Motor Driver D6060 Series

User's Manual

1. Introduction

Thank you very much for purchasing our product. Two motor drivers—the D6060 (standard driver) and the D6060E (driver with speed control function)—are available and required for USR60 series operation. We are sure that combined use of USR60 series and D6060 series will meet your needs.

2. Check Accessories

The following items are included in this set.

- Ultrasonic motor body
- Motor driver
- Motor cable
- Encoder cable (E3, E3T, E3N and E3NT only)

* Separate purchase of a signal cable for CW, CCW and speed command voltage is required.

3. Precautions

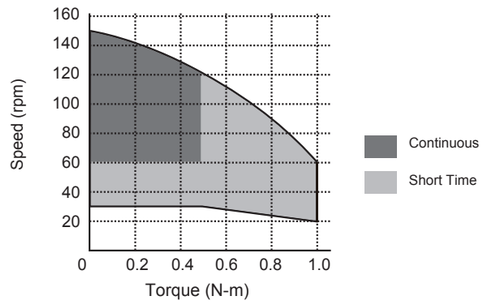
- Inaccu rate equipment wiring may cause harm to the driver.
  Read and understand these instructions before attempting to connect with an external device.
- Always use the designated motor cable.
  Readjustment is required for the driver when changing the length of the cable.
  * If you require a change of cable length after purchase, send the motor and driver to our company. In such case, you will be charged for the adjustment.
- Use shielded wire for signal cables for CW, CCW and speed command voltage to prevent noise.
- Power for the driver: 24 VDC has sufficient allowance for current capacity. Please use ones with less ripple. (2 A or more)
- Excessive inertial load will cause motor slippage when starting or stopping the motor. This slippage will cause wear on the motor and shorten working life.
- Avoid continuous operation in excess of rated load torque.
  It will cause wear on the motor parts and shorten working life.
  * When the motor is overloaded, the driver overload display LED (red) will light up and the motor will stop. When the overload display LED (red) lights, turn OFF the power connected to the driver. Eliminate the cause before turning the power ON again.
- The ultrasound motor operates under friction drive causing a larger calorific value. Sufficient measures must be taken for heat dissipation of motor and driver. Fix onto metal plate or metal chassis with good thermal conductivity to prevent case surface temperature from exceeding 55 ˚C.
- When using or storing motor, ensure that the humidity of the surrounding area is below 45 %.
- The dimensional tolerance of the motor output shaft is set at g6. Avoid press fitting to the counter hole or fitting by pounding. Doing so may cause motor rotation failure.
- Maintain overhang load at the minimum.
  Permissible load is less than 5 [Kg] at shaft end.
- Maintain thrust load at the minimum.
  Permissible load is less than 5 [Kg] at shaft end.

4. Motor and Driver Features

USR60 driver: Torque characteristics when using D6060 and D6060E are shown in the graph below. When combining USR60 series motor with encoder and 6060E, the property around the minimum speed will improve. The relationship between speed command voltage and motor speed is linear.

The D6060 includes a motor speed change function; however, it does not have a speed stabilization function. The D6060 requires a servo system to stabilize speed.
The D6060E uses an encoder signal installed on the motor to control motor speed. Minimum speed can be set lower than when using the D6060, and the speed control range will be 15 [rpm] to 150 [rpm]. Relationship between speed command voltage and motor speed will be first-order straight line, as shown in the graph.

Driver: When using the D6060 (All series)



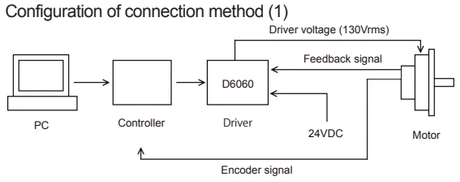
5. Basic Connection Method

Ultrasonic motor and driver are adjusted one-to-one. Therefore, one driver is required for the operation of each ultrasonic motor.

Connection method (1)

Driver: The D6060 is the most suitable driver for motors with no encoder. Use connection method (1) below to connect to motor, driver and driver control equipment (PC, microcomputer, etc.) when using the D6060.
Also use connection method (1) to enable the user's original control when using motor with encoder.

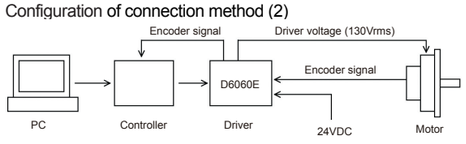
Configuration of connection method (1)



Connection method (2)

Use connection method (2) when using the D6060E to position control motor with encoder. When using the D6060E, the driver will perform speed control based on the value of speed command voltage.
*The encoder cable must be connected when using the D6060E.

Configuration of connection method (2)

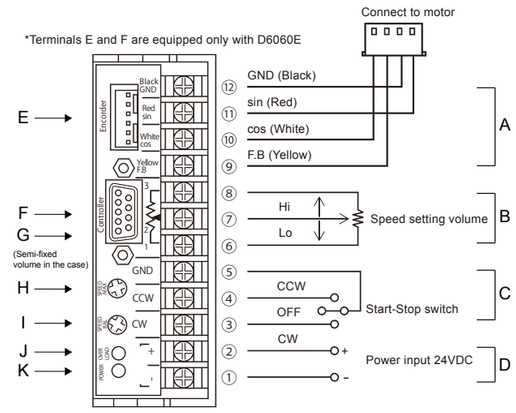


6. Names and Functions of Driver Parts

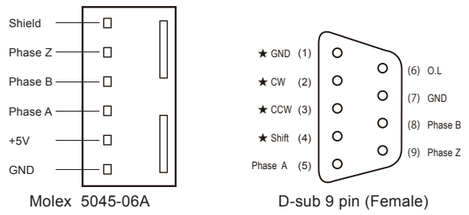
The driver is equipped with 2 LED showing operation status, 3 volumes for adjustment, a terminal to connect with the power and motor, and a terminal to connect to the encoder and controller (excluding D6060). Refer to information on the type and color of cables to be connected on the driver panel for accurate connection.

The details of each terminal are as follows:

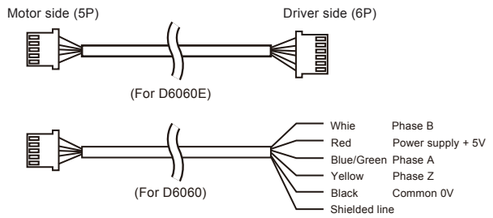
D6060/D6060E

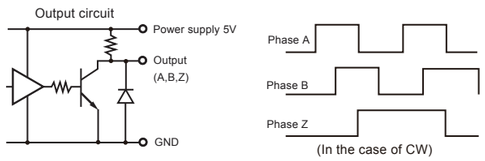


Terminal for D6060E



Encoder cable





Through output of the encoder is 5V voltage output.

A: Motor Connection Terminal
Check the color of cable for accurate connection.

B: Speed Setting Volume Connecting Terminal
Motor speed can be adjusted with a 10 [KΩ] (0.1 [W]) variable resistor (Type B is recommended).

C: Start-Stop Switch
This is the switchover terminal for motor rotation direction.
In the case of contact, use the snap switch (for minute current) with OFF switch for Single-Pole/ Double-Throw Center.

D: Power Supply 24 VDC Terminal
This is the terminal to connect DC power supply 24 [V]/2 [A].

E: Encoder Connector
Connect the encoder cable to speed control using encoder signal.

F: Controller Connector
This is the terminal for encoder signal through output and motor control signal input and output. Connecting this terminal with the controller enables control of speed and position of the motor.
When using this terminal, leave terminals ③ to ⑧ as NC.
O.L. (6) is an open collector. (L: normal, H: overload)

G: Minimum Rotational Speed Setting Volume
No load speed is set at 20 [rpm] (D6060E set at 15 [rpm]).
* The motor and driver are adjusted to the maximum condition at the time of shipment. Fundamentally, users do not need to use adjustment volume. To adjust the driver when changing the cable or for other reasons, readjust following the driver adjustment method later noted in this text.

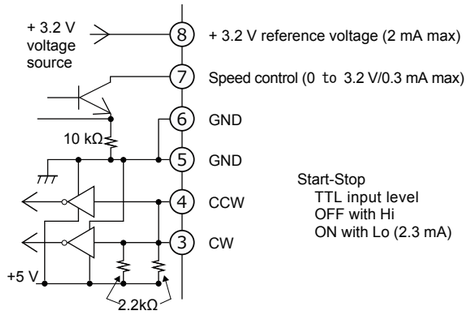
H: Maximum Rotational Speed Setting Volume
No load speed is set at 150 [rpm].

I: Balance Adjustment Volume
Volume knob for adjustment of CW and CCW rotational speed difference. (Adjustment not required for D6060E)

J: LED Indicator (Red)
Lights up when motor is overloaded and stops the motor. To reset, turn OFF the power or start switch, eliminate cause and reboot.

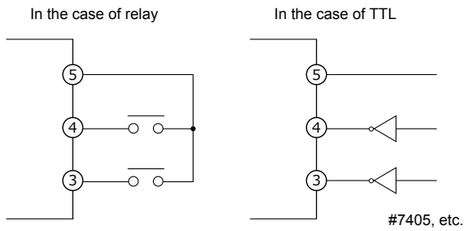
K: LED Indicator (Green)
When the light is on at the energizing state and internal fuse is blown, the light will turn off.

7. Control from External

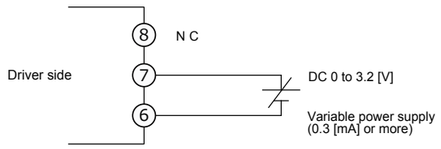


○ Inner Circuit of Driver
- Stabilized voltage of +3.2 [V] (Max 2 [mA]) is output to the speed setting volume terminal ⑧ blue.
- CW and CCW start/stop for rotation command terminal ③ and ④ turns OFF at Hi (2.5 to 5.5 [V]) and turns ON at Lo (0 to 0.4 [V]) of TTL input level.
  * Impedance for current value 2.3 [mA], ③ and ④ is 2.2 [KΩ].
- When CW and CCW are turned ON simultaneously, CW takes precedence. Refer to Timing Chart for switchover interval.

○ Start, Stop and Rotation Direction Switching by External Signal

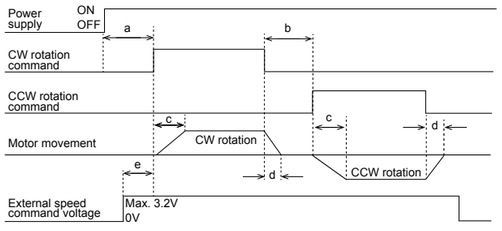


○ Speed Control by External Voltage
- To control speed with external voltage, connect with a DC variable voltage source in place of volume as shown in the diagram. Changing the voltage to 0 to 3.2 [V] enables speed control equivalent to changing volume to between 0 to max.
  * Consumption current is below 0.5 [mA] for external voltage source. Increase of command voltage speed on startup is restricted.
- For use requiring precise speed control, speed control using encoder signal of the D6060E is effective. In such case, voltage speed characteristics will be as shown in the diagram and rotational fluctuation for the range of regular use will be 0.1 to 0.5 [%].



8. Timing Chart

Operational timing for the D6060, D6060E is as described below:



1 Time required from driver power ON to start command (CW or CCW) ON is more than 100 [ms].
2 More than a 10 [ms] interval time is required to switchover forward and reverse rotation.
3 Start-up response (when no inertial load) takes approximately 50 [ms].
4 Stop response (when no inertial load) takes less than 1 [ms].
5 Reclosing after motor stops due to overload requires about a 10 [s] interval after turning OFF the power.

9. How to Adjust the Driver

Motor and driver are set at optimal state matching the specification at the time of shipment. Therefore, as a rule, driver adjustment should not be performed by user. If for some reason there is a need for adjustment, follow the directions below:

○ What You Need
- Frequency meter (Input voltage: higher than 150 [Vrms])
- Ammeter (Capacity: 5 [A])
- Tachometer (Non-contact type is desirable)
- Small phillips screwdriver

○ Adjustment procedure

Step 1. Connect frequency meter between GND and Sin (or Cos) of the motor cable. (Be careful with the measuring instrument because of high voltage.)

Step 2. Connect the speedometer and motor under a no load state.

Step 3. Adjustment of Minimum Rotational Speed (see E in the driver detail diagram)
Give rotation command to the CW direction with speed setting volume of the external at minimum, or with external speed command voltage as 0[V]. Adjust Volume E (speed increases when turning clockwise) to 30 [rpm] for the D6060 and 15 [rpm] for the D6060E under this condition.

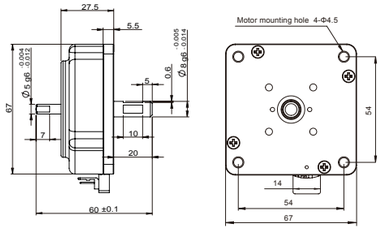
Step 4. Adjustment of Maximum Rotational Speed (See D in the driver detail diagram)
Give rotation command to the CW direction with external speed setting volume at maximum, or external speed command voltage at 3.2 [V]. Under this condition, adjust volume D (speed increase when turning clockwise) to set the speed between 150 and 155 [rpm]. Ensure that the drive frequency for the USR60 series is somewhere around 40 to 41 [KHz].

Step 5. Balance Correction (See C in the driver detail diagram)
Change the rotation direction of the CW/CCW and adjust volume C to ensure the same maximum speed for CW and CCW. Maximum speed changes according to the amount of change of volume C; repeat steps 4 and 5 to ensure the maximum speed for CW and CCW are the same.
* There is no need to correct balance for the D6060E.

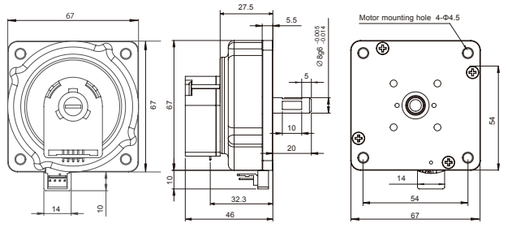
10. Motor and Driver Specifications

USR60 Series Motor

Dimensional Drawing: USR60-S3/S4/S3N/S4N



Dimensional Drawing: USR60-E3/E3T/E3N/E3NT



USR60 Series Motor for General Environment Specification Table

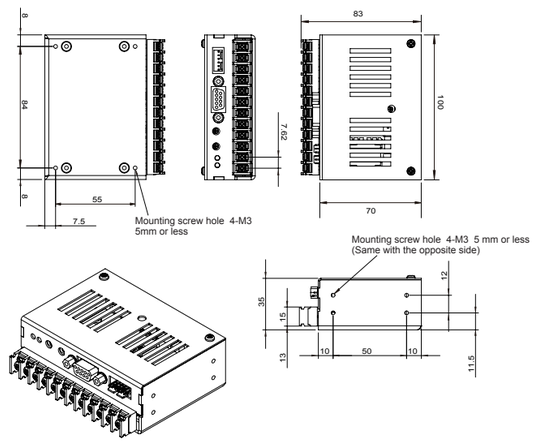
Model Name	USR60-S3	USR60-S4	USR60-E3	USR60-E3T
Drive Frequency	40 KHz to 45 KHz			
Drive Voltage	130 Vrms			
Rated Output	5.0 W			
Maximum Output	10.0 W (by Maximum Load)			
Rated Speed	100 rpm			
Maximum Speed	150 rpm			
Rated Torque	0.5 N-m (5.0 Kg-cm)			
Maximum Torque	1.0 N-m (10.0 Kg-cm)			
Holding Torque	1.0 N-m (10.0 Kg-cm)			
Response	1 ms or less (with no load)			
Direction of Rotation	CW, CCW			
Operational Temperature Range	-10 °C to +55 °C			
Temperature Limit	Surface of Stator 70 [°C], Surface of Case 60 [°C]			
Operational Humidity Range	0 to +45 % (No condensation)			
Size	67×77×47.5 mm	67×77×60 mm	67×77×66 mm	67×77×66 mm
Weight	258 g	261 g	266 g	266 g
Remarks	Single Shaft	Double Shaft	Encoder resolution: 500 P/R	Encoder resolution: 1,000 P/R

USR60 Series Non-magnetic Compatible Motor Specification Table

Model Name	USR60-S3N	USR60-S4N	USR60-E3N	USR60-E3NT
Drive Frequency	40 KHz to 45 KHz			
Drive Voltage	130 Vrms			
Rated Output	5.0 W			
Maximum Output	10.0 W (by Maximum Load)			
Rated Speed	100 rpm			
Maximum Speed	150 rpm			
Rated Torque	0.5 N-m (5.0 Kg-cm)			
Maximum Torque	1.0 N-m (10.0 Kg-cm)			
Holding Torque	1.0 N-m (10.0 Kg-cm)			
Response	1 ms or less (with no load)			
Direction of Rotation	CW, CCW			
Operational Temperature Range	-10 °C to +55 °C			
Temperature Limit	Surface of Stator 70 [°C], Surface of Case 60 [°C]			
Operational Humidity Range	0 to +45 % (No condensation)			
Size	67×77×47.5 mm	67×77×60 mm	67×77×66 mm	67×77×66 mm
Weight	250 g	254 g	272 g	272 g
Remarks	Single Shaft	Double Shaft	Encoder resolution: 500 P/R	Encoder resolution: 1,000 P/R

Driver for USR60 Series

D6060/D6060E



D6060 Series Specification Table

Model Name	D6060	D6060E
Power Supply Voltage	24 V ±0.5 V DC (12 V ±0.5 V DC)	
Oscillation Waveform	Pseudo Sine Wave	
Oscillation Frequency	40 KHz to 55 KHz	
Speed Adjustment Method	Frequency Change	
Frequency Control	Automatic Tracking Method Using Feedback of Amplitude by Vibration	Automatic Tracking Method Using Feedback of Amplitude by Encoder Signal
Motor Drive Voltage	130 Vrms	
Consumption Current	24 VDC: 2.0 A / 12 VDC: 4.0 A (Maximum)	
Over Current Protection	24 V: 2.5 A (φ5.2 Midget Fuse) 12 V: 4 A (φ5.2 Midget Fuse)	
Insulation Resistance	10 MΩ or more (Motor Unconnected)	
Withstand Voltage	1 KVAC (Motor Unconnected)	
Storage Temperature Range	-20 °C to +80 °C	
Operational Temperature Limit	-10 °C to +55 °C	
Start-Stop Control	Switching TTL Level Voltage (Prepare separately when using switch)	
Start-up Response	50 ms or less (with no load)	
Stopping Response	1 ms or less (with no load)	
No-load Adjustable Speed Range	20 rpm to 150 rpm	15 rpm to 150 rpm
Speed Setting External Voltage	0 V to 3.2 V DC	
Recommended Switch	Toggle Switch (ON-OFF-ON)	
Recommended Volume	10 KΩ, 0.1 W, B type (Must be prepared separately)	
Weight	250 g	260 g
Outline Size	(Vertical) 35 × (Horizontal) 100 × (Height) 83 [mm]	
Remarks		Speed Control Function using an Encoder Signal is equipped

11. Warranty

Guarantee period is one year or 1,000 hours of operation, whichever comes first. Malfunction during the guarantee period which is clearly caused by us will be repaired or replaced free of charge. The product is manufactured under the strictest quality control system. Should you experience product malfunction, check the following points and contact us.

1. Model (Example: USR60-S3) 2. Serial number 3. Operating time 4. Place of purchase 5. State of malfunction

⚠ Precautions Please give particular care to the points described below:

1. Avoid putting excessive load or inertial load on the motor as much as possible.
   Excess or inertial load may shorten motor life due to stator and rotor abrasion.
2. Do not place thrust load on the output shaft of the motor.
   Doing so may cause property degradation of the motor.
3. Do not place rotation force above the holding torque from outside when motor is stopped.
   Doing so may damage the motor.
4. The motor output shaft has a g6 dimensional tolerance.
   Avoid fitting with indentation or driving into a counter hole.
5. Ensure sufficient heat dissipation to hold motor case temperature to below 55 °C.
6. When using or storing the motor, ensure that humidity around the device is below 45%.
7. Motor is adjusted in the set of driver and cable.
   Readjust driver when changing combination or cable length.
8. Use driver power source with sufficient power capacity.

■Sales/Manufacturer■

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