HIWIN® MIKROSYSTEM

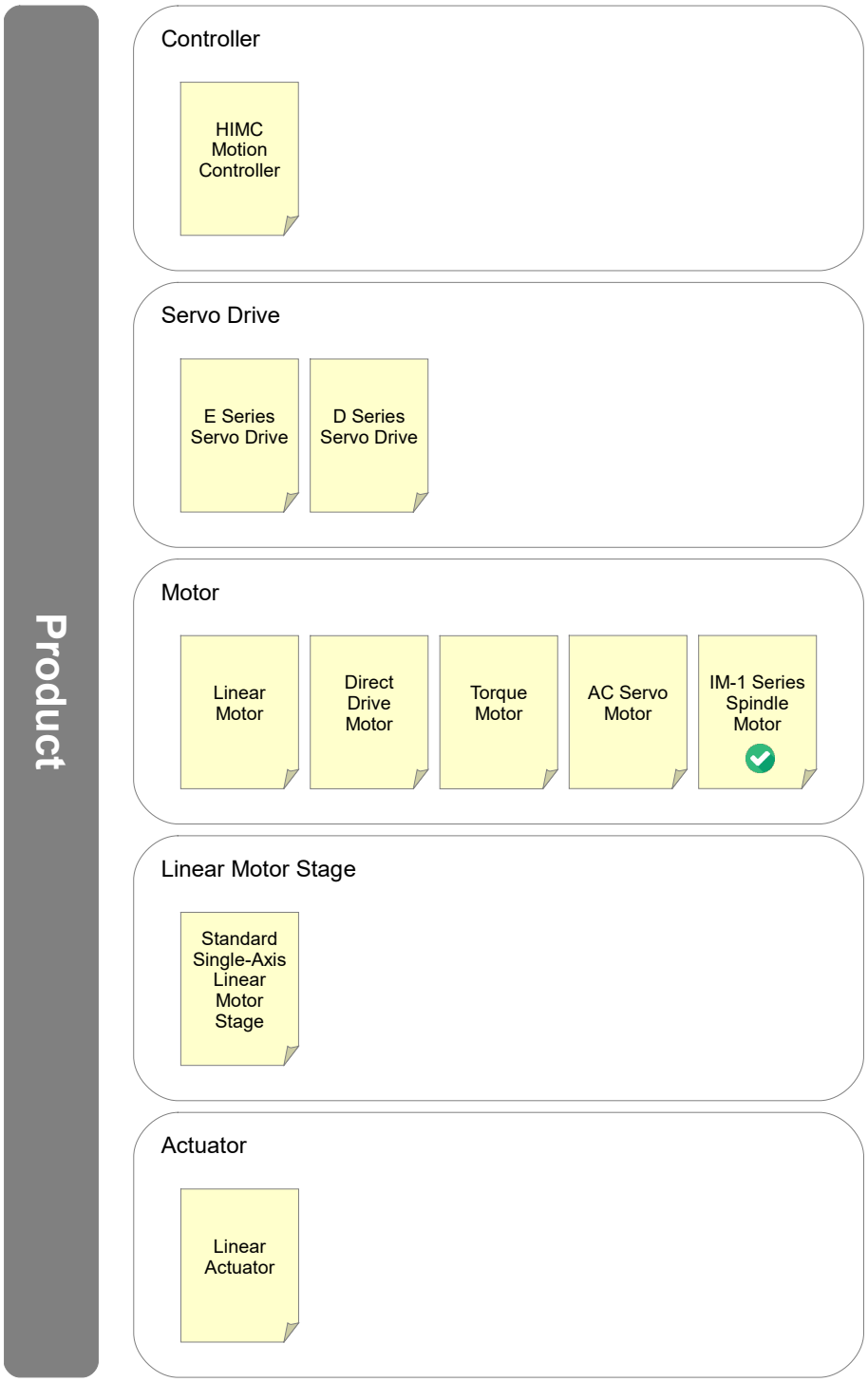
IM-1 Series Spindle Motor

User Manual

www.hiwinmikro.tw
MS01UE01-2305_V1.0

Related Documents

The figure and table of the documents related to the product are shown below. Refer to these documents as required.



Product		Doc. Name	Doc. No.	Content
Controller	HIMC Motion Controller	HIMC Installation Guide	MH07UE01-□□□□	Provides detailed information on installing and connecting HIMC motion controller.
		HIMC iA Studio User Guide	MH01UE01-□□□□	Provides detailed information on the human machine interface operation of HIMC motion controller.
		HIMC Modbus TCP User Guide	MH02UE01-□□□□	Provides detailed information on the way Modbus TCP communication protocol applied to HIMC motion controller.
		HIMC HMPL User Guide	MH06UE01-□□□□	Provides detailed information on HMPL library of HIMC motion controller.
		HIMC API Reference Guide	MH05UE01-□□□□	Provides detailed information on API library of HIMC motion controller.
		HIOM Installation Guide	MH03UE01-□□□□	Provides detailed information on installing and connecting HIOM (HIWIN mega-ulink IO module).
		ETA3 Installation Guide	MH09UE01-□□□□	Provides detailed information on installing and connecting ETA3 (HIMC remote module).
Servo Drive	E Series Servo Drive	E1 Series Servo Drive User Manual	MD09UE01-□□□□	Provides detailed information on selecting, installing, connecting, setting, performing test run for, tuning, and monitoring E1 series servo drive.
		E2 Series Servo Drive User Manual	MD28UE01-□□□□	Provides detailed information on selecting, installing, connecting, setting, performing test run for, tuning, and monitoring E2 series servo drive.
		E1 Series Servo Drive Thunder Software Operation Manual	MD12UE01-□□□□	Provides detailed information on the human machine interface operation of E1 series servo drive.
		E1 Series Servo Drive EtherCAT(CoE) Communications Command Manual	MD08UE01-□□□□	Provides detailed information on the way EtherCAT communication protocol applied to E1 series servo drive.
		E1 Series Servo Drive MECHATROLINK-III Communication Command Manual	MD24UE01-□□□□	Provides detailed information on the way MECHATROLINK-III communication protocol applied to E1 series servo drive.
		E1 Series Servo Drive PROFINET Communication Command Manual	MD02UE01-□□□□	Provides detailed information on the way PROFINET communication protocol applied to E1 series servo drive.
		E1 Series Servo Drive Gantry Control System User Manual	MD22UE01-□□□□	Provides detailed information on the usage of E1 series servo drive gantry control system.
		E1 Series Servo Drive Electronic Cam Control System User Manual	MD27UE01-□□□□	Provides detailed information on the usage of E1 series servo drive electronic cam control system.
		E1 Series Servo Drive Multi-Motion Function User Manual	MD32UE01-□□□□	Provides detailed information on the usage of E1 series servo drive multi-motion function.
		MPI Library Reference Manual	MD19UE01-□□□□	Provides detailed information on MPI library of E1 series servo drive and D series servo drive.
		MPI Examples	MD18UE01-□□□□	Provides detailed information on MPI examples of E1 series servo drive and D series servo drive.
		API Library Reference Manual for Servo Drives	MD23UE01-□□□□	Provides detailed information on API library of E1 series servo drive and D series servo drive.
		PDL Examples for E1 Series Servo Drive	MD25UE01-□□□□	Provides detailed information on PDL examples of E1 series servo drive.

Product		Doc. Name	Doc. No.	Content
Servo Drive	E Series Servo Drive	Application Note E1 PROFINET Drive Complete Setup with Siemens TIA Portal	MD30UE01-□□□□	Provides detailed information on the operation of PLC software TIA Portal when E1 PROFINET drive is used with Siemens S7 series PLC.
		Application Note E1 MECHATROLINK-III Drive Complete Setup with YASKAWA MPE720	MD31UE01-□□□□	Provides detailed information on the operation of machine controller software MPE720 when E1 MECHATROLINK-III drive is used with YASKAWA MP3000 series machine controller.
Servo Drive	D Series Servo Drive	D1 Servo Drive User Manual	MD20UE01-□□□□	Provides detailed information on selecting, installing, connecting, setting, performing test run for, tuning, and monitoring D1 servo drive.
		D2 Series Servo Drive User Manual	MD07UE01-□□□□	Provides detailed information on selecting, installing, connecting, setting, performing test run for, tuning, and monitoring D2T servo drive.
		D2T-LM Series Servo Drive User Manual	MD11UE01-□□□□	Provides detailed information on selecting, installing, connecting, setting, performing test run for, tuning, and monitoring D2T-LM servo drive.
		MPI Library Reference Manual	MD19UE01-□□□□	Provides detailed information on MPI library of E1 series servo drive and D series servo drive.
		MPI Examples	MD18UE01-□□□□	Provides detailed information on MPI examples of E1 series servo drive and D series servo drive.
		API Library Reference Manual for Servo Drives	MD23UE01-□□□□	Provides detailed information on API library of E1 series servo drive and D series servo drive.
		PDL Examples for D-series Drives User Manual	MD13UE01-□□□□	Provides detailed information on PDL examples of D series servo drive.
Motor	Linear Motor	Linear Motor User Manual	MP99UE01-□□□□	Provides detailed information on selecting, installing, and connecting linear motor.
	Direct Drive Motor	DMN Series Direct Drive Motor User Manual	MR01UE01-□□□□	Provides detailed information on selecting, installing, and connecting DMN series direct drive motor.
		DMT Series Direct Drive Motor User Manual	MR03UE01-□□□□	Provides detailed information on selecting, installing, and connecting DMT series direct drive motor.
		DMY Series Direct Drive Motor User Manual	MR04UE01-□□□□	Provides detailed information on selecting, installing, and connecting DMY series direct drive motor.
		DMS Series Direct Drive Motor User Manual	MR05UE01-□□□□	Provides detailed information on selecting, installing, and connecting DMS series direct drive motor.
		DMR Series Direct Drive Motor User Manual	MR06UE01-□□□□	Provides detailed information on selecting, installing, and connecting DMR series direct drive motor.
	Torque Motor	Torque Motor User Manual	MW99UE01-□□□□	Provides detailed information on selecting, installing, and connecting torque motor.
	AC Servo Motor	AC Servo Motor User Manual	MC03UE01-□□□□	Provides detailed information on selecting, installing, and connecting AC servo motor.
	IM-1 Series Spindle Motor	IM-1 Series Spindle Motor User Manual	MS01UE01-□□□□	Provides detailed information on selecting and installing IM-1 series spindle motor.
Linear Motor Stage	Standard Single-Axis Linear Motor Stage	Standard Single-Axis Linear Motor Stage User Manual	MM06UE01-□□□□	Provides detailed information on selecting, installing, and connecting standard single-axis linear motor stage.

Product		Doc. Name	Doc. No.	Content
Actuator	Linear Actuator	Linear Actuator User Manual	MA99UE01-□□□□	Provides detailed information on selecting, installing, and connecting linear actuator.

Approvals

Motor Model	Approvals	
	EU Directives	UL Approvals
	CE	UL
IM-1-135□□ IM-1-106□□		

Table of Contents

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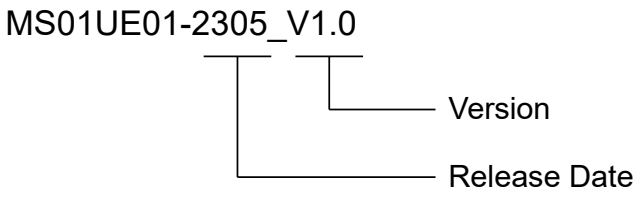
1. General information

1.1 Revision history

The version of the manual is also indicated on the bottom of the front cover.



Release Date	Version	Applicable Product	Revision Contents
May 31st, 2023	1.0	IM-1 Series Spindle Motor	First edition.

1.2 About this manual

This manual aims to assist users to install and operate IM-1 series spindle motor. Before using the product, please carefully read through this manual in accordance with the table of content, including introduction, sizing, installation, maintenance, waste disposal, troubleshooting and appendix. Follow the general precautions and safety instruction to ensure trouble-free operation.

1.3 General precautions

Before using the product, please carefully read through this manual. HIWIN MIKROSYSTEM is not responsible for any damage, accident or injury caused by failure in following the instructions of installation and operating stated in this manual.

- Before installing or using the product, ensure there is no damage on its appearance, and check if the wiring of the motor is correctly performed. Otherwise, the motor may not run normally, resulting in motor malfunction or damage. If any damage is found after inspection, please contact the sales representatives of HIWIN MIKROSYSTEM or agents or dealers.
- Carefully read through the specification noted on the product label or technical document, and check if the product is used with the power supply specified in the product requirement. Install the product in accordance with the specification and instructions stated in this manual. HIWIN MIKROSYSTEM is not responsible for any damage, accident or injury caused by the usage of incorrect power supply.
- Ensure the product is used with the rated load. Do not use the product with loads that exceed the specification standards. HIWIN MIKROSYSTEM is not responsible for any damage, accident or injury caused by improper usage.
- Do not subject the product to shock or place it in risky locations. HIWIN MIKROSYSTEM is not responsible for any damage, accident or injury caused by improper usage.
- Do not disassemble or modify the product on your own. The design of the product has been verified by structural calculation, simulation analysis and actual testing. HIWIN MIKROSYSTEM is not responsible for any damage, accident or injury caused by disassembly or modification done by users without authorization.
- Children must be supervised and be away from the product. It is forbidden to play in the area where the product is operating. Do not throw the product and its accessories and do not ride or place heavy objects on the product.
- Since the product contains strong magnet, persons with cardiac pacemakers or implanted metal devices must be away from the product. Be particularly careful with the risk of crush injury and avoid using magnetic tools or screws. Keep magnetic recording equipment or precision instruments away from the product. HIWIN MIKROSYSTEM is not responsible for any damage, accident or injury caused by the conditions above.
- Persons who do not have experience with related products may not be allowed to operate this product unless they are accompanied by supervisors or personnel familiar with the product. HIWIN MIKROSYSTEM is not responsible for any damage, accident or injury caused by the conditions above.
- If an error or any abnormal conditions occur in the product, please refer to chapter 9 and follow the instructions for troubleshooting. The product can only be repaired by qualified technician from HIWIN MIKROSYSTEM. HIWIN MIKROSYSTEM is not responsible for any damage, accident or injury caused by human factors.

- If the information of registration does not match with your purchasing or if there are any questions related to the product, please contact the sales representatives of HIWIN MIKROSYSTEM or agents or dealers.

HIWIN MIKROSYSTEM offers 1-year warranty for the product. The warranty does not cover damage caused by improper usage (Refer to the precautions and instructions stated in this manual) or natural disaster.

1.4 Safety instruction

- Carefully read through this manual before installation, transportation, maintenance, and examination. Ensure the product is correctly used.
- Carefully read through electromagnetic (EM) information, safety information, and related precautions.
- Safety precautions in this manual are classified into “DANGER,” “WARNING,” and “CAUTION.”

⚠DANGER

Imminent danger!

Indicates that death or severe personal injury will result if proper precautions are not taken.

⚠WARNING

Potentially dangerous situation!

Indicates that death or severe personal injury may result if proper precautions are not taken.

⚠CAUTION

Potentially dangerous situation!

Indicates that property damage or environmental pollution can result if proper precautions are not taken.

Warning Signs			
	No access for people with active implanted cardiac devices.		Substance hazardous to the environment!
	Warning!		Warning of crushing of hands!
	Warning of electricity!		Warning of hot surface!
	Warning of magnetic field!		Metal objects and watches are prohibited!
	Metal implants are prohibited!		Magnetic and conductive objects are prohibited!
	Do not apply excessive force!		Do not stack the products!

Mandatory Signs			
	Wear head protection!		Refer to user manual!
	Wear protective gloves!		Disconnect before carrying out maintenance or repair.
	Wear safety footwear!		Lifting point.
	Loud noise hazard!		Keep out of reach of children.

DANGER


◆ When the product is transporting, installing or operating, persons with cardiac pacemakers or implanted metal devices must be away from the product for life safety.

⚠WARNING

- Do not install the product in locations with high ambient temperature and high humidity or locations subject to dust, iron powder, cutting powder, corrosive materials, flammable gas or flammable materials.
- The peripheral devices (including servo drive and controller) must share the same power supply system with the motor. Otherwise, the voltage difference between the devices and the motor may result in burn-out.
- Check if the power supply is specified in product specification before operating, or it may cause injury or fire.
- Do not use the product with loads that exceed its specification standard and check if the temperature of the motor meets the requirement. Stop the motor immediately and turn off the power if there is peculiar smell, noise, smoke or abnormal vibration.
- Do not touch the terminals and internal parts of the product within ten minutes after power off, or the residual voltage may cause electric shock.
- Ensure the wiring is correctly performed. Otherwise, it may lead to product malfunction or burn-out. There will be a risk of injury or fire.
- Do not modify the wiring or touch the terminals or internal parts of the product, or it may cause an electric shock.

⚠CAUTION

- Wear protective gloves to prevent cuts.
- Wear safety footwear to prevent the risk of smashing by the product.
- When picking or placing the motor, do not drag the motor only by pulling its wire.
- Do not apply excessive force to the product.
- Do not stack the products to avoid collapse.
- Carefully transport the product to prevent damage.
- Transportation and storage temperature of the product: +5°C ~ +40°C.
- Operating temperature of the product: +5°C ~ +40°C.
- The rotor has strong force of attraction. Safety protection must be done and do not approach magnetic conductors (such as iron objects) to avoid danger.
- Install the product in locations with ambient temperature stated in this manual. Use cooling fan if the ambient temperature is too high.
- Do not install the product in locations which are subject to direct sunlight.
- The product is not drip-proof or waterproof, so do not store the product outdoors or in locations with humidity or locations subject to dust, harmful liquid, harmful gas or direct sunlight.
- Install and store the product in locations with less vibration.

- Install the product on noncombustible objects such as metal to avoid fire.
- Do not place heavy object on the product to avoid strong shock to the product, or it may cause malfunction or injury.
- While installing the product, take its weight into consideration. Improper installation may cause damage to the product.
- Check if the main switch is on before operating the motor.
- Check if the cooling system is operating before motor operation.
- Before power output, ensure there is at least one ground wire connects to all electrical products.
- During motor operation, nonessential friction may be produced if there are other objects on the path. If the current exceeds the maximum allowable current on its specifications, the magnetic elements inside the motor may degaussed. Please contact the sales representatives of HIWIN MIKROSYSTEM or agents or dealers if the above-mentioned condition occurs.
- Motor generates heat after running for a period of time, please use cooling fan. Disable the motor when it is not in use, so the ambient temperature will not exceed the specification.
- Do not directly touch the motor when it stops operating.
- The product may abruptly start to operate after power supply recovers. Please do not get too close to the product.
- Set external wiring for emergency stop to stop the motor at any time.

1.5 Copyright

Note:
HIWIN MIKROSYSTEM reserves the right to change the contents of this manual or product specifications without prior notice.

1.6 Manufacturer information

Table 1.6.1 Manufacturer's details

Corp.	HIWIN MIKROSYSTEM CORP.
Address	No.6, Jingke Central Rd., Taichung Precision Machinery Park, Taichung 40852, Taiwan
Tel.	+886-4-23550110
Fax	+886-4-23550123
Sales E-mail	business@hiwinmikro.tw
Customer Service E-mail	service@hiwinmikro.tw
Website	http://www.hiwinmikro.tw

1.7 Product monitoring

Please inform the sales representatives of HIWIN MIKROSYSTEM about the following contents.

- Accidental risk assessment.
- Potential source of danger involving person and property.
- Anything in this user manual which is difficult to understand.

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2. Basic safety information

2.1 Overview

This chapter explains safety notices and risk management approach of using the product.

2.2 Basic safety notices

- Stay vigilant for safety when using the product. Immediately report if there is an emergency.
- Users need to maintain a good mental state. Do not use the product without clear consciousness.
- Do not run or play in the workspace.
- It is necessary to understand chemical related to the product such as alcohol and lubricants. Mark them on the bottles to prevent accidental ingestion.
- Be sure to configure fire extinguishers and install automatic sprinklers in the operating environment to avoid fire that causes casualties and property loss.
- It is strictly forbidden to store flammable substances in the working area, smoking is prohibited in the place.

2.3 Reasonably foreseeable misuse

2.3.1 Environment factors

- Use the product outdoors.
- Store in potentially explosive environments or locations subject to corrosive solvent.
- Place with various magnetic conductors.
- Place the product in high places or stacked environments.
- Place the product on an unsafe or moving machinery.

2.3.2 Product factors

- Not maintain the product properly.
- Not aware that the product contains strong magnet, resulting in damage to related valuables.
- Accidentally ingest the lubricant of the product.

2.3.3 Personal factors

- Maintenance work by untrained or unauthorized personnel.
- Persons who have not fully read and understood this user manual.
- Not follow the instruction manual intentionally or carelessly while using the product.
- Operate the product without clear consciousness or under the influence of drugs or alcohol.

2.4 Conversions and modifications

- Do not modify, disassemble, or damage the product on your own without authorization. If there are any requirements, please contact the sales representatives of HIWIN MIKROSYSTEM.
- Do not tear the product label or attached identification card.
- Do not place other products in the carton containing HIWIN MIKROSYSTEM's logo for sale or forwarding.

2.5 Residual risks

If users operate the product with instructions in the user manual, risks can be effectively controlled and reduced. Please refer to the relevant chapters for risks and warnings of the product usage and maintenance.
If users cannot fully understand the product or have any questions after reading the manual, please contact the sales representatives of HIWIN MIKROSYSTEM, there will be professionals to assist you.

2.6 Personnel requirements

Persons with cardiac pacemakers or implanted metal devices must be away from the product for life safety. Users must carefully read through the product user manual and be authorized or familiar with the product. In addition, users must also be familiar with the safety equipment and regulations.

Table 2.6.1 Personnel requirements

Activity	Qualifications
Transport	Personnel who do not have pacemakers or implanted metal devices in their bodies.
Installation	Trained personnel.
Assembly	Trained personnel.
Maintenance and cleaning	Agents, dealers, or personnel who do not have pacemakers or implanted metal devices in their bodies.
Repair	Agents, dealers, or trained personnel.

2.7 Protective equipment

2.7.1 Requirements for personal equipment

Table 2.7.1.1 Requirements for personal equipment

Activity	Personal equipment	Description
Transport		During transport, wear safety shoes to prevent the risk of accidental drop of the product or injury.
Assembly		During assembly, the rotor needs to be lifted due to strong force of attraction. Be sure to wear a helmet.
Maintenance and cleaning		Wear protective gloves when wiping the surface of the product with lubricant and alcohol.
Operating		In case of noise, wear protective earmuffs and do not expose to it for prolonged periods of time.

2.7.2 Requirements for safety equipment

The product has different dimensions and specifications, if it cannot be carried by hand, please use a bridge crane to lift it. Be sure to wear a helmet to protect your head while lifting.

Table 2.7.2.1 Requirements for safety equipment

Activity	Protective equipment	Description
Lifting point.		Ensure the hanging ring is clamped and the load is complied with the regulation.

2.8 Labels on spindle motor

The label affixed on the carton provides detailed information on product specification.

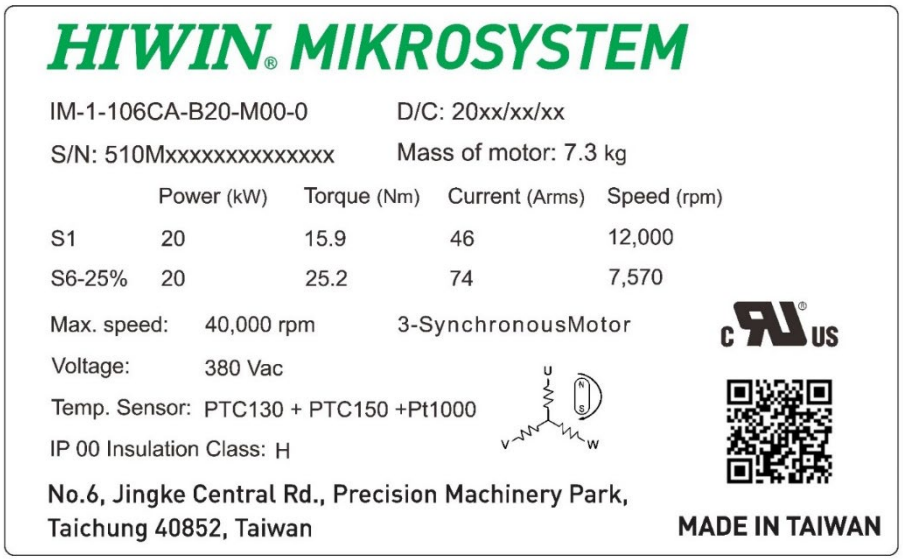


Figure 2.8.1 Shipping label

Since the rotor of the product contains strong magnet, there is a sign affixed on the outer carton to warn users away from the product, especially persons with cardiac pacemakers or implanted metal devices.

⚠WARNING

- The product contains strong magnet, do not to approach or touch it with magnetic conductors.

Note:

Before using the product, check if the label matches the specification.

3. Product description

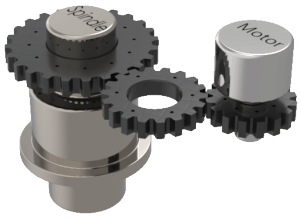
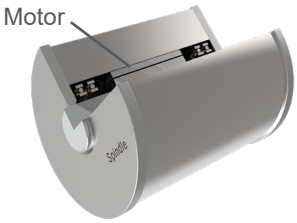
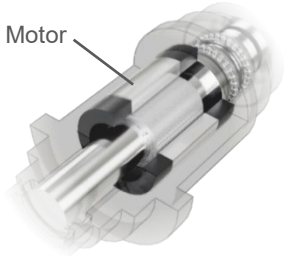
3.1 Spindle motor description

This product is applied to direct-driven and high-speed spindle, which adopts built-in technology to place the motor inside the spindle.

3.1.1 Advantages of built-in spindle

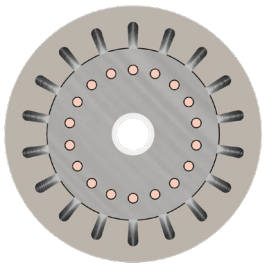
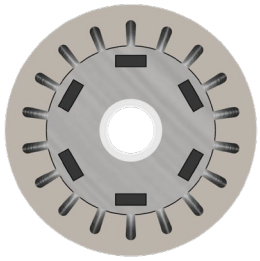
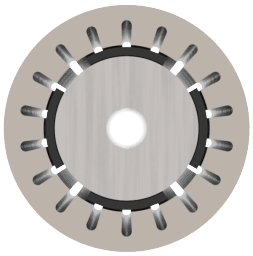
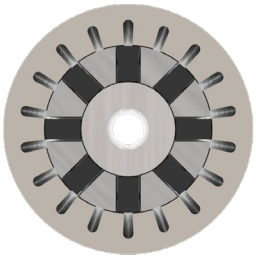
Built-in technology has the advantages of reducing the transmission power loss between mechanisms due to space omission of gears, belts, couplings or transmission, which improves the transmission efficiency and speed of the main shaft, improves precision, and saves energy and electricity.

Table 3.1.1.1 Type of spindle motor

Gear	Induction
	
Belt	**Direct**
	
Built-in	
	

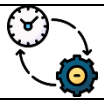
The product adopts a built-in spindle motor structure, which can increase the torque by 10%~30% compared with ordinary induction motors under the same volume. Therefore, under the same output, the volume can be reduced by about 10%~30%, and the heat loss can be reduced by 50%.

Table 3.1.1.2 Type of rotor structure

Induction	Built-in
	
Surface mount	**Embedded**
	

The advantages of the product's motor performance and added value:

Table 3.1.1.3 Product advantages

Motor performance		Speed increase: Maximum speed is increased by 10~30%.
		Reduction of thermal loss: Heat loss in the motor is reduced by 50%.
		Acceleration of time: Acceleration time of the motor from 0 to max is 36% faster to achieve max speed.
Added value		Energy saving and carbon reduction: Power consumption of spindle and carbon emissions is reduced by 55%.
		Accuracy enhancement: Reduce thermal expansion of the mandrel of spindle and improve accuracy by 75%.
		Working efficiency: Product processing efficiency is increased by 56%.

Note: Motor performance will vary according to mechanism design, assembly quality, and actual operating conditions.

3.2 Main components of spindle motor

The product consists of a stator and a rotor. It is mainly used in built-in spindles to provide power source to the spindle. The stator is divided into two types, the one without cooling jacket and the one with cooling jacket. The stator with cooling jacket provides high-efficiency heat conduction and heat management. If customers have the requirement of high-efficiency heat dissipation, it is recommended to use the stator with cooling jacket.

3.2.1 Stator type

The stator is divided into two types, the one without cooling jacket and the one with cooling jacket. The main materials are aluminum alloy, silicon steel sheet, coil and epoxy resin, and the outgoing part includes power cables and temperature sensor.

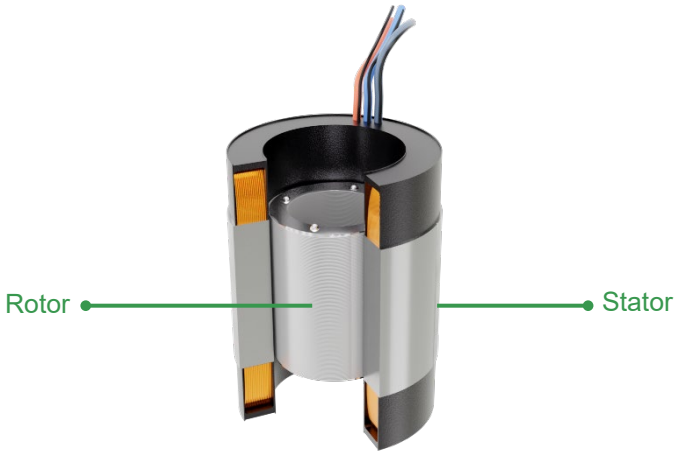


Figure 3.2.1.1 Stator without cooling jacket

Figure 3.2.1.2 Stator with cooling jacket

3.2.2 Rotor structure

The product adopts permanent magnet rotor structure. The main materials are silicon steel sheet and stainless steel. The special arrangement and combination of magnets provides high-speed expansion capability (CPSR) and wide operating range in the product.

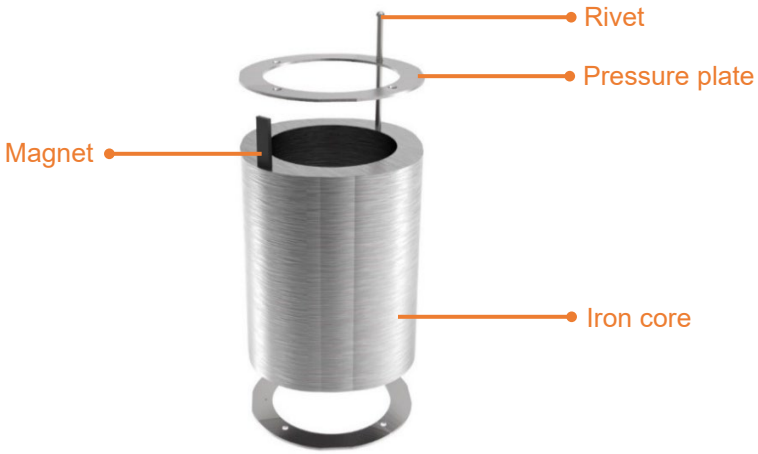


Figure 3.2.2.1 Rotor structure

Note:

1. The rotor has strong force of attraction. Safety protection must be done during assembly or transportation. Do not approach magnetic conductors (such as iron objects) to avoid danger.
2. Customized products are available, please contact the sales representatives of HIWIN MIKROSYSTEM.

3.3 Order code

Table 3.3.1 Coding principles

Code	1	2	-	3	-	4	5	6	7	8	-	9	10	11	-	12	13	14	-	15
Example	I	M	-	1	-	1	3	5	C	A	-	B	2	0	-	M	1	0	-	0
1, 2, 3: IM-1 series spindle motor	IM-1																			
4, 5, 6: External diameter of stator	083: 83 mm 106: 106 mm 135: 135 mm 160: 160 mm																			
7, 8: Height of stator	BA: 50 mm CA: 100 mm DA: 150 mm EA: 200 mm FA: 250 mm																			
9: Number of poles	A: 2 B: 4 C: 6 D: 8 E: 10																			
10, 11: Rated power	06: 5.1~6.1 kW 11: 10.1~11 kW 20: 19.1~20 kW 30: 29.1~30 kW																			
12: Motor voltage	S: 220 V M: 380 V																			
13: Motor power cable length	0: 500 mm 1: 1000 mm 2: 2000 mm																			
14: Temperature sensor	0: PTC130 + PTC150 + Pt1000 1: PTC130 + PTC150 + Pt1000 x3																			
15: Stator type	0: Without cooling jacket 1: With cooling jacket																			

Note:

1. Rated power number can be used from 1~99 kW.
2. Customized products are available, please contact the sales representatives of HIWIN MIKROSYSTEM.

3.3.1 Motor sizing

Select the appropriate motor based on the requirements for processing conditions, power system, and cooling system.

3.3.1.1 Motor sizing process

Select a suitable motor based on the requirement for processing condition, power system, cooling system, etc.

Requirement confirmation
■ Spindle type for machine tool (Turning/ Milling/ Grinding/ Drilling) ■ Spindle dimension ■ Processing condition (Turning/ Milling/ Grinding/ Drilling) ■ Cooling system ■ Drive system

↓

Torque calculation
■ Calculate the speed, torque, and power of each processing condition.

↓

Motor selection and T-N curve confirmation
■ Refer to HIWIN MIKROSYSTEM catalog and select the appropriate motor according to the calculated speed, torque, and power. ■ Confirm that the speed, torque, and power of all processing conditions are within the range of torque-speed curve of the motor.

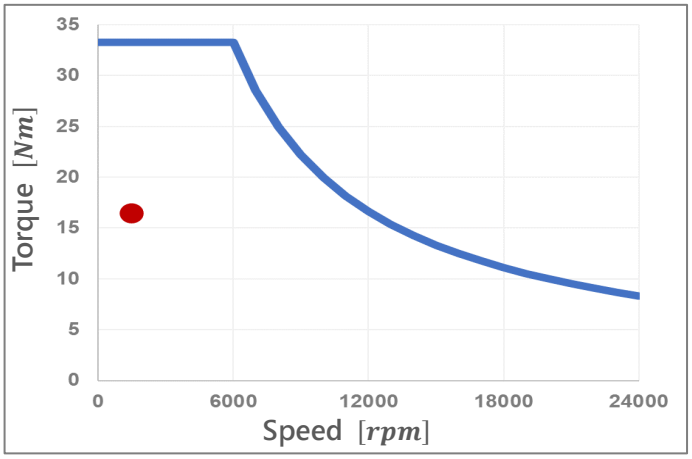


Figure 3.3.1.1.1 T-N curve

3.3.1.2 Heat loss

When the motor converts electrical energy into kinetic energy, copper loss, iron loss, and mechanical loss will inevitably occur.

- Copper loss: It is caused by resistance when current flows through the stator coil of the motor.
- Iron loss: It is divided into hysteresis loss and eddy current loss. Most of the losses are caused by the varying magnetic fields between the stator core, rotor core and rotor magnet.
- Mechanical loss: The loss includes bearing friction loss, air friction loss under high-speed rotation, and heat loss due to friction such as rotary seal.

Take spindle for example, bearing friction loss represents the highest proportion of mechanical loss. If it is necessary to calculate the loss, please contact the manufacturer of the bearing for an accurate evaluation.

Table 3.3.1.2.1 Copper loss calculation formula under rated torque

Copper loss calculation formula under rated torque
$\boldsymbol{P_c = \frac{3}{2} \cdot R_{25} \cdot \{1 + [0.00393 \cdot (\theta_c - 25)]\} \cdot {I_c}^2}$
P_c = Copper loss at a coil temperature of θ_c $[W]$ R_{25_c} = Line-to-line resistance at a coil temperature of 25°C $[\Omega]$ I_c = Rated current at a coil temperature of θ_c $[Arms]$ θ_c = Coil temperature [℃]

The iron loss of the motor is mainly caused by the change of flux during commutation process, and the frequency has a great influence on it. Since speed of the motor is proportional to the frequency, iron loss will be more significant at a high speed, and the number of pole pairs is proportional to iron loss at the same frequency. In the case of continuous high-speed spinning, the additional heat given to the rotor must be calculated in iron loss. At this time, the loss of the motor will increase sharply. It is necessary to properly adjust the operating conditions or take heat dissipation measures for the rotor to avoid overheating.

Table 3.3.1.2.2 Iron loss and frequency calculation formula

Iron loss calculation formula	Frequency calculation formula
$\boldsymbol{P_{Fe} \propto f^2}$	$\boldsymbol{f = \frac{n \cdot p}{60}}$
P_{Fe} = Iron loss $[W]$ f = Frequency $[Hz]$	n = Frequency $[rpm]$ p = Number of pole pairs

Heat loss is mainly transmitted from the coil and iron core to the motor housing through heat conduction. Take natural air cooling for example, heat loss will flow from the contact area between motor housing and air to the external environment through heat convection, and it will conduct heat away from the customer's installation surface through heat radiation and heat conduction; take water cooling for example, heat loss will be transmitted from the center of heat source to the cooling water through heat conduction. Since the convective heat transfer coefficient of cooling water is much higher than air, the effect that heat source transferred to air by convection can be ignored.

The heat dissipation method of the product can be water-cooled or oil-cooled. HIWIN MIKROSYSTEM adopts water-cooled method for verification, please refer to the locations of water inlet and outlet marked on the approved drawing. If a coolant other than water is used, the flow field pattern in the channel will change. If users have this requirement, please contact the sales representatives of HIWIN MIKROSYSTEM, we will provide a professional evaluation. In addition, the maximum coil temperature of the motor must not exceed 150°C under any operating conditions.

3.3.1.3 Continuous operating temperature

The steady-state temperature of the motor coil is determined by the ratio of copper loss to iron loss. Generally, iron loss can be ignored at a low speed. The total motor loss and rated torque T_c are defined at a coil temperature of 150°C. When the equivalent torque T_c is less than the rated torque T_c, the steady-state temperature of the motor coil under various operating conditions is given by the following formula.

Table 3.3.1.3.1 The coil steady-state temperature calculation formula

The coil steady-state temperature calculation formula
$\boldsymbol{\theta_e = \theta_{surr} + \left(\frac{T_e}{T_c}\right)^2 \cdot (\theta_c - 25)}$
θ_e = The coil steady-state temperature under equivalent torque [℃] θ_{surr} = Ambient temperature [℃] T_e = The equivalent torque under actual operation at the coil temperature of θ_e [*Nm*] T_c = Rated torque at the coil temperature of θ_c [*Nm*]

3.3.1.4 Thermal time constant

When the motor is supplied with rated current, the time required for the coil temperature to rise 63% of the difference between the initial and maximum temperatures is shown as follows.

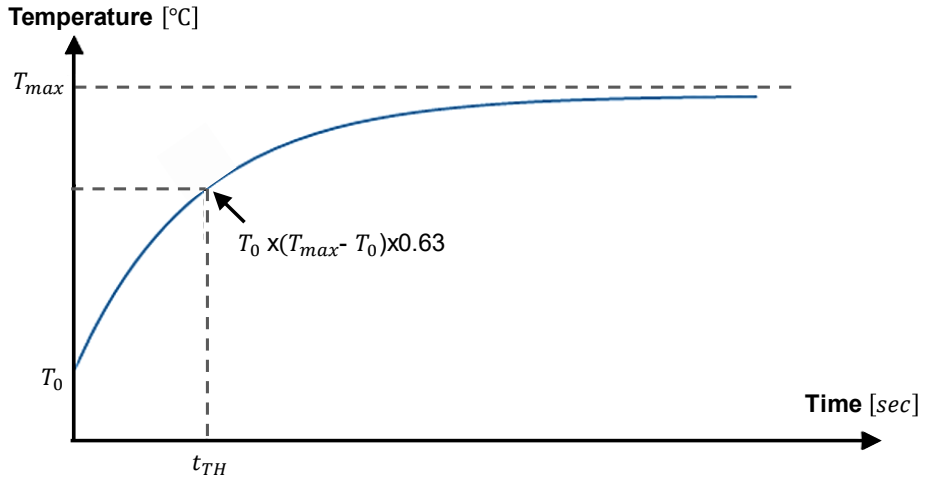


Figure 3.3.1.4.1 Curve of temperature rise

Table 3.3.1.4.1 The relationship between thermal time constant and temperature

The relationship between thermal time constant and temperature
$(\boldsymbol{t}) = \boldsymbol{\theta_i} + (\boldsymbol{\theta_{(t)}} - \boldsymbol{\theta_i}) \cdot \left(\mathbf{1} - \boldsymbol{e}^{-\left(\frac{\boldsymbol{t}}{\boldsymbol{T_{th}}}\right)}\right)$
$\theta_{(t)}$ = Coil temperature at operating time t [℃]
θ_i = Initial coil temperature [℃]
t = Operating time [sec]
T_{th} = Thermal time constant [sec]

When the operating current $\mathrm{I_e}$ is between rated current $\mathrm{I_c}$ and peak current $\mathrm{I_p}$, power-off time must be set to cool the motor, and the above-mentioned thermal time constant can be used to calculate the time required for load cycle. First, obtain coil steady-state temperature θ_e under equivalent torque through equivalent torque $\mathrm{T_e}$ under actual operation by thermal time constant $\mathrm{T_{th}}$. Then, obtain the relative maximum operating time via the following formula.

Table 3.3.1.4.2 The relationship between maximum operating time and coil steady-state temperature $\boldsymbol{\theta_e}$ under equivalent torque

The relationship between maximum operating time and coil steady-state temperature $\boldsymbol{\theta_e}$ under equivalent torque
$\boldsymbol{t_o} = -\boldsymbol{T_{th}} \cdot \boldsymbol{ln}\left(\mathbf{1} - \frac{\boldsymbol{\theta_c} - \boldsymbol{\theta_i}}{\boldsymbol{\theta_e} - \boldsymbol{\theta_i}}\right)$
t_0 = Maximum operating time [sec]

Note:

Coil temperature $\boldsymbol{\theta_c}$ of rated current cannot exceed the specified upper limit.

Table 3.3.1.4.3 The relationship between coil temperature and power-off time

The relationship between coil temperature and power-off time
$$t_b = -T_{th} \cdot ln\left(\frac{\theta(t_b) - \theta_{surr}}{\theta_c - \theta_{surr}}\right)$$
$\theta_{(t_b)}$ = Coil temperature to be cooled after power-off time t_b [℃] t_b = Power-off time [sec]

Note:

The two formulas above can determine the time allocation of load cycle during motor operation.

3.3.2 Peripheral components of the drive

To install a motor-driven power system, besides necessary driven equipment, users also need to add peripheral components such as filters, reactors, and voltage limiters to increase product lifespan and decrease the chances of mechanical failure.

Note:

If there are any questions about the peripheral components of the motor, please contact the sales representatives of HIWIN MIKROSYSTEM or agents or dealers.

3.3.2.1 Power system

To protect the motor and drive equipment, it is recommended to include the following components in power system when using the product.

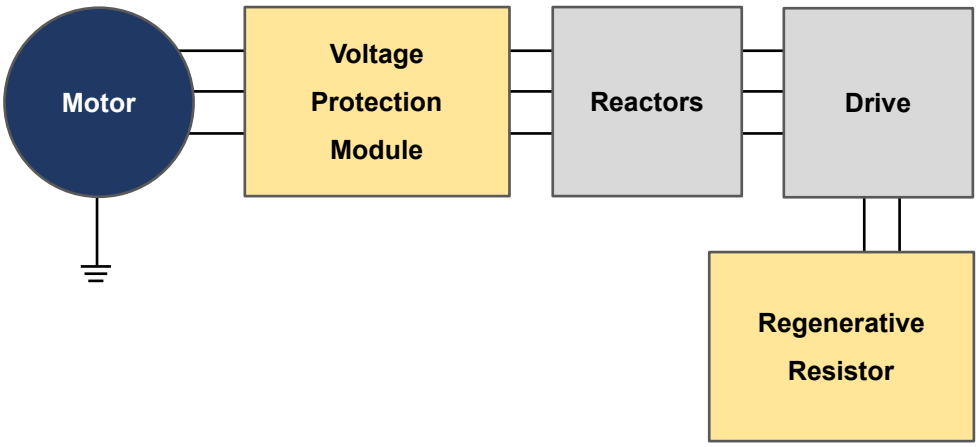


Figure 3.3.2.1.1 Mounting components for electrical equipment

3.3.2.2 Drive

The drive converts AC power with a frequency of 50Hz or 60Hz from the power company into DC power, and then outputs the variable-frequency power through power conversion technique. The position feedback encoder installed on the motor can improve the accuracy of motor position and speed control.

3.3.2.3 Reactors

The motor is output by PWM of the drive, and it produces stray inductance and capacitance through the length of power cables, poles, and terminals, which will generate high-voltage surges at motor end. Long-term high voltage will affect the motor insulation and damage the motor. To prevent this damage, a reactor must be installed at the front end during motor installation.

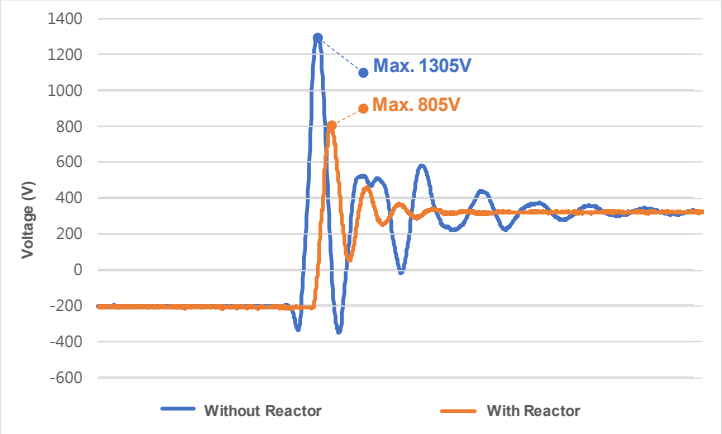


Figure 3.3.2.3.1 Motor surge voltage

3.3.2.4 Voltage Protection Module, VPM

When the motor is running at a high speed, it will generate high-voltage back EMF. Once an accident causes the motor in an uncontrollable state, the motor will be converted to a generator, and the voltage of the motor's EMF will be fed back to the driving equipment through the power cable, resulting in damage to the equipment. Voltage protection module is used to detect whether the voltage of EMF is too high. If the motor feedback voltage is higher than the voltage of VPM, the VPM will short-circuit three-phase power cable of the motor to decelerate the motor for drive protection.

3.3.2.5 Regenerative resistor

When the motor decelerates, the energy of motor driving will be fed back to the drive. If regenerative energy exceeds the allowable capacity of drive capacitor, the excess energy must be consumed by regenerative resistor to protect the drive.

3.3.3 Cooling system

The drawings and specifications of the product are marked as a water-cooled system, and the temperature of the coolant is 20°C.

Note:
If users do not use water cooling system, please contact the original manufacturer for evaluation, or contact the sales representatives of HIWIN MIKROSYSTEM or agents or dealers.

3.3.3.1 Cooling system calculation

The cooling condition marked in the motor specification is that the coil temperature of motor stator must be controlled below 150°C under the continuous operation of rated torque. If the actual equivalent torque of the motor is lower than the rated torque indicated in the specification, coolant flow rate can be reduced, and an isothermal cooler with a lower pump power can be used.

In the operating conditions, if equivalent torque T_e is less than rated torque T_c, the boundary condition of water cooling system must be adjusted based on motor power loss. The coolant flow corresponding to the equivalent torque can be obtained via the following formula.

Table 3.3.3.1.1 Coolant flow calculation corresponding to the equivalent torque

Coolant flow calculation corresponding to the equivalent torque	
$$P_e = \frac{P_c}{\left(\frac{T_c}{T_e}\right)^2}$$ $$P_e = 69.7 \cdot q_e \cdot \Delta\theta$$	P_e = Total motor loss under equivalent torque $[W]$ $\Delta\theta$ = Temperature difference between motor inlet and outlet [℃] q_e = Coolant flow under equivalent torque $\left[\frac{l}{min}\right]$

Note:

Pressure difference between inlet and outlet $(\Delta\rho_e)$ is related to coolant flow rate (q_e).

Example:

According to the specification of motor model IM-1-135CA, the rated torque T_c under water cooling conditions is 29.5 Nm; the power loss data P_c is 2,249 W; the coolant flow rate q is 8 $\left[\frac{l}{min}\right]$; the pressure difference between inlet and outlet $\Delta\rho$ is 1 bar. If the rated torque is only 20 Nm, and the temperature difference between inlet and outlet of the motor coolant is controlled at 10°C, what is the required coolant flow q_e and the pressure difference $\Delta\rho_e$ between inlet and outlet of water cooling system?

Table 3.3.3.1.2 Calculation example of coolant flow corresponding to equivalent torque

Calculation example of coolant flow corresponding to equivalent torque			
$\left[v = water = 10^{-3}\left(\frac{m^3}{kg}\right)\right]$	Parameters under water cooling	Standard situation (Datasheet)	User situation (User)
$P_e = \frac{P_c}{\left(\frac{T_c}{T_e}\right)^2} = \frac{2249}{\left(\frac{29.5}{20}\right)^2} = 1033.7\ [W]$	Torque [T]	29.5 Nm	20 Nm
	Power Loss data [P]	2249 W	1033.7 W
$1033.7 = 69.7 \times q_e \times 10$	Temperature difference between inlet and outlet [Δθ]	5°C	10°C
$q_e = 1.48\ \left[\frac{l}{min}\right]$	coolant flow [q]	8 $\left[\frac{l}{min}\right]$	1.48 $\left[\frac{l}{min}\right]$
$\Delta p_e = \Delta p \cdot \frac{q_e}{q} = 1 \times \frac{1.48}{8} = 0.185\ [bar]$	Pressure difference between inlet and outlet [Δρ]	1 bar	0.185 bar

3.3.3.2 Coolant selection

This product can also use oil cooling system, the performance of the motor must be properly adjusted in accordance with the characteristics of the coolant.

3.3.3.3 Schematic diagram of coolant inlet and outlet

HIWIN MIKROSYSTEM provides stators with cooling jacket. The flow direction of the coolant is shown as the figure below.

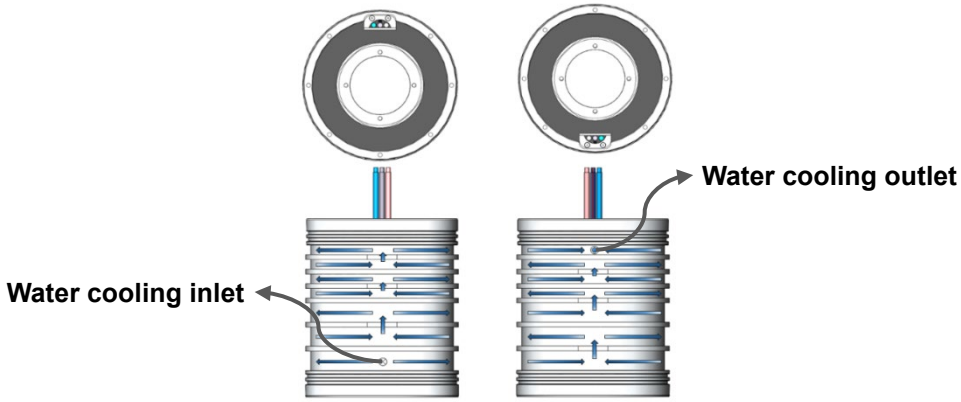


Figure 3.3.3.3.1 Schematic diagram of coolant's flow direction

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4. Transport and setup

4.1 Delivery

The stator and rotor of the product are separately packed and shipped in different dimensions of cartons. To avoid shaking or dropping of the product during transportation, the product will be fixed on the carton. Notes for transport are as follows:

- Shipping transport (including permanent magnet product shipped by sea transport and road transport) must follow the requirements below:
  I. Personnel first access to the product must have prior knowledge that the product contains strong magnet.
  II. The packaging must be marked with a shipping label noting the contain of strong magnet.
  III. Store and pack the objects containing strong magnet in compliance with the requirement.
  IV. Follow the regulations for accident.

- According to the International Air Transport Association (IATA) classification of dangerous goods, rotors containing permanent magnets are classified as Class 9 dangerous goods: contain magnetic materials or miscellaneous substances or objects. The proper name in transport is Magnetized material, No. UN2807.

- Prior approval must be obtained from the country of shipment before air transport. For shipments containing strong magnet, please note the following instructions. Consign the shipment to sea transport if the following requirements are not met.
  I. At a distance of 2.1m from the goods, compass deflection caused by the magnetic field strength will exceed 2°.
  II. At a distance of 4.6m from the goods, compass deflection caused by the magnetic field strength cannot exceed 2°.
  2° of compass deflection is equivalent to 0.418 $\mathrm{A/m}$ (0.525 $\mu\mathrm{T}$) of the magnetic field strength 4.6m from the goods.

- Products containing permanent magnets must not exceed the maximum magnetic field strength indicated in the International Air Transport Association (IATA) packing instructions of air transport. If necessary, special measures shall be taken to conform the product to the transportation requirements. If the product achieves a specific magnetic field strength, it must be clearly indicated on the packaging.

- The following are the values specified in the International Air Transport Association (IATA) packing note 953 for strong magnetism transport (only for transporting airliner UN2807 and cargo aircraft).

I. If the maximum magnetic field exceeds 0.418 A/m (0.525 μT) at a distance of 4.6m from the goods, the goods shall obtain the permission from the exporting countries or the public sectors in the country which the air transport institution belongs to; if necessary, special measures shall be taken to conform the product to the transportation requirements.

II. If the maximum magnetic field is 0.418 A/m (0.525 μT) or above at a distance of 2.1m from the goods, the shipment shall be marked and transported as dangerous goods.

III. If the maximum magnetic field is below 0.418 A/m (0.525 μT) at a distance of 2.1m from the goods, the shipment can be transported as general goods without attached report and marking.

- According to EN 60721-3-2 (2018), equipment transported in unopened packaging or weather-proof packaging and short-term storage must comply with Class 2K11 requirements and be test with the following limits:

Table 4.1.1 The environmental conditions for equipment test

Environmental parameter	Value
Temperature	+5°C ~ +40°C
Relative humidity	5% ~ 85%
Absolute humidity	1g/m^3 ~25g/m^3
Rate of change of temperature	0.5°C/min
Atmospheric pressure	70~106kPa=700~1060 hPa (Height: 3000 M)
Solar radiation	Not allowed
Condensation/ dew/ ice	Not allowed

Note:

1. If dewing occurs, do not operate the device until it is completely dry.
2. Transport the motor in an environment with good weather protection (indoors/ in factory).
3. The transportation environment must be dry and dust-free.

■ The required rating for environmental conditions is listed below:

Table 4.1.2 Environmental condition rating for equipment test

Biological environmental conditions	Class 2B1
Chemical environmental conditions	Class 2C1
Mechanically active substances	Class 2S5
Mechanical environmental conditions	Class 2M4

Note:

1. During transportation, please make sure the label affixed on the outer box matches the quantity of the order.
2. If there is any discrepancy between the content above and the International Air Transport Association (IATA) packing conditions, please refer to the latest specifications.

4.2 Transport to the installation site

Since the product contains strong magnet, persons with cardiac pacemakers or implanted metal devices must be away from the product.

⚠DANGER

- Persons with cardiac pacemakers or implanted metal devices must be away from the product for life safety.
- The rotor contain strong magnet, be careful while picking it up. Magnetic conductors shall not be around.

⚠CAUTION




- During transporting, wear safety footwear to prevent the risk of smashing by the product.
- When picking or placing the motor, do not drag the motor only by pulling its wire.
- Do not apply excessive force to the product.
- Do not stack the products to avoid collapse.
- Do not bring objects susceptible to strong magnet (such as watch) close to the rotor.
- When the product is accidently absorbed, please carefully separate the two attracted items to avoid crushing of the hand

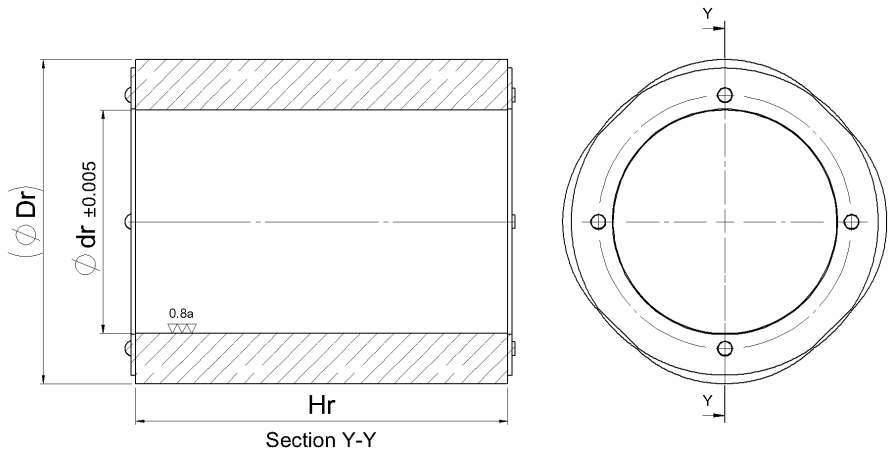
4.3 Requirements at the installation site

This section describes the installation interface and dimension definitions of the rotor and stator.

4.3.1 Rotor installation interface

Internal diameter of the rotor is made by grinding procession.

Table 4.3.1.1 Installation interface dimensions of the rotor



Motor type	ØDr (mm)	Ødr (mm)	Hr (mm)
IM-1-135CA	87	60	100.1
IM-1-135DA	87	60	150.15
IM-1-106CA	68	45	100.1

Note:

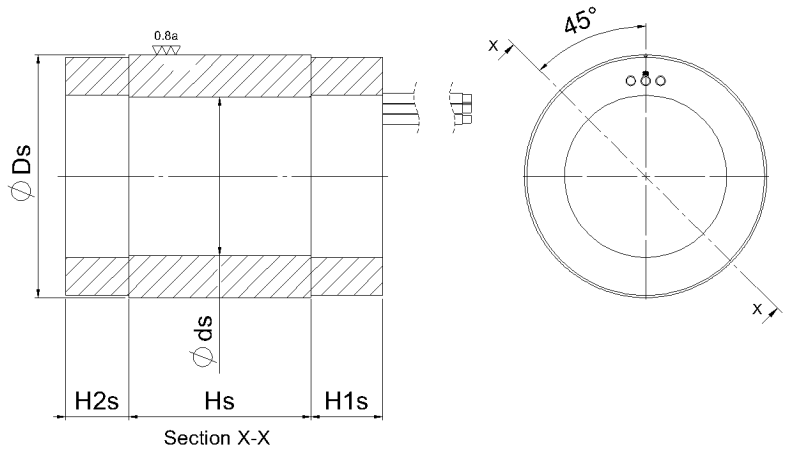
1. The final marked size is based on the provided approved drawing.
2. HIWIN MIKROSYSTEM reserves the right to change the specifications without prior notice.

4.3.2 Stator installation interface

External diameter of the stator core, made by grinding procession.

4.3.2.1 Stator without cooling jacket

Table 4.3.2.1.1 Installation interface dimensions of stator without cooling jacket



Motor type	ØDs (mm)	Øds (mm)	H2s (mm)	H1s (mm)	Hs (mm)
IM-1-135CA	134.7	88	35	40	101.15
IM-1-135DA	134.7	88	35	40	151.2
IM-1-106CA	106	69	30	35	101.15

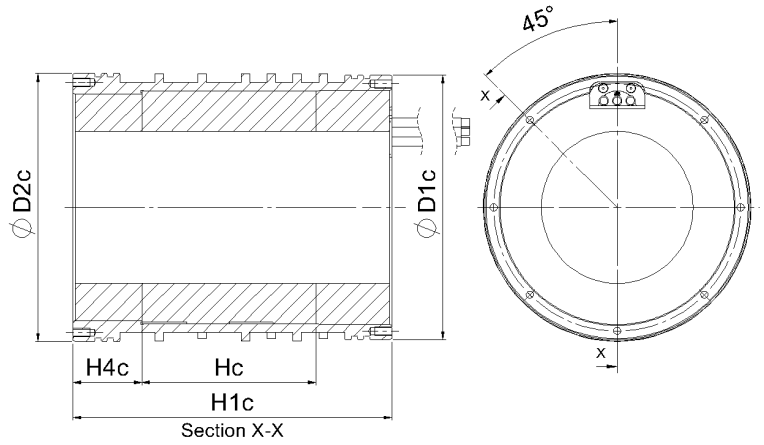
Note:

1. The final marked size is based on the provided approved drawing.
2. HIWIN MIKROSYSTEM reserves the right to change the specifications without prior notice.

4.3.2.2 Stator with cooling jacket

Please check the upper and lower dimensions of the external diameter of the cooling jacket that matched with the housing.

Table 4.3.2.2.1 Installation interface dimensions of stator with cooling jacket



Motor type	ØD1c (mm)	ØD2c (mm)	H4c (mm)	Hc (mm)	H1c (mm)
IM-1-135CA	153	155	40	101.15	185
IM-1-135DA	153	155	40	151.2	235
IM-1-106CA	123	125	35	101.15	175

Note:

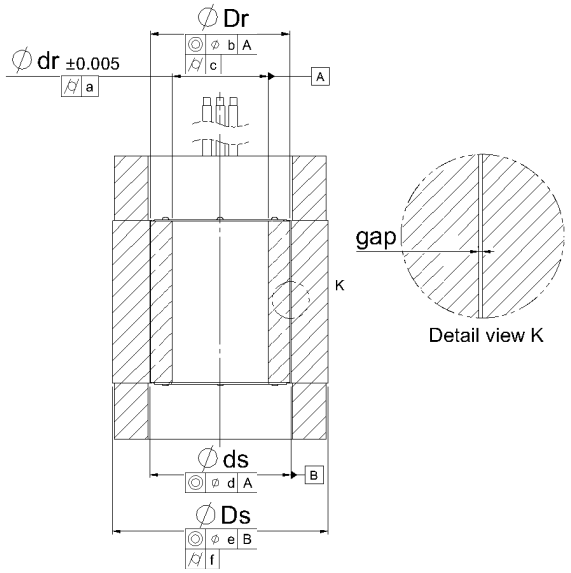
1. The final marked size is based on the provided approved drawing.
2. HIWIN MIKROSYSTEM reserves the right to change the specifications without prior notice.

4.3.3 Air gap and assembly concentricity

When installing the motor, air gap between the stator and the rotor can avoid any damage during rotation. The standard values of air gap and assembly concentricity are used to ensure interference-free rotation of the motor.

4.3.3.1 Rotor and stator without cooling jacket

Table 4.3.3.1.1 Air gap and concentricity dimensions of rotor and stator without cooling jacket



Single-sided air gap calculation formula:

$$\textbf{gap} = \frac{(\emptyset \boldsymbol{ds} - \emptyset \boldsymbol{Dr})}{\mathbf{2}}$$

gap = Single-sided air gap

$\emptyset ds$ = Internal diameter of stator silicon steel $[mm]$

$\emptyset Dr$ = Maximum external diameter of rotor $[mm]$

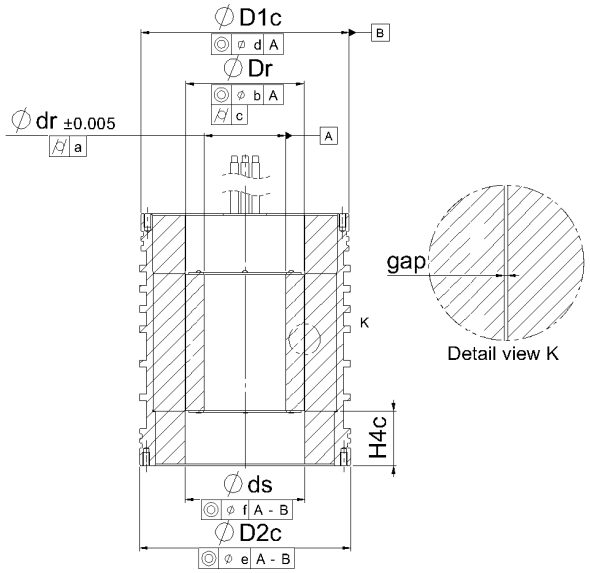
Motor type	a, b, c, d, e, f (mm)	gap (mm)
IM-1-135□□	0.05	0.5
IM-1-106□□	0.05	0.5

Note:
HIWIN MIKROSYSTEM reserves the right to change the specifications without prior notice.

4.3.3.2 Rotor-and stator with cooling jacket

Before installing the stator with cooling jacket, the external diameter of cooling jacket must be concentric with the rotor.

Table 4.3.3.2.1 Air gap and concentricity dimensions of rotor and stator with cooling jacket



Single-sided air gap calculation formula:

$$\textbf{gap} = \frac{(\emptyset \boldsymbol{ds} - \emptyset \boldsymbol{Dr})}{\mathbf{2}}$$

gap = Single-sided air gap

$\emptyset ds$ = Internal diameter of stator silicon steel $[mm]$

$\emptyset Dr$ = Maximum external diameter of rotor $[mm]$

Motor type	a, b, c, d, e, f (mm)	gap (mm)
IM-1-135□□	0.05	0.5
IM-1-106□□	0.05	0.5

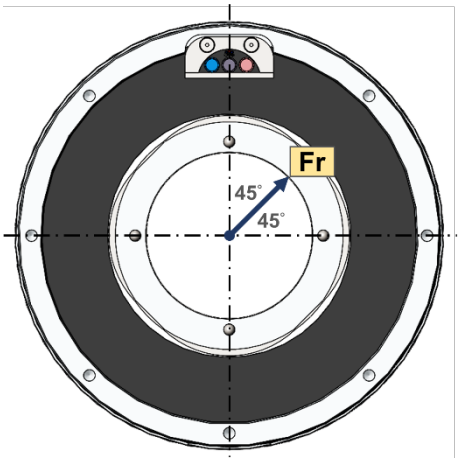
Note:

1. The iron core of the stator must be against the position of the cooling jacket H4c.
2. HIWIN MIKROSYSTEM reserves the right to change the specifications without prior notice.

4.3.4 Motor radial attraction force

When the concentricity of stator and rotor is offset, a radial attraction force will be generated.

Table 4.3.4.1 The value of motor radial attraction force



Motor type	Concentricity (mm)	Radial attraction force Fr ($\frac{N}{mm}$)
IM-1-135□□	0	0
	0.1	2.40
	0.2	4.64
IM-1-106□□	0	0
	0.1	0.93
	0.2	1.95

Note:

1. When assembling the rotor, please beware of the risk of crush injury by the force of attraction.
2. HIWIN MIKROSYSTEM reserves the right to change the specifications without prior notice.

The radial attraction forces of different height of stator are calculated as follows.

Table 4.3.4.2 Radial attraction calculation formula

Radial attraction calculation formula
Force = Radial attraction Fr x L
L = Height of stator $[mm]$

For height of motor's stator, please refer to section 3.3 **Order code** or the table below.

Table 4.3.4.3 Stator height

Motor type	Height of stator L (mm)
IM-1-xxxBA	50
IM-1-xxxCA	100
IM-1-xxxDA	150
IM-1-xxxEA	200
IM-1-xxxFA	250

Example:

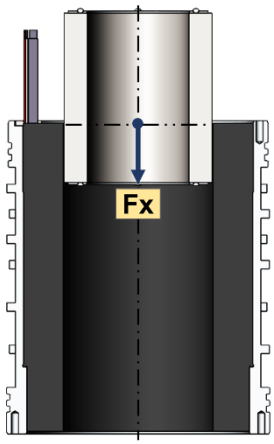
What is the radial attraction force of motor IM-1-135DA with a concentricity of 0.2 mm?

Force = radial attraction force Fr x L = 4.64 x 150 = 696 (N)

4.3.5 Motor axial attraction force

When the rotor moves towards the stator, an axial attraction force will be generated.

Table 4.3.5.1 The value of motor axial attraction force



Motor type	Maximum resultant force of axial attraction Fx (N)
IM-1-135□□	22.1
IM-1-106□□	51.1

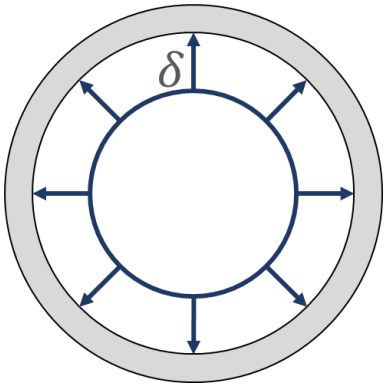
Note:

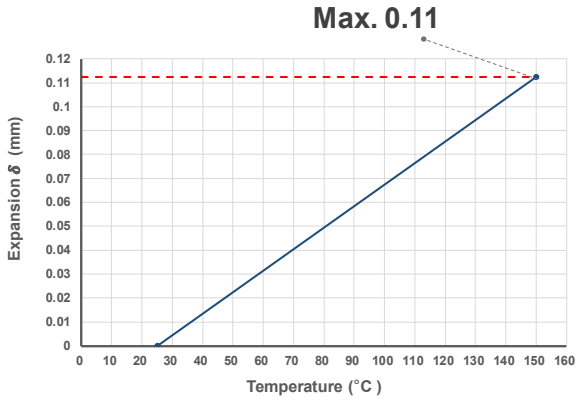
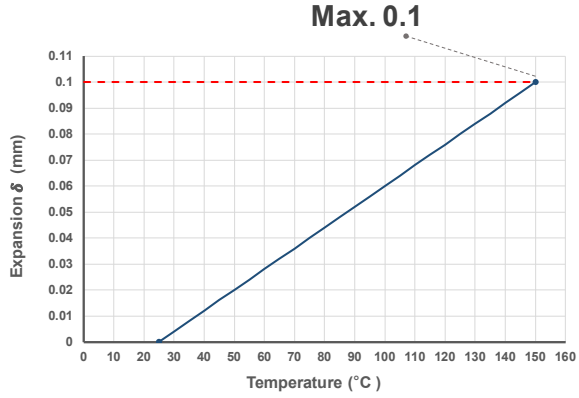
1. When assembling the rotor, please beware of the risk of crush injury by the force of attraction.
2. HIWIN MIKROSYSTEM reserves the right to change the specifications without prior notice.

4.3.6 Thermal expansion of rotor

When the rotor is heated, the internal diameter of the rotor expands due to temperature rise.

Table 4.3.6.1 Thermal expansion of rotor



Motor type	Thermal expansion curve	Maximum deformation due to thermal expansion (mm)
IM-1-135□□		0.11
IM-1-106□□		0.10

Note:

1. The ambient temperature is 25°, and the rotor heating temperature must not exceed 150°C.
2. The amount of thermal expansion is for reference, please reserve the dimension based on the actual measured value when assembling.

4.3.7 Balance calculation

Since balance quality G grade of the product's rotor reaches below G2.5 before leaving the factory, it is not recommended for customers to change the structure.

Table 4.3.7.1 Balance quality G grade of rotor

Balance quality G grade of rotor (Ref. ISO 1940-1)
A balance quality grade of G2.5, a reference speed between 500~1000 (rpm)

4.3.7.1 Balancing ring space

At front and end of the rotor, the smaller the distance d of the balancing ring space, the lower the motor's rated power. If the balancing ring is not made of magnetic material, this effect can be ignored.

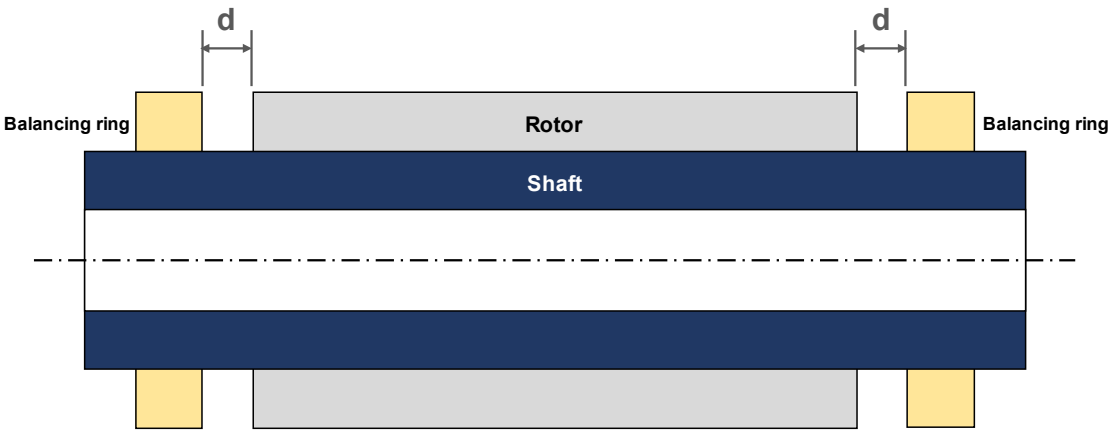


Figure 4.3.7.1.1 Magnetic balancing ring spacing diagram

Note:

1. The performance of the motor is based on the actual assembly situation of the customer.
2. This product is applied to high-speed built-in spindles. Users must be aware of the tolerance design between the spindle and the rotor. To facilitate the tolerance for customers' design and calculation, the product's rotor will be completed with internal diameter grinding before leaving the factory.

4.3.8 Thickness of the shaft

This product has different characteristics due to the different wall thickness of the shaft.

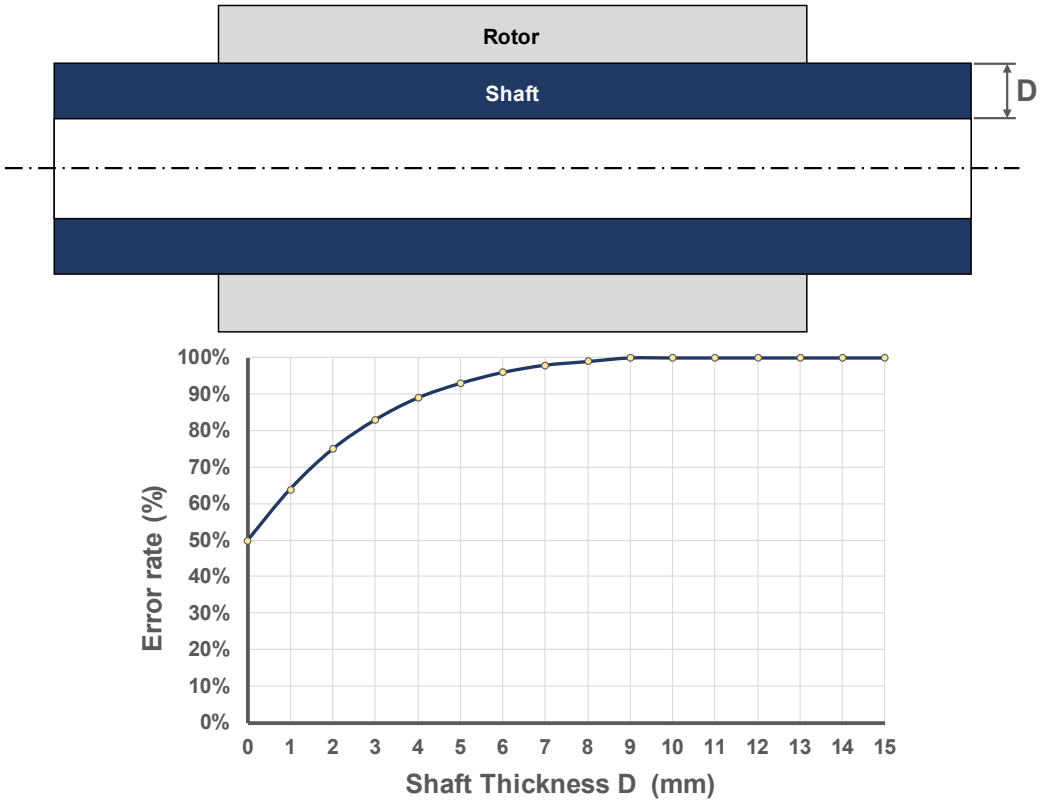


Figure 4.3.8.1 Change of wall thickness of the shaft

Note:

SCM415 material is recommended for the shaft.

4.4 Storage

Since the product contains strong magnet, please put a sign in the storage area. Persons with cardiac pacemakers or implanted metal devices must be away from the product.
Storage precautions are as follows:

- Do not install the product in locations with high ambient temperature and high humidity or locations subject to dust, iron powder, cutting powder, corrosive materials, flammable gas or flammable materials.
- The product is not drip-proof or waterproof, so do not store the product outdoors or in locations with humidity or locations subject to dust, harmful liquid, harmful gas or direct sunlight.
- Install the product in locations with less vibration.
- Store the product in the original carton after using for subsequent identification and reaching.
- According to EN 60721-3-1 (2018), equipment in unopened packaging that stored over 2 weeks needs to comply with the requirement of Class 1K21.
- The climatic and environmental temperature conditions for storage are in conformity with the conditions for transportation, both comply with the requirement of Class 2K11. Please refer to Table 4.1.1.

Table 4.4.1 The environmental conditions for long-term storage

Environmental parameter	Value
Temperature	+5°C ~ +40°C
Relative humidity	5% ~ 85%
Absolute humidity	1g/m^3 ~25g/m^3
Rate of change of temperature	0.5°C/min
Atmospheric pressure	70~106kPa=700~1060hPa (Height: 3000 M)
Solar radiation	700 W/m^2 (Class 1Z9)
Condensation/ dew/ ice	Not allowed

- The required rating for long-term environmental conditions is listed below:

Table 4.4.2 Environmental condition rating for long-term storage

Biological environmental conditions	Class 1B1
Chemical environmental conditions	Class 1C1
Mechanically active substances	Class 1S11
Mechanical environmental conditions	Class 1M11

- Please adopt the following measurement for storage if the product cannot be store in a dry environment:
  I. Use hygroscopic material to cover the motor and seal the motor for packing.
  II. Put desiccant into the sealed package, check and change the desiccant regularly.
  III. Inspect the motor regularly.

Note:

1. If the product is stored indoors, it can be stored for up to 2 years.
2. Do not crush the power cable and thermal sensor in storage.
3. The insulation resistance of the product may be decreased due to the dampness after long-term storage. Therefore, please measure the insulation resistance to avoid exceeding the specification, and store the motor in an environment with good weather protection (indoors/ in factory).

4.5 Unpacking and setup

Please unpack the product indoors, the unpack procedure of the product is as follows.

Step1. Ensure the quantity and the specification on the label are correct.
Step2. Carefully unpack the carton and beware that the rotor contain strong magnet.
Step3. Please preserve the carton after unpacking, send it back if there are any problems. If there are no questions, please deal with the packaging environmentally friendly.
Step4. Carefully take out the product and inspect if the product inside is correct without any damage on the surface. Users can take a photo to record.
Step5. Carefully transport the product to the installation site and set up. Since the rotor contain strong magnet, magnetic conductors must be away from the product.

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5. Assembly and connection

5.1 Mechanical installation

5.1.1 Mechanical mounting

The product can be used with water cooling or oil cooling system. The coolant channel of the stator with cooling jacket is shown as the figure below. O-rings on the upper and lower ends of the coolant channel are used as leak-proof devices.

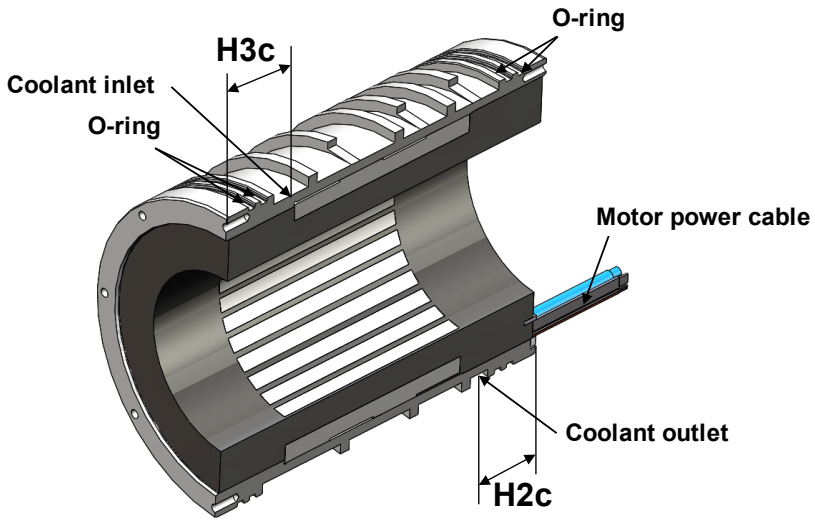


Figure 5.1.1.1 Stator with cooling jacket

5.1.1.1 Cooling jacket design and location recommendation for coolant inlet and outlet

The recommended locations for coolant inlet and outlet are shown below.

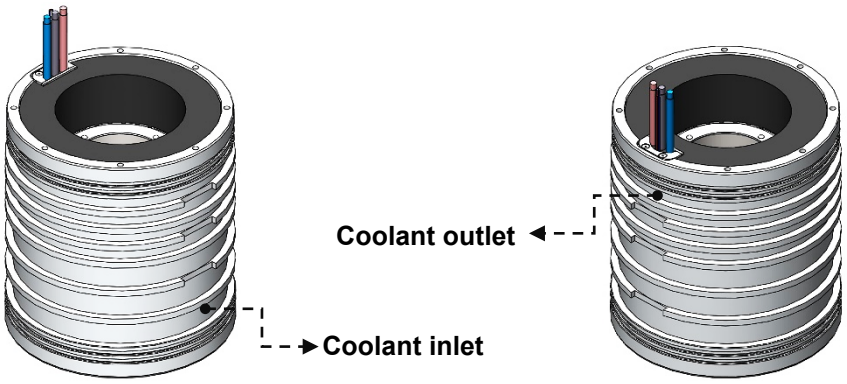
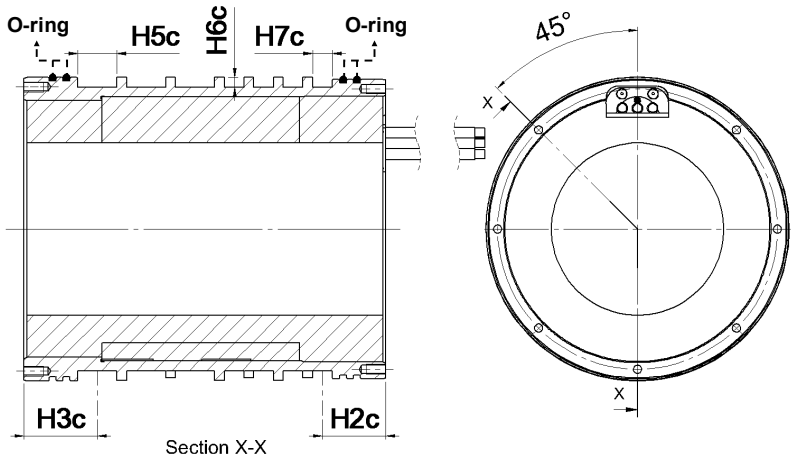


Figure 5.1.1.1.1 The recommended locations for coolant inlet and outlet

The inlet and outlet dimensions and flow channel design of the cooling jacket are shown below.

Table 5.1.1.1.1 The inlet and outlet dimensions and flow channel design of the cooling jacket



Motor type	H2c (mm)	H3c (mm)	H5c (mm)	H6c (mm)	H7c (mm)
IM-1-135□□	32.5	37.5	20.0	5.05	10.0
IM-1-106□□	27.5	32.5	20.0	3.80	10.0

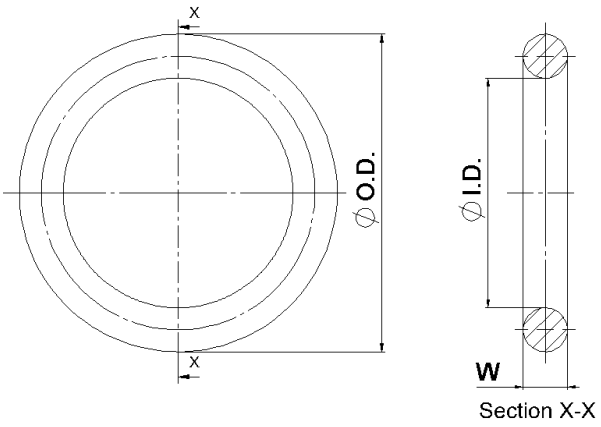
Note:

1. The coolant inlet and outlet must be aligned with the outgoing line of the motor to ensure a good circulation of coolant for cooling effect.
2. The final marked size is based on the provided approved drawing.
3. HIWIN MIKROSYSTEM reserves the right to change the specifications without prior notice.

5.1.1.2 Characteristics and specifications of O-ring

O-rings are used in cooling jacket designs.

Table 5.1.1.2.1 O-ring dimensions



Motor type	AS specifications	ØO.D.: external diameter (mm)	ØI.D.: internal diameter (mm)	W: thickness (mm)
IM-1-135□□	AS 162	150.96	145.72	2.62
IM-1-106□□	AS 047	117.58	114.02	1.78

Note:

1. If users do not use water cooling system, please contact the original manufacturer for evaluation, or contact the sales representatives of HIWIN MIKROSYSTEM or agents or dealers.
2. The final marked size is based on the provided approved drawing.
3. HIWIN MIKROSYSTEM reserves the right to change the specifications without prior notice.

O-rings are made of different materials in accordance with coolant types, refer to the table below before use.

Table 5.1.1.2.2 O-ring material selection

O-ring material	Material hardness	Coolant medium
Nitrile Butadiene Rubber, NBR	70°	Oil, Water
VITON	75°	Oil, Water
Ethylene Propylene Diene Monomer, EPDM	70°	Water

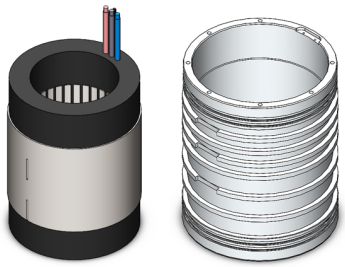
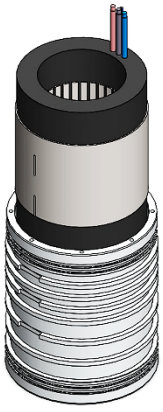
5.1.2 Product installation techniques

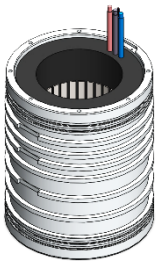
The installation of the product includes two items: stator installation, and rotor and shaft installation. Among them, the stators are divided into two types, the one without cooling jacket and the one with cooling jacket.

5.1.2.1 Installation of stator without cooling jacket

The dimension, structure, and installation interface of cooling jacket are designed by the customer. The installation steps and cautions are shown below.

Table 5.1.2.1.1 Installation of stator without cooling jacket

Step	Icon	Description
1		Prepare a stator note 1 without cooling jacket and the customer's cooling jacket.
2		Use a dust-free cloth and anhydrous alcohol to wipe the iron core surface of the stator and ensure the appearance is free from pollution, rust, sharp edges, and damage.
3		Heat up note 2 customer's cooling jacket. After heating to the target temperature, quickly install the stator without cooling jacket into the customer's cooling jacket note 3 .

Step	Icon	Description
4		Check if the assembly position of the stator is correct.

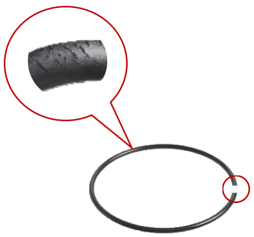
Note:

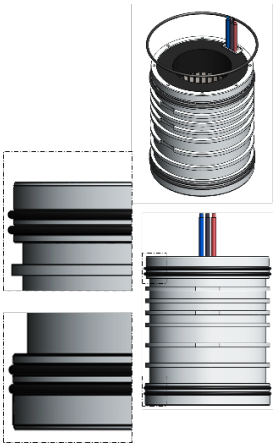
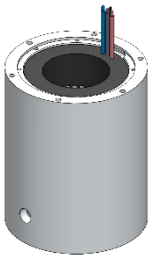
1. For the tolerance of the stator’s external diameter, refer to the approved drawing provided by HIWIN MIKROSYSTEM.
2. The factors of material and tolerance must be considered. If users cannot judge the heating temperature, please contact the original manufacturer for evaluation, or contact the sales representatives of HIWIN MIKROSYSTEM or agents or dealers for information about the cooling jacket (please refer to Section 11.4.1).
3. It is recommended to adopt a transition fit for the joint surface between the customer's cooling jacket and the stator (JIS B 0401).

5.1.2.2 Installation of stator with cooling jacket

The dimension, structure and installation interface of housing are designed by the customer. The installation steps and cautions are shown below.

Table 5.1.2.2.1 Installation of stator with cooling jacket

Step	Icon	Description
1		Prepare a stator note 1 with cooling jacket, the customer's housing and four O-rings.
2		Use a dust-free cloth and anhydrous alcohol to wipe the surface of the cooling jacket, and ensure the appearance is free from pollution, rust, sharp edges, and damage.
3		Ensure the O-ring is not chipped or cracked.
4		Painted the O-ring with a suitable lubricant such as grease or talcum powder.

Step	Icon	Description
5		Assemble the four O-rings in the groove of the stator's cooling jacket. Do not twist or scratch the O-ring during assembly.
6		Install the stator with cooling jacket into the customer's housing[note2]. The position of the housing's coolant inlet and outlet must be aligned with which of the cooling jacket. Do not damage the O-ring to avoid water leakage during assembly.
7		Check if the assembly position of the stator is correct.

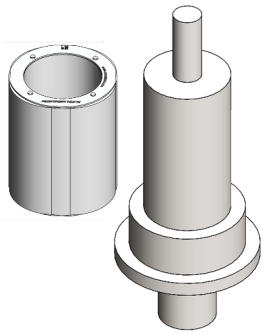
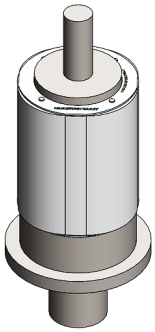
Note:

1. For the location of the stator's coolant inlet and outlet, refer to the approved drawing provided by HIWIN MIKROSYSTEM.
2. It is recommended to adopt a clearance fit for the joint surface between the customer's housing and the stator (JIS B 0401).

5.1.2.3 Installation of rotor and shaft

The dimension, structure and installation interface of shaft are designed by the customer. The installation steps and precautions are shown below.

Table 5.1.2.3.1 Rotor and shaft installation

Step	Icon	Description
1		Prepare the rotor note 1 and the customer's shaft note 2.
2		Use a dust-free cloth and anhydrous alcohol to wipe the surface of the customer's shaft, and ensure the appearance is free from pollution, rust and damage.
3		Heat up the rotor note 3.
4		After heating to the target temperature, quickly assemble the rotor to the shaft note 4.

Note:

1. For the dimension and tolerance of the rotor’s internal diameter, refer to the approved drawing provided by HIWIN MIKROSYSTEM.
2. Before assembly, be aware that the rotor is magnetic, which will generate strong force of attraction when combining with the shaft. Therefore, SCM415 is recommended as the material of the shaft.
3. To avoid damage to the rotor characteristics, the heating temperature of the rotor must not exceed 150°C. Users shall judge the heating temperature to match the tolerances corresponding to the maximum spindle speed and assembly requirements.
4. It is recommended to adopt a transition fit for the joint surface between the customer's shaft and the rotor (JIS B 0401).

5.2 Electrical installation

5.2.1 Drive and controller selection

When selecting the power supply, the rated current, peak current and operating voltage must be considered. For practical applications, refer to the product approved drawing.

Note:
For the peripheral components of the drive, please refer to section 3.3.2.

5.2.2 Temperature protection system

The product uses three types of temperature sensors, PTC130, PTC150, and Pt1000, to provide temperature information to the control system for essential motor over-temperature protection. These three temperature sensors must be installed on the drive before using the product. During operation, if the motor is overheating, users can judge whether the motor needs to be stopped by the thermal resistance jump of PTC thermistor and the output resistance of Pt1000.

Table 5.2.2.1 The functions of temperature sensors

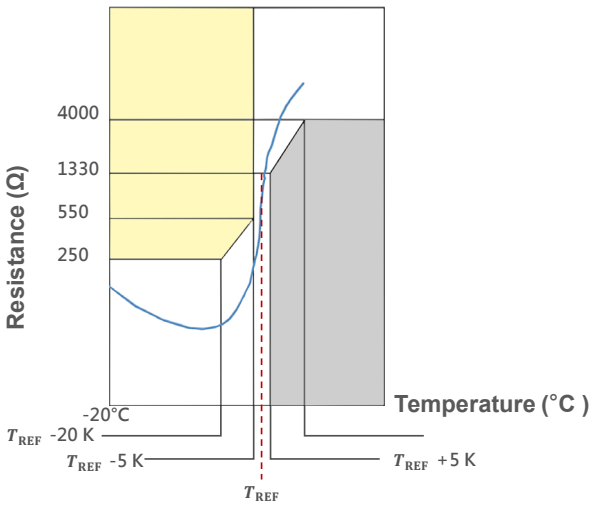
Temperature sensor type	Function
PTC130	Warning notice ≧ 130°C
PTC150	Stop operation ≧ 150°C
Pt1000	Temperature monitoring

Note:
For the actual type of temperature sensor equipped with the motor, refer to the catalog or the approved drawing.

5.2.2.1 PTC temperature sensor

There is a common method of motor over-temperature protection: to embed tiny sensing head of PTC temperature transducer in the stator winding. In normal circumstances, PTC thermistor for motor over-temperature protection is in a low resistance state, which does not affect operation of the motor. When the motor is overheating due to malfunction, the thermal resistance of PTC thermistor for over-temperature protection will jump, and the matched relay of the protection circuit will be de-energized and released. At this moment, the motor will stop running and restart after troubleshooting. The product uses PTC130 and PTC150 temperature sensors, and their resistance values will significantly increase when T_{REF}=130°C and T_{REF}=150°C respectively, and their characteristics are shown below.

Table 5.2.2.1.1 PTC temperature sensor characteristics



Temperature	Resistance
20°C < T < $T_{REF}-20\ K$	20~250 [Ω]
$T = T_{REF}-20\ K$	≦ 550 [Ω]
$T = T_{REF}+5\ K$	≧ 1330 [Ω]
$T = T_{REF}+15\ K$	≧ 4000 [Ω]

Note:

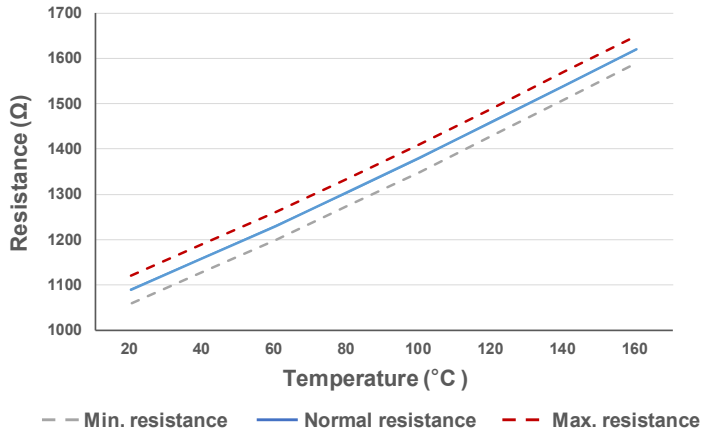
1. The advantage of the protection method is that it directly monitors temperature change inside the coil and protects the motor before the overheating temperature exceeds the insulation class of the motor. At the same time, due to the recoverability of PTC thermistor, it does not need to be replaced like resistor of fuse.
2. The resistance values of PTC130 and PTC150 temperature sensors will significantly increase when T_{REF}=130°C and T_{REF}=150°C respectively. If the measured resistance value is larger than 1330Ω, please set the warning or emergency stop function in the drive or controller. The resistance value is recommended to

take 80% of the safety coefficient, which means the protection will start to operate when it is larger than 1000Ω.

5.2.2.2 Pt1000 temperature sensor

Pt1000 is a platinum resistance temperature sensor. Since its resistance value is 1000Ω at 0°C, the actual temperature can be obtained by measuring the value of output resistance. The relationship between resistance value and temperature is shown below. The resistance value will increase or decrease linearly from -200°C to 850°C.

Table 5.2.2.2.1 Characteristics of Pt1000 temperature sensor



Temperature	Resistance
-200°C~0°C	$1000\Omega\times[1+A\theta+B\theta^2+C(\theta-100)\theta^3]$
0°C	1000Ω
0°C~850°C	$1000\Omega\times(1+A\theta+B\theta^2)$
θ = Operating temperature [℃] A = 3.9083 x 10^{-3} B = -5.7750 x 10^{-7} C = -4.1830 x 10^{-12}	

Note:

1. During commissioning, check if the motor is connected to the controller and can receive the temperature sensing signal before power on.
2. The thermal time constant (the time constant of the transition reaction process) of the thermistor is affected by the transmission medium. If the operating current exceeds the rated current, the thermal time constant of the thermistor will cause a delay in temperature response and further misjudge the motor temperature. If the above-

mentioned condition occurs, please contact HIWIN MIKROSYSTEM, and we will provide a professional evaluation.

5.2.3 UVW three-phase power cable

Before using the product, the three-phase UVW power cable on the stator must be installed to the drive, which transmits the power to the motor for operation when the drive is powered on.

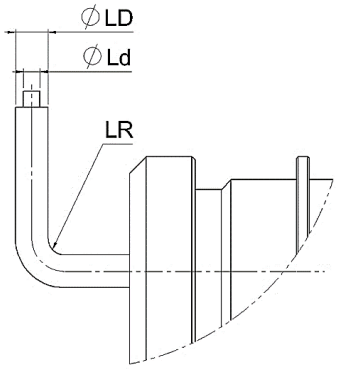
Table 5.2.3.1 Power cables and colors

Power cable	Color
U Phase	Brown
V Phase	Black
W Phase	Blue

5.2.4 Cable bending radius

The minimum bending radius of the power cable and temperature sensor cable is as follows.

Table 5.2.4.1 Bending radius

Characteristics	Icon	Formula
Minimum bending radius for fixed installation (Please calculate based on the maximum external diameter D of the cable)		LR= 3 x LD
The minimum bending radius of the wire's bending end (Please calculate based on the maximum external diameter d of the inner wire)		LR= 6 x Ld
LR = Radius of curvature LD = External diameter of power cable and temperature sensor cable Ld = Wire's external diameter of power cable and temperature sensor cable		

6. Commissioning

6.1 Commissioning

Please contact the sales representatives of HIWIN MIKROSYSTEM or agents or dealers if there are any requirements for parameters. HIWIN MIKROSYSTEM will assist to input the corresponding data and values based on the customer's controller and servo drive. The user manual will also be commissioned.

According to EN 60721-3-3 (2019), operation in fixed position must comply with Class 3K22 and be tested with the following limits:

Table 6.1.1 The environmental conditions for operation

Environmental parameter	Value
Temperature	+5°C ~ +40°C
Relative humidity	5% ~ 85%
Absolute humidity	1g/m^3 ~25g/m^3
Rate of change of temperature	0.5°C/min
Atmospheric pressure	70~106kPa=700~1060 hPa (Height: 3000 M)
Solar radiation	700 W/m^2
Movement of surrounding air	1.0 m/s
Condensation/ dew/ ice	Not allowed

Table 6.1.2 Environmental condition rating for operation

Mechanically active substances	Class 3S5
Mechanical environmental conditions	Class 3M11

Note:

1. Measure the average value every 5 minutes.
2. Motors are only allowed to operate in a well-enclosed environment (indoor/factory) with a controlled temperature.

7. Maintenance and cleaning

7.1 Maintenance

Cover the surface of the product with lubricant to prevent rust and corrosion.

⚠CAUTION

◆ Wear protective gloves before wiping the surface of the product with lubricant.

7.2 Cleaning

Regularly inspect the surface of the stator and rotor and clean them out if needed.

⚠CAUTION

◆ Cleaning method of the product: wipe with 70% alcohol.

Note:

1. It is necessary to cover the product with lubricant after wiping it with alcohol to prevent rust.
2. Since the rotor contain strong magnet, do not approach magnetic conductors (such as iron objects) to prevent the risk of crush injury by strong force of attraction.

8. Disposal

8.1 Waste disposal

8.1.1 Replace

When replacing and disassembling the motor, be aware of the following risks.

⚠WARNING

- If users fail to comply with the instructions to disassemble or deactivate the motor, it may lead to personal injury, death or property damage.

The procedure of motor replacement or disassembly are as follows.

Step1. Disconnect the motor power supply and wait for the DC power supply to be completely discharged.
Step2. Wait for the motor to be cooled down (for at least 30 minutes), and then turn off all cooling systems and vent the pressure to 0 bar.
Step3. Remove all the power cables, signal cables, and cooling tubes.
Step4. If necessary, isolate all the power connections to prevent electric shock or short circuit caused by voltage generated during disassembly.
Step5. Drain all coolant and dispose of it properly.
Step6. Clean away the foreign matter, debris, and dust on the motor.
Step7. Insert a spacer between the gaps of stator and rotor to prevent the risk of crush injury by the force of attraction.
Step8. Customer's self-designed fixing jigs can be used to fix the rotor. If the guiding fixture method is used, it is necessary to confirm that the related fixture and configuration are installed.
Step9. Remove all the fixings at the machine end. If the stator and rotor are fixed, they can be separated from the machine at the same time; if the guiding method is used, please remove the stator and rotor in the reverse order of assembly.
Step10. Use the original packaging or a safe way to pack and store the rotor and the stator correctly.

Note:

1. During motor disassembly, be careful that the O-rings may be damaged. O-rings cannot be overstretched or used with sharp tools, or it may lead to permanent damage.
2. When replacing a torque motor, it is recommended to use a new O-ring. Please refer to section 5.1.1.2 to select an appropriate O-ring material or purchase it from HIWIN MIKROSYSTEM. Refer to section 5.1.2.2 to install the O-ring on cooling jacket.
3. Since the rotor contain strong magnet, do not approach magnetic conductors (such as iron objects) to prevent the risk of crush injury by strong force of attraction.

8.1.2 Disposal

Products need to be disposed in accordance with the general recycling process in laws and regulations.

⚠CAUTION

◆ Follow local recycling laws and regulations for disposal.

- Rotor: The permanent magnets inside must be completely degaussed. They can be degaussed through high-temperature baking.
- The components of the product to be recycled after disassembly:
  1. Electronic waste: encoder components, temperature control modules, etc.
  2. Electrical waste: stators, power cables, temperature controllers, etc.
  3. Scrap metal alloys: classified by metal, such as aluminum alloys, steel, iron, etc.
- No mixing with solvents, cold cleaning agents or residue of paint.

8.1.2.1 Disposal of the rotor

Rotor with permanent magnets must be disposed of after a specific degaussing treatment to avoid subsequent danger. To prevent subsequent danger, it is recommended to turn it over to a professional recycling company.
Rotor degaussing procedure is as follows:

Step1. Place the rotor in a dedicated non-magnetic oven for baking.
Step2. Place the rotor on a strong, heat-resistant and non-magnetic jig.
Step3. The temperature in the oven must be at least 310°C for baking for at least 1 hour.
Step4. The exhaust gas generated during the baking shall be managed to avoid environmental pollution.
Step5. After baking, wait for the temperature to be cooled down to prevent the risk of scald.

Note:

1. After motor disassembly, do not approach magnetic conductors (such as iron objects) since it contains strong magnet.
2. When the rotor returns to room temperature after baking, the remaining gauge should be close to 10 Gauss, otherwise, please repeat the degaussing procedure above.

8.1.2.2 Disposal of the packaging

The materials and auxiliary materials of packaging from HIWIN MIKROSYSTEM are eco-friendly. Wood materials can be recycled and reused, which are flammable.

9. Troubleshooting

9.1 Troubleshooting

If the product is working abnormally, users can follow the table below for troubleshooting.

Table 9.1.1 Troubleshooting

Fault situation	Cause	Solution
Fail to turn the shaft by hand when the drive is not connected	Mechanical interference	Eliminate mechanical interference.
	Three-phase short circuit	Fix short circuits.
The motor fails to run in any states	Wrong wiring of the power cable	Check the power cable connected to the drive.
	Current overload	(1) Check if there is interference and remove the interfering object. (2) Fix the abnormal brake movement.
	Over temperature protection	Check the overheat setting of the drive.
	Abnormal insulation resistance	After the motor cools down, measure the stator insulation resistance (three-phase to ground). Measurement conditions: 1000 V_{DC} 60 sec > 100 MΩ @25°C If it is less than 100 MΩ, please contact HIWIN MIKROSYSTEM.
	Abnormal bearing	Replace the bearing.
Wrong running direction of the motor	Wrong setting of the encoder	Check the setting of the encoder.
	Wrong wiring of the power cable	Interchange the two-phase power cables connected to the drive.
Burning smell of the motor	Abnormal operation of the water cooler	Check the water-cooled system.
	Wrong setting of the controller	Check the value of controller setting.
	Wrong setting of the motor parameter	Check the value of motor parameter setting.
	Abnormal operation of the bearings	Check the assembly procedure.
	Wrong installation position of water inlet and outlet	Refer to the approved drawing to confirm the configuration of motor inlet and outlet.
Abnormal temperature of the motor housing	Abnormal operation of the water cooler	Check the water-cooled system.
	Wrong setting of the controller	Check the value of controller setting.

Fault situation	Cause	Solution
	Wrong setting of the motor parameter	Check the value of motor parameter setting.
	Abnormal operation of the bearings	Check the assembly procedure.
	Air bubbles in the flow channel	Directly eliminate air bubbles or increase the flow to entrain air bubbles.
Unstable running (vibration) of the motor	Abnormal insulation resistance	Check if the resistance to ground of the power cable is larger than 50 MΩ.
	Wrong installation of the encoder	Check if the encoder installation is loose.
	Wrong signal of the encoder	Check if the encoder shielded cable is loose.
	Improper drive parameter setting	Check if the control parameters are rational.
	Wrong setting of the motor type	Check the value of motor parameter setting.
	Loose connection of the motor power cable	Check the wiring of motor power cable.
	Abnormal bearing	Replace the bearing.
The motor is hard to rotate or generates friction noise	Abnormal assembly of the rotor	Check the assembly procedure.
	Imbalance of the system	Check the balance quality.
	Loose components in the system	Lock the components.
	Foreign matter in the air gap between rotor and stator.	Remove foreign matter.
The motor generates noise without rotating after a period of use, and its sound frequency is an integer multiple of PWM frequency.	Abnormal insulation resistance	After the motor cools down, measure the stator insulation resistance (three phases to ground). Measurement conditions: 1000 V_{DC} 60 sec > 100 MΩ @25°C If it is less than 100 MΩ, please contact HIWIN MIKROSYSTEM.

Note:

If the problem cannot be solved by the above-mentioned solutions, please contact the sales representatives of HIWIN MIKROSYSTEM or agents or dealers.

9.1.1 Troubleshooting form

In the event of a motor failure or error, this form assists users to provide important details to HIWIN MIKROSYSTEM, which facilitates effective troubleshooting and repair, avoiding any possible and unnecessary downtime. Please make good use of the form.

Table 9.1.1.1 Troubleshooting form

大 銀 微 系 統
HIWIN MIKROSYSTEM

Troubleshooting Form

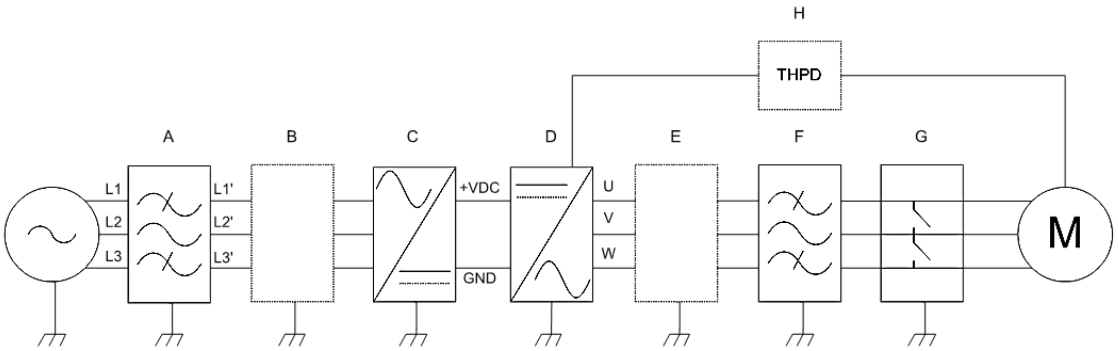
文件等級	屬性
極機密Most Confidential	
機密Confidential	V
一般	

Troubleshooting Form

Customer: Date: yyyy/mm/dd

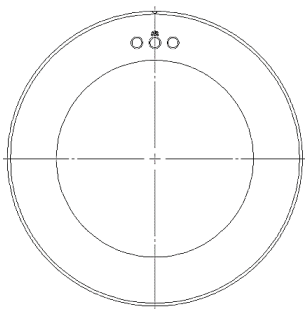
Email: Tel: Fax:		Contact person: Title:	
A. Spindle motor specifications and machine type			
Product number	e.g. FH□□xxx□□□□□	**Spec_version**	e.g. IM-1-xxx□□_A□
Serial number	Ref. label	**Machine name (Type & axes no.)**	e.g. Lathe machine
Operation date (yyyy/mm/dd)	e.g. XXXX / XX / XX	**Machine location (Country, City)**	e.g. Taiwan
B. Conditions of use			
Use coolant for cooling	☐ Yes ☐ No	**Coolant** $(l/_{min})$	e.g. □.□□
Coolant specification	☐ Water + xx % additive ☐ Oil xx $J/_{(kg*K)}$ xx $kg/_{m^3}$ ☐ Others:		
Liquid usage of machine operation	☐ None ☐ Yes, specification: e.g. Cutting fluid	**Bearing specification**	e.g. CRBD XXX □□ X □□□ C8 P5
Workpiece clamping type	☐ None ☐ Yes, specification: e.g. Magnetic; Hydraulic; Others		
C. Fault situation			
Fault description:			
Motor failure state (Current situation)	☐ Commissioning state, description: ☐ Operation state, description:		
Other operation:			
Faulty axis (Rotation; turntable)	☐ Description:		
Controller Error Messages	☐ None ☐ Yes, message: e.g. Error codes and descriptions ☐ Abruptly stop, description: ☐ decrease performance (vibration, ripple, noise), description: ☐ Others, description:		
Same fault before	☐ Yes ☐ None	**Date of occurrence (yyyy/mm/dd)**	e.g. XXXX / XX / XX
D. Controller parameters			

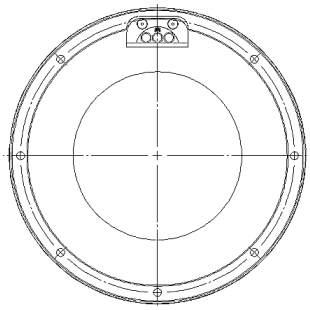
Controller brand		**Controller specification**	
☐ Others:			

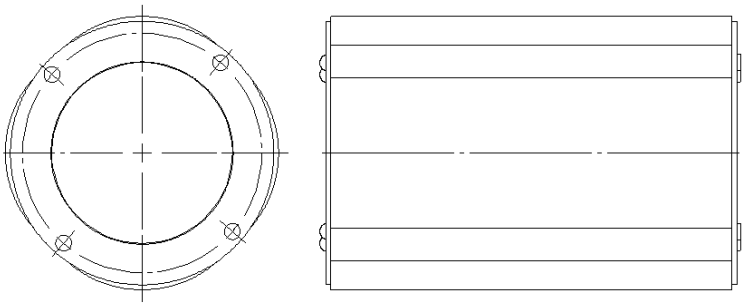


Filter specification (A)	☐ None ☐ Harmonic filer ☐ Regenerative filter ☐ EMC Filter ☐ Others:		
Chokes and reactors (B)	☐ None ☐ Line reactor ☐ Commutation choke ☐ Others:		
Power supply specification (C)	e.g. ATX	**Amplifier specification (D)**	e.g. ADA
Chokes and reactors (E)	☐ None ☐ dv/dt reactor ☐ Motor Chock ☐ Others:		
Filter specification (F)	☐ None ☐ dv/dt filter ☐ Sine wave filter ☐ Others:		
Short circuit relay type (G)	☐ None ☐ Others:		
Use the THPD (H)	☐ None ☐ Others: e.g.THPD-50M Z axis		

E. Electrical troubleshooting			
Check the motor system wiring, are there any observable loose connections or broken connections?			
☐ None ☐ Yes, description the exact location:			
Line to line resistor (U=Brown; V=Black; W=Blue)	R_{U-V}:	R_{V-W}:	R_{U-W}:
Phase to ground resistor	R_{U-G}:	R_{V-G}:	R_{W-G}:
Temperature sensor resistor	R_{Pt1000}:	R_{PTC130}:	R_{PTC150}:

F . Check			
Stator check			
Any abnormality	☐ None ☐ Yes	**Any peculiar smell**	☐ None ☐ Yes
Please mark the corresponding exception code icon in the diagram on the right: Bubbles (draw ○) Burning point (draw △)	Without cooling jacket		

<table>
<tr><td>Scratch
(draw ☰)
Flange wrinkle
(draw ~)</td><td>With cooling jacket</td><td colspan="2">  </td></tr>
<tr><td colspan="4">Cables and connections inspection</td></tr>
<tr><td colspan="2">Any damage on power cables, temperature sensor or cable connectors:</td><td colspan="2">☐ None ☐ Yes</td></tr>
<tr><td colspan="4">Rotor inspection</td></tr>
<tr><td>Any abnormal marks on the rotor (outside)</td><td>☐ None ☐ Yes</td><td>Any peculiar smell</td><td>☐ None ☐ Yes</td></tr>
<tr><td>Please mark the corresponding exception code icon in the diagram on the right:

Fall-out magnet
(draw ○)
Burning point
(draw △)
Metal filings
(draw ╳)
Scratch
(draw ☰)
Flange wrinkle
(draw ~)</td><td colspan="3">  </td></tr>
<tr><td>Is the motor greasy?</td><td colspan="3">☐ None ☐ Yes, description:</td></tr>
<tr><td>Is there any metal particles on the rotor’s surface?</td><td colspan="3">☐ None ☐ Yes, something like:</td></tr>
</table>

Note:

1. Please turn off the power and wait for the motor to cool down to the ambient temperature (about 25°C) before performing troubleshooting measurement.
2. Please contact the sales representatives of HIWIN MIKROSYSTEM or agents or dealers and submit the troubleshooting form.

10. Declaration of incorporation

10.1 Declaration of incorporation

HIWIN MIKROSYSTEM
大銀微系統股份有限公司
台灣40852台中市精密機械園區
精科中路6號
Tel : +886-4-23550110
Fax : +886-4-23550123
HIWIN MIKROSYSTEM CORP.
No.6, Jingke Central Rd., Precision Machinery Park, Taichung 40852, Taiwan
www.hiwinmikro.tw
business@hiwinmikro.tw

Declaration of Conformity

according to Low Voltage EC directive 2014/35/EU

Name and address of the manufacturer:
HIWIN MIKROSYSTEM CORP., No.6, Jingke Central Rd., Taichung Precision Machinery Park, Taichung 408226, Taiwan

Description and identification of the product:

Product	Spindle Motor
Identification	Series: IM-1-135

The object of the declaration described above is in conformity with the relevant Union harmonization legislation Directive.

2015/863	RoHS directive

References to the relevant harmonized standards used or references to the other technical specifications in relation to which conformity is declared

EN 60034-1:2010 EN 60034-1:2010/AC:2010	Rotating electrical machines - Part 1: Rating and performance
EN 60034-5:2010/A1:2007	Rotating electrical machines - Part 5: Degree of protection provided by the integral design Of rotating electric machines (IP code) - Classification
EN 60204-1:2018	Safety of machinery - Electrical equipment of machines – Part 1: General requirements

This declaration of conformity is issued under the sole responsibility of the manufacturer.

Taichung 408226, Taiwan 02.03.2023	YU, KAI-SHENG, Executive Vice President	
(Place, Date)	(Surname, first name, and function of signatory)	(Signature)

11. Appendix

11.1 Glossary

- Back EMF constant: $\mathbf{K_e}$ $[\frac{\mathbf{V_{l-l,\ rms}}}{\mathbf{krpm}}]$

  Back EMF constant is the ratio of back EMF voltage ($\mathbf{V_{l-l,\ rms}}$) to the motor rotational speed ($\mathbf{krpm}$) when the magnet is at 25°C. It is created at the movement of the coil in the magnetic field of permanent magnets.

- Rated current: $\mathbf{I_c}$ $[\mathbf{A_{rms}}]$

  Rated current is also called continuous current. It can continuously supply current to the motor coil at an ambient temperature of 25°C. Furthermore, the maximum coil temperature will not exceed 150°C under water-cooled condition of 20°C. The rated current under water cooling is $\mathbf{I_c}$, and the motor reaches the rated torque $\mathbf{T_c}$ at the same time.

- Rated torque: $\mathbf{T_c}$ $[\mathbf{Nm}]$

  Rated torque is also called continuous torque, it is the torque output when the motor runs continuously without rest at an ambient temperature of 25°C. Furthermore, the final coil temperature will not exceed 150°C under water-cooled conditions. The rated torque T_c corresponds to the rated current $\mathbf{I_c}$. applied to the motor.

- Inductance (line-to-line): $\mathbf{L_{l-l}}$ $[\mathbf{mH}]$

  Inductance is defined as inductance measured between lines when the motor operates at the coil temperature 25°C.

- Equivalent torque: $\mathbf{T_e}$ $[\mathbf{Nm}]$

  The output torque of the motor's actual operation at an ambient temperature of 25°C.

- Resistance (line-to-line): $\mathbf{R_{l-l}}$ $[\mathbf{\Omega}]$

  Resistance is defined as resistance measured between lines when the motor operates at the coil temperature of 25°C.

- Motor constant: $\mathbf{K_m}$ $\left[\frac{\mathbf{Nm}}{\sqrt{\mathbf{W}}}\right]$

  Motor constant is defined as the ratio of square root of motor output torque to consumption power when the coils and magnets are at 25°C. The larger the motor constant represents, the lower the power loss will cost when the motor outputs at a specific torque.

- Number of poles: 2ρ

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

- Peak current: $\mathbf{I_p}$ $[\mathbf{A_{rms}}]$

  Peak current is defined as 2~3 times of rated current of the motor, and the motor temperature reached by the current must not exceed 150°C; the peak current will be used when high power output is required in a short time, and heat dissipation must be completed before the motor inputs peak current in the normal operating range. After reaching the normal temperature, the peak current can be supplied again.

- Peak torque: $\mathbf{T_p}$ $[\mathbf{Nm}]$

  The torque value when the peak current is supplied to the motor. The peak current corresponding to the peak torque must not exceed 150°C of the motor temperature.

- Inertia of rotor: $\mathbf{J_m}$ $[\mathbf{kg \cdot m^2}]$

  The inertia of the rotating part against rotation is related to its shape and mass; the larger the inertia of rotor, the harder it is to start rotating from a standstill or to stop from moving.

- Balance quality G grade: $\mathbf{G}$ $[\frac{\mathbf{mm}}{\mathbf{s}}]$

  Rotor eccentricity is caused by an unbalanced rotor. As the speed increases, it causes a greater burden on the bearings, which in turn will harm the machine. Balance quality of the rotor can be represented by G. The smaller the value of G, the higher the balance precision grade.

- Thermal time constant:

  The time required for a thermistor to change from a state maintained at a certain temperature to a target temperature.

- Torque constant: $\mathbf{K_t}$ $[\frac{\mathbf{Nm}}{\mathbf{A_{rms}}}]$

  Torque constant is the motor's output torque per $\mathbf{A_{rms}}$ current. The output torque and input current show an approximate linear relationship. The non-linear part in the relationship is due to saturation in the iron core.

- Rated speed: $\boldsymbol{n_c}$ $[\mathbf{rpm}]$

  Under the rated magnetic flux, the speed of the motor increases from zero to the rated speed, and the EMF increases from zero to the rated voltage; the EMF must not exceed the rated voltage due to the limitation of the voltage provided by the servo drive.

- Maximum speed: n_p [rpm]

  It is the highest speed that can be achieved in the constant power area after entering the field weakening at a normal speed; when the operation is in the constant power area and the input current is lower than the rated current, the speed will increase, and the torque will decrease accordingly.

- Field weakening control:

  When the speed increases to the rated speed, that is, when the rated voltage is reached, if the speed needs further increase, the field weakening control must be activated to suppress the back EMF, thereby increasing the speed. The high-speed motor achieves constant power within the operating range, and at the same time maintains a certain output torque at high speeds.

- Maximum DC bus voltage: V_{AC}

  The maximum voltage for motor operating in the normal environment.

- Maximum continuous power loss: P_C [W]

  The energy loses when the motor runs continuously at rated current and the coil temperature is below 150°C. It is mainly converted into heat energy. If water cooling system is used, the loss will mostly be eliminated by the water coolant.

- Maximum pressure difference: ΔP [bar]

  Maximum pressure difference is the maximum value tolerated by the pressure difference between inlet and outlet under water cooling system with pure water, and it corresponds to minimum water flow q. If the operating environment is different, pressure difference must be modified by calculation.

- Minimum water flow: q [$\frac{l}{min}$]

  It is the minimum flow required for normal cooling under water cooling system with pure water. If the operating environment is different, water flow must be modified by calculation.

- Temperature difference under maximum power loss: $\Delta\theta$ [K]

  It is the temperature difference between inlet and outlet under water cooling system with pure water. Generally, it is defined as 5°C; if the operating environment is different, temperature difference under maximum power loss must be modified by calculation.

11.2 Unit conversion

To convert the unit in column B to the unit in column A, multiply by the corresponding figure 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

- Angular velocity

		B			
		deg/s	rad/s	rpm	rps
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}
	rps	360	6.283	60	1

- Rotary inertia

		B			
		$kg\text{-}m^2$	$lb\text{-}in^2$	$lb\text{-}ft^2$	$oz\text{-}in^2$
A	$kg\text{-}m^2$	1	3417.63	23.73	54644.81
	$lb\text{-}in^2$	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

- 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 x 9 / 5) + 32	1

Note:

The above-mentioned content is for reference, please refer to the international norms.

11.3 Tolerances and hypotheses

11.3.1 Dimensional tolerance

Dimensional tolerance corresponding to the product approved drawing is shown as table 11.3.1.1.

Table 11.3.1.1 Dimensional tolerance table for the product approved drawing

< 6	6~30	30~120	120~300	300~600	600~1200	1200~2400	> 2400
±0.1	±0.2	±0.3	±0.4	±0.5	±0.8	±1.0	±1.5

Note:

1. Unit: mm.
2. The final marked size is based on the provided approved drawing.

11.3.1.1 Hole dimensional tolerance

For hole dimensional tolerance, refer to JIS B 0401 (2016), as figure 11.3.1.1.1 shows.

Size classification (mm)		Hole Dimensional Tolerances (μm)				
		H				
Over	Equal to or lower than	6	7	8	9	10
-	3	+6 0	+10 0	+14 0	+25 0	+40 0
3	6	+8 0	+12 0	+18 0	+30 0	+48 0
6	10	+9 0	+15 0	+22 0	+36 0	+58 0
10	14	+11 0	+18 0	+27 0	+43 0	+70 0
14	18					
18	24	+13 0	+21 0	+33 0	+52 0	+84 0
24	30					
30	40	+16 0	+25 0	+39 0	+62 0	+100 0
40	50					
50	65	+19 0	+30 0	+46 0	+74 0	+120 0
65	80					
80	100	+22 0	+35 0	+54 0	+87 0	+140 0
100	120					
120	140	+25 0	+40 0	+63 0	+100 0	+160 0
140	160					
160	180					
180	200	+29 0	+46 0	+72 0	+115 0	+185 0
200	225					
225	250					
250	280	+32 0	+52 0	+81 0	+130 0	+210 0
280	315					
315	355	+36 0	+57 0	+89 0	+140 0	+230 0
355	400					
400	450	+40 0	+63 0	+97 0	+155 0	+250 0
450	500					

Figure 11.3.1.1.1 Hole dimensional tolerance

11.3.1.2 Shaft dimensional tolerance

For shaft dimensional tolerance, refer to JIS B 0401 (2016), as figure 11.3.1.2.1 shows.

Size classification (mm)		Shaft Dimensional Tolerances (μm)				
		f			g	
Over	Equal to or lower than	6	7	8	5	6
-	3	- 6 -12	- 6 -16	- 6 -20	- 2 - 6	- 2 - 8
3	6	-10 -18	-10 -22	-10 -28	- 4 - 9	- 4 - 12
6	10	-13 -22	-13 -28	-13 -35	- 5 -11	- 5 -14
10	14	-16 -27	-16 -34	-16 -43	- 6 -14	- 6 -17
14	18					
18	24	-20 -33	-20 -41	-20 -53	- 7 -16	- 7 -20
24	30					
30	40	-25 -41	-25 -50	-25 -64	- 9 -20	- 9 -25
40	50					
50	65	-30 -49	-30 -60	-30 -76	-10 -23	-10 -29
65	80					
80	100	-36 -58	-36 -71	-36 -90	-12 -27	-12 -34
100	120					
120	140	-43 -68	-43 -83	- 43 -106	-14 -32	-14 -39
140	160					
160	180					
180	200	-50 -79	-50 -96	- 50 -122	-15 -35	-15 -44
200	225					
225	250					
250	280	-56 -88	- 56 -108	- 56 -137	-17 -40	-17 -49
280	315					
315	355	-62 -98	- 62 -119	- 62 -151	- 18 -43	-18 -54
355	400					
400	450	- 68 -108	- 68 -131	- 68 -165	-20 -47	-20 -60
450	500					

Figure 11.3.1.2.1 Shaft dimensional tolerance

11.3.1.3 Geometric dimensional tolerance

For geometric dimensional tolerance, refer to JIS B 0021 (1998), as figure 11.3.1.3.1 shows.

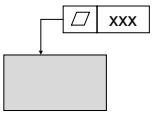
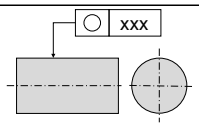
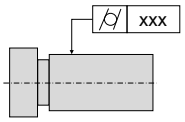
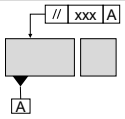
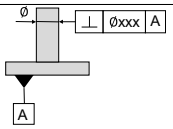
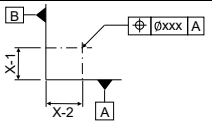
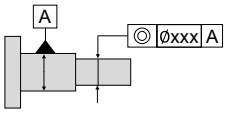
Type of tolerance		Symbol	Icon	Definition
Form	Flatness			The surface must be within two parallel planes separated by XXX mm.
	Circularity			The outer circle of any normal section must be within two concentric circles separated by XXX mm on the same plane.
	Cylndricity			The opposite plane must be within two co-axial cylindrical planes separated by XXX mm.
Orientation	Parallelism			The plane pointed by the arrow of the indicative line should be parallel to the known plane A and be within two planes separated by XXX mm in the direction of the indicative line.
	Perpendicularity			The axis of the cylinder pointed by the arrow of the indicative line should be within a cylinder of XXX mm of diameter which is perpendicular to plane A.
Location	Position			The point indicated by the arrow of the indicative line should be centered at the actual position X-1 mm from reference line A and X-2 mm from reference line B within a circle of XXX mm diameter.
	Concentricity			The axis pointed by the arrow of the indicative line must be within a cylinder of XXX mm of diameter which adopts reference axis A as an axis line.

Figure 11.3.1.3.1 Geometric dimensional tolerance

11.3.2 Hypotheses

If the cooling jacket is prepared by the customer, the indication on the approved drawing will be defined based on the tolerance and marking drawn by the customer.

11.4 Customer request form

Before selecting the motor, please carefully read the following table for your application requirements to obtain the applicable motor specifications.

Table 11.4.1 Spindle motor inquiry form

大 銀 微 系 統
HIWIN MIKROSYSTEM

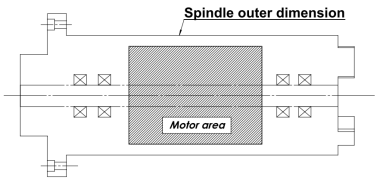
Spindle Motor

Inquiry Form

文件等級	屬性
極機密Most Confidential	
機密Confidential	V
一般	

Customer: Date: yyyy/mm/dd

Email: Tel: Fax:		Contact person: Title:	
Application	☐ PCB ☐ Molding ☐ Transportation ☐ Semiconductor ☐ Automation ☐ Machine tools ☐ Others: _____	**Tool holder**	☐ BT30 ☐ BT40 ☐ BT50 ☐ HSK-A63 ☐ HSK-A100 ☐ A2-5 ☐ A2-6 ☐ A2-8 ☐ Others: _____
Equipment	☐ Lathe ☐ Milling ☐ Grinding ☐ Drill ☐ Complex machine ☐ 5-axis machine ☐ Others: _____	**Motor requirement** (Customers can either choose “a.” or “b." to fill in)	Power: _____ kW a. ☐ Speed Rated speed: _____ rpm Max. speed: _____ rpm b. ☐ Torque Rated torque: _____ Nm Max. torque: _____ Nm
Material	☐ Aluminum ☐ Steel ☐ Alloy ☐ Wood ☐ Wafer ☐ Others: _____	**Cooling Type** Note1	☐ Water ☐ Oil: Oil Spec _____ ☐ Others: _____
Target	☐ Rail/Block ☐ Car parts ☐ Wheel frame ☐ Aircraft parts ☐ Sheet metal ☐ Others: _____	**Cooling jacket**	☐ With cooling jacket ☐ Without cooling jacket
Spindle type	☐  ☐ 	**Controller**	Brand: _____ Type: _____ Voltage: _____ V_{rms} Rate current: _____ A_{rms} Max. current: _____ A_{rms}

<table>
<tr><td>Spindle outer dimension</td><td>☐ 120mm ☐ 150mm
☐ 170mm ☐ 190mm
☐ 200mm ☐ 220mm
☐ Others: _____
  </td><td>Drive</td><td>Brand: _____
Type: _____
Voltage: _____ V rms
Rate current: _____ A rms
Max. current: _____ A rms
Drive command:
☐ Voltage ☐ Pulse
☐ Others: _____</td></tr>
<tr><td colspan="4">Other requirements:</td></tr>
</table>

Note:

1. The high-speed spindle motor is designed and verified with water cooling. If oil cooling is adopted, customers must monitor the condition of the machine.
2. After the questionnaire is submitted to HIWIN MIKROSYSTEM, we will provide a complete report and recommend a suitable spindle motor for the customer.
3. If there are any questions related to the content, please contact the sales representatives of HIWIN MIKROSYSTEM or agents or dealers.

For detailed descriptions, specifications or dimensions for the product items, please refer to the table below.

Table 11.4.2 List of reference chapters for product items

Item		Reference
Product installation interface	Rotor	4.3.1
	Stator without cooling jacket	4.3.2, 4.3.2.1
	Stator with cooling jacket	4.3.2, 4.3.2.2
Air gap and concentricity between rotor and stator	Rotor and stator without cooling jacket	4.3.3, 4.3.3.1
	Rotor and stator with cooling jacket	4.3.3, 4.3.3.2
Rotor radial attraction force		4.3.4
Rotor axial attraction force		4.3.5
Thermal expansion of rotor		4.3.6
Cooling jacket design and locations for coolant inlet and outlet		5.1.1.1
O-ring with cooling jacket		5.1.1.2
Cooling jacket heating temperature		5.1.2.1, 11.4.1

11.4.1 Cooling jacket heating temperature inquiry form

Please fill out this form if it is unable to judge the cooling jacket heating temperature.

Table 11.4.1.1 Cooling jacket heating temperature inquiry form

大 銀 微 系 統
HIWIN MIKROSYSTEM

文件等級	屬性
極機密Most Confidential	
機密Confidential	V
一般	

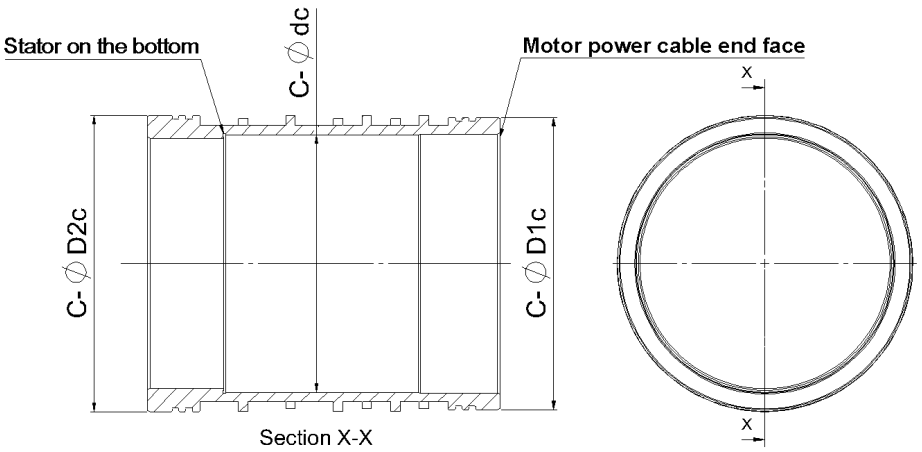
Customer Cooling jacket

Heating Temperature Inquiry Form

Customer: Date: yyyy/mm/dd

Email: Tel: Fax:		Contact person: Title:	
Product number	e.g. FH□□xxx□□□□□	**Spec_version**	e.g. IM-1-xxx□□_A□
Maximum torque S6-25% (Nm)	e.g. □□□ (Nm)	**Material of cooling jacket**	e.g. AL6061-T6

Cooling jacket dimensions (mm)



C-⌀dc	C-⌀D1c	C-⌀D2c
e.g. □□□ (mm)	e.g. □□□ (mm)	e.g. □□□ (mm)

Other requirements:

Note:

1. The assembly may fail depending on the actual situation. Factors such as cooled temperature and wrong alignment method must be considered.
2. After the questionnaire is submitted to HIWIN MIKROSYSTEM, we will provide an evaluation report of recommended heating temperature for the customers.
3. If there are any questions related to the content, please contact the sales representatives of HIWIN MIKROSYSTEM or agents or dealers.