# M A N U A L

## Digital battery - motor controller
## BAMOBIL-D3-I

for EC servo motor / HV-isolation


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**Ausgabe / Version**

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## Contents

# 1 Basic informationen

## 1.1 Further Unitek products

| | | | |
|---|---|---|---|
| Digitale servo-amplifiers for small power value | >>> | UniTek | DS205, DS403 |
| Analog three-phase servo-amplifiers<br>TVD3, TVD6, AS | >>> | UniTek | Series |
| Analog dc servo-amplifiers<br>TV3, TV6, TVQ-6 | >>> | UniTek | Series |
| Thyristor current converters<br>1Q, 4Q, Servo | >>> | UniTek | Series Classic<br>200 W bis 800 kW |
| Analog und digital | | | Series BAMOBIL<br>Series BAMOCAR |

## 1.2 Engineering instructions (MANUAL)

| | | | |
|---|---|---|---|
| 1. | MANUAL | BAMOBIL – D3-I | Hardware |
| 2. | MANUAL | NDrive2 | Software |

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

Online available as download: 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

| | |
|---|---|
| Device | BAMOBIL D3-I |
| User | Manufacturers or operators of vehicles, machines, or installations in the industrial sector (B2B, secondary enviroment) |
| Manufacturer | UniTek Industrie Elektronik GmbH |
| Dealer | |
|  | **Caution – Danger to life!<br>High voltage** |
|  | **Warning!<br>Important** |
|  | **Dangerous electric field** |

## 1.4 Delivery scope

Device BAMOBIL D3-I

**Not included in the delivery scope:**
Accessory equipment, connectors, and cable screw glands

35-pole connector type: Tyco 776164-1
14-pole connector type: Tyco 776273-1
Cable screw gland  M25x1.5

## 1.5 General information

The digital 3-phase current servo amplifiers **BAMOBIL** as component (BDM) 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-I** 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.

## 1.6 Applications

Application in all kinds of vehicles, machines, and installations for all types of industrial use with a drive power of 18 kW, 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

To be used 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.
Synchro-servo-drives are more compact than other electric 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 industrial applications.

**EC/AC motor features**
- protection rating IP65
- compact
- suitable for rough surroundings
- suitable for high dynamic overload
- free of maintenance

**Note:**
Brushless drives are used where braking operations are predominant,
e.g. with winding machines, lifts, great centrifugal masses

The braking energy is fed to the battery.
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: Pay particular attention when used with laboratory power supplies.**

**For non-earthed systems (vehicles, IT networks)**
the isolation between parts accessible to touching and high voltages must be guaranteed and monitored by using independent isolation monitors.

## 1.7 Build

- Compact devices according to the VDE, DIN and EU regulations
- Splash-proof housing IP20
- Standard digital control electronics
- Power electronics for 100 A to 450 A
- Independent 12 V= to 24 V= chopper power supply unit for the auxiliary voltages
- Nominal power input range of 12 to 120 V=
- Additional cooling unit for air or water cooling

**Galvanic isolation**
- between the housing and all electric parts
- between the auxiliary voltage connection and the power section and the control electronics
- between the power section and the control electronics
- between the control electronics and the logic inputs/logic outputs

The distance of air gaps and leakage paths adhere to the EU 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

**Characteristics**

HV isolation

- Battery-powered or dc connection 12 V= to 120 V=
- Independent auxiliary voltage connection 12 V= to 24 V=
- Digital interfaces RS232, CAN BUS (further option)
- 2 analogue inputs, programmable differential inputs
- 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
- STO / Safe Tork Off
- Position, speed and torque control
- Resolver or incremental encoder TTL, SINCOS 1 Vss, rotor position + bl tacho
- Static and dynamic current limiting
- Uniform, completely digital control unit
- Protective switch-off from the motor in case of over-voltage, under-voltage, or over-temperature
- Intrinsically safe and short-circuit proof power section
- Processor-independent hardware switch-off in case of short-circuits, circuits to earth, over-voltage and over-temperature at the output stage

### 1.8 Safety information

**In principle electronic equipment is not fault proof!**

## Caution - High voltage

# DC 200 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 x series are power electric parts used for regulating energy flow.
They are designed as components to control EC synchronous motors, ac asynchronous motors, or dc motors in vehicles, 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.

**Note:** Energy feedback during braking operation.
Pay particular attention when used with laboratory power supplies or dc power supplies.

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

**<u>The user must ensure that in the event of:</u>**

- 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.
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 device must be closed and 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 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 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

## 1.9 Commissioning

The battery servo amplifiers BAMOBIL D3-I 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 industrial, commercial applications.

When mounting the units into vehicles, 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/E 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.

## 1.10 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 occuring 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.

## 1.11 Intended applications

The devices are designed as components to control EC synchronous motors, ac asynchronous motors, or dc motors in vehicles, machines, or installations.
Any other type of application must be approved by the manufacturer.
Protection rating IP20.

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 allowed to be connected to batteries with a battery-side limitation of the charging current.
For voltages >60 V an isolation monitoring unit must be installed.

For voltages >60 V a protection against accidental contact must be installed.

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).

**Impermissible applications**
- in life-sustaining medical devices or machines
- connection to dc power supplies without over-voltage protection circuits
- in explosive environments
- in environments with acrid fumes

## 1.12 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:

| | |
|---|---|
| EU Guidelines | 2004/108/EG, 2006/95/EG, 2006/42/EG, 2002/96/EG |
| EU Standards | EN 60204-1, EN292, EN 50178, EN 60439-1, EN 61800-3, ECE-R100 |
| International standards | ISO 6469, ISO 26262, ISO 16750, ISO 20653, ISO 12100 |
| IEC/UL Regulations | IEC 61508, IEC 364, IEC 664, UL 508C, UL 840 |
| 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 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 |

## 1.13 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.

## 1.14 Technical data

**For battery voltages up to 48 V=**

| | | | | | | |
|---|---|---|---|---|---|---|
| Power supply connection | 12 V= to 48 V=<br>Please indicate battery voltage on order | | | | | |
| Auxiliary voltage connection | 12 V= to 24 V ± 10 % / 2A | | | Residual ripple < 10 %<br>Regenerating fuse | | |
| | | | | | | |
| **Data<br>BAMOBIL D3-I-62-** | **Dimension** | | **120** | **250** | **450** | |
| Supply voltage | V= | 12 bis 48 | | | | |
| Max. output voltage | V~eff | 3 x 7 bis 3 x 33 | | | | |
| Continuous current | $A_{eff}$ | | 60 | 125 | 225 | |
| Max. peak current | $A_{lo}$ | | 120 | 250 | 450 | |
| Max. power loss | W | | 300 | 600 | 1200 | |
| Pluse frequency | kHz | programmable 4-16 | | | | |
| Over-voltage switching threshold | V= | programmable up to max. 72 V | | | | |
| Input fuse | A | | 160 | 250 | 350 | |
| Bus circuit capacity | µF | 28200 | | | | |
| Weight | kg | | 2,8 | 2,8 | 4,2 | |
| Dimensions h/w/d | mm | 244 x 194 x 90 | | | | |

**For battery voltages up to 120V=**

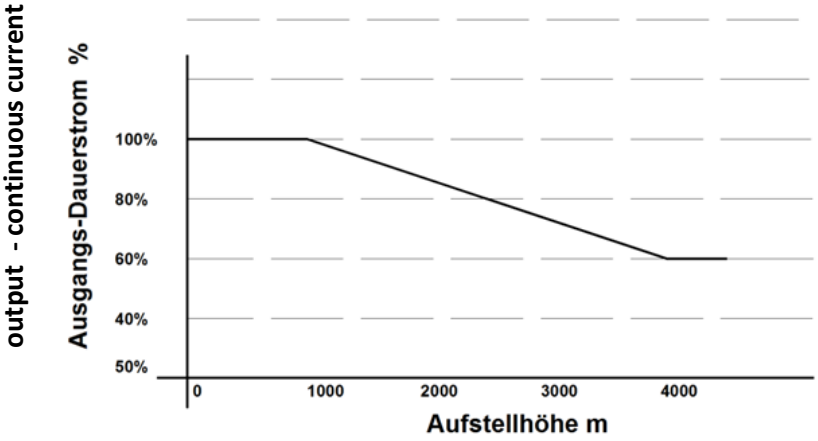
| | | | | | | |
|---|---|---|---|---|---|---|
| Power supply connection | 12 V= to 120 V=<br>Please indicate battery voltage on order | | | | | |
| Auxiliary voltage connection | 12 V= to 24 V ± 10 % / 2A | | | Residual ripple <10 %<br>Regenerating fuse | | |
| | | | | | | |
| **Data<br>BAMOBIL D3-I-160-** | **Dim** | | **100** | **200** | **300** | |
| Supply voltage | V= | 12 bis 120 | | | | |
| Max. Output voltage | V~eff | 3 x 7 bis 3 x 78 | | | | |
| Continuous current | $A_{eff}$ | | 50 | 100 | 150 | |
| Max. peak current | $A_{lo}$ | | 100 | 200 | 300 | |
| Max. power loss | W | | 300 | 600 | 1200 | |
| Pulse frequency | kHz | progammable 4-16 | | | | |
| Over-voltage switching threshold | V= | progammable up to max. 160 V | | | | |
| Input fuse | A | | 160 | 250 | 350 | |
| Bus circuit capacity | µF | 9000 | | | | |
| Weight | kg | | 2,8 | 2,8 | 4,2 | |
| Dimensions h/w/d | mm | 244 x 194 x 90 | | | | |

| Control signals | | V | A | Function | Connector |
|---|---|---|---|---|---|
| Analogue inputs | | ±10 | 0.005 | Differential input | X1 |
| Digital inputs<br>STO | ON<br>OFF | 10 - 30<br>< 6 | 0.010<br>0 | Logic IO | X1 |
| Digital outputs | | + 24 | 1 | Transistor output<br>open emitter | X1 |
| Analog output | | ± 10 | | Operational amplifier | X1 |
| | | | | | |
| Resolver, TTL, SINCOS | | | | Differential input | X7 |
| | | | | | |
| CAN interface | | | | logic IO | X9 |
| RS232 interface | | | | logic IO | X10 |

| Ambiant conditions | |
|---|---|
| Protection rating | IP20 |
| Standards | EN 60204, EN 61800, IEC 60146 |
| Operating temperature range | -30 to +65 °C |
| Extended operating temperature range | +65 °C to +80 °C performance reduced by 2 %/ °C |
| Storage and transport | -30 °C to +80 °C EN60721 |
| Site of installation | ≤ 1000 m above sea level 100 %,<br>>1000 m performance reduced by 2 % / 100 m |
| Cooling | with additional cooling unit |
| Mounting position | arbitrary |
| Contamination | Contamination degree 2 acc. to EN 61800-5-1 |
| Oscillation | 10 Hz to 58 Hz amplitude 0.075 mm (IEC 60068-2-3)<br>58 Hz to 200 Hz 1 g |
| Shock | 15 g for 11 ms |
| Environmental conditions | **Not permissible:**<br>oil mist, salt spray, water |
| Humidity range | Class F, humidity < 85 %<br>**no condensation inside allowed!** |

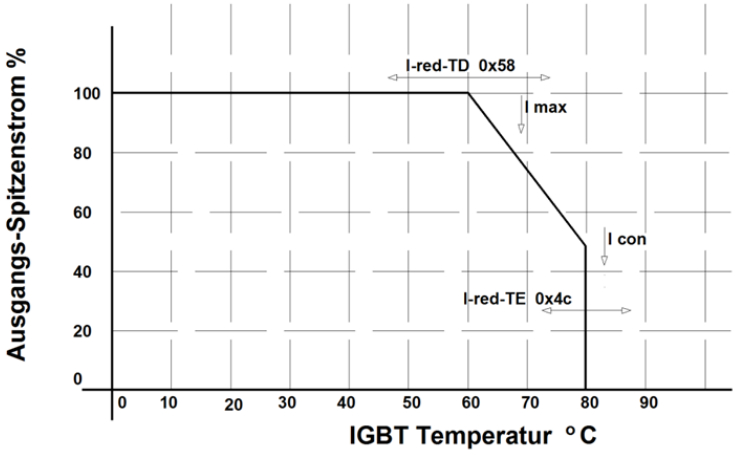
Power supply cables between the BAMOBIL and the battery must be as short as possible.
Long cables cause dynamic voltage drops due to the line impedance and as a consequence the service life of the installed ELKOs would be reduced.

**Reduction of current and power**



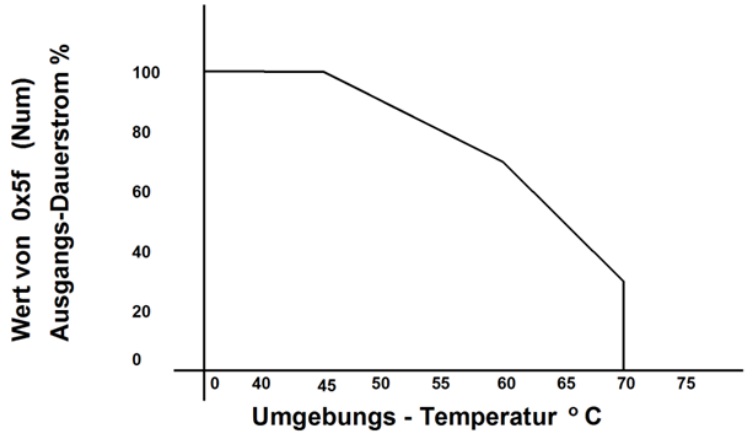

Current reduction
as a function of
the installation site

Installation site m




Current reduction
as a function of
the ambient temperature

IGBT temperature °C




Current reduction
as a function oft he
output stage temperatur

IGBT temperature °C

**Losses with version -62** (power supply 12 to 48 V)
Losses of the output stage

$I_{rms}$ = RMS value of the current demand at max. load cycle
R-FET = Max. forward resistance at the FET bridge arm
Cooling capacity base plate 10mm with aluminium housing = 2.7 °C/Watt
internal threshold temperature 85 °C

**Power loss = 2*R-FET * $I_{rms}^2$**

| | |
|---|---|
| Example 1: Device BAMOBIL D3-**I**- 62-250<br>R-FET = 1.2 mΩ<br>**$I_{rms}$** approx. 60 A | Example 2: Device BAMOBIL D3-**I**- 62-250<br>R-FET = 1.2 mΩ<br>**$I_{rms}$** approx. 100 A |
| Power loss: 0.0024 *$60^2$ = 8.64 Watt<br>Heating: 2.7*8.64 = 23.3 °C<br>Final temperature at 35 °C ambient temperature = 58.3 °C<br>An additional cooling surface is **not** necessary. | Power loss: 0.0024 *$100^2$ = 24 Watt<br>Heating: 2.7*24 = 64.8 °C<br>Final temperature at 60 °C ambient temperature = 124.8 °C<br>An additional cooling surface is necessary.<br>Additional air or liquid cooling unit. |

**Losses with version -160** (power supply 12 to 120 V)
Losses of the output stage

$I_{rms}$ = RMS value of the current demand at max. load cycle
R-FET = Max. forward resistance at the FET bridge arm
Cooling capacity base plate 10mm with aluminium housing = 2.7 °C/Watt
internal threshold temperature 85 °C

**Power loss = 2*R-FET * $I_{rms}^2$**

| | |
|---|---|
| Example 1: Device BAMOBIL D3-**I**- 60-200<br>R-FET = 4 mΩ<br>**$I_{rms}$** approx. 50A (chosen) | Example 2: Device BAMOBIL D3-**I**-160-200<br>R-FET = 4 mΩ<br>**$I_{rms}$** approx. 80A (chosen) |
| Power loss: 0.004 *$50^2$ = 10 Watt<br>Heating: 2.7*10 = 27 °C<br>Final temperature at 35 °C ambient temperature = 62 °C<br>An additional cooling surface is **not** necessary. | Power loss: 0.004 *$80^2$ = 25.6 Watt<br>Heating: 2.7*25.6 = 69.12 °C<br>Final temperature at 60 °C ambient temperature = 129.6 °C<br>An additional cooling surface is necessary.<br>Additional air or liquid cooling unit. |

**Forward resistance FET arm**

| BAMOBIL | 62-80 | 62-120 | 62-250 | 62-450 | 160-100 | 160-200 | 160-300 |
|---|---|---|---|---|---|---|---|
| R-FET mΩ | 3.5 | 1.2 | 1.2 | 1.2 | 4 | 4 | 4 |

**Cooling capacity - additional cooling unit**

| Cooling unit type | Thermal resistance | Weight |
|---|---|---|
| Air cooler (natural convection) | 0.4 °/W | 2.0 kg |
| Air cooler (ventilator) | 0.07 °/W | 2.5 kg |
| Liquid cooler | 0.012 °/W (2l/min, 0.8psi) | 1.2 kg |

# 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. 100 mm). 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)

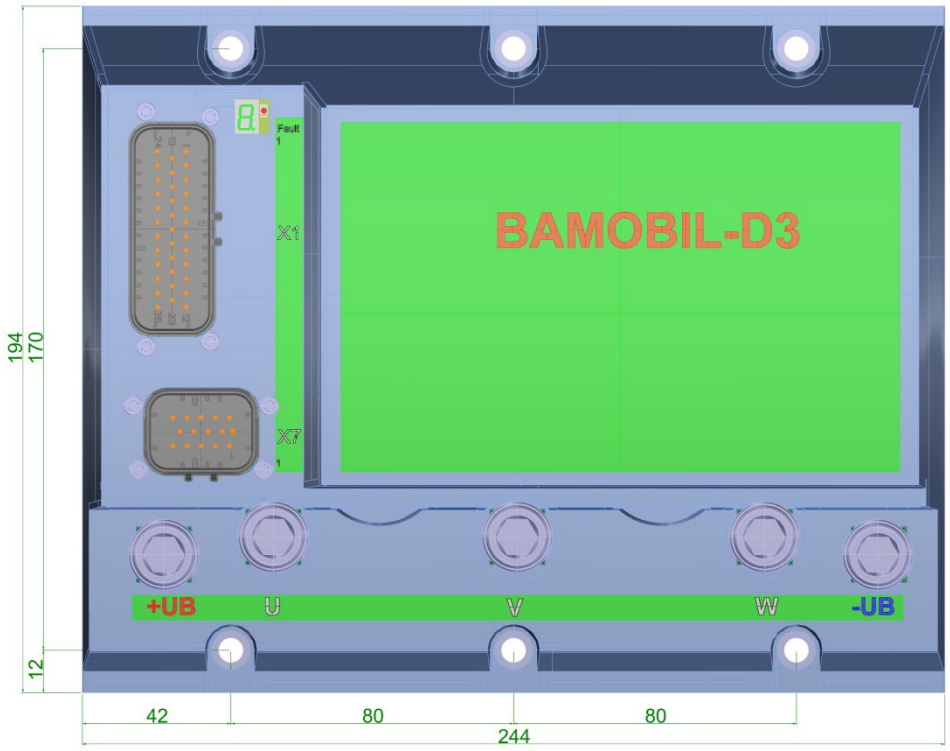
Unshielded cable heads must be kept short.

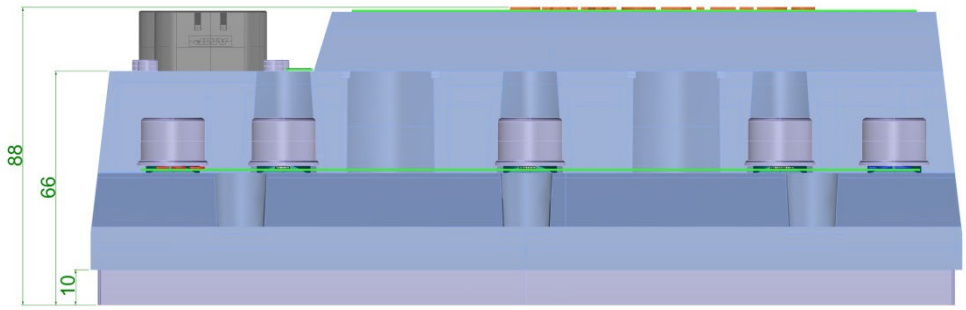
8mm cable lugs

Use vibration-proof screw connections.

For voltages > 60 V a protection against accidental contact must be installed.

## 2.2 Dimensions BAMOBIL-D3-I




Depth with connector and cable 150 mm
Cooling element at 300 A = 10 mm, >300 A = 20 mm
Thermal resistance 2,7 °/W
Fixing screw: BAMOBIL D3-I M5x20 (30)
Screws for power connections / Allen-Key M10x16 / Maximum tightening torque 15 Nm
If the mounting plate (without the additional cooling unit) is mounted onto the rear panel of the switch cabinet (4mm bright steel) and the ambient temperature is 45°C, the cooling capacity of the plate corresponds to:

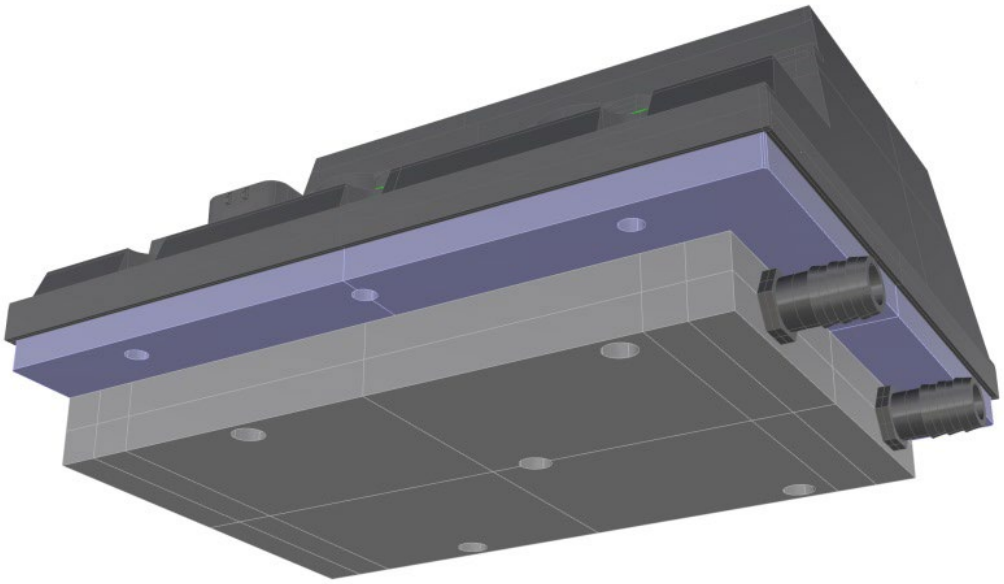
- a continuous current of 60 $A_{rms}$ (S1 duty) with BAMOBIL D3-63
- a continuous current of 45 $A_{rms}$ (S1 duty) with BAMOBIL D3-160

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

**Tyco connectors are not included in the delivery scope.**

## 2.3 Additional cooler / on request (minimum quantity)

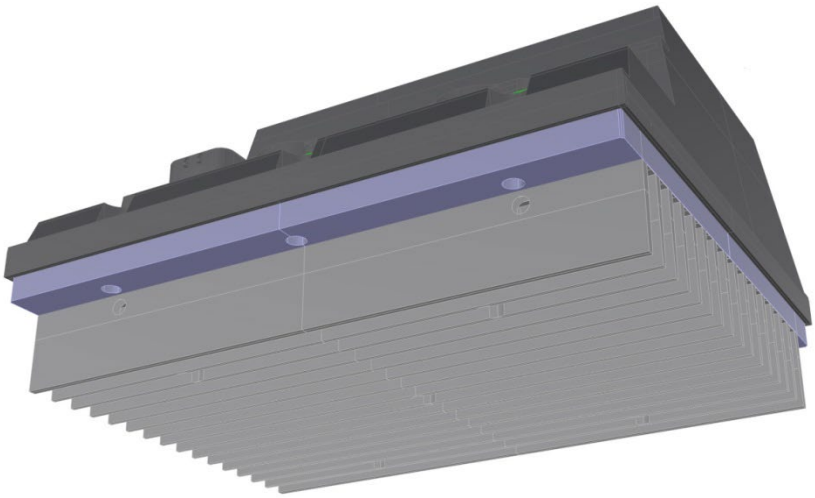
Liquid cooler



Bamobil-D3-I-wakü

| | |
|---|---|
| Thermal resistance | 0.012 $^{0}$K/W |
| Weight | 1.2 kg |
| Coolant connection | ¼ Zoll |

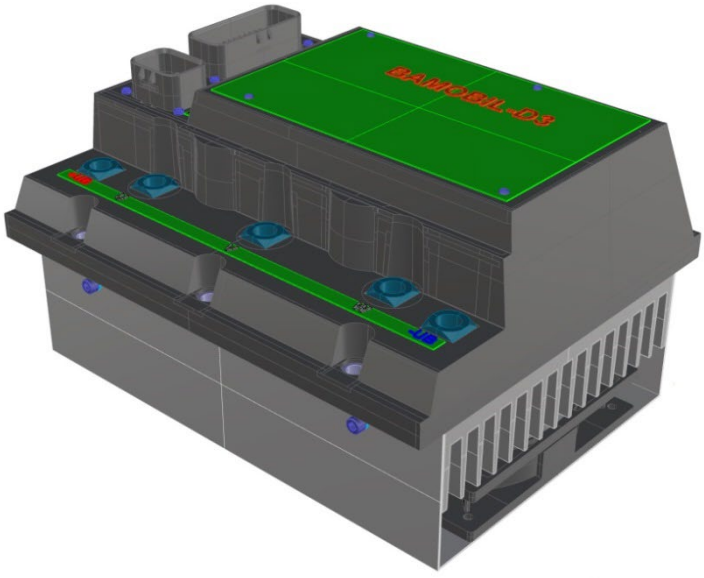
**Air cooler**



| | |
|---|---|
| Thermal resistance | 0,4 $^{0}$K/W |
| Weight | 2 kg |

Bamobil-D3-I-lukü

**Air cooler with fan**




| | |
|---|---|
| Thermal resistance | 0,07 $^{0}$K/W |
| Weight | 2,5 kg |
| Fan connection | 24 V DC |

Bamobil-D3-I-lukülu

# 3 Electrical installation

## 3.1 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!**

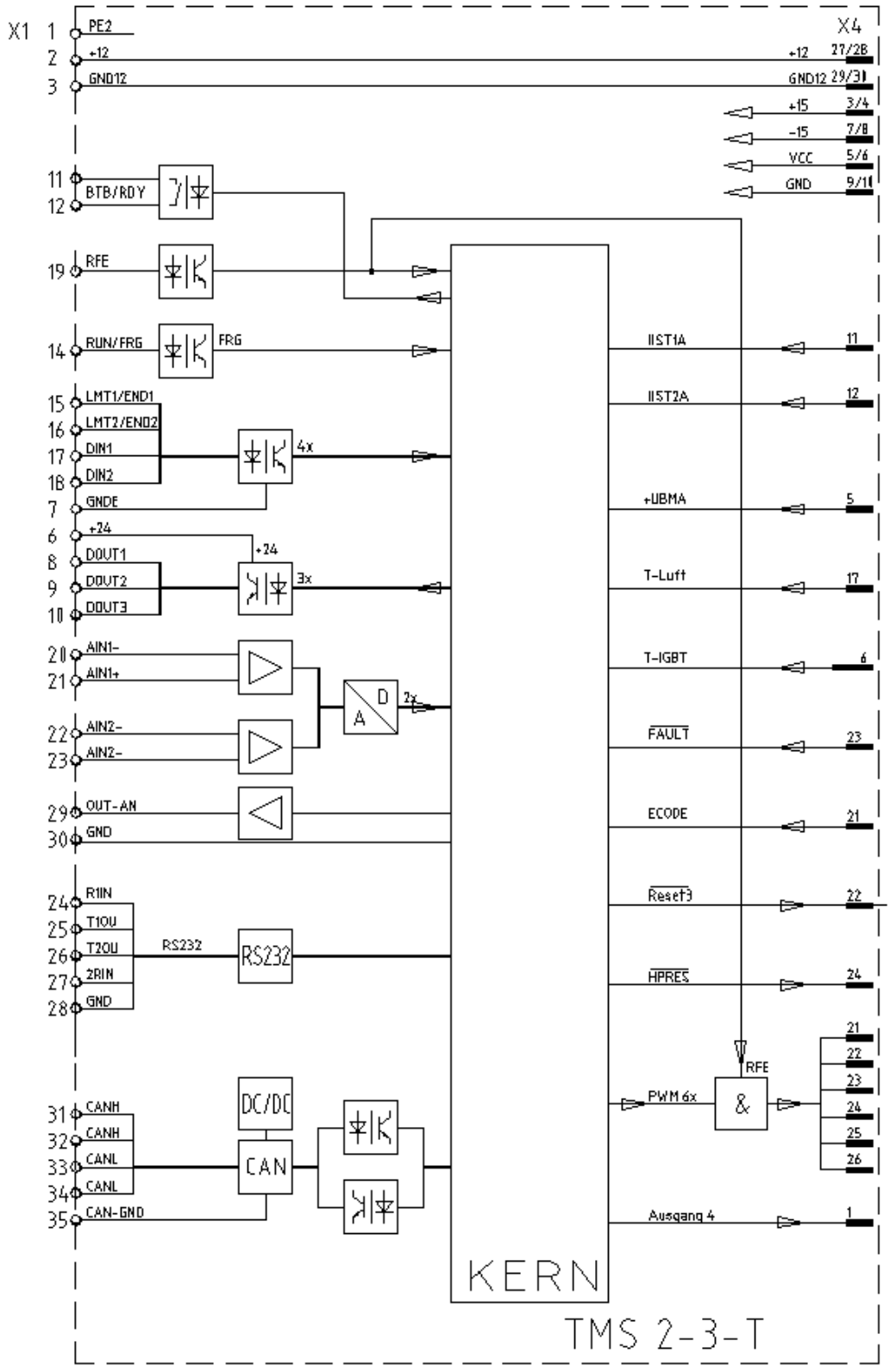
**Note:** Bad or insufficiently rated cable connections between the battery and the device may cause damage to the device! (Brake energy)

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:** Static charging voltage (ESD):
ESD voltages must not arise between the potentials and against earth. Take appropriate protective measures!

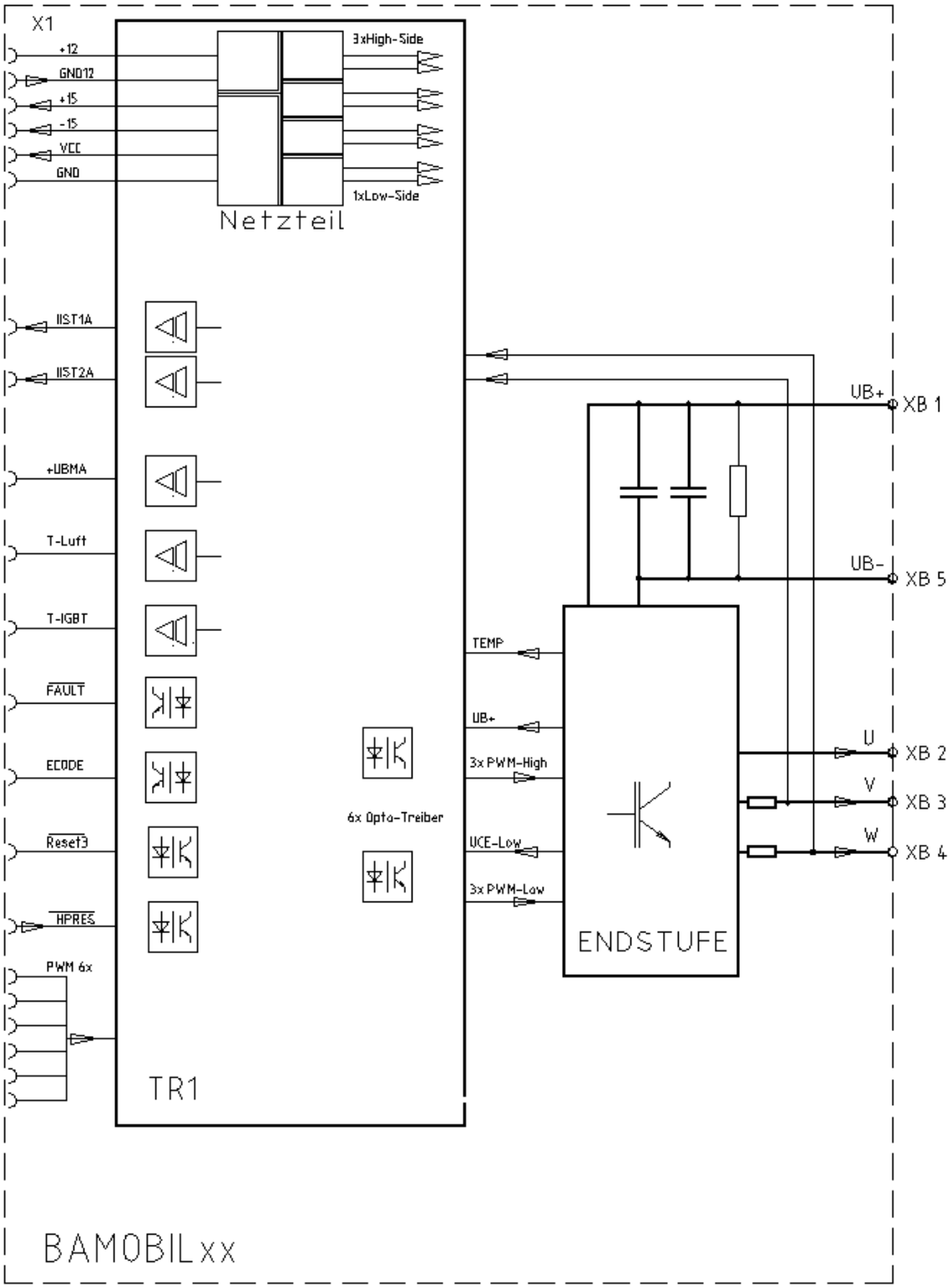
For voltages > 60 V a protection against accidental contact with exposed parts must be installed.
Use a pre-charging circuit (manufacturer Inrush limiter).

## 3.2 Circuit diagram




**Drawing side 1 of 2**

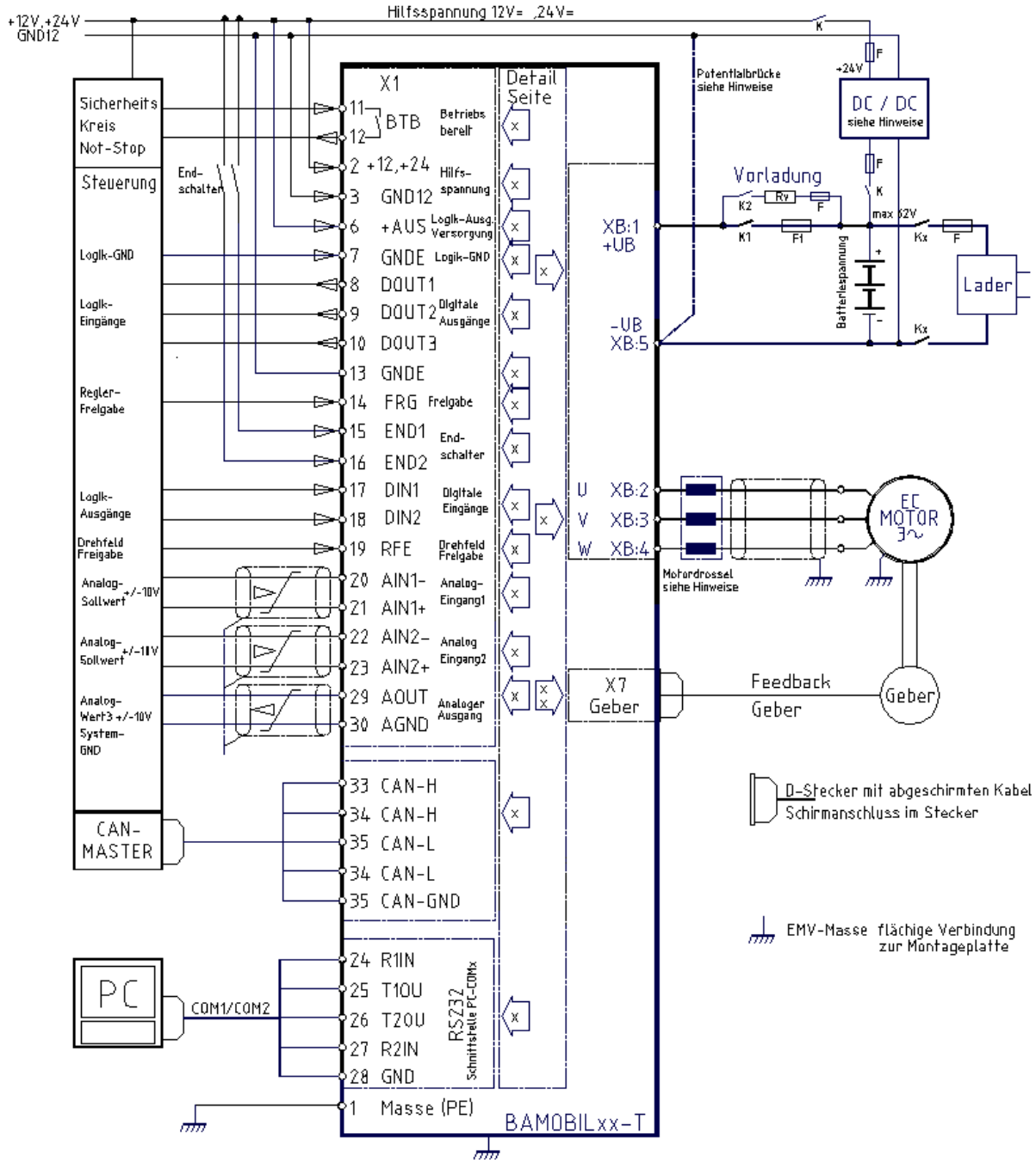
Bamobilxx-blockbild-TMS-3




**Drawing side 2 of 2**

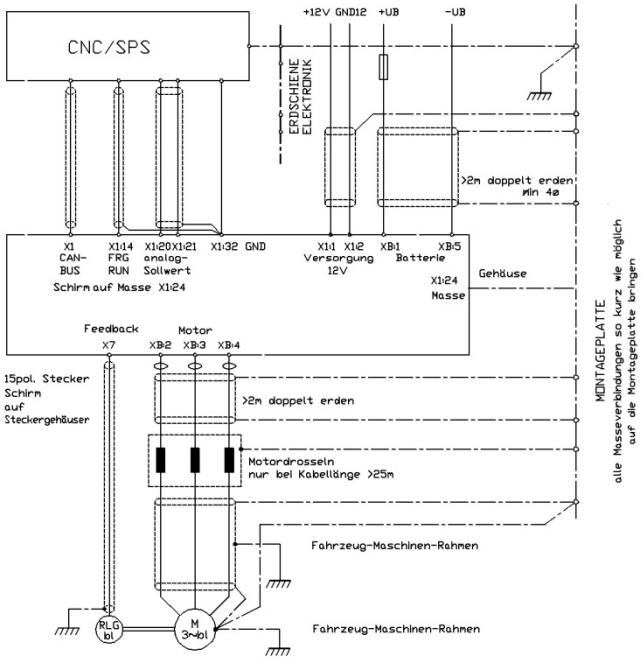
Bamobilxx-blockbild-TR2-

## 3.3 Connection diagram




bamobilxx-Tyco-D3-2-anschlussplan-4

## 3.4 EMC advice




Bamobil65-emv-1

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).

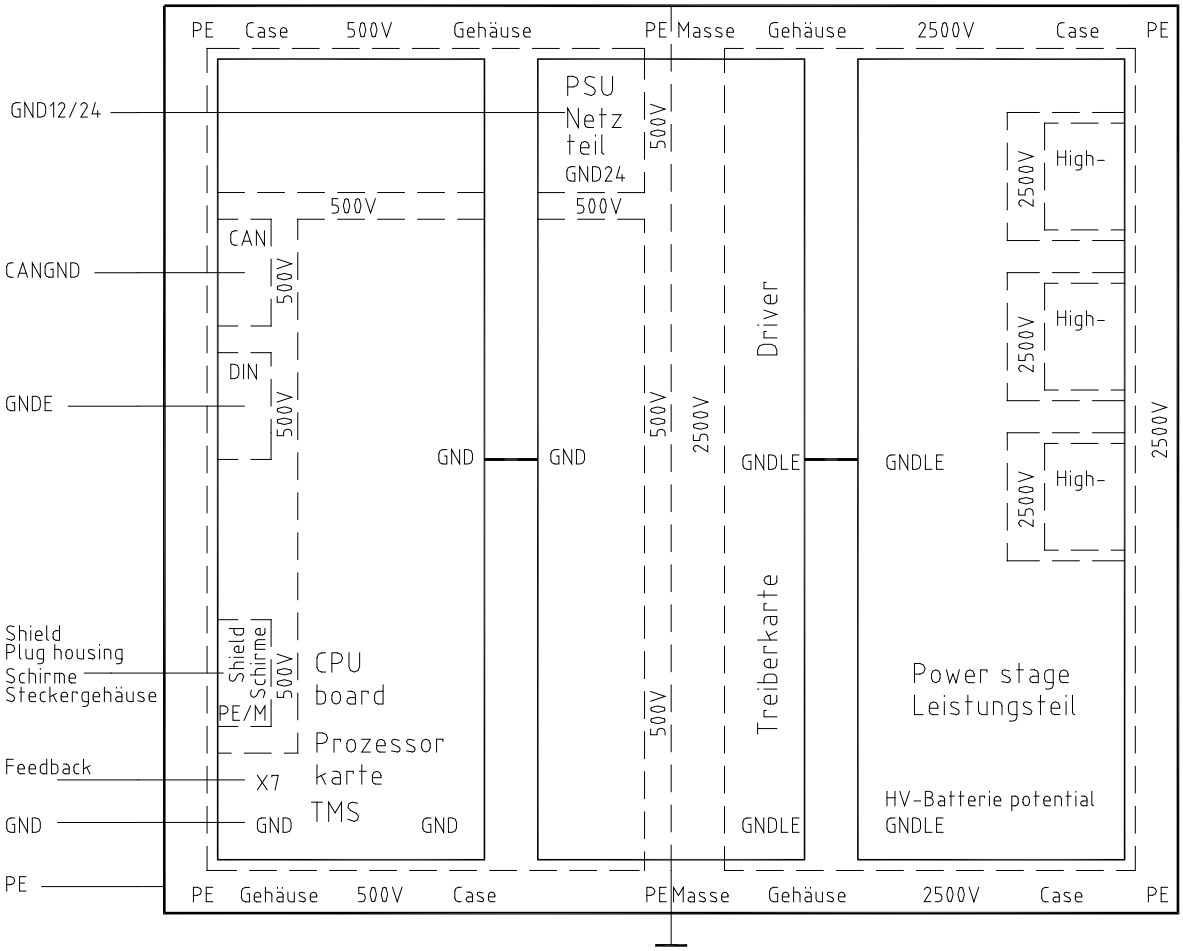
**Connection of the control conductors:**
All control conductors must be shielded. Analogue signal lines must be twisted and shielded. The shield must have surface-to-surface contact with the mounting plate (earth).

**Battery connection:**
48 V dc voltage

**Motor connection:**
Motor lines must be shielded and must have surface-to-surface contact with the mounting plate (earth). Shielded encoder cable.

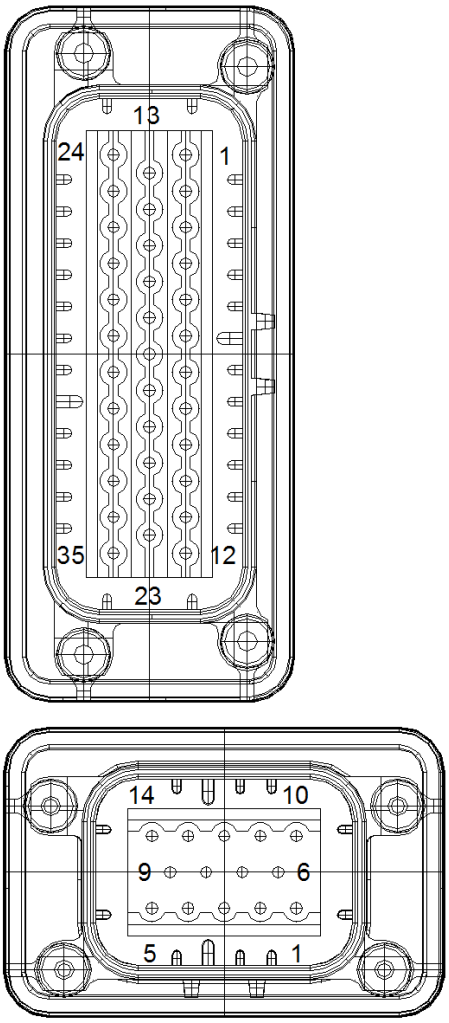
After having been mounted in vehicles, machines, and installations the operation of the device must not be started until the machine or the installation has been approved of the regulations of the EC machine guideline 2006/42/EC and the EMC guideline 2004/108/EC, for vehicles ECE-R83 and ECE-R100.
A manufacturer's declaration can be asked for.

**Potential separation**




Bamobil-D3-IM-potential-1

## 3.5 Connectors X1, X7




Bamobil65-stecker-tyco-1

| Connectors X1 control inputs / outputs | | |
|---|---|---|
| 1 | PE2 | |
| 2. | +24V | Auxiliary voltage + |
| 3 | GND24 | Auxiliary voltage 0 |
| 4 | nc | |
| 5 | nc | |
| 6 | + AUS | Supply outputs |
| 7 | GNDE | GNDE Outputs |
| 8 | DOUT1 | Digi-Output1 |
| 9 | DOUT2 | Digi-Output2 |
| 10 | DOUT3 | Digi-Output3 |
| 11 | BTB | Operational |
| 12 | BTB | Operational |
| 13 | GNDE | GNDE Input |
| 14 | FRG | Release |
| 15 | END1 | Limit switch1 |
| 16 | END2 | Limit switch2 |
| 17 | DIN1 | Digi-Input1 |
| 18 | DIN2 | Digi-Input2 |
| 19 | RFE | Rotor Enable |
| 20 | AR1 | Analog Input 1- |
| 21 | AIN1 | Analog Input 1+ |
| 22 | AR2 | Analog Input 2- |
| 23 | AIN2 | Analog Input 2+ |
| RS232 | | |
| 24 | R1IN | RS232 |
| 25 | T1OU | RS232 |
| 26 | T2OU | RS232 |
| 27 | R2IN | RS232 |
| 28 | GND | Analog GND |
| Analog Ausgang | | |
| 29 | DAC1 | Analog output |
| 30 | GND | Analog GND |
| CAN-BUS | | |
| 31, 32 | CAN H | |
| 33, 34 | CAN L | |
| 35 | CAN-GND | |

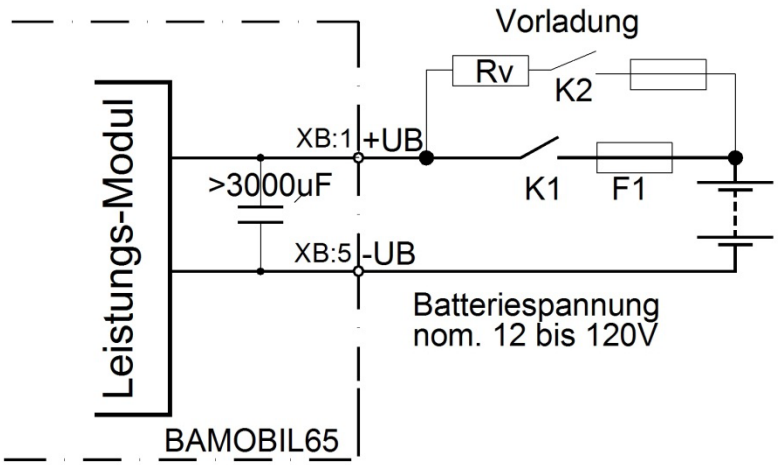
Connector 35pol: Tyco 776164-1
Connector 14pol: Tyco 776273-1

| Connector X7 Encoder connector Resolver | |
|---|---|
| 1 | |
| 2 | SIN1 |
| 3 | COS2 |
| 4 | REF1 |
| 5 | |
| 6 | Temp GND |
| 7 | |
| 8 | |
| 9 | |
| 10 | |
| 11 | Temp Signal |
| 12 | REF2 |
| 13 | COS1 |
| 14 | SIN2 |

| Connector X7 Encoder connector INC-TTL | |
|---|---|
| 1 | Kanal A |
| 2 | Kanal B |
| 3 | Kanal N |
| 4 | Kanal /A |
| 5 | GND |
| 6 | GND Temp |
| 7 | |
| 8 | Kanal /N |
| 9 | +5 VCC |
| 10 | Kanal/B |
| 11 | Temp Signal |
| 12 | Rotorlage1 |
| 13 | Rotorlage2 |
| 14 | Rotorlage3 |

| Connector X7 Encoder connector SINCOS | |
|---|---|
| 1 | ka+ |
| 2 | kb+ |
| 3 | kr+ |
| 4 | ka- |
| 5 | GND |
| 6 | GND Temp |
| 7 | kd+ |
| 8 | kr-- |
| 9 | +5 VCC |
| 10 | kb- |
| 11 | Temp-Signal |
| 12 | kd- |
| 13 | kc+ |
| 14 | kc- |

### 3.6 Battery connection




BAC65-T-Batterie-1

**Pre-charging circuit must be used.**

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

Bus circuit min. 6000 µF

Series resistor
RV approx. 10 Ohm 10 W
Charging current via K2 <16 A
Charging time max. 0.5 s.

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 = 0V)!

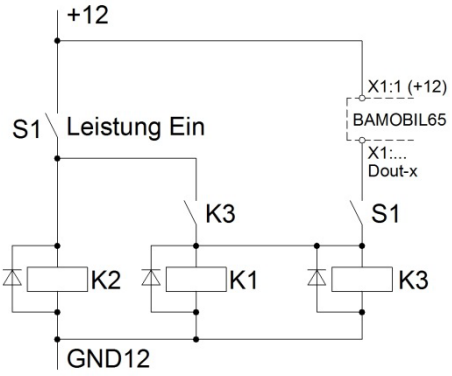
**Switch-on sequence:**
Auxiliary voltage on, (command value 0), min. 5s later power voltage on, min. 2s later enable on.

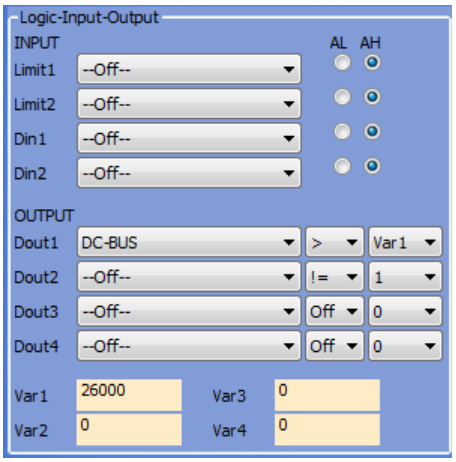
**Switch-off sequence:**
(Command value 0), enable off, min. 2s later power voltage off, auxiliary voltage off.

Always insert BTB / RDY contact in the safety circuit.
In the case of a fault in the battery terminal of the battery must be disconnected (K1 open).

## Fire hazard due to device-internal arc!

**Basic circuit for the pre-charging**

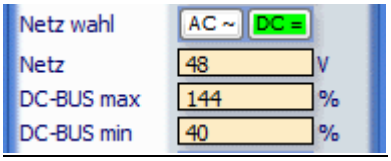



BAC65-5-Vorladung-1

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

**Note:**
The parameter DC-Bus min must be programmed to min. battery voltage (permitted discharge voltage) (100 % entsprechen 48 V)




## Warning:

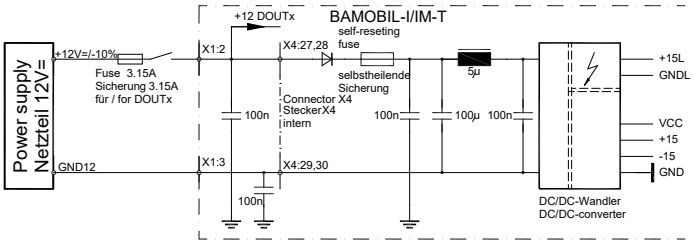
The max. supply voltage (72 V=, 160 V=) must not be exceeded at any time (not even for short intervals)!
**Danger of damage!!!**
F1 = safety fuses
**The power supply connection has no protection against reverse polarity.**
**If the polarity of the connection is wrong, the device will be destroyed!**

| Type | Battery connection bolt 12 bis 120V= bolt M10x16 | Connector cross-section | | Fuse A | | |
|---|---|---|---|---|---|---|
| | tightening torque | | | | | |
| -100, 120 | | 16 | 4 | 160 | | |
| -200, 250 | <12 Nm | 25 | 4 | 250 | | |
| -300 | XB1 (+UB=) | 50 | 1 | 350 | | |
| -450 | XB5 (-UB=) | 70 | 2/0 | 450 | | |
| **Battery connecting line <2 m. For conductor lengths from 2 to 10 m more powerful. Use an additional capacity for conductor lengths superior to 10 m!** | | | | | | |

## 3.7 Auxiliary voltage connection

Mains potential-free auxiliary
dc voltage 12 V= to 24 V= ± 10 % / 2 A
The auxiliary voltage is galvanically separated from all other voltages.
- internal regenerating fuse
- EMC filter
- external fuse only for the line protection

| | |
|---|---|
| Input voltage | 12 V to 24 V=<br>DC X1:4<br>GND24 X1:3 |
| Residual ripple1 | 10 % |
| Switch-on current | 2 A |
| Nominal current | 0.8 A |




BAC-I-T-Hilfsspannung-1

**Note:** Connect the auxiliary voltage only to a stable 12 V-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 12 V.

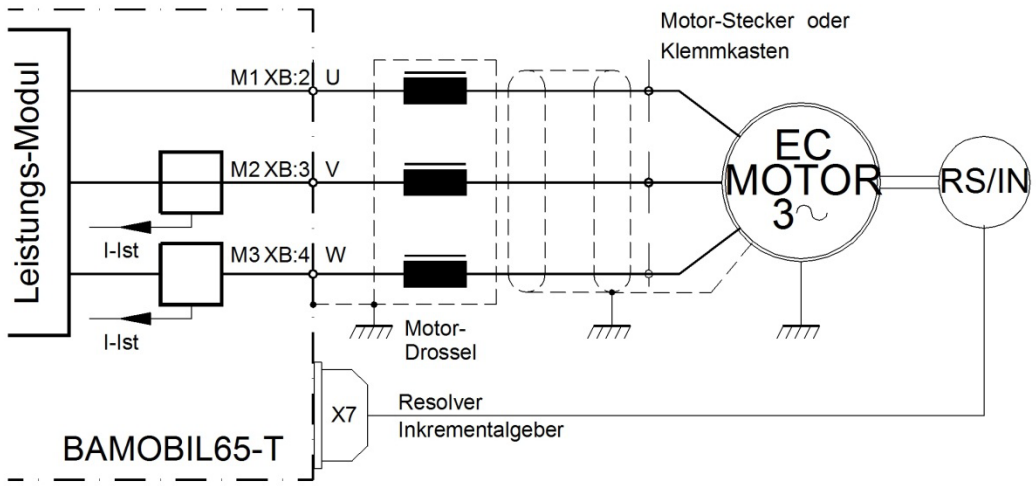
**Attention:** If the auxiliary voltage is inferior to 20 V - even in case of short-time voltage drop-outs - the internal mains module is switched off.
Any data of the RAM are deleted!
The speed and the position command values are set to zero and any calibrated data are deleted.
**The LED signal for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

**Attention:** Firmware update only when the power supply is switched off.
The auxiliary voltage and/or power supply voltage must only be switched when the BAMOBIL is disabled.
Enable input X1:14 = zero

## 3.8 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 UNITEK prior to any use.

BAC65-T-Motor-1




**Sequence of connection**

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

**Min. cable cross-section**

| **Type BAMOBIL D3-IM** | | | **-100** | **-120** | **-200** | **-250** | **-300** | **-450** |
|---|---|---|---|---|---|---|---|---|
| **Cross-section mm²** | | | 6 | 10 | 25 | 35 | 50 | 70 |
| **AWG** | | | 10 | 6 | 4 | 2 | 1 | 2/0 |

## Note:

**Any motor cable cores which are not used must be connected to earth. Dangerous voltages may arise due to capacitive coupling of the clocked motor cores.**

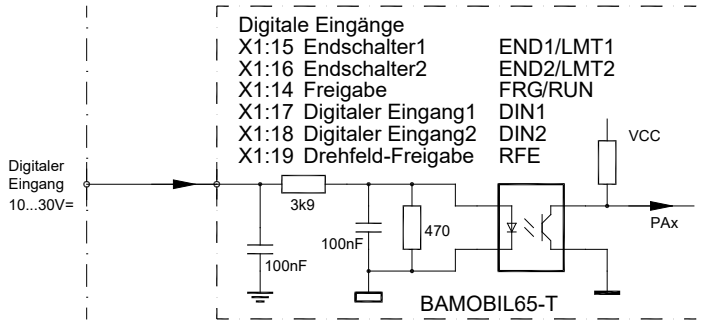
**Motor choke**
Only necessary for a shield capacity of >5 nF. Approx. 25 m motor cable

**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 cable screw gland of the BAMOBIL D3xx.
Surface-to-surface connection as short as possible to the motor side.

## 3.9 Control signals

### Digital inputs / 6 optocoupler inputs




BAC65-T-DIN-1

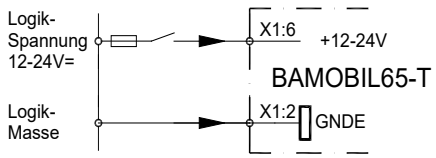
| | | |
|---|---|---|
| Input voltage | | |
| Level ON | | +10 V to +30 V |
| Level OFF | | <+6 V |
| Input current | Max. | 7,5 mA |
| Nominal-voltage / current | | +24 V / 6 mA |
| Ground – reference | GNDE | (X1:7) |

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 = 0) 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 | X1:14 | Enable | fixed | |
| RFE | X1:19 | Rotating field enable | fixed | |
| END1/LMT1 | X1:15 | Output stage switch 1 / digital input | programmable | |
| END2/LMT2 | X1:16 | Output stage switch 2 / digital input | | |
| DIN1 | X1:17 | Digital input 1 | | |
| DIN2 | X1:18 | Digital input 2 | | |

### External power supply for the inputs and outputs




BAC-65-T-Logikspannung 1

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

GNDE logic ground

## 3.10 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

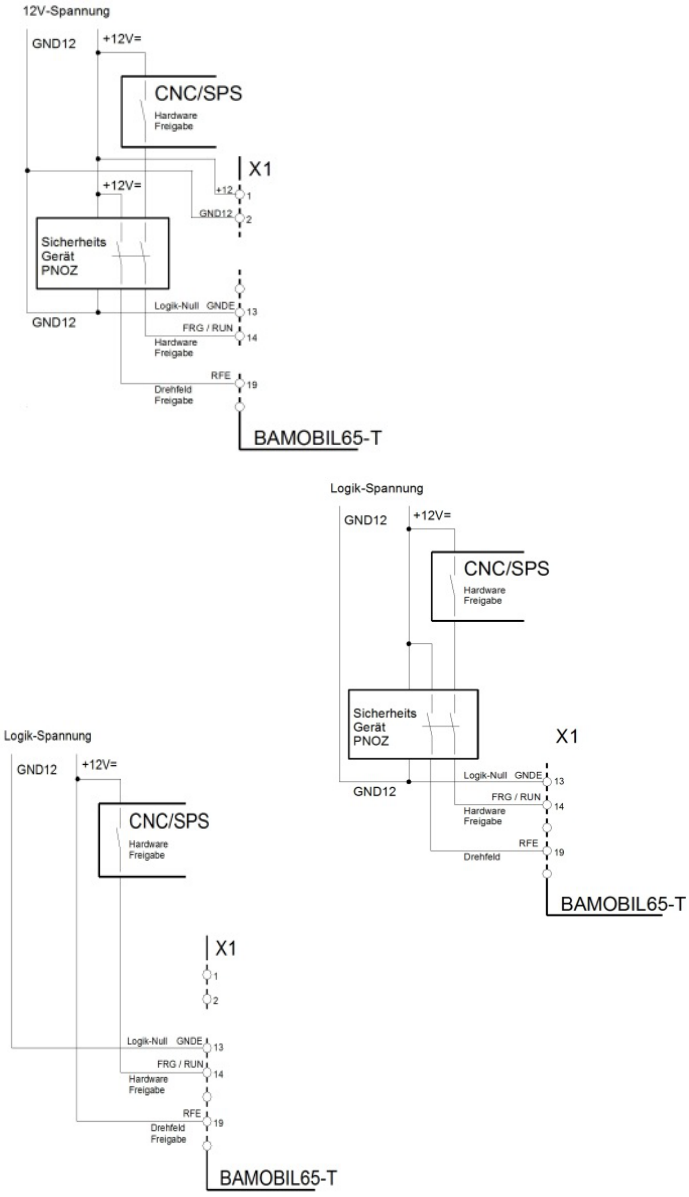
**Switching - on**
Contacts of the safety device closed, enable FRG/RUN 0.5 s after RFE switch on

**Safety switch-off**
Contacts of the safety device open:
There is no FRG/RUN signal in the 1st disable channel to disable the PMW 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

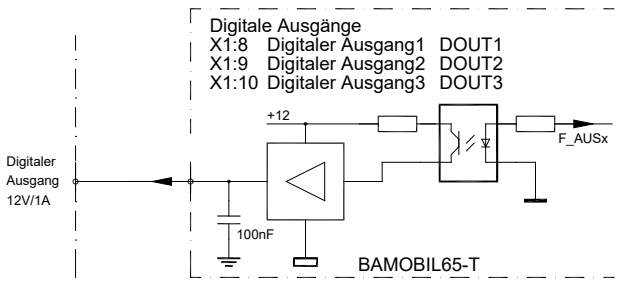
The input RFE must be bridged with the logic voltage.
If the voltage corresponds to the supply voltage, the RFE input is bridged with +24V.
Enable FRG/RUN only after at least 0.5 seconds after the RFE signal.




BAC65-T-REF 1-1/1-2/1-3

### 3.11 Digital logic outputs (open-emitter)

The logic outputs 1 to 3 are rated for 24 V and 1 A (short-time: 2 A).

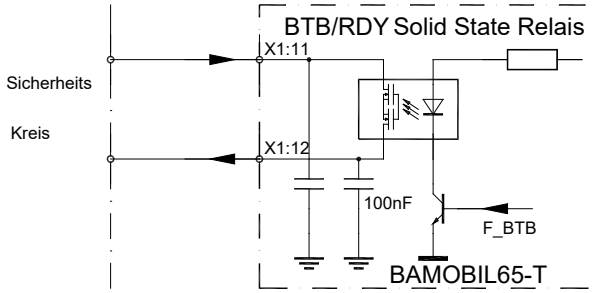



| | | |
|---|---|---|
| Output voltage | | |
| Level ON | max. | + 24 V= |
| Level OUT | | < 1 V= |
| Output current | nom | 1 A |
| Output current | max. | 2 A |
| Voltage reference +OFF | + 24 | (X1:4) |
| Ground reference | GNDE | (X1:7) |

BAC65-T-DOUT-1

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)




**BAC65-T-BTB-1**

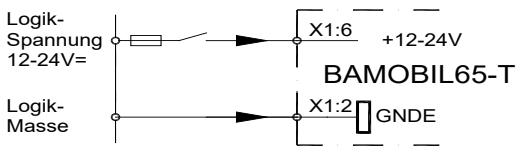
| | |
|---|---|
| Contact for | max. 48 V/0.2 A |
| Capacitive load | max. 1 µF |
| Contact resistor | max. 2 Ohm |

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.

**<u>Always install the BTB/RDY contact in the safety circuit!</u>**

**Ready for operation opens** (red LED, open relay contact)
in case of error messages
in case of under-voltage of the auxiliary voltage (< 10 V)
The message "under-voltage in the bus circuit" can be programmed (see Manual NDrive)

| Output | Connection | Function | State | Parameter |
|---|---|---|---|---|
| **BTB/RDY** | X1:11, X1:12 | ready | fixed/relay | |
| **DOUT1** | X1:8 | Digital output 1 | programmable | |
| **DOUT2** | X1:9 | Digital output 2 | programmable | |
| **DOUT3** | X1:10 | Digital output 3 | programmable | |

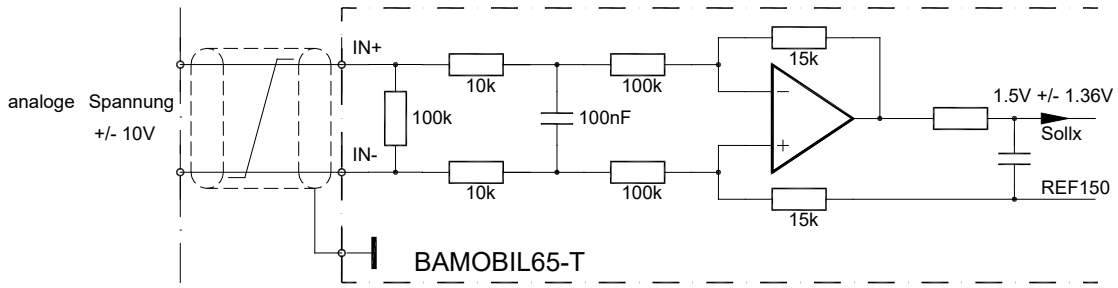



+ 12 - 24 V for logic and auxiliary voltage

GNDE logic ground

BAC-T-Logikspannung-1

## 3.12 Analoge input +/- 10 V




BAC-5-AIN-1

| Input | Output | Basic function | Voltage | State | Parameter |
|---|---|---|---|---|---|
| **AIN1+, AIN1-** | X1:20, X1:21 | Speed command value | +/- 10 V | prog. | |
| **AIN2+, AIN2-** | X1:22, X1:23 | Current limit | +/- 10 V | prog. | |

### Features

| **Differential input** | **AIN1+ / AIN1-** | **AIN2+ / AIN2-** | |
|---|---|---|---|
| **Input resistance** | 70 kOhm | | |
| **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.

The analog inputs can be assigned to different functions.

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.

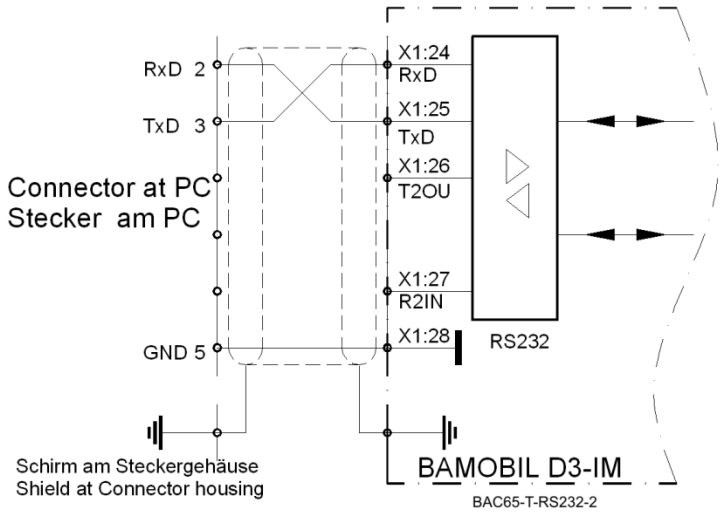
## 3.13 Analog output ±10 V

| Input | Output | Basic function | Voltage | State | Parameter |
|---|---|---|---|---|---|
| **AOUT1** | X1:31 | Speed command value | +/-10 V | prog. | |
| **GND** | X1:32 | Signal zero | 0 V | fixed | |

The analog inputs can be assigned to different functions.

### 3.14 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



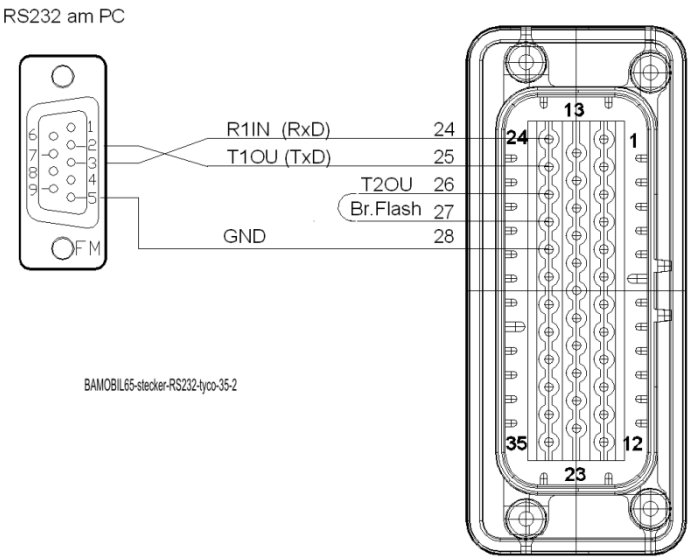

**Note:**
The serial interface is galvanically connected with the device zero (GND/AGND)

The BAMOBIL-D3-I (D-connector X10) and the serial interface (COMx) of the pc must only be connected using a shielded cable.

Install the cable only after disconnecting the device from the mains.
The interface is hard-coded to 115200Baud.
The value can be changed to 9600Baud by means of the NDrive.

Connecting cable
LiYCY 5x0.25+shield

View to the soldered side,
Shield on the housing,
Max. cable length 10m.




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

Install bridge between X1:26 and X1:2 only for Firmware update (Flash)

### 3.15 CAN-BUS

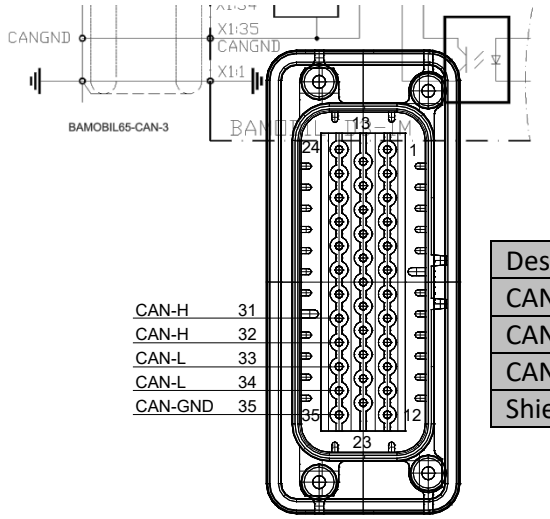
The CAN-BUS is a digital connection to the CNC control.
Optimum conditions are achieved with CNC controls and CAN components of LABOD electronic or CAN Open.
Programming and operation by means of the control panel via the CAN-BUS.
Interface complies with the standard ISO 11898.
Adjustment and programming 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.

**CAN-bus-cable**
Use a shielded bus conductor with a low shielding capacity.
Signal plus GND (+supply).
D-connector with a metal or metallized housing.
LiYCY 3x0.25+shield

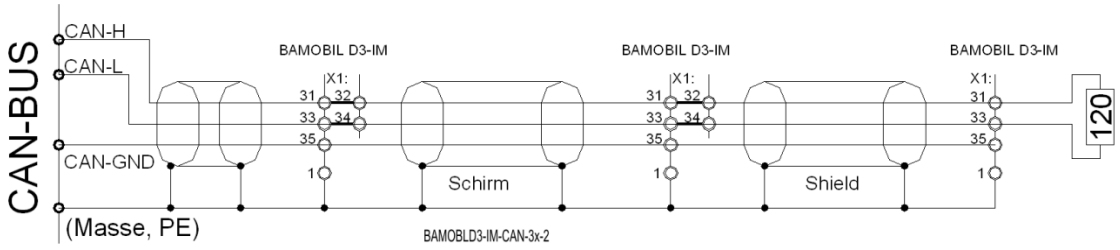
CAN-BUS-Kabel
Abgeschirmte Busleitung mit geringer
Schirmkapazität verwenden.
Signal plus GND (+Versorgung).
D-Stecker mit metallischem oder metallisiertem Gehäuse.
LiYCY 4x0.25+Schirm




| Designation | Connector no | Cable colour | Cable no. |
|---|---|---|---|
| CAN-H | X1:31,32 | green | 3 |
| CAN-L | X1:33,34 | yellow | 2 |
| CAN-GND | X1:35 | white | 4 (PE) |
| Shield | X1:1 | | |

## CAN-BUS-Connection with several BAMOBIL-D3-IM

Master Adresse xx Adresse xx Adresse xx

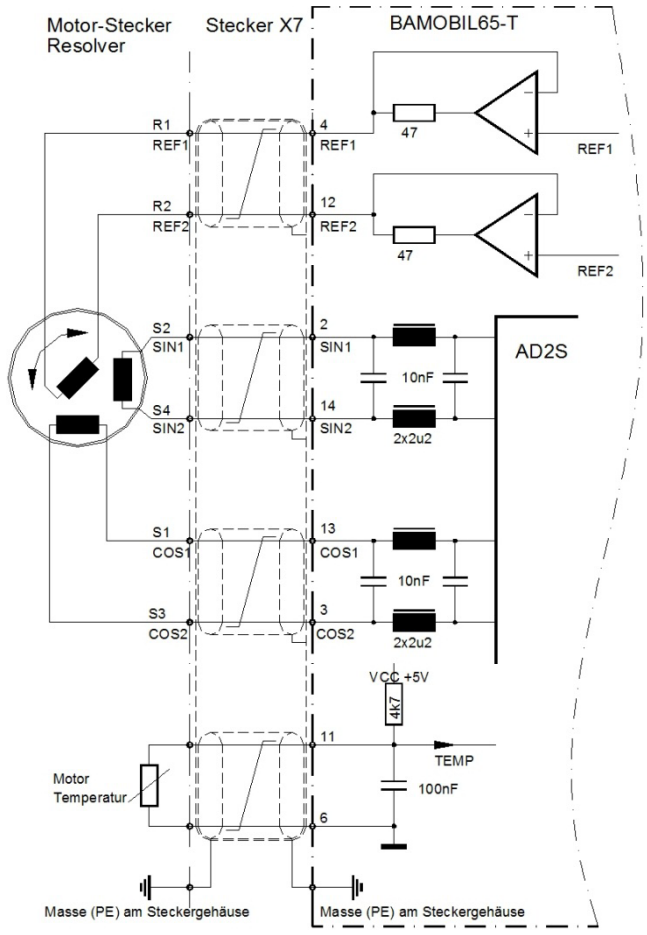



Bamobil-D3-IM-CAN-3x2

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

### 3.16 Resolver connection

Only for RS variant




BA65-5-Reso-1

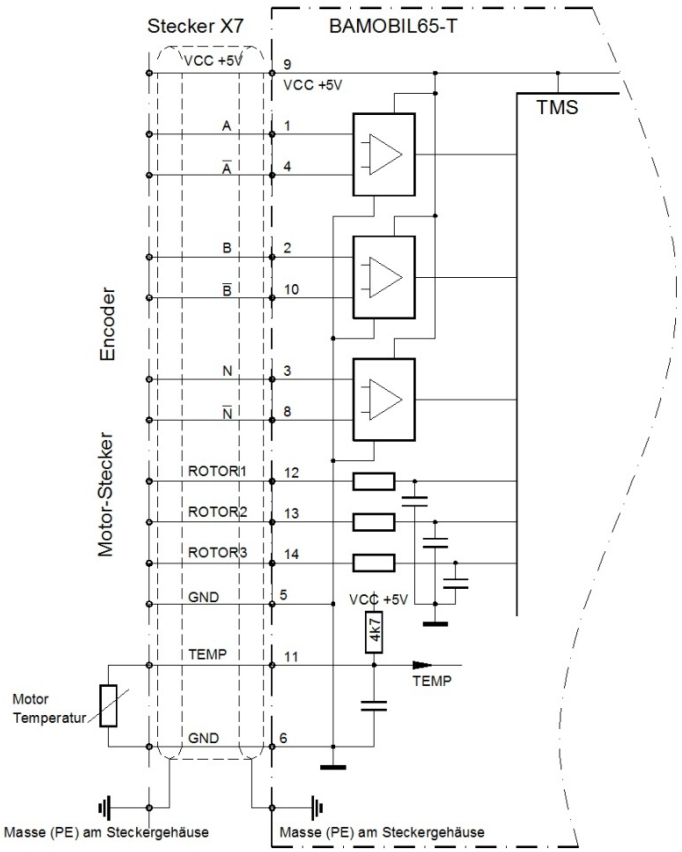
The resolver is an absolute measuring system for a motor revolution.
It is robust and not impaired by high motor temperatures.
Its build corresponds to a revolving transformer. The rotor is supplied by the reference (10 kHz). The stator supplies the sine and cosine signals modulated by the rotational 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 (10 bit).
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 | 14-pole Tyco connector |
| Connecting cable | 4 x 2 cores, twisted in pairs and shielded, additional overall shield.<br>For link chains use appropriate cables. | |
| Cable length | For >25m only use high-quality resolver cables with adequate shielding properties. | |
| Shield connection | Across connector X7: | Alle Schirme zusammenfassen und mit dem Gehäuse kontaktieren |
| | Across motor connector: | Gesamtschirm mit dem Steckergehäuse kontaktieren |
| Setting parameters | see Software-Manual NDrive | |

### 3.17 Encoder TTL Anschluss

Only for IN variant




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 500kHz.

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

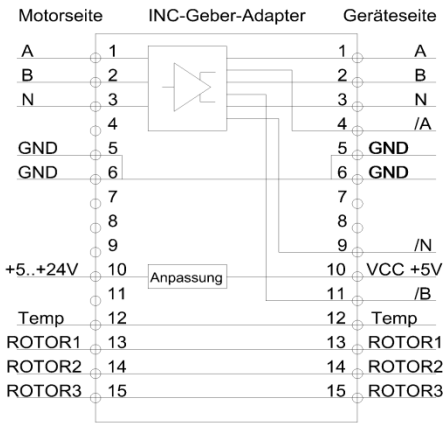
The voltage of 5V is supplied by the servo-drive.

BAC65-5-INC-1

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 | |

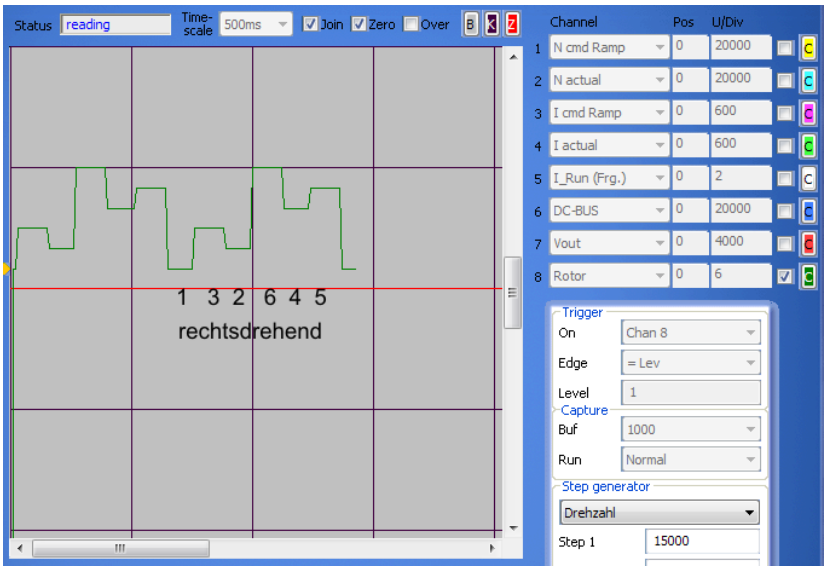
**Adapter for INC-encoder with A,B,N channel without push-pull signals**




The device input for t e 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 he 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 corrector connection**
Rotor sequence



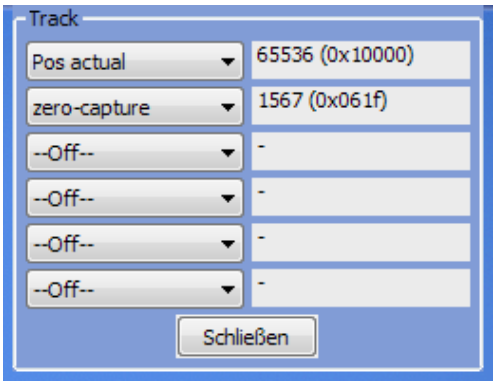

The correct sequence of the rotor signals with a motor turning clockwise is 1, 3, 2, 6, 4, 5.

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**

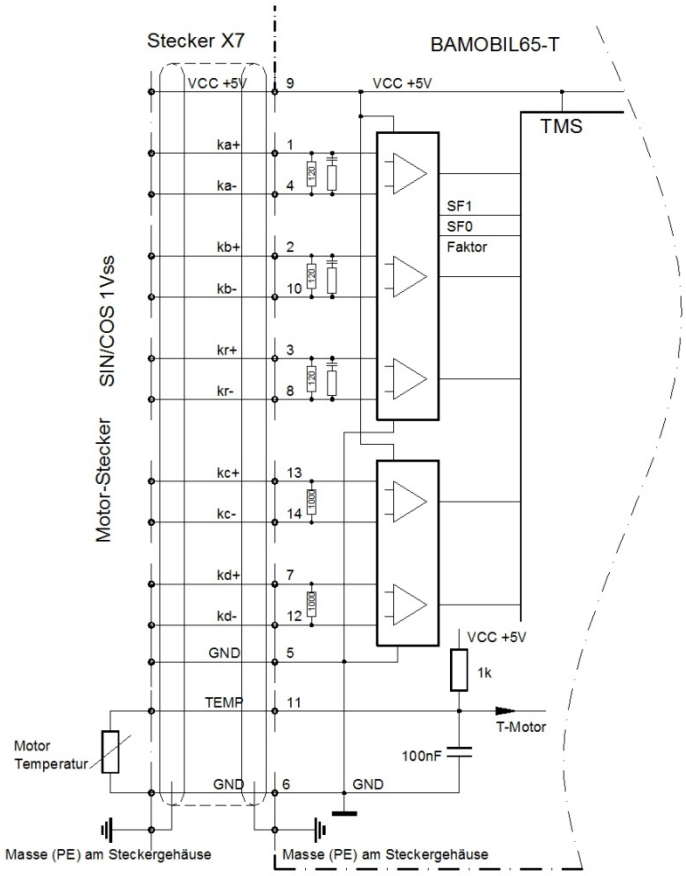
Turn motor clockwise for one revolution without enable.
One motor revolution corresponds to a position value of Num 65536. In case of different results the input of Feedback Inc-Mot (0xa6) is incorrect.




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

### 3.18 SIN COS 1Vss connection

Only for SC variation




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

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.

The resolution is automatically set to an optimum.

BAC65-5-SINCOS-1

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

| | | |
|---|---|---|
| Connector | X7 | 14-pole D-Connector |
| Connecting cable | 4x2 signal conductor, twisted and shielded | Min. cross-section 0,14 mm |
| | 2x signal conductor, 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<br>For link chains use appropriate cables | |
| Cable length | for >25m the cross-section of the cable used must be increased by on grade | |
| Shield connection | across connector X7 | Schirm mit dem Steckergehäuse kontaktieren. |
| | Across the motor connector | Schirm mit dem Steckergehäuse kontaktieren |
| Setting parameter | See software Manuel NDrive | |

# 4 Display - State

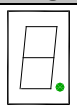
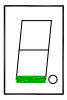
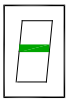
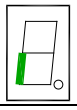
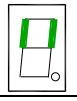
## 4.1 Status display on the servo

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.

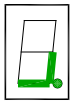
The state **"warning"** is signalled by the flashing red fault LED and the seven-segment display indicates alternately the state and the warning no.

**Display of the servo-drive states**

| Anzeige | Point/segment | State | | State of NDrive |
|---|---|---|---|---|
|  | flashing<br><br>dark | Processor active<br><br>Auxiliary voltage missing or inherent hardware failure | | |
|  | flashing<br><br>bright<br><br>dark | Starting state after reset (auxil. voltage 24V off-on). The first enable stops the flashing display.<br><br>Drive enable<br><br>Drive disabled (not enabled) | | OK = 0<br><br>OK = 1, ENA = 1<br><br>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<br><br>bright<br><br>dark | Motor current reduced to continuous current Icns<br><br>Motor current at max. current limit $I_{max}$<br><br>Normal operation; Motor current within the current limits | | Icns = 1<br><br>Icns = 0<br><br>Icns = 0 |
|  | bright for 0.1 s | Left segment:<br><br>Right segment: | A new command (value) was received from the BUS or RS232<br>Digital input change | |

Ndrive: 7segment 1-8

**Example**: Motor revolving clockwise



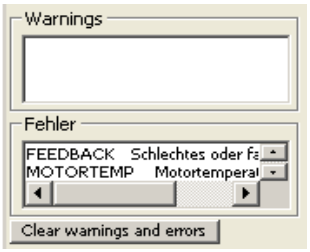
Point flashes = active processor
Bottom segment = drive enabled
Right segment = motor revolves clockwise

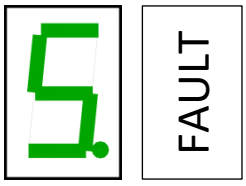
### 4.2 Status information - Error

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

| Display on the BAMOBIL | Error display on the NDrive | Meaning |
|---|---|---|
| | NOREPLAY-NORS | RS232 failure.<br>Incorrectly connected or missing connecting cable |
| 0 | BADPARAS | Damaged parameter |
| 1 | POWER FAULT | Output stage error |
| 2 | RFE FAULT | Safety circuit fault (only active with RUN) |
| 3 | BUS TIMEOUT | Transmission fault BUS |
| 4 | FEEDBACK | Encoder signal faulty |
| 5 | POWERVOLTAGE | Encoder signal faulty |
| 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 | Drive races<br>(without command value, wrong direction |
| B | USER | User - choice of error |
| C | I2R | Overload |
| D | RESERVE | |
| E | ADC-INT | Current measuring error |
| F (device-dependent) | BALLAST | Ballast circuit overloaded |
| Decimal point flashing | Processing unit active | |
| Decimal point dark | Auxiliary voltage missing or inherent hardware failure | |

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

### 4.3 Status information – Warning

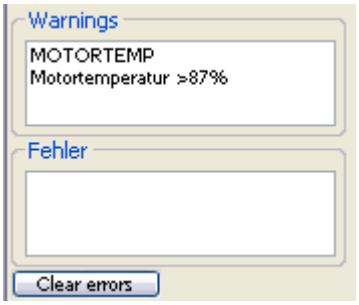
The state **"warning"** is signalled by the flashing red fault LED and the seven-segment display indicates alternately the state and the warning no.

**List of warning signals**

| Display on the servo | Warning signal on the NDrive | Meaning | ID-Address |
|---|---|---|---|
| | | | REG-ID - 0x8f |
| 0 | WARNING_0 | No device identification | Bit 16 |
| 1 | ILLEGAL STATUS | RUN signal | Bit 17 |
| 2 | WARNING_2 | FE signal inactive | 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 | Overcurrent 200 % | Bit 25 |
| A | | | Bit 26 |
| B | | | Bit 27 |
| C | I2R | Overload > 87 % | Bit 28 |
| D | | | Bit 29 |
| E | | | Bit 30 |
| F(device-ependent) | BALLAST | Ballast circuit > 87 % overloaded | Bit 31 |
| | | | |
| | | | |

**Fault**

**Example:**
flashing red,
The display swaps between the state and the warning no.,
Warning no. 5



# 5 Measured data

## 5.1 DC link voltage

(from firmware 378)
**Bus circuit voltage (nom. 48V)**

| BAMOBL D3-62 | Bus circuit voltage | Parameter 0xeb | DC bus - % |
|---|---|---|---|
| Max. voltage | 62 V | 21961 | 134 |
| Battery voltage | 48 V | 17000 | 103 |
| Overvoltage signal | 72 V | 25503 | 155 |
| Charging voltage | 56 V | 19836 | 121 |
| without charging voltage | 0 V | 0 | 0 |
| Scaling | 1 | 354.22 | 2.16 |
| DC bus 200% | 92 V | 32767 | 200 |

Parameter 0xeb = 354.22 x bus circuit voltage

**Bus circuit voltage (nom. 96V)**

| BAMOBIL D3-120 | Bus circuit voltage | Parameter 0xeb | DC bus - % |
|---|---|---|---|
| Max. voltage | 124 V | 21961 | 134 |
| Battery voltage | 96 V | 17000 | 103 |
| Overvoltage signal | 144 V | 25503 | 155 |
| Charging voltage | 112 V | 19836 | 121 |
| without charging voltage | 0 V | 0 | 0 |
| Scaling | 1 | 177,11 | 1,08 |
| DC bus 200% | 185 V | 32767 | 200 |

Parameter 0xeb = 177.11 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-100 | 700 | 560 | 50 | 60 | 800 | 100 |
| x-120 | 840 | 670 | 60 | 84 | 970 | 120 |
| x-200 | | | | | | |
| x-250 | 874 | 700 | 125 | 175 | 1010 | 250 |
| x-300 | 610 | 490 | 175 | 245 | 710 | 350 |
| x-450 | 785 | 630 | 225 | 315 | 910 | 450 |

**The basic set-up is protected in the set of parameters.**

## 5.2 Output stage temperature

| IGBT-modul temperature | Analog voltage X4 Pin6 | Parameter 0x4a |
|---|---|---|
| Max. +80 °C | 2,49 V | 25819 (FW>378) |