Orientalmotor

HP-1433-2

Compact linear actuator

DRL Series
CRD driver Photocoupler inputs

OPERATING MANUAL

Table of contents

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

- This product must be handled by qualified personnel with expert knowledge of electrical and mechanical engineering. Before using the product, read “Safety precautions” carefully to ensure correct use.
- The product is designed and manufactured for use as an internal component for general industrial equipment. Do not use the product for any other purpose.
  Oriental Motor shall not be liable whatsoever for any damage arising from a failure to observe this warning.

Composition and contents of this operating manual

This manual describes the drivers used with the **DRL** series.
To operate a **DRL** series actuator, the actuator and driver must be set up first. Read the following operating manuals regarding the **DRL** series and follow the instructions.

- **DRL Series Actuator Operating Manual**
  Explains the installation of the actuator and a load.
- **DRL Series Driver Operating Manual (this manual)**
  Explains the installation, connection, I/O, setting and troubleshooting of the driver.

Before using this product

Main features

The compact linear actuator **DRL** series is a family of linear motion actuators adopting a new mechanism: a 5-phase stepping motor incorporating a ball screw.

- **Low-speed operation at low vibration levels**

The **DRL** series adopts a micro-stepping driver offering the smooth drive function. Therefore, smooth operation with minimal vibration can be achieved even at low speed.

- **Compact driver**

The **DRL** series utilizes a compact driver using DC power supply input, making it ideal for use as an internal component in general industrial equipment.

- **Preset resolution**

With the **DRL** series actuators, you can select and set two actuator resolutions from among the 16 levels. →Page 26, 27

- **Adjustable motor currents**

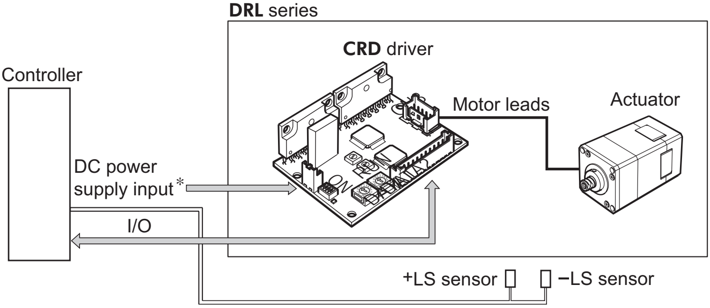
The operating current and standstill current of the motor can be adjusted individually.
→Page 29, 30

- **Selectable pulse input mode**

The 1-pulse input mode or 2-pulse input mode can be selected in accordance with the pulse output mode of the controller. →Page 28

System configuration

Operating the **DRL** series requires a controller equipped with a pulse output function.



* As for the voltage supply to the driver, use a DC power supply with reinforced insulation on both the primary and secondary sides.

Standards and CE marking

■Applicable standards

Motor Model			Applicable Standards	Certification Body	Standard File No.
SM□P SM□MG SM□PH SM□MGM	SM□M SM□PM SM□MH SM□PGH	SM□PG SM□MM SM□PGM SM□MGH	UL 60950 CSA C22.2 No.60950	UL	E208200

* □ in the motor model will contain a value representing the part number.

Driver Model	Applicable Standards	Certification Body	Standard File No.
CRD5103P CRD5107P CRD5114P	UL 60950 CSA C22.2 No.60950	UL	E208200

- The names of products certified to conform with relevant standards are represented by applicable unit model motor and driver part numbers.
- Approval conditions for UL 60950: Class III equipment, SELV circuit, Pollution degree 2

■For low voltage directive

This product is not subject to the EC's low voltage directive because its input power supply voltage is 24 VDC. However, the user is advised to perform the following actions when conducting product installation and connection.

- This product is designed for use within machinery, so it should be installed within an enclosure.
- For the driver's power supply, use a DC power supply with reinforced insulation on its primary and secondary sides.

■For EMC directive (89/336/EEC, 92/31/EEC)

This product bears the CE mark under the conditions specified in "Example of actuator and driver installation and wiring" on page 15.
Be sure to conduct EMC measures with the product assembled in your equipment by referring to "Installing and wiring in compliance with EMC directive" on page 13.

■Hazardous substances

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

Safety precautions

The precautions provided in this section are intended to ensure safe and correct use of the product, thereby preventing damage or injury to the user or other personnel. Fully understand the meaning of each item before using the product.

⚠ Warning

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

⚠ Caution

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

NOTE

The items under this heading contain important handling instructions that the user should observe to ensure safe use of the product.

⚠ Warning

General

- Do not use the product in an atmosphere containing explosive, flammable or corrosive gases, in a place exposed to water, or near flammable objects.
  Doing so may result in fire or injury.
- Provide a measure to retain the position of the moving parts of the equipment when the product is used in a vertical application. The actuator loses its holding capability when the power is cut off.
  Without an appropriate measure the moving parts will descend, resulting in injury or equipment damage.
- Do not use the actuator's built-in electromagnetic brake mechanism for stopping or for safety purposes. Using it for purposes other than holding the moving parts and actuator in position may cause injury or damage to equipment.
- 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.

Installation

- Install the driver in an enclosure in order to prevent injury.

Connection

- Always use the driver with a power supply of the rated voltage.
  Failure to do so may result in fire or electric shock.
- For the driver, use a DC power supply with reinforced insulation provided on the primary and secondary sides.
  Failure to do so may result in electric shock.
- Connect the product correctly and securely according to the wiring diagram.
  Failure to do so may result in fire or electric shock.
- Do not forcibly bend, pull or pinch the power supply cable and the motor leads.
  Doing so may result in a fire.
- If the power supply cable or motor leads connected the driver are forcibly bent or pulled, the driver will receive stress and may suffer damage.

Operation

- Turn off the power supply to the driver in case of a power failure.
  Failure to do so may result in injury or equipment damage when the actuator starts suddenly upon power recovery.
- Do not turn the A.W.OFF (All windings off) input to "ON" while the actuator is operating. If the input is turned "ON", the actuator will stop and lose its holding capability, causing possible injury or equipment damage.

- Set the operating speed and travel so that the screw shaft will not hit the stroke end or load.
  Failure to do so may result in injury or equipment damage.
- Do not set the motor operating current and standstill current too low.
  Doing so may cause the moving parts to fall, resulting in injury or equipment damage.

Maintenance and inspection

- Turn off the power to the driver when carrying out an inspection.
  Failure to do so may result in injury or equipment damage.

Repair, disassembly and modification

- Do not repair, disassemble or modify the driver.
  Doing so may result in injury.

⚠ Caution

General

- Do not touch the driver during operation or immediately after stopping.
  The surface is hot and may cause a burn.

Installation

- Do not place flammable objects near the driver.
  Doing so may result in fire or burns.
- Do not place objects near the driver that may prevent proper ventilation.
  Doing so may result in equipment damage.

Operation

- Use the actuator and driver 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.
- Turn on the power to the driver after making sure all control inputs of the driver are turned “OFF”.
  Failure to do so may cause the actuator to start accidentally, resulting in injury or equipment damage.
- Do not touch the screw shaft during operation.
  Doing so may result in injury.
- If the screw shaft must be moved directly by hand (for manual alignment, etc.), do so after confirming that the driver’s A.W.OFF (All windings off) input is “ON”.
  Failure to do so may result in injury.
- Immediately when trouble has occurred, stop running and turn off the driver power.
  Failure to do so may result in fire or injury.

Disposal

- To dispose of the driver, disassemble it into parts and components as much as possible and dispose of individual parts/components as industrial waste.

Precautions for use

This section covers the limitations and points to note regarding use of the driver.

■ Conduct the insulation resistance measurement or withstand voltage test separately on the actuator and the driver

Conducting the insulation resistance measurement or withstand voltage test with the actuator and driver connected may result in injury or damage to equipment.

■ Acceleration (acceleration/ deceleration rate)

The acceleration (acceleration/deceleration rate) when the actuator is started or stopped must be within the specified range, irrespective of the loaded mass.

Operating at an acceleration (acceleration/ deceleration rate) beyond the specified range may result in a loss of position.

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■ Operating speed

The operating speed of the actuator must be within the specified range, including during acceleration. → Page 31

■ Do not let the screw shaft hit the stroke end or load

Do not let the screw shaft hit the stroke end or load during operation, since such an impact may damage the actuator.

Should the screw shaft hit the stroke end or load, return the potentiometer for adjusting the motor operating current (RUN) to the factory set value and then retract the shaft by operating it in the reverse direction at the starting speed.

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■ Driver connectors

Always use the supplied connectors for connecting the power supply, I/O signals and motor to the driver. When crimp-fitting the leads to the contact, secure a strong connection using a crimping tool as specified by the connector manufacturer.

Oriental Motor does not supply crimping tools.

■ Use an actuator with electromagnetic brake for an application involving up/down travel.

For a lifter or other device in which the load moves up and down, use the electromagnetic brake and provide an additional safety-brake mechanism to hold the load in position. To hold the load in position, apply the electromagnetic brake only after the actuator has stopped.

Repeated braking for such a purpose will wear the brake hub excessively, causing its holding ability to drop.

■ Preventing electrical noise

See "Installing and wiring in compliance with EMC directive" on page 13 for measures with regard to noise.

Preparation

This section covers the points to be checked along with the names and functions of the respective parts.

Checking the product

Open the package and confirm that all of the following items are available.
Should you find any item missing or damaged, contact the Oriental Motor office where you purchased the product.
Check the model number of the unit against the model number on the package label.
Check the model number of the actuator and driver against the model number shown on the respective nameplates.
See the table on pages 8 to 10 for the actuator and driver combinations for each unit model.

- Actuator 1 unit

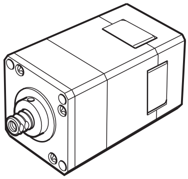
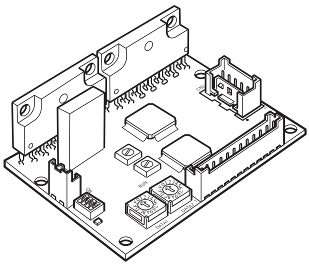


Illustration shows the standard type of **DRL60P**.

- Driver 1 unit



- Operating manual (Actuator) 1 copy
- Operating manual (Driver) 1 copy (this manual)

Note

When removing the driver from the conductive protection bag, make sure your hands are not charged with static electricity. This is to prevent damage to the driver due to static electricity.

- Motor cable 0.6 m (2 ft.) 1 piece (**DRL20**, **DRL28M**, **DRL42M**, **DRL60M** only)

- Connector housings and contacts (Molex)

Connector	Housing	Contact
● Power supply	1 piece 51103-0200 2 poles	19 piece 50351-8100
● Motor	1 piece 51103-0500 5 poles	
● I/O	1 piece 51103-1200 12 poles	

- Varistor (electromagnetic brake type only) 1piece

■How to read the model number

DRL 42 P A 2 G - 04 M G

① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨

No.	Meaning
①	Name of the series **DRL** series
②	Actuator frame size **20**: 20 mm (0.79 in.) square **28**: 28 mm (1.1 in.) square **42**: 42 mm (1.65 in.) square **60**: 60 mm (2.36 in.) square
③	Motor type **P**: Stepping **M**: High-resolution types
④	**A**: Rolled ball screw **B**: Grounded ball screw **BL**: Corrosion-resistant ground ball screw
⑤	Lead **1**: 1 mm (0.039 in.) [**DRL20**, **DRL28**] **2**: 2 mm (0.079 in.) [**DRL42**] **4**: 4 mm (0.157 in.) [**DRL60**]
⑥	Guide **G**: With guide **None**: Without guide
⑦	Stroke **02**: 25 mm (0.98 in.) [**DRL20**] **03**: 30 mm (1.18 in.) [**DRL28**] **04**: 40 mm (1.57 in.) [**DRL42**] **05**: 50 mm (1.97 in.) [**DRL60**] **06**: 60 mm (2.36 in.) [**DRL28**] **10**: 100 mm (3.94 in.) [**DRL42**, **DRL60**]
⑧	**M**: With electromagnetic brake **N**: With adjustment-knob **None**: No additional function
⑨	Driver type **G**: **CRD** (Photocoupler inputs) **None**: Without driver

■Combinations of actuators and drivers

Rolled ball screw

Unit model	Actuator model	Driver model
DRL28PA1-03G	DRL28PA1-03	CRD5107P
DRL28PA1-06G	DRL28PA1-06	
DRL28PA1-03NG	DRL28PA1-03N	
DRL28PA1G-03G	DRL28PA1G-03	
DRL28PA1G-03NG	DRL28PA1G-03N	
DRL42PA2-04G	DRL42PA2-04	
DRL42PA2-10G	DRL42PA2-10	
DRL42PA2-04MG	DRL42PA2-04M	
DRL42PA2-04NG	DRL42PA2-04N	
DRL42PA2G-04G	DRL42PA2G-04	
DRL42PA2G-04MG	DRL42PA2G-04M	
DRL42PA2G-04NG	DRL42PA2G-04N	
DRL60PA4-05G	DRL60PA4-05	CRD5114P
DRL60PA4-10G	DRL60PA4-10	
DRL60PA4-05MG	DRL60PA4-05M	
DRL60PA4-05NG	DRL60PA4-05N	
DRL60PA4G-05G	DRL60PA4G-05	
DRL60PA4G-05MG	DRL60PA4G-05M	
DRL60PA4G-05NG	DRL60PA4G-05N	

Grounded ball screw

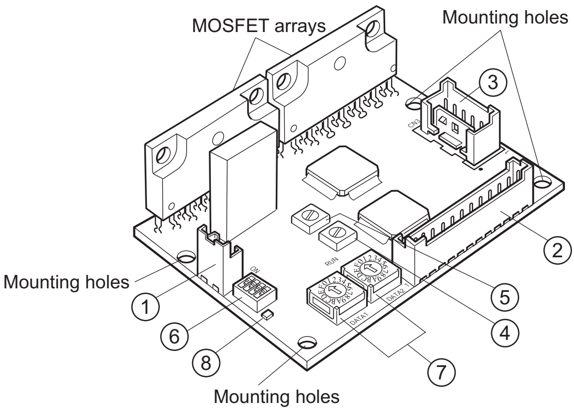
Unit model	Actuator model	Driver model
DRL20PB1-02G	DRL20PB1-02	CRD5103P
DRL20PB1-02NG	DRL20PB1-02N	
DRL20PB1G-02G	DRL20PB1G-02	
DRL20PB1G-02NG	DRL20PB1G-02N	
DRL28PB1-03G	DRL28PB1-03	CRD5107P
DRL28PB1-06G	DRL28PB1-06	
DRL28PB1-03NG	DRL28PB1-03N	
DRL28PB1G-03G	DRL28PB1G-03	
DRL28PB1G-03NG	DRL28PB1G-03N	
DRL28MB1-03G	DRL28MB1-03	
DRL28MB1-03NG	DRL28MB1-03N	
DRL28MB1G-03G	DRL28MB1G-03	
DRL28MB1G-03NG	DRL28MB1G-03N	
DRL42PB2-04G	DRL42PB2-04	
DRL42PB2-10G	DRL42PB2-10	
DRL42PB2-04MG	DRL42PB2-04M	
DRL42PB2-04NG	DRL42PB2-04N	
DRL42PB2G-04G	DRL42PB2G-04	
DRL42PB2G-04MG	DRL42PB2G-04M	
DRL42PB2G-04NG	DRL42PB2G-04N	
DRL42MB2-04G	DRL42MB2-04	
DRL42MB2-04MG	DRL42MB2-04M	
DRL42MB2-04NG	DRL42MB2-04N	
DRL42MB2G-04G	DRL42MB2G-04	
DRL42MB2G-04MG	DRL42MB2G-04M	
DRL42MB2G-04NG	DRL42MB2G-04N	
DRL60PB4-05G	DRL60PB4-05	CRD5114P
DRL60PB4-10G	DRL60PB4-10	
DRL60PB4-05MG	DRL60PB4-05M	
DRL60PB4-05NG	DRL60PB4-05N	
DRL60PB4G-05G	DRL60PB4G-05	
DRL60PB4G-05MG	DRL60PB4G-05M	
DRL60PB4G-05NG	DRL60PB4G-05N	
DRL60MB4-05G	DRL60MB4-05	
DRL60MB4-05MG	DRL60MB4-05M	
DRL60MB4-05NG	DRL60MB4-05N	
DRL60MB4G-05G	DRL60MB4G-05	
DRL60MB4G-05MG	DRL60MB4G-05M	
DRL60MB4G-05NG	DRL60MB4G-05N	

Corrosion-resistant ground ball screw

Unit model	Actuator model	Driver model
DRL28PBL1-03G	DRL28PBL1-03	CRD5107P
DRL28PBL1-03NG	DRL28PBL1-03N	
DRL28PBL1G-03G	DRL28PBL1G-03	
DRL28PBL1G-03NG	DRL28PBL1G-03N	
DRL28MBL1-03G	DRL28MBL1-03	
DRL28MBL1-03NG	DRL28MBL1-03N	
DRL28MBL1G-03G	DRL28MBL1G-03	
DRL28MBL1G-03NG	DRL28MBL1G-03N	
DRL42PBL2-04G	DRL42PBL2-04	
DRL42PBL2-04MG	DRL42PBL2-04M	
DRL42PBL2-04NG	DRL42PBL2-04N	
DRL42PBL2G-04G	DRL42PBL2G-04	
DRL42PBL2G-04MG	DRL42PBL2G-04M	
DRL42PBL2G-04NG	DRL42PBL2G-04N	
DRL42MBL2-04G	DRL42MBL2-04	
DRL42MBL2-04MG	DRL42MBL2-04M	
DRL42MBL2-04NG	DRL42MBL2-04N	
DRL42MBL2G-04G	DRL42MBL2G-04	
DRL42MBL2G-04MG	DRL42MBL2G-04M	
DRL42MBL2G-04NG	DRL42MBL2G-04N	
DRL60PBL4-05G	DRL60PBL4-05	CRD5114P
DRL60PBL4-05MG	DRL60PBL4-05M	
DRL60PBL4-05NG	DRL60PBL4-05N	
DRL60PBL4G-05G	DRL60PBL4G-05	
DRL60PBL4G-05MG	DRL60PBL4G-05M	
DRL60PBL4G-05NG	DRL60PBL4G-05N	
DRL60MBL4-05G	DRL60MBL4-05	
DRL60MBL4-05MG	DRL60MBL4-05M	
DRL60MBL4-05NG	DRL60MBL4-05N	
DRL60MBL4G-05G	DRL60MBL4G-05	
DRL60MBL4G-05MG	DRL60MBL4G-05M	
DRL60MBL4G-05NG	DRL60MBL4G-05N	

Names and functions of parts

This section covers the names and functions of the driver's respective parts.
See the reference page indicated for details on each part.



①Power supply connector (CN1) [P.20]
Connect to a 24 VDC power supply.

②Input/output signal connector (CN2) [P.20]
Connect to I/O signals.

③Motor connector (CN3) [P.20]
Connect to motor leads.

④Motor operating current potentiometer (RUN) [P.29]
Set the operating current of the motor.
If there is sufficient thrust, the current setting can be reduced to suppress increases in motor/driver temperatures.
The potentiometer is factory set to the rated current.

⑤Motor standstill current potentiometer (STOP) [P.30]
Set the current when the motor is at a standstill (in the current cutback state).
The potentiometer is factory set to 50% of the rated current.

⑥Function select switches (1P/2P, OFF/SD, R2/R1) [P.26 to 28]

- Pulse input mode select switch (1P/2P): Switch the pulse input mode between 1-pulse input mode and 2-pulse input mode.
- Smooth drive function select switch (OFF/SD): Set or cancel the smooth drive function.
- Resolution select switch (R2/R1): Switch the reference resolution between R1 and R2.

⑦Resolution setting switch (DATA1, DATA2) [P.26, 27]
You can set a desired resolution by selecting it from among the 16 resolutions.

⑧Power supply input indicator (LED)
This LED remains lit while the power supply is input.

Installation

This section covers the driver's installation location and method.

Location for installation

The driver is designed and manufactured for use as a built-in component in industrial equipment.

Install it in a well-ventilated place satisfying the following conditions, where the product can be easily accessed for the purpose of inspection.

◆ Inside an enclosure that is installed indoors (provide vent holes)
◆ Operating ambient temperature
•Grounded ball screw, Rolled ball screw
: 0 to +40 °C (+32 to +104 °F) [non-freezing]
•Corrosion-resistant ground ball screw
: +5 to +40 °C (+41 to +104 °F)
◆ Operating ambient humidity 85% or less (non-condensing)
◆ Area that is free of explosive atmosphere or 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 (rains, 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

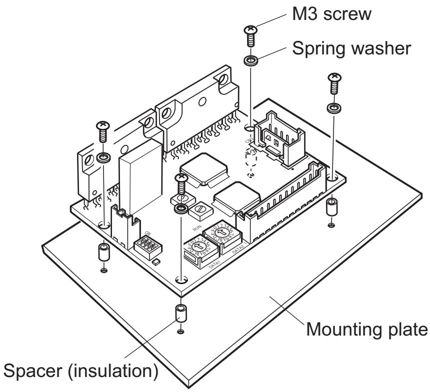
Installing the driver

When installing the driver in the device, mount it vertically or horizontally. Installing the driver under conditions other than this could reduce its radiation effect. Fix the driver directly to the metal enclosure using screws. The items shown below are necessary in order to mount the driver. (The items are not included and must be provided by the customer.)

M3 type screws	4 pieces
M3 type spring washers	4 pieces
M3 type nuts (Not necessary if tapped holes are provided in the enclosure.)	4 pieces
Spacers [5 mm (0.2 in.) or more]	4 pieces

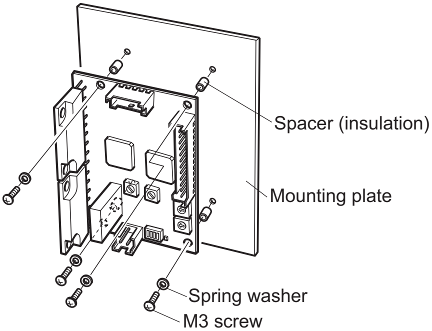
∗ Torque the mounting screw to 0.5 N·m (71 oz-in).

■Installation in the horizontal direction



There must be a clearance of at least 25 mm (0.98 in.) and 50 mm (1.97 in.) in the horizontal and vertical directions, respectively, between the driver and enclosure or other equipment. When installing two or more drivers in parallel, provide a minimum clearance of 20 mm (0.79 in.) between adjacent drivers.

■Installation in the vertical direction



There must be a clearance of at least 25 mm (0.98 in.) and 50 mm (1.97 in.) in the horizontal and vertical directions, respectively, between the driver and enclosure or other equipment.
When installing two or more drivers in parallel, provide a minimum clearance of 20 mm (0.79 in.) between adjacent drivers.

Note

- Do not install equipment generating significant heat or noise in the vicinity of the driver.
- Adjust the ventilation condition if the ambient temperature of the driver exceeds 40 °C (104 °F).
- The case containing the MOSFET arrays is insulated.

Installing and wiring in compliance with EMC directive

Effective measures must be taken with regard to EMI (electromagnetic interference) caused by the **DRL** series actuator and/or driver in the control system equipment operating nearby and EMS (electromagnetic susceptibility) of the **DRL** series actuator and/or driver. Failure to do so may result in serious impairment of the machine's functionality.
Oriental Motor conducts EMC measurement of its **DRL** series actuators and drivers in accordance with "Example of actuator and driver installation and wiring" on page 15.
The user is responsible for ensuring the machine's compliance with the EMC directive, based on the installation and wiring explained below.

Applicable standards
EMI
Emission Tests EN 61000-6-4
Radiated Emission Test EN 55011
EMS
Immunity Tests EN 61000-6-2
Radiation Field Immunity Test IEC 61000-4-3
Electrostatic Discharge Immunity Test IEC 61000-4-2
Fast Transient /Burst Immunity Test IEC 61000-4-4
Conductive Noise Immunity Test IEC 61000-4-6

■Power supply

The **DRL** series products are specifically designed for DC power supply input.
Use a DC power supply (such as a switching power supply) compliant with the EMC directive.

■Mains filter

Connect a mains filter on the input side of the DC power supply so as to prevent the noise generated in the driver from being transmitted externally via the power supply line.

When a power supply transformer is used, be sure to connect a mains filter on the AC input side of the power supply transformer.

For mains filters, use 10ESK1 (Tyco Electronics CORCOM), ZAG2210-11S (TDK Corporation), or an equivalent.

- Install the mains filter as close to the driver as possible. Also, secure the input/output cables (AWG18: 0.75 mm^2 or more) using cable clamps or the like so that the cables won't lift from the surface of the enclosure panel.
- Connect the ground terminal of the mains filter to the ground point over the shortest distance using a cable of the largest possible size.
- Do not wire the AC input cable (AWG18: 0.75 mm^2 or more) and the output cable of the mains filter (AWG18: 0.75 mm^2 or more) in parallel. If these two cables are wired in parallel, noise inside the enclosure will be connected to the power supply cable via stray capacitance, reducing the effect of the mains filter.

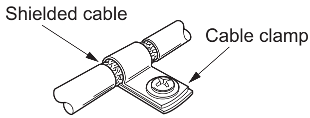
■Grounding method

When grounding the driver and mains filter, use a cable of the largest possible size and connect to the ground point over the shortest distance so that no potential difference will be generated at the grounded position. The ground point must be a large, thick and uniform conductive surface. Install the actuator onto a grounded metal surface.

■Wiring the power supply cable and I/O cable

Use a shielded cable of AWG22 (0.3 mm^2) or more in diameter for the driver power supply cable. Use a shielded cable of AWG24 (0.2 mm^2) or more in diameter for the driver I/O cable, and keep it as short as possible.

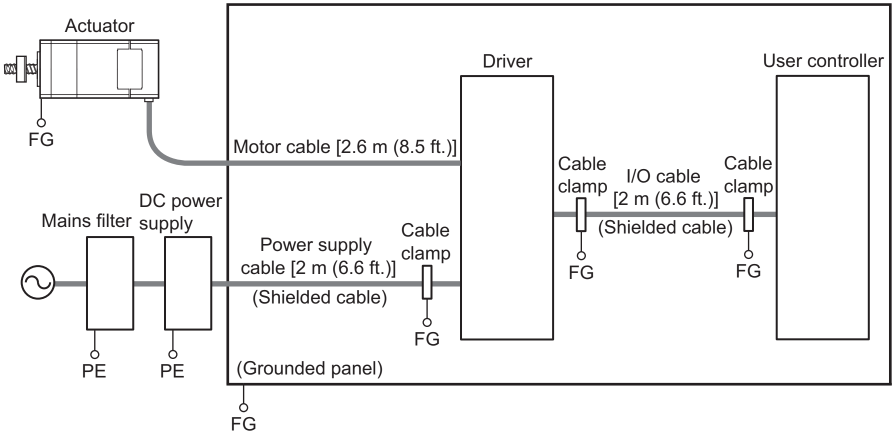
When grounding a shielded cable, use a metal cable clamp that contacts the shielded cable over the entire perimeter. Install the cable clamp at the tip of the shielded cable and connect it to an appropriate ground point.



■Notes about installation and wiring

- Connect the actuator, driver and other peripheral control equipment directly to the grounding point so as to prevent a potential difference from developing between grounds.
- When relays or electromagnetic switches are used together with the system, use mains filters and CR circuits to suppress surges generated by them.
- Keep the cable lengths as short as possible. Do not wind or bundle extra lengths.
- Separate the power source cables such as motor cable and power supply cable from the signal cables, and wire them apart by around 100 to 200 mm (3.94 to 7.87 in.). If a power source cable must cross over a signal cable, wire them at right angles. Keep an appropriate distance between the AC input cable and output cable of the mains filter.

■Example of actuator and driver installation and wiring



■Precautions about static electricity

Static electricity may cause the driver to malfunction or suffer damage. Be careful when handling the driver with the power on.

Always use an insulated screwdriver to adjust the driver's built-in motor current potentiometer.

Connection

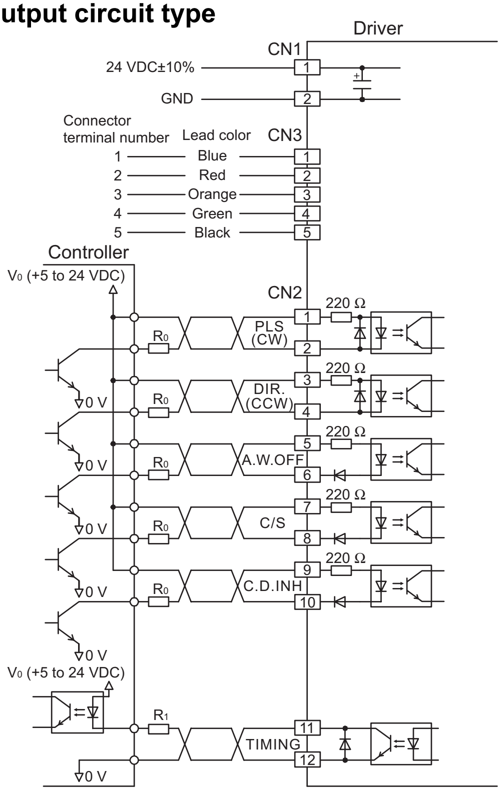
This section covers the methods of connecting the driver, actuator, power supply and controller, as well as the connection examples and I/O.

DRL20, **DRL28M**, **DRL42M**, **DRL60M** are the connector connection cable. Use the supplied motor cable.

Optional motor cables and driver cables (sold separately) are also available. See page 37 for details.

Connection example

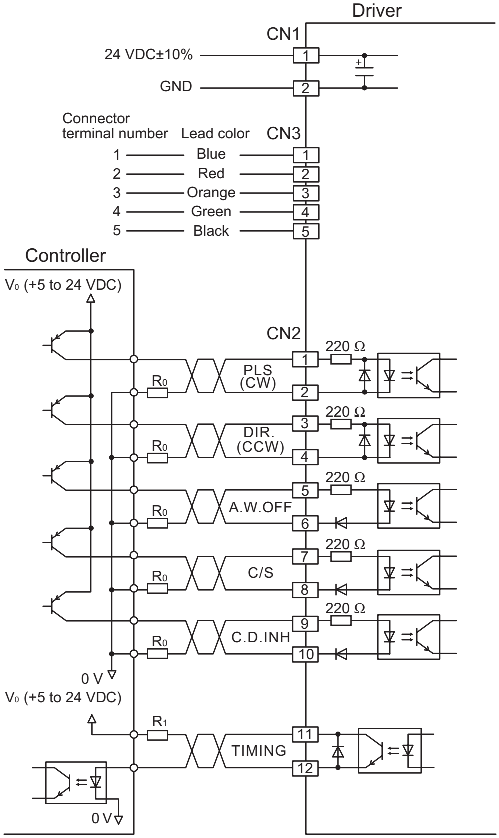
■Current sink output circuit type



Note

- Use 5 VDC as input signal voltage. If the input signal voltage exceeds 5 VDC, connect an appropriate external resistance R_0 in order to keep the input current to 10 to 20 mA or below.
  Example) When V_0 is 24 VDC R_0: 1.5 to 2.2 kΩ, 0.5 W min.
- Use the output signal voltage V_0 between 5 VDC and 24 VDC. When V_0 is equal to 5 VDC, the external resistance R_1 is not necessary. When it is above 5 VDC, connect R_1 to keep the current below 10 mA max.
- Be certain the I/O cable that connects the driver and controller is as short as possible. The maximum input frequency will decrease as the cable length increases.

■Current source output circuit type



Note

- Use 5 VDC as input signal voltage. If the input signal voltage exceeds 5 VDC, connect an appropriate external resistance R_0 in order to keep the input current to 10 to 20 mA or below. Example) When V_0 is 24 VDC R_0: 1.5 to 2.2 kΩ, 0.5 W min.
- Use the output signal voltage V_0 between 5 VDC and 24 VDC. When V_0 is equal to 5 VDC, the external resistance R_1 is not necessary. When it is above 5 VDC, connect R_1 to keep the current below 10 mA max.
- Be certain the I/O cable that connects the driver and controller is as short as possible. The maximum input frequency will decrease as the cable length increases.

Connecting the power supply

Use a power supply that can supply the following current capacity.

Driver model	CRD5103P	CRD5107P	CRD5114P
Power supply input voltage	24 VDC±10%		
Power supply current capacity	0.7 A or more	1.4 A or more	2.5 A or more

Connecting the actuator

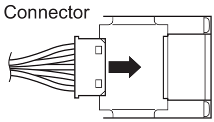
Crimp-fit the motor connector onto the motor leads and insert the connector with leads into the motor connector (CN3). To extend the motor leads, do so by using a cable of AWG22 (0.3 mm^2) to AWG18 (0.75 mm^2) in diameter and also by keeping the wiring length within 10 m (32.8 ft.). See page 21 for details.

An optional motor cables and driver cables (sold separately) is available. See page 37 for details.

Case of the connector connection cable

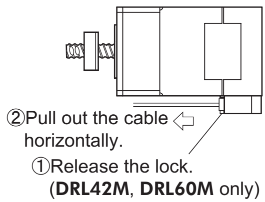
Models adopting connector coupling

Use the supplied motor cable. Orient the connector in the correct direction and insert it securely.



Note

- When disconnecting the connector-type motor cable, pull the connector horizontally along the output shaft to remove. The actuator may be damaged if force is applied in any other direction.
- The motor cables that come with the **DRL42M**, **DRL60M** have a connector with a lock mechanism. When removing this type of cable, release the connector lock first. Forcibly pulling out the cable without releasing the connector lock may damage the actuator and connector.



Connecting the electromagnetic brake

(**DRL42**, **DRL60** only)

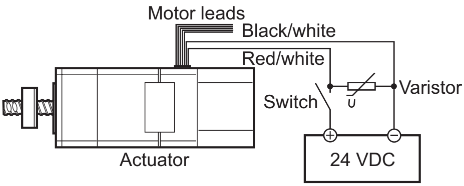
Connect the two lead wires [600 mm (24 in.)] from the actuator to the DC power supply.

1. Connect the red/white lead wire to the +24 V terminal of the DC power supply.

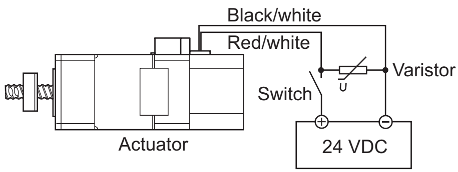
2. Connect the black/white lead wire to the GND terminal of the DC power supply.

3. Connect the varistor in parallel across the +24 V and GND terminals of the DC power supply.

●DRL42P, DRL60P



●DRL42M, DRL60M



■Connecting power supply for the electromagnetic brake

The electromagnetic brake operates via the ON/OFF status of the DC power supply.

For the electromagnetic brake, provide a power supply of 24 VDC±5%, 0.11 A or more if you are using the **DRL42**, or one of 24 VDC±5%, 0.33 A or more in the case of the DRL60.

Use a shielded cable of AWG24 (0.2 mm^2) or more in diameter to connect the electromagnetic brake to the DC power supply, keeping the length as short as possible.

Connecting I/O signals

■Connector pin assignments for driver

Connector No.	Pin No.	Type	Signal		Description
CN1	1	Input	POWER	+	+24 VDC
	2	Input		–	GND
CN2	1	Input	PLS (CW)	+	Pulse input (CW pulse)
	2	Input		–	
	3	Input	DIR. (CCW)	+	Rotation direction input (CCW pulse)
	4	Input		–	
	5	Input	A.W.OFF	+	All windings off input
	6	Input		–	
	7	Input	C/S	+	Resolution select input
	8	Input		–	
	9	Input	C.D.INH	+	Current cutback release input
	10	Input		–	
	11	Output	TIMING	+	Excitation timing output
	12	Output		–	
CN3	1	Output	MOTOR		Blue motor lead
	2	Output			Red motor lead
	3	Output			Orange motor lead
	4	Output			Green motor lead
	5	Output			Black motor lead

- When this switch is set to 1-pulse input mode, the inputs are the pulse input and the rotation direction input.
- When this switch is set to 2-pulse input mode, the inputs are CW and CCW.

Suitable connector housings and contacts

Connect the driver, using the following suitable contacts and connector housings. Optional motor cables and driver cables (sold separately) are also available. See page 37 for details.
When crimping contacts for connectors, be sure to use the crimping tool specified by the connector maker.

■Connector housing, contact, and crimping tool for driver (Molex)

For power supply	Connector housings	51103-0200
	Contacts	50351-8100
	Specified crimping tool	57295-5000
For I/O signal	Connector housings	51103-1200
	Contacts	50351-8100
	Specified crimping tool	57295-5000
For motor	Connector housings	51103-0500
	Contacts	50351-8100
	Specified crimping tool	57295-5000

- For the power supply cable, use a cable of AWG22 (0.3 mm²). Keep the wiring distance as short as possible [2 m (6.6 ft.) maximum] to suppress the effect of noise.
- For the I/O cable, use a cable of AWG24 (0.2 mm²) to AWG22 (0.3 mm²) and keep the wiring distance as short as possible [2 m (6.6 ft.) maximum] to suppress the effect of noise.

Note

- Pay attention to polarity when connecting the power supply. Connecting the power supply in reverse polarity may damage the driver.
- Firmly insert the connector in position. Incomplete connection of the connector may cause operation failure, or may damage the actuator or driver.
- When pulling out a connector, pull it out by slightly expanding the latch part of the connectors using a precision screwdriver.
- Do not wire the driver's power supply cable in the same conduit in which another power supply line or the motor cable is wired.
- After turning off the power supply, wait at least 5 sec. before turning it on again.
- Separate I/O cables at least 100 mm (3.94 in.) from electromagnetic relays and other than inductance loads. Additionally, route I/O cables perpendicular to power supply cables and motor cables, rather than in a parallel fashion.
- If the motor cable or power supply cable generates an undesirable amount of noise after wiring/installation, shield the cable or install a ferrite core.

■ Connector housing, contact and crimping tool for connector-type actuator (Molex)

DRL20, DRL28M	Connector housings	51065-0500
	Contacts	50212-8100
	Specified crimping tool	57176-5000
DRL42M	Connector housings	51103-0500
	Contacts	50351-8100
	Specified crimping tool	57295-5000
DRL60M	Connector housings	51144-0500
	Contacts	50539-8100
	Specified crimping tool	57189-5000

Note

When connecting a actuator, affix the cable at the connection part to prevent the connection part from receiving stress due to the flexing of the cable. Make the cable's radius of curvature as large as possible.

Explanation of I/O signals

■Input signals

The signal states indicate the state of the internal photocoupler “ON: power conducted; OFF: power not conducted”.

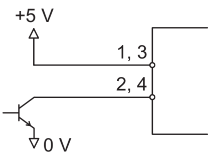
● PLS (CW) input and DIR. (CCW) input

This driver can select either 1-pulse input mode or 2-pulse input mode as the pulse input mode to match the controller used. For details on how to set the pulse input mode, see page 28, “Pulse input modes.”

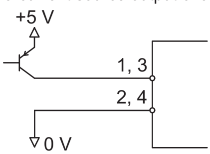
1-pulse input mode

The controller pulses are connected to the PLS+ input (pin No.1) or the PLS– input (pin No.2), and the rotation direction is connected to the DIR.+ input (pin No.3) or DIR.– input (pin No.4).

Example of connection with a current sink output circuit

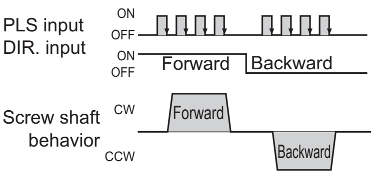


Example of connection with a current source output circuit

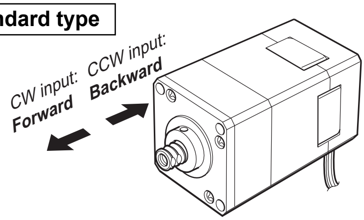


1. When the DIR. input is “ON,” turning the pulse input from “ON to OFF” causes the screw shaft to move forward one step.

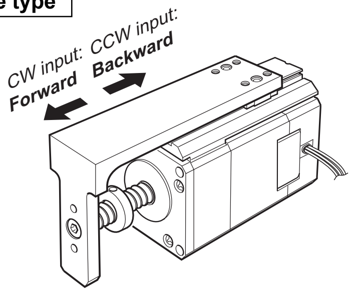
2. When the DIR. input is “OFF,” turning the pulse input from “ON to OFF” causes the screw shaft to move backward one step.



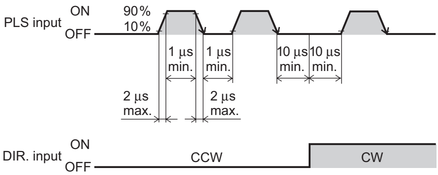
Standard type



Guide type



Input pulse signals should have a waveform with sharp rise/fall edges, as shown below.



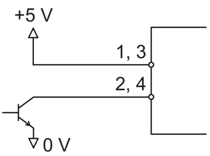
Note

- Maintain driver temperature so that the surface temperature of the MOSFET array does not exceed 90 °C (194 °F).
- The minimum value for the interval time when switching the rotational direction depends on the actuator’s size, running speed and load moment of inertia.
- Always set the photocoupler to “OFF” when not inputting pulse signals. Otherwise, the driver can’t shift to the actuator stop setting current.
- Do not input PLS input and DIR. input at the same time.
  If one of these pulses is input when the other is “ON” the actuator will not run properly.

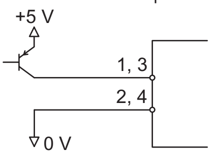
2-pulse input mode

The controller's CW pulses are connected to the CW+ (pin No.1) or the CW– (pin No.2), while the CCW pulses are connected to the CCW+ (pin No.3) or the CCW– (pin No.4).

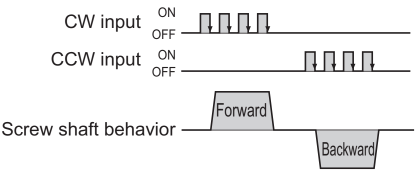
Example of connection with a current sink output circuit



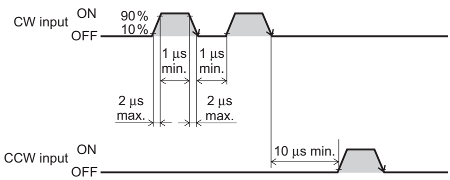
Example of connection with a current source output circuit



1. Turning the CW input from "ON to OFF" causes the screw shaft to move forward one step.
2. Turning the CCW input from "ON to OFF" causes the screw shaft to move backward one step.



Input pulse signals should have a waveform with sharp rise/fall edges, as shown below.



Note

- Maintain driver temperature so that the surface temperature of the MOSFET array does not exceed 90 °C (194 °F).
- The minimum value for the interval time when switching the rotational direction depends on the actuator's size, running speed and load moment of inertia.
- Always set the photocoupler to "OFF" when not inputting pulse signals. Otherwise, the driver can't shift to the actuator stop setting current.
- Do not input CW input and CCW input at the same time.
  If one of these pulses is input when the other is "ON" the actuator will not run properly.

●A.W.OFF (All windings off) input

This input is used during position adjustment by moving the screw shaft manually.

1. When the A.W.OFF input is turned to "ON," the driver cuts off the current supply to the motor and the actuator loses its holding torque. In this condition, the position of the screw shaft can be adjusted manually.
2. When the A.W.OFF input is turned to "OFF," the driver resumes the current supply to the motor and restores the actuator's holding torque.

Note

When operating the actuator, always keep the A.W.OFF input in the "OFF" state.

●C/S (Resolution switching) input

This input is used to select a desired resolution from the values set with the resolution setting switches (DATA1, DATA2).
How to set the resolution setting switches
→ Page 26, 27
Turning the C/S input "ON" changes the resolution to the setting of the resolution setting switch DATA2.
Turning the C/S input "OFF" changes the resolution to the setting of the resolution setting switch DATA1.

■Output signals

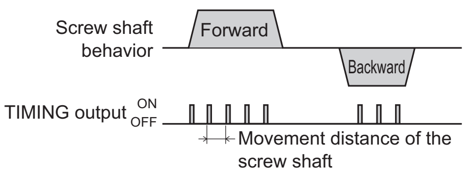
The driver's output signals are photocoupler/open-collector outputs. The signal states indicate the state of the internal photocoupler "ON: power conducted; OFF: power not conducted".

●TIMING (Excitation timing) output

This output is used to increase the accuracy of origin detection.

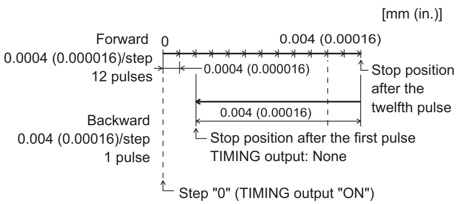
The TIMING output turns "ON" each time the screw shaft moves by the following amount:

Unit model	Movement distance of the screw shaft [mm (in.)]
DRL20, **DRL28P**	0.02 (0.0008)
DRL42P	0.04 (0.0016)
DRL60P	0.08 (0.0032)
DRL28M	0.01 (0.0004)
DRL42M	0.02 (0.0008)
DRL60M	0.04 (0.0016)



Example of TIMING output not turning "ON"

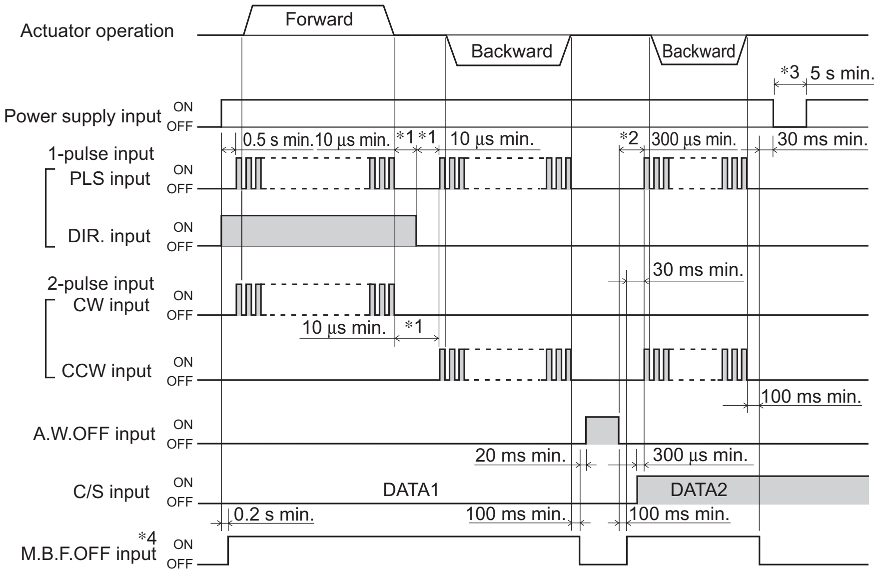
The chart below shows an operation in which the screw shaft is moved forward for 12 pulses at a resolution of 0.0004 mm (0.000016 in.) and then moved backward for one pulse at a resolution of 0.004 mm (0.00016 in.).



Note

- When using the TIMING output, set the number of input pulses or resolution as precisely as possible in such a way that the screw shaft will stop at a position corresponding to an integer multiple of the applicable travel shown in the table at left.
- When changing the resolution using the C/S (resolution switching) input, do so when the actuator is stopped with the driver's TIMING output turned "ON". Switching the C/S input in any other condition may sometimes fail to turn the TIMING output "ON".

Timing chart



The [ ] section indicates that the photocoupler diode is emitting light.

*1 "10 µs or more" indicated in connection with the direction-signal select time (1-pulse input mode) or CW/CCW-pulse select time (2-pulse input mode) indicates a circuit response time. Set it to the time required for the motor to respond to the applicable pulse input.

*2 Do not input pulse signals immediately after switching the A.W.OFF input to "OFF", given that it will affect the actuator's starting characteristics.

*3 After turning off the power supply, wait at least 5 sec. before turning the power supply back on.

*4 Applicable to the electromagnetic brake type only.

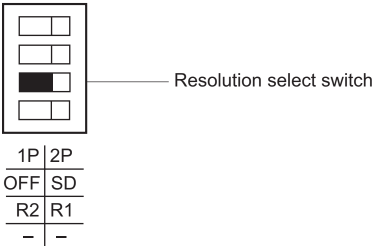
Setting

This section covers the methods of setting the resolution, switching pulse input modes, switching smooth drive function and adjusting the motor current.

Resolution

When setting the actuator's resolution, use the resolution setting switches (DATA1, DATA2) and the resolution select switches (R1, R2).

Factory settings: R1



With each of the two switches, resolutions can be preset in 16 steps and a desired setting can be selected through C/S (resolution switching) input.
For further details on C/S input, refer to page 22.
To change the resolution, change the DATA1 or DATA2 dial setting using a precision screwdriver.
The dial provides 16 settings (from 0 to 9 and A to F). The dial settings and corresponding resolutions are shown in the table below.
The resolutions corresponding to the respective dial settings are identical for DATA1 and DATA2.

Factory settings: DATA1 [0]
DATA2 [0]

[DRL20, DRL28]

* With high-resolution motors, the resolution becomes one-half the applicable value shown in the table below.

R1			R2		
Resolution setting switches DATA1/DATA2	Number of divisions 1	Resolution 1 [mm (in.)]	Resolution setting switches DATA1/DATA2	Number of divisions 2	Resolution 2 [mm (in.)]
0	1	0.002 (0.000079)	0	× 2.5	0.005 (0.0002)
1	2	0.001 (0.000039)	1	× 1.25	0.0025 (0.000098)
2	2.5	0.0008 (0.000031)	2	1.6	0.00125 (0.000049)
3	4	0.0005 (0.00002)	3	2	0.001 (0.000039)
4	5	0.0004 (0.000016)	4	3.2	0.000625 (0.000025)
5	8	0.00025 (0.0000098)	5	4	0.0005 (0.00002)
6	10	0.0002 (0.0000079)	6	6.4	0.0003125 (0.000012)
7	20	0.0001 (0.0000039)	7	10	0.0002 (0.0000079)
8	25	0.00008 (0.0000031)	8	12.8	0.00015625 (0.0000062)
9	40	0.00005 (0.000002)	9	20	0.0001 (0.0000039)
A	50	0.00004 (0.0000016)	A	25.6	0.000078125 (0.0000031)
B	80	0.000025 (0.00000098)	B	40	0.00005 (0.000002)
C	100	0.00002 (0.00000079)	C	50	0.00004 (0.0000016)
D	125	0.000016 (0.00000063)	D	51.2	0.0000390625 (0.0000015)
E	200	0.00001 (0.00000039)	E	100	0.00002 (0.00000079)
F	250	0.000008 (0.00000031)	F	102.4	0.00001953125 (0.00000077)

[DRL42] * With high-resolution motors, the resolution becomes one-half the applicable value shown in the table below.

R1			R2		
Resolution setting switches DATA1/DATA2	Number of divisions 1	Resolution 1 [mm (in.)]	Resolution setting switches DATA1/DATA2	Number of divisions 2	Resolution 2 [mm (in.)]
0	1	0.004 (0.00016)	0	× 2.5	0.01 (0.00039)
1	2	0.002 (0.000079)	1	× 1.25	0.005 (0.0002)
2	2.5	0.0016 (0.000063)	2	1.6	0.0025 (0.000098)
3	4	0.001 (0.000039)	3	2	0.002 (0.000079)
4	5	0.0008 (0.000031)	4	3.2	0.00125 (0.000049)
5	8	0.0005 (0.00002)	5	4	0.001 (0.000039)
6	10	0.0004 (0.000016)	6	6.4	0.000625 (0.000025)
7	20	0.0002 (0.0000079)	7	10	0.0004 (0.000016)
8	25	0.00016 (0.0000063)	8	12.8	0.0003125 (0.000012)
9	40	0.0001 (0.0000039)	9	20	0.0002 (0.0000079)
A	50	0.00008 (0.0000031)	A	25.6	0.00015625 (0.0000062)
B	80	0.00005 (0.000002)	B	40	0.0001 (0.0000039)
C	100	0.00004 (0.0000016)	C	50	0.00008 (0.00000315)
D	125	0.000032 (0.0000013)	D	51.2	0.000078125 (0.00000308)
E	200	0.00002 (0.00000079)	E	100	0.00004 (0.0000016)
F	250	0.000016 (0.00000063)	F	102.4	0.0000390625 (0.0000015)

[DRL60] * With high-resolution motors, the resolution becomes one-half the applicable value shown in the table below.

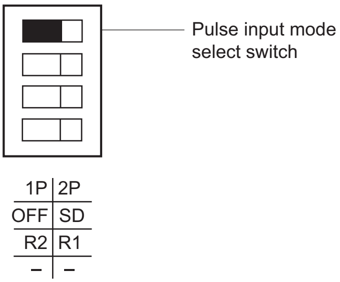
R1			R2		
Resolution setting switches DATA1/DATA2	Number of divisions 1	Resolution 1 [mm (in.)]	Resolution setting switches DATA1/DATA2	Number of divisions 2	Resolution 2 [mm (in.)]
0	1	0.008 (0.00031)	0	× 2.5	0.02 (0.00079)
1	2	0.004 (0.00016)	1	× 1.25	0.01 (0.00039)
2	2.5	0.0032 (0.00013)	2	1.6	0.005 (0.0002)
3	4	0.002 (0.000079)	3	2	0.004 (0.00016)
4	5	0.0016 (0.000063)	4	3.2	0.0025 (0.000098)
5	8	0.001 (0.000039)	5	4	0.002 (0.000079)
6	10	0.0008 (0.000031)	6	6.4	0.00125 (0.000049)
7	20	0.0004 (0.000016)	7	10	0.0008 (0.000031)
8	25	0.00032 (0.000013)	8	12.8	0.000625 (0.000025)
9	40	0.0002 (0.0000079)	9	20	0.0004 (0.000016)
A	50	0.00016 (0.0000063)	A	25.6	0.0003125 (0.000012)
B	80	0.0001 (0.0000039)	B	40	0.0002 (0.0000079)
C	100	0.00008 (0.0000031)	C	50	0.00016 (0.0000063)
D	125	0.000064 (0.0000025)	D	51.2	0.00015625 (0.0000062)
E	200	0.00004 (0.0000016)	E	100	0.00008 (0.00000315)
F	250	0.000032 (0.0000013)	F	102.4	0.000078125 (0.00000308)

Note

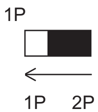
- The resolutions are given as theoretical values.
- The resolution is calculated by dividing the basic resolution by the division number.
- The C/S (resolution switching) input is effective only with respect to the division number selected for resolution 1 or resolution 2.
- Do not switch the C/S input or the resolution select switch while the actuator is operating, or the actuator may misstep and stall.

Pulse input modes

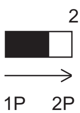
Either the 1-pulse or 2-pulse input mode may be selected in accordance with the controller used.



- When the actuator is to be controlled through the pulse signal and the rotation direction signal that specifies the motor's direction of rotation, set the pulse input mode select switch to "1P."



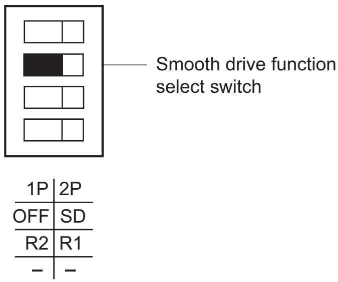
- When the actuator is to be controlled through 2-pulse signal input via the CW pulse signal and CCW pulse signal, set the pulse input mode select switch to "2P."



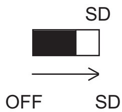
Smooth drive function

The smooth drive function achieves low-vibration, low-noise operation even in the basic resolution.
With this function, each the basic resolution is automatically divided into 16 microsteps. This provides extremely smooth operation.
This function makes it not necessary to change the pulse signals (speed, pulse count) from the controller.
The smooth drive function can be used only when the resolution is set to [DATA: 0] though [DATA: 6] for [R1] or [DATA: 0] through [DATA: 7] for [R2] (the [DATA] value indicates the [DATA1] or [DATA2] setting of the resolution setting switch on page 26, 27).

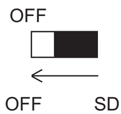
Factory setting: [SD: Smooth drive abled]



- When the smooth drive function is used



- When the smooth drive function is not used



Note

The smooth drive function does not work if the resolution is set to a division number greater than 10. The "SD" setting is ignored (the same effect as "OFF").

Motor currents

●Motor operating current

Factory setting: Motor's rated current

●Motor standstill current

Factory setting: 50% of motor operating current

When the load is light and there is a margin for thrust, the motor's operating vibration and the temperature increase of the motor and driver can be held down by lowering the motor's operating current and standstill current.

■Connection of current-setting DC ammeter

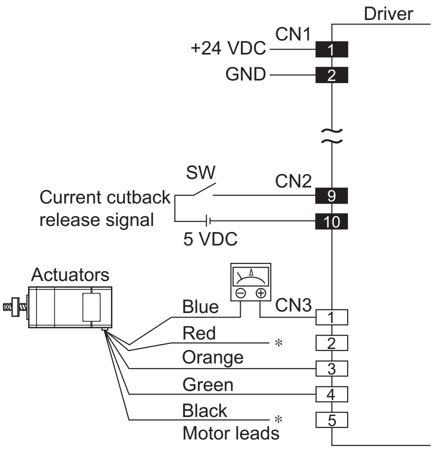
Connect the DC ammeter to the blue motor lead wire and motor connection pin No.1 in series. Do not connect the red motor leads and connection pin No.2 or black motor leads and connection pin No.5.

■Setting the motor operating current

1. Connect the motor and DC ammeter.

2. Turn the C.D.INH (current cutback release) input to "ON." Do not apply other input signals.

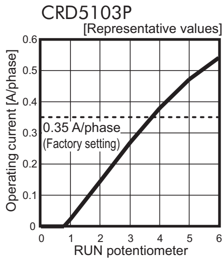
3. Turn on the driver's power supply (24 VDC).

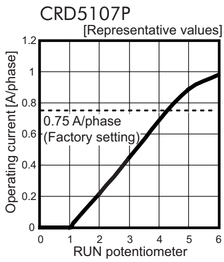


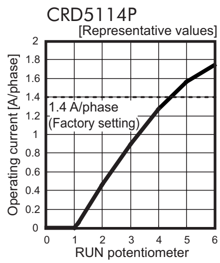
Note

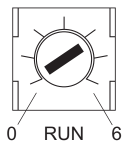
* Electric shock may result if the red and black motor lead wires are touched. Provide an insulation measure to protect against electric shock.

4. When the motor operating current potentiometer (RUN) is turned counterclock wise, the current decreases.









The scale values are not displayed on the control.

Current corresponding to a dual-phase value flows to the ammeter. A value of one-half that which is indicated equals the single-phase current value.

Sample:
- When the indication value on the ammeter shows 1.5 A, it stands for the setting of 0.75 A/phase.
- When the indication value on the ammeter shows 0.7 A, it stands for the setting of 0.35 A/phase.

5. Turn the C.D.INH (current cutback release) input to "OFF."

6. Continue setting the current while the motor is at a standstill.

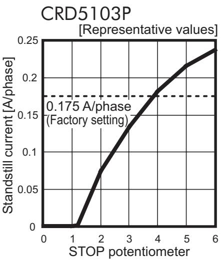
■Setting current at motor standstill

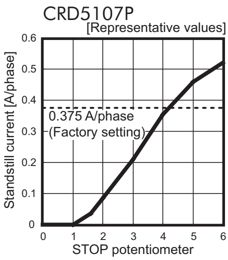
The current at motor standstill is factory set so that it will be about 50% of the motor's operating current (This proportion does not change, even if the motor's operating current is changed).

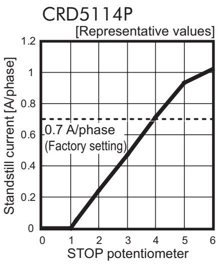
When changing the setting of current at motor standstill, use the motor stop current potentiometer (STOP).

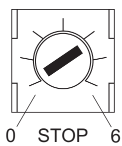
1. After connecting the motor and DC ammeter, turn the C.D.INH (current cutback release) input to "OFF" and then input the power supply to the driver.

2. When the motor stop current potentiometer (STOP) is turned counterclockwise, the current at motor standstill decreases.









The scale values are not displayed on the control.

3. When the setting is complete, turn off the power supply.

After about 0.1 sec. has passed since the pulse was stopped, the motor's operating current automatically decreases to the set value of current at motor standstill.

Note

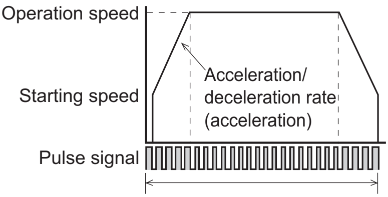
- Set the motor's operating current within the factory setting value range. Failure to do so may damage the actuator and driver. In case there is room in thrust due to a comparatively light load, adjusting the motor's operating current to a slightly lower level could raise the effect because temperature increase or vibration can be minimized.
- If the motor current potentiometer is used to adjust current, set the potentiometer graduation to 2 or more. If the potentiometer is set too low, current will become zero and the actuator will lose its holding brake torque.
- A range of adjustment of the current at motor standstill is within one-half the set value of motor operating current. When the current at motor standstill is decreased too much, actuator starting or maintenance of the location may be hindered. Do not reduce it any more than is necessary.
- When operating the potentiometer, use a precision screwdriver.
- When setting the current at motor standstill, be sure to do so after setting the motor's operating current and turning off the power supply to the driver.

Operation data

This section covers the methods of calculating the pulse output condition and positioning time needed to set the speed and acceleration (acceleration/deceleration rate) of the **DRL** series.

■Conversion formula

The pulse output must be set as in the figure below.



Set the number of pulses and pulse speed corresponding to the speed [mm/s (in/sec)] and movement distance [mm (in.)] of the **DRL** series, based on the following.

●Pulse speed and DRL series speed

The relationship between the controller's pulse speed and the speed of the **DRL** series is as follows:

$$\text{Pulse speed [Hz]} = \frac{\textbf{DRL}\text{ series speed [mm/s (in/sec)]}}{\text{Resolution [mm (in.)]}}$$

● Number of pulses and DRL series distance of movement

The relationship between the number of controller pulses and the distance the **DRL** series moves is as follows:

$$\text{Number of pulses [pulses]} = \frac{\textbf{DRL}\text{ series distance of movement [mm (in.)]}}{\text{Resolution [mm (in.)]}}$$

● Acceleration/deceleration rate and acceleration

The acceleration (acceleration/deceleration rate) when the actuator is started or stopped must conform to the ranges specified in the table below, irrespective of the loaded mass.

Unit model	Acceleration [m/s² (ft/sec²)]
DRL20, **DRL28P**	0.2 (0.66) or less
DRL42P	0.4 (1.31) or less
DRL60P	0.26 (0.85) or less
DRL28M, **DRL42M**	0.2 (0.66) or less
DRL60M	0.26 (0.85) or less

Unit model	Acceleration/deceleration rate
DRL20, **DRL28P**, **DRL42P**	10/A ms/kHz or more
DRL60P	30/A ms/kHz or more
DRL28M	5/A ms/kHz or more
DRL42M	10/A ms/kHz or more
DRL60M	15/A ms/kHz or more

The relationship between the acceleration/deceleration rate [ms/kHz] and the acceleration [m/s² (ft/sec²)] is as follows:

$$\text{Acceleration [m/s}^2\text{]} = \frac{\text{Lead [mm]} \times 10^3}{\text{B} \times 500\text{ [Hz]} \times \text{A}}$$

$$\text{Acceleration [ft/sec}^2\text{]} = \frac{\text{Lead [in.]} \times 0.0833 \times 10^6}{\text{B} \times 500\text{ [Hz]} \times \text{A}}$$

A : Number of division
B : Acceleration/deceleration rate [ms/kHz]

●Starting speed

The starting speed of the **DRL** series must conform to the ranges specified in the table below.

Unit model	Starting speed [mm/s (in/sec)]
DRL20, **DRL28**	0.2 (0.008) or less
DRL42	0.4 (0.016) or less
DRL60	0.8 (0.031) or less

If vibration occurs in a return to mechanical home operation, conform to the ranges specified in the table below.

Unit model	Starting speed [mm/s (in/sec)]
DRL20, **DRL28**	0.6 (0.024) or less
DRL42	1.2 (0.047) or less
DRL60	2.4 (0.094) or less

●Operating speed

The operating speed of the **DRL** series must conform to the ranges specified in the table below, including during acceleration.

Unit model	Starting speed [mm/s (in/sec)]
DRL20	20 (0.79) or less
DRL28P	24 (0.94) or less
DRL42P	30 (1.18) or less
DRL60P	32 (1.26) or less
DRL28M	24 (0.94) or less
DRL42M	15 (0.59) or less
DRL60M	22 (0.87) or less

■Positioning time

The following explains the formula for calculating the positioning time (reference value) of the **DRL** series: Since there is settling time dependent on such factors as the load's inertial moment and the speed setting, use these values only as a reference.

Vr : Operating speed [mm/s (in/sec)]
Vs :Starting speed [mm/s (in/sec)]
L : Movement distance [mm (in.)]
a : Acceleration [m/s² (ft/sec²)]
T : Positioning time [s]

1. Check the operating pattern

Calculate the maximum speed *Vrmax* during operation (triangular drive) from the acceleration *a*, travel *L* and assumed operating speed *Vr*.

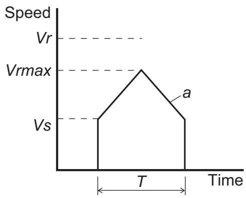
$$\underset{[\text{mm/s}]}{Vrmax} = \sqrt{L\,[\text{mm}] \times a\,[\text{m/s}^2] \times 10^3 + Vs^2\,[\text{mm/s}]}$$

$$\underset{[\text{in/sec}]}{Vrmax} = \sqrt{L\,[\text{in.}] \times a\,[\text{ft/sec}^2] \times 12 + Vs^2\,[\text{in/sec}]}$$

Vrmax : Maximum speed when a triangular-drive running pattern is assumed

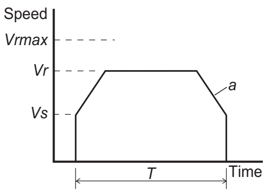
When the maximum speed is at or below the running speed:

Triangular drive



When the maximum speed exceeds the running speed:

Trapezoidal drive



However, for trapezoidal drive the maximum speed is not used. Instead, the hypothesized running speed *Vr* is used.

2. Calculate the positioning time according to the running pattern

Calculate the positioning time according to the running pattern.

●Triangular drive

$$T\,[\text{s}] = \frac{2 \times (Vrmax\,[\text{mm/s}] - Vs\,[\text{mm/s}])}{a\,[\text{m/s}^2] \times 10^3}$$

$$T\,[\text{s}] = \frac{2 \times (Vrmax\,[\text{in/sec}] - Vs\,[\text{in/sec}])}{a\,[\text{ft/sec}^2] \times 12}$$

●Trapezoidal drive

$$T\,[\text{s}] = \frac{(Vr\,[\text{mm/s}] - Vs\,[\text{mm/s}])^2 + L\,[\text{mm}] \times a\,[\text{m/s}^2] \times 10^3}{Vr\,[\text{mm/s}] \times a\,[\text{m/s}^2] \times 10^3}$$

$$T\,[\text{s}] = \frac{(Vr\,[\text{in/sec}] - Vs\,[\text{in/sec}])^2 + L\,[\text{in.}] \times a\,[\text{ft/sec}^2] \times 12}{Vr\,[\text{in/sec}] \times a\,[\text{ft/sec}^2] \times 12}$$

■Example calculate the positioning time

Calculate the positioning time for running the **DRL42** using the following settings.

- ●Movement distance *L* : 40 mm (1.57 in.)
- ●Starting speed *Vs* : 0.4 mm/s (0.016 in/sec)
- ●Acceleration *a* : 0.4 m/s² (1.13 ft/sec²)
- ●Operating speed *Vr* : 30 mm/s (1.181 in/sec)

1. Check the operating pattern

$$Vrmax = \sqrt{40 \times 0.4 \times 10^3 + 0.4^2} = 126.49\ [\text{mm/s}]$$

$$Vrmax = \sqrt{1.57 \times 1.31 \times 12 + 0.016^2} = 4.974\ [\text{in/sec}]$$

Since the maximum speed exceeds the operating speed, trapezoidal drive used.

2. Calculate the positioning time

From the formula for trapezoidal drive

[Unit: mm]

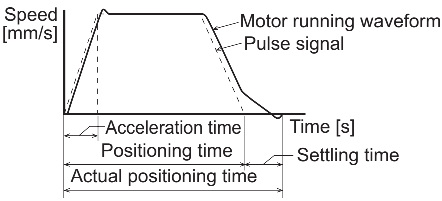
$$T = \frac{(30 - 0.4)^2 + 40 \times 0.4 \times 10^3}{30 \times 0.4 \times 10^3}$$
$$= 1.4\ [\text{s}]$$

[Unit: in.]

$$T = \frac{(1.181 - 0.016)^2 + 1.57 \times 1.31 \times 12}{1.181 \times 1.31 \times 12}$$
$$= 1.4\ [\text{s}]$$

■Settling time

With the **DRL** series, the load inertial moment and other factors cause a response delay with respect to the pulse input. A delay thus caused at stopping is called the "settling time". The calculation of accurate positioning time requires that this settling time be considered.



■Operational use of the actuator thrust

The maximum thrust of the actuator is measured during constant-speed operation without loaded mass. To "push" or "pull" an external force with the actuator moving parts a thrust against the external force is required in addition to a thrust for carrying the jig that receives the external force.
Check the necessary thrusts when "pushing" or "pulling" an external force with the moving parts.

Thrust required to accelerate the table's load mass:

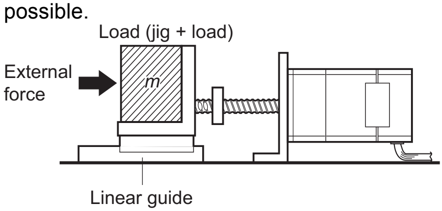
$$Fa\ [\mathrm{N}] = m\ [\mathrm{kg}] \times (a\ [\mathrm{m/s^2}] + g\ [\mathrm{m/s^2}] \times \mu)$$

$$Fa\ [\mathrm{lb.}] = \frac{0.3048 \times m\ [\mathrm{lb.}] \times a\ [\mathrm{ft/sec^2}]}{g\ [\mathrm{ft/sec^2}]} + m\ [\mathrm{lb.}] \times \mu$$

Maximum push/pull thrust:

$$F = Fmax - Fa$$

When the thrust applied to the jig is less than *F*, pushing and pulling using the actuator is possible.



Fmax : Maximum thrust of actuator [N (lb.)]
Fa : Thrust required to carry load (jig + load) [N (lb.)]
F : Thrust with which the load mass can be pushed and pulled by an external force [N (lb.)]
m : Mass of load (jig + load) [kg (lb.)]
a : Acceleration [m/s^2 (ft/sec^2)]
g : Acceleration due to gravity 9.807 [m/s^2(ft/sec^2)]
μ : Friction coefficient of linear guide 0.01

Note

Operating the actuator under a load beyond the maximum thrust or allowing the moving parts to remain locked may cause damage to the actuator.
Therefore, always operate the actuator under a load not exceeding the maximum thrust. In a lift application, operate the actuator under a load not exceeding the maximum vertical load and without the application of external force.

Inspection

It is recommended that the following items be checked regularly after operation.
Should an abnormality be noted, discontinue any use and contact your nearest Oriental Motor office.

Inspection items

- Are there any foreign objects on the driver?
- Are there any loose driver-mounting screws or connector?
- Are any of the power elements or smoothing capacitors inside the driver giving off a bad smell or showing other signs of abnormality?

Note

The driver uses semiconductor elements, so exercise due caution when handling the driver. The driver may be damaged by the effects of static electricity, etc.

Troubleshooting and remedial actions

During **DRL** series operation, the actuator or driver may fail to operate properly due to an error in speed setting or inappropriate connection. If the **DRL** series doesn't operate properly, refer to this section and take appropriate action. If the problem persists, contact your nearest Oriental Motor office.

Phenomenon	Possible cause	Remedial action
The actuator is not energized.	● The A.W.OFF input is turned "ON".	● Turn the A.W.OFF input to "OFF" and determine whether the actuator is energized.
The screw shaft can be moved by hand.	● Inappropriately adjusted motor operating current.	● Return the potentiometer for adjusting the motor operating current (RUN, STOP) to the factory set value and check the operation
The screw shaft doesn't rotate.	● Poor contact at the PLS (CW) input or DIR. (CCW) input.	● Check the controller and driver connections ● Check the pulse signal specifications (voltage, width)
	● The pulse signal is connected to the DIR. input in 1-pulse input mode.	● Connect pulse signal to the PLS input.
	● Both the CW and CCW inputs are turned to "ON" in 2-pulse input mode.	● Input pulse signal to either the CW input or CCW input once at a time. ● Be sure to turn "OFF" the terminal not receiving input.
	● The electromagnetic brake is holding. (Applicable to the electromagnetic brake only.)	● Supply power to the electromagnetic brake to release the brake.
The screw shaft rotates opposite to the specified direction.	● The DIR. input is set in reverse, when the 1-pulse input mode is selected.	● Turn the switch "ON" when the direction is set to CW; turn it "OFF" when the direction is set to CCW.
	● The CW input and CCW input are connected in reverse, when the 2-pulse input mode is selected.	● Connect the CW pulse signal and CCW pulse signal to the CW input and CCW input, respectively.
The screw shaft operation is unstable.	● Inappropriately adjusted motor operating current.	● Return the potentiometer for adjusting the motor operating current (RUN, STOP) to the factory set value and check the operation
	● Poor connection of the pulse signal.	● Check the controller and driver connections. ● Check the pulse-signal specifications (voltage, width).
Slow actuator start (self-starting operation)	● Effect of the smooth drive function	● Disable the smooth drive function and check the operation.

Phenomenon	Possible cause	Remedial action
A misstep occurs during acceleration or operation.	● Large load or significant load fluctuation.	● Check to see if the load fluctuates significantly during actuator operation.
	● The starting speed is too high.	● Set a lower starting speed at which the actuator can be started reliably.
	● The acceleration (deceleration) time is too short.	● Set a longer acceleration (deceleration) time at which the actuator can be started reliably.
	● Effect of noise.	● If effect of noise is confirmed, take an appropriate action such as isolating the actuator from the noise source, redoing the wiring or changing the I/O cables to shielded wires.
The actuator's travel amount doesn't match the setting.	● Inappropriate switching of C/S (resolution switching) input.	● Check the settings of the resolution setting switches (DATA1, DATA2) and the switching condition of the C/S input.
The actuator vibrates significantly.	● Small load.	● Turn the potentiometer for adjusting the motor operating current (RUN) slightly in the counterclockwise direction in order to lower the current. ● Vibration will increase if the actuator's output torque is too large for the load.
The actuator is abnormally hot.	● The C.D.INH input is turned "ON".	● Turn the C.D.INH input to "OFF".
	● The setting of the potentiometer for adjusting the motor standstill current (STOP) is too high.	● Return the potentiometer for adjusting the motor standstill current (STOP) to the factory set value and check the operation.
Automatic current cutback doesn't occur.	● The C.D.INH input is turned "ON".	● Turn the C.D.INH input to "OFF".
	● The setting of the potentiometer for adjusting the motor standstill current (STOP) is too high.	● Return the potentiometer for adjusting the motor standstill current (STOP) to the factory set value and check the operation.
	● The pulse signal hasn't returned to "OFF".	● Once the operation is stopped, set the pulse signal to "OFF".
TIMING signal is not output.	● The C/S input was turned "ON" while TIMING signal was not output.	● Turn the C/S input "ON" when the TIMING signal is output.
An abnormal noise is heard.	● Poor installation accuracy of actuator.	● Check the installation accuracy of the actuator.
The electromagnetic brake does not hold. (Applicable to the electromagnetic brake only.)	● Power is supplied to the electromagnetic brake.	● Cut off the power to the electromagnetic brake to allow the load to be held by the electromagnetic brake while the actuator is stopped.

Option

■Motor cable

Used for actuator connection by means of connector coupling.

Model	Cable length [m (ft.)]	Applicable product
LC5N10A	1 (3.3)	**DRL20**, **DRL28M**
LC5N10B	1 (3.3)	**DRL42M**
LC5N10C	1 (3.3)	**DRL60M**

■Driver cable

A set of three cables is provided to connect the power, I/O and motor, respectively.

Model	Cable length [m (ft.)]
LCS04SD5	0.6 (2)

■Connector sets (Molex)

A set of connector housings and contacts maching a connector-type actuator.
Each bag contains enough housings and contacts for connecting 30 actuators.

Model	Applicable product	Connector housing (30 pieces)	Contact (180 pieces)	Applicable cable
CS5N30A	**DRL20** **DRL28M**	51065-0500	50212-8100	AWG30 to 24 (0.05 to 0.2 mm^2) Outor diameter of sheathed cable: Ø1.4 mm (Ø0.06 in.) or less. Stripped length: 1.3 to 1.8 mm (0.05 to 0.07 in.)
CS5N30B	**DRL42M**	51103-0500	50351-8100	AWG28 to 22 (0.08 to 0.3 mm^2) Outor diameter of sheathed cable: Ø1.15 to 1.8 mm (Ø0.05 to 0.07 in.) Stripped length: 2.3 to 2.8 mm (0.09 to 0.11 in.)
CS5N30C	**DRL60M**	51144-0500	50539-8100	AWG24 to 18 (0.2 to 0.75mm^2) Outor diameter of sheathed cable: Ø1.4 to 3 mm (Ø0.06 to 0.12 in.) Stripped length: 3 to 3.5 mm (0.12 to 0.14 in.)

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

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