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ISO 9001 & 14001 Quality system registration certificate

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Absolute compactness  and Ultra precision

IKO Alignment Stage Direct Drive

SA...DE

SA120DE/XY
SA120DE/S
SA200DE/S

Ultra compact size contributes space saving of your machine
High resolution and response by full closed loop controlling with optical scale
Flexible combination of X-Y-θ for your design

X-Y-θ motion

We aim to be a Technology-Developing company taking customer-needs as primary source for development. With our original technologies and creativities, our function and performance differ from others. We develop and implement new and high technical skills, which pursue excellent motion performances and service for your cost saving.
IKO Alignment Stage Direct Drive SA-DE is low height and ultra compact stage performing precise X-Y motion. Two sets of linear motors and miniature linear motion rolling guides are assembled perpendicularly for X-Y axis and Direct drive system together with crossed roller bearing are mounted as if table. High resolution and high positioning accuracy can be obtained by full closed loop control with optical linear scale. Single X-axis stage and if table are specified as standard, yet other combinations are possible according to customer’s application. This is suitable for the semiconductor manufacturing process / flat panel display, alignment system by image processing control and measuring / inspection system requiring cleanliness.

**Structure of SA-DE**

- X-table
- Stator coil
- C-Lube Linear Way L
- Mechanical stopper
- Moving magnet
- Optical linear encoder scale head
- Y-axis
- Optical linear encoder scale head
- Moving magnet
- Mechanical stopper
- C-Lube Linear Way L
- Stator coil
- X-axis

**Principle of operation of SA-DE**

Alignment Stage SA-DE incorporates hall coils and optical linear scale sensor in the moving table, and a C-shaped yoke with a set of magnets facing to each other and an optical linear scale in the stator. As shown in the figure, a magnetic flux in the vertical direction is generated by the set of magnets facing each other. When a rotating magnetic flux is generated around the coil due to coil current, a force is applied to the coil in the horizontal direction. (Fleming’s left-hand rule)

A unidirectional thrust can be continuously obtained by switching the coil current according to the vertical flux direction, so that the moving part can keep moving in one direction. Acceleration is controlled by current level and position is controlled by opposition signal from the optical linear scale for traveling and accurate positioning.

**Feature of SA-DE**

**Ultra compact, low height**

Due to the assembly of direct drive systems, the product provides lower height compared to that of ball screw models. Especially the height of SA65DE is the lowest with only 52mm.

**High resolution and quick response**

Direct drive system together with high-resolution linear encoder and full-closed loop control achieves high resolution and quick response.

The graph shows actual traveled distance against 1µm of feeding command, Model SA120DE/XY.

The graph shows actual positioning time against command, Model SA120DE/XY.

**Freely combination**

In SA-DE, single X-axis and if table are lined up as standard. Combine them and make your complex stage as you like.

<table>
<thead>
<tr>
<th>Standard</th>
<th>Combination</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td>X-Y</td>
</tr>
<tr>
<td>Y</td>
<td>X-Y</td>
</tr>
<tr>
<td>F table</td>
<td>X-Y</td>
</tr>
<tr>
<td>X-Y stage</td>
<td>X-Y</td>
</tr>
<tr>
<td>X/F stage</td>
<td>X-Y/F</td>
</tr>
<tr>
<td>X-Y/F stage</td>
<td>X-Y/F</td>
</tr>
</tbody>
</table>
Identification Number

Example of identification number
SA 120 DE / 5 XYS R

1 Type
SA DE: Alignment Stage Direct Drive

2 Size
65: 65, 85: 85, 120: 120, 200: 200

3 Encoder interface specification
1: 0.1 μm
2: 0.5 μm

Resolution of encoder for X or Y axis is chosen.

Note: Only theta axis is required in 3, indicating this specification is not necessary.

4 Table structure
X: X-axis
Y: Y-axis
Z: ʻtable

In combination of axes, refer Table 1.

Table 1 Combination of axes

<table>
<thead>
<tr>
<th>Combination</th>
<th>SA65DE</th>
<th>SA120DE</th>
<th>SA200DE</th>
</tr>
</thead>
<tbody>
<tr>
<td>X: X-axis only</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>S: Theta axis only</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>XY: Two axes in X and Y</td>
<td>○</td>
<td>○</td>
<td>—</td>
</tr>
<tr>
<td>XS: Two axes in X and Z</td>
<td>○</td>
<td>○</td>
<td>—</td>
</tr>
<tr>
<td>XYS: Three axes in X, Y and Z</td>
<td>○</td>
<td>○</td>
<td>—</td>
</tr>
</tbody>
</table>

5 Surface treatment
No symbol: Electroless nickel plating
R: Black chrome surface treatment

Whole surface of table and bed are treated in both specifications.

Specification and Performance

Table 2.1 Specification and performance

<table>
<thead>
<tr>
<th>Item</th>
<th>SA65DE/1X</th>
<th>SA65DE/5X</th>
<th>SA120DE/1X</th>
<th>SA120DE/5X</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum thrust(^1)</td>
<td>N</td>
<td>25</td>
<td>10</td>
<td>20</td>
</tr>
<tr>
<td>Rated thrust(^2)</td>
<td>N</td>
<td>25</td>
<td>10</td>
<td>20</td>
</tr>
<tr>
<td>Operative stroke length mm</td>
<td>10</td>
<td>20</td>
<td>10</td>
<td>20</td>
</tr>
<tr>
<td>Maximum load mass kg</td>
<td>0.1</td>
<td>0.5</td>
<td>0.1</td>
<td>0.5</td>
</tr>
<tr>
<td>Resolution (\mu) m</td>
<td>0.27</td>
<td>0.5</td>
<td>0.4</td>
<td>0.8</td>
</tr>
<tr>
<td>Maximum speed(^3) (\mu) m/s</td>
<td>0.17</td>
<td>0.5</td>
<td>0.1</td>
<td>0.5</td>
</tr>
<tr>
<td>Mass of moving part kg</td>
<td>0.17</td>
<td>0.5</td>
<td>0.1</td>
<td>0.5</td>
</tr>
<tr>
<td>Total mass(^4) kg</td>
<td>0.35</td>
<td>2.5</td>
<td>0.35</td>
<td>2.5</td>
</tr>
</tbody>
</table>

| Ambient temperature and humidity | 0 to 40°C, 20 to 80%RH (No condensation) |

Note:\(^1\) The maximum holding time for the maximum thrust is 1sec.\(^2\)
Values are applicable when table is mounted on steel made solid mounting base and ambient temperature at 20°C.\(^3\)
If higher speed is necessary, consult IKO.\(^4\)
The value is applicable when the temperature of table becomes stable.\(^5\)
The mass of cord is not included.

Table 2.2 Specification and performance

<table>
<thead>
<tr>
<th>Item</th>
<th>SA65DE/S</th>
<th>SA120DE/S</th>
<th>SA200DE/S</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum torque(^1) (N \cdot m)</td>
<td>0.5</td>
<td>2.6</td>
<td>3.5</td>
</tr>
<tr>
<td>Rated torque(^2) (N \cdot m)</td>
<td>0.06</td>
<td>0.4</td>
<td>1.3</td>
</tr>
<tr>
<td>Maximum load mass kg</td>
<td>2.2</td>
<td>9.8</td>
<td>12.3</td>
</tr>
<tr>
<td>Operative angle Degree</td>
<td>50</td>
<td>60</td>
<td>280</td>
</tr>
<tr>
<td>Resolution (\mu) m</td>
<td>0.36</td>
<td>0.25</td>
<td>0.25</td>
</tr>
<tr>
<td>Maximum speed(^3) (\mu) m/s</td>
<td>11.3</td>
<td>13.5</td>
<td>21.8</td>
</tr>
<tr>
<td>Repeatability(^4) Second</td>
<td>0.5</td>
<td>0.8</td>
<td>0.9</td>
</tr>
<tr>
<td>Inertia of moving mass kg (\cdot m^2)</td>
<td>0.0012</td>
<td>0.002</td>
<td>0.013</td>
</tr>
<tr>
<td>Total mass(^5) kg</td>
<td>0.5</td>
<td>4</td>
<td>8</td>
</tr>
</tbody>
</table>

| Ambient temperature and humidity | 0 to 40°C, 20 to 80%RH (No condensation) |

Note:\(^1\) The maximum holding time for the maximum torque is 1sec.\(^2\)
Values are applicable when table is mounted on steel made solid mounting base and ambient temperature at 20°C.\(^3\)
If higher speed is necessary, consult IKO.\(^4\)
The value is applicable when the temperature of table becomes stable.\(^5\)
The mass of cord is not included.

\(X\) or \(Y\) axis
\(\delta\)-table

Dynamic load mass

Remark: Dynamic load mass for \(\delta\)-table is calculated as steel-made carrying cube. Acceleration is given at the outer edge of stage.
System Configuration

Positioning command type: Pulse line input operation, RS232C communication

Pulse line input
- Maximum pulse frequency: 10MHz max (2.5MHz max for AB phases)
- Pulse input types: + direction, - direction, pulse/direction, A-phase / B-phase

Sequence input
- Servo ON, -direction movement disabled, - direction movement disabled, gain, LOCK, reset, and operation.

Sensor output
- Origin, Pre-origin, + direction limit, - direction limit

Sequence output
- Servo ready, completion of positioning, alarm code 0, alarm code 1, alarm code 2

Output limitation
- Current feedback, overheating
  - Motor and driver, thrust control, servo OFF, +direction movement disabled, - direction movement disabled

Main power supply
- AC90~110V, 50/60Hz
- Instantaneous maximum current 4A

Control source
- PWM Carrier frequency 40kHz
- Parameter key 4 keys (digit selection, increment, data/parameter, and write)
- Data display
  - LED 7-segments, output current/parameter/error code, etc.
  - Current value, resolution, control mode, electronic gear, gain, completion of positioning, electric origin, acceleration filter, etc.

Analogue monitor
- 2 channels (current speed and output current)

Mass
- 1.2kg

Ambient temperature
- 0~40°C

Cooling fin temperature
- 70°C, max (Overheat interruption type)

Vibration and shock
- Vibration 0.5G, impact 5G, once

Driver

<table>
<thead>
<tr>
<th>Item</th>
<th>Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positioning command type</td>
<td>Pulse line input operation, RS232C communication</td>
</tr>
</tbody>
</table>
| Pulse line input | Maximum pulse frequency: 10MHz max (2.5MHz max for AB phases)
- Pulse input types: + direction, - direction, pulse/direction, A-phase / B-phase |
| Sequence input | Servo ON, -direction movement disabled, - direction movement disabled, gain, LOCK, reset, and operation. |
| Sensor output | Origin, Pre-origin, + direction limit, - direction limit |
| Sequence output | Servo ready, completion of positioning, alarm code 0, alarm code 1, alarm code 2 |
| Output limitation | Current feedback, overheating (motor and driver), thrust control, servo OFF, +direction movement disabled, - direction movement disabled |
| Main power supply | AC90~110V, 50/60Hz |
| Instantaneous maximum current | 4A |
| Control source | |
| PWM Carrier frequency | 40kHz |
| Parameter key | 4 keys (digit selection, increment, data/parameter, and write) |
| Data display | LED 7-segments, output current/parameter/error code, etc. |
| Parameter items (non-volatile memory) | Current value, resolution, control mode, electronic gear, gain, completion of positioning, electric origin, acceleration filter, etc. |
| Analogue monitor | 2 channels (current speed and output current) |
| Mass | 1.2kg |
| Ambient temperature | 0~40°C |
| Cooling fin temperature | 70°C, max (Overheat interruption type) |
| Vibration and shock | Vibration 0.5G, impact 5G, once |

Dimension

- TDL1-1600

Table 3 Driver

<table>
<thead>
<tr>
<th>Item</th>
<th>Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positioning command type</td>
<td>Pulse line input operation, RS232C communication</td>
</tr>
</tbody>
</table>
| Pulse line input | Maximum pulse frequency: 10MHz max (2.5MHz max for AB phases)
- Pulse input types: + direction, - direction, pulse/direction, A-phase / B-phase |
| Sequence input | Servo ON, -direction movement disabled, - direction movement disabled, gain, LOCK, reset, and operation. |
| Sensor output | Origin, Pre-origin, + direction limit, - direction limit |
| Sequence output | Servo ready, completion of positioning, alarm code 0, alarm code 1, alarm code 2 |
| Output limitation | Current feedback, overheating (motor and driver), thrust control, servo OFF, +direction movement disabled, - direction movement disabled |
| Main power supply | AC90~110V, 50/60Hz |
| Instantaneous maximum current | 4A |
| Control source | |
| PWM Carrier frequency | 40kHz |
| Parameter key | 4 keys (digit selection, increment, data/parameter, and write) |
| Data display | LED 7-segments, output current/parameter/error code, etc. |
| Parameter items (non-volatile memory) | Current value, resolution, control mode, electronic gear, gain, completion of positioning, electric origin, acceleration filter, etc. |
| Analogue monitor | 2 channels (current speed and output current) |
| Mass | 1.2kg |
| Ambient temperature | 0~40°C |
| Cooling fin temperature | 70°C, max (Overheat interruption type) |
| Vibration and shock | Vibration 0.5G, impact 5G, once |

Note: Economy and compact model TDL1-1601 is also available. Consult if required.
Table 4 Functions and performance

<table>
<thead>
<tr>
<th>Item</th>
<th>Model</th>
<th>CTN480G</th>
</tr>
</thead>
<tbody>
<tr>
<td>Order of control axes</td>
<td>4 axes</td>
<td>Simultaneous execution can be performed.</td>
</tr>
<tr>
<td>Maximum current value</td>
<td>0.2474/836848</td>
<td>pulses (signed 32-bit length)</td>
</tr>
<tr>
<td>Maximum output frequency</td>
<td>4Mpps</td>
<td></td>
</tr>
<tr>
<td>Acceleration/deceleration time</td>
<td>0 to 0.553 sec</td>
<td>(straight line, cycloidal, S-shaped acceleration/deceleration)</td>
</tr>
<tr>
<td>Output method</td>
<td>Photo coupler input, PC input by USB</td>
<td></td>
</tr>
<tr>
<td>Command input method</td>
<td>Absolute command or incremental command</td>
<td></td>
</tr>
<tr>
<td>Program capacity</td>
<td>1000 steps</td>
<td></td>
</tr>
<tr>
<td>Functions</td>
<td>Jump, call, repetition, four operations, logical operations, speed setting, acceleration/deceleration setting, timer control, I/O control, input condition branch, various editing functions (create, erase, delete, insert, copy, etc.)</td>
<td></td>
</tr>
<tr>
<td>Input number of input points</td>
<td>100 points (The number can be extended up to 80 points.)</td>
<td></td>
</tr>
<tr>
<td>Input operation</td>
<td>Start, stop, emergency stop, normal/reverse manual operation, return-to-origin, correct position reading, interrupt, completion of positioning, drive alarm input, etc. (Selection and allocation using parameters by general-purpose input)</td>
<td></td>
</tr>
<tr>
<td>Input method</td>
<td>Photo coupler input (for I/O-voltage contact or open collector)</td>
<td></td>
</tr>
<tr>
<td>Output number of output points</td>
<td>General-purpose input 20 points (The number can be extended up to 80 points.)</td>
<td></td>
</tr>
<tr>
<td>Output operation</td>
<td>Return operation, etc. (sensor detection, emergency stop, pulse output state, completion of return-to-origin, alarm ON, alarm reading, proportional control, division counter clearing (Selection and allocation using parameters by general-purpose output)</td>
<td></td>
</tr>
<tr>
<td>Output method</td>
<td>Photo coupler output (for I/O-voltage contact or open collector)</td>
<td></td>
</tr>
<tr>
<td>Power supply for I/O and I/O inputs</td>
<td>DC24V 4A</td>
<td></td>
</tr>
<tr>
<td>Other main functions</td>
<td>USB data read, write, direct execution, etc., program store/transfer by compact flash, positional correction by linear scale, backlash correction, software limit, LS stop condition, etc., linear interpolation, 2-axis circular interpolation</td>
<td></td>
</tr>
</tbody>
</table>

Remarks:
1. The model number of the dedicated teaching box (separately available) is TAE10607S-B5.
2. Cable for USB connection shall be prepared by customer. Connector A-A type is necessary. (Refer to Fig. 1.)
3. CompactFlash (Type 1) shall be prepared by customer. (Refer Fig. 2.)
4. CompactFlash is a registered trademark of SanDisk Corporation.

Table 5 General specifications

<table>
<thead>
<tr>
<th>Item</th>
<th>Model</th>
<th>CTN480G</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply voltage</td>
<td>DC24V ±10%</td>
<td></td>
</tr>
<tr>
<td>Voltage-correct circuit</td>
<td>4.5A</td>
<td></td>
</tr>
<tr>
<td>Ambient temperature</td>
<td>0 to 50°C</td>
<td></td>
</tr>
<tr>
<td>Ambient humidity</td>
<td>0 to 60% RH</td>
<td></td>
</tr>
<tr>
<td>Center stage output</td>
<td>USB 3.0 SuperSpeed (480 Mbps (plug))</td>
<td></td>
</tr>
<tr>
<td>Coolant</td>
<td>Sumitomo 3M</td>
<td></td>
</tr>
<tr>
<td>Motor connection</td>
<td>AW48-0.38A-H1</td>
<td></td>
</tr>
<tr>
<td>Link connector</td>
<td>CFS/4C/1012</td>
<td></td>
</tr>
<tr>
<td>DIN rail mounting part</td>
<td>DRT-1</td>
<td></td>
</tr>
<tr>
<td>Mass (incl. cover)</td>
<td>1.2kg</td>
<td></td>
</tr>
</tbody>
</table>

Fig.1 USB cable (A-A type connector)

Fig.2 CompactFlash (Type 1)

Thrust and Dynamic Load Mass

What is Effective thrust (Effective torque)?

Effective thrust is the effective value of the thrust required in a given operation pattern. When this value exceeds the rated thrust of Nano Linear NT, the motor may overheat or seize. When using this model, calculate the effective thrust and operate within it. However, the operation limit may vary according to the operating conditions, etc.

In general, the effective thrust is obtained as follows. (For a calculation example, see page 11.)

\[ F_{\text{eff}} = \sqrt{F_1^2 + (F_2 - 2F_1)^2 + F_3 + F_4} \]

Where, \( F_i \) is the force required for acceleration. \( F_i \) is the force due to running resistance.

The running resistance consists of the friction of the linear motion rolling guide incorporated in Alignment stage.

Inertia moment can be given by following formulae.

\[ \begin{align*}
\hat{J}_L &= \frac{1}{2} \left( I_a - I_b \right) r_a^2 \\
\hat{J}_L &= \frac{1}{2} \left( I_a - I_b \right) \left( r_f^2 + r_c^2 \right) \\
\hat{J}_L &= \frac{1}{2} \left( I_a - I_b \right) \left( r_f^2 + r_c^2 \right) \\
\end{align*} \]

What is Dynamic load mass?

The dynamic load mass is the maximum weight that permits obtaining the required acceleration and deceleration. The acceleration and deceleration of Alignment stage becomes smaller as the weight on the stage increases. Similarly, the acceleration and deceleration of rotation becomes smaller as the weight on the stage increases.

Therefore, when using this model, examine the operation pattern taking the relationship between the weight and acceleration/deceleration into consideration.
Examination Example of Operation Pattern

Calculation of acceleration/deceleration time

The thrust required for driving Alignment Stage SA -D (X or Y-axis) reaches its peak during acceleration. The thrust required during acceleration is limited by the thrust of Alignment Stage SA -D (X or Y-axis). The limit acceleration time is therefore calculated by the following formula.

- Friction resistance of the rolling guide \( F_r \)
  Use below values in each calculation
  - SA60DE/X : 0.5N
  - SA120DE/X : 3.0N

- Force due to running resistance \( F_s \)
  \( F_s = \frac{(W_e + W_i)}{2} \) [N]

- Force due to acceleration \( F_a \)
  \( F_a = (M_a + M_i) \) [N-m]

- Torque due to acceleration \( M_a \)
  \( M_a = (J_t + J_r) \cdot \frac{\omega}{2} \) [N-m]

- Torque required for acceleration \( M_r \)
  \( M_r = M_a + M_i \) [N-m]

- Limit acceleration time \( t_a \)
  \( t_a = \frac{(V_e + V_i)}{k \cdot F_s - F_a} \) [s]

where,
- \( W_e \) : Load mass kg
- \( W_i \) : Mass of the moving part kg
- \( F_s \) : Pulling resistance of the electrical cord N
- \( F_a \) : Thrust of Alignment Stage N
- \( t_s \) : Acceleration time s
- \( V \) : Travel speed m/s
- \( k \) : Safety factor (1.3)

Code pulling resistance differs depending on the cord mass and pulling method. Assume an appropriate resistance value for calculation.

Similarly, required torque for \( \delta \) table shall be considered in cluding the inertia by loaded mass. Required torque becomes maximum during acceleration and it should not exceed the maximum torque of SA -D.

- Friction resistance of the rolling guide \( M_r \)
  Use below values in each calculation
  - SA60DE/XYS : 0.03N \cdot m
  - SA120DE/XYS : 0.1N \cdot m

- Force due to running resistance \( F_s \)
  \( F_s = \frac{(W_e + W_i)}{2} \) [N]

- Force due to acceleration \( F_a \)
  \( F_a = (M_a + M_i) \) [N-m]

- Torque due to acceleration \( M_a \)
  \( M_a = (J_t + J_r) \cdot \frac{\omega}{2} \) [N-m]

- Torque required for acceleration \( M_r \)
  \( M_r = M_a + M_i \) [N-m]

- Limit acceleration time \( t_a \)
  \( t_a = \frac{(V_e + V_i)}{k \cdot F_s - F_a} \) [s]

where,
- \( J_l \) : Inertia moment by loading mass kg \cdot m²
- \( J_r \) : Inertia moment by moving mass kg \cdot m²
- \( M_s \) : Pulling resistance of the electrical cord N \cdot m
- \( M_t \) : Torque of Alignment Stage N \cdot m
- \( M_s \) : Acceleration time \( s \)
- \( V \) : Travel speed m/s
- \( k \) : Safety factor (1.3)

\( \delta \) table does not have cord and there is no pulling resistance. Inertia moment of loading mass can be given by the formulae on page 10.

Calculation example

Depending on operating ratio, the effective thrust can exceed the rated thrust value and motor may overheat, failure and could cause injury. Calculate the effective thrust of the operation pattern in order to examine whether the desired operation can be safely performed or not.

As an examination example, operating pattern using SA120DE/XYS is shown below. Below example of operation pattern is estimated considering limit acceleration time.

### Setting items

<table>
<thead>
<tr>
<th>Model</th>
<th>SA120DE/XYS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loading mass W</td>
<td>5 kg</td>
</tr>
<tr>
<td>Inertia moment by loading mass J</td>
<td>1.0 ( \times ) 10(^{-3} ) kg \cdot m(^2)</td>
</tr>
<tr>
<td>Mass of moving part W</td>
<td>3.4 kg</td>
</tr>
<tr>
<td>Travel distance L</td>
<td>0.05 m</td>
</tr>
<tr>
<td>Maximum speed V</td>
<td>0.1 m/s</td>
</tr>
<tr>
<td>Acceleration/deceleration time t</td>
<td>0.05 s</td>
</tr>
<tr>
<td>Time for constant travel speed t</td>
<td>0.05 s</td>
</tr>
<tr>
<td>Cycle time t</td>
<td>0.4 s</td>
</tr>
<tr>
<td>Pulling resistance of the cord F</td>
<td>1.0 N</td>
</tr>
<tr>
<td>Required rotation angle ( \theta )</td>
<td>180 (^{\circ})</td>
</tr>
<tr>
<td>Maximum speed V</td>
<td>2.0 ( \times ) 10(^{-3} ) kg \cdot m(^2)</td>
</tr>
<tr>
<td>Acceleration/deceleration time t</td>
<td>0.05 s</td>
</tr>
<tr>
<td>Time for constant travel speed t</td>
<td>0.05 s</td>
</tr>
<tr>
<td>Cycle time t</td>
<td>0.4 s</td>
</tr>
<tr>
<td>Pulling resistance of the cord F</td>
<td>1.0 N</td>
</tr>
<tr>
<td>Safety factor</td>
<td>1.3</td>
</tr>
</tbody>
</table>

#### STEP 1 Calculation of the thrust required for X-axis acceleration

1. Friction resistance of the rolling guide \( F_r \)
   \( F_r = F_s + F_s \)  
   \( = 3.0 + 1.0 - 4.0 \) [N]

2. Force due to acceleration \( F_a \)
   \( F_a = (V_e + V_i) \cdot \frac{\omega}{2} \)  
   \( = (5.0 + 5.9) \cdot \frac{0.1}{0.05} = 21.8 \) [N]

3. Thrust required for acceleration \( F_t \)
   \( F_t = F_r + F_a \)  
   \( = 21.8 + 4.0 - 25.8 \) [N]

Make sure that \( F_t \times 1.3 \) (safety factor) does not exceed the maximum thrust on page 6. If this values exceeds, re-examine the maximum speed, acceleration / deceleration time and other factors of the operation pattern. In this example, required thrust is smaller than maximum thrust as below.

Maximum thrust of SA120DE/X \( F_{max} = 70 \) [N] 
\( F_t \times 1.3 \) (Safety factor) \( = 25.8 \times 1.3 \approx 33.54 \) [N] \( < F_{max} \)

#### STEP 2 Calculation of the effective thrust for X-axis

Effective thrust \( F_{max} \) can be determined as follows.

\[
F_{max} = \sqrt{\frac{26.8 \times 0.05 + (25.8 - 2.40) \times 0.05 + 4.00 \times 0.05}{k}} 
\approx 11.17 \] [N]

Make sure that \( F_{max} \) does not exceed the rated thrust. If \( F_{max} \) exceeds rated thrust, re-examine the maximum speed, acceleration / deceleration time and other factors of the operation pattern. In this example, continuously operation is judged possible.

1N=0.102kgf=0.2248lbs,  
1mm=0.03937inch.
STEP 3 Calculation of the thrust and effective thrust for Y-axis acceleration

Same calculation to X-axis is needed. In case operation pattern of the Y-axis is the same as X-axis, safer condition is estimated due to light value of moving mass. (Omitted)

STEP 4 Calculation of the torque for \( \theta \) table acceleration

1. Torque due to rotation resistance \( M_r \)
   \[ M_r = M_{r1} + M_{r2} \]
   \[ = 0.1 \times 0.0 - 0.1 \text{ [N} \cdot \text{m]} \]

2. Torque due to acceleration \( M_a \)
   \[ M_a = \left( M_{a1} + M_{a2} \right) R / \tau \]
   \[ = (0.01 + 0.002) \times \frac{R}{0.05} = 0.764 \text{ [N} \cdot \text{m]} \]

3. Torque required for acceleration \( M_{req} \)
   \[ M_{req} = M_r + M_a \]
   \[ = 0.754 + 0.1 - 0.854 \text{ [N} \cdot \text{m]} \]

Make sure that \( M_{req} \times 1.3 \) (safety factor) does not exceed the maximum thrust on page 6. If this value exceeds, re-examine the maximum speed, acceleration / deceleration time and other factors of the operation pattern.

STEP 5 Calculation of effective torque

Effective torque \( M_{eff} \) can be determined as follows

\[
M_{eff} = \sqrt{\left( \frac{M_{r1} \times \tau_1 + (M_{r2} - 2 \times M_{a1}) \times \tau_2 + M_{a2} \times \tau_2}{\tau}\right)^2 + 0.05 + (0.854 - 2 \times 0.754 \times 0.05 + 0.1) \times 0.05}
\]

\[\approx 0.38 \text{ [N} \cdot \text{m]}\]

Make sure that \( M_{eff} \) does not exceed the rated torque. If \( M_{eff} \) exceeds rated torque, re-examine the maximum speed, acceleration / deceleration time and other factors of the operation pattern. In this example, continuously operation is judged possible.

When the position of loading mass offsets against rotating center, special attention is necessary because acceleration and deceleration of X-Y axis may become additional load to \( \theta \) table operating torque.

Cautions

- Alignment Stage SA - DE is a precision device. Therefore, handle it with great care and do not apply any excessive load or strong impact on it.
- Design the system that does not apply excessive force to cables.
- Use this product in a clean environment free from water, oil, dust and other foreign matters.
- Make sure that the mounting base is free from dirt and harmful protuberances.
- The flatness of the mounting base for Alignment Stage SA - DE will affect the positioning accuracy. It must be less than 10 \( \mu \)m.
- Alignment Stage SA - DE contains strong magnets. If a ferromagnetic body is placed close to Alignment Stage SA - DE, it may be attracted.
- The magnetic circuit inside Alignment Stage SA - DE is a closed circuit. However, a slight magnetic flux leak exists and may affect devices sensitive to magnetism located in the neighborhood. In such instances, please consult.
- The linear motion rolling guide assembled in Alignment Stage SA - DE is lubricated with grease. So take extreme care not to allow dirt or any foreign matters to enter into the unit.
- Alignment Stage SA - DE is machined, assembled and adjusted with high accuracy. Accordingly, never disassemble or remodel it in any case.
- If considering to use Alignment Stage SA - DE vertically, consult before designing.
- The appearance, specifications and other details of the products are subject to change without prior notice for improvement.

Note(1) Values are for reference only. For detailed information, consult.

Alignment Stage SA65DE/SA65DE/S
**Alignment Stage**

SA120DE<Assembled set>

- **SA120DE/XY**

- **SA120DE/XS**

- **SA120DE/XYS**

**Alignment Stage**

SA200DE<θ table>

- **SA200DE/S**

**Note:** Values are for reference only. For detailed information, consult.

Enclosed bolt 1/4-20 is recommended.

Hex socket head bolt M4 is recommended.