HIWIN®

Motion Control & Systems

Assembly Instructions

Torque motors DMR, TMRW, TMRI

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Contents

1. General information

1.1 About these assembly instructions

1.1.1 Version management

Table 1.1 **Version management**

Version	Date	Notes
03-3	June 2021	Update of "Basic safety notices"
03-2	November 2020	Name change TMR to DMR, "Appendix 3: Data sheets" deleted
03-1	February 2019	Various adjustments, addition of series TMRI
03-0	March 2017	Update and various additions: New model TMRWG, new chapter "Connecting liquid cooling", new data sheets
02-3	October 2016	Update of "Declaration of Conformity"
02-2	January 2016	Update of "Declaration of Conformity"
02-1	October 2015	Various adjustments, additions
02-0	November 2014	Various adjustments, additions
01-1	June 2014	Layout adaptation, additions
01-0	April 2014	Initial creation of common assembly instructions for TMR and TMRW

1.1.2 Requirements

We assume that

- operating personnel are trained in the safe operation practices for torque motors and torque motor components, and have read and understood these assembly instructions in full;
- maintenance personnel maintain and repair the torque motors and torque motor components in such a way that they pose no danger to people, property or the environment.

1.1.3 Availability

These assembly instructions must remain constantly available to all persons who work with or on the torque motors and their components.

1.2 Depictions used in these assembly instructions

1.2.1 Instructions

Instructions are indicated by triangular bullet points in the order in which they are to be carried out.
Results of the actions carried out are indicated by ticks.

Example:

- ▶ Position the torque motor over the mounting holes.
- ▶ Place the mounting bolts into the mounting holes and tighten in a spiral pattern to a torque of 10 Nm.

✓ Torque motor is mounted.

1.2.2 Lists

Lists are indicated by bullet points.

Example:
Torque motors and their components must not be operated:

- Outdoors
- In potentially explosive atmospheres
- ...

1.2.3 Depiction of safety notices

Safety notices are always indicated using a signal word and sometimes also a symbol for the specific risk (see chapter 1.2.4, Symbols used).
The following signal words and risk levels are used:

⚠ DANGER!
Imminent danger! Noncompliance with the safety notices will result in serious injury or death!

⚠ WARNING!
Potentially dangerous situation! Noncompliance with the safety notices runs the risk of serious injury or death!

⚠ CAUTION!
Potentially dangerous situation! Noncompliance with the safety notices runs the risk of slight to moderate injury!

ATTENTION!
Potentially dangerous situation! Noncompliance with the safety notices runs the risk of damage to property or environmental pollution!

1.2.4 Symbols used

The following symbols are used in these assembly instructions and on the components:

Table 1.2 **Warning signs**

	Warning of dangerous electrical voltage!		Warning of hot surfaces!
	Warning of magnetic fields!		Warning of crushing!
	Substance hazardous to the environment!		

Table 1.3 **Mandatory signs**

	Wear protective gloves!		Isolate before work!

1.2.5 Information

NOTE Describes general information and recommendations.

1.3 Warranty and liability

The manufacturer's "General conditions of sale and delivery" apply.

1.4 Manufacturer's details

Table 1.4 **Manufacturer's details**

Address	HIWIN GmbH Brücklesbünd 1 77654 Offenburg Germany
Phone	+49 (0) 781 932 78-0
Technical customer service	+49 (0) 781 932 78-77
Fax	+49 (0) 781 932 78-90
Technical customer service fax	+49 (0) 781 932 78-97
E-mail	info@hiwin.de
Website	www.hiwin.de

1.5 Copyright

1.6 Product monitoring

Please inform the manufacturer of:

- Accidents
- Potential sources of danger in the torque motors
- Anything in these assembly instructions which is difficult to understand

2. Basic safety notices

⚠ WARNING!

Danger from strong magnetic fields!
Strong magnetic fields around torque motor components (where the rotor or rotor and stator are supplied separately) pose a health risk to persons with implants (e.g. cardiac pacemakers) that are affected by magnetic fields.

- ▶ Persons with implants that are affected by magnetic fields should maintain a safe distance of at least 0.3 m from the torque motor components!

ATTENTION!

Risk of material damage!
Strong magnetic forces may destroy watches and magnetisable data storage media near to the torque motor components.

- ▶ Do not bring watches or magnetisable data storage media into the vicinity (<100 mm) of the torque motors components!

2.1 Intended use

The torque motors are electrical components and are intended exclusively for installation in machines in commercial and industrial areas.
Torque motors are components of a rotary drive system for the precise positioning in terms of time and location of fixed mounted loads, e.g. system components, within an automated system.
Torque motors are designed for installation and operation in any position. The loads being moved must be solidly mounted to the rotor.
Torque motor components must not be used outdoors or in potentially explosive atmospheres.
Torque motor components may only be used for the intended purpose as described.

- Torque motors must be operated within their specified performance limits (see catalogue "Torque Motors").
- For the safe operation of torque motors, suitable safety precautions must be taken to protect the motor against overload.
- Proper use of the torque motors includes observing the assembly instructions and following the maintenance and repair specifications.
- Use of the torque motor components for any other purpose shall be considered improper use.
- Use only genuine spare parts from HIWIN GmbH.

2.2 Reasonably foreseeable misuse

Torque motors must not be operated:

- Outdoors
- In potentially explosive atmospheres

2.3 Conversions and modifications

Conversions or modifications to the torque motors are not permitted.

2.4 Residual risks

During normal operation, there are no residual risks associated with the torque motor components. Warnings about risks that may arise during commissioning, maintenance and repair work are provided in the relevant sections.

2.5 Personnel requirements

Only trained personnel or trained specialist personnel may carry out work on the torque motor components. They must be familiar with the safety equipment and regulations before starting work (see Table 2.1).

Table 2.1 **Personnel requirements**

Activity	Qualification
Commissioning	Trained specialist personnel of the operator or manufacturer
Normal operation	Trained personnel
Cleaning	Trained personnel
Maintenance	Trained specialist personnel of the operator or manufacturer
Repairs	Trained specialist personnel of the operator or manufacturer

2.6 Protective equipment

Table 2.2 **Personal protective equipment**

Operating phase	Personal protective equipment
Commissioning	When in the vicinity of the torque motor components, the following personal protective equipment is required: ○ Safety shoes
Normal operation	When in the vicinity of the torque motor components, the following personal protective equipment is required: ○ Safety shoes
Cleaning	When cleaning the torque motor components, the following personal protective equipment is required: ○ Safety shoes
Maintenance and repairs	When carrying out maintenance and repairs, the following personal protective equipment is required: ○ Safety shoes

2.7 Labels on torque motor components

2.7.1 Warning symbols

Table 2.3 **Warning symbols**

Pictogram	Type and source of danger	Protective measures
	Danger from strong magnetic fields!	Persons whose health may be endangered by strong magnetic fields must keep a safe distance (1 m) from the torque motor components!
 	Danger of electric shock!	Disconnect the power supply of the torque motor components before maintenance or repairs!
	Danger from hot surfaces!	Let hot surfaces cool down before touching them!

2.7.2 CE mark on type plate

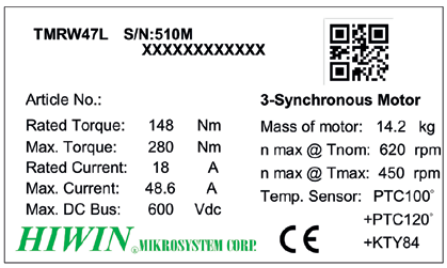


Fig. 2.1 **Type plate**

3. Description of the torque motor components

3.1 Field of application

Torque motors are components of a rotary drive system for the precise positioning in terms of time and location of fixed mounted loads, e.g. system components, within an automated system.
Torque motors are designed for installation and operation in any position. The loads being moved must be firmly attached to the rotor.
The torque motors are supplied as ready-to-install components. As supplied, the rotor and stator are secured with installation clamps.

3.2 Design of the torque motor components (example of TMRW)

Stator:
The stators of TMRW and TMRI motors comprise the outer ring with cooling channels for liquid cooling and the inner ring with the laminations and the windings cast in epoxy resin.
The stators of DMR motors do not have cooling channels on the outer ring. The inner ring likewise comprises the laminations and windings cast in epoxy resin.
Rotor:
On both DMR as well as TMRW and TMRI motors, the rotor consists of nickel-plated steel with rare-earth magnets. The rotor is mounted on the rotatable part of the customer's machine.

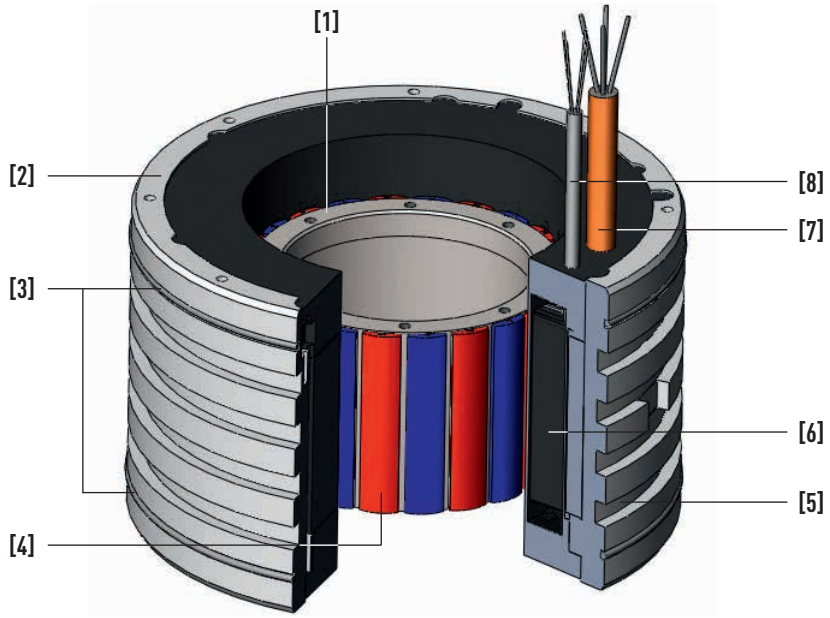


Fig. 3.1 **Design of the torque motors**

Table 3.1 **Main components of a torque motor**

Number	Description
1	Rotor
2	Stator
3	Groove for O-ring
4	Rare-earth magnets
5	Cooling channels for water cooling (TMRW, TMRI)
6	Motor winding
7	Motor cable
8	Temperature sensor cable

3.3 Functional description

DMR, TMRW and TMRI series torque motors are ready-to-install motor elements consisting of a stator and rotor. In terms of design, they are internal rotor motors. The rotor is in the form of a ring. Their high power density enables high acceleration rates and hence short cycle times. In electrical terms, they are three-phase servo motors with a higher number of poles. The TMRW and the TMRI series is equipped with cooling channels.

3.3.1 Characteristics

- Brushless motor
- Hollow shaft rotor
- Wear-free
- High power density
- Maintenance-free

3.3.2 Advantages

- High efficiency
- Extremely dynamic
- Low maintenance costs
- Compact installation dimensions
- Simple control

When integrating a direct drive, ensure high rigidity between torque transmission and recording the control variable (usually position measurement). **NOTE**

Resonances within the control circuit bandwidth degrade performance, since the motor is free from backlash. **NOTE**

3.3.3 Specifications of torque motor components

Table 3.2 **DMR torque motors**

Type	Outer diameter [mm]	Continuous torque [Nm]	Peak torque [Nm]	Installed in HIWIN rotary table (see catalogue "Rotary Tables")
DMR03	110	3.5	10.5	TMS0
DMR14	150	11.3	33.8	TMS1
DMR18	150	22.5	67.5	TMS1
DMR32	193	10.0	30.0	TMS3
DMR34	193	20.0	60.0	TMS3
DMR38(L)	193	40.0	120.0	TMS3
DMR3C(L)	193	60.0	180.0	TMS3
DMR74	291	50.0	150.0	TMS7
DMR76(L)	291	75.0	225.0	TMS7
DMR7C(L)	291	150.0	450.0	TMS7

Table 3.3 **TMRW torque motors (torque data with water cooling)**

Type	Outer diameter [mm]	Continuous torque [Nm]	Peak torque [Nm]
TMRW13(L)	160	18.8	35.6
TMRW15(L)	160	31.3	59.4
TMRW17(L)	160	43.8	83.1
TMRW1A(L)	160	62.5	118.8
TMRW1F(L)	160	93.8	178.1

Table 3.3 **TMRW torque motors (torque data with water cooling) – continuation**

Type	Outer diameter [mm]	Continuous torque [Nm]	Peak torque [Nm]
TMRW23(L)	198	35.0	66.5
TMRW25(L)	198	59.0	112.0
TMRW27(L)	198	82.5	156.0
TMRW2A(L)	198	117.5	223.0
TMRW2F(L)	198	176.0	334.5
TMRW43(L)	230	63.5	120.0
TMRW45(L)	230	106.0	203.0
TMRW47(L)	230	148.0	280.0
TMRW4A(L)	230	205.0	390.0
TMRW4F(L)	230	307.0	583.0
TMRW73(L)	310	145.0	275.0
TMRW75(L)	310	240.0	456.0
TMRW77(L)	310	335.0	640.0
TMRW7A(L)	310	480.0	910.0
TMRW7F(L)	310	720.0	1,360.0
TMRWA3(L)	385	260.0	490.0
TMRWA5(L)	385	430.0	810.0
TMRWA7(L)	385	600.0	1,100.0
TMRWAA(L)	385	860.0	1,600.0
TMRWAF(L)	385	1,290.0	2,400.0
TMRWD3(L)	485	400.0	750.0
TMRWD5(L)	485	660.0	1,230.0
TMRWD7(L)	485	930.0	1,760.0
TMRWDA(L)	485	1,340.0	2,470.0
TMRWDF(L)	485	2,000.0	3,600.0
TMRWG3(L)	565	515.0	1,002.0
TMRWG5(L)	565	930.0	1,700.0
TMRWG7(L)	565	1,255.0	2,360.0
TMRWGA(L)	565	1,810.0	3,340.0
TMRWGF(L)	565	2,720.0	5,020.0

Table 3.4 **TMRI torque motors (torque data with water cooling)**

Type	Outer diameter [mm]	Continuous torque [Nm]	Peak torque [Nm]
TMRIA5	385	540	830
TMRIA7	385	750	1,100
TMRIAA	385	1,080	1,660
TMRIAF	385	1,600	2,490
TMRIG5	565	1,140	1,770
TMRIG7	565	1,597	2,480
TMRIGA	565	2,280	3,500
TMRIGF	565	3,400	5,300

Drawings of the available torque motor components are provided in the appendix to these assembly instructions, or in the internet at www.hiwin.de.

3.3.4 Closed cooling jacket (option for TMRW and TMRI)

For easy integration of our water-cooled torque motors, we also supply them in a closed version. The connection to the cooling unit is realised via 2 G⅛ threads in the stainless steel jacket. As in the version without a closed cooling jacket, the alignment of the motor is realised easily via the fit of the stator. Available for the sizes TMRW7, TMRWA, TMRWD, TMRWG (all other sizes upon request) as well as for the sizes TMRIA and TMRIG.

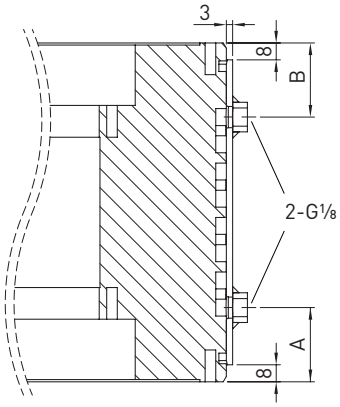


Table 3.5 **Dimensions of steel cooling jacket**

Torque motor	Dimension A [mm]	Dimension B [mm]
TMRW7	35	25
TMRWA	35	35
TMRWG	35	35
TMRWD	27	43
TMRIA	35	35
TMRIG	35	35

3.3.5 Cable outlet orientations of the TMRW torque motors

Table 3.6 **Cable outlet orientations of the TMRW torque motors**

	Standard: ○ Motor cables potted in the stator
	Option 1: ○ Motor cables potted in the stator ○ Additional strain relief plate
	Option 2: ○ Motor cables potted in the stator ○ Additional strain relief plate ○ PG screw connections
	Option 3: ○ Motor cables potted in the stator ○ Additional strain relief plate ○ 90° cable outlet

4. Transport and installation

4.1 Delivery of DMR, TMRW and TMRI

⚠ WARNING!

Risk of crushing from strong attraction forces!
Risk of injury from crushing and damage to the forcer or stator due to very strong attraction forces with unpacked rotors.

- Make sure that the installation clamps are not removed until the rotor and stator are secured by means of a bearing!
- If the rotor is supplied separately, be sure to observe the strong magnetic fields!

4.1.1 Delivery state

DMR, TMRW and TMRI torque motors are usually supplied pre-assembled. To avoid damage during transport, the rotor is fixed in the stator using installation clamps (see Fig. 4.1 and Fig. 4.2).

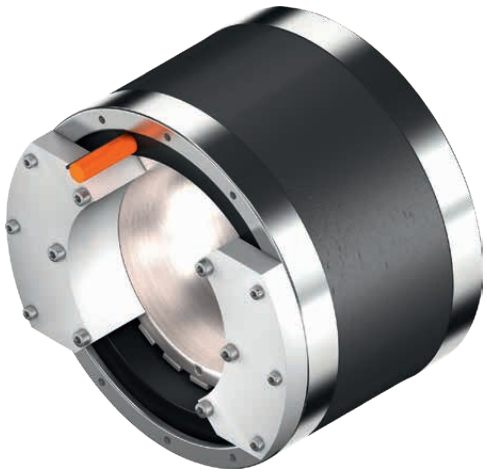


Fig. 4.1 **DMR torque motor with installation clamps**

Fig. 4.2 **TMRW/TMRI torque motor with installation clamps**

4.1.2 Packaging

As supplied, the torque motor components are wrapped in film inside padded cardboard packaging.

- ▶ Do not remove the film wrapping until just before installation.

4.1.3 Scope of delivery

- Rotor, which is secured in the stator by installation clamps
- Stator with (TMRW, TMRI) or without (DMR) cooling channels, plus motor and temperature sensor cables with open cable ends
- 2 O-rings (TMRW, TMRI)
- Type plate
- Safety notices

It is possible to have the rotor supplied separately.

4.2 Transport to the installation site

⚠ WARNING!

Danger from strong magnetic fields!

Strong magnetic fields around torque motor components (where the rotor or rotor and stator are supplied separately) pose a health risk to persons with implants (e.g. cardiac pacemakers) that are affected by magnetic fields.

- ▶ Persons with implants that are affected by magnetic fields should maintain a safe distance of at least 0.3 m from the torque motor components!

ATTENTION!

Risk of material damage!

Strong magnetic forces may destroy watches and magnetisable data storage media near to the torque motor components.

- ▶ Do not bring watches or magnetisable data storage media into the vicinity (<100 mm) of the torque motors components!

ATTENTION!

Damage to the torque motor components!

The torque motor components may be damaged by mechanical loading.

- ▶ During transport, do not transport any additional loads on the torque motor components!
- ▶ Before transport, secure the torque motor components against tilting!

NOTE

There are no magnetic fields around components in their original packaging.

- ▶ Transport torque motor components to the installation site using a suitable hoist (pay attention to weights – see appendix).
- ▶ Ensure even load distribution while lifting.

4.3 Requirements at the installation site

4.3.1 Ambient conditions

Ambient temperature	+5 °C to +40 °C
Installation site	flat, dry, vibration-free
Atmosphere	not corrosive, not explosive

4.3.2 Safety equipment to be provided by the operator

Possible safety equipment/measures:

- Personal protective equipment in accordance with UVV (German accident prevention regulations)
- Zero-contact protective equipment
- Mechanical protective equipment

4.4 Storage

⚠ WARNING!

Danger from strong magnetic fields!
Strong magnetic fields around torque motor components (where the rotor or rotor and stator are supplied separately) pose a health risk to persons with implants (e.g. cardiac pacemakers) that are affected by magnetic fields.

- Persons with implants that are affected by magnetic fields should maintain a safe distance of at least 0.3 m from the torque motor components!

There are no magnetic fields around components in their original packaging. **NOTE**

- Store the torque motor components in their transport packaging.
- Do not store the torque motor in explosive atmospheres or in environments exposed to chemicals.
- Only store the torque motor components in dry, frost-free areas with a corrosion-free atmosphere.
- Make sure that the motors are not subjected to vibrations or impacts while in storage.
- Clean and protect used torque motor components before storage.
- The ambient temperature for storing the motors should be between –10 and +50 °C.
- When storing the components, attach signs warning of magnetic fields.

4.5 Unpacking and installing

ATTENTION!

Damage to the torque motor components!
The torque motor components may be damaged by mechanical loading.

- During transport, do not transport any additional loads on the torque motor components!
- Before transport, secure the torque motor components against tilting!

The torque motor may only be installed and operated indoors. **NOTE**

- Remove protective film.
- Carefully transport components to the designated installation site.
- Ensure that the maintenance points are easily accessible.
- Dispose of packaging in an environmentally friendly way.

5. Assembly and connection

⚠ DANGER!

Danger from electrical voltage!
Before and during assembly, disassembly and repair work, dangerous currents may flow.
- Work may only be carried out by a qualified electrician and with the power supply disconnected!
- Before carrying out work on the torque motor, disconnect the power supply and protect it from being switched back on!

⚠ WARNING!

Risk of crushing from strong attraction forces!
Risk of injury from crushing and damage to the forcer or stator due to very strong attraction forces with unpacked rotors.
- Make sure that the installation clamps are not removed until the rotor and stator are secured by means of a bearing!

⚠ CAUTION!

Danger from suspended loads or falling parts!
Lifting heavy loads may damage your health.
- Use a hoist of an appropriate size when positioning heavy loads!
- Observe the applicable occupational health and safety regulations when handling suspended loads!

NOTE **The torque motor components may only be assembled by specialist personnel.**

NOTE **Do not use any spacers, shims or similar items when installing the torque motors.**

NOTE **For a closed control loop, a suitable position measuring system must be integrated.**

NOTE **For the safe operation of the torque motors, suitable safety precautions must be taken to protect the motor against overload.**

5.1 Requirements to the adjacent construction

5.1.1 Rotor

To rule out any problems with the motor's operation resulting from the influence of the magnets, a gap of approx. 1 mm should be maintained between the adjacent construction and the magnets. In Table 5.1 and Table 5.2 you can also find the maximum values for the external and internal diameter of the adjacent construction as well as the requirements for the evenness of the assembly surface.

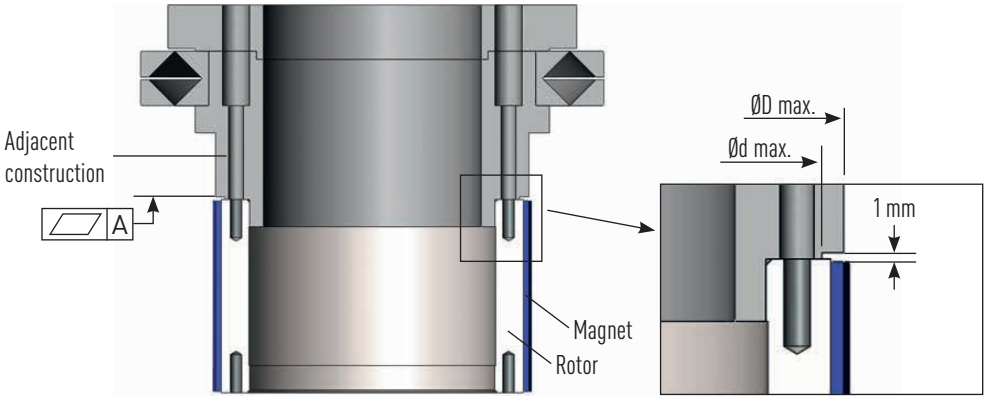


Fig. 5.1 **Rotor with adjacent construction**

Table 5.1 **Requirements for rotor installation – DMR**

Motor type	ØD [mm]	Ød [mm]	Evenness A [mm]	Evenness B [mm]
DMR0X	57.0	48.5	0.05	0.05
DMR1X	83.5	73.0	0.05	0.05
DMR3X	136.0	127.0	0.05	0.05
DMR7X	232.0	220.0	0.10	0.10

Table 5.2 **Requirements for rotor installation – TMRW/TMRI**

Motor type	ØD [mm]	Ød [mm]	Evenness A [mm]	Evenness B [mm]
TMRW1X	84.5	76.0	0.05	0.05
TMRW2X	118.0	110.0	0.05	0.05
TMRW4X	168.0	158.0	0.10	0.10
TMRW7X	232.0	217.0	0.10	0.10
TMRWAX	298.0	284.5	0.10	0.10
TMRWDX	383.0	370.0	0.15	0.15
TMRWGX	458.0	447.0	0,15	0,15
TMRIAX	298.0	284.5	0.10	0.10
TMRIGX	458.0	447.0	0.15	0.15

5.1.2 Stator

The recommended value for the tolerance of the housing internal diameter (and the stator mounting holes) is H7. Please consult Table 5.1 and Table 5.2 (evenness B) for the values for the evenness of the stator mounting surface. To ensure that the O-rings do not become damaged, which could cause leaks, we recommend applying a bevel to the housing (for dimensions see Fig. 5.2).

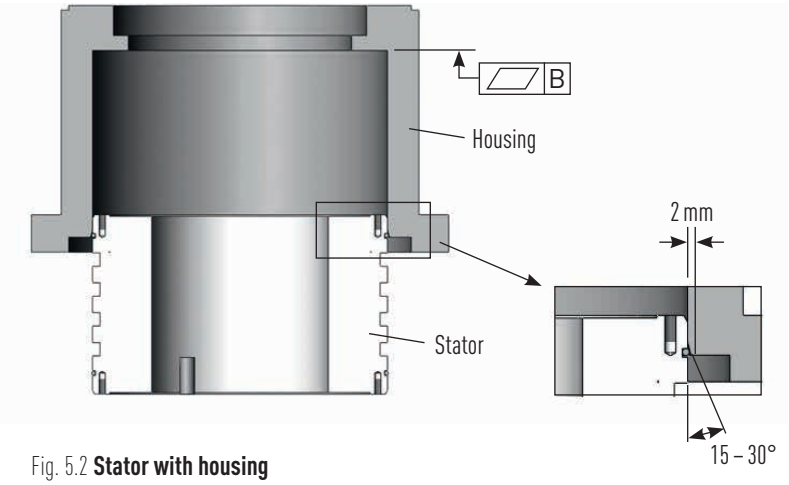


Fig. 5.2 **Stator with housing**

5.1.3 Concentricity between rotor and stator

When installing HIWIN torque motors, ensure maximum concentricity between stator and rotor. Tolerance values for axial offset lie between ± 0.1 mm (DMR models and TMRW series TMRW1X, TMRW2X, TMRW4X and TMRW7X), ± 0.2 mm (TMRW series TMRWAX, TMRWDX and TMRI series TMRIAX) and 0.25 mm (TMRWGX and TMRIGX).

5.1.3.1 Radial forces between rotor and stator

Concentricity deviations result in radial forces between stator and rotor.

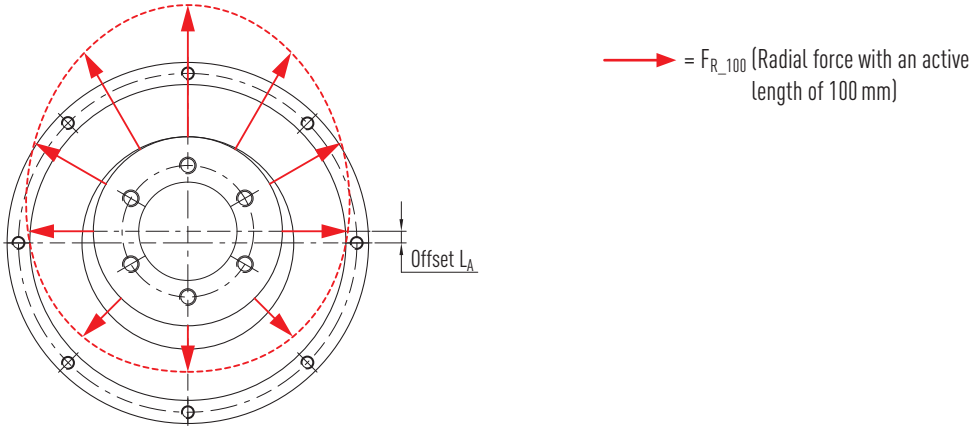


Fig. 5.3 **Illustration of the radial forces generated by concentricity deviations between stator and rotor**

Table 5.3 **Overview of radial forces for a torque motor with an active length of 100 mm**

Series	F_{R_100} [N/m]	Series	F_{R_100} [N/m]
TMRW1X	2,184	**DMR0X**	1,346
TMRW2X	2,590	**DMR1X**	1,787
TMRW4X	2,946	**DMR3X**	1,878
TMRW7X	2,899	**DMR7X**	2,121
TMRWAX	3,574		
TMRWDX	4,350		
TMRWGX	5.158		

For torque motors with different active lengths, the radial force can be calculated using the following formula:

F 5.1

$$\text{Radial force} = F_{R\_100} \times \frac{L\,[\text{mm}]}{100\,\text{mm}} \times \frac{L_A\,[\text{mm}]}{1\,\text{mm}}$$

F_{R_100} Radial force with an active length of 100 mm [N]
L_A Offset [mm]
L Active length of the laminated core (values see Table 5.4)

Table 5.4 **Active lengths L for series DMR, TMRW and TMRI**

Series	Active length L [mm]	Series	Active length L [mm]	Series	Active length L [mm]
DMR_2	20.0	**TMRW_3**	30	**TMRI_5**	50
DMR_3	32.5	**TMRW_5**	50	**TMRI_7**	70
DMR_4	40.0	**TMRW_7**	70	**TMRI_A**	100
DMR_6	60.0	**TMRW_A**	100	**TMRI_F**	150
DMR_8	80.0	**TMRW_F**	150		
DMR_C	120.0				

Exemplary calculation of the radial forces of a TMRWA3 with a concentricity deviation of 0.1 mm:

$$\text{Radial force} = 3{,}574\,\text{N} \times \frac{30\,\text{mm}}{100\,\text{mm}} \times \frac{0.1\,\text{mm}}{1\,\text{mm}} = 107.2\,\text{N}$$

5.1.3.2 Axial forces between stator and rotor

When introducing the rotor into the stator, axial forces of 10 N per magnet arise between the two components. These forces arise regardless of the axial position of the rotor in the stator.

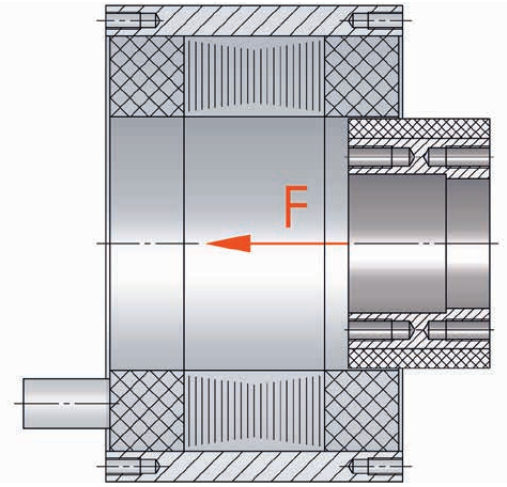


Fig. 5.4 **Diagram of the axial forces arising between stator and rotor**

5.1.4 Connection to a cooling system (TMRW/TMRI)

TMRW and TMRI torque motors can be operated with or without water cooling. Cooling channels for this purpose are located in the outer ring of the stator. O-rings limit the cooling channels at the outer edges and prevent the escape of coolant.

NOTE

To ensure good coolant circulation, the inlets and outlets for the coolant must be located in a line with the outlet for the motor cable.

For the recommended positions for the coolant inlets and outlets for the respective series, please see Table 5.5.

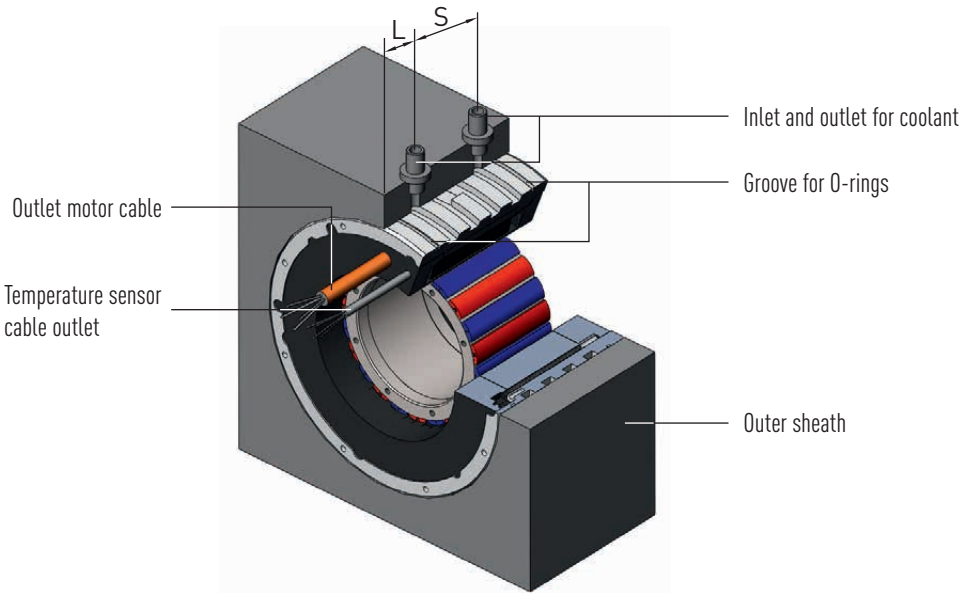


Fig. 5.5 **Diagram of the cooling system (example: TMRW torque motor)**

Table 5.5 **Recommended positions for coolant inlets and outlets**

L [mm]	S [mm]				
	20	**40**	**60**	**90**	**140**
25	TMRW13(L) TMRW43(L)	TMRW15(L) TMRW45(L)	TMRW17(L) TMRW47(L)	TMRW1A(L) TMRW4A(L)	TMRW1F(L) TMRW4F(L)
30	TMRW23(L)	TMRW25(L)	TMRW27(L)	TMRW2A(L)	TMRW2F(L)
35	TMRW73(L) TMRWA3(L) TMRWG3(L)	TMRW75(L) TMRWA5(L) TMRIA5(-WA/-WB) TMRWG5(L) TMRIG5(-SB/-WB/-WH)	TMRW77(L) TMRWA7(L) TMRIA7(-SC/-WC) TMRWG7(L) TMRIG7(-SB/-WB/-WH)	TMRW7A(L) TMRWAA(L) TMRIAA(-SC/-WC) TMRWGA(L) TMRIGA(-SB/-WB/-WH)	TMRW7F(L) TMRWAF(L) TMRIAF(-WC/-WF) TMRWGF(L) TMRIGF(-SB/-WB/-WH)
43	TMRWD3(L)	TMRWD5(L)	TMRWD7(L)	TMRWDA(L)	TMRWDF(L)

5.1.4.1 Dimensions of the cooling channels

Fig. 5.6 shows a schematic diagram of the dimensions of the cooling channels. You can find the respective values for X, Y and the internal diameter of the coolant inlets and outlets from Table 5.6.

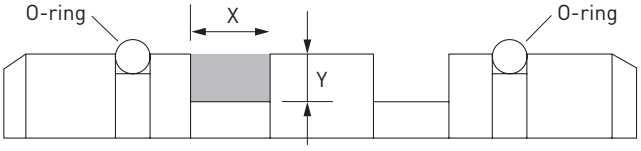


Fig. 5.6 **Dimensions of the cooling channels**

Table 5.6 **Dimensions of the cooling channels (TMRW)**

Motor type	X [mm]	Y [mm]	Ø [1] [mm]	Motor type	X [mm]	Y [mm]	Ø [1] [mm]
TMRW13(L)	8	5	8	**TMRWA3(L)**	8	5	8
TMRW15(L)	8	5	8	**TMRWA5(L)**	8	5	8
TMRW17(L)	9	5	8	**TMRWA7(L)**	9	5	8
TMRW1A(L)	8	5	8	**TMRWAA(L)**	8	5	8
TMRW1F(L)	9	5	8	**TMRWAF(L)**	9	5	8
TMRW23(L)	8	5	8	**TMRWD3(L)**	8	5	8
TMRW25(L)	8	5	8	**TMRWD5(L)**	8	5	8
TMRW27(L)	9	5	8	**TMRWD7(L)**	9	5	8
TMRW2A(L)	8	5	8	**TMRWDA(L)**	8	5	8
TMRW2F(L)	9	5	8	**TMRWDF(L)**	9	5	8
TMRW43(L)	8	5	8	**TMRWG3(L)**	8	5	10
TMRW45(L)	8	5	8	**TMRWG5(L)**	8	5	10
TMRW47(L)	9	5	8	**TMRWG7(L)**	9	5	10
TMRW4A(L)	8	5	8	**TMRWGA(L)**	8	5	10
TMRW4F(L)	9	5	8	**TMRWGF(L)**	9	5	10
TMRW73(L)	8	5	8				
TMRW75(L)	8	5	8				
TMRW77(L)	9	5	8				
TMRW7A(L)	8	5	8				
TMRW7F(L)	9	5	8				

[1] Internal diameter of coolant inlet and outlet

Table 5.7 **Dimensions of the cooling channels (TMRI)**

Motor type	X [mm]	Y [mm]	Ø [1] [mm]	Motor type	X [mm]	Y [mm]	Ø [1] [mm]
TMRIA5-WA	8	5	8	**TMRIG5-SB**	8	5	10
TMRIA5-WB	8	5	8	**TMRIG5-WD**	8	5	10
TMRIA7-SC	9	5	8	**TMRIG5-WH**	8	5	10
TMRIA7-WC	9	5	8	**TMRIG7-SB**	9	5	10
TMRIAA-SC	8	5	8	**TMRIG7-WD**	9	5	10
TMRIAA-WC	8	5	8	**TMRIG7-WH**	9	5	10
TMRIAF-WC	9	5	8	**TMRIGA-SB**	8	5	10
TMRIAF-WF	9	5	8	**TMRIGA-WD**	8	5	10
				TMRIGA-WH	8	5	10
				TMRIGF-SB	9	5	10
				TMRIGF-WD	9	5	10
				TMRIGF-WH	9	5	10

[1] Internal diameter of coolant inlet and outlet

5.1.4.2 O-ring specifications for TMRW torque motors

Table 5.8 **O-rings for sealing the water cooling system with TMRW components**

Motor type	Article number	Type of O-ring	O-ring thickness [mm]	O-ring internal diameter [mm]
TMRW1X	20-000500	Viton	2.62	152
TMRW2X	20-000501	Viton	2.62	190
TMRW4X	20-000502	Viton	2.62	222
TMRW7X	20-000503	Viton	2.50	296
TMRWAX	20-000504	Viton	4.00	370
TMRWDX	20-000506	Viton	4.00	465
TMRWGX	20-000536	Viton	4.00	550

Table 5.9 **O-rings for sealing the water cooling system with TMRI components**

Motor type	Article number	Type of O-ring	O-ring thickness [mm]	O-ring internal diameter [mm]
TMRIAX	20-000504	Viton	4.00	370
TMRIGX	20-000536	Viton	4.00	550

5.1.4.3 Position of coolant inlet and outlet with horizontal mounting position

Regardless of whether the motor cable points up or down, the coolant outlet should be located on top and the inlet underneath (see Fig. 5.7). **In addition, the coolant inlet and outlet must be in a line with the motor cable outlet.**

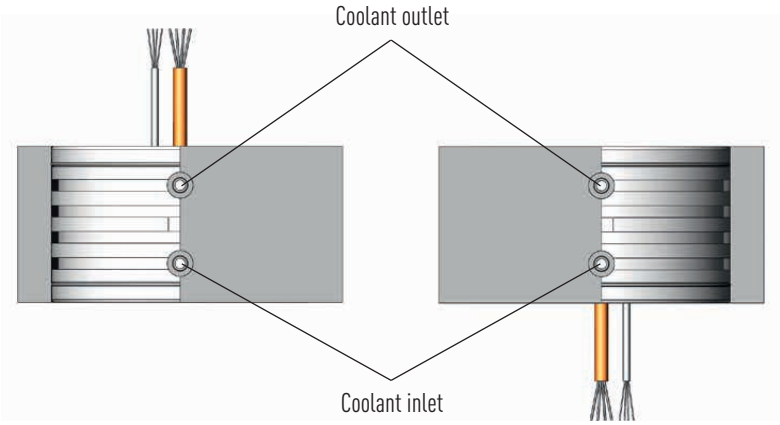


Fig. 5.7 **Coolant inlet and outlet in horizontal mounting position**

5.1.4.4 Position of coolant inlet and outlet in vertical mounting position

The orientation of the coolant inlet and outlets can be freely decided depending on the customer's requirements, **but make sure that they are located in a line with the outlet for the motor cable.**

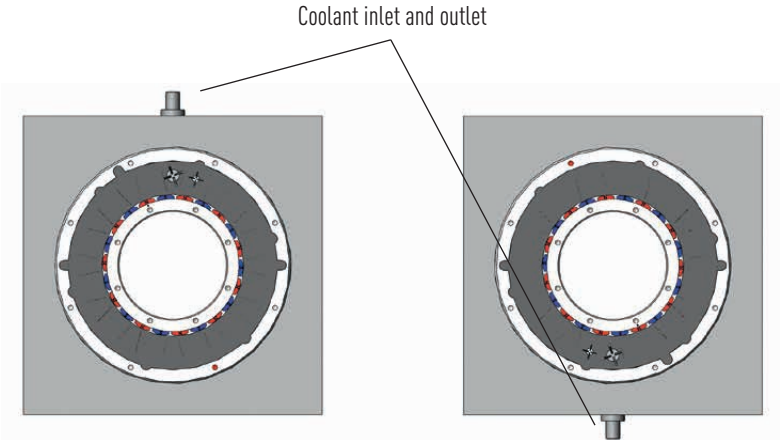


Fig. 5.8 **Coolant inlet and outlet in vertical mounting position**

5.2 Assembling the torque motor

Torque motors can be installed in two ways:

- Stator and rotor are installed together. As standard, the installation clamps are located on the motor cable outlet side. If the customer so requires, the installation clamps can be fitted on the other side instead.
- Stator and rotor are installed successively. To do this, an insertion aid is built based on the customer's mechanical data.

The procedures for both alternatives are described below, demonstrated with the example of a TMRW torque motor.

5.2.1 Installing the stator and rotor together

⚠ WARNING!

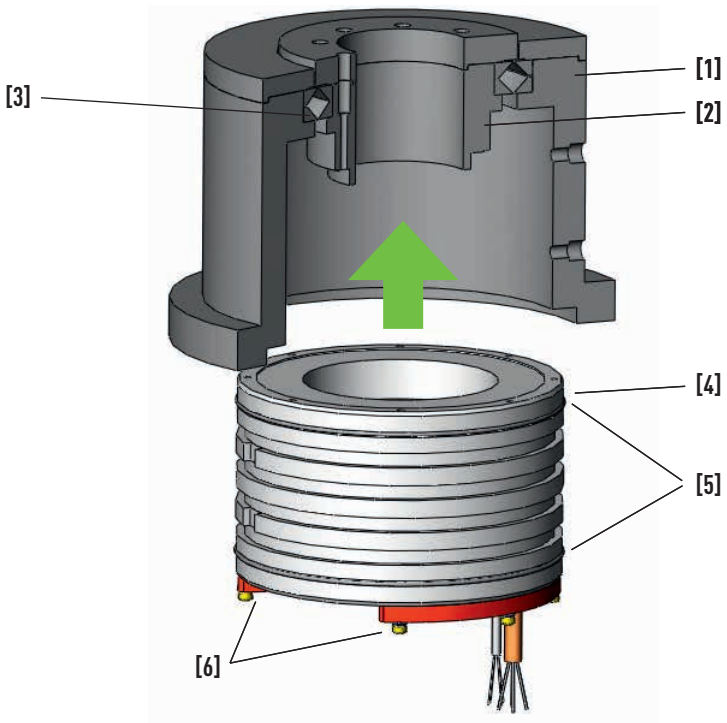
Danger from strong magnetic fields!
Strong magnetic fields around torque motor components (where the rotor or rotor and stator are supplied separately) pose a health risk to persons with implants (e.g. cardiac pacemakers) that are affected by magnetic fields.

▶ Persons with implants that are affected by magnetic fields should maintain a safe distance of at least 0.3 m from the torque motor components!

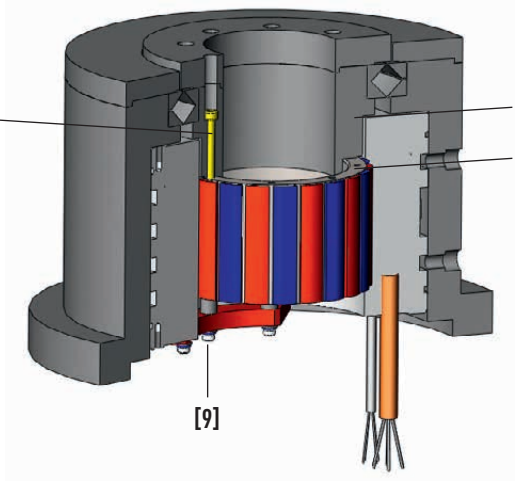
⚠ WARNING!

Risk of crushing from strong attraction forces!
Risk of injury from crushing and damage to the forcer or stator due to very strong attraction forces with unpacked rotors.

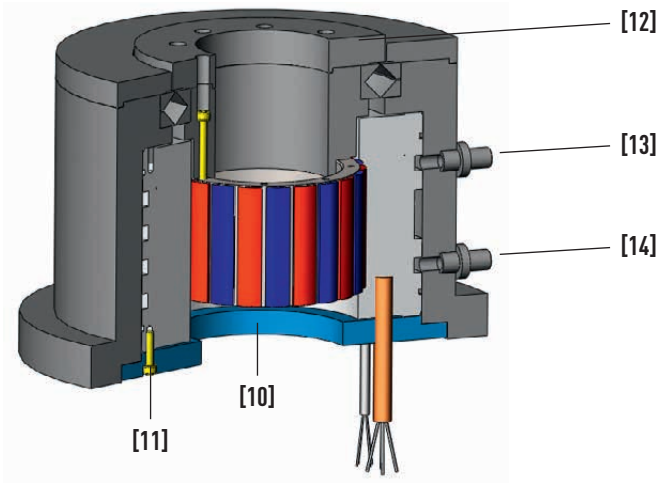
▶ Make sure that the installation clamps are not removed until the rotor and stator are secured by means of a bearing!



▶ Mount the housing **[1]**, adjacent construction **[2]** and bearing **[3]**.
▶ Place the two O-rings **[5]** into the respective grooves provided on the stator **[4]**. Take care that the O-rings do not become twisted.
▶ Place the stator (with installation clamps **[6]**) into the housing. Ensure that the coolant inlets and outlets are aligned flush with the motor cable outlet. In addition, take care not to damage the O-rings, in order to prevent leaks. See also section 5.1.2.



- Secure the rotor **[7]** to the adjacent construction **[2]**. Observe the tightening torques for the mounting bolts **[8]** (see Table 5.10, Table 5.11 and Table 5.12).
- Undo the bolts **[9]** on the installation clamps and remove the clamps **[6]**.



- Install the baseplate **[10]** and tighten the stator's mounting bolts **[11]**. Observe the tightening torques for the mounting bolts (see Table 5.10, Table 5.11 and Table 5.12).
- Move the rotary part **[12]** to check if the rotor rotates easily and smoothly.
- Mount the remaining parts, such as the connections to the coolant inlets **[14]** and outlets **[13]**, and the encoder.

✓ Torque motor is mounted.

5.2.2 Installing the stator and rotor separately with an insertion aid

⚠ WARNING!

Danger from strong magnetic fields!
Strong magnetic fields around torque motor components (where the rotor or rotor and stator are supplied separately) pose a health risk to persons with implants (e.g. cardiac pacemakers) that are affected by magnetic fields.

- Persons with implants that are affected by magnetic fields should maintain a safe distance of at least 0.3 m from the torque motor components!

⚠ WARNING!

Risk of crushing from strong attraction forces!
Risk of injury from crushing and damage to the forcer or stator due to very strong attraction forces with unpacked rotors.

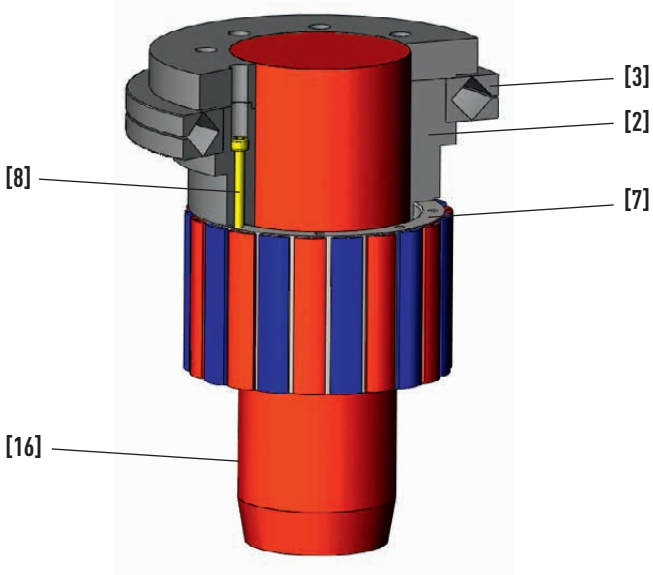
- Make sure that the installation clamps are not removed until the rotor and stator are secured by means of a bearing!

Requirements for the insertion aid:

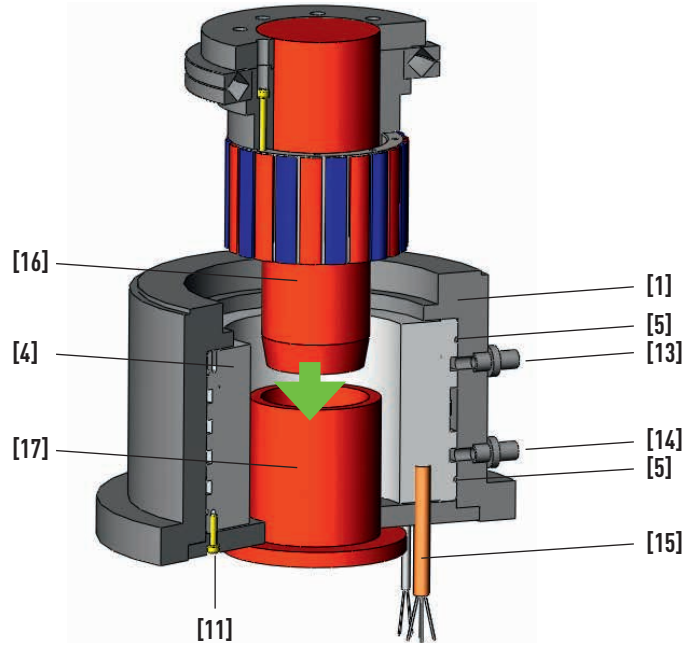
- The insertion aid is provided by the customer.
- The insertion aid consists of two parts, the insertion mandrel and the insertion tube.
- The insertion aid has to absorb the magnetic attraction forces.
- The insertion aid has to absorb the tilting moment generated by the magnets. **Guidance must be ensured before the tilting moments occur,** hence the length of the insertion aid must be greater than the height of the rotor.
- The insertion aid should slide easily; the recommended fit pairing is H7/f7.

NOTE

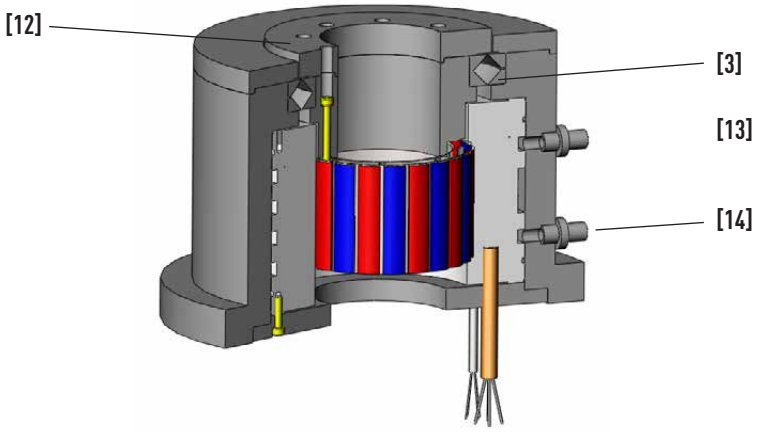
The rotor must be fitted with the insertion mandrel prior to installation, in order to absorb magnetic attraction forces between the rotor and stator and avoid other installation problems.



- Mount the adjacent construction **[2]** and bearing **[3]**.
- Install the rotor **[7]** on the adjacent construction. Observe the tightening torques for the mounting bolts **[8]** (see Table 5.10, Table 5.11 and Table 5.12).
- Secure the insertion mandrel **[16]** to the adjacent construction.



- Place the two O-rings **[5]** into the respective grooves provided on the stator **[4]**. Take care that the O-rings do not become twisted.
- Place the stator into the housing **[1]** and tighten the mounting bolts **[11]**. Observe the tightening torques for the mounting bolts (see Table 5.10, Table 5.11 and Table 5.12). Ensure that the coolant inlets **[14]** and outlets **[13]** are aligned flush with the motor cable outlet **[15]**. In addition, take care not to damage the O-rings, in order to prevent leaks. See also section 5.1.2.
- Mount the insertion tube **[17]** to the underside of the adjacent construction.
- Mount the rotor by inserting the insertion mandrel **[16]** into the insertion tube **[17]**.



- Fit the bearing **[3]** and remove the insertion aid **[16/17]**.
- Move the rotary part **[12]** to check if the rotor rotates easily and smoothly.
- Mount the remaining parts, such as the connections to the coolant inlets **[14]** and outlets **[13]**, and the encoder.

✓ Torque motor is mounted.

5.2.3 Tightening torques for mounting bolts for rotor and stator

For the motor and stator, we recommend mounting bolts of strength class 12.9. Table 5.10, Table 5.11 and Table 5.12 provide details of number and type of mounting holes and the recommended tightening torques.

Table 5.10 **Tightening torques for mounting bolts – DMR**

Motor-Type	Mounting hole		Number of mounting holes		Tightening torque [Nm]	
	Rotor	**Stator**	**Rotor**	**Stator**	**Rotor**	**Stator**
DMR03	M5 × 10DP	M4 × 8DP	6	8	8	4
DMR14 **DMR18**	M5 × 10DP	M4 × 8DP	6	8	8	4
DMR32 **DMR34** **DMR38(L)** **DMR3C(L)**	M8 × 15DP	M5 × 15DP	8	18	25	8
DMR74 **DMR76(L)** **DMR7C(L)**	M8 × 15DP	M5 × 15DP	8	18	25	8

Table 5.11 **Tightening torques for mounting bolts – TMRI**

Motor-Type	Mounting hole	Number of mounting holes	Tightening torque [Nm]
TMRIA	M6 × 12DP	24	12
TMRIG	M8 × 12DP	24	25

Table 5.12 **Tightening torques for mounting bolts – TMRW**

Motor type	Mounting hole	Number of mounting holes	Tightening torque [Nm]
TMRW13(L) **TMRW15(L)** **TMRW17(L)** **TMRW23(L)** **TMRW25(L)** **TMRW27(L)**	M5 × 10DP	8	8
TMRW1A(L) **TMRW1F(L)** **TMRW2A(L)** **TMRW2F(L)**	M5 × 10DP	16	8
TMRW43(L) **TMRW45(L)** **TMRW73(L)** **TMRW75(L)** **TMRW77(L)**	M5 × 10DP	12	8
TMRW47(L) **TMRW4A(L)** **TMRW4F(L)** **TMRW7A(L)** **TMRW7F(L)**	M5 × 10DP	24	8
TMRWA3(L) **TMRWA5(L)** **TMRWA7(L)**	M6 × 12DP	12	12
TMRWAA(L) **TMRWAF(L)**	M6 × 12DP	24	12
TMRWD3(L) **TMRWD5(L)** **TMRWD7(L)**	M8 × 12DP	12	25
TMRWDA(L) **TMRWDF(L)** **TMRWG3(L)** **TMRWG5(L)** **TMRWG7(L)** **TMRWGA(L)** **TMRWGF(L)**	M8 × 12DP	24	25

5.3 Electrical connection

⚠ DANGER!

Danger from electrical voltage!
If torque motors are incorrectly earthed, there is a danger of electric shock.
- Before connecting the electrical power supply, ensure that the torque motor is correctly earthed via the PE rail in the switch cabinet!

⚠ DANGER!

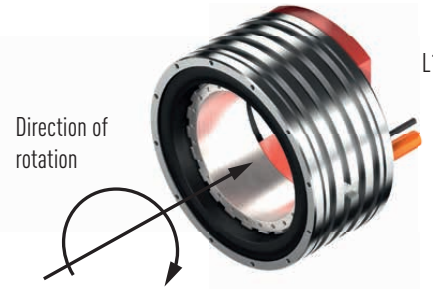
Danger from electrical voltage!
Electrical currents may flow even if the motor is not moving.
- Ensure that the torque motor is disconnected from the power supply before the electrical connections are detached from the motors.
- After disconnecting the drive amplifier from the power supply, wait at least 5 minutes before touching live parts or breaking connections.
- For safety reasons, measure the voltage in the intermediate circuit and wait until it has fallen below 40 V.

⚠ WARNING!

Risk of injury and material damage!
If the motor is overloaded, it may overheat and catch fire.
- Provide a safety device on the control and hardware side to protect the motor against overload!
- Connection of PTC temperature sensors for warning and switch-off purposes in case of overload!
- Connection of PT1000 or KTY84 sensors for temperature monitoring purposes!
- Use of an I^2t model in the drive amplifier or the higher-level controller for time limitation of currents above I_N!

5.3.1 Direction of rotation

If the motor cable is connected according to Table 5.13, the rotor will rotate in clockwise direction (view towards the rotor side without cable outlet)



L1 = U, L2 = V, L3 = W

Fig. 5.9 **Illustration of rotational direction of the rotor**

5.3.2 Motor and temperature sensor cable specifications

NOTE

Maximum length of the motor and temperature sensor cable: 8 m.
For longer cables, suitable filters must be fitted to prevent voltage peaks.

The standard length of the motor and temperature sensor cable is 1000 ± 50 mm for TMR (see Fig. 5.10) and 2000 ± 50 mm for TMRW (see Fig. 5.11).

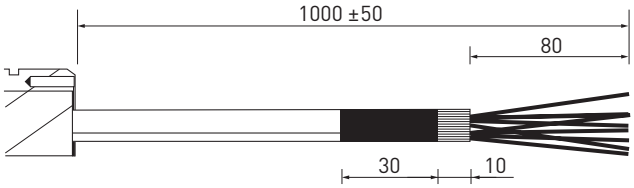


Fig. 5.10 **DMR motor and temperature sensor cable**

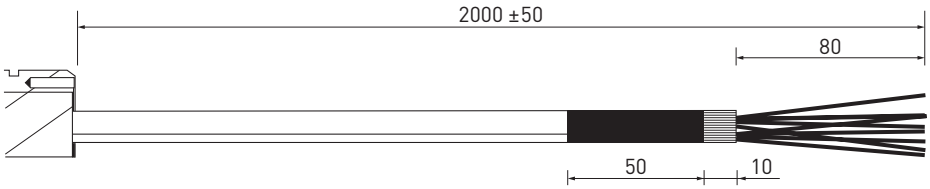
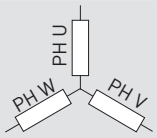


Fig. 5.11 **TMRW/TMRI motor and temperature sensor cable**

IGUS Chainflex CF27 cables with UL and CE marking are used:

Table 5.13 **Motor cable wire format**

Colour	Number	Signal	Function	Diagram
Black-1	L1	PH U	Motor phase	
Black-2	L2	PH V	Motor phase	
Black-3	L3	PH W	Motor phase	
Green/yellow	Protective earth/ground		GND	

The cable size depends on the continuous current of the motor, and can be found from the following table.

Table 5.14 **Conductor cross-section and outer diameter of and motor**

Conductor cross-section [mm²]	Outer diameter [mm]	Motor type
4 × 1.5	10.5	DMR0X, DMR1X, DMR3X, DMR7X TMRW13(L), TMRW15(L), TMRW17(L), TMRW1A(L), TMRW1F, TMRW23(L), TMRW25(L), TMRW27(L), TMRW2A(L), TMRW2F, TMRW43, TMRW45, TMRW47
4 × 2.5	12.5	TMRW43L, TMRW45L, TMRW47L, TMRW4A, TMRW4F, TMRW73, TMRW75, TMRW77, TMRW7A, TMRW7F, TMRWA3, TMRWA5
4 × 4	12.5	TMRW1FL, TMRW2FL, TMRW4AL, TMRW4FL, TMRW73L, TMRW75L, TMRW77L, TMRW7AL, TMRW7FL, TMRWA3L, TMRWA5L, TMRWA7, TMRWAA, TMRWD3, TMRWD5, TMRWD7, TMRWDA, TMRWG3, TMRWG5, TMRWG7 TMRIA5-WA
4 × 6	14.5	TMRWA7L, TMRWAAL, TMRWAF TMRIA7-SC, TMRIAA-SC, TMRIG5-SB, TMRIG7-SB, TMRIGA-SB, TMRIGF-SB
4 × 10	18.0	TMRWAFL, TMRWD3L, TMRWD5L, TMRWD7L, TMRWDAL, TMRWDF, TMRWG3L, TMRWG5L, TMRWG7L, TMRWGA, TMRWGF TMRIA5-WB
4 × 25	25.5	TMRWDFL, TMRWGAL, TMRWGFL
4 × 1 × 16	10.0	TMRIA7-WC, TMRIAA-WC, TMRIAF-WC
4 × 1 × 25	12.0	TMRIG5-WD, TMRIG7-WD, TMRIG5-WD, TMRIGA-WD, TMRIGF-WD
4 × 1 × 50	15.0	TMRIAF-WF, TMRIG5-WH, TMRIG7-WH, TMRIGA-WH, TMRIGF-WH

Table 5.15 **Temperature sensor cable**

Motor	Conductor type	Number and conductor cross section	Outer diameter [mm]
DMR	CF240	4 × 0.25 mm²	5.5
TMRW/TMRI	CF240	8 × 0.25 mm²	7.5

5.3.3 Temperature sensor function and connection

5.3.3.1 Temperature monitoring and motor protection

To protect the motor windings against thermal damage, every motor is equipped with a triple positive temperature coefficient (PTC) sensor, type SNM120 (in accordance with DIN 44082-M180). Since the degree of heating of the individual motor phases can be very different in direct drives, a PTC sensor is fitted in each phase winding (U, V and W). Each PTC element has a "quasi-switching" characteristic, i.e. the resistance suddenly increases close to the rated temperature (switching threshold, see Fig. 5.12). Due to its low heat capacity and good thermal contact with the motor winding, the PTC reacts very quickly to a rise in temperature and, in conjunction with additional protective mechanisms on the control side, ensures reliable motor protection against overload. The PTC elements located in every phase winding in HIWIN motors are wired in series; they connect via two wires.
With TMRW/TMRI there is an additional temperature circuit with positive temperature coefficient (PTC), type SNM100, for redundant use or to distinguish between warning and danger temperatures.

NOTE

Motor protection by temperature monitoring alone using PTC elements can be insufficient. This is the case, for example, if the motor is operated with currents above I_N.
HIWIN advises the use of additional protective measures on the control side, such as I^2t monitoring to limit the time of currents above I_N.

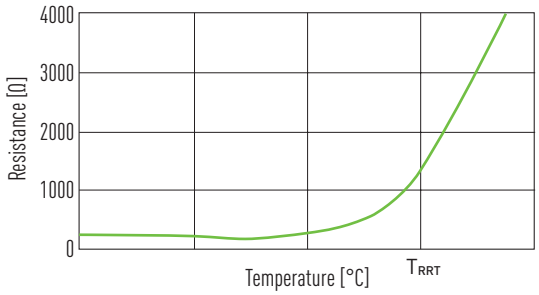


Fig. 5.12 **PTC sensors characteristic curve (T_{RRT} = rated response temperature)**

5.3.3.2 Temperature measurement

Some frequency converters have the capability of adjusting the temperature-dependent motor parameters according to the measured motor temperature. To determine the current motor temperature, it is usual to integrate a PTC thermistor into the motor.

The PTC thermistor has a nearly linear characteristic curve (see Fig. 5.13 and Fig. 5.14) and is therefore well suited to temperature measurement.

The PTC thermistor is placed between two phase windings in the motor. If an excessive temperature occurs in a phase winding that is not monitored, this cannot be displayed or evaluated immediately. Furthermore, the PTC thermistor has slow response characteristics compared to the "quasi-switching" PTC element, which are insufficient for rapid shutdown.

It is not acceptable to evaluate the PTC thermistor for motor protection purposes.

NOTE

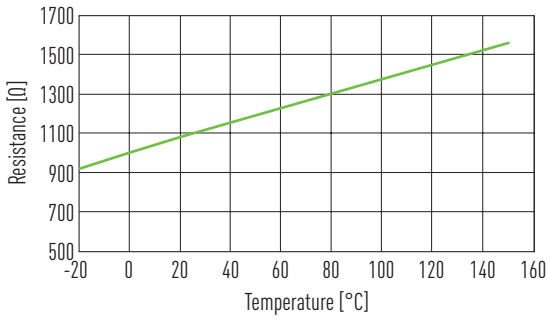


Fig. 5.13 **PT1000 sensors characteristic curve (standard)**

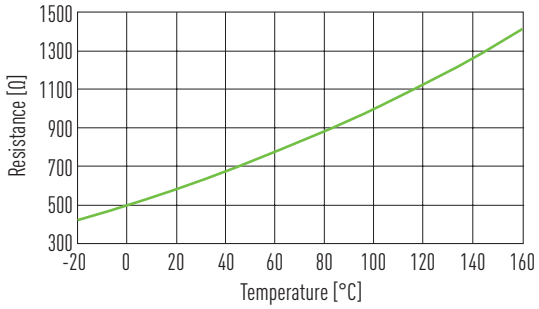


Fig. 5.14 **KTY84 sensors characteristic curve (option)**

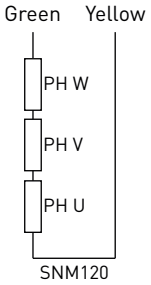


Fig. 5.15 **Temperature sensors: standard DMR**

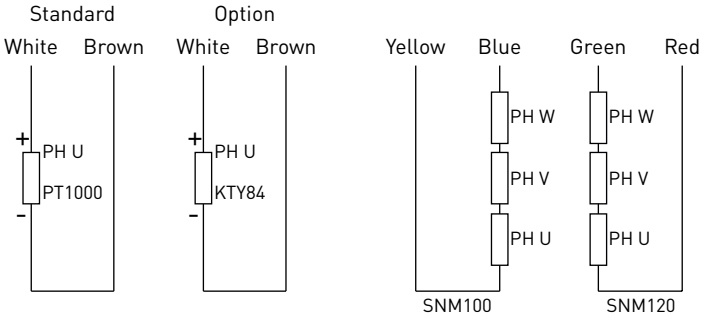


Fig. 5.16 **Type A temperature sensors: standard TMRW/TMRI**
(PTC temperature circuits to distinguish between warning and danger temperature and PT1000)

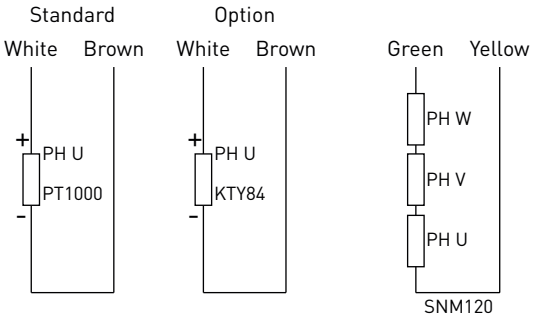


Fig. 5.17 **Type B temperature sensors: optional special version for DMR and TMRW/TMRI**

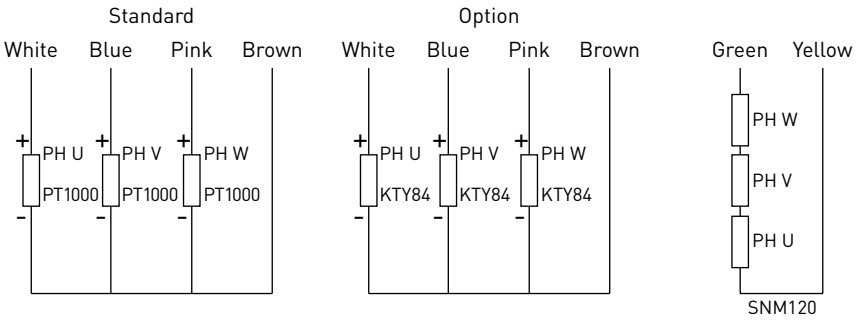


Fig. 5.18 **Type C temperature sensors: Optional special version for TMRW/TMRI with three redundant PT1000 sensors**

NOTE **These PTC elements do not have a linear characteristic curve and therefore are not suitable for determining the current motor temperature.**

NOTE **It is a mandatory requirement that the PTC elements are connected to protect the motor.**

5.3.3.3 Connection to the drive amplifier

The temperature monitoring circuits can normally be connected directly to the drive control. If the protective separation requirements in accordance with EN 61800-5-1 are to be fulfilled, the sensors must be connected to the decoupling modules provided by the drive manufacturers.

5.3.4 Drive amplifier power supply – typical values

Follow the installation instructions for the drive amplifier that is being used.

NOTE

- The minimum cross-section of the mains connection cable depends on local requirements (see VDE 0100 Part 523, VDE 0298 Part 4), the ambient temperature and the drive amplifier's required rated current.

Table 5.16 **Typical values for the power supply**

Amplifier rated current [A]	Connected load [kVA]	Max. cable cross-section of the clamps [mm²]	Recommended fuse (gL) [A]
4.0	1.7	2.5	1 × 10
5.5	2.3	2.5	1 × 16
5.7	4.2	2.5	3 × 10
10.0	7.3	2.5	3 × 16
17.0	12.4	4.0	3 × 25

5.4 Connecting liquid cooling (TMRW/TMRI linear motors)

The TMRW and TMRI series can be connected to a liquid cooling system. The linear motor's continuous torque can therefore be increased without the additional input of process heat.

5.4.1 Setting up/connecting the liquid cooling system

For a detailed description of the positioning of the cooling water connections, please refer to section 5.1.4, "Connection to a cooling system (TMRW/TMRI)". For detailed dimensions of the connection positions, please refer to the data sheets of the individual motors (see catalogue "Torque Motors").

The materials of the couplings and seals must be tested for their compatibility with the coolant and its constituents. Suitable connectors for a coolant circle are for example adaptors from the company Serto GmbH.
The recommended cooling conduit is a Jacoflon tube in a PTFE pipe with single-ply wire mesh. This can also be purchased from the company Serto GmbH.
Owing to their diffusion properties, we do not recommend the use of plastic hosing.

NOTE

**These recommendations are for outside products whose basic suitability is known to us.
Of course, equivalent products from other manufacturers may also be used. Our recommendations are intended to be an aid, not a stipulation. We never grant any warranties on the quality of outside products.**

Contact details: SERTO GmbH
www.serto.de

5.4.2 Determination and meaning of inlet temperature

There are essentially two quantities that are important in the determination of the cooler's inlet temperature: The power density of the motor and condensation.

Power density:
The lower the cooler's inlet temperature, the larger the heat rate that can be drawn out of the motor. This raises the motor's power density.

Condensation:
The motor itself is impervious to condensation, but the latter can cause damage to the surrounding machinery, e.g. corrosion. The inlet temperature should therefore be no lower than 3 K below the ambient temperature.

NOTE

The basic rule of thumb for determining the inlet temperature is as follows:
- **As low as possible for high power densities**
- **As high as needed to prevent condensation**

5.4.3 Coolant: Type and requirements

ATTENTION!

Risk of material damage!
Chemical reactions of the coolant can cause damage to linear motors and machine components!
- ▶ Monoethylene glycol water mixtures without inhibitors are not permitted!
- ▶ Check material combinations for compatibility!

The coolant is provided by the customer. Only water with an anticorrosive may be used as the coolant. This is important because untreated water can cause serious damage or disruption as a consequence of mineral scale, mould and algae formation, and corrosion, e.g.
- Reduced cooling efficiency
- Greater pressure losses in the cooling circuit
- Wear on elements in the cooling circuit (e.g. valves, gates, jets)

The cooling water must therefore contain an anticorrosive that reliably counteracts deposits and corrosion even under extreme conditions.
Owing to the risk of dirt and deposits, it is not recommended to use the machine's coolant/lubricant circuit. The coolant must be precleaned or filtered. Contaminated or unfiltered contaminant can clog the cooling circuit.

Ice formation is not allowed NOTE

Maximum particle size in the coolant used: < 100 µm NOTE

The water must fulfil the following requirements:
- Chloride concentration: c < 100 mg/l
- Sulphate concentration: c < 100 mg/l
- 6.5 ≤ pH value ≤ 9.5

The anticorrosive must fulfil the following requirements:
- (Mono)ethylene glycol basis
- The water and anticorrosive may not separate
- The anticorrosive used must be compatible with the cooler's adapters, hosing, and materials.

Check these requirements, specifically for material compatibility, with the manufacturer of the cooler or coolant!

Corrosion inhibitors include:
- Antifrogen N (made by Hoechst)

We recommend the following contact for dimensioning, design and operation of cooling systems:
BKW K-W-V GmbH
www.bkw-kuema.de

The following materials inside the motor come into contact with the coolant:
- Connections: nickel plated brass
- Viton sealing rings
- Cooling channels:
  Series TMRW1 to TMRW4: nickel plated aluminium; from series TMRW7: nickel plated steel
- Outer casing: nickel plated steel or carbon fibre (if ordered from HIWIN)

5.4.4 Dimensioning the cooler

The cooler's dimensions depend on the pressure drop and the motor power loss drawn into the cooling circuit. The calculations below take as their example an TMRW4A motor with water cooling.

The motor power loss can be calculated with the following formula.

$$P = \left(\frac{T}{K_m}\right)^2$$

P	Motor power loss [W]
T	Motor continuous torque [N]
K_m	Motor constant [N/√W]

The motor constant can be taken from the motor's data sheet. The continuous torque is the mean continuous torque in the actual application.

Figures from the data sheet:

Motor constant:	K_m	5,87 N/√W
Motor pressure drop:	Δp_m	1 bar

The example calculation uses the motor's continuous torque T_c = 91 Nm. The maximum value that can be used for T is T_{c_WC}

Coolant (water) properties:

Density	ρ	0.998 kg/dm³
Specific heat capacity	c	4.1813 kJ/kg K
Dyn. Viscosity at 20 °C	η	1.00 mPa s

$$P = \left(\frac{91\,Nm}{5.87\,Nm} \times \sqrt{W} \right)^2 = 240{,}33\,W$$

The resulting motor power loss is 240.33 W, which must be drawn off in the coolant.

Calculating the pressure drop first involves determining the volumetric flow rate used for cooling. This analyses the coolant's temperature changes at various volumetric flow rates.

$$\Delta\vartheta = \frac{P \times 60}{Q \times \rho \times c}$$

$\Delta\vartheta$	Change in coolant temperature [K]
P	Motor power loss [kW]
Q	Volumetric flow rate [l/min]
ρ	Coolant density [kg/dm³]
c	Specific heat capacity [kJ/kg K]

Table 5.17 **Change in coolant temperature as a function of volumetric flow rate**

Volumetric flow rate Q [l/min]	0.5	1	2	3	4	5	6	7	8	9	10
Change in coolant temperature $\Delta\vartheta$ [K]	6.73	3.36	1.68	1.12	0.84	0.67	0.56	0.48	0.42	0.37	0.34

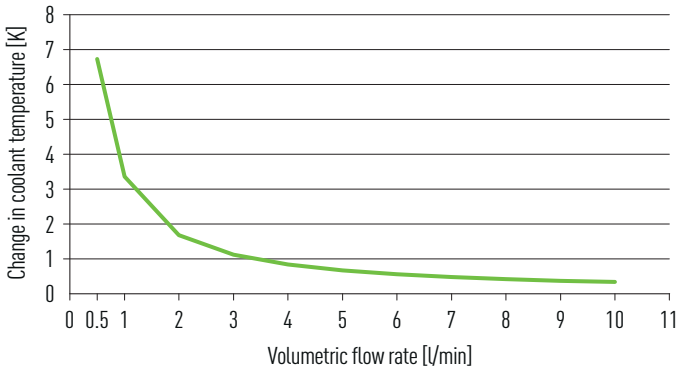


Fig. 5.19 **Change in coolant temperature (water) in kelvins under continuous current during TMRW4A motor downtime**

The graph shows that at low volumetric flow rates there are large temperature changes between the supply and return. Make sure that the temperature change is no greater than 5 K, otherwise disruptive temperature differences may occur on the motor's surface. A flow of 1 l/min would be adequate in the example shown.

Now the pressure drop can be calculated in the connecting cable. The decisive criteria here are the cable length and its internal diameter.

$$\Delta p_L = \frac{128 \times \eta \times L \times Q}{6{,}000{,}000 \times \pi \times d^4}$$

Δp_L	Pressure drop [bar]
η	Dyn. viscosity [mPa s]
L	Cable length [mm]
Q	Volumetric flow rate [ml/min]
d	Internal cable diameter [mm]

The following table lists the calculated pressure drops for a volumetric flow rate of 1 l/min (water) through various cable lengths and diameters.

Table 5.18 **Pressure drop in the cooling conduit as a function of diameter and cable length**

Cable length [mm]	Pressure drop 1/8" [bar]	Pressure drop 1/4" [bar]	Pressure drop 1/2" [bar]
1,000	0.07	0.004	0.0003
2,000	0.13	0.01	0.001
3,000	0.20	0.01	0.001
4,000	0.27	0.02	0.001
5,000	0.33	0.02	0.001
6,000	0.40	0.03	0.002
7,000	0.47	0.03	0.002
8,000	0.53	0.03	0.002
9,000	0.60	0.04	0.002
10,000	0.67	0.04	0.003
12,000	0.80	0.05	0.003
14,000	0.94	0.06	0.004
16,000	1.07	0.07	0.004
18,000	1.20	0.08	0.005
20,000	1.34	0.08	0.005

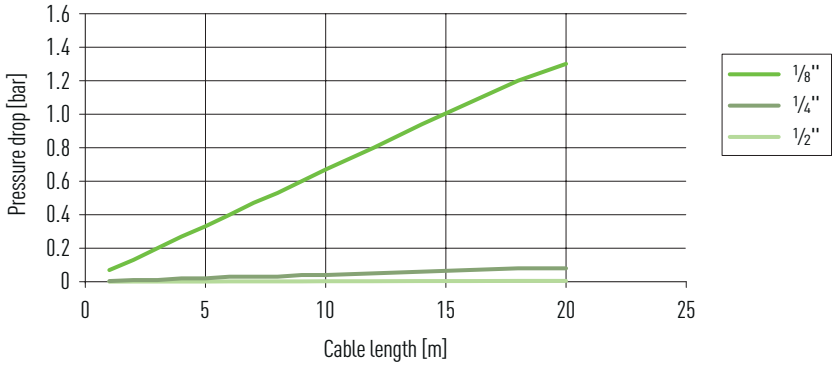


Fig. 5.20 **Pressure drop in the cooling conduit as a function of diameter and cable length**

The pressure drop increases sharply in a 1/8" hose. A hose of at least 1/4" is therefore recommended. The pressure loss over the whole system is obtained when the separate pressure drops are now added.

$\Delta p = \Delta p_m + \Delta p_L$

Δp Total pressure drop [bar]
Δp_L Pressure drop over the cable [bar]
Δp_m Pressure drop across the motor [bar]

$\Delta p = 1\,bar + 0.01\,bar = 1.01\,bar$

This motor requires a water cooler delivering about 240 W and 1 l/min under about 1.1 bar through a 3 m long 1/4" hose.

6. Commissioning

6.1 Switching on the torque motor

⚠ WARNING!

Risk of injury and material damage!
If the motor is overloaded, it may overheat and catch fire.
- Provide a safety device on the control and hardware side to protect the motor against overload!
- Connection of PTC temperature sensors for warning and switch-off purposes in case of overload!
- Connection of PT1000 or KTY84 sensors for temperature monitoring purposes!
- Use of an I^2t model in the drive amplifier or the higher-level controller for time limitation of currents above I_N!

⚠ CAUTION!

Risk of burns!
The motor heats up during operation and thus touching the motor can lead to burns!
- Provide a protective device and warning notices on the motor!!

ATTENTION!

Risk of material damage!
Danger of material damage through uncontrolled movements of the rotor in the case of a power cut!
- Make sure that suitable end stops are fitted at the end positions or that the parking brake (optional) is engaged!

NOTE

The operator should provide a controller pursuant to DIN EN ISO 12100 that prevents the machine from being started up unintentionally after power is restored, troubleshooting or the machine is stopped.

- Switch off the controller.
- Detach the motor cable.
- If applicable, connect the cable for the position measuring system.
- Switch on the controller.
- If applicable, check the position measuring system (see separate assembly instructions for the drive amplifier and position measuring system).
- Switch off the controller.
- Connect motor cable (see chapter 5.3).
- Switch on the controller.
- Perform test run at slow speed.
- Perform test under usage conditions.

✓ Torque motor is ready for operation.

6.2 Programming

NOTE

The programming of the torque motor depends on the controller and drive amplifier used.
Observe the assembly instructions for the controller and drive amplifier!

Please observe the technical data of the respective motor data sheet (see catalogue "Torque Motors") and make sure that these are used correctly interpreted in accordance with the installation instructions of the controller and drive amplifier.
The limit values specified in the motor data sheet, in particular for current and temperature, must be strictly adhered to.
To ensure safe operation and protection of the motor, additional parameters may have to be set, depending on the controller and drive amplifier used. The responsibility for correct commissioning and protection of the motor in the application lies with the commissioning personnel.
For questions regarding commissioning, please contact the manufacturer of the controller and the drive amplifier.

7. Maintenance and cleaning

⚠ WARNING!

Unauthorised repairs on the system

Unauthorised work on the system creates the risk of injuries and may invalidate the warranty.

- The system must only be serviced by specialist personnel!

Use only suitable, non-hazardous agents. Please observe the manufacturer's safety data sheets. NOTE

During maintenance:

- Secure the torque motor against being switched back on without authorisation.
- Disconnect the power supply of the torque motor.
- Secure the torque motor against being switched back on without authorisation.

Ensure that permissible ambient conditions, voltage and current loads are observed! NOTE

- Direct drive components are maintenance-free because they work on a non-contact basis.

7.1 Cleaning

⚠ CAUTION!

Aggressive media

Using aggressive media for cleaning creates the risk of injury and of damaging the torque motor components.

- Use only suitable, non-hazardous agents.
- Check the safety data sheets!

Dirt can settle and accumulate over time on the torque motor components. The torque motor components must therefore be regularly checked for dirt and cleaned if necessary, e.g. using a 70% alcohol solution.

8. Faults

8.1 Faults with the motor

Table 8.1 **Fault table**

Fault	Possible cause	Remedy
Motor does not start	Supply lines disconnected	Check connections, plug contacts may be compressed, repair if necessary. The connectors have seals, which means that a certain screw connection resistance must be overcome.
	Fuse has tripped via motor protection	Check motor protection for the right settings, remedy defects if necessary
Motor turns in the wrong direction	Encoder setting wrong	Check settings
	Input phase fault	Change over two phases on the motor
Smell of burning	Controller setup parameters are incorrect	1. Check controller settings 2. Check cooling system
	Cooling system not working properly	
	Controller setting does not match the motor parameters	
Communication fault	Motor phase connected incorrectly	Check drive amplifier, check nominal value
Motor hums and has a high current consumption	Rotor is jammed	Check motor
	Brake jammed	Check air pressure and power supply
	Fault in encoder cable	Check encoder cable
	Problem with motor insulation	Check resistance values > 50 MΩ (phase/earth and phase/sensor)
Motor heats up too much (measure temperature)	Controller setting incorrect	Check controller settings
	Overload	Carry out power measurement, if necessary use a larger motor or reduce load
	Cooling insufficient	Rectify cooling air supply or open cooling air passages, retrofit external fan if necessary
	Ambient temperature too high	Observe permissible temperature range
	Rated duty cycle exceeded, e.g. duty cycle too long	Adjust motor's rated duty cycle to the necessary operating conditions
	Damaged bearings	Check bearings
Abnormal friction noise or friction torque too high	Motor alignment problem	Check installation
	Dirt in air gap	Remove dirt

8.2 Faults during operation with drive amplifier

The faults described in chapter 8.1, "Faults with the motor" can also occur while operating the motor with a drive amplifier. For interpretation of faults and information on how to remedy them, see the drive amplifier manufacturer's installation instructions.

9. Disposal

ATTENTION!

Danger caused by environmentally hazardous substances!
The danger to the environment depends on the type of substance used.
- Clean contaminated parts thoroughly before disposal!
- Clarify the requirements for safe disposal with disposal companies and, where appropriate, with the competent authorities!

Table 9.1 **Disposal**

Fluids	
Lubricants	Dispose of as hazardous waste in an environmentally friendly way
Soiled cleaning cloths	Dispose of as hazardous waste in an environmentally friendly way
Torque motor	
Cabling, electrical components	Dispose of as electrical waste
Polypropylene (PP) components	Dispose of separately
Aluminium components (housing)	Dispose of separately
Iron components	Dispose of separately
Copper components	Dispose of separately
Brass, nickel-plated components (plug connector materials)	Dispose of separately
Nitrile butadiene rubber (NBR) components (seals)	Dispose of separately
Stainless steel components (bolts)	Dispose of separately

10. Appendix 1: Type plate

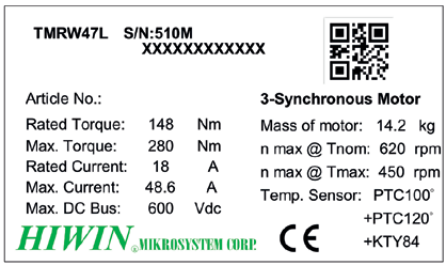


Fig. 10.1 **Type plate**

11. Appendix 2: Order codes

11.1 Order code DMR

Torque motor:
DMR: TM component

Outer diameter [mm]:
0: 110
1: 150
3: 193
7: 291

Special equipment:
0: None
C: Customer specific

Winding variant:
None: Standard winding
L: For high rotary speed

Rotor height [mm]:
2: 20
3: 30
4: 40
6: 60
7: 65
8: 80
C: 120

11.2 Order code TMRW

Torque motor:
TMRW: TM component with water cooling

Outer diameter [mm]:
1: 160
2: 198
4: 230
7: 310
A: 385
D: 485
G: 565

Special equipment:
0: None
C: Customer specific
K: Closed cooling jacket

Winding variant:
None: Standard winding
L: For high rotary speed

Rotor height [mm]:
3: 31
5: 51
7: 71
A: 101
F: 151

11.3 Order code TMRI

Torque motor:
TMRI: TM component optimised for high speed ranges

Outer diameter [mm]:
A: 360
G: 530

Special equipment:
0: None
C: Customer specific
K: Closed cooling jacket

Winding variant

Rotor height [mm]:
5: 50
7: 70
A: 100
F: 150

Notes

Notes

12. Declaration of Conformity

According to EU Directive 2014/35/EU – Low Voltage Directive

Manufacturer
HIWIN GmbH
Brücklesbünd 1
77654 Offenburg,
Germany

This declaration relates exclusively to the following product in the state in which it was placed on the market, and excludes components which are added and/or operations carried out subsequently by the final user. The declaration is no more valid, if the product is modified without agreement.

Product denomination:: Torque motors DMR_, TMRW_, TMRI_
Year of manufacture: from 2019

The manufacturer hereby declares that the product is complying with all essential requirements of the Directive 2014/35/EU (Low Voltage Directive) relating to electrical equipment.

In addition the product is in accordance with the EU Directives:
- EU Directive on electromagnetic compatibility (2014/30/EU)
- EU RoHS Directive on the restriction of hazardous substances (2011/65/EU)

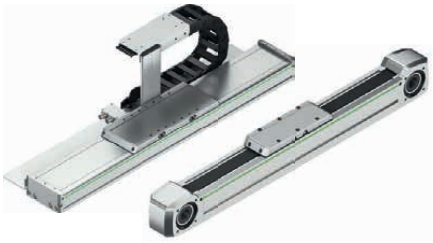
Offenburg, February 2019
Managing Director

Werner Mäurer

We live motion.

Linear Guideways

Ballscrews



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Torque Motors

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