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-Z 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 table. High resolution and high positioning accuracy can be obtained by full closed loop controlled with optical linear scale. Single X-axis stage and 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

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

Principle of operation of SA-DE

Alignment Stage SA-DE incorporates built-in optical linear scale sensor in the moving table, and a C-shaped yoke with a set of magnets facing 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)

An 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 position signal from the optical linear scale for traveling and accurate positioning.

Feature of SA-DE

Ultra compact size, 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 with high-resolution linear encoder and full-closed loop control achieves high resolution and quick response.

Freely combination

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

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

Example of identification number

SA  120  DE /  5  XYS  R

1 Type
2 Size
3 Encoder interface specification
4 Table structure
5 Surface treatment

Type
SA-DE : Alignment Stage Direct Drive.

Size
65 : 65, 85, 120
200 : 200, 260

Encoder interface specification
1 : 8-1 μm
2 : 0.5 μm
Resolution of encoder for X or Y-axis is chosen.

Table structure
X : X-axis
Y : Y-axis
Z : θ-table

Surface treatment
No symbol : Electroless nickel plating
箢 : Black chrome surface treatment
Whole surface of table and bed are treated
in both specifications.

Specification and Performance

Table 1. Specification and performance

<table>
<thead>
<tr>
<th>Item</th>
<th>Type</th>
<th>SA65DE/1X</th>
<th>SA66DE/SX</th>
<th>SA120DE/1X</th>
<th>SA120DE/SX</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum thrust(1) N</td>
<td>25</td>
<td>25</td>
<td>15</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>Rated thrust(2) N</td>
<td>3.5</td>
<td>3.5</td>
<td>2.0</td>
<td>2.0</td>
<td></td>
</tr>
<tr>
<td>Operative stroke length mm</td>
<td>10</td>
<td>20</td>
<td>10</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>Maximum load mass kg</td>
<td>0.1</td>
<td>3.9</td>
<td>2.4</td>
<td>2.4</td>
<td></td>
</tr>
<tr>
<td>Resolution(μm)</td>
<td>0.1</td>
<td>0.5</td>
<td>0.1</td>
<td>0.5</td>
<td></td>
</tr>
<tr>
<td>Maximum speed(3) m/s</td>
<td>0.27</td>
<td>0.5</td>
<td>0.4</td>
<td>0.8</td>
<td></td>
</tr>
<tr>
<td>Repeatability(4) μm</td>
<td>0.15</td>
<td></td>
<td>0.17</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mass of moving part kg</td>
<td>0.17</td>
<td></td>
<td>0.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total mass(5) kg</td>
<td>0.35</td>
<td></td>
<td>0.35</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ambient temperature and humidity</td>
<td>0 to 40 °C, 20 to 80%RH (No condensation)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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.
(4) The value is applicable when the temperature of table becomes stable.
(5) The mass of cord is not included.

Table 2. Specification and performance

<table>
<thead>
<tr>
<th>Item</th>
<th>Type</th>
<th>SA65DE/S</th>
<th>SA120DE/S</th>
<th>SA200DE/S</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum torque(1) N · m</td>
<td>0.5</td>
<td>2.0</td>
<td>3.5</td>
<td></td>
</tr>
<tr>
<td>Rated torque(2) N · m</td>
<td>0.06</td>
<td>0.4</td>
<td>1.3</td>
<td></td>
</tr>
<tr>
<td>Maximum load mass kg</td>
<td>2.2</td>
<td>5.8</td>
<td>12.3</td>
<td></td>
</tr>
<tr>
<td>Operative angle Degrees</td>
<td>50</td>
<td>60</td>
<td>280</td>
<td></td>
</tr>
<tr>
<td>Resolution</td>
<td>0.04</td>
<td>0.36</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maximum speed(3) m/s</td>
<td>180</td>
<td>360</td>
<td>720</td>
<td></td>
</tr>
<tr>
<td>Repeatability(4) μm</td>
<td>13</td>
<td>30</td>
<td>60</td>
<td></td>
</tr>
<tr>
<td>Inertia of moving mass kg²/m²</td>
<td>0.00012</td>
<td>0.002</td>
<td>0.013</td>
<td></td>
</tr>
<tr>
<td>Total mass(5) kg</td>
<td>0.5</td>
<td>5</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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.
(4) The value is applicable when the temperature of table becomes stable.
(5) The mass of cord is not included.

Dynamic load mass

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

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

**Table 3 Driver**

**Dimension**

**Note:** Economy and compact model TDL1-1601 is also available. Consult [X] if required.

**Driver**

<table>
<thead>
<tr>
<th>Type and size</th>
<th>Driver</th>
<th>Encoder cord</th>
<th>Motor relay cord</th>
<th>Limit relay cord</th>
<th>Programmable control unit</th>
<th>RS232C connecting cord</th>
</tr>
</thead>
<tbody>
<tr>
<td>SA 6DE/X</td>
<td>TDL-1600/06L</td>
<td>TAE2080-EC</td>
<td>TAE2080-EC</td>
<td>TAE2080-EC</td>
<td>TAE2080-RSP/Dub25</td>
<td>TAE2080-RSP/Dub25</td>
</tr>
<tr>
<td>SA 6DE/S</td>
<td>TDL-1600/06S</td>
<td>TAE2080-EC</td>
<td>TAE2080-EC</td>
<td>TAE2080-EC</td>
<td>TAE2080-RSP/Dub25</td>
<td>TAE2080-RSP/Dub25</td>
</tr>
<tr>
<td>SA 6DE/XS</td>
<td>TDL-1600/06L</td>
<td>TAE2080-EC</td>
<td>TAE2080-EC</td>
<td>TAE2080-EC</td>
<td>TAE2080-RSP/Dub25</td>
<td>TAE2080-RSP/Dub25</td>
</tr>
<tr>
<td>SA 6DE/XYS</td>
<td>TDL-1600/06S</td>
<td>TAE2080-EC</td>
<td>TAE2080-EC</td>
<td>TAE2080-EC</td>
<td>TAE2080-RSP/Dub25</td>
<td>TAE2080-RSP/Dub25</td>
</tr>
<tr>
<td>SA 12DE/X</td>
<td>TDL-1600/12L</td>
<td>TAE2080-EC</td>
<td>TAE2080-EC</td>
<td>TAE2080-EC</td>
<td>TAE2080-RSP/Dub25</td>
<td>TAE2080-RSP/Dub25</td>
</tr>
<tr>
<td>SA 12DE/S</td>
<td>TDL-1600/12S</td>
<td>TAE2080-EC</td>
<td>TAE2080-EC</td>
<td>TAE2080-EC</td>
<td>TAE2080-RSP/Dub25</td>
<td>TAE2080-RSP/Dub25</td>
</tr>
<tr>
<td>SA 12DE/XS</td>
<td>TDL-1600/12L</td>
<td>TAE2080-EC</td>
<td>TAE2080-EC</td>
<td>TAE2080-EC</td>
<td>TAE2080-RSP/Dub25</td>
<td>TAE2080-RSP/Dub25</td>
</tr>
<tr>
<td>SA 12DE/XYS</td>
<td>TDL-1600/12S</td>
<td>TAE2080-EC</td>
<td>TAE2080-EC</td>
<td>TAE2080-EC</td>
<td>TAE2080-RSP/Dub25</td>
<td>TAE2080-RSP/Dub25</td>
</tr>
</tbody>
</table>

**Note:**
1. Length of motor relay cord and limit relay cord is 3m.
2. Length of pulse cord and limit cord is 1.5m.
3. Length of RS232C communication code in 2m.
4. When multiple sets of SA DE are operated simultaneously, specific cords that connect drivers are required. Consult [X].
Programmable Controller CTN480G (RoHS compliance)

Super-high-function that permits program inputs up to 10,000 steps
High-speed pulse output up to 4M pps
Axis linear interpolation axis circular interpolation function provided as standard
Positional correction by linear encoder
Program storage and transfer can be performed by CompactFlash
A system can be easily configured by incorporated I/O sequence function, timer, counter, and arithmetic function without sensors
USB interface is provided as standard. This permits data editing, controller operation and direct execution by PC.
Return-to-origin is not required because of provided absolute encoder.
Simultaneous execution of optional axes can be performed by the synchronous control function.
Up to 5 programs can be simultaneously executed by the multi-task function.
Positioning accuracy can be corrected by performing position correction data previously input.
Wiring to the drive can be easily performed by the input/output function for axes.
Up to 4 connectors (8-axis control) can be connected by link connection.

Table 4 Functions and performance

<table>
<thead>
<tr>
<th>Item</th>
<th>Model</th>
<th>CTN480G</th>
</tr>
</thead>
<tbody>
<tr>
<td>5-axis control</td>
<td>4 axes (Simultaneous execution can be performed)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>±0.2147883648 pulses (signed 32-bit length)</td>
</tr>
<tr>
<td>Maximum output frequency</td>
<td></td>
<td>4MHz</td>
</tr>
<tr>
<td>Acceleration/deceleration time</td>
<td></td>
<td>0 to 85.533 sec (straight line, output, 5-shaped acceleration/deceleration)</td>
</tr>
<tr>
<td>Output method</td>
<td></td>
<td>VAC/AC direction pulse, electron step pulse, quadrature pulse, 90° phase difference pulse</td>
</tr>
<tr>
<td>Command input method</td>
<td></td>
<td>Absolute command or incremental command</td>
</tr>
<tr>
<td>Program capacity</td>
<td></td>
<td>1000 steps</td>
</tr>
<tr>
<td>Functions</td>
<td>Jump, call, repetition, four operations, logical operation, speed setting, acceleration/deceleration setting, drive enable, motor control, I/O control, step interpolation, various editing functions, linear interpolation, offset correction, index, preset, precise, etc.</td>
<td></td>
</tr>
<tr>
<td>Input number of input points</td>
<td></td>
<td>8 input General-purpose input 30 points (The number can be extended to 50-80 points.)</td>
</tr>
<tr>
<td>Operation input</td>
<td>Start, stop, emergency stop, power-off, manual operation, ref/returning, motor feedback, driver alarm input, etc. (Selection and allocation using parameters by general-purpose input)</td>
<td></td>
</tr>
<tr>
<td>Input method</td>
<td>Multi-channel input for hi-voltage contact or open collector output</td>
<td></td>
</tr>
<tr>
<td>Output number of output points</td>
<td></td>
<td>20 points (The number can be extended to 50-80 points.)</td>
</tr>
<tr>
<td>Operation output</td>
<td></td>
<td>Motor power output, sensor detection, emergency stop, pulse output, terminal completion of return-to-origin, servo ON, alarm, drive alarm, proportional control, deviation counter clearing (Selection and allocation using parameters by general-purpose output)</td>
</tr>
<tr>
<td>Power supply for input/output</td>
<td>DC24V 4A</td>
<td></td>
</tr>
<tr>
<td>Other main functions</td>
<td>USB data read, write, direct execution, etc., program storage/transfer by compact flash, positional correction by linear scale, backlash correction, software limit, linear interpolation, check function, trace, I/O, 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 TA07XX-78.
2. Cable for USB connection shall be prepared by customer. Connector A-A type is necessary. (Refer to Fig.1)
3. Compact Flash (Type I) shall be prepared by customer. (Refer to Fig.2)
4. CompactFlash is a registered trademark of SanDisk Corporation.

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 \( F_{\text{eff}} \) is obtained as follows. (For a calculation example, see page 11.)

\[
F_{\text{eff}} = \sqrt{F_t^2 \times x_t + (F_r - 2 \times x_r)^2 \times y_t \times y_r}
\]

Where, \( F_r \) is the force required for acceleration. \( F_t \) 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 formulea.

\[
\mu = \frac{1}{2} \rho \cdot \pi \cdot r^2
\]

\[
M = \frac{1}{2} m \cdot r^2
\]

\[
J_a = \frac{1}{2} (a_1^2 + b_1^2) - \frac{1}{2} (a_2^2 + b_2^2)
\]

\[
J_a = \frac{1}{12} \left[ (a_1 - a_2)^2 + (b_1 - b_2)^2 \right] + (a_1 - b_1)^2 + (a_2 - b_2)^2
\]

\[
J_a = \frac{1}{12} \left[ (a_1 - a_2)^2 + (b_1 - b_2)^2 \right] + (a_1 - b_1)^2 + (a_2 - b_2)^2
\]

Where, \( J_a \) is the Mass moment of inertia around the center of gravity.
### Examination Example of Operation Pattern

#### Calculation of acceleration/deceleration time

The thrust required for driving Alignment Stage SA-DO (X or Y-axis) reaches its peak during acceleration. The thrust required during acceleration is limited by the thrust of Alignment Stage SA-DO (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
    - SA65DE/X: 0.5N
    - SA120DE/X: 3.0N
- Force due to running resistance \( F_s \)
  - \( F_s = \frac{F_{ax} + F_{ay}}{2} \) [N]
- Force due to acceleration \( F_a \)
  - \( F_a = (W_r + W_c) \cdot \frac{L}{t} \) [N]
- Thrust required for acceleration \( F_T \)
  - \( F_T = F_s + F_a \) [N]
- Limit acceleration time \( t_a \)
  - \( t_a = \left( \frac{L}{t} \right) \cdot \frac{L}{t} \cdot \frac{L}{t} \) [s]

where,
- \( W_r \) : Load mass \( m \)
- \( W_r \) : Mass of the moving part \( m \)
- \( F_{ax} \) : Pulling resistance of the electrical cord \( N \)
- \( F_{ay} \) : Thrust of Alignment stage \( N \)
- \( L \) : 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 value for calculation.

Similarly, required torque for \( \theta \) 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-DO.

- Torque due to rotation resistance \( T_r \)
  - \( T_r = M \cdot \omega \) [N·m]
- Torque required for acceleration \( T_a \)
  - \( T_a = \frac{2}{t_a} \cdot \frac{M}{2} \cdot \frac{M}{2} \cdot \frac{M}{2} \) [N·m]
- Limit acceleration time \( L \)
  - \( L = \left( \frac{t}{t} \right) \cdot \frac{t}{t} \cdot \frac{t}{t} \) [s]

where,
- \( M_r \) : Inertia moment by loading mass \( kg\cdot m^2 \)
- \( M_r \) : Inertia moment by moving mass \( kg\cdot m^2 \)
- \( M \) : Pulling resistance of the electrical cord \( N \cdot m \)
- \( M \) : Torque of Alignment Stage \( N \cdot m \)
- \( t \) : Acceleration time \( s \)
- \( V \) : Travel speed \( m/s \)
- \( k \) : Safety factor (1.3)

\( \theta \) 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 over heated, 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 example 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</td>
<td>Wl</td>
</tr>
<tr>
<td>Inertia moment by loading mass</td>
<td>( J_c )</td>
</tr>
<tr>
<td>Mass of moving part</td>
<td>( M_l )</td>
</tr>
<tr>
<td>Travel distance</td>
<td>( L )</td>
</tr>
<tr>
<td>Maximum speed</td>
<td>( V )</td>
</tr>
<tr>
<td>Acceleration/deceleration time</td>
<td>( t_a )</td>
</tr>
<tr>
<td>Time for constant travel speed</td>
<td>( t_c )</td>
</tr>
<tr>
<td>Cycle time</td>
<td>( T )</td>
</tr>
<tr>
<td>Pulling resistance of the cord</td>
<td>( F_{ax} )</td>
</tr>
<tr>
<td>Mass of moving part</td>
<td>( M_c )</td>
</tr>
<tr>
<td>Maximum speed</td>
<td>( V )</td>
</tr>
<tr>
<td>Acceleration/deceleration time</td>
<td>( t_a )</td>
</tr>
<tr>
<td>Time for constant travel speed</td>
<td>( t_c )</td>
</tr>
<tr>
<td>Cycle time</td>
<td>( T )</td>
</tr>
<tr>
<td>Pulling resistance of the cord</td>
<td>( F_{ax} )</td>
</tr>
</tbody>
</table>

**Safety factor**

- \( k \) : Safety factor (1.3)

**STEP1 Calculation of the thrust required for X-axis acceleration**

1. Friction resistance of the rolling guide \( F_r \)
   - \( F_r = F_{ax} + F_{ay} \)
   - \( \approx 3.0 + 1.0 = 4.0 \) [N]
2. Force due to acceleration \( F_a \)
   - \( F_a = \left( W_r + W_c \right) \cdot \frac{L}{t} \)
   - \( \approx 5.0 \cdot 0.5 = 21.8 \) [N]
3. Thrust required for acceleration \( F_T \)
   - \( F_T = F_s + F_a \)
   - \( \approx 21.8 + 4.0 = 25.8 \) [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 / decelera-

tion 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 \( F_{ax} \) = 70 [N]
\( F_{ax} \times 1.3 \) (safety factor) = 91 [N] < 70 [N]

**STEP2 Calculation of the effective thrust for X-axis**

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

\[
F_{ex} = \sqrt{F_T^2 \times L_1}{\bigg(1 + (2 - F_T) \frac{t_a}{t_c} \bigg)}
\]

\[
F_T = \sqrt{\frac{25.8 \times 0.05 + (25.8 - 2 \times 4.0) \times 0.05 + 4.0 \times 0.05}{0.4}} \approx 11.17 \text{ [N]}
\]

Make sure that \( F_{ex} \) does not exceed the rated thrust. If \( F_{ex} \) exceeds rated thrust, re-examine the maximum speed, acceleration / deceleration time and other factors of the operation pattern. In this example, continuous operation is judged possible.
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 \( M_r \)
   
   \[ M_r = M_{fr} + M_{fr} = 0.1 + 0.0 = 0.1 \text{ [N·m]} \]

2. Torque due to acceleration \( M_a \)
   
   \[ M_a = (J_a + J_r) \frac{R}{s} \]
   
   \[ = (0.01 + 0.002) \times \frac{R}{0.05} = 0.764 \text{ [N·m]} \]

3. Torque required for acceleration \( M_a \)
   
   \[ M_a = 0.754 + 0.1 = 0.854 \text{ [N·m]} \]

Make sure that \( M_a \cdot 1.3 \) (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. In this example, continuous operation is judged possible.

In which the position of loading mass offsets against rotating center, special attention is necessary because acceleration and deceleration of Y-X 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 protrusions.
- The flatness of the mounting base for Alignment Stage SA-DE will affect the positioning accuracy. It must be less than 10 \( \mu \text{m} \).
- 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 contact us.
- 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 us before designing.
- The appearance, specifications and other details of the products are subject to change without prior notice for improvement.
Alignment Stage

SA120DE<Assembled set>

SA200DE<ø table>

Note(1) Values are for reference only. For detailed information, consult web: http://mdmetric.com
email: sales@mdmetric.com

1N=0.102kgf=0.2248lbs.  
1mm=0.03937inch