HIWIN®
Motion Control and System Technology

TMRW series

Installation Manual

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1. Introduction：

HIWIN TMRW series torque motor is constituted of stator and rotor. A servo-drive regulation ensures excellent acceleration capabilities and good uniformity of movement. Due to the hollow shaft design, cable systems or mechanical parts can be fed through without problems.

1.1 Unpacking instructions

Installation and operation of the motor must be in accordance with the HIWIN manual. Before using the TMRW, please read these safety instructions and precautions carefully.

	caution	1. Before using the TMRW, please read these safety instructions and precautions carefully. HIWIN is not responsible for any damage, accident, or injury caused by incorrect handling. 2. Examine the appearance of the motor for any unusual marks or damage from shipment. 3. Inspect the wires for any damage. 4. Do not disassemble the motor. Since the design of the product has been based on structure calculations, computer simulations, and prototype testing, do not disassemble the product without the permission of HIWIN engineers. 5. Supervise children when handling this product. 6. People with psychosomatic illness or insufficient experience should not handle this product, unless under the direct supervision of managers or product narrators.

If any items are damaged or incorrect item, please contact your distributor or HIWIN sales representative.

1.2 Safety symbols

symbol	meaning
	Warning of dangerous high voltage!
	Warning of magnetic fields!
	Warning of hot surfaces!
	Environmentally hazardous substance!

1.3 Instructions

(1) The product can only be repaired by HIWIN engineers. Please send the product back to us if there is any unusual phenomenon.
(2) Do not hold the TMRW by its wire harness.
(3) Do not hit the motor.
(4) Do not apply loads to the motor that are in excess of the specified value.
(5) Do not change the motor parts or disassemble the screws. HIWIN will not be responsible for any damages, injuries, or accidents that may occur.

2. Basic structure of TMRW torque motor

HIWIN TMRW series torque motor is constituted solely of stator and rotor, exclusive of bearing, positioning systems and other relative parts. The main structure is as Fig. 2.1 shows and below is the description:

Stator：With water cooing channels in the outer part, and it is made of aluminum alloys or steel. The inner part is made of lamination stack and windings covered with epoxy. Two cable outlets in one side, and that is motor power cable and temperature sensor cable. Moreover, the stator should be placed on a stiff foundation of customer's machine.

Rotor：The main structure is steel ring with attached magnets and rotor should be installed on the rotating part of customer's machine. Due to rotor has high magnetic forces of attraction, it needs to have well protection away from magnetic objects (steel objects) when installing or shipping.

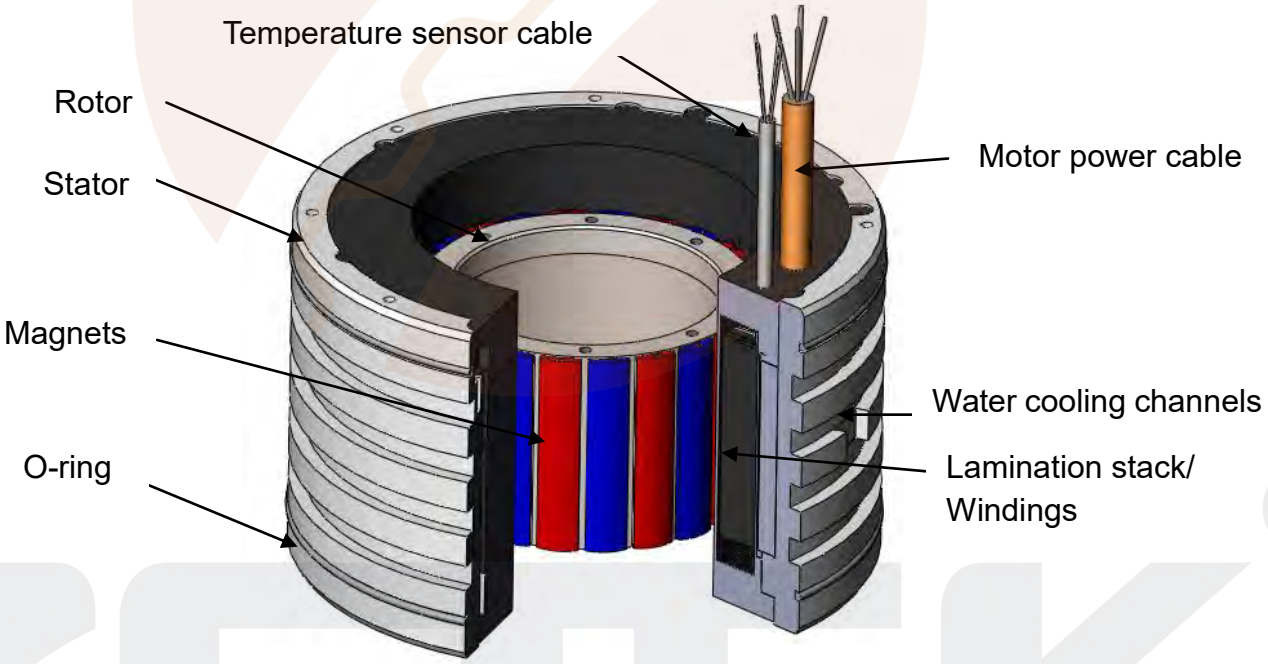


Fig. 2.1 Motor basic structure

3. TMRW torque motor installation design

TMRW series (As Fig. 3.1) can be cooled by water or air. There is a water cooling channels in the outer case of stator. And outside of the channels, there is an O-ring equipped to be leak proof. As for the **coolant inlet and outlet, these must be level with the motor cable outlet to ensure good circulation of water cooling, to reach cooling mechanisms.** The recommended position of coolant inlet/outlet is shown below:

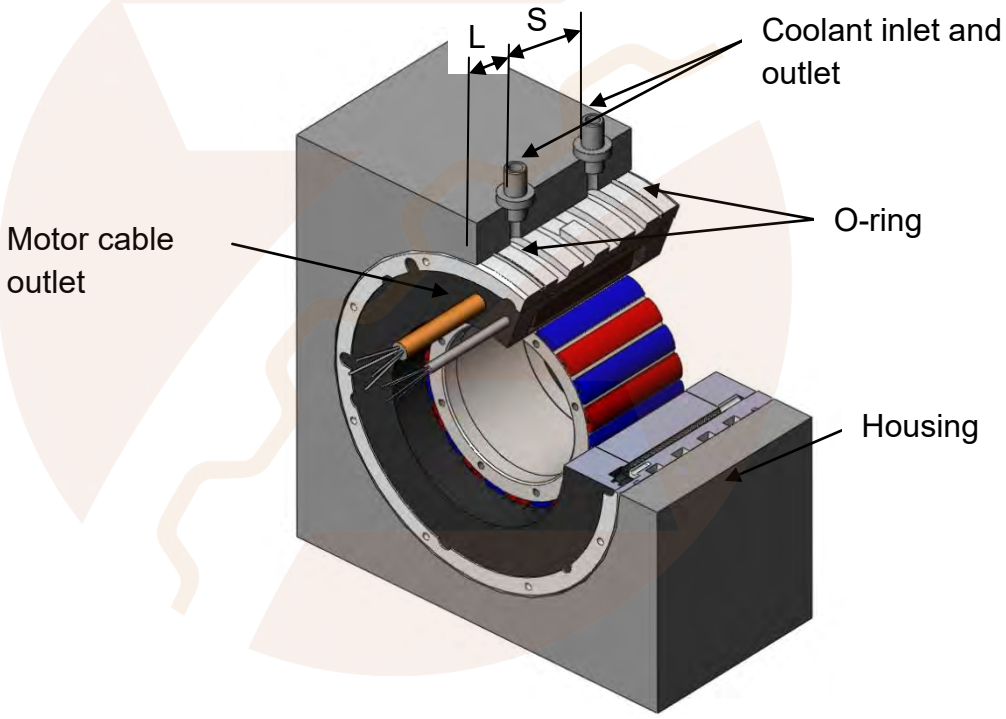


Fig. 3.1 TMRW series structure

3.1 Water cooling channels position

The recommended position for every series is as below shows:

Table 1 Water cooling channels position

L(mm)	S(mm)				
	20	40	60	90	140
25	TMRW13(L) TMRW43(L)	TMRW15(L) TMRW45(L)	TMRW17(L) TMRW47(L)	TMRW1A(L) TMRW4A(L)	TMRW1F(L) TMRW4F(L)
30	TMRW23(L)	TMRW25(L)	TMRW27(L)	TMRW2A(L)	TMRW2F(L)
35	TMRW73(L) TMRWA3(L)	TMRW75(L) TMRWA5(L)	TMRW77(L) TMRWA7(L)	TMRW7A(L) TMRWAA(L)	TMRW7F(L) TMRWAF(L)
43	TMRWD3(L)	TMRWD5(L)	TMRWD7(L)	TMRWDA(L)	TMRWDF(L)

3.2 Water cooling channels dimension

Fig. 3.2 is the water cooling channel dimension diagram while Table 2 defines the channel spec. for TMRW series.

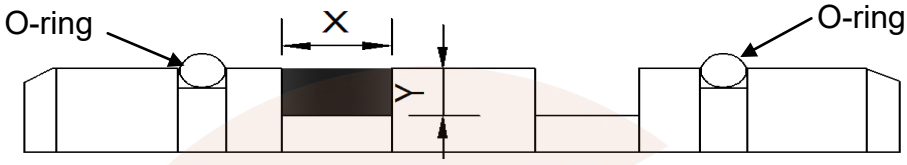


Fig. 3.2 Water cooling channel dimension

Table 2 Water cooling channel dimension

Motor Type	X(mm)	Y(mm)	Inlet/outlet internal diameter (mm)	Motor Type	X(mm)	Y(mm)	Inlet/outlet internal diameter (mm)
TMRW13(L)	8	5	8	TMRW73(L)	8	5	8
TMRW15(L)	8	5	8	TMRW75(L)	8	5	8
TMRW17(L)	9	5	8	TMRW77(L)	9	5	8
TMRW1A(L)	8	5	8	TMRW7A(L)	8	5	8
TMRW1F(L)	9	5	8	TMRW7F(L)	9	5	8
TMRW23(L)	8	5	8	TMRWA3(L)	8	5	8
TMRW25(L)	8	5	8	TMRWA5(L)	8	5	8
TMRW27(L)	9	5	8	TMRWA7(L)	9	5	8
TMRW2A(L)	8	5	8	TMRWAA(L)	8	5	8
TMRW2F(L)	9	5	8	TMRWAF(L)	9	5	8
TMRW43(L)	8	5	8	TMRWD3(L)	8	5	8
TMRW45(L)	8	5	8	TMRWD5(L)	8	5	8
TMRW47(L)	9	5	8	TMRWD7(L)	9	5	8
TMRW4A(L)	8	5	8	TMRWDA(L)	8	5	8
TMRW4F(L)	9	5	8	TMRWDF(L)	9	5	8

3.3 O-ring features:

Table 3 is the O-ring features for TMRW series.

Table 3 O-ring features

Motor Type	O-ring type	O-ring thickness(mm)	O-ring internal diameter (mm)
TMRW1x	VITON	2.62	152.07
TMRW2x	VITON	2.62	190.17
TMRW4x	VITON	2.62	221.92
TMRW7x	VITON	2.5	296
TMRWAx	VITON	4	370
TMRWDx	VITON	4	465

3.4 Coolant inlet/outlet position when mounted horizontally

No matter whether the motor cable output is facing upward or downward, the outlet should be at the top while the inlet is at the bottom. **And that the coolant inlet and outlet must be level with the motor cable outlet.**

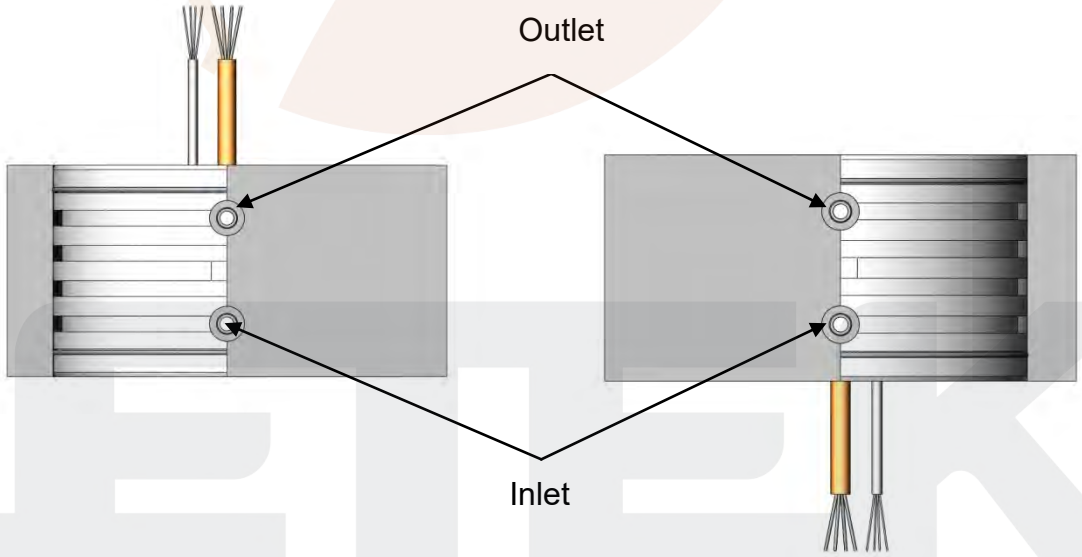


Fig. 3.3 Coolant inlet/outlet position when mounted horizontally

3.5 Coolant inlet/outlet position when mounted vertically

Directions of inlet/outlet depend on customer but **the coolant inlet/outlet must be level with the motor cable outlet.**

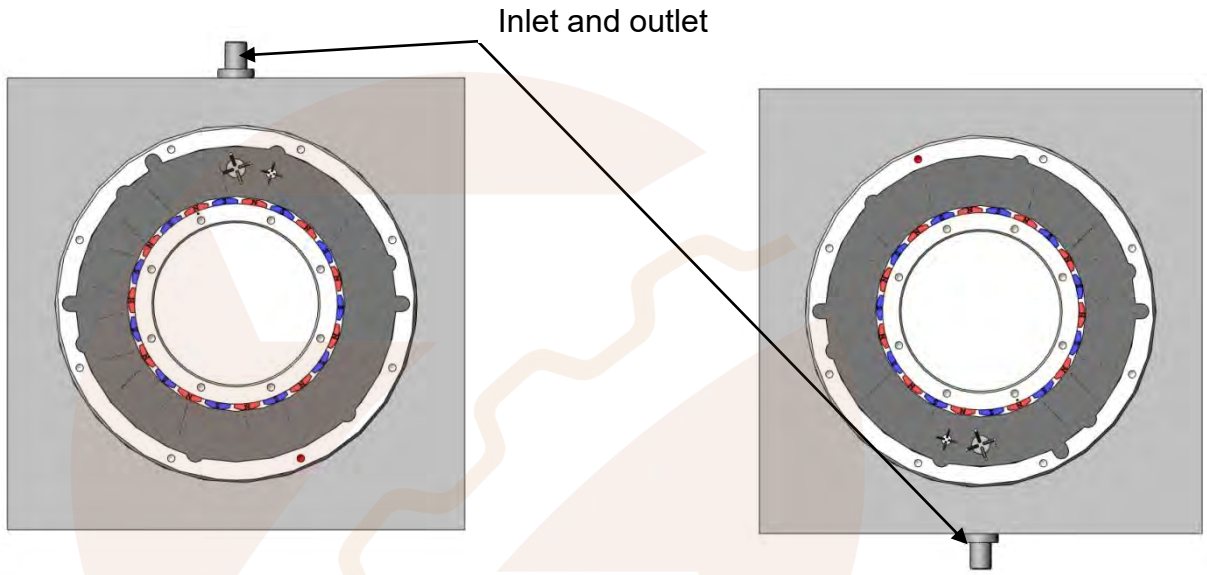


Fig. 3.4 Coolant inlet/outlet position when mounted vertically

3.6 Rotor installation introduction

In order to prevent magnet interference and motor's performance affected, there should be some space (Fig. 3.5 Φd) between customer's shaft and rotor magnet.

Table 4 defines the maximum dimension for the shaft external diameter inside the stator and the flatness specification on rotor mounting level.

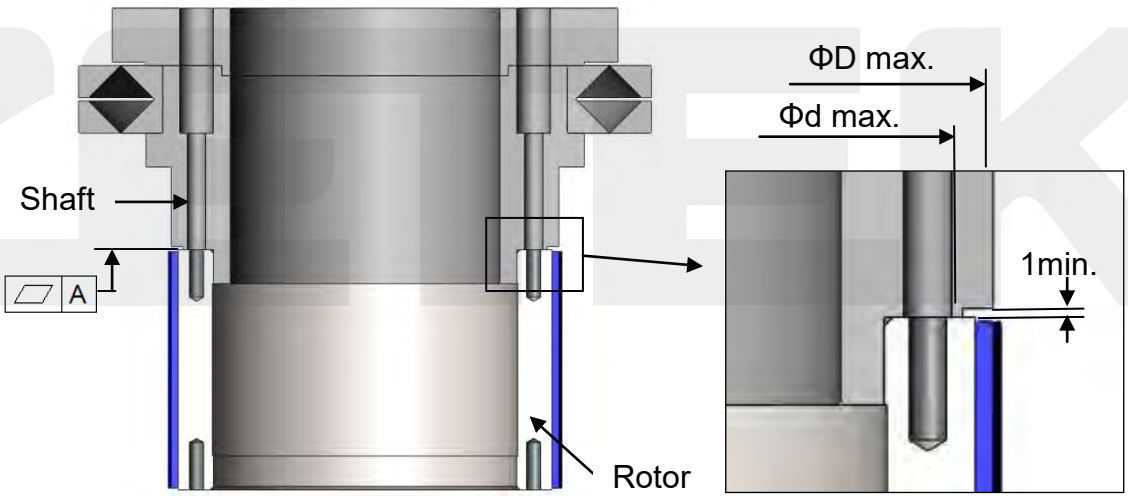


Fig. 3.5 Rotor mounting level

Table 4 Rotor mounting level suggestion

Motor Type	ΦD (mm)	Φd (mm)	Flatness A (mm)	Flatness B (mm)
TMRW1x	84.5	76	0.05	0.05
TMRW2x	118	110	0.05	0.05
TMRW4x	168	158	0.1	0.1
TMRW7x	232	217	0.1	0.1
TMRWAx	298	284.5	0.1	0.1
TMRWDx	383	370	0.15	0.15

3.7 Stator installation introduction

The recommended tolerance of housing's internal diameter (and mounting holes of stator) is H7 or H8, and the flatness stator mounting level is as defined in

Table 4 (Flatness B); the housing is suggested to be chamfered (recommended dimension is as Fig. 3.6 shows) to ensure the O-ring from being scratched and to prevent leaks from happening.

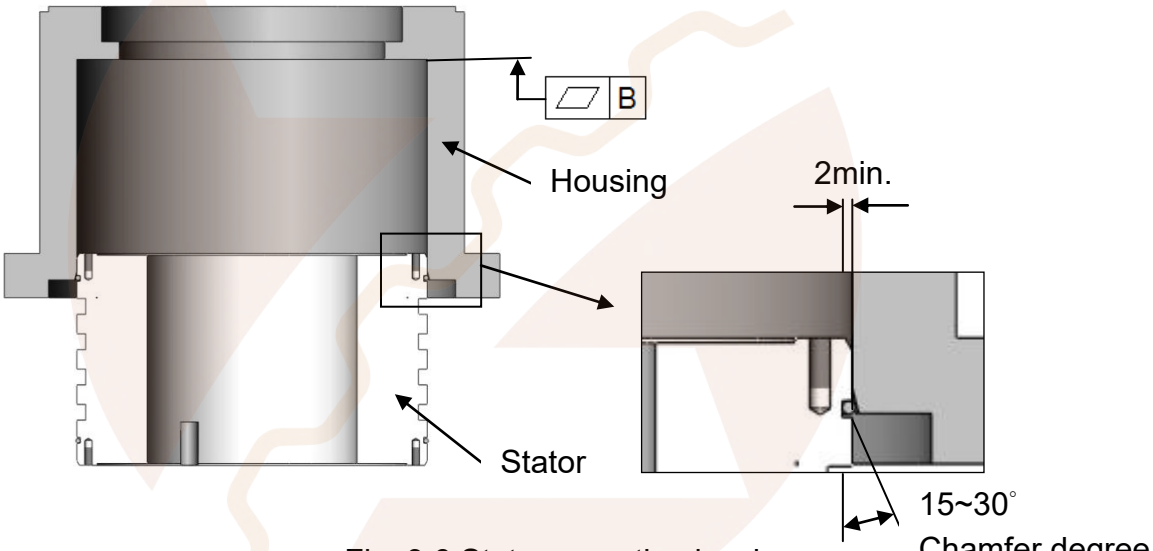


Fig. 3.6 Stator mounting level

3.8 The screw tightening torque specification for stator/rotor

The recommended level of the fixed screw to stator/rotor is hardness class 12.9. Below defines the types of threaded holes, quantity and tightening torque for every kind of motor.

Table 5 Screw tightening torque

Motor Type	Type of threaded holes	Quantity of threaded holes	Nominal tightening torque (kgf-cm)
TMRW13(L) TMRW15(L) TMRW17(L) TMRW23(L) TMRW25(L) TMRW27(L)	M5x10DP	8	80
TMRW1A(L) TMRW1F(L) TMRW2A(L) TMRW2F(L)	M5x10DP	16	80
TMRW43(L) TMRW45(L) TMRW73(L) TMRW75(L) TMRW77(L)	M5x10DP	12	80
TMRW47(L) TMRW4A(L) TMRW4F(L) TMRW7A(L) TMRW7F(L)	M5x10DP	24	80
TMRWA3(L) TMRWA5(L) TMRWA7(L)	M6x12DP	12	120
TMRWAA(L) TMRWAF(L)	M6x12DP	24	120
TMRWD3(L) TMRWD5(L) TMRWD7(L)	M8x12DP	12	250
TMRWDA(L) TMRWDF(L)	M8x12DP	24	250

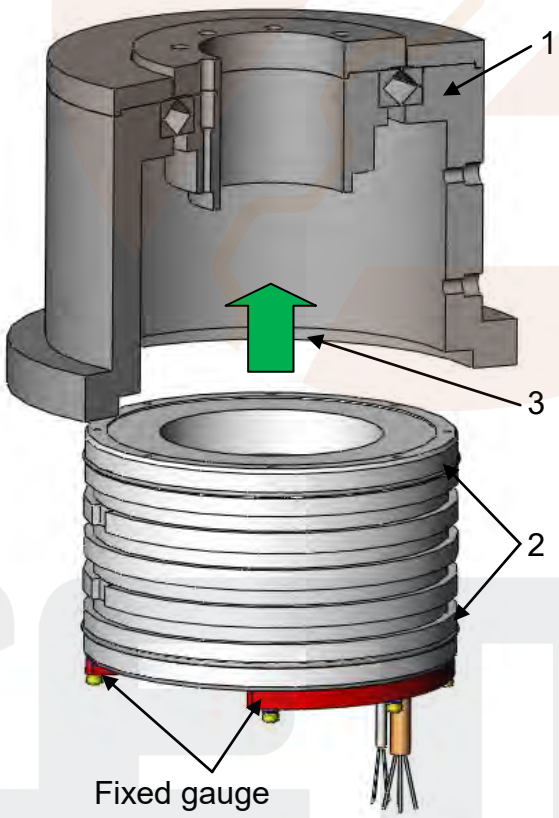
4. TMRW motor installation procedure

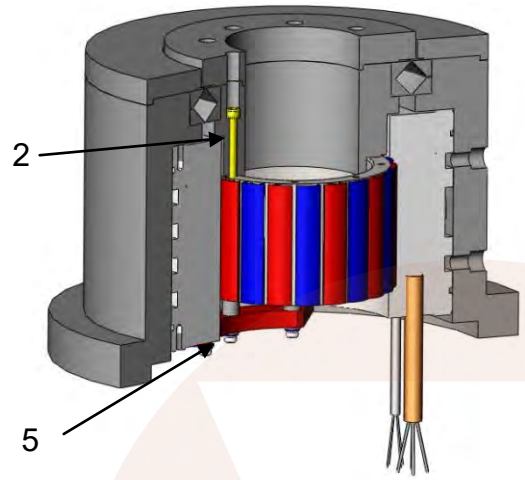
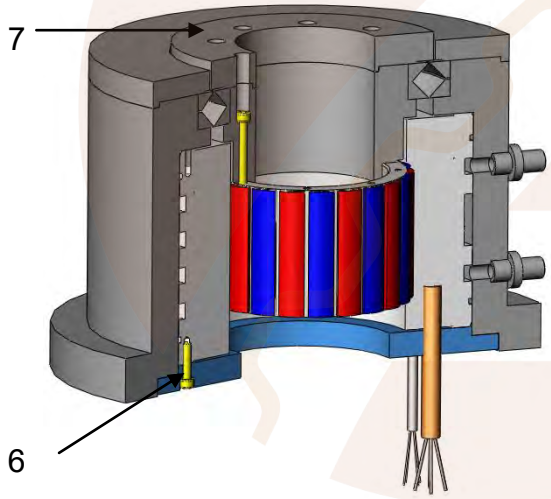
There are 2 ways to install:

- Stator/ Rotor installed together: Install with the fixed fixture and the position can be either the outlet side or the other side. Customer could consult with HIWIN sales or engineers to define the position of the fixture and confirm the drawing before placing an order.
- Stator/ Rotor installed separately: Based on the basis of customer's mechanism, a guide tool is designed for installing stator and rotor.

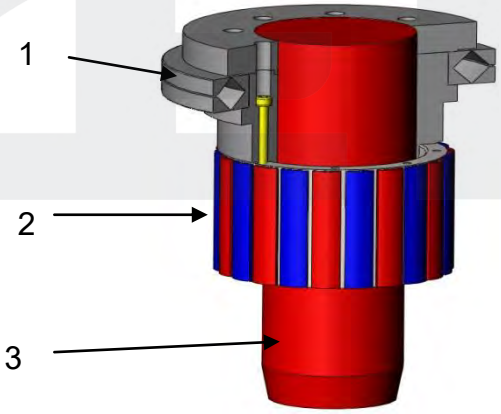
The following is the installation procedure:

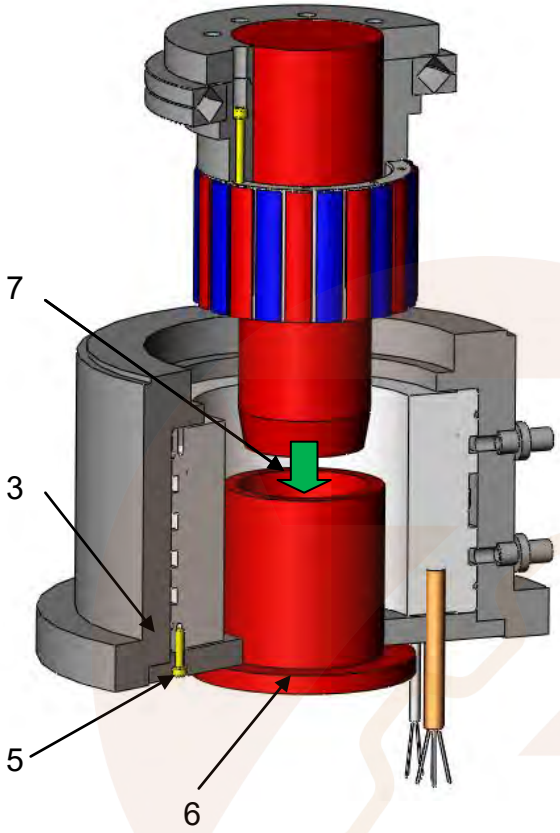
4.1 Stator/ Rotor mounted together (with HIWIN's fixture)

Diagram	Step
	1. Install the housing, shaft, and bearing. 2. Install the O-ring on the stator. Mind that the O-ring cannot be twisted. 3. Place the stator/forcer (with the fixture) into the housing. **Mind that the motor cable outlet should be aligned with the coolant outlet/inlet. Also, the O-ring cannot be damage to prevent leaks from happening.** (Housing design please refer section 3.7) WARNING: Due to rotor has high magnetic forces, it should be away from magnetic objects (steel objects).

	4. Fix the rotor on the shaft (please refer section 3.8 for screw tightening torque spec.) 5. Loosen the screw of the fixture, and dismantle the fixture.
	6. Install the bottom plate, and fasten the fixed screw of stator (please refer section 3.8 for screw tightening torque spec.) 7. Turn the rotary part. This is to check if this part is turning smoothly and there is no interference. 8. Install the remaining parts, such as the inlet/outlet connector, lower supporting bearing, encoder…etc.

4.2 Stator/ Rotor mount separately (**the guild tool is designed by customer**)

Diagram	Step
	1. Install shaft and bearing. 2. Install the rotor on the shaft (please refer section 3.8 for screw tightening torque spec.) 3. Install the jig on the shaft.



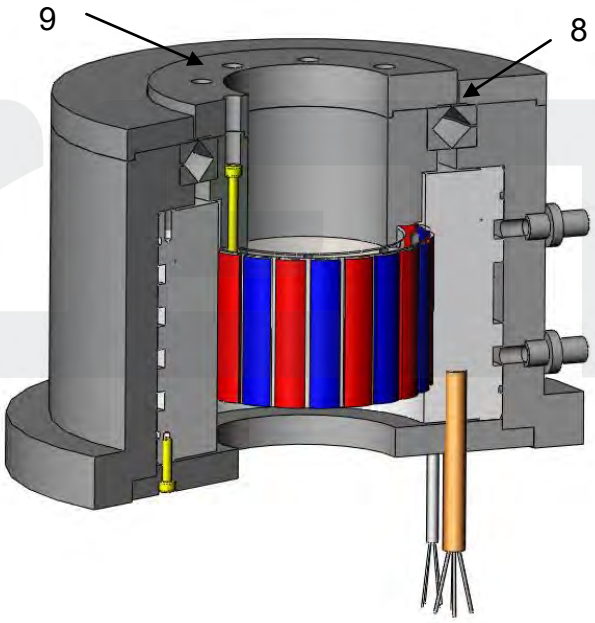
4. Install O-ring to stator. Mind that the O-ring cannot be twisted during installation.

5. Place the stator into the housing, and fasten the bolt (please refer section 3.8 for the screw tightening torque). **Mind that the motor cable outlet should be aligned with the coolant outlet/inlet. Also, the O-ring cannot be damaged to prevent leaks from happening.** (Housing design please refer section 3.7)

6. Install the guide tool of the lower side to the shaft. (If necessary)

7. Install the rotary module to a stiff foundation of customer's machine.

Note: The guild tool needs to be fitted with rotor before installation to prevent the dangers of magnetic attractions between rotor and stator or any assembly fitting problems.



8. Fix the bearing and dismantle the guide tool.

9. Turn the rotary part. This is to check if this part is turning smoothly and there is no interference.

10. Install the remaining parts, such as the inlet/outlet connector, lower supporting bearing, encoder…etc.

5. Motor cables

5.1 Power cable specification:

The standard length of power cable and temperature sensor cable is 2000mm±50mm (as Fig. 5.1), excluding the metal connector of the outlet. Customers can have the options to choose other lengths. Every extra 1m is the standard length for other options, with the longest length up to 8m. Table 6 defines the correlation between the cable color and signal.

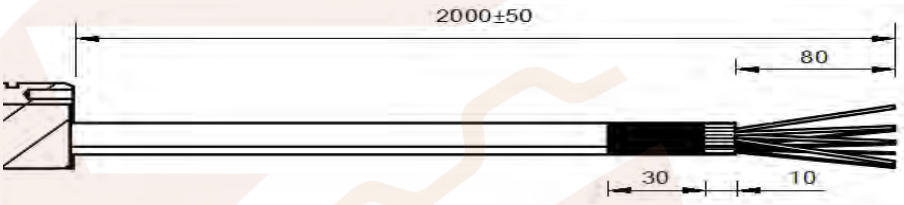
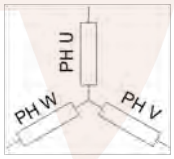


Fig. 5.1 Power cable specification

Table 6 Color definition

Color and number	Signal	Diagram
Black, No.L1/U	PH U	
Black,No.L2/V	PH V	
Black,No.L3/W	PH W	
Yellow with green	grounding	

Power cable is designed with IGUS' Chainflex (CF27), which has UL and CE approval. Cable size should be selected according to the continuous current of motor, and Table 7 defines the relationship.

Table 7 Relationship between cable size and motor

Cross sectional area(mm^2)	Motor Type
1.5	TMRW13(L)、TMRW15(L)、TMRW17(L)、TMRW1A(L)、TMRW1F、TMRW23(L)、TMRW25(L)、TMRW27(L)、TMRW2A(L)、TMRW2F、TMRW43(L)、TMRW45(L)、TMRW47(L)、、TMRW2F
2.5	TMRW4A、TMRW4F、TMRW73、TMRW75、TMRW77、TMRW7A、TMRW7F、TMRWA3、TMRWA5
4.0	TMRW1FL、TMRW2FL、TMRW4AL、TMRW4FL、TMRW73L、TMRW75L、TMRW77L、TMRW7AL、TMRW7FL、TMRWA3L、TMRWA5L、TMRWA7、TMRWAA、TMRWD3、TMRWD5、TMRWD7、TMRWDA、TMRWG3、TMRWG5、TMRWG7
6.0	TMRWA7L、TMRWAAL、TMRWAF
10.0	TMRWAFL、TMRWD3L、TMRWD5L、TMRWD7L、TMRWDAL、TMRWDF、TMRWG3L、TMRWG5L、TMRWG7L、TMRWGA、TMRWGF
16.0	TMRWDFL、TMRWGAL、TMRWGFL

5.2 Temperature sensor cable specification

Every motor is equipped with a set of SNM100 and a set of SNM 120 temperature sensor and also one in every phase (there are three sensors each set). KTY84-130 sensor installs in U phase, and with electrostatic discharge protection facility. The cross sectional area is 0.25mm^2 for every cable. Temperature sensor cables are shown in Fig. 5.2, Fig. 5.3 and Fig. 5.4.

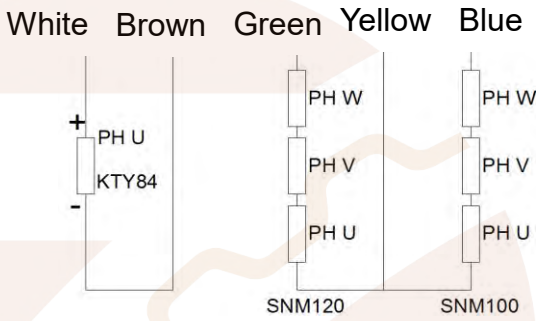


Fig. 5.2 Type A: Color reference diagram for temperature sensor cable

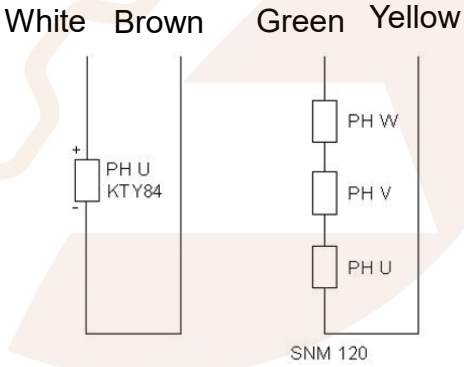


Fig. 5.3 Type B: Color reference diagram for temperature sensor cable

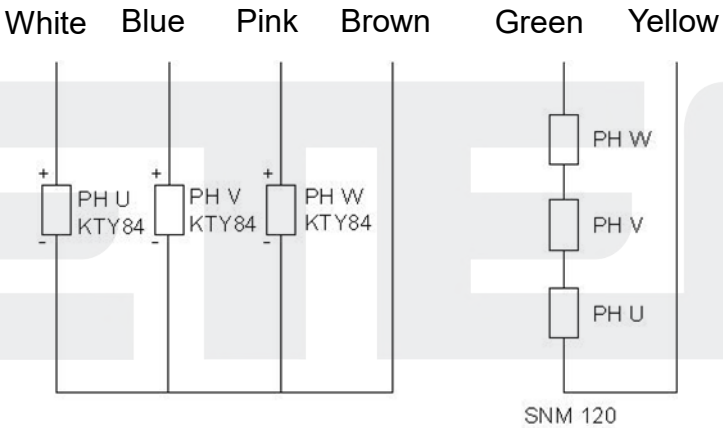


Fig. 5.4 Type C: Color reference diagram for temperature sensor cable

5.3 Temperature sensor features

KTY84-130 is a type of silicon sensor that can measure the output resistance value to get the actual temperature. The feature is shown in Table 8, and the resistance value change against the temperature is shown in Fig. 5.5 .

Table 8 KTY84-130 sensor features

Symbol	Parameter	Requirement	Min.	Standard	Max.	Unit
R_{100}	The resistance value when 100℃	$I_{(out)}$=2mA	970	-	1030	Ω
R_{250}/R_{100}	Resistance value ratio	T=250℃and 100℃	2.111	2.166	2.221	Ω
R_{25}/R_{100}	Resistance value ratio	T=25℃and 100℃	0.595	0.603	0.611	Ω

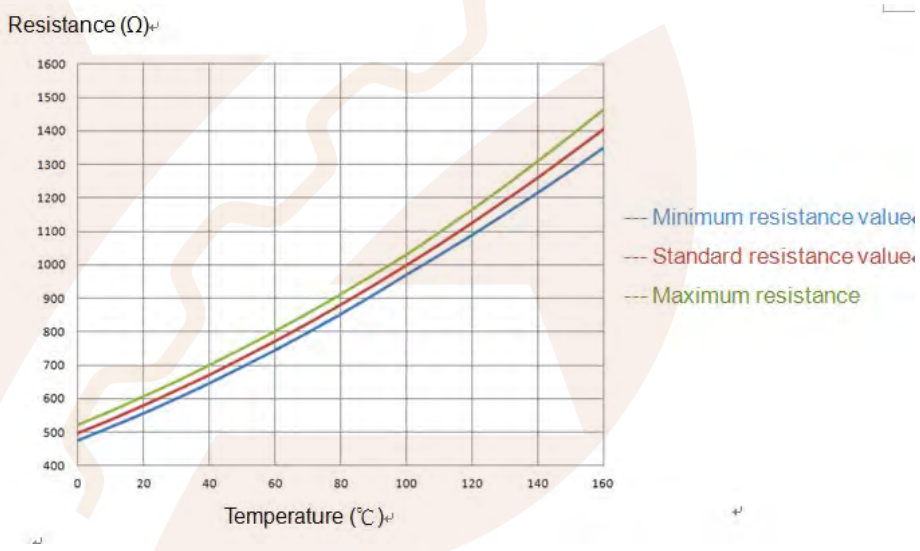


Fig. 5.5 KTY84's resistance value versus temperature

SNM 100 and SNM 120 are thermistors, the output resistance values vary according to the temperature of motor winding. The value of SNM100 will rise dramatically when T_{REF}=100℃. And the resistant value of SNM120 will also rise dramatically when T_{REF}=120℃. The feature is shown in Table 9 and Fig. 5.6.

Table 9 SNM features

Temperature	Resistance value
20℃<T<T_{REF} - 20 K	20Ω~250Ω
T=T_{REF} - 20 K	≦550Ω
T=T_{REF} + 5 K	≧1,330Ω
T=T_{REF} + 15 K	≧4,000Ω

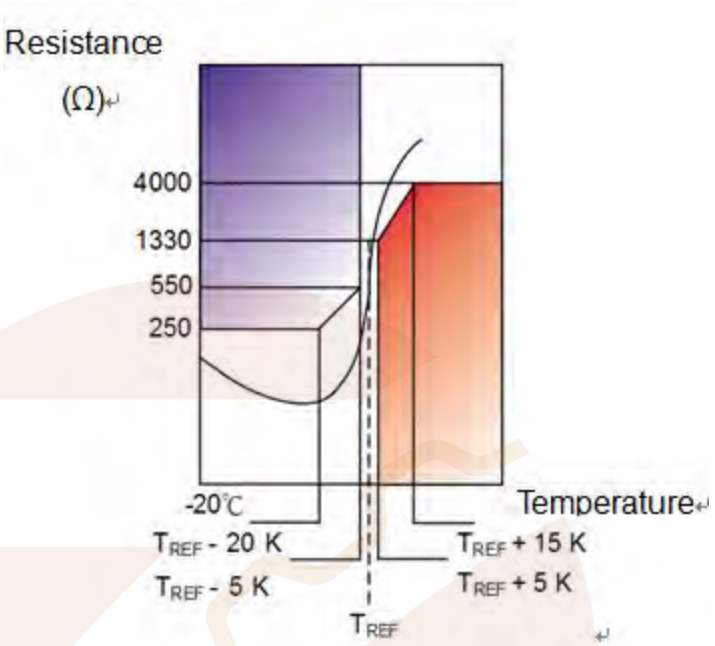


Fig. 5.6 PTC's relationship between temperature and resistance value

6. Radial forces between the stator and the rotor

When the concentricity of the stator and rotor is offset, radial forces will generate like Fig. 6.1 and Table 10 defines the value of radial force for every motor.

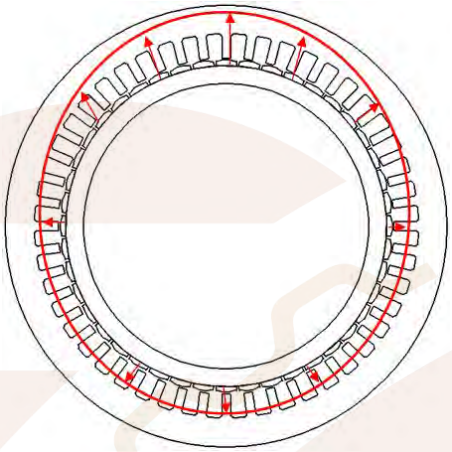


Fig. 6.1 Offset concentricity of the stator and rotor

Table 10 Radial force value

Motor	Radial force f (N/mm)
TMRW1A	2184
TMRW2A	2590
TMRW4A	2946
TMRW7A	2899
TMRWAA	3574
TMRWDA	4350

Calculation of the radial force (N/mm) is used with the following equation :

$$\text{Force} = \textit{radial force } f \times \frac{\text{L}}{100}$$

Where L (mm) represents the length of the iron core, Table 11 defines the length of the iron core.

Table 11 The length of the iron core

Motor Type	L(mm)
TMRW□**3**	30
TMRW□**5**	50
TMRW□**7**	70
TMRW□**A**	100
TMRW□**F**	150

Example:

For aTMRW7F, the radial forces value will be equal to:

$$\text{Force} = \text{TMRW7A's f} \times \frac{150}{100} = 2899 \times \frac{150}{100} = 4348.5(\text{N/mm})$$

When the rotor is inserted inside the stator, axial forces will generate like Fig. 6.2 and Table 101 defines the value of axial force for every motor.

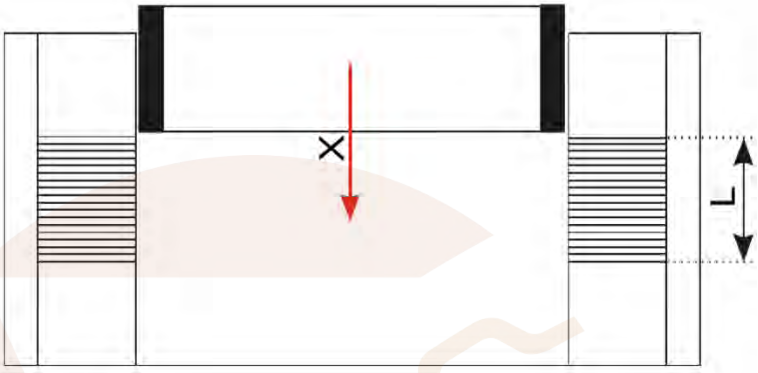


Fig. 6.2 The rotor is inserted inside the stator

Table 121 Axial force value

Motor	Axial force f (N/mm)
TMRW1□	140
TMRW2□	210
TMRW4□	360
TMRW7□	450
TMRWA□	630
TMRWD□	944

7. Safety precautions:

Before using the TMRW, please read these safety instructions and precautions carefully.

7.1 Safety instructions:

(1) The product can only be repaired by HIWIN engineers. Please send the product back to us if there is any unusual phenomenon.
(2) Do not hold the TMRW by its wire harness.
(3) Do not hit the motor.
(4) Do not apply loads to the motor that are in excess of the specified value.
(5) Do not change the motor parts or disassemble the screws. HIWIN will not be responsible for any damages, injuries, or accidents that may occur.

7.2 Wiring instructions:

(1) Ensure the specified power input value before using the product, and verify that the proper power supply is being used.
(2) Before operation, please ensure that the motor are connected correctly. Incorrect wiring may cause abnormal motor operation or even cause permanent damage to the motor.

7.3 Operation instructions:

(1) Avoid excessive friction when the motor is running.
(2) Be sure there is no object in the motion range of the system.
(3) Before starting the motor, check that the cooling system works correctly。
(4) Before starting the motor, check that the master switch works.
(5) Before switching on the power, at least one ground wire must be connected to all electrical units.
(6) Do not touch motor parts while working or shortly after stop.
(7) Performing higher than specified maximum current may cause demagnetization of magnetic components inside the motor.
(8) The motor must be operated within its specified range.
(9) Attention should be given to ensure adequate cooling and ventilation of the motor during operation.
(10) If any abnormal odor, noise, smoke, temperature rise or vibration is detected, stop the motor immediately.
(11) Ambient temperature range from +5°C to +40°C.

7.4 Maintenance and Storage instructions:

(1) Do not store the product in an inflammable environment or with chemical agents.
(2) Store the product in a place without humidity, dust, harmful gases, or liquids.
(3) Do not store the motor where it will be subjected to vibration or in risk of shock that is excess of the specified limit.
(4) The storage and transportation temperature of this product: -10℃~+50℃
(5) Clean：Wipe with Alcohol (70%)
(6) Product abandoned：Follow the local laws and regulations for recycling.

8. Troubleshooting:

Malfunction characteristic	Possible fault cause	Elimination method
Motor cannot rotate	Some of the wiring is incorrect	Check the wiring and specification is correct
Motor rotate in the wrong direction	Encoder setting is incorrect	Check the drive model is correct.
	Input phase error	Cross 2 phases of the motor.
Smell of burning	Setup parameter of the Controller is wrong	1. Check the controller's regulation parameters. 2. Check the coolant system.
	Cooling system works wrongly	
	Controller setting is incorrect of motor parameter	
Motor temperature abnormal	Setup of the controller is wrong.	1. Check the controller's regulation parameters. 2. Check the coolant system.
	Cooling system works incorrectly	
	Bearing damage	
When motor running have abnormal noise or excessive vibration.	Motor insulation problem	Check the resistance value (phase/earth and phase/sensors) >50MΩ
	Encoder mounting problem	Check the mounting
	Noise on encoder's signal	Check the encoder's shield and connection
	Controller's setting is incorrectly	Check the controller's regulation parameters
Abnormal friction noise or torque friction too high	Centering problem of the motor	Check the mounting.
	Presence of objects in the air gap	Remove objects from the air gap.