The Drive & Control Company

Rexroth
Bosch Group

Frequency-Controlled Pump Drive System

Sytronix DRn 5020

Operating Instructions
R912004808

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1 About this Documentation

1.1 Validity of the Documentation

This documentation applies to the variable speed pump drives, Sytronix DRn 5020 and with drive controllers Rexroth EFC5610.

The content of this documentation focuses on information on the electric drive system. Motors and pumps are described in separate instruction manuals. Where required, this documentation may refer to the amending documentations.

This documentation contains important information on the safe and proper transport, assembly, commissioning, maintenance, disassembly and simple troubleshooting of the product.

- You should read this documentation completely and in particular chapter 2 "Safety Instructions" on page 11 before working with the product.

This documentation is valid for DRn 5020 systems with Rexroth frequency converter EFC 5610 with firmware of version 03V08 and higher and with Sytronix ASF of version FWS-XFC01*-C14-02VRS-NN and higher.

About this Documentation

1.2 Required and Amending Documentation

The product must not be commissioned until you have been provided with the following documentations and you have understood and observed them.

Title	Document number	Document type	Catalog
Sytronix DRn 5020 Frequency-Controlled Pump Drive System	R912007127	Quick Start Guide	Controller / Converter
Rexroth Frequency Converter EFC 3610 / EFC 5610 Series	R912005856	Quick Start Guide	
Rexroth Frequency Converter EFC 3610 / EFC 5610 Series	R912005854	Operating Instructions	
Rexroth Frequency Converter Multi-Ethernet Card	R912006860	Instruction Manual	
Rexroth Frequency Converter EFC x610 Series Brake Chopper	R912007235	Operating Instructions	
Sytronix-variable-speed pump drives	R999000332	Data sheet	System Catalog
Pressure transducer with integrated electronics-type HM20	30272	Data sheet	Presssure Sensor
Rexroth IndraDyn E Standard Motors MOT-FC for Frequency Converter Operation	R911343624	Project planning manual	Motor
Variable-Speed Drive, Fixed Displacement, type A10	91485	Data sheet	Pump
Axial Piston Variable Pumps A10VO, A10VSO, A10VSNO	92714-01-B	Instruction manual	
Variable-Speed Drive, Fixed Displacement, type A4	92050	Data sheet	
Axial piston variable pump A4VSO	92050-01-B	Operating instructions	
Rexroth Sytronix Mounting and Commissioning Axial Piston Variable Pump-A10VZO / A10VSO / A4VSO	R911341629	Mounting instructions	Pump Mounting
Control Cabinet: climate control, EMC, setup, degree of protection, electrics, IndraDrive, Rexroth Fv, Sytronix	R911344988	Project planning manual	Cabinet Planning

Tab. 1-1: Required and amending documentation

☞

1. Only **Quick Start Guide** for DRn 5020 and EFC converter (Row 1 and 2) will be printed and delivered with EFC converter for Sytronix, for more information about the controller / converter please refer to the document of row 3 and this document, which can be downloaded or purchased by **Bosch Rexroth**.
2. Since the Sytronix controller have been embedded to EFC converter, both documents (Sytronix DRn 5020 and EFC 5610) are needed for operating the controller / converter.

1.3 Representation of Information

1.3.1 Consistency

Consistent safety instructions, symbols, terms and abbreviations are used so that you can quickly and safely work with your product using this documentation. For a better understanding, they are explained in the following sections.

1.3.2 Safety Instructions

In this documentation, safety instructions are included whenever sequences of actions are explained which bear the danger of personal injury or damage to property. The hazard avoidance measures described must be observed.

Safety instructions are structured as follows:

⚠ SIGNAL WORD
Type and source of danger
Consequences in case of non-compliance • Hazard avoidance measures • <Enumeration>

- **Warning sign:** Draws attention to the danger
- **Signal word:** Identifies the degree of danger
- **Type and source of danger:** Identifies the type and source of danger
- **Consequences:** Describes the consequences of non-compliance
- **Precaution:** Specifies how the hazard can be prevented

Risk classes according to ANSI Z535.6-2006

⚠ DANGER

Indicates a dangerous situation which will cause death or severe injuries if not prevented.

⚠ WARNING

Indicates a dangerous situation which may cause death or severe injuries if not prevented.

⚠ CAUTION

Indicates a dangerous situation which may cause minor to medium injuries if not prevented.

NOTICE

Indicates damage to property: The product or the environment could be damaged.

1.3.3 Symbols

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

Symbol	Meaning
☞	If this information is not observed, the product cannot be used and/or operated optimally.
•	Single, independent action.
1. 2. 3.	Numbered instruction: The numbers indicate that the actions must be carried out one after the other.

Tab. 1-2: Meaning of the symbols

1.3.4 Abbreviations

The following abbreviations are used in this documentation:

Abbreviation	Meaning
DRn system	Frequency controlled pump system
p	Pressure
Q	Flow
n	Speed
DR	Pump integrated mechanical pressure controller
DRG	Pump integrated mechanical pressure controller for remote control
α	Swivel angle of the axial piston pump
RE	Rexroth document in English language
RX	Rexroth document in another language
ESD/EMC	Electrostatic discharge/electro-magnetic compatibility
CPU	Central processing unit, processor
EFC	Frequency converter
Vg	Displacement of the pump
ASF	Application Specific Firmware, application control software for EFC frequency converter
X1, X2, ..	Digital input
EX1, EX2, ...	Digital input on extension card
AI1, AI2	Analog input
EAI	Analog input on extension card
DO1	Digital output
EDO	Digital output on extension card
AO1	Analog output
EAO	Analog output on extension card

Tab. 1-3: Abbreviations

2 Safety Instructions

2.1 General Information on this Chapter

The product has been manufactured according to the generally accepted codes of practice. However, there is still the risk of personal injury and damage to property if you do not observe this chapter and the safety instructions in this documentation.

- Read this documentation completely and thoroughly before working with the product.
- 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 product on to third parties.

2.2 Intended Use

This product is an electrohydrostatic drive system.

The DRn system is exclusively intended to be installed in a machine or to be assembled together with other components to form a machine and/or a power unit. The DRn system may only be commissioned after it has been integrated into the machine for which it is designed.

The DRn system may be used as follows:

- For constant pressure-controlled hydraulic supply

The DRn system is not suitable for performing safety-relevant functions.

☞ A plausibility check of the command and actual values (pressure and swivel angle) is not provided for in the DRn system.

- Make sure that the plausibility check is carried out in the machine control.

In order to carry out an application-specific adjustment of the parameters within the scope of the initial commissioning, please contact your Bosch Rexroth application engineer.

The product is only intended for professional use and not for private use. Intended use includes having read and understood this documentation completely, especially this chapter.

2.3 Improper Use

Any use deviating from the intended use is improper and thus not admissible. Bosch Rexroth AG does not assume any liability for damage caused by improper use. The user assumes all risks involved with improper use.

2.4 Qualification of Personnel

The activities described in this documentation require basic knowledge of mechanics, hydraulics and electrics as well as knowledge of the appropriate technical terms. For transporting and handling the product, additional knowledge of how to handle lifting tools and the necessary attachment devices is required. In order to ensure safe use, these activities may only be carried out by an expert in the field or an instructed person under the direction and supervision of an expert.

Experts are persons who are able to recognize potential dangers and take appropriate safety measures due to their technical training, knowledge and experience, as well as their knowledge of the relevant regulations pertaining to the work to be undertaken. An expert must observe the relevant specific professional rules.

The following is required as additional qualification:

- Knowledge of the wiring of the electric components
- Knowledge of the application software parameterization
- Basic control technology knowledge

2.5 General Safety Instructions

- Observe the valid regulations on accident prevention and for environmental protection.
- Observe the safety regulations and provisions of the country where the product is implemented/used.
- Exclusively use Rexroth products in technically perfect condition.
- Observe all notices on the product.
- Persons who assemble, operate, disassemble or maintain Rexroth products must not be under the influence of alcohol, other drugs or pharmaceuticals that may affect their ability to react.
- Only use accessories and spare parts authorized by the manufacturer in order to exclude hazards to persons due to inappropriate spare parts.
- Comply with the technical data and environmental conditions indicated in the product documentation.
- The installation or use of inappropriate products in safety-relevant applications could result in unintended operating states when being used which in turn could cause personal injuries and/or damage to property. Therefore, only use a product for safety-relevant applications if this use is expressly specified and permitted in the documentation of the product.
- Do not commission the product until you can be sure that the end product (for example a machine or system) where the Rexroth product is installed complies with the country-specific provisions, safety regulations and standards of application.

2.6 Product- and Technology-dependent Safety Instructions

⚠ WARNING

Pressurized system!

Danger to life, risk of injury, severe injury when working on systems that have not been stopped! Damage to property!

- Ensure that the DRn system and/or the machine is completely depressurized.
- Do not disconnect line connections, connections or components as long as the DRn system is pressurized.
- Switch off all force-transmitting components and ports (electric, pneumatic, hydraulic) according to the manufacturer's specifications and secure them against restarting. If possible, remove the mains fuse of the system.

⚠ WARNING

Leaking oil mist due to defective or improperly assembled seals!

Risk of fire, risk of explosion, danger due to allergic reactions, environmental pollution!

- Welding work may only be carried out when the DRn system is depressurized.
- Keep open fire and ignition sources away from the DRn system.

⚠ WARNING

High electrical voltage (above 50 V)!

Danger to life, risk of injury caused by electric shock or severe injury!

- Make sure the relevant system part is de-energized before assembling the DRn system or connecting and disconnecting connectors.
- Protect the system against restarting.
- Only carry out short-time measurements and tests with permanently connected protective grounding conductor at those points of the components intended for this purpose.
- After switch-off, you should generally wait for 30 minutes before you touch an electric component in order to allow the live capacitors to discharge. Measure the electrical voltage of live parts before beginning the work in order to avoid hazards caused by contact.
- Do not touch the electrical connection points of the components if the system is activated.

⚠ WARNING

High housing voltage and high leakage current!

Danger to life, risk of injury caused by electric shock or severe injury!

- Before switch-on and commissioning, ground the components of the DRn system or connect them to the protective grounding conductors at the grounding points.
- Always connect the protective grounding conductors of the DRn system components permanently to the supply network. The leakage current is greater than 3.5 mA.
- Use at least a 10 mm² copper cross-section for the entire route of the protective grounding conductor.

⚠ WARNING

Exposure to magnetic and electro-magnetic fields!

Health hazard for persons with cardiac pacemakers, metal implants and hearing aids in the immediate vicinity of electric components!

- Ban the group of persons specified above from entering the following areas:
  - Areas in which components of the DRn system are mounted, commissioned and operated
  - Areas in which motor parts with permanent solenoids are stored, repaired or mounted
- Consult a doctor if the persons specified above have to work in these areas.

⚠ CAUTION

Hot DRn system surfaces!

Risk of burning! Risk of injury!

- Only touch the surfaces of the DRn system with protective gloves or do not work on hot surfaces.

  During or after the operation, temperatures may rise to values higher than 60 °C (140 °F), depending on the operating conditions.
- Allow the DRn system to cool down sufficiently before touching it.
- Observe the protective measures of the end machine manufacturer.

⚠ CAUTION

Slip hazard due to oily surfaces!

Risk of injury!

- Protect and mark the danger zone.
- Use an oil binding agent in order to bind the leaked hydraulic fluid.
- Remove and dispose of the contaminated oil binding agent (see chapter 12 "Environmental protection and disposal " on page 121).
- Wear your protective equipment, such as safety shoes.

⚠ CAUTION

Hydraulic fluid leaking from the DRn system in an uncontrolled form (due to leakage)!

Risk of injury!

- Switch the machine off immediately (emergency stop switch).
- Identify and remedy the cause of the leakage.
- Never try to stop or seal the leak or the oil jet using a cloth.
- Never come into contact with a splashing high-pressure oil jet under any circumstances.
- Carry out visual inspections for leak-tightness of the DRn system and the oil containing components on a regular basis.

⚠ CAUTION

Contact with hydraulic fluid!

Health hazard / impairment of health, e.g. eye injuries, skin lesions, poisoning when inhaled!

- Avoid contact with hydraulic fluids.
- When dealing with hydraulic fluids, you must observe the safety instructions of the manufacturer.
- Use your personal protective equipment (e. g. safety goggles, protective gloves, suitable working clothes, safety shoes).
- If, nevertheless, hydraulic fluid comes into contact with the eyes or gets into the bloodstream or is swallowed, please consult a doctor immediately.

2.7 Obligations of the Machine End-user

The machine end-user of the products by Bosch Rexroth AG is obliged to provide for personnel training on a regular basis regarding the following subjects:

- Observation and use of the operating instructions as well as the legal regulations.
- Intended operation of the product.
- Observation of the instructions of factory security officers and of the operating instructions of the machine end-user.
- Behavior in case of emergency.

☞ Bosch Rexroth AG offers training support measures in specific fields. You can find an overview of the training contents on the Internet at http://www.boschrexroth.com/didactic.

3 Safety Instructions for Electric Drives and Controls

3.1 Definitions of Terms

Application documentation Application documentation comprises the entire documentation used to inform the user of the product about the use and safety-relevant features for configuring, integrating, installing, mounting, commissioning, operating, maintaining, repairing and decommissioning the product. The following terms are also used for this kind of documentation: Operating Instructions, Commissioning Manual, Instruction Manual, Project Planning Manual, Application Description, etc.

Component A component is a combination of elements with a specified function, which are part of a piece of equipment, device or system. Components of the electric drive and control system are, for example, supply units, drive controllers, mains choke, mains filter, motors, cables, etc.

Control system A control system comprises several interconnected control components placed on the market as a single functional unit.

Device A device is a finished product with a defined function, intended for users and placed on the market as an individual piece of merchandise.

Electrical equipment Electrical equipment encompasses all devices used to generate, convert, transmit, distribute or apply electrical energy, such as electric motors, transformers, switching devices, cables, lines, power-consuming devices, circuit board assemblies, plug-in units, control cabinets, etc.

Electric drive system An electric drive system comprises all components from mains supply to motor shaft; this includes, for example, electric motor(s), motor encoder(s), supply units and drive controllers, as well as auxiliary and additional components, such as mains filter, mains choke and the corresponding lines and cables.

Installation An installation consists of several devices or systems interconnected for a defined purpose and on a defined site which, however, are not intended to be placed on the market as a single functional unit.

Machine A machine is the entirety of interconnected parts or units at least one of which is movable. Thus, a machine consists of the appropriate machine drive elements, as well as control and power circuits, which have been assembled for a specific application. A machine is, for example, intended for processing, treatment, movement or packaging of a material. The term "machine" also covers a combination of machines which are arranged and controlled in such a way that they function as a unified whole.

Manufacturer The manufacturer is an individual or legal entity bearing responsibility for the design and manufacture of a product which is placed on the market in the individual's or legal entity's name. The manufacturer can use finished products, finished parts or finished elements, or contract out work to subcontractors. However, the manufacturer must always have overall control and possess the required authority to take responsibility for the product.

Product Examples of a product: Device, component, part, system, software, firmware, among other things.

Project planning manual A Project Planning Manual is part of the application documentation used to support the sizing and planning of systems, machines or installations.

Qualified persons In terms of this application documentation, qualified persons are those persons who are familiar with the installation, mounting, commissioning and operation of the components of the electric drive and control system, as well as with the hazards this implies, and who possess the qualifications their work

requires. To comply with these qualifications, it is necessary, among other things,

- to be trained, instructed or authorized to switch electric circuits and devices safely on and off, to ground them and to mark them.
- to be trained or instructed to maintain and use adequate safety equipment.
- to attend a course of instruction in first aid.

User A user is a person installing, commissioning or using a product which has been placed on the market.

3.2 General Information

3.2.1 Using the Safety Instructions and Passing them on to Others

Do not attempt to install and operate the components of the electric drive and control system without first reading all documentation provided with the product. Read and understand these safety instructions and all user documentation prior to working with these components. If you do not have the user documentation for the components, contact your responsible Rexroth sales partner. Ask for these documents to be sent immediately to the person or persons responsible for the safe operation of the components.

If the component is resold, rented and/or passed on to others in any other form, these safety instructions must be delivered with the component in the official language of the user's country.

Improper use of these components, failure to follow the safety instructions in this document or tampering with the product, including disabling of safety devices, could result in property damage, injury, electric shock or even death.

3.2.2 Requirements for Safe Use

Read the following instructions before initial commissioning of the components of the electric drive and control system in order to eliminate the risk of injury and/or property damage. You must follow these safety instructions.

- Rexroth is not liable for damages resulting from failure to observe the safety instructions.
- Read the operating, maintenance and safety instructions in your language before commissioning. If you find that you cannot completely understand the application documentation in the available language, please ask your supplier to clarify.
- Proper and correct transport, storage, mounting and installation, as well as care in operation and maintenance, are prerequisites for optimal and safe operation of the component.
- Only qualified persons may work with components of the electric drive and control system or within its proximity.
- Only use accessories and spare parts approved by Rexroth.
- Follow the safety regulations and requirements of the country in which the components of the electric drive and control system are operated.
- Only use the components of the electric drive and control system in the manner that is defined as appropriate. See chapter "Appropriate Use".
- The ambient and operating conditions given in the available application documentation must be observed.
- Applications for functional safety are only allowed if clearly and explicitly specified in the application documentation "Integrated Safety Technology". If this is not the case, they are excluded. Functional safety is a safety concept in which measures of risk reduction for personal safety depend on electrical, electronic or programmable control systems.
- The information given in the application documentation with regard to the use of the delivered components contains only examples of applications and suggestions.

  The machine and installation manufacturers must

  – make sure that the delivered components are suited for their individual application and check the information given in this application documentation with regard to the use of the components,

  - make sure that their individual application complies with the applicable safety regulations and standards and carry out the required measures, modifications and complements.
- Commissioning of the delivered components is only allowed once it is sure that the machine or installation in which the components are installed complies with the national regulations, safety specifications and standards of the application.
- Operation is only allowed if the national EMC regulations for the application are met.
- The instructions for installation in accordance with EMC requirements can be found in the section on EMC in the respective application documentation.

  The machine or installation manufacturer is responsible for compliance with the limit values as prescribed in the national regulations.
- The technical data, connection and installation conditions of the components are specified in the respective application documentations and must be followed at all times.

National regulations which the user has to comply with

- European countries: In accordance with European EN standards
- United States of America (USA):
  - National Electrical Code (NEC)
  - National Electrical Manufacturers Association (NEMA), as well as local engineering regulations
  - Regulations of the National Fire Protection Association (NFPA)
- Canada: Canadian Standards Association (CSA)
- Other countries:
  - International Organization for Standardization (ISO)
  - International Electrotechnical Commission (IEC)

3.2.3 Hazards by Improper Use

- High electrical voltage and high working current! Danger to life or serious injury by electric shock!
- High electrical voltage by incorrect connection! Danger to life or injury by electric shock!
- Dangerous movements! Danger to life, serious injury or property damage by unintended motor movements!
- Health hazard for persons with heart pacemakers, metal implants and hearing aids in proximity to electric drive systems!
- Risk of burns by hot housing surfaces!
- Risk of injury by improper handling! Injury by crushing, shearing, cutting, hitting!
- Risk of injury by improper handling of batteries!
- Risk of injury by improper handling of pressurized lines!

3.3 Instructions with Regard to Specific Dangers

3.3.1 Protection against Contact with Electrical Parts and Housings

☞ This section concerns components of the electric drive and control system with voltages of **more than 50 volts**.

Contact with parts conducting voltages above 50 volts can cause personal danger and electric shock. When operating components of the electric drive and control system, it is unavoidable that some parts of these components conduct dangerous voltage.

High electrical voltage! Danger to life, risk of injury by electric shock or serious injury!

- Only qualified persons are allowed to operate, maintain and/or repair the components of the electric drive and control system.
- Follow the general installation and safety regulations when working on power installations.
- Before switching on, the equipment grounding conductor must have been permanently connected to all electric components in accordance with the connection diagram.
- Even for brief measurements or tests, operation is only allowed if the equipment grounding conductor has been permanently connected to the points of the components provided for this purpose.
- Before accessing electrical parts with voltage potentials higher than 50 V, you must disconnect electric components from the mains or from the power supply unit. Secure the electric component from reconnection.
- With electric components, observe the following aspects:

  Always wait **30 minutes** after switching off power to allow live capacitors to discharge before accessing an electric component. Measure the electrical voltage of live parts before beginning to work to make sure that the equipment is safe to touch.
- Install the covers and guards provided for this purpose before switching on.
- Never touch any electrical connection points of the components while power is turned on.
- Do not remove or plug in connectors when the component has been powered.
- Under specific conditions, electric drive systems can be operated at mains protected by residual-current-operated circuit-breakers sensitive to universal current (RCDs/RCMs).
- Secure built-in devices from penetrating foreign objects and water, as well as from direct contact, by providing an external housing, for example a control cabinet.

High housing voltage and high leakage current! Danger to life, risk of injury by electric shock!

- Before switching on and before commissioning, ground or connect the components of the electric drive and control system to the equipment grounding conductor at the grounding points.

- Connect the equipment grounding conductor of the components of the electric drive and control system permanently to the main power supply at all times. The leakage current is greater than 3.5 mA.
- Establish an equipment grounding connection with a minimum cross section according to the table below. With an outer conductor cross section smaller than 10 mm^2 (8 AWG), the alternative connection of two equipment grounding conductors is allowed, each having the same cross section as the outer conductors.

Cross section outer conductor	Minimum cross section equipment grounding conductor Leakage current ≥ 3.5 mA	
	1 equipment grounding conductor	2 equipment grounding conductors
1.5 mm^2 (16 AWG)	10 mm^2 (8 AWG)	2 × 1.5 mm^2 (16 AWG)
2.5 mm^2 (14 AWG)	10 mm^2 (8 AWG)	2 × 2.5 mm^2 (14 AWG)
4 mm^2 (12 AWG)	10 mm^2 (8 AWG)	2 × 4 mm^2 (12 AWG)
6 mm^2 (10 AWG)	10 mm^2 (8 AWG)	2 × 6 mm^2 (10 AWG)
10 mm^2 (8 AWG)	10 mm^2 (8 AWG)	-
16 mm^2 (6 AWG)	16 mm^2 (6 AWG)	-
25 mm^2 (4 AWG)	16 mm^2 (6 AWG)	-
35 mm^2 (2 AWG)	16 mm^2 (6 AWG)	-
50 mm^2 (1/0 AWG)	25 mm^2 (4 AWG)	-
70 mm^2 (2/0 AWG)	35 mm^2 (2 AWG)	-
...	...	...

Tab. 3-1: Minimum cross section of the equipment grounding connection

3.3.2 Protective Extra-low Voltage as Protection against Electric Shock

Protective extra-low voltage is used to allow connecting devices with basic insulation to extra-low voltage circuits.

On components of an electric drive and control system provided by Rexroth, all connections and terminals with voltages up to 50 volts are PELV ("Protective Extra-Low Voltage") systems. It is allowed to connect devices equipped with basic insulation (such as programming devices, PCs, notebooks, display units) to these connections.

Danger to life, risk of injury by electric shock! High electrical voltage by incorrect connection!

If extra-low voltage circuits of devices containing voltages and circuits of more than 50 volts (e.g., the mains connection) are connected to Rexroth products, the connected extra-low voltage circuits must comply with the requirements for PELV ("Protective Extra-Low Voltage").

3.3.3 Protection against Dangerous Movements

Dangerous movements can be caused by faulty control of connected motors. Some common examples are:

- Improper or wrong wiring or cable connection
- Operator errors
- Wrong input of parameters before commissioning
- Malfunction of sensors and encoders
- Defective components
- Software or firmware errors

These errors can occur immediately after equipment is switched on or even after an unspecified time of trouble-free operation.

The monitoring functions in the components of the electric drive and control system will normally be sufficient to avoid malfunction in the connected drives. Regarding personal safety, especially the danger of injury and/or property damage, this alone cannot be relied upon to ensure complete safety. Until the integrated monitoring functions become effective, it must be assumed in any case that faulty drive movements will occur. The extent of faulty drive movements depends upon the type of control and the state of operation.

Dangerous movements! Danger to life, risk of injury, serious injury or property damage!

A **risk assessment** must be prepared for the installation or machine, with its specific conditions, in which the components of the electric drive and control system are installed.

As a result of the risk assessment, the user must provide for monitoring functions and higher-level measures on the installation side for personal safety. The safety regulations applicable to the installation or machine must be taken into consideration. Unintended machine movements or other malfunctions are possible if safety devices are disabled, bypassed or not activated.

To avoid accidents, injury and/or property damage:

- Keep free and clear of the machine's range of motion and moving machine parts. Prevent personnel from accidentally entering the machine's range of motion by using, for example:
  - Safety fences
  - Safety guards
  - Protective coverings
  - Light barriers
- Make sure the safety fences and protective coverings are strong enough to resist maximum possible kinetic energy.
- Mount emergency stopping switches in the immediate reach of the operator. Before commissioning, verify that the emergency stopping equipment works. Do not operate the machine if the emergency stopping switch is not working.
- Prevent unintended start-up. Isolate the drive power connection by means of OFF switches/OFF buttons or use a safe starting lockout.
- Make sure that the drives are brought to safe standstill before accessing or entering the danger zone.

- Additionally secure vertical axes against falling or dropping after switching off the motor power by, for example,
  - mechanically securing the vertical axes,
  - adding an external braking/arrester/clamping mechanism or
  - ensuring sufficient counterbalancing of the vertical axes.
- The standard equipment **motor holding brake** or an external holding brake controlled by the drive controller is **not sufficient to guarantee personal safety**!
- Disconnect electrical power to the components of the electric drive and control system using the master switch and secure them from reconnection ("lock out") for:
  - Maintenance and repair work
  - Cleaning of equipment
  - Long periods of discontinued equipment use
- Prevent the operation of high-frequency, remote control and radio equipment near components of the electric drive and control system and their supply leads. If the use of these devices cannot be avoided, check the machine or installation, at initial commissioning of the electric drive and control system, for possible malfunctions when operating such high-frequency, remote control and radio equipment in its possible positions of normal use. It might possibly be necessary to perform a special electromagnetic compatibility (EMC) test.

3.3.4 Protection against Electromagnetic and Magnetic Fields during Operation and Mounting

Electromagnetic and magnetic fields!

Hazards for persons with active medical implants or passive metallic implants, as well as for pregnant women.

- Persons with active medical implants (e.g. heart pacemakers), passive metallic implants (e.g. hip implants) and pregnant women might possibly risk hazards by electromagnetic or magnetic fields in the immediate vicinity of components of the electric drive and control system and the associated current-carrying conductors.

  Entering the following areas can cause danger to these persons:
  - Areas in which components of the electric drive and control system and the associated current-carrying conductors are mounted, commissioned and operated.
  - Areas in which parts of motors with permanent magnets are stored, repaired or mounted.
- Before entering these areas, the above-mentioned persons should seek advice from their physician.
- Observe the occupational safety and health regulations applicable at the site of operation, for installations equipped with components of the electric drive and control system and the associated current-carrying conductors.

3.3.5 Protection against Contact with Hot Parts

Hot surfaces of components of the electric drive and control system. Risk of burns!

- Do not touch hot surfaces of, for example, braking resistors, heat sinks, supply units and drive controllers, motors, windings and laminated cores!
- According to the operating conditions, temperatures of the surfaces can be **higher than 60 °C** (140 °F) during or after operation.
- Before touching motors after having switched them off, let them cool down for a sufficient period of time. Cooling down can require **up to 140 minutes**! The time required for cooling down is approximately five times the thermal time constant specified in the technical data.
- After switching chokes, supply units and drive controllers off, wait **15 minutes** to allow them to cool down before touching them.
- Wear safety gloves or do not work at hot surfaces.
- For certain applications, and in accordance with the respective safety regulations, the manufacturer of the machine or installation must take measures to avoid injuries caused by burns in the final application. These measures can be, for example: Warnings at the machine or installation, guards (shieldings or barriers) or safety instructions in the application documentation.

3.3.6 Protection during Handling and Mounting

Risk of injury by improper handling! Injury by crushing, shearing, cutting, hitting!

- Observe the relevant statutory regulations of accident prevention.
- Use suitable equipment for mounting and transport.
- Avoid jamming and crushing by appropriate measures.
- Always use suitable tools. Use special tools if specified.
- Use lifting equipment and tools in the correct manner.
- Use suitable protective equipment (hard hat, safety goggles, safety shoes, safety gloves, for example).
- Do not stand under hanging loads.
- Immediately clean up any spilled liquids from the floor due to the risk of falling!

3.3.7 Battery Safety

Batteries consist of active chemicals in a solid housing. Therefore, improper handling can cause injury or property damage.

Risk of injury by improper handling!

- Do not attempt to reactivate low batteries by heating or other methods (risk of explosion and cauterization).
- Do not attempt to recharge the batteries as this may cause leakage or explosion.
- Do not throw batteries into open flames.
- Do not dismantle batteries.
- When replacing the battery/batteries, do not damage the electrical parts installed in the devices.
- Only use the battery types specified for the product.

☞ Environmental protection and disposal! The batteries contained in the product are considered dangerous goods during land, air, and sea transport (risk of explosion) in the sense of the legal regulations. Dispose of used batteries separately from other waste. Observe the national regulations of your country.

3.3.8 Protection against Pressurized Systems

According to the information given in the Project Planning Manuals, motors and components cooled with liquids and compressed air can be partially supplied with externally fed, pressurized media, such as compressed air, hydraulics oil, cooling liquids and cooling lubricants. Improper handling of the connected supply systems, supply lines or connections can cause injuries or property damage.

Risk of injury by improper handling of pressurized lines!

- Do not attempt to disconnect, open or cut pressurized lines (risk of explosion).
- Observe the respective manufacturer's operating instructions.
- Before dismounting lines, relieve pressure and empty medium.
- Use suitable protective equipment (safety goggles, safety shoes, safety gloves, for example).
- Immediately clean up any spilled liquids from the floor due to the risk of falling!

☞ Environmental protection and disposal! The agents (e.g., fluids) used to operate the product might not be environmentally friendly. Dispose of agents harmful to the environment separately from other waste. Observe the national regulations of your country.

3.3.9 General Warnings of Damage to Property and Damage to the Product

NOTICE

Danger due to improper handling!

Damage to property!

- The DRn system may only be operated according to chapter 2.2 "Intended Use" on page 11.
- Avoid impacts against functionally relevant areas (e.g. mounting surfaces) and attachment parts (e.g. plug-in connections).

NOTICE

Mixing hydraulic fluids!

Damage to property!

- Any mixing of hydraulic fluids by different manufacturers and/or of different types by the same manufacturer is generally not admissible.

NOTICE

Contamination by fluids and foreign particles!

Premature wear and malfunctions!

- During assembly, provide for cleanliness in order to prevent foreign particles e.g. welding beads or metal chips from getting into the hydraulic lines and causing wear or malfunctions in the DRn system.
- Ensure that all connections, hydraulic lines and attachment parts (e.g. measuring devices) are clean and free of chips.
- For removing lubricants or any other heavy contamination, use industrial residue-free wipes.
- Before commissioning, ensure that all hydraulic and mechanical connections are connected.
- Only carry out cleaning processes on the DRn system if the hydraulic connections are closed.
- Make sure that the cleanliness class of the hydraulic fluid according to ISO4406©) specified in the data sheet axial piston pump , xxxx "mineral oil" and RE 90221 "environmentally acceptable hydraulic fluids".
- Filter the hydraulic fluid during filling using a suitable filter system in order to minimize solid particle contamination and reduce the water in the system.

NOTICE

Improper cleaning!

Damage to property!

- Close all openings using suitable protective caps and/or fittings in order to prevent cleaning agents from penetrating the system.
- Check that all seals and caps of electric plug-in connections are firmly fitted to prevent the penetration of cleaning agents.
- Do not use aggressive cleaning agents for cleaning. Clean the DRn system using a suitable cleaning liquid.
- The use of a high-pressure washer is not admitted.

NOTICE

Operation with a lack of hydraulic fluid!

The DRn system may be damaged or destroyed!

- Observe the system manufacturer's specifications regarding the point "Control of the hydraulic fluid" and the prescribed remedial measures for the control result.

NOTICE

Leaking or spilt hydraulic fluid!

Environmental pollution and pollution of the ground water!

- Use an oil binding agent in order to bind the leaked hydraulic fluid.
- When filling and draining the hydraulic fluid, always put a collecting pan under the motor pump unit of the DRn system.
- Observe the information in the safety data sheet of the hydraulic fluid and the machine manufacturer's specifications.

3.4 Explanation of Signal Words and the Safety Alert Symbol

The Safety Instructions in the available application documentation contain specific signal words (DANGER, WARNING, CAUTION or NOTICE) and, where required, a safety alert symbol (in accordance with ANSI Z535.6-2011).

The signal word is meant to draw the reader's attention to the safety instruction and identifies the hazard severity.

The safety alert symbol (a triangle with an exclamation point), which precedes the signal words DANGER, WARNING and CAUTION, is used to alert the reader to personal injury hazards.

⚠ DANGER

In case of non-compliance with this safety instruction, death or serious injury **will** occur.

⚠ WARNING

In case of non-compliance with this safety instruction, death or serious injury **could** occur.

⚠ CAUTION

In case of non-compliance with this safety instruction, minor or moderate injury could occur.

NOTICE

In case of non-compliance with this safety instruction, property damage could occur.

4 About This Product

4.1 Frequency Converter Type Code Description

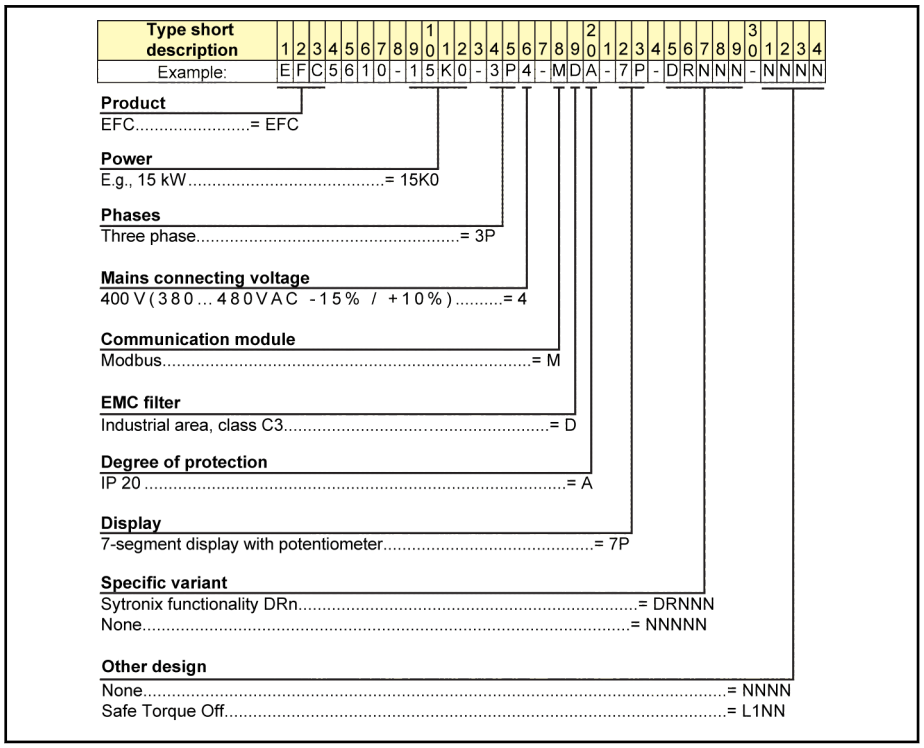


Fig. 4-1: EFC 5610 type code

This type code can be found on the Rexroth EFC converter.

About This Product

4.2 DRn 5020 ASF Type Code Description

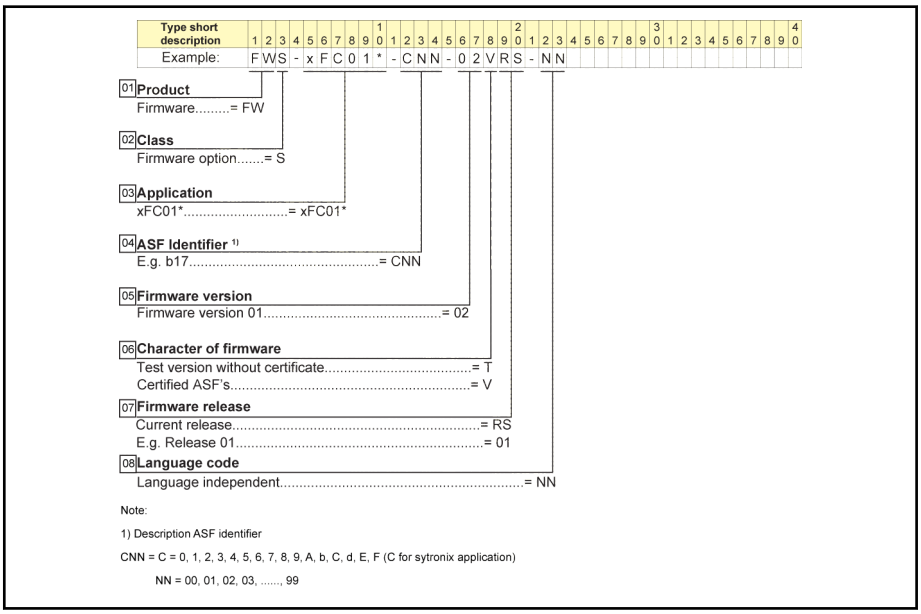


Fig. 4-2: DRn 5020 ASF type code

DRn 5020 ASF software material number: R912007039

DRn 5020 ASF software type code: FWS-XFC01*-C14-02VRS-NN

ASF: Application Specific Firmware.

The ASF type code will not be printed and placed on the EFC converter, but only a square adhesive label on the side, which represent important information from ASF type code:

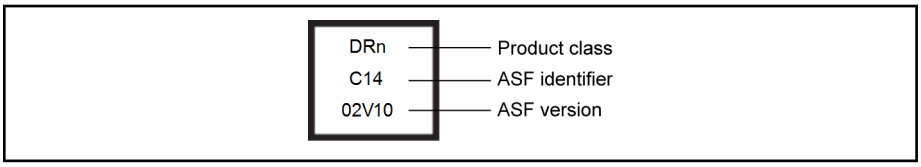


Fig. 4-3: ASF version information

4.3 Scope of Delivery

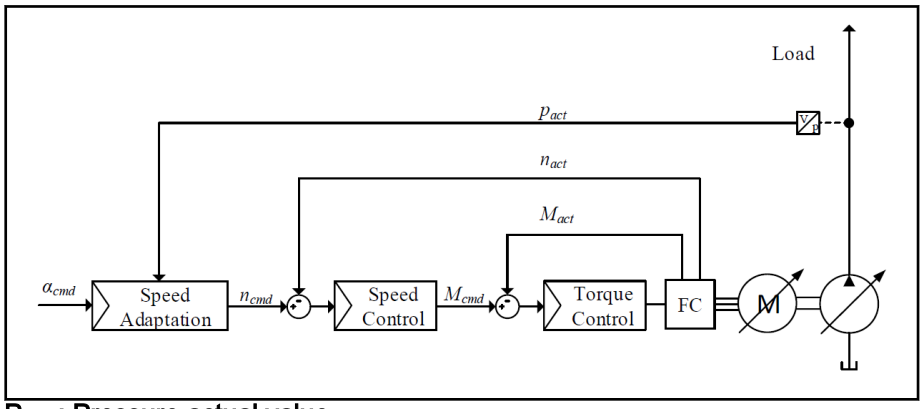
DRn 5020 based on Rexroth frequency converter EFC 5610 with Sytronix ASF offers standard and Sytronix control features. The most important components in DRn 5020 include:

- Motor-pump unit (MOT-FC motor with forced or self-ventilation, Pump types A10VZO-DR, A10VSO-DR, A10VZO-DFR1, A10VZO-DRG, A10VSO-DRG and A10VSO-DFR1)
- Rexroth EFC 5610 with Sytronix ASF and its accessories
- Pressure sensor

4.4 Product Description

The DRn 5020 system is used to realize a pressure controlled hydraulic supply.

The pressure command value for the frequency converter is set by the parameter settings of EFC 5610. The actual pressure value is measured by a pressure transducer in the hydraulic system, which provides the feedback to the frequency converter. The frequency converter controls the speed of the asynchronous motor so that the pump driven by it displaces exactly the oil volume required for providing the command pressure.



P_{ACT}: Pressure actual value
n_{CMD}: Velocity command value
α_{CMD}: Swashplate command value
M_{CMD}: Torque command value

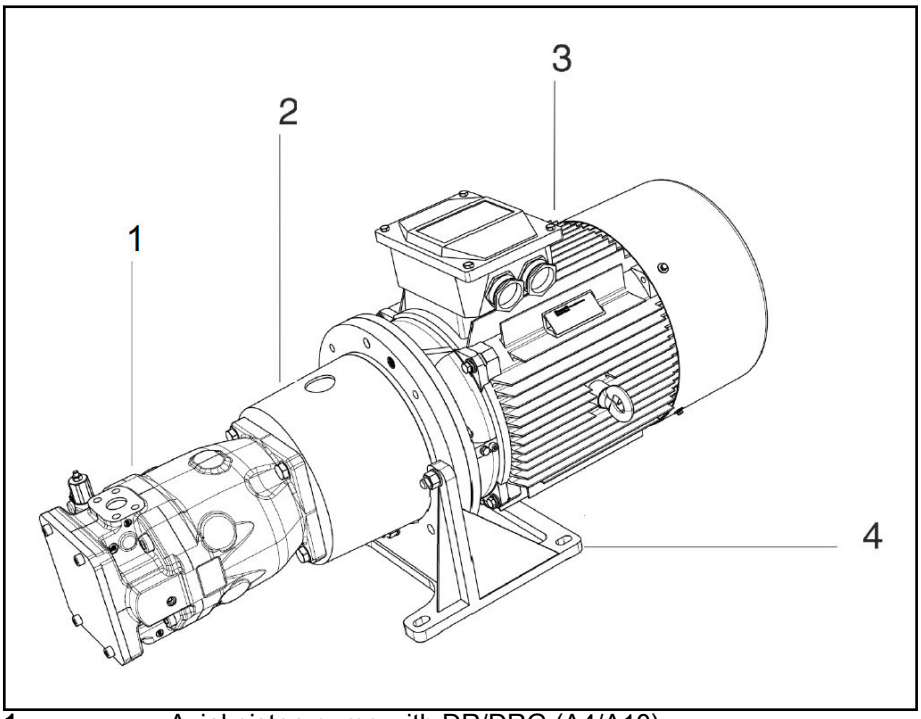
Fig. 4-4: System principle

4.5 Component Overview

4.5.1 System Components

Irrespective of the performance classes, an DRn system, in its basic configuration, consists of the subsequently listed components:

Motor pump unit



1 Axial piston pump with DR/DRG (A4/A10)
2 Bellhousing
3 Standard asynchronous motor MOT-FC
4 Pump foot (option)

Fig. 4-5: DRn system completely assembled

The motor pump unit will be delivered unassembled. As accessories for the motor pump unit, a pressure transducer for recording the actual pressure value is supplied for attachment in the pressure line of the motor pump unit.

Frequency converter

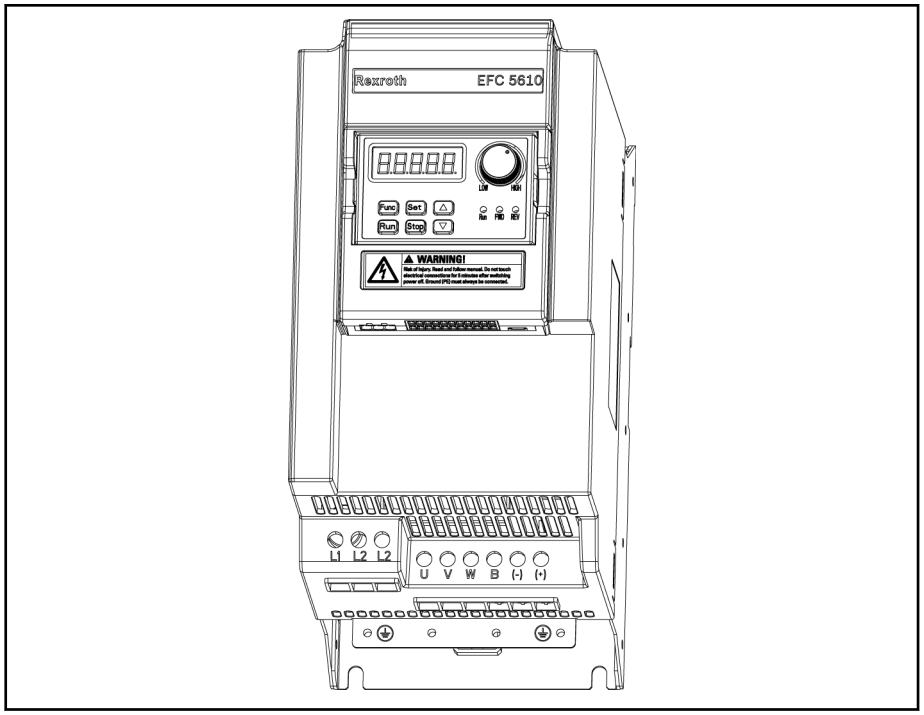


Fig. 4-6: Basic set-up of a frequency converter EFC 5610

For more information on the frequency converter and the other electric components, please refer to the documentation "Rexroth Frequency Converter EFC 5610", see chapter 1 "About this Documentation" on page 7.

Pressure transducer

Fig. 4-7: HM20-2X pressure transducer

For more information regarding the pressure transducer please refer to the “Pressure transducer with integrated electronics - type HM20”, see chapter 1 "About this Documentation" on page 7.

About This Product

4.5.2 Installation of DRn System in a Cabinet

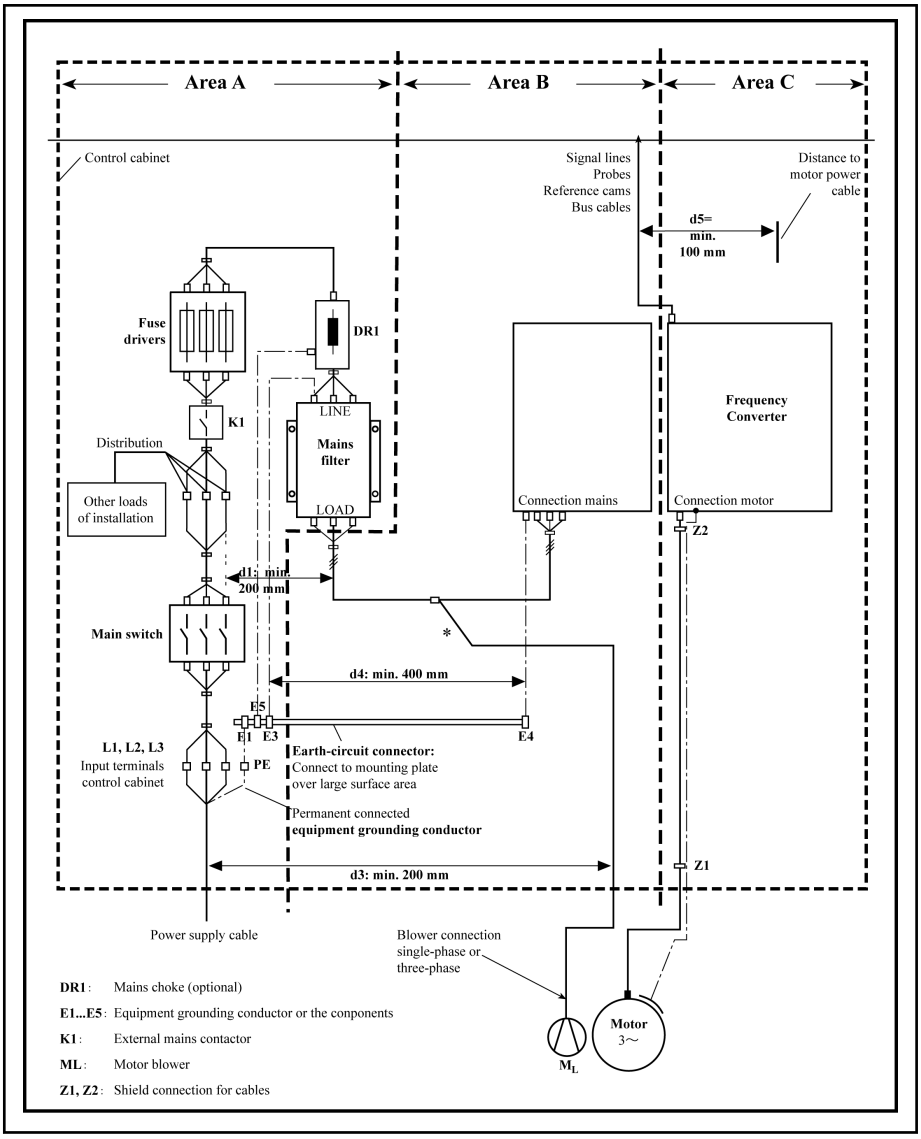


Fig. 4-8: Set-up of the DRn system

4.6 Function Specification

This document only describes the Sytronix function that has been integrated in DRn 5020 ASF. For information of basic converter function, please reference EFC 5610 documents.

Pressure compensated variable displacement pumps (e.g., Rexroth A4, A10) normally deliver a controlled pressure in a hydraulic system. A hydro-mechanical pressure controller called a compensator (“DR“ or "DRG") is used to adjust the pressure level of the pump output. The variable displacement pump only delivers as much hydraulic fluid as required to maintain pressure. If the system pressure rises above the pressure command value, pump displacement is reduced until the pressure falls back to the proper level. If the system pressure falls, pump displacement is increased to raise the pressure back up to the proper level again.

The “Sytronix-DRn“ functionality, is a control algorithm that modifies the pump speed, as needed, as opposed to operating at a constant speed. Model-based algorithms are used to optimize energy efficiency and greatly reduce ambient noise. The DR/DRG pump compensator retains its function as primary controller of system pressure.

To use "Sytronix-DRn", at least an actual pressure value, as well as a preferred swivel angle value for the relative pump volume have to be made available to the drive. As an option, the optimization of the internal models can be improved by providing a pressure command value or an actual displacement value.

The speed adaptation works independently of the pressure control that is still carried out with the hydro mechanical DR/DRG controller. In particular, the hydraulic circuit and the mechanical construction of the machine remain unaffected. Therefore, the "Sytronix-DRn" technology function is suited both for upgrading existing installations within the scope of retrofit and for designing new machine generations.

"Sytronix-DRn" has been designed for pressure control systems. In combination with remotely operated pressure control (Rexroth DRG) or pressure and flow control (Rexroth DFR), it is necessary to check whether the technology function is suited or not in individual cases.

The product provides the following features.

- Speed adaption of pressure controlled DR/DRG pumps to improve energy efficiency and noise emission
- Automatic boost function to reduce pressure drops in load switching conditions
- Automatic motor derating to ensure cooling power on lower motor speeds
- Speed masking to avoid defined speed ranges to improve noise emission
- Auxiliary pumps for oil cooling or filtering can be handled by "Sytronix-DRn"
- Protection functions
  - Detection of pressure drops
  - Soft start of electric drive
  - Actual pressure monitoring
  - Limiting maximum pump speed

  - Limiting maximum pump acceleration
  - Pressure sensor failure detection
  - Actual pressure monitoring
  - Oil change warning / error
  - Pump thermal protection
  - Sensor monitoring
  - LED flash showing converter status
- Pressure signal feedback
  - Compatible with multiple types of pressure sensors (unlimited scaling for the analog input signal)
  - High resistance capability to electromagnetic interference (with the use of high precision digital filter device for signal filtering)
  - Quick configuration for Rexroth HM20 pressure sensor
- Quick configuration for Rexroth MOT-FC_HOY motor
- Extension functions
  - Sleep / wake function

4.7 Input and Output Allocation at the Frequency Converter

4.7.1 Standard Wiring Diagram

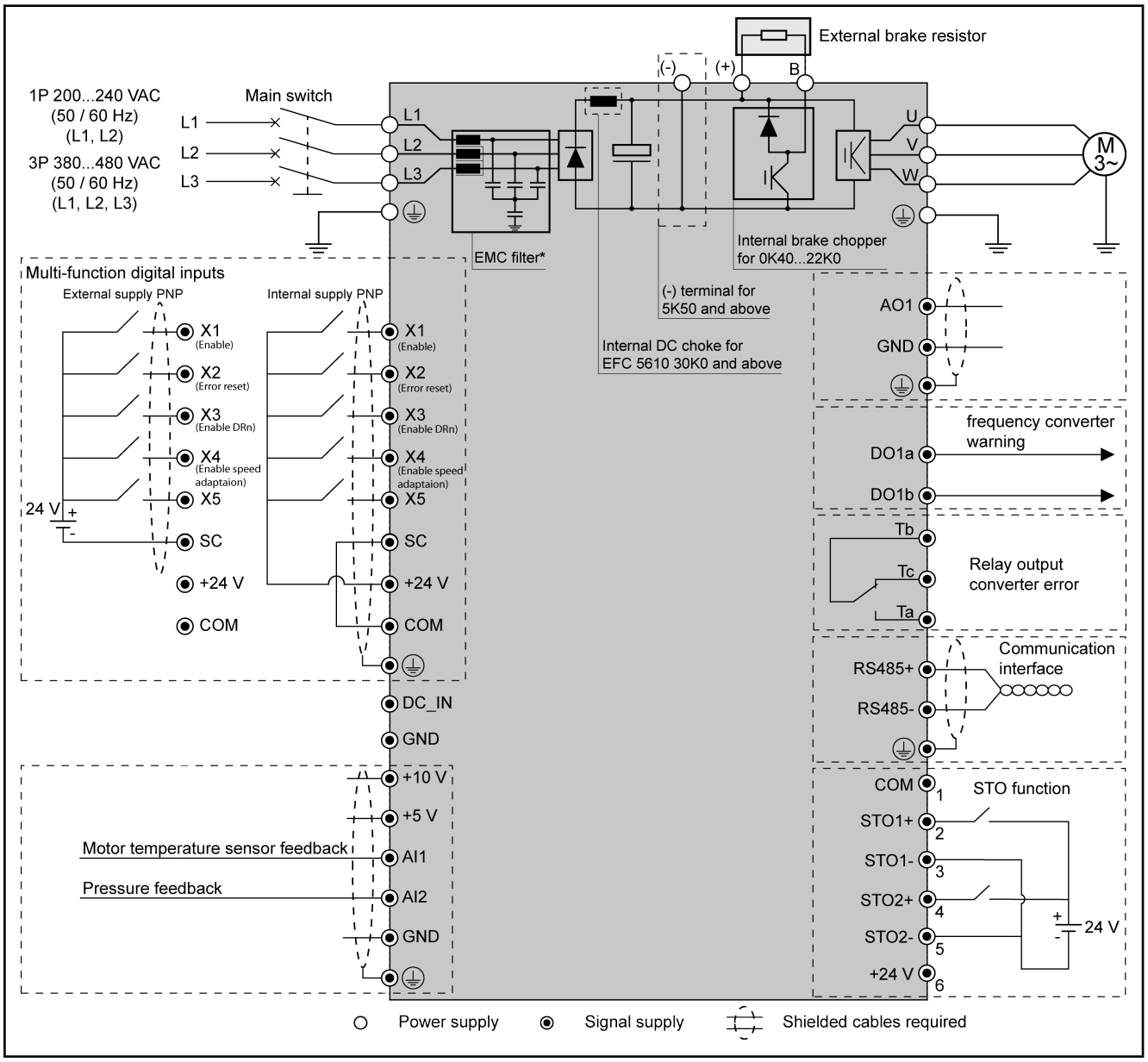


Fig. 4-9: Input/output allocation at the frequency converter

1. When ASF is active, it is given with priority for I/O connection, this means when any terminal is occupied by ASF, this terminal will go deactivated in the EFC firmware.
2. For details about the wiring of temperature sensor as shown in the diagram above, please refer to Chapter 12.10, motor protection of EFC 3610 / EFC 5610 Operating Instructions (Material Number is R912005854) about the usage of temperature sensor with current supply.

4.7.2 Control Terminals Description

Digital inputs

Terminal	Signal function	Description	Signal requirement
X1	Pump enable	Enabled: the pump can be driven by the frequency converter Disabled: the pump has no action	Inputs via opto-electric couplers: 24 VDC, 8 mA / 12 VDC, 4 mA Pulse input: Max. 50.0 kHz
X2	Error reset	–	
X3...X5	Multi-function digital inputs	See Group E1 in EFC documentation	
EX1... EX5	Multi-function digital input on extension card		
SC	Shared connection	Shared connection for isolation opto-electric couplers	–
+24 V	Power supply for digital inputs	COM is reference Isolated from GND	Max. output current: 100 mA
COM			

Analog inputs

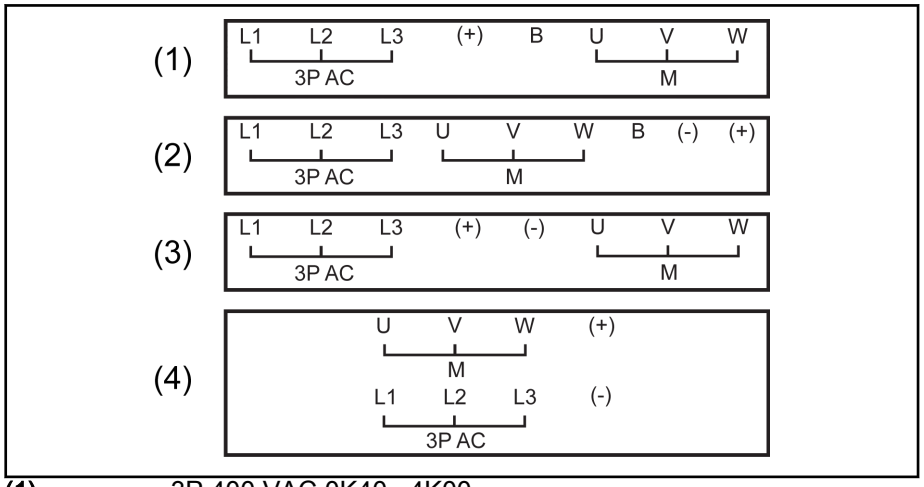
Terminal	Signal function	Description	Signal requirement
+10 V	Power supply for analog inputs	GND is reference	Max. output current: 30 mA
+5 V			Max. output current: 10 mA
AI1	Analog voltage input 1/ Analog current input 1	AI1 in DRn 5020 has no function defined	Voltage input range: 0/2...10 V Input impedance: 40 kΩ Resolution: 1/1,000 Current input range: 0/4...20 mA Input impedance: 500 Ω Resolution: 1/1,000
AI2	Analog voltage input 2/ Analog current input 2	AI2 in DRn 5020 has been set as "pressure feedback", F2.01 = 2	
EAI	Analog input on extension card	EAI in DRn 5020 has no function defined	
GND	Shared connection	Isolated from COM	–
⏚	Shielding connection	Connected with grounding terminals on heatsink internally	–

Digital outputs

Terminal	Signal function	Description	Signal requirement
DO1a	Open collector output or pulse output	See Group E2 COM is reference	Open collector output: Max. 30 VDC, 50 mA Pulse output Max. frequency: 32.0 kHz
DO1b			
Ta	Relay changeover contacts	Relay1 in DRn 5020 has been set as "converter error", C2.15 = 14	Rated capacity: 250 VAC, 3 A; 30 VDC, 3 A
Tc			
Tb	Relay shared contact		

☞ Analog outputs are not used within DRn ASF.

4.7.3 Power Terminal



(1) 3P 400 VAC 0K40...4K00
(2) 3P 400 VAC 5K50...22K0
(3) 3P 400 VAC 30K0...90K0
(4) 3P 400 VAC 110K...160K
3P AC: Three phases AC power supply
M: For three phases motor connection

Fig. 4-10: Power terminals

Terminal	Description
L1, L2, L3	Mains supply input terminals
U, V, W	Converter output terminals
B	External brake resistor terminal
(-) ①	DC negative bus terminal (only available with models of 5K50 and above)
(+) ①	DC positive bus terminal

Tab. 4-1: 3P 400 VAC power terminals description

⚠ WARNING

①: Detailed descriptions on (-) and (+) in the **Operating Instructions** must be read through and followed before any operation on these two terminals.

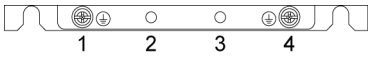


Fig. 4-11: Grounding and PE terminals

1. Grounding terminal for mains cables
2. Reserved for PE / shielding adapter (Order additionally)
3. Reserved for PE / shielding adapter (Order additionally)
4. Grounding terminal for motor cables

4.7.4 Control Terminals

Control terminals figure

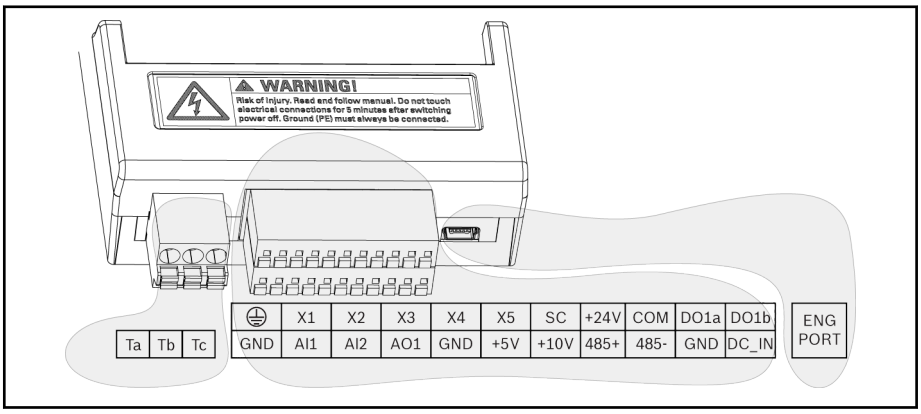


Fig. 4-12: Control circuit terminals

⚠ CAUTION **The frequency converter might be damaged!**

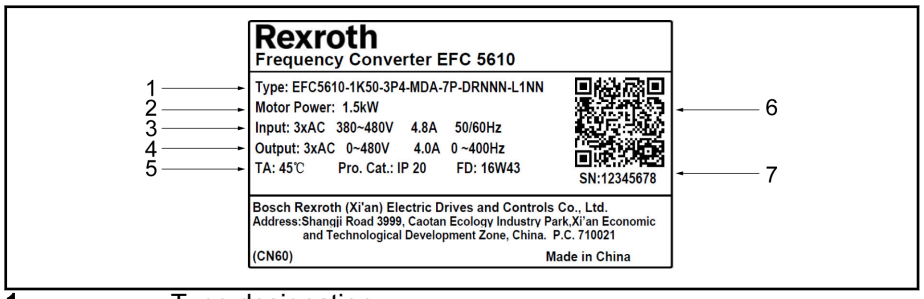
Please make sure that the power supply of the frequency converter has been switched off before plugging or unplugging the connector.

☞ The terminal block is **ONLY** for wiring convenience, which **CANNOT** be used for fixing the cables. Additional measures need to be taken by users for cable fixing purpose.

4.8 Product Identification

For more detailed information on the model and type, please refer to data sheet R999000331, see chapter 1 "About this Documentation" on page 7.

The following example shows the type plate on EFC 5610:



1	Type designation
2	Motor power
3	Input voltage type / input voltage range / input current / input frequency
4	Output voltage type / output voltage range / output current / output frequency range
5	Ambient temperature / protection category / production data
6	QR code of product
7	Serial number of product

Fig. 4-13: Nameplate of EFC 5610

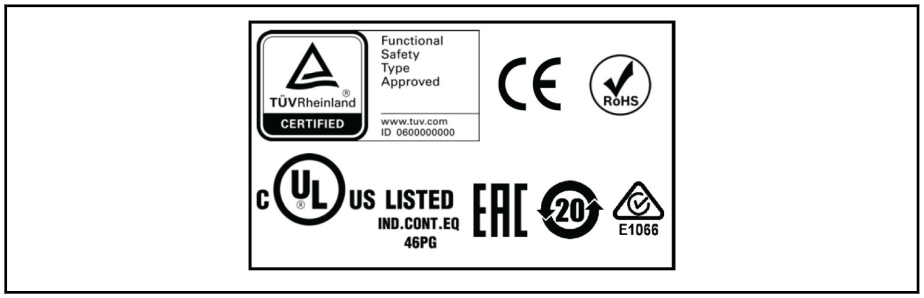
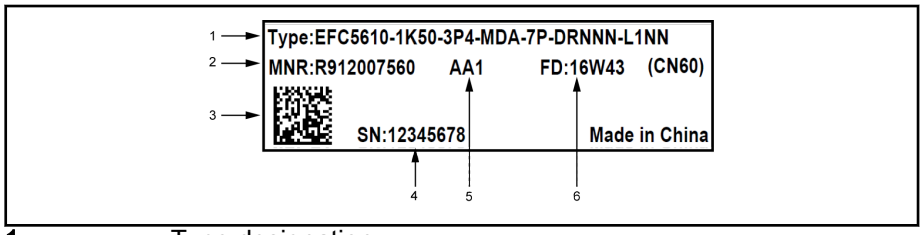


Fig. 4-14: Certification of EFC 5610



1	Type designation
2	Material number
3	QR code (Internal use)
4	Serial number of product
5	Version
6	Production data

Fig. 4-15: QR code of EFC 5610

5 Transport and Storage

5.1 Drive Controllers

See documentation of the component:

Title	Material number	Documentation type
Rexroth Frequency Converter EFC 3610 / EFC 5610 Series , edition 05 or latter	R912005854	Operating Instructions

Tab. 5-1: Documentation, drive controllers

5.2 Pressure Sensor

Title	Material number	Documentation type
HM20-2X pressure transducer for hydraulic applications	RE 30272	Data sheet

Tab. 5-2: Documentation, pressure sensor

6 Assembly and Installation

6.1 General Information

This chapter describes the assembly of the DRn system at its place of use as well as the connection to the hydraulic system and the electrical systems of the machine. For information regarding the installation in the machinery, particularly regarding its overall function and logic mode of operation, please refer to the instructions and/or the documentation for the machinery.

6.2 Unpacking

- Remove the packaging of the DRn system.
- Dispose of the packaging in accordance with the provisions valid in your country.

6.3 Installation Conditions

6.3.1 Installation Conditions for Motor Pump Unit

Before assembling the motor and the pump, ensure the following:

- Use tools, supplies, measuring and test equipment.
- Check all components for visible damage. Damaged components may not be mounted.
- Ensure that all dimensions and tolerances on the machine side are suited for the component attachment.
- Inspect all components, mounting surfaces and threads to ensure they are clean.
- Make sure that the assembly can be carried out in a dry and dust-free environment.
- Ensure that the motor-pump unit and all other used parts are clean, when they are mounted.

☞ A polluted hydraulic fluid can considerably influence the lifetime of the drive unit.

- Ensure that the temperature of the motor-pump unit is according to the environmental temperature of the installation site. Allow sufficient time to the components to adjust the temperature conditions.
- Before assembling the motor-pump unit, remove fluids that might have been filled in for storing the pump.
- Please observe that the motor-pump unit is not suited for mounting the pump under oil.
- Ensure that the minimum distance between fan screen and machine is kept to suction/blow the air.

☞ For more detailed information on dimensions and tolerances of the motor pump unit, please refer to Mounting Instructions R911345048 (A4/A10 - MOT-FC), see chapter 1 "About this Documentation" on page 7.

- Ensure that a minimum distance between fan grid and machine is complied with for aspiration and/or discharge of the air. The distance is determined by the motor construction, see the figure below.

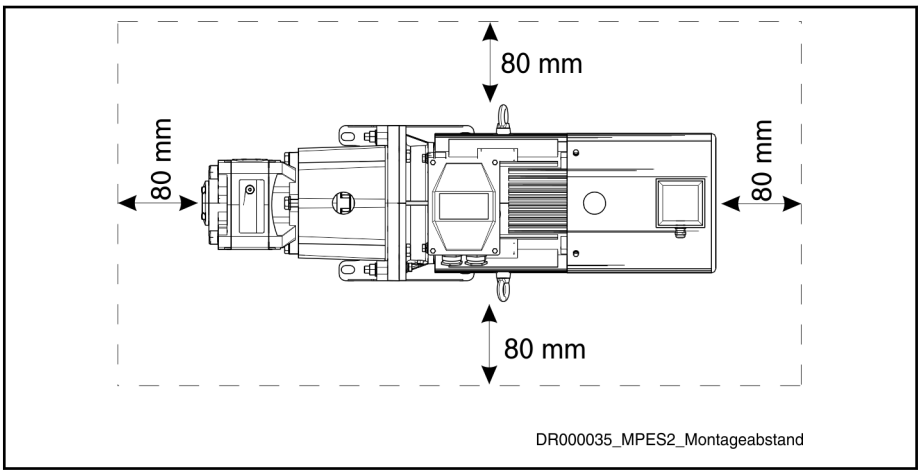


Fig. 6-1: Fan distance

- Check all components, installation surfaces and threads for cleanliness.
- Make sure that the assembly can be carried out in a dry, dust-free environment.
- Make sure that the motor pump unit and all other parts used are free from dirt when they are installed.

☞ Contamination of the hydraulic fluid may considerably reduce the life cycle of the drive unit. Make sure that the cleanliness class of the hydraulic fluid according to ISO4406©) is complied.

6.3.2 Installation Conditions for Frequency Converter and Additional Components

The frequency converter and its additional components have been designed for installation in control cabinets!

☞ For information on the installation conditions, please refer to the operating instructions "Rexroth Frequency Converter EFC 3610 / EFC 5610 Series" (R912005854) in chapter 7 "Frequency Converter Mounting", see chapter 1.2 "Required and Amending Documentation" on page 8.

6.4 Assembling the DRn System

6.4.1 Mechanically Connecting the Motor Pump Unit

The screw connection must be adjusted to the installation situation (screw-length, property class, screw-in depth, material, ...). The dimensioning of the screw connection is in the responsibility of the customer.

MOT-FC [kW]	Installation position IEC IM B35		Installation position IEC IM B5, IM V1	
	Screw / hole Ø		Screw / hole Ø	
1.5	-	-	4 x M10	12
2.2	-	-	4 x M12	15
3	-	-	4 x M12	15
4	-	-	4 x M12	15
5.5	-	-	4 x M12	15
7.5	-	-	4 x M12	15
11	4 x M12	14.5	4 x M16	18.5
15	4 x M12	14.5	4 x M16	18.5
18.5	4 x M12	14.5	4 x M16	18.5
22	4 x M12	14.5	4 x M16	18.5
30	4 x M16	18.5	4 x M16	18.5
37	4 x M16	18.5	8 x M16	18.5
45	4 x M16	18.5	8 x M16	18.5
55	4 x M20	24	8 x M16	18.5
75	4 x M20	24	8 x M16	18.5
90	4 x M20	24	8 x M16	18.5
110	4 x M24	28	4 x M20	24
132	6 x M24	28	4 x M20	24
160	6 x M24	28	4 x M20	24

Hole Ø mm (details in millimeter)

Tab. 6-1: Fastening screws for motor-pump unit

- Assemble in dry, dust free environment.
- Ensure a clean and burr-free machine-side contact surface.
- Securely screw the motor-pump unit with the machine construction.

6.4.2 Hydraulically Connecting the Motor Pump Unit

- Remove the flange covers on suction and pressure port.
- Immediately wipe off any leaking oil.
- Check the line for cleanliness.
- Ensure that the line connection contains the specified sealings.
- Lock O-rings with assembly grease against slipping , if necessary.
- Now, hydraulically connect the pump according to the specifications of the machine manufacturers.

Rexroth Sytronix Mounting and Commissioning Axial Piston Variable Pump A10VZO/A10VSO/A4VSO

- Material number: R911341629 (Edition 02)

6.4.3 Connection Technique

General Notes

General

The following work must be done by qualified personnel according to the local regulations.

⚠ WARNING **Danger to life due to electrical voltage! Handling within the area of live parts is extremely dangerous.**

All work on the electric system may only be done by skilled electricians. Tools for electricians (VDE tools) are absolutely necessary.

Before working:

1. Isolate (even auxiliary circuits).
2. Ensure that the main switch cannot be accidentally switched on again.
3. Ensure de-energization.
4. Ground and short-circuit.
5. Cover or fencing off neighbored, live parts.

Before start working, check with possible live parts a suitable measuring device (e.g. with capacitors). Wait for their discharging time.

Power connection

Before connecting the motor, check whether the power supply and power frequency consist with the nominal data. A connection overview for power and accessory connections (PTC) can be found within the terminal box. The connections must be established such that a permanent safe electrical connection is ensured. This is also valid for power, grounding and shield connection.

Power cables

Power cables for motor connection are not in the scope of delivery of the motor. Selection and assembly of suitable cables must be done by the customer.

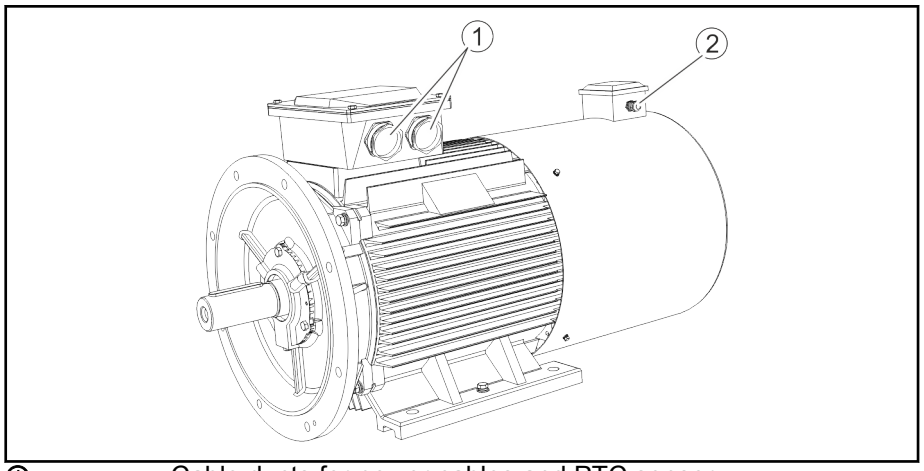
When selecting cables, please proceed very carefully and observe the requirements existing at the installation space of the cables.

Observe features, like

- resistance against coolants and lubricants from machining
- compliance of EMC directives
- fatigue limit
- non-halogen

We recommend to do crimping connections according to IEC 60352-2. Malfunctions or damage due to wrong or improper motor connection are not in the liability of Bosch Rexroth.

Connection Overview



① Cable ducts for power cables and PTC sensor
② Terminal boxes with cable ducts for motor fan connection (only available for forced ventilated motors)

Fig. 6-2: Connection Overview

Assembly and Installation

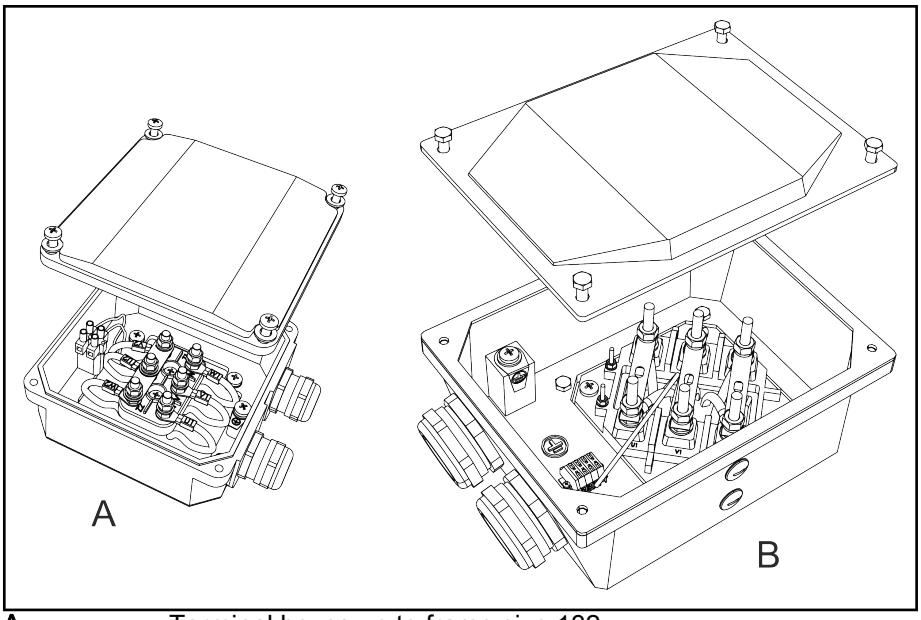
Power Connection

Connection Power Cables

Ensure that the terminal box is clean and dry. Seal not used cable ducts. Before re-assembly, check the position and correct seat of the terminal box sealing.

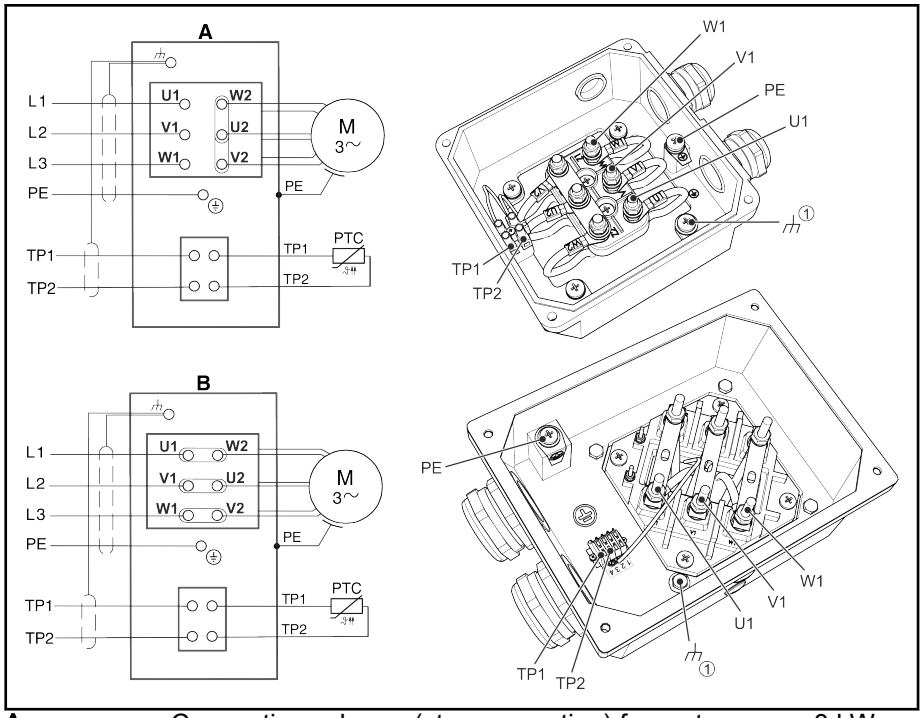
To connect the motor, use a specified power cable. This must be ordered and assembled by the customer.

1. First, determine the correct wire lengths. Therefore, open the terminal box and remove the protective cap of the cable gland.
2. Insert the cable through the cable gland up to the furthermost terminal. Mark the cable on the entry within the terminal box.
3. Pull out the cable of the terminal box and remove the cable jacket up to this mark.
4. The exposed cable shield must be split acc. to chapter chapter "Connection Total Shield Power Cables" on page 49. All further working steps about shield assembly can be done immediately or after this procedure.
5. The now accessible wires are fastened with ring terminals on the terminal stud. Strip the wires according to the size of ring terminals. The size of ring terminal depends on the diameter of the terminal stud. For diameter of the terminal stud and tightening torques refer to data sheet of the motor under chapter 1 "About this Documentation" on page 7.



A Terminal boxes up to frame size 132
B Terminal boxes from frame size 160

Fig. 6-3: Preparing power connection



A	Connection scheme (star connection) for motor power 3 kW
B	Connection scheme (delta connection) for motor power 4 kW
U1 / V1 / W1	Primary winding
PE	Protective conductor
TP1 / TP2	Connection wires temperature sensor SNM150
① ⇒ Schirm	See chapter "Connection Total Shield Power Cables" on page 49

Fig. 6-4: Connection designation within terminal boxes

A label with the connection scheme of the motor is applied on the inner side of the terminal box lid.

Connection Total Shield Power Cables

When connecting the power cable, please observe to apply the total shield of the power cable within the terminal box to keep a HF-suitable connection.

Therefore, connect the shield via a ring terminal and a screw with the terminal box. A connection screw is provided within the terminal box (refer to) to connect the shield.

Rexroth does not offer ready-made power cables to connect these motors. The professional assembly of the power cable must be done by the customer.

The following overview describes working steps which must be done to apply a ring terminal on the total shield of the power cable. Application of ring terminal onto power wires is not described in this example.

1. Remove the jacket of the power cable.

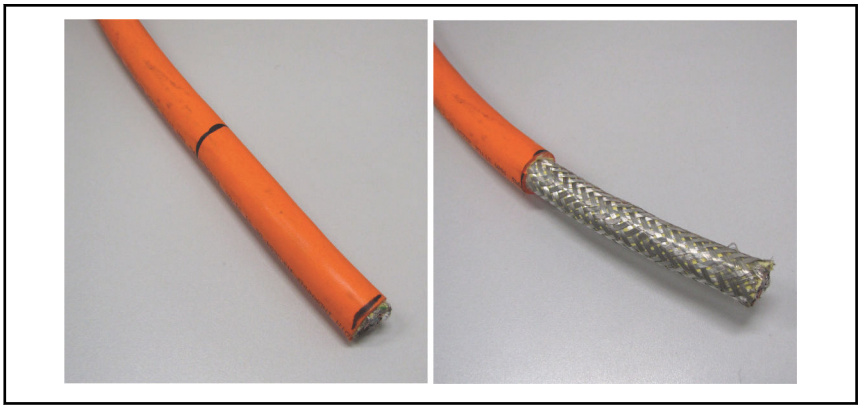


Fig. 6-5: Strip the power cable for required wire lengths.

Determine the necessary wire lengths by means of the junction within the terminal box of the motor to be connected. The unshielded cable must be kept as short as possible.

☞ Please observe that the stripped wires

- are not too long to avoid unnecessary kinks or chafes within the terminal box.
- are not too short to avoid tensile strength onto the wires after connecting within the terminal box.

2. Split the total shield of the cable braid open.

Fig. 6-6: Split the shield braid open

Split the shield braid open very carefully via the complete, stripped length.

3. Twist the total shield of the cable, cut it and solder it with the prepared cable. The cable cross section must be conform with the shield cross section. Then, strip the junction and the area of the shield connection with a heat shrink tubing.

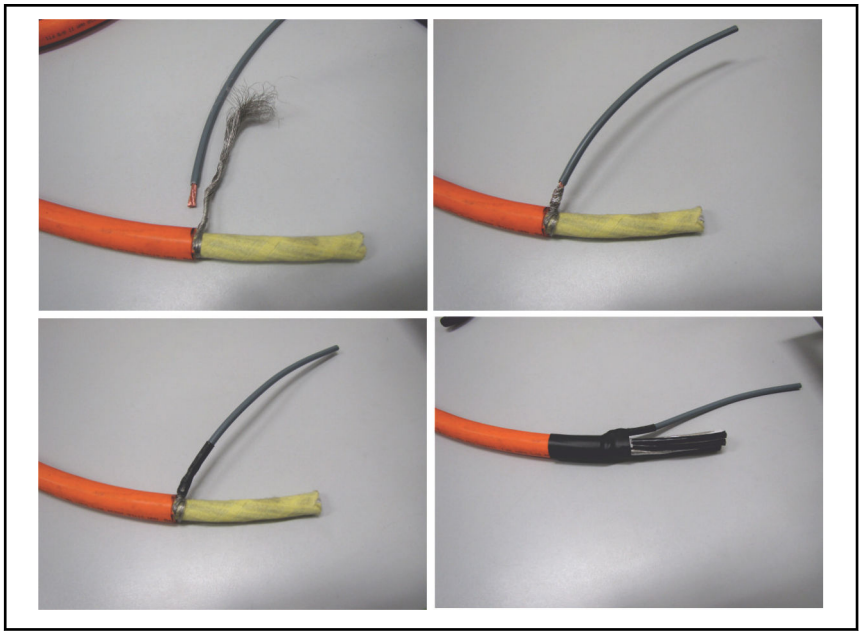


Fig. 6-7: Connection total shield with cable extension

4. Cut the soldered cable accordingly and finally assemble the correct ring terminal with a crimping tool.

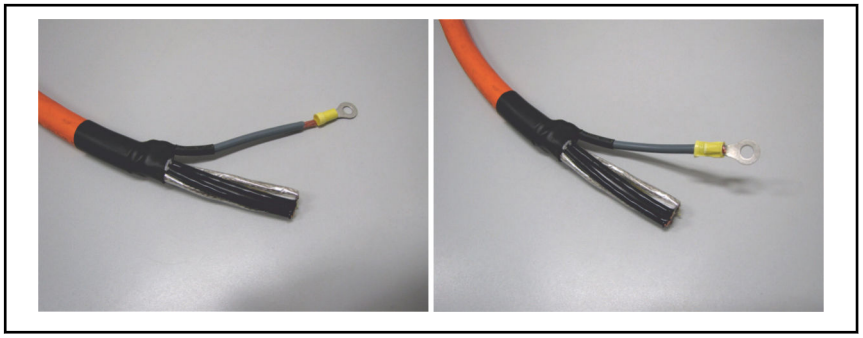


Fig. 6-8: Cut shield extension in a suitable way and assemble the ring terminal

Connect the temperature sensor

To protect the motor from thermal overload, the temperature sensor for motor protection must be connected to the drive controller. Observe the connection designation under fig. 6-4 "Connection designation within terminal boxes" on page 49 and the notes about temperature sensor in the document.

Also refer to R911343624 "Rexroth IndraDyn E Standard Motors MOT-FC for Frequency Converter Operation"

motor data sheet under chapter 1 "About this Documentation" on page 7.

In case that there is no motor temperature sensor available, it is recommended to use the internal motor temperature model. For details refer to R912005854 "Frequency Converter EFC 3610 / EFC 5610 Operating Instructions" under chapter 12.10.2 "Motor Protection".

Connect the Motor Fan

Cooling of forced-ventilated motors (design IC416) is done via an electrical fan which is mounted and separately connected onto the motor. It is operated with 400 V (star connection) or 230 V (delta connection). The fan is factory-adjusted designed for 400 V.

The electrical connection is done by means of fan terminal box on the fan housing (see fig. 6-2 "Connection Overview" on page 47). Additionally, the connection scheme is figured within the lid of the fan terminal box and shows the connection for 230 V and 400 V. The interconnection is factory-adjusted designed for 400 V.

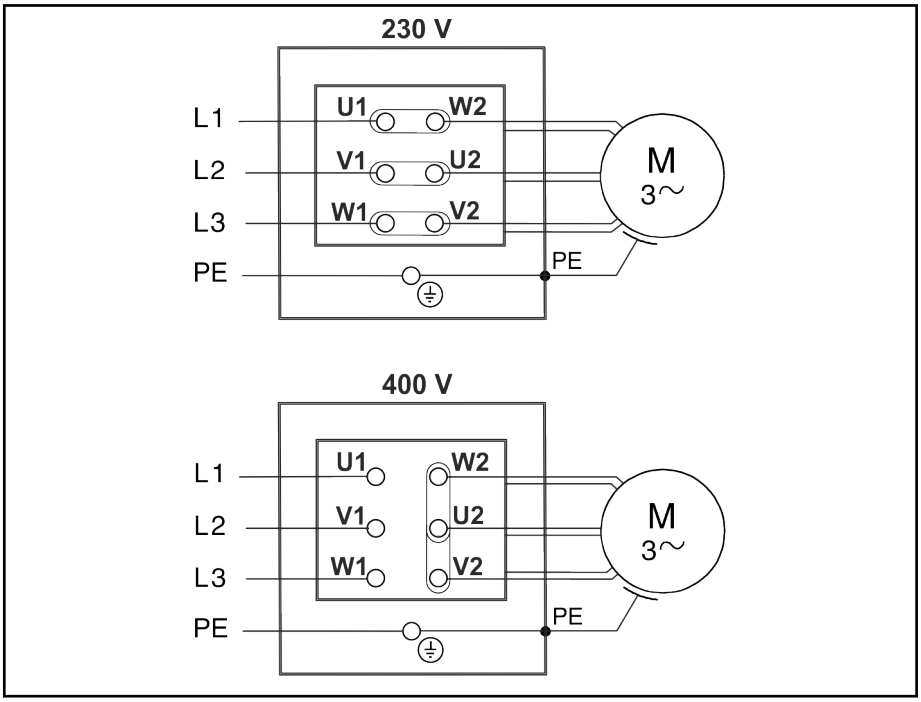


Fig. 6-9: Connection scheme motor fan

The following table contains electrical power data of the motor fan with different frame sizes.

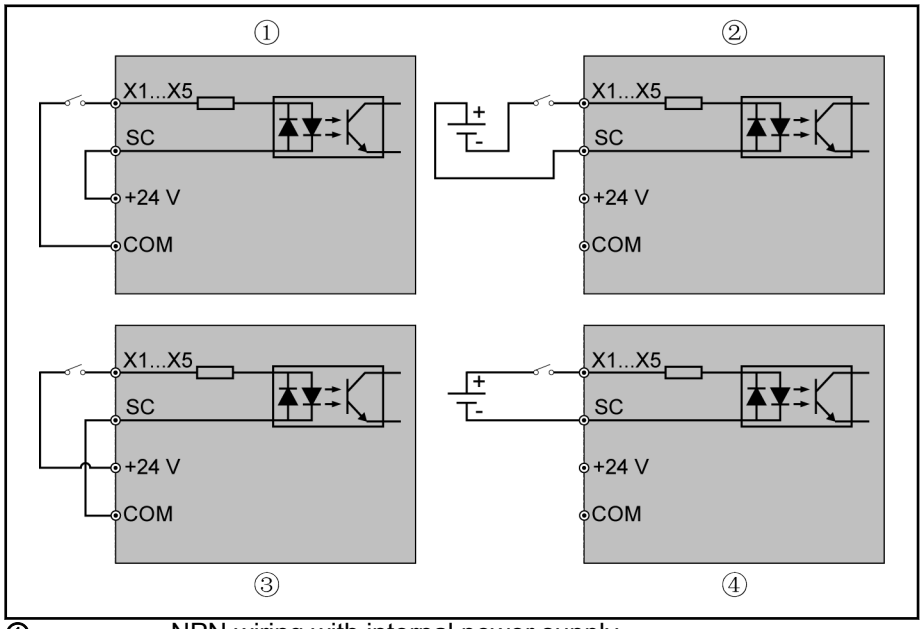
Frame	Power [W]	Current [A]	Voltage [V]	Frequency [Hz]	Interconnection
090	30	0.1	400	50	Y
100	45	0.15	400	50	Y
112	50	0.21	400	50	Y
132	90	0.4	400	50	Y
160	90	0.4	400	50	Y
180	180	0.65	400	50	Y
200	350	0.83	400	50	Y
225	350	0.83	400	50	Y
250	370	1.17	400	50	Y
280	550	1.57	400	50	Y

Frame	Power [W]	Current [A]	Voltage [V]	Frequency [Hz]	Interconnection
315	750	2.03	400	50	Y
355	1,100	2.9	400	50	Y

Tab. 6-2: Electrical parameters of the motor fan

6.4.4 Connection EFC 5610 for DRn 5020

Digital input NPN / PNP wiring

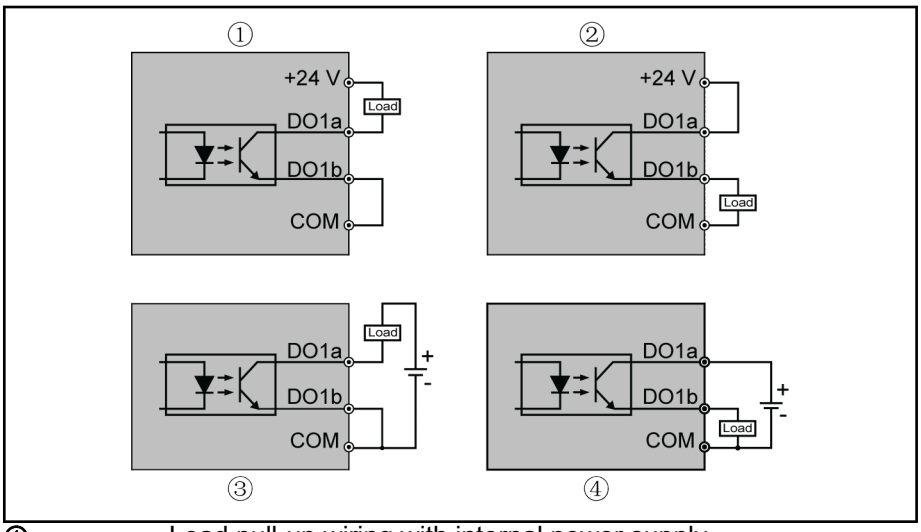


① NPN wiring with internal power supply
② NPN wiring with external power supply
③ PNP wiring with internal power supply
④ PNP wiring with external power supply

Fig. 6-10: Digital input NPN / PNP wiring

Assembly and Installation

Digital output DO1a, DO1b load pull-up / pull-down wiring



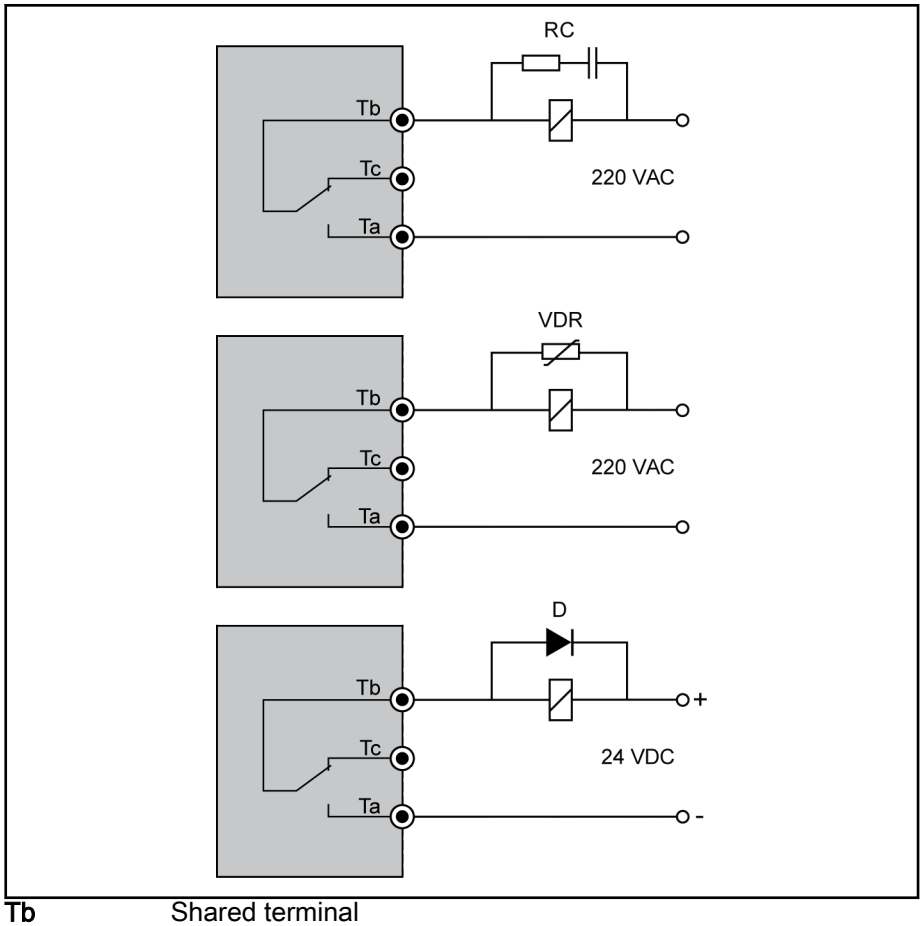
① Load pull-up wiring with internal power supply
② Load pull-down wiring with internal power supply
③ Load pull-up wiring with external power supply
④ Load pull-down wiring with external power supply

Fig. 6-11: Digital output DO1a, DO1b load pull-up / pull-down wiring

- For internal supply, **ONLY USE** terminal +24 V and **NEVER USE** terminal +10 V or +5 V!
- For external supply, its reference ground **MUST** be connected to terminal COM!

Relay output terminals

When relay output terminals are connected with inductive loads (relays, contactors, solenoid valves, motors, etc.), following noise suppression circuits need to be applied at the coils of the inductive loads, as close as possible to the inductive loads, in order to reduce the electromagnetic interference generated from inductive load action.



Tb	Shared terminal
Tc	Normally closed contact
Ta	Normally open contact
RC	RC filtering
VDR	Varistor
D	Diode

Fig. 6-12: Noise suppression circuits for relay output terminals

6.4.5 Connection of the Pressure Transducer

NOTICE

Malfunction of the DRn system due to use of a pressure transducer not suitable for the DRn system!

Damage to property!

- Use only the pressure transducer set of the Bosch Rexroth HM20 series included in the DRn system (see chapter 1 "About this Documentation" on page 7, data sheet 30272).

- Assemble the pressure transducer in suspended position (hydraulic connection at the top). In this position the pressure transducer is optimally ventilated.
- Do not install an additional valve (except for check valve) in the line between the pump and the pressure transducer (apart from the pre-load valve).
- If there is no pre-load valve in the system, you can assemble the pressure transducer directly at the pump or at the directional valve (possibly control block).
- Connect a pressure transducer with a sufficient line diameter (no minimiss connections!).
- Connect the pressure transducer at terminals AI2 and GND to the figure below.

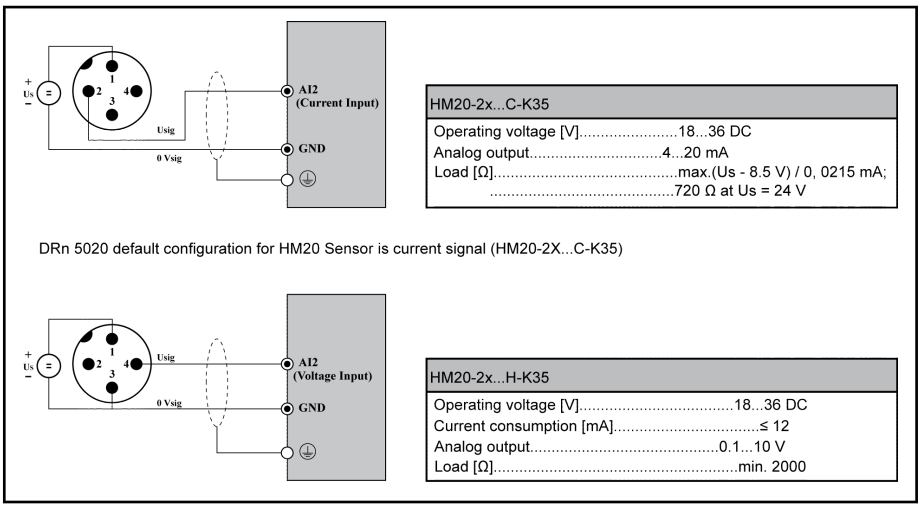


Fig. 6-13: Connection of the pressure transducer

- USE external 24 V power supply (not from EFC 5610).
- USE ONLY shielded cables.
- GND must be well connected.
- The cable shielding must be well connected to the grounding terminal.

6.4.6 Electronic Component Assembly and Installation in Control Cabinet

NOTICE

High temperature due to wrong arrangement of the components in the control cabinet!

Damage to property!

Due to the power loss in the components, the temperature of the cooling air flow at the device outlet is increased to a level above the ambient temperature at the device inlet.

- When arranging the components in the control cabinet, comply with the specified minimum distances. For information on the minimum distances, please refer to the documentation "Rexroth Frequency Converter EFC 3610 / EFC 5610 Series", see chapter 1 "About this Documentation" on page 7.

For the assembly and installation of the electric components of the DRn system in the control cabinet, you need the following documents:

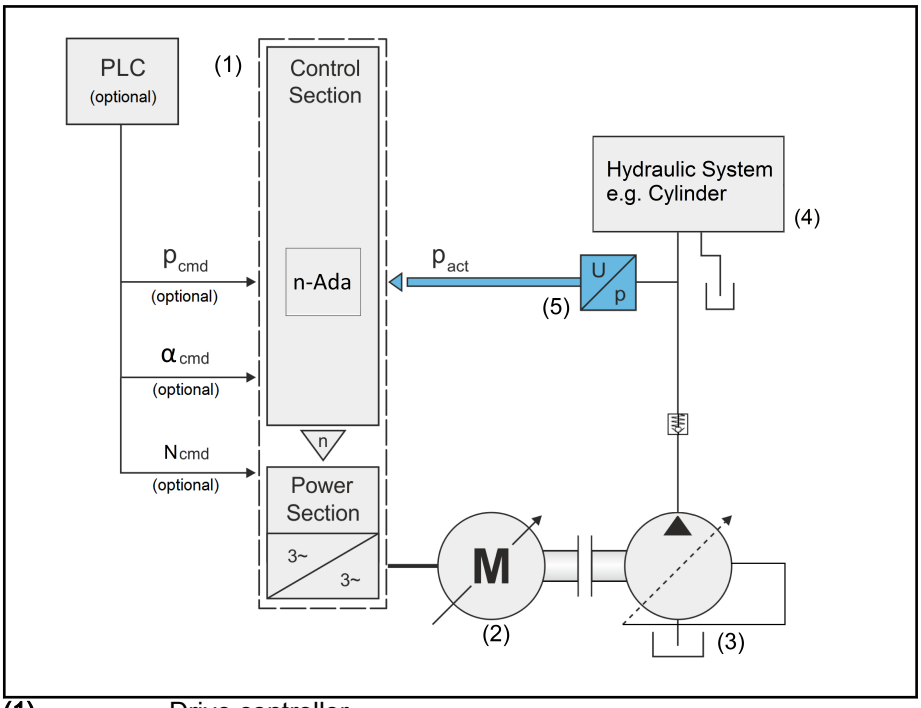
- Assemble the electric components according to the documentation "Rexroth Frequency Converter EFC 3610 / EFC 5610 Series" Operating Instructions chapter 4 or Quick Start Guide chapter 1, see chapter 1 "About this Documentation" on page 7.
- Install the electric components according to the pin assignment plan for the p-Control of the DRn system; see chapter 4.7 "Input and Output Allocation at the Frequency Converter" on page 37.

7 Commissioning of Sytronix DRn 5020 System

7.1 Introduction and Basics

7.1.1 Application type

The DRn 5020 Software is one of the Sytronix Family and especially designed for the needs in machine tools for pressure control system.



(1) Drive controller
(2) Motor
(3) Pump
(4) Hydraulic system
(5) Pressure transducer (p_{act} = actual pressure value)

Fig. 7-1: Block diagram p-control with speed adaptation

In addition to the Software Components (Drive Firmware and Software) , a Sytronix system requires following components:

- Motor, coupling and pump
- One pressure sensor at the pump output side

- In order to keep the positive direction of pump (which generates pressure), the direction of the electrical drive (Rexroth EFC 5610 with MOT-FC) of DRn system has already been set as default to run reverse, as the motor and pump have been coupled face to face.
- Pressure values are always meant to be relative to atmosphere. This applies for pump data as well as sensor values.

7.1.2 Overview of User Interface

Overview of DRn5020 IndraWorks Dialog

The IndraWorks software (14V20 or later) automatically shows the graphical user interface when connected to an EFC with DRn5020 installed. The system can be connected and configured via USB or BUS. As the DRn5020 software is installed, Sytronix folder shows up in the drive tree.

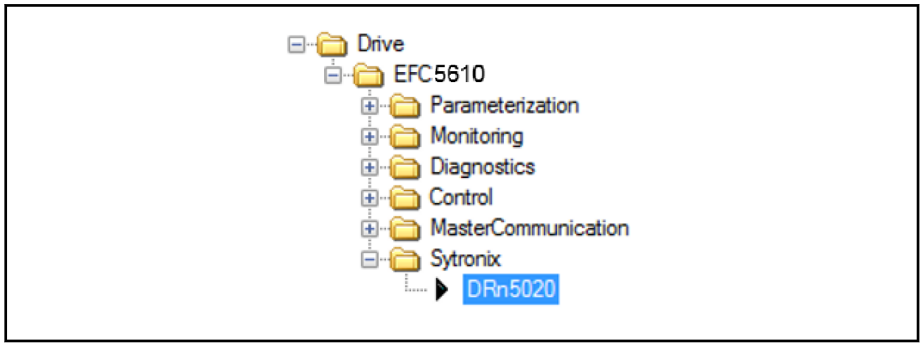


Fig. 7-2: Sytronix DRn5020 drive tree

A click on DRn5020 redirects to the overview dialog of the Sytronix function. The dialog divides into two sections. On the left side the control structure is visible ①...⑦. On the right side there are the status and system configuration buttons which pop up the sub-dialogs ⑧...⑫.

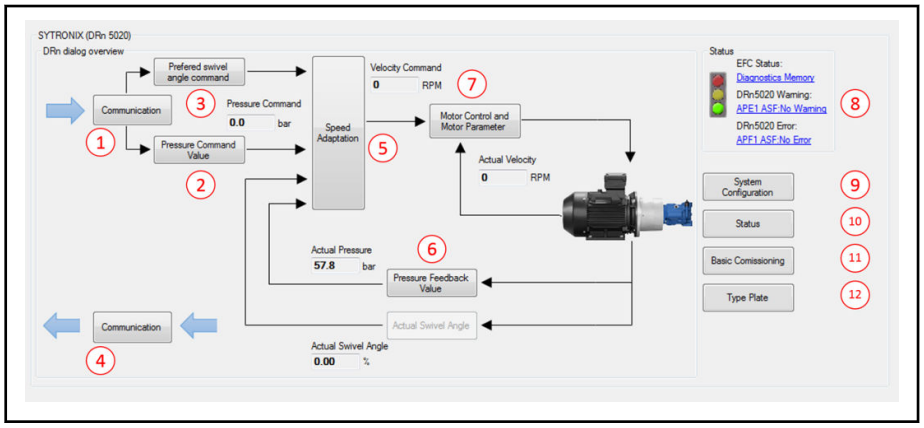


Fig. 7-3: Sytronix DRn5020 dialog

Any change via the dialog, the corresponding parameter will also be changed and saved immediately. Modifying a parameter via dialog or parameter editor are exactly the same. The DRn5020 dialog is designed for easy commissioning and quick overview over the DRn system. Important ASF parameters (F1…F4 group) can be found in this dialog and its sub-dialogs. Some important EFC parameters which are utilized in the DRn system can also be configured (e.g. motor control parameters). Further EFC parameters can be found by using the EFC dialogs or by using the parameter editor.

Introduction of the DRn5020 dialog:

- ①...⑦: Communication and Control system overview
- ⑧: Status lights and Quick diagnostics
- ⑨...⑫: Commissioning and Configuration

Communication and Control System Overview

On the top level of the dialog only read-only parameters can be shown. These parameters are greyed (can not be edited) and are showing effective set point values and actual state values of the system. A right click on the pa-

rameters shows the parameter IDs and let the user open an extra window to monitor the parameter in or let the user open the help document. If one of these values turn into red, then the engineering connection via USB or BUS might be broken.

Status Lights and Quick Diagnostics

The status lights and the quick diagnostics section are showing the system status as following:

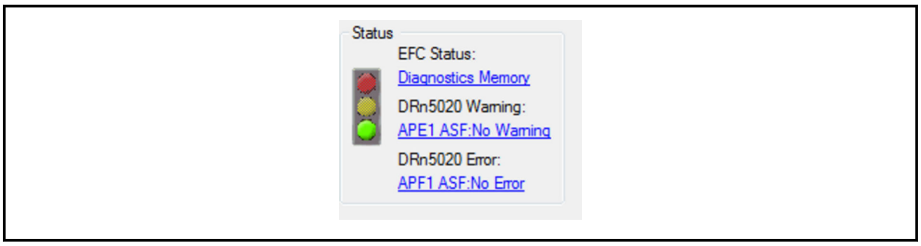


Fig. 7-4: Status lights and quick diagnostics

- Red: Converter is in error, check display or detail status (button ⑩, register errors)
- Yellow: Converter issued warning, check display or detail status (button ⑩, register warnings)
- Green: Converter is in STOP or RUN, no error or warning is pending

There are also hyperlinks which brings the user directly to the page where the error / warning can be analyzed and fixed.

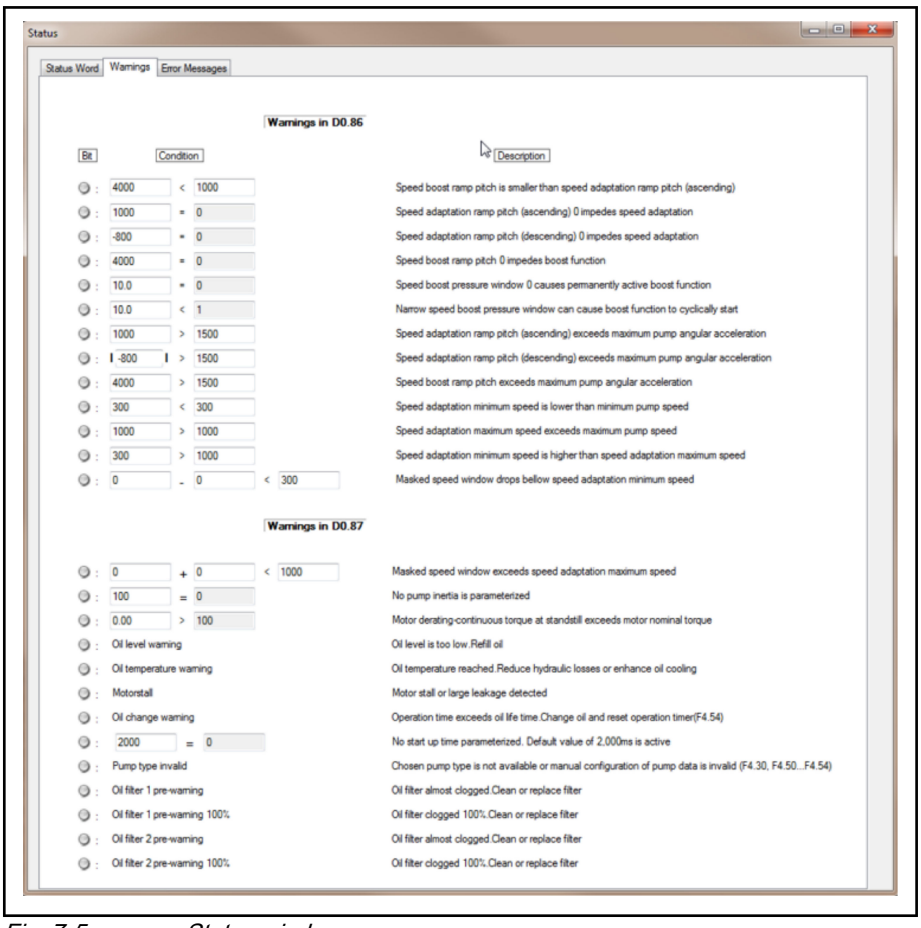


Fig. 7-5: Status window

Commissioning and Configuration

The button basic commissioning should be the first choice when you starting with a new DRn system. It opens a guided step by step wizard, which helps you reset the drive system, setup Master Communication, calibrate the motor and mechanical controls and lets you also choose your important set points and sensors. After this your system should already start running. After you hit the button ⑪ “Basic Commissioning”, the following window opens.

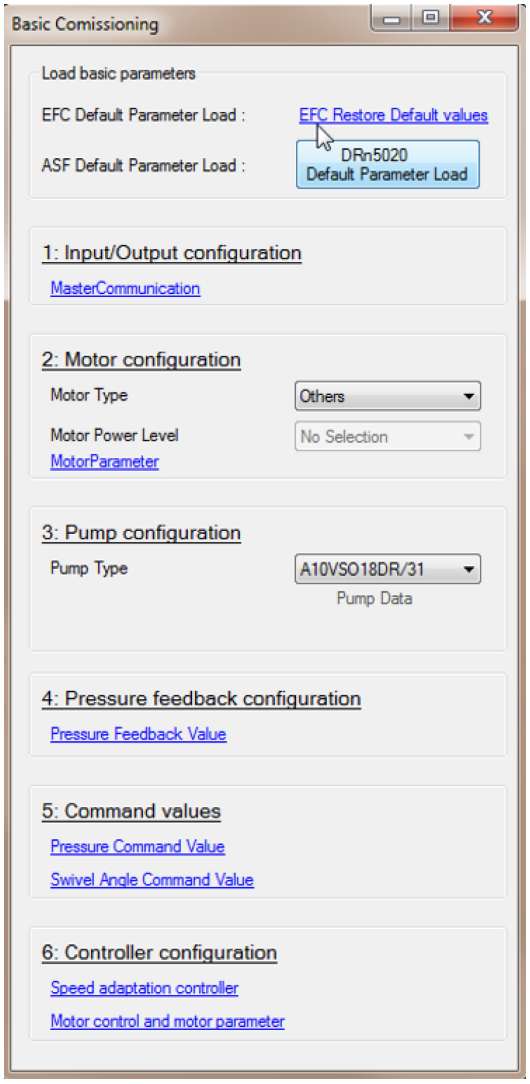


Fig. 7-6: Commissioning wizard

Step 1: Input / Output configuration

Input and Output can be delivered through communication bus, digital inputs or analog inputs. At this step following the link the user can set Master Communication Interface. For more communication parameters, go to communication dialog ① and ④ (See fig. 7-3 "Sytronix DRn5020 dialog" on page 59).

Step 2: Motor configuration

Choosing the motor type to "MOT-FC" if you have one (otherwise select others). Then go through "Motor Parameter" link and enter the motor data manually. If you have chosen "MOT-FC" you don’t have to enter the parameters in the following window and then go to "Take remote control" link get control of the drive, go back to the Auto-Tuning dialog.

Commissioning of Sytronix DRn 5020 System

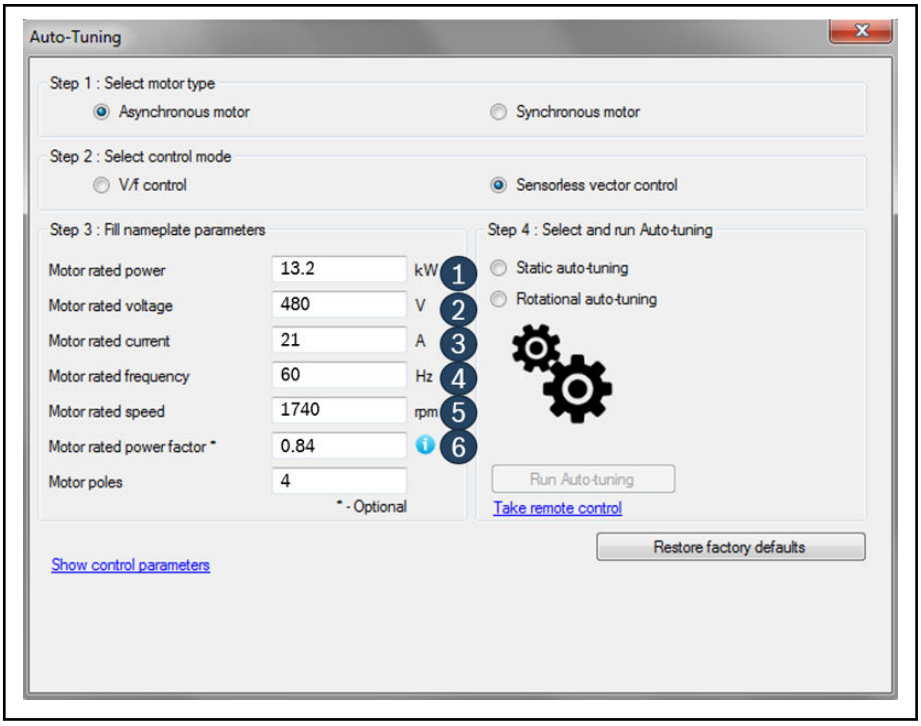


Fig. 7-7: Motor Parameters and Auto-Tuning

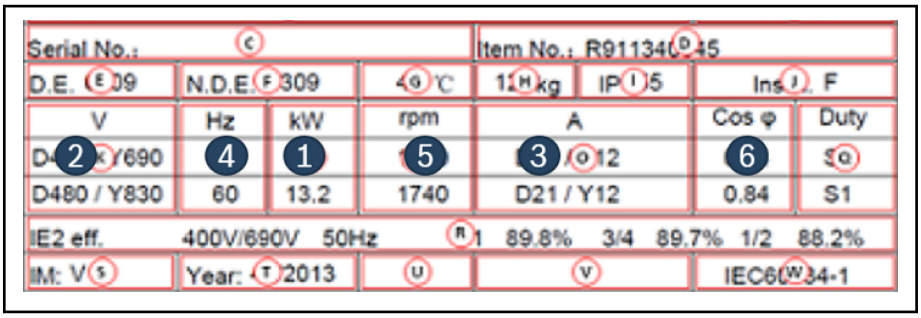


Fig. 7-8: Motor type plate

Now depending if your drive system is uncoupled or coupled with the hydraulic system you have to choose "Static" or "Rotational" auto-tuning.

Uncoupled (system can rotate without building pressure)

- > Rotational tuning

Coupled with load and valve open (system can rotate without building pressure higher then 5 bar because of coupled hydraulic system behavior)

- > Rotational tuning

Coupled with load and valve closed (system cannot rotate without building pressure valve on the high pressure side is closed and or leakage is not high enough, cylinders are in hard stops or have high friction)

- > Static auto-tuning

However rotational auto-tuning is suggested when using SVC, which is needed in DRn5020, but the hydraulic application must be made sure, that no pressure can build up while tuning e.g. load valve open, cylinder systems. Even dynamic pressure should not reach more than 5 bar, which is decided by fluid speed. If the user is unsure, pressure feedback should be monitored while the tuning is done.

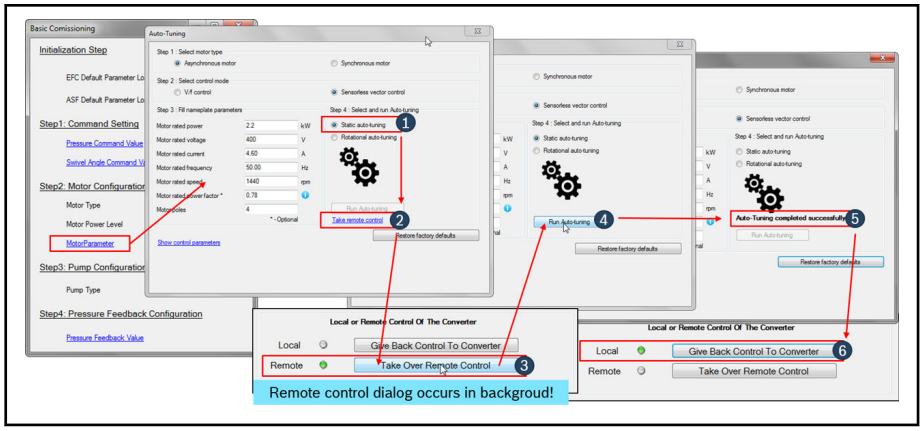


Fig. 7-9: Auto-tuning steps for "Static auto-tuning"

It is recommended to use Rotational tuning process while commissioning, but in some cases this is not possible because motor-pump group is already connected to the hydraulic circuit. So if forced to use static auto-tuning it needs to be checked, that motor inertia defined by C1.13 / C1.14 equals that of the actual motor.

- > The motor inertia, which is preconfigured by default, is suiting to the power class of the drive. This value can greatly vary on the construction of the motor, but in practice only one default value can be set. So the motor inertia value is subjected to be changed according to the motor used in the application if it's not matching to the default value

⚠ CAUTION

Danger of mechanic destruction of the pump during rotation if it is mounted with motor!

Commissioning of Sytronix DRn 5020 System

Sub-dialog Communication

The communication dialog is used to configure the source of control words and command values which can be provided to the DRn5020 function. Depended on the choices from this sub-dialog the software is listening to different sources. See chapter 7.6.2 "Frequency Converter Parameter Address" on page 116 for communication parameters.

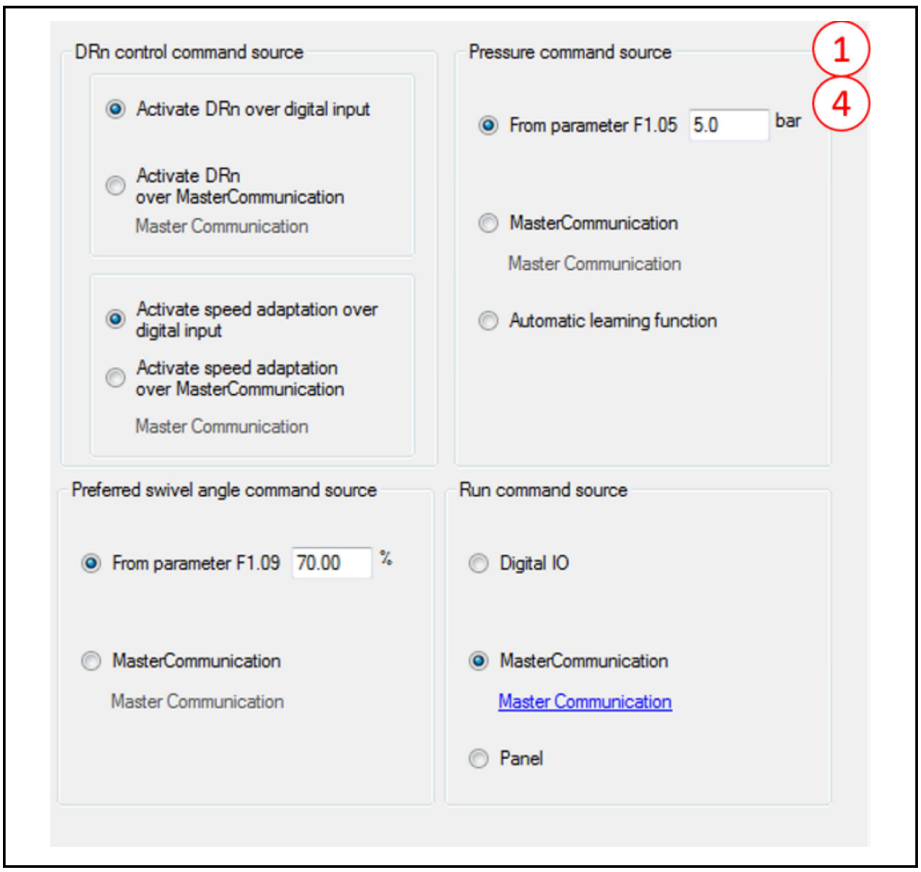


Fig. 7-10: Communication dialog

Sub-dialog Command Values

The command values dialog is used to configure specially the pressure command and preferred swivel angle command value which can be provided to the DRn5020 function. Depended on the choices from this sub-dialog the software is listening to different sources. See chapter 7.6.2 "Frequency Converter Parameter Address" on page 116 for communication parameters.

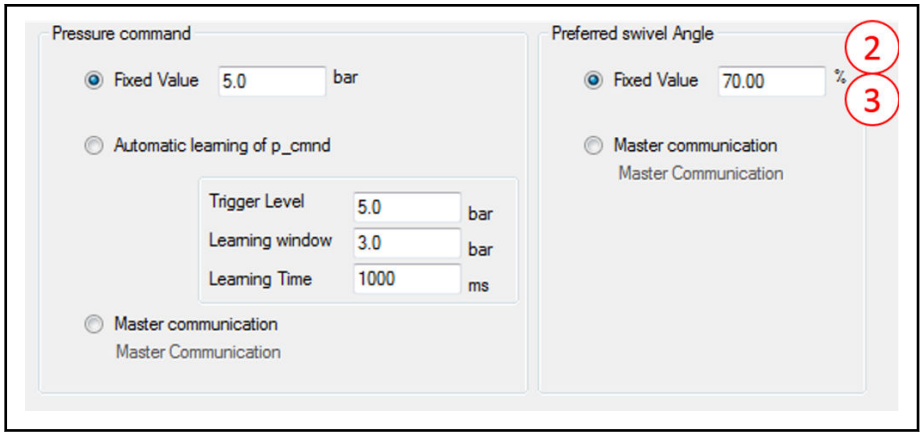


Fig. 7-11: Command values dialog

Sub-dialog Speed Adaptation

The speed adaptation dialog is used to configure the rate and limits at which the speed is adjusted by the Sytronix function. It includes the swivel angle control section, which is closed loop and the pressure boost function which is technically an open loop control. Usually only K_I is adjusted. K_P and K_D should in all regular cases be zero. For more information, see chapter "Speed Adaption" on page 72.

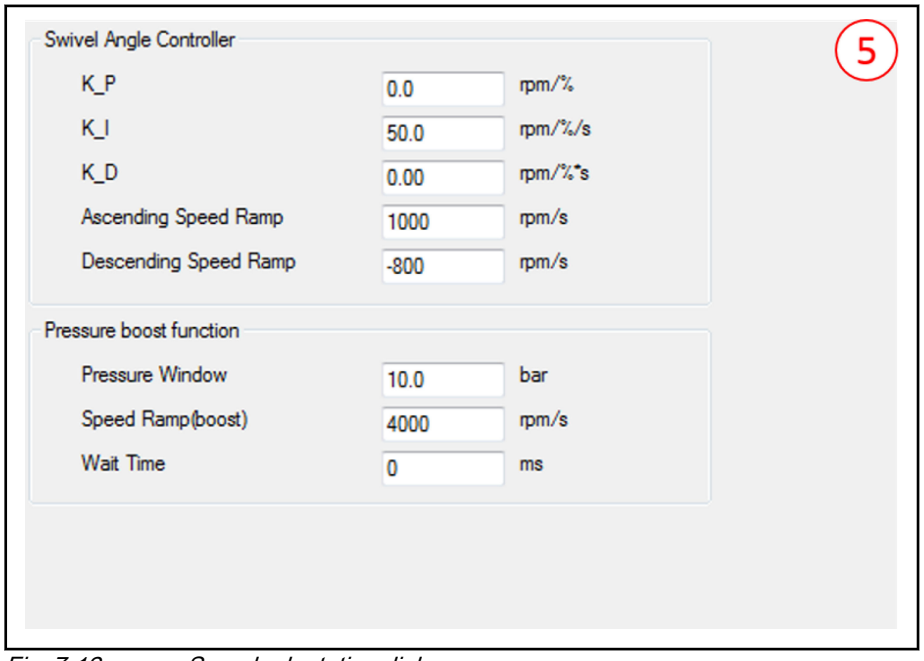


Fig. 7-12: Speed adaptation dialog

Commissioning of Sytronix DRn 5020 System

Sub-dialog Pressure Feedback

The pressure feedback dialog is used to give an easy configuration for using of pressure sensors with the EFC analog inputs. In the drop-down part, one can choose from various HM20 standard Rexroth pressure sensors.

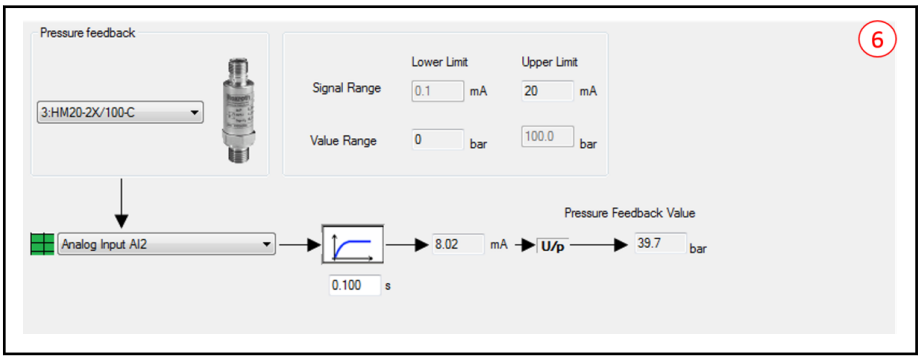


Fig. 7-13: Pressure feedback configuration

If you use HM20 standard one you can choose from the list and signal ranges and limits are automatically set. For all other sensors, it is needed to use “Other Voltage Sensor” or “Other Current Sensor”. Then adjust the limits and ranges by hand.

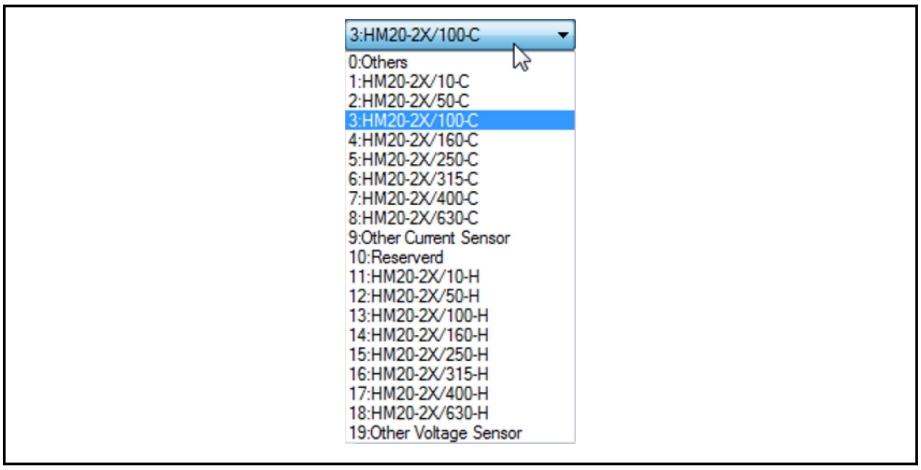


Fig. 7-14: Sensor type selection

By default, "Analog Input AI2" is selected for pressure feedback. If this is subjected to change due application specific requirement, the analog input, which reads the pressure feedback, can be changed by using the dropdown. If you hover over the green bar on the left you can see the connection layout / pins on the physical inputs, connected to the analog input which is chosen.

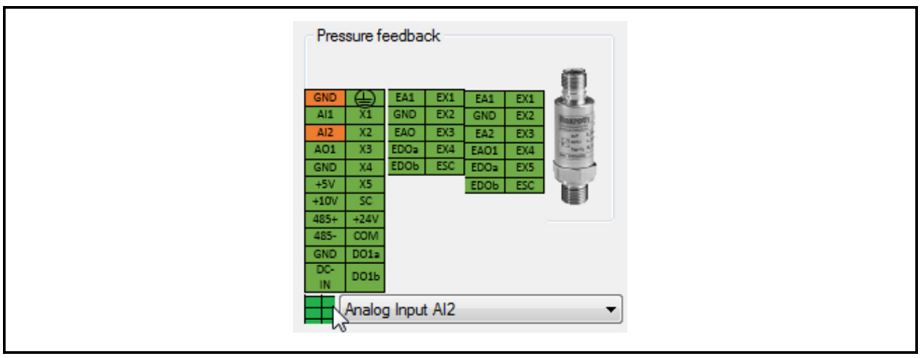


Fig. 7-15: Pressure feedback selection

Sub-dialog Motor Control and Parameters

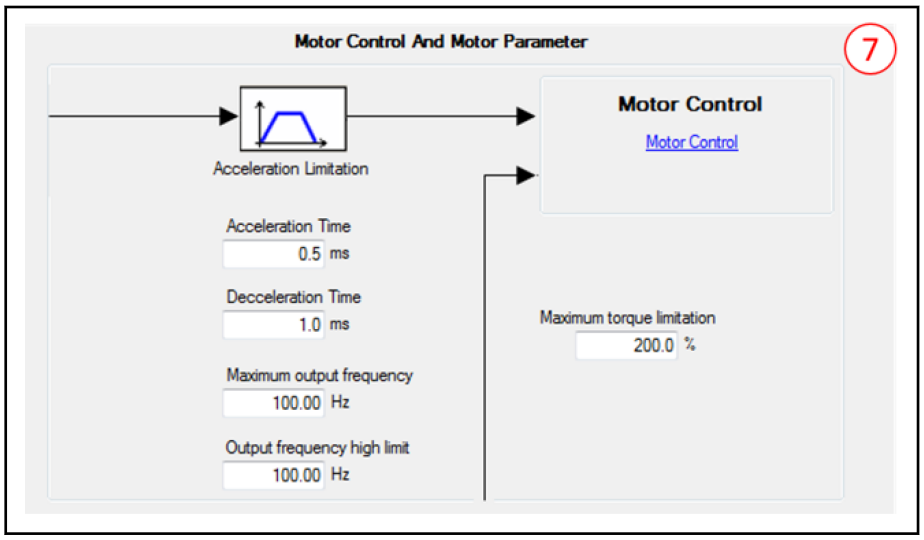


Fig. 7-16: Sub-dialog motor control and parameters

Sub-dialog System Configuration

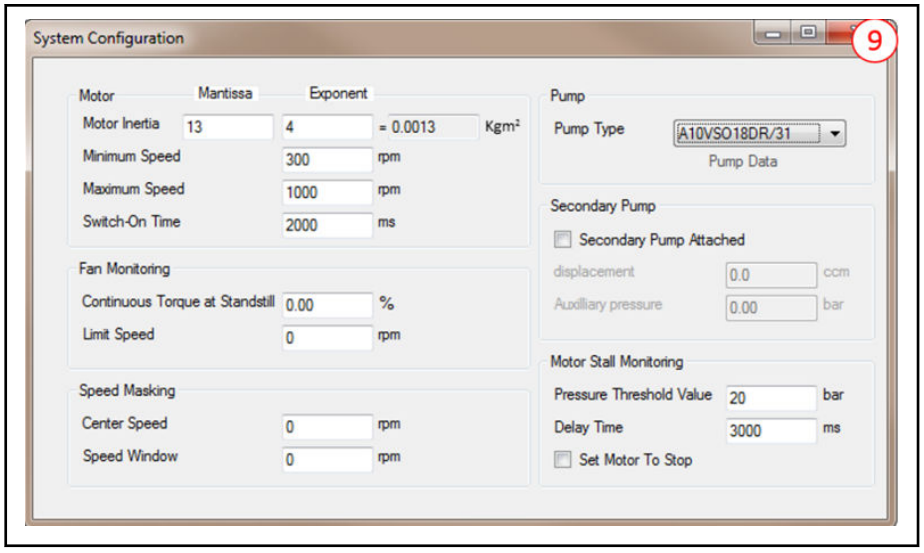


Fig. 7-17: Sub-dialog System Configuration

7.1.3 Main Functions

Load Pump Parameters

Before the speed adaptation of the "Sytronix-DRn" function can be used, some settings have to be made to configure the EFC drive system. The default values are a good base to start. Only "F1.05 Command value: Pressure" must be configured for your mechanical DR/DRG pressure control set point.

Code	Name	Setting Range	Default	Attri.
F1.05	Command value: Pressure	5.0...1,000.0 bar	5.0	Run
F3.19	Speed adaptation: Minimum speed	0...10,000 rpm	300	Run
F3.20	Speed adaptation: Maximum speed	0...10,000 rpm	1,000	Run
F3.29	Start-up time	0...30,000 ms	2,000	Run
F4.29	Pump type	0...31	1	Stop
F4.30	Pump: Maximum displacement	1.0...5,000.0 ccm	18.0	Stop
F4.50	Pump: Maximum angular acceleration	0...60,000 rad / s^2	1,500	Stop
F4.51	Pump: Maximum speed	0...10,000 rpm	1,000	Stop
F4.52	Pump: Minimum speed	0...10,000 rpm	300	Stop
F4.53	Pump: Inertia mantissa	0...10,000 *	100	Stop
F4.54	Pump: Inertia exponent	0...10 *	5	Stop

Tab. 7-1: Parameter list of system configuration

☞ *: F4.53, F4.54 have no dimension on its own. The value calculated by the mantissa and exponent has the dimension **kgm^2**.

F3.19 Speed adaptation: Minimum speed

This parameter limits the minimum speed of the speed adaptation.

- With low flow rates, the limitation of the minimum speed causes the actual swivel angle value to stationarily fall below the command value from F1.09.
- When loads are switched on, a low minimum speed can reduce the disturbance rejection of pressure control (cf. boost function in chapter "Boost Function" on page 76).

F3.20 Speed adaptation: Maximum speed

This parameter limits the maximum speed of the speed adaptation.

- The maximum speed may not exceed the allowed limit values of the A10 pump used.
- The drive is accelerated to the parameterized speed, if a pressure drop is detected or when the speed adaptation has been deactivated (cf. chapter "Boost Function" on page 76 and chapter 8 "Operation" on page 117).

F3.29 Start-up time

Setting drive enable (X1 as default) and activating DRn enable (Digital input X3 by default or ASF control word F0.20 from communication) starts the "Sytronix-DRn" function. At the beginning, the drive is accelerated in linear form to the maximum speed parameterized in F3.20 within the defined start-up time F3.29. The function can also be started from master communication, see

chapter 7.6.2 "Frequency Converter Parameter Address" on page 116 for more information. Afterwards, the speed adaptation is activated by "DRn variable speed enable" (X4 by default or ASF control word F0.20 from communication). X1, X3, X4 do not have a specific order to be set. They can be set all at once or in any order.

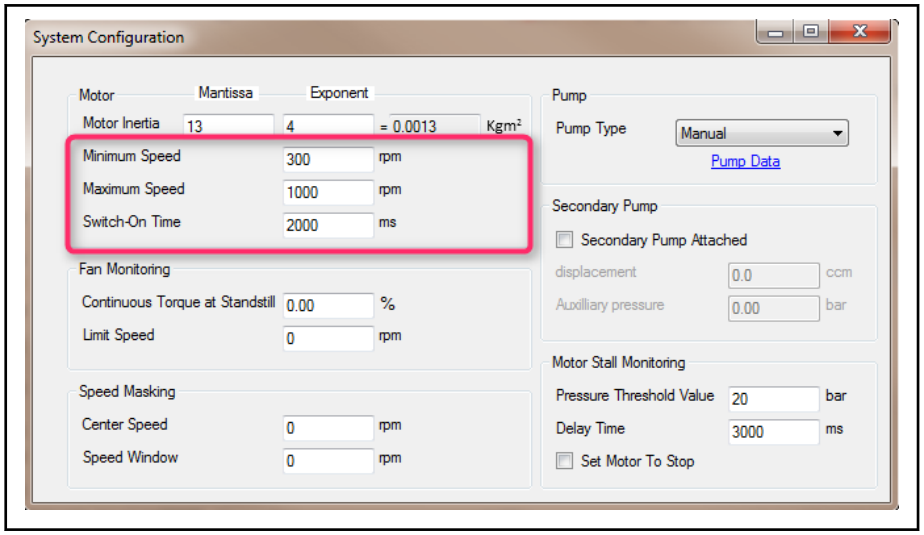


Fig. 7-18: System configuration

F1.05 Command value: Pressure

This parameter makes the command value of DR/DRG pressure control available to the drive so that pressure drops can be identified and the boost function can be activated (cf. chapter "Boost Function" on page 76).

F4.29 Pump type

The pump used is selected via this parameter according to the following table. Setting the pump type to "0" requires to parameterize the pump data manually in F4.30 and F4.50 to F4.54.

If the pump type is set to manual (F4.29 = 0), the values set in F4.30, F4.50, F4.51, F4.52 must be checked, so the values are not in conflict with some parameters (for example F3.19 Speed adaptation: Minimum speed and F3.20 Speed adaptation: Maximum speed) in the DRn functions, see chapter 14 "Troubleshooting" on page 124 for reference. The user gets APE1/APF1 fault depending which value is not set correctly. In the error case D0.86 and D0.87 (Warnings) and D0.88 and D0.89 (Errors) must be evaluated, to find which value has to be changed. For more information, see chapter chapter 14.3 "Warning Code" on page 124 and chapter 14.4 "Error Code" on page 125.

F4.29	Pump type	F4.29	Pump type
0	Manual pump configuration see F4.30, F4.50, F4.51, F4.52, F4.53, F4.54	18	A10VSO140DR/32 (High Speed)
1	A10VSO18DR/31	19	A10VSO180DR/32
2	A10VSO28DR/31	20	A4VSO*40DR/10
3	A10VSO45DR/31	21	A4VSO*71DR/10
5	A10VSO71DR/31	22	A4VSO*125DR/30
7	A10VSO100DR/31	23	A4VSO*180DR/30
9	A10VSO140DR/31	24	A4VSO*250DR/30
11	A10VSO45DR/32	25	A4VSO*250DR/30 (High Speed)
12	A10VSO45DR/32 (High Speed)	26	A4VSO*355DR/30
13	A10VSO71DR/32	27	A4VSO*355DR/30 (High Speed)
14	A10VSO71DR/32 (High Speed)	28	A4VSO*500DR/30
15	A10VSO100DR/32	29	A4VSO*500DR/30 (High Speed)
16	A10VSO100DR/32 (High Speed)	30	A4VSO*750DR/30
17	A10VSO140DR/32	31	A4VSO*1000DR/30

Tab. 7-2: Selection of pump type

F4.30 Pump: Maximum displacement

The maximum displacement volume of the pump has to be entered in this parameter. The input is only used in the case of F4.29 = 0 (manual pump type)

F4.50 Pump: Maximum angular acceleration

The maximum angular acceleration of the pump has to be entered in this parameter. The input is only used in the case of F4.29 = 0 (manual pump type)

F4.51 Pump: Maximum speed

The maximum speed of the pump has to be entered in this parameter. The input is only used in the case of F4.29 = 0 (manual pump type)

F4.52 Pump: Minimum speed

The minimum speed of the pump has to be entered in this parameter. The input is only used in the case of F4.29 = 0 (manual pump type)

F4.53 Pump: Inertia mantissa

The mantissa of the inertia of the pump has to be entered in this parameter. The input is only used in the case of F4.29 = 0 (manual pump type)

F4.54 Pump: Inertia exponent

The exponent of the inertia of the pump has to be entered in this parameter. The input is only used in the case of F4.29 = 0 (manual pump type)

Example:

To achieve a value of 0.00125 kgm^2 for the pump inertia, one has to set F4.53 = 125, F4.54 = 5.

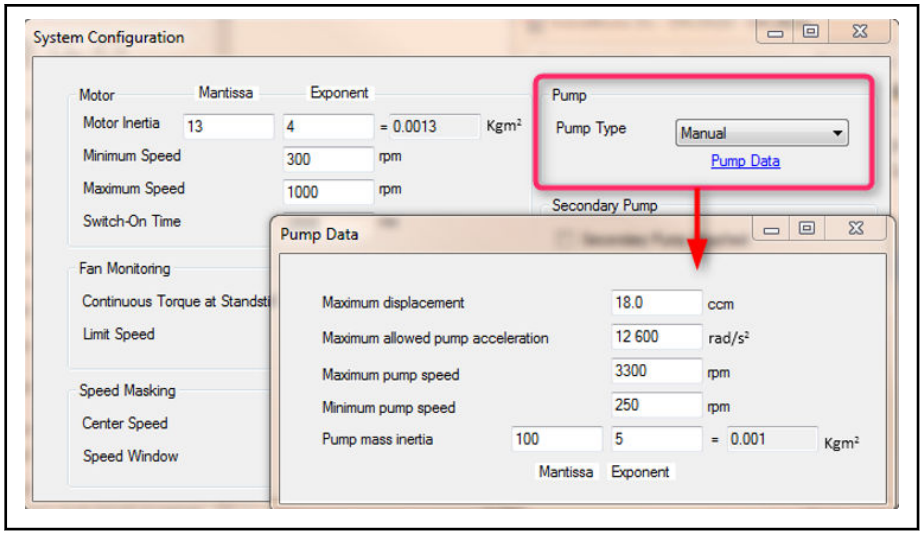


Fig. 7-19: System configuration-pump data

The pump type selection can be set from the available table tab. 7-2 "Selection of pump type" on page 70 with the dialog above. The hyperlink "Pump Data" only appears if “Manual” type is selected. For this case, the pump data from previous selection stays in the pump parameters. From this selection the user can open the pop up window and manually change to the values desired from the pump data sheet.

Commissioning of Sytronix DRn 5020 System

Speed Adaption

The speed adaptation is at the core of the "Sytronix-DRn" function and in operation at partial load allows reducing the pump speed in an intelligent way.

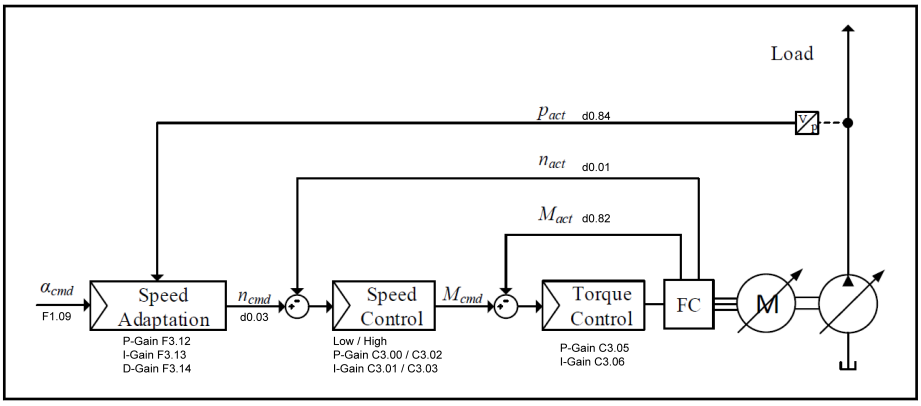


Fig. 7-20: Principle of DRn speed adaptation

The underlying principle consists in providing a preferred command value for the pump swivel angle. The speed adaptation has been designed as a PID controller and can be configured via the following parameters.

Code	Name	Setting Range	Default	Attri.
F1.08	Preferred swivel angle command source	0: Swivel angle command of F1.09 1: Communication	0	Stop
F1.09	Command value: Preferred swivel angle	0.00...100.00 %	70.00	Run
F3.12	Speed adaptation: P-gain	0.0...1,000.0 rpm/%	0.0	Run
F3.13	Speed adaptation: I-gain	0.0...1,000.0 rpm/%/s	50.0	Run
F3.16	Speed adaptation: D-gain	0.00...100.00 rpm/%*s	0.00	Run
F3.21	Speed adaptation: Ramp pitch, ascending	0...10,000 rpm/s	1,000	Run
F3.22	Speed adaptation: Ramp pitch, descending	-9,999...0 rpm/s	-800	Run

Tab. 7-3: Parameter list of speed adaption

F1.08 Preferred swivel angle command source

This parameter sets the preferred swivel angle command source for the speed adaptation.

F1.09 Command value: Preferred swivel angle

The aim of the speed adaptation is to reach the preferred swivel angle command for the DR/DRG pump. In practice it is recommended to set this parameter to values that are smaller than 80% to give the pressure control a headroom for its control actions. The value 70% is a good point to start with. If you want to achieve better energy efficiency the user can experiment with different values here. It all comes down to the load flow and the set-point pressure. The values for the majority of the systems will be in the range 40%...70%.

F3.12 Speed adaptation: P-gain

This parameter sets the P-gain of the PID controller implemented for the speed adaptation. On standard applications with slow desired adaptation speed it is recommended to set this parameter to zero.

F3.13 Speed adaptation: I-gain

This parameter sets the I-gain of the PID controller implemented for the speed adaptation. Higher values on this parameter increase the rate of the speed adaptation. If this parameter is set to high, it will disturb the mechanical pressure control and cause oscillation of the system pressure.

F3.16 Speed adaptation: D-gain

This parameter sets the D-gain of the PID controller implemented for the speed adaptation. On standard applications it is recommended to set this parameter to zero.

F3.21 Speed adaptation: Ramp pitch, ascending

This parameter limits the positive gradient of the speed adaptation. For this purpose, the output of the PID controller is monitored.

- If the ramp is too steep, this can cause instability in the superimposed pressure controller of the DR/DRG pump.
- A small ramp is noncritical, but can cause the boost function to be activated.

F3.22 Speed adaptation: Ramp pitch, descending

This parameter limits the negative gradient of the speed adaptation. For this purpose, the output of the PID controller.

- If the ramp is too steep, this can cause instability in the superimposed pressure controller of the DR/DRG pump.
- A small ramp is noncritical, but decreases the effect of the speed adaptation on the energy and noise reduction.
- If the descending ramp is to steep the drive possibly recovers to much energy and the DC link power gets to high. So its good practice to set F3.22 between -0.5...-0.8 * F3.21.

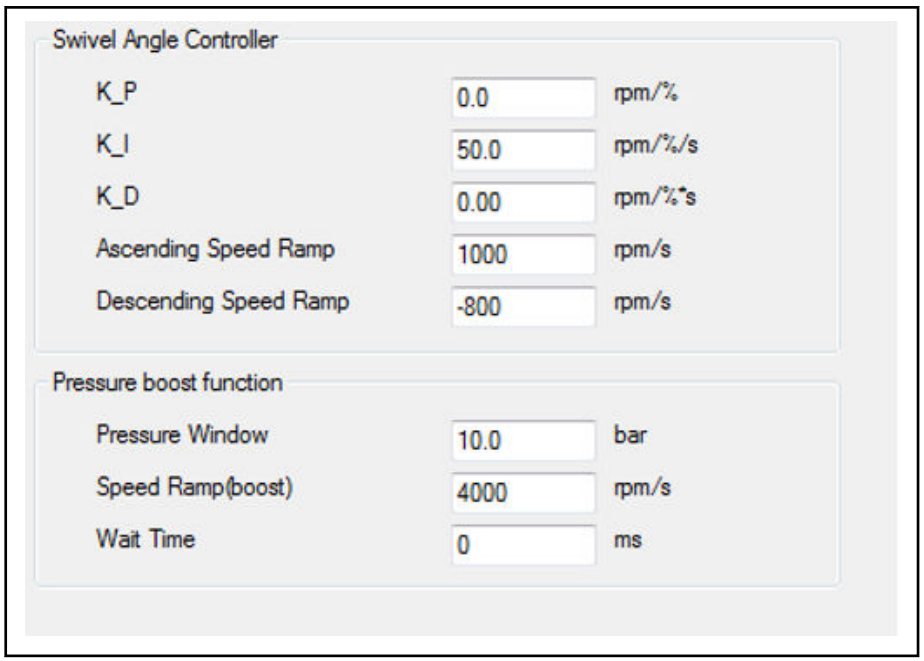


Fig. 7-21: Speed adaptation

Pressure Command Learning

The command value of the hydro mechanical DR/DRG pressure control has to be known to the drive so that pressure drops can be identified and the boost function can be activated. Typically the command pressure is known and can be parameterized in F1.05.

If the command value is not known an automatic learning algorithm can be activated by means of the following parameters:

Code	Name	Setting Range	Default	Attri.
F1.02	Control word: Pressure command source	0: Depend on the value of F1.04 1: Communication 2: Analog input 3: Learning pressure command 4: Select by digital input (F1.04 shows status)	0	Stop
F3.26	Pressure command value: Trigger level	0.0...1,000.0 bar	5.0	Run
F3.27	Pressure command value: Learning window	0.0...1,000.0 bar	3.0	Run
F3.28	Pressure command value: Learning time	0...10,000 ms	1,000	Run
D0.81	Effective pressure command value	bar		Read

Tab. 7-4: Parameter list of pressure command learning

F1.02 Control word: Pressure command source

The control word of the pressure command source has to be set to "3" to activate the pressure learning.

F3.26 Pressure command value: Trigger level

A new learning procedure is started, if the difference between pressure feedback and recently learned command pressure exceeds the threshold defined in this parameter.

The recently learned pressure command value remains active until the new learning procedure has been completed.

F3.27 Pressure command value: Learning window

The pressure feedback value is monitored after a new learning procedure has started (cf. F3.26). For this purpose, the learning window defines a symmetrical pressure window around the current pressure feedback. If the pressure feedback remains within this learning window for the time defined in F3.28, the pressure is assessed to be stable and set as the new pressure command value. The default parameters should be viable for most pressure controlled hydraulic circuits. Permanent change in load can embarrass the learn function to finish its task.

F3.28 Pressure command value: Learning time

See description of F3.27.

D0.81 Effective pressure command value

The currently learned pressure command value is displayed in this parameter for monitoring.

The figure below visualizes the learning function parameterization.

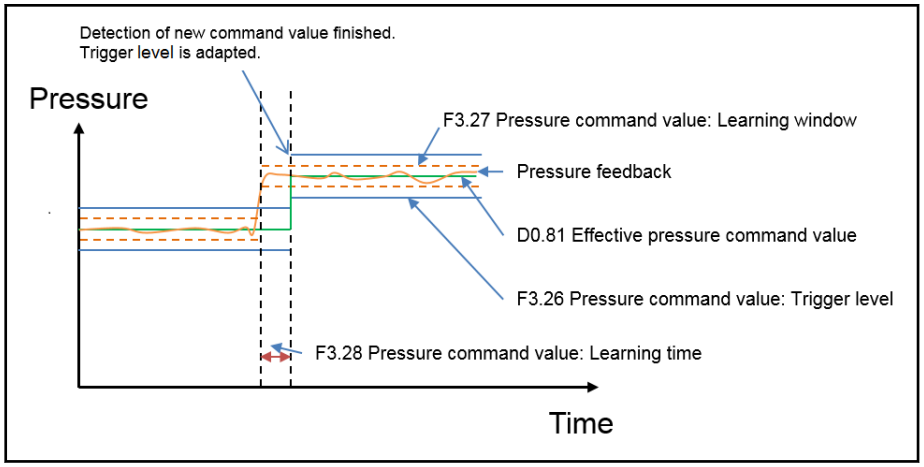


Fig. 7-22: Parameterization of pressure learning function

Specifically for the pressure command value source over automatic learning, the required parameters can be set by the dialog. The default values should do on most system configurations. A downside of the learning functions, it will always have a delay to the real pressure command value, by the Learning Time. So for time critical behavior setting by the other available options is recommended.

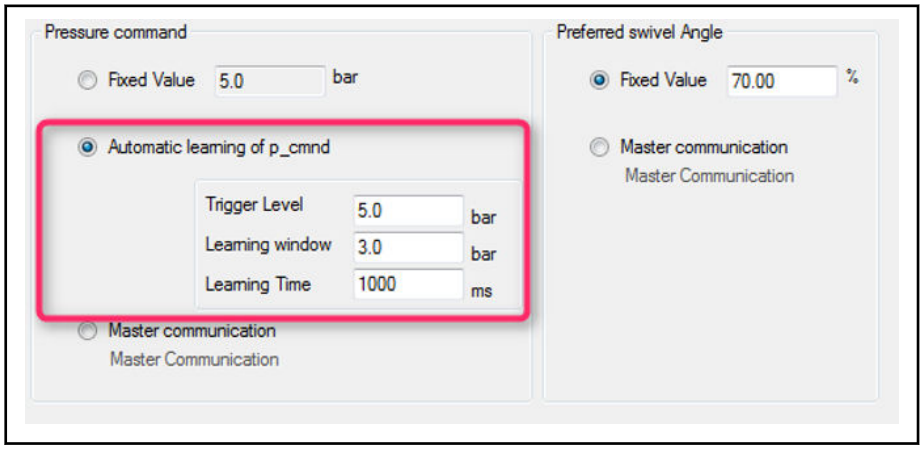


Fig. 7-23: Pressure command learning function

Boost Function

When the speed adaptation has been activated, the system pressure is continuously monitored. Thus loads that are switched on are automatically detected. If the pressure value falls below a defined threshold (F3.24), the drive speed is accelerated to the maximum speed defined in F3.20, regardless of the input from the speed adaptation. The speed adaptation is continued as soon as the command pressure has been reached again. The following parameters have to be configured:

Code	Name	Setting Range	Default	Attri.
F3.23	Speed boost: Ramp pitch	0...30,000 rpm/s	4,000	Run
F3.24	Speed boost: Pressure window	0.0...1,000.0 bar	10.0	Run
F3.25	Speed boost: Wait time	0...10,000 ms	0	Run

Tab. 7-5: Parameter list of boost function

F3.23 Speed boost: Ramp pitch

In the boost mode, the drive speed is accelerated to the maximum speed defined in F3.20. This parameter is used to limit the acceleration and avoid disturbance on the hydro-mechanical pressure controller of the DR/DRG pump. As the boost function only takes effect when a pressure drop occurs and persist only for a short time, until pressure has recovered, distinctly steeper ramps are possible than with ordinary active speed adaptation (cf. F3.21).

F3.24 Speed boost: Pressure window

The boost function is started as soon as the difference between pressure command value and actual pressure feedback exceeds this threshold value. The boost function remains active until the pressure command value has been reached again.

F3.25 Speed boost: Wait time

A small pressure window in F3.24 can lead to a cyclic start of the boost function in case of a low damped DR/DRG pressure control loop (e.g. large oil volume). This parameter defines a minimum time between subsequent boost sequences to avoid the cyclic start.

The figure below visualizes the parameterization of the boost function.

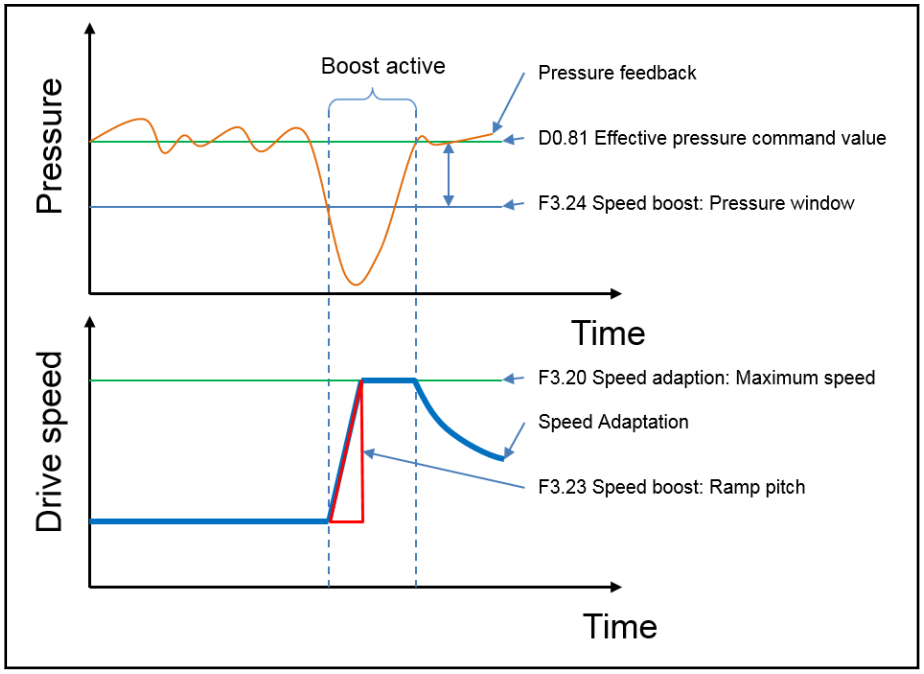


Fig. 7-24: Parameterization of boost function

If the performance of the automatic boost function does not meet the application's requirements regarding the dynamics (e.g., when big loads are switched on), "DRn variable speed enable" (X4 by default or ASF control word F0.20 from communication) can be switch-off in critical machine phases to operate the pump with maximum speed.

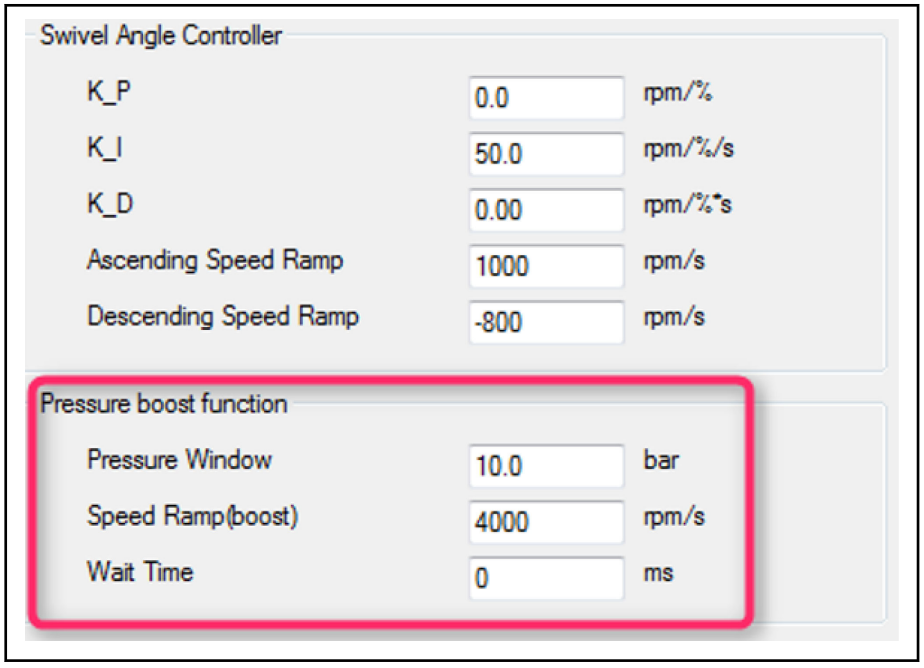


Fig. 7-25: Pressure boost function

Motor Derating

The continuously available torque decreases when the drive speed is reduced (e.g. in case of self-ventilated motors). Thus, the continuous torque has to be accordingly limited in the lower speed range. For this purpose, the Sytronix-DRn function provides motor derating that automatically adjusts the speed adaptation to the current load, if required. The derating function is parameterized via the following parameters:

Code	Name	Setting Range	Default	Attri.
C1.05	Motor rated power	See EFC documentation		
C1.09	Motor rated speed	See EFC documentation		
F4.55	Motor derating: Continuous torque at standstill	0.00...100.00 %	0.00	Stop
F4.56	Motor derating: Limit speed	0...10,000 rpm	0	Stop

Tab. 7-6: Parameter list of motor derating

C1.05 Motor rated power / C1.09 Motor rated speed

The motor derating uses the nominal motor torque as a reference value. It is internally calculated by means of C1.05 and C1.09:

$$Nominal\ torque\ [Nm] = \frac{Nominal\ power\ [kW]}{Nominal\ speed\ [rpm]} \cdot \frac{30}{\pi} \cdot 1000$$

F4.55 Motor derating: Continuous torque at standstill

The continuous torque at standstill of fan monitoring defines the torque that can be permanently held at speed zero. The input is in percent of the motor rated torque.

F4.56 Motor derating: Limit speed

The limit speed of the derating function defines the lower motor speed at which the nominal torque can be permanently held.

The figure below visualizes the parameterization of the motor derating.

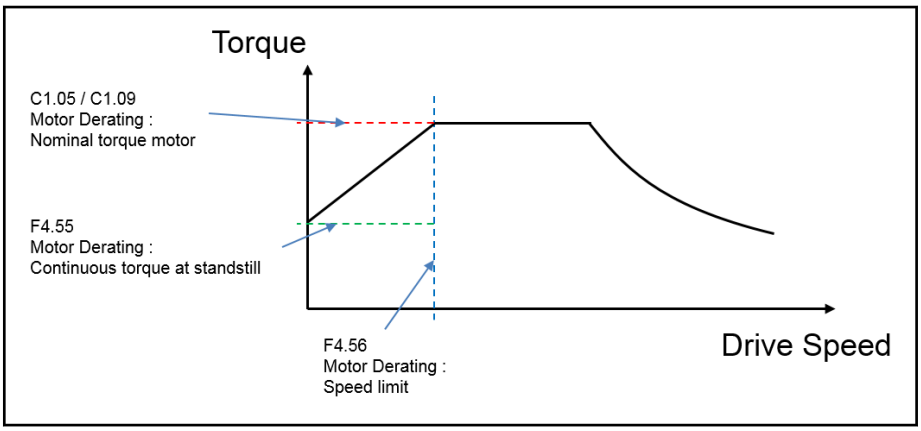


Fig. 7-26: Parameterization of motor derating

As soon as the drive speed has fallen below the parameterized speed limit value, the motor torque is monitored and it is made sure that the thermal limit characteristic from the figure above is not exceeded. The thermal overload is avoided by increasing the motor speed.

☞ The fan monitoring is deactivated as soon as one of the two parameters F4.55, F4.56 has the value "0".

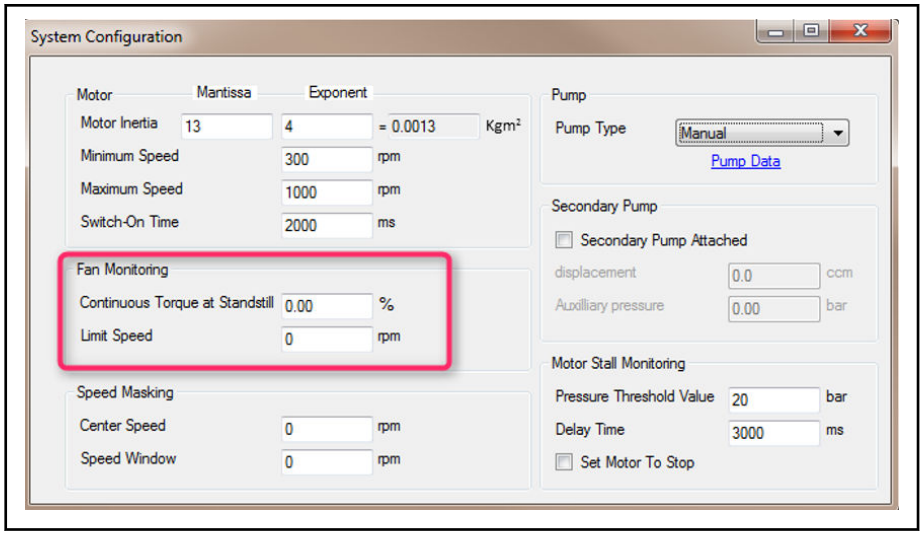


Fig. 7-27: Fan monitoring / motor derating

Speed Masking

The masking of a defined speed window can be parameterized to avoid resonance frequencies of the machine or machine frame. The following parameters have to be configured.

Code	Name	Setting range	Default	Attri.
F4.57	Speed masking: Center speed	0...10,000 rpm	0	Run
F4.58	Speed masking: Window	0...10,000 rpm	0	Run

Tab. 7-7: Parameter list of speed masking

F4.57 Speed masking: Center speed

The center speed defines the center of the speed window to be masked to avoid resonance frequencies. The center speed should be the same value as the major resonance frequency of the machine.

F4.58 Speed masking: Window

This parameter defines the width of the speed window to be masked to avoid resonance frequencies.

The figure below visualizes the parameterization of the speed masking.

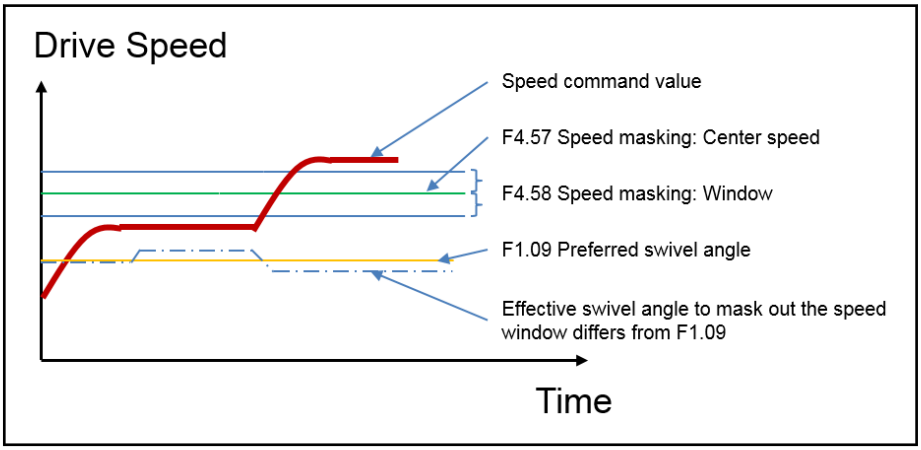


Fig. 7-28: Parameterization of speed masking

The speed masking still takes the motor derating function from previous page into account.

☞ The speed masking is deactivated as soon as one of the two parameters F4.57, F4.58 has the value "0".

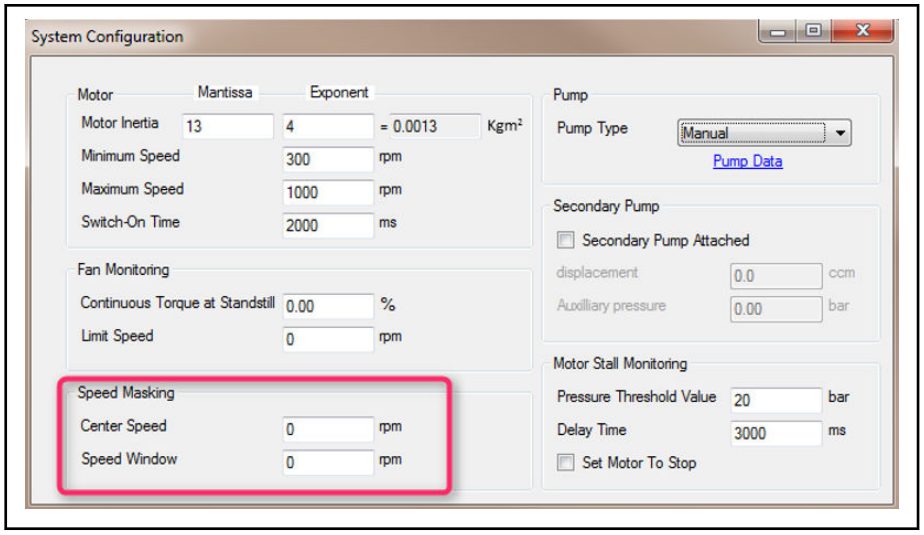


Fig. 7-29: Speed masking

Auxiliary Pump

If an auxiliary pump has been additionally installed on the motor shaft (e.g., cooling circuit or filter circuit), the additional load has to be taken into account in the speed adaptation. For the internal calculation, the following parameters have to be configured:

Code	Name	Setting range	Default	Attri.
F4.59	Auxiliary pump: Displacement	0.0...5,000.0 ccm	0.0	Stop
F4.60	Auxiliary pump: Pressure	0.00...250.00 bar	0.00	Stop

Tab. 7-8: Parameter list of auxiliary pump

F4.59 Auxiliary pump: Displacement / F4.60 Auxiliary pump: Pressure

By means of the displacement and the pressure level of the auxiliary pump a torque offset is calculated internally for the load observer:

$$Torque\ offset\,[Nm] = \frac{Displacement\,[ccm] \cdot Pressure[bar]}{20 \cdot \pi \cdot \eta}$$

☞ The auxiliary pump compensation is deactivated as soon as one of the two parameters F4.59, F4.60 have the value "0".

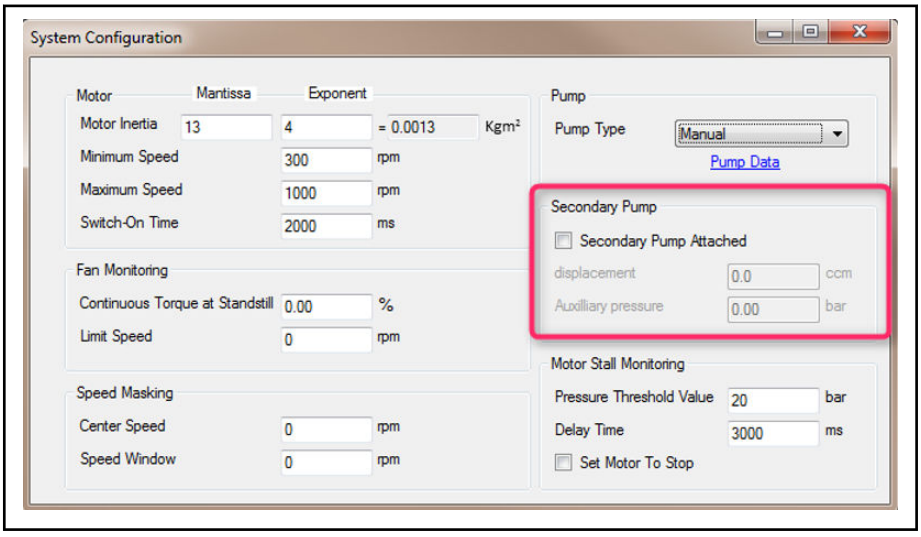


Fig. 7-30: Secondary / auxiliary pressure configuration

Motor Stall and Large Leakage Detection

Under some heavy hydraulic load conditions, there can occur a stalling of the induction motor.

This function monitors the pressure for a time. If the pressure is under that threshold for longer than the time which is set, then either a large leakage or a motor stall has occurred.

Code	Name	Setting range	Default	Attri.
F4.00	Protection function control word	0...15 Bit0=0: Issues only a warning Bit0=1: Motor stall detection sets motor setpoint speed to zero on occurence Bit3=0: Deactivate oil change detection Bit3=1: Activate oil change detection	0	Run
F4.61	Motor stall detection: Pressure threshold	0...10,000 bar	20	Run
F4.62	Motor stall detection: Wait time	0...10,000 ms	3,000	Run

Tab. 7-9: Parameter list of large leakage and motor stall detection

F4.61 Motor stall detection: Pressure threshold / F4.62 Motor stall detection: Wait time

The parameters describe a band between 0... [F4.61] bar. If the pressure actual value persist in this band longer than [F4.62] time. A motor stall or large leakage / load occurred and a reaction is triggered.

There are two reactions of this function, which is always on:

- F4.00 Bit0 = 0 - > reaction is only a warning

- F4.00 Bit0 = 1 - > reaction is a warning and speed command is set to zero to stop motor control

- F4.00 Bit3 = 0 - > disable the oil change detection

- F4.00 Bit3 = 1 - > enable the oil change detection

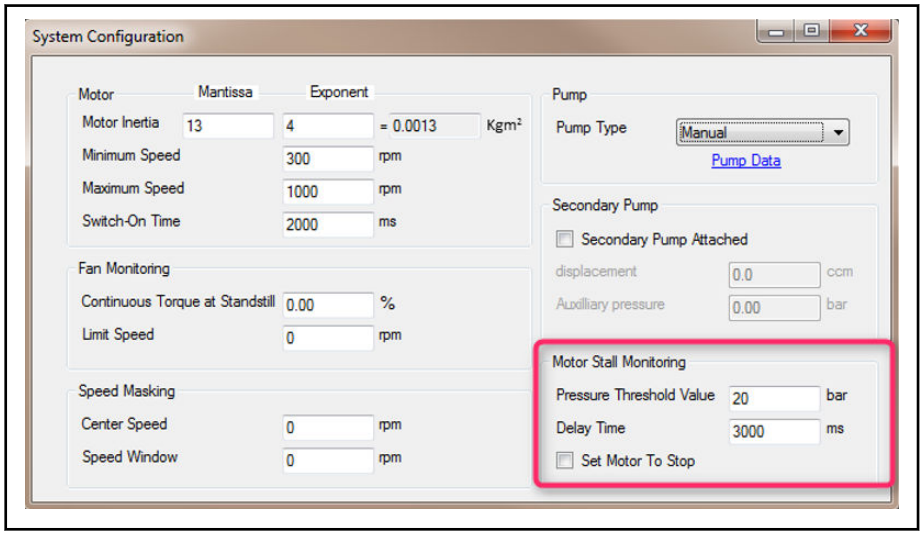


Fig. 7-31: Motor stall protection function

Commissioning of Sytronix DRn 5020 System

Configuration of Pressure Sensor

For application using Rexroth HM20 pressure transducer, configuration parameters of HM20 sensor can be automatically loaded by selecting the corresponding type code in parameter F2.10. Please make sure the right analog input channel has been set through [F2.00]...[F2.02] before setting [F2.10], since the configuration parameters (AI input mode and scaling factors) will be set for the selected channel for pressure feedback.

The pressure feedback is required to observe the hydraulic load and to trigger the automatic boost function. Therefore, analog input AI2 has to be configured with respect to the installed pressure transducer.

Code	Name	Setting range	Default	Attri.
E1.35	AI1 input mode	0: 0...20 mA 1: 4...20 mA 2: 0...10 V 3: 0...5 V 4: 2…10 V	2	Run
E1.40	AI2 input mode		1	Run
H8.05	EAI input mode	0...4 (same as E1.35) 5: -10...10 V	0	Stop
F2.00	Analog input AI1	0: No function assigned 1: Pressure command 2: Pressure feedback 3: Oil level warning / error 4: Oil temperature	0	Stop
F2.02	Extended analog input EAI		0	Stop
F2.01	Analog input AI2	0: No function assigned 1: Pressure command 2: Pressure feedback	2	Stop
F2.04	Pressure command corresponding to 10 V / 20 mA	0.1...1,000.0 bar	100.0	Stop
F2.05	Pressure command null offset in V or mA	0...5.0 V, mA	0.1	Stop
F2.06	Pressure feedback corresponding to 10V or 20mA	0.1...1,000.0 bar	100.0	Stop

Code	Name	Setting range	Default	Attri.
F2.07	Pressure feedback null offset in V or mA	0.0...5.0 V, mA	0.1	Stop
F2.10	Pressure sensor type	0: Others 1: HM20-2X/10-C 2: HM20-2X/50-C 3: HM20-2X/100-C 4: HM20-2X/160-C 5: HM20-2X/250-C 6: HM20-2X/315-C 7: HM20-2X/400-C 8: HM20-2X/630-C 9: Other 4...20mA pressure sensor 10: Reserved 11: HM20-2X/10-H 12: HM20-2X/50-H 13: HM20-2X/100-H 14: HM20-2X/160-H 15: HM20-2X/250-H 16: HM20-2X/315-H 17: HM20-2X/400-H 18: HM20-2X/630-H 19: Other 0.1...10V pressure sensor	3	Stop

Tab. 7-10: Parameter list of HM20 pressure sensor auto selection

Please refer to chapter "Sub-dialog Pressure Feedback" on page 66 set the pressure sensor via dialog.

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Load Motor Parameter

The parameters of MOT-FC_HOY motor are pre-configured in the ASF, so that the auto tuning and motor parameterization is not required when the DRn 5020 application uses preconfigured "MOT-FC_HOY" motor. Please keep [F1.15] = 1, and set F1.16 to the corresponding power level as specified below.

Code	Name	Setting range	Default	Attri.
F1.15	Motor type	0: Others 1: MOT-FC_HOY	0	Stop
F1.16	Motor power level	0: No selection 1: 0.2 kW 2: 0.3 kW 3: 0.5 kW 4: 0.7 kW 5: 1.1 kW 6: 1.5 kW 7: 2.2 kW 8: 3 kW 9: 4 kW 10: 5.5 kW 11: 7.5 kW 12: 11 kW 13: 15 kW 14: 18.5 kW 15: 22 kW 16: 30 kW 17: 37 kW 18: 45kW 19: 55 kW 20: 75 kW 21: 90 kW	0	Stop

Tab. 7-11: Motor parameter list

- Only change motor parameter by switching F1.16 to 1...21, when F1.15 = 1.
- If F1.15 = 0, no motor parameter will be changed by switching F1.16.

If the motor parameters from F1.15 / F1.16 are selected, the following parameters in EFC converter will be changed automatically.

Code	Name	Code	Name
C1.05	Motor rated power	C1.22	Rotor resistance
C1.06	Motor rated voltage	C1.23	Leakage inductance
C1.07	Motor rated current	C1.24	Mutual inductance
C1.08	Motor rated frequency	C3.00	Speed loop proportional gain 1
C1.09	Motor rated speed	C3.01	Speed loop integral time 1
C1.10	Motor rated power factor	C3.02	Speed loop proportional gain 2
C1.13	Motor inertia mantissa	C3.03	Speed loop integral time 2
C1.14	Motor inertia exponent	C3.05	Current loop proportional gain
C1.20	Motor no-load current	C3.06	Current loop integral time
C1.21	Stator resistance	-	-

Tab. 7-12: Auto-modified EFC motor control parameter list

Please refer to "Step 2: Motor configuration" below fig. 7-6 "Commissioning wizard" on page 61 to set the motor parameter via dialog.

Restore ASF Parameter

User can restore ASF parameter setting to default via F1.00, and by doing this, the following EFC parameters will be re-set to ASF default values as well. Please refer to chapter 7.5.7 "Auto-modified EFC Parameters in ASF Initialization" on page 114 for more details.

Additionally, if b0.10 is executed to restore EFC parameters, please make sure to re-execute F1.00 = 1 as a means to restore all ASF parameters to default values.

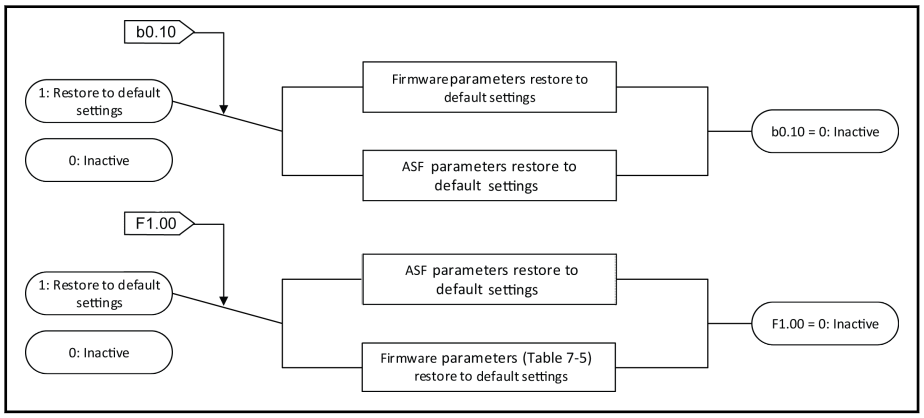

Fig. 7-32: ASF parameter restore to default

☞ By restoring ASF parameter (setting F1.00 = 1), the value of parameter F1.15 and F1.16 will not be restored.

Commissioning of Sytronix DRn 5020 System

LED Flash Showing Converter Status

Code	Name	Setting range	Default	Attri.
F2.36	DO1 output	0: No function assigned from ASF 1: Converter warning 2: Green flashing LED 3: Red flashing LED 4: Cooler on 5: Heater on	1	Run
F2.37	EDO output		0	Run
F2.40	Relay 1 output		0	Run
F2.41	Extension relay output		0	Run

Tab. 7-13: Parameter list of LED flash function

LED flash function can be activated by setting the output parameters (see parameter list in chapter 'Digital and Relay Output'). For normal status the light is always green, for warning condition the light will flash between green and yellow, and for error condition flash between red and yellow. The flash time of the yellow light represents the warning / error type. More details refer to the following figure.

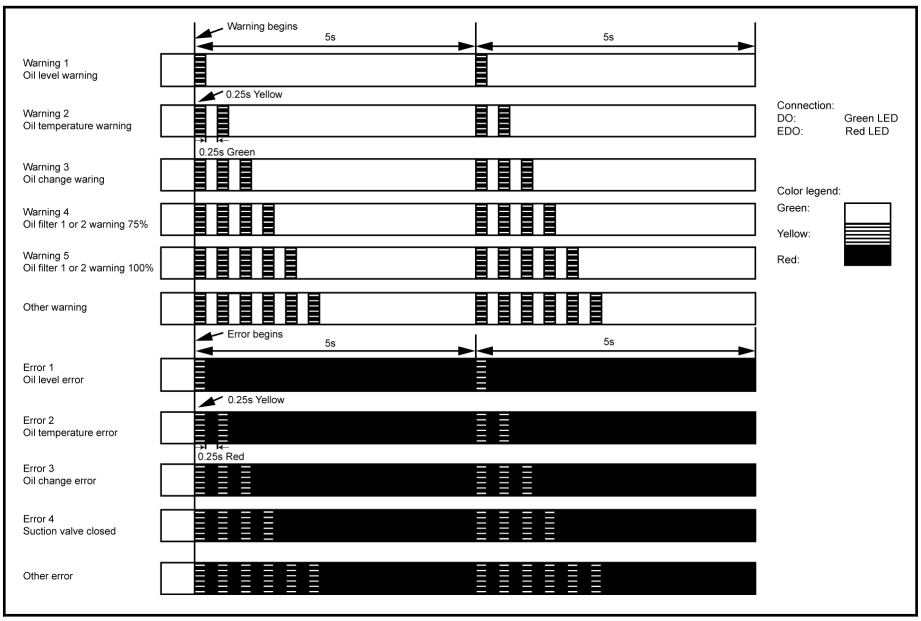

Fig. 7-33: LED flash function

Oil Change Warning / Error Function

Code	Name	Setting range	Default	Attri.
F4.00	Protection function control word	0...15 Bit0=0: Issues only a warning Bit0=1: Motor stall detection sets motor setpoint speed to zero on occurence Bit3=0: Deactivate oil change detection Bit3=1: Activate oil change detection	0	Run
F4.63	Warning hours of oil change	0...60,000 hours	36,000	Run
F4.64	Error hours of oil change	0...60,000 hours	40,000	Run
F4.65	Oil in operation time hour	-	-	Read
F4.66	Reset oil in operation time	0...1	0	Run

Tab. 7-14: Parameter list of oil change warning / error function

Oil change monitoring function can be activated by Bit3 of F4.00.

Oil operation time will be counted and saved in F4.65 when RUN command has been set, no matter if the oil change monitoring function is active or not. And also decimal part of this counter will be set to 0 after power recycle.

If this time exceeds warning or error level in [F4.63] or [F4.64], warning or error signal will be generated when the monitoring function is active. Parameter F4.66 = 1 is used to reset the oil operation time F4.65.

Oil change warning / error is related to warning d0.87 bit9 and error d0.89 bit14.

Sleep / Wake-up Function

This function is used to achieve the maximum extent of energy-saving according to the type of loads in actual applications, for example the hydraulic system with small leakage or accumulator. This function runs in parallel to the speed adaptation mode, while DRn 5020 ASF is active.

Code	Name	Setting range	Default	Attri.
E5.15	Sleep level	0.00...[E0.09] Hz	0.00	Run
E5.16	Sleep delay	0.0...3,600.0 s	60.0	Run
E5.17	Sleep boost time	0.0...3,600.0 s	0.0	Run
E5.18	Sleep boost amplitude	0.0...100.0 %	0.0	Run
E5.19	Wake up level	0.0...100.0 %	0.0	Run
E5.20	Wake up delay	0.2...60.0 s	0.5	Run

Tab. 7-15: Parameter list of sleep / wake function

The frequency converter may go into the sleep mode when all the conditions below are met:

- [Pressure feedback] > Pressure command value x [E5.19] "Wake up level"
- [Speed adaptation output] < [E5.15] "Sleep level"
- [Duration] t ≥ [E5.16] "Sleep delay"

- The wake up level or sleep boost amplitude has unit of percentage. This percentage is referred to pressure command value in bar.
- Speed adaptation output means the DRn algorithm speed setpoint that the system is controlled at for optimal operating point energy wise. This value has the same unit as sleep level, i.e. Hz.

Threshold for Oil Level / Oil Temperature

Code	Name	Setting Range	Default	Attri.
F2.36	DO1 output	0: No function assigned from ASF 1: Converter warning 2: Green flashing LED 3: Red flashing LED 4: Cooler on 5: Heater on	1	Run
F2.37	EDO output		0	Run
F2.40	Relay 1 output		0	Run
F2.41	Extension relay output		0	Run

Tab. 7-16: Parameter list of digital and relay output

The cooler and the heater are related to the oil temperature, please refer to the parameters in the table above.

Code	Name	Setting Range	Default	Attri.
F4.70	Threshold for oil level warning (warning if analog input below limit, see warning d0.87, Bit 6)	0...10 V, 20 mA	0	Run
F4.71	Threshold for oil level error (error if analog input below limit, see warning d0.89, Bit 12)	0...10 V, 20 mA	0	Run
F4.72	Threshold for oil temperature warning (warning if analog input above limit, see warning d0.87, Bit 7)	0...10 V, 20 mA	0	Run
F4.73	Threshold for oil temperature error (error if analog input above limit, see warning d0.89, Bit 13)	0...10 V, 20 mA	0	Run
F4.74	Oil cooler switching level (switch on if analog input above limit)	0...10 V, 20 mA	0	Run
F4.75	Oil heater switching level (switch on if analog input below limit)	0...10 V, 20 mA	0	Run

Tab. 7-17: Threshold for oil level / oil temperature

7.2 Getting started with DRn 5020

7.2.1 Notes on Commissioning

NOTICE

Uncontrolled start-up of the DRn system!

Damage to property!

- Ensure that the parameter settings correspond to the requirements of actual application during the first commissioning of the DRn system.
- If necessary, request missing information or commissioning support from Bosch Rexroth.

Uncontrolled motions of the axial piston pump and pump pressure at the pump outlet!

Damage to property!

Error in the motor-pump-unit control!

Damage to property!

- Make sure that all connections are free of errors.
- Make sure that any and all system safety equipment and monitoring devices are undamaged and in operation.
- Do not operate damaged products.
- If necessary, request missing information or commissioning support from Bosch Rexroth.

To commission the DRn 5020 system, proceed according to the work steps described in the following sections.

7.2.2 Hydraulic System Preparation

- Keep the documentation of all components used at hand.
- Check the DRn system for damages.
- Check all mechanical, hydraulic and electrical connections.
- Make sure that the piping is assembled in a clean and tight manner.
- Make sure that the pump suction channel is unobstructed.
- Check the hydraulic circuit diagram of the machine for direct functions/ motions during the build-up of pressure.
- Check the hydraulic fluid tanks for cleanliness.
- Fill in the hydraulic fluid according to the machine manufacturer's regulations. Only use filters with the required minimum retention rate.
- Axial piston pump A10, A4

Rexroth Sytronix Mounting and Commissioning Axial Piston Variable Pump A10VZO/A10VSO/A4VSO

- Material number: R911341629 (Edition 02)

7.2.3 Electric Hardware Connection Preparation

After the hydraulic components are mounted correctly, the electrical drives, motor and external signals should be connected correctly. Here are some hints for the connection of EFC 5610 and the external signals.

First of all, the EFC 5610 has following three areas:

Control or operating panel The operating panel is at the center of the frequency converter and composed of two areas: display and keys. The display shows mode settings and operation state of the frequency converter. The keys allow the user to program the frequency converter

Modbus/PROFIBUS Modbus is default component in the EFC 5610.

Power and control terminals

Interfaces for the power connection and to connect the EFC 5610 to the motor.

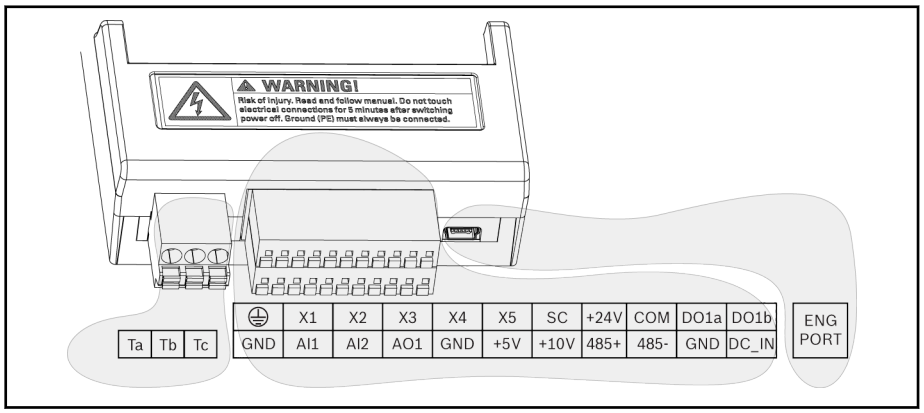

Fig. 7-34: Control circuit terminals

⚠ CAUTION **The frequency converter might be damaged!**

Please make sure that the power supply of the frequency converter has been switched off before plugging or unplugging the connector.

The terminal block is **ONLY** for wiring convenience, which **CANNOT** be used for fixing the cables. Additional measures need to be taken by users for cable fixing purpose.

7.2.4 Operating Preparation

The LED panel of EFC 5610 is removable and composed of two areas: display and buttons. The display shows mode settings and operating state of the frequency converter. The buttons allow users to program the frequency converter.

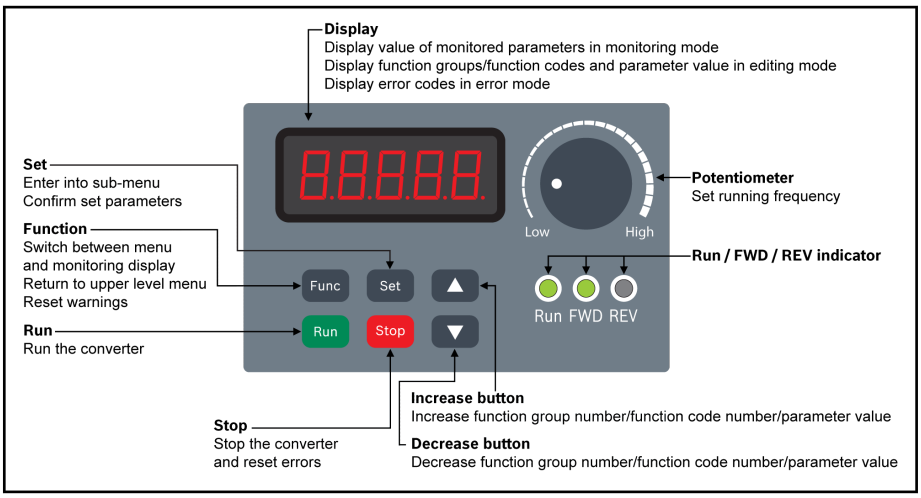

Fig. 7-35: LED panel

LED panel	**Display**: Display parameters, settings, status codes, warning codes and error codes
	Buttons: Set parameters, switch display, reset warnings, execute run and stop command, increase or decrease parameter group / code / value
	Indicator: Run, FWD, REV

7.2.5 Relevant Parameters

Code	Name	Code	Name
C0.00	Control mode (EFC 5610 only)	F2.31	AO1 output (use E2.27 for gain)
C1.05	Motor rated power	F2.36	DO1 output
C1.09	Motor rated speed	F2.37	EDO output
D0.81	Effective pressure command value	F2.40	Relay 1 output
E0.08	Maximum output frequency	F2.41	Extension relay output
E0.09	Output frequency high limit	F3.12	Speed adaptation: P-gain
E0.26	Acceleration time	F3.13	Speed adaptation: I-gain
E0.27	Deceleration time	F3.16	Speed adaptation: D-gain
E1.00	X1 input	F3.19	Speed adaptation: Minimum speed
E1.01	X2 input	F3.20	Speed adaptation: Maximum speed
E1.35	AI1 input mode	F3.21	Speed adaptation: Ramp pitch, ascending
E1.40	AI2 input mode	F3.22	Speed adaptation: Ramp pitch, descending
E2.15	Relay1 output selection	F3.23	Speed boost: Ramp pitch
E2.25	AO1 output mode	F3.24	Speed boost: Pressure window
E2.26	AO1 output setting	F3.25	Speed boost: Wait time
E5.15	Sleep level	F3.26	Pressure command value: Trigger level
E5.16	Sleep delay	F3.27	Pressure command value: Learning window
E5.17	Sleep boost time	F3.28	Pressure command value: Learning time
E5.18	Sleep boost amplitude	F3.29	Start-up time
E5.19	Wake up level	F4.00	Protection function control word
E5.20	Wake up delay	F4.29	Pump type
F1.00	ASF parameter initialization	F4.30	Pump: Maximum displacement
F1.02	Control word: Pressure command source	F4.35	Pump power
F1.04	Pressure command selection	F4.50	Pump: Maximum angular acceleration
F1.05	Pressure command digital setting 0	F4.51	Pump: Maximum speed
F1.06	Pressure command digital setting 1	F4.52	Pump: Minimum speed
F1.08	Preferred swivel angle command source	F4.53	Pump: Inertia mantissa
F1.09	Command value: Preferred swivel angle	F4.54	Pump: Inertia exponent
F1.15	Motor type	F4.55	Motor derating: Continuous torque at standstill
F1.16	Motor power level	F4.56	Motor derating: Limit speed
F2.00	Analog input AI1	F4.57	Speed masking: Center speed
F2.01	Analog input AI2	F4.58	Speed masking: Window
F2.02	Extended analog input EAI	F4.59	Auxiliary pump: Displacement

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Code	Name	Code	Name
F2.04	Pressure command corresponding to 10 V / 20 mA	F4.60	Auxiliary pump: Pressure
F2.05	Pressure command null offset in V or mA	F4.61	Motor stall detection: Pressure threshold
F2.06	Pressure feedback corresponding to 10 V / 20 mA	F4.62	Motor stall detection: Wait time
F2.07	Pressure feedback null offset in V or mA	F4.63	Warning hours of oil change
F2.10	Pressure sensor type	F4.64	Error hours of oil change
F2.14	Maximum flow limit source	F4.65	Oil in operation time hour
F2.15	DRn command source	F4.66	Reset oil in operation time
F2.16	X1 input	F4.70	Threshold for oil level warning (warning if analog input below limit)
F2.17	X2 input	F4.71	Threshold for oil level error (error if analog input below limit)
F2.18	X3 input	F4.72	Threshold for oil temperature warning (warning if analog input above limit)
F2.19	X4 input	F4.73	Threshold for oil temperature error (error if analog input above limit)
F2.20	X5 input	F4.74	Oil cooler switching level (switch on if analog input above limit)
F2.21	EX1 input	F4.75	Oil heater switching level (switch on if analog input below limit)
F2.22	EX2 input	F4.76	Oil filter pre-warning / warning 100% delay time
F2.23	EX3 input	H8.05	EAI input mode
F2.24	EX4 input		

Tab. 7-18: Relevant parameters

☞ Complete parameters can be found in chapter 7.5 "Parameter Functions" on page 107.

7.2.6 Converter I/O Configuration

Analog Input AI1

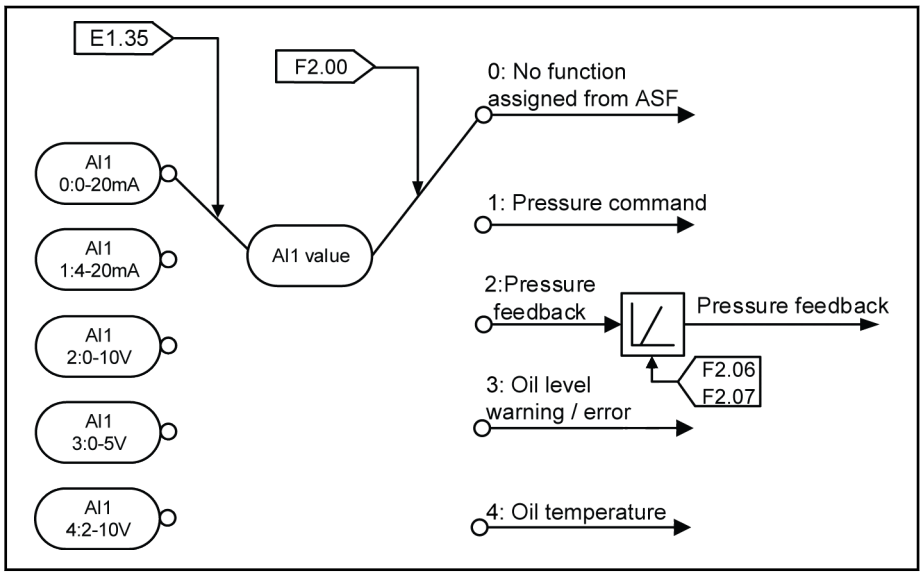


Fig. 7-36: Analog input AI1

Code	Name	Setting Range	Default	Attri.
E1.35	AI1 input mode	0: 0...20 mA 1: 4...20 mA 2: 0...10 V 3: 0...5 V 4: 2...10 V	2	Run
F2.00	Analog input AI1	0: No function assigned 1: Pressure command 2: Pressure feedback 3: Oil level warning / error 4: Oil temperature	0	Stop
F2.04	Pressure command corresponding to 10 V / 20 mA	0.1...1,000.0 bar	100.0	Stop
F2.05	Pressure command null offset in V or mA	0...5.0 V, mA	0.1	Stop
F2.06	Pressure feedback corresponding to 10 V or 20 mA	0.1...1,000.0 bar	100.0	Stop
F2.07	Pressure feedback null offset in V or mA	0.0...5.0 V, mA	0.0	Stop

Tab. 7-19: Analog input AI1 parameter list

The default setting of AI1 is [F2.00] = 0, this means no function is assigned from ASF, but from AI1 setting in EFC Firmware ONLY (see C3.41, E0.00, E0.02, E1.60, E4.00, E4.01).

It's recommended AI1 and AO1 shall be used for motor thermal protection. For details, please refer to Chapter 12.10, motor protection of EFC 3610 / EFC 5610 Operating Instructions. For Sytronix application with motor "MOT-FC...HOY", the PTC connection is arranged with AO serving as current output and AI as voltage input, while with the parameters being pre-set for

C1.72, C1.73, E1.40 and E2.25, all that need for the user is to connect to PTC sensor and set [E1.60] = 1, [E2.26] = 11 in order to activate this function.

Analog Input AI2

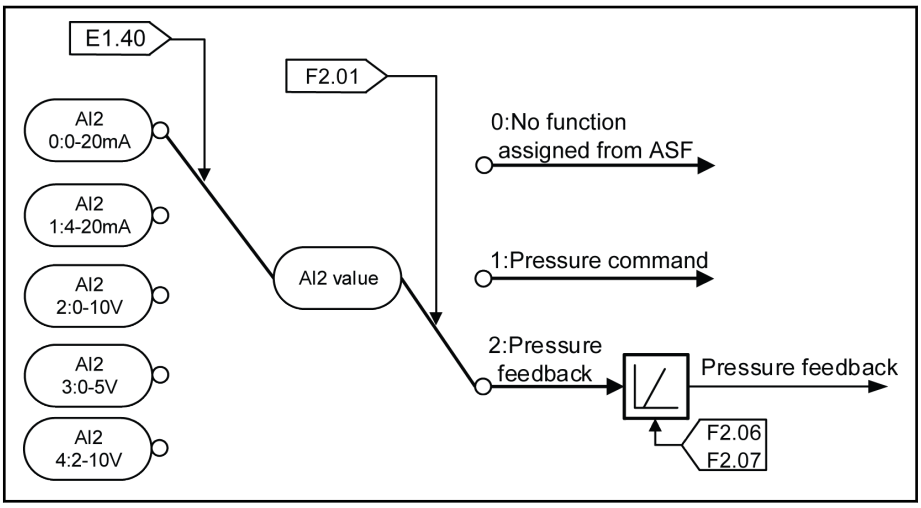


Fig. 7-37: Analog input AI2

Code	Name	Setting Range	Default	Attri.
E1.40	AI2 input mode	0: 0...20 mA 1: 4...20 mA 2: 0...10 V 3: 0...5 V 4: 2...10 V	1	Run
F2.01	Analog input AI2	0: No function assigned 1: Pressure command 2: Pressure feedback	2	Stop
F2.04	Pressure command corresponding to 10 V / 20 mA	0.1...1,000.0 bar	100.0	Stop
F2.05	Pressure command null offset in V or mA	0...5.0 V, mA	0.1	Stop
F2.06	Pressure feedback corresponding to 10 V or 20 mA	0.1...1,000.0 bar	100.0	Stop
F2.07	Pressure feedback null offset in V or mA	0.0...5.0 V, mA	0.1	Stop

Tab. 7-20: Analog input AI2 parameter list

Extended Analog Input EAI

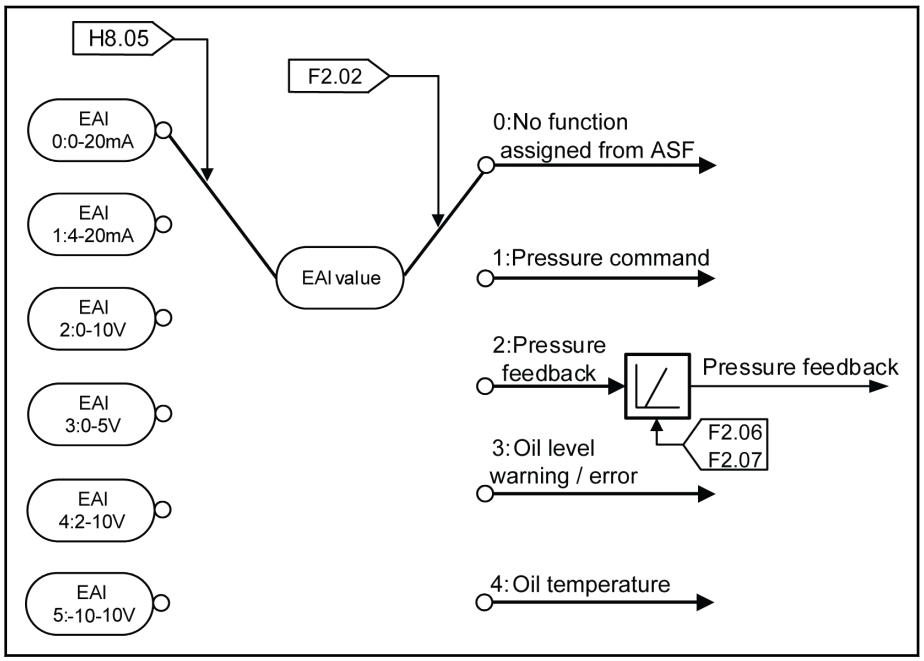


Fig. 7-38: EAI analog input

Code	Name	Setting Range	Default	Attri.
H8.05	EAI input mode	0: 0...20 mA 1: 4...20 mA 2: 0...10 V 3: 0...5 V 4: 2...10 V 5: -10...10 V	0	Stop
F2.02	Extended analog input EAI	0: No function assigned 1: Pressure command 2: Pressure feedback 3: Oil level warning / error 4: Oil temperature	0	Stop
F2.04	Pressure command corresponding to 10 V / 20 mA	0.1...1,000.0 bar	100.0	Stop
F2.05	Pressure command null offset in V or mA	0...5.0 V, mA	0.1	Stop
F2.06	Pressure feedback corresponding to 10 V or 20 mA	0.1...1,000.0 bar	100.0	Stop
F2.07	Pressure feedback null offset in V or mA	0.0...5.0 V, mA	0.1	Stop

Tab. 7-21: Analog input AI2 parameter list

Analog Output AO1

No function assigned from ASF.

Both AI1 and AO1 can be used for motor thermal protection. For details, please refer to Chapter 12.10, motor protection of EFC 3610 / EFC 5610 Operating Instruction. For Sytronix application with motor "MOT-FC...HOY", the PTC connection is arranged by using AO as current output and AI as voltage input, while with the parameters being pre-set for C1.72, C1.73, E1.40 and E2.25, all that need for the user is to connect to PTC sensor and set [E1.60] = 1, [E2.26] = 11 in order to activate this function. When the above mentioned AO1 output functions 1…4 are in use, please make sure AO1 is not in service as the power supply to the motor temperature sensor. Please refer to parameter [E2.26] = 11 and Chapter 12.10, motor protection of EFC 3610 / EFC 5610 Operating Instruction for more details.

Digital Input

Code	Name	Setting Range	Default	Attri.
F2.16	X1 input	0: No function assigned from ASF	0 (Enable)	Stop
F2.17	X2 input	1: Pressure command selection bit0 2...9: No function	0 (Error Reset)	Stop
F2.18	X3 input	10: Activate DRn function	10	Stop
F2.19	X4 input	11: Activate speed adaption	11	Stop
F2.20	X5 input	13: Oil level warning	0	Stop
F2.21	EX1 input	14: Oil temperature warning	0	Stop
F2.22	EX2 input	15: Oil filter 1 pre-warning	0	Stop
F2.23	EX3 input	16: Oil filter 1 warning 100%	0	Stop
F2.24	EX4 input	17: Oil filter 2 pre-warning 18: Oil filter 2 warning 100% 19: Oil level error 20: Oil temperature error 21: Suction valve closed error 22: Oil level warning inverse 23: Oil temperature warning inverse 24: Oil filter 1 pre-warning inverse 25: Oil filter 1 warning 100% inverse 26: Oil filter 2 pre-warning inverse 27: Oil filter 2 warning 100% inverse 28: Oil level error inverse 29: Oil temperature error inverse 30: Suction valve closed error inverse	0	Stop
F4.76	Oil filter pre-warning / warning 100% delay time	0...3,600 s	60	Run

Tab. 7-22: DI parameter list

The default setting of terminal X1 and X2 is '0', this means DI setting in EFC firmware (E1.00 and E1.01) is active. But part of the EFC firmware parame-

ters, including [E1.00] = 35 (X1 set to 'Enable'), [E1.01] = 34 (X2 set to 'Reset'), will be pre-set automatically in ASF.

The digital inputs F2.16…F2.20, are mutually exclusive, which therefore do not allow for any identical setting between the parameters, otherwise warning APF1 will be triggered.

The sensors for oil filter, oil level and oil temperature will be connected to the frequency converter EFC 5610. Therefore, ASF have to detect IO1 card and work with it. The error and warnings will be indicated by the LED and in the status word. If an error occurs, the drive needs to be stopped.

"Oil filter 1 / 2 pre-warning / warning 100%" for oil filter warning sensor. These signals will be automatically delayed by F4.76, that means a true signal lasted longer than [F4.76] seconds will be acknowledged.

The default setting of terminal X1...X5, EX1...EX4 in ASF is "0". This means no function from ASF is assigned, only EFC firmware functions assigned are active.

Part of the EFC firmware parameters, including [E1.01] = 34 (X2 set to "Reset"), will be pre-set automatically in ASF.

The digital inputs F2.16…F2.24, are mutually exclusive, which therefore do not allow for any identical setting (except 0) between the parameters, otherwise warning APF1 will be triggered.

Four pressure command parameters are available in ASF, and these can be switched according to setting of F1.02 and DI or F1.04. The following table shows the correspondence between pressure command values and the setting of the digital inputs.

Pressure command selection bit0 in digital inputs X1...X5, EX1...EX4	0	1
Pressure command selection F1.04	0	1
Active pressure command from parameter	F1.05	F1.06

Tab. 7-23: Pressure command selection with digital inputs

Digital and Relay Output

Code	Name	Setting Range	Default	Attri.
F2.36	DO1 output	0: No function assigned from ASF 1: Converter warning 2: Green flashing LED 3: Red flashing LED 4: Cooler on 5: Heater on	1	Run
F2.37	EDO output		0	Run
F2.40	Relay 1 output		0	Run
F2.41	Extension relay output		0	Run

Tab. 7-24: Parameter list of digital and relay output

The default setting of DO1 when connected to ASF is '1', i.e. the frequency converter warning. Meanwhile the default setting of relay when connected to ASF is '0', this means when ASF is not active, the function of relay setting in EFC firmware is active.

The parameter of EFC firmware, i.e. [E2.15] = 14 (set in the relay as frequency converter error), has been set automatically through ASF.

7.2.7 First Commissioning

Commissioning steps:

1. All the hardware (electric and hydraulic) connections are correctly done.
2. Make sure that the oil filter has been opened.
3. Make sure all the I/O settings are correct.
   - Pressure sensor Rexroth HM20–2X should be connected correctly (different setting for current or voltage signal) to EFC 5610, otherwise please adjust the sensor setting parameters E1.40, F2.24 and F2.26 according to the technical data of pressure sensor.
   - Motor parameters for motor MOT-FC have been saved in the frequency converter, please set F1.15 = 1 and F1.16 to choose a MOT-FC_HOY motor parameter. As default is F1.15 = 0, that means no MOT-FC motor parameter have been set.
   - Pressure command values have been set to the value which the pump is set mechanically [F1.05]= pressure level of pump.
4. Shortly run the drive system to confirm the pump rotation direction is correct.
5. Switch the machine on, to fill the machine with hydraulic fluid, and check the machine during operation.
6. Set the pressure command value according to pump requirement, and run the machine in operating circle.
7. Bleed the hydraulic lines according to customer operation requirements if necessary.

7.3 Commissioning (advanced)

7.3.1 Parameter Setting

Overview and introduction

Basic speed adaptation structure and related parameters

The basic speed adaptation structure and related parameters are shown in the following figure:

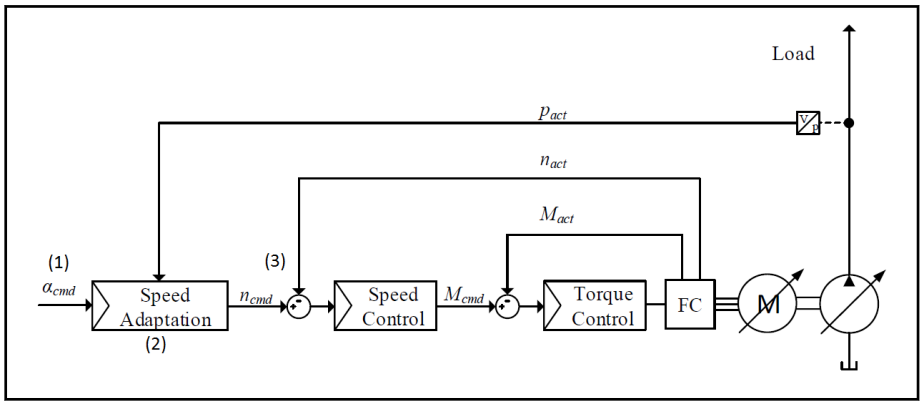


Fig. 7-39: Speed adaptation structure

(1) F1.09 Command value: Preferred swivel angle

(2) F3.12 Speed adaptation: P-gain, F3.13 Speed adaptation: I-gain, F3.16 Speed adaptation: D-gain

(3) F3.21 Speed adaptation: Ramp pitch, ascending, F3.22 Speed adaptation: Ramp pitch, descending

The information in this chapter will help you to optimize the speed adaptation according to customer application.

The underlying principle consists in providing a preferred command value for the DR/DRG pump swivel angle. The speed adaptation has been designed as a PID controller and can be configured via the following parameters.

Code	Name	Setting Range	Default	Attri.
F1.09	Command value: Preferred swivel angle	0.00...100.00 %	70.00	Run
F3.12	Speed adaptation: P-gain	0.0...1,000.0 rpm/%	0.0	Run
F3.13	Speed adaptation: I-gain	0.0...1,000.0 rpm/%/s	50.0	Run
F3.16	Speed adaptation: D-gain	0.00...100.00 rpm/%*s	0.00	Run
F3.21	Speed adaptation: Ramp pitch, ascending	0...10,000 rpm/s	1,000	Run
F3.22	Speed adaptation: Ramp pitch, descending	-9,999...0 rpm/s	-800	Run

Tab. 7-25: Parameter list of speed adaption

① Preferred swivel angle

- F1.09, Command value: Preferred swivel angle [%]

The preferred swivel angle determines the angle at which DRn operates the pump angle. This command value should be set between 10%...80%. It is responsible for the energy savings you can get from the DRn system. Good performance is between 40%...70% depending on the load flow the system has. For zero load 60%...70% is a good range. For partial load 40%...60% is good. If the system is always on full load, DRn can't save energy.

② Speed adaptation

- F3.12, Speed adaptation: P-Gain [rpm/%]
- F3.13, Speed Adaptation: I-Gain [rpm/%/s]
- F3.16, Speed adaptation: D-gain [rpm/%*s]

In general, P-Gain, D-Gain should be set to zero they are available for special problems and tuning of the speed adaptation.

The I-Gain does all the control actions needed to run the system smooth and should be valued between 20...150 for smooth and oscillation free adaptation.

Variable oil volumes can be challenging to control for a DR/DRG Pump with mechanical pressure control. Large volumes can't be controlled without oscillation if there are no hydraulic damping orifices installed.

For DRn 5020 system, the value of I-Gain (F3.13) can be increased to speed up the adaption of the drive speed when load conditions change.

The following figure shows the behaviour of DRn control with the parameter I-Gain. The hydraulic system choosen for this plots is a basic one with small volume and A10DR Pump. It shows the default value of 50, 150 and 300. The higher the gain factor is, the faster the speed adaptation is working. Too high values lead to a small overshoot in speed.

Fig. 7-40: Impact of I-Gain on adaptation speed

The following figure shows the behaviour of DRn control with the parameter boost ramp. The hydraulic system choosen for this plots is a basic one with small volume and A10DR Pump. It shows the value of 1,000, 3,000 and 6,000. The higher the gain factor is, the faster the boost function is getting back the pressure to its levels. Too high values lead to oscillation in pressure feedback.

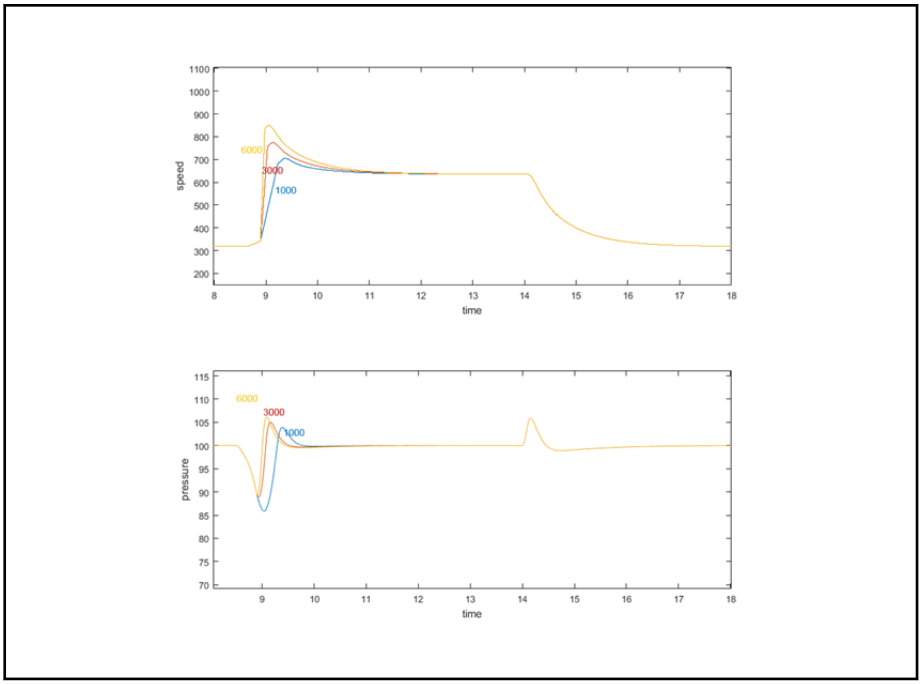


Fig. 7-41: Impact of boost ramp on adaptation speed

F3.21 Speed adaptation: Ramp pitch, ascending

This parameter limits the positive gradient of the speed adaptation. For this purpose, the output of the PID controller is monitored.

- If the ramp is too steep, this can cause instability in the superimposed pressure controller of the DR/DRG pump.
- A small ramp is noncritical, but can cause the boost function to be activated.

F3.22 Speed adaptation: Ramp pitch, descending

This parameter limits the negative gradient of the speed adaptation. For this purpose, the output of the PID controller.

- If the ramp is too steep, this can cause instability in the superimposed pressure controller of the DR/DRG pump.
- A small ramp is noncritical, but decreases the effect of the speed adaptation on the energy and noise reduction.

③ Velocity lower limitation parameter setting

F3.19 Speed adaptation: Minimum speed

This parameter limits the minimum speed of the speed adaptation.

- With low flow rates, the limitation of the minimum speed causes the actual swivel angle value to stationarily fall below the command value from F1.09.
- When loads are switched on, a low minimum speed can reduce the disturbance rejection of pressure control.

F3.20 Speed adaptation: Maximum speed

This parameter limits the maximum speed of the speed adaptation.

- The maximum speed may not exceed the allowed limit values of the DR/DRG pump used.
- The drive is accelerated to the parameterized speed, if a pressure drop is detected or when the speed adaptation has been deactivated (cf.

chapter "Boost Function" on page 76 and chapter 8 "Operation" on page 117).

④ Acceleration / deceleration ramp time settings

- E0.26, acceleration time [s]
- E0.27, deceleration time [s]

Increasing the acceleration time helps avoid over current, however will affect the performance of the speed adaptation, for which it is highly recommended to keep [E0.26] = 0.1 (default)...1.0.

The deceleration time has been set to 0.1 as default, this value can be increased if over voltage or over current error happens during deceleration, recommendation value is 0.1...2.0 according to application. In principle F3.19 and F3.20 are doing similar limiting to the acceleration of the motor. First order to stop motor from overcurrent should be to lower F3.19 / F3.20 then to make E0.26 / E0.27 higher.

☞ Acceleration [E0.26] / deceleration time [E0.27] setting is the time for frequency increase from 0.00 Hz to [E0.08] 'Maximum output frequency' / the time for frequency decrease from [E0.08] to 0.00 Hz respectively.

---

⑤ Velocity controller parameter settings

- C3.00, speed loop proportional gain
- C3.01, speed loop integral time [s]

For a smooth operation of DRn software a well tuned velocity controller is required. If the velocity loop is parameterized, a greater emphasis on the disturbance rejection over set-point tracking should be considered. The performance of a sensor less induction motor velocity control loop is altered while the motor is heating up. Therefore the control loop might be less disturbance rejective in hot state. This can lead to pressure oscillations on low speed values. If oscillations occur it is recommended to tune the velocity loop again when operating temperature is reached.

7.4 DRn Soft Start

Application To avoid the sudden increase of required electric power at system start, the soft start function increases the motor speed in a ramp with the rise time set in [F3.29].

Working principle From the moment that 'run' command is given to the converter and the DRn software, the motor speed will be increased slowly for the time set in [F3.29]. After this time, the system will reach maximum speed which is set in [F3.20].

Configuration of the parameters The related parameters of the function soft start are:

Code	Name	Setting Range	Default	Attri.
F3.20	Speed adaptation: Maximum speed	0...10,000 rpm	1,000	Run
F3.29	Start-up time	0..30,000 ms	2,000	Run

Tab. 7-26: Parameter list of DRn start-up function

7.5 Parameter Functions

7.5.1 Terminology and Abbreviation in Parameter List

- **Code:** Function / parameter code, written in Cx.xx, Dx.xx, Ex.xx, Fx.xx
- **Name:** Parameter name
- **Default:** Factory default
- **Attri.:** Parameter attribute
  - **Run:** Parameter setting can be modified when the converter is in run or stop status.
  - **Stop:** Parameter setting can only be modified when the converter is in stop status.
  - **Read:** Parameter setting is read-only and cannot be modified.
- **[Cx.xx], [Dx.xx], [Ex.xx], [Fx.xx]:** Function / parameter values

Commissioning of Sytronix DRn 5020 System

7.5.2 Group F1: Quick Start Parameter

Code	Name	Setting range	Default	Attri.
F1.00	ASF parameter initialization	0: Inactive 1: Restore to ASF default settings 2: Deactivate ASF	0	Stop
F1.02	Control word: Pressure command source	0: Depend on the value of F1.04 1: Communication 2: Analog input 3: Learning pressure command 4: Select by digital input (F1.04 shows status)	0	Stop
F1.04	Pressure command selection	0: Pressure command digital setting 0 1: Pressure command digital setting 1	0	Run
F1.05	Pressure command digital setting 0	5.0...1,000.0 bar	5.0	Run
F1.06	Pressure command digital setting 1	5.0...1,000.0 bar	5.0	Run
F1.08	Preferred swivel angle command source	0: Swivel angle command of F1.09 1: Communication	0	Stop
F1.09	Command value: Preferred swivel angle	0.00...100.00 %	70.00	Run
F1.15	Motor type	0: Others 1: MOT-FC_HOY	0	Stop
F1.16	Motor power level	0: No selection 1...21 (only change motor parameter by switching from 0 to 1...21)	0	Stop

Tab. 7-27: Parameter list of group F1

7.5.3 Group F2: Input and Output Parameter

Code	Name	Setting range	Default	Attri.
F2.00	Analog input AI1	0: No function assigned 1: Pressure command 2: Pressure feedback 3: Oil level warning / error 4: Oil temperature	0	Stop
F2.02	Extended analog input EAI		0	Stop
F2.01	Analog input AI2	0: No function assigned 1: Pressure command 2: Pressure feedback	2	Stop
F2.04	Pressure command corresponding to 10 V / 20 mA	0.1...1,000.0 bar	100.0	Stop
F2.05	Pressure command null offset in V or mA	0...5.0 V, mA	0.1	Stop
F2.06	Pressure feedback corresponding to 10 V or 20 mA	0.1...1,000.0 bar	100.0	Stop
F2.07	Pressure feedback null offset in V or mA	0.0...5.0 V,mA	0.1	Stop

Code	Name	Setting range	Default	Attri.
F2.10	Pressure sensor type	0: Others 1: HM20-2X/10-C 2: HM20-2X/50-C 3: HM20-2X/100-C 4: HM20-2X/160-C 5: HM20-2X/250-C 6: HM20-2X/315-C 7: HM20-2X/400-C 8: HM20-2X/630-C 9: Other 4...20mA pressure sensor 10: Reserved 11: HM20-2X/10-H 12: HM20-2X/50-H 13: HM20-2X/100-H 14: HM20-2X/160-H 15: HM20-2X/250-H 16: HM20-2X/315-H 17: HM20-2X/400-H 18: HM20-2X/630-H 19: Other 0.1...10V pressure sensor	3	Stop
F2.14	Maximum flow limit source	0: Depend on the value of F3.20 1: Communication	0	Stop
F2.15	DRn command source	Bit0 : Activate DRn function source • 0: Digital input • 1: Communication Bit1: Activate speed adaption source • 0: Digital input • 1: Communication	0	Stop

Commissioning of Sytronix DRn 5020 System

Code	Name	Setting range	Default	Attri.
F2.16	X1 input	0: No function assigned by ASF 1: Pressure command selection bit0 2...9: No function 10: Activate DRn function 11: Activate speed adaption 13: Oil level warning 14: Oil temperature warning 15: Oil filter 1 pre-warning 16: Oil filter 1 warning 100% 17: Oil filter 2 pre-warning 18: Oil filter 2 warning 100% 19: Oil level error 20: Oil temperature error 21: Suction valve closed error 22: Oil level warning inverse 23: Oil temperature warning inverse 24: Oil filter 1 pre-warning inverse 25: Oil filter 1 warning 100% inverse 26: Oil filter 2 pre-warning inverse 27: Oil filter 2 warning 100% inverse 28: Oil level error inverse 29: Oil temperature error inverse 30: Suction valve closed error inverse	0 (Enable)	Stop
F2.17	X2 input		0 (Error Reset)	Stop
F2.18	X3 input		10	Stop
F2.19	X4 input		11	Stop
F2.20	X5 input		0	Stop
F2.21	EX1 input		0	Stop
F2.22	EX2 input		0	Stop
F2.23	EX3 input		0	Stop
F2.24	EX4 input		0	Stop
F2.36	DO1 output	0: No function assigned by ASF 1: Converter warning 2: Green flashing LED 3: Red flashing LED 4: Cooler on 5: Heater on	1	Run
F2.37	EDO output		0	Run
F2.40	Relay 1 output		0	Run
F2.41	Extension relay output		0	Run

Tab. 7-28: Parameter list of group F2

7.5.4 Group F3: Controller Parameter

Code	Name	Setting range	Default	Attri.
F3.12	Speed adaptation: P-gain	0.0...1,000.0 rpm/%	0.0	Run
F3.13	Speed adaptation: I-gain	0.0...1,000.0 rpm/%/s	50.0	Run
F3.16	Speed adaptation: D-gain	0.00...100.00 rpm/%*s	0.00	Run
F3.19	Speed adaptation: Minimum speed	0...10,000 rpm	300	Run
F3.20	Speed adaptation: Maximum speed	0...10,000 rpm	1,000	Run
F3.21	Speed adaptation: Ramp pitch, ascending	0...10,000 rpm/s	1,000	Run
F3.22	Speed adaptation: Ramp pitch, descending	-9,999...0 rpm/s	-800	Run
F3.23	Speed boost: Ramp pitch	0...30,000 rpm/s	4,000	Run
F3.24	Speed boost: Pressure window	0.0...1,000.0 bar	10.0	Run
F3.25	Speed boost: Wait time	0...10,000 ms	0	Run
F3.26	Pressure command value: Trigger level	0.0...1,000.0 bar	5.0	Run
F3.27	Pressure command value: Learning window	0.0...1,000.0 bar	3.0	Run
F3.28	Pressure command value: Learning time	0...10,000 ms	1,000	Run
F3.29	Start-up time	0...30,000 ms	2,000	Run

Tab. 7-29: Parameter list of group F3

Commissioning of Sytronix DRn 5020 System

7.5.5 Group F4: Motor and Pump Settings

Code	Name	Setting range	Default	Attri.
F4.00	Protection function control word	0...15 Bit0=0: Issues only a warning Bit0=1: Motor stall detection sets motor setpoint speed to zero on occurence Bit3=0: Deactivate oil change detection Bit3=1: Activate oil change detection	0	Run
F4.29	Pump type	0...31	1	Stop
F4.30	Pump: Maximum displacement	1.0...5,000.0 ccm	18.0	Stop
F4.47	Maximum torque limitation	200.0...400.0 %	200.0	Stop
F4.50	Pump: Maximum angular acceleration	0...60,000 rad/s^2	1,500	Stop
F4.51	Pump: Maximum speed	0...10,000 rpm	1,000	Stop
F4.52	Pump: Minimum speed	0...10,000 rpm	300	Stop
F4.53	Pump: Inertia mantissa	0...10,000 kgm^2	100	Stop
F4.54	Pump: Inertia exponent	0...10	5	Stop
F4.55	Motor derating: Continuous torque at standstill	0.00...100.00 %	0.00	Stop
F4.56	Motor derating: Limit speed	0...10,000 rpm	0	Stop
F4.57	Speed masking: Center speed	0...10,000 rpm	0	Run
F4.58	Speed masking: Window	0...10,000 rpm	0	Run
F4.59	Auxiliary pump: Displacement	0.0...5,000.0 ccm	0.0	Stop
F4.60	Auxiliary pump: Pressure	0.00...250.00 bar	0.00	Stop
F4.61	Motor stall detection: Pressure threshold	0...10,000 bar	20	Run
F4.62	Motor stall detection: Wait time	0...10,000 ms	3,000	Run
F4.63	Warning hours of oil change	0...60,000 hours	36,000	Run
F4.64	Error hours of oil change	0...60,000 hours	40,000	Run
F4.65	Oil in operation time hour	-	-	Read
F4.66	Reset oil in operation time	0...1	0	Run
F4.70	Threshold for oil level warning (warning if analog input below limit)	0...10 V, 20 mA	0	Run
F4.71	Threshold for oil level error (error if analog input below limit)	0...10 V, 20 mA	0	Run
F4.72	Threshold for oil temperature warning (warning if analog input above limit)	0...10 V, 20 mA	0	Run
F4.73	Threshold for oil temperature error (error if analog input above limit)	0...10 V, 20 mA	0	Run
F4.74	Oil cooler switching level (switch on if analog input above limit)	0...10 V, 20 mA	0	Run

Code	Name	Setting range	Default	Attri.
F4.75	Oil heater switching level (switch on if analog input below limit)	0...10 V, 20 mA	0	Run
F4.76	Oil filter pre-warning / warning 100% delay time	0...3,600 s	60	Run

Tab. 7-30: Parameter list of group F4

7.5.6 Important EFC Parameters

Code	Name	Code	Name
b0.00	Access authority setting	C1.21	Stator resistance
C0.00	Control mode	C1.22	Rotor resistance
C0.01	Normal / Heavy duty setting	C1.23	Leakage inductance
C1.00	Motor type	C1.24	Mutual inductance
C1.01	Motor parameter tuning	C2.43	Current limitation proportional gain
C1.05	Motor rated power	C2.44	Current limitation integral time
C1.06	Motor rated voltage	C3.00	Speed loop proportional gain 1
C1.07	Motor rated current	C3.01	Speed loop integral time 1
C1.08	Motor rated frequency	C3.05	Current loop proportional gain
C1.09	Motor rated speed	C3.06	Current loop integral time
C1.10	Motor rated power factor	C3.43	Torque reference maximum value
C1.11	Motor poles	C3.44	Torque positive limit
C1.12	Motor rated slip frequency	E0.26	Acceleration time
C1.13	Motor inertia mantissa	E0.27	Deceleration time
C1.14	Motor inertia exponent	E1.60	Motor temperature sensor channel
C1.15	Torque constant	E1.61	Broken wire protection
C1.20	Motor no-load current		

Tab. 7-31: Parameter list of used EFC parameters

7.5.7 Auto-modified EFC Parameters in ASF Initialization

Code	Name	Setting range	Default	Attri.
C0.00	Control mode (EFC 5610 only)	0: V/f control 1: Sensorless vector control	1	Stop
E0.01	First run command source	0...2	1	Stop
E0.02	Second frequency setting source	0...99	0	Stop
E0.08	Maximum output frequency	50.00...400.00 Hz	100.00	Stop
E0.09	Output frequency high limit	[E0.10]...[E0.08] Hz	100.00	Run
E0.17	Direction control	0: Forward / Reverse 1: Forward only 2: Reverse only 3: Swap default direction	3	Stop
E0.26	Acceleration time	0.1...6,000.0 s	0.1	Run
E0.27	Deceleration time	0.1...6,000.0 s	0.1	Run
E1.00	X1 input	0...46	35	Stop
E1.01	X2 input	0...46	34	Stop
E1.40	AI2 input mode	0: 0...20 mA 1: 4...20 mA 2: 0...10 V 3: 0...5 V 4: 2…10 V	2	Run
E1.60	Motor temperature sensor channel	0: Inactive 1: AI1 analog input 2: AI2 analog input 3: EAI analog input	0	Stop
E2.15	Relay1 output selection	0...99	14	Stop
E2.25	AO1 output mode	0: 0...10 V 1: 0...20 mA	1	Run
E2.26	AO1 output setting	0: Output frequency 1: Setting frequency 2: Output current 4: Output voltage 5: Output power 6: AI1 analog input 7: AI2 analog input 8: EAI analog input 11: Motor temperature sensor power supply 99: Inactive	0	Run

Tab. 7-32: Auto-modified EFC parameter list

7.6 Fieldbus Communication

7.6.1 Brief Introduction

DRn 5020 frequency converter provides standard communication interface to realize the communication between the master and slave via Modbus, Profibus, Profinet, CANopen, Ethernet and other protocols. With the help of a PC, a PLC or an external computer a "single master / multiple slaves" network control can be realized (setting of pressure command, swivel angle command, modification of parameters, monitoring of frequency converter running status and error messages) to address the specific requirements of applications.

- Cycle time for command and status value exchanging is 2ms.
- Bus communication and internal ASF data communication are not synchronized.

7.6.2 Frequency Converter Parameter Address

Frequency converter parameter registers correspond to the function codes one-to-one. Reading and writing of related function codes can be achieved through reading and writing of the contents in frequency converter parameter registers via communication. The characteristics and scope of reading and writing function codes are in compliance with the frequency converter function code description. The address of a frequency converter parameter register is composed of a higher byte representing the function code group and a lower byte representing the index in the group.

Code	Name	Description	Setting range
F0.20	ASF command 1	ASF control word	0...65,535
F0.21	ASF command 2	Pressure command	50…10,000 (5.0...1,000.0 bar)
F0.22	ASF command 3	Preferred swivel angle command	0...10,000 (0.00...100.00 %)
F0.23	ASF command 4	Maximum flow limit	0...10,000 rpm

Tab. 7-33: Communication protocol

Bit	Description	Setting range
0	DRn enable (X3)	0: Inactive 1: Active
1	DRn enable (X4)	0: Inactive 1: Active
2...14	Reserved	-
15	ASF control word enable	0: Inactive 1: Active

Tab. 7-34: ASF control word definition

Information about standard firmware status word, please find Multi-Ethernet Card Instruction Manual (R912006860).

8 Operation

8.1 General Information

- During operation, ensure compliance with the described environmental conditions.
- Monitor noises, temperature and vibration at the machine at all times.
- After some operating time, check the hydraulic fluid in the tank for bubble or foam formation at the surface.

☞ Changes in operating speed, temperatures, increasing noise or power consumption are an indication of wear or damage on the machine or the DRn system. In case of deviations, please proceed according to chapter 14 "Troubleshooting" on page 124.

8.2 Modes

8.2.1 Standby Mode

Standby mode is automatically reached after every re-start, if no error was generated or identified during ramp-up.

8.2.2 Parameter Mode

You can switch over to the parameter mode by pressing the **<Func>** button on the operating unit.

☞ If the standard parameterization is insufficient for your application, contact the responsible Bosch Rexroth account manager.

8.2.3 Operating Mode

Parameter	Setting range	Description
E0.01	0: Panel 1: Multi-function digital input 2: Communication	Frequency converter control command

Tab. 8-1: Operating mode

- [E0.01] = 0, operating mode can be started by pressing the **<Run>** button on the operating unit.
- [E0.01] = 1, operating mode is triggered by the "High" signal level at the "X1" digital input.
- [E0.00] = 2, operating mode can be started via remote control from Engineering Software.

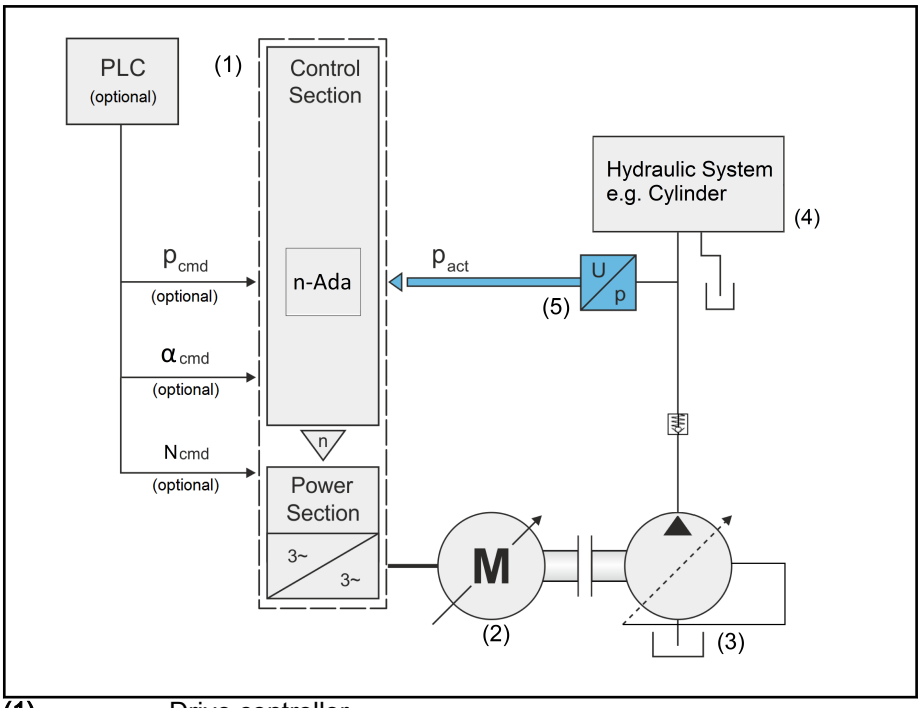
8.2.4 Error Mode

When an error or warning occurs, please terminate the error cause, then the error/warning massage can be removed from display by following there ways:

- Press [Stop] button
- Set "X2" high level
- Error reset in Engineering Software, if this is available

9 Maintenance

9.1 System Overview



(1) Drive controller
(2) Motor
(3) Pump with pressure control
(4) Hydraulic system
(5) Pressure transducer (p_{act} = actual pressure value)

Fig. 9-1: Block diagram p-control with speed adaptation

9.2 Drive Controllers

Regularly check the filters at the air inlets of the control cabinet. Replace or clean dirty filters. The electrical components themselves do not require maintenance.

10 Decommissioning

Decommission the machinery as described in the related operating instructions. To do so, carry out the following steps:

- Observe the instructions in the operating instructions for the machinery.
- Bring the drive to a standstill in a controlled form, using the machine control commands.
- Switch off the power and control voltage of the controller.
- Switch off the protective motor switch for the fan unit.
- Depressurize the pressure side (P line).
- Switch off the machine's main switch.
- Secure the system against restarting.

11 Disassembly and Replacement

11.1 Disassembly

11.1.1 Preparing for Disassembly

Decommission the machinery as described in chapter 10 "Decommissioning" on page 119.

- Do not work on running or unsecured systems.
- Before starting to work, secure the machine against unforeseeable movements and against operation by unauthorized persons.
- Allow the DRn system to cool down before starting to work.
- Do not work on hot surfaces.

11.1.2 Disassembling the Hydraulic Product

1. Before you start working, ensure that the system is depressurized.
2. Wait until the discharge time of the electric components has expired (discharge time: see the warning at the component; Rexroth IndraDrive drive controllers: discharge time = 30 minutes).
3. Disconnect all electrical connections.
4. Shut off the suction port of the motor-pump unit. In doing so, observe the instructions regarding the entire system.
5. Secure the system components and supply lines against falling or movements, before unfastening the mechanical connections.
6. Disconnect the piping on the pressure side.
7. If any residual oil escapes, catch it immediately using a suitable container, e.g. an oil tray.
8. Disassemble the system component as described in the documentation of the component.

11.2 Drive Controller

See documentation of the component:

Title	Material number	Documentation type
Rexroth Frequency Converter EFC 3610 / EFC 5610 Series	R912005856	Quick Start Guide
Rexroth Frequency Converter EFC 3610 / EFC 5610 Series	R912005854	Operating Instructions

Tab. 11-1: Documentation, EFC 5610

12 Environmental protection and disposal

12.1 Environmental protection

Production processes

The products are made with energy- and resource-optimized production processes which allow re-using and recycling the resulting waste. We regularly try to replace pollutant-loaded raw materials and supplies by more environment-friendly alternatives.

No release of hazardous substances

Our products do not contain any hazardous substances which may be released in the case of appropriate use. Normally, our products will not have any negativ influences on the environment.

Significant components

Basically, our products contain the following components:

Electronic devices
- steel
- aluminum
- copper
- synthetic materials
- electronic components and modules

Motors
- steel
- aluminum
- copper
- brass
- magnetic materials
- electronic components and modules

12.2 Disposal

Return of products

Our products can be returned to our premises free of charge for disposal. It is a precondition, however, that the products are free of oil, grease or other dirt.

Furthermore, the products returned for disposal must not contain any undue foreign material or foreign components.

Send the products ”free domicile” to the following address:

Bosch Rexroth AG
Electric Drives and Controls
Buergermeister-Dr.-Nebel-Strasse 2
97816 Lohr am Main, Germany

Packaging

The packaging materials consist of cardboard, wood and polystyrene. These materials can be recycled anywhere without any problem.

For ecological reasons, please refrain from returning the empty packages to us.

Batteries and accumulators

Batteries and accumulators can be labeled with this symbol.

The symbol indicating "separate collection" for all batteries and accumulators is the crossed-out wheeled bin.

The end user within the EU is legally obligated to return used batteries. Outside the validity of the EU Directive 2006/66/EC keep the stipulated directives.

Used batteries can contain hazardous substances, which can harm the environment or the people´s health when they are improper stored or disposed of.

After use, the batteries or accumulators contained in Rexroth products have to be properly disposed of according to the country-specific collection.

Recycling

Most of the products can be recycled due to their high content of metal. In order to recycle the metal in the best possible way, the products must be disassembled into individual modules.

Environmental protection and disposal

Metals contained in electric and electronic modules can also be recycled by means of special separation processes.

Products made of plastics can contain flame retardants. These plastic parts are labeled according to EN ISO 1043. They have to be recycled separately or disposed of according to the valid legal requirements.

13 Extension and Modification

You will be considered responsible for any extensions to or modifications of the product.

Declarations become invalid

If you effect any extensions to or modifications of the product marketed by Bosch Rexroth or changes in the software, this means you are changing the condition of the product as supplied. Any statements made by Bosch Rexroth regarding this product will then become invalid.

If you have any questions, please contact your nearest Bosch Rexroth service center or directly contact the headquarters. The addresses are available at www.boschrexroth.com.

14 Troubleshooting

14.1 Display of LED Characters

Character	A	b	C	d	E	F	H	I	L
Display									
Character	n	O	o	P	r	S	t	U	–
Display									–

Tab. 14-1: Display of LED characters

14.2 Status Code

Code	Description
8.8.8.8.8.	Displayed at power on, detecting the operating panel
'-' '--' '---' '----' '-----'	During parameter backup…
tUnE	Motor parameter tunning
PSLP	PID sleeping
-PF-	Modified parameters which are different from default value
-EP-	Parameters with invalid settings
PAr1	Parameter set switching from set 2 to set 1
PAr2	Parameter set switching from set 1 to set 2

14.3 Warning Code

Code	Description
P.oFF	Displayed only at power down / drop in stop state
S.Err	Parameter change blocked
C-dr	Communication disconnection
PrSE	Parameter setting contradiction
FLE	Fan maintenance period expired
noCP	No modified parameter
PLE	Pump leakage
Aib-	Analog input broken wire detection
OCi	Communication data exceeds value range
Fdi	Fieldbus process data invalid
APF1 APF2 APF3 APF4 APF5	For detailed information about the warning, please see chapter 14.5.1 "Warnings" on page 133

14.4 Error Code

14.4.1 Error 1 (OC-1): Overcurrent at Constant Speed

Possible reason	Solution
Sudden load change in run mode	Reduce occurrence and scale of sudden change
Low mains voltage	Check input power supply
Motor power and frequency converter power do not match	Motor power has to match with frequency converter power
Excessive inertia or load	Check power of motor and frequency converter, check load
The motor cable is too long	• Decrease the carrier frequency (C0.05) • Use a frequency converter with larger power
Excessive torque compensation	Reduce torque compensation setting (C2.22) till the current decreases

14.4.2 Error 2 (OC-2): Overcurrent during Acceleration

Possible reason	Solution
Excessively short acceleration time	Increase acceleration time (E0.26)
Excessive start-up frequency	Reduce start frequency (E0.36)
Excessive load rotation inertia or impact	Increase acceleration time (E0.26), reduce sudden load change
Running command active while motor is coasting	Restart after motor stop or start with speed capture (E0.35)
Wrong setting of V/f curve related parameters	Adjust setting of V/f curve related parameters
Motor power and frequency converter power do not match	Motor power has to match with frequency converter power
Excessive torque compensation	Reduce torque compensation setting (C2.22) till the current decreases
Wrong motor parameters setting	Correct motor parameters setting

14.4.3 Error 3 (OC-3): Overcurrent during Deceleration

Possible reason	Solution
Excessively short deceleration time	Increase deceleration time (F3.22)
Excessive load rotation inertia	Use suitable brake components. Information about external EFC brake choppers you can find in R912007235
Motor power and frequency converter power do not match	Motor power has to match with frequency converter power
Excessive overexcitation braking factor	Reduce [E0.55]
Wrong motor parameter setting	Correct motor parameters setting

Troubleshooting

14.4.4 Error 4 (OE-1): Overvoltage at Constant Speed

Possible reason	Solution
Surge voltage from power supply	Check input power supply
Motor to earth short circuit causes DC-bus capacitors overcharged	Check motor connection
Excessive load rotation inertia	Use suitable brake components. Information about external EFC brake choppers you can find in R912007235
Noise interference	Check wiring of control circuit, main circuit and grounding

14.4.5 Error 5 (OE-2): Overvoltage during Acceleration

Possible reason	Solution
Surge voltage from power supply	Check input power supply
Motor to earth short circuit causes DC-bus capacitors overcharged	Check motor connection
Direct start during motor running	Restart after motor stop or start with speed capture (E0.35)
Excessively short acceleration time	Increase acceleration time (E0.26) or use S-curve (E0.25, E0.28, E0.29)

14.4.6 Error 6 (OE-3): Overvoltage during Deceleration

Possible reason	Solution
Surge voltage from power supply	Check input power supply
Motor to earth short circuit causes DC-bus capacitors overcharged	Check motor connection
Excessive load rotation inertia	Use suitable brake components
Excessively short deceleration time	• Increase deceleration time (F3.22) • Use a brake resistor or a brake resistor unit • Enable stall overvoltage prevention during deceleration (C0.25)
Wrong wiring of brake resistor	Check the wiring of brake resistor. Information about external EFC brake choppers you can find in R912007235
The brake chopper is damaged	Contact with service

14.4.7 Error 7 (OE-4): Overvoltage during Stop

Possible reason	Solution
Excessive inertia on the load	• Increase deceleration time (F3.22) • Use suitable brake components Information about external EFC brake choppers you can find in R912007235
Surge voltage from the power supply	Check input power supply

14.4.8 Error 8 (UE-1): Undervoltage during Run

Possible reason	Solution
Power failure during running	Check input power supply
Main circuit capacitor deterioration	Contact with service

14.4.9 Error 9 (SC): Surge Current or Short Circuit

Possible reason	Solution
External phase-phase short circuit of motor	Check motor wiring
Earth surge	Remove the short circuit and check motor
Internal error of power module	Contact with service
Surge current	Increase the acceleration time (E0.26), reduce the overexcitation braking factor (E0.55)

14.4.10 Error 10 (IPH.L): Input Phase Loss

Possible reason	Solution
Abnormal, omitted or broken connections of frequency converter power supply	Check power supply connections, remove omitted or broken connections
Broken fuse	Check fuse
Imbalance in the three phases of input power supply	Check if the imbalance situation exceeds converter withstand capability
Main circuit capacitor deterioration	Contact with service

14.4.11 Error 11 (OPH.L): Output Phase Loss

Possible reason	Solution
Abnormal, omitted or broken connections of frequency converter outputs	Check the connections of frequency converter outputs, remove omitted or broken connections
Imbalance in the three phases of outputs	Check motor

14.4.12 Error 12 (ESS-): Soft Start Error

Possible reason	Solution
Soft start resistor value has been changed due to over temperature	Contact with service
Power failure	Check the input power supply
Input phase loss occurs during start-up (3 phase)	Remove the input phase loss
Main circuit capacitor deterioration	Contact with service

Troubleshooting

14.4.13 Error 20 (OL-1): Converter Overload

Possible reason	Solution
Long time overload	Reduce overload time, reduce load
Wrong settings of V/f curve related parameters	Adjust settings of V/f curve related parameters
Motor power and frequency converter power do not match	Motor power has to match with frequency converter power
Overload happens at lower speed	• Reduce load at lower speed • Reduce the carrier frequency (C0.05) • Use a frequency converter with larger power
Excessive load, excessive short Acc. / Dec. time or cycle	• Adjust load, acceleration/deceleration time or cycle • Use a frequency converter with larger power
Low mains voltage	Check input power supply
Excessive torque compensation	Reduce torque compensation setting (C2.22) till the current decreases

14.4.14 Error 21 (OH): Converter over Temperature

Possible reason	Solution
Frequency converter (heat sink) temperature is higher than max. allowable temperature 85 °C	• Reduce ambient temperature, improve ventilation and heat dissipation; clear dust, cotton wadding in air ducts; check fan and its power supply connection (if available) • Reduce load if necessary • Reduce carrier frequency (C0.05)
Temperature detection circuit error	Contact with service

14.4.15 Error 22 (UH): Converter under Temperature

Possible reason	Solution
Ambient temperature is lower than -10 °C	Provide a reasonable ambient temperature that frequency converter requires
Temperature sensor defect	Contact with service

14.4.16 Error 23 (FF): Fan Failure

Possible reason	Solution
Fan defect	Contact with service

14.4.17 Error 30 (OL-2): Motor Overload

Possible reason	Solution
Motor locked	Prevent motor lock
Normal motor runs long time with large load at low speed	• Increase frequency converter output frequency • Reduce load • Use variable frequency motor or set zero speed load (C1.76) to a higher value • Set correct motor thermal model protection time constant (C1.74)
Low mains voltage	Check input power supply
Wrong settings of V/f curve related parameters	Adjust settings of V/f curve related parameters
Excessive sudden load change	Check load
Wrong input of rated motor current	Correct rated motor current in (C1.07)
Multiple motors are driven by one frequency converter	Connect only one motor to the frequency converter
Excessive overexcitation braking factor	Reduce [E0.55]
Wrong motor protection parameter settings	Adjust settings of C1.74, C1.75 and C1.76 according to actual motor situations

14.4.18 Error 31 (Ot): Motor over Temperature

Possible reason	Solution
Excessive load or bad cooling	• Check load • Provide a better cooling condition
Temperature sensor defect	Check the motor temperature sensor feedback signal
Wrong motor protection parameter settings	Different motor with different maximum temperature, set motor protection parameters according to actual protection circuits (C1.72, C1.73, C1.74)

14.4.19 Error 32 (t-Er): Motor Parameter Tuning Error

Possible reason	Solution
Motor power and frequency converter power do not match	Motor power has to match with frequency converter power
Wrong setting of motor parameters	Correct motor parameters setting according to motor nameplate
No connection of converter and motor	Check motor cable connections

14.4.20 Error 33 (AdE-): Synchronous Motor Angle Detection Error

Possible reason	Solution
Internal error occurs during synchronous motor angle detection	Contact with service

Troubleshooting

14.4.21 Error 38 (AibE): Analog Input Broken Wire Detection

Possible reason	Solution
Analog input wire is disconnected	Check wiring of AI1, AI2 and EAI

14.4.22 Error 39 (EPS-): DC_IN Power Supply Error

Possible reason	Solution
DC_IN power supply voltage is out of range 20...28 V	Check the voltage supply on DC_IN terminal and make sure the voltage is within the range of 20...28 V

14.4.23 Error 40 (dir1): Forward Running Lock Error

Possible reason	Solution
Direction control [E0.17] = '1: Forward only' Direction command is reverse	Correct the parameter setting

14.4.24 Error 41 (dir2): Reverse Running Lock Error

Possible reason	Solution
Direction control [E0.17] = '2: Reverse only' Direction command is forward	Correct the parameter setting

14.4.25 Error 42 (E-St): Terminal Error Signal

Possible reason	Solution
External error caused by input signals via external terminals	Check external terminals status
Wrong wiring / setting of multi-function external terminals	Ensure the right external signals have been connected correctly to the right multi-function external terminals which are assigned for external error input ([E1.00]...[E1.04] = 32, 33)
Converter stop caused by E-Stop active command via Modbus communication	Check the stop command via Modbus communication (0X0088: stop according to parameter setting; 0X0090: E-stop active). If converter receives 0X0090 , E-St will be displayed

14.4.26 Error 43 (FFE-): Firmware Version Mismatch

Possible reason	Solution
Operating panel may be placed to the frequency converter with older/newer firmware	Contact with service
Control board may be removed to another device	Contact with service
Extension card may be installed to the frequency converter with older/newer firmware	Contact with service

14.4.27 Error 44 (rS-): Modbus Communication Error

Possible reason	Solution
Device connection problem	Check device communication connection
Communication target error	Check status of communication target

14.4.28 Error 45 (E.Par): Parameter Settings Invalid

Possible reason	Solution
Parameter settings are invalid after firmware update or extension card removed	Contact with service

14.4.29 Error 46 (U.Par): Unknown Parameter Restore Error

Possible reason	Solution
Parameter backup could not restore a parameter which can not be shown on the panel	Check with ConverterWorks or contact with service

14.4.30 Error 48 (idA-): Internal Communication Error

Possible reason	Solution
Internal error caused by communication between control boards	Contact with service

14.4.31 Error 49 (idP-): Internal Parameter Error

Possible reason	Solution
Internal error caused by parameter handling	Contact with service

14.4.32 Error 50 (idE-): Converter Internal Error

Possible reason	Solution
Internal error occurs	Contact with service

14.4.33 Error 51 (OCd-): Extension Card Internal Error

Possible reason	Solution
Extension card was successfully detected by the device at start-up, but the communication failed afterwards	Contact with service

14.4.34 Error 52 (OCc): Extension Card PDOs Configuration Error

Possible reason	Solution
Internal communication error between communication card and converter control board	Contact with service

14.4.35 Error 53 (Fdi-): No Valid Process Data

Possible reason	Solution
No valid process data is received from remote communication server, the remote communication server may be turned off	Check remote communication server

14.4.36 Error 54 (PcE-): Remote Control Communication Error

Possible reason	Solution
Error if communication to IndraWorks/ConverterWorks is lost during remote control	• Check communication status between frequency converter and IndraWorks/ConverterWorks • Contact with service

14.4.37 Error 55 (PbrE): Parameter Backup / Restore Error

Possible reason	Solution
Error occurs during parameter backup/restore process	Contact with service

14.4.38 Error 56 (PrEF): Parameter Restore Error after Firmware Update

Possible reason	Solution
Error occurs if parameter settings cannot be restored after firmware update	Contact with service

14.4.39 Error 60 (ASF-): Application Firmware Error

Possible reason	Solution
Error message if the application firmware was not loaded correctly or trail use is over	Contact with service

14.4.40 Error 61 (APE1): Application Error

Possible reason	Solution
Application error	For detailed information about the error, please see chapter 14.5.2 "Error Code" on page 136

14.5 Diagnosis

14.5.1 Warnings

Warnings of the DRn function are displayed in the parameters D0.86 and D0.87 according to the following tables. When a warning occurs, the display shows "APE1" in every case. The value in the "Code" column can be examined from D0.86 and D0.87 to find out which warning occurred.

A warning can occur when DRn is already driving the motor. As long there is a warning in the queue you can operate. But its recommended to stop the function and clear the warning.

Bit	Code	Condition	Reason	Solution
0	1	F3.23 < F3.21	Speed boost ramp pitch is smaller than speed adaptation ramp pitch (ascending)	Either set F3.23 higher or F3.21 smaller
1	2	F3.21 = 0	Speed adaptation ramp pitch (ascending) 0 impedes speed adaptation	Configure F3.21 to be greater than zero
2	4	F3.22 = 0	Speed adaptation ramp pitch (descending) 0 impedes speed adaptation	Configure F3.22 to be smaller than zero
3	8	F3.23 = 0	Speed boost ramp pitch 0 impedes boost function	Set F3.23 greater than zero and greater than F3.21
4	16	F3.24 = 0	Speed boost pressure window 0 causes permanently active boost function	Widen the boost pressure window F3.24 to values greater than 0 and greater than the noise of the pressure sensor
5	32	F3.24 < 1	Narrow speed boost pressure window can cause boost function to cyclically start	Widen the boost pressure window F3.24 to values greater than 0 and greater than the noise of the pressure sensor. A good value to start is 5 bar
6	64	F3.21 > F4.50	Speed adaptation ramp pitch (ascending) exceeds maximum pump angular acceleration	Reduce F3.21 to values that are smaller than the maximal angular acceleration of the pump
7	128	|F3.22| > F4.50	Speed adaptation ramp pitch (descending) exceeds maximum pump angular acceleration	Reduce the absolute value of F3.22 (which must be negative) to values that are smaller than the maximal angular acceleration of the pump
8	256	F3.23 > F4.50	Speed boost ramp pitch exceeds maximum pump angular acceleration	Reduce F3.23 to values that are smaller than the maximal angular acceleration of the pump
11	2048	F3.19 < F4.52	Speed adaptation minimum speed is lower than minimum pump speed	Reduce F3.23 to values that are smaller than the maximal angular acceleration of the pump
12	4096	F3.20 > F4.51	Speed adaptation maximum speed exceeds maximum pump speed	Lower F3.20 to values that are under the maximal speed of the pump

Troubleshooting

Bit	Code	Condition	Reason	Solution
13	8192	F3.19 ≥ F3.20	Speed adaptation minimum speed is greater than or equal to speed adaptation maximum speed	Set F3.20 and F3.19 so that F3.20 is bigger than F3.19
15	32768	F4.57 – F4.58 < F3.19	Masked speed window drops bellow speed adaptation minimum speed	Change the window so it does not collide with minimum speed boundary

Tab. 14-2: Warnings in D0.86

Bit	Code	Condition	Reason	Solution
0	1	F4.57 + F4.58 > F3.20	Masked speed window exceeds speed adaptation maximum speed	Consider setting the window so it does not collide with maximum speed boundary
4	16	F4.53 = 0	No pump inertia is parameterized	Consider setting F4.35 to the pump inertia. This value is only needed for pump type manual
5	32	F4.55 > 100	Motor derating-continuous torque at standstill exceeds motor nominal torque	Continuous torque at standstill must be set to values smaller then 100% of nominal torque. Set F4.55 to < 100
6	64	Oil level warning	Oil level is too low	Refill oil
7	128	Oil temperature warning	Oil temperature reached	Reduce hydraulic losses or enhance oil cooling
8	256	D0.84 < F4.61	The hydraulic pressure has fallen below the given threshold F4.61 for a set amount of time F4.62. Possibly a motor stall or a too high hydraulic load condition has occurred	Check hydraulic pipelines for breaks and leakages Check if drive maximum torque/ power is exceeded Default values may need to be changed to be appropriate for the application
9	512	Oil change warning	Operation time exceeds oil life time	Change oil and reset operation timer (F4.54)
10	1024	F3.29 = 0	No start-up time parameterized. Default value of 2,000 ms is active	Chose F3.29 to a value greater than 0
11	2048	Pump type invalid	Chosen pump type is not available or manual configuration of pump data is invalid (F4.30, F4.50...F4.54)	Chose pump type to an available pump
12	4096	Oil filter 1 pre-warning	Oil filter almost clogged	Clean or replace filter
13	8192	Oil filter 1 warning 100%	Oil filter clogged 100%	Clean or replace filter

Bit	Code	Condition	Reason	Solution
14	16384	Oil filter 2 pre-warning	Oil filter almost clogged	Clean or replace filter
15	32768	Oil filter 2 warning 100%	Oil filter clogged 100%	Clean or replace filter

Tab. 14-3: Warnings in D0.87

If different warnings are generated simultaneously, the value of D0.86 or D0.87 are combined and different warning codes from the table show up. For example, Bit0 and Bit1 of D0.86 are combined, diagnostic code will be 1 (Bit0)+2 (Bit1) = 3.

14.5.2 Error Code

Errors of the DRn function are displayed in the parameters D0.88 and D0.89 according to the following tables. When an error occurs, the display shows "APF1" in every case. The value in the "Code" column can be examined from D0.88 and D0.89 to find out which error occurred.

An error prevent DRn from starting and driving the motor. As long as an error is in queue DRn will put out zero speed as a set-point value.

Bit	Code	Condition	Reason	Solution
6	64	F3.21 > F4.50	Speed adaptation ramp pitch (ascending) exceeds maximum pump angular acceleration	Set F3.21 to smaller values
7	128	|F3.22| > F4.50	Speed adaptation ramp pitch (descending) exceeds maximum pump angular acceleration	Set the absolute value of F3.22 to smaller values
8	256	F3.23 > F4.50	Speed boost ramp pitch exceeds maximum pump angular acceleration	Set F3.23 to smaller values
11	2048	F3.19 < F4.52	Speed adaptation minimum speed is lower than minimum pump speed	Set F3.19 to higher values
12	4096	F3.20 > F4.51	Speed adaptation maximum speed exceeds maximum pump speed	Set F3.20 to smaller values
13	8192	F3.19 > F3.20	Speed adaptation minimum speed is higher than speed adaptation maximum speed	Set F3.20 and F3.19 so that F3.20 is bigger than F3.19

Tab. 14-4: Errors in D0.88

Bit	Code	Condition	Reason	Solution
1	2	Parameter setting fault	Parameter setting repetition	Check if parameter settings are in conflict
5	32	F4.55 > 100	Motor derating-continuous torque at standstill exceeds motor nominal torque	Continuous torque at standstill must be set to values smaller then 100% of nominal torque. Set F4.55 to <100
11	2048	Pump type invalid	Chosen pump type is not available or manual configuration of pump data is invalid (F4.30, F4.50...F4.54)	Chose pump type to an available pump
12	4096	Oil level error	Oil level too low	Refill oil. See chapter "Digital Input" on page 100 for more information
13	8192	Oil temperature error	Oil temperature reached	Reduce hydraulic loses or enhance oil cooling. See chapter "Digital Input" on page 100 for more information

Bit	Code	Condition	Reason	Solution
14	16384	Oil change error	Operation time exceeds oil life time	Change oil and reset operation timer F4.54. See chapter "Digital Input" on page 100 for more information
15	32768	Suction valve closed	Suction valve closed	Open the valve at suction line

Tab. 14-5: Errors in D0.89

If different errors are queued, the value of D0.88 or D0.89 are superimposed and different error codes from the table show up. For example, Bit0 and Bit1 of D0.86 are queued, diagnostic code will be 64 (Bit6)+128 (Bit7) = 192.

14.5.3 Monitoring Parameter

Code	Description	Unit
H0.01	Status word standard firmware	-
d0.01	Actual speed	rpm
d0.03	Speed command value	rpm
d0.80	DRn status word	-
d0.81	Effective pressure command value	bar
d0.82	Torque actual value	Nm
d0.83	Effective swivel angle command value	%
d0.84	Pressure feedback	bar
d0.85	Pump: Actual swivel angle	%
d0.86	ASF Display06, Warning low word	-
d0.87	ASF Display07, Warning high word	-
d0.88	ASF Display08, Error low word	-
d0.89	ASF Display09, Error high word	-

Tab. 14-6: Monitoring parameter

For detailed information about parameter D0.80, please refer to the following table.

Bit	Description
0	DRn active
1	Speed adaption active
2	Warning active
3	Error active
4	p_cmd reached
5	Max speed reached
6	Min speed reached
7	Boost active
8	Ramp limiter active
9	Learn p_cmd enabled
10	Learn p_cmd active
11	Speed masking active
12	Fan monitoring active
13	Start-up active
14	ConstSpeed active

Tab. 14-7: Bit definition of D0.80

The following table shows the bit definition of H0.01.

Bit	Value	Description
15 ... 8	–	Error code (equals to [E9.05])
7	1	Error
	0	No error
6	1	Stall over current
	0	Normal
5	1	Stall over voltage
	0	Normal
4	1	Decelerating
	0	Not in deceleration
3	1	Accelerating
	0	Not in acceleration
2	1	Jogging
	0	Not in jog
1	1	Running
	0	Stop
0	1	Reverse
	0	Forward

Tab. 14-8: Bit definition of H0.01 (status word)

Information about standard firmware status word also can be found in Multi-Ethernet Card Instruction Manual (R912006860).

14.5.4 General DRn system troubleshooting

Problem	Reason	Solution
Boost function repeatedly activated	Possible reasons can be: 1. Cyclic load change which trigger boost 2. Too fast speed adaptation which is disturbing pressure control 3. Bad tuning of velocity control	1. Set pressure window to higher value 2. Lower Ramp pitch , boost ramp 3. Configure boost wait time F3.25 with a value bigger then slowest hydraulic system time constant 4. Tune the velocity control to be more disturbance rejective
General pressure oscillation	1. Hydraulic dead volume may be to big and lead to oscillation in the pressure control loop 2. Bulk Modulus changing due heat or air enclosure in the hydraulic oil can alter the pressure control loop and lead to oscillation 3. Velocity loop prone to disturbances on rising motor winding resistance temperature can lead to oscillations in speed and therefore in pressure	1. Use damping nozzles to damp pressure oscillations in the mechanical controller 2. Tune the velocity control to be more disturbance rejective

Tab. 14-9: DRn system troubleshooting

15 Service and support

15.1 Sales and Service Network

Please contact your personal account manager first.

If you do not have a personal account manager, please contact the next sales organization. For the corresponding contact data, please refer to chapter 15.2 "Internet Contact" on page 140"

15.2 Internet Contact

For additional information on service, repair and training as well as the current addresses of our sales organizations, please refer to: http://www.boschrexroth.com.

15.3 Preparation of Information

We can help you in a fast and efficient way if you keep the following information available:

- Detailed description of the failure and the boundary conditions
- Information on the name plate of the products concerned, particularly type key and serial numbers
- Phone, fax numbers and email address under which you are available in case of enquiries.

On the basis of this information we will process your request quickly and efficiently.

Specify the hydraulic set-up of the machine (e. g. hydraulic circuit diagram or sketch; place of installation of the pressure transducer, check valves, if applicable, set-up of suction area).

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Notes

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