shows that position (1) and pressure sensors (2) are already integrated. A deliberate separation (3) between sensors and EEPROM represents the functions of the network card (4), logic card (5) and the following field bus (6), and the display cards. Thanks to the integrated non-contact position and pressure sensors, repeatability, and the reliability of the process. In addition, the IMVS tests itself by comparing all signals in and out of the logic card.

The IMVS works directly with the available medium as well as with pneumatic low pressure (**Figure 1**) or up to 200 barg input pressure. Hydraulic high pressures up to 400 barg (**Figure 7**) also pose no problems. Another advantage is the use of manufacturer independent SOVs at a medium-free device.

The IMVS can be used with the configurations "One out of One" (1oo1), "One out of Two" (1oo2), and "Two out of Two" (2oo2) in the SIL loop. Thus, a wide range of Emergency Shut Down (ESD) or High-Integrity Pressure Protection System (HIPPS) applications can be successfully implemented.

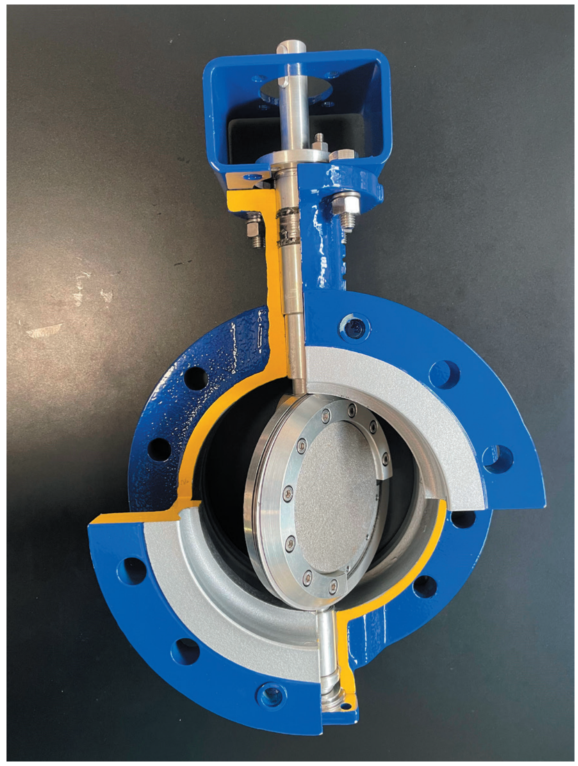
With the help of common communication protocols, the IMVS can be easily integrated directly into the control and supervisory level, which significantly simplifies the perfect exchange of the field level with the entire automation pyramid. Further real-time data exchanges with all PLCs (e.g. DeltaV, Honeywell, and Yokogawa) offers the advantage of being able to use numerous certified documents and modules.

The extended temperature ranges from -40°C to +75°C with an OLED screen, the full coverage of explosion-proof certification for worldwide installations, the free software for easy calibration and data download, wide-range voltage input (19.2 - 57.6 VDC), easy retrofitting to all existing altar fittings, configuration via



Source: Emerson

Figure 7: **Hydraulic High Pressure Control Panel**



Source: Emerson

Figure 8: **Cross section sample bare Vanessa 30,000 Tripple Offset Valve**

Bluetooth, HART and/or Modbus Protocols as well as especially the numerous diagnoses with constant real-time relays are further advantages.

For critical main processes, appropriate valves are used that have been specifically developed for these extremes to keep the process running safely and reliable. This is where triple offset valves (TOVs) are favored over conventional valves due to their increased durability, reliability, and lower operating costs.

Emerson's Series 30,000 TOVs uses a sealing system consisting of a stationary seat and a rotating sealing surface sharing an identical shape: an inclined conic section. When these cones overlap, closed position is reached, and sealing occurs. This 'quarter turn globe' concept is made possible using three 'offsets' designed to completely eliminate rubbing. Optimized seating angles and rotational characteristics provide enhanced tightness via an ingenious combination of the triple offset design and a flexible metal seal ring across all basic, cryogenic, and high temperature configurations.

The seat of the TOV is designed to minimize wear, reduce maintenance costs, and extend service life. The advanced sealing performance ensure that your processes run reliably with maximum efficiency even under extreme operating conditions. All these benefits are accompanied by large weight a saving savings compared to other valves. This reduces cost and complexity of installation, operation, and maintenance.

TAKEAWAY

Outperforming traditional designs by being more durable, reliable, and cost-effective: The package of a smart valve monitoring system (e.g., Emerson's IMVS.2) fitted on a well-established valve actuator (e.g., Emerson's Biffi ALGAS) on top of a true triple offset valve (e.g. Emerson's Vanessa) performs by providing predictive analysis with the intent of identifying potential failures. With early identification of potential issues, you can act or plan for action before a failure occurs and avoid costly unplanned downtime.

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