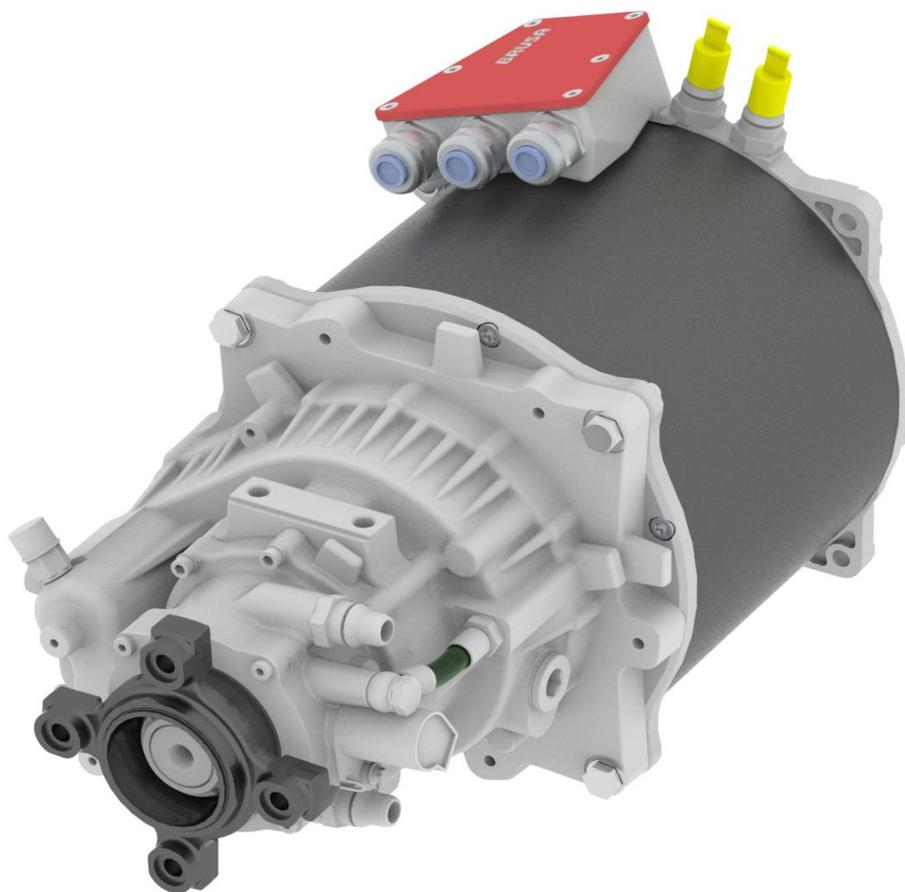




TECHNICAL DATA  
AND START-UP



**DTSP1-028**

## 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** Marc Voppichler

## REVISIONS

REVISION	DATE	NAME	CHANGE	RELEASE
rev01	12.01.2016	M. Voppichler	Creation Update of chap. - Motor/Gearbox combinations (page 2) - 4.3, 4.4, 5.2, 6	
rev02	15.01.2016	M. Voppichler	Front page updated	
rev03	18.01.2016	M. Voppichler	Updated all pictures to the new gearbox version Chap. 6.7.2 updated Chap. 6.7.3 updated Chap. 6.7.7 updated	
rev04	26.01.2016	M. Voppichler	Chap. 6.6 updated Chap. 6.11 updated Chap. 8.2 updated Chap. 6.7.4 updated Chap. 6.7.5 updated	
rev05	09.05.2016	M. Voppichler	- New Parking Lock information added - Information about additional flange	
rev06	13.05.2016	M. Voppichler	Updated delivery contents	PL, 24.05.2016
rev07	28.11.2016	A. Girod	Chap. 13 updated; Chap. 14 new	
rev08	24.08.2017	M. Cvorak	Chap. 6.7.2 Fixing points Gearbox updated	
rev09	08.12.2017	M. Cvorak	Chap. 6.7.8 amount of gearbox oil updated, torque of screws updated	

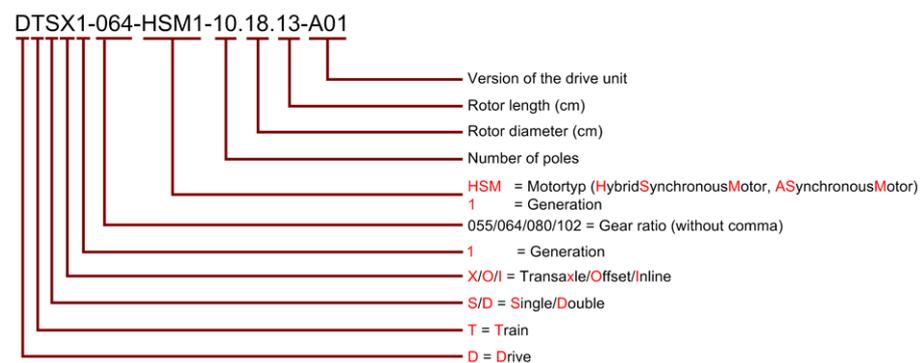


## VALIDITY

This manual is only valid for the following motor/gear box combinations:

MOTOR TYPE
DTSP1-028-HSM1-6.17.12
DTSP1-028-HSM1-10.18.13
DTSP1-028-HSM1-10.18.22

Decoding of the motor designation is as follows:



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# 1 Foreword

Dear customer!

With the BRUSA drive unit you have obtained 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 this manual – particularly the chapter *Safety and Warning Instructions* – carefully before you install the drive unit or carry out any other work on it!

# 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.	NAME
<b>HSM</b>	Hybrid Synchronous Motor	<b>NTC</b>	Resistor with Negative Temperature Coefficient
<b>GND</b>	Minus wiring System, vehicle earth Terminal 31	<b>PDU</b>	Power Distribution Unit (HV distribution box)
<b>HV</b>	High Voltage, DC Link Voltage	<b>PTC</b>	Resistor with Positive Temperature Coefficient
<b>LV</b>	Low Voltage	<b>PWM</b>	Pulse Width Modulation
<b>DTSP</b>	Drive Train Single Planetary	<b>GSP</b>	Gearbox Single Planetary

## 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 symbols are used. You will find an overview as well as their meaning in the following table:

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

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

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

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 local and/or country-specific safety instructions and guidelines for accident prevention!

The system integrator and/or distributor of the device must therefore supplement the present general safety instructions by country-specific 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!
- Under no circumstances should you use cleaning agents containing solvents to clean the motor! These can damage the seals and lead to leaks in the motor!
- 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!
- During installation and the laying of cables, observe the maximum bending radii given by the manufacturer! Avoid laying the cables alongside sharp edges and mechanical components!

## 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 an 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 the system does not reconnect.
  - Keep ignition key safe to prevent unauthorised access.
  - Keep service / maintenance plug safe to prevent unauthorised access and/or 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 Derating

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

The temperature measurement takes place through an NTC in the stator winding head. Derating becomes active at around 100°C through the variable resistance value. The inverter processes the signal from the motor and begins to gradually reduce the phase current from this motor temperature onwards:

- at a temperature of  $\leq 100^{\circ}\text{C}$   $\rightarrow I_{\text{max}}$
- at a temperature of  $\geq 160^{\circ}\text{C}$   $\rightarrow I = 0 \text{ A}$

### 3.4.2 Overload protection

If the motor reaches the defined maximum temperature of 170°C despite derating, an emergency shut-down (overload protection) takes place to protect the motor from damage.

The temperature measurement takes place through 3 PTCs in the stator winding head (1 unit per phase). If one of the PTCs reaches the defined maximum value, the linked up inverter recognises this and transmits via CAN the error message *E\_TempMot*. In this case the inverter disconnects the phase current immediately.

To resume operation, the fault in the linked inverter must be acknowledged.

## 3.5 Requirements of the start-up personnel

All courses of action described in this manual may only be carried out by a qualified electrician! Specialist staffs are 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 motors and the gearbox.

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

All work sequences and illustrations are based on the HSM1–6.17.12 model and are applicable to all models mentioned in this handbook. In the case of model-specific deviations, corresponding instructions are available.

### 4.2 Scope of the entire documentation

#### INFORMATION



To set the motor up successfully, besides this manual you will need the appropriate motor table for this motor! The motor table is usually included in the delivery content and must be loaded onto the linked up inverter (see the technical information for the inverter).

### 4.3 Delivery contents

#### 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 70mm<sup>2</sup> cables you can use 50mm<sup>2</sup> cable lugs too. The diameter of 70mm<sup>2</sup> cables fits without problems into 50mm<sup>2</sup> cable lugs and is qualified by BRUSA Elektronik AG.

	NAME	PIECES	ILLUSTRATION
1.	HSM1 hybrid synchronous motor	1	
2.	GSP1 gear box (Transmission ratio 1:2.842)	1	
3.	Cable lugs for HV-cables (depending on the motor): 25mm <sup>2</sup> M6 cable lug without insulation for HSM1-10.18.04 35mm <sup>2</sup> M6 cable lug without insulation for HSM1-6.17.12 35mm <sup>2</sup> M6 cable lug without insulation for ASM1-6.17.12 50mm <sup>2</sup> M6 cable lug without insulation for HSM1-10.18.13 50mm <sup>2</sup> M6 cable lug without insulation for HSM1-10.18.22	3	
4.	Cable lug for grounding (depending on the motor): 25mm <sup>2</sup> M8 cable lug without insulation for HSM1-10.18.04 35mm <sup>2</sup> M8 cable lug without insulation for HSM1-6.17.12 35mm <sup>2</sup> M8 cable lug without insulation for ASM1-6.17.12 50mm <sup>2</sup> M8 cable lug without insulation for HSM1-10.18.13 50mm <sup>2</sup> M6 cable lug without insulation for HSM1-10.18.22	1	
5.	M8x10 hexagonal screw (Ground GND)	1	
6.	M8 washer for grounding screw	1	
7.	Cable length of sensor cable: 1m (Connection Motor / Inverter)	1	
8.	Quick connection cooling water connection pieces 90° Norma PS3 For dimensions see chapt. 6.10.2 <i>Cooling water connections</i>	2	

## 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	<b>RAAA041</b>	---
2.	Quick connection cooling water connection pieces 0° Norma PS3 For dimensions see chapt. 6.10.2 <i>Cooling water connections</i>	<b>MHAA775</b>	
3.	M18 x 1.5 cooling water connection pieces For dimensions see chapt. 6.10.2 <i>Cooling water connections</i>	<b>MAAA366</b>	
4.	14 pole Lemo connecting cable (inverter - motor) 1 m	<b>11139</b>	
5.	14 pole Lemo connecting cable (inverter - motor) 2 m	<b>11140</b>	
6.	14 pole Lemo connecting cable (inverter - motor) 4 m	<b>11141</b>	

## 4.5 EU Guidelines

This manual has been produced under application and consideration of the DTSP1-028 Drivetrain EC guidelines, national laws and harmonised standards (EN) valid at the time of production relevant to the product.

## 4.6 Contact information of the manufacturer

### **BRUSA Elektronik AG**

**Neudorf 14**

**9466 Sennwald**

**Switzerland**

**Phone:** +41 81 758 09 - 00

**Fax:** +41 81 758 09 - 99

**Internet:** [www.brusa.biz](http://www.brusa.biz)

**E-mail:** [support@brusa.biz](mailto:support@brusa.biz)

## 5 Use and limits of the product

### 5.1 Proper use

The BRUSA DTSP1-028 has been designed for the following uses. In the case of planned operations in other areas, please contact the company BRUSA Elektronik AG beforehand at the manufacturer address as given in chapt. 4.6.

- Installation in a drive train for hybrid vehicles
- Full drive for electric vehicles / linking up with several hybrid synchronous motors possible
- Installation in a drive train for fuel cell vehicles
- Use as a high performance drive (racing sports)
- Full drive for utility vehicles (electric and hybrid)
- Full drive for electric boats
- Test stand applications

#### 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 DTSP1-028. Operation outside of the defined limits can lead to life-threatening situations!

- Max HV input voltage (operation): 450 V
- Max. permitted phase voltage: 690 V<sub>ACeff</sub>
- Min. ambient temperature: - 40°C
- Max. ambient temperature: + 85°C
- Min. coolant temperature at Inlet: - 40°C
- Max. coolant temperature at Inlet: + 65°C
- Max. cooling circuit pressure: 1.0 bar

## 6 About this device

### 6.1 Technical data

BASIC DRIVETRAIN DATA	DTSP1-028-HSM1-6.17.12		DTSP1-028-HSM1-10.18.13		DTSP1-028-HSM1-10.18.22	UNIT
	DMC524	DMC534	DMC534	DMC544	DMC544	
Type of final drive	Planetary	Planetary	Planetary	Planetary	Planetary	
Transmission	1:2.842	1:2.842	1:2.842	1:2.842	1:2.842	---
Maximum power	96	120	157	185	220	kW
Continuous power (ECE R85) at 25°C*	70	70	93	93	145	kW
Max. input speed gear box	12'000	12'000	12'000	12'000	12'000	rpm
Max. output speed gear box	4'225	4'225	4'225	4'225	4'225	rpm
Continuous output torque (ECE R85) at 25°C*	360	360	460	460	750	Nm
Max. Input torque	220	320	305	385	460	Nm
Max. Output torque	610	890	850	1'070	1'280	Nm
Inverter current	300	450	450	600	600	Aeff

\*coolant temperature

BASIC ELECTRICAL DATA	DTSP1-028-HSM1-6.17.12	DTSP1-028-HSM1-10.18.13	DTSP1-028-HSM1-10.18.22	UNIT
Compatible inverter	DMC524 / DMC534	DMC534 / DMC544	DMC544	—
Recommended input voltage of device (min / max)	300 - 450	300 - 450	300 - 450	V
Level of motor efficiency	95	95	95	%
Level of gear box efficiency	98	98	98	%

CONNECTIONS	DTSP1-028-HSM1-6.17.12	DTSP1-028-HSM1-10.18.13	DTSP1-028-HSM1-10.18.22	UNIT
Phases U, V, W: 3 M6 cable lugs, recommended cable diameter	35	50	70	mm <sup>2</sup>
Ground GND M8 cable lug, recommended cable diameter	35	50	70	mm <sup>2</sup>
Motor sensor connector pin number	14	14	14	—

BASIC MECHANICAL DATA	DTSP1-028-HSM1-6.17.12	DTSP1-028-HSM1-10.18.13	DTSP1-028-HSM1-10.18.22	UNIT
Total length	504	504	592	mm
Total width	303	303	303	mm
Total height	326	326	326	mm
Weight (without gear oil)	72.6	72.1	97.1	kg
IP protection	IP67	IP67	IP67	—

THERMAL / COOLING SYSTEM	DTSP1-028-HSM1-6.17.12	DTSP1-028-HSM1-10.18.13	DTSP1-028-HSM1-10.18.22	UNIT
Coolant mixture ratio (water / glycol)	50 / 50	50 / 50	50 / 50	—
Derating temperature range	117 - 160	117 - 160	117 - 160	°C
Maximum operational temperature (activation of overload protection)	170	170	170	°C
Amount of coolant in motor	0.6	0.6	0.9	l
Amount of coolant in gearbox	0.04	0.04	0.04	l
Minimum coolant temperature at inlet	- 40	- 40	- 40	°C
Maximum coolant temperature at inlet	65	65	65	°C
Flow rate	6 - 8	6 - 8	6 - 8	l/min
Pressure drop @ 6l / min $T_{coolant} = 25^{\circ}C$ (motor) <i>(at standard Norma PS3 90° quick connector)</i>	ca. 120	ca. 120	ca. 180	mbar
Pressure drop @ 6l / min $T_{coolant} = 25^{\circ}C$ (gearbox) <i>(at standard Norma PS3 90° quick connector)</i>	ca. 25	ca. 25	ca. 25	mbar
Ambient temperature range for storage	- 40...+85	- 40...+85	- 40...+85	°C
Ambient temperature range in operation	- 40...+85	- 40...+85	- 40...+85	°C

GSP GEAR BOX INFORMATION	GSP	UNIT
Oil type	Hypoid gear oil API-GL5 SAE 75W-90	
Oil-fill capacity	500	ml
Total length	253	mm
Total width	272	mm
Total height	272	mm
Transmission	1:2.842	---
Max. speed (number of revolutions)	12'000	rpm
Weight (without oil)	20.6	kg
Max. output torque	1'670	Nm
Max. force on park lock lever	100	N

## 6.2 Function

### 6.2.1 Basic function HSM1 hybrid synchronous motor

The HSM1 hybrid synchronous motor is a water-cooled 3-phase AC motor. The motor is based on the combination of a permanent synchronous motor and a reluctance motor whereby the advantages of both versions have been coordinated and combined with one another. The HSM works with internal magnets which have an optimum flow direction at low magnetic resistance due to a self-developed alignment to one another.

Through this a remarkably high and consistent power delivery can be achieved while using less energy. The power delivery takes place over a large speed range. In addition, the HSM1 is extremely efficient and is best suitable for use as a traction drive with constant transmission ratio. With these properties, the HSM1 is a very good choice for drive systems which require constant and high power over a large speed range.

To achieve optimum results with this motor, it is paramount that the connected inverter is exactly adjusted to the motor. Inverters of the company BRUSA Elektronik AG are already specially optimised for use in these motors.

## 6.2.2 Basic function of the GSP gear box

The gearbox is attached on the back (against of the driving direction) of the motor. This version is for rear-wheel drive only. A gearbox version for front-wheel drive is available separately. The planetary gear box is basically made up of a sun gear, three planet wheels and a ring gear. The ring gear is fixed in the housing. The transmission is tapped at the planet carrier.

Because an electric motor does not generate a torque when idle, a clutch between the motor and the gear box is not necessary. In all gear box versions there is a fixed transmission (final drive) with the ratio 2.842.

The gear turns in the reverse direction while reversing. During this, the speed should be limited to 50km/h for safety reasons.

The gearbox has its own cooling system.

To secure the vehicle against rolling away, a mechanical parking lock is installed.

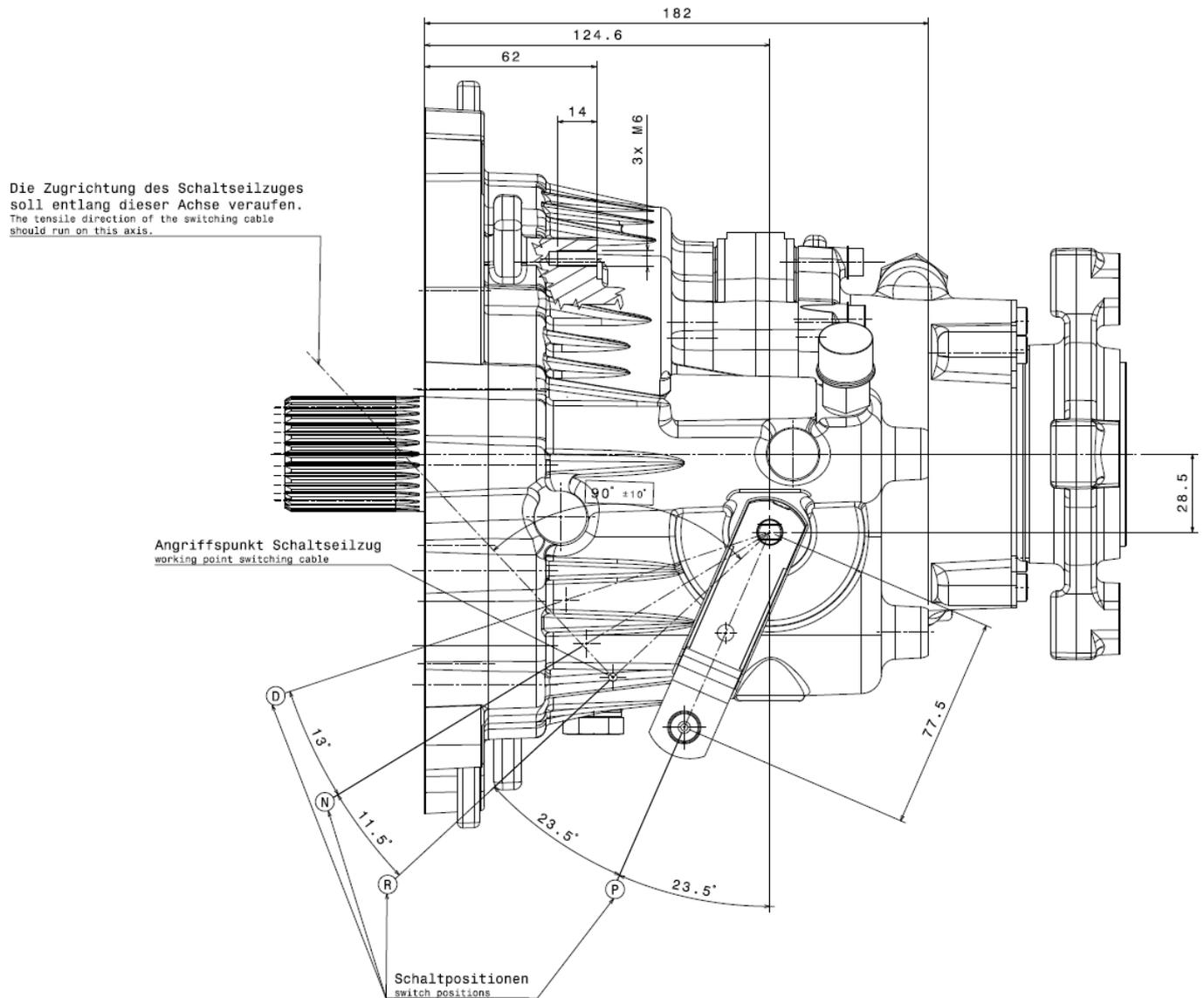
## 6.2.3 Position sensor

The position sensor is located between the posterior end-shield and the end-shield cover. The position sensor transmits the position and speed information of the rotor via the motor sensor connection on the inverter. The NTC and PTC resistors are connected to the inverter over the motor sensor connection as well.

## 6.2.4 Parking lock

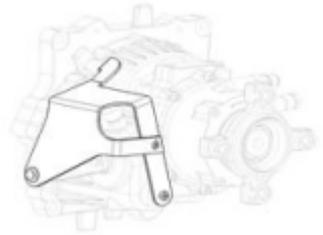
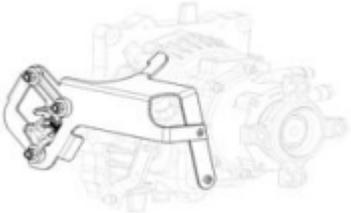
The parking lock is a mechanical lever.

The parking lock is only engaged in position "P". The parking lock is controlled with a gear selector lever and a cable pull, for example from the Mercedes Sprinter. In the following picture you can also see the different positions of the parking lock lever while driving "D", reversing "R" or neutral "N".



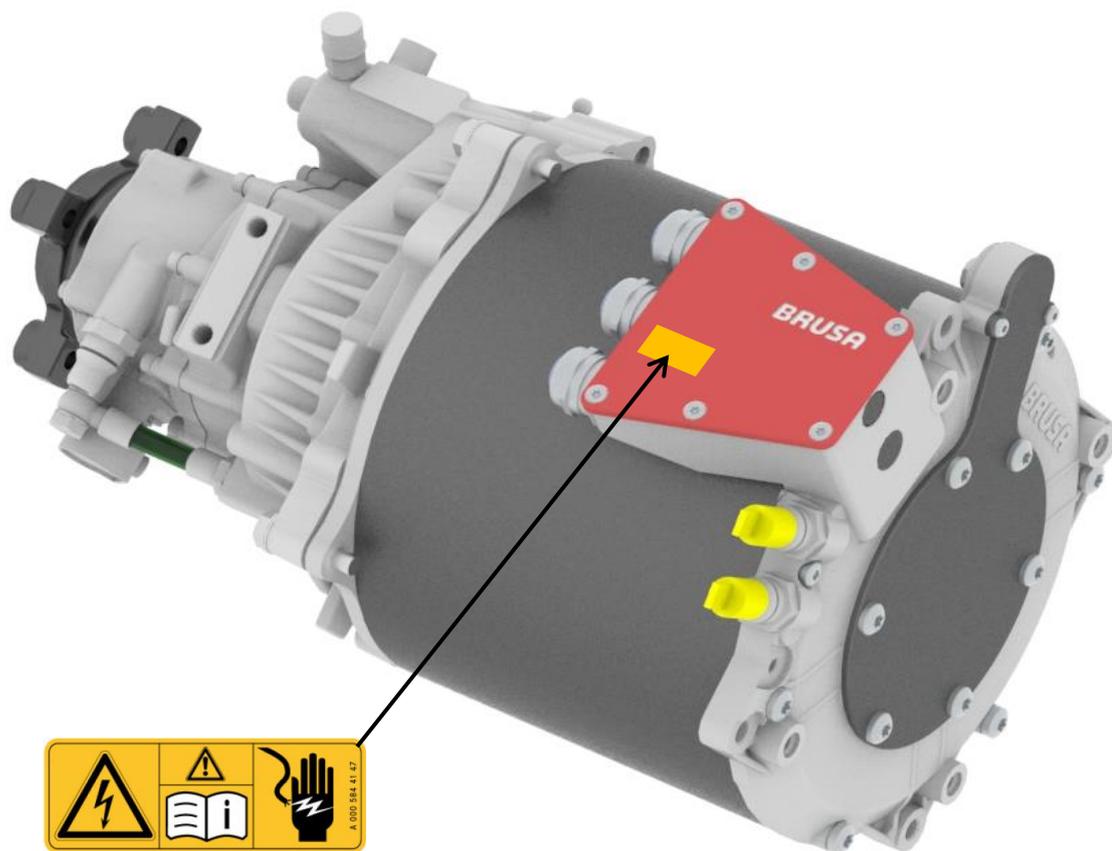
## 6.2.5 Park lock holder

It's possible to order two different park lock holders for the park lock lever at BRUSA Elektronik AG.

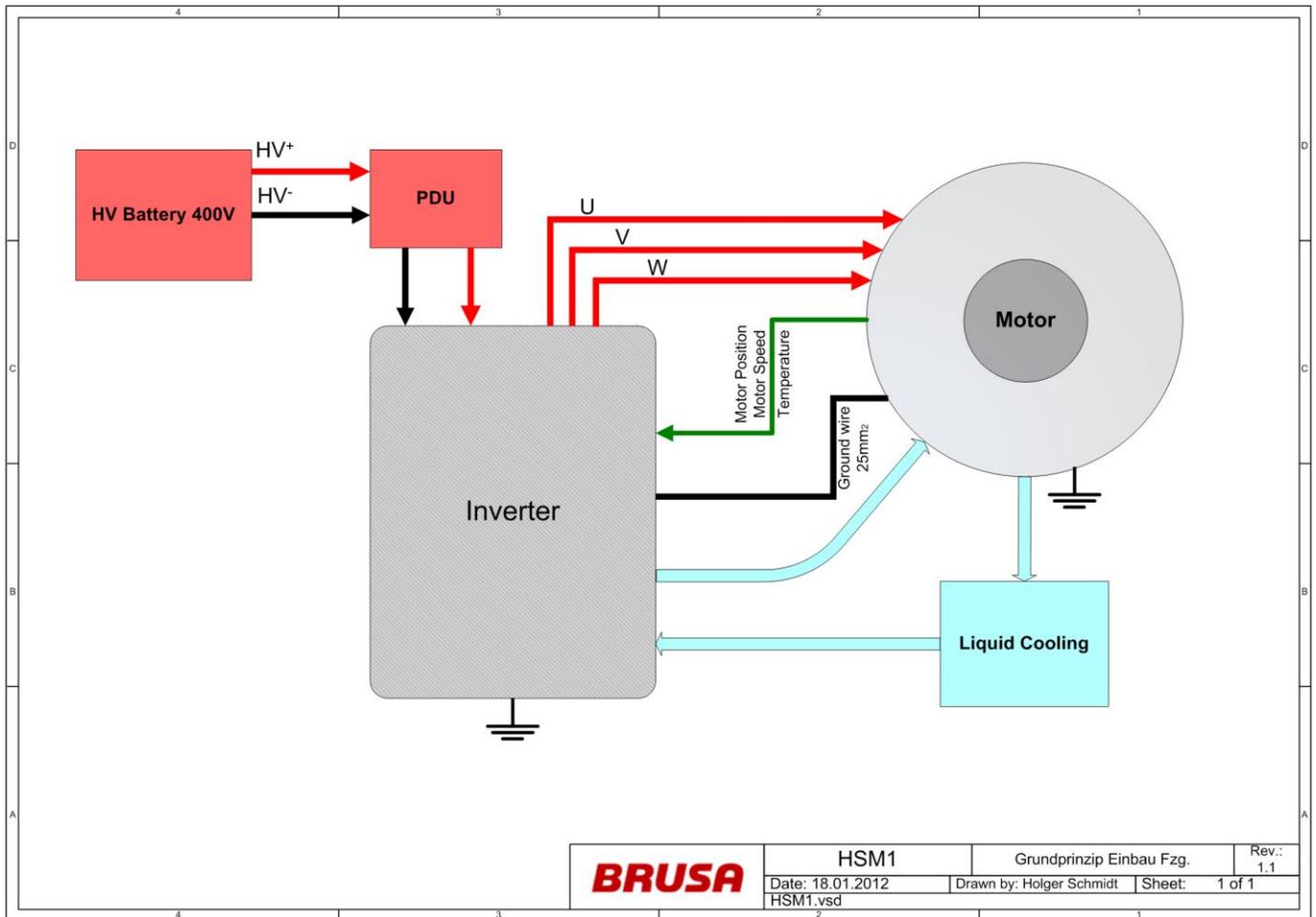
MEANING	PROD. NO.	ILLUSTRATION
Park lock holder for fixed position "D"	16285	
Park lock holder for switching cable	16281	

### 6.3 Warnings on the motor

Warning signs are attached to the motor 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 contact BRUSA support at the manufacturer address given in chapt. 4.6!



## 6.4 Basic principle for vehicle installation

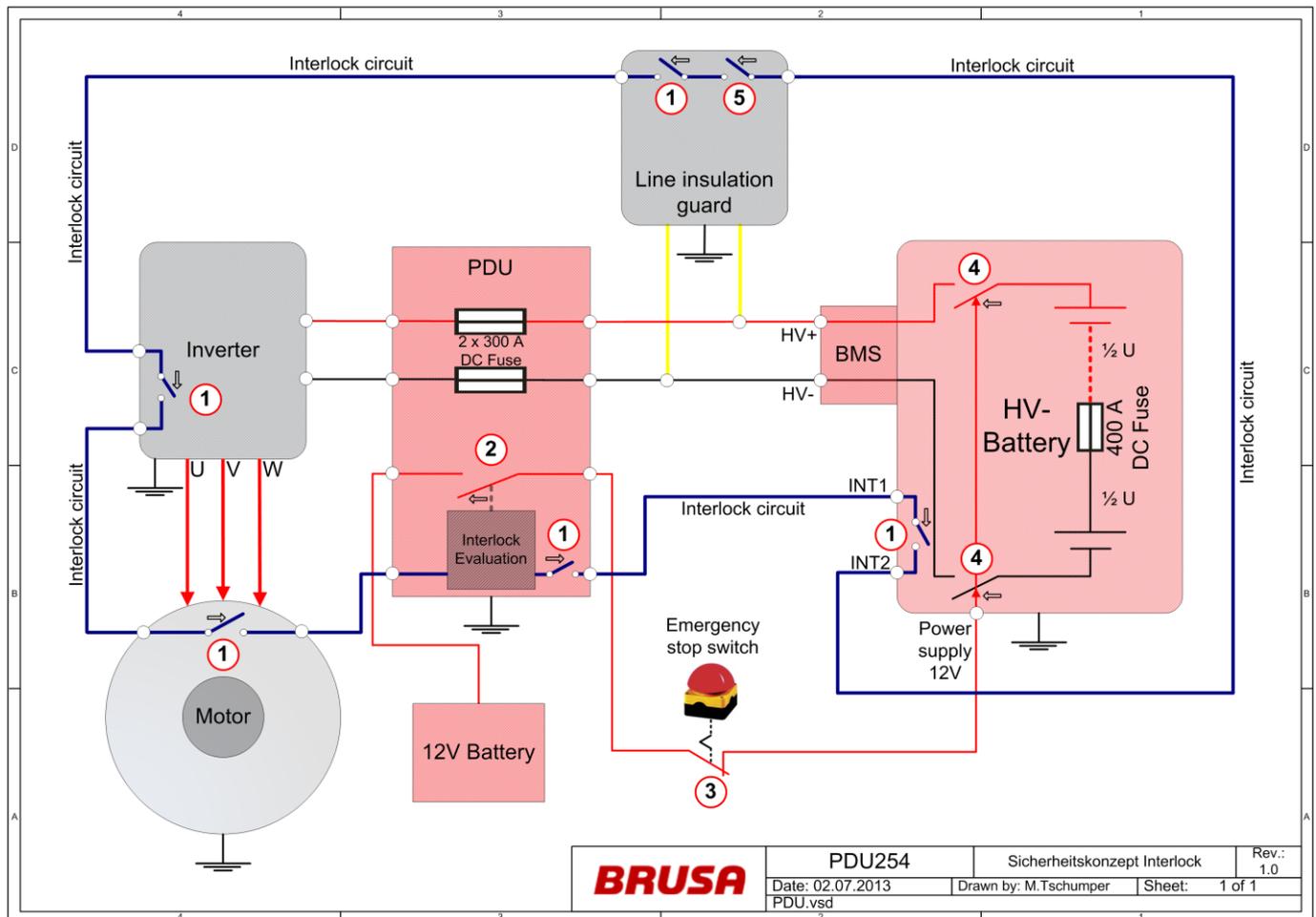


## 6.5 Safety measures for vehicle installation

### 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!



### 6.5.1 Principle of operation Interlock

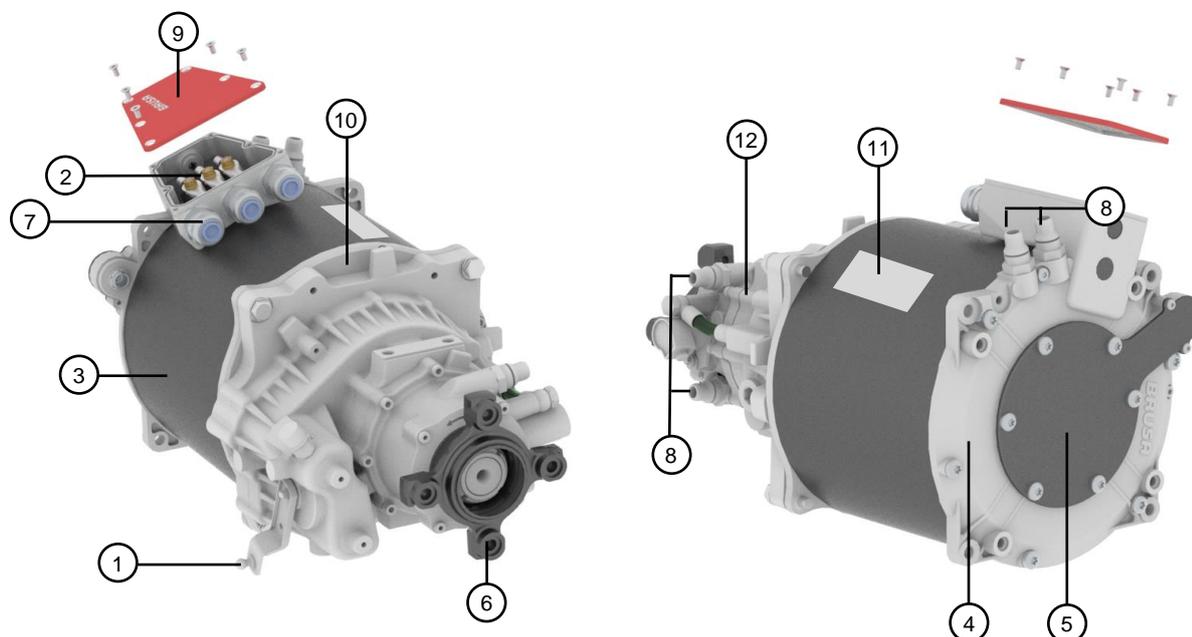
The interlock switch (1) is closed if the corresponding interlock condition of each device is met (closed service cover, plugged HV connections ...). The interlock evaluation of the PDU switches the 12V supply voltage (2) of the HV contactors (4) in the battery if the interlock circuit is closed. The 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.

### INSTRUCTION



The interlock function is currently not implemented in BRUSA motors. Therefore the interlock function of the motors has to be guaranteed by the vehicle manufacturer.

## 6.6 Overview of the main structural components



1. Parking Lock	2. Terminal Board
3. Cooling Jacket	4. Posterior End-Shield
5. End-Shield Cover	6. Drive Shaft Flange
7. Connection Box Phases U, V, W (R, S, T)	8. Cooling Water Connections
9. Connection Box Cover	10. Anterior End-Shield / Gear Box Housing
11. Type Plate	12. GSP Gearbox

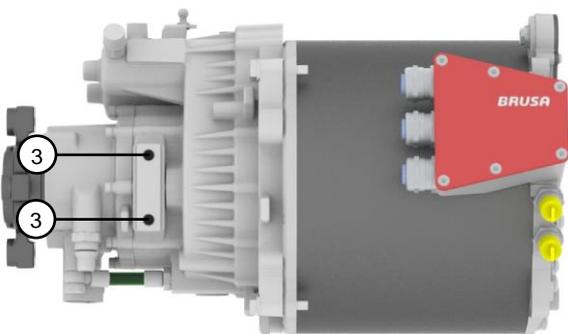
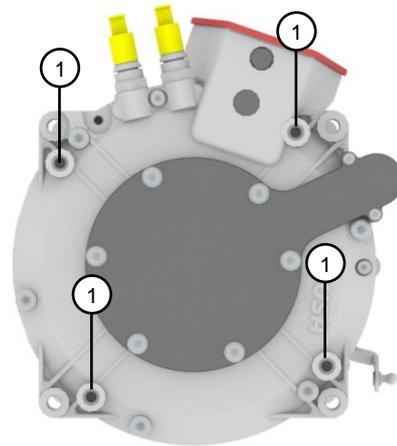
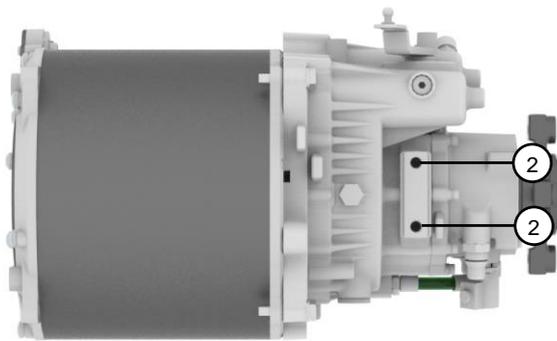
## 6.7 Dimensions and installation information

### 6.7.1 Rotor offset

The rotor offset is determined during assembly and is noted on a sticker on the motor housing (usually near the motor sensor connector). Parameters for the rotor offset must be set during the start-up of the inverter. You can find further information on the process in the technical information for the inverter.

If the sticker on the housing is illegible or missing, please contact BRUSA support, stating the serial number, at the manufacturer address given in chapt. 4.6..

## 6.7.2 Fixing points



- |   |   |
|---|---|
| 1. Fixing points Posterior End-Shield (M10) | 2. Fixing points gearbox bottom (M12 x 1.5) |
| 3. Fixing points gearbox top (M12 x 1.5)    |   |

### INFORMATION

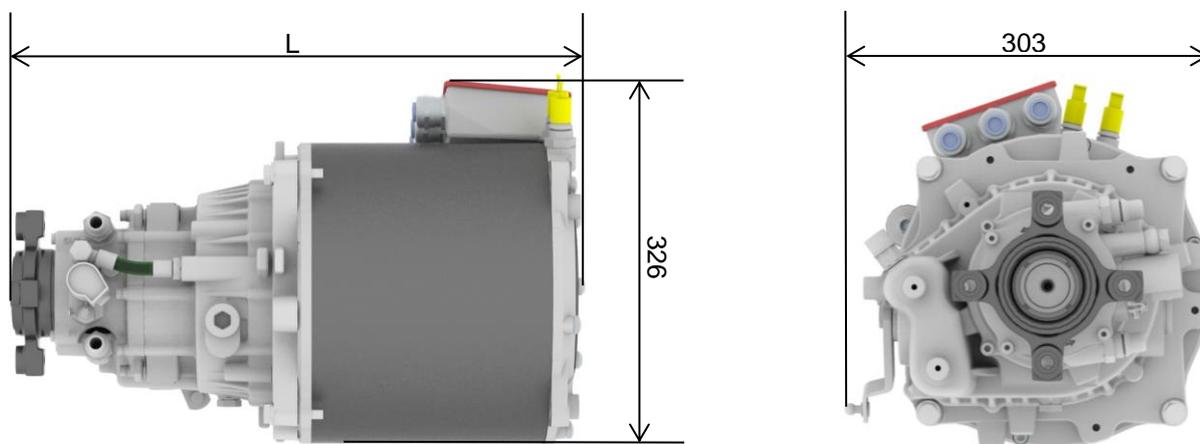


Assembly instructions for the fixing points:

The fixing points of the rear end shield are provided with an M10 thread.

The fixing points of the gearbox are provided with an M12 thread.

## 6.7.3 Dimensions



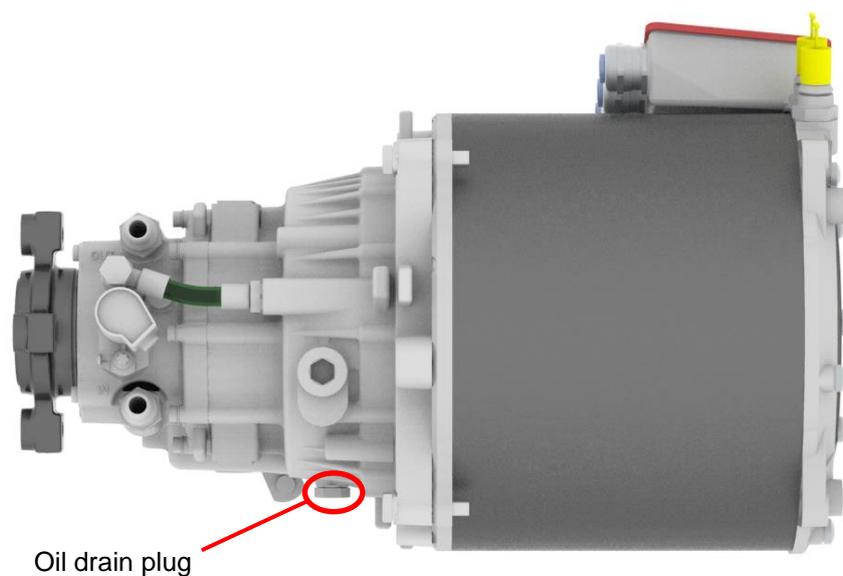
MOTOR TYPE	TOTAL LENGTH (L)	UNIT
HSM1-6.17.12	504	mm
HSM1-10.18.13	504	mm
HSM1-10.18.22	592	mm

## 6.7.4 Installation position

### INFORMATION



In any event the motor must be installed in such a way that the oil drain plug is the lowest point of the gearbox.



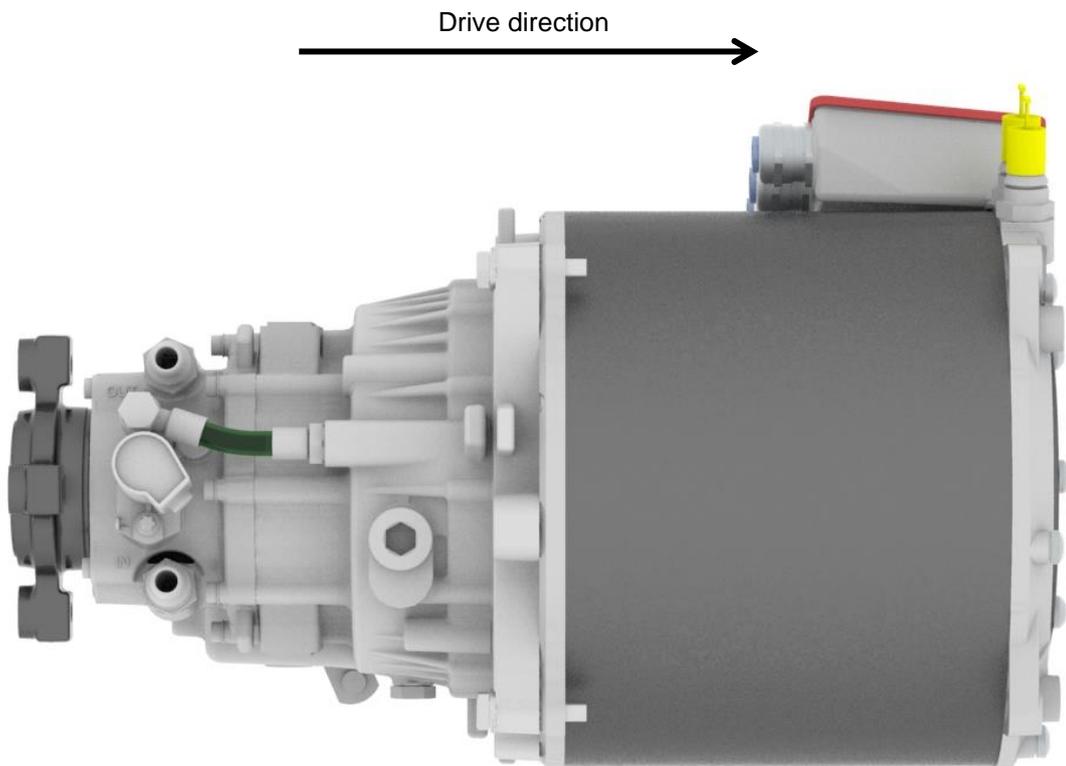
Oil drain plug

### 6.7.5 Drive direction

#### INFORMATION



The gearbox is attached on the back (against of the driving direction) of the motor

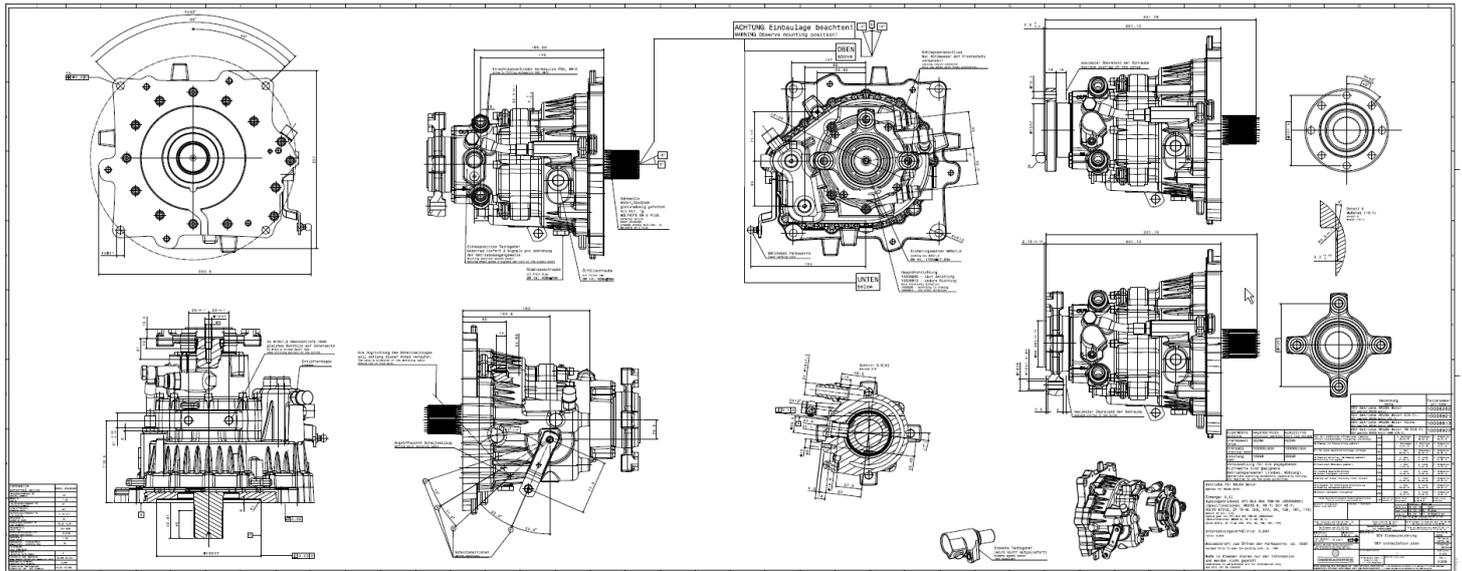


## 6.7.6 Customer Drawing

### INFORMATION

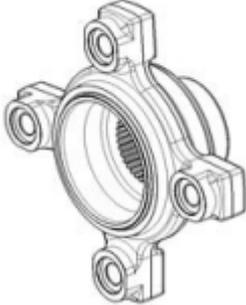
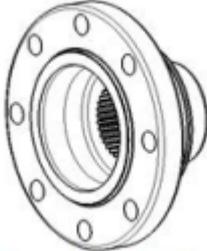


On our FTP-Server, you can find a Customer Drawing of the Drive Train as well as the CAD-Stepfiles:  
[http://www.brusa.biz/files/drive/10\\_indexContent/StartHere\\_Motor&Drivetrain\\_S&M.html](http://www.brusa.biz/files/drive/10_indexContent/StartHere_Motor&Drivetrain_S&M.html)



## 6.7.7 Drive flange

There are two different types of drive flanges available:

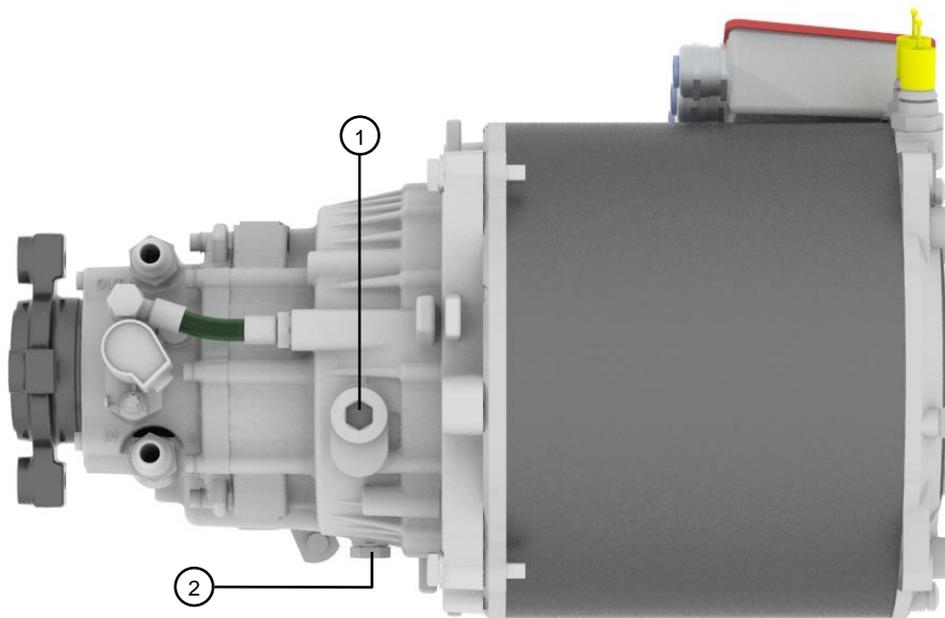
MEANING	PROD. NO.	ILLUSTRATION
<p>Flange HAVGNCV2</p> <p> Torque for drive shaft screws:</p> <ul style="list-style-type: none"> <li>• 1st Step: 15Nm</li> <li>• 2nd Step: +70°</li> </ul>	---	
<p>Flange DIN ISO 7646</p> <p> Torque for drive shaft screws:</p> <ul style="list-style-type: none"> <li>• 1st Step: 15Nm</li> <li>• 2nd Step: +70°</li> </ul>	16320	

## 6.7.8 Filling up and checking of gearbox oil

### INFORMATION



You have to fill in gearbox oil before starting up the motor. Otherwise, the gearbox gets destroyed! Organize yourself the recommended gearbox oil in Chap. 6.1. in the GSP gear box information. The gearbox oil can be used for lifetime. To fill in the gearbox oil, perform the steps below.



1. Oil Fill Plug

2. Oil Drain Plug

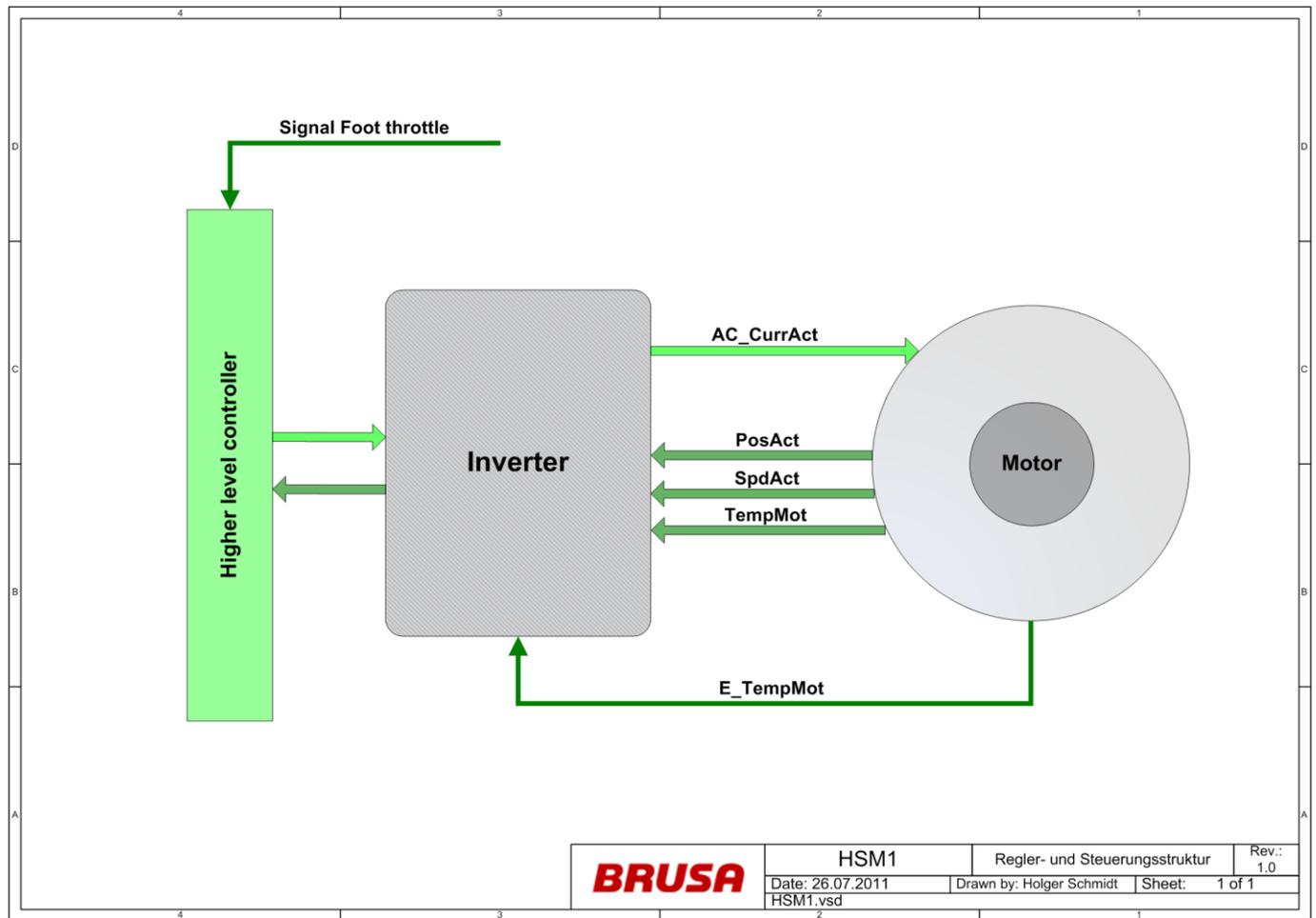
PROCEDURE STEP	ILLUSTRATION / OTHER INFORMATION
1. Open the oil fill plug (1).	---
2. Open the oil drain plug (2).	---
3. Drain all the oil out of the gearbox	---
4. Close the oil drain plug (2).	Screw torque: 40 +/-4 Nm
5. Pour 500ml (±15ml) of gearbox oil in.	For information on the oil specification see chap. 6.1 <i>Technical data</i>
6. Close the oil fill plug (1)	Screw torque: 50 +/-5 Nm

### WARNING



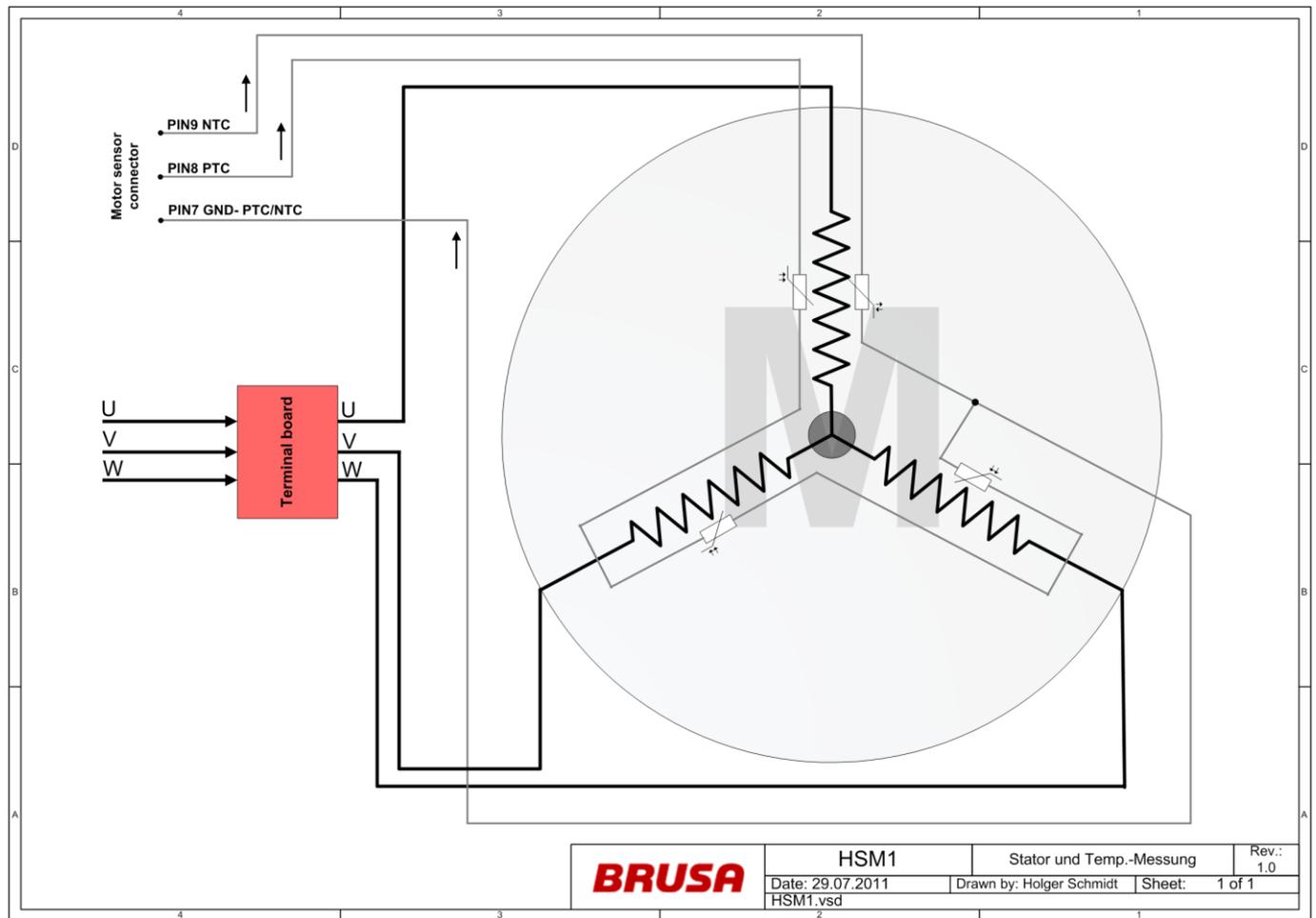
Without gear oil, the gearbox gets destroyed very quickly during operation!  
In any case, make sure you filled up the gear oil before start up!  
BRUSA provides no warranty services for damage due to lack of gear oil!

## 6.8 Regulation and control system



<b>AC_CurrAct</b>	Phase current generated by inverter (U, V, W)	<b>TempMot</b>	Current motor temperature
<b>PosAct</b>	Current motor position	<b>E_TempMot</b>	Excessive temperature (phase current cut-off)
<b>SpdAct</b>	Current speed		

## 6.9 Stator and temperature measurement



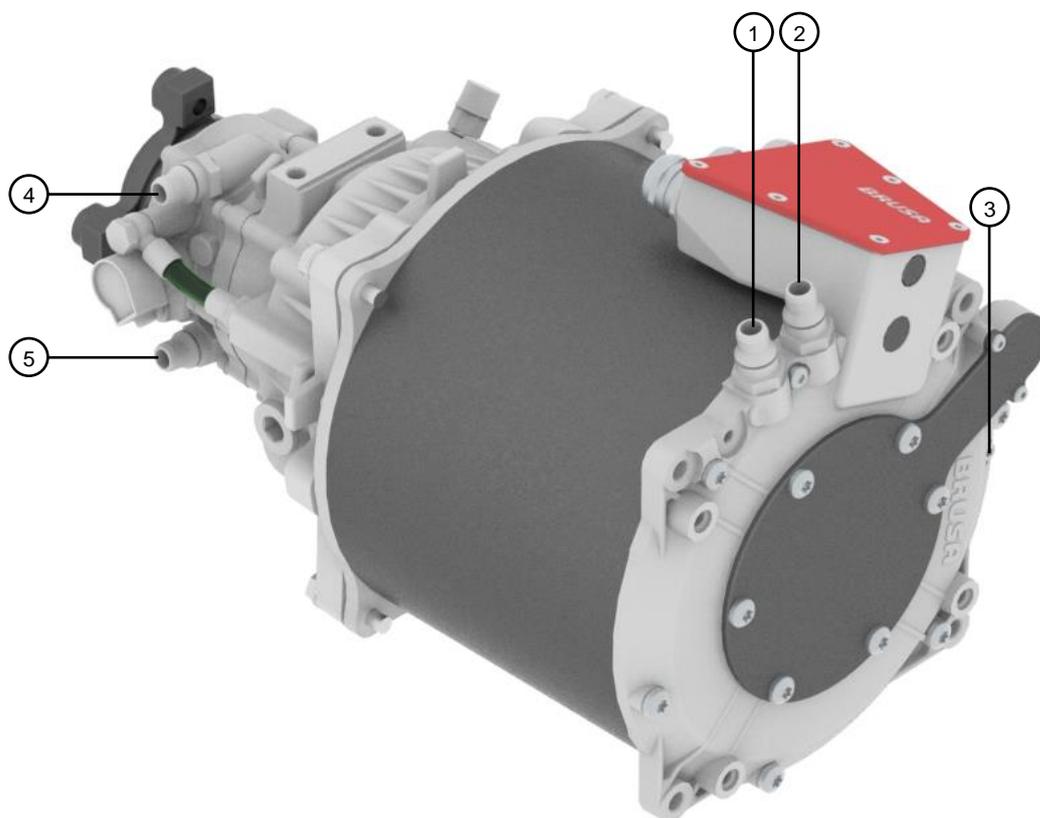
## 6.10 Mechanical connections

### 6.10.1 Cooling system

#### INSTRUCTION



Observe the cooling liquid mixture ratio (water / glycol) which is adapted to the outside temperature! You can find information on the mixture ratio in the manufacturer's technical data.



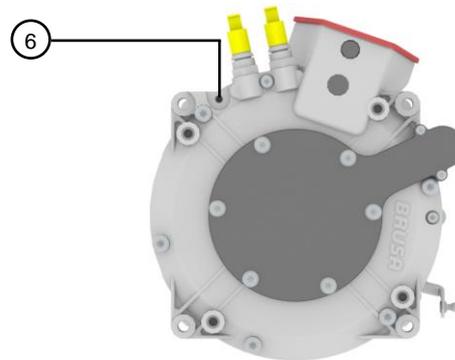
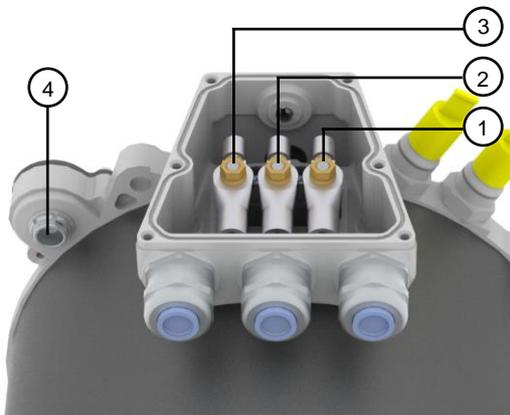
1. Cooling water outlet connection	2. Cooling water inlet connection
3. Cooling system ventilation screw	4. Cooling water outlet Gearbox
5. Cooling water inlet Gearbox	

## 6.10.2 Cooling water connections

<b>Quick connector for cooling Water connection pieces 90° Norma PS3 (MHAA776)</b>	<b>Quick connector for cooling Water connection pieces 0° Norma PS3 (MHAA775)</b>

## 6.11 Connections electrical

You will find the required cable types and diameters in chapt. 6.1 *Technical data*



- |                 |                            |
|-----------------|----------------------------|
| 1. Phase U      | 2. Phase V                 |
| 3. Phase W      | 4. Motor sensor connection |
| 5. Ground (GND) |                            |

### INFORMATION



Torque phase cable nuts M6 = 3 Nm

If the torque is too high, the thread will be destroyed and the terminal board has to be changed. You can order the spare parts given in chapt. 12 by contacting the manufacturer 4.6.

### 6.11.1 Grounding Screw

#### WARNING



#### Sparking! Fire hazard!

A loose ground circuit can lead to sparking and subsequent fires!  
Ensure that the earth connection is connected correctly!

### INFORMATION



The grounding screw (1) must be connected with the earth of the vehicle and/or testing bay. The cable diameter of the earth cable must correspond to the dimensions of the HV wiring. For EMC reasons we generally recommend an additional ground connection (25 mm<sup>2</sup>) to the inverter!

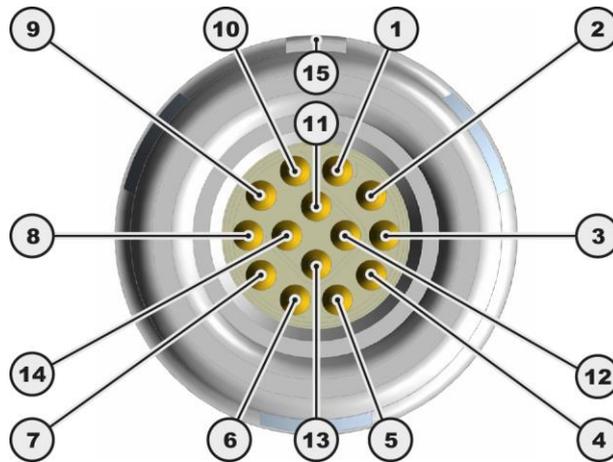
Torque earthing screw (1) M8 x 10 = 15 Nm

## 6.11.2 PIN assignment of motor sensor connection

### INFORMATION



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



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

## 6.12 Gearbox type plate

		Neudorf 14 CH-9466 Sennwald www.brusa.biz			
<b>1:</b> Type: DTSP1-028-HSM1-10.18.13-A01 Drivetrain Single Planetary		<b>2:</b> Date: 15-07		<b>3:</b> S-No: 0000000000	
<b>4:</b> Max. output torque: 1060 Nm		<b>5:</b> Max. output speed: 4225 rpm		<b>6:</b> Gear ratio: 2.84	
15589_0000000000_DTSP1-028-HSM1-10.18.13-A01_15-07					

1. Drivetrain Type	2. Date of production
3. Serial number	4. Max. output torque
5. Max. output speed	6. Gear ratio

## 7 Profiles and diagrams

### INFORMATION

For more information about the motor itself, please visit our FTP-Server.

There you can find all the datasheets and motor manuals, which includes all the efficiency diagrams, information about thermal behaviour and more.



Link to FTP-Server:

[http://www.brusa.biz/files/drive/10\\_indexContent/StartHere\\_Motor&Drivetrain\\_S&M.html](http://www.brusa.biz/files/drive/10_indexContent/StartHere_Motor&Drivetrain_S&M.html)

## BRUSA Motor & Drivetrain Documentation

### Product Information

Motors	Meaning	Drivetrains with gearboxes	Meaning
ASM	Asynchronous motor	DTDP1	Double Planetary Traction Drive
HSM	Hybrid synchronous motor	DTSX1	Single Transaxle Drivetrain
IPM	Internal permanently excited synchronous motor	DTDO1	Double Offset Traction Drive
		DTSO1	Single Offset Traction Drive

### Datasheet

- [BRUSA\\_DB\\_EN\\_ASM1.pdf](#)
- [BRUSA\\_DB\\_EN\\_HSM1.pdf](#)
- [BRUSA\\_DB\\_EN\\_HSM1\\_750V.pdf](#)
- [BRUSA\\_DB\\_EN\\_HSM1\\_10.18.04.pdf](#)

### Drivetrain Flyer

- [DTDP1](#)
- [DTSX1](#)
- [DTDO1](#)
- [DTSO1](#)
- [DTSP1](#)

### Manual

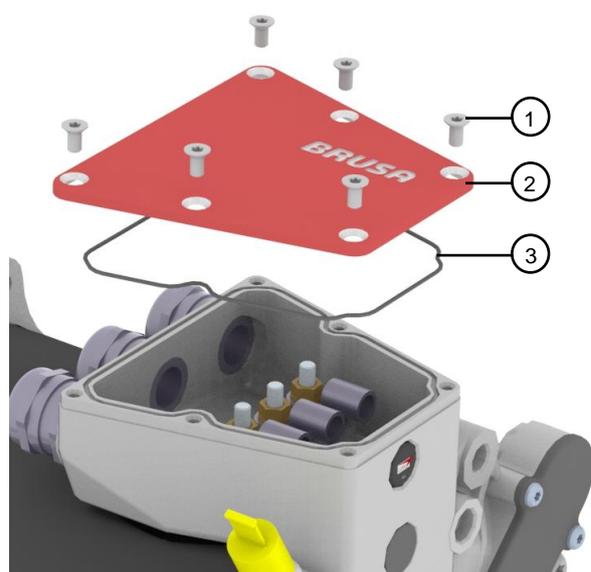
- [Motor Manual \[EN\]](#)
- [DTSX1 Manual \[EN\]](#)

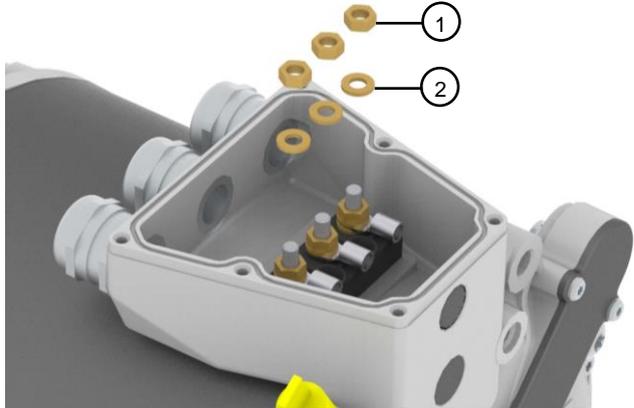
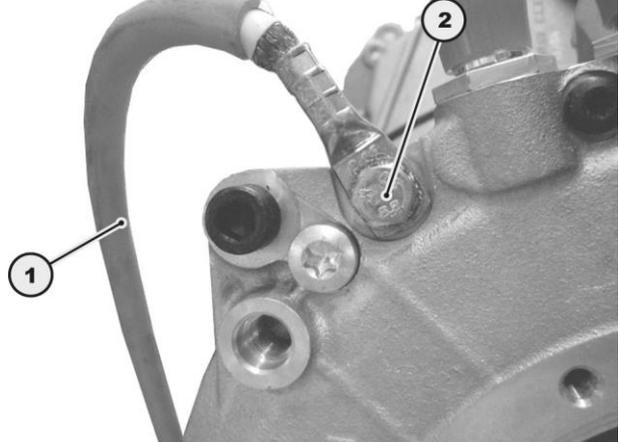
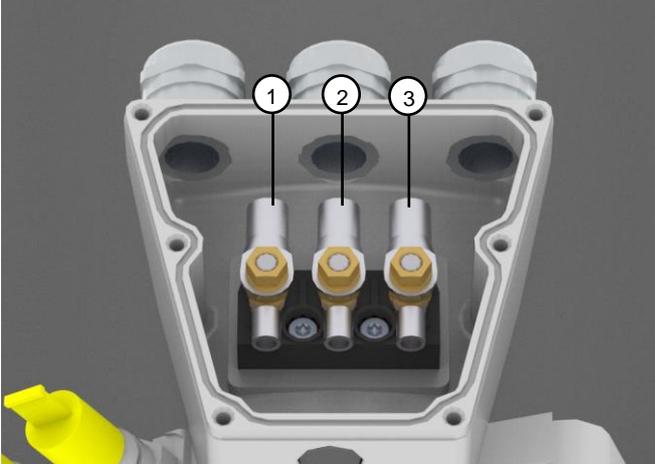
### HSM CAD Data

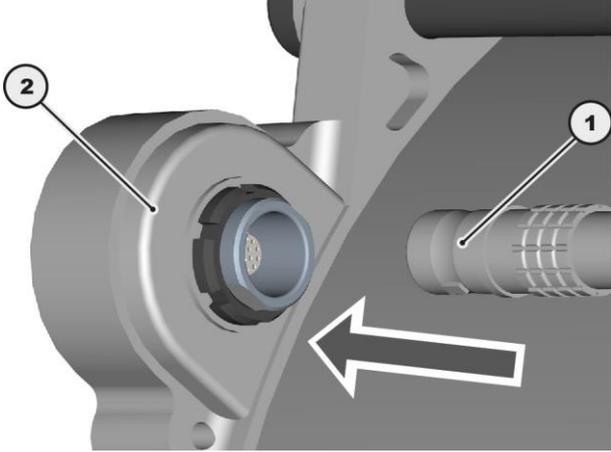
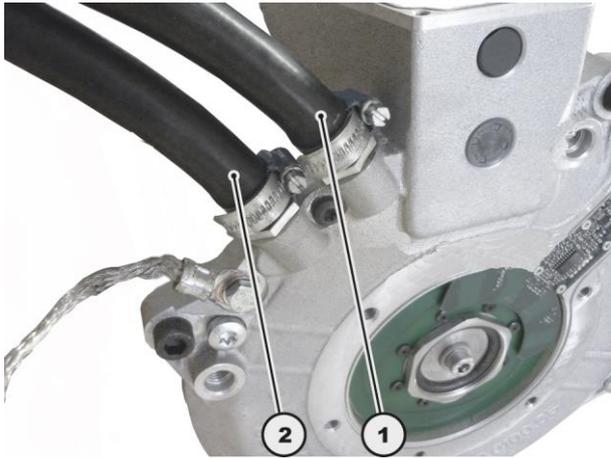
- 3D Step Data [HSM1-10.18.04-A01](#)
- 3D Step Data [HSM1-10.18.04-A02](#)
- 3D Step Data [HSM1-10.18.13-D01](#)
- 3D Step Data [HSM1-10.18.13-D02](#)

## 8 Installation / start-up

INSTRUCTION	
	<p><b>Damage to the motor!</b> You must ensure that you upload the appropriate motor table for this motor! The wrong data can lead to damage to the motor and to the inverter!</p>
INSTRUCTION	
	<p><b>Damage to the cable!</b> During installation and the laying of cables, observe the maximum bending radius given by the manufacturer! Avoid laying the cables alongside sharp edges and mechanical components!</p>
INFORMATION	
	<p>Visually check the packing material and the motor in particular for damages (e.g. cracks in the motor and gear box housing) before installation. Each motor undergoes a strict quality and function test at BRUSA before distribution. However, we have no control over transportation routes which can sometimes take a long time and the shipping of our products.</p>

PROCEDURE STEP	ILLUSTRATION / OTHER INFORMATION
<p><b>7.</b> Insert the motor into its position and connect the mechanical coupling components. Please adhere to the installation instructions, see chapt. 6.7.2</p>	---
<p><b>8.</b> Check that all connecting elements are secure.</p>	---
<p><b>9.</b> Unscrew the screws (1).  Take the connection box cover (2) with the O-ring (3) off.</p>	

PROCEDURE STEP	ILLUSTRATION / OTHER INFORMATION
<p><b>10.</b> Unscrew the nuts (1). Remove the washers (2).</p>	
<p><b>11.</b> Connect the ground wire (1) with the car body and the screw (2).</p> <p> For EMC reasons we generally recommend an additional ground connection (25 mm<sup>2</sup>) to the inverter!</p> <p> Torque = 15 Nm</p>	
<b>NOTE</b>	
<p> Ensure that you connect the phases correctly! Mixing up the phases will lead to a change in the rotating direction of the motor or to malfunctions in the motor depending on the connection version.</p>	
<p><b>12.</b> Connect the HV supply.</p> <ul style="list-style-type: none"> <li>➤ Phase U (1)</li> <li>➤ Phase V (2)</li> <li>➤ Phase W (3)</li> </ul> <p> Ensure that the cable fittings are positioned correctly and that they are secure.</p> <p> Torque of screws M6 = 3 Nm</p> <p> Torque of M25 screw-in plug on connection box = 15 Nm</p> <p> See chapt. 8.1 Connecting the HV supply to assemble the HV cables</p>	

PROCEDURE STEP	ILLUSTRATION / OTHER INFORMATION
<p>13. Put the O ring in the guide slot.</p> <p>Screw down the connection box cover.</p> <p> Torque = 5 Nm</p>	<p>---</p>
<p>14. Connect the motor sensor cable (1) with the motor sensor switch (2).</p>	
<p>15. Connect the cooling water pumps (1) and (2).</p> <p> Pay attention while doing so to the cooling water inlet (1) and the cooling water outlet (2).</p>	
<p>16. Ventilate the cooling system.</p> <p> <b>See chapt. 8.2 Ventilating the cooling system</b></p>	<p>---</p>
<p><b>INFORMATION</b></p>	
<p> The motor is now ready for operation. During the initial start-up, start the motor with care and caution!</p>	

## 8.1 Connecting the HV supply

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).

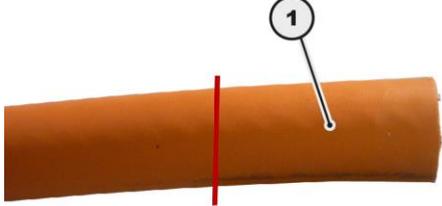
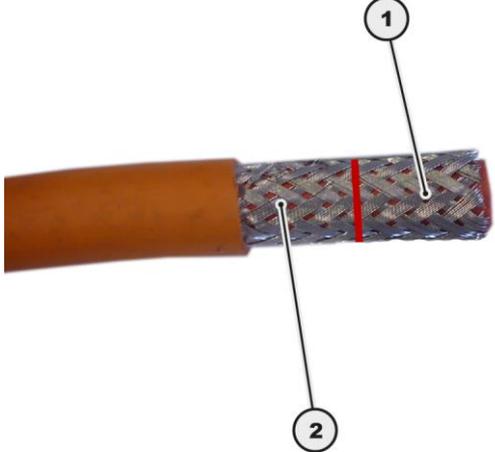
### For the HV connections we recommend:

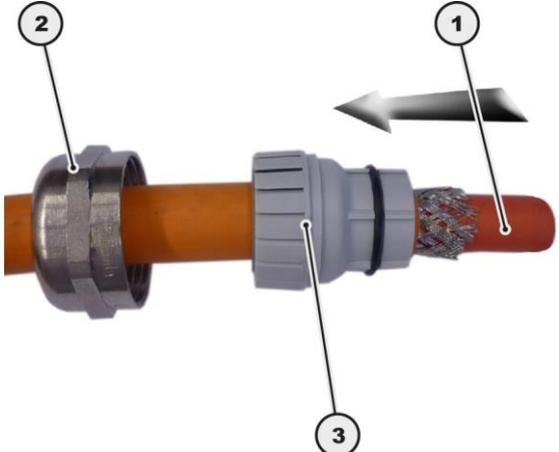
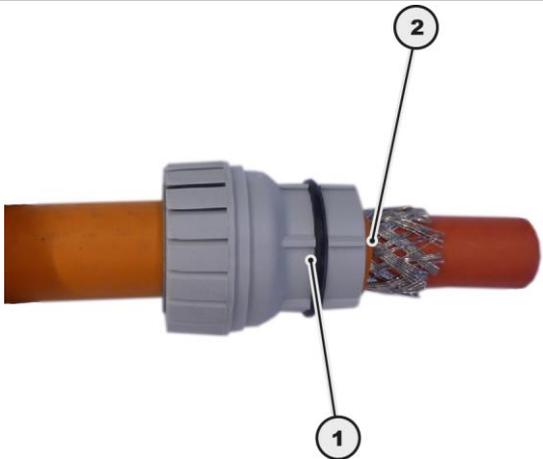
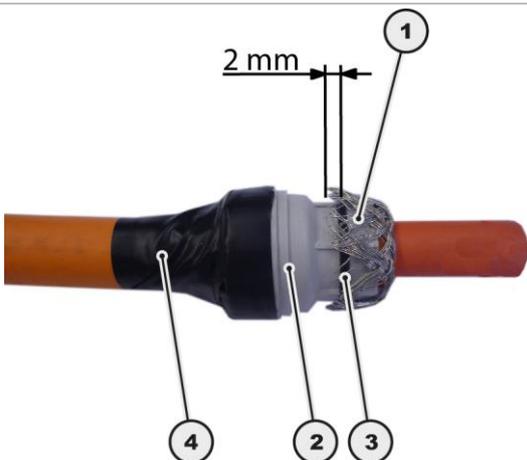
- A shielded, insulated automotive cable (e.g. Huber & Suhner).
- Cable lug, for the type see chapter *12 Spare Parts*
- To assemble the cable lugs, using the appropriate crimping tool is absolutely necessary!

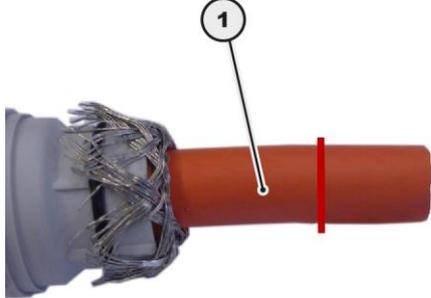
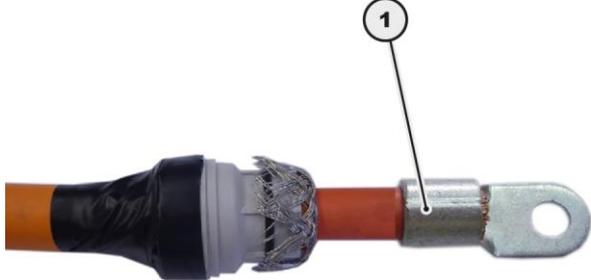
#### INSTRUCTION



Make absolutely sure that the individual strands of the shielding braid (1) do not jut out over the sealing ring (3) under any circumstances! Once in the integrated state, this will lead to leakages and subsequently to the leaking of water into the housing!

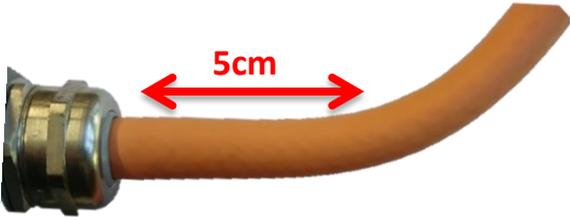
PROCEDURE STEP	ILLUSTRATION / OTHER INFORMATION
<p><b>17. Insulate 35 mm of the HV cable (1).</b></p> <ul style="list-style-type: none"><li>💡 Ensure that you do not damage the shielding braid underneath it!</li><li>💡 The lengths of the phase cables in the connection box are different, so this will have to be adjusted accordingly for U V W.</li></ul>	
<p><b>18. Shorten the shielding braid (1) by 20 mm.</b></p> <ul style="list-style-type: none"><li>💡 The cable-side shielding braid (2) must be a length of around 15 mm.</li></ul>	

PROCEDURE STEP	ILLUSTRATION / OTHER INFORMATION
<p><b>19.</b> Lead the HV cable (1) through the union nut (2). Lead the HV cable (1) through the terminal insert (3).</p>	
<p><b>20.</b> Place the terminal insert (1) with the front edge flush with the cable insulation (2).</p>	
<p><b>21.</b> 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).</p>	

PROCEDURE STEP	ILLUSTRATION / OTHER INFORMATION
<p><b>22.</b> Insulate 16 mm of the HV cable (1).</p> <p> The lengths of the phase cables in the connection box are different, so this will have to be adjusted accordingly for U V W.</p>	
<p><b>23.</b> Assemble the cable lug (1) at the end of the cable.</p> <p> No strands should stick out at the sides!</p> <p> The crimping must be hexagonal. Ensure that the crimping has no deformations at the sides because this will make later installations in the housing difficult!</p>	
<p><b>24.</b> Check the secure positioning of the cable lug manually.</p>	<p>---</p>
<p><b>25.</b> Assemble a shrinkage tube (1) on the cable lug (2).</p> <p> The assembly of a shrinkage tube (1) is absolutely necessary because otherwise contacting can result in the housing!</p>	

**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](http://hummel.com).

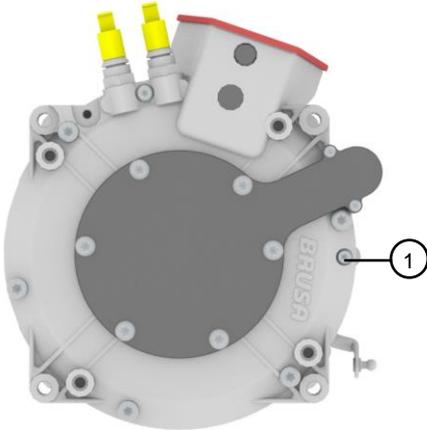
## 8.2 Ventilating the cooling system

### INSTRUCTION



Air pockets in the cooling passage along with generally insufficient cooling of the motor lead to increased wear!

Ensure that the cooling circuit is fault-free.

PROCEDURE STEP	ILLUSTRATION / OTHER INFORMATION
1. Switch on the cooling circuit.	---
2. Place a suitable collection container under the ventilation hole.	---
3. Open the ventilation screw (1).	
4. Leave the cooling circuit on until no more air bubbles come out of the ventilation hole.	---
5. Tighten the ventilation screw.  Torque = 7 Nm	---
6. Check the cooling water level.	---

### 8.3 Carrying out the HV test

#### DANGER



**High voltage!**  
**Danger to life!**



The motor housing can be live with high voltage during the HV test! Under no circumstances should you touch the motor housing!

Only carry out the test in a secure environment (no access by outside persons possible)!

#### INSTRUCTION



Destruction of the stator windings!

You must adhere to the given test voltage and testing time!

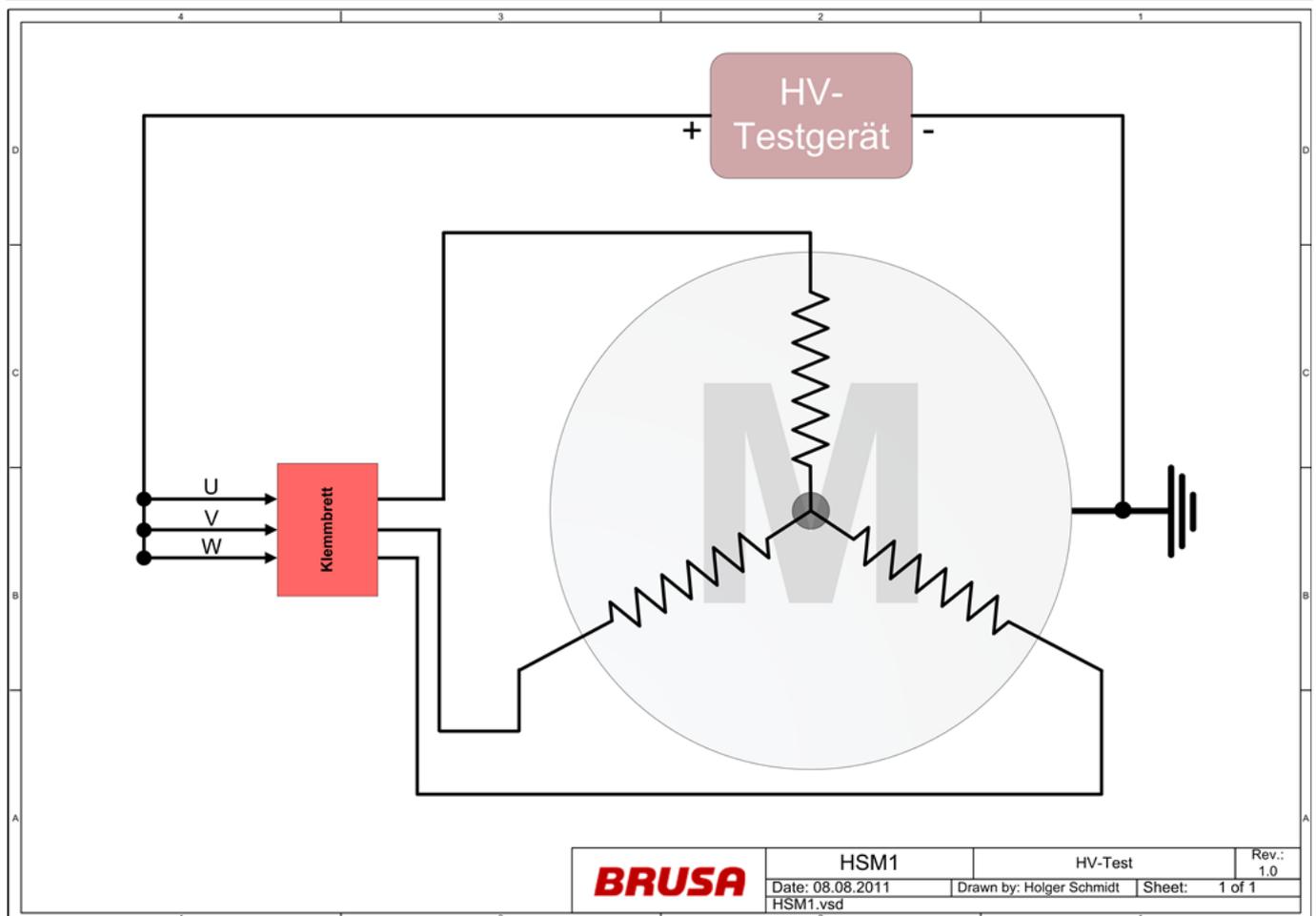
Exceeding this test voltage and testing time can lead to damage to the motor!

#### INFORMATION



The HV test ensures that there are no ground short circuits present within the windings and from the windings and temperature sensors to the housing.

The HV test must only be carried out after working on the HV supply (e.g. after the changing of the terminal board).



PROCEDURE STEP	ILLUSTRATION / OTHER INFORMATION
<p><b>7.</b> Connect the HV measuring device as is demonstrated in the diagram above:</p> <p> HV- to the ground connection of the motor. HV+ to the phases U, V, W.</p>	---
<p><b>8.</b> Set the test voltage on the HV measuring device to 2000 V<sub>AC</sub> (2800 V<sub>DC</sub>).</p> <p> The test duration after reaching the test voltage (2000 V<sub>AC</sub> or 2800 V<sub>DC</sub>) is 5 seconds.</p> <p> Rampe T<sub>rise</sub> / T<sub>fall</sub> = 2 seconds.</p>	---
<p><b>9.</b> Switch the HV measuring device on and carry out the test.</p> <p>Note the test result.</p> <p> Max. Leakage current = 15 mA</p>	---
<p><b>10.</b> Switch off the HV measuring device.</p> <p>Disconnect the HV measuring device from the motor.</p>	

In the event of a negative test result (leakage current > 10 mA), the phase cables and the phase connections to the terminal block must be checked for damage. If no damage or short-circuit is apparent, the motor must be examined by the company BRUSA. For this please refer to the manufacturer address given in chapt. 4.6.

## **9 Error correction**

As the motor does not have its own control architecture, control faults are always set by the connected inverter. Use the technical information of the inverter as an aid in the event of any faults occurring. If you cannot find an appropriate solution there, please contact BRUSA support at the manufacturer address given in [chapt. 4.6](#).

Likewise, if mechanical problems or direct damage to the motor should occur in spite of our high quality standards, we would ask you to refer directly to our support team.

## 10 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

# 11 Maintenance

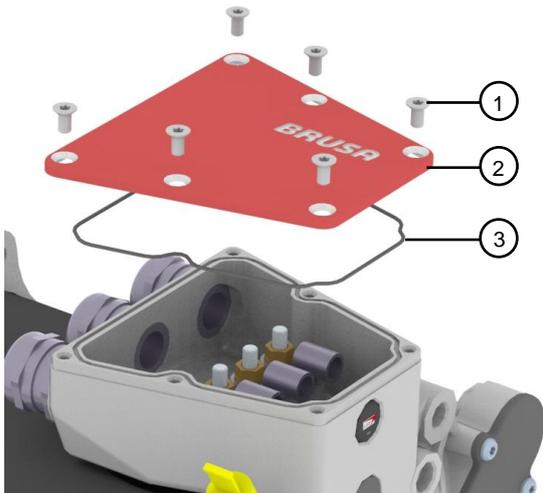
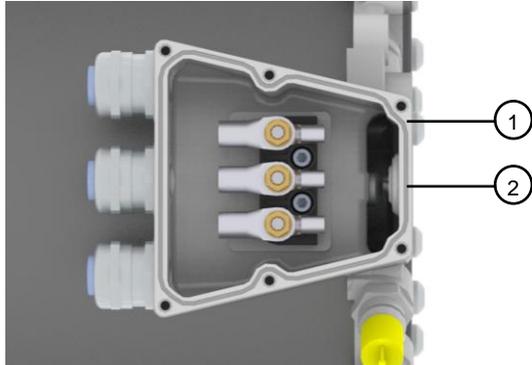
## DANGER



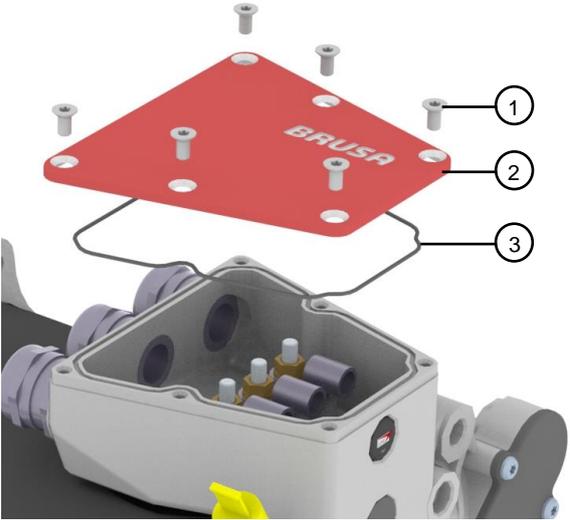
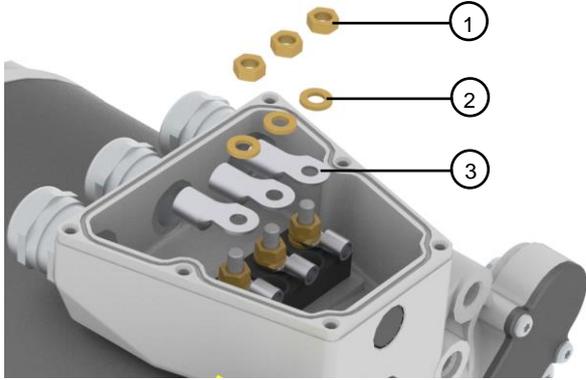
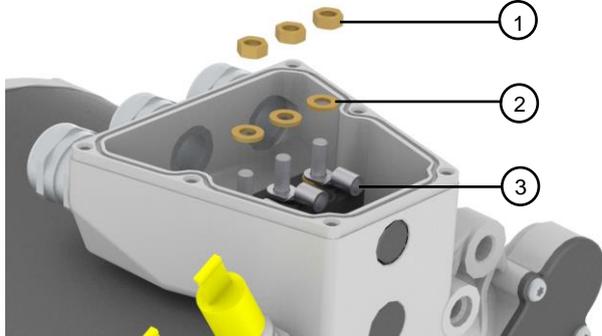
**High voltage!**  
**Danger to life!**

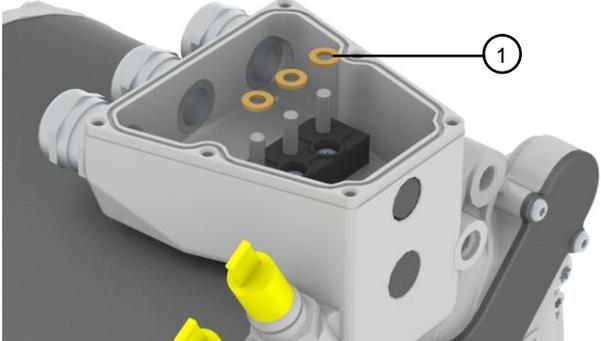
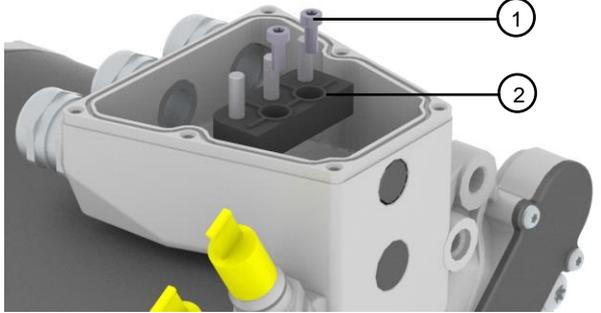
Even when the HV supply is switched off, a turning motor can still produce voltage! In general, disconnect the HV supply before starting work on the motor and ensure that no voltage is live in the components in question!

### 11.1 Changing the O-ring connection box

PROCEDURE STEP	ILLUSTRATION / OTHER INFORMATION
<p>1. Disconnect the HV supply. Ensure that there is no high voltage present.</p>	
<p>2. Unscrew the screws (1). Take the connection box cover (2) with the O-ring (3) off.</p>	
<p>3. Clean the sealing surface (1) and the nut (2) with a suitable tool and cleaning agent. There should be no dirt particles in the nut (2).</p>	
<p>4. Put the new O-ring in the cleaned nut.</p>	<p>---</p>
<p>5. Position the connection box cover carefully. Tighten the screws. (Torque = 5Nm)</p>	<p>---</p>

## 11.2 Changing the terminal board

PROCEDURE STEP	ILLUSTRATION / OTHER INFORMATION
<p>1. Disconnect the HV supply. Ensure that there is no high voltage present.</p>	
<p>2. Unscrew the screws (1).</p> <p>Take the connection box cover (2) with the O-ring (3) off.</p>	
<p>3. Loosen the screws (1).</p> <p>Take the screws (1) with washers (2) out.</p> <p>Remove the phase cable (3).</p>	
<p>4. Loosen the screws (1).</p> <p>Take the screws (1) with washers (2) out.</p> <p>Remove the cable lugs (3).</p>	

PROCEDURE STEP	ILLUSTRATION / OTHER INFORMATION
<p>5. Remove the washers (1).</p>	
<p>6. Loosen the screws (1).</p> <p>Remove the terminal board (2).</p>	
<b>INSTRUCTION</b>	
<p> Ensure that you connect the phases correctly! Mixing up the phases will lead to a change in the rotating direction of the motor or to malfunctions in the motor depending on the connection version.</p>	
<p>7. Insert the new terminal board (1). The assembly takes place logically in reverse order.</p> <p> You must adhere to the installation sequence depicted (1) - (9).</p> <p> M6 Screw torque = 3 Nm</p> <p> M5 Screw torque = 3 Nm</p>	---
<p>8. Carrying out the HV Test</p> <p> See chapt. 8.3 <i>Carrying out the HV test</i></p>	---

## 12 Spare parts

For more spare parts see chapt. 4.3 *Delivery contents*

### 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

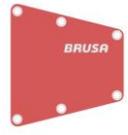


For 70mm<sup>2</sup> cables you can use 50mm<sup>2</sup> cable lugs too. The diameter of 70mm<sup>2</sup> cables fits without problems into 50mm<sup>2</sup> cable lugs and is qualified by BRUSA Elektronik AG.

	NAME	PIECES	ILLUSTRATION
9.	HSM1 hybrid synchronous motor	1	
10.	GSP1 gear box (Transmission ratio 1:2.842)	1	
11.	Cable lugs for HV-cables (depending on the motor): 25mm <sup>2</sup> M6 cable lug without insulation for HSM1-10.18.04 35mm <sup>2</sup> M6 cable lug without insulation for HSM1-6.17.12 35mm <sup>2</sup> M6 cable lug without insulation for ASM1-6.17.12 50mm <sup>2</sup> M6 cable lug without insulation for HSM1-10.18.13 50mm <sup>2</sup> M6 cable lug without insulation for HSM1-10.18.22	3	
12.	Cable lug for grounding (depending on the motor): 25mm <sup>2</sup> M8 cable lug without insulation for HSM1-10.18.04 35mm <sup>2</sup> M8 cable lug without insulation for HSM1-6.17.12 35mm <sup>2</sup> M8 cable lug without insulation for ASM1-6.17.12 50mm <sup>2</sup> M8 cable lug without insulation for HSM1-10.18.13 50mm <sup>2</sup> M6 cable lug without insulation for HSM1-10.18.22	1	
13.	M8x10 hexagonal screw (Ground GND)	1	
14.	M8 washer for grounding screw	1	
15.	Cable length of sensor cable: 1m (Connection Motor / Inverter)	1	

	NAME	PIECES	ILLUSTRATION
16.	Quick connection cooling water connection pieces 90° Norma PS3 For dimensions see chapt. 6.10.2 <i>Cooling water connections</i>	2	

Optional delivery contents

	NAME	PIECES	PROD. NO.	ILLUSTRATION
1.	Terminal board	1	RAAA093	
2.	M6 hexagonal nut (Fixing of the cable lugs to the motor phases)	1	RAAA094	
3.	M6 washer without DIN125A chamfer	1	RAAA095	
4.	M6 cable lug without insulation (Compression cable lugs for motor phases connection) ➤ <b>Direct purchase:</b> Vogt AG <a href="http://www.vogt.ch">http://www.vogt.ch</a> Product no: <b>3582A</b>	1	WHAA038	
5.	M8 cable lug without Insulation (Compression cable lug for connecting ground) ➤ <b>Direct purchase:</b> Vogt AG <a href="http://www.vogt.ch">http://www.vogt.ch</a> Product no: <b>3584A</b>	1	LAAA702	
6.	O-ring connection box	1	MAAA355	
7.	Bleeder screw (M6 x 10)	1	MAAA377	
8.	USIT sealing ring for M6 bleeder screw	1	CJAA055	
9.	M8 x 10 hexagonal screw (Ground GND)	1	RAAA079	
10.	Connection box cover	1	11535	
11.	Quick connection cooling water connection pieces 90° Norma PS3	1	MHAA776	

NAME	PIECES	PROD. NO.	ILLUSTRATION
12. M18 x 1.5 cooling water connection pieces for quick coupling	1	MHAA777	
13. Cable glands for 13 mm - 18 mm cable diameter	1	RAAA040	
14. Cable glands for 9 mm - 16 mm cable diameter		RCAA144	

## 13 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](http://www.brusa.biz/en/support/terms-conditions.html).

## 14 Instructions regarding 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 24 March 2006, electronic devices may no longer be disposed of along with ordinary household waste but must be separately collected and recorded by a specialist services.

Disposal through a specialist service significantly helps to avoid dangers to people and nature. Therefore, in the case of disposal, we recommend contacting a recognised specialist disposal service.

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