

NP ROBO series

Linear Actuator

[Linear Shaft Motor integrated]

SLP15 / SLP25 / SLP35

User's Manual

NPM

Nippon Pulse Motor Co., Ltd

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1. Preface

Please read this manual and the manuals of all other equipments connected with this robot before you install, wire, maintain and inspect this robot. Please always keep this manual at hand. Store this manual lest a person who does not have enough knowledge about the equipments and security, can access this manual easily.

2. This manual's purpose and organization

Thank you for purchasing our high performance Single Axis Linear Stage, the NP ROBO series. This manual's purpose is to provide the detailed information for installation, wiring, operation, maintenance and inspection of Nippon Pulse Motor (hereinafter called "NPM") high performance single axis linear stage, NP ROBO series SLP15, SLP25, SLP35 (hereinafter called "robot").

To install, wire, operate, maintain and inspect this robot, please follow the contents of chapter 1, other warnings, directions and procedures described in this manual.

This robot is designed and manufactured for general industry. Do not use for a purpose that requires a high level of security. Do not use this robot for medical and other equipments that maintain and control human life and safety of human body, for a purpose to carry human, and a purpose other than general industry.

3. Important Notice



Before you start to install, operate, maintain and inspect this robot, please read this manual and all manuals of connected equipment and peripheral equipment, and follow the procedures. These works should be done by a person who has enough knowledge about the equipments and safety information. Follow the notices below and use this robot stage correctly and safely.

- 1) Any work on this stage must be performed only by a person who has enough knowledge about this robot and safety.
- 2) Do not perform any work on this robot before you read and understand this manual and the manuals of all equipment and peripheral devices connected with this robot.
- 3) To perform any work on this robot, please follow the procedures described in this manual.
- 4) To install, wire, operate, maintain and inspect this stage, you should know about potential risks. We have predicted the potential risks that this robot has, to the extent possible and showed the countermeasures and precaution statements in this manual. However, we cannot predict all risks. Therefore, you should give your full attention to the safety, not only to the contents described in this manual.
If you do not follow this manual, NPM assumes no responsibility for whatever any resulting damages, malfunction, repair and accident.
- 5) The contents of this manual include dangerous works. Therefore, store this manual lest that a person who does not have enough knowledge about this robot and safety, has access to this manual easily.
- 6) To dispose this robot, please follow the regulations of the local government.
- 7) If you use this robot in combination with more than one axis or other robots, please read and follow the JIS (JIS B 8433) "Robots for industrial environments-safety requirements" and "Industrial Safety

and Health Law".

- 8) NPM has a copy right and publication right about this manual. Do not misuse, expose and copy a part or whole manual without our written approval.
- 9) The contents of this manual may be changed to improve, corrected or deleted without prior notice. Please obtain the latest version of this manual, confirm the contents and keep it.

4. Product Warranty

4-1. In the case of purchase from a supplier other than NPM

Regarding the product warranty in the case of purchase from a supplier other than NPM, please contact to the supplier

4-2. Warranty period

The warranty period is one year from the date of the delivery to an assigned place.

4-3. Warranty scope

If defects are found in the product during the warranty period under normal use following this document, NPM will repair the product without charge. However, the following cases are not covered by the warranty and free repair does not apply to the product even during the warranty period.

- The product are modified or repaired by other than NPM or an authorized person by NPM.
- The defect results from falling of the product after delivery or mishandling in transit.
- -Wearing of components, natural deterioration or fatigue (motor axle bearing, gear, grease, cables, etc.)
- The defect results from any use other than original use.
- The product has been subjected to natural disaster or force majeure such as fire, earthquake, lightning strike, wind and flood, salt, and electrical surges.
- The defects or damage results from the cause other than the fault of NPM.

Note 1) The products exported to outside Japan are not covered by the warranty.

Note 2) Only if the product with defects is carried to the specific place to repair, NPM will repair the product. NPM will not provide on-site repair.

Note 3) The warranty period of the repaired product is not extended beyond the warranty period of the product before the failure. It is the same as the warranty product of the product before the repair.

Note 4) This warranty covers the product. It does not cover the detriments caused by the product's defects, etc.

Note 5) A replacement may be provided instead of a repair at the direction of NPM.

This documents aims to describe the detail of the function of the product and it does not warrant fitness for a particular purpose of the customers.

The examples of application and circuit diagram in this manual are described for your reference. Please confirm the feature and the safety of device or equipment before use.

Please do not use this product for the following use in principle.

If you use the product for the following use, please contact our sales department.

- Any equipment that may require high reliability or safety, such as nuclear facility, electricity or gas supply system, transportation facilities, vehicle, various safety system, medical equipment, etc.
- Any equipment that may directly affect human survival or property
- Usage under conditions or circumstances that are not specified in the brochure, manual, etc.

When this product is used in any equipment where faults or malfunctions may directly affect human survival or property, please secure high reliability and security with redundancy design, etc.

5. Safety information



This chapter shows the safety precautions you should follow when you install and wire this robot.

- 1) Only a person who has enough knowledge about this robot and the safety can work with this robot.
- 2) Do not work with this robot until you read the manual of all equipments and peripheral devices connected with this robot.
- 3) Follow the procedures described in this manual.

5-1. Safety symbols and the meanings

This manual categorizes the warning terms according to the degree of danger as follows. Understand the meaning of these terms and follow the precautions.

The safety precautions include the following “Dangers”, “Warnings” and “Cautions”.

- “Dangers” show the contents that will cause an imminent risk to fatal and serious injury if you do not follow the procedures and instructions.



- “Warnings” show the contents that may cause a risk to fatal and serious injury if you do not follow the procedure and instructions.



- “Warnings” show contents that may cause a risk to slight injury or damage of equipment if you do not follow the procedure and instructions.



The contents of “cautions” may cause a serious result according to a condition.

Read this manual thoroughly before you operate this robot.

If you do not follow these safety precautions, we assume no responsibility for any damages.

In this manual, kinds of assumed accident are shown by the following signal words in accordance with the contents or warnings (or cautions).

Understand the following signal words and follow the contents (follow the instruction of this manual.)

Signal words	Meanings	Signal words	Meanings
	You may get a shock.		You may damage your back.
	You may be caught between moving parts.		You may be caught between moving parts.

5-2. Safety precautions

5-2-1. Precautions at delivery

When the product arrives, confirm the model name of the product and whether or not optional items and accessory, etc. are included with the product.

5-2-2. Precautions for installation environment and maintenance

Warnings



- 1) The slider of the moving part of this robot moves between the mechanical limits. Establish the safeguarded area to prevent someone from entering the range that this robot moves. However, if you combine other things with the moving part, please be careful because the range of movement varies.



- 2) Please carry out all work from outside a safeguarding cover. If you cannot (if someone has to enter the safeguarded area), remove the danger. If someone enters inside of a safeguarding cover, prepare a safety circuit. Connect to an appropriate E-STOP circuit at user's risk. This robot itself does not have an emergency stop circuit. Therefore, apply power from an equipment that has an emergency stop circuit.



- 3) If you have to set a guard inside the operating range of this robot, set a guard that is strong enough to stop the force of this robot.

Cautions



- 1) Do not install this robot in the following environment. It may cause electric shock or fire.
 - Outdoor, out of range between 0 to 40 °C of surrounding temperature, out of range between 20% to 80% of humidity, in place of environment with condensation and with shock or vibration.
 - In place of environment with corrosive gas, inflammable gas, chemicals, moisture, oil, salt, oil-mist, cutting fluid, dust, magnetized dust such as iron powder.
- 2) Do not store this robot in the following environment.
Even though the storage environment conforms to the above environment, storage environment should be -20 to 60 °C in temperature. Prevent condensation from occurring at the long term.
- 3) Do not use and store this robot in any place where it will be subjected to direct sunlight. It may cause malfunction.



- 4) Do not use this robot in place of environment with electrical noise, strong magnetic field and radiation. It may cause malfunctions.
- 5) If brightness of work area is under 300 lux, prepare a working light, etc.

5-2-3. Precautions for setting

Dangers

- 1) This robot has powerful magnet inside the shaft. Therefore, if you use medical equipment such as a heart pacer, do not enter within 50 cm from this robot.



- 2) Never touch the shaft inside of this robot. Especially, never hold up the robot by grabbing the shaft. If the shaft bends by force, the shaft touches moving parts and it causes abnormal noise and dust. Also, it may cause to break moving parts and cause a short accident.


Warnings


- 1) Do not use magnetic material near this robot. The material could be pulled toward the magnet and it may cause a fatal or serious injury by a part of the body being caught.



- 2) Do not disassemble or modify this robot. The magnet inside the shaft could leap out.



- 3) Use a nonmagnetic tool for installation. Use of magnetic tool may result in fatal or serious injury by a part of the body being caught.



- 4) Be sure to power off when you install this robot. Otherwise malfunction may result in injury.



- 5) The longer the stroke is, the heavier the robot becomes. Use an appropriate support tool or work with multiple persons when you carry or install the robot.


Cautions

- 1) Use a table that satisfies the following conditions for installing this robot.
 - A table that is rigid enough to endure the reaction force caused at driving.
 - A table that its flatness of mounting surface is 0.1mm/(500mmx500mm) or less.
 - A table that has enough space for the whole mounting surface of this robot.
 - A table that its element is nonmagnetic material. (Do not use magnetic elements.)
- 2) A table should be fixed with the specified bolts. See chapter 7.
- 3) Do not put something on this robot or step on it. It may cause deformity or malfunction of this robot.
- 4) Do not hold the moving part and the cables of this robot when you carry and install the robot. It may cause injury or cable damage.
- 5) We recommend you to use the dedicated orthogonal jig. Be sure that the orthogonal jig restricts usable models in combination. See 6.10.
- 6) Please note that when you use multi-axis tables, the rigidity and transportable weight restrict usable models in combination.
- 7) If you use this robot vertically, select and install a dropping preventive device. This robot is assumed to be used in horizontal or wall hanging; it itself does not have a feature to prevent dropping at power off and servo off.
- 8) Be careful not to bend a cover when you touch the upper cover, etc. If the cover, etc. is bent, it could touch with the moving part and it causes abnormal noise and dust.

5-2-4. Precautions for wiring**Warnings**

- 1) Read all manuals of equipments connected with this product before wiring. Start wiring after understanding work procedures thoroughly.



- 2) Be careful not to wire motor, encoder and extension cables incorrectly, which causes malfunction. If motor, encoder and extension cables are not finished, be sure to attach appropriate connectors according to the manual of the servo driver. Defects due to incorrect wiring by the users are not included in the warranty.



- 3) When you insert or remove cable or cable connectors, power it off. Otherwise It causes electrocution hazard.

**Cautions**

- 1) Connect motor and encoder extension cable with this robot without fail.
- 2) Make sure to keep motor extension cables and encoder cables away from each other as possible. It causes malfunctions.



- 3) The warranty is available only when you use the optional authorized motor and encoder extension cable. Do not extend cables themselves. It may cause to slow down the performance.
- 4) Do not damage or put stress on the cables. Do not put something on the cables or put the cables between things. It may cause electrocution hazard and cable damage.
- 5) If brightness of work area is under 300 lux, prepare a working light, etc.

5-2-5. Precautions at operating**Warnings**

- 1) Do not enter the operating range while operating or servo on. Entering the operating range could cause a fatal or serious injury.



- 2) If you need to work in the operating range while this robot is turned on, never work alone. Be sure to be in another worker's view or be sure to be within the speaking range. Be sure that the worker can stop this robot by the emergency stop switch, etc.



- 3) This robot does not have the dedicated emergency stop switch. To avoid unexpected occurrence, apply power from the equipment that has a stop circuit.



- 4) If abnormal heat, smoking, abnormal smell or fire occur, shut down power immediately. It could cause fire or malfunction.



- 5) If noise or vibration increases abnormally in operating, stop operation immediately. It could cause breakdown or malfunction of the robot.



Cautions



- 1) Be sure to adjust and confirm parameters of the servo driver connected before operating the robot. Otherwise unforeseen movement could occur.
- 2) If you operate this robot, be sure that there is nothing that may touch with moving parts in the driving direction.

5-2-6. Precautions at maintenance and inspection



Warnings

- 1) Do not disassemble or modify this robot. If you need to modify or repair the robot, contact us.



- 2) Be sure to remove danger before maintenance and inspection.



Cautions

If brightness of work area is under 300 lux, prepare a working light, etc.

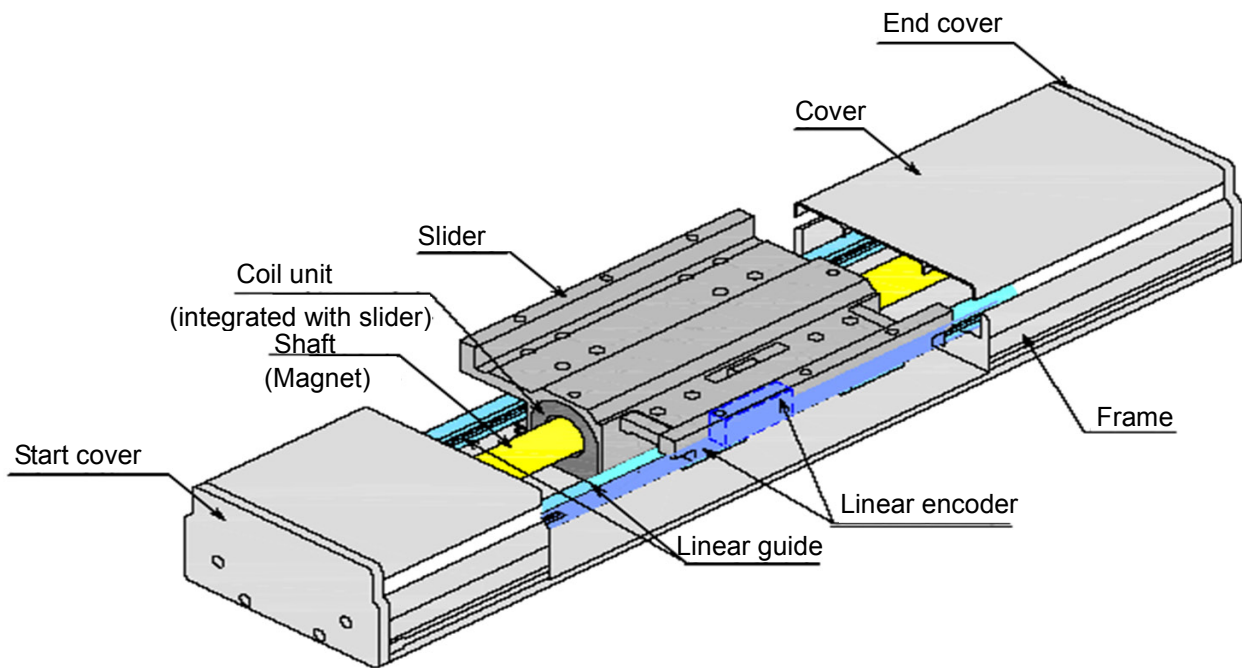
5-2-7. Other precautions



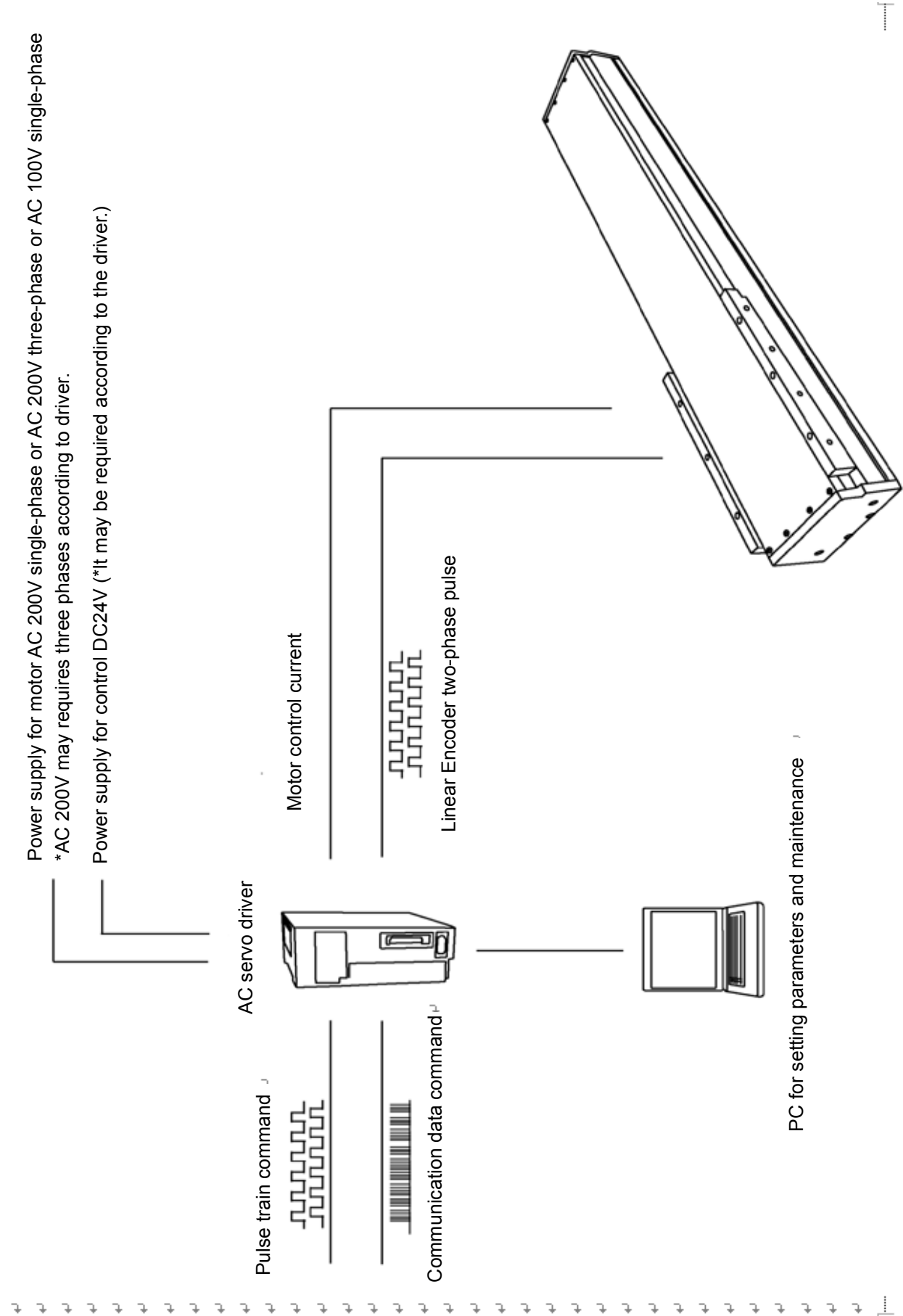
Cautions

This robot has powerful magnet inside the shaft. Do not put magnetic storage medium closer. It could destroy data.

6-2. Part names



6-3. System configuration



6-4. SLP 15 Specifications**6-4-1. SLP 15 performance**

Rated specification		Unit	Specification
Encoder *1		mm	0.001
Continuous Force		N	17
Peak Force *2		N	90
Continuous Current *3		A	0.51
Peak Current *2		A	2.7
Force Constant		N/A	33
Back EMF		V/m/s	11
Resistance *4		ohm	56
Inductance *4		mH	24
Magnetic Pitch (N-N)		mm	60
Maximum Acceleration *5		G	3.5
Maximum Velocity *5*6		m/s	3.0
Repeatability		mm	±0.0005
Max Load	Horizontal	kg	5
	Wall		3
Stroke *7	Single Forcer	mm	100 to 1300 (100 interval)
	Double Forcer		100 to 1200 (100 interval)
Driver Power Supply		V	Single phase 100, Single phase, 3-phase 200
Operating Temperature		°C	0 to 40
Operating Humidity		%	20 to 80(no condensation)
Storage Temperature		°C	-20 to 60
Slider weight		kg	0.54
Number of linear block used		piece	2
Linear block seal resistance		N/piece	0.2

*1: An encoder LIDA279 made by Heidenhain is used.

*2: Peak Force given is based on the output with the use of the following driver.
Hitachi Production Machine System ADA3-01LL3 (3 phase, 200V)

*3: The effective amperage when the temperature increase of the coil front becomes 110k.

*4: An average value of U-V, U-W, and V-W.

*5: There are instances when this is not achieved due to load or operation specifications.

*6: There are instances when this is not achieved due to the length of the stroke.

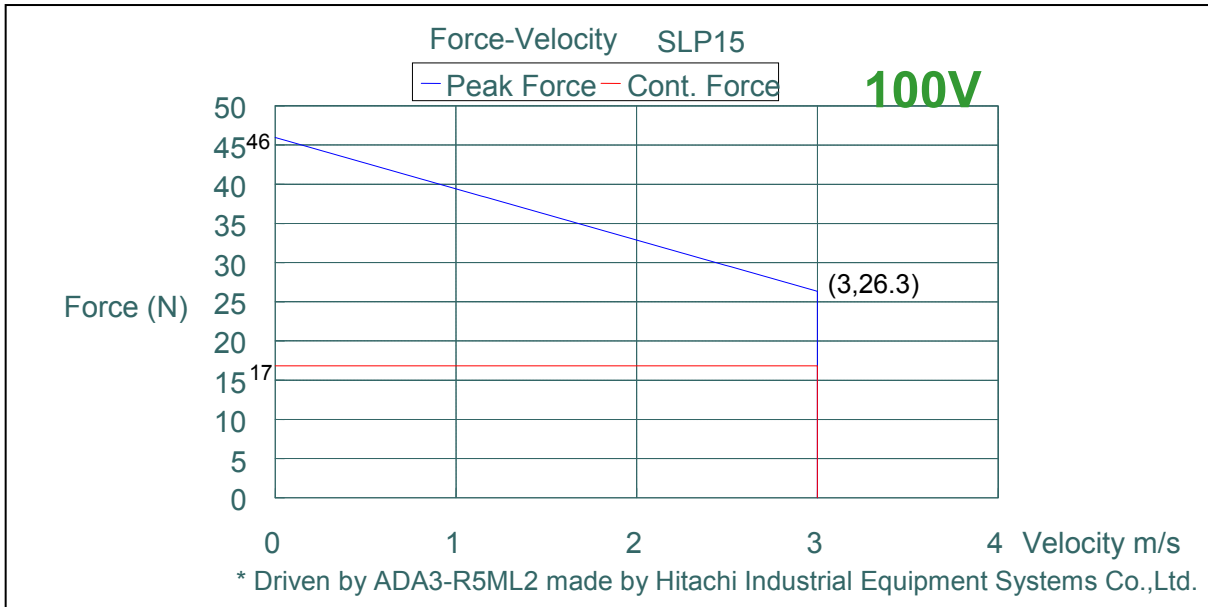
*7: Single slider can be 2000 mm maximum and double slider can be 1900mm maximum.
Please inquire concerning that are not listed.

"Stroke" means the distance between mechanical stoppers.

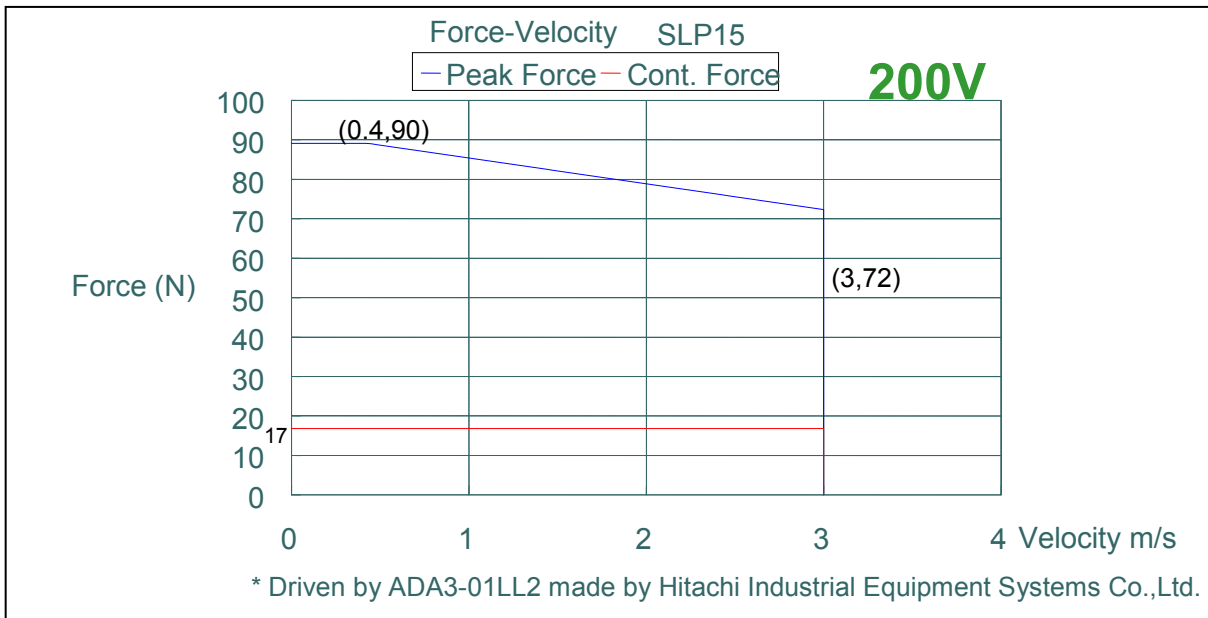
6-4-2. SLP15 Force-Velocity curve

The following figures show the correlation between this robot operation speed and its force that the robot can provide at that speed.

《Driver AC100V》



《Driver AC200V》



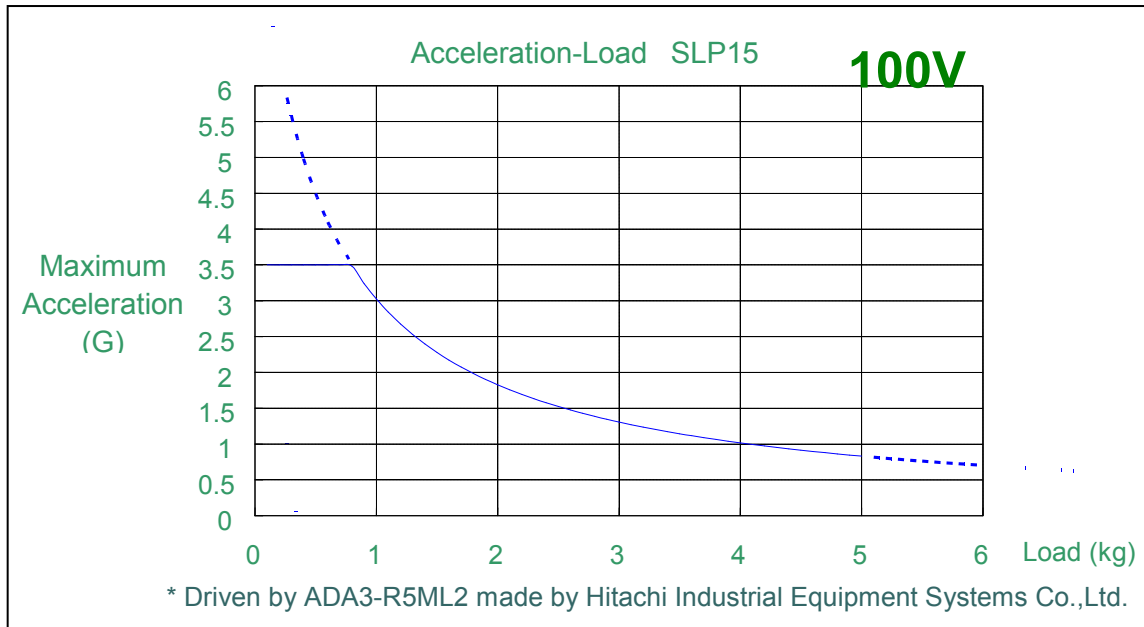
Cautions

- 1) Use beyond the maximum speed causes significant degradation or breakdown of the robot and results in danger. Operate under the maximum speed.
- 2) To operate the robot, operation pattern should satisfy the selection criteria. Put an operating pattern into the selection criteria and confirm if it satisfy the criteria. See 7.3.

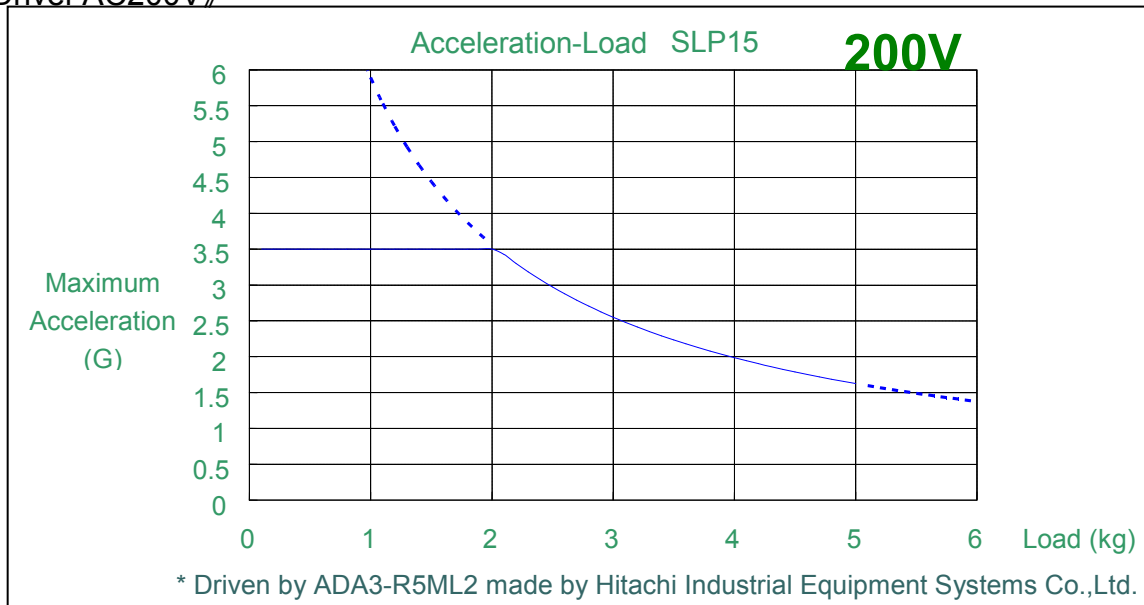
6-4-3. SLP15 Acceleration - Load curve

The following figures show the correlation between the load and the acceleration that this robot can make. Acceleration may not arrive at the maximum in a certain operation pattern. Please use this as a guide for model selection by using operation pattern (work load) you want.

《Driver AC100V》



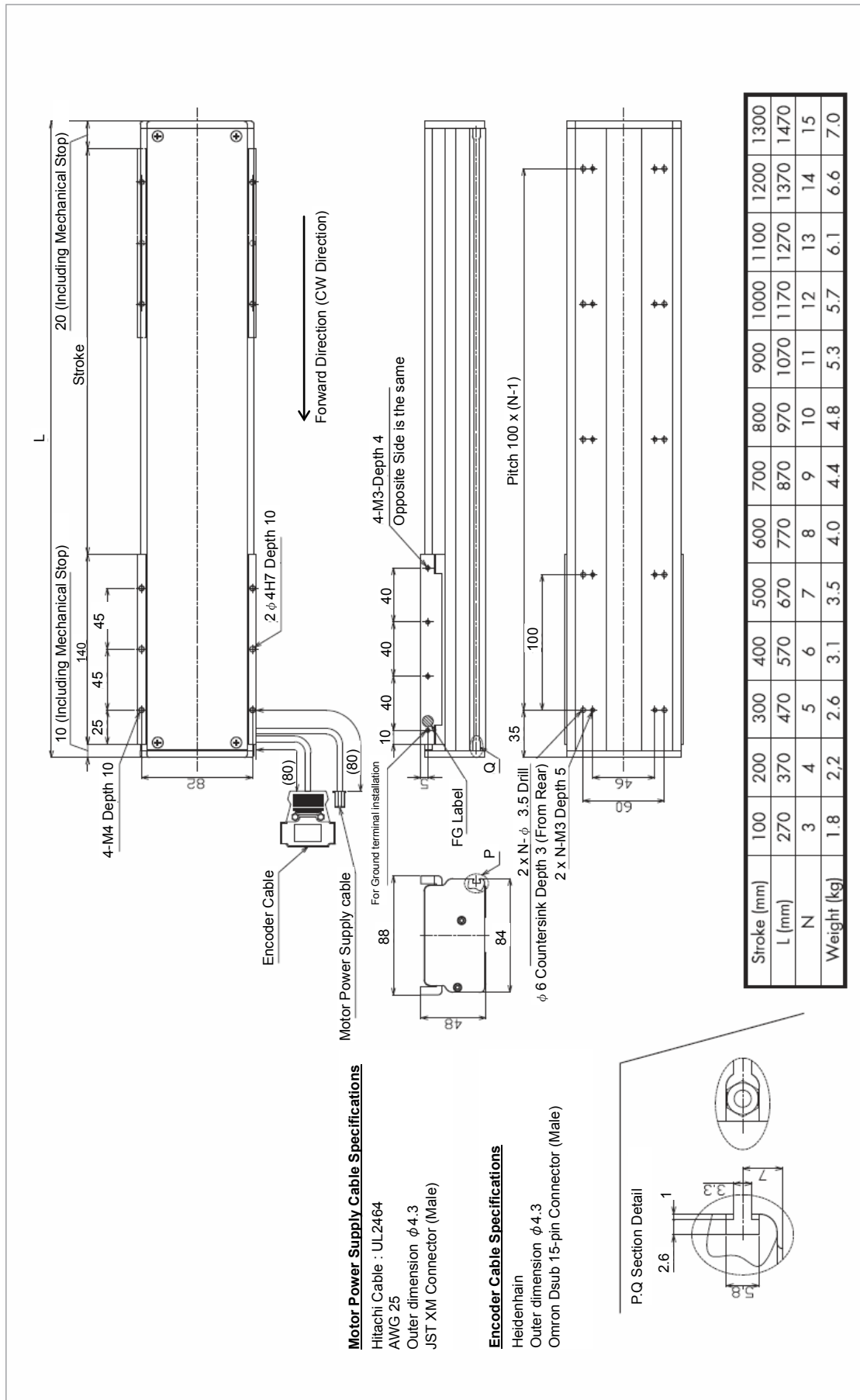
《Driver AC200V》



 **Cautions**

- 1) Use beyond the maximum speed and load causes significant degradation or breakdown of the robot and results in danger. Operate under the maximum speed and load.
- 2) To operate the robot, operation pattern should satisfy the selection criteria. Put an operating pattern into the selection criteria and confirm if it satisfy the criteria. See 7.3.

6-4-4. SLP15 Single Slider External dimensions



Motor Power Supply Cable Specifications

Hitachi Cable : UL2464
 AWG 25
 Outer dimension φ4.3
 JST XM Connector (Male)

Encoder Cable Specifications

Heidenhain
 Outer dimension φ4.3
 Omron Dsub 15-pin Connector (Male)

6-5. SLP 25 Specifications**6-5-1. SLP 25 performance**

Rated specification		Unit	Specification
Encoder *1		mm	0.001
Continuous Force		N	80
Peak Force *2		N	340
Continuous Current *3		A	1.2
Peak Current *2		A	5.1
Force Constant		N/A	66
Back EMF		V/m/s	22
Resistance *4		ohm	22
Inductance *4		mH	31
Magnetic Pitch (N-N)		mm	90
Maximum Acceleration *5		G	3.5
Maximum Velocity *5*6		m/s	3.0
Repeatability		mm	±0.0005
Max Load	Horizontal	kg	30
	Wall		15
Stroke *7	Single Forcer	mm	200 to 1200(100 interval)
	Double Forcer		200 to 1000(100 interval)
Drive Power Supply		V	Single phase100, Single phase, 3-phase 200
Operating Temperature		°C	0 to 40
Operating Humidity		%	20 to 80(no condensation)
Storage Temperature		°C	-20 to 60
Slider weight		kg	3.3
Number of linear block used		piece	4
Linear block seal resistance		N/piece	0.2

*1: An encoder LIDA279 made by Heidenhain is used.

*2: Peak Force given is based on the output with the use of the following driver.
Hitachi Production Machine System ADA3-01LL3 (3 phase, 200V)

*3: The effective amperage when the temperature increase of the coil front becomes 110k.

*4: An average value of U-V, U-W, and V-W.

*5: There are instances when this is not achieved due to load or operation specifications.

*6: There are instances when this is not achieved due to the length of the stroke.

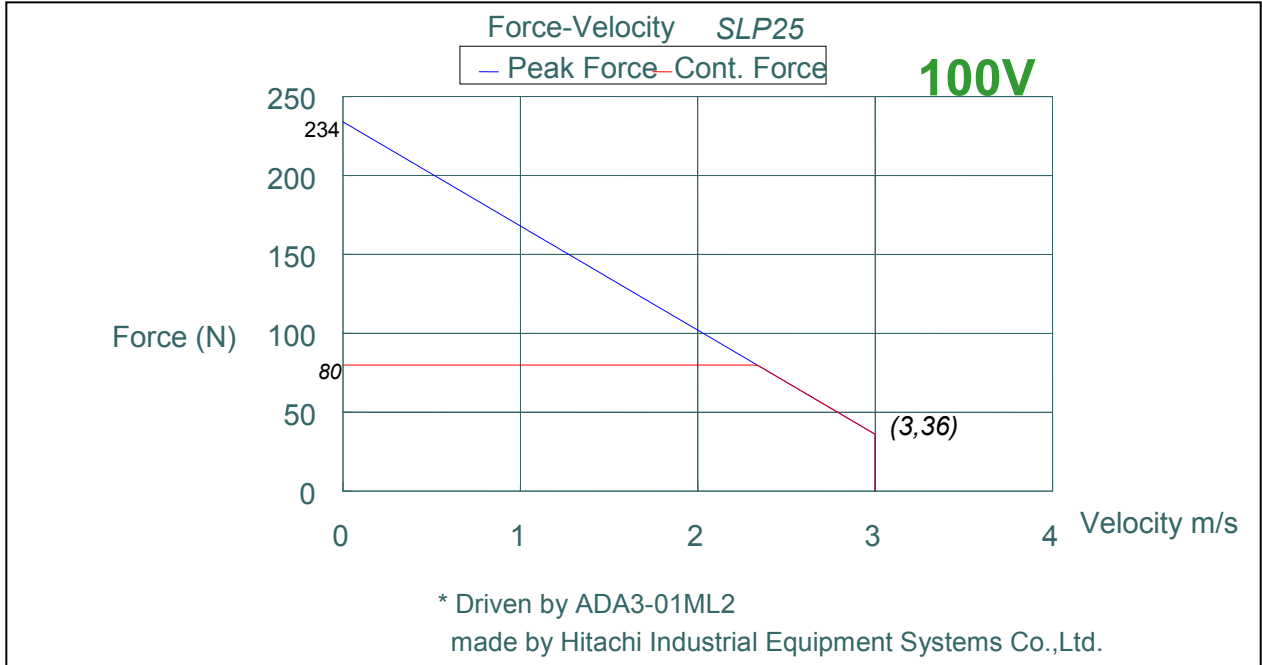
*7: Single slider can be 2000 mm maximum and double slider can be 1800mm maximum.
Please inquire further concerning strokes that are not indicated above.

"Stroke" means the distance between mechanical stoppers.

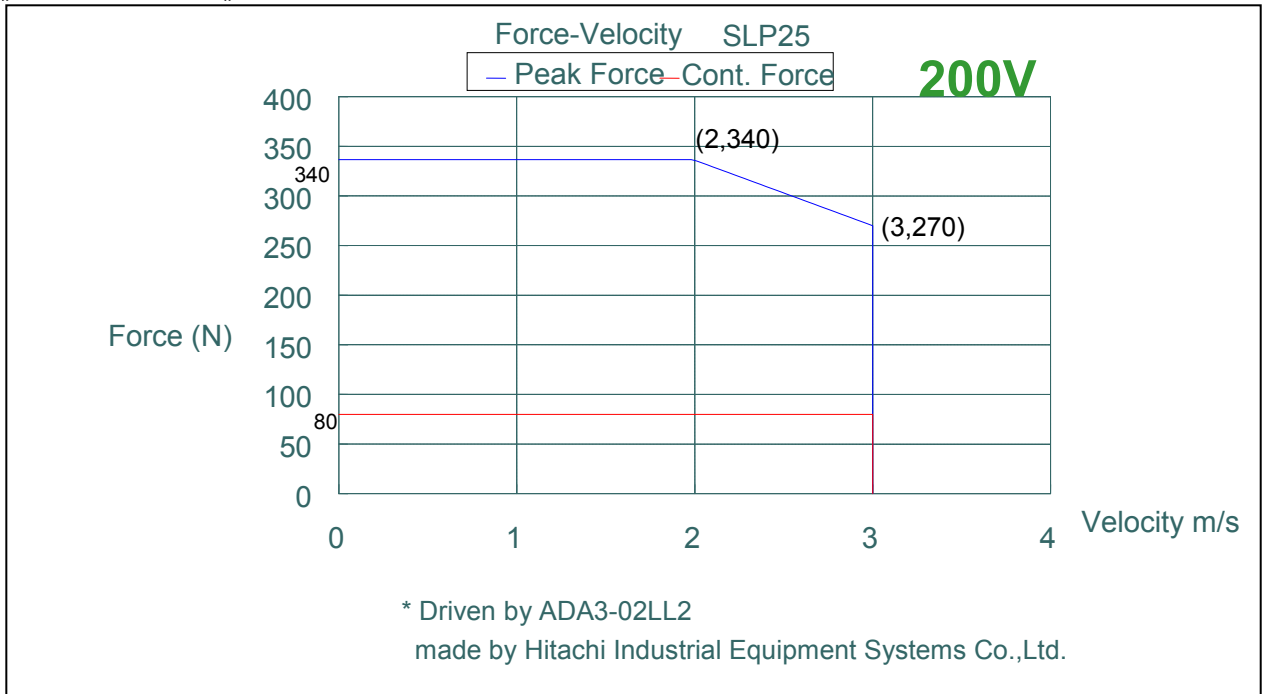
6-5-2 SLP 25 Force-Velocity curve

The following figures show the correlation between this robot operation speed and its force that the robot can provide at that speed.

《Driver AC100V》



《Driver AC200V》



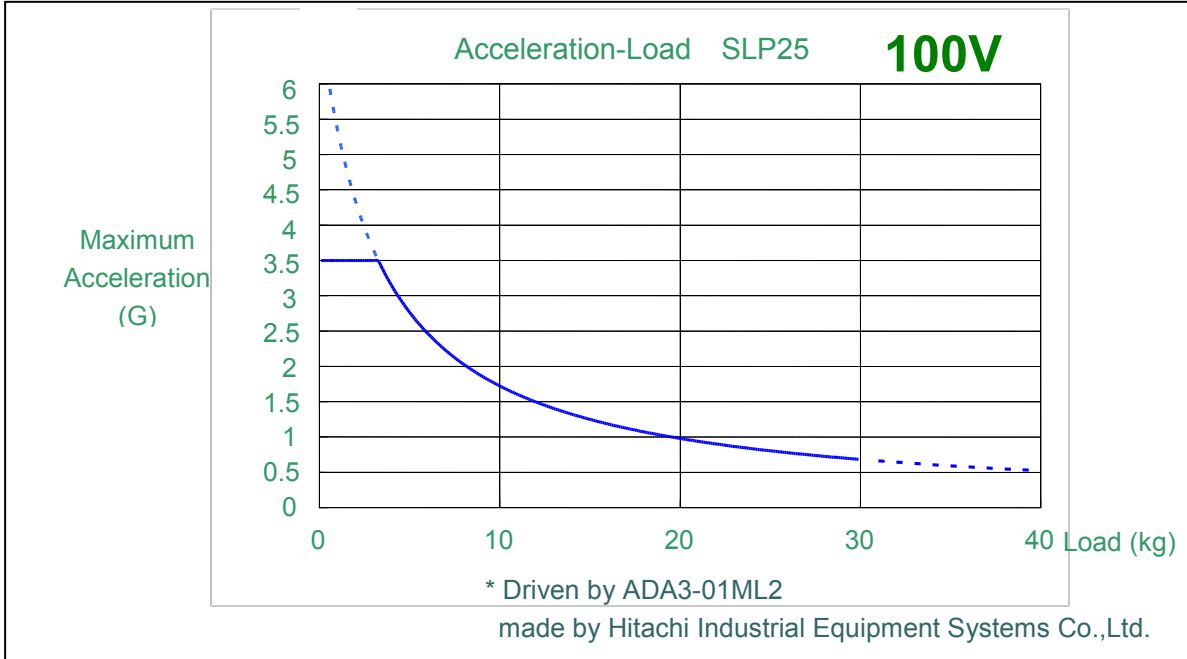
 **Cautions**

- 1) Use beyond the maximum speed causes significant degradation or breakdown of the robot and results in danger. Operate under the maximum speed.
- 2) To operate the robot, operation pattern should satisfy the selection criteria. Put an operating pattern into the selection criteria and confirm if it satisfy the criteria. See 7.3.

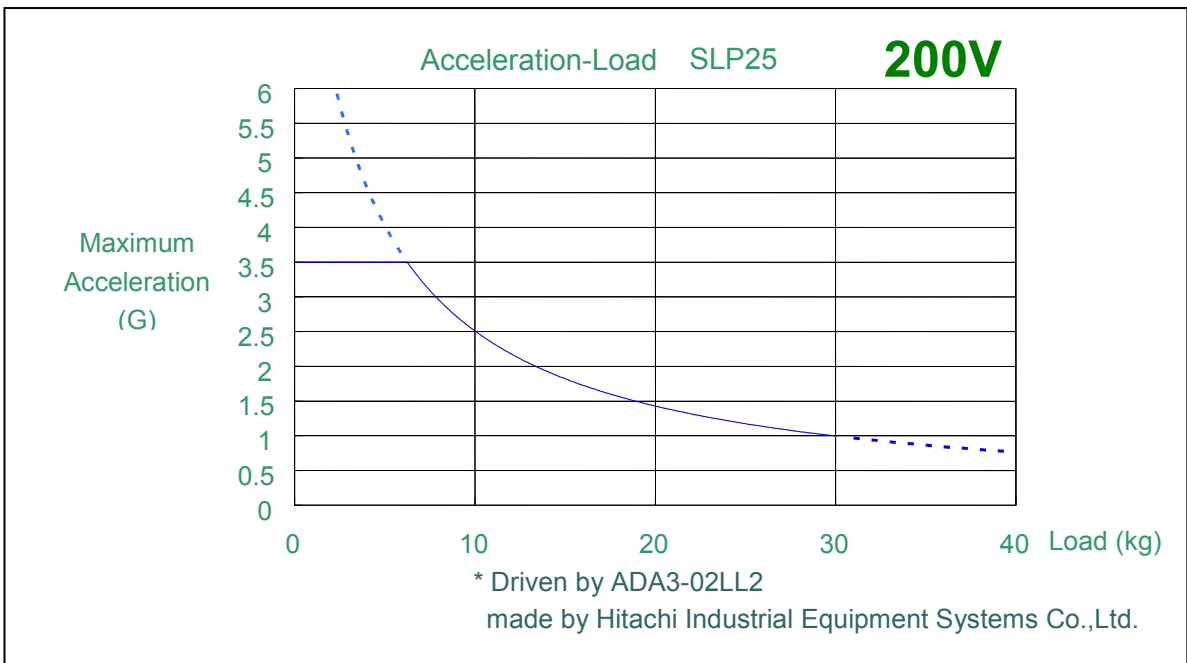
6-5-3 SLP 25 Acceleration-Load curve

The following figures show the correlation between the load and the acceleration that this robot can make. Acceleration may not arrive at the maximum in certain operation pattern. Please use this as a guide for model selection by using operation pattern (work load) you want.

《Driver AC100V》



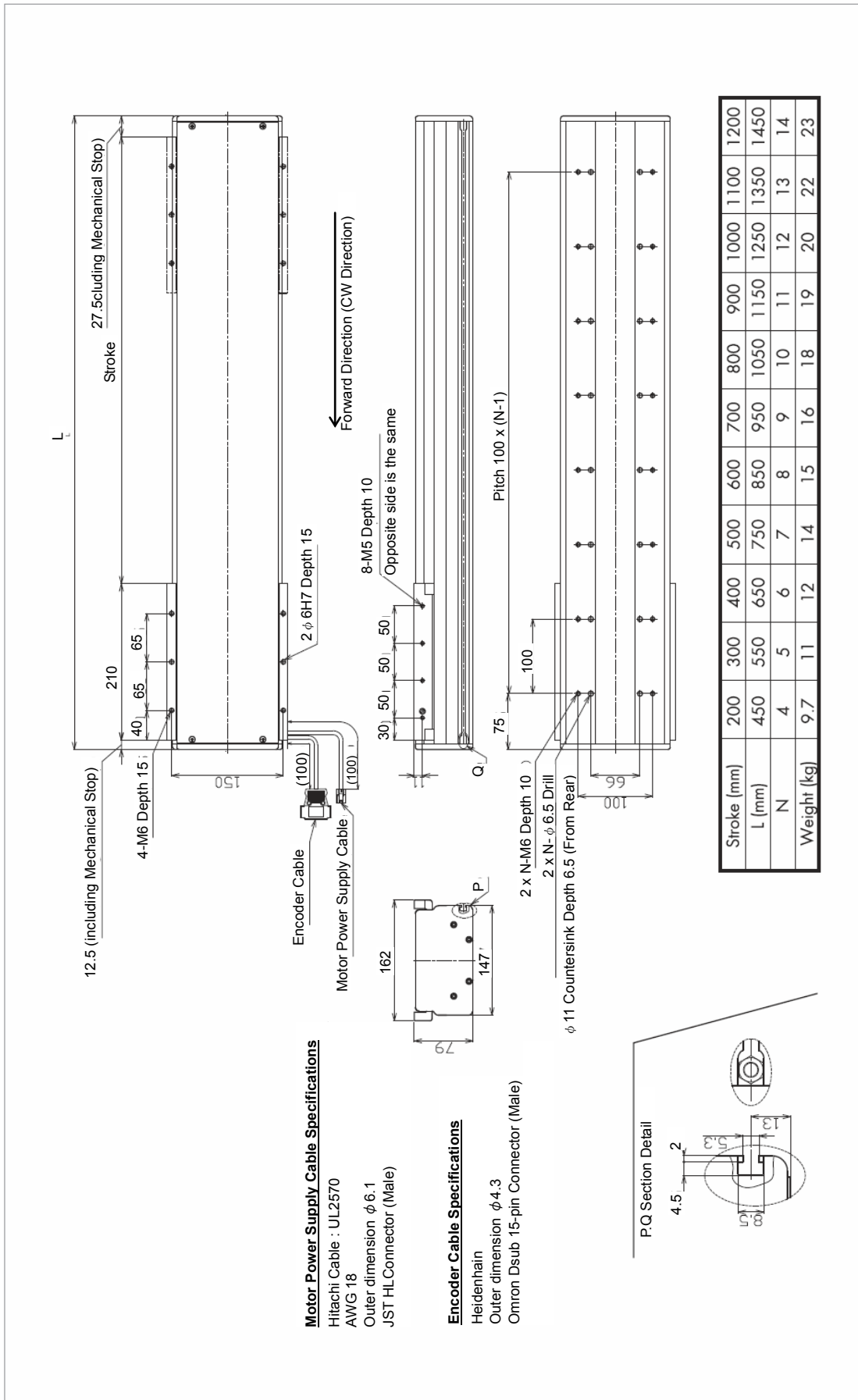
《Driver AC200V》



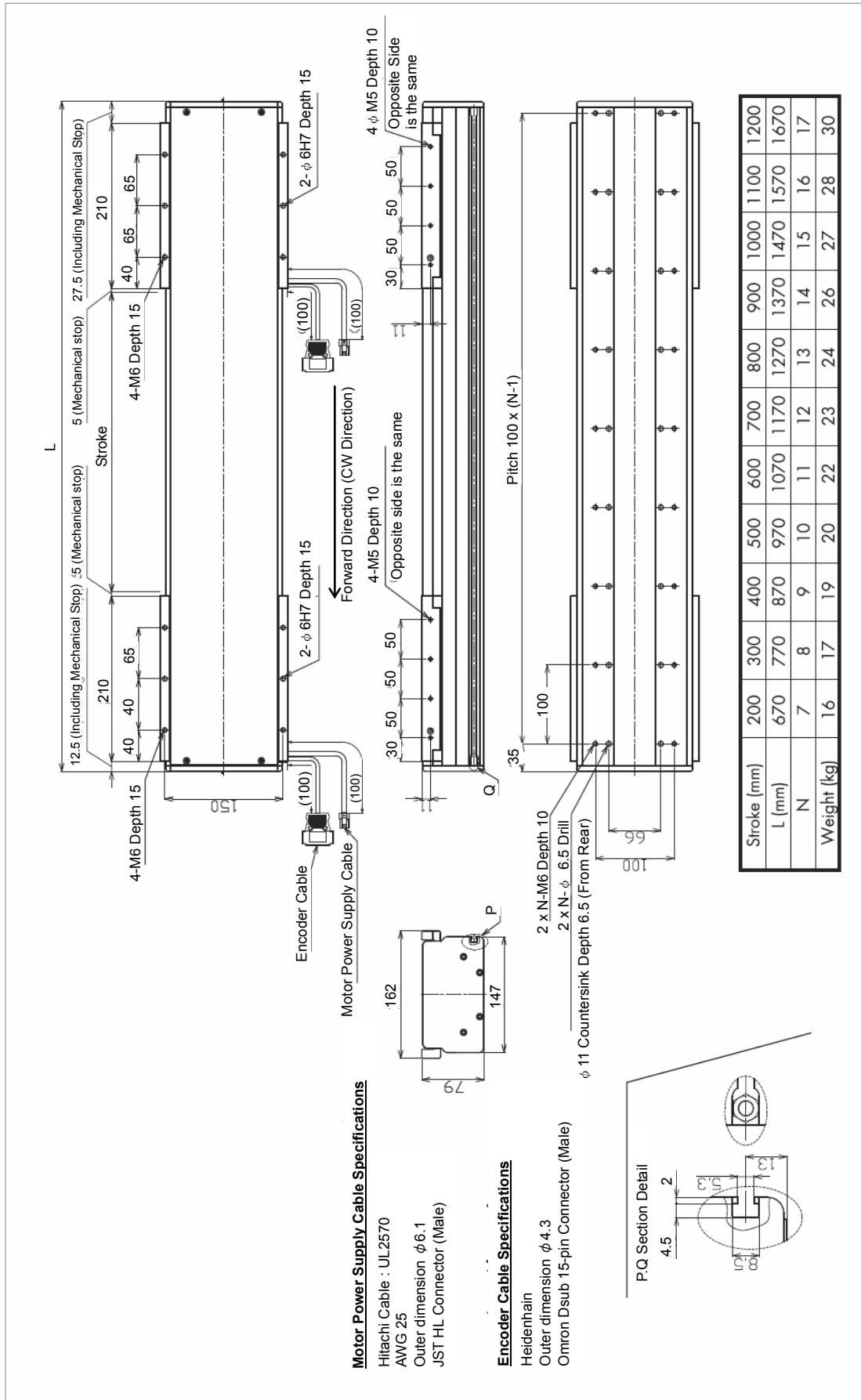
⚠ Cautions

- 1) Use beyond the maximum speed and load causes significant degradation or breakdown of the robot and results in danger. Operate under the maximum speed and load.
- 2) To operate the robot, operation pattern should satisfy the selection criteria. Put an operating pattern into the selection criteria and confirm if it satisfy the criteria. See 7.3.

6-5-4 SLP25 Single Slider External dimensions



6-5-5 SLP25 Double Slider External dimensions



6-6. SLP 35 Specifications**6-6-1 SLP 35 performance**

Rated specification		Unit	Specification
Encoder *1		mm	0.001
Continuous Force		N	185
Peak Force *2		N	970
Continuous Current *3		A	2.7
Peak Current *2		A	14.4
Force Constant		N/A	68
Back EMF		V/m/s	22
Resistance *4		ohm	7.2
Inductance *4		mH	12
Magnetic Pitch (N-N)		mm	120
Maximum Acceleration *5		G	3.5
Maximum Velocity *5*6		m/s	3.0
Repeatability		mm	±0.0005
Max Load	Horizontal	kg	60
	Wall		30
Stroke *7	Single Forcer	mm	200~1200(100 interval)
	Double Forcer		200~1000(100 interval)
Driver Power Supply		V	Single phase 100, Single phase, 3-phase 200
Operating Temperature		°C	0 to 40
Operating Humidity		%	20 to 80(no condensation)
Storage Temperature		°C	-20 to 60
Weight		kg	5.0
Number of linear block used		piece	4
Linear block seal resistance		N/piece	0.2

*1: An encoder LIDA279, Heidenhain is used.

*2: Peak Force given is based on the output with the use of the following driver.
Hitachi Production Machine System ADA3-08LL2 (3 phase, 200V)

*3: The effective amperage when the temperature increase of the coil front becomes 110k.

*4: An average value of U-V, U-W, and V-W.

*5: There are instances when this is not achieved due to load or operation specifications.

*6: There are instances when this is not achieved due to the length of the stroke.

*7: Single slider can be 2000 mm maximum and double slider can be 1700mm maximum.

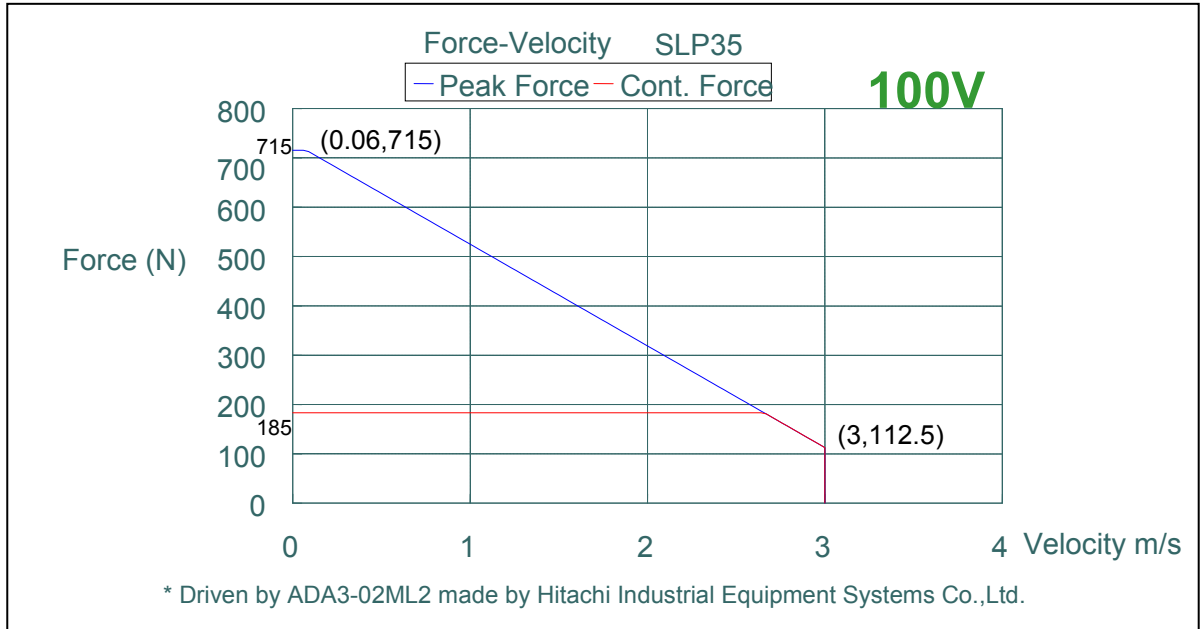
Please inquire concerning strokes that are not indicated above.

"Stroke" means the distance between mechanical stoppers.

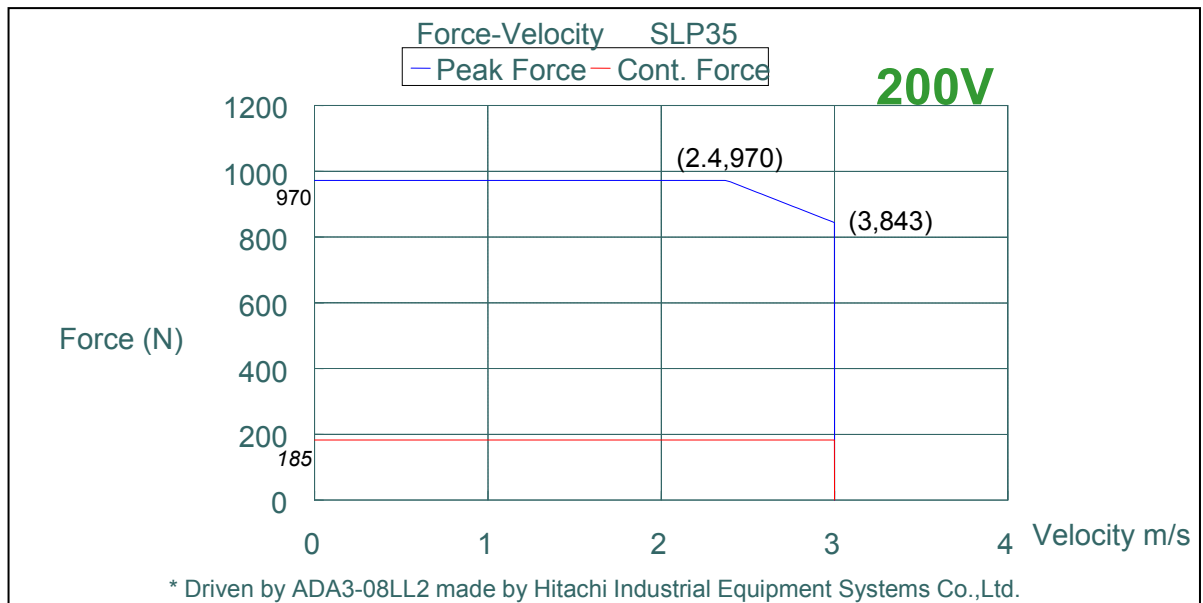
6-6-2. SLP35 Force-Velocity curve

The following figures show the correlation between this stage operation speed and its force that the robot can provide at that speed.

《Driver AC100V》



《Driver AC200V》



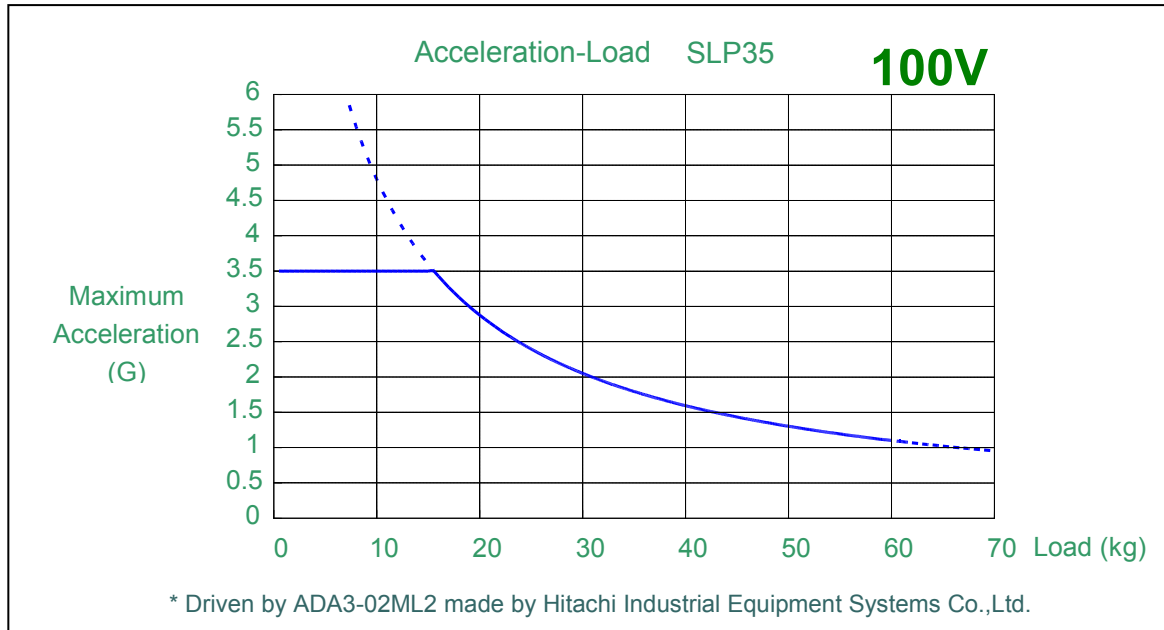
Cautions

- 1) Use beyond the maximum speed causes significant degradation or breakdown of the robot and results in danger. Operate under the maximum speed.
- 2) To operate the robot, operation pattern should satisfy selection criteria. Put an operating pattern into selection criteria and confirm if it satisfy the criteria. See 7.3.

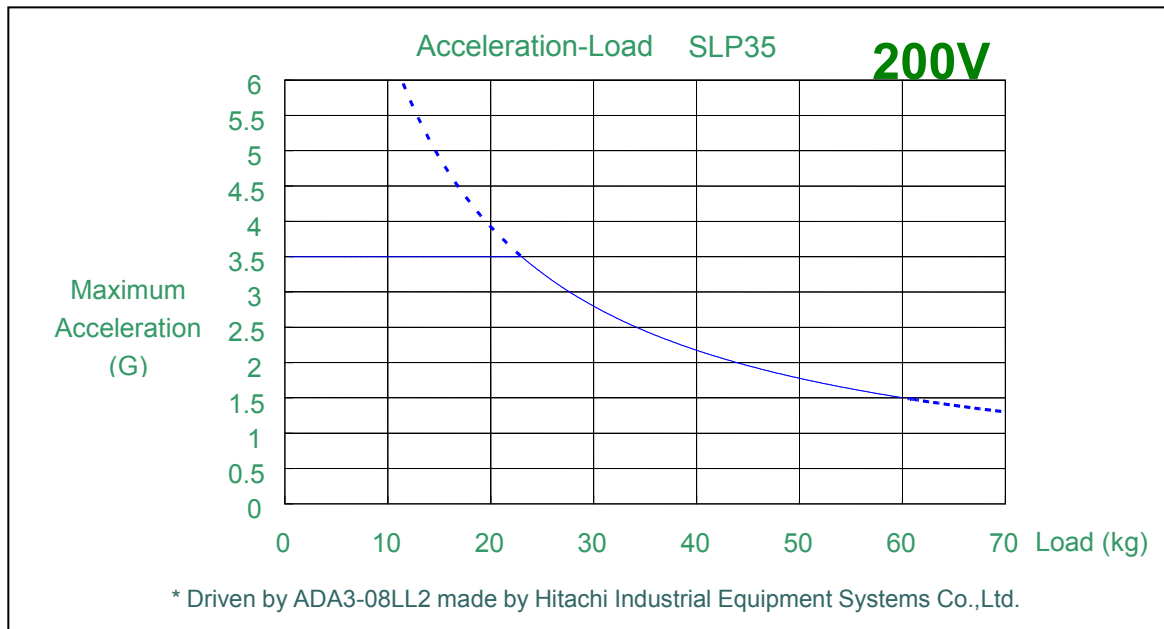
6-6-3. SLP35 Acceleration - Load curve

The following figures show the correlation between the load and the acceleration that this robot can make. Acceleration may not arrive at the maximum in certain operation pattern. Please use this as a guide for model selection by using operation pattern (work load) you want.

《Driver AC100V》



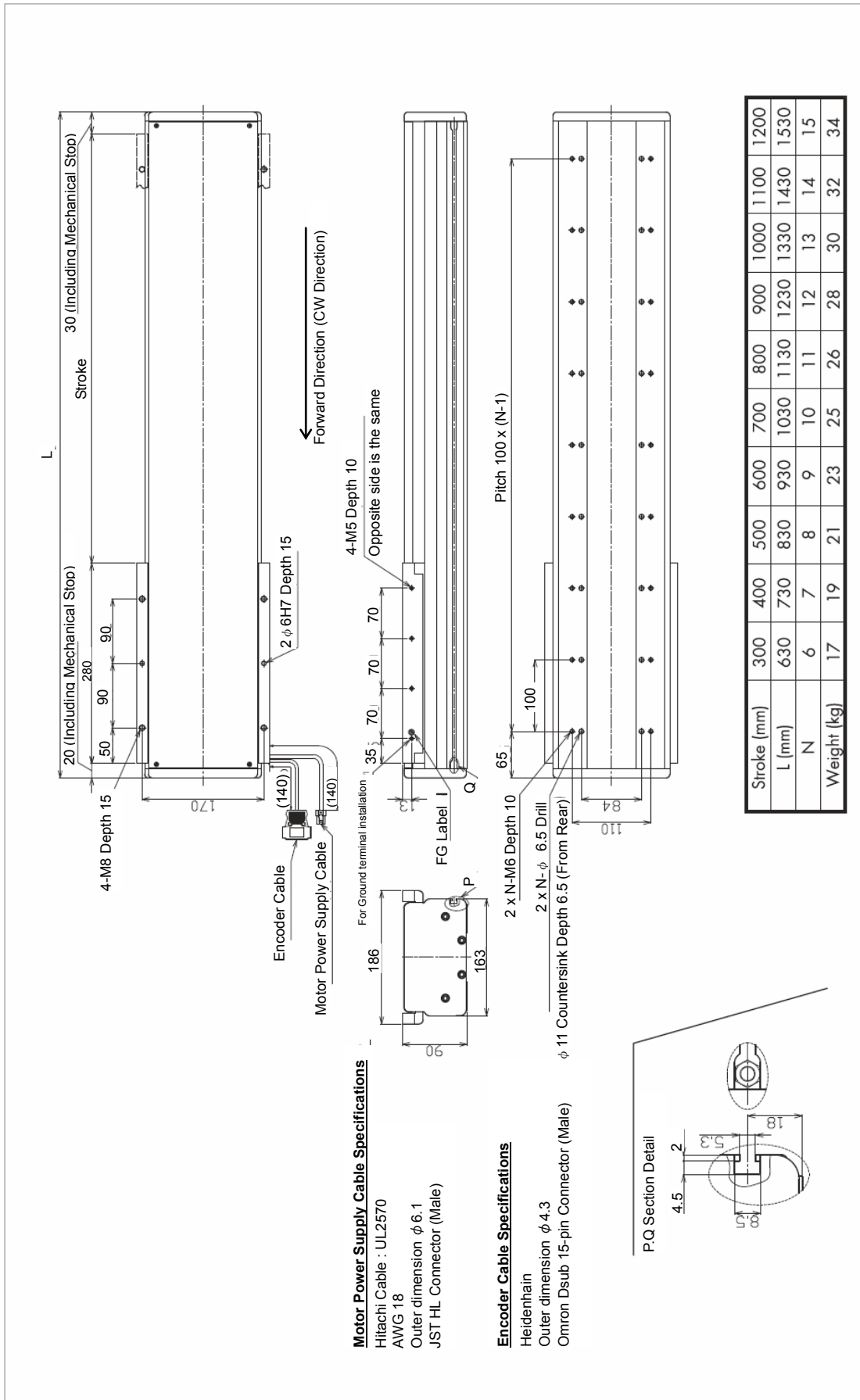
《Driver AC200V》



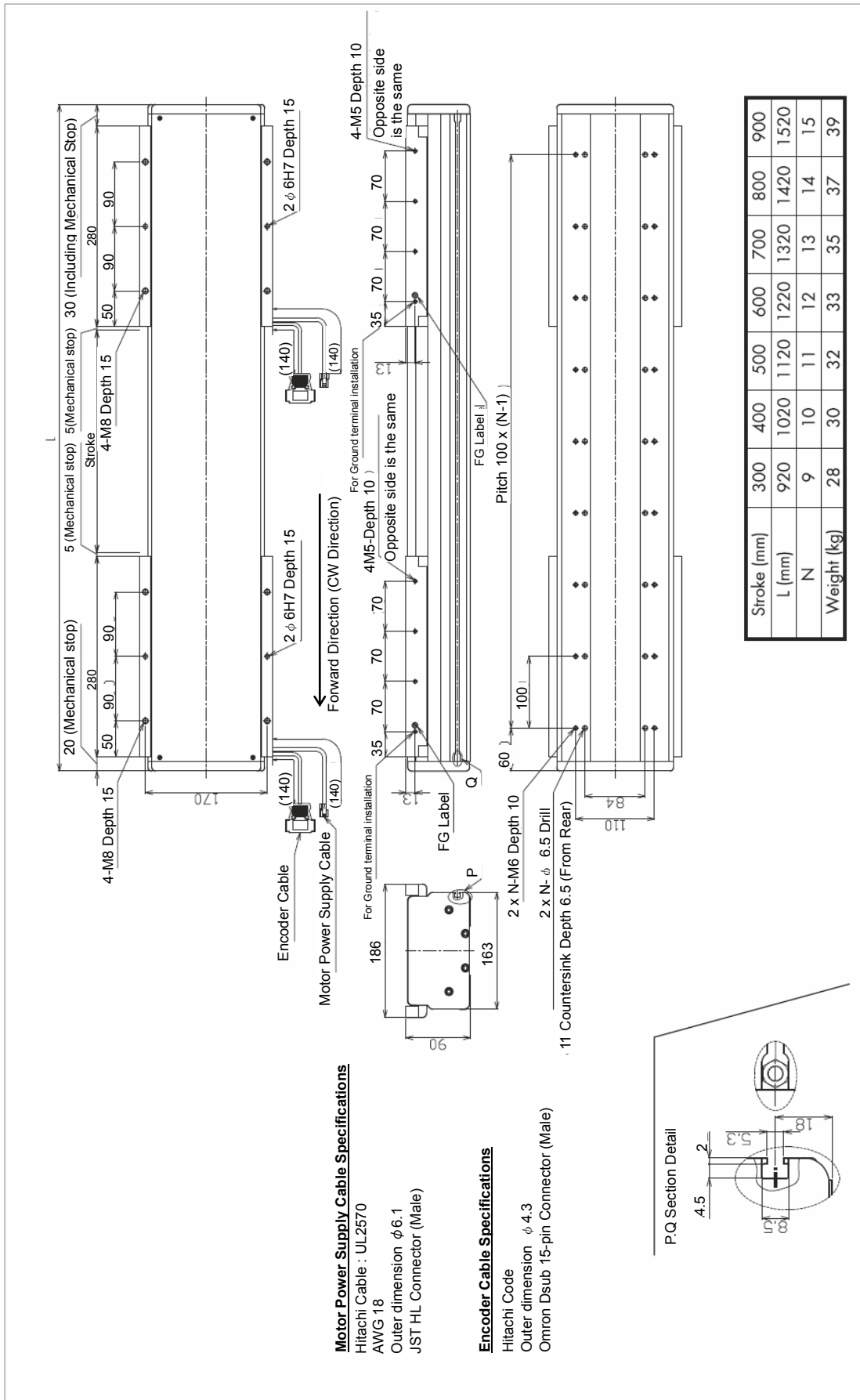
 **Cautions**

- 1) Use beyond the maximum speed causes significant degradation or breakdown of the robot and results in danger. Operate under the maximum speed and the maximum load.
- 2) To operate the robot, operation pattern should satisfy the selection criteria. Put an operating pattern into the selection criteria and confirm if it satisfy the criteria. See 7.3.

6-6-4. SLP35 Single Slider

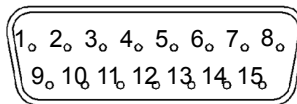


6-6-5. SLP35 Double Slider External Dimensions



6-7. Linear encoder specifications

Manufacturer		Heidenhain
Model		Exposed linear encoder LIDA279
Method		Incremental method
Measuring standard		Steel scale tape
Thermal expansion coefficient		$\alpha_{them}=10ppm/K$
Accuracy grade		$\pm 30\mu m$
Incremental signal		TTL×50
Grating period		200 μm
Integral interpolation		50-fold
Signal period		4 μm
Resolution (after 4-fold)		1 μm
Cutoff frequency		—
Scanning frequency		$\leq 25kHz$
Edge separation		$\geq 0.175\mu s$
Max. traversing speed		$\leq 5m/s$
Vibration from 55 to 2000Hz		$\leq 200m/s^2$ (IEC 60 068-2-6)
Shock 11ms		$\leq 500m/s^2$ (IEC 60 068-2-27)
Operating temperature		0 to 50°C
Weight	scanning head	20g
	Scale	20g/m
	Connector	32g
	Cable	30g
Power supply		5V±5%、<200mA(no load)
Cable		$\phi 4.3$ With D-sub15pin connector (male)



Dsub 15-pin connector

Pin No. (Color)	Power input		Signal output					
	4 (brown /green)	2 (white /green)	1 (brown)	9 (green)	3 (gray)	11 (pink)	14 (red)	7 (black)
	5V	0V	A+	A-	B+	B-	Z+	Z-

* Unlisted pin Nos are no connection.

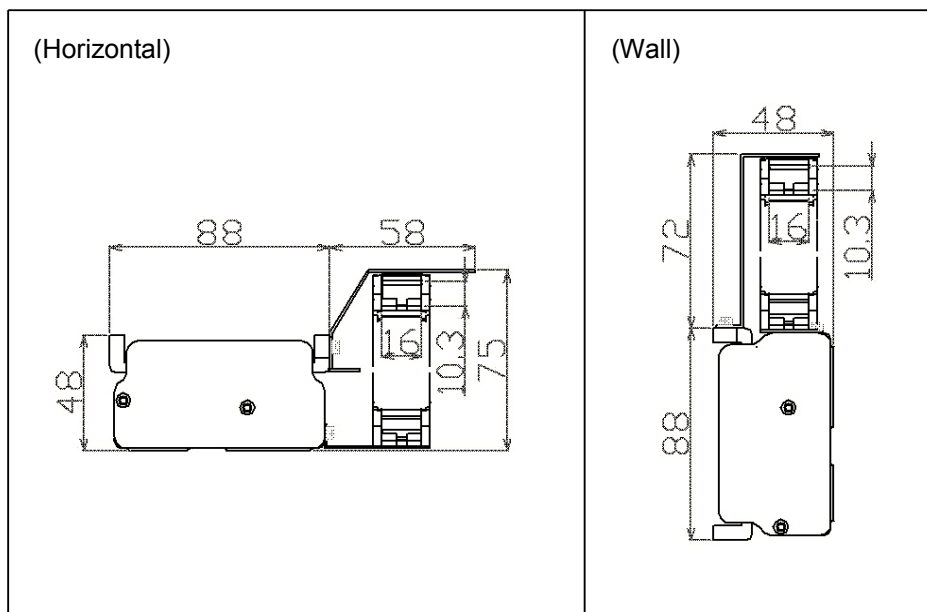
* Shield should be moved toward the connector housing.

6-8. Cable Carrier specifications

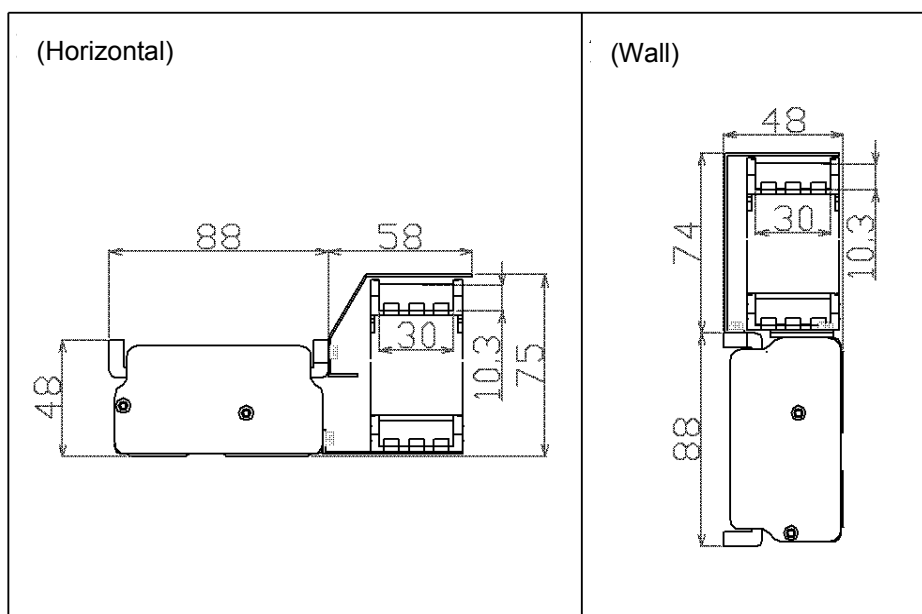
6-8-1. SLP15 Horizontal and wall installation

Type	Part No.	
S type	Igus Inc.	07.16.028.0
M type	Igus Inc.	07.30.028.0

SLP15 S type installation dimension



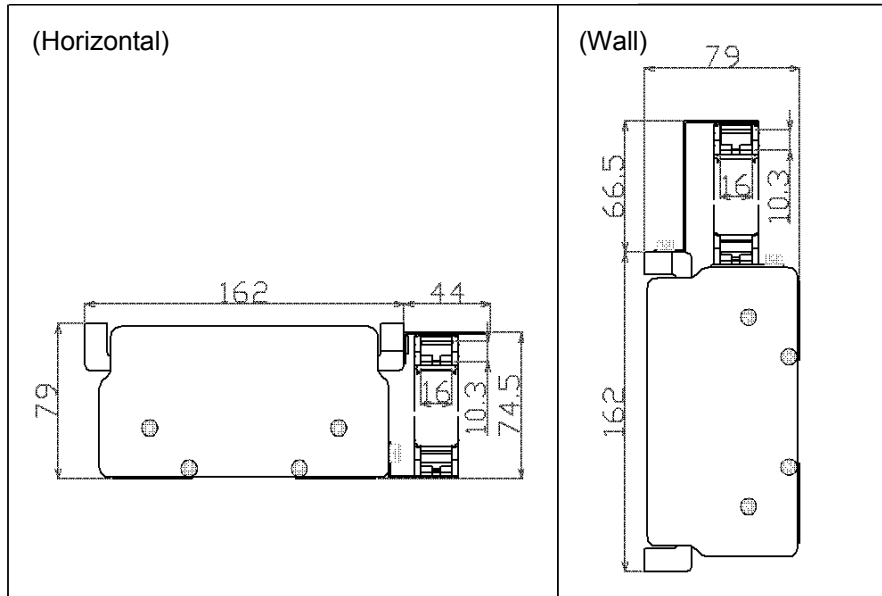
SLP15 M type installation dimension



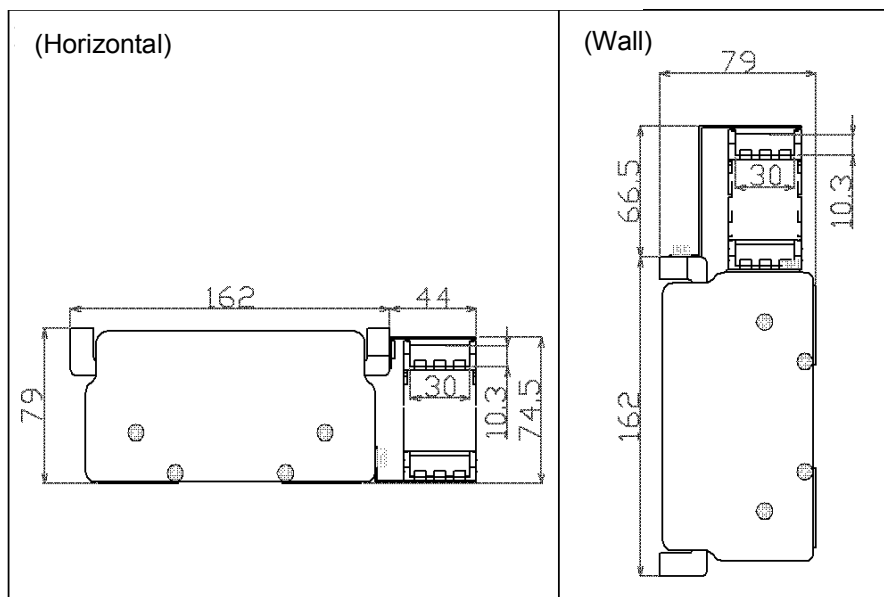
6-8-2. SLP25 Horizontal and wall installation

Type	Part No.	
S type	Igus Inc.	07.16.028.0
M type	Igus Inc.	07.30.028.0

SLP25 S type installation dimension



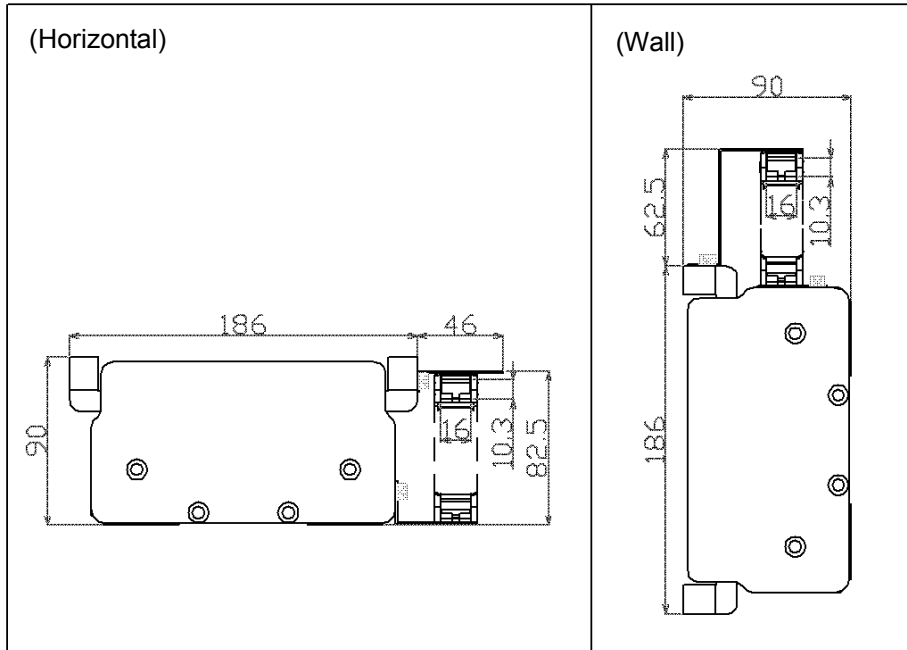
SLP25 M type installation dimension



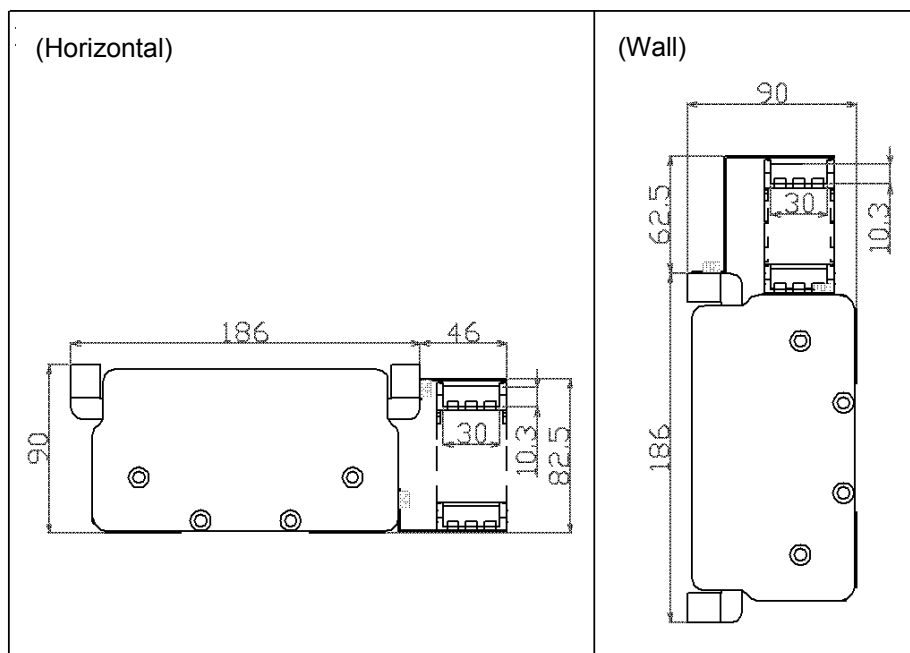
6-8-3. SLP35 Horizontal and wall installation

Type	Part No.	
S type	Igus Inc.	07.16.028.0
M type	Igus Inc.	07.30.028.0

SLP35 S type installation dimension



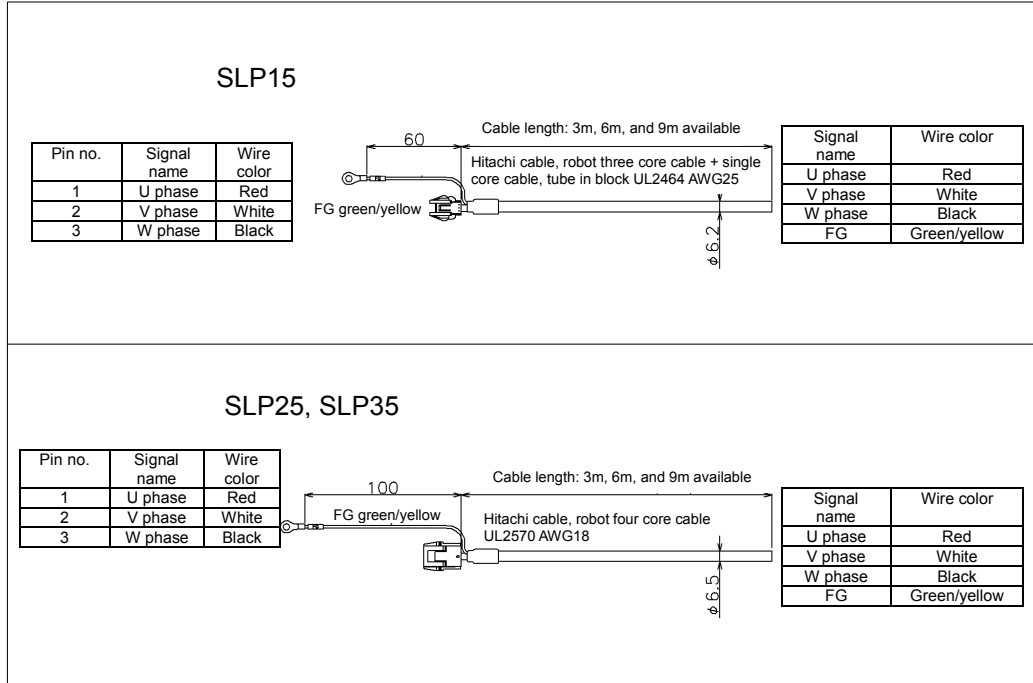
SLP35 M type installation dimension



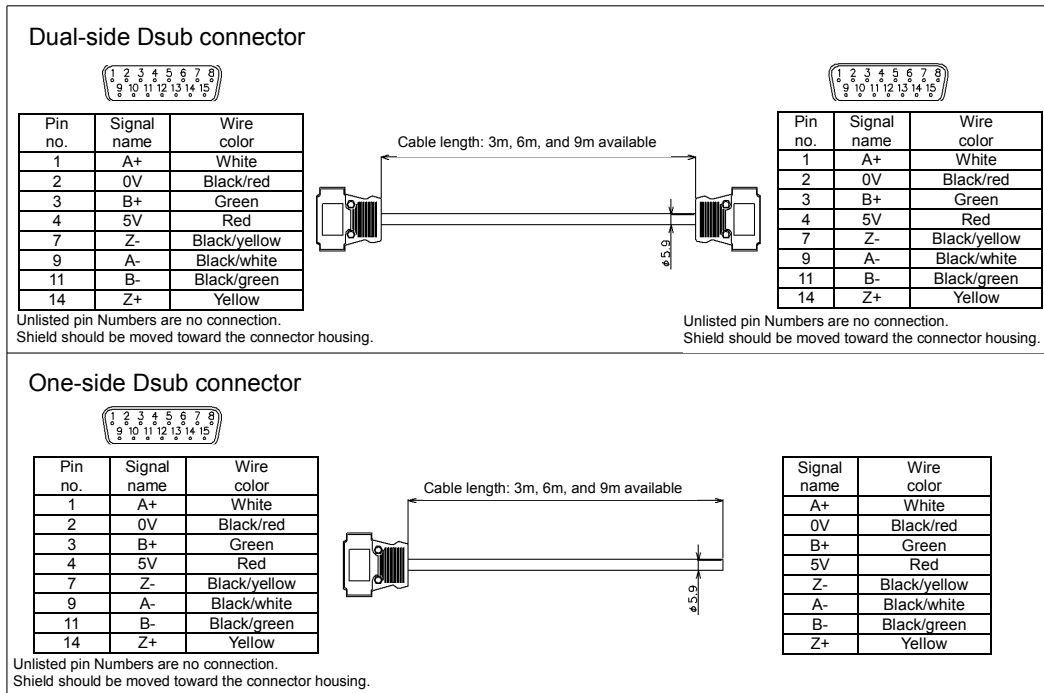
6-9. Extension Cable specifications

6-9-1. Motor power cable and encoder cable

Motor Power Cable



Encoder Cable

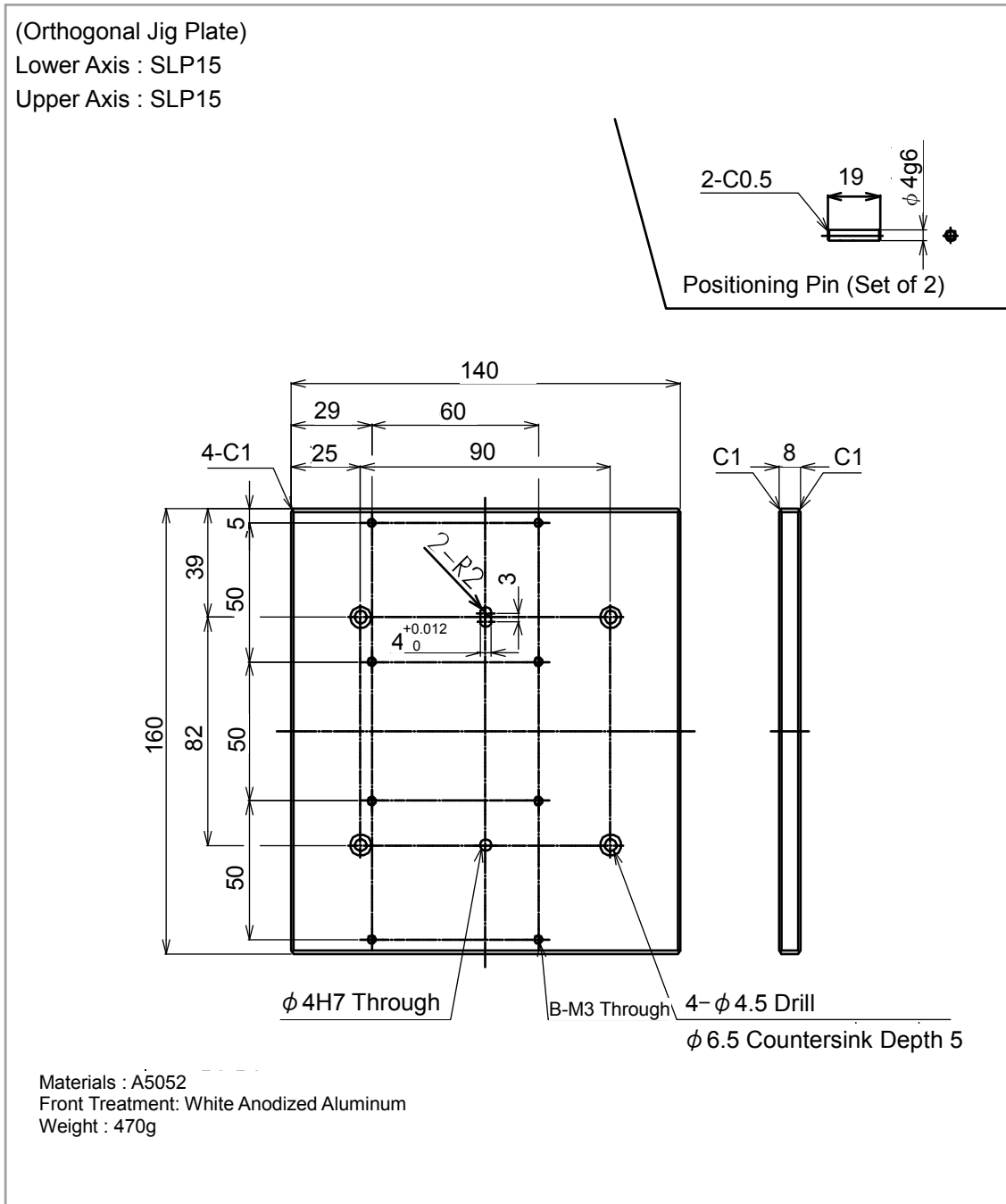


6-10. Orthogonal Jig Plate for use with X-Y Table

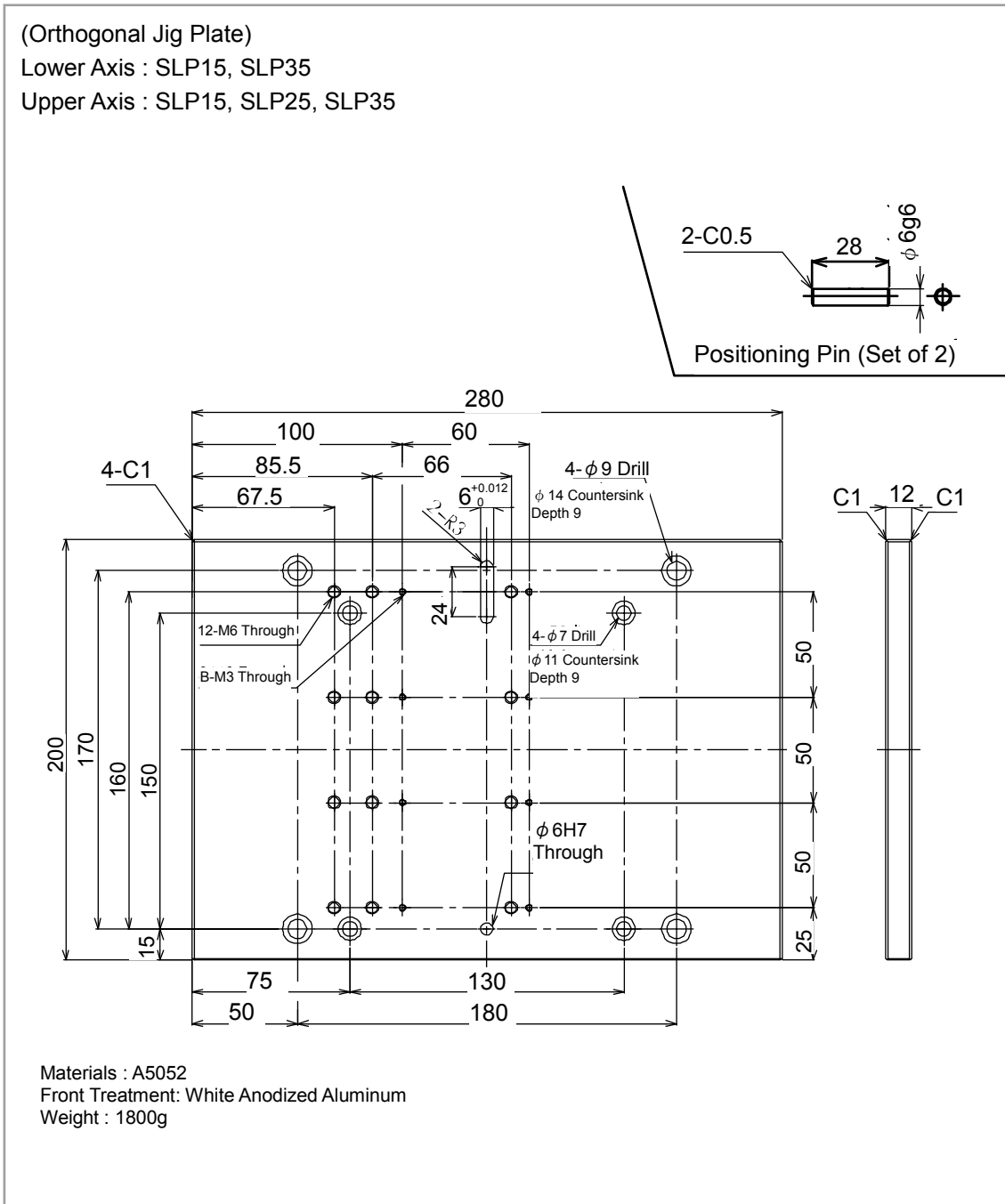
6-10-1. How to use orthogonal jib plate

When constructing a multiple-axis table utilizing several SLP Series, installation is exceptionally easy with the placement of this jig in between the axes. It is also possible to easily gain orthogonal precision between the lower axis and the upper axis by positioning the two attached positioning pins to the precision holes on the face of the stage's slider installation. However, because there is a limit to the possible combinations between models, please use the models suitable for multiple axes in the figures below.

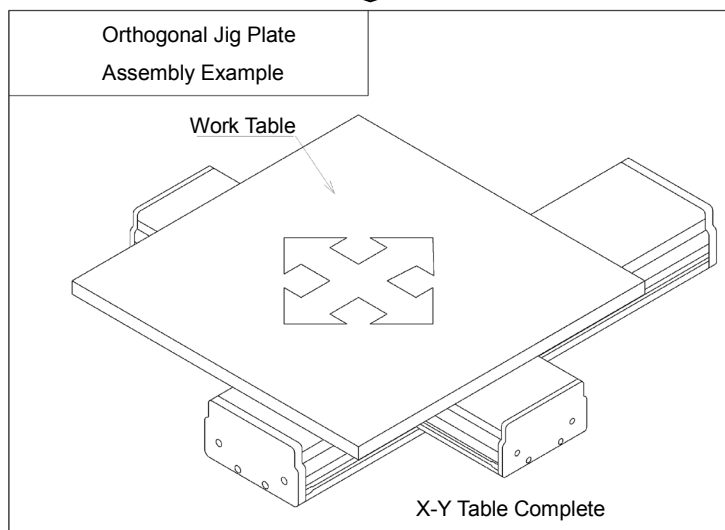
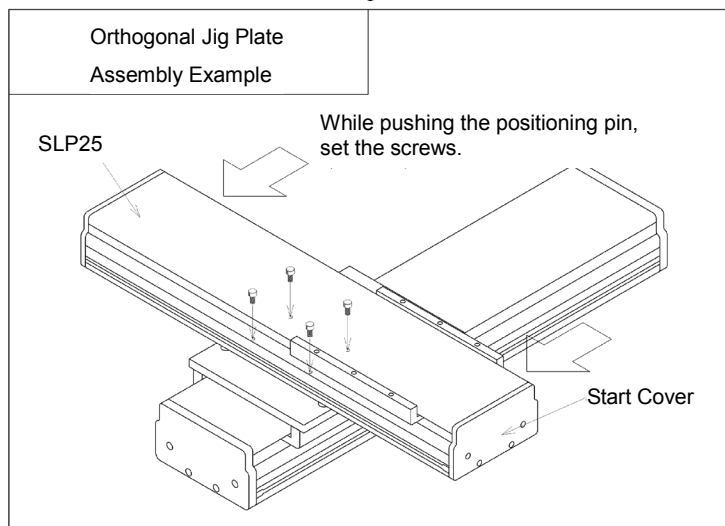
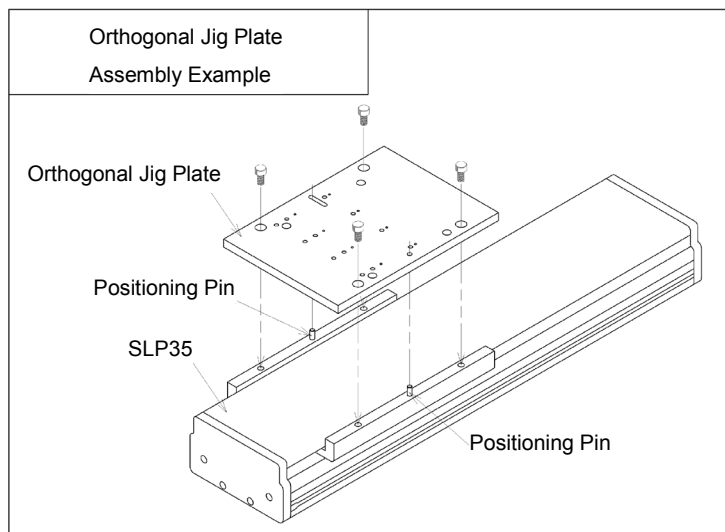
- Orthogonal Jig Plate A



- Orthogonal Jig Plate B



Orthogonal Jig Plate Instruction Directions



7. Installation, wiring, operation

7-1 How to install the robot

7-1-1. Table for installing the robot



Cautions

Use a table that satisfied the following conditions for installing this robot.

- A table that is rigid enough to endure the reaction force caused at driving the robot.
- A table that its flatness of mounting surface is 0.1mm/ (500mmx500mm) or less.
- A table that has enough space for the whole mounting surface of this robot.
- A table that its element is nonmagnetic material. (Do not use magnetic elements.)

7-1-2. Installation using counterbored holes

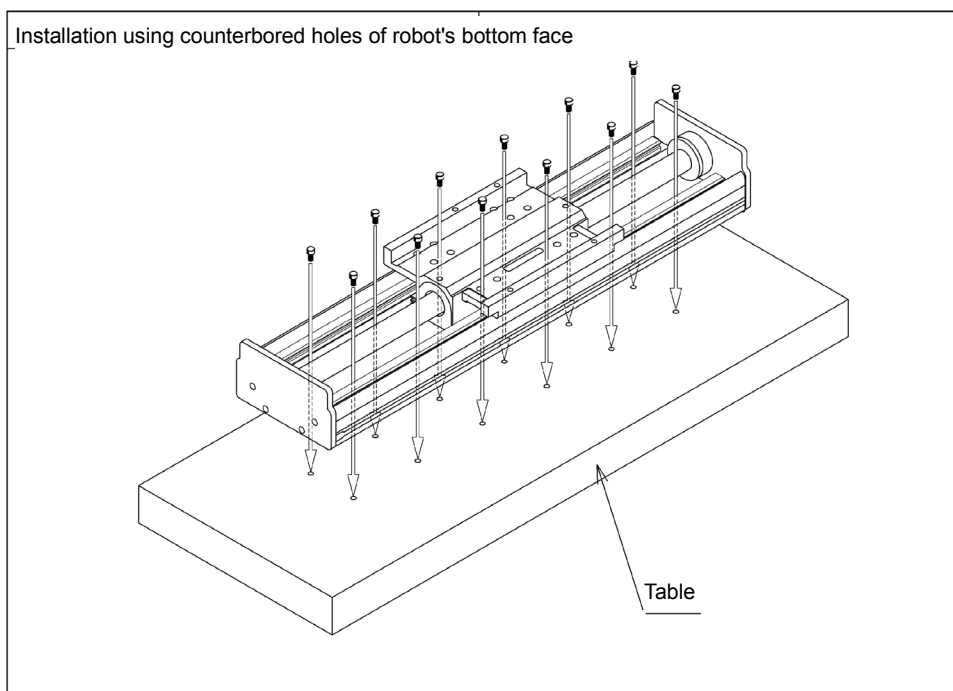
Bore tapped holes on the table and fix the robot with no cover with the following specified bolts and torque wrench from the upper side.



Warning

Use a nonmagnetic tool for installation. Otherwise it could result in fatal or serious injury by a part of the body being caught.

Robot type	Bolt	Torque wrench
SLP15	M3 length more than 8mm Material: SUS304	1.18N · m to 1.57 N · m (12kgf · cm to 16kgf · cm)
SLP25	M6 length more than 15mm Material: SUS304	9.8N · m to 12.75 N · m (100kgf · cm to 130kgf · cm)
SLP35	M6 length more than 15mm Material: SUS304	9.8N · m to 12.75 N · m (100kgf · cm to 130kgf · cm)

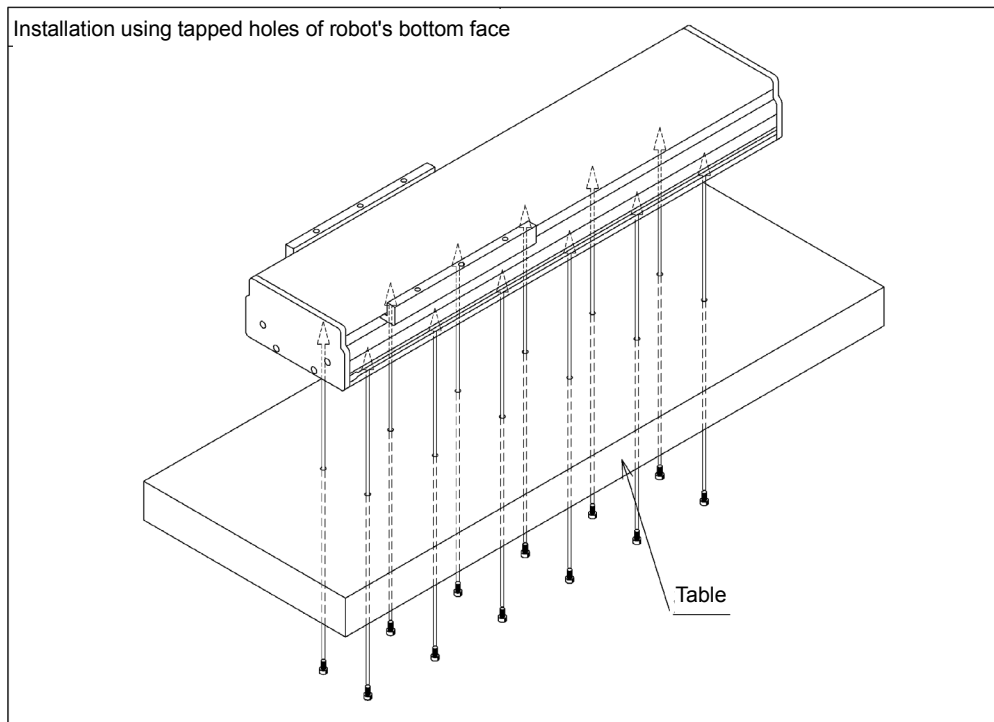


7-1-3. Installation using tapped holes

Bore through holes on the table and fix the robot with the following specified bolts and torque wrench from the bottom side.

If you use longer bolts than the specified one, bolts pass through the frame of the robot and touch the moving parts, and that could break the robot. Be careful of the bolt length.

Robot type	Bolt	Torque wrench
SLP15	M3 thickness of table + 5mm Material: SUS304	1.18N · m to 1.57 N · m (12kgf · cm to 16kgf · cm)
SLP25	M6 thickness of table + 10mm Material: SUS304	9.8N · m to 12.75 N · m (100kgf · cm to 130kgf · cm)
SLP35	M6 thickness of table + 10mm Material: SUS304	9.8N · m to 12.75 N · m (100kgf · cm to 130kgf · cm)



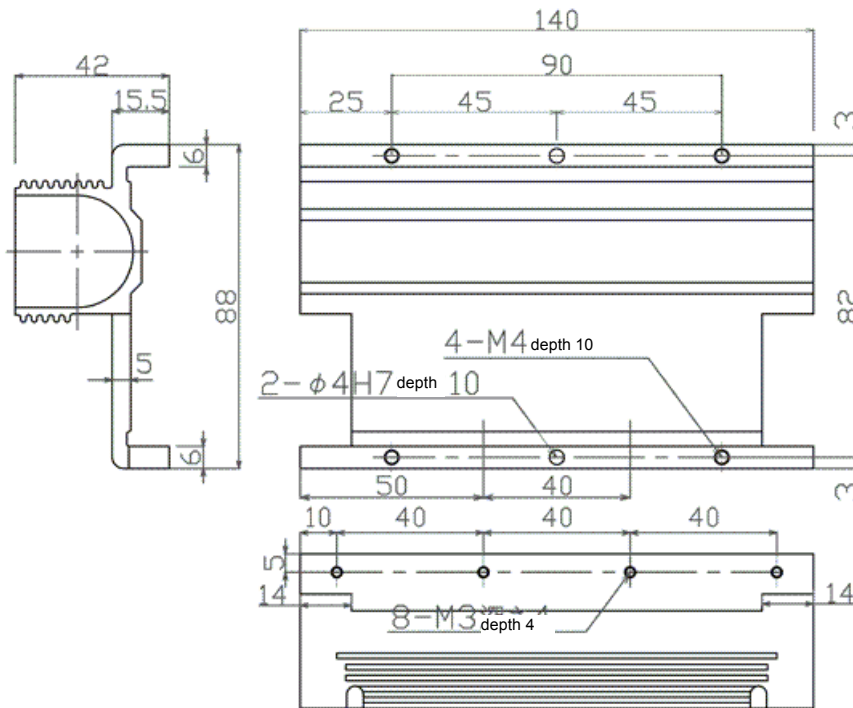
7-1-4. Mounting the load to the slider

Fix the load to the tapped holes on the slider.

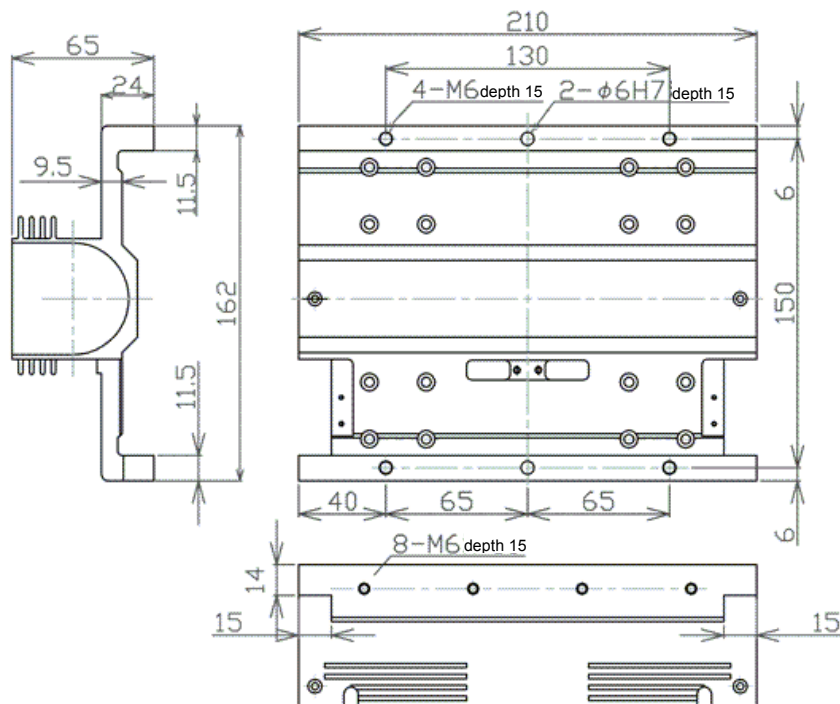
The slider has two holes for positioning pins. If you need repeatability of installation and uninstallation, please use these holes for positioning pins.

Prepare positioning pins by yourself. Refer to the following figures about the depth of tapped holes and holes for parallel pins.

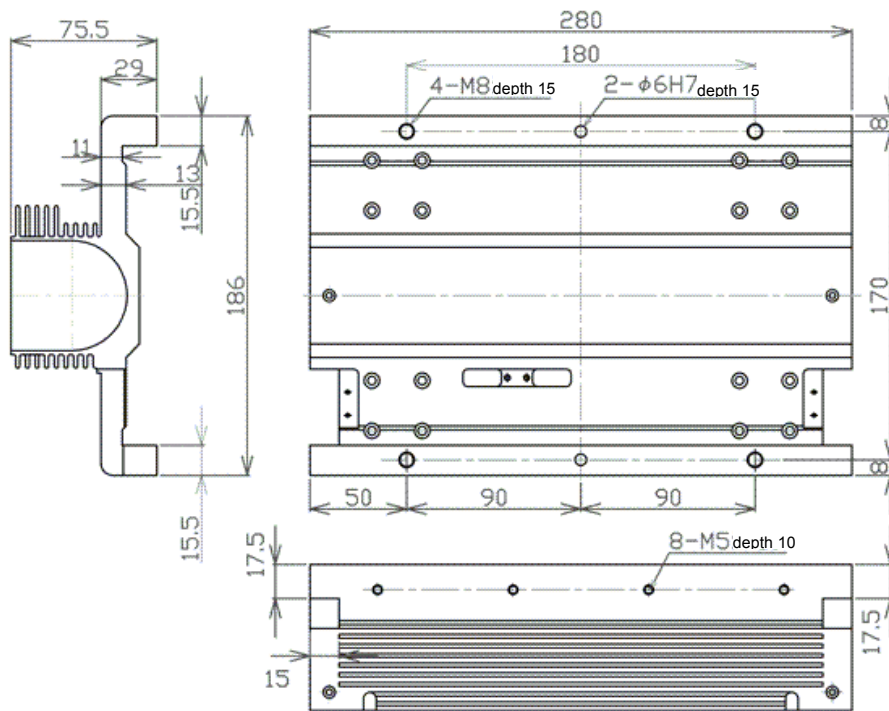
<< SLP15 >>



<< SLP25 >>

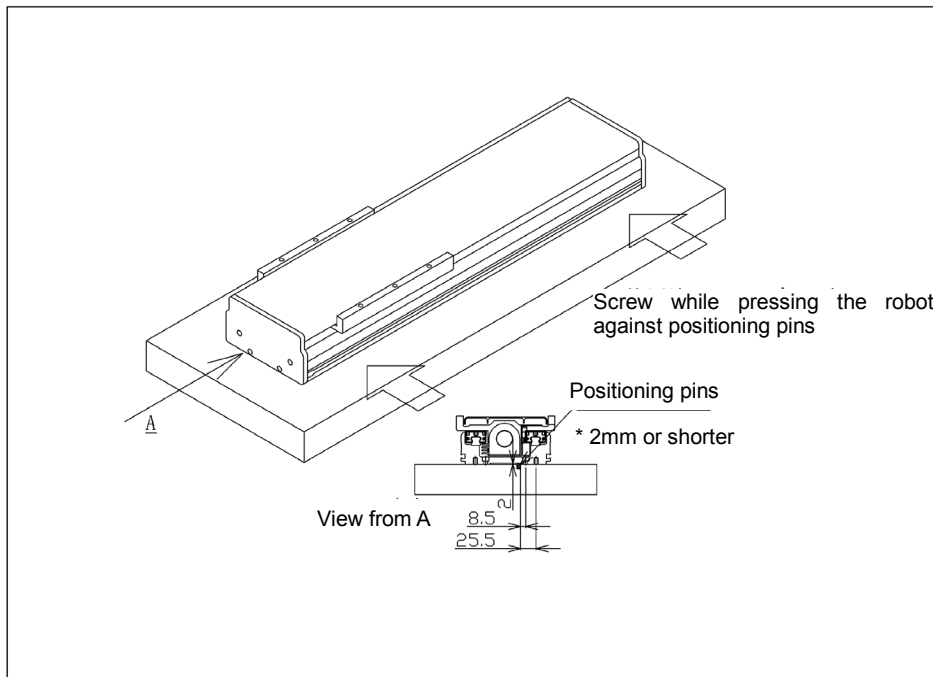
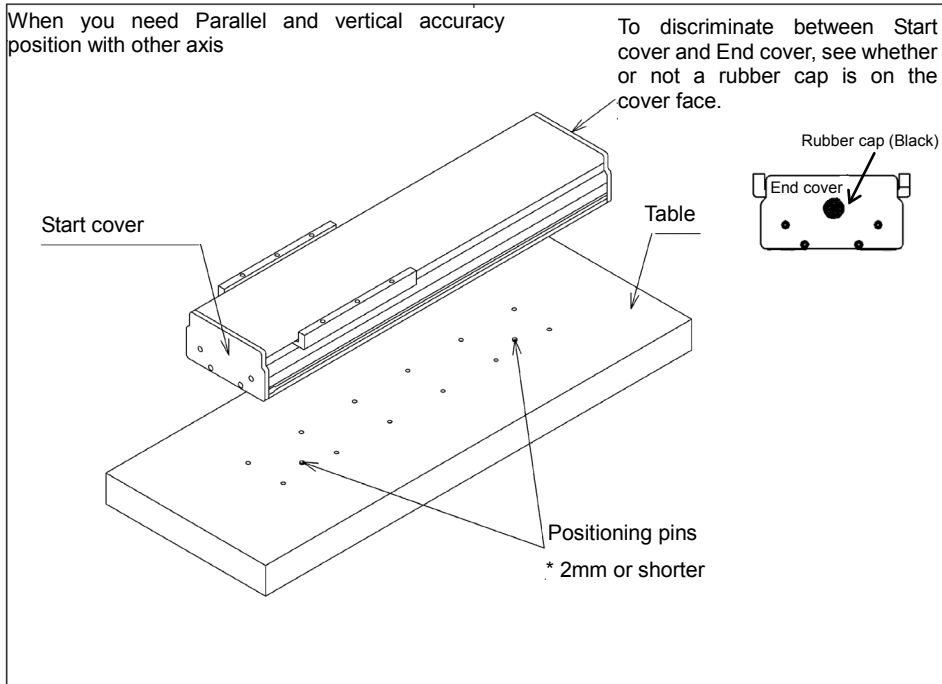


<< SLP35 >>



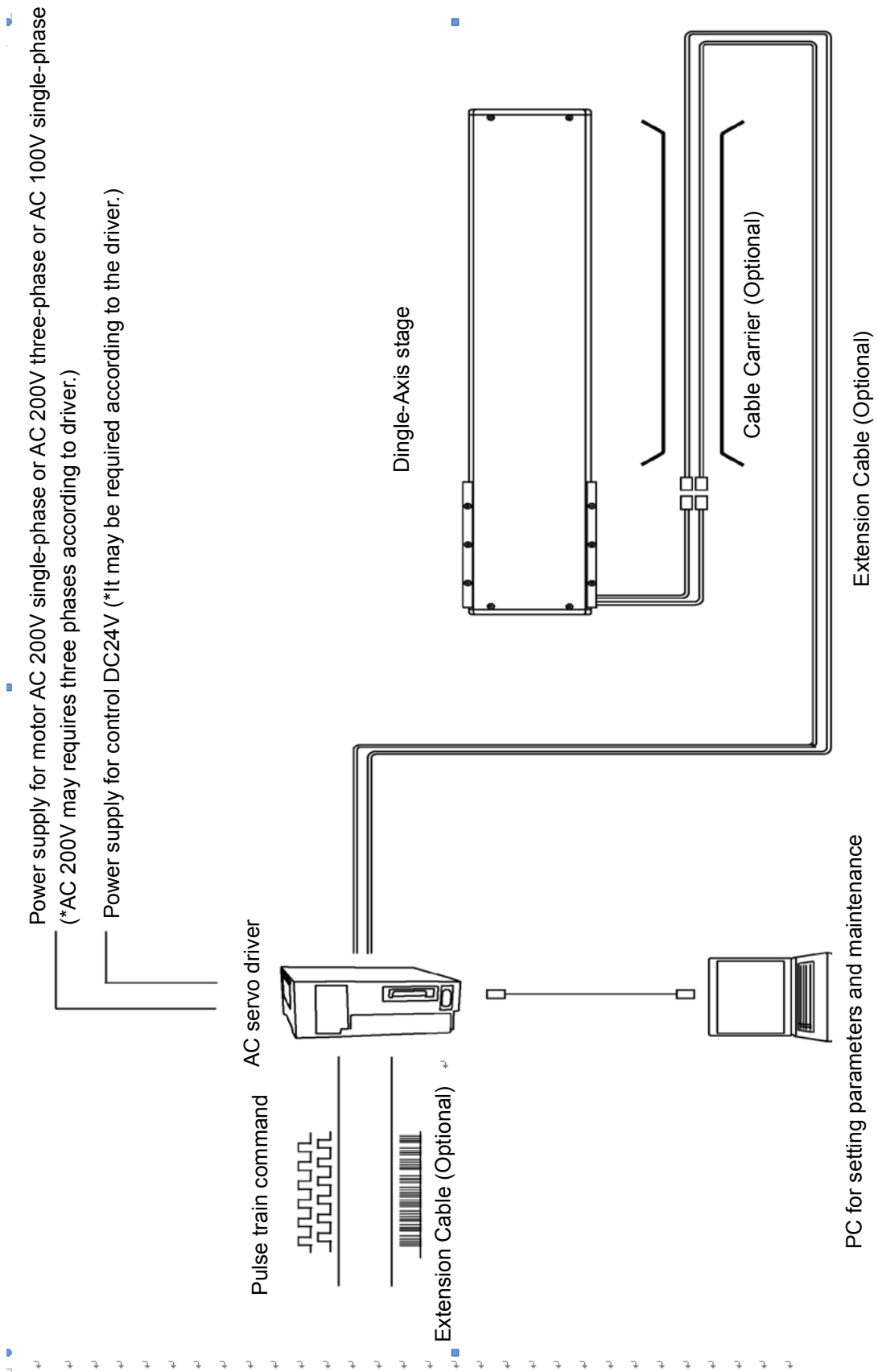
7-1-5. Parallel and vertical angle accuracy with other axis or peripheral equipment

If you use other axis or peripheral equipment in parallel or vertical accurately with this robot, you can use the positioning pins. Press the reference point of robot's bottom face against positioning pins and identify the position of the robot. Follow the length of bolts and torque as described previously and fix them steadily. Prepare positioning pins by yourself.



7-2. Wiring

7-2-1. System connection



7-2-2. Compatible driver

The following shows compatible drivers for each robot.

* To select the driver, please contact our sales representatives.

Stage model	Manufacturer	Compatible driver model	
SLP15	Hitachi Industrial Equipment Systems Co.,Ltd.	ADAX3-R5ML2	AC100V single-phase
		ADAX3-01LL2	AC200V three-phase
	Sanyo Denki Co.,Ltd.	RS1E01LA	AC100V single-phase
		RS1A01LA	AC200V single-phase
	Servoland corporation	SVFM2	AC100V single-phase
		SVFH2	AC200V single-phase
	Nikki Deso Co.,Ltd.	DCC0A1A-201D	AC100V single-phase
		DCC0A2A-401D	AC200V single-phase
	Panasonic Corporation	MADDT1105L01	AC100V single-phase
		MADDT1205L01	AC200V single-phase
SLP25	Hitachi Industrial Equipment Systems Co.,Ltd.	ADAX3-01ML2	AC100V single-phase
		ADAX3-02LL2	AC200V three-phase
	Sanyo Denki Co.,Ltd.	RS1E01LA	AC100V single-phase
		RS1A01LA	AC200V single-phase
	Servoland corporation	SVFM4	AC100V single-phase
		SVFH3	AC200V single-phase
	Nikki Deso Co.,Ltd.	DCC0A1A-201D	AC100V single-phase
		DCC0A2A-401D	AC200V single-phase
	Panasonic Corporation	MADDT1107L01	AC100V single-phase
		MADDT1207L01	AC200V single-phase
SLP35	Hitachi Industrial Equipment Systems Co.,Ltd.	ADAX3-02ML2	AC100V single-phase
		ADAX3-08LL2	AC200V three-phase
	Sanyo Denki Co.,Ltd.	RS1E03LA	AC100V single-phase
		RS1A03LA	AC200V single-phase
	Servoland corporation	SVFM8	AC100V single-phase
		SVFH8	AC200V single-phase
	Nikki Deso Co.,Ltd.	DCC0A1A-201D	AC100V single-phase
		DCC0A2A-401D	AC200V single-phase
		DCC0A2A-801D	AC200V three-phase
	Panasonic Corporation	MCDDT3120L01	AC100V single-phase
MCDDT3520L01		AC200V single/three-phase	

7-2-3. How to wire

Be careful not to wire motor lines and encoder lines incorrectly. Incorrect wiring causes malfunction. If optional motor line and encoder line are not handled, or you do not purchase optional cables, follow the manual of the servo driver connected with this robot and handle them without fail. The malfunction causes by the part that you handled is not included in the warranty. Pin assignment and specifications of the motor lines and encoder lines are as follows.

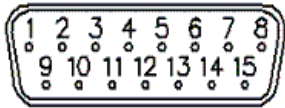
The FG of motor lines of optional cables should be connected with the holes for the ground terminal of slider without fail.

<< Motor line >>

Pin no.	Signal name	Wire color
1	U phase	Red
2	V phase	White
3	W phase	Black

Model	Specification of motor line
SLP15	Hitachi cable, Ltd. UL2464 AWG25, Diameter ϕ 4.3 JST XM connector male
SLP25	Hitachi cable, Ltd. UL2570 AWG18 Diameter ϕ 6.1 JST HL connector male
SLP35	Hitachi cable, Ltd. UL2570 AWG18 Diameter ϕ 6.1 JST HL connector male

<< Encoder line >>



Pin no.	Signal name	Wire color
1	A+	White
2	0V	Black/Red
3	B+	Green
4	5V	Red
7	Z-	Black/Yellow
9	A-	Black/White
11	B-	Black/Green
14	Z+	Yellow

Model	Specification of encoder line
SLP15	Heidenhain Corporation
SLP25	Diameter ϕ 4.3
SLP35	Omron Dsub15 pin connector

Unlisted pin Nos are no connection.

Shield should be moved toward the connector housing.

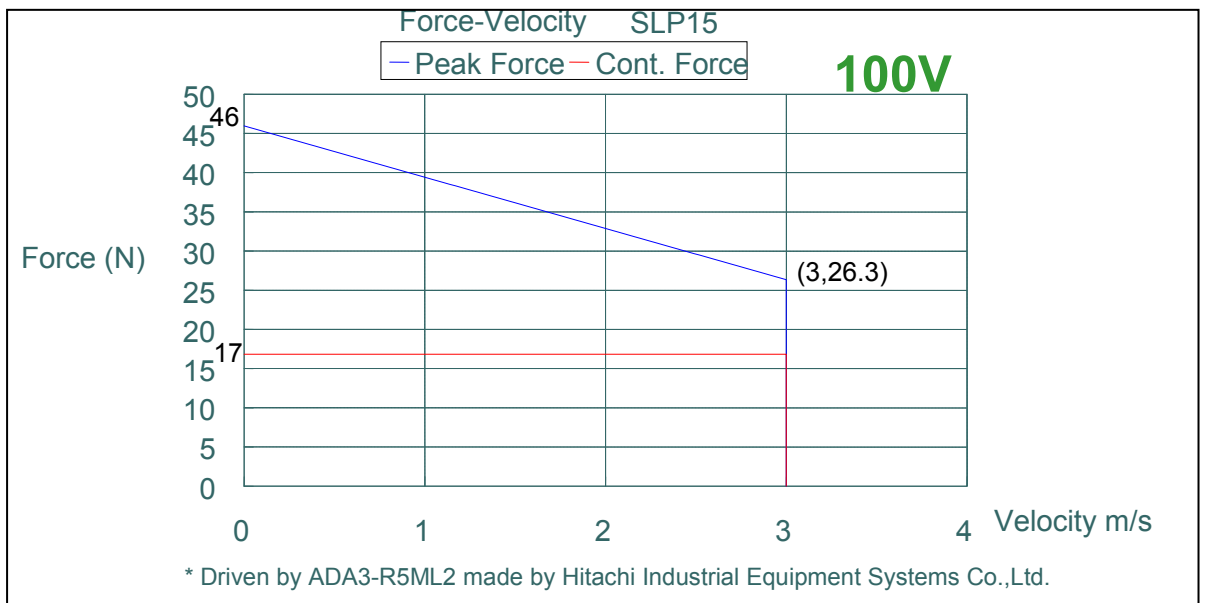
7-3. Operation

7-3-1. Selection criterion

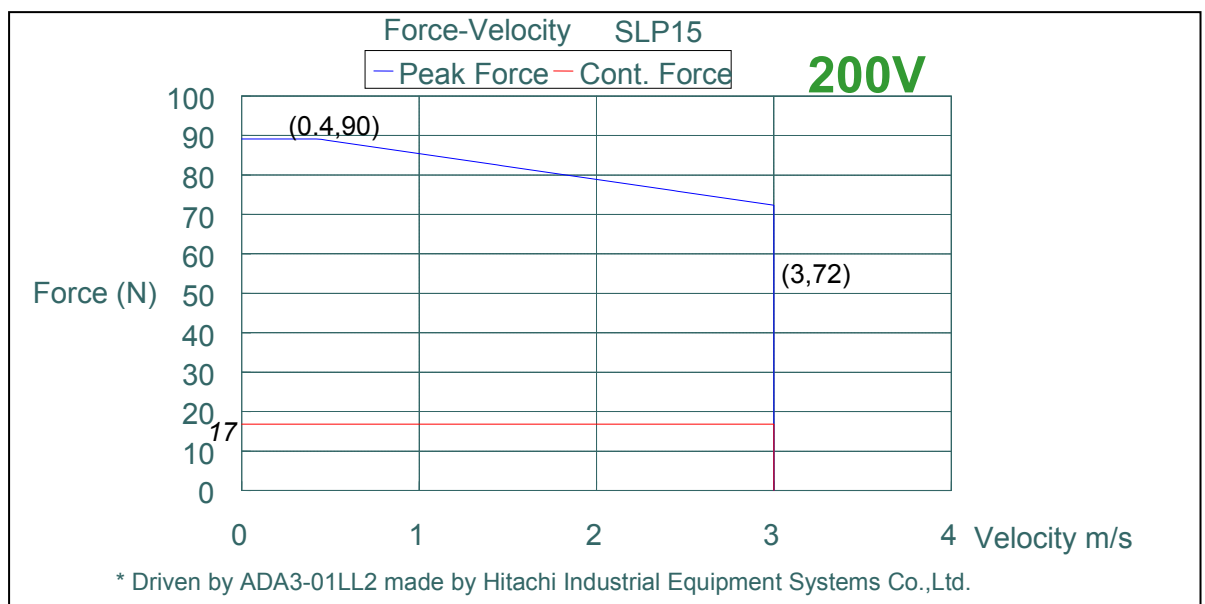
For operation, operation pattern should satisfy the following selection criteria. Before operating the robot, check whether or not the operation pattern satisfies criteria. The following criteria of effective force are that operation temperature is 25°C and the degree of elevation of internal coil is 25°C.

- 1) Necessary maximum force should be 80 % or less of the Peak Force of the robot.
- 2) Effective Force should be 45% or less of the Continuous Force.

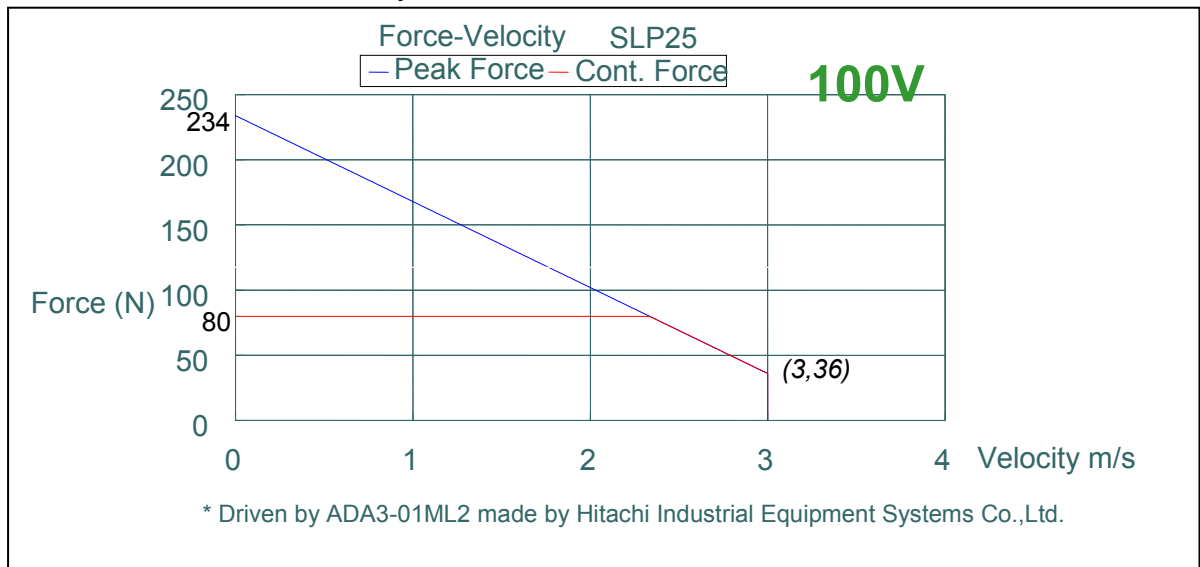
《SLP15 Driver AC100V Force-Velocity curve》



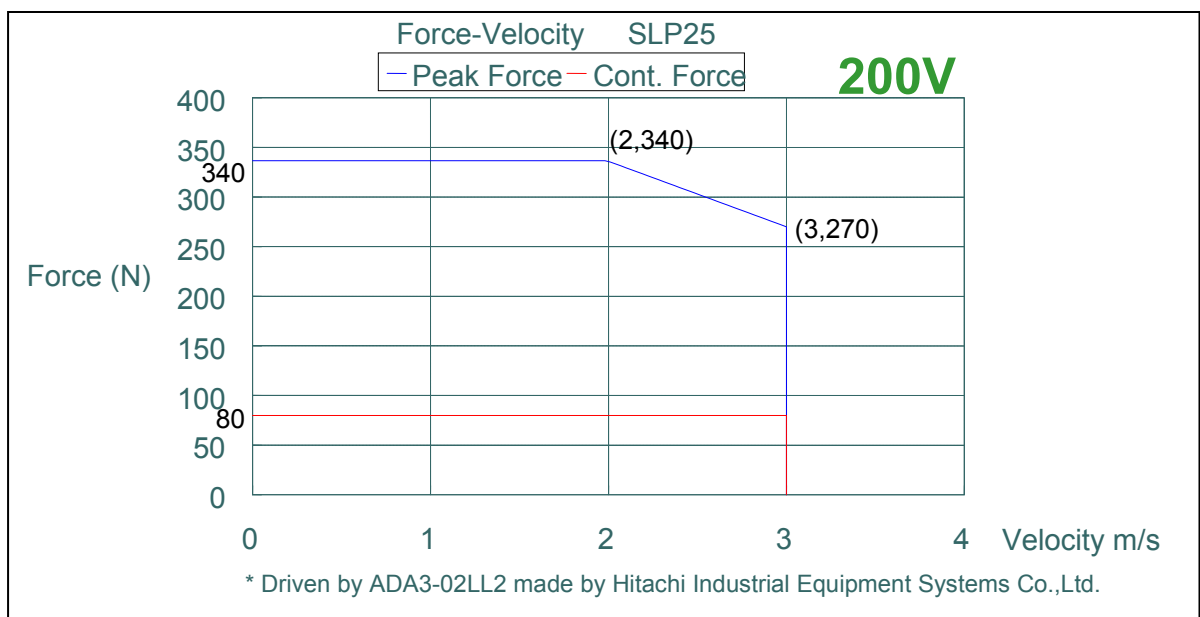
《SLP15 driver AC200V Force-Velocity curve》



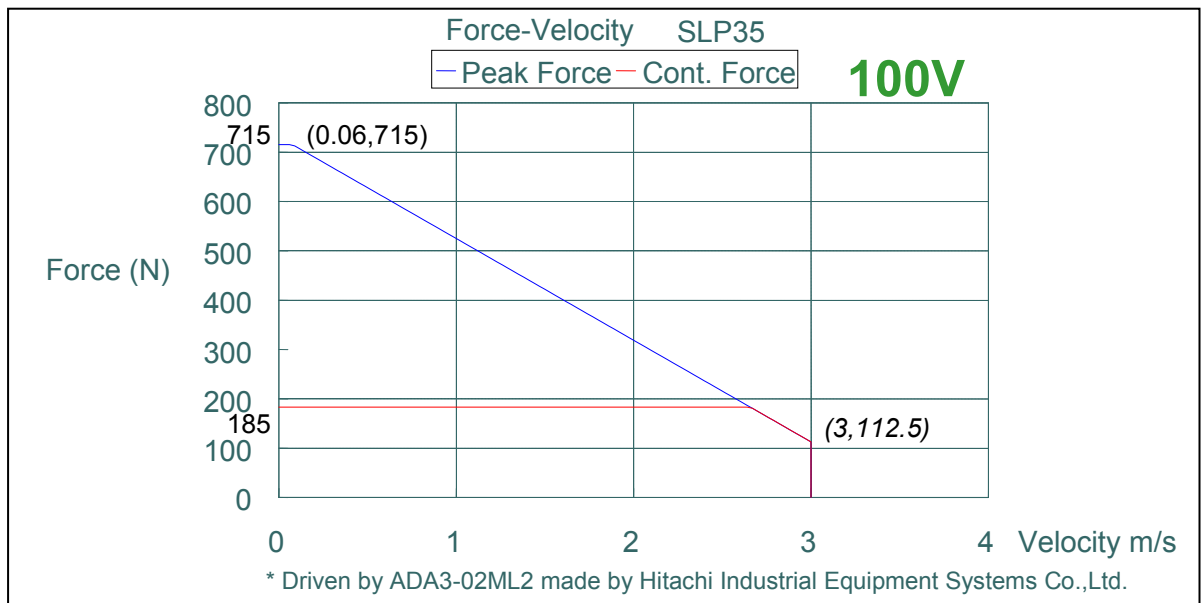
《SLP25 Driver AC100V Force-Velocity curve》



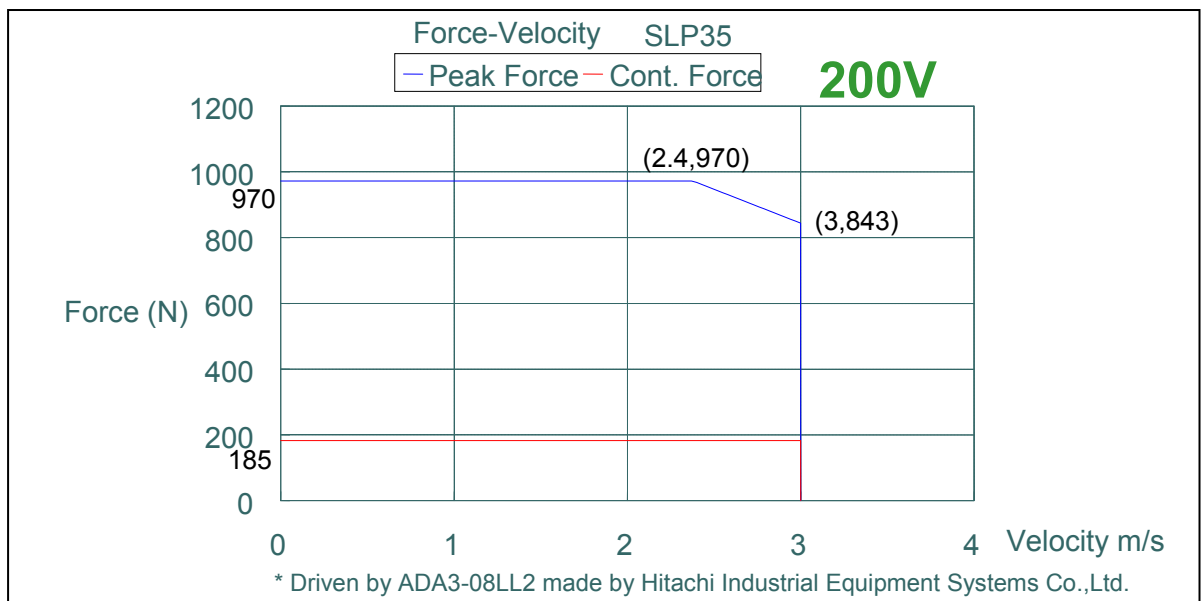
《SLP25 driver AC200V Force-Velocity curve》



《SLP35 Driver AC100V Force-Velocity curve》

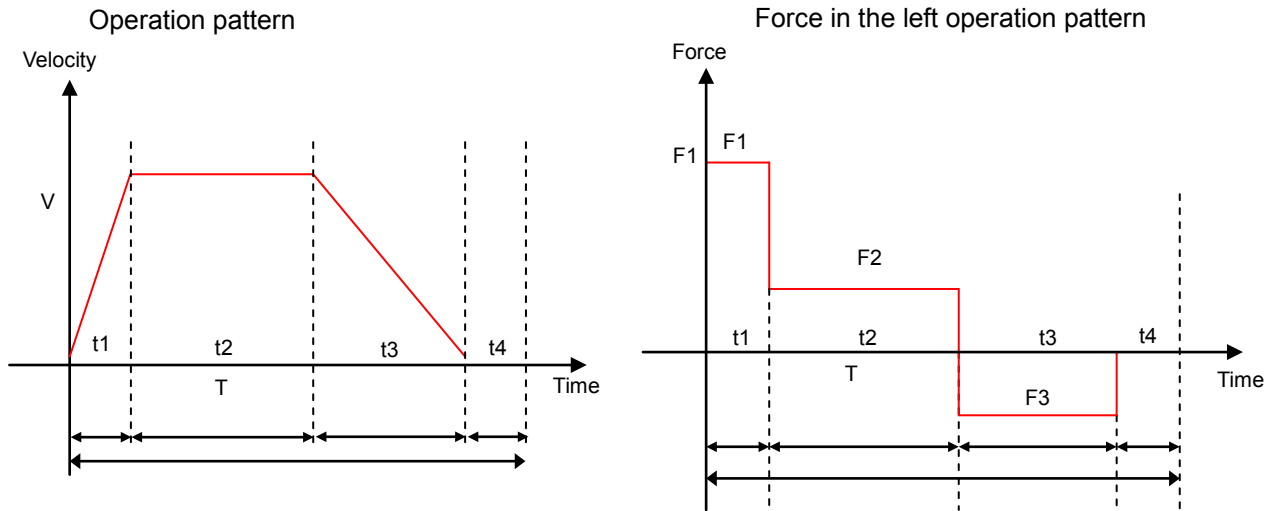


《SLP35 Driver AC200V Force-Velocity curve》



7.3.2 Selection criteria

The followings show an example of selection criteria of the operation pattern.



- T: Operation time per cycle(s)
- t1: Acceleration time t2 : Constant speed time
- t3: Deceleration time t4 : Stopping time
- F1: Force at acceleration F2 : Force at constant speed F3 : Force at deceleration

<< Condition 1. Calculation of necessary maximum force >>

Calculate force at acceleration and deceleration. Larger force of either at acceleration or deceleration is the necessary maximum force. The necessary maximum force should be 80% or less of the peak force. Each force is calculated as follows.

Specifications	Unit	SLP15	SLP25	SLP35
Slider weight	MC(kg)	0.54	3.3	5.0
Number of linear block used	n(piece)	2	4	4
Linear block seal resistance	f(N)	0.2	2.0	2.0

Force at acceleration $F1=(MC+ML) \times V / t1 + Fr$

$Fr=\mu \times (MC+ML) \times G + (f \times n)$

Force at deceleration $F3=(MC+ML) \times V / t3 - Fr$

- MC: Slider weight (kg) ML: Load weight (kg) V: Moving speed (m/s)
- Fr: Travel resistance (N) G: Acceleration of gravity=9.807(m/s²) μ : Friction coefficient=0.01
- f: Linear block seal resistance(N) n: Number of linear block used(piece)

Read out peak force of the robot from force-velocity curve on the previous page. If the necessary maximum force calculated above is 80% or less of the peak force of robot, condition 1 is satisfied.

The necessary maximum force \leq Peak force of robot \times 80%

<< Condition 2 Calculation of effective force >>

Effective force in operation pattern should be 45 % or less of the continuous force of robot.

However, conditions of the effective force are that operational temperature is 25°C and the degree of elevation of internal coil is 25°C.

Force for operation is calculated as follows.

Specification	Unit	SLP15	SLP25	SLP35
Slider weight	MC(kg)	0.54	3.3	5.0
Number of linear block used	n(piece)	2	4	4
Linear block seal resistance	f(N)	0.2	2.0	2.0

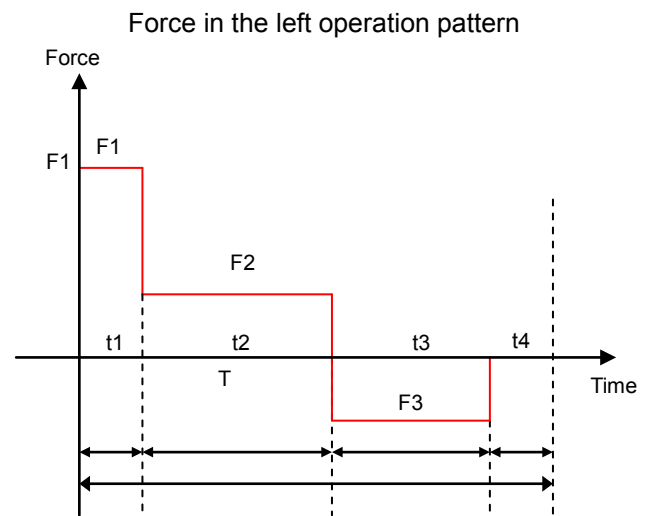
$$\text{Effective force } F_{\text{eff}} = \sqrt{\frac{F1^2 \times t1 + F2^2 \times t2 + F3^2 \times t3}{T}}$$

Force at acceleration $F1 = (MC + ML) \times V / t1 + Fr$
 $Fr = \mu \times (MC + ML) \times G + (f \times n)$

Force at constant speed $F2 = Fr$

Force at deceleration $F3 = (MC + ML) \times V / t3 - Fr$

- MC: Slider weight (kg)
- ML: Load weight (kg)
- V: Moving speed (m/s)
- Fr: Travel resistance(N)
- G: Acceleration of gravity=9.807(m/s²)
- μ: Friction coefficient=0.01
- f: Linear block seal resistance(N)
- n: Number of linear block used (peace)



Read out peak force of the robot from force-velocity curve on the previous page. If the necessary maximum force calculated above is 80% or less of the peak force of robot, condition 2 is satisfied.

$$\text{Effective force} \leq \text{Continuous force} \times 45\%$$

8. Maintenance and inspection**8-1. Items to be inspected and inspection interval**

Please maintain and inspect the robot in the following interval regarding the following items.

The following inspection interval is based on eight hours operating per day.

Please adjust the interval according to your operating time per day.

Item	Inspection period			
	Before operation	after one month	after half year	after one year
Check loosening of bolt, etc. for installing	•	•	•	•
Check cable for damages	•	•	•	•
Check cable carrier for damages and loosening	•	•	•	•
Check connection of connector	•	•	•	•
Check grease in linear guide				•
Check abnormal noise and vibration	•	•	•	•

* Regarding Grease up linear guide, please contact our representatives.

CAUTION

The descriptions in this manual may be changed without prior notice to improve performance or quality.

***NPM* Nippon Pulse Motor Co., Ltd.**

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Issued in April 2011