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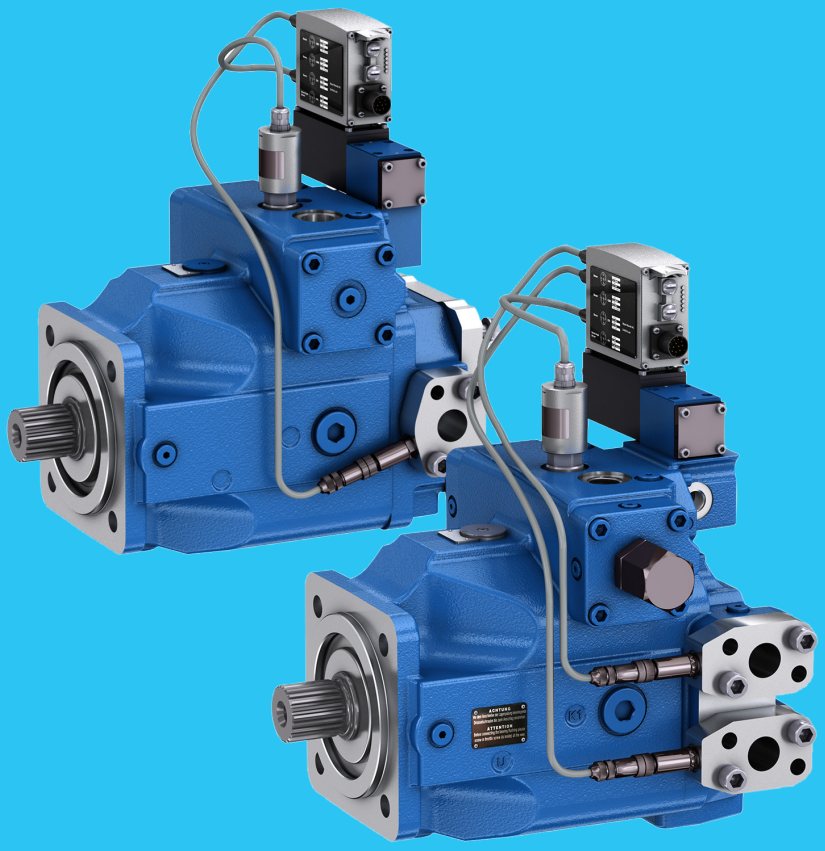
Instruction manual

Control system HS5E(V)(L)

for Axial piston variable pump A4VSO, A4VBO, A4VSG and A4CSG



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The cover shows an example application. The product delivered may differ from the image on the cover.

The original operating instructions were created in German.

Contents

1 About this documentation

1.1 Validity of the documentation

This documentation is valid for axial piston units with an HS5E(V)(L) control system:

- Axial piston variable pump A4VSO
- Axial piston variable pump A4VSG
- Axial piston variable pump A4CSG
- Axial piston variable pump A4VBO

This documentation is intended for project engineers, operators, machine/system manufacturers, assemblers and service engineers.
This documentation contains important information on safe and proper transportation, assembly, commissioning, operation, maintenance, removal, and simple troubleshooting of the A4... with HS5E(V)(L) control system.

▶ Read this documentation completely, in particular the chapters entitled 2 "Safety instructions" page 10 and 3 "General instructions on damage to equipment and the product" on page 18 before you start work with the A4... with HS5E(V)(L) control system.

1.2 Required and supplementary documentation

▶ Only commission the axial piston unit if the documentation marked with the book symbol 🕮 is available to you and you have understood and observed it.

Table 1: Required and supplementary documentation

	Title	Document number	Document type
🕮	**Order confirmation** Contains the order-related technical data for your axial piston variable pump A4... with HS5E(V)(L) control system.	–	Order confirmation
🕮	**Installation drawing** Contains the outer dimensions, all ports and the hydraulic circuit diagram for your axial piston variable pump A4... with HS5E(V)(L) control system.	Please request the installation drawing from your contact at Bosch Rexroth.	Installation drawing
🕮	**Axial piston variable pump A4... with HS5E(V)(L) control system** Contains the permissible technical data, ports, main dimensions and circuit diagrams of standard versions.	92076	Data sheet
🕮	**Axial piston variable pump A4VSO** **Axial piston variable pump A4VSG** **Axial piston variable pump A4CSG** **Axial piston variable pump A4VBO** Contains the permissible technical data, ports, main dimensions and circuit diagrams of standard versions.	92050 92100 92105 92122	Data sheet
🕮	**Axial piston variable pump A4VSO for HFC hydraulic fluids** Contains the permissible technical data.	92053	Data sheet
🕮	**Swivel angle sensor type VT-SWA-Lin-1x/G15** Contains the permissible technical data.	30263	Data sheet
🕮	**Pressure transducer with integrated electronics type HM 20** Contains the permissible technical data.	30272	Data sheet

Table 1: Required and supplementary documentation

	Title	Document number	Document type
🕮	**Hydraulic fluids based on mineral oils and related hydrocarbons** Describes the requirements for mineral oil-based hydraulic fluids and related hydrocarbons for operation with Rexroth hydraulic components and provides support for selection of suitable hydraulic fluids for the hydraulic system.	90220	Data sheet
🕮	**General Instruction Manual for Axial Piston Units** Contains additional information on the use of Rexroth axial piston units.	90300-B	Instruction manual
🕮	**Instruction Manual for Axial Piston Unit A4VSO** **Instruction Manual for Axial Piston Unit A4VSG** **Instruction Manual for Axial Piston Unit A4CSG** **Instruction Manual for Axial Piston Unit A4VBO** Contains additional information on the use of Rexroth axial piston units.	92050-01-B 92100-01-B 92105-01-B 92122-01-B	Instruction manual
🕮	**Information on the application of hydrostatic drives at low temperatures** Contains additional information on the application of Rexroth axial piston units at low temperatures.	90300-03-B	Manual
🕮	**Storage and preservation of axial piston units** Contains additional information on storage and preservation.	90312	Data sheet
🕮	Rexroth HydraulicDrive functions (firmware and software descriptions)	30338-FK	Functional description
🕮	Rexroth HydraulicDrive functions (firmware and software descriptions) Additional information	30237-Z	Functional description
🕮	Rexroth HydraulicDrive functions (Parameter description)	30330-PA	Parameter description
🕮	Rexroth HydraulicDrive functions (Description of diagnosis)	30330-WA	Description of diagnosis
🕮	Rexroth HydraulicDrive functions (Firmware description)	30330-RN	Firmware description
🕮	Pressure transducer with integrated electronics, type HM 20	30272-MON	Assembly instructions
🕮	Installation, commissioning and maintenance of hydraulic systems	07900	Data sheet
🕮	Declaration of environmental compatibility	30030-U	Environment data sheet

1.3 Representation of information

Standardized safety instructions, symbols, terms and abbreviations are used throughout this documentation so that you can work quickly and safely with your product. For clarification, they are explained in the sections below.

1.3.1 Safety instructions

In this documentation, safety instructions appear in the chapter 2.6"Product-specific safety instructions" on page 13 and in the chapter 3"General instructions on material damage and product damage" on page 18 as well as before a sequence of actions or before action instructions in which there is a danger of personal injury or property damage. Always follow the measures for danger prevention associated with the use of this product.

Safety instructions are set out as follows:

⚠ SIGNAL WORD
Type and source of danger! Consequences of noncompliance ▶ Danger prevention measures

- **Warning sign:** draws attention to the danger
- **Signal word:** identifies the degree of the danger
- **Type and source of danger:** indicates the type and source of the danger
- **Consequences:** describes what occurs if safety instructions are disregarded
- **Precautions:** states how the danger can be avoided

Table 2: Hazard classes as defined in ANSI Z535.6

Warning sign, signal word	Meaning
⚠ DANGER	Identifies a dangerous situation that will result in death or serious injury if it is not avoided.
⚠ WARNING	Identifies a dangerous situation that may result in death or serious injury if it is not avoided.
⚠ CAUTION	Identifies a dangerous situation that may result in minor to moderate injury if it is not avoided.
NOTICE	Property damage: The product or surrounding area may be damaged.

1.3.2 Symbols

The following symbols indicate notices that are not safety-relevant but increase understanding of the documentation.

Table 3: Meaning of symbols

Symbol	Meaning
	If this information is disregarded, the product cannot be used and/or operated to its full extent.
▶	Single, independent action
1. **2.** **3.**	Numbered instruction: The numbers indicate that the actions must be completed in order.

1.3.3 Designations

This documentation uses the following designations:

Table 4: Designations

Designation	Meaning
A4VSO	Axial piston variable pump, open circuit
A4VSG	Axial piston variable pump, closed circuit
A4CSG	Axial piston variable pump, closed circuit
A4VBO	Axial piston variable pump, open circuit, high-pressure unit
HS5E	Control system with integrated **O**n **B**oard **E**lectronics and external control pressure supply
HS5EV, HS5EL	Control system with integrated **O**n **B**oard **E**lectronics and internal control pressure supply
FWA-HYDRV-HDB-XXVXX	Firmware for HydraulicDrive
HM20	Pressure transducer, Type HM20
IndraWorks	Service tool for commissioning, parameterizing, and diagnosing the HydraulicDrive
VT-SWA-Lin-1X/G15	Swivel angle sensor

As umbrella term for "Axial piston variable pump A4VSO, A4VBO and A4VSG, A4CSG", the designation "Axial piston unit" will be used in the following.

1.3.4 Abbreviations

This documentation uses the following abbreviations:

Table 5: Abbreviations

Abbreviation	Meaning
ATEX	EC directive on explosion protection (**At**mosphère **ex**plosible)
DB	Pressure relief valve
PT	P**ressure** T**ransducer**
EMC	**E**lectro**m**agnetic **c**ompatibility
GND	Ground
n.c.	not connected
p	Pressure (character in formulas)
PC	**P**ersonal **C**omputer
PCV	**Pre**c**ompression **V**olume
p_{diff}	Control difference between the pressure command value and the actual pressure value
PE	**P**rotective **E**arth
p_{actual}	Actual pressure value
P_{set}	Pressure command value
SW	**S**wivel **a**ngle
SW_{act}	Swivel angle actual value
SW_{set}	Swivel angle command value
U_R	Supply voltage
DIN	**D**eutsches **I**nstitut für **N**ormung (German Institute for Standardization)
ISO	**I**nternational **O**rganization for **S**tandardization
JIS	**J**apan **I**ndustrial **S**tandard
RE	**R**exroth document in the **E**nglish language
VDI 2230	Directive for the systematic calculation of high duty bolted joints and joints with one cylindrical bolt from the VDI (**V**erein **D**eutscher **I**ngenieure - Association of German Engineers)

2 Safety instructions

2.1 About this chapter

The HS5E(V)(L) control system has been manufactured according to the generally accepted rules of current technology. There is still, however, a risk of personal injury or property damage if this chapter and the safety instructions in this documentation are not observed.

- ▶ Read this documentation completely and thoroughly before working with the HS5E(V)(L) control system.
- ▶ Keep this documentation in a location where it is accessible to all users at all times.
- ▶ Always include the required documentation when you pass the axial piston unit on to third parties.

2.2 Intended use

The HS5E(V)(L) control system is a hydraulic component, which means that in its field of application, it is classified neither as complete nor as partly complete machinery in the sense of EC Machinery Directive 2006/42/EC. The component is exclusively intended to form partly completed machinery or complete machinery together with other components. The component should only be commissioned after it has been installed in the machine/system for which it is intended, and the safety of the entire system has been established in accordance with the Machinery Directive.
This product is intended for the following use:
The pressure flow control system is used for the electro-hydraulic pressure and swivel angle control and torque limitation of an axial piston variable pump type A4VSO, A4VBO, A4VSG or A4CSG.

- ▶ Observe the technical data, the application and operating conditions and the performance limits according to the data sheets listed on page 6 and the order confirmations.

The HS5E(V)(L) control system is a piece of technical work equipment and it is not intended for personal use.
Intended use includes having completely read and understood this documentation, especially the chapter on 2 "Safety instructions".
Operation is only allowed if you comply with national EMC regulations for the present application. If you need information about EMC-compliant installation, refer to Bosch Rexroth's EMC test documentation (see data sheet 92076). Ensuring compliance with the limit values required by national regulations is the responsibility of the manufacturer of the system or machine.
• European countries: EC directive 2014/30/EU (EMC Directive)
• USA: See the national electrical system regulations (NEC), National organization of the manufacturers of electrical systems (NEMA) as well as regional building regulations.

- ▶ Observe the technical data, the application and operating conditions and the performance limits as specified in the data sheet 92076 and in this document and in the order confirmation. Information about approved hydraulic fluids can be found in data sheet 92076.

The axial piston unit is only intended for commercial use and not for private use.

2.3 Improper use

Any use other than that described as intended use is considered improper.
Bosch Rexroth AG is not liable for damages resulting from improper use. The user is solely responsible for any risks arising from improper use.
The following foreseeable forms of faulty usage are also considered improper (this list is not exhaustive):

- Use outside the operating parameters approved in the data sheet and in the order confirmation (unless specifically approved by the customer)
- Use of non-approved fluids, e.g. water or polyurethane components
- Changes to factory settings by unauthorized persons.
- Use of assembled parts (e.g. control unit, valves) not in combination with the specified Rexroth components
- Use of the axial piston unit with assembled parts under water at a depth of more than 10 meters without the necessary additional measures, for example pressure equalization. Units with electrical components (e.g. sensors) generally cannot come into contact with water.
- Use of the axial piston unit under a continuous pressure differential between housing and ambient pressure greater than 2 bar, with the ambient pressure always lower than the case pressure. Momentary (t < 0.1 s) pressure peaks of up to 4 bar are allowed. Beyond this, the maximum permissible case pressure specified in the data sheet should not be exceeded.
- If you do not comply with the domestic EMC regulations for the present application. If you need information about EMC-compliant installation, refer to Bosch Rexroth's EMC test documentation (see data sheet 92076). Ensuring compliance with the limit values required by national regulations is the responsibility of the manufacturer of the system or machine (European countries: EC directive 2014/30/EU (EMC Directive); USA: See the national electrical system regulations (NEC), National organization of the manufacturers of electrical systems (NEMA) as well as regional building regulations
- Use of the HS5E(V)(L) control system in an explosive environment unless the component or machine/system has been certified as being compliant with ATEX directive 2014/34/EU.
- Use of the axial piston unit in a corrosive atmosphere
- Use of the axial piston unit in aircraft or spacecraft

2.4 Personnel qualifications

The activities described in this documentation require a basic understanding of mechanics, electricity and hydraulics, as well as familiarity with associated technical terms. For transporting and handling the product, knowledge regarding the use of lifting devices and lifting accessories is required. In order to ensure safe use, these activities should only be performed by skilled personnel or an instructed person under the direction and supervision of skilled personnel.
Skilled personnel refers to persons who possess the professional training, knowledge and experience, as well as the understanding of the regulations relevant to the work to be done that are necessary to recognize possible dangers and take the appropriate safety measures. Skilled personnel must follow the rules relevant to their field and have the necessary expert knowledge of hydraulics and electrical systems.

Hydraulic expert knowledge includes:
- Being able to read and fully understand hydraulic circuit diagrams
- In particular, fully understanding the relationships with regard to safety devices
- comprising of knowledge regarding the function and layout of hydraulic components.

Expert knowledge of electrical systems includes:
- Reading and fully understanding electrical circuit diagrams,
- In particular, fully understanding the relationships with regard to safety devices
- and understanding how electrical components function and are put together.

Bosch Rexroth offers you measures supporting training in specific areas.
You can find an overview of the training contents on the Internet at:
www.boschrexroth.com/training.

2.5 General safety instructions

- Observe applicable accident prevention and environmental protection regulations.
- Observe the safety regulations of the country in which the product is used/operated.
- Use Rexroth products only when they are in good working order.
- Observe all notices on the product.
- Do not assemble, operate, remove or maintain Rexroth products if under the influence of alcohol, drugs or medication that may affect your reaction time.
- Only use genuine Rexroth accessories and spare parts to ensure there is no hazard to persons from unsuitable spare parts.
- Observe the technical data and ambient conditions specified in the product documentation.
- If unsuitable products are installed or used in applications that are of relevance to safety, unexpected operating conditions may occur in the application, which could result in personal injury or property damage. For this reason, only use the product in safety-relevant applications if this use is expressly indicated and approved in the product documentation, e.g. in explosion protection areas or in safety-related parts of a control system (functional safety).
- Only commission the product if it has been determined that the end product (e.g. machinery/system) in which the Rexroth products are installed complies with the country-specific provisions, safety regulations and standards for the application.
- Use tools appropriate for the work being performed and wear appropriate protective clothing to prevent punctures and cuts (e.g. when removing protective covers, disassembly).
- There is a risk of entanglement when operating the axial piston unit with a bare shaft end. Check whether or not your machine requires additional safety measures for your application. If necessary, make sure these are appropriately implemented.
-
- Depending on the type of control used, electromagnetic effects can be produced when using solenoids. Applying a direct voltage signal (DC) to solenoids does not

create electromagnetic interference (EMI) nor is the solenoid affected by EMI. Potential electromagnetic interference (EMI) exists if the solenoid is energized with a modulated direct current (e.g. PWM signal). The machine manufacturer should conduct appropriate tests and take appropriate measures to ensure that other components or operators (e.g. with a pacemaker) are not affected by this potentiality.

2.6 Product-specific safety instructions

The following safety instructions apply to chapters 3 to 11.

⚠ WARNING

Danger from excessive pressure!

Risk of death or injury, or property damage!

Improperly changing the factory pressure settings can result in a pressure increase beyond the maximum permissible pressure.

Operating the unit above the maximum permissible pressure can cause components to burst and hydraulic fluid to escape under high pressure.

High pressures can result due to deactivation of pressure control, using a pressure sensor that is not parameterized in the electronic system, parameterizing the electronics parameters incorrectly, or setting the wrong command values.

- Changes to the factory settings may only be made by Bosch Rexroth specialists.
- In addition, a pressure relief valve is required in the hydraulic system as back-up. If the axial piston unit is equipped with a pressure cut-off and/or pressure controller, this is not an adequate safeguard against pressure overload.

Danger due to suspended loads!

Risk of death or injury, or property damage!

Improper transportation may cause the axial piston unit to fall down and lead to injury, e.g. crushing or fracture, or damage to the product.

- Make sure that the load bearing capacity of the lifting device is sufficient to safely bear the weight of the axial piston unit.
- Never stand or reach under suspended loads.
- Ensure a stable transport position.
- Use your personal protective equipment (e.g. safety goggles, safety gloves, suitable working clothes, safety shoes).
- Use suitable lifting devices for transport.
- Observe the prescribed position of the lifting strap.
- Observe the national laws and regulations on occupational health and safety, and transportation.

⚠ WARNING

System/machine under pressure!

Risk of death or serious injury when working on unsecured machines/systems!

Property damage!

- Switch off the relevant machine/system part and secure these against reactivation according to the parameters by the machine/system manufacturer.
- Ensure that all relevant components of the hydraulic system are depressurized. For this purpose, observe the parameters indicated by the machine/system manufacturer.
- When working at hydraulic systems with stored pressure energy (e.g. accumulators), hydraulic components may even be pressurized after the pressure supply has been switched off. During work, hydraulic fluid may escape or hydraulic components may fly around and cause serious injuries. Before starting work at the system, ensure that the hydraulic system is depressurized.
- Please note that the hydraulic system might still be pressurized even after separation from the actual pressure supply.
- Do not disconnect any line connections, ports or components as long as the hydraulic system is under pressure.

Escaping hydraulic fluid mist!

Risk of explosion and fire hazard, health hazard, risk of environmental pollution!

- Depressurize the relevant machine/system component and repair the leak.
- Only perform welding work when the machine/system is depressurized.
- Keep open flames and ignition sources away from the axial piston unit.
- If axial piston units are located in the vicinity of ignition sources or powerful thermal radiators, a shield must be erected to ensure any escaping hydraulic fluid cannot be ignited, and to protect hose lines from premature aging.

Hydraulic fluid will explode when making contact with water!

Risk of explosion and fire!

- Do not bring hot hydraulic fluids in contact with water.

Electrical voltage!

Danger to life or risk of injury due to electric shock or property damage!

- Always diskonnect the voltage supply to the relevant machine/system part before assembling the product and/or connecting or diskonnecting the connector. Protect the machine/system against being re-energized.

⚠ WARNING

Danger from unexpected machine movement!

Danger to life or risk of injury! Unintentional or careless actuation of the manual override of the solenoids can cause unexpected machine movements.

- Use the manual override only for functional testing or in the event of technical malfunctions.
- Using the manual override on a permanent basis (e.g. by wedging, blocking) is not permitted.
- The use of the manual override is only permitted with limited technical data (e.g. 0.25 × maximum data).
- Check whether or not your machine requires additional safety measures for your application to avoid unintentional actuation. If necessary, make sure these are appropriately implemented.
- Wear suitable protective clothing.

Restriction of control function!

Risk of injury or property damage!

Under certain circumstances, moving parts in control equipment (e.g. valve spools) can get stuck in an undefined position due to contamination (e.g. impure hydraulic fluid, abrasion or residual dirt from components). As a result, the hydraulic fluid flow and the build-up of torque in the axial piston unit can no longer respond correctly to the operator's specifications. Even the use of various filter elements (external or internal flow filtration) will not rule out a fault but merely reduce the risk.

- Check whether your application requires remedial measures on your machine in order to bring the driven consumer to a safe position (e.g. safe stop).
- If necessary, make sure these are appropriately implemented.

Escaping hydraulic fluid due to leakage of machine/system components!

Risk of burning and risk of injury due to escaping hydraulic fluid jet!

- Depressurize the relevant machine/system component and repair the leak.
- Never attempt to block or seal the leak or hydraulic fluid jet with a cloth.

⚠ CAUTION

High noise development during operation!

Risk of hearing damage or hearing loss!

The noise emission of axial piston units depends on rotational speed, working pressure and installation conditions, among other factors. The sound pressure level may rise above 70 dB (A) in certain application conditions.

- Always wear hearing protection near a running axial piston unit.

⚠ CAUTION

Hot surfaces on the axial piston unit and HS5E(V)(L) control system!
Risk of getting burnt!
- Allow the axial piston unit and the HS5E(V)(L) control system to cool down sufficiently before touching them.
- Wear heat-resistant, protective clothing, e.g. gloves.

Improper cable and line routing!
Risk of stumbling and property damage! Due to incorrect routing of lines and cables, both a risk of stumbling as well as damage to parts and components can occur, e.g. due to lines and connectors being torn off.
- Always install cables and lines in a way that nobody can fall over them, that they are not bend or twisted, do not chafe on edges and are not guided through ducts with sharp edges without sufficient protection.

Contact with hydraulic fluid!
Risk of adverse health effects, e.g. eye injury, skin irritation, toxication from inhalation!
- Avoid any contact with hydraulic fluids.
- When handling hydraulic fluids, the safety instructions of the lubricant manufacturer need to be observed at all times.
- Use your personal protective equipment (e.g. safety goggles, safety gloves, suitable working clothes, safety shoes).
- Immediately seek medical attention, however, if hydraulic fluid gets into your eyes or blood circuit or if you swallow it accidentally.

Danger from improper handling!
Slip hazard! Risk of slipping on wet surfaces when climbing on the axial piston unit.
- Never grab or climb onto the axial piston unit.
- Check how to safely get on top of the machine/system.

Missing potential equalization on the hydraulic unit!
Uncontrolled function of the axial piston unit.
- Missing or incorrect potential equalization on the hydraulic unit can lead to its functions being uncontrolled. Depending on the application, this can lead to hazards to persons. This means that you must ensure proper potential equalization by means of the existing pin assignment on the connector side.

Interference in case of energy fluctuations and/or energy failure with HS5E, open circuit (A4VSO, A4VBO)!
Uncontrolled movements in the system:
- In case of energy fluctuations and/or energy failure, the axial piston unit will return into the basic position $V_{g\,min}$ if the control pressure supply is sufficient. Limiting the minimum displacement can cause torque to be generated in the application.
  Check whether additional measures are necessary on your machine for the application in order to guarantee that the torque is switched off. If necessary, make sure these are appropriately implemented.

⚠ CAUTION

Interference in case of energy fluctuations and/or energy failure with HS5E, closed circuit (A4VSG, A4CSG)!

Uncontrolled movements in the system:

- In case of energy fluctuations and/or energy failure, the axial piston unit will open if the control pressure supply is sufficient -$V_{g\,max}$ or α = -100%.
  Check whether additional measures are necessary on your machine for the application in order to guarantee that the torque is switched off. If necessary, make sure these are appropriately implemented.

Interference in case of energy fluctuations and/or energy failure with HS5EV, open circuit (A4VSO, A4VBO)!

Uncontrolled movements in the system:

- In case of energy fluctuations and/or failure, the unit will move to different swivel angles, depending on the available load pressure (system-related). If the load pressure is missing, the axial piston unit will move in $V_{g\,max}$.
  Check whether additional measures are necessary on your machine for the application in order to guarantee that the torque is switched off. If necessary, make sure these are appropriately implemented.

Interference in case of energy fluctuations and/or energy failure with HS5EL, closed circuit (A4CSG)!

Uncontrolled movements in the system:

- In case of energy fluctuations and/or failure, the unit will move to -$V_{g\,max}$ (α=-100%) depending on the available and sufficient load pressure and boost pressure (system-related).
  Check whether additional measures are necessary on your machine for the application in order to guarantee that the torque is switched off. If necessary, make sure these are appropriately implemented.

NOTICE

Interference due to electromagnetic radiation!

Uncontrolled movements in the system.

- The hydraulic unit with its electronic components can interfere with other electronics systems by emitting electromagnetic radiation. Apart from this, hydraulic units with electronic components can be interfered with by the electromagnetic radiation of other electronics systems and magnetic fields. In both cases, this can lead to uncontrolled movements in the system.
- Pay attention to the limit values for electromagnetic radiation and, if necessary, screen electronic components, connection and signal lines appropriately.
- Make sure that there is an adequate distance between the electronics, including the connection and signal lines, and high-voltage current-conducting lines.

2.7 Personal protective equipment

Personal protective equipment is the responsibility of the user of the axial piston unit with HS5E(V)(L) control system. Observe the safety regulations in your country. All pieces of personal protective equipment should be intact.

3 General instructions on property damage and product damage

The following notes apply for chapters 3 to 14.

NOTICE

Danger from improper handling!

Product can be damaged!

- Do not subject the product to improper mechanical loads.
- Never use the product as handle or step.
- Do not put/place any objects on the product.
- Do not strike the drive shaft of the axial piston unit.
- Do not set/place the axial piston unit on the drive shaft or assembled parts.
- Do not strike assembled parts (e.g. sensors or valves).
- Do not hit sealing surfaces (e.g. on the working ports).
- Leave the protective covers on the axial piston unit until you connect the lines.
- Diskonnect all electrical connectors before arc welding and painting operations.
- Make sure the electronic components (e.g. sensors) do not build up electrostatic charges (e.g. during painting).

Risk of property damage due to inadequate lubrication!

Product can be damaged or destroyed!

- Never operate the axial piston unit with insufficient hydraulic fluid. Specifically, make sure that the rotary group has sufficient lubrication.
- When commissioning a machine/system, make sure that the housing area and the working lines of the axial piston unit are filled with hydraulic fluid and remain filled during operation. Avoid air inclusions in the forward drive shaft bearing, especially with the axial piston unit installed with the drive shaft up.
- Check the hydraulic fluid level in the housing area regularly and recommission, if necessary. With above-reservoir installation, the housing area may drain via the drain line after longer standstill periods (air enters via the shaft seal) or via the working line (gap leakage). This means the bearings are insufficiently lubricated when the system is turned on.
- Make sure the suction line is always filled with hydraulic fluid during commissioning and operation.
- With above-reservoir installation, an axial piston unit must be moved to full swivel angle after no more than three seconds during commissioning and recommissioning. Make sure that the axial piston unit really does suck in hydraulic fluid and build up pressure.

NOTICE

Mixing hydraulic fluids!

Product can be damaged!

- Before installation, remove all fluids from the axial piston unit to prevent mixing with the hydraulic fluid used in the machine/system.
- Any mixture of hydraulic fluids of different manufacturers and/or different types of the same manufacturer is generally not permissible.

Contamination of hydraulic fluid!

The cleanliness of the hydraulic fluid impacts the service life of the axial piston unit. Contamination of the hydraulic fluid may lead to premature wear and malfunctions!

- Always ensure a work environment in the assembly location that is free from dust and foreign particles to prevent foreign particles, e.g. welding beads or metal cuttings, from entering the hydraulic lines and lead to wear and malfunctions in the product. The axial piston unit should be clean when installed.
- Only use clean ports, hydraulic lines and assembled parts (e.g. measuring devices).
- When plugging the ports, no contamination may ingress.
- Before commissioning, ensure that all hydraulic connections are tight and that all seals and plugs of the plug-in connection are correctly installed and undamaged to prevent fluids and foreign particles from entering the product.
- Filter the hydraulic fluid when filling the system with a suitable filter system to minimize the solid particle contamination and water in the hydraulic system and to achieve the required cleanliness level.

Improper cleaning!

Product can be damaged!

- Plug all openings with appropriate protective covers in order to prevent cleaning agents from entering the axial piston unit.
- Never use solvents or aggressive cleaning agents. Use only water and, if necessary, a mild cleaning agent to clean the axial piston unit.
- Do not point a high-pressure cleaner at sensitive components, e.g. shaft seal, electrical connections and components.
- Use fiber-free cloths for cleaning.

Environmental pollution due to improper disposal!

Careless disposal of the axial piston unit and its assembled parts, the hydraulic fluid and the packaging material can cause environmental pollution!

- Dispose of the axial piston unit, hydraulic fluid and packaging in accordance with the regulations in your country.
- Dispose of the hydraulic fluid in accordance with the applicable safety data sheet for the hydraulic fluid.

NOTICE

Danger from chemical or corrosive environmental conditions!
Product can be damaged! If the axial piston unit is exposed to chemical or corrosive environmental conditions, such as sea water, fertilizer or road salt, it can result in corrosion or, in extreme cases, malfunction. Leaks may lead to a leakage of hydraulic fluid.

- Take appropriate measures to protect the axial piston unit from chemical or corrosive environmental conditions.

Leakage or spilling of hydraulic fluid!
Risk of environmental pollution and contamination of ground water!

- Always place a drip tray under the axial piston unit when filling and draining hydraulic fluid.
- Use a suitable binding agent to collect any leaked hydraulic fluid.
- Observe the parameters in the safety data sheet for the hydraulic fluid and the specifications provided by the machine/system manufacturer.

Danger from hot components!
Nearby products can be damaged! Due to a heat development in components (e.g. solenoids), adjacent products may be damaged during assembly if no sufficient safety distance is complied with.

- When installing the axial piston unit, check the safety distances to nearby products to ensure that they are not damaged.

The warranty exclusively applies to the delivered configuration.
The warranty will be voided if the product is incorrectly installed, commissioned or operated, or if it is used or handled improperly.

4 Scope of delivery

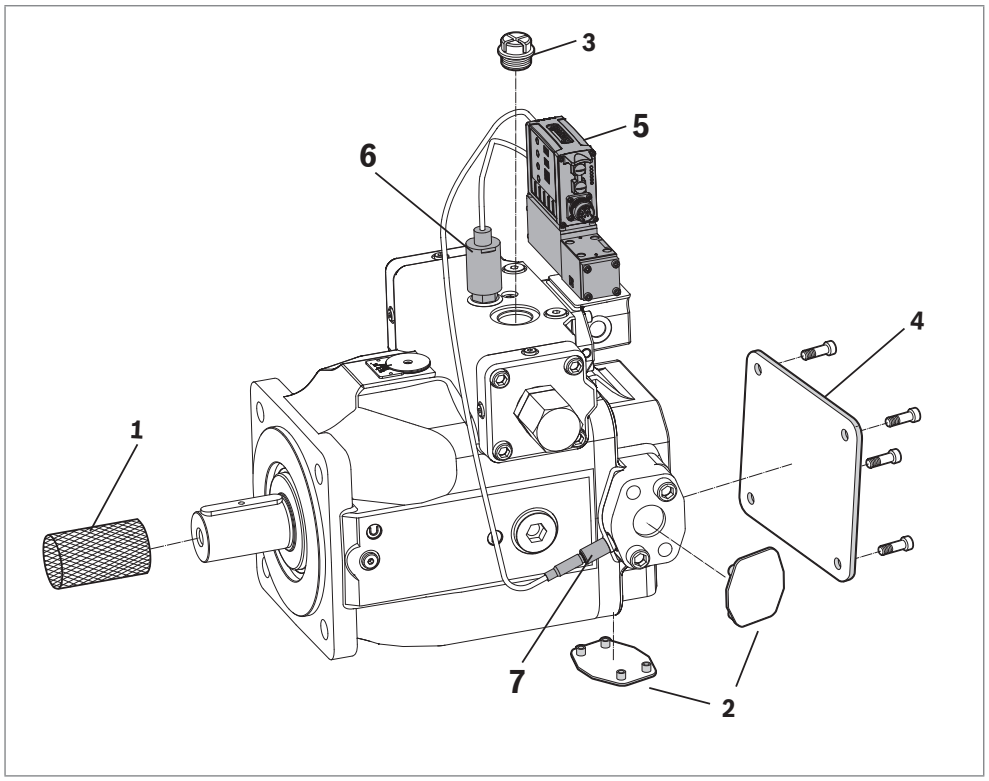


Fig. 1: Example: Axial piston unit A4VSO with HS5EP control system, clockwise rotation with through drive

Included in the scope of delivery:
- Axial piston unit HS5E(V)(L)(P) control system according to order confirmation

The following parts come assembled on the unit:
- Transport protection of the drive shaft with keyed shafts (**1**)
- Protective covers (**2**)
- Protective plug/threaded plug (**3**)
- For version with optional through drive (U99) plugged with pressure-tight cover (**4**)
- HS5E pilot control valve (**5**)
- Swivel angle sensor (**6**)
- Pressure transducer (1x with open circuit, 2 pieces with closed circuit) including cable (**7**) (only with HS5E(V)(L)**P**)

5 About this product

5.1 Performance description

The HS5E(V)(L) control system is used for electro-hydraulic control of the swivel angle, pressure, and torque limitation of an axial piston unit. It is designed for stationary applications.

Refer to the data sheet 92076 and the information contained in this document and the order confirmation for the technical data, operating conditions and operating limits of the HS5E(V)(L) control system.

5.2 Product description

The HS5E(V)(L) control system is based on an axial piston variable pump in swashplate design for hydrostatic drives. The HS5E control system is intended for the open and the closed circuit and the HS5EV control system only for the open circuit. The flow is proportional to the drive speed and the displacement. The flow can be smoothly changed by adjusting the swashplate.

Open circuit In the open circuit, the hydraulic fluid flows from the reservoir to the variable pump and is transported from there to the consumer via a directional valve. From the consumer, the hydraulic fluid flows back to the reservoir via the directional valve.

Closed circuit In the closed circuit, the hydraulic fluid flows from the variable pump to the consumer and from there directly back to the variable pump. The movement of the consumer is changed, e.g., by reversing the flow direction in the variable pump.

5.2.1 Axial piston unit layout

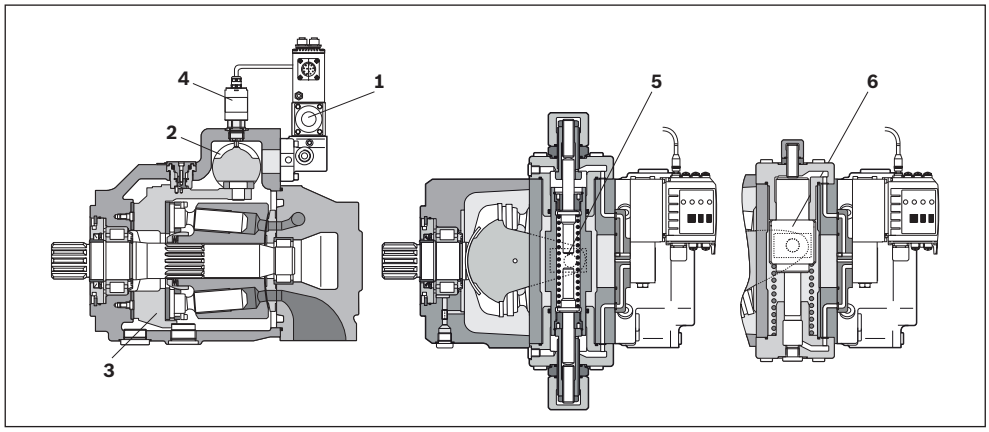


Fig. 2: Cutaway diagram of A4VSO....HS5E and HS5EV
(HS5E pilot control valve shown rotated by 90°)

1 HS5E pilot control valve
2 Stroking piston
3 Swashplate
4 Swivel angle sensor
5 Stroking piston for HS5E
6 Stroking piston for HS5EV

5.2.2 Functional description HS5E(L)

An electrically actuated proportional valve with OBE (**1**) controls the swivel angle and pressure of the A4V... variable pump and limits its torque. By means of the pump's stroking piston (**2**), this valve determines the position of the swashplate (**3**). With a non-rotating pump and depressurized actuating system, the system uses spring centering to retain the swashplate in swivel angle position "zero" or at swivel angle value "zero" (when properly calibrated, "retention" is by spring force only).
The control electronics consists of one swivel angle controller, one pressure controller, and one valve controller as well as one torque limiter. A swivel angle sensor (**4**) determines the position of the swashplate, with a pressure measuring sensor acquiring the actual pressure value. Both of the actual values are fed to the control electronics and linked with one another via the software. The torque actual value is formed from the product of the actual pressure value, the actual swivel angle value, and the displacement. By means of a minimum value former, the controller software ensures that the controller that corresponds to the operating point is always active.
In the static state, i.e. the swivel angle command value is equal to the actual swivel angle value; the torque command value is equal to the torque actual value; or the pressure command value is equal to the actual pressure value, the valve's control spool is in the central position.
If the higher-level controllers request an increase in the swivel angle, for example (which corresponds to an increase in the flow), the system must keep deflecting the valve spool from the central position until the swivel angle has reached the required value.
The sectional view (see Fig. 2, position 5) shows the A4VSO variable pump with HS5E control; the on-board control electronics actuates the proportional valve (**1**).
Notice on **HS5E** control:
With a de-energized proportional valve and a clockwise-turning pump, as well as control pressure present, the pump swivels in the following cases:
– Standard version A4VSO and A4VBO to swivel angle α = 0% ($V_{g\,min}$)
– Standard version A4VSG and A4CSG to swivel angle α = –100%.
With the **HS5E**, the necessary control pressure supply must be provided externally. On the other hand, the **HS5EL** obtains the control pressure supply internally from the boost pressure or from the high-pressure lines **A** or **B** (depending on which pressure is highest).
Notice on **HS5EL** control:
With a de-energized proportional valve and a clockwise-turning pump, as well as control pressure present (>20 bar), the pump swivels in the following cases:
– Standard version A4CSG to swivel angle α = -100%

5.2.3 Functional description HS5EV

An electrically actuated proportional valve with OBE (**1**) controls the swivel angle and pressure of the A4V... variable pump and limits its torque. By means of the pump's stroking piston (**2**), this valve determines the position of the swashplate (**3**).

If the pump is not rotating and load pressure is not available, the swashplate is pressed into the swivel angle position of the maximum flow ($V_{g\,max}$) by means of the spring.
The control electronics consists of one swivel angle controller, one pressure controller, and one valve controller as well as one torque limiter. A swivel angle sensor (**4**) determines the position of the swashplate, with a pressure measuring sensor acquiring the actual pressure value. Both of the actual values are fed to the control electronics and linked with one another via the software. The torque actual value is formed from the product of the actual pressure value, the actual swivel angle value, and the displacement.
In the static state, i.e. the swivel angle command value is equal to the actual swivel angle value; the torque command value is equal to the torque actual value; or the pressure command value is equal to the actual pressure value, the valve's control spool is in the central position.
If the higher-level controllers request an increase in the swivel angle, for example (which corresponds to an increase in the flow), the system must keep deflecting the valve spool from the central position until the swivel angle has reached the required value.
The sectional view (see Fig. 2, position 6) shows the A4VSO variable pump with HS5EV control; the on-board control electronics actuates the proportional valve (**1**).
Information about HS5EV control:
With a de-energized proportional valve and available load pressure (> 20 bar), the pump swivels in the following cases:
– Standard version A4VSO and A4VBO to swivel angle α = –100%

5.3 Parallel and cascade control of the HS5E(V)(L) control system

The pump controller has two different control structures. It is possible to switch between them using pump controller control word "P-0-2950, pump controller control word" bit 15. Setting bit 15 = 0 uses the parallel structure; with bit 15 = 1, you use the cascade structure. Using both structures, it is possible to control the pressure and the swivel angle. Depending on the machine's system characteristics, both of the structures offer different advantages.
When switching over from the parallel structure to the cascade structure, the cascade control is always initialized in swivel angle control mode. If switching over to pressure control were necessary, the switching logic would then carry it out. On switching back to the parallel structure, you do not need to take into account any special initialization.
The pump controller differentiates between an open circuit and a closed one. You make this selection using parameter "P-0-2989, configuration of pump controller". The closed circuit makes possible four-quadrant operation; for this, two pressure sensors on the pump are required.

Basic operating modes

In the possible operating modes, up to two controllers are continuously active:
- Swivel angle controller
- Pressure controller

These controllers alternate automatically and on a stepless basis by means of the switching logic.
The controller takes over whose actual value has best approximated the command value.

In general, for the transition of a system from a given initial state to a given final state, a fast transition as well as a stable state are aimed for. Various control algorithms are used in control engineering to implement these requirements.
The HS5E pilot control valve has 4 sets of control parameters to allow optimum adjustment to plant-specific requirements. For this, up to four instances of the relevant parameters for control are created in the HydraulicDrive after activation of the respective set of control parameters. The setting of the individual controller parameters depends on the control properties of the overall system. In this connection, you must take into account the following factors:
- The hydraulic layout of the system (e.g. piping, branches)
- The connected oil volume

5.3.1 Parallel control structure

The control structure below is used in the HydraulicDrive:

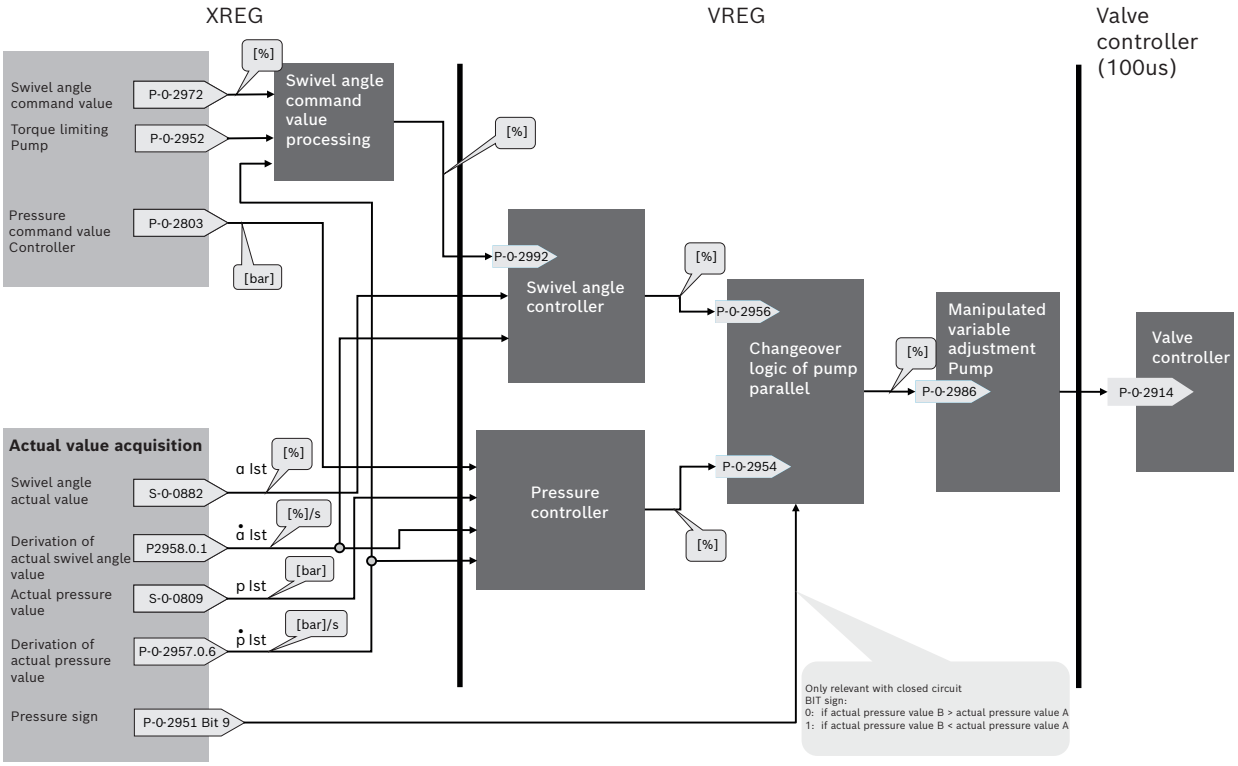


Fig. 3: Overview of controller parallel structure

The parallel structure with the pressure and swivel angle controllers is called in the "Pressure and swivel angle control" or "Pressure/flow control" operating modes.
The swivel angle command value is adapted in swivel angle command value processing before it is passed on to the actual swivel angle controller.
For pump control, the pressure and swivel angle controllers are active at the same time and both generate a manipulated variable. In the pump switching logic, the system passes on as standard the lowest manipulated variable from these two controllers (minimum value former function). Using this minimum value former ensures that only one of these two pressure or swivel angle variables is ever regulated and that it is possible to dynamically switch between both control modes. It is possible to modify the output parameter of the pump switching logic using different characteristic curves and functions in the pump manipulated variable

adaptation. The system passes on the output parameter as a valve command value to the valve controller.

5.3.2 Cascading control structure

The control structure below is used in the HydraulicDrive:

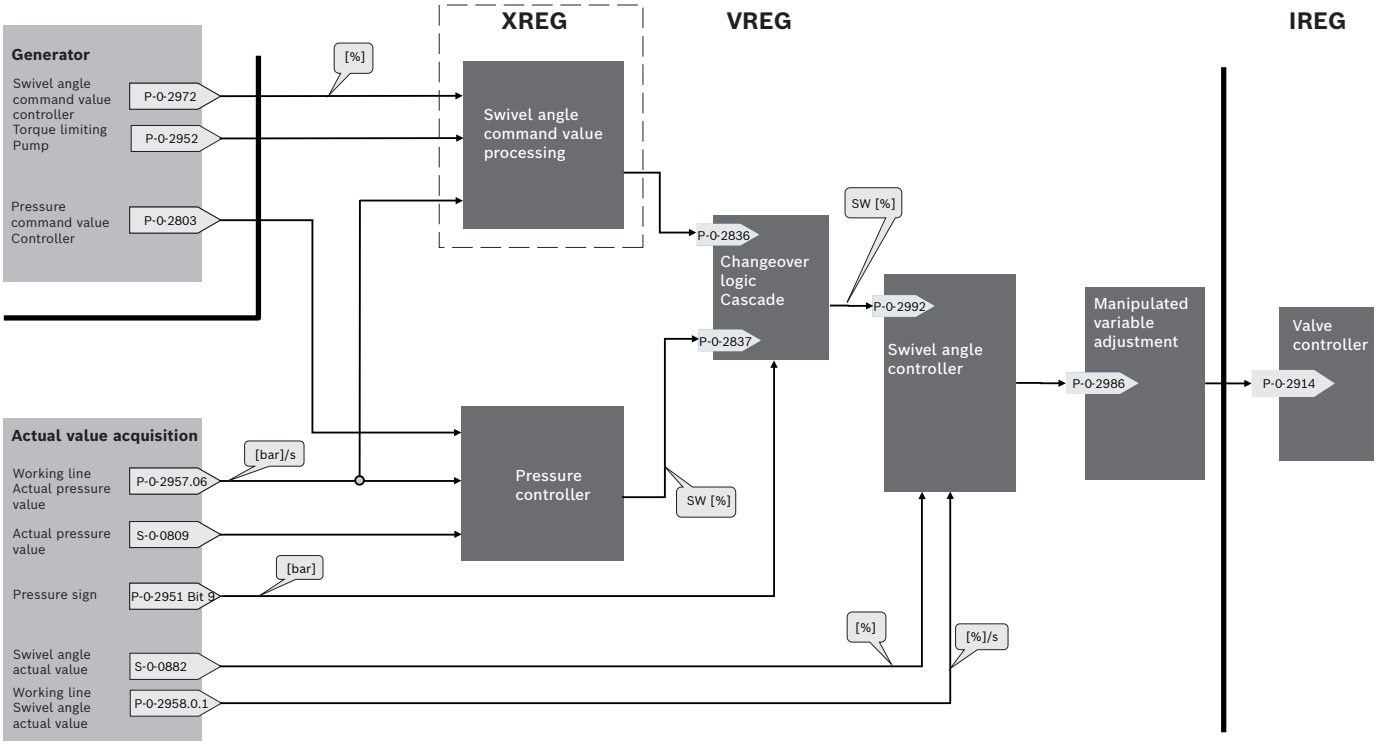


Fig. 4: Overview of controller cascade structure

The cascade structure with the pressure and swivel angle controllers is called in the "Pressure and swivel angle control" or "Pressure/flow control" operating modes. The system offsets the swivel angle command value in swivel angle command value processing with different variables. The outputs of swivel angle command value processing and of the pressure controller are passed on to the switching logic. In the switching logic, the system forms the swivel angle command value that is valid for control. In actual pressure value acquisition, the system compares the different actual pressure values and generates from them the resulting sign for the switching logic. The output of the swivel angle controller is passed on to the manipulated variable adjustment of the swivel angle controller.

5.3.3 Controller parameters (parallel)

The controller parameters below are involved in pressure and swivel angle control:

Table 6: Controller parameter

Description of the controller parameter	Parameter number
Pressure controller P-gain 1 positive	P-0-2963
Pressure controller P-gain 1 negative	P-0-2964
Pressure controller time constant D component positive	P-0-2969
Pressure controller time constant D component negative	P-0-2970
Pressure controller time constant swivel angle feedback	P-0-2971
Gate time derivation actual pressure value 1	P-0-2960
Gate time derivation actual pressure value 2	P-0-2979
Swivel angle controller P-gain	P-0-2977
Swivel angle controller time constant D component	P-0-2978
p-point feedback time constant	P-0-2974
p-point feedback filter time	P-0-2973

After activation of the extended pressure controller with an inflected characteristic curve, the additional controller parameters below are active:

Table 7: Controller parameter

Description of the controller parameter	Parameter number
Pressure controller P-gain 2 positive	P-0-2965
Pressure controller P-gain 2 negative	P-0-2966
Pressure controller deviation, positive threshold	P-0-2967
Pressure controller deviation, negative threshold	P-0-2968

5.3.4 Control parameter sets

For the HS5E(V)(L), you have the option of configuring and using up to four different parameter sets. Using these parameter sets, it is possible to optimize the control behavior of the HS5E(V)(L) to different connected oil volumes.

5.3.5 Special operating modes

In this chapter, we will describe specific applications. In these cases, the basic operating modes are active (see page 24).

Starting up at zero pressure open circuit HS5E

To start up the HS5E systems with an open circuit unit, it is not necessary to provide hydraulic circuitry for classical depressurized start-up.

If no command values are specified for the pressure and swivel angle, virtually load-free start-up is possible.

Starting up at zero pressure closed circuit HS5E

With a closed circuit unit, the swivel angle corresponding to the flow direction must be preselected even if pressure control is run.

Starting up at zero pressure HS5EV

The HS5EV control system starts without load pressure with maximum swivel angle (+100% $V_{g\,max}$). This may result in pressure peaks in the system until the system is adjusted.

Check whether or not your machine requires additional safety measures for your application to avoid unintentional movement. If necessary, make sure these are appropriately implemented.

Stand-by operation

Operating mode of the pump in which the system statically regulates an operating point by means of a corresponding command value over a longer period of time. Pay attention to the information about permissible pressures in chapter 5.3.6 "Working pressure limits" on page 29.

Behavior without drive enable

If the drive enable is canceled, the electronics regulate to the specified internal command value (factory setting is 10% α_{set}, p_{set}15 bar).

Behavior without enable or in the case of a fault or a voltage drop with HS5E

- If the hardware enable is canceled, the output stage of the electronics is de-energized.
  With a de-energized proportional valve and an existing control pressure, the pump swivels in the following cases:

– Standard version A4VSO and A4VBO to swivel angle α = 0% ($V_{g\,min}$)
– Standard version A4VSG and A4CSG to swivel angle α = –100%.
  If there is no control pressure, the spring centering takes effect and swivels the pump to 0% swivel angle:
  Pump control spring centering comes standard. It is used for setting and adjustment in the depressurized neutral position, but without a defined reset during high-pressure operation. Spring centering is not a safety device. To minimize the control fluid consumption, the stroking chambers are sealed in sizes 125 to 1000 and can be bled via the ports R2 to R7.

Behavior without enable or in the case of a fault or a voltage drop with HS5EV

- If the hardware enable is canceled, the output stage of the electronics is de-energized.
  With a de-energized proportional valve and an existing load pressure (>20 bar), the pump swivels in the following cases:

– Standard version A4VSO and A4VBO to swivel angle in direction
  α = -100%. After reduction of the load pressure, an equilibrium of < 10 bar will settle.
  If no load pressure is available, the axial piston unit is pressed to +100% flow ($V_{g\,max}$) by means of the adjustment spring.

Behavior without enable or in the case of a fault or a voltage drop with HS5EL

- If the hardware enable is canceled, the output stage of the electronics is de-energized.
  With a de-energized proportional valve and an existing load pressure (>20 bar), the pump swivels in the following cases:

– Standard version A4CSG to swivel angle α = -100%
  If there is no control pressure, the spring centering takes effect and swivels the pump to 0% swivel angle:
  Pump control spring centering comes standard. It is used for setting and adjustment in the depressurized neutral position, but without a defined reset during high-pressure operation. Spring centering is not a safety device. To minimize the control fluid consumption, the stroking chambers are sealed in sizes 125 to 1000 and can be bled via the ports R2 to R7.

Check whether or not your machine requires additional safety measures for your application to avoid unintentional movement. If necessary, make sure these are appropriately implemented.

5.3.6 Working pressure limits

⚠ WARNING

Parts that shoot out and escaping jets of fluid!
Risk of serious injuries! The electrical pressure control does not have a pressure limitation function.
▶ Make sure that the maximum working pressure is not exceeded.

Maximum working pressure

The working pressure that is stated in the data sheet must not be exceeded.

External control pressure fluid for HS5E

With external control pressure fluid supply, the HS5E pump control system works independently of the actual high-pressure circuit, which makes possible actual adjustment independently of the working pressure in the range from "0 to 100%" with A4VSO and A4VBO and "±100%" with A4VSG and A4CSG (change of flow direction!).

With a de-energized proportional valve and an existing control pressure, the pump swivels in the following cases:
– Standard version A4VSO and A4VBO to swivel angle α = 0% ($V_{g\,min}$)
– Standard version A4VSG and A4CSG to swivel angle α = −100%.
This can lead to cavitation and damage to the pump.
You can find the maximum and minimum pressures in data sheet 92076.

In the case of energy fluctuations or failures, with adequate control pressure supply, the unit moves to the minimum swivel angle possible (standard version A4VSO and A4VBO to swivel angle α = 0% ($V_{g\,min}$) and standard version A4VSG and A4CSG to swivel angle α =-100%). Limiting the minimum displacement can cause torque to be generated in the application.
Check whether additional measures are necessary on your machine for the application in order to guarantee that the torque is switched off. If necessary, make sure these are appropriately implemented.

Internal control pressure fluid for HS5EV

With internal control pressure fluid supply, the HS5EV pump control system works dependent on the high-pressure circuit. With a sufficient load pressure (> 20 bar), the control can take control positions in the swivel angle range from "0 to ±100 %" at A4VSO.

With a de-energized proportional valve and available load pressure (> 20 bar), the pump swivels in the following cases:
– Standard version A4VSO and A4VBO to swivel angle α = -100% ($V_{g\,min}$).
This can lead to cavitation and damage to the pump.
You can find the maximum and minimum pressures in data sheet 92076.

With load pressure between 0 bar and < 20 bar, the pump may take undefined swivel angle positions between α = ±100%.
This can lead to cavitation and damage to the pump.
You can find the maximum and minimum pressures in data sheet 92076.
Check whether additional measures are necessary on your machine for the application in order to guarantee that the torque is switched off. If necessary, make sure these are appropriately implemented.

In case of energy fluctuations and/or energy failure, the unit will move to different swivel angles, depending on the available load pressure (system-related). In case of missing load pressure, the unit will go to $V_{g\,max}$. Limiting the minimum displacement can cause torque to be generated in the application. Check whether additional measures are necessary on your machine for the application in order to guarantee that the torque is switched off. If necessary, make sure these are appropriately implemented.

Internal control pressure fluid for HS5EL

With internal control pressure fluid supply, the HS5EL pump control system works dependent on the high-pressure circuit or the boost pressure. With a sufficient load pressure (> 20 bar), the control can take control positions in the swivel angle range of "-100 to +100%" for A4CSG.

With a de-energized proportional valve and available load pressure (> 20 bar), the pump swivels in the following cases:
– Standard version A4CSG to swivel angle α = -100% (Vg min).
This can lead to cavitation and damage to the pump.
You can find the maximum and minimum pressures in data sheet 92076.

With control pressures between 0 bar and < 20 bar, the pump may take undefined swivel angle positions between α = ±100%.
This can lead to cavitation and damage to the pump.
You can find the maximum and minimum pressures in data sheet 92076.
Check whether additional measures are necessary on your machine for the application in order to guarantee that the torque is switched off.
If necessary, make sure these are appropriately implemented.

In the case of energy fluctuations or failures, with adequate control pressure supply, the unit moves to the minimum swivel angle possible, standard version A4CSG to swivel angle α =-100%. Limiting the minimum displacement can cause torque to be generated in the application. Check whether additional measures are necessary on your machine for the application in order to guarantee that the torque is switched off. If necessary, make sure these are appropriately implemented.

5.4 Ambient conditions

5.4.1 Oil-immersed applications

Only the HS5M control system is suitable for use in oil-immersed applications (HLP hydraulic fluids according to DIN 51524). Using HS5E(V)(L) control systems with integrated electronics is not permissible for fluid-immersed applications.

5.4.2 Ambient temperature

The maximum permissible ambient temperature range for HS5E(V)(L) control systems is -20 °C to +60 °C. It is crucial to pay attention to the information in the valid 92076 data sheet for the HS5E(V)(L) control system and the information in this instruction manual.

We recommend installation in an area with moving ambient air, e.g. in the airflow of an electric motor.
This applies in particular to the installation location of the integrated on-board electronics.

Make sure that there is adequate heat dissipation for the electronics.

5.5 Notes on the selection of hydraulic fluids

The HS5E(V)(L) control system has been designed for the use of hydraulic fluids according to DIN 51524 (HL/HLP).

- Adhere to all limits specified in the data sheet regarding temperature, viscosity, cleanliness of the hydraulic fluid.

5.5.2.1 HFC fluids

You are only allowed to use HFC with the basic pump with option "F" (see type code of data sheet 92050). In the case of an application with HFC fluid, be aware that the service life of the HS5E(V)(L) control system is reduced compared to the standard application. This is due to the reduced lubricity of the HFC fluid.
There are separately available commissioning regulations for pump systems when using HFC fluids (data sheet 92053, amongst others).

5.6 Noise development

For design reasons, the axial piston pump generates an increased change in the flow compared to a vane pump, for example, which results in pressure pulsation. This can affect fluid noise in addition to airborne and structure-borne noise propagation. In the final analysis, all of these factors result in an overall picture of "noise". Frequently, this leads to other components being stimulated too, which creates noises. This means that when check valves are used, for example, it may be necessary to adapt the springs that are used to the conditions in the system if stimulation with noise generation happens.

In the case of the sound pressure level values that are listed in the technical documentation, the data was determined in an acoustic room. This means that environmental influences, like the installation location, the overall mechanical concept, the piping, etc., for example, are not taken into account.

5.6.1 Noise development in the unit

"Noise" consists of various components. The "noise" overall result is not just affected by airborne sound but also by structure-borne and fluid noise.
Due to unfavorable installation and piping conditions, the sound pressure level of the overall system can be 5 to 10 dB(A) higher than the pump's individual value.
Measures for reducing noise include, for example:

- Low-noise containers
- A damping ring between the pump and the pump carrier
- Elastic pipe feedthrough
- Damping rails below the motor
- Installing the pump at an adequate distance from the container wall

5.6.2 Pulsation damper

With some special applications, we recommend using a pulsation damper for operation. Due to the reduction in the pressure pulsation that is typical of pumps, this also positively affects the noise level of the hydraulic system.
You can find information about this in data sheet RE 50142.

5.7 Master/slave operation

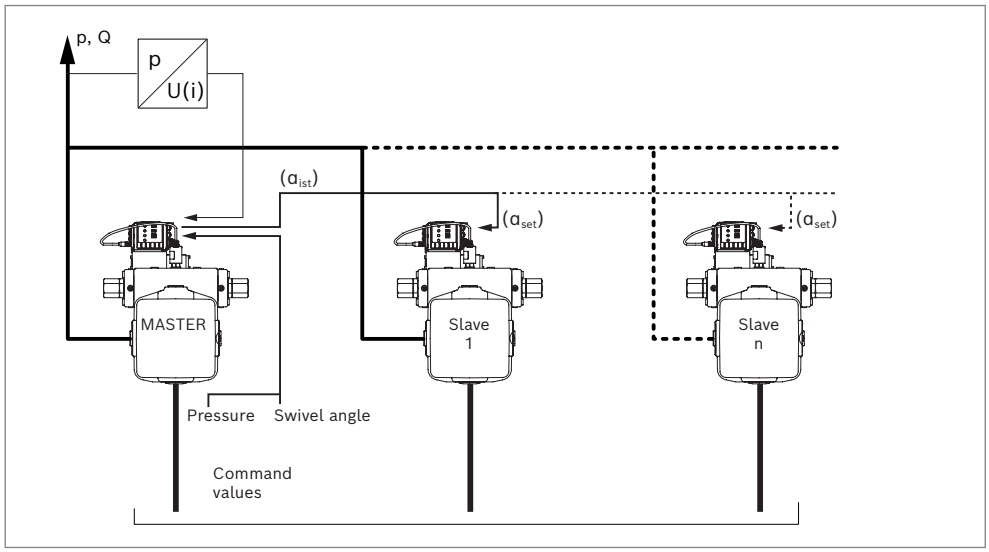


Fig. 5: Hydraulic coupling of HS5E control systems

In theory, you can hydraulically couple any HS5E(V)(L) control systems you like to achieve higher displacements.
When doing this, you only need to specify one master pump to which the pressure transducer is connected.
The master now regulates both the pressure and the swivel angle according to the external command value specifications and passes on its internal swivel angle command value to the slave pumps as the swivel angle command value. This guarantees even and synchronous swiveling.

5.7.1 Circuitry of HS5E(V)(L)

The two illustrations below show the circuitry for master/slave operation with analog signals. As an alternative to this, you can also set up master/slave operation by means of a fieldbus system and the machine control. For more information on this system, refer to the functional description of the firmware.

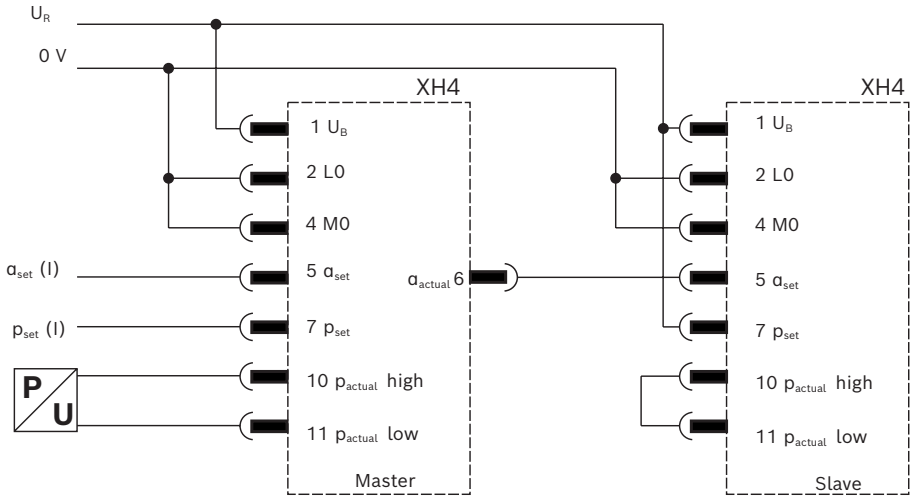


Fig. 6: Example HS5E(V)(L) circuitry for master/slave operation (analog)

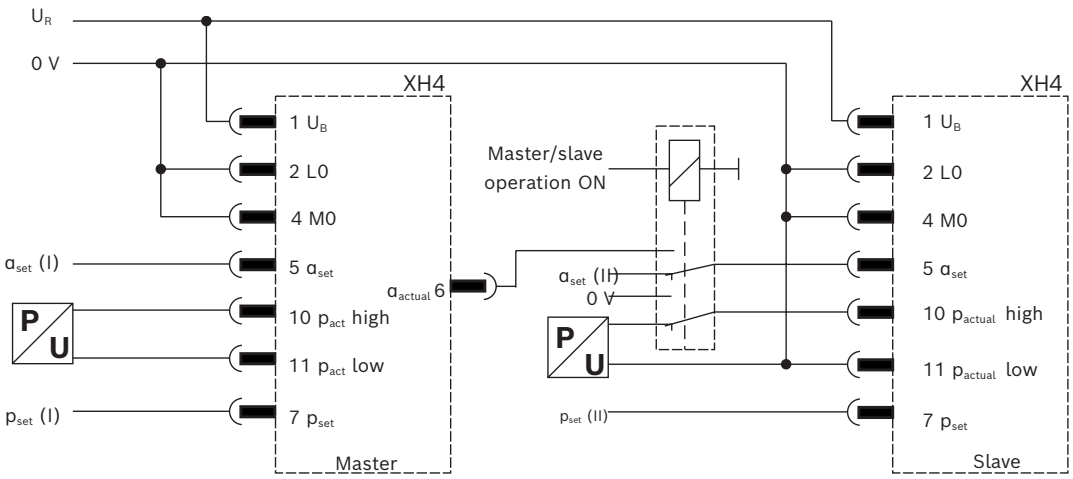


Fig. 7: Example of HS5E(V)(L) for (analog) master/slave operation and independent individual operation; alternatives possible

Notes:

- For the configuration of analog command value specification, see the HydraulicDrive functional description (see data sheet 30338).
- The port for the pump's position transducer is not drawn in.
- As an option, you can install the coupling element (relay, analog switch) to regulate both pumps independently from one another. With the slave pump, this means that it is possible in the suggestion shown here to carry out both swivel angle and pressure control.
- For "master/slave" operating mode, signal p_{set}(II) must be switched to the maximum (+10 V).
- If closed-loop pressure control is to be realized also in the "master/slave" operating mode, only the pressure transducer of the master is evaluated for controlling purposes. If you also want to run in hydraulically separated operation, a separate pressure transducer is required for the slave.
- You must parameterize the slave pumps as slaves in the configuration of the HS5E pilot control valve.
- If there is no special circuitry of the signal branch of the slave pump's pressure transducer, its pressure controller intervenes in an undesirable way in swivel angle control when the actual pressure value p_{actual}(II) reaches values in the range from about 80% of the command value p_{set}(II) onward. You can avoid this by switching a 0 V signal on pin 10 instead of the pressure transducer output signal via a second channel of coupling element "K1" in "master/slave" mode. Make sure that the P and D controller parameters on the slave are not set higher than on the master. Slave units can be calibrated by means of the corresponding calibration cycle.

5.7.1.1 Switching over to (analog) master/slave mode

Starting point

The 0 V reference potential of the PLC/command value source and M0/L0 of the HS5E pilot control valve must be connected.

Switching over to master/slave operation

At low working pressure, the system uses a change-over contact that is suitable for extra-low signal voltages (or, as an alternative, a non-wearing analog switch) to disconnect the swivel angle command value of the slave pump that previously came from the control and to connect the swivel angle actual value coming from the HS5E pilot control valve of the master pump.

The pressure command value of the slave pump is set to 100% (possibly by means of a second change-over contact or in software) so that the pressure control virtually switches off this unit.

Switching off master/slave operation

- Actuate both pumps shortly **before** switching over to pressure control (low, equal pressure level), still hydraulically decoupled from one another. Here, the optimum situation would be if the swivel angle actual values were approximately the same. The two flow command values (generally 100%) come from the control.

Connection of unused, electrical signal inputs

All of the analog inputs that are not used, e.g. the actual pressure value input in the case of swivel angle control, must be interconnected with 0 Volts.

Notwithstanding, unused differential amplifier inputs can also be short-circuited.

5.8 Description of the IndraWorks commissioning tool

There is one option for configuring and parameterizing the HS5E(V)(L) control system:

▶ Using the Bosch Rexroth's IndraWorks software.
For the HS5E(V)(L) control system, the current IndraWorks version must be used.

The IndraWorks Ds software is available for free on the Rexroth website at the following link:

`www.boschrexroth.de/HS5E`

(in the "Downloads" subdirectory)

5.8.1 System requirements

Minimum requirements:

- An IBM-compatible PC, with a Pentium IV processor at least
- CPU clock frequency 2 GHz
- Main memory: 4 GB
- 5 GB of free hard disk space on drive C: (incl. temporary memory during installation)
- A DVD drive (when installing from DVD)
- Graphics resolution:
  - 800x600 pixels
  - 16-bit color depth

Indraworks Engineering is designed for a default screen setting of 96 dpi. If you use any other settings, this can lead to screen elements being displayed incompletely or incorrectly.

Recommended condition

- An IBM-compatible PC with an i5 quad core processor
- Main memory: 4 GB with a 64-bit operating system

Supported operating systems

The following operating systems are supported:

- Microsoft Windows 7 (32-bit or 64-bit version)
- Microsoft Windows 8 (32-bit or 64-bit version)
- Microsoft Windows 10 (32-bit or 64-bit version)

5.8.2 Firmware update

⚠ CAUTION

Uncontrolled movements of the drive!

Risk of injury! The system overwrites all of the data on the control and software resets it!

- ▶ Switch the drive motor off! A software reset is the same as switching the control off and back on again and you must only carry it out with the system in a safe state.

The current firmware is available on the Rexroth website at the following link:

`www.boschrexroth.de/HS5E`

(in the "Downloads" subdirectory)

You transfer new firmware to the HS5E pilot control valve in IndraWorks in the menu item "Downloads" -> "Firmware Management".

The HS5E pilot control valve is delivered ex-works with the current firmware. Older firmware versions on request.

5.9 Switch-on sequence of electronics/hydraulics

Due to the different monitoring routines that are integrated on the electronics assemblies, the system can issue fault messages in the case of adverse switch-on sequences. These fault messages lead to uncertainty even though there is no "real" reason for them.

Be aware of the special considerations with suspended loads!

Table 8: Switch-on/switch-off sequence

HS5E pilot control valve	
Switch on:	• Electronics voltage supply • Command value specification: α_{set} = 50% and p = 20 bar • Set drive release • Switch on the motor • Suppress the warnings until the target engine speed has been reached • Open the isolator valve (if present)
Switch off:	• Command value specification: α_{set} = 50% and p = 20 bar • Close the isolator valve (if present) • Suppress the warnings • Switch off the electric motor • Switch off the electronics voltage supply

5.10 Product identification

The axial piston unit can be identified by the name plate. The following example shows an A4... with HS5E(V)(L) control system name plate:

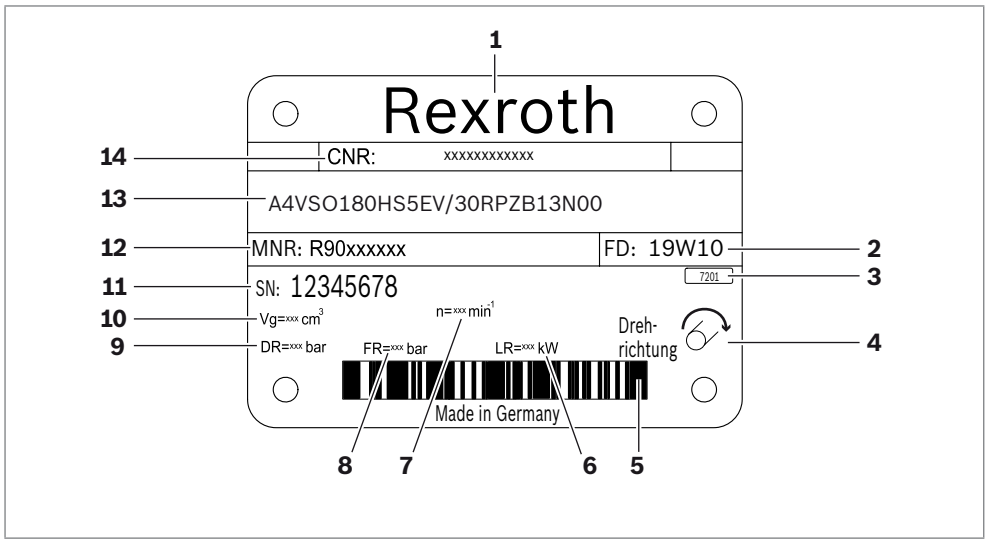


Fig. 8: Sample name plate A4VSO...HS5EV control system

1 Manufacturer
2 Manufacturing date
3 Internal plant designation
4 Direction of rotation (viewed on drive shaft) – here: clockwise
5 Bar code
6 Power setting (optional)
7 Rotational speed
8 Flow setting (optional)
9 Pressure controller setting (optional)
10 Maximum displacement
11 Serial number
12 Material number of the axial piston unit
13 Type code
14 Customer material number

6 Transport and storage

- Always observe the required ambient conditions for transport and storage, see chapter 6.2 "Storing the axial piston unit" on page 40.

Notes on unpacking can be found in chapter 7.1 "Unpacking" on page 42.

6.1 Transporting the axial piston unit

The following optional means of transport can be applied depending on the weight and duration of transport:

• Transporting with a lifting device (eye bolt or lifting strap)

Dimensions and weights

Table 9: Dimensions and weights (without through drive) of A4VSO

Size		40	71	125	180	250	355	500	750	1000
Weight approx.	kg	55	68	100	115	197	220	335	475	620
Width	mm	Dimensions vary by equipment. The values applicable for your axial piston unit can be found in the installation drawing (request if necessary).								
Height	mm									
Depth	mm									

Weight may vary by equipment.

6.1.1 Transport with lifting devices

For transporting, the axial piston unit can be connected to a lifting device via an eye bolt in the drive shaft or in the housing. Alternatively, it can also be transported with a lifting strap.

Only use the lifting strap if you are unable to achieve the required installation position with transport using the eye bolts.

Transporting with eye bolt in drive shaft

The axial piston unit can be transported suspended from an eye bolt screwed into the drive shaft as long as only outward (pulling) axial forces are applied.

- For all female threads, use a stud end from the same system of units and of the correct size.
- To do this, screw an eye bolt completely into the female thread on the drive shaft. The thread size is indicated in the installation drawing.
- Make sure that the eye bolt can bear the total weight of the axial piston unit plus 20%.

You can hoist the axial piston unit with the eye bolt screwed into the drive shaft, as shown in Fig. 9.

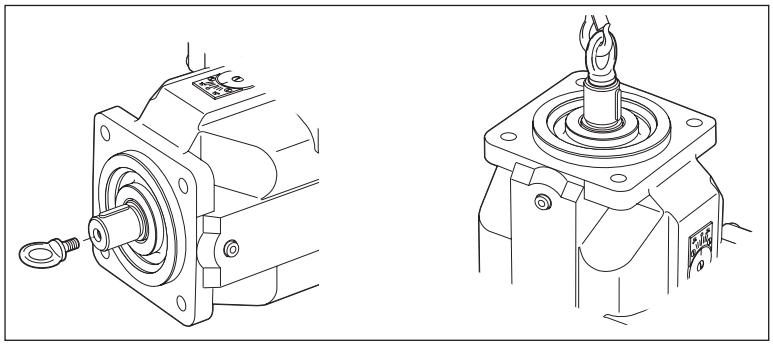


Fig. 9: Mounting the eye bolt in the drive shaft

Transport with lifting strap

WARNING! Danger due to suspended loads!
During transport with lifting strap, the axial piston unit can topple out of the lifting strap and cause injury.

- Use the widest possible lifting strap.
- Make sure that the axial piston unit is securely fixed with the lifting strap.
- Only guide the axial piston unit by hand for fine positioning and to avoid swinging.
- Never stand or reach under suspended loads.

- Place the lifting strap around the axial piston unit so that it does not pass over assembled parts (e.g. valves, electrical assembled parts, and sensors (red arrows see Fig. 10)) and that the axial piston unit is not suspended from assembled parts.

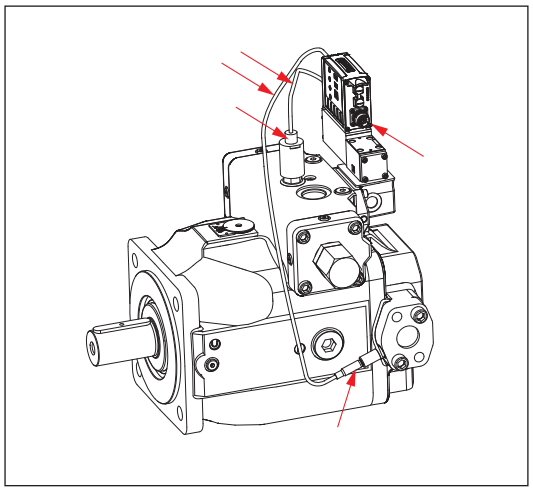


Fig. 10: Transporting the axial piston unit

6.2 Storing the axial piston unit

Requirement

- The storage areas must be free of corrosive materials and gases.
- To prevent damage to the seals, do not operate ozone-forming equipment (e.g. mercury-vapor lamps, high-voltage equipment, electric motors, sources of electrical sparks or electrical discharge) in storage areas.
- Storage areas should be dry. Recommended relative humidity ≤ 60%
- Ideal bearing temperature: +5 °C to +20 °C.
- Minimum storage temperature: 0 °C.
- Maximum storage temperature: +70 °C.
- Keep out of direct sunlight.
- Do not stack axial piston units and store them in a shock-proof manner.
- Do not store the axial piston unit on the drive shaft or assembled parts, e.g. sensors or valves.
- For other storage conditions, see Table 10.

▶ Check the axial piston unit monthly to ensure professional storage.

After delivery

The axial piston units come in corrosion protection packaging (corrosion protection film) provided at the factory.
Table 10 lists the maximum permissible storage times for an originally packed axial piston unit as per data sheet 90312.

Table 10: Storage time with factory corrosion protection

Storage conditions	Standard corrosion protection	Long-term corrosion protection (optional)
Closed, dry room, uniform temperature between +5 °C and +20 °C. Undamaged and closed corrosion protection film.	Maximum 12 months	Maximum 24 months

The entitlement under warranty is rendered void if the requirements and storage conditions are not adhered to or after expiration of the maximum storage time (see Table 10).

How to proceed once the max. storage time elapses:

1. Check the entire axial piston unit for damage and corrosion prior to installation.
2. Perform a test run to check the axial piston unit for proper functioning and leak-tightness.
3. If storage time exceeds 24 months, replace the shaft seal.

Once the max. storage time has elapsed, we recommend that you have the axial piston unit checked by your Bosch Rexroth service partner.

For questions regarding repair and spare parts, contact your proper Bosch Rexroth service partner or the service department of the manufacturer's plant of the axial piston unit, see chapter 10.5 "Spare parts" on page 87.

After removal An uninstalled axial piston unit must be preserved with corrosion protection for the duration of storage.

The following instructions only refer to axial piston units operated with a mineral oil-based hydraulic fluid. Other hydraulic fluids require other specific preservation measures. In such a case, consult your local contact person; you can find their contact information at
www.boschrexroth.com/addresses.

Bosch Rexroth recommends the following procedure:

1. Clean the axial piston unit, see chapter 10.1 "Cleaning and care" on page 85.
2. Drain the axial piston unit.
3. For storage times up to 12 months: Moisten the inside of the axial piston unit with mineral oil and fill with approx. 100 ml mineral oil.
   For storage times up to 24 months: Fill the axial piston unit with VCI 329 corrosion protection (20 ml).
   Filling is carried out via the drain port, see chapter 7.4 "Installing the axial piston unit", Fig. 16 on page 51.
4. Plug all ports so they are airtight.
5. Coat unpainted areas of the axial piston unit with mineral oil or suitable, easily removable corrosion protection, e.g. acid-free grease.
6. Pack the axial piston unit with desiccant airproof in corrosion protection film.
7. Store the axial piston unit in a shock-proof manner; for further conditions see "Requirement" on page 40 in this chapter.

7 Installation

Prior to installation, the following documents should be to hand:
- Data sheet of the axial piston unit (contains the permissible technical data, main dimensions and circuit diagrams of standard versions)
- Installation drawing for the axial piston unit (can be obtained from your contact person at Bosch Rexroth, if required)
- Hydraulic circuit diagram for the axial piston unit (in the data sheet and on the installation drawing)
- Hydraulic circuit diagram for the machine/system (available from the machine/system manufacturer upon request)
- Order confirmation (contains the order-related technical data for your axial piston unit)

7.1 Unpacking

The axial piston unit comes in a polyethylene material (PE) corrosion protection film.

CAUTION! Danger due to falling parts!
If the packaging is not opened correctly, parts may fall out and damage the parts or even result in injury.
- ▶ Place the packaging on a level underground with sufficient load-bearing capacity.
- ▶ Only open the packaging from the top.

- ▶ Remove the packaging from the axial piston unit.
- ▶ Check the axial piston unit for transport damage and completeness; see chapter 4 "Scope of delivery" on page 21.
- ▶ Dispose of the packaging in accordance with the regulations in your country.

7.2 Installation conditions

The installation position and location of the axial piston unit essentially determine how it is installed and commissioned (such as when filling and air bleeding the axial piston unit).
- ▶ Fasten the axial piston unit so that the expected forces and torque can be transferred without any danger. The machine/system manufacturer is responsible for sizing the fastening elements.
- ▶ Observe the permissible radial forces on the drive shaft when driving with radial loading (belt drives). If necessary, store the belt pulley separately.
- ▶ Make sure the axial piston unit is always filled with hydraulic fluid during commissioning and operation. Also do this also after relatively long standstill periods, since the axial piston unit may drain out through the hydraulic lines.
- ▶ Direct the leakage in the housing area to the reservoir through the highest drain port. Use a line size that matches the port.

- Avoid using a check valve in the drain line.
  Exception: Above-reservoir installation, drive shaft upward.
  A check valve in the drain line (cracking pressure 0.5 bar) can prevent the system from draining through the drain line. Please note the correct flow direction.
- To keep noise values low, use elastic elements to isolate all connecting lines from all vibration-capable components (e.g. reservoir).
- Make sure the suction, drain, and return lines flow into the reservoir below the minimum fluid level under all operating conditions. This will prevent air from being drawn in and foam from forming.
- Make sure that a minimum suction pressure of 0.8 bar abs. (without charge pump) and/or 0.7 bar abs. (with charge pump) is present at port "**S**" during operation and at cold start, in all installation positions and installation locations for the axial piston pump, see Fig. 11. See data sheet for other pressure values.

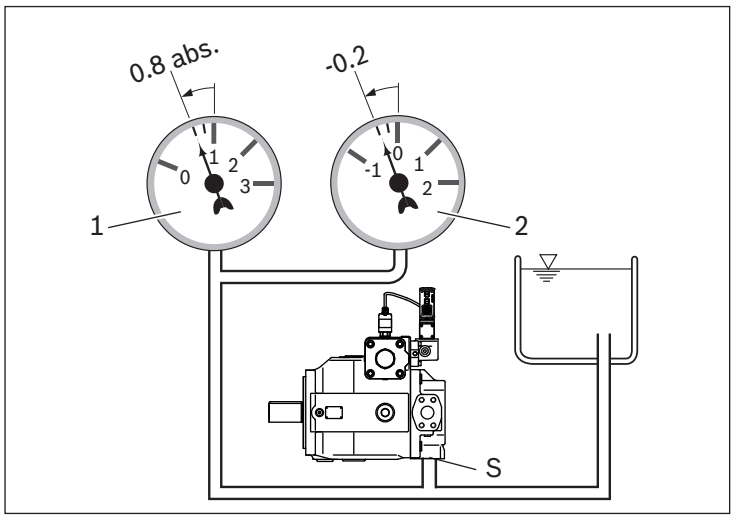


Fig. 11: Suction pressure

1 Absolute pressure gauge
2 Standard pressure gauge (relative)

The suction conditions improve with below-reservoir installation

- Make sure that the working environment at the installation site is completely free of dust and foreign substances. The axial piston unit should be clean when installed. Contamination of the hydraulic fluid can considerably affect the function and service life of the axial piston unit.
- Use fiber-free cloths for cleaning.
- Use suitable, mild cleaning agents to remove lubricants and other heavy contamination. Do not allow cleaning agents to enter into the hydraulic system.

7.3 Installation position

The following installation position are permissible. The pipeline routing shown illustrates the basic layout.

7.3.1 Below-reservoir installation (standard)

Below-reservoir installation means that the axial piston unit is installed outside of the reservoir below the minimum fluid level.

Recommended installation position: 1 and 2.

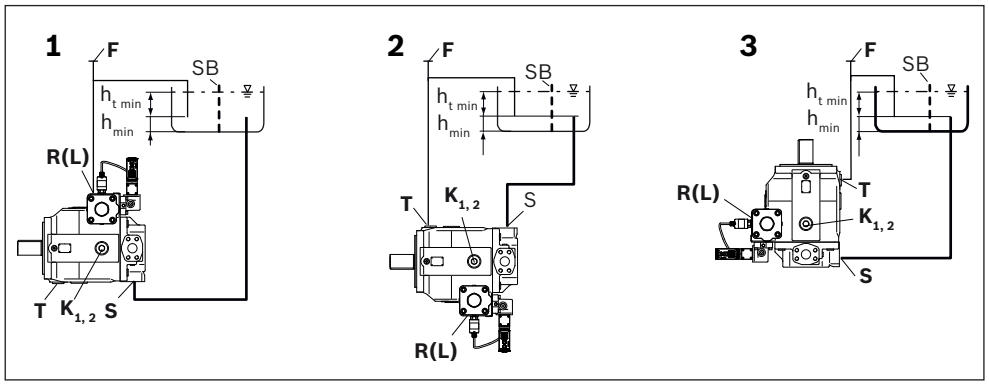


Fig. 12: Below-reservoir installation A4VSO with installation positions 1–3

T, R(L)	Highest drain port	$\mathbf{h_{t\,min}}$	Minimum required immersion depth (200 mm)
S	Suction port	$\mathbf{h_{min}}$	Minimum required distance to reservoir bottom (100 mm)
SB	Baffle (baffle plate)		

Table 11: Below-reservoir installation

Installation position	Air bleed	Filling
1 (drive shaft horizontal)	**R(L)**	**R(L)**
2 (drive shaft horizontal)	**T**	**T**
3 (drive shaft vertically down)	**T**	**T**

7.3.2 Above-reservoir installation

Above-reservoir installation means that the axial piston unit is installed above the minimum fluid level of the reservoir.

To prevent the axial piston unit from draining, a height difference $\mathbf{h_{ES\,min}}$ of at least 25 mm at port **T** is required in installation position 6.

Observe the maximum permissible suction height $\mathbf{h_{S\,max}}$ = 800 mm. The permissible suction height $\mathbf{h_S}$ is derived from the total pressure loss.

Recommendation for installation position 6 (drive shaft upward): A check valve in the drain line (cracking pressure 0.5 bar) can prevent the housing area from draining.

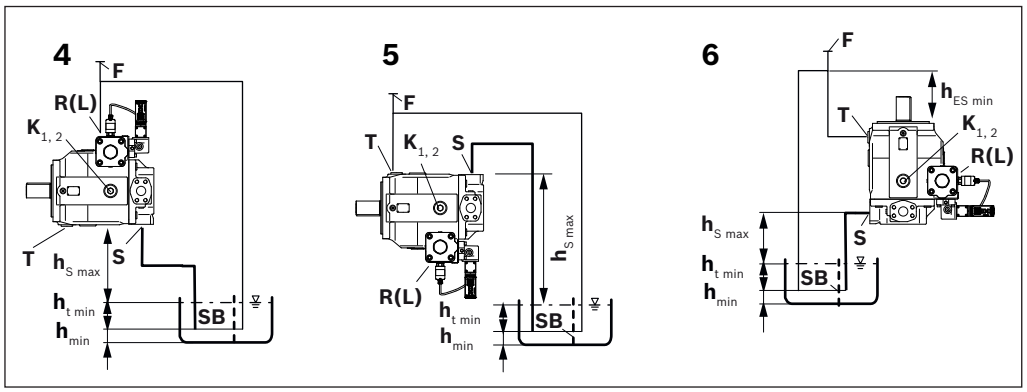


Fig. 13: Above-reservoir installation A4VSO with installation positions 4-6

F	Filling/air bleeding	$\mathbf{h_{min}}$	Minimum required distance to reservoir bottom (100 mm)
T, R(L)	Highest drain port	$\mathbf{h_{ES\ min}}$	Minimum required height needed to protect the axial piston unit from draining (25 mm)
S	Suction port	$\mathbf{h_{S\ max}}$	Maximum permissible suction height (800 mm)
SB	Baffle (baffle plate)		
$\mathbf{h_{t\ min}}$	Minimum required immersion depth (200 mm)		

Port **F** is part of the external piping and must be provided on the customer side to simplify the filling and air bleeding.

Table 12: Above-reservoir installation

Installation position	Air bleed	Filling
4 (drive shaft horizontal)	**F**	**R(L) (F)**
5 (drive shaft horizontal)	**F**	**T (F)**
6 (drive shaft vertically down)	**F**	**T (F)**

7.4 Installing the axial piston unit

7.4.1 Preparation

1. Compare the material number and designation (type code) with the parameters in the order confirmation.

If the material number for the axial piston unit does not match the one in the order confirmation, contact your local contact person for clarification. You can find their contact information at `www.boschrexroth.com/addresses`.

2. Before installing, completely drain the axial piston unit to prevent mixing with the hydraulic fluid used in the machine/system.

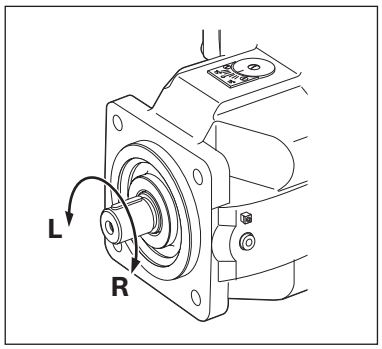


Fig. 14: Direction of rotation

L Counter-clockwise

R Clockwise

3. Check the permissible direction of rotation of the axial piston unit (on the name plate) and make sure that this corresponds to the direction of rotation of the output drive/drive shaft of the machine/system.

The direction of rotation as indicated on the name plate determines the direction of rotation of the axial piston unit as viewed on the drive shaft; see chapter 5.10 "Product identification" on page 37.

7.4.2 Dimensions

For standard versions, the data sheet contains all required installation dimensions as well as the dimensions of the ports and circuit diagrams.
If necessary, an installation drawing can be requested.
Also observe the manuals provided by the manufacturers of the other hydraulic components when selecting the required tools.

7.4.3 General instructions

Follow these general notices when installing the axial piston unit:

- Note that certain installation positions will affect the control system. Gravity, dead weight and case pressure can cause minor characteristic shifts and changes in response time.
- Torsional vibrations and speed variations may cause leaks in the shaft seal and increased rotary angular acceleration of the rotary group of the axial piston unit. At risk are diesel drives with a small number of cylinders and low flywheel mass and toothed belt or V-belt drives. Belts can lose much of their pre-charge pressure after just a short operating time.
  An automatic clamping device can lessen the speed variations and vibrations, and thus avoid subsequential damage.
  – When using drives with toothed belts or V-belts, always use an automatic clamping device.

- On the drive of an axial piston unit, a cardan shaft may cause vibrations and impermissible rotary angular accelerations. Depending on the frequency and temperature, this may cause leaks in the shaft seal and damage the rotary group.
- If a shared drain line is used for several units, make sure that the respective case pressure in each unit is not exceeded. The shared drain line must be dimensioned to ensure that the maximum permissible case pressure of all connected units is not exceeded in any operating condition, particularly at cold start. If this is not possible, separate drain lines must be laid if necessary.

The version of installation for the axial piston unit depends on the connecting elements to the drive side. The following descriptions explain the installation of the axial piston unit:
- With a coupling
- On a gearbox
- On a cardan shaft

7.4.4 Installation with a coupling

The following describes how to assemble the axial piston unit with a coupling:

NOTICE!Danger from improper handling!
Product can be damaged!
- ▶ Do not assemble the coupling hub on the drive shaft of the axial piston unit by striking it.

1. Assemble the specified coupling half on the drive shaft of the axial piston unit according to the instructions of the coupling manufacturer.

The drive shaft of the axial piston unit is equipped with a female thread. Use this female thread to pull the coupling element onto the drive shaft. The size of the female thread can be seen in the installation drawing.

2. Clamp the coupling hub onto the drive shaft or ensure permanent lubrication of the drive shaft. This prevents the formation of frictional corrosion and the associated wear.
3. Transport the axial piston unit to the installation location.
4. Remove dirt and foreign particles from the installation location.
5. Assemble the coupling on the output shaft of the drive motor in accordance with the parameters provided by the coupling manufacturer.

Do not fasten down the axial piston unit until the coupling has been correctly installed.

6. Fasten the axial piston unit at the installation location.
7. Align the drive shaft of the axial piston unit and the output shaft of the drive motor so there is no angular deviation.
8. Make sure no excessive axial and radial forces are acting on the drive shaft.

9. For bell housing installation, check the coupling axial play through the bell window according to the manufacturer's specifications.
10. Details on the required tools and tightening torques for the mounting bolts are available from the machine/system manufacturer.
11. When using elastic couplings, check that the drive does not resonate after completing the installation.

7.4.5 Installation on a gearbox

The following describes how to assemble the axial piston unit on a gearbox.
After installing on a gearbox, the axial piston unit is covered and is difficult to access:

- Before installing, make sure that the spigot diameter centers the axial piston unit (observe tolerances) and that no excessive axial or radial forces are acting on the drive shaft of the axial piston unit (installation length).
- Protect the drive shaft against frictional corrosion by providing permanent lubrication.
- Fasten the axial piston unit at the installation location.

For attachment via gear wheel or helical gear shaft

No gearing forces higher than the permissible axial and radial forces should act on the shaft; if necessary, support the gear wheel at the gearbox output separately.

7.4.6 Installation with cardan shaft

The following describes how to connect the axial piston unit to the drive motor with a cardan shaft.

Notice!Damage to the axial piston unit and leaks at the shaft seal!
Improperly installed cardan shafts generate unbalances. This results in vibrations and excessive forces on the drive shaft.

- Observe the cardan shaft manufacturer's assembly instructions.

1. Position the axial piston unit near the intended installation location. Allow enough space for the cardan shaft to fit through on both sides.
2. Place the cardan shaft on the output shaft of the drive motor.
3. Push the axial piston unit to the cardan shaft and place the cardan shaft on the drive shaft of the axial piston unit.
4. Bring the axial piston unit to the installation position and fasten it. If necessary, details on the required tools and tightening torques for the mounting bolts can be obtained from the system manufacturer.

7.4.7 Completion of assembly

1. Remove any installed transport screws.

Use a suitable tool for this to prevent damage to the sealing and functional surface. If the sealing or functional surface is damaged, contact your Bosch Rexroth service partner or the service department of the manufacturer's plant for the axial piston unit.

CAUTION!Operation with protective plugs!
Operating the axial piston unit with protective plugs may result in injury or damage to the axial piston unit.

- Before commissioning, remove all protective plugs and replace them with suitable, pressure-resistant, metal threaded plugs or connect the appropriate lines.

2. Remove the transport protection.
The axial piston unit is delivered with protective covers (**1**, **3**) and protective plugs (**2**). They are not pressure-resistant and have to be removed prior to connection. Use a suitable tool for this to prevent damage to the sealing and functional surfaces. If sealing or functional surfaces are damaged, contact your Bosch Rexroth service partner or the service department of the manufacturer's plant of the axial piston unit.

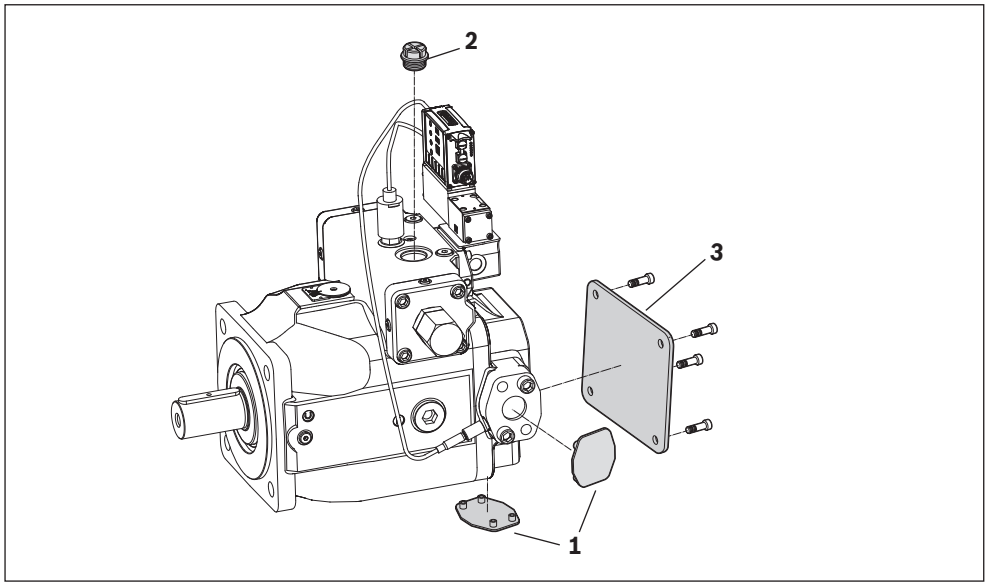


Fig. 15: Removing transport protection Example A4VSO with HS5E - control system

1 Protective cover
2 Protective plug
3 For version with a through drive, metallic protective cover and mounting bolts

Ports intended for connecting lines come with protective plugs and/or threaded plugs, which serve as transport protection. All ports required for functional operation must be connected (see table 13 "Ports A4... Series 1x and 30" on page 53). Failure to do so could lead to malfunctions or damage. If a port is not being used, plug it with a threaded plug since the protective plugs are not pressure-resistant.

3. For versions with through drive, assemble the auxiliary pump according to the pump manufacturer's manual.

7.4.8 Hydraulically connecting the axial piston unit

NOTICE

Insufficient suction pressure!

Generally, a minimum permissible suction pressure at port **S** is specified for axial piston pumps in all installation positions. If the pressure at port **S** drops below the specified values, damage may occur which may lead to the axial piston pump being damaged beyond repair!

- ▶ Make sure the required suction pressure is maintained. This is influenced by:
  - The piping (e.g. suction cross-section, pipe diameter, length of suction line)
  - The position of the reservoir
  - The viscosity of the hydraulic fluid
  - A filter element or check valve in the suction line (check the level of contamination of the filter element regularly)
  - The geodesic height of the place of use

The machine/system manufacturer is responsible for dimensioning of the lines. Connect the axial piston unit to the rest of the hydraulic system in accordance with the hydraulic circuit diagram of the machine/system manufacturer.
The ports and fastening threads are designed for the maximum permissible pressures p_{max}, see Table 13 "Ports A4... Series 1x and 30" on page 53. The machine/system manufacturer is required to ensure that the connecting elements and lines correspond to the specified application conditions (pressure, flow, hydraulic fluid, temperature) with the necessary safety factors.

Connect only hydraulic lines that are match the axial piston unit port (pressure level, size, system of units).

Information on routing of lines

Observe the following information when routing the suction, pressure and drain lines

- Lines and hoses should be installed without pre-charge pressure so no further mechanical forces are applied during operation that will reduce the service life of the axial piston unit and, possibly, the entire machine/system.
- Use suitable seals as sealing material.
- Suction line (pipe or hose)
  - The suction line should be as short and straight as possible.
  - Measure the line cross section of the suction line so the pressure at the suction port does not drop below the minimum permissible pressure. Make sure the maximum suction pressure is not exceeded (e.g. when prefilling).
  - Make sure the connections and connecting elements are airtight.
  - The hose must be pressure-resistant, also to external air pressure.
- Pressure line
  - For the pressure lines, use only pipes, hoses and connecting elements rated for the operating pressure range specified in data sheet 92050 (see table 13).

- Drain lines
  - Always route the drain lines so that the housing is constantly filled with hydraulic fluid and to ensure no air gets through the shaft seal, even during extended standstill periods.
  - The case pressure must never exceed the limit values specified for the axial piston unit in the data sheet.
  - The drain line inflow in the reservoir should always be below the minimum fluid level (see chapter 7.3 "Installation position" on page 44).
- If the axial piston unit is equipped with installed screw fittings, do not remove them. Screw the stud end of the fitting directly into the installed fitting.

Risk of confusion with threaded connections

Axial piston units are used in application areas that use the metric system as well as the Anglo-American (imperial) and the Japanese measuring system (JIS – **J**apan **I**ndustrial **S**tandard). Various kinds of seals are also used.
The system of units, the kind of seal and the size of female thread and stud ends (e.g. threaded plug) must all match.
There is a risk of confusion due to the limited ways of visually telling them apart.

WARNING!Leaky and bursting stud ends!
For fittings, if a stud end that does not match the system of units, kind of seal and size of the female thread is pressurized, the stud end may loosen itself or even be ejected from the hole in a projectile-like manner. This can result in serious injury and property damage. Hydraulic fluid can escape from this leakage point.

- ▶ Use the drawings (installation drawing) to determine the required stud end for each fitting.
- ▶ Make sure the right fittings, mounting bolts and threaded plugs are installed.
- ▶ For all female threads, use a stud end from the same system of units and of the correct size.

Port overview A4VSO

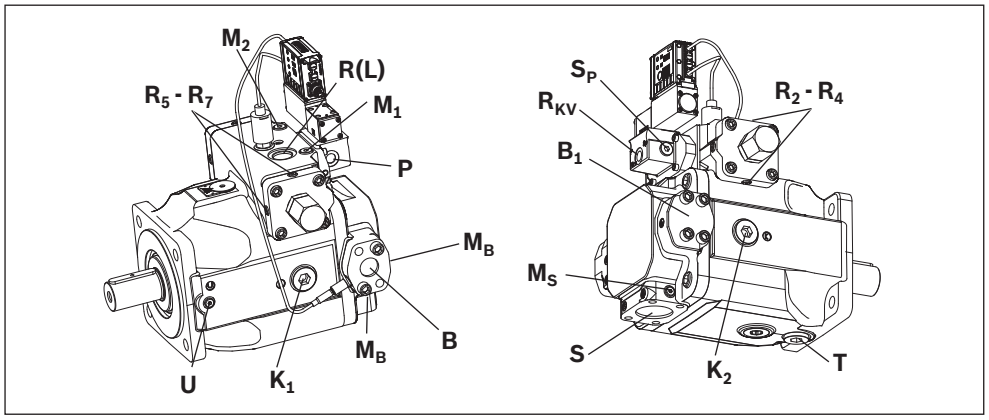


Fig. 16: Example A4VSO 125 to 355/30 with HS5E pilot control valve, clockwise rotation

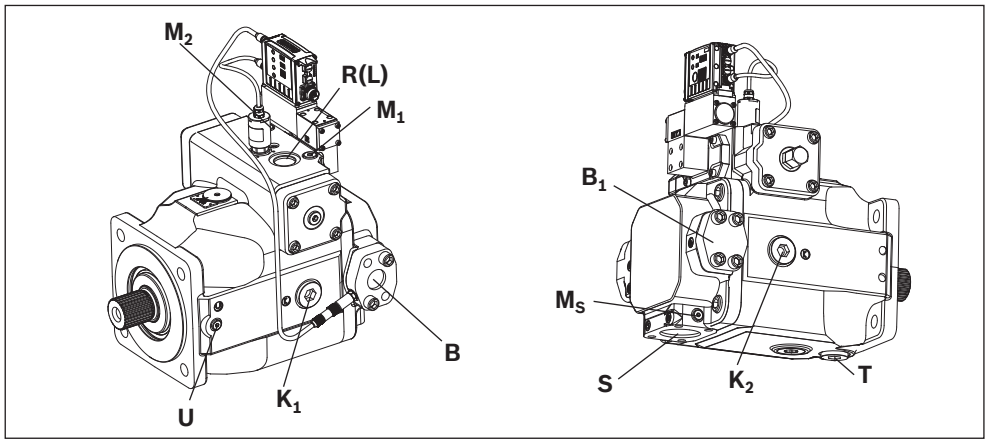


Fig. 17: Example A4VSO 125 to 355/30 with HS5EVP control system, clockwise rotation

Port overview A4VSG

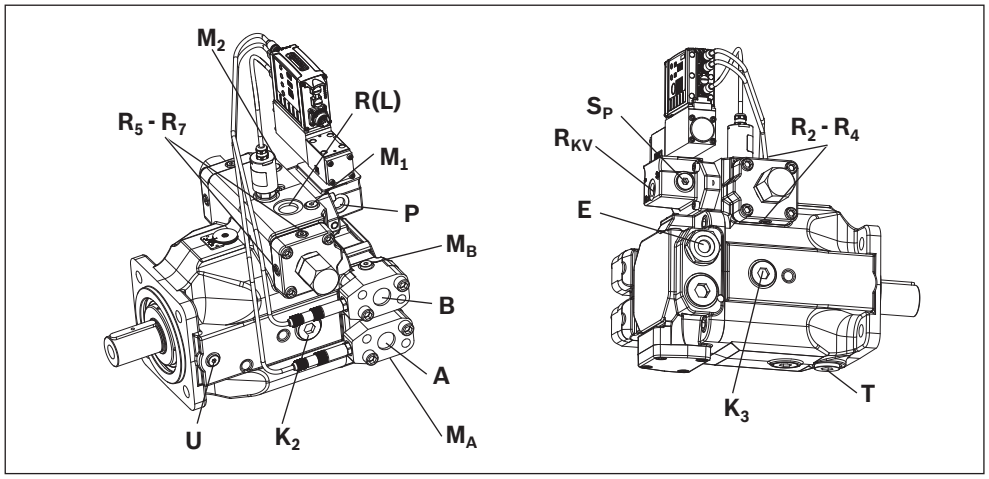


Fig. 18: Example A4VSG 125 to 355/30 with HS5E pilot control valve, clockwise rotation

Port overview A4CSG

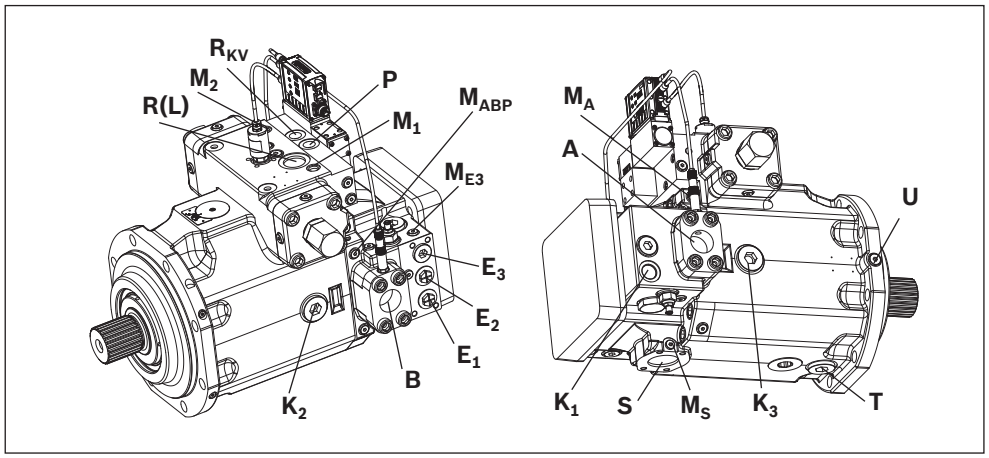


Fig. 19: Example A4CSG 500/30 with HS5EP control system, clockwise rotation

Ports for A4CSG with HS5EL on request

Table 13: A4 ports... Series 1x and 30

Ports, control system[1]					**HS5E(P)**		**HS5EV(P)**[7]		p_{max} [bar][2]	**State**
				Series	1x	30	1x	30		
	A4...	VSO	VSG	CSG						
B	Working port	●	–	–	●	●	●	●	400	O
B_1[4]	Additional connection	●	–	–	●	●	●	●	400	O
B_1[5]	second pressure port (high-pressure series)	●	–	–	●	●	●	●	400	O
S	Suction port	●	–	–	●	●	●	●	30	O
S	Boost pump suction port	●	–	●	●	●	●	●	30	O
A, B	Working port	–	●	●	●	●	–	–	400	O
K_1, K_2, K_3	Flushing port	●	●	●	●	●	●	●	4	X[7]
U	Bearing flushing	●	●	●	●	●	●	●	4	O[6]
T	Fluid drain	●	●	●	●	●	●	●	4	X[3]
R(L)	Fluid filling and air bleeding	●	●	●	●	●	●	●	4	O[3]
M_B	Measuring working pressure	●	–	–	●	●	●	●	400	X
M_S	Measuring suction pressure	●	–	●	●	●	●	●	30	X
M_A, M_B, M_{ABP}[*)]	Measuring working pressure	–	●	●[*)]	●	●	–	–	400	X
M_1, M_2	Measuring control pressure	●	–	●	–	●	●	●	400	X
P	Control pressure port	●	–	–	●	●	–	–	350	X
S_p	Control pressure port of accumulator port	●	–	–	●	●	–	–	350	X
E	Boost pressure supply	–	●	–	●	●	–	–	50	O
E_3	Boost pressure supply	–	–	●	–	●	–	–	40	O
M_{E3}	Measuring boost pressure supply	–	–	●	–	●	–	–	40	O
E_1	Filter, supply	–	–	●	–	●	–	–	40	X
E_2	Filter, return	–	–	●	–	●	–	–	40	X
R_{KV}	Control fluid return flow	●	–	–	●	●	–	–	5	X
K_4	Accumulator port	–	–	●	–	●	–	–	40	X
R_2 - R_7	Air bleeding the stroking chamber	●	–	–	–	●	–	–	350	X
X_A, X_B	Pilot pressure measuring	–	–	●	–	●	–	–	350	O

1) The measuring system and thread size can be found in the data sheet and/or the installation drawing.

2) Depending on the application, momentary pressure peaks can occur. Keep this in mind when selecting measuring devices and fittings.

3) Depending on the installation position, **T** $_{or\ R(L)}$ must be connected (see chapter 7.3 "Installation position" on page 44)

4) **Version 13**: for A4VSO NG 40 to 355

5) **Version 25**: for A4VSO NG 40 to 1000

6) Must be connected for version for HFC hydraulic fluids

7) Only available for open circuit

O = Must be connected (plugged on delivery)

X = Plugged (in normal operation)

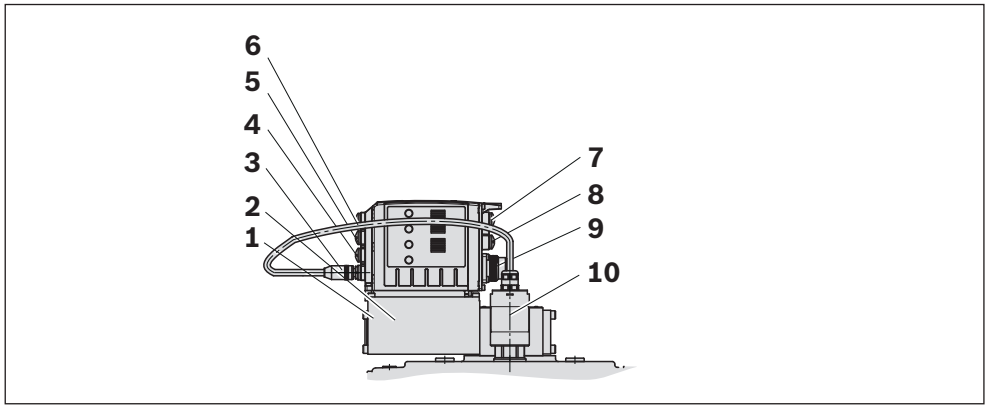


Fig. 20: Port overview A4VSO with HS5E(V)(L) control system and swivel angle sensor, clockwise rotation.

Table 14: Example A4VSO, sizes 40 to 1000

1	Proportional solenoid
2	Inductive position transducer for valve position
3	X8A actual swivel angle input
4	Reserved, X2N
5	Configurable sensor interface X2M2 (pressure sensor input)
6	Configurable sensor interface X2M1 (pressure sensor input)
7	Multi-EtherNet interface X7E1
8	Multi-EtherNet interface X7E2
9	Plug-in connector XH4
10	VT-SWA-LIN.... Swivel angle sensor

Tightening torques

The following tightening torques apply:

- Fittings:
  Observe the manufacturer's specifications regarding the tightening torques of the fittings used.
- Female threads in the axial piston unit:
  The max. permissible tightening torques $M_{G\,max}$ are the maximum values for the female threads and should not be exceeded. Please refer to Table 15 for the values.
- Threaded plugs:
  For the metallic threaded plugs supplied with the axial piston unit, the required tightening torques of threaded plugs M_V apply. Please refer to Table 15 for the values.
- Mounting bolts:
  For mounting bolts with metric ISO threads according to DIN 13 and/or ASME B1.1 threads, we recommend checking the tightening torque in individual cases in accordance with VDI 2230.

Table 15: Tightening torques for female threads and threaded plugs

Ports Standard	Thread size	Maximum permissible tightening torque of female threads $M_{G\,max}$	Required tightening torque of threaded plugs M_V	WAF hexagon socket of the threaded plug
DIN 3852	M8 × 1	10 Nm	7 Nm[1)]	3 mm
	M10 × 1	30 Nm	15 Nm[2)]	5 mm
	M12 × 1.5	50 Nm	25 Nm[2)]	6 mm
	M14 × 1.5	80 Nm	35 Nm[1)]	6 mm
	M16 × 1.5	100 Nm	50 Nm[1)]	8 mm
	M18 × 1.5	140 Nm	60 Nm[1)]	8 mm
	M22 × 1.5	210 Nm	80 Nm[1)]	10 mm
	M26 × 1.5	230 Nm	120 Nm[1)]	12 mm
	M27 × 2	330 Nm	135 Nm[1)]	12 mm
	M33 × 2	540 Nm	225 Nm[1)]	17 mm
	M42 × 2	720 Nm	360 Nm[1)]	22 mm
	M48 × 2	900 Nm	400 Nm[1)]	24 mm
ISO 11926	5/16-24 UNF-2B	10 Nm	7 Nm	1/8 in
	3/8-24 UNF-2B	20 Nm	10 Nm	5/32 in
	7/16-20 UNF-2B	40 Nm	18 Nm	3/16 in
	9/16-18 UNF-2B	80 Nm	35 Nm	1/4 in
	3/4-16 UNF-2B	160 Nm	70 Nm	5/16 in
	7/8-14 UNF-2B	240 Nm	110 Nm	3/8 in
	1 1/16-12 UN-2B	360 Nm	170 Nm	9/16 in
	1 5/16-12 UN-2B	540 Nm	270 Nm	5/8 in
	1 5/8-12 UN-2B	960 Nm	320 Nm	3/4 in
	1 7/8-12 UN-2B	1200 Nm	390 Nm	3/4 in

1) The tightening torques for the threaded plugs are valid for the condition "dry" and "lightly oiled".

2) The tightening torques for the threaded plugs are valid for the condition "dry" – in the condition "lightly oiled", the tightening torques for M10 × 1 are reduced to 10 Nm and for M12 × 1.5 to 17 Nm.

Procedure To connect the axial piston unit to the hydraulic system:

1. Remove the protective plugs and/or threaded plugs from the ports where the connections should be made according to the hydraulic circuit diagram.
2. Make sure the sealing surfaces of the hydraulic ports and functional surfaces are not damaged.
3. Use only clean hydraulic lines or flush them before installation. (Observe chapter 7.5 "Performing flushing cycle" on page 57 when you flush the hydraulic system.)
4. Connect the lines in accordance with the installation drawing and the machine or system circuit diagram. Check that all ports are connected or plugged with threaded plugs. With inside-reservoir installation, the housing of the axial piston unit must be filled before fitting the lines and filling the reservoir with hydraulic fluid.
5. Properly tighten the fittings (observe tightening torques!). Mark all properly tightened fittings, e.g. with a permanent marker.
6. Check all pipes and hose lines and every combination of connecting pieces, couplings or connecting points with hoses or pipes to ensure they are in safe working condition.

7.4.9 Electrically connecting the axial piston unit

NOTICE

Short circuit due to penetrating hydraulic fluid!

Fluid can penetrate the product and cause a short circuit!

- Do not install axial piston units with electric components (e.g. electric controls, sensors) in a reservoir below the fluid level (inside-reservoir installation). The HS5M control is available for applications below the fluid level (see data sheet 92076).

The machine/system manufacturer is responsible for electric control layout.
Electrically controlled axial piston units must be connected in accordance with the electrical circuit diagram for the machine/system.
For axial piston units with electrical control and/or mounted sensors, observe the parameters in data sheet 92076, e.g.:

- Permissible voltage range
- Permissible current
- Correct pin assignment
- An Ethernet M12 to RJ45 connection cable (ports X7E1 & X7E2), additional information in type designation RKB0044/xxx.x (xxx.x: length in meters)

7.5 Performing flushing cycle

In order to remove foreign particles from the system, Bosch Rexroth recommends a flushing cycle for the hydraulic system before the first commissioning. To avoid internal contamination, do not include the axial piston unit in the flushing cycle.

Use an additional flushing unit to perform the flushing cycle. Follow the instructions of the flushing unit's manufacturer for the exact procedure during the flushing cycle.

7.6 Electrically connecting the HS5E(V)(L) control system

The machine or system manufacturer is responsible for the layout of the electric control.

For electrically controlled HS5E(V)(L) control systems, the electric control must be connected correctly according to the circuit diagram of the system manufacturer.

Damage to the device due to incorrect installation is not covered by the warranty!

1. Switch off the power supply to the relevant system component.
2. Connect the HS5E pilot control valve electrically (24 V).

7.6.1 Cable sets

Accessories for HS5E(V)(L)	Material number	Data sheet
Plug-in connector, 12-pin for central connection XH4 without cable (assembly kit)	R900884671	08006
Plug-in connector, 12-pin for central connection XH4 with cable set 2 x 5 m	R900032356	
Plug-in connector, 12-pin for central connection XH4 with cable set 2 x 20 m	R900860399	
Pressure transducer HM 20-2X, Measuring range 630 bar (4 ... 20 mA)	R901342035	30272
Test device VT-PDFE-1-1X/V0/0	R900757051	29689-B
Compact power supply unit VT-NE32-1X	R900080049	29929
An Ethernet M12 to RJ45 connection cable (ports X7E1 & X7E2), additional information in type designation RKB0044/ xxx.x (xxx.x: length in meters)	R911172135	

7.6.2 Wiring the electronic components

In general, the following applies:

- Keep the number of intermediate terminals as low as possible.
- You are not allowed to align electromagnetic sources of interference in the immediate vicinity of the HS5E pilot control valve.
- You are not allowed to route power cables in the vicinity of the HS5E pilot control valve.

- Due to the application in a hydraulic environment, use only cable types that are designated as being oil-resistant. Otherwise, hardening of the cable sheath can result in it becoming brittle and in individual wires breaking.
- Only ever choose cables with the actual number of wires that you need (avoid "idle" wires).
- Run the lines for the command and actual values as short as possible.
- The signal lines to the HS5E pilot control valve must always be shielded. You must connect the line shield to ground on one side in the control cabinet.
- Strip the cable shield as short as possible and connect it according to the information in the data sheet 92076.
- The contacts on the plug-in connector must not be subjected to any mechanical loading. This can lead to a defective connection between the mating connector and the plug-in connector.

Due to the integration of the control electronics in the valve housing at the factory, you do not need to carry out any additional wiring for the position transducer systems of the pump and the valve. The only wiring that is necessary is to link the 12-pin central connection of the integrated electronics to the customer-provided control, the pressure sensor, and the fieldbus connection that may be present. Preassembled cable sets of various lengths are available for the connection. If desired, we can supply the 12-pin plug-in connector individually for you to wire yourself. (see data sheet 08006).

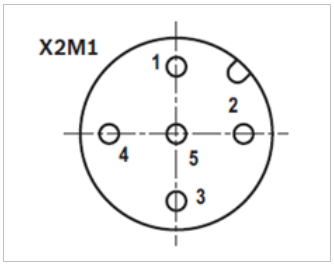
7.6.3 Connection to the swivel angle sensor

The VT-SWA-Lin G15 swivel angle sensor, which is directly connected to the HS5E pilot control valve ex-works, determines the pump's swivel angle. The HS5E pilot control valve supplies the sensor.

7.6.4 X2M1 and X2M2: Analog, configurable pressure sensor interface (coding A), M12, 5-pin, socket

Table 16: Pin assignment of X2M1 and X2M2:

Pin	Assignment
1	+ 24 V voltage output (sensor supply) [1]
2	Sensor signal input current (4 ... 20 mA) [2]
3	GND
4	Sensor signal input voltage (0 ... 10V) [2]
5	Negative differential amplifier input to pin 4 (optional)



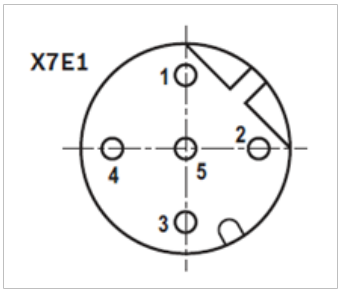
1) Maximum load capacity 50 mA, voltage output same as connected voltage supply at input XH4.

2) Only one signal input per interface can be configured

7.6.5 X7E1 and X7E2: Plug-in connector assignment for Ethernet interface (coding D), M12, 4-pin, socket

Table 17: Pin assignment of X7E1 and X7E2:

Pin	Assignment
1	TxD +
2	RxD +
3	TxD -
4	RxD -
5	not assigned



Use a shielded bus cable as the data cable. When doing this, the shield should be connected to the connector housing.

7.6.6 LED status indicators

LED	Interface	Sercos	EtherNET/IP	EtherCAT	PROFINET
1	**X7E1**	Activity	Activity	not used	Activity
2		Link	Link	Link/Activity	Link
3	**Electronics-module**	S	Network status	Network status	Network status
4		Module status	Module status	Module status	Module status
5	**X7E2**	Activity	Activity	not used	Activity
6		Link	Link	Link/Activity	Link

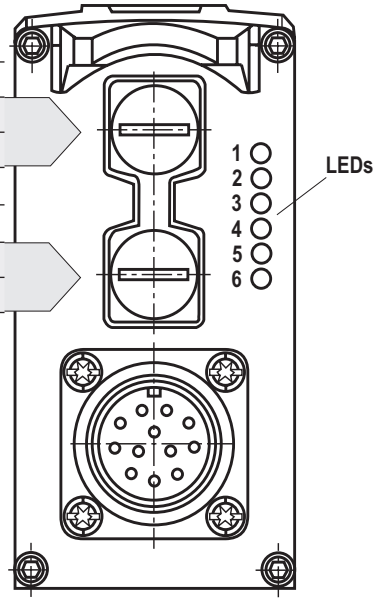


Table 18: Indicators of status LED

Module status LED (LED 4)	Indicator status
Off	no voltage supply
Green/red flashing	Self-test
Green flashing	Drive ready for operation
Green	in control
Red flashing	Warning
Red	Fault

Network status LED	Indicator status
Off	no voltage supply
Green	Operation

LEDs 1, 2, 5, and 6 refer to interfaces "X7E1" and "X7E2"
- Link: Cable is plugged in, connection has been established (lit up permanently)
- Activity: Data has been sent/received (flashing)

Module status LEDs 3 and 4 refer to the electronics module

For a detailed description of the diagnosis LEDs, refer to the functional description of the Rexroth HydraulicDrive.

7.6.7 Voltage supply of the HS5E pilot control valve

The HS5E pilot control valve is supplied with 24 V DC. If this system-side voltage supply is not present, you can use the VT-NE30-2X/ power supply unit according to RE 29929. You connect the 24 V of the power supply unit to connections 1 (+24 V) and 2 (L0) of the plug-in connector.

With the available connection cable, this corresponds to the two black wires of the 1 mm² cross-section 3-pole cable. In this context, you must connect the wire labeled "1" to +24 V and the one labeled "2" to L0 (Ground). The yellow/green wire must be connected to ground.

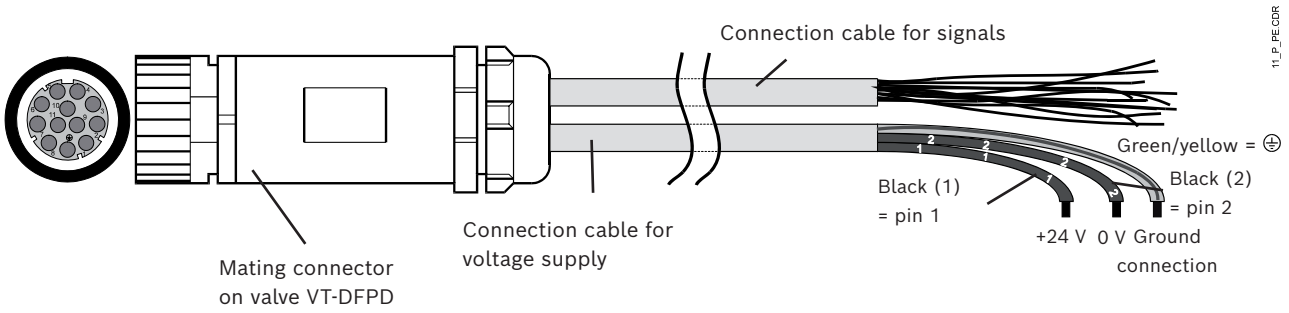


Fig. 21: Connecting the voltage supply of the HS5E pilot control valve

Recommendation:
On the system-side, the voltage supply of the HS5E pilot control valve should be fuse-protected using a 4 A slow-blow fuse

The HS5E pilot control valve does not have an enable input to block the function of the valve.
In the event of a fault, the drive enable should be canceled via fieldbus. All other safety-relevant intervention must be carried out by the higher-level control (e.g. drive motor OFF, close isolator valves, etc.)

7.6.8 Selection, installation location, and installation direction of the pressure transducer

Selection of the pressure transducers

To reduce the number of variants, only the 630 bar pressure stage of the HS5E control systems is listed. If necessary, it is also possible to combine other pressure stages (under selection of the appropriate electrical interface!) It is, however, only possible to deal with orders for pressure transducers of this type separately from the HS5E(V)(L) control system.
A differentiation is made on a signal-specific basis between
• sensors with a current interface, and
• sensors with a voltage interface.

Here, the usual signal limits are between 0...20 mA or 0...10 V.
Within these limits, there are further modifications that depend, for example, on whether cable breaks are to be monitored too.
From a technical point of view, the efficiency of the pressure transducer must be matched to the HS5E(V)(L) control system to make it possible to achieve optimum results for accuracy, dynamics, and reproducibility.
The pressure transducers that we recommend are listed in the RE sheets of the respective HS5E system.

Pressure transducer HM20-2x (current)

The pressure transducer "HM20-2X" (for version HS5E(V)(L)P) with (4...20 mA) current interface has a two-wire connection and makes it possible to transfer signals on a noise-immune basis across relatively long distances (depending on the cable and the permissible ohmic resistance of the pressure transducer).
Looping in of further pick-ups is possible taking into account the respective input resistances.
For more detailed information about the pressure transducer, see data sheet 30272.

Pressure transducer HM20-2x (voltage)

The pressure transducer "HM20-2X" with (0.1...10 V) voltage interface has a three-wire connection and a built-in DC/DC converter that effectively rules out interference with the analog signal that is caused by the voltage supply.
You should avoid a transmission of the signal across long distances.
The benefit of the pressure transducer is that you easily check the signals using a voltmeter without needing to interfere with the connection lines.
For more detailed information about the pressure transducer, see data sheet 30272.

Pressure transducer connection

The pressure transducer is connected to ports **X2M1** and **X2M2**. Alternatively, it can also be connected to the HS5E pilot control valve via the central connector. In case of connection of the pressure transducer via the central connector, the supply voltage must comply with the specification.

⚠ CAUTION

Uncontrolled rise in pressure!
Risk of injury!
- ▶ You must carry out wiring such that the pressure transducer is not short-circuited, since in the absence of a pressure signal, the control electronics can no longer detect the pressure, which results in an uncontrolled rise in pressure.

Place of installation of the pressure transducer

We have found that locations that are not in the immediate vicinity of the pump and which are located downstream of the (flexible) pressure hose are favorable for attaching the pressure transducer:
- Always between the pump and a check valve that may be installed
- Do not use Minimess lines

Mounting orientation of the pressure transducer

We recommend suspended installation of the pressure transducer to rule out air bleeding problems (and any associated control oscillations) right from the start.

If the installation position of the pump leads to a pressure transducer that is installed directly into the pump being positioned vertically, we recommend choosing a different installation position for the pressure transducer.

8 Commissioning

⚠ WARNING

Danger while working in the danger zone of a machine/system!

Danger to life, risk of injury or serious injury!

- Pay attention to and eliminate potential danger sources before commissioning the axial piston unit.
- Make sure no one is in the danger zone of the machine/system.
- The emergency stop button for the machine/system should be within the operator's reach.
- Always follow the instructions of the machine/system manufacturer during commissioning.

⚠ CAUTION

Commissioning an incorrectly installed product!

Risk of injury and property damage!

- Make sure that all the electrical connections and hydraulic ports are connected or plugged correctly.
- Commission only a fully installed, fully functioning product with original accessories from Bosch Rexroth.

NOTICE

Missing seals and plugs lead to non-compliance with the protection class!
Fluids and foreign particles can penetrate and damage the product.
- Prior to commissioning make sure that all seals and connectors are tight.

Lack of hydraulic fluid!
Inadequate amounts of hydraulic fluid can destroy the product.
- Make sure that the housing of the A4V with HS5E(V)(L) control system is filled with hydraulic fluid during commissioning and operation. Also do this after relatively long standstill periods, since the A4V with HS5E(V)(L) control system may drain out through the hydraulic lines.

Penetrating contaminants!
Damage to A4V with HS5E(V)(L) control system! Any contamination of the hydraulic fluid leads to wear and malfunctions. Foreign particles like welding beads or metal cuttings in the hydraulic lines, for example, can damage the A4V with HS5E(V)(L) control system.
- Ensure utmost cleanliness during commissioning.
- Make sure that no contaminants penetrate when plugging the measuring ports.

Air pockets in the area of the bearings!
The device can be destroyed.
- Make sure that the pump housing is completely filled with hydraulic fluid at commissioning and during operation with the "drive shaft upwards" installation position.
- Check the hydraulic fluid level in the housing area regularly; if necessary, recommission. With above-reservoir installation, the housing area may drain via the drain line after longer standstill periods (air enters via the shaft seal ring) or via the working line (gap leakage). The bearings are thus insufficiently lubricated when recommissioning.
- Make sure that the suction line is always filled with hydraulic fluid during commissioning and operation.

The system generates a warning message if the sensor system fails or malfunctions!
Uncontrolled movements in the system.
- As delivered from the factory, the electronics are configured such that the system generates a warning message if the sensor system fails or malfunctions. This warning message is not issued via an analog signal. If required, it is possible to change the configuration such that the system generates a fault message. This message is output as an analog signal and it can be further-processed.
- Using the machine control unit, you must ensure that the system is transferred to a safe state.

8.1 Initial commissioning

During all work on commissioning the axial piston unit, observe the general safety instructions and intended use in chapter 2 "Safety instructions" on page 10.

- Allow the product to acclimatize for a few hours before initial commissioning so that no condensation water can form inside the housing.
- Connect the pressure gauge for the working pressure, case pressure and suction pressure to the specified measuring points on the axial piston unit or in the hydraulic system, to check the technical data at first operation.
- During commissioning, monitor the temperature of the hydraulic fluid in the reservoir to ensure that it lies within permissible viscosity limits.

8.1.1 Filling the axial piston unit

Professional filling and air bleeding is required to prevent damage to the axial piston unit and to maintain proper function.

Bosch Rexroth evaluates hydraulic fluids on the basis of the Fluid Rating according to data sheet 90235. For hydraulic fluids which have been positively evaluated in the Fluid Rating, please refer to data sheet 90245 "Bosch Rexroth fluid rating list for Rexroth hydraulic components (pumps and motors)". Selection of hydraulic fluid shall make sure that the operating viscosity in the operating temperature range is within the optimum range (ν_{opt}; see selection diagram in the data sheet 92050).

To ensure the functional reliability of the axial piston unit, cleanliness level 20/18/15 according to at least ISO 4406 is required for the hydraulic fluid. At a hydraulic fluid viscosity of less than 10 mm^2/s (e.g. due to high temperatures during short-term operation) at the drain port, a cleanliness level of at least 19/17/14 according to ISO 4406 is required. You can find parameters on the permissible and optimal viscosities and admissible temperatures in data sheet 92050.
Permissible temperatures:

Ambient temperature at the pump:	-20 to +60 °C
Hydraulic fluid temperature range	-20 to +70 °C

Procedure Proceed as follows to fill the axial piston unit:

1. Place a drip tray under the axial piston unit to collect any hydraulic fluid that may leak.

NOTICE!Contaminated hydraulic fluid!
The cleanliness levels of commercial hydraulic fluids are usually insufficient for the requirements of our components.

- Use a suitable filter system to filter hydraulic fluids during filling to minimize solid particle contamination and water in the hydraulic system.

2. Fill and air bleed the axial piston unit via the appropriate ports; see chapter 7.3 "Installation position" on page 44. Also fill the hydraulic lines of the system.

NOTICE!Risk of property damage due to inadequate lubrication!
Product can be damaged or destroyed!
- When using a shut-off valve in the suction line, make sure that the drive of the axial piston unit can only be started when the shut-off valves are open.
- Dimension a shut-off valve in the suction line so that no inadmissible pressure drop occurs in the suction area when the shut-off valve is open.

3. If you use a shut-off valve in the suction line, only operate the axial piston unit with opened shut-off valves.
4. Test the direction of rotation of the drive motor. To do this, run the drive motor briefly at the lowest rotational speed (inching). Make sure that direction of rotation of the axial piston unit matches the details on the name plate, see also chapter 5.10 "Product identification", Fig. 8: Example name plate A4VSO...HS5EV control system on page37.
5. Operate the axial piston pump at a low rotational speed (starter speed for internal combustion engines and/or inching mode for electric motors) until the hydraulic system is completely filled and air bled. To verify, drain the hydraulic fluid at the drain port until there are no bubbles in the fluid.

8.1.2 Testing the hydraulic fluid supply

The axial piston unit should always have a sufficient supply of hydraulic fluid.
For this reason, the supply of hydraulic fluid must be ensured at the start of the commissioning process.
When you test the hydraulic fluid supply, constantly monitor noise development and check the hydraulic fluid level in the reservoir. If the axial piston unit becomes louder (cavitation) or the leakage fluid is discharged with bubbles, this is an indication that the axial piston unit is not being sufficiently supplied with hydraulic fluid.
Notes on troubleshooting can be found in chapter 14 "Troubleshooting" on page 92.
To test the hydraulic fluid supply:

1. Allow the drive motor to run at the lowest rotational speed. The axial piston unit should be operated without load. Pay attention to leaks and noises.
2. Check the axial piston unit's drain line during the test. The drain fluid should be without bubbles.
3. Increase the load and check whether the working pressure rises as expected.
4. Perform a leak test to ensure the hydraulic system is sealed and can withstand the max. pressure.
5. Check the suction pressure at port **S** of the axial piston pump at nominal speed and max. swivel angle. Refer to data sheet 92050 for the permissible value.
6. At maximum pressure, check the leakage pressure at port $\mathbf{K_1}$, or $\mathbf{K_2}$. For the permissible value, please refer to the data sheets from Table 1 "Required and supplementary documentation" on page 6.

8.1.3 Performing a functional test

⚠ WARNING

Improperly connected axial piston unit!

Mixing up the ports will cause malfunctions (e.g. lift instead of lower) and could present a hazard to personnel and equipment!

- Before the functional test, check whether the piping specified in the hydraulic circuit diagram has been installed.

Once you have tested the hydraulic fluid supply, perform a functional test of the machine/system. The functional test should be performed according to the specifications of the machine/system manufacturer.
The axial piston unit is tested for functional capability and performance before delivery according to the technical data. During commissioning, make sure the axial piston unit was installed in the machine/system as intended.

- After starting the drive motor, check in particular the specified pressures, e.g. working pressure and case pressure.
- Perform a leak test without and with load prior to normal operation.
- If necessary, remove the pressure gauge and plug the ports with the specified threaded plugs.

8.1.4 Connection to the control (IndraWorks)

We will assume that IndraWorks has already been installed. If this is not the case, install IndraWorks as described in manual R911344285. After this, you must connect the HS5E pilot control valve to the PC’s Ethernet port and modify the (TCP/IPv4) IP address of the network port to match the IP address range of the HS5E pilot control valve. The default address of the HS5E pilot control valve is 192.168.0.1. If the IP address is incorrect, the row is highlighted in red. After you have configured the network port, you can open IndraWorks and start a network search:

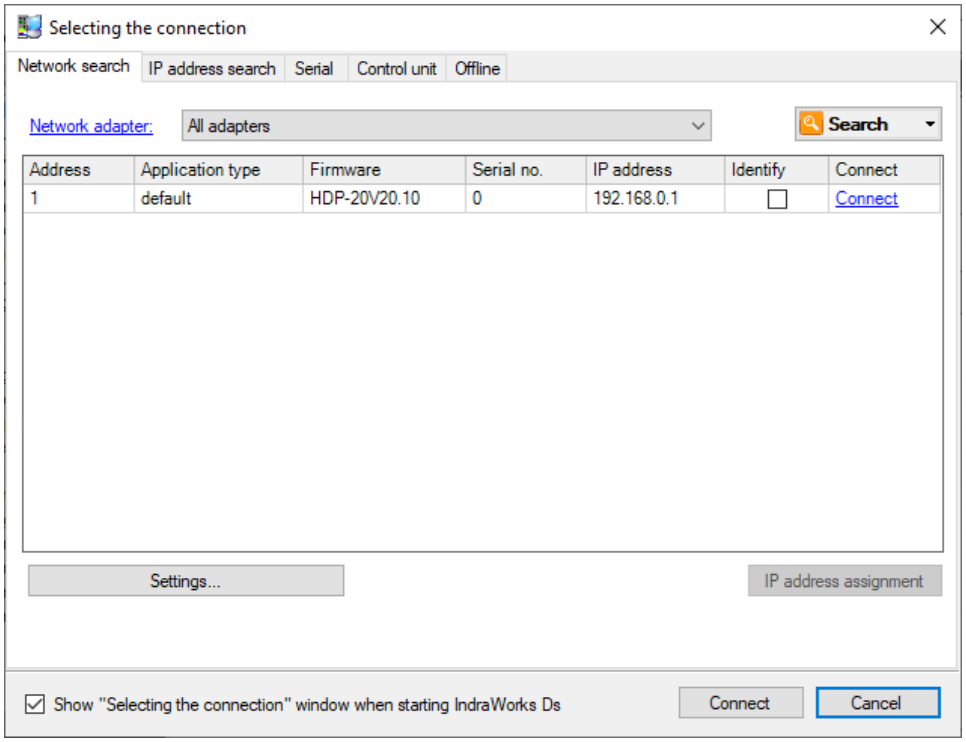


Fig. 22: Connection selection

By clicking on the OK pushbutton, you can now establish a connection to the selected system.

If EtherCat or VARAN are activated as the fieldbus system, you can deactivate them for direct communication with IndraWorks. To do this, click on the EtherCAT/VARAN Deactivation pushbutton to send the deactivation command. As an alternative with these bus systems, it is possible to access the HS5E pilot control valve via the control's engineering port.
It is advisable to have a second Ethernet port on your PC or laptop for parallel operation of the Internet, for example.

8.1.5 Making the basic setting on the control electronics

You must have installed the IndraWorks engineering tool to be able to set the control electronics. Users must configure the HS5E(V)(L) control system to match customer-specific requirements. This mainly affects the following settings:

- As-delivered, the command value specification is analog.
  When using BUS, you must make the corresponding master communication setting.
- Pressure acquisition settings (only with HS5E(V)(L), not HS5E(V)(L)P if using the pressure transducer included in the scope of delivery)
- Setting of torque limitation
- Controller optimization (see chapter 8.1.7 "Setting controller parameters" on page 76 or also refer to the additional information in data sheet 30237-Z).

In the condition as delivered from the factory, the variable-speed mode is deactivated. If the control system shall work in variable-speed mode, this operating mode must be activated and parameterized (see data sheet 30237-Z and firmware and software description 30338-FK)

To set the enable during commissioning, you use Easy Startup mode. You use IndraWorks to configure this mode and to start it.

8.1.5.1 Setting pressure sensors, voltage, or current interface X2M1, X2M2 (analog inputs/outputs)

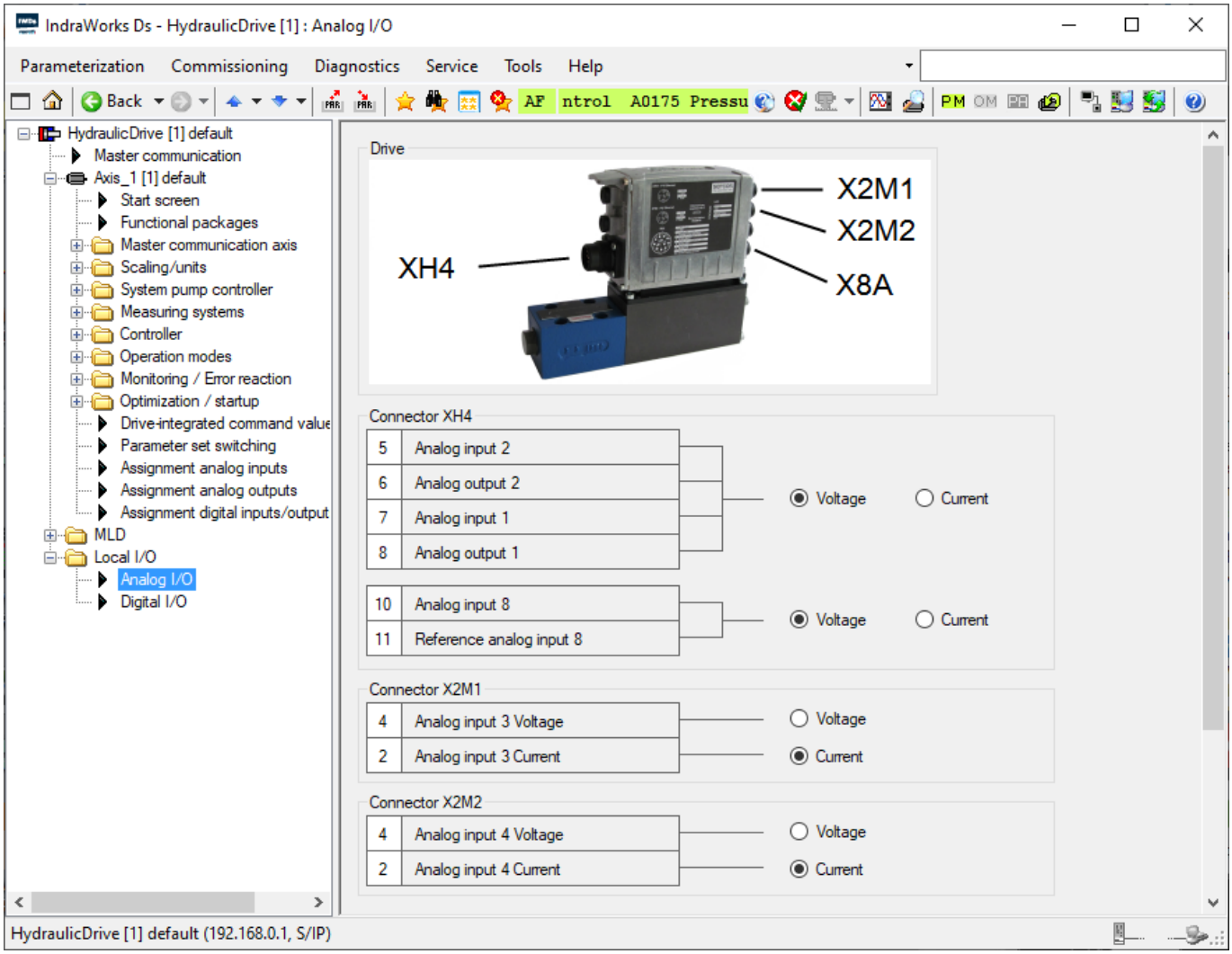


Fig. 23: Setting of pressure sensors, voltage points or interfaces

8.1.5.2 Settings of pressure transducer

For applications in the open circuit A4VSO and A4VBO

With applications in an open circuit, it can be an advantage to be able to switch between several pressure transducers. The HS5E pilot control valve gives you the option of connecting two pressure transducers. For this, you must configure two assignments for the corresponding analog inputs with destination actual pressure value 1 (P-0-2940) and actual pressure value 2 (P-0-2941). The assignment with destination actual pressure value 1 must always be present, since an A4Vx O with HS5E(V)(L) control system always needs one valid actual pressure value for control. Refer to chapter 7.6.8 on page 61 for the various options for connecting a pressure transducer.

For applications in the closed circuit A4VSG and A4CSG

For applications in the closed circuit, two pressure transducers are required. The HS5E pilot control valve gives you the option of connecting two pressure transducers. For this, you must configure two assignments for the corresponding analog inputs with destination actual pressure value A (S-0-0803) and actual

pressure value B (S-0-0804). Refer to chapter 7.6.8 on page 61 for the various options for connecting a pressure transducer.

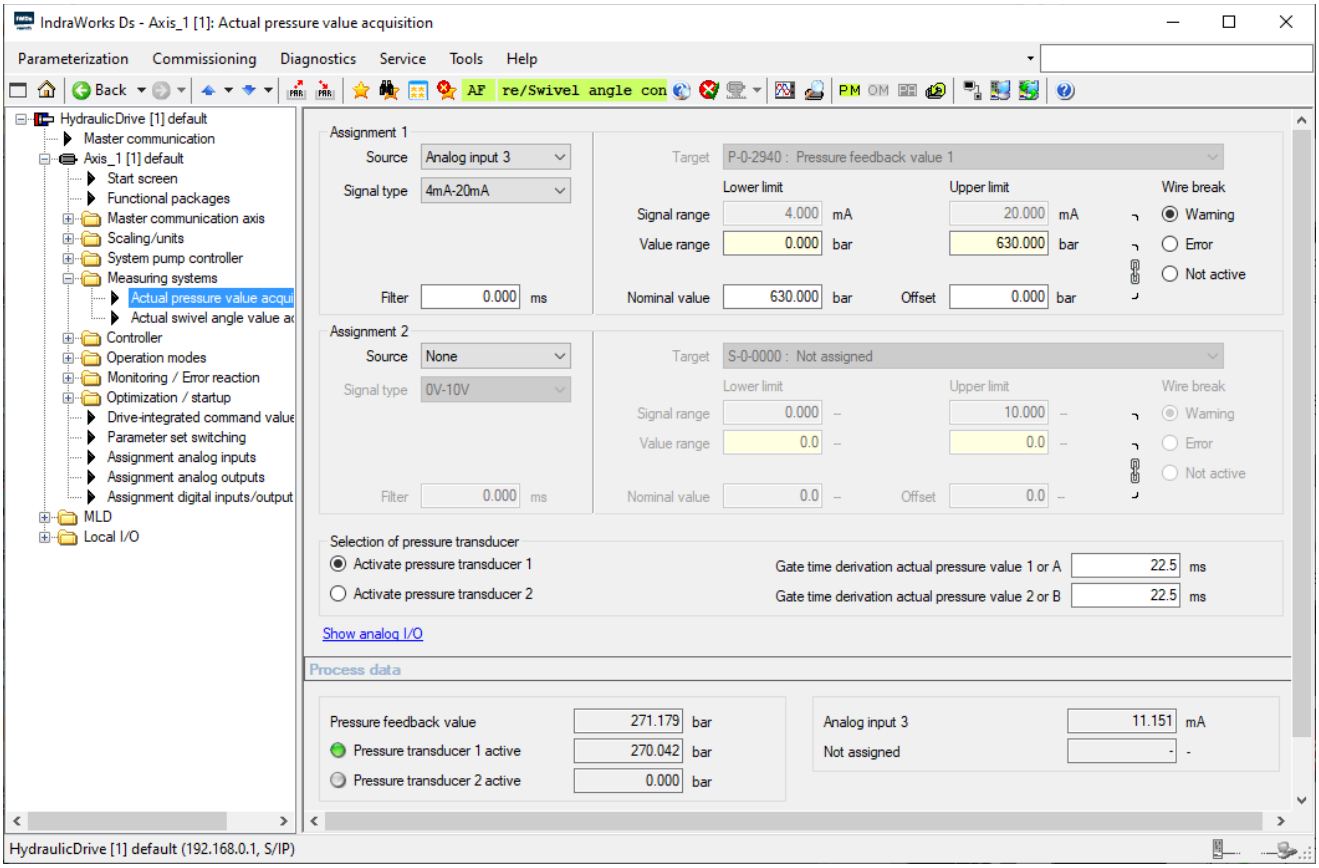


Fig. 24: Actual pressure value acquisition (example of open circuit with pressure transducer)

8.1.5.3 Setting of torque limitation

For torque limitation to be able to operate, it needs a valid actual pressure value from a pressure sensor.

100% corresponds to the torque of the pump at the actually set maximum displacement and to the value of pressure standardization.
or
To protect the drive motor from overloading, it is possible to limit the maximum torque of the pump. Parameter "P-0-2952, Torque limitation of pump, relative" is a relative variable in percent and is relative to the maximum torque of the pump at normal pressure (P-0-2957.0.1).

Determination of the characteristics		
Flow	$q_v = \frac{V_g \times n \times \eta_v}{1000}$	[l/min]
Torque	$M = \frac{V_g \times \Delta p}{20 \times \pi \times \eta_{mh}}$	[Nm]
Power	$P = \frac{2 \pi \times M \times n}{60000} = \frac{q_v \times \Delta p}{600 \times \eta_t}$	[kW]

Key

V_g Displacement per revolution [cm³]

Δp Differential pressure [bar]

n Rotational speed [rpm]

η_v Volumetric efficiency

η_{hm} Hydraulic-mechanical efficiency

η_t Total efficiency ($\eta_t = \eta_v \times \eta_{hm}$)

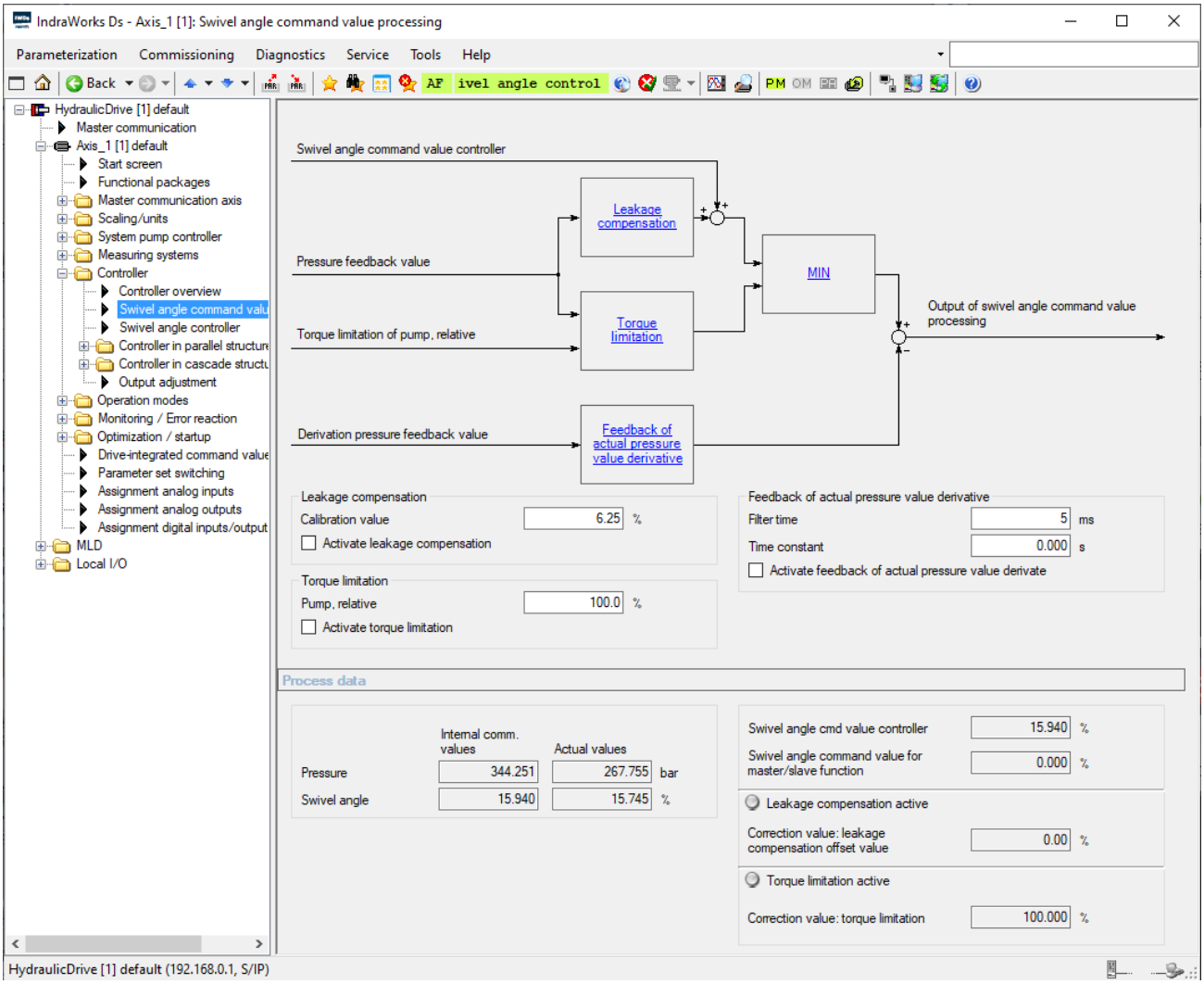


Fig. 25: Parameters for torque limitation

At determination of the torque limitation value, it is assumed that efficiencies are 100%.

Example: Electric motor output of 75 kW at 1480 rpm should not be exceeded. The pump of the NG 355 was limited mechanically to 320 cm^3. The value for pressure standardization was input as 350 bar.

Electric motor	M	=	$\frac{60{,}000}{2\pi}$	×	$\frac{P}{n}$	=	$\frac{9549}{}$	×	$\frac{75}{1480}$	= 483.9 Nm
Maximum pump torque	M	=	$\frac{vG}{20\pi}$	×	Δp	=	$\frac{320}{62.83}$	×	$\frac{350}{}$	= 1782.5 Nm
Torque limiting Pump relative									$\frac{483.9}{1782.5}$	= 27.1 %

8.1.5.4 Settings of swivel angle sensor

At the factory, the HS5E(V)(L) control system is fitted with the appropriate swivel angle sensor for the pump. If the type of swivel angle sensor changes or the HS5E pilot control valve is replaced, you may need to modify the selection values in the "Actual swivel angle value acquisition" window appropriately.

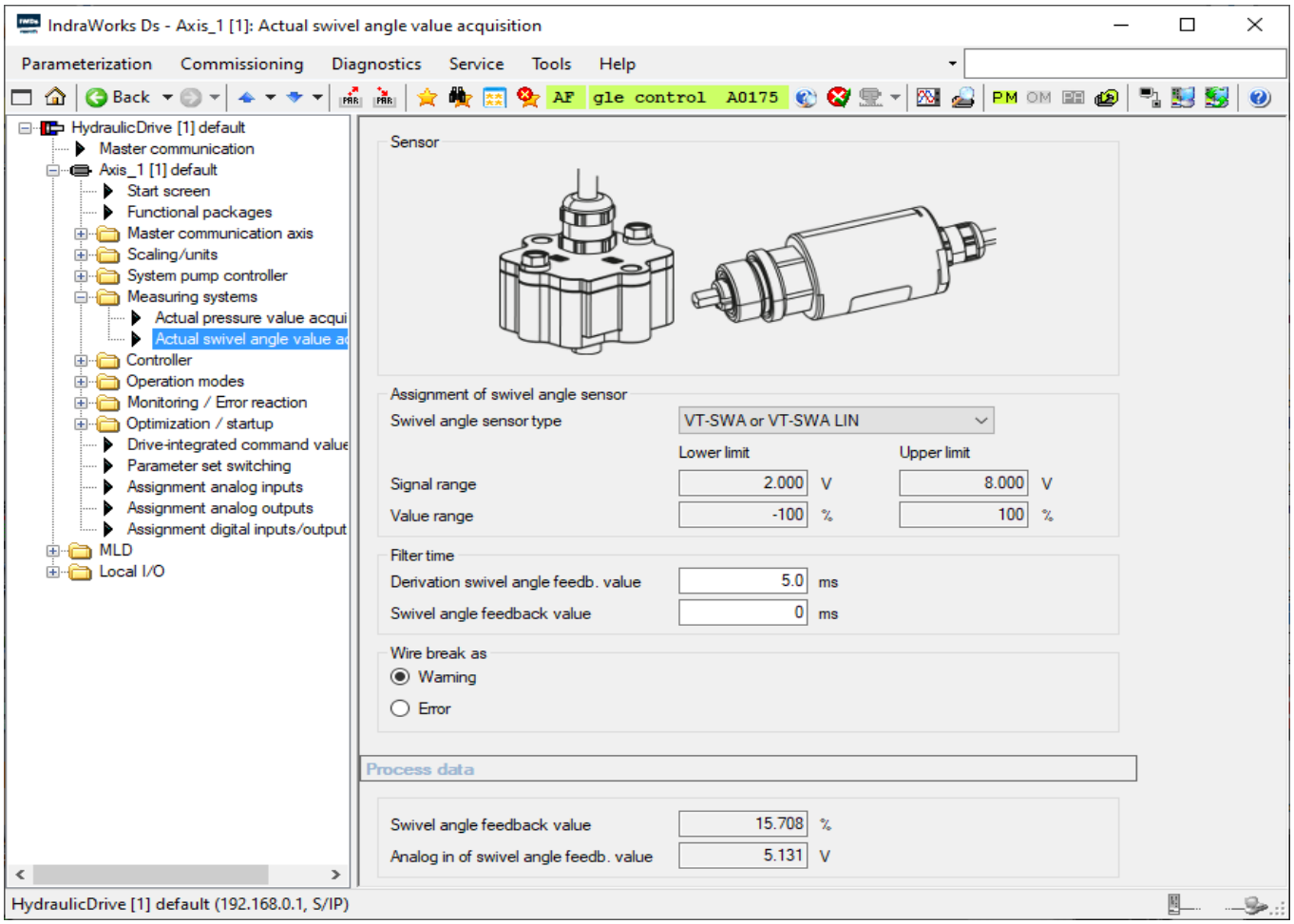


Fig. 26: Actual swivel angle value acquisition

8.1.5.5 Entry of pump and motor values

Via the structure tree "System pump controller" → "Pump/drive motor" you can open the following window. In this window, you must check the values for the displacement of the pump, the direction of rotation, the hydraulic version, the system/control and the drive speed and, if required, adjust them.

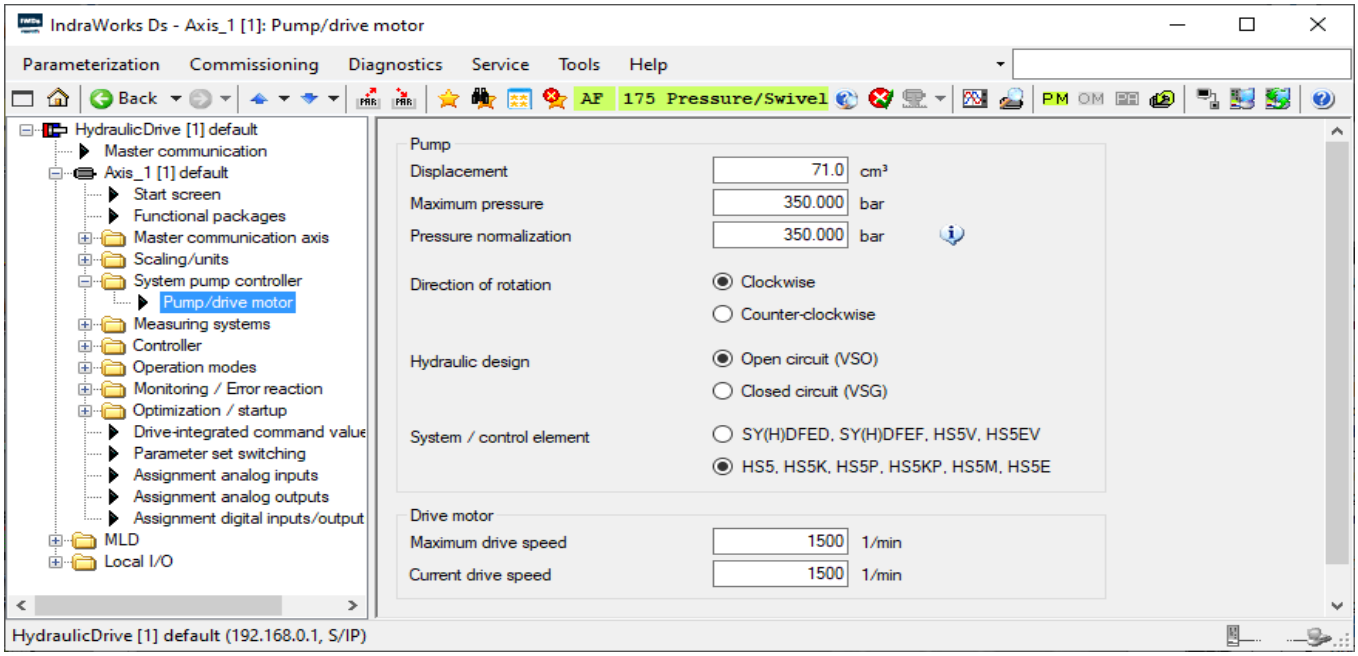


Fig. 27: Pump/drive motor

8.1.6 Switching on the drive motor of the pump

To prevent undefined states, the voltage supply of the valve electronics should always be switched on first, then the drive motor of the pump as well as the control pressure and the load pressure (see chapter 5.9 "Switch-on sequence of electronics/ hydraulics" on page 36).

Following this, you should check the following points (motor is still switched off!):

1. No fault messages are present and the drive enable is set.
2. The actual swivel angle value (SW_{act}) of the pump is:
   - A4 open circuit HS5E ▶ close to neutral position via spring-centering
   - A4 open circuit HS5EV ▶ $V_{g\,max}$ or α=+100%
   - A4 closed circuit HS5E ▶ close to neutral position via spring-centering
   - A4 closed circuit HS5EL ▶ close to neutral position via spring-centering

▶ Notice: In this state, warning E2282, "Control deviation pump controller" can be issued because the drive motor is still at a standstill. Later, when the motor is running, this warning should no longer be issued. To suppress the warning while the motor is at a standstill, you can enter a swivel angle command value of < 5%

Table 19: Errors and their remedy/cause

Fault	Remedy/cause
No voltage supply available	Check voltage supply at the central plug of the electronics
Field bus does not work	Check wiring Check IP address
Fault in the pressure measurement branch	Read out the actual pressure value (p_{actual}); it must be 0 bar. The output signal of the pressure transducer must match the type of control electronics (current, voltage, nominal value).
Fault in the swivel angle measurement branch	Comparison of the actual swivel angle value (SW_{act}) with the visual indicator on the axial piston unit.

Further explanations on the analysis of faults can be found in chapter 14 "Troubleshooting" on page 92.

1. Close all directional valves upstream of consumers.
2. Open directional valve to the oil reservoir for depressurized circulation.
3. Before activating the motor, feed forward low command values (e.g. p = 15 bar, SW = 10%).

In this state, the HS5E pilot control valve reports an "error" (excessive control difference). When the electronics is working properly, the fault message disappears when the motor is switched on (control difference now equal to zero).

▶ Switching on the drive motor of the pump!

8.1.7 Setting controller parameters

The following description is to simplify setting of the controller parameters. Depending on the application, you may not need to modify all of the parameters listed here.

8.1.7.1 Setting controller parameters for cascade structure

Factory setting:

When the HS5E(V)(L) control system is delivered, controller parameters have already been entered as the default value. This controller setting sets the controller to slow behavior, which is stable with most systems.

To customize the controller to plant-specific requirements, you need to modify a few parameters.

8.1.7.2 P-gain (proportional gain)

Table 20: P-gains

Parameters	Designation
P-0-2809	Pressure controller cascade P-gain
P-0-2977	Swivel angle controller P-gain

These parameters are multiplied by the control difference of the respective controller. This means that they have the effect of a linear gain factor in the controller. The lower this value is set, the slower is the controller’s response. However, if you select a value that is too high, the system can become unstable. When customizing the controller parameters to plant-specific behavior, you generally only need to modify the P-gain in the pressure controller.

8.1.7.3 Dead volume

Table 21: Dead volume

Parameters	Designation
P-0-2813	Pressure controller dead volume

You use this parameter to specify the dead volume of the system. The dead volume is calculated as the oil volume that is in the system between the pump and the consumer. The behavior of the pressure controller depends on the dead volume. This means that you must always enter the current dead volume on this parameter.

8.1.7.4 Setting value of integrator

Table 22: Setting value of integrator

Parameters	Designation
P-0-2806.0.4	Pressure controller integration time
P-0-2806.0.6	Pressure controller accuracy window of integrator
P-0-2812	Pressure controller derivation of actual pressure value feedback of integrator

There are various parameters for setting the integrator. In this connection, the integration time corresponds approximately to the regulating speed of the pump system. In the pressure controller, there is a path for the integrator with feedback of the change in pressure. This makes it possible to limit the integration value at transitions.
If the actual pressure value is in the range of the accuracy window by the pressure command value, the integrator value is not adjusted any more.

8.1.7.5 D component

Table 23: D component

Parameters	Designation
P-0-2816	Pressure controller of cascade factor of D component positive
P-0-2817	Pressure controller of cascade factor of D component negative
P-0-2978	Swivel angle controller time constant D component

The D component scales the change of the actual value signal and ensures a damped transient response of the pressure or swivel angle controller. Differentiation results in very high sensitivity, which also responds to undesirable signals such as interference and can make the system unstable. In the case of a constant actual value, the D-component does not respond, since the change rate is zero. The higher the D-component, the slower is the system’s response.
With the cascade structure, the D component is only used to increase damping in the controller on an as required basis.

8.1.7.6 Setting the pressure controller parameters

The pump controller in the cascade structure consists of a pressure controller with a lower-level swivel angle controller. The settings of the swivel angle controller are mainly dependent on the pump size and you do not normally need to set them on a plant-specific basis. This means that it is generally enough to adapt the controller parameters in the pressure controller.

Below, we will give you information about setting the individual parameters:

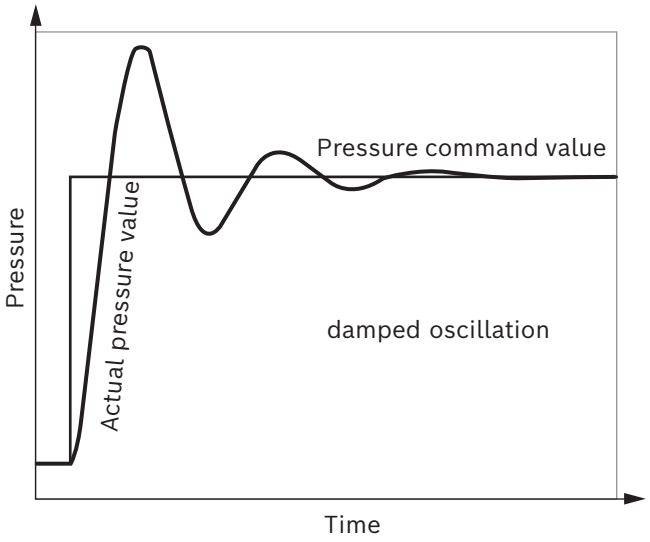


Fig. 28: Damped oscillation

Step	Behavior/result	Measure
1	Overshoots (damped oscillation)	Check the value of the dead volume (P-0-2813) and correct it if necessary.
2	Overshoots (damped oscillation)	Increase feedback of integrator (P-0-2812) to reduce initial overshoots
3	Actual pressure value still overshooting	Reduce P-gain (P-0-2809); if necessary, increase D component

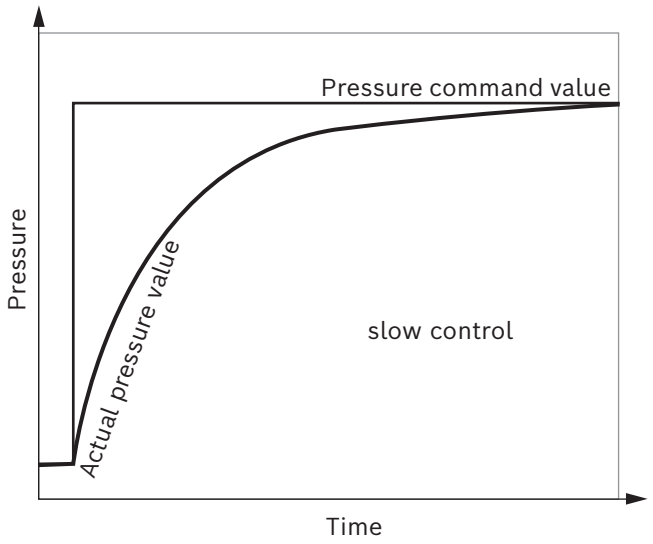


Fig. 29: Damped oscillation

Step	Behavior/result	Measure
1	Slow response	Check the value of the dead volume (P-0-2813) and correct it if necessary.
2	Response is still slow	Increase P-gain (P-0-2809); if necessary, reduce D component positive (P-0-2816)
3	Response is still slow	Reduce the integration time (P-0-2806.0.4)

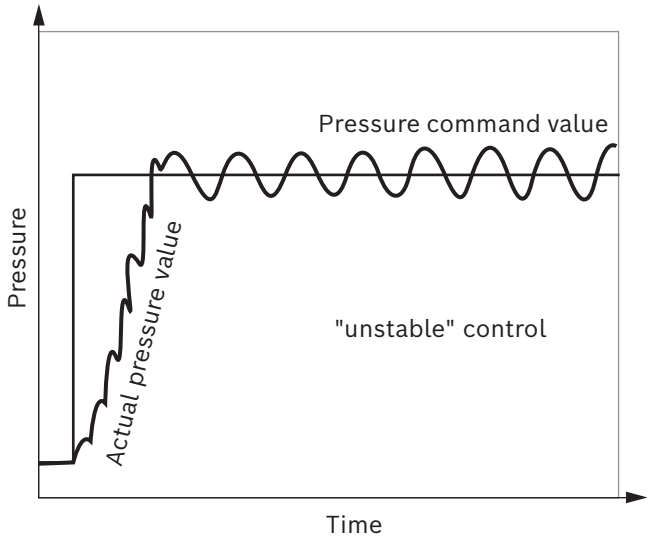


Fig. 30: Unstable control

Step	Behavior/result	Measure
1	Rapid but unstable response	Check the value of the dead volume (P-0-2813) and correct it if necessary.
2		Reduce P-gain (P-0-2809); if necessary, reduce D component
3		Increase the integration time (P-0-2806.0.4)
4		Reduce parameter for feedback derivation actual pressure value (P-0-2812)

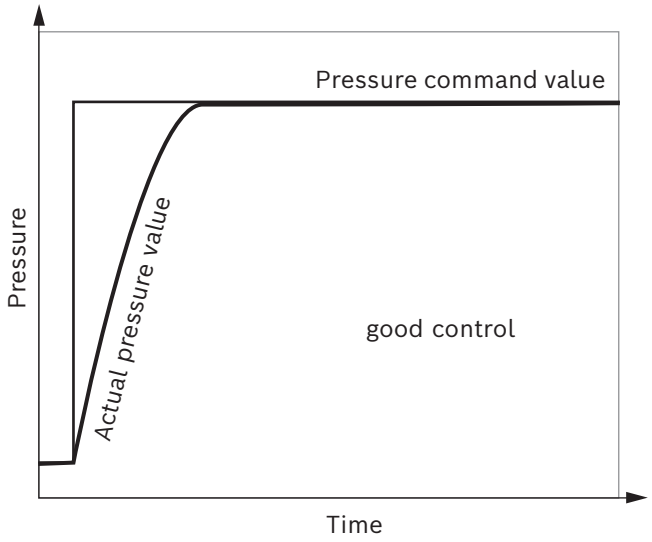


Fig. 31: Good control

If the control behavior is good, no further measures are required.

8.1.8 Calibrating the HS5E(V)(L) control system

With regular calibration, the calibration functions of the HS5E(V)(L) control system make it possible to achieve consistent system behavior by compensating long-term drifts.

You can only carry out the points below in conjunction with a pressure sensor.
Provision by customer or order of an HS5E(V)(L)**P** control system.
We recommend calibrating the HS5E(V)(L) control system in the following order:

1. Calibration of pressure transducer 1 and 2 or **A** and **B**, if required
2. Calibration of the valve offset
3. Calibration of the swivel angle sensor's offset
4. Calibration of the swivel angle sensor's gain
5. Calibration of leakage compensation

You can find further information about configuring and controlling the calibration functions in the functional description of the HydraulicDrive firmware (data sheet 30330-RN).

The individual calibration functions can be started via IndraWorks and the "Pump controller calibration" dialog.

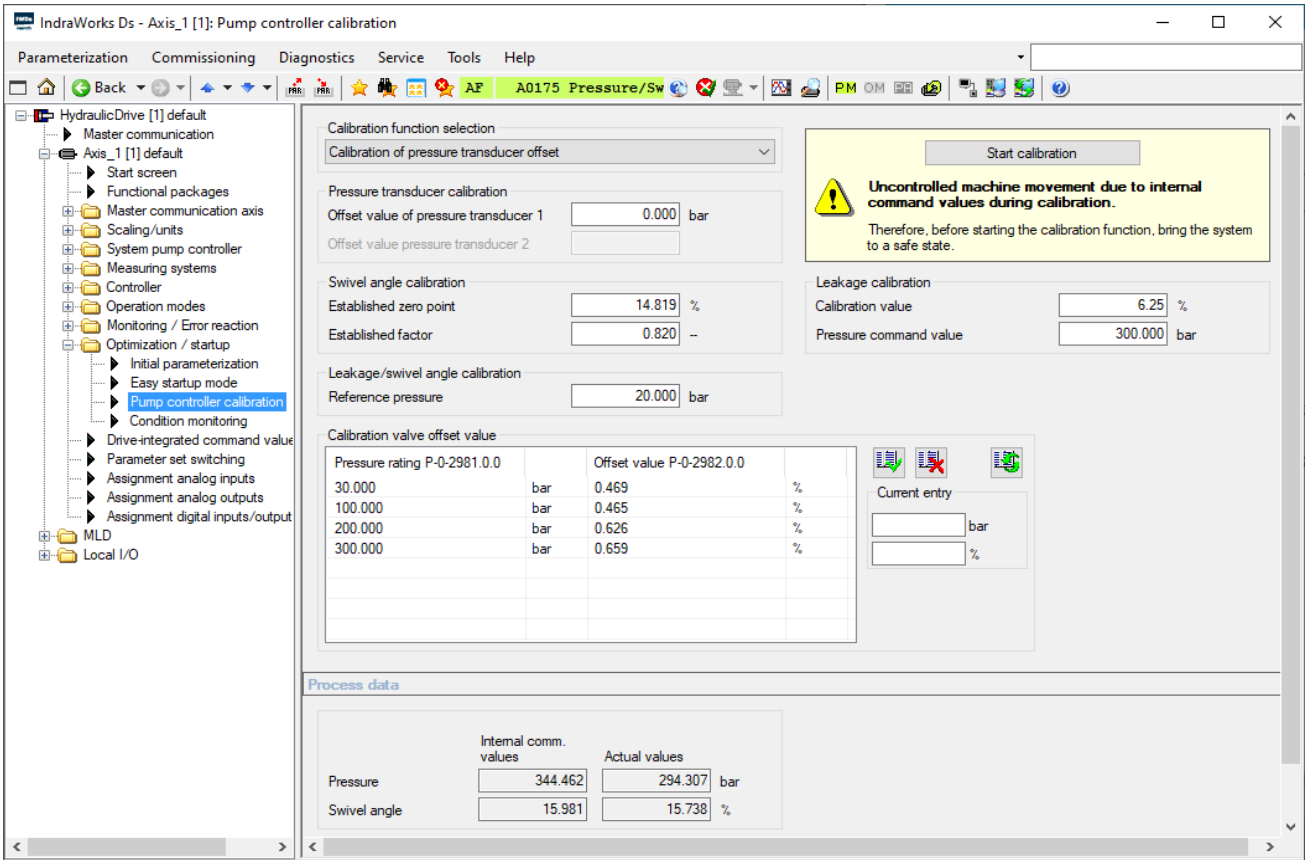


Fig. 32: Calibration

For calibrating the HS5E(V)(L) control system, the hydraulic fluid must have reached operating temperature.

Attention: the calibration function of the swivel angle zero point does not ensure that the pressure in **A** and **B** is reached in the closed circuit at 0% swivel angle specification.
If this is desired, the swivel angle zero point has to be readjusted manually.

8.1.9 Saving parameters

After carrying out commissioning, you should save the parameter set of the HS5E pilot control valve. If an error occurs, this is the only way to restore the parameters or transfer them to a replacement valve.

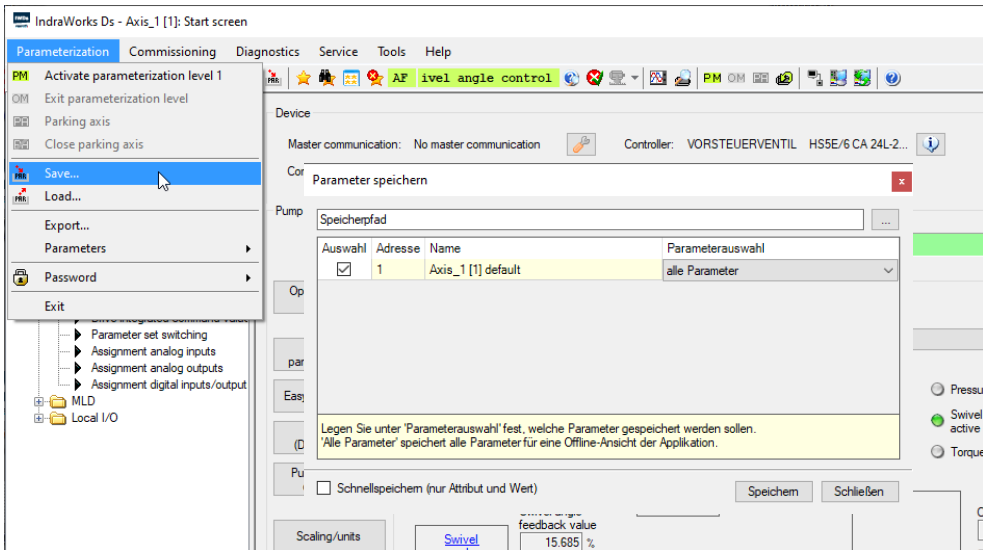


Fig. 33: Back-up of parameters

Please back up the parameters as follows

- Use the parameterization menu to select "Save"
- Select the memory path in the separately opened window and select and save "all parameters" under parameter selection.

8.2 Running-in phase

NOTICE

Property damage due to insufficient viscosity!

Elevated hydraulic fluid temperature may excessively reduce viscosity and damage the product!

- Monitor the operating temperature during the running-in phase, e.g. by measuring the leakage temperature.
- Reduce the loading (pressure, rotational speed) of the axial piston unit if unacceptable operating temperatures and/or viscosities occur.
- Excessively high operating temperatures indicate faults that have to be analyzed and eliminated.

The bearings and sliding surfaces are subject to a running-in phase. The increased friction at the start of the running-in phase results in increased heat development which decreases with increasing operating hours. Volumetric and mechanical-hydraulic efficiency is also greater until the running-in phase of about 10 operating hours is concluded.

To ensure that contamination in the hydraulic system does not damage the axial piston unit, Bosch Rexroth recommends the following procedure after the running-in phase:

- After the running-in phase, have a hydraulic fluid sample analyzed for the required cleanliness level.
- Change the hydraulic fluid if the required cleanliness level is not reached.
  If a laboratory test is not carried out after the running-in phase, it is recommended to change the hydraulic fluid.

8.3 Recommissioning after standstill

Depending on the installation conditions and ambient conditions, changes may occur in the system which make recommissioning necessary.
The following criteria may make recommissioning necessary:
• Air in the hydraulic system
• Water in the hydraulic system
• Old hydraulic fluid
• Other contamination

- For recommissioning, proceed as described in chapter 8.1 "Initial commissioning" on page 65.

9 Operation

This product is a component which requires no settings or changes during operation. For this reason, this chapter of the manual does not contain any information on adjustment options. Use the product only within the performance range specified in the technical data. The machine/system manufacturer is responsible for proper project planning of the hydraulic system and its control.

10 Maintenance and repair

NOTICE

Overdue inspection and maintenance work!
Property damage!
- Perform the specified inspection and maintenance work at the intervals described in this manual.

10.1 Cleaning and care

NOTICE

Damage to seals and electrical system due to mechanical effects!
The jet of a high-pressure cleaner may damage the seals and electrical system of the axial piston unit!
- Do not point the high-pressure cleaner at sensitive components, e.g. shaft seal ring, electrical connections, and electrical components.

For cleaning and care of the axial piston unit, observe the following:
- Check whether all seals and plug-in connections are securely seated to ensure no moisture can penetrate into the axial piston unit during cleaning.
- Use only water and, if necessary, a mild cleaning agent to clean the axial piston unit. Never use solvents or aggressive cleaning agents.
- Remove major external contamination and keep clean sensitive and important components, such as solenoids, valves, indicators and sensors.

10.2 Inspection

In order to keep the axial piston unit running reliably for a long time, Bosch Rexroth recommends testing the hydraulic system and axial piston unit on a regular basis, and documenting and archiving the following operating conditions:

Table 24: Inspection schedule

Tasks to be performed		Interval
Hydraulic system	Check hydraulic fluid level in the reservoir.	Daily
	Check the operating temperature under comparable load condition at the drain port and in the reservoir.	Weekly
	Perform hydraulic fluid analysis: Viscosity, aging and contamination	Yearly or every 2000 operating hours (whichever occurs first)
	Check filter: The replacement interval may vary depending on the cleanliness of the hydraulic fluid. We recommend using a contamination indicator.	Yearly or every 1000 operating hours (whichever occurs first)
Axial piston unit	Check axial piston unit for leakage. Early detection of hydraulic fluid loss can help to find faults on the machine/system and rectify them. This is why Bosch Rexroth recommends always keeping the axial piston unit and system clean.	Daily
	Check axial piston unit for unusual noise development.	Daily
	Check mounting elements for tight seating. Check all fastening elements only when the hydraulic system is switched off, depressurized and cooled down.	Monthly

10.3 Maintenance

The axial piston unit is low-maintenance when used as intended.

The service life of the axial piston unit is heavily dependent on the quality of the hydraulic fluid. This is why we recommend changing the hydraulic fluid at least once per year or every 2000 operating hours (whichever occurs first), or having it analyzed by the hydraulic fluid manufacturer or a laboratory to determine its suitability for further use.

The service life of the axial piston unit is limited to the service life of the bearings used if the permissible operating parameters are observed. You can ask your local contact person about service life based on load cycle. You can find their contact information at

`www.boschrexroth.com/addresses`

Based on these parameters, a maintenance interval should be determined by the system manufacturer for the replacement of the bearings and included in the maintenance schedule of the hydraulic system.

10.4 Repair

Bosch Rexroth offers a comprehensive range of services for the repair of Rexroth axial piston units.
Repairs on the axial piston unit and its assembled parts should only be performed by service centers certified by Bosch Rexroth.

- Only use original spare parts from Rexroth to repair the Rexroth axial piston units, otherwise the functional reliability of the axial piston unit cannot be guaranteed, and the warranty will be voided.

In the event of questions regarding repair, contact your responsible Bosch Rexroth Service partner or the service department of the manufacturer's plant for the axial piston unit, see chapter 10.5 "Spare parts" for further information.

10.5 Spare parts

⚠ CAUTION

Use of unsuitable spare parts!
Spare parts that do not meet the technical requirements specified by Bosch Rexroth can cause injury and property damage!

- Only use original spare parts from Rexroth to repair the Rexroth axial piston units, otherwise the functional reliability of the axial piston unit cannot be guaranteed, and the warranty will be voided.

The spare parts lists for axial piston units are order-specific. When ordering spare parts, specify the material and serial number of the axial piston unit as well as the material numbers of the spare parts.
Address all questions regarding spare parts to your proper Bosch Rexroth Service partner or the service department of the manufacturer's plant of the axial piston unit.

Bosch Rexroth AG
An den Kelterwiesen 14
72160 Horb a.N., Germany
Hotline +49 9352 405060

Spare parts can be found online at `www.boschrexroth.com/eshop`

For general inquiries, please contact your local contact person. You can find their contact information at
`www.boschrexroth.com/addresses`

10.5.1 Replacement of components

The replacement of some components of the HS5E(V)(L) control systems is described in the following.

Swivel angle sensor VT-SWA-LIN-...-G15 for HS5E(V) control systems

General
The product is a sensitive component and must therefore be handled with care. You must not subject the product to hard impacts and keep it away from magnetic parts! Until it has been installed in the pump housing, the original packaging is the safest place to store it.

			Size
ASSEMBLY KIT	VT-SWA-LIN-1X/G15-1-C20	R901425681	40; 125; 180
ASSEMBLY KIT	VT-SWA-LIN-1X/G15-2-C20	R901425682	71
ASSEMBLY KIT	VT-SWA-LIN-1X/G15-3-C20	R901425683	250 and larger

Assembling the VT-SWA-LIN-...-G15 swivel angle sensor

- Tighten the sensor to 25 $+^{5}$ Nm (WAF 27).
- Tighten the sensor cable on the pilot control valve to 0.6 ±6% Nm.
- Calibrate the swivel angle offset and factor according to chapter 8.1.8 "Calibrating the HS5E(V)(L) control system" on page 80.

Seal kits for the pump

By quoting the Mat. No. of the pump, you can get seal kits that are either matched to specific individual components or are a complete package.

HS5E pilot control valve

The HS5E pilot control valve is a component that is sensitive to contamination. When replacing it, make sure that no contaminants enter fluid-carrying parts of the valve and the pump.

Before replacing the new control valve, Bosch Rexroth recommends saving the parameters of the valve to be replaced and to transfer the data to the replacement valve. See also chapter 8.1.9 "Saving parameters" on page 82

With replacement valves, no matching data for the current control system is stored.

Load basic parameters

When the Load basic parameters command is executed, the current data that matches the control system is lost.

Before doing this, back up the parameters as described in chapter 8.1.9 "Saving parameters" on page 82.

To exchange the HS5E pilot control valve, loosen the 4 mounting screws of the HS5E pilot control valve. Lift off the HS5E pilot control valve and check and clean the sealing surface. Check the HS5E pilot control valve for correct seat of the O-rings and attach the HS5E pilot control valve onto the sealing surface correctly positioned and carefully. Insert the mounting bolts and tighten the mounting bolts to a tightening torque of 9 ±1.8 Nm. The exchanged HS5E pilot control valve must be adjusted according to the HS5E(V)(L) control system:

- Carry out the parameterization of the HS5E pilot control valve according to the description in chapter 8.1.5 "Making the basic setting on the control electronics" on page 68.
- Carry out calibration according to the description in chapter 8.1.8 "Calibrating the HS5E(V)(L) control system" on page 80.

HS5E pilot control valve	HS5E/6 CA 24L-2X/VH0/24MD7G	< size 250	R901448624
HS5E pilot control valve	HS5E/6 CA 40L-2X/VH0/24MD7G	≥ size 250	R901448627

For HFC hydraulic fluids

HS5E pilot control valve	HS5E/6 CA 24L-2X/MH0/24MD7G	< size 250	R901467728
HS5E pilot control valve	HS5E/6 CA 40L-2X/MH0/24MD7G	≥ size 250	R901467727

Pressure transducer HM20-2X

Undo the electric connection at the pressure transducer's connector. Replace the pressure transducer by unscrewing the old pressure transducer and screwing in the new one. Tighten the pressure transducer to a maximum torque of 20 to 25 Nm. Re-connect the electric connection of the pressure transducer.
Tighten the M12 cable connections to 0.6 $^{\pm 6\%}$ Nm.

You can obtain appropriate installation keys for low-torque ranges like this from manufacturers like the Murr company, for example.

Table 25: Rexroth part number of cable set

Rexroth part number	Cable set	Cable length [cm]
R901472424	7000-40501-2410060	60
R901472416	7000-40501-2410070	70
R901472425	7000-40501-2410080	80
R901472418	7000-40501-2410090	90
R901464411	7000-40501-2410100	100
R901472426	7000-40501-2410110	110
R901472420	7000-40501-2410120	120

Please contact us to select the appropriate cable.

Due to the setting behavior of the seal in the distributor or socket, you can tighten the round connector after a short time.
This time is already taken into account in the defined tightening torque!
If used properly, the IP 67 degree of protection is guaranteed without retightening.
One-off retightening is possible. However, it is advisable not to retighten the plug-in connection on a regular basis, since this affects the electrical properties of the seal and its correct function.

11 Removal and replacement

11.1 Required tools

Removal can be performed using standard tools. No special tools are necessary.

11.2 Preparing for removal

1. Decommission the relevant system part as described in the instruction manual for the machine or system.
   - Relieve pressure in the hydraulic system according to the instructions of the machine or system manufacturer.
   - Make sure the relevant system components are depressurized and de-energized.
2. Secure the relevant system part against reactivation.

11.3 Performing the removal

Proceed as follows to remove the axial piston unit:

1. Make sure you have the appropriate tools and wear personal protective equipment.
2. Allow the axial piston unit to cool down until it can be removed without danger.
3. For below-reservoir installation, before removing the axial piston unit, seal the connection to the reservoir and/or drain the reservoir.
4. Place a drip tray under the axial piston unit to collect any hydraulic fluid that may leak.
5. Diskonnect the lines and collect the escaping hydraulic fluid in the drip tray.
6. Remove the axial piston unit. Use a suitable lifting device.
7. Completely drain the axial piston unit.
8. Plug all openings.

11.4 Preparing the components for storage or further use

▶ Proceed as described in chapter 6.2 "Storing the axial piston unit" on page 40.

12 Disposal

Careless disposal of the axial piston unit, the hydraulic fluid and the packaging material can result in environmental pollution.
Observe the following when disposing of the axial piston unit:

1. Completely drain the axial piston unit.
2. Dispose of the axial piston unit and packaging material in accordance with the regulations in your country.
3. Dispose of the hydraulic fluid in accordance with the regulations of your country. Also observe the applicable safety data sheet for the hydraulic fluid.
4. Disassemble the axial piston unit into its constituent parts for proper recycling.
5. For example, separate the parts into:
   - Castings
   - Steel
   - Aluminum
   - Non-ferrous metal
   - Electronic waste
   - Plastic
   - Seals

13 Extension and conversion

Do not modify the axial piston unit and/or its assembled parts. Unauthorized conversions may cause malfunctions of the control and adjustment system or to failure of the axial piston unit.
This also includes changing the settings, the wiring or the software.
Changes to settings on the customer side should only be made using the product-specific setting instructions.

The warranty from Bosch Rexroth only applies to the configuration as delivered. Any modification, extension or software customization voids the warranty.

Setting screws are protected against unauthorized adjustment by tamper-proof caps. Removal of the tamper-proof cap will void the warranty. If you need to change the settings, please contact your local contact person; you can find their contact information at
`www.boschrexroth.com/addresses`.

14 Troubleshooting

Table 27 may assist you in troubleshooting. This table is not exhaustive.
Issues may occur in practice that are not listed here.
Only authorized personnel may perform troubleshooting inside a safety area designated by the machine manufacturer.

14.1 How to proceed for troubleshooting

- Perform troubleshooting if possible with reduced operating data (e.g. slowly swinging in or out and slow pressure increase).
- Use a systematic and targeted approach, even when pressed for time. Random, indiskriminate removal and changing of settings could make it impossible to determine the original cause of the fault.
- First get a general idea of how your product functions in conjunction with the entire system.
- Try to find out whether or not the product was functioning properly in conjunction with the entire system before the fault occurred.
- Try to determine any changes to the entire system in which the product is installed:
  - Have there been any changes to the application conditions or operating range of the product?
  - Has maintenance work recently been carried out? Is there an inspection or maintenance log?
  - Have any changes (e.g. upgrades) or repairs been made to the overall system (machine/system, electrics, control) or to the product? If yes: What changes?
  - Has the hydraulic fluid been changed?
  - Has the product or machine been used as intended?
  - How does the malfunction appear?
- Try to get a clear idea of the cause of the fault. Directly ask the (machine) operator.
- Document the work carried out.
- If the fault cannot be corrected, please refer to one of the contract addresses at:
  www.boschrexroth.com/addresses.

14.2 Error/diagnosis memory

For diagnosis purposes, the HS5E(V)(L) control system is fitted with an internal error and diagnosis memory. To open the error memory, select **"Diagnosis"** → **"Diagnosis memory".**

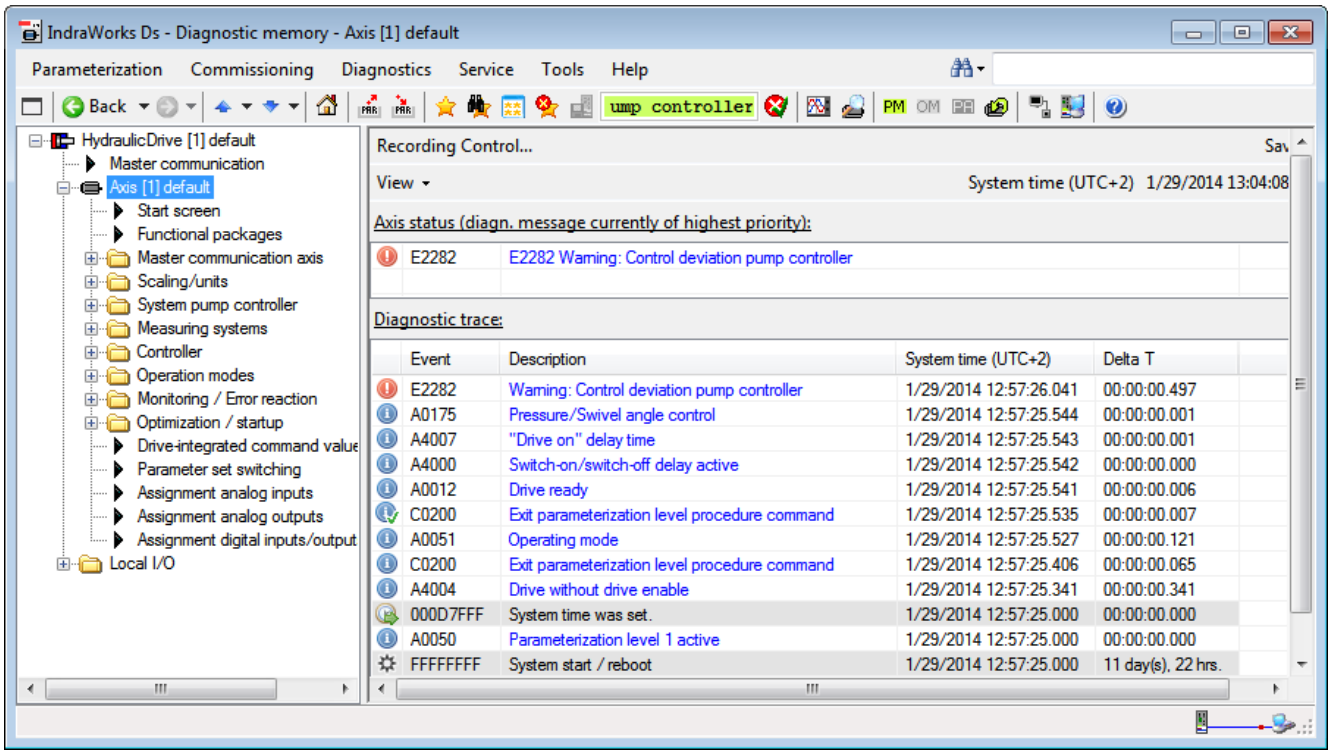


Fig. 34: Error/diagnosis memory

14.2.1 Fault diagnosis

At pin 3 of the central connector the signal "drive ready" can be output. For this, the factory assignment of the digital output to parameter P-0-0115, bit 1 must be activated. This signal can be used to find out whether control is active and that no fault message is present. Should a fault message occur during operation or the controller enable be withdrawn, this bit is set to 0.
Here, the following applies:

Table 26: Messages

Meaning of the message	Output signal at pin 3
Electronics OK	24 V
Fault message present or no controller enable set	0 V

14.3 Malfunction table

Table 27: Axial piston unit malfunction table

Malfunction	Possible cause	Remedy
Unusual noises	Insufficient air bleeding of the hydraulic system	Fill the axial piston unit, suction line for the hydraulic pump and the reservoir
		Completely air bleed the axial piston unit and hydraulic system
		Check correct installation position
	Insufficient suction conditions, e.g. insufficient dimensioning of the suction line, viscosity of the hydraulic fluid too high, suction height too high, suction pressure too low, foreign particles in the suction line, impermissible filter in the suction line	Machine/system manufacturer: Check the system, e.g. optimize inlet conditions, use suitable hydraulic fluid
		Fill the suction line with hydraulic fluid
		Remove foreign particles from the suction line
	Drive speed too high	Machine/system manufacturer: Reduce drive speed
	Wrong direction of rotation	Machine/system manufacturer: Check correct direction of rotation, see chapter 7.4.1 "Preparation" on page 45
	Improper mounting of the axial piston unit	Check the mounting of the axial piston unit according to the specifications of the machine/system manufacturer – observe tightening torques
	Improper mounting of assembled parts, hydraulic lines or improper installation of the coupling	Fasten assembled parts according to the parameters provided by the coupling fitting manufacturer
	Valve and controller vibrate	Optimize the adjustment of the controller of the axial piston unit and the pressure limitation in the hydraulic system
	Mechanical damage to the axial piston unit (e.g. bearing damage)	Replace axial piston unit
		Contact Bosch Rexroth Service
Increased, unusual vibration	Bearings worn	Contact Bosch Rexroth Service

Table 27: Axial piston unit malfunction table

Malfunction	Possible cause	Remedy
No or insufficient flow	Insufficient air bleeding of the hydraulic system	Fill the axial piston unit, suction line for the hydraulic pump and the reservoir
		Completely air bleed the axial piston unit and hydraulic system
	Faulty mechanical drive (e.g. defective coupling)	Contact machine/system manufacturer
	Drive speed too low	Contact machine/system manufacturer
	Insufficient suction conditions, e.g. insufficient dimensioning of the suction line, viscosity of the hydraulic fluid too high, suction height too high, suction pressure too low, foreign particles in the suction line, impermissible filter in the suction line	Machine/system manufacturer: Check the system, e.g. optimize inlet conditions, use suitable hydraulic fluid
		Fill the suction line with hydraulic fluid
		Remove foreign particles from the suction line
	Hydraulic fluid not in optimal viscosity range	Machine/system manufacturer: Check temperature range and use suitable hydraulic fluid
	Insufficient pilot pressure or control pressure	Check pilot pressure or control pressure
		Contact Bosch Rexroth Service
	Malfunction of the control device or controller of the axial piston unit	Contact Bosch Rexroth Service
	Control of the control device defective	Check control (contact machine/system manufacturer or Bosch Rexroth Service)
	Wear or mechanical damage to the axial piston unit	Replace axial piston unit
		Contact Bosch Rexroth Service

Table 27: Axial piston unit malfunction table

Malfunction	Possible cause	Remedy
No or insufficient pressure	Insufficient air bleeding of the hydraulic system	Fill the axial piston unit, suction line for the hydraulic pump and the reservoir
		Completely air bleed the axial piston unit and hydraulic system
		Check correct installation position
	Faulty mechanical drive (e.g. defective coupling)	Contact machine/system manufacturer
	Drive power too low	Contact machine/system manufacturer
	Insufficient suction conditions, e.g. insufficient dimensioning of the suction line, viscosity of the hydraulic fluid too high, suction height too high, suction pressure too low, foreign particles in the suction line, impermissible filter in the suction line	Machine/system manufacturer: Check the system, e.g. optimize inlet conditions, use suitable hydraulic fluid
		Fill the suction line with hydraulic fluid
		Remove foreign particles from the suction line
	Hydraulic fluid not in optimal viscosity range	Machine/system manufacturer: Check temperature range and use suitable hydraulic fluid
	Insufficient pilot pressure or control pressure	Check pilot pressure or control pressure
		Contact Bosch Rexroth Service
	Malfunction of the control device or controller of the axial piston unit	Contact Bosch Rexroth Service
	Control of the control device defective	Check control (contact machine/system manufacturer or Bosch Rexroth Service)
	Wear or mechanical damage to the axial piston unit	Replace axial piston unit
		Contact Bosch Rexroth Service
	Output unit defective (e.g. hydraulic motor or cylinder)	Contact machine/system manufacturer
Pressure/flow fluctuations/ instabilities	Insufficient air bleeding of the hydraulic system	Fill the axial piston unit, suction line for the hydraulic pump and the reservoir
		Completely air bleed the axial piston unit and hydraulic system
		Check correct installation position
	Insufficient suction conditions, e.g. insufficient dimensioning of the suction line, viscosity of the hydraulic fluid too high, suction height too high, suction pressure too low, foreign particles in the suction line, impermissible filter in the suction line	Machine/system manufacturer: Check the system, e.g. optimize inlet conditions, use suitable hydraulic fluid
		Fill the suction line with hydraulic fluid
		Remove foreign particles from the suction line
	Valve and controller vibrate	Optimize the adjustment of the controller of the axial piston unit and the pressure limitation in the hydraulic system
	Unstable control signal	Contact machine/system manufacturer or Bosch Rexroth Service
	Malfunction in the control devices or the controller	Contact Bosch Rexroth Service

Table 27: Axial piston unit malfunction table

Malfunction	Possible cause	Remedy
Excessively high temperature of hydraulic fluid and housing	Excessively high inlet temperature at the axial piston unit	Machine/system manufacturer: Inspect system, e.g. malfunction in the cooler, insufficient hydraulic fluid in the reservoir
	Wrong setting and/or malfunction of the pressure limitation and pressure control valves (e.g pressure controller)	Optimize the adjustment of the pressure limitation and pressure control valves of the axial piston unit and the pressure safeguarding in the hydraulic system
		Contact Bosch Rexroth Service
		Contact machine/system manufacturer
	Axial piston unit worn	Replace axial piston unit; contact Bosch Rexroth Service

Table 28: Malfunction table of HS5E control systems

Malfunction	Possible cause	Remedy
Message "analog input, wire break" at actual pressure value input	Actual pressure value of the relevant pressure transducer fell below or exceeded the limit value, that is, the value is outside the permissible measuring range of the A/D converter.	Test actual pressure value signal (wire rupture, working range, signal type, polarity).
Message "Wire rupture of swivel angle sensor"	Defective swivel angle sensor cable (visual inspection)	Replace swivel angle sensor
	Defective swivel angle sensor	Replace swivel angle sensor
	Internal electronics fault	Have the HS5E pilot control valve repaired by the Rexroth Service or replace the HS5E pilot control valve
Message "Valve error pump controller" (deviation between command and actual position of the valve spool)	Valve spool jams due to contamination	Replace the HS5E pilot control valve, see chapter 10.5.1 on page 87
	Internal electronics fault	Replace the HS5E pilot control valve, see chapter 10.5.1 on page 87
Message "Control deviation pump controller"	Backpressure cannot be built up (minimum pressure at the pump 8...10 bar)	Check that the hydraulic system is leak-free and that the withdrawal is not excessively high
	Drive motor switched off or rotational speed too low	Check electrical control and motor control
	Valve spool does not move as a result of electronics fault	Replace the HS5E pilot control valve, see chapter 10.5.1 on page 87
	Valve spool jams due to contamination	Replace the HS5E pilot control valve, see chapter 10.5.1 on page 87
Start-up of the drive to the "Ready for operation" operating condition e.g. with current signal 4...20 mA not possible	Inputs at the central connector are configured as current interface via IndraWorks	Analog inputs at the central connector must not be configured as a current interface.

Table 28: Malfunction table of HS5E control systems

Malfunction	Possible cause	Remedy
Humming noise in the pressure control or pressure/flow fluctuations	Air pocket around the sensor	Bleed control system, pump (see 8, on page 63) and pipes completely
	Problem with the cable shield	Connect shield to ground
	Incorrect protective earth connection in the control cabinet	Properly connect protective earth connector
	No connection from M0 to L0	Connect M0 (XH4, pin 4) and L0 (XH4, pin 2) in the control cabinet
	Unfavorable place of installation/mounting technique for the pressure transducer	Change installation location (e.g. suspended mounting, no Minimess line, no throttling point between pump and pressure transducer), see page 44
	Improperly high gain of the actual pressure controller	Reduce P-gain, see chapter 8.1.7.2 on page 76
Screaming noise	Oil level in the reservoir too low; pump partly aspires air	Top up oil
	Pump draws in air	Change routing of the suction line
	Suction line leaky	Seal suction line
	Pump cavitates when pressure is reduced Diagnosis: Measure, whether the pressure in the pressure line overshoots	Optimize controller, reduce the command value via a ramp or in steps
	Fluid in the reservoir is mixed with air; cooling and/or filtration circuit leaky	sealing
Other unusual noise	Drive speed too high	Machine or system manufacturer
	Wrong direction of rotation	Machine or system manufacturer
	Inadequate suction conditions, e.g. air in the suction line, insufficient diameter of the suction line, viscosity of the hydraulic fluid too high, suction height too high, suction pressure too low, foreign particles in the suction line	Check whether shut-off valves are open
		Machine or system manufacturer (e.g. optimize inlet conditions, use suitable hydraulic fluid)
		Completely air bleed the control system, fill suction line with hydraulic fluid
		Remove foreign particles from the suction line
	Incorrect mounting of the control system	Check mounting of the control system according to the specifications of the machine or system manufacturer. Observe tightening torques
	Incorrect mounting of the assembled parts, e.g. coupling and hydraulic lines	Fasten assembled parts according to the parameters provided by the coupling fitting manufacturer
	Air in the pump or in the preload valve	Bleed pump and preload valve
	Wear/mechanical damage to the control system	Replace the control system, contact Rexroth Service
No or insufficient pressure (< 4 bar)	Faulty mechanical drive (e.g. defective coupling)	Machine or system manufacturer
	Hydraulic fluid not in optimal viscosity range	Use suitable hydraulic fluid (machine or system manufacturer)
	Output unit defective (e.g. hydraulic motor or cylinder)	Machine or system manufacturer
	Wear/mechanical damage	Replace the control system, contact Rexroth Service

Table 28: Malfunction table of HS5E control systems

Malfunction	Possible cause	Remedy
Pressure statically at approx 5...12 bar, cannot be changed	Supply voltage not within the permissible range Diagnosis: Check the status LEDs	Check, whether the central connector XH4 is connected to the HS5E pilot control valve
		Check voltage at the last interconnection point (terminal strip) upstream the HS5E pilot control valve
	Command value for pressure, swivel angle or power (optional) is 0 bar or 0%, respectively	If you use, for example, exclusively closed-loop pressure control, provide a swivel angle command value of 100%
	Swivel angle sensor defective	Check swivel angle measurement, see chapter 8.1.5.4 on page 73
	Piston is stuck in the HS5E pilot control valve	Contact Rexroth Service
Pressure too low	Actual pressure value acquisition incorrectly configured	Check actual pressure value in IndraWorks and, if required, correct configuration of actual pressure value acquisition
		Replace pressure transducer, see page 89
		Change installation location of the pressure transducer (do not install upstream of the preload valve; if possible, close to the consumer)
	Pressure transducer defective/not connected Diagnosis: Measure signal from PT and compare with indication on the pressure gauge	Replace pressure transducer, see page 89 Connect pressure transducer
	Control system does not work in closed-loop pressure control	Increase swivel angle command value
		Check that the hydraulic system is leak-free and that the withdrawal is not excessively high
	HS5E pilot control valve faulty	Replace the HS5E pilot control valve, see chapter 10.5.1 on page 87
Pressure too high	Actual pressure value acquisition incorrectly configured	Check actual pressure value in IndraWorks and, if required, correct configuration of actual pressure value acquisition
		Replace pressure transducer, see page 61
	Pressure transducer defective/not connected Diagnosis: Measure signal from PT and compare with indication on the pressure gauge	Replace pressure transducer, see page 61 Connect pressure transducer
	HS5E pilot control valve faulty	Replace the HS5E pilot control valve, see chapter 10.5.1 on page 87
Insufficient flow	Pressure controller active	Increase pressure command value
	Actual swivel angle acquisition improperly set	Recalibrate swivel angle sensor
	Rotational speed speed too low (slip, incorrect frequency, wrong motor)	Contact machine or system manufacturer
	Damage to the pump (excessive pump leakage)	Rotary group damaged, Contact Rexroth Service
	Wear/mechanical damage to the control system	Replace the control system, contact Rexroth Service

Table 28: Malfunction table of HS5E control systems

Malfunction	Possible cause	Remedy
Drive motor shuts down due to overloading	Excessive power consumption of the pump	Reduce torque limit
		Reduce swivel angle command value
		Check actual pressure value acquisition
	Overcurrent protection of motor does not work properly	Check setting and function
	Piston is stuck in the HS5E pilot control valve Diagnosis: Compare actual value and valve command value in IndraWorks	Replace the HS5E pilot control valve, see chapter 10.5.1 on page 87
	Actual swivel angle value acquisition maladjusted or not functioning properly	Swivel angle measurement check
	Valve electronics defective	Replace the HS5E pilot control valve, see chapter 10.5.1 on page 87
Hydraulic fluid temperature too high	Too high inlet temperature at control system	Inspect system, e.g. malfunction in the cooler, insufficient hydraulic fluid in the reservoir
	DB in preload valve opens Diagnosis: Pipe to the reservoir heats up	Pressure must be lower than the cracking pressure of the preload valve. Keep overshoots and pressure pulsation to a minimum
	Malfunction of the pressure control valves (e.g. high-pressure relief valve, pressure cut-off, pressure controller)	Contact Rexroth Service
	Control system worn out	Replace the control system, contact Rexroth Service
Setting of swivel angle sensor causes problems		For more information on this topic, refer to chapter 8.1.5.4
The connection to IndraWorks has failed; the row on the display is red.	Input error	Use 192.168.0.1 as the correct IP address

14.3.1 Swivel angle measurement check

The settings for swivel angle measurement are made at the factory. After you have replaced the swivel angle sensor, you must carry out calibration; see chapter 8.1.8 "Calibrating the HS5E(V)(L) control system" on page 80. Bosch Rexroth recommend repeating calibration or checking it at certain intervals.

15 Technical data

The permissible technical data for your axial piston unit can be found on the data sheet 92076.
The data sheet can be found on the Internet and/or in the online product catalog at:
www.boschrexroth.de/HS5E

Order-related technical data for your axial piston unit can be found in the order confirmation.

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