

# MANUAL

## Digital three-phase Servo Amplifier

### BAMOCAR-PG-D3

EC-synchronous-servo motors

AC-asynchronous-servo motors



**UNITEK**

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## 2 Basic information

### 2.1 History

Version	Modifications	Date
03/2017 – V02	Capital 2 / Firmware state Capital 4 / Note for CAN-BUS	10. July 2017
09/2017 – V03	Page 4 / Article no. added Page 15 / Dimensions changed Page 16 / Temperature range changed Page 29 / item $\mu$ F is changed	21. Sept.2017

### 2.2 Further UNITEK products

For synchronous and asynchronous motors			
Digital AC servo amplifiers (mains up to 480V~)		UNITEK	DS205, DS403, DPCxx
Digital AC servo amplifiers for battery operation		UNITEK	Series BAMOBIL-D3
Analog three-phase servo amplifier (mains 400V~)		UNITEK	Series TVD
For dc motors			
Analog DC servo amplifier for battery operation			Series BAMOBIL-A
Analog DC servo amplifier (operation via the mains)		UNITEK	Series TV
Thyristor current converter 1Q, 4Q, servo		UNITEK	Classic series 200W bis 800kW

### 2.3 Engineering instructions (MANUAL)

- |    |        |                       |                               |
|----|--------|-----------------------|-------------------------------|
| 1. | MANUAL | BAMOCAR               | Hardware                      |
| 2. | MANUAL | NDrive x              | Software                      |
| 3. | MANUAL | Commissioning BAMOCAR | Commissioning - error detect. |

**Use all three MANUALS for the engineering, the installation, and the commissioning!**

CD (UNITEK-DOKU-SOFT) supplied with the delivery of the units.

Online available as download version on the UNITEK website ([www.unitek-online.de](http://www.unitek-online.de) or [www.unitek.eu](http://www.unitek.eu)).




The hardware MANUAL comprises warning and safety advices, explanations of standards, mechanical and electrical installation advices.

The MANUAL must be available for all persons who are concerned with the unit.

**2.4 Validity**

Hardware state:	TMS 2-3d, driver 1-8
Firmware state:	> FW 470

**2.5 Designations and symbols**

<b>Unit:</b>	BAMOCAR-PG-D3
<b>User:</b>	Manufacturers or operators of machines or installations in the industrial sector (B2B, secondary environment).
<b>Manufacturer:</b>	UNITEK Industrie Elektronik GmbH
<b>Dealer:</b>	
	<b>Caution – Danger to life! High voltage!</b>
	<b>Warning! Important!</b>
	<b>Dangerous electric fields!</b>

**Scope of delivery**

BAMOCAR-PG-D3-x device, documentation, CD UNITEK DOKU-SOFT in the box.

Not included (to be ordered as accessories):

PG screw connection

Control connectors:

- X1 ..( In/Out) = Article no. G435 / Binder 99-5662-15-19
- X7 (Feedback) = Article no. G436 / Binder 99-5661-15-19
- X9 (CAN BUS) = Article no. G437 / Binder 99-0436-14-05

Programming cable X10 = Article no. G432 / Binder 79-3464-52-06

## 2.6 General product information

The digital 3-phase current servo amplifiers **BAMOCAR-PG-D3xx** in combination with the motor provide a 4-quadrant drive which can be used in both rotation directions for drive operations and brake operations with energy feed-back.

According to the installed parameter components the amplifiers are suitable for EC synchronous motors, ac asynchronous motors, or dc motors.

The individual drive versions have different advantages and disadvantages.

The **EC drive** (synchronous motors) has the highest efficiency and performance per weight and volume and provides a drive solution free of maintenance and with a wide dynamic control range. However, the high braking torque in case of motor short-circuits is a disadvantage and it is also difficult to control the field weakening range.

From the electrical view, the EC synchronous motor (brushless dc motor) is a synchronous motor with a permanent magnet rotor and a three-phase current stator.

The physical characteristics correspond to those of dc motors, i.e., the current is proportional to the torque and the voltage is proportional to the speed. The speed is steadily controlled up to the current limit (max. torque). In case of an overload the speed drops and the current remains constant.

The speed/torque characteristic is rectangular.

Current, speed, and position are precisely measured. The field frequency is not controllable, it is automatically adjusted.

The motor voltages and the motor currents are sinusoidal.

The **ac drive** (asynchronous motors) has the widest speed range due to the single field weakening and there is no braking torque in case of a motor circuit. However, the unit size and the worse efficiency is a disadvantage. The rotating field frequency can be controlled in due consideration of the motor specific parameters (field-based control). The motor voltages and motor currents are sinusoidal.

With both 3-phase current systems there will be no motor movement neither when the rotating field is switched off nor in case of an output stage damage. Most of the heat losses are generated in the motor stator.

The **dc drive** (dc motor) has the most uniform running and a wide control range. It is possible to provide an emergency operation by directly connecting the battery voltage. The carbon brushes and the heat development in the armature are disadvantages. The drive may run at high speed in case of an output stage damage.

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

Current, speed, and position are precisely measured. The speed is steadily controlled up to the current limit (max. torque). In case of an overload the speed drops and the current remains constant. The speed/torque characteristic is rectangular. Field weakening might occur with separately excited motors.

The **BAMOCAR-PG-D3xx** can be used as position amplifier or torque or speed amplifier.

The speed actual value is generated in the encoder unit (resolver or others) or internally generated (without sensors). It is necessary to provide an encoder system for wide control ranges and high control dynamics.

### Warning/Attention:

For dc, ac, or bl-servo amplifiers which are supplied via the dc mains, it must be checked that the energy is fed back into the bus during brake operation.  
(External ballast circuit)



## 2.7 Applications/build/features

**Application** in all kinds of vehicles, boats, machines, and installations with a drive power of 140 kW under hard application conditions, especially as 4Q-servo-drive for

- highly dynamic acceleration and braking cycles
- a wide control range
- a high efficiency
- small motor dimensions
- a uniform, accurate and smooth running
- for the speed or torque control or combined speed/torque control incorporated within or independent of position control loops. For drives with constant speed as in conveyors, spindle drives, pumps, transversal or longitudinal pitch drives, synchronous multiple motor drives.

### **Particularly suitable for:**

Battery-driven vehicles such as electric vehicles and boats, forklifts, transportation systems as well as battery-supplied machines and installations such as assembly machines, metal working machines, food processing machines, robots and handling systems, conveyors, stone working machines, and for many other battery-supplied applications.

### **Build:**

- Robust unit for switch cabinet mounting according to the VDE, DIN and EC regulations, protection rating **IP65**
- for rough ambient conditions and high dynamic overloads
- maintenance-free
- power connections protected against accidental contact with exposed parts
- power electronics for (S1 operation) 125 A, 200 A
- power input range nom. 12 to 700 V=
- liquid cooling (special version air cooling)
- standard digital control electronics
- Independent 12/24 V chopper power supply unit for the auxiliary voltages

### **Galvanic isolation between:**

- power connection, motor connection, and all other control connections
- auxiliary connection and all other voltages
- housing and heat sink
- the distances of air gaps and leakage paths adhere to the EU standards
- no internal isolation watchdog, Y2 capacitors to the housing

### **Components:**

- Completely isolated IGBT power semi-conductors, comfortably over-dimensioned
- Only components customary in trade and industrially standardised are used
- SMD equipment

**Characteristics:**

Battery connection 12 V= to 700 V= (dc mains, take restrictions into account)

- ✓ Independent auxiliary voltage connection 24 V= or 12 V=
- ✓ Digital interfaces RS232, CAN BUS (further option)
- ✓ 2 analogue inputs, programmable differential inputs
- ✓ Digital inputs/outputs, programmable, optically de-coupled
- ✓ Linear command value ramp, non-linear (s-function)
- ✓ Logic for enable and the output stage switch, emergency stop function, safety
- ✓ BTB ready for operation, solid state relay contact
- ✓ Position, speed and torque control
- ✓ Feedback encoder systems: resolver, incremental encoder, SINCOS 1 Vss, rotor position + bl tachometer
- ✓ Static and dynamic current limiting
- ✓ Uniform, completely digital control unit
- ✓ Processor-independent hardware switch-off in case of over-voltage, under-voltage, short-circuits, circuits to earth, and over-temperature at the amplifier or motor
- ✓ Intrinsically safe and short-circuit proof power section (EN50178)

**Attention: Braking energy**

The braking energy is fed to the battery.  
The battery must absorb the braking energy.

**Note:**

Pay particular attention when used with laboratory power supplies.

For dc mains the braking energy must be absorbed in the mains without the voltage exceeding the permissible value. If this cannot be guaranteed, a ballast circuitry must be used.

**Note:**

**For non-earthed systems (vehicles, boats, machines)**

the isolation between parts accessible to touching and high voltages must be guaranteed and monitored by using independent isolation monitors.



## 2.8 Safety regulations

In principle electronic equipment is not fault proof!

# Caution - High voltage

## DC 800V=

### Shock hazard! / Danger to life!

### Discharge time of the bus circuit >4 min.



Before installation or commissioning begins, this manual must be thoroughly read and understood by the skilled technical staff involved. It must be ensured that the documentation (manuals) and thus, the knowledge of the unit and especially the safety advices must be available for all persons who are concerned with the unit

If any uncertainty arises or if any function is not or not sufficiently described in the documentation, the manufacturer or dealer should be contacted.

Any incorrect installation/connection may damage the device!

Any incorrect programming may cause dangerous movements!

#### Intended applications:

The devices of the **BAMOCAR-PG-D3** are power electric parts used for regulating energy flow. They are designed as components to control EC synchronous motors, ac asynchronous motors in vehicles, machines, or installations.

For applications in residential areas additional EMC measures are necessary.

Any other type of application must be approved by the manufacturer.

The user must draw up a hazard analysis for his end product.

Protection rating IP65

## Connection only to batteries

**Operation only allowed when the device is closed!**

**The control and power connections can be charged with high voltage without an active operation!**

**The minimum discharge time of the bus circuits is at least 4 minutes!**

**Measure the voltage before any disassembly!**



The user must draw up a hazard analysis for his machine, vehicle, or installation.

**The user must ensure that in the event of:**

- device failure
- incorrect operation,
- loss of regulation or control

the axis will be safely de-activated.



It must also be ensured that the vehicles, machines, equipment, or vehicles are fitted with device independent monitoring and safety features.

The user must take appropriate measures so that man as well as property are not exposed to danger due to incorrect or improper movements at any time!

Im Betrieb muss das Gerät geschlossen sein.

All plugged connectors must be snapped properly or secured by screws.

The safety systems must be enabled.



When the device is open and/or the safety systems are de-activated, it must be ensured by the operator that only skilled and suitably trained personnel has access to the units.

**Assembly**

- should only be carried out when all voltages have been removed and the units are secured
- should only be carried out by suitably trained personnel

**Installation**

- should only be carried out when all voltages have been removed and the units are secured
- should only be carried out by suitably trained personnel for electricians
- should only be carried out in accordance with health and safety guidelines

**Adjustments and programming**

- should only be carried out by suitably trained personnel with knowledge in electronic drives and their software
- should only be carried out in accordance with the programming advice
- should only be carried out in accordance with health and safety guidelines

## 2.9 Commissioning

The battery servo amplifiers **BAMOBIL PG - D3** are components of the electronic drive technology. They are functional only in connection with an electrical consumer (e.g. a motor). Their use is limited for commercial applications.

When mounting the units into vehicles, boats, machines, and installations the proper operation of the units may not be started until it is ensured that the machine, the installation, or the vehicle comply with the regulations of the EC machinery directive 2006/42/EG and the EMC guideline 2004/108/EG.

On the installation and test conditions described in the chapter 'EMV advices' it is adhered to the EC guideline 2004/108/EG including the EMC standards EN61000-2 and EN61000-4.

For applications in residential areas additional EMC measures are necessary.

A manufacturer's declaration can be requested.

The manufacturer of the machine or installation is responsible for observing the threshold values demanded by the EMC laws.

## 2.10 Safety advices

### Machinery directive

The manufacturer of the machine or installation must draw up a hazard analysis for his product. He must make sure that any unpredictable movements do not cause damage neither to persons nor to property.

### Skilled personnel

#### Hardware

The skilled qualified personnel must feature a training and instruction for an assignment in the field of electronic drive engineering. They must have knowledge of the standards and accident prevention regulations for drive engineering applications and they must be familiar with this field of activity. Eventually occurring dangerous situations are realized.

The local regulations (IEC, VDE, VGB) are known to the qualified personnel and they are observed during the works.

#### Software

The skilled qualified personnel for handling the software must be trained to safely program the units in the machines and installations. Incorrect parameter settings may cause improper and impermissible movements. Any parameter settings have to be checked for faulty operation. Acceptance tests must be thoroughly carried out according the four-eyes principle

### Working environment

Incorrect handling of the units may cause damage to persons or property.

The units must be closed during operation.

Any unit covers must not be removed!

Disconnect the power supply prior to any works on electric connections. It must be ensured the battery voltage is safely switched off.

Any voltages and residual voltages (buffer circuit) must be measured prior to any works on the unit. Max. permissible voltage <42 V.

High temperatures (> 70°C) may arise.

The working environment may be dangerous for persons having electronic medical aids or appliances (e.g. cardiac pacemakers). Sufficient distance to these electrical parts must be observed.

### Exposure

During transport and storage the prescribed and specified climatic conditions must be adhered to. The units must not be mechanically damaged. Warped and bent housing parts may influence or damage the isolation distances. Damaged units must never be installed!

The units comprise parts which may be damaged by electrostatic discharge. The general recommendations for handling electrostatic devices must be observed. Special attention should be paid to strongly isolating plastic films and synthetic fiber.

For the operation it must be ensured that the environmental conditions in the switch cabinet are adhered to. This applies in particular to the impermissible condensation on the units.

## 2.11 Intended applications

The devices are designed as components to control EC synchronous motors and ac asynchronous motors in vehicles, boats, machines, or installations.

Any other type of application must be approved by the manufacturer.

Protection rating IP65.

The devices must only be mounted in vehicles, boats, machines, or installations.

For applications in residential areas additional EMC measures are necessary.

The user must draw up a hazard analysis for his end product.

Power connection only to batteries. Isolation watchdogs must be installed for voltages >60V.

The capacities between clocked power modules and the housing (0.022  $\mu$ F Y2 capacitors). Use external insulation measuring instruments.

The control connections (terminal X1, plugs X7, X8, X9, X10) of the unit comply with the "safe electrical isolation SELV" acc. to EN 61800-5-1. The user must ensure that the complete control wiring complies with the standards.

It must be paid attention to the equipotential bonding for components which are connected to the unit and which do not have isolated inputs and outputs (equalizing connection GND). The equalizing currents may destroy components and parts.

When measuring the isolation the units must be disconnected or the power connections must be bridged together and the control connections must be bridged together.

Non-observance will cause damage to the semi-conductors in the unit.

Repeating circuits to earth and short circuits the values of which are all below the response threshold for short circuits may cause damage to the output stages (conditionally short-circuit proof acc. to standard EN 50178, EN61800-5-1).

### Impermissible applications

- in life-sustaining medical devices or machines
- connection to power supply units or dc power supplies without protection circuits
- on ships
- in explosive environments
- in environments with acrid fumes

## 2.12 Regulations and guidelines

The device and its associated components can only be installed and switched on where the local regulations and technical standards have been strictly adhered to:

EG Guidelines	2004/108/EG, 2006/95/EG, 2006/42/EG, 2002/96/EG
EG 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 statutory accident insurance and prevention institution	VGB4

### EU standards and regulations observed for the components of the unit

Standard	Description	Version
EN 60146-1,-2	Semiconductor converters	2010
EN 61800-1,-2,-3	Speed-variable electrical drives	2010
EN 61800-5-1	Electric power drive systems	2010
EN 60664-1	Isolation coordinates - low voltage	2012
EN 61010	Safety regulations - control units	2011
EN 61508-5	Functional safety of electric, electronic systems	2011
EN 60068-1,-2	Environmental influences	2011
ISO 20653	Type of protection of the electrical equipment of vehicles	
ECE-R100	Conditions for battery-driven electric vehicles	
UL 508 C	UL Regulations - converter	2002
UL 840	UL Regulation - clearance and creepage distances	2005

### EU standards and regulations which must be observed by the user

Standard	Description	Version
EN 60204	Safety and electrical equipment of machines	2011
EN 50178	Equipment of power plants	1998
EN 61800-3	Speed-variable electric drives - EMC	2010
EN 60439	Low voltage switching device combinations	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 machines	2011
ISO 13849	Safety of machines and controls	2011
IEC 364	Protection against electric shocks	2010
IEC 664	Isolation coordinates - low voltage	2011

### 2.13 Risks

The manufacturer aims to keep the remaining risks emanating from the unit as low as possible by means of constructive, electrical, and software measures.

In the field of drive engineering the following known remaining risks must be considered regarding the risks arising from machines, vehicles, and installations.

#### Impermissible movements

caused by:

- failure of safety watchdogs or switched-off safety watchdogs during commissioning or repair works
- software errors in upstream controls, errors in bus systems
- non-monitored hardware and software errors in actuating elements and connecting cables
- inverted sense of control
- faults during the parameter setting and wiring
- limited response time of the control features. Ramps, limits
- operations not permitted in the specifications
- electromagnetic interferences
- electrostatic interferences, lightning strikes
- failure of components
- failure in the brakes



#### Dangerous temperatures

caused by:

- faults during the installation
- faulty connections, bad contacts, aging
- faults in the electric safety system, incorrect types of fuses
- operations not permitted in the specifications
- negative climatic conditions, lightning strikes
- failure of components

#### Dangerous voltages

caused by:

- faulty earthing of the unit or motor
- faulty connections, bad contacts, aging
- faulty potential isolation, failure of components
- conductive contamination, condensation



#### Dangerous fields

The units, the inductive and capacitive accessories as well as the power wiring can generate strong electric and electromagnetic fields. These fields may be dangerous for persons having electronic medical aids or appliances (e.g. cardiac pacemakers). Sufficient distance to these electrical parts must be observed.

The switch cabinet must be labeled accordingly.



## 2.14 Technical data

## For three-phase current motors

Auxiliary voltage connection	12 V= to 700 V=
Auxiliary voltage connection	12 V= or 24 V= $\pm 10\%$ / 4 A (2 A) residual ripple <10 %, regenerating fuse

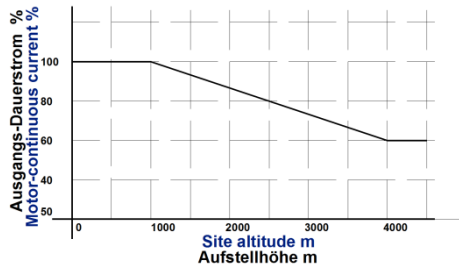
Data BAMOCAR D3-400-(700)	Dim.	125/250	200/400	125/250	200/400
Supply voltage, rated value	V=	24 up to max. 400		24 up to max. 700	
Max. output voltage, rated value	V~eff	up to 3x260		up to 3x450	
Continuous current	A <sub>eff</sub>	125	200	125	200
Max. peak current	A <sub>Io</sub>	250	400	250	400
Max. power loss	kW	2	3	2.6	4
Pulse frequency	kHz	8-24		8-16	
Over-voltage switching threshold	V=	440		800	
Input fuse	A	160	250	160	250
Weight	kg	8.5			
Dimensions h x w x d	mm	355 x 230 x 135			
Size		2			

Control signals		V	A	Function	Connector
Analogue inputs		$\pm 10$	0.005	Differential input	X1
Digital inputs	ON OFF	10-30 <6	0.010 0	Logic IO	X1
Digital outputs		+24	1	Transistor output open emitter	X1
Resolver / TTL / SINCOS				Differential input	X7
CAN interface				Logic IO	X9
RS232 interface				Logic IO	X10



<b>Ambient conditions</b>	
<b>Protection rating</b>	IP 65
<b>Standards</b>	EN60204, ISO 16750 , EN61800, IEC60146
<b>Protection class</b>	
<b>Over-voltage</b>	+10%
<b>Operating temperature range</b>	0 to +45 °C
<b>Extended operating temperature range</b>	from +45 °C to +65°C performance reduced by 2% / °C
<b>Storage and transport</b>	-30 °C to +80 °C EN60721
<b>Installation altitude</b>	≤ 1000m above sea level 100 %, >1000m performance reduced by 2%/100 m
<b>Cooling</b>	Liquid cooling unit max. 65°C, 12 l/min, pressure max. 1.3 bar
<b>Mounting position</b>	independent
<b>Contamination</b>	Contamination degree 2 acc. to EN 61800-5-1
<b>Vibration</b>	10Hz to 58Hz ampl. 0.075 mm (IEC 60068-2-3) 58 Hz to 200Hz 1 g
<b>Shock</b>	15 g for 11 ms
<b>Environmental conditions</b>	<b>Not permissible:</b> condensation (dew), ice formation, oil mist, salt spray, water
<b>Humidity</b>	class F, humidity <85 % <b>condensation not allowed!</b>

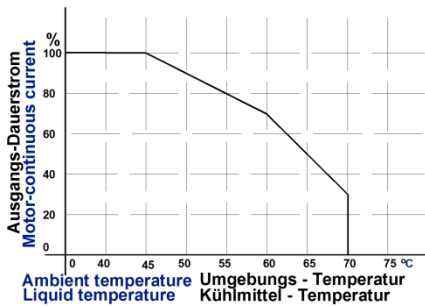
Current reduction (torque reduction)



Only with air cooling

Permissible current limit depending on the installation altitude

2-1 ED-Ired-Höhe-5



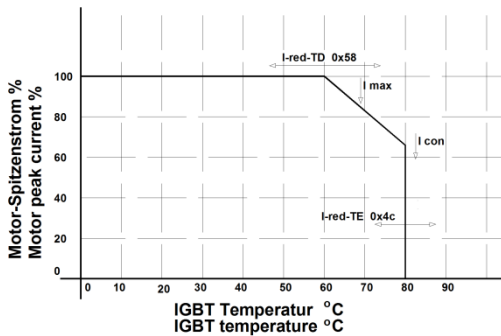
With air cooling

Permissible current limit depending on the ambient temperature

With liquid cooling

Permissible current limit depending on the temperature of the cooling agent

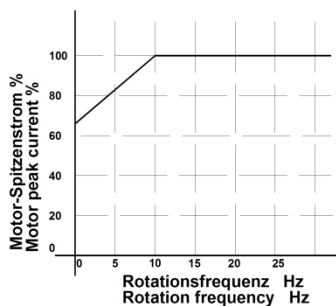
2-2 ID-Ired-Um-temp-5



Programmable current reduction depending on the IGBT module temperature. Starting temperature of the reduction I-red-TD 0x58

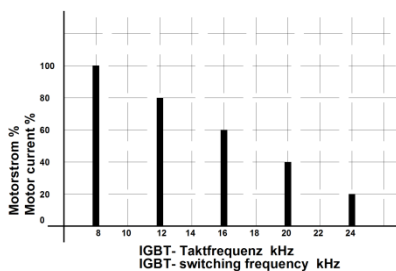
Final temperature of the reduction I-red-TE 0x4c

2-3 ED-Ired-IGBT-Temp-5



Automatic current reduction depending on the rotation frequency (motor speed)

2-4 ED-Ired-rot-5



Automatic current reduction depending on the pulse frequency

2-5 ED-Ired-IGBT-takt-5

### 3 Mechanical installation

#### 3.1 Important notes

Check the device for mechanical damage.  
Only devices in perfect working order can be mounted.

Disconnect the power supply prior to any assembly.  
Disconnect the positive and negative battery pole and the dc mains.  
The device must only be mounted by suitably trained personnel.

The mounting position of the devices with ground plate and those with additional cooling unit (air by means of fan, liquid) is arbitrary.

If the heat is not dissipated sufficiently the device switches off via its temperature watchdog.

Any bore hole dimensions for the fixation of the device must be taken from the dimension diagrams or from the drilling plan, not from the device.

The filter and the choke have to be mounted near to the device.

The line shields and the mounting plate must have surface-to-surface contact.  
The power supply lines (battery line and motor line) must be routed separately from each other.  
Observe the min. line cross-section.

A safe earth connection must be provided between the housing and the mass level (vehicle chassis earth, earth of the switch cabinet)

Unshielded cable heads must be kept short.

Only use specified connectors.

Use vibration-proof screw connections.

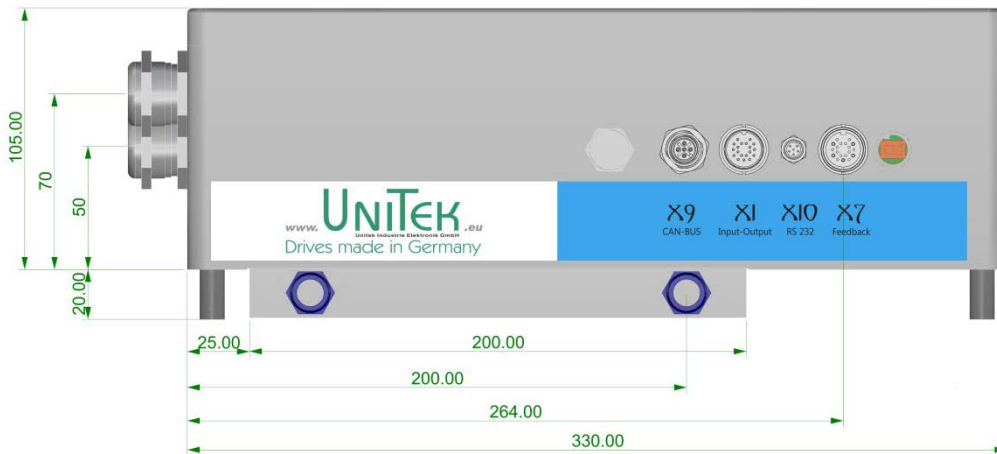
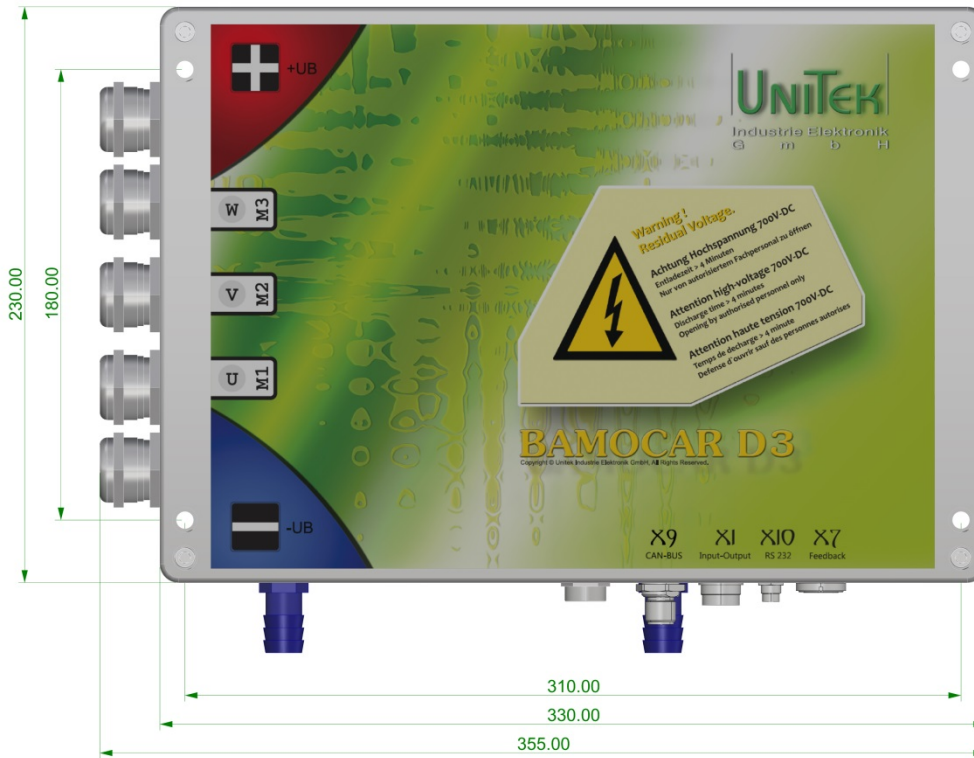
Power supply cables between the BAMOCAR and the battery must be as short as possible.

Long cables cause dynamic voltage drops due to the line impedance and as a consequence the service life of the installed capacitors would be reduced.



### 3.2 Dimensions BAMOCAR

#### Standard version (connectors partly equipped)



#### Liquid cooling

Connection

Hose connection: metal ¼-13

Input temperature: < 50°C

Flow rate: max. 12l/min

Pressure: max. 1.3 bar

#### Power connection

PG-cable glands M25x1.5 with shield spring

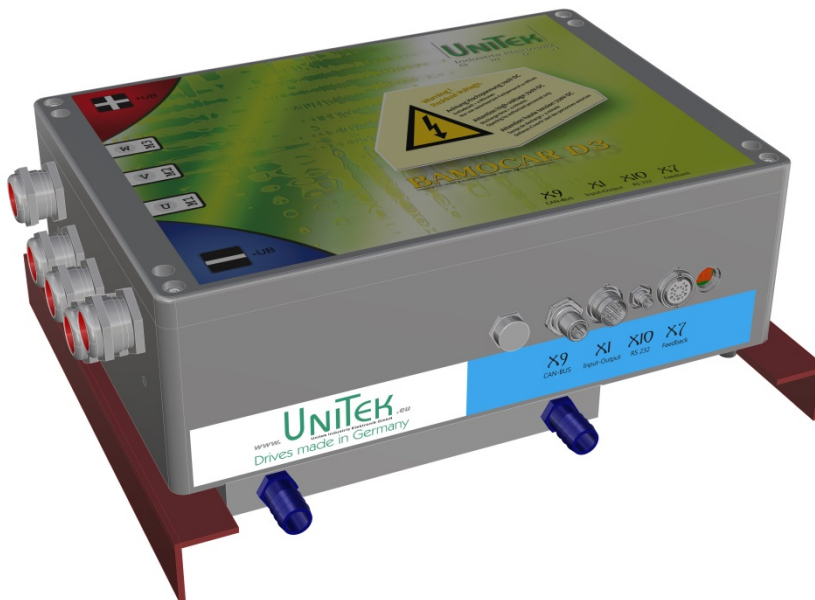
Recommended cable gland

Lapp- SKINTOP- MS-x

Pflitsch- blueglobe TRI

### 3.3 Mounting onto mounting rails

4 x screw M5x20



### 3.4 Mounting onto a mounting surface



4 x distance pipe for M5 l = 20 mm  
4 X screw M5x40

## 4 Electrical installation

### 4.1 Important advices

The order of the connections to the connector or terminal numbers is obligatory!

All further advice is non-obligatory.

The input and output conductors may be altered or supplemented in accordance with the electrical standards and guidelines.

Adhere to:

- connection and operating instructions
- local regulations
- EU guideline 2996/42/EC
- guidelines for vehicles ECE-R100, ISO 6469, ISO 26262
- VDE and TÜV regulations and Trade body guidelines

Electrical installation should only be carried out when all voltages have been removed!

Ensure that the device is safely disconnected from the power supply

- place the short-circuit bracket
- affix warning signs

The installation should only be carried out by suitably trained personnel for electrical engineering.



Compare the connection data with those indicated on the type plate.

Ensure that the correct fuses have been provided for the power supply and the auxiliary voltage.

Power supply conductors and control lines must be routed separately from each other.

Connection shields and grounding must be carried out in compliance with the EMC guidelines.

Use the correct line cross-sections.

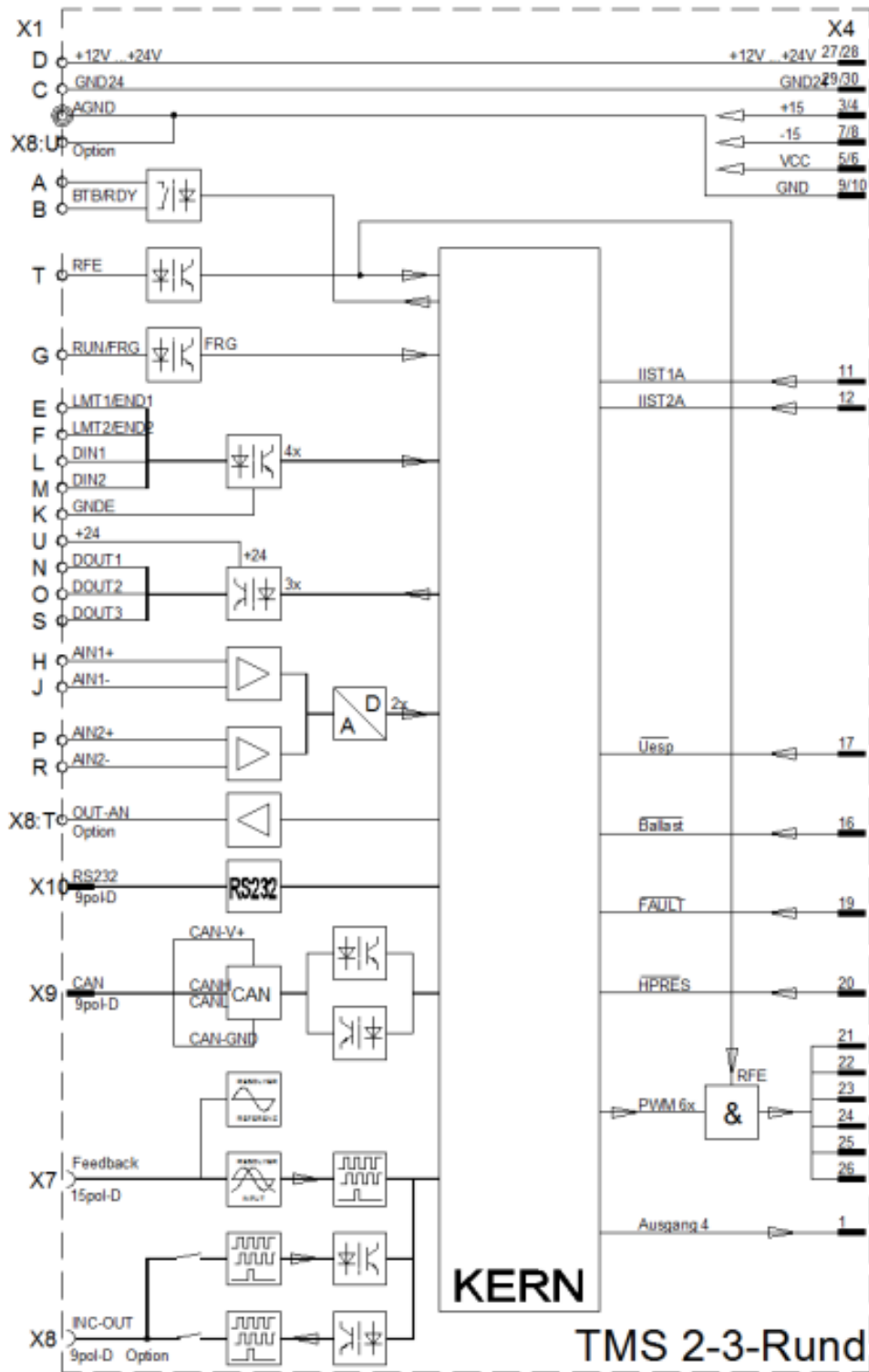
### Insert external isolation monitors!

**Note:** Bad or insufficiently rated cable connections between the battery and the device may cause damage to the device! (Brake energy)

**Note:** Power supply cables between the BAMOCAR-D3 and the battery must be as short as possible. Long cables cause dynamic voltage drops due to the line impedance and as a consequence the service life of the installed capacitors would be reduced.

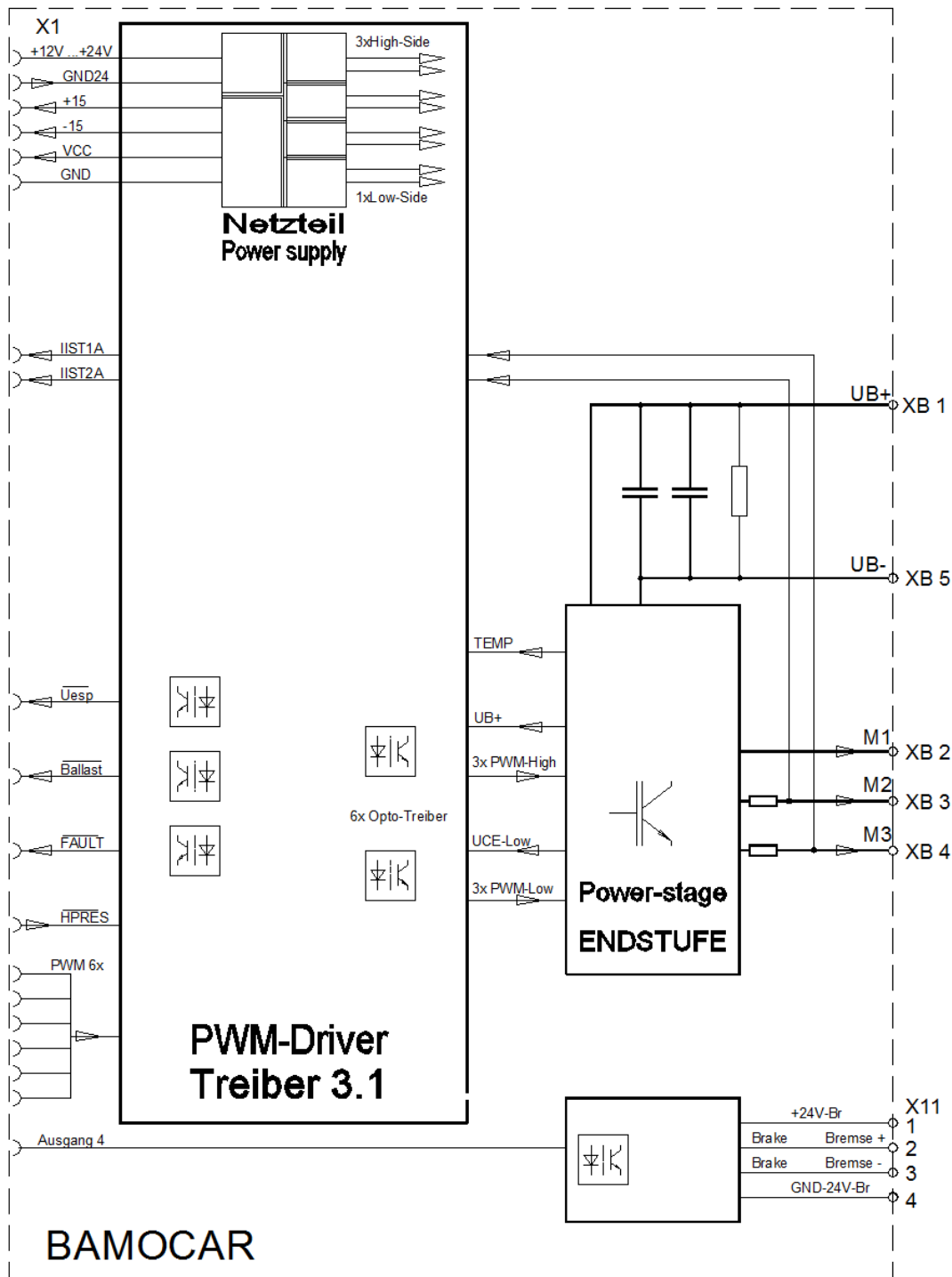


4.2 Circuit diagram



4-1 BAC-blockbild-3-TMS-rund

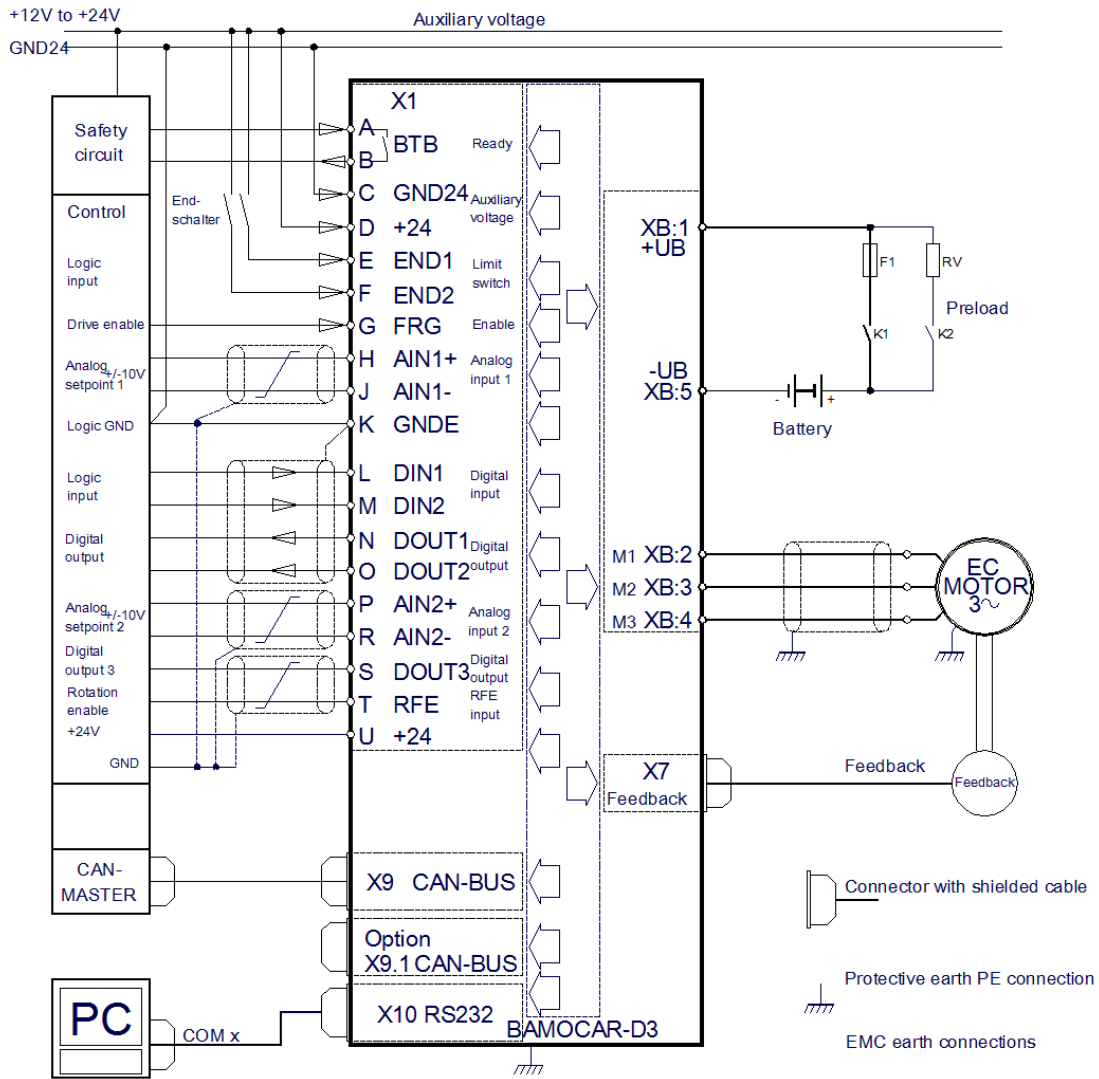
Circuit diagram



4-2 BAC-blockbild-3



4.3 Connection diagram



4-3 E-BAC-anschlussplan-2



4.5 Connectors

Standard version

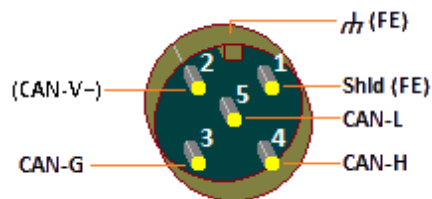


Membrane Ventil      **X9** CAN BUS      **X1** Control In-Output      **X10** RS232 Parameter      **X7** Feedback Sensor      Monitor Status-error

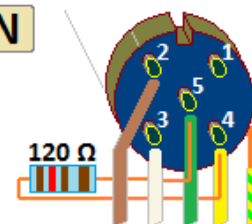
Connector X1		Control inputs/outputs		<p>Connector plug connector female Binder 99-5662-15-19</p>
A	brown	BTB	ready for operation	
B	red	BTB		
C	pink	GND24	auxiliary voltage 0	
D	yellow	+24	auxiliary voltage +	
E	green	END1/LMT1	limit switch 1	
F	blue	END2/LMT2	limit switch 2	
G	violet	FRG/RUN	enable	
H	grey	AIN1+	analog input 1	
J	white	AIN1-		
K	black	GNDE	logic zero	
L	br-green	DIN1	digital input 1	
M	br-yellow	DIN2	digital input 2	
N	wh-green	DOUT1	digi-output 1	
O	red-blue	DOUT2	digi-output 2	
P	wh-yellow	AIN2+	analog input 2	
R	wh-red	AIN2-		
S	wh-grey	DOUT3	digi-output 3	
T	wh-black	RFE	rotating field enable	
U	wh-blue	+24V	auxiliary voltage+	

Stecker X9 CAN

- 1 PE
- 2 Supply IN
- 3 CAN GND
- 4 CAN H
- 5 CAN L

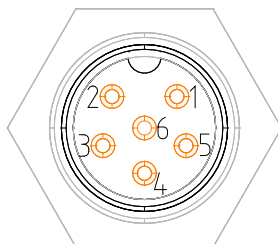


**X9 CAN**



**Connector X10 RS232**

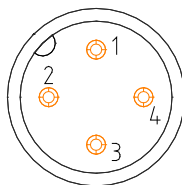
- 1 brown R2IN
- 2 white TxD
- 3 blue T2OU
- 4 black T2OU
- 5 grey RxD
- 6 pink GND



Connector plug Binder 79-3464-52-06  
(connector female)

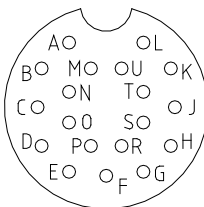
**Option connector X11 brake**

- 1 +24 V-Br
- 2 Brake +
- 3 Brake -
- 4 GND-24V-Br



Connector plug Binder 99-0429-15-04  
(connector female)

**Feedback encoder connector X7  
Connector female device**



**Connector plug**  
Binder 99-5661-15-19

Connector X7 Encoder plug Resolver		Connector X7 Encoeder plug INC-TTL		Connector X7 Encoder plus SIN/COS		Connector X7 Encoder plug bl	
A		A	channel A	A	channel ka+	A	MP tachometer
B		B	channel /N	B	channel kr+	B	
C	SIN1	C	channel B	C	channel kb+	C	tacho 1
D		D	supply +5V	D	supply +5V	D	supply +15V
E	COS2	E	channel N	E	channel kr+	E	tacho 2
F		F	channel /B	F	channel kb-	F	
G	REF2	G	channel /A	G	channel ka-	G	tacho 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 position3	K	channel kd-	K	rotor position3
L	temp GND	L	supply GND	L	supply GND	L	supply GND
M	COS1	M	rotor position2	M	channel kc+	M	rotor position2
N		N		N	channel kd+	N	
O	SIN2	O	rotor position1	O	channel kc-	O	rotor position1
P		P				P	
Encoder plug INC							

**For all connectors: connector view from the solder / crimp side**

4.6 Power connections 1000 V / 400 A

Cable gland metal M25x1.5

Connection- Battery plus

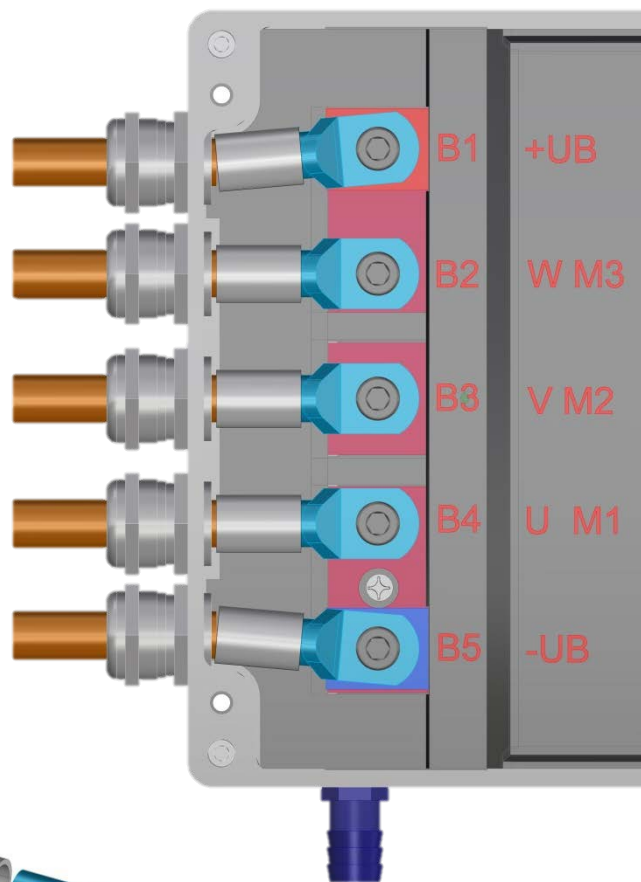
Connection – Motor W

Connection – Motor V

Connection -- Motor U

Connection- Battery minus

Cables maximal 50mm<sup>2</sup> (AWG 1/0)

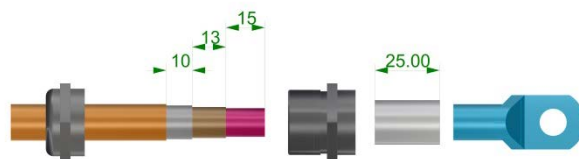


Power connections 1000 V / 400 A



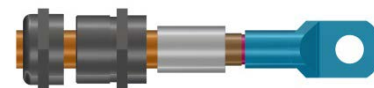
**Preparation**

- Strip outer insulation/jacket to 38 mm
- Shorten shield to 10 mm
- Strip inner insulation/dielectric to 15 mm
- Cut 25mm cable lug insulation from braided sleeve or heat shrink tubing
- Have a correct cable lug for M10 screw



**Pre-assembly**

- Slip complete cable gland, including shield brusing, onto cable
- Slip the cable lug insulation onto cable
- Crimp the inner conductor into the cable lug (15 mm)



**Mounting**

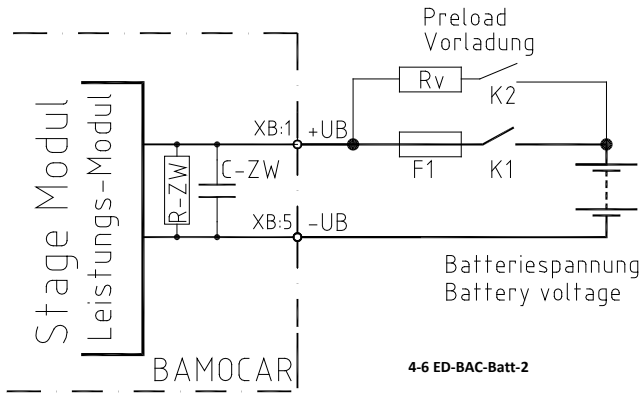
- Screw gland body into device.
- Loosely attach the cable lug to the internal conductor bar.
- Bolt type M10x12 self-locking or with a disc washer, toothed wasche rare prohibited .
- Tighten gland cap-nut.
- Tighten internal connection. Max locking torque 20Nm.



Connecting screw: M10x12

Cable gland : M25 metal with screen contact (Not in the delivery)

4.7 Battery connection



**Note:**

Bus circuit capacitor C-ZW  
 at 400 V 320 μF  
 at 700 V 320 μF  
 Discharge resistance R-ZW 50 kΩ

Series resistor  
 RV approx. 40 Ohm 50 W

Charging current via K2 <20 A

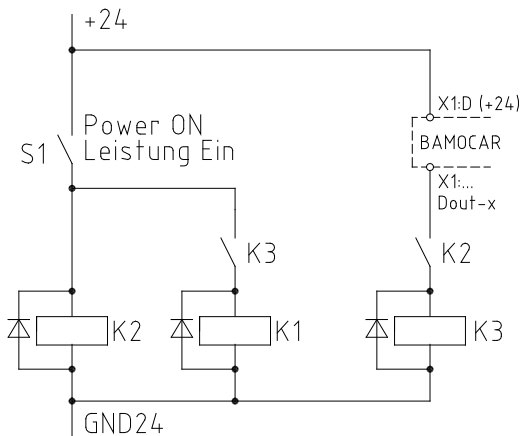
**Note:**

Enable (RUN) only after the main contactor K1 is activated.

The max. supply voltage (battery voltage) 450 V= (780 V=) must not be exceeded at any time (not even for short intervals)!  
 Danger of damage! / Error message: OVERVOLTAGE / F1 = safety fuse

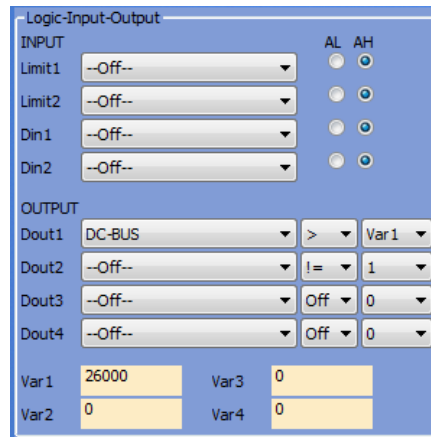


Block diagram of the pre-charging



Programming example:

The output Dout1 switches the relay K3 when the bus circuit voltage (DC-BUS) is greater than the variable 1.



**Warning:**

The power supply connection has no protection against reverse polarity. If the polarity of the connection is wrong, the device will be destroyed!



Type	Battery connection	Connector cross-section		Fuse AT	Drive contactor size
		mm <sup>2</sup>	AWG		
-125/250		25	2	160	
-200/400		35	1	250	

Battery connecting line <2m. For conductor lengths from 2 to 10m more powerful. Use an additional capacity for conductor lengths superior to 10m!

### 4.8 Auxiliary voltage connection

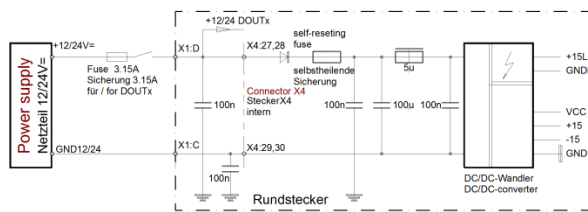
Mains potential-free auxiliary

dc voltage +12 V= (4 A) to +24 V= (2 A) ±10 %

The auxiliary voltage

- is galvanically connected with the logic voltage
- is galvanically isolated from all internal supply voltages of the device and from the housing
- internal regenerating fuse
- EMC filter

External fuse only for the line protection



Input voltage	12-24 V DC	X1:4
	GND24	X1:3
Residual ripple	10%	
Switch-on current	4A	
Nominal current	at 12V	1.4A
	at 24V	0.9A

Neg. connection of the power supply to earth

#### **Attention:**

In addition to the internal supply current (1.4A) the sum of the output currents (DOUT) must be provided by the mains module 12/24 V.

**If the auxiliary voltage is inferior to 10.5V there will be the error message 'hardware error 1' (power fault)**

If the auxiliary voltage is inferior to 10 V - even in case of short-time voltage drop-outs - the internal mains module is switched off. Temporary data of the RAM are deleted. The digital speed and the command torque values are set to zero. **The LED signal for the state 'OK' is dark.**



Firmware download only when the power supply is switched off!

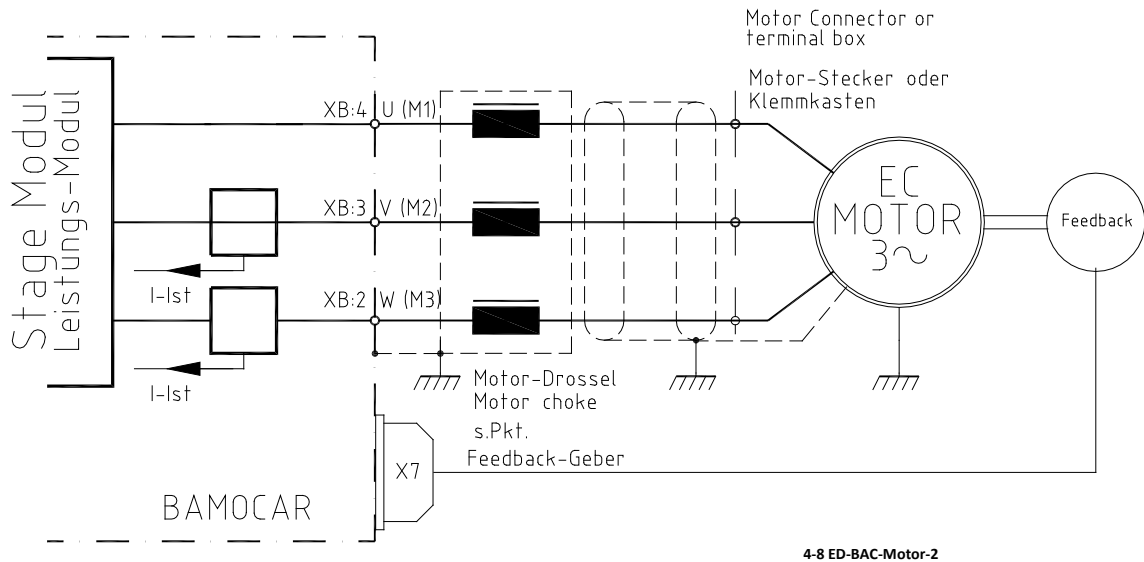
The auxiliary voltage and/or power supply voltage must only be switched when the BAMOCAR is disabled.

No disable.

Enable input X1:G = zero

### 4.9 Motor power connection

Only electronically commutating synchronous motors (brushless dc motors, EC motors) with resolver or incremental encoder must be used. These motors must be approved of by the manufacturer prior to any use.



4-8 ED-BAC-Motor-2

#### Sequence of connection

<b>Cable</b>	M1	M2	M3		Motor cable 3 cores + protective conductor single-shielded, for 1000 V= shield capacity 150 pF/m min. cross-section see table
<b>Motor phase</b>	U	V	W		
<b>Connecting bolt</b>	XB:2	XB:3	XB:4		
<b>Only one correct connecting sequence is possible!</b>					

#### Min. cable cross-section

<b>Type BAMOBIL D3-xx</b>	-125	-200		Motor choke, only necessary for shield capacities superior to >5 nF. motor cable approx. 25 m
<b>Cross-section mm<sup>2</sup></b>	25	35		
<b>AWG</b>	2	1		

#### Motor choke

Only necessary for a shield capacity of >5 nF. Approx. 25m motor cable

#### Magnetic rings:

against HF failures of the sensor systems. Slide the rings onto the motor lines.

#### Connection of the shield

Surface-to-surface connection to the switch cabinet inlet.

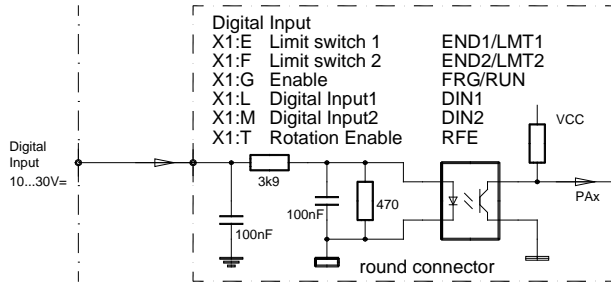
Surface-to-surface connection as short as possible to the motor side.

**For long motor cables the motor cable shield must be connected at multiple times with the vehicle or machine frame (e.g. ground terminals every 5 m).**



## 5 Control connections

### 5.1 Digital inputs



5-1 E-BAC-DIN-2

Input voltage		
Level ON		+10 to +30 V
Level OFF		<+6 V
Input current	Max.	7,5 mA
Nominal voltage/current		+24 V/6 mA
Ground reference	GNDE	(X1:K)

The enable input (FRG/RUN) and the input for the rotating field enable (RFE) are fixed, they cannot be programmed.

Without the enable FRG/RUN the servo-drive is electronically disabled (no PWM pulses).

Without the rotating field enable RFE the rotating field of the output stage is additionally disabled (2nd disable channel).

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

The remaining four digital inputs can be programmed.

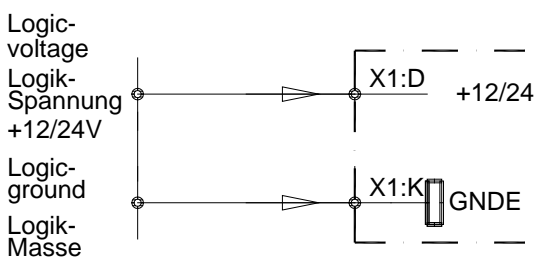
The inputs LMT1 (X1:E) and LMT2 (X1:F) are preferably to be used as inputs of the output stage switch.

Input	Connector	Function	State
FRG/RUN	X1:G	Enable	fixed
RFE	X1:T	Rotating field enable	fixed
END1/LMT1	X1:E	Output stage switch 1 / digital input	programmable
END2/LMT2	X1:F	Output stage switch 2 / digital input	programmable
DIN1	X1:L	Digital input 1	programmable
DIN2	X1:M	Digital input 2	programmable

The enable (FRG X1:G) must not be initiated before the auxiliary voltage (12-24 V) and the power voltage have been switched on. Error message 5(POWERVOLTAGE).



#### External power supply for the inputs and outputs



+12 – 24 V for logic and auxiliary voltage

GNDE logic ground

5-2 ED-BAC-Logic-2

## 5.2 Safety input RFE (Rotating field enable) Stop class 0

### Warning:

If the inputs of the enable or of the rotating field enable are switched off, the drive is free of torque. The drive could move if there is no mechanical brake or block provided.



The motor conductors are not dead. Only the rotating field is disabled. Prior to any work or maintenance on the motor or the BAMOCAR, the battery motor controller must be completely disconnected from the mains power supply of the battery.



### Operation with an RFE input

Two-channel disable of the enable via a safety switching device.

Enable input FRG/RUN +  
Rotating field enable input RFE.

### Switching-on

Contacts of the safety device closed, enable FRG/RUN 0.5s after RFE.

### Safety switch-off

Contacts of the safety device open:

- there is no FRG/RUN signal in the 1<sup>st</sup> disable channel to disable the PWM pulses in the processor
- there is no RFE signal in the 2<sup>nd</sup> disable channel to disable the PWM pulses at the output of the processor

### Restart

Release the safety switching device.

Contacts of the safety device closed.

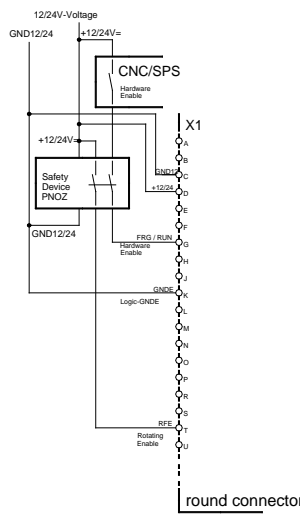
The motor can only move after a second disable FRG/RUN (after the rotating field enable).

### Operation without RFE input

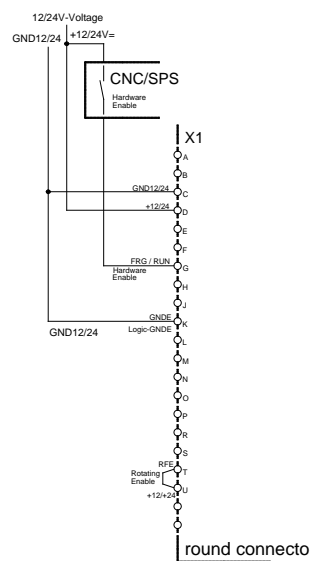
The input RFE must be bridged with the logic voltage.

If the logic voltage corresponds to the supply voltage, the RFE input is bridged with +12/+24 V.

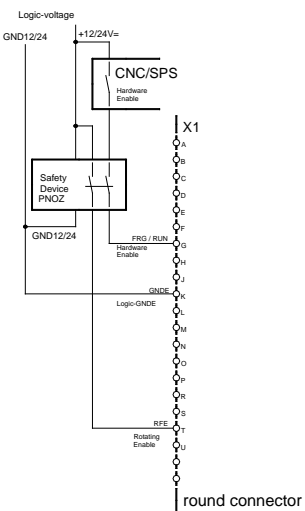
Enable FRG/RUN at least 0.5 s after the RFE signal.



5-3 E-BAC-REF1-2

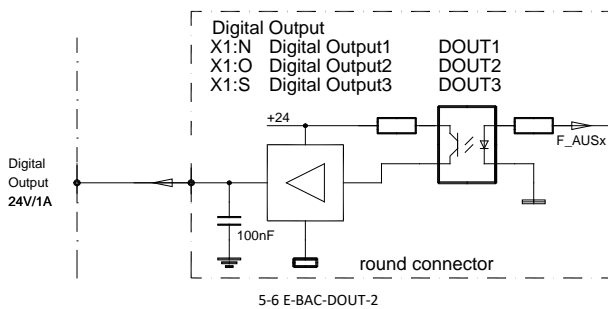


5-4 E-BAC-RFE2-2



5-5 E-BAC-RFE-4-2

### 5.3 Digital outputs (open emitter)

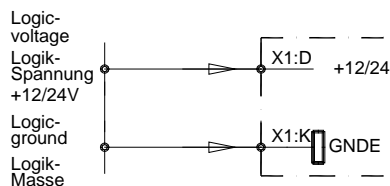


Output voltage	
Level ON	+12 to +24 V=
Level OFF	<1 V=
Output current	nom 1 A
Output current	max. 2 A,1s
Voltage reference	+24 (X1:D)
Ground reference	GNDE (X1:C)

Output	Connector	Function	State	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	X11	Brake (option) 4	programmable	

**Note:**

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

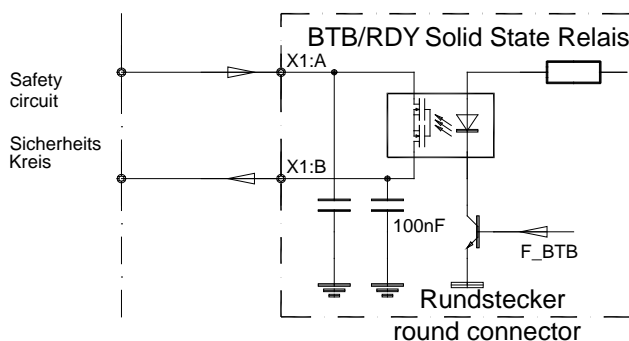


5-7 ED-BAC-Logic-2

+12 to + 24 V for logic and auxiliary voltage  
Always pay attention to the total current of all outputs

GNDE logic ground

### Signal contact "Ready BTB/RDY" (Solid state relay)



5-8 ED-BAC-BTB-2

Contact for	max. 48 V/0,5 A
<b>(not short-circuit proof)</b>	
Capacitive load	max. 1 mF
Contact resistor	max. 2 Ohm
The contact is closed when the device is ready for operation. <b>Always install the BTB/RDY contact in the safety circuit!</b> <b>Install a fuse 0.5 Af to secure the BTB/RDY signal path!</b> In case of failures the contact is open. (Option)7segment-LED 'state' display	



### Ready BTB opens (open BTB relay contact, (option red LED))

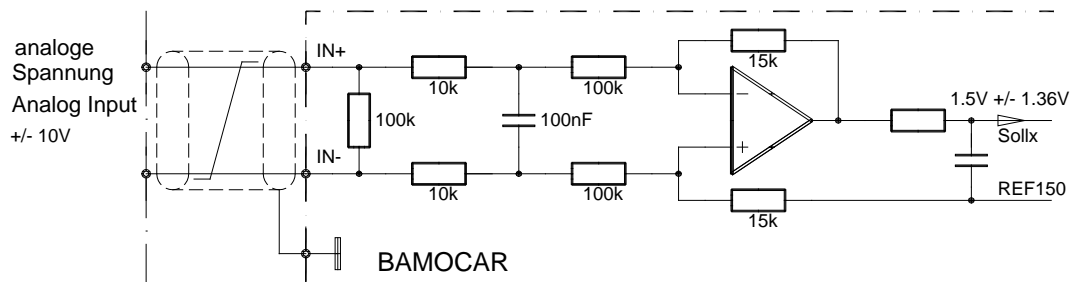
in case of error messages

BTB with or without under-voltage monitoring (BTB-Power).

The message "under-voltage in the bus circuit" can be programmed (see Manual NDrive-x)



## 5.4 Analog input +/- 10 V



5-9 ED-BAC-AIN-2

Input	Connector	Basic function	Voltage	State	Parameter
AIN1+, AIN1-	X1:H, X1:J	Speed command value	+/- 10 V	prog.	
AIN2+, AIN2-	X1:P, X1:R	Current limit	+/- 10 V	prog.	

## Features

Differential input	AIN1+ / AIN1-	AIN2+ / AIN2-	
Input resistance	70 kΩ		
Threshold voltage	+/- 12 V		
Resolution	11 Bit + sign		

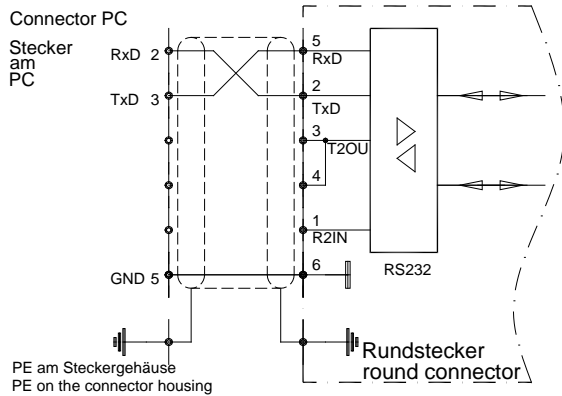
The direction of rotation of the motor can either be changed by swapping the +/- connections at the differential input, or by means of a logic input or by programming. (See NDrive-x)

The analog inputs can be assigned to different functions. (See NDrive-x)

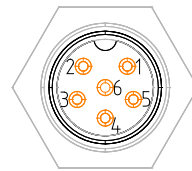
With a digital command value (RS232, x-bus) the analog input AIN1 can be programmed as external analog speed limit and the analog input AIN2 can be programmed as external analog current limit. (See NDrive-x)

### 5.5 Serial interface RS 232

The device is programmed and operated during commissioning via the serial pc interface RS232. There is a software description in the Manual DS NDrive.



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



5-10 ED-BAC-RS232-2

The controller (D-plug X10) and the serial interface (COMx) of the pc must only be connected using a null modem cable.

**Do not use a null modem link cable!**

Install the cable only after disconnecting the device from the mains.

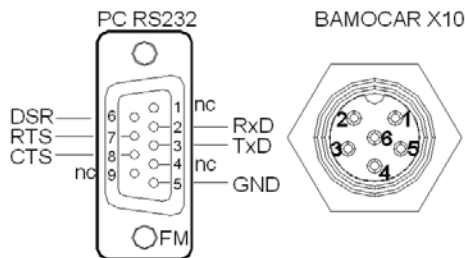
The interface is hard-coded to **115200 Baud**.

Null modem connecting cable

View to the soldered side

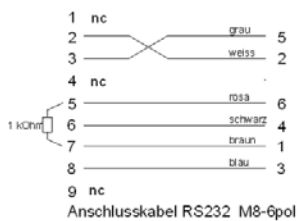
Shield on the housing

Max. cable length 10m



BAMOCAR

Connector X10	RS232
1	P/D (CTS) R2IN
2	TxD
3	V+ (RTS)
4	V+ (DTR)
5	RxD
6	GND



Colors = recommendation

### 5.6 CAN-BUS

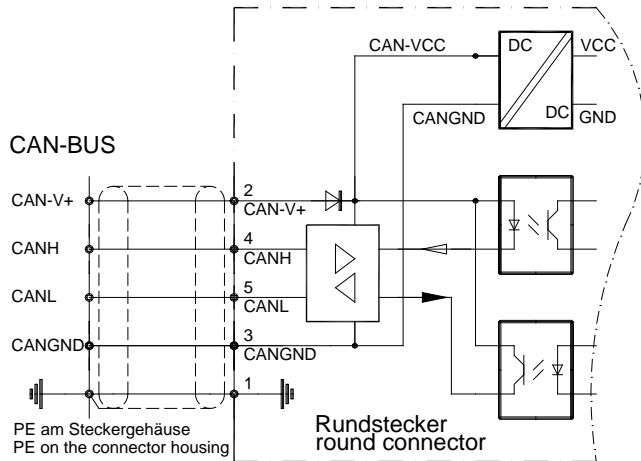
The CAN-BUS is a digital connection to the CNC control.

Optimum conditions are achieved with CNC controls and CAN components of LABOD electronic or CAN Open.

Programming and operation by means of the control panel via the CAN-BUS.

Interface complies with the standard ISO 11898.

Adjustment and programming see Manual NDrive and -CAN Manual.



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

The voltage is supplied via an internal, isolated DC-DC converter.

**CAN-BUS isolated /  
CAN Gnd to common potential**

5-11 ED-BAC-CAN-2

#### CAN BUS cable

Use a shielded bus conductor with a low shielding capacity.

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

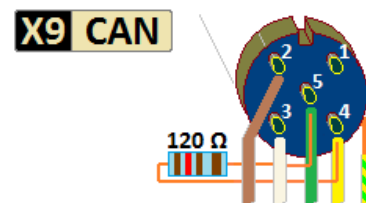
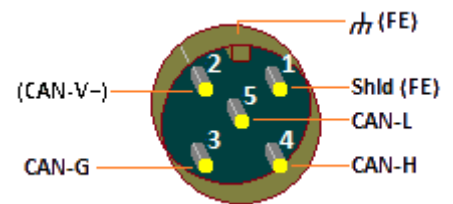
Circular connector M12-5p / LiYCY 4 x 0.25 + shield

Designation	Connector no. X9 CAN-BUS	Cable colour
PE	1	Shield
CAN-V+	2	brown
CAN-GND	3	white
CAN-H	4	green
CAN-L	5	yellow

**(Note: colors can be different)**

View on device side

At the connector - view on the soldered crimp side

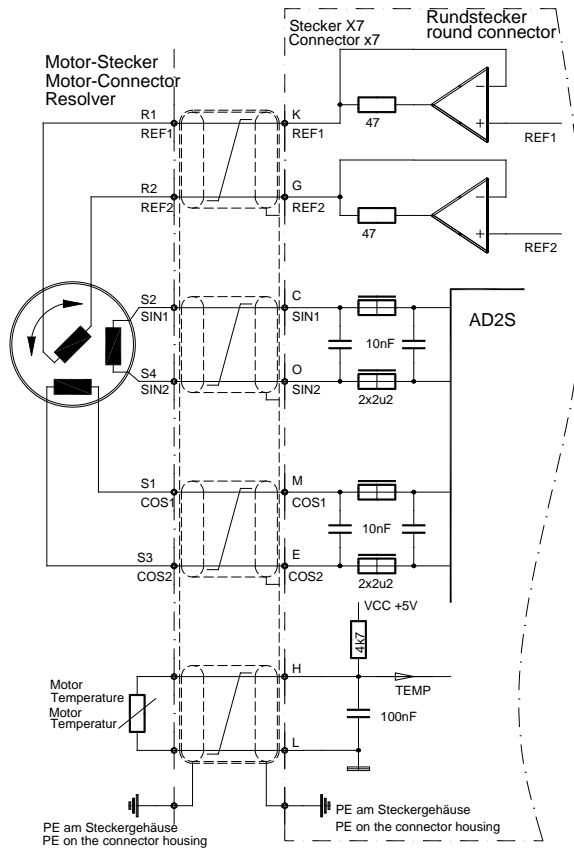


Terminating resistor at both ends of the bus line > 120 Ohm between the CAN-H and CAN-L.

### 5.7 Resolver connection

#### Only with BAMOCAR D3-RS

5-12 ED-BAC-Reso-2



The resolver is an absolute measuring system for a motor revolution.

It is robust and not impaired by high motor temperatures.

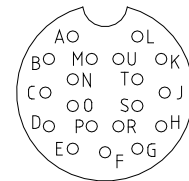
Its build corresponds to a revolving transformer. The rotor is supplied by the reference (10kHz). The stator supplies the sine and cosine signals modulated by the rotational frequency. The amplitudes of these signals are analyzed and digitalized in the servo-drive. The resolution is automatically set to an optimum of 10, 12, or 14 bit.

The max. possible speed is 50 000 (10 bit).

The digitalized signals are used for the polar wheel angle, the position and speed control, and the incremental output.

**Connector X2 Encoder connector resolver**

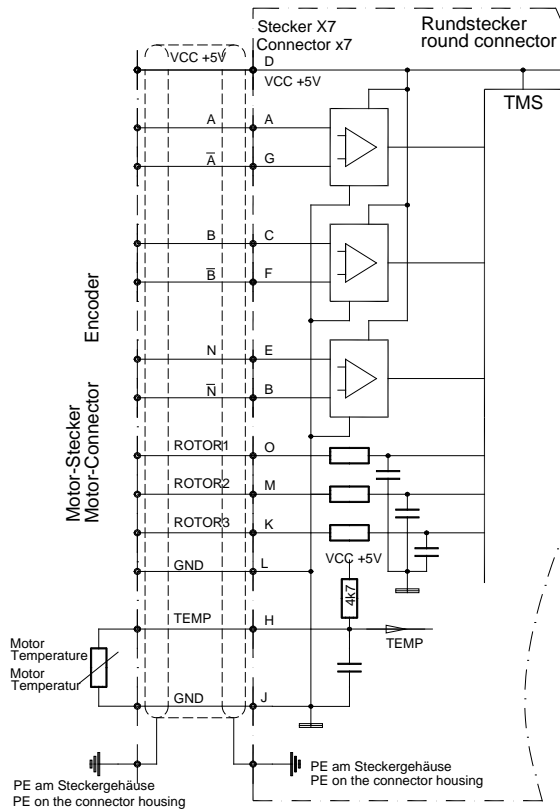
- A
- B
- C SIN 1
- D
- E COS 2
- F
- G REF 2
- H Temperature signal
- J
- K REF 1
- L Temperature GND
- M COS 1
- N
- O SIN 2
- P



Only use motors with a 2-, 4-, 6-, or 8-pole resolver which have been approved by the manufacturer. Observe the motor specific connection data sheet (RS)!		
Connector	X7	19-pin round connector
Connecting cable	4 x 2 cores, twisted in pairs and shielded, additional overall shield. For link chains use appropriate cables!	
	Min. cross-section 0.25 mm	
Cable length	for >25 m only use high-quality resolver cables with adequate shielding properties.	
Shield connection	across connector X7	combine all shields and connect them to the housing
	across the motor connector	connect the overall shield to the connector housing
Setting parameters	see software Manual NDrive	

### 5.8 Encoder connection TTL

Only with BAMOCAR D3-IN



5-13 EC-BAC-end-2

TTL incremental encoder (encoder) with 2 counter tracks and 1 zero track plus 3 rotor position tracks. Counter tracks with or without push-pull output.

(For single connection A, B, N do not connect the negative inputs.)

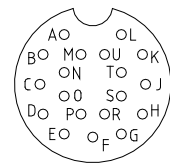
The counter input corresponds to RS485. Max. counting frequency 500 kHz.

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

The voltage of 5 V is supplied by the servo-drive.

**ConnectorX7 Encoder connector INC**

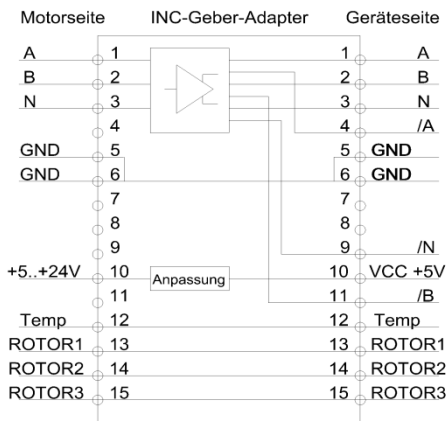
- A Channel A
- B Channel /N
- C Channel B
- D Supply +5V
- E Channel N
- F Channel /B
- G Channel /A
- H Temperature signal
- J Temperature GND
- K Rotor position 3
- L Supply GND
- M Rotor position 2
- N
- O Rotor position 1
- P



Only use motors with TTL incremental encoders which have been approved by the manufacturer. Observe the motor specific connection data sheet (IN)!		
Connector	X7	19-pin round connector
Connecting cable	10 shielded signal conductors	min. cross-section 0.14mm
	2 supply lines	min. cross-section 0.5mm
	For link chains use appropriate cables!	
Cable length	for >25m the cross-section of the cable used must be increased	
Shield connection	across connector X7	connect the shield to the connector housing
	across the motor connector	connect the shield to the connector housing
Setting parameters	see software Manual NDrive	



**Adapter for INC encoder with A, B, N channel without push-pull signals**



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

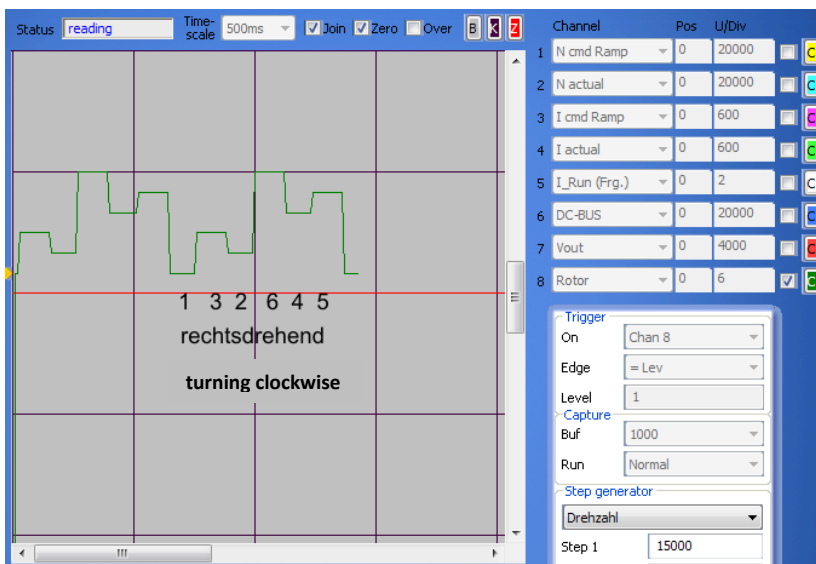
Encoders without push-pull signals (e.g. position encoders) with different supply voltages are used for many simple applications. For these applications the INC adapter must be installed.

The adapter converts the counter signals A, B, N to the push-pull signals A, /A, B, /B, N, /N.

For supply voltages which differ from 5V the voltage must be specified on order and externally be connected.

**Checking the correct connection**

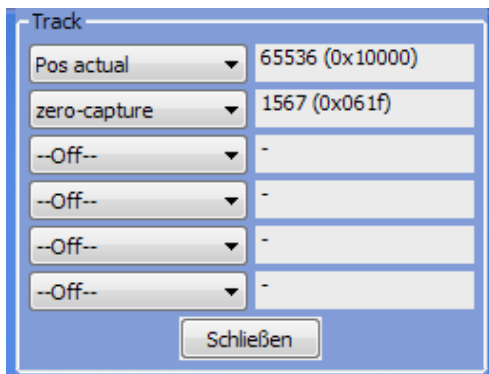
Rotor sequence



The correct sequence of the rotor signals with a motor turning clockwise is 1, 3, 2, 6, 4, 5.

If the sequence of numbers is different the encoder connection of the rotor position signals Rotor1, Rotor2, Rotor3 (U,V,W ) is not correct.

Use the connection diagram!



**Numerical value**

Turn motor clockwise for one revolution without enable.

One motor revolution corresponds to a position value of Num 65536. In case of different results the input of Feedback Inc-Mot (0xa6) is incorrect.

**Zero angle**

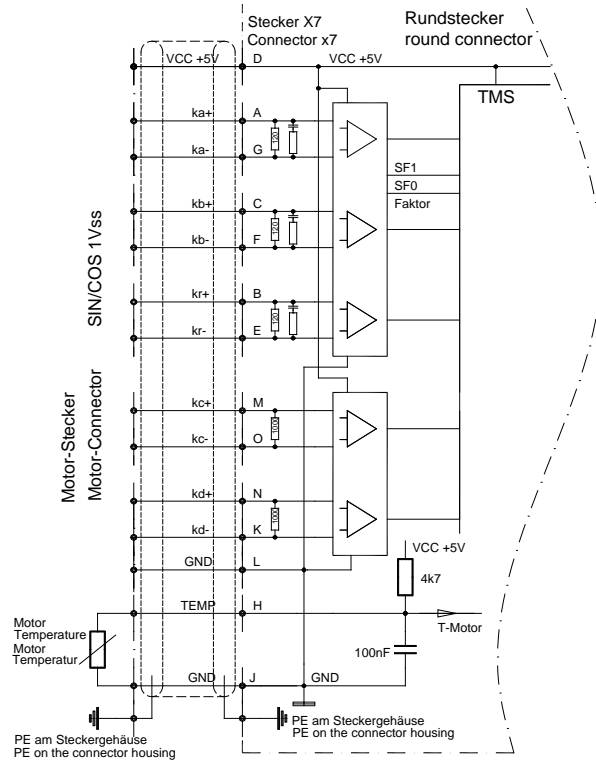
Motor turning clockwise and anti-clockwise at 10 % - 100 % speed.

The value of zero-capture must remain constant.

### 5.9 SIN COS 1Vss connection

Only with BAMOCAR D3-SC

5-14 ED-BAC-SC-2



Incremental encoder (encoder) with 2 analog, sinusoidal counter tracks and 1 zero track plus 2 commutating tracks. Differential signals 1 Vss

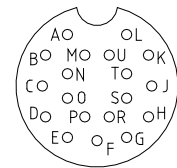
Max. counting frequency 500kHz.

The incremental encoder is galvanically connected with the device zero (GND). The voltage of 5 V is supplied by the servo-drive.

The resolution is automatically set to an optimum.

**Connector X7    Encoder connector SIN/COS**

- A Channel ka+
- B Channel kr+
- C Channel kb+
- D Supply +5V
- E Channel kr+
- F Channel kb-
- G Channel ka-
- H Temperatur signal
- J Temperatur GND
- K Channel kd-
- L Supply GND
- M Channel kc+
- N Channel kd+
- O Channel kc-
- P



Only use motors with SIN/COS encoders (SC) which have been approved by the manufacturer. Observe the motor specific connection data sheet (SC)!

Connector	X7	19-pin round connector
Connecting cable	2 x 2 signal conductors, twisted and shielded	min. cross-section 0.14 mm
	3 x 2 signal conductors, twisted and shielded	min. cross-section 0.14 mm
	2 x supply lines, 2 x temp	min. cross-section 0.5 mm
Cable type	(4 x (2 x 0.14) + (4 x 0.14) C + 4 x 0.5) C For link chains use appropriate cables!	
Cable length	for >25 m the cross-section of the cable used must be increased by one grade	
Shield connection	across connector X7	connect the shield to the connector housing
	across the motor connector	connect the shield to the connector housing
Setting parameters	see software Manual NDrive	

### 5.10 Rotor position encoder - connection via a bl-tacho

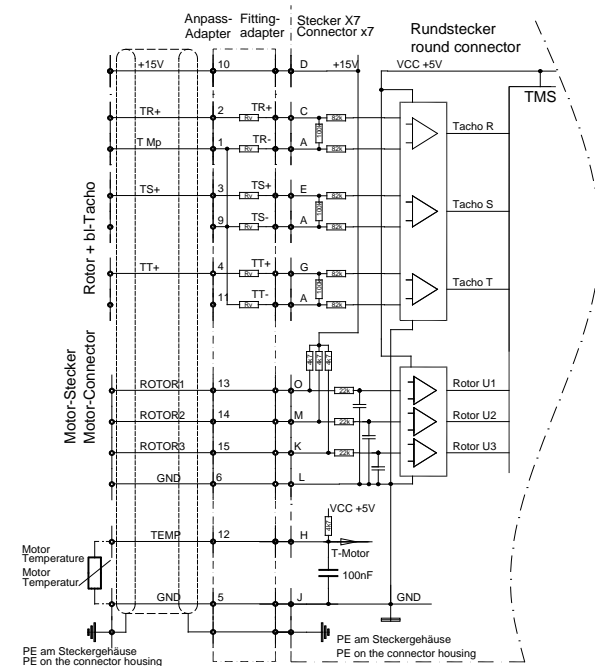
Only with BAMOCAR D3-bl

3 rotor position encoder signals (Hall sensors) for the commutation; with or without a brushless tacho.

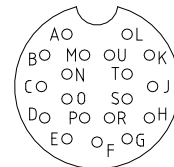
The rotor position encoder is galvanically connected with the device zero (GND). The voltage of 15V is supplied by the servo-drive.

Provide an adapter in case the tacho voltage at rated speed is superior to 10V~.

For lower tacho voltages connect X7: pin 1, 9, and 11. Connect the tacho center point to X7:1.



Connector X7	Encoder connector bl
A	MP-Tacho
B	
C	Tacho 1
D	Supply +15V
E	Tacho 2
F	
G	Tacho 3
H	Temp signal
J	Temp GND
K	Rotor position 3
L	Supply GND
M	Rotor position 2
N	
O	Rotor position 1
P	



ED-BAC-bl-2

Only use motors with rotor position encoders (bl) which have been approved by the manufacturer.		
Observe the motor specific connection data sheet (bl)!		
Connector	X7	19-pin round connector
Connecting cable	12 x signal conductors, supply lines, temp.	min. cross-section 0.25 mm
	For link chains use appropriate cables!	
Cable length	for >25 m the cross-section of the cable used must be increased by one grade	
Shield connection	across connector X7	connect the shield to the connector housing
	across the motor connector	connect the shield to the connector housing
Setting parameters	see software Manual NDrive	








### 5.11 State displays

The state "**normal**" is signalled by a bright green seven-segment display + decimal point (display of the state).

The state "**fault**" is signalled by a bright red fault LED and the seven-segment display indicates the error no.

The state "**warning**" is signalled by the flashing red fault LED and the seven-segment display indicates alternately the state and the warning no.

#### Display of the BAMOCAR states

Display	Point/segment	State	State of NDrive
	flashing dark	Processor active Auxiliary voltage missing or inherent hardware failure	
	flashing bright dark	Starting state after reset (auxil. voltage 24V off-on). The first enable stops the flashing display. Drive enable Drive disabled (not enabled)	OK = 0 OK = 1, ENA = 1 OK = 1, ENA = 0
	bright	Speed zero (standstill signal)	NO = 1
	bright	Drive revolves clockwise, N currently positive	NO = 0
	bright	Drive revolves anti-clockwise, N currently negative	NO = 0
	flashing bright dark	Motor current reduced to continuous current $I_{cns}$ Motor current at max. current limit $I_{max}$ Normal operation; Motor current within the current limits	$I_{cns} = 1$ $I_{cns} = 0$ $I_{cns} = 0$
	bright for 0.1 s	A new command (value) was received from the BUS or RS232.	

**Example:** Motor revolving clockwise



Point flashes = active processor  
Bottom segment = drive enabled  
Right segment = motor revolves clockwise


## 5.12 Error displays

The red LED "fault" is bright and the fault no. is indicated by the green seven-segment display.

### List of errors

Error display	Description	Display	Address
NOREPLY-No RS	RS232 interface not plugged or disturbed		
			<b>REGID 0x8f</b>
BADPARAS	Damaged parameter	0	Bit 0
POWER FAULT	Output stage error	1	Bit 1
RFE FAULT	Safety circuit fault (only active with RUN)	2	Bit 2
BUS TIMEOUT	Transmission fault BUS	3	Bit 3
FEEDBACK	Encoder signal faulty	4	Bit 4
POWERVOLTAGE	Encoder signal faulty	5	Bit 5
MOTORTEMP	Motor temperature too high	6	Bit 6
DEVICETEMP	Device temperature too high	7	Bit 7
OVERVOLTAGE	Overvoltage >1.8 x UN	8	Bit 8
I_PEAK	Over-current 300%	9	Bit 9
RACEAWAY	Drive races (without command value, wrong direction)	A	Bit 10
USER	User - choice of error	B	Bit 11
I <sup>2</sup> R	Overload	C	Bit 12
RESERVE		D	Bit 13
HW_FAIL	Firmware is not compatible with the hardware	E	Bit 14
BALLAST (device-dependent)	Ballast circuit overloaded	F	Bit 15

**Note:** With BAMOCAR the error F (BALLAST) has no function.

	<b>Fault</b>	<b>Example:</b>	POWERVOLTAGE (missing power voltage)
		FAULT LED red	
		Error no. 5	

**Note:**

When applying the auxiliary voltage with the enable closed (FRG/RUN X1:7 active) the red LED signals an error. There is no error signal displayed in the 7-segment display.


### 5.13 Warning signals

The state "warning" is signaled by the flashing red fault LED and the seven-segment display indicates alternately the state and the warning no.

#### List of warning signals

Error display	Description	Address	
			<b>REGID 0x8f</b>
WARNING_0	No device identification	0	Bit 16
ILLEGAL STATUS	RUN signal, EMI	1	Bit 17
WARNING_2	RFE signal inactive, (without RUN)	2	Bit 18
		3	Bit 19
		4	Bit 20
POWERTVOLTAGE	Power voltage too small or missing	5	Bit 21
MOTORTEMP	Motor temperature >87 %	6	Bit 22
DEVICETEMP	Device temperature > 87%	7	Bit 23
OVERVOLTAGE	Overvoltage >1.5 x UN	8	Bit 24
I_PEAK	Overcurrent 200 %	9	Bit 25
		A	Bit 26
		B	Bit 27
I2R	Overload >87%	C	Bit 28
		D	Bit 29
		E	Bit 30
BALLAST (device-dependent)	Ballast circuit >87% overloaded	F	Bit 31

**Note:** With BAMOCAR the warning F (BALLAST) has no function.

	<b>Fault</b>	<p><b>Example:</b> flashing red, The display swaps between the state and the warning no., Warning no. 5</p>
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## 6 Measured data

### 6.1 Bus circuit battery voltage

from firmware FW450

#### Bus circuit dc bus voltages, battery voltage (400 V)

BAMOCAR D3-400	Bus circuit voltage	Parameter 0xeb
Max. voltage	460 V	25158
Battery voltage	370 V	20211
Overvoltage switch-off	440 V	24059
Charging voltage	340 V	18561
without power voltage	0 V	0
Scaling	1	54,971
Tolerance		+/-2 %

Parameter 0xeb = 54.971 x bus circuit voltage (tolerance +/-2%)

#### Bus circuit dc bus voltages, battery voltage (700V)

BAMOCAR D3-700	Bus circuit voltage	Parameter 0xeb
Max. voltage	800 V	24045
Battery voltage	700 V	20883
Overvoltage switch-off	780 V	23413
Charging voltage	680 V	20250
without power voltage	0 V	0
Scaling	1	31,499
Tolerance		+/-2 %

Parameter 0xeb = 31.499 x bus circuit voltage (tolerance +/-2%)

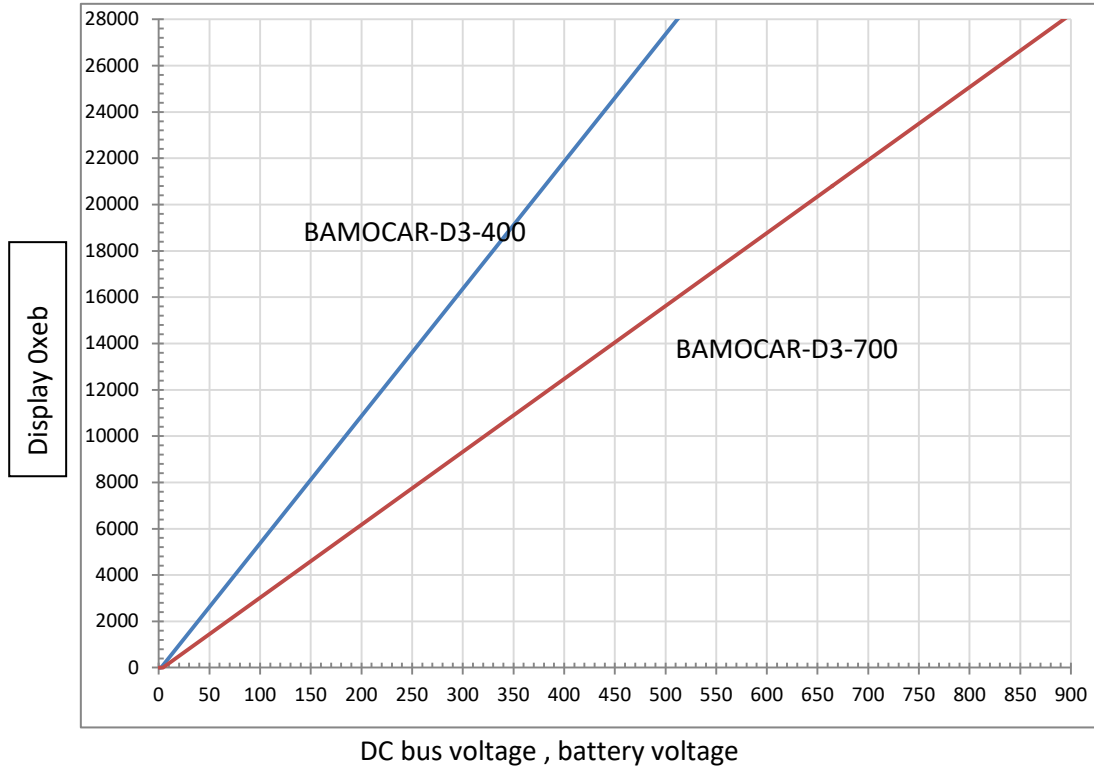
#### Current - actual value

BAMOCAR-D3	I 100 %	Calibration rated current			Peak current	
		I-device			DC blocked	
Max. value +/- 11Bit	mV	Num	Aeff	A=pk	Num	A=pk
250/150	520	350	125	176	506	250
400/250	785	560	200	282	808	400

In the set of parameters the basic set-up data are protected.

## 7 Bus circuit dc bus voltages (battery voltage)

### 7.1 Bus circuit dc / bus voltages



Measuring tolerance +/- 2 %

**Note:** For dc bus voltages <50 V (at 400 V) or < 100V ( at 700 V) the measured values are not linear!

Settings for BAMOCAR 400/400			
DC bus max (0xa5H)	for threshold voltage	Num 0xeb	Note
72 %	440 V =	24059	
66 %	400 V =	21860	
DC bus min (0xa5L)	for undervoltage		
52 %	320 V	17462	
44 %	270 V	14713	

Settings for BAMOCAR 700/400			
DC bus max (0xa5H)	for threshold voltage	Num 0xeb	Note
83 %	750 V =	23496=	
78 %	700 V =	21921=	
DC bus min (0xa5L)	for undervoltage		
63 %	600 V =	18771=	
52 %	500 V =	15621=	

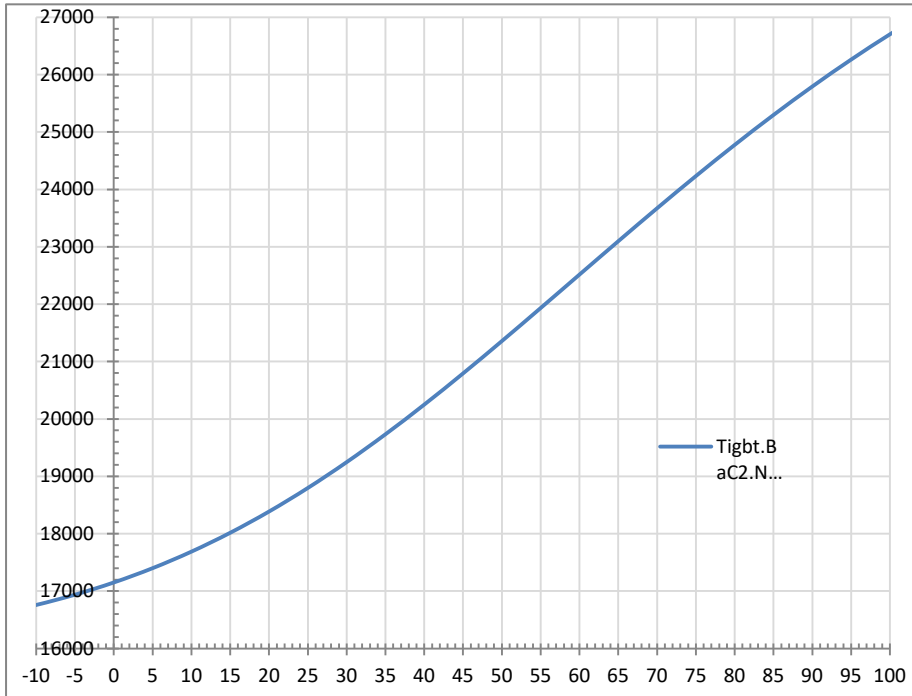


## 8 Output stage temperature

### 8.1 Output stage temperatur

IGBT – Module temperature	Parameter 0x4a
+80 °C	24000 (FW>450)

Display 0x4a

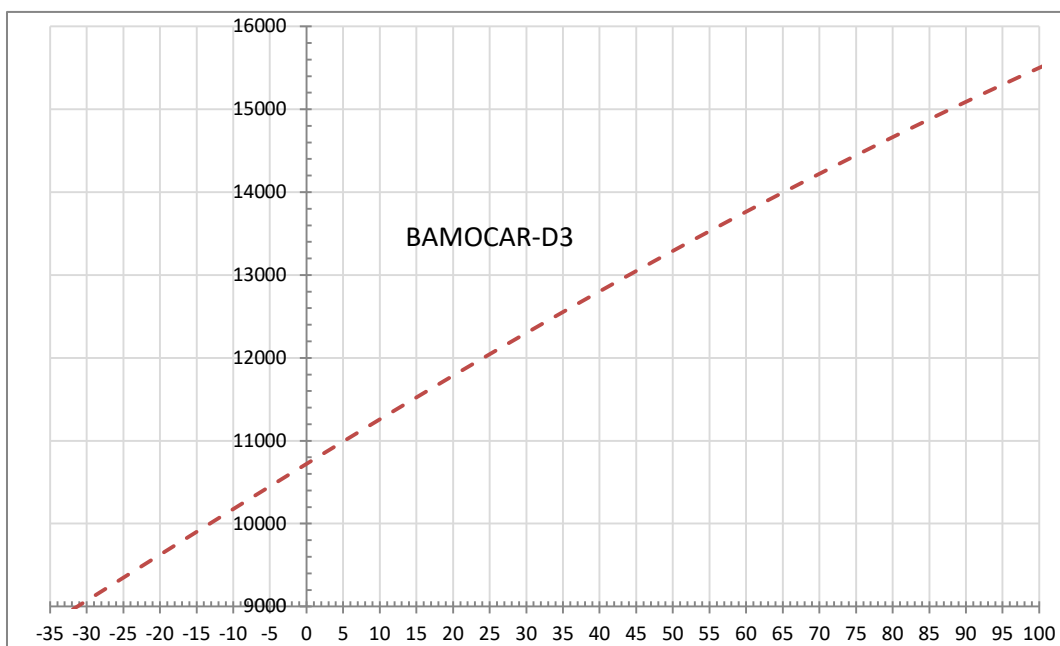


[°C]	[Q]	[n]
-35	83131	16245
-30	62115	16308
-25	46960	16387
-20	35897	16487
-15	27728	16609
-10	21629	16759
-5	17028	16938
0	13524	17151
5	10830	17400
10	8742	17688
15	7108	18017
20	5821	18387
25	4799	18797
30	3982	19247
35	3324	19733
40	2790	20250
45	2356	20793
50	1999	21357
55	1705	21933
60	1461	22515
65	1258	23097
70	1088	23671
75	944	24232
80	823	24775
85	720	25296
90	633	25792
95	558	26261
100	493	26702

IGBT temperature

Indoor air temperature	Parameter 0x4b
+ 45 °C	13000 (FW>450)

Display 0x4b



Indoor air temperature

## 9 Warranty

### 9.1 Warranty

UNITEK warrants that the device is free from material and production defects. Test results are recorded and archived with the serial number.

The warranty time begins from the time the device is shipped, and lasts two years.

UNITEK undertakes no warranties for devices which have been modified for special applications.

During the warranty period, UNITEK will, at its option, either repair or replace products that prove to be defective, this includes guaranteed functional attributes. UNITEK specifically disclaims the implied warranties or merchantability and fitness for a particular purpose. For warranty service or repair, this product must be returned to a service facility designated by UNITEK.

For products returned to UNITEK for warranty service, the buyer shall prepay shipping charges to UNITEK and UNITEK shall pay shipping charges to return the product to the buyer.

However, the buyer shall pay all shipping charges, duties and taxes for products returned to UNITEK from another country.

The foregoing warranty shall not apply to defects resulting from:

- improper or inadequate repairs effected by the buyer or a third party,
- non-observance of the manual which is included in all consignments,
- non-observance of the electrical standards and regulations,
- improper maintenance
- acts of nature.

All further claims on transformation, diminution and replacement of any kind of damage, especially damage, which does not affect the UNITEK device, cannot be considered. Follow-on damage within the machine or system, which may arise due to malfunction or defect in the device cannot be claimed. This limitation does not affect the product liability laws as applied in the place of manufacture (i.e. Germany).

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All connection circuitry described is meant for general information purposes and is not mandatory.

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