RCS2-RA13R
ROBO Cylinder Ultra-High Thrust Type

Maximum Press Force 2t

www.intelligentactuator.com
The Birth of the Ultra-High Thrust Actuator Can Be Used as a Simple Press Too

RCS2-RA13R

This electrical actuator provides high-precision positioning control and a maximum of 2 tons of pressing force thanks to its high-output servo motor. Makes it easy to set the pressing force adjustment and position control that are so difficult with hydraulic presses.

1 Provides a maximum pressing force of 2 t (19600 N) and position repetition precision of ±0.01 mm

Provides a maximum of 2 t (19600 N) pressing force, greatly improving the thrust compared to previous electric actuators. This makes it possible to use this even for work such as press fitting and staking that require powerful pressing force. Also, speed adjustment during movement, height management during press fitting, and other such adjustments that were difficult with mechanical presses and hydraulic presses can be made easily by just changing the variables.

Usage examples

- Pin press fitting
  The press fitting position (height) can be adjusted.

- Bearing press fitting
  The pressing speed can be adjusted.

- Staking work
  The pressing force can be adjusted.

- Raising and lowering heavy objects
  Can lift and lower up to 300 kg
Thanks to the ball spline, the rod can handle both radial and rotating loads.

Because a ball spline is used as the rotation stopper for the rod, if the load is light, the road can handle both radial and rotational loads without the necessity to add a guide mechanism.

Can transport a maximum of 500 kg horizontally or 300 kg vertically.

The rated high thrust of 10211 N makes it possible to transport work of 500 kg horizontally or 300 kg vertically. When the option holding brake is installed, it can be set so that when the unit is used vertically and the power is switched off, the rod does not descend and interfere with peripheral equipment.

* This horizontal transport is for when an external guide is attached and the actuator is used for thrust.

For the operation method, both a positioner and pulse string control are supported.

The controller supports both positioner operations, in which the unit is moved by just specifying the desired position number, and pulse string control, which allows the customer to freely change the moving position, speed, and acceleration and deceleration. Direct connection to DeviceNet, CC-Link, and ProfiBus is also possible.

**The field network is an option setting.

* Pulse string control through a field network is not possible.
System configuration

Pulse converter AK-04 (option)

Contents: Pulse converter (AK-04) + Input/output E-Con connector
Please use this option when the upper-level controller output pulses use the open collector specifications.
This converter is for converting command pulses to the differential technique when the upper-level controller output pulses use the open collector specifications. Converting to the differential technique improves the capacity to withstand noise. Two phases of differential output equivalent to that for line driver 26C31 are output. The input/output connectors are E-CON connectors, which are easy to wire in the field.

Basic specifications
- Input power supply: 24 VDC=±10% (50mA max.)
- Input pulses: Open collector (12 mA max. collector current)
- Input frequency: 200 kHz max.
- Output pulses: 26C31 equivalent differential output (10 mA max.)
- External dimensions: See figure on the right (Cable connector not included)
- Weight: 10 g max. (Cable connector not included)
- Accessories: Input/output E-CON connector
37104-3122-000FL, made by 3M
(Compatible wire: AWG No.24-26, 0.14 - less than 0.3 mm²
Finished exterior form ø1.0 ... 1.2 mm)
Model

RCS2 — RA13R — 750 — T2 —

Series Type Encoder type Motor type Lead Stroke Adaptive controller Cable length Options
1 Incremental 2.5 1st type 50 50mm SCOT
1A Absolute 125 2nd type 

When selecting multiple options, enter them in alphabetical order.

Brakes
C Reverse Motor Spec
2 Spec & Cable exit location
3

Reverse Motor Spec/Cable Exit Location (option)

Option code (No notation) C2 R1 L1
Reverse Motor Spec Up (standard) Up Right Left
Cable Exit Location Up (standard) Right Up

Foot fitting/flange (option)

Foot fitting Stand-alone model RCS2-FT-RA13
Flange Stand-alone model RCS2-FL-RA13

<table>
<thead>
<tr>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>50</td>
<td>40</td>
<td>2</td>
<td>42.5</td>
</tr>
<tr>
<td>75</td>
<td>65</td>
<td>2</td>
<td>47.5</td>
</tr>
<tr>
<td>150</td>
<td>40</td>
<td>3</td>
<td>42.5</td>
</tr>
<tr>
<td>200</td>
<td>65</td>
<td>3</td>
<td>47.5</td>
</tr>
</tbody>
</table>
RCS2 RA13R
Robo-Cylinder Ultra-High Thrust Rod Type
Main unit width 130mm
200V servo motor
Motor reversing specifications

Model item | RCS2-RA13R
---|---
Encoder type | Incremental specifications
| Absolute specifications
Motor type | 750W
Motor rated voltage | 750W
Lead | 2.5mm
Lead (mm) | 2.5
Lead (mm) | 2.5
Stroke (mm) | 50
Stroke (mm) | 50
Adaptive controller | T2.5CON
Adaptive controller | T2.5CON
Cable length (m) | 1
Cable length (m) | 1
Options | See the option price table below.

Correlation diagram of pressing force and current restriction value

Notes:
- The numbers for the relationship between the pressing force and current restriction value are just rough representations, as they may differ from the actual numbers.
- There can be variation in the pressing force when the current restriction value is low, so use at 20% or higher.
- The movement speed is fixed to 10 mm/s for pressing operation.
- Be aware that since the graph is for pressing at 10 mm/s, if the speed is different, the pressing force drops.
- Depending on the operating conditions, the rise in the motor temperature may reduce the pressing force.

Caution
(1) When pressing operations are carried out, the continuous usage time is determined by the pressing force set. Even in normal operation, it is necessary that the continuous operation thrust be less than the rated thrust to take load and duty ratio into account.
(2) The horizontal transport weight is the figure for when an external guide is used also and the rod is free from external force other than in the direction of progress.
(3) When the optional brake is installed, a brake box is required besides the main unit and controller. (For accessories, see Page 7.)

Actuator specifications

- Lead and transportable weight

<table>
<thead>
<tr>
<th>Model</th>
<th>Motor output (W)</th>
<th>Lead (mm)</th>
<th>Maximum transportable weight (kgf)</th>
<th>Rated thrust (N)</th>
<th>Maximum thrust (N)</th>
<th>Stroke (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>RCS2-RA13R</td>
<td>750</td>
<td>2.5</td>
<td>400</td>
<td>200</td>
<td>5106</td>
<td>9800</td>
</tr>
<tr>
<td>RCS2-RA13R</td>
<td>1-750-2.25</td>
<td>1.25</td>
<td>500</td>
<td>300</td>
<td>10211</td>
<td>19600</td>
</tr>
</tbody>
</table>

Codes: ① Encoder type ② Stroke ③ Cable length ④ Options

Table by ① Encoder type / ② Stroke

<table>
<thead>
<tr>
<th>Stroke (mm)</th>
<th>Incremental</th>
<th>Absolute</th>
</tr>
</thead>
<tbody>
<tr>
<td>50</td>
<td>1t type (lead 2.5)</td>
<td>1t type (lead 1.25)</td>
</tr>
<tr>
<td>100</td>
<td>2t type (lead 2.5)</td>
<td>2t type (lead 1.25)</td>
</tr>
<tr>
<td>150</td>
<td>2t type (lead 2.5)</td>
<td>2t type (lead 1.25)</td>
</tr>
</tbody>
</table>

Table by cable length

<table>
<thead>
<tr>
<th>Type</th>
<th>Cable code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard type</td>
<td>P (1m)</td>
</tr>
<tr>
<td>Standard type</td>
<td>S (3m)</td>
</tr>
<tr>
<td>Standard type</td>
<td>M (5m)</td>
</tr>
<tr>
<td>Special length</td>
<td>X06 (8m)</td>
</tr>
<tr>
<td>Special length</td>
<td>X11 (10m)</td>
</tr>
<tr>
<td>Special length</td>
<td>X16 (15m)</td>
</tr>
<tr>
<td>Special length</td>
<td>X20 (20m)</td>
</tr>
<tr>
<td>Special length</td>
<td>R01 (3m)</td>
</tr>
<tr>
<td>Special length</td>
<td>R03 (5m)</td>
</tr>
<tr>
<td>Special length</td>
<td>R05 (5m)</td>
</tr>
<tr>
<td>Special length</td>
<td>R06 (5m)</td>
</tr>
<tr>
<td>Special length</td>
<td>R10 (10m)</td>
</tr>
<tr>
<td>Special length</td>
<td>R11 (11m)</td>
</tr>
<tr>
<td>Special length</td>
<td>R15 (15m)</td>
</tr>
<tr>
<td>Special length</td>
<td>R16 (16m)</td>
</tr>
</tbody>
</table>

Actuator specifications

<table>
<thead>
<tr>
<th>Item</th>
<th>Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drive type</td>
<td>Ball screw ø32 mm, C10 form relieved</td>
</tr>
<tr>
<td>Position repetition precision</td>
<td>±0.01mm</td>
</tr>
<tr>
<td>Backlash</td>
<td>0.2mm max</td>
</tr>
<tr>
<td>Rod diameter</td>
<td>ø50 mm (ball spline)</td>
</tr>
<tr>
<td>Permitted rod moment</td>
<td>120N·m</td>
</tr>
<tr>
<td>Usage ambient temperature and humidity</td>
<td>0°C～+60°C, 85% RH max. (no condensation allowed)</td>
</tr>
</tbody>
</table>
**Controller**

**Adaptive controller**

The RCS2-RA13R can operate with the controllers below. Select the type that matches your application.

<table>
<thead>
<tr>
<th>Name</th>
<th>Appearance</th>
<th>Model</th>
<th>Features</th>
<th>Maximum number/positioning points</th>
<th>Input power supply</th>
<th>Power supply capacity</th>
<th>Standard price</th>
<th>Reference page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positioner mode</td>
<td></td>
<td>SCON-C-75X1-AP-2-2</td>
<td>Can position up to 512 points.</td>
<td>512</td>
<td>Single phase</td>
<td>1569 VA max.</td>
<td></td>
<td>P7</td>
</tr>
<tr>
<td>Solenoid mode</td>
<td></td>
<td></td>
<td>Can operate with the same control as for a solenoid.</td>
<td>3/7</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pulse string</td>
<td></td>
<td></td>
<td>Pulse string input dedicated type</td>
<td>61</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>input control cable</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* [1] is the encoder type (B: Incremental/A: Absolute).
Controller

Scon
Ultra-high position controller

- Position controller that can position up to 512 points
- Support for pulse string input makes possible free operation under customer control
- Can be directly connected to DeviceNet, CC-Link, and Profinet

Type List

There are two types of SCON controllers, the standard specifications that operate with PIO or pulse string input and the optional network specifications that operate connected to a field network. Both types have incremental specifications and absolute specifications, but when operating with pulse string input, operation is only incremental.

<table>
<thead>
<tr>
<th>Type name</th>
<th>Specifications</th>
<th>Standard specifications</th>
<th>Network connection specifications (Option)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Details</td>
<td>Positioning mode / Teaching mode / Solenoid mode / Pulse string mode</td>
<td>DeviceNet connection specifications</td>
<td>CC-Link connection specifications</td>
</tr>
<tr>
<td>Position point count</td>
<td>512 max.</td>
<td>(Unrestricted)</td>
<td>512 max.</td>
</tr>
<tr>
<td>I/O type code</td>
<td>NP / PN</td>
<td>DV</td>
<td>CC</td>
</tr>
<tr>
<td>Supported encoder type</td>
<td>Incremental / Absolute</td>
<td>Incremental / Absolute</td>
<td>Incremental / Absolute</td>
</tr>
</tbody>
</table>

Model

SCON C 750

Series Type Motor type Encoder type I/O type I/O cable length Power supply voltage

Controller specifications:
- Controller series type: SCON
- Power supply capacity: 1569 VA max.
- Input power supply: Single phase 200-230 ±10% VAC
- Maximum voltage: ±10%
- Maximum number of axes controlled: 1 axis
- Position detection technique: Incremental / Absolute encoder
- Safety circuit configuration: Dispel not possible
- Drive power cutoff: Internal relay cut-off
- Enable input: 8 contact input (internal power feed type)
- Speed setting: 1 m/min - upper limit, depending on actuator
- Acceleration setting: 0.21 G / 1 - upper limit, depending on actuator
- Operation technique: Positioner operation/pulse stringing control

Position
- Position count: 512 max.
- Data storage device: EEPROM
- Data input method: Teaching box or PC software
- Standard I/O: 16 Inputs/16 Outputs (NPN/NPN can be selected)
- Expanded I/O: Not possible
- Serial communication functions: Teaching port (RS485)

General specifications:
- Usage ambient temperature and humidity: 0-40°C, 10-95% (no condensation allowed)
- Usage ambient temperature: There must be no corrosive gas and low levels of dust
- External dimensions: 72 (W) x 209.5 (H) x 121 (D)
- Weight: 1.1 kg
- Accessories: I/O flat cable (40 lines)

Specifications

Dimension Diagram

- Controller main unit
- Brake box (accessory) (Accessory with brake specifications)

Caution
The brake box requires a 24 VDC (1A max.) power supply.
I/O wiring diagram

Positioning mode / Teaching mode / Solenoid mode

Pulse string mode (differential output)

I/O signal table

* The contents in the ( ) in the above signal names are the functions before the return to the origin.
Pulse string type input/output specifications (differential line driver specifications)

- **Input section**
  
  Maximum input: Line driver interface 500 kpps
  Pulse count open connector interface 200 kpps (AK-04 required). Insulation type: photocoupler insulation

- **Output section**
  
  Output type: Line driver output
  Insulated/non-insulated: Non-insulated

Pulse string type input/output specifications (open collector specifications)

* For the 24VDC power supply connected to AK-04, use the same one connected to the PIO interface.
* Make the cable between the pulse output unit (PLC) and the AK-04 as short as possible. Use a cable no longer than 2 meters between the AK-04 and the pulse connector.
### Teaching box

**Features**: This is a teaching device equipped with position input, test run, monitor, and other functions.

**Models**:
- CON-T (standard type)
- RCM-E (simple teaching box)
- RCM-P (data setting unit)

### PC software (for Windows only)

**Features**: This is startup support software equipped with program/position input, test run, monitor, and other functions. It increases functions required for debugging operations and contributes to shortening the start-up time.

**Model**: RCM-101-MW (with external device communications cable + RS232 converter unit).

**Configuration**: PC software (CD) - RS232 converter adapter RCB-CV-MM - External device communication cable CB-RA-A10050

**Model**: RCM-101-USB (with external device communications cable + USB cable).

**Configuration**: PC software (CD) - USB converter adapter RCB-CV-USB - External device communication cable CB-RA-A10050

### Regeneration resistance unit

**Features**: This unit returns to heat the regeneration current generated when the motor decelerates. Check the operation direction and lead for the actuator operating in the table below and if regeneration resistance is required, prepare it.

**Model**: REU-2 (For SCON/SSEL)

**Specifications**:
- Main unit weight: 0.9 kg
- Internal regeneration resistance value: 22 Ohm
- Main unit – controller connection cable (accessory): CB-SG-REU2010 (for SSEL)

**Yardstick for required count**:

<table>
<thead>
<tr>
<th>Lead 2.5 type</th>
<th>Lead 1.25 type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Horizontal</td>
<td>Vertical</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

* Depending on the operating conditions, more regeneration resistance than above may be required.

### Absolute data storage battery

**Features**: This battery is for storing absolute data when operating with an absolute specifications actuator.

**Model**: AB-5

### Specifications

<table>
<thead>
<tr>
<th>Item</th>
<th>CON-T</th>
<th>RCM-E</th>
<th>RCM-P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data Input</td>
<td>○</td>
<td>○</td>
<td>×</td>
</tr>
<tr>
<td>Manualing</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Usage ambient temp.</td>
<td>Temperature: 0 to 40°C, Relative Humidity: 85% Max</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Usage ambient atmosphere</td>
<td>There must be no corrosive gas and dust must not be particularly bad</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Environmental Resist.</td>
<td>IPS4</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Weight</td>
<td>~400g</td>
<td>~400g</td>
<td>~360g</td>
</tr>
<tr>
<td>Cable Length</td>
<td>5m</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Display</td>
<td>28 character by 4 line LCD display</td>
<td>16 character by 2 line LCD display</td>
<td>16 character by 2 line LCD display</td>
</tr>
</tbody>
</table>
Maintenance Parts

When it is necessary to make arrangements for a replacement cable or the like after product purchase, find the model below.

Motor cable / motor robot cable

Model CB-RCC-MA□□□ / CB-RCC-MA□□□-RB

* For □□, enter the cable length (L), up to 30 meters, Example: 080 = 8 meters

Encoder cable / encoder robot cable

Model CB-RCS2-PLA□□□ / CB-X2-PLA□□□

* For □□, enter the cable length (L), up to 30 meters, Example: 080 = 8 meters

I/O flat cable

Model CB-PAC-P1O□□□

* For □□, enter the cable length (L), up to 30 meters, Example: 080 = 8 meters

SCON pulse string control cable

Model CB-SC-P10S□□□

* For □□, enter the cable length (L), up to 30 meters, Example: 080 = 8 meters
When this machine is used, it is necessary to fulfill the following three conditions.

Condition 1. The pressing time must be no longer than the determined time.
Condition 2. The continuous operating thrust for one cycle must be no greater than the actuator’s rated thrust.
Condition 3. There must be one pressing operation for one cycle.

Selection method

**Condition 1** Pressing time

The maximum pressing time relative to each pressing command value is determined as in the table below. Always use a pressing time no greater than the time in the table below. If this machine is used in violation of the values in the table below, trouble may occur in the actuator.

<table>
<thead>
<tr>
<th>Pressing command value (%)</th>
<th>Maximum pressing time (s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Below 70</td>
<td>300</td>
</tr>
<tr>
<td>80 - 100</td>
<td>230</td>
</tr>
<tr>
<td>110</td>
<td>95</td>
</tr>
<tr>
<td>120</td>
<td>58</td>
</tr>
<tr>
<td>130</td>
<td>43</td>
</tr>
<tr>
<td>140</td>
<td>33</td>
</tr>
<tr>
<td>150</td>
<td>27</td>
</tr>
<tr>
<td>160</td>
<td>21</td>
</tr>
<tr>
<td>180</td>
<td>18</td>
</tr>
<tr>
<td>190</td>
<td>15</td>
</tr>
<tr>
<td>200</td>
<td>13</td>
</tr>
</tbody>
</table>

**Condition 2** Continuous operation thrust

Check that the continuous operation thrust $F_t$ for one cycle taking the load and duty ratio into account is less than the rated thrust of the ultra-high thrust actuator. There must be one pressing operation for one cycle.

The continuous operation thrust $F_t$ for one cycle is calculated from the equation below.

$$F_t = \sqrt{\frac{F_{uw}\times t_{uw} + F_{sw}\times t_{sw} + F_{uw}\times t_{uw} + F_{sw}\times t_{sw} + F_{uw}\times t_{uw} + F_{sw}\times t_{sw} + F_{uw}\times t_{uw} + F_{w}\times t_{w}}{t}}$$

- $F_{uw}$ is the thrust required for acceleration 1
- $F_{sw}$ is the thrust required for deceleration 1
- $F_{uw}$ is the thrust required for acceleration 2
- $F_{sw}$ is the thrust required for deceleration 2
- $F_{w}$ is the thrust required for standby

F1a/F2a/F1d/F2d depend on the operation direction, so calculate with the equation below.

For horizontal use (acceleration/deceleration the same)
- For vertical use: Acceleration during descent
- For vertical use: Constant-speed movement during descent
- For vertical use: Deceleration during descent
- For vertical use: Acceleration during ascent
- For vertical use: Constant-speed movement during ascent
- For vertical use: Deceleration during ascent
- For vertical use: Standby

$$F_{uw} = (M+m) \times 9.8 - (M+m) \times d$$
$$F_{sw} = (M+m) \times 9.8 + (M+m) \times d$$

**Notes**

- $M$ : Moving section weight (kg)
- $m$ : Load weight (kg)
- $d$ : Command acceleration/deceleration (m/s²)
- $a$ : Thrust taking the external guide traveling resistance into account

*1 When an external guide or the like is installed, it is necessary to take the traveling resistance into account.
Ultra-high thrust type selection conditions

- *ta* is the acceleration time, but the calculation method is different for (1) trapezoidal patterns and (2) triangular patterns.
  The difference between trapezoidal patterns and triangular patterns can be judged by whether the speed attained is greater or less than the set speed when the system is operated the movement distance with the set speed.

  
  Attained speed \( (V_{\text{max}}) = \sqrt{\text{movement distance (m)} \times \text{set acceleration (m/s)}} \)

  Set speed < attained speed: (1) Trapezoidal pattern
  Set speed > attained speed: (2) Triangular pattern

For (1) Trapezoidal pattern
  \[ a = \frac{V_s}{a} \quad V_s: \text{Set speed (m/s)} \quad a: \text{Command acceleration (m/s}^2) \]

For (2) Triangular pattern
  \[ t = \frac{V_s}{a} \quad V_s: \text{Attained speed (m/s)} \quad a: \text{Command acceleration (m/s}^2) \]

- *tf* is the constant-speed time. Calculate the distance traveled at constant speed.
  \[ t = \frac{L}{V} \quad L: \text{Distance traveled at constant speed (m)} \quad V: \text{Command speed (m/s)} \]

- Distance traveled at constant speed = movement distance – acceleration distance – deceleration distance
  \[ \text{acceleration distance (deceleration distance)} = \frac{V^2}{2a} \]

- *td* is the deceleration time. If the acceleration and the deceleration are the same, then the deceleration time is the same as the acceleration time.
  \[ t = \frac{V_s}{a} \quad V_s: \text{Set speed (trapezoidal pattern) or attained speed (triangular pattern) (m/s)} \quad a: \text{Command deceleration (m/s}^2) \]

If the continuous operation thrust \( F_t \) found this way is less than the rated thrust, the pattern can be run.

**Ultra-high thrust actuator lead 2.5 type**  Rated thrust: 5100N

**Ultra-high thrust actuator lead 1.25 type**  Rated thrust: 10,200N

If the run conditions satisfy Condition 1 and Condition 2 above at the same time, the pattern can be operated.
If either of the conditions cannot be satisfied, take measures such as reducing the pressing operation time or lowering the duty ratio.

**Example question**

**Using the above selection method, try the operation pattern selection work.**

Running conditions:
- Machine type used: Ultra-high thrust actuator lead 1.25 type
- Installation posture: Vertical
- Speed: 62 mm/s
- Acceleration: 0.098 m/s^2 (0.01G, same value for deceleration too)
- Movement distance: 50mm
- Loaded weight: 100kg
- Pressing command value: 200% (2000kgf)
- Pressing time: 3s
- Standby time: 2s
- Also, the same operation conditions are set for ascent and descent.

Graphing the above operation conditions gives the figure on the right.
We will make the calculation according to the selection method.

**Condition 1.** Check the press operation time.

From Table 1 on Page 12, the pressing time was 3 seconds and the maximum pressing time is 13 seconds for a pressing command value of 200%, so this shows that the pressing time is OK.

**Condition 2.** Find the continuous operation thrust.

Substitute the above operation pattern into the above continuous operation thrust equation.

\[
F_t = \sqrt{\frac{F_{ws} \times t_{ws} + F_{ws'} \times t_{ws'} + F_{ws} \times t_{ws} + F_{ws'} \times t_{ws'} + F_{ws} \times t_{ws} + F_{ws'} \times t_{ws'} + F_{ws} \times t_{ws} + F_{ws'} \times t_{ws'}}{t}}
\]

Here, when you check the operation t1a/t1d/t2a/t2d operation pattern, the attained speed \(V_{max}\) = \(\sqrt{0.05 \times 0.098} \leq 0.07 \text{ m/s},\) which is greater than the set speed of 62 mm/s \((0.06 \text{ m/s}),\) so the pattern becomes trapezoidal.

Therefore, \(t1a/t1d/t2a/t2d = 0.062 \leq 0.098 \leq 0.63 \text{ s}.\)

Next, if \(t1f/t2f\) is calculated,

the distance traveled at constant speed = 0.05 - \((0.062 \times 0.062) \approx 2\times 0.098) \times 0.011 \text{ m, so } t1f/t2f = 0.011 \approx 0.062 \leq 0.17 \text{ s}.

Also, if \(F_{1a}/F_{1d}/F_{2a}/F_{2d}\) is calculated from the equation,

\[
F_{1a} = F_{2d} = (9 + 100) \times 9.8 - (9 + 100) \times 0.098 \rightarrow 1058N
\]

\[
F_{1d} = F_{2a} = (9 + 100) \times 9.8 + (9 + 100) \times 0.098 \rightarrow 1079N
\]

\[
F_{1f} = F_{2f} = F_w = (9 + 100) \times 9.8 \rightarrow 1068N
\]

Substituting the above numbers into the continuous operation thrust equation, gives

\[
F_t = \sqrt{\left( (1058 \times 1058) \times 0.63 + (1068 \times 1068) \times 0.17 + (1079 \times 1079) \times 0.63 + (19600 \times 19600) \times 3 + (1079 \times 1079) \times 0.63 \right) + (1068 \times 1068) \times 0.17 + (1058 \times 1058) \times 0.63 + (1068 \times 1068) \times 2} = (0.63 + 0.17 + 0.63 + 3 + 0.63 + 0.17 + 0.63 + 2) \leq 12113N
\]

Since this exceeds the rated thrust of 10,200 N for the ultra-high thrust actuator 2-ton type, this operating pattern cannot be run.

So we try extending the standby time. (Lowering the duty ratio)

Here, if we recalculate with \(t_w = 6.12s (t = 12s),\) \(F_t = 9814N\) and the pattern can be run.

---

**Moment selection documentation**

The ultra-high thrust actuator can apply load to the rod with the range of the conditions of the equations below.

\[
M + T \geq 120 \text{ (N \cdot m)}
\]

- Load moment \(M = Wg \times L_2\)
- Load torque \(T = Wg \times L_1\)

\(\bigstar g = \text{Acceleration due to gravity} \quad 9.8\)

* \(L_1 = \text{Distance from the center of the rod to the center of gravity of the work}\)
* \(L_2 = \text{Distance from the actuator installation surface to the center of gravity of the work} + 0.07\)

If the above conditions are not met, take load off the rod, for example by installing an external guide.