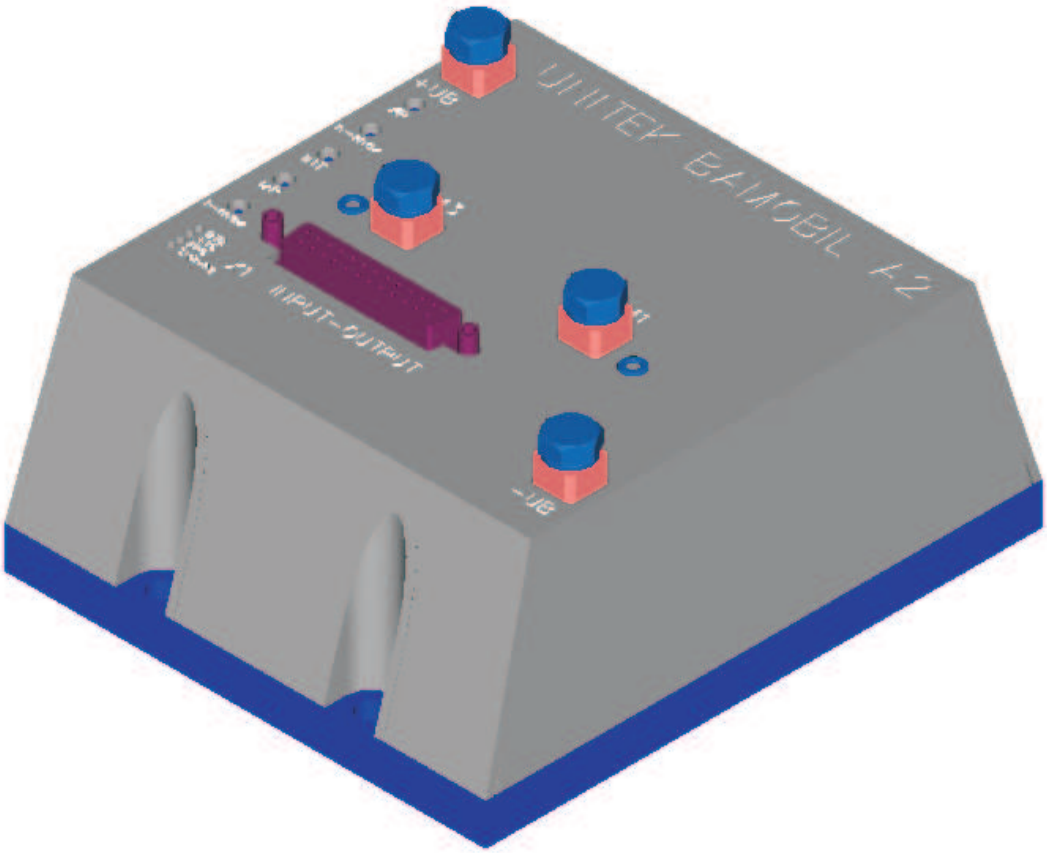
BAMOBIL-A2

MANUAL

Battery Drive
BAMOBIL A2-x-50...200
for DC-Motors



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Version
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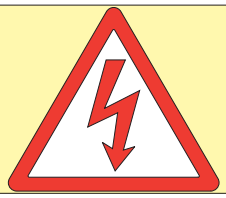
Content

Contens

Electronic Equipment is not fault proof. This fact should be borne in mind for all possible operating conditions.

ATTENTION - High Voltage
DC 60V=



Before installation or commissioning begins, this manual must be thoroughly read and understood by the technical staff involved.
If any uncertainty arises, the Manufacturer or Dealer should be contacted.
BAMOBIL - devices are Power Electric parts used for regulating energy flow.
Protection rating IP53.

Standards and Guidelines:

The device and it's associated components can only be installed and switched on where the local laws and technical standards have been strictly adhered to:

EU-Guidelines	89/392/EWG, 84/528/EWG, 86/663/EWG, 72/23/EWG
	EN60204, EN50178, EN60439-1, EN60146, EN61800-3
- IEC/UL	IEC364, IEC 664, UL508C, UL840
- VDE-regulations	VDE100, VDE110, VDE160

- TÜV-regulations
- Regulations of Professional and Occupational bodies: VGB4

The user must ensure that in the event of :

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

the axis will be safely de-activated.

It must also be ensured that the machine or equipment be fitted with device independent monitoring and safety features.

Setting Adjustments

- should only be carried out by suitably trained personnel
- should only be carried out in accordance with Health and Safety guidelines

Installation

- should only be carried out when all Voltages have been removed.

QS Test results are archived with the device serial number by the manufacturer.

CE The device adheres to the following: Guideline EU 89/336/EWG. EMV standards EN61000-2 and EN61000-4.

IIntroduction

The Battery-Drive series BAMOBIL-A2 in combination with low-voltage dc motors provide a Drive solution with excellent control characteristics.
The current (I) in a dc motor is proportional to the torque. The voltage across a dc motor is proportional to the speed.
As parameters, both current (I) and speed lend themselves to precise measurement.
The speed actual value can be obtained from the armature or dc tacho voltage.
A robust analog controller is built around these parameters. The speed and current loops are implemented using PI (proportional Integral) controllers.

Uses

Battery powered machines and vehicles of all types with a Drive power of up to 5,6kW, especially where the following is required:

* **a wide control range**
* **high dependability**
* **small motor dimensions**
* **highly repeatable, accurate and quiet moves**
* **speed control**
* **torque control**
* **combined speed/torque control**
* **incorporated within, or independent of position control loops.**

Particularly suitable for:

* **Battery powered vehicles such as cleaning machines, electric boats, fork lifts, automated warehouse transporters etc.**
* **Solar or wind powered Island devices.**

Build

IP53 rating to VDE – DIN and EU guidelines.
Analog control electronics
Power section using IGBT semiconductors, comfortably overdimensioned.

Features

* **Battery powered or**
* **Mains isolated dc (See advice page 8!)**
* **Bipolar differential command-value input**
* **PWM input (option)**
* **Speed and Torque regulation**
* **Static and dynamic current (I) limiting. (Temperature controlled)**
* **Measurement points for current(I) and speed**
* **Drive enable and emergency-stop logic**
* **Brake logic**
* **Main Fuse logic**
* **Temperature watchdog**

Technical Data

Power Connection

Type BAMOBIL A2 - 62		
Battery Supply Voltage	24V to 48V (Option 12V)	
dc supply Mains isolated dc	24V to 48V (Option 12V)	
	See advice page 8! Brake energy!!	
Output Voltage 0.95 x U_B	max. 23V to max. 47V	
Control Voltage Connection	24V= -10%,+20%, max. 0.5A ac component < 20%, Gnd = -UB (Option 48V with isolated DC/DC convertor)	

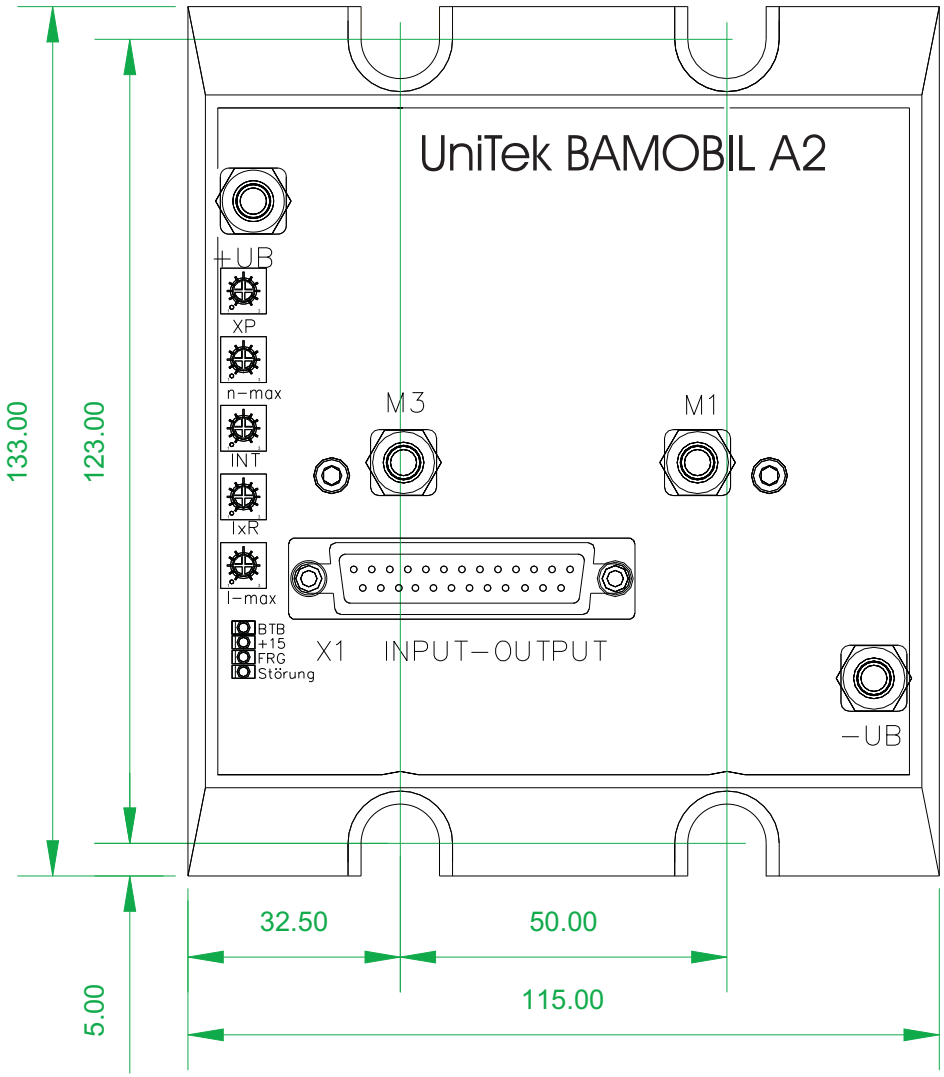
Specification

BAMOBIL A2 - 62 - x		50	100	150	200
Continuous max.	A=	25	50	75	100
Peal current (I)	A=	50	100	150	200
Power, max.	W	2300	4700	6900	9400
Power, contin.	W	1150	2350	3450	4700
Fuses external	AF	80	160	160	200
Power loss S3 50%	W	50	120	180	260
Cooling		Self	See cooling advice		
Dimensions	WxHxD	See dimensional drawings			
Weight	Kg	1			
Weight with fan	Kg	1.9			

Common Specifications

Protection rating	IP50
Format	VDE0100 Group C VDE 0160
Moisture rating	Class F to DIN 40040 No condensation allowed
Operating range	0 ... 45°C
Extended range	to 60°Creduced by 2% /°C
Storage	-30°C to +80°C
Speed controller	
Control precision (without actual	value error) ± 0.5%
Control range	1:1000
Temperature watchdog	80°C

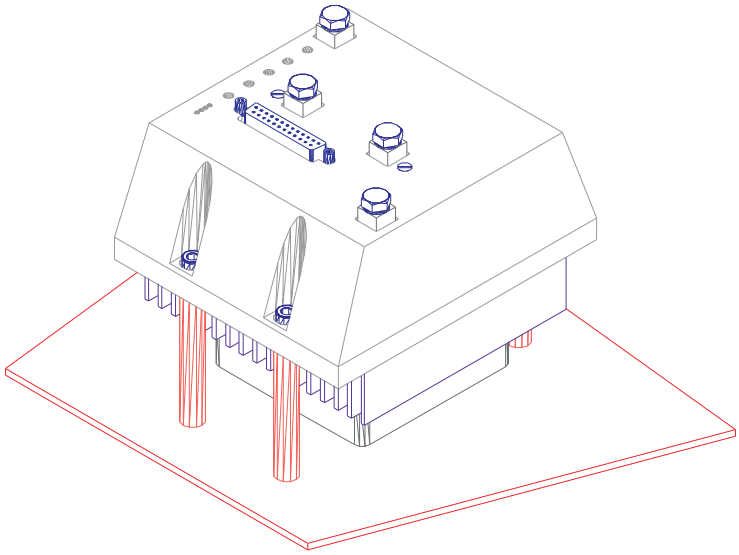
Dimensions BAMOBIL A2
Basic Device



Heat dissipation
The heat dissipation of the integrated heat plate is limited to approx. 50W. Dissipation can be enhanced by selecting an appropriate mounting plate or (because sheet metal only offers limited dissipation) a ventilation fan should be employed.

Mechanical Installation- Torque Note
The Electrical Connection bolts can withstand a maximum torque of 4.5Nm. A higher applied torque can damage the internal press-solder connections

Dimensions BAMOBIL A2
Ventilation fan option

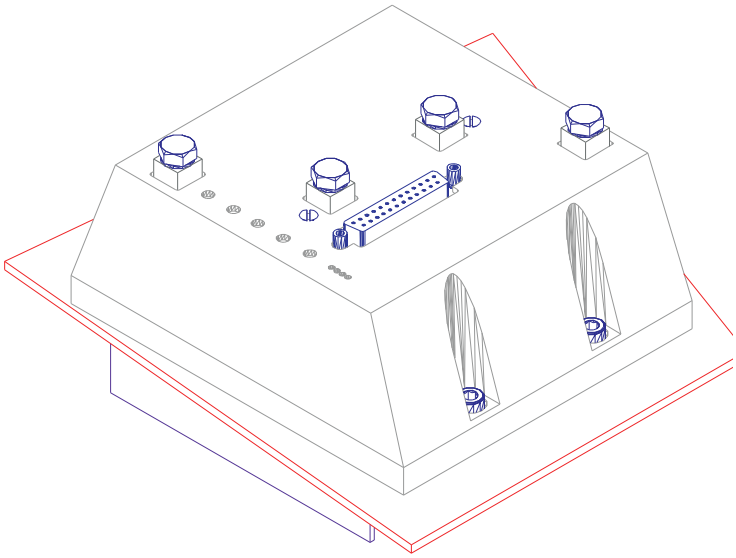


Mounting on the switchboard

Mounting height without connector 130mm

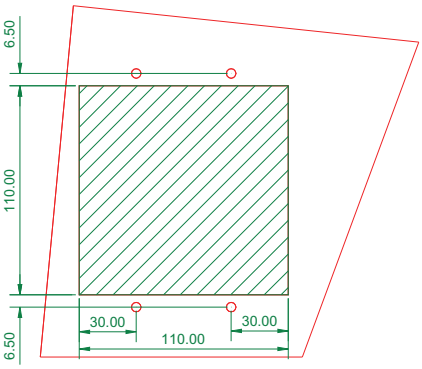
Distance bold 10x60 mm inside 5.5 mm

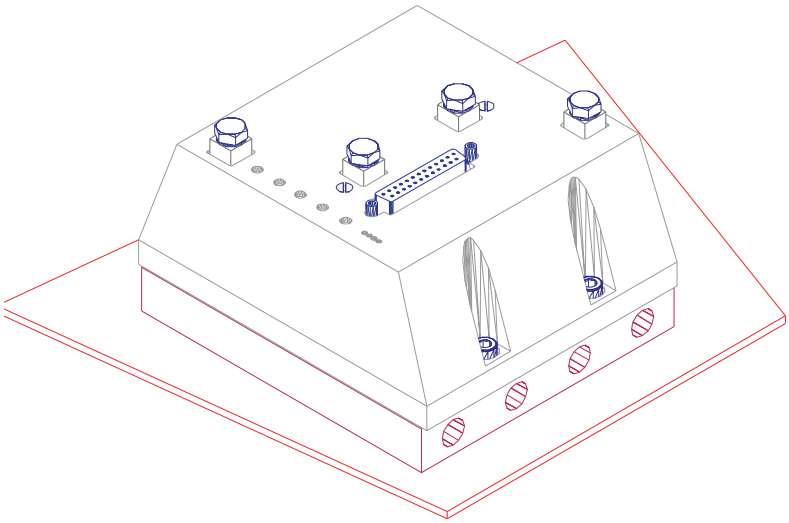
Screws M5 x 80
Fan connect. 24V=



Recess - Mounting

Mounting height without connector 70mm.
Recess depth 60mm
Screws M5x30, M5 x 20

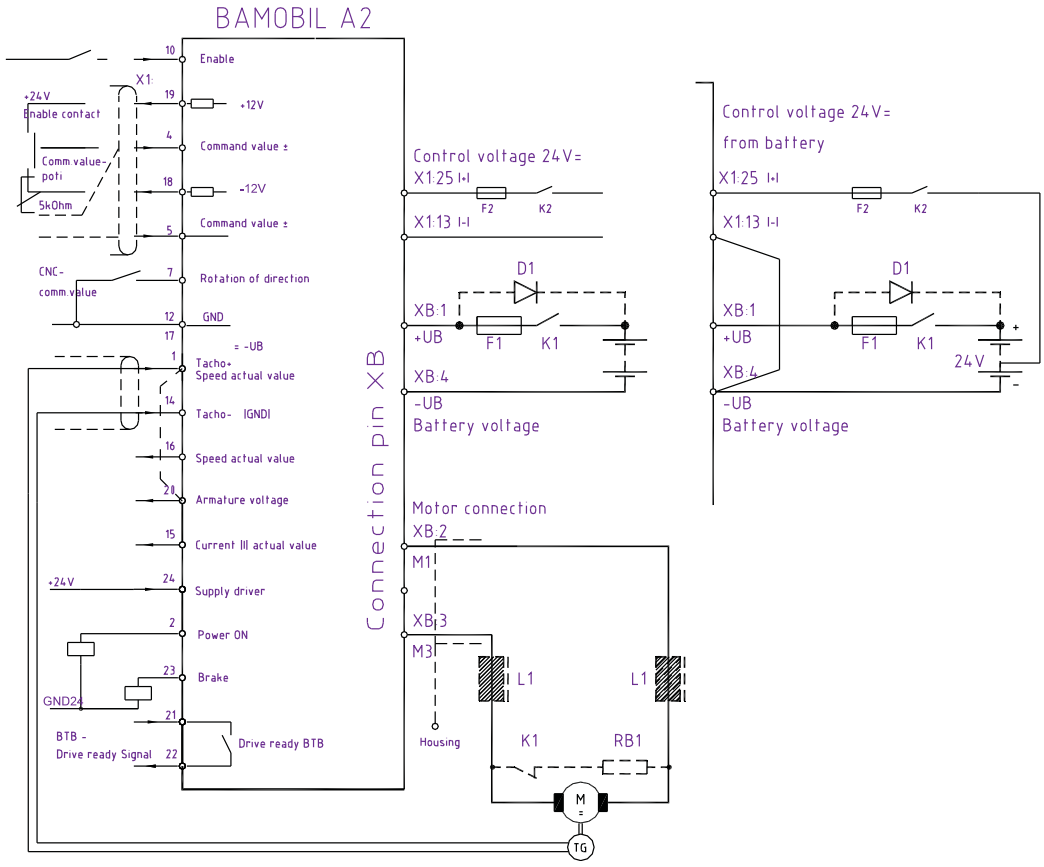




Liquid cooled heat sink

Mouting height without connector 90mm

Screws M5 x 40



Caution:

Power Connections XB:1 (+UB), XB:4 (-UB)

Connection Polarity: No Polarity swap protection is possible. False polarity connection may destroy the power section!

The Power Connection should not be removed during braking! Where required, protection diode D1 should be employed with Current(I) Rating = Device peak current(I).

Connection to a dc supply or mains operated dc supply

When using a dc supply other than a battery, braking generated over-voltage must be limited to 20% of the operating bus voltage. This may be achieved by reducing the internal resistance of the power source or by employing ballast circuitry. Under standard operating conditions, the over-voltage watchdog will switch the Drive to fault condition. However in the case of a very small motor resistance, the corresponding rapid braking voltage rise may damage the power section.

Control Voltage Connection X1:25, X1:13

Polarity protected. Always check the fan connection polarity. The control voltage can be switched independently of the power connection. Always check the voltage tolerance and ac component tolerance. When supplied from the battery bolts, connect X1:13 to XB:4 (-UB).

Motor Connection XB:2 (M1), XB:3 (M3)

For a positive command value, M1 is positive with respect to M3.

The motor connections may be swapped.

EMC problems may be reduced through the use of a choke and shielded cables.

A power drop-out brake energy dissipater may be implemented using contact K1 and Brake resistor RB1

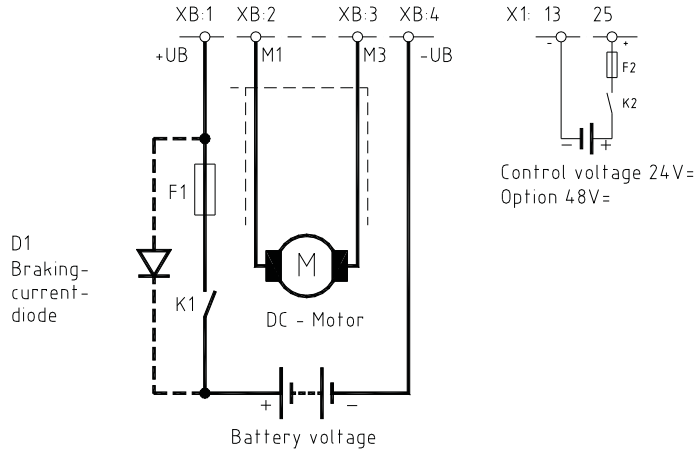
Control connections - See detailed descriptions

Power Connections

Warning:
The order of the connections to the connector numbers or screw terminals is obligatory.
All further advise is non-obligatory.
The input and output conductors may be altered or supplemented in accordance with electrical standards.

Note:

- Connection and operating instructions
- Local regulations
- EU guidelines 89/392/EWG, 84/528/EWG, 86/663/EWG
- VDE, TüV and Trade body guidelines
- CE advice, EMC



Attention:
A dc bus over-voltage condition may destroy the Drive.
The BAMOBIL-A2 must maintain the Battery connection (+UB XB:1, -UB XB:4) for 1s after the Drive enable signal has been disabled. This allows for possible Brake generated over-voltage to be limited by the battery.
To protect against the uncontrolled switching-off of the battery during braking, protection diode D1 should be installed.
For advice on connection to dc supplies other than a battery, refer to page 8.
For a positive Command value, M1 is positive w.r.t. M3.

Conductors (minimum values)

Dimensioning	For A	50	100	150	200
Battery connection	mm^2 (AWG)	6 (10)	16 (4)	25 (2)	35 (1)
Motor connection	mm^2 (AWG)	6 (10)	10 (10)	16 (4)	25 (2)
Supply Fuse F1	A	50	100	160	200
Control voltage	mm^2 (AWG)	0.5 (20)			
Control voltage fuse	AF	1			

Warning:
Battery cable length < 2m
For longer cable runs, increase the cross-sectional area by 1 stage!
For cable length > 5m install additional capacitors on the Drive.
Cable connector bolts, torque rated to 4.5Nm

Control Connections
The connection advice is provided as general information and is not obligatory.
Note:
- Connection and operating instructions
- Local regulations
- EU machine guidelines 89/392/EWG.
- VDE, TüV and Trade body guidelines

Connector pin-outs 25 way D connector
X1:1 to X1:25

Signal conductors
Shielded and separated from Power conductors.
Command value pair, twisted and shielded

Logic Connections
Relays with Gold contacts or reed relays. Contact current, 6mA

Drive enable, internal logic voltage

- Logic voltage +24V	X1:25
- Contact circuit between	X1:25 and X1:10 (FRG Drive enable)

Drive enable, external logic voltage

- Drive enable voltage +10 … +30V	X1:10
- GND	X1:13 (GND24)

Drive enabled
- Command value and Speed controller are immediately active.

Drive disabled
- Command value and Speed controller are immediately de-activated.

Make sure that the Battery Voltage remains connected to the Drive for at least 10s after the Drive has been disabled.

Control Voltage

- dc voltage	X1:25	24V= -10%,+20%
	X1:13	GND24
- Operating range	21 to 30V	
- Current rating	0.5A	

Optional extended Control Voltage range 24/48V using DC/DC converter
- internally isolated DC/DC converter
- dc 24V to 48V ±20%
- Operating range 19 to 48V
- Current rating 0.5A

Ventilation Fan connection
24 or 48V dc, max. 0.3A

Speed Command value, Bipolar

Voltage source for command value +/- 10V, 10mA
Output resistance 470R (for a Command value pot. of 5K)

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

Command value input

- Nominal Command value Voltage 10V dc (max. 12V dc)
- Differential input
- Input resistance 50k
- Relay contact: Use Gold, or reed contact

Attention
The command value pair should be twisted and shielded. The shield should be connected on one side only.

Connections:

Command value using internal voltage supply

Command value X1:4 (Signal)
X1:17 (GND)
Bridge X1:5 to X1:17

Command value from external CNC/PLC voltage

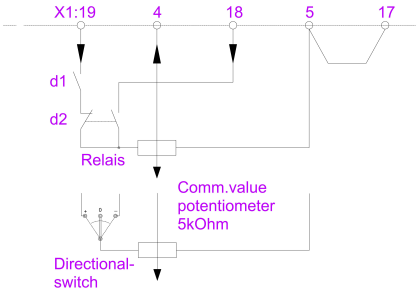
Command value X1:4 (Signal)
X1:5 (GND)

Command value Current (I) from external CNC/PLC

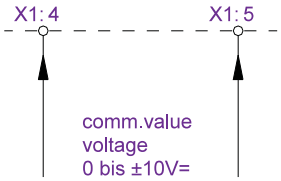
Command value Current (I) … ± 20mA. Resistor = 500R

Command value current (I) X1:4 (Signal)
X1:5 (GND)

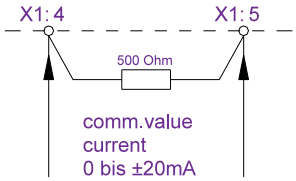
Using internal voltage source



CNC / PLC



Current (I)



Attention:
Do not use a command value current (I) range 4 to 20mA.

Speed **Command Value , Unipolar**

Voltage source for Command value +10V, 10mA
Output resistance 470R (for a Command value pot. of 5K)
+12V X1:19
GND X1:17

Command value input
- Nominal Command value Voltage 10V dc (max. 12V dc)
- Differential input
- Input resistance 50k
- Relay contact: Use gold, or reed contact

Attention
The command value pair should be twisted and shielded. The shield should be connected on one side only.

Connections:

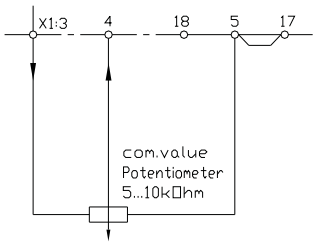
Command value using internal voltage supply
Command value X1:4 (Signal)
X1:17 (GND)
Bridge X1:5 to X1:17

Command value from external CNC/PLC voltage
Command value X1:4 (Signal)
X1:5 (GND)

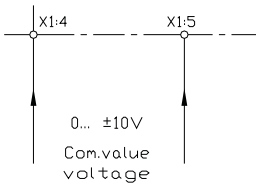
Command value Current (I) from external CNC/PLC
Command value Current (I) … ±20mA Resistor = 500R

Command value current (I) X1:4 (Signal)
X1:5 (GND)

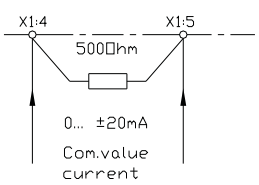
Using internal voltage source



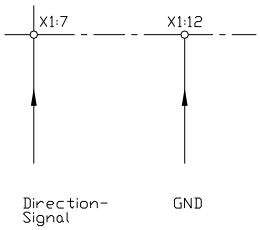
CNC / PLC



Current (I)



Direction



Change of direction
Changing the direction of the command value polarity

Direction - X1:7 (signal – direction)
X1:12 (GND)

Drive ready signal BTB

Solid-State relay
Signal contact X1:21 - X1:22
Switch Rating max. 48V; 0.3A, Ri < 2.5 Ohm

The Drive ready signal (BTB from the German Betriebsberiet) informs the controlling device (CNC/PLC) that the Drive is functional
The BTB signal can be daisy chained to other Drives.

The maximum delay once the control voltage has been applied is 1 second.

Function	Display	BTB relay
Drive Ready	LED V4 bright green	Contact closed
Error	LED V1 bright red	Contact open

BTB drops when	Function	The error is
Over Temperature	Heat sink exceeds 75°C	Saved
Under Voltage	U_B < 18V	Not Saved
Over Voltage	U_B > $U_{nominal}$ + 25%	Saved
Short circuit/ circuit to earth	Motor conductors	Saved

To clear the error, re-enable the Drive (rising flank)

Attention:
The Drive Ready (BTB) contact must be fed back to the CNC/PLC or wired into the emergency stop circuit!
It is possible for the Drive to initiate motion without being instructed to do so!
Fault saving is not effective for all errors!

Analog parameter measurement

Function	Motor Current(I)	Speed	Armature Voltage
Connector	X1:15	X1:16	X1:20
Peak Current (I)	±5.0V		
Contin. Current (I)	±2.5V		
Speed		With n_{max} poti ±5V	
Armature Voltage			max. ± 24V
Output resistance	1k	4k7	1k

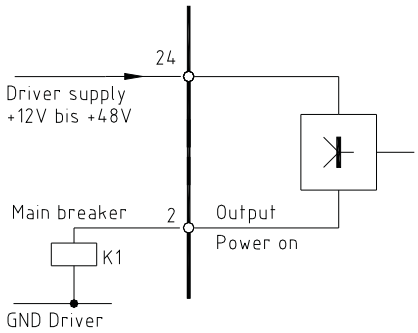
Solid State Driver Outputs

Driver Supply Voltage	X1:24	Bridge to +24 (X1:25) or independent voltage 12 to 48V
Reference	X1:13	GND24
Maximum switching current (I)		1A

Driver Output for Main Breaker

When the control voltage is applied, and no error is present, The *Power on* (x1:2) output will be switched to the supply voltage present on X1:24.

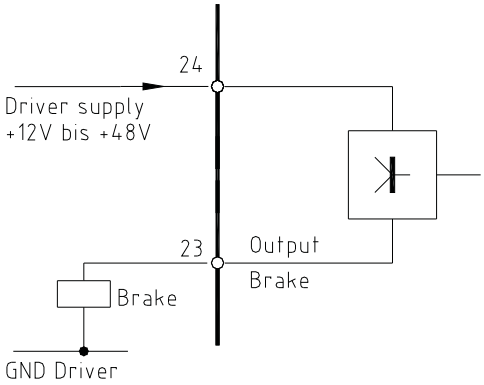
If an error occurs, the output will be disabled, and the main breaker will drop out



Brake Output Driver

If the Drive is disabled by switching off the Drive Enable (FRG) input *or*
if the Drive is enabled but the Command Value is zero, then
the Brake driver output (X1:23) is switched off. The Brake is activated.

If the Drive is enabled by switching on the Drive enable (FRG) and the Command Value is greater than zero, the Brake driver output (X1:23) is switched on. The Brake is de-activated.

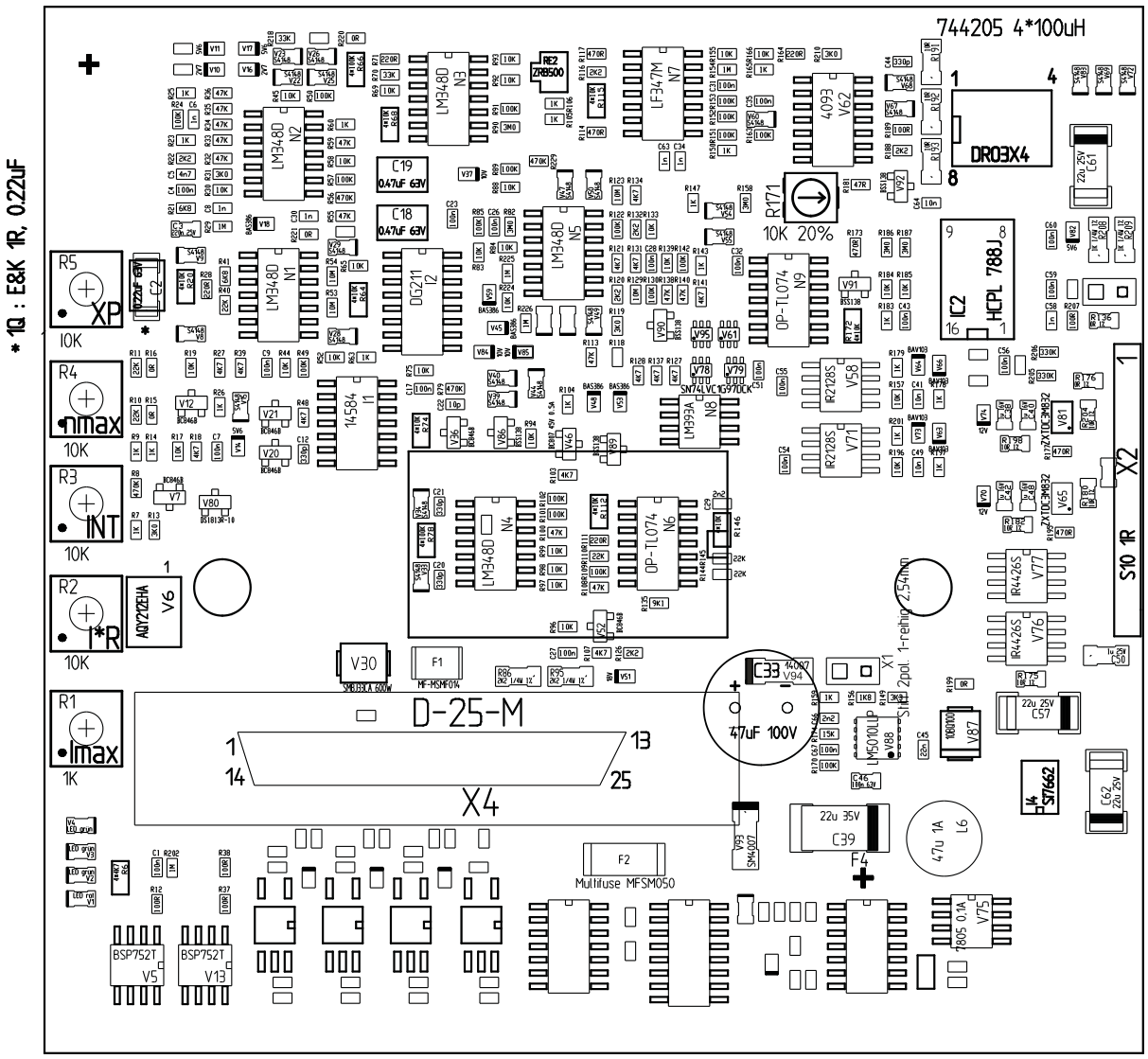


Control Signals

Function	Description	Connector Number
Tacho+	Tacho input plus	X1:1
Power On	Main Contacter control driver output	X1:2
	Free	X1:3
Command val. +	Command value + input	X1:4
Command val. -	Command value - input	X1:5
Clk	PWM clock input	X1:6
-Direction	PWM Direction, Command val. invert i/p	X1:7
+Direction	PWM Direction input	X1:8
+12-INDU	PWM supply input	X1:9
FRG	Drive enable input	X1:10
GND12	GND reference for PWM supply	X1:11
GND	GND	X1:12
GND24	GND ref. for Control Voltage	X1:13
Tacho-	Tacho input minus (GND)	X1:14
I-Ist-A	Analog output current (I)	X1:15
N-Ist-A	Analog output Speed	X1:16
GND	Ground	X1:17
-12E	Supply for Command value pot.	X1:18
+12E	Supply for Command value pot.	X1:19
Anker-A	Analog output Armature voltage	X1:20
BTB	Drive ready	X1:21
BTB	Drive ready	X1:22
Brake	Output Brake Control	X1:23
Supply	Voltage Power Supply for Driver outputs +12V= to +48V=	X1:24
+24V	Control Voltage +24V=	X1:25

Connector housing = GND

Power connection		
+ UB	Battery plus	XB:1
- UB	Battery minus	XB:4
M1	Motor connection 1	XB:2
M2	Motor connection 2	XB:3



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Display	Function
V4 green	Drive ready (no error)
V3 green	+15 internal supply voltage
V2 green	Drive enable
V1 red	Fault, error

Pot.	Function
R5	XP
R4	nmax
R3	INT
R2	IxR
R1	Imax

Potentiometer Adjustments

Function	Pot.
Speed adjustment	R4 (n_{max})
Current limit	R1 (I_{max})
Command value Integrator	R3 (INT)
Amplification Proportional (**P**) component	R5 (X_P)
IxR compensation	R2 (IxR)

LED Displays

Function	Colour	Description
BTB	V4 green	Drive ready
+15	V3 green	Control Voltage internal
Enable	V2 green	Drive enable
Fault	V1 red	Fault

Parameter measurement test points

Function	Description
Speed	actual speed N-Ist-A
Current (I)	actual current I-Ist-A
Armature Voltage	Armature Anker-A
BTB contact	Drive ready/ fault

Adjustment advice

Adjustments
- to be carried out only by qualified personnel
- Observe all safety regulations
- Follow the correct adjustment sequence

Optimisation	Adjust with potentiometer
Actual value matching	n_{max} adjustment
Current limiting	I_{max} adjustment
Speed control	X_P adjustment
Path / motion control	In the PLC/CNC control

Attention:
When optimising start with the innermost control loop and work out.

Sequence:

Current loop	Dependant on the motor circuit load time constant. (motor inductance and motor resistance) This will be factory optimised
Speed loop	Axis dependant. (inertia, friction) This should be adjusted to the desired axis dynamic. (see page 22)
Position loop	This will be optimised within the controlling device (CNC/PLC)

Test Points

Measurement	Max. Value	Connector
Command Value	±10V	X1:4
Speed	± 5V	X1:16
Current actual value	± 5V	X1:15

Command Value

Function	max. value	Connector
Input Signal	± 10V=	X1:4
Input Gnd		X1:5

For a differential input > The Signal and GND connections are interchangeable.
Using the internal supply > Bridge X1:5 to X1:17, GND to X1:17

Using current(I) as a command value.

Command value using external current source	0	to	± 20mA
External load resistor for Command val.	0	to	± 10V

Comm. Val. Resistor **R-Soll** ohm = Comm. val voltage / Comm. val. Current(I)

Attention:
Do not use a command value current (I) of 4 to 20mA.

Command value integrator
Linear integrator
Time adjustment with potentiometer INT (R3)

Integration time limits:	pot. left full scale	250ms
	pot. right full scale	30s

Current(I) Limiting

Peak current(I) range 0 to 200% contin. current(I) Pot. I_{max} (R1)

If the heatsink temperature rises above 70°C the current limit reverts to the continuous value.

Current actual value

Current (I) actual value measurement on X1:15		
Command value	Measured value I_{max} (Temperature <70°C)	Measure value I_D (Temperatur >70°C)
±	± 5V	± 2.5V

Speed Actual value

dc Tacho only

Tacho connection

Input X1:1 =Tacho (Signal)
Input X1:14 =Tacho (GND)
Connector housing =Shield

Command value input X1:4 positive Tacho input X1:1 negative

Tacho Voltage
for maximum speed
Limiting values minimum 5V=, maximum 25V=

Rough adjustment
For higher Tacho voltages use an **external** series resistor

Tacho voltage [V]	external series resistor R [Ω]
>25 to 50V	22 k
50 to 100V	47 k
100V to 150V	100k

Control using armature voltage feedback with IxR compensation
Externally connect the armature voltage output X1:20 to the tacho input X1:1.
A bridge internally in the connector housing X1:20 to X1:1 would suffice.

Speed – Fine adjustment
with potentiometer n_{max} (R2 clockwise = faster)

Command value from Potentiometer:
With a 1V input, adjust the speed to 10% of the maximum required
With a 10V input make fine adjustment to achieve 100%

Command value from CNC/PLC:
With a 0.8V command value, adjust the speed to 10% of the required max.

IxR Compensation
Adjust using pot. IxR. Turning clockwise increases compensation. If the setup is overcompensated the axis will oscillate!

Direction change
Swap the Motor **and** Tacho connections.

In an armature feedback application, only the Motor connections need to be changed.

Speed control loop circuit

- Amplification adjustment with potentiometer X_P (R5)

Basic set-up
soldered in components
P term = 100kΩ
I term = 22nF
- amplification pot. X_P to 50%
- This set-up will suit the majority of applications

Adjusting without measurement equipment
Connect the motor.
Command value = 0
X_P = 10% (clockwise increases amplification)

Enable the drive,
- Turn potentiometer X_P clockwise until the axis begins to oscillate
- Turn X_P back until the oscillation disappears
- Turn X_P back two clicks

Drive Behaviour:

Amplification too small	Amplification too high
Slow oscillations 1… 0.1Hz	Vibrations 30 … 200Hz
Large overshoots	Shudders during acceleration
Overshoots destination position	Shudders during braking and at position

Attention:

Drives connected to PLC/CNC controls
- For the maximum speed output from the controller, adjust the n_{max} pot. to give a speed command value of between 8 and 9 V.

Standard Installation

Before commissioning, check the following connections

Connection	Voltage	Terminals
Battery connection	Max. 24V or max. 48V	XB:1, XB:4
Control Voltage	24V= -10%, +20%	X1:25, X1:13
Motor connection	Max. 23V or max. 47V	XB:2, XB:3
Always read the name plate details!		

Power Connections

Battery	2 supply cables. Check the polarity!
Motor	2 motor cables

Control connections

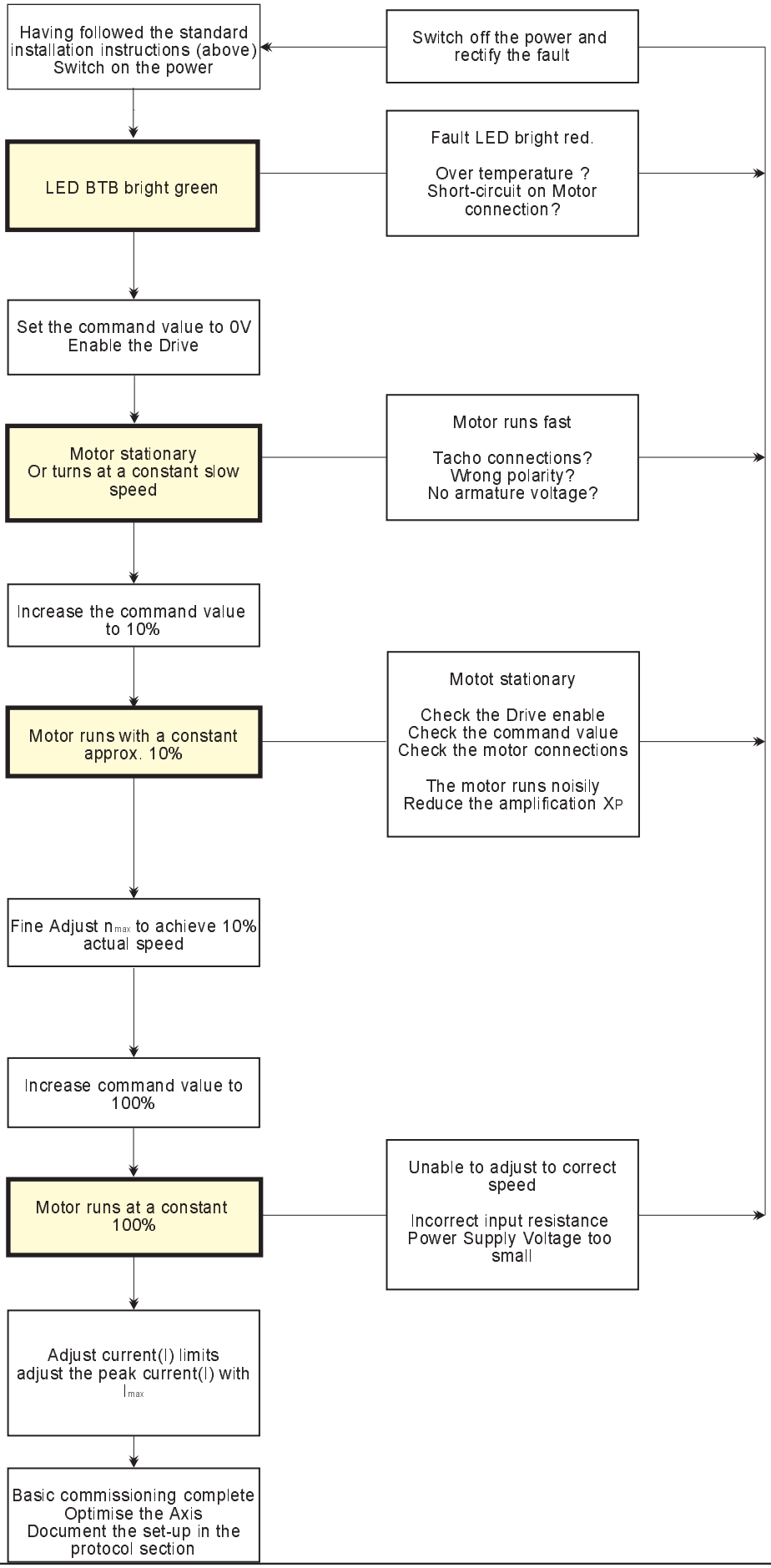
Control voltage	24V= -10%,+20%	X1:25, X1:13
Drive ready (BTB)	Contact terminals between	X1:21, X1:22
Drive enable	Contact terminals between	X1:25, X1:10
Command value from PLC/CNC	Differential input ± 10V	X1: 4, X1: 5

Command value using a pot. supplied by the Drive internal supply		Bridge X1:5 to X1:17
Command value supply	Plus 12V (470R)	X1:19
Command value supply	Minus 12V (470R)	X1:18
Command value	± 10V	X1:4

Actual value – Tacho	± 24V	X1:1 (GND X1:14)
Armature Voltage feedback Bridge X1:20 to X1:1		

Base settings for initial commissioning

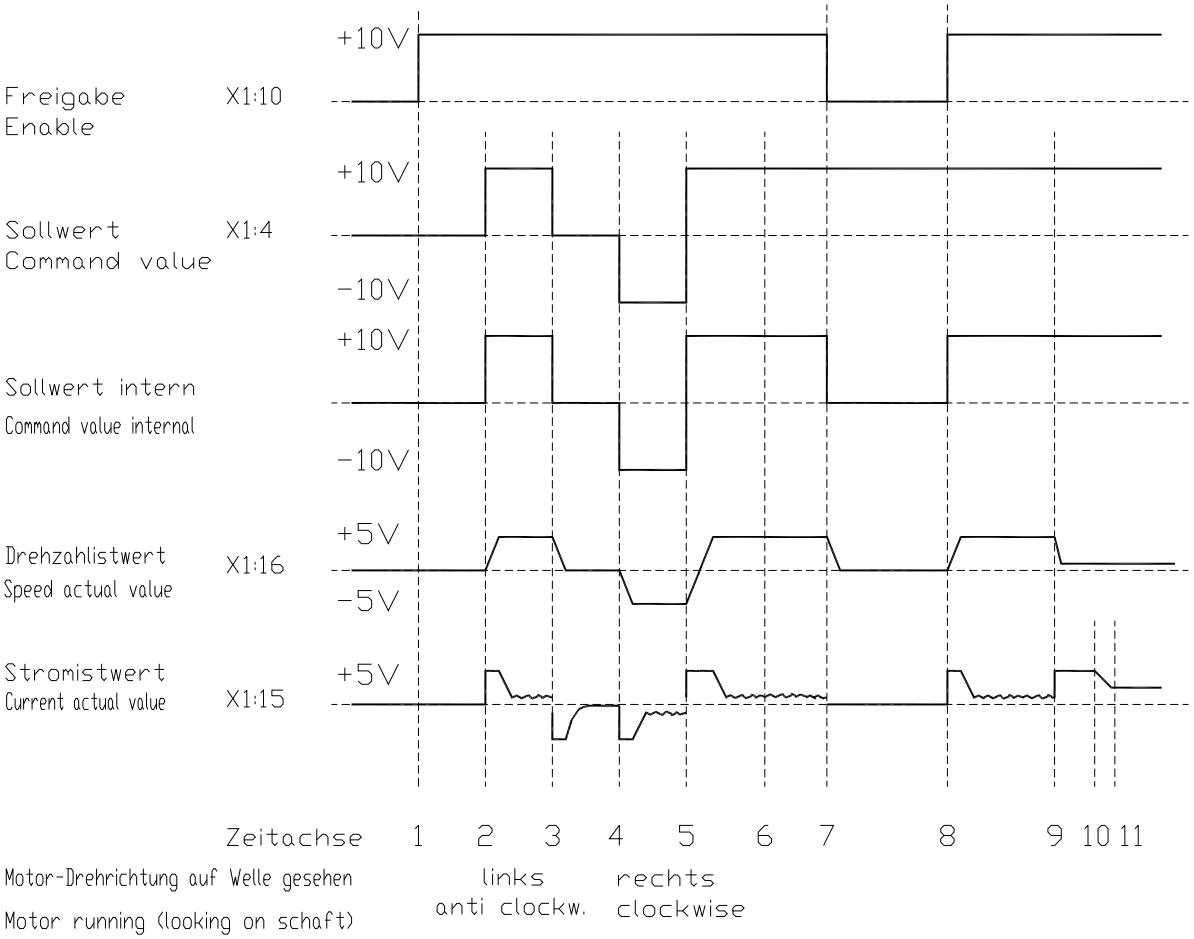
Function	Potentiometer	Setting
Peak current(I)	I_{max}	20%
Continuous current(I)	I_D	100%
Amplification	X_P	10%
Speed	n_{max}	0%
IxR	IxR compensation	50%


Having followed the standard installation instructions (above) Switch on the power
Switch off the power and rectify the fault
LED BTB bright green
Fault LED bright red.
Over temperature ?
Short-circuit on Motor connection?
Set the command value to 0V
Enable the Drive
Motor stationary
Or turns at a constant slow speed
Motor runs fast
Tacho connections?
Wrong polarity?
No armature voltage?
Increase the command value to 10%
Motor runs with a constant approx. 10%
Motot stationary
Check the Drive enable
Check the command value
Check the motor connections
The motor runs noisily
Reduce the amplification XP
Fine Adjust nmax to achieve 10% actual speed
Increase command value to 100%
Motor runs at a constant 100%
Unable to adjust to correct speed
Incorrect input resistance
Power Supply Voltage too small
Adjust current(I) limits adjust the peak current(I) with Imax
Basic commissioning complete
Optimise the Axis
Document the set-up in the protocol section

Functional Faults

Fault	Causes
Error LED bright red	Over-temperature on heatsink short-circuit on Motor connection Final stage fault Overvoltage Overvoltage arising during braking
Motor stationary, no torque	Drive enable missing (LED drive enable dark) Current Limit pot. I_{max} turned onto left limit Motor connection open-circuit No Power Voltage Armature voltage feedback - Bridge X1:1-X1:20 missing
Motor runs away	Incorrect tacho polarity Tacho connection open-circuit
Motor running noisily	Amplification X_P too high Interference on command value signal
Unable to adjust to the correct speed using pot. n_{max}	Incorrect external Tacho series resistor Incorrect command value

Signalplan
Signal scheme



Time sequence

1	Drive enable	Motor stationary, holding torque applied
2	positive command value	Motor accelerates
3	Command value 0V	Motor brakes
4	Command value negative	Motor accelerates
5	Command value positive	Motor brakes and accelerates
6	Constant speed	Motor travels using load current
7	Drive disabled	Motor coasts
8	Drive enabled	Motor accelerates
9	Over load condition	Speed collapses, Current goes to maximum peak current
10	Overload, Temperature > 70°C	Current is reduced to continuous current
11	Continuous current limit	

Commissioning Protocol					
Customer			Machine no.		
Drive			Serial no.		
Connection					
Battery Voltage =			Control Voltage =		
Fuse A			Fuse A		
Inputs					
Enable	Contact	PLC/CNC	Voltage =		
Command value	Pot.	PLC/CNC	Voltage =		
Actual value settings					
Tacho	V/1000 rpm		R23 k		
armature Voltage	V/1000 rpm		R27 k		
IxR comp.	R2		R8 k		
Speed control loop settings					
P term			I term		
Potentiometer settings					
Current (I)	I_{max} R1	Setting			
Amplification	X_P R5	Setting			
Speed	n_{max} R4	Setting			
Measured data IxR R2					
Motor voltage	max. V=				
Tacho voltage	max. V=				
Motor current (I)	Peak A=		Contin A=		
Motor data					
Manufacturer			Type		
Serial no.		Motor voltage		Motor Current(I)	
Tacho voltage		Brake		Fan	