Battery-less Absolute Encoder
No Battery, No Maintenance,
No Homing, and No Price Increase.
No Going Back to Incremental.

Easy Automation Concept

~ Lower Costs with the ROBO Cylinder® ~

Volume 4

ROBO CYLINDER

IAI
Quality and Innovation
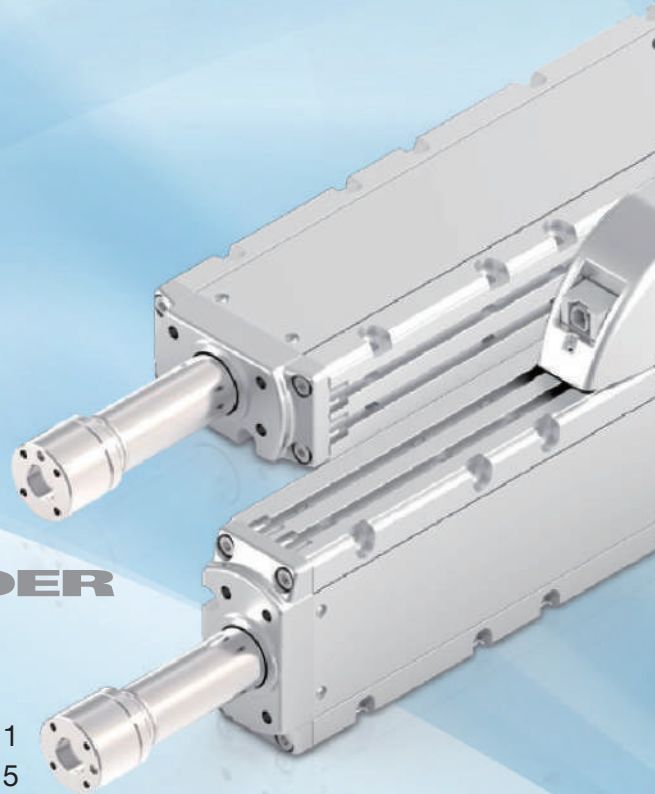
1. Application Examples

Deburring System

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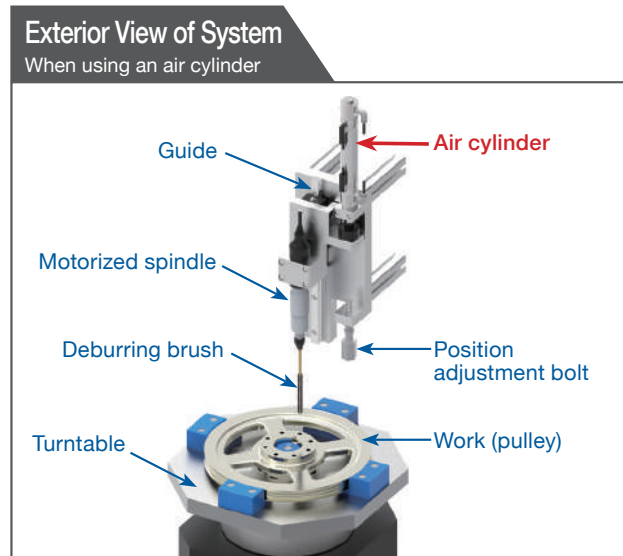www.electromate.com
sales@electromate.com

There is no need to reposition tools, which significantly reduces the cycle time.

1 System Overview

Exterior View of System
When using an air cylinder

- Guide
- Air cylinder
- Motorized spindle
- Deburring brush
- Position adjustment bolt
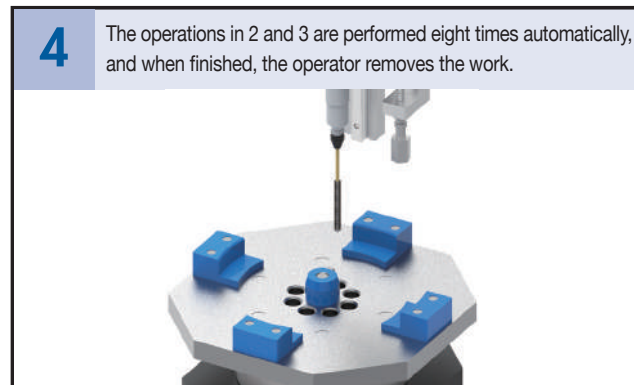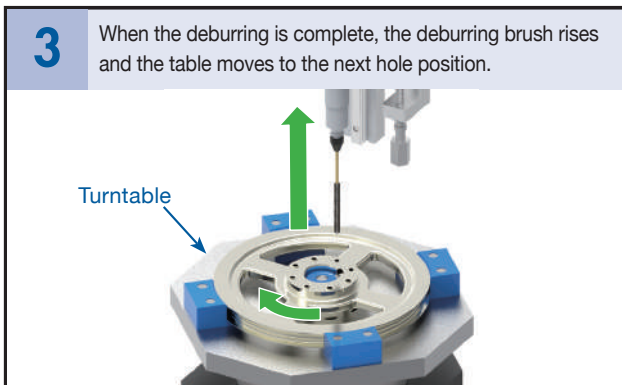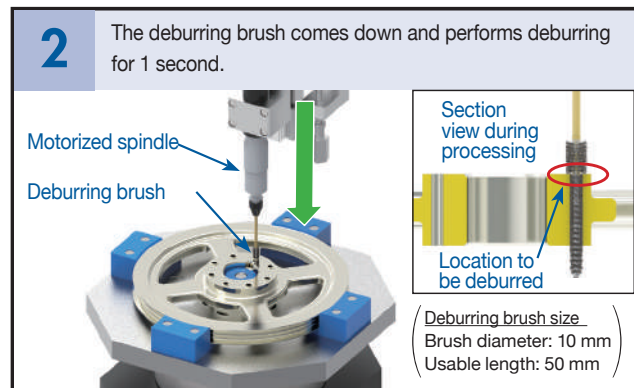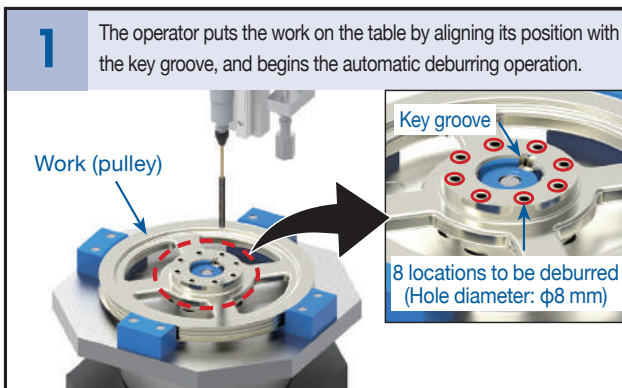- Turntable
- Work (pulley)

(1) Explanation of Process

This system removes burrs around holes drilled in a pulley[1].
Eight locations are deburred.
The deburring brush attached to the motorized spindle[2] is used to remove the burrs along the edge of holes.
An air cylinder is used to move the deburring brush up and down.

[1] Pulley: A gear that transmits motive power through a belt, etc., passed around it.
[2] Motorized spindle: A unit that uses a motor to turn and has chucks at its tip to hold a tool in place.

(2) Explanation of Operation

1 The operator puts the work on the table by aligning its position with the key groove, and begins the automatic deburring operation.

- Work (pulley)
- Key groove
- 8 locations to be deburred (Hole diameter: φ8 mm)

2 The deburring brush comes down and performs deburring for 1 second.

- Motorized spindle
- Deburring brush
- Section view during processing
- Location to be deburred

Deburring brush size
Brush diameter: 10 mm
Usable length: 50 mm

3 When the deburring is complete, the deburring brush rises and the table moves to the next hole position.

- Turntable

4 The operations in 2 and 3 are performed eight times automatically, and when finished, the operator removes the work.

Issues Requiring Improvement

1. Eliminates tool repositioning
2. Longer tool life
3. Shortens the cycle time

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2 Improvements Achieved by the ROBO Cylinder

The issues were resolved by replacing the air cylinder of the deburring system with a ROBO Cylinder.

Point 1 Eliminating the need to change the tool stopping position and achieving a longer life

(1) Condition When using an Air Cylinder

The air cylinder is used to move up and down the motorized spindle to which the deburring brush is attached.
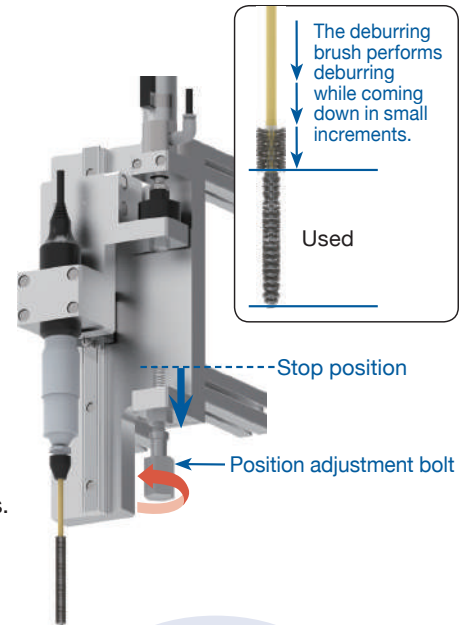
The deburring brush will wear after repeated deburring at the same position.
Accordingly, the position of the deburring brush must be changed periodically.

The condition of the work is visually inspected, and if the work has not been deburred sufficiently, the stopping position of the air cylinder rod is lowered by approx. 1 mm to perform deburring again.

The operator changes the position using the adjustment bolt.
This operation takes approximately 2 minutes and is performed every 15 minutes or so. (Average 43 times/day)

This adjustment is repeated and when the deburring brush is finally consumed, the brush is replaced.

One deburring brush can perform an average of 6,000 deburring cycles.

The deburring brush performs deburring while coming down in small increments.

Used

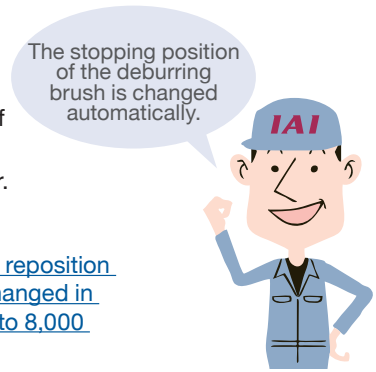Stop position

Position adjustment bolt

(2) Improvements Found with the ROBO Cylinder

The ROBO Cylinder lets you program operation patterns beforehand.

As for repositioning of the deburring brush, a test was conducted to examine and program optimal values for the number of deburring cycles and the pitch of downward feed.

When the deburring brush reaches its life, a lamp turns on to notify the operator.

The stopping position of the deburring brush is changed automatically.

By programming the ROBO cylinder and automating the operation, the need to reposition the deburring brush was eliminated. Also, the stopping position can now be changed in 0.5-mm increments, allowing one deburring brush to increase its performance to 8,000 deburring cycles.

Number of times the tool stopping position is changed

Air cylinder	Average **43** times/day	ROBO Cylinder	**0** times/day

Number of deburring cycles (Tool life)

Air cylinder	Average **6,000** times/piece	ROBO Cylinder	**8,000** times/piece

Point 2

Significantly shorter cycle time,

achieved by speed change during use and optimized operation pattern

Operation pattern per cycle
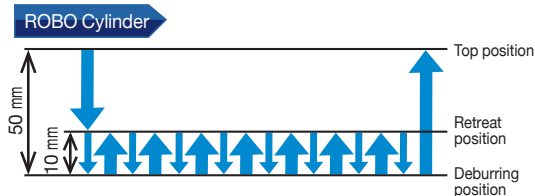
High speed | Low speed

(1) Condition When using an Air Cylinder

With the air cylinder, the speed cannot be changed during operation.
To suppress impact when the deburring brush contacts the work, the brush comes down at low speed and rises at high speed.
The cycle time per work (deburring of 8 locations) is 28.0 seconds.
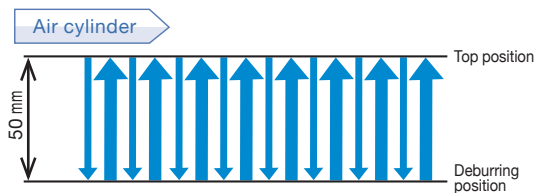
(2) Improvements Found with the ROBO Cylinder

The ROBO Cylinder lets you change the operating speed while the system is in operation.
The brush comes down at high speed to immediately before the deburring position, after which the speed changes to low.
After the deburring, the brush can now rise at high speed.
Also, the ROBO Cylinder can move to any desired position, so the distance of rise can be minimized (10 mm).

As a result, the cycle time was reduced to 18.4 seconds.

Air cylinder
50 mm
Top position
Deburring position

ROBO Cylinder
50 mm
10 mm
Top position
Retreat position
Deburring position

Processing cycle time (Average time excluding work setting/removal time)

Air cylinder	ROBO Cylinder
28.0 seconds	**18.4** seconds

Point 3

Number of replacement units required when the system is used for 10 years:

6 Air Cylinders = 0 ROBO Cylinder

(1) Condition When using an Air Cylinder

The air cylinder drops its speed (thrust force) after 2 million operations or so due to deterioration of gaskets, etc.
The air cylinder reaches its life expectancy in approximately 1.5 years and then needs to be replaced.

(2) Improvements Found with the ROBO Cylinder

By adopting the ROBO Cylinder, the service life was extended. In this example, the ROBO Cylinders will last for 10 years or longer.
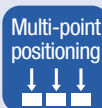
Service life (in this example)

Air cylinder	ROBO Cylinder
Approx. **1.5** year	**10** years or longer

7 Benefits of the ROBO Cylinder

- With the ROBO Cylinder, the speed, acceleration, and deceleration can be set for each position.
  A stable movement is possible by setting the best speed, acceleration, and deceleration.
- You can also change the speed during use.

Multi-point positioning

Speed, Acceleration/ Deceleration setting function

Please visit here for "The 7 Benefits of the ROBO Cylinder"

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3 Cost Cutting Effect

(1) Conditions

Required production quantity	650 pieces/day
Labor cost	$18*/hour (1 person/system)
Deburring brush	$20*/piece
Annual operation days	250 days

(2) Prices of adopted ROBO Cylinders

Product model	Price
RCP3-SA4C-I-35P-2.5-100-P1-S-B	$443*
PSEL-CS-1-35PIB-NP-2-0	$440*

(3) Comparison of air cylinder and ROBO Cylinder

Item	System using air cylinder	System using ROBO Cylinder
Cycle Time	58.0 seconds/piece [1] Processing cycle time 28.0 seconds [2] Work changeover by operator Average 30 seconds [1] + [2] = 58.0 seconds	48.4 seconds/piece [1] Processing cycle time 18.4 seconds [2] Work changeover by operator Average 30 seconds [1] + [2] = 48.4 seconds
Line operating hours	11.9 hours/day [1] Manufacturing time 10.5 hours [2] Tool height adjustment time 2 minutes x 43 times = 1.43 hours [1] + [2] ≒ 11.9 hours	8.7 hours/day Manufacturing time 8.7 hours * There is no adjustment time, because the height is adjusted automatically.
Labor cost	$53,550*/year 11.9 hours x 250 days x $18* = $53,550*	$39,150*/year 8.7 hours x 250 days x $18* = $39,150*
Annual tool cost	$4,340*/year 217 pieces x $20* = $4,340* (Average processing runs per piece: 6,000 times)	$3,260*/year 163 pieces x $20* = $3,260* (Average processing runs per piece: 8,000 times)
Purchase Cost of Replacement Cylinder (Assuming 10 years)	$720*/10 years Air cylinder $120*/unit x Approximately 6 replacements (Service life 1.5 years/unit) = $720*	$0*/10 years

Exterior View after Improvement
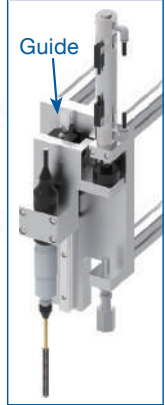(ROBO Cylinder adopted)

Please visit here for the video.
www.intelligentactuator.com/eac-v04

RCP3-SA4C

Conventional system

Guide

◆ Facility Benefits of Adopting ROBO Cylinders
• Reduction of component parts (guides, etc.)

(4) Annual cutting effect

	Air Cylinder		ROBO Cylinder		
Labor cost	$53,550*	–	$39,150*	=	$14,400*
Annual tool cost	$4,340*	–	$3,260*	=	$1,080*
Purchase Cost of Replacement Cylinder	$72* ($720*/10 years)	–	$0*	=	$72*
			Difference	=	$15,552*

Result

There is no more adjustment work during processing, while the tool life increased to 1.3 times and the cycle time decreased by 17%.

This resulted in significant labor cost reduction of **$15,552*** a year.

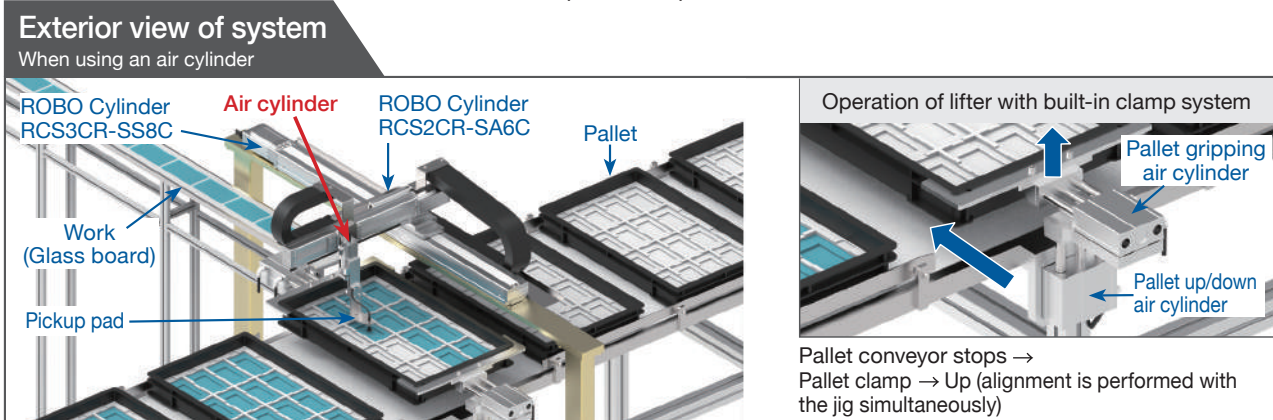What's more, the ROBO Cylinder need not be replaced for at least 10 years.

* Exchange Rate: 1(USD)=100(Japanese Yen)

Work Transfer System

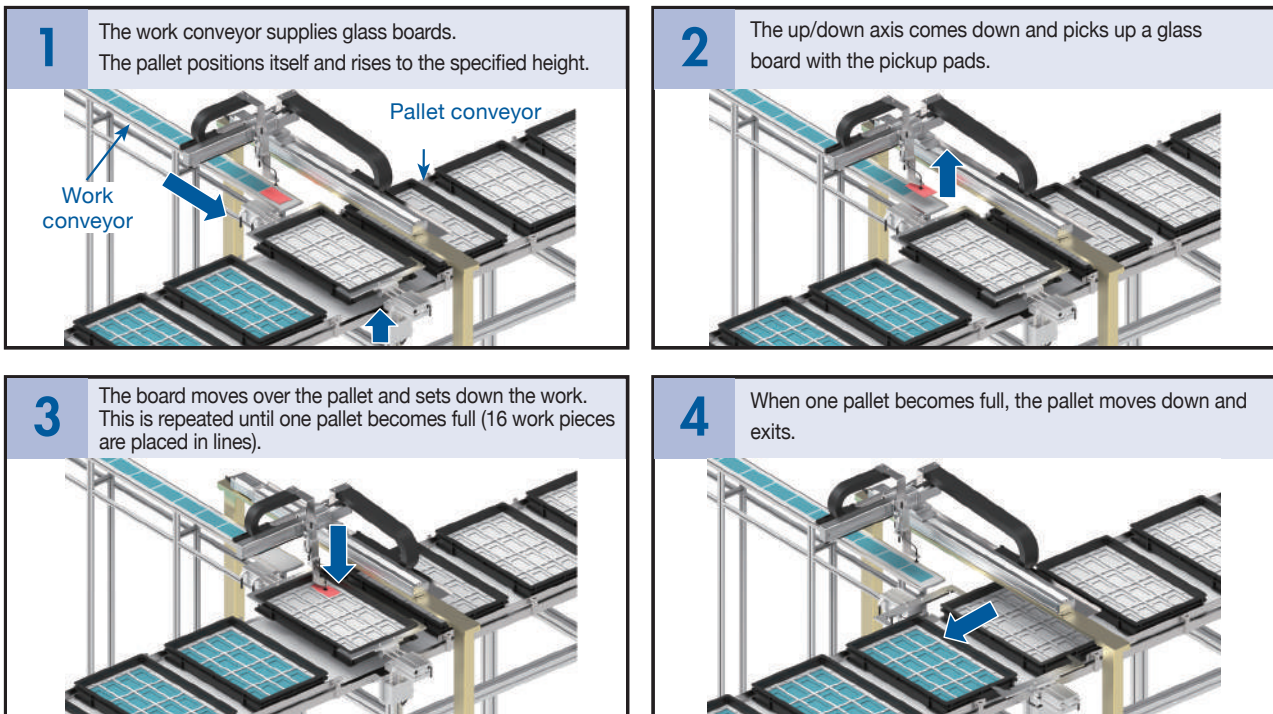## Arching the operation path to reduce the cycle time by 25%

1 System Overview

(1) Explanation of Process

Glass boards are placed on a pallet in this process.
16 work pieces are placed in lines on one pallet.
This process is performed in a clean room.

Exterior view of system
When using an air cylinder

ROBO Cylinder RCS3CR-SS8C — Air cylinder — ROBO Cylinder RCS2CR-SA6C — Pallet — Work (Glass board) — Pickup pad

Operation of lifter with built-in clamp system

Pallet gripping air cylinder — Pallet up/down air cylinder

Pallet conveyor stops →
Pallet clamp → Up (alignment is performed with the jig simultaneously)

(2) Explanation of Operation

1 The work conveyor supplies glass boards.
The pallet positions itself and rises to the specified height.

Pallet conveyor
Work conveyor

2 The up/down axis comes down and picks up a glass board with the pickup pads.

3 The board moves over the pallet and sets down the work. This is repeated until one pallet becomes full (16 work pieces are placed in lines).

4 When one pallet becomes full, the pallet moves down and exits.

Issues Requiring Improvement

1. Shorten the cycle time
2. Shorten the changeover time

5

2 Improvements Achieved by the ROBO Cylinder

The issues were resolved by replacing the air cylinder used for the up/down axis of the transfer system with a ROBO Cylinder.

Point 1 Reducing the travel time with arch motion

(1) Problems Experienced While Using the Air Cylinder

It takes an average of 4 seconds* to transfer one work piece.

  * Time needed to pick up a work piece from the conveyor and put it on the pallet, and then return to above the work conveyor. The transfer speed varies at different positions within the pallet depending on how close or far the position is to/from the work conveyor.

It takes 64 seconds to position work pieces on one pallet.

The cycle time must be reduced to meet the customer's request for production increase.

The request cannot be met with the current system that uses an air cylinder for the up/down axis.

Operation path of up/down axis per cycle

Air cylinder

Travel time
4 seconds

[1] Stopper
    (Shock absorber)
[2] Stopper block

[1]
[2]
[1]
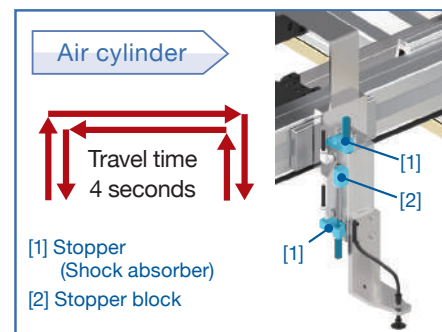
(2) Improvements Found with the ROBO Cylinder

By replacing the up/down axis with one based on the ROBO Cylinder, the axis can be interlocked with the horizontal axis to perform arch-motion operation (figure on the right).
This enabled the shortest travel path.
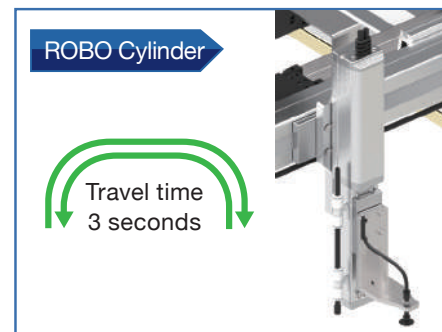
As a result, the transfer time was reduced.
It now takes an average of 3 seconds to transfer one work piece, and 48 seconds to line up all the work pieces.

ROBO Cylinder

Travel time
3 seconds

Work positioning time (Time needed to place all 16 work pieces on one pallet, excluding pallet changeover time)

Air cylinder **64** seconds

ROBO Cylinder **48** seconds

7 Benefits of the ROBO Cylinder

• With the ROBO Cylinder, the speed, acceleration, and deceleration can be set for each position.

  A stable movement is possible by setting the best speed, acceleration, and deceleration.

• You can also change the speed during use.

Multi-point positioning

Speed, Acceleration/ Deceleration setting function
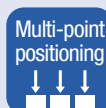
Please visit here for "The 7 benefits of the ROBO Cylinder"

www.intelligentactuator.com/7

Point 2 — Shorter changeover time

(1) Problems Experienced While Using the Air Cylinder

Several types of pallets are used, each having a different height.

With an air cylinder, dedicated jigs are used to adjust the pallet heights because the travel distance remains the same (figure on the right).

Changeover of these dedicated jigs takes approx 10 minutes, and two changeovers are required per day.
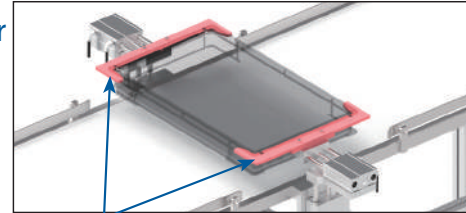
Dedicated jigs for pallet height adjustment

Type A — Low

Type B — High
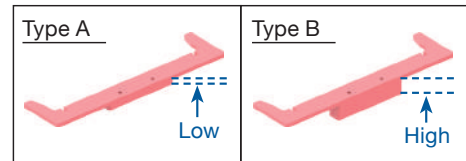
(2) Improvements Found with the ROBO Cylinder

The ROBO Cylinder can be stopped at desired positions.

Programs are created beforehand for different pallet heights.

This eliminates the need to replace dedicated jigs to adjust the pallet heights.

When changing pallets, all you need to do is switch the programs.

All you need to do is switch the programs!

Changeover time

| Air cylinder | 10 minutes | ROBO Cylinder | 0.2 minute |

Point 3

Number of replacement units required when the system is used for 10 years:

13 Air Cylinders = 0 ROBO Cylinder

Air cylinders have an average service life of approx. 2 million operations, which translates to approx. 0.7 year in this example. ROBO Cylinders have a service life of 10 years or longer.

Service life (in this example)

| Air cylinder | Approx. 0.7 year | ROBO Cylinder | 10 years or longer |

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3 Cost Cutting Effect

(1) Conditions

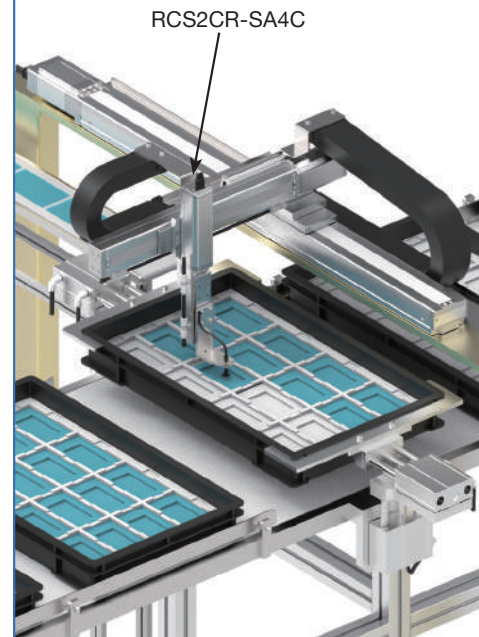|	
Required production quantity	12,000 pieces/day
Labor cost	$18*/hour One operator oversees three lines.
Annual operation days	240 days

(2) Prices of adopted ROBO Cylinders

Product model	Price
RCS2CR-SA4C-WA-20-10-50-T2-S-B	$1,080*
XSEL-P-3-150WAI-30DWAI-20WAIB-NI-EEE-3-3	$3,405*

Exterior View after Improvement
(ROBO Cylinder adopted)

Please visit here for the video.

www.intelligentactuator.com/eac-v04

RCS2CR-SA4C

(3) Comparison of air cylinder and ROBO Cylinder

Item	System using air cylinder	System using ROBO Cylinder
Cycle Time	80 seconds/pallet [1] Transfer of 1 work piece 4 seconds [2] Pallet changeover time 16 seconds [1] x 16 times + [2] = 80 seconds	64 seconds/pallet [1] Transfer of 1 work piece 3 seconds [2] Pallet changeover time 16 seconds [1] x 16 times + [2] = 64 seconds
Line operating hours	17 hours/day [1] Manufacturing time 16.67 hours [2] Changeover time 0.33 hour [1] + [2] = 17 hours	13.34 hours/day [1] Manufacturing time 13.33 hour [2] Changeover time 0.01 hour [1] + [2] = 13.34 hours
Labor cost	$73,440*/year 17 hours x 240 days x $18* = $73,440*	$57,628.8*/year 13.34 hours x 240 days x $18* = $57,628.8*
Purchase Cost of Replacement Cylinder (Assuming 10 years)	$7,800*/10 years Air cylinder $600*/unit x 13 replacements (Service life 0.7 year) = $7,800*	$0*/10 years

(4) Annual Cutting Effect

	Air cylinder	ROBO Cylinder		
Labor cost	$73,440* –	$57,628.8*	=	$15,811.2*
Purchase Cost of Replacement Cylinder	$780* – (Air cylinder $7,800* / 10 years)	$0*	=	$780*
		Difference	=	$16,591.20*

Result

The cycle time decreased by 25% and and the changeover time dropped to 1/50th or less.

This resulted in significant labor cost reduction of **$16,591.20*** a year.

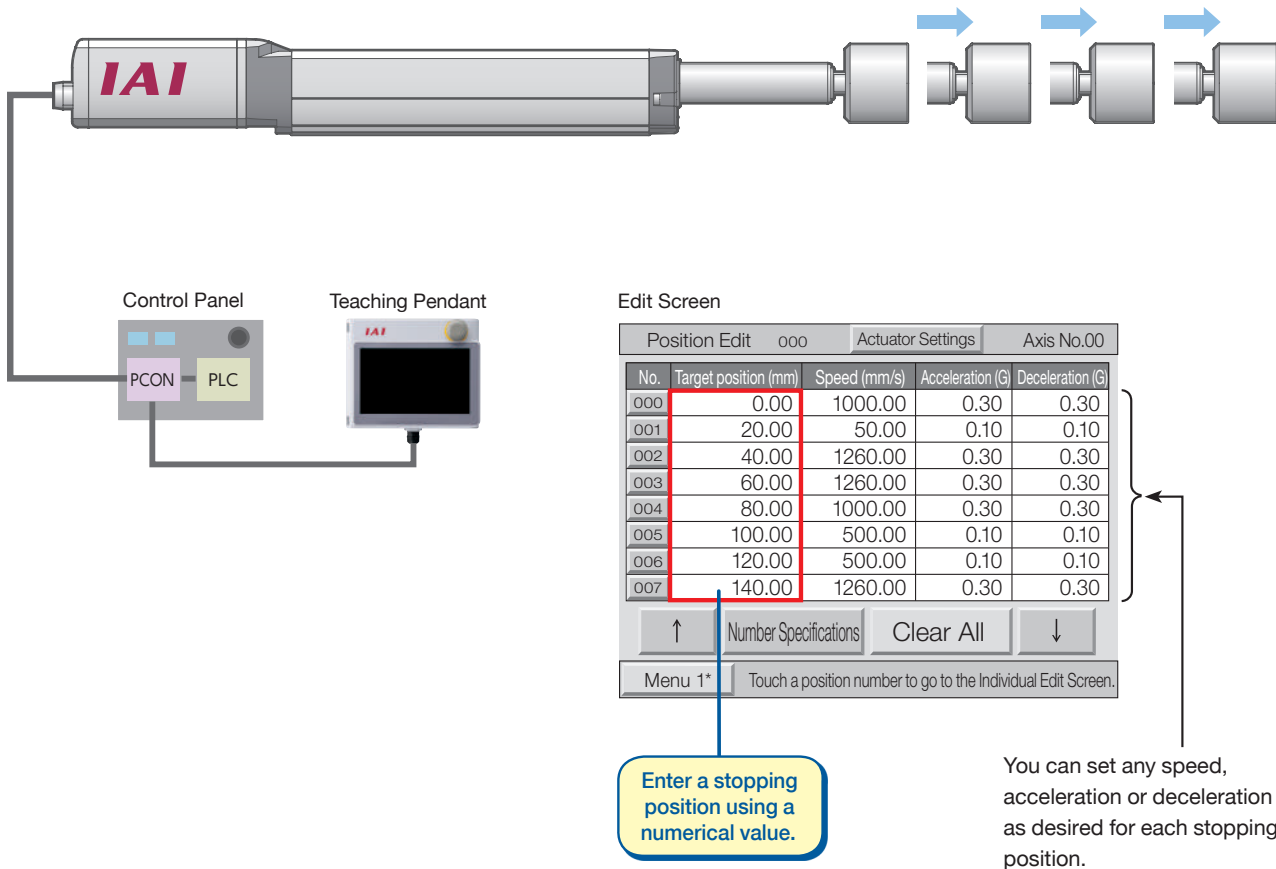What's more, the ROBO Cylinder need not be replaced for at least 10 years.

* Exchange Rate: 1(USD)=100(Japanese Yen)

8

4: Multi-point Positioning

The ROBO Cylinder supports multi-point positioning.

The ROBO Cylinder lets you set stopping positions easily from the teaching pendant using numerical values (coordinates from the home position).
Accurate positioning can be performed, to a maximum of 512 points.

Control Panel

Teaching Pendant

PCON — PLC

Edit Screen

Position Edit	000	Actuator Settings	Axis No.00

No.	Target position (mm)	Speed (mm/s)	Acceleration (G)	Deceleration (G)
000	0.00	1000.00	0.30	0.30
001	20.00	50.00	0.10	0.10
002	40.00	1260.00	0.30	0.30
003	60.00	1260.00	0.30	0.30
004	80.00	1000.00	0.30	0.30
005	100.00	500.00	0.10	0.10
006	120.00	500.00	0.10	0.10
007	140.00	1260.00	0.30	0.30

↑	Number Specifications	Clear All	↓

Menu 1*	Touch a position number to go to the Individual Edit Screen.

Enter a stopping position using a numerical value.

You can set any speed, acceleration or deceleration as desired for each stopping position.

[Air Cylinder]

Air cylinders are rarely used for multi-point positioning.

An air cylinder can be stopped at a given position by setting a stopper. To perform multi-point positioning, another air cylinder is needed to drive the stopper.

Also, a shock absorber is needed to prevent impact upon stopping.

Visual Inspection Method

Purpose of Visual Inspection

The purpose is to prevent problems.
Find abnormalities early and remove their causes to eliminate problems.

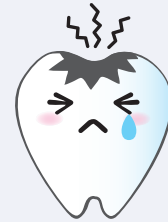It's like visiting a dentist regularly to eliminate cavities!
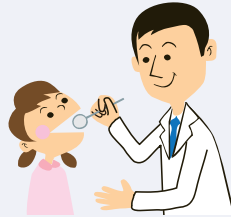
What happens if nothing is done?

Failure may occur and the line may stop.
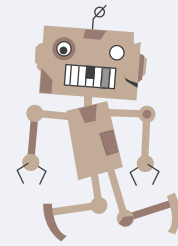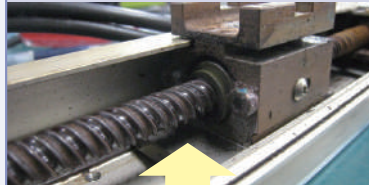
You may have cavities.

What to inspect?

Visually inspect both the interior and exterior of the equipment.
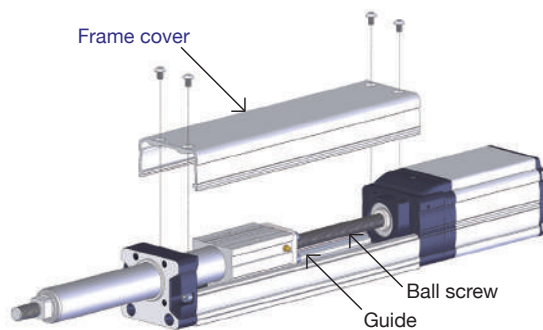
Cable	Ball screw, guide	Stainless sheet
Sheath worn or scratched?	Grease dried up, or any dust or dirt? Any cracks or dents?	Any cracks or dents?

Checking the interior of the rod-type actuator is so easy!

Frame cover

Ball screw

Guide

[Visual Inspection Procedure]

[1] Remove the frame cover. (Note)

[2] Visually check the rod, ball screw, and guide groove.

[3] Clean and add grease, if necessary.

[4] Install the frame cover.

The reference drawing shows the rod-type radial cylinder RCP5.

(Note) The cover is removed differently depending on the model, and the inspection intervals also vary according to the conditions of use.
For details, refer to the operation manual.

4: AND Circuit and OR Circuit

AND circuit

In sequence control, a circuit that actuates when two or more contacts connected in series turn ON, is called an "AND Circuit." The example below shows an "AND Circuit" that turns on a lamp using two pushbuttons.
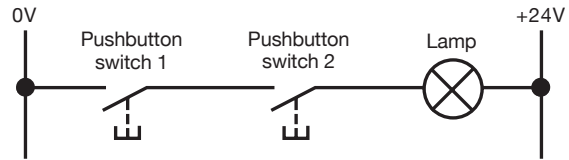
1. Example of Wiring

Pushbutton switch 1   Pushbutton switch 2

Battery   Lamp
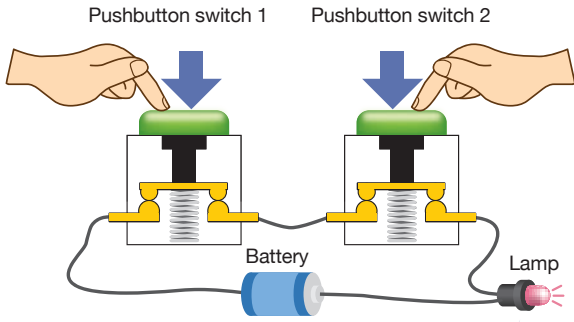
The lamp is off when either switch is not pressed.
The lamp turns on when both switches is pressed.

2. Circuit Diagram

The circuit diagram below assumes a 24-VDC power supply [Note] commonly used for control circuits of actual mechanical systems.
This circuit diagram is called a "Development Connection Diagram."
The symbols used on the diagram are specified by JIS C 0617.

0V   Pushbutton switch 1   Pushbutton switch 2   Lamp   +24V

(Note) The power-supply circuit is not shown.

OR circuit

A circuit that actuates when at least one of two or more contacts connected in parallel turns ON, is called an "OR Circuit."
The example below shows an "OR Circuit" that turns on a lamp using two pushbuttons.
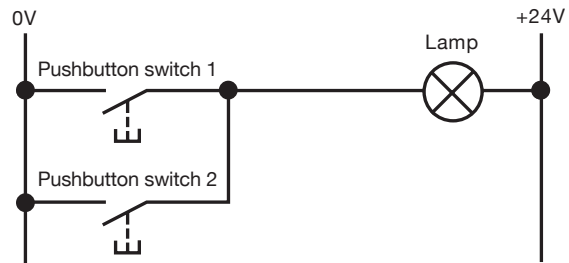
1. Example of Wiring

Pushbutton switch 1

Pushbutton switch 2

Lamp

Battery
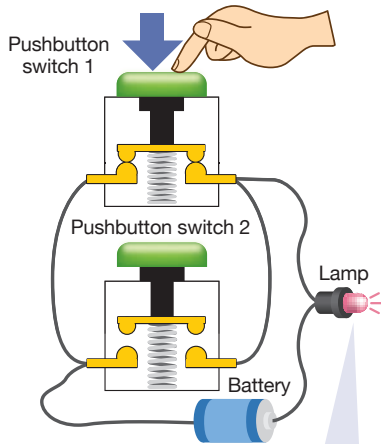
The lamp is off when both switches are not pressed.
The lamp turns on when either switch is pressed.

2. Circuit Diagram

The circuit diagram below assumes a 24-VDC power supply [Note].

0V   Pushbutton switch 1   Lamp   +24V

Pushbutton switch 2

(Note) The power-supply circuit is not shown.

"AND Circuit" and "OR Circuit" Using PLC

If a PLC is used, connect the pushbutton switch wires to input terminals of the PLC, and connect the lamp wire to an output terminal of the PLC.
The wiring is the same for an "AND circuit" and an "OR circuit," because both are created by writing a ladder program in the PLC.

1. PLC I/O Circuit Diagram
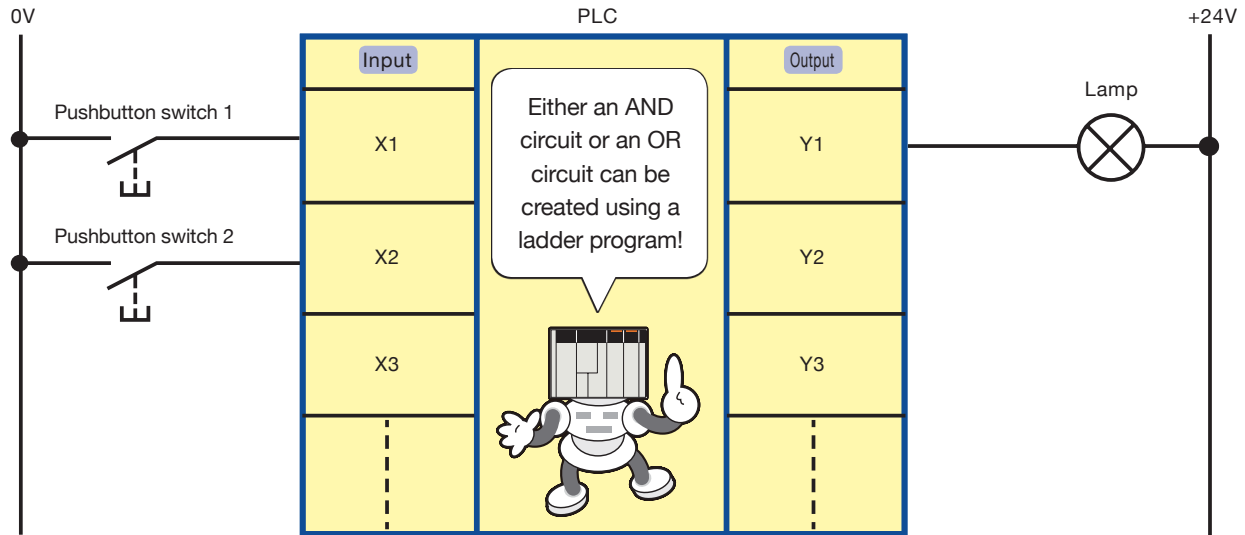
2. Ladder Program

A PLC lets you design circuits using software, instead of traditional relays.
A dedicated software program is used to create circuits as if drawing relay circuits. This program is called "Ladder Program."
Under a ladder program, pushbutton switch 1 is replaced by contact X1, pushbutton switch 2 is replaced by contact X2, and the lamp is replaced by relay coil Y1. X1, X2 and Y1 are called "Addresses."

(1) AND circuit

(2) OR circuit

12
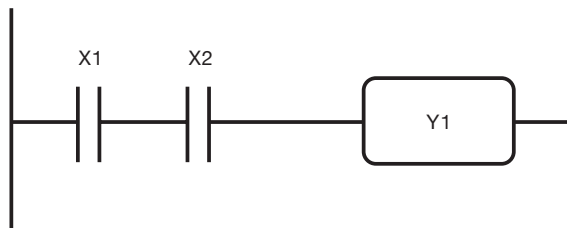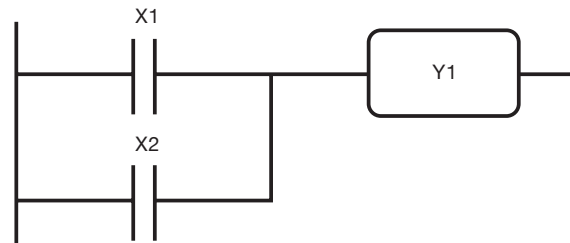
Use the TAG command and GOTO command if you want to repeat the same operation, or ignore an operation depending on the condition, in the program.
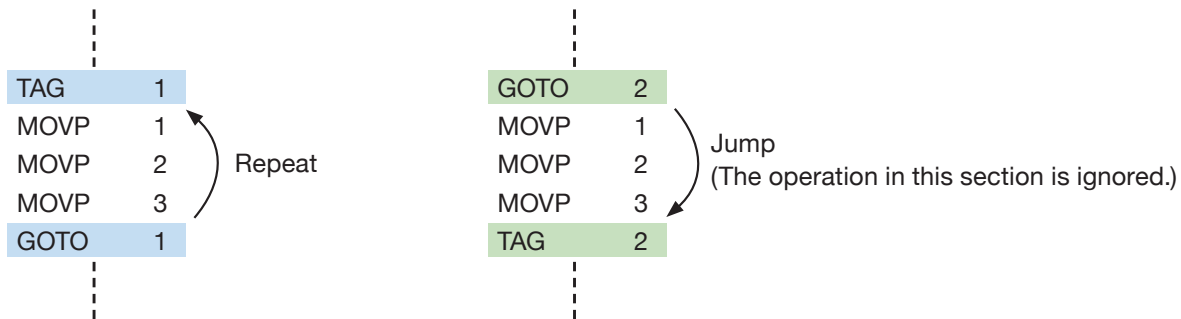
1. Commands and their functions

(1) TAG (Jump To)

Used as a destination for the GOTO (Jump) command.
This command is used to indicate where to jump to after the GOTO command, using a number.
The TAG command can appear before or after the GOTO command.

(2) GOTO (Jump)

This command lets you repeat a section of the program and jump to a specified location.
Processing jumps to a tag of the same number as the one specified by GOTO.
If a tag of the specified number exists before the current position, processing returns to that tag and repeats the applicable section of the program. If a tag of the specified number exists after the current position, processing jumps to that tag and ignores the skipped section of the program.
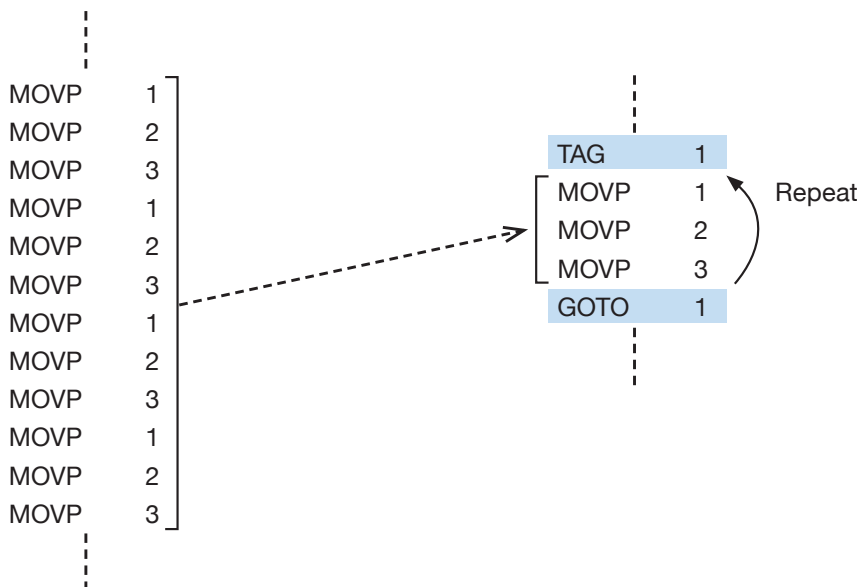
TAG	1
MOVP	1
MOVP	2	Repeat
MOVP	3
GOTO	1

GOTO	2
MOVP	1	Jump
MOVP	2	(The operation in this section is ignored.)
MOVP	3
TAG	2

2. Using TAG/GOTO

Assume you want to repeat positioning to Nos. 1, 2 and 3 . . . .

[1] Without the TAG/GOTO commands, you must continue to write the same commands.

[2] By using the TAG/GOTO commands, all you need are five lines.

MOVP	1
MOVP	2
MOVP	3
MOVP	1
MOVP	2
MOVP	3
MOVP	1
MOVP	2
MOVP	3
MOVP	1
MOVP	2
MOVP	3

TAG	1
MOVP	1	Repeat
MOVP	2
MOVP	3
GOTO	1

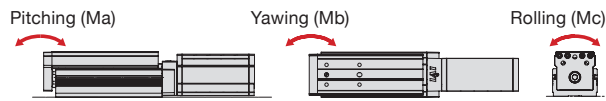The program has become so short.

IAI

ROBO Cylinder® RCP6 Series
Table Type (TA)

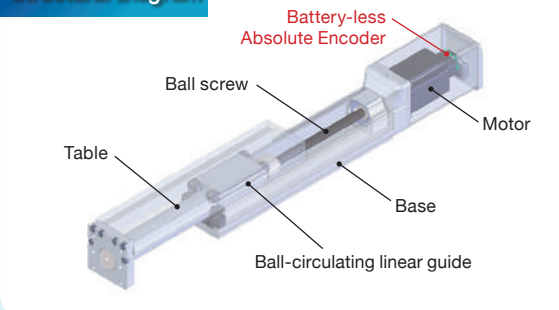– All models come standard with battery-less absolute encoder –

Feature

■ You can mount tooling using the tapped holes in the table top and the end plate.

■ The table has built-in ball-circulating guides to handle pitching (Ma), yawing (Mb) and rolling (Mc) moments.

<Moment directions for table type>

Pitching (Ma)   Yawing (Mb)   Rolling (Mc)

Structural Diagram

Battery-less Absolute Encoder

Ball screw

Table
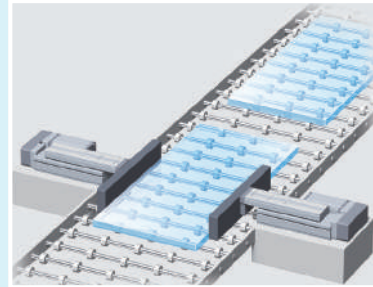
Motor

Base

Ball-circulating linear guide

Applications

■ Replacing table-type air cylinders
■ Clamping work pieces from left and right
■ Aligning work pieces to one side on a conveyor
■ Positioning and pressing work pieces at the front face of a table
■ Vertically moving axes in orthogonal axis combinations

Example of Use

Positioning work pieces on a conveyor

New Function

Double-block specification (optional) is available

Compared to the single block specification, the use of two guide blocks increases the allowable dynamic moment to up to 4.3 times in the pitching (Ma) and yawing (Mb) directions and also doubles the payload (horizontal).

Easy to install

The actuator can now be installed on its end plate. The added mounting pattern allows you to use the actuator in additional configurations.
Also, the reamed holes added to the end plate ensure positioning repeatability of work pieces.

Double blocks

Reamed hole

Can be installed using the end plate!
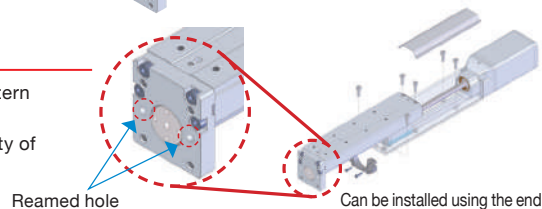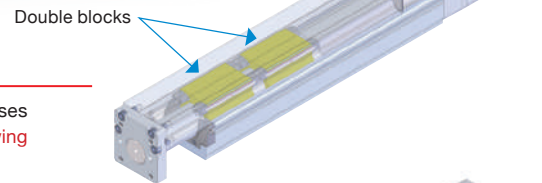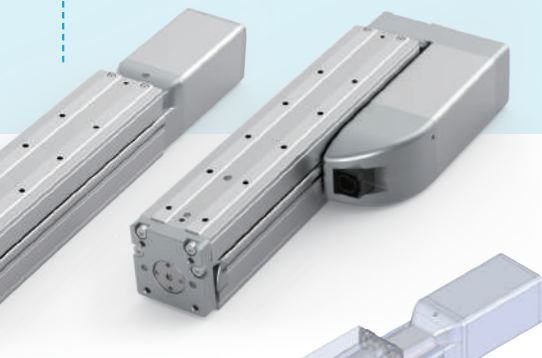
Please visit here for detailed information.
http://www.intelligentactuator.com/rcp6

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IK Series

**ROBO Cylinder® configurations
Cartesian Robot**

The ROBO Cylinder® equipped as standard with a Battery-less Absolute Encoder has been added to the "IK Series". It helps reduce the design and assembly steps. The ROBO Cylinder® RCP6 Series has been adopted to achieve even higher speeds compared with conventional models.

Product Overview
Industrial Automation Robots

www.IntelligentActuator.com

* Most product catalogs and overview catalog are also available. Please visit our website to download them.

SUPPORT Three IAI offices are available in the US to serve you.

Support for phase of planning, product selection, quotation, problem solving, maintenance, training, etc.

http://www.intelligentactuator.com/inquiry/

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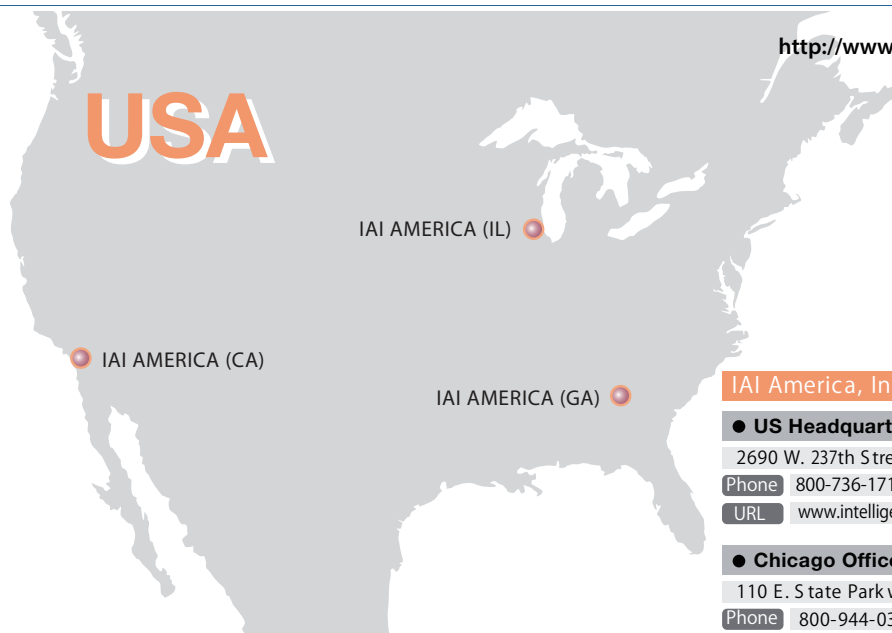
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The information contained in this booklet may change without prior notice due to product improvement.