M A N U A L

Digital Battery Motor Controller
BAMOBIL-D3.3
for EC-servo motor

UniTek
Industrie Elektronik
G m b H

Basic - informationen

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Use all MANUALs for the engineering, the installation, and the commissioning!

Online available as download version on the UNITEK website 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.

1.3 Designations and symbols

Unit:	BAMOBIL
User:	Manufacturers or operators of machines or installations in the industrial sector (B2B, secondary environment)
Manufacturer:	UniTek Industrie Elektronik GmbH
Dealer:	
	Caution – Danger to life! **High voltage**
	Warning! **Important**

1.4 General product information

The digital current servo amplifiers **BAMOBIL-D3-xx** 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 provide 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. The unit size and the worse efficiency. 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.
The active current and the magnetising current must be supplied by the controller.
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 **Bamobil D3** 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.

1.5   Application / build / features

Application in all kinds of vehicles, machines and installations with a drive power of 7,5 kW,
Especially as 4Q-servo-drive for
- highly dynamic acceleration an d braking cycles
- a wide control range
- a high efficiency
- small motor dimensions
- a uniform, accurate and smooth running

To be used for the speed or torque control or combined speed/torque control incorporated
within or independent of position control loops.

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:
- Compact devices according to the VDE, DIN and EU regulations, protection rating IP40
- For <60 V no protection of the connections against accidental contact
- Splash-proof housing IP53 (option)
- Standard analogue control electronics
- Power electronics for 50 A, 80 A, 100 A, 120 A, 150 A, 250 A, 350 A and 450 A
- Independent 24 V chopper power supply unit for the auxiliary voltages
- Nominal power input range of 12 to 48 V dc
- Additional cooling unit for air or water cooling

Galvanic isolation:
- The negative battery voltage is connected with the device GND
- The housing and the heat sink are galvanically isolated from all electric parts
- The distance of air gaps and leakage paths adhere to the VDE standards

Components:
- FET power semi-conductors, comfortably over-dimensioned
- Only components customary in trade and industrially standardised are used
- SMD equipment
- 7-segment LED displays

Features:

- ✓ Battery-powered of dc connection 24 V= bis 48 V
- ✓ Independent auxiliary voltage connection 24 V=
- ✓ Digital interfaces RS232, CAN-BUS (further option)
- ✓ 2 analogue inputs, programmable differential input
- ✓ 4 digital inputs / outputs, programmable, optically de-coupled
- ✓ Linear command value ramp, non-linear (s-function)
- ✓ Logic for enable and the output stage switch
- ✓ BTB-ready for operation, solid state relay contact
- ✓ Position, speed and torque control
- ✓ Resolver or incremental encoder TTL, SINCOS 1Vss, rotor position +bl tacho
- ✓ Encoder output or 2nd encoder input
- ✓ Static and dynamic current limiting
- ✓ Uniform, completely digital control unit
- ✓ Protective switch-off from the motor in case of over-voltage, under-voltage, or overtemperature
- ✓ Intrinsically safe and short-circuit proof power section
- ✓ Processor-independent hardware switch-off in case of short-circuits, circuits to earth, overvoltage and over-temperature of the amplifier.

1.6   Safety regulations

<u>Electronic equipment is not fault proof!</u>

Caution – High voltage

DC 160 V =
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 **BAMOBIL** series are power electric parts used for regulating energy flow.

They are designed to control EC synchronous motors and ac asynchronous motors in stationary machines or installations for industrial applications.

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 IP20 (version BAMOBIL-x-IM for IP65)

Connection only to batteries.
Special attention should be paid to voltages> 60 V:

Operation only allowed when the switch cabinet is closed or locked!

The control and power connections may be voltage-carrying without the axis operating!

The discharge time of the bus circuit is superior to 4 min!

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 machines, equipment, or vehicles are fitted with device independent monitoring and safety features.
Appropriate measures must be taken so that man as well as property are not exposed to danger due to incorrect or improper movements at any time!

During operation the switch cabinet must be closed and the safety systems must be enabled.
When the switch cabinet 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 electrics
- 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 software
- should only be carried out in accordance with the programming advice
- should only be carried out in accordance with health and safety guidelines

1.7   Commissioning

When mounting the units into 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.

1.8   Safety advice

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.
When operating the units the switch cabinet must be closed and the safety systems must be enabled!
Exceptions to this are the first commissioning or if switch cabinet repair works have to be carried out by the skilled qualified personnel.
Any unit covers must not be removed!
Disconnect the power supply prior to any works on electric connections and safeguard the switch cabinet against switching-on.
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.

1.9   Intended applications

The devices are designed to control EC synchronous motors, ac asynchronous motors or dc motors in vehicles, machines or installations.

For voltage over 60V it is only allowed to install the units in switch cabinets or machine frames which are similar to switch cabinets. Industrial site of operation only.
For applications in residential areas, additional EMC measures are necessary.

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

Only permissible for the connection to a battery with charging current limiting on the battery side.
For voltage over 60 V protective covers and isolation watchdogs must be installed.
It must be borne in mind that the auxiliary voltage connection and the device ground are connected with the negative potential of the battery voltage. The CAN-BUS is isolated from the potential.

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.

For any isolation measurements the devices must be disconnected or the power connections must be bridged among each other and the control connections must be bridged among each other. 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 EN50178).

Impermissible applications
- in life-sustaining medical devices or machines
- across unearthed or asymmetrical power supplies
- on ships
- in explosive environments
- in environments with acrid fumes

1.10 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:

EU Guidelines	2004/108/EG, 2006/95/EG, 2006/42/EG, 2002/96/EG
EU 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 Regulations	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 60664-1	Isolation coordinates - low voltage	2012
EN 61010	Safety regulations - control units	2011
EN 61800-5-1	Electric power drive systems	2010
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	Elektrical 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

1.11 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.

1.12 Technical data

Version for battery voltage to 48 V=

Power supply connection	24 V= to 48 V=
	Please indicate battery voltage on order!
Auxiliary voltage connection	24 V= ± 10 % / 2A residual ripple <10% regenerating fuse

BAMOBIL D3-xx	Dim.	80	120	250	450	
Supply voltage	V=	24 bis 48				
Max. output voltage	V~eff	3 x 14 bis, 3 x 33				
Continuous current	A_{eff}	40	60	125	225	
Max. peak current	A_{lo}	80	120	250	450	
Max. power loss	W	200	300	600	1200	
Plus frequency	kHz	8				
Over-voltage switching thereshold	V=	programmable up to max. 68 V				
Input fuse	A	80	160	250	500A	
DC-Bus capitability	µF	18800	28200	28200	28200	
Weight	Kg	2.2	2.3	3.6	3.7	
DimensionsHxBxT	mm	244x194x90				
Unit size		2	2	2	2	

Control signals		V	A	Funkction	Connection
Analog inputs		± 10	0.005	differential input	X1
Digitale inputs	ON	10-30	0.0100	logic IO	X1
	OFF	<6			
Digitale outputs		+24	1	transistor output open emitter	X1
Resolver, TTL, SINCOS				differential input	X7
2. Encoder input		>3.6V		optically decoupled	X7
Encoder		>4.7V		optically decoupled	X8
CAN-interface				communication I/O	X9
RS232 interface				communication I/O	X10

Ambient conditions	
Protection rating	IP20
Standard	EN60204, , EN61800, IEC60146
Operating temperature range	-10 bis +45°C
Extended operating temperature range	+45°C bis +60°C performance reduced 2 % /°C
Storage temperature	-30°C bis +80°C , EN60721
site of installation	≤ 1000m ü.NN 100 %, >1000m performance reduced 2 %/100m
Cooling	with additional cooler
Mounting position	any
Contamination	contamination degree 2 to EN 61800-5-1
Oscillation	10 Hz to 58 Hz Ampl. 0,075 mm (IEC 60068-2-3) 58 Hz to 200Hz 1 g
Shock	15 g for 11 ms
Enviroment conditions	not permitted: condensation, icing, oilfog, saltfog, water
Humidity range	class 3K3 humidity <85 % not condensation!

Programming	Version	Software-Version
BAMOBIL-xx-RS	Resolver	
BAMOBIL-xx-IN	Encoder-TTL	
BAMOBIL-xx-SC	Encoder-SINCOS 1Vss	
BAMOBIL-xx-BL	Rotorlage + bl-Tacho	

Attention:

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

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

2 Mechanical installation

2.1 Important instruction

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 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.

Devices with an additional cooling unit without a fan must be mounted vertically. Please note that there will be a performance reduction when they are mounted horizontally.
Ensure that the ventilation is sufficient and that there is enough space for the discharged ventilation air (min. 100mm). 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.
10 mm cable lugs
Use vibration-proof screw connections.

Note: Concerning the power supply connection and the auxiliary voltage connection of the battery please check:
negative power supply voltage = negative auxiliary voltage
The internal connection is destroyed in case of a reverse polarity of the auxiliary voltage.

Note: If the power voltage (-UB) and the auxiliary voltage (GND24) from the negative pole of the battery are zero, the negative connector -UB (XB:5) and the GND24 connector (X1:3) directly on the BAMOBIL must be bridged by means of a cable with a diameter of 2.5 mm²!

2.2 Dimensions BAMOBIL D3
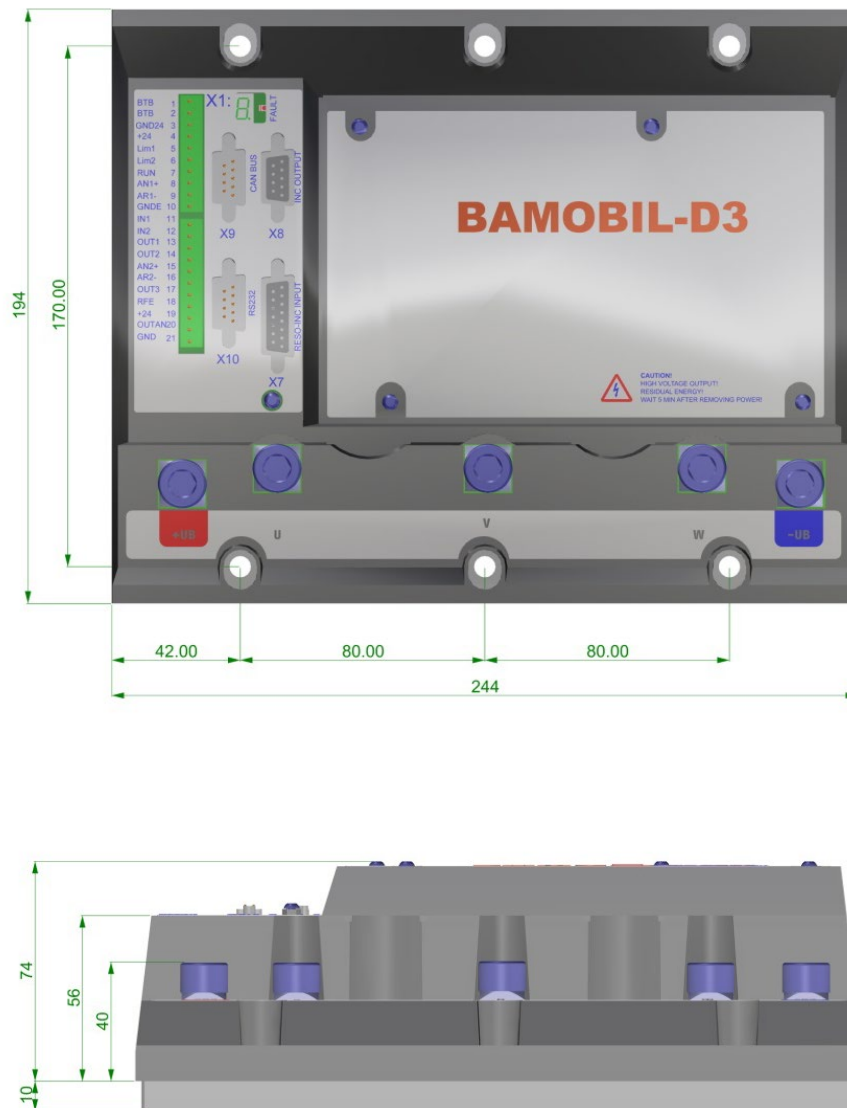
Mounting depth without connector:
BAMOBIL up to 120 A = 85 mm, BAMOBIL up to 150 A = 95 mm
Screws: BAMOBIL bis 120 = M5 x 20 / BAMOBIL ≤ 150 = M5 x 30

If the mounting plate (without the additional cooling unit) is mounted onto the rear panel of the switch cabinet (4mm bright steel), the cooling capacity of the plate corresponds to:

- a continuous current of 35A (S1 duty) when the plate is 10mm thick
- a continuous current of 50A when the plate is 20mm thick

For currents superior to 50Aeff. (for intermittent duty S2, S3) it is necessary to provide an additional cooling unit or a heat dissipating mounting plate.

Connecting screws **M10** x 16
maximal permissible torque: 12 Nm

2.3 Dimensions - with an additional cooling unit (optional)

for control panel mounting
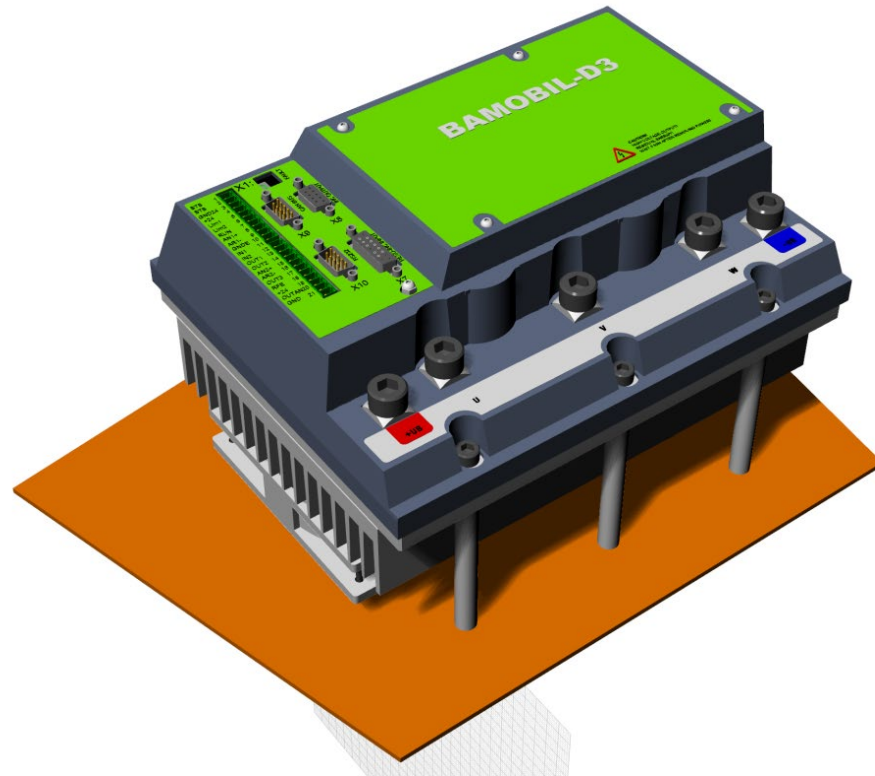
Mounting depth without connector
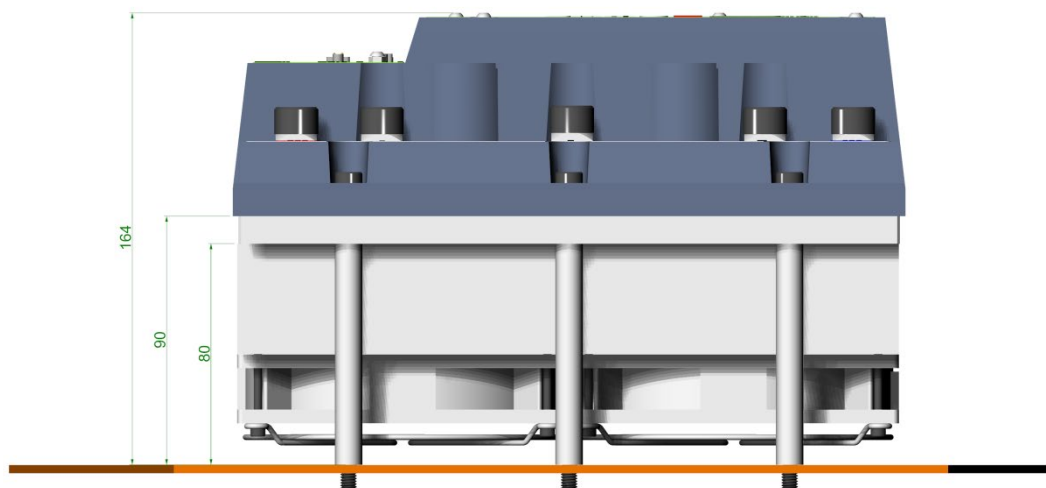
(optional):
Fixing bore hole dimensions: see basis device
Fixing screws M5x110mm
Vertical mounting position,
Distance tube 80 mm, Ø inside> 5,5 outside 10 mm Ø

2.4 Mounting / Through-mounting

6x M5

min 241.50

80.00

80.00

40.60

4.40

min 161.50

170.00

84

70
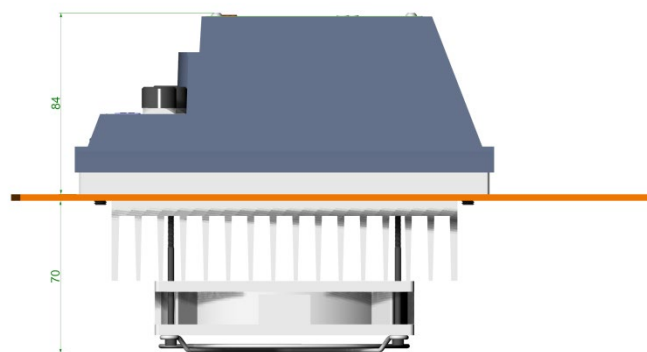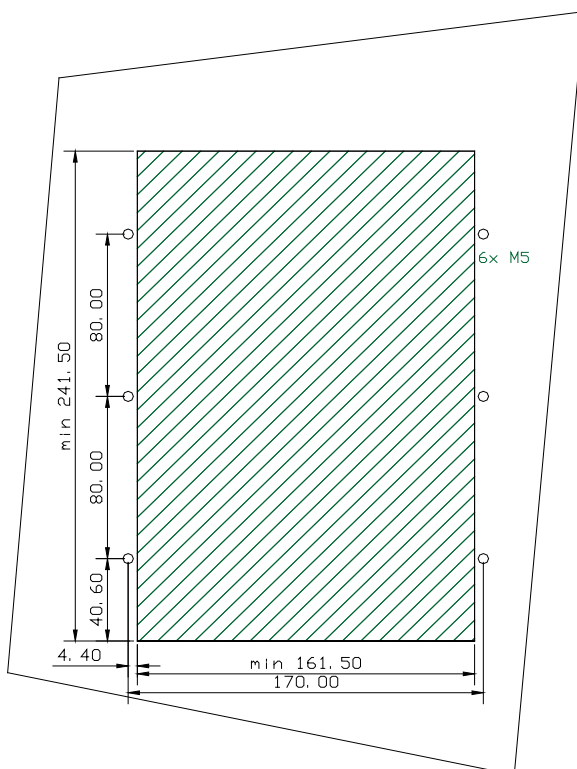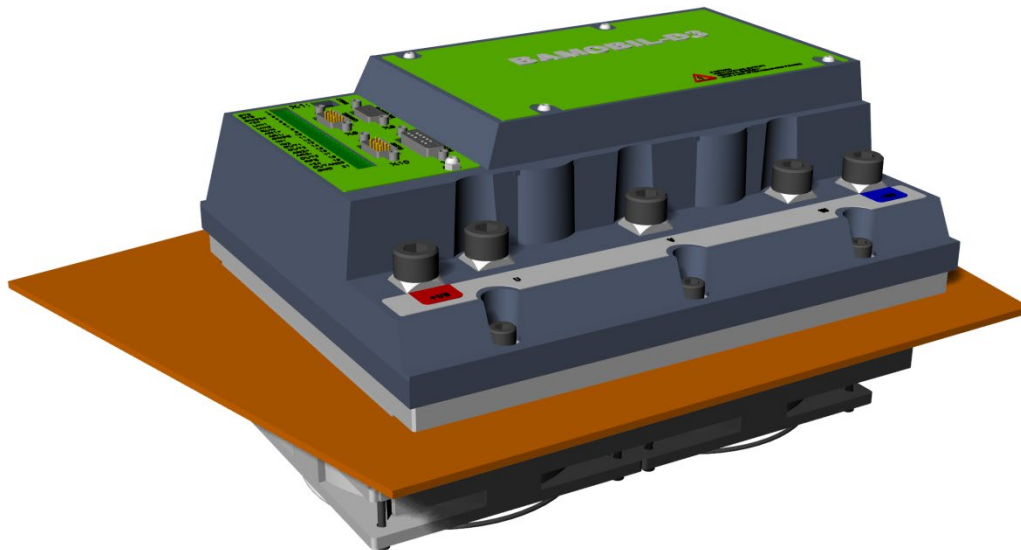
Control panel break through
Fixing screws M5 x 30

3 Electrical installation

3.1 Important advice

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.

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 BAMOBIL 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 ELKOs would be reduced.

Note: Concerning the power supply connection and the auxiliary voltage connection of the battery please check:
**negative power supply voltage = negative auxiliary voltage.**
The internal connection is destroyed in case of a reverse polarity of the auxiliary voltage.

Note: If the power voltage (-UB) and the auxiliary voltage (GND24) from the negative pole of the battery are zero, the negative connector -UB (XB:5) and the GND24 connector (X1:3) directly on the BAMOBIL must be bridged by means of a cable with a diameter of 2.5 mm²!
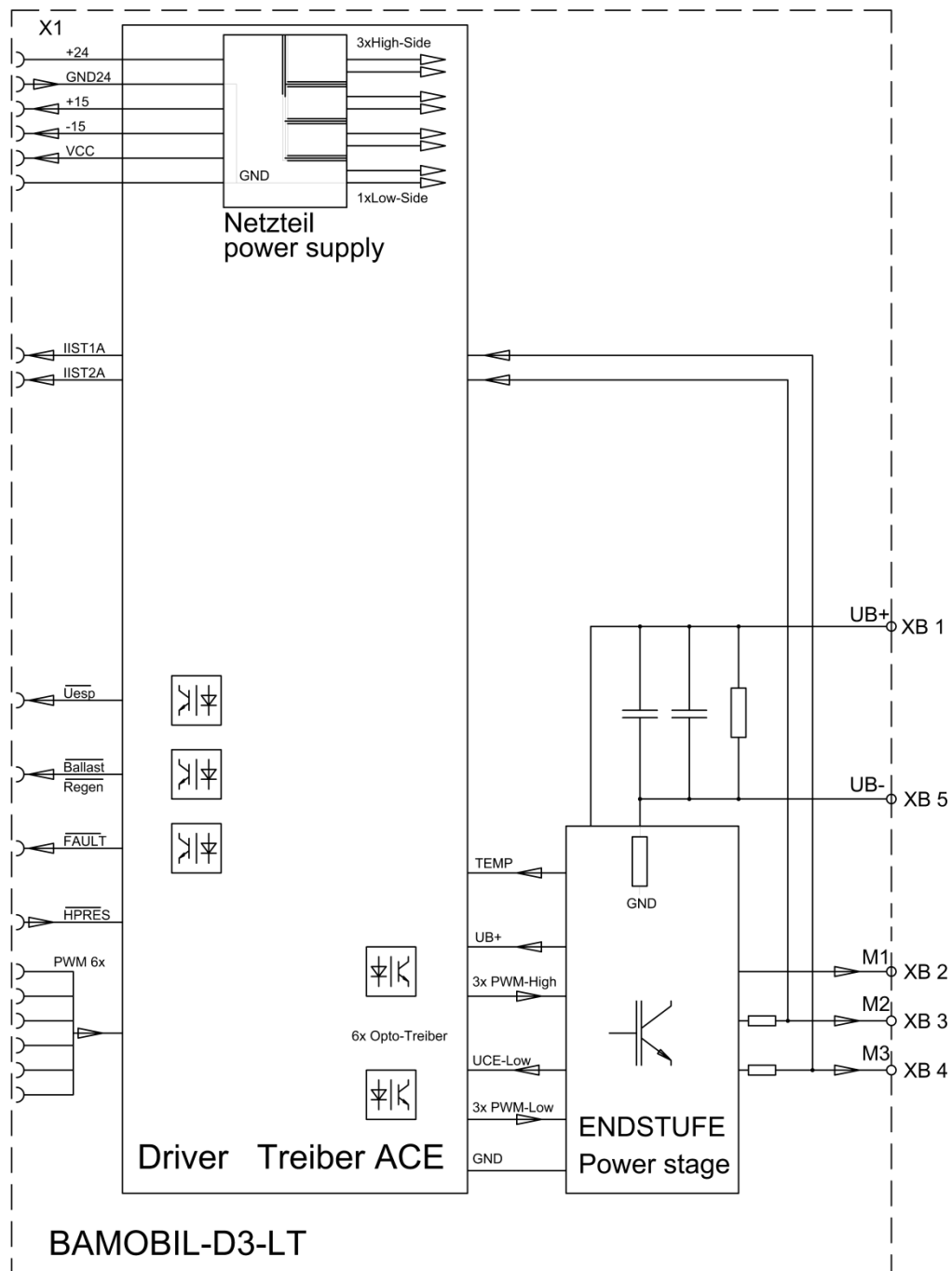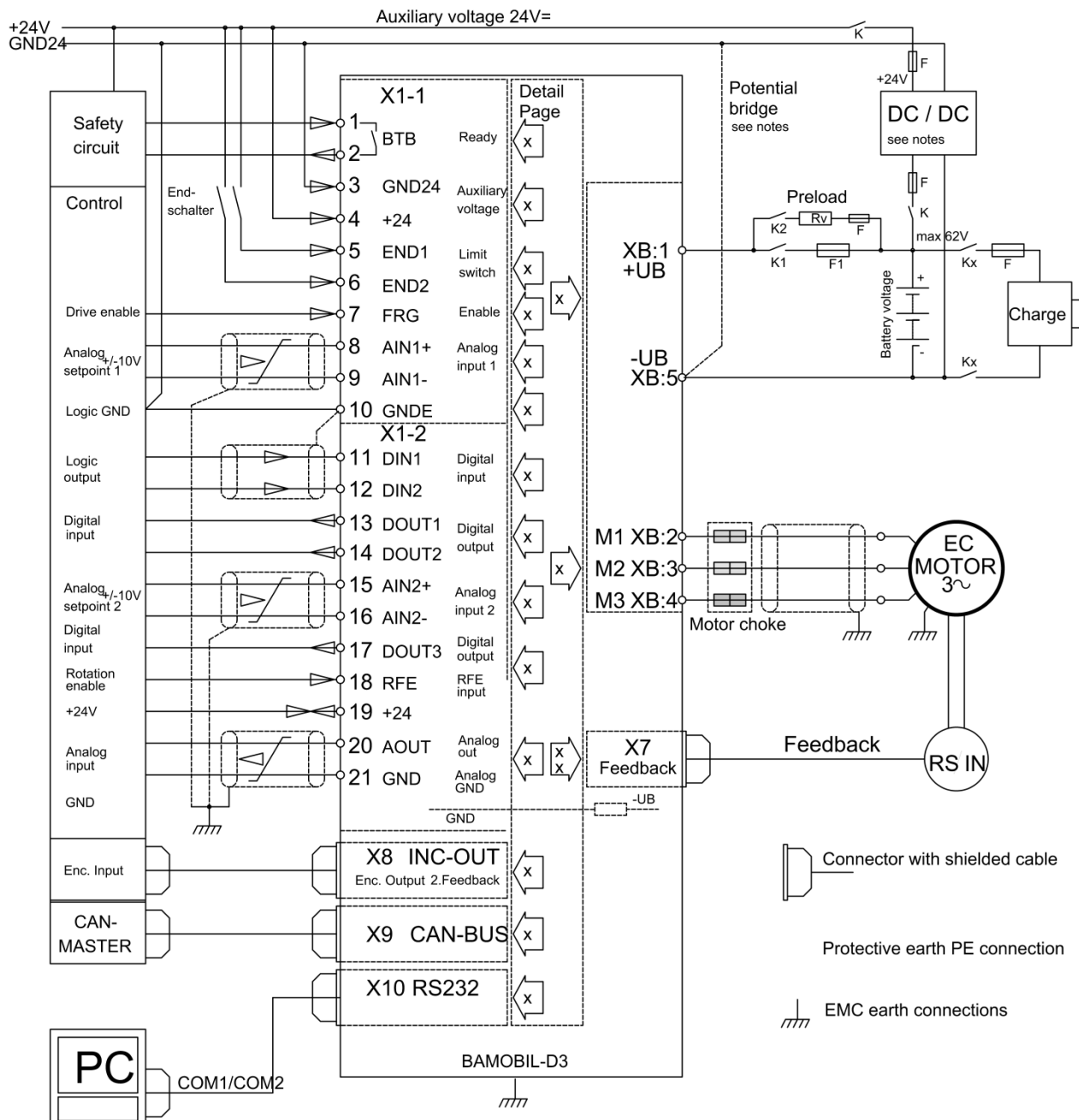
Blank page / print condition !!!!
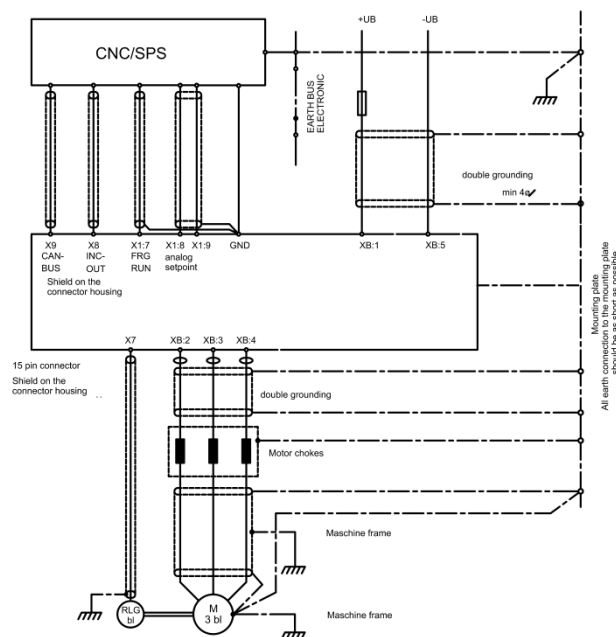
3.2 Circuit diagram
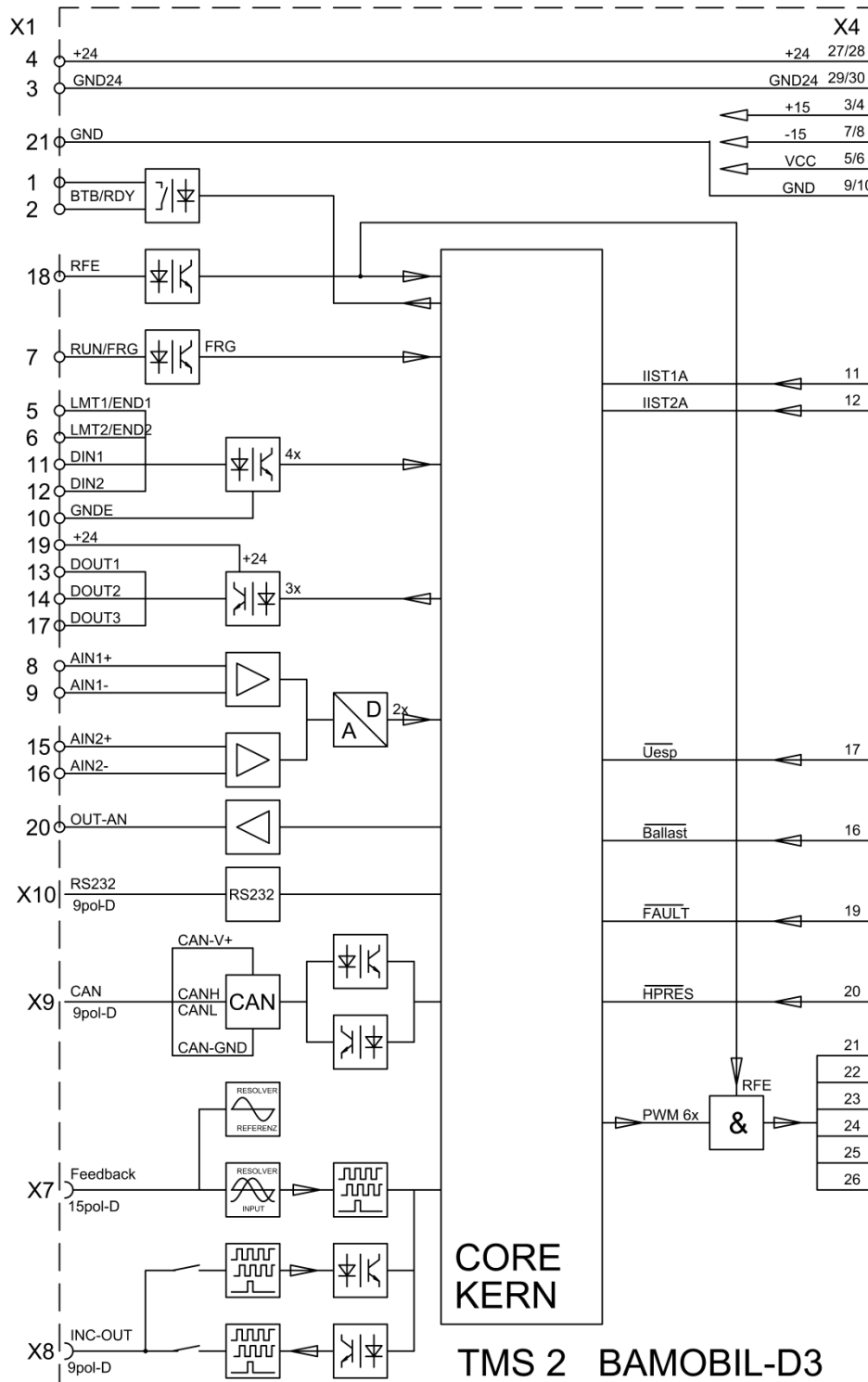
Circuit diagramm

3.3 Conncection diagram

3.4 EMV

The devices adhere to the EU guidelines 2004/108/EC and the technical standard EN 61800-3 provided that the following conditions are observed:

Mounting:
The device is conductively mounted on a 500 x 500 x 5 mm bright aluminium mounting plate.
The mounting plate must be connected to $-U_B$ using a 10 mm² wire.
The motor housing must be connected to $-U_B$ using a 10 mm² wire.
The device ground X-AGND must be connected to the mounting plate using a 1.5 mm² wire.
The housing must be connected to the mounting plate (earth).

Connection of the control conductors:
All control conductors must be shielded. Analogue signal lines must be twisted and shielded. The shield must have surface-to-surface contact with the mounting plate (earth).

Battery connection:
48V dc voltage

Motor connection:
Motor lines must be shielded, and must have surface-to-surface contact with the mounting plate (earth).
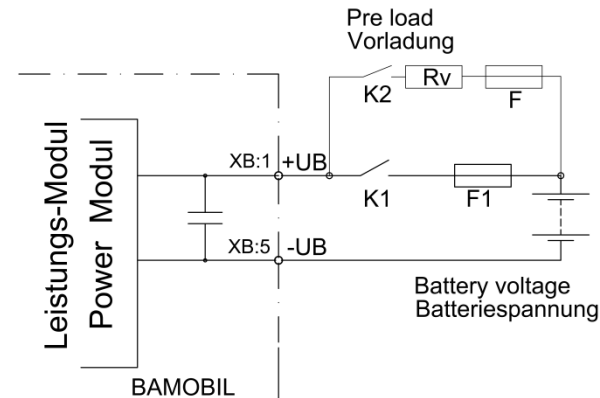
After having been mounted in machines and installations the operation of the device must not be started until the machine or the installation has been approved of the regulations of the EC machine guideline 2006/42/EC and the EMC guideline 2004/108/EC, for vehicles ECE-R83 and ECE-R100.
A manufacturer's declaration can be asked for.

3.5 Connectors

CAN-BUS X9

nc	6	1	nc
CAN-H	7	2	CAN-L / CAN-GND
nc	8	3	nc
CAN-V+	9	4	nc
		5	nc

Encoder output input X8

Cannel A	9	5	GND
Cannel B	8	4	Cannel N
Cannel N	7	3	Cannel B
Select	6	2	Cannel A
		1	+5V

X1

Ready	BTB/RDY	1
	BTB/RDY	2
Auxiliary voltage	GND24	3
	+24	4
Limit Switch	END1/LMT1	5
	END2/LMT2	6
Enable	FRG/RUN	7
Analog Input 1	AIN1+	8
	AIN1-	9
Logic GND	GNDE	10
Digital Input	DIN1	11
	DIN2	12
Digital Output	DOUT1	13
	DOUT2	14
Analog Input 2	AIN2+	15
	AIN2-	16
Digital Output	DOUT3	17
Rotation enable	RFE	18
	+24	19
Analog output	AOUT	20
	GND	21

Resolver X7

SIN2	15	8	nc
COS1	14	7	nc
REF1	13	6	Temperatur Motor (GND)
Temperatur Motor	12	5	nc
	11	4	REF2
	10	3	COS2
	9	2	SIN1
		1	

further feedback connections
Incrementel TTL, SINCOS, Rotor

RS232 X10

nc	6	1	nc
RTS	7	2	RX
CTS	8	3	TX
nc	9	4	DTR
		5	GND

3.6 Battery connection

Pre-charging circuit must be used.

When directly switching on K1 the charging current may be up to 5 kA.

Bus circuit: see technical detail

Series resistor
RV approx. 10 Ω 10 W
Charging current via K2 < 16 A
Charging time max. 1 sec.

Switching delay for K1 by means of a time-lag relay (2 seconds after K2) oder by means of a bus circuit monitoring.

Attention:
The main contactor (K1) must only be switched when the BAMOBIL
is blocked (enable X1:7 FRG = 0 V)!
Enable signal about K1 auxiliary contact lock

Switch-on sequence:
Auxiliary voltage on (Sollwert 0),
Circuit on (K2)
after circuit (7*C*R) power voltage on (K1),
minimal 2 Sec. later release on.

Switch-off sequence:
(Command value 0), enable off, min. 2s later power voltage off,
auxiliary voltage off.

BTB/RDY contact is always to be put into the safety circuit!
In the case of a fault in the battery connection must be disconnected (K1 open).
Fire hazard due to arcing within the device!

Diagramm pre-charging


```
+24

          Leistung Ein        X1:4 (+24)
S1 \      Power ON            BAMOBIL
                              X1:...
                              Dout-x
        \ K3        \ K2

  ⊲|K2     ⊲|K1       ⊲|K3

GND24
```


Abbildung 4-1

Programming example:

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

Note:

The parameter DC-BUS min must be programmed to min. battery voltage (permitted discharge voltage).
(100 % correspond to 48 V)

Abbildung 4-2

Warning

The max. supply voltage (62 V=, 160 V=) must not be exceeded at any time (not even for short intervals)!
D a n g e r   o f   d a m a g e !
F1 = safety fuses

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 bolt 24, 48 V= bolt M8x16	Connector cross-section		Fuse A		
80	Torque	16	4	80		
120	<12Nm	35	2	160		
250	XB1 (+UB=)	70	00	250		
450	XB5 (-UB=)	185	350	500		
Battery connecting line <2m. **For conductor lengths from 2 to 10m more powerful.** **Use an additional capacity for conductor lengths superior to 10m!**						

Auxiliary voltage connection

Mains potential-free auxiliary
dc voltage 24 V= ±10 %/2 A
The auxiliary voltage
 - is galvanically connected with
   the logic voltage
- is galvanically connected with
   the power voltage
- has internal regenerating fuses
- has an EMC filter
- the external fuse is only for the
  line protection
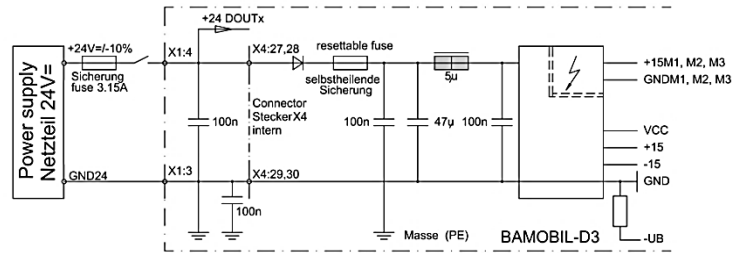
Input voltage	24 V DC X1:4
	GND24 X1:3
Residual ripple	10 %
Switch-on current	2 A
Nominal current	0.8 A

Attention:
If the power voltage (-UB) and the auxiliary voltage (GND24) from the negative pole of the battery are zero, the negative connector -UB (XB:5) and the GND24 connector (X1:3) directly on the BAMOBIL must be bridged by means of a

cable with a diameter of 2.5 mm²!

Note: Connect the auxiliary voltage only to a stable 24 V voltage supply source (battery or mains unit).

Attention: In addition to the internal supply current (0.8 A) the sum of the output currents (DOUT) must be provided by the mains module 24 V.

Attention: If the auxiliary voltage is inferior to 20 V- even in case of short-time voltage drop-outs - the internal mains module is switched off.
Any data of the RAM are deleted!
The speed and the position command values are set to zero and any calibrated data are deleted.
The LED signal for the state "OK" is dark.

Attention: Firmware is switched off when power voltage.

Auxiliary voltage and or power voltage switch
　　　　　with inhibited BAMOBIL.
Sharing - 1:7 input X = zero

3.7   Motor Leistungsanschluss

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 manufacturer prior to any use. (Motor specific connection and parameter standards and guidelines).
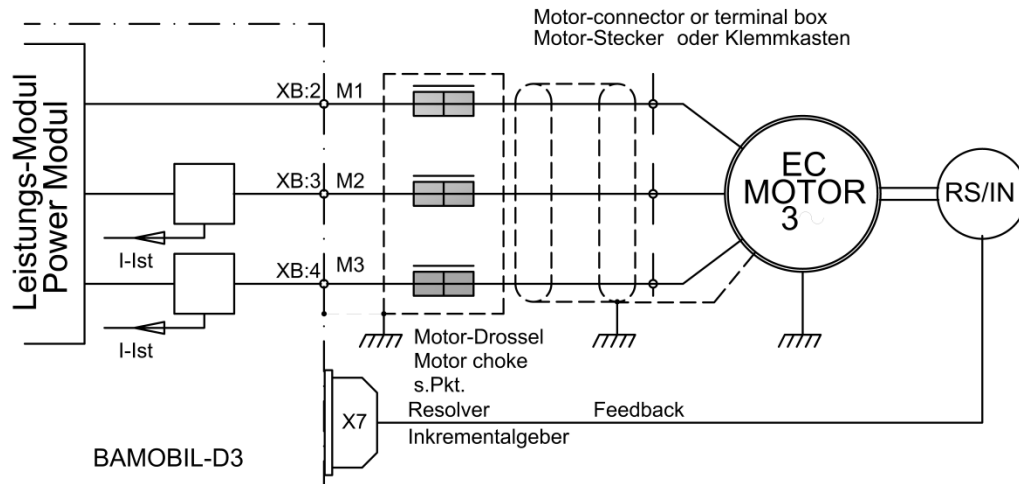
Sequence of connection

Cable	M1	M2	M3	Motor cable
Motor phase	U	V	W	3-core, single-shielded for 200 V=,
Connecting bolt	XB:2	XB:3	XB:4	shield capacity = 150pF/m min. cross-section see below table
Only one correct connecting sequence is possible!				

Min. cable cross-section

Type BAMOBIL D3-x	-80	-120	-150	-250	-450
Cross-section mm²	6	10	16	25	95
AWG	10	6	4	2	0000

Motor choke
Only necessary for a shield capacity of >5 nF / Approx. 25 m 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 input.
Surface-to-surface connection as short as possible to the motor side.

3.8   Digitale input

6 Optokoppler-Eingänge
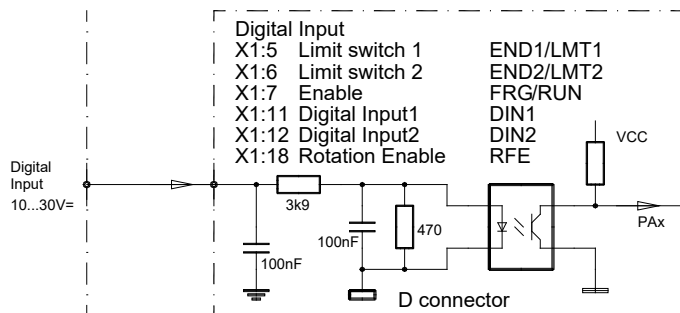
Input voltage		
Level ON		+10 bis +30 V
Level OFF		<+6 V
Input current	max.	7,5 mA
Nominal voltage / current		+24 V/6 mA
ground reference	GNDE	(X1:10)

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 electronically disabled (2nd disable channel).
The drive is free of torque (no holding torque).

The remaining four digital inputs can be programmed.
The inputs LMT1 (X1:5) and LMT2 (X1:6) are preferably to be used as inputs of the output stage switch.

Input	Connector	Function	State	Parameter
FRG/RUN	X1:7	Enable	fixed	
RFE	X1:18	Rotating field enable	fixed	
END1/LMT1	X1:5	Output stage switch 1 / digital input	programmable	
END2/LMT2	X1:6	Output stage switch 2 / digital input		
DIN1	X1:11	Digital input 1		
DIN2	X1:12	Digital input 2		

+24 V for the logic and the auxiliary voltage

GNDE logic ground
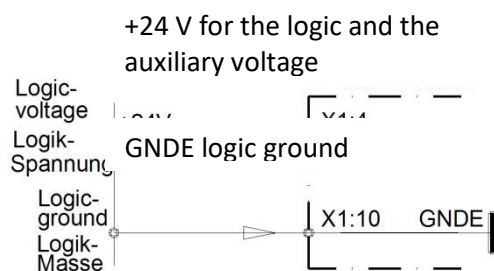
External power supply for the inputs and outputs

3.9 Safety input RFE (Rotating field enable)

Warning:
If the input 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 servo-drive, the servo-drive must be completely disconnected from the mains power supply.

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 1st disable channel to disable the PWM pulses in the processor
- there is no RFE signal in the 2nd 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 +24 V.
Enable FRG/RUN at least 0.5s after the RFE signal.
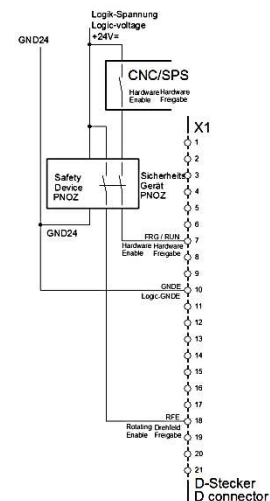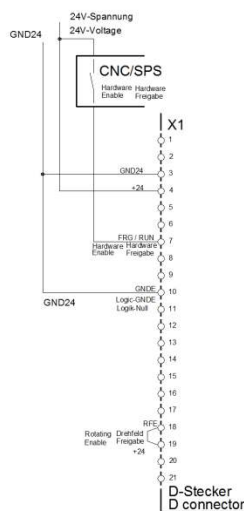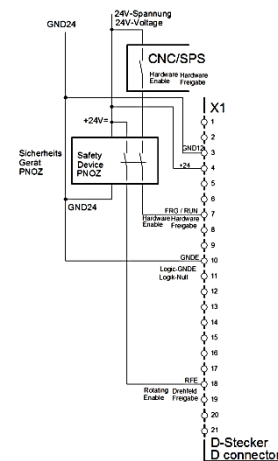
3.10 Digital logic outputs (open emitter)

The logic outputs 1 to 3 are rated for 24V and 1A (short-time: 2A)
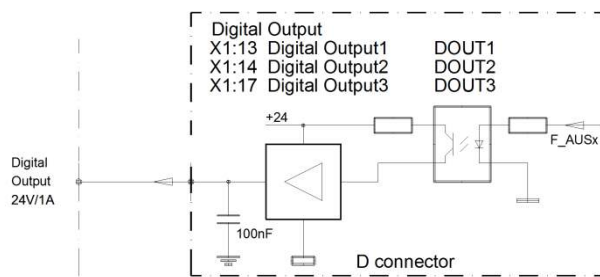
Output voltage		
Level ON	max.	+24 V=
Level OFF		<1 V=
Output current	nom.	1 A
Output current	max	2 A
Voltage reference	+24	(X1:4)
Ground reference	GNDE	(X1:10)

It is possible to program an energy saving program (clocked output).
The logic output 4 (24V, 3A) at the power section is only available with certain devices.

Signal contact "Ready BTB/RDY" (Solid state relay)
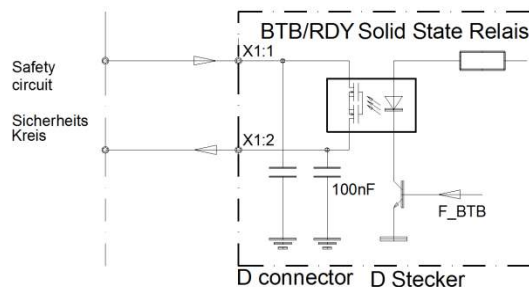
Contact for	max. 48 V/0.2 A
Capacitive load	max 1 myF
Contact resistor	max 2 Ohm

The contact is closed when the device is ready for operation.
State signal via seven-segment LED display.
In case of failures the contact is open.

BTB opens (red LED, open relay contact)
in case of error messages
in case of under-voltage of the auxiliary voltage (<20 V)
The message "under-voltage in the bus circuit" can be programmed (see Manual NDrive)

Output	Connector	Function	State	Parameter
BTB/RDY	X1:1, X1:2	ready	fixed/relay	
DOUT1	X1:13	Digital output 1	Programmable	
DOUT2	X1:14	Digital output 2	Programmable	
DOUT3	X1:17	Digital output 3	Programmable	
DOUT4	Xx:Xx	Digital output 4	Programmable	
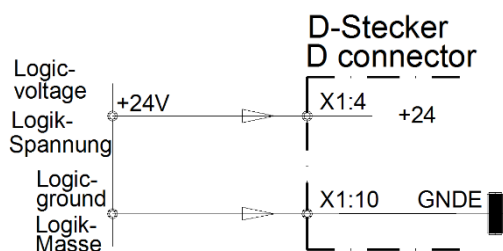
+24 V for the logic and the auxiliary voltage summation of all outputs observed

GNDE logic ground

3.11 Analog input +/- 10V
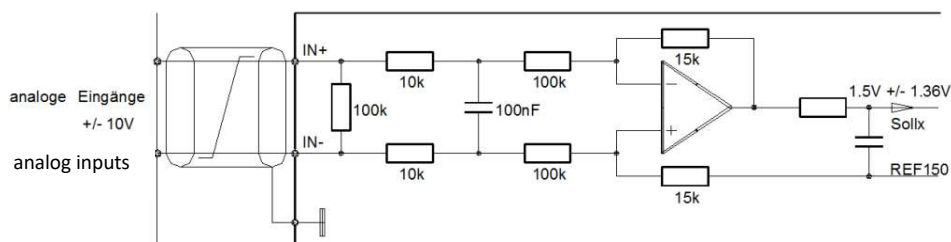
Input	Output	Basic function	Voltage	State	Parameter
AIN1+, AIN1-	X1:8, X1:9	Speed command value	+/- 10V	programmable	
AIN2+, AIN2-	X1:15, X1:16	Current limit	+/- 10V	programmable	

Features

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

The analog inputs can be assigned to different functions.

With a digital command value (RS232, x-bus)
  - the analog input AIN1can be programmed as external analog speed limit
  - and the analog input AIN2 can be programmed as external analog current limit.

3.12 Analog output +/- 10V

Input	Output	Basic function	Voltage	State	Parameter
AOUT1	X2:20	Speed command value	+/-10V	programmable	
GND	X2:21	Signal zero	0 V	fixed	

3.13 Serial interface RS 232

BAMOBIL-D3 is programmed and operated during commissioning via the serial pc interface RS232.
There is a software description in the Manual DS NDrive.
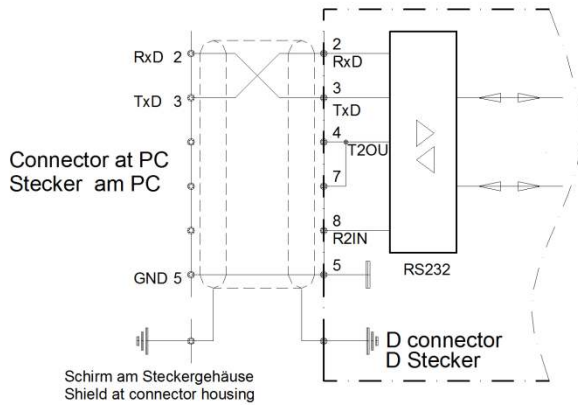
The serial interface is galvanically connected with the device zero (GND/AGND).

The BAMOBIL-D3 (D connector 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.
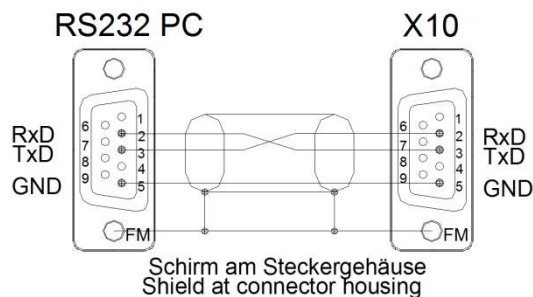
FM = Buchse/Socket

In case of strong interferences at the interface a line filter should be installed.
Notebooks with a USB-RS232 converter are usually susceptible to interference.
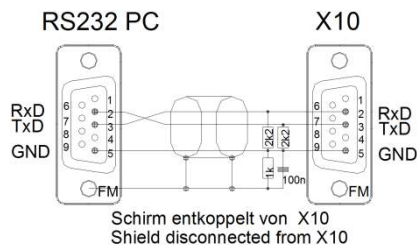
3.14 CAN-BUS

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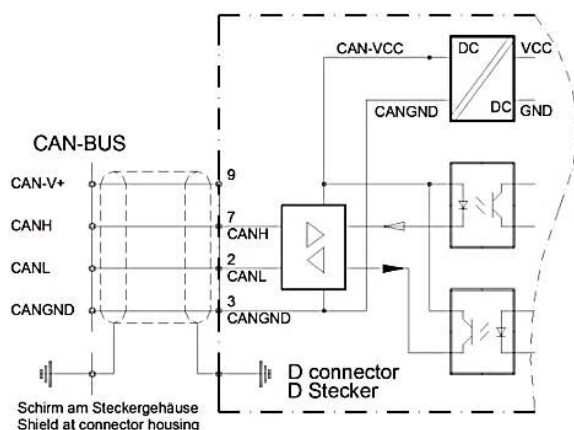
The BUS interface is galvanically isolated from the internal device voltage.

The voltage is supplied via an internal, isolated DC-DC converter or over the BUS-Cable.
Can-V +9 to 15 V=

CAN-BUS isolated/ CAN Gnd to common potential

CAN bus cable

Use a shielded bus conductor with a lo shielding capacity.
Signal plus GND (+supply).
D-connector with a metal or metallized housing.
LiYCY 4x0.25+shield.

Desgination	Connector no.	Cable colour
CAN-V+	9	brown
CAN-GND	3	white
CAN-H	7	green
CAN-L	2	yellow

(Note: colors can be different)
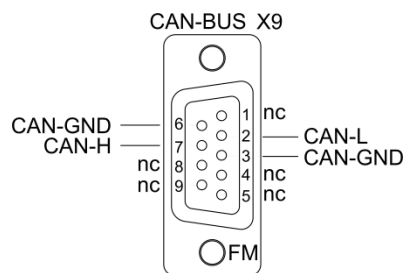
CAN-BUS connection with several BAMOBIL-D3

Master   Address xx   Address xx   Address xx
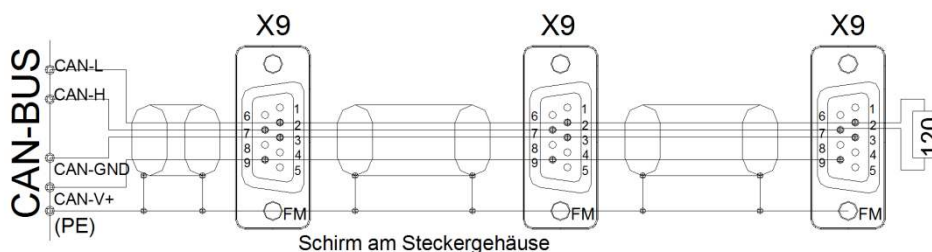
Shield to the connector

Terminating resistor at the end of the bus line > 120hm between the CAN-H and CAN-L.

3.15 Resolveranschluss

only for BAMOBIL-D3-RS
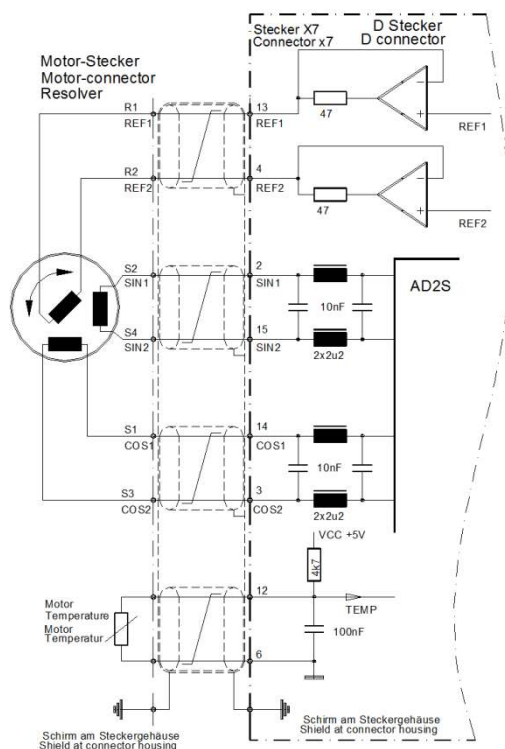
The resolver is an absolute measuring system for a motor revolution.
It is robust and not impaired by high motor temperatures.
Its build corresponds to a revolving transformer. The rotor is supplied by the reference (10kHz). The stator supplies the sine and cosine signals modulated by the rotational 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 50000 (10bit).
The digitalized signals are used for the polar wheel angle, the position and speed control, and the incremental output.
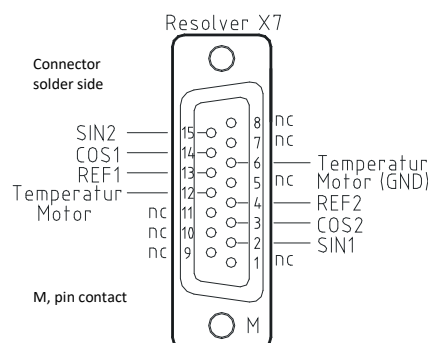
Use only motors with a 2-, 4-, 6-, or 8-pole resolver which have been approved by the manufacturer. Observe the motor specific connection data sheet (RS)!

Connector	X7	15-pole D-connector
Connecting cable	4 x 2 cores, twisted in pairs and shielded, additional overall shield. For link chains usw appropriate cabeles!	
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 tot he connector housing
Setting parameters	see software Manual NDrive	

3.16 Encoder TTL Anschluss

Only for BAMOBIL D3-xx-IN
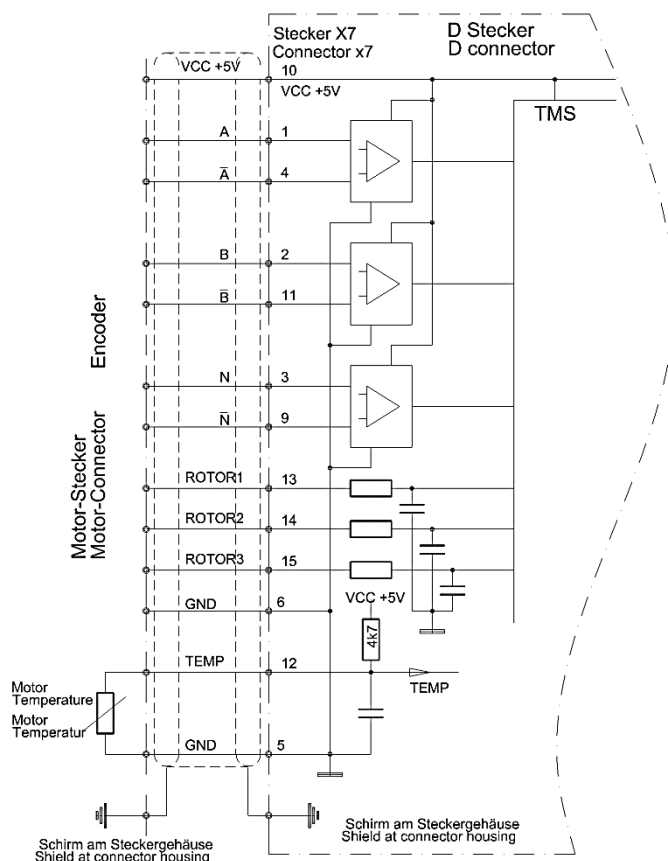
TTL incremental encoder (encoder) with 2 counter tracks and 1 zero track plus 2 rotor position tracks. Counter tracks with or without push-pull output.
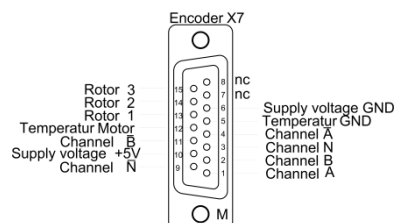
(For single connection A, B, N do not connect the negative inputs.)

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

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

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

Use only motors with TTL incremental encoders and rotor position tracks which have been approved by the manufacturer. Observe the motor specific connection data sheet (IN)!

|		
Connector	X7	15-pole D-connector
Connecting cable	10 shielded signal conductors,	min. cross-section 0.14 mm
	2 supply lines	min. cross-section 0.5 mm
	For link chains use appropriate cables!	
Cable length	for >25m 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 parameter	see software Manual NDrive	

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

Motorside | Device side | INC encoder adapter

Rotor sequence
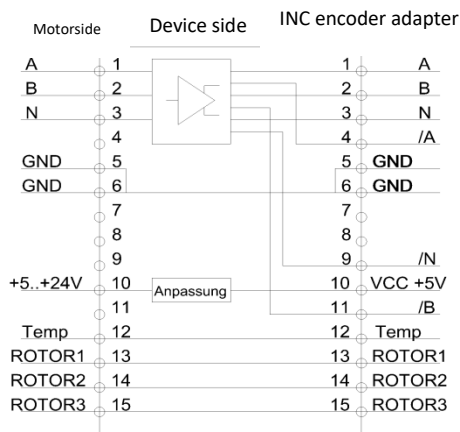
The device input for the incremental counter signals requires the push-pull counter pulses for a reliable identifiation.
Encoders without push-pull signals (e.g. position encoders) and with different supply voltages are used for many simply applications.
For these applications the INC adapter must be installed.
The adapter converts the counter signals A, B, N into the push-pull signals A, / A, B,/ B, N, / N.
Supply voltages other than 5V must be specified in the order and they must be connected externally.

Verification that the connection is correct
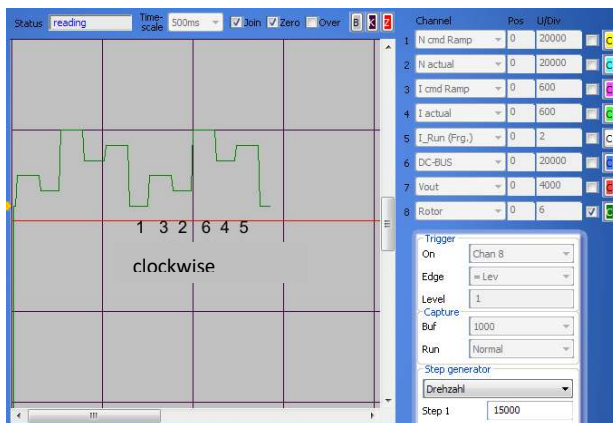
The correct sequence of the rotor signals for a clockwise motor is 1,3,2,6,4,5.

In the event of a different sequence of numbers the encoder connection of the rotor position signals Rotor 1, Rotor 2, Rotor 3
(U, V, W) is incorrect.

Follow the wiring diagram!

Numerical value
Turn the motor without one turn clockwise.

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.
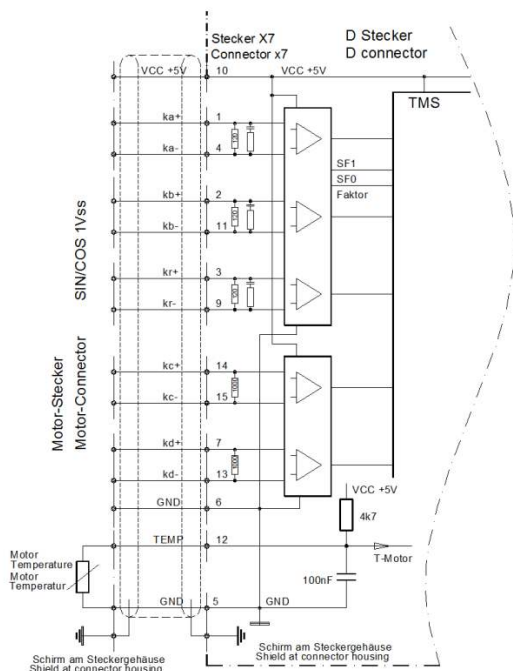

Zero angle
Motor turning clockwise and anti-clockwise at 10%-100% speed.
The value of zero-capture must remain constant.

### 3.17 SIN COS 1Vss connection

Only for BAMOBIL-D3-xx-SC

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

Max. counting frequency 500kHz.

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

The resolution is automatically set to an optimum.
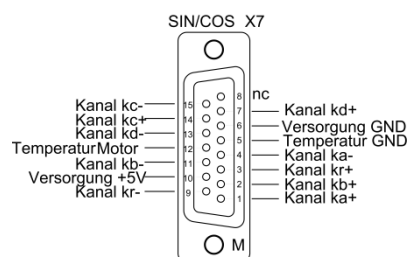
M,pin contact / connector solder side

Use only motors with SIN/COS encoders (SC) with have been approved by the manufacturer.
Oberserve the motor specific connection data sheet (SC)!

|		
Connector	X7 15pole D-connector	
Connecting cable	4x signal conductors, twisted and shielded	min.cross-section 0,14 mm
	2x signal conductors, shielded	min. cross-section 0,14 mm
	4x supply lines, temp.,	min. cross-section 0,5 mm
Cable type	(4x(2x0,14)+(4x0,14)C+4x0,5)C	
	for links chains use appropriate cables!	
Cable length	for >25m the cross-section of the cable used must be increased by one grade	
Shiled connection	across connector X7	Schirm mit dem Steckergehäuse kontaktieren.
	across the motor connector	Schirm mit dem Steckergehäuse kontaktieren.
Seeting parameter	see software Manual NDrive	

3.18 Rotor position encoder – connection via a bl-tacho

Only for BAMOBIL-D3-xx-bl
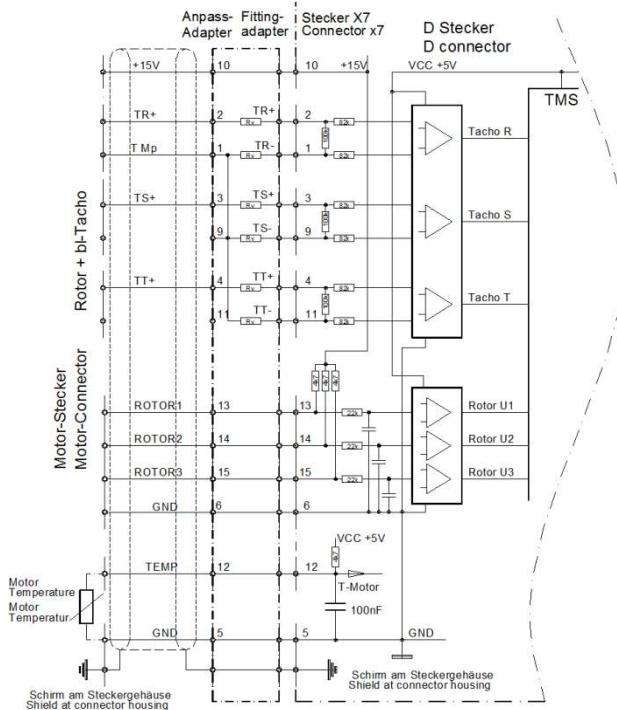
3 rotor position encoder signals (Hall sensors) for the commutation; with or without a brushless tacho.
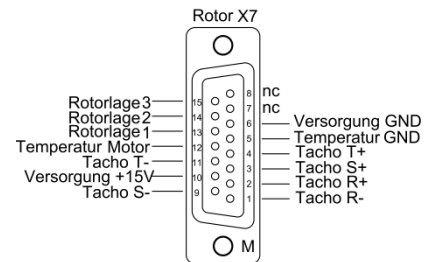
The rotor position encoder is galvanically connected with the device zero (GND).
The voltage of 15V is supplied by the servo-drive.

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 side / solder side

Use only motors with rotor position encoders (bl) which have been approved by the manufacturer.
Observe the motor specific connection data sheet (bl)!

Connector	X7 15-pole D-connector	
Connecting cable	12 x signal conductors, supply lines, temp.	min. cross-section 0,25 mm
Cable type	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 the connector X7	connect the shield to the connector housing
	acorss the motor connector	connect the shield to the connector housing
Setting parameter	see software Manual NDrive	

3.19 X8 TTL-Encoder output or input(2)

The D-connector X8 is connected as input or output (default).

Output   X8 pin 6 not connected or bridged with GND
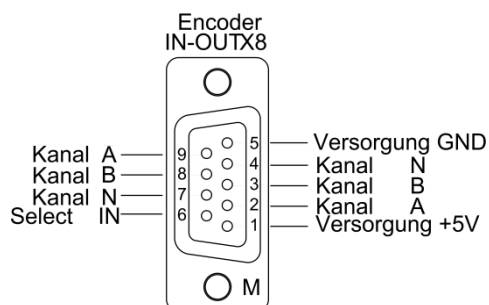Input   X8 pin 6 bridged with +5V (X8:1)
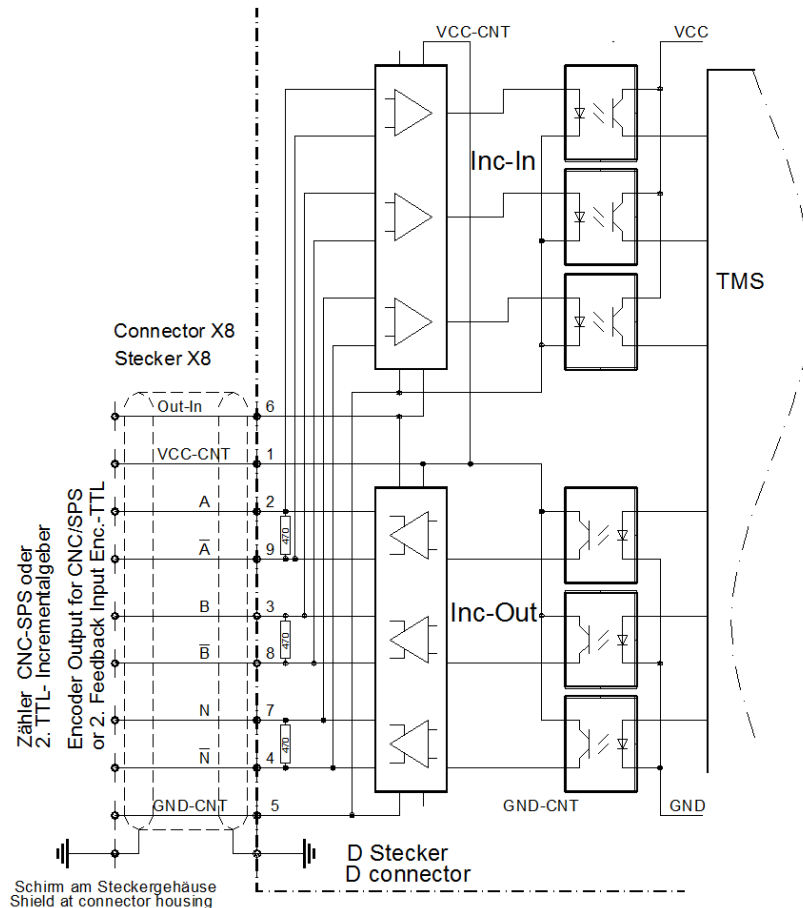
9-pole D-connector (M, pins)

connector assignment

Note:
X8 as input

Connect X8:6 (select IN) with X8:1 (+5 V) in the D-connector

3.20 X8 as TTL encoder output / input

Output

The encoder signals supplied by the motor (feedback) are available at the output of the D-connector X8 TTL encoder signals for the CNC control.

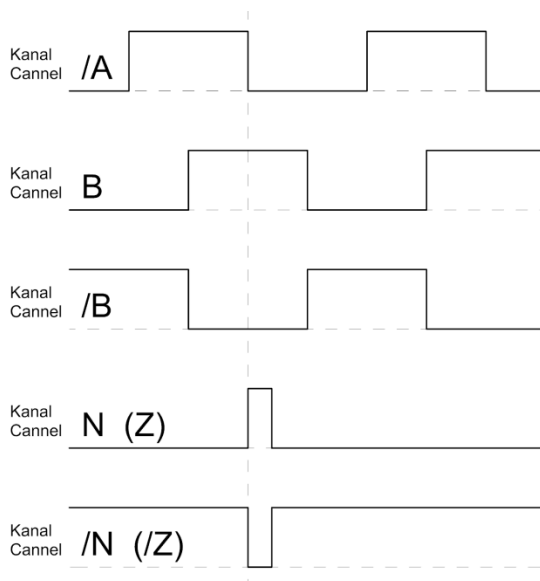The encoder output is internally isolated.
The voltage is supplied via the encoder line from the CNC/PLC control.
Voltage supply +5V ±0.2V.
The output signal corresponds to RS485.

Option: Internal supply from the servo-drive (LBR1 + LBR2)

For RS and SC the resolution can be programmed. (Parameter 0 x a4, Bit1), for IN it corresponds to the encoder no. of pulses.

Pulse signals   (motor revolving clockwise)

Output level	low	< 0.5 V
	high	>4.5 V
Slope	< 0,1 µs	
Zero pulse	min.	0.2 µs
Output frequency	max.	200 kHz
Pulse/rpm for RS, SC	programmable	
for IN	encoder no. of pulses	

Input

Note: X8 pin 6 (select IN) must be bridged with X8 pin 1 (+5V)!

The encoder input is internally isolated.
The voltage is supplied via the encoder line.
Option: Internal supply from the servo-drive.
The input signal correspond to RS485.
Input frequency max. 200 kHz.

Option: Internal supply from the servo-drive (LBR1 + LBR2)

The encoder input can be programmed for different functions; see software Manual DS-NDrive.

3.21 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 servo-drive state

Display	Point/segment	State		State of NDrive
	flashing	Processor active		
	dark	Auxiliary voltage missing or inherent hardware failure		
	flashing	Starting state after reset (auxil. voltage 24V off-on). The first enable stops the flashing display.		OK = 0
	bright	Drive enable		OK = 1, ENA = 1
	dark	Drive disabled (not enabled)		OK = 1, ENA = 0
	bright	Speed zero (standstill signal)		N0 = 1
	bright	Drive revolves clockwise, N currently positive		N0 = 0
	bright	Drive revolves anti-clockwise, N currently negative		N0 = 0
	flashing	Motor current reduced to continuous current Icns		Icns = 1
	bright	Motor current at max. current limit I_{max}		Icns = 0
	dark	Normal operation; Motor current within the current limits		Icns = 0
	bright for 0.1 s	left segment	A new command (value) was received from the BUS or RS232	
		right segment	Digital input changed	

Example: Motor revolving clockwise
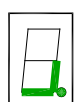
Point flashes	= active processor
Bottom segment	= drive enabled
Right segment	= motor revolves clockwise

3.22 Error display

The red LED "fault" is bright and the fault number is indicated by the green seven-segment display.

List of errors

Display Controller	Error display NDrive	Description
0	BADPARAS	**Defective parameter**
1	POWER FAULT	Output stage fault
2	RFE FAULT	Faulty safety circuit (only active for RUN)
3	BUS TIMEOUT	Transmission fault BUS
4	FEEDBACK	Encoder signal faulty
5	POWERVOLTAGE	No power supply voltage
6	MOTORTEMP	Motor temperature too high
7	DEVICETEMP	Device temperature too high
8	OVERVOLTAGE	Overvoltage >1.8 x UN
9	I_PEAK	Over-current 300%
A	RACEAWAY	Racing (no command value, incorrect polarity)
B	USER	User – error selection
C	12R	Overload
D	RESERVE	
E	ADC-INT	current measuring fault
F (device dependent)	BALLAST	Ballast curcuit overload
Flashing decimal point		Active processor
Dark decimal point		No auxiliary voltage or unit-internal hardware fault

LED displays on the servo

In case of an error the red LED 'fault' lights up and the error no. is indicated.
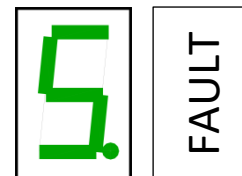The BTB (ready) contact is opened.
The software ‚BTB message' switches from 1 to 0.
The state message ‚RDY' extinguishes.

When the enable is switched off, the error message is still displayed.

The error message deleted:
When the enable is switched on, the function 'cancel errors' is activated via a digital input or a CAN BUS.

Note:

When applying the 24V auxiliary voltage with the enable closed (FRG/RUN X1:7 aktiv) the red LED signals an error. There is no fault signal displayed in the 7-segment display.

3.23 Warnings

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 Controller	Warning signals NDrive	Description	ID-Address
			0x8f
0	WARNING_0	Inconsistent device identification	Bit 16
1	ILLEGAL STATUR	Faulty RUN signal, EMI	Bit 17
2			Bit 18
3			Bit 19
4			Bit 20
5	POWERVOLTAGE	Power voltage too small or missing	Bit 21
6	MOTORTEMP	Motor temperature > 87%	Bit 22
7	DEVICETEMP	Device temperature > 87%	Bit 23
8	OVERVOLTAGE	Overvoltage >1.5 x UN	Bit 24
9	I_PEAK	Over-current 200%	Bit 25
A			Bit 26
B			Bit 27
C	I2R	Overload > 87%	Bit 28
D			Bit 29
E			Bit 30
F	BALLAST (device dependent)	Ballast circuit overload > 87%	Bit 31

LED displays on the servo

In case of a warning state the red LED changes (low-frequency) and the seven-segment display shows alternately the warning no. (red LED) and the operating state (LED dark).
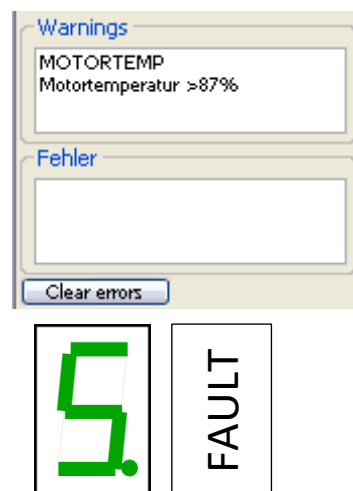
3.24 Measured data

from firmware 378
Bus circuit voltage (48 V)

BAMOBIL D3-62	Bus circuit votlage	Parameter 0xeb	DC-BUS - %
Max. voltage	62 V	24775	150
Battery voltage	48 V	19180	116
Overvoltage switch-off	70 V	28771	170
Charging voltage	56 V	22377	136
Without charging voltage	0 V	0	0
Scaling	1	399,59	2,42
DC bus	82 V	32767	200

Parameter 0xeb = 399,59 x Bus circuit voltage

Current actual value

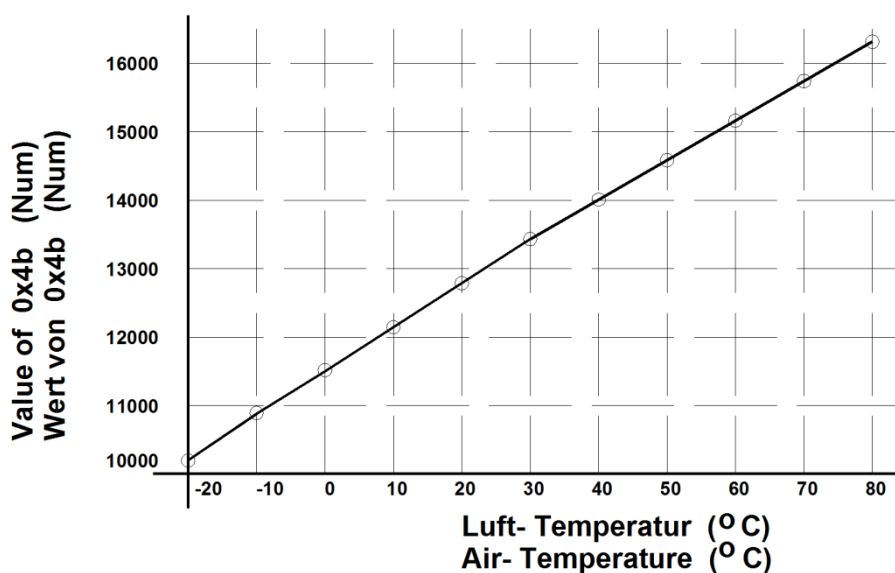| BAMOBIL-D3	I 100 %	Calibration rated current I-device			Peak current DC blocked	
Max. value +/- 11Bit	mV	Num	Aeff	A=	Num	A=
x-80	560	450	40	56	650	80
x-100	700	560	50	60	800	100
x-120	840	670	60	84	970	120
x-250	874	700	125	175	1010	250
x-350	610	490	175	245	710	350
x-450	785	630	225	315	910	450

In the set of parameters the basic set-up is protected.

3.25 Endstufen-Temperatur

IGBT module temperature	Analo voltage X4 Pin6	Parameter 0x4a
Maximal +80	2,60	16820 (FW>400)
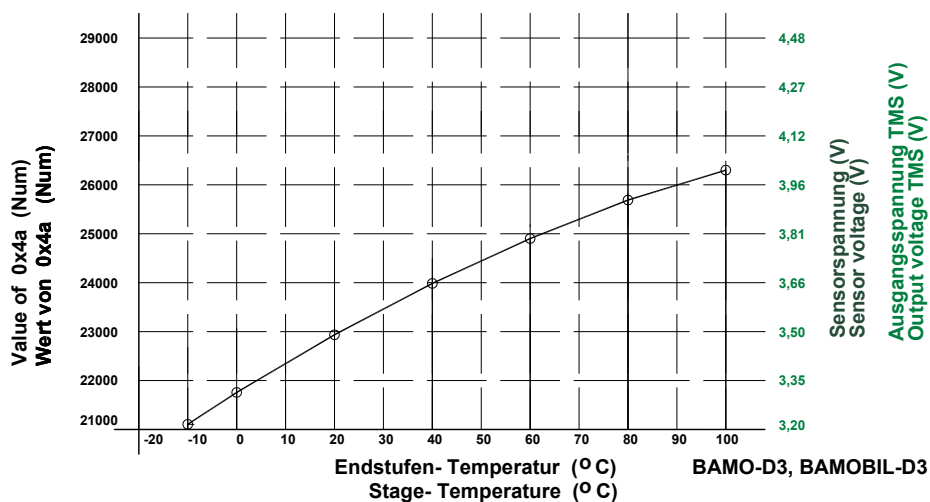
Bamobil-Bamo-Temperatur-IGBT-3

Luft-Temp-1