ES-Gripper

Instruction Manual

ES-Gripper Instruction Manual Rev.3.0

Document No. G-IM002

Table of Contents

1. Introduction

Thank you for purchasing the ES-Gripper. This document is the instruction manual for the ES-Gripper.
Please be sure to read this document in order to use this product properly and safely.

2. Notes

■Meaning of labels and pictorial symbols

⚠ **Warning**	Indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.
⚠ **Caution**	Indicates a potentially hazardous situation which, if mishandled, could result in personal injury or property damage.

⚠ Warning

- When handling this product, the designer or specifier with sufficient knowledge and experience of the equipment, device, or system in which it is to be installed should make the decision and perform testing and analysis as necessary. The performance and safety of any device, equipment, or system incorporating this product is the responsibility of its designer or the person who determined its specifications.
- Do not install or remove this product from any device, equipment, or system until you are sure of its safety.
- Do not use the product for any purpose, under any conditions of use, or in any manner other than those described in this manual. If you intend to use the product for purposes or under conditions other than those described, please consult with I-PEX in advance.
- This product is not waterproof. Do not splash water or other liquids on it. Failure to do so may result in electric shock, fire, or malfunction.
- Do not touch or place your hand or body close to the unit while it is in operation.

⚠ Caution

- Follow the notes described in this manual.
- Do not allow this product to operate beyond the specified range of motion. Doing so may cause damage or performance degradation.
- Do not drop or impact the product. Doing so may cause a malfunction.
- Do not twist or bend the arm strongly with both hands or hit it against other objects. The torque sensor built into the product may be damaged.
- Do not pull the cable coming out of the back of the product strongly or bend it excessively.
  Doing so may cause the cable to break.
- Since weak magnetism is generated around the floating mechanism of this product, please be careful to keep magnetism-sensitive PCs, electronic devices, watches, etc. away from the product.
- If the product is not operated for a long period of time, the air supply should be turned off because of the load on the product. Also, prevent water or foreign matter from entering the product by installing a blank plug in the air supply port (one-touch joint), etc., as it may cause malfunction of the floating base.

【Storage】

- When storing the product, please put floating stop tape on the product to prevent the floating mechanism from being overloaded.
- Do not use or store the product in the following places. Doing so may cause malfunction.
  (1) Where temperature and humidity are extremely high or low
  (2) Where there is condensation
  (3) Places with a lot of dust
  (4) Places where static electricity is generated
  (5) Places where the product is easily splashed with water or other liquids
  (6) Places subject to vibration or shock

【Disclaimer】

- Never deviate from the operating and handling instructions given in this manual or disregard the specifications, etc.
- We shall not be liable for any damages caused by failure to observe the information contained in this document.
- Earthquake, lightning, windstorm, flood, and fire other than our responsibility, acts by third parties, or other accidents, intentional or negligent by the customer, we shall not be liable for any damage caused by misuse or other peculiar conditions.
- We assume no responsibility for any loss or corruption of data in the computer that occurs while using this product.
- For any damage resulting from malfunctions caused by the combination of connected devices or software that we are not involved in, we assume no responsibility whatsoever.
- We assume no responsibility for any damages or infringement of patents or other rights resulting from the use of this product.
- No license to any patents or other rights of any third party or our company is granted by this document.
- The copyright law prohibits the unauthorized reproduction of any part of the contents of this document, including but not limited to copying or printing.
- Product details described in this document are subject to change without notice.

【Warranty Period】

- 1 year after delivery

  However, even within this period, if the product is used more than 1,000,000 times*, deterioration of consumables such as springs and O-rings. This may cause performance degradation or malfunction. Therefore, no warranty is given.

  In this case, we will check the deterioration and usage conditions, and consider how to deal with the situation upon consultation between the two companies.

  *Number of center locks = Number of times air is supplied to the ES-Gripper

Contact for inquiries

E-Mail : order_es-gripper@i-pex.com

In the unlikely event of damage to the packaging or initial defects, please contact the window.

3. About ES-Gripper

3.1 Product Overview

ES-Gripper is an end effector of robots that enable to achieve the goal of connectors assembly robotic automation. I-PEX torque sensor (ESTORQ) is inside of ES-Gripper, the load is detectible during connector assembly process.

The data can be output, force traceability can be obtained, and the load threshold can be determined for each robot position. By setting the output torque force, it can be used for OK/NG judgment of the process, collision and mating completion judgment.

In addition, it has an alignment correction function (floating) for mating axis misalignment and inclination between connectors. I-PEX currently have two types of products with different alignment directions.

3.2 Main Specification

Table 1 <Specifications>

Item	FINE X+θ TYPE For Horizontal Mating	FINE X+Y+θ TYPE For Vertical Mating
Model	RG005-0105-0＊-EGE0	RG006-0105-0＊-EGE0
Power-Supply Voltage	DC 5 V	
Rated Torque	5 N･m	
Output Form	RS422	
Current Consumption	120 mA Max.	
Operating Temperature Range	0 ~ 70 °C (No Condensation)	
Baud Rate ※1	115.2 kbps	
Sampling Frequency ※1	1 kHz	
Outer Dimensions	Lasted in Section 8	
Movable Range: X, Y directions※2	1 mm Max.	2 mm Max.
Recommended Range of Motion: X, Y directions ※2	0.8 mm	1.8 mm
Movable Range: θ direction ※2	10 ° Max.	5.2 ° Max.
Recommended Movable Range: θ direction ※2	9.4 °	4.6 °
Repeatability: X, Y directions	±0.05 mm	
Repeatability: θ direction	±0.5°	
Centripetal Force	Yes	
Center Lock Mechanism	Yes	
Attachment weight capacity	1.5 kg	1.5 kg
Weight ※3	905 g	710 g
Allowable moment ※4	1.8N･m	3.0 N･m
Cable Length	3.0 m	

※1 The baud rate can be changed to 307.2 kbps and the sampling period to 5 kHz.

※2 At full stroke exceeding the movable range, the stopper hits and stops.
Repeated use at full stroke (when hitting the stopper) may cause malfunction.
Therefore, please use it follow the recommended movable range.

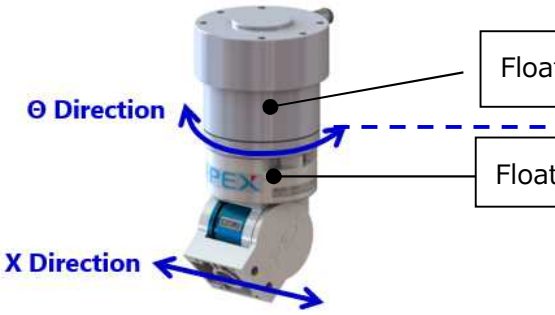
※3 Excluding cable weight.

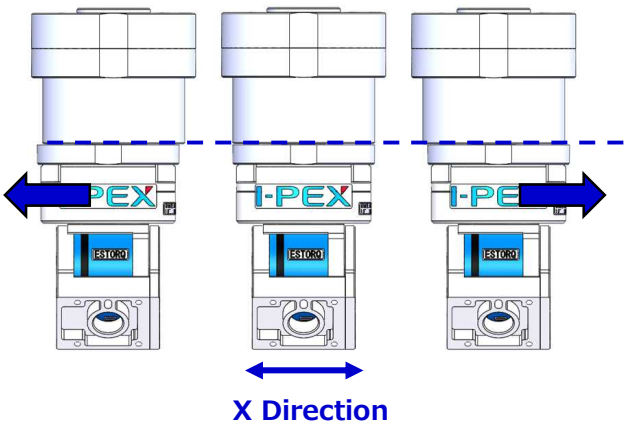
※4 Please note when designing attachments.(See Section 5.2.1)

<FINE X+θ TYPE>

Movable direction: X direction, θ direction

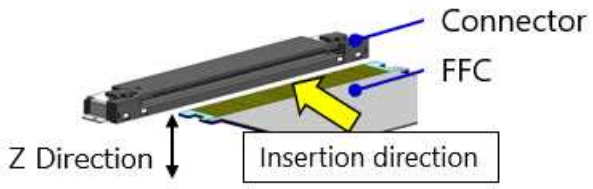
Horizontal mating recommended

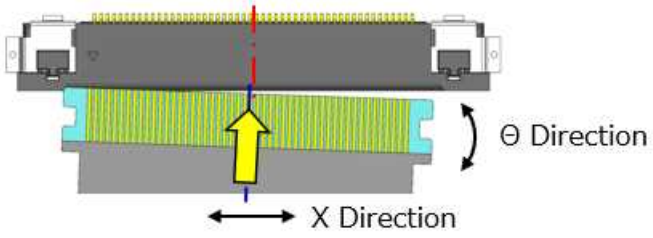




Movable range: X direction	**±1mm Max.**
Movable range: θ direction	**±10° Max.**

<Horizontal mating connector insertion>





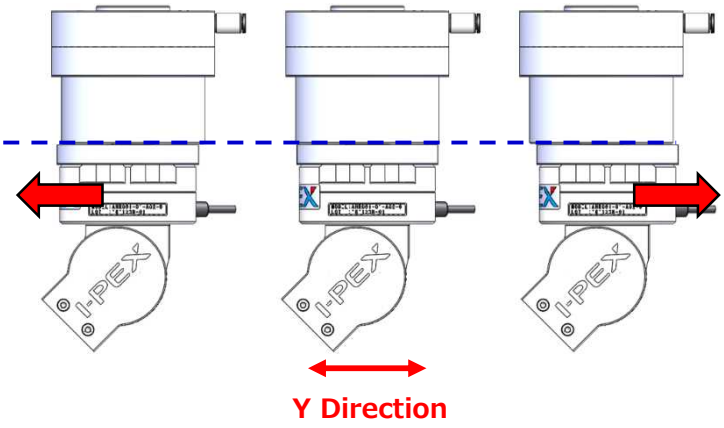
Direction to absorb misalignment of horizontal mating by floating

<FINE X+Y+θ TYPE>

Movable direction: X, Y directions, θ direction

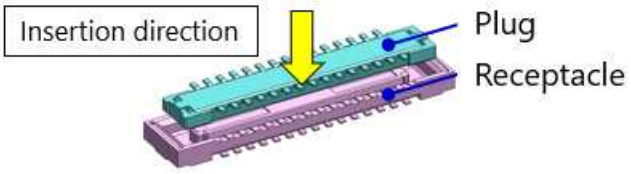
※In addition to the X direction, it can also move in the Y direction.

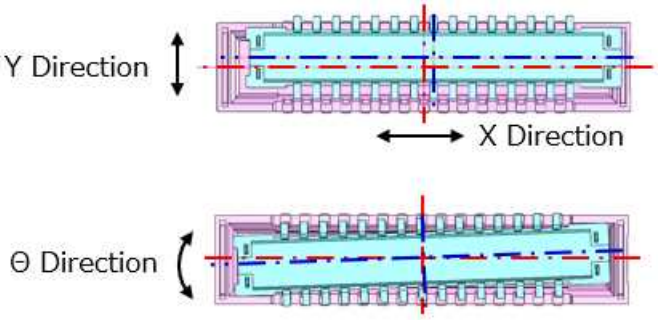
Vertical mating recommended



Movable range: X, Y directions	**±2mm Max.**
Movable range: θ direction	**±5.2° Max.**

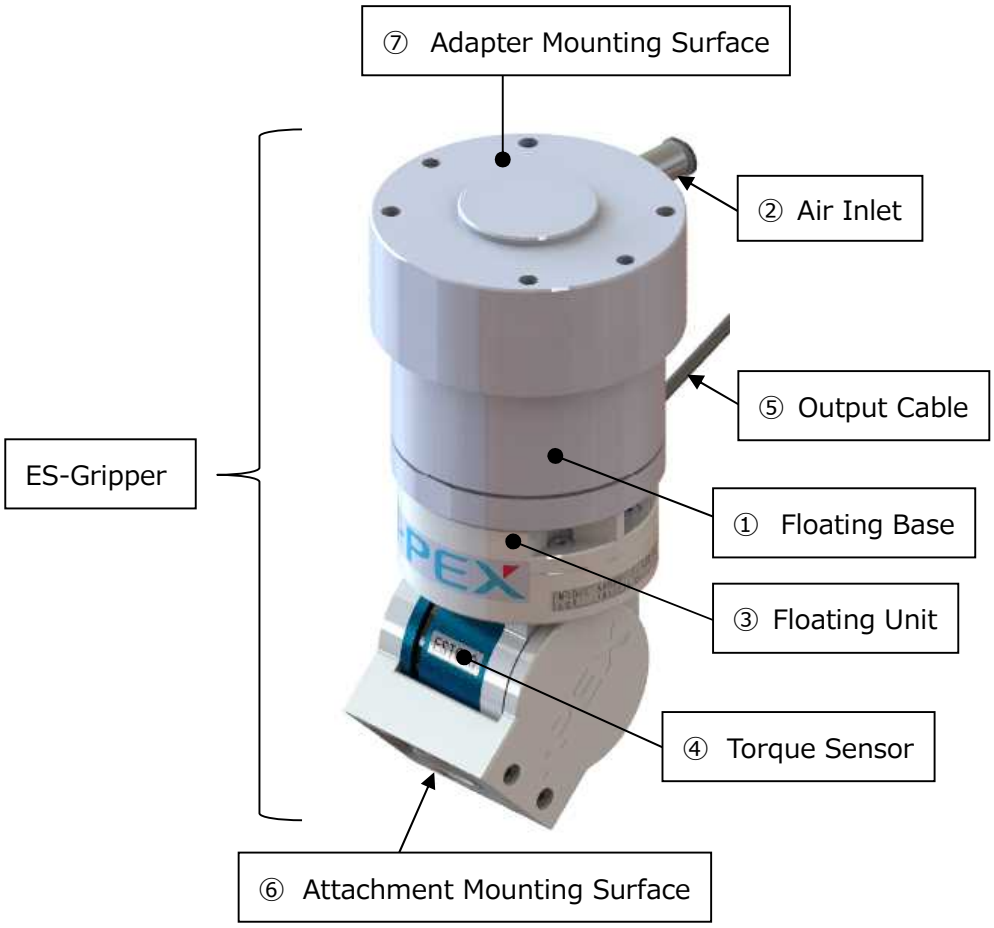
<Vertical mating connector insertion>





Direction to absorb misalignment of vertical mating by floating

3.3 Name and Function of Each Part



ES-Gripper Body Schematic

① Floating Base: This part is attached to the robot and constitutes the "Floating Mechanism" and "Center Lock Mechanism".

② Air Inlet: Air piping is required to switch ON/OFF of floating mechanism. (See Section 5.2.4)

③ Floating Unit: The unit has an attachment mounting surface and can be moved during alignment correction. When the connector is inserted, it floats by the mating guide of the connector and corrects the misalignment.

※Utilizing connectors mating guides for achieving alignment performance.

④ Torque Sensor: A 5Nm torque sensor that detects the force applied to the attachment.

⑤ Output Cable･･･This is a cable for outputting torque data.

⑥ Attachment Mounting Surface: This is the mounting surface between attachment and body.

★The attachment must be prepared by customer. (See Section 5.2.1)

※It is also possible to consult with I-PEX about the attachment design.

⑦ Adapter Mounting Surface: This is the mounting surface between adapter (Flange) and robot.

★Adapters must be prepared by customer. (See Section 5.2.2)

4. Packing Contents

☐ ES-Gripper x 1

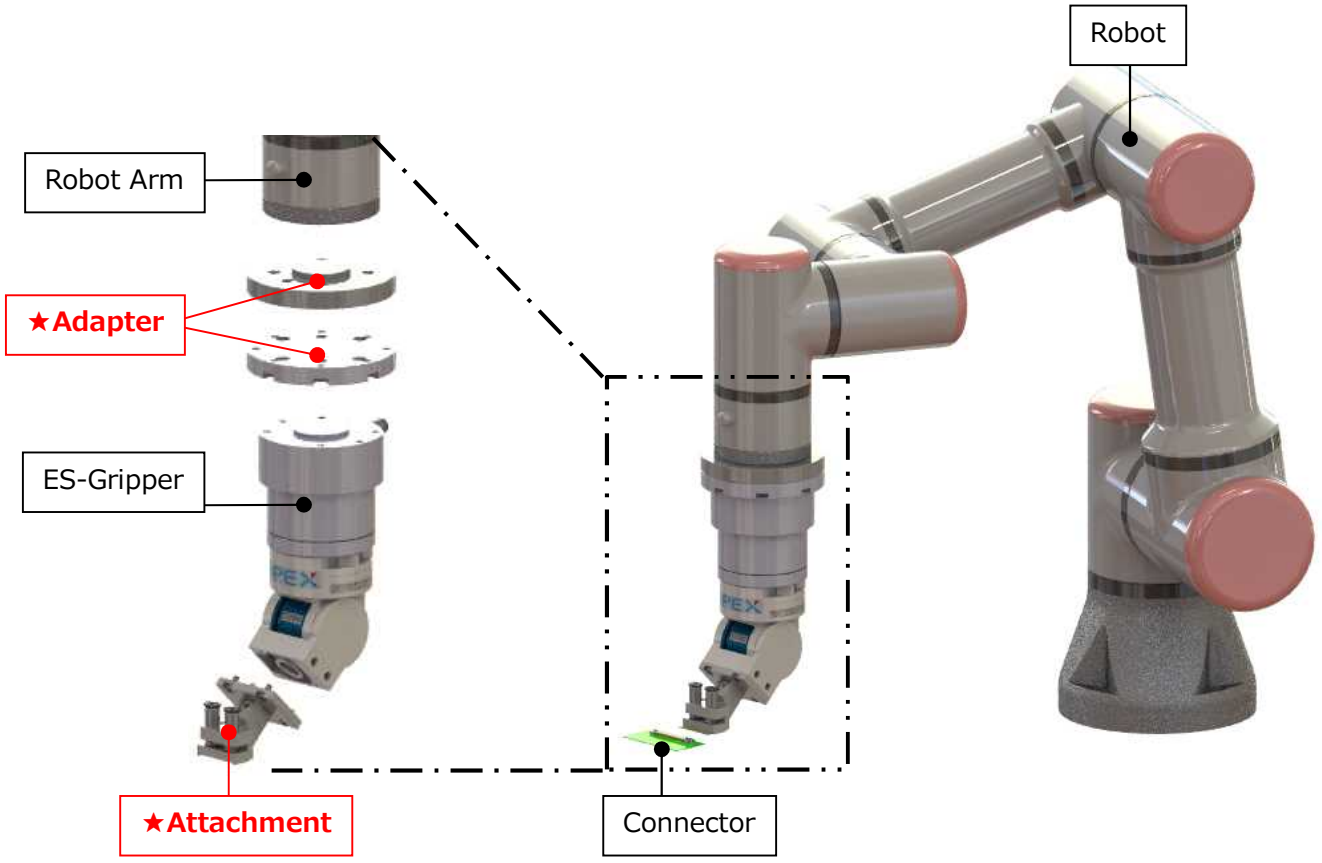
5. How to use

5.1 Installation example for automatic connector insertion

1. Install the attachment to ES-Gripper Body. (See Section 5.2.1)
2. Install ES-Gripper Body to Robot. (See Section 5.2.2)
3. Connecting output cable of ES-Gripper Body. (See Section 5.2.3)
4. Air piping of ES-Gripper Body. (See Section 5.2.4)

【Notes】

- When attaching the ES-Gripper Body to the robot, keep the flange surface horizontal.
- The floating unit may move while if it is tilted and floating base is not supplied with air (it is in the floating ON state).
- Because the floating range is short, the floating unit becomes a full stroke during the mounting and teaching processes. Please be careful not to damage the product.



Mounting Parts Diagram

Overview of Connector Assembly Robotic Automation

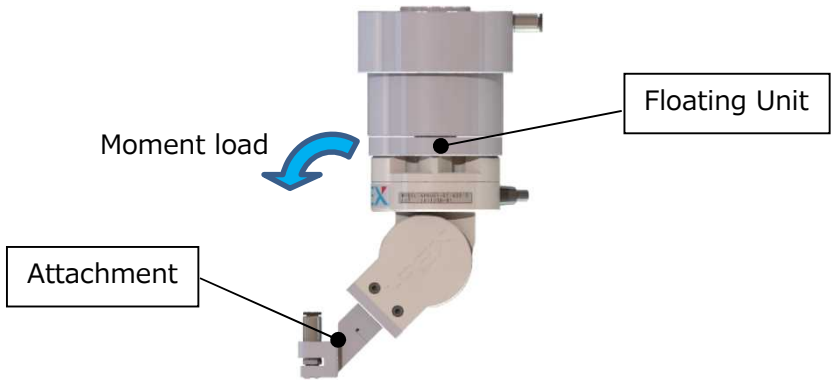
5.2 Preparation for Installation

5.2.1 Attachment Installation

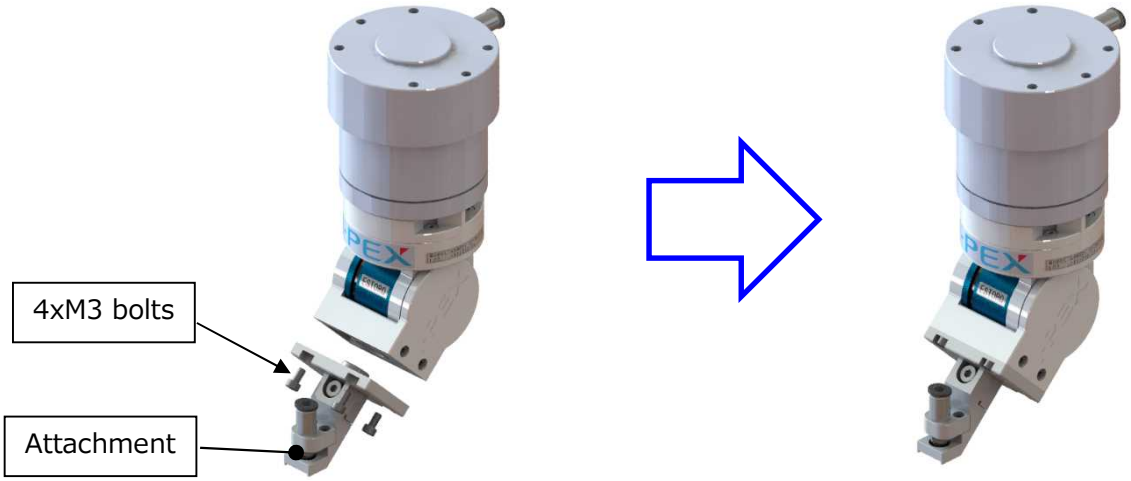
※**Customers need to prepare attachments** by referring to the attachment mounting surface dimensions in section 8.

【Notes】

Ensure that the moment load applied to the floating unit is less than the allowable moment specified in Table1 <Specifications>.



Install the attachment to the ES-Gripper with 4 pcs M3 bolts.



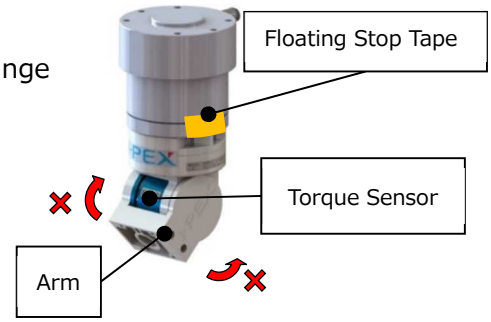
Attachment Installation Diagram

【Notes】

・I-PEX recommend 1.14N・m (1.8T series) for the tightening torque of M3 bolts.

・Please work on the installation with the floating stop tape attached.
If the ES-Gripper is subjected to a force that moves it beyond the specified range of motion, this may cause damage or performance degradation.

・Do not twist or bend the arm strongly with both hands or hit it against other objects. The torque sensor built into the product may be damaged.



5.2.2 Robot Mounting Adapter

Prepare an adapter that matches the mounting hole on the top of the ES-Gripper, and attach it to the robot you are using.

※ **Customer needs to prepare the adapter** by referring to the adapter mounting surface dimensions in Section 8 .

※ Please make adaptor according to the mounting surface dimensions described in the ES-Gripper outline drawing.

※ Use bolts with a strength classification of 10.9 or A2-70 or higher for mounting bolts.

※ I-PEX recommend 5.4N･m (1.8T series) for the tightening torque of M5 bolts.

【Notes】

･When installing the ES-Gripper to the robot,
Do not give a shock that exceeds the specified floating movable range.

･Install ES-Gripper to the robot with the stop floating tape stretched, please remove the tape before use.

･When removing the ES-Gripper from the robot, please attach tape (masking tape is recommended) to stop the floating.

5.2.3 Connecting the Output Cable

You can choose discrete wires (6xAWG28) or with USB connector for the cable end on the connection side.

After installing ES-Gripper to the robot, connect the cable to the robot's control box or PC.

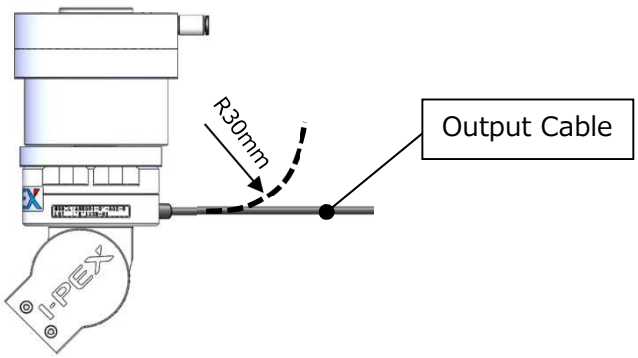
When selecting discrete wires, please strip the cable ends before use.

(See Section 10.3 for wire colors and signal definitions.)

【Notes

･Fix the cable wiring so that tension is not applied to the floating. If tension is applied to the floating, positional deviation may occur when locking ⇒ unlocking the floating.

･The minimum cable bend radius (recommended) is R 30 mm.



5.2.4 Air Piping

Floating lock/unlock is switched by air supply/exhaust, so air piping is required.

・Connect an outer diameter Φ4 air hose to the joint connected to the ES-Gripper.

・Compressed air working pressure range: 0.3 ~ 0.6 MPa.

【Notes】

・Always perform flushing (blowing compressed air) inside the piping before piping to the product. Contamination by dust or rust generated during piping work may cause air leakage or malfunction.

・Use clean dry air. Drainage, dust, etc. may cause malfunction.

・Before supplying air to the product or operating the robot, check the safety around the operating range.

・When removing the ES-Gripper from the robot, make sure that there is no residual pressure inside the product.

5.3 Operation Confirmation

5.3.1 Confirmation Points

After completing the preparation, make sure that floating locks when air is supplied and unlocks when air supply is stopped.

After completing the operation confirmation, please teach the robot.

5.4 Automatic Insertion Setting

5.4.1 Precautions During Teaching

The floating unit floats when a load is applied without air supply, and when air is supplied, it returns to its original position and the floating is locked because of the "Center Lock Mechanism".

【Notes】

・When unlocking (air supply OFF) from the floating lock (air supply ON) state, set the adapter mounting so that it is horizontal. In the floating ON state when air is not supplied to the floating base, the floating unit may move due to the dead weight of the product if it is tilted.

5.4.2 Points for Using ES-Gripper

・FINE X+θ TYPE is suitable for horizontal mating with mating guides.

・FINE X+Y+θ TYPE is suitable for vertical mating with mating guides.

・Keep the adapter mounting surface horizontal.

FINE X+θ TYPE

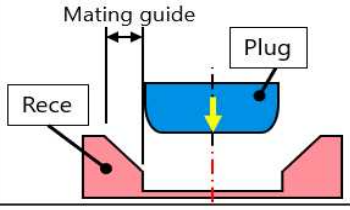
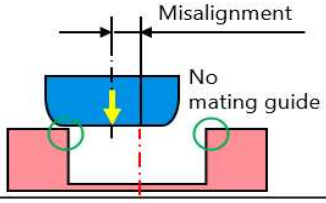
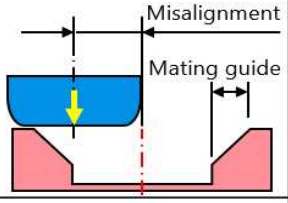
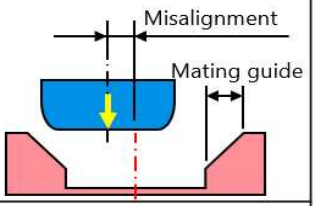
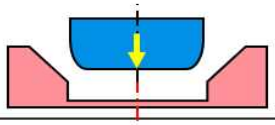
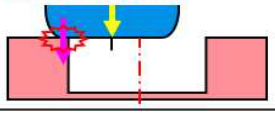
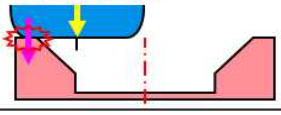
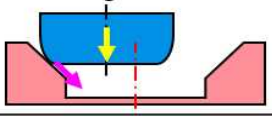
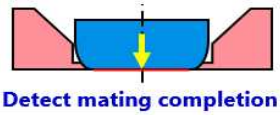
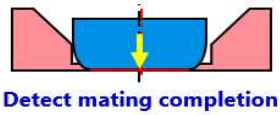
FINE X+Y+θ TYPE

① ES-Gripper floating does not work for connectors without mating guides. In this case, collision occurs at the insertion entrance, but it is possible to detect collision by setting a threshold.

② ES-Gripper Floating does not work well in situations where the mating misalignment exceeds the movable range. In this case as well, there will be collisions at the insertion entrance, but it is possible to detect collisions by setting a threshold.

③ Even if the mating guide on the object to be mated exceeds the movable range, only the amount of deviation within the movable range can be corrected. Mating is possible if the amount of deviation is within the movable range.

Table 2 <For Vertical Mating Insertion>

	Normal mating	① No mating guide	② With mating guide Misalignment > mating guide	③ With mating guide Range of motion ≧ Misalignment
Before insertion				
During insertion				
Mating complete	 Detect mating completion	It is possible to detect the colliding load and use it for avoidance depending on the teaching settings.	It is possible to detect the colliding load and use it for avoidance depending on the teaching settings.	 Detect mating completion

【Notes】

・Set the mounting surface of the flange adapter horizontally during the insertion.

In the floating ON state where air is not supplied to the floating base, the floating unit may move if it is tilted due to the weight of the product.

5.4.3 Features of ES-Gripper

As described in the product overview, ES-Gripper has the following features.

・With a built-in torque sensor, the load applied to the attachment can be detected when the connector is inserted.

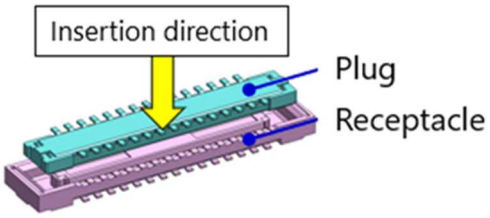
・Floating makes it possible to correct the misalignment of mating axes and inclination between connectors.

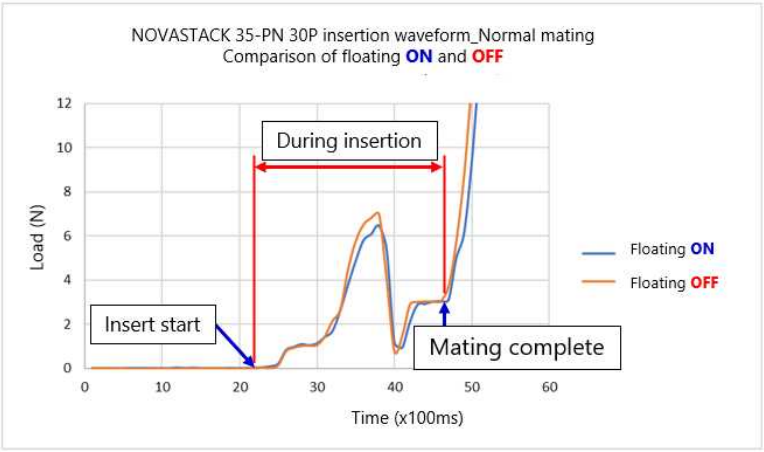
・By setting the load threshold for each position of the robot, it can be used to determine whether the process is OK/NG, collisions, or mating completion.

Using vertical mating connector insertion as an example, I-PEX will introduce what can be done from the insertion waveform created from the torque data output by the torque sensor.

The torque value output from the torque sensor is converted into a load to create an insertion waveform. (Refer to item 7 for the conversion formula)

<Normal Mating without Misalignment>



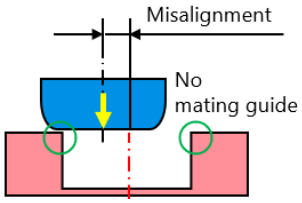


The insertion force can be obtained from the data output of torque sensor.

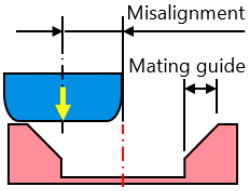
In normal mating with no mating axis misalignment, insertion can be performed in the same way as when floating is turned off.

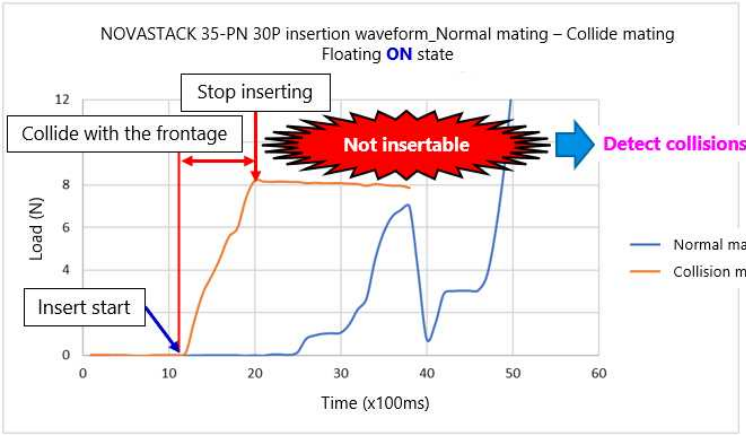
<Collision Detection due to Mating Axis Misalignment>

① Without Mating Guide Collision detection



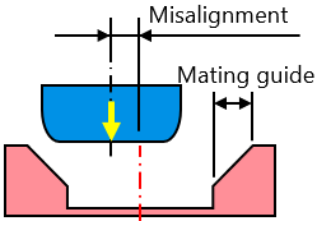
② With Mating Guide Collision detection

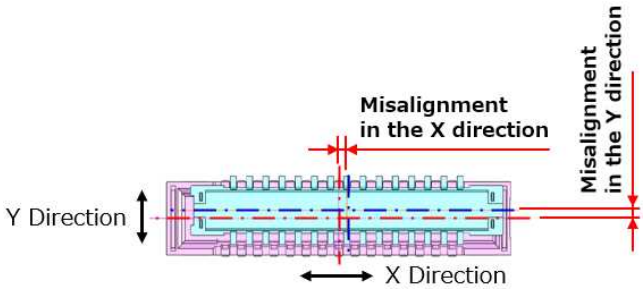




If the mating axis misalignment occurs exceeds the mating guide, alignment correction by floating does not work and it collides with the frontage (insertion entrance). **By setting the threshold as described in Section 5.4.4, collisions can be detected and used for NG judgment.**

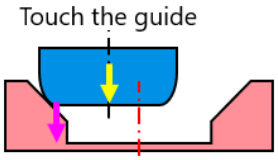
③ With Mating Guide

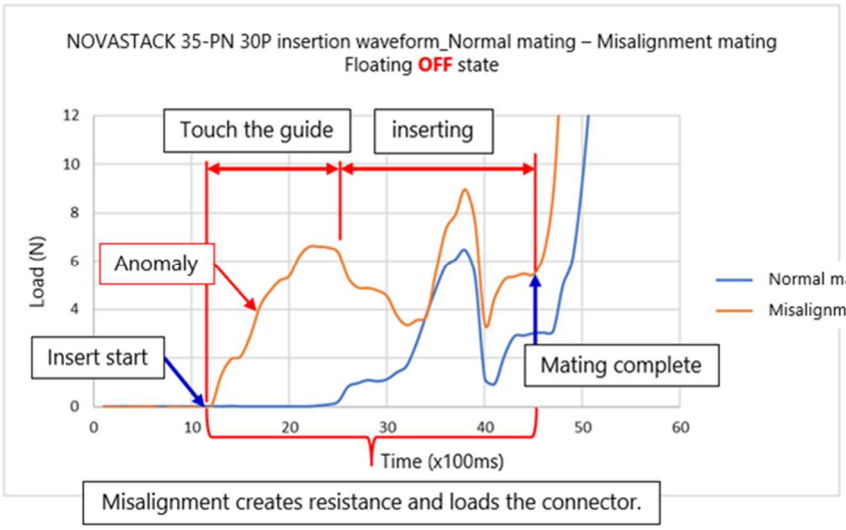




The State of Misalignment

<Floating OFF>

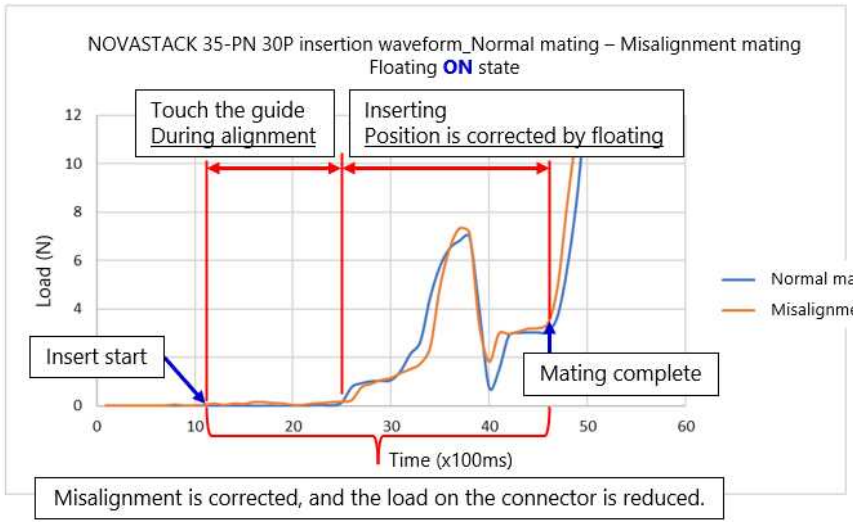




Floating ON

When misalignment occurs and there is no floating (OFF), it can be seen that the connector is forcibly inserted and damaged.

<Floating ON>



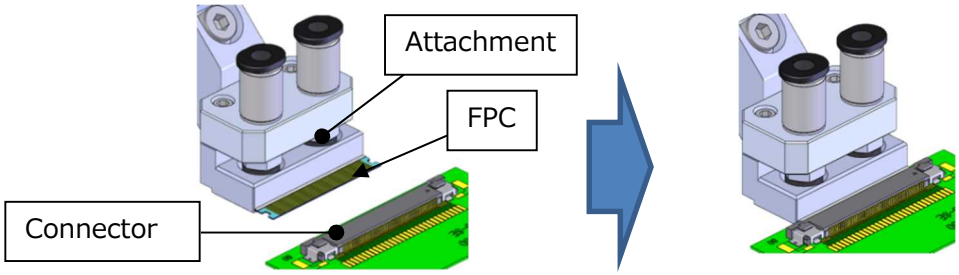
When floating is used (ON), it can be inserted with almost the same force as normal mating without mating axis misalignment, and the connector is not damaged.
This allows **the floating to align and compensate mating misalignment.**

5.4.4 Points for Threshold Setting

Here is an example of threshold setting for horizontal mating connectors. Use it as a reference for thresholds and OK/NG judgments during teaching.

Horizontal mating connector: EVAFLEX5-SE 50P (made by I-PEX)

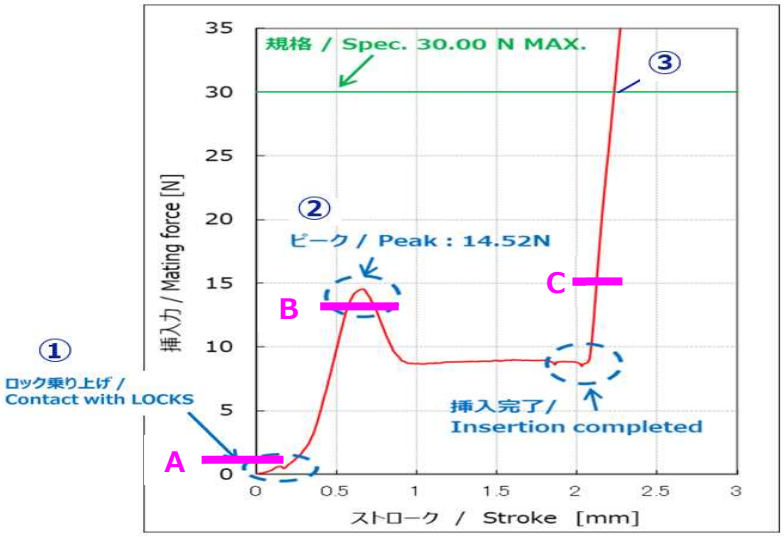
The process of inserting the FPC sucked by the attachment into the connector



Automatic Insertion of Horizontal Mating

The force applied when inserting the FPC into the connector is shown in the table below.

The horizontal axis represents the distance that the FPC moves, and the vertical axis represents the force that the FPC receives at that time.



Insertion Waveform

Example of Threshold Setting and Judgment

① Contact with locks : Threshold A… OK if less than 2N / NG if over 2N
NG may collide at the entrance during insertion.

② Peak Insertion Force : Threshold B: OK if higher than 13N / NG if lower than 13N
NG has the possibility of signal pin damage on the connector side.

③ Insertion Completed : Threshold C: OK if higher than 15N / NG if lower than 15N
NG means that the attachment is pushing the FPC, and there is a possibility of FPC looking ears damage.

※ If it is OK, proceed to the next process, and if it is NG, please consider restarting the process or stopping, and raising an alarm.

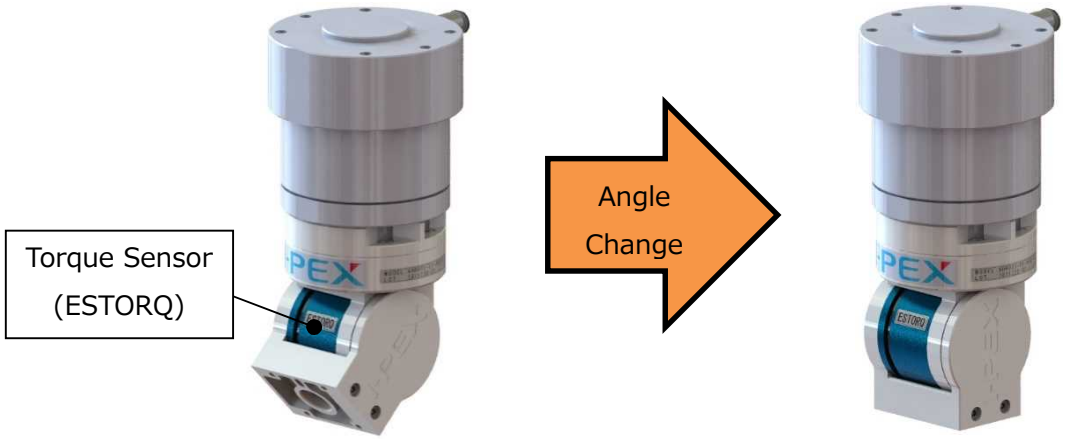
6. Attachment Mounting Angle

The attachment mounting port at the time of shipment is in 45° type, but it is possible to change the mounting port angle of the attachment to a vertical type depending on the application.

※It is necessary to change the angle by customer yourself.

6.1 Types of Attachment Mounting Port

It is effective when it is necessary to insert the attachment in a narrow space, or when the weight of the attachment using an air chuck is large.



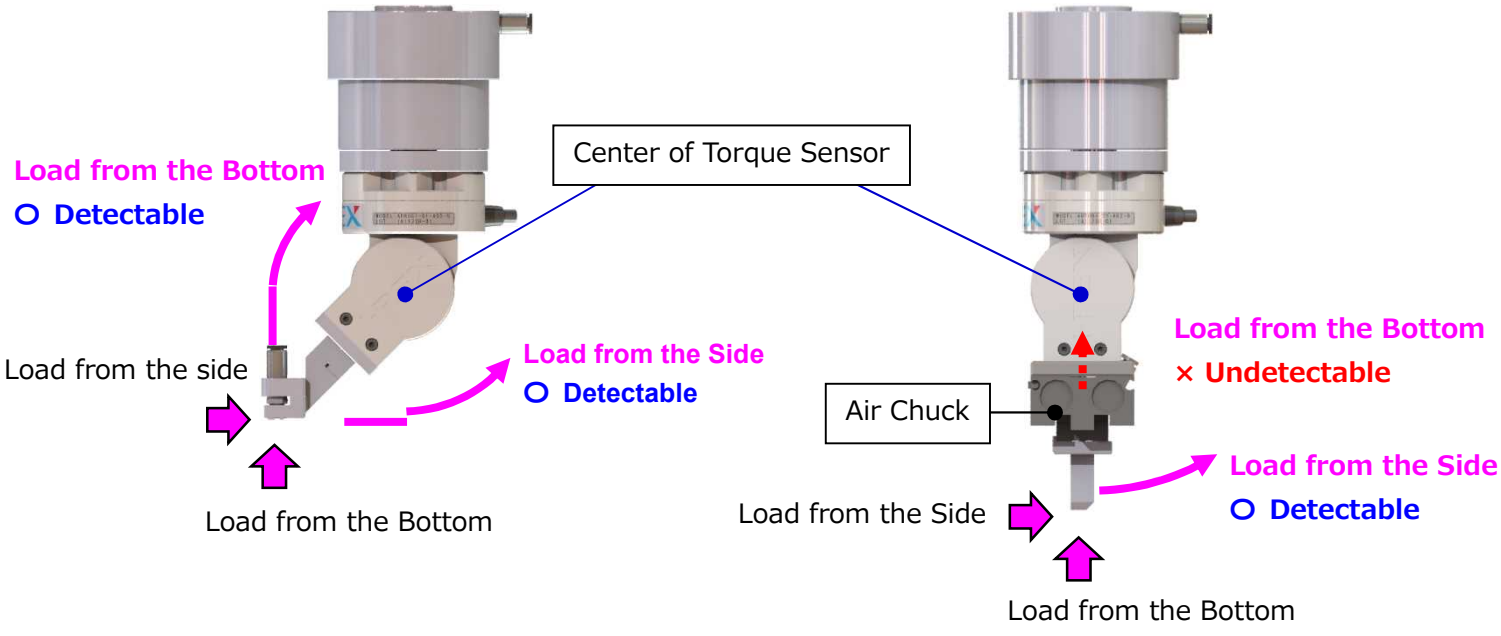
Shipping State
Attachment Mounting Port: 45° Type

State after Changing the Angle
Attachment Mounting Port: Vertical Type

<Force Detection>

The force that can be detected by the torque sensor is the force acting in the direction of rotation.

The detection state changes depending on the difference in the mounting angle, so please be careful when considering the attachment.



Attachment Mounting Port: 45° Type

Attachment Mounting Port: Vertical Type

6.2 How to Change Attachment Mounting Angle

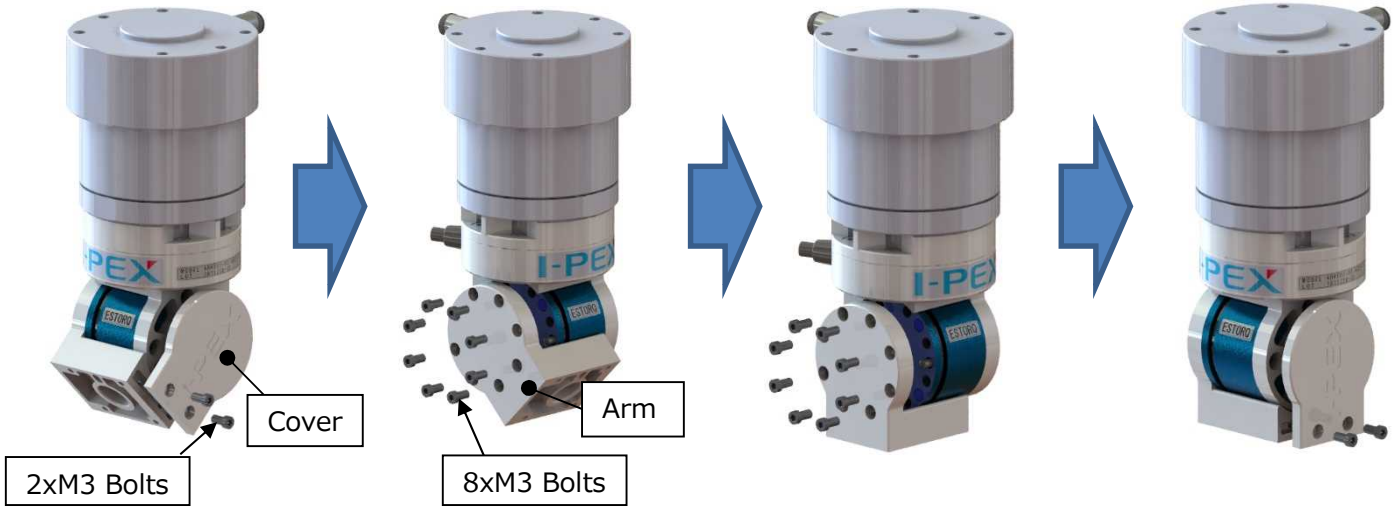
The following shows the procedure for changing attachment mounting port from 45° to the vertical type.

■ Things to be Prepared

Hex wrench (size: 2mm)

※Bolts and knock pins can be reused.

<Angle Change Procedure>



①Remove 2pcs M3 bolts and the cover.

※Please reuse the bolts.

②Remove 8pcs M3 bolts and arm.

③Install the arm with 8 bolts with the attachment mounting part of the arm facing downward.

※Please reuse the knock pin that comes with ESTORQ.

④Attach the cover with 2pcs M3 bolts.

【Notes】

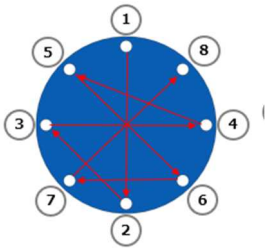
・When working on the ES-Gripper, please secure it so that it will not move (a jig or similar tool is recommended), and install it with the floating stop tape attached.
If the ES-Gripper is subjected to a force that causes it to move beyond its specified range of motion, it may be damaged or performance may be impaired.

・Do not remove any bolts other than those required to change the angle as shown in the above figure.

・Be careful not to give a strong shock to the product during the installation and change work.

・After lightly tightening the bolts all over, tighten them diagonally as shown in the "Example of Tightening Order of Bolts" below.

・I-PEX recommend 1.14N・m (1.8T series) for the tightening torque of M3 bolts.



Example of Tightening Order of Bolts

7. Calculation Method of Detectable Load

The load that can be detected by the torque sensor (rated torque of 5Nm) installed in the ES-Gripper changes depending on the angle difference of the attachment mounting port and the shape of the attachment. Check if the attachment shape can detect the insertion load using the following calculation method. ※Use the following formula when converting the torque value (Nm) output from the torque sensor to the load (N).

<Load calculation that can be Detected by the Torque Sensor>

<Calculation Formula>

F = T / sinθ x 1000 / L

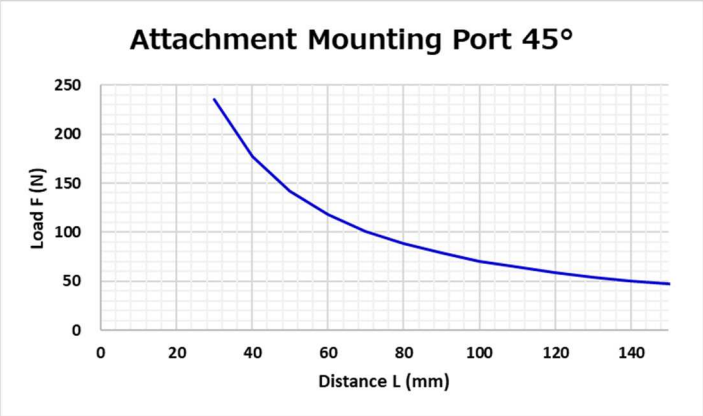
F : Detected load (N)

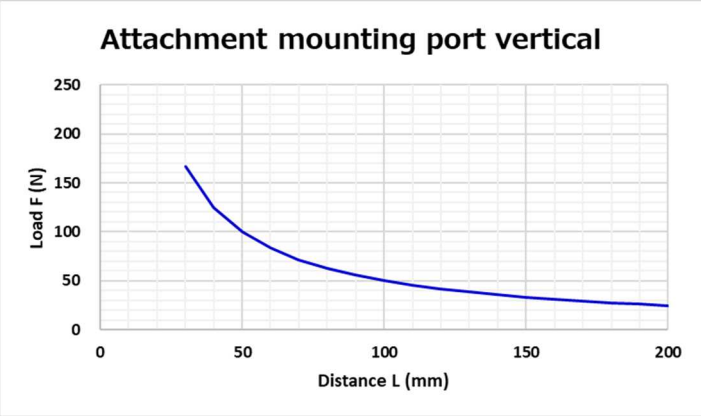
T : Torque value output from the torque sensor (Nm)

L: Distance from the center of the torque sensor to the point that receives the load (mm)

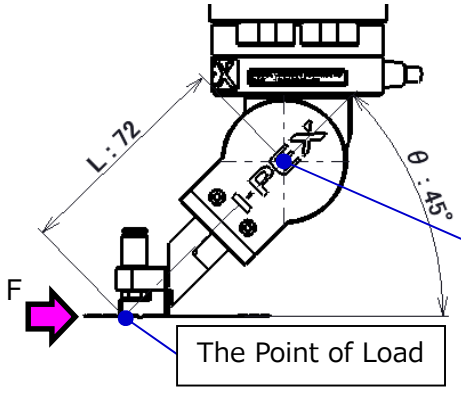
θ : Angle from the center of the torque sensor to the point receiving the load (°)

<By attachment mounting port: Reference diagram of the load that can be detected by 5Nm torque sensor based on the distance L>

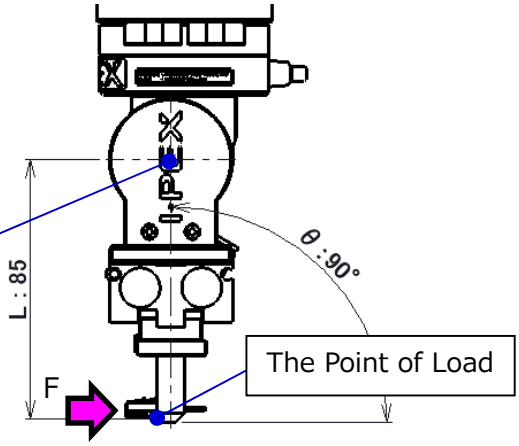




<Example of Attachment Mounting Port 45° type>



<Example of attachment mounting port vertical type>



Center of Torque Sensor

<Calculation Example from Above>

F = 5Nm / sin45° x 1000 / 72mm = 98.2N

The attachment shape, the load that can be detected by the 5Nm torque sensor is up to 98.2N.

<Calculation Example from Above>

F = 5Nm / sin90° x 1000 / 85mm = 58.8Nm

The attachment shape, the load that can be detected by the 5Nm torque sensor is up to 58.8N

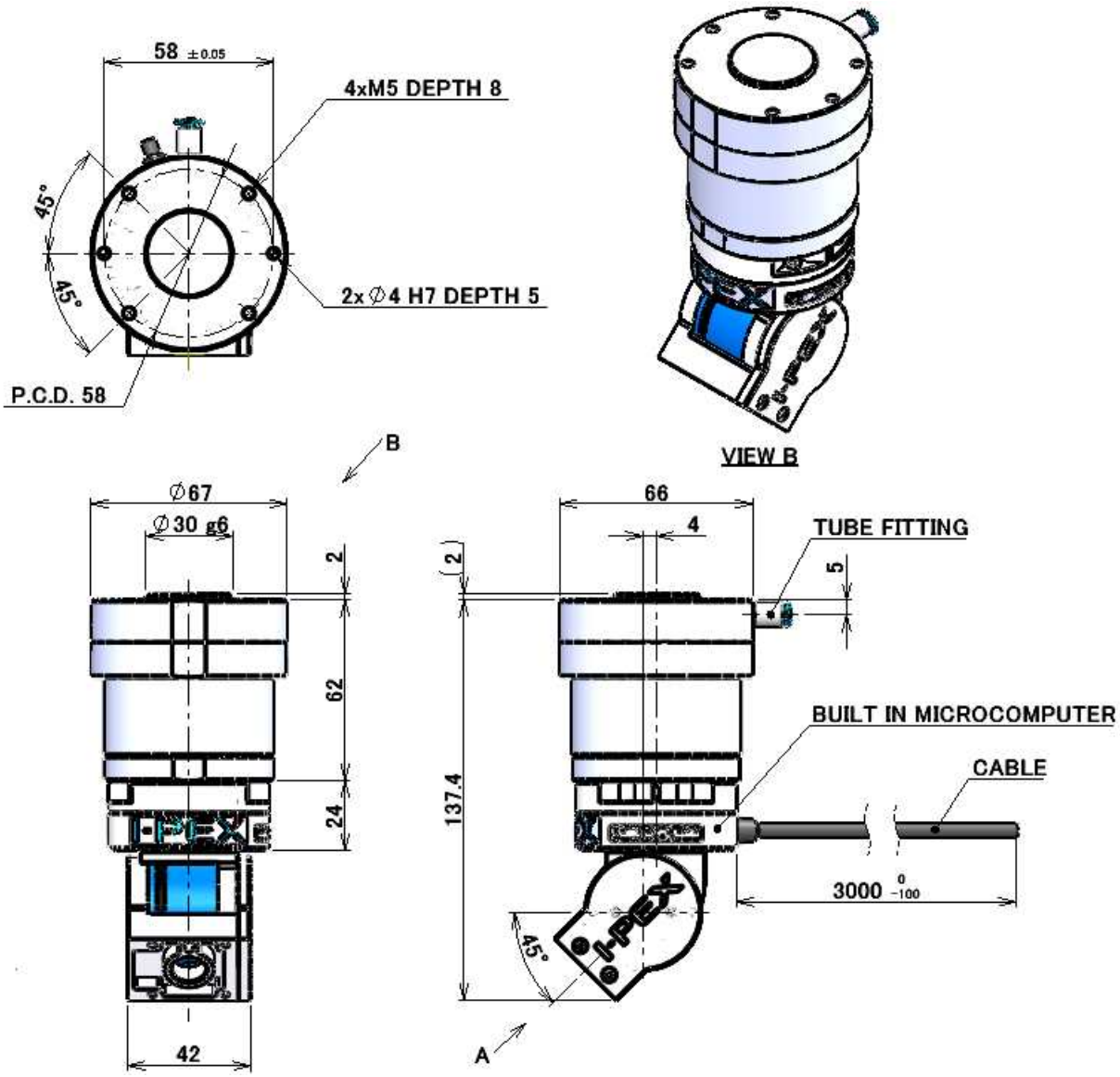
8. ES-Gripper Outline Drawing

Describe the external dimensions for each type.

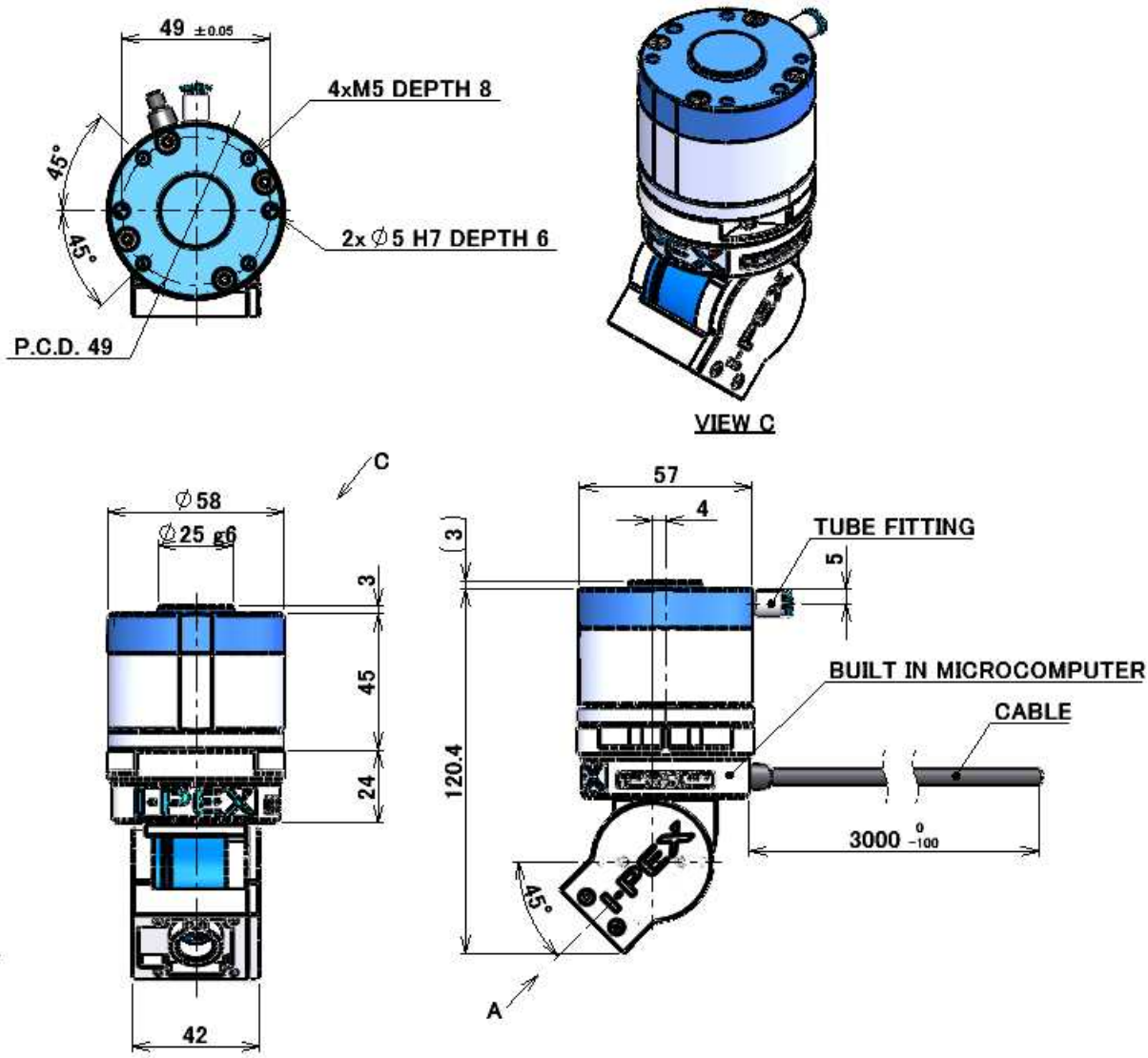
Please refer to this drawing when preparing "attachments" and "adapters".

■Use bolts with a length that does not go deeper than the specified screw hole depth.
Using bolts that are too long can cause damage.

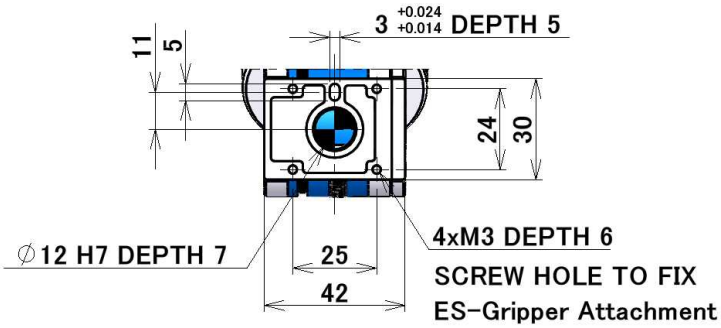
<Outline Drawing of FINE X+θ TYPE>



<Outline Drawing of FINE X+Y+θ TYPE>



<Attachment Mounting Surface Dimensions>



VIEW A (ES-Gripper Attachment FIX PART)

NOTES.
1. MATERIAL
FRAMEWORK : ALUMINIUM
2. ES-Gripper Body USES MAGNETIC PARTS.

9. Driver Install

9.1 USB driver download

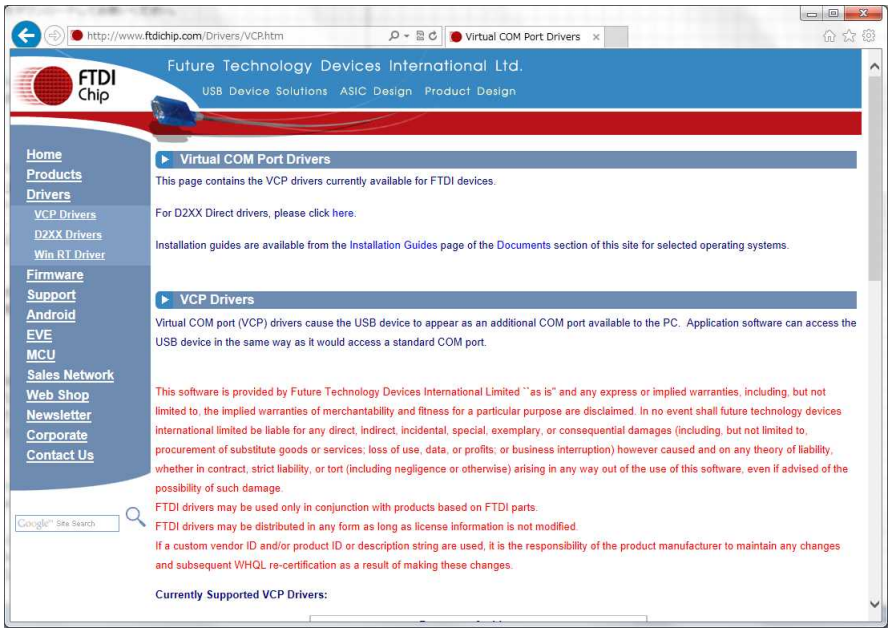
※USB output type only（option）

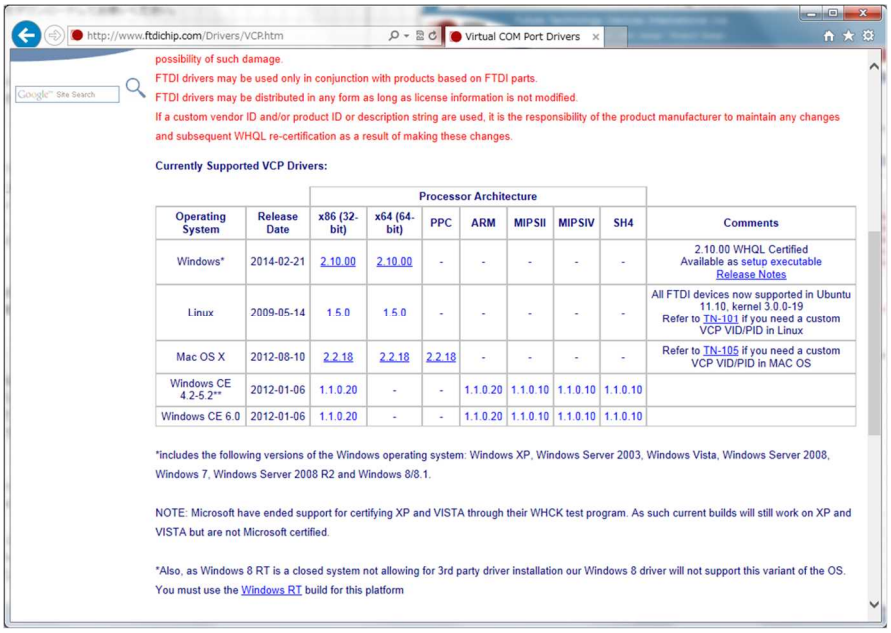
It`s necessary to install USB driver in advance if you connect this product to PC.

Please download the latest version of USB driver software from manufacturer`s website.

http://www.ftdichip.com/Drivers/VCP.htm

Please unzip the downloaded file to suitable place in advance.





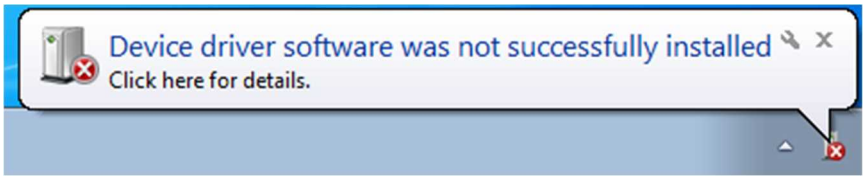
9.2 USB Driver Install

Windows 10 / Windows11 :

When USB is connected to PC, driver installation starts automatically.

When the picture below is displayed, it is necessary to install driver manually.

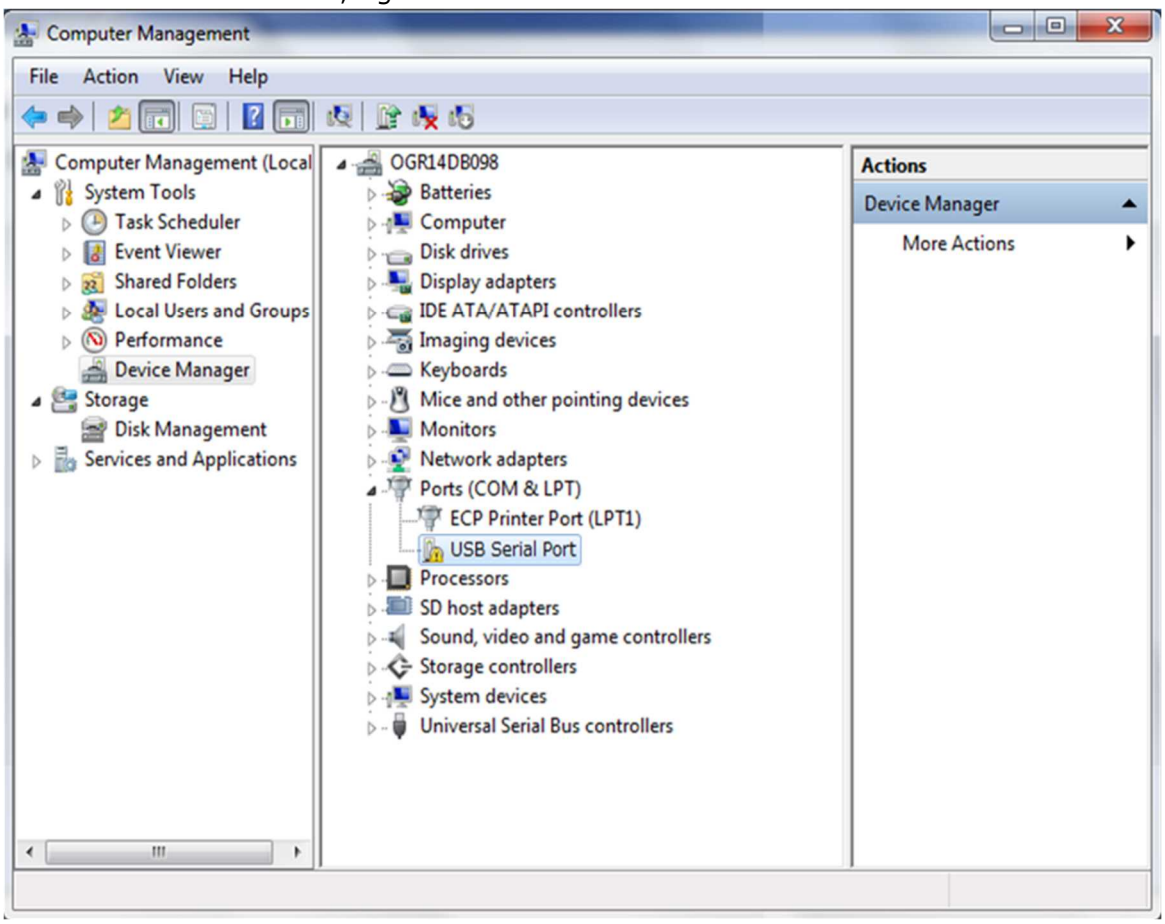
If the picture below is not displayed, driver is already installed, please perform `9.3 USB driver setting'



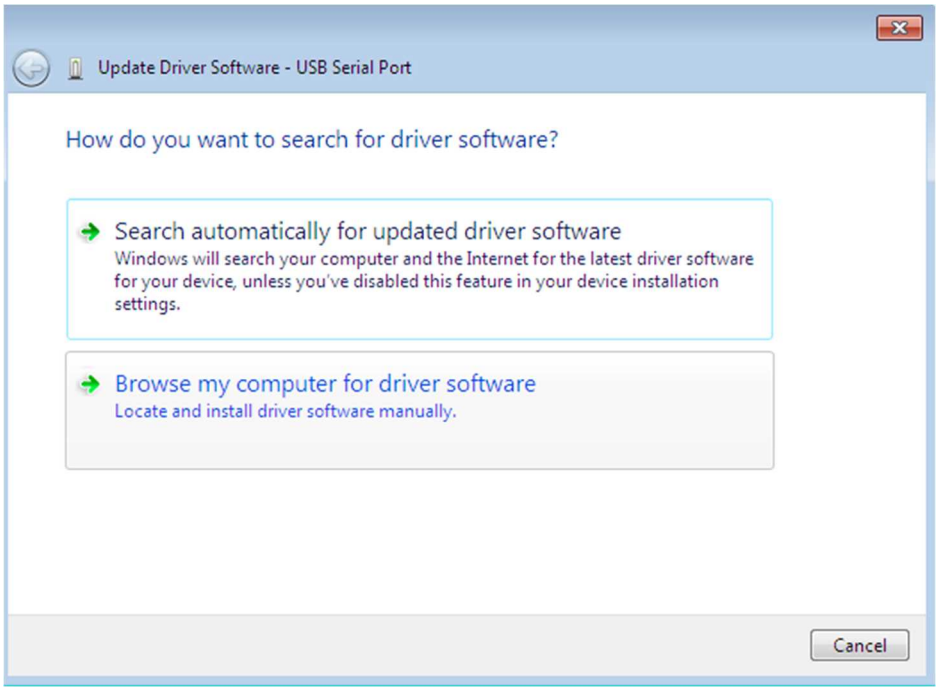
Please right click `Computer'→ `Management'→ `Device manager',

Please display `Device manager display'.

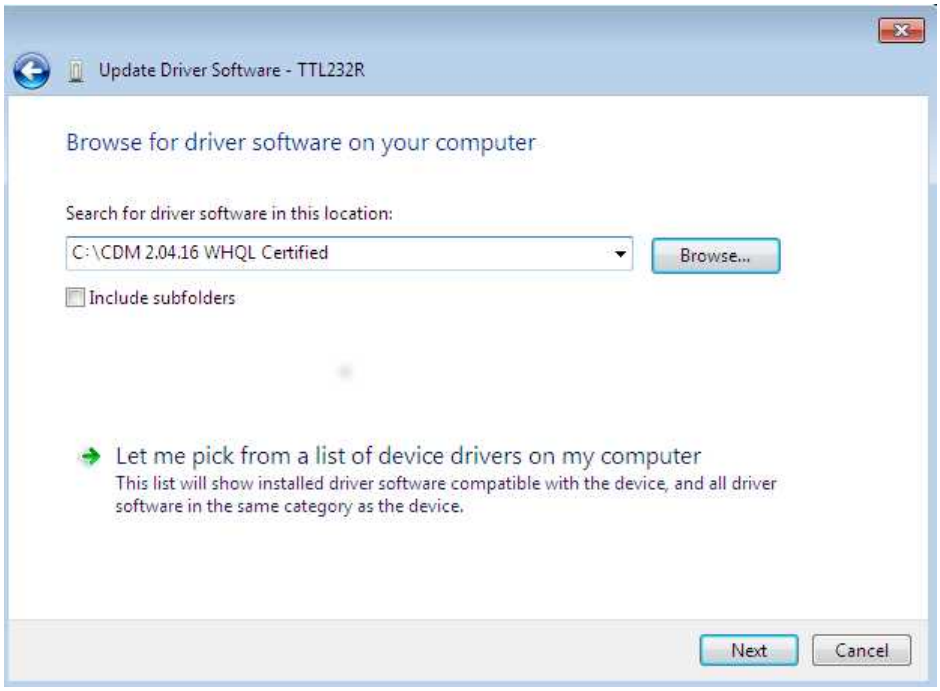
Please select "USB Serial Port", right click → `Driver'→ `Renewal of software'



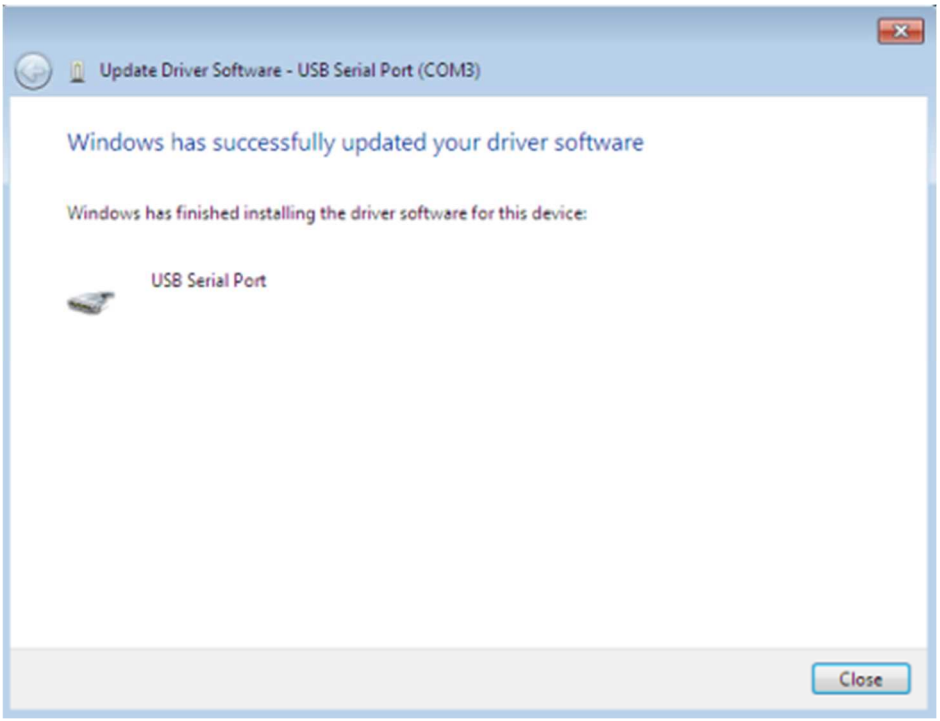
When the picture below is displayed, please select `install ~'



When the picture below is displayed, please push `Reference button' and select the folder unzipped at 9.1 and click `Next'.



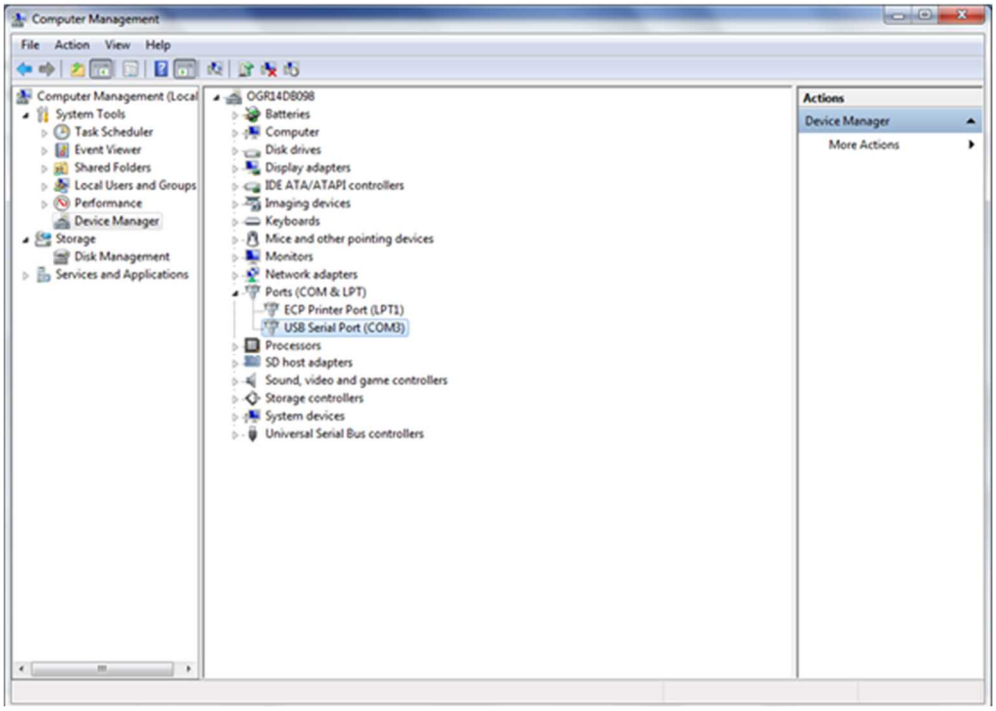
When the picture below is displayed, please push `Finish button'



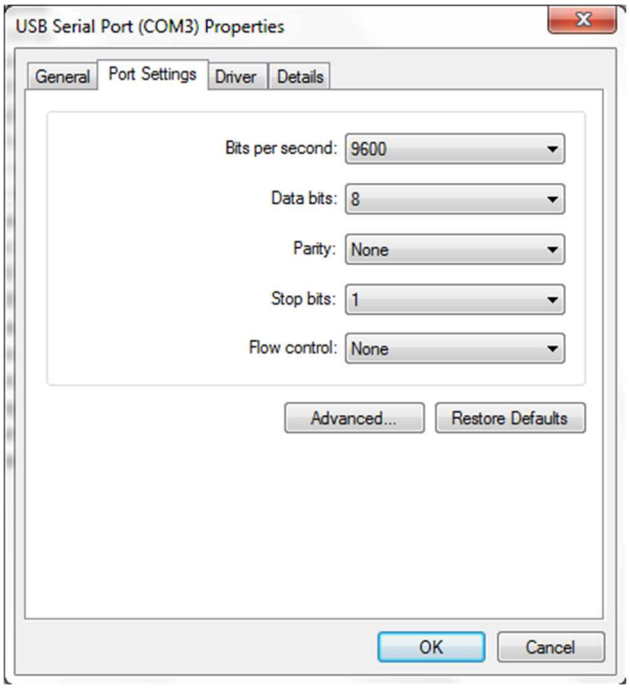
9.3 USB Driver Setting

USB driver communicates once per 16 msec through USB in default setting.
There is the case that it cannot receive the data correctly depend on the sampling setting of this product.
It can be avoided above phenomenon by performing detail setting of driver bellow.

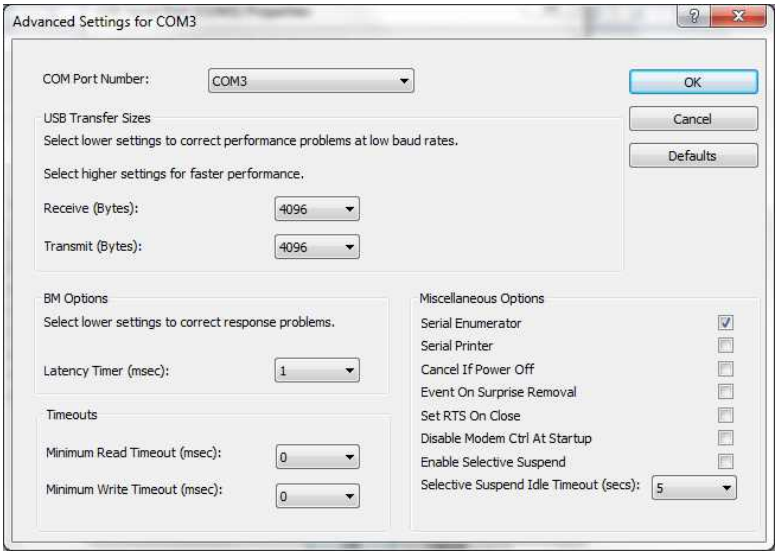
Please right click `My computer' → `Management' → `Device manager',
And please display `Device manager screen'
Please select "USB Serial Port" and right click → select `Property'



Please select `Port setting tab' and push `Detail button' in middle of screen.



Please change the value of `BM option' to `1'



If you take off USB of external equipment and insert it again, new setting is read, and it becomes to be possible to communicate correctly.

10. Communication Specification

This product can send measuring data to external equipment, such as PC, through serial communication. By receiving data from specific data formats, data can be controlled by original application or external equipment.

The interface for this product has following variety.

◆ USB,RS422 ⇒ Section 10.1 (USB requires a separate driver installation)

10.1 Communication System

Communication system for this product has following two varieties.

◆ **Single data communication system**

It sends measuring data each time depending on the request from external equipment.

◆ **Continuous data communication system**

It sends measuring data with fixed sampling cycle.

10.2 Communication System Setup

Refer to below table for communication setup values.

Table 3 <Communication Setup values>

Item	Value
Sampling frequency	1 kHz *1
Baud rate	115.2 kbps
Data bit	8bit
Parity	No
Stop bit	1bit
Flow control	No

* 1 For continuous data communication method.
Single data communication mode depends on the R command transmission interval.

10.3 Cable (RS422)

Correspondence between wiring color and signal name is as follows.
Signal lines are all seen from the sensor side.

Table 4 <Cable Colors and Signal names>

Number	Cable color	Signal name	Remarks
1	Red	Vcc	5 V power supply
2	Blue	GND	Power supply ground
3	Orange	TXD+	Transmission data +
4	Green	TXD-	Transmission data -
5	Yellow	RXD+	Received data +
6	White	RXD-	Received data-
7	Shielded wire	FG	Frame ground

For Vcc, GND, and FG connect to power supply such as DC stabilized power supply.
As for external capturing equipment, such as PLC, refer to Table 5.

Table 5 <Signal Names for External Capturing Equipment>

PLC etc.		ESTORQ side
RXD+	⇔	TXD+
RXD-	⇔	TXD-
TXD+	⇔	RXD+
TXD-	⇔	RXD-

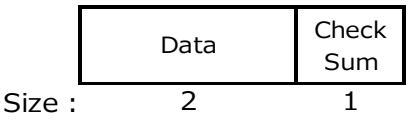
10.4 Data Format

Data format for this product is Binary format.

Table 6 <Data Format>

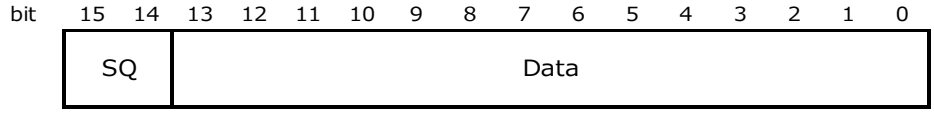
Format	Data length
Binary	3 byte

◆ Binary Format（3byte）



Check Sum : XOR added value of each byte data.

<Data part details>



SQ : Figure of 0 to 3 in sequential data is added in series

Data : Torque data is outputted in range of 0 to 16383.

e.g.: Case for 10Nm of rated force

(Date is outputted up to 1.1times of rated force)

-11Nm･･･**00 0000 0000 0000 (0)

0Nm･･･**10 0000 0000 0000 (8192)

11Nm･･･**11 1111 1111 1111 (16383)

＊ : The upper 2 bits are sequential data

10.5 Command

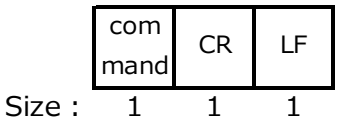
Following commands are installed in the robot.

These commands do not include reply data from this product.

Table 7 <Commands contents>

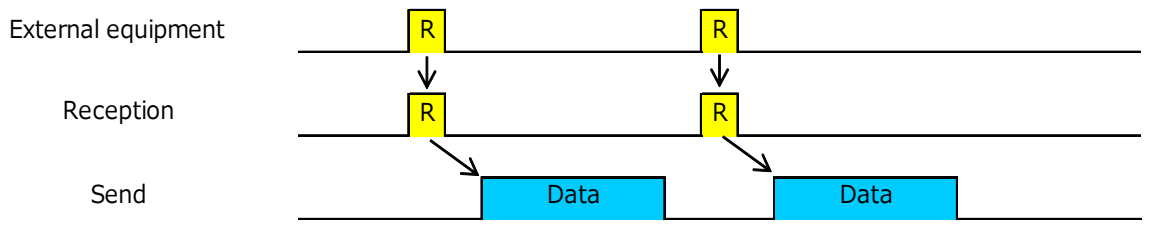
Item	Content
S	Requests to start the sequential data communication.
E	Requests to finish the sequential data communication.
R	Requests the data in simple data communication.
O*	Resets the measurement data. Sets the torque value to zero when this command is executed. This setup will retain after turning toe power on again.
V	Receives version information.

*O･･･Letter O

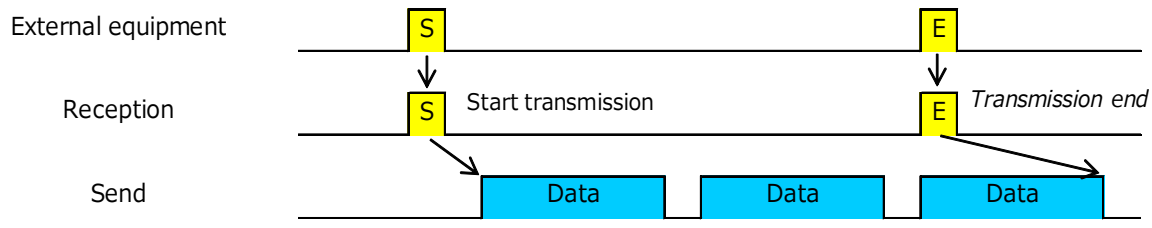


Command example :

Simle data communiation system



Sequential data communication system



Data Data transmission + microcomputer processing time

ES-Gripper Instruction Manual Rev.3.0