HIWIN® MIKROSYSTEM

DMN Direct Drive Motor

User Manual

www.hiwinmikro.tw
MR01UE01-2601_V1.0

Related Documents

Through related documents, users can quickly understand the positioning of this manual and the correlation between manuals and products. Go to HIWIN MIKROSYSTEM's official website → Download → Manual Overview for details (https://www.hiwinmikro.tw/Downloads/ManualOverview_EN.htm).

Approvals

Motor Model	Approvals		
	EU Directives		UL Approvals
	EMC Directive: 2014/30/EU reference standard EN 61000-6-2:2019 EN 61000-6-4:2019	LVD Directive: 2014/35/EU reference standard EN 60034-1:2010	Rotating Electrical Machines reference standard UL 1004-1 UL 1446
DMN42/71/93/95/9A			
DMN2x/44			

Note:
EN: Europischen Normen = European standard
CE refers to European standards.
(Publication of harmonised standards under Union harmonisation legislation)
from the HIWIN MIKROSYSTEM CORP. website. (https://www.hiwinmikro.tw/en/download)

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Table of Contents

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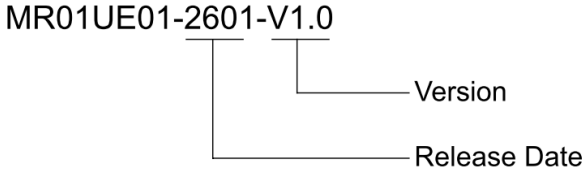
1. General information

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
Jan. 22th, 2026	1.0	Direct Drive Motor (DMN Series)	1. First edition.

1.2 About this manual

This manual is mainly about HIWIN's standard direct drive motor series (also referred to as "motors" in the manual). This manual provides users information about how to handle, assemble and operate the motor in a completely safe condition. Unless any specific document is mentioned, this manual is also applicable to customized products.

HIWIN's liability is in any case limited to the function of the motor and does not cover customer's entire system or machine. If any failure or technical problem occurs and this product does not provide a solution, please contact HIWIN for technical support. Please do not hesitate to notify us if you find any error or necessary correction in this document. Except for motor replacement, the customer or anyone who owns or operates the system is responsible to evaluate all safety and compatibility issues of the entire system. HIWIN cannot know and will not be responsible for any motor failure or system dis-function caused by any possible reasons.

1.3 General precautions

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

- Before installing or using the product, ensure there is no damage on its appearance. If any damage is found after inspection, please contact HIWIN or local distributors.
- Ensure the wiring is not damaged and can be normally connected.
- Do not disassemble or modify the product. The design of the product has been verified by structural calculation, computer simulation and actual testing. HIWIN is not responsible for any damage, accident or injury caused by disassembly or modification done by users.
- Keep children away from the product.
- People with psychosomatic illness or insufficient experience should not use the product alone. The supervision of managers or product docents is definitely needed.
- If the order information does not match your order, please contact HIWIN or local distributors.

HIWIN 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 precautions

- **Depictions used in this user manual:**
  - **Instructions**

    Instructions are indicated by diamond point.

    Example:

    - ◆ If you are affected, stay a minimum distance of 500 mm from the permanent magnets.
    - ◆ Trigger threshold for static magnetic fields of 0.5 mT according Directive 2013/35/EU.
  - **Lists**

    Lists are indicated by bullet point.

    Example:

    - Warning notice system
    - Basic safety notices
  - **Information**

    Information is to describe general information and recommendations.

    Example:

    - For reference DGUV rule 103-013 of the German Social Accident Insurance specifies requirements when working with magnetic fields.
    - Do not bring watches or magnetisable data storage media into the vicinity (<300 mm) of the direct drive systems!

- **Warning notice system**

Safety notices are always indicated using a signal word and sometimes also a symbol for the specific risk. Different safety alert symbols refer to different types of dangers. Please be aware of personal safety while handling the goods with warning labels on it.

⚠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.

Attention
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!		

Mandatory Signs			
	Wear head protection!		Refer to user manual!
	Wear protective gloves!		Disconnect before carrying out maintenance or repair.
	Wear safety footwear!		Lifting point.

■ Basic safety notices

DANGER

Risk of death as a result of strong magnetic fields!

Strong magnetic fields around direct drive systems represents a danger for people with active medical implants, who come close to the motors. This is also the case when the motor is switched off.

- ◆ If you are affected, stay a minimum distance of 500 mm from the permanent magnets
- ◆ Trigger threshold for static magnetic fields of 0.5 mT according Directive 2013/35/EU

Also take national and local guidelines or requirements into account.

- ▶ For reference DGUV rule 103-013 of the German Social Accident Insurance specifies requirements when working with magnetic fields

Attention

Risk of physical damage to watches and magnetic storage media.

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

- ▶ Do not bring watches or magnetisable data storage media into the vicinity (<300 mm) of the direct drive systems!

Attention

Safety distance to the rotor

- The rotor's magnetic fields is permanent. When you come into direct body contact with the rotor, a static magnetic flux density of 2 T is not exceeded.

■ Transport to the installation side

⚠ DANGER

Risk of death as a result of strong magnetic fields!

Strong magnetic fields around direct drive motor systems represents a danger for people with active medical implants, who come close to the motors. This is also the case when the motor is switched off.

- ◆ If you are affected, stay a minimum distance of 500 mm from the permanent magnets
- ◆ Trigger threshold for static magnetic fields of 0.5 mT according Directive 2013/35/EU

Also take national and local guidelines or requirements into account.

- For reference DGUV rule 103-013 of the German Social Accident Insurance specifies requirements when working with magnetic fields.

⚠ WARNING

Danger from heavy loads!

Lifting heavy loads may damage your health.

- ◆ Use a hoist of an appropriate size when positioning heavy loads which are over 20 kg!
- ◆ Observe applicable occupational health and safety regulations when handling suspended loads!
- ◆ Motors with stator and rotor fixture can be hung with hanging holes. The strength of the components should be considered when hanging under any circumstances.

ATTENTION

Risk of physical damage to watches and magnetic storage media.

Strong magnetic forces may destroy watches and magnetisable data storage media near to the direct drive motor system! ◦

- ◆ Do not bring watches or magnetisable data storage media into the vicinity (<300 mm) of the direct drive motor systems!

ATTENTION

Damage of the direct drive motor system!

The direct drive system may be damaged by physical operations.

- ◆ Do not pull the cable directly.
- ◆ No heavy load or sharp object on motor.

■ Assembly and connection

DANGER

Danger from electrical voltage!

Before and during assembly, disassembly and repair work, dangerous currents may flow.

- Work may only be carried out by a qualified electrician and with the power supply disconnected!
- Before carrying out work on the direct drive motor system, disconnect the power supply and protect it from being switched back on!

DANGER

Risk of crushing from strong forces of attraction!

- Assemble the rotors and stators carefully!
- Do not place fingers or objects between the rotors and stators!
- The rotor and magnetizable objects may accidentally attract each other and collide!
- Two rotors may accidentally attract each other and collide!
- The magnetic force of the rotor acting on the object may be as high as several kN, which may cause a certain part of the body to be clamped.
- Do not underestimate the attraction force and operate carefully.
- Wear safety gloves when necessary.
- At least two people are required to cooperate during operation.
- If the assembly steps have not yet reached the installation of the rotor, please place the rotor in a safe and proper place first.

- Never take multiple rotors at once.
- Never place two rotors directly together without any protection.
- Do not bring any magnetizable materials close to the rotor! If the tool must be magnetized, please hold it firmly with both hands and slowly approach the rotor!
- It is recommended to install the rotor immediately after unpacking!
- When installing the stator and rotor, an installation auxiliary device is required to assemble the stator and rotor individually. Please follow the correct method.
- Keep the following tools at hand at any time to release body parts (hands, fingers, feet, etc.) clamped by magnetic force.
  - Hammer made of non-magnetized solid material (about 3Kg)
- Two wedge blocks composed of non-magnetized materials (wedge-shaped sharp angle 10°~15°, minimum height 50mm).

WARNING

Danger from heavy loads!

Lifting heavy loads may damage your health.

- Use a hoist of an appropriate size when positioning heavy loads which are over 20 kg!
- Observe applicable occupational health and safety regulations when handling suspended loads!
- Motors with stator and rotor fixture can be hung with hanging holes. The strength of the components should be considered when hanging under any circumstances.

ATTENTION

Damage of the direct drive motor system!

The direct drive system may be damaged by physical operations.

- Do not pull the cable directly.
- No heavy load or sharp object on motor.

Electrical installation

DANGER

Danger from electrical voltage!

If motors are incorrectly grounded, there is a danger of electric shock.

- Before connecting the electrical power supply, ensure that the motor system is correctly grounded.

DANGER

Danger from electrical voltage!

Electrical currents may flow even if the motor is not moving.

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

Maintenance and cleaning

DANGER

Danger from electrical voltage!

Before and during assembly, disassembly and repair work, dangerous currents may flow.

- Work may only be carried out by a qualified electrician and with the power supply disconnected!
- Before carrying out work on the direct drive motor system, disconnect the power supply and protect it from being switched back on!

DANGER

Risk of crushing from strong forces of attraction!

- Assemble the rotors and stators carefully!
- Do not place fingers or objects between the rotors and stators!
- The rotor and magnetizable objects may accidentally attract each other and collide!
- Two rotors may accidentally attract each other and collide!

- The magnetic force of the rotor acting on the object may be as high as several kN, which may cause a certain part of the body to be clamped.
- Do not underestimate the attraction force and operate carefully.
- Wear safety gloves when necessary.
- At least two people are required to cooperate during operation.
- If the assembly steps have not yet reached the installation of the rotor, please place the rotor in a safe and proper place first.
- Never take multiple rotors at once.
- Never place two rotors directly together without any protection.
- Do not bring any magnetizable materials close to the rotor! If the tool must be magnetized, please hold it firmly with both hands and slowly approach the rotor!
- It is recommended to install the rotor immediately after unpacking!
- When installing the stator and rotor, an installation auxiliary device is required to assemble the stator and rotor individually. Please follow the correct method.
- Keep the following tools at hand at any time to release body parts (hands, fingers, feet, etc.) clamped by magnetic force.
  - Hammer made of non-magnetized solid material (about 3Kg)
- Two wedge blocks composed of non-magnetized materials (wedge-shaped sharp angle 10°~15°, minimum height 50mm).

⚠ WARNING

Risk of crushing from moving parts!

- The operator should provide equipment to prevent from reaching into the danger area of the machine!

⚠ WARNING

Risk of burns!

The motor heats up during operation and thus touching the motor can lead to burn!

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

⚠ WARNING

Unauthorized repairs on the system.

The motor heats up during operation and thus touching the motor can lead to burn!

- Unauthorized work on the system creates the risk of injuries and may invalidate the warranty.
- The system must only be serviced by specialist personnel!

1.5 Requirements

We assume that

- Operating staff are trained in the safe operation practices for direct drive motor systems and have read and understood this user manual in full.
- Maintenance staff maintain and repair the direct drive motor systems in such a way that they pose no danger to people, property or the environment.

1.6 Copyright

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

1.7 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

1.8 Product monitoring

Please inform HIWIN MIKROSYSTEM, the manufacturer of the direct drive motor systems, of:

- Accidents
- Potential sources of danger in the direct drive motor systems

Anything in this user manual which is difficult to understand

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2. Basic safety information

2.1 Overview

Direct drive motors are linear or rotary motors that drive a load directly, without the need for mechanical transmission components such as gearboxes and belts. This simplifies the system, improves efficiency, and prolongs the motor's lifespan. They offer exceptional speed control and power for their size and weight, making them suitable for a wide range of applications such as automation equipment or industrial machinery. Direct drive motors are preferred by machine builders for their dynamic and quiet operations, as they do not rely on traditional transmission components like gears, belts, couplings, and chains. By eliminating these components, direct drive motors offer superior efficiency and power density, resulting in exceptional performance across the system and beyond.

Direct drive motors are designed to be installed and operated in any position. The loads being moved must be securely mounted to the rotating part, and the fixed parts must also be firmly fixed to a stationary position.

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

Direct Drive motor components may only be used for the intended purpose as described.

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

2.2 Basic safety notices

DANGER

Risk of death as a result of strong magnetic fields!

Strong magnetic fields around direct drive systems represents a danger for people with active medical implants, who come close to the motors. This is also the case when the motor is switched off.

- If you are affected, stay a minimum distance of 500 mm from the permanent magnets
- Trigger threshold for static magnetic fields of 0.5 mT according Directive 2013/35/EU

Also take national and local guidelines or requirements into account.

- For reference DGUV rule 103-013 of the German Social Accident Insurance specifies requirements when working with magnetic fields

Attention

Risk of physical damage to watches and magnetic storage media.

Strong magnetic forces may destroy watches and magnetisable data storage media near to the direct drive motor system!

- Do not bring watches or magnetisable data storage media into the vicinity (<300 mm) of the direct drive systems!

Attention

Safety distance to the rotor

- The rotor's magnetic fields is permanent. When you come into direct body contact with the rotor, a static magnetic flux density of 2 T is not exceeded.

- When taking or placing the product, do not just pull the cable and drag it.
- Do not subject the product to shock.
- Ensure the product is used with rated load.
- According to IEC 60034-5 standard, all HIWIN direct drive motors have the following class of protection: IP40.
- HIWIN direct drive motors have an insulation class A according to IEC 60085 standard

2.3 Reasonably foreseeable misuse

Direct drive motors must not be operated:

- Outdoors
- In potentially explosive atmospheres.

2.4 Conversions and modifications

Modifications of the direct drive motor systems are not permitted! Please contact HIWIN MIKROSYSTEM for special request.

2.5 Residual risks

Normal operation of the direct drive motor systems constitutes no residual risks. Warnings about risks that may arise during maintenance and repair work are provided in the relevant sections.

2.6 Personnel requirements

Only authorized and competent persons may carry out work on the torque motor components. They must be familiar with the safety equipment and regulations before starting work. (See Table 2.6.1)

Table 2.6.1 Personnel requirements

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

2.7 Protective equipment

■ Personal protective equipment

Table 2.7.1 Personal protective equipment

Operating phase	Mandatory Signs	Personal protective equipment
Transport, Normal operation, Cleaning and Maintenance		To avoid the risk of accidental dropping and injury, please wear safety shoes.
		It is necessary to use a hanging method and wear a safety helmet for protection.
		When lubricating the product surface and wiping with alcohol, please wear latex gloves.
Commissioning		If there is noise, do not expose yourself to the noise for a long time, and wear protective earplugs.

■ Safety equipment

This product comes in different sizes and specifications. If it cannot be manually handled, please use a crane for lifting. When lifting, be sure to wear a safety helmet to protect your head

Table 2.7.2 Safety equipment

Operating phase	Mandatory Signs	Safety equipment
Hanging		Ensure that the lifting rings are securely clamped and the load is within the specified limit.

2.7.1 The danger of strong magnetic fields

The permanent magnet in the direct drive motor rotor has a very strong magnetic field. When there is no input current, the strong magnetism of the motor comes from the permanent magnets on the rotor, and the magnetic field strength is inversely proportional to the distance (Figure 2.7.1); and additional electromagnetic fields are generated during motion.

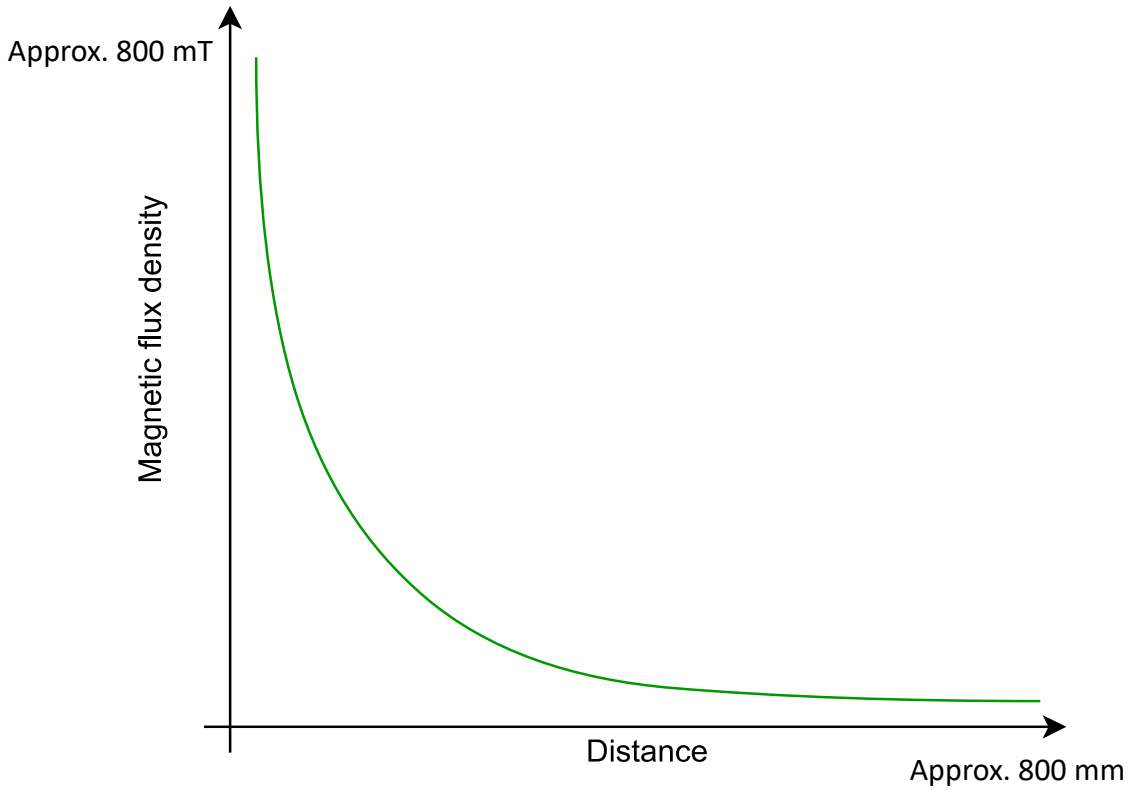


Figure 2.7.1 Schematic representation of the static magnetic field of rotor.

DANGER

Risk of death as a result of strong magnetic fields!

Strong magnetic fields around direct drive motor systems represents a danger for people with active medical implants, who come close to the motors. This is also the case when the motor is switched off.

- If you are affected, stay a minimum distance of 500 mm from the permanent magnets
- Trigger threshold for static magnetic fields of 0.5 mT according Directive 2013/35/EU

Also take national and local guidelines or requirements into account.

- For reference DGUV rule 103-013 of the German Social Accident Insurance specifies requirements when working with magnetic fields

DANGER

Risk of crushing from strong forces of attraction!

There is a risk of crushing from the strong forces of attraction emitted by the rotors and stators, as they are assembled with opposing polarity!

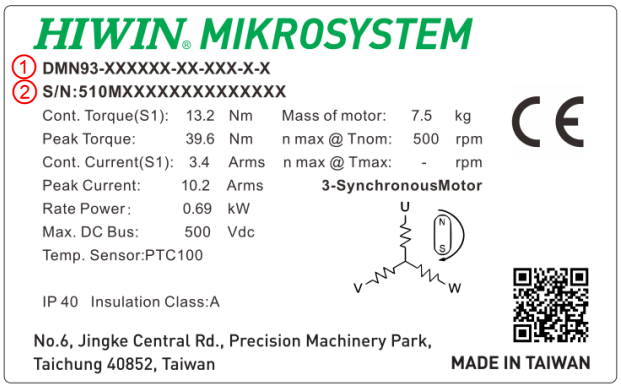
Strong magnetic fields around direct drive motor systems represents a danger for people with active medical implants, who come close to the motors. This is also the case when the motor is switched off.

- Assemble the rotors and stators carefully!
- Do not place fingers or objects between the rotors and stators!
- The rotor and magnetizable objects may accidentally attract each other and collide!
- Two rotors may accidentally attract each other and collide!
- The magnetic force of the rotor acting on the object may be as high as several kN, which may cause a certain part of the body to be clamped.
- Do not underestimate the attraction force and operate carefully.
- Wear safety gloves when necessary.
- At least two people are required to cooperate during operation.
- If the assembly steps have not yet reached the installation of the rotor, please place the rotor in a safe and proper place first.
- Never take multiple rotors at once.
- Never place two rotors directly together without any protection.
- Do not bring any magnetizable materials close to the rotor! If the tool must be magnetized, please hold it firmly with both hands and slowly approach the rotor!
- It is recommended to install the rotor immediately after unpacking!
- When installing the stator and rotor, an installation auxiliary device is required to assemble the stator and rotor individually. Please follow the correct method.
- Keep the following tools at hand at any time to release body parts (hands, fingers, feet, etc.) clamped by magnetic force.
  - Hammer made of non-magnetized solid material (about 3Kg)
- Two wedge blocks composed of non-magnetized materials (wedge-shaped sharp angle 10°~15°, minimum height 50mm).

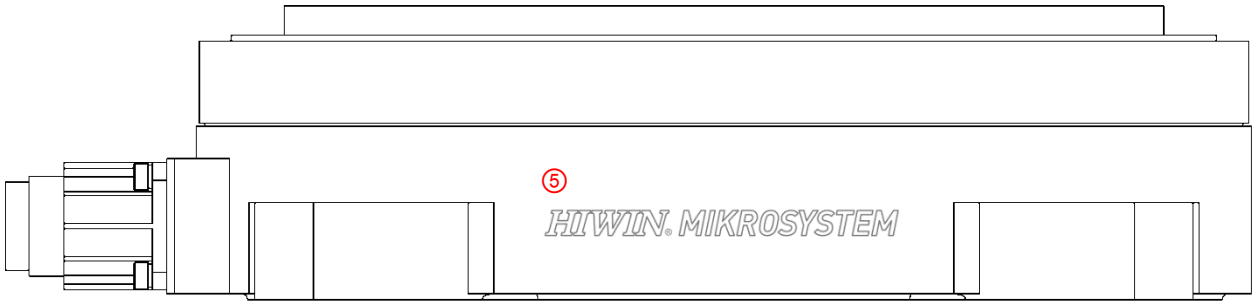
2.8 Labels on DMN direct drive motor

Each motor has the specific mark. 2 name labels and 3 simple labels are delivered in the package.

Here is an example of these labels

Name label	Simple label
	

Trademark	Label



① : Motor type
② : Serial number
③ : Article number
④ : Drawing number
⑤ : Laser engraving trademark

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3. Product description

3.1 DMN direct drive motor description

The DMN series is a standard type of HIWIN direct drive motor.

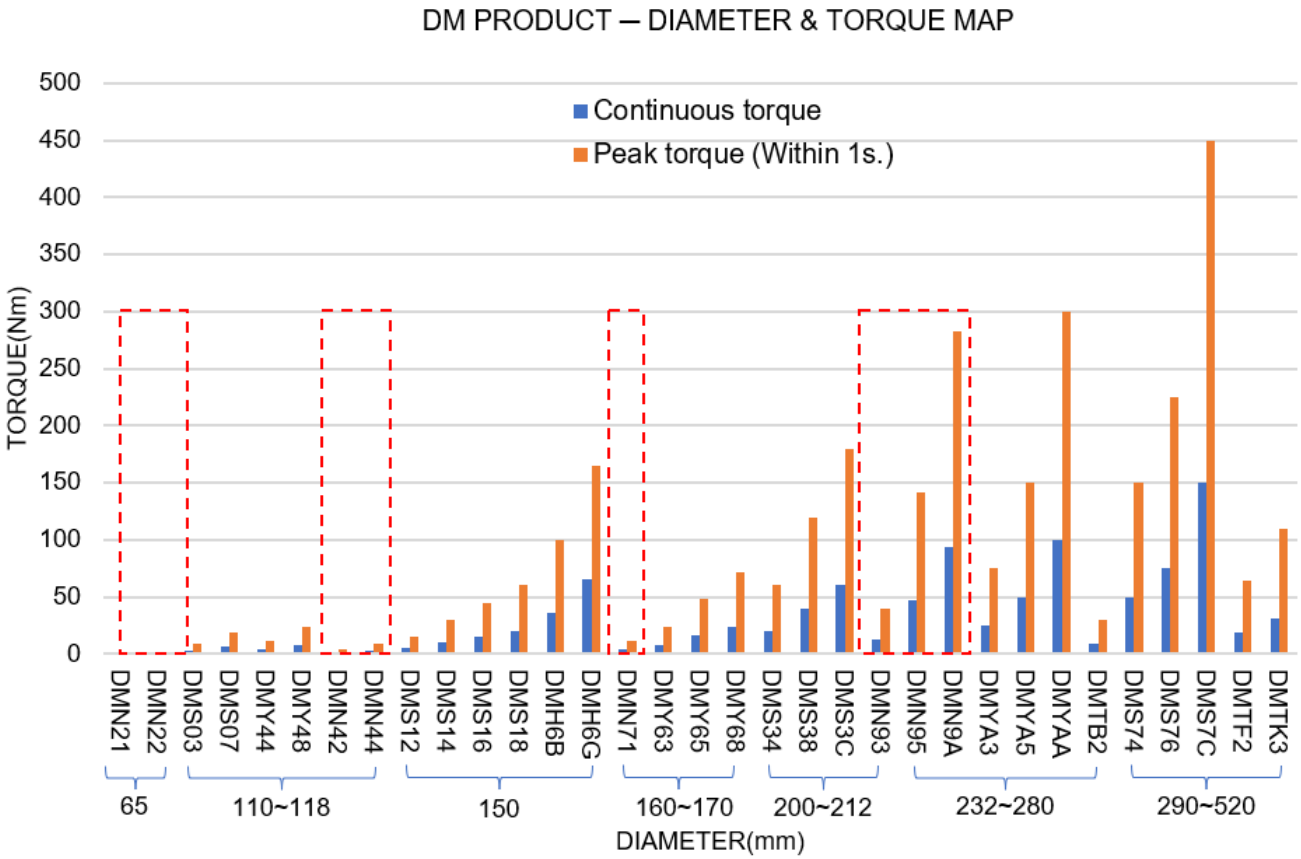


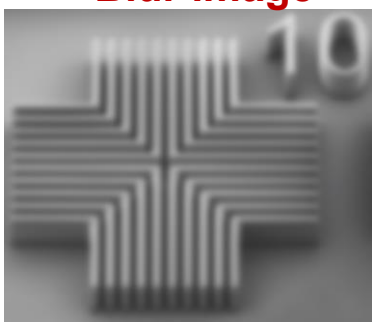
Figure 3.1.1 DIAMETER & TORQUE MAP

The DMN series inherits the advantages of direct drive motors, which can be directly connected to the load without the need for any reduction mechanism, achieving high precision and high responsiveness. More importantly, in the development process, resulting in the world's unique DMN series motors with low profile, a super-smooth and easy to install characteristics. The three main features are:

1. Low profile: The design of customer-side modules can have a lower center of gravity, improve structural strength, make equipment operation more stable, and achieve productivity improvement.

2. Smooth: The excellent velocity ripple is very suitable for customers to use in optical inspection, obtaining clear images and accurate measurement results.

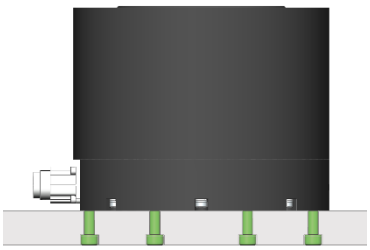
Blur image



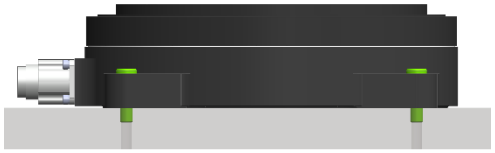
Clear image

3. Easy to install: The Flange-type design allows customers to directly fix it from the top of view, avoiding the hassle of flipping the motor or fixing alignment from the bottom.

DMS



DMN



3.2 Main components of DMN direct drive motor

In DMN series, the motor is designed for the inner rotor, and assembled with HIWIN bearing, with mounting holes.

The basic motor structure is as shown in the Figure 3.2.1.

- Stator part

  The stator part is made of electrical steel, and the inner part is composed of coils. There are two cable outlets on one side, motor power cable and encoder cable. It should be installed on the fixed part of customer's machine.

- Rotor part

  The rotor part is an aluminum disk with evenly attached magnets inside. It should be installed with the rotary part of customer's machine.

- Bearing

  Cross-roller bearings, this bearing achieves the goal of low wear, low dust generation and satisfy the clean room requirement.

- Encoder

  Encoder disk is installed in the rotor part. Built-in optical encoder provides the motor with high position accuracy and high resolution performance.

Figure 3.2.1 Basic structure of DMN series

3.2.1 Special phenomenon of DMN direct drive motor

Third-party drive with HIWIN MIKROSYSTEM's direct drive motor may fail to find the Z phase signal of encoder and cause homing failure. We suggest that you contact the drive manufacturer for Z phase signal reception settings.

3.3 Order code

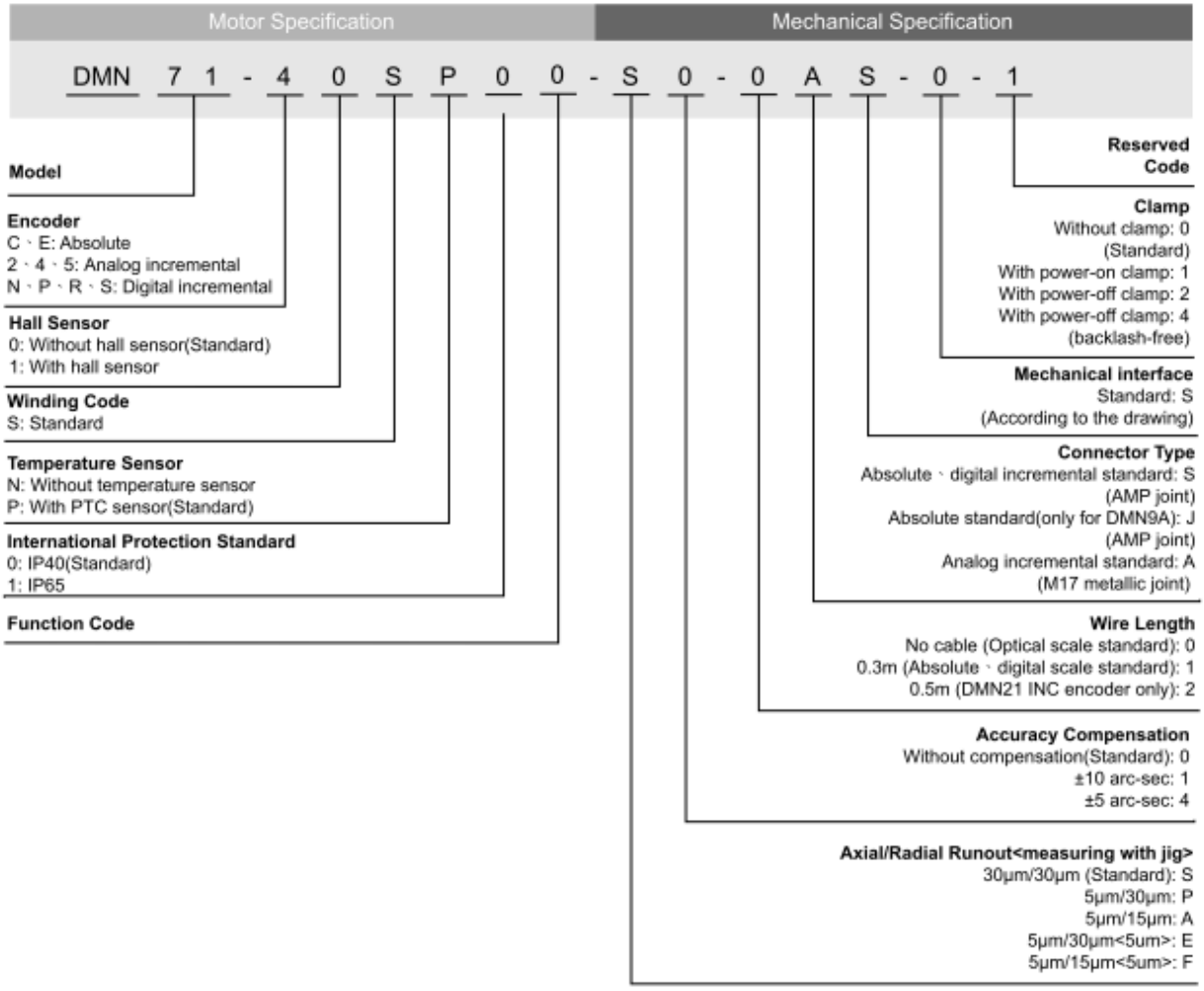


Figure 3.3.1 Order Code

3.4 Basic motor sizing

The way to select a suitable motor based on speed, moving distance, and loading inertia is described in the following contents. The basic process for sizing a motor is as below.

Requirement

- Operating environment
- Installation (horizontal or vertical)
- Driving method
- Load conditions (loading inertia, friction and cutting force)
- Speed condition (maximum acceleration and velocity)
- Duty cycle

↓

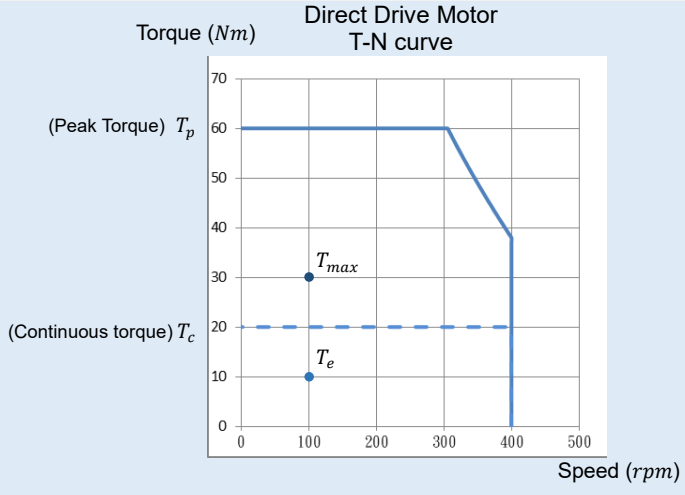
Torque calculation

- Calculate the torque corresponding to the speed under each operation condition
- Calculate equivalent torque

↓

Motor sizing and T-N curve confirmation

- Select the appropriate motor from HIWIN's catalogue in accordance with calculated maximum torque, equivalent torque and speed.
- Ensure the speed and the corresponding torques under all operating conditions is within the range of torque-speed curve of the motor.
- Confirm the equivalent torque is within the continuous torque of the motor.



■ Symbol

φ	Angular displacement (rad)	I_p	Peak current (A_{rms})
t	Moving time (sec)	I_e	Equivalent current (A_{rms})
α	Angular acceleration (rad/s^2)	I_c	Continuous current (A_{rms})
ω	Angular velocity (rad/s)	ω_0	Initial angular velocity (rad/s)
J_L	Load inertia (kgm^2)	m	Loading Mass (kg)
J	Rotor inertia (kgm^2)	R_L	External diameter of loading Mass (m)
T_p	Peak torque (Nm)	r_L	Internal diameter of loading Mass (m)
T_c	Continuous torque (Nm)	a_L 、b_L	Side length of loading Mass (m)
T_j	Inertia torque (Nm)	S	Distance from gravity center to rotary center (m)
K_t	Torque constant (Nm/A_{rms})		

STEP 1 Requirement

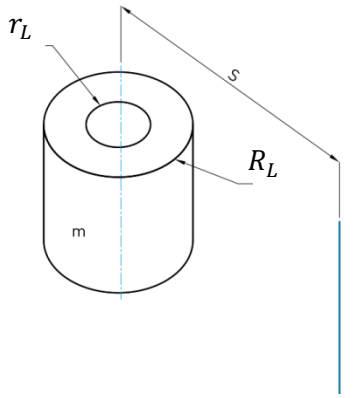
To size a proper motor, the following formula of load inertia and motion must be understood before sizing.

Calculation of load inertia

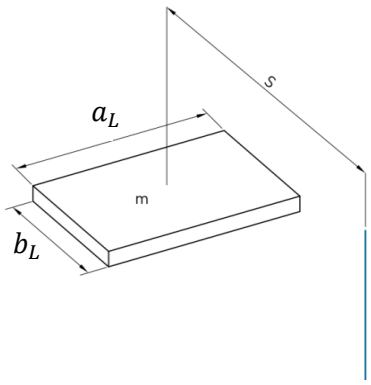
Load inertia can be determined by 3D drawing software or the formula. Basic formula is as below.

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

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



Rotary center



Rotary center

Determine motion speed and parameters

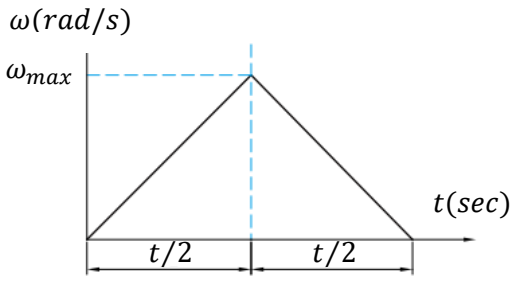
Basic kinematics equations are described as below.

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

Where ω_0 is initial angular velocity, ω is angular velocity, α is angular acceleration, α is moving time and φ is angular displacement.
Users can choose two of the four parameters (ω, α, t and φ) as designed parameters. The left two parameters can be calculated by above equations.
*For D1 series drives, it is recommended to have an inertia ratio less than 100. If the inertia ratio is greater than 150, it is recommended to select a Hall sensor.
*For E series drives, it is recommended to have an inertia ratio less than 150

※ Motion velocity profile

Motion profiles for motor can be classified into “Trapezoidal profile” and “Triangular profile”. Trapezoid profile is usually used in scanning applications. Its motion profile can be divided into acceleration, constant velocity and deceleration. The maximum angular acceleration can be determined by the basic kinematics equations mentioned above. Triangle profile is usually used in point-to-point applications. Its motion profile can be divided into acceleration and deceleration, and its motion profile and formula can be simplified as below.



$\omega_{max} = 2 \times \frac{\varphi}{t}$ or $\omega_{max} = \sqrt{\alpha \times \varphi}$, $\alpha_{max} = \frac{4\varphi}{t^2}$

Other trajectory profiles like “s-curve”, “full-jerk“, “sine“, “modified sine“, will not going to discuss in the manual.

- ◆ “S-curve”, “sine“, “modified sine“ are also computable in HIWIN.
- ■ Different types of trajectory profiles which can provide advantages or disadvantages depending on the application requirements.

The jerk in “Triangular profile” and “Trapezoidal profile” will be ±∞.

STEP 2 Torque calculations

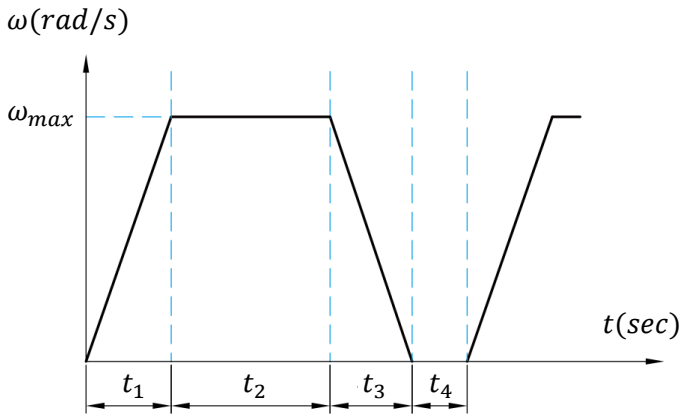
The maximum torque can be calculated by the following equation.

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

Where T_j is inertia torque, T_f is the torque caused by friction torque, cutting force or external force.

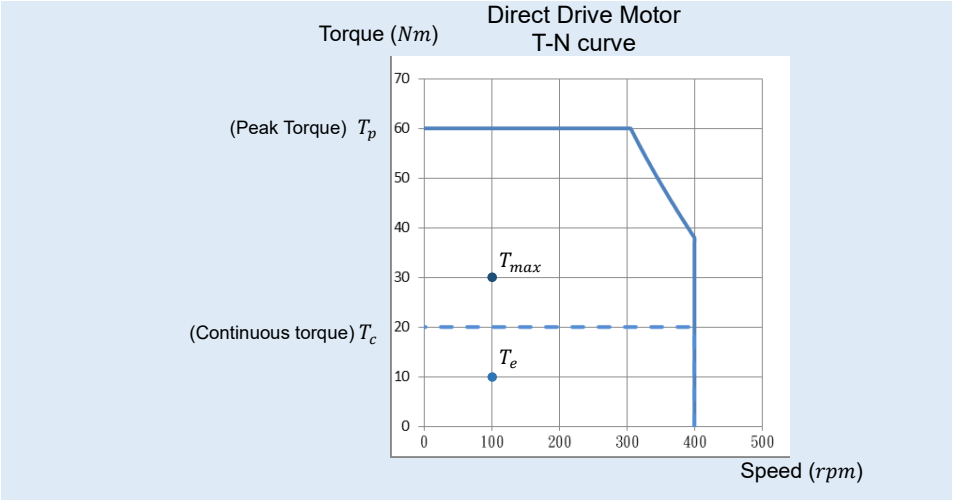
In most cases, the motions are cyclic point-to-point movements. The equivalent torque of a cyclic motion with a dwell time of t_4 second can be calculated as below.

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



STEP 3 Motor sizing and T-N curve confirmation

With the help of HIWIN's motor specification, users can select the appropriate motor from peak torque and equivalent torque, and ensure speed and torque under all operating conditions is within the range of the motor's T-N curve.



Motor sizing is determined as follows.

$T_{max} < T_p$

$T_e < T_c$

Users need to consider the ratio of equivalent torque and continuous torque. Generally, the ratio (T_e/T_c) is recommended to be within 0.7.

$$I_{max} = \frac{T_{max}}{K_t}$$

$$I_e = \frac{T_e}{K_t}$$

See also Section 3.4.1 for understanding more about thermal calculation.

Note:

The torque-speed curve provided in the specification is for a specific voltage, regardless of the speed limit of the bearing and the position feedback system. The customer should also set the maximum speed limit of the overall mechanism when sizing to avoid bearing life or position feedback system failure result in abnormal operation or damage of the motor.

3.4.1 Thermal calculation

3.4.1.1 Heat loss

When the motor converts electric energy into kinetic energy, copper loss, iron loss and mechanical loss are inevitable. Copper loss is the loss generated by the resistance when the current flows through the stator coil of the motor. Iron loss, which can be classified into hysteresis loss and eddy current loss, is generated by the conversion of the magnetic field between stator iron core and rotor magnet. As for mechanical loss, it is generally much less than copper loss and iron loss; therefore, it can be ignored.
Copper loss under continuous torque is calculated as below.

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

P_c=copper loss at coil temperature θ_c $[W]$
R_{25}= line-to-line resistance at coil temperature 25℃ $[\Omega]$
α_{25}: temperature coefficient of cooper @ 25℃ ($\alpha_{25} \fallingdotseq 0.003844$)
I_c=continuous current at coil temperature θ_c $[A_{rms}]$
θ_c= coil temperature [℃] (100℃)
Iron loss is mainly caused by the change of magnetic flux during the operation and is influenced by the frequency a lot. Since rotational speed is directly proportional to frequency, iron loss will be larger at high speed. However, rotational speed for HIWIN direct drive motor is low, so iron loss is relatively less than copper loss. Rotational speed value indicated by HIWIN drawing and specification is the maximum peak speed that the motor can reach. Under the continuous operation of high speed, iron loss must calculate extra heat given to rotor. At this time, motor loss increases rapidly. To avoid overheating, users need to appropriately adjust operating conditions or apply heat dissipation on rotor.
Iron loss is mainly generated by eddy current and frequency. The faster the speed is, the more the iron loss will be.

$$P_{Fe} \propto f^2$$

P_{Fe}= iron loss $[W]$
f = frequency $[Hz]$
Definition of frequency：

$$f = \frac{n \cdot 2p}{120}$$

n = rotational speed $[rpm]$
$2p$ = Number of poles
Heat loss mainly transmits the loss of coil and iron core to motor outer casing via heat conduction. Take natural air cooling for example. Loss heat source will be transmitted from the surface of outer casing contacted by the air to external environment via heat convection, and from the customer's installation surface via heat radiation and heat conduction. Ensure parameters you use fit the specification, and keep coil temperature from exceeding 100℃. Please contact HIWIN for other applications.

3.4.1.2 Continuous operating temperature

Steady state temperature of motor coil is determined by the proportion of copper loss and iron loss. When rotational speed is low, iron loss may not be considered. Both total loss and rated continuous torque(T_c) are defined when coil temperature is 100℃. When equivalent torque (T_e) is less than rated continuous torque (T_c), steady state temperature of motor coil under various operating conditions can be known by the following formula.

When operating current is lower than rated current (I_{eff}<I_c), the relationship between temperature and torque is as below.

$$\theta_e = \theta_{surr} + \left(\frac{T_e}{T_c}\right)^2 (\theta_{cont.} - 25)$$

$\theta_{cont.}$ = steady state temperature of coil under rated condition (100℃) [℃]

θ_e= steady state temperature of coil under equivalent torque [℃]

θ_{surr}= ambient temperature [℃] (ambient temperature for air cooling)

T_e= equivalent torque under actual operation [Nm] (when coil temperature is θ_e)

T_c= rated continuous torque [Nm] ((when coil temperature is $\theta_{cont.}$)

3.4.1.3 Thermal time constant

The temperature of the coil of the motor is related to the thermal time constant during operation. The thermal time constant is defined as the time required for the temperature difference to reach 63.2% of the difference between the steady-state temperature and the initial temperature (Figure 3.4.1). The time to reach the thermal steady-state is about 5 times the thermal time constant.

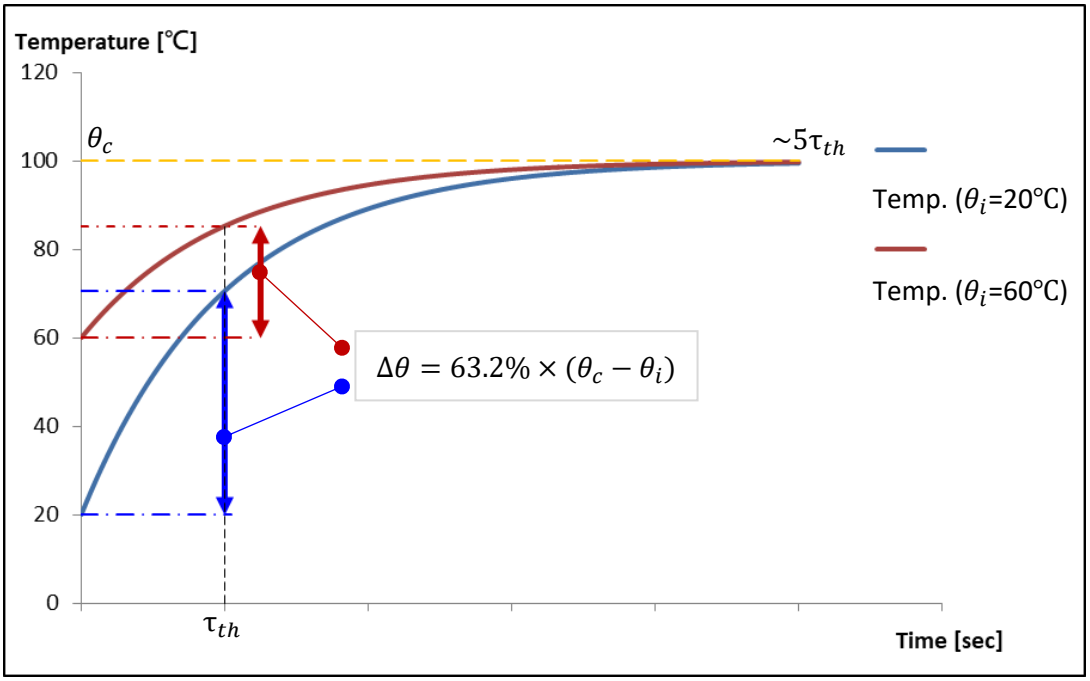


Figure 3.4.1 Curve of temperature rising

The relationship between thermal time constant and temperature is

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

$\theta(t)$= coil temperature [℃] (at the operating time t)

θ_i= initial coil temperature [℃]

t= operating time [sec]

τ_{th}= thermal time constant [sec]

When operating current is between rated current and peak current ($I_c < I_e < I_p$), power off time should be set to cool the motor. The thermal time constant mentioned above can be applied to calculate the time for load cycle. Refer to **Section 3.4.1.1** to get steady state temperature of coil under equivalent torque (θ_e) through equivalent torque under actual operation (T_e). Then, get the relative maximum operating time via the following formula.

The relationship between steady state temperature of coil under equivalent torque (θ_e) and maximum operating time is

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

t_0= maximum operating time [sec]

Note: Coil temperature (θ_c) here cannot exceed the specification's upper limit.(100℃)

The relationship between coil temperature and power off time is

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

$\theta(t_b)$= coil temperature to be cooled [℃] (after power off time t_b)

t_b= power off time [sec]

The time allocation of load cycle during motor operation can be determined by the two formulas above.

3.4.1.4 Stall conditions

When the motor speed is extremely slow (including standstill), the current commutation speed inside the motor is very slow, the current will accumulate in certain sets of coils inside the motor. If continuous current is used at this time, it will eventually lead to insufficient heat dissipation, which will end up the motor overheat.

The concept is as followings, Figure 3.4.2：

a. The arrow is like an air flow around the motor for heat dissipation, and the amount of air that can flow out per unit of time is fixed.

b. When under stall condition, the temperature of the motor will be concentrated on a certain two phases or a certain phase of the motor.

c. The air flow around the motor has not increased, so the heat of the motor will continue to accumulate in some coils.

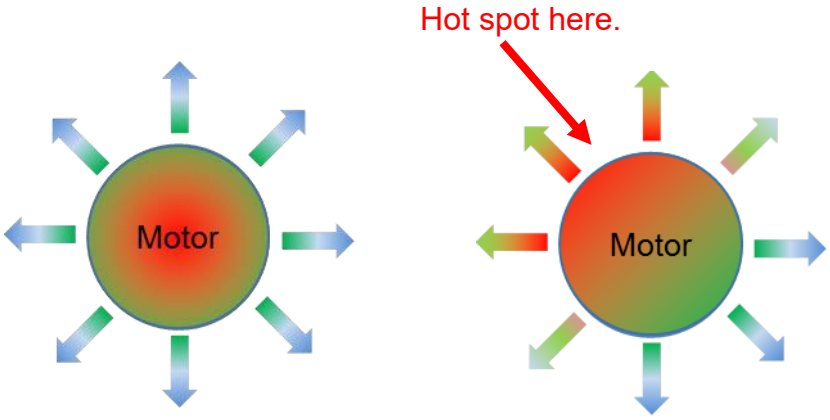


Figure 3.4.2 Normal operation (Left), Stall condition (right)

When the motor operates at a motor frequency lower than 1 Hz, it is regarded as stall condition.

The relationship between motor frequency, motor speed and the number of poles is as follows:

$$\mathrm{n} = \frac{120f}{2p}\ [rpm]$$

n= rotational speed $[rpm]$

f= Electrical frequency $[Hz]$

$2p$= Number of poles

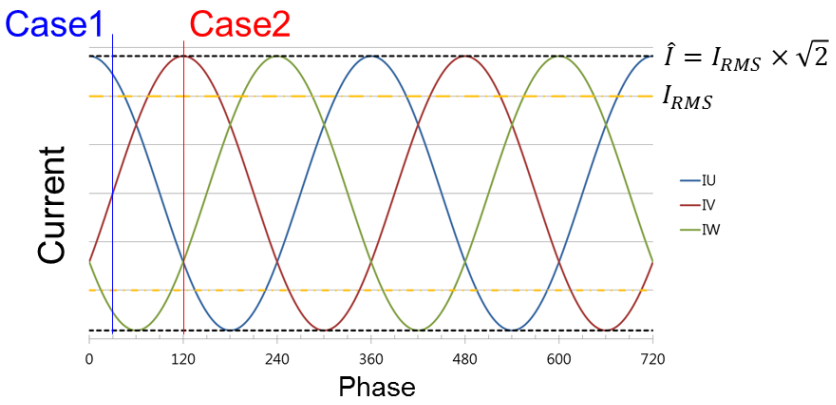


Figure 3.4.3 Current in motor @ different phase

As mentioned earlier, when the motor speed is extremely low and the motor is operating in stall condition, the current will exceed the continuous current that each phase can withstand on two-phase or single-phase as shown in Figure 3.4.3, the operating current must be properly reduced to avoid overheating. There are two boundaries in the stalled condition. At any electrical angle, the current must be between the following two cases:

Case1 Overcurrent on both phases. (Example of U, W phase)

➔ Current down to **81%** continuous current ($\frac{1}{\sqrt{1.5}}$)

➔ Modify Current: $I_{phase\_U} = I_{phase\_W} = \frac{1}{\sqrt{1.5}} I_c$

Case2 Overcurrent on single phase. (Example of V phase)

➔ Current down to **70%** continuous current ($\frac{1}{\sqrt{2}}$)

➔ Modify Current: $I_{phase\_V} = \frac{1}{\sqrt{2}} I_c$

Stall condition is easily ignored by users in application and calculation. If the motor speed is lower than the speed shown in Table 3.4.1, it must be regarded as a stall condition. The operation conditions must be carefully estimated. Current and temperature must be monitored. This is to prevent the motor from getting damaged by overheating.

Table 3.4.1 Stall Speed of HIWIN Direct Drive Motor - DMN Series

Type	Speed [rpm]
DMN2x	12
DMN4x	7.5
DMN71	7.5
DMN93	5.46
DMN95	5.46
DMN9A	5.46

3.4.1.5 Oscillation in a very small angle

When the motor operates within a small angular range, current may accumulate in certain one or two phase coils, leading to localized heating and hotspots in the motor. In such cases, evaluation should be conducted using stall conditions (Section 3.4.1.4, Case2) to prevent motor overheating. When the back-and-forth movement occurs within the angular range specified in Table 3.4.2, the operation conditions must be carefully estimated. The operating current must be properly reduced to avoid overheating, current and temperature must be monitored. This is to prevent the motor from getting damaged by overheating.

Table 3.4.2 (Stall) Angular range of HIWIN Direct Drive Motor - DMN Series

Series	Angular range [deg]
DMN2x	36
DMN4x	22.5
DMN71	22.5
DMN93	16.37
DMN95	16.37
DMN9A	16.37

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4. Transport and setup

4.1 Delivery

■ **Transport precautions**

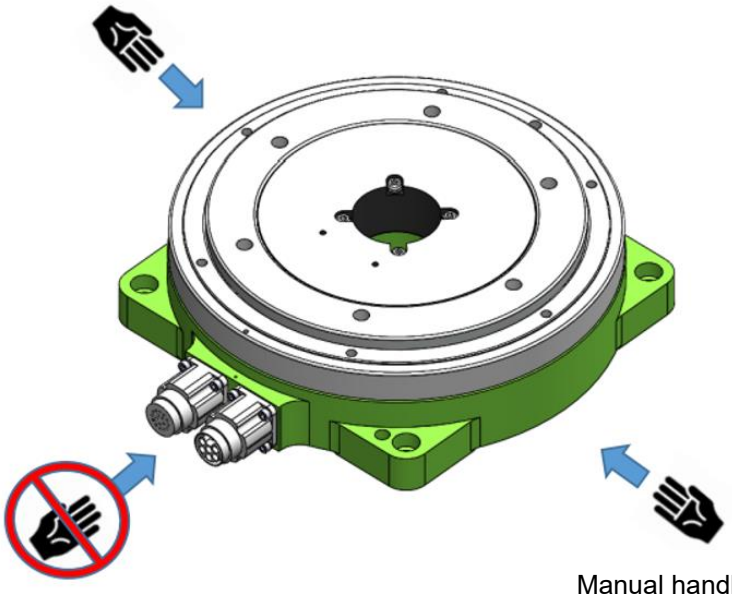
1. Permanent magnets are listed as Dangerous Goods (Magnetized material: UN2807) according to International Air Transport Association (IATA).
2. For products containing permanent magnets, no additional measures on packaging are required to resist the magnetic field in sea freight and inland transportation.
3. When transporting products containing permanent magnets by air, the maximum permissible magnetic field strengths specified by the appropriate IATA Packing Instruction must not be exceeded. Special measures may be required so that these products can be shipped. Above a certain magnetic field strength, such shipments must be labelled in accordance with Packing Instruction 953 from IATA (Please refer below or the latest regulation from IATA.)
   i、 Products whose highest field strength exceeds 0.418 A/m (0.525 μT) or 2° of compass deviation, as determined at a distance of 4.6 m from the product, require shipping authorization from the responsible national body of the country from where the product is being shipped (country of origin) and the country where the airfreight company is based. Special measures need to be taken to enable the product to be shipped.
   ii、 When shipping products whose highest field strength is equal to or greater than 0.418 A/m (0.525 μT) or 2° of compass deviation, as determined at a distance of 2.1 m from the product, shipment is conducted with regulation of Dangerous Goods Transportation.
   iii、 When shipping products whose highest field strength is less than 0.418 A/m (0.525 μT), as determined at a distance of 2.1 m from the product, you do not have to notify the relevant authorities and you do not have to label the product.
4. Shipping originally packed motor components neither has to be disclosed nor marked.
5. Transport conditions must comply with EN 60721-3-2:2018 (refer to Table 4.1.1).

Table 4.1.1 Transport conditions

Environmental parameter	Unit	Value
Air temperature	(℃)	5~40
Relative humidity	(%)	5~85
Rate of change of temperature	$(℃/min)$	0.5
Condensation		Not allowed
Formation of ice		Not allowed
Transport condition		Class 2K11
Transport the motor in an environment with good weather protection (indoor/factory)		
Biological conditions	Class 2B1	
Chemically active substances	Class 2C1	
Mechanically active substances	Class 2S5	
Mechanical conditions	Class 2M4	

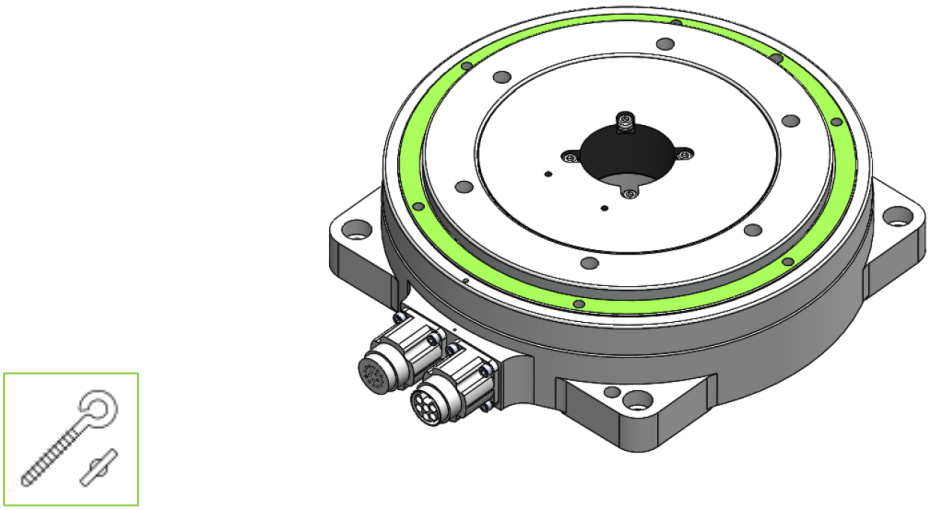
4.2 Transport to the installation site

To prevent injury to personnel or damage to the motor, customers must pay attention to select appropriate lifting or handling positions as shown in the Figure 4.2.1 to Figure 4.2.3 .



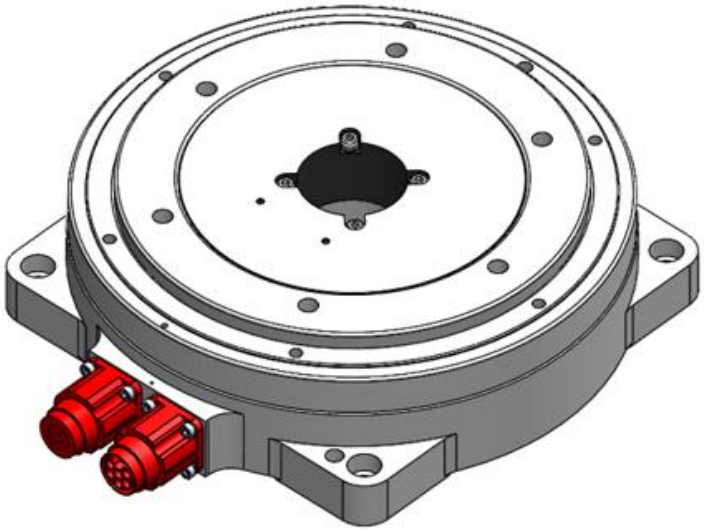
Manual handling from base

Figure 4.2.1 Handling illustration (Manual handling)



Hang evenly from screw holes
in rotary parts

Figure 4.2.2 Handling illustration (use lifting jig)



Avoid connector impact

Figure 4.2.3 Operating precautions

4.3 Requirements at the installation site

DANGER

Danger from electrical voltage!

Before and during assembly, disassembly and repair work, dangerous currents may flow.

- Work may only be carried out by a qualified electrician and with the power supply disconnected!
- Before carrying out work on the direct drive motor, disconnect the power supply and protect it from being switched back on!

DANGER

Risk of death as a result of strong magnetic fields!

Strong magnetic fields around direct drive motor systems represents a danger for people with active medical implants, who come close to the motors. This is also the case when the motor is switched off.

- If you are affected, stay a minimum distance of 500 mm from the permanent magnets
  - Trigger threshold for static magnetic fields of 0.5 mT according Directive 2013/35/EU

Also take national and local guidelines or requirements into account.

- For reference DGUV rule 103-013 of the German Social Accident Insurance specifies requirements when working with magnetic fields

WARNING

Danger from heavy loads!

Lifting heavy loads may damage your health.

- Use a hoist of an appropriate size when positioning heavy loads which are over 20 kg!
- Observe applicable occupational health and safety regulations when handling suspended loads!
- Motors with stator and rotor fixture can be hung with hanging holes. The strength of the components should be considered when hanging under any circumstances.

ATTENTION

Risk of physical damage to watches and magnetic storage media.

Strong magnetic forces may destroy watches and magnetisable data storage media near to the direct drive motor system! ◦

- Do not bring watches or magnetisable data storage media into the vicinity (<300 mm) of the direct drive motor systems!

ATTENTION

Damage of the direct drive motor system!

The direct drive system may be damaged by physical operations.

- Do not pull the cable directly.
- No heavy load or sharp object on motor.

4.4 Storage

DANGER

Risk of death as a result of strong magnetic fields!

Strong magnetic fields around direct drive motor systems represents a danger for people with active medical implants, who come close to the motors. This is also the case when the motor is switched off.

- If you are affected, stay a minimum distance of 500 mm from the permanent magnets
- Trigger threshold for static magnetic fields of 0.5 mT according Directive 2013/35/EU

Also take national and local guidelines or requirements into account.

- For reference DGUV rule 103-013 of the German Social Accident Insurance specifies requirements when working with magnetic fields

■ Maintenance and storage precautions

- Do not store the product in an inflammable environment or with chemical agents.
- Store the product in a place without humidity, dust, harmful gases or liquids.
- Install the product in location with less vibration.
- The way to clean the product: wipe with alcohol (70%)
- The way to discard the damaged product: recycle it according to local laws and regulations.
- Storage conditions must comply with EN 60721-3-1:2018(refer to Table 4.4.1).
- Motor can be stored for up to two years indoor with the following conditions:
  - Dry
  - Dust-free
  - No vibration
  - Good ventilation
  - Resistance to extreme weather
  - Indoor air does not contain corrosive gas
  - Prevent motor vibration and moisture
- If no dry storage environment is available, the following measures need to be taken:
  - Wrap the motor with moisture-absorbing material, and then seal the motor.
  - Put desiccant in the sealed package; the desiccant needs to be checked and replaced if necessary.
  - Check the motor regularly.
- Motors should be stored in the original packages and laid flat. It can be temporarily stored outside the package if sufficient support and protection is provided. Also, the storage environment needs to meet the requirements. Please make sure that the cables must face upwards in case of pinching.

- After long-term storage and removal of the motor, the insulation resistance value may be reduced due to moisture. Before installing the machine, confirm the insulation resistance state of the motor. Use an inspection instrument that meets EN61557. The test must reach 100MΩ after 60 seconds at 500V_{DC}. If it does not meet the specifications, the motor may be damp. If it is used directly, it may cause insulation damage. Please contact HIWIN for assistance.

Table 4.4.1 Storage conditions

Environmental parameter	Unit	Value
Air temperature	(℃)	-5~40
Relative humidity	(%)	5~85
Absolute humidity	(g/m^3)	1~25
Rate of change of temperature	$(℃/min)$	0.5
Air pressure	(kPa)	70~106
Solar radiation	(w/m^2)	700
Condensation		Not allowed
Formation of ice		Not allowed
Long-term storage conditions		Refer Class 1K21
Store the motor in an environment with good weather protection. (indoor/factory)		
Biological conditions	Class 1B1	
Chemically active substances	Class 1C1	
Mechanically active substances	Class 1S11	
Mechanical conditions	Class 1M11	

4.5 Unpacking and setup

⚠ WARNING!

Danger from heavy loads!

Lifting heavy loads may damage your health.

- Use a hoist of an appropriate size when positioning heavy loads which are over 20 kg!
- Observe applicable occupational health and safety regulations when handling suspended loads!
- Motors with stator and rotor fixture can be hung with hanging holes. The strength of the components should be considered when hanging under any circumstances.

- Please disassemble and assemble this product indoors. The precautions for disassembling the product package are as follows:
- Please confirm that the quantity and the specifications of the label are correct.
- Please save the disassembled carton and send it back if there is any problem later. If there is no problem, please dispose of the packaging in an environmentally friendly manner.
- Please take out the product carefully (see refer Figure 4.2.2), confirm that the appearance is not damaged and the internal product is correct, and you can take pictures for storage.

5. Assembly and connection

5.1 Mechanical installation

DMN is a shaft flat motor. In order to achieve stable and precise motor performance, it is recommended to use all installation holes and tighten them to the specified torque during installation. Specifically, when installing the fixing part, all the countersunk holes on the motor base (yellow area) must be used for even and segmented tightening to the specified torque (Table 5.1.1,Figure 5.1.2). It is generally recommended to use a crosswise sequence tightening pattern and divide the tightening torque into three stages. To avoid deformation of the base, it is also suggested that when tightening the inner screws, the outer screws should be temporarily fastened with a leveling bracket until all inner screws are tightened. During the installation of the rotating part, it is also recommended to tighten evenly and in segments to the specified torque, using a star-shaped tightening pattern and dividing the tightening torque into three stages. As the same time, it is also desired to ensure that the flatness of the mounting surface is within 0.01/300mm.

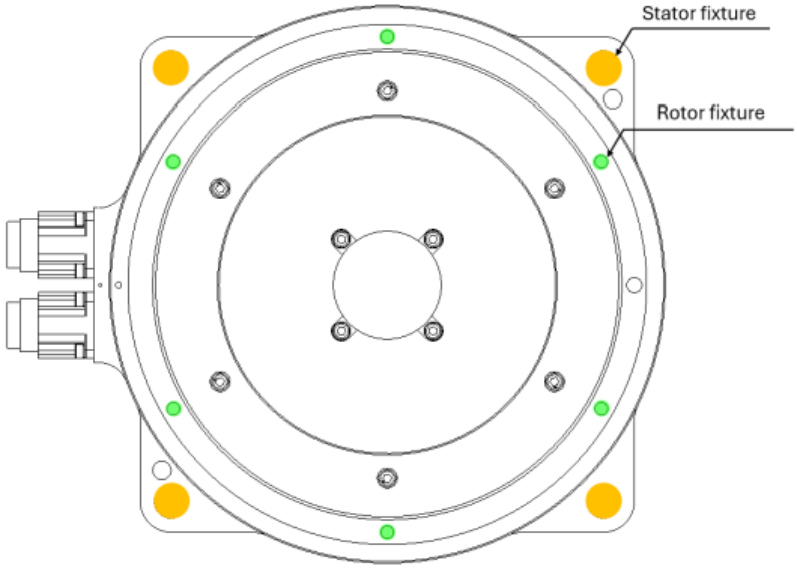


Figure 5.1.1 Illustration of the location of the fixed mounting holes (DMN71 as an example)

5.1.1 Mechanical mounting

5.1.1.1 Screw tightening torque

Screws with a strength class of 12.9 are required for fixed screws. Specification of threaded holes, screw tightening torque for each series are given in Table 5.1.1.

Table 5.1.1 Screw tightening torque of DMS series

Series	(Rotor part)		(stator part)	
	Specification of threaded holes	Screw tightening torque $(kgf-cm)$	Specification of holes / counter-bore	Screw tightening torque $(kgf-cm)$
DMN21、22	M3x0.5Px5DP	17	Ø4.5 THRU, Ø7.5x13DP	40
DMN42、44	M5x0.8Px8DP	81	Ø6.6 THRU, Ø11x11DP	138
DMN71	M5x0.8Px8DP	81	Ø6.6 THRU, Ø11x7DP	138
DMN93	M5x0.8Px8DP	81	Ø9 THRU, Ø15x14DP	334
DMN95、9A	M8x1.25Px12DP	334	Ø12 THRU	663

*Tighten the fixing screws in a crosswise sequence using a torque wrench in three steps to the specified tightening torque.

- Stage 1 40% of tightening torque
- Stage 2 70% of tightening torque
- Stage 3 100% of tightening torque

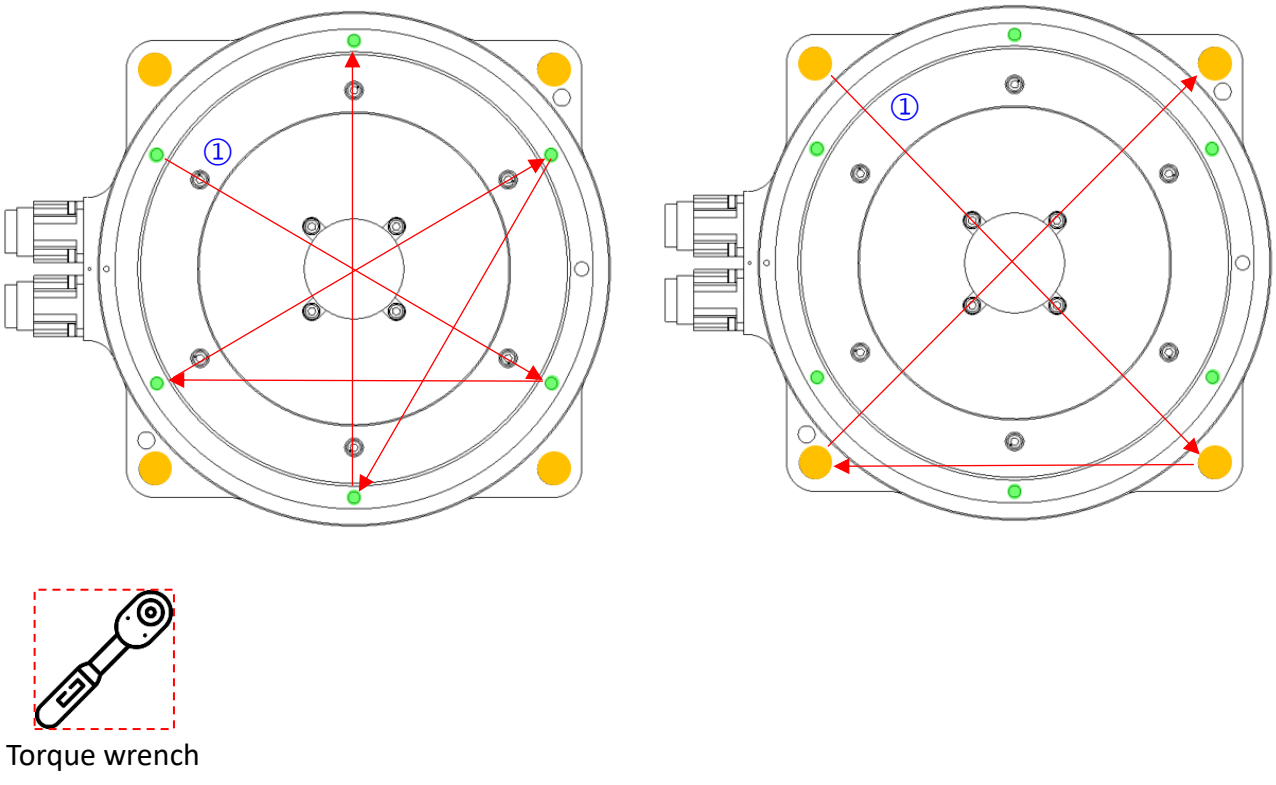


Figure 5.1.2 Tightening of fixing screws

5.1.2 Direction of rotation

From the front of the motor (with the mounting holes for customer rotation facing forward).If the motor cable is connected according to Figure 5.1.3. The rotor part will rotate in clockwise direction

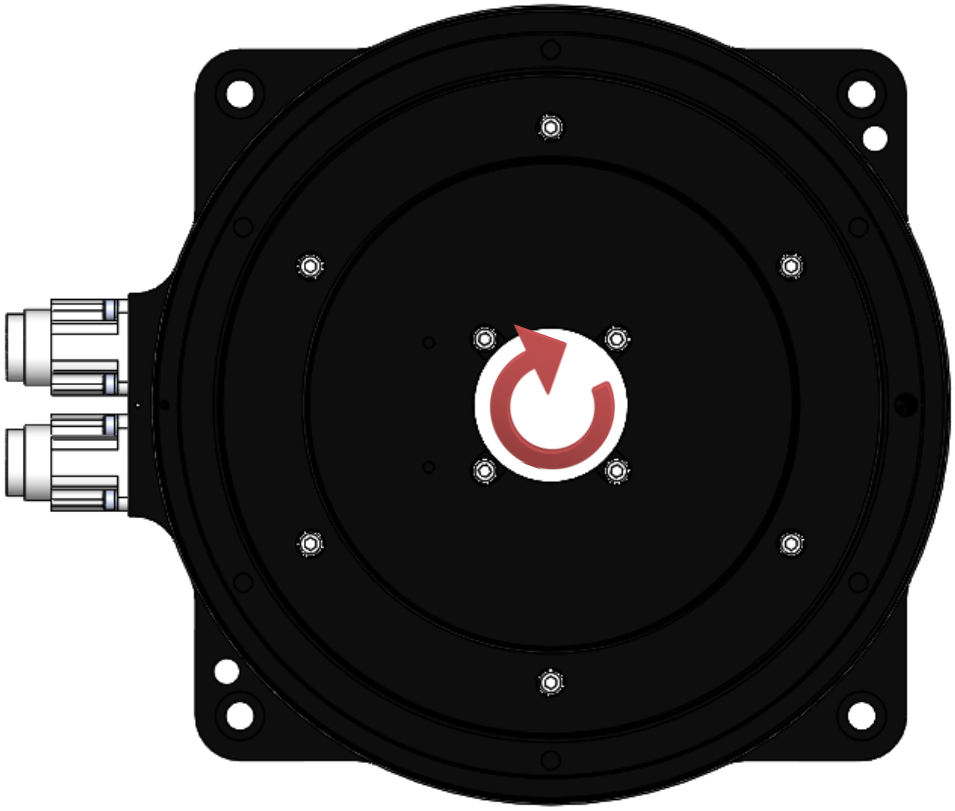


Figure 5.1.3 Illustration of rotational direction of the rotor part

5.2 Electrical installation

DANGER

Danger from electrical voltage!

Before and during assembly, disassembly and repair work, dangerous currents may flow.

- Work may only be carried out by a qualified electrician and with the power supply disconnected!
- Before carrying out work on the direct drive motor system, disconnect the power supply and protect it from being switched back on!

DANGER

Danger from electrical voltage!

If motors are incorrectly grounded, there is a danger of electric shock.

- Before connecting the electrical power supply, ensure that the motor system is correctly grounded.

5.2.1 Wiring precautions

- Before using the product, carefully read through the specification noted on product label, and ensure the product is used with power supply specified in product requirement.
- Check if the wiring is correct. Incorrect wiring may make the motor operate abnormally, or even cause permanent damage to the motor.
- Select extension cord with shield. The shield must be grounded.
- Do not connect motor cable and encoder cable to the same extension cord.
- Motor cable and encoder cable contain shield. The shield must be grounded.

5.2.2 Cable

- The incremental encoder (Figure 3.3.1) the motor uses a circular metric connector.
- The absolute encoder (Figure 3.3.1) standard length of the motor cable and encoder cable is 300 mm $\pm$30 mm, and the connector is included.

5.2.2.1 Installation and cable routing

During installation, it is necessary to ensure that the motor is firmly secured. In cases where the installation is unstable or the machine base has poor rigidity, the motor's performance may not be fully utilized, and the same applies to the installation of the load. Vibration can occur due to shaking, instability, or loose screws. (Refer to Section 5.1)

It is necessary to confirm that the motor, driver, power supply, and all other components are properly connected. If it is used with HIWIN's driver, the cable routing configuration can refer to Section 11.4.1.

5.2.2.2 Circular connectors specification

The relationship between the pin assignment of the metal power connector cable and the signals is shown in Table 5.2.1.

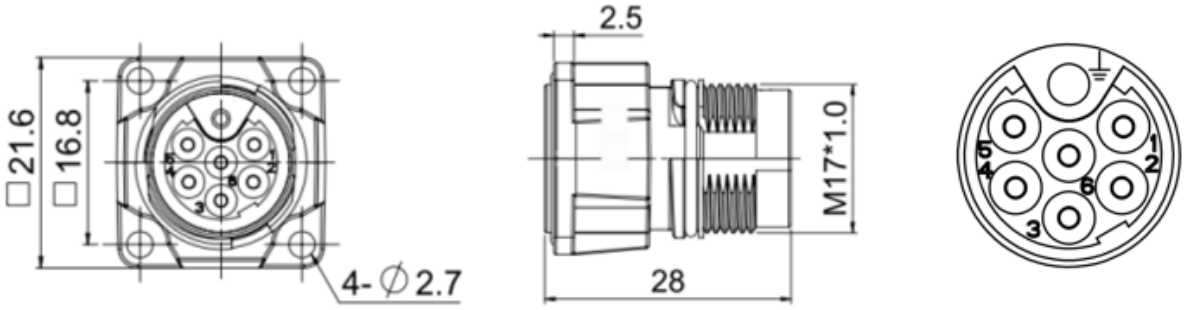


Figure 5.2.1 Motor connector

Table 5.2.1 Motor pin assignment (standard type)

Position	Signal
1	V
2	U
3	W
⏚	PE

For the version with temperature control, the relationship between the pin assignments of the metal power connector cable and the signals is shown in Table 5.2.2

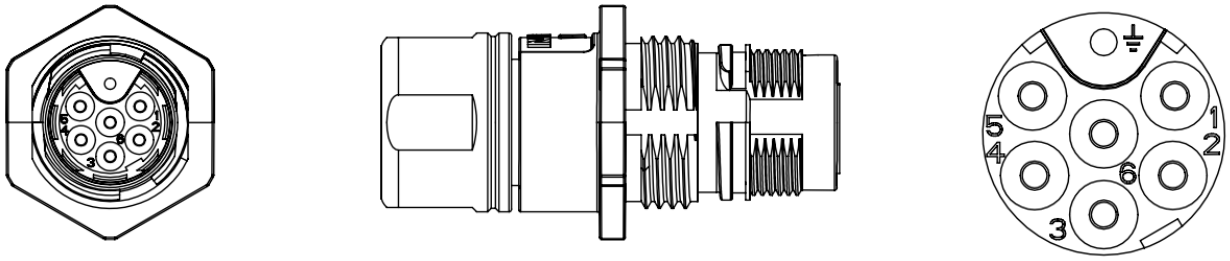


Figure 5.2.2 Encoder connector(with temperature control)

Table 5.2.2Encoder pin assignment (standard type)

Position	Signal
4	V
1	U
3	W
5	T+
6	T-
⏚	PE

The relationship between the encoder connector pin assignment and the signals is shown in Table 5.2.3.

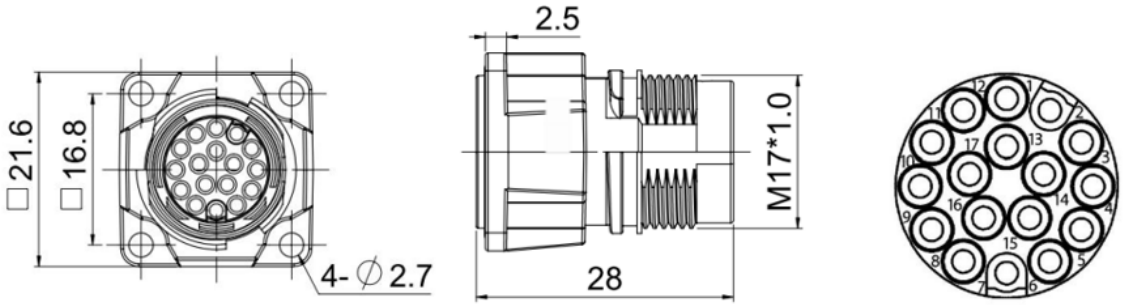


Figure 5.2.3 Encoder connector

Table 5.2.3 Encoder pin assignment (standard type)

Function	Position	Signal
Power	4	5V
	5	5V
	6	0V
Incremental signals	2	U2-
	3	U1-
	9	U2+
	10	U1+
Reference mark	1	U0-
	8	U0+
	Case	Shield
Temperature switch	11	T+
	12	T-

5.2.2.3 Encoder cable and rectangular connectors specification

With a specification of AWM STYLE 2517 and a wire diameter of Ø6.5. The end of the motor cable uses a 172167-1 connector (male). The cross-section of wire is determined by the value of continuous current.

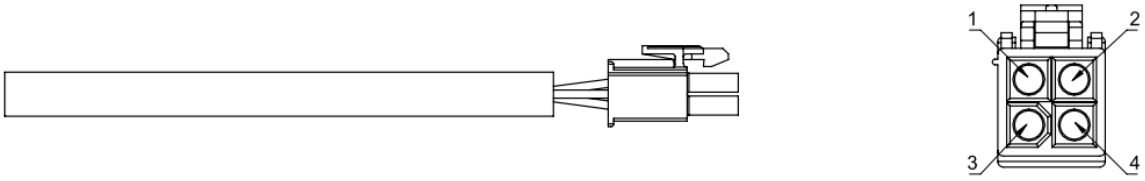
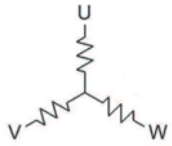


Figure 5.2.4 Motor connector

Note: Motor cable contains shield. The shield must be grounded (Section 5.2.2.4).

The relationship between motor connector and signal is given in Table 5.2.4

Table 5.2.4 Relationship between motor connector and signal

172167-1 (male)	Signal	Diagram
3	U	
2	V	
1	W	
4	PE	

The temperature controlled version uses an AWM STYLE 2517 power cable with a diameter of Ø8. The end of the motor cable uses a 172168-1 connector (male). The cross-section of wire is determined by the value of continuous current.

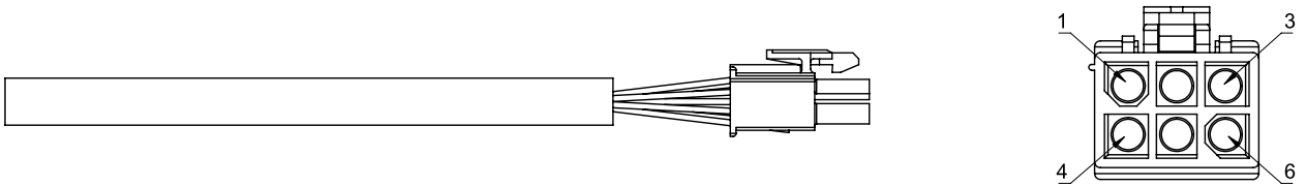
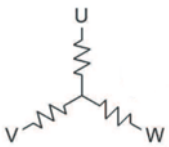


Figure 5.2.5 Motor connector (with temperature control)

Note: Motor cable contains shield. The shield must be grounded (Section 5.2.2.4).

The relationship between motor connector and signal is given in Table 5.2.5.

Table 5.2.5 Pin assignment

172168-1 (male)	Signal	Diagram
1	U	
2	V	
3	W	
4	PE	
5	T+	
6	T-	

With a specification of AWM STYLE 20276(20963) and a wire diameter of Ø4.5(Ø3.7). The end of the encoder cable uses a 1-172169-9 connector (male). The cross-section of wire is determined by the value of continuous current.(Figure 5.2.6,Table 5.2.6 to Table 5.2.8.)

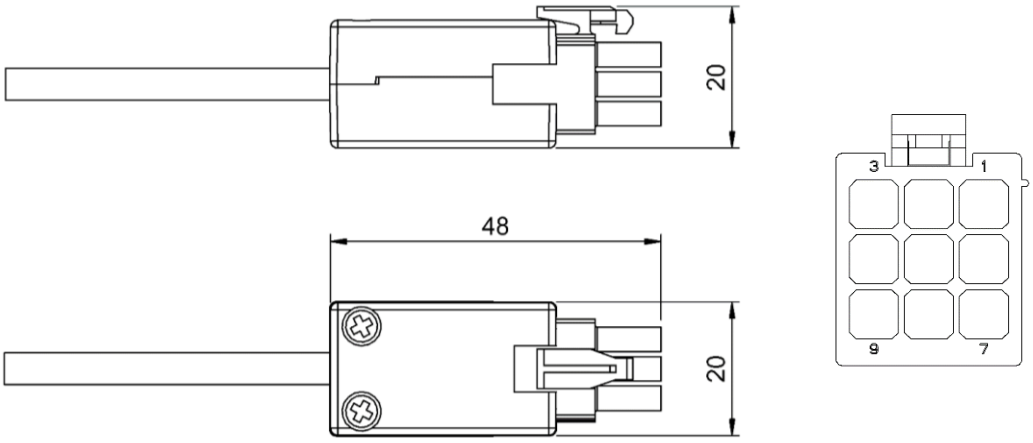


Figure 5.2.6 External electronics dimension of Encoder cable

Table 5.2.6 Digital incremental pin assignment

Function	1-172169-9 (male)	Signal
Power	1	5V
	2	0V
Incremental signal	3	A+
	4	A-
	5	B+
	6	B-
Reference mark	7	Z+
	8	Z-
	9	Shield

Table 5.2.7 Absolute encoder T-code communication pin assignment

Function	1-172169-9 (male)	Signal
Power	1	5V
	2	0V
Serial signals	7	PS+
	8	PS-
	9	Shield

Table 5.2.8 Absolute encoder Biss C communication pin assignment

Function	1-172169-9 (male)	Signal
Power	1	5V
	2	0V
Serial signals	3	MA+
	4	MA-
	5	SLO+
	6	SLO-
	9	Shield

5.2.2.4 Electromagnetic Compatibility (EMC)

It is necessary to install and connect the cable shields properly to protect conductors. Correct installation not only protects personal safety, but also reduces noise. The power modules of the motor controller all use PWM voltage switching to control the motor. PWM switching will cause EMI radiation, which has negative effect on the sensor signal. Therefore, to make an EMC environment, shields must be used on following cables:

- All cables on the power module (including the adapter wires connected to modules such as filters and reactors).
- All motor cables (including motor cable and encoder cable)
- Sensor cables.
- Feedback signal cables.

To reduce interference, the following methods and tests are recommended:

- Independent shields must be used on motor cables and encoder cables. If the cable is longer than 1 meter, the shields at both ends of the cable must be grounded.
- The long cables and the motor power cables close to the sensor cables must be grounded with a shield.
- The grounding resistance of all grounding positions to the system should be less than 1Ω (according to standard IEEE 80).
- When the groundings of different machines are connected to each other, it is recommended to use ground straps or surface contact. Please try to avoid using a ground wire with a small cross-section.
- When the equipment is grounded, it is recommended to use a ground wire with an equivalent copper wire with cross-section area of at least 6 mm^2.
- Do not open or disconnect the circular connector or cable glands on the stator because the shield inside may be damaged or out of function.
- When a self-made cable extension cable is used, please make sure that the design and installation comply with EMC standards.

There are two types of grounding for shields. One is to use circular connector with an IP66 or above. As to the connecting method, please refer to the circular connector's installation manual. The shields must have a conductive connection to the circular connector, as shown in Figure 5.2.7. The other is single shield installation. The motor cable shield can be connected to a metal structure (such as a frame, control box or machine) by a cable clamp. During installation, the grounding position must be close to the controller/Drive and motor, as shown in Figure 5.2.8and Figure 5.2.9. ◦

Each grounding method has the pros and cons. The most important thing is that the grounding resistance of every equipment must be as low as possible to provide a balanced electric potential for the equipment.

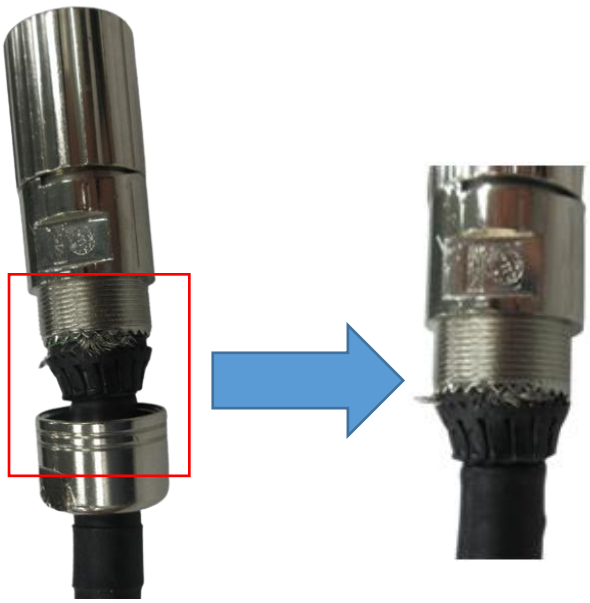


Figure 5.2.7 The shields must have a conductive connection to the circular connector (Schematic)

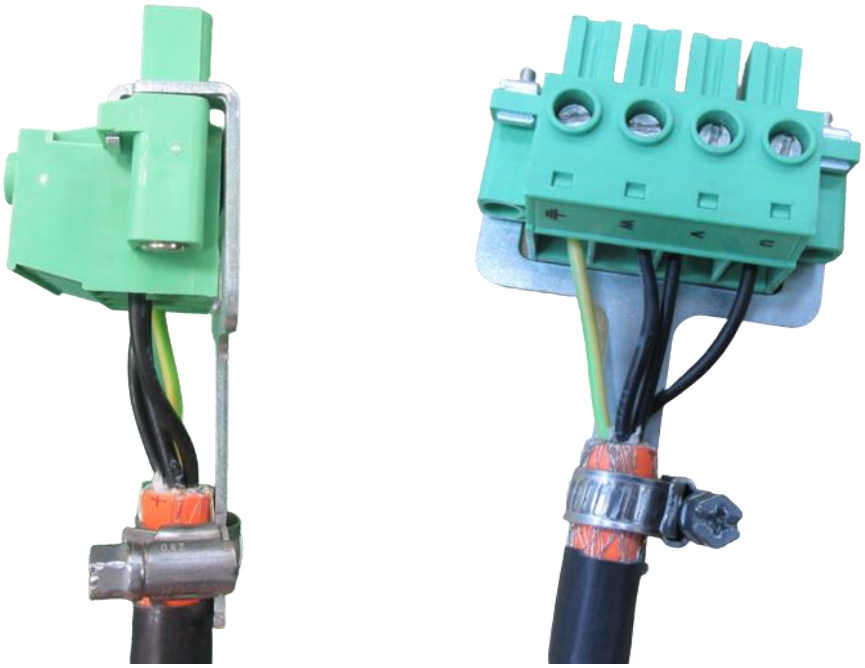


Figure 5.2.8 Use a tube ring to fix the shield on shield connecting plate (Schematic)

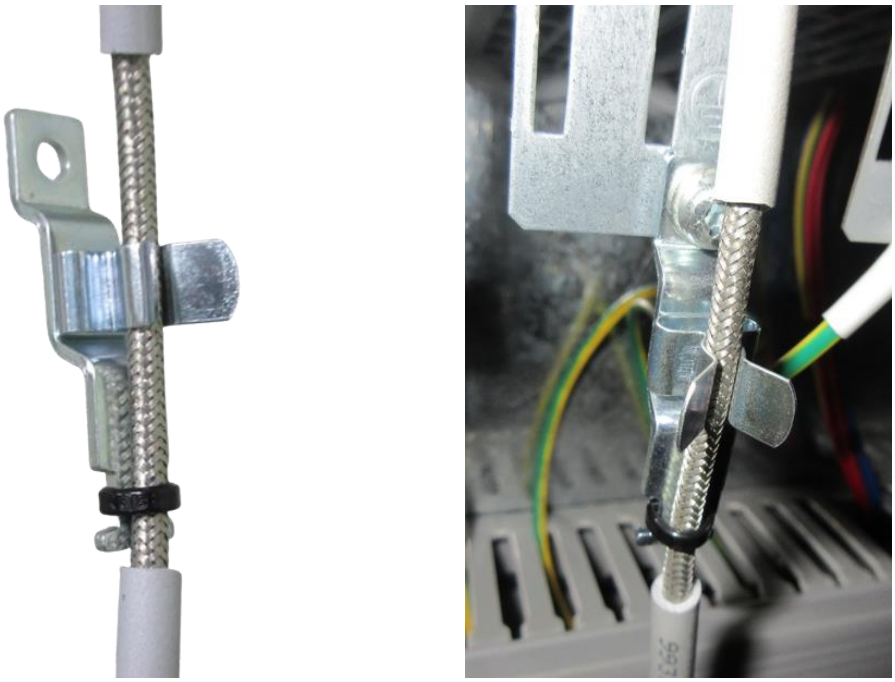
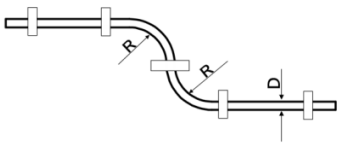
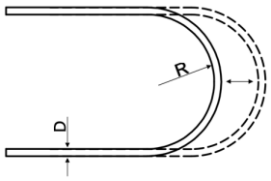


Figure 5.2.9 Use a fixed ground clamp to ground the shield (Schematic)

5.2.2.5 Bending radius of cable

The minimum bending radius of motor cable and encoder cable for torque motor is given in the following Table 5.2.9.

Table 5.2.9 Bending radius of cable

Feature	Diagram	Motor cable	Encoder cable
Min. bending radius of fixed installation		R= 3 x D	R= 5 x D
Min. bending radius of moving installation		R= 5 x D	R= 12 x D

The minimum bending radius of motor and encoder extension cables for direct drive motors is given in the following Table 5.2.10 to Table 5.2.11.

Table 5.2.10 Minimum bending radius for extension cables with metallic connectors

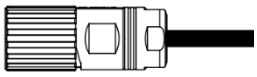
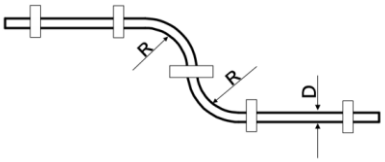
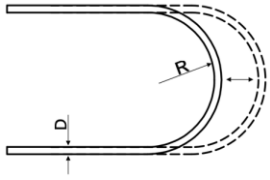
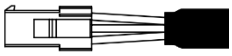
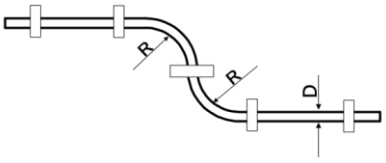
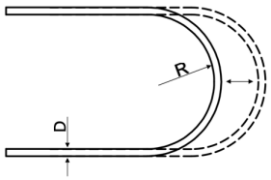
Cable connector diagram	Feature	Diagram	Motor cable	Encoder cable
	Min. bending radius of fixed installation		R= 3 x D	R= 2 x D
	Min. bending radius of moving installation		R= 5 x D	R= 10 x D

Table 5.2.11 Minimum bending radius for extension cables with rectangular connectors

Cable connector diagram	Feature	Diagram	Motor cable	Encoder cable
	Min. bending radius of fixed installation		R= 10 x D	R= 8 x D
	Min. bending radius of moving installation		R=12.5 x D	R= 10 x D

Note:

1. The bending radius may be different from the information provided in above table because of the modification of cable suppliers. In this case, please refer to the specification from the cable supplier.
2. The cable connector illustration is for reference only. For detailed extension cable specifications, please refer to Section 11.4 Accessories.

5.2.2.6 Temperature sensor

PTC100 are thermistors. Their output resistance changes according to coil temperature. Resistance of PTC100 rises drastically when T_{REF}=100℃. Their features are given in Table 5.2.12 and Figure 5.2.10.
※There are 3 PTC in series, the controller must NOT trigger at a value lower than the resistance value given at ambient temperature.(refer to Table 5.2.12)

Table 5.2.12 Features of PTC

Features of	Resistance	3 PTC in series resistance
20℃<T<T_{REF} - 20K	20Ω~250Ω	60Ω~750Ω
T=T_{REF} - 5K	≦ 550Ω	≦ 1,650Ω
T=T_{REF} + 5K	≧ 1,330Ω	≧ 3,990Ω
T=T_{REF} + 15K	≧ 4,000Ω	≧ 12,000Ω

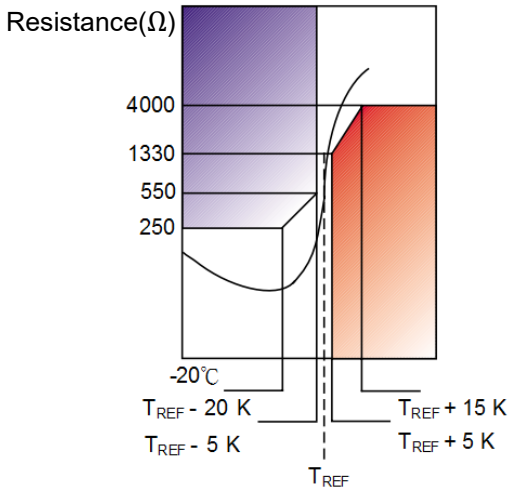


Figure 5.2.10 Relationship between PTC temperature and resistance

5.2.2.7 Temperature monitoring and motor protection

To protect the motor windings against thermal damage, every motor is equipped with a triple positive temperature coefficient (PTC) sensor, type SNM100 (in accordance with DIN 44082-M180). Since the degree of heating of the individual motor phases can be very different, a PTC sensor is fitted in each phase winding (U, V and W). Each PTC element has a “Quasi-switching” characteristic, i.e. the resistance suddenly increases close to the rated temperature (switching threshold, Figure 5.2.10). Due to its low heat capacity and good thermal contact with the motor winding, the PTC reacts very quickly to a rise in temperature and, in conjunction with additional protective mechanisms on the control side, ensures reliable motor protection against overload. The PTC elements located in every phase winding in HIWIN motors are wired in series; they connect via two wires.
Note:
Motor protection by temperature monitoring alone using PTC elements can be insufficient. This is the case, for example, if the motor is operated with currents above continuous current.

HIWIN advises the use of additional protective algorithm on the control side. Also, the calculation of max. operating time with currents above continuous current can be found in Section 3.4.1.2.

5.2.2.8 Connection to the drive amplifier

The temperature monitoring circuits can normally be connected directly to the drive control. If the protective separation requirements in accordance with EN61800-5-1 are to be fulfilled, the sensors must be connected to the decoupling modules provided by the drive manufacturers.

5.2.3 Power supply and controller selection

The continuous current, peak current and bus voltage must be considered while selecting a power supply. In addition, the resonance effect which can be induced in motors by some drive systems must be taken into account. Motors are assembled with several individual coils connected in series. Each one of these coils has an inductance in series and a stray capacitance to earth. The LC network obtained possesses a resonant frequency, so when an electrical oscillation is applied to the phase inputs (in particular the PWM modulation frequency), the neutral point of the motor can oscillate with very high amplitudes with respect to earth, and the insulation can be damaged as a consequence of these oscillations. This phenomenon is more pronounced in motors with a large number of poles (such as torque motors).

Under ideal conditions, the 600V_{DC} bus voltage generated by the power supply should be ±300V_{DC} relative to earth. However, in some configurations, the voltage between the bus and earth will have an oscillating voltage, and the peak of the high voltage will be transmitted to the motor. The oscillation voltage between the bus and earth depends on system characteristics. By experience, a system with few axes connected to the bus voltage is less liable to have disturbing oscillations on the bus, but for example in a large machine tool with many axes and several spindles, the oscillations can reach high amplitudes. If the frequency of these oscillations is close to the resonant frequency of the motor, it can lead to over-voltage failures on the neutral point.

The case where the PWM modulation frequency of the controller happens to correspond to the resonant frequency of the motor. In this case, the fundamental harmonic of the PWM modulation frequency is directly exciting the resonant frequency of the motor, and very high voltages are thus obtained on the neutral point. Also, as the PWM voltage is a square wave, it contains odd harmonics (1, 3, 5, 7, etc..) that can also excite the motor resonance. Fortunately, these harmonics have a smaller amplitude that the fundamental.

In another case, it may also lead an over-voltage failure. In this case, the fundamental harmonic of the PWM modulation frequency is directly exciting the resonant frequency of the motor, and very high voltages are thus obtained on the neutral point. In addition, because the PWM voltage is a square wave, it contains odd harmonics (1, 3, 5, 7, etc.) that can also excite motor resonance.

In conclusion, to prevent any failure from occurring, two elements must be considered: the oscillations between the bus voltage and earth and the PWM modulation frequency. If both elements above do not enter into resonance with the motor, then there is no risk for the motor.

When selecting power supply, please check the conditions below:

Peak voltages and dV/dt gradients generated by the power supply must not exceed the values below:

600 V_{DC} controllers:600 V_p maximum (at the PWM frequency) and a voltage gradient: 11 kV/μs.

As shown in Figure 5.2.11, and Table 5.2.13.

The cable between the controller and the motor will generate a reflected wave due to the impedance mismatch between the cable and the motor, and the reflected voltage will be superimposed with the subsequent input voltage, causing the voltage to rise. This phenomenon will be more obvious when the motor cable is longer. If the length of the cable between the controller and the motor is longer than 10 m, it is necessary to measure voltages at the motor terminals to ensure they are lower than specified above.

If the measured value is greater, a dV/dt filter must be inserted between the controller and the motor for protection.

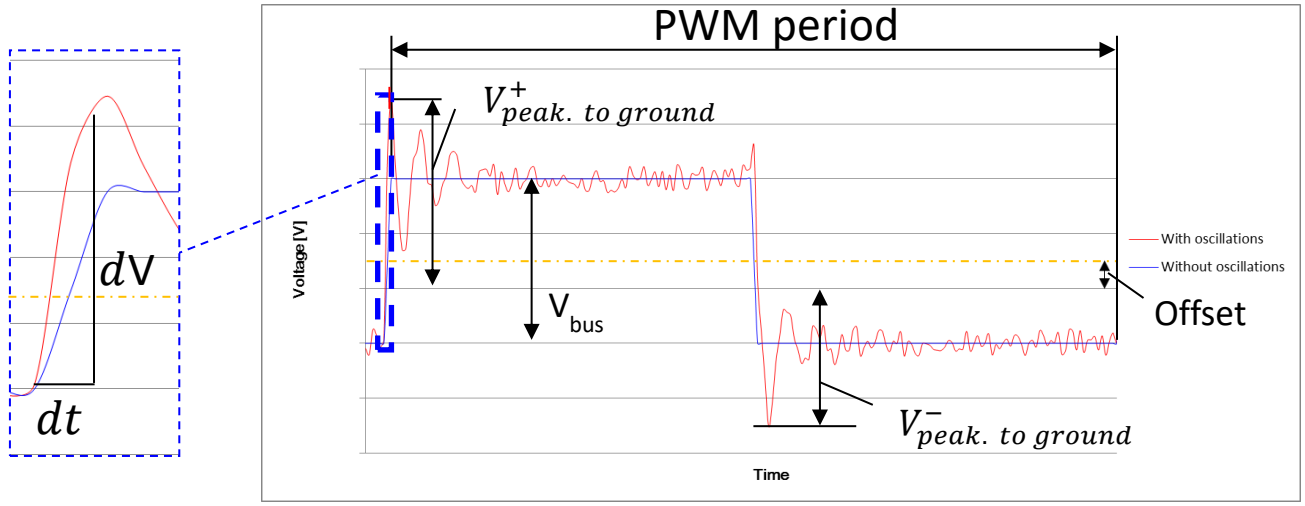


Figure 5.2.11 Voltage oscillation schematic

Table 5.2.13 Voltage limitation of power supply and neutral point (DMN Series)

V_{bus}	Max. 600 V_{DC}
$\lvert V^+_{peak.\ to\ ground}\rvert$	< 600 V_p (phase to ground) @ PWM frequency
$\lvert V^-_{peak.\ to\ ground}\rvert$	< 600 V_p (phase to ground) @ PWM frequency
Voltage gradient $\lvert dV/dt\rvert$	< 11 $kV/\mu s$ (instantaneous) If it is difficult to obtain instantaneous voltage gradient, the following formula can be used to estimate (Figure 5.2.12) : $\lvert dV/dt\rvert = \lvert(90\%V_{pp} - 10\%V_p)/t_r\rvert$

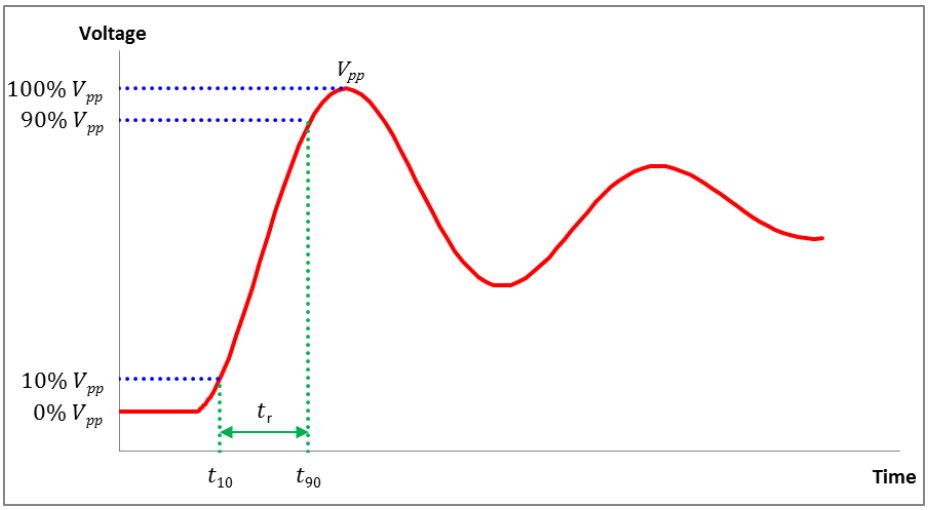


Figure 5.2.12 Rising time t_r definition

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6. Commissioning

6.1 Commissioning

DANGER

Danger from electrical voltage!

Before and during assembly, disassembly and repair work, dangerous currents may flow.

- Work may only be carried out by a qualified electrician and with the power supply disconnected!
- Before carrying out work on the direct drive motor system, disconnect the power supply and protect it from being switched back on!

DANGER

Risk of death as a result of strong magnetic fields!

Strong magnetic fields around direct drive motor systems represents a danger for people with active medical implants, who come close to the motors. This is also the case when the motor is switched off.

- If you are affected, stay a minimum distance of 500 mm from the permanent magnets
- Trigger threshold for static magnetic fields of 0.5 mT according Directive 2013/35/EU

Also take national and local guidelines or requirements into account.

▶ For reference DGUV rule 103-013 of the German Social Accident Insurance specifies requirements when working with magnetic fields

ATTENTION

Risk of physical damage to watches and magnetic storage media.

Strong magnetic forces may destroy watches and magnetisable data storage media near to the direct drive motor system! ◦

- Do not bring watches or magnetisable data storage media into the vicinity (<300 mm) of the direct drive motor systems!

For parameters, please contact our engineering department. Input the corresponding data according to the requirements of the controller and driver, and adjust it according to the controller and driver manual.

■ Operation precautions

- ◆ Avoid excessive friction when the motor is running.
- ◆ Ensure there is no object in the motion range of the system.
- ◆ Before starting the motor, ensure the main switch is on.
- ◆ Before transmitting electricity, ensure at least one ground wire is connected to all electrical products.
- ◆ Do not directly touch motor parts after motor is assembled.
- ◆ If the current exceeds the maximum specified current, magnetic components in the motor may be demagnetized. When it happens, please contact HIWIN or local distributors.
- ◆ Do not operate the product in an environment that exceeds its rated load.
- ◆ When the motor is running, its temperature must be within the specification.
- ◆ If any abnormal odor, noise, smoke, temperature rise or vibration is detected, stop the motor and turn off the power immediately.
- ◆ Don't cool the motor or its parts below room temperature to prevent condensation on the motor, which rapidly degenerate the windings.

▶ Fixed operation environment conditions must comply with EN 60721-3-3:2019 (refer to Table 6.1.1)

Table 6.1.1 Operation environment conditions.

Environmental parameter	Unit	Value
Air temperature	$(℃)$	+5~+40
Relative humidity	$(\%)$	5~85
Absolute humidity	(g/m^3)	1~25
Rate of change of temperature [1)]	$(℃/min)$	0.5
Air pressure [2)]	(kPa)	78.4~106
Solar radiation	(w/m^2)	700
Movement of surrounding air [3)]	(m/s)	1
Condensation	-	Not allowed
Formation of ice	-	Not allowed
[1)] Averaged over a period of time of 5 min. [2)] Conditions in mines are not considered. Severity value is different from Class 3K22. (up to 78.4 kPa) (altitudes up to 2000 m). [3)] Uncontrollable air flow may affect cooling systems based on natural convection.		
Mechanically active substances	Class 3S5	
Mechanical conditions	Class 3M11	

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7. Maintenance and cleaning

7.1 Maintenance

DANGER

Danger from electrical voltage!

Before and during assembly, disassembly and repair work, dangerous currents may flow.

- Work may only be carried out by a qualified electrician and with the power supply disconnected!
- Before carrying out work on the direct drive motor system, disconnect the power supply and protect it from being switched back on!

DANGER

Risk of death as a result of strong magnetic fields!

Strong magnetic fields around direct drive motor systems represents a danger for people with active medical implants, who come close to the motors. This is also the case when the motor is switched off.

- If you are affected, stay a minimum distance of 500 mm from the permanent magnets
- Trigger threshold for static magnetic fields of 0.5 mT according Directive 2013/35/EU

Also take national and local guidelines or requirements into account.

- For reference DGUV rule 103-013 of the German Social Accident Insurance specifies requirements when working with magnetic fields

DANGER

Risk of crushing from strong forces of attraction!

- Assemble the rotors and stators carefully!
- Do not place fingers or objects between the rotors and stators!
- The rotor and magnetizable objects may accidentally attract each other and collide!
- Two rotors may accidentally attract each other and collide!
- The magnetic force of the rotor acting on the object may be as high as several kN, which may cause a certain part of the body to be clamped.
- Do not underestimate the attraction force and operate carefully.
- Wear safety gloves when necessary.
- At least two people are required to cooperate during operation.
- If the assembly steps have not yet reached the installation of the rotor, please place the rotor in a safe and proper place first.
- Never take multiple rotors at once.
- Never place two rotors directly together without any protection.
- Do not bring any magnetizable materials close to the rotor! If the tool must be magnetized, please hold it firmly with both hands and slowly approach the rotor!
- It is recommended to install the rotor immediately after unpacking!

- When installing the stator and rotor, an installation auxiliary device is required to assemble the stator and rotor individually. Please follow the correct method.
- Keep the following tools at hand at any time to release body parts (hands, fingers, feet, etc.) clamped by magnetic force.
  - Hammer made of non-magnetized solid material (about 3Kg)
- Two wedge blocks composed of non-magnetized materials (wedge-shaped sharp angle 10°~15°, minimum height 50mm).

ATTENTION

Risk of physical damage to watches and magnetic storage media.

Strong magnetic forces may destroy watches and magnetisable data storage media near to the direct drive motor system!。

- Do not bring watches or magnetisable data storage media into the vicinity (<300 mm) of the direct drive motor systems!

ATTENTION

Damage of the direct drive motor system!

The direct drive system may be damaged by physical operations.

- Do not pull the cable directly.
- No heavy load or sharp object on motor.

Please read all safety instructions before performing motor maintenance

⚠ Safety Instruction

- Obstacle removal and maintenance can only be performed by HIWIN technicians or authorized dealers, and with appropriate protective equipment.
- Do not perform any maintenance actions while the motor is running. The controller must stop the motor first.
- Please turn off the power and the main switch of the machine (Please refer to the machine manufacturer's instructions for operation).
- After the power is turned off, there will be residual voltage in the system. Please wait for sufficient discharge time before disconnecting all power connections.
- Disassemble the motors in order.

HIWIN direct drive motor is a direct drive system, there will be no wear during operation, but even so, improper operation or incorrect use environment will still shorten the life of the motor or even damage it. It is recommended to conduct measurement and maintenance every quarter:

- Mechanism is checked properly assembled and the electrical parts are all connected.
- Detect possible wear or aging of the cable.
- To test the insulation resistance of the three phases of the motor. It must meet the requirements of $500V_{DC}$ 60 sec>100 MΩ@25℃. If the insulation resistance decreases gradually at the same temperature compared to the previous several measurements, the motor may have begun to age, so special attention should be paid.

7.2 Cleaning

It is recommended to conduct measurement and maintenance every quarter:

- The way to clean the product: wipe with alcohol (70%)
- Clean the metal particles on the motor regularly.
- Regularly check the motor to keep it clean and undamaged.

7.2.1 Test run

After confirming all system is fine, and power system are installed, perform a trial run and adjust it according to the controller and driver manual.

8. Disposal

DANGER

Danger from electrical voltage!

Before and during assembly, disassembly and repair work, dangerous currents may flow.

- Work may only be carried out by a qualified electrician and with the power supply disconnected!
- Before carrying out work on the direct drive motor system, disconnect the power supply and protect it from being switched back on!

DANGER

Risk of death as a result of strong magnetic fields!

Strong magnetic fields around direct drive motor systems represents a danger for people with active medical implants, who come close to the motors. This is also the case when the motor is switched off.

- If you are affected, stay a minimum distance of 500 mm from the permanent magnets
- Trigger threshold for static magnetic fields of 0.5 mT according Directive 2013/35/EU

Also take national and local guidelines or requirements into account.

- For reference DGUV rule 103-013 of the German Social Accident Insurance specifies requirements when working with magnetic fields

DANGER

Risk of crushing from strong forces of attraction!

- Assemble the rotors and stators carefully!
- Do not place fingers or objects between the rotors and stators!
- The rotor and magnetizable objects may accidentally attract each other and collide!
- Two rotors may accidentally attract each other and collide!
- The magnetic force of the rotor acting on the object may be as high as several kN, which may cause a certain part of the body to be clamped.
- Do not underestimate the attraction force and operate carefully.
- Wear safety gloves when necessary.
- At least two people are required to cooperate during operation.
- If the assembly steps have not yet reached the installation of the rotor, please place the rotor in a safe and proper place first.
- Never take multiple rotors at once.
- Never place two rotors directly together without any protection.
- Do not bring any magnetizable materials close to the rotor! If the tool must be magnetized, please hold it firmly with both hands and slowly approach the rotor!
- It is recommended to install the rotor immediately after unpacking!
- When installing the stator and rotor, an installation auxiliary device is required to assemble the stator and rotor individually. Please follow the correct method.

- Keep the following tools at hand at any time to release body parts (hands, fingers, feet, etc.) clamped by magnetic force.
  - Hammer made of non-magnetized solid material (about 3Kg)
- Two wedge blocks composed of non-magnetized materials (wedge-shaped sharp angle 10°~15°, minimum height 50mm).

⚠ WARNING

Danger from heavy loads!

Lifting heavy loads may damage your health.

- Use a hoist of an appropriate size when positioning heavy loads which are over 20 kg!
- Observe applicable occupational health and safety regulations when handling suspended loads!
- Motors with stator and rotor fixture can be hung with hanging holes. The strength of the components should be considered when hanging under any circumstances.

ATTENTION

Risk of physical damage to watches and magnetic storage media.

Strong magnetic forces may destroy watches and magnetisable data storage media near to the direct drive motor system! ◦

- Do not bring watches or magnetisable data storage media into the vicinity (<300 mm) of the direct drive motor systems!

ATTENTION

Damage of the direct drive motor system!

The direct drive system may be damaged by physical operations.

- Do not pull the cable directly.
- No heavy load or sharp object on motor.

8.1 Waste disposal

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

⚠ WARNING

Injury and material damage if not correctly disposed of

If the direct drive motor or related components (especially the rotor with strong magnets) are not handled correctly, it may cause personal injury, death or property damage.

◆ Please ensure that the direct drive motor and related components are disposed of correctly.

Appropriate disposal process:

- The permanent magnets in the rotor assembly must be completely demagnetized.
- The components to be recycled need to be disassembled:
  - Electronic waste (e.g. encoder components, temperature control modules, etc.)
  - Electrical waste (e.g. stator, cables, etc.)
  - Scrap metal alloys (classified by metal)
  - Insulation material
- No mixing with solvents, cold cleaning agents, or residue of paint

⚠CAUTION

Danger caused by environmentally hazardous substances!

The danger to the environment depends on the type of substance used.

Clean contaminated parts thoroughly before disposal!

◆ Clarify the requirements for safe disposal with disposal companies and, where appropriate, with the competent authorities!

Table 8.1.1 Disposal

Fluids	
Lubricants	Dispose of as hazardous waste in an environmentally friendly way
Soiled cleaning cloths	Dispose of as hazardous waste in an environmentally friendly way
Direct dive motor	
Cabling, electrical components	Dispose of as electrical waste
Plastic components	Dispose of separately
Steel components	Dispose of separately
Aluminum components	Dispose of separately

9. Troubleshooting

9.1 Troubleshooting

Table 9.1.1 Troubleshooting

Symptom	Cause	Action
Motor cannot be rotated manually without connecting the controller	Mechanical interference	Remove interference
	Motor three-phase short circuit	Fix three-phase short circuit
Motor can’t rotate at all.	Wrong cable wiring	Check the cable connected to the controller.
	Current overload	Check whether there are interfering objects and remove them. Fix the brake clamping failure.
	Over temperature protection	Check the over temperature setting of controller
	Abnormal insulation resistance	Measure insulation resistance after cooling Measurement of stator three-phase to ground (U/V/W to PE): 500V_{DC} 60 sec>100 MΩ@25℃ If it does not reach 100 MΩ, please contact HIWIN
Wrong rotating direction	Wrong encoder setting	Check encoder setting.
	Wrong motor power cable wiring	Interchange the two-phase power cable connected to the controller.
Smell of burning	Abnormal ambient temperature	Check ambient temperature.
	Wrong controller setting	Check controller setting.
	Wrong motor parameters setting	Check motor parameters setting.
Abnormal temperature of motor outer casing	Speed is too slow	Use the stall condition when switching frequency<1 Hz
	Abnormal ambient temperature	Check ambient temperature.
	Wrong controller setting	Check controller setting.
	Wrong motor parameters setting	Check motor parameters setting.

Symptom	Cause	Action
Unstable rotation (vibration)	Insulation failure	Check the resistance value of phase/earth is larger than 50 MΩ.
	Wrong encoder signal	Check encoder grounding and connection.
	Wrong controller setting	Check controller setting.
	Wrong motor parameters setting	Check motor parameters setting.
Hard to rotate or abnormal friction noise	Unbalanced system	Check the dynamic balance
	Loose system	Check for locking and fix.
	Foreign object blocks the rotor part	Remove foreign object.
Reference signal mark error	Mounting error	Check the pin assignment

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10. Declaration

10.1 Declaration

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	Rotary Table
Identification	Series: DMS, DMN, DMY, DMR, DMT, DMH

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

2014/30/EU	EMC directive
2011/65/EU	RoHS directive

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

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

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

Taichung 408226, Taiwan		
06.02.2024	**YU, KAI-SHENG, Executive Vice President**	
(Place, Date)	(Surname, first name, and function of signatory)	(Signature)

11. Appendix

11.1 Glossary

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

  The back EMF constant, K_v, is the ratio of the back EMF voltage (V_{rms}) to the motor rotational speed (rad/s) when the magnet is at 25℃. It is created at the movement of the coil in the magnetic field of permanent magnets.

- **Continuous current: I_c (A_{rms})**

  The continuous current, I_c, is the current that can be continuously supplied to the motor coils at the ambient temperature 25℃, and the final temperature of coil can't exceed 100℃. Under this condition, the motor reaches the rating continuous torque T_c.

- **Continuous torque: T_c (Nm)**

  The continuous torque, T_c, is the maximum torque the motor is able to generate continuously at the ambient temperature 25℃ and the final temperature of coil can't exceed 100℃). This continuous torque correspond to I_c supplied to the motor.

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

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

- **Resistance at 25℃ (line-to-line): R_{25} (Ω)**

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

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

  The motor constant, K_m, is defined as the ratio of square root of motor output torque to consumption power when the coils and magnets are at 25℃. The larger motor constant represents the lower power loss when the motor outputs at the specific torque.

- **Number of poles: 2p**

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

- **Peak current: I_p (A_{rms})**

  The peak current, I_p, is the current corresponding to torque output of the motor, and the motor temperature reached by current can't demagnetize magnet. Generally speaking, peak current can be granted to supply 1 second when the motor is operating in the normal condition and the input current phase is balanced.

- **Peak torque: T_p (Nm)**

  The peak torque, T_p, is the maximum torque that the motor outputs less than 1 second. Peak current corresponding to the torque cannot demagnetize magnet.

- **Rotor inertia:J (kgm^2)**

  The rotor inertia, J, is the rotary component resists any changes in its state of motion, including changes to its speed and direction. It is related to the shape and mass.

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

  The stall current, I_s,is the upper limit of current when the motor is at the room temperature 25°C and in the stall condition.

- **Stall torque: $T_S/T(N_m)$**

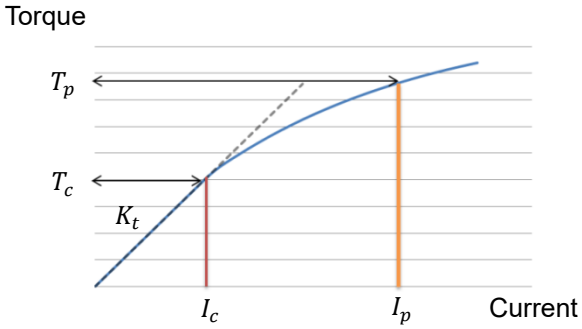
  The stall torque, T_S, is the upper limit of torque when the motor is at the room temperature 25°C and in the stall condition.

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

  The thermal resistance, R_{th}, is defined as the resistance suffered heat from motor coil to dissipate the environment (consider the natural convection and radiation for air cooling when ambient temperature is at 25℃). Higher thermal resistance represents the larger temperature difference between the coil and environment under the same heat source.

- **Torque constant:K_t (Nm/A_{rms}) at magnet temperature of 25**℃

  The torque constant, K_t, is ratio between as the motor's output torque per RMS current. Output torque and input current shows a linear relationship at low current. The non-linear relationship is due to saturation in the iron core.



- **Maximum speed**

  Maximum speed is defined as maximum speed provided under specific torque (usually continuous torque). If there is a bearing installed inside the motor, the maximum speed may be limited by the bearing's DN value. There are two conditions to define the maximum speed of the motor:maximum speed under continuous torque, maximum speed under peak torque.

- **Electrical time constant: $T_e(ms)$**

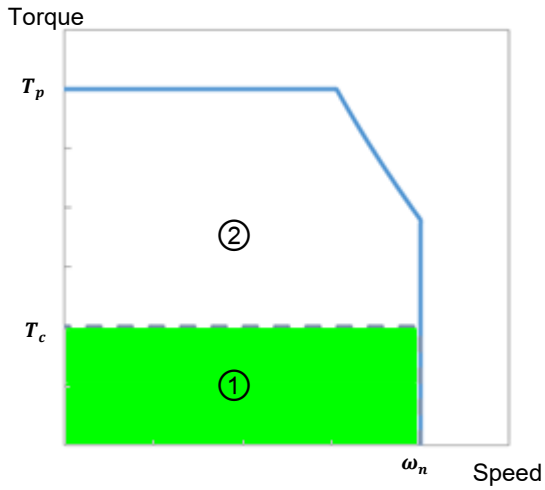
  Electrical time constant is defined as the ratio of line-to-line inductance and line-to-line resistance.

- **Rated speed: ω_n (rpm)**

  Rated speed, ω_n, is defined as the speed at which the rotor will not be damaged due to the high temperature of the rotor (>80℃) caused by iron loss when the motor is running continuously without rest; if the speed exceeds this speed, the working cycle must be reduced or additional heat dissipation design must be conducted for rotor. Please refer to the T-N Curve for the explanation of the motor working range.

- **T-N Curve**

  The T-N curve is defined as the comparison chart of the torque and the speed that can be output under a certain input voltage of the motor. Considering the temperature rise of the motor, the figure can be divided into two operating ranges as shown below:



  ①：When the motor is air-cooled and the torque is less than T_c, it can run continuously below ω_n without break.

  ②： When the motor is air-cooled and the torque is greater than T_c, the duty cycle must be reduced. When T_p is reached, only 1 second output is allowed to avoid overheating of the stator.

- **Maximum input voltage (V_{DC})**

  Maximum input voltage is the maximum voltage for the motor operating in the normal environment.

- **Resolution: p/rev**

  Resolution is the quantity of motor feedback points during one rotation.

- **Accuracy: arc-sec**

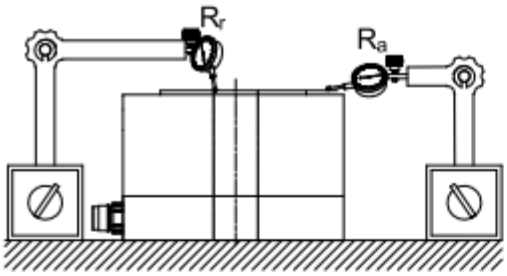
  Accuracy is the error between the target position and the actual position; in the HIWIN's definition, the motor is measured clockwise and counterclockwise twice per 22.5° to take the maximum error.

- **(Bi-)Repeatability: arc-sec**

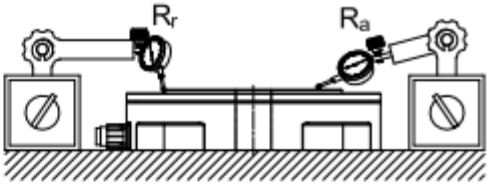
  (Bi-)Repeatability is the repetition when the motor moves to the same angle.

- **Axial runout and radial runout:**

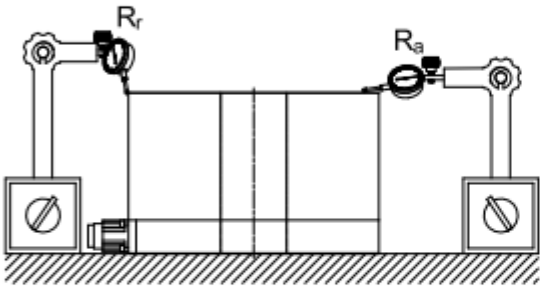
  Axial runout is the runout R_a by measuring the parallel direction between the installation end and rotary axis when the motor rotates; radial runout is defined as runout R_r by measuring the vertical direction between the installation and the rotary axis when the motor rotates. Refer to the figure below for the measurement criteria.



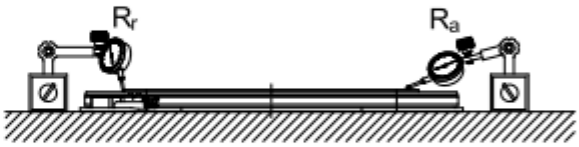
(A) DMS inner rotation type



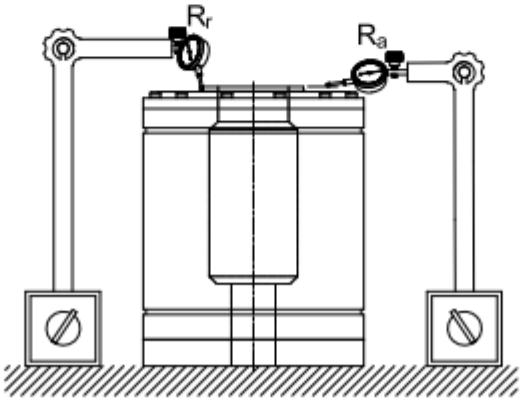
(B) DMN Outer rotation type



(C) DMY outer rotation type

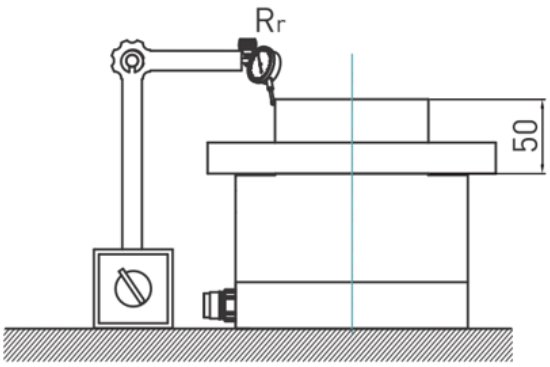


(D) DMT outer rotation type



(E) DMH inner rotation type

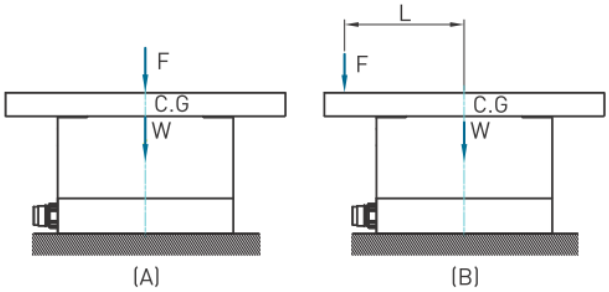
For option <measuring with jig>, the measuring point is 50 mm above top of motor, refer to figure below.



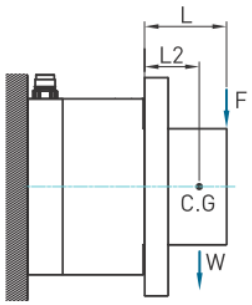
■ Loading capacity

The load of motor must be considered when it is operating. The load can be calculated by external force and the installation to identify the motor structure tolerates or not. The axial force (Fi, i=A,B,C)applied to the motor in the calculation needs be less than the maximum axial load $F_i < F_a$, and can be used when the applied torque (Mi, i=A,B,C) needs to be less than the maximum torque load Mi < M.

- Horizontal installation, external force on C.G point (Figure A)
  Assume external force F, axial force applied to the motor FA=F+load weight W
  Torque applied to the motor MA=0
- Horizontal installation, external force on distance L from C.G point (Figure B)
  Assume external force F, axial force applied to the motor FB=F+load weight W
  Torque applied to the motor MB=FxL
- Laterally installation, external force on top of loading (Figure C)
  Assume external force F, axial force applied to the motor FC=F+load weight W
  Torque applied to the motor
  MC=Fx(L+0.03m)+Wx(L2+0.03m)



(A) (B)



(C)

■ Maximum continuous power loss: P_c (W)

Maximum continuous power loss is the energy lost when the motor runs continuously under continuous current and the coil temperature is 100℃.

■ Motor power (W)

Motor power is the maximum continuous rated power of the motor.

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

■ Linear velocity (Linear use only)

		B				
		m/s	cm/s	mm/s	ft/s	in/s
A	m/s	1	100	1000	3.281	39.37
	cm/s	0.01	1	10	3.281×10^{-2}	0.3937
	mm/s	0.001	0.1	1	3.281×10^{-3}	3.937×10^{-2}
	ft/s	0.3048	30.48	304.8	1	12
	in/s	0.0254	2.54	25.4	8.333×10^{-2}	1

■ Angular velocity (Rotational use only)

		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

■ Force (Linear use only)

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

■ Rotary inertia (Rotational use only)

		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

■ Length (Linear use only)

		B				
		m	cm	mm	ft	in
A	m	1	100	1000	3.281	39.37
	cm	0.01	1	10	3.281×10^{-2}	0.3937
	mm	0.001	0.1	1	3.281×10^{-3}	3.937×10^{-2}
	ft	0.3048	30.48	304.8	1	12
	in	0.0254	2.54	25.4	8.333×10^{-2}	1

■ Torque (Rotational use only)

		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

11.3 Tolerances and hypotheses

11.3.1 Tolerances

Except for the size specifications, there is tolerance of ±10% for all specification value mentioned in the motor specifications. The dimensions without marked tolerance are with general tolerances, except the effective depth of the thread and the positioning pin hole. The tolerance table is shown in the approved drawing.

11.3.2 Hypothesis of heat transfer

The assumptions of all specifications are based on natural air cooling.
Hypothesis of air cooling condition: ambient temperature around motor: 25℃;

11.3.3 Ambient assumptions

The continuous current is tested to comply with norms IEC60204-1 for the selected power cable at an ambient temperature of 30℃ maximum for motors. Higher ambient temperature may have to be de-rated in order to preserve compliance with aforementioned norms.

11.4 Accessories

11.4.1 Drive

Table 11.4.1 Combinations to work with servo drive

			
Drive		E1 servo drive	E2 servo drive
DM Series		Model	
DMY series	DMY4x	ED1□-□□-05	ED2□-□□-006
	DMY6x	ED1□-□□-10	ED2□-□□-006
	DMYA3/A5	ED1□-□□-04	ED2□-□□-003
	DMYAA	ED1□-□□-10	ED2□-□□-006
DMN series	DMN2x	ED1□-□□-04	ED2□-□□-003
	DMN4x	ED1□-□□-04	ED2□-□□-003
	DMN71	ED1□-□□-10	ED2□-□□-006
	DMN93	ED1□-□□-10	ED2□-□□-006
	DMN95	ED1□-□□-10	ED2□-□□-006
	DMN9A	ED1□-□□-20	ED2□-□□-012
DMS series	DMS0x	ED1□-□□-04	ED2□-□□-003
	DMS1x	ED1□-□□-10	ED2□-□□-006
	DMS3x	ED1□-□□-05	ED2□-□□-003
	DMS3x-□□L	ED1□-□□-12	ED2□-□□-006
	DMS7x	ED1□-□□-05	ED2□-□□-003
	DMS7x-□□L	ED1□-□□-12	ED2□-□□-006
DMT series	DMTxx	ED1□-□□-05	ED2□-□□-003
DMH series	DMH6B	ED1□-□□-10	ED2□-□□-006
	DMH6G	ED1□-□□-20	ED2□-□□-009

*E1 series can work with incremental encoder direct drive motor.

ESC(Excellent Smart Cube)is requested for incremental encoders.

*E2 series can be used with direct drive motors of various encoders.

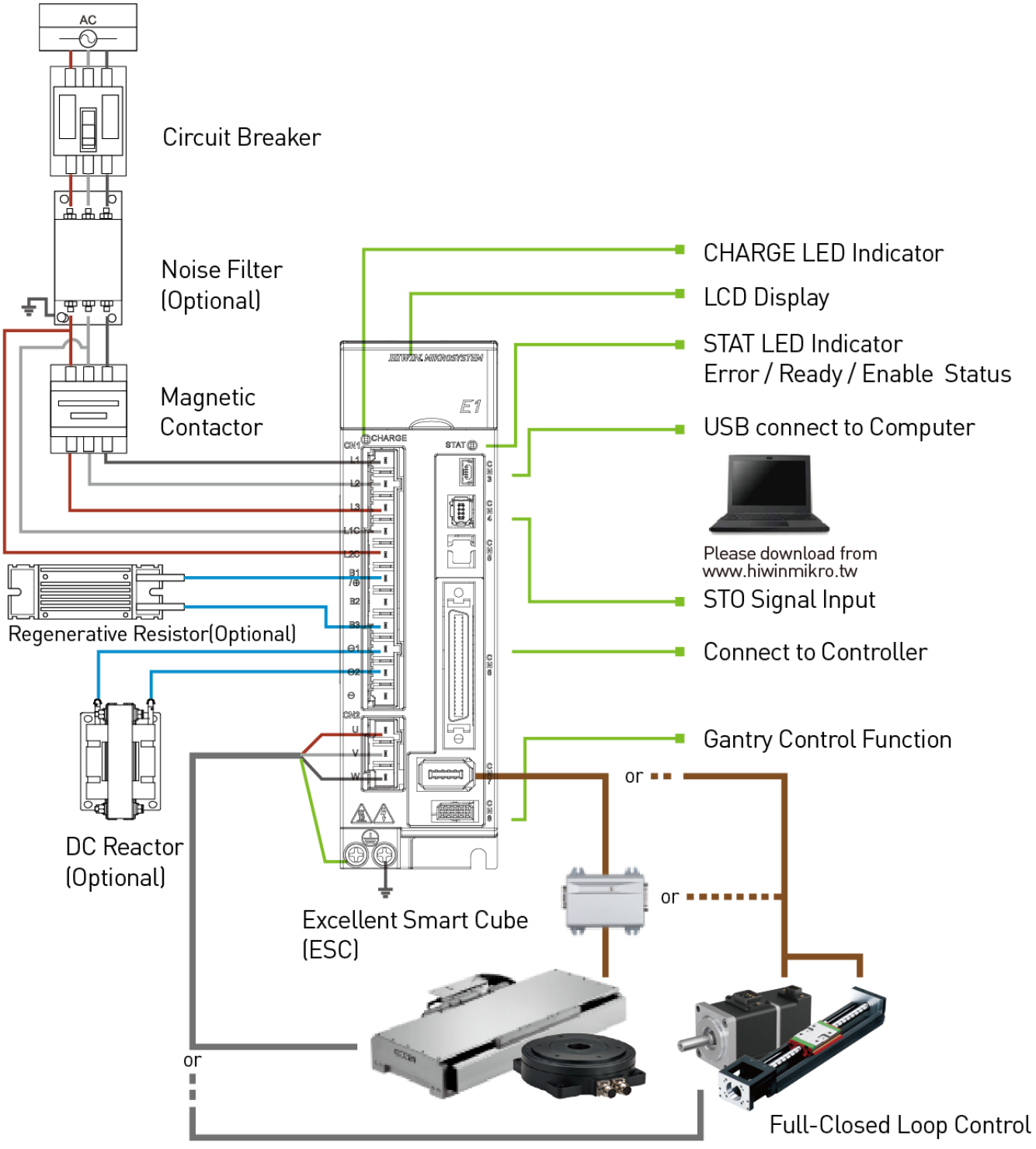


Figure 11.4.1 E1 Wiring Diagrams

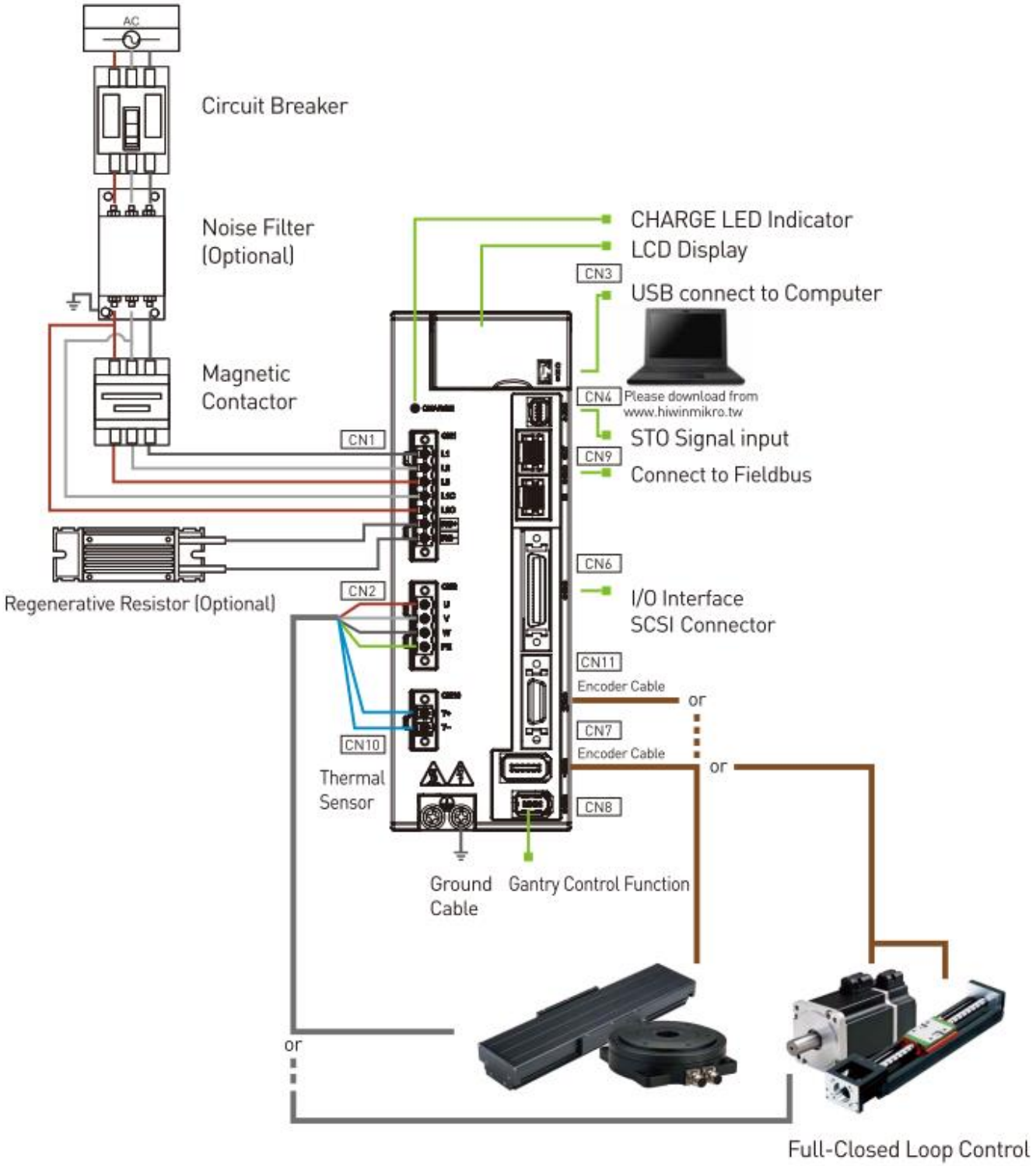
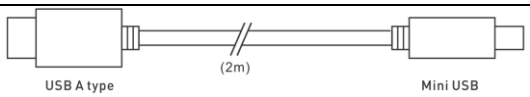


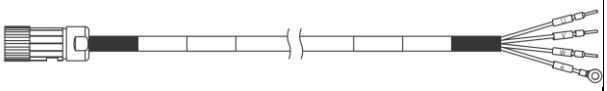
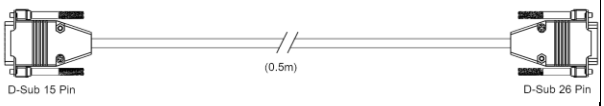
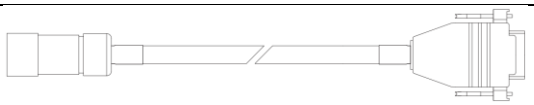
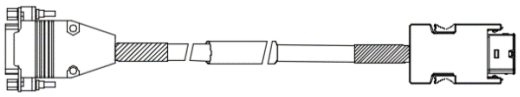
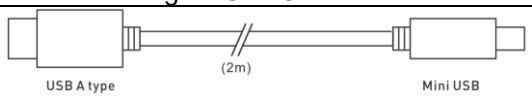
Figure 11.4.2 E2 Wiring Diagrams

11.4.2 E1 Drive and Accessories-ABS

Part name	Model	Connector	Description
Drive	E1 Series	-	
Motor Power Cable	HVPS04AB□□MB	CN2	4PIN interface; supports 20-bit encoders or less. 
Encoder Cable	HVE23IAB□□MB	CN7	
USB Communication Cable	051700800366	CN3	
Control Signal Cable	HE00EJ6DA300 (Standard 50 pins)	CN6	Connect servo drive (standard) to controller via CN6 to receive or send pulse command, voltage command, I/O signal, analog monitoring output signal, encoder output signal, etc. The cable (3m) is with open ends.
	HE00EJ6DC300 (Fieldbus 36 pins)		Send or receive I/O signal, analog monitoring output signal, encoder output signal, etc. via CN6 on Fieldbus servo drive. The cable (3 m) is with open ends.
EMC Accessory	051800200044 Filter (Single-phase power supply)	-	Single-phase filter FN2090-10-06, for 400 W ~ 1 kW models (rated current: 10 A, leakage current: 0.67 mA)
	051800200071 Filter (Three-phase power supply)	-	Three-phase filter FN3025HL-20-71, for 400 W ~ 4 kW model (rated current: 20 A, leakage current: 0.4 mA)

□□	03	05	07	10
Cable Length(m)	3	5	7	10

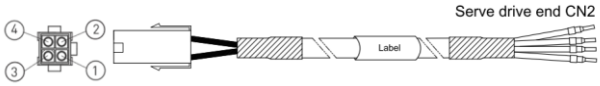
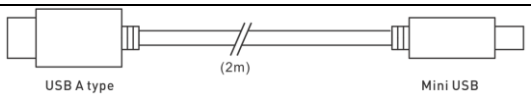
11.4.3 E1 Drive and Accessories-INC

Part name	Model	Connector	Description
Drive	E1 Series	-	
Motor Power Cable	LMACS-□□0FE	CN2	
Excellent Smart Cube	ESC-SS	-	Excellent Smart Cube (ESC) converts signals, such as encoder signal, signal of thermal sensor, Hall signal, etc. from the motor side into serial communication format for E1 series servo drive. For model explanation of Excellent Smart Cube (ESC), please refer to table below.
ESC Encoder Extension Cable (DMTB2-0、DMTF2-0、DMTK3-3 only)	HE0084100640	-	
ESC Encoder Extension Cable (Excluding DMT)	HE00EJWDA□00	-	 ESC to HIWIN direct drive motor with incremental feedback system (analog encoder)Internal digital Hall signal and thermal signal supported
ESC Encoder Communication Cable	HE00EJUDA□00	CN7	 For connecting ESC to CN7 on the servo drive
USB Communication Cable	051700800366	CN3	
Control Signal Cable	HE00EJ6DA300 (Standard 50 pins)	CN6	Connect servo drive (standard) to controller via CN6 to receive or send pulse command, voltage command, I/O signal, analog monitoring output signal, encoder output signal, etc. The cable (3m) is with open ends.
	HE00EJ6DC300 (Fieldbus 36 pins)		Send or receive I/O signal, analog monitoring output signal, encoder output signal, etc. via CN6 on Fieldbus servo drive. The cable (3 m) is with open ends.
EMC Accessory	051800200044 Filter (Single-phase power supply)	-	Single-phase filter FN2090-10-06, for 400 W ~ 1kW models (rated current: 10 A, leakage current: 0.67 mA)
	051800200071 Filter (Three-phase power supply)	-	Three-phase filter FN3025HL-20-71, for 400W ~ 4kW model (rated current: 20 A, leakage current: 0.4 mA)

□□	03	05	07	10
Cable Length(m)	3	5	7	10

□	3	5	7	A
Cable Length(m)	3	5	7	10

11.4.4 E2 Drive and Accessories-ABS

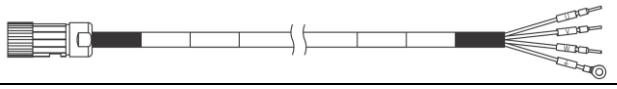
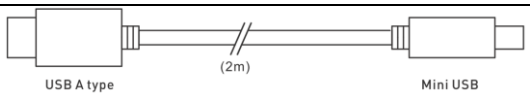
Part name	Model	Connector	Description
Drive	E2 Series	-	
Motor Power Cable	HVPS04AA□□MB	CN2	4PIN interface; supports 20-bit encoders or less. 
	LMACS-□□□ME	CN2	6PIN interface; supports 21-bit encoders or higher. 
	LMACS-□□□F	CN2	Metal connector 
Encoder Cable	HVE23IAB□□MB	CN7	
USB Communication Cable	051700800366	CN3	
Control Signal Cable	HE00EJ6DA300 (Standard 50 pins)	CN6	Connect servo drive (standard) to controller via CN6 to receive or send pulse command, voltage command, I/O signal, analog monitoring output signal, encoder output signal, etc. The cable (3m) is with open ends.
	HE00EJ6DC300 (Fieldbus 36 pins)		Send or receive I/O signal, analog monitoring output signal, encoder output signal, etc. via CN6 on Fieldbus servo drive. The cable (3m) is with open ends.
EMC Accessory	051800200100 Filter (Single-phase power supply)	-	Single-phase filter FN2090-16-06, for 400 W ~ 1 kW models (rated current: 16 A, leakage current: 1.02 mA)
	051800200071 Filter (Three-phase power supply)	-	Three-phase filter FN3025HL-20-71, for 400 W ~ 4 kW model (rated current: 20 A, leakage current: 0.4 mA)

□□MB	03	05	07	10
Cable Length(m)	3	5	7	10

□□□ME	030	050	070	100	150
Cable Length(m)	3	5	7	10	15

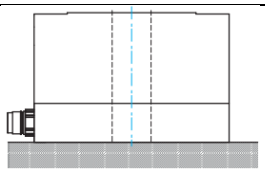
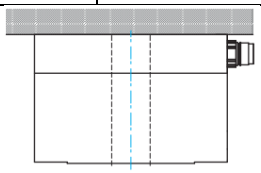
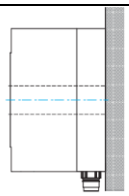
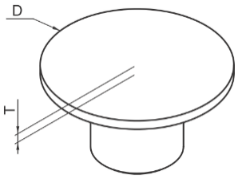
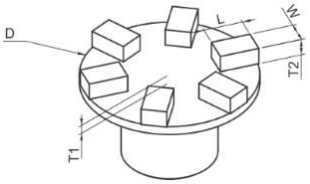
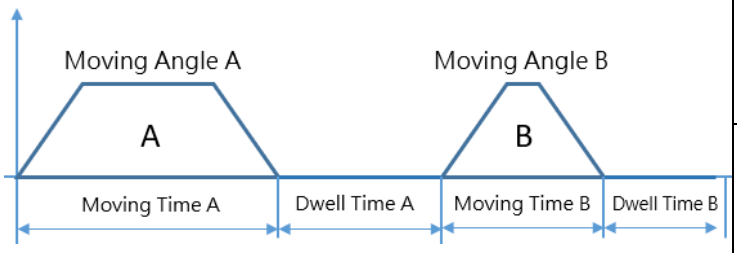
□□□F	020	040	060	090
Cable Length(m)	2	4	6	9

11.4.5 E2 Drive and Accessories-INC

Part name	Model	Connector	Description
Drive	E2 Series	-	
Motor Power Cable	LMACS-□□0FE	CN2	
Encoder Cable	LMACE□□AM	CN3	For incremental feedback types with hall sensor  Intercontec Model : ASTA876FR1085200A000 Drive Connector(3M) Model : 10120-3000VE
USB Communication Cable	051700800366	CN3	 USB A type (2m) Mini USB
Control Signal Cable	HE00EJ6DA300 (Standard 50 pins)	CN6	Connect servo drive (standard) to controller via CN6 to receive or send pulse command, voltage command, I/O signal, analog monitoring output signal, encoder output signal, etc. The cable (3m) is with open ends.
	HE00EJ6DC300 (Fieldbus 36 pins)		Send or receive I/O signal, analog monitoring output signal, encoder output signal, etc. via CN6 on Fieldbus servo drive. The cable (3m) is with open ends.
EMC Accessory	051800200100 Filter (Single-phase power supply)	-	Single-phase filter FN2090-16-06, for 400 W ~ 1 kW models (rated current: 16 A, leakage current: 1.02 mA)
	051800200071 Filter (Three-phase power supply)	-	Three-phase filter FN3025HL-20-71, for 400 W ~ 4 kW model (rated current: 20 A, leakage current: 0.4 mA)

□□	03	05	07	10	15
Cable Length(m)	3	5	7	10	15

11.5 Customer request form

<table>
<tr><td>Company Name:</td><td colspan="2">Email:</td><td>Tel:</td></tr>
<tr><td>Industrial:</td><td colspan="3">Device Name:</td></tr>
<tr><td rowspan="2">Environment</td><td colspan="2">□Normal environment(25ºC)</td><td>□Clean room , Class:</td></tr>
<tr><td colspan="2">□Pollution environment</td><td>□Other:</td></tr>
<tr><td>Installation</td><td> 
□Horizontal</td><td> 
□Upside Down</td><td> 
□Laterally</td></tr>
<tr><td>Load Type</td><td> 
□</td><td> 
□</td><td>□Other</td></tr>
<tr><td rowspan="3">Load Conditions</td><td colspan="2">Total moment of inertia:_____ kgm^2 , Size:_____mm</td><td>Separate document:
□Attached □Not attached</td></tr>
<tr><td colspan="3">□Even load(Number:____、Mass:____or Material:____、Size:____)
□Unbalanced load
(Number:____、Mass:____or Material:____、Size:____、Offset of C.G.:____ mm)</td></tr>
<tr><td colspan="3">Note:</td></tr>
<tr><td>External Force</td><td colspan="3">□None □Yes:___kg、Offset of C.G.:____mm
□At all times □When stopped □when rotating</td></tr>
<tr><td>Application</td><td colspan="2"> 
</td><td>□Point to Point □Scan
Moving Angle A:___°
Moving Time A:___sec
Dwell Time A:___sec

Moving Angle B:___°
Moving Time B:___sec
Dwell Time B:___sec</td></tr>
<tr><td>Required accuracy</td><td colspan="3">Repeatability:±( ) arcsec *Repeatability:±( )um，Offset of C.G. ( )mm
Accuracy:±( ) arcsec *Accuracy:±( )um，Offset of C.G. ( )mm
*optional</td></tr>
<tr><td>Surface rotation Accuracy</td><td colspan="3">□Standard
□Customized (Axial run out ____um、Radial run out ____um)</td></tr>
<tr><td>Clamp</td><td colspan="3">□None □Power Off Clamp □Power On Clamp
□Power Off Clamp (zero backlash)</td></tr>
<tr><td>Other requirements</td><td colspan="3"></td></tr>
</table>

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