BAMOBIL-A1

MANUAL

Battery - motor controller
BAMOBIL A1-x-200..300
for DC motors

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Content

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Electronic devices are fundamentally not fail-safe.

Attention DC voltage

DC 60V=

This manual must be carefully read and understood by qualified personnel before installation or commissioning.
If anything is unclear, contact the manufacturer or dealer.
The devices of the BAMOBIL series are electrical equipment (EB) of the power electronics for the regulation of the energy flow. Protection class IP53.

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

EC Directive 89/392/EEC, 84/528/EEC, 86/663/EEC, 72/23/EEC
EN60204EN50178, EN60439-1, EN60146, EN61800-3
- IEC/ULIEC364 , IEC 664, UL508C, UL840
- VDE regulations VDE100, VDE110, VDE160
- TÜV regulations
- Regulations of the employers' liability insurance association: VGB4

Connection only to battery or mains potential-free DC voltage Observe notes on page 8!

The user must ensure:
- that after a failure of the unit
- in the event of incorrect operation,
- in case of failure of the regulation and control unit, etc.

the drive is guided into a safe operating state.

Machines and systems must also be equipped with monitoring and safety devices that are independent of the equipment.

Adjustments
- Only by qualified electricians
- Observe safety regulations

Assembly work
- only in the de-energised state.

QS
The units are archived by their serial number with their test data at the manufacturer.

CE
The EC Directive 89/336/EEC with the EMC standards EN61000-2 and EN61000-4 is complied with.

General

General
Together with the low-voltage DC motor, the BAMOBIL-A1 battery motor controller forms a drive unit that is characterised by high control quality. With the DC motor, the current is proportional to the torque and the voltage is proportional to the speed. Current and speed are measured precisely.
The analogue control circuits of the servo amplifier are simple. The actual speed value is generated from the armature voltage or from the DC tachogenerator.
The speed controller and the current controller are designed as P-I controllers.

Application
Machines and vehicles of all types up to a battery-powered drive output of 5.6 kW especially with
- for large control ranges
- at high efficiency
- for small motor dimensions
- with even, smooth running

for speed control, torque control or combined speed-torque control with or without superimposed position control.

Insert
Battery-powered vehicles such as cleaning machines, electric boats, electric vehicles, forklifts, transport systems,
Solar or wind-powered stand-alone systems,
as well as in many other battery-powered machines and systems

Structure:
Built-in unit IP53 according to VDE, DIN and EC directives.
Uniform analogue control electronics.
Power electronics with FET power semiconductors, generously dimensioned

Properties:
* Battery - connection or
* mains potential-free DC voltage (observe notes on page 8!)
* Bipolar differential setpoint input
* Unipolar input with directional signal input
* PWM input (option)
* Speed and torque control
* Static and dynamic current limit (temperature controlled)
* Measurement outputs for current and speed
* Release logic, quick stop
* Brake logic
* Main contactor logic
* Temperature monitoring

Technical data Power

connection

Type BAMOBIL A1	**24**	**48**
Battery voltage	12, 24V	36,48V
DC mains potential-free	12, 24V	36 to 48V
Output voltage $0.95 \times UB$	max. 23 V	max. 47V

Auxiliary voltage connection	24V= ±20%, max. 0.5A, ripple <20% GND = -UB (Option 48V with isolated DC/DC converter)

Specification

Device BAMOBIL A1		**200**	**300**
Continuous current max.	A=	100	150
Peak current max. (5s)	A=	200	300
El. power max	W	9400	14000
Continuous output	W	4700	7000
External fuses	AF	200	300
Power loss S3 50%	W	260	390
Cooling		See cooling instructions	
Dimensions	WxHxD	See dimensional drawing	
Weight	Kg	1	
Weight with additional cooler	Kg	1.95	

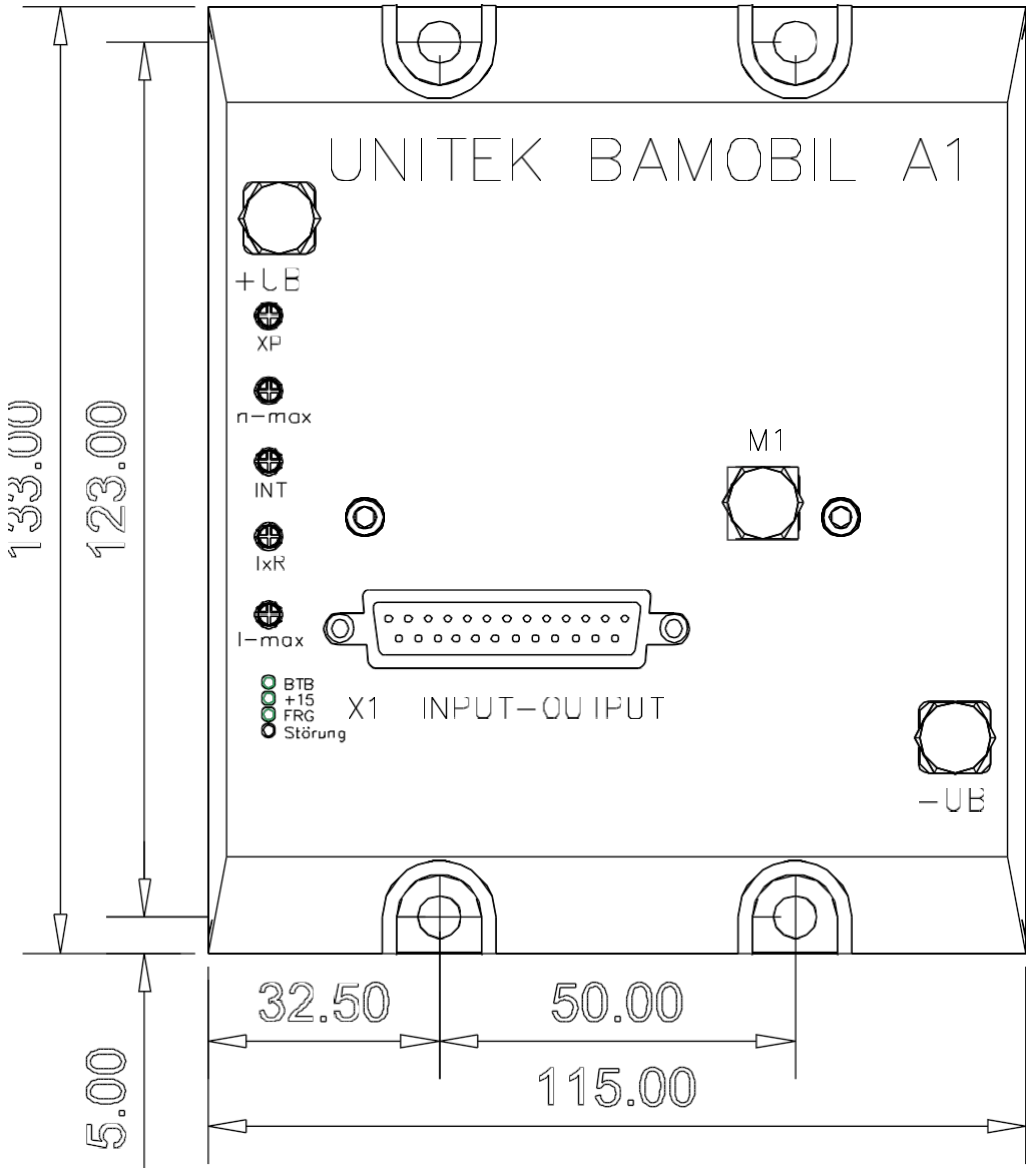
Common specification

Protection		classIP 50
Unit		designVDE 0100 Group C VDE 0160
Moisture		exposureClass F according to DIN 40040 no condensation Installation altitude< 1000m above sea lev
Operating extended Bb.		range0 ... 45°C up to 60°C red. 2%/°C Storage range-30°C to + 80°C
Speed controller		
Control accuracy	o.Actual value	error± 0.5%
Control range		1: 1000
Temperature monitoring		80°C

Dimensi on drawing

Dimension drawing BAMOBIL A1

Basic unit



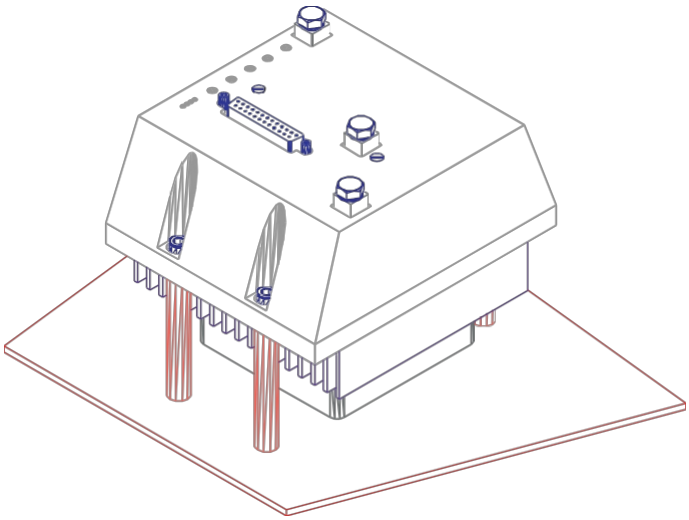
Note the power dissipation:

The cooling plate can only dissipate low power loss (approx. 50W)
Further power loss must be dissipated through the mounting surface or an additional cooler (sheet steel is a poor heat conductor).

Observe the mechanical connection torque.

The connecting bolts allow a maximum torque of **4.5Nm.**
Higher torques can damage the internal press-solder joint.

Dimension drawing BAMO A1
Body variants with additional cooler

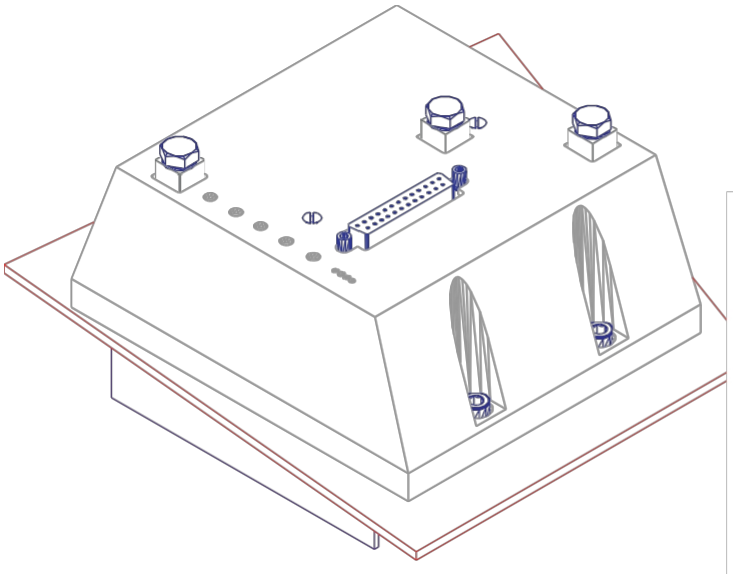


Mounting on the control panel
Installation depth o.St. 130mm

Spacer bolt 10x60 mm
inside 5.5 mm

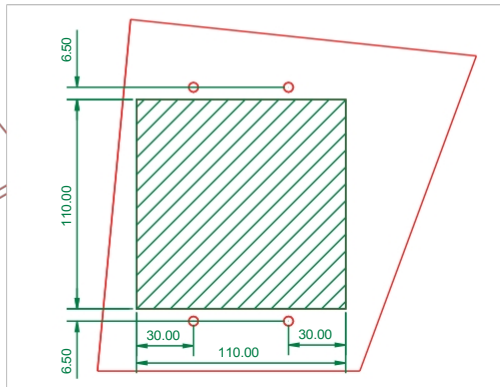
Screws M5 x 80 Fan

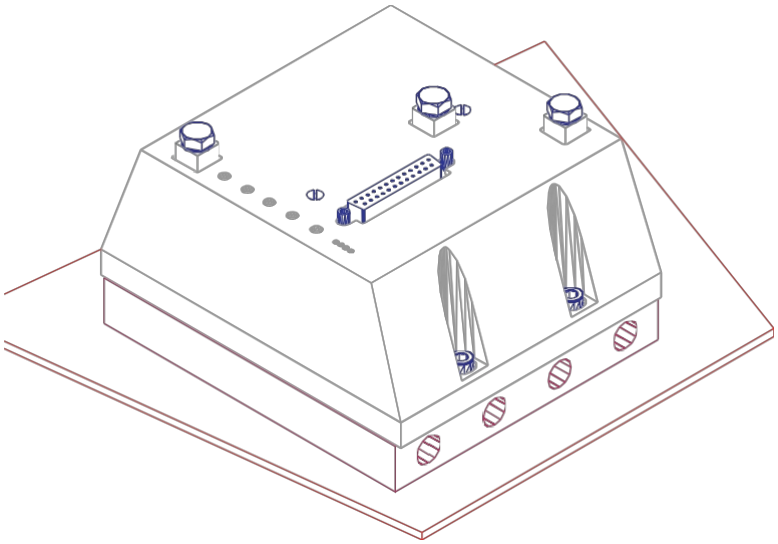
connection 24V=



Push-through mounting
Installation depth o.St.

70mm Screws M5x30





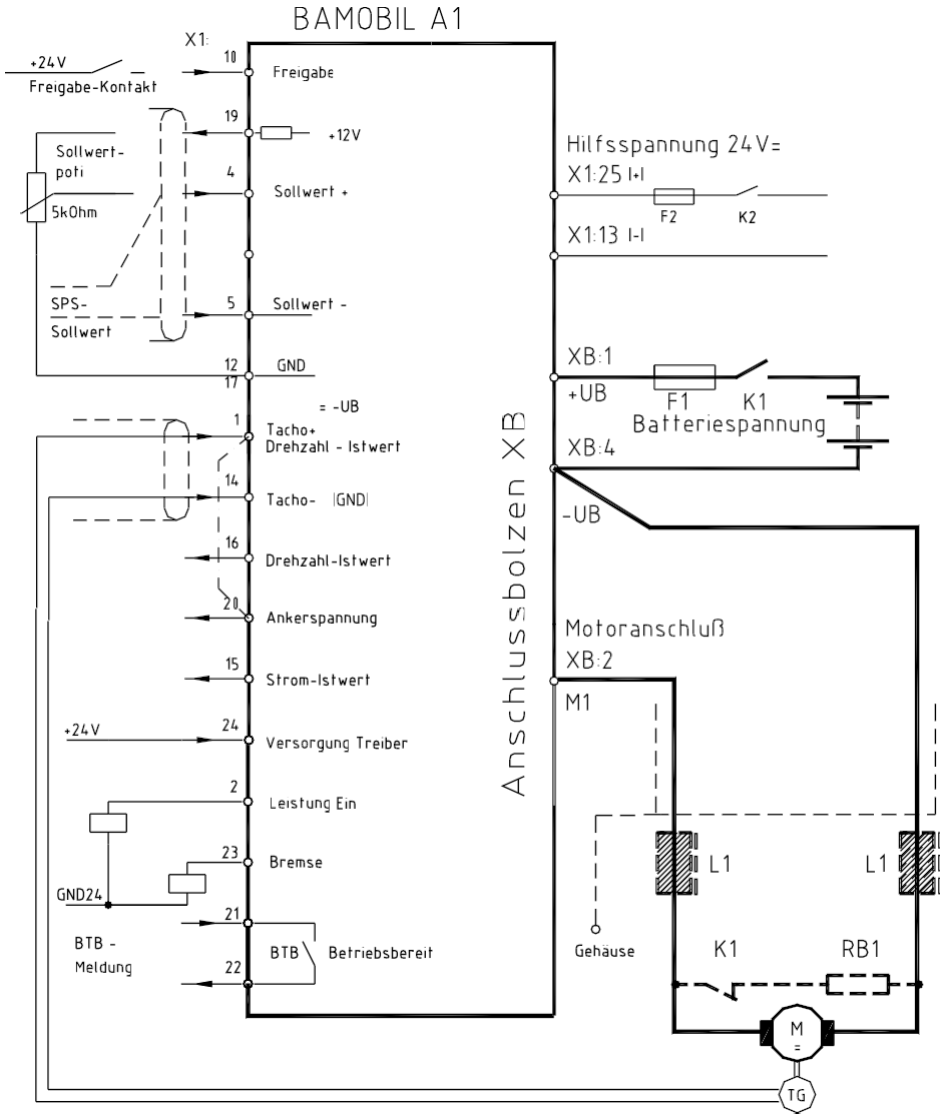
Liquid cooler installation

depth o.St. 90mm

Screws M5 x 40

Dimensi on drawing

Connection overview



Note:
Power connection XB:1 (+UB) , XB:4 (-UB)
Connection polarity >>no reverse polarity protection possible
If the connection is incorrect, the
power amplifier can be destroyed!

Auxiliary voltage connection X1:25, X1:13
Reverse polarity protected. Observe polarity for fans. The connection can be switched independently of the power connection. Observe voltage tolerance and residual ripple. Internal isolated DC/DC converter.

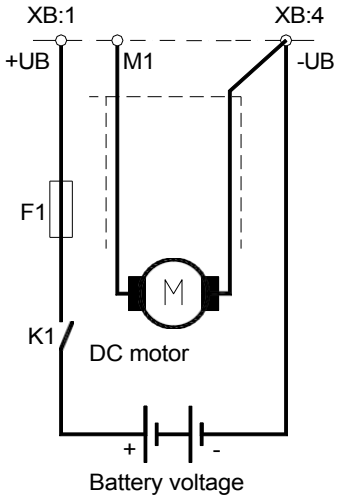
Motor connection XB:2 (M1), XB:4 (-UB)
With positive direction (+direction), M1 is positive against -UB.
The motor connections can be exchanged.
Shielded cable only in case of EMC problems.

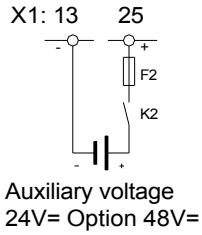
For control connections, see detailed notes.

Power connections

Attention:
The assignment of the connections to the plug numbers or terminals is binding.
All further information on this is non-binding
The input and output lines can be changed or supplemented in compliance with the electrical regulations.

Note:
- **Connection and operating instructions**
- **local regulations**
- **EC Directive 89/392/EEC, 84/528/EEC, 86/663/EEC**
- **VDE, TÜV and the Employer's Liability Insurance Association.**
- **CE - Notes, EMC**





If the setpoint is positive, M1 is positive against -UB.

Connection (minimum values)

Dimensioning	at A	200	300
Connection cable battery	mm² (AWG)	35 (1)	50 (1/0)
Connection cable motor	mm² (AWG)	25 (2)	50 (1/0)
Power assurance F1	A	200	300
Auxiliary voltage	mm² (AWG)	0,5 (20)	
Fuse protection F2	AF	1	

Attention: Observe mechanical connection torque 4.5 Nm.

Control ports
The connection instructions are for general information only and are not binding.

Note:
- Connection and operating instructions
- local regulations
- EC Machinery Directive 89/392/EEC
- VDE, TÜV and the Employer's Liability Insurance Association.

Connection numbers D-connector
25pin X1:1 to X1:25

Signal lines
Shielded and separated from power lines. Setpoints
twisted in pairs and shielded.

Logic connections
Relay with gold contacts or reed relay. Contact current 6mA.

Enable -internal logic voltage

- Logic voltage +24V	X1:25
- Contact chain betweenX1	:25 andX1 :10 (FRG)

Enable -external logic voltage

- Enable voltage +10 ... +30V	X1:10
- GNDX1	:13 (GND24)

Switch on release
- The setpoint and speed controller are released immediately.

Switch off release
- The setpoint and speed controller are locked immediately.

Auxiliary voltage

-dc voltage	X1:	2524V= ±20%
	X1:13	GND24

-operating range 19V to 30V
-current consumption 0.5A

Option auxiliary voltage 24/48V DC/DC
-internal potential-separating DC/DC converter
-dc voltage 24V to 48V = ±20%
-operating range 19 to 60V
-current consumption 0.5A

Fan connection
DC voltage 24V or 48V, max. 0.3A

Speed reference Unipolar

Voltage source for setpoints ±10V, 10mA Output resistance
470 Ω (for setpoint potentiometer 5kΩ)

+12V	X1:19
-12V	X1:18
GND	X1:17

Setpoint input
- Setpoint voltage Nominal +10V= (max. +12V=)
- Differential input
- Input resistance 50 kΩ
- Relay contacts: Use gold or reed contacts

Attention
Setpoint lines twisted in pairs and shielded. Shield connection on one side.

Connection :

Setpoint voltage with internal supply

SetpointX1	:4 (signal)
	X1:17 (GND)
BridgeX1	:5 - X1:17

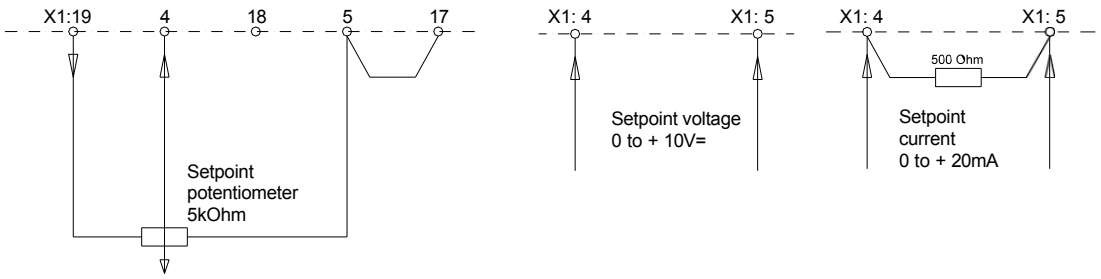
Setpoint voltage external from PLC/CNC

SetpointX1	:4 (signal)
	X1:5 (GND)

Setpoint current external from PLC/CNC
Resistor for setpoint current 0 ... ±20mA >>> R-set = 500Ω

Setpoint currentX1	:4 (signal)
	X1:5 (GND)

Int.supply **CNC/SPS** **Setpoint current**



Attention:
Do not use setpoint current 4 to 20mA

Free

PWM setpoint with direction signal

Optical separation of the input signals

Power supply GND	X1:9 X1:11	12V to 24V +/-10%
Input for PWM clock +direction	X1:6 X1:8	Frequency range 1 to 10kHz

Signal conditions Clock and direction

ONE	Input voltage	< 5V
OFF	Input voltage	> 9V
Internal resistance2		.2 kOhm

Function
The inputs are designed for open-collector drivers. (Zero active) PWM 0-100% corresponds to the internal setpoint 0-5V (0-100%)

The +direction releases the controller internally.

Free

Ready-for-use message BTB

Semiconductor relay
Signal contactX1 :21 - X1:22
Switching values max . 48V; 0.3A, Ri <2.5Ω

The ready-to-operate message (BTB) signals to the control unit (CNC/PLC) that the drive is operational.
Connect BTB messages of several drives in series.

Switch on delay after auxiliary voltage >>>max . 1sec.

Function	Display	BTB relay
Ready for operation	LED green bright	Contact closed
Error	LED red bright	Contact open

BTB falls off at	Function	Error becomes
Overtemperature	Heat sink above 75 C°	saved
Undervoltage	UB < 18V	not stored
Overvoltage	$U_B > U_{nenn}$ + 25%	saved
Short circuit, earth fault	Motor cable	saved

Reset memory with enable switch on (switch-on edge)

Attention:
It is essential to use the BTB contact in the CNC/PLC control or in the EMERGENCY STOP circuit!
Self-starting possible!
Fault memory is not effective for all faults!

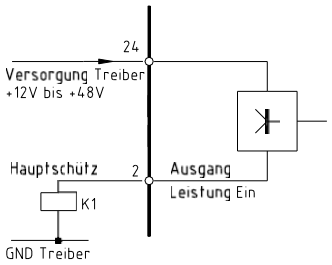
Analogue measurement outputs			
Function	**Motor current**	**Speed**	**Armature voltage**
Connection	X1:15	X1:16	X1:20
Measured value peak current	+5,0V		
Measured value continuous current	+2,5V		
Measured value speed		after n-max Poti ±5V	
Measured value armature voltage			± 12V or ± 24V
Output resistance	1kΩ	4.7kΩ	1kΩ

Driver outputs
(High Side Driver)

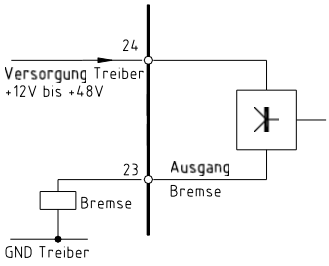
Supply voltage for driver	X1:24	Bridge to +24 (X1:25) or separate voltage 12V to 48V
Reference mass	X1:13	GND24
Switching current maximum		1A

Driver output for main contactor
When the unit is ready for operation (no error), the auxiliary voltage is switched on. the output ***Power On*** (X1:2) is switched to supply voltage (X1:24). In the event of a

fault, the output is blocked and the main contactor drops out.



Driver output for brake
If the enable (FRG) is switched off or the setpoint voltage is zero, the ***brake*** output (X1:23) is blocked. The brake is active.
When enable (FRG) is switched on and the setpoint voltage is greater than zero, the ***brake*** output (X1:23) is switched to supply. The brake is free.



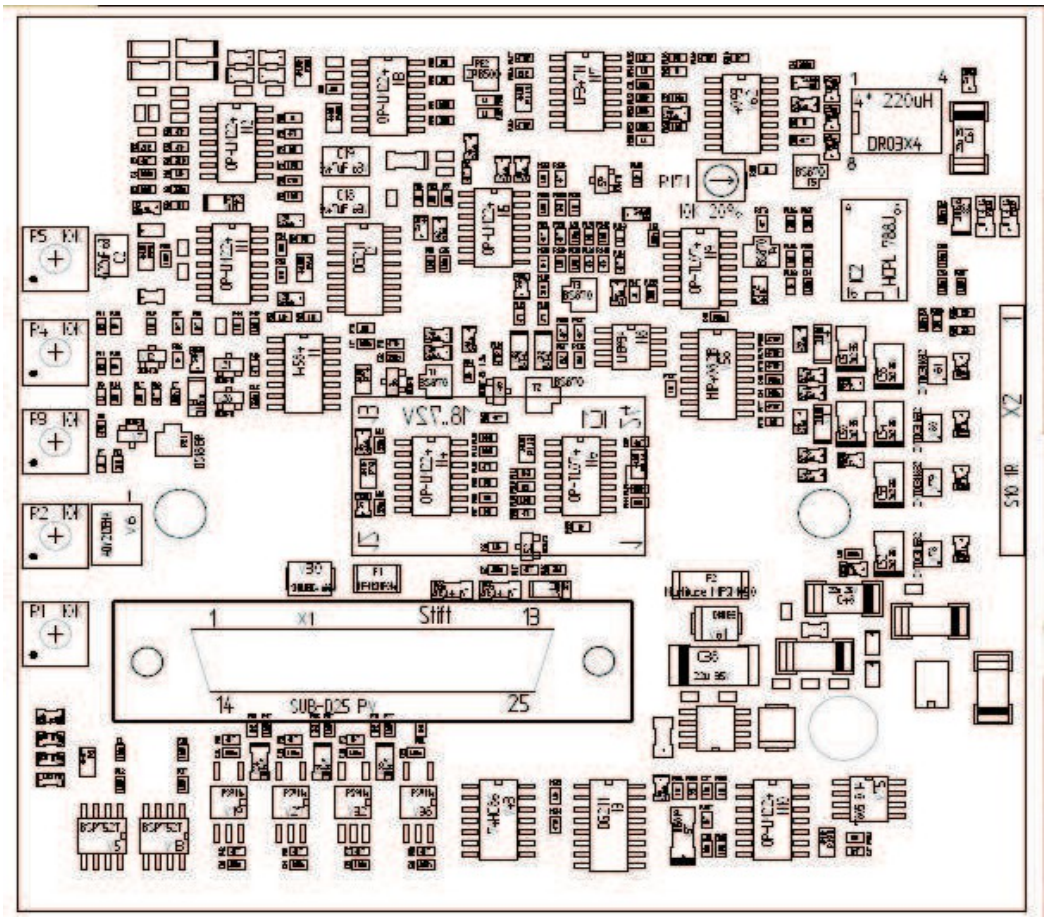
Connector diagram

Control ports		
Function	**Designation**	**Plug number**
Speedo+	Speedometer input plus	X1:1
Power On	Output control main contactor	X1:2
	free	X1:3
Set point +	Setpoint input plus	X1:4
Set point -	Setpoint input minus	X1:5
Clock	Clock PWM	X1:6
-direction	Direction PWM, setpoint polarity inverse	X1:7
+direction	Direction PWM	X1:8
+12-INDU	PWM supply	X1:9
FRG	Release	X1:10
GND12	Ground PWM	X1:11
GND	Mass	X1:12
GND24	Ground auxiliary voltage	X1:13
Speedometer -	Speedometer input - minus (GND)	X1:14
I-It-A	Analogue output current	X1:15
N-Actual	Analogue output speed	X1:16
GND	Mass	X1:17
-12E	Supply setpoint potentiometer	X1:18
+12E	Supply setpoint potentiometer	X1:19
Anchor-A	Analogue output armature voltage	X1:20
BTB	Ready for operation	X1:21
BTB	Ready for operation	X1:22
Brake	Brake control output	X1:23
Supply	Auxiliary voltage outputs +12V= to 48V=	X1:24
+ 24	Auxiliary voltage +24V=	X1:25

Connector housing = GND (ground)

Power connections		
+ UB	Battery plus	XB:1
- UB and M2	Battery minus and motor connection 2	XB:4
M1	Motor connection 1	XB:2

Component overview



Display	*Function*
V4 green	BTB Ready for operation (no error)
V3 green	+15internal supply voltage
V2 green	Release
V1 red	Malfunction (Error, Fault)

Potentiometer	*Function*
R5	X_P
R4	nmax
R3	INT
R2	I x R
R1	Imax

Block diagram

Setting potentiometer

Function	Potentiometer	
Speed alignment	R4 $(n)_{max}$	
Current limit	R1$(I)_{max}$	
Setpoint integrator	R3 (INT)	
Amplification P-share	R5 (XP)	
IxR - Compensation	R2	

LED display

Function	Colour	Display
BTB	green	Ready for operation
+15	green	Auxiliary voltage internal
FRG	green	Release
Malfunction	red	Error

Message outputs

Function	Designation	
Speed	N-Actual	
Power	I-It-A	
Armature voltage	Anchor-A	
BTB -Contact	BTB/Disturbance	

Setting instructions

Settings
- Only by trained personnel
- Observe safety regulations
- Observe setting sequence

Optimisation	Adjust with potentiometer
Actual value adjustment	n_{max} Setting
Current limits	I -setting$_{max}$
Speed controller	X -setting$_{P}$
Position controller	in the CNC PLC control system

Attention:
Always optimise control loops from the inside out. Sequence:

Current	controllerDetermined by the load circuit time constant (motor circuit inductance and motor circuit resistance) Factory optimised
Speed	controllerDetermined by the drive (inertia, friction torques) Optimise for drive dynamics (see page 22)
Optimise	position controller of the control system (CNC\PLC)

Measured values		
Measured value	max. value	Measuring point
Set point	± 10V	X1:4
Actual speed value	± 5V	X1:16
Actual current value	± 5V	X1:15

Set point

Function	max. value	Connection	
Input signal	± 10V=	X1:4	
Input GND		X1:5	

With differential input>signal and GND
- connection exchangeable With internal supply>bridge X1:5 -
X1:17, GND to X1:17

Setpoint as current signal

Setpoint from external current source	0 to	± 20mA
External load resistor for setpoint	0 to max.	±10V

Setpoint resistance R-Soll [Ω] = Setpoint voltage / Setpoint current

Attention:
Do not use setpoint current 4 to 20mA.
.

Setpoint integrator
Linear integrator
Time setting with potentiometer INT (R3)

Time range : left stop250ms right
stop 30s

Current limitation

Peak current range 0 to 200% Rated current potentiometer
I_{max} (R1)

Internally resetting current limits
At a heat sink temperature > C, the current limit is reset to the continuous current.

Actual current value

Measured value Actual current value X1:15		
Set point	Measured value I_{max} (temperature <70)°	Measured value I_D (temperature >70)°
±	max. 5V	max. 2.5V

Actual speed value

DC tachogenerator tacho

connection only

Input X1: 1= Tacho (signal)
Input X1: 14= Tachometer (GND)
Connector housing= shield

Setpoint input X1:4 positive>> Tacho input X1:1 negative

Speedometer voltage
at maximum speed
Limit values>> minimum 5V=, maximum ??V=
Coarse adjustment
Use **external** series resistor for higher tachometer voltages

Speedometer voltage [V]	**Series resistor [W]**
>25 to 50V	22 k
50 to 100V	47 k
100V to 150V	100k

Armature voltage control with IxR compensation
external feedback of armature voltage X1:20 to tacho input X1:1 Bridge in connector from X1:20 to X1:1

Speed - fine adjustment
with potentiometer (P2 clockwise faster) Setpoint from potentiometer:
at 1V setpoint adjust to 10% maximum speed at 10V setpoint fine adjust to 100%.

Setpoint of CNC\SPS:
at 0.8V adjust setpoint to 10% maximum speed

IxR compensation
Adjust with potentiometer (IxR clockwise greater) If overcompensation occurs, the drive oscillates !

Change direction of rotation
Replace motor **and** speedometer connection

For armature voltage control, only replace the motor connection.

Speed controller- Wiring

- Gain potentiometer $_{XP}$ (R5)

Basic setting fixed
soldered values P -
proportion= 100 kΩ
I - proportion =22 nF
- Gain potentiometer Xp to 50%
- optimal for most drives.

Adjustment without measuring equipment

Connect the motor,
Set point= 0
$_{XP}$ = 10% (clockwise gain greater) Release
controller,
- Turn potentiometer Xp clockwise until the drive oscillates
- Turn potentiometer Xp counterclockwise until the oscillation subsides,
- Turn the Xp potentiometer 2 positions further to the left.

Drive behaviour:

Gain too small	**Reinforcement too large**
long-wave oscillations 1... 0.1Hz	short oscillations 30 ... 200Hz
long overshoots	shakes >when accelerating,
Overruns target position	shakes >when braking and in position

Attention:
When operating with CNC\PLC controls
-at maximum speed
-Set the speed setpoint to 8 to 9V with potentiometer $_{nmax.}$

Basic setting

Check connections before commissioning

Connection	Voltage	Clamps
Battery connection	max.24V or max.48V	XB:1, XB:4
Auxiliary voltage	24V= ± 20%	X1:25, X1:13
Motor connection	max. 23V or max. 47V	XB:2, XB:4
Observe the type plate!		

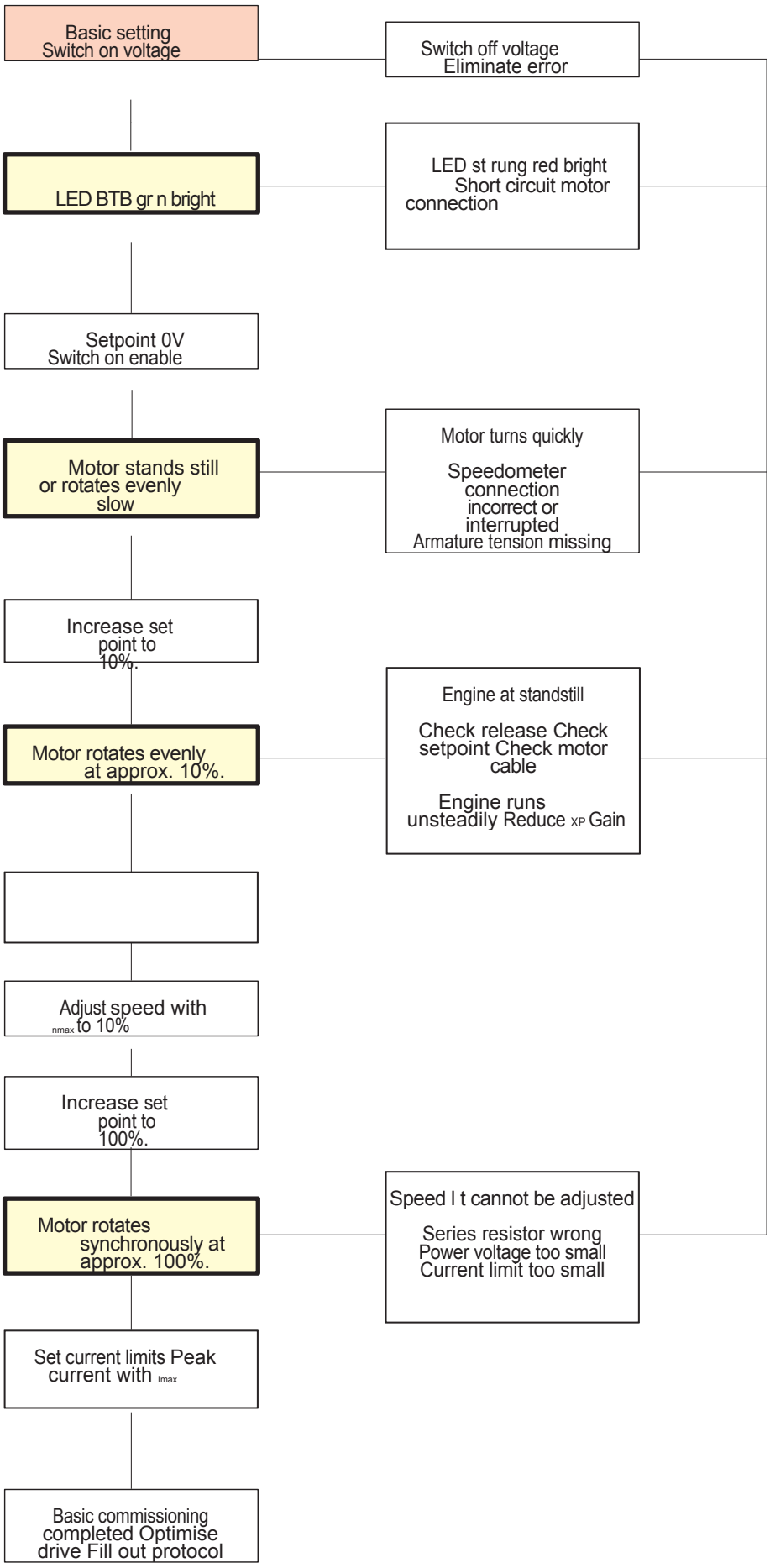
Basic connection Power connections	
Battery	2x power connection, observe polarity!
Motor	2x motor cable

Basic connection Control connections		
Auxiliary voltage	24V= ± 20%	X1:25, X1:13
BTB	Contact between	X1:21, X1:22
Release	Contact between	X1:25, X1:10
Setpoint from PLC	Differential input ± 10V	X1: 4, X1: 5

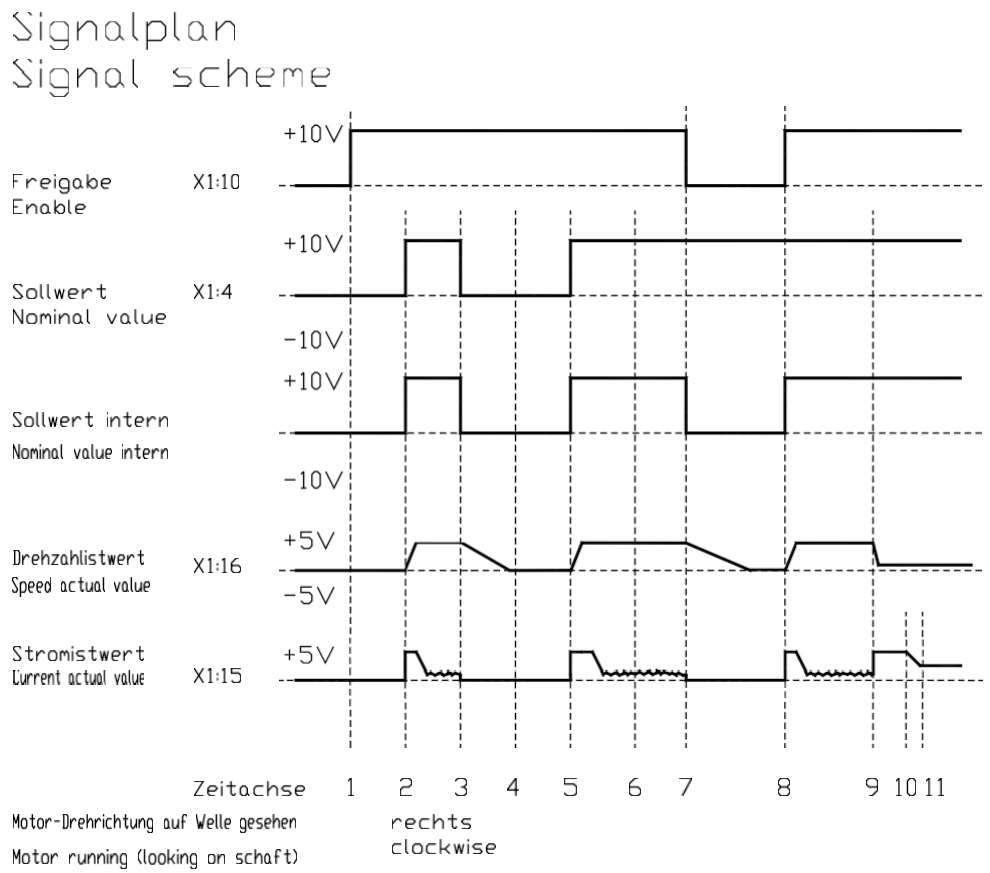
Setpoint with internal potentiometer supply		Bridge X1:5-X1:17
Setpoint supply	Positive12V (470 Ω)	X1:19
Setpoint supply	Negative 12V (470 Ω)	X1:18
Set point	± 10V	X1:4

Actual value speedometer	±24V	X1:1 (GND X1:14)
For	armature voltage control bridge from X1:20 to X1:1	

Basic setting for first commissioning		
Function	**Potentiometer**	**Setting**
Peak current	Imax	20%
Continuous current	ID	100%
Reinforcement	Xp	10%
Speed	nmax	0%
IxRt	IxR compensation	50%


Basic setting
Switch on voltage
Switch off voltage
Eliminate error
LED BTB gr n bright
LED st rung red bright
Short circuit motor
connection
Setpoint 0V
Switch on enable
Motor stands still
or rotates evenly
slow
Motor turns quickly
Speedometer
connection
incorrect or
interrupted
Armature tension missing
Increase set
point to
10%.
Motor rotates evenly
at approx. 10%.
Engine at standstill
Check release Check
setpoint Check motor
cable
Engine runs
unsteadily Reduce XP Gain
Adjust speed with
nmax to 10%
Increase set
point to
100%.
Motor rotates
synchronously at
approx. 100%.
Speed I t cannot be adjusted
Series resistor wrong
Power voltage too small
Current limit too small
Set current limits Peak
current with Imax
Basic commissioning
completed Optimise
drive Fill out protocol

Functional error	
Error	***Causes***
Light emitting diode red bright	Overtemperature of heat sink or motor. Short circuit at motor connection Power stage fault, overvoltage Overvoltage during braking.
Motor stands still, no torque	Enable missing (LED FRG dark) Current limit Imax Left stop Motor connection interrupted No power voltage
Engine runs up	Tachopolarity incorrect Tacho connection interrupted
Engine runs unsteadily	Gain XP too high. Setpoint disturbances
Speed cannot be adjusted with potentiometer nmax	External tacho droop incorrect, setpoint incorrect



Timeline		
1	Release on	Engine stops with moment style
2	Set point positive	Motor accelerated
3	Setpoint 0V	Motor runs out freely
4	Setpoint 0v	Engine at standstill
5	Set point positive	Motor accelerated
6	Constant speed	Motor rotates with load current
7	Release from	Motor runs out freely, unit is locked
8	Release on	Motor accelerated
9	Overload	Speed collapses, current goes to max. peak current
10	Overload temperature >70 C°	Current reduced to continuous current
11	Continuous current limit	

Commissioning - Protocol					
Customer			Machine no.		
Device			Serial no.		
Connection					
Battery voltage [V=]			Auxiliary voltage [V=]		
Fuse protection [A]			Fuse protection[A]		
Inputs					
Release	Contact	PLC/CNC	Voltage [V=]		
Set point	Potentiometer	PLC/CNC	Voltage [V=]		
Setting actual value					
Speedometer	V=/1000UPM		R23 [kΩ]		
Anchor tension.	V=/1000UPM		R27 [kΩ]		
IxR comp.	R2		R8 [kΩ]		
Speed controller setting					
P share			I share		
Potentiometer positions					
Peak current	I_{max} R1	Position			
Reinforcement	X $R5_P$	Position			
Speed	n_{max} R4	Position			
Measured values IxR R2					
Motor voltage.	max. [V=]				
Speedometer tension.	max. [V=]				
Motor current	Tip [A=]		permanent [A=]		
Motor data					
Manufacturer			Type		
Serial no.		Motor voltage.		Motor current	
Speedometer voltage.		Brake		Fan	