

Instruction handbook

Language **English**
Translation
Document No. 5.94035.10
Part No. 228950
Status 15-Apr-2020

be in motion **be in motion**



Servo-Power-Unit

BUS 621, 622, 623, 624

E	5.94035.10
----------	------------

Read the Instruction handbook before starting any work!

Copyright This Instruction handbook may be copied by the owner in any quantity, but only for internal use. This Instruction handbook may not be copied or reproduced, in whole or in part, for any other purposes.
The use and disclosure of information contained in this Instruction handbook are not permitted.
Designations and company marks contained in these Instruction handbook could be trademarks, the use of which by third parties for their own purposes could violate the rights of the rights holder.

Preliminary information

Warning Insofar as this document is identified as being preliminary information, the following applies:

This version is regarded as providing advance technical information to users of the described devices and their functions at an early enough time in order to adapt to any possible changes or expanded functionality.

This information must be regarded as being preliminary, as it has not yet passed through Baumüller's internal review process. In particular, this information is still subject to changes, thus no legal liability can be derived from this preliminary information. Baumüller assumes no liability for damages that might arise from this possibly faulty or incomplete version.

If you detect or suspect any content errors and/or major form errors in this preliminary information, we request that you notify the Baumüller support specialist responsible for you. Please provide us, via this employee, with your insights and comments so that we can take them into account and include them when transitioning from the preliminary information to the final information (as reviewed by Baumüller).

The conditions stipulated in the following section under „Obligatory“ are invalid in case of preliminary information.

Obligatory

This Instruction handbook are a part of the equipment/machine. This Instruction handbook must be available to the operator at all times and must be in legible condition. If the equipment/machine is sold or moved to another location, these Instruction handbook must be passed on by the owner together with the equipment/machine.

After any sale of the equipment/machine, this original and all copies must be handed over to the buyer. After disposal or any other end use, this original and all copies must be destroyed.

When the present Instruction handbook are handed over, corresponding sets of instruction handbooks of a previous version are automatically invalidated.

Please note that the specifications/data/information **are current values according to the printing date**. These statements are **not legally binding** with regard to measurements, computation or calculations.

Baumüller Nürnberg GmbH reserves the right, in developing its products further, to change the technical specifications and handling of its products concerned without prior notice.

No liability can be accepted concerning the correctness of these Instruction handbook unless otherwise specified in the General Conditions of Sale and Delivery.

© Baumüller Nürnberg GmbH

Ostendstr. 80 - 90
90482 Nuremberg
Germany

Tel. +49 9 11 54 32 - 0
Fax: +49 9 11 54 32 - 1 30

Email : mail@baumueller.com
Internet: www.baumueller.com



Table of Contents

1	General	7
1.1	Information on the instruction handbook	7
1.2	Key to symbols	8
1.3	Limitation of liability	9
1.4	Copyright protection	9
1.5	Other applicable documents	9
1.6	Spare parts	10
1.7	Disposal	10
1.8	Guarantee provisions	10
1.9	Customer service	10
1.10	Terms used	10
2	Safety	11
2.1	Contents of the instruction handbook	11
2.2	Changes and modifications to the device	11
2.3	Usage for the intended purpose	12
2.4	Risk assessment according EU Directive	13
2.5	Responsibility of the operating company	15
2.6	Protective devices	16
2.7	Training of the personnel	17
2.8	Personal protective equipment	18
2.9	Special hazards	19
2.10	Fire fighting	20
2.11	Safety equipment	21
2.12	Conduct in case of danger or accidents	21
2.13	Signs and labels	22
3	Technical Data	25
3.1	Dimensions	25
3.1.1	Dimensions	26
3.2	Weight	27
3.3	Operating requirements	27
3.3.1	Requirements to the energy supply / supply system	27
3.3.2	Motor requirements	28
3.3.3	Required environmental conditions	29
3.3.4	Coherence between rated current and peak current	30
3.3.5	Cooling	31
3.4	Electrical data	32
4	Design and Operation	35
4.1	Function description	35
4.2	Block circuit diagram	36
4.3	Interconnecting devices	37
4.4	Variants - Basic version / version with Safe Torque Off (STO)	37
4.5	Marking the device - Type code	37
4.6	UL notes	38
4.7	Display and operation elements	38



Table of Contents

5	Transport and Packaging	39
5.1	Safety notes for transport	39
5.2	What to observe when transporting	39
5.3	Transport inspection	40
5.4	Unpacking	40
5.5	Disposal of the packaging	40
6	Mounting	41
6.1	Safety notes	41
6.2	Preparing for mounting	43
6.3	Drilling templates/installation space	45
6.4	Assembly instructions	46
6.5	Attachment	46
7	Installation	47
7.1	Safety notes	47
7.2	Voltage test	49
7.3	Demands on the power supply	49
7.4	Requirements to the connecting cables	50
7.5	PE connection and RCD compatibility	50
7.6	Installation requirements with regard to EMC	51
7.7	Avoid bearing currents	52
7.8	Requirements for the motor temperature sensors	54
7.9	Installation procedure	55
7.10	Wiring diagram	56
7.10.1	Connection instructions	57
7.11	Pin assignment	58
7.11.1	Power connections	58
7.11.2	Control connectors	59
7.12	Accessories	60
8	Operation	61
8.1	Safety notes	61
8.2	Function diagram	62
8.3	Operation	63
8.4	Messages and warnings	63
9	Maintenance	67
9.1	Safety notes	67
9.2	Environmental condition	67
9.3	Inspection intervals - maintenance notes	68
9.4	Repairs	69
10	Shutdown, Storage	71
10.1	Safety instructions	71
10.2	Requirements to the executing personnel	72
10.3	Shutdown	72
10.4	Demounting	72
10.5	Storage conditions	73
10.6	Recommissioning	74
11	Disposal	75
11.1	Safety notes	75
11.2	Disposal facilities/authorities	77



Appendix A - Abbreviations	79
Appendix B - Safe Stop	81
B.1 Methods to avoid an unexpected starting	81
B.2 Safe Torque Off (STO)	84
B.2.1 Safety classifications and safety notes	84
B.2.2 Function principle STO	86
B.3 Safe stop	89
B.3.1 Safety categories according to EN ISO 13849-1	89
B.3.2 The safety relay	89
B.3.3 Application example for a machine of category 3 of EN ISO 13849-1	91
B.3.4 Application example for machine of category 4	93
Table of Figures	95
Index	97
Overview of Revisions	99



Table of Contents

1

GENERAL

1.1 Information on the instruction handbook

This instruction handbook provides important information on handling the device. A prerequisite for safe work is compliance with all specified safety notes and procedural instructions.

Additionally, the valid accident prevention regulations and general safety regulations applicable to the scope of application the device must be complied with.

Read the instruction handbook, particularly the safety notes chapter, completely before beginning any work on the device. The instruction handbook is part of the product and must be kept accessible to personnel at all times in the immediate vicinity of the device.

1.2 Key to symbols

Warning notes

Warning notes are identified by symbols in these instruction handbook. The notes are introduced by signal words that express the extent of the danger.

It is imperative that these notes be complied with and are conscientiously regarded in order to prevent accidents, personal injury and material damage.



DANGER!

...points out an immediately dangerous situation that will lead to severe injuries or death if not avoided.



WARNING!

...points out a potentially dangerous situation that could lead to severe injuries or death if not avoided.



CAUTION!

...points out a potentially dangerous situation that could lead to minor or slight injuries if not avoided.



NOTICE!

...points out a potentially dangerous situation that could lead to material damage if not avoided.

Recommendations



NOTE!

...highlights useful tips and recommendations, as well as information for efficient and problem-free use.

1.3 Limitation of liability

All specifications and notes in these instruction handbook were compiled taking into account the applicable standards and regulations, the state of the art and our knowledge and experience of many years.

The manufacturer assumes no liability for damages due to:

- noncompliance with the instruction handbook
- usage for other than the intended purpose
- usage by untrained personnel

The actual scope of delivery can vary in case of optional equipment, laying claim to additional order options, or on account of the latest technical changes to the explanations and representations described herein.

The user bears the responsibility for performing service and initial operation in accordance with the safety regulations of the applicable standards and all other relevant governmental or local regulations concerning the dimensioning and protection of conductors, grounding, disconnectors, overcurrent protection, etc.

The person who carried out the mounting or installation is liable for any damage incurred when assembling or connecting the device.

1.4 Copyright protection

The instruction handbook must be treated confidentially. It is to be used exclusively by personnel who work with the device. The consignment of the instruction handbook to third persons without the written permission of the manufacturer is prohibited.

**NOTE!**

The specific contents, text, drawings, images and other representations are copyrighted and subject to industrial property rights. Any prohibited usage is punishable by law.

**NOTE!**

Please note, that BAUMÜLLER is not responsible to examine whether any (industrial property) rights of third parties are infringed by the application-specific use of the BAUMÜLLER products/components or the execution.

1.5 Other applicable documents

Components of other manufacturers are integrated into the device. For these purchased parts, hazard assessments have been performed by the respective manufacturers. The compliance of the design construction with the applicable European and national regulations has been declared for the components by the respective manufacturers.

1.6 Spare parts



WARNING!

False or defective spare parts can lead to damage, malfunction or complete failure, thus endangering safety.

Therefore:

- Only use original spare parts of the manufacturer.

Procure spare parts through an authorized dealer or directly from the manufacturer.

Refer to [▶Accessories and Spare Parts◀](#) from page 273.

1.7 Disposal

Insofar as no take-back or disposal agreement has been made, please disassemble units correctly and properly recycle the constituent parts.

Refer to [▶Disposal◀](#) on page 75.

1.8 Guarantee provisions

The guarantee provisions are stated in a separate document of the sales documents.

The devices described herein may only be operated in accordance with the stipulated methods, procedures and conditions. Anything else not presented here, including the operation of devices in mounted positions, is not permitted and must be cleared with the plant on a case-by-case basis. If the devices are operated in any other manner than as described within these instruction handbook, then all guarantee and warranty rights are rendered null and void.

1.9 Customer service

Our customer service is available to provide you with technical information.

Info on the responsible contact persons is available at all times via telephone, fax, mail or the Internet.

1.10 Terms used

The term „device“ or the item designation „**BUS 621, 622, 623, 624**“ are also used in this documentation for this Baumüller product “Servo-Power-Unit“. A list of the abbreviations used can be found in [▶Appendix A - Abbreviations◀](#) from page 79.

2

SAFETY

This section provides an overview of all of the important safety aspects for optimum protection of personnel as well as for the safe and problem-free operation.

2.1 Contents of the instruction handbook

Each person who is tasked with performing work on or with the device must have read and understood the instruction handbook before working with the device. This also applies if the person who is involved with this kind of device or a similar one, or has been trained by the manufacturer.

2.2 Changes and modifications to the device

In order to prevent hazards and to ensure optimum performance, no changes, additions or modifications may be undertaken on the device that have not been explicitly approved by the manufacturer.

2.3 Usage for the intended purpose

The device is conceived and constructed exclusively for usage compliant with its intended purpose described in these instruction handbook.

The devices of the model series **BUS 621, 622, 633, 624** is a servo controller. Devices are also available in graduated design size and performance classes.

The devices **BUS 621, 622, 633, 624** are used exclusively as a converter for controlling a motor.

A device is considered as being used compliant with its intended purpose if all notes and information of these instruction handbook are adhered to.



WARNING!

Danger arising from usage for an unintended purpose!

Any usage that goes beyond the intended purpose and/or any non-compliant use of the device can lead to dangerous situations.

Therefore:

- Only use the device compliant with its intended purpose.
- Observe all specifications of these instruction handbook.
- Ensure that only qualified personnel work with/on this device.
- When configuring, ensure that the device is always operated within its specifications.
- Mount the device on a wall that can sufficiently bear the load.
- The device must always be operated within a control cabinet.
- Ensure that the power supply complies with the stipulated specifications.
- The device may only be operated in a technically flawless condition.
- Only operate the device in combination with components approved by Baumüller Nürnberg GmbH.
- The device has been developed in such a manner that it fulfills the requirements of the category C3 according to IEC 61800-3:2012.
- The device is not intended to be connected to the public power supply system. To operate the device in primary surroundings of the category C2/C1 (residential, business and commercial areas, directly on a public low-voltage power supply without an intermediate transformer), special measures to reduce the transient emissions (line-internal and radiated) must be provided for and certifiable by the system builder. Otherwise, EMC interference could occur without such additional measures.

2.4 Risk assessment according EU Directive

Earth current	<p>Check the quality of the earth connection:</p> <ul style="list-style-type: none">- before connecting the device to the power supply for the first time and- within the recommended service intervals <p>Requirements:</p> <ul style="list-style-type: none">• Cross section of the grounding cable according EN 61800-5-1• Note the required torque of connection!• Grounded mounting plate made of metal• Mains filter, device and shielding of the motor cable are on the same HF potential
Stored electric charge	<p>Do not touch electrically live parts before the discharge time of 15 min runs up, check zero-potential before touching.</p>
Electromagnetic fields	<p>The device causes electromagnetic fields when operating.</p> <p>Any person with individual device for cardiac assistance (pacemaker, defibrillator) must stay in sufficient distance to the operating device.</p>
Burn injuries	<p>Please note that the surface of the device can heat up considerably.</p> <ul style="list-style-type: none">• Wear safety gloves!
Radiated emission	<p>The high-frequency electromagnetic fields within the operation environment must not exceed the field strength of the second environment according EN 61800-3.</p>
Internal or external ignition source	<p>Internal or external ignition sources are not allowed within the environment of the devices!</p> <ul style="list-style-type: none">• Use ABC powder for extinguishing a fire!
Gas	<p>Toxic fumes can be released in case of failure.</p> <p>No flammable fume or dust and no flammable/explosive gases are permitted within the environment of the devices!</p> <p>In order to avoid damage to persons because of explosions:</p> <ul style="list-style-type: none">• ventilate the area and• immediate evacuation.
Transportation and mounting	<p>Falling down of the device can cause damage to persons.</p> <p>Note the weight of the device when selecting the mounting screws!</p> <p>Select the fastening torques of the mounting screws according the specification of the screw manufacturer!</p> <ul style="list-style-type: none">• Wear safety helmets/shoes!

2.4 Risk assessment according EU Directive

Mounting

Unprotected hands can be injured at the sharp edges of the device.

- Wear safety gloves!

Unprotected eyes can be injured by thrown up metal particles caused by drilling or making cut-outs.

- Wear safety glasses!

Short-circuit in power cables

In case of a short-circuit high current flows. This current induces a magnetic field in cable loops. The magnetic field can cause failures of the device.

To avoid additional damage in case of a short-circuit in power cables,

- The connection between power supply and device or between device and motor must be laid without loop.

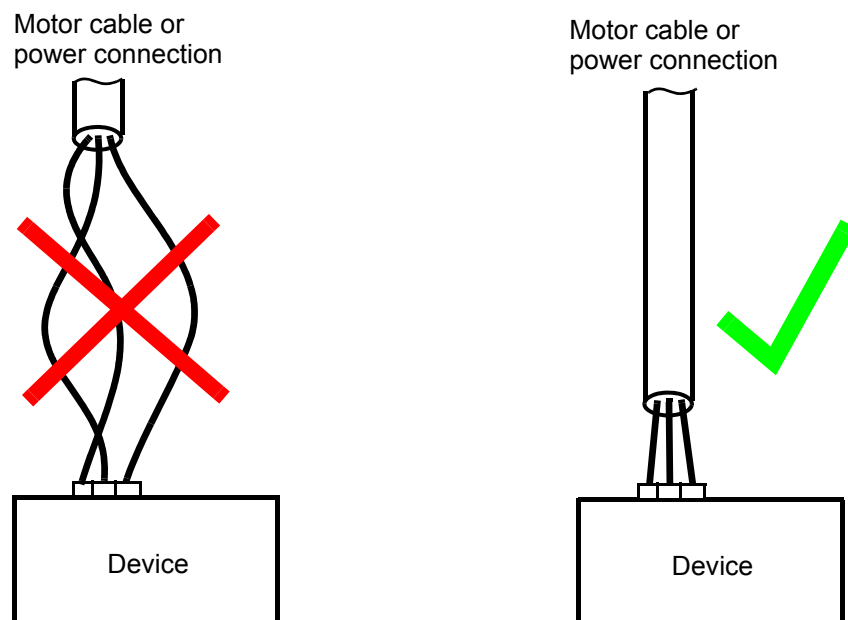


Figure 1: Wiring of the power cables

Installation

If a shielded cable is connected unshielded and this causes failure of the device/danger to persons, the system manufacturer is responsible for.

Brake resistor connection

The dissipation of the heat loss of the external brake resistor must be ensured.

Communication errors

Ensure that a failure of the device will cause no danger to persons.

The safety notes of all further chapters of this documentation need to be carefully observed!

2.5 Responsibility of the operating company

The device will be used in commercial areas. Thus, the proprietor of the device is subject to the legal work safety regulations.

Along with the notes on work safety in these instruction handbook, the safety, accident prevention and environmental protection regulations valid for the area of application of this device must be complied with. Whereby:

- The operating company must inform himself about the applicable work health and safety regulations and ascertain, in a hazard assessment, any additional hazards that could arise from the special working conditions in the use area of the device. These must then be implemented in the form of instruction handbook for operation of the device.
- These instruction handbook must be kept accessible to personnel working with the device at all times in the immediate vicinity of the device.
- The specifications of the instruction handbook must be adhered to completely and without exception.
- The device may only be operated in a technically faultless and operationally safe condition.

2.6 Protective devices

Protection class	
BUS 621, 622, 623, 624	IP 20

All devices **BUS 621, 622, 633, 624** must be installed in an appropriate control cabinet to meet the protection classification required in EN 61800-5-1, chapter 4.2.3.3.



DANGER!

Risk of fatal injury from electrical current!

There is an immediate risk of fatal injury if live electrical parts are contacted.

Therefore:

- The device must be in operated inside of a control cabinet that provides protection against direct contact of the devices and at least meets the requirements of EN 61800-5-1, Chapter 4.2.3.3.
- Fault protection according EN 60204-1:2018, section 6.3 is fulfilled by measures of preventing touch voltages.

2.7 Training of the personnel

**WARNING!****Risk of injury due to insufficient qualifications!**

Improper handling can lead to significant personal injury and material damage.

Therefore:

- Certain activities can only be performed by the persons stated in the respective chapters of these instruction handbook.

In these instruction handbook, the following qualifications are stipulated for various areas of activity:

- **Operating personnel**

- The drive system may only be operated by persons who have been specially trained, familiarized and authorized.
- Troubleshooting, maintenance, cleaning, maintenance and replacement may only be performed by trained or familiarized personnel. These persons must be familiar with the instruction handbook and act accordingly.
- Initial operation and familiarization may only be performed by qualified personnel.

- **Qualified personnel**

- Electrical engineers authorized by Baumüller Nürnberg GmbH, and qualified electricians of the customer or a third party who have learned to install and maintain Baumüller drive systems and are authorized to ground and identify electrical power circuits and devices in accordance with the safety engineering standards of the company.
- Qualified personnel have had occupational training or instruction in accordance with the respective locally applicable safety engineering standards for the upkeep and use of appropriate safety equipment.

2.8 Personal protective equipment

The wearing of personal protective equipment is required when working in order to minimize health and safety risks.

- The protective equipment necessary for each respective type of work shall always be worn during work.
- The personal safety signs present in each working area must be observed.



Protective work clothing

should be snug-fitting work clothes, with low tearing resistance, narrow sleeves and with no extending parts. It serves to primarily protect against...

No rings or chains should be worn.



Hard hat

to protect against falling down and flying around objects.



Safety shoes

to protect against heavy objects falling down.



Protective gloves

to protect hands against friction, abrasion, puncturing or more severe injuries, as well as contact with hot objects.

Wear for special work.



Protective eye wear

to protect the eyes against flying around objects and sprayed liquids.

2.9 Special hazards

In the following section, the remaining marginal risks will be stated that have been identified as a result of the hazard analysis.

Observe the safety notes listed here and the warning notes in the further chapters of this Instruction handbook to reduce health risks and dangerous situations.

Electrical current



DANGER!

Risk of fatal injury from electrical current!

There is an immediate risk of fatal injury if live electrical parts are contacted. Damage to the insulation or individual components can be life-threatening.

Therefore:

- Switch off the electrical power immediately in case of damage to the power supply insulation.
- Only allow work on the electrical system to be performed by qualified personnel.
- Switch off the current when any kind of work is being performed on the electrical system and ensure safety before switching on again.

Danger from residual energy



DANGER!

Risk of fatal injury from electrical current!

Stored electric charge.

Discharge time of the rack system = discharge time of the device with the longest DC link discharge time in the rack system.

Refer to [▶Electrical data◀](#) from page 32.

Therefore:

- Do not touch electrically live parts before taking into account the discharge time of the capacitors.
- Pay attention to the corresponding notes on the device.
- If additional capacitors are connected to the DC link, the DC link discharge can take a much longer time. In this case, the necessary waiting period must itself be determined or a measurement made as to whether the equipment is de-energized. This discharge time must be posted, together with an IEC 60417-5036 (2002-10) warning symbol, on a clearly visible location of the control cabinet.

2.10 Fire fighting

Moving components



WARNING!

Risk of injury from moving components!

Rotating components and/or components moving linearly can result in severe injury.

Therefore:

- Do not touch moving components during operation.
- Do not open any covering during operation.
- The amount of residual mechanical energy depends on the application. Powered components still turn/move for a certain length of time even after the power supply has been switched off. Ensure that adequate safety measures are taken.

2.10 Fire fighting



DANGER!

Risk of fatal injury from electrical current!

There is a risk of electric shock if an electrically-conductive, fire-extinguishing agent is used.

Therefore:

- Use the following fire-extinguishing agent:



ABC powder / CO₂

2.11 Safety equipment

**WARNING!****Risk of fatal injury due to non-functional safety equipment!**

Safety equipment provides for the highest level of safety in a facility. Even if safety equipment makes work processes more awkward, under no circumstances may they be circumvented. Safety can only be ensured by intact safety equipment.

Therefore:

- Before starting to work, check whether the safety equipment is in good working order and properly installed.

2.12 Conduct in case of danger or accidents

Preventive measures

- Always be prepared for accidents or fire!
- Keep first-aid equipment (e.g. first-aid kits, blankets, etc.) and fire extinguishers readily accessible.
- Familiarize personnel with accident alarm, first aid and rescue equipment.

And if something does happen: respond properly.

- Stop operation of the device immediately with an EMERGENCY Stop.
- Initiate first aid measures.
- Evacuate persons from the danger zone.
- Notify the responsible persons at the scene of operations.
- Alarm medical personnel and/or the fire department.
- Keep access routes clear for rescue vehicles.

2.13 Signs and labels

The following symbols and information signs are located in the working area. They refer to the immediate vicinity in which they are affixed.



WARNING!

Risk of injury due to unreadable symbols!

Over the course of time, stickers and symbols on the device can become dirty or otherwise unrecognizable.

Therefore:

- Maintain all safety, warning and operating labels on the device in easily readable condition.



Electrical voltage

Only qualified personnel may work in work areas that identified with this.

Unauthorized persons may not touch working materials marked correspondingly.



DANGER!

Risk of fatal injury from electrical current!

Stored electric charge.

Discharge time of the rack system = discharge time of the device with the longest DC link discharge time in the rack system.

Refer to [▶Electrical data◀](#) from page 32.

Therefore:

- Do not touch before taking into account the discharge time of the capacitors and electrically live parts.
- Heed corresponding notes on the equipment.
- If additional capacitors are connected to the DC link, the DC link discharge can take a much longer time. In this case, the necessary waiting period must itself be determined or a measurement made as to whether the equipment is de-energized. This discharge time must be posted, together with an IEC 60417-5036 (2002-10) warning symbol, on a clearly visible location of the control cabinet.



CAUTION!

Risk of injury due to hot surface!

Therefore:

- Wear protective gloves



NOTE!

When in operation, the top of the device can heat up to temperatures > 70 °C!

**Signs and labels
devices with
safety level**



NOTE!

Only a device marked with the TÜV Rheinland certification label and the safety label fulfills a certified safety function within the meaning of PL classification according ISO 13849 or SIL according EN 61800.



new logo



former logo

TECHNICAL DATA

3.1 Dimensions

The following dimension drawings show the main dimensions of the devices. By means of the dimension drawings the space requirements within the control cabinet are determined. The dimension drawings in [▶Drilling templates/installation space◀](#) from page 45 must be used in order to do the required drilling / segments.

**NOTE!**

All dimensions in mm.

3.1 Dimensions

3.1.1 Dimensions

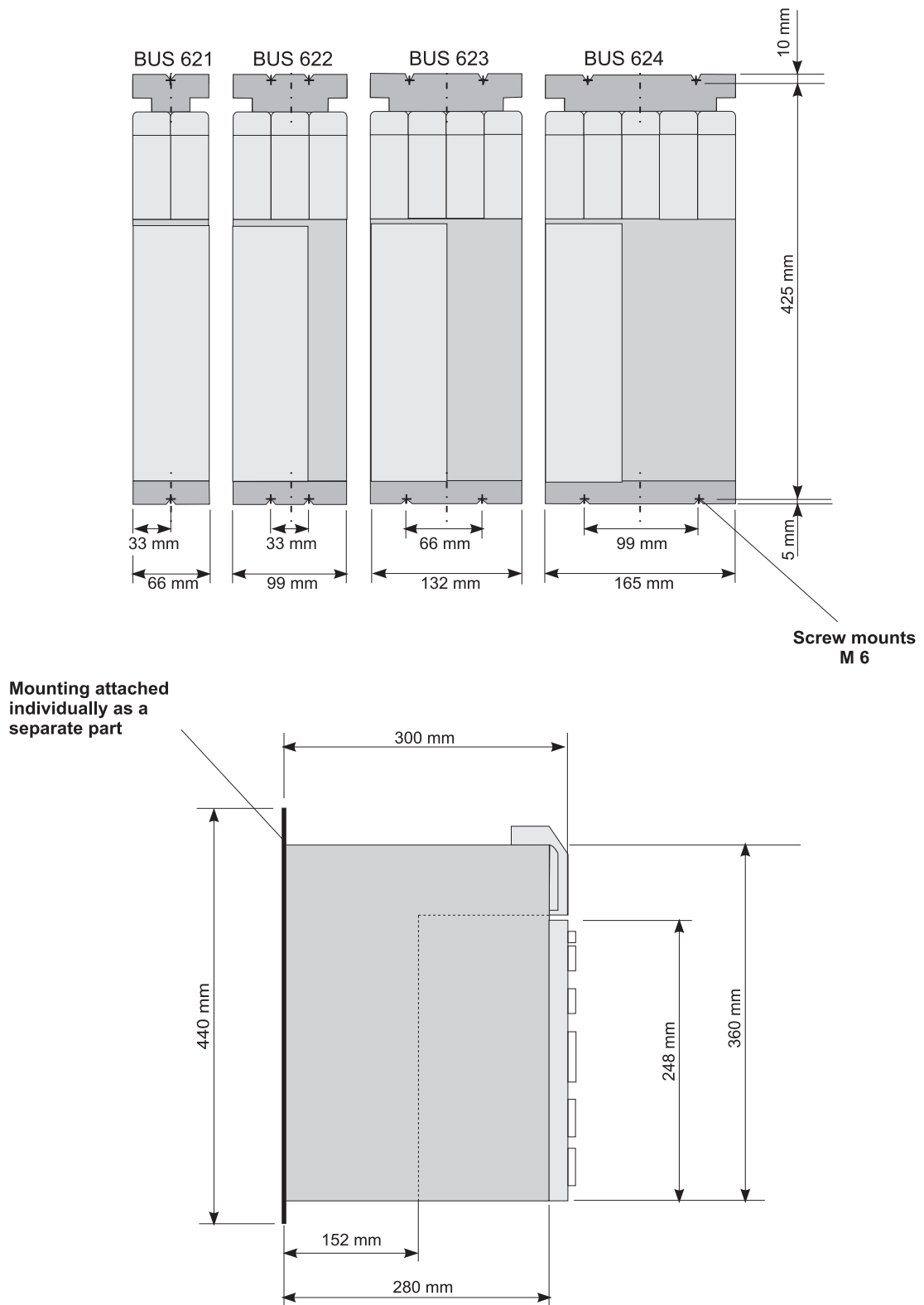


Figure 2: Dimensions

3.2 Weight

Device	Dimensions (W x H x D)	Weight, without controller modules
BUS 621	66 x 360 x 280 mm	5 kg
BUS 622	99 x 360 x 280 mm	7.5 kg
BUS 623	132 x 360 x 280 mm	10 kg
BUS 624	165 x 360 x 280 mm	12.5 kg

3.3 Operating requirements

3.3.1 Requirements to the energy supply / supply system



NOTE!

A proper operation of the performance modules **BUS 621, 622, 633, 624** can only be guaranteed on Baumüller frequency changers or network frequency changers.

See the operating instructions for basic unit BUG / BUC.

Control voltage ¹⁾ (U _{DC})	+ 24 V -15% / +20% ²⁾
--	----------------------------------

¹⁾ The control voltage must correspond with PELV (EN61800-5-1, Chapter 3.2.14) and SELV (EN61800-5-1, Chapter 3.2.28).
The fan performance is reduced at a control voltage of < 24 V. It may therefore be necessary to reduce the output currents as well.
If you include UL508C: limit the current to 4 A (UL-listed) and to a max. voltage of 30 V_{DC}.

²⁾ according to EN61131-2, Table 7.

3.3 Operating requirements

3.3.2 Motor requirements

Devices **BUS 621, 622, 633, 624** are designed to operate three-phase current motors with a terminal motor voltage of 3 x 350 V (typical for servo motors of Baumüller). Devices **BUS 621, 622, 633, 624** are designed to operate 3 x 400 V (standard asynchronous motors and customer-specific motors of Baumüller). The motors must be operated wye-connected. The rated DC link voltage is 540 V_{DC}. The DC link voltage may rise up to 780 V to 800 V in braking operation. The connected motor must be designed for these DC link voltages.

The DC link voltage remains between 640 V and 760 V continuously (not only in the braking operation), if the **BUS 621, 622, 633, 624** power modules are operated at a voltage-controlled DC link. The connected motor must be able to operate at these voltages continuously.

The device can be used at lower voltages, also (e.g. 3 x 230 V). However, here, the three-phase current motors must be designed for the operation with power inverters with up to 800 V DC link voltage, because the brake resistor threshold remains (refer to [►Electrical data◄](#) from page 32). For these reasons three-phase motors with $U_{DC, rated} \geq 540$ V must be used, only.

3.3.3 Required environmental conditions

Transport temperature range	- 25 °C to + 70 °C
Transport climatic category EN 60721-3-2	2 K 3
Storage temperature range	- 25 °C to + 55 °C
Storage climatic class EN 60721-3-1	1 K 4
Operation environment	Industrial system ¹⁾ Category C2 according EN61800-3 for operation in Second Environment
Operation temperature range	Min. 5 °C to max. 55 °C (with derating above 40 °C) ²⁾
Operation climatic class EN 60721-3-3	3 K 3
Installation altitude	up to 2000 m (with derating above 1000 m) ²⁾
Humidity (operation) EN 60721-3-3	Relative humidity: 5 % to 95 % no condensation and absolute humidity: 1 g/m ³ to 29 g/m ³
Ionizing and non-ionizing radiation	Lower than measurable range
Vibration, shock and repetitive shock EN 61800-5-1, section 5.2.6.4 Vibration test	Max. 1 g during operation
Degree of pollution EN 61800-5-1, table 6, Tab. 2	2

¹⁾ For the operation in an environment of category C2 according to IEC 61800-3:2012, additional measures may be required. The manufacturer of the installation / user must provide the following evidence in this case: The additional measures are effective. The specified limit values of category C2, which are described in IEC 61800-3, are complied with.

²⁾ Refer to Technical Data Basic Unit.



NOTICE!

Normally, non-conductive pollution occurs. Conductive pollution is unacceptable. Conductive pollution can lead to the destruction of the device. The customer is responsible for destructions, which were caused by pollution due to conductive materials or components.

3.3.4 Coherence between rated current and peak current

- Calculation of the thermal RMS current from the dimensioning cycle

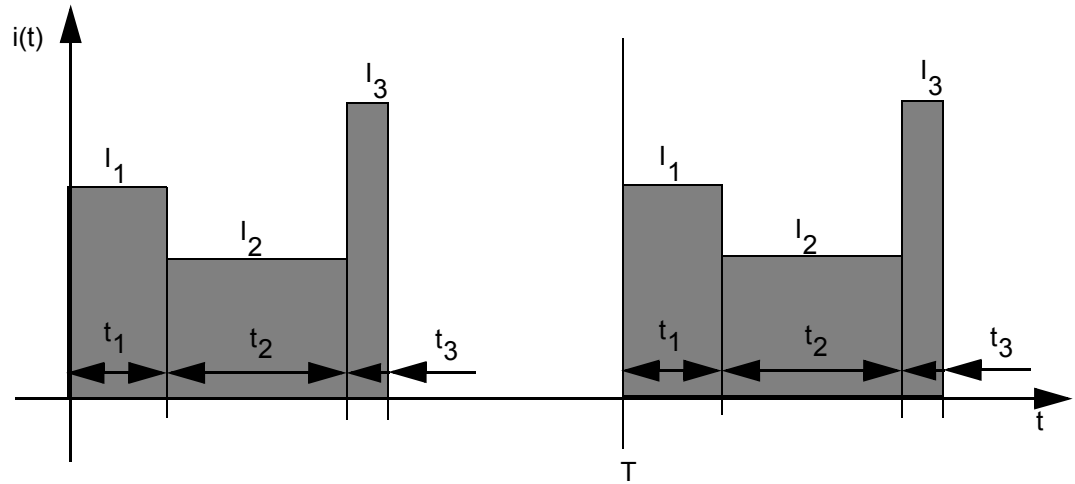


Figure 3: Calculation of the thermal RMS current

$$I_{\text{eff}} = \sqrt{\sum_{n=1}^k I_n^2 \cdot \frac{t_n}{T}} = \sqrt{I_1^2 \cdot \frac{t_1}{T} + I_2^2 \cdot \frac{t_2}{T} + I_3^2 \cdot \frac{t_3}{T}}$$

- Coherence between peak current and rated current for the dimensioning of a motion cycle

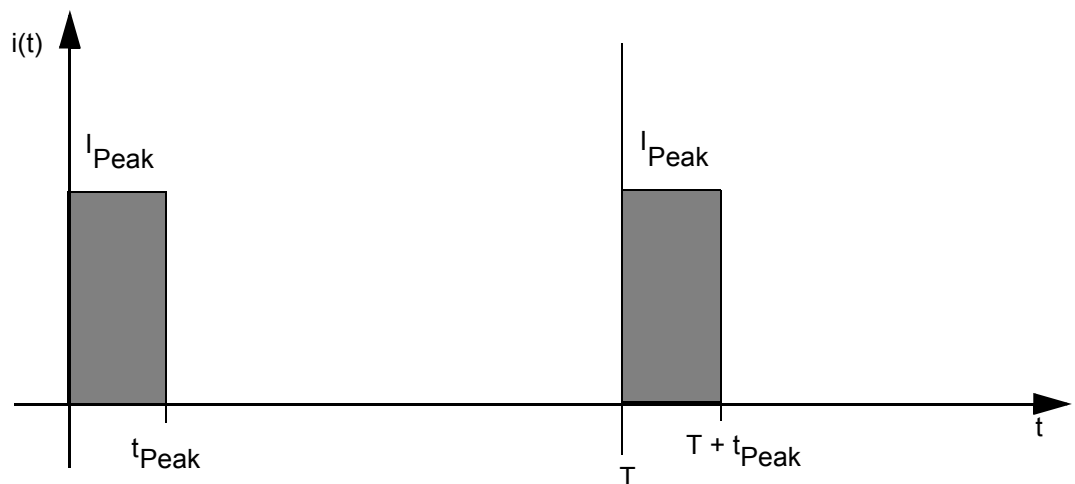


Figure 4: Coherence between peak current and rated current

$$\frac{t_{\text{Peak}}}{T} = \left(\frac{I_{\text{Rated}}}{I_{\text{Peak}}} \right)^2$$

- Coherence between peak current of drive and the braking peak current

Assumptions: $P_{\text{Shaft, Acceleration}} = P_{\text{Shaft, Braking}}$, $\cos \varphi_{\text{ Acceleration}} = \cos \varphi_{\text{ Braking}}$

$$\frac{I_{\text{max,Phase,Acceleration}}}{I_{\text{max,Phase,Braking}}} = \frac{U_{\text{DC link, Braking}}}{U_{\text{DC link, Acceleration}}} \left(\frac{1}{\eta_{\text{Motor}}} \right)^2$$

Typical values:

$$U_{\text{DC link, Braking}} = 780 \text{ V}$$

$$U_{\text{DC link, Acceleration}} = 540 \text{ V}$$

$$\eta_{\text{ Motor}} = 0.9$$

Typically resulting in:

$$I_{\text{max,Phase,Braking}} = 0.56 \cdot I_{\text{max,Phase,Acceleration}}$$

3.3.5 Cooling

Cooling air temperature ¹⁾ (rated temperature: 40 °C)	Min. 0 °C to max. 55 °C,
Cooling air requirement	Refer to >Electrical data< from page 32

¹⁾ Air temperature in the entire suction area of the device.

3.4 Electrical data

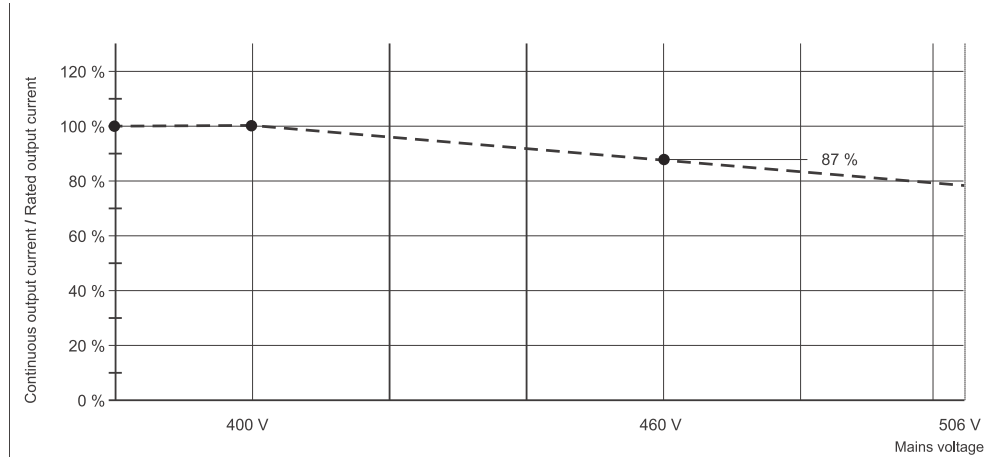
3.4 Electrical data

Power unit	BUS 621		BUS 622	BUS 623	BUS 624		
Control *	Slot for BUS 6 controller cassette						
DC link voltage nominal value maximum (< 2 min)	0 ... 685 V _{DC} 540 V _{DC} 760 V _{DC}						
Low voltage supply for controller and ¹⁾ moitoring functions	+ 24 V _{DC} - 10% + 20%						
Power input without controller	22 W		22 W	27 W	39 W		
Capacitor DC Link	50 µF		110 µF	235 µF	500 µF		
Switch on: Ready for use after ²⁾	≤ 10 s						
Output voltage ³⁾	3 x 0 V _{AC} ... connection voltage BUG - 30 V resp. 3 x 0,74 • DC link voltage						
Output frequency	0 Hz ... 300 Hz						
Output power ⁴⁾	1,4 kVA	3,5 kVA	7 kVA	10,5 kVA	14 kVA	26 kVA	31 kVA
Typ. motor power ⁴⁾	0,8 kW	2 kW	4 kW	6 kW	8 kW	15 kW	20 kW
Typ. motor max. power ⁵⁾	1,2 kW	3 kW	6 kW	9 kW	12 kW	23 kW	30 kW
Output nominal current (I _{eff}) ^{4) 6)}	2 A	5 A	10 A	15 A	20 A	38 A	45 A
Output max. current (I _{eff}) ^{6) 7)}	3 A	7,5 A	15 A	22 A	30 A	55 A	67 A
permitted transistor clock frequency	3 ... 8 kHz						
Power loss during rated operation ⁴⁾ without low voltage supply	30 W	75 W	150 W	170 W	230 W	450 W	550 W
safety relay (as an option) coil side nominal voltage operating voltage coil resistance contact side max. switching voltage max. switching current max. switching capacity	24 V (SELV) 18,4 V to 50,4 V at T _u = 20 °C 1300 Ω ±10 % 25 V _{AC} resp. 60 V _{DC} (SELV) 5 A (max. permanent current 6 A) 1500 VA _{AC} / 30 W _{DC}						
type of protection	IP 20						
Operational environment range T _B	0 ... 40 °C (with power reduction 55 °C)						
Reduction for nominal output current (45 ... 55 °C)	0 % / °C			3 % / °C			
Installation hight ⁸⁾	1000 m above sea level						
Relative humidity	15 % ... 85 % no condensation						
Storage temperature range	- 30 °C ... + 70 °C						
Short circuit proof	partly short circuit proof						
Dimensions Width	66 mm		99 mm	132 mm	165 mm		
Height	360 mm						
Depth	280 mm						
Weight without controller	5 kg		7,5 kg	10 kg	12,5 kg		

* not supplied, must be ordered separately

1 According to EN 61131-2 (Table 5). With a supply voltage < 24 V the fan power is reduced. Therefore, it may be necessary to reduce the output current additionally.

- 2 Depends on the connected DC Link capacity.
- 3 The output voltage is a pulse-commutated DC. The setting range refers to the r.m.s. value of the fundamental wave.
- 4 At DC Link voltage 540 V_{DC}
- 5 For max. 1 s
- 6 The unit provides the rated/maximum output current up to the connection voltage. When the input voltage exceeds the rated voltage, reduce the output currents at constant output power proportionally.



Characteristic 1: Output currents in relation to the connection voltage

- 7 Maximum duration of the peak output current is 1 s. The duration depends on the motor current and the temperature of the heat sink. See Technical Description/Operating Instructions of the controller (V-controller: P139).
- 8 Characteristic curve for output reduction depending on installation height see technical data of supply unit

DESIGN AND OPERATION



NOTE

A proper operation of the performance modules **BUS 621, 622, 633, 624** can only be guaranteed on Baumüller frequency changers or network frequency changers.

4.1 Function description

The devices are servo inverters by Baumüller Nürnberg GmbH. The devices consist of a power module with an integrated slot for the controller.

Power unit

The power unit has been constructed as a 3-phase bridge using IGBT technology, and converts control signals from the controller cassette into voltage pulses to supply Baumüller 3-phase motors (asynchronous and synchronous).

Monitoring

The power unit is self-protecting and has monitoring functions for the DC link voltage, earth connection current and motor current.

Safety relay (as an option)

Some applications demand that it must be possible to stop a drive electronically without the need for contactors in the motor cables and without switching of the DC link voltage to achieve an immediate production restart.

The actuator in this function is switched torqueless.

The function is structured as a dual channel for fulfilling safety requirements according to DIN EN ISO 13849- 1, EN 62061 and EN 61800-5-2 and therefore has two separate cutoff methods, which are used to cut off the commutation in the power part.

4.2 Block circuit diagram

The first cutoff method is realized by a force operated relay, a safety relay, the force operated contacts of which interrupt the auxiliary voltage supply of the actuators and therefore prevent the power transistors from starting.

The second cutoff method, the pulse enable / pulse lock is performed via the controller (V-controller or M-drive) and also blocks the new pulses for the power transistors. Detailed information can be found in [▶Appendix C - Safety Technology◀](#) ab Seite 81.

4.2 Block circuit diagram

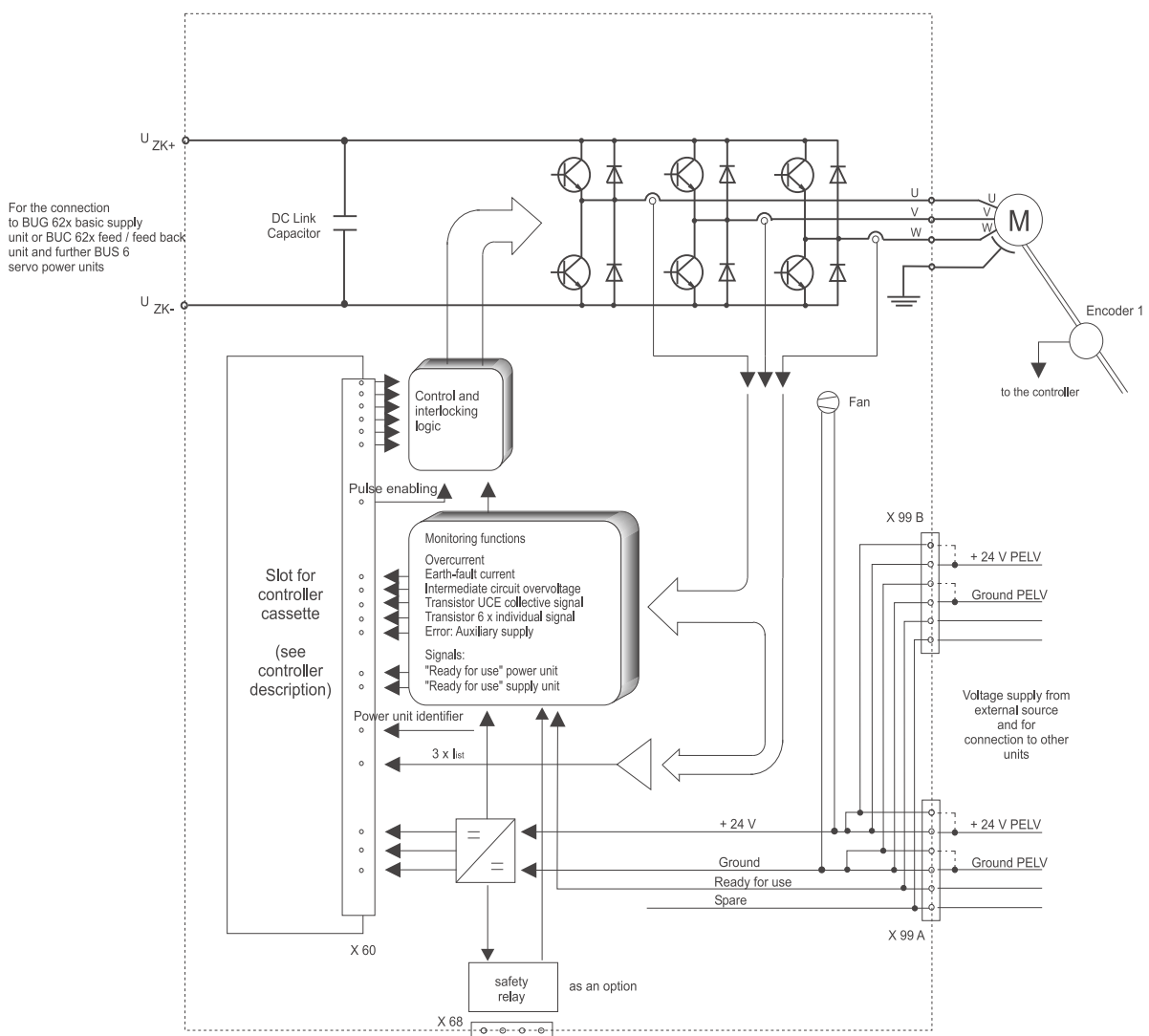


Figure 5: Block circuit diagram

4.3 Interconnecting devices

The device Servo-Power-Unit **BUS 621, 622, 633, 624** can be combined with other Baumüller devices.

4.4 Variants - Basic version / version with Safe Torque Off (STO)

In addition to the basic version of the units, there are also equipment versions, which combined with especially executed controllers, meet the requirements for safety function STO (Safe Torque Off) according to DIN EN ISO 13849-1, EN 62061 and EN61800-5-2.

These power modules carry the type description **BUS62x-xx/xx-xx-M-xxx-001**

The following controllers approved for this function are available:

M-drive with type description: **BUS6-MC-xx-xxxx-xxxx-Slxx-...**

or

V-controller with type description: **BUS6-S1-VC-...**

4.5 Marking the device - Type code

You will also find the type code of the unit on the type label (specification sticker) of the unit.

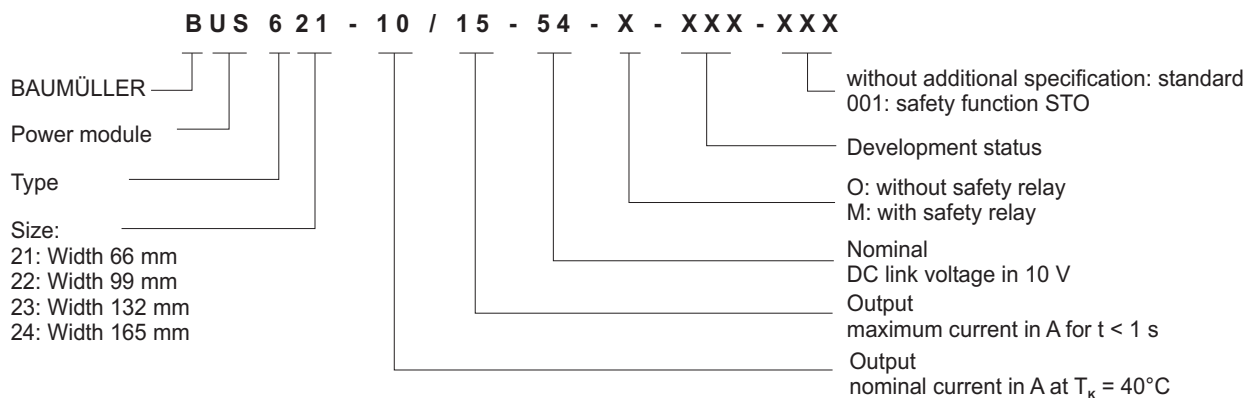


Figure 6: Type code



NOTE

This type code applies exclusively for the power module.



NOTE!

A device with safety relay, whose part number does **not** start with „06“, does not apply as a safety device as defined by the PL classification according to ISO 13849 or SIL according to EN 61800. This device is not certificated for safety functions

Devices with the approval mark of TÜV Rheinland and the Safety label provide a certified safety function, only, refer to [Page 23](#).



Functional
Safety
Type
Approved

www.tuv.com
ID 0600000000

4.6 UL notes

The notes below must be observed at a cUL - conformity drive.

In case you consider UL 508 C observe the notes below also:

- [Instruction Handbook of controller](#)
 - Adjustment for motor overload monitoring (I^2t)
- [Requirements to the connecting cables](#) on page 50
 - Use 60 °C/75 °C copper wire only for all devices
 - Use Class 1 wire only.
- [Power connections](#) on page 58
 - Note tightening torque for connection terminals.
- [Required environmental conditions](#) on page 29
 - Use the device only in a pollution degree 2 environment
 - Observe the maximum environmental temperature and the derating
- [Requirements to the energy supply / supply system](#) on page 27
 - 24 V supply must not reach more than 30 V DC. Additional fuse protection with max. 4 A fuse.
- [Requirements for the motor temperature sensors](#) from page 54
 - Observe the connecting data of the motor temperature sensor.

4.7 Display and operation elements

Refer to Instruction Manual of the controller.

TRANSPORT AND PACKAGING

5.1 Safety notes for transport

**NOTICE!****Damage due to unauthorized transport!**

Transport handled by untrained personnel can lead to a substantial amount of material damage.

Therefore:

- The unloading of the packages upon delivery as well as the in-house transport should only be done by trained personnel.
- Contact Baumüller Nürnberg GmbH sales office if necessary.

**WARNING!****Danger of mechanical hazard!**

Secure devices against falling down.

Therefore:

- Take suitable measures, such as supports, hoists, straps, etc., to ensure that devices cannot fall down.
- Use appropriate handling material.

5.2 What to observe when transporting

For initial transport of the device, it is packed at the manufacturer. If the device is to be further transported, ensure that the following conditions are met throughout the entire transport:

- Climate class 2 K 3 as per EN 60721-3-2
- Temperature range - 25 °C up to + 70 °C
- Vibration, shock, continuous shock class 2 M 1 as in EN 60721-3-2

5.3 Transport inspection

Upon receiving the delivered goods, immediately examine them for completeness and transport damage.

If there is outwardly visible transport damage, proceed as follows:

- Do not accept the delivery or conditionally accept it with reservations.
- Note the extent of the damage on the transport documents or on the delivery note of the transport agent.
- Immediately file a complaint with the freight carrier. Have the complaint confirmed in writing and immediately contact the responsible representative of Baumüller Nürnberg GmbH.



NOTE!

The device may not be operated if there is visible transport damage!

5.4 Unpacking

After having received the still packaged device:

- Avoid transport shocks and hard jolts, e.g. when putting an item down.

If no transport damage is visible:

- Open the packaging of the device.
- Verify the delivery scope based on the delivery note.

File a claim with the responsible Baumüller representative if the delivery is incomplete.



NOTE!

Claim each individual deficiency as soon as it has been detected. Damage claims can only be validly asserted within the claim registration period.

5.5 Disposal of the packaging

The packaging consists of cardboard, plastic, metal parts, corrugated cardboard and/or wood.

- When disposing of the packaging, comply with the national regulations.

6

MOUNTING

The device is designed for mounting in a control cabinet.

Mounting consists of the following steps:

- 1 Prepare mounting
(for drill holes/cut-out segments, refer to [▶Drilling templates/installation space◀](#) from page 45)
- 2 Install
(fixing refer to [▶◀](#) on page 46)

6.1 Safety notes



NOTE!

Mounting shall only be performed by employees of the manufacturer or by other qualified personnel.

Qualified personnel are persons who – on account of their occupational training, experience, instruction and knowledge of relevant standards and stipulations, accident prevention regulations and operating conditions – are authorized by the persons responsible for the safety of the facilities to perform the respective activities that are necessary, while at the same time recognizing and preventing any potential risks. The qualifications necessary for working with the device are, for example:

- Occupational training or instruction in accordance with the standards of safety engineering for the care and use of appropriate safety equipment.



WARNING!

Danger as a result of faulty mounting!

The mounting requires qualified personnel with adequate experience. Faulty mounting can lead to life-threatening situations or substantial material damage.

Therefore:

- Only allow mounting to be performed by employees of the manufacturer or by other qualified personnel.



WARNING!

Danger of mechanical impact!

Secure devices against falling down.

Therefore:

- Take suitable measures, such as supports, hoists and assisting personnel, to ensure that device cannot fall down.
- Use appropriate means of transport.



NOTICE!

Danger due to electrostatic discharge.

The connecting terminals of the device are partially at risk due from ESD.

Therefore:

Please heed the respective notes.

**CAUTION!****Danger due to sharp edges.**

If the device is lifted with unprotected hands during mounting, palms or fingers can be cut. If the device falls, feet could be injured.

Therefore:

- Ensure that only qualified personnel, who are familiar with the safety notes and assembly instructions, mount this device.



Wear safety gloves.



Wear safety shoes.

6.2 Preparing for mounting

Based on the planning documents and the drilling pattern (refer to [► Drilling templates/installation space◄](#) from page 45), the cutout sections and the positions of the attachment drill holes can be determined.

**NOTICE!****Property damage due to conductive contamination.**

Therefore:

- When performing installation work of any kind, it must be ensured that no foreign material (e.g. drill shavings, copper strands, etc.) gets into the device as a result.
- If possible, the drilling of the holes should be done before mounting the device and the configuring of the cables should take place outside of the control cabinet. If this is not possible, the device must be appropriately covered.

Remove this covering again prior to start!



CAUTION!

Eye injury due to flung particles.

Metal particles are flung when making the drill holes and the cutout sections.

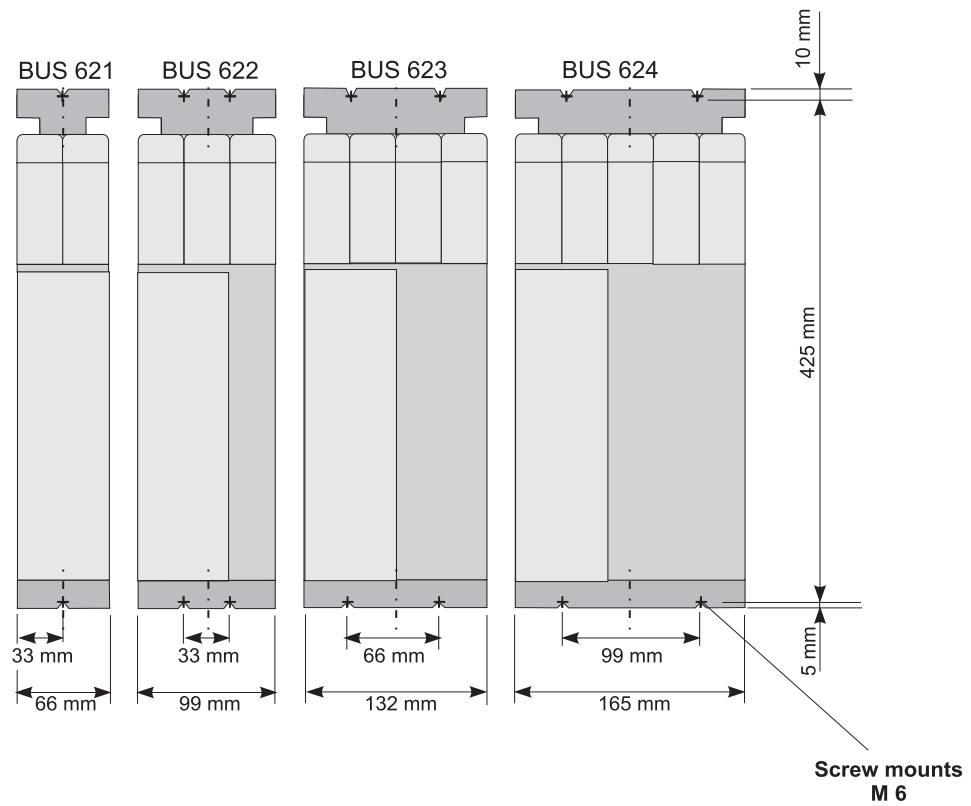
Therefore:



Wear protective eye wear!

- ▶ Preparing drill holes and cutout sections.

6.3 Drilling templates/installation space



Mounting attached individually as a separate part

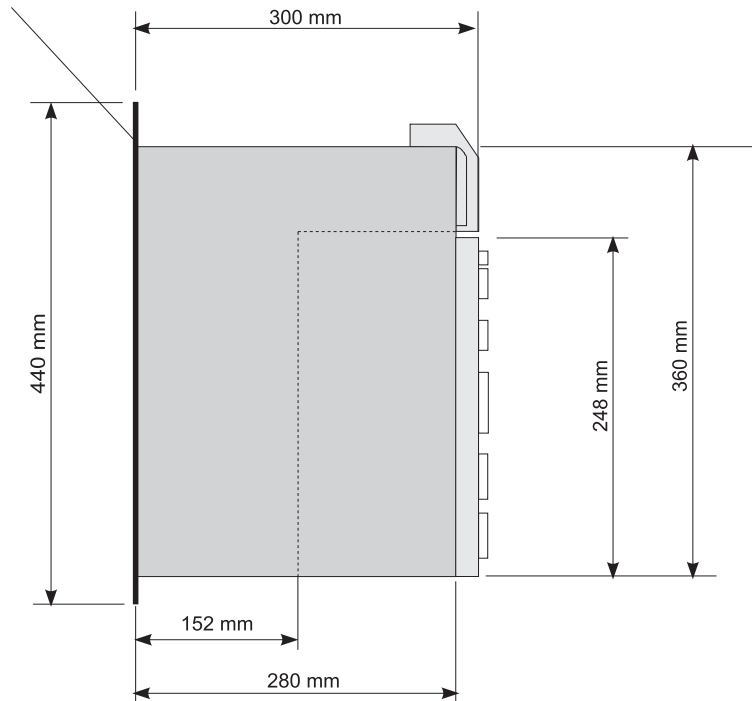


Figure 7: Drilling templates/installation space

6.4 Assembly instructions

Perform the assembly as follows:

- 1 If necessary, provide a suitable transporting/lifting device
 - 2 Provide suitable fasteners
 - 3 Assemble the device.
- The units must be installed in the switch cabinet vertically. The power module BUS 62x must be arranged near to the feed / feed back unit BUC 624, 625 or the basic feed unit BUG 622, 623 and the DC Link must be connected by the connection bars supplied with the unit. When delivered, the connection bars are fastened to the front bars of the units BUS 62x.



NOTICE!

*The risk is: **Destruction of the units.***

Longer connections are not permitted, as they may cause damage to the equipment.



NOTICE!

*The risk is: **Overheating of the device.***

The following measures must be strictly observed to avoid the danger of device overheating.

- Ventilation must be from bottom to top.
- Unrestricted ventilation must be guaranteed.
- A space of at least
100 mm
must be left above and below the units, and sufficient cool air and air circulation is to be provided.
- Coolant temperature 50 mm under the units, up to 40 °C. With higher temperatures (up to max. 55 °C), power output of the units must be reduced by 3 % per °C.
- Do not locate any additional sources of heat above or below the units.

6.5 Attachment

1. Attach the mounting backplate to the control cabinet (for sizes, see [▶Figure 7◀](#) on page 45).
The backplate can be used as a mounting and drilling template. The backplates of neighbouring units must be directly next to one another.
2. Push back the retaining plate spring and hang the unit in place.
The unit is then held fast between the mounting backplate and the back wall.
3. To dismantle the unit, press the retaining plate spring and lift out upwards.

7

INSTALLATION

This chapter describes the electrical installation of the device. The mechanical mounting is described in [▶Mounting◀](#) from page 41.

Prior to installation, ensure that the technical prerequisites have been fulfilled:

- 1 Check the demands on the electrical power supply.
- 2 Check the requirements for the electrical cables and the provision of corresponding cables.
- 3 Check the properties of the connections and the specified configuration of the respective cables.

7.1 Safety notes



NOTE!

Installation shall only be performed by employees of the manufacturer or by other qualified personnel.

Qualified personnel are persons who – on account of their occupational training, experience, instruction and knowledge of relevant standards and stipulations, accident prevention regulations and operating conditions – are authorized by the persons responsible for the safety of the facilities to perform the respective activities that are necessary, while at the same time recognizing and preventing any potential risks. The qualifications necessary for working with the device are, for example:

- Occupational training or instruction, and the authorization to commission, ground and mark electrical power circuits and devices in accordance with the standards of the safety engineering.
- Occupational training or instruction, in accordance with the standards of work safety, for the care and use of appropriate safety equipment.



WARNING!

Danger because of faulty installation and initial commissioning!

Installation and commissioning require qualified personnel with adequate experience. A installation fault can cause danger situations or large damage of property.

Therefore:

- Only personnel from manufacturer or qualified personnel operate while installation and initial commissioning



DANGER!

Risk of fatal injury from electrical current!

Inevitably, when operating this electrical device, certain parts of it are energized with hazardous voltage.

Therefore:

- Pay heed to areas on the device that could be dangerous during the electrical installation.
- Pay heed to areas on the device that could still be electrically energized after operation.

Danger from residual energy



DANGER!

Risk of fatal injury from electrical current!

Stored electric charge.

Discharge time of the system = discharge time of the device with the longest DC link discharge time in the DC link connection.

Therefore:

- Do not touch before taking into account the discharge time of the capacitors and electrically live parts.
- Heed corresponding notes on the equipment.
- If additional capacitors are connected to the DC link, the DC link discharge can take a much longer time. In this case, the necessary waiting period must be determined or a measurement made as to whether the equipment is de-energized. This discharge time must be posted, together with an IEC 60417-5036 (2002-10) warning symbol, on a clearly visible location of the control cabinet.

7.2 Voltage test



DANGER!

Risk of fatal injury from electrical current!

During the routine test of these devices, a voltage test is performed by Baumüller Nürnberg GmbH in accordance with EN 61800-5-1, Section 5.2.3.2. It is thus unnecessary for the customer to do this.

Therefore:

- Subsequent tests of the devices using high voltages may only be performed by Baumüller Nürnberg GmbH.
- Disconnect the converter from the system during high-voltage testing!

7.3 Demands on the power supply

Minor deviations from requirements in the power supply can lead to malfunctioning of the device. If the power supply deviates too much from the requirements, the device can be destroyed.

The devices may only be operated in industrial networks.

The destruction of the device can cause personal injury.



DANGER!

Risk of fatal injury from electrical current!

If the requirements for the power supply are not complied, the device can be damaged or destroyed, thereby greatly endangering individuals.

Therefore:

- Prior to installation, ensure that the demands for power supply have been fulfilled.

7.4 Requirements to the connecting cables

- ▶ Take into account IEC/EN 60204-1, Chapter 13 when selecting the cable.
- ▶ The protective ground cross-section of the cable must be compliant with IEC/EN 60204-1, Section 5.2, Tab. 1.
- ▶ A fixed connection for the protective ground conductor is mandatorily specified for operation of the device.
- ▶ Use copper cable approved for a minimum of 60 °C (drives < 3 x 100 A) or 75 °C (drives ≥ 3 x 100 A), if comply with UL 508C.

For further details (e.g. maximum permitted length), refer to [▶Cabling◀](#) from page 274.

7.5 PE connection and RCD compatibility

Depending on the functional principle, leakage current >3.5 mA_{AC} or >10 mA_{DC} can flow through the protective ground conductor. Consequently, a stationary ground conductor connection in accordance with EN 61800-5-1 is required.



DANGER!

Risk of fatal injury from electrical current!

This product can cause direct and/or alternating current in the protective ground conductor.

The leakage current, due to the functional principle of the device, can lead to premature triggering of the fault current protective device or generally prevent triggering of it.

Therefore:

- Wherever a differential current device (RCD) is used for protection in case of direct or indirect contact, only an RCD of the type B is permitted on the power supply side of the device.
- Otherwise a different protective measure must be utilized, such as separation from the surroundings by means of double or enhanced isolation, or separation from the power supply system by means of an isolating transformer, for example.

7.6 Installation requirements with regard to EMC



NOTE!

The emission of radio frequency interference (RFI) is to a great extent dependent on the wiring, spatial expansiveness and the arrangement of the components in the system. Ensuring electromagnetic compatibility compliance in accordance with legal requirements is therefore only possible on the completely assembled system and is thus the responsibility of the system manufacturer or proprietor (re Art. 6, Par. 9 of the EMVG; European EMC law).



NOTE!

The important information on EMC-compliant installation can be found in these instruction handbook. Additional notes on building a CE-compliant system, that are imperative to take heed of, can be found in the Baumüller manual „Mains filter BFN“, 5.09010. This manual can be obtained from Baumüller Nürnberg GmbH.

In order to have EMC-compliant and problem-free use within the framework of the legislation, the following aspects must be taken into account.

In case of any questions, please contact Sales or the Applications department of Baumüller Nürnberg GmbH.

- Only use Baumüller motor cables and Baumüller components.
- Use suitable mains filters recommended by Baumüller Nürnberg GmbH.
- Mount all components on a single mounting plate with a continuously good electrically-conductive surface (e.g. galvanized steel plate).
- Keep the ground connection device/ground plate as short as possible (< 30 cm), using fine-stranded cables with a large cross section (>10 mm²).
- When installing, be sure to follow the correct sequence:
power supply system - fuse - filter - choke - (ferrite core) - **BUS 621, 622, 633, 624** - (motor filter) - motor.
- Ensure that the motor cable is continuous, without interruption.
Do not interrupt motor cables with terminals, contactors or fuses, for example.
- If possible route the cables on the surface of the grounded mounting plate (i. e. the least effective antenna height).
- When routing in parallel, minimum clearance of 20 cm should be observed between signal and control cables vis-à-vis the power cables.
- Cables of different EMC categories (e.g. signal cables - mains cables and/or motor cables) should be crossed at a 90 ° angle.
- Contact the major cable shield when laying cables through walls, which separate different EMC areas
- Contact all the cable's shields on both sides surface-to-surface and also well-conductive with ground.

7.7 Avoid bearing currents



NOTE

The pulsed output voltage of a converter causes additional motor bearing currents. Bearing currents cause localized melting on ball race and rolling body as well as wear of the lubricant. This leads to a reduced service life of the bearing.

Bearing currents depend on:

- Motor speed
- Switching frequency of the converter
- Grounding

Furthermore the height of the bearing currents depends on:

- the applied bearing voltage
- the dielectric characteristic of the bearing lubrication



NOTE

The reduction of bearing currents requires the consideration of the **whole speed-variable drive system** and its installation!

Baumüller supports you with on-site measurements and with development and implementation of suitable preventative measures.

Avoiding bearing damage

- Basically the **grounding system** must be installed appropriately to ensure a forced return of the common mode current.
- The cause of bearing current damage, that means the amplitude and slope of the common mode voltage is reduced by using toroidal cores. The use of toroidal cores is therefore a **preferred measure**.
- In addition the using of **current-isolated bearings** (standard for AC drives from motor size 180 and higher) can reduce the effects of the common mode voltage.
- The shaft can be grounded (and the bearing currents redirected) by using special grounding rings or grounding brush(es).
- Furthermore modified **motor cables** (for high frequencies, cable shield with low impedance, symmetric cable design) can be used in order to lead the capacitive currents to a large extent back to the converter via the cable shield.

Toroidal cores



NOTE

It is recommended to use toroidal cores in order to reduce/to avoid bearing currents. Part numbers and the number of recommended toroidal cores, refer to [►Toroidal cores◄](#) on page 311 in chapter Accessories and Spare Parts.

- The toroidal cores are made of nanocrystalline material. The toroidal cores cover all three phases of the converter output. The time variable common mode current induces a magnetic field into the toroidal core, which counteracts against the change of the common mode current.
- For this reason the toroidal core operates a current-compensated choke, which limits the rate of change and the amplitude of the common mode voltage and therefore reduces the bearing currents significantly.
- Because of the higher amplitude and frequency of the common mode voltage when using an active mains rectifier unit, there are used toroidal cores with a lower permeability for optimized modulation of the cores (saturation and temperature characteristics).

Installation of toroidal cores

- ◊ The three phases **without shielding** and **without PE** must be lead through the cores. The cores must be installed and attached near the motor connection of the **BUS 621, 622, 633, 624** .
- ◊ When using toroidal cores it is further recommended to use current isolated bearings on the nondrive end for synchronous/asynchronous main drives sizes 180 and higher.



Figure 8: Mounting - single ring core



Figure 9: Mounting - several ring cores

7.8 Requirements for the motor temperature sensors

To protect the motor against not permitted overheating, a motor temperature sensor can be connected to the Servo-Power-Unit device. The device switches off of the motor when a settable threshold temperature has been exceeded.



NOTE!

The thermal memory of the motor and the speed-dependent electronic motor overload protection is not available if no motor temperature sensor is used.

Type	Additional requirements:	Isolation
KTY84/PT1000	-	SELV/PELV
MSKL ¹⁾ (PTC)	$R = 1 \text{ k}\Omega$ at $T_{\text{Threshold}}$, $I_{\text{max}} < 2 \text{ mA}$	SELV/PELV

¹⁾ Motor protection resistor (PTC) as per DIN 44080-082



NOTE!

The motor temperature sensor should be installed in such a manner that „safe electrical separation“ is ensured. The motor temperature sensors integrated into Baumüller motors meet these requirements. If third-party motors are connected, the proprietor must ensure that the temperature sensors used in the motor of a third-party manufacturer motor comply with the „safe electrical separation“ function.

7.9 Installation procedure



DANGER!

Risk of fatal injury from electrical current!

Electrically live parts are life-threatening.

Therefore:

- Make certain that the parts to be mounted (e.g. power supply cables) and the mounting areas are de-energized for the entire duration of mounting the device.

- Lay all cables EMC-compatible.
- Connect cables (refer to [►Wiring diagram◄](#) from page 56).
(Observe the torques!)

The installation consists of the following steps:

- 1 Route all cables EMC-compliant.
- 2 Connect the lines (see [►Wiring diagram◄](#) from page 56)
(Also observe the approved torques).
 - Connect the motor via terminals 1U2, 1V2, 1W2, PE. Note the correct phase connection (rotation).
(Observe the approved torques).
 - Connect the ground wire to terminal PE (a fixed protective earth connection is mandatory).
 - Connect the 24 V supply via connectors X100-1/2, X100-5/6.
(when including UL508C: limit the current to 4 A).
 - Connect the transmitter (see operating instructions of the controller).



NOTE!

Plugging in and pulling out encoder cables while they are energized is prohibited, and could lead to their destruction.

Therefore, always first switch off the 24 V supply voltage and lock the encoder connectors when operating.

- Connect the temperature sensor of the motor.
- Connect the safety relay.

7.10 Wiring diagram

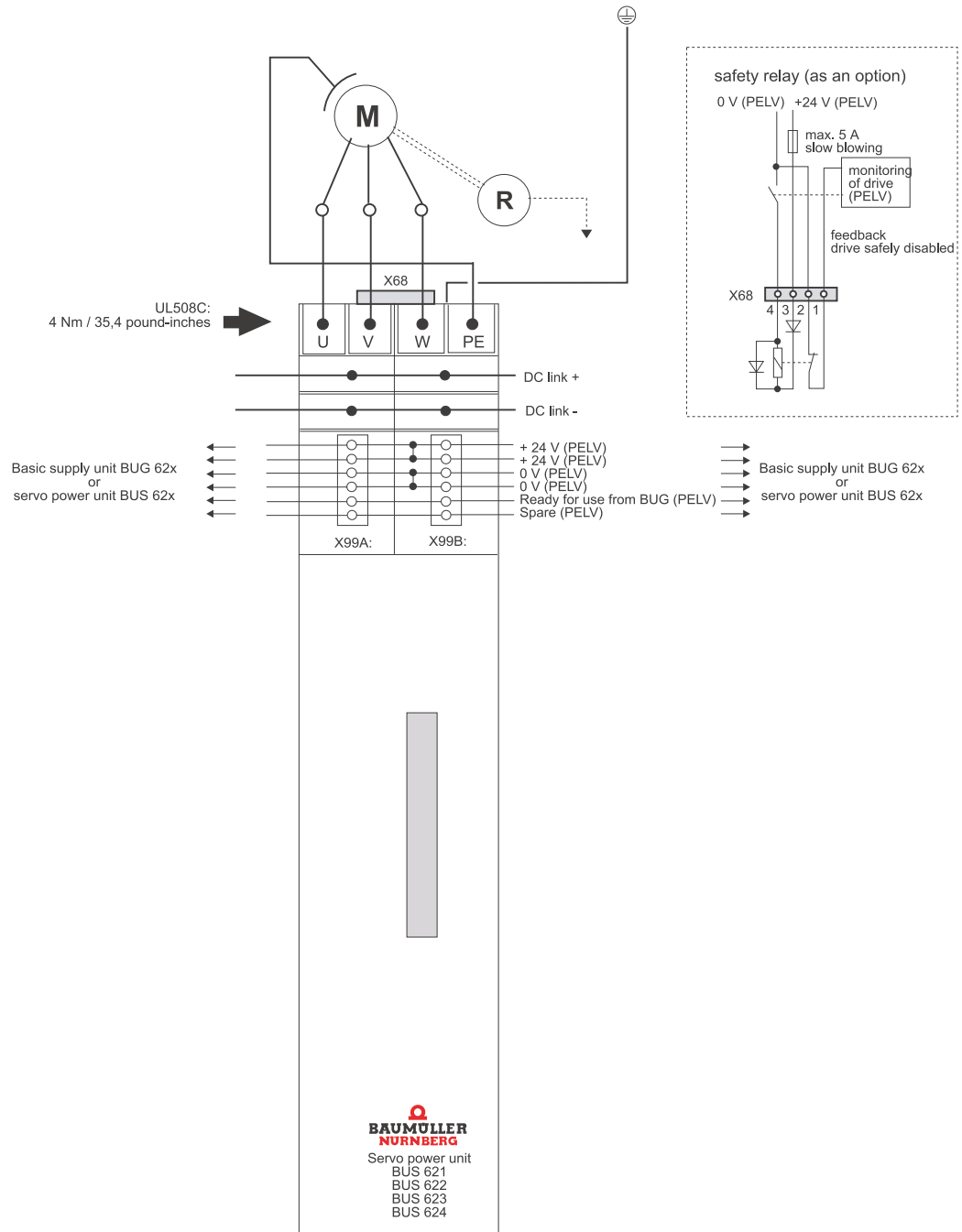


Figure 10: Connection diagram

7.10.1 Connection instructions

Ground leakage circuit breaker	<p>Relatively high leakage to ground occurs in the converter and the motor, i.e. the drive may be incompatible with residual current protective devices.</p> <p>Reference should be made to EN 50178 / VDE0160 / 4.98 sect. 5.2.11 before configuration.</p>
U, V, W	Motor connections. See EMC instructions for routing the lines.
PE	<p>Control cabinet ground, cross sections according to EN 60204-1:1997</p> <p>When including UL508C: Only 60°C / 75°C copper lines may be connected (UL508C, nominal tightening torque of the connecting screws: 4 Nm or 35.4 psi.</p>
ZK+, ZK-	<p>DC link connection to the feed-in unit and to additional power modules.</p> <p>When including UL508C: Nominal tightening torque of the connecting screws: 4 Nm or 35.4 psi.</p>



DANGER!

*The risk is: **Electricity**. Live parts are life-threatening.*

The DC Link carries electrical potential: it is imperative that the provided cover is used.

Power supply 24 V	24 V voltage supply with secure isolation (SELV) according to EN 50178 for supplying the electronic parts
	Current input without controller
	<ul style="list-style-type: none"> • BUS 621 0,9 A • BUS 622 0,9 A maximum current • BUS 623 1,1 A at 24 V - 10 % • BUS 624 1,6 A



NOTE

The power supply has capacitors at its input (250 µF); which means, on switching the 24 V supply, charging current is present!

At continuous operation below 24 V the cooling power of the internal ventilator is reduced. Power reducing of the power module on inquiry.

7.11 Pin assignment

7.11.1 Power connections

- **U, V, W, PE**

U, V, W: Motor connections, M 6 terminals
PE: Control cabinet ground, M 4 terminal

If UL508C has to be observed: Use 60°C / 75° C copper conductors only (UL508C, Nov 27, 1996, Tab. 39.2). Nominal tightening torque of the terminal screws: 4 Nm resp. 35,4 pound-inches.

- **ZK+, ZK-**

Connection of the power unit to the DC Link of the basic feed unit BUG 62x resp. to other BUS 62x basic feed units must be done by the connection bars supplied with the unit. When delivered, the connection bars are fastened to the front bars of the units BUS 62x
M 6 terminals



NOTICE!

*The risk is: **Destruction of the units.***

Longer connections than those with the included rails are not allowed, otherwise there is risk of destroying the equipment!

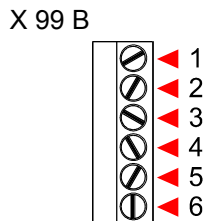
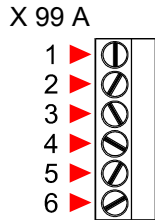
If UL508C has to be observed:

Nominal tightening torque of the terminal screws: 4 Nm resp. 35,4 pound-inches.

7.11.2 Control connectors

- Connection strip X99A/X99B

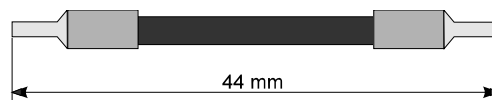
Connector no.	Assignment
1, 2	+ 24 V (PELV) Connector for power supply to the units, both connectors internally bypassed, 2nd connector with power supply current > 10 A
3, 4	Ground 24 V (PELV) Connector for power supply to the units, both connectors internally bypassed, 2nd connector with power supply current > 10 A
5	Ready for use, internal Ready for use message from the supply converter to all units attached to the DC link.
6	Reserved (PELV)



All connectors are connected to each other (i.e. connector 1 of X99A is connected to connector 1 of X99B ...). Because of this they can be used as BUS-connection from one Baumüller unit to the other.

The signals can be executed as a bus connection, due to the connection of X99A with X99B of the next unit in the line.

Recommended connection lead length - 44 mm.

**NOTE**

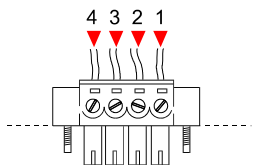
A maximum current greater than 10 A per single connector may cause damage to the equipment.

If higher currents are needed do build a multiple feeder system.

If UL508C has to be observed: Limit the current to 4 A.

- **Connection strip X68**

safety relay (as an option)



Connector no.	Description
1	feedback contact 1 (SELV)
2	feedback contact 2 (SELV)
3	+24 V (SELV)
4	ground connection 24 V (SELV)

- **X60 plug 64-pin**

X60 connects the controller cassette internal with the motor side converter. See description controller for external connections of controller cassette.

7.12 Accessories

- EMC package
 - on requirement available:
 - EMC filter
 - shielded cables
 - shield clamps

OPERATION

8.1 Safety notes

**WARNING!****Risk of injury due to improper operation!**

Improper operation can lead to severe personal injury or material damage.

Therefore:

- Perform all operational steps according to these instruction handbook.
- Before beginning any work, ensure that all coverings and protective devices are installed and are functioning properly.
- The control cabinet in which the device is installed should be protected against contact with electrically live parts.
Keep all doors of the control cabinet closed during operation.

**NOTICE!****Environmental conditions that do not meet the requirements.**

Environmental conditions that are non-compliant can lead to property damage.

Therefore:

- Ensure that the environmental conditions are kept compliant during operation (refer to [►Required environmental conditions◄](#) on page 29).

**WARNING!****Risk of injury due to insufficient qualifications!**

Inevitably, when operating this electrical device, certain parts of this device are energized with hazardous voltage. Improper handling can lead to significant personal injury and material damage.

- Only qualified personnel may work on this device!

8.2 Function diagram

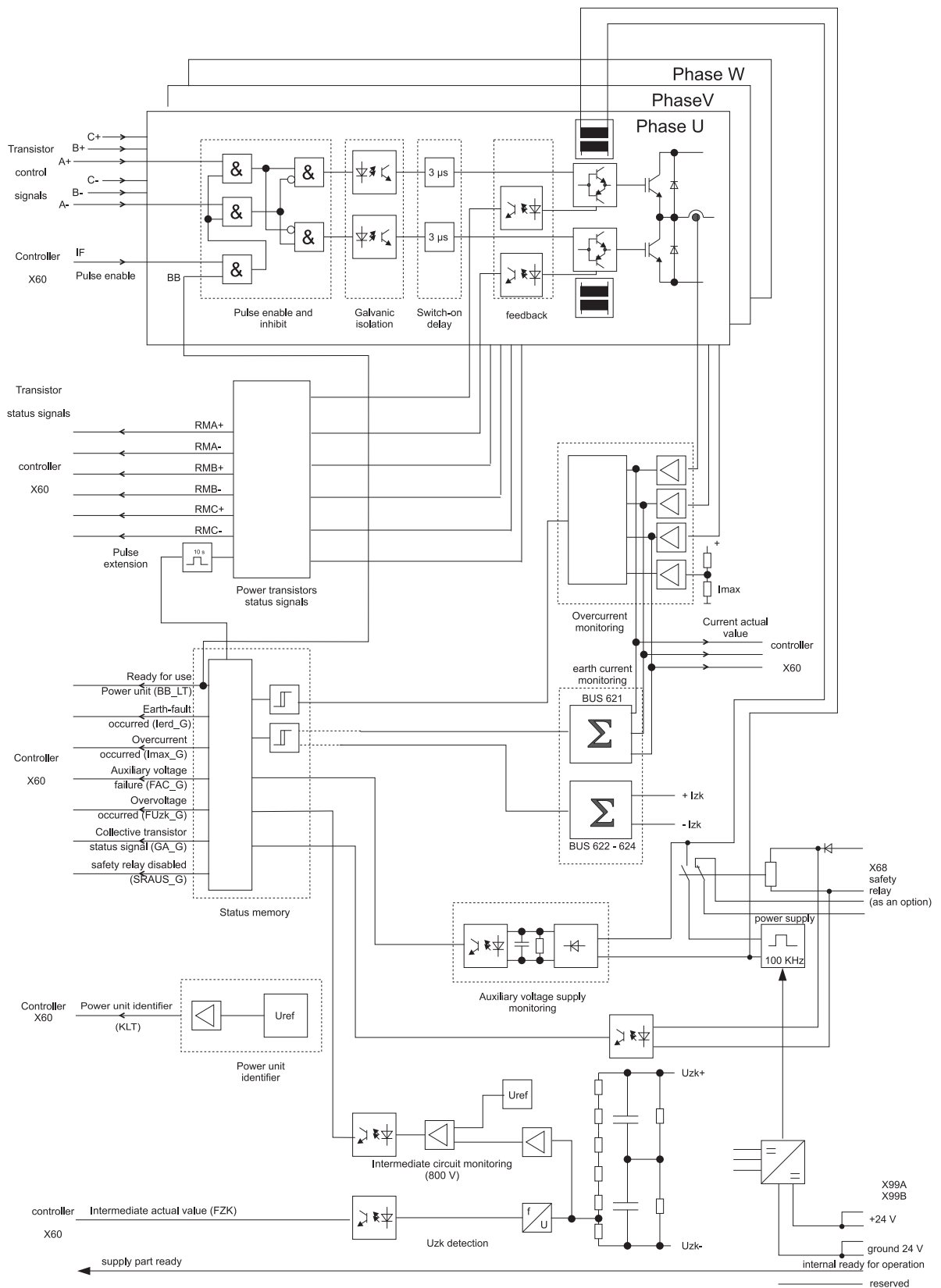


Figure 11: Function diagram

8.3 Operation

All messages given by a BUS 62x power module monitoring device are saved there.

Error saving can be reset via a signal from the controller (see controller description).

The feed unit reset signal does only affect the feed unit itself and does not cancel error saving in the BUS 62x power module.

Setting the BUS 62x power module is not necessary.

8.4 Messages and warnings

To use the monitoring the +24 V power supply (X99A or X99B) must be available.

Following features are monitored:

- Overcurrent in the motor cables
- Earth-fault current
- DC Link voltage
- Power transistors switching status
- state of safety relay

• Overcurrent message

Motor current in the motor phases is monitored, and on exceeding phase current by 30 % of the permitted peak current, an overcurrent message is generated. This error message is saved and a pulse inhibit is made.

The overcurrent message can be reset by a controller reset.

For display and message resetting, see controller description.



NOTE!

The overcurrent message should be seen as protection, and limitation of the permitted peak of the motor phase currents is determined by the controller.

• Earth-fault monitoring

The earth fault current of the power unit, and thus the motor current, is monitored for earth faults. An earth fault message is generated if the fault current exceeds 10 % of the power unit's peak current.

Earth-fault monitoring can be reset by a controller reset.

For display and message resetting, see controller description.

- **DC Link monitoring**

The amount of the DC Link voltage is monitored in the power unit. If it reaches 800 V an error message is generated.

DC Link monitoring can be reset by a controller reset.

For display and message resetting, see controller description.



NOTE

The DC Link voltage can rise until it is shut off if the drive brakes and no, or too little, ballast switching is available in the DC Link.

- **Power transistors switching status monitoring**

During the power transistor switch-on command, the collector-emitter saturation voltage is monitored. If a too-high saturation voltage is detected in a conductive state, overcurrent of the power transistors is the reason, e.g. by a short-circuit of the motor terminals, and a controlled shut-down procedure follows, which shuts down the transistor and generates an error message.

This monitoring feature can be reset by a controller reset.

For display and message resetting, see controller description.



NOTE

To guarantee recovery of the transistor after switching off due to overcurrent, the error message can only be reset after at least 5 seconds (typically, 10 seconds).

- **Auxiliary voltage supply monitoring**

The power unit auxiliary voltage supply is monitored and generates an error message on appearance of a fault.

This monitoring feature can be reset by a controller reset.

For display and message resetting, see controller description.

- **Supply monitoring**

Basic unit monitoring has no direct influence on the power unit.

The ready for use message of the basic unit, connector X99A and X99B connection 5 and the reserve circuit connection 6 is transferred, free of potential, to the controller cassette, where it is processed (see controller description).

- **Head sink temperature monitoring**

The power unit has no temperature monitoring feature of its own, as the head sink temperature is not greatly time-critical.

The head sink has a linear temperature sensor which passes measurements on to the controller. Temperature monitoring is thus taken over by the controller (see controller description).

Ready for use

All error messages produced by the BUS 62x power module monitoring are saved there. As soon as there are no more errors present or saved, the power module is ready for use and reports this via the controller connection plug (X60).

If there is an error, a pulse inhibit takes place.



NOTE

After supplying the 24V supply voltage and the mains voltage, the power unit is ready for use after approximately 5 seconds.

Reset

Error saving is reset via a signal from the controller (see controller description).

- **Safety relay (as an option)**

For an immediate production restart, it is necessary to stop a drive electronically and to ensure, that the DC link voltage does not have to be switched off. Furthermore many users want no contactors in the motor cables.

	Relay	feedback contact	internal contact
running	engaged (+24 V supply)	open	closed triggering is connected to supply
safe condition	released (no +24 V supply)	closed active signal	open triggering without supply

The transition *safe condition*⇒*running* always is a result of a RESET (initialised by a higher control).

To detect „safe condition“ correctly, it is recommended to combine the output signals in a suitable way and to rescan the information every 10 ms.

Power unit messages in correlation with the safety relay

power unit message	BBLT ready to operate power unit	GA_G * group-transistor state message	SRAUS_G * safety relay disengaged	FAC_G * auxiliary voltage interrupted	RMA+/RMA-RMB+/RMB-RMC+/RMC-
running	High	Low	Low	Low	Low
safe condition	Low	Low	High	High	High

*_G stored
 High ⇔ Logic level +5 V
 Low ⇔ Logic level 0 V

Sequence of drive control:

Pulse enable OFF ⇒ safety relay OFF ⇒ stored messages (see above) ⇒ safety relay On
 ⇒ RESET by controller ⇒ pulse enable ON

MAINTENANCE

9.1 Safety notes

Basic information

**DANGER!****Risk of fatal injury from electrical current!**

Inevitably, when operating this electrical device, certain parts of it are energized with hazardous voltage.

Therefore:

- Pay heed to areas on the device that could be dangerous during the electrical installation.
- Pay heed to areas on the device that could still be electrically energized after operation.

**WARNING!****Risk of injury due to improperly performed maintenance work!**

Improper maintenance can lead to severe personal injury and material damage.

Therefore:

- Before beginning work, make sure that there is enough space for mounting.
- Make sure that the mounting area is kept clean and orderly. Parts and tools that are loosely stacked or lying around are a potential accident source.

9.2 Environmental condition

If the prescribed environmental conditions are adhered to, then the device is maintenance-free. For the prescribed environmental conditions refer to [►Required environmental conditions◄](#) on page 29.

9.3 Inspection intervals - maintenance notes

Preventive maintenance is prescribed to keep the device in an optimum operating condition and ensure a long service life. It is recommended to have inspections performed regularly by qualified personnel.

Daily inspection:

Basic check points as to whether discrepancies have occurred during operation:

- Does the motor work as desired?
- Is the operating environment normal?
- Is the cooling system working normally?
- If an unusual vibration or noise is noticed during operation.
- Does the motor overheat during operation?

Regularly scheduled inspection:

Before checking, switch off the input voltage and wait until the device's capacitors have discharged.



DANGER!

Risk of fatal injury from electrical current!

Therefore:

- Switch off voltage before performing work!
- Only qualified personnel may mount, install and maintain the devices.
- Please remove all metallic objects worn, such as watches or rings, for example, before beginning to work on the device.
- Only insulated tools are permitted.



DANGER!

Risk of fatal injury from electrical current!

Stored electric charge.

Discharge time of the system = discharge time of the device with the longest DC link discharge time in the DC link connection.

Therefore:

- Do not touch before taking into account the discharge time of the capacitors and electrically live parts.
- Heed corresponding notes on the equipment.
- If additional capacitors are connected to the DC link, the DC link discharge can take a much longer time. In this case, the necessary waiting period must be determined or a measurement made as to whether the equipment is de-energized. This discharge time must be posted, together with an IEC 60417-5036 (2002-10) warning symbol, on a clearly visible location of the control cabinet.

9.4 Repairs

In case of device damage, please inform your sales office or:

Baumüller Nürnberg GmbH

Ostendstr. 80 - 90
90482 Nuremberg
Germany

Tel. +49 9 11 54 32 - 0
Fax: +49 9 11 54 32 - 1 30

Mail: mail@baumueller.com
Internet: www.baumueller.com

SHUTDOWN, STORAGE

In this chapter we describe, how you decommission and store the device.

10.1 Safety instructions

- Refer to [▶Safety◀](#) from page 11 and the information in [▶Transport and Packaging◀](#) from page 39.

The shutdown of the device may only be carried out by for this qualified personnel.



DANGER!

Risk of fatal injury from electrical current!

Stored electric charge.

Discharge time of the system = discharge time of the device with the longest DC link discharge time.

Therefore:

- Do not touch electrically live parts before taking into account the discharge time of the capacitors.
- Assure, that all electric connections are current-free and are safe against switch-on.
- Before working, check at the electrical connections with suitable measuring devices, that the connections are off-circuit.
- Remove the connections not until the safe isolation from supply has been checked.
- If additional capacitors are connected to the DC link, the DC link discharge can take a much longer time. In this case, the necessary waiting period must itself be determined or a measurement made as to whether the equipment is de-energized. This discharge time must be posted, together with an IEC 60417-5036 (2002-10) warning symbol, on a clearly visible location of the control cabinet.

10.2 Requirements to the executing personnel

The personnel, who is appointed to setting out of operation, must have the required knowledge and instructions, which is necessary for an execution according to the rules. Select the personnel in such a way, that the safety instructions, which are mounted to the device and its parts as well as to the connections, are understood and applied to.

10.3 Shutdown

Execute the setting out of operation as follows:

- 1 put the device off-circuit and assure the device against unintentional restart.
- 2 check the isolation from supply of all connections (earliest 10 minutes after switching off).
- 3 demount the connections and protect the connections according to the safety instructions.
- 4 document the shut down setting.

10.4 Demounting

The demounting assumes a completed, documented setting out of operation.



NOTICE!

Note sharp edges.

In case, while installing, you lift a device with unprotected hands, fingers/palm can be cut. If the device falls off, your feet can be cut up.

Therefore:

- Ensure that only qualified personnel, who are familiar with the safety notes and assembly instructions, demount this device.



Wear safety gloves.



- Wear safety shoes.

- 1 secure the device against falling off/out.
- 2 loosen all mechanical connections.
- 3 lift the device out of the control cabinet.
- 4 store the device in a suitable packing.
- 5 at transportation pay attention to, that the device is not damaged by wrong storage or severe shocks, also refer to [►What to observe when transporting◄](#) auf Seite 39.

In case you want to dispose the device, additional data is available in chapter [►Disposal◄](#) from page 75.

10.5 Storage conditions

The device is maintenance-free. If you keep to the environmental conditions during the entire period of storage, you can assume, that the device will not be damaged. In case the environmental conditions during storage are not kept, you should assume that the device is damaged after storage.



CAUTION!

Property damage because of incorrect storage conditions

Incorrect storage can damage/destroy the device.

Therefore:

Assure, that the environmental conditions are kept during the entire period of storage:

- Climatic category 1K4
- Temperature range -25 °C to +55 °C



CAUTION!

Recommissioning without forming of the capacitors.

From six months storage period on, the capacitors are destroyed during commissioning, if they are not formed beforehand

- Reform the DC link capacitors:
 - by supplying the device ready-to-operate for at least one hour with supply voltage
 - but do not transmit a pulse enable during this time.
- Consider, that it is imperative, to connect the accordingly prescribed line commutating reactor for this forming procedure. Devices, where no line commutating reactor is necessary can directly be supplied with mains voltage.

10.6 Recommissioning

Execute commissioning as with a new device, refer to [►Mounting◄](#) from page 41, [►Installation◄](#) from page 47.



CAUTION!

Recommissioning without forming of the capacitors.

From six months storage period on, the capacitors are destroyed during commissioning, if they are not formed beforehand

- Reform the DC link capacitors:
 - by supplying the device ready-to-operate for at least one hour with supply voltage
 - but do not transmit a pulse enable during this time.
- Consider, that it is imperative, to connect the accordingly prescribed line commutating reactor for this forming procedure. Devices, where no line commutating reactor is necessary can directly be supplied with mains voltage.

11

DISPOSAL



NOTE!

Baumüller products are not subject to the scope of application of the EU's Waste Electrical and Electronic Equipment Directive (WEEE, 2012/19/EU). Hence, Baumüller is not obligated to bear any costs for taking back and disposing of old devices.

11.1 Safety notes



DANGER!

Risk of fatal injury from electrical current!

Stored electric charge.

Discharge time of the system = discharge time of the device with the longest DC link discharge time in the DC link connection.

Refer to [▶Electrical data◀](#) from page 32.

Therefore:

- Do not touch before taking into account the discharge time of the capacitors and electrically live parts.
- Heed corresponding notes on the equipment.
- If additional capacitors are connected to the DC link, the DC link discharge can take a much longer time. In this case, the necessary waiting period must be determined or a measurement made as to whether the equipment is de-energized. This discharge time must be posted, together with an IEC 60417-5036 (2002-10) warning symbol, on a clearly visible location of the control cabinet.



CAUTION!

Danger due to sharp edges.

If the device is lifted with unprotected hands during deinstallation, palms or fingers can be cut. If the device falls, feet could be injured.

Therefore:

- Ensure that only qualified personnel, who are familiar with the safety notes and assembly instructions, mount this device.



Wear safety gloves.



Wear safety shoes.



WARNING!

Danger of physical impact!

Secure device against falling down.

Therefore:

- Take suitable measures, such as supports, hoists and assisting personnel, to ensure that device cannot fall down.
- Use appropriate means of transport.



NOTICE!

Avoid polluting the environment as a result of improper disposal.

Therefore:

- Only dispose in compliance with the health and safety regulations.
- Take heed of any special local regulations. If you are unable to directly ensure safe disposal yourself, commission a suitable disposal contractor.
- In the event of a fire, hazardous substances could possibly be generated or released.
- Do not expose electronic components to high temperatures.
- Beryllium oxide is used as inner insulation, for example for various power semiconductors. The beryllium dust that is generated upon opening is injurious to the health.
Do not open electronic components.
- Dispose of capacitors, semiconductor modules and electronic scrap as special waste.

**WARNING!****Danger as a result of faulty deinstallation!**

The deinstallation and disposal requires qualified personnel with adequate experience.

Therefore:

- Only allow deinstallation and disposal to be performed by qualified personnel.

11.2 Disposal facilities/authorities

Ensure that the disposal is handled in compliance with the disposal policies of your company, as well as with all national regulations of the responsible disposal facilities and authorities. In case of doubt, consult the bureau of commerce or environmental protection authority responsible for your company.



APPENDIX A - ABBREVIATIONS

A	Ampere	I_{set}	Current set value
AC	Alternating current	LT	Power unit
BB	Ready-to-operate	M24	Reference potential 24 V
BBext	Ready-to-operate (external)	MR1	Torque direction 1
BBint	Ready-to-operate (internal)	MR2	Torque direction 2
BSA	Reference potential analog	n = 0	Speed = 0
BSD	Reference potential digital	n_{ist}	Speed actual value
CiA	CAN in Automation	n_{max}	Maximum speed
DC	Direct current	n_{min}	Minimum speed
DIN	Deutsches Institut für Normung e.V. (German Institute for Standardization)	NN	Altitude over sea level
EMF	Electromotive force	n_{soll}	Speed set value
EMC	Electromagnetic compatibility	PE	Protective conductor
EN	European standard	PELV	Protective extra-low voltage with safety separation, earthed
ESD	Electrostatic discharge	RF	Controller enable
EXT, ext	external	SELV	Safety extra-low voltage with safety separation
FI	Residual current	SH	Quick stop
HS	Main contactor	SM	Synchronous motor
î	Peak current, curve shape not defined	TM	Motor temperature sensor
I_{AC}	Effective value, alternating current	U	Voltage
I_{Aist}	Armature current actual value	Û	Peak voltage
I_{DC}	Effective value, direct current	U_A	Armature voltage
I_{eff}	Effective value, alternating current	U_{AC}	Effective value, alternating voltage
IF	Pulse enable	U_{DC}	Effective value, direct-current voltage
I_F	Field current	U_{eff}	Effective value, alternating voltage
ID No.	Identification number	U_{ZK}	DC-link voltage
Ink	PPR count of incremental encoder	V	Volt
IS	Impulse inhibit	VDE	Association for Electrical, Electronic & Information Technologies
ISO	International Organization for Standardization	ZK	DC-link

B

APPENDIX B - SAFE STOP

In this chapter the safety function „Safe stop“ is described for Servo-Power-Unit.

B.1 Methods to avoid an unexpected starting

In order to avoid danger for persons, for example operators, service- and maintenance technicians, the machine must be kept in a safe state (safe stop), while taking action in the dangerous area of the machine. Therefore a reliable prevention of an unexpected starting is required (Machine Directive 2006/42/EG, attachment I, 1.2.4; EN ISO 12100-1; EN 60204-1, 5.4; EN 62061; EN 61800-5-2). Unexpected starting causes a risk for persons, because of its unexpected occurrence (EN 292-1).

Besides the transmission of the enable state into the operating state of the machine, the unexpected starting of the machine must be considered. This is the transmission from the safe stop into an unsafe moving. Unexpected starting refers to an interruption of the control loop of the machine. The drive achieves the maximum speed at maximum acceleration, due to its control. The operator will not be able to leave the danger area or to remove his hand from the danger area. Therefore, the drive must be kept safe „off-position“ with opened and electrical interlocked safety devices. The motor must be in torqueless state. Thus, the motor cannot generate a dangerous movement.

The prevention of an unexpected starting of the machine is reached with electrical separated safety devices, e.g. contactors.

This is not state of the art, because the conventional operation in the power circuit of the drive may cause unnecessary wear on the switching element and long response times in the machine.

Some machine types are not electrically isolated between the electrical connection of the drive and the power supply. If, for example, a drive supplied by a power converter is stopped and started again very often and in short intervals. The constant discharging and recharging of the DC link represents a great stress for the parts and leads to disturbing delays and early failures of the parts.

The integration of the protection function is more efficient for preventing an unexpected starting directly into the inverter. Here, the drive is not isolated from the power supply. However, the commutation of the power semiconductors is safety prevented in the inverter.

In power modules BUS 621, 622, 623 624, this occurs by the safety relay, which switches off the power supply for the IGBT control (cutoff method 1).

A second cutoff method is realized by the two usable Baumüller controllers M-Drive and V-controller via the pulse enable channel: Here, the pulses for the IGBT activation are also blocked.

Physical relationship

The precondition for starting an AC motor is the generation of a rotating field, which drives the armature of the motor. When having variable-speed AC current drives, in the microprocessors usually a complex pulse pattern is generated. Then the pulses are amplified and are used for switching the power semiconductors. If no defined pulse pattern is available or the amplifying connection is interrupted, e. g. by switching off the power supply with a relay (safety relay), then a rotary field cannot be generated. An error at the pulse pattern generation therefore cannot lead to a starting of the motor, as long as the second precondition, namely the interruption of the amplifying power supply is available and vice versa. The protection against unexpected starting is reached by an electromechanical method which is superior to the electronics. This is reached by a safe isolation, which is not executed in the load circuit.

Energy supply of the motor windings at a stop is reached by inhibiting the power semiconductors. Semiconductors can fail or can be started accidentally, due to electromagnetic interferences. The behavior of the shut down drive must be considered, in case of this error. The fail and the accidental switching on of a single or of several power semiconductors at the same DC-link pole, does not cause does not lead to an uncontrollable starting, as there is no current flow. If an additional power semiconductor is enabled at another pole, current is able to flow through the motor. If, thereby the DC link is directly short-circuited, the fuses which are upstreamed to the converter are tripped, the motor doesn't start. If the DC link is „short-circuited“ over a winding of the motor, a magnetic field can be set up in the motor. If it is an asynchronous motor, then the generated d. c. magnetic field cannot cause a movement of the rotor. By the permanent-magnetic synchronous motor the rotor will rotate into a notch position. The angular movement which is covered is dependable of the choke 's position and the number of pole pairs of the motor. It amounts to maximum 180° /number of pole pairs. Subsequently the enabled DC link operates like a brake, this means after the ending of the movement the drive is in a blocked state. A starting of the drive is impossible. If a machine with a synchronous motor is planned, the possible movement must be considered, because it can lead to a dangerous movement. Therefore the machine constructor must carry out a safety evaluation for the residual movement.

**NOTE**

At total failure of an internal driver (IGBT) or an control element, it can trigger a temporary excitation of the drive (also in the STO state).

If the link to a winding of the motor is „short-circuited“, a magnetic field develops in the motor. If this is an asynchronous motor, the generated DC field cannot effect a movement of the rotor.

The rotor in a permanently energized synchronous motor will rotate into a notch position. The angular movement depends on the rotor position and the number of pole pairs of the motor. It amounts to a maximum of $180^\circ/\text{number of pole pairs}$.

The possible movement must be considered, if a machine with a synchronous motor is developed.

**NOTE**

The function is limited to the prevention of an unexpected starting. The switching of the safety relay, while the rotor of the motor is rotating, causes an uncontrolled „coasting“ of the machine. Braking with the converter is not possible.

**DANGER!****Danger to life by electrical current!**

Power supply voltage can be present at the motor and at the device, if STO / Safe stop function is active.

Therefore:

- De-energize the device, as it would be done with a device without safety relay. The device and the motor is **not** de-energized by the safety relay!

**NOTE**

There is no isolation from the supply system if the function STO/Safe stop is activated. There can be potential at the converter and at the motor. In the case of maintenance-, service- and repair- works on electrical components of the drive system, protection against dangers must be provided by other means (e. g. main switch).

B.2 Safe Torque Off (STO)

B.2.1 Safety classifications and safety notes

according to EN ISO 13849-1 and EN 62061

The power modules BUS 621, 622, 623, 624 in device models "-001", in conjunction with the two Baumüller controllers

- M-Drive of version "BUS6-MC-xx-xxxx-xxxx-**S1xx**-..."

or

- V-controller of version "BUS6-**S1**-VC-..."

have the safety function STO (Safe Torque Off).

The actuator in function STO is switched torqueless.

If no load acts on the drive shaft, the drive will stop after coming to a rest (coasting). No active threat therefore comes from the drive, provided that the STO function is selected. A start of the drive without the withdrawal of the STO function is not possible.

The STO-function meets the following safety classifications and standards:

- PL-d according to DIN EN ISO 13849-1 with the following parameters:
 - Structure: cat 3
 - MTTF_d: high
 - DC: low
- SIL 2 according to EN 62061 and 61508 with $PFH_{DssD} = 3 \times 10^{-10}$

Additional instructions for the STO function: EN 61800 part 5.2



NOTE!

Devices with the approval mark of TÜV Rheinland and the Safety label provide a certified safety function, only, refer to [▶Page 23◀](#).



**NOTE**

The safety classifications are valid, if the following safety notes were considered and were complied with.

- The classification of the safety category applies only to the STO function.
- The following switching measures must be met to achieve the safety function:
 - Two-channel connection of the cutoff
 - Control of the force-operated opener
 - Using an external circuit or a switching device that is suitable for the two-channel circuit with the necessary control (i.e., safety relay or safety controller)
- The perfect function of the relay must be checked at least once a year. The relay must hereby be unplugged, and the NC contact must be monitored for the closing function.
- Prior to switching on the drive for the first time (via a safety device), the state of the NC contact must be monitored for its closing function.
- Abruptly stopping the drive or an out-of-round operation can be triggered by an error in the safety chain. The drive must be switched off when this error occurs.
- Function STO separates the drive only from its torque and not the voltage. For safe separation of the supply, another action (i.e. the use of a main switch) must be used.
- In the unlikely event of total failure of an internal driver (IGBT) or an actuator element, it can trigger a temporary excitement of the drive (also in the STO state). The angular movement covered in this case depends on the rotor position and the number of pole pairs of the motor. It amounts to a maximum of $180^\circ/\text{number of pole pairs}$.

B.2.2 Function principle STO

Applications that require a risk reduction according to category 3, performance level d or SIL2 according to chapter [►B.2.1 Safety classifications and safety notes◄](#) from page 84 must have two independent cutoff paths, which are used to shut down the commutation in the power section of the inverter.

The power modules of series BUS 621, 622, 623, 624 have these two cutoff paths in connection with the Baumüller controllers M-drive or V-control.

The connection diagrams in this chapter and the instructions for the safety levels at the preceding page must be considered for the two-channel cutoff.

Cutoff path 1:

Safety relay of the power modules BUS621, 622, 623, 624

The function of the safety relay is executed in fail-safe-technic, also named closed-circuit principle. The safety function "safe stop" is active, as long as no voltage is applied to the input connectors (X68: 3,4). Consequently the functioning of the safety function is guaranteed if power failure takes place. In order to deactivate "safe stop" a voltage of 24 V has to be applied to the connectors, which are intended for this use (X68: 3,4).

For the external error monitoring of the safety relay', the instantaneous control state can be interrogated at its positively driven status signal contact (X68: 1,2). In case there is no voltage applied to the safety relay (X68: 3,4), that means during the "safe stop", then the status signal contact is closed (NC contact). Also a parting of a cable can thusly be recognized as an error.

If the voltage at the input connectors of the relay (X68: 3,4) is switched off, then the converter generates one or two error messages (F0204 and/or F0206), which it displays on the V-controller. The drive can only be taken in operation again, if these messages are deleted after a reset of the safety relay with a reset signal from the controller (for example by X26, pin programmable or over the interface to a bus system).

Cutoff path 2:

Pulse enable of the two usable controller types M-drive and V-controller.

The safety function pulse enable is active, as long as no voltage is present at the input connectors. In this case, the pulses for the IGBT activation are blocked.

In order to deactivate the second shutdown path, a voltage of 24 V must be applied to the available connectors.

Input connectors of the controllers:

M-drive: BUS6-MC-xx-xxxx-xxxx-**S1xx**-... : X26: IF+, IF-

V-controller: BUS6-**S1**-VC-...: X26:14, 20

The closing- and opening sequence of the release signals as well as of the safety relay must be considered in order to assure a faultless operation of the drive.

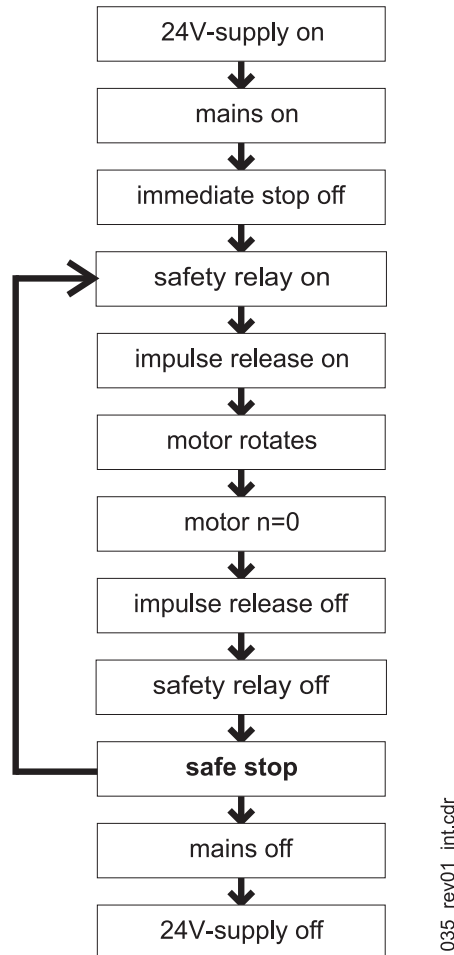


Figure 12: Sequence diagram of the safety relay

Before the commissioning of the machine, in which the converter with the safety relay is built in, the safety function “protection against unexpected starting” must be checked. For that purpose a safety device must be executed (for example door contact). The motor must now be zero-torque.

The two cutoff paths are shown in the following figures for the two usable controller types M-drive and V-control.

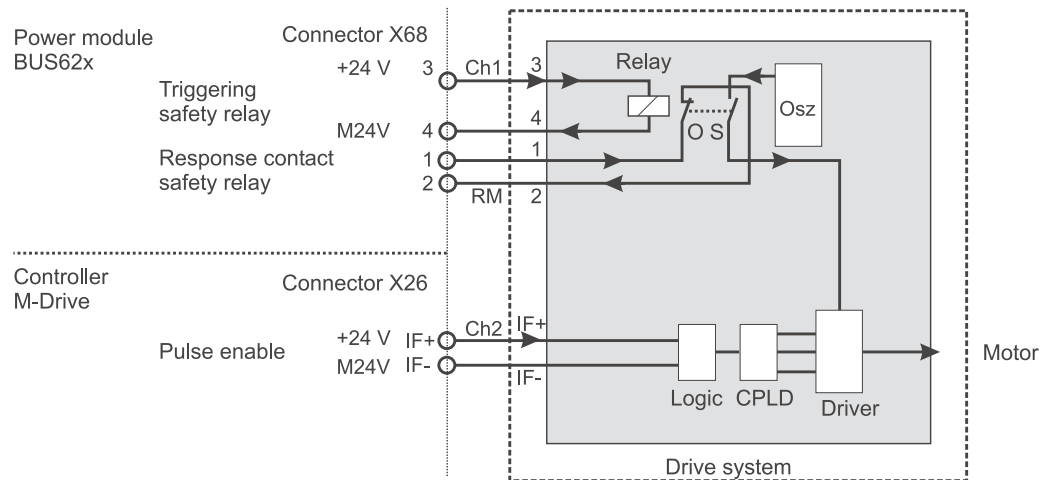


Figure 13: Cutoff paths for power modules BUS 621, 622, 623, 624 with controller M-drive

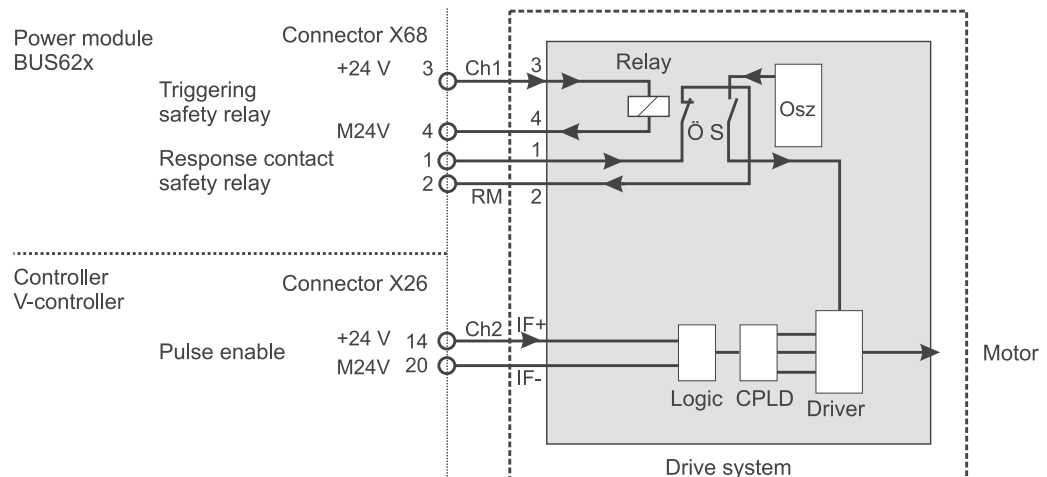


Figure 14: Cutoff paths for power module BUS621, 622, 623, 624 with V-controller

The **first cutoff path** on connector 68 of the power modules (safety relay) is realized by a positively driven relay, which interrupts the driver supply for the activation of the motor. Only when the relay is energized can the drive be set in motion (control inputs X68:3 and X68:4).

The condition of the relay contact can be queried via the force operated opener (signal outputs X68: 1 and X68:2).

The **second cutoff path** (pulse enable), which is guided via the respective controller, is used for a quick disconnect and leads over a semiconductor chain.

Only when the inputs are supplied with voltage will the driver generate the necessary signals for the motor rotation.

These are the following signal inputs:

M-drive: connector X26: IF+ and IF-
 V- controller: connector X26: 14 and 20

B.3 Safe stop

B.3.1 Safety categories according to EN ISO 13849-1

Dependent on the possible dangers (these dangers are rated due to the consideration of the severity of the injuries, the frequency of the length of stay within the danger area and the possibilities to prevent dangers) safety-related components of machines must meet defined safety criteria. The requirements to safety-based parts are divided into five categories in the standard EN ISO 13849-1.

Category B requires basic requirements. Safety-approved components and principles in category 1, additionally. In category 2 an error between inspection intervals can lead to a loss of the safety function.

Category 3 complies with the level „the single-error-certainty to recognize errors partially“. The safety-related components may not lead to a loss of safety function, if one single error occurs. The errors are not all detected by the system, however. The accumulation of undetected errors can lead to a loss of the safety function.

Category 4 complies with level „Self-monitoring“. This component detects possible errors. These errors are reported in time. Therefore, the loss of the safety function is avoided.

B.3.2 The safety relay

The function of the safety relay is performed in fail-safe technology, also called closed-circuit principle. The safety function "safe stop" is active, as long as no voltage is present at the input connectors (X68: 3,4). The function of the safety function is therefore guaranteed, even at a power failure. In order to deactivate the function "safe stop", a voltage of 24V must be applied to the appropriate connectors (X68: 3,4).

For external monitoring of the safety relay, the current switching condition can be queried on its force operated response contacts X68:3,4). If no voltage is present on the safety relay (X68: 3,4) therefore during the "safe stop", the response contacts are closed (opener). Even a broken cable can therefore be detected as an error.

If the voltage is switched off at the input connectors of the relay (X68: 3,4), then the inverter generates one or two error messages (F0204 and / or F0206), which it displays on the V-controller. The drive can only be put into operation again, if these messages are deleted after switching on the safety relays with a reset signal from the controller (i.e. X26, programmable pin or via the interface to a bus system).

Applications that require a risk reduction according to category 3 performance level d or SIL2 must have a second, independent disconnecting path. The safety relay is simply a disconnecting path. The connection diagram and the requirements and instructions in accordance with [►B.2.1 Safety classifications and safety notes◄](#) from page 84 must be considered for a two-channel cutoff.

The closing- and opening sequence of the release signals as well as of the safety relay must be considered in order to assure a faultless operation of the drive.

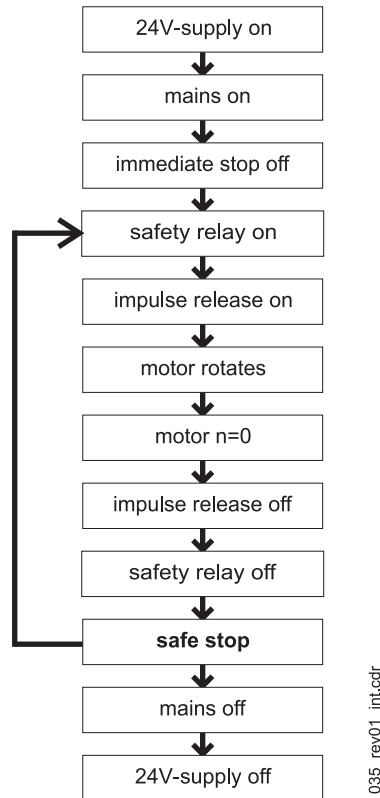


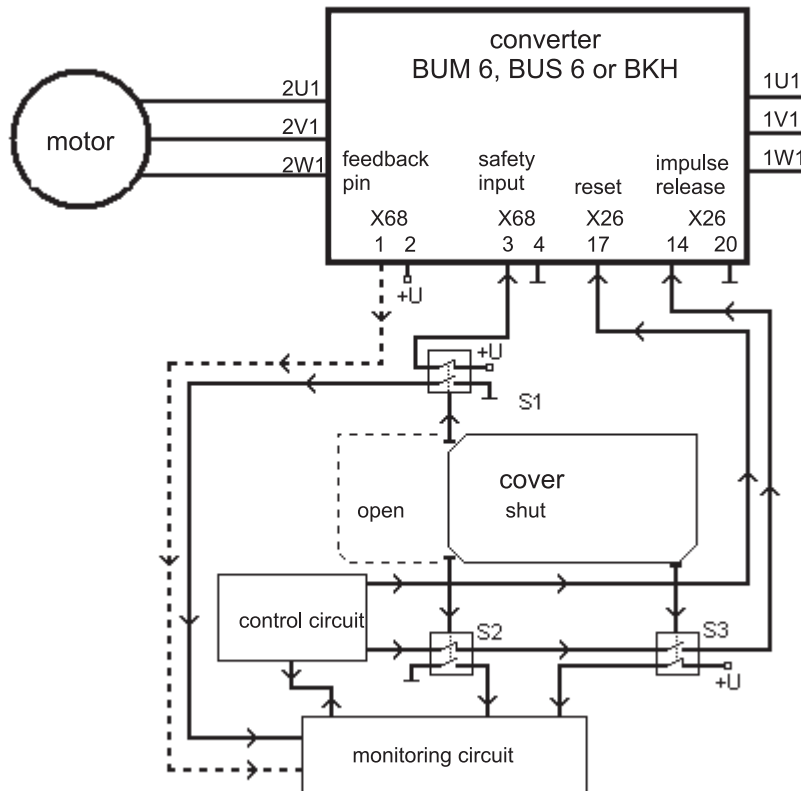
Figure 15: Sequence diagram of the safety relay

Baumüller-devices of the series BUM 6, BUS 6 and BKH, which are made with one safety relay (optional), comply with the requirements of the category 3 (EN ISO 13849-1) for the safety-relevant using “protection against unexpected starting”, if the configuring and installation instructions are complied with.

Before the commissioning of the machine, in which the converter with the safety relay is built in, the safety function “protection against unexpected starting” must be checked. For that purpose a safety device must be executed (for example door contact). The motor must now be zero-torque.

B.3.3 Application example for a machine of category 3 of EN ISO 13849-1

The following diagram shows an example of the application and wiring of a machine tool, in which the safe removal of workpieces with an open protective cover is possible according to Category 3 (EN ISO 13849-1).



036_rev01_int.cdr

Figure 16: Example for an application for safe stop according to category 3 (EN ISO 13849-1)

The switching-off of the electrical drive motor takes place dual-ported.

- S2 (NC contact) and S3 (NO contact) have hardware effects on the pulse release input of the converter (X26: 14). Only if S2 and S3 display a closed cover (and therewith a safe condition) voltage is being applied to the impulse release input of the converter.
- S1 (NC contact) has hardware effects on the safety relay of the converter. Only if S1 displays a closed cover (and therewith a safe condition) voltage is applied to the safety relay input (X68: 3) and therewith allows a torque generation at the shaft of the motor. The NO contact of S1 is connected with the monitoring circuit.
- The monitoring circuit, a fail-safe monitoring control of the category 3 (EN ISO 13849-1), checks on its own the directly connected switching contacts of the position switch S1 (NO contact), S2 (NO contact) and S3 (NC contact). If the barrier is not completely closed or a theoretical impossible condition of the position switch contacts is present (for example S1 and S2 show a different switching condition or S2 and S3 show the same switching condition), then the control circuit will not get a release signal from the monitoring circuit. A missing release signal of the monitoring device leads to a direct switching off of the converter by

means of the control circuit. If the monitoring circuit has recognized an error (for example different switch condition of S1 and S2), this is displayed to the operator and a commissioning of the drive is not possible until the error has been repaired.

- The status signal contact of the safety relay (X68: 1,2; NC contact) can additionally be evaluated by the monitoring circuit (not obligatory).
- The position switches, which are used, must unavoidable have actuated and mechanical connected contacts as well as a dual-port connection (NC contact/ NO contact). The mechanical operating at the safety device must take place unavoidable, that means tamper-resistant.

The connection cables between the safety relay input (X68: 3,4) and the control as well as between the impulse release input at the converter (X3:5) and the controller must not be installed outside the control cabinet in a common cable channel.

B.3.4 Application example for machine of category 4

Additional procedures when configuring a machine make it possible with a converter of the category 3 (EN ISO 13849-1) at safety-relevant operations for the “protection against unexpected starting” also category 4 for the complete drive.

A possibility is the usage of a contactor, with which the external conductors of the motor cable is short-circuited.

The diagram shows exemplary the usage and cabling of a Baumüller converter of the series BUM 6, BUS 6 or BKH of a machine tool, at which the safe taking of work pieces at opened barrier according to category 4 (EN ISO 13849-1) is possible.

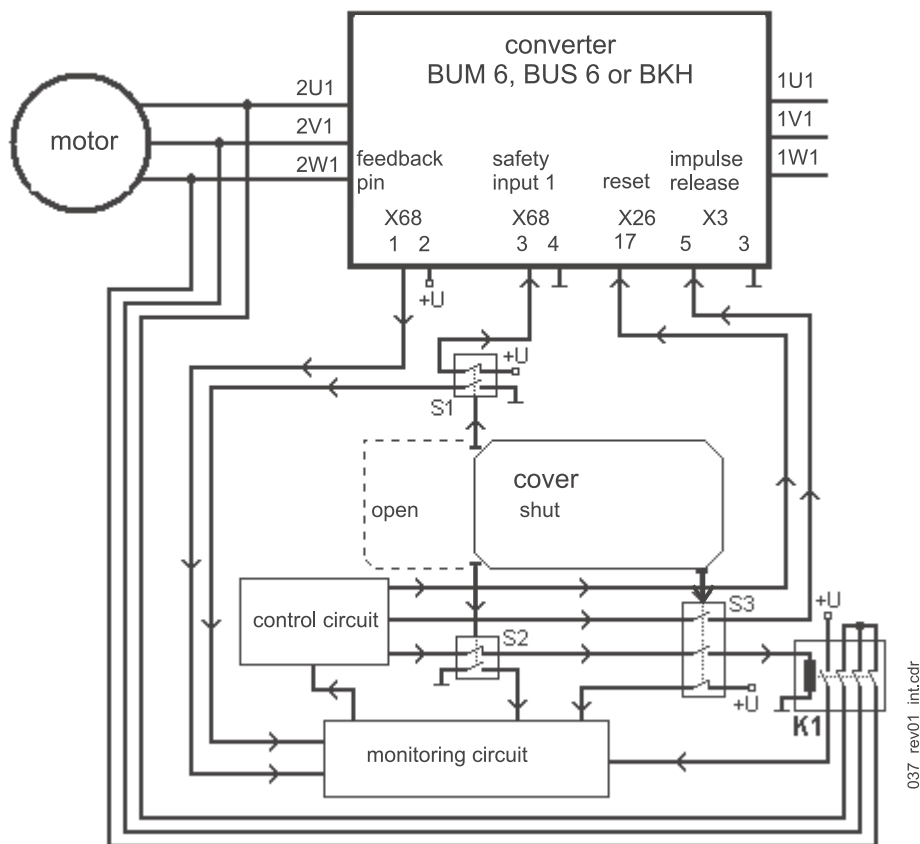


Figure 17: Example for an application for safe stop according to category 4 (EN ISO 13849-1)

The switching-off of the electrical drive motor takes place three-ported.

- The contactor K1 with three NC contacts short-circuits the current to the motor in the release state in all poles (closed-circuit current principle), so that no electrical energy of the converter arrives at the motor. S2 (NC contact) and S3 (NO contact) effectuate K1. Only if S2 and S3 display a closed barrier (and therewith a safe condition) K1 starts up and the short-circuit in the motor line is reset. The status signal contact of K1 (NO contact) to the monitoring circuit is constructed with mechanical with the NC contacts connected contacts. The selection of the contactor takes place after its limiting short-time current load capability (10 ms). This must be bigger than the nominal current of the used semiconductor fuses at the mains input of the converter.

- S1 (NC contact) has hardware effects on the safety relay of the converter. Only then if S1 displays a closed barrier (and therewith a safe condition) voltage is applied to the safety relay input (X68: 3) and therewith makes a torque generation at the shaft of the motor. The NO contact of S1 is connected with the monitoring circuit.
- S3 (NO contact) has hardware effects on the impulse release input of the converter (X26: 14). Only if S3 displays a closed barrier (and therewith a safe condition) voltage is applied to the impulse release input of the converter.
- The monitoring circuit, a fail-safe monitoring control of the category 4 (EN ISO 13849-1), checks on its own the directly connected switch contacts of the position switches S1 (NO contact), S2 (NO contact), S3 (NC contact) and the status signal contact of the safety relay (X68: 1,2; NC contact) as well as the contactor K1 (NO contact). If the barrier is not completely closed or a theoretic impossible condition of the position switch contacts is present (for example S1 and S2 show a different switch condition or S2 and S3 show the same switch condition or the status signal contact of the safety relay is opened/closed, although the status signal contact of S1 is closed/opened), the control circuit receives no release signal of the monitoring signal. A missing release signal of the monitoring device leads to a direct switching off of the converter by means of the control circuit. If the monitoring circuit has recognized an error (for example different switch condition of S1 and S2), this is displayed to the operator and the commissioning of the drive is not possible until the error has been repaired.
- The position switches, which are used, must unavoidably have actuated and mechanical connected contacts as well as a dual-port connection (NC contact/ NO contact). The mechanical operating at the safety device must take place unavoidably, that means tamper-resistant.

The connection cables between the contactor K1 and the control circuit as well as between the safety relay input at the converter (X68: 3,4) and the control circuit must not be installed outside the switching cabinet in a common cable channel.



NOTE

All information given in the Operation Manual of the converter, especially the chapters safety instruction, installation and commissioning, must absolutely be observed.

For the use and the installation of the safety devices the legal and official requirements of the government safety organizations and of the EU-Directives for safety requirements at installations and machines (for example EN 60204-1, security of machines, electric equipment and EN 292-2 security of machines general configuration directives) are valid.



Table of Figures

Wiring of the power cables.....	14
Dimensions	26
Calculation of the thermal RMS current	30
Coherence between peak current and rated current.....	30
Block circuit diagram	36
Type code	37
Drilling templates/installation space	45
Mounting - single ring core.....	53
Mounting - several ring cores.....	53
Connection diagram.....	56
Function diagram	62
Sequence diagram of the safety relay.....	87
Cutoff paths for power modules BUS 621, 622, 623, 624 with controller M-drive.....	88
Cutoff paths for power module BUS621, 622, 623, 624 with V-controller.....	88
Sequence diagram of the safety relay.....	90
Example for an application for safe stop according to category 3 (EN ISO 13849-1).....	91
Example for an application for safe stop according to category 4 (EN ISO 13849-1).....	93



Table of Figures



Index

A		L	
Abbreviations	79	Limitation of liability	9
Accidents	21	Low voltage supply	27, 32
Assembly instructions	46	M	
Attachment	46	Maintenance	67
C		Max. current	32
Caution	8	Messages	63
Connection instructions	57	Modifications	11
Connection strip X99A/X99B	59	Motor max. power	32
Coolant temperature range	32	Motor temperature sensor	54
Cooling	31	Moving	20
Customer service	10	Moving components, danger from	20
D		N	
Danger	8	Nominal current	32
Danger situation	21	Note	8
DC link capacitor	32	Notice	8
DC link discharge time	48, 68, 75	O	
DC link voltage	32	Operating personnel	17
Demounting	72	Operating requirements	27
Designation	37	Operation, improper	61
Disposal	10, 75	Output voltage	32
E		P	
Edges, sharp	43, 72	Packaging, disposal of	40
Electrical current, dangers of	19	PE connection	50
EMC package	60	Personnel, qualified	17
Energy supply / requirements	27	Personnel, training	17
F		Power part	35
Fire fighting	20	Power reduction	32
G		Protective equipment	18
Guarantee provisions	10	Protective eye wear	18
H		Protective gloves	18
Hard hat	18	Protective work clothing	18
Hazards, special	19	R	
I		Recommissioning	74
Initial commissioning	47	Repairs	69
Inspection	68	Required environmental conditions	29
inspection	68	Residual energy, danger from	19, 48
Installation	47	S	
Installation space	45	Safe stop	81
Installation, procedure	55	Safety categories	89
Interconnecting devices	37	Safety equipment	21
K		Safety relay	55, 86, 89
Key to symbols	8	Safety shoes	18
		Servo inverter	35
		Shutdown	71, 72
		Signs	22



Index

Signs and labels	22
Spare parts	10
Storage	71
Storage conditions	73

T

Temperature range	29
Temperature sensor	54
Terminals	55
Transport	39
Transport inspection	40
Type code	37
Typical motor power	32

U

UL508C	27, 55
Unexpected starting	81
Unpacking	40
Usage, compliant with the intended purpose	12

V

Voltage test	49
--------------	----

W

Warning	8
Warning notes	8
Weight	27

X

X60	60
X68	60

Z

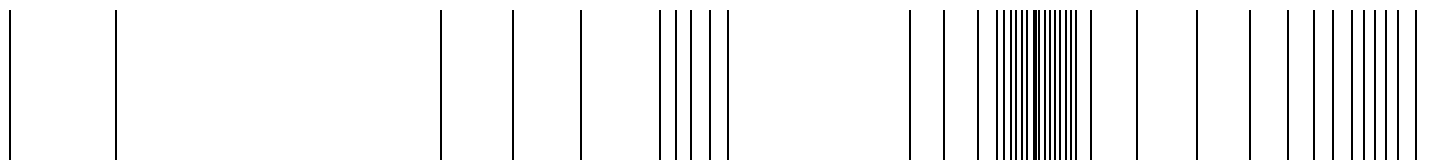
ZK+, ZK-	58
----------	----



Overview of Revisions

Version	Status	Changes
5.94035.09	21-Sep-2009	Revision chapter Safe Stop
5.94035.10	20-Apr-2020	Revision new layout

be in motion



Baumüller Nürnberg GmbH Ostendstraße 80-90 90482 Nürnberg T: +49(0)911-5432-0 F: +49(0)911-5432-130 www.baumueller.com

All information given in this manual is customer information, subject to change without notice. We reserve the right to further develop and actualize our products continuously using our permanent revision service. Please notice, that specifications/data/information are current values according to the printing date. These statements are not legally binding according to the measurement, computation and calculations. Before you make any information given in this manual to the basis of your own calculations and/or applications, please make sure that you have the latest edition of the information in hand. No liability can be accepted concerning the correctness of the information.