

OPERATING MANUAL

2-Phase Stepping Motor PKP Series Flat Type

Introduction

■ Before use

Only qualified personnel of electrical and mechanical engineering should work with the product.

Use the product correctly after thoroughly reading the "Safety precautions." In addition, be sure to observe the contents described in warning, caution, and note in this manual. The product described in this manual is designed and manufactured to be incorporated in general industrial equipment. Do not use for any other purpose. Oriental Motor Co., Ltd. is not responsible for any compensation for damage caused through failure to observe this warning.

Safety precautions

The precautions described below are intended to ensure the safe and correct use of the product, and to prevent the customer and others from exposure to the risk of injury. Use the product only after carefully reading and fully understanding these instructions.

Description of signs

	Handling the product without observing the instructions that accompany a "WARNING" symbol may result in serious injury or death.
	Handling the product without observing the instructions that accompany a "CAUTION" symbol may result in injury or property damage.
	The items under this heading contain important handling instructions that the user should observe to ensure the safe use of the product.

Description of graphic symbols

	Indicates "prohibited" actions that must not be performed.
	Indicates "compulsory" actions that must be performed.

 WARNING	
	<ul style="list-style-type: none"> Do not use the product in explosive or corrosive environments, in the presence of flammable gases, in places subjected to splashing water, or near combustibles. Doing so may result in fire or injury. Do not forcibly bend, pull or pinch the lead wires and connector. Doing so may result in fire. Do not disassemble or modify the product. Doing so may result in injury.
	<ul style="list-style-type: none"> Assign qualified personnel to the task of installing, wiring, operating/controlling, inspecting, and troubleshooting the product. Handling by unqualified personnel may result in fire or injury. Take measures to keep the moving part in position if the product is used in vertical operations such as elevating equipment. Failure to do so may result in injury or damage to equipment. Install the product inside an enclosure. Failure to do so may result in injury. Connect the lead wires securely according to the wiring diagram. Failure to do so may result in fire.

Thank you for purchasing an Oriental Motor product.

This Operating Manual describes product handling procedures and safety precautions.

- Please read it thoroughly to ensure safe operation.
- Always keep the manual where it is readily available.

CAUTION

	<ul style="list-style-type: none"> Do not use the product beyond its specifications. Doing so may result in injury or damage to equipment. Keep your fingers and objects out of the openings in the product. Failure to do so may result in fire or injury. Do not touch the product during operation or immediately after stopping. Doing so may result in a skin burn(s). Do not carry the motor by holding the motor output shaft or lead wires. Doing so may result in injury. Keep the area around the product free of combustible materials. Failure to do so may result in fire or a skin burn(s). Do not leave anything around the motor and driver that would obstruct ventilation. Doing so may result in damage to equipment. Do not touch the rotating part (output shaft) during operation. Doing so may result in injury.
	<ul style="list-style-type: none"> Provide a cover over the rotating parts (output shaft) of the motor. Failure to do so may result in injury. Use a motor and driver only in the specified combination. Failure to do so may result in fire. Provide an emergency stop device or emergency stop circuit external to the equipment so that the entire equipment will operate safely in the event of a system failure or malfunction. Failure to do so may result in injury. When an abnormal condition has occurred, immediately stop operation to turn off the driver power. Failure to do so may result in fire or injury. The motor surface temperature may exceed 70 °C (158 °F) even under normal operating conditions. If the operator is allowed to approach the motor in operation, affix a warning label shown in the figure on a conspicuous position. Failure to do so may result in a skin burn(s).



Warning label

Precautions for use

- **When conducting the insulation resistance measurement or the dielectric strength test, be sure to separate the connection between the motor and the driver.**

Conducting the insulation resistance measurement or dielectric strength test with the motor and driver connected may result in damage to the product.

- **Do not apply a radial load and axial load in excess of the specified permissible limit**

Operating the motor under an excessive radial load or axial load may damage the bearings (ball bearings). Be sure to operate the motor within the specified permissible limit of radial load and axial load.

- **Motor surface temperature**

The motor surface temperature may exceed 100 °C (212 °F) under certain conditions (operating ambient temperature, operating speed, duty cycle, etc.). To prevent the bearings (ball bearings) from reaching its usable life quickly, use the motor in conditions where the surface temperature does not exceed 100 °C (212 °F).

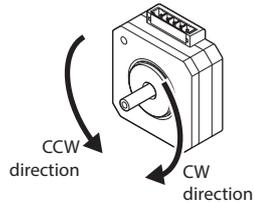
Use the geared motor in a condition where the gear case temperature does not exceed 70 °C (158 °F), in order to prevent deterioration of grease and parts in the gear case.

To protect the encoder, use the motor with encoder in a condition where the surface temperature of the motor does not exceed 85 °C (185 °F).

● **Rotation direction of the motor output shaft**

If the motor is excited in the order shown in the table, it rotates in the clockwise (CW) direction when viewed from the motor output shaft side.

Excitation sequence	Black	Green	Red	Blue
1	-	+	+	-
2	-	+	-	+
3	+	-	-	+
4	+	-	+	-



● **Rotation direction of output flange of Harmonic geared type**

The output flange of the Harmonic geared type rotates in the opposite direction to the rotation direction of the motor output shaft.

● **Motors with encoder**

● **Take measures against static electricity to the encoder.**

The encoder uses semiconductor components. Since static electricity may damage semiconductor components, be extremely careful when handling it.

● **Do not apply a strong impact to the output shaft or encoder.**

Doing so may result in damage to the encoder.

● **Do not connect or disconnect the connector while the power is on.**

Doing so may result in damage to the encoder.

● **Keep the encoder away from a strong magnetic field.**

A magnetic sensor is built into the encoder. Installing the motor near equipment that generates a strong magnetic field may affect the angular accuracy of the encoder. Pay attention to the environment for transportation and storage or the installation location for use.

Preparation

■ **Checking the product**

Verify that the items listed below are included. Report any missing or damaged items to the Oriental Motor sales office from which you purchased the product.

- Motor 1 unit
- Instructions and Precautions for Safe Use..... 1 copy

■ **How to identify the product model**

Verify the model name of the purchased motor against the model name shown on the nameplate.

● **Motor frame size 42 mm (1.65 in.)**

● **Standard type**

PKP 2 4 2 D 23 A 2 - R3E L
 1 2 3 4 6 7 8 10 13 14

● **Harmonic geared type**

PKP 2 4 2 D 23 A 2 H 100 R3E L
 1 2 3 4 6 7 8 10 11 12 13 14

● **Motor frame size 60 mm (2.36 in.)**

● **Standard type**

PKP 2 6 2 F D 15 A W - R3E L
 1 2 3 4 5 6 7 8 9 13 14

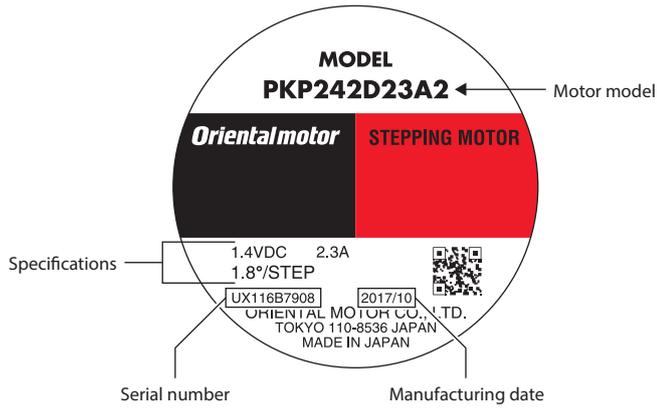
● **Harmonic geared type**

PKP 2 6 2 F D 15 A W H 100 R3E L
 1 2 3 4 5 6 7 8 9 11 12 13 14

1	Series	PKP: PKP Series
2	Number of phases of motor	2: 2-Phase
3	Motor frame size	4: 42 mm (1.65 in.) [51 mm (2.01 in.) for harmonic geared type] 6: 60 mm (2.36 in.) [61 mm (2.40 in.) for harmonic geared type]
4	Motor case length	
5	Motor identification	F: Motor frame size 60 mm (2.36 in.)
6	Number of lead wires	D: 4 Pieces
7	Motor winding specifications	
8	Shaft type	A: Single shaft
9	Cable type	Blank: Connector-coupled type W: Lead wire type
10	Reference number	
11	Gearhead type	Blank: Flat type H: Flat type motor with harmonic gear
12	Gear ratio	
13	Encoder resolution	R3E: 200 P/R R3F: 400 P/R R3J: 1,000 P/R
14	Encoder output circuit type	L: Line driver output Blank: Voltage output

Information about nameplate

The figure shows an example.



memo The position describing the information may vary depending on the product.

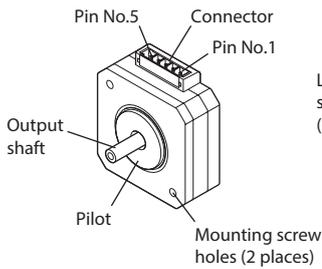
Names of parts

Connector type

The pin numbers as well as the colors of lead wires are shown in the figures.

Standard type

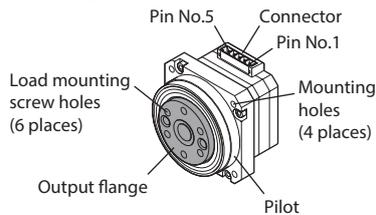
Motor frame size: 42 mm (1.65 in.)



Harmonic geared type

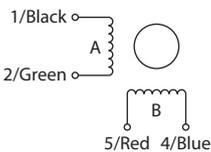
Motor frame size: 51 mm (2.01 in.)

The area indicated in gray color represents a rotating part.

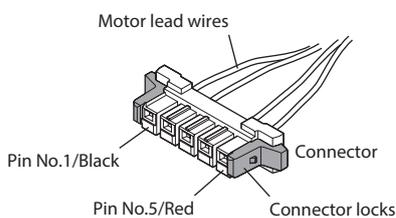


Wiring connection diagram (Bipolar four lead wires)

The connection diagrams show our connection cable. (The Pin No.3 is not used.)



Connection cable



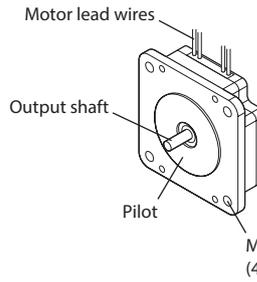
Applicable connector/lead wire

Type	Model
Connector housing	MDF97A-5S-3.5C (HIROSE ELECTRIC CO., LTD.)
Contact	MDF97-22SC (HIROSE ELECTRIC CO., LTD.)
Designated crimping tool	HT801/MDF97-22S (HIROSE ELECTRIC CO., LTD.)
Applicable lead wire	<ul style="list-style-type: none"> Conductor size: AWG24 to 22 (0.2 to 0.3 mm²) Outer diameter of wire insulation: ø1.24 to 1.38 mm (ø0.049 to 0.054 in.) Stripping length of wire insulation: 1.8 to 2.3 mm (0.071 to 0.091 in.)

Lead wire type

Standard type

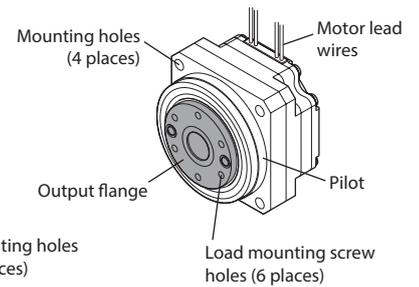
Motor frame size: 60 mm (2.36 in.)



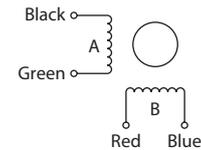
Harmonic geared type

Motor frame size: 61 mm (2.40 in.)

The area indicated in gray color represents a rotating part.



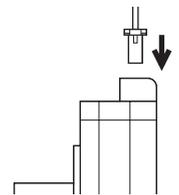
Wiring connection diagram (Bipolar four lead wires)



Connection

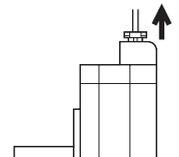
When inserting the connector

Hold the connector main body, and insert it in straight securely. Inserting the connector in an inclined state may result in damage to connector or a connection failure.



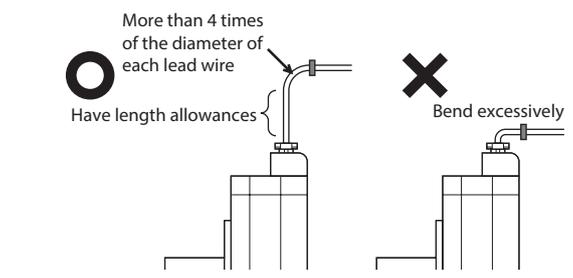
When pulling out the connector

Pull out the connector in straight while releasing the lock part of the connector. Having the motor lead wires or pulling out the connector in a state of being locked may damage the connector.



Note

Secure the lead wires at the connection part to prevent the connection part from receiving stress due to the flexing of the lead wires or the lead wires' own mass. Also, do not excessively bend the lead wires near the connection part of the connector. Applying stress on the motor lead wires may cause poor contact or disconnection, leading to malfunction or heat generation.



Connection with the drivers of Oriental Motor

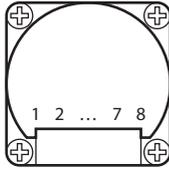
Refer to the following table when connecting with the drivers of Oriental Motor. "Color" in the table shows the colors of lead wires of our connection cable.

Connection with the CVD Series

Driver CN2 Pin No.	Connector type		Lead wire type
	Pin No.	Color	Color
1	4	Blue	Blue
2	5	Red	Red
3	-	-	-
4	2	Green	Green
5	1	Black	Black

■ Connecting the encoder section

● Pin arrangement



Pin number	Lead wire color *	Signal name		Function
		Line driver output	Voltage output	
1	Black	GND	GND	Power supply input (ground)
2	Red	A+	A	Phase A output positive side
3	Brown	A-	N.C.	Phase A output negative side
4	Green	B+	B	Phase B output positive side
5	Blue	B-	N.C.	Phase B output negative side
6	Yellow	Z+	Z	Phase Z output positive side
7	Orange	Z-	N.C.	Phase Z output negative side
8	White	Vcc	Vcc	Power supply input (+5 V)

* It indicates the colors of the lead wires for the encoder connection cable of Oriental Motor.

● Applicable connector and lead wire

Type	Part number
Connector housing	51021-0800 (Molex, LLC)
Contact	50079-8X00 (Molex, LLC)
Designated crimp tool	57177-5000 or 200218-1900 (Molex, LLC)
Applicable lead wire	<ul style="list-style-type: none"> Conductor size: AWG28 to 26 (0.08 to 0.128 mm²) Outer diameter of wire insulation: ϕ0.5 to 1.04 mm (ϕ0.02 to 0.04 in.) Stripping length of wire insulation: 1.4 to 1.9 mm (0.06 to 0.07 in.)

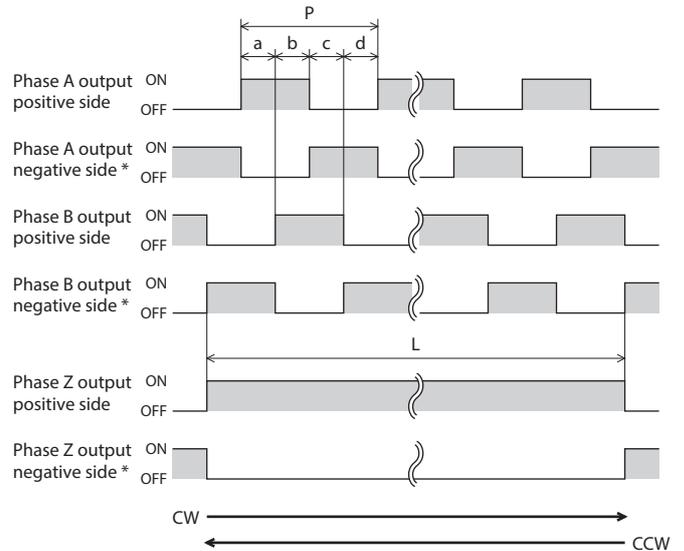


Use a shielded cable to extend the wiring or reduce the influence of noise. Also, keep the product away from power cables, such as motor or power supply cables, and wire it at the shortest possible distance.

● Specifications

Item	Model name indicating the resolution and output circuit type					
	R3EL	R3FL	R3JL	R3E	R3F	R3J
Resolution (P/R)	200	400	1,000	200	400	1,000
Output type	Incremental					
Output circuit type	Line driver output (equivalent to 26C31)			Voltage output		
Output circuit						
Output signal	Phase A, Phase B, Phase Z: 3 Channels					
Maximum sink current	20 mA					
Output voltage	H level: 2.5 V or more			H level: 4.3 V or more (no load)		
	L level: 0.5 V or less			L level: 0.5 V or less		
Response frequency	200 kHz or less			100 kHz or less		
Power supply voltage	5 VDC \pm 10 %					
Current consumption (no load)	30 mA or less			45 mA or less		
Angular accuracy	\pm 0.36° (Conversion value at motor output shaft)					

● Output waveform



* Line driver output only

● Waveform accuracy

- Duty cycle: 50% \pm 12.5% for both phase A output and phase B output
- Phase Z output: $L^* = (\text{Encoder resolution}/50) \times P$
- Phase difference: $a, b, c, d = P/4 \pm P/8$
- Rise and fall time of signal: 1 μ s or less (at connector terminal)
* 7.2° when converted to motor output shaft

Installation

Location for installation

The motor is designed and manufactured to be incorporated in equipment. Install it in a well-ventilated location that provides easy access for inspection. The location must also satisfy the following conditions:

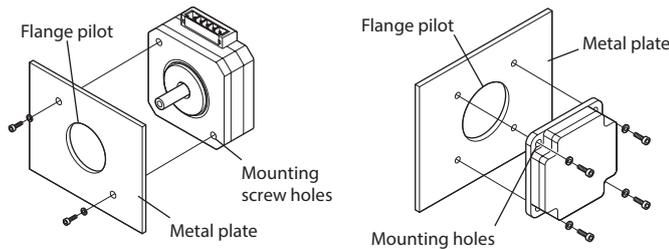
- Inside an enclosure that is installed indoors (provide vent holes)
- Operating ambient temperature
 - 10 to +50 °C (+14 to +122 °F) (non-freezing)
 - Harmonic geared type: 0 to +40 °C (+32 to +104 °F) (non-freezing)
- Operating ambient humidity 85 % or less (non-condensing)
- Area free of explosive atmosphere, toxic gas (such as sulfuric gas), or liquid
- Area not exposed to direct sun
- Area free of excessive amount of dust, iron particles or the like
- Area not subject to splashing water (rain, water droplets), oil (oil droplets), or other liquids
- Area free of excessive salt
- Area not subject to continuous vibrations or excessive shocks
- Area free of excessive electromagnetic noise (from welders, power machinery, etc.)
- Area free of radioactive materials, magnetic fields or vacuum
- 1,000 m (3,300 ft.) or lower above sea level

Installation method

The motor can be installed in any direction. Install the motor onto an appropriate flat metal plate having excellent vibration resistance and heat conductivity. When installing the motor, secure it with screws (not included) so that there is no gap between the motor and metal plate.

Standard type

Motor frame size: 42 mm (1.65 in.) Motor frame size: 60 mm (2.36 in.)

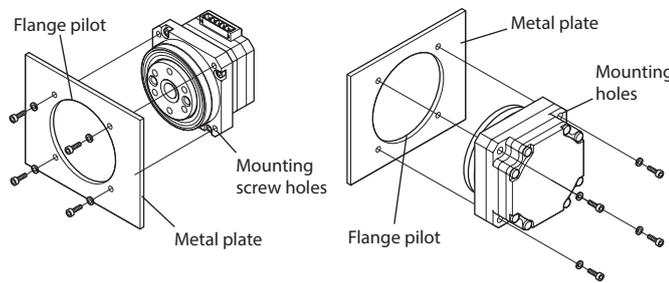


Motor frame size [mm (in.)]	Nominal size	Tightening torque [N·m (oz-in)]	Effective depth of screw thread [mm (in.)]
42 (1.65)	M3	1 (142)	4.5 (0.18)
60 (2.36)	M4	2 (280)	–

Values of the tightening torque are recommended. Tighten the screws with a suitable torque according to the design conditions of the metal plate to be installed.

Harmonic geared type

Motor frame size: 51 mm (2.01 in.) Motor frame size: 61 mm (2.40 in.)



Motor frame size [mm (in.)]	Nominal size	Tightening torque [N·m (oz-in)]	Effective depth of screw thread [mm (in.)]
51 (2.01)	M3	1 (142)	7 (0.28)
61 (2.40)	M4	2 (280)	–

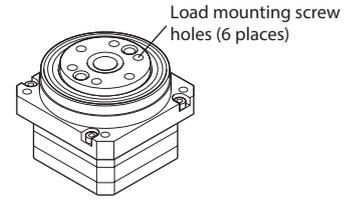
Values of the tightening torque are recommended. Tighten the screws with a suitable torque according to the design conditions of the metal plate to be installed.

Installing a load

When installing a load on the motor, align the axis of rotation of the output shaft with that of the load. Be careful not to damage the output shaft or bearings (ball bearings) when installing a coupling or pulley to the motor output shaft.

Harmonic geared type

Install a load using the load mounting screw holes.



Load mounting screw hole

Motor frame size [mm (in.)]	Nominal size	Tightening torque [N·m (oz-in)]	Effective depth of screw thread [mm (in.)]
51 (2.01)	M3	2.0 (280)	6 (0.24)
61 (2.40)	M4	4.5 (630)	5 (0.20)



Since the tightening torque for the load mounting screw is large, using a mechanically weak load or screws may cause damage. Satisfy the following conditions for the load and mounting screws. Also, be sure to tighten with the specified torque.
Material of load: Steel
Mounting screw: Use a bolt which tensile strength ranking is 12.9 or higher

Permissible radial load, permissible axial load, and permissible moment load

The radial load, axial load, and moment load on the motor output shaft must be kept under the permissible values in the table.

Standard type

Motor frame size [mm (in.)]	Permissible radial load [N (lb.)]			Permissible axial load [N (lb.)]
	Distance from the tip of motor output shaft [mm (in.)]			
	0 (0)	5 (0.2)	10 (0.39)	
42 (1.65), 60 (2.36)	20 (4.5)	25 (5.6)	34 (7.6)	5 (1.12)

Harmonic geared type

Calculate the axial load and load moment for the Harmonic geared type using the International System of Units (N, N·m).

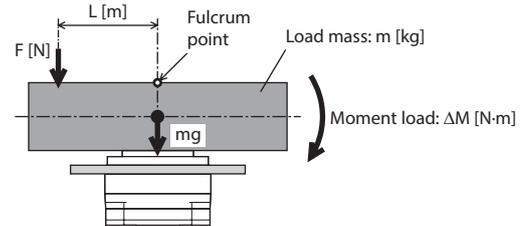
Motor frame size [mm (in.)]	Permissible axial load [N]	Permissible moment load [N·m]
51 (2.01)	200	8.5
61 (2.40)	450	10.1

How to calculate loads of Harmonic geared type

Use the calculating formula below for the axial load and moment load of Harmonic geared type.

Example 1; When an external force F is applied on the position of distance L from the center of the output flange

Axial load: $F_s [N] = F + mg$ (Load mass)
Moment load: $\Delta M [N\cdot m] = F \times L$



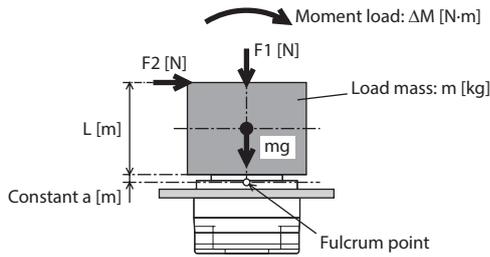
Example 2; When external forces F1 and F2 are applied on the position of distance L from the mounting face of the output flange

Axial load: $F_s [N] = F_1 + mg$ (Load mass)

Moment load: $\Delta M [N\cdot m] = F_2 \times (L + \text{constant } a) *$

* Motor frame size 51 mm (2.01 in.): constant $a = 0.0129 [m]$

Motor frame size 61 mm (2.40 in.): constant $a = 0.0140 [m]$



Inspection and maintenance

■ Inspection

It is recommended that periodic inspections would be conducted for the items listed below after each operation of the motor. If an abnormal condition is noted, discontinue any use and contact your nearest Oriental Motor sales office.

Inspection item

- Check if any of the screws having installed the motor is loose.
- Check if an unusual noise is generated from a bearing part (ball bearings).
- Check if a damage or stress is applied on the motor lead wires.
- Check if the connection part with the connector or the driver is loose.
- Check if the motor output shaft and the load shaft are out of alignment.

■ Warranty

Check on the Oriental Motor Website for the product warranty.

■ Disposal

Dispose the product correctly in accordance with laws and regulations, or instructions of local governments.

Specifications

Check on the Oriental Motor Website for the product specifications.

General specifications

Degree of protection		IP20
Operation environment	Ambient temperature	-10 to +50 °C (+14 to +122 °F) (non-freezing) Harmonic geared type: 0 to +40 °C (+32 to +104 °F) (non-freezing)
	Humidity	85 % or less (non-condensing)
	Altitude	Up to 1,000 m (3,300 ft.) above sea level
	Surrounding atmosphere	No corrosive gas, dust, water or oil
Storage environment	Ambient temperature	-20 to +60 °C (-4 to +140 °F) (non-freezing)
	Humidity	85 % or less (non-condensing)
Shipping environment	Altitude	Up to 3,000 m (10,000 ft.) above sea level
	Surrounding atmosphere	No corrosive gas, dust, water or oil
Insulation resistance	100 MΩ or more when 500 VDC megger is applied between the windings and the case.	
Dielectric strength	Sufficient to withstand the following conditions applied between the windings and the case for 1 minute. • 0.5 kVAC 50/60 Hz	

Regulations and standards

■ RoHS Directive

This product does not contain the substances exceeding the restriction values.

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- Please contact your nearest Oriental Motor office for further information.

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