The Drive & Control Company

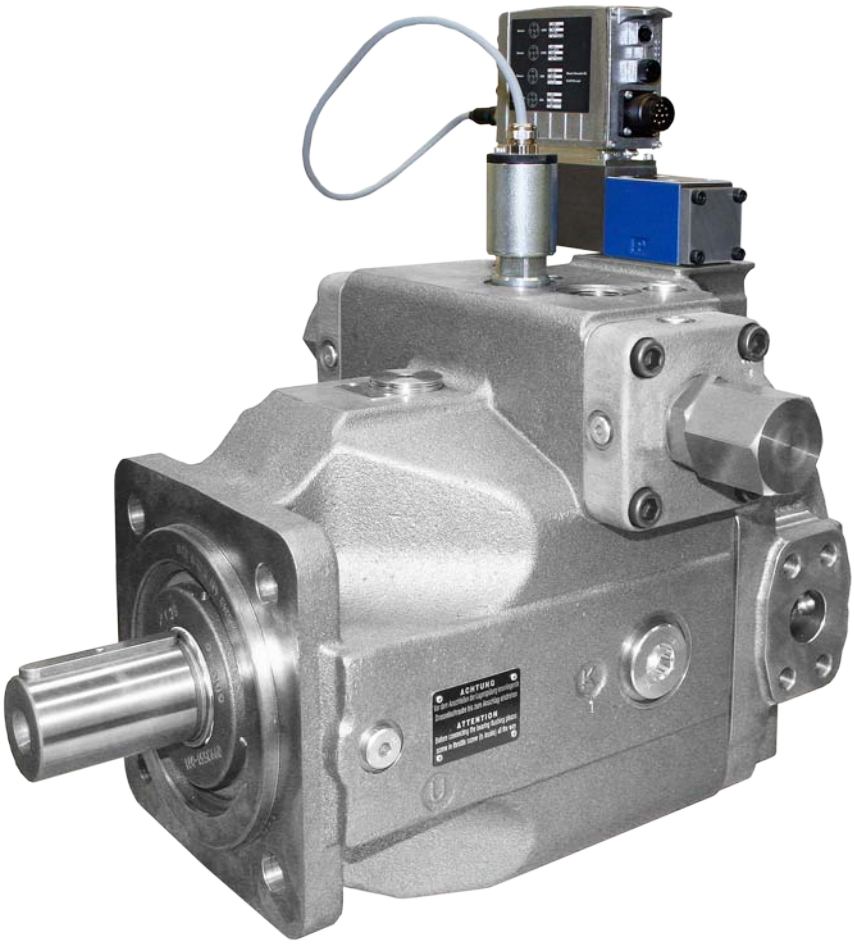
Rexroth
Bosch Group

Axial piston variable pump A4... with HS5E pilot control valve

Series 10, 11 and Series 3x

Instruction manual
RE 92076-01-B/10.2017

Replaces: –.–
English



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

The original instruction manual was created in the German language.

Contents

1 About this documentation

1.1 Validity of the documentation

This documentation is valid for axial piston units with an HS5E pilot control valve:

- 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 planning engineers, operators, machine/system manufacturers, assemblers, and service engineers.
This documentation contains important information on safe and proper transportation, installation, commissioning, operation, maintenance, removal, and simple troubleshooting of the A4... with HS5E pilot control valve.

- Read this documentation completely, in particular, chapter 2 “Safety instructions” on page 10 and chapter 3 “General instructions on damage to property and the product” on page 19, before you start work on the A4... with HS5E pilot control valve.

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 of your axial piston variable pump A4... with HS5E pilot control valve.	–	Order confirmation
🕮	**Installation drawing** Contains the outer dimensions, all ports and the hydraulic circuit diagram for your axial piston variable pump A4... with HS5E pilot control valve.	Please request the installation drawing from your contact at Bosch Rexroth.	Installation drawing
🕮	**Axial piston variable pump A4... with HS5E pilot control valve Series 3x** Contains the permissible technical data.	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.	92050 92100 92105 92122	Data sheet
🕮	**Axial piston variable pump A4VSO For HF 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
🕮	**Mineral oil-based hydraulic fluids and related hydrocarbons** Describes the requirements on a mineral oil-based hydraulic fluid and related hydrocarbons for operation with Rexroth hydraulic components, and assists you in selecting a hydraulic fluid for your 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
🕮	**General Instruction Manual for Axial Piston Units** Contains additional information on the use of Rexroth axial piston units.	90300-B	Instruction manual

Table 1: Required and supplementary documentation

	Title	Document number	Document type
🕮	**Instruction Manual for Axial Piston Unit A4VSO** Contains additional information on the use of Rexroth axial piston units.	92050-01-B	Instruction manual
🕮	**Instruction Manual for Axial Piston Unit A4VSG** Contains additional information on the use of Rexroth axial piston units.	92100-01-B	Instruction manual
🕮	**Instruction Manual for Axial Piston Unit A4VBO** Contains additional information on the use of Rexroth axial piston units.	92122-01-B	Instruction manual
🕮	**Information on the use of hydrostatic drives at low temperatures** Contains additional information on the use 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
🕮	Installation, commissioning and maintenance of hydraulic systems	07900	Data sheet
🕮	Rexroth HydraulicDrive functions (firmware and software descriptions)	30338-FK	Functional 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. To give you a better understanding they are explained in the sections below.

1.3.1 Safety instructions

This documentation includes safety instructions in chapter 2.6 “Product-specific safety instructions“ on page 14 and in chapter 3 “General instructions on damage to property and the product” on page 19 and before a sequence of actions or an instruction for action involving a risk of personal injury or damage to equipment. The described danger prevention measures must be observed.

Safety instructions are set out as follows:

⚠ SIGNAL WORD
Type and source of danger! Consequences of noncompliance ▶ Measures to prevent danger

- **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 the safety instructions are not complied with
- **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 injuries if it is not avoided.
⚠ WARNING	Identifies a dangerous situation that may result in death or serious injuries if it is not avoided.
⚠ CAUTION	Identifies a dangerous situation that may result in minor to moderate injuries if it is not avoided.
NOTICE	Property damage: The product or the environment may get damaged.

1.3.2 Symbols

The following symbols indicate information that is not safety-relevant but increases understanding of the documentation.

Table 3: Meaning of the symbols

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

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	Pilot control valve with **o**n **b**oard **e**lectronics
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

The designation "axial piston unit" will be used below as the umbrella term for “axial piston variable pump” A4... with HS5E pilot control valve.

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**compression **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	Swivel angle
SW_{act}	Swivel angle actual value
SW_{set}	Swivel angle command value
U_B	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 control system has been manufactured according to the generally accepted rules of current technology. There is, however, still a danger of personal injury or property damage if this chapter and the safety instructions in this documentation are not complied with.

- Read this documentation completely and thoroughly before working with the HS5E 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 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 may 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 for control of the electrohydraulic pressure and swivel angle of an axial piston variable pump.
Observe the technical data, operating conditions and performance limits as specified in the data sheet and order confirmation.
The HS5E control system is a piece of technical work equipment and it is not intended for personal use.
Intended use includes having read and understood this documentation completely, especially chapter 2 “Safety instructions” on page 10.
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 chapter “Electrical connection of the pilot valve” on page 96). Ensuring compliance with the limit values required by national regulations is the responsibility of the manufacturer of the system or machine.
• European countries: EU Directive 2014/30/EU (EMC Directive)
• USA: See the National Electrical Code (NEC), national organization of the manufacturers of electrical systems (NEMA) as well as regional building regulations.

- Comply with the technical data, the application and operating conditions, and the performance limits as specified in data sheet 92076 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 professional use and not for private use.

2.3 Improper use

Any use other than that described as intended use shall be considered as improper and is therefore impermissible.
Bosch Rexroth AG is not liable for damages resulting from improper use. The user shall bear all risks arising from improper use.
The following foreseeable faulty usages are also be considered to be improper (this list does not claim to be exhaustive):

- Use outside the operating parameters approved in the data sheet or 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 add-ons (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 from case pressure to ambient pressure of greater than 2 bar, whereby the ambient pressure must always be lower than the case pressure. Short-term pressure peaks (t < 0.1 s) of up to 4 bar are permitted. Beyond this, the maximum case pressure specified on the data sheet cannot 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 chapter "Electrical connection of the pilot valve" on page 96). Ensuring compliance with the limit values required by national regulations is the responsibility of the manufacturer of the system or machine. European countries: EU 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 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 basic mechanical, electrical and hydraulics expertise, as well as knowledge of the associated technical terms. For transporting and handling the product, additional knowledge is necessary with regard to working with lifting devices and their slings. 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 persons are those who can recognize possible dangers and take the appropriate safety measures due to their professional training, knowledge, and experience, as well as their understanding of the relevant regulations pertaining to

the work to be done. 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:
- Reading and fully understanding hydraulic circuit diagrams,
- especially fully understanding the relationships with regard to safety devices
- and understanding how hydraulic components work and are put together.

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

Bosch Rexroth offers training support for specialized fields. An overview of the training contents can be found online at: www.boschrexroth.com/training.

2.5 General safety instructions

- Observe the applicable accident prevention and environmental protection regulations.
- Observe the safety regulations and provisions 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.
- Persons who install, operate, remove or maintain Rexroth products may not be under the influence of alcohol, drugs or medication that may affect their reaction time.
- Only use genuine Rexroth accessories and spare parts to ensure there is no hazard to persons due to 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 injury to personnel or property damage. For this reason, only use the product in safety-relevant applications if this use is expressly specified and permitted in the product documentation, for example in explosion protection applications or in safety-related parts of a control system (functional safety).
- You may only commission the product if it has been determined that the end product (for example, machinery or 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 that these are properly implemented.
- Depending on the type of control used, electromagnetic effects can be produced when using solenoids. When a direct current is applied, solenoids do not cause electromagnetic interference nor is their operation impaired by electromagnetic

interference. Other behavior can result when a modulated direct current (e.g. PWM signal) is applied. Potential electromagnetic interference for persons (e.g. persons with a pacemaker) and other components must be tested by the machine manufacturer.

2.6 Product-specific safety instructions

The following safety instructions apply to chapters 3 to 11.

⚠ WARNING

Danger from excessively high pressure!

Risk of death or injury, or property damage!

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

Operating the unit above the permissible maximum 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 must only be made by Bosch Rexroth specialists.
- In addition, a pressure relief valve is required in the hydraulic system as a back-up. If the axial piston unit is equipped with a pressure cut-off and/or a pressure controller, this is not an adequate back-up against pressure overload.

Danger from suspended loads!

Risk of death or injury, or property damage!

Improper transportation may cause the axial piston unit to fall down and lead to injuries e.g. crushing or broken bones 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 put your hands under a suspended load.
- Make sure the unit remains stable during transport.
- Wear your personal protective equipment (e.g. safety goggles, safety gloves, suitable working clothes, safety shoes).
- Use suitable lifting devices for transportation.
- Observe the prescribed position of the lifting strap.
- Observe the national laws and regulations on work and health protection and transportation.

System/machine under pressure!

Danger to life or risk of injury, serious injuries when working on machines/systems not secured! Risk of property damage!

- Switch off the entire system and secure it against reconnection according to the parameters provided by the machine/system manufacturer.
- Make sure that all relevant components of the hydraulic system are depressurized. Follow the parameters given by the machine/system manufacturer.
- Note that the hydraulic system may still may be under pressure even after the pressure supply itself has been disconnected.
- Do not disconnect any line connections, ports and components as long as the hydraulic system is under pressure.

⚠ WARNING

Escaping oil mist!

Risk of explosion and fire, 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 that any escaped hydraulic fluid cannot be ignited, and to protect hose lines from premature aging.

Electrical voltage!

Risk of injury from electric shock or risk of property damage!

- Always set up the relevant part of the machine/system so that it is free of electrical voltage before you install the product or when connecting and disconnecting connectors. Protect the machine/system against being re-energized.

Danger from unforeseen 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 additional protective measures are necessary for the application on your machine in order to avoid unintentional actuation. If necessary, make sure that these are properly implemented.
- Wear suitable protective clothing.

Restriction of the control function!

Risk of injury or property damage!

Moving parts in control equipment (e.g. valve spools) can, under certain circumstances, get stuck in position as a result of 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 that remedial measures be taken on your machine in order to bring the driven consumer into a safe position (e.g. safe stop).
- If necessary, make sure that these are properly implemented.

⚠ CAUTION

High noise development during operation!
Risk of hearing damage or hearing loss!
The noise emission of axial piston units depends on, among other factors, rotational speed, working pressure and installation conditions. The sound pressure level may rise above 70 dB (A) in certain application conditions.

- Always wear hearing protection when in the vicinity of the operating axial piston unit.

Hot surfaces on the axial piston unit and HS5E control system!
Risk of burning!

- Allow the axial piston unit and the HS5E control system to cool down sufficiently before touching them.
- Wear heat-resistant protective clothing, e.g. gloves.

Improper routing of cables and lines!
Risk of stumbling and property damage! Improper routing of cables and lines can cause a risk of stumbling as well as damage to equipment and components, for example, tearing of lines and connectors.

- Always lay cables and lines in such a way that no one can trip over them, that they do not become kinked or twisted, do not rub on edges and do not run without adequate protection through sharp-edged ducts.

Contact with hydraulic fluid!
Risk of adverse health effects, e.g. eye injury, skin irritation, poisoning from inhalation!

- Avoid contact with hydraulic fluids.
- When working with hydraulic fluids, strictly observe the safety instructions provided by the lubricant manufacturer.
- Wear your personal protective equipment (e.g. safety goggles, safety gloves, suitable working clothes, safety shoes).
- Consult a doctor immediately if hydraulic fluid gets in your eyes or bloodstream, or is swallowed.

Escaping hydraulic fluid due to machine/system leakage!
Risk of burns and risk of injury due to escaping oil jet!

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

Danger from improper handling!
Risk of slipping! 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.

⚠ CAUTION

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 people. This means that you must ensure proper potential equalization by means of the existing pin assignment on the connector side.

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, connecting, and signal lines appropriately.
- Make sure that there is an adequate distance between the electronics, including the connecting 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 control system. Observe the safety regulations and provisions in your country.

All pieces of personal protective equipment must be intact.

3 General instructions on damage to property and the product

The following notes apply to chapters 3 to 7.

NOTICE

Danger from improper handling!

Product can get damaged!

- Do not expose the product to excessive mechanical loads.
- Never grab or climb onto the product.
- Do not place/lay 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 strike sealing surfaces (e.g. working ports).
- Leave the protective covers on the axial piston unit until you connect the lines.
- Disconnect all electrical connectors before electro-welding or painting operations.
- Make certain that the electronic components (e.g. sensors) do not become electrostatically charged (e.g. during painting operations).

Risk of property damage due to inadequate lubrication!

Damage or destruction of product possible!

- 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. Air inclusions in the forward drive shaft bearing are to be prevented, especially with the installation position “drive shaft upwards”.
- 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) or via the working line (gap leakage). This means the bearings are insufficiently lubricated when the system is turned on.
- Make sure that 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 of hydraulic fluids!

Product can get damaged!

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

Contamination of the hydraulic fluid!

The cleanliness of the hydraulic fluid has a considerable impact on the cleanliness and service life of the hydraulic system. Contamination of the hydraulic fluid can cause premature wear and malfunctions.

- Make sure that the working environment at the installation site is fully free of dust and foreign substances in order to prevent foreign particles, such as welding beads or metal cuttings, from getting into the hydraulic lines and causing product wear or malfunctions. The axial piston unit must be installed in a clean condition.
- Use only clean ports, hydraulic lines and assembled parts (e.g. measuring devices).
- No contamination may enter the ports when they are plugged.
- Before commissioning, make sure that all hydraulic connections are tight and that all of the seals and plug-in connections are installed correctly to ensure that they are leak proof and fluids and foreign particles are prevented from penetrating the product.
- Use a suitable filter system to filter hydraulic fluid during filling to minimize solid particle contamination and water in the hydraulic system.

Improper cleaning!

Product can get damaged!

- Plug all openings with the appropriate protection equipment in order to prevent cleaning agents from entering the hydraulic system.
- Never use solvents or corrosive 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 result in environmental pollution.

- Dispose of the axial piston unit, hydraulic fluid and packaging in accordance with the national 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 get 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. Hydraulic fluid can escape if leaks occur.

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

Escaping or spilling 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 the hydraulic fluid.
- Use an oil binding agent if hydraulic fluid is spilled.
- Observe the parameters in the safety data sheet for the hydraulic fluid and the specifications provided by the system manufacturer.

Danger from hot components!
Nearby products can become damaged! Components which heat up (e.g. solenoids) can cause damage to nearby products if they are too close during installation.

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

The warranty only applies to the delivered configuration.
The entitlement to warranty cover will be rendered void if the product is incorrectly installed, commissioned or operated, or if it is used or handled improperly.

4 Scope of delivery

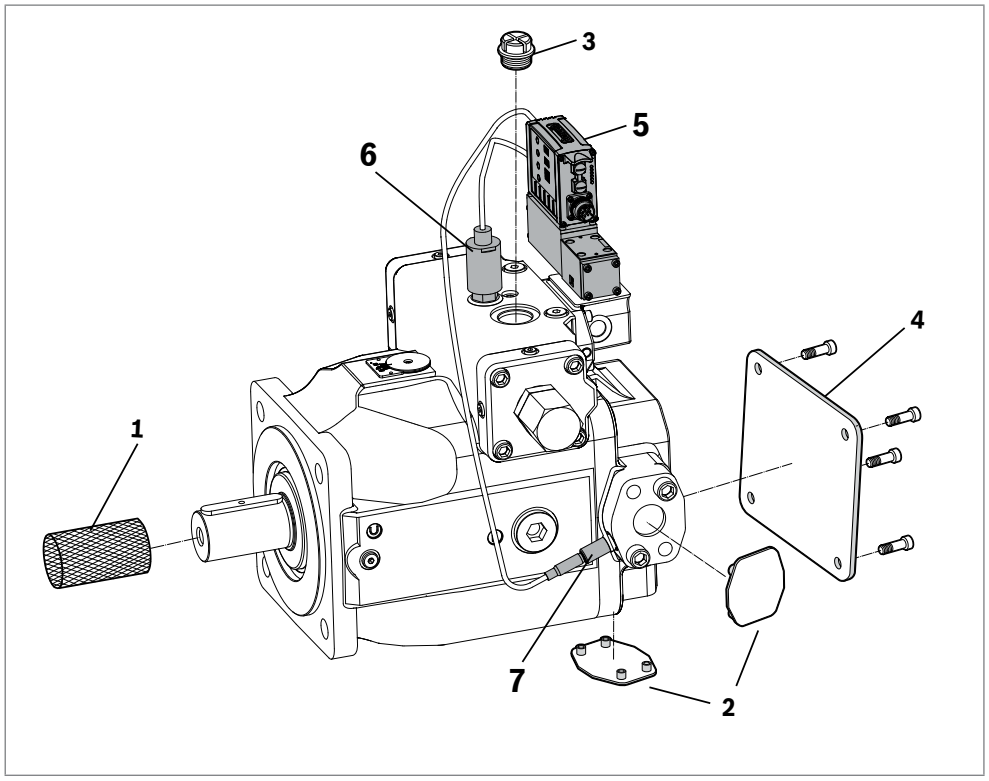


Fig. 1: Axial piston unit with HS5E(P) control system, clockwise rotation with through drive

The scope of delivery includes the following:
- Axial piston unit with HS5E(P) control system as per order confirmation

The following parts are also assembled prior to delivery:
- Transport protection of the drive shaft with keyed shafts (**1**)
- Protective covers (**2**)
- Protective plug/threaded plug (**3**)
- For version with optional through drive closed with fail-safe cover (**4**)
- HS5E pilot control valve (**5**)
- Swivel angle sensor (**6**)
- Pressure transducer plus cable (**7**) (with HS5E**P** only)

5 About this product

5.1 Performance description

The HS5E control system is used for electrohydraulic 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 and the order confirmation for the technical data, operating conditions and operating limits of the HS5E control system.

5.2 Unit description

The HS5E control system is based on an axial piston variable pump in swashplate design for hydrostatic drives in open circuit. The flow is proportional to the drive speed and the displacement. The flow can be infinitely varied by adjusting the swashplate angle.

Open circuit With an 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.

5.2.1 Layout of the axial piston unit

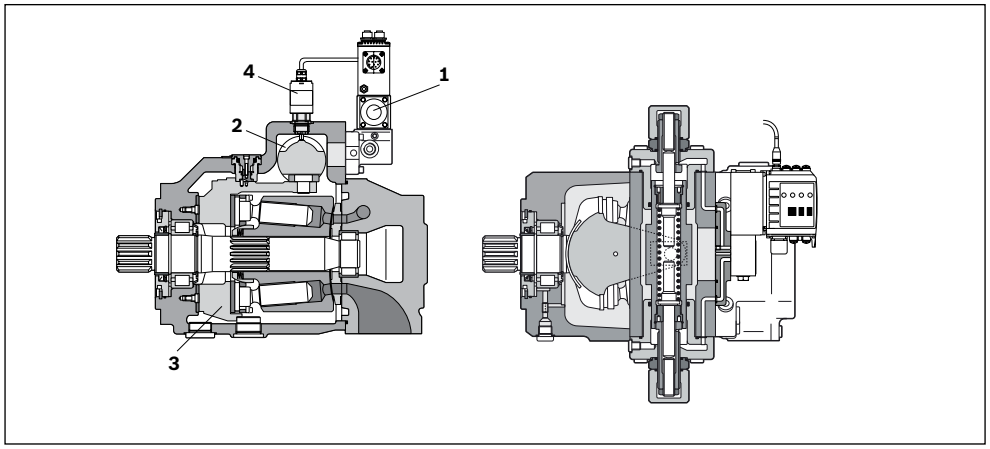


Fig. 2: Cutaway diagram of A4VSO....HS5E

1 HS5E control system
2 Stroking piston
3 Swashplate
4 Swivel angle sensor

5.2.2 Functional description

An electrically actuated proportional valve (**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 shows the A4VS... variable pump with HS5E control; the internal control electronics actuates the proportional valve (**1**).
Information about 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 to swivel angle α = 0% ($V_{g\,min}$)
– Standard version A4VSG to swivel angle α = –100%

5.3 Parallel and cascade control of the HS5E 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, you need two pressure sensors on the pump.

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 digital controller has four 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:

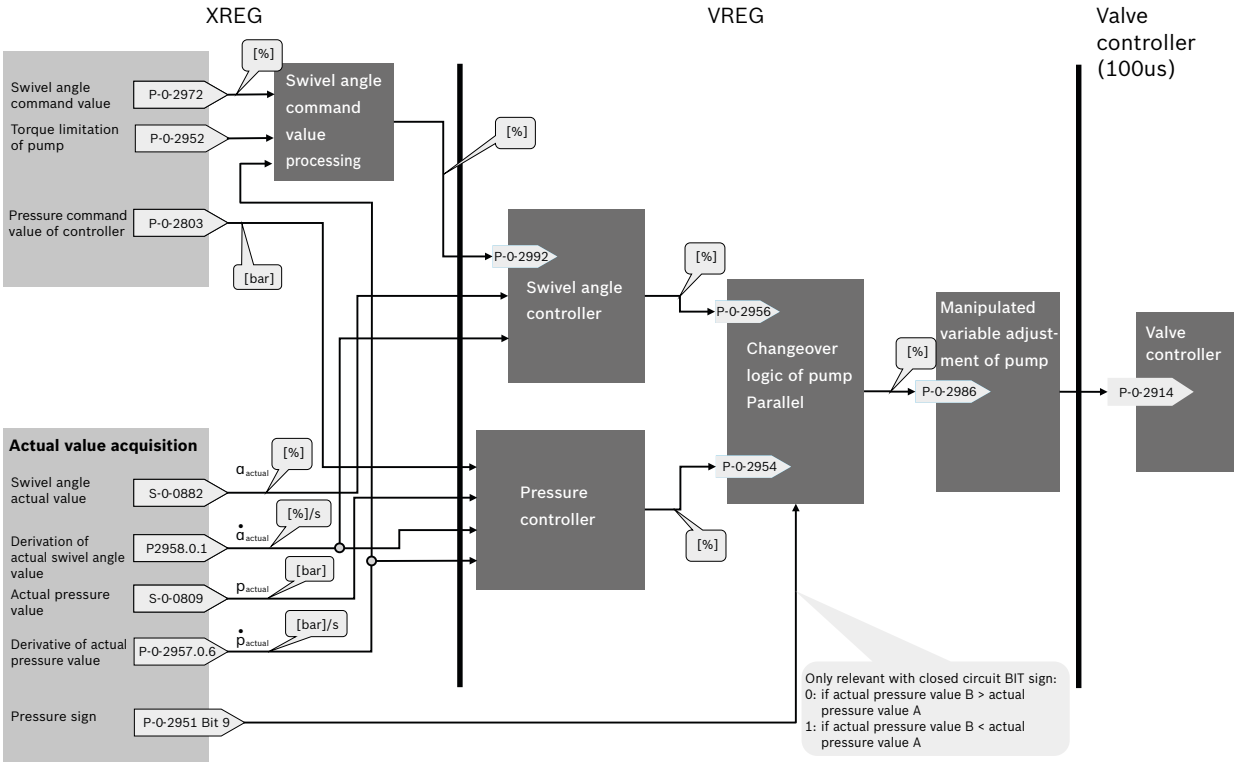


Fig. 3: Overview of controller parallel structure

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). 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 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:

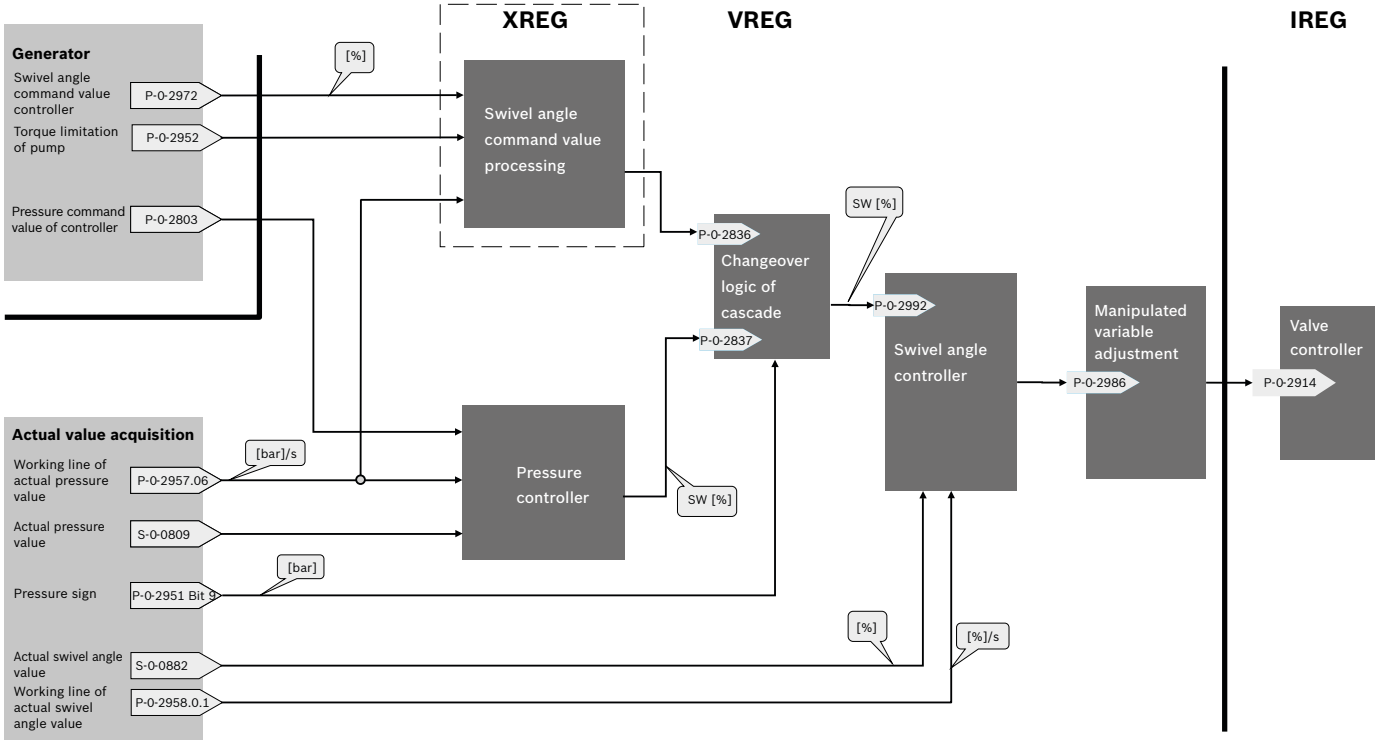


Fig. 4: Overview of controller cascade structure

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, 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 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

To start up the HS5E systems, 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.

Stand-by operation

Operating mode of the pump in which the system statically regulates an operating point by means of a corresponding command value. Pay attention to the information about permissible pressures in chapter 5.3.6 “Working pressure limits/external pilot oil” (page 27).

Behavior without drive enable

Operating mode of the pump with reference to the lowest achievable swivel angle, which does not generally come about on its own if active control is not active.

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

- If the hardware enable is canceled, the output stage of the electronics is de-energized.
  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 to swivel angle α = 0% ($V_{g\,min}$)
– Standard version A4VSG to swivel angle α = –100%

When the valve electronics are deenergized without control pressure via the spring-centering:

- The spring-centering of the pump control is standard. It is used for setting and adjustment in depressurized neutral position, but without defined reset during high-pressure operation. The spring-centering is not a safety device. To minimize control fluid consumption, the stroking chambers are sealed in the case of sizes 125 to 1000 and can be bled via ports R2 to R7.

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 pilot oil

With external pilot oil supply, the HS5E pump runs 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 ±100% with A4VSG (change of flow direction!)

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 to swivel angle α = 0% ($V_{g\,min}$)
– Standard version A4VSG 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 returns to the basic setting (standard version A4VSO to swivel angle α = 0% ($V_{g\,min}$) and standard version A4VSG 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 that these are properly implemented.

5.4 Ambient conditions

5.4.1 Oil-immersed applications

Only the HS5 control system is suitable for use in oil-immersed applications. Using HS5E systems with integrated electronics is not allowed here.

5.4.2 Ambient temperature

The maximum permissible ambient temperature range for HS5E control systems is -20 °C to +60 °C. It is crucial to pay attention to the information in the valid RE sheet for the HS5E control system.

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 selecting hydraulic fluids

The HS5E control system has been designed for the use of hydraulic fluids according to DIN 51 524 (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 HFCs with HS5E control systems that have the “F” option (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 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 (RE 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 noise 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

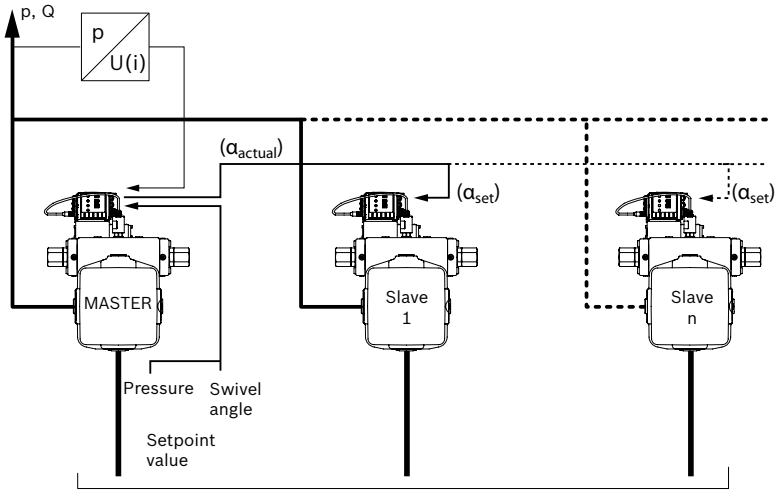


Fig. 5: Hydraulic coupling of HS5E control systems

In theory, you can hydraulically couple any HS5E 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.
Now, the master 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

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.

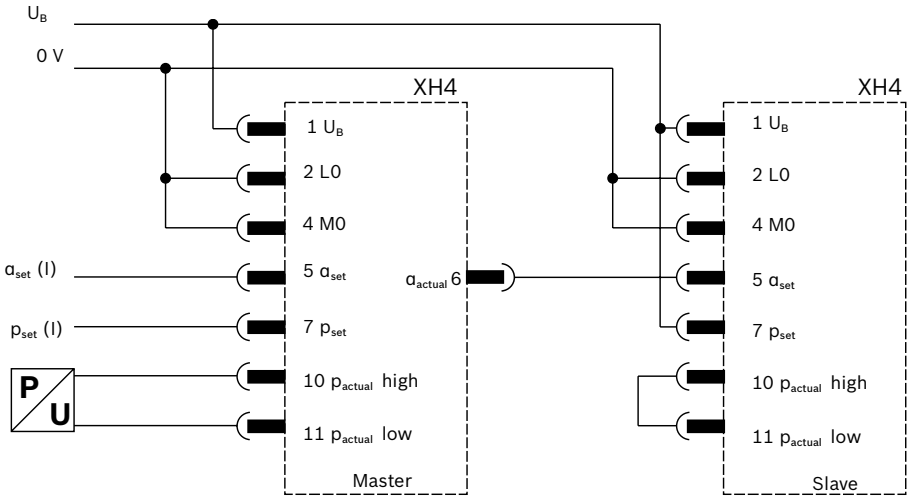


Fig. 6: Example of HS5E circuitry for (analog) master/slave operation

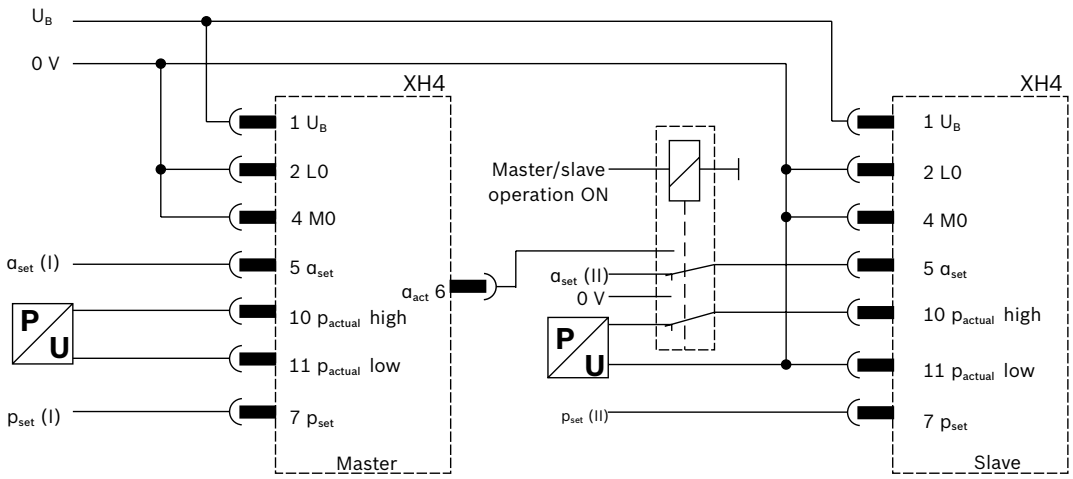


Fig. 7: Example of HS5E for (analog) master/slave operation and independent individual operation with possible alternatives

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 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 needed 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.

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 electronics 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 electronics 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 control system:

- Using the Bosch Rexroth's IndraWorks software. You must use IndraWorks version 14V14 or later for the HS5E system.

The IndraWorks Ds software is available for free on the Rexroth website in the "SYDFED" area; a dedicated HS5E page is in preparation.

`www.boschrexroth.de/sydfe->SYDFED`

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: (including temporary memory for installation)
- A DVD drive (when installing from DVD)
- Graphics resolution:
  - 800 x 600 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

- Microsoft Windows XP Professional with at least SP3 (32-bit or 64-bit version)
- Microsoft Windows 7 (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.

Rexroth provides the current firmware with project files in each case. You need firmware FWA-HYDRV-HDB....20V12 or higher.
You transfer new firmware to the control in menu item “Downloads” -> “Firmware Management”.

Current firmware projects are also available to download on the Rexroth website under “Download”, visit: `http://www.boschrexroth.de/sydfe -> sydfed`

The HS5E is delivered ex-works with the current firmware. You can find older firmware by visiting: `http://www.boschrexroth.de/sydfe -> sydfed`, or 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!

Digital electronics of HS5E:	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 motor 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 pilot control valve name plate:

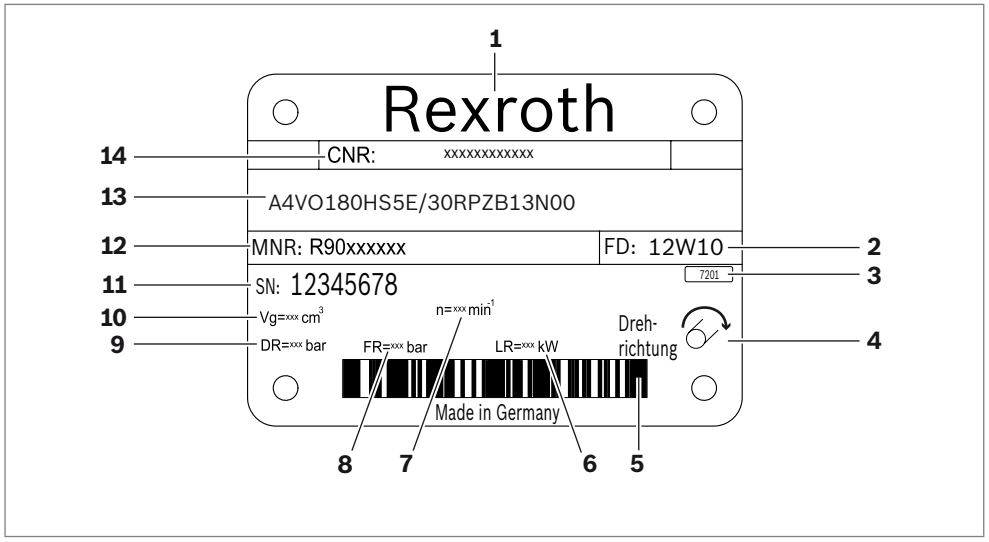


Fig. 8: Name plate A4... with HS5E pilot control valve

1 Manufacturer
2 Manufacturing date
3 Internal plant designation
4 Direction of rotation (viewed on drive shaft) – shown here: clockwise
5 Bar code
6 Power setting (optional)
7 Rotational speed
8 Flow setting (optional)
9 Pressure control 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 38.

Information on unpacking can be found in chapter 7.1 “Unpacking” on page 40.

6.1 Transporting the axial piston unit

The following transportation options are available depending on the weight and duration of transport:

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

Dimensions and weights

Table 8: Dimensions and weights (without through drive) of A4VSO

Size		40	71	125	180	250	355	500	750	1000
Ground	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 Transporting with a lifting device

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.

Transport with eye bolt in the 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 stated 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 as shown in Fig. 9 with the eye bolt screwed into the drive shaft.

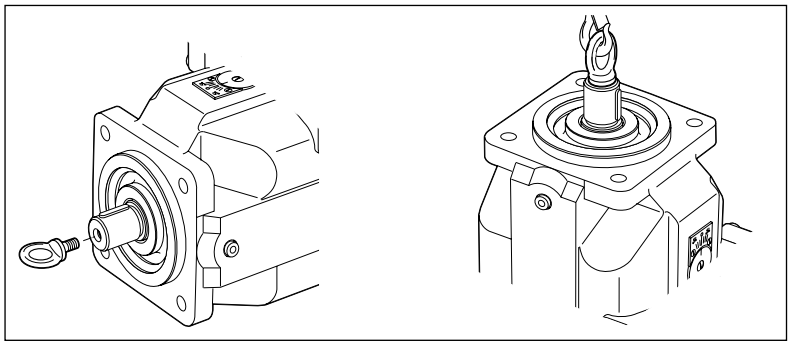


Fig. 9: Mounting the eye bolt in the drive shaft

Transport with lifting strap

WARNING! Danger from suspended loads!
During transport with a lifting device, the axial piston unit can topple out of the lifting strap and cause injuries.

- 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 oscillations.
- Never stand or put your hands under a suspended load.

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

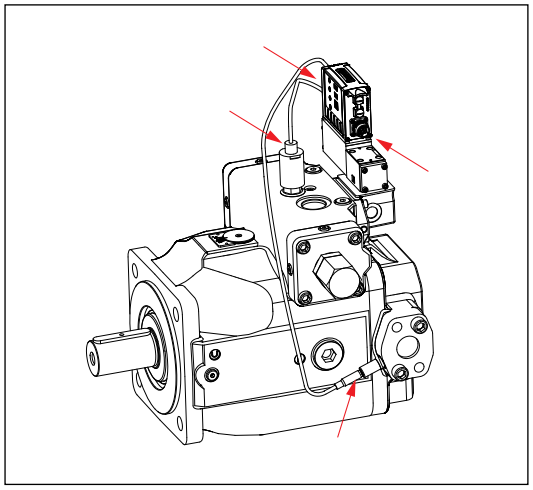


Fig. 10: Transporting the axial piston unit

6.2 Storing the axial piston unit

Requirements

- The storage areas must be free of corrosive materials and gases.
- To prevent damage to the seals, ozone-forming equipment (e.g. mercury-vapor lamps, high voltage equipment, electric motors, sources of electrical sparks or electrical discharge) must not be operated in storage areas.
- The storage areas must be dry. Recommended relative humidity ≤ 60%
- Ideal storage 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 further storage conditions, see Table 9.

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

After delivery

The axial piston units are provided with corrosion protection packaging at the factory (corrosion protection film).
Table 9 lists the maximum permissible storage times for an originally packed axial piston unit as per data sheet 90312.

Table 9: Storage time with factory corrosion protection

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

Warranty is void if the requirements and storage conditions are not observed or after expiration of the maximum storage time (see Table 9).

Procedure after expiration of the maximum storage time:

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 function and leak-tightness.
3. If the storage time exceeds 24 months, the shaft seal must be replaced.

After expiration of the maximum storage time, we recommend that you have the axial piston unit inspected by your Bosch Rexroth service partner.

In the event of questions regarding repair and spare parts, 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” on page 81.

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

The following instructions only refer to axial piston units which are operated with a mineral oil-based hydraulic fluid. Other hydraulic fluids require preservation measures that are specifically designed for them. In such cases, consult Bosch Rexroth Service, see Chapter 10.5 “Spare parts” on page 81 for the address.

Bosch Rexroth recommends the following procedure:

1. Clean the axial piston unit, see Chapter 10.1 “Cleaning and care” on page 79.
2. Empty the axial piston unit.
3. For storage times up to 12 months: Coat the inside of the axial piston unit with mineral oil and fill with about 100 ml mineral oil.
   For storage times up to 24 months: Fill the axial piston unit with corrosion protection VCI 329 (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 airproof.
5. Moisten the unpainted areas of the axial piston unit with mineral oil or suitable, easily removable corrosion protection, e.g. acid-free grease.
6. Package the axial piston unit with desiccant in corrosion protection film so it is airproof.

   Store the axial piston unit in a shock-proof manner, see “Requirements” on page 38 in this chapter.

7 Installation

Prior to installation, the following documents must be to hand:
- Installation drawing for the axial piston unit (can be obtained from your contact at Bosch Rexroth)
- Hydraulic circuit diagram for the axial piston unit (in the installation drawing)
- Hydraulic circuit diagram for the machine/system (available from the machine/system manufacturer)
- Order confirmation (contains the order-related technical data for your axial piston unit)
- Data sheet for the axial piston unit (contains the permissible technical data)

7.1 Unpacking

The axial piston unit is delivered in a corrosion protection film made of polyethylene material (PE).

CAUTION! Danger from parts falling out!
Opening the packaging incorrectly can result in parts falling out, which can be damaged or even cause injury!
- ▶ Place the packaging on a level, load-bearing surface.
- ▶ 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 22.
- ▶ Dispose of the packaging material according to the national regulations in your country.

7.2 Installation conditions

The installation location and position of the axial piston unit essentially determine the procedures during installation and commissioning (such as when filling and air bleeding the axial piston unit).
- ▶ Fix the axial piston unit so that the expected forces and torques can be transferred without any danger. The machine/system manufacturer is responsible for dimensioning the fasteners.
- ▶ Observe the permissible radial forces on the drive shaft when driving with radial loading (belt drives). If necessary, the belt pulley must be stored separately.
- ▶ Make sure that the axial piston unit is air bled and filled with hydraulic fluid during commissioning and operation. Do this also after relatively long standstill periods, since the axial piston unit may drain through the hydraulic lines.
- ▶ The leakage in the housing area must be directed to the reservoir via the highest drain port. Use the line size which is appropriate for 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 down, decouple all connecting lines from all vibration-capable components (e.g. reservoir) using elastic elements.

- Make sure that the suction, drain, and return lines flow into the reservoir below the minimum fluid level in all operating conditions. This will prevent air from being drawn in and foam from being formed.
- Make sure that a minimum suction pressure of 0.8 bar absolute (without charge pump) or 0.7 bar absolute (with charge pump) absolute 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 pressure values.

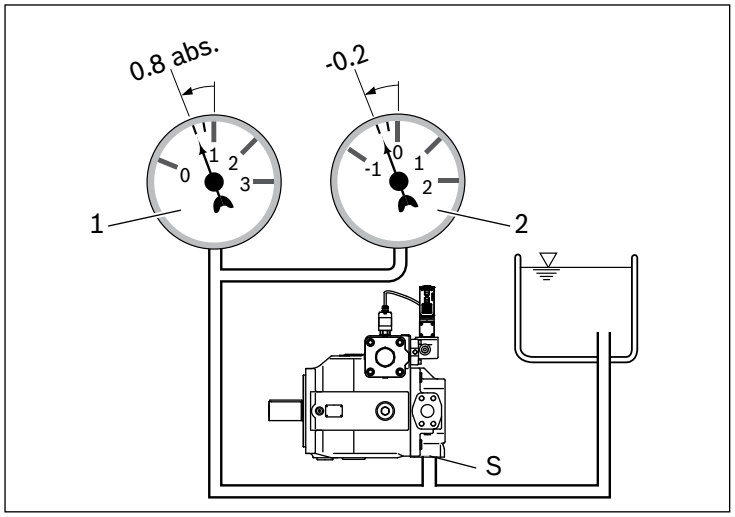


Fig. 11: Suction pressure

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 must be installed in a clean condition. 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 difficult-to-remove contamination. Cleaning agents must not enter the hydraulic system.

7.3 Installation position

The following installation positions 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 and below the minimum fluid level of the reservoir.

Recommended installation position: 1 and 2.

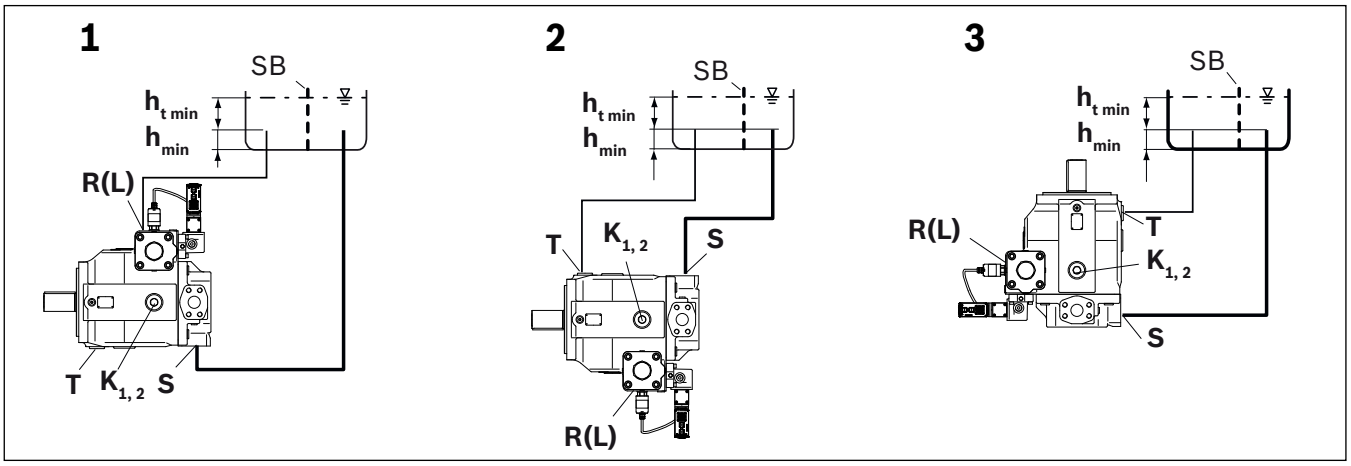


Fig. 12: Below-reservoir installation of A4VSO with installation position 1-3

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

Table 10: 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 downward)	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.

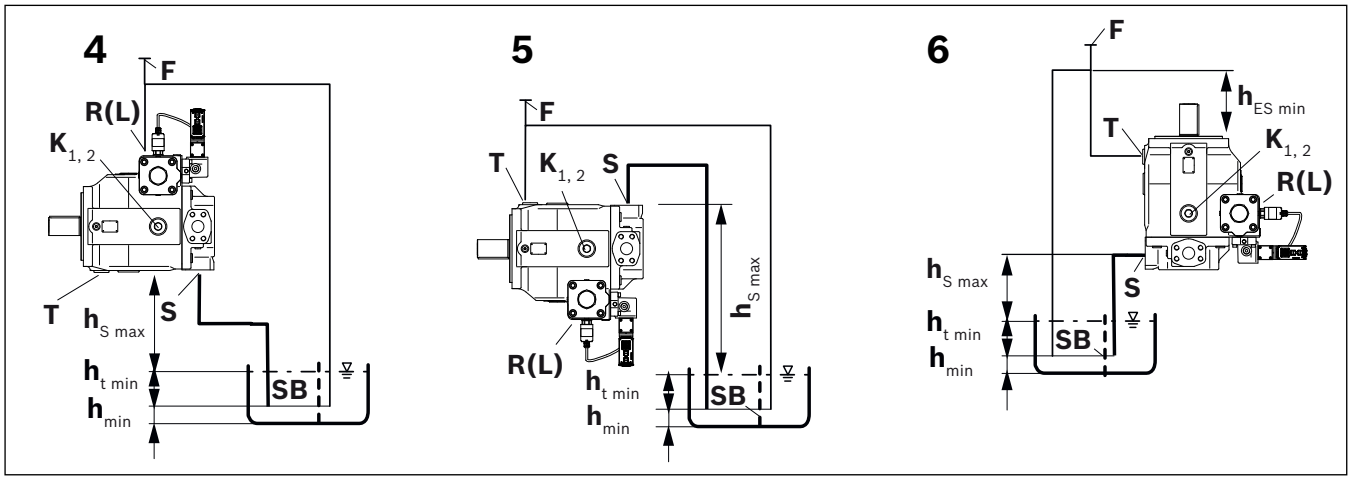


Fig. 13: Above-reservoir installation of A4VSO with installation position 4-6

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 make filling and air bleeding easier.

Table 11: 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 downward)	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 details in the order confirmation.

If the material number for the axial piston unit does not match the one in the order confirmation, contact Bosch Rexroth Service for clarification, see Chapter 10.5 “Spare parts” on page 81.

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

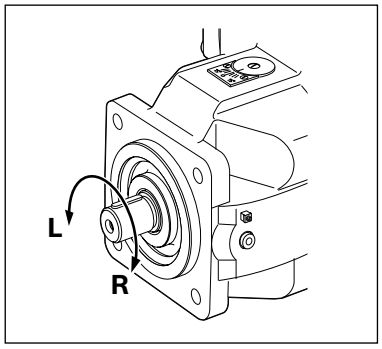


Fig. 14: Direction of rotation

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 shaft of the machine/system.

The direction of rotation as specified 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 35.

7.4.2 Dimensions

The installation drawing contains the dimensions for all connections and ports on the axial piston unit. 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 instructions when installing the axial piston unit:

- Note that you can expect certain installation positions to affect the control device. Gravity, dead weight and case pressure can cause minor characteristic shifts and changes in response time.
- Torsional vibrations and speed variations may cause leakages on the shaft seal and increased rotary angular accelerations 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 a large part 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, they may result in leakage on the shaft seal and damage to the rotary group.
- If a shared drain line is used for several units, make sure that the respective case pressure 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 operational circumstances, particularly at cold start. If this is not possible, separate drain lines must be installed if necessary.

The type of installation to be used 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
- to a cardan shaft

7.4.4 Installation with coupling

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

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

1. Install the specified coupling half onto 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. Install the coupling on the output shaft of the drive motor in accordance with the specifications provided by the coupling manufacturer.

The axial piston unit must not be tightened down 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 that there is no angular deviation.
8. Make sure that no impermissible axial and radial forces act 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 flexible couplings, check that the drive is free of resonance after completing the installation.

7.4.5 Installation on a gearbox

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

- Therefore, before installing, make sure that the spigot diameter centers the axial piston unit (observe tolerances) and that no impermissible axial or radial forces act 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 helically-toothed shaft

No gearing forces higher than the permissible axial and radial forces are to act on the shaft, if necessary the gear wheel must be supported separately at the gearbox output.

7.4.6 Installation with cardan shaft

How to connect the axial piston unit via a cardan shaft on a drive motor is described in detail in the following.

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

- Observe the cardan shaft manufacturer's assembly instructions.

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

7.4.7 Completing installation

1. Remove any mounted 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**) and a protective plug (**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 for the axial piston unit.

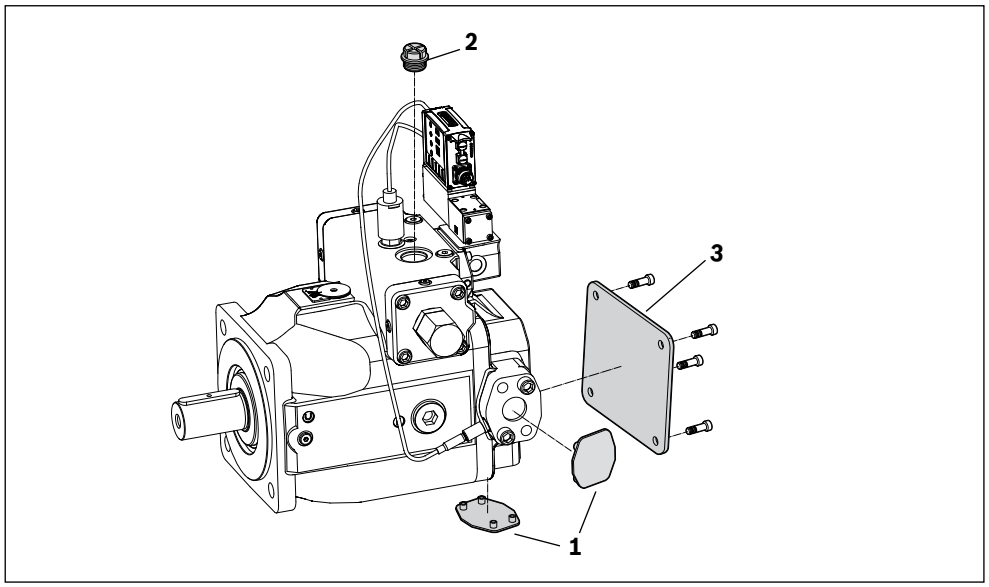


Fig. 15: Removing transport protection

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

Ports intended for connecting lines are provided with protective plugs or threaded plugs, which serve as transport protection. All of the ports required for functional operation must be connected (see Table 12 “A4V ports Series 3x” on page 51). Failure to do so could lead to malfunctions or damage. If a port is not connected, it must be plugged with a threaded plug because protective plugs are not pressure-resistant.

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

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 that the necessary suction pressure is not undercut. 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, if fitted, (check the filter element's level of contamination on a regular basis)

The machine/system manufacturer is responsible for dimensioning the lines. The axial piston unit must be connected 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 12 "A4V ports Series 3x" on page 51. The machine/system manufacturer must 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 appropriate for the axial piston unit port (pressure level, size, system of units).

Notices on routing lines

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

- Lines and hoses must be installed without pre-charge pressure, so that no further mechanical forces are applied during operation that will reduce the service life
- of the axial piston unit and, if applicable, 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 that the pressure at the suction port does not drop below the minimum permissible pressure. Make sure that the maximum suction pressure is not exceeded (e.g. when pre-filling).
  - Make sure the connections and connecting elements are airtight.
  - The hose must be pressure-resistant, also regarding external air pressure.
- Pressure line
  - For the pressure lines, use only pipes, hoses and connecting elements rated for the working pressure range specified in data sheet 92050 (see Table 12).

- Drain line
  - Always route the drain lines so that the housing is constantly filled with hydraulic fluid and to ensure that no air gets through the shaft seal even during extended standstill periods.
  - Under no operating circumstances may the case pressure exceed the maximum limit values specified for the axial piston unit in the data sheet.
  - The drain line inflow in the reservoir must always be below the minimum fluid level (see chapter 7.3 “Installation position” on page 42).
- If the axial piston unit is equipped with installed screw fittings, these must not be unscrewed. Screw the stud end of the fitting directly into the installed fitting.

Risk of confusion with threaded connections

Axial piston units are employed in application areas that use the metric measuring system as well as the Anglo-American (imperial) and the Japanese measuring system (JIS – **J**apan **I**ndustrial **S**tandard). Moreover, various kinds of seal are 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 or bursting stud ends!
For fittings, if a stud end which is of a different measurement system, kind of seal and size with respect to 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

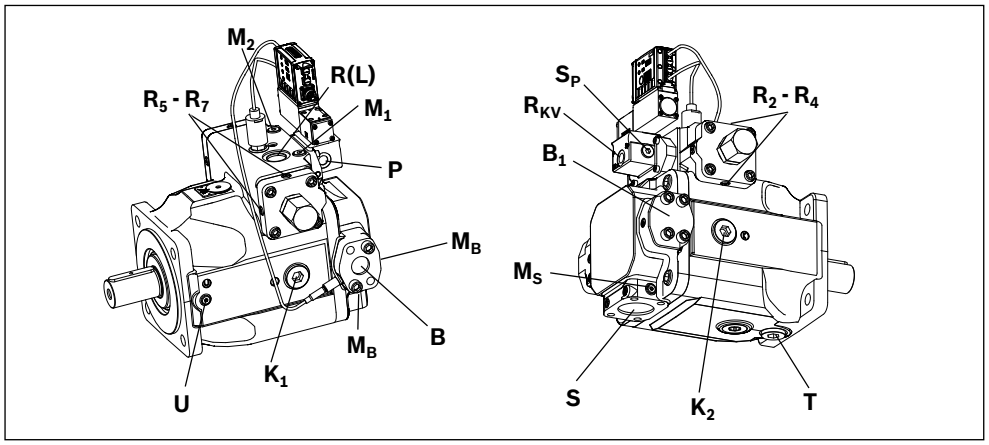


Fig. 16: Port overview of A4VSO with HS5E controller, clockwise rotation

Table 12: A4V ports Series 3x

Ports[1]		p_{max} **[bar]**[2]	**State**
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
K_1	Flushing port	4	X
K_2	Flushing port	4	X
U	Flushing port	4	O[6]
T	Fluid drain	4	X[3]
R(L)	Fluid filling and air bleeding	4	O[3]
M_B	Measuring port working pressure	400	X
M_S	Measuring port suction pressure	30	X
M_1, M_2	Measuring port control pressure	400	X
P	Control pressure port	350	X
S_p	Control pressure port of accumulator port	350	X
R_{KV}	Control fluid return flow	5	X
R_2 - R_7	Air bleeding of stroking chamber	350	X

[1] The measuring system and thread size can be taken from the installation drawing.

[2] Short-term pressure peaks may occur depending on the application. 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 42)

[4] Version 13: for NG 40 to 355

[5] Version 25: for NG 40 to 1000

[6] Must be connected for version for HFC hydraulic fluids.

O = Must be connected (plugged on delivery)

X = Plugged (in normal operation)

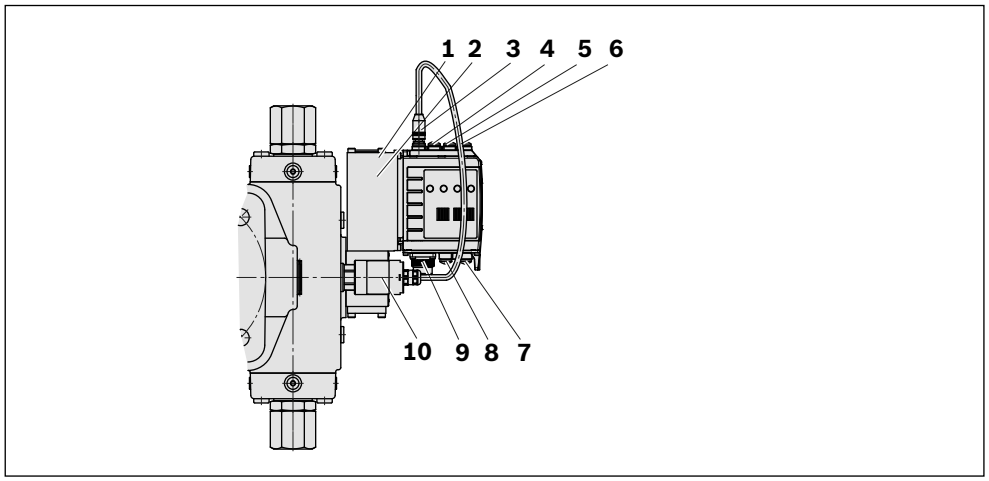


Fig. 17: Port overview A4VSO with HS5E controller, clockwise rotation

Table 13: Example A4VSO, sizes 40 to 1000

1	Proportional solenoid
2	Inductive position transducer for valve position
3	Swivel angle actual value input X8A
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-G15 swivel angle sensor

Tightening torques

The following tightening torques apply:

- Fittings:
  Observe the manufacturer's specifications regarding the tightening torques of the used fittings.
- Female threads in the axial piston unit:
  The maximum permissible tightening torques $M_{G\,max}$ are maximum values of the female threads and must not be exceeded. For values, see Table 14.
- Threaded plugs:
  For the metallic threaded plugs supplied with the axial piston unit, the required tightening torques of threaded plugs M_V apply. For values, see Table 14.
- Mounting bolts:
  For mounting bolts with metric ISO thread according to DIN 13 or thread according to ASME B1.1, we recommend checking the tightening torque in individual cases in accordance with VDI 2230.

Table 14: Tightening torques for female threads and threaded plugs

Ports Standard	Thread size	Maximum permissible tightening torque of the female threads $M_{G\,max}$	Required tightening torque of the 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 or threaded plugs at the ports at which the connections are to be made according to the hydraulic circuit diagram.
2. Make sure that the sealing surfaces of the hydraulic ports and functional surfaces are not damaged.
3. Use only clean hydraulic lines or flush them before installation. (Pay attention to Chapter 7.5 “Performing flushing cycle” on page 55, when you flush out the entire system.)
4. Connect the lines in accordance with the installation drawing and the machine or system circuit diagram. Check whether all ports are connected or plugged with threaded plugs. With inside-reservoir installation, the axial piston unit case must be filled before fitting the lines and filling the reservoir with hydraulic fluid.
5. Tighten the fittings correctly (note tightening torques!). Mark all correctly 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 condition for safe working.

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 the layout of the electric control.
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, please observe the specifications in data sheet 92076, such as:

- Permissible voltage range
- Permissible current
- Correct pin assignment
- An Ethernet M12 to RJ45 connecting 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 entire system before the initial commissioning. To avoid internal contamination, the axial piston unit must not be included in the flushing cycle.

The flushing cycle must be performed with an additional flushing unit. Follow the instructions of the flushing unit's manufacturer for the exact procedure during the flushing cycle.

7.6 Connecting the HS5E control system electrically

The machine or system manufacturer is responsible for the layout of the electric control.
For electrically controlled HS5E 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 control system electrically (24 V).

7.6.1 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 pilot valve.
- You are not allowed to route power cables in the vicinity of the pilot 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 cables for the command and actual values as short as possible.
- The signal lines to the pilot valve must always be shielded. You must connect the cable 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 (see “Signals to the central connector” on page 97).
- 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 cabling 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)

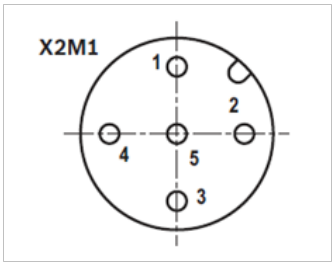
7.6.2 Connection to the swivel angle sensor

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.

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

Table 15: 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)

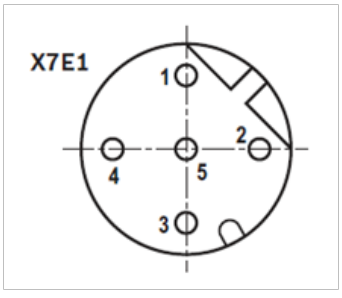


1) Maximum load capacity 50 mA, voltage output same as connected voltage supply at input XH4.
2) Only one signal input per interface can be configured

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

Table 16: 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.

7.6.5 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

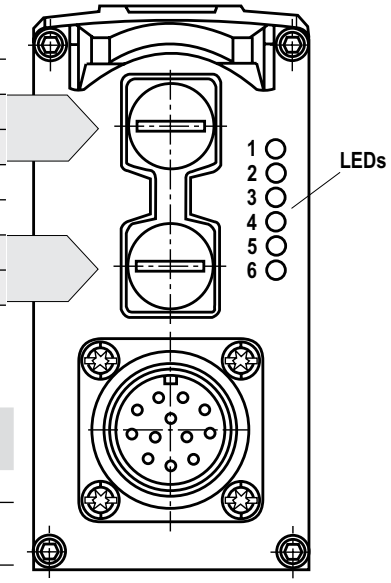


Table 17: Indication of status LED

Module status LED (LED 4)	Indication status
OFF	No voltage supply
Green/red blinking	Self-test
Green blinking	Drive ready for operation
Green	in control
Red blinking	Warning
Red	Fault

Network status LED	Indication 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 diagnostics LEDs, refer to the functional description of the Rexroth HydraulicDrive.

7.6.6 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 connecting 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.

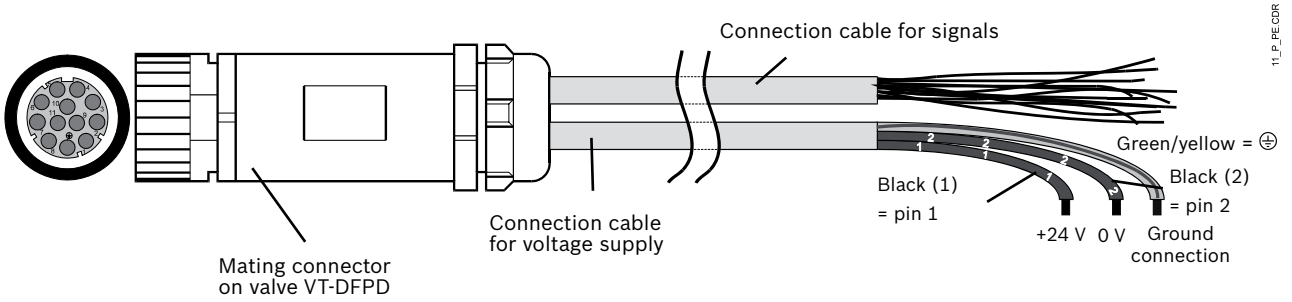


Fig. 18: Connecting the voltage supply of the HS5E pilot control valve

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 pilot 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.)

7.6.7 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 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 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.

- Our pressure transducer model “HM20-2X” (HS5EP) 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.
- Our pressure transducer model “HM20-2X” with (0...10 V) voltage interface has a three-wire connection and a built-in DC/DC converter that effectively rules out disturbances to the analog signal that are caused by the voltage supply.
  You should avoid transferring 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.

⚠ 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 hoses

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.

Pressure transducer HM20 (current)

The HM20 pressure transducer has a two-wire current interface and it can be connected to the pilot valve via the central connector.
The supply voltage for the pressure transducer must comply with the specification.
For more detailed information about the pressure transducer, see data sheet 30272.

Pressure transducer HM20 (voltage)

The HM20 pressure transducer has a 0...+10 V voltage output as the actual pressure value signal and you can connect it to the pilot valve.
The supply voltage for the pressure transducer must comply with the specification.
For more detailed information about the pressure transducer, see data sheet 30272.

8 Commissioning

⚠ WARNING

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

Danger to life or risk of injury or serious injury!

- Pay attention to and eliminate potential danger sources before operating 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 must be within the operator's reach.
- Always follow the instructions of the machine/system manufacturer during commissioning.

⚠ CAUTION

Commissioning an improperly installed product!

Risk of injury and property damage!

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

NOTICE

Missing seals and plugs lead to noncompliance 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 HS5E control system is filled with hydraulic fluid at commissioning and during operation. Do this in the case of relatively long standstill periods too, since the HS5E control system can drain through the hydraulic lines.

Penetrating contaminants!

Damage to the HS5E 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 HS5E control system.

- Ensure the utmost cleanliness during commissioning.
- Make sure that no contaminants penetrate when sealing the measuring ports.

NOTICE

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). This means that the bearings are insufficiently lubricated when recommissioning.
- Make sure that the suction line is always filled with hydraulic fluid at commissioning and during operation.

NOTICE

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 for commissioning the axial piston unit, observe the general safety instructions and intended use detailed 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 the commissioning process, monitor the temperature of the hydraulic fluid in the reservoir to ensure that it lies within the permissible viscosity limits.

8.1.1 Filling the axial piston unit

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

The axial piston unit should be filled with a filling unit (10 µm filter grade). The axial piston unit must not be operated while it is being filled by the filling unit.

Use only a hydraulic fluid that conforms to the following requirements:
You can find details of the minimum requirements on hydraulic fluids as well as the permissible and optimum viscosity in Bosch Rexroth data sheets 90220, 90221, and 90222. The titles of the data sheets can be found in Table 1 “Required and supplementary documentation” on page 6.
To ensure the functional reliability of the axial piston unit, at least cleanliness level 18/16/13 according to ISO 4406 is necessary for the hydraulic fluid for particle sizes of 4/6/14 µm.
Permissible temperatures:
Ambient temperature at the pump: -20 to +60 °C
Hydraulic fluid temperature range: -20 to +70 °C

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 hydraulic fluids on delivery do not normally conform to the requirements for our components.

- Use a suitable filter system to filter hydraulic fluids during filling to minimize solid impurities 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 42. The hydraulic lines of the system must also be filled.

NOTICE! Risk of property damage due to inadequate lubrication!
Damage or destruction of product possible!

- When using a shut-off valve in the suction and/or drain line, make sure that the drive of the axial piston unit can only be started when the shut-off valves are open.

3. When using a shut-off valve in the suction and/or drain line, only operate the axial piston unit when the shut-off valves are open.
4. Test the direction of rotation of the drive motor. To do this, rotate the drive motor briefly at the lowest rotational speed (inching). Make sure that the direction of rotation of the axial piston unit agrees with the details of the name plate, see chapter 5.10 “Product identification”, Fig. 8: Name plate A4... with HS5E pilot control valve on page 35.
5. Operate the axial piston pump at a lower rotational speed (starter speed for internal combustion engines or inching operation for electric motors) until the hydraulic system is completely filled and air bled. For checking purposes, drain the hydraulic fluid at the drain port and wait until it drains without bubbles.

8.1.2 Testing the hydraulic fluid supply

The axial piston unit must 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 the noise development and check the hydraulic fluid level in the reservoir. If the axial piston unit becomes louder (cavitation) or the drain fluid is discharged with bubbles, this is an indication that the axial piston unit is not being sufficiently supplied with hydraulic fluid.

For information on troubleshooting, see chapter 14 “Troubleshooting” on page 87.

To test the hydraulic fluid supply:

1. Allow the drive motor to run at the lowest rotational speed. The axial piston unit must 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 that the hydraulic system is sealed and can withstand the maximum pressure.
5. Check the suction pressure at port **S** of the axial piston pump at nominal speed and maximum 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 $\mathbf{K_2}$. Refer to the data sheets in Table 1 “Required and supplementary documentation” on page 6 for the permissible value.

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 endanger persons 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, you must perform a functional test on the machine/system. The functional test should be performed according to the instructions 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, it must be ensured that the axial piston unit was installed properly in the machine/system.

- 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, disconnect 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 system 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 system. The default address of the HS5E system is 192.168.0.1. If the IP address is wrong, the row is highlighted in red. After you have configured the network port, you can open IndraWorks and start a network search:

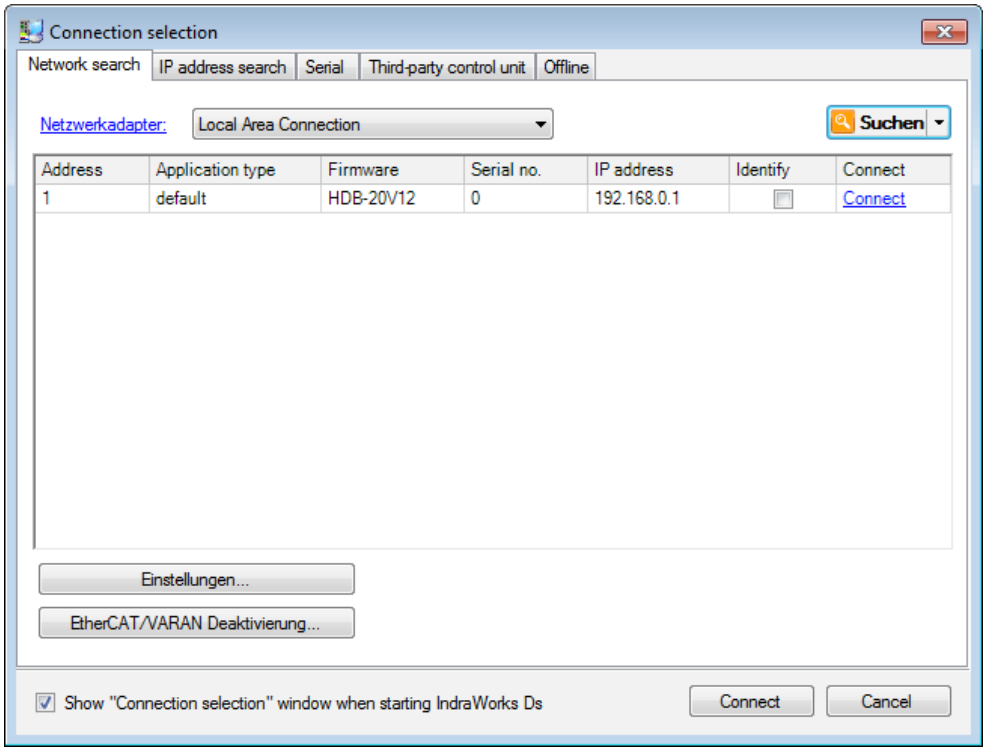


Fig. 19: Connection selection

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 system 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 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.
- The settings for pressure acquisition (with HS5E only, not with HS5EP when using the supplied pressure transducer)
- Setting of torque limitation
- For information on controller optimization, see chapter 8.1.7 "Setting controller parameters" on page 71.

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)

New screenshot from Martin

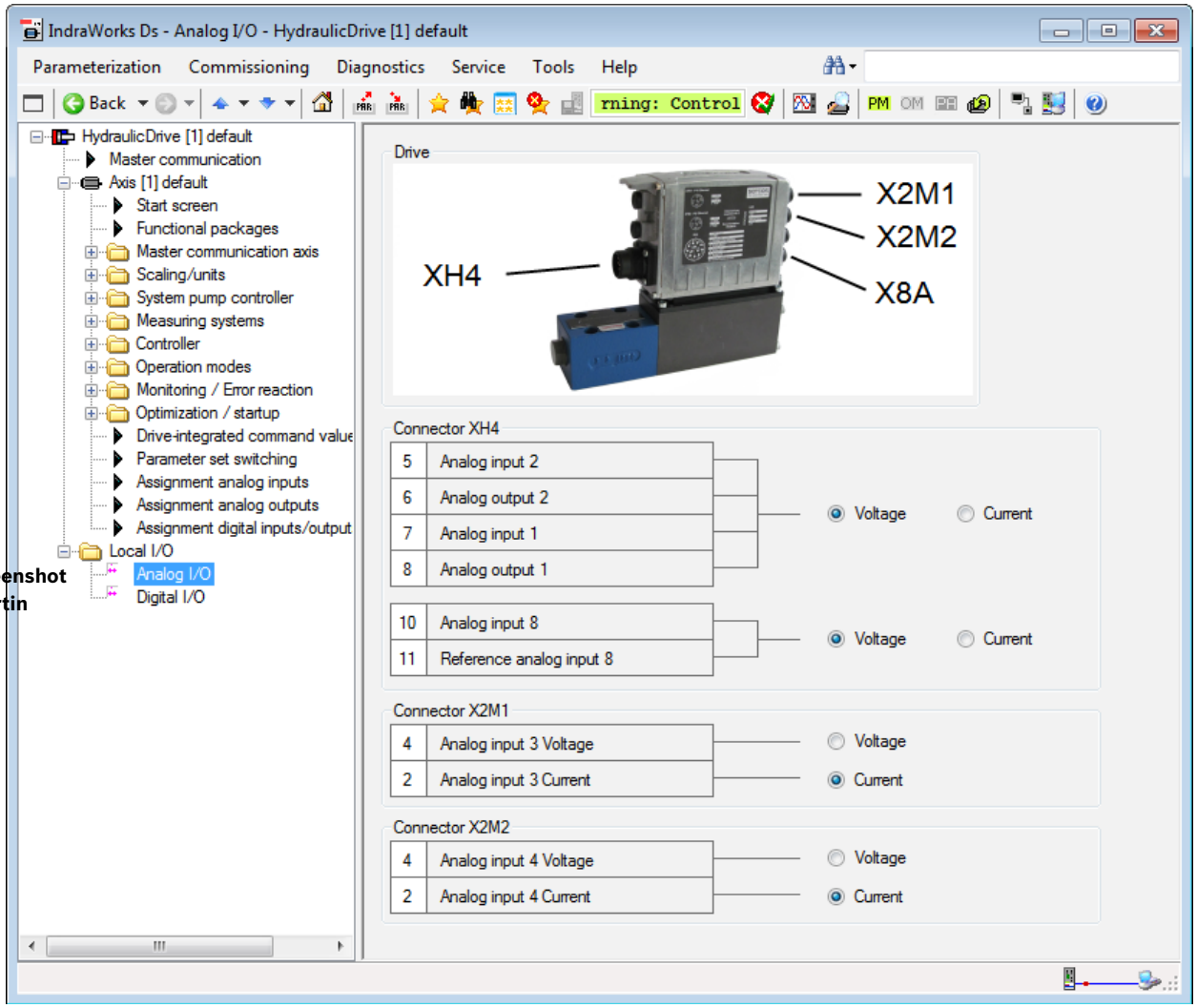


Fig. 20: Setting pressure sensor, voltage or current interfaces

8.1.5.2 Settings of pressure transducer

With some applications, it can be an advantage to be able to switch between several pressure transducers. The HS5E control system 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 the HS5E control system always needs one valid actual pressure value for control. Refer to chapter 7.6.7 on page 58 for the various options for connecting a pressure transducer.

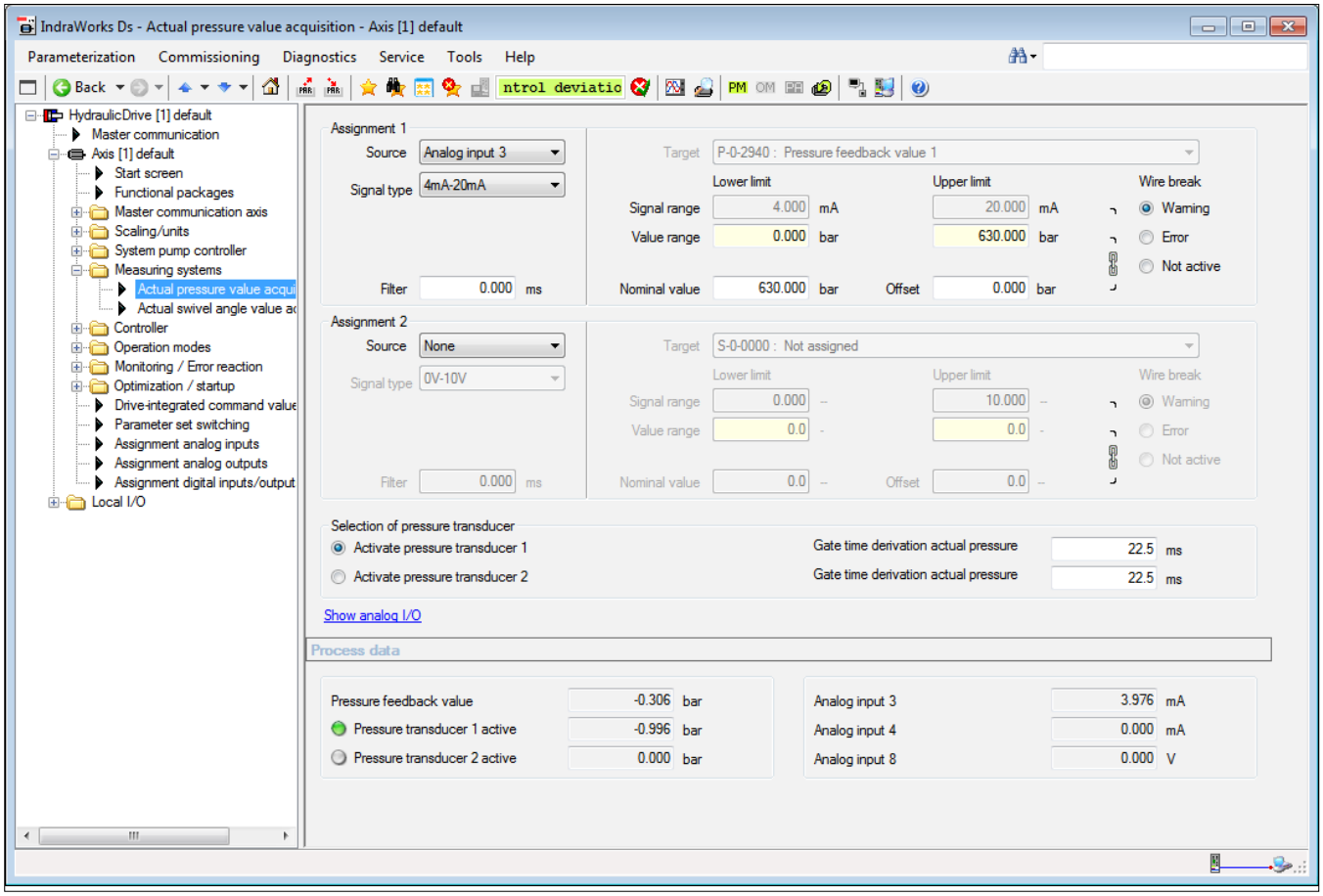


Fig. 21: Actual pressure value acquisition

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).

Determining the characteristics		
Flow	$q_v = \frac{V_g \times n \times \eta_v}{1000}$	[l/min]
Torque	$T = \frac{V_g \times \Delta p}{20 \times \pi \times \eta_{mh}}$	[Nm]
Power	$P = \frac{2 \pi \times T \times n}{60000} = \frac{q_v \times \Delta p}{600 \times \eta_t}$	[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 ($\eta_t = \eta_v \times \eta_{hm}$)

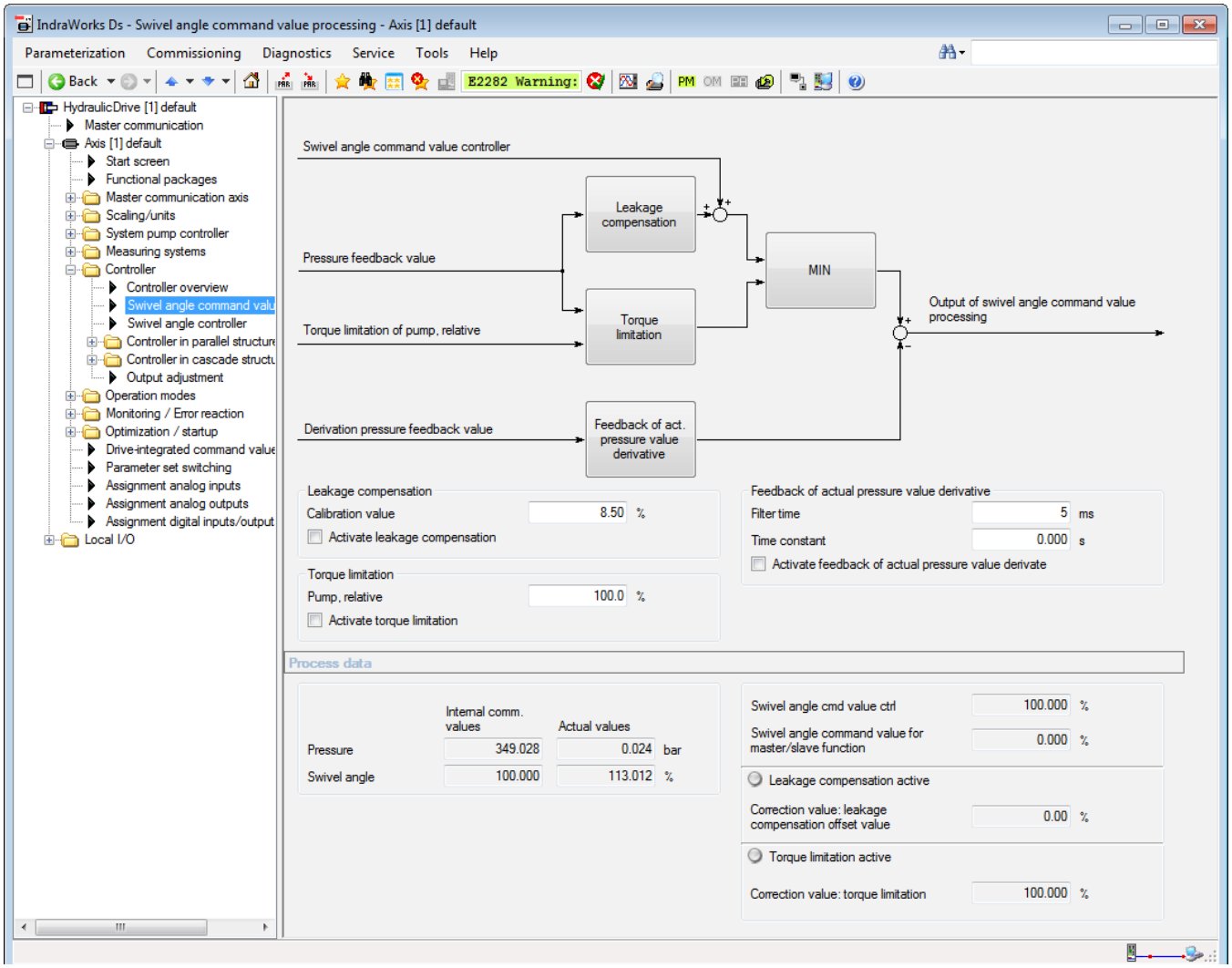


Fig. 22: Parameters for torque limitation

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 cm³. The value for pressure standardization was input as 350 bar.

Electric motor	T	=	$\frac{60{,}000}{2\pi}$	×	$\frac{P}{n}$	=	$\frac{9549}{}$	×	$\frac{75}{1480}$	=	483.9	Nm

Maximum pump torque	$T = \frac{vG \times \Delta p}{20\pi} = \frac{320 \times 350}{62.83}$	=	1782.5	Nm
Torque limitation Pump relative	$\frac{483.9}{1782.5}$	=	27.1	%

8.1.5.4 Settings of swivel angle sensor

At the factory, the HS5E control system is fitted with the appropriate swivel angle sensor for the pump. If the type of swivel angle sensor changers or a replacement pilot valve is set up, you may need to modify the selection values in the “Actual swivel angle value acquisition” window appropriately.

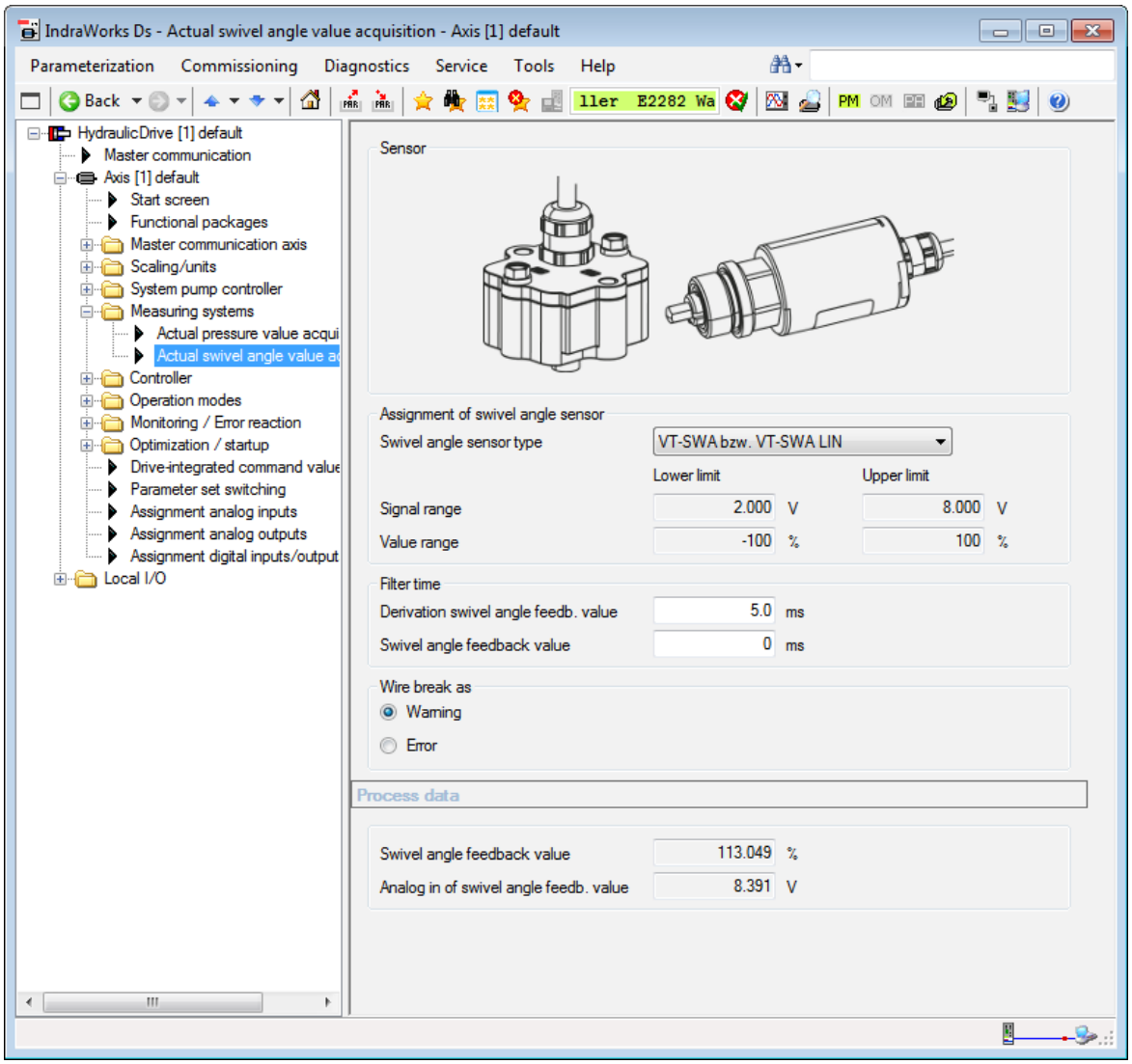


Fig. 23: Actual swivel angle value acquisition

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 design, the system/control and the drive speed and, if required, adjust them.

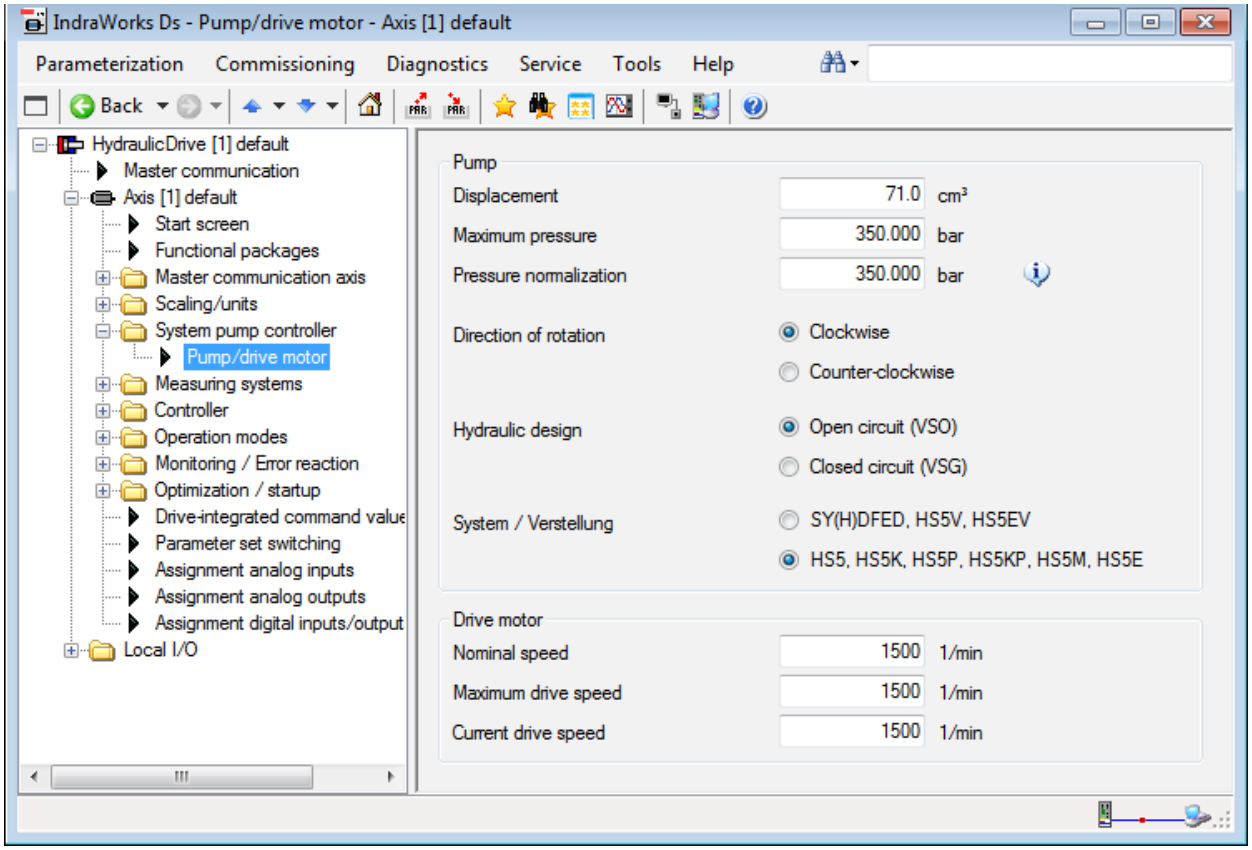


Fig. 24: Pump/drive motor

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 (see Chapter 5.9 “Switch-on sequence of electronics/hydraulics” on page 34).

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 close to the neutral position (swiveled in above the 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 18: 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 display on the axial piston unit.

Further explanations on the analysis of faults can be found in Chapter 14 “Trouble-shooting” on page 87.

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).

▶ Switch 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 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 19: 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 20: 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 21: 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 22: 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:

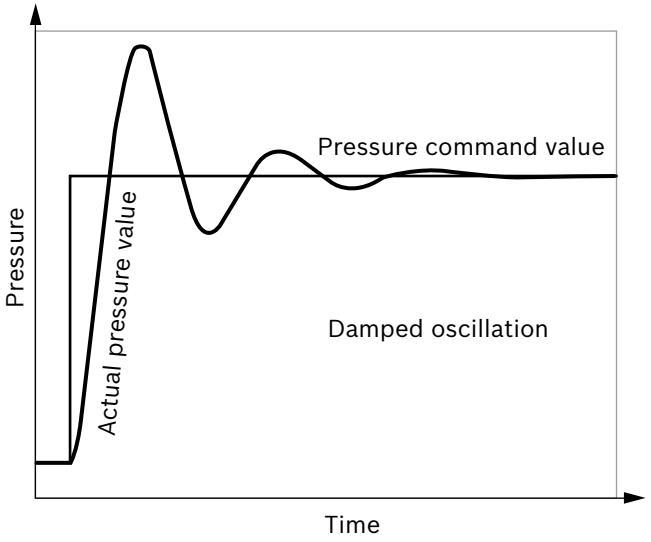


Fig. 25: Damped oscillation

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

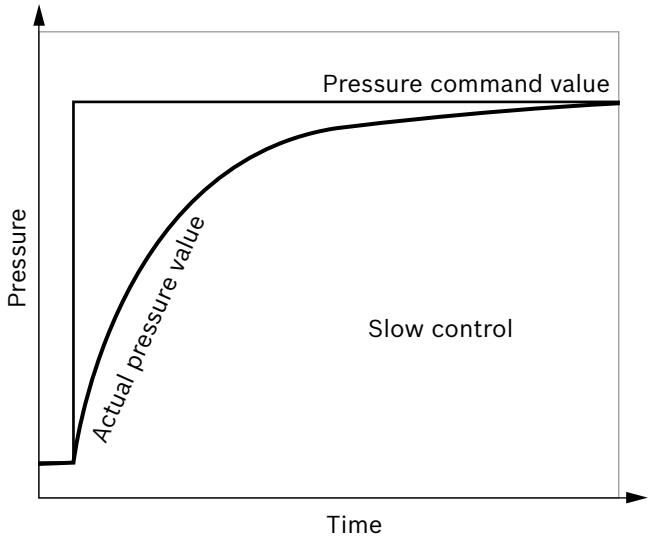


Fig. 26: Damped oscillation

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)

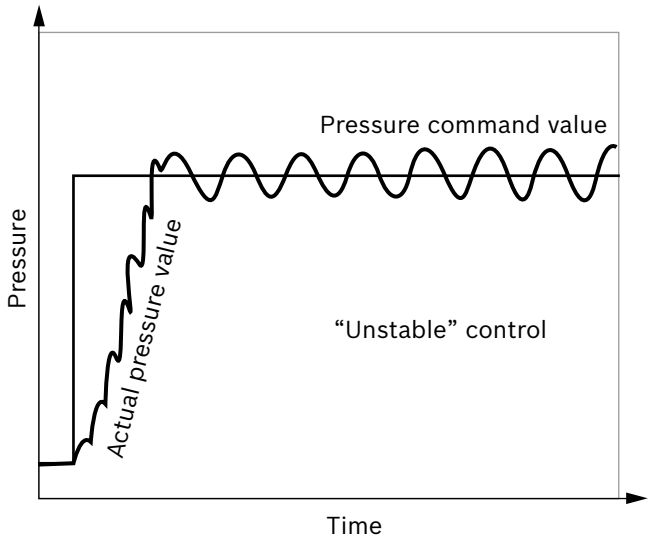


Fig. 27: Unstable control

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)

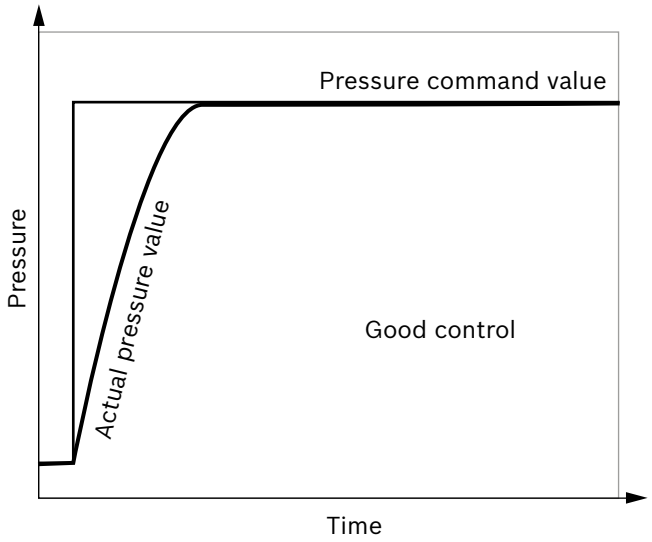


Fig. 28: Good control

If the control behavior is good, no measures need to be taken.

8.1.8 Calibrating the HS5E control system

With regular calibration, the calibration functions of the HS5E 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.
We recommend calibrating the HS5E control systemin the following order:

1. Calibration of the pressure transducer (provided by the customer)
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 activating the calibration functions in the functional description of the HydraulicDrive firmware (data sheet 30338).

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

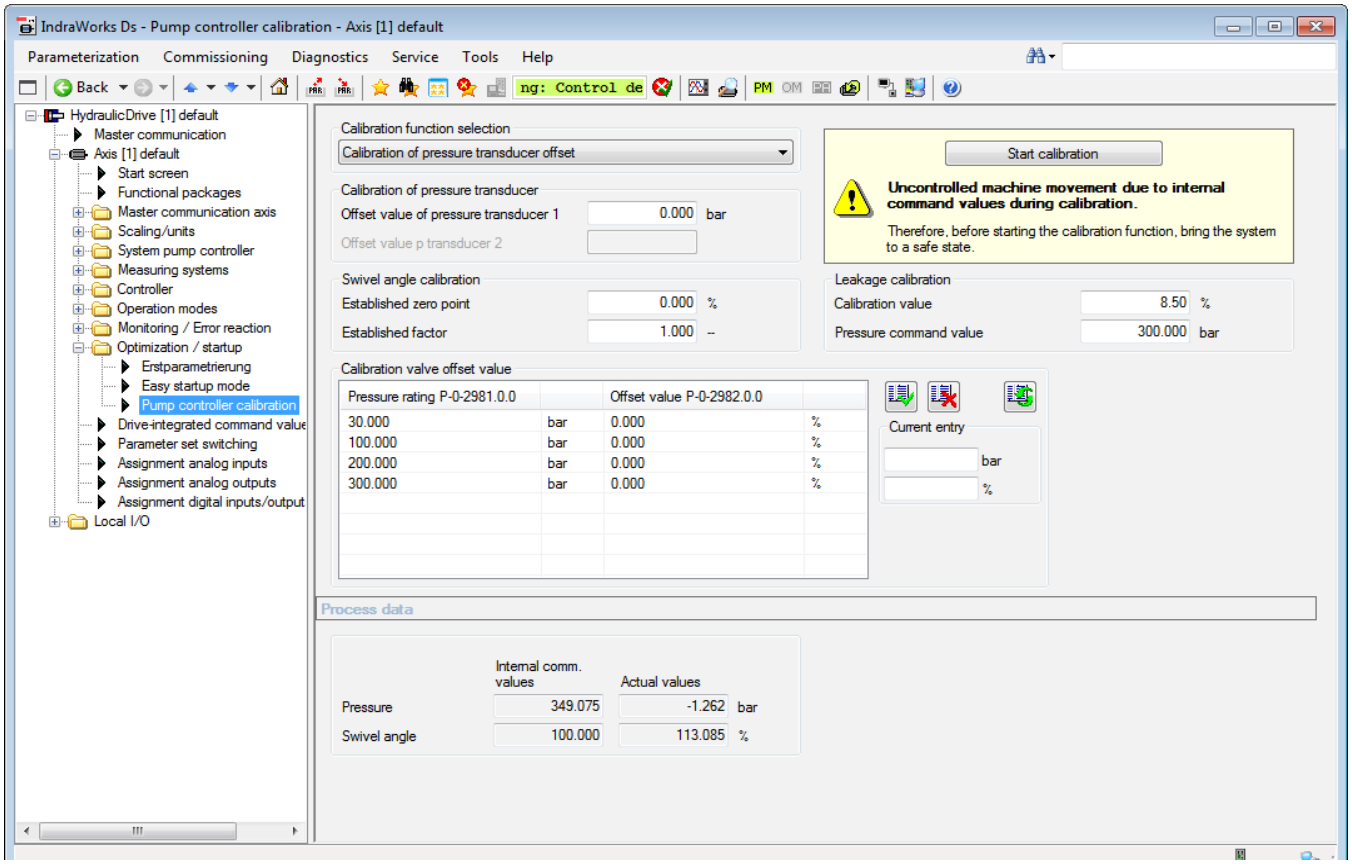


Fig. 29: Calibration

For calibrating the HS5E control system, the hydraulic fluid must have reached operating temperature.

8.1.9 Saving parameters

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

8.2 Running-in phase

NOTICE

Property damage by insufficient viscosity!

An increased hydraulic fluid temperature may reduce the viscosity values by too much 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 impermissible operating temperatures and/or viscosities occur.
- Operating temperatures that are too high 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. The volumetric and mechanical-hydraulic efficiency increases as well through the conclusion of the running-in phase of approx. 10 operating hours.

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.

Among others, 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 61.

9 Operation

The 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 the proper project planning of the hydraulic system and its control.

10 Maintenance and repair

NOTICE
Inspection and maintenance work overdue! Risk of 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 influences! 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 that 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 corrosive cleaning agents.
- ▶ Remove major external contamination and keep sensitive and important components, such as solenoids, valves, displays and sensors, clean.

10.2 Inspection

In order to enable long and reliable operation of the axial piston unit, Bosch Rexroth recommends testing the hydraulic system and axial piston unit on a regular basis, and documenting and archiving the following operating conditions:

Table 23: Inspection schedule

Task to be performed		Interval
Hydraulic system	Check level of hydraulic fluid in the reservoir.	Daily
	Check the operating temperature under comparable load condition at the drain port and in the reservoir.	Weekly
	Conduct analysis of hydraulic fluid: Viscosity, aging and contamination	Yearly or every 2000 operating hours (whichever occurs first)
	Check filter: Depending on the degree of contamination of the hydraulic fluid, the replacement interval can vary. We recommend using a contamination indicator	Yearly or every 1000 operating hours (whichever comes 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. For this reason, Bosch Rexroth recommends that the axial piston unit and system are always kept in a clean condition.	Daily
	Check axial piston unit for unusual noise development.	Daily
	Check fastening elements for tight seating. All fasteners have to be checked 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. For this reason, 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 by the service life of the bearings used. On the basis of the load cycle, you can ask the responsible Bosch Rexroth service partner about the service life, see Chapter 10.5 “Spare parts” on page 81 for an address. Based on these details, a maintenance interval is to 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 may only be performed by service centers certified by Bosch Rexroth.

- Use exclusively original spare parts from Rexroth to repair the Rexroth axial piston units, otherwise the functional reliability of the axial piston unit cannot be assured and the warranty is void.

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 which do not comply with the technical requirements as laid down by Bosch Rexroth can cause injury and property damage.

- Use exclusively original spare parts from Rexroth to repair the Rexroth axial piston units, otherwise the functional reliability of the axial piston unit cannot be assured and the warranty is void.

The spare parts lists for axial piston units are order-specific. When ordering spare parts, quote 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 responsible Bosch Rexroth Service partner or the service department of the manufacturer's plant for the axial piston unit.

Bosch Rexroth AG
An den Kelterwiesen 14
72160 Horb a.N., Germany
Hotline +49 9352 405060
spares.horb@boschrexroth.de

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

For general inquiries, please contact your local contact person, you can find the address at `www.boschrexroth.com/addresses`

10.5.1 Replacement of components

The replacement of some components of the HS5E control systems is described in the following.

Accessories

Accessories for HS5E	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 connecting cable (ports X7E1 & X7E2), additional information in type designation RKB0044/ xxx.x (xxx.x: length in meters)	R911172135	

Swivel angle sensor VT-SWA-LIN-...-G15 for HS5E 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

Installing 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 control system" on page 75.

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 pilot 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.

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 76.

To replace the pilot valve undo the four screws at the recessed corners of the name plate on the pilot valve. After replacement, tighten the screws to a tightening torque of 9 Nm ±1.8%. Newly installed valves with integrated electronics need to be adjusted:

- If the parameter settings (R parameters) in the replaced valve differ from the factory setting, the settings must be adjusted on the installed valve.
- Carry out calibration according to the description in Chapter 8.1.8 “Calibrating the HS5E control system” on page 75.

HS5E pilot control valve	HS5E/6 CA 24L-2X/VH/&	< Size 250	R901448624
HS5E pilot control valve	HS5E/6 CA 40L-2X/VH/&	≥ Size 250	R901448627

For HFC hydraulic fluids

HS5E pilot control valve	HS5E/6 CA 24L-2X/MH/&	< Size 250	R901467728
HS5E pilot control valve	HS5E/6 CA 40L-2X/MH/&	≥ Size 250	R901467727

Pressure transducer HM20-X

Undo the electrical connection on the pressure sensor’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 - 25 Nm. Tighten the M12 cable connections to 0.6 Nm ±6%.

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

Table 24: 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 entire system 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 that the relevant system components are not under pressure or voltage.
2. Secure the complete system against being re-energized.

11.3 Performing removal

Proceed as follows to remove the axial piston unit:

1. Make sure you have the appropriate tools and wear personal protective equipment.
2. Check whether the hydraulic system is depressurized.
3. Allow the axial piston unit to cool down until it can be removed without danger.
4. For below-reservoir installation, before removing the axial piston unit from the complete system, seal the connection to the reservoir or drain the reservoir.
5. Place a drip tray under the axial piston unit to collect any hydraulic fluid that may leak.
6. Loosen the lines and collect the escaping hydraulic fluid in the drip tray.
7. Remove the axial piston unit. Use a suitable lifting device.
8. Completely drain the axial piston unit of hydraulic fluid.
9. 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 38.

12 Disposal

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

1. Completely drain the axial piston unit of hydraulic fluid.
2. Dispose of the axial piston unit and packaging material in accordance with the national regulations in your country.
3. Dispose of the hydraulic fluid according to the national regulations in your country. Also observe the applicable safety data sheet for the hydraulic fluid.
4. Disassemble the axial piston unit into its individual parts and properly recycle these parts.
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 or its assembled parts. This includes also the change of the setting screws or the wiring.
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 product configuration as delivered. The warranty is void if the unit is modified or extended.

Setting screws are protected against unauthorized resetting by means of tamper-proof caps. Removal of the tamper-proof cap will void the warranty. If you need to change settings, contact your Bosch Rexroth service partner (for the address, see Chapter 10.5 “Spare parts” on page 81.

14 Troubleshooting

Table 26 may help you with troubleshooting. This table does not cover everything. 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 with troubleshooting

- Perform troubleshooting if possible with reduced operating data (e.g. slowly swinging in or out and slow pressure increase).
- Proceed in a systematic and purposeful manner, even when pressed for time. Random and imprudent removal and changing of settings could result in the inability to ascertain the original cause of the fault.
- First obtain a general overview of how your product works in conjunction with the entire system.
- Try to find out whether or not the product was working 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:
  - Were there any changes to the product's application conditions or operating range?
  - 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, which?
  - Has the hydraulic fluid been changed?
  - Has the product or machine been used as intended?
  - How did 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 you cannot rectify the fault, contact one of the contact addresses which can be found at:
  `www.boschrexroth.com/addresses`.

14.2 Error/diagnosis memory

For diagnosis purposes, the HS5E control system is fitted with an internal error and diagnosis memory. To open the error memory, select **“Diagnosis”→ “Diagnosis memory”.**

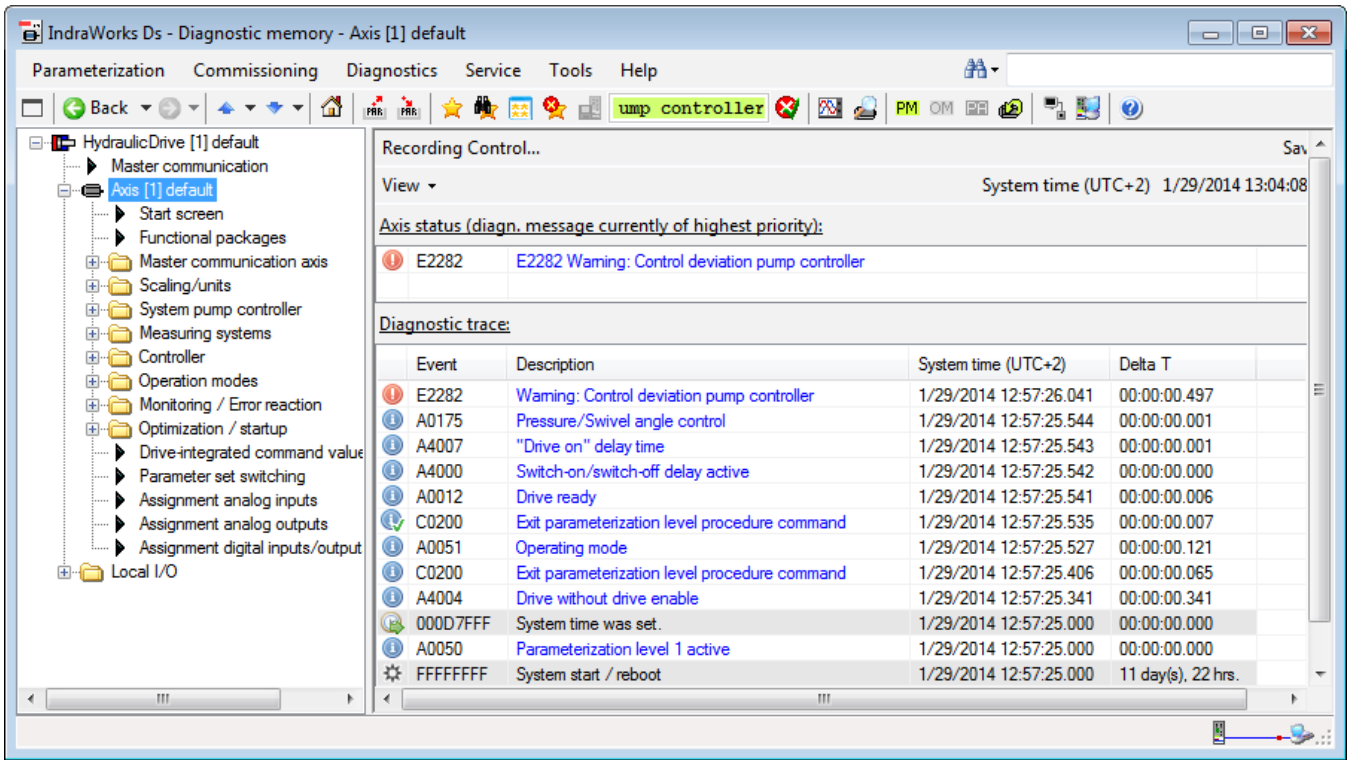


Fig. 30: Error/diagnosis memory

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 25: 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 26: 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, contaminants 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 44
	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	Mount assembled parts according to the information provided by the coupling or fitting manufacturer
	Valve and controller vibrations	Optimize the adjustment 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 26: 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, contaminants 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 optimum 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 26: 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, contaminants 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 optimum 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, contaminants 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 vibrations	Optimize the adjustment 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 26: Axial piston unit malfunction table

Malfunction	Possible cause	Remedy
Excessive temperature of hydraulic fluid and housing	Excessive 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 or malfunction of the pressure relief valve and the pressure control valve (e.g. pressure controller)	Optimize the adjustment of the pressure relief and pressure control valves of the axial piston unit and the pressure limitation 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 27: 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 pilot valve repaired by Rexroth Service or replace pilot valve
Message “Valve error pump controller” (deviation between command and actual position of the valve spool)	Valve spool jams due to contamination	Replace pilot valve, see chapter "10.5.1" on page 82
	Internal electronics fault	Replace pilot valve, see chapter "10.5.1" on page 82
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 pilot valve, see chapter "10.5.1" on page 82
	Valve spool jams due to contamination	Replace pilot valve, see chapter "10.5.1" on page 82
Humming noise in the pressure control or fluctuations in pressure/flow	Air pocket around the sensor	Bleed control system, pump (see 8, on page 60) 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 42
	Improperly high gain of the actual pressure controller	Reduce P-gain, see Chapter 8.1.7.2 on page 71

Table 27: Malfunction table of HS5E control systems

Malfunction	Possible cause	Remedy
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	Seal
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	Mount assembled parts according to the information provided by the coupling or 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 (for example, defective coupling)	Machine or system manufacturer
	Hydraulic fluid not in optimum 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
Pressure statically at approx 5...12 bar, cannot be changed	Supply voltage not within the permissible range Diagnosis: Check the status LEDs	Check, whether central plug XH4 is connected to the pilot valve
		Check voltage at the last interconnection point (terminal strip) upstream of the pilot 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 69
	Spool jams in pilot valve	Contact Rexroth Service

Table 27: Malfunction table of HS5E control systems

Malfunction	Possible cause	Remedy
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 83
		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 83 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
	Pilot valve defective	Replace pilot valve, see chapter "10.5.1" on page 82
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 58
	Pressure transducer defective/not connected Diagnosis: Measure signal from PT and compare with indication on the pressure gauge	Replace pressure transducer, see page 58 Connect pressure transducer
	Pilot valve defective	Replace pilot valve, see chapter "10.5.1" on page 82
Insufficient flow	Pressure controller active	Increase pressure command value
	Actual swivel angle acquisition improperly set	Recalibrate swivel angle sensor
	Drive 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.
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
	Spool jams in pilot valve Diagnosis: Compare actual value and valve command value in IndraWorks	Replace pilot valve, see chapter "10.5.1" on page 82
	Actual swivel angle value acquisition maladjusted or not working properly	Swivel angle measurement check
	Valve electronics defective	Replace pilot valve, see chapter "10.5.1" on page 82

Table 27: Malfunction table of HS5E control systems

Malfunction	Possible cause	Remedy
Hydraulic fluid temperature too high	Too high inlet temperature at control system	inspect system, for example, 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 control system”on page 75. Bosch Rexroth recommend repeating calibration or checking it at certain intervals.

15 Technical data

The permissible technical data values for your axial piston unit can be found on data sheet 92076.
The data sheet can be found on the internet at
www.boschrexroth.com/mediadirectory
Additional information can be found in the online product catalog
Mobile Hydraulics: www.boschrexroth.com/axial-piston-pumps
Order-related technical data for your axial piston unit can be found in the order confirmation.

15.1 Electrical connection of the pilot valve

Table 28: Electrical Datas

Type			HS5E
Supply voltage[1)]	Nominal voltage		24 VDC
	Lower limit value		18 VDC
	Upper limit value		36 VDC
	Maximum permissible residual ripple		2.5 Vss
Power consumption		Maximum	40 W
Required external fuse protection			4 A, slow-blow
AD/DA resolution	Analog inputs		12 bit
	Analog outputs[2)]		10 bit
Actual pressure value Input XH4, Pins 10 and 11	Analog voltage		0 to 10 V
	Analog current		0 to 20 mA With configuration to current input: Maximum permissible input current 30 mA
Ambient temperature range at the pump		v	-20 to +60 °C
Storage temperature range of pump/electronics		v	0 to +70 °C

[1)] Supply voltage is used directly for sensor connections **X2M1, X2M2,** and **X8M** (no internal voltage limitation)
[2)] Outputs can be parameterized; for as-delivered condition, see page 52

Pin assignment of central connector

The following table shows the pin assignment of the central connector 11 + PE for pilot control valve HS5E. The column “code” refers to the cable kit that can be ordered as optional accessories.
The following cable sets can be ordered from Bosch Rexroth:
Type: Plug-in connector 11+PE for central connector XH4
• Without cable (assembly kit) Mat. no. R900884671
• With cable kit 2 x 5 m Mat. no R900032356
• With cable kit 2 x 20 m Mat. no R900860399
• Ethernet M12 connecting cable, please contact Rexroth for the material number.
(Please contact us if the unit is to be used outside the specified range of values)

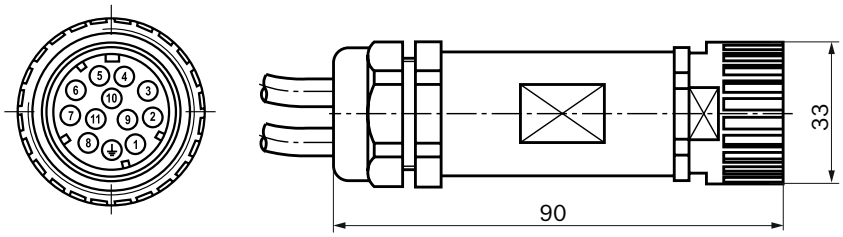


Fig. 31: Pin assignment of the central connector

Table 29: Signals to the central connector

Pin	Signal	Description	Signal direction	Signal level	Code
1	+ UB	Voltage supply	IN	+24 V	1
2	L0	Reference potential for voltage supply	-	-	2
⏚	Ground	Ground connection for the electronics	-	-	Yellow/ green
3	DO	Switching output 24 V, max. 1.5 A Factory setting: Error signal	OUT	Logical 24 V (Load $I_{max} \leq 50$ mA)	White
4	M0	Reference potential for analog signals	-	-	Yellow
5	AI 2	Analog input 2 (or digital input, to be configured by means of software) Factory setting: Software command value standardized	IN	Analog +/-10 V or 0-20 mA (digital 24V)	Green
6	AO 2	Analog output 2 Factory setting: Software actual value standardized	OUT	+/- 10V or 0-20 mA (Load $I_{max} \leq 1$ mA)	Violet
7	AI 1	Analog input 1 (or digital input, to be configured by means of software) Factory setting: Pressure command value standardized	IN	+/- 10 V or 0-20 mA or 24 V digital	Pink
8	AO 1	Analog output 1 Factory setting: Actual pressure value standardized	OUT	+/- 10V or 0-20 mA (load $I_{max} \leq 1$ mA)	Red
9	DI	Digital input (use can be freely configured) Factory setting: Error reset	IN	Logical 24 V	Brown
10	Actual pressure value High	Actual pressure value input: Signal level dependent on parameter setting. Factory setting depending on option 14 in the ordering code: 0-10 V (V) or disabled (F)	IN	0-10 V, 0-20 mA (freely configurable)	Black
11	Actual pressure value Low	Reference potential for actual pressure value signal (p_{actual} High)	-	-	Blue
n.c.					Gray

Connect M0 and L0 in the control cabinet to prevent potential shifts.

15.2 Environmental compatibility for the areas EMC, clime and mechanical load

Type			HS5E
Mechanical loading: sine test according to DIN EN 60068-2-6			10 ... 2000 Hz/maximum of 10g/10 cycles/3 axes
Mechanical loading: Noise check according to DIN EN 60068-2-64			20 ... 2000 Hz/10g RMS/30g peak/30 min/3 axes
Mechanical loading: Transport shock according to DIN EN 60068-2-27			15g/11ms/3 axes
Electromagnetic compatibility (EMC)			
▶ EN 61000-6-2 / EN 61000-6-3 – EN 61000-4-2 ESD – EN 61000-4-4 burst – EN 61000-4-5 surge – EN 61000-4-6 HF line-conducted – EN 55016-2-1 radio interference voltage			10 kV CD/15 kV AD with BWK B 2 kV with BWK B 0.5 kV (sym./asym.) with BWK B 10 Veff (150 kHz ... 80 MHz) with BWK A 0.15 ... 30 MHz, Class A, EN 55022
Maximum relative humidity (non-condensing)			95%
Design of electronics			Integrated on pilot valve (OBE)
Electrical connection			See page 92, below
Type of protection according to EN 60529	Pump including pilot valve		IP 65 with mounted and locked plug-in connectors

Notice: The information about mechanical loading only refers to components containing electronics, i.e. the HS5E pilot control valve, HM20 and the VT-SWA-Lin.

16 Alphabetical index

The Drive & Control Company

Rexroth
Bosch Group

Bosch Rexroth AG
Mobile Applications
An den Kelterwiesen 14
72160 Horb a.N.
Germany
Phone: +49 7451 92-0
info.ma@boschrexroth.de
www.boschrexroth.com

Your local contact person can be found at:
www.boschrexroth.com/addresses

Subject to change
Printed in Germany
RE 92076-01-B/10.2017