Subsea Valve Actuator – SVA
An Electro-mechanical Actuator with Hydrostatic Drive
For Subsea Control and Production System

Technical Information

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Introduction

The Subsea Valve Actuator (SVA) is an electro-mechanical actuator with hydrostatic drive designed to complete the range of traditional hydraulic and all-electric subsea actuators for subsea control and production systems.

The SVA achieves the same safety performance as hydraulic actuators, but with much better reliability. It also provides a simple electric interface similar to those in all-electric actuators (without umbilicals for hydraulic fluid power).

Optimized for manufacturing, the system is based on industrial standard components produced to the highest quality standards, using efficient lean production methods. Because of its modular design, each user can easily configure his or her own application solution without a costly redesign of the system.

Main Features

- Interface for Subsea Gate Valve – Bonnet per API 6A / ISO 10423 and API 17F / ISO 13628-6
- Modular design for operation up to 3,000 m depth with complete redundant drive and safety system
- Energy efficiency system including hydraulic clamping of fail-safe spring package and low voltage components
- Control system with built-in SIL 2 or SIL 3 functional safety, including monitoring during emergency closure
- Condition Monitoring Sensors integrated for
  - Redundant actuator absolute position
  - Different working pressures
  - Temperature
  - Pressure-compensation volume
  - Water ingress detection
- Override for ROV Class 4 interface emergency closure or opening including position indicator per API RP17H / ISO 13628-8
- Redundant analog subsea electrical interface following the Subsea instrumentation interface standardization (SIIS)
- Redundant pressure compensation system with electric components also protected against sea water ingress

The Subsea Valve Actuator from Bosch Rexroth completes the range of traditional hydraulic and all-electric subsea actuators for the ultimate realization of the All Subsea Factory.
The Application

All Subsea Factory

The All Subsea Factory reflects the market trend to move all the equipment needed for the offshore exploration and production of Oil & Gas (petroleum hydrocarbons) down to the seabed itself. The main benefits of this technology are increased automation, safety and efficiency, with considerable reductions in cost and in negative impacts to the environment. The actuator system shown here is suitable for any subsea production system, i.e. even in shallow water, but its benefits increase with the applied water depth and tie back distance, being a good solution for ultra-deep production fields.

Subsea Tree and Manifolds

Subsea trees and manifolds are essential equipment for subsea production. The actuator technology proposed here is suitable for any kind of subsea valves, and demonstrates a higher Technology Readiness Level (TRL) for the linear actuation of gate valves. However, rotary actuators can also be provided on demand, for use in applications such as choke valves.
**Product Description**

**Subsea Control Architecture**

The Subsea Valve Actuator is controlled by an Actuator Control Module (ACM), which provides the motion control algorithm, the safety signal and the condition monitoring features for each actuator. A second ACM is used to monitor the proper functioning of the system and, in case of failure, to take over control of the actuators.

Both ACMs are connected to the Subsea Control System, which provides the command to open or close the valves from the Master Control Station. Both ACMs can be included in a single enclosure or each one may have its own enclosure, depending on the user’s maintenance strategy.

- Both Actuator Control Modules (ACM) can read all the sensor inputs of a Subsea Valve Actuator (SVA)
- Only the Master ACM can drive the outputs (logic controlled with redundant relays)
- Both ACMs exchange their information via CAN
- When the Slave ACM detects a failure of Master ACM, it asks the SCM to restart the Master and takes over the control of the SVA (becoming the new Master)
**Product Description**

**System Design**

**Modular Structure**

The figure below illustrates the design concept of the Subsea Valve Actuator.

- The actuator is mechanically connected to the gate valve via a standardized bonnet interface
- The modular cylinder design allows the application of different types of spring systems and materials
- In this system, all components are immersed in hydraulic fluid with a reliable pressure compensation system
- A redundant electro-hydrostatic drive system performs the commanded open and close functions

- An independent and redundant safety control releases the emergency closure function performed by the fail-safe spring
- A set of sensors can be provided for the condition monitoring function
- All electric components inside the actuator use analog electronics and subsea cabling to ensure robustness
- A standard interface is provided for intervention, when needed, using Remote Operated Vehicles (ROVs)

**External Interfaces**

The actuator is connected to each control module (ACM) by two independent electric subsea cables, so that in case of failure of a single electric control, the other unit assumes the control automatically. As optional features, a mechanical override can be provided, including position indicator and a port integrating a hot stab to refill the hydraulic fluid. Additionally, a seawater filter protects the pressure compensation against the ingress of dirty particles, and a bursting disc protects the service technicians against system overpressure during decommissioning.

- Bursting disc as safety protective device
- Optional: Position indicator for manual override
  - C = close position
  - O = open position
  - N = neutral (automatic mode)
- Optional: Manual override
- Sea-water filter for pressure compensation
- Subsea electronic connectors
- Optional: Hydraulic refill port (not shown in this picture)
Product Description

System Design

1a) Cylinder module with fail-safe spring
1b) Drive system (in redundant system design)
1c) Safety control module (release spring by power cut off) with double redundancy system design (i.e. redundant for failing to open and redundant for failing to close)
1d) Pressure compensation (with redundant system design)
1e) Spindle system for the manual override connection (ROV Class 4 interface)

Sensors for condition monitoring: BG001, BG002, BG501
- Redundant position monitoring of the actuator
- Functionality check of valves and drive system (also for diagnosis of the safety function)
- Position feedback control in the test cycle
- Detection of hydraulic fluid leakage and monitoring of pressure compensation system

Pressure transmitter: BP001, BP002, BP101, BP201
- Pressure monitoring
- Functionality check in all critical circuit paths of valves and drive system (also for diagnosis of the safety function)

Water contamination sensor: BM001
- Detection of any water contamination (risk of onset of corrosion degradation)

Temperature sensor: BT001
- Monitoring of hydraulic fluid temperature (to monitor remaining hydraulic fluid life)

Remark: All output signals from each sensor are replicated for both actuator control modules.
**Product Description**

**System Design**

**Working Principle**

The simplified schematic diagram explains the functional principles of the Subsea Valve Actuator.

**Figure 1a)** shows the interface to the bonnet with a four-chamber hydraulic cylinder and a fail-safe closure spring module. Depending on the application requirements, the design allows for the selection of different types of springs (disc or coil spring with different materials). Chambers A and B of the cylinder are used to move the actuator in or out. Chamber C of the cylinder is used to clamp the spring hydraulically, so that it does not need to be moved by each cylinder actuation, thus reducing energy demand. The cylinder movement is monitored with a redundant absolute position encoder and two pressure sensors, allowing precise position control, as well as safety and condition monitoring.

**Figure 1b)** shows the principle of the drive system, which applies an electric motor submerged in oil driving a dual pump system. The applied pumps are robust and compact: Two are used to be able to move the cylinder back without having to use the fail-safe spring (energy efficiency). Two such drive systems are implemented to ensure system reliability. Each system is able to provide the needed drive force individually, or both can be used together to reduce the load. Besides monitoring the electric motor drive, the position encoder (BG001 and BG002) and the pressure transmitters (BP001 and BP002) are also used for condition monitoring.

**Figure 1c)** shows the safety control module. Standard on-off safety valves are applied, with a long track record in safety functions in many critical industrial applications. The valves are normally open, so that by releasing the electric power of their solenoids, the valves open the cylinder chambers and allow the spring to move the cylinder back to the safe position. To achieve high reliability for safety functions as well as for normal operations, four valves are used in a redundant system with two additional pressure sensors (BP101 and BP201) to detect a failure of any single valve. The electric cables of the valves’ solenoids are directly connected to the safety control signal, and completely independent of the drive system. Thus, even if the drive system continues to be operated, the safety function can be triggered independently and will perform correctly.

**Figure 1d)** shows the pressure compensation system. This system ensures that the internal hydraulic fluid pressure is in a range from 0.5 to 2 bar above the environmental pressure (air or sea water). A redundant system was selected to avoid any possible contamination by sea water inside the system, which is a pre-condition for the use of standard industrial components inside. Furthermore, all seals were designed with additional safety factors to reduce the overall possibility of any sea water ingress. Nevertheless, the system is designed so that no critical failure should occur via water contamination: The solenoids of the safety valves are inside a separate sealed enclosure and all the internal cables are subsea suitable (i.e. to withstand the pressure and protects against short-circuit); an additional water detection sensor (BM001) and a temperature sensor (BT001) are used to monitor the quality of the hydraulic fluid; and a position encoder is used in the pressure compensation system to detect any possible leakage to the outside.

**Figure 1e)** shows the manual override interface, which can be used by a Remote Operated Vehicle (ROV) or an Autonomous Underwater Vehicle (AUV) to operate the actuator using a Class 4 rotary torque docking interface per ISO 13628-8 and API RP17H. Turn the valve counterclockwise to open; to close the valve, turn it clockwise. The maximum torque allowed and the number of turns is given in the technical drawings of your specific actuator type and size. A position indicator shows the status of the gate valve:

- C: means “manually” close
- O: means “manually” open
- N: means “neutral”, i.e. any position under control of the internal drive system (open, close or intermediate)

A simplified variant of the Subsea Valve Actuator is also available to minimize manufacturing costs. The cylinder has only two chambers, so that the spring is always used to move the actuator back into position. As a result, the drive system uses only one simple pump, and fewer sensors are integrated. However, the safety philosophy remains the same.
Special Features

System Reliability with Condition Monitoring

The Subsea Valve Actuator is designed to perform for 25 years with higher system uptime and only minimal maintenance. The actuator system is built using robust standard components designed for heavy-duty work cycles (e.g. the industrial valves used in the system are qualified for more than 10 million cycles). A redundant architecture of the key modules ensures high system reliability. The current position of the actuator cylinder is monitored by a redundant sensor, and an additional set of sensors can be provided to implement a condition monitoring system using a special software module in the Actuator Control Module. System reliability has been evaluated using different methods (calculation, simulation, testing and field data analysis) and validated through an extensive inspection and testing program based on API 17N with support of classification societies.

The pressure compensation system give an example of the design for reliability approach applied in the Subsea Valve Actuator. A membrane is used to transfer the seawater pressure to the internal fluid pressure. A spring pre-loaded piston generates an overpressure of 0.5 to 2 bars and provides a second barrier against seawater ingress. That means, in case of any water contamination, that there is no risk of an electrical short-circuit; only a slow degradation of the material due to corrosion may occur, which can be quickly detected if the water detection sensor is applied. A position encoder can be integrated in the pressure compensation system to quantify the risk of hydraulic fluid leakage to the environment. With both sensors, the condition monitoring system can predict the demand for preventive maintenance.

On request, a tool can also be provided for the ROV to refill the hydraulic fluid on the seabed, which also minimizes the risk of seawater ingress.

All the electric cables inside the actuator are made out subsea connectors. Further, the safety valve solenoids are protected in a separated chamber. These measures prevent not only an electrical short-circuit from water contamination, but also ensure a longer lifetime of the electrical components (no material degradation).
Special Features

Functional Safety

The Subsea Valve Actuator provides a redundant on-command closure of the gate valve. If the commanded closure fails, the emergency closure using the spring module can be released by the redundant safety valves.

The safety control system was designed according to IEC 61508, IEC 61511 and ISO 13849, taking all applied technologies (i.e. mechanics, hydraulics, electronics and software) into account. The figure below shows an overview of the proposed Functional Safety Architecture:

1. Subsea Control Module (SCM) triggers the safety function by cutting off a redundant 24 V DC electric signal (like an emergency stop button on an industrial machine) after receiving a command from the operator via the Master Control Station (MCS) to start an emergency closure.
2. Actuator Control Module (ACM) triggers safety functions of all valve actuators by using industrial safety relays. All electric controls are now in passive mode (electrically disconnected) and just monitoring the performance of the safety function.
3. Subsea Valve Actuator (SVA) activates the redundant industrial safety control valves (by cutting off the energy of their solenoids) and monitors the emergency closure of the gate valve with its sensors.

Important remarks:

- A shutdown of the complete control system is not required, allowing monitoring of system behavior during the emergency closure and a fast restart of the production system to increase system availability (uptime).
- If the two redundant and independent systems fail (command closure and emergency closure), then other countermeasures shall be considered by the operator until an ROV or AUV can be used to manually operate the mechanical override to close the gate valve during the emergency situation or to re-open it after that.
- The advanced variant of the Subsea Valve Actuator can use one of the redundant drive systems to close the gate valve in case of failure from the fail-safe spring by an emergency closure, if electric power is still available.
- The safety control of the SVA basic fulfills the SIL 2 requirements already. To achieve SIL 3, all available sensors in the SVA advanced must be properly used for the monitoring of the safety function. Furthermore, the Actuator Control Module must regularly execute a test sequence (once a day is suggested), which is able to verify the proper function of all components inside the actuator without disturbing the productivity of the gate valve.
Special Features

Energy Efficiency

Electro-mechanical actuators with hydrostatic drives provide higher power density (compact design coupled with high forces), lower static friction forces and greater freedom to optimize the system control under different operating conditions (speed x loads).

The Subsea Valve Actuator makes use of this principle to increase energy efficiency. Furthermore, special features are available in the advanced version to minimize both stand-by and peak power consumption:

▶ Besides the standard speed and position control, an additional control algorithm is integrated to operate with limited power supply. It allows the actuator to reduce power consumption significantly if a longer cycle time is acceptable for the required stroke to operate the valve.

▶ The solenoids of the safety valves are adjusted for this application, reducing the standby power needed to keep them closed during continuous operation – less than 20 W in total.

▶ A hydraulic clamping of the fail-safe spring reduces the power consumption during each actuation of the gate valve without disturbing the emergency closure safety function.

The figure below provides an example of the power consumption during the actuation of a 2 1/16” gate valve at a water depth of 3,000 m.

a) commanded open (move out cylinder)
b) commanded close (move in cylinder)

Key Parameters:

▶ Well-pressure: 10 kpsi (690 bar)
▶ Actuator stroke: 63 ±0.2 [mm]
▶ Nominal stroke time open: 60 [s]
▶ Nominal stem force: 180 [kN]
▶ Fail-safe spring considering worst case forces of all applicable modules

Here, only the power needed for the movement is considered, i.e. for the cylinder and drive system, with approximately 210 W peak power.

In the figure above a), one can see that the power consumption remains smooth over the entire stroke movement. This is the result of the power limit control system, which reduces the overall peak power.

In b), some energy is needed to move the cylinder back, as the fail-safe spring remains hydraulically clamped. By the end of closure c), a peak in power is shown to provide the theoretical maximum close force, which in reality is not needed.
**Special Features**

**Environmentally friendly**

The Subsea Valve Actuator protects the environment against any leakage of the lubrication and control fluid to the sea world. The compact design reduces the amount of fluid inside the system considerably. The redundant pressure compensation minimizes the risk of any leakage. The hydraulic fluids were qualified in an extensive test program based on API 17F / ISO 13628-6 and the fluid qualification program from Bosch Rexroth (see RE 90235).

A specific fluid was selected because of its properties regarding compatibility with all utilized standard components, high lubrication and dielectric properties as well resistance to sea water ingress and longer lifetime. The selected fluid also fulfills all applicable environmental requirements for subsea systems, such as from the OSPAR commission regarding the North-East Atlantic area or from the U.S. Environmental Protection Agency regarding the Gulf of Mexico area. The design of the tribological system was further improved by testing the compatibility of the selected seal types and materials.

**Modular Design**

The modular design of the Subsea Valve Actuator supports the industrialization and standardization of subsea control systems, offering different options for the user to configure its application-specific features without a system redesign. For example, the fail-safe module is designed to allow the selection of different types and materials for the springs. The drive system can be integrated into the actuator or can be provided in a separated, retrievable module. A manual override can be provided on demand. The functional safety, energy efficiency and condition monitoring functionalities can be selected according to the user’s expectations. The majority of the applied components are industrial standards, produced to high quality levels using competitive manufacturing processes.

The ACM takes advantage of industrial electronic controls designed from the ground up for industry 4.0, with connectivity features in the firmware.

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**Subsea Cabling**

**Connection of Actuator Control Module to Subsea Control Master**

ACM => SCM
- Pins 1 - 2: Power supply (e.g. 230 V AC, 350 V DC or 48 V DC)
- Pins 3 - 4: CANopen (high, low) acc. to SIIS
- Pins 5 - 7: Safety emergency closure (2x high, 1x low) (safety trigger signal is optional, it uses 24 V DC)

**Connection of Subsea Valve Actuator to Actuator Control Module**

SVA => ACM
- Pins 1 - 6: Electric motor drive
- Pins 7 - 8: Low power supply (24 V DC)
- Pins 9 - 10: Safety valves’ solenoids
- Pins 11 - 12/19: Sensors signals (quantity depends on the optional configuration)
General Technical Data

Environmental Conditions

<table>
<thead>
<tr>
<th>Item</th>
<th>Applicable to all devices</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subsea condition:</td>
<td></td>
</tr>
<tr>
<td>▶ Environment</td>
<td>Subsea: sea water (salt) with possible dirt particles</td>
</tr>
<tr>
<td>▶ Water depth</td>
<td>0 to 3,000 m (design / test: 0 to 3,300 m)</td>
</tr>
<tr>
<td>▶ Deployment velocity (laying down and lift up)</td>
<td>Max. ± 5 m/s (effect in pressure: ± 0.5 bar/s)</td>
</tr>
<tr>
<td>▶ Enclosure</td>
<td>IP 68 from 0 to 3,300 m water depth exposition up to 25 years</td>
</tr>
<tr>
<td>▶ Resistance to salt spray</td>
<td>1,000 h acc. to ISO 9227 (DIN 50021)</td>
</tr>
<tr>
<td>▶ Housing material</td>
<td>Stainless steel for components in contact with sea water</td>
</tr>
<tr>
<td>Temperature:</td>
<td></td>
</tr>
<tr>
<td>▶ Operating</td>
<td>-5 °C to 40 °C (design / test: -18 °C to 70 °C)</td>
</tr>
<tr>
<td>▶ Storage / Transport</td>
<td>-18 °C to 50 °C</td>
</tr>
<tr>
<td>Vibration resistance:</td>
<td>Applicable to all electric / electronic components</td>
</tr>
<tr>
<td>▶ Sinusoidal vibrations</td>
<td>5 Hz to 25 Hz with ± 2 mm displacement</td>
</tr>
<tr>
<td>(ISO 13628-6:2012, Q2 test type)</td>
<td>25 Hz to 150 Hz with 5 g acceleration</td>
</tr>
<tr>
<td></td>
<td>2 cycles per axis</td>
</tr>
<tr>
<td>▶ Random-shaped vibrations</td>
<td>20 Hz to 80 Hz at 3 dB per octave rise;</td>
</tr>
<tr>
<td>(ISO 13628-6:2012)</td>
<td>80 Hz to 350 Hz at 0.04 g2/Hz;</td>
</tr>
<tr>
<td></td>
<td>350 Hz to 2,000 Hz at − 3 dB per octave roll-off;</td>
</tr>
<tr>
<td></td>
<td>composite excitation level shall be 6 g rms</td>
</tr>
<tr>
<td>Shock resistance:</td>
<td>Applicable to all electric / electronic components</td>
</tr>
<tr>
<td>▶ Transport shock (ISO 13628-6:2012, Q2 test type)</td>
<td>10 g acceleration, 11 ms half sine</td>
</tr>
<tr>
<td></td>
<td>6 cycles in each direction (pos. / neg.)</td>
</tr>
<tr>
<td>Electromagnetic compatibility:</td>
<td>Applicable to all electric / electronic components</td>
</tr>
<tr>
<td>▶ Further guidance</td>
<td>IEC 61000-2 and IEC 61000-1-2</td>
</tr>
</tbody>
</table>

Subsea Valve Interface

<table>
<thead>
<tr>
<th>Item</th>
<th>SVA basic</th>
<th>SVA advanced</th>
</tr>
</thead>
<tbody>
<tr>
<td>Customer</td>
<td>Original equipment manufacturer of Subsea Trees and Manifolds</td>
<td></td>
</tr>
<tr>
<td>Valve description</td>
<td>Subsea Gate Valve, size acc. to specification (per API 6A:2010 / ISO 10423:2009)</td>
<td></td>
</tr>
<tr>
<td>Valve interface</td>
<td>Connection bonnet incl. lock ring according to drawing from the manufacturer</td>
<td></td>
</tr>
<tr>
<td>Operator description</td>
<td>Subsea Valve Actuator (SVA) with ROV Class 4 interface</td>
<td></td>
</tr>
<tr>
<td>Well fluid design pressure</td>
<td>According to specification (e.g. 10 kpsi = 69 MPa = 690 bar)</td>
<td></td>
</tr>
<tr>
<td>Valve service</td>
<td>According to specification (e.g. water injection, production well...)</td>
<td></td>
</tr>
<tr>
<td>Design standard</td>
<td>Per API 17D:2011 / ISO 13628-4:2010 and</td>
<td></td>
</tr>
<tr>
<td>Stem connection</td>
<td>According to drawing from the manufacturer</td>
<td></td>
</tr>
<tr>
<td>Valve orientation</td>
<td>Horizontal with bolts used to align the position of the bonnet</td>
<td></td>
</tr>
<tr>
<td>Stem seals</td>
<td>Means shall be provided to prevent leakage of well bore fluid into the actuator such as valve bore sealing mechanisms (to be provided by customer not scope of this supply).</td>
<td></td>
</tr>
<tr>
<td>(API 17D:2011 / ISO 13628-4:2010)</td>
<td>Means shall be provided to prevent over-pressuring of the actuator piston and compensation chambers, in the event that well bore pressure leaks into the actuator. (to be provided by customer – not included in scope of supply.)</td>
<td></td>
</tr>
<tr>
<td>Protection from well bore pressure</td>
<td>Means shall be provided to prevent leakage of well bore fluid into the actuator such as valve bore sealing mechanisms (to be provided by customer not scope of this supply).</td>
<td></td>
</tr>
<tr>
<td>(API 17D:2011 / ISO 13628-4:2010)</td>
<td>Means shall be provided to prevent over-pressuring of the actuator piston and compensation chambers, in the event that well bore pressure leaks into the actuator. (to be provided by customer – not included in scope of supply.)</td>
<td></td>
</tr>
</tbody>
</table>

Remark:
For properties which depend on the size of the actuated valve (such as dimensioning, forces, stroke, pressure and electrical system interface), please see the datasheet of the specific actuator with the related interface drawings.
## Main Advantages

### Technical Aspects

The following table provides a relative comparison among different technologies available for the actuation of gate valves in subsea trees and manifolds:

- An electro-hydraulic multiplexed control system (conventional hydraulic actuators with topside hydraulic power unit)
- An electro-mechanical subsea control system (benchmark based on state of the art all-electric actuator)
- An electro-mechanical actuator with hydrostatic drive (the novel concept of the Subsea Valve Actuator)

Relative comparison among the different technologies available for the actuation of gate valves in subsea trees and manifolds.

<table>
<thead>
<tr>
<th>Key technical features</th>
<th>Conventional hydraulic (+ Topside HPU)</th>
<th>Electro-mechanical (All-Electric)</th>
<th>Electro-mech. with hydrostatic drive (SVA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Top side complexity (hydraulic power unit - HPU with related infrastructure and footprint)</td>
<td>⚫</td>
<td>⚫</td>
<td>⚫</td>
</tr>
<tr>
<td>Umbilical complexity: hydraulic supply lines and couplers</td>
<td>⚫</td>
<td>⚫</td>
<td>⚫</td>
</tr>
<tr>
<td>Environmentally friendly: leakage of hydr. fluid to sea water</td>
<td>⚫</td>
<td>⚫</td>
<td>⚫</td>
</tr>
<tr>
<td>Maximum design (cylinder open) force</td>
<td>⚫</td>
<td>⚫</td>
<td>⚫</td>
</tr>
<tr>
<td>Cylinder stroke work</td>
<td>⚫</td>
<td>⚫</td>
<td>⚫</td>
</tr>
<tr>
<td>Opening time / closing time (reaction time)</td>
<td>⚫</td>
<td>⚫</td>
<td>⚫</td>
</tr>
<tr>
<td>Max. water depth (incl. tie backs and step out)</td>
<td>⚫</td>
<td>⚫</td>
<td>⚫</td>
</tr>
<tr>
<td>Qualified cycles / in pressure chamber</td>
<td>⚫</td>
<td>⚫</td>
<td>⚫</td>
</tr>
<tr>
<td>Dimensioning diameter / length (subsea)</td>
<td>⚫</td>
<td>⚫</td>
<td>⚫</td>
</tr>
<tr>
<td>Power consumption standby / maximum</td>
<td>⚫</td>
<td>⚫</td>
<td>⚫</td>
</tr>
<tr>
<td>Emergency stop function (functional safety)</td>
<td>⚫</td>
<td>⚫</td>
<td>⚫</td>
</tr>
<tr>
<td>Fail safe spring (for emergency stop)</td>
<td>⚫</td>
<td>⚫</td>
<td>⚫</td>
</tr>
<tr>
<td>System reliability and availability</td>
<td>⚫</td>
<td>⚫</td>
<td>⚫</td>
</tr>
<tr>
<td>ROV override to open and close the valve</td>
<td>⚫</td>
<td>⚫</td>
<td>⚫</td>
</tr>
<tr>
<td>Complexity of the subsea control module</td>
<td>⚫</td>
<td>⚫</td>
<td>⚫</td>
</tr>
<tr>
<td>Condition monitoring system (incl. auto test procedure)</td>
<td>⚫</td>
<td>⚫</td>
<td>⚫</td>
</tr>
<tr>
<td>Motion control (accurate position, speed and force control)</td>
<td>⚫</td>
<td>⚫</td>
<td>⚫</td>
</tr>
<tr>
<td>System start up by commissioning and after shutdown</td>
<td>⚫</td>
<td>⚫</td>
<td>⚫</td>
</tr>
<tr>
<td>Maintenance at subsea (demand frequency and duration)</td>
<td>⚫</td>
<td>⚫</td>
<td>⚫</td>
</tr>
<tr>
<td>Standardization and industrialization (interfaces, modularity)</td>
<td>⚫</td>
<td>⚫</td>
<td>⚫</td>
</tr>
</tbody>
</table>
Main Advantages

Economical Aspects (CAPEX + OPEX)

The SVA provides the following cost savings:

- In comparison to a typical hydraulic system, it saves:
  - Topside Hydraulic Power Unit (CAPEX and footprint) with the regular refill of hydraulic fluid (OPEX)
  - Umbilicals with hydraulic power lines, able to be operated with simplified electrical system, such as Direct Current and Fiber Optic (DC/FO)
  - Any piping work is at the subsea trees and manifolds, saving not only the material but also high commissioning costs (due to the typical work intensive tasks with certified welders and intensive Factory and Site Acceptance Tests)
  - No hydraulic maintenance procedures are needed with complicated flushing and refilling processes of subsea fluids at seabed
- In comparison to a typical all-electric actuator, it saves:
  - Up to 75% of the electric peak power needed for each actuator. If the whole subsea production field is considered, the overall demand for electric power is reduced considerably, with not only an impact on OPEX but much more in CAPEX (for subsea electric power distribution equipment)
  - The high safety level, system reliability and condition monitoring optimize the system availability (up time) increasing the overall efficiency of the subsea production system

Key Customer Benefits

- Cost-effective modular design using industrial components inside and lean production management processes
- Environmentally friendly set-up with redundant pressure compensation and no leakage of fluid to the sea world
- Minimal power consumption (up to 75% reduction in comparison to currently available all-electric actuators)
- High availability and condition monitoring, designed to operate up to 25 years with minimum maintenance
- Independent safety control able to achieve up to Safety Integrity Level 3 (IEC 61511, IEC 61508, ISO 13849)
- Integration of a mechanical override in the actuator for ROV Class 4 interface to open or close the gate valve
- Advanced Electric Controls using standard components including Industry 4.0 connectivity in the firmware and SIIS standard interface

The Subsea Valve Actuator is as reliable as existing solutions or even more reliable, with no hydraulic umbilical and no risk of expelling fluid into seawater; it provides a standard electric interface with integrated condition monitoring, energy efficiency and safety functions.
## Configure your Standard

|   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| 01 | 02 | 03 | 04 | 05 | 06a | 06b | 07 | 08 | 09 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 |
| SVA | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |

### Valve type
- Gate valve: G
- Choke valve: C
- Ball valve: B

### Valve size
- 3/4": 1
- 2": 2
- 5": 5

### OEM interface
- OEM x1, Bonnet y11: A
- OEM x1, Bonnet y12: B
- OEM x2, Bonnet y21: C

### Well pressure
- 10 kpsi (690 bar): 10
- 15 kpsi (1024 bar): 15

### Nominal forces (IN: open / OUT: close)
- Opening force e.g. +175 kN: 175
- Closing force e.g. -40 kN: 40

### Nominal stroke
- Stroke length in mm, e.g. 63 mm: 63

### Spring module (model/materials)
- Model (written in the vertical, 3 lines):
  - 1 piece of coil spring: C1
  - 1 package of "x" disc springs (1 column, in series): DX
  - 1 package of "x" coil springs ("x" columns, in parallel): CX
- Material (written in the vertical, 3 lines):
  - Compatible with hydraulic fluid: H
  - Resistance to sea water ingress: S
  - Extra specification (e.g. Inconel): X

### Functional safety
- Min. achievable safety level: SIL2
- Max. achievable safety level (incl. safety sensors): SIL3

### Energy efficiency design
- Basic: B
- Optimized (incl. low peak power control algorithm): O

### Condition monitoring
- Disable: D
- Activated (incl. complete set of sensors): A
### Configure your Standard

| 01 | 02 | 03 | 04 | 05 | 06a | 06b | 07 | 08 | 09 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 |
| SVA | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |

#### Electric interfaces

- **Redundancy:** 1x: connector  2x: redundant connectors
- **Manufacture:** Gisma
- **Type:** BR10 (fix underwater)  BR80 (seawater retrievable)
- **Pins:** 7  12  19  ...

#### ROV interfaces

- **Mechanical override with torque tool Class 4 interface (per API RP17H / ISO 13628-8)**
- **Hydraulic override with torque tool Class 4 interface (per API RP17H / ISO 13628-8)**
- **Hot-stab interface to refill hydraulic fluid without contamination of seawater**

#### Integration

- **Compact linear (one single cylinder form)**
- **Distributed in two blocks connected (1 block with cylinder/fail safe spring and 1 block with drive and control)**
- **Retrievable underwater**

#### Actuator Control Module

- **Provided within Subsea Control Module (SCM)**
- **Basic version provided by Bosch Rexroth**
- **Advanced version provided by Bosch Rexroth**

#### Connectivity

- **Not provided**
- **Connectivity package offered via ACM to the SCM**
- **Connectivity package offered via ROV connection port**

#### Classification society

- **DNV GL**

#### Painting ABS

- **Natural material without painting (i.e. stainless steel uncoated)**
- **Painted in subsea yellow (RAL 1004) acc. to Bosch Rexroth procedures**
- **Customer specific**

#### Additional data

- **Description**

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**Remark** about the configuration code:

In case you cannot find a configuration which fits your project application, please contact us.

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