Rotating joint 2-axis unit

Wrist Unit is now available

1 IAI’s Unique design makes the parts light and compact.

![Small S type](image1)

- Unit weight: 2.8 kg
- Maximum Payload 2.0 kg
- **B-axis** ±100 deg.
- **T-axis** ±360 deg.

![Medium M type](image2)

- Unit weight: 1.6 kg
- Maximum Payload 1.0 kg
- **B-axis** ±105 deg.
- **T-axis** ±360 deg.

2 Ideal for reducing the cost of equipment. Low cost compared to 6-axis articulated robots.

Diagonal approaches and tip swiveling, possible until now only with vertically articulated robots, can now be performed with the minimum required axis configuration. Ideal for reducing the cost of equipment.

![Configuration example](image3)

| (1) Wrist Unit: WU-S |
| (2) Table Type: RCP6-TA6C Stroke: 320 mm |
| (3) Slider Type: RCP6-SA7R Stroke: 300 mm |
| (4) Controller: MSEL |

Equipped with a Battery-less Absolute Encoder as Standard
Combination with a high-straightness cartesian robot makes it capable of avoiding obstacles and working in tight spaces.

Work in tight spaces

It is also ideal for work with a wide operation range.

Work in a wide operation range

The combination pattern, number of axes and stroke can be freely selected according to the application.

Flexible combinations

3 Orthogonal axes and interpolation commands are possible

(1) When connecting Wrist Unit and 2-axis actuator (*1)

*1 Stepper motor mounted actuator

Wrist Unit (for 2 axes) Single Axis/Cartesian Robot (up to 2 axes)

MSEL

XSEL-RA/SA expanded motion control function (equipped as standard)

* Please refer to P.19 for more information.

(2) When connecting Wrist Unit and 3-axis or more actuator (*2)

*2 Stepper/servo motor mounted actuator

Wrist Unit (for 2 axes) Single Axis/Cartesian Robot (up to 6 axes)

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*2 Stepper/servo motor mounted actuator

Wrist Unit (for 2 axes) Single Axis/Cartesian Robot (up to 6 axes)
Application Examples

Bottle labeling equipment
This device affixes labels to bottles. Adjusts the angle to the labeling surface on the B-axis and rotates the label on the T-axis to change the orientation.

Automotive connector inspection equipment
This device inspects the external view of connectors for automobiles, using a camera. The Wrist Unit rotates the connector for inspection from various angles.

Controller connection example
“Wrist Unit + ROBO Cylinder 2-axis configuration” can be controlled with a single MSEL controller.

Controller connection example
“Wrist Unit + ROBO Cylinder 3-axis configuration” can be controlled with the MCON controller, using XSEL-RA/SA expanded motion control.

Please refer to P.17 for more information.
Please refer to P.19 for more information.
**WU Series List**

<table>
<thead>
<tr>
<th>Type</th>
<th>Compact type</th>
<th>Medium type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
<td>WU-S</td>
<td>WU-M</td>
</tr>
</tbody>
</table>

**External view**

<table>
<thead>
<tr>
<th>Axis configuration</th>
<th>B-axis (wrist swing)</th>
<th>T-axis (wrist rotation)</th>
<th>B-axis (wrist swing)</th>
<th>T-axis (wrist rotation)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operation range</td>
<td>±100 deg.</td>
<td>±360 deg.</td>
<td>±105 deg.</td>
<td>±360 deg.</td>
</tr>
<tr>
<td>Max. torque *1</td>
<td>0.65N·m</td>
<td>0.65N·m</td>
<td>1.65N·m</td>
<td>1.65N·m</td>
</tr>
<tr>
<td>Max. allowable moment of inertia *2</td>
<td>0.0085kgm²</td>
<td>0.0075kgm²</td>
<td>0.015kgm²</td>
<td>0.0165kgm²</td>
</tr>
<tr>
<td>Max. load weight</td>
<td>1kg</td>
<td>2kg</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Max. speed *3</td>
<td>750 deg/s</td>
<td>1200 deg/s</td>
<td>900 deg/s</td>
<td>1200 deg/s</td>
</tr>
<tr>
<td>Max. acceleration/deceleration</td>
<td>0.7 G (6865 deg/s²)</td>
<td>0.7 G (6865 deg/s²)</td>
<td>0.7 G (6865 deg/s²)</td>
<td>0.7 G (6865 deg/s²)</td>
</tr>
<tr>
<td>Motor type</td>
<td>28□ Stepper motor</td>
<td>28□ Stepper motor</td>
<td>35□ Stepper motor</td>
<td>35□ Stepper motor</td>
</tr>
<tr>
<td>Unit weight</td>
<td>1.6kg</td>
<td>2.8kg</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reference page</td>
<td>P.13</td>
<td>P.15</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*1 Indicates the maximum torque at low speed. The output torque varies with the speed.

*2 Indicates the maximum moment of inertia in rotation. Value when the acceleration is 0.3 G.

*3 Maximum set speed with no load.

*4 When the rotational axes of the B-axis and T axis are horizontal with respect to the floor surface or when the center of gravity of the transported object is offset from the rotational axis, the unit will be subject to load torque due to the weight of the object. The allowable moment of inertia decreases when load torque is present. Please refer to "Model Selection Process (P.10 on)" for more information.

**Model Specification Items**

**WU Series**

- **Type**
  - S: Compact type
  - M: Medium type

**WA Encoder**

- **Type**
  - Battery-less Absolute

**PM1 Applicable Controllers**

- **Cable Length**
  - N: None
  - P: 1m
  - S: 5m
  - M: Specified length
  - X: Robot cable

- **Options**
  - A1: Cable exit direction (Right)
  - A2: Cable exit direction (Bottom)
  - A3: Cable exit direction (Left)
  - AC1.5: Actuator's pigtail cable length change
  - VC: With air fitting
  - CVR: Cable (air fitting) in opposite position
  - WCS: With wiring collar
## Options

### Cable exit direction

<table>
<thead>
<tr>
<th>Model</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1 / A2 / A3</td>
<td>Specify when changing the Actuator's pigtail cable exit direction.</td>
</tr>
</tbody>
</table>

### Actuator's pigtail cable length change

<table>
<thead>
<tr>
<th>Model</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>AC1.5</td>
<td>This option extends the length of the Actuator's pigtail cable exiting the actuator body to 1.5 m. (Standard length is 0.2 m) When this option is selected, the maximum cable length between the actuator and controller will be 18 m (X18, R18).</td>
</tr>
</tbody>
</table>

### With air fitting

<table>
<thead>
<tr>
<th>Model</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>VC</td>
<td>This option allows attachment of an air fitting (φ6) for connecting pneumatic devices such as vacuum pads to the side of the main body. It is mounted on the same side as the Actuator's pigtail cable outlet. Please refer to the dimensions on the product pages. (WU-S: P.14, WU-M: P.16)</td>
</tr>
</tbody>
</table>

### With wiring collar

<table>
<thead>
<tr>
<th>Model</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>WCS</td>
<td>When using electric grippers or similar wiring is made easy by using the wiring collar. Use the wiring collar as the base to which the wiring bracket (to be prepared by the customer) is to be attached. Please refer to the dimensions on the product pages. (WU-S: P.14, WU-M: P.16)</td>
</tr>
</tbody>
</table>

### Cable (air fitting) in opposite position

<table>
<thead>
<tr>
<th>Model</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>CVR</td>
<td>This option allows the Actuator's pigtail outlet, air fitting, and wiring collar (optional) to be mounted on the other side (opposite position). Please refer to the dimensions on the product pages. (WU-S: P.14, WU-M: P.16)</td>
</tr>
</tbody>
</table>
Mounting Method

- **Body mounting method**
  The body mounting surface should be a machined surface or a plane with similar accuracy.
  The actuator has screw holes and positioning holes for body mounting on the top (mounting surface A) and side (mounting surface B). For details on positions and dimensions, refer to the product pages.

  1. When using mounting surface A
     (Thread depth WU-S: M4 through (screw depth: 6) / WU-M: M5 through (screw depth: 10)

  2. When using mounting surface B
     (Thread depth WU-S: M4 depth 8 / WU-M: M5 depth 10)

- **Body installation orientation**
  All 6 orientations below are possible.

- **Tool mounting method**
  The unit is provided with screw holes for bracket mounting to the body tip (mechanical interface), screw holes for air piping mounting, and positioning holes. Refer to the dimensions (WU-S: P.12, WU-M: P.14) for details regarding the position and dimensions.
  Do not apply excessive force to the output shaft when tightening bolts or air piping threads. The mechanical interface is provided with holes for a hook wrench. Use these to fix the output shaft in the rotating direction.

  1. When using bracket mounting screws
     (Thread depth WU-S: M4 depth 6 / WU-M: M4 through (screw depth: 6)

  2. When using air piping mounting screws
     Seal the threaded part of the air piping with sealing tape, etc.
     (Thread depth WU-S: M6 through (screw depth: 4.5) / WU-M: M6 through (screw depth: 4.5)
Model Selection Process

Follow steps 1 through 4. For a selection example, refer to the following pages.

**Step 1**
Check the weight of the transported object

![Diagram of weight of transported object](image)

Weight of transported object \(\leq\) Maximum payload

**Step 2**
Check the moment of inertia

Check the presence of load torque on the B- and T-axes

If “Yes”

\[
\text{Moment of inertia applied to B- and T-axes} \leq \text{Corrected allowable moment of inertia for compact and medium types}^*
\]

If “None”

\[
\text{Moment of inertia applied to B- and T-axes} \leq \text{Allowable moment of inertia for compact and medium types}^*
\]

*It varies with the speed and acceleration/deceleration.

“Formulae for calculating moment of inertia of typical shapes” are on page 12.

**Step 3**
Check the allowable dynamic thrust load

Make sure that the thrust load (load perpendicular to the mounting surface) does not exceed the allowable dynamic thrust load.

![Diagram of dynamic thrust load](image)

Dynamic thrust load: \(F\) \(\leq\) Allowable dynamic thrust load

**Step 4**
Check the allowable dynamic load moment

Make sure that the load moment does not exceed the allowable dynamic moment.

![Diagram of dynamic load moment](image)

Dynamic load moment: \(M\) \(\leq\) Allowable dynamic load moment
Reference Data

Model Selection Example: Automotive Connector Inspection Equipment

The model selection example given is based on the application example “Automotive connector inspection equipment” (P. 3).

Automotive connector inspection equipment

Overview
This device inspects the external view of connectors for automobiles, using a camera. The Wrist Unit rotates the connector for inspection from various angles.

Step 1 Check the weight of the transported object
<Weight of transported object = weight of tool + weight of workpiece>

<table>
<thead>
<tr>
<th></th>
<th>Maximum load weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>WU-S: Compact type</td>
<td>1kg</td>
</tr>
<tr>
<td>WU-M: Medium type</td>
<td>2kg</td>
</tr>
</tbody>
</table>

Transported object = 0.02[kg] + 0.013[kg] = 0.033[kg]

Both WU-S (compact) and WU-M (medium) can be used

Step 2 Check the moment of inertia
Check the presence of load torque on the B- and T-axes

If “Yes”
- Calculate the load torque and obtain the corrected allowable moment of inertia. Then calculate the moment of inertia and check that it does not exceed the allowable value.

If “None”
- Calculate the moment of inertia and confirm that it is less than the allowable moment of inertia.

Conditions in which load torque is applied

<table>
<thead>
<tr>
<th>Installation orientation</th>
<th>Presence of load torque</th>
</tr>
</thead>
<tbody>
<tr>
<td>B-axis</td>
<td>(1) Yes (2) Yes (3) None (4) Yes (5) Yes</td>
</tr>
<tr>
<td>T-axis</td>
<td>(1) None (2) Yes (3) None (4) None (5) Yes</td>
</tr>
</tbody>
</table>

As the current example of the “automotive connector inspection equipment” corresponds to these, the B-axis and T-axis are calculated and confirmed as described below.

1. [B-axis] Load torque “Yes”
2. [T-axis] Load torque “None”
1. Check B-axis

(1) Calculating load torque $T_l$

$$T_l = m_l g (r_0 + r_{CT}) \times 10^{-3} + m_w g (r_0 + r_{CW}) \times 10^{-3}$$

$$= 0.02 \times 9.8 \times (39 + 25) \times 10^{-3} + 0.013 \times 9.8 \times (39 + 60) \times 10^{-3}$$

$$= 0.025 \text{ [Nm]}$$

(2) Calculating the allowable moment of inertia correction factor $C_j$

$$C_j = \frac{T_{max} - T_l}{T_{max}}$$

First, calculate with the value for the compact type (S)

$$C_j = \frac{T_{max} - T_l}{T_{max}} = \frac{0.58 - 0.025}{0.58} = 0.96$$

(3) Calculating the corrected allowable moment of inertia $J_{tl}$

$$J_{tl} = J_{max} C_j (\text{kgm}^2)$$

Output torque by speed [Nm]

<table>
<thead>
<tr>
<th>Speed deg./s</th>
<th>WU-S: Compact type</th>
<th>WU-M: Medium type</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0.65 0.65</td>
<td>0 1.65 1.65</td>
</tr>
<tr>
<td>150</td>
<td>0.65 0.65</td>
<td>150 1.65 1.65</td>
</tr>
<tr>
<td>300</td>
<td>0.62 0.62</td>
<td>300 1.65 1.65</td>
</tr>
<tr>
<td>450</td>
<td>0.6 0.6</td>
<td>450 1.65 1.65</td>
</tr>
<tr>
<td>600</td>
<td>0.58 0.58</td>
<td>600 1.58 1.58</td>
</tr>
<tr>
<td>750</td>
<td>0.52 0.52</td>
<td>750 1.36 1.36</td>
</tr>
<tr>
<td>900</td>
<td>0.45 0.45</td>
<td>900 1.14 1.14</td>
</tr>
<tr>
<td>1050</td>
<td>0.45 0.45</td>
<td>1050 0.96 0.96</td>
</tr>
<tr>
<td>1200</td>
<td>0.45 0.45</td>
<td>1200 0.79 0.79</td>
</tr>
</tbody>
</table>

Allowable moment of inertia by speed/acceleration [kgm$^2$]

<table>
<thead>
<tr>
<th>Speed deg./s</th>
<th>WU-S: Compact type</th>
<th>WU-M: Medium type</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0.008 0.0035</td>
<td>0 0.0015 0.0126</td>
</tr>
<tr>
<td>150</td>
<td>0.008 0.0035</td>
<td>150 0.0150 0.0126</td>
</tr>
<tr>
<td>300</td>
<td>0.008 0.0035</td>
<td>300 0.0118 0.0072</td>
</tr>
<tr>
<td>450</td>
<td>0.008 0.0035</td>
<td>450 0.0055 0.0054</td>
</tr>
<tr>
<td>600</td>
<td>0.008 0.0035</td>
<td>600 0.0055 0.0054</td>
</tr>
<tr>
<td>750</td>
<td>0.0035</td>
<td>750 0.0054</td>
</tr>
<tr>
<td>900</td>
<td>0.0035</td>
<td>900 0.0036</td>
</tr>
<tr>
<td>1050</td>
<td>0.0035</td>
<td>1050 0.0036</td>
</tr>
<tr>
<td>1200</td>
<td>0.0025</td>
<td>1200 0.0036</td>
</tr>
</tbody>
</table>
(4) Checking the moment of inertia of the transported object

Using the Formulae for calculating moment of inertia of typical shapes (P.12), calculate the moment of inertia of the tool and workpiece to be used and make sure they do not exceed the corrected allowable moment of inertia (4) \( \leq \) (3) obtained in (3).

(1) Moment of inertia of piping/vacuum pad: \( J_{BT} \)

Calculation when simplified to cylinder

\[
J_{BT} = \frac{mT(D^2 + H^2)}{4} + mT(r0 + rCT)^2
\]

\[
= \frac{0.02 \times (0.01^4 + 0.05^4)}{4} + 0.02 \times (0.039 + 0.025)^2
\]

\[
= 8.62 \times 10^{-5}
\]

(2) Moment of inertia of connector: \( J_{BW} \)

Calculation when simplified to cuboid

\[
J_{BW} = \frac{mW(A^2 + C^2)}{12} + mW(r0 + rCW)^2
\]

\[
= \frac{0.013 \times (0.03^2 + 0.02^2)}{12} + 0.13 \times (0.039 + 0.06)^2
\]

\[
= 1.28 \times 10^{-4}
\]

From the results of (1) and (2)

\[
J_{BT} + J_{BW} = 8.62 \times 10^{-5} + 1.28 \times 10^{-4}
\]

\[
= 2.1 \times 10^{-4}
\]

Usable, as it is less than the corrective allowable moment of inertia obtained in (3)

2. Checking T-axis

Load torque "None"

Moment of inertia applied on T-axis < Allowable moment of inertia for compact and medium types.

* It varies with the speed and acceleration/deceleration.

If load torque is not applied, using the Formulae for calculating moment of inertia of typical shapes (P.12), calculate the moment of inertia of the tool and workpiece to be used and make sure they do not exceed the corrected allowable moment of inertia.

(1) Moment of inertia of piping/vacuum pad: \( J_{TT} \)

\[
J_{TT} = \frac{mT \times D^2}{8}
\]

\[
= \frac{0.02 \times 0.01^4}{8}
\]

\[
= 2.50 \times 10^{-7}
\]
(2) Moment of inertia of the connector: \( J_{W} \)

\[
J_{W} = \frac{m_{W}(A^2 + B^2)}{12}
\]

\[
= \frac{0.013 \times (0.03^2 + 0.05^2)}{12}
\]

\[
= 3.68 \times 10^{-6} \text{ [kgm}^2\text{]}
\]

From the results of (1) and (2)

**Moment of inertia of transported object around T-axis**

\[
= J_{I} + J_{W}
\]

\[
= 2.50 \times 10^{-6} + 3.68 \times 10^{-6}
\]

\[
= 3.9 \times 10^{-6} \text{ [kgm}^2\text{]}
\]

From the allowable moment of inertia (table below), we see that WU-S (compact) can be used.

---

**Operating conditions of the Wrist Unit**

- **T-axis rotation**
  - Speed: 600 [deg/s]
  - Acceleration: 0.3 [G]

<table>
<thead>
<tr>
<th>Speed deg/s</th>
<th>B-axis 0.3G</th>
<th>B-axis 0.7G</th>
<th>T-axis 0.3G</th>
<th>T-axis 0.7G</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0.0085</td>
<td>0.0085</td>
<td>0.0075</td>
<td>0.0035</td>
</tr>
<tr>
<td>150</td>
<td>0.0085</td>
<td>0.0085</td>
<td>0.0075</td>
<td>0.0035</td>
</tr>
<tr>
<td>300</td>
<td>0.0085</td>
<td>0.0085</td>
<td>0.0065</td>
<td>0.0035</td>
</tr>
<tr>
<td>600</td>
<td>0.0085</td>
<td>0.0085</td>
<td>0.0065</td>
<td>0.0025</td>
</tr>
<tr>
<td>750</td>
<td>0.0065</td>
<td>0.0065</td>
<td>0.0055</td>
<td>0.0025</td>
</tr>
<tr>
<td>900</td>
<td></td>
<td>0.0065</td>
<td>0.0055</td>
<td>0.0025</td>
</tr>
<tr>
<td>1050</td>
<td></td>
<td>0.0065</td>
<td>0.0055</td>
<td>0.0025</td>
</tr>
<tr>
<td>1200</td>
<td></td>
<td>0.0065</td>
<td>0.0055</td>
<td>0.0025</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Speed deg/s</th>
<th>B-axis 0.3G</th>
<th>B-axis 0.7G</th>
<th>T-axis 0.3G</th>
<th>T-axis 0.7G</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0.0150</td>
<td>0.0150</td>
<td>0.0165</td>
<td>0.0126</td>
</tr>
<tr>
<td>150</td>
<td>0.0150</td>
<td>0.0150</td>
<td>0.0165</td>
<td>0.0126</td>
</tr>
<tr>
<td>300</td>
<td>0.0150</td>
<td>0.0127</td>
<td>0.0165</td>
<td>0.0090</td>
</tr>
<tr>
<td>600</td>
<td>0.0099</td>
<td>0.0036</td>
<td>0.0108</td>
<td>0.0054</td>
</tr>
<tr>
<td>750</td>
<td>0.0036</td>
<td>0.0099</td>
<td>0.0054</td>
<td></td>
</tr>
<tr>
<td>900</td>
<td>0.0036</td>
<td>0.0099</td>
<td>0.0045</td>
<td></td>
</tr>
<tr>
<td>1050</td>
<td>0.0036</td>
<td>0.0099</td>
<td>0.0045</td>
<td></td>
</tr>
<tr>
<td>1200</td>
<td></td>
<td>0.0081</td>
<td>0.0045</td>
<td></td>
</tr>
</tbody>
</table>

**Step 3** Check the allowable dynamic thrust load

**Dynamic thrust load: \( F \)**

\[
F = (m_{T} + m_{W}) \cdot (a + g) \cdot 9.8 \text{ [N]}
\]

\[
= (0.02 + 0.13) \times (0.3 + 1.0) \times 9.8
\]

\[
= 0.42 \text{ [N]}
\]

From the allowable dynamic thrust load (table below), we see that WU-S (compact) can be used.

**Allowable dynamic thrust load**

<table>
<thead>
<tr>
<th>Type</th>
<th>Allowable thrust load</th>
</tr>
</thead>
<tbody>
<tr>
<td>WU-S: Compact</td>
<td>330N</td>
</tr>
<tr>
<td>WU-M: Medium</td>
<td>450N</td>
</tr>
</tbody>
</table>

\( m_{W} \): Cuboid weight 0.013 [kg]
\( m_{T} \): Tool weight 0.02 [kg]
\( m_{W} \): Workpiece weight 0.013 [kg]
\( g \): Gravitational acceleration 1.0 [G]
\( a \): Travel acceleration of Z-axis 0.3 [G]
Step 4  
Check the allowable dynamic load moment

\[ M = m \cdot a \cdot 9.8 \left( L_0 + r_{CT} \right) \times 10^{-3} + m_W \cdot a \cdot 9.8 \left( L_0 + r_{CW} \right) \times 10^{-3} \]  

\[ M = 0.02 \times 0.3 \times 9.8 \left( 17.5 + 25 \right) \times 10^{-3} + 0.013 \times 0.3 \times 9.8 \left( 17.5 + 60 \right) \times 10^{-3} \]

\[ = 0.025 + 0.030 \]

\[ = 0.055 \text{ [Nm]} \]

From the allowable dynamic moment (table below), we see that WU-S (compact) can be used

<table>
<thead>
<tr>
<th>WU-S: Compact type</th>
<th>1.4Nm</th>
</tr>
</thead>
<tbody>
<tr>
<td>WU-M: Medium type</td>
<td>4.2Nm</td>
</tr>
</tbody>
</table>

WU-S (compact) can be used, as seen from the results of steps 1 to 4

Formulae for calculating moment of inertia of typical shapes

1. When the rotational axis passes through the center of the object

(1) Moment of inertia of cylinder 1

* The same formula can be applied irrespective of the height of the cylinder (also for circular plate)

\[ I = M \times D^2 / 8 \]

Moment of inertia of cylinder: \( I \) (kg·m²)  
Cylinder weight: \( M \) (unit: kg)  
Cylinder diameter: \( D \) (m)

(2) Moment of inertia of cylinder 2

\[ I = M \times \left( D^2 / 4 + H^2 / 3 \right) / 4 \]

Moment of inertia of cylinder: \( I \) (kg·m²)  
Cylinder weight: \( M \) (kg)  
Cylinder diameter: \( D \) (m)  
Cylinder length: \( H \) (m)

(3) Moment of inertia of prism 1

* The same formula can be applied irrespective of the height of the prism (also for rectangular plate)

\[ I = M \times \left( A^2 + B^2 \right) / 12 \]

Moment of inertia of prism: \( I \) (kg·m²)  
One side of prism: \( A \) (m)  
One side of prism: \( B \) (m)

2. When the center of the object is offset from the rotational axis

(4) Moment of inertia of cylinder 3

* The same formula can be applied irrespective of the height of the cylinder (also for circular plate)

\[ I = M \times D^2 / 8 + M \times L^2 \]

Moment of inertia of cylinder: \( I \) (kg·m²)  
Cylinder weight: \( M \) (kg)  
Cylinder diameter: \( D \) (m)  
Distance from rotational axis to center: \( L \) (m)

(5) Moment of inertia of cylinder 4

\[ I = M \times \left( D^2 / 4 + H^2 / 3 \right) / 4 + M \times L^2 \]

Moment of inertia of cylinder: \( I \) (kg·m²)  
Cylinder weight: \( M \) (kg)  
Cylinder diameter: \( D \) (m)  
Cylinder length: \( H \) (m)  
Distance from rotational axis to center: \( L \) (m)

(6) Moment of inertia of prism 2

* The same formula can be applied irrespective of the height of the prism (also for rectangular plate)

\[ I = M \times \left( A^2 + B^2 \right) / 12 + M \times L^2 \]

Moment of inertia of prism: \( I \) (kg·m²)  
Prism weight: \( M \) (kg)  
One side of prism: \( A \) (m)  
One side of prism: \( B \) (m)  
Distance from rotational axis to center: \( L \) (m)
WU Wrist Unit

WU-S

Actuator Specifications

<table>
<thead>
<tr>
<th>Model</th>
<th>Axis configuration</th>
<th>Operation range (deg.)</th>
<th>Max. speed (deg/s)</th>
<th>Max. payload (kg)</th>
<th>Max. acceleration/deceleration (G)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Independent</td>
<td>Simultaneous</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>operation</td>
<td>operation of the B- and T-axes</td>
<td></td>
</tr>
<tr>
<td>WU-S-WA-PM1-①</td>
<td>B-axis (wrist swing)</td>
<td>±100</td>
<td>750</td>
<td>600</td>
<td>0.7 G (6865 deg/s) 0.3 G (2942 deg/s)</td>
</tr>
<tr>
<td></td>
<td>T-axis (wrist rotation)</td>
<td>±360</td>
<td>1200</td>
<td>600</td>
<td>0.7 G (6865 deg/s) 0.3 G (2942 deg/s)</td>
</tr>
</tbody>
</table>

Legend: ① Cable length ② Options

Options

- Name: Option code: Reference page
  - Cable exit direction (Right): A1: See P.5, P.14
  - Cable exit direction (Bottom): A2: See P.5, P.14
  - Cable exit direction (Left): A3: See P.5, P.14
  - Actuator's pigtail cable length change: AC1.5: See P.5, P.14
  - Cable (air fitting) in opposite position: CVR: See P.5, P.14
  - With air fitting: VC: See P.5, P.14
  - With wiring collar: WCS: See P.5, P.14

Cable Length <per axis *1>

<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></td>
<td>S:3m</td>
</tr>
<tr>
<td></td>
<td>M:5m</td>
</tr>
<tr>
<td>Specified length</td>
<td>X06(6m) to X10(10m)</td>
</tr>
<tr>
<td></td>
<td>X11(11m) to X15(15m)</td>
</tr>
<tr>
<td></td>
<td>X16(16m) to X20(20m)²</td>
</tr>
<tr>
<td>Robot cable</td>
<td>R01(1m) to R03(3m)</td>
</tr>
<tr>
<td></td>
<td>R04(4m) to R05(5m)</td>
</tr>
<tr>
<td></td>
<td>R06(6m) to R10(10m)</td>
</tr>
<tr>
<td></td>
<td>R11(11m) to R15(15m)</td>
</tr>
<tr>
<td></td>
<td>R16(16m) to R20(20m)²</td>
</tr>
</tbody>
</table>

*1 G = 9807 deg/s²

Name and Coordinates of Each Axis

- B-axis (bending)
- T-axis (turning)

When making a selection, it is necessary to calculate the moment of inertia of the operating conditions and to use a model that allows that moment of inertia. Calculate the moment of inertia of the transported object for the B- and T-axes respectively. Please refer to “Model Selection Process (P.7 on)” for more information.

(Note 1) Shows maximum set speed with no load.
(Note 2) When the rotational axes of the B-axis and T-axis are horizontal with respect to the floor surface or when the center of gravity of the transported object is offset from the rotational axis, the unit will be subject to load torque due to the weight of the object. The allowable moment of inertia decreases when load torque is present. Please refer to “Model Selection Process (P.7 on)” for more information.

Cable between actuator and controller:
* ① Required for both B- and T-axes. Select the cable length in the model name to have 2 cables attached.
* ② When Actuator's pigtail cable length change "AC1.5" is selected as an option, 18 m (X18, R18) will be the maximum length.

Please refer to P.6 for more information on the installation method and orientation.
**Wrist Unit**

### Applicable Controllers

<table>
<thead>
<tr>
<th>Name</th>
<th>External view</th>
<th>Max. number of connectable axes</th>
<th>Power supply voltage</th>
<th>Control method</th>
<th>Maximum number of positioning points</th>
<th>Reference page</th>
</tr>
</thead>
<tbody>
<tr>
<td>MSEL-PC/PG</td>
<td>4</td>
<td>Single phase 100 to 230V AC</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>See P.15</td>
</tr>
</tbody>
</table>

* Please contact our sales representative for control using expanded motion control with the XSEL-RA/SA controller. (See P. 19)

---

**Options**

- **Cable exit direction**
- **Air fitting (model: VC)**
- **Wiring collar (model: WCS)**
- **Cable (air fitting) opposite position (model: CVR)**

---

**Dimensions**

CAD drawings can be downloaded from our website.

www.intelligentactuator.com

---

**WU-S**
**Actuator Specifications**

<table>
<thead>
<tr>
<th>Model specifications items</th>
<th>WU</th>
<th>M</th>
<th>WA</th>
<th>PM1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Series</td>
<td>WU</td>
<td>M</td>
<td>WA</td>
<td>PM1</td>
</tr>
<tr>
<td>Type</td>
<td>M</td>
<td>M</td>
<td>WA</td>
<td>PM1</td>
</tr>
<tr>
<td>Encoder Type</td>
<td>M</td>
<td>M</td>
<td>WA</td>
<td>PM1</td>
</tr>
<tr>
<td>Applicable Controllers</td>
<td>N</td>
<td>M</td>
<td>PM1MSEL</td>
<td></td>
</tr>
<tr>
<td>Cable Length</td>
<td>N</td>
<td>P</td>
<td>1m</td>
<td>3m</td>
</tr>
<tr>
<td>Options</td>
<td>M</td>
<td>S</td>
<td>X</td>
<td>R</td>
</tr>
</tbody>
</table>

**Legend:**
- N: None
- P: 1m
- 1m: 3m
- S: Specified Length
- R: Robot Cable

*1 Does not include a controller
*2 Please refer to P.4 for more information about the model specification items.

---

**Actuator Specifications**

| WU-M-WA-PM1                   | B-axis (wrist swing) | ±105 | 900 | 600 | 2 |
| T-axis (wrist rotation)       | ±360 | 1200 | 600 |

**Legend:**
- Cable length: per axis

---

**Options**

<table>
<thead>
<tr>
<th>Name</th>
<th>Option Code</th>
<th>Reference page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cable exit direction (Right)</td>
<td>A1</td>
<td>See P.S, P.14</td>
</tr>
<tr>
<td>Cable exit direction (Bottom)</td>
<td>A2</td>
<td>See P.S, P.14</td>
</tr>
<tr>
<td>Cable exit direction (Left)</td>
<td>A3</td>
<td>See P.S, P.14</td>
</tr>
<tr>
<td>Actuator's pigtail cable length change</td>
<td>AC1.5</td>
<td>See P.S, P.14</td>
</tr>
<tr>
<td>Cable (air fitting) in opposite position</td>
<td>CVR</td>
<td>See P.S, P.14</td>
</tr>
<tr>
<td>With air fitting</td>
<td>VC</td>
<td>See P.S, P.14</td>
</tr>
<tr>
<td>With wiring collar</td>
<td>WCS</td>
<td>See P.S, P.14</td>
</tr>
</tbody>
</table>

---

**Cable Length <per axis>*1**

<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>Specified length</td>
<td>X06(6m) to X10(10m)</td>
</tr>
<tr>
<td>Specified length</td>
<td>X11(11m) to X15(15m)</td>
</tr>
<tr>
<td>Specified length</td>
<td>X16(16m) to X20(20m)*2</td>
</tr>
<tr>
<td>Robot cable</td>
<td>R01(1m) to R03(3m)</td>
</tr>
<tr>
<td>Robot cable</td>
<td>R04(4m) to R05(5m)</td>
</tr>
<tr>
<td>Robot cable</td>
<td>R06(6m) to R10(10m)</td>
</tr>
<tr>
<td>Robot cable</td>
<td>R11(11m) to R15(15m)</td>
</tr>
<tr>
<td>Robot cable</td>
<td>R16(16m) to R20(20m)*2</td>
</tr>
</tbody>
</table>

---

**Name and Coordinates of Each Axis**

- B-axis (bending)
- T-axis (turning)

---

**Actuator Specifications**

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drive system</td>
<td>Stepper motor + timing belt + bevel gear</td>
</tr>
<tr>
<td>Positioning repeatability</td>
<td>±0.015 deg.</td>
</tr>
<tr>
<td>Lost motion</td>
<td>0.06 degrees</td>
</tr>
<tr>
<td>Allowable dynamic thrust load*1</td>
<td>450N</td>
</tr>
<tr>
<td>Allowable dynamic load moment*1</td>
<td>4.2N²m</td>
</tr>
<tr>
<td>Unit weight</td>
<td>2.8kg</td>
</tr>
<tr>
<td>Brake retaining torque*2</td>
<td>2.8N m</td>
</tr>
<tr>
<td>Ambient operating temperature/humidity</td>
<td>0~40°C, 85% RH or less (Non-condensing)</td>
</tr>
</tbody>
</table>

*1 Using the unit with a load exceeding the values above leads to reduced service life and/or damage.
*2 Equipped with brake as standard.

---

When making a selection, it is necessary to calculate the moment of inertia of the operating conditions and to use a model that allows that moment of inertia. Calculate the moment of inertia of the transported object for the B- and T-axes respectively. Please refer to “Model Selection Process (P.7 on)” for more information.

(Note 1) Shows maximum set speed with no load.
(Note 2) When the rotational axes of the B-axis and T-axis are horizontal with respect to the floor surface or when the center of gravity of the transported object is offset from the rotational axis, the unit will be subject to load torque due to the weight of the object. The allowable moment of inertia decreases when load torque is present. Please refer to “Model Selection Process (P.7 on)” for more information.

---

When using the unit with a load exceeding the values above leads to reduced service life and/or damage.

---

Please refer to P.6 for more information on the installation method and orientation.

---

RoHS: Please refer to P.6 for more information on the installation method and orientation.

---

*1 G = 9800 deg/s²
### Options

- **Cable exit direction**
- **Air fitting (model: VC)**
- **Wiring collar (model: WCS)**
- **Cable (air fitting) in opposite position Model: CVR**

### Applicable Controllers

<table>
<thead>
<tr>
<th>Name</th>
<th>External view</th>
<th>Max. number of connectable axes</th>
<th>Power supply voltage</th>
<th>Control method</th>
<th>Maximum number of positioning points</th>
<th>Reference page</th>
</tr>
</thead>
<tbody>
<tr>
<td>MSEL-PC/PG</td>
<td></td>
<td>4</td>
<td>Single phase 100 to 230 V AC</td>
<td>-</td>
<td>-</td>
<td>30000</td>
</tr>
</tbody>
</table>

* Please contact our sales representative for control using expanded motion control with the XSEL-RA/SA controller (See P. 19)

CAD drawings can be downloaded from our website. www.intelligentactuator.com
Program controller enabling operation of RCP6/RCP5/RCP4/RCP3/RCP2 Series actuators. One MSEL controller can handle various forms of control with up to 4-axis.

### List of Models

Program controller for Wrist Unit WU.

<table>
<thead>
<tr>
<th>Name</th>
<th>Type</th>
<th>Max. number of controlled axes</th>
<th>No. of positions</th>
<th>Power</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Single phase 100 to 230V AC</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- **MSEL**
- **WUS** and **WUM** use 2 axes.

### Model Specification Items

<table>
<thead>
<tr>
<th>MSEL</th>
<th>1-axis specification</th>
<th>2-axis specification</th>
<th>3-axis specification</th>
<th>4-axis specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>B</td>
<td>Battery-less absolute specification</td>
<td>Incremental specification</td>
<td>Simple absolute specification</td>
<td></td>
</tr>
<tr>
<td>PG</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
</tbody>
</table>

**WAI**

- **SA**: Battery-less absolute specification
- **SA**: Incremental specification
- **SA**: Simple absolute specification

**WUS**

- **WUS**: For WU-S
- **WUS**: For WU-M

**WUM**

- **WUM**: For WU-M

The motor type symbol is normally the same as that of the actuator to be connected, but there are some models for which motor types of the controller and actuator do not match. Be sure to check the corresponding models listed below during selection.

- **28P**: Supports 2-axis stepper motor
- **42P**: Supports 3-axis stepper motor
- **42P**: Supports 4-axis stepper motor

* Battery-less absolute and simple absolute cannot be used together. When using simple absolute, all axes must be simple absolute.

*1: To comply with the safety category, the customer will need to install a safety circuit outside the controller.
The figure on the right is an example when connecting the Wrist Unit to the second and third axes of the MSEL controller.

When using the Wrist Unit, connect so that the combination of symbols in “Actuator’s pigtail cable”, “Cable” and “Controller” will match.

System Configuration

Connectable actuators

- Integrated Motor-encoder Cable
  - Actuator RCP2 Series
  - Standard: 1 m/3 m/5 m
  - Supplied with the actuator
- Integrated Motor-encoder Cable
  - Actuator RCP2 compact rotary
  - Standard: 1 m/3 m/5 m
  - Supplied with the actuator
- Integrated Motor-encoder Cable
  - Actuator RCP3 Series
  - Standard: 1 m/3 m/5 m
  - Supplied with the actuator

Options
- Teaching Pendant
  - Model: TB-Q2
  - Supported versions: PC/PG Ver.1.10 or later
- PC software
  - Model: IA-101-X-MW-JS
  - Supported versions: IA-101-X-USBS
- PLC
- Expansion PIO/Various field networks
  - Included with expansion PIO specification
  - PIO flat cable
    - Model: CB-PAC-PIO020
    - Standard: 2m
- Remote I/O unit
  - Model: EIOU-1-□□□
  - Optional

Accessories
- Dummy plug
  - Model: DP-4S
  - Included with MSEL-PG / IA-101-X-USBS
- Connector conversion cable
  - Model: CB-SEL-SJS002
  - Included with TB-01-SJ / IA-101-X-MW-JS

Electromagnetic Relay

Options
- Emergency stop switch
- Enable switch
- Options
  - Expansion PIO/Various field networks
    - Included with expansion PIO specification
    - PIO flat cable
      - Model: CB-PAC-PIO020
      - Standard: 2m
- Remote I/O unit
  - Model: EIOU-1-□□□

Other accessories
- Actuator pigtail cable
- Cable
- MSEL Controller

* Emergency stop switch, enable switch, electromagnetic relay, and other devices may be connected and wired as necessary. The factory setting with no external devices connected still operates properly.
### XSEL-RA/SA expanded motion control function

**Note:** It is not possible to interpolate between an actuator directly connected to XSEL and an actuator connected to the controller on the network.

#### 1. Interpolation command of Cartesian Robot + Wrist Unit possible

#### 2. What to prepare

- (1) XSEL-RA/SA controller (equipped with expanded motion function as standard)
- (2) MECHATROLINK-III dedicated cable (to be prepared by the customer)
- (3) MCON-C, P/A/D/SCON-CB as needed (MECHATROLINK-III option selected)

---

<table>
<thead>
<tr>
<th>XSEL-RA/SA (main application section V1.10 or later)</th>
<th>MECHATROLINK-III dedicated cable (to be prepared by the customer)</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1.png" alt="Image" /></td>
<td><img src="image2.png" alt="Image" /></td>
</tr>
</tbody>
</table>

- **Interpolation commands in SEL language are possible**
- **Up to 32 axes can be connected**

- **MCON-C**
  - Up to 8 axes can be connected (MECHATROLINK-III option selected)

- **PCON-CB**
  - x 2 units (MECHATROLINK-III option selected)

- **Connectable controllers**
  - MCON
  - PCON-CB
  - SCON-CB
  - ACON-CB
  - DCON-CB
  - (MECHATROLINK-III option selected)

---

<table>
<thead>
<tr>
<th>Program example</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Example) When interpolating 1, 3 and 4 axes</td>
</tr>
<tr>
<td>XAXS 11010 : Axis pattern setting for 1, 3 and 4 axes</td>
</tr>
<tr>
<td>XSON : Servo on for 1, 3 and 4 axes</td>
</tr>
<tr>
<td>XMVL 20 : 1, 3 and 4 axes moved to position No. 20</td>
</tr>
</tbody>
</table>

---

**Wrist Unit**
- (for 2 axes)

**Single Axis/Cartesian Robot**
- (up to 6 axes)

---

**Wrist Unit**
- (for 2 axes)

**Single Axis/Cartesian Robot**
- (all 32 axes connectable)

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  - The information contained in this product brochure may change without prior notice due to product improvements.

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