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Safety instructions for electric drive and control systems

.Safety instructions for electric drive and control systems

.Basic information

.Using and passing on the safety instructions

Do not install and operate any components of the electric drive and control system before carefully reading all provided documents. These safety instructions and all other user instructions have to be read prior to working with these components. If you do not have the user documentation for the components, contact our Rexroth sales representative. Request the immediate delivery of these documents to the person or persons in charge of the safe operation of the components.

In the case of vending, rental and/or distribution of the components in any other form, include these safety instructions in the national language of the user.

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, personal injury, electric shock or even death.

.Requirements for safe use

Prior to initial commissioning of the components of the electric drive and control system, read the following instructions to avoid personal injury and/or property damage. You must comply with these safety instructions.

- In the case of damage due to non-compliance with the safety instructions, Rexroth shall not assume any liability.
- Prior to commissioning, read the operating, maintenance and safety instructions. If you are not able to sufficiently understand the language used in the application documentation, please contact and inform your vendor.
- Appropriate and professional transport, storage, assembly and installation, as well as thorough operation and maintenance, are the basis of correct and safe operation of the component.
- Only qualified personnel may use components of the electric drive and control system or work in its close proximity.
- Only use accessories and spare parts approved by Rexroth.
- Comply with the safety instructions and regulations of the country in which the components of the electric drive and control system are operated.
- Only use components of the electric drive and control system as intended. Please refer to chapter **Intended use**.
- The ambient and operating conditions specified in this application documentation have to be complied with.
- Applications for functional safety are only allowed if they are explicitly and unambiguously specified in the application documentation "Integrated Safety Technology". If this is not the case, these applications are excluded. Functional safety includes parts of the overall safety in which measures of risk reduction for personal safety depend on electric, electronic or programmable controls.
- The specifications contained in the application documentation regarding the use of the provided components are only application examples and recommendations.
- For their individual application, the machine manufacturer and the system installer have to
  - verify the applicability of the provided components and the specifications made for their use in this application documentation,
  - synchronize the applicability with the safety regulations and standards applicable for their application and to execute the required measures, modifications and additions.

- Commissioning of the provided components is prohibited until is has been established that the machine or the system in which the components are installed corresponds to the country-specific provisions, safety regulations and standards of the application.
- Operation is only allowed when complying with the national EMC regulations for the relevant application.
- For information about EMC-compliant installation, refer to the section on EMC in the relevant application documentation.
- The system or machine manufacturer is responsible for compliance with the limit values specified in the national regulations.
- The technical data, connection and installation conditions of the components are contained in the relevant application documentations and must be complied with.
- Country-specific laws and regulations must be observed.

.Hazards due to incorrect use

- High electrical voltage and high operating current! Danger to life or serious personal injury due to electric shock!
- High electrical voltage due to incorrect connection! Danger to life or personal injury due to electric shock!
- Dangerous movements! Danger to life, serious personal injury or property damage due to 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! Personal injury by crushing, shearing, cutting, hitting!
- Risk of injury by improper handling of batteries!
- Risk of injury by improper handling of pressurized lines!

.Instructions with regard to specific dangers

.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 personal 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 electrical components in accordance with the connection diagram.
- Even for short measurements or tests, operation is only allowed with the equipment grounding conductor permanently connected to the specified points of the components.
- Before accessing electrical parts with voltage potentials higher than 50 V, disconnect electrical components from the mains or from the voltge source. Protect the electrical component against restart.
- Observe the following aspects in the case of electrical components:

Prior to touching an electrical component, always wait for **30 minutes** after switching off power in order for live capacitors to discharge. Before beginning to work, measure the electrical voltage of live parts to make sure that the equipment is safe to touch.

- Install the provided covers and safety devices for protection against contact prior to switch-on.
- Do not touch any electrical connection points of the components while power is turned on.
- Do not connect or disconnect live parts.
- Under certain 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!

- Prior to switching on and commissioning, ground or connect the electric drive and control system components to the equipment grounding conductor at the grounding points.
- Connect the equipment grounding conductor of the electric drive and control system components 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 mm2 (8 AWG), the alternative connection of two equipment grounding conductors is allowed, each having the same cross section as the outer conductors.

.Minimum cross section of equipment grounding connection

Cross section of outer conductor	Minimum cross section of equipment grounding conductor Leakage current ≥ 3.5 mA	
	1 equipment grounding conductor	2 equipment grounding conductors
1.5 mm2 (AWG 16)	10 mm2 (AWG 8)	2 × 1.5 mm2 (AWG 16)
2.5 mm2 (AWG 14)		2 × 2.5 mm2 (AWG 14)
4 mm2 (AWG 12)		2 × 4 mm2 (AWG 12)
6 mm2 (AWG 10)		2 × 6 mm2 (AWG 10)
10 mm2 (AWG 8)		-
16 mm2 (AWG 6)	16 mm2 (AWG 6)	-
25 mm2 (AWG 4)		-

Cross section of outer conductor	Minimum cross section of equipment grounding conductor Leakage current ≥ 3.5 mA	
	1 equipment grounding conductor	2 equipment grounding conductors
35 mm2 (AWG 2)		-
50 mm2 (AWG 1/0)	25 mm2 (AWG 4)	-
70 mm2 (AWG 2/0)	35 mm2 (AWG 2)	-

.Protective extra-low voltage as protection against electric shock

Protective extra-low voltage is used to connect devices with basic insulation at extra-low voltage circuits.

At 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**).

.Protection against dangerous movements

Dangerous movements can be caused by incorrect control of connected motors. In the following, the different reasons are listed:

- Improper or wrong wiring or cable connection
- Operating errors
- Incorrect parameter input prior to commissioning
- Malfunction of sensors and encoders
- Defective components
- Errors in the software or firmware

These errors can occur immediately after switch-on or after an undefined time of operation.

As far as possible, the monitoring functions in the components of the electric drive and control system rule out malfunction in the connected drives. Regarding personal safety, in particular the danger of personal injury and/or property damage, this alone cannot be relied upon to ensure complete safety. Until the implemented monitoring functions are active, it must be assumed in any case that faulty drive movements will occur. The faulty movements depend on the type of control and the operating state.

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

Prepare a **risk assessment** for the system or machine, with their specific conditions, in which the components of the electric drive and control system are installed.

As specified in the risk assessment, the user has to provide monitoring functions and higher-level measures in the system for personal safety. The safety regulations applicable to the system or machine have to be included. Unintended machine movements or other malfunctions are possible if safety devices are disabled, bypassed or not activated.

.To avoid accidents, personal 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 covering
  - Light barriers
- Make sure the safety fences and protective coverings are strong enough to resist maximum possible kinetic energy.
- Mount emergency stop switches in the immediate reach of the operator. Before commissioning, verify that the emergency stop equipment works. Do not operate the machine if the emergency stop 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 axis,
  - adding an external braking/arrester/clamping mechanism or
  - ensuring sufficient counterweight for the axis.
- The standard equipment **motor holding brake** or an external holding brake controlled by the drive controller is **not sufficient to guarantee personal safety**!
- De-energize the components of the electric drive and control system using the master switch, and make sure they cannot be switched back on in the case of:
  - Maintenance and repairs
  - Cleaning work
  - Long service interruptions
- Avoid operating high-frequency, remote control and radio equipment in close proximity to 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.

.Protection against electromagnetic and magnetic fields during operation and mounting

.Electromagnetic and magnetic fields!

.Health hazard for persons with active implantable medical devices (AIMD) such as pacemakers or passive metallic implants.

- Hazards for the above-mentioned groups of persons by electromagnetic and magnetic fields in the immediate vicinity of drive controllers and the associated current-carrying conductors.
- Access to these areas can pose an increased risk to the above-mentioned groups of persons. They should seek advice from their attending doctor.
- If overcome by possible effects on above-mentioned persons during operation of drive controllers and accessories,

remove the exposed persons from the vicinity of conductors and devices.

.Protection against contact with hot parts

- 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.
- After having switched them off, allow the motors to cool down long enough before touching them. Cooling down may 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 off chokes, supply units and drive controllers, 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 system must take measures to avoid injuries caused by burns in the final application. Possible measures: warnings at the machine or system, guards (shieldings or barriers) or safety instructions in the application documentation.

.Protection during handling and mounting

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

- Comply with the relevant statutory regulations of accident prevention.
- Use suitable mounting and transport equipment.
- 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!

.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 since this may cause leakage or explosion.
- Do not throw batteries into open flames.
- Do not disassemble any 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. Comply with the national regulations of your country.

.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).
- Comply with 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. Comply with the national regulations of your country.

.Explanation of signal words and the safety alert symbol

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

The signal word is intended to draw the reader's attention to the safety instruction and describes 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!

Non-compliance with this safety instruction **will** result in death or serious personal injury.

WARNING!

Non-compliance with this safety instruction **can** result in death or serious personal injury.

CAUTION!

Non-compliance with this safety instruction can result in moderate or minor personal injury.

NOTICE!

Non-compliance with this safety instruction can result in property damage.