rexroth
A Bosch Company

Application Manual

ctrlX DRIVE

DC/DC Converter XMV

R911413650, Edition 01

Liability

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DOK-XDRV**-XMV********-AP01-EN-P DC-AE/EPI5 (UdSt; BaBo)

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1.1.1 Introduction

The products of Rexroth are developed and manufactured to the state-of-the-art. Prior to delivery, the products are checked for their fail-safe state.

⚠ WARNING	**Personal injury and property damage due to incorrect use of the products!** The products have been designed for use in an industrial environment and may only be used as intended. If the products are not used as intended, this may lead to situations resulting in property damage and personal injury.

NOTICE	**Damages resulting from unintended use** The user shall solely bear the risks for damages arising of unintended use of the products; Rexroth as manufacturer shall not assume any warranty, liability or compensation for damages.

Before using Rexroth products, make sure that all the prerequisites for an intended use of the products are satisfied:

- Anyone that in any way, shape or form uses our products must have read and understood the relevant safety instructions and the intended use.
- Do not change the original state of the hardware products, i.e., do not make any structural modifications. Software products must not be decompiled and their source codes must not be modified.
- Damaged or defective products must not be installed or commissioned.
- It has to be ensured that the products are installed according to the provisions specified in the documentation.

1.1.2 Areas of use and application

DC/DC converter by Rexroth are used to supply a variable DC voltage. The devices may be operated both in a voltage-controlled mode and in a current-controlled mode. Both infeeding mode and regenerative mode is possible. Controlling and monitoring the DC/DC converter may require additional sensors and actuators.

The DC/DC converter may only be used with the accessories and attachments specified in this documentation. Components that are not expressly mentioned may neither be attached nor connected. The same applies to cables and lines.

Operation is only allowed in the specified configurations and combinations of the components using the software and firmware as specified in the relevant functional descriptions.

DC/DC converter have to be programmed before commissioning to ensure that the functions specific to the application can be executed.

Device types with different power and interfaces are available for using the DC/DC converter in specific applications.

Typical applications include, for example:

- Battery buffers
- Battery test stands
- Fuel cell applications
- Test stands for DC motors

DC/DC converter may only be operated under the specified assembly and installation conditions, in the specified position of normal use and under the specified ambient conditions (temperature, degree of protection, humidity, EMC, etc.).

1.2 Unintended use

"Unintended use" refers to using the DC/DC converter outside of the operating conditions, technical data and specifications described in this documentation.

- DC/DC converter must not be used if they are exposed to operating conditions that do not meet the specified ambient conditions. This includes, for example, operation under water, under extreme temperature fluctuations or extreme maximum temperatures.
- Furthermore, DC/DC converter may not be used in applications that have not been expressly authorized by Rexroth. Please refer to the specifications in the general safety instructions!

Components of the ctrlX DRIVE drive system are **products of category 3** (with limited availability) according to IEC 61800-3. This category comprises EMC limit values for conducted and radiated emission. To comply with this category (limit values), use appropriate measures to suppress inteferences in the drive system (e.g., mains filters, shielding measures).

These components are not intended for use in a public low voltage system for residential areas. If these components are operating in such a network, high frequency interferences are to be expected. Additional measures for interference suppression can be required.

2 Safety instructions for electric drive and control systems

2.1 Basic information

2.1.1 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.

2.1.2 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 regulations to be complied with by the user

- 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 regional manufacturing specifications
  - National Fire Protection Association (NFPA) regulations
- Canada: Canadian Standards Association (CSA)
- Other countries:
  - International Organization for Standardization (ISO)
  - International Electrotechnical Commission (IEC)

2.1.3 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!

2.2 Instructions with regard to specific dangers

2.2.1 Protection against contact with electrical parts and housings

NOTICE	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.

  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.

  Measure the electrical voltage both conductor against conductor and conductor against ground (PE).

  Particularly if **DC bus ground capacitor pairs without discharging resistors (HAS04.1-003-NN1-NN)** are used, dangerous voltages against ground may be present for more than **24 hours** after the power supply was switched off. Only when voltage cannot be measured anymore between the positive and the negative DC bus connections is it allowed to discharge the DC bus ground capacitor pairs against ground. For this purpose, use the appropriate high-resistance device (e.g., DUSPOL® by "Benning Elektrotechnik und Elektronik GmbH & Co. KG"; observe the Operating Manual!).
- 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.

Table 1: 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)		-
35 mm2 (AWG 2)		-
50 mm2 (AWG 1/0)	25 mm2 (AWG 4)	-
70 mm2 (AWG 2/0)	35 mm2 (AWG 2)	-
X mm2	(X × 0.5) mm2 (applies to X ≥ 50)	-

2.2.2 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**).

2.2.3 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.

2.2.4 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.

2.2.5 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 having switched them off, allow the chokes to cool down long enough before touching them. Cooling down may require **up to 140 minutes**!
- After switching off 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.

2.2.6 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!

2.2.7 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 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.

NOTICE	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.

2.2.8 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).
- 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.

2.2.9 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.

3 Fields of application

In addition to the Project Planning Manual "ctrlX DRIVE Drive Systems" [R911386578 (German edition), R911386579 (English edition)], this documentation describes the application as DC/DC converter.

The **Project Planning Manual "ctrlX DRIVE Drive Systems"** contains:

- Ambient and operating conditions of the ctrlX DRIVE devices
- Mechanical data of the XMV devices
- Description of the connection points
- Description of the additional components, such as smoothing choke XLL, DC bus capacitor unit XLC, DC bus adapter XAS4
- ...

- „XMV“ devices of the „ctrlX DRIVE“ series are only intended for operation as DC/DC converters and supply a variable DC voltage.
- These devices may be operated both in a voltage-controlled mode and in a current-controlled mode.
- Both infeeding mode and regenerative mode is possible.

4 Components allowed for the DC/DC converter mode

The following components are allowed for the DC/DC converter mode.

DC/DC converter

- XMV2-W0050ANC-xxxxxNNNNxx-S02RSNxNNNPNNN
- XMV2-W0080ANC-xxxxxNNNNxx-S02RSNxNNNPNNN
- XMV2-W0210ANC-xxxxxNNNNxx-S02RSNxNNNPNNN

Data:

See Project Planning Manual "ctrlX DRIVE Drive Systems" [R911386578 (German edition), R911386579 (English edition)]

Smoothing choke

- XLL1-1NG402M0G-0050NNNNN-NNNNNN
- XLL1-1NG401M8G-0080NNNNN-NNNNNN
- XLL1-1WG401M0G-0210NNNNN-NNNNNN

Data:

See Project Planning Manual "ctrlX DRIVE Drive Systems" [R911386578 (German edition), R911386579 (English edition)]

DC bus capacitor unit

- XLC1-W01M2-A-0750-NN

Data:

See Project Planning Manual "ctrlX DRIVE Drive Systems" [R911386578 (German edition), R911386579 (English edition)]

DC bus connection adapter

- XAS4-W0120-UNIVERSAL-005-NN
- XAS4-W0300-UNIVERSAL-005-NN

Data:

See Project Planning Manual "ctrlX DRIVE Drive Systems" [R911386578 (German edition), R911386579 (English edition)]

DC bus ground capacitor pair

- HAS04.1-003-NNx-NN

Data:

See Project Planning Manual "IndraDrive ML Drive Systems with HMU05" [R911344278 (German edition), R911344279 (English edition)]

5 General requirements

- Ambient conditions: See Project Planning Manual "ctrlX DRIVE Drive Systems" [R911386578 (German edition), R911386579 (English edition)]
- The DC/DC converter is a two-quadrant converter that works as a **buck converter**.
  The DC/DC converter can be feeding as well as regenerative.
- The DC/DC converter is intended for operation at a **DC bus that does not jump** (only DC voltage against ground; no voltage peaks by switching actions).
- Operation at an **IT mains with insulation monitors at the DC output** results in a DC offset that causes the voltages in the entire system to be offset (DC/DC converter, supply unit, IT mains, wiring, other devices at the mains or DC bus).
  ➥ Chapter 9.1 DC/DC converter mode without XLI and XVR on page 37
- Operation at an **IT mains with insulation monitor and supply unit** (e.g., XVR) causes an additional voltage load at the mains connection. Due to the electric strength of the upstream supply unit (and possible other devices at the mains), additional restrictions may result for the range of control.
  ➥ Chapter 9.2 DC/DC converter mode with XLI and XVR on page 41
- Further operation is not allowed in the case of ground fault.
- Required components for operation:
  - **Smoothing choke** of type XLL1...-G...
  - **Output capacitor** (XLC1) for smoothing the voltage and current ripples.
  - **Input capacitor** (XLC1): XMV2-W0050 and XMV2-W0080 require an additional input capacitor if they are not directly connected to a ctrlX DRIVE supply unit.
  - **DC bus ground capacitor pair** (HAS04.1-003-NNx-NN) for capacitive connection against ground.
    Some insulation monitors require an HAS04.1-003-NN**1**-NN without discharging resistors to increase the impedance against ground. In this case, install an additional separate discharging device.
  - For operation mode "voltage control" as well as for firmware function "power limitation in current control":
    Transducer/measuring amplifier (galvanically isolated; DC 0 ... 1000 V to 0 ... 10 V), e.g. by "Knick". The transducer/measuring amplifier provides the measured values of the output voltage that are read in via the analog input at the control section. Make sure that the high voltage input and the measuring signal output are safely isolated.
- For systems in which the **charge energy against ground has to be limited**, both HAS04.1-003-NNx-NN and the device-internal ground capacitors (XMV, supply unit) have to be taken into account.
  When calculating the charge energy, the DC offset in the case of operation “DC/DC converter at IT mains with insulation monitor at **voltage output**“ has to be taken into account. See also application examples (➥ Chapter 9.1.1 DC/DC converter at IT mains with insulation monitor at voltage output on page 37).
  The device-internal ground capacitors and HAS04.1-003-NN**1**-NNN do not have any discharging resistors. Therefore, discharging has to be implemented by other means (e.g., by external resistors). In this case, the DC offset also has to be taken into account.

6 Overall connection diagram XMV

XMV2-W0050

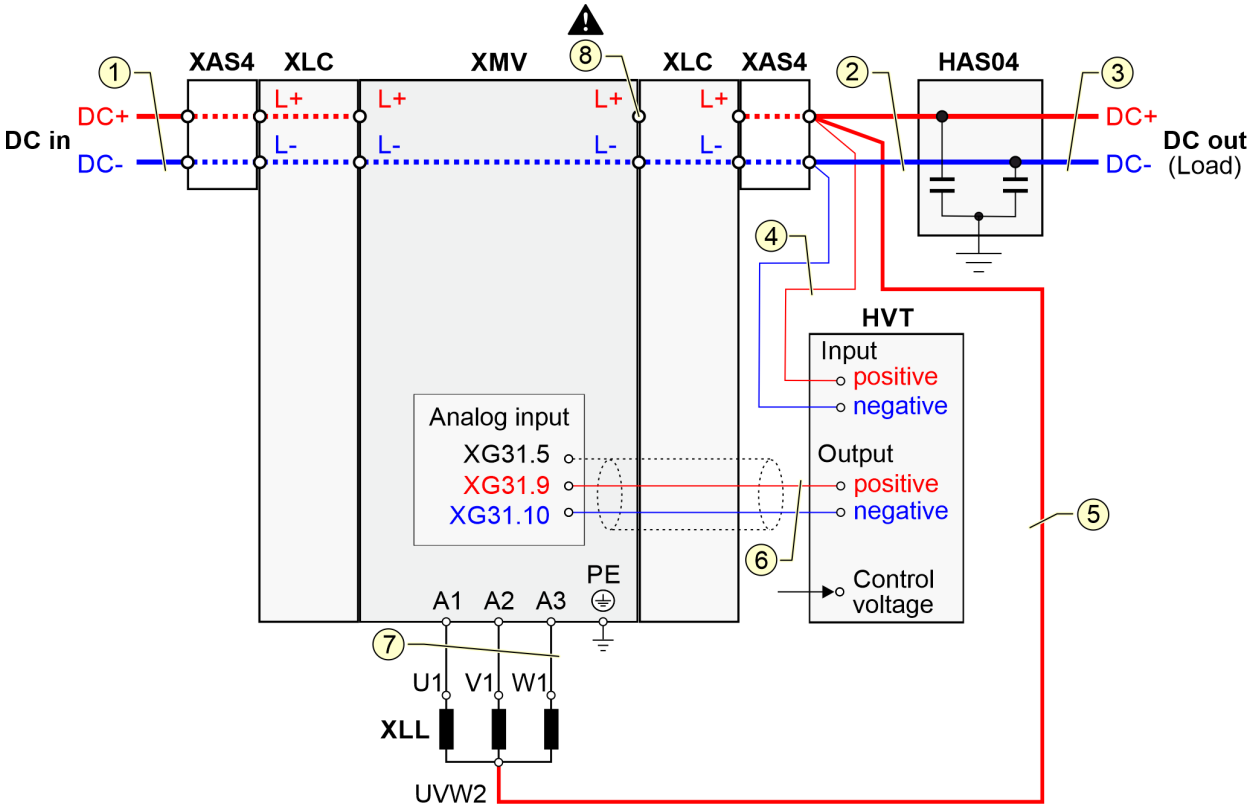


Fig. 1: XMV2-W0050

1	Twisted or parallel lines
2	**16 mm²**; short and parallel lines
3	Shielded lines; connect shield at both ends (control cabinet, load)
4	Twisted lines
5	**16 mm²**; shielded lines; connect shield at both ends (XMV, XLL)
6	Shielded or twisted lines
7	**6 mm²**
⚠8	**L+ connection points of XMV and XLC must not be connected to each other here!**
DC in	DC bus voltage (usually the power supply)
DC out	DC output (load connection)
HAS04	DC bus ground capacitor pair; install as near as possible to the output; HAS04.1-003-NNN: Standard variant with discharging resistors. If an insulation monitor is used, use DC bus ground capacitor pairs HAS04.1-003-NN**1** without discharging resistors where applicable. In this case, install an additional separate discharging device.
HVT	High-voltage transducer; measuring transducer that converts the output DC voltage to a 0 ... 10 V measuring signal
XAS4	DC bus adapter XAS4-W0120-UNIVERSAL-005-NN
XLC	DC bus capacitor unit XLC1-W01M2-A-0750-NN
XLL	DC bus choke (smoothing choke); XLL1-1NG402M0G-0050NNNNN-NNNNNN
XMV	DC/DC converter XMV2-W0050

XMV2-W0080

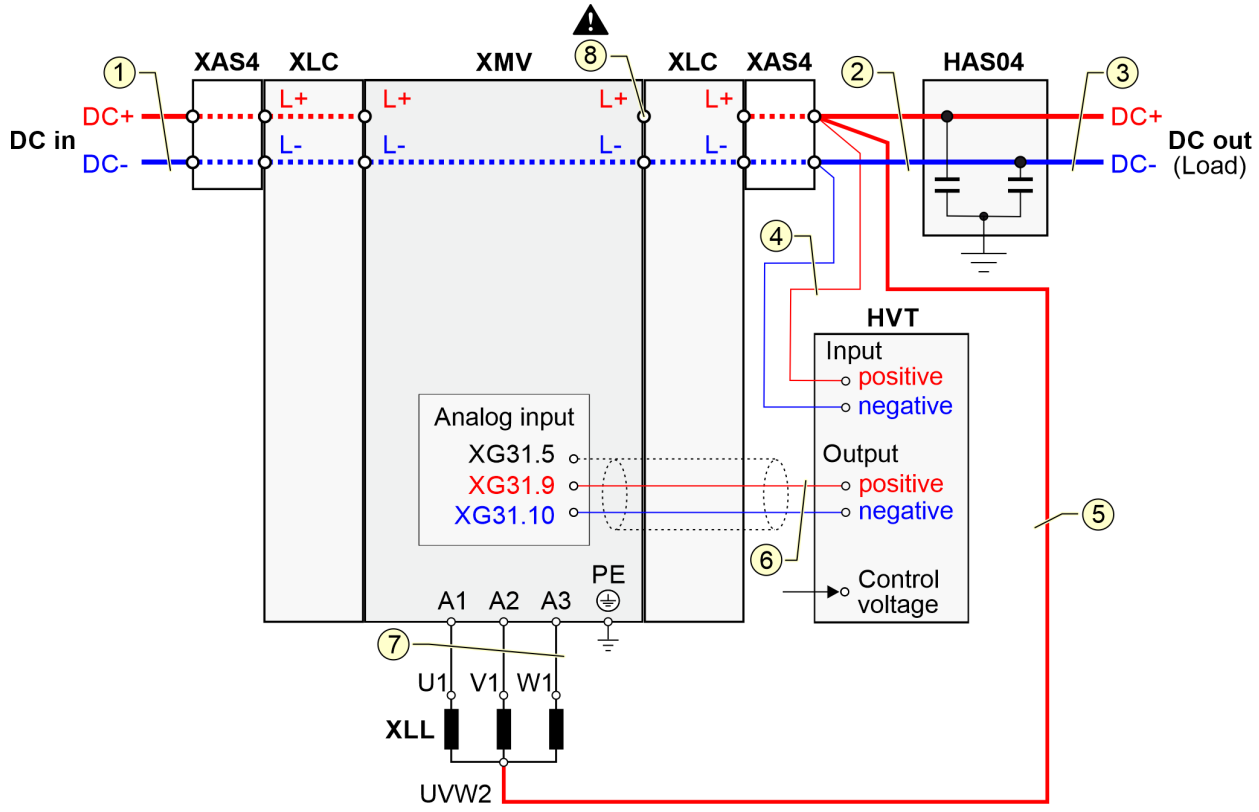


Fig. 2: XMV2-W0080

1 Twisted or parallel lines
2 **25 mm²**; short and parallel lines
3 Shielded lines; connect shield at both ends (control cabinet, load)
4 Twisted lines
5 **25 mm²**; shielded lines; connect shield at both ends (XMV, XLL)
6 Shielded or twisted lines
7 **10 mm²**
⚠8 **L+ connection points of XMV and XLC must not be connected to each other here!**
DC in DC bus voltage (usually the power supply)
DC out DC output (load connection)
HAS04 DC bus ground capacitor pair; install as near as possible to the output; HAS04.1-003-NNN: Standard variant with discharging resistors. If an insulation monitor is used, use DC bus ground capacitor pairs HAS04.1-003-NN**1** without discharging resistors where applicable. In this case, install an additional separate discharging device.
HVT High-voltage transducer; measuring transducer that converts the output DC voltage to a 0 ... 10 V measuring signal
XAS4 DC bus adapter XAS4-W0120-UNIVERSAL-005-NN
XLC DC bus capacitor unit XLC1-W01M2-A-0750-NN
XLL DC bus choke (smoothing choke) XLL1-1NG401M8G-0080NNNNN-NNNNNN
XMV DC/DC converter XMV2-W0080

XMV2-W0210

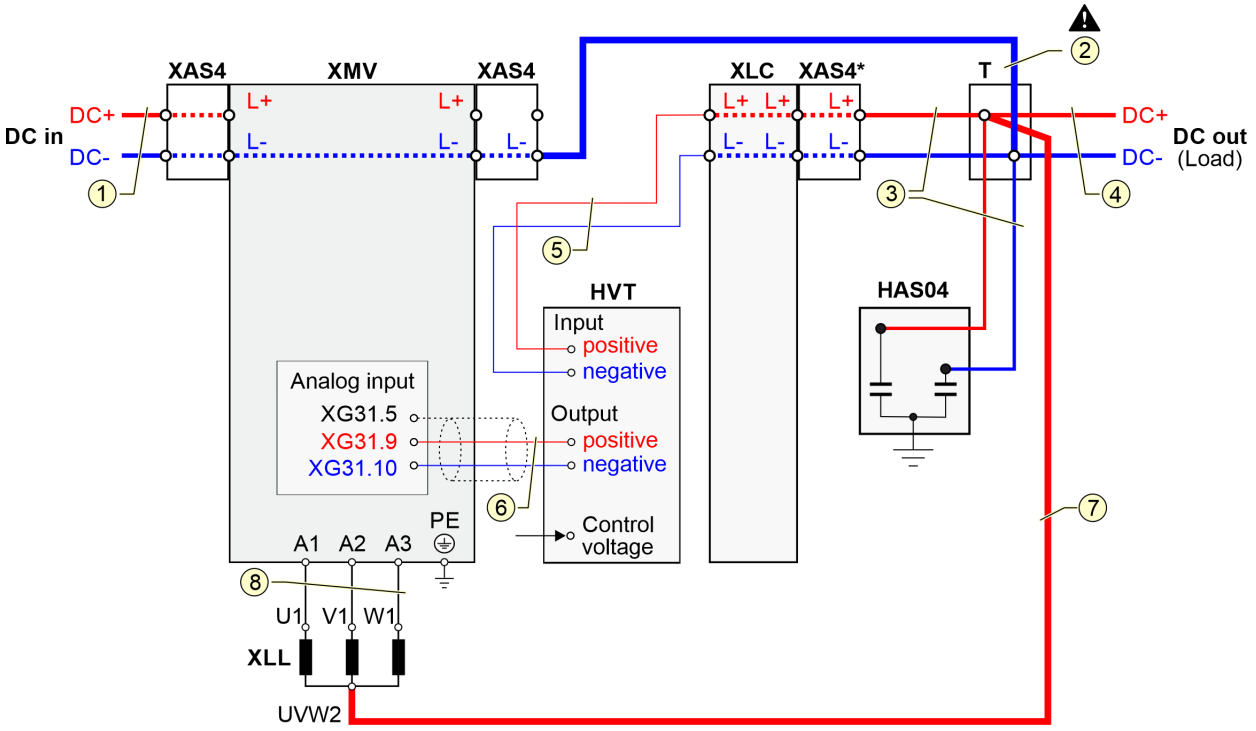


Fig. 3: XMV2-W0210

1	Twisted lines
⚠2	**2 × 50 mm²; star wiring at the output is mandatory:** output current must not flow via XLC (**risk of damage** due to low current carrying capacity of L+/L- connection points at XLC)
3	**6 mm²**; short and parallel lines
4	Shielded lines; connect shield at both ends (control cabinet, load)
5	Twisted lines
6	Shielded or twisted lines
7	**< 150 mm²**; shielded lines; connect shield at both ends (XMV, XLL)
8	**35 mm²**
DC in	DC bus voltage (usually the power supply)
DC out	DC output (load connection)
HAS04	DC bus ground capacitor pair; install as near as possible to the output; HAS04.1-003-NNN: Standard variant with discharging resistors. If an insulation monitor is used, use DC bus ground capacitor pairs HAS04.1-003-NN**1** without discharging resistors where applicable. In this case, install an additional separate discharging device.
HVT	High-voltage transducer; measuring transducer that converts the output DC voltage to a 0 ... 10 V measuring signal
T	Line terminal
XAS4	DC bus adapter XAS4-W0300-UNIVERSAL-005-NN
XAS4*	DC bus adapter XAS4-W0120-UNIVERSAL-005-NN; can also be mounted at the left of XLC
XLC	DC bus capacitor unit XLC1-W01M2-A-0750-NN
XLL	DC bus choke (smoothing choke) XLL1-1NG401M0G-0210NNNNN-NNNNNN
XMV	DC/DC converter XMV2-W0210

7 Data

Mechanical data XMV (such as dimensions):

See Project Planning Manual "ctrlX DRIVE Drive Systems" [R911386578 (German edition), R911386579 (English edition)]

7.1 Control voltage

Table 2: Control voltage supply data

Designation	Symbol	Unit	XMV2-W0050	XMV2-W0080	XMV2-W0210
Control voltage input	U_{N3}	V	24 ±20%		
Max. inrush current at 24 V supply	I_{EIN3_max}	A	4		
Pulse width of I_{EIN3}	$t_{EIN3Lade}$	ms	20		
Input capacitance	C_{N3}	mF	1.7		

Overvoltage

Overvoltage greater than 33 V has to be discharged by the appropriate electrical equipment of the machine or installation.

This includes:

- 24V power supply units that reduce incoming overvoltage to the allowed value.
- Overvoltage limiters at the control cabinet input that limit existing overvoltages to the allowed values. This, too, applies to long 24V lines that are run in parallel to power cables and mains cables and that can absorb overvoltages by inductive or capacitive coupling.

7.2 Input and output voltage range XMV2-W0050

Table 3: DC bus input

DC bus	Symbol	Unit	Value
Voltage range	U_{DC}	V	DC 250 ... 820
Rated voltage	U_{DC_nenn}	V	DC 750
RMS value against ground max.	$U_{DC\_Erde\_max}$	V	**Operation only allowed at balanced-to-ground DC bus**
Monitoring value of maximum voltage, switch-off threshold	$U_{DC\_limit\_max}$	V	DC 900
Monitoring value of minimum voltage, switch-off threshold	$U_{DC\_limit\_min}$	V	parmeterizable
Capacitance in DC bus	C_{DC}	mF	-
Capacitance in DC bus against ground	C_Y	nF	2 × 100

Table 4: DC voltage at output for compliance with controller performance

Voltage	Symbol	Unit	Value
Minimum voltage [1) 3)]	$U_{DC\_out\_min}$	V	DC 20 Restricted output voltage range (see ➦Table 5 Restricted output voltage range on page 24)
Maximum voltage [2) 3)]	$U_{DC\_out\_max}$	V	Input voltage - 20 V Restricted output voltage range (see ➦Table 5 Restricted output voltage range on page 24)

1) Output voltages of < 20 V are possible, but deteriorate the control accuracy and control time

2) A voltage difference of < 20 V between input voltage and output voltage is possible, but deteriorates the control accuracy and control time

3) Operating states outside of the allowed voltage range are temporarily possible for running up the system. Permanent operation, such as applying a DC bus voltage without drive enable, is not allowed

Table 5: Restricted output voltage range

DC bus voltage [V]	Minimum output voltage [V]	Maximum output voltage [V]
800	350	450
750	270	480
700	185	515
650	97	554
600	0	600

7.3 Input and output voltage range XMV2-W0080/-W0210

Table 6: DC bus input

DC bus	Symbol	Unit	Value
Voltage range	U_{DC}	V	DC 250 ... 820
Rated voltage	U_{DC_nenn}	V	DC 750
RMS value against ground max. [1)]	$U_{DC\_Erde\_max}$	V	DC 600
Monitoring value of maximum voltage, switch-off threshold	$U_{DC\_limit\_max}$	V	DC 900
Monitoring value of minimum voltage, switch-off threshold	$U_{DC\_limit\_min}$	V	parmeterizable
Capacitance in DC bus XMV2-W0080	C_{DC}	mF	-
Capacitance in DC bus XMV2-W0210	C_{DC}	mF	2.72
Capacitance in DC bus against ground	C_Y	nF	2 × 100

1) According to the connection point of the insulation monitor, the allowed voltage „RMS value against ground max.“ may lead to a **limitation of the range of control** (➥ Chapter 9 Application examples on page 37).

With the insulation monitor connected at the output, operation outside of the allowed range of control has to be reliably excluded, since otherwise safe separation to the protective extra-low voltage level is not given!

Until the output voltage has run up, insulation monitoring has to be carried out **symmetrically** at the DC bus!

Table 7: DC voltage at the output to comply with the control performance

Voltage	Symbol	Unit	Value
Minimum voltage [1)]	$U_{DC\_out\_min}$	V	DC 20
Maximum voltage [2)]	$U_{DC\_out\_max}$	V	Input voltage - 20 V

1) Output voltages of < 20 V are possible, but deteriorate the control accuracy and control time

2) A voltage difference of < 20 V between input voltage and output voltage is possible, but deteriorates the control accuracy and control time

7.4 Control accuracy and current ripples

The current ripples strongly depend on the design of the components used (output capacitances) and on the controller setting.

Depending on the design and controller setting, the actual values may deviate from the values specified below.

Table 8: Control accuracy and current ripples

Control accuracy	XMV	Unit	f = 8 kHz	f = 16 kHz
Control accuracy of current[1)]	W0050	%	0.66	1.68
	W0080	%	1.75	3.33
	W0210	%	0.52	1.67
Current ripple without additional output choke [2)]	W0050	A_{rms}	0.43	0.12
	W0080	A_{rms}	0.51	0.16
	W0210	A_{rms}	1.47	0.45

1) Example with the following properties:

- The control accuracy was determined at nominal device current
- DC bus XVR with 750 V
- XMV in current control
- Output capacitance XLC1-W01M2-A-0750-NN
- Capacitive load 290 mF
- XMV2-W0050 / XLL1-1NG402M0G-0050
- XMV2-W0080 / XLL1-1NG401M8G-0080
- XMV2-W0210 / XLL1-1WG401M0G-0210

2) Current ripple can be reduced with another choke between output capacitor and load

7.5 DC output

Table 9: DC output

DC/DC converter		Symbol	Unit	XMV2		
				W0050	W0080	W0210
Switching frequency	Switching frequency of the power output stage	f_s	kHz	8, 16		
DC bus	Rated input current (UL ratings)	I_{In_UL}	A	49	77	180
	Rated input voltage (output voltage is 20 V lower)	U_{DC_nenn}	V	750		
	Maximum output power at U_{DC_nenn}	P_{DC_nenn}	kW	36.8	57.8	135
Current 8 kHz	Continuous current	$I_{DC\_out\_cont\_8}$	A	50	80	210
	Corner voltage	$U_{DC\_power\_cont\_8}$	V	720 [1)]	707	630
	Max. output current at 730 V at DC output	$I_{DC\_out\_max\_8}$	A	49	78	181
	Total IGBT power dissipation in watt	$P_{DC\_diss\_cont\_8}$	W	258	406	1239
Current 16 kHz	Continuous current	I_{out_cont16}	A	37	54	102
	Corner voltage	$U_{DC\_power\_cont\_16}$	V	-	-	-
	Max. output current at 730 V at DC output	$I_{DC\_out\_max\_16}$	A	37	54	102
	Total IGBT power dissipation in watt	$P_{DC\_diss\_cont\_16}$	W	364	518	1260

1) With **XMV2-W0050**, only a restricted output voltage range is possible. In addition, the DC bus voltage has to be balanced to ground (no DC offset).

See ➦ Table 5 Restricted output voltage range on page 24.

7.6 Output power

In order not to overload the connection points at the DC bus input, the power has to be limited as the output voltage increases.

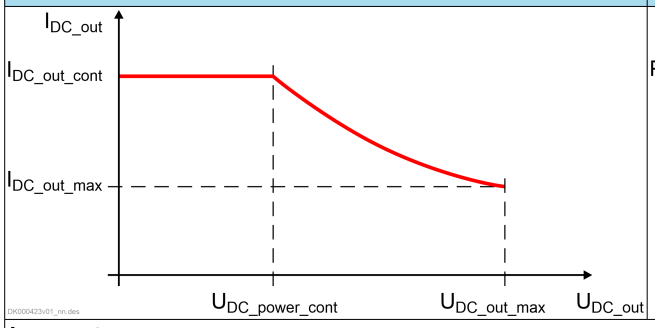
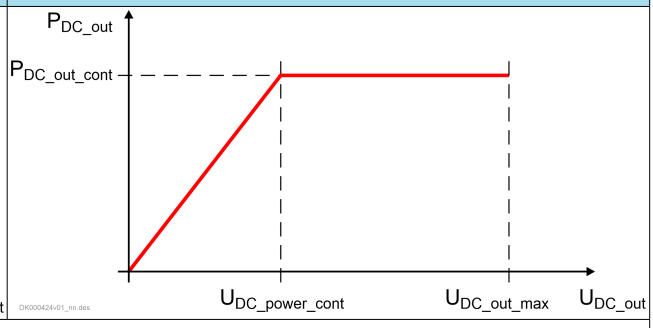
For this purpose, the output current has to be reduced at and above an output voltage "Corner voltage ($U_{DC\_power\_cont}$)".

The values can be calculated as follows:

Table 10: Calculations

Designation	Symbol	Formula 1)
Continuous output power	$P_{DC\_out\_cont}$	$I_{in\_UL} \times U_{DC} \times 0.98$
Maximum output voltage	$U_{DC\_out\_max}$	U_{DC} - 20 V (XMV2-W0050: See also ➦ Table 4 DC voltage at output for compliance with controller performance on page 24)
Maximum output current at maximum output voltage	$I_{DC\_out\_max}$	$(I_{in\_UL} \times U_{DC} \times 0.98) \div (U_{DC}$ - 20 V)
Corner voltage	$U_{DC\_power\_cont}$	$(I_{in\_UL} \times U_{DC} \times 0.98) \div (I_{DC\_out\_cont})$
Maximum allowed output current depending on output voltage	I_{DC_out}	$(I_{in\_UL} \times U_{DC} \times 0.98) \div (U_{DC\_out})$ $I_{DC\_out} > I_{DC\_out\_cont} \Rightarrow$ current limitation to $I_{DC\_out\_cont}$
Continuous output current	$I_{DC\_out\_cont}$	Current allowed up to corner voltage $U_{DC\_power\_cont}$
1) U_{DC} = DC bus input voltage I_{in_UL} = DC bus input current		

Table 11: Output current/output power vs. output voltage

Output current vs. output voltage	Output power vs. output voltage
	

I_{DC_out} Output current
$I_{DC\_out\_cont}$ Continuous output current
$I_{DC\_out\_max}$ Maximum output current at maximum output voltage
U_{DC_out} Output voltage
$U_{DC\_out\_max}$ Maximum output voltage
$U_{DC\_power\_cont}$ Corner voltage
P_{DC_out} Output power
$P_{DC\_out\_cont}$ Continuous output power

A measuring amplifier/transducer is required to limit the output power.

Parameters for limiting the output power:	
S-0-1741.0.187	Power limit positive
S-0-1741.0.188	Power limit negative

➥ Chapter 8.5 Power limitation on page 34

7.7 Smoothing choke XLL ↔ XMV

Table 12: XLL ↔ XMV

	XMV		
	W0050	W0080	W0210
XLL	XLL1-1NG402M0G-0050	XLL1-1NG401M8G-0080	XLL1-1NG401M0G-0210

8 Parameterization

8.1 Analog input

To operate the DC/DC converter in voltage control or to determine the output power, it is required to determine the output voltage via a measuring/isolation amplifier and connect it at the analog input X31.9/10.

The setting depends on the output voltage to be determined and on the ratio of the measuring/isolation amplifier.

Example: 0 ... 10 V at the analog input correspond to 0 ... 750 V at the output.

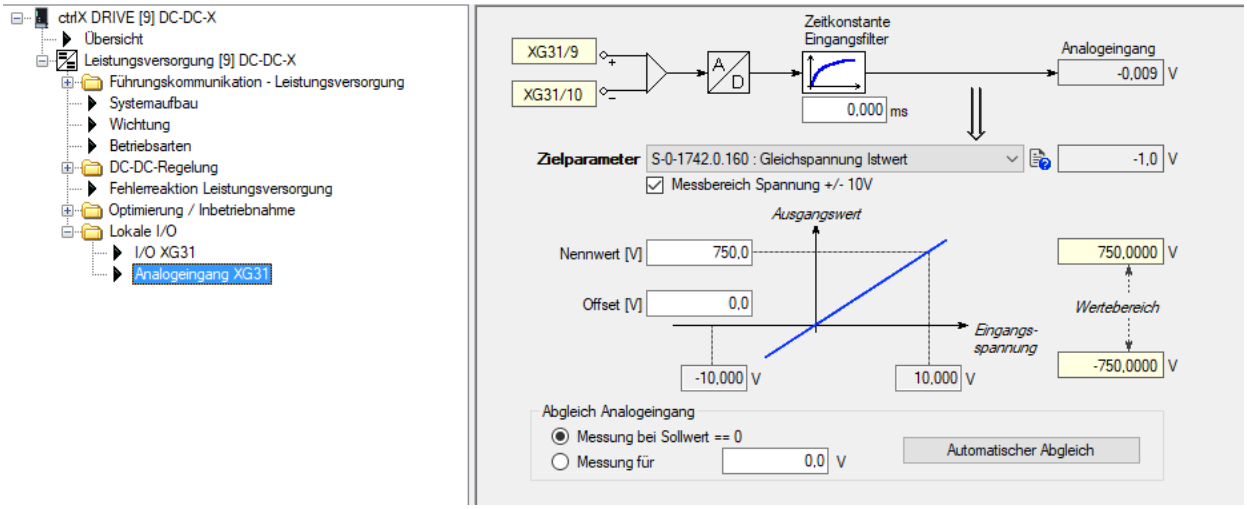


Fig. 4: Analog input

Table 13: Parameters involved

Parameter	Value (example)
P-0-2900.0.1 Analog input, control word	0b0000.0001.0010.0000 ±10V / controller clock
P-0-2900.0.2 Analog input, target parameter	S-0-1742.0.160
P-0-2900.0.3 Analog input, nominal value	750 V
P-0-2900.0.4 Analog input, offset	0.0 V
P-0-2900.0.5 Analog input, filter time	0.0 ms
P-0-2900.0.8 Analog input, lower limit of signal range	-10 V
P-0-2900.0.9 Analog input, upper limit of signal range	+10 V

8.2 Signaling readiness for power output to the DC/DC converter

S-0-0240 DC Bus Power Control

Bit 0 of S-0-0240 signals to the DC/DC converter that the supply unit (e.g., XVR) is ready for power output.

If the bit = 0, the DC/DC converter cannot be activated or switches off (with „F2826 Undervoltage“) when the bit becomes "0".

Therefore, the bit should be set or deleted via the control.

Alternatively, the readiness for power output may be signaled via a wiring of the I/Os.

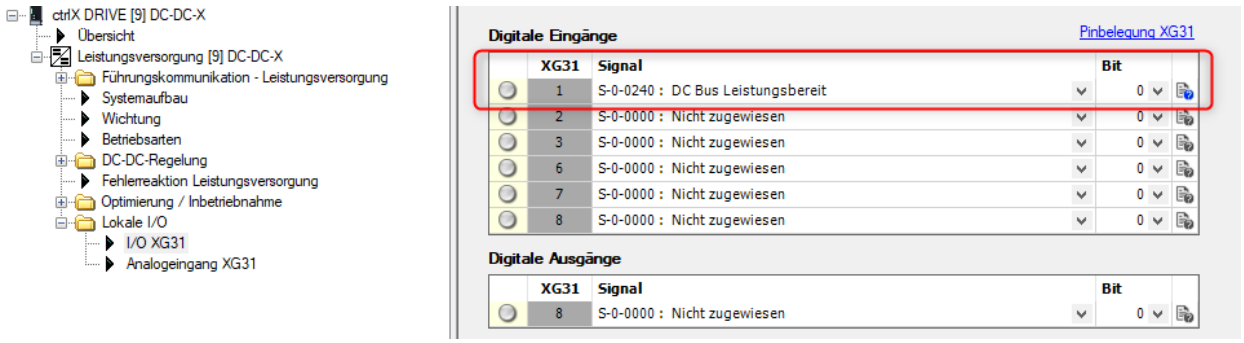


Fig. 5: Digital input

8.3 DC/DC converter control word

8.3.1 S-0-1741.0.150 DC/DC converter control word

This parameter specifies whether the DC voltage is built up before control is enabled.

DC output voltage built up prior to enabling	
Required	S-0-1741.0.150 = 0000.0000.0000.000**0**:
Not required	S-0-1741.0.150 = 0000.0000.0000.000**1**:

8.3.2 Building up the DC output voltage prior to enabling is required (soft start)

S-0-1741.0.150 = 0000.0000.0000.0000	
bb	S-0-1720.0.1 = 0x0000
Bb	S-0-1720.0.1 = 0x1000
Lb; voltage build-up („soft start“)	S-0-1720.0.1 = 0x5000 Similar to the voltage control mode. The command voltage is controlled with 1/10 of device peak current.
AF; enabling control (voltage or current)	S-0-1720.0.1 = 0xD000 → 0xD100 Dynamic switching between primary operation mode and secondary operation mode. Direct switching between voltage and current control, depending on the primary/secondary operation mode that was set.

8.3.3 Building up the DC output voltage prior to enabling is <u>not</u> required (no soft start)

S-0-1741.0.150 = 0000.0000.0000.000**1**

The command S-0-1720.0.1 = 0x5000 may be skipped

Advantages

- It is possible to go directly from „Bb“ to „AF“ . This is important if you want to go directly to current control (e.g., mere current source) without having to take the long way via voltage control.
- It is possible to switch between the operation modes with inactive output stage:
  S-0-1720.0.1 = 0x9000 → 0x1000 → 0x9100
  (= voltage control → output stages locked → current control)

Example: Activating the battery via a contactor and charging it

- S-0-1720.0.1 = 0x9000
  Provides the output voltage (charging capacitors with maximum current to battery level)
- S-0-1720.0.1 = 0x1000
  Switches off the output stages (output voltage remains stable and switches on the contactor)
- S-0-1720.0.1 = 0x9100
  Switches to current control

If the output stages are not switched off, but the device is switched directly to current control, this happens (according to switching point in time and switching duration):

- Voltage control still active when contactor already closed:

Small voltage differences between battery and capacitors already cause high currents; battery and DC/DC converter work against each other

- Current control already active when contactor not yet closed:
  Even with command value 0, a small current flows (ripple) that inevitably charges or discharges the capacitors. When the contactor is switched on, a voltage difference between capacitors and battery may cause high compensating currents.

However, it is also possible in this mode to switch directly between voltage and current control:

0x9000 ↔ 0x9100

8.4 Current limitation

Via the DC current limit values, the output current can be limited in its amplitude.

This is required if the external components (e.g., smoothing choke) cannot carry the full device current or the connected load requires this.

Table 14: Parameters involved

Parameter	Value (example)
S-0-1741.0.180 Bipolar DC current limit value	196.4%
S-0-1741.0.181 Positive DC current limit value	
S-0-1741.0.182 Negative DC current limit value	
S-0-1701.0.1 Nominal current of power supply	18 A

The following scaling applies:

"S-0-1701.0.1 Nominal current of power supply" corresponds to 100% / √2 = 70.7% of the single-phase current.

The current is limited per phase ⇒ output current = 3 × phase current

Example:

Nominal current of power supply = 18 A per phase ⇒ 18 A × 3 = 54 A

Limitation to ±50 A:

Bipolar DC current limit value = (50 A / 18 A) × 70.7% = 196.4%

8.5 Power limitation

To limit the energy withdrawn from the DC bus or regenerated to the DC bus, it is possible to set limit values.

If the product of output voltage and output current (actual values) exceeds the limits set here, the current is reduced accordingly.

Table 15: Parameters involved

Parameter	Value (example)
S-0-1741.0.187 Power limit positive	
S-0-1741.0.188 Power limit negative	
S-0-1742.0.163 Output power actual value	

The power limitation should not be used for power control, since the control loop has not been designed for this purpose. In the case of active power limitation, the voltage and current ripple may get bigger.

The power limitation only works with a correct voltage feedback.

The power limitation should be adjusted to the applied DC bus voltage.

8.6 Controller output limitation

To limit the output voltage in the case of an error (e.g., external voltage measurement fails), the range of control of the buck converter, and thus the maximum possible output voltage, can be limited.

For this purpose, the maximum output voltage can be entered in the parameter "**S-0-1741.0.186** DC current controller output limitation".

Depending on the direction of current, output current and switching frequency, a deviation of ±50 V is possible.

If the output current is positive, the deviation is negative. If the current is negative, the deviation is positive. In the case of controller output limitation, the output voltage is produced by limiting the PWM sampling ratio. This means that a steady PWM is reached in the case of limitation. Thus, controlling the direct current is impossible when a higher voltage is applied to the DC output.

In this case, the power section is switched off due to overload.

9 Application examples

9.1 DC/DC converter mode without XLI and XVR

9.1.1 DC/DC converter at IT mains with insulation monitor at voltage output

This operation mode is not allowed for XMV2-W0050.

An XMV2 device is operated at a supply unit connected to an IT mains.

Thus, the DC bus voltage L+ and L- first is isolated and due to the impedance of the Y-capacitors it is distributed symmetrically against ground (picture 1, ➦ Table on page 38). This voltage distribution corresponds to the distribution at a TT/TN mains.

If insulation monitors are used at the output (often integrated in batteries, for example) and switched against ground from $U_{out}+$ and $U_{out}-$ as shown below, these insulation monitors cause the entire DC bus voltage to be offset against ground due to their impedance.

L- then is offset against ground by **half the battery voltage ($-U_{Bat}/2$)**.

L+ then is offset to **U_{DC} - $U_{Bat}/2$** against ground which can cause the voltage against ground to be too high (picture 2, ➦ Table on page 38).

However, the voltage $U_{DC\_Erde\_max}$ (see ➦ Chapter 7.3 Input and output voltage range XMV2-W0080/-W0210 on page 25) must not be exceeded!

Reducing the DC bus voltage or limiting the minimum output voltage allows the voltage U_{DC_Erde} to be limited to valid values (picture 3, ➦ Table on page 38). The following applies: The smaller the output voltage, the greater the offset in the entire IT mains against ground.

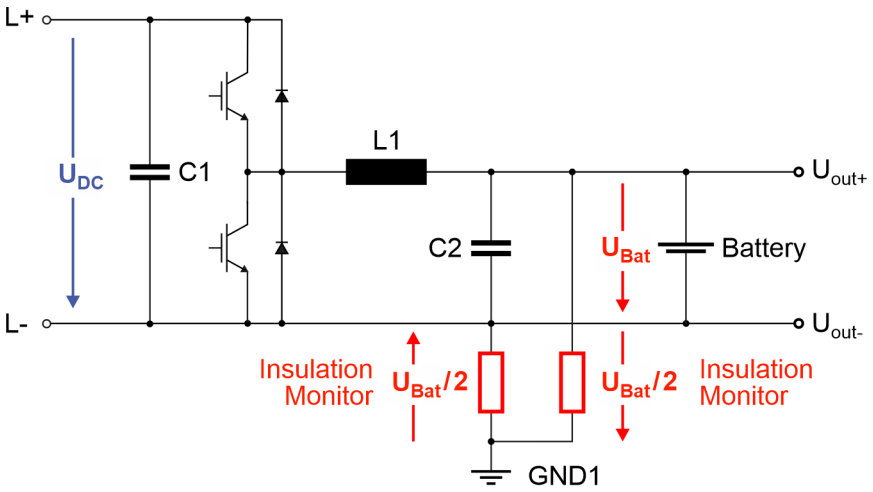
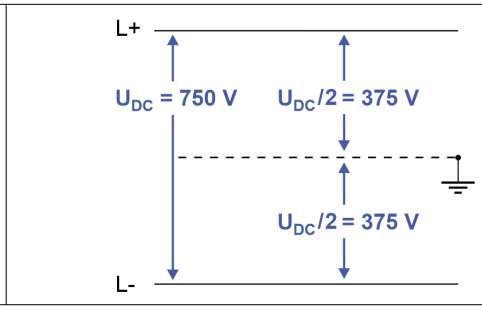
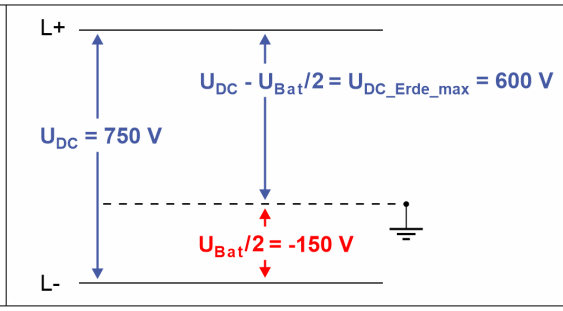
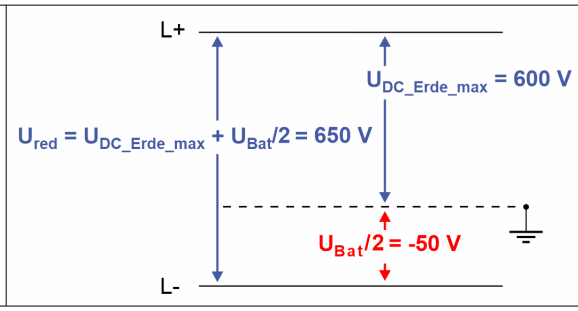


Fig. 6: Voltage offset in DC bus by insulation monitors

Picture 1		Voltage against ground with U_{DC} = 750 V without voltage offset by insulation monitors
Picture 2		Voltage against ground with U_{DC} = 750 V and U_{Bat} = 300 V with voltage offset by insulation monitors
Picture 3		Voltage against ground with U_{DC_red} = 650 V and U_{Bat} = 100 V with voltage offset by insulation monitors

The possible minimum output voltage is calculated according to the formula below:

$U_{Bat\_min} = 2 \times (U_{DC} - U_{DC\_Erde\_max})$

The reduced DC bus voltage with given U_{Bat_min} is calculated according to the formula below:

$U_{DC\_red} = U_{Bat\_min}/2 + U_{DC\_Erde\_max}$

With the insulation monitor connected at the output, operation outside of the allowed range of control has to be reliably excluded, since otherwise safe separation to the protective extra-low voltage level is not given! Until the output voltage has run up, insulation monitoring has to be carried out symmetrically at the DC bus!

9.1.2 DC/DC converter at IT mains with insulation monitor at DC voltage input

An XMV2 device is operated at a supply unit connected to an IT mains.

Thus, the DC bus voltage L+ and L- first is isolated and due to the impedance of the Y-capacitors it is distributed symmetrically against ground (picture 1, ➥ Table on page 39). This voltage distribution corresponds to the distribution at a TT/TN mains.

If insulation monitors are used symmetrically at the DC bus, the DC bus voltage is not offset against ground.

It is not required to limit the voltage range for the DC/DC converter.

The output voltage at U_{out-} then always has half the DC bus voltage against ground; this has to be taken into account for the connected load (picture 2, ➥ Table on page 39).

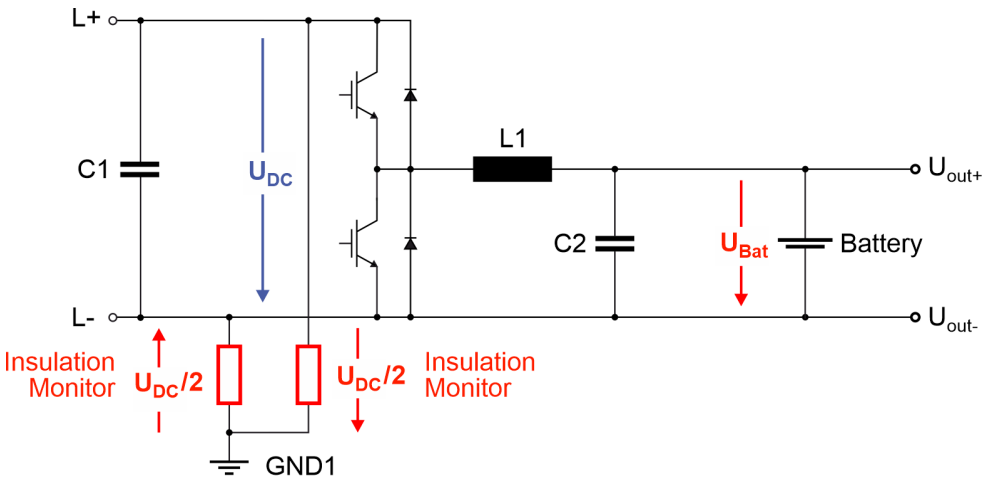
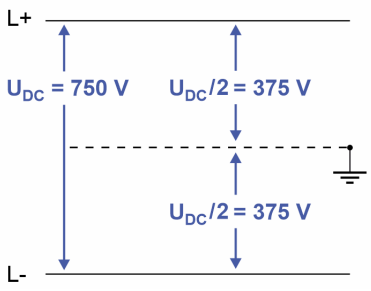
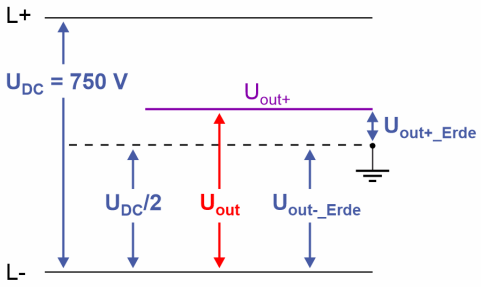


Fig. 7: Voltage offset at DC voltage input by insulation monitor

Picture 1		Voltage against ground, nominal
Picture 2		Output voltage offset by $U_{DC}/2$ against ground

9.1.3 DC/DC converter at IT mains with insulation monitor and one-sided connection

A one-sided connection of an insulation monitor with an impedance against ground, e.g. at L- or U_{out}-, has the effect that this output is drawn to ground potential.

Thus, all other voltages have their operating voltages against ground.

Here, a maximum input voltage of 600Vdc is possible, for example, independent of the output voltage.

Such a connection is not allowed.

9.2 DC/DC converter mode with XLI and XVR

9.2.1 DC/DC converter at IT mains with insulation monitor at voltage output

This operation mode is not allowed for XMV2-W0050.

If the DC/DC converter is supplied from XVR / XLI at an IT mains under the described conditions (Chapter 9.1.1 DC/DC converter at IT mains with insulation monitor at voltage output on page 37), it has to be taken into account that all connected components and the connected axes are offset by the absolute voltage value $U_{Bat}/2$ or $(U_{DC} - U_{Bat})/2$ against ground.

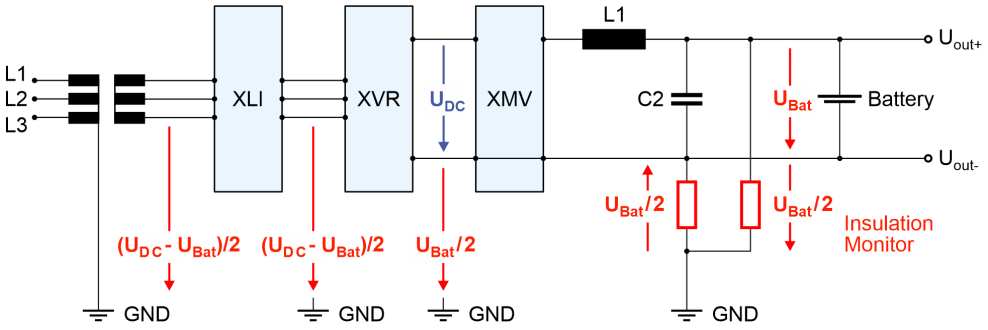


Fig. 8: DC/DC converter at IT mains; only the DC terms of the voltages have been marked

Thereby, more limitations by the components in the incoming circuit may occur.

The peak value $\hat{u}_{sec,earth}$ of the conductor ground voltage at the XLI input (secondary side of isolating transformer) must not exceed $\hat{u}_{sec,earth,max}$ = 962 V.

The peak value is calculated as follows:

$$\hat{u}_{sec,earth} = \frac{1}{2} k_{overshoot} U_{DC} + \sqrt{\frac{2}{3}} U_{sec} + \frac{1}{2}(U_{DC} - U_{Bat}) + \hat{u}_{IsoMon}$$

Fig. 9: Peak value of conductor ground voltage

$k_{overshoot}$	1.3 (overshooting factor)
U_{DC}	DC bus voltage
U_{sec}	Transformer secondary voltage (phase-phase, rms value)
U_{Bat}	Output voltage of DC/DC converter
$\hat{u}_{IsoMon}$	Test voltage of insulation monitor (peak value)

Thus, the greater the voltage difference between DC bus and DC/DC converter output, the higher the conductor ground voltage at the XLI input.

With mains voltage and DC bus voltage given, the resulting **minimum allowed output voltage** is:

$$U_{Bat\_min} = (1 + k_{overshoot}) U_{DC} - 2\hat{u}_{sec,earth,max} + 2\sqrt{\frac{2}{3}} U_{sec} + 2\hat{u}_{IsoMon}$$

Fig. 10: Minimum allowed output voltage

With the insulation monitor connected at the output, operation below the allowed range of control has to be reliably excluded, since otherwise safe separation to the protective extra-low voltage level is not given!

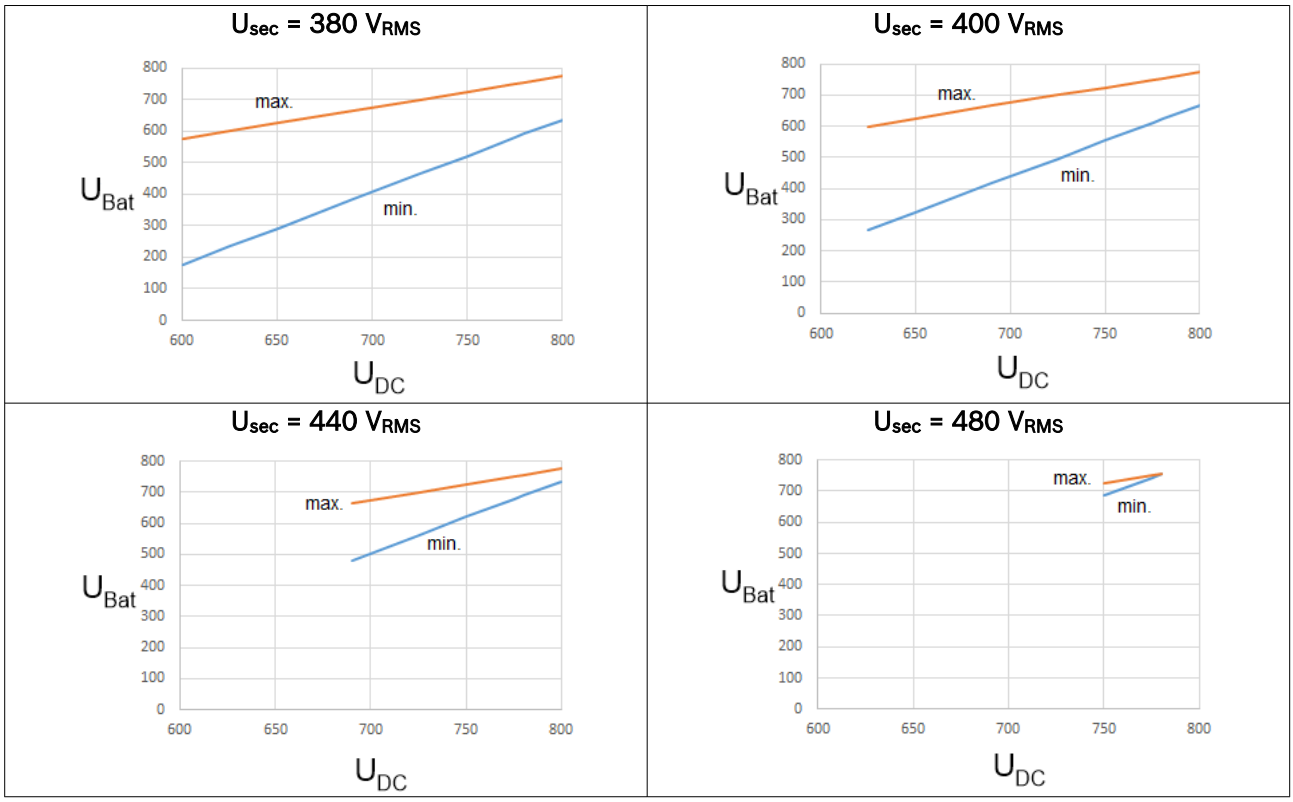
Until the output voltage has run up, insulation monitoring has to be carried out symmetrically at the DC bus or at the XLI input!

The upper output voltage U_{Bat} is limited to values smaller than the DC bus voltage U_{DC} (to allow control with regard to $U_{Bat} \leq U_{DC} - 20V$).

By reducing the DC bus voltage, the allowed range of control can be extended and moved to lower values. The selected transformer secondary voltage has to be accordingly low (examples: see table below). For a large range of control, the DC bus voltage can track the output voltage.

For project planning, observe that power derating occurs when mains voltage and/or DC bus voltage is reduced.

Table 16: Allowed range of control for output voltage U_{Bat} depending on the DC bus voltage U_{DC}; for the insulation monitor, a test voltage of $\hat{u}_{IsoMon}$ = 50 V_{peak} is assumed



When selecting and parameterizing the insulation monitor, the mains capacitors of XLI and their discharging resistors have to be taken into account.

Further operation is not allowed in the case of ground fault.

9.2.2 DC/DC converter at IT mains with insulation monitor at DC voltage input

As described (➦ Chapter 9.1.2 DC/DC converter at IT mains with insulation monitor at DC voltage input on page 39), the voltage is distributed symmetrically against ground in all components connected in the incoming circuit of the DC/DC converter.

At U_{out-}, the output voltage then always has half the DC bus voltage against ground; this has to be taken into account for the connected load.

10 Environmental protection and disposal

10.1 Environmental protection

Production processes

The products are manufactured using production processes that are energy efficient and raw material-optimized. These processes facilitate recycling of waste products. In regular intervals, we strive to replace polluted raw material, auxiliary material and process material with environmentally sustainable alternatives.

No release of hazardous substances

Our products do not contains any hazardous material which could be released during intended use. There are usually no negative effects on the environment.

Basic components

Our products contains the following components:

Electronic devices	Motors
· Steel	· Steel / stainless steel
· Aluminum	· Aluminum
· Copper	· Copper
· Plastics	· Brass
· Electronic components	· Magnetic materials
	· Electronic components

10.2 Disposal

Return

Products by Bosch Rexroth can be returned to us for disposal free of charge. However, this requires that the products are free from oil, grease or other dirt.

Furthermore, no inappropriate foreign material or components must be included in the return consignment.

Send the products to the following address, carriage free:

Bosch Rexroth AG

Electric Drives and Controls

Bürgermeister-Dr.-Nebel-Straße 2

97816 Lohr am Main, Germany

Packaging

Packaging materials consist of cardboard, plastics, wood and polystyrene. The materials can be easily recycled or disposed of.

Due to ecological reasons, try to avoid return consignments.

Batteries and accumulators

Batteries and accumulators can be identified with this symbol.

The crossed-out waste bin symbol refers to collecting batteries separately.

End users in the EU are legally bound to return used batteries and accumulators. Outside the scope of the EU Directive 2006/66/EC, the applicable regulations have to be complied with.

Batteries and accumulators may contain hazardous substances which can harm the environment or human health when stored or disposed of improperly.

The batteries or accumulators contained in products by Bosch Rexroth must be returned to the country-specific collection systems for proper disposal.

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 assemblies.

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

Plastic parts of the products may contain flame retardants. These plastic parts are labeled according to EN ISO 1043 and have to be recycled or disposed of separately according to the relevant prevailing statutory provisions.

11 Service and support

Our worldwide service network provides an optimized and efficient support. Our experts provide you with advice and assistance. You can contact us **24/7**.

Service Germany

Our technology-oriented Competence Center in Lohr, Germany, is responsible for all your service-related queries for electric drive and controls.

Contact the **Service Hotline** and **Service Helpdesk** under:

Phone:	**+49 9352 40 5060**
Fax:	**+49 9352 18 4941**
Email:	➦ service.svc@boschrexroth.de
Internet:	➦ http://www.boschrexroth.com

Additional information on service, repair (e.g. delivery addresses) and training can be found on our internet sites.

Service worldwide

Outside Germany, please contact your local service office first. For hotline numbers, refer to the sales office addresses on the internet.

Preparing information

To be able to help you more quickly and efficiently, please have the following information ready:

- Detailed description of malfunction and circumstances
- Type plate specifications of the affected products, in particular type codes and serial numbers
- Your contact data (phone and fax number as well as your e-mail address)

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