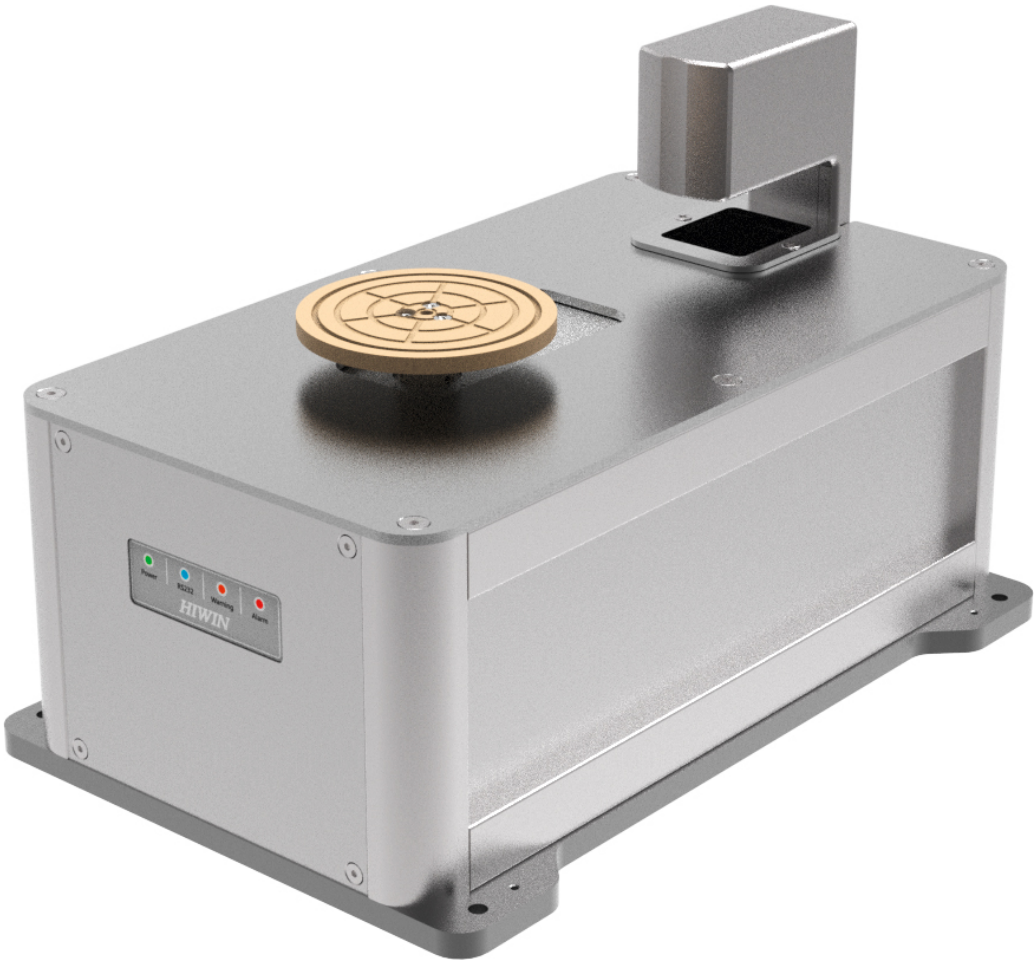
HIWIN®



C29UE004-2308

Assembly Instructions

Wafer Aligner

HPA-01-0-EN-2312-MA

Imprint

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Contents

1 Safety (please read before use)

1.1 Safety-related descriptions

⚠ **Danger!** Imminent danger!

There is an imminent danger that may lead to severe injuries if not avoided.

⚠ **Warning**! Potentially dangerous situation!

Incorrect operation may result in severe personal injury.

⚠ **Caution!** Potentially dangerous situation!

IncorrectIncorrect may result in personal injury or property damage.

The precautions below allow you to use the product safely and correctly to avoid causing danger to yourself or others. Please comply with international specifications (ISO/IEC). Note 1: Japanese industrial specifications (JIS)
Note 2: Other safety regulations
Note 3: Common compliance

Note 1

EN ISO12100: Safety of machinery – General principles for design – Risk assessment and risk reduction.

EN 60204-1: Safety of machinery – Electrical equipment of machines
Part1: General requirements.

Note 2

JIS B 9960-1 Safety of machinery – Electrical equipment of machines – Part 1: General requirements.

JIS B 8433-1 Robots and robotic devices –Safety requirements for industrial robots – Part 1: Robots

(Safety of machinery – Electrical equipment of machines – Part 1: General requirements)

Note 3

Please comply with the following most current standards:

EN 61000-6-2: Generic standards – Immunity for industrial environments.

EN 61000-6-4: Generic standards – Emission standard for industrial environments.

Restriction of Hazardous Substances Directive (RoHS): 2011/65/EU + (EU)/2015/863.

Labor safety and health regulations.

SEMI S2 Environmental, Health, and Safety Guideline for Semiconductor Manufacturing Equipment

- Please have the system designer or someone with sufficient knowledge and experience select the product specifications. Read the user manual carefully and complete relevant safety education training before operating this product.
- The dangers, warnings and cautions contained in this section do not cover all situations. Make sure to comply with the specifications and safety regulations mentioned above.
- No further notice will be given for any changes made to the contents of this manual.

⚠ **Danger!** Imminent danger!

There is an imminent danger that may lead to severe injuries if not avoided.

- Do not use this product outside the specification range. Avoid product malfunctions and damages which can result in a reduction in the usage life.
- When there are system abnormalities such as power outages and stops, please design safety circuit equipment to prevent any dangers and damages from occurring.
- Do not use this product in environments with flammable or explosive gases to prevent the risk of explosions or fires.
- Please confirm that the equipment surface of the machine where the aligner will be installed is grounded.
- When wiring the product, please refer to the manual. When plugging in and unplugging cables or connecting terminals, please do so quickly and properly; hot swapping is prohibited.
- Do not use this product in environments where water and oil might drip onto the product. Avoid electrical shocks and fires.
- Confirm the safety of the range of motion of this product before supplying power to or moving this product, and strictly follow the safety measures of the system when performing adjustments after installing the system.
- Do not disassemble, repair or modify this product, and avoid personal accidents, electric shocks, fires, malfunctions and damages.

⚠ **Warning**! Potentially dangerous situation!

Incorrect operation may result in severe personal injury.

- Do not expose the product directly to radiant heat sources, and use it at an ambient temperature between 5–40°C.
- Please use the product in environments with an ambient humidity of 30–65% without condensation.
- Please use the product at an altitude of under 1000 meters.
- Please use the product in environments with light intensity of greater than 500 lux and stable light to avoid impairment of the measuring accuracy of the laser sensor.
- Do not use this product at locations with corrosive gas or corrosive chemical solutions to prevent rust, corrosion and other deterioration.
- Do not use this product at locations with strong impacts or vibrations.
- Do not use this product at locations with strong electromagnetic waves, strong currents, or interference due to static electricity to prevent product malfunction.
- Please use suitable bolt-locking torque to fix the product in place.
- Do not get close to or touch the product while it is moving to prevent your fingers from getting clamped or stuck in the device.
- When personnel accidentally get stuck in the device, please disconnect the power immediately or press the stop button of the external safety circuit device, and then adjust the transmission mechanism manually after confirming that power is disconnected to free personnel.
- Do not touch the power connection terminal to prevent electric shocks.
- If there is a power outage during operation, please disconnect the power immediately to prevent sudden movements after power is restored, which can result in damage to the mechanical device or personal accidents.
- If the product heats up abnormally, smokes, releases strange odours or continuously makes strange sounds, please disconnect the power immediately to prevent product damages or fires.
- When the product is moving, do not apply any external force to the product.
- The product includes the CCD light penetration mapping sensor. Please note the following during use:

The product uses the semiconductor laser as the light source.

⚠ **Warning**! Potentially dangerous situation!

Incorrect operation may result in severe personal injury.

- Use of controls, adjustments, or procedures that differ from those specified here may result in exposure to harmful radiation.
- Follow the instructions in this manual. If they are not followed, people may be harmed (eyes and skin).

Precautions for type 1 laser product

- Do not disassemble this product. Laser emission will not stop automatically when the product is disassembled.
- Do not look directly at the beam.

⚠ **Caution!**

- This product employs a semiconductor laser for its light source.
- Use of controls, adjustments or procedures that differ from those specified here may result in exposure to harmful radiation.
- Follow the instructionsin this manual. If they are not followed, people may be harmed (eyes and skin).

Precautions for class 1 laser products

- Do not disassemble this product. Laser emission from this product is not automatically stopped when it is disassembled.
- Do not stare into the beam.

Sensor head	IG-010-028
Wavelength	660 nm
OUTPUT	62 μW
Pulse width	48 μs
FDA (CDRH) Part1040.10*	Type 1 Laser Product
IEC60825-1	Type 1 Laser Product

This classification is based on the IEC 60825-1 standard, which meets the requirements of FDA (CDRH) Laser Notice No. 50.

⚠ **Caution!** Potentially dangerous situation!

Incorrect operation may result in personal injury or property damage.

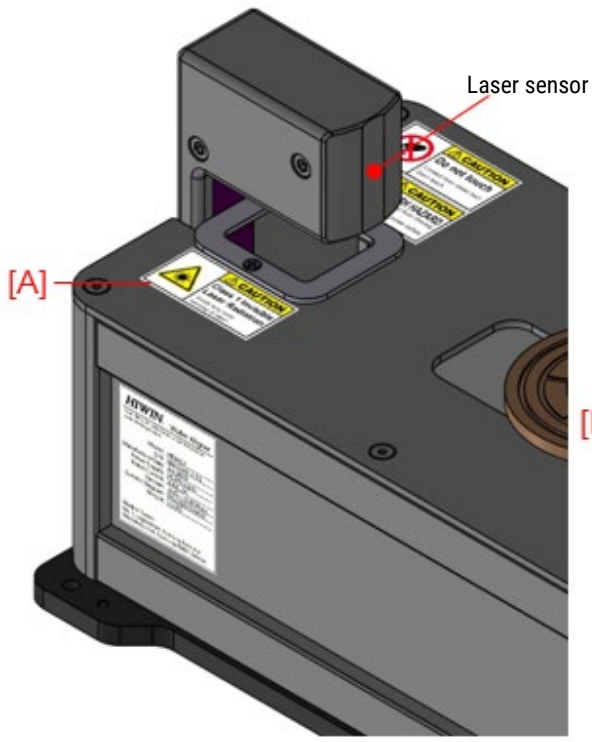
- Do not hold movable parts or cables with your hands to prevent product damage when installing the product.
- Do not place your fingers or any external objects into any opening parts of the product to prevent electrical shock, personal accidents and fires.
- When using the product, make sure that the lens of the laser sensor is clean, and keep the surface of the lens free of dirt and dust from fingerprints so as not to affect the function of the product.
- The motor will generate heat while running, causing the temperature of the product surface to increase. Please prevent negative effects on surrounding work objects.
- Cables and air pipes of the product must not be damaged; please perform regular inspections on a monthly basis. If the cables are damaged, bent excessively, tugged, curled or clamped, the product may malfunction and fire may occur due to factors such as power leakage or poor contact.
- Please make sure there is sufficient space for maintenance and inspections, and perform regular maintenance.
- When using the product, the maximum energy consumption is 48 W.
- Please wear safety shoes or related protective gear when using the product.

- Please handle the product according to local waste disposable regulations when it cannot be used or discarded.
- The actual noise measurement result of the product is <70 dB. (Condition: 1 meter away from the product, 1.6 meters above ground level, and operated at 80% of the maximum speed.) If the noise exceeds 80 dB (A) while operating, personal protective devices must be worn.

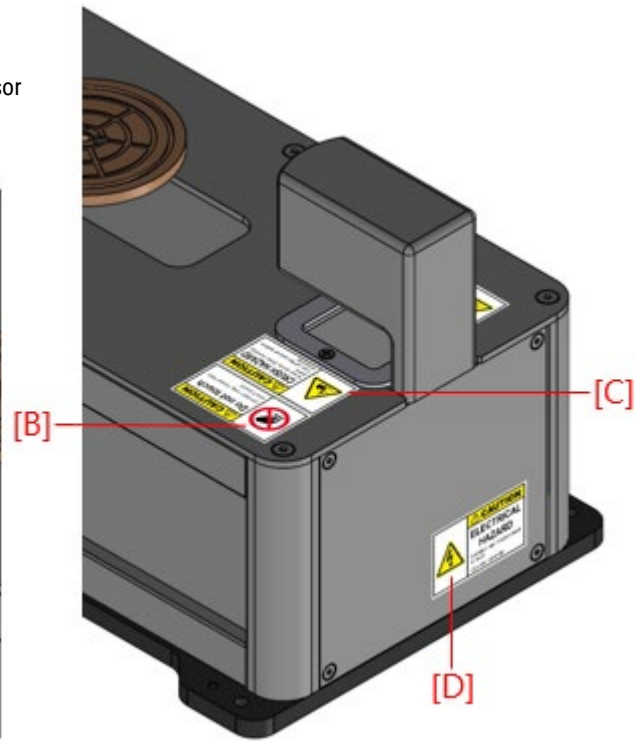
1.2 Location and descriptions of warning signs

Warning signs	Caution
	Electrical hazard Contact may cause shock or burns.
	Crush hazard Contact may cause crushing injuries.
	Do not touch Contact may cause harm.
	Class 1 invisible laser radiation Avoid prolonged viewing of the laser.

- Take HPA812 as an example:



Front view of the product (status indicator location)

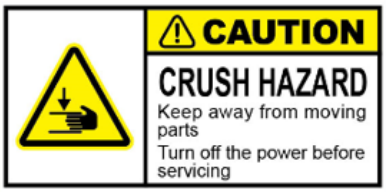


Rear view of the product (warning label location)

Descriptions of warning label icons

Warning sign A

Warning sign B



Warning sign C

Warning sign D

Item	Injury description
A	Eye injury
B	Do not touch (laser hazard)
C	Risk of pinching
D	Beware of electric shock

1.3 Warranty

The warranty period of this product is 12 months; the warranty does not cover any malfunctions caused by any of the following:

- Operating methods, operating environments and storage specifications defined in the product manual exceeded.
- After installation is completed by professional installers, damages caused by change of installation location or usage environment, or improper transport method for any reason.
- Collisions and accidents resulting in product damages due to improper operation or installation.

The following situations are not covered by the warranty:

- Products with product numbers or manufacture dates (month and year) that cannot be verified.
- Use of products and components other than genuine HIWIN products.
- Arbitrary addition or removal of any product component.
- Arbitrary modification of the lines or cables of the product.
- Any modifications to the product appearance and arbitrary removal of product components, for example, removing the sensor component or drilling and cutting the product, etc.
- Any damages caused by natural disasters, such as: fire, earthquake, tsunami, lightning, wind and flooding, etc.
- If product was damaged due to any of the situations described above, HIWIN will not provide any warranty or compensation unless the user's analysis can prove that it was caused by product defects.

For detailed information concerning the warranty and terms, please contact your purchasing dealer or technical staff.

2 Machine overview

2.1 Machine description

- The HPA series is a wafer aligner controlled by three axes. The entire series uses the micro single-axis robot module from HIWIN to to take advantage of its high speed, high precision, high rigidity, high efficiency and compact size.
- The embedded controller design (all-in-one design) makes an additional controller and wiring space unnecessary. The product size is the smallest in the industry among products with similar specifications and conditions.
- It is equipped with a smart light-transmitting laser sensor that can support the profile detection function of transparent, translucent and opaque objects. It can be used for wafers and glass with a minimum diameter of 2 inches to a maximum of 12 inches.
- The cleanliness level of the product is ISO Class 3 (Class 1), and its areas of application include semiconductors, optoelectronics and other industries.
- It can complete two-stage wafer alignments and correct wafer centre points, meaning centring is possible with a repeat accuracy of ±0.1 mm within 5.9 seconds for the HPA series, within 6.9 seconds for the HPA-W series, and within 10.9 seconds for the HPA-W series.
- Complies with related safety specifications and directives. The device achieves the cat.0 stop function and is recommended for use with the safety circuit of the system integrator, it performs real-time monitoring of various functions such as the motor drive control system, sensing system, vacuum system and cycle system, providing users with the most comprehensive and reliable protection.
- Stop function: power input cut-off through the external stop circuit.
- User-friendly design; status indicators are provided on the exterior of the product to display the usage status of the product in real time. There are also groove designs on the two sides of the product to make holding and transporting the product easier and more secure.
- To ensure that the entire life cycle of the product complies with environmental protection objectives, the entire series of products has been designed in accordance with European environmental protection directives (RoHS2), uses grease with the lowest water pollution level (WGK1), and is delivered in environmentally friendly packaging materials (NBSK).

2.2 Key machine specifications

Table 2.1: HPA product specification

Item		Specifications		
Model		2-inch, 3-inch, 4-inch 5-inch and 6-inch shared type	4-inch, 5-inch, 6-inch and 8-inch shared type	8-inch and 12-inch shared type
Model number		HPA26	HPA48	HPA812
Wafer size		2”, 3”, 4”, 5”, 6”	4”, 5”, 6”, 8”	8”, 12”
Wafer material		Transparent, translucent, opaque (*Note 1)		
Wafer features		Flat/Notch (SEMI Standard)		
Wafer thickness		0.4–0.8 mm (*Note 2)		
Wafer warped		< ± 0.1 mm (*Note 2)		
Number of motion axes		3-axis (X, Y, θ)		
Wafer handling method		Vacuum suction (Chuck)		
Motion range	X	56 mm	63 mm	70 mm
	Y	±10 mm		
	θ	Continuous		
Allowable wafer offset (*Note 3)		2 inch: R4 mm 3 inch: R4 mm 4 inch: R4 mm 5 inch: R4 mm 6 inch: R4 mm	4 inch: R5 mm 5 inch: R8 mm 6 inch: R8 mm 8 inch: R10mm	8 inch: R10 mm 12 inch: R10 mm
Accuracy (*Note 4)	Centring	< ± 0.1 mm		
	Notch angle	< ± 0.2°		
Resolution	X	0.0003 mm		
	Y	0.0003 mm		
	Θ	0.009°		
Alignment time [Note 5]		<5.9 s		
Communication protocol		RS232 (*Note 6)		
Power	Voltage	VDC 24 ± 10%		
	Current	Max. 2A		
Safety circuit		The stop activates after disconnection (*Note 7)		
Vacuum	Pipe diameter	Ø 4 mm		
	Pressure	-0.05 – -0.08 MPa		
	Flow	10 L/min (ANR)		
Cleanliness		Class 1		
Ambient temperature		5–40 °C		
Ambient humidity		30–65% (No condensation)		
Weight		6 kg	5.8 kg	5.5 kg
Size		L288 x W190 x H276 mm^3	L288 x W190 x H206 mm^3	L288 x W190 x H186 mm^3

Note 1

Applicable to materials such as silicon wafers, substrate and glass.

Note 2

Please contact the original manufacturer for any other special application needs.

Note 3

The allowable wafer offset means that the wafer centre must be within a radius range of max. R 10 mm (depends on wafer size) with the chunk as the centre.

Note 4

The repeat accuracy is based on aligning the edge of the dummy wafer 30 times and taking notch feature coordinates for statistical analysis, and defines the repeat accuracy of the wafer centre and the notch angle (RP=Ave+3σ).

Note 5

This calculates the single run time of the shortest path between the starting position and corrected position of the notch or flat; the calculation period of this time is from when the motor starts until when the motor stops operating, not including the handling time for the user to send and receive the command.

Note 6

The connector type of the RS232 cable is a DB9-F connector on both ends with a cable length of 3 metres.

Note 7

This is a wet contact that can be directly connected to the stop button on its own. If a serial device has to be connected, the dry contact must be used for switching. If a stop circuit is required, it must be disconnected from the power supply. When the system component activates the stop function, the product will stop immediately.

- HPA-W series (warped wafer):

Item		Specifications	
Model		4-inch, 5-inch, 6-inch and 8-inch shared type	8-inch and 12-inch shared type
Model number		HPA48-W	HPA812-W
Wafer size		4”, 5”, 6”, 8”	8”, 12”
Wafer material		Transparent, translucent, opaque (*Note 1)	
Wafer features		Flat/Notch (SEMI Standard)	
Wafer thickness		0.4–0.8 mm (*Note 2)]	
Wafer warped		< ± 1.5 mm (difference of height <3 mm) (*Note 2)	
Number of motion axes		3-axis (X, Y, θ)	
Wafer handling method		Vacuum suction (chuck)	
Motion range	X	63 mm	70 mm
	Y	±10 mm	
	θ	Continuous	
Allowable wafer offset (*Note 3)		R5 mm	R10 mm
Accuracy (*Note 4)	Centring	< ± 0.1 mm	
	Notch angle	< ± 0.2°	
Resolution	X	0.0003 mm	
	Y	0.0003 mm	
	θ	0.009°	
Alignment time (*Note 5)		< 6.9 s	
Communication method		RS232 (*Note 6)	
Power	Voltage	VDC 24 ± 10%	
	Current	Max. 2A	
Safety circuit		The stop activates after disconnection (*Note 7)	
Vacuum	Pipe diameter	Ø 4 mm	
	Pressure	-0-05 – -0.08 MPa	
	Flow	10 L/min (ANR)	
Cleanliness		Class 1	
Ambient temperature		5–40°C	
Ambient humidity		30–65% (no condensation)	
Weight		6.3 kg	6 kg
Size		L288 x W190 x H218 mm^3	L288 x W190 x H198 mm^3

Note 1

Applicable to materials such as silicon wafers, substrate and glass.

Note 2

Please contact the original manufacturer for any other special application needs.

Note 3

The allowable wafer offset means that the wafer centre must be within a radius range of max. R 10 mm (depends on wafer size) with the chunk as the centre.

Note 4

The repeat accuracy is based on aligning the edge of the dummy wafer 30 times and taking notch feature coordinates for statistical analysis, and defines the repeat accuracy of the wafer centre and the notch angle (RP=Ave+3σ).

Note 5

This calculates the single run time of the shortest path between the starting position and corrected position of the notch or flat; the calculation period of this time is from when the motor starts until when the motor stops operating, not including the handling time for the user to send and receive instructions.

Note 6

The connector type of the RS232 cable is a DB9-F connector on both ends with a cable length of 3 metres.

Note 7

This is a wet contact that can be directly connected to the stop button on its own. If a serial device has to be connected, the dry contact must be used for switching. If a stop circuit is required, it must be disconnected from the power supply. When the system component activates the stop function, the product will stop immediately.

- HPA-E series (edge handling):

Item		Specifications	
Model		8-inch	12-inch
Model number		HPA8-E	HPA12-E
Wafer size		8”	12”
Wafer material		Transparent, translucent, opaque (*Note 1)	
Wafer features		Notch (SEMI Standard)	
Wafer thickness		0.4–0.8 mm (*Note 2)	
Wafer warped		< ± 0.1 mm (*Note 2)	
Number of motion axes		3-axis (X, Y, θ)	
Wafer handling method		Edge contact with 1mm spot width	
Motion range	X	8 mm	8 mm
	Y	15.5 mm	
	θ	Continuous	
Allowable wafer offset (*Note 3)		R4 mm	R4 mm
Accuracy (*Note 4)	Centring	< ± 0.1 mm	
	Notch angle	< ± 0.2°	
Resolution	X	0.0003 mm	
	Y	0.0003 mm	
	θ	0.009°	
Alignment time (*Note 5)		< 10.9 s	
Communication method		RS232 (*Note 6)	
Power	Voltage	VDC 24 ± 10%	
	Current	Max. 2A	
Safety circuit		The stop activates after disconnection (*Note 7)	
Cleanliness		Class 1	
Ambient temperature		5–40°C	
Ambient humidity		30–65% (no condensation)	
Weight		6.3 kg	6.4 kg
Size		L295.1 x W210 x H255 mm^3	L345.1 x W310 x H255 mm^3

Note 1

Applicable to materials such as silicon wafers, substrate and glass.

Note 2

Please contact the original manufacturer for any other special application needs.

Note 3

The allowable wafer offset means that the wafer centre must be within a radius range of max. R 10 mm (depends on wafer size) with the chunk as the centre.

Note 4

The repeat accuracy is based on aligning the edge of the dummy wafer 30 times and taking notch feature coordinates for statistical analysis, and defines the repeat accuracy of the wafer centre and the notch angle (RP=Ave+3σ).

Note 5

This calculates the single run time of the shortest path between the starting position and corrected position of the notch or flat; the calculation period of this time is from when the motor starts until when the motor stops operating, not including the handling time for the user to send and receive instructions.

Note 6

The connector type of the RS232 cable is a DB9-F connector on both ends with a cable length of 3 metres.

Note 7

This is a wet contact that can be directly connected to the stop button on its own. If a serial device has to be connected, the dry contact must be used for switching. If a stop circuit is required, it must be disconnected from the power supply. When the system component activates the stop function, the product will stop immediately.

- HPA-S series (stand-alone):

Item		Specifications
Model		8-inch, 6-inch and 12-inch
Model number		HPA612-S
Wafer size		6”, 8”, 12”
Wafer material		Transparent, translucent, opaque (*Note 1)
Wafer features		Notch (SEMI Standard)
Wafer thickness		0.4–0.8 mm (*Note 2)
Wafer warped		< ± 0.1 mm (*Note 2)
Number of motion axes		3-axis (X, Y, θ)
Wafer handling method		Vacuum suction (Chuck)
Motion range	X	75 mm
	Y	15.5 mm
	θ	Continuous
Allowable wafer offset (*Note 3)		R4 mm
Accuracy (*Note 4)	Centring	< ± 0.1 mm
	Notch angle	< ± 0.2°
Resolution	X	0.0003 mm
	Y	0.0003 mm
	θ	0.009°
Alignment time (*Note 5)		< 10.9 s
Communication method		RS232 (*Note 6)
Power	Voltage	VDC 24 ± 10%
	Current	Max. 2A
Safety circuit		The stop activates after disconnection (*Note 7)
Vacuum	Pipe diameter	Ø 4 mm
	Pressure	-0.05 – -0.08 MPa
	Flow	Ø 4 mm
Cleanliness		ISO Class 3 (ISO 14644)
Ambient temperature		5–40°C
Ambient humidity		30–65% (no condensation)

Note 1

Applicable to materials such as silicon wafers, substrate and glass.

Note 2

Please contact the original manufacturer for any other special application needs.

Note 3

The allowable wafer offset means that the wafer centre must be within a radius range of max. R 10 mm (depends on wafer size) with the chunk as the centre.

Note 4

The repeat accuracy is based on aligning the edge of the dummy wafer 30 times and taking notch feature coordinates for statistical analysis, and defines the repeat accuracy of the wafer centre and the notch angle (RP=Ave+3σ).

Note 5

This calculates the single run time of the shortest path between the starting position and corrected position of the notch or flat; the calculation period of this time is from when the motor starts until when the motor stops operating, not including the handling time for the user to send and receive instructions.

Note 6

The connector type of the RS232 cable is a DB9-F connector on both ends with a cable length of 3 metres.

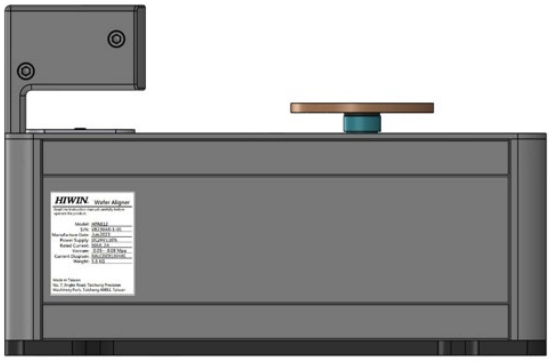
Note 7

This is a wet contact that can be directly connected to the stop button on its own. If a serial device has to be connected, the dry contact must be used for switching. If a stop circuit is required, it must be disconnected from the power supply. When the system component activates the stop function, the product will stop immediately.

2.3 Standard shipping contents

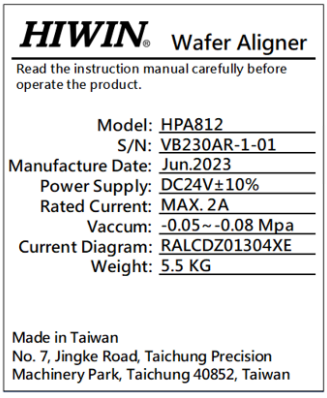
- Wafer aligner unit: A total of 1 unit
  - Power and stop connector: A total of 1 unit
    (Pin definitions: 24V, 0V, STOP+, STOP-)
  - RS232 cable: A total of 1 cable
    (DB9-F connector on both ends, dual magnetic clasps, cable length 3 meters)
- Anti-static rubber washers (rear glue included): eight pieces in total (HPA-E type only).

Location of product serial number label



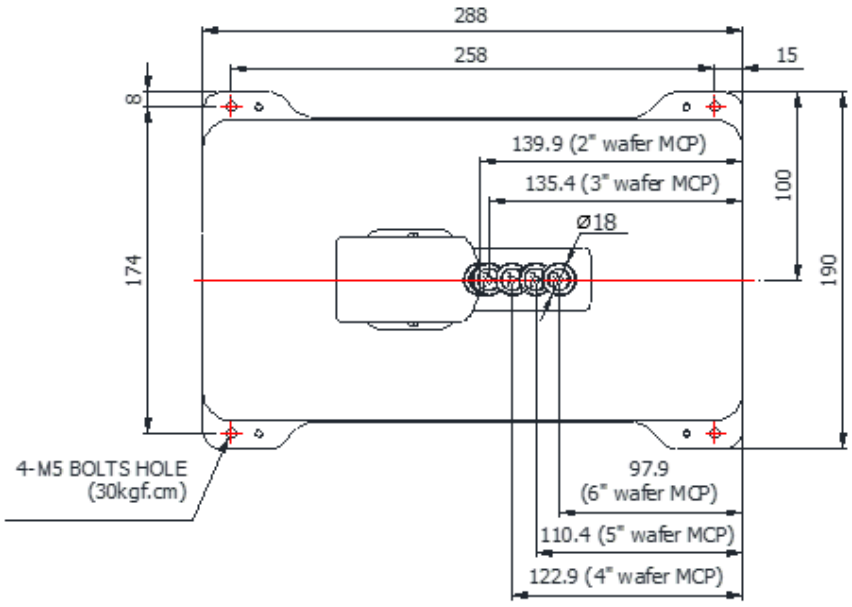
- The data on the type plate must match the machine data on the Declaration of Incorporation

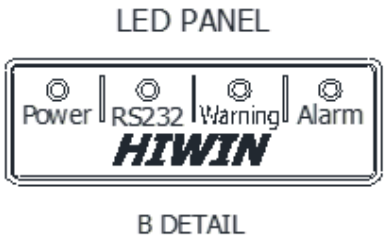
Product serial number label

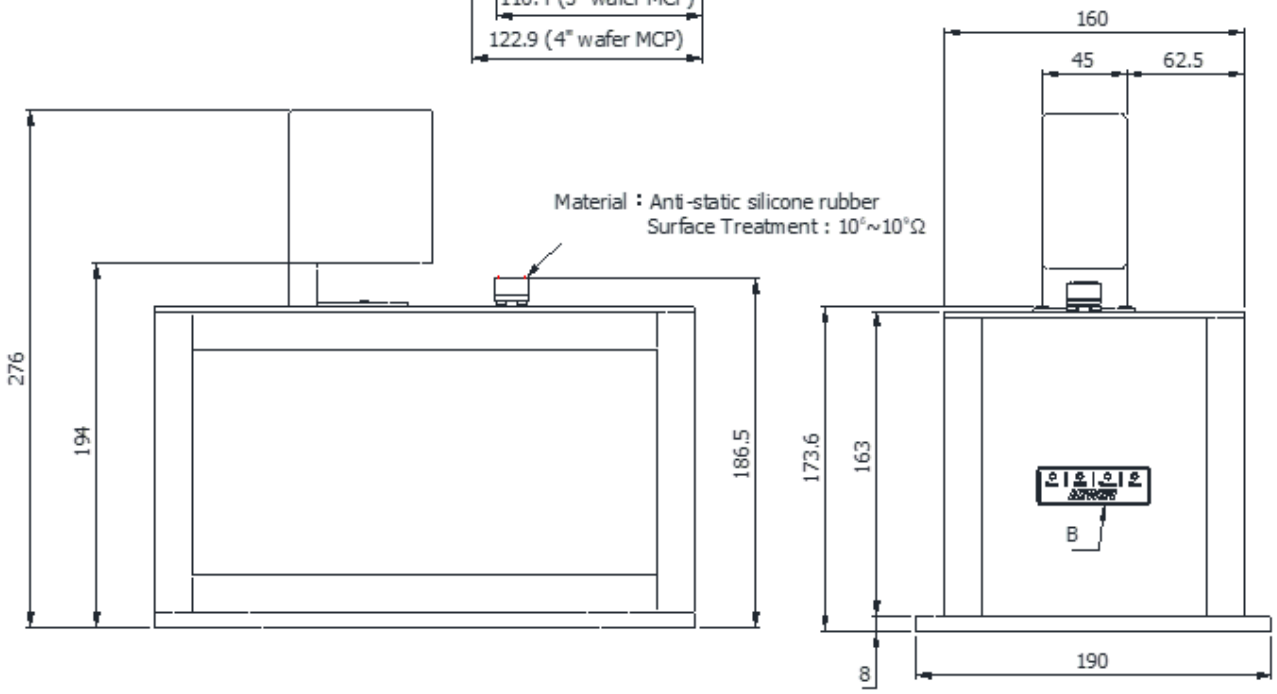


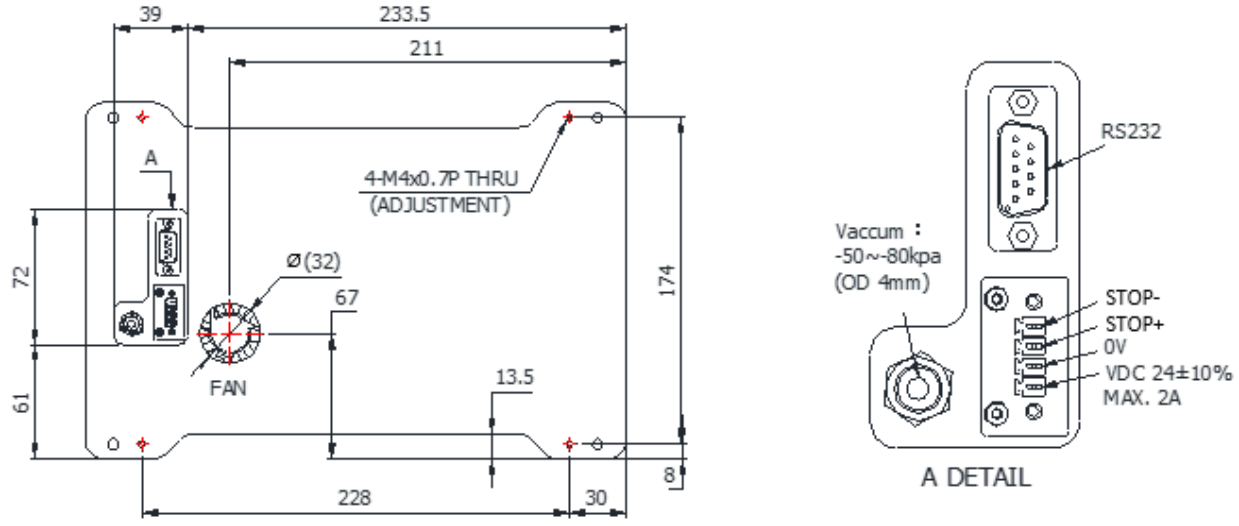
2.4 Product dimensions

- HPA26 (2”, 3”, 100 mm, 125 mm, 150 mm)

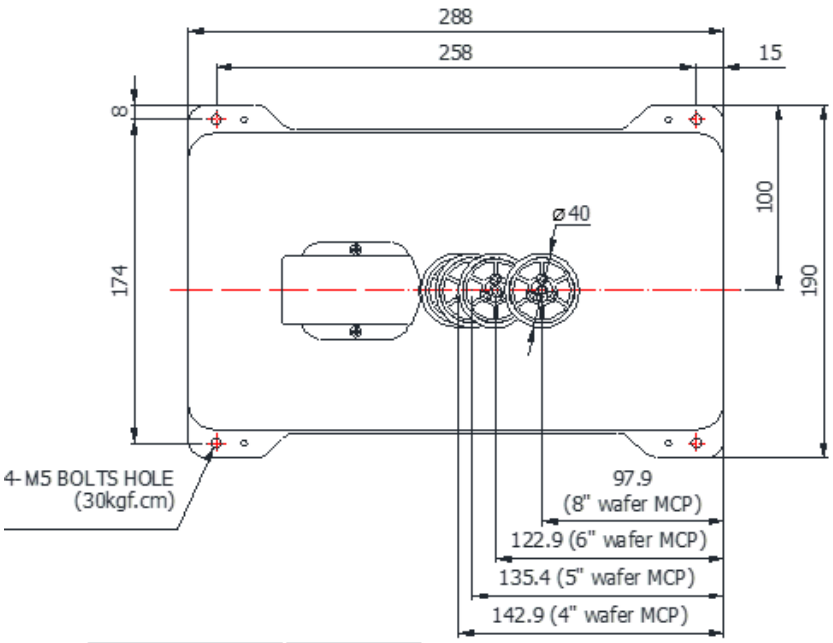


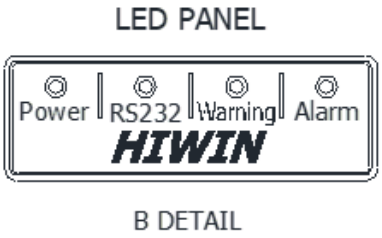


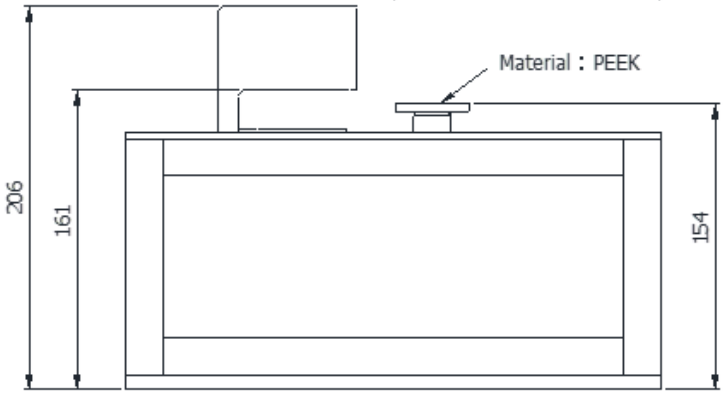


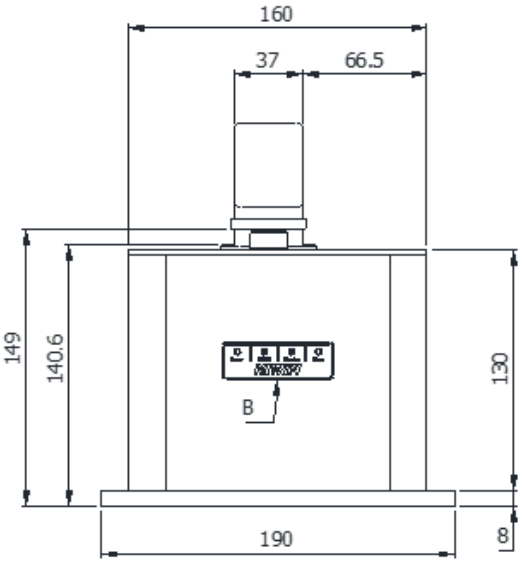


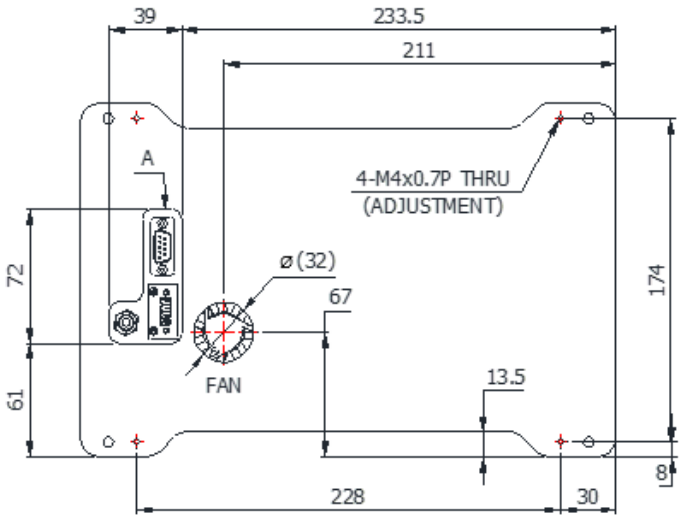
- HPA48 (100 mm, 125 mm, 150 mm, 200 mm)

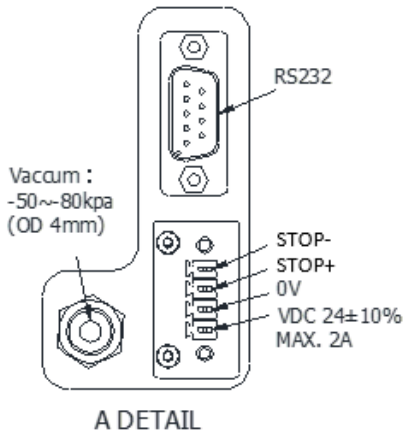




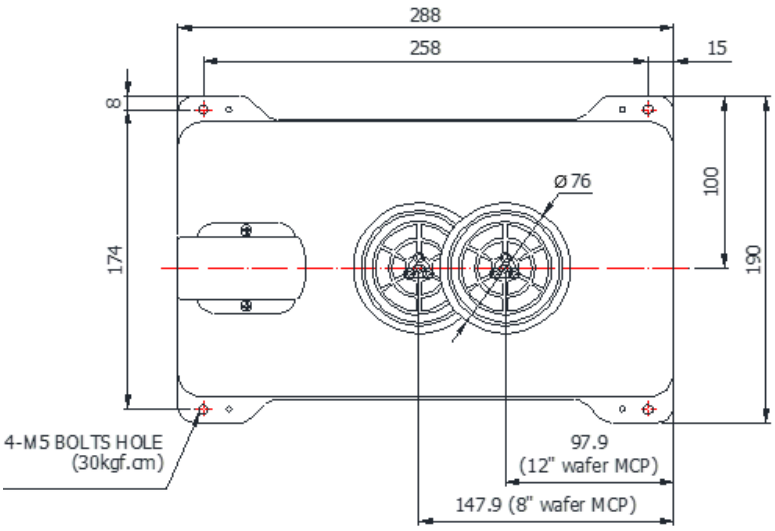


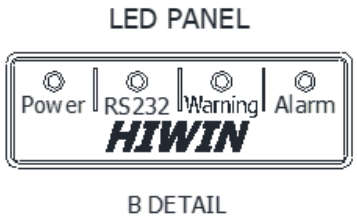




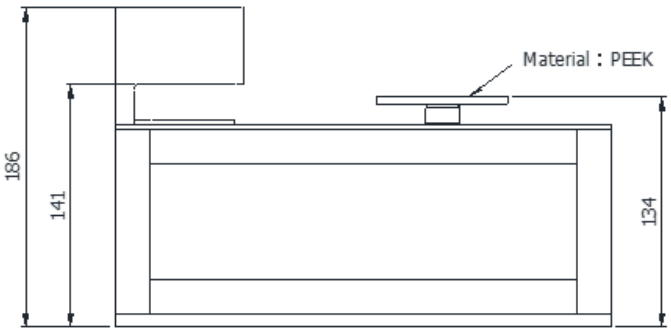


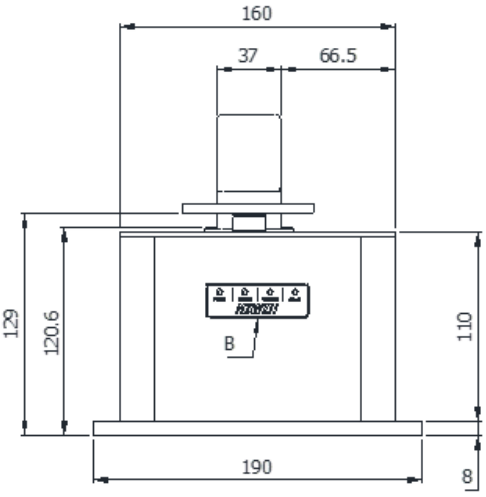
- HPA812 (200 mm, 300 mm)

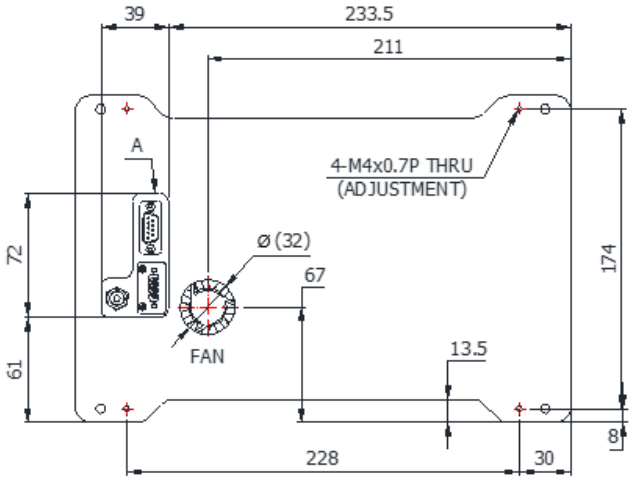


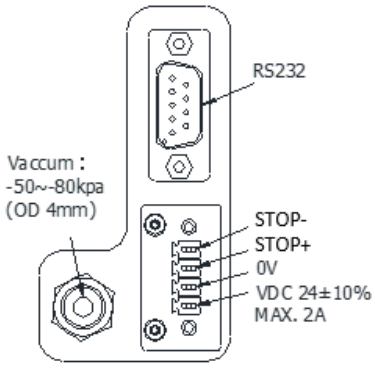


B DETAIL



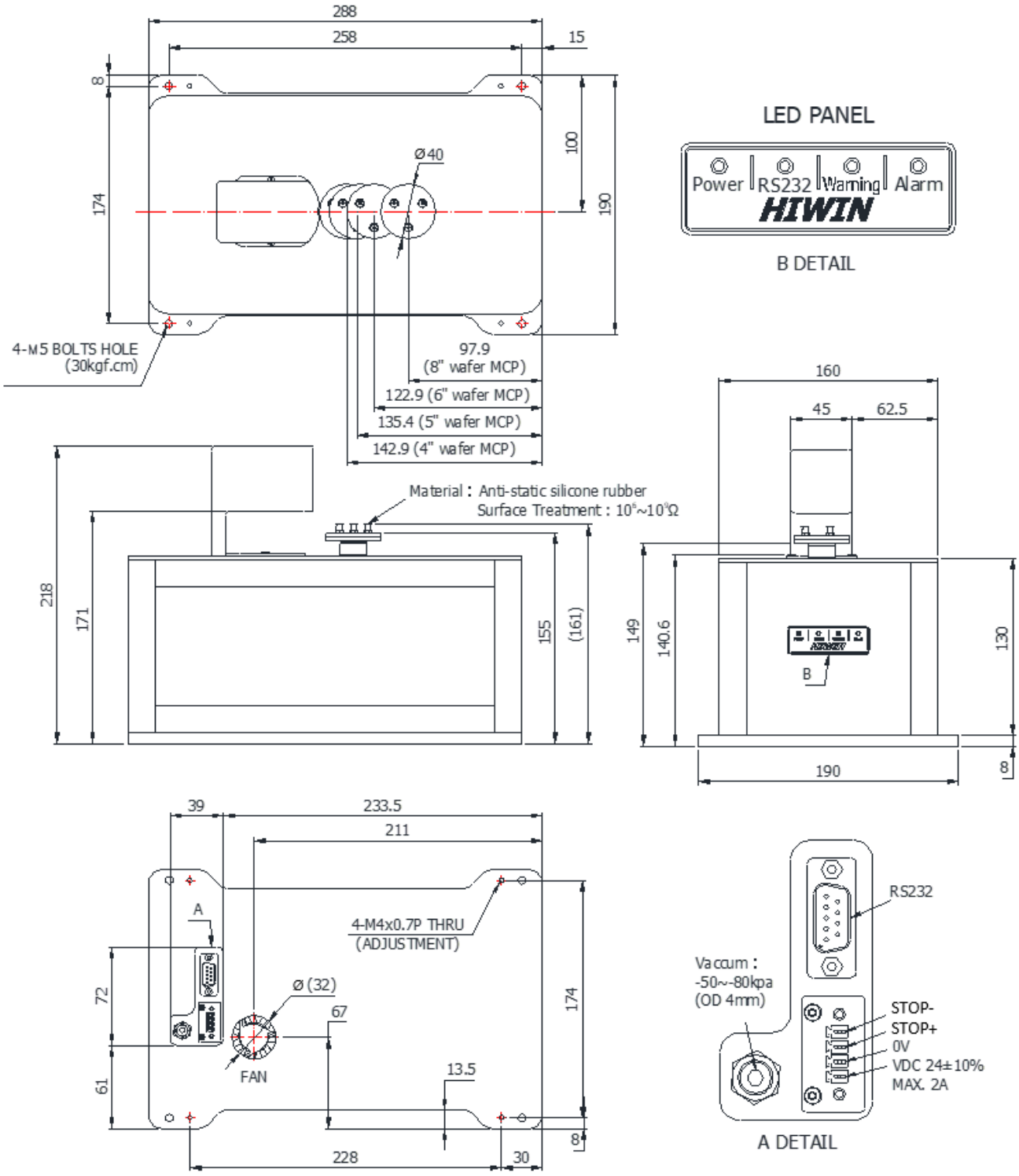




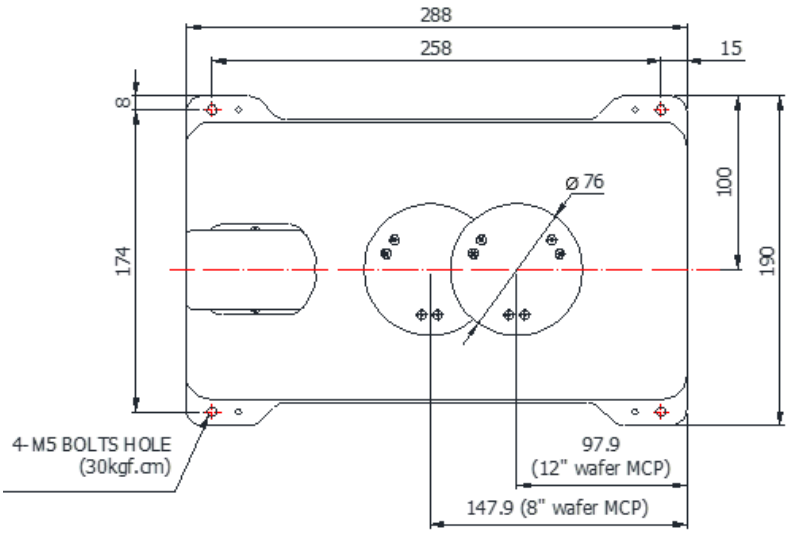


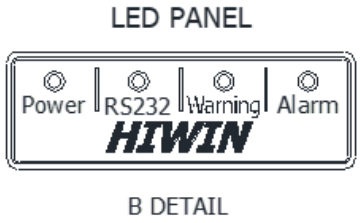
A DETAIL

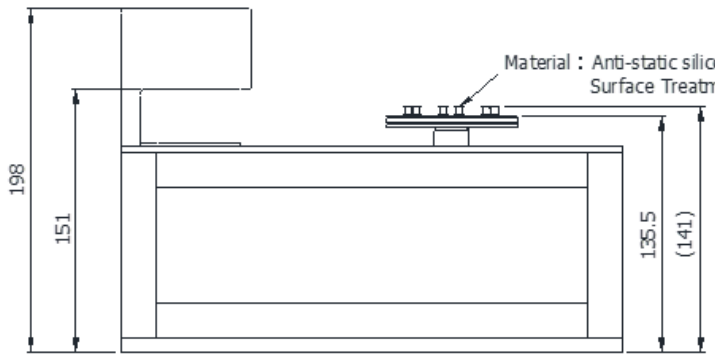
- HPA48-W (100 mm, 125 mm, 150 mm, 200 mm)

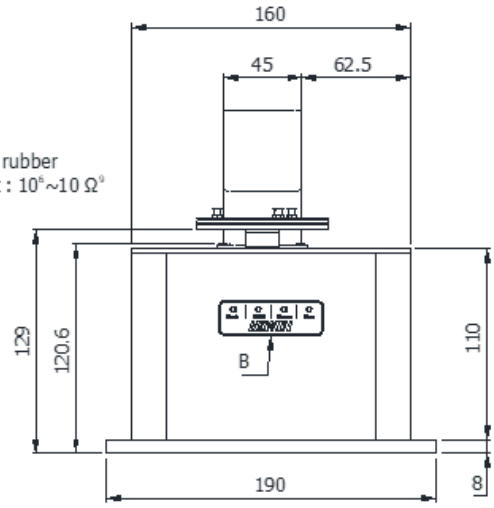


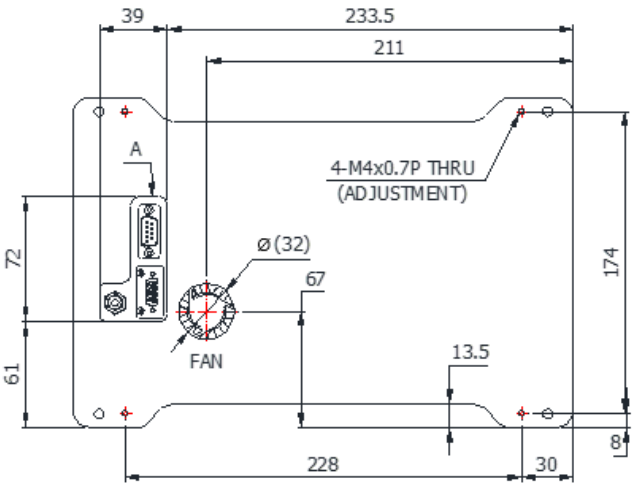
- HPA812-W (200 mm, 300 mm)

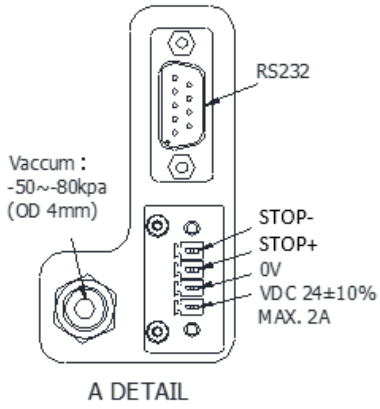




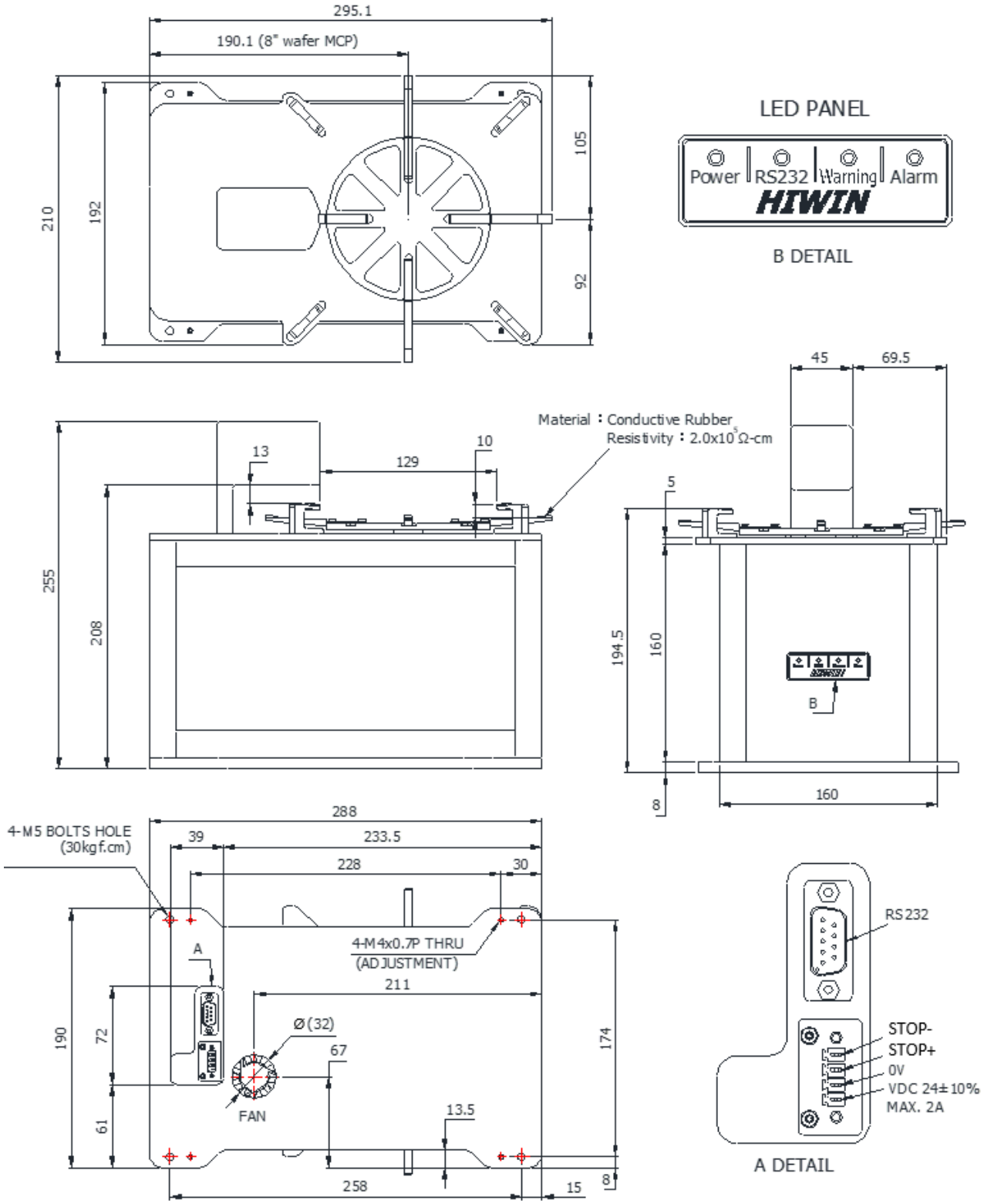




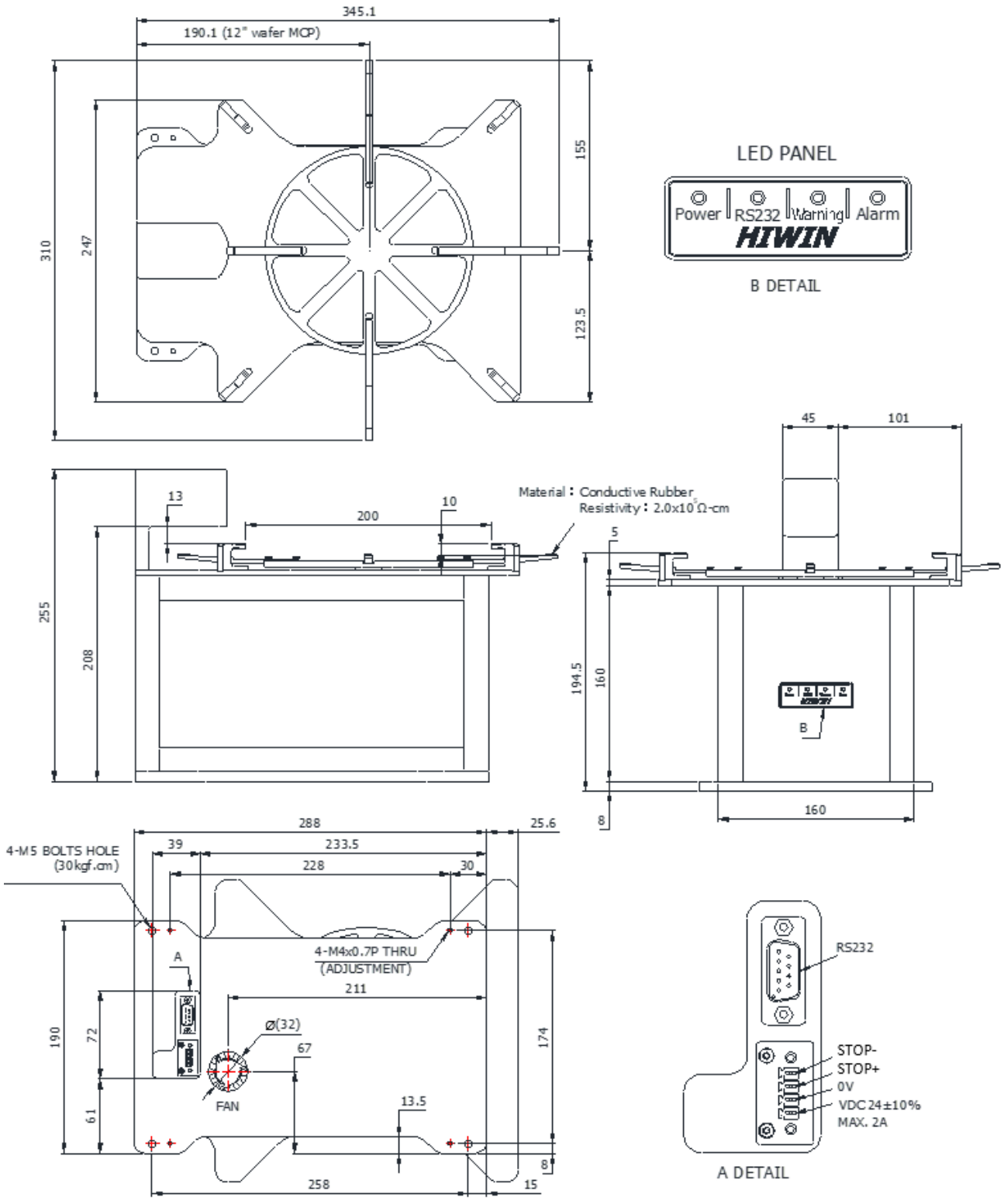




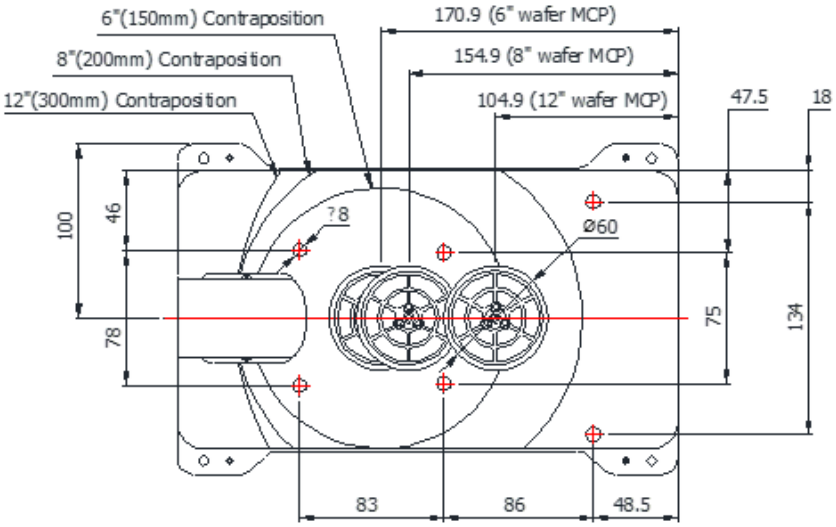
- HPA8-E (200 mm)

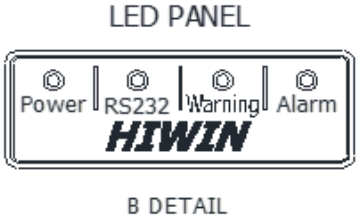

295.1
190.1 (8" wafer MCP)
210
192
105
92
LED PANEL
Power
RS232
Warning
Alarm
HIWIN
B DETAIL
45
69.5
Material : Conductive Rubber
Resistivity : 2.0x10^5 Ω-cm
13
129
10
255
208
5
194.5
160
B
8
160
288
4-M5 BOLTS HOLE
(30kgf.cm)
39
233.5
228
30
A
4-M4x0.7P THRU
(ADJUSTMENT)
211
Ø(32)
67
190
72
61
FAN
13.5
174
258
15
8
RS232
STOP-
STOP+
0V
VDC 24±10%
MAX. 2A
A DETAIL

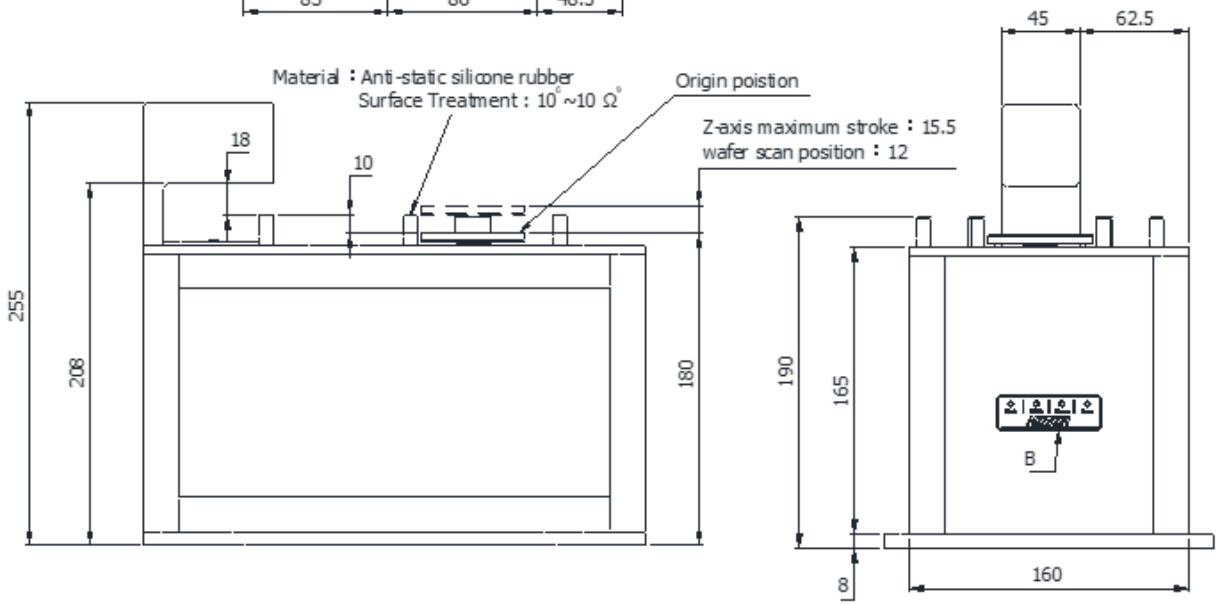
- HPA12-E (300 mm)

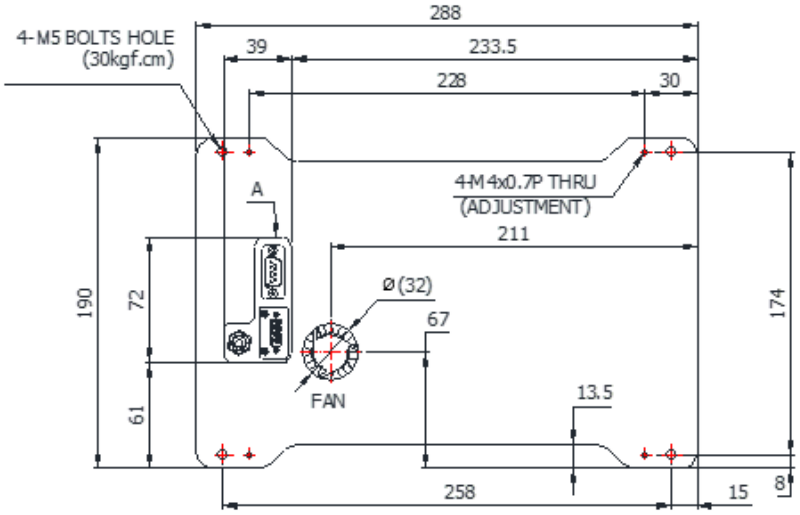


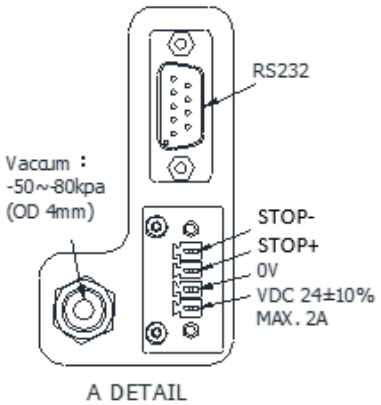
- HPA612-S (150 mm, 200 mm, 300 mm)









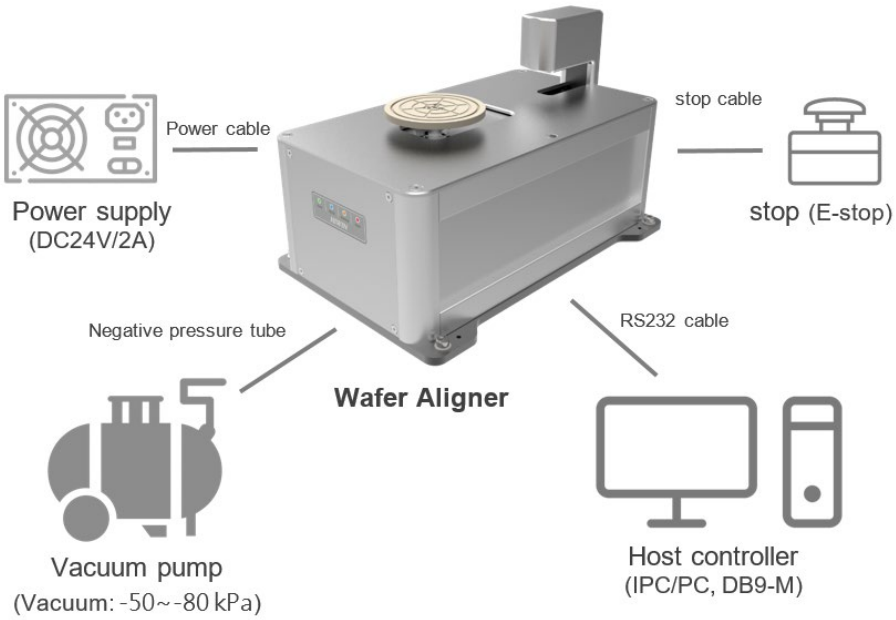


3 Machine installation description

- Please have the system designer or someone with sufficient knowledge and experience select the product specifications. Read the user manual carefully and complete relevant safety education training before operating this product.

3.1 System architecture diagram

Fig. 3.1: System architecture diagram



Note 1

Standard accessories include one wafer aligner unit, one power and stop connector, and one RS232 cable (connector type is D SUB-9PIN female connector with a cable length of 3 metres); the user must prepare the rest.

Note 2

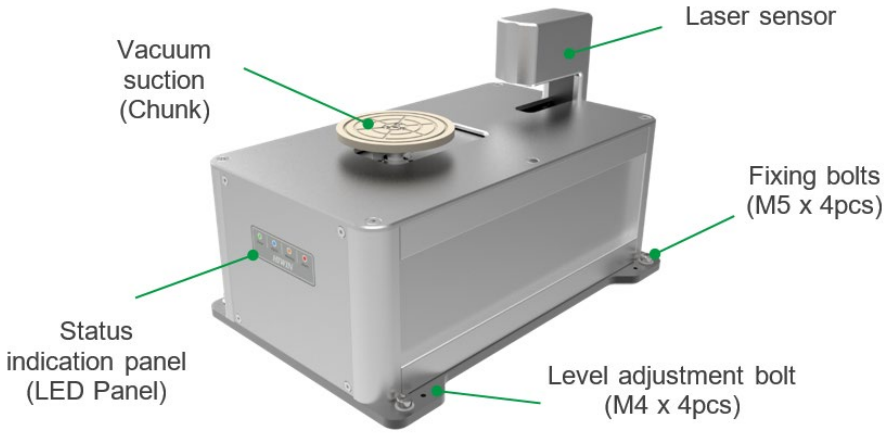
HPA-E series requires no negative pressure source.

⚠ **Caution!** Potentially dangerous situation!

Incorrect operation may result in personal injury or property damage.

3.2 Names and functional descriptions of each part

- Product body:



Descriptions of the functions of the LED panel:

Table 3.1: Descriptions of the functions of the LED panel

Code	Name	Colour	Functional definition
Power	Power indicator	Green	After 24V/0V power is supplied, the power indicator will permanently remain on.
RS232	Communication indicator	Blue	When the system is in the communication state, the communication indicator will keep flashing until it turns off when communication is over.
Warning	Warning indicator	Orange	When the system issues warnings, the warning indicator will flash twice every other second. *(Note 1)
Alarm	Alarm indicator	Red	When the system issues alarms, the alarm indicator will flash twice every other second. *(Note 2) (Note 3) (Note 4)

Note 1

If there are problems with user settings including parameters that were not set, parameters that were set incorrectly, instruction string errors or a new instruction received before the current instruction was processed, the system will issue warnings, but the warning indicator will not light up.

Note 2

If it is an alarm triggered by a stop, the alarm indicator will flash three times per second.

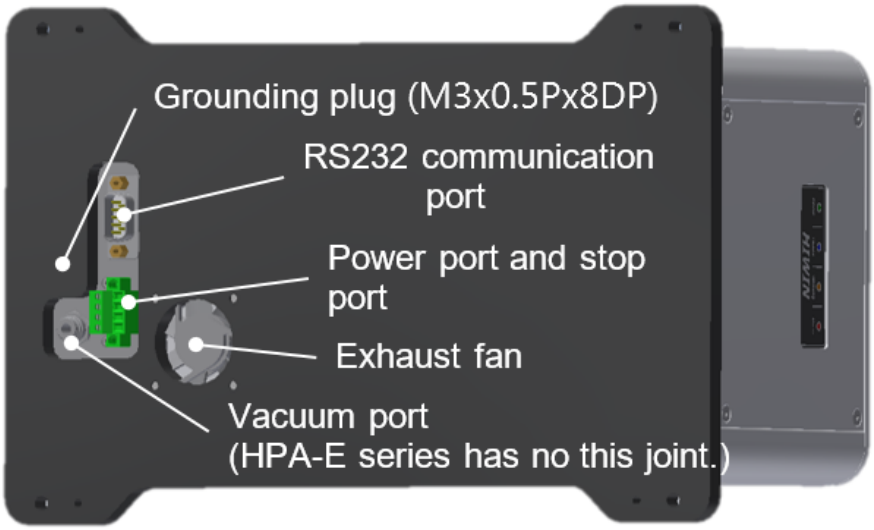
Note 3

If it is in the firmware update programming mode (Bootloader), the alarm indicator will flash once every other second.

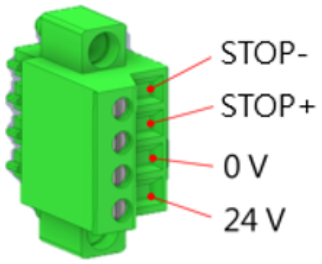
Note 4

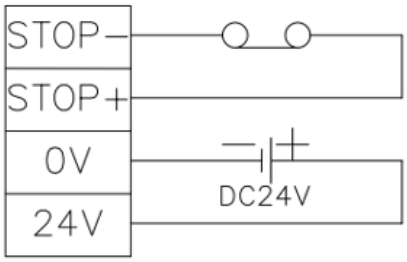
If the firmware update was abnormal,, the alarm indicator will flash twice every 2 seconds; please contact HIWIN/the manufacturer.

- Electrical interface:



The pin definitions and wiring diagram of the power and stop connector are as follows: when STOP+, STOP- are disconnected, the stop function is activated, and the product stops moving immediately.





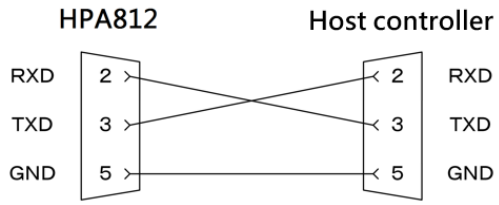
The stop pin is a wet contact. It can be docked with the safety circuit of the system integrator. If you need to connect the equipment in series, you must use a dry contact to switch. If a stop circuit is required, it must be disconnected from the power supply. When the system component activates the stop function, the product stops immediately.

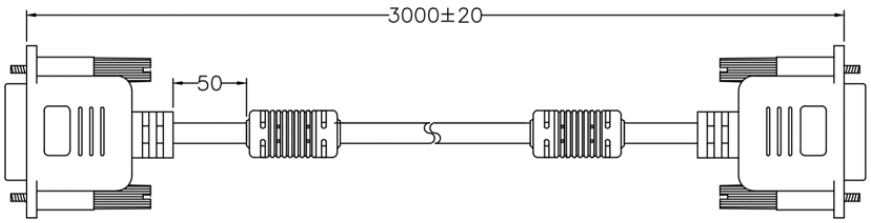
The RS232 communication port type is a D-Sub 9 PIN female connector; the pin definitions are as follows:

Table 3.2: The pin definitions of D-Sub 9 PIN female connector

Pin no.	Code	Description
1	N/A	
2	RXD	Receiving data
3	TXD	Transmitting data
4	N/A	
5	GND	Signal ground
6	N/A	
7	N/A	
8	N/A	
9	N/A	

The RS232 cable connector type is a D-Sub 9 PIN female connector; the cable pin definitions are as follows:





3.3 Installation safety measures

⚠ **Caution!** Potentially dangerous situation!

Incorrect operation may result in personal injury or property damage.

Environmental conditions:

- Do not use this product in environments with flammable or explosive gases to prevent the risk of explosions or fires.

- Do not use this product at locations with corrosive gas or corrosive chemical solutions to prevent rust, corrosion and other deterioration.
- Do not use this product at locations with strong electromagnetic waves, strong currents, or interference due to static electricity to prevent product malfunction.
- Do not use this product in environments where water and oil might drip into the product. Avoid electrical shocks and fires.
- Do not use this product at locations with strong impacts or vibrations.
- Please keep the ambient lighting stable, avoid impairment of the the measuring accuracy of the laser sensor.

Installation conditions:

- Please use a levelling device and use suitable bolt-locking torque to install the product in place.

Bolt specifications	Bolt length	Recommended locking torque
M5x0,8P	≥ 20 L	2.8–3.4 (Nm)

Note

Use of anti-loosening bolt glue or use with spring washers is recommended because they can improve the bolting effect of the product. Also check whether the bolts have become loose o ensure that the product functions normally.

- Please make sure there is sufficient space for maintenance and inspections, and perform routine maintenance.
- When using the product, the maximum energy consumption is 48 W.
- There is an exhaust cooling fan set up on the bottom of this product; keep the corresponding fan holes and airflow channels clean & clear to avoid product malfunction.
- When wiring the product, please refer to the manual. When plugging in and unplugging cables or connecting terminals, please do so quickly and properly; hot swapping is prohibited.
- When there are system abnormalities such as power outages and stops, please design safety circuit equipment to prevent any dangers and damages from occurring.Cables and vacuum pipe of the product must not be damaged; please perform regular inspections on a monthly basis. If the cables are damaged, bent excessively, tugged, curled or clamped, the product may malfunction and fire may occur due to factors such as power leakage or poor contact.

⚠ Caution!

- 1. The safety circuit is designed by the system integrator
- 2. The device only achieves the cat.0 stop function

4 Machine operation instructions

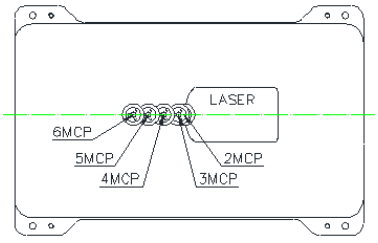
4.1 Introduction to moving points

Table 4.1: Introduction, definition of points

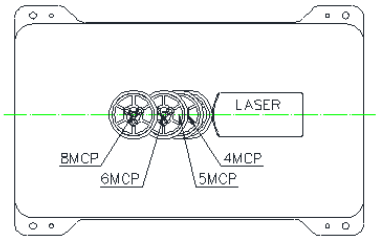
Point	Name	Definition
OP	Hardware edge point	During reset, the chunk will move to the hardware edge position.
HP	Software origin	If the wafer size is not set, after the origin is reset, the chunk will move to the original software position (home).
2MCP	2" wafer measurement centre point	Measures the centre point position of the 2-inch wafer.
3MCP	3" wafer measurement centre point	Measures the centre point position of the 3-inch wafer.
4MCP	4" wafer measurement centre point	Measures the centre point position of the 4-inch wafer.
5MCP	5" wafer measurement centre point	Measures the centre point position of the 5-inch wafer.
6MCP	6" wafer measurement centre point	Measures the centre point position of the 6-inch wafer.
8MCP	8" wafer measurement centre point	Measures the centre point position of the 8-inch wafer.
12MCP	12" wafer measurement centre point	Measures the centre point position of the 12-inch wafer.

4.2 Definition of coordinates

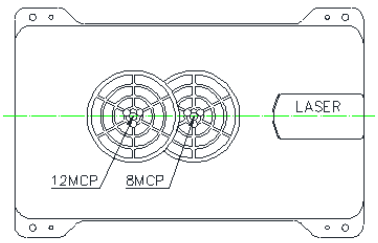
- The system coordinates and each edge range are explained by the top view diagram.



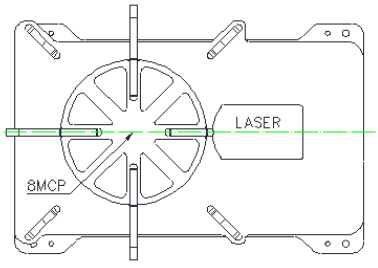
Model: HPA26



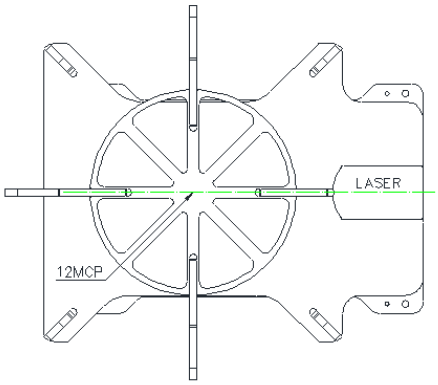
Model: HPA48 ,HPA48－W



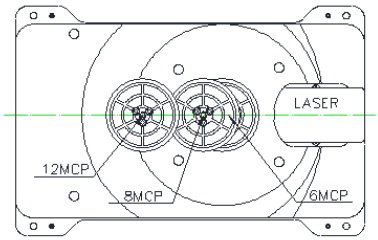
Model: HPA812 ,HPA812－W



Model: HPA8－E



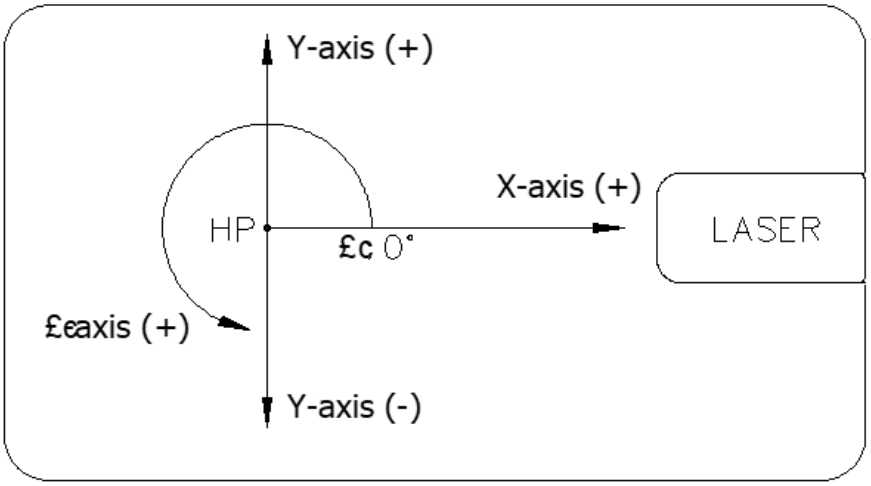
Model: HPA12－E



Model: HPA612－S

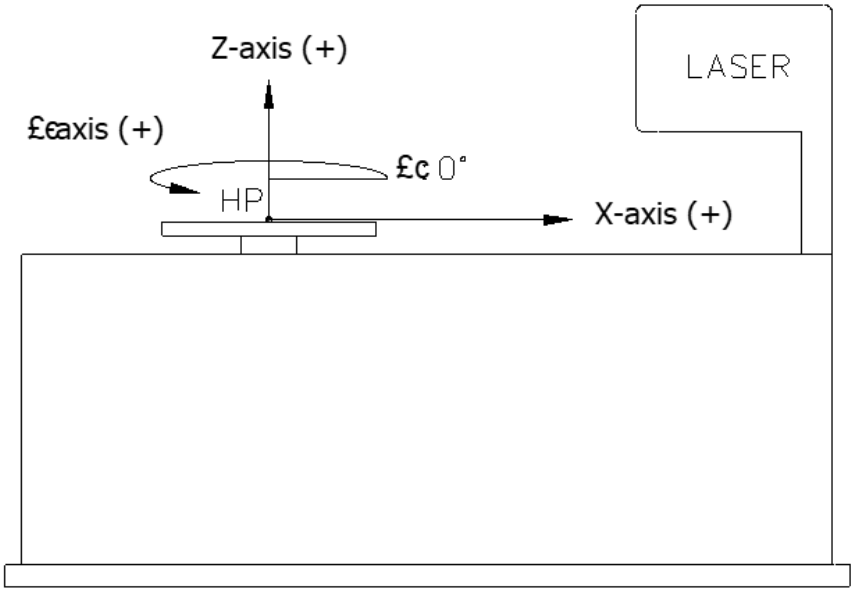
- Definitions of each axis coordinates:
  - Model: HPA series and HPA-W series

Top view diagram



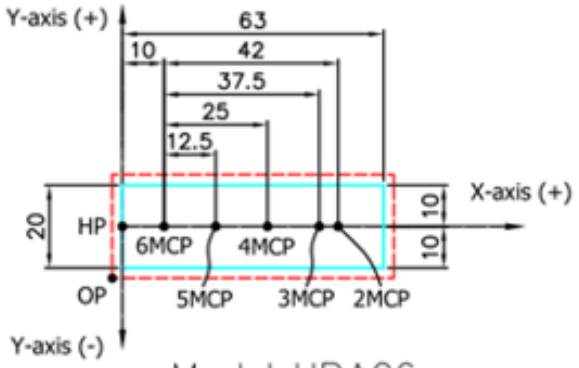
  - Model: HPA-E series, HPA-S series:

Side view

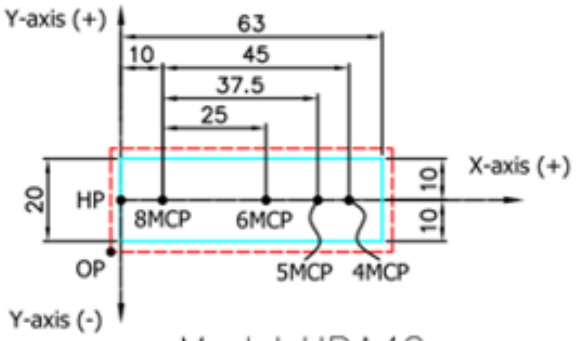


- Definitions of each edge range:

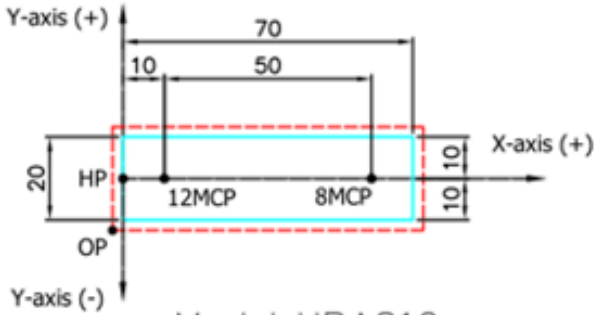
: mechanical limit
: software limit
(Unit: mm)



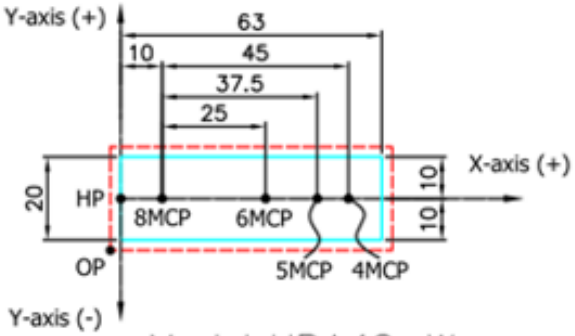
Model: HPA26



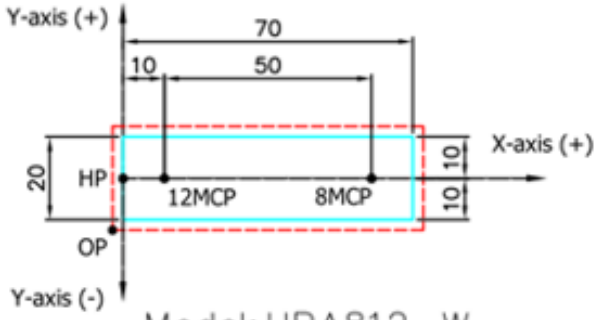
Model: HPA48



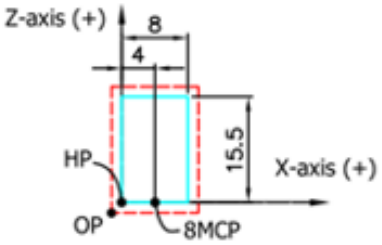
Model: HPA812



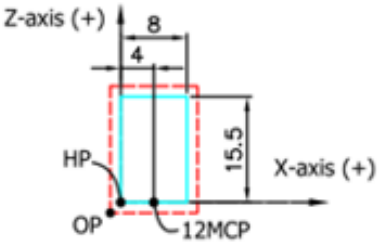
Model: HPA48–W



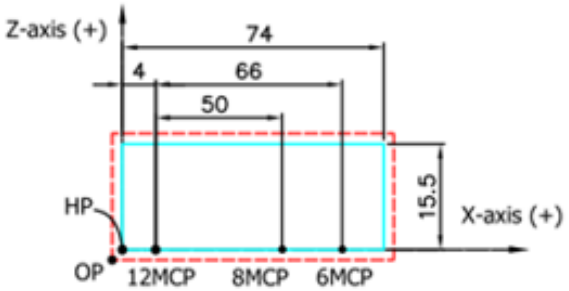
Model: HPA812–W



Model: HPA8–E

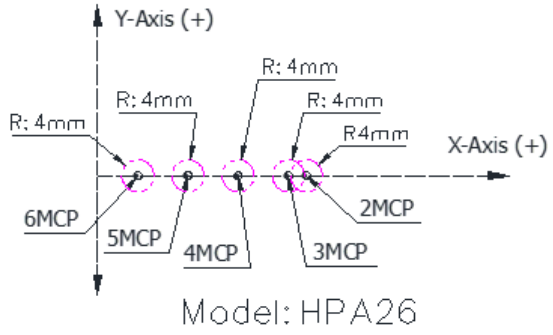


Model: HPA12–E

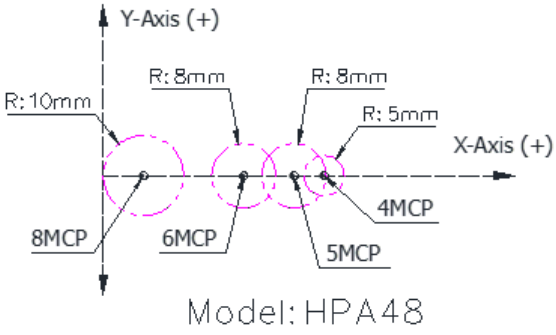


Model: HPA612–S

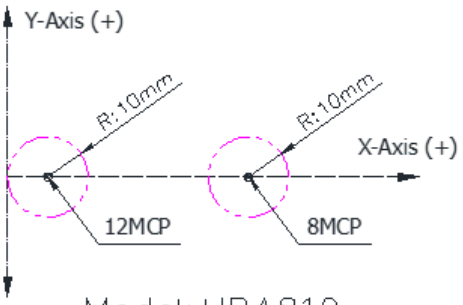
- Wafer edge search range:



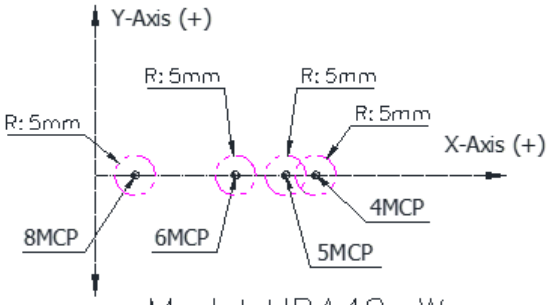
Model: HPA26



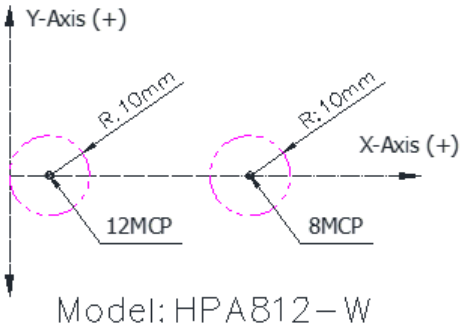
Model: HPA48



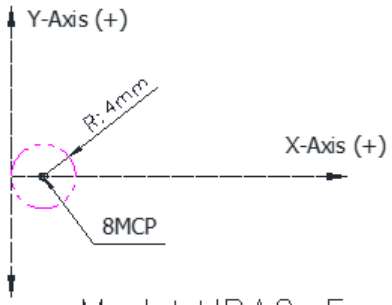
Model: HPA812



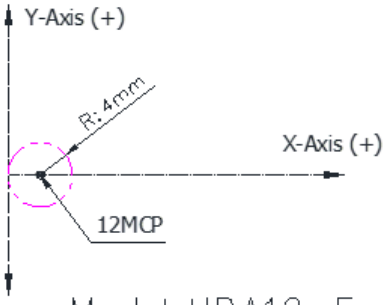
Model: HPA48–W



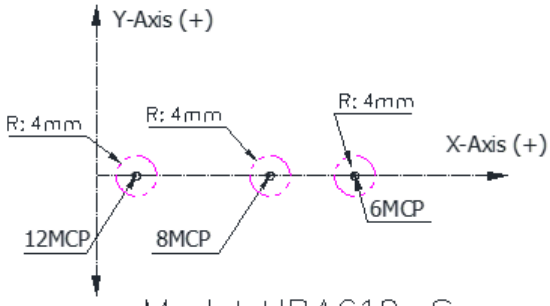
Model: HPA812–W



Model: HPA8–E



Model: HPA12–E



Model: HPA612–S

4.3 Operation notice

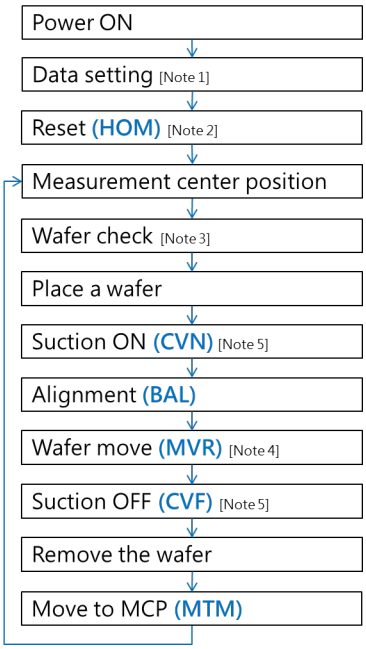
⚠ **Caution!** Potentially dangerous situation!

Incorrect operation may result in personal injury or property damage.

- According to the terms and conditions of the laser sensor, it is recommended that the product be warmed up for more than ten minutes after turning on the power to stabilize the circuit and ensure the accuracy of laser measurement.
- Do not use the product outside its specification range, and avoid product malfunctions and damages which can result in a reduction in the usage life. When the product is moving, do not apply any external force to the product, and do not touch the power connection terminals to avoid electric shocks.
- Confirm the safety of the range of motion of this product before supplying power to or moving this product, and strictly follow the safety measures of the system when performing adjustments after installing the system.
- Do not get close to or touch the product while it is in motion to prevent your fingers from getting clamped or stuck in the device.
- When personnel accidentally get stuck in the device, please disconnect the power immediately or press the stop button of the external safety circuit device, and then adjust the transmission mechanism manually after confirming that power is disconnected to free personnel.
- If there is a power outage during operation, please disconnect the power immediately to prevent sudden movements after power is restored, which can result in damage to the mechanical device or personal accidents.
- If the product heats up abnormally, smokes, releases strange odours or continuously makes strange sounds, please disconnect the power immediately to prevent product damages or fires.
- In case of special applications, such as non-standard SEMI spec size, wafer warpage, rim defect detection, film coverage or protrusion, special material or thickness, please contact the original manufacturer first.

4.4 Operating procedures

For standard product operating procedures, please refer to the following flowchart, and confirm and peform operations step by step. When the power is turned on, after an abnormal power failure, or after a stop is initiated, a reset must be executed first, and then the motion command can be executed. When the product return command is executed abnormally and an alarm error type is issued, please clear the alarm (ERS) first. For details, please refer to Chapter 5 Communication command list (command list) and Chapter 6 Error message (error code) description.



Note 1

Product parameter setting contains wafer size (WSZ), wafer type (_WT), alignment material (GLM) and wafer direction/coordinates (FWO). After the parameters are set, first save the settings (SPS), and then the entire parameter settings will be saved. The next time the aligner is turned on, the system will automatically read the whole wafer parameter settings which were previously saved with the save settings SPS instruction. If the SPS instruction is not executed before turning off the aligner, the parameter settings will not be saved.

Note 2

The product's default factory wafer size (WSZ) is zero; when resetting to the origin (HOM), the chunk will move to the origin (HP) by default. If the origin reset (HOM) is executed after setting the wafer size (WSZ), the chunk will move to the corresponding measurement centre point (MCP) according to the setting value of the wafer size.

Note 3

The read laser value (DOC) instruction can be used for wafer checks to confirm whether wafers exist through the feedback signal of the laser sensor. Use this instruction to determine whether there is a wafer on the machine or not and make sure to confirm the settings, including aligning material and wafer size.

Note 4

If, after the wafer alignment and correction motion has been completed, related rotation or straight-line movement based on the wafer centre is needed, such as optical character recognition (OCR) for the wafer, the relative position movement instruction (MVR) can be used.

Note 5

The vacuum activation (CVN) and the vacuum deactivation (CVF) instructions in the procedures before and after the wafer alignment (BAL) instruction may be executed via the configuration of the vacuum status (FVC) instructions before wafer alignment. The system will activate or deactivate the vacuum automatically before wafer alignment. The vacuum does not have to be activated or deactivated for the HPA-E series.

5 Command list

5.1 Communication protocol

The default communication formats are as follows:

- Serial communication: RS232
- Communication method: Full-duplex transmission
- Baud rate: 115200 bps
- Parity: None
- Data bit: 8 Bit
- Stop bit: 1 Bit

Command format messages are all composed of ASCII codes; the message codes are as shown below:

- CR (Carriage Return): 0x0d [Carriage Return]
- LF (Line Feed): 0x0a [Line Feed]
- Space (Space): 0x20 [Space]

The definitions of the communication delimiting symbols are as follows:

- Host controller → HPA812:
  Receiving delimiter: CR LF
- HPA812 → Host controller:
  Transmitting delimiter: CR LF

Example: Host controller HPA812

→ HOM

← BUSY

← END

5.2 Command list

- Motion instructions:

Table 5.1: Motion instructions

Function	Instruction	Type
Origin reset	HOM	Motion
Alignment	BAL BAL retries	Motion
Clear alarm	ERS	Motion
Move to origin	MTH	Motion
Move to measurement centre point	MTM	Motion
Relative position movement	MVR axis	Motion

- Read instructions:

Table 5.2: Read instructions

Function	Instruction	Type
Read value of laser sensor	CCD	Read
Read current position	CPO CPO axis	Read
Read vacuum pressure value	CVD	Read
Read laser detection object	DOC	Read
Read last error code	PER	Read
Read motor status	SMD SMD axis	Read
Read machine status	STA	Read
Configuration of readable model	SWH	Read
Read firmware version	VER VER value	Read

- Read/Write instructions:

Table 5.3: Read/Write instructions

Function	Instruction	Type
Read/ Write wafer type	_WT _WT value	Read/Write
Read/ Write feature sensitivity	COF COF value	Read/Write
Read/ Write end position check of the linear movement	CPS CPS value	Read/Write
Read/ Write vacuum status after clearing the error code	ERC ERC value	Read/Write
Read/ Write vacuum status after alignment	FVC FVC value	Read/Write
Read/ Write wafer direction	FWO FWO value	Read/Write
Read/ Write aligning material	GLM GLM value	Read/Write
Read/ Write vacuum monitor status	VMD VMD value	Read/Write
Read/ Write wafer size	WSZ WSZ value	Read/Write

- Write instructions:

Table 5.4: General instructions

Function	Instruction	Type
Auto initiation of laser sensor offset	ADA	Write
Deactivate vacuum	CVF	Write
Activate vacuum	CVN	Write
Restore factory default parameters	DEF	Write
Write motor excitation status	SME axis	Write
Save settings	SPS	Write
Stop motion	STP	Write

- Response instructions:

Table 5.5: Response instructions

Function	Instruction	Type
1 Instruction executing	BUSY	Response
2 Instruction execution completed	END	Response
3 Instruction execution abnormal	ERR	Response

- Event instructions:

Table 5.6: Event instructions

Function	Instruction	Type
Reporting function	EVT EVT value	Read/Write
Reporting state machine	STM STM E STM E value	Event/ Read/ Write
Input and output status of reporting	GIO GIO E GIO E value	Event/ Read/ Write
Status of the report stopping position	POS POS E POS E value	Event/ Read/ Write
Reporting laser detection object status	DOC DOC E DOC E value	Event/ Read/ Write

5.3 Motion instructions

Motion instruction types: their detailed functional definitions and descriptions are as follows:

If the movement position error of the X-, Y- or θ-axis exceeds ±0.03 mm/±0.03 mm/±0.3°, the system will issue the “ERR POSITION ERROR”.

5.3.1 Origin reset (HOM)

Function	Instruction	Type	Description
Origin reset	HOM	Motion	○ **HPA series and HPA-W series:** 1 The chuck will first move to the X- and Y-axis's hardware edge (OP), and then move to the corresponding measurement centre point according to the set wafer size. 2 If the wafer size is not set, the chuck will confirm the hardware edge (OP) and then move to the origin (HP). 3 The origin reset only works for the X- and Y-axis; only during the warm-up process is it performed for the θ-axis. ○ **HPA-E series and HPA-S series:** 1 The chuck will first move to the X- and Z-axis's hardware edge (OP) and then move to the corresponding measurement centre point according to the set wafer size. 2 If the wafer size is not set, the chuck will confirm the hardware edge (OP) and then move to the origin (HP). 3 Returning to HP only applies to X- and Z-axis; θ-axis rotates to the defined T-index, HPA-S series θ axis only performs a warm-up action.
Example description	**Communication instructions (execution/return)**		**Description**
	→ **HOM** ← BUSY ← END		○ **Execute reset motion instruction** ○ Command executing ○ Command completed

⚠ **Caution!** Potentially dangerous situation!

Incorrect operation may result in personal injury or property damage.

- Origin reset must first be performed after the machine power is turned on and after initiating a stop.
- Do not place any wafers before completion of the origin reset; this will prevent misjudgment of the origin position or collisions.

5.3.2 Alignment (BAL)

Function	Instruction	Type	Description
Alignment	BAL BAL retries	Motion	○ **HPA series, HPA-W series and HPA-S series:** 1 Confirm that the chuck position is at the measurement centre of the corresponding wafer size, activate the vacuum and confirm the vacuum status is ON before activating wafer alignment. 2 The process of the wafer alignment calibration cycle isthe θ-axis rotating for more than one circle, and then the wafer feature angle and the position of the wafer center being calibrated in order (applicable to firmware HPA_T 2.3.1 or higher version). 3 If the alignment feature is not set, only the wafer centre will be calibrated. 4 Instruction BAL: Executes the wafer alignment cycle once; if the alignment result is abnormal, error code ERR-04-11 is issued. 5 Instruction BAL 2: Executes the wafer alignment cycle a maximum of two times; if the alignment result is abnormal, error code ERR-04-11 is issued. 6 Instruction BAL 3: Executes the wafer alignment cycle a maximum of three times; if the alignment result is abnormal, error code ERR-04-11 is issued. 7 Retries parameter settings: 0, 2 or 3 times. ○ **HPA-E series:** 1 Confirm that the chuck position is at the measurement centre of the corresponding wafer size and the θ-axis rotates to the T-index before wafer alignment is activated. 2 The process of the wafer alignment calibration cycle is the θ-axis rotating for more than one circle, and the position of the wafer centre and then the wafer feature angle being calibrated in order. 3 Instruction BAL: Executes the wafer alignment cycle once; if the alignment result finds no feature, alignment will restart after rotating for an angle; if the alignment result is abnormal, error code ERR-04-11 is issued. 4 Instruction BAL 2: Executes the wafer alignment cycle a maximum of three times; if the alignment result is abnormal, error code ERR-04-11 is issued. 5 Instruction BAL 3: Executes the wafer alignment cycle a maximum of four times; if the alignment result is abnormal, error code ERR-04-11 is issued. 6 Retries parameter settings: 0, 2 or 3 times.
Example description	**Communication instructions (execution/return)**		**Description**
	→ **BAL** ← BUSY ← END		○ **Execute alignment instruction** ○ Command executing ○ Command completed

5.3.3 Clear alarm (ERS)

Function	Instruction	Type	Description
Clear alarm	ERS	Motion	1 Clear the error status. 2 If the alarm was triggered by a stop, the alarm must be cleared first (ERS) and origin reset performed (HOM).
Example description	**Communication instructions (execution/return)**		**Description**
	→ **ERS** ← BUSY ← END		○ **Execute clear alarm instruction** ○ Command executing ○ Command completed

⚠ **Caution!** Potentially dangerous situation!

> Incorrect operation may result in personal injury or property damage.
>
> Please confirm the machine's status and remove the wafer.

5.3.4 Move to origin (MTH)

Function	Instruction	Type	Description
Move to origin	MTH	Motion	○ **HPA series, HPA-W series and HPA-S series:** 1 Moves the chuck to the origin (HP). ○ **HPA-E series:** 1 Moves the chuck to HP, and the θ-axis rotates to the T-index.
Example description	**Communication instructions (execution/return)**		**Description**
	→ **MTH** ← BUSY ← END		○ **Instruction to execute move to origin** ○ Command executing ○ Command completed

5.3.5 Move to measurement centre point (MTM)

Function	Instruction	Type	Description
Move to measurement centre point	MTM	Motion	○ **HPA series, HPA-W series and HPA-S series:** 1 Move the chuck to the corresponding measurement centre point according to the set wafer size. ○ **HPA-E series:** 1 Based on the configured wafer size, move the chuck to the corresponding measurement and the θ-axis rotates to the T-index.
Example description	**Communication instructions (execution/return)**		**Description**
	→ **MTM** ← BUSY ← END		○ **Execute move to measurement centre point instruction** ○ Command executing ○ Command completed

5.3.6 Relative position movement (MVR axis)

<table>
<tr><th>Function</th><th>Instruction</th><th>Type</th><th>Description</th></tr>
<tr><td>Relative position movement</td><td>MVR axis</td><td>Motion</td><td>
○ HPA series and HPA-W series:
1 Performs relative movement for single axis
2 The movement unit of the X-axis and Y-axis is 0.01mm, the movement unit of the θ-axis is 0.1°.
3 Motion ranges of each axis are as follows:
<table>
<tr><th>Model / Axis</th><th>HPA26</th><th>HPA48
HPA48-W</th><th>HPA812
HPA812-W</th></tr>
<tr><td>X-axis (0.01mm/per unit)</td><td>0–5600</td><td>0–6300</td><td>0–7000</td></tr>
<tr><td>Y-axis (0.01mm/per unit)</td><td>-1000–1000</td><td>-1000–1000</td><td>-1000–1000</td></tr>
<tr><td>θ-axis (0.1deg/per unit)</td><td>0–3599</td><td>0–3599</td><td>0–3599</td></tr>
</table>
4 Relative movement distances that can be set for each axis are as follows:
<table>
<tr><th>Model / Axis</th><th>HPA26</th><th>HPA48
HPA48-W</th><th>HPA812
HPA812-W</th></tr>
<tr><td>X-axis (0.01mm/per unit)</td><td>-5600–5600</td><td>-6300–6300</td><td>-7000–7000</td></tr>
<tr><td>Y-axis (0.01mm/per unit)</td><td>-2000–2000</td><td>-2000–2000</td><td>-2000–2000</td></tr>
<tr><td>θ-axis (0.1deg/per unit)</td><td>-3599–3599</td><td>-3599–3599</td><td>-3599–3599</td></tr>
</table>
○ HPA-E series and HPA-S series:
1 Performs relative movement for single axis
2 The movement unit of the X-axis and Z-axis is 0.01mm, the movement unit of the θ-axis is 0.1°.
3 Motion ranges of each axis are as follows:
<table>
<tr><th>Model / Axis</th><th>HPA8-E, HPA12-E</th><th>HPA612-S</th></tr>
<tr><td>X-axis (0.01mm/per unit)</td><td>0–800</td><td>0–7500</td></tr>
<tr><td>Z-axis (0.01mm/per unit)</td><td>0–1550</td><td>0–1550</td></tr>
<tr><td>θ-axis (0.1deg/per unit)</td><td>0–3599</td><td>0–3599</td></tr>
</table>
4 Relative movement distances that can be set for each axis are as follows:
<table>
<tr><th>Model / Axis</th><th>HPA8-E, HPA12-E</th><th>HPA612-S</th></tr>
<tr><td>X-axis (0.01mm/per unit)</td><td>-800–800</td><td>-7500–7500</td></tr>
<tr><td>Z-axis (0.01mm/per unit)</td><td>-1550–1550</td><td>-1550–1550</td></tr>
<tr><td>θ-axis (0.1deg/per unit)</td><td>-3599–3599</td><td>-3599–3599</td></tr>
</table>
</td></tr>
<tr><td>Example description</td><td colspan="2">Communication instructions (execution/return)</td><td>Description</td></tr>
<tr><td></td><td colspan="2">→ CPO T
← 1800
← END
→ MVR T 900
← BUSY
← END
→ CPO T
← 2700
← END</td><td>○ Read current position of the θ-axis
○ Reply current position of the θ-axis
○ Command completed
○ Move the θ-axis relatively for 900 units
○ Command executing
○ Command completed
○ Read current position of the θ-axis
○ Reply current position of the θ-axis
○ Command completed</td></tr>
</table>

⚠ **Caution!** Potentially dangerous situation!

Incorrect operation may result in personal injury or property damage.

– HPA series and HPA-W series:

- If the BAL instruction was not executed after powering on, please execute the relative position movement (MVR T) instruction first; the system will perform relative rotation using the chuck as the centre.
- After the BAL instruction is executed, the relative position movement (MVR T) instruction is executed, which performs relative rotation of the position of the θ-axis, and calibrates the X-axis and Y-axis at the same time.
- To ensure the wafer is secure, the relative movement instruction (MVR) automatically activates the negative pressure and keeps monitoring the negative pressure status.

– HPA-E series and HPA-S series:

- If the BAL instruction was not executed after powering on, please execute the relative position movement (MVR T) instruction first; the system will perform relative rotation using the chuck as the centre.
- After the BAL instruction, the relative position movement (MVR T) instruction is executed, which performs relative rotation of the position of the θ-axis.

5.4 Read instructions

Read instruction types: their detailed functional definitions and descriptions are as follows:

5.4.1 Read value of laser sensor (CCD)

Function	Instruction	Type	Description
Read value of laser sensor	CCD	Read	1 Read value of laser sensor. 2 The value definitions are as follows: >32500: The laser sensing area is completely covered. <160: The laser sensing area is not covered.
Example description	**Communication instructions (execution/return)**		**Description**
	→ **CCD** ← 15000 ← END		○ **Read value of laser sensor** ○ Reply value of laser sensor ○ Command completed

⚠ **Caution!** Potentially dangerous situation!

Incorrect operation may result in personal injury or property damage.

- Use this instruction to confirm the laser sensor lens is clean; the CCD value must be less than 200.
- Please contact HIWIN/the manufacturer if the CCD value is still greater than 200 after cleaning the laser sensor lens.

5.4.2 Read current position (CPO / CPO axis)

Function	Instruction	Type	Description
Read current position	CPO CPO axis	Read	○ **HPA series and HPA-W series:** 1 Read the current absolute position for all axes or a single axis. 2 The unit of the X- and Y-axis is 0.01mm; the unit of the θ-axis is 0.1°. 3 Motion ranges of each axis are as follows:

Axis \ Model	HPA26	HPA48 HPA48-W	HPA812 HPA812-W
X-axis (0.01mm/per unit)	0–5600	0–6300	0–7000
Y-axis (0.01mm/per unit)	-1000–1000	-1000–1000	-1000–1000
θ-axis (0.1deg/per unit)	0–3599	0–3599	0–3599

4 The instruction definitions are as follows:

CPO: read the current positions of X-axis, Y-axis and θ-axis.

CPO axis: read the current position of each axis individually.

5 Read the current positions of X-axis, Y-axis and θ-axis; due to the rounding of the decimal place, the maximum tolerance of the CPO value is ±1.

○ **HPA-E series and HPA-S series:**

1 Read the current absolute position of each axis or a single axis.

2 The unit of the X- and Z-axis is 0.01mm; the unit of the θ-axis is 0.1°.

3 Motion ranges of each axis are as follows:

Axis \ Model	HPA8-E, HPA12-E	HPA612-S
X-axis (0.01mm/per unit)	0–800	0–7500
Z-axis (0.01mm/per unit)	0–1550	0–1550
θ-axis (0.1deg/per unit)	0–3599	0–3599

4 The instruction definitions are as follows:

CPO: read the current positions of X-axis, Z-axis and θ-axis.

CPO axis: read the current position of each axis individually.

5 Read the current positions of X-axis, Z-axis and θ-axis; due to the rounding of the decimal place, the maximum tolerance of the CPO value is ±1.

Example description	Communication instructions (execution/return)	Description
	→ **CPO T** ← 1800 ← END → **CPO** ← 1000,0,1800 ← END	○ **Read current position of the θ-axis** ○ Reply current position of the θ-axis ○ Command completed ○ **Read current position of each axis** ○ Reply position of each axis ○ Command completed

⚠ **Caution!** Potentially dangerous situation

Incorrect operation may result in personal injury or property damage.

- The position of the θ-axis is 0 before the BAL instruction is executed; after the BAL instruction is executed, the position of the θ-axis is updated.

5.4.3 Read vacuum pressure value (CVD)

Function	Instruction	Type	Description
Read vacuum pressure value	CVD	Read	1 Reads the vacuum pressure value when the vacuum is enabled. 2 The vacuum pressure range is-50 kPa – -80 kPa (applicable to firmware HPA_T 2.X.29 or higher version).
Example description	**Communication instructions (execution/return)**		**Description**
	→ CVD ← -60 ← END		○ **Read vacuum pressure value** ○ Reply vacuum pressure value ○ Command completed

⚠ **Caution!** Potentially dangerous situation!

Incorrect operation may result in personal injury or property damage.

If the vacuum pressure value exceeds the -50 kPa – -80 kPa range, the aligner will issue a vacuum error alarm.

The instruction is not applicable to the HPA-E series.

5.4.4 Read laser detection object (DOC)

Function	Instruction	Type	Description
Read laser value	DOC	Read	1 Detects whether there are covers within the laser sensing range. 2 The value definitions are as follows: 0: No workpiece. 1: There is a workpiece. 2: ADC IC abnormal. 3: Full coverage, and the mapping sensing value ≧28 mm. If the laser signal is abnormal, value 2 will be displayed.
Example description	**Communication instructions (execution/return)**		**Description**
	→ DOC ← 0 ← END		○ **Read laser value** ○ Reply laser value ○ Command completed

⚠ **Caution!** Potentially dangerous situation!

Incorrect operation may result in personal injury or property damage.

▶ Use this instruction to determine whether there is a wafer on the machine or not; make sure to confirm the settings, including alignment material and wafer size.

Read last error code (PER)

Function	Instruction	Type	Description
Read last error code	PER	Read	1 The error code will be cleared after the machine power is turned off. 2 If no abnormalities occur, “NO ERROR” is displayed. 3 After the clear alarm instruction is executed, the last error code still exists. 4 The error code is not saved when the parameter setting is abnormal (ERR SETTING) or there is an incorrectcommand (ERR COMMAND).
Example description	**Communication instructions (execution/return)**		**Description**

Function	Instruction	Type	Description
	→ **PER** ← ERR XXXX ← END		○ **Read last error code** ○ Reply last error code ○ Command completed

5.4.5 Read motor status (SMD / SMD axis)

Function	Instruction	Type	Description
Read motor status	SMD	Read motor status	1 Read the motor status for all axes or a single axis. 2 Definitions of the motor statuses are as follows: 1: Motor status normal. 0: Motor status abnormal. 3 The instruction definitions are as follows: SMD: read the motor status of X-axis, Y- (or Z-)axis and θ-axis. SMD axis: read each motor status individually.
Example description	**Communication instructions (execution/return)**		**Description**
	→ **SMD** ← 1,1,1 ← END → **SMD T** ← 1 ← END		○ **Read the motor status of all axes** ○ Reply to the motor status of the X-axis, Y- (or Z-)axis and θ-axis ○ Command completed ○ **Read θ-axis motor status** ○ Reply θ-axis motor status ○ Command completed

⚠ **Caution!** Potentially dangerous situation!

Incorrect operation may result in personal injury or property damage.

- Use the read motor status instruction only when there is an empty load.
- When reading the motor status, the system will perform reciprocal jogging to confirm the drive situation.

5.4.6 Read machine status (STA)

Function	Instruction	Type	Description
Read machine status	STA	Read	1 Confirms the hardware component functions or statuses, such as laser sensor, pressure sensor and fan, etc. 2 Uses hexadecimal system to display the system status.
Example description	**Communication instructions (execution/return)**		**Description**
	→ **STA** ← 0015 ← END		○ **Read system status instruction** ○ System status reply [0015=0001+0004+0010] ○ Command completed

Return code descriptions	Sequence	Hexadecimal	Function	Description
	1	0001	Check fan status	Confirms that the fan status is normal
	2	0002	Reserved	Reserved
	3	0004	Chuck vacuum sensor ON	Confirms that the vacuum status is ON
	4	0008	Reserved	Reserved
	5	0010	Check laser sensor status	Confirms that the laser sensor is normal
	6	0020	Reserved	Reserved
	7	0040	Reserved	Reserved

Function	Instruction	Type	Description	
	8	0080	Reserved	Reserved
	9	0100	Reserved	Reserved
	10	0200	Reserved	Reserved
	11	0400	Reserved	Reserved
	12	0800	Reserved	Reserved
	13	1000	Reserved	Reserved
	14	2000	Reserved	Reserved
	15	4000	Reserved	Reserved
	16	8000	Reserved	Reserved

5.4.7 Configuration of readable model (SWH)

Function	Instruction	Type	Description
Configuration of readable model	SWH	Read	○ **HPA series and HPA-W series:** 1 Reads the current firmware version of the machine. 2 Instruction VER: Reads the firmware version of the Master MCU (θ-axis). 3 Instruction VER X: Reads the firmware version of the Slave1 MCU (X-axis). 4 Instruction VER Y: Reads the firmware version of the Slave2 MCU (Y-axis). ○ **HPA-E series and HPA-S series:** 1 Reads the current firmware version of the machine. 2 Instruction VER: Reads the firmware version of the Master MCU (θ-axis). 3 Instruction VER X: Reads the firmware version of the Slave1 MCU (X-axis). 4 Instruction VER Z: Reads the firmware version of the Slave2 MCU (Z-axis).
Example description	**Communication instructions (execution/return)**		**Description**
	→ **VER** ← V3.5.3 ← END → **VER X** ← V3.0.6 ← END		○ **Reads the Master firmware version** ○ Reply firmware version ○ Command completed ○ **Reads the firmware version of** Slave1 ○ Reply firmware version ○ Command completed

5.5 Read/Write instructions

Read/Write instruction types: their detailed functional definitions and descriptions are as follows:

5.5.1 Read/write wafer type (_WT / _WT value)

Function	Instruction	Type	Description
Read/Write wafer type	_WT	Read/Write wafer type	1 Read/Write wafer type. 2 The value definitions are as follows: 0: Wafer with no notch or flat. 1: Wafer with notch [factory default setting]. 2: Wafer with one or multiple flats. 3 The instruction definitions are as follows: _WT: Read wafer type. _WT value: Write wafer type.
Example description	**Communication instructions (execution/return)**		**Description**
	→ **_WT** ← 0 ← END → **_WT 1** ← 1 ← END		○ **Read wafer type** ○ Reply wafer type ○ Command completed ○ **Write wafer type** ○ Reply wafer type ○ Command completed

⚠ **Caution!** Potentially dangerous situation!

Incorrect operation may result in personal injury or property damage.

HPA-E series only supports _WT=1 function.

5.5.2 Read/write feature sensitivity (COF / COF value)

Function	Instruction	Type	Description
Read/Write feature sensitivity	COF	Read/Write feature sensitivity	1 Read/Write the sensitivity for detecting wafer features. 2 The sensitivity thresholds are defined as below. 0: Low sensitivity, with accommodative criteria for determining the feature tracks [factory default setting]. 1. High sensitivity, with more rigorous criteria for determining the feature tracks 3 The instruction definitions are as follows: COF: read the sensitivity threshold. COF value: configure the sensitivity threshold.
Example description	**Communication instructions (execution/return)**		**Description**
	→ **COF** ← 0 ← END → **COF 1** ← 1 ← END		○ **Read the sensitivity threshold** ○ Return the sensitivity threshold ○ Command completed ○ **Configure the sensitivity threshold** ○ Return the sensitivity threshold ○ Command completed

⚠ **Caution!** Potentially dangerous situation!

Incorrect operation may result in personal injury or property damage.

- If the wafer features (flat/notch) or the profile of wafer are abnormal, the system issues ERR-04-11.
- When configured with low sensitivity, the tolerance of the wafer features or the profile noises is higher; in case of high sensitivity, the accuracy of wafer alignment is higher.

5.5.3 Read/Write the end position check of the X-axis and Y-(or Z-)axis (CPS / CPS value)

Function	Instruction	Type	Description
Read/Write the end position check of the X-axis and Y-axis	CPS CPS value	Read/Write	1 The end position check function of the X-axis and Y-axis (or Z-axis) after reading/writing the motion instruction (MTH, MTM and MVR). 2 The position detections of the X-axis and Y-axis (or Z-axis) are defined as follows: 0: Deactivate the end position check of the X-axis and Y-axis (or Z-axis). 1: Activate the end position check of the X-axis and Y-axis (or Z-axis) [factory default setting]. 3 The instruction definitions are as follows: CPS: Read the end position check of the X-axis and Y-axis (or Z-axis). CPS value: Configure the end position check status of the X-axis and Y-axis (or Z-axis).
Example description	**Communication instructions (execution/return)**		**Description**
	→ **CPS** ← 1 ← END → **CPS 0** ← 0 ← END		○ **Read the end position check of the X-axis and Y-axis (or Z-axis).** ○ Return the end position check status ○ Command completed ○ **Configure the end position check status of the X-axis and Y-axis (or Z-axis).** ○ Return the end position check status ○ Command completed

5.5.4 Read/Write vacuum status after clearing the error code (ERC / REC value)

Function	Instruction	Type	Description
Read/Write vacuum status after clearing the error code	ERC ERC value	Read/Write	1 Read/Write vacuum status after clearing the error code. 2 The definition of vacuum status after clearing the error code. 0: Maintain the current vacuum status [factory default setting]. 1: Vacuum automatically disabled status. 3 The instruction definitions are as follows: ERC: Read the vacuum status after clearing the error code. ERC value: Write the vacuum status after clearing the error code (applicable to firmware HPA_T 3.5.2 or T 2.X.35 or higher version).
Example description	**Communication instructions (execution/return)**		**Description**
	→ **ERC** ← 0 ← END → **ERC 1** ← 1 ← END		○ **Read vacuum status after clearing the error code** ○ Return vacuum status ○ Command completed ○ **Write vacuum status after clearing the error code** ○ Return vacuum status ○ Command completed

⚠ **Caution!** Potentially dangerous situation!

Incorrect operation may result in personal injury or property damage.

The instruction is not applicable to the HPA-E series and HPA-S series.

5.5.5 Read/Write vacuum status after alignment (FVC / FVC value)

Function	Instruction	Type	Description
Read/Write vacuum status after alignment	FVC FVC value	Read/Write	1 Read/Write vacuum status after alignment. 2 Definitions of the vacuum status after alignment are as follows: 0: Keep vacuum at the enabled status [factory default setting]. 1: Vacuum automatically disabled status. 3 The instruction definitions are as follows: FVC: Read vacuum status after alignment. FVC value: Write vacuum status after alignment.
Example description	**Communication instructions (execution/return)**		**Description**
	→ **FVC** ← 0 ← END → **FVC 1** ← 1 ← END		○ **Read vacuum status after** alignment ○ Reply vacuum status ○ Command completed ○ **Write vacuum status after** alignment ○ Reply vacuum status ○ Command completed

5.5.6 Read/Write wafer direction (FWO / FWO value)

Function	Instruction	Type	Description
Read/Write wafer direction	FWO FWO value	Read/Write	1 Read/write the angle of the wafer's directional feature, such as a notch or primary flat. 2 The unit of the angle is 0.1°, and the angle range is 0–3599 [the factory default setting is 0°]. 3 The instruction definitions are as follows: FWO: Read angle setting. FWO value: Write angle.
Example description	**Communication instructions (execution/return)**		**Description**
	→ **FWO** ← 0 ← END → **FWO 1800** ← 1800 ← END		○ **Read notch setting angle** ○ Reply notch setting angle ○ Command completed ○ **Write notch angle** ○ Reply notch angle ○ Command completed

5.5.7 Read/Write aligning material (GLM / GLM value)

Function	Instruction	Type	Description
Read/Write alignment material	GLM GLM value	Read/Write	1 Read/Write the detection sensitivity of the laser sensor. 2 The value definitions are as follows: 0: Set to measure non-transparent objects [factory default setting]. 1: Set to measure transparent and translucent objects. 2: Set to measure non-transparent and transparent objects (overlaid wafer). 3 The instruction definitions are as follows: GLM: Read the alignment object material setting. GLM value: Write alignment object material.
Example description	**Communication instructions (execution/return)**		**Description**
	→ **GLM** ← 0 ← END → **GLM 1** ← 1 ← END		○ **Read alignment object material** ○ Reply alignment object material ○ Command completed ○ **Write aligning object material** ○ Reply alignment object material ○ Command completed

⚠ **Caution!** Potentially dangerous situation!

Incorrect operation may result in personal injury or property damage.

- The transparent object of the overlaid wafer is usually transparent glass.
- GLM=2 configuration only applies to firmware version V2.X.36 or V.3.5.3.0 or later. In case of update of the old version firmware, the configurations of the mapping sensors must be taken into account.

5.5.8 Read/Write vacuum monitor status (VMD / VMD value)

Function	Instruction	Type	Description
Read/Write vacuum monitor status	VMD VMD value	Read/Write	1 Read/Write vacuum monitor status. 2 The value definitions are as follows: 0: When activating vacuum (CVN) and wafer alignment (BAL), the system only determines if the vacuum is established but does not measure the negative pressure. [Note 1][Note 2] 1: When activating vacuum (CVN) and wafer alignment (BAL), the system detects if the negative pressure is in the range of 50~-80kPa as in the product specs [factory default]. 3 The instruction definitions are as follows: VMD: Read vacuum monitor status. VMD Value: Write vacuum monitor status (applicable to firmware HPA_T 3.5.3 or T 2.X.36 or higher version).
Example description	**Communication instructions (execution/return)**		**Description**
	→ **VMD** ← 1 ← END → **VMD 0** ← 0 ← END		○ **Read vacuum monitor status.** ○ Return vacuum monitoring status ○ Command completed ○ **Write vacuum monitor status.** ○ Return vacuum monitoring status ○ Command completed

⚠ **Caution!** Potentially dangerous situation!

Incorrect operation may result in personal injury or property damage.

- It is recommended to use the negative pressure specification for the product to prevent excessive or insufficient supply of negative pressure resulting in the wafer dropping or wafer breakage.
- Where the supply of negative pressure is lower than -15 kPa or higher than -100 kPa, the system cannot determine if the vacuum is established and returns an abnormal vacuum error.
- The instruction is not applicable to the HPA-E series.

5.5.9 Read/Write wafer size (WSZ / WSZ value)

Function	Instruction	Type	Description
Read/Write wafer size	WSZ WSZ value	Read/Write	1 Read/Write wafer size. 2 The unit of wafer size is inches, and the values are defined as follows: ○ **Model: HPA26** 0: Null [factory default setting] 2: Wafer size is 2" 3: Wafer size is 3" 4: Wafer size is 4" (100 mm) 5: Wafer size is 5" (125 mm) 6: Wafer size is 6" (150 mm) ○ **Model: HPA48, HPA48-W** 0: Null [factory default] 4: Wafer size is 4" (100 mm) 5: Wafer size is 5" (125 mm) 6: Wafer size is 6" (150 mm) 8: Wafer size is 8" (200 mm) ○ **Model: HPA812, HPA812-W** 0: Null [factory default] 8: Wafer size is 8" (200 mm) 12: Wafer size is 12" (300 mm) ○ **Model: HPA8-E** 0: Wafer size is not configured [factory default] 8: Wafer size is 8" (200 mm) ○ **Model: HPA12-E** 0: Wafer size is not configured [factory default] 12: Wafer size is 12" (300 mm) ○ **Model: HPA612-S** 0: Null [factory default] 6: Wafer size is 6" (150 mm) 8: Wafer size is 8'' (200 mm) 12: Wafer size is 12''(300mm) 3 The instruction definitions are as follows: VMD: Read vacuum monitor status. VMD Value: Write vacuum monitor status.
Example description	**Communication instructions (execution/return)**		**Description**
	→ **WSZ** ← 8 ← END → **WSZ 12** ← 12 ← END		○ **Read wafer size** ○ Reply wafer size ○ Command completed ○ **Write wafer size** ○ Reply wafer size ○ Command completed

5.6 Write instructions

Write instruction types: their detailed functional definitions and descriptions are as follows:

5.6.1 Auto initiation of laser sensor offset (ADA)

Function	Instruction	Type	Description
Auto initiation of mapping sensor offset	ADA	Write	1 The range of auto initiation of the laser sensor offset is 0–5266. In case of initiation failure (ERR-07-07), please clean the mirror surface of the laser sensor and clear all obstacles in the laser range. 2 After the firmware is updated, auto initiation of the laser sensor offset is required for the initiation configuration and the SPS instruction must be executed upon completion to save (applicable to firmware HPA_T 3.5.1 or higher version).
Example description	**Communication instructions (execution/return)**		**Description**
	→ **ADA** ← XXXX ← END		○ **Write the auto initiation of laser sensor offset** ○ Return the initiation offset value ○ Command completed

⚠ **Caution!** Potentially dangerous situation!

Incorrect operation may result in personal injury or property damage.

The DEF instruction does not reset the configuration.

5.6.2 Disable vacuum (CVF)

Function	Instruction	Type	Description
Disable vacuum	CVF	Write	1 Disable vacuum to release the wafer [factory default setting].
Example description	**Communication instructions (execution/return)**		**Description**
	→ **CVF** ← BUSY ← END		○ **Write disable vacuum** ○ Command executing ○ Command completed

⚠ **Caution!** Potentially dangerous situation!

Incorrect operation may result in personl injury or property damage.

This instruction is not applicable to the HPA-E series.

5.6.3 Enable vacuum (CVN)

Function	Instruction	Type	Description
Enable vacuum	CVN	Write	1 Enable vacuum to suck up the wafer. 2 After enabling vacuum, if the pressure sensor determines that the negative pressure is outside the range, it will issue an alarm and disable the vacuum.
Example description	**Communication instructions (execution/return)**		**Description**
	→ **CVF** ← BUSY ← END		○ **Write enable vacuum** ○ Command executing ○ Command completed

⚠ **Caution!** Potentially dangerous situation!

Incorrect operation may result in personal injury or property damage.

This instruction is not applicable to the HPA-E series.

5.6.4 Restore factory default parameters (DEF)

Function	Instruction	Type	Description
Restore factory default parameters	DEF	Write	1 Set instruction parameters such as GLM, _WT, FWO, WSZ, FVC, ERC, COF, VMD and CPS to factory default setting.
Example description	**Communication instructions (execution/return)**		**Description**
	→ **DEF** ← BUSY ← END		○ **Execute restore factory default parameters** ○ Command executing ○ Command completed

5.6.5 Write motor excitation status (SME value)

Function	Instruction	Type	Description
Write motor excitation status	SME value	Write	1 Write motor excitation status. 2 Definitions of the motor excitation parameters are as follows: 11: Enable excitation status for the X-axis motor. 10: Disable excitation status for the X-axis motor. 21: Enable excitation status for the Y-axis motor. 20: Disable excitation status for the Y-axis motor. 31: Enable excitation status for the θ-axis motor. 30: Disable excitation status for the θ-axis motor.
Example description	**Communication instructions (execution/return)**		**Description**
	→ **SME 11** ← BUSY ← END → **SME 30** ← BUSY ← END		○ **Write enable excitation status for the X-axis motor** ○ Command executing ○ Command completed ○ **Write release excitation status for the θ-axis motor** ○ Command executing ○ Command completed

5.6.6 Save the settings (SPS)

Function	Instruction	Type	Description
Save the settings	SPS	Write	1 After setting the various wafer parameters, make sure to execute the save settings (SPS) instruction. 2 Continuing from above, if the SPS instruction was not executed, when the machine is powered off, the parameter settings will not be saved. 3 After the machine is powered up, the various wafer parameters previously saved with the SPS instruction will be read automatically.
Example description	**Communication instructions (execution/return)**		**Description**
	→ **SPS** ← BUSY ← END		○ **Execute save setting (SPS)** ○ Command executing ○ Command completed

5.6.7 Save the settings (SPS)

Function	Instruction	Type	Description
Stop motion	STP	Write	1 The motor of all axes will stop the motions immediately.
Example description	**Communication instructions (execution/return)**		**Description**
	→ **STP** ← BUSY ← END		○ **Write each axis stop motion** ○ Command executing ○ Command completed

5.7 Response instructions

Response instruction types: their detailed functional definitions and descriptions are as follows:

5.7.1 Instruction executing (BUSY)

Function	Instruction	Type	Description
Instruction executing	BUSY	Response	1 Instruction executing.
Example description	**Communication instructions (execution/return)**		**Description**
	→ HOM ← **BUSY** ← END		○ Execute reset motion instruction ○ Command executing ○ **Command completed**

5.7.2 Instruction execution completed (END)

Function	Instruction	Type	Description
Instruction execution completed	END	Response	1 Instruction execution completed.
Example description	**Communication instructions (execution/return)**		**Description**
	→ HOM ← BUSY ← **END**		○ Execute reset motion instruction ○ **Command executing** ○ Command completed

5.7.3 Instruction execution abnormal (ERR)

Function	Instruction	Type	Description
Instruction execution abnormal	ERR	Response	1 Instruction execution abnormal
Example description	**Communication instructions (execution/return)**		**Description**
	→ HOM ← BUSY ← **ERR XXXX**		○ Execute reset motion instruction ○ Command executing ○ **Motion error (error code: XXXX)**

5.8 Event instructions

Reporting (EVENT) instruction types: their detailed functional definitions and descriptions are as follows:

The function is only applicable to firmware HPA_T 3.5.3 or higher version.

5.8.1 Reporting function (EVT/ EVT value)

Function	Instruction	Type	Description
Reporting function	EVT EVT value	Read/Write	1 Read/Write the reporting function 2 The definitions of the reporting function are as following: 0: Activate the reporting function [factory default setting] 1: Deactivate the reporting function 3 The instruction definitions are as follows: EVT: Read the reporting function configuration EVT value: Write the reporting function (applicable to firmware HPA_T 3.5.3 or higher version)
Example description	**Communication instructions (execution/return)**		**Description**
	→ **EVT** ← 0 ← END → **EVT 1** ← 1 ← END		○ **Read the reporting function configuration** ○ Return the reporting function configuration ○ Command completed ○ **Write the reporting function** ○ Return configuration of the reporting function ○ Command completed

5.8.2 Machine reporting state (STM/STM E/STM E value)

Function	Instruction	Type	Description
Reporting state machine	STM STM E STM E value	Event/ Read/ Write	1 Read/Write reporting state machine function. 2 STM: Read the current status of the state machine. 3 STM E: Read the state machine reporting configuration. 4 STM E value: Write the state machine reporting function individually. 0: Deactivate the state machine reporting function individually [factory default]. 1: Activate the state machine reporting function individually (the EVT reporting function must be activated first). (applicable to firmware HPA_T 3.5.3 or higher version)

Example description	Communication instructions (execution/return)	Description
	→ **STM** ← 1 ← END → **STM E** ← 0 ← END → **STM E 1** ← 1 ← END → HOM ← BUSY ← **EVT STM 2** ← END ← **EVT STM 1**	○ **Read the state machine status** ○ Return the state machine status ○ Command completed ○ **Read the state machine reporting configuration** ○ Return the **state machine** reporting function ○ Command completed ○ **Write the state machine reporting function individually** ○ Return configuration of the **state machine** reporting function ○ Command completed ○ Execute reset motion instruction ○ Command executing ○ **Return the state machine status** ○ Command completed ○ **Return the state machine status**

Return code descriptions	State machine status	Return format of state machine	Description
	1	EVT STM 1	IDLE
	2	EVT STM 2	BUSY
	3	EVT STM 3	WARNING
	4	EVT STM 4	ALARM
	5	EVT STM 5	EMG
	6	EVT STM 6	STOP

5.8.3 Reporting input/output status (GIO /GIO E/GIO E value)

Function	Instruction	Type	Description
Input and output status of reporting	GIO GIO E GIO E value	Event/ Read/ Write	1 Read/Write the reporting input/output function. 2 GIO: Read the current input/output status. 3 GIO E: Read the input/output reporting function. 4 GIO E value: Write the input/output reporting function individually. 0: Deactivate the input/output reporting function individually [factory default]. 1: Activate the input/output reporting function individually (the EVT reporting function must be activated first). (applicable to firmware HPA_T 3.5.3 or higher version)

Example description	Communication instructions (execution/return)	Description
	→ **GIO** ← FFFF/FFFF (Input/Output) ← END → **GIO E** ← 0 ← END → **GIO E 1** ← 1 ← END → CVN ← BUSY ← END ← **EVT GIO FFFF/FFFF**	○ **Read the input and output status** ○ Return the input and output status ○ Command completed ○ **Read input/output reporting function** ○ Return the input and output reporting function ○ Command completed ○ **Write the input/output reporting function individually** ○ Return configuration of the input and output reporting function ○ Command completed ○ Configured as activating the vacuum ○ Command executing ○ Command completed ○ **Return the input and output status**

Return code descriptions	Sequence	Return format of input	Description
	1	0001	FAN sensor
	2	0002	Reserved
	3	0004	Reserved
	4	0008	Reserved
	5	0010	SWITCH 1 (Please refer to the definition of SWH instruction)
	6	0020	SWITCH 2 (Please refer to the definition of SWH instruction)
	7	0040	SWITCH 3 (Please refer to the definition of SWH instruction)
	8	0080	Reserved
	9	0100	Reserved
	10	0200	Reserved
	11	0400	Reserved
	12	0800	Reserved
	13	1000	Reserved
	14	2000	Reserved
	15	4000	Reserved
	16	8000	EMG

Return code descriptions	Sequence	Return format of output	Description
	1	0001	GLM 0
	2	0002	GLM 1
	3	0004	GLM 2
	4	0008	Reserved
	5	0010	Vacuum ON
	6	0020	Reserved
	7	0040	Reserved
	8	0080	Reserved
	9	0100	Reserved
	10	0200	Reserved
	11	0400	Reserved
	12	0800	Reserved
	13	1000	Reserved
	14	2000	Reserved
	15	4000	Reserved
	16	8000	Reserved

5.8.4 Reporting stopping position status (POS / POS E / POS E value)

Function	Instruction	Type	Description
Status of stopping position reporting	POS POS E POS E value	Event/ Read/ Write	1 Read/Write the stopping position reporting function. 2 POS: Read the current status of stopping position. 3 POS E: Read stopping position reporting function. 4 POS E value: Write the stopping position reporting function individually. 0: Deactivate the stopping position reporting function individually [factory default setting]. 1: Activate the stopping position reporting function individually (the EVT reporting function must be activated first). (applicable to firmware HPA_T 3.5.3 or higher version)

Example description	Communication instructions (execution/return)	Description
	→ **POS**	○ **Read the status of the stopping position**
	← 0	○ Return the status of the stopping position
	← END	○ Command completed
	→ **POS E**	○ **Read the stopping position reporting configuration**
	← 0	○ Return the stopping position reporting function
	← END	○ Command completed
	→ **POS E 1**	○ **Write the stopping position reporting function individually**
	← 1	○ Return configuration of the stopping position reporting function
	← END	○ Command completed
	→ HOM	○ Execute reset motion instruction
	← BUSY	○ Command executing
	← END	○ Command completed
	← **EVT POS 5**	○ **Return the status of the stopping position**

Return code descriptions	Status of stopping position	Return format of stopping position	Description
	1	EVT POS 0	N/A position (not reset after the machine is on)
	2	EVT POS 1	BAL result
	3	EVT POS 2	STOP position
	4	EVT POS 3	EMG position
	5	EVT POS 4	Vacuum error position
	6	EVT POS 6	MTH position
	7	EVT POS 7	MTM position
	8	EVT POS 8	MVR T position
	9	EVT POS 9	MVR X position
	10	EVT POS 10	MVR Y position
	11	EVT POS 11	WSZ 2 position
	12	EVT POS 12	WSZ 3 position
	13	EVT POS 13	WSZ 4 position
	14	EVT POS 14	WSZ 5 position
	15	EVT POS 15	WSZ 6 position
	16	EVT POS 16	WSZ 8 position
	17	EVT POS 17	WSZ 12 position
	18–30	EVT POS 17~30	Reserved
	31	EVT POS 31	Error position

5.8.5 Reporting laser detection object status (DOC /DOC E/DOC E value)

Function	Instruction	Type	Description
Reporting laser detection object status	DOC DOC E DOC E value	Event/ Read/ Write	1 Read/Write the laser detection object reporting function. 2 DOC: Read the current laser detection object status. 3 DOC E: Read the laser detection object reporting function. 4 DOC E value: Write the laser detection object reporting function individually. 0: Deactivate the laser detection object reporting function individually [factory default setting]. 1: Activate the laser detection object reporting function individually (the EVT reporting function must be activated first.) (Applicable to firmware HPA_T 3.5.3 or higher version)

Example description	Communication instructions (execution/return)	Description
	→ **DOC** ← 0 ← END → **DOC E** ← 0 ← END → DOC E 1 ← 1 ← END → Wafer Placement ← **EVT DOC 1**	○ **Read the laser detection object status** ○ Return the laser detection object status ○ Command completed ○ **Read the laser detection object reporting function** ○ Return the laser detection object reporting function ○ Command completed ○ **Write the laser detection object reporting function individually** ○ Return configuration of the laser detection object reporting function ○ Command completed ○ Place the wafers ○ **Return the laser detection object status**

Return code descriptions	Laser detection object status	Return format of laser detection object	Description
	0	EVT DOC 0	No blocking in the laser detection range
	1	EVT DOC 1	Partial blocking in the laser detection range
	2	EVT DOC 2	Laser ADC IC abnormal
	3	EVT DOC 3	Full blocking in the laser detection range

⚠ **Caution!** Type and source of warning

Incorrect operation may result in personal injury or property damage.

- The laser detection object instruction (DOC 1) and the laser detection object reporting instruction (EVT DOC 1) are different as the DOC instruction is given manually, and the reporting function automatically returns whenever the status is changed.

6 Troubleshooting and repair

- Please have the system designer or someone with sufficient knowledge and experience select the product specifications. Read the user manual carefully and complete relevant related safety education training before operating this product.

Error type	Error code	Description	Error type
ERR RESET FAIL	ERR-01-01	Origin reset motion abnormal. ▶ Please execute origin reset (HOM) again.	Alarm
	ERR-01-02	After origin reset, X-axis stop position error. ▶ Please execute origin reset (HOM) again.	
	ERR-01-03	After origin reset, Y-axis stop position error. ▶ Please execute origin reset (HOM) again.	
	ERR-01-04	Origin rest was not executed first after powering on or alarms, and motion instructions were executed instead. ▶ Please execute origin reset (HOM) again.	
	ERR-01-05	After origin reset, Z-axis stop position error (HPA-E and HPA-S only). ▶ Please execute origin reset (HOM) again.	
ERR POSITION ERROR	ERR-02-01	After motion instruction (MVR, HOM), θ-axis stop position abnormal; motor exceeded control position. ▶ Please check whether the θ-axis motor is abnormal. If rotation is not smooth or there are strange noises, troubleshoot, clear the error code (ERS), and send the instruction again.	Alarm
	ERR-02-02	After motion instruction (MVR, HOM), θ-axis stop position abnormal; motor did not reach the control position. ▶ Please check whether the θ-axis motor is abnormal. If rotation is not smooth or there are strange noises, troubleshoot, clear the error code (ERS), and send the instruction again.	
	ERR-02-03	After motion instruction (MTH, MTM, MVR axis, BAL), X-axis stop position abnormal. ▶ Please check whether the machine motor and encoder are abnormal.	

⚠ **Caution!** Incorrect operation may result in personal injury or property damage.

When an alarm occurs, the alarm needs to be cleared (ERS); if the alarm was triggered by a stop, the alarm needs to be cleared (ERS) and origin reset (HOM) needs to be performed.

Error type	Error code	Description	Error type
ERR POSITION ERROR	ERR-02-04	After motion instruction (MTH, MTM, MVR axis, BAL), Y-axis stop position abnormal. ▶ Please check whether the machine motor and encoder are abnormal.	Alarm
	ERR-02-05	After motion instruction (HOM, MTH, and MTM), θ-axis stop position abnormal; motor exceeded control position. (HPA-E only) ▶ Please check whether the θ-axis motor is abnormal. If rotation is not smooth or there are strange noises, troubleshoot, clear the error code (ERS), and send the instruction again.	
	ERR-02-06	After motion instruction (HOM, MTH, and MTM), θ-axis stop position abnormal; motor did not reach control position (HPA-E and HPA-S only). ▶ Please check whether the θ-axis motor is abnormal. If rotation is not smooth or there are strange noises, troubleshoot, clear the error code (ERS), and send the instruction again.	
	ERR-02-07	After motion instruction (MTH, MTM, MVR axis, BAL), Z-axis stop position abnormal (HPA-E and HPA-S only). ▶ Please check whether the machine motor and encoder are abnormal.	
ERR VACUUM STATUS ERROR	ERR-03-01	After enabling vacuum, the pressure sensor detected that the negative pressure status was lower than -50 kPa. ▶ Please check whether the negative pressure (vacuum) is normal.	Warning
	ERR-03-02	After enabling vacuum, the pressure sensor detected that the negative pressure status was higher than -80kPa. ▶ Please check whether the negative pressure (vacuum) is normal.	
	ERR-03-03	After the vacuum is disabled, the pressure sensor status is ON. ▶ Please check whether the negative pressure (vacuum) is normal.	

⚠ **Vorsicht!** Incorrect operation may result in personal injury or property damage.

When alarm occurs, the alarm needs to be cleared (ERS); if the alarm was triggered by a stop, the alarm needs to be cleared (ERS) and origin reset (HOM) needs to be performed.

Error type	Error code	Description	Error type
ERR ALIGN ERROR	ERR-04-01	Before executing the alignment instruction (BAL), the position of the X-axis motor is not at the measurement centre point. ▶ Please perform measurement centre point reset (MTM).	Warning
	ERR-04-02	Before executing the alignment instruction (BAL), the position of the Y-axis motor is not at the measurement centre point. ▶ Please perform measurement centre point reset (MTM).	Warning
	ERR-04-03	When executing primary alignment, the motion failed, and the θ-axis motor exceeded the control position. ▶ Please check whether the θ-axis motor is abnormal. If rotation is not smooth or there are strange noises, troubleshoot, clear the error code (ERS), and send the alignment instruction (BAL) to execute the motion.	Alarm
	ERR-04-04	When executing primary alignment, the motion failed, and the θ-axis motor did not reach the control position. ▶ Please check whether the θ-axis motor is abnormal. If rotation is not smooth or there are strange noises, troubleshoot, clear the error code (ERS), and send the alignment instruction (BAL) to execute the motion.	Alarm
	ERR-04-05	When moving the position to the starting point of secondary alignment, the motion failed, and the θ-axis motor exceeded the control position [Note 1]. ▶ Please check whether the θ-axis motor is abnormal. If rotation is not smooth or there are strange noises, troubleshoot, clear the error code (ERS), and send the alignment instruction (BAL) to execute the motion.	Alarm

⚠ **Caution!** Incorrect operation may result in personal injury or property damage.

When an alarm occurs, the alarm needs to be cleared (ERS); if the alarm was triggered by a stop, the alarm needs to be cleared (ERS) and origin reset (HOM) needs to be performed.

Error type	Error code	Description	Error type
ERR ALIGN ERROR	ERR-04-06	When moving the position to the starting point of secondary alignment, the motion failed, and the θ-axis motor did not reach the control position [Note 1]. ▶ Please check whether the θ-axis motor is abnormal. If rotation is not smooth or there are strange noises, troubleshoot, clear the error code (ERS), and send the alignment instruction (BAL) to execute the motion.	Alarm
	ERR-04-07	When executing secondary alignment, the motion failed, and the θ-axis motor exceeded the control position [Note 1]. ▶ Please check whether the θ-axis motor is abnormal. If rotation is not smooth or there are strange noises, troubleshoot, clear the error code (ERS), and send the alignment instruction (BAL) to execute the motion.	Alarm
	ERR-04-08	When executing secondary alignment, the motion failed, and the θ-axis motor did not reach the control position [Note 1]. ▶ → Please check whether the θ-axis motor is abnormal. If rotation is not smooth or there are strange noises, troubleshoot, clear the error code (ERS), and send the alignment instruction (BAL) to execute the motion.	Alarm
	ERR-04-09	θ-axis rotation position error, motor exceeded the control position. ▶ Please check whether something in the machine is abnormal, such as the negative pressure (vacuum), motor and encoder, etc.	Alarm
	ERR-04-10	θ-axis rotation position error, the motor did not reach the control position. ▶ Please check whether something in the machine is abnormal, such as the negative pressure (vacuum), motor and encoder, etc.	Alarm

⚠ **Caution!** Potentially dangerous situation!

Incorrect operation may result in personal injury or property damage.

▶ When an alarm occurs, the alarm needs to be cleared (ERS); if the alarm was triggered by a stop, the alarm needs to be cleared (ERS) and origin reset (HOM) needs to be performed.

Note 1

There are four error codes for ERR-04-05 ~ ERR-04-08, and they are only applicable to versions earlier than firmware HPA_T 2.1.13.

Error type	Error code	Description	Error type
ERR ALIGN ERROR	ERR-04-11	After executing the alignment instruction, the wafer feature cannot be identified. ▶ Please check whether the wafer feature (notch) is abnormal, whether the parameter settings (_WT, GLM) have errors, and whether it is within the measurement range (DOC). ▶ Please check whether the glass of the laser sensor is dirty.	Warning
	ERR-04-12	Negative pressure (vacuum) abnormal during the alignment instruction. ▶ Please check whether the negative pressure (vacuum) is normal.	Warning
	ERR-04-13	Laser sensing abnormal during the alignment instruction. ▶ Please check whether the wafer placement position exceeded the laser scanning range or confirm whether the laser is normal.	Alarm
	ERR-04-14	Before executing the alignment instruction (BAL), the position of the Z-axis motor is not at the measurement centre point (HPA-E and HPA-S only). ▶ Please return to the measurement point (MTM).	Warning
	ERR-04-15	Before executing the alignment instruction (BAL), the position of the T-axis motor is not at the measurement centre point (HPA-E and HPA-S only). ▶ Please return to the measurement point (MTM).	Warning
	ERR-04-16	Failure of the primary rotation calibration, the motor exceeded the control position (HPA-E and HPA-S only). ▶ Please check whether the θ-axis motor is abnormal. If rotation is not smooth or there are strange noises, troubleshoot, clear the error code (ERS) and send the alignment instruction (BAL) to execute the motion.	Alarm

⚠ **Caution!** Incorrect operation may result in personal injury or property damage.

When an alarm occurs on the product, the alarm needs to be cleared (ERS); if the alarm was triggered by a stop, the alarm needs to be cleared (ERS) and origin reset (HOM) needs to be performed.

Error type	Error code	Description	Error type
ERR ALIGN ERROR	ERR-04-17	Failure of the primary rotation calibration, the motor did not reach the control position (HPA-E and HPA-S only). ▶ Please check whether the θ-axis motor is abnormal. If rotation is not smooth or there are strange noises, troubleshoot, clear the error code (ERS) and send the alignment instruction (BAL) to execute the motion.	Alarm
	ERR-04-18	Failure of the secondary rotation calibration, the motor exceeded the control position (HPA-E and HPA-S only). ▶ Please check whether the θ-axis motor is abnormal. If rotation is not smooth or there are strange noises, troubleshoot, clear the error code (ERS) and send the alignment instruction (BAL) to execute the motion.	Alarm
	ERR-04-19	Failure of the secondary rotation calibration, the motor did not reach the control position (HPA-E and HPA-S only). ▶ Please check whether the θ-axis motor is abnormal. If rotation is not smooth or there are strange noises, troubleshoot, clear the error code (ERS) and send the alignment instruction (BAL) to execute the motion.	Alarm
ERR ALIGN LIMIT OVER	ERR-05-01	After executing the alignment instruction, the correction value of the wafer centre exceeded the allowable offset. ▶ Please check whether the wafer placement position exceeded the correction range.	Warning
ERR ERROR CLEAR	ERR-06-01	After the abnormal status (alarm) is eliminated, the alarm was not turned off. ▶ After eliminating the abnormal status (alarm), please clear the alarm (ERS).	Alarm
	ERR-06-02	Stop occurred, but the status was not turned off. ▶ Please initiate a stop.	
ERR SETTING ERROR	ERR-07-01	Write parameter error (ex. overstroke/ setting range exceeded) ▶ Please check whether the set parameters match the definition; please refer to the command list.	Warning

⚠ **Caution!** Incorrect operation may result in personal injury or property damage.

When an alarm occurs on the product, the alarm needs to be cleared (ERS); if the alarm was triggered by a stop, the alarm needs to be cleared (ERS) and origin reset (HOM) needs to be performed.

Error type	Error code	Description	Error type
ERR SETTING ERROR	ERR-07-02	Related parameters not set yet. ▶ Please set correction-related parameters (WSZ, _WT, GLM and FWO, etc.).	Warning
	ERR-07-03	Motor excitation abnormal. ▶ Please send the SMD instruction to query the excitation status of the motor; if the motor is de-excited, please send the SME instruction to enable motor excitation.	
	ERR-07-04	Abnormal model configuration. ▶ Please check the corresponding model of the DIP switch configuration via the SWH instruction to query the DIP switch configuration.	
	ERR-07-05	Version compatibility problem. ▶ Please check the version and the models supported by the version (VER instruction version inquiry).	
	ERR-07-06	After updating the firmware, the laser offset is not calibrated. ▶ Please refer to the user manual for operation of the ADA instruction.	
	ERR-07-07	The laser offset is not calibrated, failed to initiate. ▶ Please clean the mirror surface of the mapping sensor and clear all obstacles in the laser range, and then give the instruction again.	
ERR COMMAND ERROR	ERR-08-01	Instruction string error. ▶ Please check whether the instruction sent matches the definition; please refer to the command list.	Warning
	ERR-08-02	New instruction was received before replying to the previous instruction. ▶ Please stop sending instructions, wait for the current instruction to finish executing (END), and send the new instruction.	
ERR SYSTEM	ERR-09-01	Stop triggered. ▶ Please correct the abnormal status, and then initiate a stop.	Alarm
	ERR-09-02	Fan abnormal. ▶ Please correct the abnormal status of the fan, and then execute motions.	
ERR FLASH	ERR-10-01	FLASH abnormal. ▶ Please contact HIWIN/the manufacturer.	Alarm

⚠ **Caution!** Incorrect operation may result in personal injury or property damage.

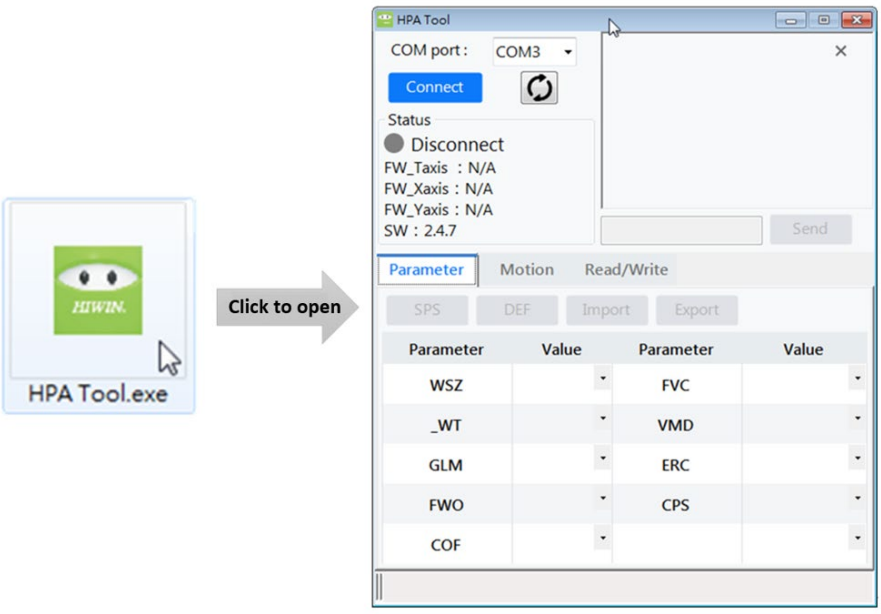
When an alarm occurs, the alarm needs to be cleared (ERS); if the alarm was triggered by a stop, the alarm needs to be cleared (ERS) and origin reset (HOM) needs to be performed.

7 Parameter configuration software (HPA tool)

- Please have the system designer or someone with sufficient knowledge and experience select the product specifications. Read the user manual carefully and complete relevant safety education training before operating this product.

The parameter configuration software (HPA Tool) specific to the aligner,is mainly used for showing the system parameters, configuring/backing up the system parameters and the simple instruction operations, and for users to observe the current status of the machine, manually perform tests and export logs, as shown in Fig. 7.1.

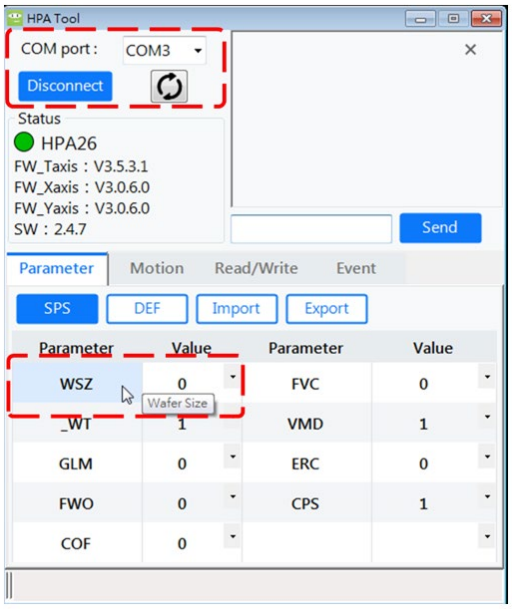
Fig. 7.1: The HPA Tool



7.1 System connection

When connecting the system, as shown in Fig. 7.2, the model of the machine and the versions of the soft- and firmware as well as the system parameters are shown instantly and the simple operation function buttons are activated for the users to configure the application. Tips are provided for each function button to describe the how to use the instruction (e.g. WSZ=wafer size).

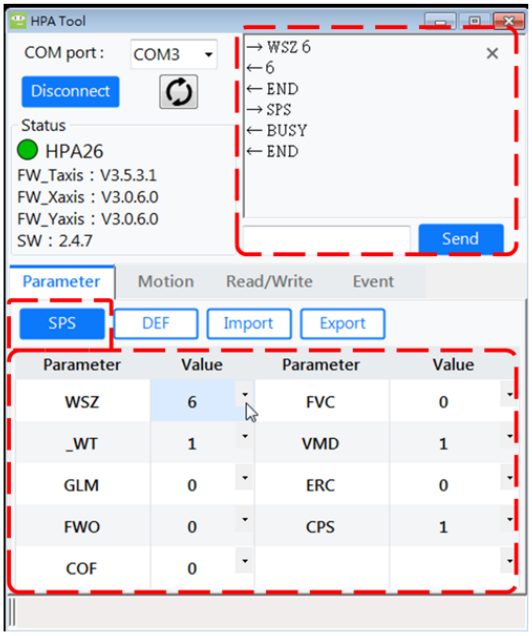
Fig. 7.2: The HPA Tool software interface (connect)



7.2 Description of the parameter page

The Parameter page shows the functions of the system parameter and parameter backup, as shown in Fig. 7.3. For writing/reading the system parameters, click on the value or the drop-down menu to configure, and press the SPS button to save the parameter upon completion of the configuration. The window at the top right shows the current configuration status.

Fig. 7.3: Parameter page



The parameter backup function (import/export) can be configured by clicking on it, as shown in Fig. 7.4. For importing the parameter, the parameter must conform to the spec, as shown in Table 7.1 and Table 7.2.

Fig. 7.4: Import / Export page

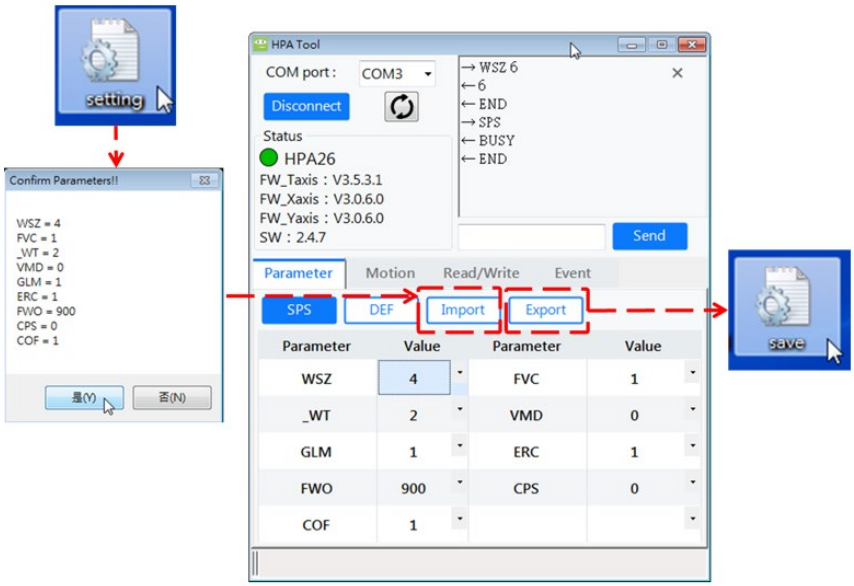


Table 7.1: System parameter definition formats for HPA and HPA-W series

System parameters	HPA26 Data format (range)	HPA48, HPA48-W Data format (range)	HPA812, HPA812-W Data format (range)
WSZ	2, 3, 4, 5, 6	4, 5, 6, 8	8, 12
_WT	0, 1, 2	0, 1, 2	0, 1, 2
GLM	0, 1, 2	0, 1, 2	0, 1, 2

System parameters	HPA26 Data format (range)	HPA48, HPA48-W Data format (range)	HPA812, HPA812-W Data format (range)
FWO	0–3599	0–3599	0–3599
FVC	0, 1	0, 1	0, 1
CPS	0, 1	0, 1	0, 1
ERC	0, 1	0, 1	0, 1
COF	0, 1	0, 1	0, 1
VMD	0, 1	0, 1	0,1

Table 7.2: System parameter definition formats for HPA-E series

System parameters	HPA8-E Data format (range)	HPA12-E Data format (range)
WSZ	8	12
_WT	1	1
GLM	0, 1, 2	0, 1, 2
FWO	0–3599	0–3599
CPS	0, 1	0, 1
COF	0, 1	0, 1

Note

System parameters such as FVC, ERC, VMD are not applicable to the HPA-E series

Table 7.3: System parameter definition formats for HPA-S series

System parameters	HPA612-S Data format (range)
WSZ	6, 8, 12
_WT	0, 1, 2
GLM	0, 1, 2, 3
FWO	0–3599
CPS	0, 1
ERC	0, 1
COF	0, 1
VMD	0, 1
EVS	0, 1
AWO	0–4

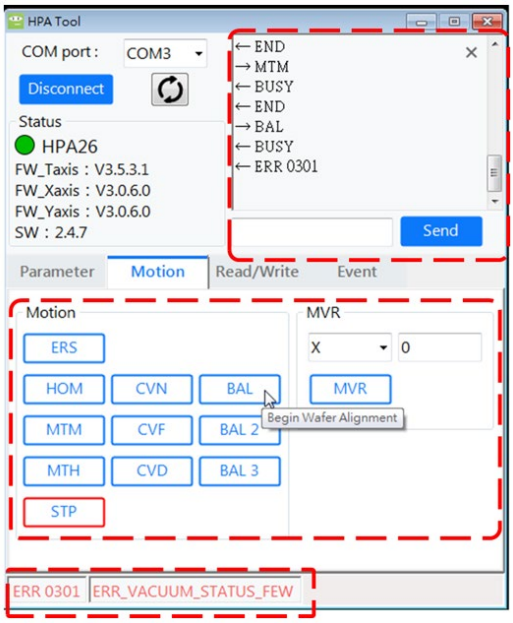
Note

System parameters such as FVC are not applicable to the HPA-S series

7.3 Description of the motion page

The Motion page provides the frequently used operating instructions, as shown in Fig. 7.5. After giving the instruction, the top-right window shows the current status and error codes instantly, and the name of the error code is shown at the bottom. Furthermore, the bottom of the top-right window provides an instruction entry field for users to give the instructions related to the aligner.

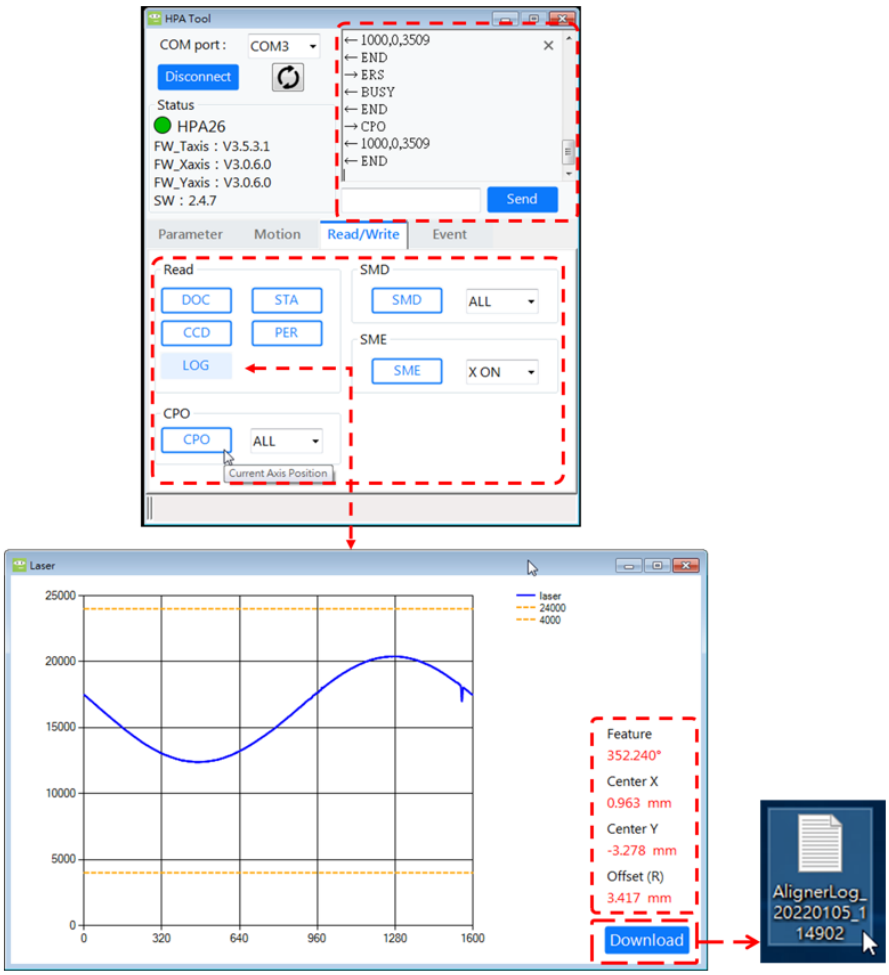
Fig. 7.5: Motion page



7.4 Description of Read/Write page

The Read/Write page provides users with information about the relevant status of the system. As shown in Fig. 7.6, when the user wants to send feedback to HIWIN , the current system parameters can be output using the LOG button and displayed in graphics for user observation forthe System status. Press the Download button to save the data.

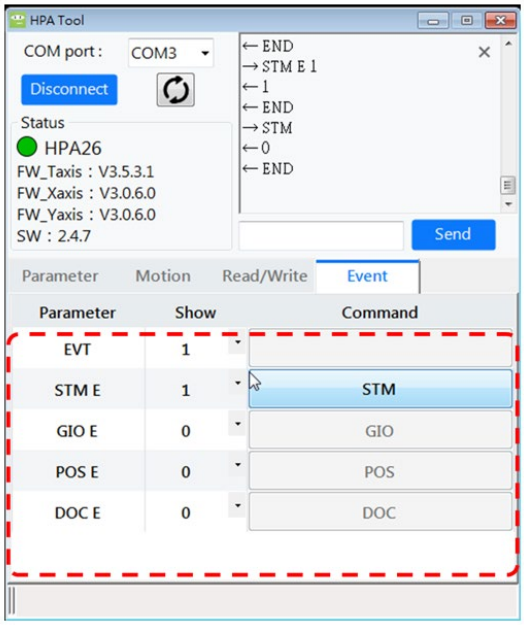
Fig. 7.6: Read/Write page



7.5 Descrition of event page

The Event page lets users define the system reporting function (event function), as shown in Fig. 7.7. This interface can be used if a user wants to write/read the system status, GPIO, positions and laser object detection function,. Please note that the EVT function must be activated to read the related status. The function page is only applicable to the versions after FW: 3.5.3.0 and SW: 2.4.X.X.

Fig. 7.7: Event page



8 Maintenance

- Please have the system designer or someone with sufficient knowledge and experience select the product specifications. Read the user manual carefully and complete relevant safety education training before operating this product.

8.1 Types of electrical work (SEMI S2)

According to SEMI-S2 regulations, maintenance of this product is classified as Type1 or Type2 electrical work; descriptions of other levels of electrical work are as shown in the table below:

Table 8.1: Types of electrical work

Type 1	Equipment is not energized in any way.
Type 2	Equipment is energized. Energized circuits are covered or insulated.
Type 3	Equipment is energized. Energized circuits are exposed, and there is risk of accidentally touching uninsulated energized components. The exposed electrical potential in a dry location is effective value 30 V, peak value 42.4 V, 60 VDC, or 240 VA or less.
Type 4	Equipment is energized. Energized circuits are exposed, and there is risk of accidentally touching uninsulated energized components. The exposed electrical potential in a dry location is effective value 30 V, peak value 42.4 V, 60 VDC, or 240 VA or more.

⚠ **Danger!** Type and source of warning

There is an imminent danger that may lead to severe injuries if not avoided.

▶ Requirements for Type1 electrical work:

Before starting work, please switch off the power of the product controller, switch off the power of the host equipment, and execute lock/tag out operations.

▶ Requirements for Type2 electrical work:

One person should hold the teach pendant and operate the manipulator; another person should observe the overall working range of the manipulator and be prepared to press the stop button if anything goes wrong.

8.2 Daily inspections

No	Inspection item	inspection contents	Inspection methods	Electrical work level
1	Appearance	Observe the appearance of the product to make sure there are no damages.	Visual inspection	Type 1
2	Cleanness	Confirm that there are no dust or oil stains on the outside of the product.	Visual inspection	Type 1
3	Bolts	Confirm that the bolts on the outside of the product are not loose or missing.	Visual inspection	Type 1
4	Connectors	Confirm that the electrical port connectors are connected properly.	Visual inspection	Type 1
5	Pipelines	1 Confirm that the appearances of the cables/tubes are normal. 2 Confirm that the wirings of the cables/tubes are not bent or twisted.	Visual inspection	Type 1
6	Vacuum	1 After enabling the vacuum, the chunk can suck normally without air leakage. 2 After disabling the vacuum, the chunk can release the negative pressure normally.	Instruction test Manual inspection	Type 2

No	Inspection item	inspection contents	Inspection methods	Electrical work level
7	Noises/vibrations	When executing origin reset (HOM), make sure there are no obvious noises, no obvious rough operations, and no abnormal vibrations, etc.	Instruction test Visual inspection	Type 2
8	Precision	Execute the relative movement instruction (MVR) and ensure there are no abnormal motions or excessive stop position differences.	Instruction test Visual inspection	Type 2
9	Laser sensor Lens	1 Make sure there are no dust, dirt or scratches on the lens surface. 2 Read the CCD value; it must be less than 200.	Visual inspection Instruction test	Type 2

⚠ Warning!

Incorrect operation may result in personal injury or property damage.

- Execute the inspections described above daily, and confirm whether the product functions are normal before starting to use this product. If the inspections described above were not executed or abnormal phenomenon were ignored, resulting in broken wafers or damages to the equipment, the warranty will not cover them.

8.3 Regular inspections

No.	Inspection cycle (month)			Inspection items	Inspection contents	Inspection methods	Electrical work level
	3M	6M	12M				
1	●	●	●	Appearance	1 Observe the appearance of the product to make sure there are no damages.	Visual inspection	Type 1
2	●	●	●	Cleanness	1 Confirm that there are no dust or oil stains on the outside of the product.	Visual inspection	Type 1
3	●	●	●	Bolts	1 Confirm that the bolts on the outside of the product are not loose or missing.	Visual inspection	Type 1
4	●	●	●	Connectors	1 Confirm that the electrical port connectors are connected properly.	Visual inspection	Type 1
5	●	●	●	Pipelines	1 Confirm that the appearances of the cables/pipes are normal. 2 Confirm that the wirings of the cables/ pipes are not bent or twisted.	Visual inspection	Type 1
6	●	●	●	Vacuum	1 After enabling the vacuum, the chunk sucks normally without air leakage. 2 After disabling the vacuum, the chunk can release the negative pressure normally.	Instruction test Manual inspection	Type 2
7	●	●	●	Noises/vibrations	1 When executing origin reset (HOM), make sure there are no obvious noises, no obvious rough operations, and no abnormal vibrations, etc.	Instruction test Visual inspection	Type 2
8	●	●	●	Precision	1 Execute the relative movement instruction (MVR) and ensure there are no abnormal motions or excessive stop position differences.	Instruction test Visual inspection	Type 2

No.	Inspection cycle (month)			Inspection items	Inspection contents	Inspection methods	Electrical work level
	3M	6M	12M				
9	●	●	●	Laser sensor lens	1 Make sure there are no dust, dirt or scratches on the lens surface. 2 Read the CCD value; it must be less than 200.	Visual inspection Instruction test	Type 2
10		●	●	Stop	1 Confirm that the stop function is normal.	Manual inspection	Type 2
11		○	●	Cleaning and maintenance of the transmission module	1 Clean and lubricate the transmission mechanisms of each axis. 2 If the environment is dusty or motions are performed frequently, please perform an inspection every six months.	Manual inspection	Type 1
12		○	●	Timing belt	1 Clean the belt of each axis. 2 Confirm that the belts have no severe wear & tear (gear width less than half), and no cracks or ruptures. 3 Confirm that the tension of the belts is not too loose or too tight.	Visual inspection Manual inspection	Type 1
13		○	●	Fan	1 Confirm that the fan is not dirty and exhaust is normal. 2 If the environment is dusty or motions are performed frequently, please perform an inspection every six months	Visual inspection Manual inspection	Type 2
14			●	LED panel	Confirm that the LED display of the product's various statuses is normal.	Instruction test Visual inspection	Type 2

⚠ **Caution!** Type and source of warning

Incorrect operation may result in personal injury or property damage.

▶ Product maintenance instructions:

Product users are obligated to conduct regular maintenance to reduce the possibility of occurrence of random failures; overhaul plans must be arranged when the product has been used for over three years or has an accumulated operation of 11,520 hours in order to maintain product performance and reduce failure rates.

▶ Please contact HIWIN/the manufacturer or dealer for evaluation of regular inspections, maintenance, repairs and replacements of components and accessories.

8.4 Cleaning and maintenance

Before performing maintenance for the X- and Y-axis of single-axis robots, please use the relative movement instruction (MVR) to move the X- and Y-axis to the following maintenance positions first:

- X= 0 (mm)
- Y= -10 (mm)

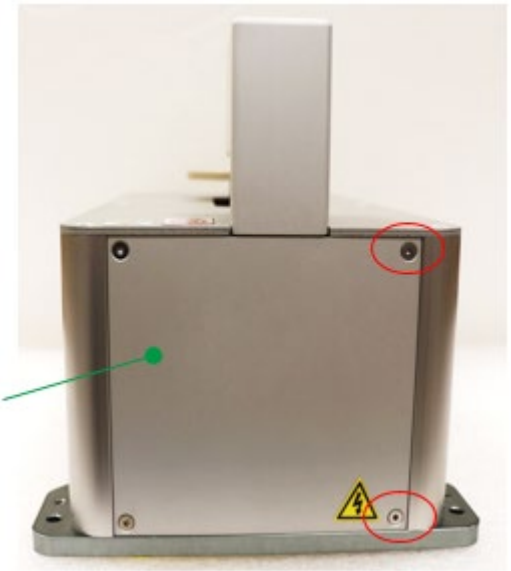
When confirmed that the electrical work level is Type1, perform the following steps in sequence to remove the screws, top board, and side boards:

- Step 1: Remove the two screws on the left side of the front cover, as shown in the figure below:

Fig. 8.1: Remove screws on the left side of the front cover

- Step 2: Remove the two screws on the right side of the rear cover, as shown in the figure below:

Fig. 8.2: Remove screws on the right side of the rear cover

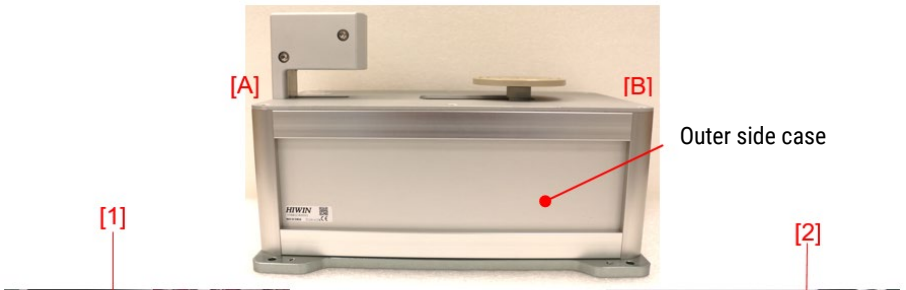


- Step 3: Remove the six screws on the top cover, as shown in the figure below, and rotate the top sheet metal 90 degrees clockwise:

Fig. 8.3: Remove screws on the top cover

- Step 4: Remove the screws on the right and left sides inside the frame and remove the entire side cases, as shown in the figure below:

Fig. 8.4: Remove the screws on the right and left sides



Top view figure A

Top view figure B

Item	Description
1	Left side bolt
2	Right side bolt

Check whether the lubricating grease in the ball screw groove of the X- and Y-axis transmission module and the two inner grooves of the U-shaped track is insufficient or dirty, as shown in the figure below:

Fig. 8.5: The lubricating grease in the ball screw (A)

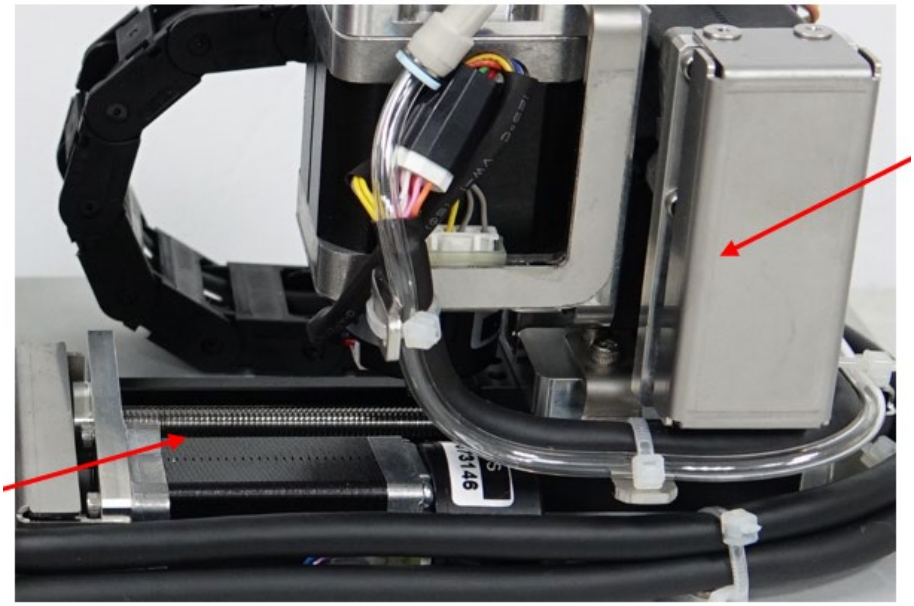


Fig. 8.6: The lubricating grease in the ball screw (B)

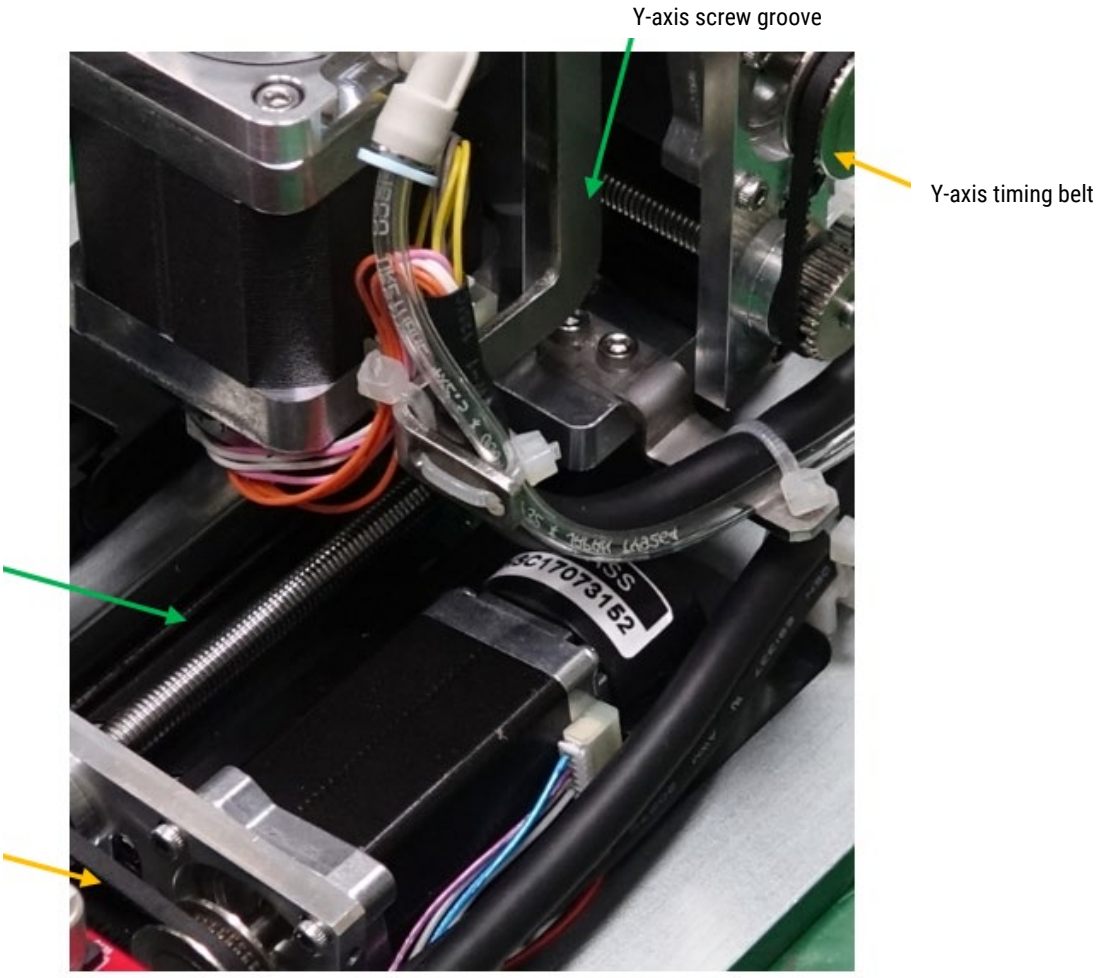
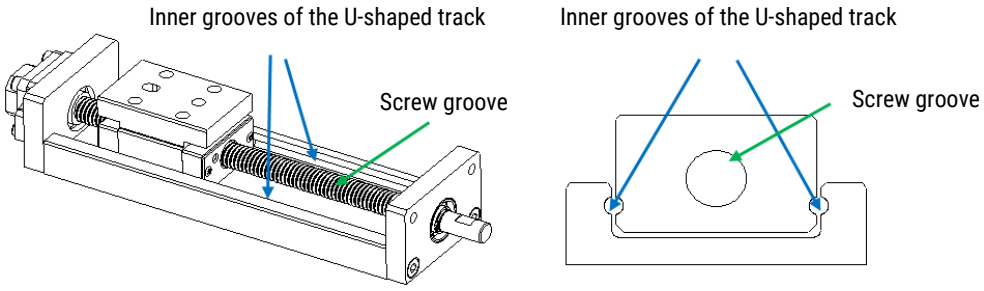


Fig. 8.7: The lubricating grease in the ball screw (C)



Transmission module schematic diagram

Transmission module sectional view

If there is insufficient lubricating grease, please apply lubricating grease on the surface of the screw groove and the two inner grooves of the U-shaped track; if the lubricating grease is dirty, first remove the dirt with a clean wiping cloth or cotton swab, then add grease with the method described above. If dusty environments or frequent motions caused severe contamination, please clean and lubricate repeatedly until no dirt is present.

The recommended lubricating grease is ISOFLEX TOPAS NCA 52; its features include low dust generation, high wear resistance, low friction and long-term lubrication, or other lubricating grease with similar features.

Table 8.2: Lubricating grease is ISOFLEX TOPAS NCA 52

Grease		KLÜBER LUBRICATION
Article number		ISOFLEX TOPAS NCA 52 004179
Colour		Beige
Base oil		Synthetic hydrocarbon oil
Consistency enhancer		Special calcium soap
Service temp. (°C)		-45–125
NLGI grade (0.1 mm)		265–295
Viscosity (cst)	40°C	30
	100°C	5,9
Drop point		> 210
4-ball test (ASTM D2266)		366 µm

When adding lubricating grease, it is recommended to simply apply a layer of grease on the surface of the screw groove and the two inner grooves of the U-shaped track. Performing maintenance procedures such as cleaning and adding grease regularly can ensure smooth and stable operation of the product. It can also prolong the usage life of the product.

Finally, refer to the previous steps and complete them in reverse to lock the screws back in place; after performing daily inspections, use the relative movement instruction (MVR) to run full-stroke reciprocation of the X- and Y-axis several times. If there are no strange noises, vibrations or other abnormal phenomenon, the cleaning and maintenance procedures of the transmission module are complete.

8.5 Clean and maintenance of the laser lenses

Please blow the dust on the transmitter and the receiver away with clean air; if the dirt is thick, it may be wiped off with a soft cloth moistened with alcohol. Confirm that there are no dust, dirt or scratches on the lenses of the transmitter and receiver and confirm the mapping sensor lenses are clean with the CCD instruction; the CCD value must be lower than 200.

9 Appendix

9.1 Firmware update procedures (using master as an example)

- STEP 1: Switch off the DC24V power of the aligner first, and then remove the four hex socket countersunk screws on the rear metal cover, as shown in the red marking in Fig. 9.1. Open the rear metal cover of the aligner, switch the two-stage black firmware programming (boot loader) switch on the circuit board to the left (ON), and it will switch from normal mode to programming mode, as shown in the yellow frame in Fig. 9.2. In front of the black two-stage bootloader switch, there is a white three-stage switch, whose definitions from left to right are Master (θ-axis), Slave 1 (X-axis) and Slave 2 (Y-axis). This white three-stage switch defines the axis for the firmware update. If you want to update the θ-axis, for example, the white three-stage switch must be switched to the left (Master), as shown in the blue frame in Fig. 9.2.

Fig. 9.1: First, switch off the power and remove the screws in the red frame in the figure above.

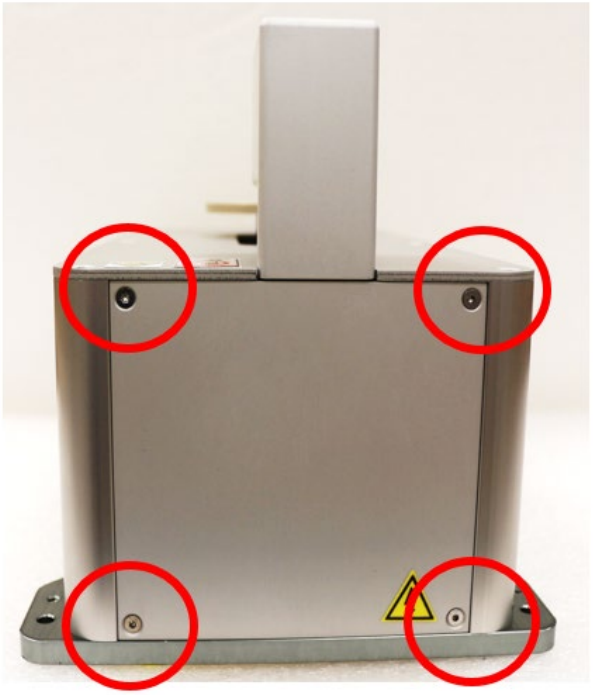


Fig. 9.2: Switch the bootloader switch in the yellow frame to the left (ON) to enter programming mode; switch the axis selection switch in the blue frame to the left (Master-θ-axis)

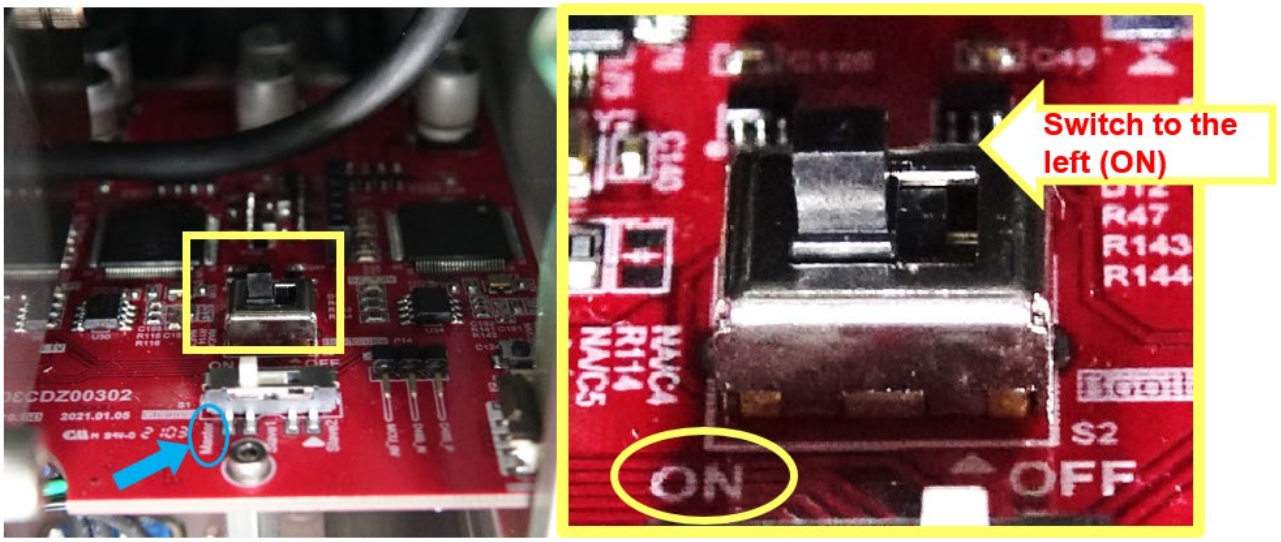
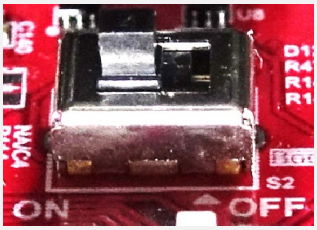
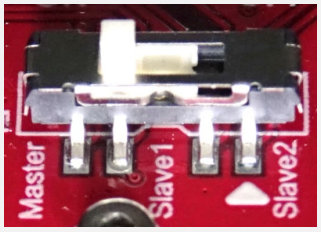


Table 9.1: Descriptions of the hardware switch for aligner firmware update

Function	Switch features	Functional definition	
		Left position (ON)	Right position (OFF)
Firmware update programming	Black two-stage switch 	Firmware programming mode (Bootloader mode)	Normal use mode (Bootloader mode)

Function	Switch features	Functional definition		
		Left position (Master)	Middle position (Slave1)	Right position (Slave1)
Axis (MCU) selection	White three-stage switch 	θ-axis	X-axis	Y-axis

- STEP 2: After switching on the DC24V power of the aligner, make sure that the two red LED lights (Slave1 and Slave2) on the circuit board inside the machine and the abnormal indicator (Master) on the status indication (Alarm) panel flash continuously.

⚠ Beware!

The red light will not flash in normal mode; the red light will flash continuously after entering programming mode

Fig. 9.3: The two red LED lights (yellow frame in the figure above) in the machine flash continuously

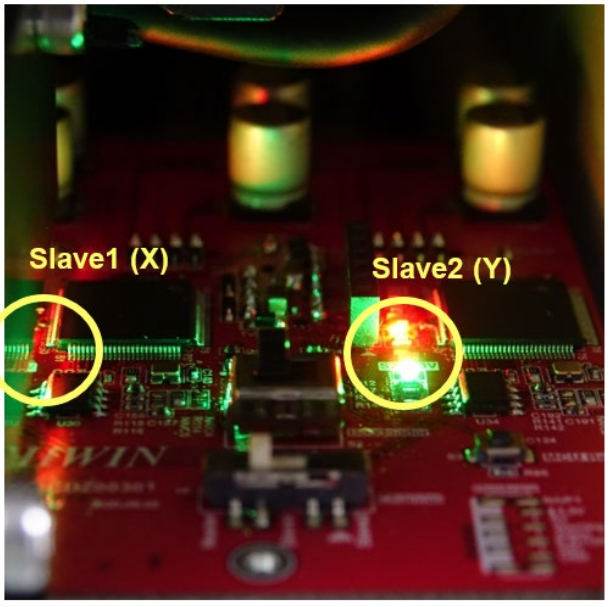


Fig. 9.4: The abnormal indicator on the status indication panel flashes continuously

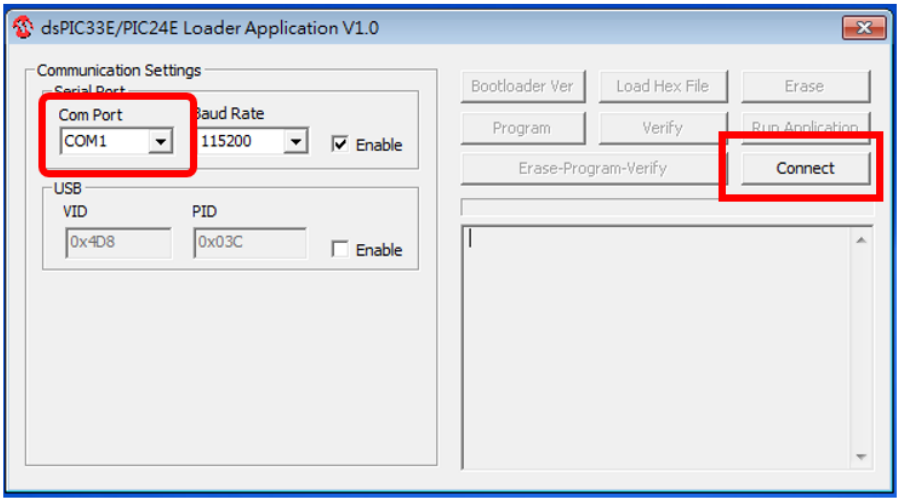
- STEP_3: Open the PC Loader.exe 

programming program, select the COM Port and connect (Press Connect).

⚠ Beware!

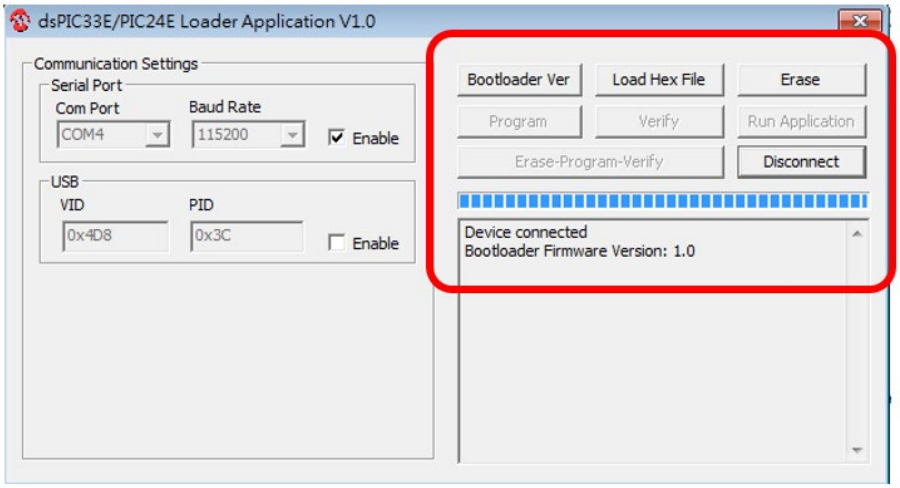
> The COM Port must be between COM 1~COM 10.

Fig. 9.5: Operating interface of the PC Loader programming program



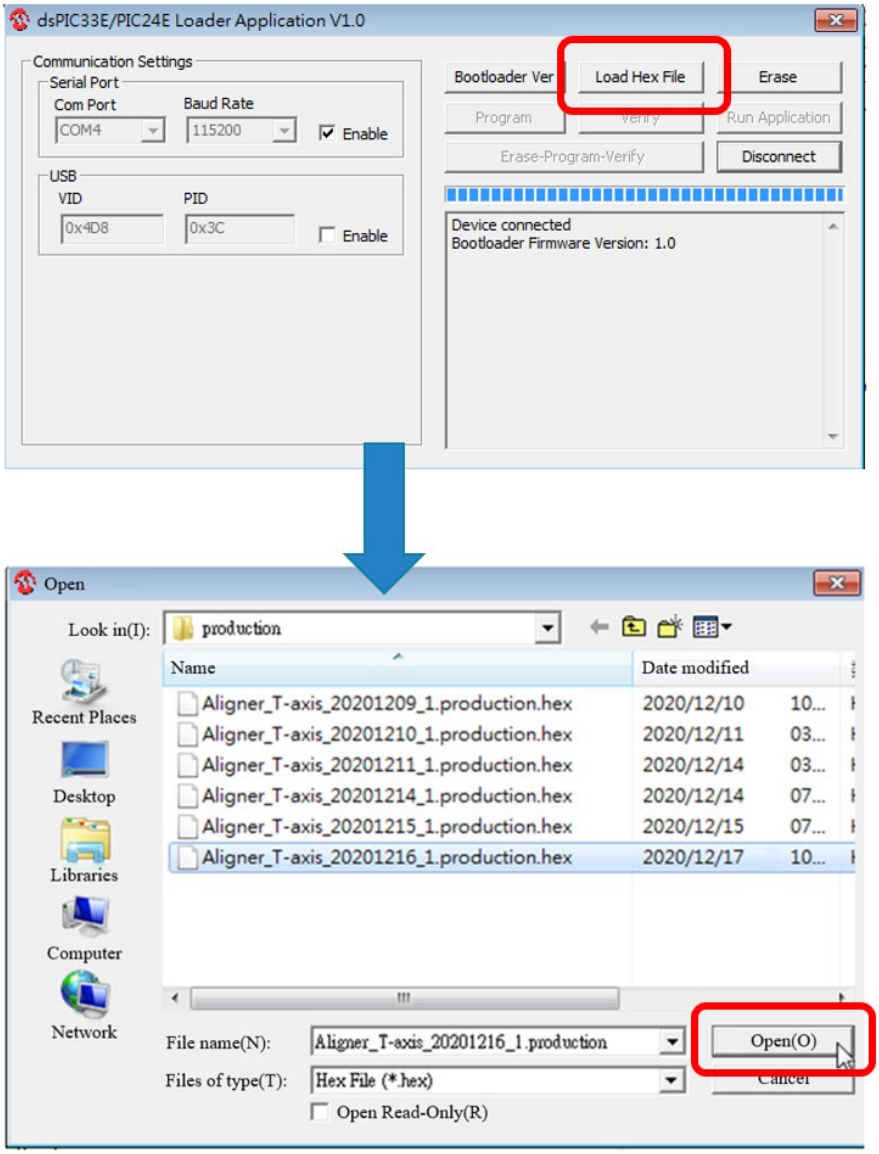
- STEP 4: Connection completed.

Fig. 9.6: Connection completed screen



- STEP 5: Select program update file (Load Hex File).

Fig. 9.7: Selecting program update window

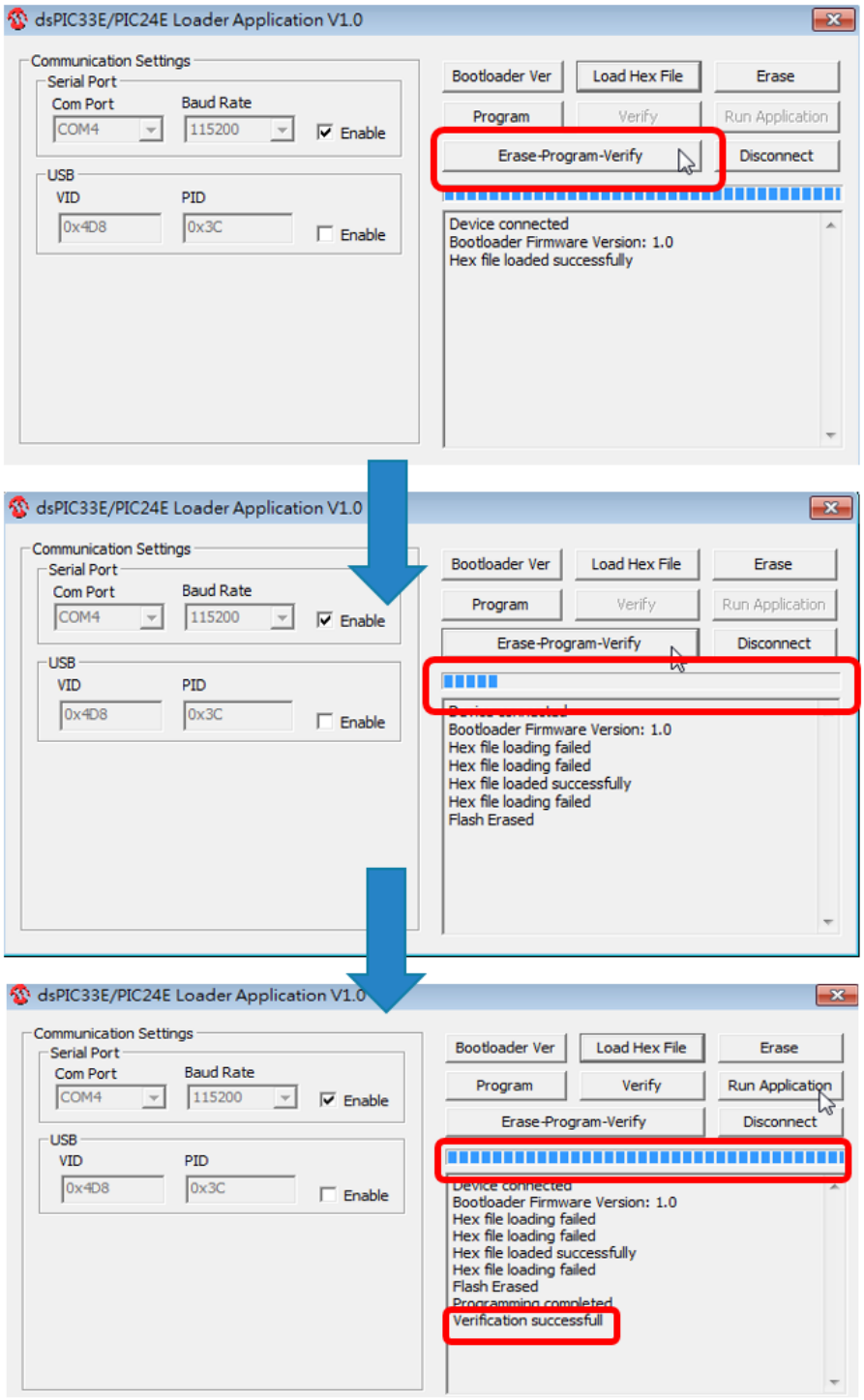


⚠ Beware!

The path to open the file can only be alphanumeric, and no other language is supported to make sure the the file can be opened.

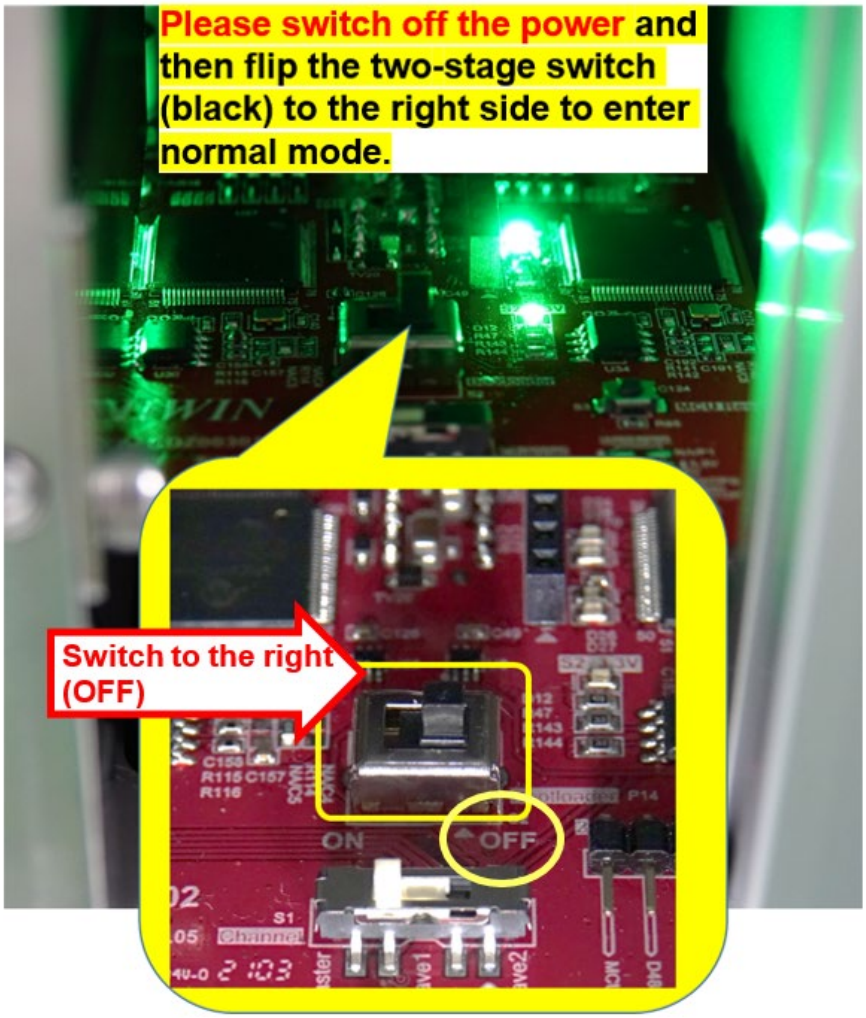
- STEP 6: Click Erase-Program-Verify to execute a program update. Please note that only one axis can be updated at a time when updating the firmware version program. If other axes need to be also updated, the power must be disconnected, and then start again from STEP 2.

Fig. 9.8: Executing program update



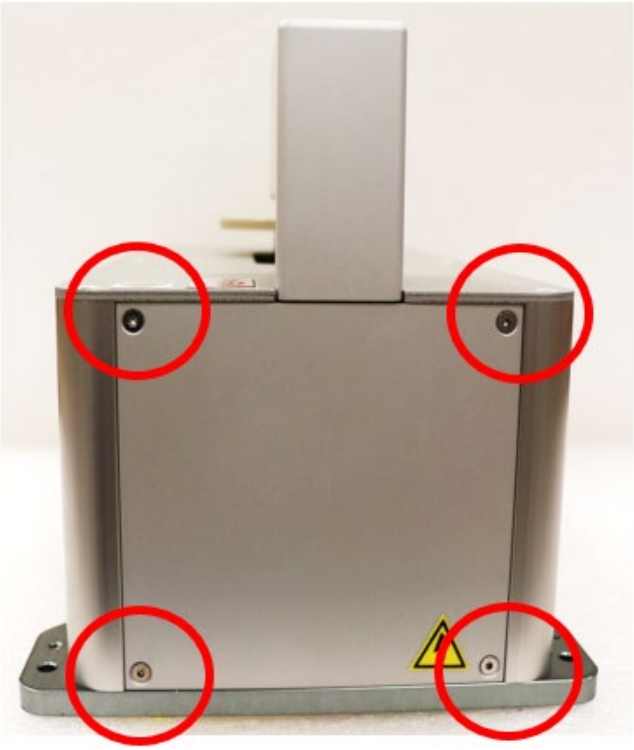
- STEP 7: Switch off the DC 24 V power of the aligner again, and switch the black two-stage bootloader switch on the circuit board to the right (OFF), and it will return to normal mode from programming mode, as shown in the yellow frame in Fig. 9.9. If the power is turned on again at this time, you will see that the two red LED lights on the circuit board inside the machine and the abnormal indicator on the status indication panel all go off, meaning that the machine's current status is normal. Users can operate the aligner normally.

Fig. 9.9: Switch the bootloader switch in the yellow frame to the right (OFF) to return to normal mode.



- STEP 8: Lock the four hex socket countersunk screws back onto the rear sheet metal, as shown in the red frame in Fig. 9.10. Finally, turn on the DC24V power and the firmware update process is complete. If the Master MCU firmware is updated to V3.5.1 or higher, STEP 9 must be executed again.

Fig. 9.10: Lock the screws in the red frame part in the figure above and reconnect the power, and the firmware update process is complete



- STEP 9: To activate the HPA Tool for parameter configuration, please clean the mirror surface of the laser sensor and clear all the obstacles in the laser area. Then execute the ADA instruction to configure the initial laser sensor offset with an output value between 0–5266, as shown in Fig. 9.11of the HPA tool configuration screen. Finally, execute the SPS instruction to save the laser parameter.

To ensure the firmware updating process is correct, the user may execute the HOM instruction. If the machine is functioning normally, the firmware has updated successfully, as shown in Fig. 9.12 HPA tool execution screen.

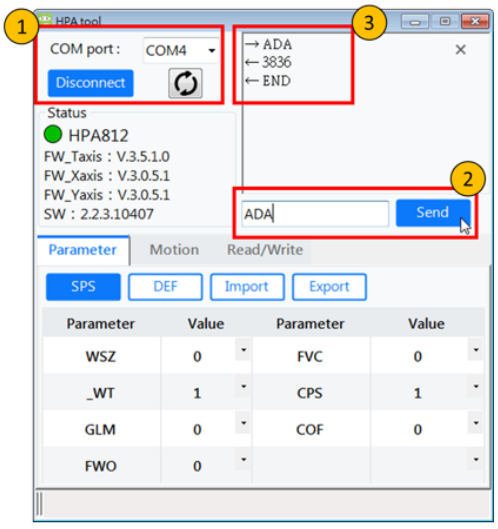


Fig. 9.11: ADA instruction configuration screen

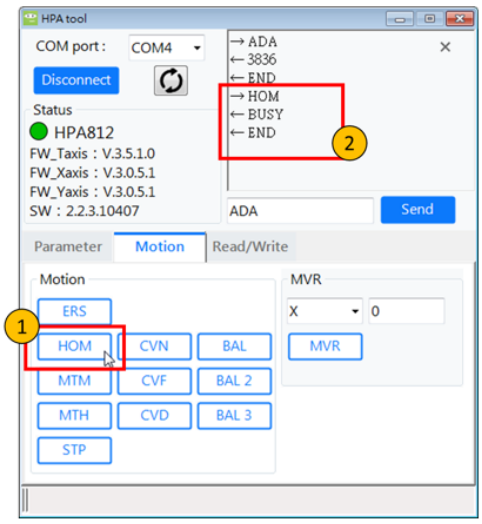


Fig. 9.12: HOM instruction configuration screen

Without the HPA Tool, other communication test software may be used, for examplethe AccessPort communication test software as shown below:

Fig. 9.13: Executinge the ADA and SPS instructions with AccessPort

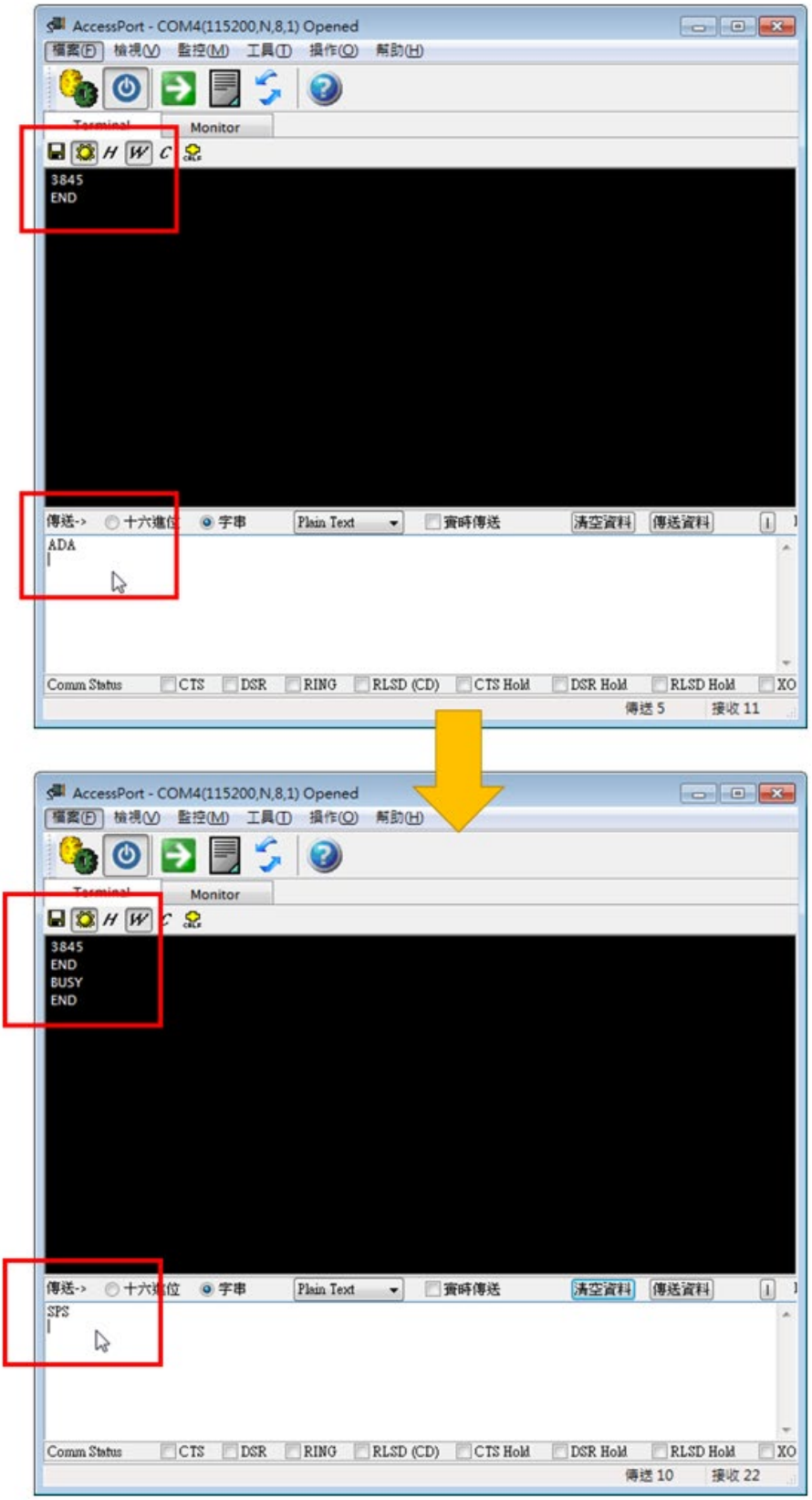


Fig. 9.14: Executing the HOM (home return) instruction with AccessPort

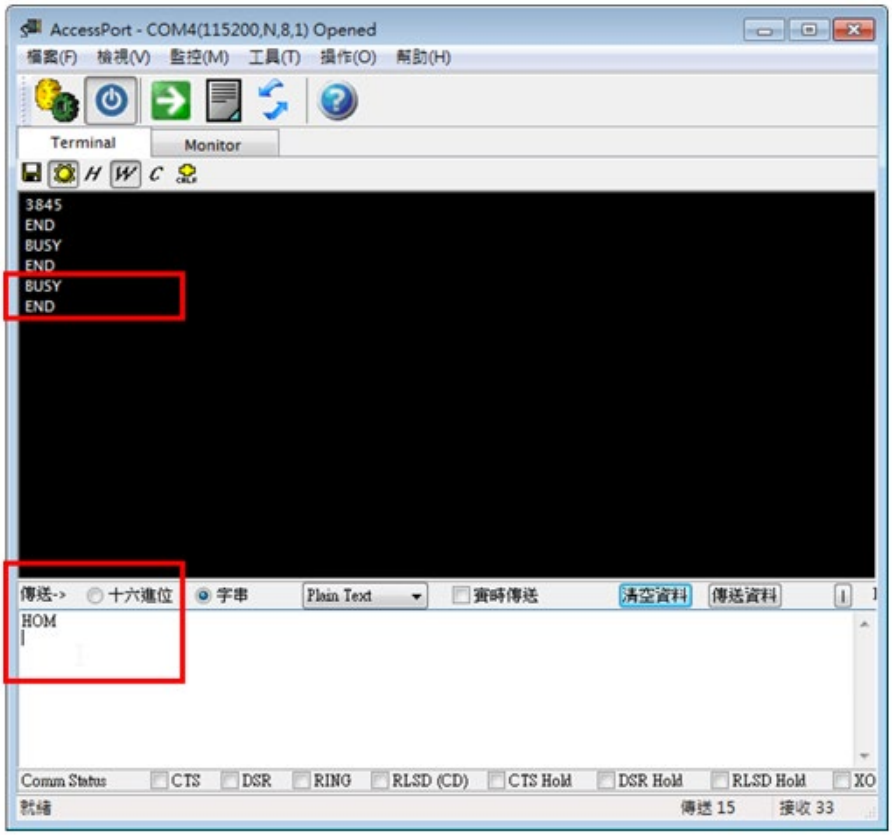
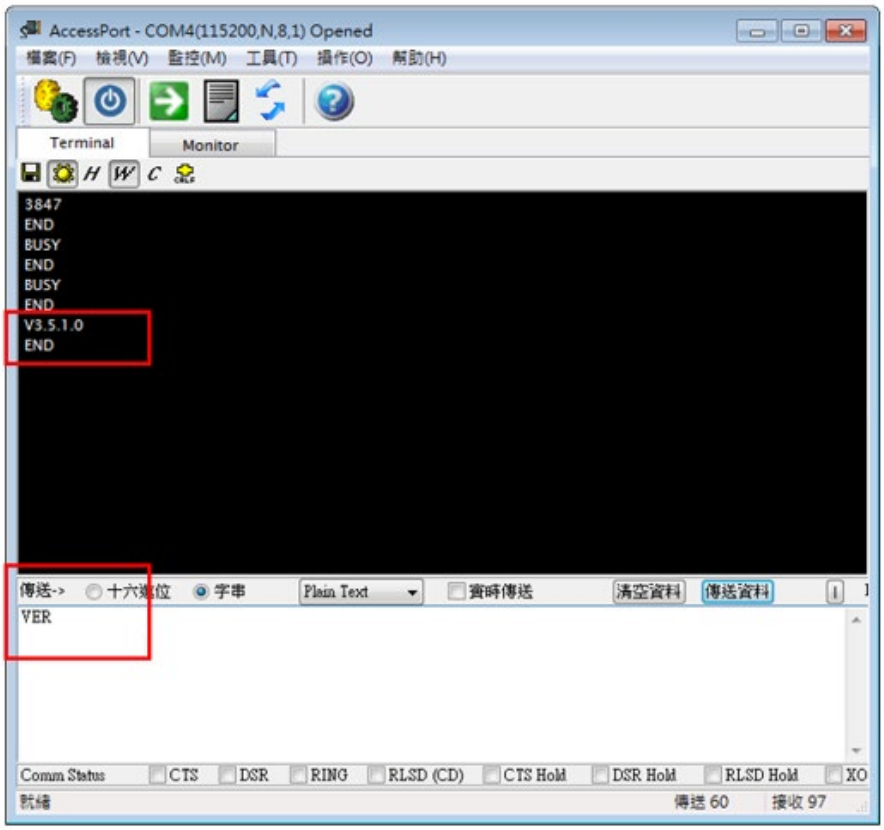


Fig. 9.15: Executing the VER instruction (querying firmware version) with AccessPort



9.2 Example of serial communication reception

Below is a sample program of the communication between the aligner and upper control which is based on Visual studio C++ via RS232 communication.

```
int CRS232::ReadData(void *buffer, int limit)
{
	//In case of communication problems, please set the limit to 1, and remove the data in the buffer to the ending character for interpretation.
	//while (Msg.IsFinish())
	//{
	//	BYTE cs;
	//	ReadData(&cs, 1);
	//	Msg.Add(cs);
	//}
	//Msg.Decode();
	//

	if (!potcolCheck || NULL == hComm)
		return(0);

	BOOL bReadStatus;
	DWORD dwBytesRead, dwErrorFlags;
	COMSTAT ComStat;

	//Clear the error at the communication port
	ClearCommError(hComm, &dwErrorFlags, &ComStat);

	//Check if any data in the buffer
return 0	if (!ComStat.cbInQue);
	dwBytesRead = (DWORD)ComStat.cbInQue;



	//Limitation of the reading length
	if (limit < (int)dwBytesRead)
		dwBytesRead = (DWORD)limit;

	//Reading operation
	bReadStatus = ReadFile(
		hComm,//Communication handles
		buffer,//Receiving data buffer
		dwBytesRead,//Byte amount to be read
		&dwBytesRead,//Byte amount actually read
		&m_ov_r);//overlappedStructure

	//Check if the communication IO operation finished
	if (!bReadStatus)
	{
		if (GetLastError() == ERROR_IO_PENDING)//The communication IO operation not finished
		{
			WaitForSingleObject(m_ov_r.hEvent, 2000);//Waiting for communication in the designated time
IO Operation finished
			return((int)dwBytesRead);
		}
		return(0);
	}
	return((int)dwBytesRead);
}
```

9.3 Model selection table

Customer name		Date	
Contact		Phone	
E-Mail		Fax	
Address			

1	Pre-selected model number	
2	Wafer size	☐ 2” ☐ 3” ☐ 4”(100mm) ☐ 5”(125mm) ☐ 6”(150mm) ☐ 8”(200mm) ☐ 12”(300mm) ☐ Others:
3	Wafer thickness	Wafer thickness: _____ mm Wafer maximum warpage: _____ mm
4	Wafer features	☐ N/A ☐ Notch ☐ Flat (flat edge) ☐ Double-flat (flat edge) ☐ Others:
5	Wafer material	☐ Wafer ☐ Glass ☐ Sapphire substrate ☐ Others:
6	Wafer loading method	☐ PEEK (Standard) ☐ PEEK_ESD (10^6–10^9 Ω) ☐ Aluminium ☐ Others:
7	Wafer contact material	
8	Accuracy requirements	
9	Alignment time	
10	Communication method	☐ Serial communication (RS232) ☐ Others:
11	Usage environment	☐ Clean room ISO class: _____ ☐ Dust IP: _____ X ☐ Water IP: X _____ ☐ High temperature _____°C ☐ Low temperature _____°C ☐ Chemical corrosion ☐ Humidity ☐ Vibration ☐ Others:
12	Application method/process	
13	Remarks	

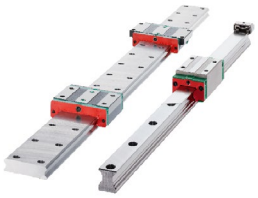
10 Safety certification

CE complies with the standards	
Machine Directive	2006/42/EC
Low Voltage Directive (LVD)	2014/35/EU
Machine Safety Ddirective	EN ISO 12100:2010
	EN 60204-1:2006+AC:2010
Electromagnetic Compatibility Directive (EMC)	EN 61000-6-2:2005
	EN 61000-6-4:2007+A1:2011
Restriction of Hazardous Substances Directive (RoHS 2)	2011/65/EU (2015/863)
Industrial standards	
Environmental, Health, and Safety Guideline for Semiconductor Manufacturing Equipment	SEMI S2

For the HIWIN Wafer Aligner_HPA series, the Declaration of Incorporation of partly completed machinery with the following contents is applied (Based on Machinery Directive 2006/42/EC ANNEX II 1.B.).

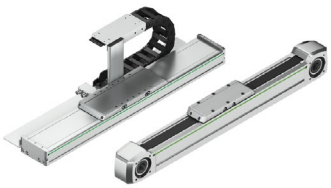
Item	Contents			
Manufacturer name	HIWIN TECHNOLOGIES CORP.			
Manufacturer address	No. 7, Jingke Rd., Taichung Precision Machinery Park, Taichung 40852, Taiwan			
Product information	Equipment	Wafer Aligner		
	Model Name	HPA812, HPA812-W, HPA48, HPA48-W, HPA26, HPA8-E, HPA12-E, HPA612-S		
Applied directive and standards	Machinery Directive (MD) 2006/42/EC	○ EN ISO 12100 ○ EN 60204-1:2018		
	Low Voltage Directive (LVD) 2014/35/EU	○ EN 60204-1:2018		
	EMC Directive (EMC) 2014/30/EU	○ EN IEC 61000-6-2:2019 ○ EN IEC 61000-6-4:2019		
	Restriction of Hazardous Substances (RoHS) 2011/65/EU and 2015/863/EU	–		
	(Industrial standards) Environmental, Health, and Safety Guideline for Semiconductor Manufacturing Equipment – Semi S2			
Importer/Distributor in EU	Name	Werner Mäurer	Address	HIWIN GmbH, Brücklesbünd 1, D-77654 Offenburg
	Name	Chuang-Pao Yang	Address	HIWIN Srl, Via Pitagora, 4 - 20861 Brugherio (MB)
Note	The partly completed machinery must not be put into service until the final machinery into which it is to be incorporated has been declared to be in conformity with the provisions of the Machinery Directive.			

We live motion.

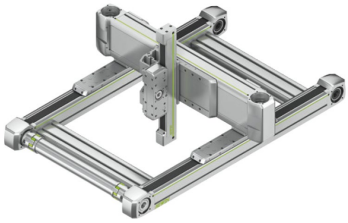


Linear Guideways

Ballscrews



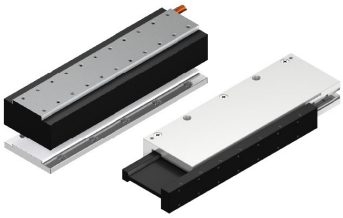
Linear Axes



Linear Axis Systems

Torque Motors

Robots



Linear Motors

Rotary Tables

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