Oriental motor

HM-7409-4

OPERATING MANUAL
2-Phase Stepping Motor
PK Series (with Encoder)

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.

Introduction

■ Before using the motor

Only qualified personnel should work with the product.
Use the product correctly after thoroughly reading the section "Safety precautions".
The product described in this manual has been designed and manufactured for use in general industrial machinery, and must not be used for any other purpose. For the power supply use a DC power supply with reinforced insulation on its primary and secondary sides. Oriental Motor Co., Ltd. is not responsible for any damage caused through failure to observe this warning.

■ Hazardous substances

RoHS (Directive 2002/95/EC 27Jan.2003) compliant

Safety precautions

The precautions described below are intended to prevent danger or injury to the user and other personnel through safe, correct use of the product. Use the product only after carefully reading and fully understanding these instructions.

⚠Warning

Handling the product without observing the instructions that accompany a "Warning" symbol may result in serious injury or death.

- Do not use the product in explosive or corrosive environments, in the presence of flammable gases, locations subjected to splashing water, or near combustibles. Doing so may result in fire or injury.
- Assign qualified personnel the task of installing, wiring, operating/controlling, inspecting and troubleshooting the product. Failure to do so may result in fire or injury.
- Provide a means to hold moving parts in place for applications involving vertical travel. The motor loses holding torque when the power is shut off, allowing the moving parts to fall and possibly causing injury or damage to equipment.
- Install the motor in an enclosure in order to prevent injury.
- Keep the input-power voltage within the specified range to avoid fire.
- Connect the cables securely according to the wiring diagram in order to prevent fire.
- Do not forcibly bend or push the connector. Doing so may fire.
- Do not forcibly bend, pull or pinch the cable. Doing so may fire.
- For the power supply use a DC power supply with reinforced insulation on its primary and secondary sides. Failure to do so may result in electric shock.
- Turn off the power in the event of a power failure, or the motor will suddenly start when the power is restored and may cause injury or damage to equipment.
- Do not disassemble or modify the motor. This may cause injury. Refer all such internal inspections and repairs to the branch or sales office from which you purchased the product.

⚠Caution

Handling the product without observing the instructions that accompany a "Caution" symbol may result in injury or property damage.

- Do not use the motor beyond its specifications, or injury or damage to equipment may result.
- Do not touch the motor during operation or immediately after stopping. The surface is hot and may cause a burn.
- Do not hold the motor output shaft or motor cable. This may cause injury.
- 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.
- Conduct the insulation resistance measurement or withstand voltage test separately on the motor and the driver. Conducting the insulation resistance measurement or withstand voltage test with the motor and driver connected may result in injury or damage to equipment.
- To prevent bodily injury, do not touch the rotating parts (output shaft) of the motor during operation.
- Immediately when trouble has occurred, stop running and turn off the driver power. Failure to do so may result in fire or injury.
- To dispose of the motor, disassemble it into parts and components as much as possible and dispose of individual parts/components as industrial waste.

Checking the product

Open the package and confirm that all of the following items are available. To verify that the unit you've purchased is the correct one, check the model number shown on the nameplate. Should you find any item missing or damaged, contact the Oriental Motor sales office where you purchased the product.

- Motor ..... 1 unit
- Encoder cable [0.6 m (2 ft.)] ..... 1 pc.
  [**PK2□-L** only]
- Motor cable [0.6 m (2 ft.)] ..... 1 pc.
  [**PK244PA□**, **PK246PA□** only]

∗ The square box in the motor type will contain a number representing the encoder specifications.

- Operating manual (this manual)..... 1 copy

Installation

■ Location for installation

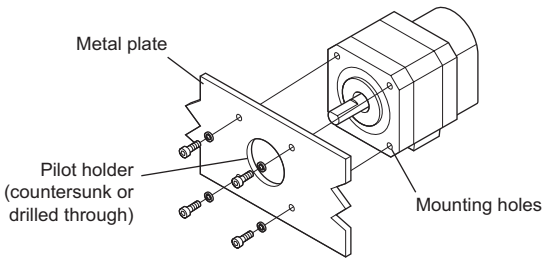
The motor is designed and manufactured for installation in equipment. Install it in a well-ventilated location that provides easy access for inspection. The location must also satisfy the following conditions:

- Inside an enclosure that is installed indoors (provide vent holes)
- Operating ambient temperature
  –10 °C to +50 °C (+14 °F to +122 °F) (non-freezing)
- Operating ambient humidity 85%, maximum (non-condensing)
- Area that is free from an explosive nature or toxic gas (such as sulfuric gas) or liquid
- Area not exposed to direct sun
- Area free of excessive amount dust, iron particles or the like
- Area not subject to splashing water (storms, water droplets), oil (oil droplets) or other liquids
- Area free of excessive salt
- Area not subject to continuous vibration or excessive shocks
- Area free of excessive electromagnetic noise (from welders, power machinery, etc.)
- Area free of radioactive materials, magnetic fields or vacuum

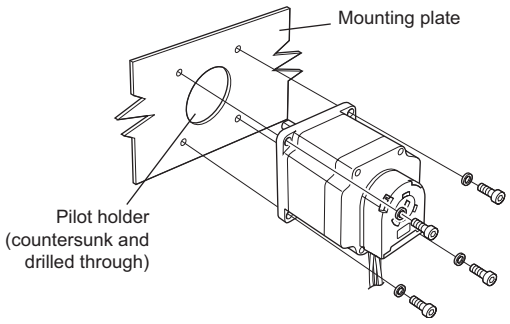
■ How to install the motor

Install the motor onto an appropriate flat metal plate having excellent vibration resistance and heat conductivity. When installing the motor, secure it with four bolts (not supplied) through the four mounting holes provided. Leave no gap between the motor and plate.

Installation method A



Installation method B



Motor type	Bolt size	Tightening torque [N·m (lb-in)]	Effective depth [mm (in.)]	Installation method
PK24□	M3 P0.5	1 (8.8)	4.5 (0.18)	A
PK26□	M4	2 (17.7)	–	B

∗ The square box in the motor type will contain a number representing the motor length.

■ Permissible overhung load and permissible thrust load

The overhung load on the motor's output shaft or gear output shaft must be kept within the permissible values listed below. The thrust load must not exceed the motor's mass.

Motor type	Permissible overhung load [N (lb.)]			
	Distance from the top of motor's output shaft [mm (in.)]			
	0 (0)	5 (0.2)	10 (0.4)	15 (0.6)
PK24□	20 (4.5)	25 (5.6)	34 (7.6)	52 (11.7)
PK26□	54 (12.1)	67 (15)	89 (20)	130 (29)

∗ The square box in the motor type will contain a number representing the motor length.

■ Installing a load

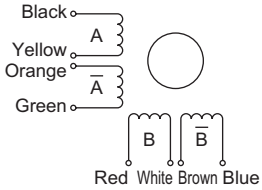
When connecting a load to the motor, align the centers of the motor's output shaft and load shaft. Be careful not to damage the output shaft or the bearings when installing a coupling or pulley to the motor's output shaft.

Note Do not apply strong impact to the motor's shaft, since it can damage the encoder.

Connection

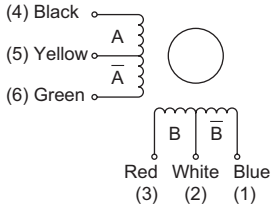
■ Wiring diagram

- 8 lead wire type

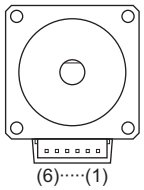


- 6 lead wire type [( ): Pin number]

Wiring diagram



Pin assignments of **PK244PA□**, **PK246PA□**



PK244PA□ and **PK246PA□** are connector type motor. Use the supplied motor cable. If you are using the connector set or when you are providing your own connector or cable, connect based on the pin numbers shown. The conforming connector and the cable are as follows.

Conforming connector and cable

Housing contact (Molex)	51103-0600 50351-8XXX
Cable	AWG28 to 22 (0.08 to 0.3 mm^2) Cable outer diameter Ø1.15 to 1.8 mm (0.045 to 0.071 in.) Stripping the cable 2.3 to 2.8 mm (0.091 to 0.11 in.)
Crimping tool (Molex)	57295-5000

Optional motor cables and connector set (sold separately) are available from Oriental Motor.

Note
- Secure the motor connector cable in place so that the connection won't be subjected to stress induced by a bent cable or the cable's own mass. The cable's radius of curvature should be as large as possible.
- When removing the motor cable, pull it out horizontally toward the output shaft. The motor may be damaged if force is applied in any other direction. The motor cable (both supplied and sold separately) employs a connector with a lock. When removing this type of cable, release the connector lock first. Forcibly pulling out the cable without releasing the connector lock may damage the motor.

Encoder specifications

Note Use the motor within the encoder specifications.

The HEDS-5540, 5600 and 5640 series encoders by Agilent Technologies, Inc., are used.

■ Absolute maximum ratings

Item	Symbol	Min.	Max.	Note
Storage temperature [°C (°F)]	T_S	−40 (−40)	100 (212)	–
Operating temperature [°C (°F)]	T_A	−40 (−40)	100 (212)	–
Supplied voltage (V)	Vcc	−0.5	7	–
Output voltage (V)	Vo	–0.5	Vcc	–
Output voltage/ channel (mA)	I_{OUT}	–1.0	5	–
Vibration (Hz)	–	5	1000	20 G
Rotation speed (r/min)	–	–	30,000	–
Rotation acceleration (rad/sec^2)	–	–	250,000	–

■ Recommended operating ranges

Item	Symbol	Min.	TYP.	Max.	Note
Temperature [°C (°F)]	T_A	−40 (−40)	–	100 (212)	–
Supplied voltage (V)	Vcc	4.5	5.0	5.5	Ripple < 100 mVp-p
Load capacity (pF)	C_L	–	–	100	2.7 kΩ, pull-up
Response frequency (kHz)	f	–	–	100	Rotating speed (r/min) × $\frac{N}{60}$

Note
- The encoder specifications are designed to guarantee operation based on a response frequency of 100 kHz. However, the encoder can be operated at a minimum response frequency of 100 kHz.
- 2.7 kΩ pull-up resistors required for HEDS-5540 and 5640.

■ Electrical characteristics

The following characteristic values assume operation under the recommended operating conditions:

- 2-channel type HEDS-5600 series

Item	Symbol	Min.	TYP.*	Max.	Note
Supply current (mA)	Icc	–	17	40	–
Output voltage "High" (V)	V_{OH}	2.4	–	–	I_{OH} = –40 µA max.
Output voltage "Low" (V)	V_{OL}	–	–	0.4	I_{OL} = 3.2 mA
Rise time (ns)	tr	–	200	–	C_L = 25 pF
Fall time (ns)	tf	–	50	–	R_L = 11 kΩ pull-up

∗ TYP values are based on V_{CC} = 5.0 V and T_A = 25 °C (77 °F)

- 3-channel type HEDS-5540, 5640 series

Item	Symbol	Min.	TYP.*	Max.	Note
Supply current (mA)	Icc	30	57	85	–
Output voltage "High" (V)	V_{OH}	2.4	–	–	I_{OH} = –200 µA max.
Output voltage "Low" (V)	V_{OL}	–	–	0.4	I_{OL} = 3.86 mA
Rise time (ns)	tr	–	180	–	C_L = 25 pF
Fall time (ns)	tf	–	40	–	R_L = 2.7 kΩ pull-up

∗ TYP values are based on V_{CC} = 5.0 V and T_A = 25 °C (77 °F)

■ Encoder characteristics

Unless otherwise specified, the following characteristics assume that the encoder unit is installed within the allowable ranges of error and operated under the recommended operating conditions. Each characteristic value indicates the worst value within one rotation of the code wheel.

- 2-channel type HEDS-5600 series

Item	Symbol	Min.	TYP.*	Max.
Pulse width error (°e)	ΔP	–	7	45
Logic width error (°e)	ΔS	–	5	45
Phase error (°e)	ΔØ	–	2	20
Position error (arc min.)	Δθ	–	10	40
Cycle error (°e)	ΔC	–	3	5.5

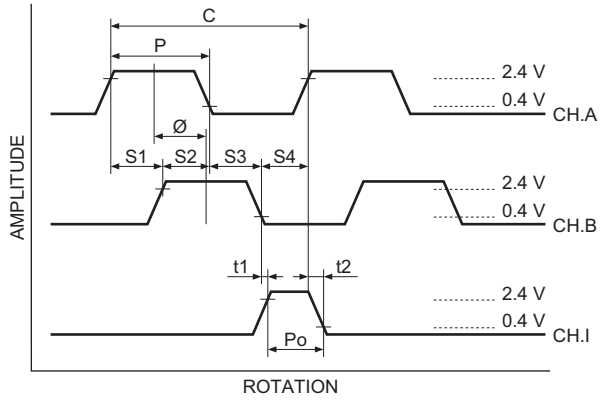
∗ TYP values are based on V_{CC} = 5.0 V and T_A = 25 °C (77 °F)

- 3-channel type HEDS-5540, 5640 series

Item	Symbol	Min.	TYP.*	Max.
Pulse width error (°e)	ΔP	–	5	35
Logic width error (°e)	ΔS	–	5	35
Phase error (°e)	ΔØ	–	2	15
Position error (arc min.)	Δθ	–	10	40
Cycle error (°e)	ΔC	–	3	5.5
Index pulse width (°e)	Po	55	90	125
CH.I rise after CH.A and CH.B fall (ns) [T_A: −25 to +100 °C (−13 to +212 °F)]	t_1	10	100	250
CH.I fall after CH.B or CH.A rise (ns) [T_A: −25 to +100 °C (−13 to +212 °F)]	t_2	70	150	1000

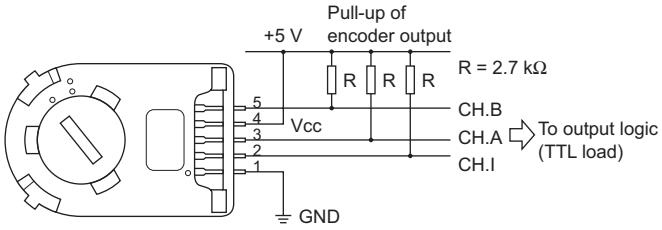
∗ TYP values are based on V_{CC} = 5.0 V and T_A = 25 °C (77 °F)

■ Output waveform



■ Electrical interface

We recommend that the CH.A, CH.B and CH.I outputs be pulled up with a resistance of 2.7 kΩ (±10%) in order to shorten the rise time of the output pulse. Install a pull-up resistor near the encoder (within 1 m).



■ Applicable connectors

Manufacturer	Model numbers
Tyco Electronics AMP	103686-4 640442-5
Du Pont	65039-032 (housing) 4825X-000 (contact)
Avago Technologies Limited	HEDS-8902 (for 2 channels: 4 lead wires) HEDS-8903 (for 3 channels: 5 lead wires)
Molex	2695 series (housing) 2759 series (contact)

■ Definition of terms

- Count (N)

Number of pulses per rotation of the code wheel.

- One cycle

One output pulse cycle = 360°e (electrical angle)

- Position error (Δθ)

Difference between the shaft's actual rotating angle and the rotating angle calculated from the encoder's output pulse count.

- Cycle error (ΔC)

Deviation from the ideal value (360°/ N) of the shaft's actual rotating angle relative to the encoder output pulse per period, expressed as an electrical angle.

- Pulse width (P)

Width of the output pulse in the High state within a cycle, expressed as an electrical angle.

- Pulse width error (ΔP)

Deviation of the pulse width from the ideal value (180°e).

- Logic value (S)

Width corresponding to any of the four Logic states within each cycle formed by the outputs of phases A and B and expressed as an electrical angle.

- Logic width error (ΔS)

Deviation of logic width from the ideal value (90°e).

- Phase (Ø)

Phase difference between the outputs of phase A and that of phase B, measured at the centers of the respective High pulses.

- Phase error (ΔØ)

Deviation of phase from the ideal value (90°e).

- Rotating direction

When the motor's shaft rotates clockwise, the output pulse of phase A rises first. When it rotates in the counterclockwise direction, the output pulse of phase B rises first. (The motor shaft's rotating direction indicates the direction as viewed from the motor shaft side.)

- Index pulse width (Po)

The number of electronical degrees that an index output is high during one full shaft rotation. This value is nominally 90°e or 1/4 cycle.

Inspection

It is recommended that periodic inspections 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 office.

- Check for any unusual noises in the motor's bearings (ball bearings) or other moving parts.
- Are there any loose connector connections, or any scratches or signs of stress in the motor cable?
- Are the motor's output shaft and load shaft out of alignment?

Precautions for use

- Operate the motor with a surface temperature not exceeding 100 °C (212 °F).

The motor casing's surface temperature may exceed 100 °C (212 °F) under certain conditions (ambient temperature, operating speed, duty, etc.). Keeping the surface temperature of the motor casing below 100 °C (212 °F) will also maximize the life of the motor bearings (ball bearings).

- Do not apply strong physical impact to the motor's shaft.

The motor's shaft is equipped with an optical encoder. To prevent damage to the encoder, when transporting the motor or connecting a load, please handle the motor shaft carefully so as to protect it from strong impact.

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

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