

Servo-Hydraulic Actuator – SHA Fields of Application

Technical Information



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Product Description

The servo-hydraulic actuator (SHA) combines the power density of hydraulics with the dynamics, accuracy and flexible networking capability of electric servos, in a small oil volume system.

Combining extreme forces with micrometer positioning accuracy: The servo-hydraulic actuators (SHA) are heavy duty complete systems for pressing, joining or forming applications, all combined in an economical package.

The SHA provides users with a complete package, which is optimized and tested from the network connection to the piston rod – including pre-configured drive control parameters, software, firmware and technology functions for “alternating control”.

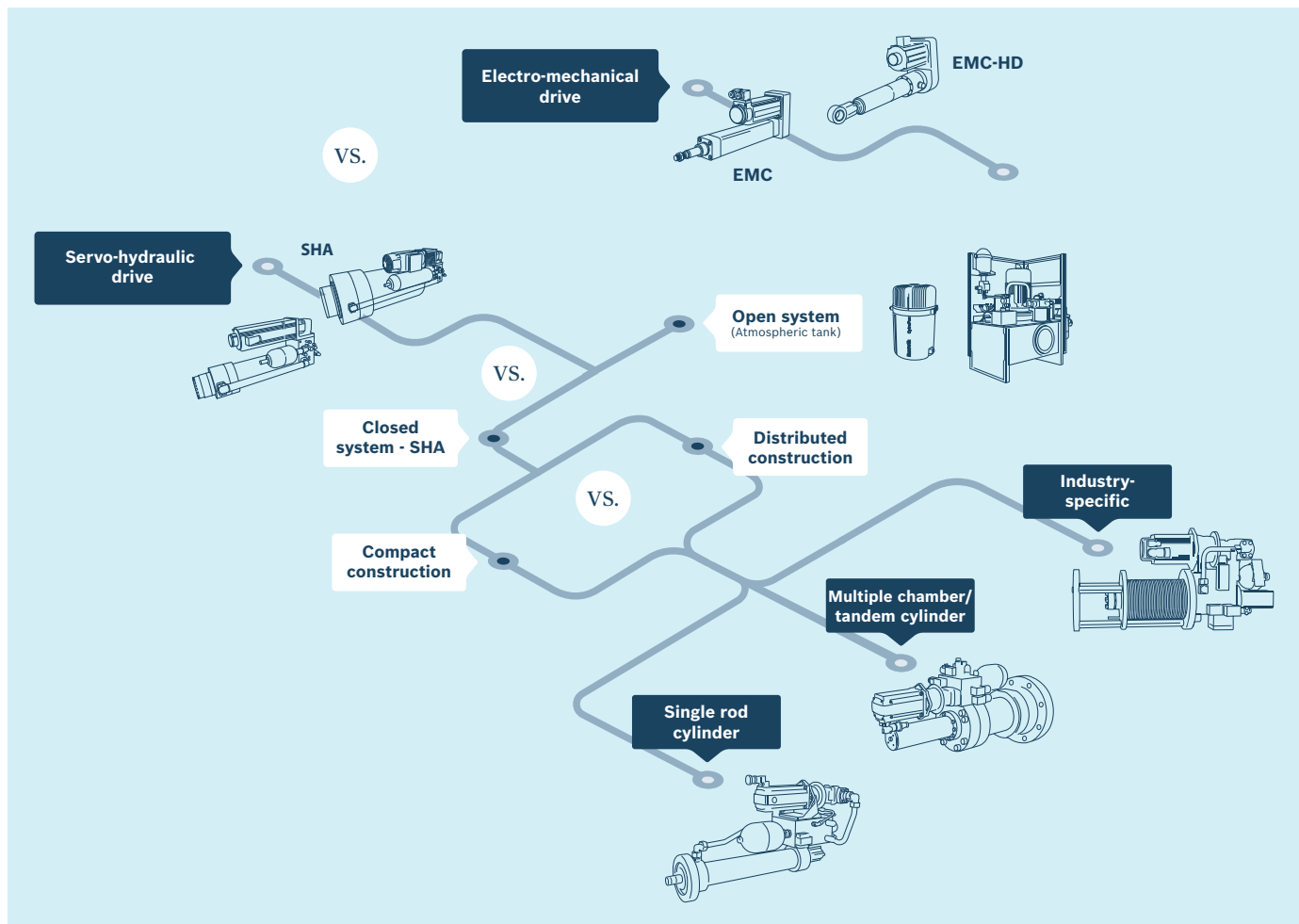
Machine control cabinets complete the overall system.

The portfolio according to the pre-engineered solutions offers

- ▶ Maximum forces up to 1.200 kN (269770 lbf)
- ▶ Stroke length up to 1,0 m (39.4 in)
- ▶ Cylinder speeds up to 800 mm/s (31.5 in/s)
- ▶ Positioning accuracy up to 10 µm
- ▶ Repeat accuracy up to 5 µm

On request, larger forces, longer strokes and higher cylinder speeds may be realized outside pre-engineered solutions.

Drive Navigator of linear Actuators



Product Features – Advantages and Customer Benefits

Advantages of hydraulics

- ▶ Large actuating forces – hydraulic operating principle
- ▶ Robustness – long service life
- ▶ Simple overload protection – pressure relief valve

Advantages of electrics

- ▶ High precision and dynamics – servo-motors and converters
- ▶ Connectivity – flexible connection to fieldbus
- ▶ Control and diagnostics – technology function (PFC) with monitoring and protective function

System advantages

- ▶ Ready-to-install solution – pre-assembled, filled and with minimum amount of interfaces
- ▶ Easy startup – Plug & Run
- ▶ Little maintenance expenditure – closed system, diagnostics-capable
- ▶ Energy-efficient operation – power on demand
- ▶ I4.0-capability – open
- ▶ Self-contained, separated from central hydraulics – flexibility
- ▶ Bosch Rexroth – key components connected within the system

Customer benefits

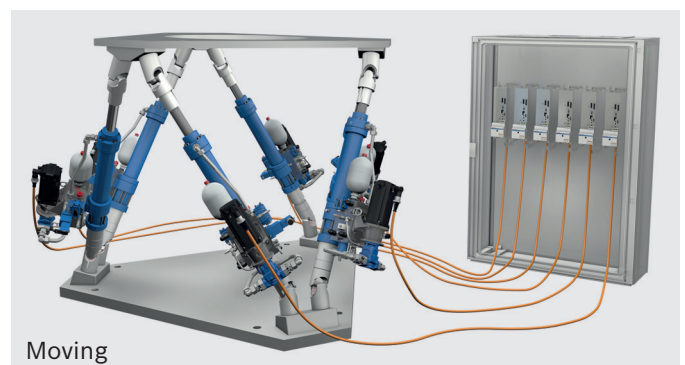
- ▶ Time savings through fast, easy integration and startup
- ▶ High machine uptime
- ▶ Low operating and maintenance costs – energy, insurance
- ▶ Cost savings through open standards in the control concept
- ▶ Efficient engineering – construction kit principle
- ▶ Bosch Rexroth – custom system solutions, worldwide after-sales service

Fields of Application

Servo-hydraulic actuators (SHA) can be used in a multitude of applications. Due to their specific properties, they offer advantages in terms of accuracy, dynamics and controllability. Thus, they contribute to shorter cycle times, increased flexibility and quality in the production process.

Featuring a flexible construction with either compact or decentralized design, the SHA can be easily adapted to the available installation space for integration into the machine.

Fields of Application – Examples



Structure

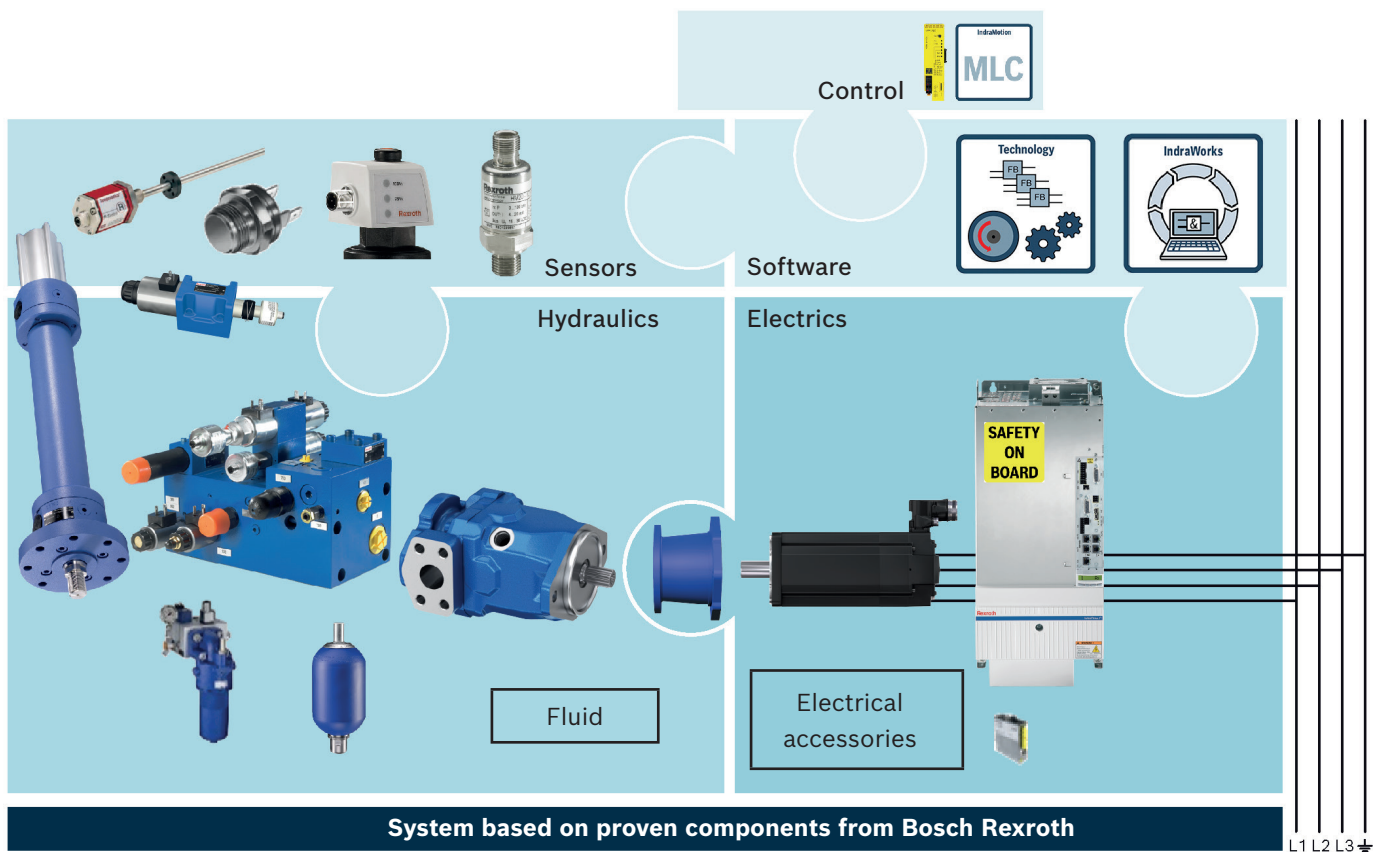
The main components of the SHA include an IndraDrive controller with technology function PositionForceControl (PFC), the IndraDyn S motor, a hydraulic cylinder with integrated position measuring system and an axial piston pump for the closed hydraulic system.

In addition, pressure and temperature sensors, a compensating tank, a filter and valves are integrated in the hydraulic manifold. Apart from the power electronics, the standard scope of supply includes mains filters and power chokes.

If required, it's possible to integrate further safety functions like Safely Limited Speed (SLS), Safe Standstill or Safe Torque Off (STO).

These safety functions are provided by the safe drive technology in the frequency converter.

The SHA communicates with the machine control over a fieldbus system.



Constructions

Cylinder integrated

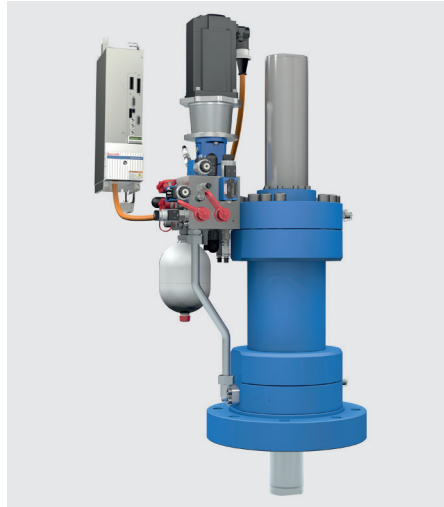
- ▶ Complete integration of the cylinder and the motor pump unit into the hydraulic manifold
- ▶ Optimized in terms of installation space

Compact

- ▶ Complete or partial integration of the cylinder and the motor/pump unit with the hydraulic manifold
- ▶ Optimized in terms of installation space

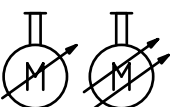
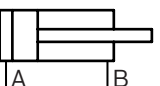

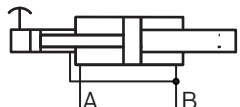
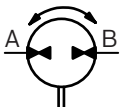
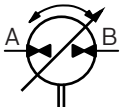
Distributed

- ▶ Connection of a standard cylinder and the standard motor/pump unit to a hydraulic manifold by means of hose assemblies or pipes
- ▶ Optimized in terms of flexibility



Solution Matrix

The SHA solution matrix shown below offers a multitude of combinations for realizing servo-hydraulic actuators. Rexroth's wide product range of components allows to build the right SHA system solution for the individual customer application.

	Single rod cylinder	Double rod cylinder	Multiple chamber / tandem cylinder
			
	A1	B1	E1
	A2	B2	E2

- ▶ **A1 = Single rod cylinder with fixed displacement pump**

- ▶ A2 = Single rod cylinder with variable displacement pump

- ▶ B1 = Double rod cylinder with fixed displacement pump

- ▶ **E1 = Multiple chamber / tandem cylinder with fixed displacement pump**

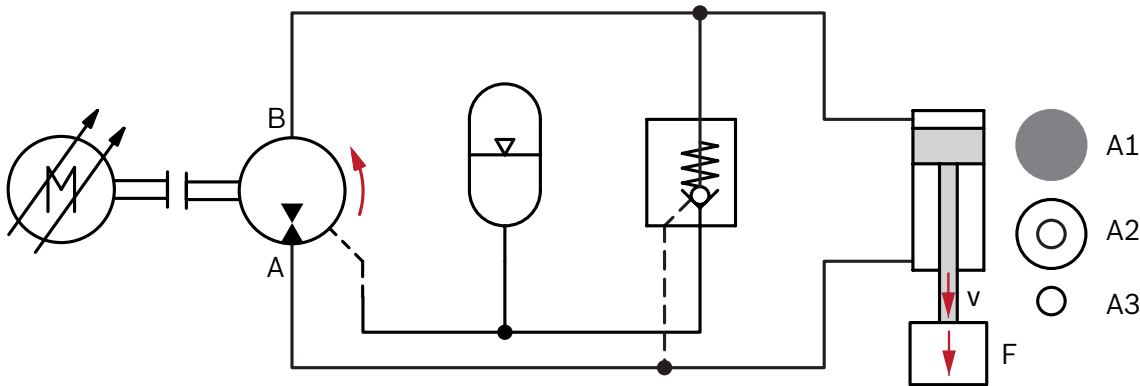
Additional information on the function principles can be found further below in this technical information.

Operating Principle of Solution Matrix A1

The simplified representation of the operating principles shows only the essential components, the directions of movement of the cylinder and a possible direction of force.

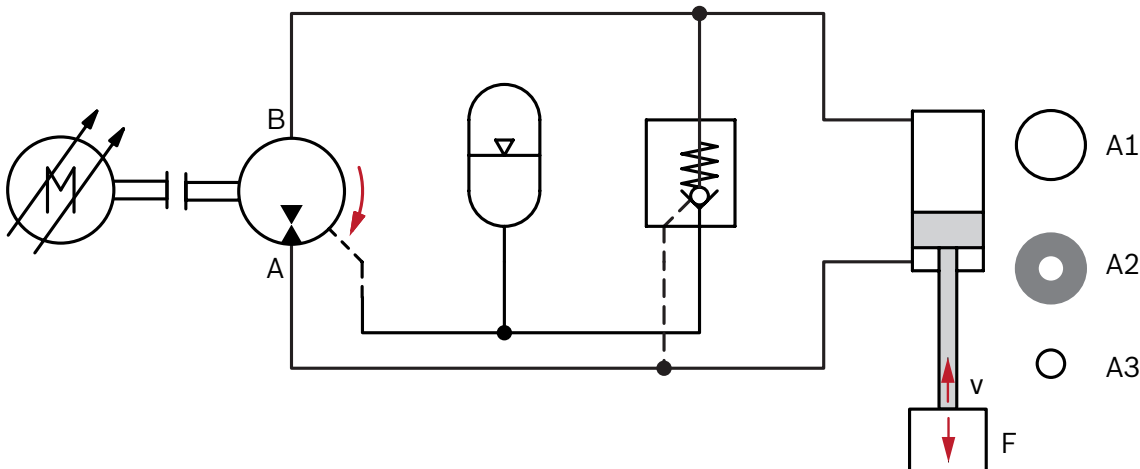
Cylinder extending

- ▶ The pump displaces fluid from A to B
- ▶ During extending, the effective area is A1
- ▶ The fluid flows from chamber A2 via the pump into piston chamber A1
- ▶ The differential volume of piston rod A3 is supplied from the reservoir into piston chamber A1



Cylinder retracting

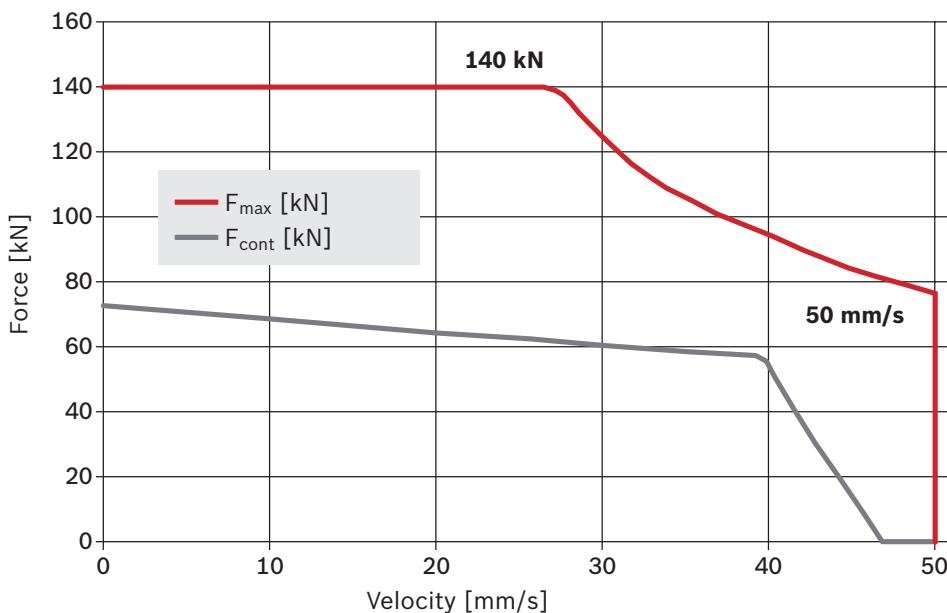
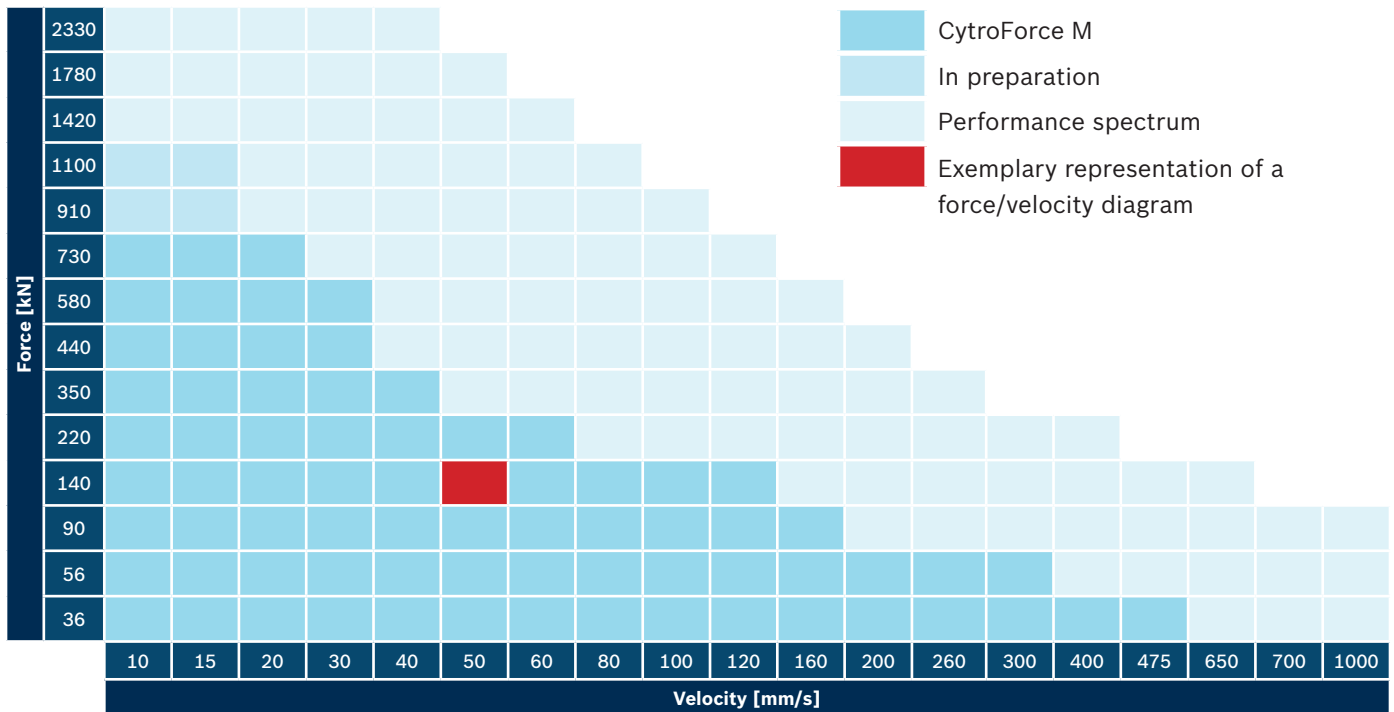
- ▶ The pump displaces fluid from B to A
- ▶ During retracting, the effective area is A2
- ▶ The fluid flows from chamber A1 partially via the pump into chamber A2
- ▶ The differential volume of piston rod A3 is directed via a valve into the reservoir



Technical Data of Solution Matrix A1

The following table describes the performance data of variant A1 – single rod cylinder with fixed displacement axial piston pump from the solution matrix of the SHA. The forces and velocities shown below, refer to the piston side of the CSH1/3 cylinder. The maximum force is generated at a pressure of 250/300 bar.

The maximum cylinder velocity of the standard types refers to a maximum flow speed of 5 m/s in the line ports and a pump displacement size of 10 (NG10). The complete range of solutions is based on enlarged inlet ports of the cylinder.

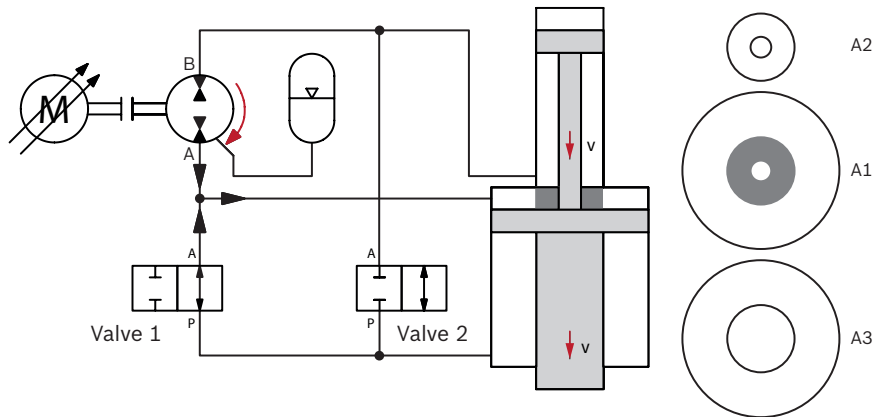


The performance limit shown in the force/velocity diagram refers to the highlighted SHA system solution from solution matrix A1.

For engineering of a SHA system solution for your application, please get in touch with your personal contact at Bosch Rexroth or send an e-mail to: sha@boschrexroth.de

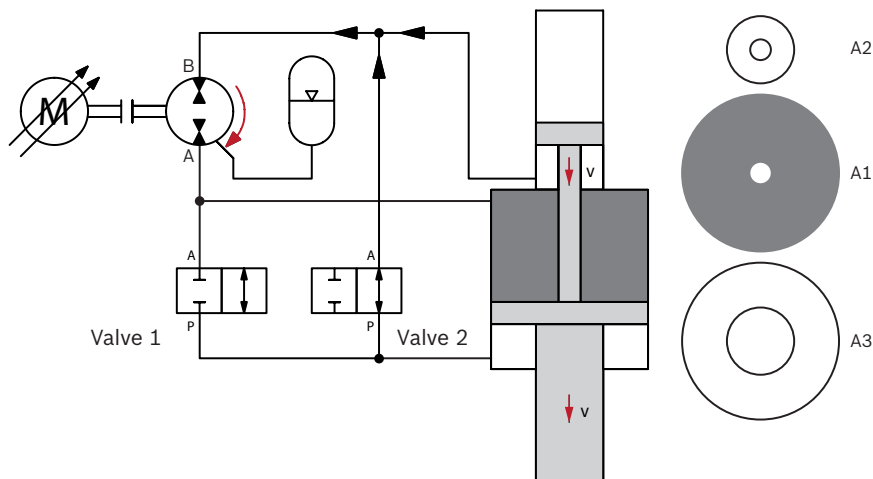
Operating Principle of Solution Matrix E1

The simplified representation of the operating principles shows the essential components, the directions of movement of the cylinder and a possible direction of force.



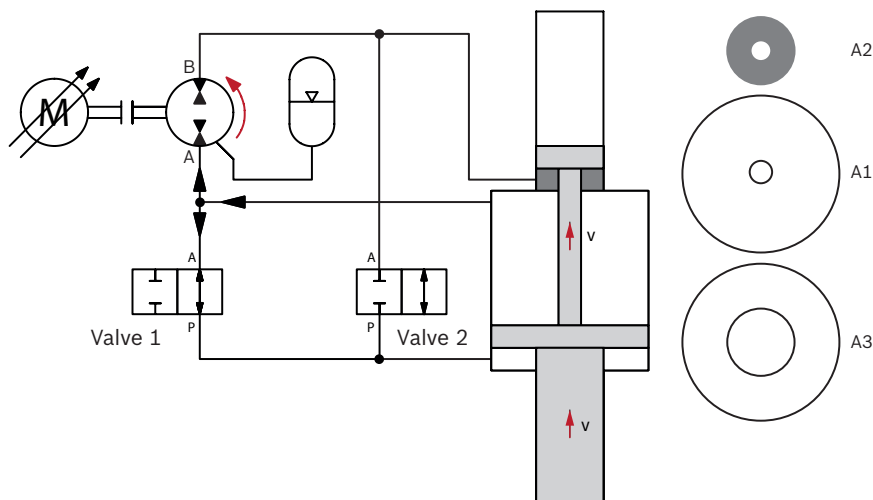
Cylinder extending in rapid speed

- ▶ The pump displaces fluid from B to A
- ▶ During extending in rapid speed, the acting surface is A2
- ▶ The fluid flows from chamber A2 via the pump into chamber A1
- ▶ The displaced volume from chamber A3 flows via valve 1 into chamber A1



Cylinder extending in creep speed

- ▶ The pump displaces fluid from B to A
- ▶ During extending in creep speed, the acting surface is A1
- ▶ The displaced volume from chamber A2 and A3 flows via valve 2 into the chamber A1



Cylinder retracting in rapid speed

- ▶ The pump displaces fluid from A to B
- ▶ During retracting in rapid speed, the acting surface is A2
- ▶ The fluid flows from chamber A1 via the pump into piston chamber A2
- ▶ The displaced volume from chamber A1 flows via valve 1 also in chamber A3

Brief Description of PFC Function

The IndraDrive technology function PositionForceControl (PFC) is used for positioning and for controlling the force of a hydraulic cylinder.

This system function is an integral part of the scope of supply (SHA) has to be only parameterized.

Further programming is not required.

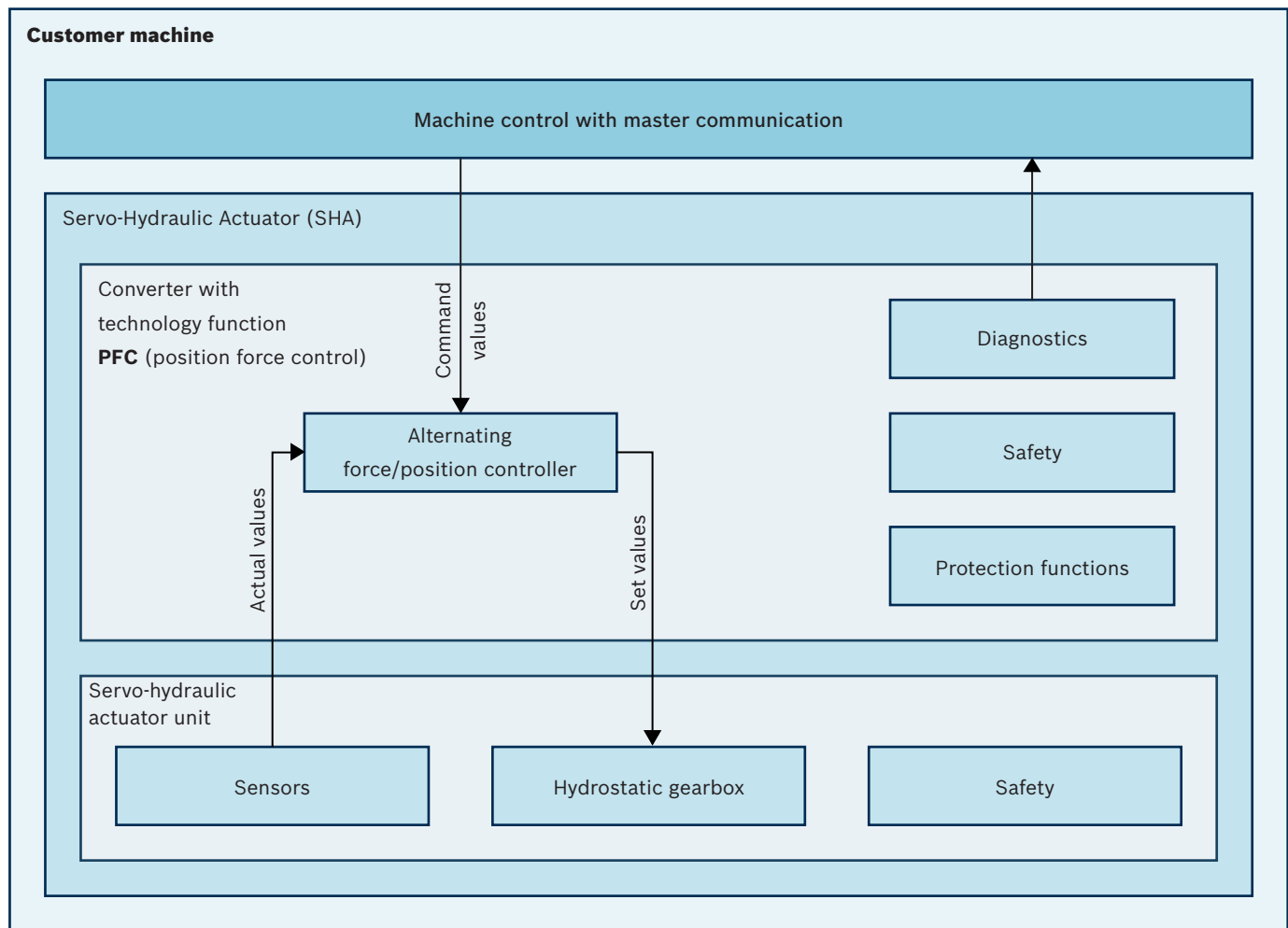
The position is controlled by means of a position encoder.

The force is controlled by means of pressure sensors in the cylinder chambers or via a force sensor at the cylinder.

The controller transition between force and position is alternating. The accuracy of the control depends on the resolution, the encoder accuracy/jitter, freedom of signals from disturbance and the entire hydraulic system setup.

Further information can be found in our commissioning Manual:

R911379550 Rexroth Sytronix – SvP 7020 PFC
Variable-Speed Positioning of Hydraulic Axes



Standard Control Cabinet CAB-X for Servo-Hydraulic Actuators (SHA)

Overview

CAB-X is a standard solution (for servo-hydraulic actuators) of the SHA variant which can be used as simple package solution.

Electrical control, wired and tested for function, consisting of

- ▶ Control cabinet – size depending on controller
- ▶ RAL7035
- ▶ Controller outlet including HCS drive controller
- ▶ Protective PTC thermistor function
- ▶ Regulated power supply, 24 VDC
- ▶ Circuit variations

Operation

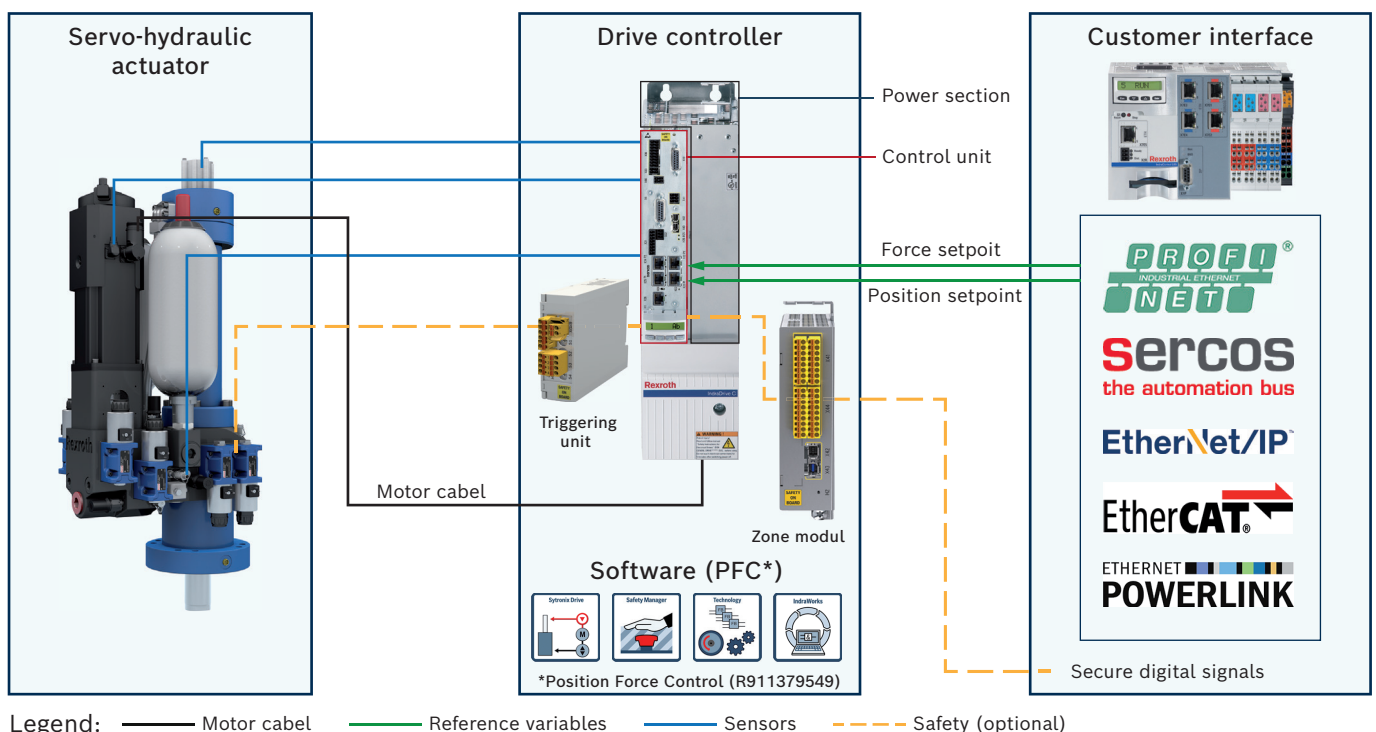
- ▶ Main switch
- ▶ Emergency stop push button
- ▶ Indicator lights (fault/warning/operation)

Options

- ▶ Housing in special colors or made out of stainless steel
- ▶ External filters in case of special requirements
- ▶ Protection class higher than IP54
- ▶ Reserve space for additional equipment
- ▶ Motor outlet for third-party fan

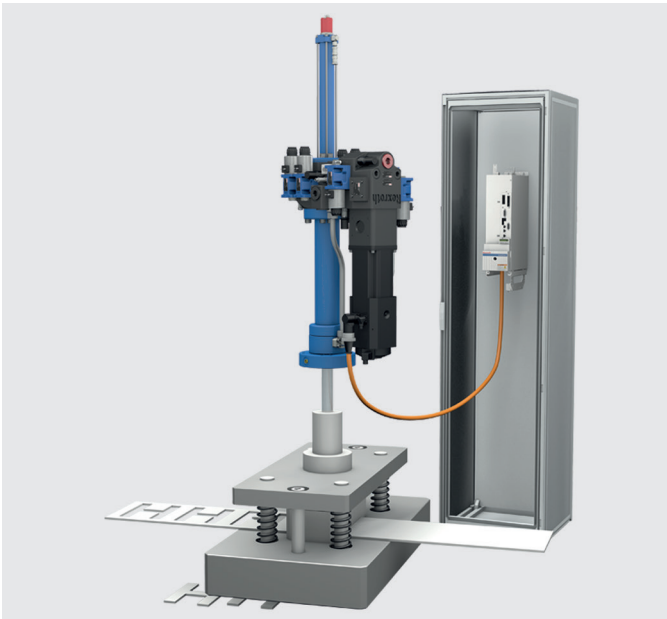


System structure



Steps to finding a Solution

Project description with picture



For target-oriented engineering, the following information must be available completely:

- ▶ Brief project description with picture(s)
- ▶ Cylinder orientation within the machine
- ▶ Additional boundary conditions
- ▶ Process sequence in the form of an F/s/t or F/v/t profile

Please send enquiries to sha@boschrexroth.de

Cylinder orientation

☐

☐

☐

☐ Please tick as appropriate

Additional boundary conditions

	Value	Unit	Comment (min, max, range, ca., etc.)
Moved (reduced) mass <i>m</i>		kg	
Ambient temperature <i>t</i>		°C	
Cable length from actuator to control cabinet		m	
Fieldbus system	<input type="checkbox"/> ProfiNet <input type="checkbox"/> EtherCAT <input type="checkbox"/> sercos <input type="checkbox"/> Other _____		
Safety technology with Performance Level	<input type="checkbox"/> STO – Safe-Torque-Off PL: _____ <input type="checkbox"/> Safe Standstill PL: _____		
	<input type="checkbox"/> SLS – Safely-Limited Speed PL: _____ <input type="checkbox"/> Other _____		

Steps to finding a Solution

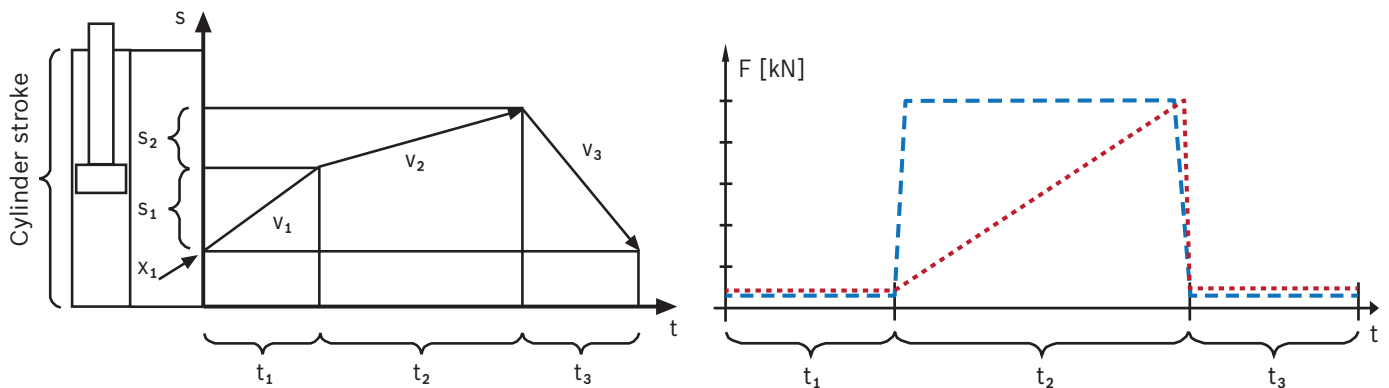
Indication of counter forces F as a function of position s or time t .

Enter only the forces that result from the process (do not enter weight forces).

If there are several load cases, the most critical load case has to be taken as a base for engineering.

Process sequence

The diagrams shown correspond to possible examples.



Parameter	Value	Unit	Comment (min, max, range, ca., etc.)
Distance between piston – cylinder cap x_1		mm	Starting point of the movement
Rapid advance velocity v_1		mm/s	
Rapid advance distance s_1		mm	
Rapid advance time t_1		s	
Force F_1		kN	
Feed rate v_2		mm/s	
Feed distance s_2		mm	
Feed time t_2		s	
Force F_2		kN	
Rapid return velocity v_3		mm/s	
Rapid return distance $s_3 = s_1 + s_2$		mm	
Rapid return time t_3		s	
Force F_3		kN	
Stop until restart of cycle t_4		s	
Max. acceleration a_1		mm/s ²	
Max. deceleration a_2		mm/s ²	
Cycle duration (in case of cyclic movements)		s	

► For complex multiple-step movements the table has to be extended accordingly.

More Information:

CytroForce M

Manual [RD 62270-B](#)

Data Sheet [RD 62270](#)

Control Cabinet CAB-EFC und CAB-HCS

Technical Information [RE 08146](#)

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