

MANUAL

Digital battery - motor controller

BAMOCAR-PG-D3-400/400

BAMOCAR-PG-D3-700/250

BAMOCAR-PG-D3-700/400

for EC servo motor

for AC asynchronous servo motor



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1 Basic - Information

1.1 More products

For synchronous motors and asynchronous motors			
Digital AC servo amplifier (mains up to 480V~)		UNITEK	DS series / DPC series
Digital AC servo amplifier for battery operation		UNITEK	BAMOBIL-D3 series
Analogue three-phase servo amplifier (mains 400V~)		UNITEK	TVD series
For DC motors			
Analogue DC servo amplifier for battery operation		UNITEK	BAMOBIL-A2/BAMO series
Analogue DC servo amplifier (mains operation)		UNITEK	Series TV
Thyristor converter 1Q, 4Q, servo		UNITEK	Classic series 200 W to 800 kW

1.2 Project planning instructions (MANUAL)

- | | | | |
|----|--------|-------------------|----------|
| 1. | MANUAL | BAMOCAR-PG-D3-xxx | Hardware |
| 2. | MANUAL | NDrive x | Software |




Use all MANUALs for project planning, installation and commissioning!

Online as download: www.unitek.eu

Hardware MANUAL contains warnings and safety instructions, explanations of standards, mechanical and electrical installation instructions.

The MANUAL must be made accessible to all persons working with the unit.

1.3 Designations and symbols used

Device	BAMOCAR-PG-D3-700/400, 700/250, 400/400
User:	Vehicles, boats, machinery or plant manufacturers or operators in the industrial sector (B2B, second environment)
Manufacturer:	UNITEK Industry Electronics GmbH
	Danger to life! High voltage
	Warning. Important
	Dangerous electric fields

Scope of delivery / in the shipping box:

- Unit BAMOCAR- PG-D3-x
- Hint for download "Operating Instructions / Manual"

Not included (order as accessory):

- PG screw fittings
- Control plug:

X1 (In/Out)	Order number G435 / Binder 99-5662-15-19
X7 (feedback)	Order number G436 / Binder 99-5661-15-19
X9 (CAN-BUS)	Order number G437 / Binder 99-0436-14-05
- Control cable:

X10 RS232 cable	Order number G432 / Binder 79-3464-52-06
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1.4 General product information

The digital three-phase servo amplifier **BAMOCAR-PG-D3-400/400, 700/250, 700/400** forms a 4-quadrant drive unit together with the motor, driving and braking with energy feedback in both directions of rotation. Depending on the installed parameter set, the amplifier is suitable for EC synchronous motors, AC asynchronous motors or DC motors.

The drive concepts are characterised by different advantages and disadvantages.

The **EC drive** (synchronous motor) has the highest efficiency and the highest power per weight and volume. It is maintenance-free and has high control dynamics. The disadvantage is the field weakening range, which is difficult to control, and the high braking torque in the event of a motor short circuit.

The EC synchronous motor (brushless DC motor) in its electrical version is a synchronous motor with permanent magnet rotor and three-phase stator.

The physical properties correspond to those of the DC motor, i.e. the current is proportional to the torque and the voltage is proportional to the speed. The speed is controlled stably up to the current limit (max. torque). In case of overload, the speed decreases at constant current.

Rectangular speed-torque characteristic.

Current, speed and position are measured exactly.

The rotating field frequency is not a controlled variable, it adjusts itself independently.

The motor voltages and motor currents are sinusoidal.

The **AC drive** (asynchronous motor) has the highest speed range due to the simple field weakening and it does not generate a braking torque in the event of a motor short circuit. The disadvantage is the size and the poorer efficiency. The controlled variable is the rotating field frequency, taking into account the motor-specific parameters (field-oriented control). The motor voltages and motor currents are sinusoidal.

With both three-phase systems, no motor movement takes place if the rotating field is switched off or there is power stage damage. The heat loss occurs mainly in the motor stator.

The **DC drive** (direct current motor) has the best synchronisation and a high control range. Emergency operation can be achieved by directly connecting the battery voltage. Disadvantages are the carbon brushes and the heat generation in the armature. The drive can rotate at high speed in the event of a power stage failure.

The current is proportional to the torque and the voltage is proportional to the speed.

Current, speed and position (bearing) are measured exactly. The speed is controlled stably up to the current limit (max. torque). In case of overload, the speed decreases at constant current.

Rectangular speed-torque characteristic.

Field weakening is possible with externally excited motors.

BAMOCAR-PG-D3-xxx can be used as a position controller, torque or speed amplifier. The actual speed value is generated from the encoder unit (resolver or other) or internally (sensorless). A large control range and high control dynamics require an encoder system.

Warning / Caution:

For DC, AC and BL servo amplifiers fed from the DC mains, the energy feedback into the DC link during braking operation must be taken into account.
(External ballast circuit)



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1.5 Application/use/design/property

Application:

In vehicles, boats, machines and plants of all kinds up to a drive power of 100 kW in rough use, especially as 4Q servo drives for:

- highly dynamic acceleration and braking processes,
- large control ranges,
- high efficiency,
- small motor dimensions,
- smooth, quiet running and
- for speed control, torque control or combined speed-torque without superimposed position control,
- conveyor drives, spindle operation, pumps, transverse and longitudinal dividing drives, multi-motor synchronous drives.

Deployment:

In battery-powered vehicles such as electric vehicles, electric boats, forklifts, transport systems as well as in battery-powered machines and systems such as automatic assembly machines, metalworking machines, X-Y tables, food processing machines, robots and handling systems, rack conveyors, stone processing machines and in many other battery-powered applications.

Structure:

- Compact unit according to VDE- DIN and EC directives / protection class **IP65** (option IP69K)
- For harsh environment and high dynamic overload
- Maintenance free
- Contact protection of the power connections
- Power electronics for (S1 operation) 125 A_{eff}, 200 A_{effA}
- Power input range nom. 12... 700 V=
- Liquid cooling (special version air cooling)
- Uniform digital control electronics
- Independent 12.. 24 V chopper power supply for the auxiliary voltages

Galvanic separation between:

- Power connection, motor connection and all other control connections
- Auxiliary voltage connection and all other voltages
- Housing and cooling block.
- Clearance and creepage distances comply with EU standards
- No internal insulation monitoring, Y2 capacitors to housing

Features:

- Fully insulated IGBT power semiconductors, generously dimensioned
- Only commercially available components in industrial standard
- SMD assembly

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Features:

Battery connection 12 V= / 700 V= (DC mains, observe restrictions).

- ✓ Independent auxiliary voltage connection 24 V= or 12 V=
- ✓ Digital interfaces RS232, CAN-BUS (further option)
- ✓ Analogue inputs, programmable differential inputs
- ✓ Digital inputs and outputs, programmable, opto-decoupled
- ✓ Setpoint ramps linear
- ✓ Enable and limit switch logic, emergency stop function, safety
- ✓ BTB-ready, solid state relay
- ✓ Position, speed and torque control
- ✓ Feedback encoder systems: resolver, encoder incremental encoder, SINCOS 1Vpp, Rotor position + BL tachometer
- ✓ Static and dynamic current limit
- ✓ Uniform fully digital control unit
- ✓ Processor-independent protective shutdown in case of overvoltage, undervoltage Short circuit, earth fault and overtemperature of amplifier or motor
- ✓ Intrinsically safe short-circuit-proof power section (EN50178)

Attention: Braking energy

The braking energy is fed back into the battery.

The battery must be able to absorb the braking energy.

If the battery is disconnected from the unit during braking operation high DC link voltages can occur.



Pay special attention when operating on laboratory power supplies!

In DC networks, the network must absorb the braking energy without the voltage rising above the permissible value. If this is not ensured, a ballast circuit must be used.

In the case of non-grounded systems (vehicles, boats, machines) the insulation between the touchable parts and the HV voltages must be monitored with an independent insulation monitor.

1.6 Safety regulations

Electronic devices are fundamentally not fail-safe!

Attention high voltage

DC > 800 V

Danger of shock! / Danger to life!

DC link discharge time > 4 min.



This MANUAL must be carefully read and understood by qualified personnel before installation or commissioning. The knowledge and understanding of the appliance and especially of the safety instructions must be accessible to all persons involved in the application. If anything is unclear, or if other functions are not described or not described in sufficient detail in the documentation, the manufacturer or dealer must be contacted. Incorrect installation can lead to the destruction of the units! Incorrect programming can trigger dangerous movements!

Intended use:

The devices of the **BAMOCAR- PG-D3** series are electrical equipment of the power electronics for the regulation of the energy flow. They are intended as components for controlling EC synchronous motors and AC asynchronous motors in vehicles, machines or systems. When used in residential areas, additional EMC measures are necessary. Deviating applications require the approval of the manufacturer. The user must prepare a hazard analysis of his end product.

Protection class IP65 (option IP69K).

Connection to batteries only!

Operation only permitted with the unit closed!
Control and power connections can lead to voltages without the drive operating!
DC link discharge time is greater than 4 minutes!
Measure voltage before disassembly!



The user must prepare a hazard analysis for his machine, vehicle or plant.

The user must ensure:

- that after a failure of the unit,
- in case of operating errors,
- in case of failure of the regulation and control unit, etc.

the drive is guided into a safe operating state.



Vehicles, boats, machines and installations must also be equipped with monitoring and safety devices that are independent of the equipment. The user must take appropriate measures to ensure that inadmissible movements do not cause danger to people and property!

The unit must be closed during operation.
All connectors must be securely engaged or screwed down.
The protective systems must be active.

With the unit open and/or protection systems deactivated, the user must ensure that only qualified personnel have access to the units.



Assembly work

- Only in a secured, de-energised state
- Only by trained specialist personnel

Installation work

- Only in a secured, de-energised state
- Only by trained electricians
- Observe the safety regulations.

Setting and programming work

- Only by qualified personnel with knowledge of electronic drives and software
- Observe programming instructions
- Observe safety instructions

1.7 Commissioning

The servo amplifiers **BAMOCAR-PG-D3-400/400, 700/250, 700/400** are components of electronic drive technology.

They are only functional in connection with an electrical consumer (e.g. motor).

The use is limited to commercial applications.

In the case of installation in vehicles, boats, machines and systems, the start of the intended operation of the device is prohibited until it has been determined that the machine, system or vehicle complies with the provisions of the EC Machinery Directive 2006/42/EC and the EMC Directive 2004/108/EC.

The EC Directive 2004/108/EC with the EMC standards EN61000-2 and EN61000-4 is complied with under the installation and test conditions specified in the chapter EMC notes.

When used in residential areas, additional EMC measures are necessary.

A manufacturer's declaration can be requested.

Compliance with the limit values required by EMC legislation is the responsibility of the manufacturer of the vehicle, system or machine.

1.8 Details of the safety instructions

Machinery Directive

The vehicle, machine or plant manufacturer must prepare a hazard analysis for his product. He must ensure that no unforeseeable movements can lead to personal injury or damage to property.

Qualified staff

Hardware

Qualified personnel are characterised by education and training for the use of electronic drive technology. They know the standards and accident prevention regulations for drive technology and can assess the application. Possible dangers are recognised.

The local regulations (IEC, VDE, VGB) are known to the qualified personnel and are taken into account.

Software

Qualified personnel for the software must be trained for the safe programming of the devices in the machines and systems. Incorrect parameterisation can lead to unauthorised movements. The parameter settings must be checked against incorrect operation. Careful acceptance tests are to be carried out with a 4-eyes principle

Working environment

Incorrect handling of the units can lead to damage to property or personal injury.

Only operate the units when the unit is closed or the control cabinet is secured!

Unit covers must not be removed.

Work on electrical connections only in a de-energised state.

The battery voltage must be safely switched off.

The voltages and residual voltages (intermediate circuit) must be measured before working on the unit.

The maximum permissible voltage must be < 42 V.

High temperatures > 70 °C may occur.

Working environments may be hazardous for wearers of electronic medical devices.

(e.g. pacemakers) can be dangerous. A sufficient distance to these electrical parts must be maintained.

Stress

During transport and storage, the prescribed climatic conditions must be observed.

The units must not show any mechanical damage. Bent housing parts can damage the insulating sections. Never install damaged units!

The units contain components that can be damaged by electrostatic discharge. The general recommendations for handling ESD-components must be observed. Special attention must be paid to highly insulating plastic foils and synthetic fibres.

For operation, it must be ensured that the environmental conditions in the control cabinet are complied with. This applies in particular to the non-permitted condensation of the units.

1.9 Intended use

The devices are intended as components for controlling EC synchronous motors and AC asynchronous motors in vehicles, boats, machines or systems.

Deviating applications require the approval of the manufacturer.

The unit protection class is IP65 (option IP69K).

Installation is only permitted in vehicles, boats, machines or systems.

Additional EMC measures are necessary for use in residential areas.

The user must prepare a hazard analysis of his end product

Only approved for connection to a battery with battery-side charging current limitation.

Use external insulation monitors for voltage > 60 V.

The user must ensure that the standards are observed throughout the control wiring.

In the case of components connected to the unit without potential-separated inputs/outputs, attention must be paid to the potential equalisation (equalisation connection GND). The equalising currents can destroy components.

For insulation measurements, the units must be disconnected or the power connections among each other and the control connections among each other must be bridged.

Non-observance can destroy semiconductors in the unit.

Repetitive earth and short circuits below the short-circuit threshold can damage the output stages.
(Conditionally short-circuit proof according to EN 50178, EN61800-5-1)

Impermissible applications:

- In life-supporting medical equipment or machines.
- On power supply units or DC mains without protective circuits.
- In potentially explosive atmospheres.
- In environments with corrosive vapours.

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1.10 Regulations and guidelines

The units and the associated components must be installed and connected in accordance with the local legal and technical regulations:

EC Directive	2004/108/EC, 2006/95/EC, 2006/42/EC, 2002/96/EC
EC standards	EN60204-1, EN292, EN 50178, EN60439-1, EN61800-3, ECE-R100
International Standards	ISO 6469, ISO 26262, ISO 16750, ISO 20653, ISO 12100
IEC/UL	IEC 61508, IEC364, IEC 664, UL508C, UL840
VDE regulations and TÜV regulations	VDE 100, VDE 110, VDE 160
Regulations of the employers' liability insurance association	VGB4

EU standards and regulations taken into account in the appliance

Standard	Explanation	Output
EN 60146-1,-2	Semiconductor power converter	2010
EN 61800-1,-2,-3	Variable speed electric drives	2010
EN 61800-5-1	Electric power drive systems Safety	2010
EN 60664-1	Insulation coordination low voltage	2012
EN 61010	Safety regulations for control units	2011
EN 61508-5	Functional safety of electrical, electronic systems	2011
EN 60068-1,-2	Environmental influences	2011
ISO 20653	Protection class of electrical equipment of vehicles	
ECE-R100	Conditions battery-powered electric vehicles	
UL 508 C	UL regulation power converter	2002
UL 840	UL Regulation Air and Creepage Distances	2005

EU standards and regulations to be observed by the user

Standard	Explanation	Output
EN 60204	Safety and electrical equipment of machines	2011
EN 50178	Equipment of heavy current installations	1998
EN 61800-3	Variable speed electric drives -EMC	2010
EN 60439	Low-voltage switchgear and controlgear assemblies	2011
EN 1175-1	Safety of electric industrial trucks	2011
ISO 6469	Electric road vehicles	2009
ISO 26262	Functional safety of electric road vehicles	2011
ISO 16750	Electrical components Vehicles	2010
ISO 12100	Safety of machinery	2011
ISO 13849	Safety of machines and controls	2011
IEC 364	Protection against electric shock	2010
IEC 664	Insulation coordinates low voltage	2011

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1.11 Risks

The manufacturer endeavours to reduce the residual risks emanating from the device as far as possible through design, electrical and software measures.

Following known residual risks from drive technology must be taken into account in the risk assessment of machines, vehicles and systems.

Impermissible movements

caused by:

- the failure or deactivation of safety monitoring systems during commissioning or repairs
- Software errors in upstream controls or errors in BUS systems
- Unmonitored hardware and software errors in the actuator or the connecting cables
- Inverted sense of the rules
- Error in parameterisation or wiring
- Limited reaction time of the control properties. Ramps, limits
- Operation outside the specifications
- Electromagnetic disturbances
- Electrostatic disturbances, lightning strike
- Component failure
- Fault in the brakes



Dangerous temperatures

caused by:

- Error during installation
- Defects at connections, bad contacts, ageing
- Error in electrical fuse protection, wrong fuse types
- Operation outside the specifications
- Weather influences, lightning strike
- Component failure

Dangerous voltages

caused by:

- Faulty earth connection of unit or motor
- Faulty insulation monitoring
- Defects at connections, bad contacts, ageing
- Error in potential separation, component failure
- Conductive pollution, condensation



Dangerous fields

The units, the inductive and capacitive accessories, and the power cabling can generate strong electric and electromagnetic fields. These can be dangerous for wearers of electronic medical aids (e.g. pacemakers). A sufficient distance to these electrical parts must be maintained.



The installation area must be marked accordingly.

1.12 Technical data

Version for three-phase motors

Version for three phase motors				
Data BAMOCAR	Dim.	400-400	700-250	700-400
Auxiliary voltage connection	V=	12 V= .. 24 V = ±10 % /peak 4A (2 A) Residual ripple <10 % (self-healing fuse)		
Supply voltage	V=	12 to. max. 400	12 to max. 700	
Output voltage max.	V~eff	up to 3x260	up to 3x450	
Continuous current	Aeff	200	125	200
Continuous power max	kVA	75	85	135
Peak current max.	A _{lo peak}	400	250	400
Peak current max.	A~eff	285	178	285
Peak power max.	kW			
Power loss max.	kW	3	2	4
Clock frequency	kHz	8-16		
Rotation frequency max.	Hz	1000		
Overvoltage switching threshold	V=	440	800	
Input fuse	A	250		
DC link capacity	µF	320		
Weight	kg	8,5		
Dimensions HxWxD	mm	355 x 230 x 135		

Control signals		V	A	Function	Connection
Analogue inputs		± 10	0.005	Differential input	X1
Digital inputs	ON	10-30	0.010	Logic IO	X1
	OFF	<6	0		
Digital outputs		+24	1	Transistor output open emitter	X1
Analogue output		Not available			
Resolver / TTL / SINCOS				Differential input	X7
CAN interface				Logic IO	X9
RS232 interface				Logic IO	X10

Environmental conditions	
Protection class	IP 65 (option IP69K)
Standards	EN60204, ISO 16750, EN61800, IEC60146
Overvoltage	400 V and 700 V DC +10 %
Operating temperature range	-30 to +85 °C
Storage, transport	-30 °C to +80 °C EN60721
Installation height	≤ 1000m above sea level 100 %, >1000 m power reduction 2 %/100 m
Cooling	Liquid cooler -30 to max. 65°C, 12 l/min, Pressure max. 6 bar >65 °C Power reduction 2 %/°C
Extended cooling range	Cooling medium 65 to 80 °C Torque reduction (see table)
Mounting position	independent
Pollution	Pollution degree 2 according to EN 61800-5-1
Vibration	10..58 Hz Amplitude 0.075 mm according to IEC 60068-2-358 ..200 Hz 1 g
Shock	15 g for 11 ms
Environmental conditions	Not permissible: Condensation, ice formation, oil mist, salt mist, water
Humidity	Class F Humidity < 85 no internal condensation!

Environmental conditions

The closed housings are resistant to most environmental influences.
Special attention should be paid to the connection plugs.

To prevent internal condensation, pressure equalisation valves with moisture protection are installed.
In case of oil mist or salt spray, the function of the valves may be impaired.
Internal condensation can also occur when the heat sink temperature is colder than the ambient temperature.

Short-term occurrence of impermissible environmental conditions is not critical.

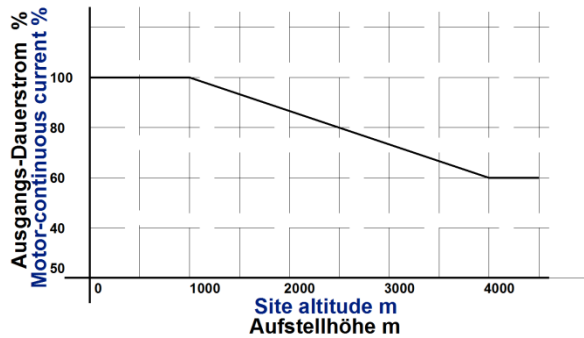
Ice formation can damage the seals.
Operation under water is not permitted.

Humidity

The function of the pressure equalisation valves is overloaded.
Increased humidity in conjunction with salty air can lead to corrosion of the aluminium heat sink.

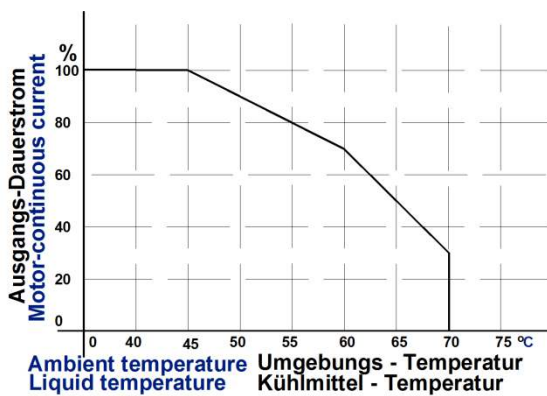
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Current reduction (torque reduction)



Only with air cooler

Permissible current limit depending on the installation height (not automatic, but must be observed by the user).

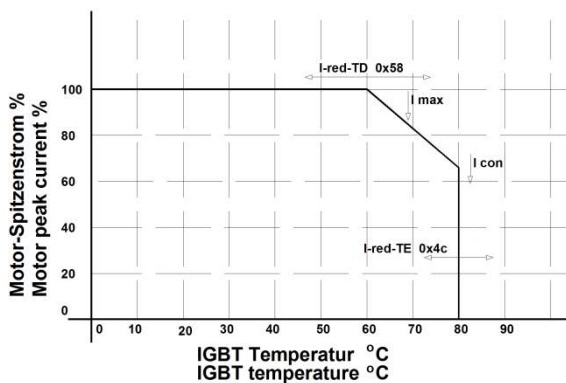


For air cooler

Permissible current limit depending on the ambient temperature.

For liquid coolers

Permissible current limit depending on to the coolant temperature.



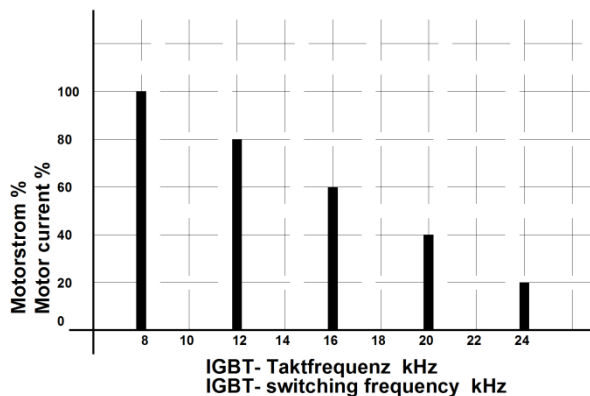
Dependence on IGBT module temperature

Operating temperature of the reduction.
I-red-TD 0x58

Final temperature of the reduction
I-red-TE 0x4C

Protection limits

Warning from 0x4A = 24600 Num
Disable at 0x4A = 25200 Num



Automatic current reduction in
Dependence on the clock frequency.

2 Mechanical installation

2.1 Important notes

Check the unit for mechanical damage.
Only install faultless units.

Mounting only in de-energised state.
Disconnect the positive and negative battery terminals, disconnect the DC mains.
Assembly only by trained specialist personnel.



The installation position is arbitrary for units with liquid cooler.

If the heat dissipation is too low, the unit switches off via its thermal monitoring.

Take the unit mounting holes from the dimensional drawing or the drilling plan, do not mark off the unit.

Mount the filter and choke spatially close to the unit.

Contact the cable shields with the mounting surface.
Lay the power cables (battery and motor cables) separately from the signal cables.
Observe the minimum cable cross-section.

Safe earth connection from the enclosure to the ground level
(vehicle ground, control cabinet ground)

Shieldless cable ends as short as possible.



Use only specified plugs.

Use vibration-proof screw connections.

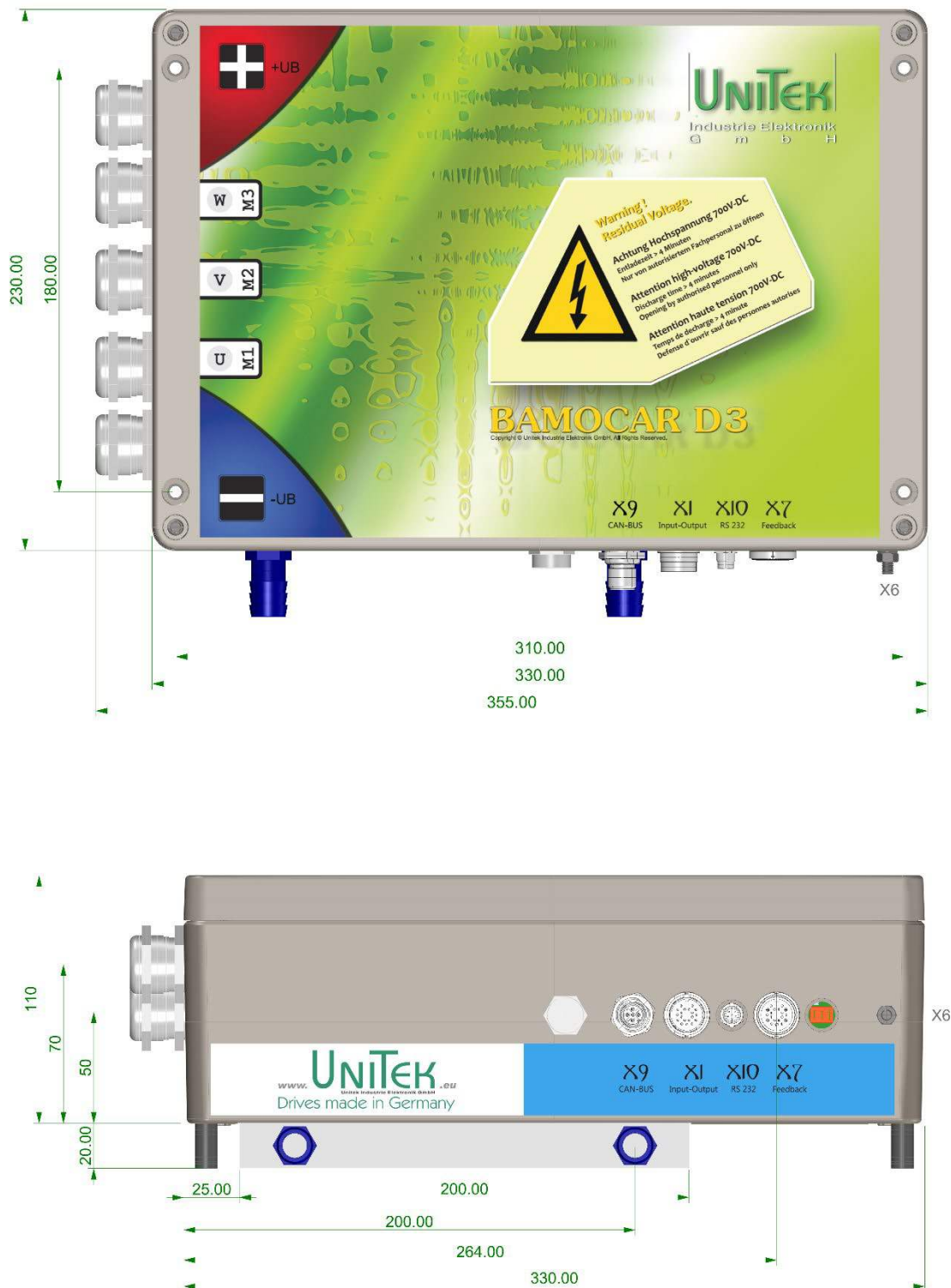
Attention:

Power connection cable from BAMOCAR to battery as short as possible.
Longer cables lead to dynamic voltage drops due to the cable impedance.
These stress the built-in capacitors and shorten the service life.



2.2 Dimension drawing BAMOCAR-PG-D3-400/400, 700/250, 700/400

Standard version (4 connectors fitted)



Power connection:

Screws for power connections:
Allen key M10 x 20 /
Max. tightening torque 20 Nm

PG cable entry metal M25 x 1.5
With shield insert
Cable diameter max. 21 mm

Recommended cable glands:
Lapp-SKINTOP-MS-x
Pflitsch-blueglobe TRI

Liquid cooler:

Cooling medium down to -40 degrees (water + glycol)

Hose connection:	Metal G¼-13
Input temperature:	< 65 °C
Flow rate:	6 to 12 l / min
Print:	max. 6 bar
Pressure loss (10 l/min):	max. 0.56 bar
Thermal resistance:	K/W 0.01
Weight:	2,4 kg

Mechanical installation

2.3 Mounting on mounting rails

4 x M5x20 bolt



Support rail and mounting surface must be provided by the customer

2.4 Mounting on mounting surface



Mounting screws: M5 x 40
Spacer rollers: 10 x 20 inside 6.5

3 Electrical installations

3.1 Important notes

The connection instructions are binding in their assignment of the connections to the plug numbers or terminal numbers!

All further information on this is non-binding. The input and output lines can be changed and supplemented taking into account the electrical regulations and guidelines.

The regulations to be observed are

- Connection and operating instructions
- Local regulations
- EC regulations such as EC Machinery Directive 2006/42/EC
- Vehicle regulations ECE-R100, ISO 6469, ISO 26262
- VDE, TÜV and Employer's Liability Insurance Association regulations

Electrical installation only in de-energised state.

Ensure secure activation.

- Insert shorting bar
- Put up warning signs

Installation only by electrotechnically trained personnel



Compare the connection values with the nameplate data.

Ensure correct fusing of the auxiliary voltage supply.

Lay power cables and control cables spatially separated.

Carry out shield connections and earthing measures in accordance with EMC directives.

Use the correct cable cross-sections.

Note polarity!

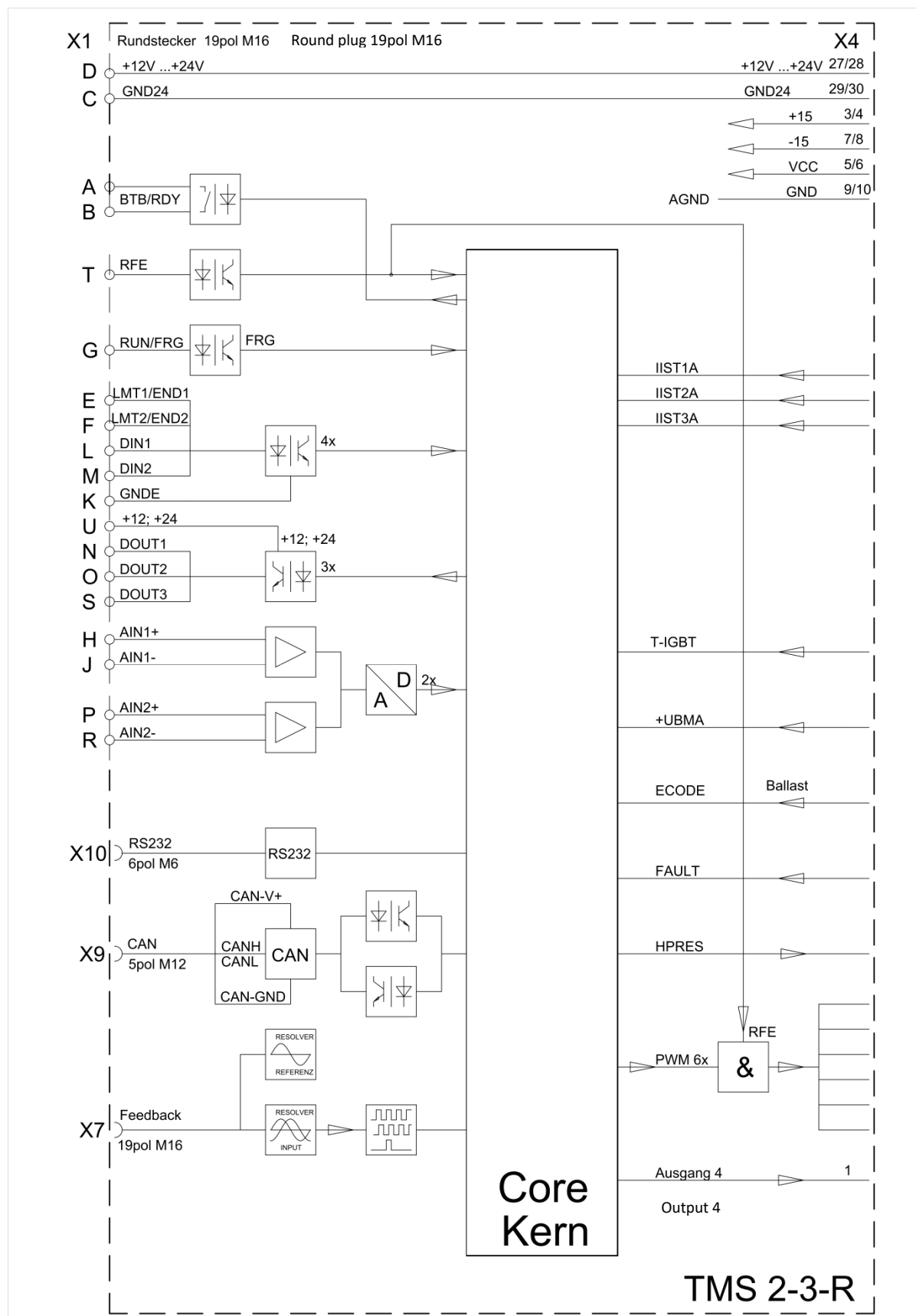
Attention:

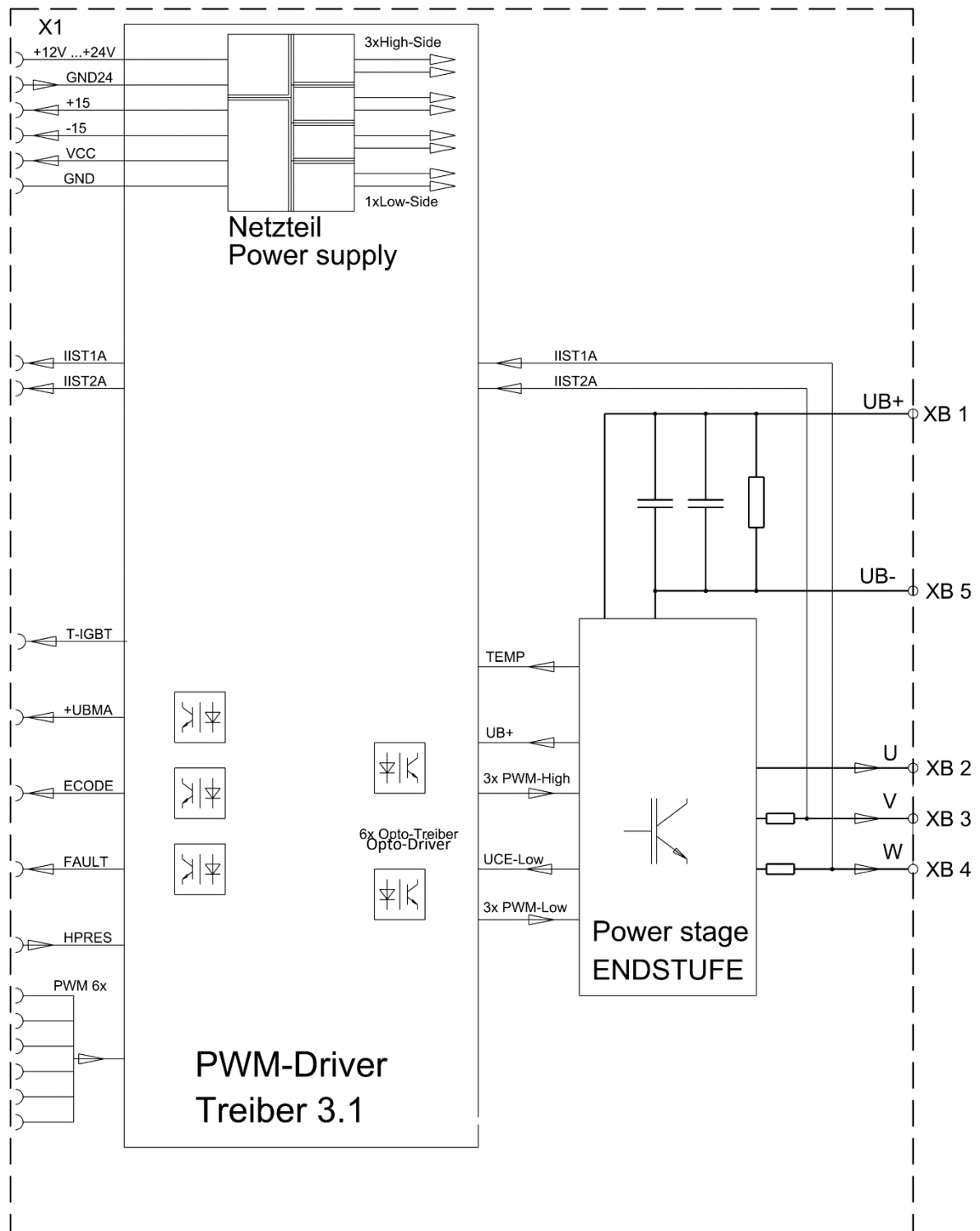
Use external insulation monitors!

- Poor or undersized cable connections between the battery and the unit can damage the unit! (Braking energy)
- The power connection cable from the BAMOCAR to the battery should be as short as possible. Longer cables lead to dynamic voltage drops due to the cable impedance. These stress the built-in capacitors and shorten the service life.

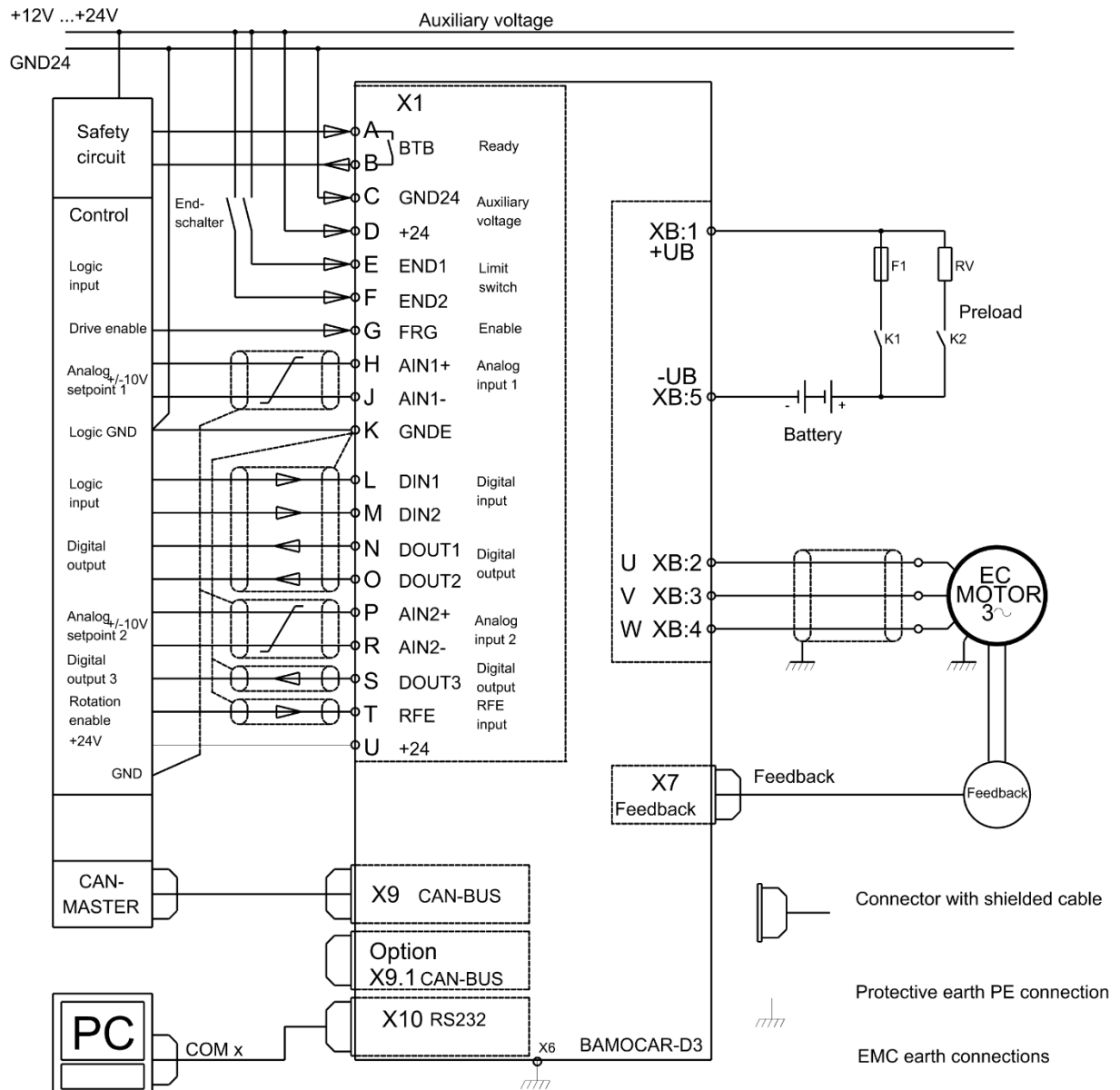


3.2 Block diagrams

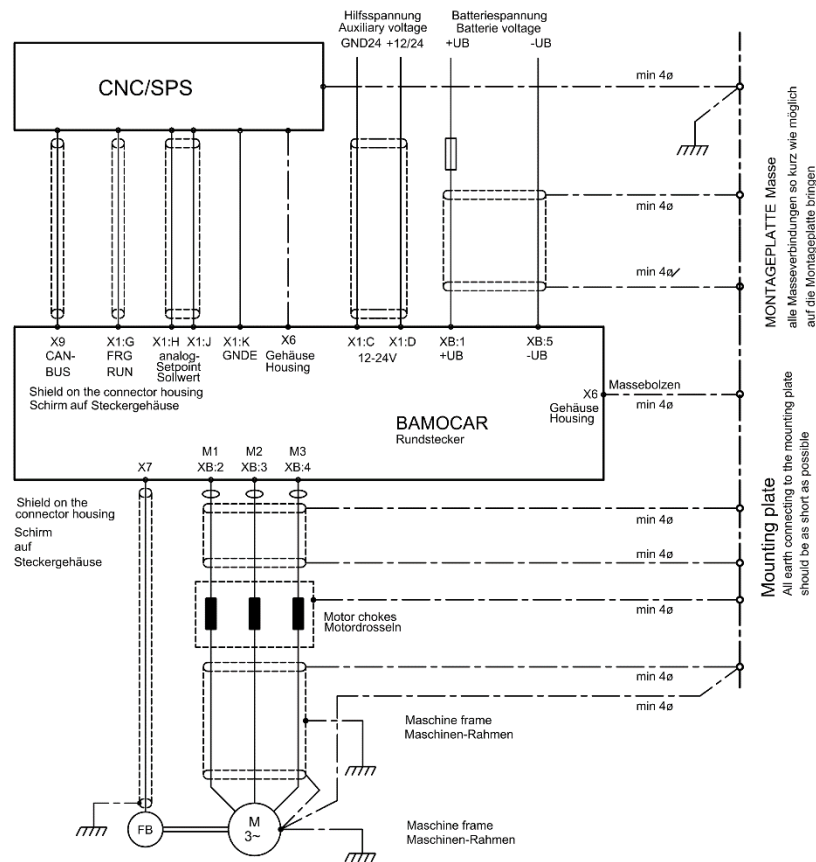




3.3 Connection overview



3.4 EMC



The units comply with the EC Directive 2004/108/EC in the standards EN61800-3 under the following installation and test conditions

Mounting:

Device conductively mounted on bare mounting plate 500 x 500 x 5 mm.

Mounting plate connected to ground via 10 mm².

Motor housing connected to ground via 10 mm².

Power shields connected to mounting plate.

X1:1 (PE2) connected to X6 via 1.5 mm².

X6 (housing ground) connected to mounting plate via 4 mm² cable.

Battery cable and motor cable shielded.

Control connections:

Signal lines shielded, analog signal lines twisted and shielded

Shield: short contact on ground bolt X6.

Battery connection:

12..700 V DC

Motor connection:

Motor cable shielded, flat earth contact

When installed in machines and systems, the inclusion of the

The use of the appliance for the intended purpose is prohibited for as long as the appliance is in use, until it has been established that the machine or system complies with the

provisions of the EC Machinery Directive 2006/42/EC.

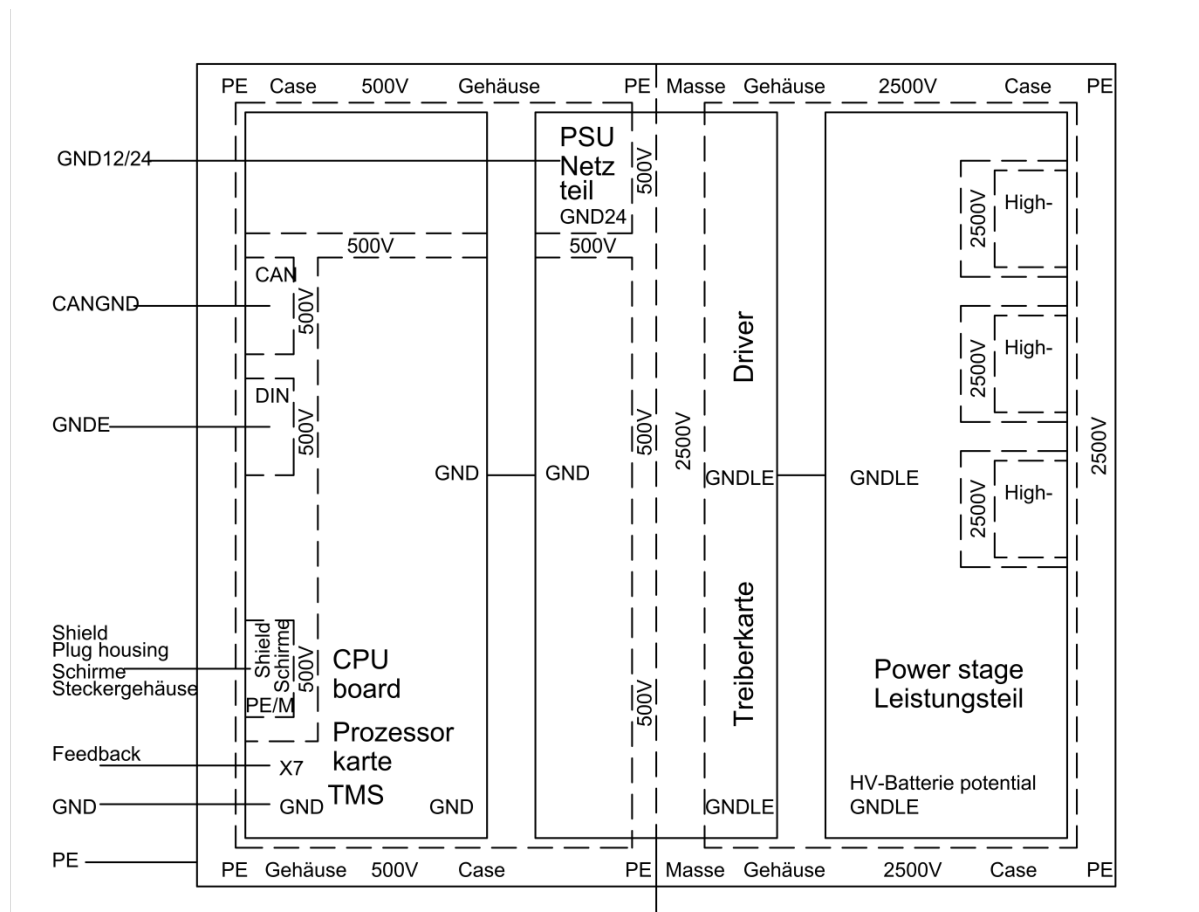
and complies with the EMC Directive 2004/108/EC.

For vehicles ECE-R83, ECE-R100.



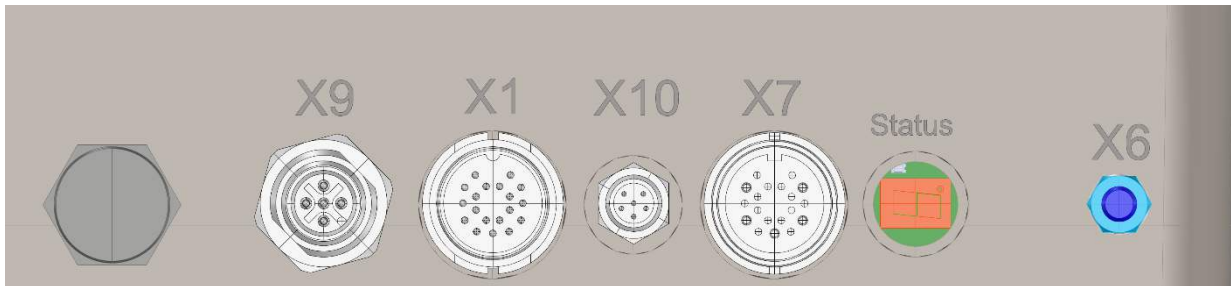
A manufacturer's declaration can be requested.

Potential separation



3.5 Connector overview

Plugs are not included in the scope of delivery.



Pressure equalisation
Valve

X9 CAN
BUS

X1 Tax
Inputs/Outputs

X10 RS232
Parameter

X7 Feedback
Encoder

Display
Status error

Connector X1 Control inputs/outputs			
A	brown	BTB	Ready for operation
B	red	BTB	
C	pink	GND24	Auxiliary voltage 0
D	yellow	+24 V	Auxiliary voltage +
E	green	END1/LMT1	Limit switch 1
F	blue	END2/LMT2	Limit switch 2
G	violet	FRG/RUN	Release
H	grey	AIN1+	Analogue input1
J	white	AIN1-	
K	black	GNDE	Logic Zero
L	brown-green	DIN1	Digital input1
M	brown-yellow	DIN2	Digital input2
N	white-green	DOUT1	Digi output1
O	red-blue	DOUT2	Digi-output2
P	white-yellow	AIN2+	Analogue input2
R	white-red	AIN2-	
S	white-grey	DOUT3	Digi output3
T	white-black	RFE	Rotary field release
U	white-blue	+24 V	Auxiliary voltage+



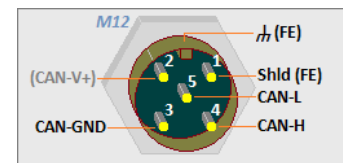
X1
CTRL



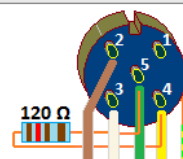
Unit View of connector pins
Connection plug:
Binder 99-5662-15-19
Cable view on solder side

Connector X9	CAN
1	FE
2	CAN-V+
3	CAN-GND
4	CAN-H
5	CAN-L

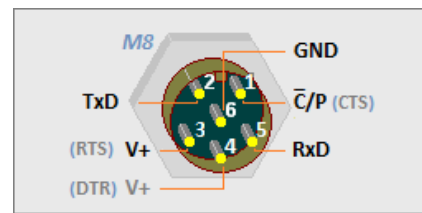
Unit View of connector pins
Connection plug:
Binder 99-0436-14-05
Cable view on solder side



X9
CAN



Connector X10 RS232		
1	brown	C/P (CTS)
2	white	TxD
3	blue	V+ (RTS)
4	black	V+ (DTR)
5	grey	RxD
6	pink	GND



**X10
RS232**



Unit View of connector pins

Connection plug:

Binder 79-3464-52-06

Cable view on solder side

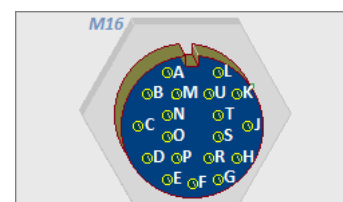
Connector X7 Encoder plug Resolver		Connector X7 Encoder plug INC-TTL		Connector X7 Encoder plug SIN/COS		Connector X7 Encoder plug BL	
A		A	Channel A	A	Channel ka+	A	MP speedometer
B		B	Channel /N	B	Channel kr+	B	
C	SIN1	C	Channel B	C	Channel kb+	C	Speedometer 1
D		D	Supply +5V	D	Supply +5V	D	Supply +15 V
E	COS2	E	Channel N	E	Channel kr+	E	Speedometer 2
F		F	Channel/B	F	Channel kb-	F	
G	REF2	G	Channel /A	G	Channel ka-	G	Speedo 3
H	Temp signal	H	Temp signal	H	Temp signal	H	Temp signal
J		J	Temp GND	J	Temp GND	J	Temp GND
K	REF1	K	Rotor position 3	K	Channel kd-	K	Rotor position 3
L	Temp GND	L	Supply GND	L	Supply GND	L	Supply GND
M	COS1	M	Rotor position 2	M	Channel kc+	M	Rotor position 2
N		N		N	Channel kd+	N	
O	SIN2	O	Rotor position 1	O	Channel kc-	O	Rotor position 1
P		P				P	

Unit View of plug socket

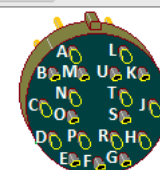
Connection plug:

Binder 99-5661-15-19

Cable view on solder side



**X7
FB**



Electrical installations

3.6 Auxiliary voltage connection

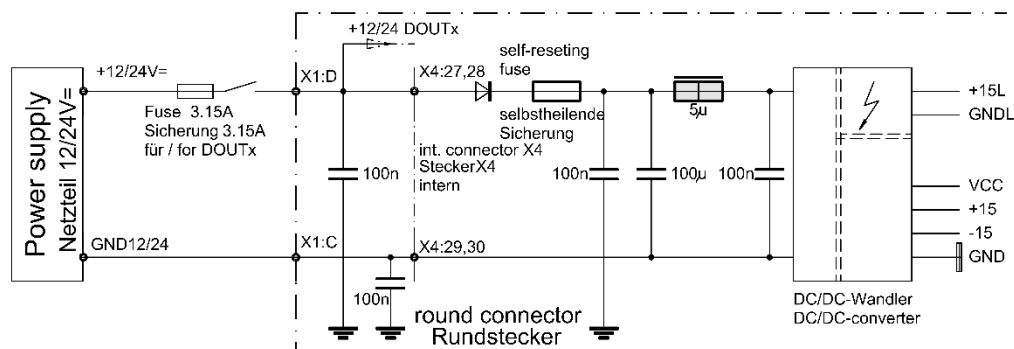
Mains potential-free auxiliary DC $V = (4\text{ A})$ to $+24\text{ V} = (2\text{ A}) \pm 10\%$.

Observe the type plate!

The auxiliary voltage has

- Galvanic connection to the logic voltage
- Galvanic protective separation from all internal supply voltages and from the housing.
- Internal self-healing fuse
- EMC filter

External fuse for line protection only



Input voltage	12.. 24 V DC	X1:D
	GND24	X1:C
Residual ripple	10 %	
Inrush current	max. 4 A	
Nominal current	1.4 A	at 12 V
	0.9 A	at 24 V

Connect the negative terminal of the power supply unit to earth.

Attention:

- In addition to the internal supply current (1.4 A at 12 V / 0.9 A at 24 V), the total current of the outputs (DOUT) must be supplied by the power supply unit.
- **If the auxiliary voltage is less than 10.5 V, the error message hardware error 1 (Power Fault) appears.**
- If the auxiliary voltage is less than 10 V, including brief voltage interruptions, the internal power supply unit switches off.
 - Temporary data in the RAM memory is deleted.
 - Digital speed and torque setpoints are set to 0.
 - **Message OK in the status is dark.**
- Firmware download only with power switched off!
- Only switch auxiliary voltage and/or power voltage when BAMOCAR is locked.
 - No clearance.
 - Enable input X1:G = zero

3.7 Power connections

PG cable gland

Metal M25 x 1.5 with shield contact

Connection - battery positive pole

Connection - Motor W

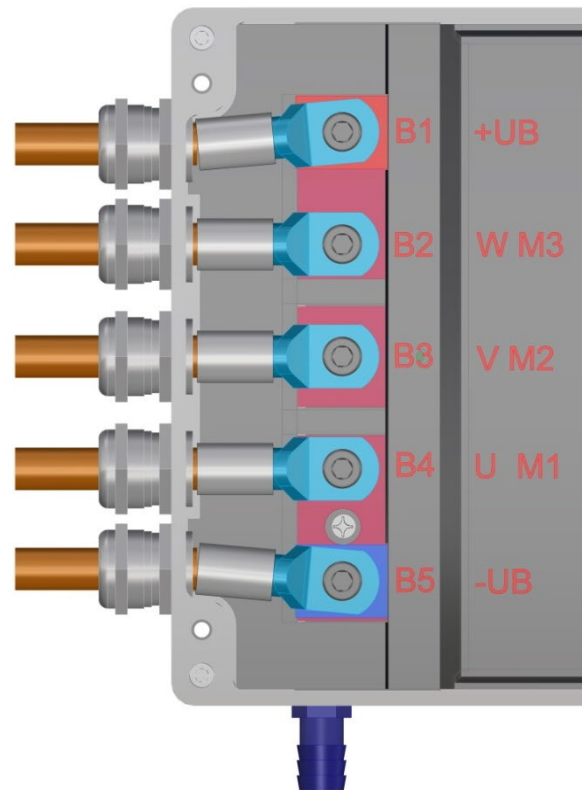
Connection - Motor V

Connection-- Motor U

Connection - battery negative pole

Connection cable maximum 50 mm2

Structure:



Only use cables with shield layer!

Connection example:

Adapt dimensions to the cable and cable gland used!

Remove outer insulation to 34... 38 mm, shorten shield layer to 10 mm.

Shorten inner insulation. Copper strands 7..12 mm.

Cable lug insulation 25 mm (fabric hose or shrink hose).

Cable lug for M10 screw.

Push on the PG screw connection with shield springs.

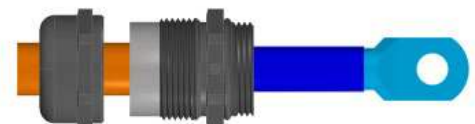
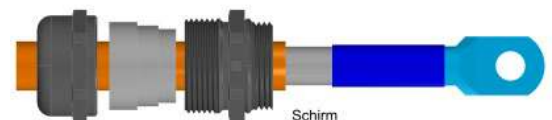
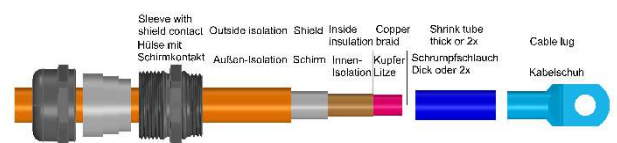
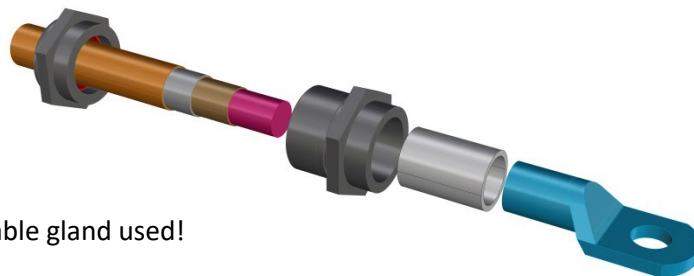
Slide on the cable shoe insulation.

Press the cable strands into the cable lug (15 mm).

Screw in the PG gland in the unit.

Screw cable lug onto the internal busbar. Tighten the cap of the PG screw connection.

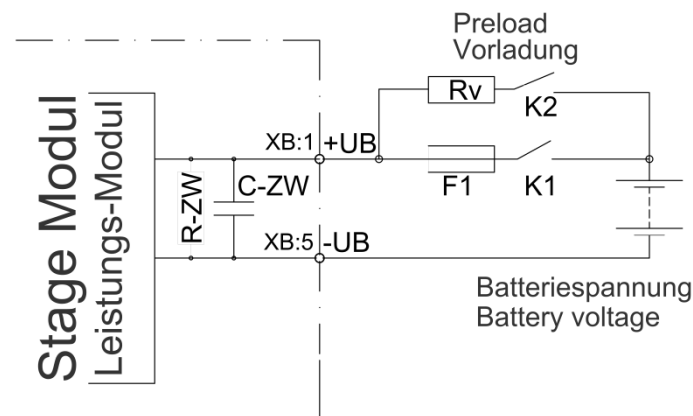
Tighten the cable gland on the cable lug.



Connection screw: M10 x 12 (self-locking or corrugated washer, no toothed lock washer)
Maximum tightening torque 20 Nm

Remark: The cable gland is not included in the scope of delivery.

3.8 Battery connection



DC link capacitor C-ZW
at 400 V 320 μ F
at 700 V 320 μ F

Discharge resistance R-ZW:
50 k Ω

Series resistor
RV approx. 40 Ω , 50 W

Charging current via K2:
< 20 A

Attention:

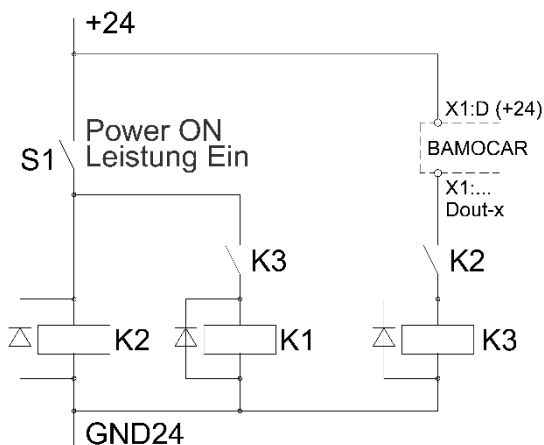
Enable (RUN) only after the main
contactor K1 has been switched.

The maximum connection voltage (battery voltage) 450 V= (780 V=),
do not exceed even for a short time - risk of destruction!
Error message: OVERVOLTAGEF1
= slow-blow fuse



Programming an output for the pre-charge:

The output Dout1 switches the relay K3 if the DC link voltage (DC BUS) is greater than variable 1.



Logic-Input-Output			
INPUT		AL AH	
Limit1	--Off--	<input type="radio"/>	<input checked="" type="radio"/>
Limit2	--Off--	<input type="radio"/>	<input checked="" type="radio"/>
Din1	--Off--	<input type="radio"/>	<input checked="" type="radio"/>
Din2	--Off--	<input type="radio"/>	<input checked="" type="radio"/>
OUTPUT			
Dout1	DC-BUS	>	Var1
Dout2	--Off--	!=	1
Dout3	--Off--	Off	0
Dout4	--Off--	Off	0
Var1	26000	Var3	0
Var2	0	Var4	0

Attention:

The power connection has no reverse polarity protection.
If the polarity of the power connection is reversed, the unit may be destroyed.

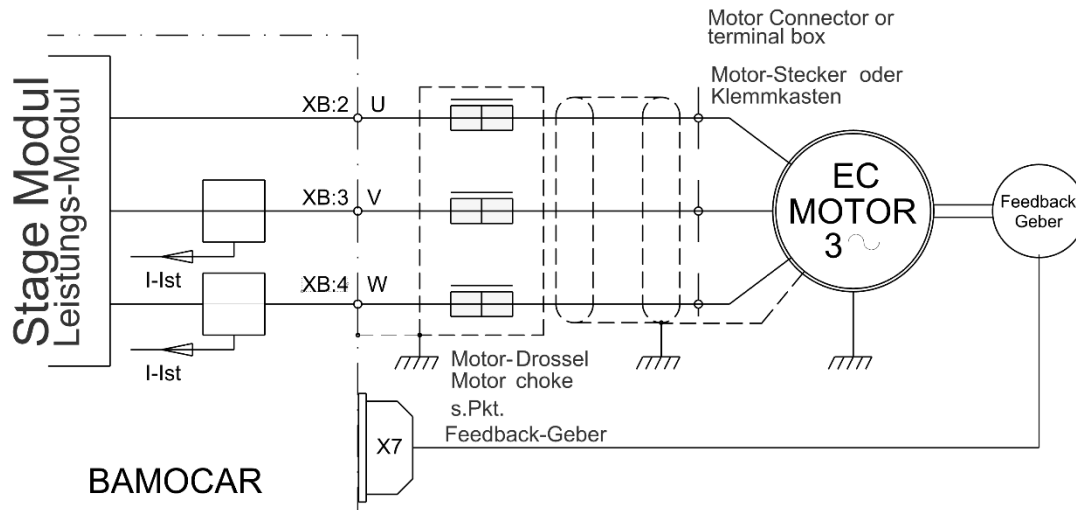


Type	Battery connection	Connection cross-section		Fuse AT	Drive-
		mm ²	AWG		Contactor size
250/400		35	1	250	

**Battery connection <2 m, from 2 to 10 m make connection stronger.
Use additional capacity from 10 m! Lay positive and negative cables in parallel.
Maximum connection cross-section 50 mm², cable lug for M10.**

3.9 Motor power connection

For synchronous motors (brushless DC motors, EC motors) and AC servo motors with feedback encoder.



Follow-up

Cable designation	M1	M2	M3	Motor cable 3 cores + protective earth single shielded, for 1000 V= Shield capacitance 150 pF/m Minimum cross-section s. Table
Motor phases	U	V	W	
Connection terminal	XB:2	XB:3	XB:4	

Minimum cable cross-section

Type BAMOCAR	250	400	Motor choke Only necessary from a screen capacity of of >5 nF. approx. 25 m motor cable
Cross section mm ²	25	35	
AWG		1	

Motor choke

Only necessary from a shield capacity of >5 nF / approx. 25 m motor cable.

Ferrite rings

In case of HF interference coupling on Sensor systems, slide ferrite rings over the motor cable.

Shield connection

Flat connection at the control cabinet input or machine/vehicle frame.

Flat or shortest possible connection on the motor side.

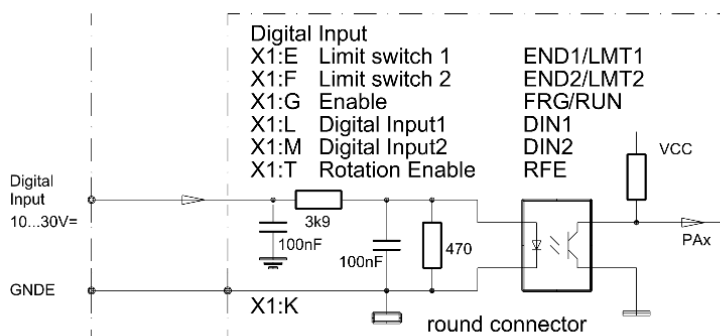
If the motor cables are long, connect the motor cable shields to earth (mounting frame) several times (e.g. earth connection every 2 metres).



4 Control ports

4.1 Digital inputs

Input voltage		
ON level		+10.. +30 V
OFF level		< +6 V
Input current	Max.	7.5 mA
Nominal voltage/current		+24 V/6 mA
Reference mass	GNDE	(X1:K)



The enable input (FRG/RUN) and the input for rotating field enable (RFE) are permanently assigned and cannot be programmed.

Without FRG/RUN enable, the servo is electronically locked (no PWM pulses).

Without rotating field release RFE, the rotating field of the output stage is additionally blocked (second blocking channel).

The drive is torque-free (no holding torque).

The other 4 digital inputs are freely programmable.

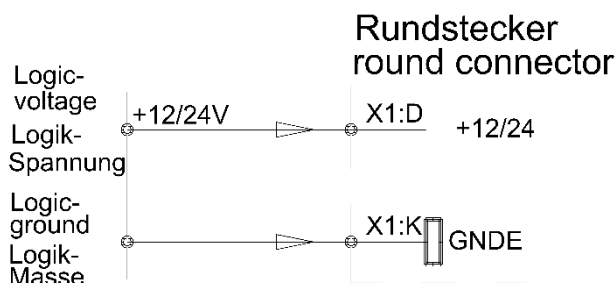
The inputs LMT1 (X1:E) and LMT2 (X1:F) are preferably to be used as limit switch inputs.

Entrance	Connection	Function	Status	
RFE	X1:T	Rotary field/enable	fixed	
FRG/RUN	X1:G	Enable	fixed	
END1/LMT1	X1:E	Limit switch1/Dig. input	programmable	
END2/LMT2	X1:F	Limit switch2/Dig. input	programmable	
DIN1	X1:L	Digital input1	programmable	
DIN2	X1:M	Digital input2	programmable	

The enable (FRG X1:G) may only be activated after the auxiliary voltage (12-24 V) and the power voltage (both) have been switched on.



External power supply for inputs and outputs



+12 ..+24 V for logic and auxiliary voltage

GNDE Logic Mass

4.2 Safety input RFE (rotating field - enable) / stop category 0

When the input of the release or the rotating field release is switched off the drive is torque-free. Without mechanical brake or lock the drive may fall through or move

The motor cables are not voltage-free. Only the rotating field is blocked. When working on the motor or BAMOCAR, the battery motor controller must be separated from the battery high voltage.



Operation with RFE input

Two-channel enabling lock via a Safety switchgear.
Enable input FRG/RUN.
Rotary field enable input RFE.

Switch on

Safety device contacts closed.
Release FRG/RUN 0.5 s after RFE.

Safety shutdown

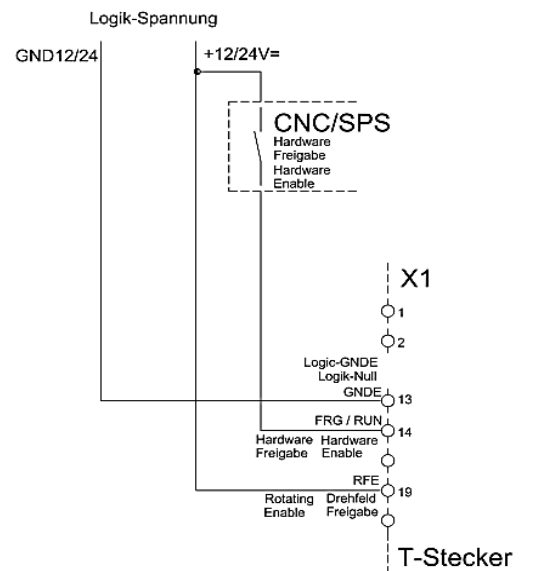
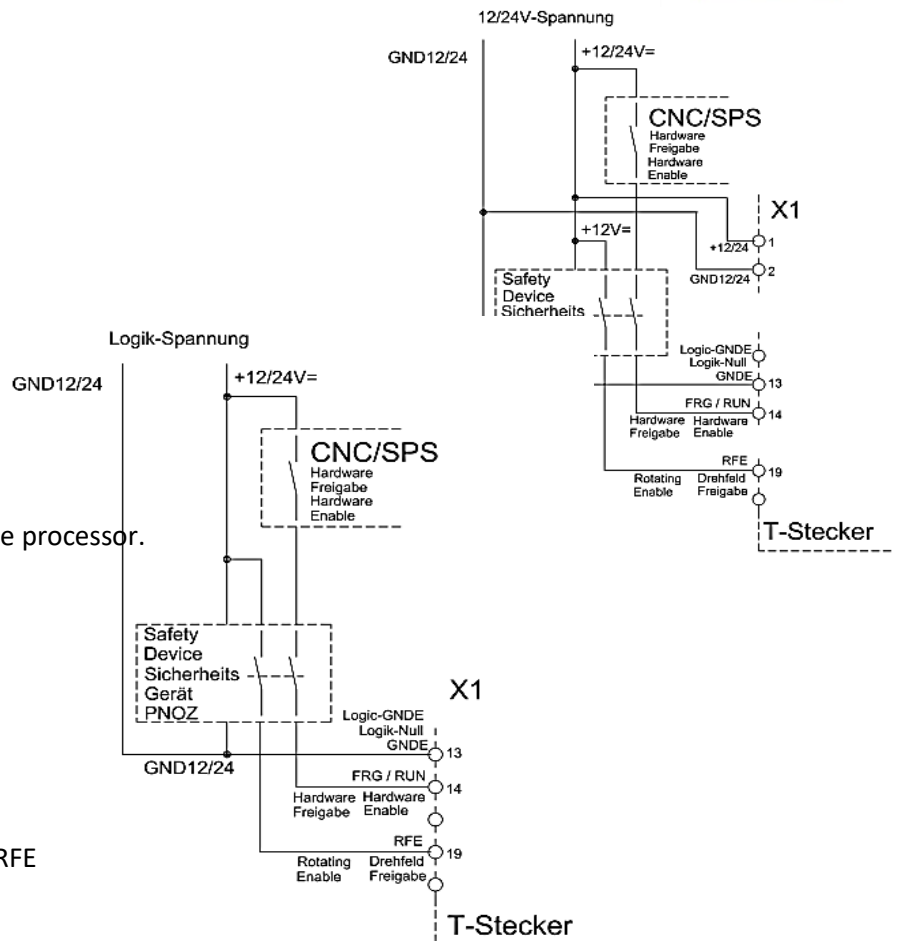
Safety device contacts opened.
No FRG/RUN signal blocks in the first blocking channel the PWM pulses in the processor.
No RFE signal blocks the PWM pulses in a second barrier channel after the Processor.

Switch on again

Unlock the safety device.
Safety device Contacts closed.
Only after renewed release FRG/RUN in time after the rotating field release RFE the motor can move.

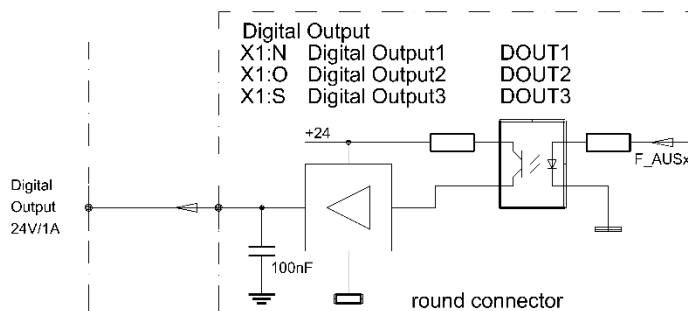
Operation without RFE input

The RFE input must be connected to the logic voltage.
If the logic voltage is equal to the supply voltage, the RFE input is bridged with +24 V.
The release FRG/RUN at least 0.5 s after the RFE signal.



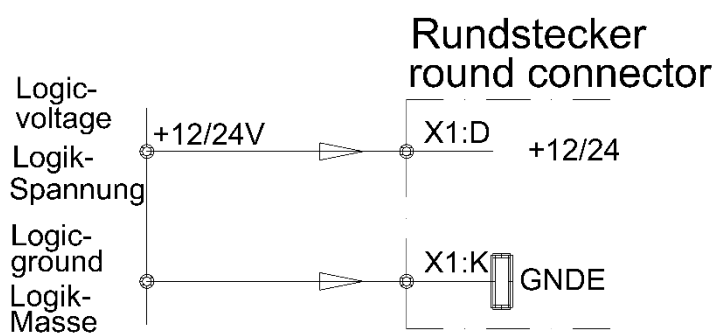
4.3 Digital outputs (Open emitter)

Output voltage		
ON level	+12.. +24 V=	
OFF level		< 1 V=
Output current	nom	1 A
Output current	max.	2 A, 1s
Reference voltage	+24 V	(X1:D)
Reference mass	GNDE	(X1:K)



Output	Connection	Function	Status	Parameter
BTB/RDY	X1:A X1:B	Ready for operation	fixed Solid State Relay	
DOUT1	X1:N	Digital output 1	programmable	
DOUT2	X1:O	Digital output 2	programmable	
DOUT3	X1:S	Digital output 3	programmable	
DOUT4 (option)	X11	Brake (option) 4	programmable	

The auxiliary voltage is also the supply voltage for the logic outputs.



+12.. +24 V for logic and auxiliary voltage
Observe the total current of all outputs

GNDE Logic Mass

Control ports

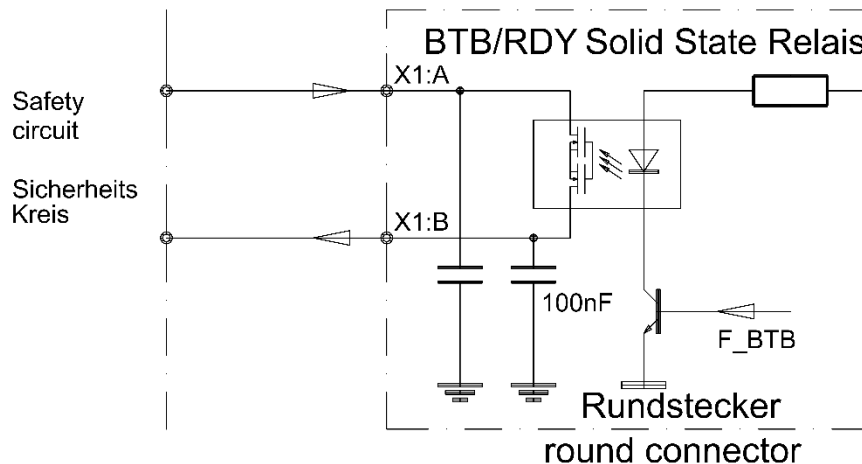
4.4 Signalling contact Ready for operation (solid state relay) / Ready BTB / RDY

Hardware safety circuit with solid state relay contact.

Software: Message Signal Parameter Status RDY (0x40 Bit 14)

Ready for operation BTB = logical 1

In the event of a fault, this safety circuit is disconnected by the relay and the RDY status is set to 0.
Other control units (e.g. BMS, VCU, etc.) can react.



Contact for max. 48 V / 0.5 A (not short-circuit-proof)

Capacitive load: max. 1 μ F

Contact resistance: max. 2 Ω

Ready for operation BTB

The BTB relay contact is closed.

Not ready for operation

BTB relay contact is open.

Red LED and error messages with 7-segment status LED.

Always insert BTB/RDY contact in the safety circuit!

Secure BTB/RDY signal path with 0.5 AF!

BTB function for undervoltage monitoring.

BTB message also in the absence of power voltage Programming in NDrive:

Parameter BTB Power = without (0x5A_{Bit5} = 1).

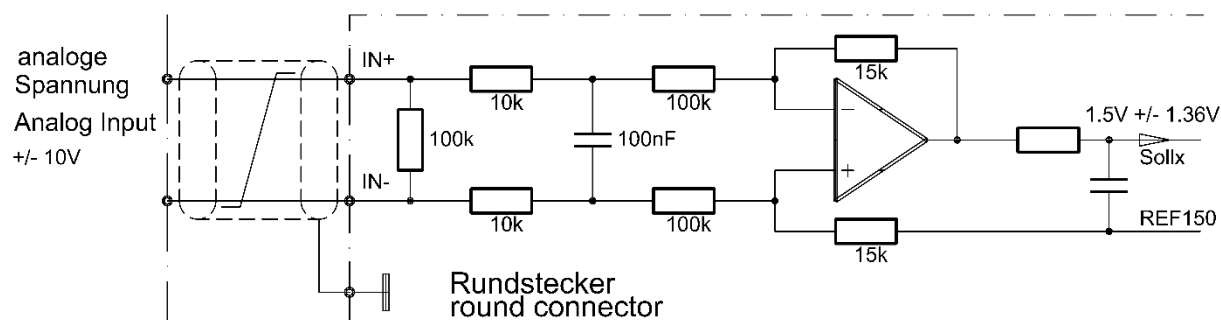
No BTB message in case of missing power voltage

Programming in NDrive: Parameter BTB Power = with (0x5A_{Bit5} = 0).

(see NDrive-x manual)



4.5 Analogue inputs ± 10 V



Entrance	Connection	Basic function	Voltage	Status	Parameter
AIN1+, AIN1-	X1:H, X1:J	Speed setpoint	± 10 V	prog.	
AIN2+, AIN2-	X1:P, X1:R	Current limit 2. speed setpoint	± 10 V	prog.	

Properties

Differential input	AIN1+ / AIN1-	AIN2+ / AIN2-	
Input resistance	70 k Ω		
Voltage limit	± 12 V		
Resolution	11 bit + sign		

The direction of motor rotation can be changed by swapping the +/- connections on the differential input, by a logic input or by programming (see NDrive-x).

The analogue inputs can be assigned to different functions (see NDrive-x).

The analogue input AIN1 can be programmed as an external analogue speed limit and the analogue input AIN2 can be programmed as an external analogue current limit.

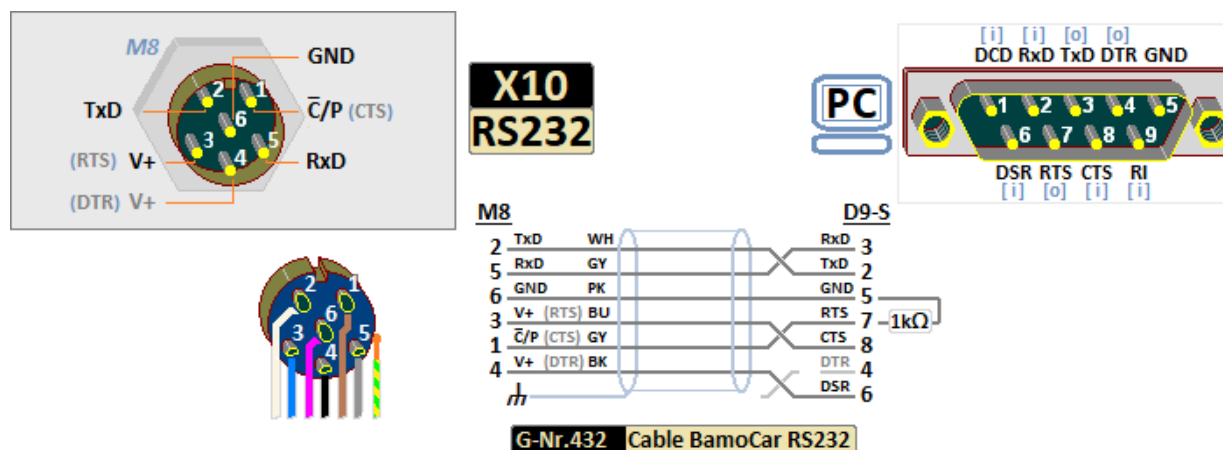
4.6 Analogue output - not available

There is no analogue output in this BAMOCAR variant.

Control ports

4.7 Serial interface RS232

The unit is programmed via the serial PC interface RS232 and operated during commissioning. The software is described in the NDrive software manual.



Attention:

The serial interface is galvanically connected to the device zero (GND/AGND).

Connection between **BAMOCAR-PG-D3-400/400, 700/250, 700/400** (round plug X10) and the serial interface (COMx) on the PC only with a shielded null modem cable.

Only plug in the cable when the power is off.

The interface is factory set to 115200 baud.
This can also be changed to 9600 baud with NDrive.

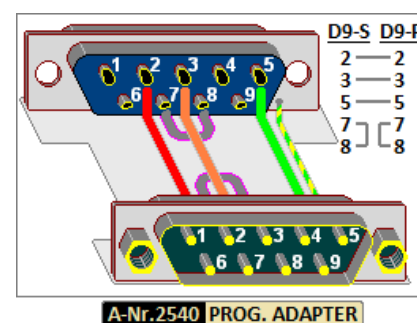
Connecting cable: LiYCY 5x0.25 + shield; cable length max. 10 m
Screen on the housing

RS232 cable: order no. G432 / Binder 79-3464-52-06

In case of strong interference on the interface, a line filter should be used.
Laptops with USB RS232 converters are usually sensitive to interference.

For firmware update:

Plug in short-circuit jumper X10:1 to X10:3 (D-connector 7 to 8), then
switch on auxiliary voltage.
Start Flash programme.



Control ports

4.8 CAN-BUS

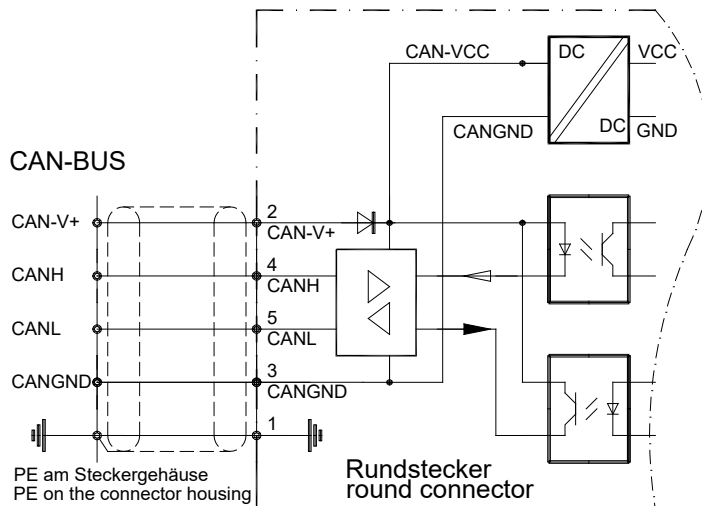
The CAN-BUS is the digital connection to the CNC control.

Optimum conditions with CNC controls and CAN components from LABOD electronic or CAN Open.

Programming and operation via control panel with CAN-BUS.

Interface according to ISO 11898.

For setting and programming, see NDrive and CAN Manual.



The BUS interface is galvanically separated from the internal device voltage.

Power is supplied via an internal isolated DC-DC converter.

CAN-BUS is isolated /
CAN GND must be connected

CAN BUS cable

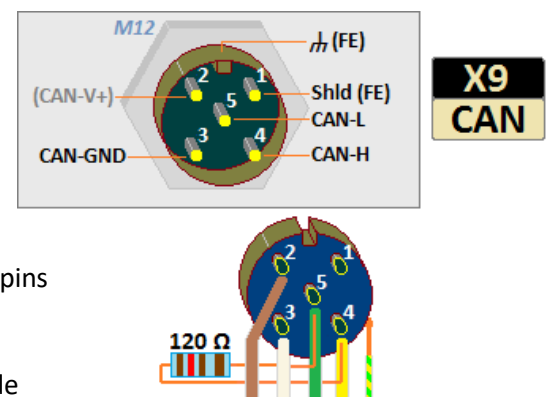
Use shielded bus cable with low shield capacity.

Signal plus GND (+supply internal DC/DC converter, galvanically isolated)

Round plug M12-5p / LiYCY 4 x 0.25 + screen

Designation	Plug	Cable colour
FE	X9:1	Shield
CAN-V+	X9:2	brown
CAN-GND	X9:3	white
CAN-H	X9:4	green
CAN-L	X9:5	yellow

(Attention: Colours can be different)



Unit View of connector pins

Connection plug:

Binder 99-0436-14-05

Cable view on solder side

Termination resistor at both ends of the bus line / 120 Ohm between CAN-H and CAN-L

Control ports

4.9 Resolver connection

Only for BAMOCAR-PG-D3-RS

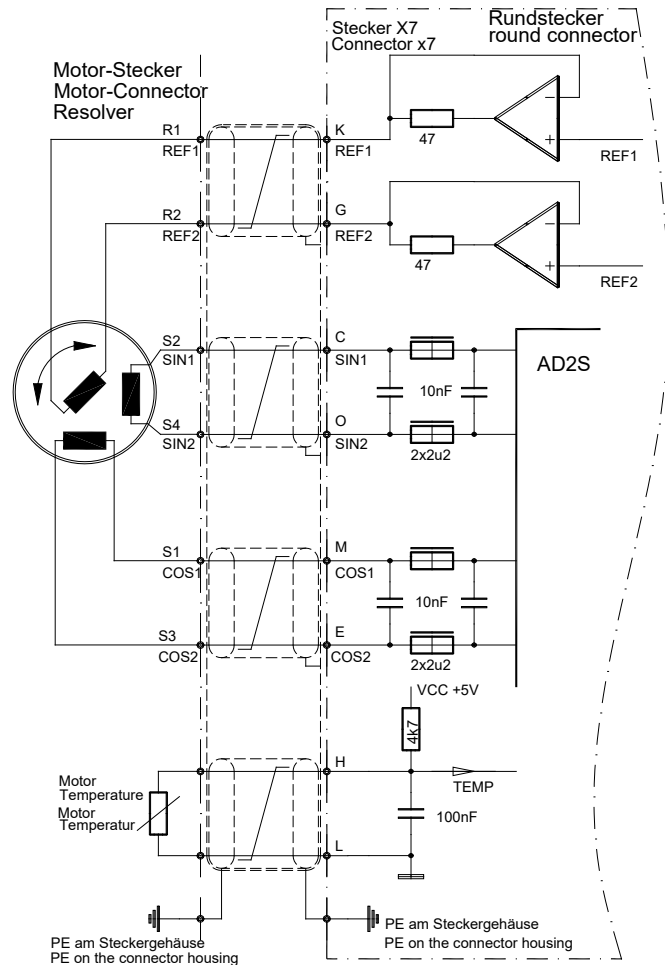
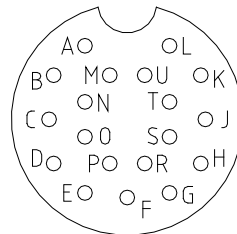
The resolver is an absolute measuring system for one motor revolution.
It is robust and insensitive to high engine temperatures.
The design corresponds to a rotating transformer.
The rotor is fed by the reference (10 kHz).
The stator supplies the sine and cosine signals modulated by the rotational frequency.
In the servo amplifier, the amplitudes of these signals are evaluated and digitised.
The resolution is automatically set to 10, 12 or 14 bits.
The maximum possible speed is 50 000 rpm (10 bit).
The digitised signals are used for the pole wheel angle, the position control, the speed control and for the incremental output.

Connector

X2

A	
B	
C	SIN 1
D	
E	COS 2
F	
G	REF 2
H	Temperature signal
J	
K	REF 1
L	Temperature GND
M	COS 1
N	
O	SIN 2
P	

Socket on the unit



Only use motor with 2, 4, 6 or 8 pole resolver approved by the manufacturer.

Connector plug	X7	19-pin round plug
Connection cable	4 x 2 cores twisted in pairs and shielded, plus overall shield. Use only suitable cable for drag chain Minimum cross section 0.25 mm	
Cable length	for >25 m, only use high-quality resolver cables with improved shielding properties.	
Shield connection	at connector X7	combine all umbrellas and Contact with the housing
	on the motor plug	Contact the overall shield with the connector housing
Setting parameters	see software manual NDrive	

Control ports

4.10 Encoder TTL connection

Only for BAMOCAR-PG-D3-IN

TTL incremental encoder (encoder) with 2 counting tracks and one zero track plus 3 rotor position marks. Counting tracks with or without push-pull output.

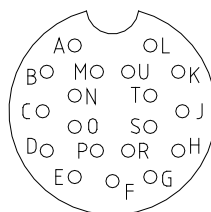
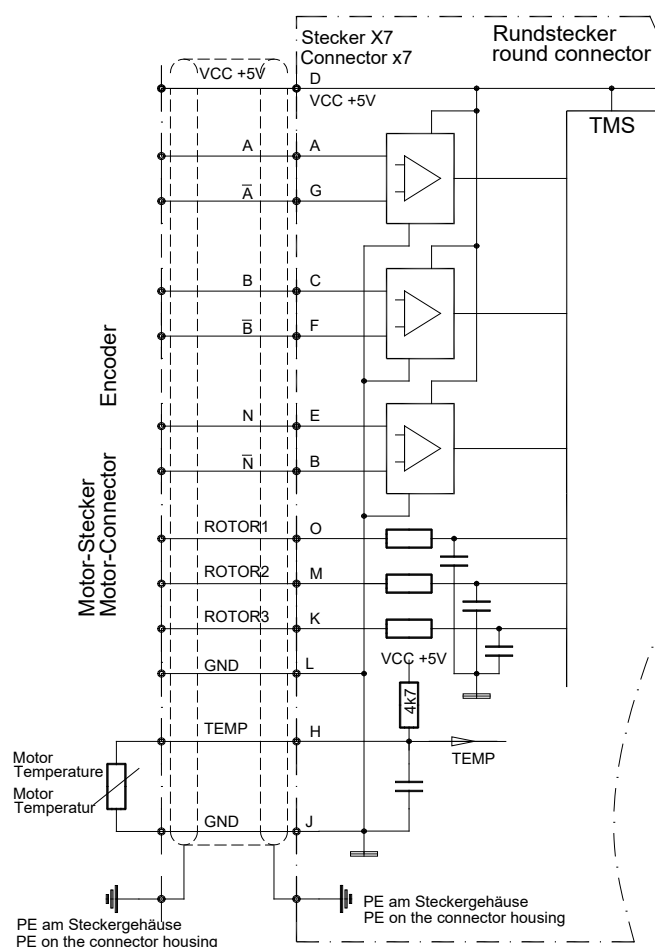
(With single connection A, B, N the negated inputs).

Count input corresponds to RS485. Maximum counting frequency 500 kHz.

The incremental encoder is galvanically with the device zero (GND) connected.

Supply voltage 5 V supplies the servo.

Connector X7	Encoder plug INC
A	Channel A
B	Channel /N
C	Channel B
D	Supply +5V
E	Channel N
F	Channel /B
G	Channel /A
H	Temperature signal
J	Temperature GND
K	Rotor position
L	Supply GND
M	Rotor position 2
N	Rotor position 1
O	
P	



Only use motors approved by the manufacturer with TTL incremental encoder and rotor position tracks.		
Connector plug	X7	19 pole round plug
Connection cable	11 x signal wires shielded	Minimum cross section 0.14 mm
	2 x supply wires	Minimum cross section 0.5 mm
	Use only suitable cable for drag chain	
Cable length	for >25 m cross-section one step larger	
Shield connection	at connector X7	Contact the shield with the connector housing.
	on the motor plug	Contact the shield with the connector housing.
Setting parameters	see software manual NDrive	

Control ports

Adapter for INC encoders with A, B, N channels without push-pull signals

The device input for the incremental counting signals requires the push-pull counting pulses for reliable detection.

In many simple applications, encoders without push-pull signals (e.g. bearing encoders)

are used with different supply voltages.

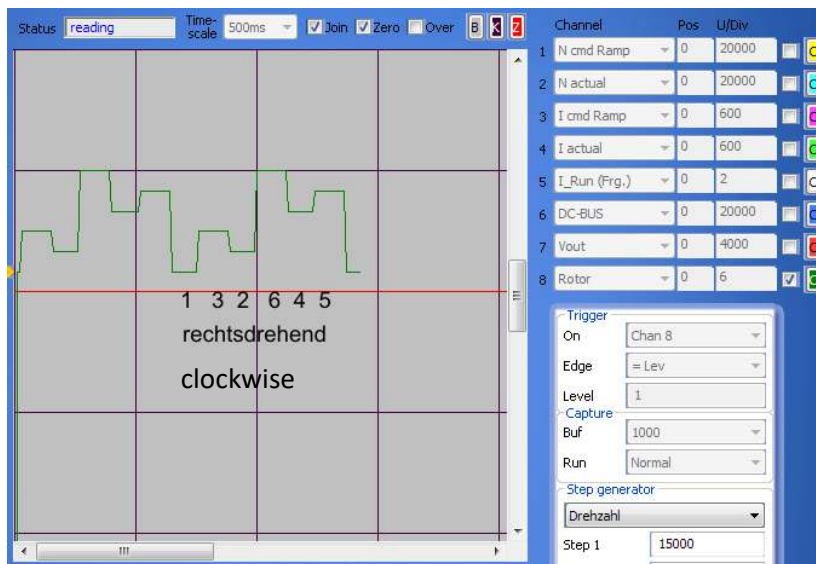
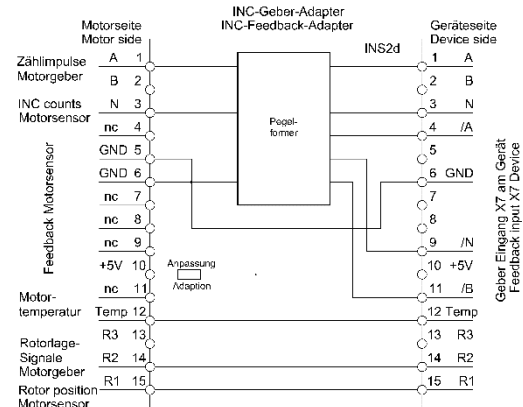
In these applications, the INC adapter must be used.

The adapter converts the counting signals A, B, N into the push-pull signals A, /A, B, /B, N, /N.

For supply voltages other than 5V, the voltage must be specified in the order and connected externally.

Checking for correct connection

Rotor sequence



The correct sequence of rotor signals with clockwise turning Motor is 1, 3, 2, 6, 4, 5

With other number sequence the encoder connection of the rotor position signals Rotor1, Rotor2, Rotor3, (U, V, W) is wrong

Use connection diagram!

Numerical value

Turn the motor one turn to the right without release.

Track	
Pos actual	65536 (0x10000)
zero-capture	1567 (0x061f)
--Off--	-
--Off--	-
--Off--	-
--Off--	-
Schließen	

One motor revolution corresponds to a position value of Num 65536.

If the result is different, the input of Feedback Inc-Mot (0xA6) is incorrect.

Zero angle

Motor rotating right and left at 10..100 % speed.

The value of zero-capture must remain constant.

Control ports

4.11 SIN COS 1V_{ss} Connection

Only for BAMOCAR-PG-D3-SC

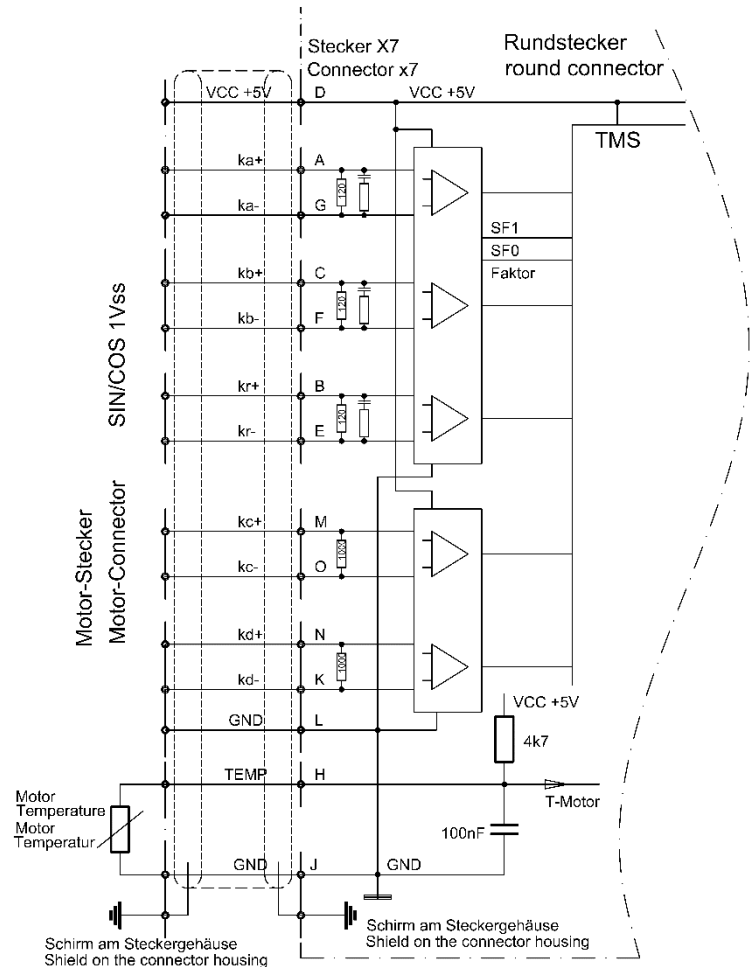
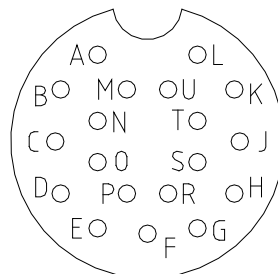
Incremental encoder
with 2 analogue sinusoidal
Counting lanes and one zero lane
plus 2 commutation tracks.
Differential signals 1 V_{ss}.

Maximum counting frequency 500 kHz.

The incremental encoder is
galvanically connected to the device zero
(GND) connected.

Supply voltage 5 V is supplied by the
Servo.

Connector X7	Encoder plug SIN/COS
A	Channel ka+
B	Channel kr+
C	Channel kb+
D	Supply +5V
E	Channel kr+
F	Channel kb-
G	Channel ka-K
H	Temperature signal
J	Temperature GND
K	Channel kd-
L	Supply GND
M	Channel kc+
N	Channel kd+
O	Channel kc-
P	



Only use motors approved by the manufacturer with SIN / COS encoder (SC).		
Connector plug	X7	19-pin round plug
Connection cable	6 x 2 signal wires drill-shielded	Minimum cross section 0.14 mm
	2 x supply wires	Minimum cross section 0.5 mm
Cable type	(4 x (2 x 0.14) + (4 x 0.14) C + 4 x 0.5) C Use only suitable cable for drag chain	
Cable length	for > 25 m cross-section one step larger	
Shield connection	at connector X7	Contact the shield with the connector housing.
	on the motor plug	Contact the shield with the connector housing.
Setting parameters	see Software Manual NDrive	

4.12 Rotor position sensor connection with BL tacho

Only for BAMOCAR-PG-D3-BL

3 rotor position sensor signals (Hall sensors) for commutation.

With or without brushless tachogenerator.

The rotor position sensor is galvanically connected to the device zero (GND).

Supply voltage 15 V from servo.

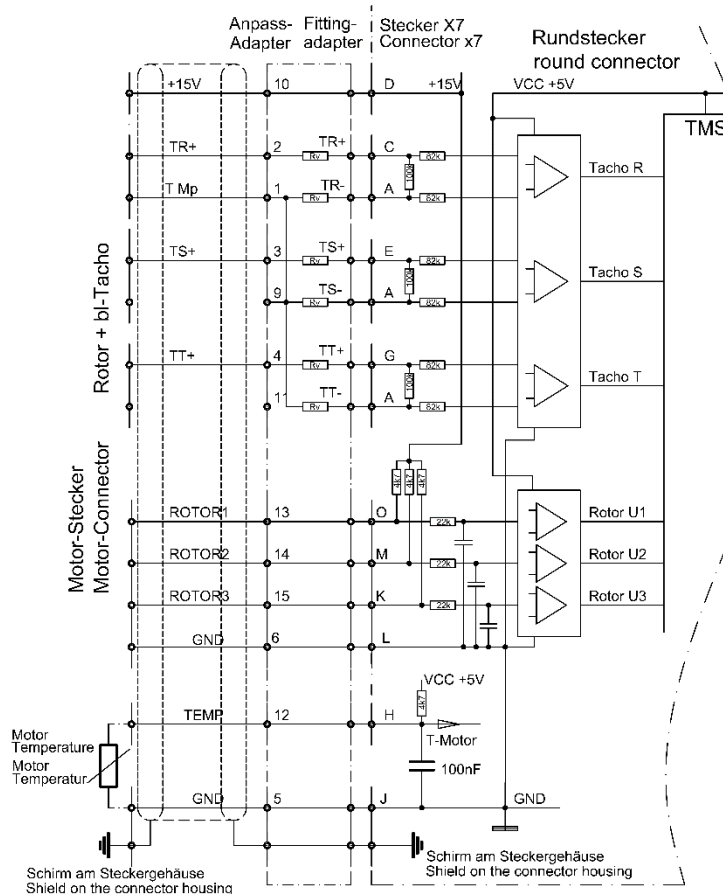
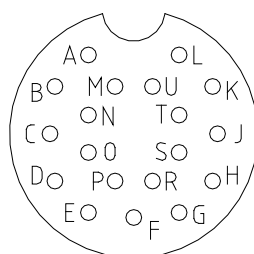
Adaptor if the tachometer voltage at nominal speed is greater than 10 V~.

For smaller tachometer voltages

X7: Connect pin 1, 9 and 11.

Connect tacho centre to X7:1.

Connector X7	Encoder plug bl
A	MP speedometer
B	
C	Speedometer 1
D	Supply +15 V
E	Speedometer 2
F	
G	Speedo 3
H	Temp Signal
J	Temp GND
K	Rotor position 3
L	Supply GND
M	Rotor position 2
N	
O	Rotor position 1
P	



Only use motors with rotor position sensor (BL) approved by the manufacturer.		
Connector plug	X7	19-pin round plug
Connection cable	7 x signal wires	Minimum cross section 0.25 mm
	2 x supply wires	
	2 x temperature veins	
	Use only suitable cable for drag chain.	
Cable length	for > 25 m cross-section one step larger.	
Shield connection	at connector X7	Contact the shield with the connector housing.
	on the motor plug	Contact the shield with the connector housing.
Setting parameters	see software manual NDrive	

Status information








5 Status information

In the **"Normal"** state, the green 7-segment display plus decimal point lights up as an operating indicator (status display).

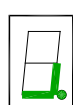
In the **"Error"** state, the red error LED lights up and the green 7-segment display indicates the error number.

In the **"Warning"** state, the red error LED flashes and the green 7-segment display alternates between the status and the warning number.

5.1 Status display on the BAMOCAR

Display	Dot/ dash	State	Status at NDrive
	flashes dark	Processor active Auxiliary voltage missing or unit-internal hardware error	
	flashes lights up dark	Start status after reset (auxiliary voltage 24V off-on) The first release ends the flashing state Drive enabled Drive locked (not enabled)	OK = 0 OK = 1, ENA = 1 OK = 1, ENA = 0
	lights up	Speed equal to zero (message standstill)	N0 = 1
	lights up	Drive turns right, N currently positive	N0 = 0
	lights up	Drive turns left, N currently negative	N0 = 0
	flashes lights up dark	Motor current reduced to continuous current I_{cns} Motor current at maximum current limit I_{max} Normal operation, motor current within the current limit	$I_{cns} = 1$ $I_{cns} = 0$ $I_{cns} = 0$
	lights up for 0,1 s	A new command (value) has been received from the BUS or RS232.	

Example: Motor clockwise



Dot flashes = Processor active
Bottom line = Drive enabled
Right line = Motor turns right

Status information

5.2 Status information - Error


In the "Error" state, the red error LED "FAULT" lights up and the green 7-segment display indicates the error number.

Display on the servo:	Error in NDrive:	Meaning:	Address: RegID 0x8F
	NOREPLY-No RS	RS232 interface not plugged in or disturbed.	
0	BADPARAS	Parameter damaged	Bit 0
1	POWERFAULT	Hardware error	Bit 1
2	RFE	Safety circuit faulty (only active with RUN)	Bit 2
3	BUS TIMEOUT	CAN TimeOut Time exceeded	Bit 3
4	FEEDBACK	Bad or wrong encoder signal	Bit 4
5	POWERVOLTAGE	Power voltage missing	Bit 5
6	MOTORTEMP	Engine temperature too high	Bit 6
7	DEVICETEMP	Unit temperature too high	Bit 7
8	OVERVOLTAGE	Overvoltage > 1.8 x UN reached	Bit 8
9	I_PEAK	Overcurrent or strong oscillating current detected	Bit 9
A	RACEAWAY	Spinning (without setpoint, wrong direction)	Bit 10
B	USER	User - Error selection	Bit 11
C			Bit 12
D			Bit 13
E	HW_ERR	Current - Measurement error	Bit 14
F	BALLAST	Ballast circuit overloaded	Bit 15

Attention:

- Error F is a device-dependent error (no function with BAMOBIL and BAMOCAR).
- When the auxiliary voltage is applied with the enable closed (FRG/RUN X1:7 active), the red LED shows an error. There is no error indication in the 7-segment display.
- Error 1 (POWEWRFAULT) is a sum error message of the hardware monitoring: ("I_FAULT" permanently set)
 - Overvoltage on the DC link
 - Driver card Voltage monitoring (15 V, 5 V)
 - Undervoltage monitoring of the auxiliary voltage (< 10 V)
 - Overtemperature in one IGBT module
- ("I_FAULT" not permanently set)
 - Dangerous overcurrent (cause can be too high or oscillating currents, bad controller settings or hardware defects (e.g. IGBT module)).

Example: Error 5

	Fault	Illuminated display: <ul style="list-style-type: none"> • FAULT LED red - on • Error number 5 is displayed 	POWERVOLTAGE (Power voltage missing)
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When the auxiliary voltage is applied with the enable closed (FRG/RUN X1:7 active), the red LED shows an error. There is no error indication in the 7-segment display.

5.3 Status information - Warnings


In the "**Warning**" state, the red error LED flashes and the green 7-segment display alternately shows the status and the warning number.

Display on the servo:	Warnings in NDrive:	Meaning:	Address: RegID 0x8FH
0	WARNING_0	Device detection inconsistent	Bit 16
1	ILLEGAL STATUS	RUN Signal disturbed, EMI	Bit 17
2	SAFE_IN	RFE input inactive (without RUN input active)	Bit 18
3			Bit 19
4			Bit 20
5			Bit 21
6	MOTORTEMP	Engine temperature > (I-red-TM or 93 % of M-Temp)	Bit 22
7	DEVICETEMP	Unit temperature > 87 % of limit	Bit 23
8	Vout_Sat	Limit of existing voltage output reached	Bit 24
9	I_PEAK	Overcurrent 200 %	Bit 25
A	RACEWAY	Resolution range of the speed measurement exceeded	Bit 26
B			Bit 27
C			Bit 28
D			Bit 29
E			Bit 30
F	BALLAST	Ballast circuit > 87 % overloaded	Bit 31

Attention:

- Warning F is a device-dependent warning (without function for BAMOCAR).

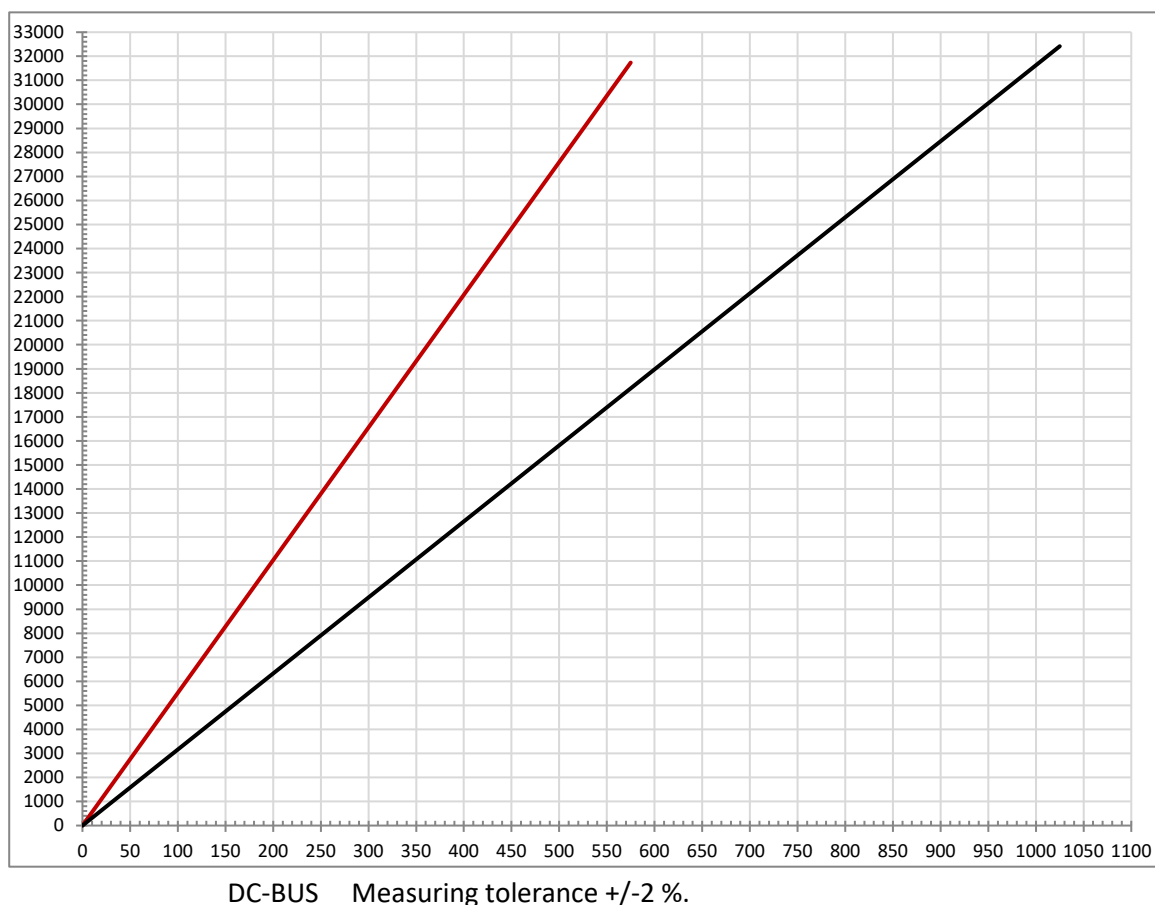
Example: Warning 7

	Fault	Illuminated display: <ul style="list-style-type: none"> FAULT LED red - flashing The display alternates between status and warning number 7 	DEVICETEMP Engine temperature > (I-red-TM or 93 % of M-Temp)
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6 Measured values

6.1 DC link DC BUS voltage, battery voltage (400 V and 700 V)

BAMOCAR	400V			700V		
	DC-BUS voltage	Parameter 0xEB	DC BUS %	DC-BUS voltage	Parameter 0xEB	DC BUS %
Maximum voltage	460 V	25300	154	800 V	25200	154
Overvoltage cut-off	440 V	24200	148	780 V	24570	150
without power voltage	0 V	0	0	0	0	0
Standardisation	1 V	55,0	0,3363	1 V	31,5	0,1925
Tolerance : +/-2 %						

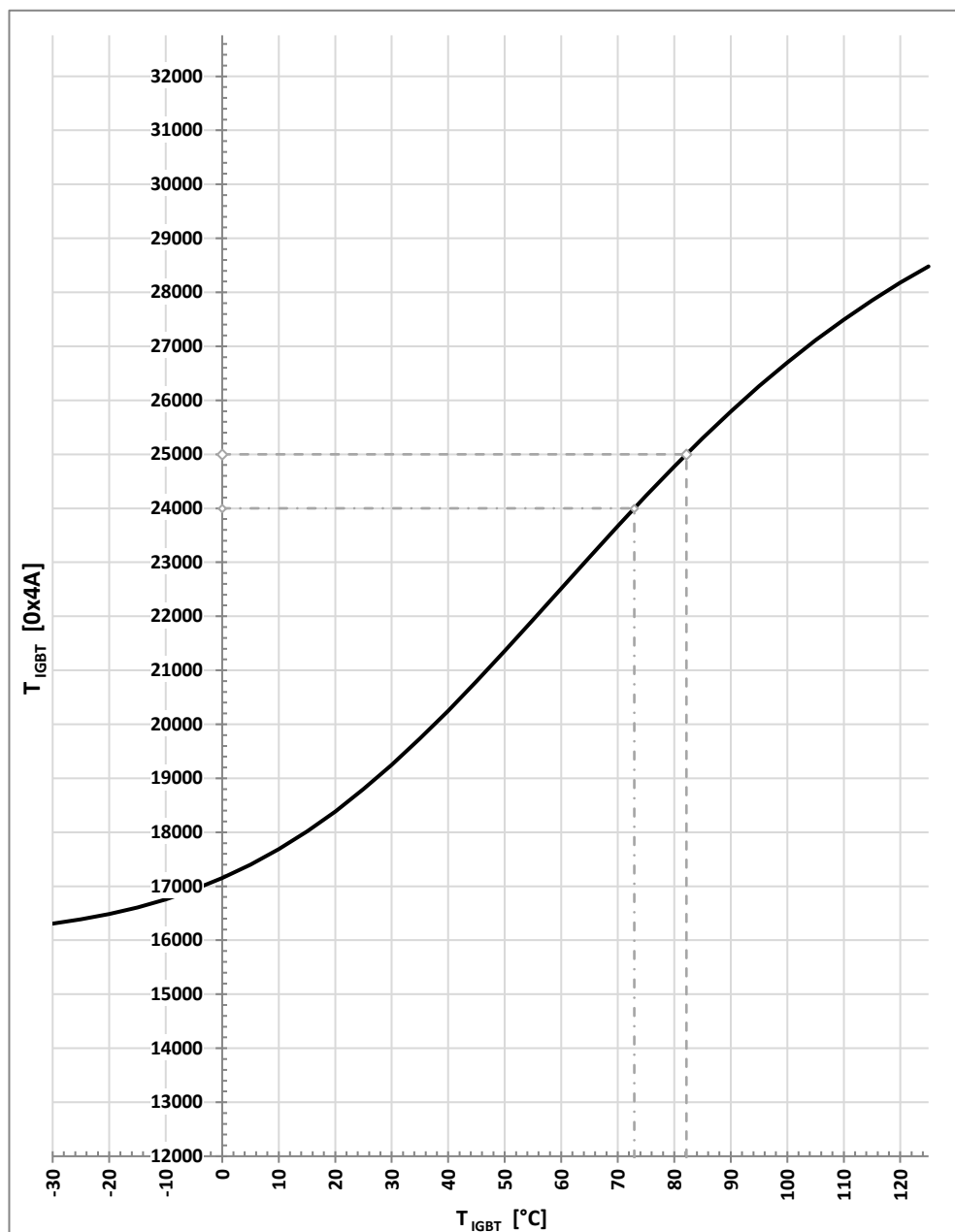


Example of settings on the BAMOCAR-PG-D3-400			
DC BUS max. (0xA5 _H)	for limit voltage	Num 0x0b	Comment
144 %	440 V=	24200	1 % corresponds to 3 V
DC BUS min. (0xA5 _L)	for undervoltage		
101 %	300 V=	16500	
Example of settings on the BAMOCAR-PG-D3-700			
DC BUS max. (0xA5 _H)	for limit voltage	Num 0x0b	Comment
144 %	750 V=	23625	1 % corresponds to 5.2 V
DC BUS min. (0xA5 _L)	for undervoltage		
116 %	600 V=	18900	

6.2 Power stages - temperature

Sensor: 3x NTC (in IGBT)

T_deg	.	[0x4A]
125 °C		28480
120 °C		28179
115 °C		27851
110 °C		27497
105 °C		27114
100 °C		26702
95 °C		26261
90 °C		25792
85 °C		25296
80 °C		24775
75 °C		24232
70 °C		23671
65 °C		23097
60 °C		22515
55 °C		21933
50 °C		21357
45 °C		20793
40 °C		20250
35 °C		19733
30 °C		19247
25 °C		18797
20 °C		18387
15 °C		18017
10 °C		17688
5 °C		17400
0 °C		17151
-5 °C		16938
-10 °C		16757
-15 °C		16609
-20 °C		16487
-25 °C		16387
-30 °C		16308



Warning overtemperature at 72.9 °C (Num 24000)

Error message overtemperature at 82,2 °C (Num 25000)

The current reduction, as a function of the temperature, is programmed with the parameters I-red-TD (0x58) and I-red-TE (0x4C) (see NDrive manual).

Current - actual value

BAMOCAR	I 100 %	Calibration nominal current I-device			Peak current DC blocked	
Maximum value +/- 11Bit	mV	Num	A~eff	A~eff	Num	A=pk
250	440	335	125	500	176	265
400	700	535	200	803	282	424

The basic settings are protected in the parameter set.