Oriental motor

HP-1420-5

# Compact actuator
# DRL Series
# DFC driver Photocoupler inputs

## OPERATING MANUAL

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.

**Table of Contents**

## Notes to the user

- 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. For the driver, use a DC power source with reinforced insulation provided on the primary and secondary sides. Oriental Motor shall not be liable whatsoever for any damage arising from a failure to observe this warning.
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## 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

This section covers items you should know before using this driver.

## Introduction

This section covers the main features and system configuration.

### ■ Main features

The compact actuator **DRL** series is a family of linear motion actuators adopting a new mechanism : a stepping motor incorporating a ball screw.
Available are the standard type, in which the ball screw is used as the output shaft, and the guide type, in which a linear guide serves as an anti-spin mechanism for the ball screw.

#### ● Low-speed operation at low vibration levels

**DRL** series driver achieves smooth, low-speed operation with extremely low vibration, thanks to a micro-stepping driver, which enables stepping at minute angles.

#### ● 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

A desired motor resolution can be selected and set from among 16 preset values. ➡ Page **18**

#### ● Adjustable motor currents

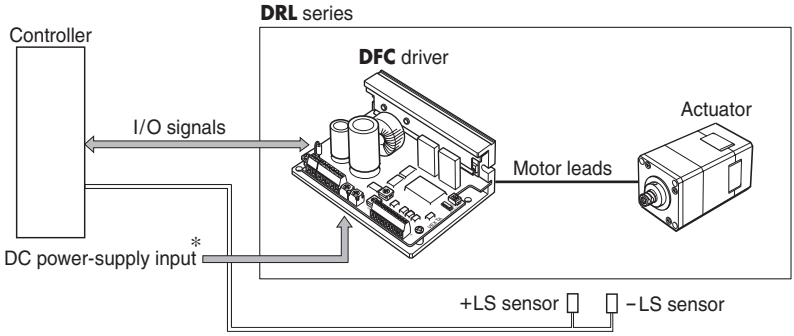
The operating current and standstill current of the motor can be adjusted individually. ➡ Page **18**

#### ● Selectable pulse input mode

The 2-pulse input mode or 1-pulse input mode can be selected in accordance with the pulse output mode of the controller. ➡ Page **20**

### ■ 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 source with reinforced insulation on both the primary and secondary sides.

### ■ Hazardous substances

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

## 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 page 5 for the actuator and driver combinations for each unit model.

● Actuator : 1 unit

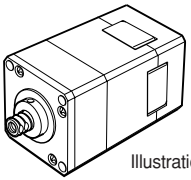
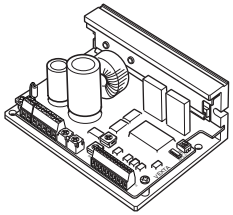


Illustration shows the standard type.

● Driver : 1 unit



● Operating manual (Actuator) : 1 copy

● Operating manual (Driver) : 1 copy

**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.

## ■ How to read the model number

**DRL 42 P A 2 G - 04 D**
① ② ③ ④ ⑤ ⑥ ⑦ ⑧

| No. | Meaning |
|---|---|
| ① | Name of the series **DRL** series |
| ② | Actuator frame size **28**: 1.10 inch (28 mm) square **42**: 1.65 inch (42 mm) square **60**: 2.36 inch (60 mm) square |
| ③ | Motor type **P**: Stepping |
| ④ | **A**: Rolled ball screw **B**: Grounded ball screw |
| ⑤ | Lead **1**: .039 inch (1 mm) [**DRL28**] **2**: .079 inch (2 mm) [**DRL42**] **4**: .157 inch (4 mm) [**DRL60**] |
| ⑥ | Guide **G**: With guide **None**: Without guide |
| ⑦ | Stroke **03**: 1.18 inch (30 mm) [**DRL28**] **04**: 1.57 inch (40 mm) [**DRL42**] **05**: 1.97 inch (50 mm) [**DRL60**] |
| ⑧ | Driver type **D**: **DFC** **None**: Without driver |

## ■ Combinations of actuators and drivers

**Standard type**

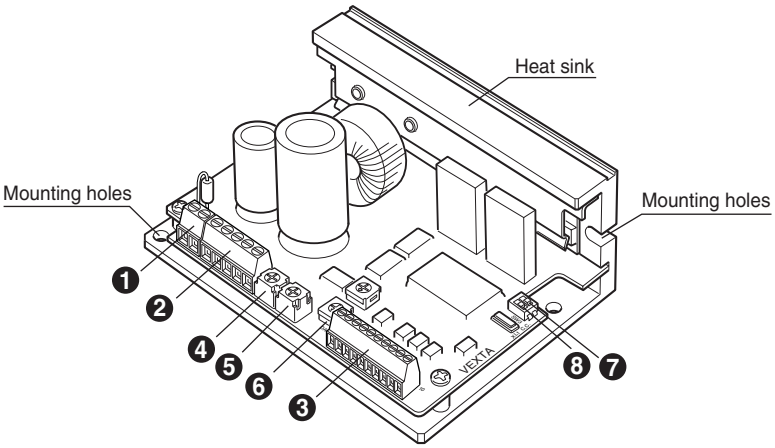
| Unit model | Actuator model | Driver model | Lead [inch (mm)] |
|---|---|---|---|
| **DRL28PA1-03D** | DRL28PA1-03 | DFC5107T | .039 (1) |
| **DRL28PB1-03D** | DRL28PB1-03 | DFC5107T | .039 (1) |
| **DRL42PA2-04D** | DRL42PA2-04 | DFC5107T | .079 (2) |
| **DRL42PB2-04D** | DRL42PB2-04 | DFC5107T | .079 (2) |
| **DRL60PA4-05D** | DRL60PA4-05 | DFC5114T | .157 (4) |

**Guide type**

| Unit model | Actuator model | Driver model | Lead [inch (mm)] |
|---|---|---|---|
| **DRL28PA1G-03D** | DRL28PA1G-03 | DFC5107T | .039 (1) |
| **DRL28PB1G-03D** | DRL28PB1G-03 | DFC5107T | .039 (1) |
| **DRL42PA2G-04D** | DRL42PA2G-04 | DFC5107T | .079 (2) |
| **DRL42PB2G-04D** | DRL42PB2G-04 | DFC5107T | .079 (2) |
| **DRL60PA4G-05D** | DRL60PA4G-05 | DFC5114T | .157 (4) |

## 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.




❶ **Power-supply terminal blocks (TB1)** ➡ Page **13**
Connected to a 24 VDC or 36 VDC power supply.

❷ **Motor Terminal blocks (TB2)** ➡ Page **13**
Connected to motor leads.

❸ **I/O terminal blocks (TB3)** ➡ Page **13**
Connected to I/O signals.

❹ **Potentiometer for adjusting the motor operating current (RUN)** ➡ Page **18**
This potentiometer sets the operating current of the motor.
If there is sufficient torque, the current setting can be reduced to suppress increases in motor/driver temperatures.
The potentiometer is factory-set to [the rated current].

❺ **Potentiometer for adjusting the motor standstill current (STOP)** ➡ Page **18**
This potentiometer sets the current when the motor is at a standstill (in the current-cutback state).
The potentiometer is factory-set to [50 percent of the rated current].

❻ **Resolution setting switches (DATA1, DATA2)** ➡Page **18**
DATA1 and DATA2 each set one of 16 resolutions.
DATA1 and DATA2 are selected with the C/S (resolution switching) input.
The factory setting is [0] for both DATA1 and DATA2.

❼ **Pulse-input mode switch (1P/2P)** ➡ Page **20**
Set to 2-pulse input mode or 1-pulse input mode.
The factory setting is [1P: 1-pulse input mode].

❽ **DC check switch (C.C.)** ➡ Page **19**
Switch used when adjusting the motor s running current.
When running the motor, always have this switch set to OFF.
The factory setting is OFF.

# Safety precautions

This product is designed for incorporation into industrial equipment. Touching the product during operation may result in bodily injury or property damage, since the screw shaft is rotating and the surface remains very hot. To prevent bodily injury or damage to the product, be sure the product is handled and operated only by qualified personnel familiar with operations involving electronic equipment.

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 screw shaft 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 screw shaft will descend, resulting in injury or equipment damage.

### Installation

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

### Connection

- Always use the driver with a power source of the rated voltage. Failure to do so may result in fire or electric shock.
- For the driver, use a DC power source 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.

### Operation

- Turn off the power 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 motor 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 screw shaft 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 use the actuator and driver beyond their specifications. Doing so may result in injury or equipment damage.
- Do not touch the driver (heat sink) 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.
- Before operating, confirm that the emergency-stop function is working properly. 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.
- Should you find any abnormality, immediately turn off the power to the driver. Failure to do so may result in fire or injury.

## Disposal

- When disposing of the driver, treat it as ordinary industrial waste.

# Precautions for use

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

## ■ 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. ➡ Page **21**

## ■ Maximum speed

The operating speed of the actuator must be within the specified range, including during acceleration.
➡ Page **21**

## ■ 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. ➡ Page **21**

## ■ Driver's heat-sink temperature

When operating the motor, keep the driver's heat-sink temperature to 158°F (70°C) or below. If the temperature exceeds 158°F (70°C), the driver may be damaged.

## ■ Preventing electrical noise

Take the following anti-noise measures to prevent malfunction of the driver and actuator due to external noise.

### ● Connecting actuator

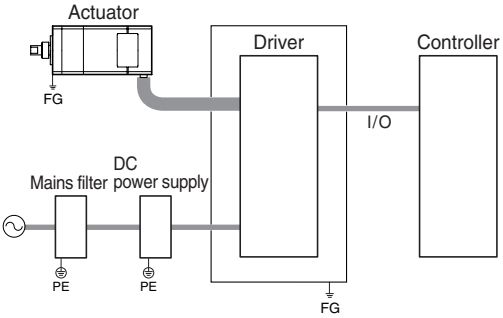
It is recommended that braided screen cable be used for connection between the driver and actuator.

### ● Connecting I/O cable

- Minimize the length of the I/O cable.
- Wire the control I/O cables by maintaining a minimum distance of 12 inch (300 mm) from the inductive loads of electromagnetic relays, etc., as well as the power lines of the power source, actuator and the like. Do not wire the control I/O cables in the same duct or pipe in which power lines are wired.

### ● Connecting mains filter

Install a mains filter in the AC input line to the power transformer in order to prevent the noise generated within the driver from propagating outside via the power source for the driver.
Install the mains filter as close to the AC input terminal of power source for the driver as possible, and use cable clamps and other means to secure the input and output cables firmly to the surface of the enclosure.
Connect the ground terminal of the noise filter to the grounding point, using as thick and short a wire as possible.
Do not place the AC input cable (Between AWG18 (0.75 $mm^2$) and AWG16 (1.25 $mm^2$)) parallel with the mains filter output cable (Between AWG18 (0.75 $mm^2$) and AWG16 (1.25 $mm^2$)). Parallel placement will reduce mains filter effectiveness if the enclosure's internal noise is directly coupled to the power-supply cable by means of stray capacitance.



# 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 installed indoors (with ventilation holes provided)
- Ambient temperature : +32°F to +104°F (0°C to +40°C) [non-freezing]
- Ambient humidity : 85% or less (no condensation)
- A place free of explosive gasses, or toxic gases (sulfide gas, etc. ) or liquids
- A place not exposed to direct sunlight
- A place not exposed to significant amounts of dust or iron powder
- A place not exposed to water (rain, water droplets), oil (oil droplets) or other liquids
- A place not exposed to air having a high salt content
- A place not subject to continuous vibration or excessive shock
- A place not subject to significant electromagnetic noise caused by welding machines, power equipment, etc.
- A non-vacuum place without radioactive substances or magnetic fields

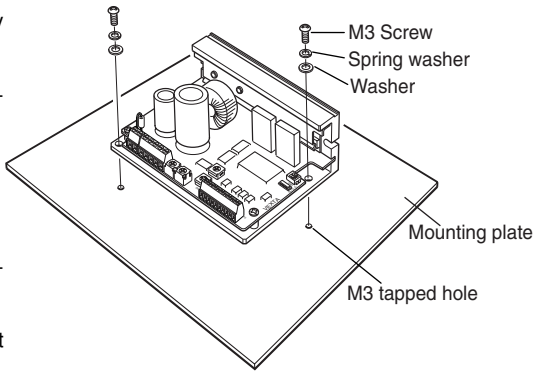
## Direction of installation

When installing the driver in an enclosure, always install it in the direction illustrated at the right.
There must be a clearance of at least 1 inch (25 mm) and 2 inch (50 mm) 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 .8 inch (20 mm) between adjacent drivers.

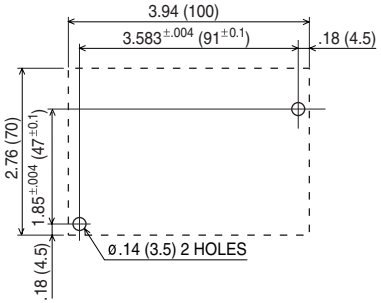
## Installing the driver

Fix the driver to the mounting plate using M3 screws.

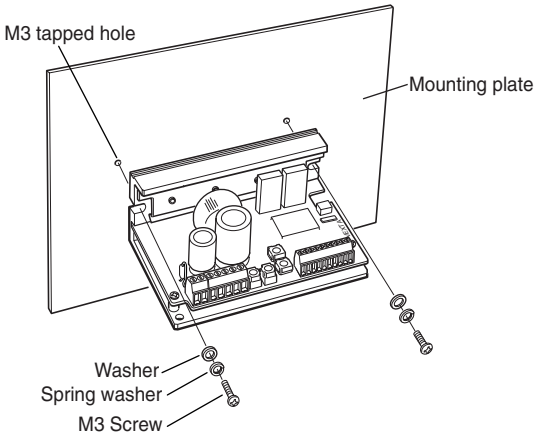
### ■ Installation in the horizontal direction




● **Plate cutout for mounting** Unit : inch (mm)

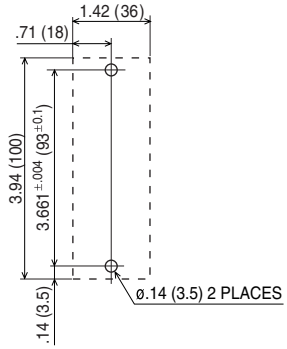


## ■ Installation in the vertical direction




### ● Plate cutout for mounting

Unit : inch (mm)




**NOTE**

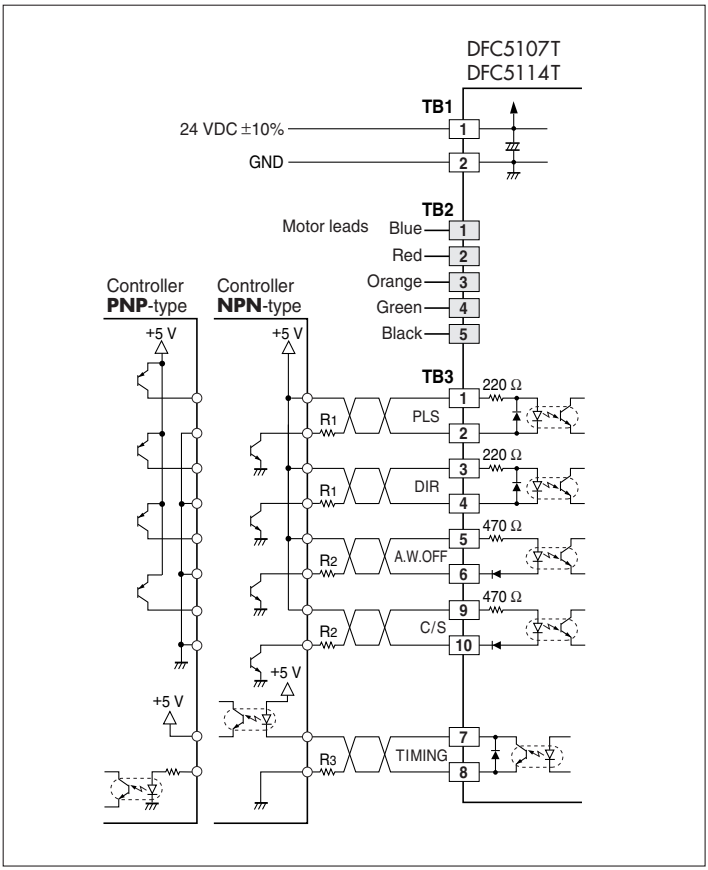
- Do not install equipment generating significant heat or noise in the vicinity of the driver.
- Adjust the ventilation condition if the ambient temperature of the driver exceeds 104°F (40°C).

# Connections

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

## Connection examples

The driver's power-supply voltage is 24 VDC±10%.




### ■ Terminal blocks

Screw terminals are used.
Remove the insulation from the core, then insert the core into the terminal and tighten with terminal screws.
Strip 0.24 to 0.31 inch (6 to 8 mm) of insulation.
Tighten the terminal screw to the specified tightening torque.

## Connecting the power supply

Connecting the power-supply wires into the driver's power-supply terminal blocks (TB1).
Use a cable of AWG20 (0.5 $mm^2$) for the power-supply line.

### ■ Power-supply voltage

The driver's input power-supply voltage is 24 VDC ±10%.
Use a power supply capable of supplying the power/current capacity as shown below.

| Driver model | Current capacity |
|---|---|
| DFC5107T | 1 A minimum |
| DFC5114T | 2 A minimum |

### ■ Terminal blocks pin assignments

**TB1**

| Pin No. | Signal name | Explanation |
|---|---|---|
| 1 | +24 V | 24 VDC ±10% |
| 2 | GND | |

## Connecting the motor

Connecting the motor leads into the driver's motor terminal blocks (TB2).
Use a cable with a wire of a size ranging between AWG20 (0.5 $mm^2$) and AWG18 (0.75 $mm^2$) to extend the motor leads.

### ■ Terminal blocks pin assignments

**TB2**

| Pin No. | Explanation |
|---|---|
| 1 | Connect the blue motor lead. |
| 2 | Connect the red motor lead. |
| 3 | Connect the orange motor lead. |
| 4 | Connect the green motor lead. |
| 5 | Connect the black motor lead. |

## Connecting I/O signals

Connecting the I/O signal wires into the driver's I/O terminal blocks (TB3).
Use a cable with a wire of a size ranging between AWG24 (0.2 $mm^2$) and AWG22 (0.3 $mm^2$) for the I/O cable, and keep it as short as possible.

### ■ Terminal blocks pin assignments

**TB3**

| Pin No. | Signal name | Explanation |
|---|---|---|
| 1 | PLS+(CW+)* | Pulse (CW pulse) input photocoupler anode side |
| 2 | PLS−(CW−)* | Pulse (CW pulse) input photocoupler cathode side |
| 3 | DIR+(CCW+)* | Rotation direction (CCW pulse) input photocoupler anode side |
| 4 | DIR−(CCW−)* | Rotation direction (CCW pulse) input photocoupler cathode side |
| 5 | A,W.OFF+ | All windings of input anode side |
| 6 | A.W.OFF− | All windings of input cathode side |
| 7 | TIMING+ | Excitation timing output collector side |
| 8 | TIMING− | Excitation timing output emitter side |
| 9 | C/S+ | Resolution switching input anode side |
| 10 | C/S− | Resolution switching input cathode side |

* The signal in parentheses applies when [2P: 2-pulse input mode] is selected with the pulse-input mode switch.

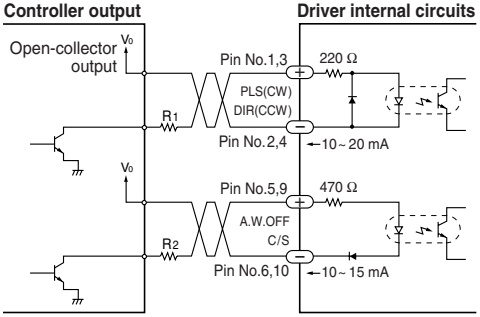
**NOTE**

- Pay attention to polarity when connecting the power supply. Connecting the power supply in reverse polarity may damage the driver.
- Do not wire the driver's power-supply cable in the same conduit in which another power line or the motor cable is wired.
- After turning off the power supply, wait at least 5 seconds before turning it on again.

# Explanation of I/O signals

## ■ Input signals

All driver input signals are photocoupler inputs.
The signal state indicates the [ON: current supplied] or [OFF: current not supplied] status of the internal photocoupler rather than the voltage level of the signal.




The input signal voltage must be between 5 VDC and 24 VDC, inclusive.
If the input signal voltage exceeds 5 VDC, connect external resistances (R1, R2) as illustrated above and limit the input current as follows:

$$R_1 = \frac{V_0}{20\ \text{mA}} - 220\ [\Omega]$$

$$R_2 = \frac{V_0}{15\ \text{mA}} - 470\ [\Omega]$$

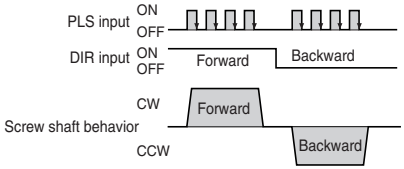
### ● PLS(CW) input and DIR(CCW) input

This driver can select either 1-pulse input mode or 2-pulse input mode as the pulse-input mode to match the controller used.
How to set the pulse-input mode ➡ Page **20**

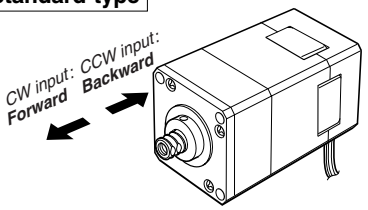
### ● 1-pulse input mode (factory setting)

Connect the Pulse output of the positioning controller to the PLS+ input and PLS− input, and connect the Rotation direction output to the DIR+ input and DIR− input.

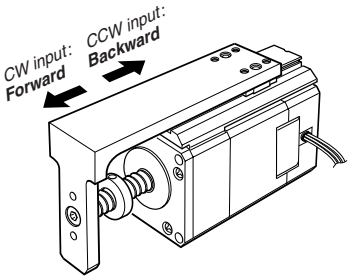
***1.*** When the DIR input is [ON], turning the PLS input from [ON to OFF] causes the screw shaft to move forward one step.
***2.*** When the DIR input is [OFF], turning the PLS input from [ON to OFF] causes the screw shaft to move backward one step.




**Standard type**



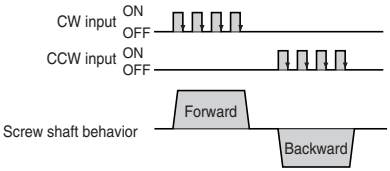

**Guide type**



### ● 2-pulse input mode

Connect the CW pulse output of the positioning controller to the CW+ input and CW− input, and connect the CCW pulse output to the CCW+ input and CCW− input.

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.

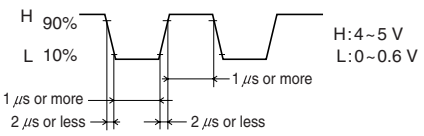



**NOTE**

- If a pulse signal is not input, be sure to set the photocoupler to [OFF]. Do not input pulse signals to the CW and CCW inputs simultaneously.
- If one input receives a pulse signal while the other input has its photocoupler turned to [ON], the motor cannot operate correctly.

**Pulse-signal waveform**

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




The figure shows the pulse signal's voltage level.

## ● A.W.OFF (All windings off) input

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

**⚠ Warning**

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. A load may descend, resulting in injury or equipment damage.

**⚠ Caution**

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.

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 motor, 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 **18**

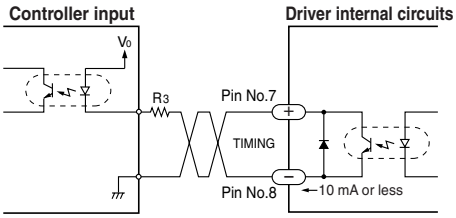
Turning the C/S input [ON] changes the resolution to the setting of the resolution setting switch DATA2.
Turning the C/S input [OFF] changes the resolution to the setting of the resolution setting switch DATA1.

**Example: DRL42**

- Turning the C/S input [OFF] when DATA1 is set to 0 [.00016 inch (0.004 mm)] changes the resolution to .00016 inch (0.004 mm).
- Turning the C/S input [ON] when DATA2 is set to 6 [.000016 inch (0.0004 mm)] changes the resolution to .000016 inch (0.0004 mm).

## ■ Output signals

All driver output signals are photocoupler/open-collector outputs.
The signal state indicates the [ON: current supplied] or [OFF: current not supplied] status of the internal photocoupler or transistor rather than the voltage level of the signal.



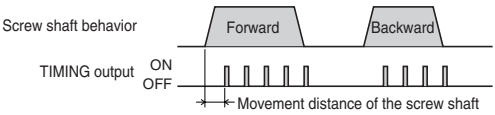

The output signal voltage must be between 5 VDC and 24 VDC, inclusive.
If the output signal voltage exceeds 5 VDC, connect external resistance as illustrated above and limit the output current 10 mA or less.

$$R_3 = \frac{V_0}{10\ mA}\ [\Omega]$$

### ● TIMING (Excitation timing) output

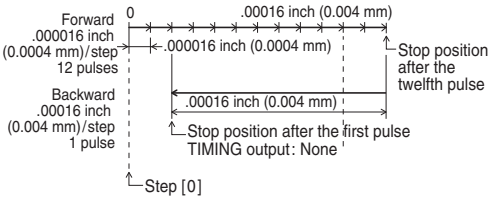
This output is used to increase the accuracy of origin detection.
The TIMING output turns [ON] each time the screw shaft moves by the following amount:

| Unit model | Movement distance of the screw shaft [inch (mm)] |
|---|---|
| **DRL28** | .0008 (0.02) |
| **DRL42** | .0016 (0.04) |
| **DRL60** | .0032 (0.08) |




**Example of TIMING output not turning [ON]**

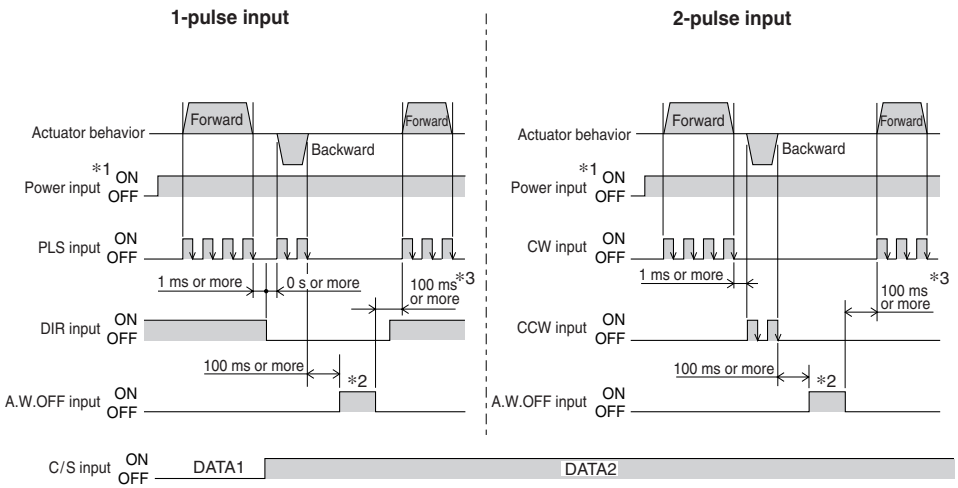
The chart below shows an operation in which the screw shaft is moved forward for 12 pulses at a resolution of .000016 inch (0.0004 mm) and then moved backward for one pulse at a resolution of .00016 inch (0.004 mm).




**NOTE**

- When using the TIMING output, set the number of input pulses or resolution so that the screw shaft will stop at a position corresponding to an integer-multiple of .0008 inch (0.02 mm), .0016 inch (0.04 mm) or .0032 inch (0.08 mm).
- When changing the resolution using the C/S (resolution switch) 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



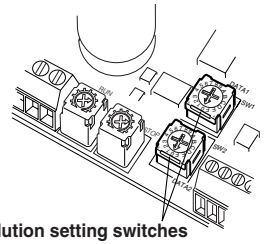

*1. After turning off the power supply, wait at least 5 seconds before turning it on again.
*2. When the A.W.OFF input is turned to [ON], the motor current turns off and the screw shaft loses its holding torque.
*3. This duration is subject to change, depending on the motor size, operating speed and load inertial moment.

# Settings

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

## Resolution

When setting the motor's resolution, use the resolution setting switches (DATA1 and DATA2).



**Resolution setting switches**
Factory settings : DATA1 [0], DATA2 [0]

- There are 16 settings, ranging from [0] to [F]. The resolution for each setting is given in the table below.
- When changing a resolution setting, use a insulated screwdriver to switch the DATA1 or DATA2 scale.
- The resolution set by DATA1 or by DATA2 is selected with the C/S (resolution switching) input.
  C/S (resolution switching) input ➡ Page **15**

DATA1, DATA2

## Motor current

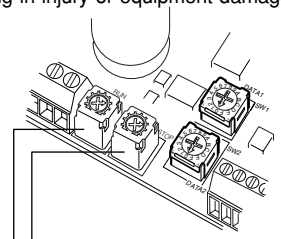
Set the motor operating current and standstill current of actuator.

**⚠ Warning**

Do not set the motor operating current and standstill current too low. The actuator will lose its holding brake force and the load may drop, causing injury or equipment damage.

**⚠ Caution**

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.



Potentiometer for adjusting the motor standstill current (STOP)
Potentiometer for adjusting the motor operating current (RUN)

| Resolution setting switches DATA1/DATA2 | Number of divisions | Actuator's resolution [inch (mm)] | | |
|---|---|---|---|---|
| | | DRL28 | DRL42 | DRL60 |
| 0 | 1 | .00008 (0.002) | .00016 (0.004) | .00032 (0.008) |
| 1 | 2 | .00004 (0.001) | .00008 (0.002) | .00016 (0.004) |
| 2 | 2.5 | .000032 (0.0008) | .000063 (0.0016) | .000126 (0.0032) |
| 3 | 4 | .00002 (0.0005) | .00004 (0.001) | .00008 (0.002) |
| 4 | 5 | .000016 (0.0004) | .000032 (0.0008) | .000063 (0.0016) |
| 5 | 8 | .00001 (0.00025) | .00002 (0.0005) | .00004 (0.001) |
| 6 | 10 | .000008 (0.0002) | .000016 (0.0004) | .000032 (0.0008) |
| 7 | 20 | .000004 (0.0001) | .000008 (0.0002) | .000016 (0.0004) |
| 8 | 25 | .0000032 (0.00008) | .0000063 (0.00016) | .0000126 (0.00032) |
| 9 | 40 | .000002 (0.00005) | .000004 (0.0001) | .000008 (0.0002) |
| A | 50 | .0000016 (0.00004) | .0000032 (0.00008) | .0000063 (0.00016) |
| B | 80 | .000001 (0.000025) | .000002 (0.00005) | .000004 (0.0001) |
| C | 100 | .0000008 (0.00002) | .0000016 (0.00004) | .0000032 (0.00008) |
| D | 125 | .00000063 (0.000016) | .00000126 (0.000032) | .00000252 (0.000064) |
| E | 200 | .0000004 (0.00001) | .0000008 (0.00002) | .0000016 (0.00004) |
| F | 250 | .00000032 (0.000008) | .00000063 (0.000016) | .00000126 (0.000032) |

### ● Motor operating current

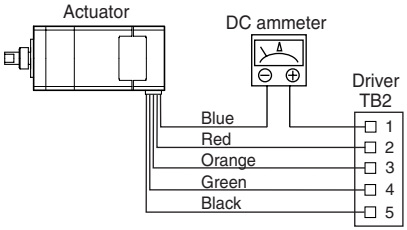
Factory setting: Motor's rated current
If the load is small and there is sufficient torque, the operating current can be reduced to suppress vibration and temperature rise of the motor.

### ● Motor standstill current

Factory setting : 50 percent of motor operating current

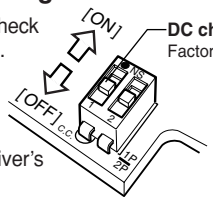
## ■ Setting method

An ammeter is needed to set the motor current.
Connect the driver, motor and DC ammeter.




### ● Motor operating current

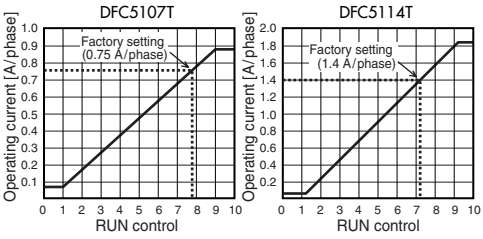
**1.** Turn the DC check switch to [ON].

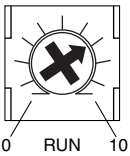



**2.** Turn on the driver's power supply.

**3.** Manipulate the potentiometer for adjusting the motor operating current (RUN).
Adjust the potentiometer using an insulated screwdriver.
One-half the value displayed on the ammeter is the current per phase of the motor.

**● DRL28, DRL42** **● DRL60**




The scale values are not displayed on the control.

**4.** After adjusting the operating current, return the current check switch to [OFF].

**NOTE**

- After adjusting the run current, always return the current check switch to [OFF]. If this switch is set to [ON], when the actuator stops the motor current does not decrease to the motor-standstill current level.
- When adjusting the motor operating current, be sure the current doesn't exceed the factory setting. Failure to do so may damage the actuator or driver.

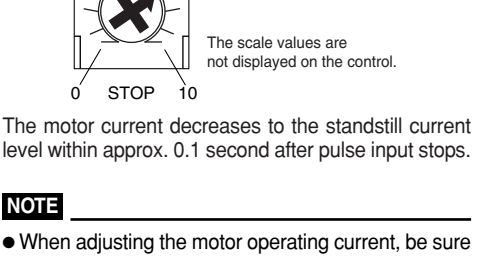
### ● Motor standstill current

**1.** Turn the DC check switch to [OFF].

**2.** Turn on the driver's power supply.

**3.** Manipulate the potentiometer for adjusting the motor standstill current (STOP).
Adjust the potentiometer using an insulated screwdriver.
One-half the value displayed on the ammeter is the current per phase of the motor.

**● DRL28, DRL42** **● DRL60**







The scale values are not displayed on the control.

The motor current decreases to the standstill current level within approx. 0.1 second after pulse input stops.

**NOTE**

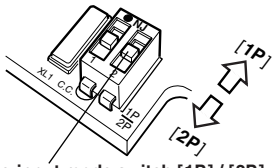
- When adjusting the motor operating current, be sure the current doesn't exceed the factory setting. Failure to do so may damage the actuator or driver.

## Pulse-input mode

Set the pulse-input mode switch to either 1-pulse input mode or 2-pulse input mode, whichever the controller uses.

**NOTE**

- Set the pulse-input mode switch when the driver power is off.




**Pulse-input mode switch [1P] / [2P]**
Factory setting: [1P:1-pulse input mode]

### ■ Setting 1-pulse input mode

When operating the actuator with pulse input and rotation-direction input, switch the pulse-input mode switch to [1P].

### ■ Setting 2-pulse input mode

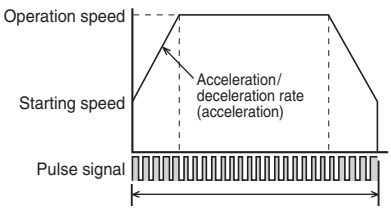
When operating the actuator with two pulses (CW pulse input and CCW pulse input), switch the pulse-input mode switch to [2P].

# 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 [in/sec (mm/s)] and movement distance [inch (mm)] 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:

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

### ● 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:

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

### ● 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** [ft/sec$^2$ (m/s$^2$)] |
|---|---|
| **DRL28** | .66 (0.2) or less |
| **DRL42** | 1.31 (0.4) or less |
| **DRL60** | .85 (0.26) or less |

| Unit model | Acceleration/deceleration rate |
|---|---|
| **DRL28** | 10/number of divisions ms/kHz or more |
| **DRL42** | 10/number of divisions ms/kHz or more |
| **DRL60** | 30/number of divisions ms/kHz or more |

The relationship between the acceleration/deceleration rate [ms/kHz] and the acceleration [ft/sec$^2$ (m/s$^2$)] is as follows:

$$\text{Acceleration [ft/sec}^2\text{]} = \frac{\text{Lead [inch]} \times 0.0833 \times 10^6}{\text{Acceleration/deceleration rate [ms/kHz]} \times 500 \text{ [Hz]} \times \text{Number of divisions}}$$

$$\text{Acceleration [m/s}^2\text{]} = \frac{\text{Lead [mm]} \times 10^3}{\text{Acceleration/deceleration rate [ms/kHz]} \times 500 \text{ [Hz]} \times \text{Number of divisions}}$$

### ● Starting speed

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

| Unit model | **Starting speed** [in/sec (mm/s)] |
|---|---|
| **DRL28** | .008 (0.2) or less |
| **DRL42** | .016 (0.4) or less |
| **DRL60** | .031 (0.8) 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** [in/sec (mm/s)] |
|---|---|
| **DRL28** | .024 (0.6) or less |
| **DRL42** | .047 (1.2) or less |
| **DRL60** | .094 (2.4) or less |

### ● Maximum speed

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

| Unit model | **Maximum speed** [in/sec (mm/s)] |
|---|---|
| **DRL28** | .94 (24) |
| **DRL42** | 1.18 (30) |
| **DRL60** | .94 (24) |

## ■ 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 [in/sec (mm/s)]
*Vs*: Starting speed [in/sec (mm/s)]
*L*: Movement distance [inch (mm)]
*a*: Acceleration [ft/sec$^2$ (m/s$^2$)]
*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*.

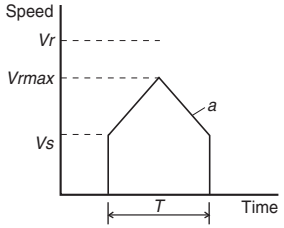
$$Vrmax\ [in/sec] = \sqrt{L\ [inch] \times a\ [ft/sec^2] \times 12 + Vs^2\ [in/sec]}$$

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

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

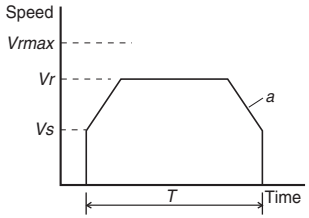
When the maximum speed is at or below the running speed:

**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**

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

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

● **Trapezoidal drive**

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

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

## ■ Example Calculate the positioning time

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

● Movement distance *L*: 1.574 inch (40 mm)
● Starting speed *Vs*: .016 in/sec (0.4 mm/s)
● Acceleration *a*: 1.31 ft/sec$^2$ (0.4 m/s$^2$)
● Operating speed *Vr*: 1.181 in/sec (30 mm/s)

### *2.* Check the operating pattern

$$Vrmax = \sqrt{1.574 \times 1.31 \times 12 + 0.016^2} = 4.974\ [in/sec]$$

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

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

### *3.* Calculate the positioning time

From the formula for trapezoidal drive

Unit = inch

$$T = \frac{(1.181 - 0.016)^2 + 1.574 \times 1.31 \times 12}{1.181 \times 1.31 \times 12}$$

$$= 1.4\ [s]$$

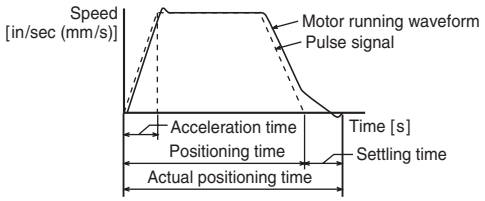
Unit = mm

$$T = \frac{(30 - 0.4)^2 + 40 \times 0.4 \times 10^3}{30 \times 0.4 \times 10^3}$$

$$= 1.4\ [s]$$

## ■ 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 table, 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 table.

**Thrust required to accelerate the table's load mass:**

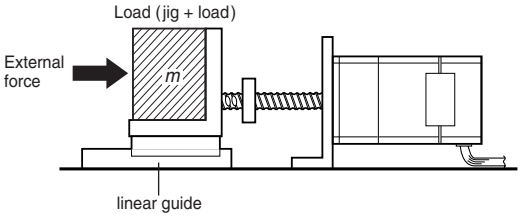
$$Fa\,[\text{lb.}] = m\,[\text{lb.}] \times \left( \frac{a\,[\text{ft/sec}^2]}{g\,[\text{ft/sec}^2]} + \mu \right)$$

$$Fa\,[\text{lb.}] = m\,[\text{kg}] \times (a\,[\text{m/s}^2] + g\,[\text{m/s}^2] + \mu)$$

**Maximum push/pull thrust:**

$$Fa = Fmax - Fa$$

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




*Fmax*: Maximum thrust of actuator [lb. (N)]
*Fa*: Thrust required to carry load (jig + load) [lb. (N)]
*F*: Thrust with which the load mass can be pushed and pulled by an external force [lb. (N)]
*m*: Mass of load (jig + load) [lb. (kg)]
*a*: Acceleration [ft/sec$^2$ (m/s$^2$)]
*g*: Acceleration due to gravity 32.2 (9.807) [ft/sec$^2$(m/s$^2$)]
*μ*: Friction coefficient of linear guide 0.01

**NOTE**

- Operating the actuator under a load beyond the maximum thrust or allowing the table 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 ?
- 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.<br>The screw shaft can be moved by hand. | ●An anti-spin mechanism is not provided for the screw shaft. | ●With the standard-type actuator, the screw shaft can be moved by hand even during excitation. Always equip the product with an external anti-spin mechanism. |
| | ●The A.W.OFF input is turned [ON]. | ●Turn the A.W.OFF input to [OFF] and determine whether the actuator is energized. |
| | ●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 CW input or CCW input. | ●Check the controller and driver connections<br>●Check the pulse-signal specifications (voltage, width) |
| | ●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.<br>●Be sure to turn [OFF] the terminal not receiving input. |
| | ●The pulse signal is connected to the DIR input in 1-pulse input mode. | ●Connect pulse signal to the PLS input. |
| The screw shaft rotates opposite to the specified direction. | ●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 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 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.<br>●Check the pulse-signal specifications (voltage, width ). |

| 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 motor can be started reliably. |
| | ●The acceleration (deceleration) time is too short. | ●Set a longer acceleration (deceleration) time at which the motor can be started reliably. |
| | ●Effect of noise. | ●If effect of noise is confirmed, take an appropriate action such as isolating the motor 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 switch) input. | ●Check the settings of the resolution setting switches (DATA1, DATA2) and the switching condition of the C/S input. |
| The motor 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.<br>●Vibration will increase if the motor's output torque is too large for the load. |
| The actuator is abnormally hot. | ●The DC check switch is set to the [ON] side. | ●Set the DC check switch to the [OFF] side. |
| | ●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 DC check switch is set to the [ON] side. | ●Set the DC check switch to the [OFF] side. |
| | ●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. |

# Specifications

| Driver model | DFC5107T | DFC5114T |
|---|---|---|
| Power-supply input *1 | 24 VDC±10% | |
| | 1A minimum | 2A minimum |
| Input signals | Photocoupler input<br>Photocoupler [ON] condition: +4.5 ~ 5 V<br>Photocoupler [OFF] condition: 0 ~ +1 V<br>CW, CCW : Equivalent input impedance 220 Ω, Input current 10~20 mA<br>A.W.OFF, C/S : Equivalent input impedance 470 Ω, Input current 10~15 mA | |
| Output signals | Photocouple/open-collector output External use condition: 24 VDC or less, 10 mA or less<br>TIMING | |
| Function | Automatic current-cutback | |
| Cooling method | Natural air-cooling | |
| Mass lb. (kg) | 0.44 (0.2) | |

*1 The current value shown for each driver power-supply input indicates the maximum input value.
(The specific value changes, depending on the pulse speed.)

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

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