Servo-Hydraulic Actuator – SHA
Fields of Application

Technical Information

Contents

Product Description 2
Drive Navigator of linear Actuators 2
Product Features – Advantages and Customer Benefits 3
Fields of Application 3
Fields of Application – Examples 3
Structure 4
Constructions 5
Solution Matrix 5
Operating Principle of Solution Matrix A1 6
Technical Data of Solution Matrix A1 7
Brief Description of PFC Functions 8
Control Cabinet for Servo-Hydraulic Actuators SHA 9
Steps to finding a Solution 10 - 11
System Code 12
Product Description

The 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 force with micrometer positioning accuracy: The new 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” (closed loop bump-less transfer between pressure/force and position control).

Drive amplifier control cabinets complete the overall system.

The portfolio according to the construction kit principle offers
- Maximum forces up to 2,600 kN (584,500 lbf)
- Stroke length up to 1.8 meter (71 in)
- High speed up to 1.1 meter/sec (43.3 in/sec)

On request, larger forces, longer strokes and higher traversing speeds may be realized outside the construction kit.

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 bus
▶ Control and diagnostics – technology function (PFC) with monitoring and protective function

System advantages
▶ Ready-to-install solution – pre-assembled, filled and with only a few defined 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 both, shorter cycle times and 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

Bending

Lifting

Pressing

Moving
Structure

The main components of the SHA basically comprise an IndraDrive controller with technology function Position-ForceControl (PFC), the IndraDyn S motor, a hydraulic cylinder with integrated position measuring system and an axial piston pump for the hydraulic closed system. In addition, pressure and temperature sensors, a compensating tank, a filter and valves are integrated in the hydraulic block. Apart from the power electronics, the standard scope of supply includes mains filters and power chokes. Optionally, various functions (e.g. safety technology) may be added in the form of valves or electronics. The SHA communicates with the higher-level machine control over a bus system.
Constructions

Compact
- Full or partial integration of the cylinder and the motor/pump group with the hydraulic block
- Optimized in terms of installation space

Distributed
- Connection of the standard cylinder and the standard motor/pump group to the hydraulic block by means of hose assemblies or pipes
- Flexibility

Solution Matrix

The SHA solution matrix shown below offers a multitude of combination options for realizing servo-hydraulic actuators.

Bosch Rexroth’s wide product range of components allows the optimum SHA system solution to be engineered for the individual customer application.

<table>
<thead>
<tr>
<th></th>
<th>Single rod cylinder</th>
<th>Double rod cylinder</th>
<th>Multiple area/tandem cylinder</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="Single Rod" /></td>
<td><img src="image" alt="A1" /></td>
<td><img src="image" alt="B1" /></td>
<td><img src="image" alt="E1" /></td>
</tr>
<tr>
<td><img src="image" alt="Double Rod" /></td>
<td><img src="image" alt="A2" /></td>
<td><img src="image" alt="B2" /></td>
<td><img src="image" alt="E2" /></td>
</tr>
</tbody>
</table>

The focus is on the following system solutions:
- **Single rod cylinder with fixed displacement pump – A1**
- Single rod cylinder with variable displacement pump – A2
- Double rod cylinder with fixed displacement pump – B1
- Multiple area/tandem cylinder with fixed displacement pump – E1

Further information on the operating principle as well as technical data for solution A1 – single rod cylinder with fixed displacement pump – can be found further below in this technical information.
Operating Principle of Solution Matrix A1

The simplified representation of the operating principles merely shows 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 X1
- The fluid flows from annulus chamber X2 via the pump into piston chamber X1
- The differential volume of piston rod X3 is transported from the reservoir into piston chamber X1

**Cylinder retracting:**
- The pump displaces fluid from B to A
- During retracting, area X2 is effective
- The fluid flows from annulus chamber X1 partially via the pump into annulus chamber X2
- The differential volume of piston rod X3 is fed 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 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. The total power results from the enlarged line ports at the cylinder.

<table>
<thead>
<tr>
<th>Force [kN]</th>
<th>25</th>
<th>50</th>
<th>100</th>
<th>250</th>
<th>500</th>
<th>750</th>
<th>1,000</th>
<th>1,500</th>
<th>2,000</th>
<th>2,500</th>
</tr>
</thead>
<tbody>
<tr>
<td>Velocity [mm/s]</td>
<td>25</td>
<td>50</td>
<td>100</td>
<td>250</td>
<td>500</td>
<td>750</td>
<td>1,000</td>
<td>1,500</td>
<td>2,000</td>
<td>2,500</td>
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<tr>
<td>25</td>
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<td>300</td>
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<td></td>
<td></td>
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<tr>
<td>400</td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>500</td>
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<tr>
<td>600</td>
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<tr>
<td>700</td>
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<td></td>
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<td>800</td>
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<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

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

For engineering an 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
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 of an SHA and just has to be parameterized. Further programming is usually not required. The position is controlled by means of a position encoder. The sensor is mostly installed directly in the cylinder. The force is controlled by means of pressure sensors in the cylinder chambers or via a force sensor at the cylinder.

The transition between controllers 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 mains adaptor, 24 VDC
- Circuitry variants

Operation:
- Main switch
- Emergency stop push button
- Signal lamps (fault/warning/operation)

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

Machine control with master communication
Control cabinet with converter and technology function PFC
Servo-hydraulic actuator unit
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

<table>
<thead>
<tr>
<th></th>
<th>Value</th>
<th>Unit</th>
<th>Comment (min, max, range, ca., etc.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moved (reduced) mass m</td>
<td></td>
<td>kg</td>
<td></td>
</tr>
<tr>
<td>Ambient temperature t</td>
<td></td>
<td>°C</td>
<td></td>
</tr>
<tr>
<td>Cable length from actuator to control cabinet</td>
<td></td>
<td>m</td>
<td></td>
</tr>
<tr>
<td>Bus system</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
**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 one has to be taken as a basis for engineering.

**Process sequence**
The curve shapes shown correspond to possible examples.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Unit</th>
<th>Comment (min, max, range, ca., etc.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distance between piston - cylinder cap $x_1$</td>
<td></td>
<td>mm</td>
<td>Starting point of the movement</td>
</tr>
<tr>
<td>Rapid advance velocity $v_1$</td>
<td></td>
<td>mm/s</td>
<td></td>
</tr>
<tr>
<td>Rapid advance distance $s_1$</td>
<td></td>
<td>mm</td>
<td></td>
</tr>
<tr>
<td>Rapid advance time $t_1$</td>
<td></td>
<td>s</td>
<td></td>
</tr>
<tr>
<td>Force $F_1$</td>
<td></td>
<td>kN</td>
<td></td>
</tr>
<tr>
<td>Feed rate $v_2$</td>
<td></td>
<td>mm/s</td>
<td></td>
</tr>
<tr>
<td>Feed distance $s_2$</td>
<td></td>
<td>mm</td>
<td></td>
</tr>
<tr>
<td>Feed time $t_2$</td>
<td></td>
<td>s</td>
<td></td>
</tr>
<tr>
<td>Force $F_2$</td>
<td></td>
<td>kN</td>
<td></td>
</tr>
<tr>
<td>Rapid return velocity $v_3$</td>
<td></td>
<td>mm/s</td>
<td></td>
</tr>
<tr>
<td>Rapid return distance $s_3 = s_1 + s_2$</td>
<td></td>
<td>mm</td>
<td></td>
</tr>
<tr>
<td>Rapid return time $t_3$</td>
<td></td>
<td>s</td>
<td></td>
</tr>
<tr>
<td>Force $F_3$</td>
<td></td>
<td>kN</td>
<td></td>
</tr>
<tr>
<td>Break until restart of cycle $t_4$</td>
<td></td>
<td>s</td>
<td></td>
</tr>
<tr>
<td>Max. acceleration $a_1$</td>
<td></td>
<td>mm/s²</td>
<td></td>
</tr>
<tr>
<td>Max. delay $a_2$</td>
<td></td>
<td>mm/s²</td>
<td></td>
</tr>
<tr>
<td>Cycle duration (in case of cyclic movements)</td>
<td></td>
<td>s</td>
<td></td>
</tr>
</tbody>
</table>

- For complex multiple-step movements the table has to be extended accordingly.
## System Code

<table>
<thead>
<tr>
<th>01</th>
<th>02</th>
<th>03</th>
<th>04</th>
<th>05</th>
<th>06</th>
<th>07</th>
<th>08</th>
<th>09</th>
<th>10</th>
<th>11</th>
<th>12</th>
<th>13</th>
<th>14</th>
<th>15</th>
<th>16</th>
</tr>
</thead>
<tbody>
<tr>
<td>SHA</td>
<td>A1</td>
<td>NN</td>
<td>-</td>
<td>/</td>
<td>-</td>
<td>10</td>
<td>N</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>*</td>
</tr>
</tbody>
</table>

### Functional solution
- 02 Single rod cylinder with fixed displacement pump

### Additional functions
- 03 No additional function

### Construction
- 04 Distributed – block with motor/pump group
  - Compact linear
  - Compact parallel
  - Compact rectangular

### Nominal force
- 05 Force in kN, e.g. 100

### Stroke
- 06 Stroke length in mm, e.g. 100

### Pump type
- 07 A10

### Controller (variable displacement pump)
- 08 No variable displacement pump

### Pump size
- 09 e.g. NG 10

### Motor
- 10 e.g. MSK071C

### Type of cooling (motor)
- 11 Natural convection
  - Axial fan, blowing
  - Liquid cooling

### Drive controller
- 12 HCS02
  - HCS03

### Maximum current
- 13 e.g. 028 A

### Connectivity
- 14 Not provided
  - Multi-Ethernet

### Safety
- 15 Not provided
  - Safe halt, electrical

### Additional data
- 16 Consecutive number

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