

**High power density,
electric control:**

How self-contained actuators optimize machines and systems.

Self-contained actuators were originally developed for application-specific linear movements. As standardized system solutions, the electro-hydraulic linear direct drives are now being used across a range of sectors.

What approaches exist and what are the advantages for machine manufacturers and end users?

The trends are clear: Machines and systems should be smaller, simpler and less expensive. At the same time, the need for energy efficiency and process safety is growing – as is the desire for electrification and modularization. How can all of these requirements be taken into account in a future-viable machine design for linear movements? Self-contained actuators are an interesting solution here. They allow decentralized infrastructures with electric control in spite of their smaller footprint and reduced oil volume and with no need for hydraulics expertise.

Thanks to their encapsulated hydraulic transmission, self-contained actuators are an easy-to-use, robust and long-lasting alternative to electro-mechanical axes. The previous limits as regards cooling, power density and service life are being redefined. A number of sectors recognized this potential early on and introduced suitable solutions.

WHY WERE SELF-CONTAINED ACTUATORS DEVELOPED?

From a technical perspective, self-contained actuators are electro-hydrostatic actuators. The main aim when developing them was to replace conventional hydraulic systems with self-contained linear direct drives operated exclusively using electrical energy. Because self-contained actuators contain their own pump, there is no need for separate hydraulic components and hoses. This way, system architectures can be simplified, while the safety and reliability of linear movements increase.

The technology was originally developed for the aviation and aerospace industry as a way of controlling redundant systems such as control surfaces and chassis using hydrostatic actuators. Given the high power density in the smallest of spaces and the electrically operated encapsulated hydraulic system, this successful concept is

now used in other sectors too. In the process industry for example, hydrostatic actuators are widespread as a way of controlling shut-off and control valves in a decentralized manner.

Self-contained actuators are also used in highly branched control architectures such as chemical and production systems. Unlike with a centralized hydraulic supply system, electricity and control cables can be laid economically over long distances, even to a production system on the seabed. Here, hydrostatic actuators use the existing control line to feed process fluids into a bore hole for example. Other applications can be found in power plants. The actuators control for example the gas supply to the turbines and in many cases are the only hydraulic function.

Self-contained actuators are also used in a range of special areas, for example in welding machines, during controlled joining work or – with a separated system architecture – in ring rolling mills in the steel industry. The food industry too relies on linear direct drives with hermetically sealed hydraulic transmission systems, for example when pressing frozen blocks of fish into shape.

WHAT SOLUTION PATTERNS CAN BE SEEN?

As the examples above show, the requirements are different in the individual branches of industry. While in the process industry the focus is on decentralization over long distances, the issues of redundancy, electrification and energy density dominate in aviation. In industry and heavy industry, the priority lies not only in increasing efficiency and controllability and optimizing processes but also in monitoring with the help of integrated sensor systems and the straightforward exchanging of data with higher-level IT systems. In the food sector, the special requirements as regards cleanliness, hygiene and freedom from abrasion play a key role.

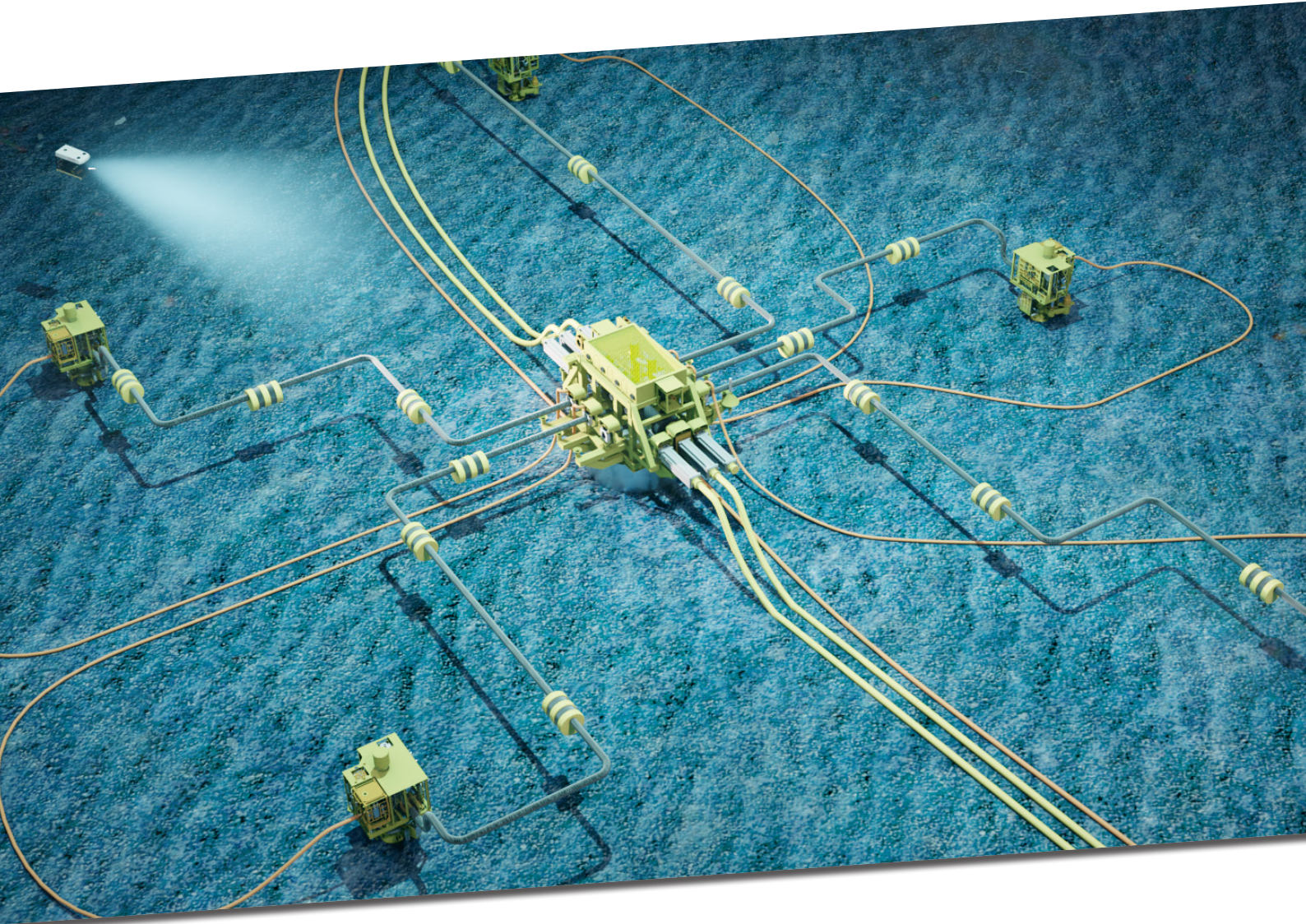
In spite of the specific differences, the solution patterns show that there are numerous general benefits which can be seized upon for a wide range of applications.



▲ **Highly compact self-contained actuator for a wide range of new applications in the power class up to 6.2 kW.**

i What is a self-contained actuator?

Self-contained actuators are highly effective: They combine an electric motor, a pump and a hydraulic cylinder with important control functions and shut-off devices in a compact, hermetically sealed system. As a result of the electro-hydraulic design together with modern converter and control technology, linear movements and forces can be controlled precisely and easily. If no power is required, the motor stands still. Any loads or forces applied are supported by the integrated isolation valves. The result of this power-on-demand control system: Minimal electricity consumption and, ultimately, lower CO₂ emissions during the entire process. Their many advantages make self-contained actuators ideal not only as a modern substitute for hydraulic cylinders with central power units but also as a long-lasting, maintenance-free alternative for electro-mechanical linear direct drives.



▲ **Underwater production systems use subsea valve actuators (SVAs) to control process valves. Compared to hydraulic drives, the electrically powered SVAs offer improved safety and are also much more reliable, energy-efficient and sustainable.**

For example, the lower energy consumption compared to conventional hydraulic systems can be used to optimize existing machines. If these existing machines and systems are upgraded with modern, decentralized electro-hydraulics, the lower electricity consumption indirectly reduces CO₂ emissions too. After all, self-contained actuators use a displacement control system with a variable-speed drive instead of loss-causing valves. Compared to the conventional design with a central power unit, the energy requirement can be reduced by up to 80 percent depending on the application. The integrated solution

comprising a variable-speed drive, a hydraulic cylinder, control functions and shut-off devices is tailored to the specific application and meets the exact power requirements in each individual part of the process. As part of a pilot project involving a drawing press, the Technical University of Dresden was able to demonstrate that the energy consumption of the drawing cushion could be reduced by up to 40 percent¹.

¹ Energy Efficiency of Displacement Control Drive Systems in Hydraulic Forming Presses | Request PDF ([researchgate.net](https://www.researchgate.net))

With the help of self-contained actuators, machine manufacturers and users are able to make up for the lack of hydraulics specialists. Because self-contained actuators can be controlled in a manner similar to electro-mechanical linear direct drives, the control architecture in engineering remains the same. Commissioning too is straightforward and, in terms of connections, requires just a power and control cable as well as signal and control lines for the sensor systems and valves.

In many applications, compact self-contained actuators are used instead of an electro-mechanical linear direct drive. This is either to meet more stringent requirements as regards the footprint and, in relation to the overall length of the axis, to allow a larger cylinder stroke or to improve running performance and optimize the operating life as Hertzian contact pressure is not an issue as it would be with ²electro-mechanics. The encapsulated hydrostatic transmission system can also reduce the maintenance outlay because no separate lubrication or external supply of lubricants is needed.



▲ Press application with self-contained actuator, modular system comprising electrical and hydraulic series components.

HOW DO SELF-CONTAINED ACTUATORS BECOME A USABLE PRODUCT?

Given the wide range of applications that could benefit from self-contained actuators, the question is how to come up with standardized products which can be selected, adapted and commissioned as easily as possible from the range of similar solutions available. Control of the self-contained actuator using conventional frequency converters is a key requirement here. A wide range of standardized cylinders, low-noise hydraulic pumps and, depending on the application, precisely adjustable servo motors is another key requirement when coming up with a universal system solution.

In order to ensure efficient engineering, it should be easy to select and configure self-contained actuators. It should

also be possible to order them ready to install if possible. As far as installation is concerned, this should be possible without piping, hoses and fluid tanks. Commissioning should only require electrical knowledge as well as a knowledge of control technology as regards power and signal processing. Another requirement relates to monitoring – a standardized product should provide at least the sensor systems and, if necessary, complete connectivity too.

On the other hand, there are specific requirements in many sectors which do not allow full standardization with catalog products. This is the case for example if very large forces, excessively long strokes, particular load conditions and work functions or specific designs

² Hertzian contact pressure (named after the German physicist Heinrich Hertz) refers to the greatest tension encountered in the middle of the point of contact between two elastic bodies.

SELF-CONTAINED ACTUATORS FROM BOSCH REXROTH

Self-contained actuators from Bosch Rexroth are designed to offer maximum added value over the entire life cycle – with their compact design with fully electric control and open interfaces, energy-efficient, quiet operation and long, low-maintenance operating life.

Thanks to the modular **CytroForce** plug and produce solution, self-contained actuators become an easy-to-configure, easy-to-use and low-maintenance out-of-the-box product with an integrated control system and connectivity module and can even expand safety functions. Axis-specific windows in the IndraWorks software speed up commissioning.

In the power class up to 6.2 kW, **CytroMotion** takes advantage of the benefits of self-contained actuators for

numerous new applications. Standardized interfaces allow conventional frequency converters and control units to be connected. Via integrated pressure sensors, process forces can easily be measured and internal system parameters monitored.

Bosch Rexroth creates customer and sector-specific solutions efficiently with the help of a modular system for **servo-hydraulic axes SHA**. The self-contained actuators which are put together using standard modules combine a variable-speed servo drive with a control block, hydraulic cylinder, safety valves and sensors as necessary. For particularly constructive requirements, the intelligent self-contained actuator for high-power applications is also available in a separated design. Thanks to the wide range of electric and hydraulic series components, the SHA is scalable in terms of power and function.

are involved. However, even these requirements can be met cost-effectively with slightly adapted yet essentially standardized components. If manufacturers produce a comprehensive portfolio of highly integrated complete systems, standardized assembly groups and customer-specific solutions such as control blocks and cylinders, machines and systems can be produced with minimal engineering input on the part of the customer.

As a basis for the broadest possible range of applications, the portfolio of self-contained actuators should be highly resistant to leaks, should allow straightforward control via electrical connections and should require little or no maintenance.



- ▲ **Straightforward configuration, optimum process: Modular complete system with integrated control system, connectivity module and optional safety functions.**

STANDARDIZATION LEADS TO MORE ADVANCED SELF-CONTAINED ACTUATORS

As standardized solutions with fully electric control and encapsulated hydraulics, self-contained actuators open up a broad spectrum of applications for machine manufacturers and end users. The resulting added value calls into question the previous practice involving hydraulics and electro-mechanics. After all, the power density and simplicity of the long-lasting and, in certain cases, maintenance-free system solutions are compelling.

If, as part of the digital transformation, the manufacturers provide intuitive configurators to help users to select, configure and commission systems, this will speed up engineering and commissioning for a shorter time to market.

As a result, self-contained actuators not only conserve resources and thus help to protect the environment. They are also an economical system solution for future-viable machine design and greater competitiveness.

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