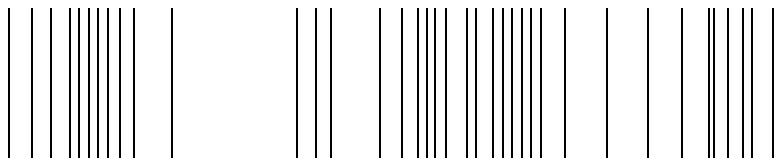


be in motion **be in motion**



POWER CONVERSION EQUIPMENT



**Mono Power Unit / Power
Module**

BUM 61 / BUS 61

Manual

E

5.97028.09



Title	Manual
Product	Mono Power Unit / Power Module BUM 61 / BUS 61
Version	5.97028.09
Status	2005-01-25
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Manufacturer	<p>Baumüller Nürnberg GmbH Ostendstr. 80 - 90 D-90482 Nürnberg Germany Tel. +49 9 11 54 32 - 0 Fax: +49 9 11 54 32 - 1 30 www.baumueller.de</p>

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ABBREVIATIONS

AC	Alternating current
BUM	Baumüller Single Power Unit
BUS	Baumüller Power Module
DC	Direct current
DIN	Deutsches Institut für Normung e.V. (German Standardization Authority)
EMC	Electromagnetic compatibility
EN	European Standard
MC	Main contactor
a.m.s.l.	Altitude above mean sea level
PELV	Protective extra-low voltage, grounded
SELV	Safety extra-low voltage
PE	Protective earth
SM	Synchronous motor
ZK	DC link

1 SAFETY INSTRUCTIONS

Introductory remarks

During operation, the principles on which converter and motor work, lead to leakage currents to ground. These are dissipated via the required PE connections and may lead to premature tripping of a current-operated e.l.c.b..

A DC component in the fault current may occur in the event of a short-circuit to frame or earth fault which makes a triggering of the higher-level current-operated e.l.c.b. more difficult or even impossible.

Connection of the converter to the mains using only the current-operated e.l.c.b. is therefore prohibited (prEN 50178 / VDE 0160 / 11.94, sections 5.2.11 and 5.3.2.1)

Protection of the units against direct contact is by installing the converters into common control cabinets that meet the minimum requirements as per pr EN 50178 / VDE 0160 / 11.94, section 5.2.4, in terms of the degree of protection.

Plastic covers attached to the units and covering control electronics, power unit and device connection, offer additional touch contact protection during commissioning and 'occasional use' of close-by control elements. (DIN VDE 0106 Part 100, Accident Prevention Regulation VBG4 "Electrical Systems and Equipment).

Personal safety is governed by DIN/VDE protective measures and safety standards.

If there are no PE connections on unit or motor, personal injury and/or considerable damage to material assets must be expected.

General information

These operating instructions contain the information required for the as-intended use of the products described herein. The document is intended for specially trained, skilled personnel who are well-versed in all warnings and maintenance activities.

The units are manufactured in accordance with state-of-the-art requirements and are safe to operate. They can be safely installed and put into operation and function without problems as long as the operating instructions are observed.



DANGER

Certain parts of this electrical unit carry hazardous voltage during operation.

Ignoring these safety instructions and warnings may result in death, serious personal injury and/or damage to material assets.

Only qualified personnel who are familiar with safety, assembly, operating and maintenance instructions may carry out work on this unit.

Danger information

On the one hand, the information below is for your own personal safety and on the other to prevent damage to the described products or to other connected units.

Safety instructions

In the context of the operating instructions and the information on the products themselves, the terms used have the following meanings:



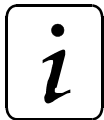
DANGER

This means that **death, severe personal injury or considerable damage to material assets** will **occur**, unless appropriate safety precautions are taken.



WARNING

This means that **death, severe personal injury or considerable damage to material assets** may **occur**, unless appropriate safety precautions are taken.



NOTE

This draws your attention to **important information** about the product, handling of the product or to a particular section of the documentation.

Qualified personnel

Qualified personnel in the sense of the safety-relevant information in these operating instructions or on the products themselves are considered persons who are familiar with setting up, assembling, commissioning and operating the product and who have qualifications commensurate with their activities.

- Trained or instructed or authorised to commission, ground and mark circuits and equipment in accordance with recognized safety standards.
- Trained or instructed in accordance with recognized safety standards in the care and use of appropriate safety equipment.

As-intended use



WARNING

You may only use the unit/system for the purposes specified in the operating instructions and in conjunction with the third-party equipment and components recommended or authorised by BAUMÜLLER NÜRNBERG GmbH.

For safety reasons, unauthorized modifications and changes to the unit are not permitted. The operator must immediately report any changes that might impact on unit / system safety.

Voltage test

BAUMÜLLER carries out a voltage test according to EN 50178 / VDE 0160 / 11.94, Section 9.4.5 for each unit.

Subsequent high-voltage tests must only be carried out by BAUMÜLLER NÜRNBERG GmbH.



WARNING

Disconnect all cables from BAUMÜLLER units prior to carrying out high-voltage tests on complete control cabinet installations.

2 TECHNICAL DATA

2.1 General

The single power unit BUM 61 and the power module BUS 61 are suitable for medium power range applications.

V controller boards are provided for control purposes. All V controller combinations may be used with up to three PCB levels.

Since all controller types are configured module by module, a separate description is available for each of these, specifying the respective characteristics and technical data.

The single power unit BUM 61 consists of the mains-end supply converter and the motor-end inverter, whereas the power module BUS 61 comprises only the motor-end inverter. Power is supplied via the DC link connections.

2.1.1 Functional description

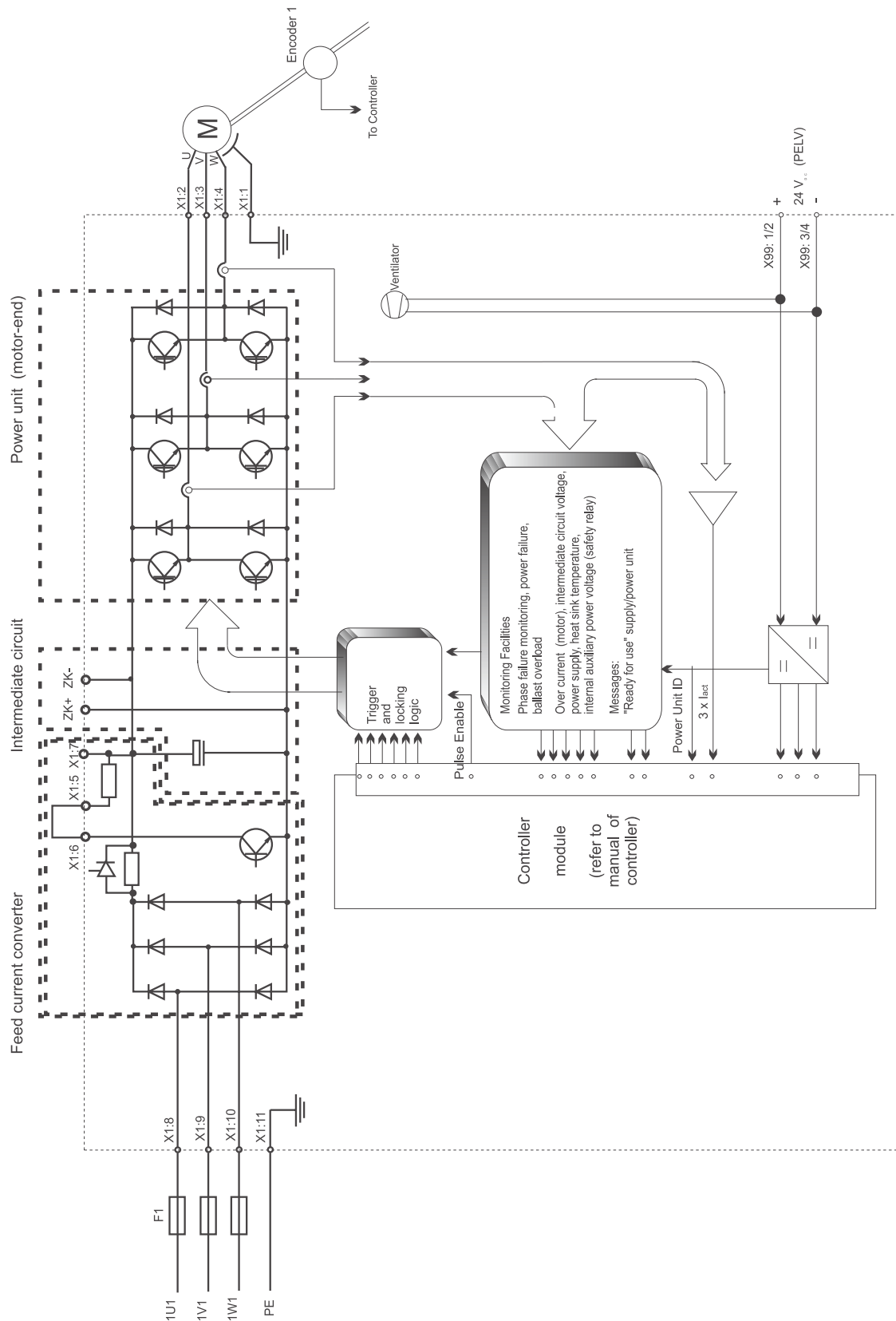
The complete unit BUM 61 consists of the three components of supply converter, motor-end inverter and controller unit. The various controller units are described in separate operating instructions and are not the object of this documentation.

- **Supply converter**
In the case of BUM 61, the supply converter is designed as an uncontrolled B6 rectifier with start current limiting and ballast circuit.
- **Start current limiting**
If there were no limiting circuit, direct device connection to the mains would lead to impermissibly high surge currents as a consequence of the DC link capacity. To avoid these surge currents, the start current is limited by a resistor.
- **Ballast circuit**
During specific operating states, the linked motor feeds power back into the converter. This power is stored in the DC link and increases the DC link voltage. To avoid reaching the overvoltage cut-off threshold, the fed-back power is converted into heat in the internal or external ballast resistor from a certain DC link voltage.
- **Motor-end inverter**
The inverter on the motor side consists of the IGBT power unit and the corresponding sensors. The sensors supply measuring signals for the closed-loop control and also ensure the self-protection of the power electronics.
The inverter is triggered by the controller used.

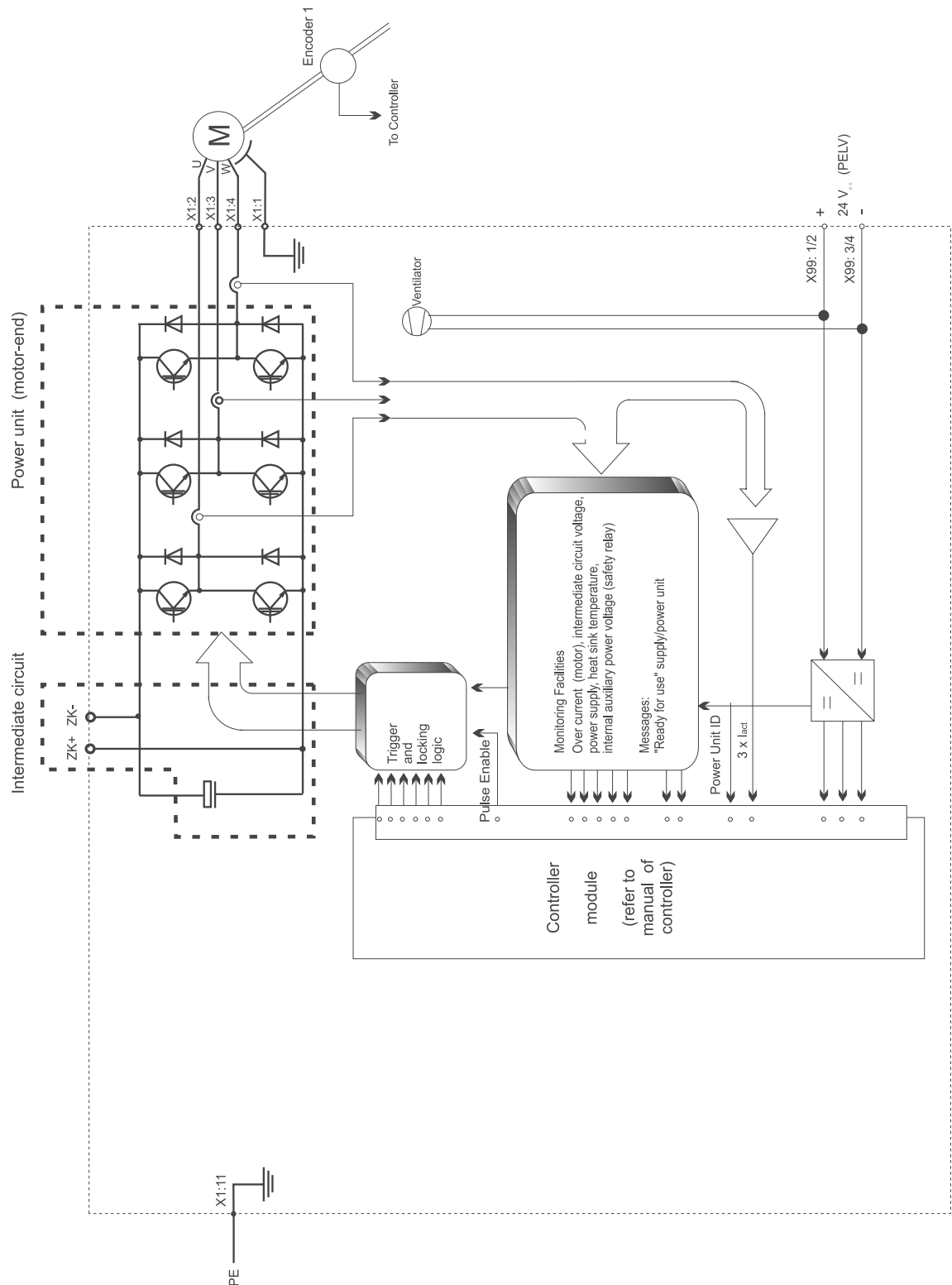
The power module BUS 61 has no supply converter with start current limiting and ballast circuit, comprising only the motor-end inverter and the controller unit.

In combination with devices with supply converters, this particular device may be used to set up multi-axis systems that allow power exchange via the DC links.

2.1.2 Block diagram BUM 61 (in principle)



2.1.3 Block diagram BUS 61 (in principle)



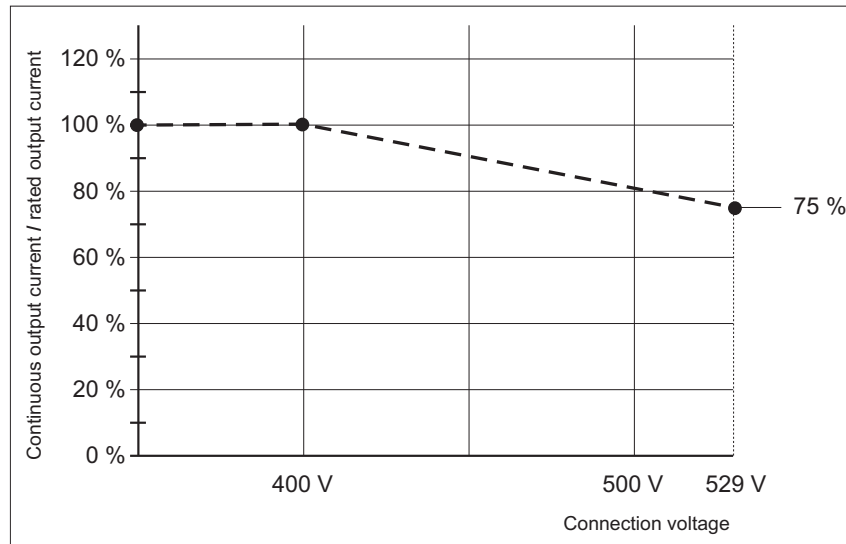
2.2 Technical data

		BUS 61 - 20 / 30 BUM 61 - 20 / 30	BUS 61 - 30 / 45 BUM 61 - 30 / 45	BUS 61 - 40 / 60 BUM 61 - 40 / 60
Connection voltage (mains) ¹⁾		3 x 400 - 460 V _{AC} -15% +15%, 48 - 62 Hz		
Supply voltage ²⁾		+ 24 V _{DC} - 20% / +20% (max. 55 W)		
Input power		15 kVA	23 kVA	29 kVA
Rated DC link voltage ³⁾		540 V _{DC}		
DC link capacity (internal)		925 µF	1160 µF	1395 µF
DC link capacity (external)		-	-	-
Output voltage ⁴⁾		3 x 0 V _{AC} ... 95 % of the connection voltage		
Output frequency ⁵⁾		0 Hz. ...400 Hz		
Continuous output power	at 4kHz ¹⁰⁾	max. 13 kVA	max. 20 kVA	max. 27 kVA
Continuous output power	at 8kHz ¹⁰⁾	max. 10,5 kVA	max. 16 kVA	max. 21 kVA
max. continuous motor power	at 4kHz ¹⁰⁾	9 kW	14 kW	18 kW
Max. continuous motor output	at 8kHz ¹⁰⁾	7.2 kW	11 kW	14.5 kW
Rated output current ^{6) 7) 8)}	at 4kHz ¹⁰⁾	20 A	30 A	40 A
Rated output current ^{6) 7) 8)}	at 8kHz ¹⁰⁾	16 A	24 A	32 A
Peak output current ^{6) 7) 9)}	at 4kHz ¹⁰⁾	30 A	45 A	60 A
Peak output current ^{6) 7) 9)}	at 8kHz ¹⁰⁾	30 A	45 A	60 A
Ballast current (external) (BUM 61 / BUS 61 with ballast only)		max. 40 A		
Connected load via DC link bar connection (BUM 61 only)		max. 14 kW		
Ballast resistor, internal (BUM 61 / BUS 61 with ballast only)		32 Ω / 150 W (short-term 18 kW (0.1 s))		
Ballast resistor, external (BUM 61 / BUS 61 with ballast only)		> 20 Ω continuous output as required up to max. 15 kW		
Ballast resistor cut-in threshold (BUM 61 / BUS 61 with ballast only)		780 V		
Ambient temperature ¹¹⁾		40 °C (rated temperature) 55 °C (maximum temperature)		
Power loss ³⁾	Connection Supply	245 W max. 55 W	350 W max. 55 W	460 W max. 55 W
Degree of protection		IP 20		
Site altitude ¹²⁾		max. 1000 m a.m.s.l.		
Relative humidity		15% ... 85% no condensation		
Temperature range for storage		-30 °C ... +70 °C		
Dimensions (W x H x D)		132 x 490 x 300 mm		
Weight including standard V controller		18.6 kg		

- Inter-phase voltage deviation must be max. +/-3.0 %.
- According to DIN 19240.
Low-voltage supply at voltages < 24 V reduce the fan power. It may therefore be necessary to reduce the output currents as well.
- All rated values refer to a connection voltage of 400 V and a supply voltage of 24 V.

4. The output voltage is an impulse-commutated direct voltage. The setting range refers to the r.m.s. value of the fundamental wave.
5. The output frequency depends on the controller used.
6. R.m.s. value at an ambient temperature of 40 °C.
7. The unit provides the rated/maximum output currents 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.



8. The rated output current must be reduced between 40 °C and 55 °C. The rated output current is calculated according to the following formula:

$$I_A = I_{A(40^{\circ}\text{C})} \cdot \left(1 - \frac{\text{Ambient temperature} - 40^{\circ}\text{C}}{^{\circ}\text{C}} \cdot 0,03 \right)$$

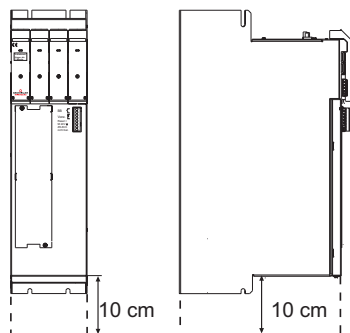
Example: Rated output current = 30A, ambient temperature = 47 °C:

$$I_A = 30\text{A} \cdot \left(1 - \left(\frac{47^{\circ}\text{C} - 40^{\circ}\text{C}}{^{\circ}\text{C}} \cdot 0,03 \right) \right) = 30\text{A} \cdot 0,79$$

The rated output current must therefore be reduced to: 23.7 A

9. The peak output current is available for periods $\leq 1\text{s}$. Rate the load cycle in such a way that the resulting output current r.m.s. value does not exceed the rated current.
10. Chopping frequency of the inverter.
(see description parameter P103 in the description of the V-controller)

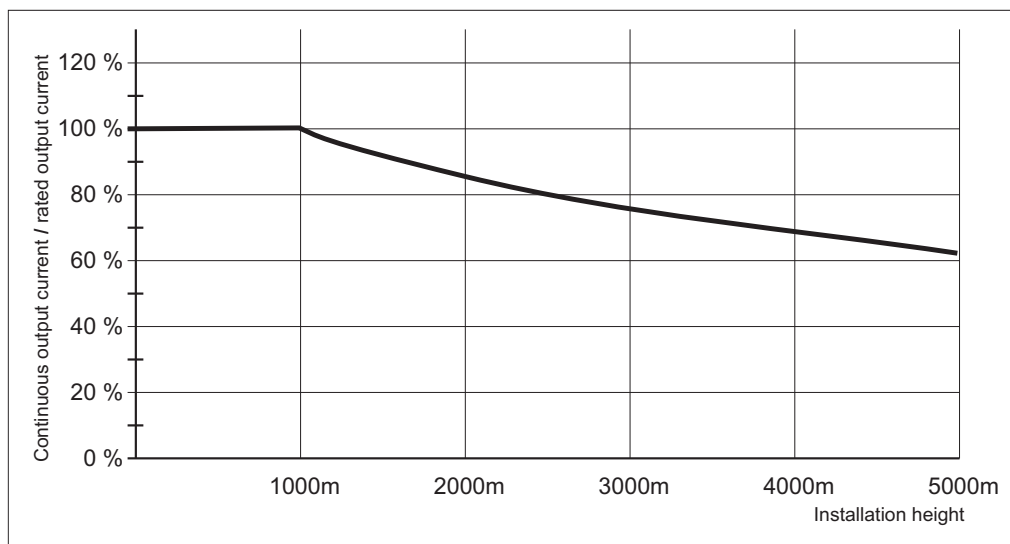
11. The ambient temperature is determined as follows:



- Determine several measuring points covering the entire area as illustrated at a distance of 10 cm.
- Measure the temperature at these measuring points.

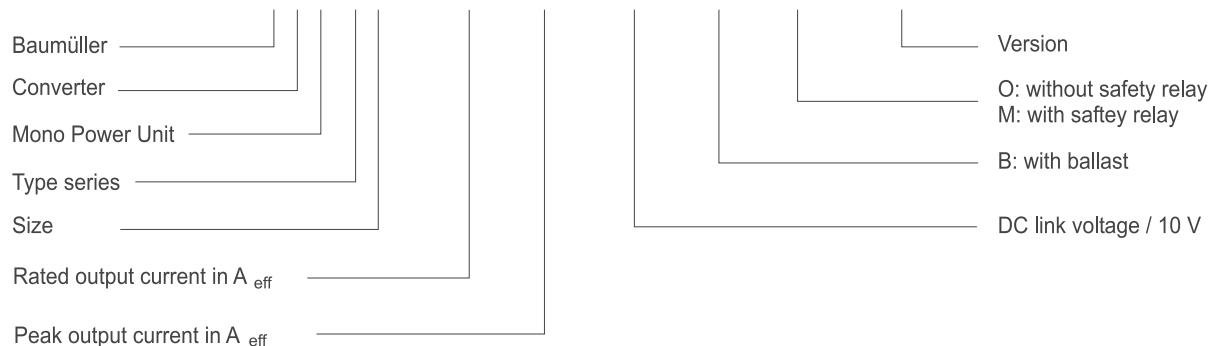
The highest value is the ambient temperature.

12. Characteristic 2: Values in relation to the site altitude.

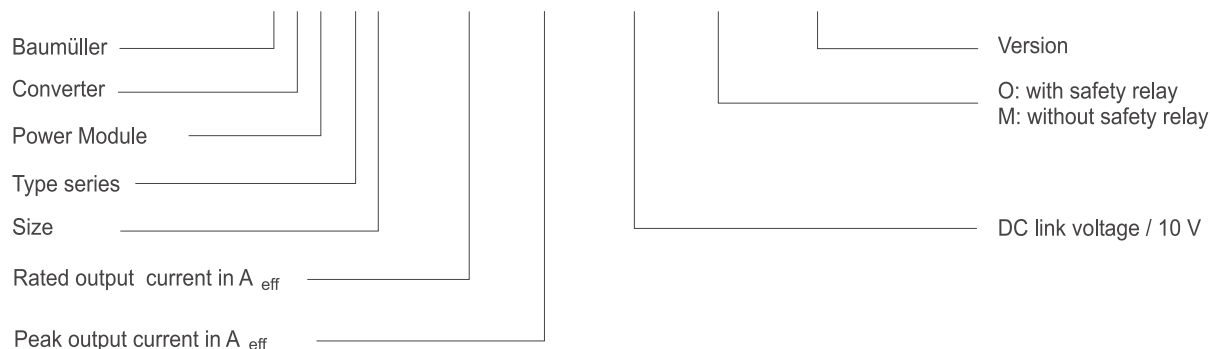


2.3 Type key

BUM 61 - 20 / 30 - 54 - B - X - XXX
BUM 61 - 30 / 45 - 54 - B - X - XXX
BUM 61 - 40 / 60 - 54 - B - X - XXX



BUS 61 - 20 / 30 - 54 - X - XXX
BUS 61 - 30 / 45 - 54 - X - XXX
BUS 61 - 40 / 60 - 54 - X - XXX



3 TRANSPORT, UNPACKING

The units are packed at the factory in accordance with order specifications.

Avoid in-transit vibration and shocks, e.g. when setting the units down.

After unpacking the units and checking that the shipment is complete and undamaged, you can start assembly.

The packing consists of fibreboard, corrugated cardboard and/or wood and can be disposed of according to the local regulations.

Report any transport damage without delay.



DANGER

Units that have suffered transport damage must not be connected before a proper voltage test has been carried out.

Non-observance of this information will result in death, severe personal injury or considerable damage to material assets.

4 ASSEMBLY

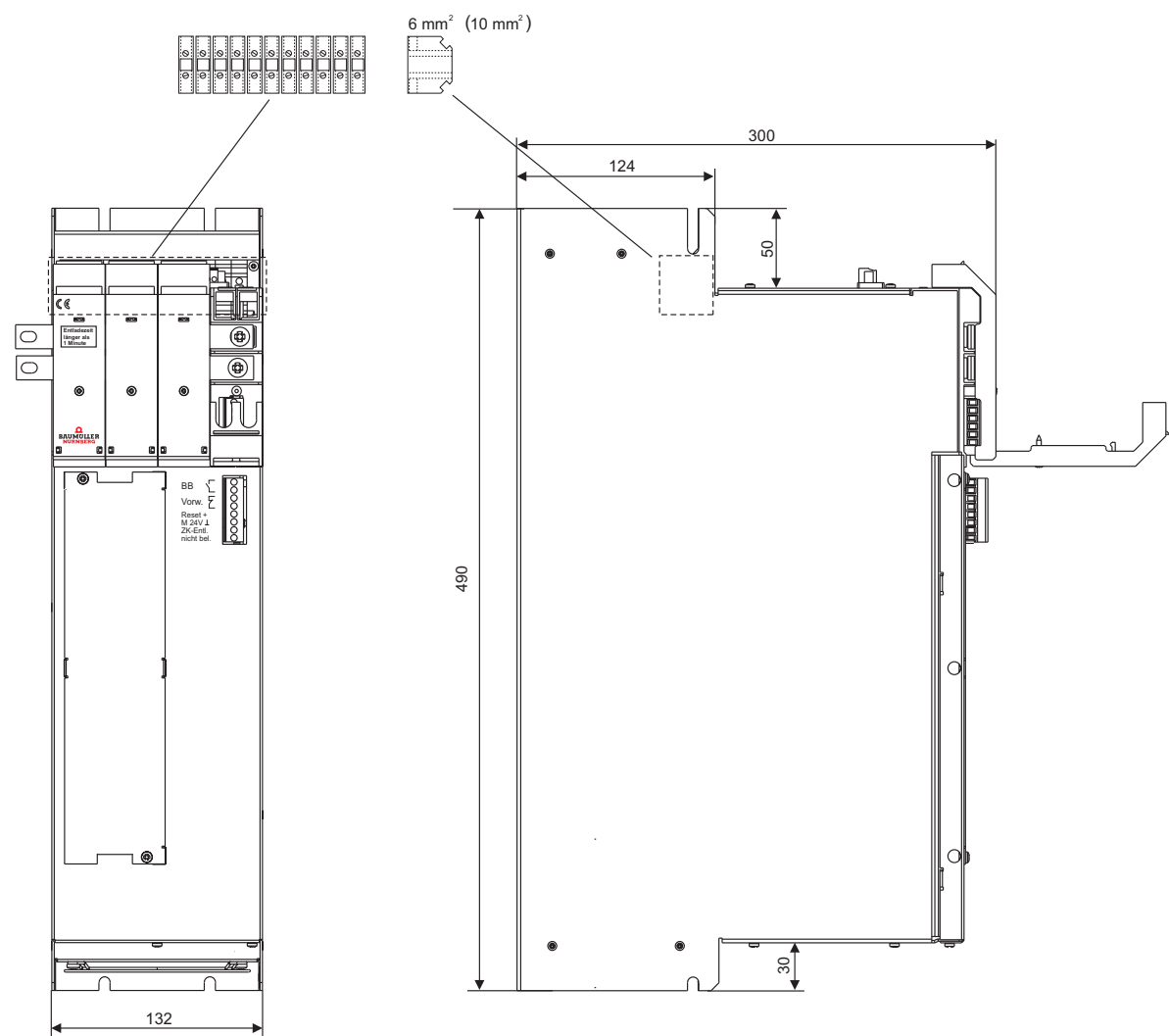


WARNING

The user is responsible for the assembly of the unit described, the motor, and the other devices according to the safety regulations (e.g. EN, DIN, VDE) and all other relevant national or local regulations concerning the conductor ratings and protection, grounding, disconnectors, overcurrent protection, etc.

Plastic covers attached to the devices and covering the device connection, offer additional touch contact protection during commissioning and 'occasional use' of close-by control elements. (DIN VDE 0106 Part 100, Accident Prevention Regulation VBG4 "Electrical Systems and Equipment).

4.1 Dimensions



4.2 Assembly information

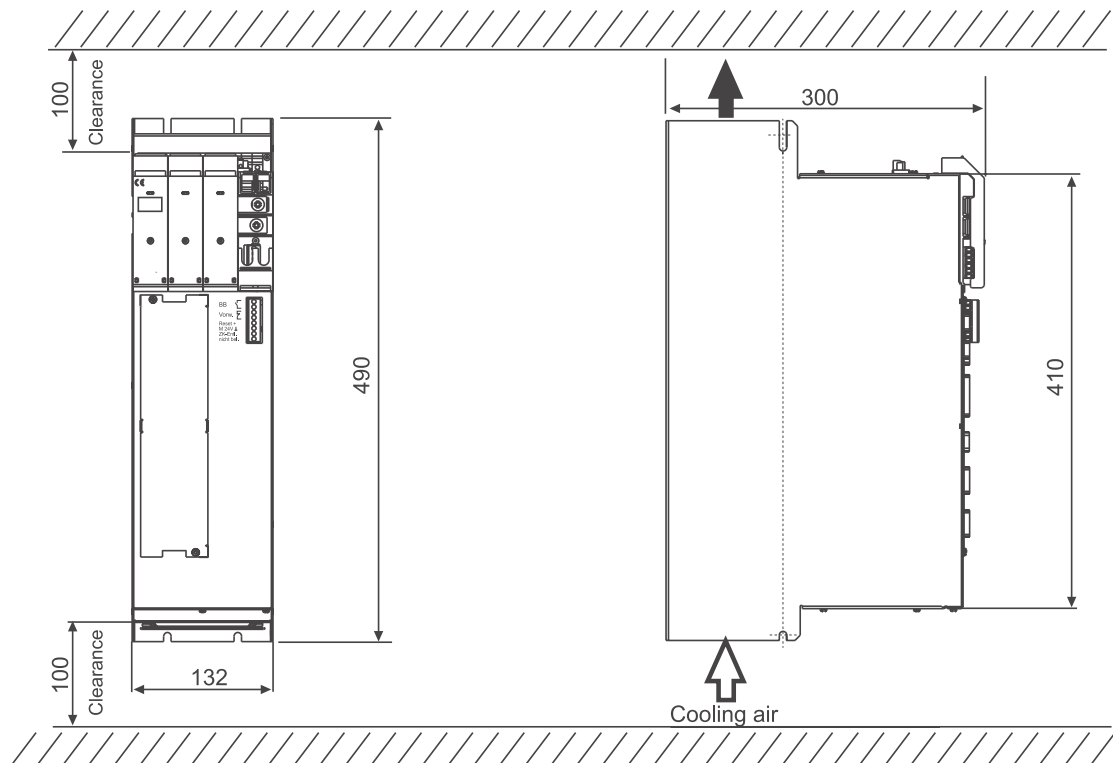


WARNING

The following measures for ventilation must be strictly observed.
Non-observance may lead to the device overheating.

- Ensure sufficient cooling air and ventilation!
- Ventilation must be from bottom to top, maintain a free space above and below the unit (refer "Free space" on page 23).
- The rated output of the unit is possible only up to a specific ambient temperature! The output must be reduced when higher temperatures occur (see "Technical data" on page 14).
- Do not locate any additional heat sources above the units.
- Pollution degrees 3 and 4 as per pr EN 50178:1994, section 5.2.15.2 must be avoided. The units are suitable for installation in closed operating environments. (VDE 0558 Part 1a, Section 5.4.3.2.1 and 5.4.3.2.2)

4.3 Free space



4.4 Attachment



WARNING

Inexpert lifting can cause personal injury or damage to material assets.

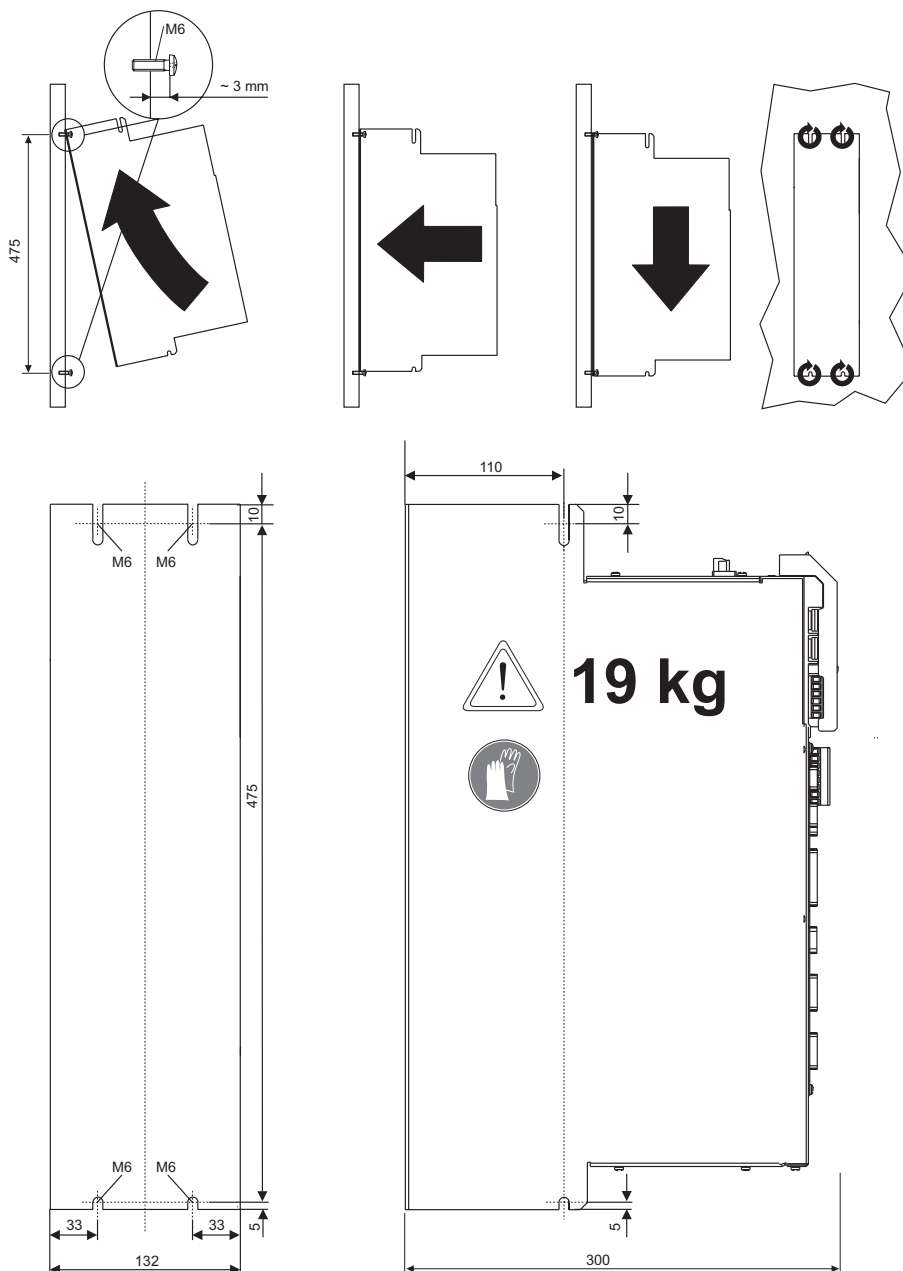
Qualified personnel only may lift the unit using suitable equipment.

Observe the weight of the unit!



Use protective gloves!

- Attach the unit / module vertically to the rear or lateral wall of the control cabinet.
Arrange several units / modules side by side.



5 INSTALLATION

5.1 Danger information



WARNING

This equipment carries a dangerously high voltage and has dangerous rotating parts (fans). Ignoring the safety and warning information may result in death, severe personal injury or damage to property.

The machine operator is responsible for mounting the power unit, the motor, the transformer and any other equipment in accordance with appropriate safety regulations (e.g. DIN, VDE); equally, you must ensure that all other relevant national and local regulations are met with regard to cable ratings and protection, grounding, disconnectors, overcurrent protection, etc.

Relatively high leakage to ground occurs in the converter and the motor, i.e. the drive may be incompatible with current-operated e.l.c.b.s (corresponding to provisional standard EN 50178:1994 Section 5.2.11.2).

You may only use variable-speed drives in applications that correspond to valid EN specifications.



DANGER

The DC link carries a voltage! It is imperative that the provided cover is used

Be particularly careful before touching the drive shaft directly or indirectly with your hands. This is only allowed when the system is deenergized and the drive is stationary.

Safety devices must never be deactivated.

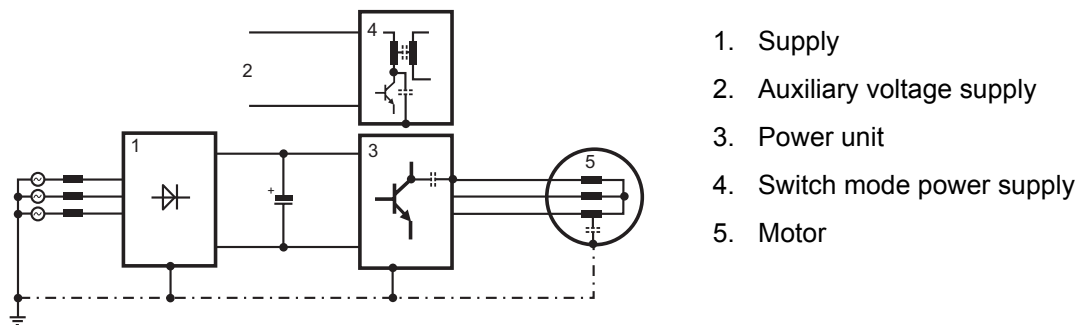
5.2 EMC information

General information on converters

New semiconductor technology (MCTs and IGBTs) aim at minimizing the power loss in the converter through faster switching operations, leading to ever smaller power units. This means that specific requirements must be met for the operation of converters to avoid electromagnetic influences caused by switching operations.

Disturbances may be caused by:

- capacitive fault currents. Caused by high rates of voltage rise when switching bipolar transistors and IGBTs.



- high currents and rates of current rise in the motor cables. The interfering energy bound in magnetic fields reaches frequencies of a few Hertz up to approx. 30 MHz. Due to the high rates of voltage rise, additional electromagnetic fields occur with frequencies of up to approx. 600 MHz.
- high chopping rates and fast logic circuits (electromagnetic field / 16 MHz .. 1 GHz).
- System perturbations and harmonics. These are caused by commutations and non-sinusoidal system loads in particular in the case of mains-commutated converters (100 Hz ... 20kHz).

German Electromagnetic Compatibility Act (EMVG)

This converter corresponds to EMVG §5 Section 5, Sentence 3 of EMVG (German Electromagnetic Compatibility Act) dated 09 Nov.92.

'Appliances, systems and components within the meaning of 3 above produced and intended solely as supplied parts or spare parts for processing by firms or persons with expertise in the field of electromagnetic compatibility shall not be required to satisfy the protection requirements and the requirements set out in §4 (1) nor do they require an EC declaration of conformity and marking provided they are not standalone appliances, systems and components.'

This takes into account that EMC is vitally dependent on how the individual modules and components are assembled in the control cabinet. In view also of the overall costs of the machine, preference should be given to interference-suppressing the entire system rather than its individual components.

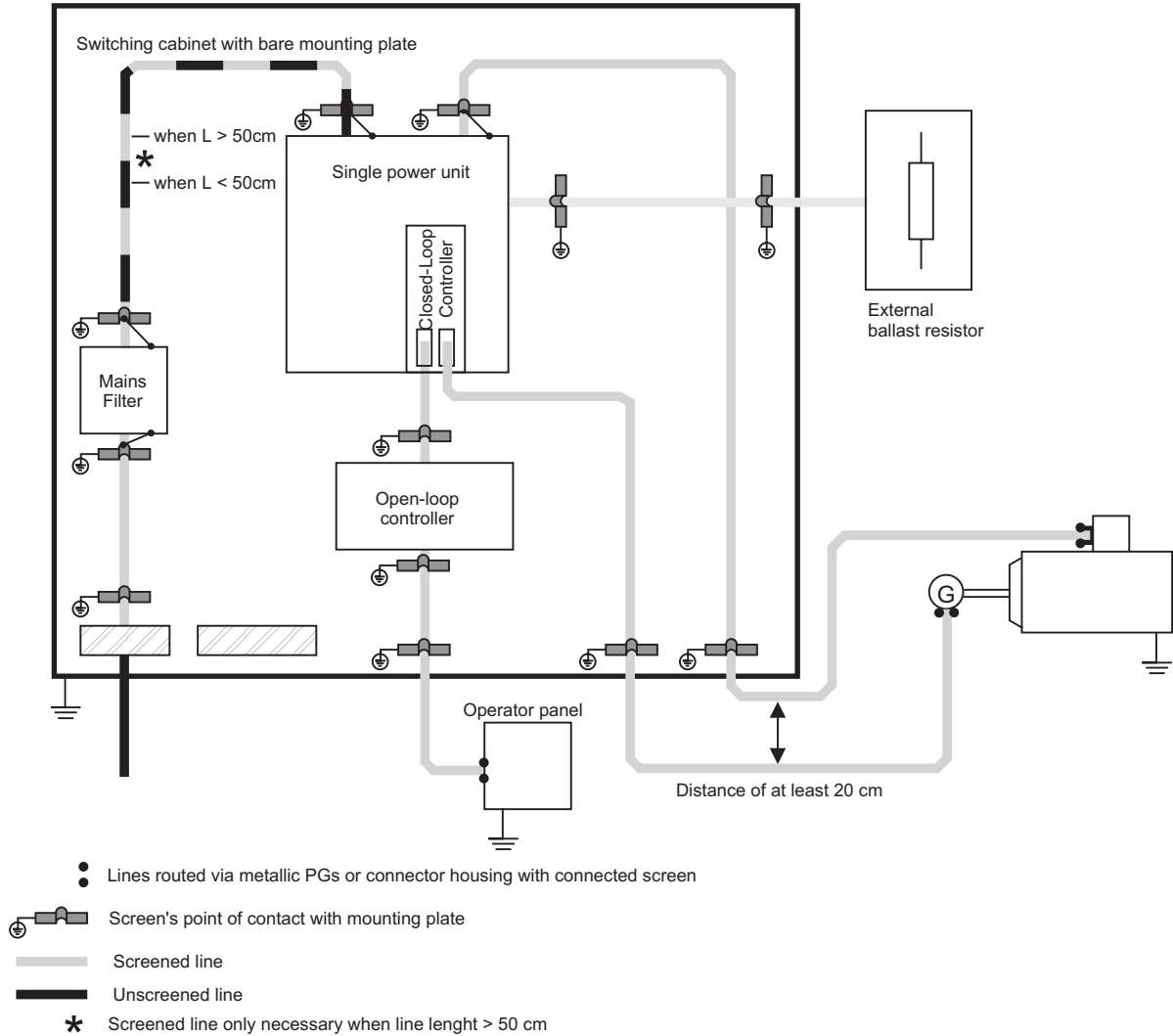
The information on the next pages is intended to allow the user to configure his plant according to the latest knowledge in the field of EMC and to comply with legal regulations.

Measures for ensuring EMC

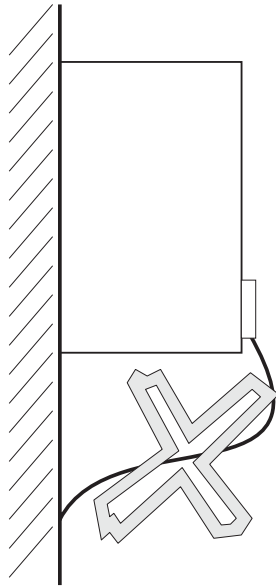
To ensure EMC you must observe the configuration information below.

Cabling

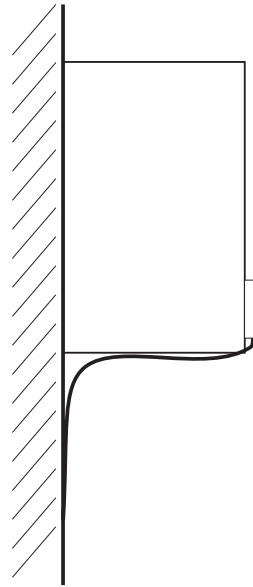
- To suppress disturbance outside the converter always screen **all** connected cables. Also observe the sections in chapter 'Screening'.



- The shortest possible effective antenna height is produced by laying the cable directly on to the ground of metallic racks.

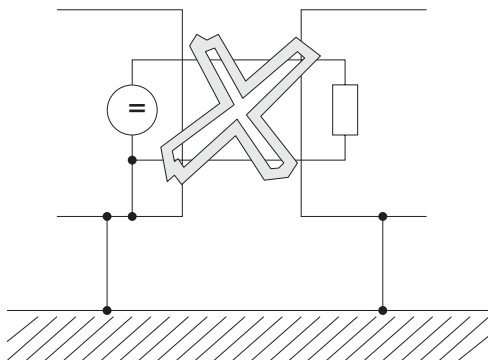


wrong

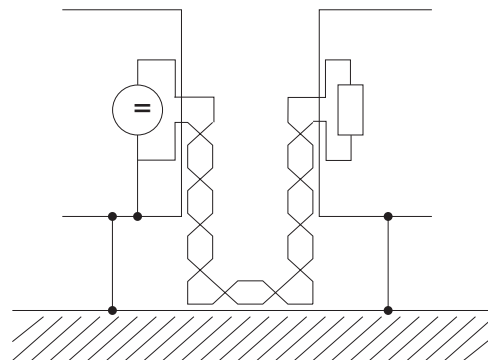


right

- As a rule, lay all cables as closely as possible to the ground system conductors to reduce the loop area effective for magnetic coupling.



wrong



right

- Laying signal and control cables parallel with power cables requires a minimum distance of 20 cm between the conductors.
- Cables of different EMC categories should only cross at an angle of 90°.
- For symmetrical signal transmission (e.g. differential amplifier inputs for the speed setpoint), twist the conductors of each pair together and twist the pairs of wires together.
- The converter / ground plate ground connection should be as short as possible (<30 cm). Use large cross-sections (>10 mm²).
- Disturbances such as contactors, transformers, reactors and modules susceptible to disturbance such as μ processors, bus systems etc. should be arranged at a distance of at least 20 cm from the converter and its cabling.
- Avoid reserve loops on overlong cables.
- Reserve wires in cables must be grounded at both ends (additional screening, avoidance of capacitively coupled, hazardous contact voltages).

Grounding

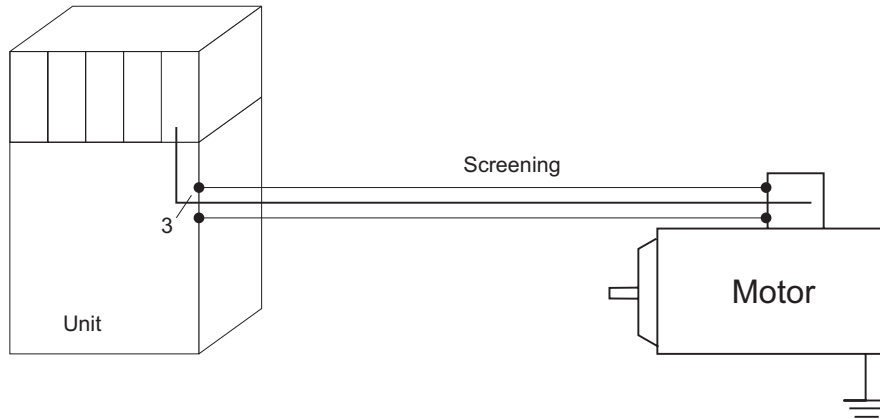
- The classic star grounding system no longer suffices from an EMC perspective to reduce the impact of higher-frequency interference generated through converter operation. Better results can be achieved by a reference surface to be linked to the units' ground (e.g. bright metal mounting plate and housing parts).
- Where no large-area reference surface is possible, the main equipotential bonding strip should be arranged directly at the converter that, compared to other components in the control cabinet, generates the highest potential jumps due to the steep switching edges (ground connection < 30 cm if possible).
- To avoid earth loops, lay all ground connectors and screens closely to the ground.
- If the controller reference potential of the converter can be grounded, use the largest-possible cross section and a short cable (<30 cm) for this purpose.
- Remove insulating layers such as varnish, adhesives, etc. from the ground connections. If necessary, use serrated lock washers (DIN 6798) or similar measures to ensure a permanent, conductive contact. To prevent corrosion on ground connections, use suitable metal combinations (electrochemical series of metals) and keep conductive electrolytes away from the connection by a protective coating (e.g. grease).
- Always connect screens at both ends over a large surface and conductive to ground. This is the only way to attenuate the effect of magnetic and high-frequency disturbances. Where earth loop-related problems occur (double grounding of the setpoint conductor screen, for example), connect the receiver end galvanically, the transmitter end capacitively.
- External cable screens running through separators between different EMC areas must be connected to these separators.
Cables which are passed through the panels of screening housings without special measures (e.g. filtering), may impair the screening effect of these housings. For this reason, you must make a conductive connection of the cable screens at the point at which the cable enters the housing.
The distance between the last screen contact point and the cabinet exit must be as short as possible.

Screening

- The screen is effective against magnetic fields when it is connected to ground at both ends.

With electrical fields, the screening is effective if the screen is connected to ground at one end.

For high-frequency electrical or magnetic fields (depending on the cable length), always connect the screen at both ends because of the linkage (electromagnetic field).



Connecting the screen to ground at both ends means in effect that the cable does not leave the screening 'system housing'.

- Connecting cable screens to ground at both ends does not completely eliminate impact due to earth loops (ground system potential variations). However, these are very rare if you observe the measures of the above chapters "Cabling" and "Grounding".

The HF connection of a screen to ground can also be capacitive to prevent low-frequency disturbances caused by earth loops.

Screen cables passing through different EMC areas must not be interrupted at the terminals, but should be run straight to the next module as the screening effect would otherwise be severely reduced.

The screen connection should be of low impedance and over a large surface. Where MHz-range disturbances occur, cable ends with a length of as little as 3 cm (1 cm wire = 10 nH) reduce the screening effect by up to 30 dB !



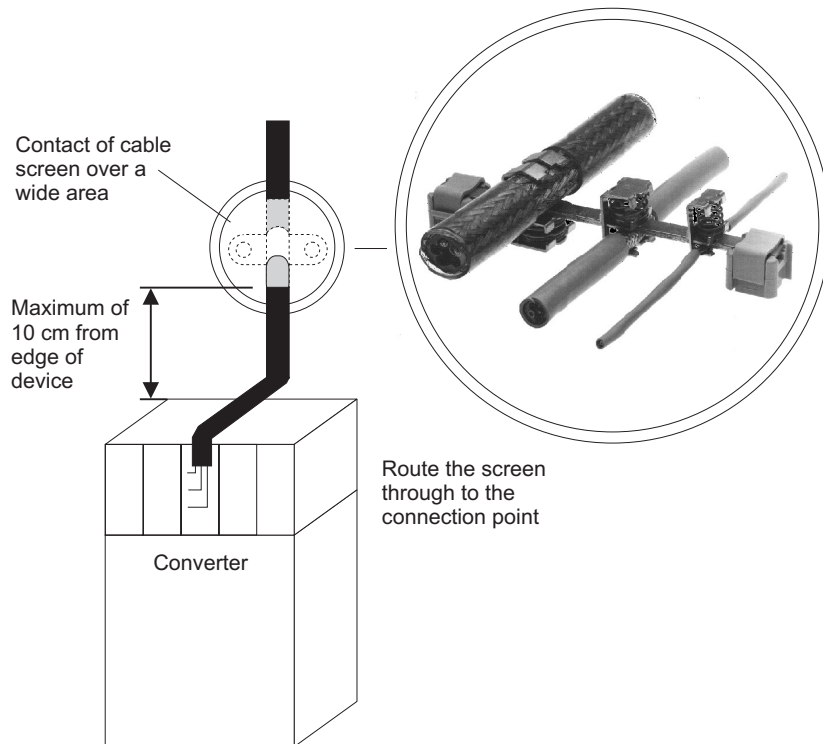
NOTE

The screen braid must have a coverage of at least 85%.

The following cables have a particularly high interference potential:

- Motor cable
- Cable to external ballast resistors
- Cable between mains filter and converter

- Suggested screen connection



Filtering

Although no filters are necessary for converter functioning, compliance with EMC standards may require them to be arranged at the input or output end.

If you have any queries about the filter dimensioning, please ask for the description "Baumüller Filters for Mains Applications BFN".

Filter assembly

- Mount the filter next to the converter. If the cables are longer than 30 cm, screen the mains cable between converter and filter (grounding at both ends).
- Input and output cables of the filter must be separated physically (distance > 30 cm).
- Connect the filter housing to ground over a large surface.

Leakage currents

Due to the principle of operation, stray capacities in the filter, power unit, motor cable and motor winding cause leakage currents of 100 mA and higher.

This means that converters with current-operated e.l.c.b. can be incompatible!

Observe the safety instructions in pr EN 50178:1994, section 5.2.11.2.

5.3 Applicable standards

The power units of the series BUM/BUS 61 are built-in devices according to prEN 50178 / VDE 0160 / 11.94, Section 5.2.6 and DIN VDE 0558 Part 1/07.87, Section 5.4.3.2.1.

Plastic covers attached to the devices and covering the power connections offer additional touch contact protection during commissioning and 'occasional use' of close-by control elements (DIN VDE 0106 part 100, accident prevention regulation "Electrical Systems and Equipment" VBG4).

If the devices are to be installed in closed electrical environments according to pr EN 50178/VDE 0160/ 11.94, section 5.2.7 and DIN VDE 0558 part 1/07.87, section 5.4.3.2.2, the user must take additional measures to ensure that the requirements according to pr EN 50178/VDE 0160/11.94, section 5.2.4 are met.

Mains connection

The power unit is intended for the permanent mains connection to TN and TT mains according to DIN VDE 0100, part 410/11.83 with a phase-to-phase mains voltage of up to 3 x 460 V + 15% ('and max. 5000 A short-circuit current' if UL508C, Nov. 27, 1996, tab. 44.1 is taken into consideration).

The power unit can be connected to IT mains using a line-side isolating transformer with the neutral grounded at the secondary side.

During operation, the principles on which converter and motor work, lead to leakage currents to earth. These are dissipated via the required PE connections and may lead to premature tripping of a line-side current-operated e.l.c.b.. A DC component in the fault current may occur in the event of a short-circuit to frame or earth fault which makes a triggering of the higher-level current-operated e.l.c.b. more difficult or even impossible. Universal-current sensitive current-operated e.l.c.b. and current-operated e.l.c.b. for AC and pulsating DC fault currents with a rated fault current of 300 mA are suitable.

Connection of the converter to the mains using only the current-operated e.l.c.b. is prohibited (pr EN 50178 / VDE 0160 /11.94, sections 5.2.11 and 5.3.2.1)

Climatic conditions / Temperature

In terms of the climatic requirements, the devices meet the prerequisites of climatic category 3K3 for weather-protected locations as per pr EN 50178/VDE 0160/11.94, section 6.1, table 7, line 3 or table 1 of EN 60721-3-1,2,3,4 in consideration of Notes 1 and 3 of pr EN 50178/ VDE 0160/11.94, section 6.1. The actual operating temperature range is larger and between 0 and +55 °C. For storage and transport, the specifications of Table 7 (lines 5 and 6) of prEN 50178/VDE 0160/11.94, Section 6.1 apply.

Deviating from these specifications, the storage and transport temperature of the units may reach values between -30 and +70 °C (see technical data).

Degree of protection

The degree of protection of the units is IP 20 acc. to EN 60529 (DIN VDE 0470-1).

The units are equipment of protection class I according to IEC 536/3 and DIN VDE 0106 part 1 (prEN 50178/VDE 0160/11.94, section 5.2.9).

Protection class I equipment features basic insulation plus an additional safety mechanism to protect against harmful shock currents. This additional protection is ensured by connecting enclosure and miscellaneous components to the PE conductor, so that there may be no voltage at all should the basic insulation fail. For these converters, insulation is designed as per prEN 50178/ VDE 0160/11.94, section 5.2.9.1 at least as per basic insulation requirements across its whole length. This also applies to the insulation between the individual circuits.

- The control connections of the converters are safely isolated from the mains and designed for PELV/ SELV circuit connection.
- The following criteria were considered for the dimensioning of clearances in air and creepage distances:
Pollution degree 2 as per prEN 50178/VDE 0160/11.94, section 5.2.15.2, table 2, line 3:
- Normally, only non-conductive pollution occurs. If the units are not in operation, condensation may bring about occasional short-term conductance.
- Overvoltage category III acc. to IEC 664-1, table 1 for clearances in air between mains current circuits and their environments acc. to prEN 50178/VDE0160/11.94, section 5.2.16.1.
- Voltage range of the mains current circuits for TN and TT systems acc. to DIN VDE 0100 part 410 / 1996 with a phase-to-earth voltage ≤ 500 V.
- Insulating material IIIa for creepage distances acc. to prEN 50178/VDE0160,/11.94, Section 5.2.17.

5.4 Safety relay

In this chapter we describe the safety relay.

5.4.1 Methods to avoid an unexpected starting

In order to avoid hazards against persons, for example operators, service- and maintenance technics, the machine has to be kept in a secure condition (safe stop), while interfering in the hazardous area of the machine. That is why a reliable prevention of an unexpected starting is demanded (amongst other things Machine directive 89/392/EEG, appendix I, 1.6.3, last passage; EN 292-2, 4.1.4; EN 60204-1, 5.4). Under unexpected starting is to be understood every starting that can cause a risk when appearing unexpected for persons (EN 292-1). Moreover, besides the transition of the release- to the operating condition of the machine also the unexpected ramp-up of the machine, this means the transition from the safe stop into an unsafe moving has to be considered. This is necessary, because the unexpected ramp-up usually is to be led back to an interruption of the control loop of the machine. In this case the drive is, because of its control system, anxious to achieve highest speed at maximal acceleration. If an unexpected starting occurs, the operator therefore doesn't have the possibility anymore to remove himself or his hand from the hazard area. This is why the drive has to be stopped and has to be kept safe in its 'off-position', when having opened, electrical interlocked safety devices. The motor may not have torque and thus cannot generate a dangerous movement.

The prevention of an unexpected starting of the machine can be reached by electrical separated safety devices, e.g. contactors. By some machine types it has to be done without the isolation of the electrical connection of the drive to the mains, if e. g. a drive supplied by a power converter is often stopped and started again. The constant dis- and re-charging of the DC-link represents a big stress for the concerned parts and often leads to disturbing delays and failures of these parts.

The requirement for the starting of a three-phase a. c. motor is the generation of a rotating field, which drives the inductor of the motor. When having variable-speed three-phase current drives, usually in the micro-processors a complex pulse pattern is generated, then the pulses are amplified and are used for the switching of the power semiconductors. If either no defined pulse pattern is available or the amplifying connection is interrupted, e. g. by switching off of the power supply with a relay (safety relay), no rotary field can be generated. An error by the pulse pattern generation therefore cannot lead to a starting of the motor, as long as the second condition, namely the interruption of the amplifying power supply is available and contrary. The protection against unexpected starting is reached by an electromechanical method which is superior to the electronics. It is reached by a safe isolation - elsewhere than in the load circuit.

The power supply to the windings of the motor is reached at a stoppage by inhibiting the power semiconductor. As semiconductors possibly can fail or be started, because of electromagnetic disturbances, the behavior of the shut down drive has to be considered if such a fault scenario arises. The fail or "accidental" turning on of a single or of more power semiconductors at the same DC-link pole does not lead to an uncontrolled starting, as no current flow is accomplished. Not until additionally a further power semiconductor is enabled at another DC-link 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 properties cannot cause a lurch of the inductor. By the permanent-magnetic synchronous motor the inductor will rotate into a notch position. The therewith angular movement which is covered is dependable of the inductor's position and the number of pole pairs of the motor. It amounts to maximal $180^\circ/\text{number of pole pairs}$. Subsequently the enabled DC-link operates like a brake, this means after the ending of the lurching movement the drive is in a blocked condition. A starting of the drive is impossible. If a machine with a synchronous motor is planned, the possible sudden movement must be considered, because it can lead to a dangerous movement. Therefore the machinist must carry out a safety evaluation for the residual movement.

The function of the safety relay is limited to the prevention of an unexpected starting. The switching of the safety relay, while the inductor of the motor is rotating, causes an uncontrolled "coasting" of the machine, a braking with help of the converter is not possible anymore.



WARNING

Both on the motor and at the unit there can be mains voltage although safety relay is switched off.

If required, switch the appliance off-circuit like an appliance without a safety relay - the safety relay does not switch the appliance and the motor off- circuit!

Turning off the safety relay has no isolation from the supply system as a consequence. Therefore, mains potential can be both at the converter and at the motor. The protection against electric hazards has to be therefore saved with other means (for example master switches) when maintaining, servicing or repairing electrical components of the drive system.

5.4.2 Safety categories

Dependant of the possible hazards (these are rated due to the consideration of the severity of the injuries, the frequency of the length of stay within the hazard area and possibilities in order to prevent hazards) security relevant components of machines have to meet certain safety criteria. The requirements to safety-based parts are divided into five categories in the standard EN 954-1.

In category B basic demands, in 1 additionally safety-technical proved components and principles are claimed. In category 2 an error between inspection intervals can lead to a loss of the safety function.

Category 3 accords to the level "the single-error-certainty to recognize errors partially". The safety-relevant components must be in such a way, that a single error doesn't lead to a loss of the safety function, whereat not the complete possible errors can be self-contained recognized by the system. Therefore an accumulation of unrecognized errors can lead to a loss of the safety function.

Category 4 accords to the level "Self-monitoring". This component recognizes self-contained possible errors and signals these in time of the loss of the safety function. Also if up to three from one another independent errors arise the safety function is always maintained.

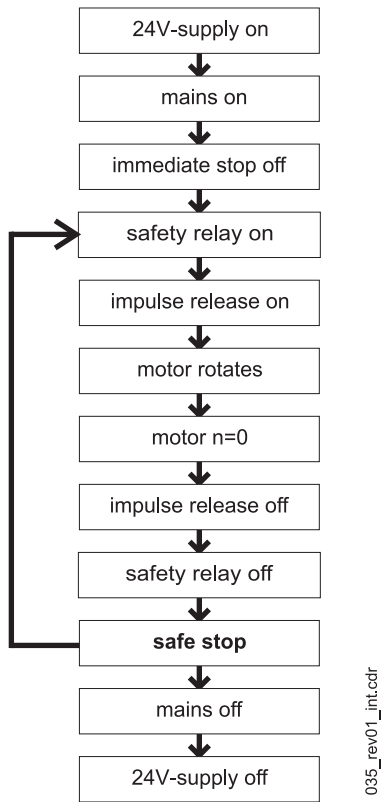
5.4.3 The safety relay

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 terminals (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 terminals, 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 terminals 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).

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.



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 954-1) 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.

If the reliability performance of the “protection of unexpected starting” once has been determined, then this safety function of the converter doesn’t have to be checked by an external monitoring, as the device checks itself on possible errors and if necessary displays a message as well as turns off the drive.

- 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.

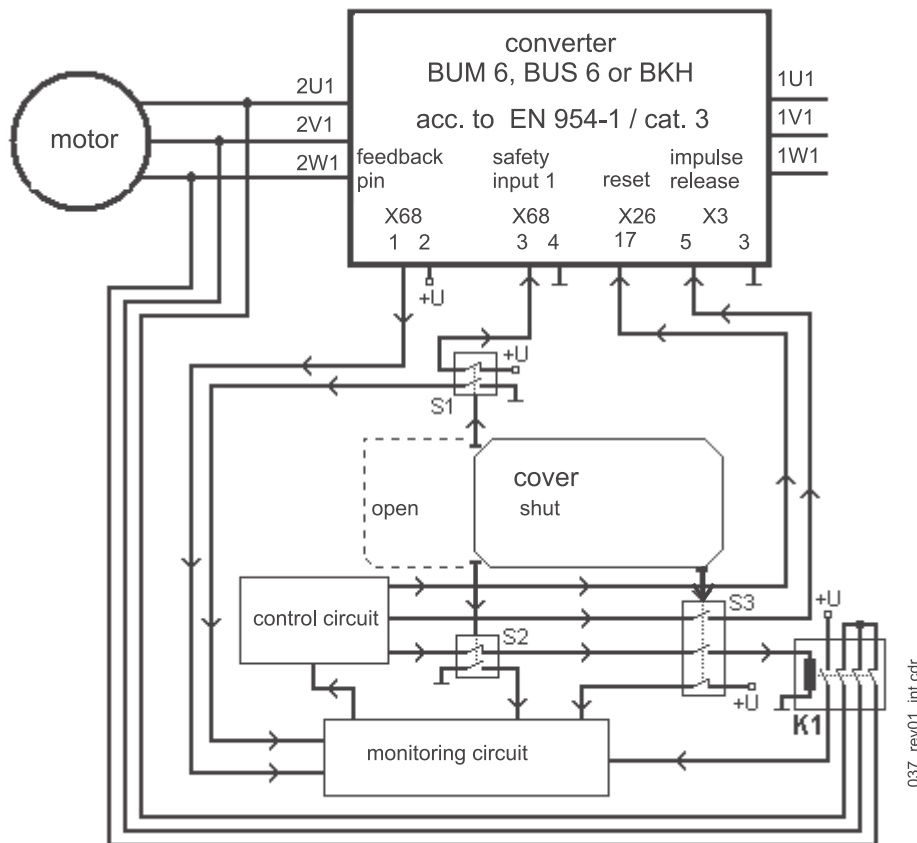
The connection cables between the safety relay input (X68: 3,4) and the control as well as between the impulse release input at the converter (X3:5) and the controller must not be installed outside the control cabinet in a common cable channel.

Application example for machine of category 4

Additional procedures when configuring a machine make it possible with a converter of the category 3 (EN 954-1) 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 954-1) is possible.



Example for an application for safe stop according to category 4 (EN 954-1)

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 954-1), 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 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 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

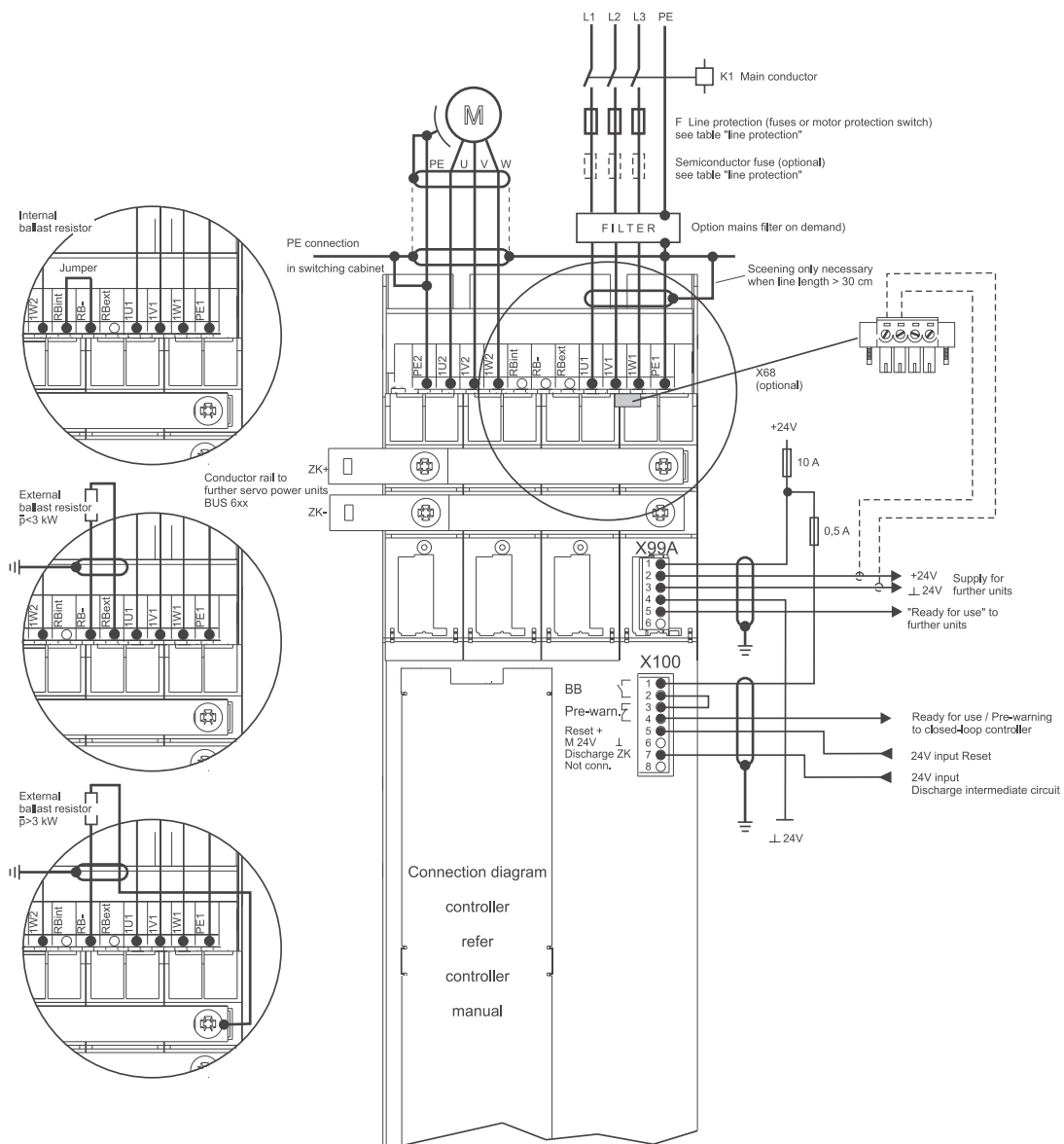
All information given in the Operation Manual of the converter, especially the chapters safety instruction, installation and commissioning, must absolutely be observed.

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.

5.4.4 Service time

The mechanical service time of the safety relay is at least 1×10^7 cycles of operation.

5.5 Connection diagram BUM 61



NOTE

Observe information in chapter 'ballast circuit'.

Fuses

Fusible links of duty class gL DIN VDE 0636 part 21 as well as MCBs, tripping characteristic K as per DIN VDE 0641 A4 may be used for mains-end protection of BUM 61 and cables. These fuses protect from overloads and consequential damage due to defects caused by fire, for example, but cannot prevent short-circuits or ground faults in the DC link from largely destroying the device.

Additional semiconductor fuses DIN VDE 0636, part 2, may be connected in series with the fuses to protect the input-end rectifier circuit from complete destruction, thus allowing the device to be repaired.

Mains voltage		400 V	480 V
Fuses	BUM 61 - 20/30 BUM 61 - 30/45	32 A	25 A
Fuses	BUM 61 -40/60	40 A	35 A
Semiconductor protection *	BUM 61 - 20/30 BUM 61 - 30/45	63 A	40 A
Semiconductor protection *	BUM 61 -40/60	63 A	63 A

* Please note if using semiconductor fuses:

Mains recovery after a short-term mains interruption may trigger the fuse.

Ballast circuit

The internal or an external ballast resistor may be connected depending on the requirements given by the application. Please note:

- Without internal or external ballast resistor, the charging circuit for the DC link does not work, in other words, 'Ready' is not possible.
- The internal ballast resistor is monitored for periodic overloads, an overload cancelling the basic unit's 'Ready' status. (-> on V controller error 110).



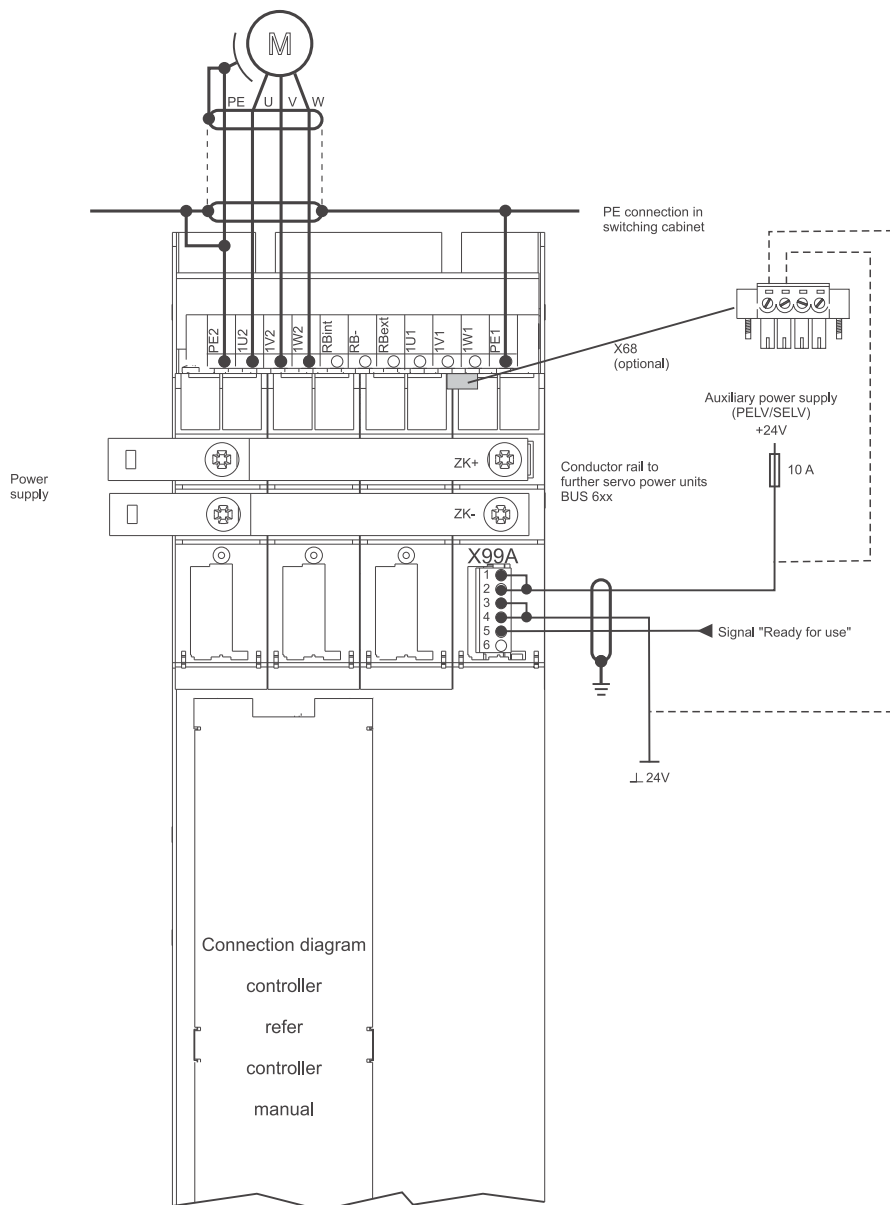
NOTE

The terminals for the ballast resistor are not overload, short-circuit and ground fault- proof. Connection of a resistor with too low an ohmic rating will destroy the device.

Resistors

- The internal resistor is activated by connecting a jumper between terminals RB- and RBint (refer "Connection diagram BUM 61" on page 40).
- External resistors with an actual continuous output of < 3 kW (*) are connected to terminals RB- and RBext (refer "Connection diagram BUM 61" on page 40).
- External resistors with an actual continuous output of > 3 kW (*) are connected to terminals RB- and ZK+ (DC link bar under the cover) (refer "Connection diagram BUM 61" on page 40).

* 'Actual continuous output' is the output that, depending on the application, is converted as braking power into heat on a time-average base.



5.7 Terminal strips and plug-in terminals

5.7.1 Power connections

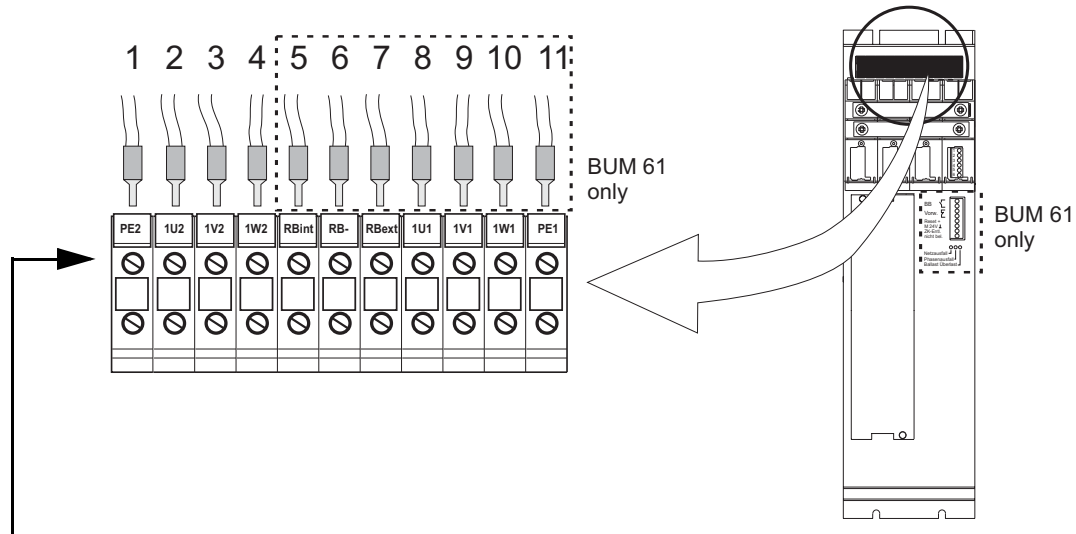


DANGER

Danger to life!

The permissible connection value (see 'Technical data') must never be exceeded.

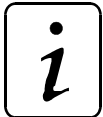
Terminal strip X1



Screw connections for cables with / without connector sleeve.
If UL508C is taken into consideration: Rated tightening torque 1.2 Nm or 10.6 pound-inches

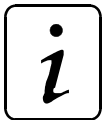
Terminal	Pos. ¹⁾	Description	U _{range} ²⁾	I _{range} ³⁾	A ⁴⁾
PE2	1	Earth connection	max. 570 V	max. 60 A	10 - 25 mm ² 8 - 4 AWG
1U2	2	Motor connection phase U			
1V2	3	Motor connection phase V			
1W2	4	Motor connection phase W			
RBint	5	Ballast resistor connection (BUM 61 only)	between RB- and RBint/RBext max. 780 V _{DC}	max. 40 A	
RB-	6	For internal ballast resistor: RB- is linked to RBint (jumped)			
RBext	7	WARNING Remove the jumper between RB- and Rbint when connecting an external ballast resistor! Otherwise the protective circuit of the internal ballast resistor would cancel out the functioning of the external ballast resistor and possibly overload and destroy the power unit. For external ballast resistor: The ballast resistor is connected to RB- and RBext.			
1U1	8	Mains connection, phase L1 (BUM 61 only)	400 V -15 % up to 460V +15%	max. 60A	
1V1	9	Mains connection, phase L2 (BUM 61 only)			
1W1	10	Mains connection, phase L3 (BUM 61 only)			
PE1	11	Earth connection			

1. Position
2. Voltage range (r.m.s. value)
3. Current range (r.m.s. value)
4. Select the connection cross-section in accordance with the applicable standards (VDE 0113/0298, among others), depending on the application. The specified values indicate which flexible conductors are safely connected.
If UL508C is taken into consideration: Only 60°C / 70° C copper conductors must be connected (UL508C, Nov 27, 1996, tab. 39.2. Rated tightening torque of the connecting screws: 1.2 Nm or 10.6 pound-inches.)



NOTE

It is vital to ensure the U, V, W connection assignment when connecting a permanent-field synchronous motor.



NOTE

Since start current limiting operates with the help of the ballast resistor, BUM 61 may be operated only if either the internal or an external ballast resistor is connected.



NOTE

Further information for considering the US standard UL508C (UL Standard for Safety for Power Conversion Equipment):

The devices are suitable for connection to mains with max. 5000 A short-circuit current (UL508C, Nov 27, 1996, Tab. 44.1)

DC link terminals ZK+ and ZK- (adding units)

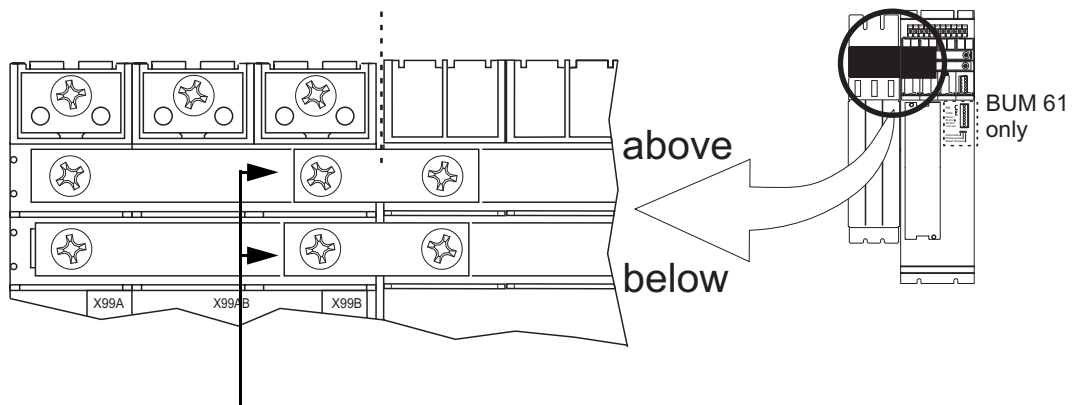
If a Baumüller unit is added to BUM 61 or BUS 61 is connected to a power unit, the DC links of the two units must be connected to each other.

If you add power modules to BUM 61, the BUM 61 supply converter supplies the connected power modules. The individual modules exchange power (e.g. during braking).



DANGER

The total power of the motors supplied by BUM 61 via the added power modules must not be higher than the power the BUM 61 supply converter can supply.



Screw connections for bar connection M6

If UL508C is taken into consideration: Rated tightening torque 4 Nm or 35.4 pound-inches

Terminal	Pos. ¹⁾	Description	U _{range} ²⁾	I _{range} ³⁾	A ⁴⁾
ZK+	top	DC link connection Connection of two Baumüller units	between ZK+ and ZK- max. 780 V _{DC}	max. 26 A	16 mm ²
ZK-	bottom				

1. Position
2. Voltage range (r.m.s. value)
3. Current range (r.m.s. value)
4. Conducting cross-section of the bars



DANGER

Reassemble and tighten the supplied covers after having connected the DC links of the two units using a bar.

5.7.2 Control connections



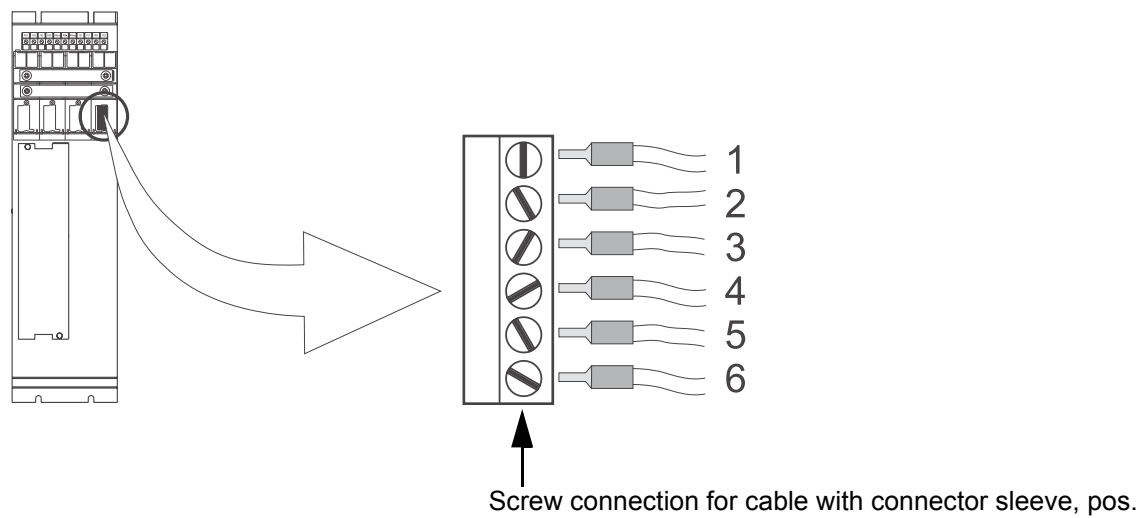
WARNING

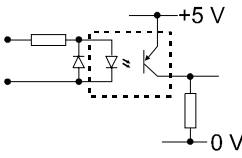
All externally applied control voltages (24 V) must comply with the regulations for PELV or SELV.

The permissible maximum current per terminal must not be exceeded as otherwise the unit will be overloaded (risk of damage).

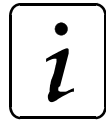
The minimum current of 10 mA per relay contact must not be fallen short of as otherwise proper functioning will not be ensured.

Plug-in terminal X99A (BUS61)⁶⁾



Terminal	Pos. ¹⁾	Description	U _{range} ²⁾	I _{range} ³⁾	A ⁴⁾
+24 V	1	+ 24 V_{DC} (PELV) ⁵⁾ Terminals 1 and 2 are bridged internally	24 V +20 % 24 V -20 %	max. 10 A	0.2 - 2.5 mm ² 24 - 12 AWG
+24 V	2				
M 24 V	3	Ground 24 V_{DC} (PELV) Terminals 3 and 4 are bridged internally	0 V		
M 24 V	4				
BB _{int.}	5	Input signal 'Supply unit ready' 0 V: Supply unit not ready 24 V: Supply unit ready 	0 V or 24 V (PLC level)	max. 20 mA	
ZUS.	6	Bidirectional signal 'Reset bus'		-	

- 1. Position from the top
- 2. Voltage range (r.m.s. value)
- 3. Current range (r.m.s. value)
- 4. Cross-section of the conductor Observe EMC requirements (see "EMC information" on page 26)
- 5.

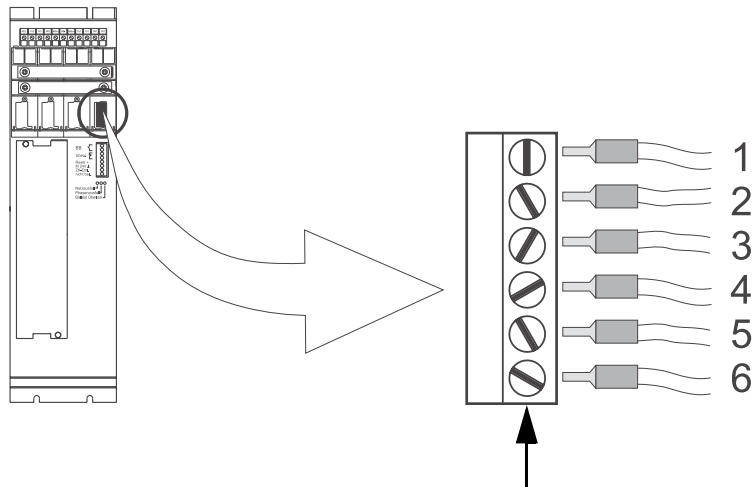


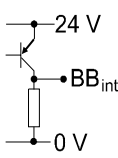
NOTE

The input of the internal power supply includes capacitors (440 µF) so that charging currents occur when the 24V supply is switched!

- 6. Functionality of plug-in terminal X99A for special variants of BUS 61 see section 6.5!

Plug-in terminal X99A (BUM61)



Terminal	Pos. ¹⁾	Description	U _{range} ²⁾	I _{range} ³⁾	A ⁴⁾
+24 V	1	+ 24 V_{DC} (PELV) ⁵⁾ Terminals 1 and 2 are bridged internally	24 V +20 % 24 V -20 %	max. 10 A	0.2 - 2.5 mm ² 24 - 12 AWG
+24 V	2				
M 24 V	3	Ground 24 V_{DC} (PELV) Terminals 3 and 4 are bridged internally	0 V		
M 24 V	4				
BB _{int.}	5	Message 'Supply unit ready' 0 V: Supply unit not ready 24 V: Supply unit ready 	0 V or 24 V (PLC level)	max. 80 mA	
ZUS.	6	Bidirectional signal 'Reset bus'			

1. Position from the top
2. Voltage range (r.m.s. value)
3. Current range (r.m.s. value)
4. Cross-section of the conductor Observe EMC requirements (see "EMC information" on page 26)
- 5.



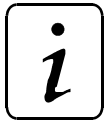
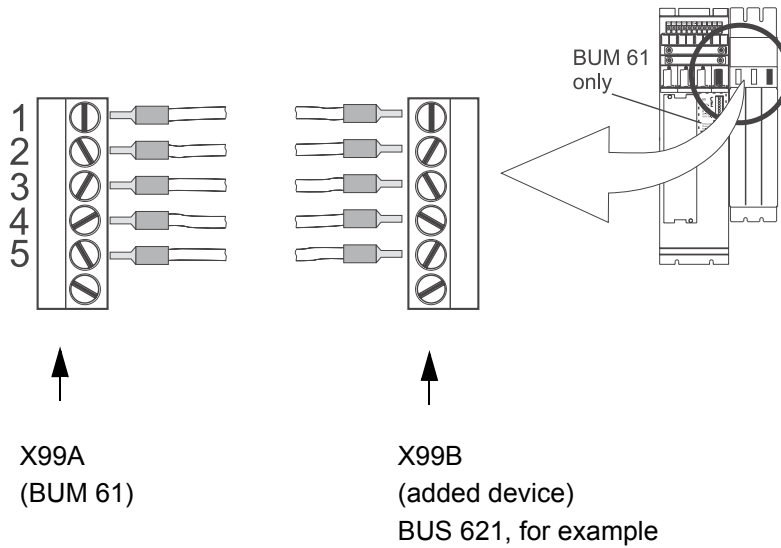
NOTE

The input of the internal power supply includes capacitors (440 µF) so that charging currents occur when the 24V supply is switched!

X99A (adding units)

Adding a Baumüller unit to BUM 61 requires the terminals 1 through 5 of X99B of the added unit to be connected to terminals 6 through 2 of X99A of BUM 61.

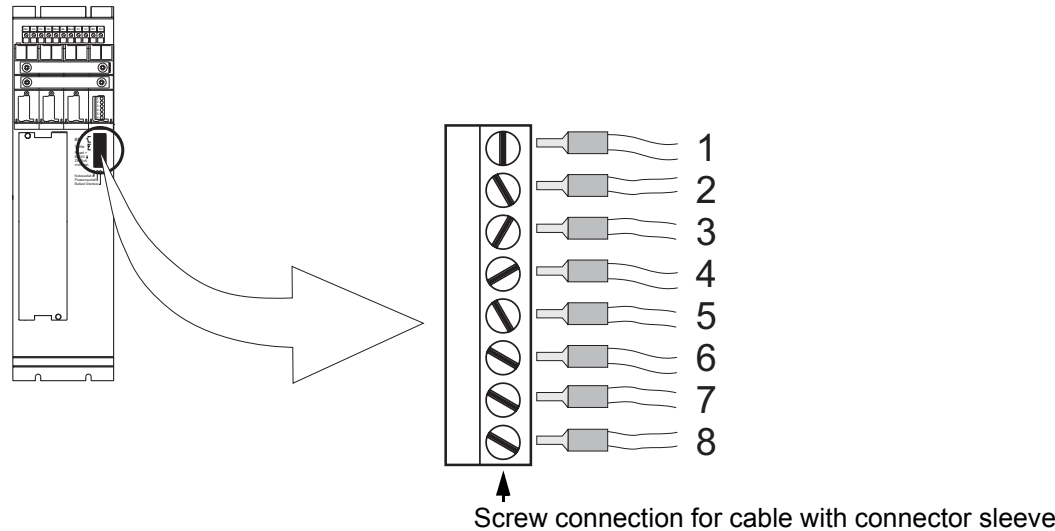
Connection



NOTE

The combination of two plug-in terminals and connecting cables (see figure above) is available as an accessory from Baumüller Nürnberg.

Plug-in terminal X100 (BUM 61 only)⁶⁾



Terminal	Pos. ¹⁾	Description	U _{range} ²⁾	I _{range} ³⁾	A ⁴⁾
BB	1	Message ' External ready ' ⁵⁾ Contacts open: Supply unit not ready	24 V	0,5 A	0.2 - 2.5 mm ² 24 - 12 AWG
	2	Contacts closed: Supply unit ready			
Vorw.	3	Message ' Early warning ' ⁵⁾ Contacts closed: Supply unit – no early warning			
	4	Contacts open: Supply unit – early warning			
Reset +	5	Potential-free opto-coupler input to reset supply unit error messages. 	24 V (PLC level)	max. 20 mA	
M 24 V ⊥	6	Reference point of inputs +Reset and ZK-Entl. (identical to X99A; 3,4)	0 V	-	
ZK-Entl.	7	Control signal input to activate the function 'Discharge DC link'	24 V (PLC level)	max. 20 mA	
Not assigned	8	Reserved	-	-	

1. Position
2. Voltage range (r.m.s. value)
3. Current range (r.m.s. value)
4. Cross-section of the conductor
5. This message refers to the BUM 61 supply unit only, not the controller !
6. Functionality of plug-in terminal X99A for special variants of BUS 61 see section 6.5!

5.7.3 Safety relay (optional)

The safety relay may be used to de-energies the drive by switching off the voltage supply (+24 V) of the safety relay.



WARNING

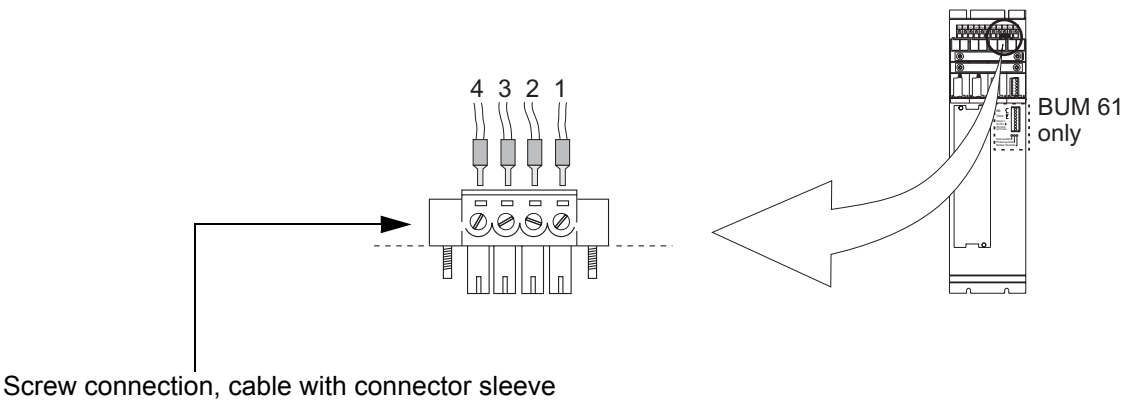
All externally applied control voltages (24 V) must comply with the regulations for PELV or SELV.
The minimum current of 10 mA per relay contact must not be fallen short of as otherwise proper functioning will not be ensured.




NOTE

The safety relay must be supplied 24 V to enable the drive to operate.

Plug-in terminal X68



Terminal	Pos. ¹⁾	Description	U _{range} ²⁾	I _{range} ³⁾	A ⁴⁾
	1 2	Feedback whether the safety relay has switched	+24 V	max. 8 A Ohmic load	max. 1.5 mm ²
+24 V	3	+ 24 V connection for the safety relay (PELV)	+24 V	max. 21 mA	
M 24 V	4	Ground connection for the safety relay (PELV)	0 V		

- 1. Position
- 2. Voltage range (r.m.s. value)
- 3. Current range (r.m.s. value)
- 4. Cross-section of the conductor

5.8 Accessories

- **EMC package**
 - EMC filter
 - Screened cables
 - Connection parts

6 COMMISSIONING

6.1 Danger information



WARNING

This unit carries dangerous voltage and contains dangerous rotating parts (fans). Non-observance of the safety instructions and warnings may result in death, serious personal injury and/or damage to material assets.

Check before commissioning that the plastic covers are in place over the live parts (power unit connections).

The user is responsible for the assembly of power unit, motor, line reactor and other devices according to the safety regulations (e.g. DIN, VDE) and all other relevant national or local regulations concerning the conductor ratings and protection, grounding, disconnectors, overcurrent protection, etc.

Personal safety is governed by DIN/VDE protective measures and safety standards. If there are no PE connections on the unit, the commutation choke or the motor, personal injury must be expected as the surface may carry hazardous voltage.

The power connections of the power unit carry potential!

The parts of the power unit carry hazardous voltage even if the main contactor has released.

Leakage currents to earth always occur in power unit and motor during operation. These are dissipated via the required PE connections and may lead to premature tripping of a line-side current-operated e.l.c.b..

A DC component in the fault current may occur in the event of a short-circuit to frame or earth fault which makes a triggering of the higher-level current-operated e.l.c.b. more difficult or even impossible. Make the PE connection according to DIN EN 60204 / VDE 0113 Part 1 / 06.93, Section 8.2.2. considering EN 50178 / VDE 0160/11.94, Sections 5.3.2.1 and 8.3.4.4.



WARNING

Drive malfunctioning

Wrong or uncontrolled movement of the driven machine components can not be ruled out during initial commissioning. Therefore, proceed with particular care.

To avoid personal injury, carefully check all higher-level safety equipment for perfect functioning prior to switching on the drive.

Special care must be taken when touching the drive shaft directly or indirectly (by hand). This is permissible only when the shaft is at standstill and the power unit is de-energized. Machine parts which are freely accessible during operation (shafts, fans, etc.) must be covered.

Protection against contact according to Paragraph 4 Section 4 VBG 4

Protection against direct contact comprises all measures against danger which can result from touching the live parts of electrical equipment.

The live parts must therefore be protected from direct contact by insulation, design, position, arrangement or permanently installed facilities. Protection in this case means the standard covers, barriers and procedures used and applied to ensure that nobody can touch the live components.

Control cabinets must have emergency OFF facilities to cut off any potentially hazardous voltages. This does not include equipment whose disconnection could give rise to yet further dangers. The emergency OFF trip must be arranged to be easily reached in case of danger. Activities of a distinctly more dangerous nature require the presence of a second person.

The operator must ensure that unauthorized persons do not work on the machine.

Subsequent high-voltage tests must only be carried out by BAUMÜLLER NÜRNBERG GmbH. Disconnect all cables from the units prior to carrying out high-voltage tests on complete switchgear cabinet installations.

Any error will de-energize the drive, causing the motor to coast to standstill. Take this circumstance into particular account for travelling and lifting drives.



WARNING

The operator must immediately report any safety-relevant changes to the machine.

Ensure before dismantling safety equipment for commissioning, repair and maintenance, that the machine is shut down in exact compliance with applicable regulations. Remount and check the safety equipment immediately after completing commissioning, repair and maintenance work.

This list of measures required for safe power unit operation is not complete. If you should need further information or if special problems arise please contact BAUMÜLLER NÜRNBERG or a sales agency. Please observe the warnings in Chapter 1 of these operating instructions.



NOTE

Before touching the modules, the operator must release any electrostatic charge to protect electronic components from high voltages generated through electrostatic charge, by simply touching a conductive, grounded object immediately before, for example.



This label is placed in a visible location on units with electrostatically susceptible components and / or modules.

6.2 Operation

The device is almost exclusively operated via the controller (refer controller description), the only exception being error reset (acknowledgement) via the optocoupler input 'Reset' of plug-in terminal X100.

6.3 Monitoring functions and their messages

The monitoring functions are listed below. For more detailed information refer "Monitoring functions" from Page 62.



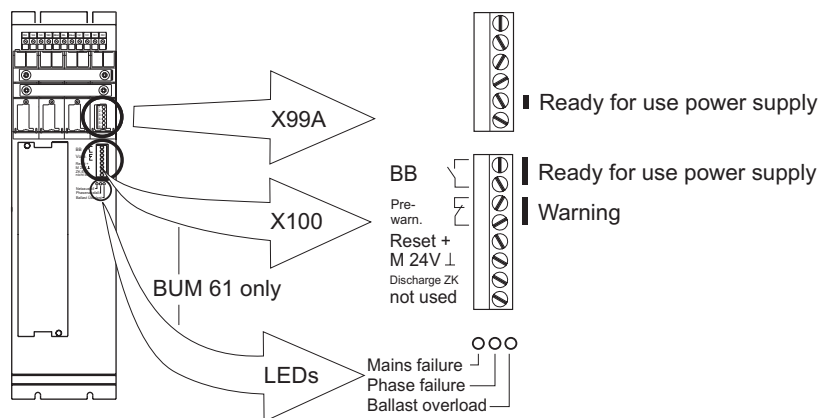
NOTE

Monitoring functions are active only when the +24V supply voltage (X99A) is applied.

The monitoring functions of BUM 61 are divided into two groups, the first being 'Monitoring functions, supply unit' and the second 'Monitoring functions, motor-end power unit'. This arrangement reflects the internal setup of the unit and offers compatibility with the modular Baumüller system (motors / drives / systems). BUS 61 monitoring functions consist of the 'Monitoring functions, motor-end power unit'.

Monitoring functions, supply unit (BUM 61 only)

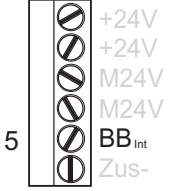
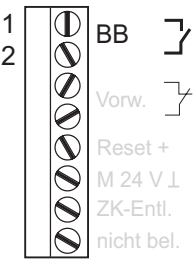
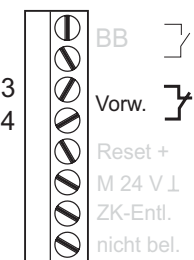
The 'Monitoring functions, supply unit' generate three messages indicated via LEDs. If none of these messages is present, the message 'Supply unit ready' is passed outside via plug-in terminals and on to the controller. In addition to this, a warning signal is generated and passed outside via plug-in terminals. The illustration below shows the location of the associated plug-in terminals and LEDs.



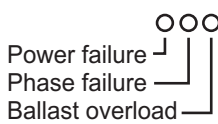
Monitoring functions, motor-end power unit

The messages generated by the 'Monitoring functions, motor-end power unit' are exclusively sent to the controller to be processed.

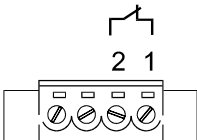
6.3.1 Messages via plug-in terminals (supply unit BUM61)

Plug-in terminal	Description
 <p>X99A</p>	<p>'Supply unit ready'</p> <p>This connection is for the linkup with other Baumüller units and serves for the transmission of the message 'Supply unit ready' to all connected units.</p> <p>0V (PLC level): The message 'Supply unit ready' is not present.</p> <p>24V (PLC level): The message 'Supply unit ready' is present.</p>
 <p>X100</p>	<p>'Supply unit ready'</p> <p>This potential-free relay contact is for evaluation by the user.</p> <p>Contact open: The message 'Supply unit ready' is not present.</p> <p>Contact closed: The message 'Supply unit ready' is present.</p>
 <p>X100</p>	<p>Early warning</p> <p>This potential-free relay contact is for evaluation by the user.</p> <p>Contact closed: The message WARNING is not present.</p> <p>Contact open: The message WARNING is present.</p>

6.3.2 Messages via LEDs (supply unit BUM61)

	<p>'Mains failure / phase failure / ballast resistor overload'</p> <p>Left hand LED on: Mains failure: No mains voltage at at least two phases.</p> <p>Central LED on: Phase failure: No mains voltage at one phase.</p> <p>Right hand LED on: Ballast resistor overload: The internal ballast resistor is overloaded.</p>
---	---

6.3.3 Safety relay function

 <p>X68</p>	<p>Many applications require the drive to be brought into a state in which the motor is safely prevented from producing a torque.</p> <p>This requirement is fulfilled by the optional safety relay in which the voltage supply for output stage driver optocoupler triggering is deactivated by means of a relay, so that, if the safety relay is not switched on, the optocouplers cannot be triggered from the input side. Not even at a defect in the subsequent driver circuit or the power semiconductors can current flow through the motor windings. At least two defects must occur in different output stage areas before a current can flow and thus a torque be generated. The relay used is a 'safety relay with positive-action contacts' as per EN 50205. Once the feedback contact is closed, the internal switching contact has safely interrupted the driver voltage supply.</p> <p>The feedback contact may be evaluated by the user.</p> <p>Timing</p> <p>The safety relay is a mechanical element with appropriate delay periods, which means that the following timing must be adhered to:</p> <p>Switch off: When the feedback contact closes, the drive is in safe state.</p> <p>Switch on The feedback contact opens approx. 20 ms from voltage application. The error messages must be acknowledged in the controller only 100 ms (including safety allowance) from closure of the feedback contact.</p> <p>Contact closed:</p> <p>No +24 V supply for the safety relay. The output stage and / or the inverter is disabled, so that the drive can not generate a torque.</p> <p>Contact open:</p> <p>+24 V supply for the safety relay is applied. The controller can trigger the output stage and / or the inverter, the drive is active.</p>
---	--

6.3.4 Ready

There are three different 'ready' messages in a drive:

- 'Supply unit ready' (available and visible in BUM 61 (X99 + X100)) generated by the monitoring functions of the supply unit,
- 'Power unit ready' (available in BUM 61 and BUS 61 and **not** visible) generated by the monitoring functions of the power unit.

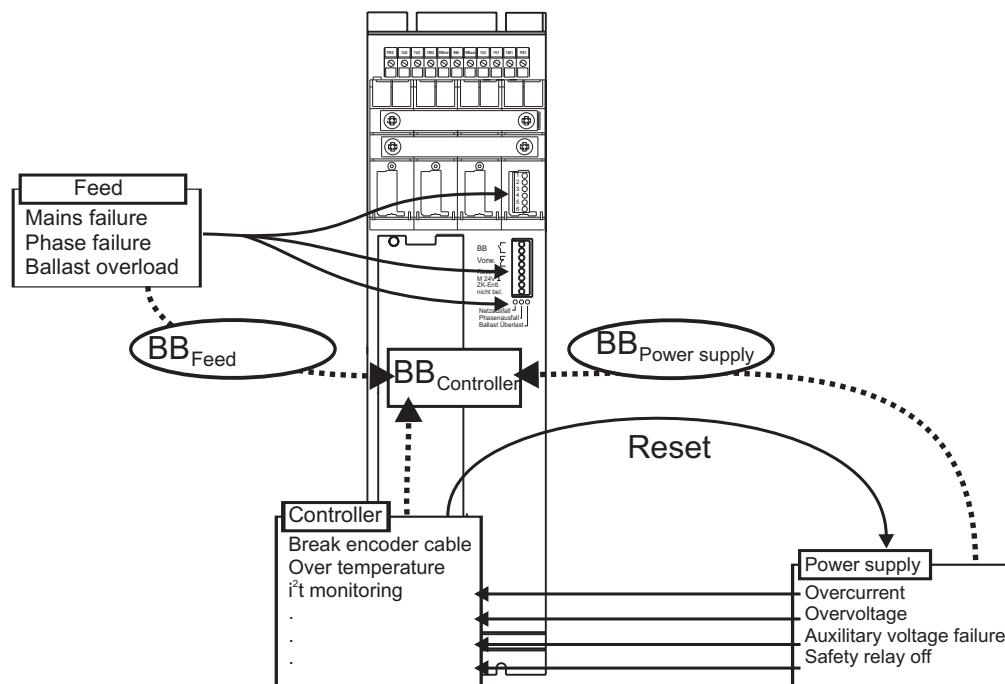
The controller used processes the two above messages and links them with its own controller monitoring functions, generating 'Controller ready' as required.

- 'Controller ready' (available in the controller), generated by the controller.



NOTE

The drive can be enabled only on 'Controller ready' (refer illustration).



NOTE

The drive is ready approx. 3.5 seconds after the +24V supply voltage and the mains voltage have been applied.

'Power unit ready' after approx. 0.5 s.

'Controller ready' after approx. 3 s

6.3.5 Monitoring functions

The following table lists all monitoring functions. The individual monitoring functions will be described in detail on the pages below.

Monitoring function			Relay cont.	V-controller	Reset
Supply unit	Phase failure	WARNING	X100; 3,4	-	-
		▼ after 10 seconds			
		No Ready	X 100; 1,2	F 0110 ¹⁾	24 V ²⁾
	Mains failure	WARNING	X100; 3,4	-	-
		▼ if $U_{ZK} < 310V$			
		No Ready	X 100; 1,2	F 0110 ¹⁾	24 V ²⁾
	Overload, internal ballast resistor		X100; 1,2 / 3,4	F 0110 ¹⁾	24 V ²⁾
Motor-end power unit	Overcurrent (motor)		-	F 0202	Controller ³⁾
	Overvoltage DC link		-	F 0201	Controller ³⁾
	Overtemperature, heat sink		-	F 0205	Controller ³⁾
	internal auxiliary voltage		-	F 0204	Controller ^{3) 4)}
	Safety relay		X 68; 1,2 ⁴⁾	F 0206	Controller ^{3) 4)}

1. The V controller always outputs this collective message in the event of an error in the supply unit.

2. Trigger reset input (apply +24V at Reset+, X100, optocoupler input).

or

switch +24V supply voltage off and on again.

This clears **all** messages of the supply unit!

Action on the WARNING message allows the drive to be brought to a defined operating state before the power unit clears the 'Supply unit ready' message.

3. You must clear this message by a controller reset.

The controller documentation specifies how to display and clear the message.

4. This message occurs only if the optional safety relay is switched off. The safety relay is switched off only if the +24V supply voltage for the relay is not applied. The +24 V supply voltage for the relay must be switched on again before the message can be cleared via a controller reset.



NOTE

Reset: If the message cannot be reset, it is very likely that the cause of the error has not yet been removed.

Monitoring functions, supply unit

- **Monitoring function, phase failure**

The voltage of all mains phases is monitored. The relay contact 'Warning' opens if one mains phase carries no voltage, the central LED coming on to signal improper operation to the user. Should the voltage return within 10 s, the 'Warning' message is cleared and normal operation continues.

Should the mains phase go without voltage for longer than 10 s, the relay contact 'Ready' opens as well. 'Supply unit ready' is also cleared and thus no longer transmitted to the controller.

- **Monitoring function, mains failure**

A 'mains failure' has occurred if at least two phases carry no mains voltage. The monitoring function responds with opening the relay contact 'Warning' and the left hand LED coming on at the same time. The DC link voltage will fall as a consequence of the mains failure. Once it has fallen below 310 V, the function also opens the relay contact 'Supply unit ready' (X100; 1,2).

Should the mains voltage return before the 310 V threshold has been reached, however, the message 'Warning' is cleared, the relay contact (X100; 1,2) is closed again, and normal operation continues.



NOTE

- The message 'Supply unit ready' F0110 evaluated by the V controller can not be reset by the V controller even after the cause has been eliminated. The reset procedure is described on Page 62.
- Since it can be determined only after about 30 ms whether the event that occurred was indeed a mains failure and not a phase failure, the central LED comes on briefly before the left hand LED then indicates a mains failure.
- In the case of a mains failure, the time elapsing between mains off and disabling 'Supply unit ready' is dependent on the current DC link load.



NOTE

After the +24V supply voltage has been switched on, the tripping of the mains failure monitoring function is stored only if the **mains** is identified as **'OK'** before it fails. This means that the error message 'Mains failure' is not immediately present automatically if only the +24V supply voltage is switched on.

To enable automatic startup after a mains interrupt, for example, storage of the message 'Mains failure' (F0110) may be suppressed by continuously triggering the reset input (apply +24V and M24V to X99AB, optocoupler input). Once the mains supply returns, the message WARNING is cleared and 'Ready' generated as long as a mains failure duration > 0 seconds has been set. Refer to 'Mains failure duration' in the controller description.



WARNING

Permitting automatic drive starts puts the operating personnel into severe danger. Machine-end protection measures must be taken if you do choose to permit automatic drive starts !

- **Monitoring function, internal ballast resistor**

The internal ballast resistor is monitored by electronically mapping the ballast resistor's thermal behavior.

Overloads lead to the opening of relay contacts 'Supply unit ready' (X100; 1,2) and 'Warning' (X100; 3,4). The right hand LED comes on. 'Supply unit ready' is no longer transmitted to the controller, the controller signalling this error as 'Supply unit error' (F0110).



WARNING

A short-circuit of the ballast circuit output will destroy the unit.



NOTE

The monitoring function 'Internal ballast resistor' exclusively monitors the internal ballast resistor. When connecting external ballast resistors, make sure to provide overload protection by looping thermostats into the ready conductor, for example.

Monitoring functions, motor-end power unit

- **Monitoring function, overcurrent (motor)**

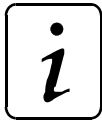
Each of the three motor phase currents is monitored.

If a phase current is exceeded by 30% of the peak value of the permissible peak current, BUM 61 / BUS 61 generates an overcurrent signal to be stored in BUM 61 / BUS 61. The message 'Motor-end power unit ready' is no longer passed on to the controller, and the unit / the module de-energizes. The V controller indicates the overcurrent signal as (F0202). The overcurrent signal may be reset via a controller reset.

- **Monitoring function, overvoltage, DC link**

The voltage of the DC link is monitored.

If the DC link voltage exceeds 800 V, a message is generated. The message 'Motor-end power unit ready' is no longer passed on to the controller, and the unit / the module de-energizes. The V controller indicates the overvoltage signal as (F0202). The overvoltage signal may be reset via a controller reset.



NOTE

The DC link voltage can rise until it is switched off if the drive brakes and no or an insufficient ballast circuit is connected to the DC link.

- **Monitoring function, overtemperature, heatsink**

The temperature of the heatsink is monitored.

A linear thermal sensor is located on the heat sink the measured value of which is passed on to the controller. The controller thus takes over temperature monitoring (refer controller description) which must be set in accordance with the technical data in the controller description. The V controller indicates overtemperatures with error number F0205.



WARNING

Set a maximum of 85 °C as higher values may destroy the unit.

- **Monitoring function, internal auxiliary voltage**

The voltage required to trigger the power transistors of the motor-end power unit, is monitored. A message is generated if there is no such internal auxiliary voltage, and stored in BUM 61 / BUS 61. The message 'Motor-end power unit ready' is no longer passed on to the controller, and the unit / the module de-energizes. The V controller indicates the auxiliary voltage supply error message as (F0204) and can reset this error message by means of a reset after the safety relay has been switched on again.



NOTE

As a rule, this error will occur only if the (optional) safety relay was switched off by the user.

- **Monitoring function, safety relay (option)**

The switching state of the safety relay is monitored.

If the optional safety relay is used, the drive can be operated only if a 24 V voltage is applied to connections X68; 3,4. This will open the feedback contact (X68; 1,2).

BUM 61 / BUS 61 generates a message if there is no 24 V safety relay voltage. The message 'Motor-end power unit ready' is no longer passed on to the controller, and the unit / the module de-energizes. The V controller indicates the message as (F0206) and can reset this error message by means of a reset after the safety relay has been switched on again.

6.3.6 Additional functions

Reset bus (X99A; 6) to acknowledge supply unit errors

The bidirectional reset bus offers the possibility of connecting several BUM 61 in parallel and thus to make a generated reset signal available to all devices.

The reset signal is Low active (ground 24 V).

1. **One** of the used controllers generates a reset. **All** error messages of **all** supply units connected are reset. The controller error messages are not reset!
2. An external control applies a Low signal to the reset bus. **All** error messages of **all** supply units connected are reset. The controller error messages are not reset!

Discharge DC link (X100; 7) - BUM 61 and BUS 61 special variant (see section 6.5 "Special variants") only

Application of a 24V signal leads to DC link discharge by use of the ballast circuit, but only if the internal monitoring function has detected a three-phase mains failure. The signal should be present until the DC link has been discharged. The time required can be estimated as follows:

$$\text{Discharge time [s]} = \frac{4 \times \text{overall capacitance } [\mu\text{F}] \times \text{ballast resistor } [\Omega]}{1.000.000}$$

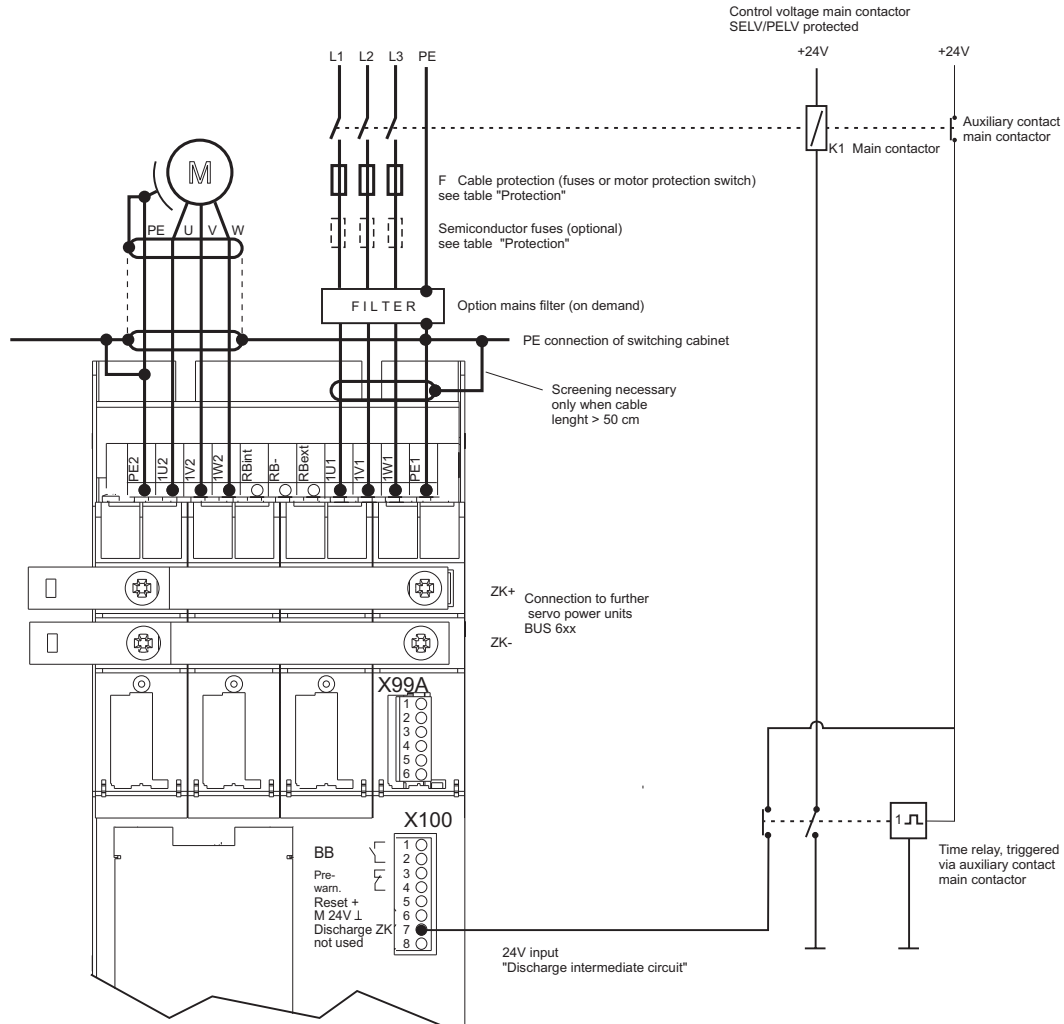


DANGER

Make sure that the mains is not switched on again as long as the 24 V signal is present.

6.4 Suggested applications

Suggested application for 'Discharge DC link' (BUM 61 only)

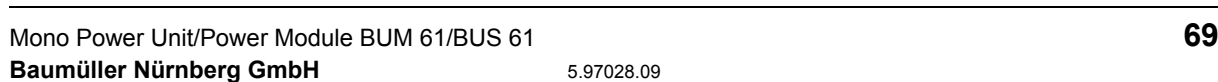


Shown switch position: Main contactor OFF, timer on, DC link is being discharged

It may be appropriate in some applications to couple the DC links of two units with own mains supply for the purpose of exchanging power among the two drives, or to supply further power modules without own mains supply via the shared DC link.

To ensure that the total mains current is distributed evenly among the two supply rectifiers of the coupled units, this application loops line-side commutation reactors into the mains supply line of both units.

The total power of the units connected in parallel corresponds to the sum of the DC link powers of both units. Where further power modules are supplied via the DC link, the motor power total must not exceed the available DC link power.



Dimensioning the ballast resistors

The ballast resistors to be selected for this application must be dimensioned in such a way that only the actually generated braking power may be converted. 'Overdimensioning' (i. e., a resistor with a lower ohmic rating) is not recommended. The ballast resistors should be identical in both BUM 61.

Example:

- Connecting 2 BUM61-40/60 in parallel:
- Total DC link power: 36 kW
- Braking power required by the application: 21 kW

The resulting total resistance is:

$$R_{\text{ges}} = \frac{U^2}{p} = \frac{780^2 [\text{V}]^2}{21 [\text{kW}]} = 29 [\Omega]$$

- Selected resistors: 2 x 56 Ω

6.5 Special Variants

6.5.1 BUS 61 with DC link discharge and ballast function

The BUS 61 is also available as a special variant equipped with DC link discharge and ballast function.

Ballast function

The ballast function works the same way as with the "normal" BUM 61.

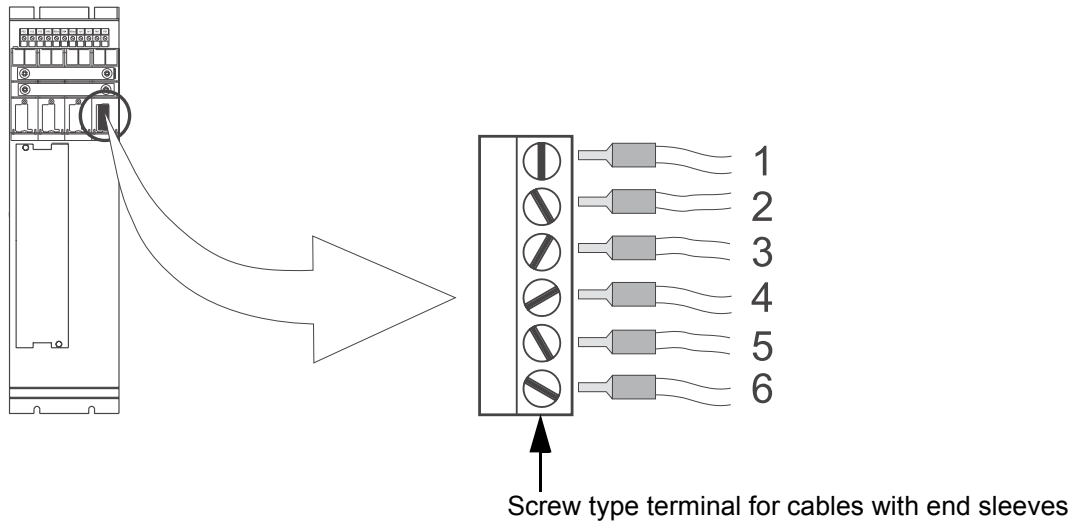
DC link discharge function

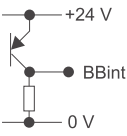
When you use the DC link discharge function, you activate - like with the BUM 61 - the DC link discharge process by connecting the X100/7 terminal "ZK-Entl."

Please keep in mind, that this function can be executed also with power supply connected (to the respective feed unit).

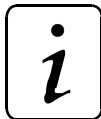
Please observe that the BUS 61 special variant has different functions wired to the X99A and X100 connectors when compared to the functions described in section 5.5.2. The functions of the BUS 61 special variant are shown on the next pages:

X99A plug-in terminal



Terminal	Pos. ¹⁾	Description	U _{range} ²⁾	I _{range} ³⁾	A ⁴⁾
+24 V	1	+ 24 V_{DC} (PELV) ⁵⁾ Terminals 1 and 2 are bridged internally	24 V +20 % 24 V -20 %	max. 10 A	0.2 - 2.5 mm ² 24 - 12 AWG
+24 V	2				
M 24 V	3	Ground 24 V_{DC} (PELV) Terminals 3 and 4 are bridged internally	0 V		
M 24 V	4				
BB _{int.}	5	Message "Ready ballast" 0 V: internal ballast has been overloaded 24 V: internal ballast ready for use 	-	-	
ZUS.	6	Bidirectional signal 'Reset bus'	0 V or 24 V (PLC level)	-	

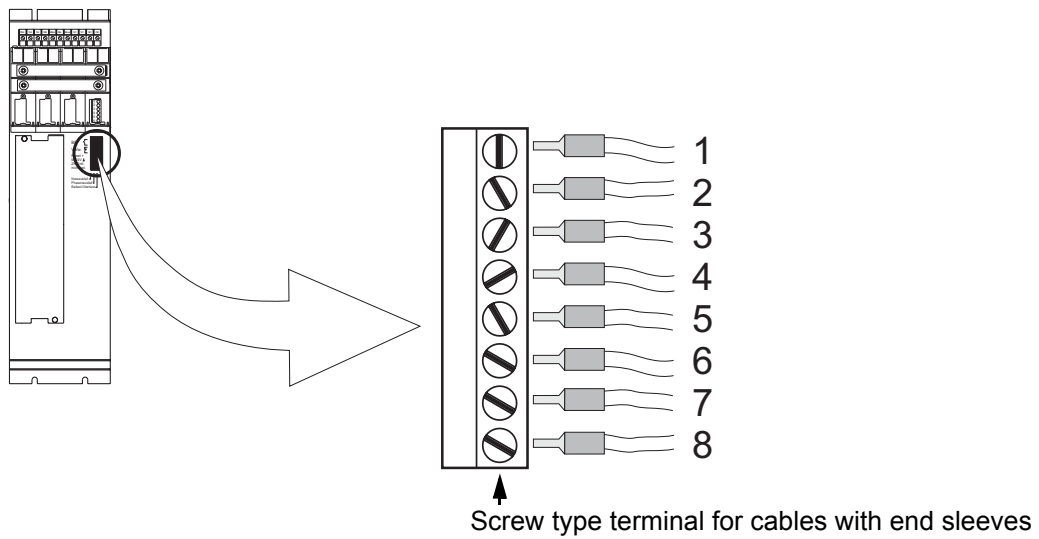
1. Position from the top
2. Voltage range (r.m.s. value)
3. Current range (r.m.s. value)
4. Cross-section of the conductor Observe EMC requirements (see "EMC information" on page 26)
- 5.



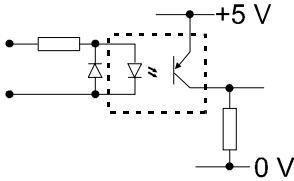


NOTE

The input of the internal power supply includes capacitors (440 µF) so that charging currents occur when the 24V supply is switched!

X100 plug-in terminal



Terminal	Pos. ¹⁾	Description	U _{range} ²⁾	I _{range} ³⁾	A ⁴⁾
BB 	1	Message "Ready for use ballast" contacts open:	-	-	0.2 - 2.5 mm ² 24 - 12 AWG
	2	internal ballast has been overloaded contacts closed: internal ballast is ready for use			
Vorw. 	3	No functionality			
	4				
Reset +	5	Potential-free opto-coupler input to set 'ZUS' signal at X99A/6. 	24 V (PLC level)	max. 20 mA	
M 24 V ⊥	6	Reference point of inputs +Reset and ZK-Entl. (identical to X99A; 3,4)	0 V	-	
ZK-Entl.	7	Control signal input to activate the function 'Discharge DC link'	24 V (PLC level)	max. 20 mA	
Not assigned	8	Reserved	-	-	

1. Position
2. Voltage range (r.m.s. value)
3. Current range (r.m.s. value)
4. Cross-section of the conductor



NOTE

The "DC link discharge" function can be activated independently of the actual state of the feed unit. This way it can happen, that the DC link discharge would work against the charging circuit of the feed unit connected or the power supply connected, because the DC link discharge is possible also with power supply active.

This may lead to overload and destruction of the DC link discharge circuit and even to destruction of the feed unit.

In order to avoid destruction when the power supply is also active, you may interlock the "ZK-Entl."-input externally (see also section 6.4).

If a BUM 61 is used as an feed unit, both "ZK-Entl."-inputs must be connected in parallel (prerequisite: reference potential of control voltage is identical).

This way overload and destruction of the DC link discharge circuit and feed unit can be avoided.



NOTE

If you use the operational software "WinBASS" together with an appliance of the BUM/BUS 61-20/30 series, please select the "BUS 622" menu item instead.

7 MAINTENANCE



WARNING

This device carries dangerous voltage and contains dangerous rotating parts (fans). Non-observance of the safety instructions and warnings may result in death, severe personal injury and/or damage to material assets.

All maintenance and service work must only be carried out when the unit is de-energized.

Do not begin work on the DC link of the device until you have made sure that neither potential nor voltage (residual charge) is applied.

Ensure before dismantling safety equipment for commissioning, repair and maintenance, that the machine is shut down in exact compliance with applicable regulations. Remount the safety equipment immediately after completing commissioning, repair and maintenance work.

After carrying out any work on the machine –regardless of whether this involves the motor, the actual value detection or the power unit – the owner must acceptance-test the entire drive and document this chronologically in the machine log.

Failure to comply will make the owner liable under the law.

7.1 Maintenance information

This device is maintenance-free.

Prohibition of unauthorized modifications

For safety reasons, unauthorized modifications and changes to the drive are not permitted.

7.2 Environmental conditions

If you keep to the environmental conditions during the entire period of storage, you can assume, that the device will not be damaged.



WARNING

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

Reform the capacitors by supplying the device ready-for use for at least 48 hours with supply voltage, but no impulse enable.

7.3 Recommissioning

Carry out commissioning as with a new device.



WARNING

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

Reform the capacitors by supplying the device ready-for use for at least 48 hours with supply voltage, but no impulse enable.

7.4 Disposal

The units consist essentially of the following components and materials:

Component	Material
Various spacers, current transformer and fan housings, etc.	Plastic
PCB with the entire control electronics	Basic material Epoxy resin fibreglassmaterial, copper-clad on both sides and through-contacted; various electronic components such as capacitors, resistors, relays, semiconductor elements, etc.

Electronic components may contain dangerous substances.

If used as intended, the various components pose no danger to human beings or the environment.

Hazardous substances may be created or released through fire.

Electronic components must not be opened, since beryllium oxide is used as internal insulation in various power semiconductors, for example.

The beryllium dust set free when the components are opened, is dangerous to your health.

The units and modules must be recycled at the end of their service life.

If recycling is not possible, dispose of the units and modules according to the respective country's national, regional and local regulations.

8 APPENDIX

8.1 Manufacturer Declaration

HERSTELLERERKLÄRUNG IN SINNE DER EG-MASCHINENRICHTLINIE 89/392/EWG, ANHANG IIB

Manufacturer Declaration in Accordance with the EC-Machine Guidelines 89/392/EEC, Appendix II B

Hiermit erklären wir, daß es sich bei dieser Lieferung um die nachfolgend bezeichnete Maschinenkomponente handelt und dass ihre Inbetriebnahme solange untersagt ist, bis festgestellt wurde, dass die Maschine, in die diese Komponente eingebaut ist, den Bestimmungen der EG-Maschinenrichtlinie 89/392/EWG, Anhang II B entspricht.

We herewith declare that this delivery includes the following specified machine component and that its putting into operation is prohibited until the declaration is made that the machine, in which this component is built in, complies with the regulations of the EC-machine guideline 89/392/EWG, appendix II B.

Bezeichnung der Maschinenkomponente:
Specification of the machine component:

Typenbezeichnung:
Type:

Einzel-Leistungseinheit

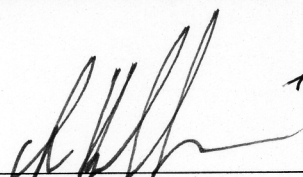
BUM 61 - .. / .. - .. - .. - ..

Leistungsmodul

BUS 61 - .. / .. - .. - .. - ..

Nürnberg, den 25.01.2005

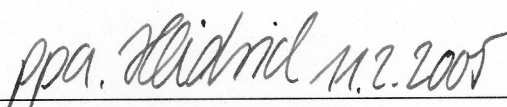
Hersteller-Unterschrift:
Signature of the Manufacturer:



Andreas Baumüller

Geschäftsleitung
Head Division

16.02.2005



ppa. Dr. Peter Heidrich

Entwicklungsleiter
Head of Development

8.2 Declaration of Conformity

KONFORMITÄTSERKLÄRUNG IM SINNE DER EG-NIEDERSpannungsRichtlinie 73/23/EWG

EG Declaration of conformity of equipment regarding low voltage directive 73/23/EWG

Bezeichnung der Maschinenkomponente:

Typenbezeichnung:

Specification of the machine component:

Type:

Einzel-Leistungs-Einheit

BUM 61 - .. / .. - .. - . - . - ..

Leistungsmodul

BUS 61 - .. / .. - .. - . - . - ..

Die Übereinstimmung des bezeichneten Produkts mit den Vorschriften der Richtlinie wird
nachgewiesen durch die Einhaltung folgender Normen:

Conformity of the signified product with the guidelines will be proved by following rules:

EN 50178: 1994 (VDE 0160/11.94)

„Ausrüstung von Starkstromanlagen mit elektronischen Betriebsmitteln“


EN 50178: 1994 (VDE 0160/11.94)

„Equipment of power installation concerned electronic operating materials“

Nürnberg, den 25.01.2005

Hersteller-Unterschrift:

Signature of the Manufacturer:



16.02.2005

Andreas Baumüller

Geschäftsleitung

Head Division



16.02.2005

ppa. Dr. Peter Heidrich

Entwicklungsleiter

Head of Development

8.3 General Conditions of Sale and Delivery

1. Obligation and Conclusion of Contract

- a) Deliveries of goods and provision of services shall be effected exclusively based on these trading conditions. They are an essential component of the contracts for delivery and shall be considered as having been accepted by the placing of an order. In the case of constant business relations, they also apply for the future contracts.
- b) Agreements diverging from the contract and verbal collateral agreements shall only be binding if they have been confirmed in writing by Baumüller Nürnberg GmbH (hereinafter referred to as Baumüller). Diverging trading conditions on the behalf of the purchaser shall be without obligation, even where these have not been expressly objected to. These General Conditions of Sale and Delivery shall be considered as having been accepted by the purchaser at the latest when the delivery is accepted.
- c) In as far as deliveries of goods are subject to separate external obligations in accordance with the Law Concerning Foreign Trade and Payments with respect to the Federal Office for Economics, the purchaser has to observe the relevant conditions at his/her own responsibility.

2. Price and Offers

Offers are subject to confirmation, not binding and apply subject to material supply possibilities. Supplements and amendments require written confirmation. Prices are ex works and are subject to confirmation. Invoicing takes place in accordance with the prices valid on the date of delivery.

3. Extent of Delivery and Delivery Time

- a) Specified delivery periods/dates are without obligation, in as far as nothing else to the contrary has been expressly agreed upon in writing. Delivery periods do not commence until the purchaser has fulfilled all duties of co-operation, in particular regarding details of performance. In the event that the agreed deposits for orders are delayed, then the delivery time shall be extended accordingly.
- b) The purchaser is entitled, in particular in the event of a delay in delivery of longer than 3 months, to set an appropriate period of grace and after its expiry, to withdraw from the order. Claims to compensation due to non-fulfilment or delay shall be excluded, in as far as Baumüller is not responsible for intent or gross negligence.
- c) Baumüller is entitled at any time to effect partial deliveries and partial services, as well as to invoice these accordingly

4. Delivery Problems

- a) Delays/preventions in the delivery of goods or the provision of services due to force majeure entitle Baumüller to delay the production and delivery by the duration of the obstruction plus an appropriate period of time or to withdraw in part or in whole from the order.
- b) Industrial disputes or other circumstances which substantially impede or render impossible the delivery, such as, in particular, disturbances in the operating processes, problems in procuring materials, official directives also apply as force majeure, irrespective of whether they arise with regard to Baumüller or suppliers.
- c) In these cases, Items 4 a), b), the purchaser shall have no claim to compensation due to non-fulfilment or delay of the delivery.

5. Packaging

Items for sale and delivery items are packaged and transport insurance policies are taken out according to the instructions of and at a cost to the purchaser. Upon demand, the packaging material has to be returned without delay, free of freight charges and expenses.

6. Dispatch and Passing of Risk

Deliveries shall be made ex works. The dispatch shall be effected at a cost to and at the risk of the recipient of the service/the purchaser. The risk passes to the recipient of the delivery/purchaser as soon as the delivery items leave the works. This shall apply at the latest, from the transferral of the delivery items to the person carrying out the transport, forwarding agent or carrier.

7. Warranty

In the event that a delivery item is defective, Baumüller shall deliver an additional replacement or make a subsequent improvement at its own choice. Multiple subsequent improvements are permissible. Other warranty claims on the behalf of the purchaser, in particular also due to direct or indirect consequential damage are excluded. The pre-condition for any warranty is the normal contractual use of the delivery items. In the event of the utilization of warranty services, the motor, the replacement part or the device has to be sent in free of freight charges, packaging costs or customs duties after prior co-ordination with Baumüller. Baumüller is exempted from any warranty if the party ordering returns the goods complained about without prior co-ordination or contrary to agreement. Warranty claims expire one month after rejection of a defect on which notice is given, in as far as the purchaser remains silent in this respect.

8. Notification of Defects

- a) The purchaser shall examine the subject matter of the contract and delivery items immediately and give notice of any defects without delay, however, no later than 7 days after receipt of the delivery. In case of non-obvious defects notice has to be given in writing without delay after their discovery, however, no later than 6 months from the point of delivery. In the event that the purchaser does not give notice of any defects in writing within this period of time, then the subject matter of the contract shall be considered as having been approved.
- b) The purchaser shall allow Baumüller a suitable inspection of defects of which notice is given and shall place all necessary/requested technical information, in particular, inspection records and test reports at Baumüller's disposal. In the event that the purchaser fails to do so, then the delivery items shall be considered as not having been complained about and as being approved. In the event that the purchaser alters the delivery items, then he/she shall lose his/her warranty claims.
- c) In the event of an established material defect or performance defect, Baumüller can eliminate the defect or supply a replacement. The purchaser can demand rescission or a reduction after the expiry of an appropriately set period of grace. Further claims on the behalf of the purchaser, in particular to the reimbursement of dismantling costs or installation costs are excluded. The same applies to damages which do not affect the delivery item itself.
- d) Natural wear and tear and damage which arises after the transferral of risk, in particular also due to incorrect or

negligent handling, excessive demands or other unsuitable use not in conformity with the contract are excluded from the warranty. The same applies in particular for defects which are attributable to atmospheric discharges, overvoltages and chemical influences.

- e) If no case of warranty is in existence or in the event that this subsequently turns out to be the case, the purchaser shall remunerate the utilization or the use of an item or of a right, as well as services provided and expenses to an appropriate amount. Baumüller is entitled to a right of control as referred to in §§ 315 ff. BGB [German Civil Code].

9. Liability

Contractual or legal claims on the behalf of the purchaser against Baumüller are limited to intent and gross negligence. This does not apply in as far as claims from the ProdHaftG [Product Liability Act] have been enforced. Baumüller shall only be held liable to the amount of the damage foreseeable in accordance with the purpose of the contract. Material damage which exceeds the value of a delivery/service is not foreseeable in this sense. The liability is limited in terms of amount to the remuneration contractually owed.

10. Payments

- a) Invoices are payable at the time agreed in the contract, at the latest within 30 days after the invoice date, in cash and without deductions. The purchaser can only offset with claims which are final and absolute or undisputed. The same applies to the exercising of rights of retention.
- b) In the event of a delay in payment on the behalf of the purchaser, interest to the rate of 4 % above the respective minimum lending rate of the German Federal Bank, however at least 10 % has to be paid without separate proof being required.
- c) Failure to comply with the terms of payment or circumstances which endanger the credit worthiness of the purchaser result in all claims immediately becoming due. In these cases, deliveries shall only be made against payment in advance.
- d) Cash payments, bank transfers or cheque and bill payments shall not be considered as payment/fulfilment of the obligation before the amount due for payment has been irrevocably received by Baumüller or credited to Baumüller's account.
- e) Payments have to be made directly to Baumüller. The field staff are not entitled to accept payments or to issue extensions or waivers without separate written authority.

11. Reservation of Ownership

- a) The ownership of delivery items remains reserved up to the fulfilment of all existing claims against the purchaser from the business relation. Any bundling with other items shall be effected by the purchaser for Baumüller. Then, the entire product shall be considered as reserved goods.
- b) The purchaser is entitled to sell the reserved goods in orderly business transactions. All claims to which the purchaser is entitled from this sale or other legal grounds shall be assigned by him/her in advance to Baumüller. Baumüller shall accept the assignment. In the event that the reserved goods are bundled or sold with other items standing in the possession of third parties, then the assignment shall only apply to the amount of the invoice value of the reserved goods. The purchaser is authorised to collect these assigned claims. Upon request, he/she has to make notice of the assignment to the debtor.
- c) The purchaser shall inform Baumüller without delay of impending and enforced access on the behalf of third parties to the reserved goods or to the assigned claims.

The purchaser shall bear the costs incurred by this.

- d) The authorization on the behalf of the purchaser to dispose of the reserved goods and to collect assigned claims expires in the event that the terms of payment are not complied with, in particular, also in the case of bill and cheque protests. In this case, Baumüller is entitled to take possession of the reserved goods. The purchaser bears the costs incurred by this. The taking back of goods shall only represent a withdrawal from the contract when this is expressly stated.
- e) In the event that the value of the securities granted exceeds the secured claims in terms of amount by more than 20 %, then Baumüller shall renounce the securities exceeding this value.

12. Drawings and Documentation

Baumüller is entitled to the exclusive property right and copyright to cost estimates, drawings and all other documentation. These documents may not be made accessible to third parties without prior written consent. In the event that a contract is not concluded, not implemented or otherwise ended, then all documents have to be returned immediately and unsolicited. There shall be no right to retention to these documents.

13. Copyright (in particular Software / Licence)

- a) Baumüller is exclusively entitled to all rights to the software/edited versions, in particular property rights and copyrights to the relinquished software, in particular for the controlling of machines, systems and installations.
- b) Baumüller grants the purchaser/buyer the non-exclusive, non-transferable right to use the relinquished software in the framework of the contractual purpose at the contractually intended location/on the places in existence at the time of purchase (single licence). The software shall only be used on the associated purchased contractual item. Any use extending beyond this is prohibited. In the event of a use extending beyond this, Baumüller shall have the rights referred to in Items 14 c), 14 d).
- c) It is prohibited to make copies of the relinquished software, whether in whole or in part, in as far as the making of copies of the machine-readable material in the framework of the required data backup or as copies for internal company use has not separately been agreed upon with prior written consent from Baumüller. Processing of the relinquished software, in particular by means of alteration, translation or by bundling with other programs shall only be permitted after prior written consent from Baumüller. Protection notices from Baumüller on/in the software may not be removed and also have to be adopted onto copies and edited versions. Copies produced contrary to this condition shall come under the possession and copyright of Baumüller. Baumüller can prohibit the use of such copies and elect to demand the immediate surrender or complete destruction with proof of this destruction.
- d) The buyer is not permitted to extend the licence in terms of location/work places/machines/machine types or to grant rights of utilization or grant sub-licences. The extension of the licence shall be permitted by Baumüller exclusively against a separate remuneration which has to be agreed upon in writing.

14. Applicable Law

The law of the Federal Republic of Germany is authoritative for all rights and obligations from and in connection with this contract. The regulations of the UN Sales Convention (CISG) are excluded.

15. Place of Performance and Place of Jurisdiction

The place of performance for delivery and payment is the seat of Baumüller. The place of jurisdiction for all disputes from and in connection with this contract, in particular also for cheque and bill liabilities is the seat of Baumüller.

16. Miscellaneous

In the event that individual or several conditions of these Conditions of Sale and Delivery should be or become ineffective in part or in whole, then the validity of the remaining conditions shall remain unaffected by this. The parties shall complement/replace the ineffective or incomplete condition with an appropriate regulation which most extensively corresponds to the economic purpose of the contractually desired regulation. The same applies for the case of the presence of a gap in the regulations.

For the case that acceptance and installation are also agreed upon, then the following conditions, Items 18 and 19 shall also apply:

17. Acceptance

- a) The inspection of the delivery items ready for acceptance shall take place in the Baumüller works. The purchaser shall bear the costs of this inspection. In the event that the purchaser fails to perform the inspection, then the delivery items shall be considered as having been delivered in conformity with the contract when they leave the works.
- b) The purchaser is obliged to take delivery of goods and services from Baumüller without delay. Immaterial defects do not entitle the purchaser to refuse the acceptance.
- c) In the event that the purchaser does not declare within 7 days after notification of the readiness for acceptance on the behalf of Baumüller or after receipt of the contractual service in writing and with exact, examinable specification of reasons that he/she refuses the acceptance, then the acceptance shall be considered as having been declared and the orderly performance of the contract as having been ascertained.
- d) The agreed service shall be considered as having been accepted when the item delivered has been put into operation by the purchaser himself/herself or upon his/her

instructions by third parties beyond the functional test required to carry out the acceptance. This also applies in the event that the purchaser refuses the functional test/the acceptance without sufficient cause.

- e) Experts to be designated by both parties shall take part in the acceptance inspection. The result of the functional test shall be entered in a record to be signed by the purchaser in consideration of the technical specifications.

18. Erection and Installation

Erection and installation shall only be effected in the case of express agreement at the following further conditions:

- a) The purchaser makes required workers and material available at his/her own expense.
- b) Before the commencement of installation works the purchaser shall make available unsolicited all required specifications, in particular concerning the location of power lines which have been laid such that they are hidden and similar installations, as well as the required static specifications.
- c) Before the commencement of the erection/installation, the delivery items required for the commencement of works have to be on site and all preliminary works progressed to the extent that the erection/installation can immediately begin and be completely carried out without interruption.
- d) In the event that the erection, installation or putting into operation is delayed due to circumstances for which Baumüller is not responsible, then the purchaser shall bear the costs for idle time and journeys required on the behalf of the installation personnel.
- e) The installation personnel working time has to be certified weekly by the purchaser. The purchaser shall present to the installation personnel a written certification regarding the ending of the erection/installation without delay.
- f) Baumüller shall not be held liable for the installation personnel works, in as far as the works are not connected to the delivery and the erection or installation.
- g) Trial runs on systems not supplied by Baumüller shall not be carried out by the installation personnel.

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be in motion

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