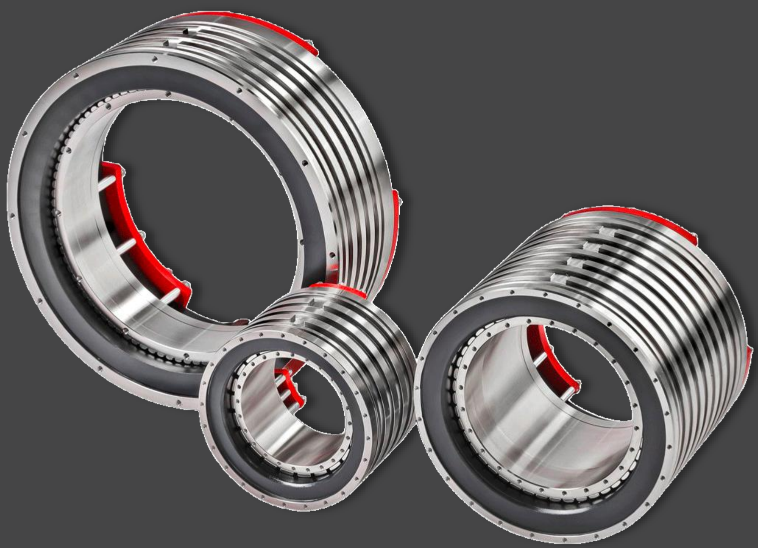

ASSEMBLY INSTRUCTIONS

Torquemotor

TM-Komponenten-05-0-EN-2604-MA
Translation from original version MW99UE01-2602

hiwin.de

legal information

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Contents

1 General information

	Approvals		
	EU Directives		UL approvals
Engine model	EMC Directive: 2014/30/EU Reference standard EN 61000-6-2:2005 EN 61000-6-4:2007+A1:2011	Low Voltage Directive: 2014/35/EU Reference standard EN 60034-1:2010	Rotating electrical machines Reference standard UL 1004-1 UL 1446
TMRW□□	CE		cULus
	Approvals		
	EU Directives		UL approvals
Motor type	EMC Directive: 2014/30/EU Reference standard EN 61000-6-2:2019 EN 61000-6-4:2019	Low Voltage Directive: 2014/35/EU Reference standard EN 60034-1:2010	Rotating electrical machines Reference standard UL 1004-1 UL 1446
TM-5-□□	CE UKCA		cULus
	Approvals		
	EU Directives		UL approvals
Motor model	EMC Directive: 2014/30/EU Reference standard EN 61000-6-2:2005 EN 61000-6-4:2007+A1:2011	Low Voltage Directive: 2014/35/EU Reference standard EN 60034-1:2017	Rotating electrical machines Reference standard UL 1004-1 UL 1446
IM-2-□□	CE UKCA		cULus

Note:
EN: European Standards = European Standard
CE refers to European standards.
(Publication of harmonised standards in accordance with the Union's harmonisation legislation)
IEC: International Electrotechnical Commission

UKCA: UK Conformity Assessed

1.1 About this manual

This manual primarily covers HIWIN's standard torque motor series (described as 'motors' in the manual) TMRW/TM-5/IM-2. This manual provides users with information on the handling, installation and operation of the motor under completely safe conditions. Unless a specific document is mentioned, this manual also applies to customised products.

HIWIN's liability is limited in all cases to the function of the torque motor and does not extend to the customer's entire system or machine. Should a failure or technical problem occur and this product not provide a solution, please contact HIWIN for technical support. Please do not hesitate to notify us if you find any errors or necessary corrections in this document. With the exception of motor replacement, the customer or any other person who owns or operates the system is responsible for checking all safety and compatibility aspects of the entire application, provided that HIWIN cannot obtain complete system and application information. HIWIN cannot be aware of motor or system failures caused by possible causes and accepts no liability for this.

1.2 General precautions

Please read these instructions carefully before using the product. HIWIN accepts no liability for damage, accidents or injuries caused by failure to follow the installation and operating instructions contained in this manual.

- Before installing or using the product, ensure that it is undamaged on the outside. If you discover any damage during the inspection, please contact HIWIN or your local sales partner.
- Ensure that the cabling is undamaged and can be connected normally.
- Do not dismantle or modify the product. The product's design has been verified through static calculations, computer simulations and practical tests. HIWIN accepts no liability for damage, accidents or injuries caused by dismantling or modifications carried out by the user.
- Keep children away from the product.
- Persons with psychosomatic conditions or insufficient experience should not use the product alone. Supervision by supervisors or product specialists is essential.
- Failure to observe the warning notices and safety instructions in this manual may result in death, personal injury or property damage. If the registration details do not match your order, please contact HIWIN or your local sales partner.

The warranty does not cover damage caused by improper use (see the precautions and instructions listed in this manual) or natural disasters.

1.2.1 Availability

The assembly instructions must always be available to all persons working with or on the products mentioned. The assembly instructions are also available at HIWIN.de.

1.3 Safety notices

This device has been carefully designed to ensure safe and reliable operation, provided that the user assembles and installs the power supply and cooling systems strictly in accordance with the instructions in these assembly instructions, whilst strictly adhering to all specified technical parameters and permissible tolerances.

Although the content of these assembly instructions has been compiled to the best of our knowledge and belief, it may not cover all the information required for safe operation or all the details that operating personnel must observe.

If you have any questions, please contact HIWIN.

1.3.1 Instructions

Instructions are labelled with dashes in the order in which they are to be typed.
The results of the actions performed are labelled with an arrow.

Example:

– Instruction 1

– Action 2

✓ Result.

1.3.2 Lists

Lists are labelled with bullet points.

Example:

Lubricants

– reduce wear

– protect against dirt

– …

1.3.3 Presentation of safety notices

Safety notices are always labelled with a signal word and, in some cases, with a hazard-specific symbol (see section1.3.4 Symbols used).

The following signal words and hazard levels are used:

⚠ **Danger!** Immediate danger!

Non-compliance with the safety notices will result in serious injury or death!

⚠ **Warning**! Potentially dangerous situation!

Non-compliance with the safety notices may result in serious injury or death!

⚠ **Caution!** Potentially dangerous situation!

Non-compliance with the safety notices may result in moderate to minor injuries!

❗ **Caution!** Potentially dangerous situation!

Non-compliance with the safety notices may result in damage to property or environmental pollution!

1.3.4 Symbols used

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

Warning sign			
	No access for persons with pacemakers.		Substance hazardous to the environment!
	Warning!		Warning: risk of crushing!
	Warning: dangerous electrical voltage!		Warning: hot surfaces!
	Warning: magnetic fields!		

mandatory signs			
	Wear head protection!		Refer to the instruction manual!
	Wear protective gloves!		Disconnect the power supply before carrying out maintenance or repair work.
	Wear safety footwear!		Lifting point

1.3.5 Notes

Note:
Describes general information and recommendations.

1.4 Basic safety notices

Danger! Risk of death due to strong magnetic fields!

Strong magnetic fields in the vicinity of torque motors pose a danger to people with active medical implants who are in the vicinity of the motors. This also applies when the motor is switched off.

- If you are affected, maintain a minimum distance of 300 mm from the permanent magnets
- Trigger threshold for static magnetic fields of 0.5 mT in accordance with Directive 2013/35/EU
- Please also observe national and local guidelines or requirements.
- For reference: DGUV Rule 103-013 of the German Social Accident Insurance sets out requirements for working with magnetic fields

⚠ **Caution!** Risk of physical damage to watches and magnetic storage media.

Strong magnetic forces can destroy watches and magnetisable data carriers in the vicinity of the torque motor!

- Do not bring watches or magnetisable data carriers within close proximity (<300 mm) of the torque motors!

⚠ **Caution!** Safety distance from the rotor.

The rotor's magnetic field is permanent. In the event of direct physical contact with the rotor, the static magnetic flux density does not exceed 2 T.

1.4.1 Transport to the installation site

⚠ **Danger!** Risk of death due to strong magnetic fields!

Strong magnetic fields in the vicinity of torque motors pose a danger to people with active medical implants who are in the vicinity of the motors. This also applies when the motor is switched off.

- If you are affected, maintain a minimum distance of 300 mm from the permanent magnets
- Trigger threshold for static magnetic fields of 0.5 mT in accordance with Directive 2013/35/EU
- Please also observe national and local guidelines or requirements.
- For reference: DGUV Rule 103-013 of the German Social Accident Insurance sets out requirements for working with magnetic fields

⚠ **Warning**! Danger from heavy loads!

Lifting heavy loads can lead to strains or sprains.

- Use a lifting device of suitable sizing to position heavy loads over 20 kg!
- Observe the applicable health and safety regulations when handling suspended loads!
- Motors with stator and rotor transport devices (bridges) can be suspended from the suspension holes. When suspending, the strength of the components must always be taken into account.
- Use eye bolts that comply with the requirements of DIN 580 or JIS B1168.

⚠ **Caution!** Risk of physical damage to watches and magnetic storage media.

Strong magnetic forces can destroy watches and magnetisable data storage media in the vicinity of the torque motor!

- Do not place watches or magnetisable data carriers within 300 mm of the torque motors!

⚠ **Caution!** Damage to the torque motor system!

The torque motor can be damaged by mechanical impact.

- Do not pull directly on the cable.
- Do not place heavy loads or sharp objects on the motor.

1.4.2 Installation and connection

⚠ **Danger!** Danger due to electrical voltage!

Dangerous currents may flow before and during installation, dismantling and repair work.

- Work must only be carried out by a qualified electrician and with the power supply switched off!
- Before working on the drive system for the direct drive, disconnect the power supply and secure it against being switched on again!

⚠ **Danger!** Risk of death due to strong magnetic fields!

Strong magnetic fields in the vicinity of torque motors pose a risk to people with active medical implants who are in the vicinity of the motors. This also applies when the motor is switched off.

- If you are affected, maintain a minimum distance of 300 mm from the permanent magnets
- Trigger threshold for static magnetic fields of 0.5 mT in accordance with Directive 2013/35/EU
- Please also observe national and local guidelines or requirements.
- For reference: DGUV Rule 103-013 of the German Social Accident Insurance sets out requirements for working with magnetic fields

⚠ **Danger!** Risk of crushing due to strong attraction forces!

- Assemble the rotors and stators with care!
- Do not place fingers or objects between the rotors and stators!
- The rotor and magnetisable objects may accidentally attract each other and collide!
- Two rotors may accidentally attract each other and collide!
- The magnetic force exerted by the rotor on the object can amount to several kN, which may result in a body part becoming trapped.
- Do not underestimate the attraction force and proceed with caution.
- Wear safety gloves if necessary.
- At least two people are required for the work.
- If the assembly steps have not yet progressed to the installation of the rotor, please store the rotor in a safe and suitable place for the time being.
- Never handle several rotors at the same time.
- Never place two rotors directly against each other without a protective device.
- Do not bring magnetisable materials near the rotor! If the tool needs to be magnetised, please hold it firmly with both hands and approach the rotor slowly!
- It is recommended that you install the rotor immediately after unpacking!
- When assembling the stator and rotor, an installation aid is required to fit the stator and rotor together individually. Please follow the correct procedure.
- Always have the following tools ready to free body parts (hands, fingers, feet, etc.) held by magnetic force.
- Hammer made of non-magnetised, solid material (approx. 3 kg)
- Two wedge-shaped runners made of non-magnetised materials (wedge-shaped, acute angle 10°–15°, minimum height 50 mm).

⚠ **Warning**! Danger from heavy loads!

Lifting heavy loads can lead to strains or sprains.

- Use a hoist of suitable sizing to position heavy loads over 20 kg!
- Observe the applicable health and safety regulations when handling suspended loads!
- Motors with stator and rotor transport devices (bridges) can be suspended from the suspension holes. When suspending, the strength of the components must always be taken into account.
- Use eye bolts that comply with the requirements of DIN 580 or JIS B1168.

⚠ **Caution!** Damage to the torque motor system!

The torque motor can be damaged by mechanical impact.

- Do not pull directly on the cable.
- Do not place heavy loads or sharp objects on the motor.

1.4.3 Electrical installation

⚠ **Danger!** Danger due to electrical voltage!

Dangerous currents may flow before and during assembly, disassembly and repair work.

- Work must only be carried out by a qualified electrician and with the power supply switched off!
- Before working on the drive system for the direct drive, disconnect the power supply and secure it against being switched on again!

⚠ **Danger!** Danger due to electrical voltage!Art und Quelle der Warnung

If the motors are not earthed correctly, there is a risk of electric shock.

- Before connecting the power supply, ensure that the motor system is properly earthed.

1.4.4 Maintenance and cleaning

⚠ **Danger!** Danger due to electrical voltage!

Electric currents can flow even when the motor is at a standstill.

- Ensure that the direct drive drive system is disconnected from the power supply before disconnecting the electrical connections from the motors.
- After disconnecting the servo drive from the power supply, wait at least 5 minutes before touching live parts or disconnecting connections.

⚠ **Danger!** Risk of crushing due to strong attraction forces!

- Assemble the rotors and stators with care!
- Do not place fingers or objects between the rotors and stators!
- The rotor and magnetisable objects may accidentally attract each other and collide!
- Two rotors may accidentally attract each other and collide!
- The magnetic force exerted by the rotor on the object can amount to several kN, which can result in a body part becoming trapped.
- Do not underestimate the attraction force and proceed with caution.
- Wear safety gloves if necessary.
- At least two people are required for the work.
- If the assembly steps have not yet progressed to the installation of the rotor, please store the rotor in a safe and suitable place for the time being.

- Never handle several rotors at the same time.
- Never place two rotors directly against each other without a protective device.
- Do not bring any magnetisable materials near the rotor! If the tool needs to be magnetised, please hold it firmly with both hands and approach the rotor slowly!
- It is recommended that you install the rotor immediately after unpacking!
- When assembling the stator and rotor, an installation aid is required to fit the stator and rotor together individually. Please follow the correct procedure.
- Always have the following tools ready to free body parts (hands, fingers, feet, etc.) held by magnetic force.
- Hammer made of non-magnetised, solid material (approx. 3 kg)
- Two wedge-shaped runners made of non-magnetised materials (wedge-shaped, acute angle 10°–15°, minimum height 50 mm).

⚠ **Warning**! Risk of crushing from moving parts!

- The operator should provide devices that prevent hands from reaching into the machine’s danger zone!

⚠ **Warning**! Risk of burns

The motor heats up during operation, so touching the motor may result in burns!

- After disconnecting the servo drive from the power supply, wait at least 5 minutes before removing the cover and touching the motor.

⚠ **Warning**! Unauthorised repairs to the system.

The motor becomes hot during operation, so touching the motor may result in burns!

- Unauthorised work on the system poses a risk of injury and may invalidate the warranty.
- The system must only be serviced by qualified personnel!

1.5 Requirements

Qualified technical personnel are defined as individuals who are familiar with the procedures for the installation, assembly, commissioning and operation of this product and who possess the following necessary qualifications and expertise:

- Operators have been trained in the operating procedures for torque motors and have read and understood this user manual in full.
- Maintenance personnel carry out maintenance and repair work on torque motors to prevent hazards to persons, property or the environment.
- Knowledge of all relevant standards, regulations, accident prevention regulations and operating conditions.
- Ability to identify and mitigate potential hazards.
- Use of suitable personal protective equipment.
- Completion of a basic first-aid course.

1.6 Copyright

1.7 Warranty and liability

The manufacturer's "General Terms and Conditions of Sale and Delivery" apply in all cases.

1.8 Manufacturer's details

Address	HIWIN GmbH Brücklesbünd 1 77654 Offenburg
Telephone	+49 (0) 781 / 9 32 78 - 0
Technical Customer Service	+49 (0) 781 / 9 32 78 - 77
Fax	+49 (0) 781 / 9 32 78 - 90
Technical Customer Service Fax	+49 (0) 781 / 9 32 78 - 97
Email	support@HIWIN.de
Website	HIWIN.de

1.9 Product monitoring

Please inform HIWIN, as the manufacturer of the products mentioned, about:

- Accidents
- Potential hazards associated with the torque motors
- Ambiguities in these instructions

1.10 Intended use

⚠ **Warning**! Risk of death and property damage due to improper use

If you use HIWIN torque motors or their components improperly, there is a risk of death, serious injury and/or property damage.

- Always use the motors exclusively for industrial or commercial systems.
- • Do not use the motors in potentially explosive atmospheres (Ex zones).
- • Protect the motors from contamination and contact with corrosive substances.
- • Ensure that the conditions at the installation site comply with all
- specifications in this documentation. Please
- any deviations regarding country-specific regulations where necessary.
- • If you wish to use special versions or variants that differ in technical details from the motors described here, please consult HIWIN.

⚠ **Warning**! Risk of personal injury and property damage due to non-compliance with the Machinery Directive 2006/42/EC or the EU Machinery Regulation 2023/1230

Failure to comply with the Machinery Directive or the Machinery Regulation may result in death, serious personal injury and/or damage to property. The motors must only be used for industrial or commercial installations.

- •The products supplied are intended exclusively for installation in a machine. Commissioning is prohibited until the conformity of the end product with the Machinery Directive 2006/42/EC or the EU Machinery Regulation 2023/1230 has been established.

Torque motors are components of a rotating drive system for the precise positioning, in terms of both time and location, of fixed loads, e.g. system components, within an automated plant.

Torque motors are sized for installation and operation in any orientation. The loads to be moved must be securely mounted to the rotor.

Torque motor components must not be used outdoors or in potentially explosive atmospheres.

Torque motor components must only be used for the intended purpose described.

- Torque motors must be operated within their specified performance limits.
- To ensure the safe operation of torque motors, appropriate precautions must be taken to protect the motor from overload.
- Proper use of the torque motors includes following the assembly instructions and adhering to the maintenance and repair instructions.
- The use of torque motor components for other purposes is considered improper use.
- Use only original spare parts from HIWIN.

2 Basic safety notices

⚠ **Danger!** Risk of death due to strong magnetic fields!

Strong magnetic fields in the vicinity of torque motors pose a danger to people with active medical implants who are in the vicinity of the motors. This also applies when the motor is switched off.

- If you are affected, maintain a minimum distance of 300 mm from the permanent magnets
- Trigger threshold for static magnetic fields of 0.5 mT in accordance with Directive 2013/35/EU
- Please also observe national and local guidelines or requirements.
- For reference: DGUV Rule 103-013 of the German Social Accident Insurance sets out requirements for working with magnetic fields

⚠ **Caution!** Risk of physical damage to watches and magnetic storage media.

Strong magnetic forces can destroy watches and magnetisable data carriers in the vicinity of the torque motor!

- Do not bring watches or magnetisable data carriers within close proximity (<300 mm) of the torque motors!

⚠ **Caution!** Safety distance from the rotor

The rotor's magnetic field is permanent. In the event of direct physical contact with the rotor, the static magnetic flux density does not exceed 2 T.

- When picking up or putting down the product, do not simply pull on the cable or drag it across the floor.
- Do not subject the product to shocks.
- Ensure that the product is operated at the rated load.
- In accordance with standard IEC 60034-5, all HIWIN torque motors have the following protection classes: IP20 for the stator and IP00 for the rotor.
- HIWIN torque motors have insulation class F (TM-5 / IM-2 series) and class B (TMRW series) in accordance with standard IEC 60085.

2.1 Reasonably foreseeable misuse

Avoid the following improper use and conditions:

Operating and maintenance errors:

- Failure to observe the safety notices and guidelines in this manual.
- Direct connection of the torque motor to the mains (mains voltage).
- Direct connection of temperature sensors to the inverter.
- Operation or maintenance of the motor by untrained or unauthorised personnel.
- Working on the motor when it is not adequately secured.
- Careless or wilful negligence in handling the motor.
- Underestimation of the magnetic attraction force of permanent magnets.
- Failure to observe the required safety distances for persons with pacemakers, implanted defibrillators and/or metal implants.
- Underestimation of the voltages induced by inductance in cables.
- Incorrect commutation setting when installing or replacing the encoder.
- Contact with hot surfaces.
- Handling the motor without personal protective equipment (PPE).

- Ignoring damage to the equipment.

Errors relating to the operating environment and conditions:

- Use of the motor for non-industrial or commercial applications (e.g. in the home).
- Operation under unsuitable environmental conditions (e.g. outside the specified temperature or humidity range).
- Use in hazardous areas (e.g. potentially explosive environments).
- Operation whilst the equipment is dirty (e.g. covered in dust or oil).
- Allowing contact with aggressive substances (e.g. acids, alkalis, corrosive chemicals).
- Operation with insufficient cooling.

Errors in disposal and modification:

- Failure to comply with the information and specifications on the type plate.
- Incorrect packaging, storage or transport.
- Dismantling (opening) of the motor housing.
- Incorrect disposal of the end-of-life motor.

2.2 Alterations and modifications

- The product must not be altered, dismantled or damaged without authorisation. If you have specific requirements, please contact our company's sales department and describe your needs.
- Do not remove the product label or the attached identification cards without authorisation.
- Cardboard boxes bearing our company's logo must not be used for the sale or distribution of other products.

2.3 Residual risks

⚠ **Warning**! Injury and property damage due to non-compliance with the Machinery Directive 2006/42/EC or the EU Machinery Regulation (EU) 2023/1230Art und Quelle der Warnung

There is a risk of death, serious injury and/or property damage if the Machinery Directive 2006/42/EC or the EU Machinery Regulation (EU) 2023/1230 is not carefully observed.

- The products included in the scope of delivery are intended exclusively for installation in a machine. Commissioning is prohibited until it has been fully established that the end product complies with the Machinery Directive 2006/42/EC or the EU Machinery Regulation (EU) 2023/1230.
- Please observe all safety notices and pass these safety notices on to the end user.

If the user operates the product correctly and follows the instructions and precautions in the user manual, they can effectively control and reduce the risk of incidents. The relevant sections of the user manual contain information on maintenance as well as the potential risks and warning notices associated with the use of the product.

However, residual risks may still exist in connection with the use of this product. For example, whilst it is important to advise customers and operators to read the user manual, it is not certain that they will fully understand the instructions for the product. Should you have any questions regarding the user manual, please contact our company's sales department at . We will then provide you with professional advice.

2.4 Personnel requirements

All work and the installation of this unit must be carried out exclusively by qualified and fully trained specialist personnel who have read and understood the assembly instructions. Work on the torque motor components must only be carried out by authorised and competent persons. Before commencing work, they must be familiar with the safety equipment and regulations.

Qualifications	Qualification
commissioning	Trained specialist personnel from the operator or manufacturer
Mechanical installation	Qualified and experienced personnel
Electrical connection	Only qualified electricians may carry out work on the electrical system. Alternatively, the work may be carried out by trained technicians under the direct guidance and supervision of a qualified electrician, in compliance with all technical specifications.
Cleaning	Qualified and experienced personnel
Maintenance	Trained specialist staff from the operator or manufacturer
Repairs	Trained specialist staff from the operator or manufacturer

- The unit must only be installed and operated in accordance with the assembly instructions.
- During operation, all relevant laws, guidelines and regulations regarding safety, accident prevention and environmental protection must be observed.
- All necessary structural safety devices and appropriate warning signs must be installed and available in the work area.
- All work must be carried out exclusively by suitably qualified and fully trained technical personnel.
- Ensure that the operator has completed practical safety training for the torque motor and has read and understood this user manual in full.
- Personnel are required to wear suitable personal protective equipment (PPE) that complies with all health and safety guidelines.
- The unit must not be structurally modified without authorisation.
- The prescribed maintenance intervals and the associated maintenance work must be observed.

2.5 Protective equipment

Personal protective equipment

Table2 .1 : Personal protective equipment

Operating phase	mandatory signs	Personal protective equipment
Transport, assembly, cleaning and maintenance		When transporting the product, wear safety footwear to avoid the risk of accidental falls and injuries.
		When assembling the rotor, it is necessary to use a lifting device and wear a safety helmet for protection due to the strong suction force.
		Please wear latex gloves when lubricating the product surface and when wiping it down with alcohol.
commissioning		If noise occurs, do not expose yourself to it for a length of time that is prolonged and wear ear protection.

Safety equipment

This product is available in various sizes and types. If it cannot be handled manually, please use a crane for lifting. When lifting, always wear a safety helmet to protect your head

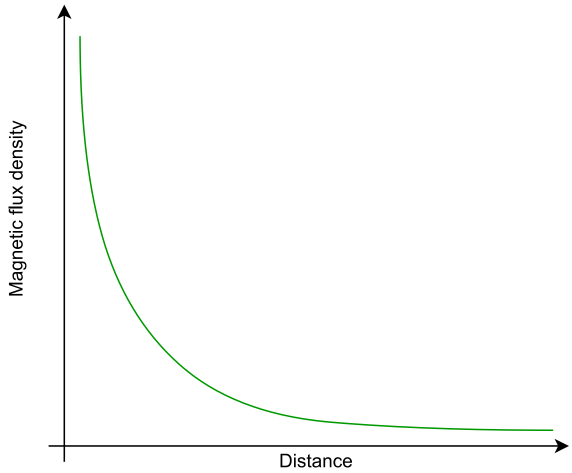
Table2 .2 :

Operating phase	mandatory signs	Safety equipment
Suspension		Ensure that the lifting eyes are securely clamped and that the load is within the specified limit.

2.5.1 Danger from strong magnetic fields

The permanent magnet in the rotor of the direct drive motor generates a very strong magnetic field. When no input current is flowing, the motor’s strong magnetism comes from the permanent magnets on the rotor, and the magnetic field strength is inversely proportional to the distance; during movement, additional electromagnetic fields are generated.

Fig.2 .1 : Schematic representation of the static magnetic field of a rotor



⚠ **Danger!** Risk of death due to strong magnetic fields!

Strong magnetic fields in the vicinity of torque motors pose a danger to people with active medical implants who are in the vicinity of the motors. This also applies when the motor is switched off.

- If you are affected, maintain a minimum distance of 300 mm from the permanent magnets
- Trigger threshold for static magnetic fields of 0.5 mT in accordance with Directive 2013/35/EU
- Please also observe national and local guidelines or requirements.
- For reference: DGUV Rule 103-013 of the German Social Accident Insurance sets out requirements for working with magnetic fields

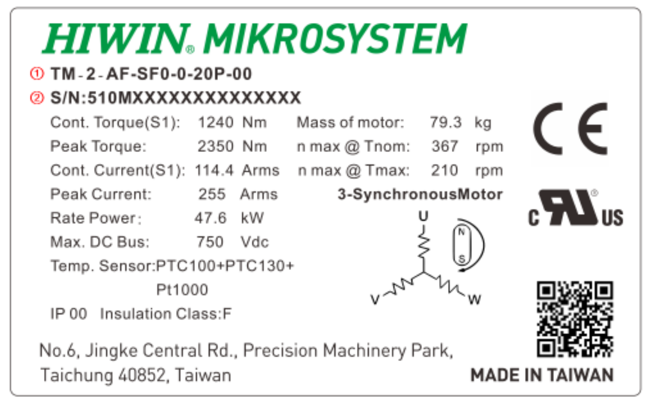
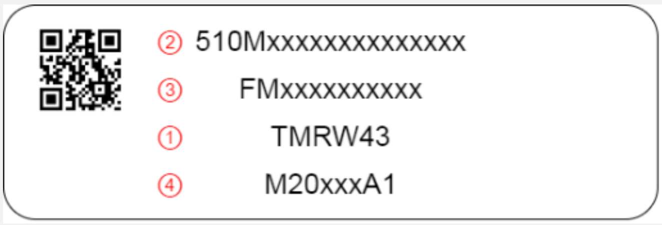
⚠ **Danger!** Risk of crushing due to strong attraction forces!

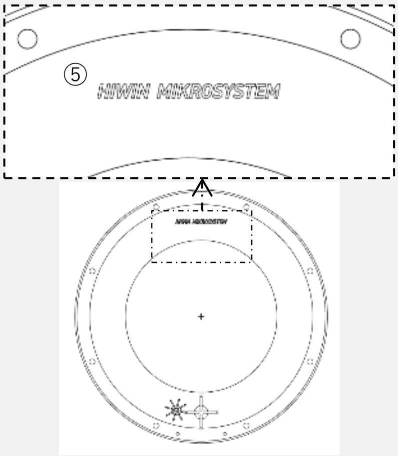
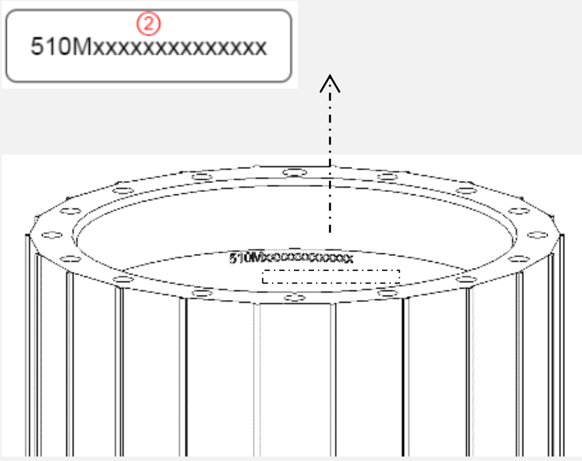
- Assemble the rotors and stators with care!
- Do not place fingers or objects between the rotors and stators!
- The rotor and magnetisable objects may accidentally attract each other and collide!
- Two rotors may accidentally attract each other and collide!
- The magnetic force exerted by the rotor on the object can amount to several kN, which may result in a body part becoming trapped.
- Do not underestimate the attraction force and proceed with caution.
- Wear safety gloves if necessary.

- At least two people are required for the work.
- If the assembly steps have not yet progressed to the installation of the rotor, please store the rotor in a safe and suitable place for the time being.
- Never handle several rotors at the same time.
- Never place two rotors directly against each other without a protective device.
- Do not bring magnetisable materials near the rotor! If the tool needs to be magnetised, please hold it firmly with both hands and approach the rotor slowly!
- It is recommended that you install the rotor immediately after unpacking!
- When assembling the stator and rotor, an installation aid is required to fit the stator and rotor together individually. Please follow the correct procedure.
- Always have the following tools ready to free body parts (hands, fingers, feet, etc.) held by magnetic force.
- Hammer made of non-magnetised, solid material (approx. 3 kg)
- Two wedge-shaped runners made of non-magnetised materials (wedge-shaped, acute angle 10°–15°, minimum height 50 mm).

2.6 Nameplate on the torque motor

Each rotor and each stator is marked with specific labelling. The scope of delivery includes 2 name labels, 3 simple labels and 2 O-rings. There is also a magnetic warning sign on the rotor. Here is an example of these labels

Nameplate	simple label
	

Stator labelling	Rotor simple label
	

1 Motor type

2 serial number

3 article number

4 Number of drawings

5 Laser-engraved trademark

Magnetic warning sign

3 product description

3.1 Description of the torque motor

The torque motor is based on the design of a permanent magnet synchronous motor (PMSM), which increases efficiency and generates high torque. Unlike servo motors with gearboxes, the torque motor can be connected directly to the load and deliver torque. The advantages are listed below.

Simple design

- Large hollow shaft – The rotor with a large hollow shaft simplifies the design. Cables can be routed easily, and various components can be housed within it.
- Fewer components – Direct connection to the load reduces the number of intermediate components and further improves reliability.
- Compact – The characteristics of the large hollow shaft and the direct connection allow for a more compact mechanical design.



Cost reduction

- No gearbox – Reduces installation effort and maintenance costs.
- No wear parts – Significant reduction in downtime and maintenance intervals. Production can continue uninterrupted.
- Long service life – Without wear and reduction gearing, the service life of the machine is significantly improved.



Improved performance

- High dynamic response – With no transmission delays such as elastic connections, backlash and friction, it offers optimum motion characteristics.
- Low torque – Multiple polarities combined with HIWIN’s optimised motor design reduce torque during operation.
- Low moment of inertia – A large hollow shaft rotor reduces the load.

– High accuracy – The direct connection to the load makes position feedback more accurate.



3.2 Main components of the torque motor

3.2.1 General view

The HIWIN torque motor can achieve optimum performance through water cooling. Bearing, position measurement systems and other associated parts are excluded from the scope of supply. The basic structure of the motor is shown inFig.3 .1 .

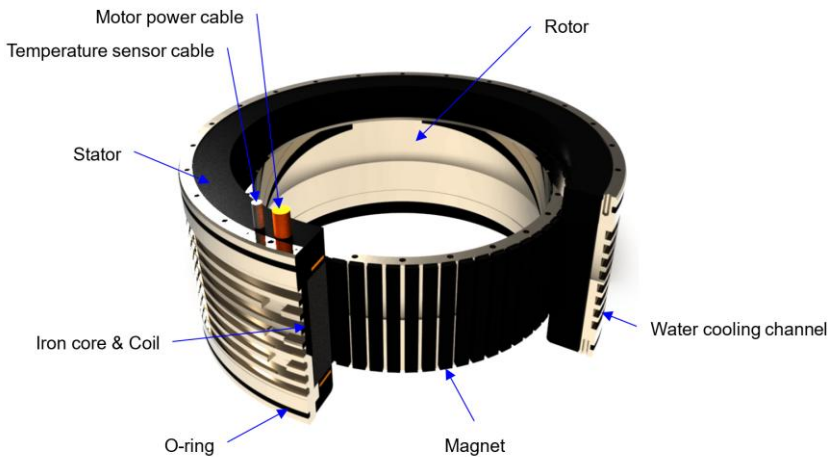
– stator

  The stator of the TMRW/TM-5/IM-2 series contains a water cooling channel. The outer housing is made of an aluminium alloy or steel, whilst the interior consists of an iron core and coils with an epoxy coating. On one side there are two cable outlets: the motor cable and the temperature sensor cable. The stator should be installed on a fixed part of the customer’s machine.

– Rotor

  The main structure consists of a steel ring with evenly spaced magnets. The rotor should be installed on the rotating part of the customer’s machine. Due to the strong magnetic attraction force, adequate protection is required during installation and handling. To avoid hazards, keep the product away from magnetic conductors (e.g. iron objects).

Fig.3 .1 : Basic structure of the torque motor



3.3 order code

3.3.1 Order code for the TMRW series

		Motor specification		Function		Feature	
Number		1	2	3	4	5	6
Code		TMRW	4	7	L	C	XX
1	TMRW	Type: TMRW: Torque motor					
2	4	Outer diameter of the stator: 1: Ø160 mm 2: Ø198 mm 4: Ø230 mm 7: Ø310 mm A: Ø385 mm D: Ø485 mm G: Ø565 mm					
3	7	Rotor height (magnet): 3: 30 mm 5: 50 mm 7: 70 mm A: 100 mm F: 150 mm					
4	L	Winding code: Standard L: Low back-EMF					
5	C	Optional: Standard C: Custom					
6	XX	Reserved: Standard XX: Specification code See motor data sheet					

Order code for the IM-2 series

		Motor specification		Sensor		cable outlet		Reserved	
Number		**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Code		**IM-2**	**7**	**5**	**SD0**	**0**	**20**	**V**	**XX**
1	**IM-2**	Type: IM-2: IM motor							
2	**7**	Outer diameter of the stator: 1: Ø160 mm 2: Ø198 mm 4: Ø230 mm 7: Ø310 mm A: Ø385 mm D: Ø485 mm G: Ø565 mm							
3	**5**	Rotor height (magnet): 3: 30 mm 5: 50 mm 7: 70 mm A: 100 mm F: 150 mm							
4	**SD0**	Code Torque/speed characteristics See motor data sheet							
5	**0**	Temperature sensor configuration: 0: PTC130+PTC100+Pt1000 (standard) 1: PTC130+PTC100+Pt1000x3							
6	**20**	Cable length: 20: 2.0 m (standard) 05: 0.5 m 10: 1.0 m							
7	**V**	Cable type: S: Straight outlet V: Straight outlet with cable clamp H: 90° tangential outlet with cable clamp (temporarily straight outlet) P: All cables (U/ V/ W/ G) separated with cable clamp (straight outlet)							
8	**XX**	Reserved: 00 : Stator and rotor are supplied separately (standard version) 03 : Assembly of stator and rotor and final dispatch (bridge on the cable side) Note: Applies only to rotors (magnets) with a height of less than 101 mm.							

Fig.3 .2 : Cable outlet type

S: Straight output

V: Straight output with cable clamp

P: All cables separate with cable clamp (straight output)

H: 90° outlet in tangential direction with cable clamp (temp. cable, straight outlet)

1. Cable only.
2. The illustration shown above is a schematic sketch; please refer to the approval drawings for the exact dimensions.

3.3.2 Order code for the TM-5 series

		Motor specification		Sensor		cable outlet		Reserved	
Number		1	2	3	4	5	6	7	8
Code		TM5	7	5	PB6	0	20	V	XX

1	**TM5**	Type: TM-5: torque motor
2	**7**	Outer diameter of the stator: 1: Ø160 mm 2: Ø198 mm 4: Ø230 mm 7: Ø310 mm A: Ø385 mm D: Ø485 mm G: Ø565 mm
3	**5**	Rotor height (magnet): 3: 30 mm 5: 50 mm 7: 70 mm A: 100 mm F: 150 mm
4	**PB6**	Code Torque/speed characteristics See motor data sheet
5	**0**	Configuration of the temperature sensor: 0: PTC130+PTC100+Pt1000 (default) 1: PTC130+PTC100+Pt1000x3
6	**20**	Cable length: 20: 2.0 m (standard) 05: 0.5 m 10: 1.0 m
7	**V**	Type of cable outlet[1)]: S: Straight outlet V: Straight outlet with cable clamp H: 90° outlet in tangential direction with cable clamp (temporary cable, straight outlet) P: All cables separate with cable clamp (straight outlet)
8	**XX**	Reserved: 00 : Stator and rotor are supplied separately (standard version) 03 : Assembly of stator and rotor and final dispatch (bridge on the cable side) Note: Applies only to rotors (magnets) with a height of less than 101 mm. T0 : Low-flow version; stator and rotor are supplied separately T3 : Low-flow version, stator and rotor assembly plus final delivery (bridge on the cable side) Note: Applies only to rotors (magnets) with a height of less than 101 mm.

Fig.3 .3 : Cable outlet type

S: Straight outlet

V: Straight output with cable clamp

P: All cables separated with cable clamp (straight output)

H: 90° outlet in tangential direction with cable clamp (temp. cable straight outlet)

1. Cable only.

2. The illustration shown above is a schematic sketch; please refer to the approval drawings for the exact dimensions.

3.4 configuration

3.5 Selection of the torque motor

The following sections describe the selection of a suitable motor based on speed, travel distance and load inertia. The basic procedure for sizing a motor is as follows.

Requirements

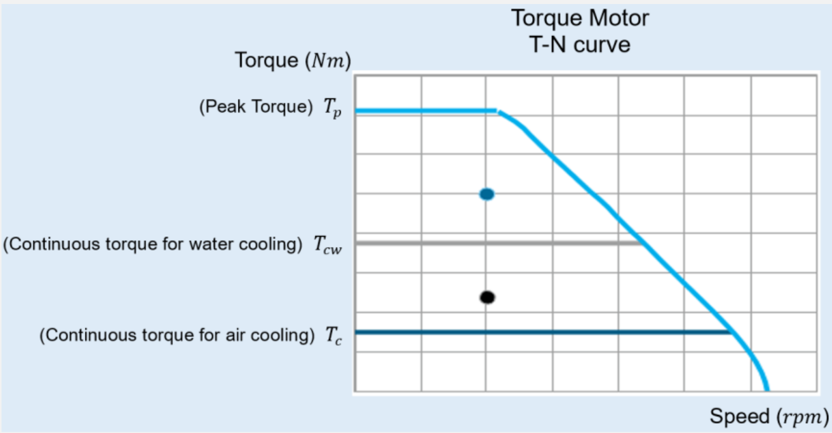
- Operating environment
- Installation (horizontal or vertical)
- Operating mode
- Load conditions (load inertia, friction and shear force)
- Speed conditions (maximum acceleration and speed)
- Duty cycle

Calculation of torque

- Calculation of the torque corresponding to the speed under all operating conditions
- Calculation of the equivalent torque

Motor sizing and confirmation of the T-N curve

- Select the appropriate motor from the HIWIN catalogue based on the calculated maximum torque, equivalent torque and speed.
- Ensure that the speed and the corresponding torque remain within the range of the motor's torque-speed curve under all operating conditions.
- Ensure that the equivalent torque lies within the motor's continuous torque rating.



– Symbol

φ	Angular displacement (rad)	I_p	peak current (A_{eff})
t	Movement time (sec)	I_e	Equivalent current (A_{eff})
α	Angular acceleration (rad/s^2)	I_c	continuous current(A_{eff})
ω	Angular velocity (rad/s)	ω_0	Initial angular velocity (rad/s)
J_L	Load inertia(kgm^2)	m	Load mass (kg)
J	Rotor mass inertia (kgm^2)	R_L	Outer diameter (m)
T_p	Peak torque (Nm)	r_L	Inner diameter load weight (m)
T_c	Continuous torque (Nm)	a_L, b_L	Side length Load weight (m)
T_i	Moment of inertia (Nm)	S	Distance from centre of gravity to centre of rotation (m)
K_t	Torque constant (Nm/A_{eff})		

1 Requirements

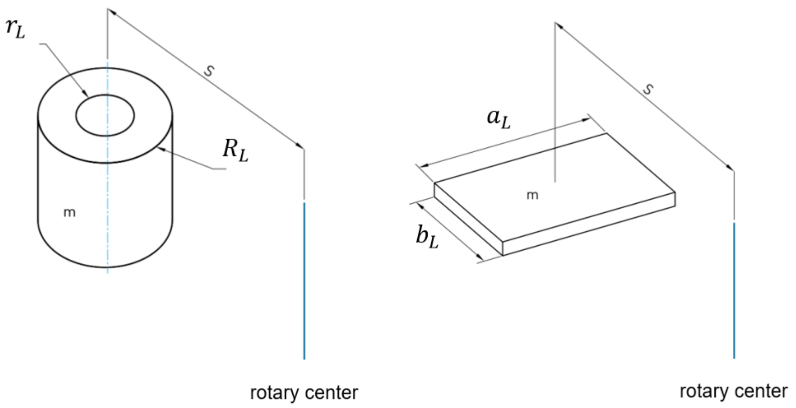
To select a suitable motor, the following formula for load inertia and motion must be understood prior to selection.

Calculation of load inertia

Load inertia can be determined using 3D drawing software or the formula. The basic formula is as follows.

Moment of inertia of a hollow cylinder $J_L = m\left(\frac{R_L+r_L}{2} + S^2\right)$

Moment of inertia of a rectangle $J_L = m\left(\frac{a_L+b_L}{12} + S^2\right)$



Determining the velocity and parameters of motion

The basic kinematic equations are described below.

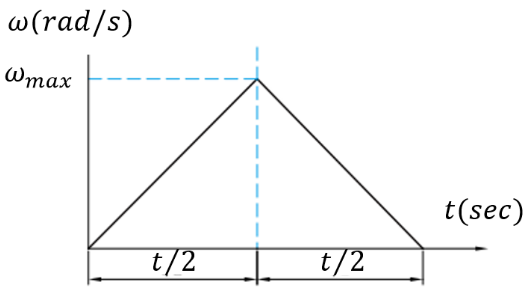
$$\omega = \omega_0 + \alpha t$$

$$\varphi = \omega_0 t + \frac{1}{2}\alpha t^2$$

Here,ω is the angular velocity,α is the angular acceleration,t is the time of motion, andφ is the angular displacement. Users can make a selection of two of the four parameters (ω ,α ,t andφ). The two parameters on the left can be calculated using the above equations.

Motion speed profile

Motion profiles for torque motors can be divided into "trapezoidal profile" and "triangular profile". The trapezoidal profile is generally used in scanning applications. Its motion profile can be divided into acceleration, constant speed and deceleration. The maximum angular acceleration can be determined using the basic equations of kinematics mentioned above. The triangular profile is normally used for point-to-point applications. Its motion profile can be divided into acceleration and deceleration, and its motion profile and formula can be simplified as follows.



$\omega_{max} = 2 \times \frac{\varphi}{t}$

$\omega_{max} = \sqrt{\alpha \times \varphi}$

$\alpha_{max} = \frac{4\varphi}{t^2}$

2 Calculation of torque

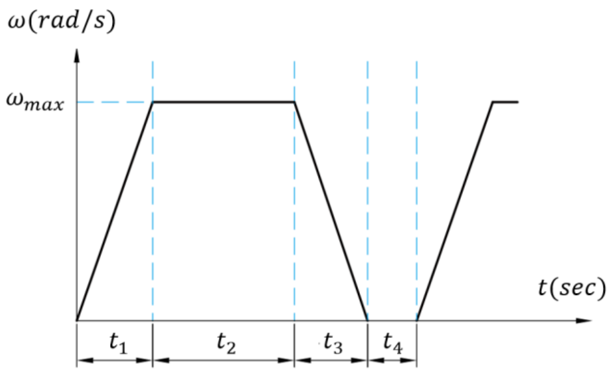
The maximum torque can be calculated using the following equation.

$T_{max} = (J + J_L) \times \alpha_{max} + T_f = T_i + T_f$

Here, T_i is the moment of inertia and T_f is the torque caused by friction torque, shear force or external force.

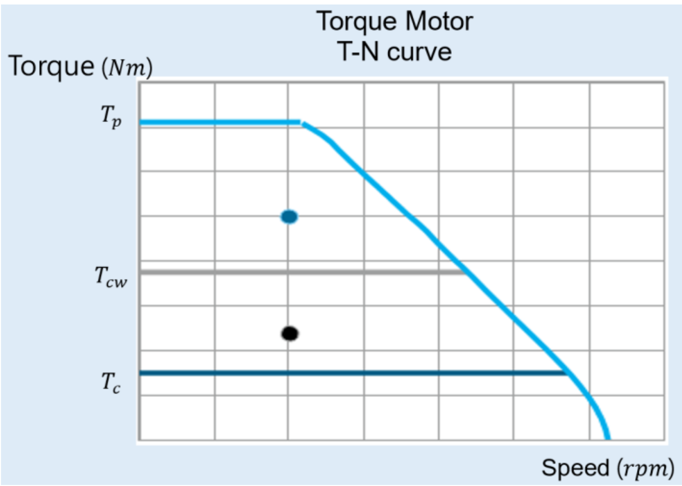
In most cases, these are cyclic point-to-point movements. The equivalent torque of a cyclic movement with a dwell time of t_4 seconds can be calculated as follows.

$$T_e = \sqrt{\frac{(T_i + T_f)^2 \times t_1 + T_f^2 \times t_2 + (T_i - T_f)^2 \times t_3}{t_1 + t_2 + t_3 + t_4}}$$



3 Motor sizing and confirmation of the T-N curve

Using the HIWIN motor specification, the operator can perform a selection of the appropriate motor based on the peak torque and equivalent torque, and ensure that the speed and torque remain within the range of the motor's T-N curve under all operating conditions.



Motor sizing is determined as follows.

$$T_{max} < T_p$$

$$T_e < T_c$$

Operators must take into account the ratio between the equivalent torque and the continuous torque. It is generally recommended that the ratio (T_e /T_c) be within 0.7. The continuous torque for the TMRW/TM-5/IM-2 series can be divided into air-cooled and water-cooled types. If the motor is operated with water cooling, the continuous torque for water cooling can be used as a reference value for comparison.

Note:

The torque-speed curve specified in the technical data sheet applies to a specific voltage, regardless of the speed limit of the bearing and the position measurement system. When selecting the appropriate specifications, the operator should also determine the maximum speed of the entire mechanism to prevent the service life of the bearings or a failure of the position measurement system from leading to abnormal operation or damage to the motor.

3.1 Thermal calculation

3.1.1 Heat loss

When a motor converts electrical energy into kinetic energy, copper losses, iron losses and mechanical losses are inevitable. Copper loss is the loss caused by resistance when current flows through the motor's stator coil. Iron losses, which can be divided into hysteresis losses and eddy current losses, arise from the interaction of the magnetic field between the stator's iron core and the rotor magnet. Mechanical losses are generally much smaller than copper and iron losses and can therefore be neglected.

The copper loss at continuous torque is calculated as follows.

$$P_c = \frac{3}{2} R_{25}\{1 + [0{,}00393(\theta_c - 25)]\} I_c^2$$

P_c= Copper losses at a coil temperature of θ_c [W]

R_{25}= Wire resistance at a coil temperature of 25 °C [Ω]

I_c= Continuous current at a coil temperature of θ_c [A_{eff}]

θ_c= Coil temperature [°C] (120 °C for TMRW series, 130 °C for TM-5/IM-2 series)

Iron loss is mainly caused by the change in magnetic flux during the commutation process and is highly dependent on frequency. As the speed is directly proportional to the frequency, iron loss is greater at high speeds. However, the speed of the HIWIN torque motor is low, so the iron loss is comparatively lower than the copper losses. The speed value specified in the HIWIN drawing and specification is the maximum speed that the motor can achieve. During continuous operation at high speeds, iron losses must account for the additional heat input to the rotor. At this point, motor losses increase rapidly. To prevent overheating, operators must adjust the operating conditions accordingly or provide heat dissipation at the rotor.

Iron losses are mainly caused by eddy currents and frequency. The higher the speed, the greater the iron loss.

$P_{Fe} \propto f^2$
P_{Fe}= Iron loss [W]

f = Frequency [Hz]

Definition of frequency:

$$f = \frac{n \cdot p}{60}$$

n = Rotational speed (revolutions per minute)

p = Number of pole pairs

Heat losses are mainly transferred via heat conduction from the windings and the iron core to the motor housing. Take natural air cooling, for example: the heat source is dissipated to the environment via heat convection from the surface of the housing in contact with the air, and is transferred to the customer's mounting surface via heat radiation and heat conduction. In water cooled systems, the heat source is transferred via heat conduction from the centre of the heat source to the cooling water. As the thermal conductivity of cooling water is much higher than that of air, the effect of the heat source being dissipated to the air via convection can be neglected. The TMRW series is available for both water cooling and air cooling, whilst the TM-5 and IM-2 series are primarily available for water cooling. Ensure that the parameters you use comply with the specifications, and take care that the coil temperature does not exceed 130 ° C. (For TMRW, this value is 120 ° C). Please contact HIWIN for other applications.

3.1.2 Continuous operating temperature

The steady state temperature of the motor winding is determined by the ratio of copper losses to iron losses. At low speeds, iron losses can be neglected. Both the total loss and the rated continuous current ($_{Tc}$) are defined when the coil temperature is 120° C. (For TM-5 & IM-2, this is 130° C). If the equivalent torque ($_{Te}$) is less than the rated continuous torque ($_{Tc}$), the steady state temperature of the motor coil under various operating conditions can be determined using the following formula.

$$\theta_e = \theta_{surr} + \left(\frac{I_e}{I_c}\right)^2 (\theta_c - 25)$$

θ_c = steady state temperature of the coil under rated conditions (TMRW: 120 / TM-5 & IM-2: 130) [°C]

θ_e= Steady state temperature of the coil at equivalent torque [°C]

θ_{surr}= Ambient temperature [°C] (ambient temperature for air cooling / water temperature for water cooled cooling)

I_e = Equivalent current in actual operation [A_rms] (when the winding temperature is θ_e)

I_c = Rated continuous current [A_rms] (at a coil temperature of θ_(cont.), this depends on the heat dissipation conditions. For air cooling, this refers to the continuous current under air cooling. For water cooled cooling, this refers to the continuous current under water cooled cooling.

I_p = peak current [A_rms]

T_e = equivalent torque in actual operation [Nm] (at a coil temperature of θ_e)

T_c = rated continuous torque [Nm] （(at a coil temperature of θ_(cont.)）

T_p = peak torque [Nm]

When the motor is in operation, the ratio of output torque to current leads to saturation of the iron core as the current increases. The linear relationship becomes non-linear, making it difficult to estimate the current. This relationship cannot be described directly by an equation. However, the current can be estimated according to the following conditions in Figure 3.4:

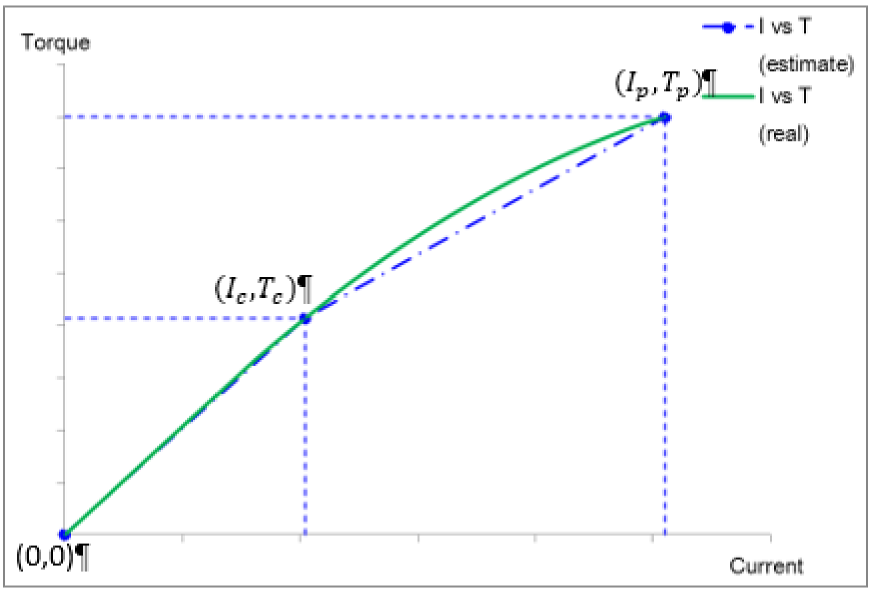
Case A: ($T_e < T_c$) is equal to ($I_e < I_c$)

$$I_i = I_{cw} + \frac{(T_i - T_{cw})(I_p - I_{cw})}{T_p - T_{cw}}$$

Case B: ($T_c < T_e < T_p$) is equal to ($I_c < I_e < I_p$)

$$I_i = I_{cw} + \frac{(T_i - T_{cw})(I_p - I_{cw})}{T_p - T_{cw}}$$

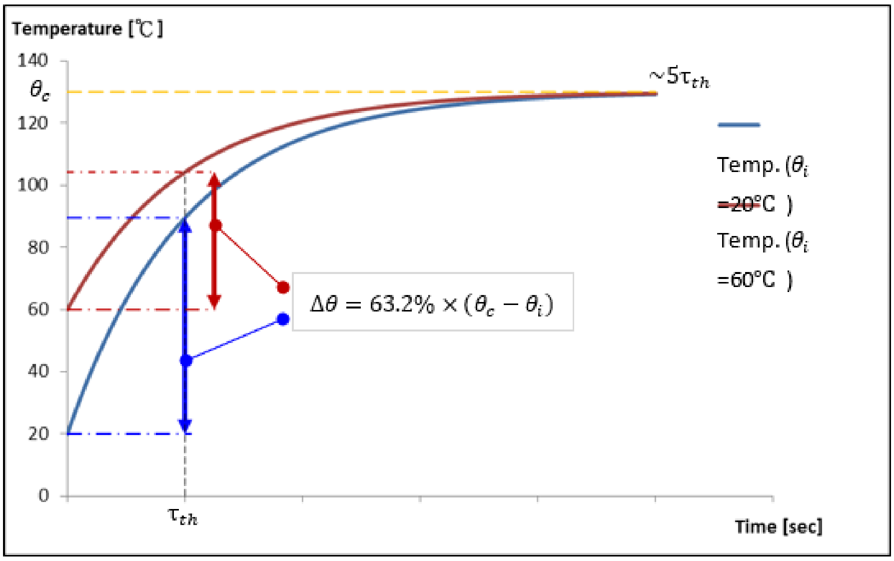
Fig.3 .1 : Current versus torque curve



3.1.2.1 Thermal time constant

The temperature of the motor winding during operation depends on the thermal time constant. The thermal time constant is defined as the time required for the temperature difference to reach 63.2% of the difference between the steady state temperature and the initial temperature. The time taken to reach thermal equilibrium is approximately five times the thermal time constant.

Fig.3 .2 : Temperature rise curve



The relationship between the thermal time constant and temperature is

$$\theta(t) = \theta_i + (\theta_c - \theta_i) \cdot \left(1 - e^{-\left(\frac{t}{\tau_{th}}\right)}\right)$$

$\theta(t)$= coil temperature [°C] (at operating time t)
θ_i= coil temperature [°C]
t= operating time [sec]
τ_{th}= thermal time constant [sec]

If the operating current lies between the rated current and the peak current ($I_c < I_e < I_p$), a shutdown time should be set to allow the motor to cool down. The thermal time constant mentioned above can be used to calculate the time for the duty cycle. See3.1.2 Continuous operating temperature to determine the steady state temperature of the coil at equivalent torque (θ_e) based on the equivalent torque in actual operation (T_e). Then determine the relative maximum operating time using the following formula.

The relationship between the coil's steady state temperature at equivalent torque (θ_e) and the maximum operating time is

$$t_0 = -\tau_{th} \cdot ln\left(1 - \frac{\theta_c - \theta_i}{\theta_e - \theta_i}\right)$$

t_0= maximum operating time [sec]

Note: The coil temperature (θ_c) must not exceed the maximum value specified in the technical data.
(120°C for the TMRW series, 130°C for TM-5 / IM-2)

The relationship between coil temperature and cut-off time is

$$t_b = -\tau_{th} \cdot ln\left(1 - \frac{\theta(t_b) - \theta_c}{\theta_{surr} - \theta_c}\right)$$

$\theta(t_b)$= coil temperature to be cooled [°C] (after the cut-off timet_b)

t_b= cut-off time [sec]

The temporal distribution of the duty cycle during motor operation can be determined using the two formulas above.

3.1.2.2 Standstill condition

When the motor speed is extremely low (including standstill), the current commutation speed in the motor is very slow, causing current to accumulate in certain coil groups within the motor. If a continuous current is applied at this point, this will eventually lead to insufficient heat dissipation, resulting in the motor overheating.

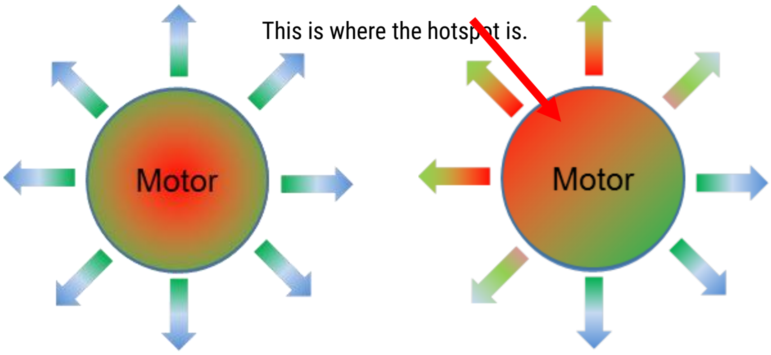
The concept is as follows:

a. The arrow represents the water flow for heat dissipation around the motor, with the volume of water flowing out per unit being fixed.

b. In the blocked state, the motor's temperature concentrates in certain two phases or a specific phase of the motor.

c. As the water flow around the motor has not increased, the motor's heat continues to accumulate in some coils.

Fig.3 .3 : Normal operation (left), blocked state (right)

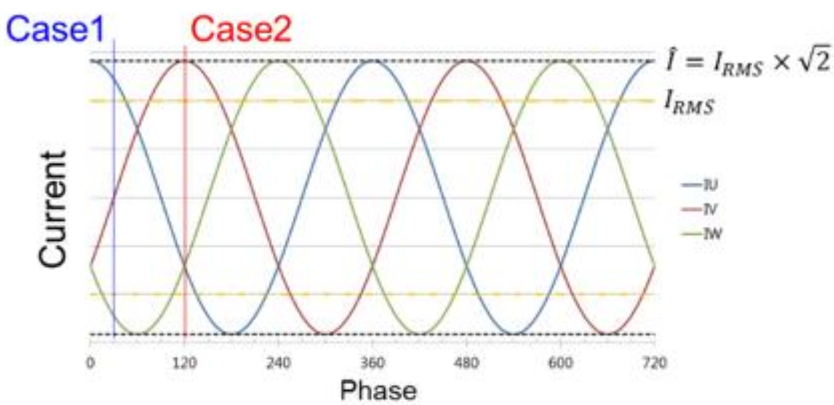


If the motor runs at a frequency below 1 Hz, this is considered a locked-rotor condition.
The relationship between motor frequency, motor speed and the number of poles is as follows:

$$n = \frac{f}{p}\ [1/s]$$

n= speed $[1/s]$
f= electrical frequency $[1/s]$
p= pole pairs

Fig.3 .4 : Current in the motor at different phases



As already mentioned, at extremely low motor speeds and in the locked-rotor condition, the current exceeds the continuous current that each phase can withstand in two-phase or single-phase operation, as shown in0 Fig.3 .4 : Current in the motor at different phases . The operating current must be reduced accordingly to prevent overheating. In the locked-rotor condition, there are two limit values. For every electrical angle, the current must lie between the following two cases:

Case 1: Overcurrent in both phases. (Example for phases U and W)

- Current reduction to **81%** of the continuous current ($\frac{1}{\sqrt{1.5}}$)
- Adjust current: $I_{phase\_U} = I_{phase\_W} = \frac{1}{\sqrt{1.5}} I_{c(w)}$

Case 2: Overcurrent in one phase. (Example: phase V)

- Reduce current to **70%** of the continuous current ($\frac{1}{\sqrt{2}}$)

Adjust current: $I_{phase\_V} = \frac{1}{\sqrt{2}} I_{c(w)}$

For the stall current: TMRW = 70%, IM-2 and TM-5 = 80%.

The locked-rotor condition is easily overlooked by users during application and calculation. If the motor speed is below the value specified in Table3 .1 **Fehler! Verweisquelle konnte nicht gefunden werden.** , this must be regarded as a locked-rotor condition. The operating conditions must be carefully assessed. Current and temperature must be monitored. This is to prevent the motor from being damaged by overheating.

Table3 .1 : Lock-up speed of the HIWIN torque motor

TMRW	TM-5	IM-2	Speed [rpm]
TMRW1x, TMRW2x, TMRW4x	TM-5-1x, TM-5-2x	IM-2-2x	5.45
-	-	IM-2-4x	3
TMRW7x	TM-5-4x, TM-5-7x	-	2.73
-	TM-5-A, TM-5-Dx	-	2
TMRWAx	-	IM-2-Ax	1.82
-	TM-5-Gx	-	1.71
TMRWDx, TMRWGx	-	IM-2-Gx	1.36

3.1.3 Cooling

3.1.3.1 Calculation of the cooling system

The motor specifications given in the drawing and technical data for the HIWIN torque motor are sized for operation in a water cooled environment, with a coolant temperature of 20 °°C . The use of oil as a coolant is also permitted. Simply adjust the motor power output according to the properties of the coolant. The cooling conditions specified in the technical data: The coil temperature should be below 120°C (130°C for TM-5/IM-2) when the stator is operated continuously at the continuous torque. If the equivalent torque in actual operation is lower than the continuous torque specified in the technical data, reduce the cooling water flow rate to avoid excessive pump consumption. The cooling conditions can be adjusted accordingly using the following formulae.

Adjust the cooling system parameters according to the motor power loss:

If the equivalent torque is lower than the continuous torque ($T_e < T_c$), determine the corresponding coolant flow rate using the following formulae.

$$P_e = \frac{p_c}{\left(\frac{T_c}{T_e}\right)^2}$$

$$P_e = 69.7 \cdot q_e \cdot \Delta\theta$$

P_e= Total motor loss at equivalent torque [W]

$\Delta\theta$ = Temperature difference between motor inlet and outlet [°C]

q_e= Coolant flow rate[l/min] (at constant torque)

The pressure difference between the inlet and outlet (ΔP_{eff}) depends on the coolant flow rate (q)

$$\Delta P_{eff} = \Delta P \cdot \frac{q_e}{q}$$

ΔP_{eff}= Pressure difference between inlet and outlet [bar] (at equivalent torque)

ΔP = Pressure difference between inlet and outlet [bar] (in the data sheet)

q = Coolant flow rate [l/min] (in the data sheet)

⚠ **Caution!** Motor overheating due to insufficient motor cooling

> Motor damage; parts of the motor or the insulation system may be damaged if the flow rate in the water cooled systems is too low.
>
> – Set the water flow rate to the value specified in the data sheet

– To reduce the motor cooling water flow rate to less than 70% of the specified minimum flow rate, please contact HIWIN for confirmation.

Example

In the specifications for the TMRWAF type, the continuous torque (T_c) under water cooling is 1290Nm , the power loss (P_c) is 8262 W, the coolant flow rate (q) is 23.7 l/min and the pressure difference between the inlet and outlet (ΔP) is 3bar . If the continuous torque used is only 600Nm and the temperature difference between the inlet and outlet is to be 6°C , what are the coolant flow rate (q_e) and the pressure difference between the inlet and outlet (ΔP_{eff}) in the cooling water system? [$v_{water} = 10^{-3}(m^3/kg)$]

$$P_e = \frac{p_c}{\left(\frac{T_c}{T_e}\right)^2} = \frac{8262}{\left(\frac{1290}{600}\right)^2} = 1787(W)$$

$$1787 = 69.7 \times q_e \times 6$$

$$q_e = 4.27(l/min)$$

$$\Delta P_{eff} = \Delta P \cdot \frac{q_e}{q} = 3 \times \frac{4.27}{23.7} = 0.54(bar)$$

The differences between the parameters in the data sheet and the operating parameters are listed in the following table.

Table3 .2 : Difference between data sheet parameters and operator parameters

Parameter (under water-cooling conditions)	**data sheet**	**User**
Torque (T)	1290 Nm	600 Nm
Power loss (P)	8262 W	1787 W
Temperature difference between inlet and outlet (Δθ)	5 °C	6 °C
Coolant flow rate (q)	22 l/min	4.27 l/min
Pressure difference between inlet and outlet (ΔP)	3 bar	0.54 bar

3.1.3.2 Selection of coolant

The coolant must be provided by the user. A corrosion-inhibiting coolant must be used for HIWIN torque motors. The design and performance testing of HIWIN torque motors are based on pure water. If customers use oil as a coolant, heat dissipation is reduced at the same flow rate, thereby also reducing motor performance; otherwise, the flow rate should be increased to maintain motor performance. Please contact HIWIN for further information.

The coolant must be pre-treated and filtered to prevent blockage of the cooling channel. The maximum permissible particle size in the coolant is 100 micrometres, and it must not freeze. The use of untreated water can lead to failures or damage caused by deposits, algae growth or slime formation, as well as corrosion, such as: reduced thermal conductivity, pressure loss due to a reduction in cross-sectional area, and blockage of various components. With regard to water quality, at least the following requirements must be met:

Chloride and sulphate must be below 100 ppm.

The mineral salt content must be below 2000 ppm.

$6.5 \leq pH \leq 9.5$

Compatibility with the O-ring material

%If an anti-corrosion agent is added (the base substance is ethylene glycol monoethyl ether), it must not react with water and the freezing point must be at least -5 °C (°C). The anti-corrosion agent must be compatible with the connections and materials in the cooling system, including the motor's O-ring. Please check this with the supplier of the additive! It is generally recommended that the concentration should not exceed 50 ppm ( ).

In addition to oil, the addition of various solvents to water also leads to a reduction in its specific heat capacity (C_p) (please check the properties with the supplier). It is necessary to reduce the engine power accordingly. When using glycol as an additive, please refer to the following table.

Table3 .1 : Specific heat capacity of ethylene glycol-based aqueous solutions at various temperatures

	Specific heat capacity C_p (KJ/kg K)			
Concentration of ethylene glycol (percentage by weight)	**Temperature range**			
	0 °C	**10** °C	**20** °C	**30** °C
0	4,203	4,195	4,189	4,185
10	4,071	4,079	4,087	4,096
20	3,918	3,935	3,951	3,968
30	3,764	3,807	3,807	3,828
40	3,595	3,647	3,647	3,674
50	3,412	3,473	3,473	3,504

Note

It is recommended to mix the water with a suitable ion neutraliser rather than using glycol, as this has the added benefit of reducing corrosion and the risk of blockages.

Example

Here we can perform a calculation based on the engine conditions specified in the examples above. If we assume that the customer uses only water with 20% glycol as the coolant, the effect of the reduced heat capacity must be taken into account and the flow rate increased to maintain the heat dissipation per unit.

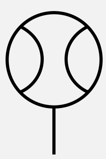
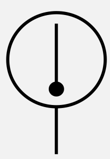
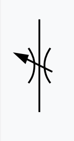
The table shows that the heat capacity of pure water below 20 °°C is 4.189 $(KJ/kg\ K\ )$ and the heat capacity of water with 20% glycol is 3.951 $(KJ/kg\ K\ )$

$$q_e = \frac{4.189}{3.951} \times 22 = 23.3\ (\ l/min)$$

Table3 .3 :

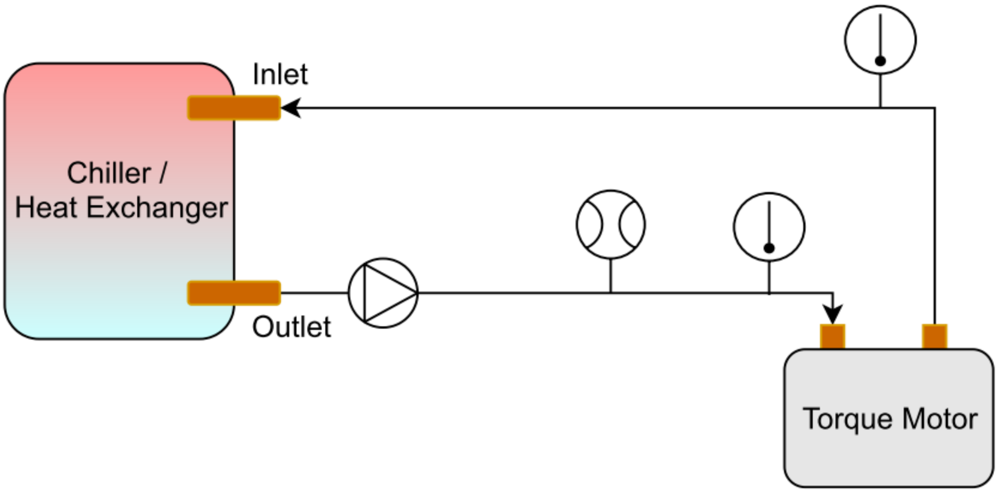
Parameter (under water cooling conditions)	**data sheet**	**User**
Torque (T)	1290 Nm	1290 Nm
Power loss (P)	8262 W	8262 W
Temperature difference between inlet and outlet (Δθ)	5°C	5°C
Coolant flow $(q\ )$	22 l/min	23.3 l/min
Medium	0% pure water	20% glycol with water

3.1.3.3 Coolant diagram

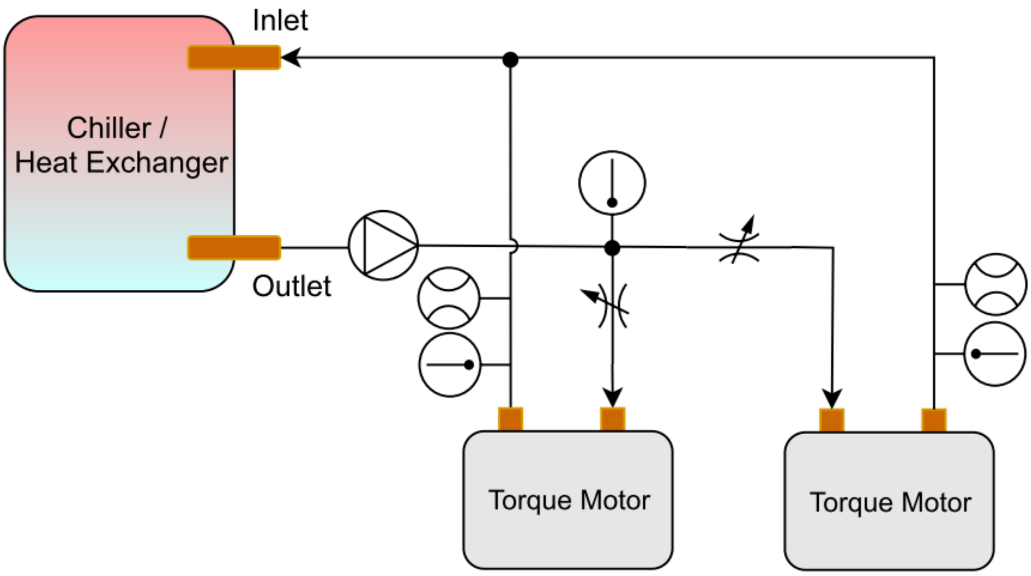
	Pump		Flow meter		Thermometer		Flow control (adjustable)

This section shows a simple schematic diagram of the water cooling system:

a. Single torque motor

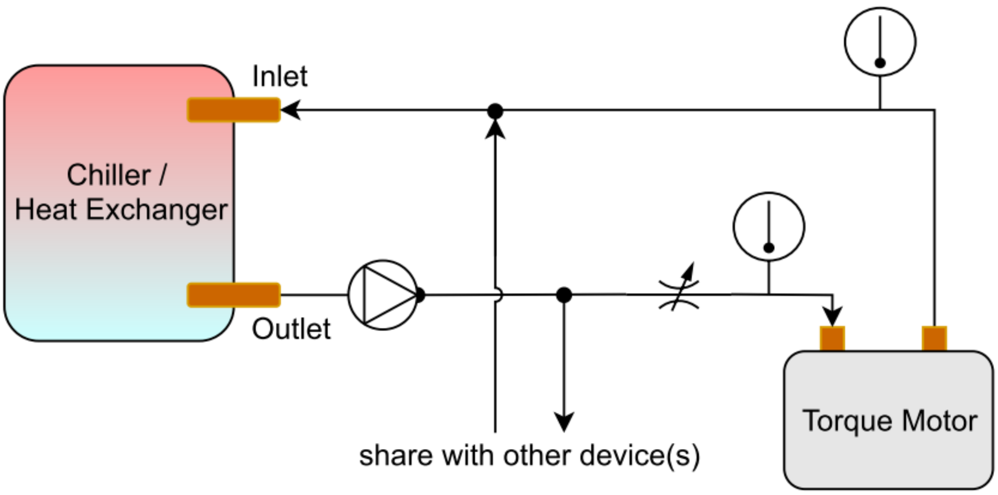


b. Parallel operation



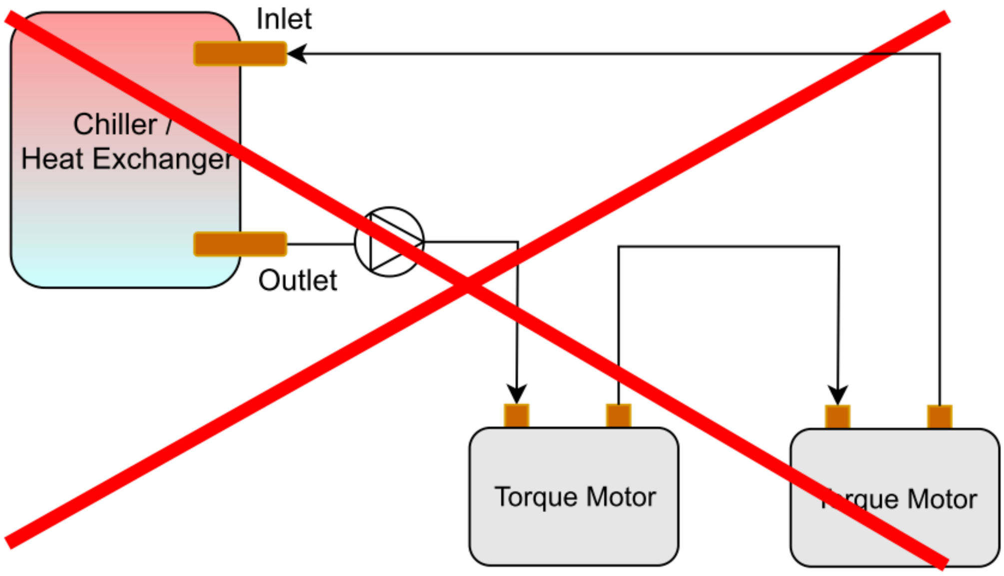
c. Shared use with other devices

In any case, when sharing the flow with other devices, the flow should be monitored and controlled.



d. Series connection

Never use a series connection!



3.2 Selection of the servo drive

3.2.1 Selection of the power supply and controller

When performing a selection of a power supply, the continuous current, peak current and bus voltage must be taken into account. In addition, consideration must be given to the resonance effect that can be induced in motors by certain drive systems. Motors consist of several individual coils connected in series. Each of these coils has a series inductance and a stray capacitance to earth. The resulting LC network has a resonance frequency. Consequently, when an electrical oscillation is applied to the phase inputs (particularly the PWM modulation frequency), the motor's neutral point can oscillate with very high amplitudes relative to earth, and the insulation may be damaged as a result of these oscillations. This phenomenon is more pronounced in motors with a large number of poles (such as torque motors).

Under ideal conditions, the $600-V_{DC}$ -bus voltage generated by the power supply should be $\pm300V_{DC}$ relative to earth. In some configurations, however, the voltage between the bus and earth exhibits a ripple voltage, and the peak of the high voltage is transmitted to the motor. The ripple voltage between the bus and earth depends on the system characteristics. Experience shows that a system with few axes connected to the bus voltage is less prone to disruptive oscillations on the bus; however, in a large machine tool with many axes and multiple shafts, for example, the oscillations can reach high amplitudes. If the frequency of these oscillations is close to the motor's resonance frequency, this can lead to overvoltage faults at the neutral point.

The case where the PWM modulation frequency of the controller happens to coincide with the motor's resonance frequency. In this case, the fundamental frequency of the PWM modulation directly excites the motor's resonance frequency, resulting in very high voltages at the neutral point. Furthermore, as the PWM voltage is a square wave, it contains odd harmonics (1, 3, 5, 7, etc.), which can also excite the motor resonance. Fortunately, these harmonics have a lower amplitude than the fundamental frequency.

In another scenario, a surge failure may also occur. In this case, the fundamental frequency of the PWM modulation frequency directly excites the motor's resonance frequency, resulting in very high voltages at the neutral point. As the PWM voltage is also a square wave, it contains odd harmonics (1, 3, 5, 7, etc.), which can also excite motor resonance.

In summary, two factors must be taken into account to prevent failures: the oscillations between the bus voltage and earth, and the PWM modulation frequency. If neither of the above factors resonates with the motor, there is no risk to the motor.

Please note the following conditions during the selection of the power supply:
dV/dtThe peak voltages and current gradients generated by the power supply must not exceed the following values:

300-V_{DC} -controllers: 750V_p (phase to ground at the PWM frequency), voltage gradient: 8$kV/\mu s$.

600- or 750-V_{DC} -controllers: maximum 1050V_p (phase to earth at the PWM frequency) and a voltage gradient of 11 $kV/\mu s$.

The cable between the controller and the motor generates a reflected wave due to the impedance mismatch between the cable and the motor, and the reflected voltage superimposes on the subsequent input voltage, causing the voltage to rise. This phenomenon becomes more pronounced the longer the motor cable is. It is necessary to measure the voltages at the motor terminals to ensure that they are below the values specified above. If the measured value is higher, a filter (dV/dt) must be installed between the controller and the motor for protection.

Fig.3 .5 : Schematic representation of the fluctuation in the phase-to-earth voltage for the " " (600/750-V_{DC} controller)

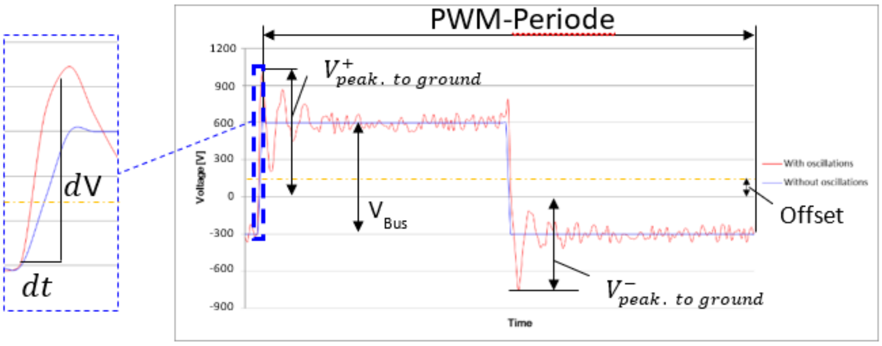


Table3 .4 :

Point	600/750 V DC controller
V_{bus}	Max. 750
$\lvert V^+_{peak.\ to\ ground}\rvert$	< 1050V_p (phase to earth) at PWM frequency
$\lvert V^-_{peak.\ to\ ground}\rvert$	< 1050V_p (phase to earth) at PWM frequency
Voltage gradient $\lvert dV/dt\rvert$	< 11$kV/\mu s$ (instantaneous) If it is difficult to determine the instantaneous voltage gradient, the following formula can be used for estimation. $\lvert dV/dt\rvert = \lvert(90\%V_{pp} - 10\%V_p)/t_r\rvert$

3.2.2 Voltage reflection in the cable

When an electromagnetic wave is transmitted through a cable, voltage and current fluctuations occur along the cable. If the length of the cable is relatively short compared to the wavelength, this phenomenon can be neglected and the voltage is considered to be constant along the entire length of the cable. However, if the frequency of the electromagnetic wave is high enough, the wavelength becomes very short. In this case, a distinct voltage distribution can be observed in the cable. The voltage distribution in the cable must be calculated using transmission line theory. In transmission line theory, electricity is regarded as an electromagnetic wave propagating through the cable. An impedance mismatch during transmission leads to a reflection of the incident wave. This phenomenon is more likely to occur when a motor is used. This is because the impedance of the motor is relatively greater than that of the cable. Consequently, a reflected voltage is generated, which is superimposed on the incident voltage waveform.

This phenomenon is influenced by the rise time of the voltage signal. According to IEC 61800-8, the typical rise timet_r is 50 ns to 1μs . Once the propagation velocity$v$ has been calculated based on the characteristic inductance and characteristic capacitance of the cable, the critical lengthl_{cr} at which the maximum reflected voltage occurs can be estimated:

$$v = \frac{1}{\sqrt{L_0 C_0}}\ (typical\ 50{\sim}300\, m/\mu s)$$

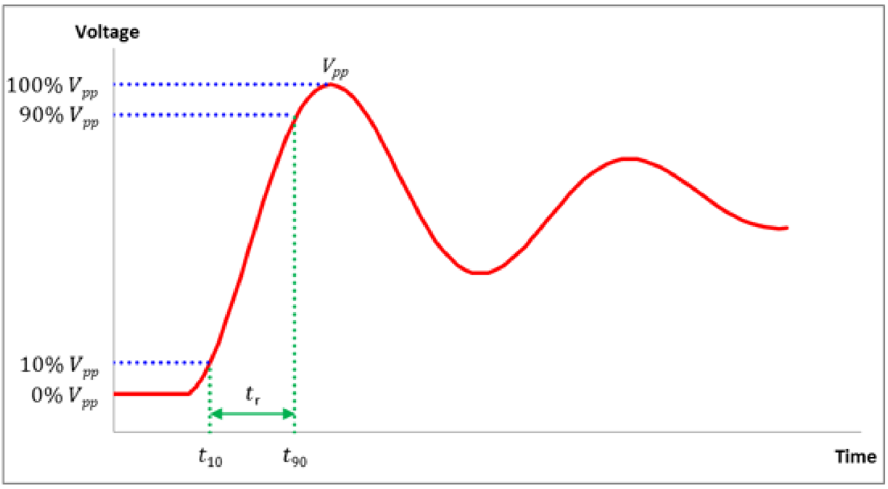
$$l_{cr} = \frac{\nu t_r}{2}$$

ν= The pulses propagate along the motor cable at a propagation speed

L_0= characteristic inductance of the cable

C_0= characteristic capacitance of the cable

Fig.3 .6 : Rise time t_r



First, determine l_{cr} . If the characteristic impedances of the motor Z_m and the cable Z_0 are known, the maximum voltage generated at the motor under the following conditions can be estimated:

1. If the motor cable length l_c is greater than the critical length l_{cr} :

$$V_{mot} = (1 + \Gamma)V_{inv}$$

2. When the motor cable length l_c is below the critical length l_{cr} :

$$V_{mot} = \left(1 + \frac{l_c}{l_{cr}}\Gamma\right)V_{inv}$$

V_{mot}= The peak voltage at the motor terminals

V_{inv}= The output voltage of the power converter

Γ= Reflection coefficient depending on the impedance mismatch between the motor cable and the motor:

$$\Gamma = \frac{Z_m - Z_0}{Z_m + Z_0}$$

The characteristic impedance Z_0 of the cable is accurately defined and depends on the cable parameters, such as L_0 ,C_0 the characteristic impedance R_0 the characteristic admittance G_0 . If we assume that the cable is lossless, Z_0 can be expressed as follows:

$$Z_0 \sim \sqrt{\frac{L_0}{C_0}}$$

However, the motor impedance Z_m cannot be readily determined. It is merely known that as motor power increases, the impedance Z_m decreases and the reflection coefficient also falls.

If voltage reflection occurs and the voltage is too high, the worst-case scenario is almost complete reflection ($\Gamma \approx 1$), which leads to $V_{mot} \approx 2V_{inv}$.

Fig.3 .7 : Voltage ratio as a function of the ratio of line lengths (illustration)

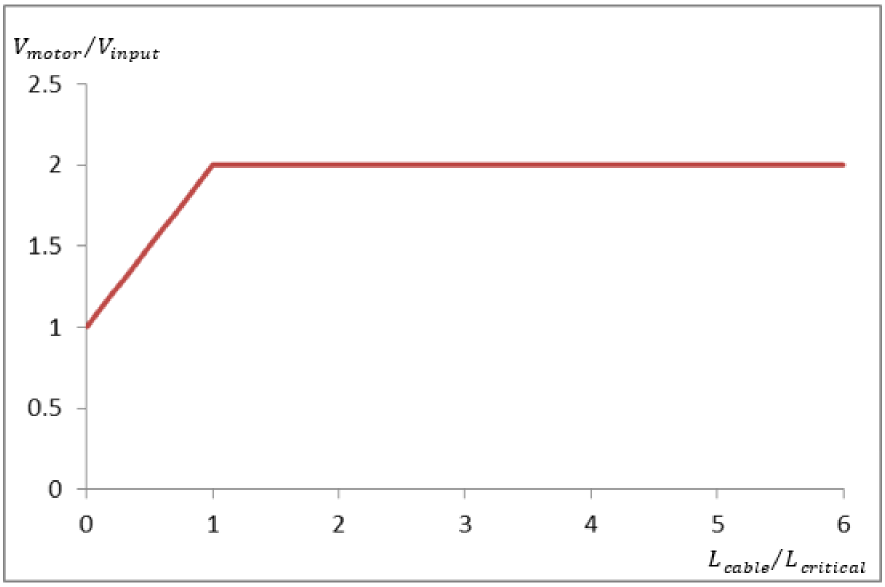
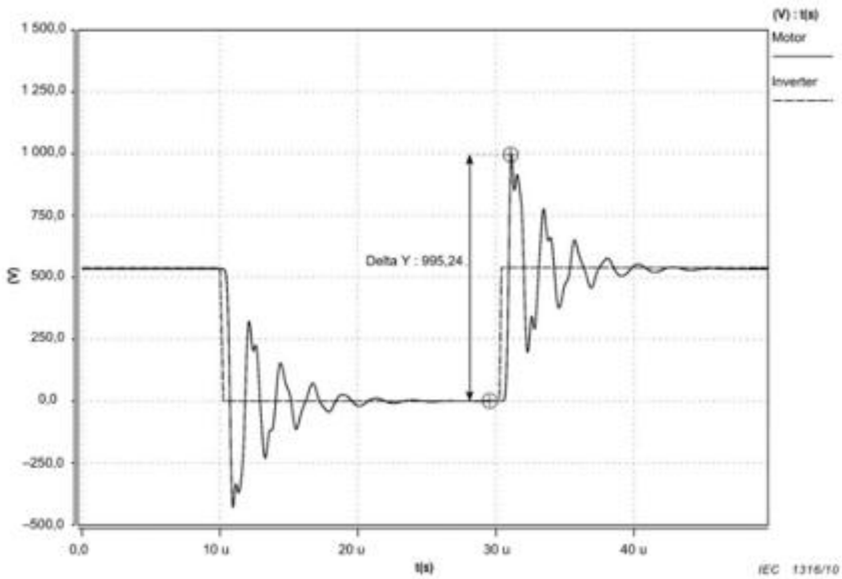
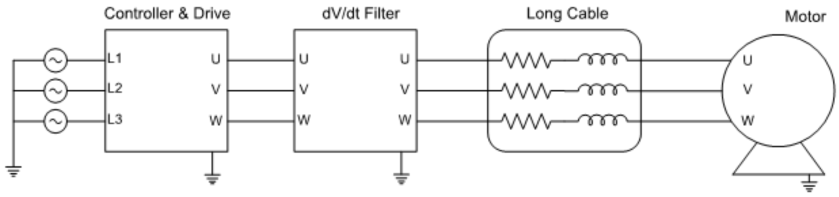


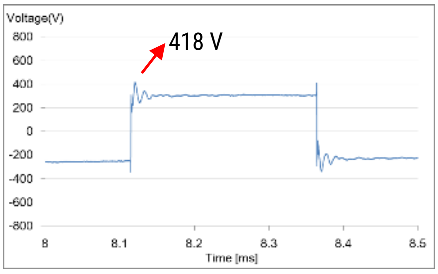
Fig.3 .8 : 4 Example of the inverter output voltage and the voltage at the motor terminals for a motor cable length of 200 m (IEC 61800-8:2010)



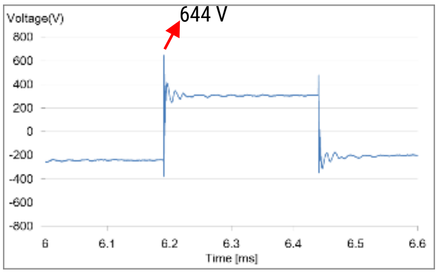
In addition to extending the rise time of the input voltage and shortening the motor cable length as much as possible, a filter (dV/dt, sine wave, choke, etc.) can also be installed between the motor and the controller to reduce the voltage gradient and minimise the risk of insulation breakdown at the motor due to excessive voltage stress. Generally, a filter manufacturer requires that the filter be installed close to the controller – the closer, the better.

Fig.3 .9 : dV/dt filter configuration

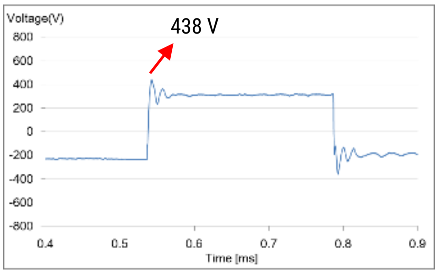




(a). Length of the cable 2 m



(b). Length of the cable 23 m



(c). Length of the cable 23 m + dV/dt filter

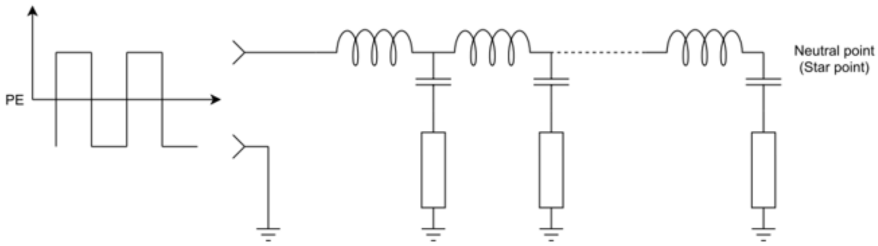
Fig.3 .10 : Example of the relationship between the motor voltage (phase to earth).

3.2.3 Neutral point or star point Oscillation phenomenon

When a voltage with a high switching frequency is applied to the motor, the motor can be regarded as an RLC circuit consisting of resistance, inductance and stray capacitance. The star point is located at the end of the circuit, as shown below. At this point, the voltage between the motor and earth oscillates in the circuit, and the maximum value is generated at the star point, as shown in the following figure. If the frequency of the input voltage is close to the resonance frequency, the coil insulation near the star point is destroyed due to the continuously generated high voltage to earth.

Note: This phenomenon is more evident when the motor is at a standstill.

Fig.3 .11 : Simplified equivalent circuit (lattice network)



As shown in the figure, this can simply be regarded as a low-pass filter from the motor input terminal to the neutral point. Its characteristics are determined by the type of the motor and the wiring. Due to its low-pass characteristics and the fact that the cut-off frequency is generally in the range of 20 kHz to 200 kHz, it is impossible for it to be affected by reflections from the cables, whose voltage is around 1 to 2 MHz. Therefore, insulation damage near the neutral point should not be caused by reflections from the cables or voltage gradients.

If oscillation occurs, the voltage amplitude is not excessive even near the resonance frequency, provided there is sufficient damping. However, the natural damping inside the motor is generally insufficient to prevent the occurrence of excessive voltage spikes. In this case, the neutral point is subjected to the voltage at the PWM modulation frequency until the insulation breaks down. In general, it can be observed that, for motors of the same size with different wiring configurations, a type with a higher torque constant is more likely to result in a resonance frequency. Damping decreases and the peak value of the resonance voltage at the neutral point increases.

It is very difficult to predict whether this resonance will occur in the entire system including the motor. Even if the voltage relative to earth before entering the motor meets the requirements, a high voltage difference to earth may still arise at the neutral point in some cases. It is therefore recommended, with the exception of motors in the TM-5 series, where there is no risk of motor damage at a controller output voltage of 600 VV_{DC} , to use a motor with a neutral conductor for the first unit and to measure the voltage to earth at the neutral point during motor activation. If the result of the voltage measurement shows no risk of damage to the motor insulation, the motor's neutral conductor can be ignored or left connected after insulation testing.

However, should the situation appear risky, a common solution is to disconnect a neutral wire from the motor and install a 'snubber' to suppress this voltage. As regards the use of a 'snubber', the configuration varies depending on the operating principles developed by the various suppliers. It is not possible to explain all the details in this manual.

Note

After taking the measurement, you can contact HIWIN for advice on assessing voltage risks and possible solutions. Please contact HIWIN for applications.Tip_Cross-Ref

Fig.3 .12 : without snubber

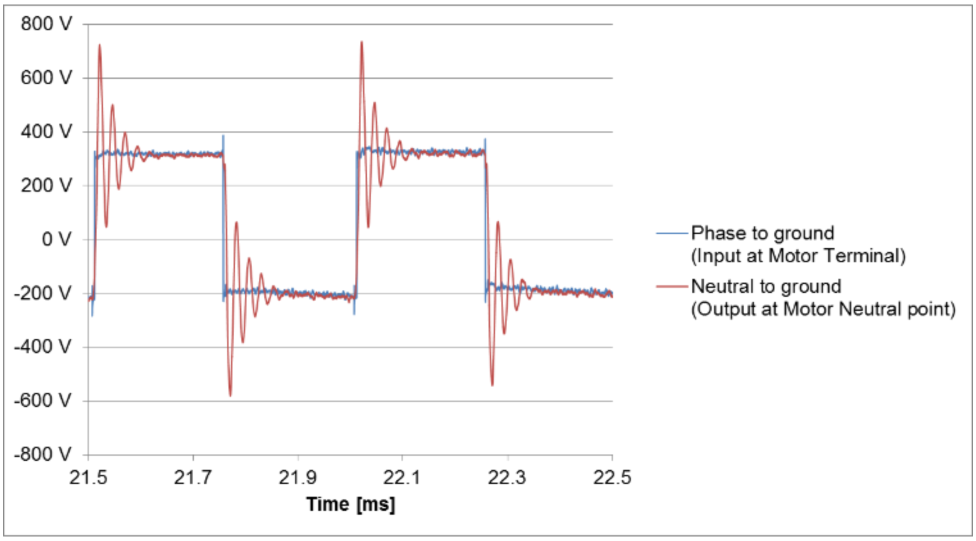


Fig.3 .13 : With snubber

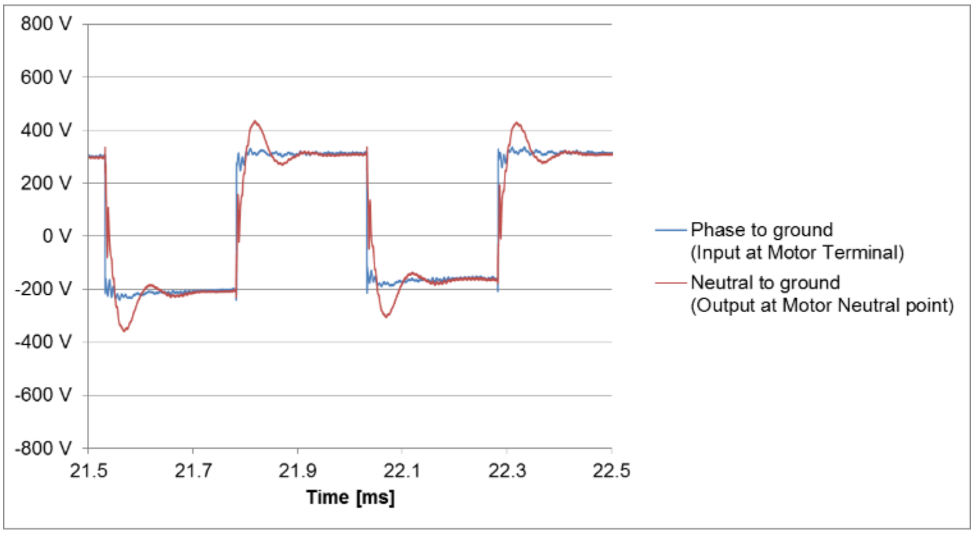
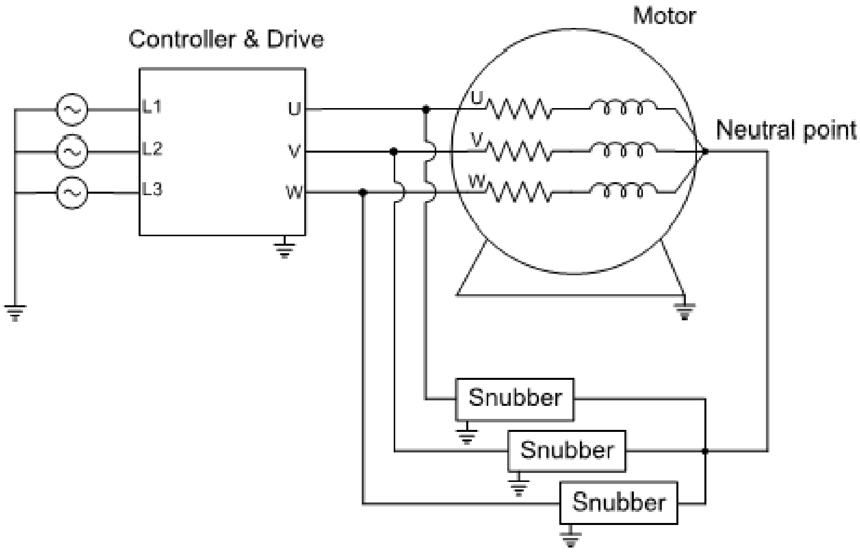
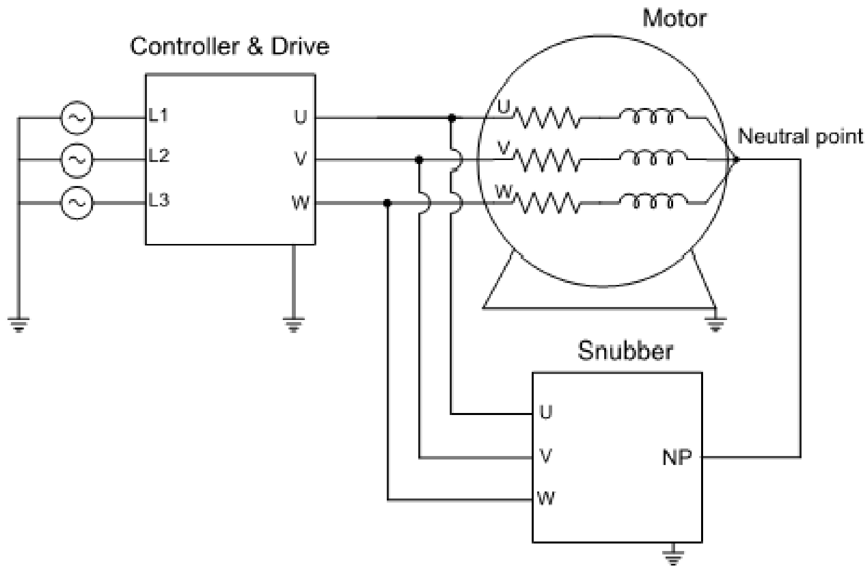


Fig.3 .14 : Snubber wiring



(a). Schaltplan A



3.2.4 Measurement of the zero-point voltage

⚠ **Danger!** Danger due to electrical voltage!

Dangerous currents may flow before and during connection or measurement work.

– Connection work must only be carried out by a qualified electrician and with the power supply switched off!

– Before carrying out connection and measurement work on the motor system, disconnect the power supply and secure it against being switched on again!

⚠ **Danger!** Danger due to electrical voltage!

Risk of electric shock at the measuring point connection.

– The overlapping sections of the measuring leads must be covered with insulating materials such as insulating paper, insulating tape, etc.

Equipment requirements

(1) Drive
(2) Motor (with external neutral point)
(3) Oscilloscope (bandwidth > 150 MHz)
(4) High-voltage differential probes (maximum voltage: Vpk-pk ±1500 V, bandwidth > 5 MHz)

Procedure for voltage measurement

1 Disconnect the power supply and secure it against being switched on again.

2 Wire the device in accordance with the circuit diagramFig.3 .16 and connect the following two points using a high-voltage differential probe:

3 Measure the voltage to earth (defined as CH1) at the drive output.

4 Measure the voltage from the neutral point to earth (defined as CH2).

5 The measurement points for earthing must be in the same position.

6 Once the connection is complete, switch on the power supply and activate the motor (no rotation required).

7 Observe the voltage waveform using an oscilloscope. Here is an example of the voltage waveformFig.3 .15 .

8 Screenshot of the output voltage waveform. It is necessary to record the maximum voltage difference and include at least 5 complete waveforms (as shown in**Fehler! Verweisquelle konnte nicht gefunden werden.** Fig.3 .15).

9 Save the voltage waveform data as a CSV file, which must contain the time and voltage value data based on the synchronisation of two measurement points.

10 If the drive motor has different PWM modulation frequencies, the PWM modulation frequency of the drive must be changed. The modulation frequencies that can be used should all be measured and recorded individually.

11 Repeat the above steps to measure the voltage between neutral and earth in turn.

When recording the voltage waveform, note that the voltage may change periodically (as shown inFig.3 .15). Please record the peak voltage.

As the motor is in a locked state, it will become hot. Please switch on the cooler during the measurement.

The activation current should be limited and must not exceed the stall current.

Data evaluation

Note the length of the cable from the drive output measurement point to the motor interface (near the motor mounting surface).

Please provide HIWIN with screenshots of the voltage waveform and CSV files containing the data so that HIWIN can assist you with risk assessment and the provision of solutions.

Fig.3 .15 :A recorded diagram of the voltage waveform.

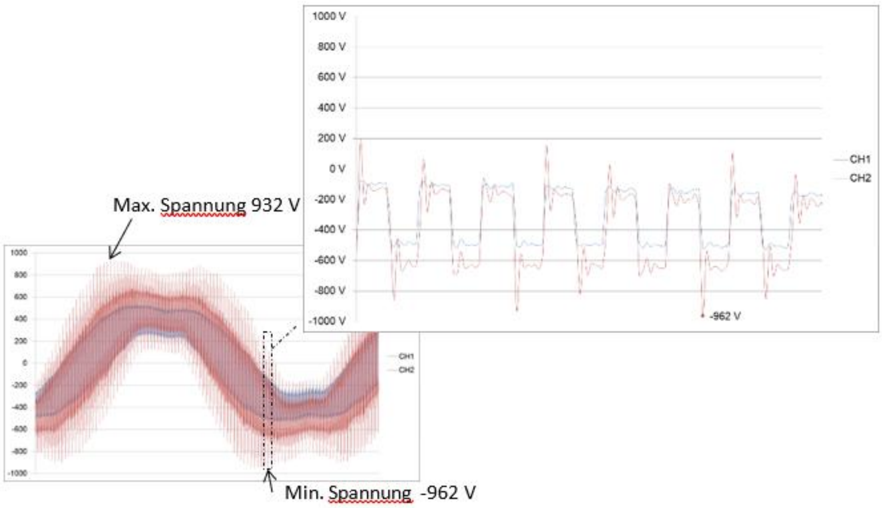
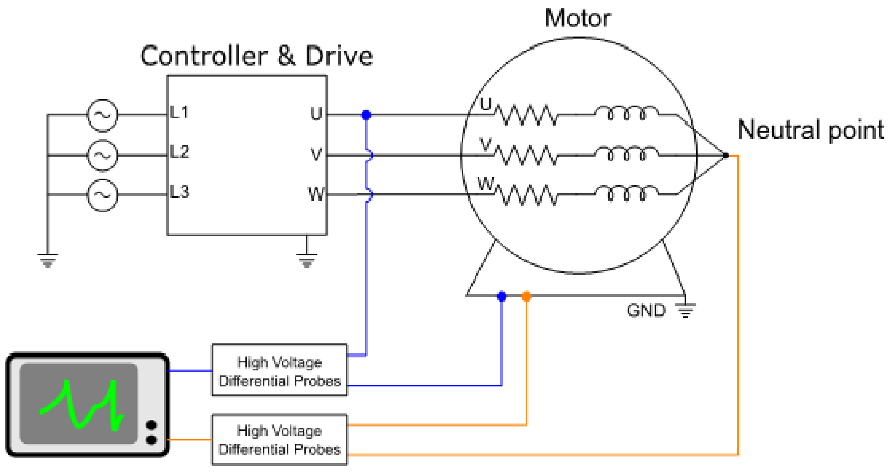


Fig.3 .16 : The circuit diagram for neutral point measurement.



4 Transport and installation

4.1 Delivery

⚠ **Danger!** Risk of death due to strong magnetic fields!

Strong magnetic fields in the vicinity of torque motors pose a danger to people with active medical implants who are in the vicinity of the motors. This also applies when the motor is switched off.

- If you are affected, maintain a minimum distance of 300 mm from the permanent magnets
- Trigger threshold for static magnetic fields of 0.5 mT in accordance with Directive 2013/35/EU
- Please also observe national and local guidelines or requirements.
- For reference: DGUV Rule 103-013 of the German Social Accident Insurance sets out requirements for working with magnetic fields

⚠ **Warning**! Danger from heavy loads!

Lifting heavy loads can lead to strains or sprains.

- Use a hoist of suitable sizing to position heavy loads over 20 kg!
- Observe the applicable health and safety regulations when handling suspended loads!
- Motors with stator and rotor transport devices (bridges) can be suspended from the suspension holes. When suspending, the strength of the components must always be taken into account.
- Use eye bolts that comply with the requirements of DIN 580 or JIS B1168.

⚠ **Caution!** Risk of physical damage to watches and magnetic storage media.

Strong magnetic forces can destroy watches and magnetisable data storage media in the vicinity of the torque motor!

- Do not place watches or magnetisable data carriers within 300 mm of the torque motors!

⚠ **Caution!** Damage to the torque motor system!

The torque motor can be damaged by mechanical impact.

–Do not pull directly on the cable.

–Do not place heavy loads or sharp objects on the motor.

Precautions during transport

- Permanent magnets are classified as dangerous goods (magnetised material: UN2807) by the International Air Transport Association (IATA).
- No additional packaging measures are required for products containing permanent magnets to provide resistance to the magnetic field during sea freight and land transport.
- When transporting products containing permanent magnets by air, the maximum permissible magnetic field strengths specified in the relevant IATA packing instructions must not be exceeded. Special measures may be required for the shipment of these products. From a certain magnetic field strength, such shipments must be labelled in accordance with IATA Packing Instruction 953 (see below or the current IATA regulations).
  - Products whose maximum field strength exceeds $0.418 A/m$ ($0.525 \mu T$) or 2° compass deviation, measured at a distance of $4.6 m$ from the product, require a shipping authorisation from the competent national authority of the country from which the product is being shipped (country of origin), as well as from the country in which the air

freight carrier is based. Special measures must be taken to enable the shipment of the product.

  - When shipping products with a maximum field strength of $0.418 A/m$ ($0.525 \mu T$) or 2° compass deviation, measured at a distance of $2.1 m$ from the product, shipment must be carried out in accordance with the regulations for the transport of dangerous goods.
  - When shipping products with a maximum field strength of less than $0.418 A/m$ ($0.525 \mu T$), measured at a distance of $2.1 m$ from the product, you are not required to notify the relevant authorities or carry out labelling of the product.

- The shipment of motor components in their original packaging does not need to be reported or labelled.
- The transport conditions must comply with standard EN 60721-3-2:2018.

Table4 .1 : Transport conditions

Environmental parameters	**unit**	**Value**
Air temperature	(°C)	-5~40
Relative humidity	(%)	5–85
Temperature change rate	(° C/min)	0.5
Condensation		Not permitted
Ice formation		Not permitted
Transport conditions		Class 2K11
Transport the motor in an environment with good weather protection (indoor area/factory)		
Biological conditions	Class 2B1	
Chemically active substances	Class 2C1	
Mechanically active substances	Class 2S5	
Mechanical conditions	Class 2M4	

4.2 Transport to the installation site

⚠ **Danger!** Risk of death due to strong magnetic fields!

Strong magnetic fields in the vicinity of torque motors pose a risk to people with active medical implants who are in the vicinity of the motors. This applies even when the motor is switched off.

- If you are affected, maintain a minimum distance of 300 mm from the permanent magnets
- Trigger threshold for static magnetic fields of 0.5 mT in accordance with Directive 2013/35/EU
- Please also observe national and local guidelines or requirements.
- For reference: DGUV Rule 103-013 of the German Social Accident Insurance sets out requirements for working with magnetic fields

⚠ **Warning**! Danger from heavy loads!

Lifting heavy loads can lead to strains or sprains.

- Use a lifting device of suitable sizing to position heavy loads over 20 kg!
- Observe the applicable health and safety regulations when handling suspended loads!
- Motors with stator and rotor transport devices (bridges) can be suspended from the suspension holes. When suspending, the strength of the components must always be taken into account.
- Use eye bolts that comply with the requirements of DIN 580 or JIS B1168.

⚠ **Caution!** Risk of physical damage to watches and magnetic storage media.

Strong magnetic forces can destroy watches and magnetisable data storage media in the vicinity of the torque motor!

– Do not place watches or magnetisable data carriers within 300 mm of the torque motors!

⚠ **Caution!** Damage to the torque motor system!

The torque motor can be damaged by mechanical impact.

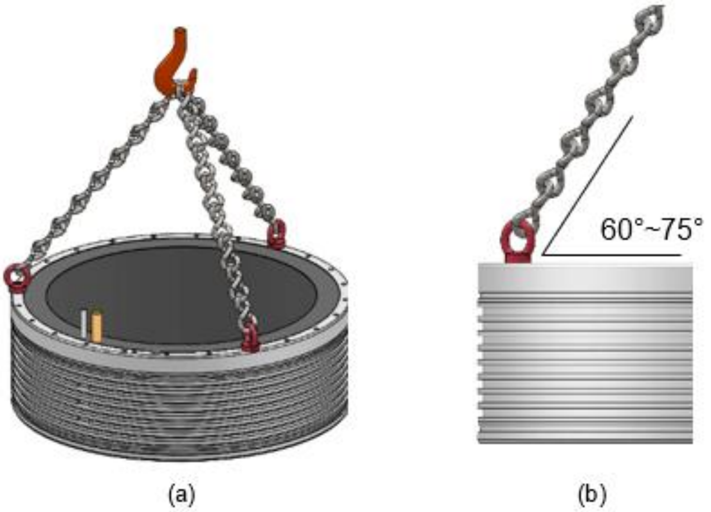
–Do not pull directly on the cable.

–Do not place heavy loads or sharp objects on the motor.

Always use the lifting eyes to lift the motor, the stator and the rotor

If three or more rings (in accordance with DIN 580) are used, the rings must be positioned at equal distances. The length of the rope between the motor's lifting points must be the same throughout.

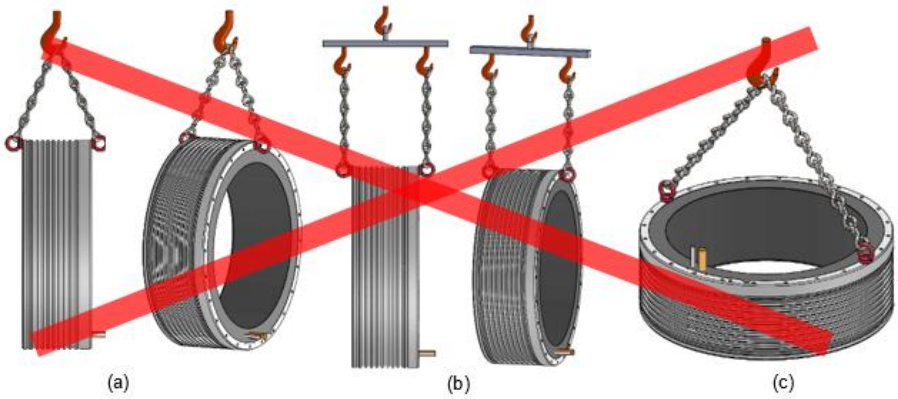
Fig.4 .1 : Handling the motor directly using lifting eyes



(a). Use more than three rings (b). Ring inclusion angle

Please avoid suspending motors with a weight of more than 30 kg and motors with a size larger than the D series. This prevents the motor from being damaged by excessive strain. It is recommended to use a front three-point system for mounting, either by using an additional bracket or a method with adjustable spacing.

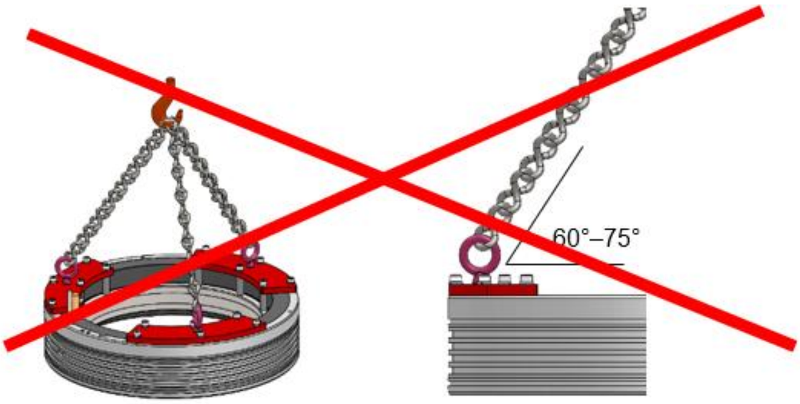
Fig.4 .2 : Please avoid suspending the motor from objects that are too heavy or too large



Do not use the lifting eyes and the transport device (bridge) to handle the motor (stator and rotor) directly.

Use the mounting holes on the rotor and stator for lifting. Please use lifting eyes that are positioned at equal distances from one another. The length of the rope between the motor's lifting points must be the same throughout.

Fig.4 .3 : Handling the motor using lifting eyes and the transport device (bridge) is not permitted



Note

Depending on the motor weight and design conditions, the number of transport devices (bridges) varies from case to case. Please refer to the approval drawings for the exact number of transport devices (bridges).

4.3 Requirements at the installation site

⚠ Danger to life due to strong magnetic fields!

Strong magnetic fields in the vicinity of torque motors pose a danger to people with active medical implants who are in the vicinity of the motors. This also applies when the motor is switched off.

- If you are affected, maintain a minimum distance of 300 mm from the permanent magnets
- Trigger threshold for static magnetic fields of 0.5 mT in accordance with Directive 2013/35/EU
- Please also observe national and local guidelines or requirements.
- For reference: DGUV Rule 103-013 of the German Social Accident Insurance sets out requirements for working with magnetic fields

⚠ **Warning**! Danger from heavy loads!

Lifting heavy loads can lead to strains or sprains.

- Use a lifting device of suitable sizing to position heavy loads over 20 kg!
- Observe the applicable health and safety regulations when handling suspended loads!
- Motors with stator and rotor transport devices (bridges) can be suspended from the suspension holes. When suspending, the strength of the components must always be taken into account.
- Use eye bolts that comply with the requirements of DIN 580 or JIS B1168.

⚠ **Caution!** Risk of physical damage to watches and magnetic storage media.

Strong magnetic forces can destroy watches and magnetisable data storage media in the vicinity of the torque motor!

- Do not place watches or magnetisable data storage media within 300 mm of the torque motors!

⚠ **Warning!** Risk of damage to the torque motor system!

The torque motor can be damaged by mechanical impact.

–Do not pull directly on the cable.

–Do not place heavy loads or sharp objects on the motor.

⚠ **Danger!** Risk of crushing due to strong attraction forces!

- Install the rotors and stators with care!
- Do not place fingers or objects between the rotors and stators!
- The rotor and magnetisable objects may accidentally attract each other and collide!
- Two rotors may accidentally attract each other and collide!
- The magnetic force exerted by the rotor on the object can amount to several kN, which can result in a body part becoming trapped.
- Do not underestimate the attraction force and proceed with caution.
- Wear safety gloves if necessary.
- At least two people are required for the work.
- If the assembly steps have not yet progressed to the installation of the rotor, please store the rotor in a safe and suitable place for the time being.
- Never handle several rotors at the same time.
- Never place two rotors directly against each other without a protective device.
- Do not bring magnetisable materials near the rotor! If the tool needs to be magnetised, please hold it firmly with both hands and approach the rotor slowly!
- It is recommended that you install the rotor immediately after unpacking!
- When assembling the stator and rotor, an installation aid is required to fit the stator and rotor together individually. Please follow the correct procedure.
- Always have the following tools ready to free body parts (hands, fingers, feet, etc.) held by magnetic force.
- Hammer made of non-magnetised, solid material (approx. 3 kg)
- Two wedge-shaped runners made of non-magnetised materials (wedge-shaped, acute angle 10°–15°, minimum height 50 mm).

4.4 Storage

⚠ Danger to life due to strong magnetic fields!

Strong magnetic fields in the vicinity of torque motors pose a danger to people with active medical implants who are in the vicinity of the motors. This also applies when the motor is switched off.

- If you are affected, maintain a minimum distance of 300 mm from the permanent magnets
- Trigger threshold for static magnetic fields of 0.5 mT in accordance with Directive 2013/35/EU
- Please also observe national and local guidelines or requirements.
- For reference: DGUV Rule 103-013 of the German Social Accident Insurance sets out requirements for working with magnetic fields

Precautions for storage

- Do not store the product in a flammable environment or together with chemical substances.
- Store the product in a location free from moisture, dust, harmful gases or liquids.
- Install the product in a location with low vibration levels.
- Cleaning the product: Wipe with alcohol (70%)

– Disposal of the damaged product: Dispose of it in accordance with local laws and regulations.
– Storage conditions must comply with standard EN 60721-3-1:2018
– The motor can be stored indoors for up to two years under the following conditions:
  – Dry
  – Dust-free
  – No vibrations
  – Well-ventilated
  – Resistance to extreme weather conditions
  – The ambient air must not contain any corrosive gases
  – Avoid motor vibrations and moisture
– If a dry storage environment is not available, the following measures must be taken:
  – Wrap the motor in moisture-absorbing material and place a seal around it.
  – Place desiccant in the package with seal; the desiccant must be checked and replaced if necessary.
  – Check the motor regularly.
– Motors should be stored in their original packaging and laid flat. Temporary storage outside the packaging is possible provided that adequate support and protection are ensured. Furthermore, the storage environment must meet the requirements. Please ensure that the cables are facing upwards to prevent them from becoming trapped, as shown inFig.4 .4 below.
– Following long-term storage and removal of the motor, the insulation resistance value may be reduced due to moisture. Check the motor's insulation resistance before installing the machine. Use a test device that complies with standard EN61557. The test must achieve a value of 100MΩ after 60 seconds at $1000V_{DC}$. If the specifications are not met, the motor may be damp. Direct use may result in insulation damage. Please contact HIWIN for recommendations.

Fig.4 .4 : Schematic representation of bearing storage outside the packaging

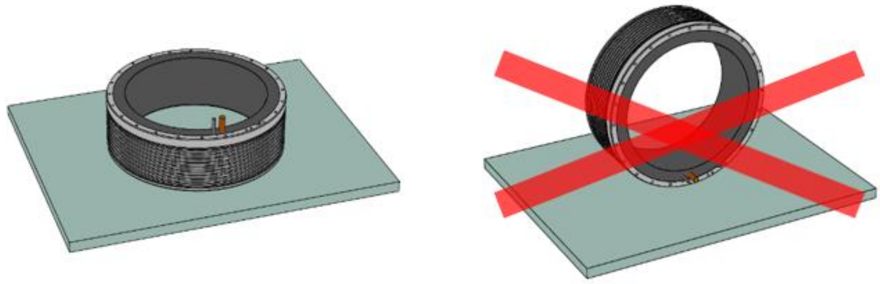


Table4 .2 : Storage conditions

Environmental parameters	**unit**	**Value**
Air temperature	(°C)	-5 to 40
Relative humidity	(%)	5–85
Absolute humidity	(g/m^3)	1–25
Temperature change rate	$(°C/min)$	0.5
Atmospheric pressure	(kPa)	70–106
Solar radiation	(w/m^2)	700
Condensation		Not permitted
Ice formation		Not permitted
Conditions for long-term storage		See Class 1K21
Store the motor in an environment with good weather protection. (Indoors/factory)		

Environmental parameters	unit	Value
Biological conditions	Class 1B1	
Chemically active substances	Class 1C1	
Mechanically active substances	Class 1S11	
Mechanical conditions	Class 1M11	

4.5 Unpacking and setting up

⚠ **Warning**! Danger from heavy loads!

Lifting heavy loads can lead to strains or sprains.

- Use a hoist of suitable sizing to position heavy loads over 20 kg!
- Observe the applicable health and safety regulations when handling suspended loads!
- Motors with stator and rotor transport devices (bridges) can be suspended from the suspension holes. When suspending the motor, always take the strength of the components into account.
- Use eye bolts that comply with the requirements of DIN 580 or JIS B1168.

Please disassemble and assemble this product indoors. The precautions for unpacking the product are as follows:

- Please check that the quantity and the details on the simple label are correct.
- Please open the box carefully and note that the rotor contains a magnet.
- Should the product need to be returned to HIWIN due to a fault, please use the original packaging to ensure safe transport. If the product is in perfect condition, please dispose of the packaging in an environmentally friendly manner.
- Please store the packaging properly; should the product need to be returned to the original manufacturer due to product issues, please use the original packaging or environmentally friendly product packaging to ensure the product’s safety during transport before returning it.
- Please remove the product from the packaging with care, check that the exterior is undamaged and the contents are correct, and take photographs for documentation if necessary.
- Please transport the product carefully to the installation site prior to assembly. As the rotor contains a magnet, magnetically conductive objects must be kept away from it.

5 Assembly and connection

5.1 Mechanical installation

⚠ **Danger!** Danger due to electrical voltage!

Dangerous currents may flow before and during assembly, disassembly and repair work.

- Work must only be carried out by a qualified electrician and with the power supply switched off!
- Before working on the drive system for the direct drive, disconnect the power supply and secure it against being switched on again!

⚠ **Danger!** Risk of crushing due to strong attraction forces!

- Install the rotors and stators with care!
- Do not place fingers or objects between the rotors and stators!
- The rotor and magnetisable objects may accidentally attract each other and collide!
- Two rotors may accidentally attract each other and collide!
- The magnetic force exerted by the rotor on the object can amount to several kN, which may result in a body part becoming trapped.
- Do not underestimate the attraction force and proceed with caution.
- Wear safety gloves if necessary.
- At least two people are required for this work.
- If the assembly steps have not yet progressed to the installation of the rotor, please store the rotor in a safe and suitable place for the time being.
- Never handle several rotors at the same time.
- Never place two rotors directly against each other without a protective device.
- Do not bring magnetisable materials near the rotor! If the tool needs to be magnetised, please hold it firmly with both hands and approach the rotor slowly!
- We recommend installing the rotor immediately after unpacking!
- When assembling the stator and rotor, an installation aid is required to fit the stator and rotor together individually. Please follow the correct procedure.
- Always have the following tools to hand to free body parts (hands, fingers, feet, etc.) held in place by magnetic force.
- Hammer made of non-magnetised, solid material (approx. 3 kg)
- Two wedge-shaped runners made of non-magnetised materials (wedge-shaped, acute angle 10°–15°, minimum height 50 mm).

⚠ **Danger!** Risk of death due to strong magnetic fields!

Strong magnetic fields in the vicinity of torque motors pose a danger to people with active medical implants who are in the vicinity of the motors. This also applies when the motor is switched off.

- If you are affected, maintain a minimum distance of 300 mm from the permanent magnets
- Trigger threshold for static magnetic fields of 0.5 mT in accordance with Directive 2013/35/EU
- Please also observe national and local guidelines or requirements.
- For reference: DGUV Rule 103-013 of the German Social Accident Insurance sets out requirements for working with magnetic fields

⚠ **Warning**! Danger from heavy loads!

Lifting heavy loads can lead to strains or sprains.

- Use a lifting device of suitable sizing to position heavy loads over 20 kg!

- Observe the applicable health and safety regulations when handling suspended loads!
- Motors with stator and rotor transport devices (bridges) can be suspended from the suspension holes. When suspending, the strength of the components must always be taken into account.
- Use eye bolts that comply with the requirements of DIN 580 or JIS B1168.

⚠ **Caution!** Risk of physical damage to watches and magnetic storage media.

Strong magnetic forces can destroy watches and magnetisable data storage media in the vicinity of the torque motor!

- Do not place watches or magnetisable data carriers within 300 mm of the torque motors!

⚠ **Caution!** Damage to the torque motor system!

The torque motor can be damaged by mechanical impact.

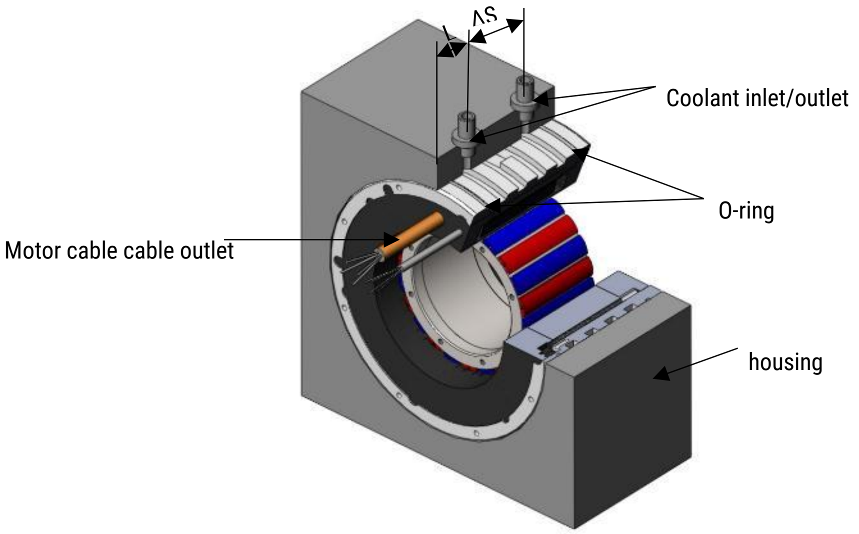
–Do not pull directly on the cable.

–Do not place heavy loads or sharp objects on the motor.

5.1.1 Water cooled design

HIWIN torque motors can be cooled by water or air. (TM-5 and IM-2 are water cooled as standard.) The cooling channel is attached to the outer housing of the stator. An O-ring is installed outside the cooling channel to act as a seal. To ensure good circulation of the coolant, the coolant inlets and outlets must be aligned according to the position shown on the approved drawing.

Fig.5 .1 : Basic structure of a HIWIN torque motor



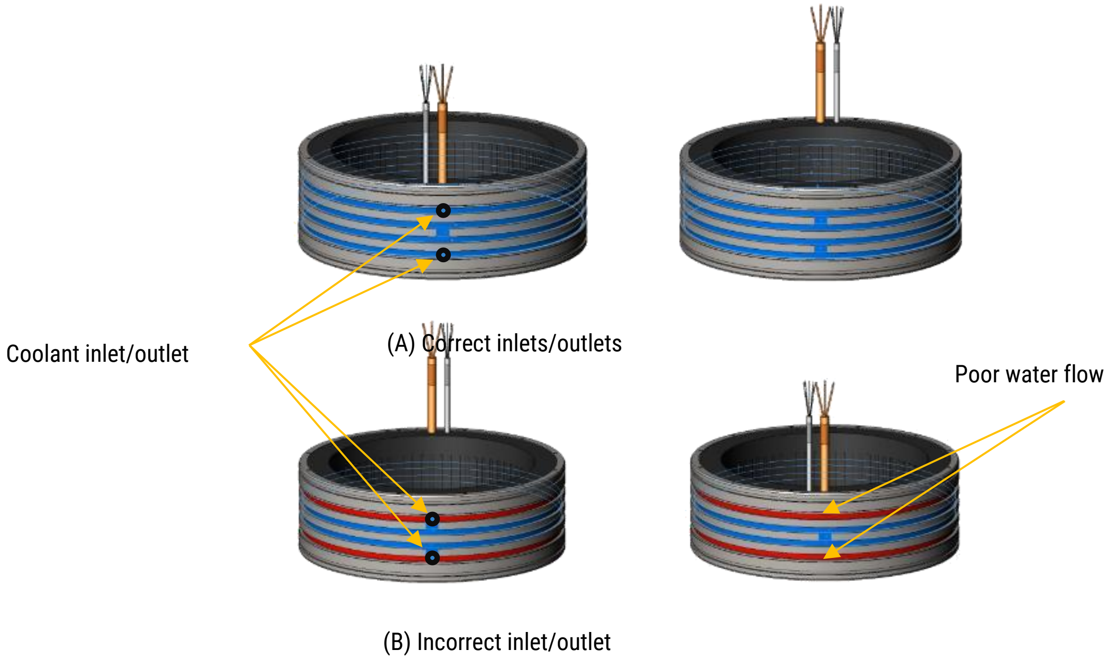


Fig.5 .2 : Effect of installation location on coolant inlet/outlet

5.1.1 Position of the water cooling channel

The recommended position of the coolant inlet/outlet for each series is given below.

Table5 .1 : Position of coolant inlets and outlets for the TMRW seriesTable 6.1

L (mm)	ΔS (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)	TMRW75(L) TMRWA5(L)	TMRW77(L) TMRWA7(L)	TMRW7A(L) TMRWAA(L)	TMRW7F(L) TMRWAF(L)
43	TMRWD3(L)	TMRWD5(L)	TMRWD7(L)	TMRWDA(L)	TMRWDF(L)
35	TMRWG3(L)	TMRWG5(L)	TMRWG7(L)	TMRWGA(L)	TMRWGF(L)

Table5 .2 : IM-2 Series: Coolant inlet/outlet position

L (mm)	ΔS (mm)				
	20	40	60	90	140
25	IM-2-13 IM-2-43	IM-2-15 IM-2-45	IM-2-17 IM-2-47	IM-2-1A IM-2-4A	IM-2-1F IM-2-4F
30	IM-2-23	IM-2-25	IM-2-27	IM-2-2A	IM-2-2F
35	IM-2-73 IM-2-A3	IM-2-75 IM-2-A5	IM-2-77 IM-2-A7	IM-2-7A IM-2-AA	IM-2-7F IM-2-AF
43	IM-2-D3	IM-2-D5	IM-2-D7	IM-2-DA	IM-2-DF
35	IM-2-G3	IM-2-G5	IM-2-G7	IM-2-GA	IM-2-GF

Table5 .3 : TM-5 Series: Coolant inlet/outlet position

L (mm)	ΔS (mm)				
	20	40	60	90	140
25	TM-5-13 TM-5-43	TM-5-15 TM-5-45	TM-5-17 TM-5-47	TM-5-1A TM-5-4A	TM-5-1F TM-5-4F
30	TM-5-23	TM-5-25	TM-5-27	TM-5-2A	TM-5-2F
35	TM-5-73 TM-5-A3	TM-5-75 TM-5-A5	TM-5-77 TM-5-A7	TM-5-7A TM-5-AA	TM-5-7F TM-5-AF
43	TM-5-D3	TM-5-D5	TM-5-D7	TM-5-DA	TM-5-DF
35	TM-5-G3	TM-5-G5	TM-5-G7	TM-5-GA	TM-5-GF

5.1.1.1 Dimensions of the water cooling channel

The dimensions of the water cooling channels for the individual series are listed in the following table.

Fig.5 .1 : Diagram of the water cooling channel dimensions

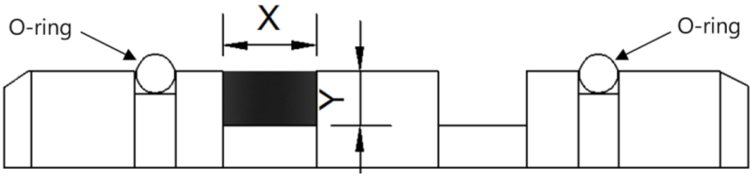


Table5 .4 : Dimensions of the cooling channel for the TMRW series

Type	X (mm)	Y (mm)	Internal diameter inlet/outlet (mm)	Type	X (mm)	Y (mm)	Inlet/outlet internal diameter (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	4	8				
TMRW75(L)	8	4	8				
TMRW77(L)	9	4	8				
TMRW7A(L)	8	4	8				
TMRW7F(L)	9	4	8				

Note:
The water cooling inlets and outlets listed above must have the smallest internal diameter to ensure the minimum water flow rate specified in the data sheet. The maximum pressure that HIWIN torque motors can withstand is 10 bar.

Dimensions of the cooling channels for the IM-2 series

Type	X (mm)	Y (mm)	Inlet/outlet internal diameter (mm)	Type	X (mm)	Y (mm)	Inlet/outlet internal diameter (mm)
IM-2-23	8	5	8	IM-2-A3	8	6	8
IM-2-25	8	5	8	IM-2-A5	8	6	8
IM-2-27	9	5	8	IM-2-A7	9	6	8
IM-2-2A	8	5	8	IM-2-AA	8	6	8
IM-2-2F	9	5	8	IM-2-AF	9	6	8
IM-2-43	8	5	8	IM-2-G3	8	5	10
IM-2-45	8	5	8	IM-2-G5	8	5	10
IM-2-47	9	5	8	IM-2-G7	9	5	10
IM-2-4A	8	5	8	IM-2-GA	8	5	10
IM-2-4F	9	5	8	IM-2-GF	9	5	10
IM-2-73	8	4	8				
IM-2-75	8	4	8				
IM-2-77	9	4	8				
IM-2-7A	8	4	8				
IM-2-7F	9	4	8				

Note:
The water cooling inlets and outlets mentioned above must have the smallest internal diameter to ensure the minimum water flow rate specified in the data sheet. The maximum pressure that HIWIN torque motors can withstand is 10 bar.

5.1.1.3 Configuration of the cooling channel

Dimensions of the cooling channels of the TM-5 series

Type	X (mm)	Y (mm)	Internal diameter inlet/outlet (mm)	Type	X (mm)	Y (mm)	Inlet/outlet internal diameter (mm)
TM-5-13	8	5	8	TM-5-A3	8	6	8
TM-5-15	8	5	8	TM-5-A5	8	6	8
TM-5-17	9	5	8	TM-5-A7	9	6	8
TM-5-1A	8	5	8	TM-5-AA	8	6	8
TM-5-1F	9	5	8	TM-5-AF	9	6	8
TM-5-23	8	5	8	TM-5-D3	8	5	8
TM-5-25	8	5	8	TM-5-D5	8	5	8
TM-5-27	9	5	8	TM-5-D7	9	5	8
TM-5-2A	8	5	8	TM-5-DA	8	5	8
TM-5-2F	9	5	8	TM-5-DF	9	5	8
TM-5-43	8	5	8	TM-5-G3	8	5	10
TM-5-45	8	5	8	TM-5-G5	8	5	10
TM-5-47	9	5	8	TM-5-G7	9	5	10
TM-5-4A	8	5	8	TM-5-GA	8	5	10
TM-5-4F	9	5	8	TM-5-GF	9	5	10
TM-5-73	8	4	8				
TM-5-75	8	4	8				
TM-5-77	9	4	8				
TM-5-7A	8	4	8				
TM-5-7F	9	4	8				

Note

The inlet/outlet for the cooling water mentioned above must have the smallest internal diameter to ensure the minimum water flow rate specified in the data sheet.

The maximum pressure that HIWIN torque motors can withstand is 10 bar.

barTorque motors with a cooling jacket (reserved code: J☐) can withstand a pressure of 5 MPa.

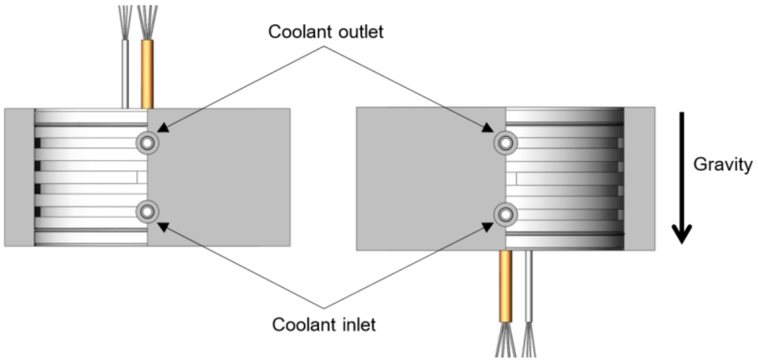
5.1.1.2 Configuration of the cooling channel

Two common configurations for cooling channels are described below. Regardless of which configuration is used, it is essential to ensure that the inlet and outlet correspond to the position specified in the approved diagram, and that any air is removed from the cooling circuit after installation.

The shaft is mounted vertically

Regardless of whether the cable outlet faces upwards or downwards, the coolant outlet should be at the top and the coolant inlet at the bottom. (Defined by the direction of gravity.) Furthermore, the coolant inlet and outlet must be aligned with the cable outlet (see the drawing approved by HIWIN for the position of the cable outlet). The coolant inlet and outlet of the torque motor with cooling jacket (reserved code J□) are located on the end face of the motor output side. Please refer to the section " for the connection relationships between the coolant inlet and outlet and the cooling channel. The lower cooling channel (defined by the direction of gravity) should be selected as the coolant inlet and the upper cooling channel as the coolant outlet.

Fig.5 .3 : Position of coolant inlet / outlet for horizontal installation



The shaft is mounted horizontally

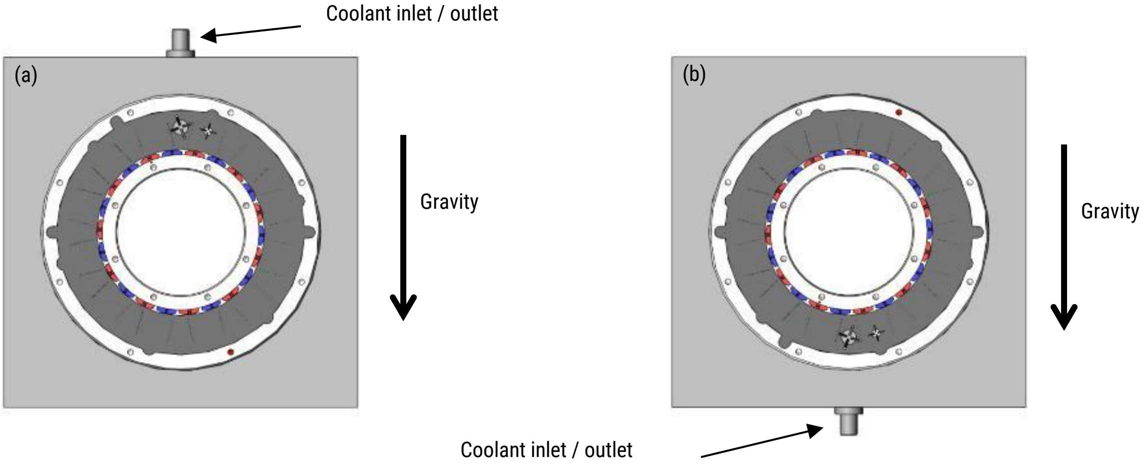
If the flow rate corresponds to the motor's minimum water flow rate, customers can specify the direction of the coolant inlet and outlet as shown at5.1.1.5 Cooling interface adapter for torque motor with cooling jacket (Reserved code: J□) . The coolant inlet and outlet must be aligned with the motor's cable outlet (see HIWIN-approved drawing for the position of the motor's cable outlet). Note that air bubbles in the cooling channel may not be able to escape if the coolant inlet/outlet is not located at the highest point (defined by the direction of gravity). It is recommended that the vent hole and vent screw be positioned at the highest point. For torque motors with a cooling jacket (reserved code J□), it is recommended that the coolant inlet/outlet be positioned at the highest point, as shown in5.1.1.6 Installation of the cooling connection for torque motors with a cooling jacket (Reserved code: J□) .

Warning!

> If the flow rate does not correspond to the motor's minimum water flow, the coolant inlet and outlet can only be installed at the highest point, as shown inFig.5 .4 .

Fig.5 .4 : Position of coolant inlet and outlet for vertical installation (a) Inlet and outlet at the highest point

(b) Inlet and outlet at the lowest point



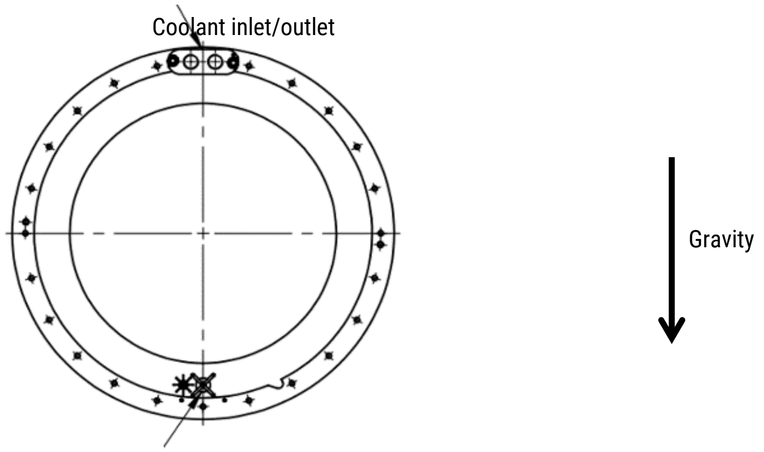


Fig.5 .5 : Position of the coolant inlet and outlet for vertical installation (for the torque motor with cooling jacket)

Bleed the cooling circuit after installation is complete

Air bubbles and air pockets in the cooling circuit reduce cooling performance. This leads to localised overheating or even overheating of the unit. The cooling circuit must therefore be vented after the cooling system has been installed and connected.

The cooling circuit must be fitted with a bleed screw to release the air bubbles.

1. Position the unit so that the bleed screw is at the highest possible point (relative to gravity).
2. Loosen the bleed screw and start up the cooling system.
3. If fluid leaks out, retighten the bleed screw as soon as possible.
4. After wiping, visually check for leaks. No coolant should be dripping or leaking.

5.1.1.3 O-ring features

The O-ring specifications for each series are listed in the table below.

Table5 .5 : O-ring specifications

type	Material	Shore A	O-ring thickness (mm)	Inner diameter of the O-ring
TMRW1☐ / TM-5-1☐	VITON	70°	2.62	152.07
TMRW2☐ / TM-5-2☐ / IM-2-2☐	VITON	70°	2.62	190.17
TMRW4☐ / TM-5-4☐ / IM-2-4☐	VITON	70°	2.62	221.92
TMRW7☐ / TM-5-7☐ / IM-2-7☐	VITON	70°	2.5	296
TMRWA☐ / TM-5-A☐ / IM-2-A☐	VITON	70°	4	370
TMRWD☐ / TM-5-D☐	VITON	70°	4	465
TMRWG☐ / TM-5-G☐ / IM-2-G☐	VITON	70°	4	550

Note

Greasing the O-ring with a standard lubricant helps to improve the seal.

The quality of the O-rings supplied by HIWIN complies with ISO 3601 standards (series G & class N); different brands of fluoroelastomers have different product names, also known as FKM and FPM. These include Viton® from DuPont™ in the USA, Dyneon™ from 3M in the USA and DAI-EL from Daikin® in Japan. If customers need to replace the O-ring themselves, they can not only purchase it directly from HIWIN but also contact local suppliers to obtain materials equivalent to Viton. Please note that the hardness must be above 70° Shore A. The O-ring of the torque motor with cooling jacket is installed internally. Customers must not dismantle the cooling jacket to replace the O-ring.

5.1.1.4 Dimensions of the transport device (bridge)

⚠ **Warning**! Danger from heavy loads!

Lifting heavy loads can lead to strains or sprains.

- Use a hoist of suitable sizing to position heavy loads over 20 kg!
- Observe the applicable health and safety regulations when handling suspended loads!
- Motors with stator and rotor transport devices (bridges) can be suspended from the suspension holes. When suspending the motor, always take the strength of the components into account.
- Use eye bolts that comply with the requirements of DIN 580 or JIS B1168.

⚠ **Caution!** Risk of physical damage to watches and magnetic storage media.

Strong magnetic forces can destroy watches and magnetisable data storage media in the vicinity of the torque motor!

- Do not place watches or magnetisable data carriers within 300 mm of the torque motors!

⚠ **Caution!** Damage to the torque motor system!

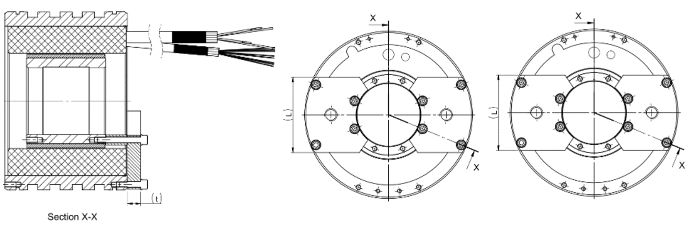
The torque motor can be damaged by mechanical impact.

–Do not pull directly on the cable.

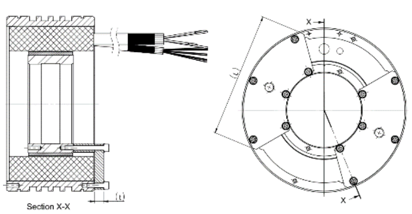
–Do not place heavy loads or sharp objects on the motor.

The dimensions of the transport device (bridge) for each series are as follows:
(As standard, the stator and rotor of the TM-5/IM-2 are shipped separately. Please contact HIWIN if you require the motor to be shipped fully assembled.)

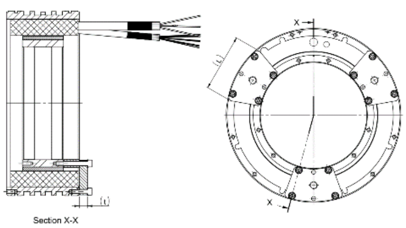
TMRW1 series



TMRW2 series

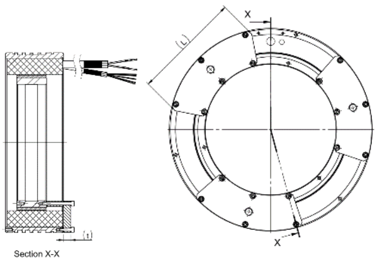


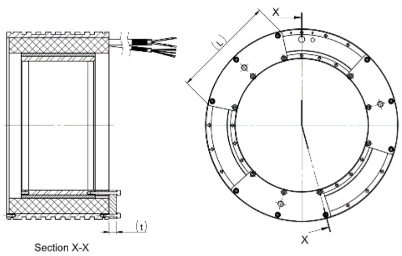
TMRW4 series



TMRW7 series

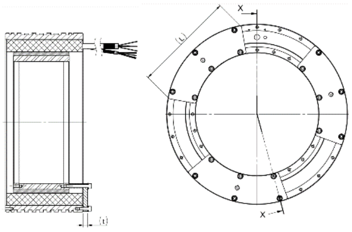
TMRWA series





TMRWD series

TMRWG series



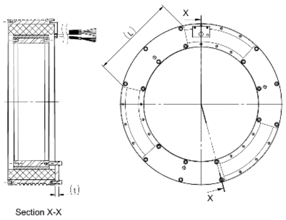


Fig.5 .6 : Schematic diagram of the transport device (bridge)

Table5 .6 : Dimensions of the transport device (bridge)

Motor type	**Maximum length of the mounting claws: L (mm)**	**Thickness of the mounting claws: t (mm)**
TMRW1□	72	12
TMRW2□	151	10
TMRW4□	76	10
TMRW7□	166	12
TMRWA□	205	15
TMRWD□	274	12
TMRWG□	312	12

The dimensions given above may be modified depending on the design purpose. The correct specifications are still based on the approval drawing

5.1.1.5 Cooling interface adapter for torque motor with cooling jacket (Reserved code: J□)

A cooling interface adapter is located on the front face of the stator, as shown in Figure 5.1.8. On delivery, the coolant inlets and outlets on this adapter are covered or sealed. Do not remove the covers or seals from the cooling interface adapter before connecting the cooling line to the motor, to prevent foreign objects from entering and blocking the cooling channel. The adapter was fitted to the motor prior to delivery. If the customer needs to remove it, please follow the instructions below. The seal, including the cooling interface adapter, was inspected prior to delivery to ensure quality. If customers remove the cooling interface adapter, HIWIN accepts no responsibility for any leaks

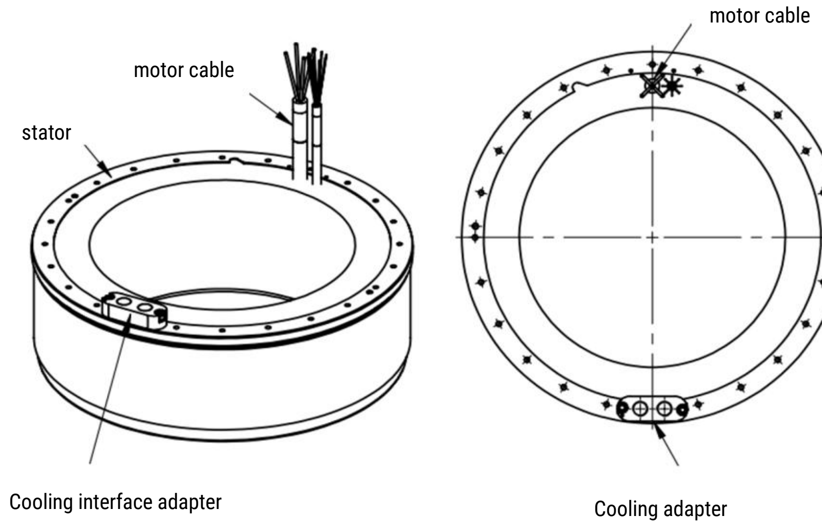


Fig.5 .7 : Cooling adapter

There is a marked bore on the front face of the cooling interface adapter . The coolant inlet and outlet closest to this marked hole is connected to the cooling channel furthest from the motor cable. The other is connected to the cooling channel closest to the motor cable. The direction of the coolant inlet and outlet can be determined using this marked hole.

The size of the cooling interface adapter and the specifications of the coolant inlets and outlets are shown in the following figures and tables.

The O-ring serves as a seal between the cooling interface adapter and the end face of the stator. The characteristics of the O-ring for each series are listed in5.1.1.3 O-ring features**Fehler! Verweisquelle konnte nicht gefunden werden.** .

Table5 .7 : The size of the cooling adapter

type	A	B	C	E	Coolant inlet/outlet Technical data
	Unit: mm				
TM-5-7□-....-J□	26	---	10.5	140.5	G1/4 x 9DP
TM-5-A□-....-J□	31.5	15	16	173.5	G3/8 x 9DP
TM-5-D□-....-J□	31.5	14	16	219	G3/8 x 9DP
TM-5-G□-....-J□	31.5	10	16	260	G3/8 x 9DP

Fig.5 .8 : TM-5-7□-....-J□ Cooling interface adapter

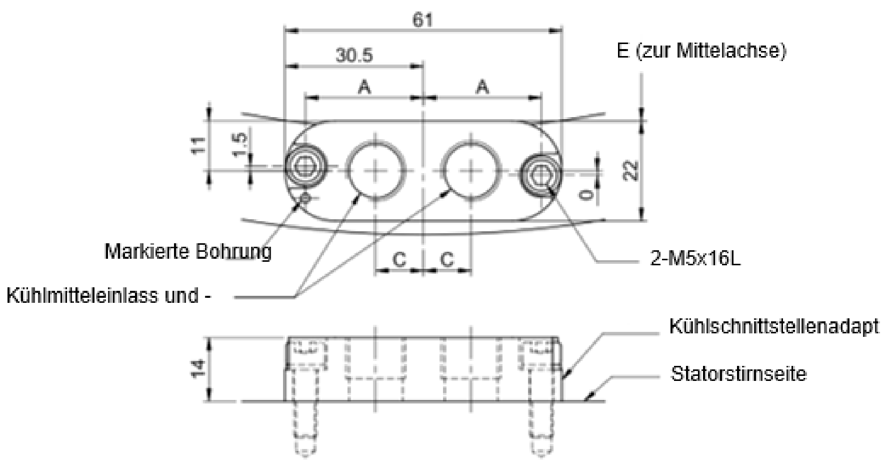


Fig.5 .9 : TM-5-A☐/D☐/G☐-....-J☐ Cooling interface adapter

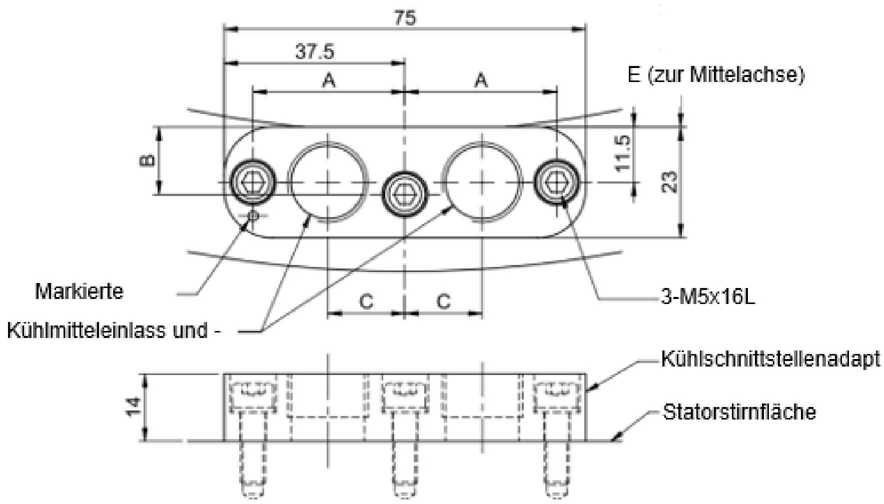
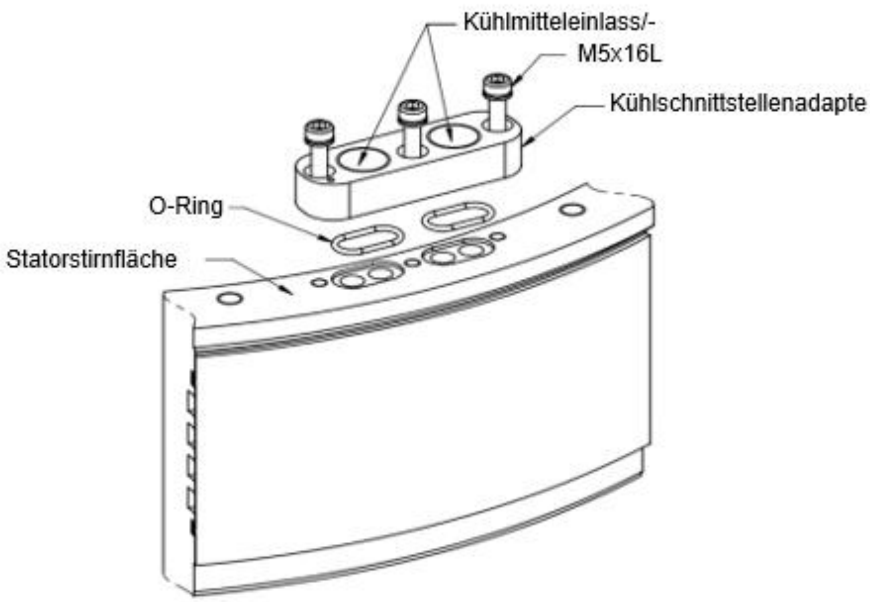


Table5 .8 :

type	Material	Shore A	O-ring thickness (mm)	Inner diameter of the O-ring
TM-5-7▫-....-J☐	VITON	70∘	1.78	12.42
TM-5-A▫-....-J☐	VITON	70°	1.78	15.6
TM-5-D☐-....-J☐	VITON	70°	1.78	15.6
TM-5-G☐-....-J☐	VITON	70°	1.78	15.6

When installing the cooling interface adapter, please refer to the following diagram for the configuration. The O-ring grooves on each mounting surface and on the front face of the stator should be cleaned and dried. Use SEMS screws of strength class 12.9 or M5x16L Nylok Blue Patch screws to secure the cooling interface adapter. Tighten the screws gradually and evenly in stages; the tightening torque is 65–80 kgf-cm (all screws should be tightened to the same torque). Do not use liquid threadlocker to prevent overflow of the threadlocker onto the O-ring, as this may compromise the O-ring's sealing performance.

Fig.5 .10 : Configuration of the cooling adapter components



5.1.1.6 Installation of the cooling connection for torque motors with a cooling jacket (Reserved code: J☐)

The motor is supplied with a cooling interface adapter, but without a cooling connection. The specifications for the coolant inlet/outlet on the cooling interface adapter are listed in the following chapters. Customers must provide a special straight-threaded connection with a seal at the point of contact with the adapter surface. The type and tightening torque should comply with the manufacturer's requirements. Do not use sealant to prevent overflow onto the O-ring beneath the cooling interface adapter and compromising its sealing performance. It is also recommended not to use any type of sealant to prevent it from becoming trapped between the sealing material and the adapter surface, leading to seal failure.

⚠ **Danger!** Risk of death due to strong magnetic fields!

Strong magnetic fields in the vicinity of torque motors pose a risk to people with active medical implants who are in the vicinity of the motors. This also applies when the motor is switched off.

- If you are affected, maintain a minimum distance of 300 mm from the permanent magnets
- Trigger threshold for static magnetic fields of 0.5 mT in accordance with Directive 2013/35/EU
- Please also observe national and local guidelines or requirements.
- For reference: DGUV Rule 103-013 of the German Social Accident Insurance sets out requirements for working with magnetic fields

⚠ **Warning**! Danger from heavy loads!

Lifting heavy loads can lead to strains or sprains.

- Use a lifting device of suitable sizing to position heavy loads over 20 kg!
- Observe the applicable health and safety regulations when handling suspended loads!
- Motors with stator and rotor transport devices (bridges) can be suspended from the suspension holes. When suspending, the strength of the components must always be taken into account.
- Use eye bolts that comply with the requirements of DIN 580 or JIS B1168.

⚠ **Caution!** Risk of physical damage to watches and magnetic storage media.

Strong magnetic forces can destroy watches and magnetisable data storage media in the vicinity of the torque motor!

- Do not place watches or magnetisable data carriers within 300 mm of the torque motors!

⚠ **Caution!** Damage to the torque motor system!

The torque motor can be damaged by mechanical impact.

- Do not pull directly on the cable.
- Do not place heavy loads or sharp objects on the motor.

To prevent the motor's operation from being disrupted by the influence of the magnets, a certain gap must be maintained between the customer's shaft and the rotor magnet. The recommended dimensions for the outer diameter (ØD), the inner diameter (Ød) and the flatness of the rotor mounting surface (flatness A) can be found in the following tables:

Fig.5 .2 : Rotor mounting surface (TMRW/TM-5)

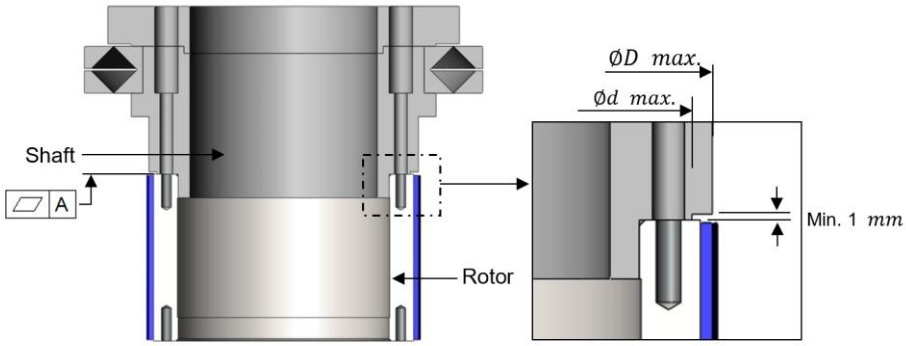
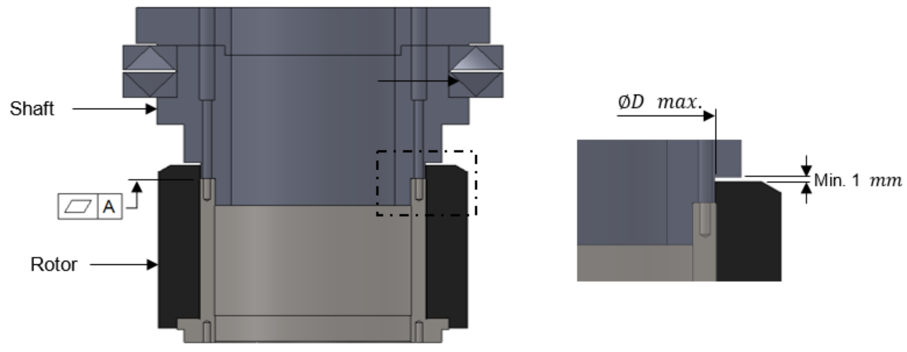
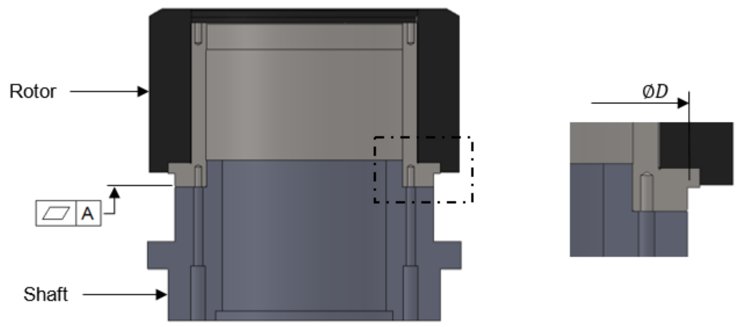


Table5 .9 : Suggested mounting interface (TMRW/TM-5)

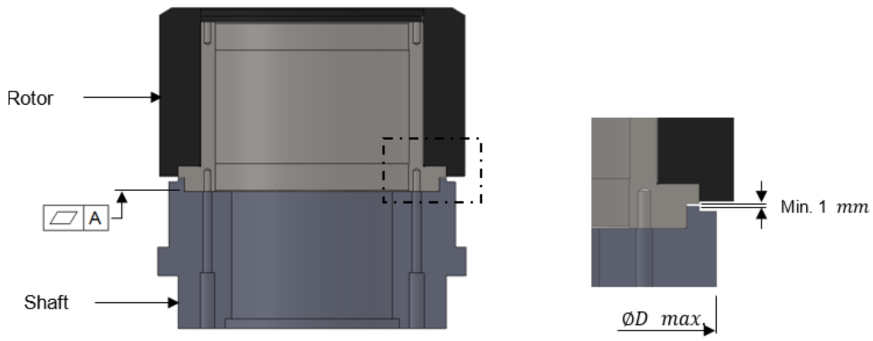
type	ØD (mm)	Ød (mm)	Flatness A (mm)	Flatness B (mm)
TMRW1□	84	76.5	0.05	0.05
TM-5-1□	88	78	0.05	0.05
TMRW2□	117.5	110.4	0.05	0.05
TM-5-2□	118	108	0.05	0.05
TMRW4□	168	158.5	0.1	0.1
TM-5-4□	168	158.5	0.1	0.1
TMRW7□	233	222.5	0.1	0.1
TM-5-7□	228	218.3	0.1	0.1
TMRWA□	296.5	284.5	0.1	0.1
TM-5-A□	298.5	289/288	0.1	0.1
TMRWD□	382	370	0.15	0.15
TM-5-D□	382.5/385.5	373/372	0.15	0.15
TMRWG□	457	447	0.15	0.15
TM-5-G□	457.5	448/445	0.15	0.15



Type A



Type B



Type C

Table5 .1 : Proposed mounting interface (IM-2)

Type	**ØD (mm)**			**Flatness A (mm)**	**Flatness B (mm)**
	Type A	Type B	Type C		
IM-2-2□	61.5	86	118	0.05	0.05
IM-2-4□	140.0	N/A	168	0.10	0.10
IM-2-7□	164.5	190	228	0.10	0.10
IM-2-A□	236.5	264	298	0.10	0.10
IM-2-G□	N/A	420	458	0.15	0.15

5.1.2 Sizing of the stator interfaces (without cooling jacket)

The recommended tolerance for the inner diameter of the housing and the stator mounting holes is **H7** or **H8**, and the recommended flatness specification for the stator mounting surface (flatness B) is given in0 Table5 .9 . It is recommended that the housing be chamfered, deburred and rounded (the recommended dimensions are shown inFig.5 .11Fehler! Verweisquelle konnte nicht gefunden werden.) to prevent scratches on the O-ring and associated fluid leaks.

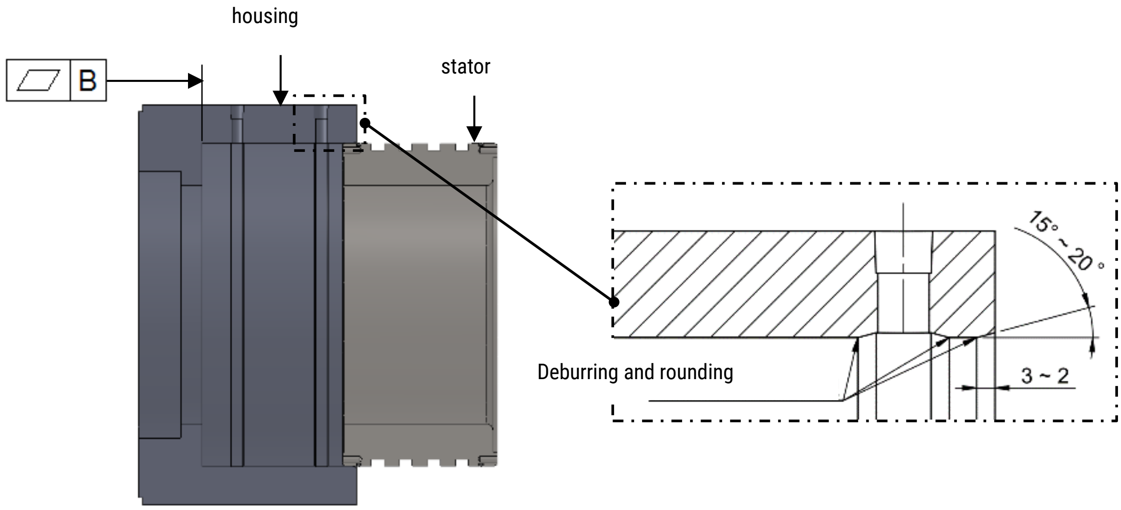


Fig.5 .11 : Stator mounting interface

5.1.3 Air gap and assembly concentricity

The air gap between the stator and rotor protects the motor from damage during rotation. Provided you adhere to the standard values for the air gap and the requirements for assembly concentricity, as specified inFig.5 .3 andTable5 .2 onTable5 .4 , the motor will not be affected during rotation.

Fig.5 .3 : Diagram for air gap and concentricity of the arrangement

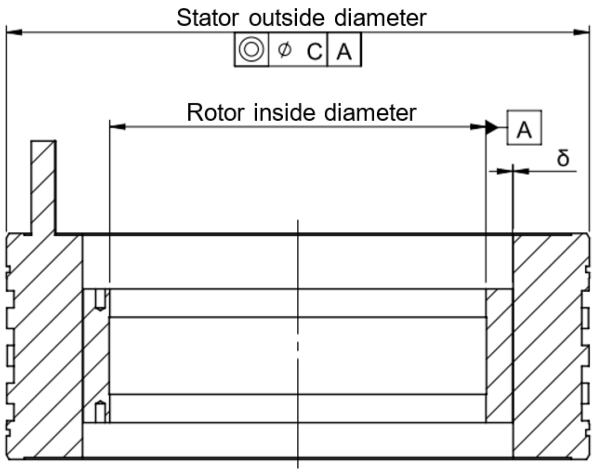


Table5 .2 : TMRW series air gap and concentricity of the arrangement

Motor type	Air gap: δ (mm)	Alignment concentricity: C (mm)
TMRW1□	0.4	0.2
TMRW2□	0.4	0.2
TMRW4□	0.4	0.2
TMRW7□	0.4	0.2
TMRWA□	0.5	0.3
TMRWD□	0.5	0.3
TMRWG□	0.5	0.5

Table5 .3 : Air gap of the TM-5 series and concentricity of the arrangement

Motor type	Air gap: δ (mm)	Concentricity of the arrangement: C (mm)
TM-5-1☐	0.25	0.1
TM-5-2☐	0.25	0.1
TM-5-4☐	0.35	0.1
TM-5-7☐	0.45	0.1
TM-5-A☐	0.45	0.2
TM-5-D☐	0.65	0.3
TM-5-G☐	0.65	0.3

Table5 .4 : Air gap of the IM-2 series and concentricity of the arrangement

Motor type	Air gap: δ (mm)	Concentricity of the arrangement: C (mm)
IM-2-2☐	0.55	0.1
IM-2-4☐	0.45	0.1
IM-2-7☐	0.70	0.1
IM-2-A☐	0.65	0.2
IM-2-G☐	0.75	0.3

5.1.4 Force between stator and rotor

⚠ **Danger!** Risk of death due to strong magnetic fields!

Strong magnetic fields in the vicinity of torque motors pose a danger to people with active medical implants who are in the vicinity of the motors. This also applies when the motor is switched off.

- If you are affected, maintain a minimum distance of 300 mm from the permanent magnets
- Trigger threshold for static magnetic fields of 0.5 mT in accordance with Directive 2013/35/EU
- Please also observe national and local guidelines or requirements.
- For reference: DGUV Rule 103-013 of the German Social Accident Insurance sets out requirements for working with magnetic fields

5.1.4.1 radial load

Concentricity deviations give rise to radial loads between the stator and the rotor. (As shown inFig.5 .4) The value of the radial load for each row is given inTable5 .5 .

Fig.5 .4 : Concentricity deviation of stator and rotor

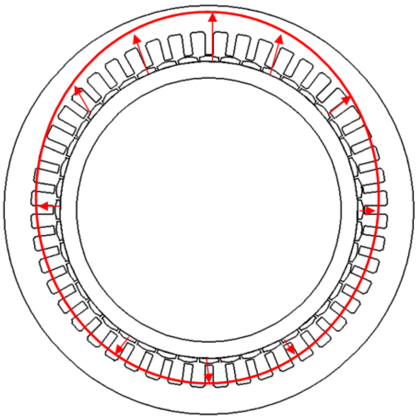


Table5 .5 : Value of the radial load

Type	Radial load:f (N/mm)	Type	Radial load:f (N/mm)	Type	Radial load:f (N/mm)
TMRW1A	2184	TM-5-1A	2378	IM-2-2A	6684
TMRW2A	2590	TM-5-2A	2651	IM-2-4A	3783
TMRW4A	2946	TM-5-4A	4476	IM-2-7A	9700
TMRW7A	2899	TM-5-7A	4319	IM-2-AA	16390
TMRWAA	3574	TM-5-AA	6052	IM-2-GA	20648
TMRWDA	4350	TM-5-DA	7064	-	-
TMRWGA	5158	TM-5-GA	8001	-	-

The radial load varies depending on the length of the iron core.

$$\text{Kraft} = \text{Radialkraft f} \times \frac{\text{L}}{100}$$

L stands for the length of the iron core. The length of the iron core is as shown below for each series.

Table5 .6 : Length of the iron core

Type	L (mm)
TMRW☐3 / IM-2-☐3 / TM-5-☐3	30
TMRW☐5 / IM-2-☐5 / TM-5-☐5	50
TMRW☐7 / IM-2-☐7 / TM-5-☐7	70
TMRW☐A / IM-2-☐A / TM-5-☐A	100
TMRW☐F / IM-2-☐F / TM-5-☐F	150
TMRW☐J / IM-2-☐J / TM-5-☐J	190
TMRW☐K / IM-2-☐K / TM-5-☐K	200
TMRW☐L / IM-2-☐L / TM-5-☐L	210

– Example

Radial load of the TMRW7F:

$$\text{Kraft} = \text{TMRW7F's f} \times \frac{150}{100} = 2899 \times \frac{150}{100} = 4348{,}5\frac{\text{N}}{\text{mm}}$$

5.1.4.2 Axial force

When the rotor moves towards the stator, an axial force is generated between the stator and the rotor. (SeeFig.5 .5) The maximum value of the axial force for each series is given atTable5 .7 . The "X" inFig.5 .5 represents the direction of movement.

Fig.5 .5 : Axial misalignment of stator and rotor

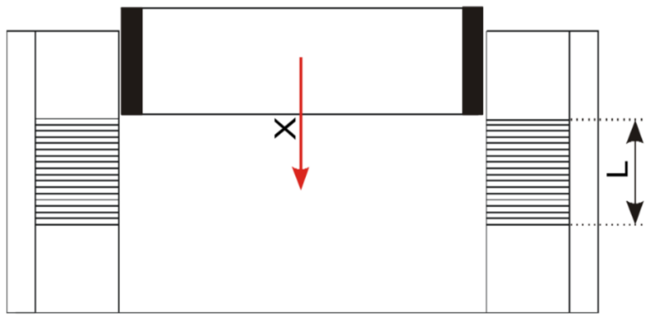


Table5 .7 : Maximum value of the axial force

Type	Axial force:f (N/mm)	Type	Axial force:f (N/mm)	Type	Axial force:f (N/mm)
TMRW1□	118	TM-5-1□	118	IM-2-2□	185
TMRW2□	176	TM-5-2□	192	IM-2-4□	216
TMRW4□	300	TM-5-4□	242	IM-2-7□	268
TMRW7□	375	TM-5-7□	369	IM-2-A□	384
TMRWA□	528	TM-5-A□	398	IM-2-G□	480
TMRWD□	944	TM-5-D□	639	-	-
TMRWG□	1335	TM-5-G□	740	-	-

5.1.4.3 Tightening torque for the screws

Screws of strength class 12.9 are required for the stator and rotor mounting bolts. The descriptions of the threaded holes, the number of threaded holes and the screw tightening torque for each series are specified in the following tables.

Table5 .10 : TMRW/TM-5 screw tightening torque

TMRW series	TM-5 series	Specification of threaded holes	screw tightening torque $(kgf - cm)$	screw tightening torque (Nm)
TMRW1 series TMRW2 series TMRW4 series TMRW7 series	TM-5-1 series TM-5-2 series TM-5-4 series TM-5-7 series	M5 x 0.8P x 10DP	81	7.95
TMRWA series	TM-5-A series	M6 x 1P x 12DP	138	13.54
TMRWD series TMRWG series	TM-5-D series TM-5-G series	M8 x 1.25P x 12DP	334	32.76

Table5 .11 :IM-2 screw tightening torque

IM-2 series	Part	Specification of threaded holes	screw tightening torque $(kgf - cm)$	screw tightening torque (Nm)
IM-2-2 series IM-2-4 series IM-2-7 series	stator	M5 x 0.8P x 10DP	81	7.95
	Rotor	M6 x 1.0P x 12DP	138	13.54
	Rotor	M6 x 1.0P x 12DP	138	13.54
IM-2-A series	Stator/Rotor	M6 x 1P x 12DP	138	13.54
IM-2-G series	Stator/Rotor	M8 x 1.25P x 12DP	334	32.76

5.1.5 Direction of rotation

If the motor cable is connected in accordance with0 Table5 .14 , the rotor rotates clockwise (viewed from the side of the rotor without the cable outlet,Fig.5 .6).

Fig.5 .6 : Illustration of the rotor's direction of rotation

5.1.6 Mechanical installation

⚠ **Danger!** Risk of death due to strong magnetic fields!

Strong magnetic fields in the vicinity of torque motors pose a danger to people with active medical implants who are in the vicinity of the motors. This also applies when the motor is switched off.

- If you are affected, maintain a minimum distance of 300 mm from the permanent magnets
- Trigger threshold for static magnetic fields of 0.5 mT in accordance with Directive 2013/35/EU
- Please also observe national and local guidelines or requirements.
- For reference: DGUV Rule 103-013 of the German Social Accident Insurance sets out requirements for working with magnetic fields

⚠ **Warning**! Danger from heavy loads!

Lifting heavy loads can lead to strains or sprains.

- Use a lifting device of suitable sizing to position heavy loads over 20 kg!
- Observe the applicable health and safety regulations when handling suspended loads!
- Motors with stator and rotor transport devices (bridges) can be suspended from the suspension holes. When suspending, the strength of the components must always be taken into account.
- Use eye bolts that comply with the requirements of DIN 580 or JIS B1168.

⚠ **Caution!** Risk of physical damage to watches and magnetic storage media.

Strong magnetic forces can destroy watches and magnetisable data storage media in the vicinity of the torque motor!

– Do not place watches or magnetisable data carriers within 300 mm of the torque motors!

⚠ **Caution!** Damage to the torque motor system!

The torque motor can be damaged by mechanical impact.

–Do not pull directly on the cable.

–Do not place heavy loads or sharp objects on the motor.

There are two ways to install the motor.

Assemble the stator and rotor together

They are assembled using the transport device (bridge) supplied with the torque motor, whereby the position of the transport device (bridge) can be either on the output side or on the other side. Before ordering, customers can contact HIWIN sales or HIWIN technicians regarding the positioning of the transport device (bridge). HIWIN provides customers with a drawing for confirmation.

Assemble the stator and rotor separately

Depending on the customer's mechanism, a guide tool is required for the assembly of the stator and rotor.

The recommended assembly steps are described below.

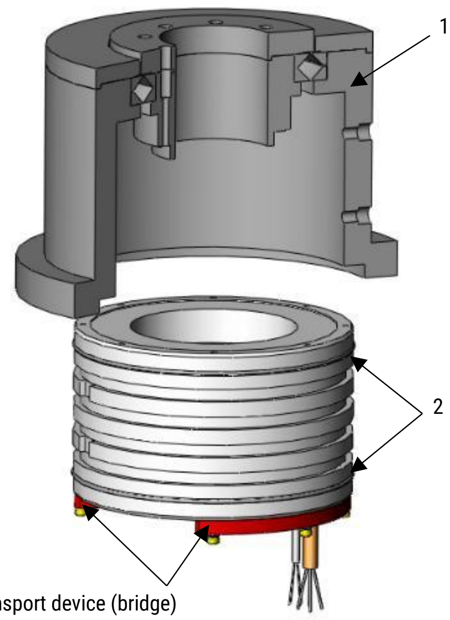
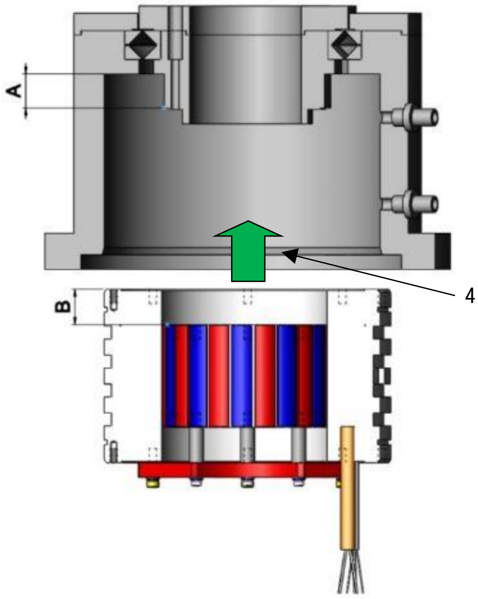
Diagram	Step
	Fit the housing, shaft and bearings. Fit the O-ring to the stator. Note: The O-ring must not be twisted.

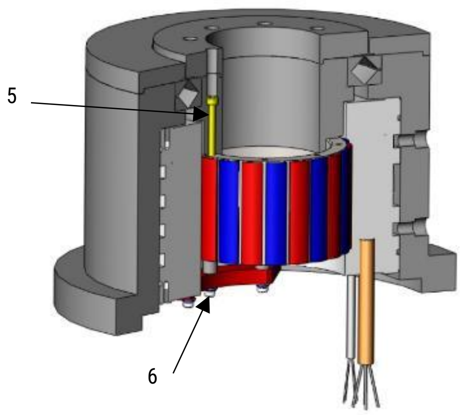
Figure	Step



To ensure that the motor is not affected by the tensile force generated by the transport device (bridge) and the counterpieces during the assembly process, measure the distance of the shaft (as shown in A) and the height of the stator and rotor (as shown in B).

Insert the stator and rotor assembly (together with the transport device (bridge)) into the housing. The cable outlet for the motor cable must be aligned with the coolant inlet/outlet. To prevent water leakage, the O-ring must not be damaged. Be aware of the strong magnetic attraction force of the rotor. Keep it away from magnetic conductors (e.g. iron objects) to avoid hazards.

Note: Please refer to the drawing approved by HIWIN for the position of the cable outlet for the motor cable.

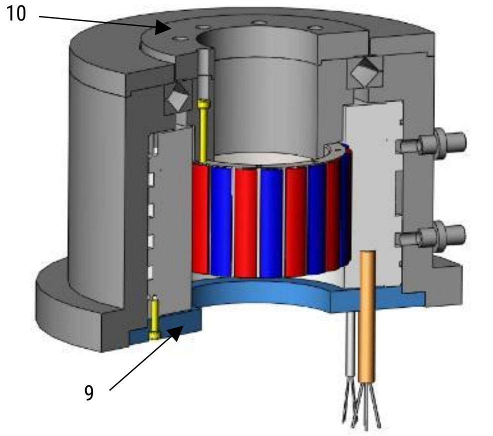


Secure the rotor to the shaft. The screw tightening torque at this stage is 80 per cent of the nominal value “.

Loosen all bolts on the transport device (bridge) by approximately 1/8 of a turn. If the distance A > B, loosen the rotor mounting bolts first. If the distance A < B, loosen the stator mounting bolts first.

Tighten the rotor mounting bolts to the specified torque, fully loosen the bolts on the transport device (bridge) and remove the transport device (bridge).

Ensure that the screws are tightened to the specified torque.

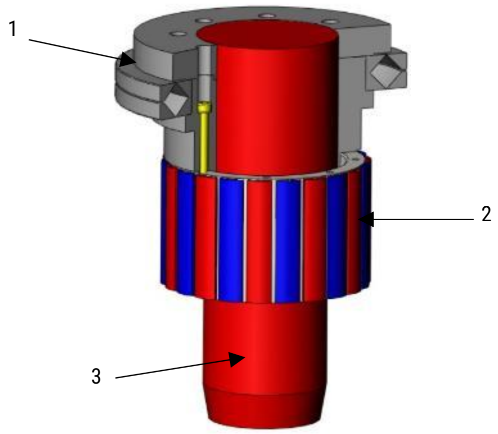


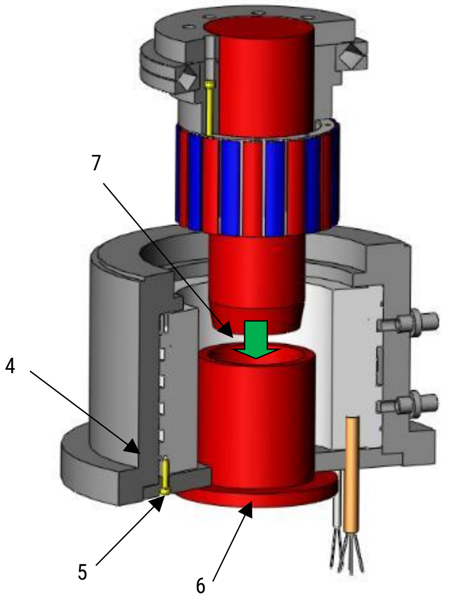
Fit the base plate and tighten the stator mounting bolts.

Turn the rotating part. Ensure that it turns smoothly and that there are no obstructions.

Fit the remaining parts, such as the coolant inlet and outlet connectors, the lower support bearing and the encoder.

5.1.6.1 Assemble the stator and rotor separately

Diagram	Step
	Fit the shaft and bearing. Fit the rotor onto the shaft Fit the guide tool onto the shaft.



Fit the O-ring to the stator.

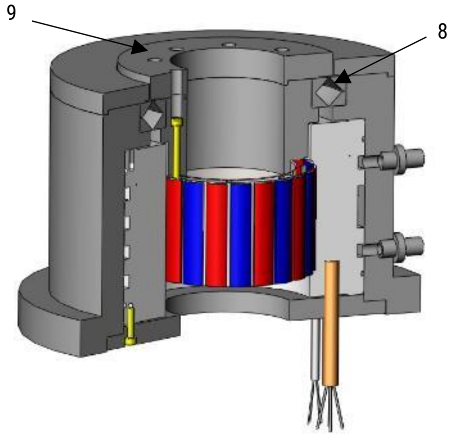
Note: Do not twist the O-ring.

Insert the stator assembly into the housing and tighten the stator mounting bolts. The motor cable outlet must be aligned with the coolant inlet/outlet. To prevent water ingress, the O-ring must not be damaged.

Note: Please refer to the drawing approved by HIWIN for the position of the cable outlet for the motor cable.

If necessary, attach the lower tool to the shaft.

Mount the rotating module onto the stationary part. To avoid the risk of strong magnetic attraction between the stator and rotor, which could even lead to failure of the assembly, the guide tool must be brought into contact and combined prior to assembly.



Secure the bearing and remove the alignment tool.

Check the air gap and the concentricity of the assembly.

Rotate the rotating part. Ensure that it rotates smoothly and that there are no obstructions.

Fit the remaining parts, such as the coolant inlet and outlet connections, the lower support bearing and the encoder.

5.2 Electrical connection

⚠ **Danger!** Danger due to electrical voltage!

Electric currents can flow even when the motor is at a standstill.

- Ensure that the direct drive system is disconnected from the power supply before disconnecting the electrical connections from the motors.
- After disconnecting the servo drive from the power supply, wait at least 5 minutes before touching live parts or disconnecting connections.

⚠ **Danger!** Danger due to electrical voltage!

If the motors are not earthed correctly, there is a risk of electric shock.

- Before connecting the power supply, ensure that the motor system is properly earthed.

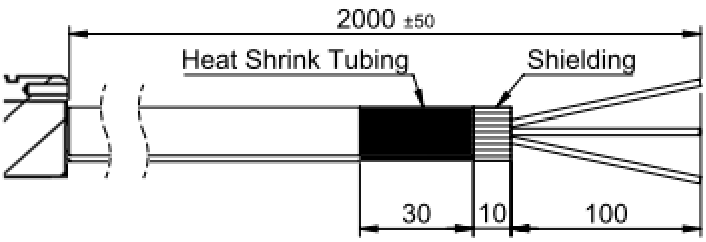
5.2.1 Precautions regarding cabling

- Before using the product, carefully read the technical specifications on the product label and ensure that the product is operated using the power supply specified in the product requirements.
- Check that the wiring is correct. Incorrect wiring can lead to motor malfunction or even permanent damage to the motor.
- Use a shielded extension cable. The shielding must be earthed.
- Do not connect the power cable and the temperature sensor cable to the same extension lead.
- The power cable and the temperature sensor cable are shielded. The shielding must be earthed.

5.2.2 cable

The standard length of the power cable and the temperature sensor cable is 2000 $mm \pm 50mm$, with the metal plug not included in the scope of delivery. Customers may select cables of other lengths, with an incremental step size of 500 mm , up to a total length of 10000mm (in the event of a total length, including extension cable, exceeding 10 metres).

Fig.5 .12 : Cable specification



5.2.2.1 Specification of the power cable

The power cables used are the Chainflex®(CF27), Chainflex®(CF270) and Chainflex®(CF310) manufactured by IGUS, as well as the Olflex®Servo FD 796CP manufactured by LAPP®, all of which hold UL and CE certificates. The cable cross-section is determined by the continuous current rating under water cooled conditions.

The power cable contains a shield. The shield must be earthed.

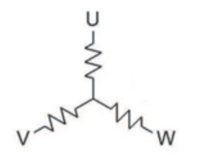
Table5 .12 : Relationship between conductor cross-section and type of the motor

Cross-sectional Cross-sectional area (mm^2)	**type**				
1.5	TMRW13(L)	TMRW15(L)	TMRW17(L)	TMRW1A(L)	TMRW1F
	TMRW23(L)	TMRW25(L)	TMRW27(L)	TMRW2A(L)	TMRW2F
	TMRW43	TMRW45	TMRW47	TM-5-13-LA6	TM-5-15-LA6
	TM-5-17-LA6	TM-5-1A-LA6	TM-5-23-SA6	IM-2-23-PA	IM-2-25-PA
	IM-2-27-PA	IM-2-43-LA	IM-2-45-LA		
2.5	TMRW43L	TMRW45L	TMRW47L	TMRW4A	TMRW4F
	TMRW73	TMRW75	TMRW77	TMRW7A	TMRW7F
	TMRWA3	TMRWA5	TM-5-13-SA6	TM-5-15-SA6	TM-5-17-SA6
	TM-5-1A-SA6	TM-5-1F-PA6	TM-5-1F-SA6	TM-5-23-PB6	TM-5-25-SA6
	TM-5-25-PB6	TM-5-27-SA6	TM-5-27-PB6	TM-5-2A-SA6	TM-5-2A-PB6
	TM-5-2F-PB6	TM-5-43-PA6	TM-5-43-SA6	TM-5-45-PA6	TM-5-45-SA6
	TM-5-47-SA6	TM-5-4A-SA6	TM-5-4F-SA6	TM-5-73-PB6	TM-5-75-PB6
	TM-5-77-PB6	TM-5-G3-WA6	IM-2-23-PB	IM-2-25-PB	IM-2-27-PB
	IM-2-2A-PB	IM-2-2F-PB	IM-2-73-SA	IM-2-A3-PB	
4.0	TMRW1FL	TMRW2FL	TMRW4AL	TMRW4FL	TMRW73L
	TMRW75L	TMRW77L	TMRW7AL	TMRW7FL	TMRWA3L
	TMRWA5L	TMRWA7	TMRWAA	TMRWD3	TMRWD5
	TMRWD7	TMRWDA	TMRWG3	TMRWG5	TMRWG7
	TM-5-2F-SB6	TM-5-47-PB6	TM-5-4A-PB6	TM-5-73-SB6	TM-5-75-SB6
	TM-5-77-SB6	TM-5-7A-SB6	TM-5-7F-SB6	TM-5-A3-PC6	TM-5-A5-PC6
	TM-5-A7-PC6	TM-5-AA-PC6	TM-5-AF-PC6	TM-5-D3-WA6	TM-5-D5-WA6
	TM-5-D7-WA6	TM-5-DA-WA6	TM-5-DF-WA6	TM-5-G5-WA6	TM-5-G7-WA6
	TM-5-GA-WA6	IM-2-43-SA	IM-2-45-SA	IM-2-47-SA	IM-2-4A-SA
	IM-2-4F-SA	IM-2-73-SB	IM-2-75-SB	IM-2-77-SB	IM-2-7A-SB
	IM-2-A3-PC	IM-2-A5-PC	IM-2-A7-PC	IM-2-AA-PC	IM-2-G5-SB
	IM-2-G7-SB	IM-2-GA-SB			
6.0	TMRWA7L	TMRWAAL	TMRWAF	TM-5-4F-SB6	TM-5-A3-SC6
	TM-5-A5-SC6	TM-5-G3-WB6	IM-2-2A-PD	IM-2-2F-PD	IM-2-47-SB
	IM-2-4A-SB	IM-2-4F-SB			
10.0	TMRWAFL	TMRWD3L	TMRWD5L	TMRWD7L	TMRWDAL
	TMRWDF	TMRWG3L	TMRWG5L	TMRWG7L	TMRWGA
	TMRWGF	TM-5-7A-SD6	TM-5-7F-SD6	TM-5-A7-PF6	TM-5-AA-PF6
	TM-5-AF-PF6	TM-5-D3-WB6	TM-5-D5-WB6	TM-5-D7-WB6	TM-5-DA-WB6
	TM-5-DF-WB6	TM-5-G5-WB6	TM-5-G7-WB6	TM-5-GA-WB6	TM-5-GF-WB6
	IM-2-75-SD	IM-2-77-SD	IM-2-7A-SD	IM-2-7F-SD	IM-2-A5-PF
	IM-2-A7-PF	IM-2-AA-PF	IM-2-AF-PF	IM-2-G5-SD	IM-2-G7-SD
	IM-2-GA-SD	IM-2-GF-SD			
25.0	TMRWDFL	TMRWGAL	TMRWGFL	IM-2-AF-SF	IM-2-GF-SH
	IM-2-7F-WD				
35.0	TM-5-GF-WE6				

Table5 .13 : Relationship between wire cross-section and power cable capacity

Cross-sectional Cross-sectional area (mm^2)	Type of power cable		
	Cable type: S, V, A, H		Cable core: P
1.5	CF27.15.04.D	796CP-0027950	
2.5	CF27.25.04.D	796CP-0027951	CF310.UL.25.01
4.0	CF270.UL.40.04.D	796CP-0027952	CF310.UL.40.01
6.0	CF270.UL.60.04.D	796CP-0027953	CF310.UL.60.01
10.0	CF270.UL.100.04.D	796CP-0027954	CF310.UL.100.01
16.0	CF270.UL.160.04.D	796CP-0027955	CF310.UL.160.01
25.0	CF270.UL.250.04.D	796CP-0027956	CF310.UL.250.01
35.0			CF310.UL.350.01

Table5 .14 : Relationship between the colour of the power cable and the signal

Colour & number	Signal	Diagram
Black, No. L1/U	U	
Black, No. L2/V	V	
Black, No. L3/W	W	
Yellow with green	ground	

5.2.2.2 Specification of the temperature sensor cable

⚠ **Warning**! Incorrect connection of the temperature monitoring circuits poses a risk of electric shock.

In the event of a fault, the circuits do not provide safe electrical isolation

from the power circuits.

– You must therefore comply with the guidelines for safe electrical isolation in accordance with DIN EN 61800-5-1 (formerly safe electrical isolation in accordance with DIN EN 50178)

Chainflex® (CF240) from IGUS® is used as the temperature sensor cable. In the standard version (Type B), three temperature sensors are provided: one set of PTC100, one set of PTC120(130) is installed on each phase winding, and one Pt1000 is installed on phase U as standard. The temperature sensors used in the individual types are listed in the table below. The cross-section of the temperature sensor cable is 0.25 mm²and the pin assignment of the temperature sensor cable for the individual types is shown in the figures below.

Warning!

Please ensure that the temperature control cable is connected. If the temperature sensor is not monitored and the motor is damaged, HIWIN accepts no liability for accidents at work or damage to property.

Table5 .15 : Temperature sensors used for each type

type	temperature sensor	Notes
Type A	PTC120(130) + Pt1000	-
Type B	PTC100 + PTC120(130) + Pt1000	Standard
Type C	PTC120(130) + 3x Pt1000	-
Type D	PTC100 + PTC120(130) + 3x Pt1000	

Fig.5 .13 : type A

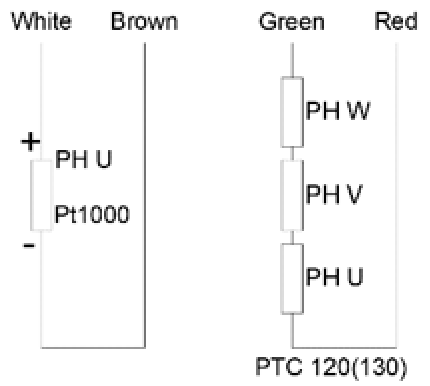


Fig.5 .14 : type B

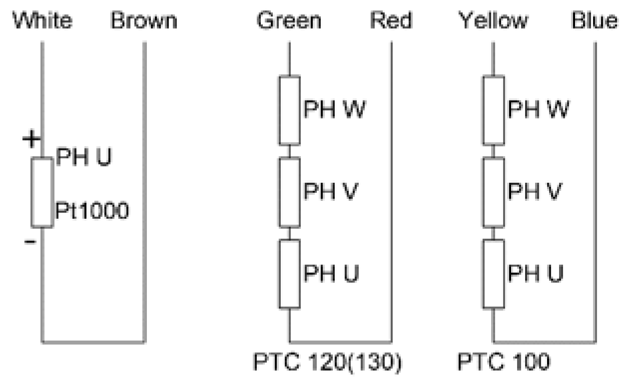


Fig.5 .15 : type C

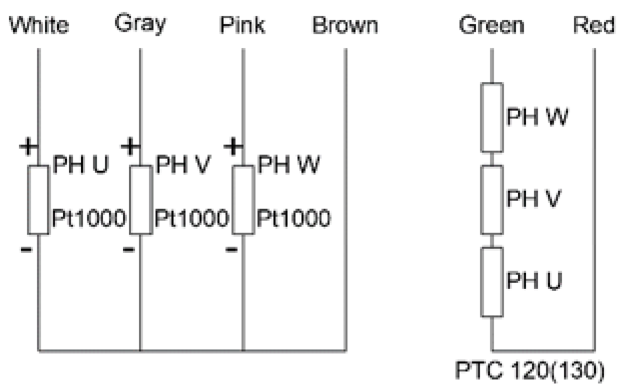
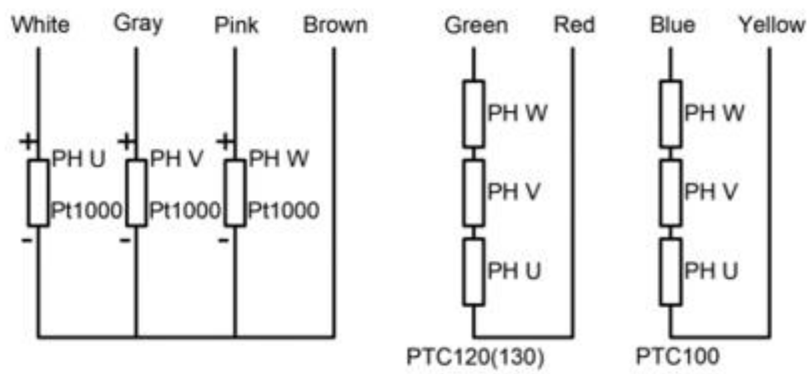


Fig.5 .16 : type D



5.2.2.3 Electromagnetic compatibility (EMC)

⚠ **Danger!** Danger due to electrical voltage!

Electric currents may flow even when the motor is at a standstill.

– Ensure that the direct drive drive system is disconnected from the power supply before disconnecting the electrical connections from the motors.
– After disconnecting the servo drive from the power supply, wait at least 5 minutes before touching live parts or disconnecting connections.

⚠ **Danger!** Danger due to electrical voltage!Art und Quelle der Warnung

If the motors are not earthed correctly, there is a risk of electric shock.

– Before connecting the power supply, ensure that the motor system is properly earthed.

To protect the conductors, it is necessary to route and connect the cable shields correctly. Correct installation not only protects personal safety but also reduces interference noise. The controller's power modules all use PWM voltage switching to control the motor. The PWM switching causes EMI radiation, which has a negative effect on the sensor signal. To create an EMC-compliant environment, therefore, shielding must be used on the following cables:

– All cables on the power module (including the adapter cables connected to modules such as filters and chokes).
– All motor cables (including the power cable, temperature sensor cable and encoder cable)
– Sensor cable.
– Signal cables.
– To reduce interference, the following methods and tests are recommended:
– Separate shields must be used for motor cables and temperature sensor cables. If the length of the cable is greater than 1 metre, the shields must be earthed at both ends of the cable.
– Cables of long length and motor cables located near sensor cables must be earthed via a shield.
– The earth resistance of all earth points to the system should be less than 1Ω (in accordance with IEEE 80).
– If the earth connections of different machines are interconnected, the use of earth straps or surface contact is recommended. Please avoid using an earth cable with a small cross-section.
– If the device is earthed, it is recommended to use an earthing cable with a copper wire equivalent having a cross-sectional area of at least 10 $^{mm^2}$.
– Do not open or disconnect the circular connector or cable glands on the stator, as the shielding inside may be damaged or lose its function.
– If a self-made extension cable is used, please ensure that the design and installation comply with EMC standards.

There are two types of earthing for shields. One type involves using a circular connector with an IP66 rating or higher. Please refer to the circular connector's installation instructions for details on the connection method. The shields must have a conductive connection to the circular connector. The other option is to install a separate shield. The motor cable shield can be secured to a metal structure (e.g. a frame, a switch cabinet or a machine) using a cable clamp. During installation, the earth connection point must be located near the controller and the motor.

Each earthing method has its advantages and disadvantages. The most important thing is that the earth resistance of each device must be as low as possible to ensure a balanced electrical potential for the device.

Fig.5 .17 : The shields must have a conductive connection to the circular connector

Fig.5 .18 : Use a tubular ring to secure the shield to the shielding connection plate

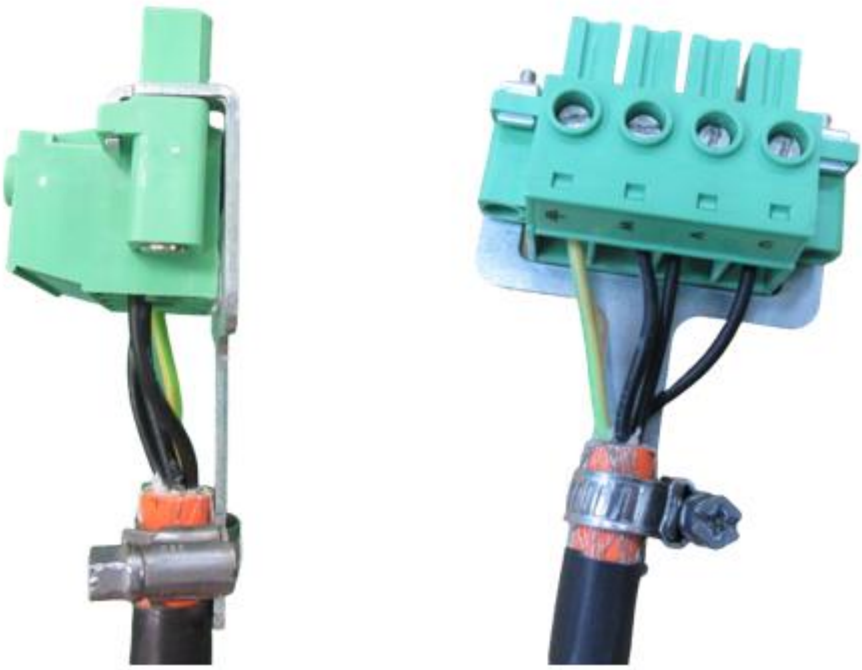
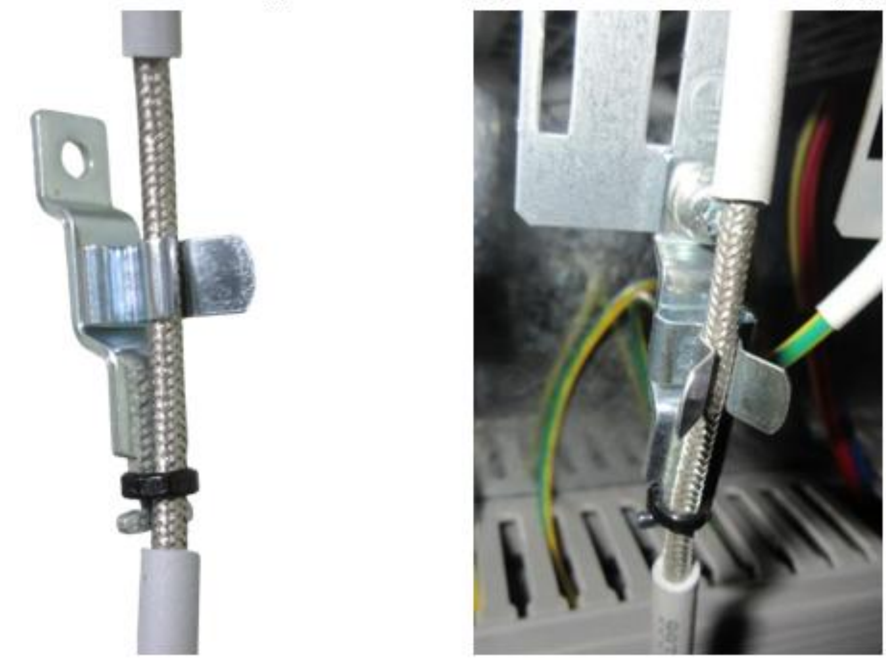


Fig.5 .19 : Use a fixed earth terminal to earth the shield



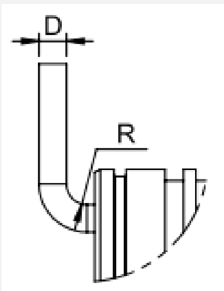
5.2.2.4 Bending radius of the cable

Warning!

> Please strictly adhere to the minimum requirements for the bending radius of power cables to avoid insulation faults or a reduction in the product's service life.

The minimum bending radius for power cables and temperature sensor cables for torque motors is specified in the following table.

Table5 .16 :

Diagram	Type of cable	article number	Min. bending radius for fixed installation	Min. bending radius for flexible installation
	power cable	Olflex® Servo FD 796 CP	R = 4 x D	R = 7.5 x D
		Chainflex® CF27	R = 4 x D	R= 7.5 x D
		Chainflex® CF270	R= 5 x D	R= 10 x D
		Chainflex® CF310	R= 4 x D	R = 7.5 × D
		Chainflex® CFPE	R = 4 x D	R = 7.5 x D
	temperature sensor cable	Chainflex® CF240.PUR	R= 5 x D	R= 10 x D

Due to version updates by the cable manufacturers, the bending radius may differ from the figures in the table above. In such cases, should specifications be missing or not correspond to the manufacturer's latest version, please adhere strictly to the data provided by the cable manufacturer.

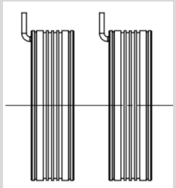
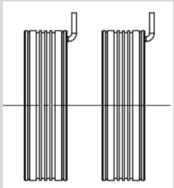
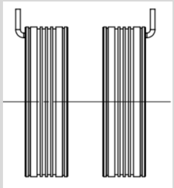
5.2.3 Setting up parallel operation

Warning!

For settings and sizing relating to parallel operation, please contact HIWIN to enquire about the specific parameters. This is necessary to prevent drive failure or the risk of malfunctions during commissioning.

The torque motor can be operated in parallel on the same axis. Follow the instructions at0 Table5 .8 to connect the power cables correctly. The wiring details for type 1 and type 2 are shown in the following figures.

Table5 .8 : Connection of motor cables for parallel operation

					Type 1				**Type 2**	
										
				servo drive	Master	Slave	Master	Slave	Master	Slave
TMRW	1	A	Series	U	U	U	U	U	U	V
	2	D		W	W	W	W	W	W	W
	7	G		L	V	L	V	V	V	U
TMRW4 series				U	U	U	U	U	U	W
				W	W	W	W	W	W	U
				V	V	V	V	V	V	V
TM-5 Series				U	U	U	U	U	U	U
				W	W	W	W	W	W	V
				V	V	V	V	V	V	W

Please note the following points when operating several motors in parallel.

- To operate the motors in parallel, please contact HIWIN to obtain the parameters for parallel operation.
- M motors operated in parallel should be of the same type.
- The phase sequence of the counter-EMF of the motors operated in parallel should be identical.
- When connecting in parallel, ensure that the relative position of the stator and rotor is set in accordance with0 Fig.5 .20 and0 Fig.5 .21 . The stator reference point in TMRW is the position opposite the outlet and in TM-5 it is the pin hole. The rotor reference point in TMRW is the marking point and in TM-5 it is the Pin hole. If the motors are operated at rated load but the home position marking is not aligned with the home position, one of the motors in parallel operation may become overloaded and overheat.
- The power cable and the temperature sensor cable are shielded. The shielding must be earthed.
- Please do not connect the motor's power cable to the drive immediately after installation. The user must first drive the motor manually. Record the closely spaced peak values of the master and slave (movement at constant speed) using an oscilloscope. Check whether the waveforms overlap (the phase angle deviation between master and slave is less than ±5°, and the same applies to the other phases). Only after this check may the user connect the motor cable to the drive and supply power.

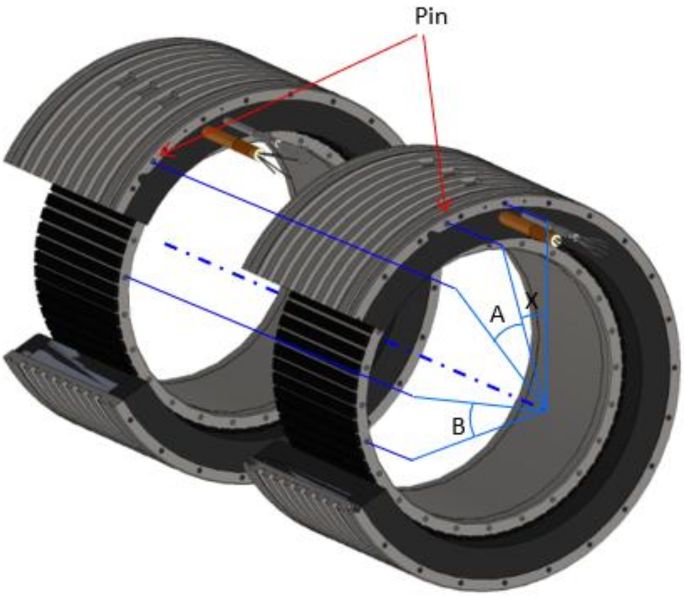
X is the angle between the stator with the Pin and the outgoing cable.

A is the relative angular position of the pin holes on the stators of the master and slave motors. For a motor without pin holes, it is the relative angular position of the outgoing cable.

B is the relative angular position of the pin holes on the rotors of the master and slave motors. For a motor without pin holes, it is the relative angular position of the reference mark.

Design 1

Fig.5 .20 :

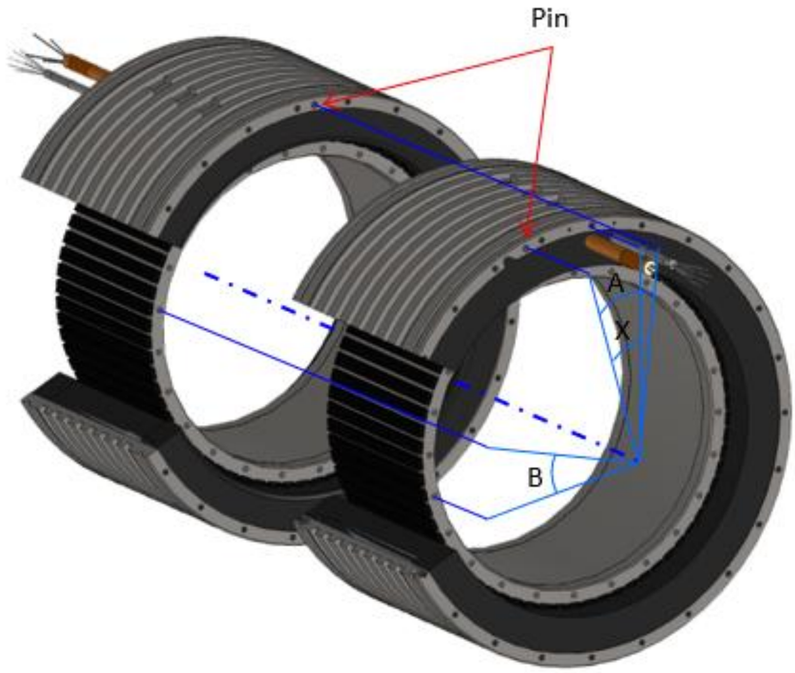


series	p (pole pairs)	X [degrees] (Pin)	A [degrees]	B [degrees]	Position error tolerance [degrees]
TMRW1	11	0		$Z \times \frac{360}{p}$	±0.454
TMRW2	11	0			±0.454
TMRW4	11	0			±0.454
TMRW7	22	0			±0.227
TMRWA	33	0			±0.151
TMRWD	44	0			±0.113
TMRWG	44	0			±0.113
TM-5-1	11	30			±0.454
TM-5-2	11	30			±0.454
TM-5-4	22	22.5			±0.227
TM-5-7	22	22.5			±0.227
TM-5-A	30	20			±0.166
TM-5-D	30	18.75			±0.166
TM-5-G	35	18.75			±0.142

where Z $\in$ integers, (0, $\pm$1, $\pm$2), enter the nearest integer based on requirements.

Design 2

Fig.5 .21 :



series	p (pairs of poles)	X [degrees] (Pin)	A [degrees]	B [degrees]	Position error tolerance [degrees]
series	series	series			±0.454
TMRW1	TMRW1	TMRW1			±0.454
TMRW2	TMRW2	TMRW2			±0.454
TMRW4	TMRW4	TMRW4			±0.227
TMRW7	TMRW7	TMRW7			±0.151
TMRWA	TMRWA	TMRWA			±0.113
TMRWD	TMRWD	TMRWD	$Z \times \frac{360}{p} + 2X$	$Z \times \frac{360}{p}$	±0.113
TMRWG	TMRWG	TMRWG			±0.454
TM-5-1	TM-5-1	TM-5-1			±0.454
TM-5-2	TM-5-2	TM-5-2			±0.227
TM-5-4	TM-5-4	TM-5-4			±0.227
TM-5-7	TM-5-7	TM-5-7			±0.166
TM-5-A	TM-5-A	TM-5-A			±0.166
TM-5-D	TM-5-D	TM-5-D			±0.142

where Z ∈ integers, (0, ±1, ±2), enter the nearest integer based on requirements.

Fig.5 .22 : Wiring diagram for parallel operation test (example: Type 2, Series 3 and measurement on drive U-V)

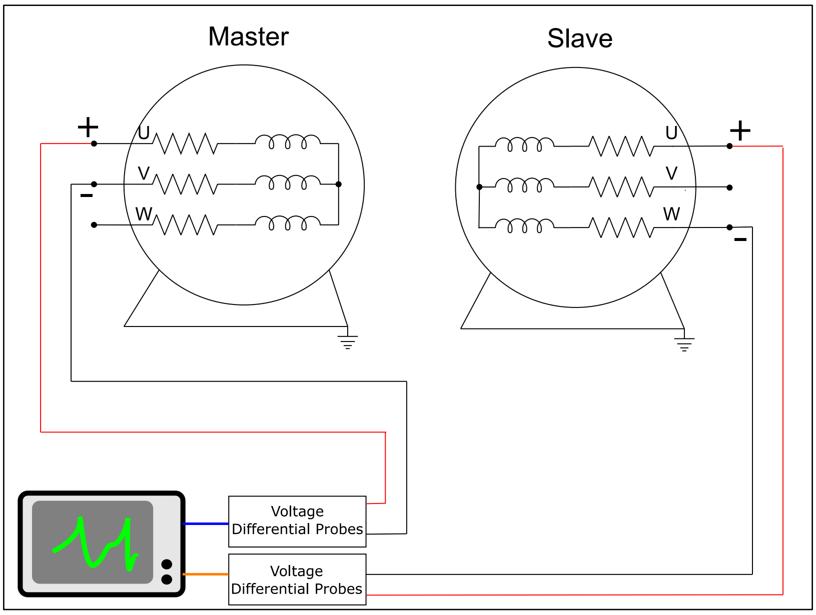
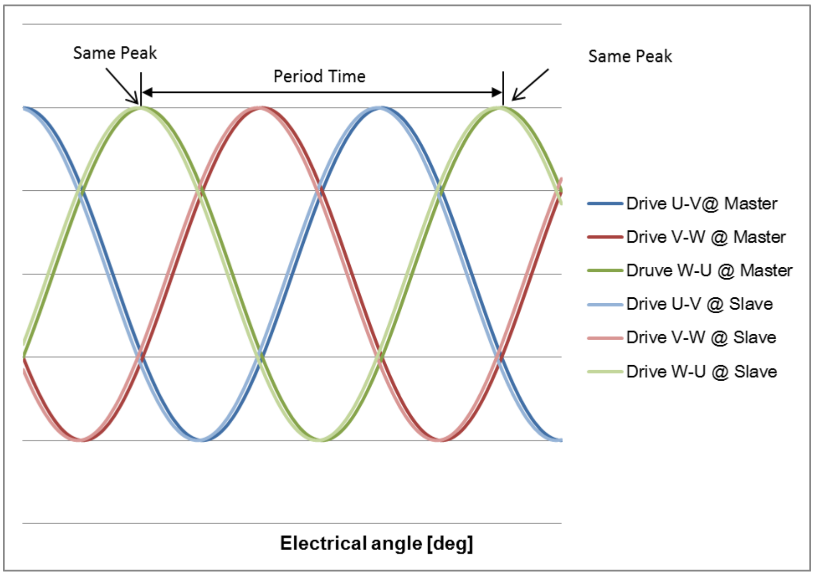


Fig.5 .23 : Permissible electrical phase shift between master and slave motor.



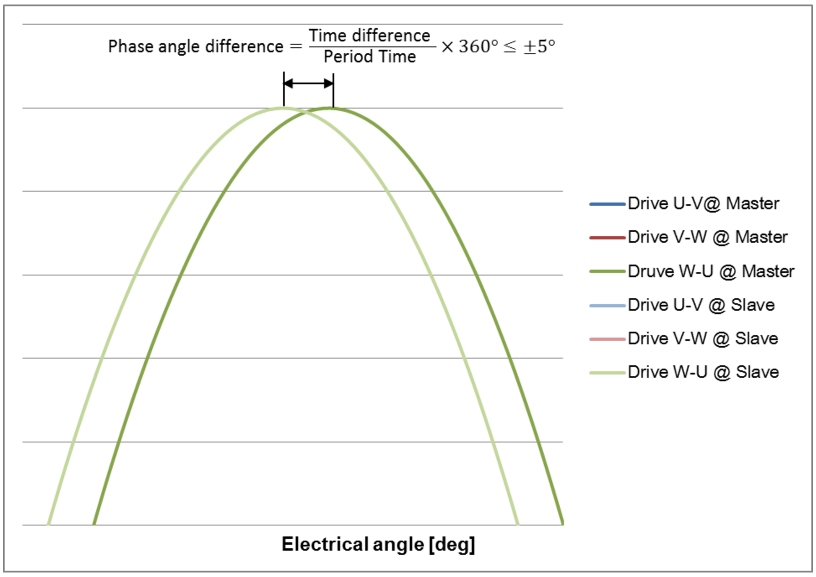


Fig.5 .24 : Type A, Type 1, Series 1–3

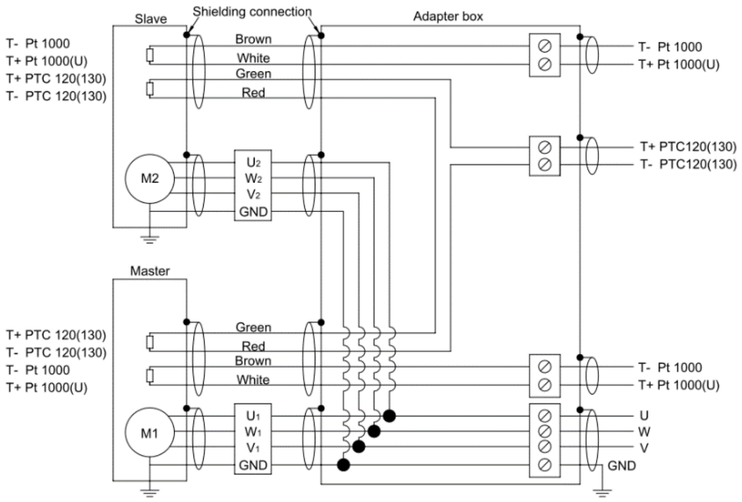


Fig.5 .25 : Type A, type 2, series 1

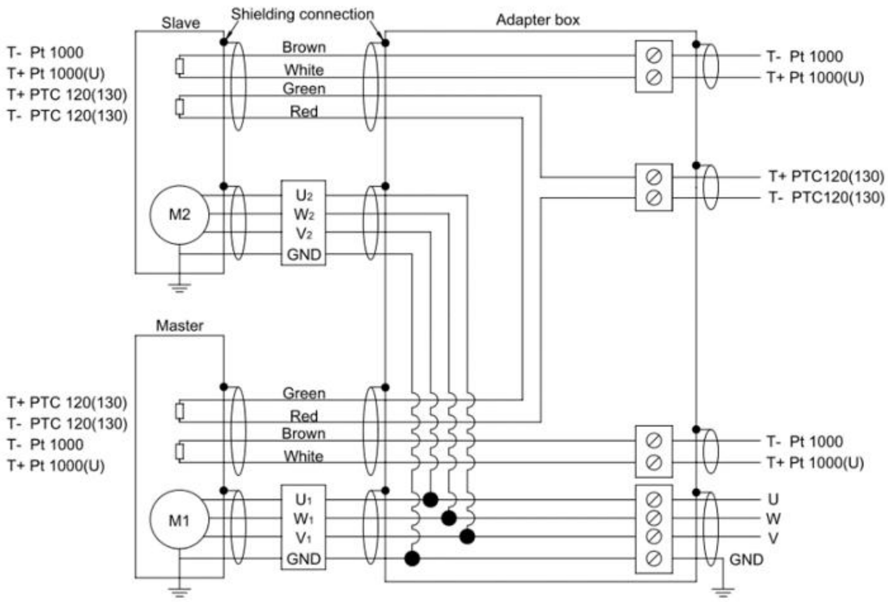


Fig.5 .26 : Type A, Type 2, Series 2

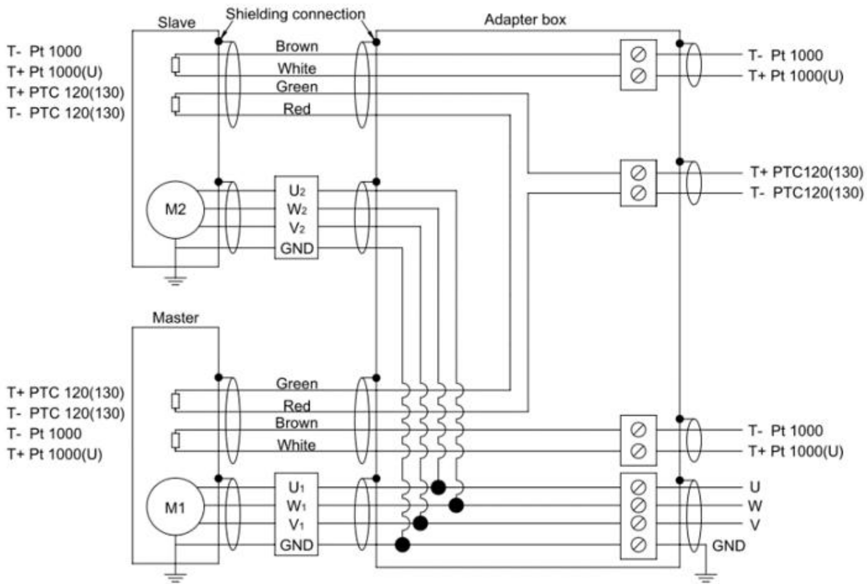


Fig.5 .27 : Type A, Series 2, Series 3

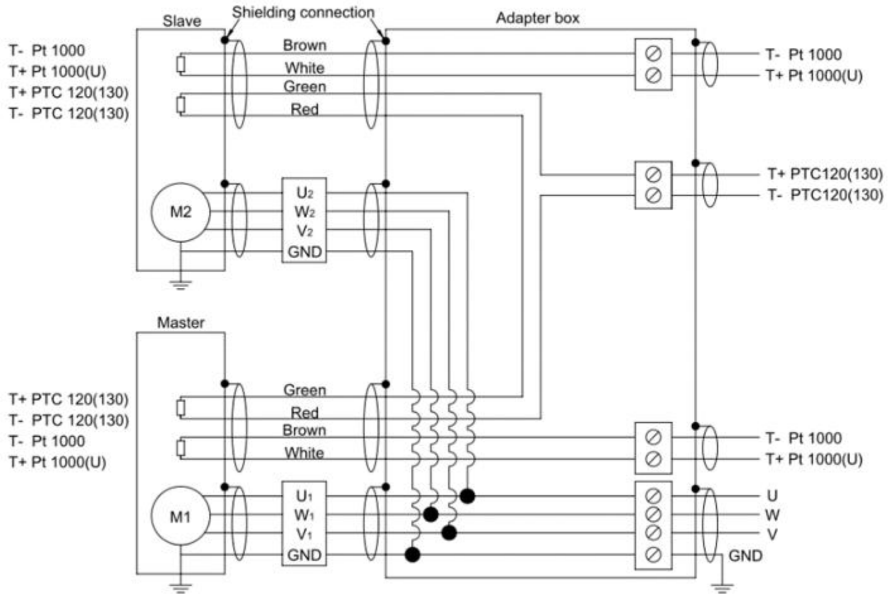


Fig.5 .28 : Type B, series 1–3

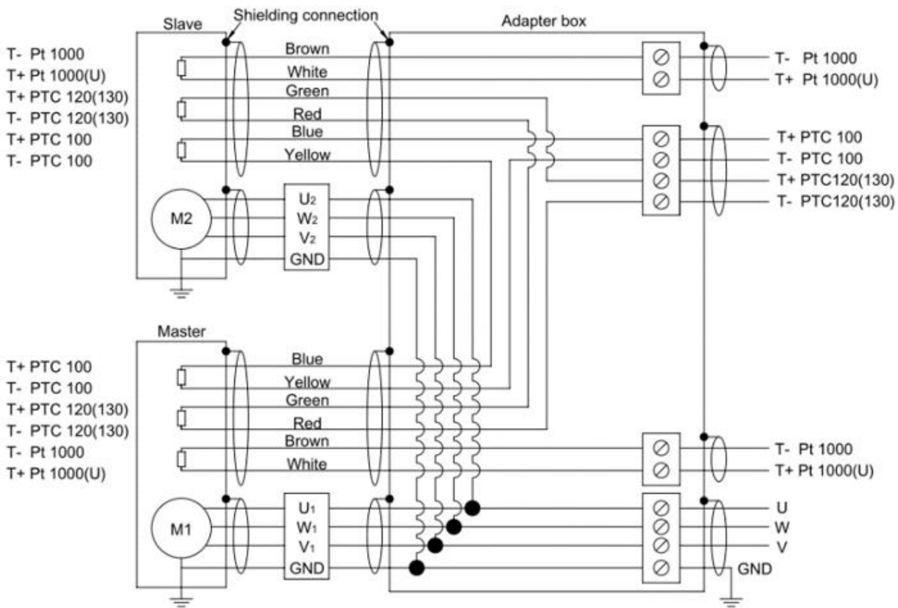


Fig.5 .29 : Type B, series 2, range 1

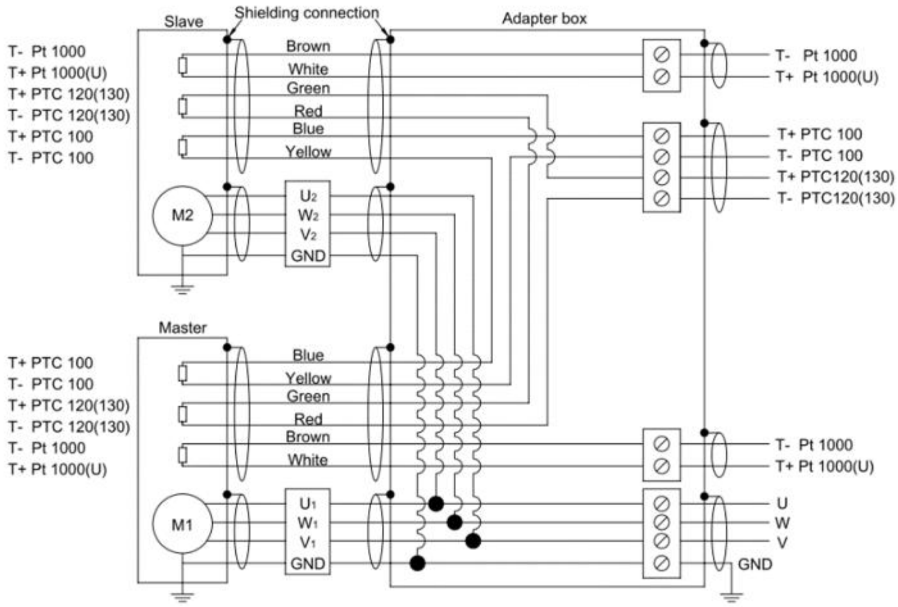


Fig.5 .30 : Type B, series 2, series 2

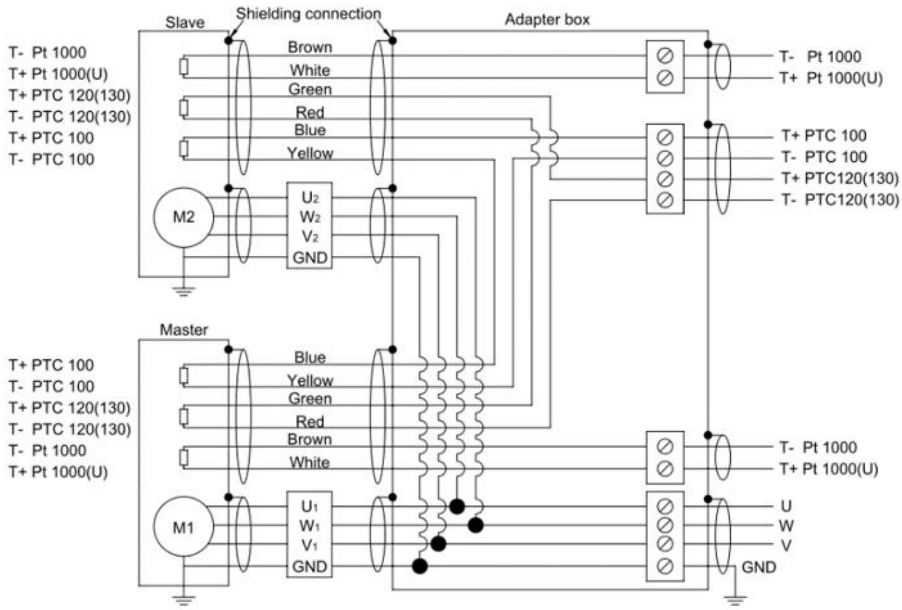


Fig.5 .31 : Type B, series 2, series 3

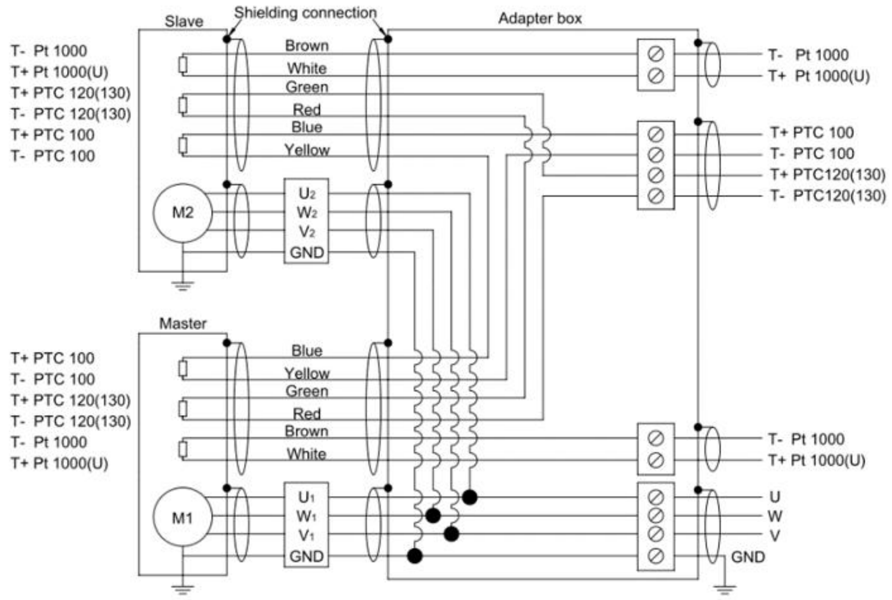


Fig.5 .32 : Type C, series 1–3

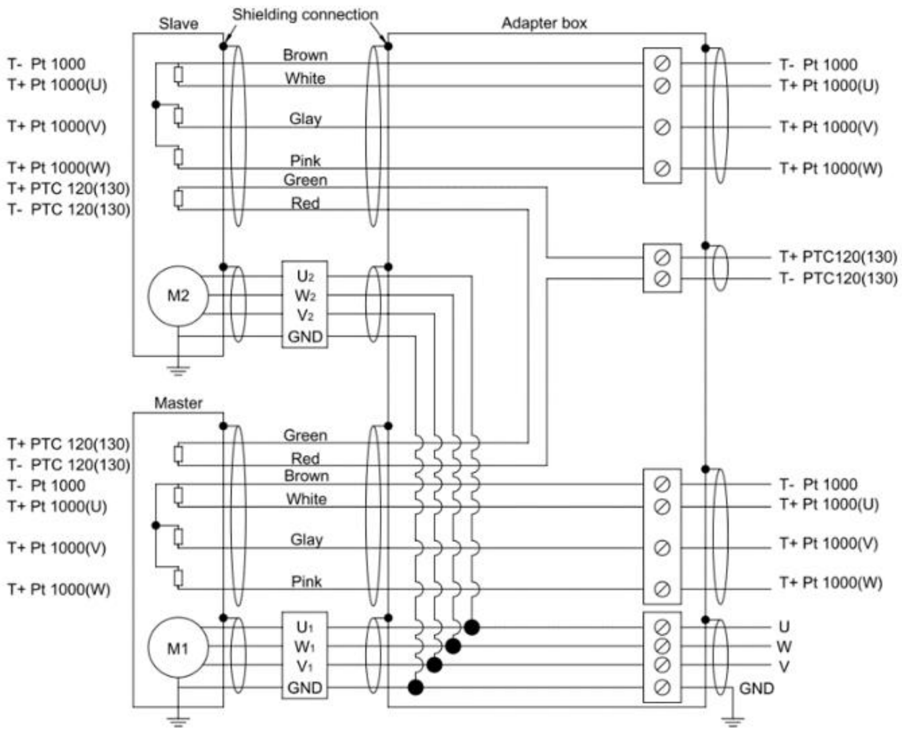


Fig.5 .33 : Type C, series 2, series 1

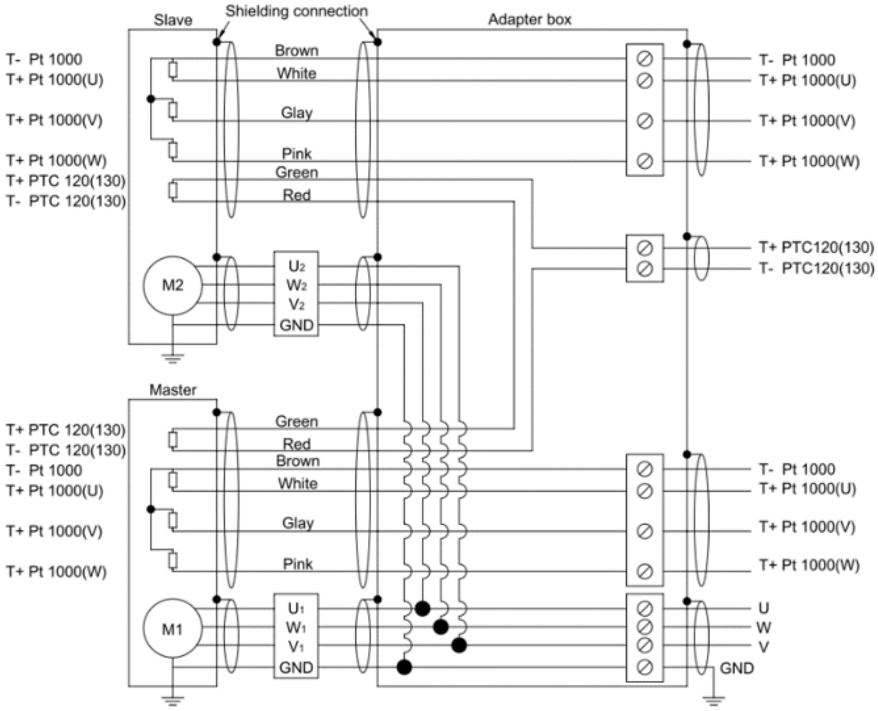


Fig.5 .34 : Type C, series 2, series 2

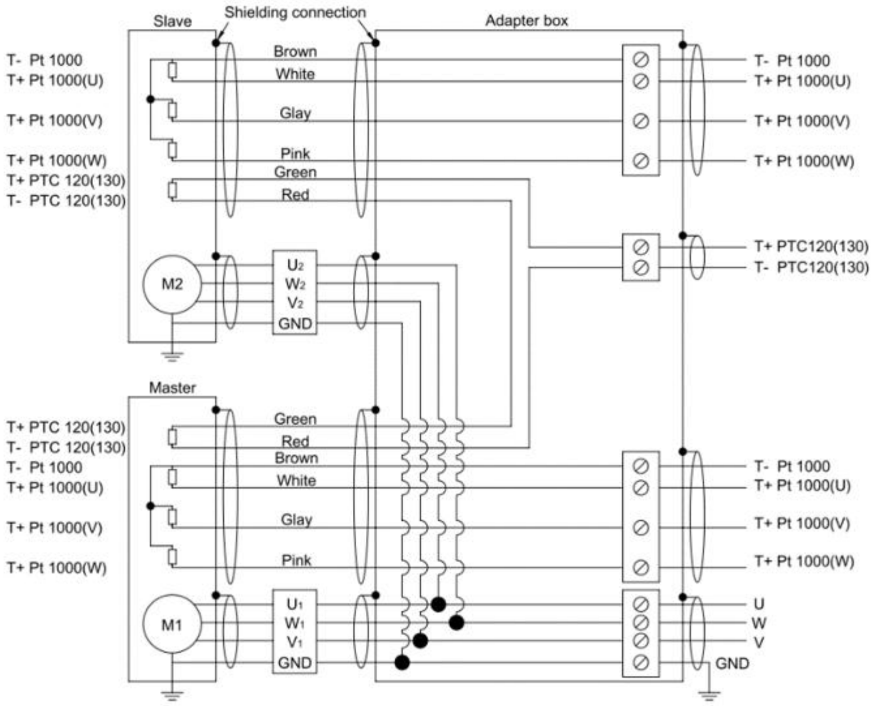


Fig.5 .35 : Type C, type 2, series 3

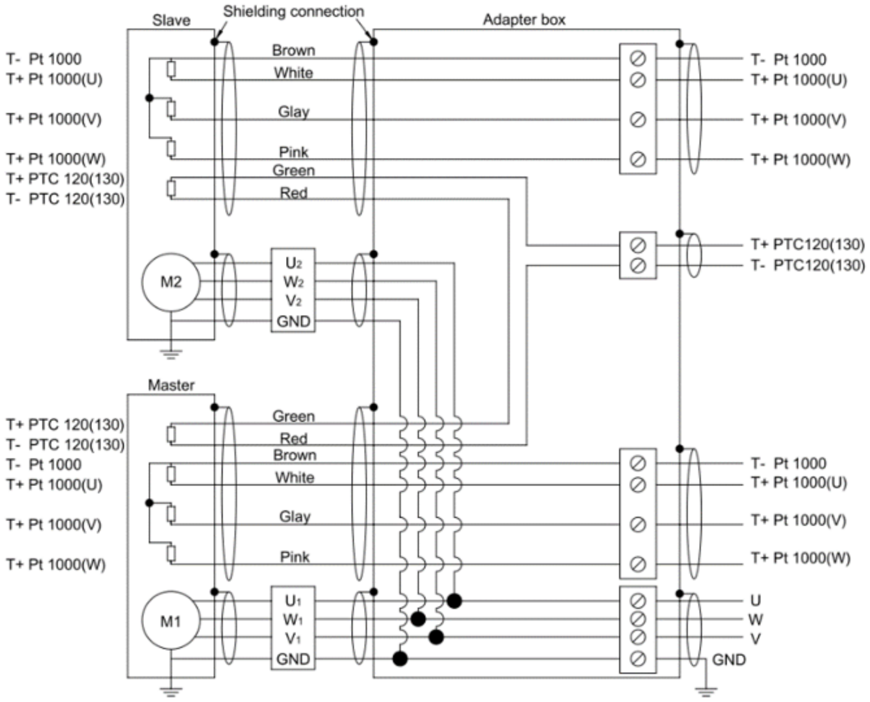


Fig.5 .36 : Type D, type 1, series 1–3

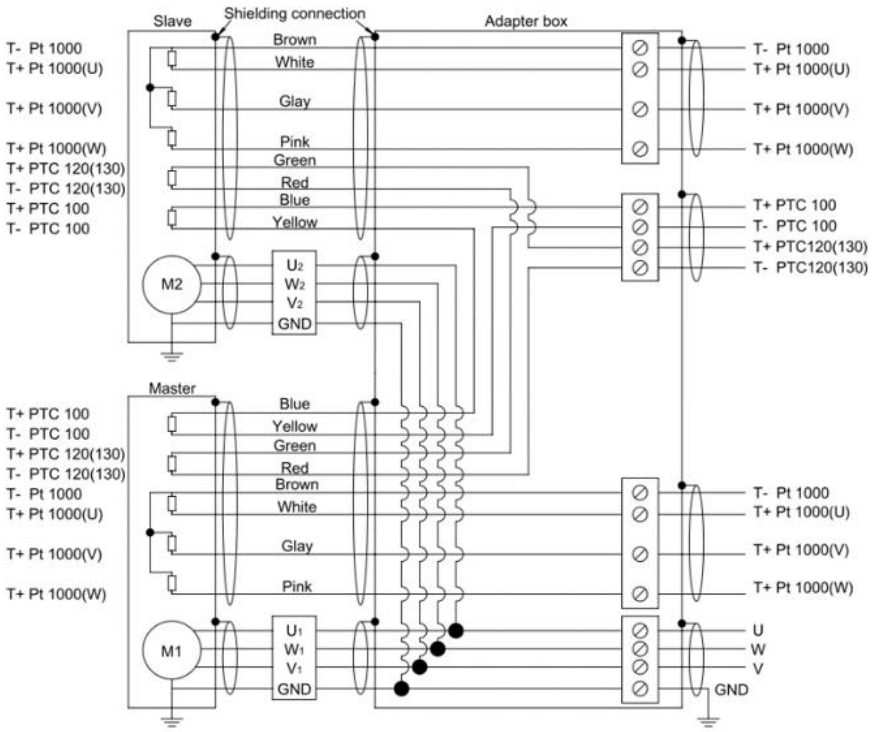


Fig.5 .37 : Type D, series 2, series 1

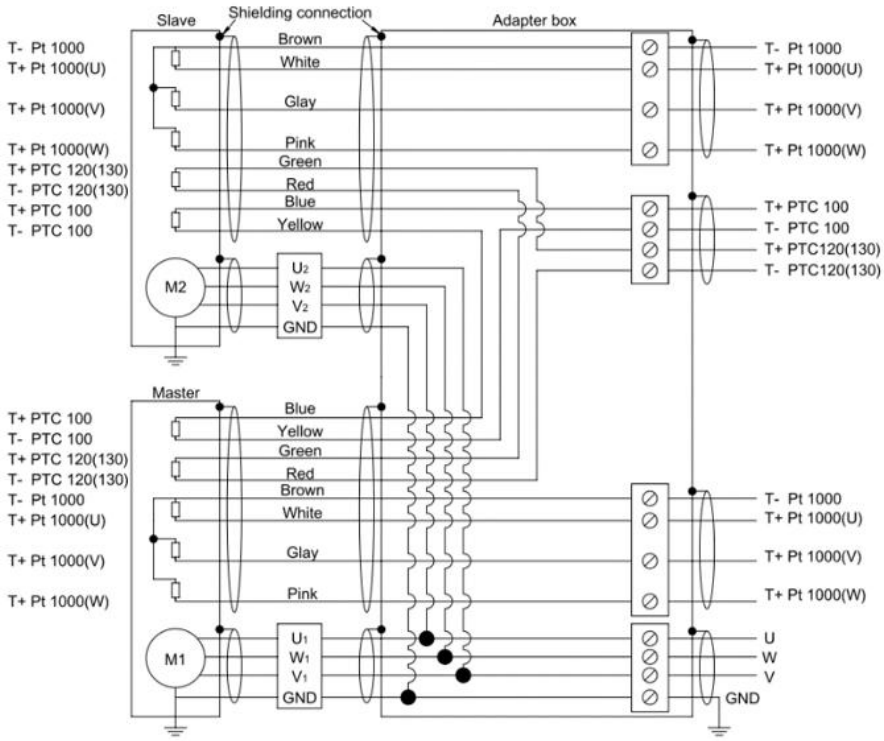


Fig.5 .38 : Type D, series 2, series 2

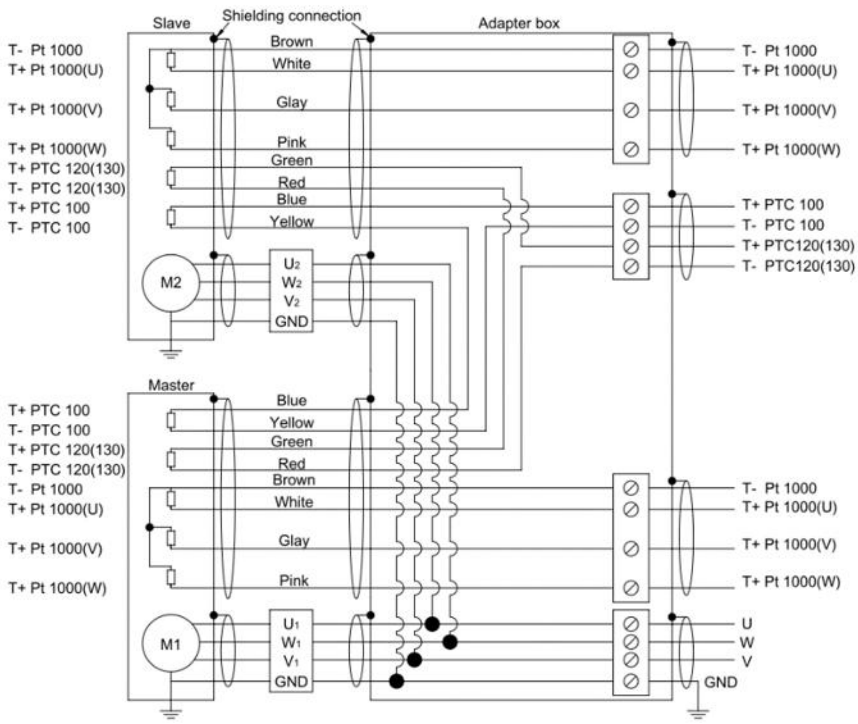
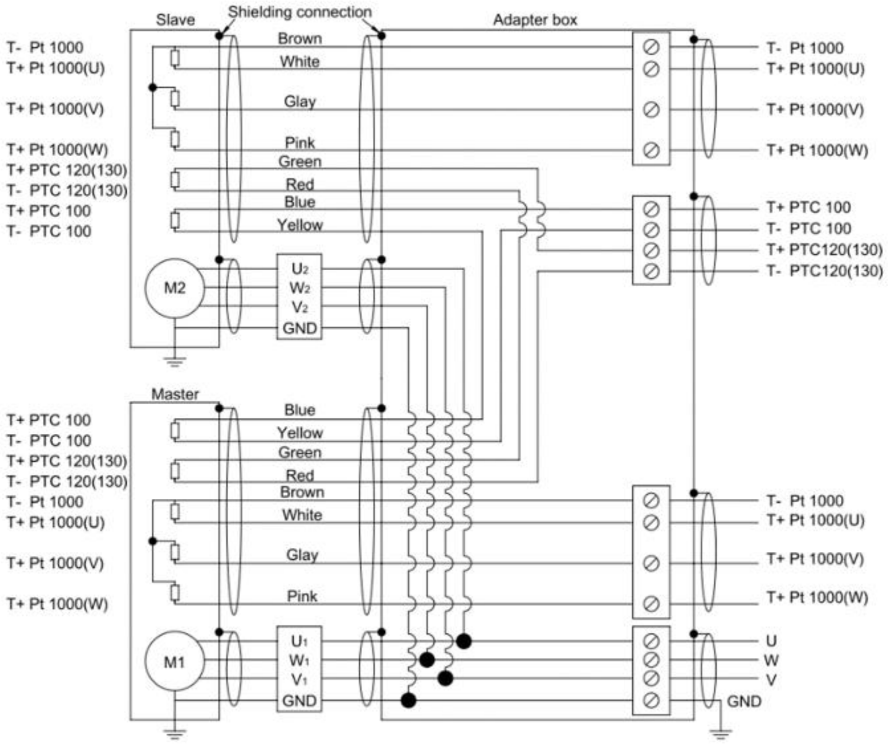


Fig.5 .39 : Type D, Type 2, Series 3



5.2.4 temperature sensor

Warning!

Please ensure that the temperature cable is correctly connected. HIWIN accepts no liability for accidents at work or damage to property resulting from motor failure due to a failure to monitor the temperature sensors.

Ω°CPt1000 is a platinum resistance temperature sensor (RTD) characterised by a resistance value of 1000 Ω at 0 °C and corresponding to tolerance class B. The corresponding temperature can be calculated by measuring the output resistance value. The relationship between resistance and temperature is shown in the figure below. The operating temperature range is between -55°C and 190°C .

The standard relationship between resistance and temperature is as follows:

Temperature range: -55°C ~ 0°C

$$R_\theta = R_0[1 + A\theta + B\theta^2 + C(\theta - 100)\theta^3]$$

In the temperature range: 0°C ~ 190°C

$$R_\theta = R_0(1 + A\theta + B\theta^2)$$

R_0 = 1000 [Ω]

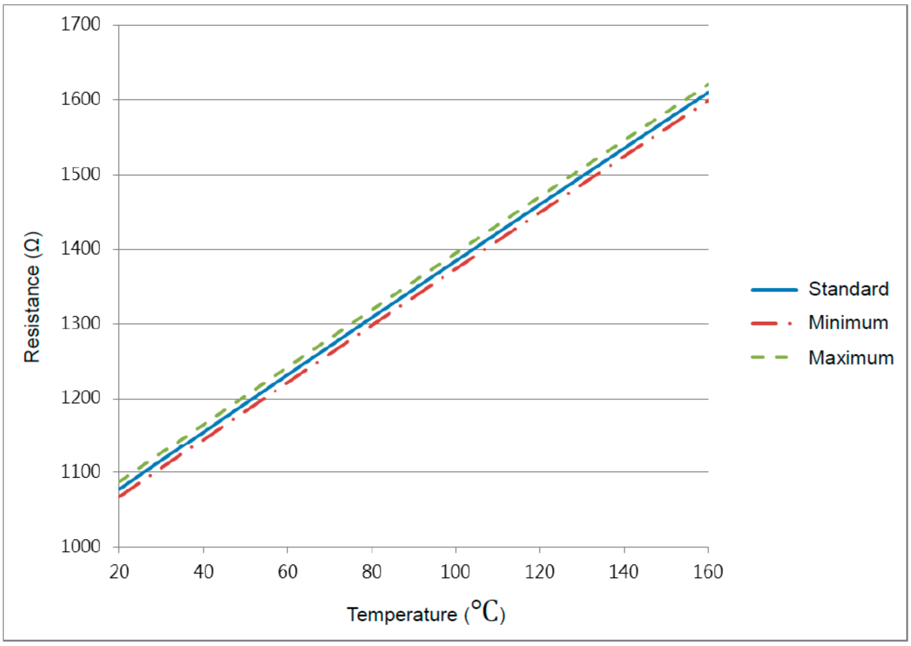
C = -4.1830 × 10^{-12}[°C^{-4}]

A = 3.9083 × 10^{-3} [°C^{-1}]

θ = Temperature [°C]

B = -5.7750 × 10^{-7}[°C^{-2}]

Fig.5 .7 : Relationship between resistance and temperature (Pt1000)



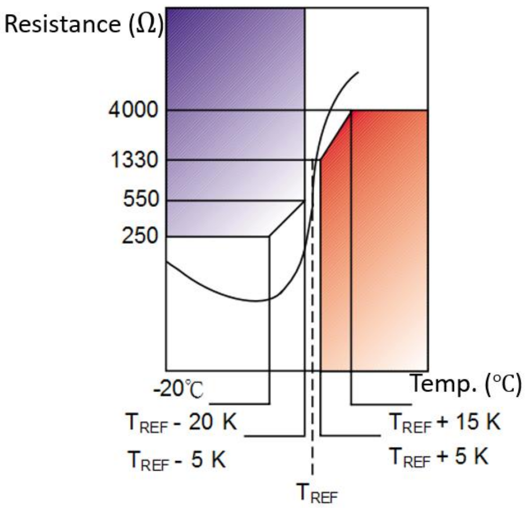
PTC100 and PTC120(130) are thermistors. Their output resistance varies depending on the coil temperature. The resistance of the PTC100 increases dramatically when T_{REF} = 100°C , whilst the resistance of the PTC120(130) increases dramatically when T_{REF} = 120(130) °C . Their characteristics are shown in**Fehler! Verweisquelle konnte nicht gefunden werden.** Table5 .17 and0 Fig.5 .40 .

Three PTCs are connected in series; the controller must NOT trip at a value lower than the resistance value specified at ambient temperature.

Table5 .17 : Properties of PTC

Characteristics of	resistance	3 PTCs in series Resistance
20°C <T<TREF - 20K	20Ω ~250Ω	60 Ω ~ 750Ω
T=TREF - 5K	≦ 550Ω	≦ 1,650Ω
T=TREF + 5K	≧ 1,330 Ω	≧ 3,990Ω
T=TREF + 15K	≧ 4,000Ω	≧ 12,000Ω

Fig.5 .40 : Relationship between PTC temperature and resistance



To protect the motor windings from thermal damage, each motor is equipped with a triple PTC (Positive Temperature Coefficient) sensor of the SNM120/130 type (in accordance with DIN 44082-M180). As the degree of heating of the individual motor phases can vary considerably, a PTC sensor ( ) is installed in each phase winding (U, V and W). Each PTC element exhibits a 'quasi-switching' characteristic, i.e. the resistance rises abruptly near the rated value. Due to its low thermal 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 each phase winding of HIWIN motors are connected in series; they are connected via two wires. In the TMRW/TMRW/IM-2, there is an additional positive temperature coefficient (PTC) circuit, type PTC 100, for redundant use or to distinguish between warning and danger temperatures.

Note

Motor protection based solely on temperature monitoring via PTC elements may be insufficient. This is the case, for example, when the motor is operated at currents exceeding the continuous current.

HIWIN recommends the use of an additional protection algorithm on the control side. The calculation of the maximum operating time for currents above the continuous current can be found in the sectionThermal time constant3.1.2.1 Thermal time constant

5.2.4.1 Connection to the servo drive

⚠ **Warning**!

The temperature sensor can usually be connected directly to the drive. However, to meet the requirements for protective separation in accordance with EN 61800-5-1, the sensor must be connected via a coupling module provided by the drive manufacturer.

6 commissioning

6.1 commissioning

For parameters, please contact our technical department. Enter the relevant data in accordance with the requirements of the controller and the drive, and make the settings in accordance with the controller and drive manuals.

Precautions

- Avoid excessive friction whilst the motor is running.
- Ensure that there are no objects in the range of the system's movement.
- Before starting the motor, ensure that the cooling system is functioning correctly and meets the minimum flow requirements specified in the data sheet.
- Before starting the motor, ensure that the main switch is turned on.
- Before connecting the power supply, ensure that at least one earth cable is connected to all electrical products.
- Do not touch the motor parts directly after assembly.
- If the current exceeds the specified maximum current value, the magnetic components in the motor may become demagnetised. In this case, please contact HIWIN or your local sales partner.
- Do not operate the product in an environment where the rated load is exceeded.
- During motor operation, its temperature must remain within the specified range.
- If you notice any unusual odours, noises, smoke, a rise in temperature or vibrations, stop the motor and switch off the power supply immediately.
- Do not cool the motor or its parts below room temperature to prevent condensation forming on the motor, as this will cause rapid damage to the windings.
- Torque motor with cooling jacket (Reserved code: J□): During installation and use of the stator, shocks or pressure on the housing may cause the coolant to leak. It is therefore recommended to leave a gap between the stator mounting space and the cooling housing to prevent this.
- Torque motor with cooling jacket (Reserved code: J□): Under all circumstances, ensure that the cooling system is functioning normally before powering the stator. Even a brief rise in temperature whilst uncooled can cause irreversible damage to the stator.
- Torque motor with cooling jacket (Reserved code: J□): The fasteners (springs) used to secure the cooling housing must not be removed, regardless of whether they are located on the upper edge, the lower edge or in the fixed bore of the cooling housing. If any of the fasteners (springs) are removed and this results in a patent infringement, motor damage or a leak of coolant, HIWIN accepts no liability.
- The specified operating environmental conditions must comply with standard EN 60721-3-3:2019.
- If auxiliary brakes or braking devices are used during commissioning, please ensure that the clamping times are synchronised to prevent motor overload.
- During commissioning, ensure that the temperature sensor is connected to monitor the motor and check that it remains within the specified operating temperature range.

Table6 .1 :

Environmental parameters	unit	Value
Air temperature	(°C)	+5 to +40
Relative humidity	(%)	5–85
Absolute humidity	(g/m^3)	1–25
Temperature change rate [1)]	$(°C/min)$	0.5

Environmental parameters	unit	Value
Atmospheric pressure [2)]	(kPa)	78.4–106
Solar radiation	(w/m^2)	700
Ambient air movement [3)]	(m/s)	1
Condensation	-	Not permitted
Ice formation	-	Not permitted

[1)] Average value over a period of $5min$.

[2)] Conditions in mines are not taken into account. The severity differs from Class 3K22. (up to 78.4 ° $kPa)$ (altitudes above sea level up to 2000 m m).

[3)] Uncontrollable air currents may impair cooling systems based on natural convection.

Mechanically active substances	Class 3S5
Mechanical conditions	Class 3M11

7 Maintenance and cleaning

7.1 Maintenance and cleaning

⚠ **Danger!** Danger from electrical voltage!

Electric currents may flow even when the motor is at a standstill.

- Ensure that the direct drive drive system is disconnected from the power supply before disconnecting the electrical connections from the motors.
- After disconnecting the servo drive from the power supply, wait at least 5 minutes before touching live parts or disconnecting connections.

⚠ **Danger!** Risk of death due to strong magnetic fields!

Strong magnetic fields in the vicinity of torque motors pose a danger to people with active medical implants who are in the vicinity of the motors. This also applies when the motor is switched off.

- If you are affected, maintain a minimum distance of 300 mm from the permanent magnets
- Trigger threshold for static magnetic fields of 0.5 mT in accordance with Directive 2013/35/EU
- Please also observe national and local guidelines or requirements.
- For reference: DGUV Rule 103-013 of the German Social Accident Insurance sets out requirements for working with magnetic fields

⚠ **Danger!** Risk of crushing due to strong attraction forces!

- Assemble the rotors and stators with care!
- Do not place fingers or objects between the rotors and stators!
- The rotor and magnetisable objects may accidentally attract each other and collide!
- Two rotors may accidentally attract each other and collide!
- The magnetic force exerted by the rotor on the object can amount to several kN, which may result in a body part becoming trapped.
- Do not underestimate the attraction force and proceed with caution.
- Wear safety gloves if necessary.
- At least two people are required for the work.
- If the assembly steps have not yet progressed to the installation of the rotor, please store the rotor in a safe and suitable place for the time being.
- Never handle several rotors at the same time.
- Never place two rotors directly against each other without a protective device.
- Do not bring magnetisable materials near the rotor! If the tool needs to be magnetised, please hold it firmly with both hands and approach the rotor slowly!
- It is recommended that you install the rotor immediately after unpacking!
- When assembling the stator and rotor, an installation aid is required to fit the stator and rotor together individually. Please follow the correct procedure.
- Always have the following tools ready to free body parts (hands, fingers, feet, etc.) held by magnetic force.
- Hammer made of non-magnetised, solid material (approx. 3 kg)
- Two wedge-shaped runners made of non-magnetic materials (wedge-shaped, acute angle 10°–15°, minimum height 50 mm).

⚠ **Caution!** Risk of physical damage to watches and magnetic storage media.

Strong magnetic forces can destroy watches and magnetisable data carriers in the vicinity of the torque motor!

– Do not bring watches or magnetisable data carriers within close proximity (<300 mm) of the torque motors!

⚠ **Caution!** Damage to the torque motor system!

The torque motor can be damaged by mechanical impact.

–Do not pull directly on the cable.

–Do not place heavy loads or sharp objects on the motor.

Please read all safety notices before carrying out maintenance work on the motor

⚠ **Warning**! Art und Quelle der Warnung

- The removal of obstructions and maintenance work must only be carried out by HIWIN technicians or authorised dealers, using suitable protective equipment.
- Do not carry out any maintenance work whilst the motor is running. The controller must stop the motor first.
- Please switch off the power supply and the machine's main switch (refer to the machine manufacturer's instruction manual).
- Residual voltage is still present in the system after the power supply has been switched off.

The HIWIN torque motor is a direct drive drive system in which no wear occurs during operation. However, improper operation or an unsuitable operating environment may shorten the motor's service life or even damage it. Should HIWIN or an authorised dealer determine that maintenance of the motor is required, please observe the safety notices under point 1 regarding the procedure for maintenance or disassembly. The product requires routine measurements and maintenance on a quarterly or half-yearly basis:

- The detection mechanism or electrical connections must not be loosened.
- Check the cable for any signs of wear or ageing.
- Check the air gap between the stator and rotor to ensure there are no leaks through which foreign objects, dust or particles could enter.
- Check the insulation resistance of the motor's three phases. It must meet the requirements of 1000 V_{DC} 60 sec. > 100 MΩ at 25 °C. If the insulation resistance gradually decreases at the same temperature compared to previous measurements, the motor may have started to age, so special attention is required.

7.2 Cleaning

If the product is integrated into machinery, typical contaminants include oil stains or metallic and non-metallic residues caused by friction from auxiliary components. Please read all safety notices before starting to clean the motor.

Warning!

- Please wear suitable personal protective equipment (PPE) when clearing blockages. For example, ensure that chemical-resistant gloves (e.g. latex) are worn before handling cleaning agents.
- Do not carry out any maintenance work whilst the motor is running. The motor must first be stopped by the controller.
- Please switch off the power supply and the machine's main switch (refer to the machine manufacturer's instruction manual).
- After switching off the power supply, residual voltage remains in the system. Please allow sufficient time for the system to discharge before disconnecting all power connections.
- Switch off the cooling system, release the pressure to drain the coolant, and remove the cooling connection (follow the cooling machine manufacturer's instructions).
- Remove the motors one by one.

It is recommended that measurements and maintenance be carried out quarterly:

- Regularly remove metal particles from the motor.
- Check the coolant level and quality regularly.
- Check the flow rate of the cooling system and remove any contaminants and particles.
- Measure the flow rate of the cooling system and clear any partial blockages.

7.3 Test run

Once you have ensured that the brake, cooling system and drive system are installed, carry out a test run and make the necessary adjustments in accordance with the controller and drive manuals. Please note the following:

- Uncontrolled movements of driven machine or plant components during
- commissioning, operation, maintenance and repair.
- In the event of a fault, exceptionally high
- temperatures may occur.
- Improper connection may result in dangerous touch voltages.
- Operational electrical, magnetic and electromagnetic fields may be generated

8 Disposal

8.1 Waste disposal

8.1.1 Decommissioning

Please follow the instructions below when dismantling or decommissioning the motor:

⚠ **Warning**! Risk of injury and damage to property!

> Failure to follow the instructions for dismantling or decommissioning the motor may result in injury, death or property damage.
>
> Please dismantle or deactivate the motor in accordance with the following instructions:

1. Disconnect the motor from the power supply and wait until the DC power supply has completely discharged.
2. Wait until the motor has cooled down (at least 30 minutes), then switch off all cooling systems and release the pressure to 0 bar.
3. Remove all power cables, signal cables and cooling hoses.
4. If necessary, disconnect all electrical connections to avoid the risk of electric shock from voltage generated by the rotating motor during disassembly or from torque caused by short circuits.
5. Drain all internal coolant and dispose of it properly.
6. Remove any foreign objects, dirt and dust from the motor.
7. Insert the spacer between the gaps in the stator and rotor.
8. If stator and rotor mounting plates or custom-designed stator and rotor mounting devices are available, use these plates/devices to secure the stator and rotor.
9. If the guide device method is used, ensure that the appropriate device and configuration are installed.
10. Remove all fasteners on the machine side. Once the stator and rotor are secured, they can be removed from the machine simultaneously; if the guide device is used, please remove the stator and rotor in the reverse order to that used during assembly. Take care during removal not to damage the O-ring.
11. When removing the O-ring, take care not to stretch it excessively. Stretching by more than 10% can cause permanent damage; furthermore, it is not permitted to twist it or use sharp tools.
12. Use the original packaging or a secure method to pack and store it properly.

Note

When replacing with a new torque motor, the use of a new O-ring is recommended; if the O-ring needs to be replaced, please refer to5.1.1.3 O-ring features to purchase a suitable O-ring, or purchase it from HIWIN.

8.1.2 Disposal

Products must be disposed of in accordance with regional or national regulations.

⚠ **Warning**! Risk of injury and property damage due to improper disposal

> If the torque motor or associated components (in particular the rotor with strong magnets) are not handled correctly, this may result in injury, death or property damage.
>
> Please ensure that the torque motor and associated components are disposed of correctly.

Proper disposal procedure:

- The permanent magnets in the rotor assembly must be completely demagnetised.
- The components to be recycled must be dismantled:
  - Electrical waste (e.g. encoder components, temperature control modules, etc.)
  - Electrical waste (e.g. stator, cables, etc.)
  - Metal alloy scrap (sorted by metal type)
  - Insulating material
- Do not mix with solvents, cold cleaning agents or paint residues

8.1.2.1 Disposal of rotors

Rotors with permanent magnets must undergo a special demagnetisation treatment before disposal to avoid hazards during further disposal. It is recommended that disposal be carried out by a professional recycling company.

After dismantling the motor, the rotor must be packed separately in secure packaging.

Steps for demagnetising the rotor:

It must be placed in a special non-magnetic oven for burning out, with the rotor laid on a stable and heat-resistant base. Throughout the demagnetisation process, the temperature in the furnace must be at least 310 °C (Curie point) to burn out the rotor for 1 hour, and the exhaust gases produced during burning should be treated to prevent environmental pollution.

Note

After demagnetisation and return to normal temperature, the residual magnetism value should be close to 10 Gauss; otherwise, it is recommended to repeat the process described above.

8.1.2.2 Disposal of packaging

The packaging materials and packaging aids used by HIWIN are not problematic materials. With the exception of wooden materials, they can be recycled and reused.

9 Troubleshooting

9.1 Troubleshooting

Table9 .1 : Troubleshooting

Symptom	Cause	Action
The motor cannot be turned manually without a controller connected	Mechanical obstruction	Rectify fault
	Three-phase short circuit on the motor	Rectify the three-phase short circuit
The motor does not rotate at all.	Incorrect wiring of cables	Check the cable connected to the controller.
	Current overload	Check for any obstructions and remove them. Rectify the fault when operating the brake.
	Over-temperature protection	Check the over-temperature setting of the controllers
	Unusual insulation resistance	Measure the insulation resistance after cooling Measurement of the stator three-phase earth connection (U/V/W to PE): 1000V_{DC} 60 sec. > 100 MΩ at 25 °C°C If the value does not reach 100 MΩ , please contact HIWIN
Incorrect direction of rotation	Incorrect encoder setting	Check the encoder setting.
	Incorrect wiring of the motor power cable	Swap the two phases of the power cable connected to the controller.
Smell of burning	Cooling system malfunction	Check the cooling system.
	Incorrect controller setting	Check the controller setting.
	Incorrect motor parameter settings	Check the motor parameter settings.
Unusual temperature of the motor housing	Speed is too low	Use the lock-on mode if the electrical frequency is <1 Hz
	Cooling system malfunction	Check the cooling system.
	Incorrect controller setting	Check the controller setting.
	Incorrect motor parameter settings	Check the motor parameter settings.
	Bearing malfunction	Check the installation.
	Speed is too low	Use the stall mode if the electrical frequency is <1 Hz
Unstable rotation (vibration)	Insulation fault	Check that the resistance between phase and earth is greater than 50 MΩ.
	Incorrect installation of the encoder	Check that the encoder is securely fastened.
	Incorrect encoder signal	Check the grounding and connection of the encoder.
	Incorrect controller settings	Check the controller.
	Incorrect motor parameter settings	Check the motor parameter settings.
Difficult to turn or unusual friction noises	Incorrect installation of the rotor	Check the assembly.
	System is out of balance	Check the dynamic balancing
	Loose mounting	Tighten it securely
	Foreign object in the air gap	Remove the foreign object.
The motor generates high local heat (irregularly)	Air bubbles in the cooling circuit	Remove air bubbles or increase the flow rate to remove air bubbles.

Symptom	Cause	Action
	Incorrect positioning of the cooling circuit inlet and outlet	Check that the cooling circuit inlet and outlet fit in accordance with the approved drawing.
After a while, a noise occurs when the motor is switched on without rotation; the frequency of the noise corresponds to the n×PWM modulation frequency. (n=1, 2, 3 ….)	Insulation fault	Check that the resistance between phase and earth is greater than 50 MΩ .

10 Declaration of Conformity

10.1 1 Declaration of Conformity

in accordance with the Low Voltage Directive 2014/35/EU

The manufacturer HIWIN GmbH, Brücklesbünd 1, 77654 Offenburg
Documentation Department: HIWIN GmbH, Brücklesbünd 1, 77654 Offenburg

We hereby declare that the component described below:

Product designation: Electric drive component
Series/type designation: TMRW, IM-2, TM-5
Year of manufacture: from 2025

Complies with all essential requirements of the Low Voltage Directive 2014/35/EU. Furthermore, the product complies with EC Directive 2011/65/EU (RoHS) and amending Directive 2015/863/EU.

This declaration applies exclusively to the product in the condition in which it was placed on the market and excludes components that are subsequently added and/or modified by the end user. The declaration is no longer valid if the product is modified without consent.

Reference to the relevant harmonised standards applied or to the other technical specifications on the basis of which conformity is declared:

EN 60204-1:2018	Safety of machinery – Electrical equipment of machines – Part 1: General requirements
EN 61000-6-2:2005	Electromagnetic compatibility (EMC) – Part 6-2: Generic standards – Immunity for industrial environments
EN 61000-6-4:2007 /A1:2011	Electromagnetic compatibility (EMC) – Part 6-4: Generic standards – Emission for industrial environments
EN 60034-1:2010/AC:2010	Rotating electrical machines – Part 1: Design and performance
EN 60034-5:2001/A1:2007	Rotating electrical machines Part 5: Degrees of protection provided by the overall design of rotating electrical machines

Additional explanations:

This product is a component that cannot fully meet the requirements for complete appliances, machines or systems. It may therefore only be used for installation purposes. The product's electrical and mechanical safety can only be assessed once it has been installed in the product intended for the end user. The EMC characteristics may change following the installation of the component. Therefore, the end product (complete devices, machines or systems) must be checked by the manufacturer of the end product.

Offenburg, April 2026
Werner Mäurer, Management

11 Appendix

11.1 Glossary

Counter-EMF constant (line-to-line):$K_v \left(\frac{V_{rms}}{rad/s}\right)$

The counter-EMF constant,K_v , is the ratio of the counter-EMF voltage (V_{rms}) to the motor speed (rad/s) when the magnet is at 25°C . It arises when the coil moves within the magnetic field of permanent magnets.

Continuous current:I_c/I_{cw} (A_{rms})

The continuous current, I_c , is the current that can be continuously applied to the motor coils at an ambient temperature of 25°C , whereby the final temperature of the coil must not exceed 120°C
(130°C for the TM-5/IM-2 series). Under this condition, the motor achieves the rated continuous torque T_c ; depending on the continuous current and the coil temperature, the torque motor responds toI_c for air cooling andI_{cw} for water cooled cooling

Continuous torque:T_c/T_{cw} (Nm)

The continuous torque,T_c , is the maximum torque that the motor can continuously generate at an ambient temperature of 25°C and a coil temperature of no more than 120°C (130°C for the TM-5/IM-2 series). This continuous torque corresponds toI_c/I_{cw} supplied to the motor; depending on the continuous current and coil temperature, the torque motor responds toT_c for air cooling andT_{cw} for water cooled cooling.

Inductance (line-to-line): L (mH)

The inductance is defined as the line-to-line inductance when the motor is operated at a coil temperature of 25 °°C .

Line-to-line resistance at 25 °°C (line-to-line):R_{25} **(Ω)**

The resistance is defined as the resistance measured line-to-line when the motor is running at a coil temperature of 25 °°C .

Motor constant:K_m $\left(\frac{Nm}{\sqrt{W}}\right)$

The motor constant,K_m , is defined as the ratio of the square root of the motor output torque to the power consumption when the coils and magnets are at 25°C . A higher motor constant indicates lower power loss when the motor delivers the specified torque.

Number of poles: 2p

2p represents the number of pole pairs of the rotor, where p is the number of pole pairs.

Peak current:I_p (A_{rms})

The peak current,I_p , is the current corresponding to the motor's torque, and the motor temperature reached as a result of this current cannot demagnetise the magnets. Generally, the peak current can be applied for 1 second when the motor is running under normal operating conditions and the phases of the input currents are balanced. The motor must then rest for at least 6 seconds after reaching its normal operating temperature before the peak current can be applied again. (Please contact HIWIN for more accurate information regarding the length of time)

Peak torque:T_p (Nm)

The peak torque,T_p , is the maximum torque delivered by the motor for less than 1 second. The peak current corresponding to this torque cannot demagnetise the magnets.

Rotor inertia:J (kgm^2)

Rotor inertia, J , is the property of the rotating part to provide resistance to any change in its state of motion, including changes in its speed and direction of rotation. It depends on the shape and mass.

Stall current:I_s/I_{sw} (A_{rms})

The stall current,I_s , is the maximum current when the motor is at 25°°C s and at a standstill. Depending on the heat dissipation, the torque of the torque motor corresponds toI_s for air cooling andI_{sw} for water cooled operation.

Stall torque:T_s/T_{sw} **(**Nm **)**

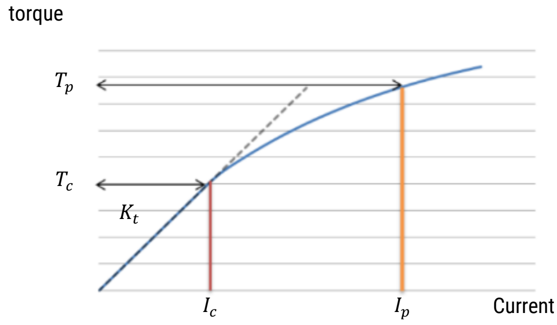
The stall torque,T_s , is the upper limit of the torque when the motor is at 25°C and at a standstill. Depending on the heat dissipation, the torque motor corresponds toT_s for air cooling andT_{sw} for water cooled cooling.

Thermal resistance: R_{th} (K/W)

°C°CThe thermal resistance, R_{th} , is defined as the resistance that heat must overcome on its way from the motor winding to the environment (taking into account natural convection and radiation for air cooling when the ambient temperature is 25 °C, and forced water cooling for water cooled systems when the water is at 25 °C). A higher thermal resistance indicates a greater temperature difference between the winding and the environment for the same heat source.

Torque constant: K_t (Nm/A_{rms}) at a magnet temperature of 25°C

The torque constant, K_t , is the ratio between the motor's output torque and the effective current. At low current values, the output torque and input current are in a linear relationship. The non-linear relationship is due to saturation in the iron core.



Maximum speed

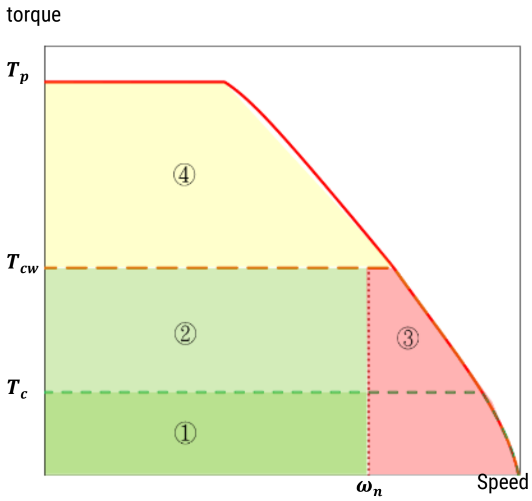
The maximum speed is defined as the maximum speed achieved at a specific torque (usually continuous torque). There are three conditions for determining the maximum speed of a torque motor: maximum speed at air-cooled continuous torque, maximum speed at water cooled continuous torque, and maximum speed at peak torque.

Nominal speed: ω_n (rpm)

The nominal speed (ω_n) is defined as the speed at which the rotor is not damaged by the high temperature of the rotor (>80 °°C) caused by iron losses when the motor runs continuously without interruption; if the speed exceeds this value, the duty cycle must be reduced or additional heat dissipation for the rotor must be provided. Please refer to the T-N curve for the motor's range.

T-N curve (TMRW/TM-5)

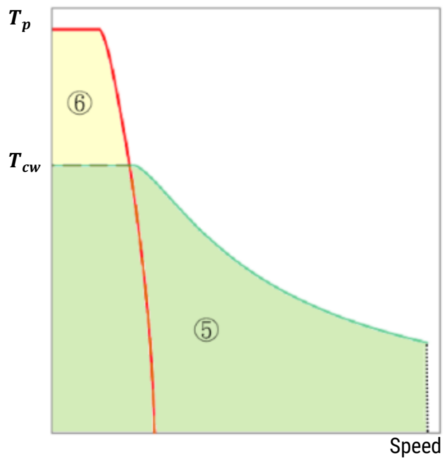
The T-N curve is defined as a comparative diagram of the torque and speed that can be output at a specific input voltage of the motor. Taking into account the temperature rise of the motor, the diagram can be divided into four ranges, as shown below:



① : If the motor is air-cooled and the torque is below T_c , it can run continuously without interruption at speeds below ω_n .
①+②: If the motor is water cooled and the torque is below T_{cw} , it can run continuously without interruption at ω_n .
③: If the motor is air-cooled and the torque is less than T_c , or if it is water cooled and the torque is less than T_{cw} but the speed is greater than ω_n , the duty cycle factor must be reduced or additional heat dissipation measures must be provided on the rotor to prevent the rotor from overheating.
④ : If the motor is air-cooled and the torque is greater than T_c , or if it is water cooled and the torque is greater than T_{cw} , the duty cycle must be reduced. When T_p is reached, only a 1-second output is permitted to prevent the stator from overheating.

T-N curve (IM-2)

The T-N curve is defined as a comparative diagram of the torque and speed that can be output at a specific input voltage of the motor. Taking into account the temperature rise of the motor, the curve can be divided into two ranges, as shown on the next page:



⑤ : If the motor is water cooled and the torque is less than T_{cw} , it can run continuously below the maximum speed under field weakening without interruption.

⑥ : If the motor is water cooled and the torque is greater than T_{cw} , the duty cycle must be reduced. When T_p is reached, only a 1-second output is permitted to prevent the stator from overheating.

Maximum input voltage (V_{DC})

The maximum input voltage is the maximum voltage at which the motor can be operated under normal ambient conditions.

Maximum continuous power loss: P_c (W)

°C°CThe maximum continuous power loss is the energy lost when the motor runs continuously at continuous current and the coil temperature is 120 °C (130 °C for TM-5/IM-2). It is mainly converted into heat. In a water cooled cooling system, the loss is largely dissipated by the coolant.

Maximum pressure difference: Δp (bar)

The maximum pressure difference is the maximum value tolerated between the inlet and outlet in a water cooled cooling system using pure water. It corresponds to the minimum water flow rate q. In the event of deviating operating conditions, the pressure difference must be adjusted by calculation (see section**Fehler! Verweisquelle konnte nicht gefunden werden.** **Fehler! Verweisquelle konnte nicht gefunden werden.**

Minimum water flow rate: q (l/min)

The minimum water flow rate is the minimum flow rate required for normal cooling in a water cooled cooling system using pure water. If operating conditions differ, the water flow rate must be adjusted by calculation (see section**Fehler! Verweisquelle konnte nicht gefunden werden.** **Fehler! Verweisquelle konnte nicht gefunden werden.**).

Temperature difference at maximum power dissipation: $\Delta\theta$ (℃)

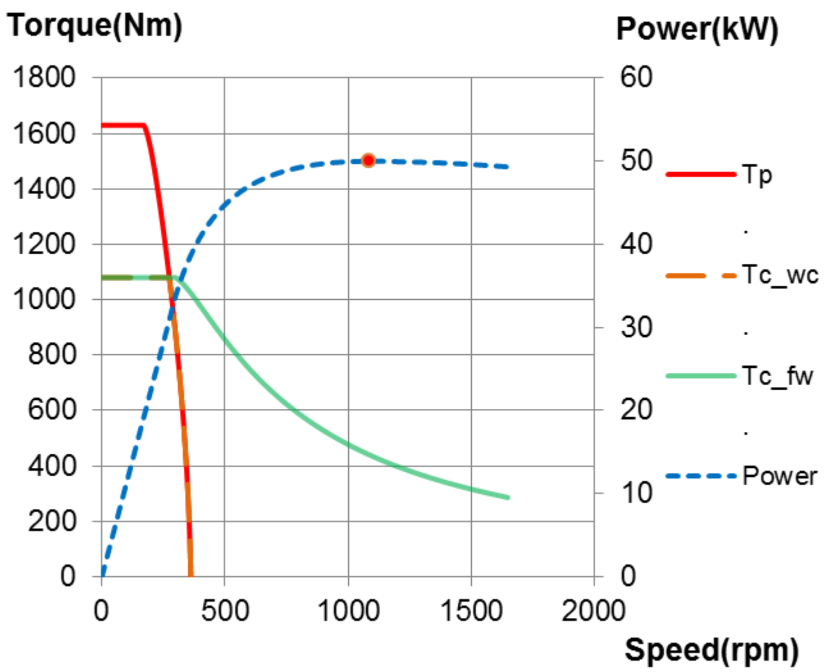
The temperature difference at maximum power dissipation is the temperature difference between the inlet and outlet in a water cooled cooling system using pure water. It is generally set at 5 °C (℃). If the operating environment differs, the temperature difference at maximum power dissipation must be adjusted by calculation (see section**Fehler! Verweisquelle konnte nicht gefunden werden.** **Fehler! Verweisquelle konnte nicht gefunden werden.**

Nominal power (kW)

The nominal power is the maximum continuous nominal power, as specified on the motor's nameplate.

For the IM-2 series, the nominal power in field-weakening mode is higher than in normal operation; therefore, the definition of nominal power for the IM-2 series corresponds to the maximum continuous nominal power in field-weakening mode.

The diagram is shown below; the red dot represents the maximum nominal power in field-weakening mode



11.2 Unit conversion

To convert the unit in column B to the unit in column A, multiply by the corresponding value in the table.

Mass

		B			
		g	kg	lb	oz
A	g	1	0.001	0.0022	0.03527
	kg	1000	1	2.205	35.273
	lb	453.59	0.45359	1	16
	oz	28.35	0.02835	0.0625	1

Linear velocity

		B				
		m/s	cm/s	mm/s	ft/s	in/s
A	m/s	1	100	1000	3.281	39.37
	cm/s	0.01	1	10	3.281×10^{-2}	0.3937
	mm/s	0.001	0.1	1	3.281×10^{-33}	$3.937 \times^{10^{-2}}$
	ft/s	0.3048	30.48	304.8	1	12
	in/s	0.0254	2.54	25.4	8.333×10^{-2}	1

Angular velocity

		B			
		deg/s	rad/s	rpm	rpm
A	deg/s	1	1.745×10^{-2}	0.167	2.777×10^{-3}
	rad/s	57.29	1	9.549	0.159
	rpm	6	0.105	1	1.667×10^{-2}
	r/s	360	6.283	60	1

Force

		B		
		N	lb	oz
A	N	1	0.2248	3.5969
	lb	4.4482	1	16
	oz	0.2780	0.0625	1

Moment of inertia

		B			
		$kg\cdot m^2$	$lb\text{-}in^2$	$lb\text{-}ft^2$	$oz\text{-}in^2$
A	$kg\cdot m^2$	1	3417.63	23.73	54,644.81
	$lb\text{-}in^2$	2.926×10^{-4}	1	6.943×10^{-3}	15.99
	$lb\text{-}ft^2$	4.214×10^{-2}	144.02	1	2302.73
	$oz\text{-}in^2$	1.83×10^{-5}	6.254×10^{-2}	4.34×10^{-4}	1

length

		B				
		m	cm	mm	ft	in
A	m	1	100	1000	3.281	39.37
	cm	0.01	1	10	3.281×10^{-2}	0.3937
	mm	0.001	0.1	1	3.281×10^{-33}	3.937×10^{-2}
	ft	0.3048	30.48	304.8	1	12
	in	0.0254	2.54	25.4	8.333×10^{-2}	1

torque

		B			
		N·m	lb-in	lb-ft	oz-in
A	N·m	1	8.851	0.7375	140.84
	lb-in	0.113	1	8.333×10^{-2}	16
	lb-ft	1.355	11.99	1	191.94
	oz-in	7.1×10^{-3}	6.25×10^{-2}	5.21×10^{-3}	1

Temperature

		B	
		°C	°F
A	°C	1	(°F - 32) x 5 / 9
	°F	(°C × 9 / 5) + 32	1

11.3 Tolerances and assumptions

11.3.1 Tolerances

With the exception of sizes, tolerances of ±10% apply to all values stated in the motor specifications. Dimensions without specified tolerances are subject to general tolerances, with the exception of the effective thread depth and the Pin bore. The tolerance table is shown in the approved drawing.

11.3.2 Assumptions regarding heat transfer

The assumptions for all specifications are based on water cooled cooling and natural air cooling. For other heat dissipation conditions, individual tests must be carried out for verification.

Assumptions for air cooling: Ambient temperature around stator/rotor: 20 ° C;

Assumptions for water cooled cooling:

- Ambient temperature around the rotor: 20°C
- Inlet water temperature: 20°C
- Temperature difference between inlet and outlet water: 5°C
- External temperature of the stator: average 22.5°C

The heat exchange characteristics of the stator are defined in accordance with the number of cooling systems and the interface design as perTable5 .1 .

11.3.3 Ambient conditions

°CThe continuous current is tested in accordance with the IEC 60204-1 standards for the selected power cable at a maximum ambient temperature of 30 ° C for motors. At higher ambient temperatures, the nominal power may need to be reduced to ensure compliance with the above standards.

11.4 Features

- THPD is used only with HIWIN torque motors.
- A Pt1000 sensor can also be used.
- It converts three temperature sensor inputs from the motor into one analogue output and two digital outputs and sends these to the controller.
- Real-time temperature monitoring is achieved through software compensation. Even under extreme operating conditions, motor overheating can be prevented.
- The controller can retrieve complete information on the motor temperature using the following methods.

  Analogue temperature output: Pt1000

  Digital alarm output: Alarm

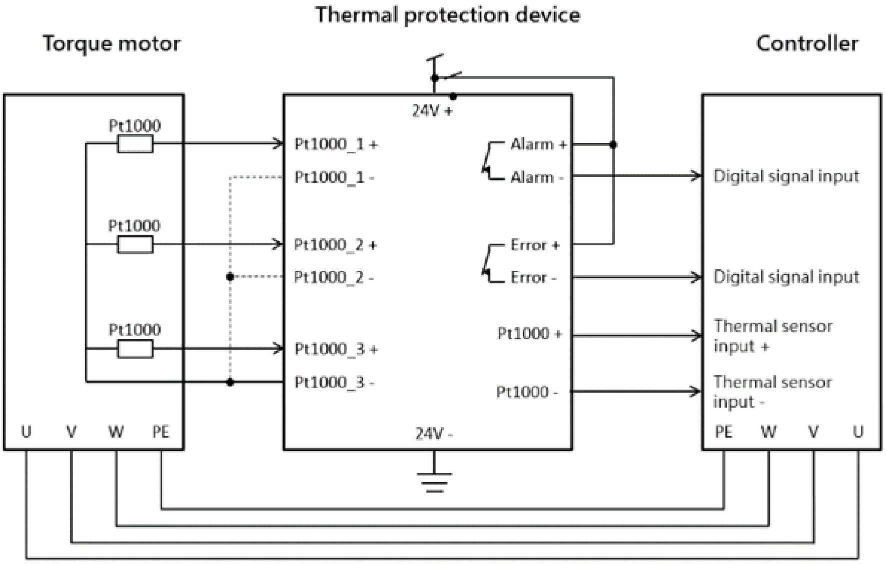
  Digital fault output: Fault

11.4.1 Wiring of the temperature module

If the motor's temperature sensor is a Pt1000, it must be used with THPD-1000-□□□. The connection diagram is shown below.

□□□: 120 for TMRW, 130 for TM-5/IM-2.

Fig.11 .1 : Pt1000 wiring diagram



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