BRUSA

TECHNICAL DATA AND STARTUP

DMC514 (ISU)
DMC524 (ISU)
DMC534 (ISU)
DMC544

Translation of the original German operating instructions.

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LEGAL NOTICE

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Updates	In light of the further technical development of our products, we reserve the right for structural changes. Any changes will be disclosed in the relevant manuals through the replacement of the relevant pages and/or a revision of the electronic data storage device.
Writer / Author	Holger Schmidt

REVISIONS

REVISION	DATE	NAME	CHANGE
rev11	04.06.2015	F. Müller	- chap. 9.5 add information about cable and terminal insert
rev12	30.09.2015	M. Voppichler	- chap. 8.3.5 “Pin 9 CNH, Pin 10 CNL (CAN-Bus, CAN-Interface)” deleted - chap. 8.4 “LV current consumption” added - Cooling system warnings added (chap. 8.7)
rev13	18.11.2015	M. Voppichler	- adjusted delivery content - adjusted diameters of cooling water connections
rev14	29.04.2016	M. Voppichler	- adjusted delivery content - Warning about terminal insert (chap. 9.5) - Chap. 12 added
rev15	28.11.2016	A. Girod	- Chapter 14 Warranty new
rev16	02.05.2017	M. Cvorak	- Chapter 8.3, LV input voltage range
rev17	15.09.2017	M. Cvorak	- Chapter 4.3, DEL: LEMO-cable from “delivered content”

VALIDITY

This manual is valid only for the following devices:

TYPE
DMC514 (ISU) - Ser.No. > 1000
DMC524 (ISU) - Ser.No. > 1000
DMC534 (ISU) - Ser.No. > 1000
DMC544 - Ser.No. > 1000

BRUSA

Table of contents

1 Foreword

Dear customer!

With the BRUSA inverter DMC5x4 you have received a very capable and versatile product. As this is a component of high performance electronics, we require specialist knowledge in the dealing with as well as the operation of the product!

Read the manual - particularly the chapter *3 Safety and warning instructions* - carefully before you inverter DMC5x4 or carry out any other work!

2 List of abbreviations

Throughout this manual, some specific technical abbreviations are used. You will find an overview as well as their meaning in the following table:

ABBR.	MEANING	ABBR.	MEANING
AUX	Wiring System Plus Terminal 30	**DMC**	Digital Motor Controller
DMC5x4	DMC514 inverter, 524,534 and 544	**IL1:**	**I**nter**l**ock
EN	Device activation Terminal 15	**IL2:**	**I**nter**l**ock
GND	Minus wiring System, vehicle ground Terminal 31	**ISU:**	**I**nverter **S**afety **U**nit
High	High level (logic level)	**Low**	**Low** level (logic level)
HV	High voltage, DC-link voltage (**h**igh **v**oltage)	**LV**	Low voltage
HV+	High voltage plus (**h**igh **v**oltage+)	**LV+**	Low voltage plus (**l**ow **v**oltage+)
HV-	High voltage minus (**h**igh **v**oltage-)	**LV-**	Low voltage minus (**l**ow **v**oltage-)

3 Safety and warning instructions

In this chapter you will find safety instructions which apply to this device. These refer to assembly, start-up and running operation in the vehicle. Always read and observe these instructions in order to protect people's safety and lives and to avoid damage to the device!

3.1 Symbols and their meaning

Throughout this manual, some specific technical abbreviations are used. You will find an overview as well as their meaning in the following table:

PROHIBITION SYMBOLS

SYMBOL	MEANING	SYMBOL	MEANING
	General prohibition		Warning high voltage Touching forbidden
	Switching on forbidden		

WARNING SYMBOLS

SYMBOL	MEANING	SYMBOL	MEANING
	General hazard warning		Electromagnetic field warning
	Potentially explosive warning		Battery hazard warning
	Hot surface warning		High electrical voltage warning
	High pressure warning / fluid spurting out		Fire hazard warning

MANDATORY SIGNS

SYMBOL	MEANING	SYMBOL	MEANING
	Disconnect device from voltage		Disconnect device from mains

INFORMATION SIGNS

SYMBOL	MEANING	SYMBOL	MEANING
	Important information on avoiding possible damage to property		Important information

3.2 Safety instructions and danger levels

DANGER

This instruction warns against serious, irreversible risks of injury and in some cases death!

Avoid these dangers by observing these instructions!

WARNING

This instruction warns against serious, irreversible risks of injury!

Avoid these dangers by observing these instructions!

CAUTION

This instruction warns against serious, irreversible risks of injury!

Avoid these dangers by observing these instructions!

INSTRUCTION

This instruction warns against possible damages to property if the following instructions and work procedures are not observed.

INFORMATION

This type of instruction discloses important information for the reader.

3.3 Generally applicable safety measures

The following safety measures have been developed based on the knowledge of the manufacturer. They are not complete, they can be supplemented by place and/or country specific safety instructions and guidelines for accident prevention!

The present safety instructions from the system integrator and/or distributor must therefore be supplemented by specific country and local guidelines.

3.3.1 Safety instructions for cooling water systems

WARNING
 **Spurting cooling fluid!** **Skin burning hazard!** Check the tightness of the cooling water system, particularly the pipes, screw joints and pressure tanks. Resolve recognisable leakages immediately!

3.3.2 Safety instructions for mechanical systems

DANGER
 **Potential explosion area!** **Danger to life!** Do not store any highly flammable materials or combustible fluids in the direct surroundings of the device! Sparks at the device connections can set these on fire and lead to explosions!

CAUTION
 **Hot surfaces!** **Burn hazard!** The device produces high temperatures when in operation! Handle the device with care and caution!

3.3.3 Safety instructions for handling and operation

INSTRUCTION	
	A high cooling water temperature reduces the life span! So take ongoing care to ensure sufficient cooling of the device! Do not place the device in direct sunlight and in close proximity to heat sources! Although if the device has high IP protection, you should avoid placing it in direct contact with water (rain, spurting water) if possible! Under no circumstances should you put a low-resistance connection between the HV contacts, the housing contacts and the LV contacts! This will lead to malfunctions and furthermore to the destruction of the device! Prevent any penetration of fluids into the device (e.g. during assembly work)! The penetration of fluids will lead to a short circuit and subsequent damage to the device! Under no circumstances should you operate the device if liquid is leaking in anywhere, refer immediately to the company BRUSA Elektronik AG!

3.3.4 Safety instructions for electrical systems

DANGER

High voltage!

Danger to life!

Under no circumstances should you touch the HV wires or HV connections without ensuring that there is no voltage beforehand!

The device may only be connected by a qualified electrician!

Under no circumstances should you bypass or avoid security installations! Any malfunctions resulting from this could have life threatening consequences!

Always use an insulation monitoring unit for ongoing monitoring of the galvanic isolation between HV and LV circuits!

Before starting work with the device, the shut-down of the coupled motors must be ensured! Even when the HV supply is switched off, a turning motor can still produce voltage!

INSTRUCTION

Under no circumstances should the device be opened without authorisation! The opening of the device (housing sealed-up) leads directly to the forfeit of any guarantee and warranty rights!

INFORMATION

Adhere strictly to the following 5 safety rules when working on a HV grid:

Disconnect system from power.
→ Switch off the ignition
→ Remove service / maintenance plug and/or turn off main battery switch
→ Remove fuse

Ensure that system does not reconnect.
→ Keep ignition key safe to prevent unauthorised access.
→ Keep service / maintenance plug safe to prevent unauthorised access.
Use lockable cover cap to ensure that the main battery switch does not reconnect.

Check that it is not live with a suitable voltage tester (note voltage range!)

Ground and short-circuit the system.

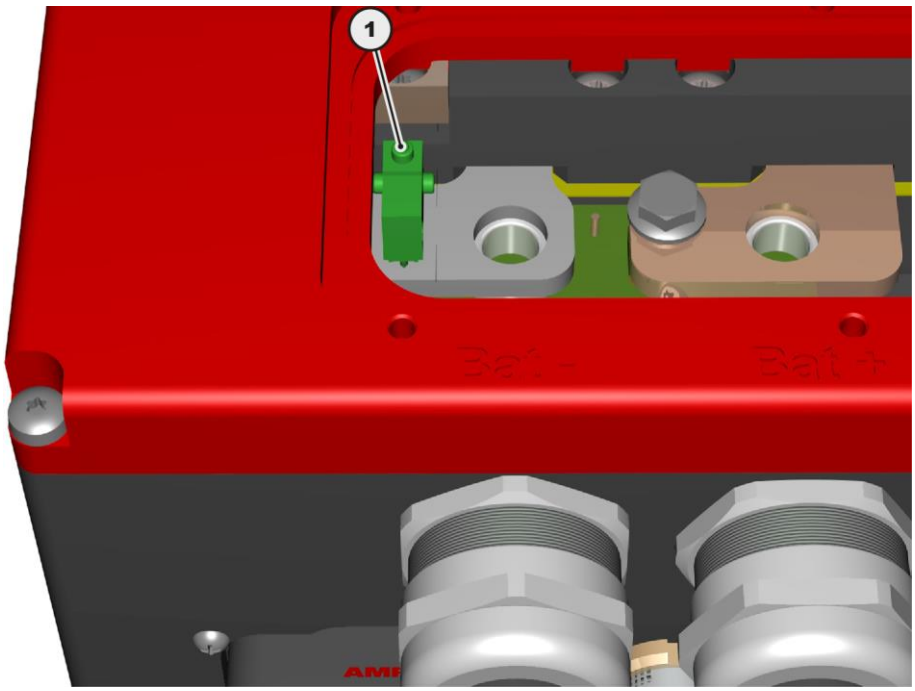
Cover or seal-off adjacent live parts.

3.4 Safety installations / power limitations

3.4.1 Interlock

INFORMATION
The pins *IL1* and *IL2* on the control connector must be connected and evaluated by the customer for this.

The interlock switch (1) protects the operator from injuries from the HV connections. The interlock switch (1) is automatically activated as soon as the service cap is opened.



1. Interlock switch

3.4.2 Short-circuit protection

If a short-circuit of the power output stage is detected (e.g. short circuit of the motor phases) then the power output stage is immediately deactivated. A corresponding error is detected over CAN. The error must be confirmed before further operation.

3.4.3 Automatic discharge of DC-link voltage

DANGER
 **High voltage!** **Danger to life!** If the High voltage is present, the HV connections are live! Under no circumstances should you touch the HV connections without ensuring that there is no voltage beforehand! In the case of additional connected capacities, consider a correspondingly longer discharge time!

As soon as the voltage on the HV connections is switched off (manually or automatically), active discharge of DC-link capacitors takes place in the inverter.

3.4.4 Monitoring of HV voltage

Integrated in the inverter is an overvoltage protective circuit, which deactivates the inverter immediately when the HV voltage is too high (Error mode). A corresponding error is detected over CAN. The error must be confirmed before further operation.

If the voltage of the HV input falls below the minimum voltage, the inverter is again deactivated (Error mode). A corresponding error is detected over CAN. The error must be confirmed before further operation.

3.4.5 Overload protection (derating)

INSTRUCTION
 Continuous operation at the temperature limit will inevitably lead to a higher level of wear of the components!

This security installation is the inverter's self-protection. If the inverter rises in temperature, this means a decrease in power (derating) to protect the inverter from damage through overheating. The power will subsequently be reduced until the temperature falls back to the target range.

The temperature measurement takes place in the high power switches and is set in the factory.

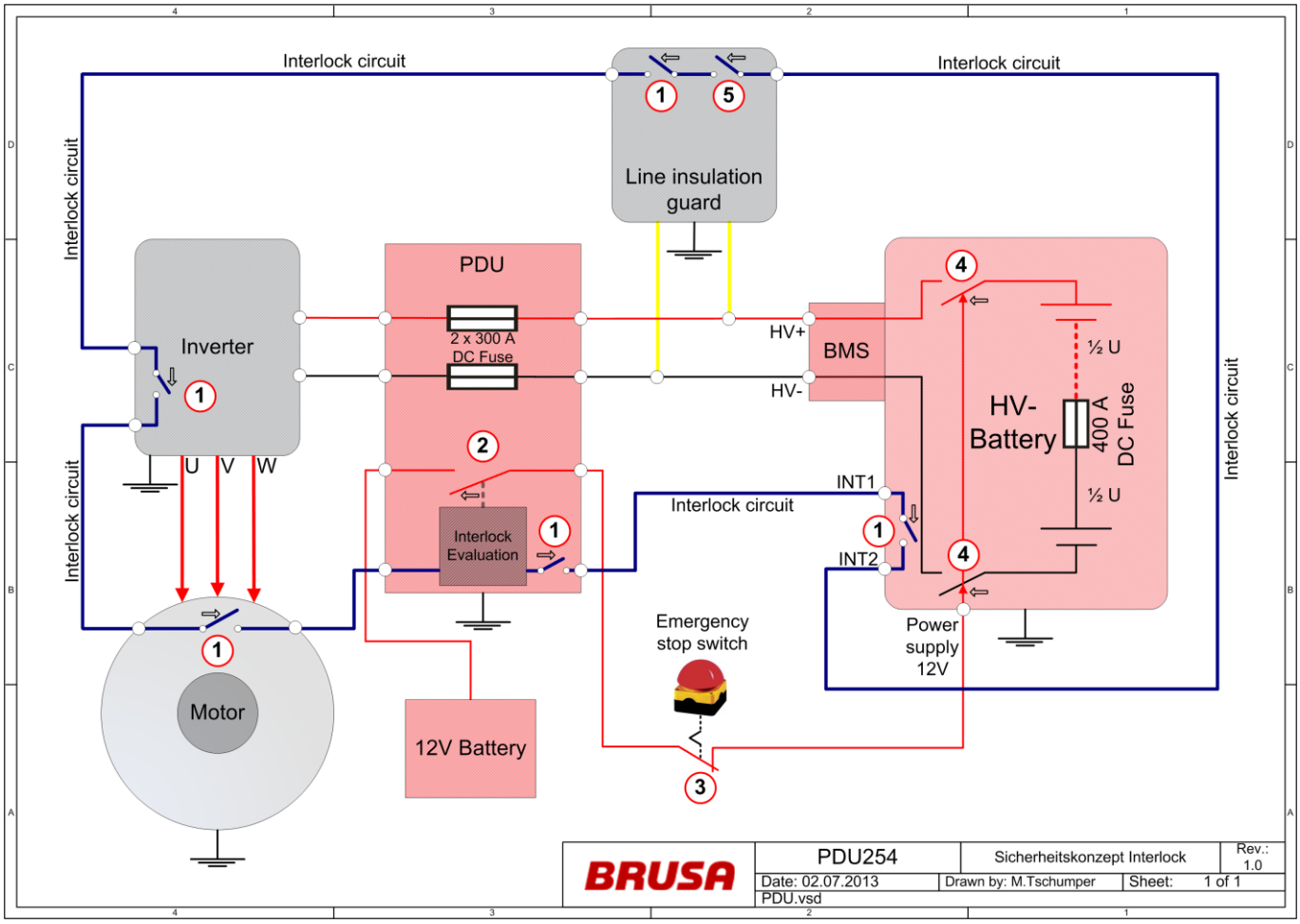
3.4.6 Inverter safety unit (ISU)

INFORMATION
 In general, the customer or the integrator is responsible for the safety of the system, in which the inverter is integrated. The device is set up for the use of an *Inverter Safety Unit (ISU).* This protective function was developed in accordance with ISO26262 and can meet the criteria of ASIL-C. The ISU is not a standard protective function and can be applied by BRUSA optionally. You can find detailed information on the ISU on the attached sheet *DMC_ISU.pdf*

3.5 Safety measures for vehicle installation

INFORMATION

This safety measure is a recommendation by the company BRUSA Elektronik AG and is understood as a basic requirement for the safe operation of electric vehicles!



3.5.1 Principle of operation Interlock

The interlock switch (1) is closed if the corresponding interlock condition of each device is met (closed service cover, plugged HV connections ...). The interlock evaluation of the PDU switches the 12V supply voltage (2) of the HV contactors (4) in the battery if the interlock circuit is closed. The emergency stop switch (3) also interrupts the 12V supply voltage of the HV contactors (4). The second interlock (5) of the line insulation guard interrupts the interlock circuit, if a fault in the HV- insulation is detected.

3.6 Requirements for the start-up personnel

All courses of action described in this manual may only be carried out by a qualified electrician! Specialist staff is defined as electricians who dispose of

professional training,
knowledge and experience in the field of electronics / electric mobility,
as well as knowledge of relevant requirements and dangers

which they can display in practice. Furthermore, they must be able to assess the work assigned to them independently, detect possible dangers and establish necessary protection measures.

4 General

4.1 Content and scope of this manual

The present documentation gives the reader an overview of all required working steps in the installation and operation of the device and the safety measures necessary for these.

Furthermore, you can find technical information, usage information and a basic description of the inverter and its specific components.

The operation and safety instructions given in the previous chapters must be strictly adhered to ensure the ongoing optimum functioning of the inverter and to meet the guarantee requirements of BRUSA Elektronik AG.

All work sequences and illustrations are based on the *DMC524* model and are applicable to all model versions mentioned in this handbook. In the case of model-specific deviations, corresponding instructions are available.

4.2 Scope of the entire documentation

INFORMATION	
	To start up the inverter successfully, you will need the entire documentation as well as different software and firmware. With the provision of the customer package, it is ensured that they are complete and up-to-date. The updating of specific documents is carried out automatically and can be seen in the history.

The customer package includes the following indexes:

Manual:
Contains all information fundamentally necessary for the installation and operation of the inverter.

Firmware / motor table:
Contains the necessary firmware, a motor specific motor parameter table and instructions for installation.

Tools:
Contains additional tools for the operation, parameter setting and maintenance of the inverter.

Debugging / calibration:
Contains additional specific documentation for further work on the inverter (e.g. error analysis, rotor offset adjustment).

History:
Listing of all upgrades within the customer package with a specification of the affected documents or software / firmware etc.

4.3 Delivered mechanical components

INFORMATION
The components stated below are contained in the delivery and are necessary for the start-up! In the case of possible missing parts, please refer to the manufacturing address given in chapter *4.6.*

INFORMATION
For the DMC544, you can use the same cable lugs as for the DMC534. The diameter of 70mm^2 cables fits without problems into 50mm^2 cable lugs and is qualified by BRUSA Elektronik AG.

MEANING	PIECES	ILLUSTRATION
1. DMC5x4 inverter	1	
2. M8 x 10 screws for the cable lugs	6	
3. M8 serrated lock washer for M8 x 10 screws	6	
4. Cable lugs (compression cable lugs) for HV and motor cables M8 x 25 mm^2 without insulation (DCMC514) *VOGT AG type. 3575A* M8 x 35 mm^2 without insulation (DCMC524) *VOGT AG type. 3584A* M8 x 50 mm^2 without insulation (DCMC534 and DMC544) *VOGT AG type. 3590A*	5	
5. Cable lug (compression cable lugs) for grounding M8 x 25 mm^2 90° without insulation (DCMC514) *GLOMAR AG type. DIN-25-08-W* M8 x 35 mm^2 90° without insulation (DCMC524) *GLOMAR AG type. DIN-35-08-W* M8 x 50 mm^2 90° without insulation (DCMC534 and DMC544) *GLOMAR AG type. DIN-50-08-W*	1	

MEANING	PIECES	ILLUSTRATION
6. 23 pole control connector with crimp terminals *AMPSEAL 770680-1*	1	
7. SN/LP contacts *AMPSEAL 770854-1* for wire diameter: 0.5 mm^2 We recommend the use of the following crimping tool: *Tyco 58440-1*	25	
8. Normaquick cooling water connection pieces 0° Norma PS3	2	
9. Software package (For a listing see chapter *4.2 Scope of the entire documentation)*	1	---
10. Entire documentation (For a listing see chapter *4.2 Scope of the entire documentation*)	1	---

4.4 Optional delivery contents

INFORMATION
These accessories can be obtained optionally from BRUSA Elektronik AG.

	MEANING	TYPE	ILLUSTRATION
1.	Special key for HV cable fitting	**RAAA041**	---
2.	Normaquick cooling water connection pieces 90° Norma PS3	**MHAA776**	
1.	M18x1.5 D16 cooling water connection	**MAAA366**	
1.	Rubber seal for M18x1.5 D16 cooling water connection	**MAAA365**	
2.	Protective cap for M18x1.5 D16 cooling water connection	**MHAA682**	
3.	Cable glands for 13 mm - 18 mm cable diameter	**RAAA040**	
4.	Cable glands for 9 mm - 16 mm cable diameter	**RKAA144**	
5.	14 pole Lemo connecting cable (inverter - motor) 2 m	**11140**	
6.	14 pole Lemo connecting cable (inverter - motor) 4 m	**11141**	
7.	Spare- CEQ 25 mm2	**11471**	---
8.	Spare- CEQ 35 mm2	**11472**	
9.	Spare- CEQ 50 mm2	**11473**	
10.	Conversion switch resolver to digital	**MHAA745**	---

4.5 EU-guidelines

This manual has been produced under the application and in respect of Inverter DMC5x4 EG guidelines, national regulations and harmonised standards (EN) which were valid at the time of production.

4.6 Contact information of the manufacturer

BRUSA Elektronik AG
Neudorf 14
9466 Sennwald
Switzerland

Phone: +41 81 758 19 - 00
Fax: +41 81 758 19 - 99
Internet: www.brusa.biz
E-mail: support@brusa.biz

5 Intended use of the device

5.1 Proper use

The BRUSA DMC5x4 inverter has been designed for the following uses. In the case of planned operations in other sections, please contact the company BRUSA Elektronik AG beforehand at the manufacturers address as given in chapter *4.6.*

The DMC5x4 inverter is a universal inverter for the driving of different three phase motors, such as for example:

- Induction Motor or Asynchronous Motor (ASM)
- Permanently Excited Synchronous Motor (PSM)
- Hybrid synchronous motor (HSM)
- Internal Permanently Excited Synchronous Motor (IPM)

The BRUSA DMC5x4 inverter has generally been designed for integration into power trains. The inverter can also be operated in generator mode. This can be done in combination with a range extender (combustion motor for range extension). In this way, the inverter is inserted between a generator and a battery to convert the produced electricity and store it in the battery.

INFORMATION
This equipment is a custom built evaluation kit destined for professionals to be used solely at research and development facilities for such purposes.

5.2 Improper use / limits of the product

The carrying out of applications which do not conform to the conditions and requirements stated in the technical documents and datasheets of the manufacturer is viewed as improper use.

The following limit values are set for the operation of the DMC5x4 inverter. Operation out with the defined limits can also lead to life-threatening situations!

The following limit values are set for the DMC5x4 inverter by the manufacturer and must be adhered to in all cases:

- Max HV input voltage (operation): 450 V
- Max HV input voltage (without damage): 520 V
- Min temperature of surroundings: - 40°C
- Max temperature of surroundings: + 85°C
- Min coolant temperature: - 40°C
- Max coolant temperature: + 65°C
- Maximum pressure cooling water system: 1.0 bar
- The three-phase output voltage given out from the frequency inverter cannot be used to drive a one-phase motor!

6 About this device

6.1 Technical data

HV AND LV POWER SUPPLY	DMC514	DMC524	DMC534	DMC544	UNIT
Min. Input voltage at terminal 15 (connect inverter)	6	6	6	6	V
Min. Input voltage at terminal 15 (automatic disconnection of the inverter)	2	2	2	2	V
Min. HV input voltage for operation (Software disconnection)	120	120	120	120	V
Min. HV input voltage for operation	130	130	130	130	V
Min. HV input voltage for full electrical output (V_{DCmin})	200	200	200	200	V
Max. HV input voltage (operation) (V_{DCmax})	450	450	450	450	V
HV input voltage software disconnection	460	460	460	460	V
HV input voltage hardware disconnection	480	480	480	480	V
Max. HV input voltage of device (without damage):	520	520	520	520	V
Max. protective fuse[1)]	150	300	450	600	A
X capacity (for HV pre-charging)	200	380	560	740	uF
Y capacity (for dimensioning of insulation monitoring unit)	98 + 98	128 + 128	158 + 158	188 + 188	nF

1: semiconductor fuse for DC / e.g. fuse type FWH 500V from Bussmann

THREE PHASE OUTPUT U, V, W (R, S, T)	DMC514	DMC524	DMC534	DMC544	UNIT
RMS current duration (I_{ACcont})	112	225	337	450	A
Periodic cycle with max. current 30 sec 100%, 90 sec 50%	150	300	450	600	A
Continuous output (V_{DC}=75%V_{DCmax}, I_{AC}=I_{ACcont}, cosφ=0.9)[1] (P_{ACcont}) *1	39	79	118	160	kW
Max. output (V_{DC}=75%V_{DCmax}, I_{AC}=I_{ACmax}, cosφ=0.9)[1] (P_{ACmax}) *1	52	105	157	212	kW
PWM frequency (symmetric modulation) (f_{PWM})	24	24	24	24	kHz
Efficiency (V_{DC}=75%V_{DCmax}, P_{AC}=P_{ACcont}, cosφ=0.9) *1	0.97	0.97	0.97	0.97	---

***1:** 100% AC Sine Modulation, Phase-to-Phase AC Voltage amplitude = V_{DC}

MECHANICS AND EQUIPMENT	DMC514	DMC524	DMC534	DMC544	UNIT
Height	88	88	88	88	mm
Width	240	240	240	240	mm
Length (without cable lugs and connections)	250	360	470	580	mm
Length (with cable lugs and connections)	276	386	496	606	mm
Weight (with cooling water)	6.5	9.5	12.5	15.5	kg
IP protection	IP67	IP67	IP67	IP67	---

CONNECTIONS	DMC514	DMC524	DMC534	DMC544	UNIT
HV+, HV- high voltage: 2 M8 cable lugs, recommended cable diameter	25	35	50	70	mm^2
Phases U, V, W: 3 M8 cable lugs, recommended cable diameter	25	35	50	70	mm^2
23 pole AMP, wire diameter	0.5	0.5	0.5	0.5	mm^2
Motor sensor connector, number of contacts	14	14	14	14	---

THERMAL	DMC514	DMC524	DMC534	DMC544	UNIT
Amount of coolant in device	0.3	0.6	0.9	1.2	l
Flow rate	6-10	6-10	6-10	6-10	l/min
External diameter of cooling water connection pieces	18	18	18	18	mm
Minimum coolant temperature at inlet	- 40	- 40	- 40	- 40	°C
Maximum coolant temperature at inlet	+ 65	+ 65	+ 65	+ 65	°C
Coolant pressure drop @ 6l/min, $T_{coolant}$ = 25°C (with a water to glycol mixture ratio of 50 / 50)	70	120	150	180	mbar
Maximum pressure of the coolant	1	1	1	1	bar
Maximum particle size in the coolant	0.2	0.2	0.2	0.2	mm
Ambient temperature range for storage	- 40 to + 85	- 40 to + 85	- 40 to + 85	- 40 to + 85	°C
Ambient temperature range in operation	- 40 to + 85	- 40 to + 85	- 40 to + 85	- 40 to + 85	°C

INSTRUCTION

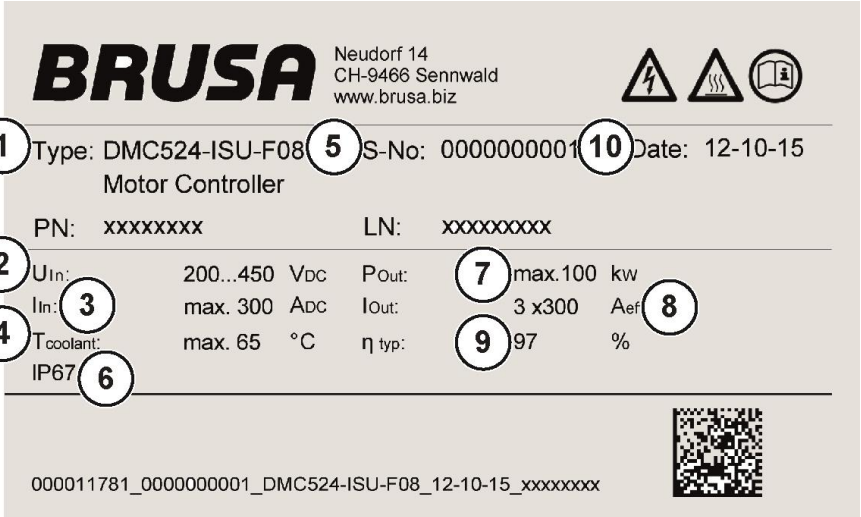
- The mixing ratio of glycol and water must be at least 50% / 50%. Apart from that, the inverter will fail at low temperatures.

WARNING

When the abovementioned points based on the cooling are not complied, the inverter will fail!

6.2 Type plate

The type plate is on the back of the device and contains the following information:



1.	Classification	**2.**	Operating voltage (section)
3.	Maximum input current	**4.**	Maximum coolant temperature at inlet
5.	Serial number	**6.**	IP protection category
7.	Max. power	**8.**	Maximum phase currents (U, V, W)
9.	Level of efficiency	**10.**	Date of manufacture

6.3 Device warnings

Warning signs are installed on the device to warn the operator of possible dangers. Should one of these warning signs fail or become illegible due to wear and tear, it must be immediately renewed! To get an original label, please refer to BRUSA support at the manufacturing address given in chapter *4.6*!

6.4 Basic function

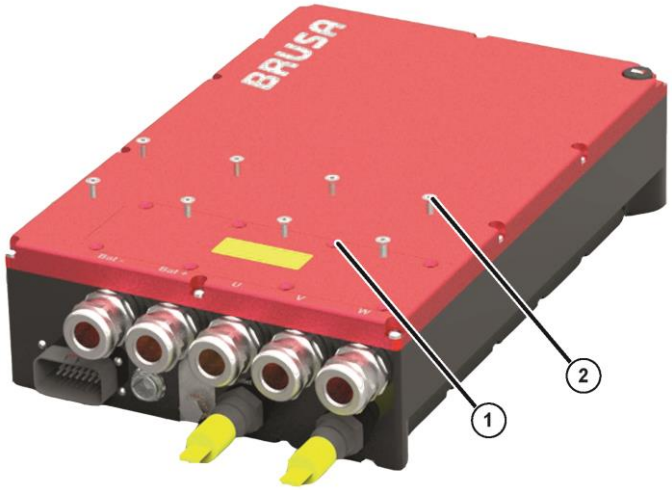
The DMC5x4 inverter is a universal inverter which can be used to drive different three phase motors.

The power output stage of the DMC5x4 is based on the most capable, resonant SoftSwing® topology which was developed and patented by BRUSA Elektronik AG. SoftSwing® topology achieves minimal switching losses and excellent EMC features which are above average. Through this, the use of applications with motor frequencies of up to 2 kHz is possible. With its very compact and easy assembly method, the DMC5x4 inverter is suitable for practically any application.

To drive a motor, the corresponding motor parameter table is necessary. This must be tailored to the specific motor by BRUSA who will also set the parameters!

6.5 Covers

INFORMATION
Only the covers mentioned in this chapter may be removed by the customer! Torque for M4 x 08 screws: 2.5 Nm



1. Service lid

2. M4 x 08 screws (8 pieces)

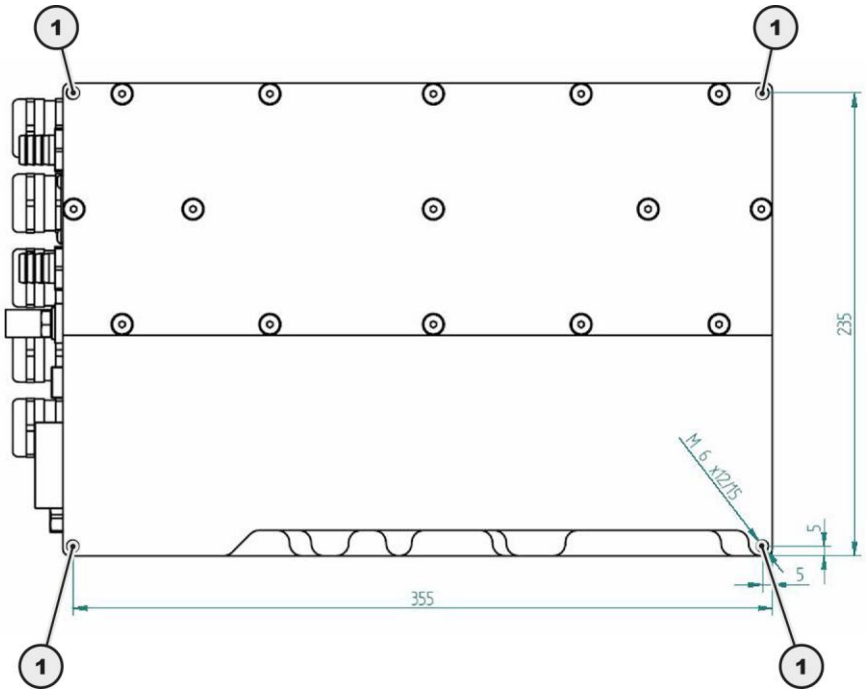
6.6 Assembly information

6.6.1 Installation position

Even if the device has high IP protection, install it well above the fording depth of the vehicle. Ensure for the installation positioning that the connection side is tilted downwards. This prevents water accumulation on the cable sealing which could result in water leaking into the housing.

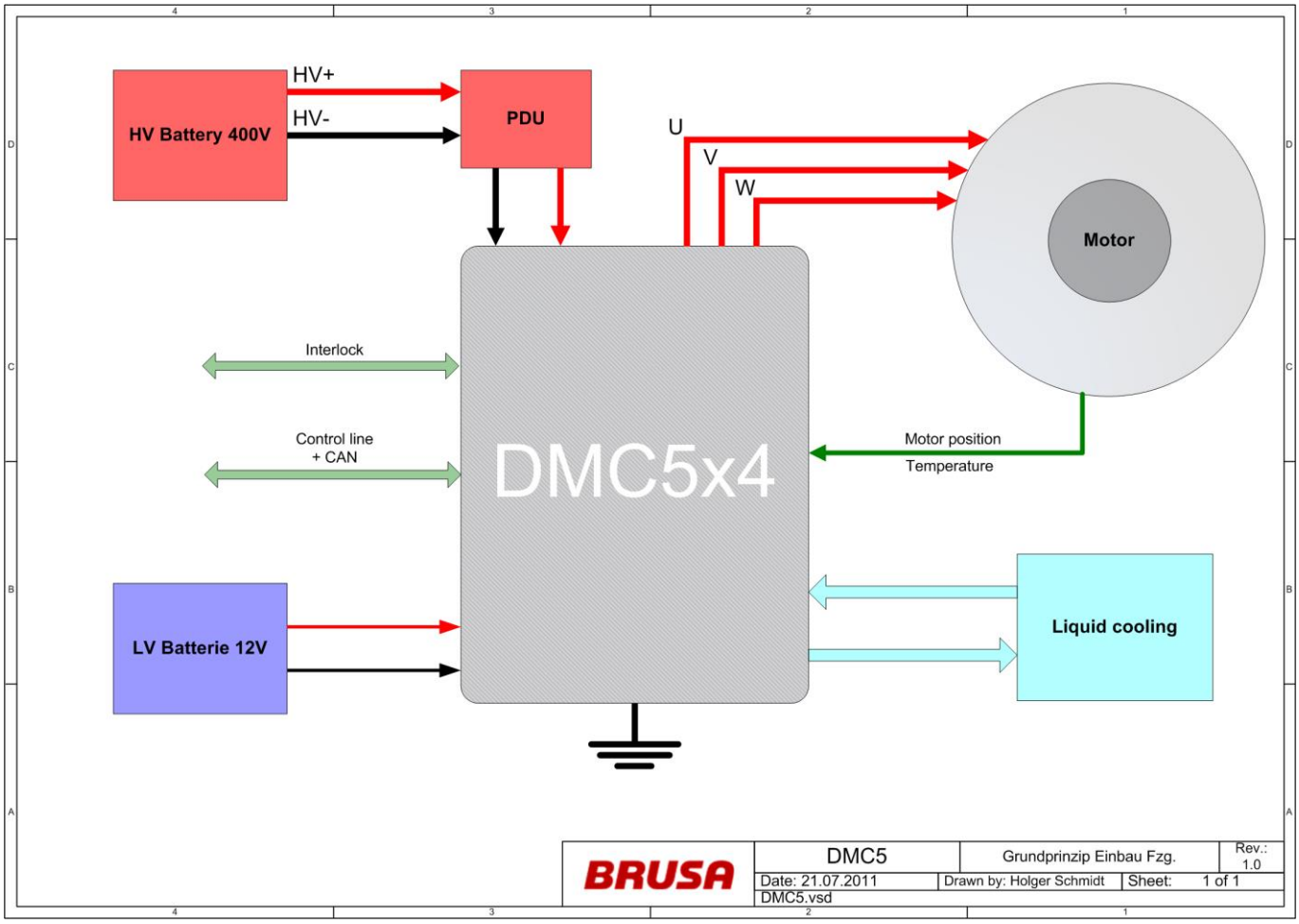
6.6.2 Fixing (as in example DMC524)

INFORMATION
Recommended screw types: Cylinder screw ISO 4762 - M6 x 30 - 8.8 **or** Hexagon screw ISO 4017 - M6 x 30 - 8.8 Torque for M6 x 30 screws: 10 Nm +/-0.5

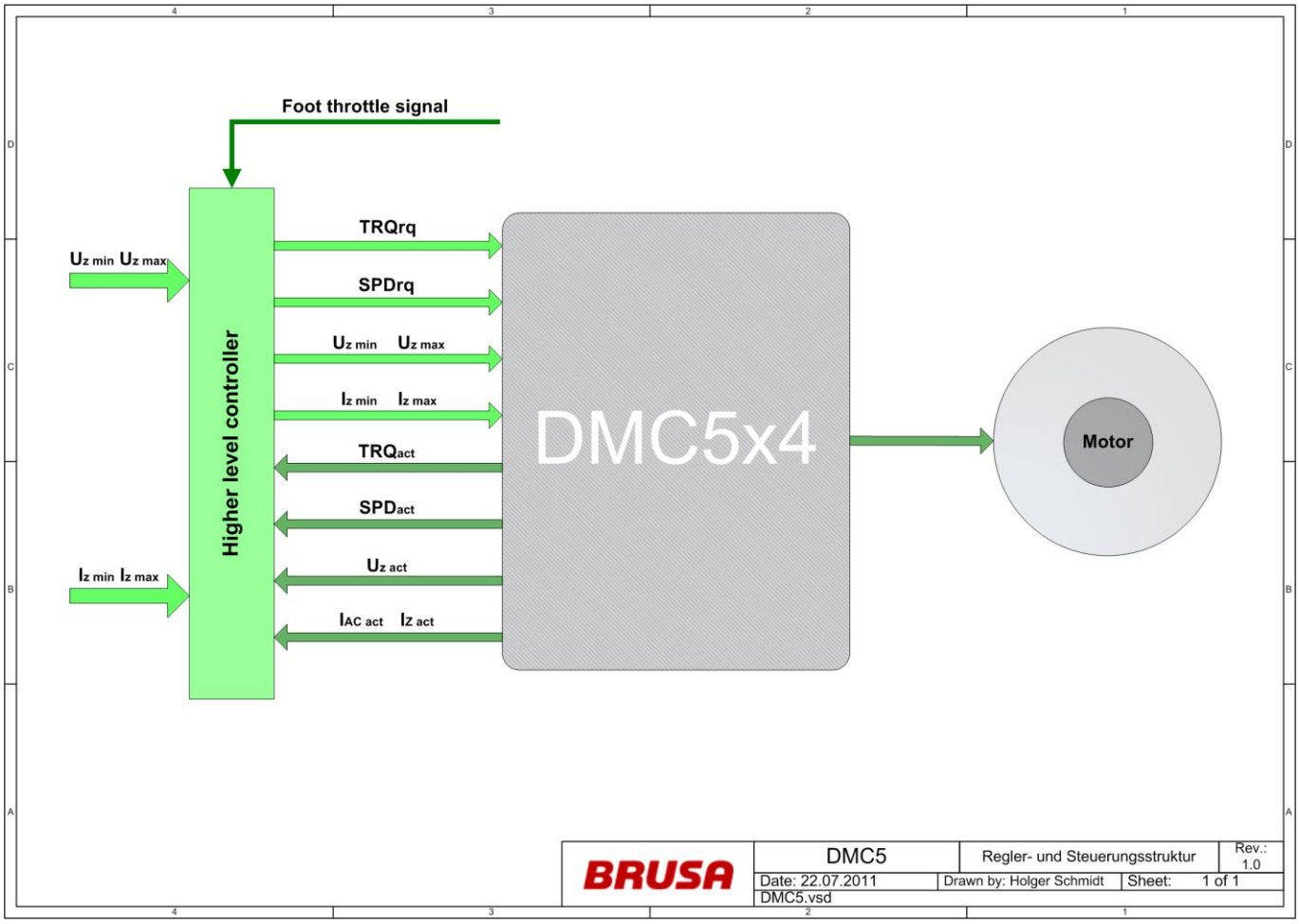


1. Screw fixing points (4 pieces)

6.7 Example of use

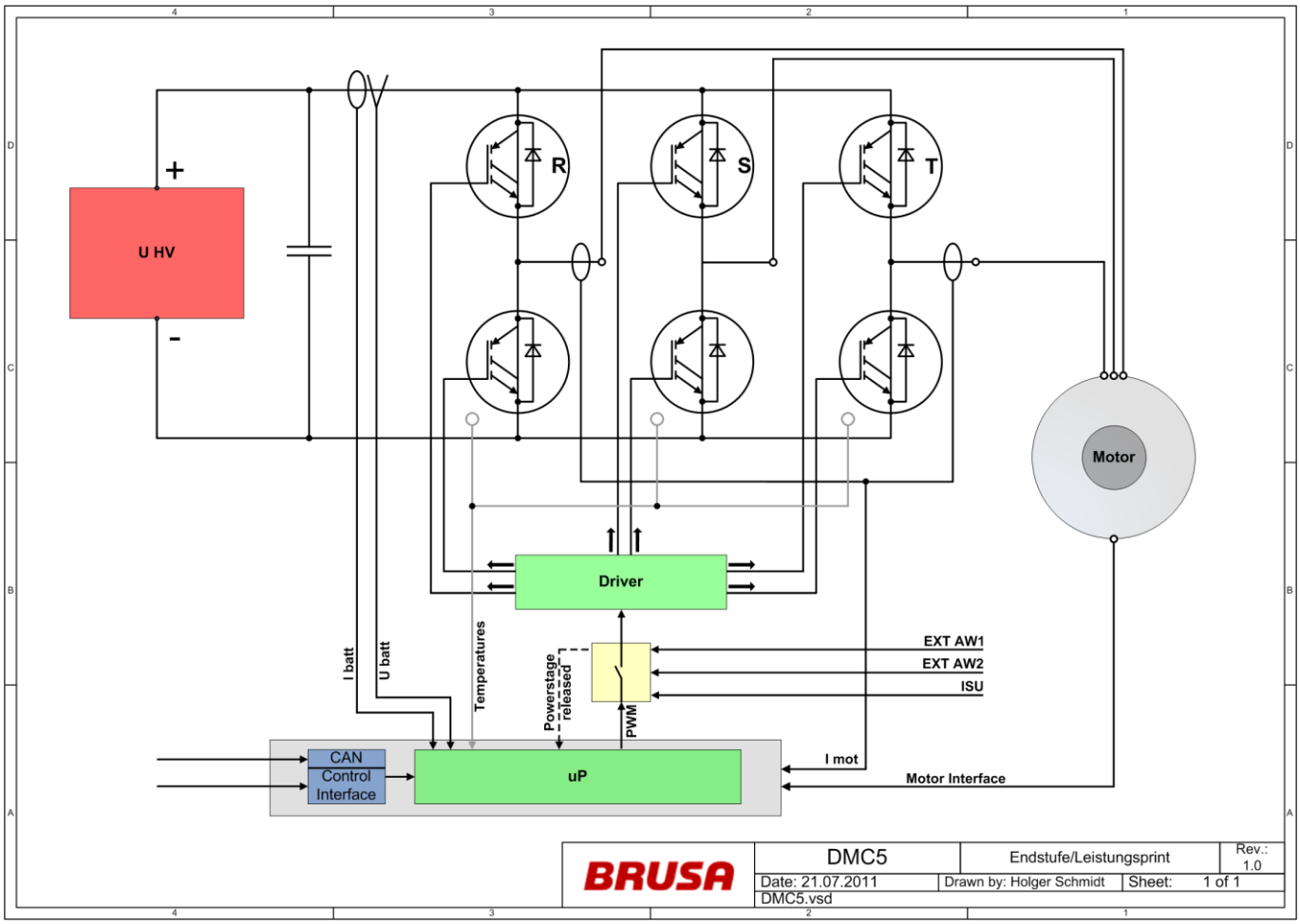


6.8 Input and output values

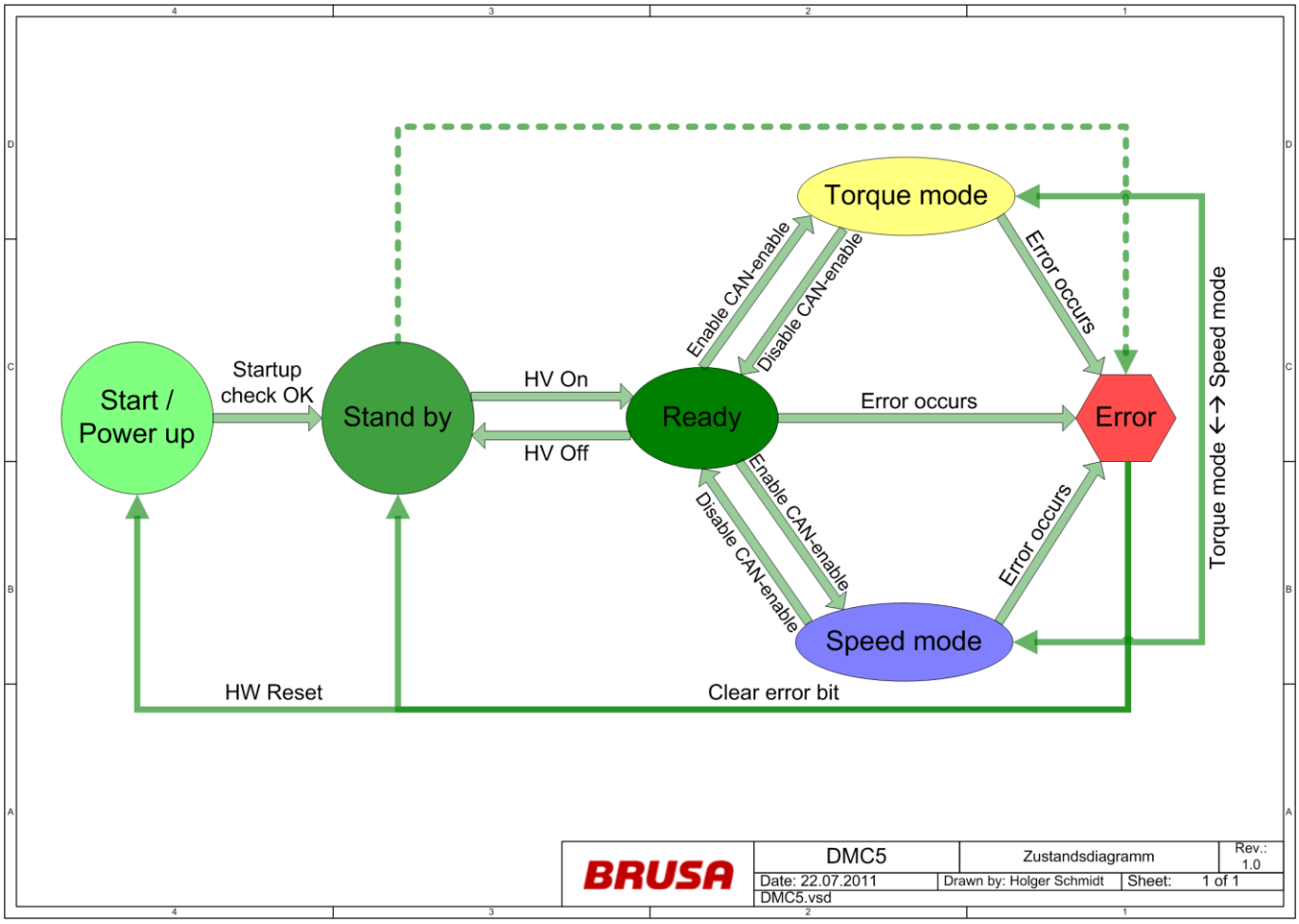


TRQrq, TRQact	Requested and current torque	**Iz min, Iz max**	Min. and max. high voltage current (DC)
SPDrq, SPDact	Requested and current speed	**Uz act**	Current high voltage
Uz min, Uz max	Min. and max. high voltage (DC)	**IAC act, Iz act**	High voltage actual current phases and actual current

6.9 Block diagram output stage / power print



6.10 Operating modes of the inverter



1.	**Start / Power up:** This mode can be viewed as standby state. The requirements for this are: Terminal 30 connected (12 V is engaged) Connect terminal 15 (activation of the ignition key)
2.	**Standby:** The activation of this mode takes place automatically after the start-up process (after activation of Start mode / Power up). For detailed information see also the descriptions of Pin 2 and Pin 3 (see chapter *8.3.2 Pin 2 AUX (Wiring system terminal 30)* and chapter *8.3.3 Pin 3 EN (Enable, Power ON)).*
3.	**Ready:** As soon as a voltage is present at the HV inputs, the inverter switches to this mode automatically. For this it is required that the inverter is in *standby* mode. From this mode, the inverter can drive the motor through *CAN-enable*.

4.	**Speed mode:** In this mode, the main controller is the speed regulator. The entry of the speed takes place over CAN. The negative or positive torque can be reduced at the same time. The inverter continuously attempts to follow the given speed (in respect of the limited torque value). It is always possible that the desired operating point cannot be reached through a limitation elsewhere (e.g. motor temperature, HV battery voltage etc.). Under some circumstances this can also lead to a complete deactivation (*Error Mode*).
5.	**Torque mode:** In this mode, the main controller is the torque regulator. Setting of the torque value takes place over CAN. The inverter can be limited in its power with the following limitations: Too high motor temperature Too high inverter temperature Too high / too low DC voltage DC and AC Current Power **INFORMATION**  If no limitation is active, the motor will attempt to reach the entered value immediately! If there is no load on the drive side, the motor accelerates until it reached the maximum speed!
6.	**Error mode:** If an error occurs, the inverter switches to this mode. Errors which have occurred can be confirmed with the command *DMC_ClrError* over CAN, see *DMC5_ISU_CAN_Spec.HTML* If the error remains, the cause must be found and dealt with, see *DMC5_ErrorsAndWarnings.pdf*

6.11 Regulatory approach and limitations

Detailed information on the regulatory approach and possible limitations can be found in the manual *DMC5_ControlConcept.pdf*

6.12 Error and warning messages

Error and warning messages are generally produced over CAN and have different effects on the function of the inverter.

For a targeted diagnosis, an event log can be read out through the provided software *PARAM-Tool*. You can find detailed information in the manual *PARAM_Manual.pdf*

6.12.1 Error definition

Errors invariably lead to shut down the inverter (Error mode). The resuming of operation is not taken place here automatically.

Errors must always be cleared with the command *DMC_ClrError*. This can take place alternatively through a hardware reset. You will find further information in the manual *DMC5_ControlConcept.pdf.*

You will find a list of possible error and warning messages along with their description in the manual *errors_and_warnings.pdf*

The statuses of each error are periodically updated in CAN messages.

6.12.2 Warning message definition

Warning messages do not cause shut down of the inverter. They can however in many cases lead to a reduction in output. The statuses of each warning message are periodically updated in CAN messages.

7 Level of inverter efficiency

7.1 DMC514 measured with HSM1-10.18.04 at 400V (first quadrant)

DMC514															
	Torque [Nm]														
Speed [rpm]	0	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150
1000		77.39	79.95	84.24	86.43	87.75	88.65	89.30	89.78	90.13	90.35					
2000		80.93	87.80	90.47	91.90	92.79	93.38	93.88	94.15	94.11	94.21					
3000		90.18	93.43	94.56	95.12	95.40	95.53	95.57	95.54	95.48	95.38					
4000		90.27	93.15	94.75	95.50	95.96	96.22	96.40	96.52	96.57	96.56					
5000		90.44	94.36	95.69	96.27	96.62	96.90	97.05	97.07	96.85						
6000		92.00	95.11	96.86	97.36	97.56	97.66	97.33	97.30	97.25						
7000		93.06	95.84	96.99	97.43	97.63	97.21	97.10								
8000		93.75	96.10	96.87	97.28	97.20	97.10									
9000		94.24	96.30	96.95	97.16	97.15										
10000		94.60	96.45	97.01	97.15											
11000		94.87	96.61	97.13	97.05											
12000		96.44	97.26	97.30												

*The efficiency map is only valid for the inverter

7.2 DMC524 measured with HSM1-6.17.12 at 400V (first quadrant)

DMC524															
	Torque [Nm]														
Speed [rpm]	10	20	30	40	50	60	70	80	100	120	140	160	180	200	220
1000	74.32	82.62	86.02	87.79	88.80	89.47	89.93	90.25	90.65	90.81	90.83	90.80	90.62	90.40	90.14
2000	84.56	89.84	91.91	92.94	93.54	93.95	94.22	94.41	94.65	94.74	94.72	94.65	94.52	94.36	94.18
3000	88.77	92.68	94.19	94.95	95.39	95.70	95.88	96.01	96.18	96.23	96.20	96.13	96.04	95.89	95.73
4000	91.05	94.28	95.52	96.13	96.47	96.69	96.84	96.92	97.04	97.06	97.04	96.95	96.84	96.71	96.57
5000	92.64	95.36	96.38	96.90	97.17	97.36	97.48	97.54	97.55	97.49	97.35	97.12	96.88	96.90	96.98
6000	93.85	96.18	97.06	97.42	97.60	97.68	97.71	97.70	97.60	97.41	97.04	96.91	96.93	96.94	
7000	94.77	96.74	97.33	97.61	97.72	97.75	97.74	97.71	97.50	97.01	96.94	96.95			
8000	95.51	97.01	97.49	97.68	97.76	97.78	97.76	97.64	97.21	97.11	97.13				
9000	95.84	97.18	97.61	97.78	97.82	97.82	97.72	97.54	97.23	97.26	97.11				
10000	95.87	97.11	97.67	97.82	97.88	97.79	97.60	97.26	97.23	97.22					
11000	95.91	97.26	97.69	97.81	97.83	97.69	97.48	97.26							
12000	95.96	97.35	97.74	97.87	97.82										

*The efficiency map is only valid for the inverter

7.3 DMC534 measured with HSM1-10.18.13 at 400V (first quadrant)

DMC534															
	Torque [Nm]														
Speed [rpm]	0	20	40	60	80	100	120	140	160	180	200	220	240	260	280	300
	1000	78.57	84.89	87.29	88.49	89.13	89.48	89.64	89.68	89.64	89.53	89.38	89.17	88.91	88.64	88.35
	2000	86.66	90.93	92.46	93.23	93.62	93.82	93.90	93.90	93.84	93.72	93.57	93.38	93.15	92.90	92.71
	3000	90.18	93.43	94.56	95.12	95.40	95.53	95.57	95.54	95.48	95.38	95.27	95.10	94.90	94.68	94.47
	4000	92.36	94.88	95.78	96.19	96.38	96.46	96.48	96.46	96.40	96.38	96.26	96.13	95.96	95.79	95.65
	5000	93.04	95.33	96.15	96.53	96.69	96.76	96.78	96.76	96.75	96.67	96.56	96.43	96.26	96.07	
	6000	94.49	96.37	96.97	97.22	97.31	97.31	97.23	97.09	96.91	96.65	96.29	95.91			
	7000	95.28	96.85	97.30	97.43	97.42	97.34	97.16	96.91	96.52	95.95					
	8000	95.82	97.15	97.43	97.45	97.41	97.23	96.95	96.28							
	9000	96.24	97.26	97.46	97.45	97.32	97.03	96.32								
	10000	96.41	97.32	97.44	97.39	97.14										
	11000	96.50	97.31	97.44	97.31											
	12000	96.54	97.34	97.37	97.19											

*The efficiency map is only valid for the inverter

7.4 DMC544 measured with HSM1-10.18.13-W7 at 400V (first quadrant)

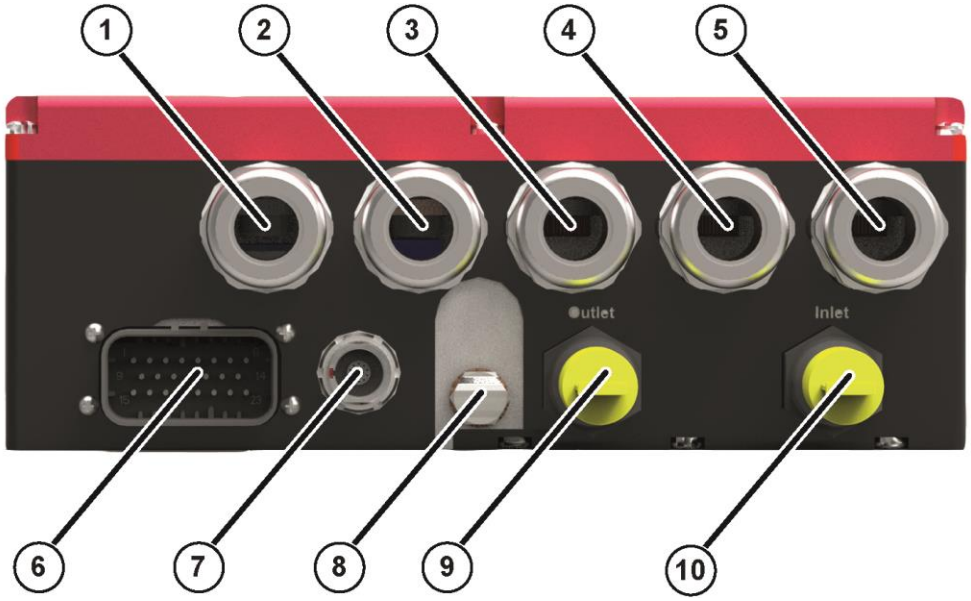
DMC544																
	Torque [Nm]															
Speed [rpm]	0	20	40	60	80	100	120	140	160	180	200	220	240	260	280	300
	1000	80.32	80.97	82.74	84.38	85.16	85.72	85.98	86.03	85.95	85.76	85.53	85.19	84.75	84.23	82.79
	2000	83.27	88.46	90.49	91.51	92.04	92.35	92.49	92.54	92.52	92.44	92.33	92.17	92.00	91.77	91.51
	3000	86.23	90.61	92.25	93.07	93.51	93.72	93.84	93.85	93.80	93.70	93.57	93.40	93.20	92.94	92.72
	4000	89.18	92.75	94.00	94.62	94.97	95.09	95.18	95.16	95.07	94.96	94.80	94.62	94.40	94.11	
	5000	90.77	94.11	95.07	95.60	95.83	95.94	95.95	95.87	95.78	95.65	95.49	95.29	95.05	94.81	
	6000	91.79	94.71	95.68	96.17	96.40	96.47	96.46	96.41	96.32	96.19	96.03	95.86	95.62	95.36	
	7000	92.53	95.35	96.23	96.61	96.76	96.78	96.74	96.67	96.52	96.29	96.02	95.54			
	8000	92.96	95.68	96.47	96.81	96.92	96.90	96.81	96.64	96.36	96.02	95.36				
	9000	94.19	96.19	96.85	97.07	97.06	96.94	96.72	96.41	95.74						
	10000	95.09	96.71	97.09	97.11	96.98	96.70	95.98								
	11000	95.52	96.84	97.09	97.04	96.82	96.71									
	11500	95.64	96.84	97.09	97.02	96.85										
	12000	95.79	96.88	97.11	97.00	96.79										

*The efficiency map is only valid for the inverter

8 Connections

8.1 Circuit connections

INFORMATION
For connections 1 - 5 the following specifications are recommended: Shielded, insulated automotive cable (e.g. Huber & Suhner). Cable lug without insulation for each M8 cross section (e.g. Vogt AG). Torque for cable lug (M8 x 10): 15 Nm.

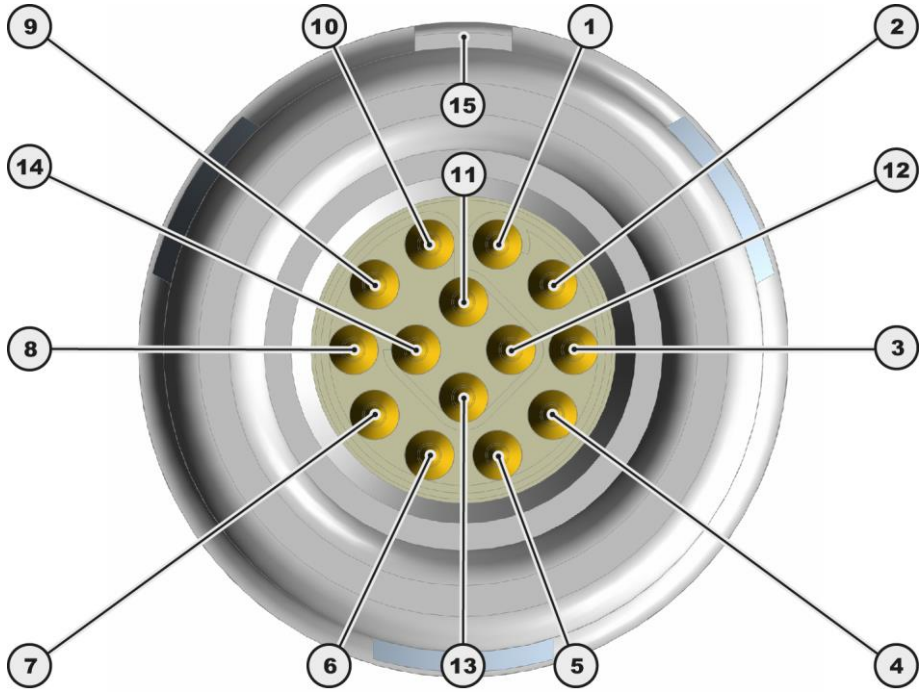


1.	High voltage- (HV-)	**2.**	High voltage+ (HV+)
3.	Motor phase U	**4.**	Motor phase V
5.	Motor phase W	**6.**	Control connector (Chapter *8.3 Pin assignment of control connector*)
7.	Motor sensor connection (14 pole low voltage) (Chapter *8.2 Pin assignment motor sensor connection*)	**8.**	Grounding screw (Chapter *8.5 Grounding screw*)
9.	Cooling water outlet (Chapter *8.6 Cooling water connections*)	**10.**	Cooling water inlet (Chapter *8.6 Cooling water connections*)

8.2 Pin assignment motor sensor connection (device side)

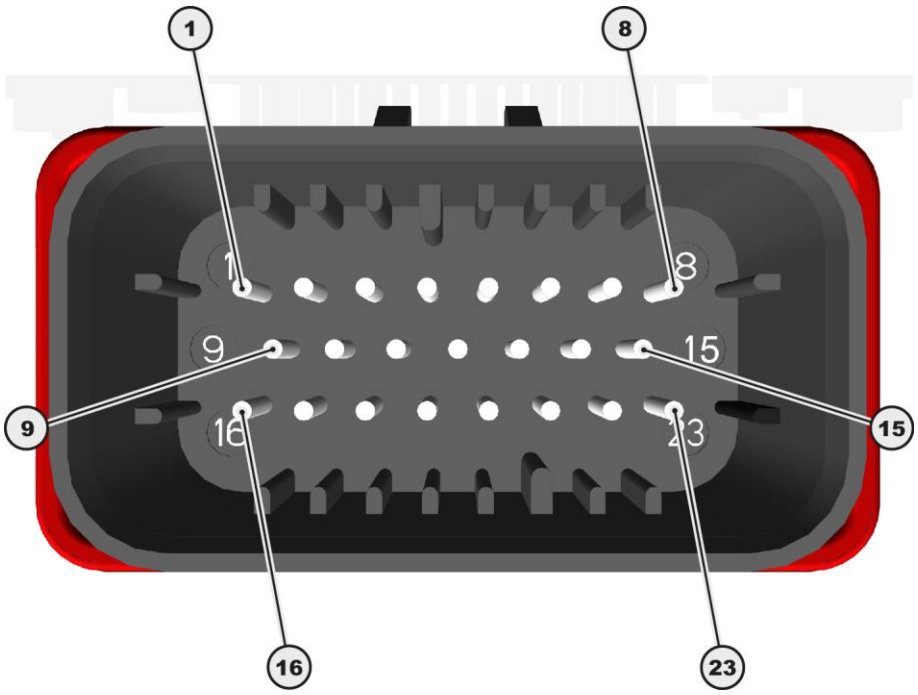
INFORMATION

The pin assignment of the motor sensor connection is BRUSA specific and deviates from the standard pin assignment standards of the cable manufacturer!



1.	**POS3**	6 bit absolute position bit 3	**2.**	**POS4**	6 bit absolute position bit 4
3.	**POS5**	6 bit absolute position bit 6	**4.**	**GND-NTC**	Ground NTC / PTC
5.	**NTC**	Motor temperature sensor	**6.**	**PTC**	Motor overheat switch-off
7.	**VCC-GEB**	Motor sensor- supply voltage 6 V_{DC}	**8.**	**POS0**	6 bit absolute position bit 0
9.	**POS1**	6 bit absolute position bit 1	**10.**	**POS2**	6 bit absolute position bit 2
11.	**GND**	Ground	**12.**	**MOTB**	Motor B (incremental)
13.	**MOTA**	Motor A (incremental)	**14.**	**UPD**	Position update data
15.	**——**	Centering groove			

8.3 Pin assignment of control connector (device side)



1.	**GND***	Ground (Minus wiring system, terminal 31, input range 6 – 32V)	**2.**	**AUX***	+12 V (Plus wiring system, terminal 30, input range 6 – 32V)
3.	**EN***	Enable (Power ON, terminal 15, input range 6 – 32V)	**4.**	**DO0**	Reserve
5.	**DO1**	Reserve	**6.**	**DO2**	Reserve
7.	**DO3**	Reserve	**8.**	**PG1**	Ground reserve
9.	**CNL***	CAN low	**10.**	**CNH***	CAN high
11.	**TXD****	RS232 Transmit (9 pole D-Sub pin 2)	**12.**	**RXD****	RS232 Receive (9 pole D-Sub pin 3)
13.	**PRO****	Enable firmware download	**14.**	**PG2**	Ground reserve
15.	**PG3****	RS232 ground (9 pole D-Sub: pin 5)	**16.**	**DI0**	Reserve
17.	**Ext. AW1***	External shut down path 1 (Plus wiring system, terminal 30, input range 6 – 32V)	**18.**	**Ext. AW2***	External shut down path 2 (Plus wiring system, terminal 30 Input range 6 – 32V)
19.	**IL1***	Interlock signal loop	**20.**	**IL2***	Interlock signal loop
21.	**AI1**	Reserve	**22.**	**AI2**	Reserve
23.	**AI3**	Reserve			

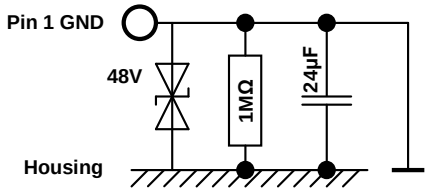
* = The connections must be wired for normal operation!

** = Programming of the inverter is necessary!

8.3.1 Pin 1 GND (ground terminal 31)

INFORMATION
If DMC5x4 control signals are connected with other vehicle components, then the connection to the vehicle's ground must take place at this pin.

Internal wiring



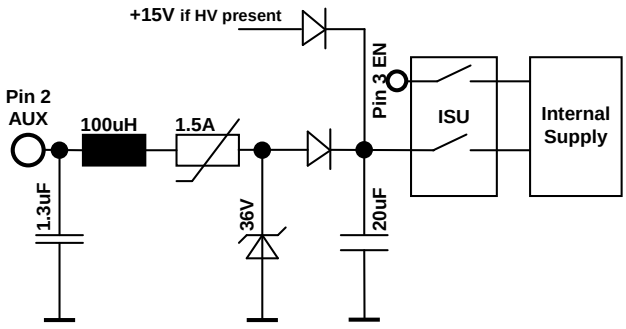
Direct ground connection of the inverter's control electronics.

The signal ground is connected with the inverter housing through a few components. These components serve for self protection and constitute a defined connection.

8.3.2 Pin 2 AUX (Wiring system terminal 30)

INFORMATION
Aside from the HV inputs, this 12 V inlet is also necessary for the functioning of the inverter! The inverter is generally ready for operation when the following requirements are met: Voltage is applied at the HV inlet (> V_{DCmin}) Voltage is applied at pin 2 (terminal 30) Pin 17 and pin 18 are active, see chapt. *8.3.7 Pin 17 EXT AW1, Pin 18 EXT AW2 (External shut down path 1 + 2)* Pin 1 (terminal 31) is connected No error messages present

Internal wiring



The internal 5 V supply is generated with this pin and offers the following possibilities:

CAN communication

Microprocessor programming (firmware)

Voltage measurement

As soon as HV is applied, LV is released:

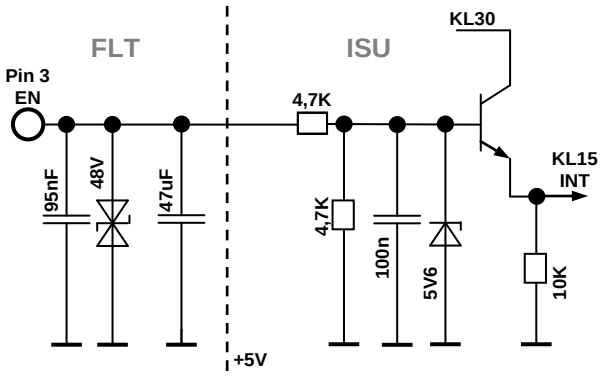
If HV voltage = 0 V, LV is loaded with </= 150 mA

If HV voltage > 100 V, the wiring system is loaded with </= 30 mA.

8.3.3 Pin 3 EN (Enable, Power ON)

INFORMATION
To program new firmware, pin 3 must be *high*!

Internal wiring



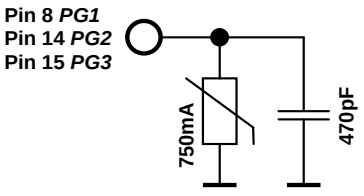
If voltage is applied at pin 2 and pin 3 = *high*, this effects the start-up of the controller. Communication with the inverter is thereby enabled. If additional HV voltage is applied, this effects the activation of *Ready* mode.

The internal device logic is only fed if pin 3 = *high*. This is also the case if HV+ and HV- are already applied in high voltage. Pin 3 has the function of terminal 15.

8.3.4 Pin 8 PG1, 14 PG2, 15 PG3 (Reserve ground, RS232 ground)

INFORMATION
The additional ground connections are intended to simplify the external wiring.

Internal wiring



The pins 8, 14 and 15 are each connected with pin 1 *GND* via a reversible fuse (PTC) and are thereby protected.

The following allocation is recommended:

Pin 8: Reserve

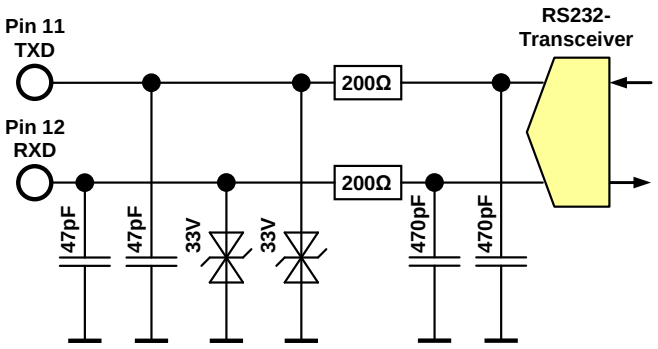
Pin 14: CAN-GND

Pin 15: 9 pole D-Sub: Pin 5

8.3.5 Pin 11 TXD, Pin 12 RXD (RS232 interface)

INFORMATION
This interface is NOT intended for general use! It is designed for firmware updates. Should you have questions regarding this, refer to BRUSA support at the manufacturing address given in chapter *4.6.*

Internal wiring



The RS232 port enables a direct, serial connection between the inverter and a PC. You will find the configurations for this in the manual *SW-FW-SHC3_Firmware_download.pdf*
In this document you will find all information regarding programming and the settings necessary for it.

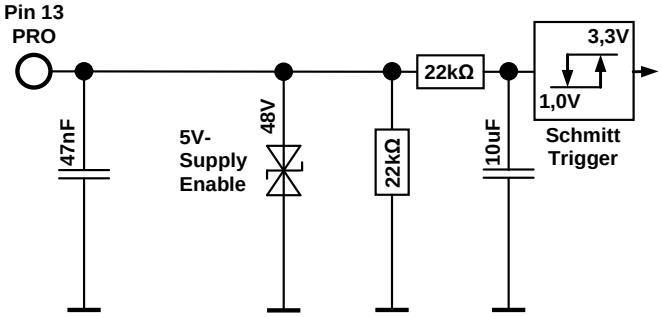
The firmware for the microprocessor can be downloaded over this interface (provided by BRUSA). Pin 13 *PRO* must be *high* for this.

8.3.6 Pin 13 PRO (Enable firmware programming)

INSTRUCTION
The programming of the wrong firmware can lead to the damage of the inverter! The programming may only be carried out after consultation with the company BRUSA Elektronik AG!

INFORMATION
This pin is only activated for the programming of a new firmware (Pin *PRO* = *high*). Pin 3 *EN* must also be *high* for this. In normal operation, this pin may not be wired or it must be directly connected with terminal 31. An open circuit can lead to a reset of the inverter!

Internal wiring



As soon as Pin 13 *PRO* is *high*, the following processes are triggered:

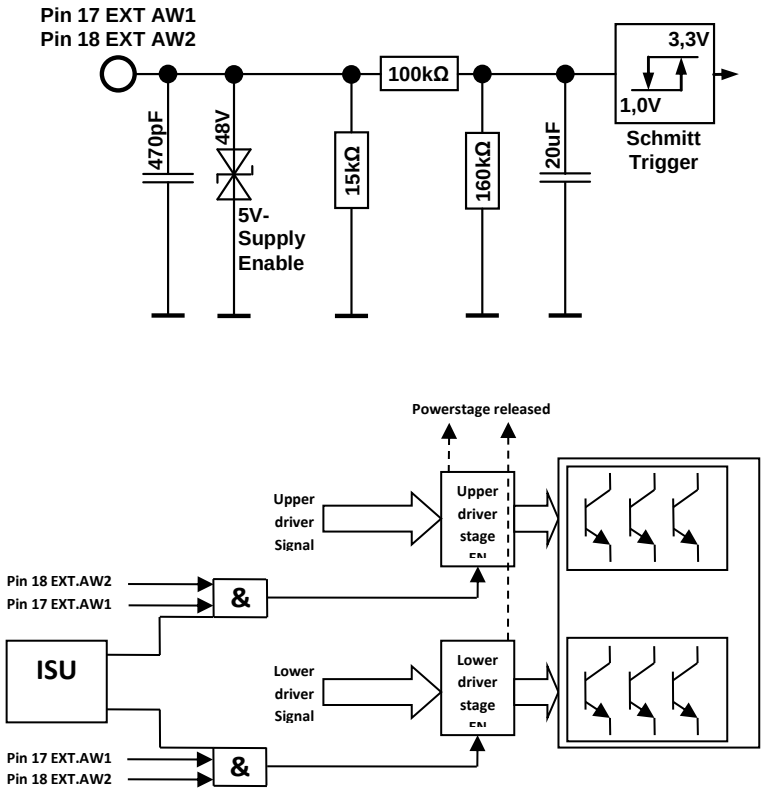
The inverter is stopped (reset) if it is in operation.

The programming can now be carried out via the serial interface.

8.3.7 Pin 17 EXT AW1, Pin 18 EXT AW2 (External shut down path 1 + 2)

INFORMATION
These pins must be active for the basic functioning of the inverter. This function is also intended as an additional safety installation. The shutdown takes place redundantly through this at the output stage drivers (see illustration). If this function is not used, both pins must be connected with terminal 30!

Internal wiring



To enable the output stage, pin 3 *EN* must also be *high*.
The both different circuits enable a redundant, direct switching off of the output stages.
The output stage can be released through higher-level control via these pins.

8.3.8 Pin 19 IL1, Pin 20 IL2 (Interlock 1 + 2)

DANGER

High voltage!

Danger to life!

The bypassing or short-circuiting of safety installations can result in fatal dangers through high voltage!

The interlock is a security installation and under no circumstances can it be disabled or bypassed!

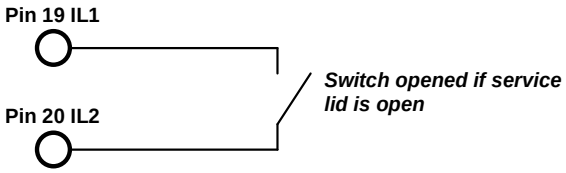
INFORMATION

This function must be implemented by the customer by connecting and assessing both pins (pin 19 *IL1* and Pin 20 *IL2)*!

The interlock switch is automatically activated as soon as the service cap is opened.

As a result, the high voltage connections will be forced to disconnect immediately! See chapter *3.4.1 Interlock.*

Internal wiring



Max switching voltage = 32 V

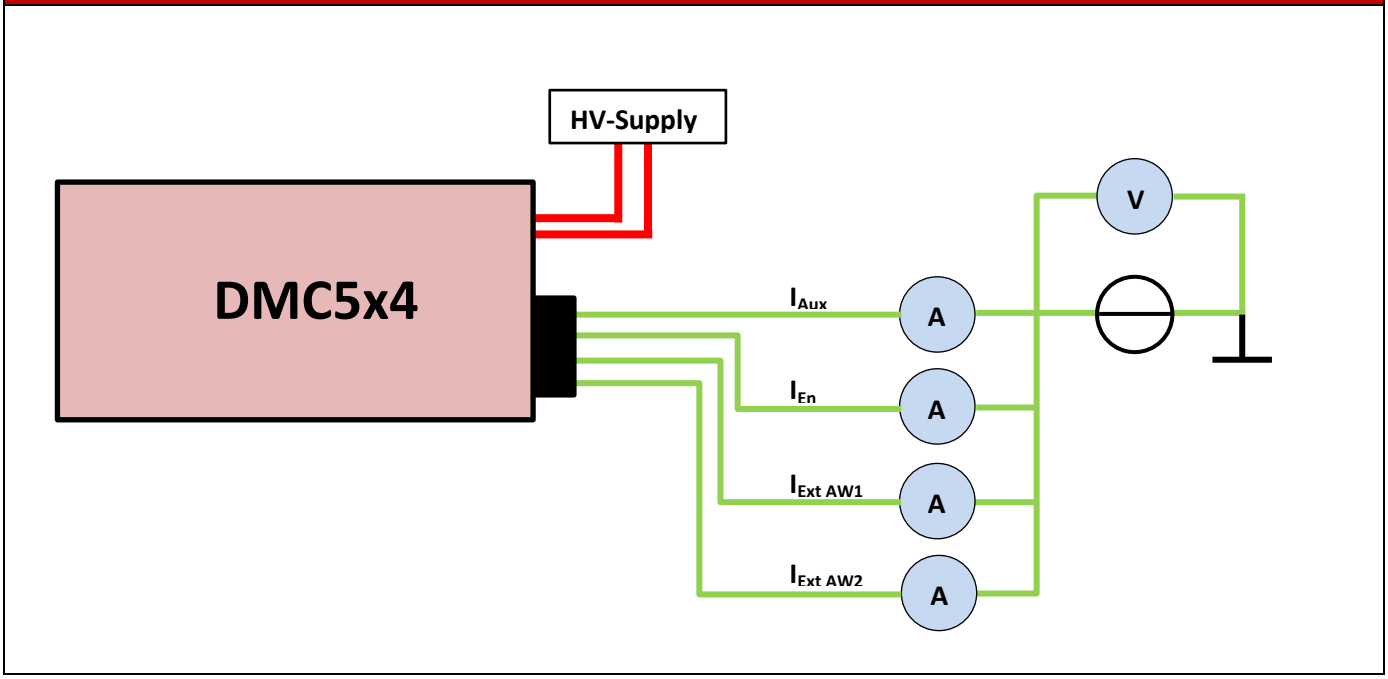
Max switching current = 30 mA

8.4 LV current consumption

In the following tables you can see the LV current consumption of the control connector.

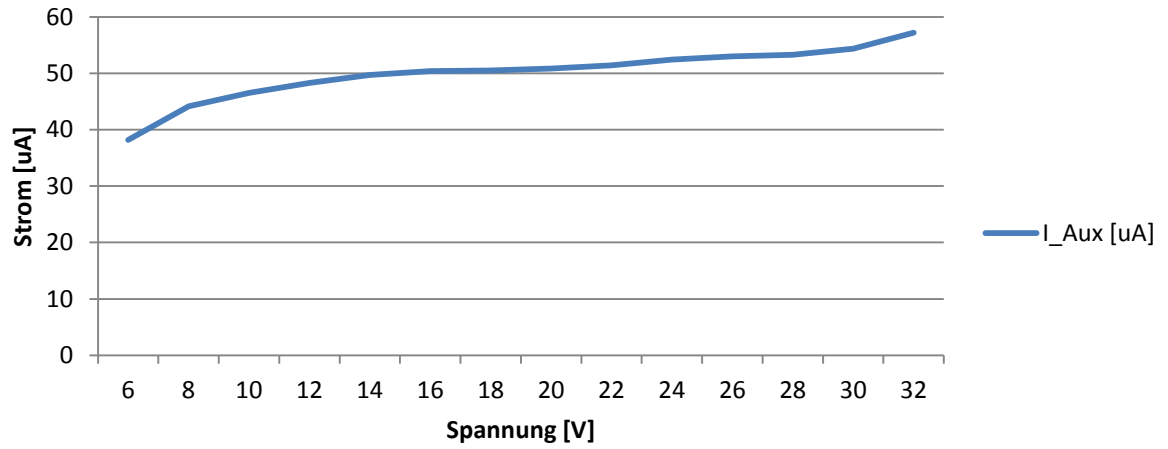
The currents were measured as follows:

Test setup

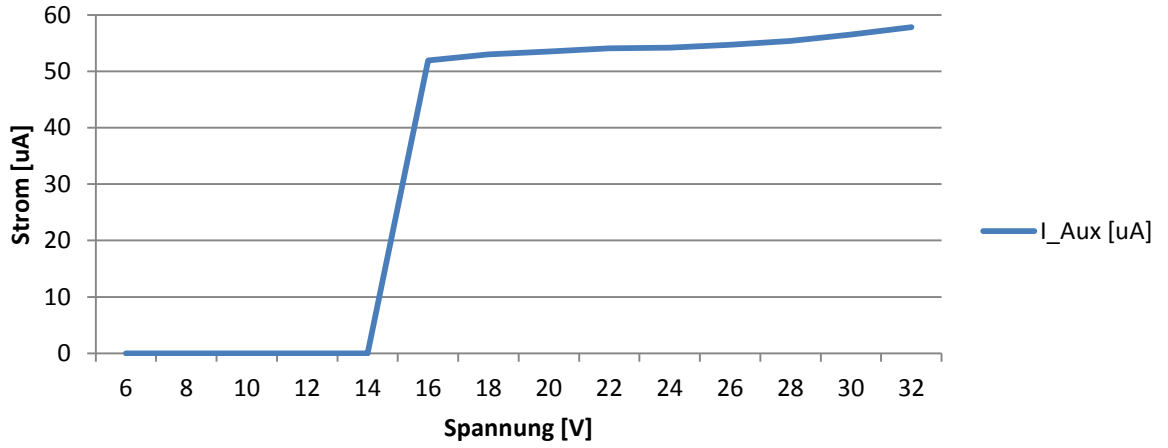


8.4.1 I_{Aux}

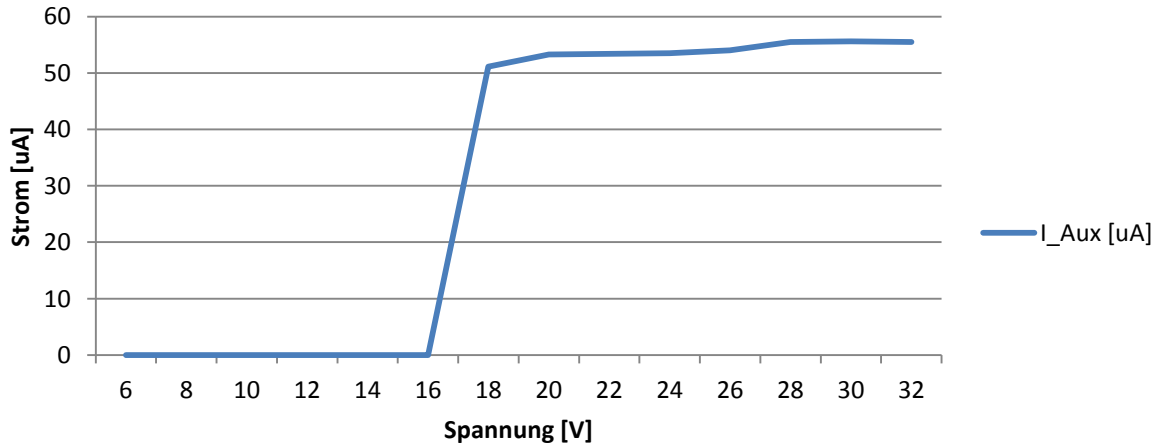
I_{Aux} [µA] without HV



I_{Aux} [µA] @ 300V

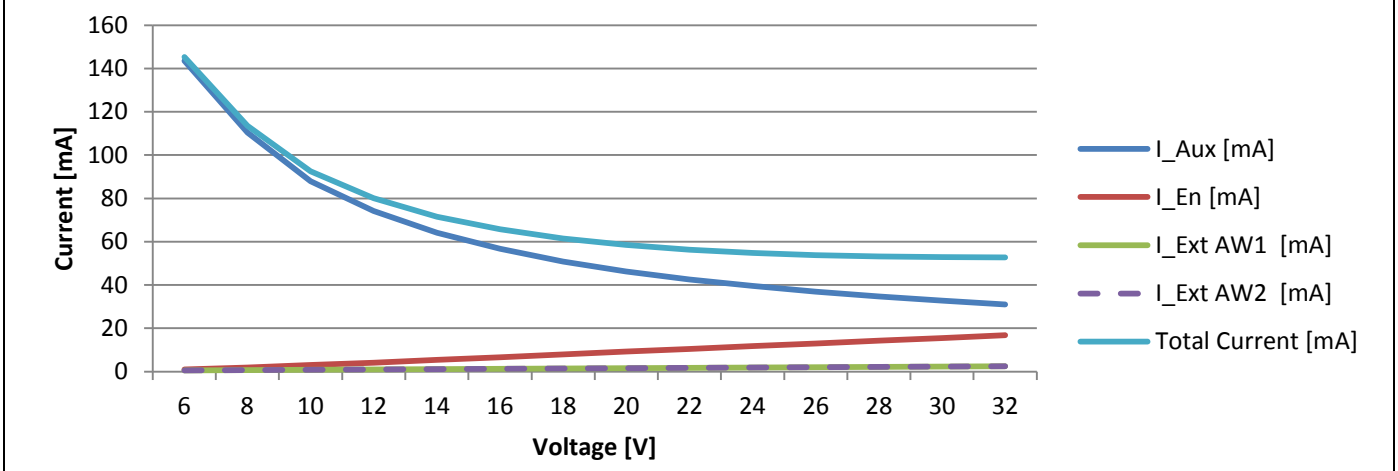


I_{Aux} [µA] @ 400V

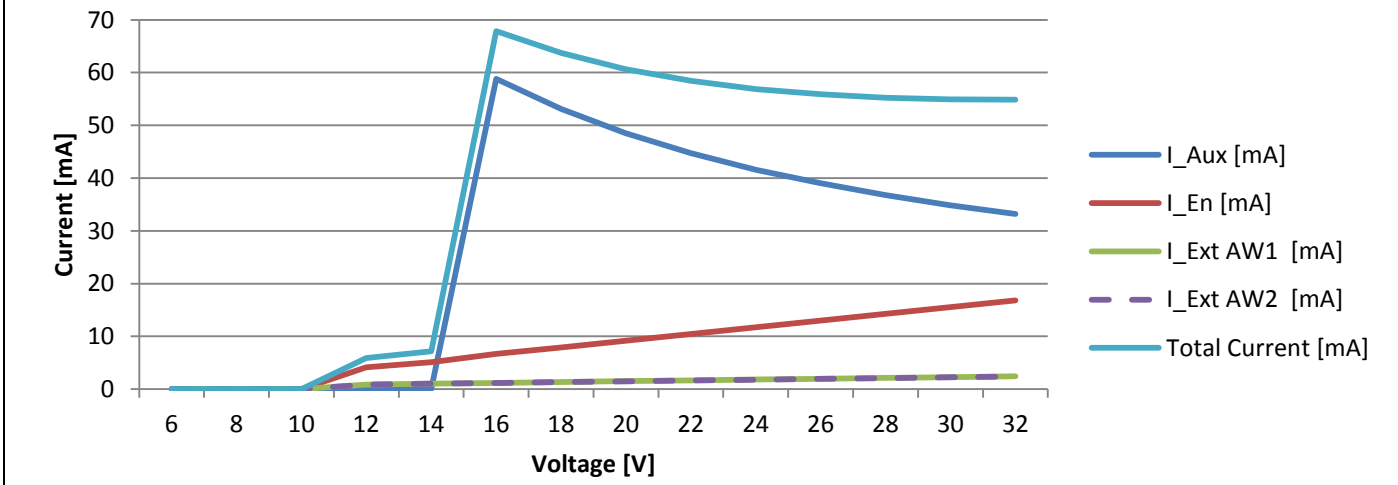


8.4.2 $I_{Aux} + I_{En} + I_{Ext\ AW1} + I_{Ext\ AW2}$

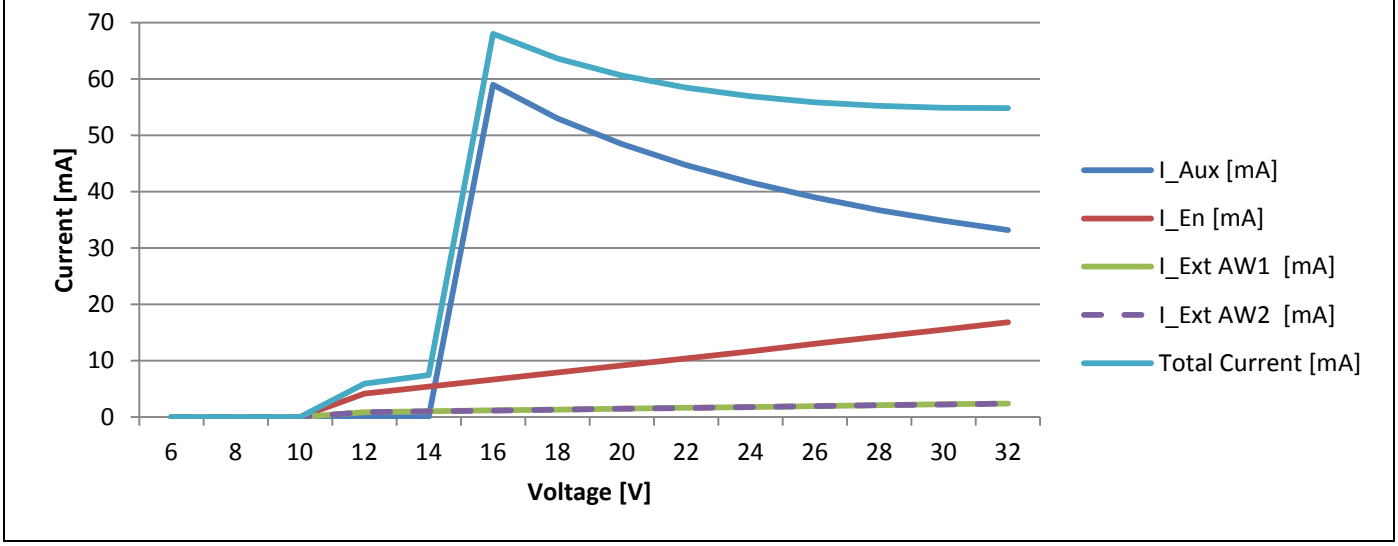
$I_{Aux} + I_{En} + I_{Ext\ AW1} + I_{Ext\ AW2}$ without HV



$I_{Aux} + I_{En} + I_{Ext\ AW1} + I_{Ext\ AW2}$ @ 300V



$I_{Aux} + I_{En} + I_{Ext\ AW1} + I_{Ext\ AW2}$ @ 400V



8.5 Grounding screw

WARNING

Sparking!

Fire hazard!

A loose ground circuit can lead to sparking and subsequent fires!

Ensure that the ground connection is connected correctly!

INFORMATION

The grounding screw (1) must be connected with the ground of the vehicle and/or testing bay. We generally recommend a direct connection to the motor.

The cable diameter of the ground cable must correspond to the dimensions of the HV wiring.

Torque grounding screw (1) M8 x 10 = 15 Nm

8.6 Cooling water connections

INFORMATION
The cooling water hose gets attached to the Normaquick terminals (1) and (2). Optionaly, you can order normal cooling water connections for hose clamps, see chapter *4.4 Optional delivery contents.* The Normaquick connections have an inner diameter of 11 mm. Cooling water inlet (1) Cooling water outlet (2)

8.7 Cooling circuit Information and Warnings

INFORMATION

For correct operation, the following points have to be considered:

- The mixing ratio of the coolant has to be at least 50% water and 50% glycol. Otherwise the inverter will be destroyed at low temperatures!
- The flow rate has to be between 6 l/min and 10 l/min!
- If the particle size is over 0.2mm, the liquid pins get clogged!
- The water pump must be active, even if the motor isn't running when the inverter PWM is active. The reason is, that the inverter also could clock when the vehicle is standing!

WARNING

When the abovementioned points based on the cooling getting ignored, the inverter will fail!

8.7.1 Cooling water filter

INSTRUCTION

For a proper cooling, please ensure the max. permissible particle size in the cooling water.

The max. allowable particle size in the cooling water is 0.2mm.

If this cannot be guaranteed, a water filter should be installed at the coolant inlet.

9 Start-up

DANGER

High voltage!

Danger to life!

While connecting the HV wiring, fatal injuries can occur if the HV wiring is live!

So check that the HV battery is not live before start-up!

INFORMATION

In this chapter, you will be lead step-by-step through each stage of the start-up. The given procedure must absolutely be adhered to!

PROCEDURE STEP	ILLUSTRATION / OTHER INFORMATION
1. Have the necessary additional documentation and the required additional equipment ready.	see chapter *4.2 Scope of the entire documentation*
2. Install the provided software.	This step is only necessary if the inverter is **not** integrated into a customer-provided CAN network and/or **no** customer specific software is used for this.
3. Integrate the device mechanically into the specified position.	Use the screws and torques stated, see chapter *6.6.2 Fixing (as in example DMC524)*
4. Ensure that the HV battery is not active.	---
5. Build the interlock circuit and check the functioning.	see chapt. *8.3.8 Pin 19 IL1, Pin 20 IL2 (Interlock 1 + 2)*
6. If it is not already done, build all the connections at the inverter.	see chapter *8 Connections*
7. Close the *service cap*.	see chapter *6.5 Covers* The interlock switch is activated.
8. Ventilate and check the cooling system.	see chapter *9.2 Ventilate and check cooling system*
9. Connect the motor with inverter over the motor sensor cable.	---
10. Build the 12V supply.	---
11. Establish communication between the *PARAM_Tool* and the inverter.	see manual *Param operation.pdf*
12. Parameters can now be set for the inverter with the applied software (e.g. *PARAM_Tool* from BRUSA).	see manual *Param operation.pdf*
13. If it is not already done, load the motor parameter table onto the inverter.	see chapter *9.3 Load motor parameter table onto inverter*
14. Build the HV supply.	see chapter *9.4 Build HV supply*
15. If it has not already been done, carry out rotor offset adjustment.	see manual *DMC5_RotorOffest_adjustment.pdf*
16. The inverter is now ready for operation and can be operated though CVI.	see chapter *10 Operation* of the inverter through CVI

9.1 System requirements for *PARAM-tool* software

Windows XP / Vista / WIN7 (32Bit /64Bit)
Serial port RS232 (firmware download)

9.2 Ventilate and check cooling system

INSTRUCTION
Air pockets in the cooling passage along with generally insufficient cooling of the inverter lead to increased wear! Ensure that the cooling circuit is fault-free.

PROCEDURE STEP	ILLUSTRATION / OTHER INFORMATION
1. Switch on the cooling circuit.	—
2. Leave the cooling circuit on for around 30 s.	To avoid the overheating of the device, flow must be ensured as soon as the inverter is switched on via *CAN enable*!
3. Switch off the cooling circuit.	—
4. Check the cooling water level.	—

9.3 Load motor parameter table onto inverter

To ensure the smooth driving of the motor, motor parameter tables corresponding to BRUSA motors are also provided. These must be installed on the inverter using the *PARAM-Tool* software.

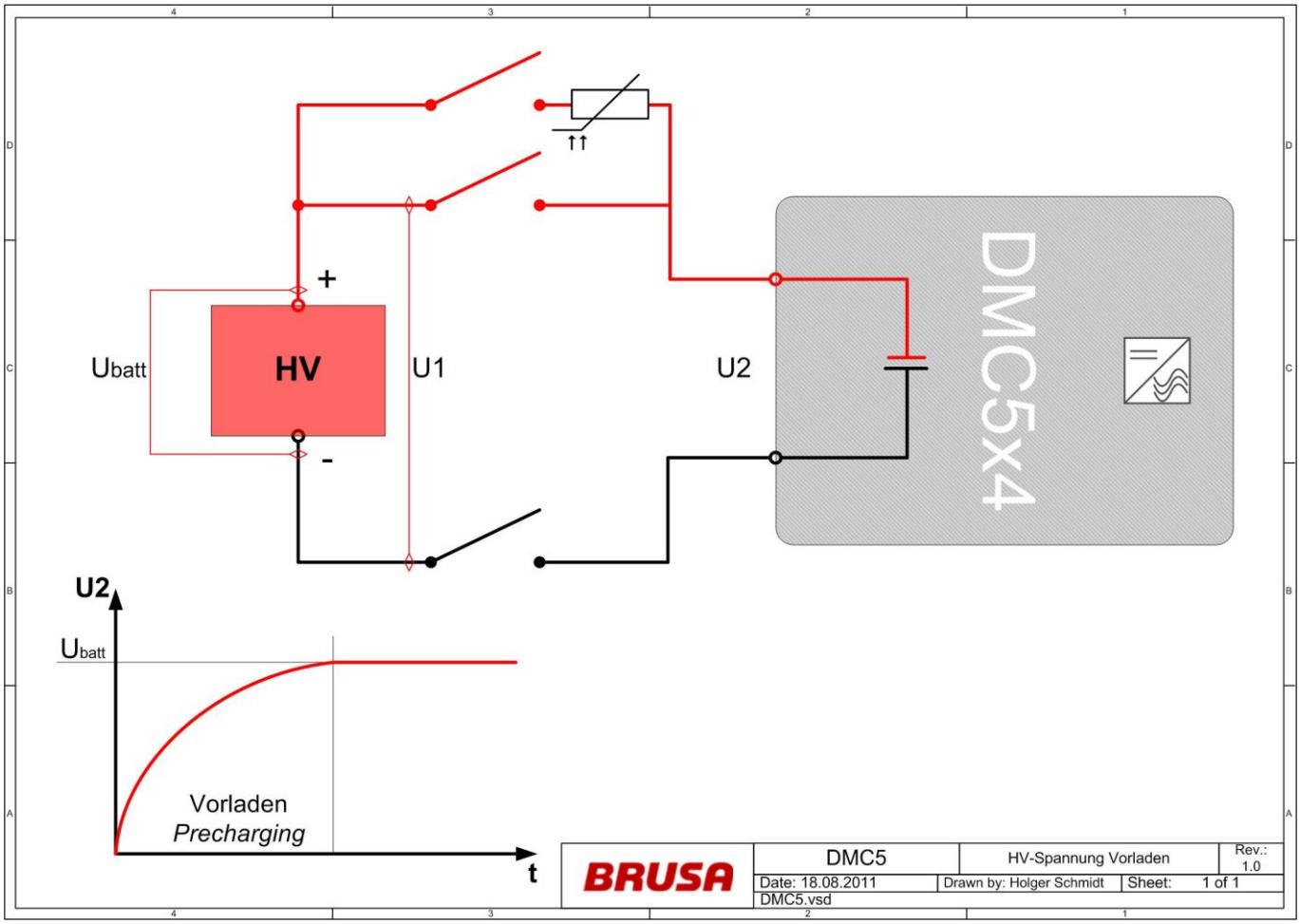
If using other brands of motor, the corresponding tables must be invoiced for and developed by BRUSA Elektronik AG!

You will find instructions for installation and settings in the manual *PARAM_Manual.pdf*

9.4 Build HV supply

INFORMATION

Before the HV connections are switched via a contactor, a pre-loading of the high voltage must take place. The device specific X capacity values can be found in the technical data, see chapt. *6.1 Technical data*



1.	Close the pre-charging contactor (1).
2.	Close the main contactor (3).
3.	Check that current U1 = U2. If so,
4.	Close the main contactor (2).
5.	Open the pre-charging contactor (1).

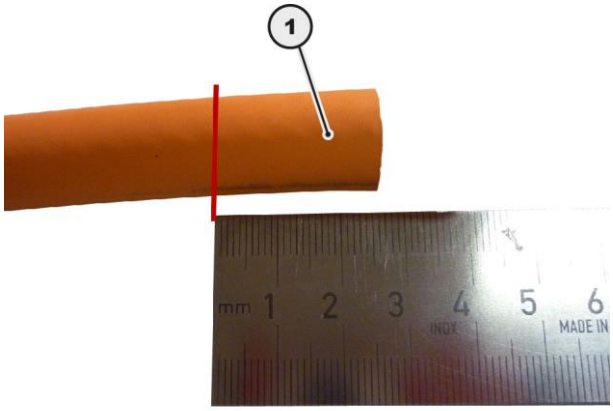
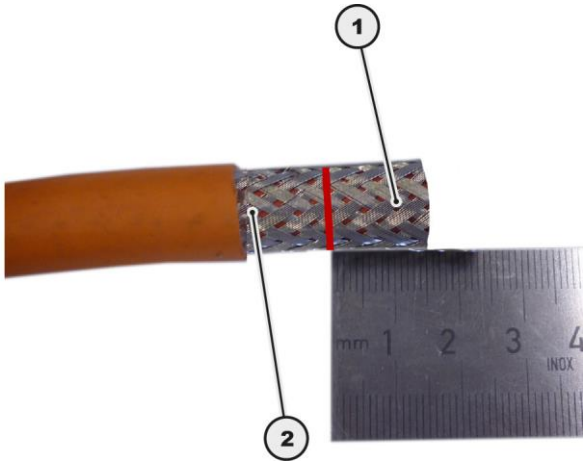
9.5 Build HV-lines

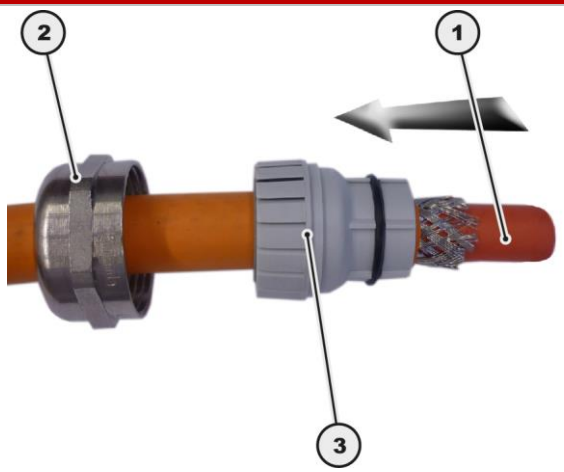
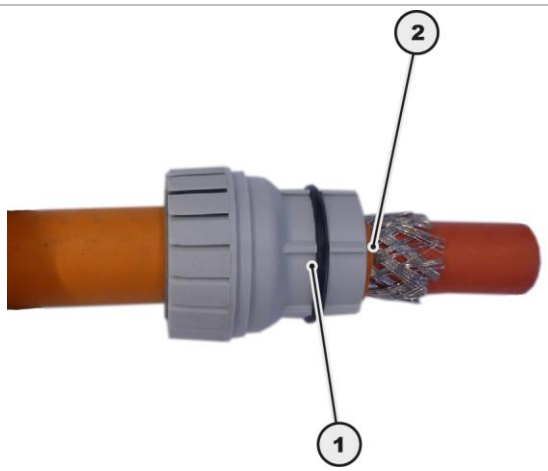
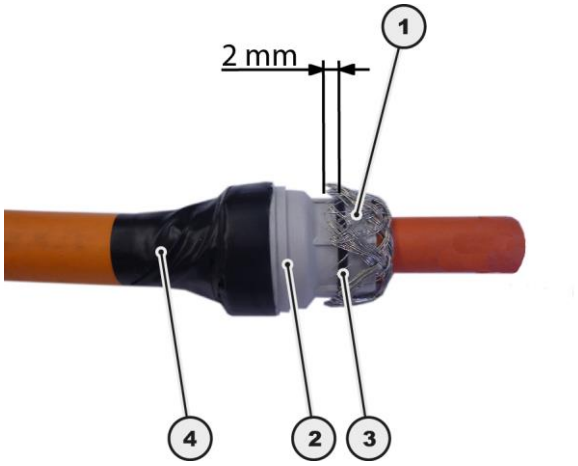
The building of the HV wiring must be carried out in accordance with the following instructions. Here it is important that no strands are damaged and that none stick out at the sides on the assembled cable. So check that the screw connections are correct for each completed cable and that the cable lug is fixed properly (pull test).

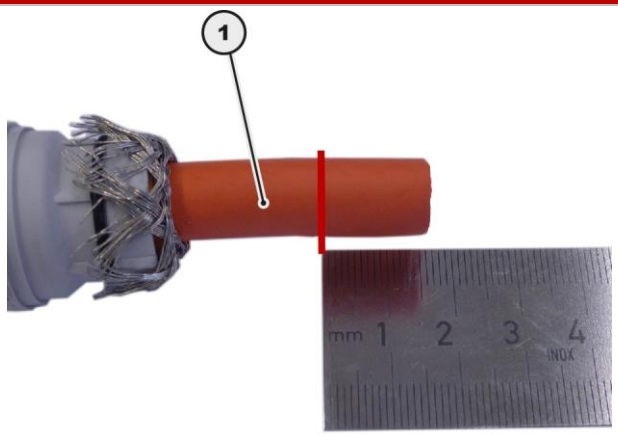
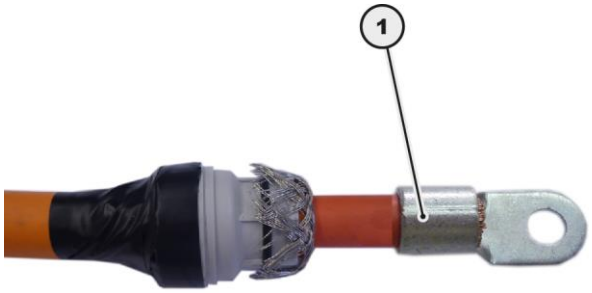
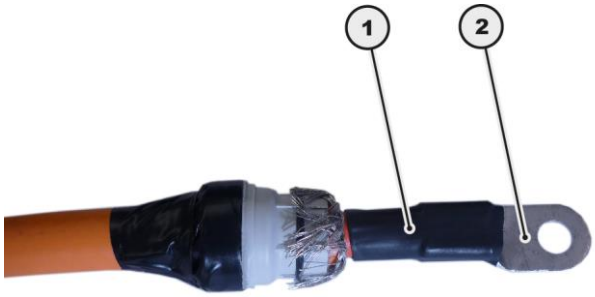
For the HV connections we recommend:

A shielded, insulated automotive cable (e.g. Huber & Suhner).
A cable lug (for type see chapter *4.3 Delivered mechanical components*)
To assemble the cable lug, using the appropriate crimping tool is absolutely necessary!

INSTRUCTION	
	You must absolutely make sure that the individual strands of the shielding braid (4) do not jut out again under any circumstances! Once in the integrated state, this will lead to damage of the sealing lip and subsequently to the leaking of water into the housing! So cut all strands which stick out more!

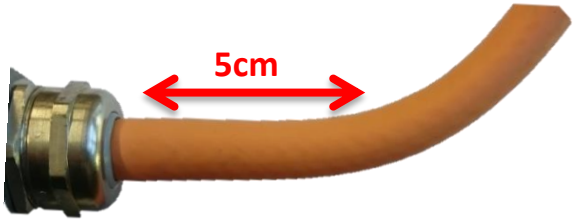
PROCEDURE STEP	ILLUSTRATION / OTHER INFORMATION
1. Insulate 25 mm of the HV cable (1). Ensure that you do not damage the shielding braid underneath it!	
2. Shorten the shielding braid (1) by 15 mm. The cable-side shielding braid (2) must be a length of around 10 mm.	

PROCEDURE STEP	ILLUSTRATION / OTHER INFORMATION
3. Lead the HV cable (1) through the union nut (2). Lead the HV cable (1) through the terminal insert (3).	
4. Place the terminal insert (1) with the front edge flush with the cable insulation (2).	
5. Put the shielding braid (1) over the terminal insert (2). During this, the shielding braid (1) may overlap the O-Ring (3) by a maximum of 2 mm. Fix the terminal insert (2) in position on the HV cable, eg. with electrical tape (4).	

PROCEDURE STEP	ILLUSTRATION / OTHER INFORMATION
6. Insulate 16 mm of the HV cable (1).	
7. Assemble the cable lug (1) at the end of the cable. No strands should stick out at the sides! The crimping must be hexagonal. Ensure that the crimping has no deformations at the sides because this will make later installations in the BMS housing difficult!	
8. Check the secure positioning of the cable lug manually.	---
9. Assemble a shrinkage tube (1) on the cable lug (2). The assembly of a shrinkage tube (1) is absolutely necessary because otherwise contacting can result in the BMS housing!	

INSTRUCTION

During the layout of the cable take care that the first part of the cable is at least 5cm straight before it will be bend to a radius.



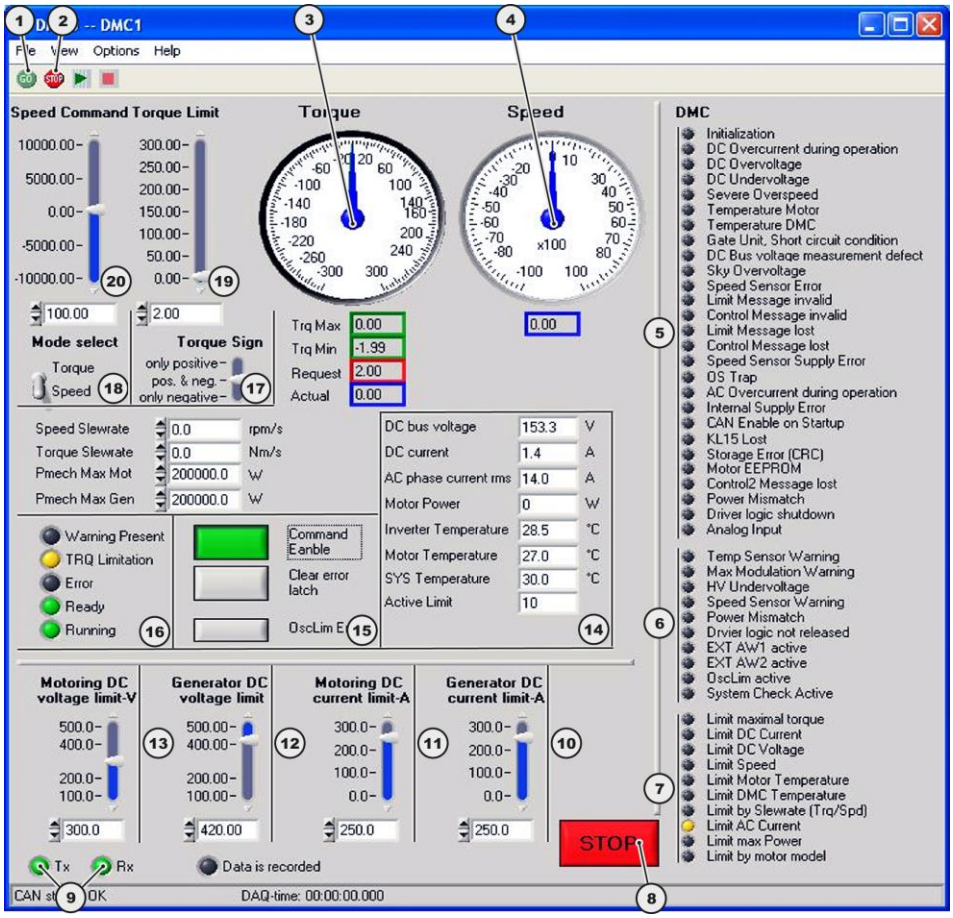
WARNING

If you have to reassembly the cable you have to use a new terminal insert. Otherwise it can cause a leakage.
The terminal inserts can be ordered from BRUSA Elektronik AG or directly from hummel.com.

10 Operation of the inverter through CVI

INFORMATION

The chapter is only relevant if you are working with the supplied CVI software *CANAP_DMC5* !



1.	Activation of the CAN communication	**2.**	Deactivation of the CAN communication
3.	Torque	**4.**	Speed (number of revolutions)
5.	Error messages	**6.**	Warning messages
7.	Limitations	**8.**	Stop button (deactivate motor)
9.	CAN connection status	**10.**	Generator DC-current limitation value
11.	Motor DC-current limitation value	**12.**	Generator DC-voltage limitation value
13.	Motor DC-voltage limitation value	**14.**	Display of different actual values
15.	Command enable = switch output stage on/off Clear error latch = confirm error message	**16.**	Status reports
17.	Selector switch for torque signs	**18.**	Selector switch for speed mode or torque mode
19.	Torque limit (the desired value can be set and/or entered either at the slide control or in the input field below).	**20.**	Default speed (the desired value can be set and/or entered either at the slide control or in the input field below).

10.1 Build connection between CVI and the inverter

PROCEDURE STEP	ILLUSTRATION / OTHER INFORMATION
1. Switch on the inverter.	Activate terminal 15 in addition to terminal 30. The status *Rx* (9) will then flash.
2. Click the button *GO* (1).	The CAN connection is activated. Both statuses *Tx* and *Rx* (9) should light up green.
3. Click the button *Clear Error latch* (15).	Errors in the queue are deleted. The button *Clear Error latch (*15) should now be dark. The LED *Ready* (16) should now light up green. All error statuses in the area (5) should be dark.
4. Select the desired mode with the selector switch (18).	*Torque Mode* or *Speed Mode*.
5. Set the DC limits (10), (11), (12), (13) and check the set values.	---
6. Enter the desired speed (20) and the desired torque (19).	---

INFORMATION
 If no limitation is active, the motor will attempt to reach the entered value immediately! If there is no load on the drive side, the motor accelerates until it reached the maximum speed!

7. Click the button *Command Enable* (15).	The motor runs at the value set previously (speed or torque). The target values can now be read in the section (14) as well as on the rpm counter (4) and the meter (3). Limitations can be changed during operation in sections (10) to (13). These have a direct impact on operation.

10.2 Disconnect the communication between CVI and the inverter / Switch off the inverter

For the disconnection an existing connection, there are other possibilities. These are as follows:

Click the button *STOP* (8).

Click the button *Command Enable* (15).

Press the button *ESC* on the operating keypad.

Click the button *Stop* (2). **With this, the CAN connection is deactivated!** The reaction time is dependant on the timeout configuration.

10.3 Fix CVI problems

ERROR	POSSIBLE CAUSES	CORRECTION
Error active, cannot be removed	With an incompatible or faulty CAN matrix, it is possible that the errors displayed in the section (5) are incomplete!	Analyse and remove errors in the manual *DMC5_ErrorsAndWarnings.pdf*.
Limitation active	The limitation value is set too high or too low.	Check limitation value. Check default values, see manual *Param operation.pdf*
CAN connection cannot be activated	Faults in the connection or wiring	Check wiring and CAN / USB adapter. Check all connections on inverter Carry out error analysis with the *DMC5_ErrorsAndWarnings.pdf*

11 Error correction

You will find a list of all possible errors in the manual *DMC5_ErrorsAndWarnings.pdf*.

Always try to clear all errors which occur with the help of this manual. Should errors reappear, please refer to BRUSA support at the manufacturing address given in chapter *4.6.*

12 Flooding in the device

DANGER
 **If there is water in your device, take the device out of operation immediately!** **Disconnect the supply voltage and all other connections!** Check the housing on damage and also the insulation of the HV-cables! Please refer to BRUSA support at the manufacturing address given in chapter *4.6*.

13 Instructions for disposal

A basic requirement for the re-use and recycling of used electronic devices is the correct disposal.

With the implementation of the electric and electronic device regulation (ElektroG) since the 24th of March 2006, electronic devices may no longer be disposed of along with ordinary household waste, rather they must be separately collected and recorded by a specialist services.

Disposal through a specialist service basically helps the avoidance of dangers to people and nature. So, in the case of disposal, we recommend turning to a recognised specialist disposal service.

14 Warranty and guarantee

The warranty corresponds to the regulations in our currently valid general terms and conditions see under www.brusa.biz/en/support/terms-conditions.html.

15 Index