Product Operation Manual

Industrial Slim-type Parallel Electric Gripper

PGE Series

Drive Control Integrated

This document is the operation manual of the drive-controlled all-in-one PGE series products, applicable to the following models:

Applicable models	Maximum clamping force	Stroke
PGE-5-26	5 N	26 mm
PGE-8-14	8 N	14 mm
PGE-15-26	15 N	26 mm
PGE-50-26	50 N	26 mm
PGE-100-26	100N	26mm

Revision of curriculum vitae

Date	Versions	Modified content
20200426	V1.0	Preliminary version, writing hardware wiring and instruction related instructions
20200720	V2.0	Update part of the description with a major update to the IO model
20210101	V2.1	Add automatic initialization function
20210727	V2.2	Modify high resistance description to disconnect, add communication format and IO details, batch update, line sequence modification
20211008	V2.3	Remove irrelevant information from the operation section and rearrange the layout
20211228	V2.4	Change the initialization description, add diagrams and comments
20220810	V2.5	Update the new version of the line sequence, the old version of the line sequence refer to the old version of the manual
20221021	V2.6	Change cable definition and update schematic image
20221220	V3.0	Add control flow; update line sequence definition diagram; fix related errors.
20230327	V3.1	Add notes.

Catalog

1 Overview of gripper

The PGE series is an industrial slim-thin parallel electric gripper with the number representing the maximum clamping force of the gripper. The gripper are equipped with a pair of parallel fingertips that run symmetrically during movement. The main structure of the gripper are smooth rectangular structure with 5 side mounting holes to meet the different installation conditions of the equipment. It is also equipped with an 8-core communication interface. And has the following characteristics:

Force position and speed controllable: The gripper can be programmed to adjust the clamping position, clamping force value and running speed of the gripper, which can be matched in any combination.

Multiple communication modes: The gripper body are controlled by the standard **Modbus-RTU** protocol and **IO mode.** Other communication protocols such as USB, EtherCAT, CAN , TCP/IP etc. can be transferred via protocol converters.

Clamping judgment: The clamping process is a combination of force control and position control.

Clamping feedback: The status of the gripper can be read by programming or judged by the indicator on the gripper body.

Fingertip can be customized: The fingertip s ' can be replaced according to the real-time situation, suitable for precision machining, parts assembly and other fields.

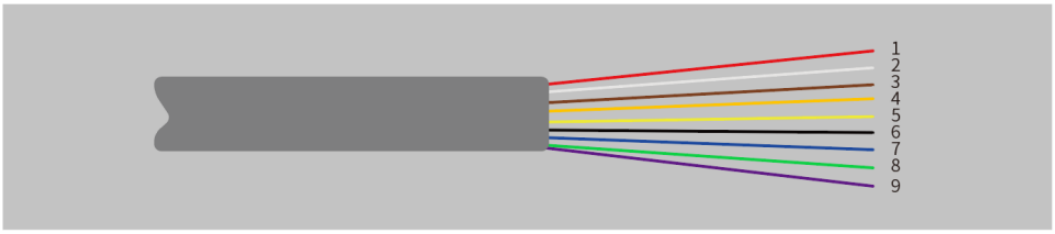
1.1 Definition of indicator light

The gripper can provide real-time feedback on the status of the gripper. In addition to being readable by command, it can also be judged on the color of the indicator:

Indicator light color description
-**Uninitialized state**: red light blinks, other lights are not lit.
-**Initialization completion status**: The blue light is always on, indicating that it is in an operable state.
-**Command status received**: red light flashes rapidly once (the jaw indicator will appear off purple because the blue light is always on at this time).
-**Clamped object status**: green light is always on, other lights are not on.
-**Object drop status**: Green light flashes.

1.2 Pin definition

The definition of the line sequence on the gripper body is shown in Figure 1.1:



Serial Number	Cable Line	Definition	Description
1	Red	24V	Power supply 24V DC positive
2	White	INPUT1	IO mode digital input 1
3	Brown	INPUT2	IO mode digital input 2
4	Orange	OUTPUTI	IO mode digital output 1
5	Yellow	OUTPUT2	IO mode digital output 2
6	Black	GND	Power supply DC negative
7	Blue	485_B	T/R+ Communication line positive, T/R+
8	Green	485_A	T/R- Communication line negative, T/R-
9	Braided thread	PGND	rotect Ground

Fig. 1.1 Cable line marking diagram

Note: Please distinguish the line sequence according to the line label, if the line label is lost, off, forgotten, etc., please contact our staff, with the determination of the line sequence. If you do not contact our staff, due to the wrong line sequence, resulting in damage to the gripper, the consequences will be self-responsible.

2 RS485 control

The gripper command is controlled by standard Modbus-RTU. Please refer to *2.3.1 Command Format* for some description of Modbus-RTU command *(*Modbus-RTU is a standard communication format on the market, widely used in industry, please refer to the web for specific detailed format*);* please refer to *2.1.1 Debugging Software Installation and Wiring* for specific wiring method; please refer to 2.3.2 for specific communication Please refer to *2.3.3 for details of the commands*.

2.1 RS485 debugging software description

The debugging software is specially designed for controlling and setting debugging parameters of the gripper on the computer side. As the computer side generally does not have RS485 interface, it is necessary to use the USB to 485 module to convert the interface to USB interface, so that the gripper can be easily debugged and controlled on the computer side.

2.1.1 Debugging software installation and wiring

The connection is made through the debugging software, which is essentially controlled through the RS485 interface. The specific connection needs to connect **24V, GND, 485_A(T/R+,485+) , 485_B(T/R-,485-) at the gripper** end for a total of 4 wires, the power supply is 24V DC regulated power supply, and the USB socket of the module is plugged into the USB port of the computer. **Wiring definitions are different for different series, please follow the instructions of the specific gripper for wiring,** as follows:

485A access 485 to USB module T/R+.
485B Access 485 to USB Module T/R-.
24V connects to the positive terminal of 24V DC regulated power supply.
GND is connected to the negative terminal of 24V DC regulated power supply

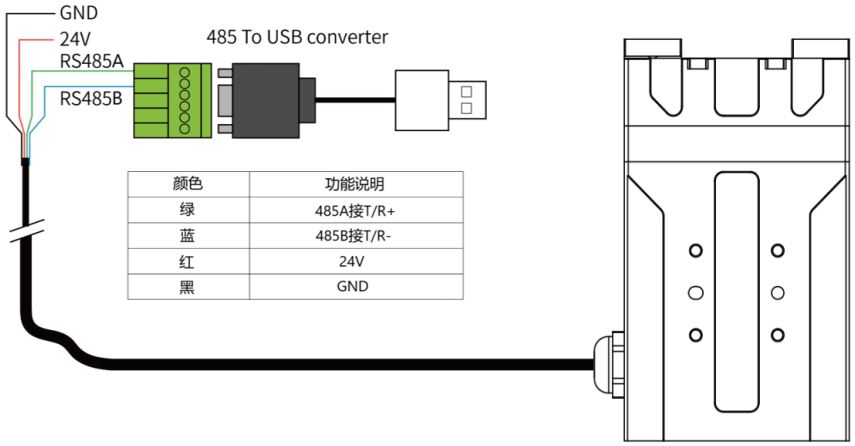


Figure 2.1 Diagram of RS485 connection method

Wiring instructions
①: When the device (computer) has RS485 interface, the communication can be directly connected to RS485+ and RS485- communication cable instead of through USB to 485 module
②: Through this way of wiring, you can use other serial debugging software (such as Modbus Poll, etc.) for debugging

The software can be downloaded from the official website, and the software installation process **integrates software and drivers**, both of which are installed together.
It is recommended to check the **Create shortcut box during** the installation process

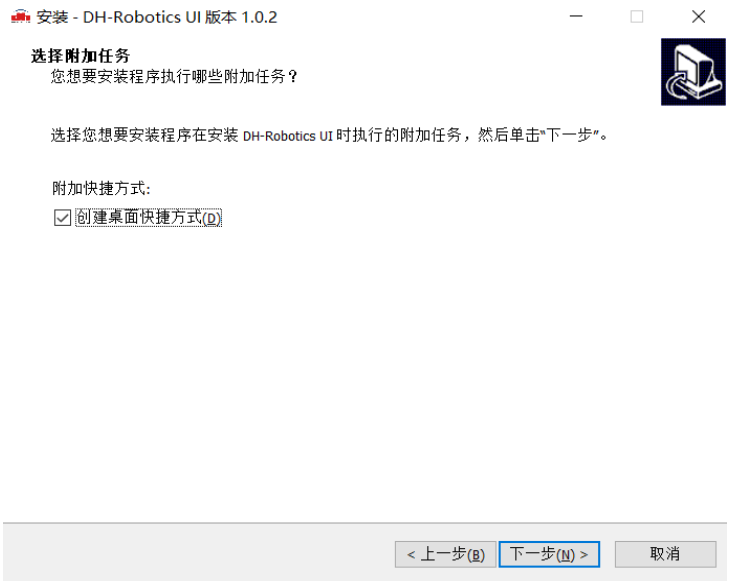


Figure 2.2(a) Installation interface

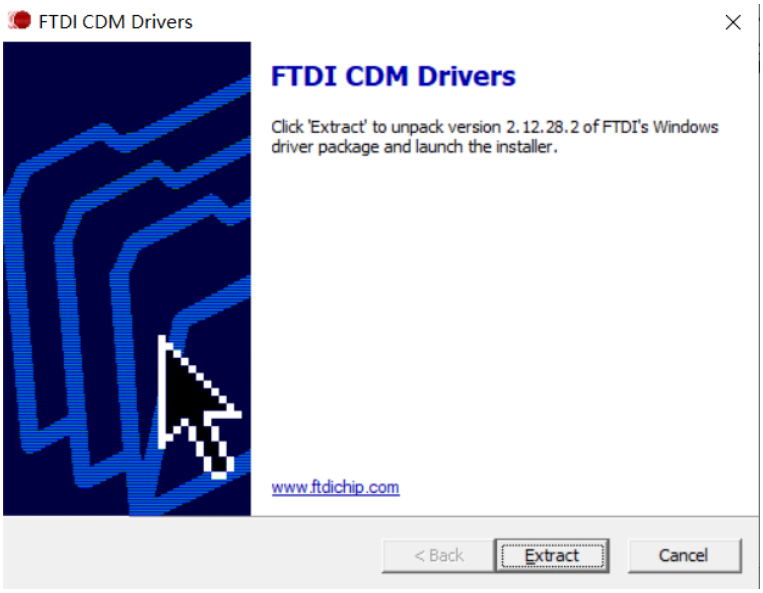


Figure 2.2(b) Driver installation interface

2.1.2 Instructions for using the debugging software

Before use, you need to follow the instructions (see 2.1.1 Debugging Software Installation and Wiring) to connect the corresponding wiring.

Open the software, the software will automatically identify the serial port, automatically identify the baud rate of the clamp claw, ID number and other information for automatic connection. The following figure shows:

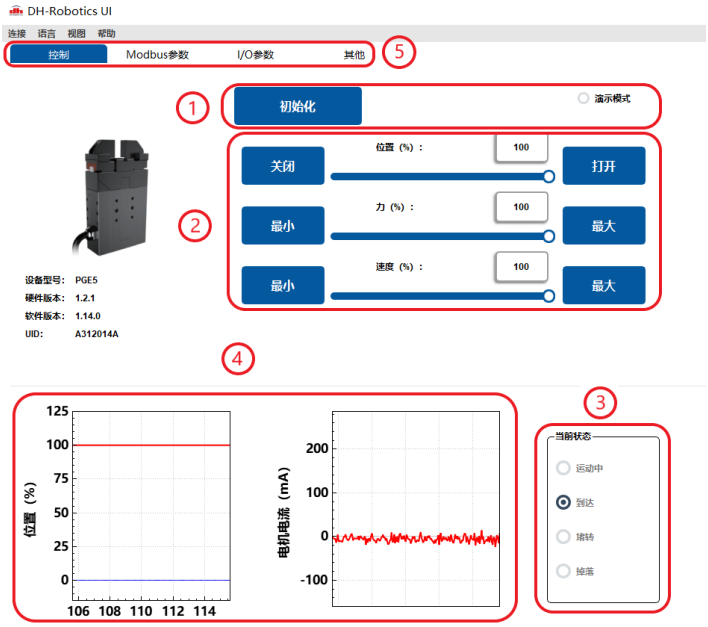


Figure 2.3 Main control interface

Specific interface descriptions are shown below:

Interface Description

-①**Initialization and demonstration mode**: The jaws need to be initialized for zero calibration before operation, and the demonstration mode is a cyclic program.

-②**Control interface**: The position, force and speed of the jaws can be controlled.

-③**Clamping status**: real-time display of the clamping status of the jaws.

-④**Real-time graph of position and current**: Real-time display of position and current. The current indicates the current of the internal motor, not the actual current consumed by the gripper. The current real-time graph can reflect the stability of clamping force.

-⑤ **Parameter setting**: Modbus-RTU configuration parameters such as baud rate, parity bits, etc. can be configured; IO parameters are for the configuration of IO mode related parameters;

The gripper body uses Modbus-RTU for communication, and can read and write data to the internal register, and can read and write data to the gripper data

at View-[Register], including control, feedback, user parameters, and I/O parameters as shown in the following figure:

Figure 2.4 Register Control

If there are multiple 485 devices, sometimes it is necessary to modify the **baud rate** and **ID number of the gripper**, the parameters can be modified in the Modbus-RTU parameters at

Figure 2.5 Modbus-RTU parameters

You can set and configure the gripper I/O parameters at [I/O Parameters], and **when the parameters are modified, please note that you can save them by clicking the Save button. The** following figure shows the operation of opening IO mode:

Figure 2.6 Open IO mode

The steps for switching IO are shown below:

Switching IO mode steps
-①**Open IO mode**: Open IO mode first.
-②**Configuration of 4 groups of IO parameters**: 4 groups of parameters for the jaws, including position and force setting
-③**Save**: Click the Save button to write the parameters to the internal Flash registers, and reboot to control.
-④**Restart**: After restart, the jaws will be initialized automatically and the status light will change to blue. That is, the switch to IO mode is successful, you can control the jaws according to the INPUT signal, and the operation status will be fed back through OUTPUT.

Attention
-IO mode and 485 mode control are in conflict.
-In this software, after the jaws open IO mode, the 485 mode is restricted, and it is not possible to operate and control the jaws in the software.
-IO mode is turned on without affecting the 485 communication function
-IO and 485 communication, can be controlled at the same time, following the principle of 'first send first response, second send later response'

2.2 RS485 default configuration

Clamp gripper ID: 1
Baud rate: 115200
Data bits: 8
Stop bit: 1
Checksum bit: No checksum bit

2.3 Instruction Description

2.3.1 Command Format

The gripper use the standard Modbus-RTU protocol and support 03, 04, 06, 10 function codes.

When the gripper are controlled, the 03 and 06 function codes are generally used to read and control the gripper. 03 function code and 06 function code are **read and write single registers, and the** control instruction consists of five parts: address code (1 byte), function code (1 byte), start address (2 bytes), data (2 bytes), and check code (2 bytes). Let's take the initialization instruction 01 06 01 00 00 01 49 F6 as an example, as shown in Table 2.1.

Table 2.1 Command Format

Address Code	Function Code	Register Address	Register Data	CRC Checksum
01	06	01 00	00 01	49 F6

Address code: Indicates the ID number of the gripper. It can be modified in the device ID, the default is 1. 01 means the Modbus ID of the gripper is 01.
Function code: Describe the read/write operation to the gripper, whether to read data to the gripper or to write data to the gripper, common function codes are 03 (read holding register), 06 (write holding register). The initialization instruction function code is 06, which means ready to write.
Register address: The address corresponding to the gripper function. The initialization instruction address is 0x0100.
Register data: Write data to the specific register address so as to control the read data. The initialization instruction is to write 01 to represent for initialization.
CRC check code: To ensure that the terminal device does not respond to the data that changes during transmission, to ensure the safety and efficiency of the system. 16-bit cyclic hyperactive method is used for CRC check, and according to the conversion of the previous data, the CRC check code of the initialization instruction is 49 F6.

If you need to read multiple register addresses or write register addresses, you can use the 04 (0x) and 10 (0x) function codes to read and write to the gripper consecutive register addresses, please refer to the Modbus-RTU standard protocol www.ip33.com/crc.html for the specific control instruction format.

2.3.2 Command Overview

The command consists of a base control address table and a parameter configuration address table.

Basic control address table: contains initialization, force value, position, speed and their corresponding feedback commands, which are the main control

commands. As shown in Table 2.2.

Parameter configuration table: contains the parameter configuration of the gripper, including the modbus-RTU related configuration and IO related configuration that can be written. It should be noted that after configuring the required parameters, it needs to be saved by writing to Flash at 0x0300. As shown in Table 2.3.

Table 2.2 Base control address table

Function	Modbus address (hexadecimal)	Description	Write to	Read
Initializing the gripper	256 (0x0100)	Re-calibration of gripper and return to zero	Write 1: return to zero (find one-way position); Write 0xA5: recalibrate	0: not in the initialization process; 1: in the initialization process; 2: in the initialization
Power Value	257 (0x0101)	gripper force value	20-100, percentage	Read the current set force value
Location	259 (0x0103)	Movement to the designated position	0-1000, thousandths ratio	Read the current set position
Speed	260 (0x0104)	Running at set speed	1-100, percentage	Read the current set speed
Initialization status feedback	512 (0x0200)	Feedback on the current initialization status of the gripper	--This Modbus address is read only	0: not initialized; 1: initialized successfully
Clamping status feedback	513 (0x0201)	Feedback on the current gripping status of the gripper	--This Modbus address is read only	0: in motion, 1: arriving at position; 2: clamping object; 3: object falling
Location Feedback	514 (0x0202)	Feedback of current gripper position information	--This Modbus address is read only	Read the current real-time location

Table 2.3 Parameter configuration address table

Function	Modbus address (hexadecimal)	Description	Write to	Read
Write to save	768 (0x0300)	Write to flash	0: default, 1: write all parameters to flash	Write to flash operation, default read returns 0
Initialization direction	769 (0x0301)	Configure gripper initialization direction	0: open; 1: close (default: 0)	Read the current setting value
Device ID	770 (0x0302)	Configure gripper Modbus ID	1-255 (default: 1)	Read the current setting value
Baud rate	771 (0x0303)	Configure gripper Modbus baud rate	0-5: 115200, 57600, 38400, 19200, 9600, 4800 (default: 0)	Read the current setting value
Stop bit	772 (0x0304)	Configure gripper Modbus stop bit	0: 1 stop bit; 1: 2 stop bits (default: 0)	Read the current setting value
Check digit	773 (0x0305)	Configure gripper Modbus check bits	0: no parity; 1: odd parity; 2: even parity (default: 0)	Read the current setting value
IO parameter testing	1024 (0x0400)	Direct control of 4 groups of IO functions	1; 2; 3; 4	--This Modbus address is only written to
Reserved	-	-	-	-
IO mode switch	1026 (0x0402)	Turn on the IO function switch	0: off, 1: on (default: 0 off)	Read the current setting value
IO parameter configuration	1029-1040 (0x0405-0410)	Four sets of IO parameters	Position 1, force 1, speed 1 to position 4, force 4, speed 4	Read the current setting value
Automatic initialization	1284 (0x0504)	Automatic power-up initialization configuration	0: No initialization at power-up; 1: Automatic	Read the current setting value (need to write 01 at 0x300,

			initialization at power-up (0: default)	effective for re-powering)

2.3.3 Command Details

2.3.3.1 Initializing the gripper

This command is the command related to the initialization of the gripper at 0x0100. Details of the specific initialization commands are shown in Table 2.4 below.

Table 2.4 Initialization Instructions

Function	Address	Description	Write to	Read
Initializing the gripper	0x0100	Re-calibration of gripper and return to zero	Write to 0x01: return to the zero position (find the one-way position); Write to 0xA5: Recalibration	0: not in the initialization process; 1: In the initialization process; 2: Initialization in progress

The gripper need to be initialized before RS485 connection control, for re-calibrating the gripper and returning to zero position, please do not control during the gripper initialization. Depending on the gripper model, the initialization time is about 0.5-3 seconds, please control after the initialization is finished. 0x01 and 0xA5 are functionally different, as shown below:

0x01: Writing 0x01 will perform a unidirectional initialization based on the value of *the 2.3.3.9 Initialization* Direction register to find the maximum position or minimum position (i.e. unidirectional limit bit), after which the position percentage is calculated based on the total travel value saved (see 0xA5). If the initialization direction is open and the current position of the gripper is also open, the gripper are visually initialized with no action.

0xA5: After sending 0xA5, the gripper perform a close to open action, regardless of the gripper's position and state.

Note:

1. The initialization process of the 1.0xA5 instruction is looking for the maximum and minimum positions. If the maximum or minimum position is blocked during this process, the wrong stroke will be recognized, for example, the 0 position in Figure 2.6 will be recognized as the width of the clamped object.
2. 0xA5 initialization is required and saved after the customer replaces the fingertip.
3. 0x01 instruction is to control the initialization of the gripper in one direction, and the stroke is the stroke saved after the last 0xA5 initialization.

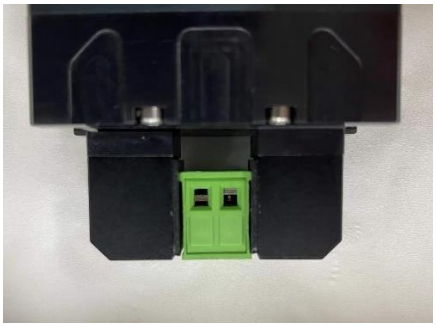


Figure 2.6 Example of error initialization

The initial specific execution initialization command is shown below:

Execute initialization successfully (write operation):

Send: 01 06 01 00 00 01 49 F6

Return: 01 06 01 00 00 01 49 F6

Fully initialized (write operation):

Send: 01 06 01 00 00 A5 48 4D

Send save command after initialization, see 2.3.3.8 Write save

Return: 01 06 01 00 00 A5 48 4D

Use 0x01 function code again, the trip will be consistent with A5

2.3.3.2 Force values

The command is related to the gripper force value and the address is 0x0101. The details of the grip force command are shown in Table 2.5 below.

Table 2.5 Force command

Function	Address	Description	Write to	Read
Power Value	0x0101	Set force value	20-100, percentage	Read the current set force value

Force values range from 20 to 100 (%) and correspond to the hexadecimal data 00 14 - 00 64. Once you set the force value, the gripper will move in position to grip or hold open the target object with the **set force value.**

As an example of setting and reading 30% force values:

Set 30% force value (write operation):

Send: 01 06 01 01 00 1E 59 FE

Return: 01 06 01 01 00 1E 59 FE

Read the current set force (read operation):

Send: 01 03 01 01 00 01 D4 36

Return: 01 03 02 xx xx crc1 crc2

2.3.3.3 Location

This command is the command related to setting the position of the gripper at 0x0103. Details of the specific position commands are shown in Table 2.6 below.

Table 2.6 Position commands

Function	Address	Description	Write to	Read
Location	0x0103	Set gripper position	0-1000, thousandths ratio	Read the current set position

The position value range is 0-1000 (‰), corresponding to the hexadecimal data 00 00 - 03 E8 , you can read the real-time position at the 0x0202 address, please refer to *2.3.3.7 Position feedback*. As an example, set and read position 500 (%):

Set 500 position (write operation):

Send: 01 06 01 03 01 F4 78 21

Return: 01 06 01 03 01 F4 78 21

Read the current set position (read operation):

Send: 01 03 01 03 00 01 75 F6

Return: 01 03 02 xx xx crc1 crc2

Read the current real-time position (read operation):

Send: 01 03 02 02 00 01 24 72

Return: 01 03 02 xx xx crc1 crc2

2.3.3.4 Speed

This command is the gripper setting speed related command at 0x0104. Details of the specific speed commands are shown in Table 2.7 below.

Table 2.7 Speed commands

Function	Address	Description	Write to	Read
Speed	0x0104	Running at set speed	1-100, percentage	Read the current set speed

Speed values range from 1 to 100 (%), corresponding to hexadecimal data 00 01 - 00 64 . To set and read 50 (%) speed as an example:

Set 50% speed (write operation):

Send: 01 06 01 04 00 32 48 22
Return: 01 06 01 04 00 32 48 22

Read current speed (read operation):
Send: 01 03 01 04 00 01 C4 37
Return: 01 03 02 xx xx crc1 crc2

2.3.3.5 Initializing state feedback

This command is the command related to the initialization status feedback of the gripper reading at 0x0200. The details of the specific initialization status feedback are shown in Table 2.8 below.

Table 2.8 Initialization Status Feedback

Function	Address	Description	Write to	Read
Initialization status feedback	0x0200	Feedback on the current initialization status of the gripper	Cannot write	0: not initialized; 1: initialization successful; 2: initialization in progress

The initialization status feedback can be used to obtain whether or not initialization has been performed. Specific read instructions are shown below:
Read initialization status (read operation):
Send: 01 03 02 00 00 01 85 B2
Return: 01 03 02 00 00 B8 44 (current uninitialized state)

2.3.3.6 Clamping status feedback

This command is related to the gripper clamping status feedback, address is 0x0201. The specific clamping status feedback details are shown in Table 2.9 below.

Table 2.9 Feedback on clamping status

Function	Address	Description	Write to	Read
Clamping status feedback	0x0201	0: in motion, 1: arriving at position; 2: clamping object; 3: object falling	Cannot write	00; 01; 02; 03

The clamping status feedback is used to read the current status of the gripper,

which can be divided into 4 states as follows

Feedback status description
The different returned command data, representing different states of the gripper, are as follows:
-00: The gripper are in motion.
-01: The gripper stop moving and the gripper do not detect a clamped object.
-02: The gripper stop moving, and the gripper detect a clamped object.
-03: After the gripper detect the clamped object, the object is found to fall.

Note: If the jaws clamp the object before reaching the specified position, then the jaws are also considered to have clamped the object at this time (feedback is: 02).

Read clamping status feedback (read operation):

Send: 01 03 02 01 00 01 D4 72

Return: 01 03 02 00 02 39 85 (Return 02 represents clamped objects)

2.3.3.7 Position Feedback

This command is a real-time feedback command for the gripper position at 0x0202. The specific position feedback details are shown in Table 2.10 below.

Table 2.10 Position Feedback

Function	Address	Description	Write to	Read
Location Feedback	0x0202	Feedback of current gripper position in real time	Cannot write	Read the current real-time location

Position feedback can be used to read the current **real time position of the** gripper. The specific reading commands are shown below:

Read position status (read operation):

Send: 01 03 02 02 00 01 24 72

Return: 01 03 02 xx xx crc1 crc2

2.3.3.8 Write to save

This command is the command related to write and save configuration parameters for the gripper, address is 0x0300. The specific write and save details are shown in Table 2.11 below.

Table 2.11 Write to save

Function	Address	Description	Write to	Read
Write to save	0x0300	Save manually configured parameters	0: default, 1: write all parameters to flash	Unreadable, returns 0 by default

Write Save can be used to save the IO configuration as well as the parameter configuration of RS485. The specific setup commands are shown below:

Write to save (write operation):

Send: 01 06 03 00 00 01 48 4E

Return : 01 06 03 00 00 01 48 4E

Attention

-If IO configuration and RS485 parameters are configured for the jaws. The parameters **must be** saved by FLASH write in this command. (Note: The write operation will last 1-2 seconds, during which no other commands will be responded, so it is recommended not to use this command in real-time control)

2.3.3.9 Initialization direction

This command is related to setting the gripper initialization direction of the gripper at address 0x0301. Details of the specific set initialization direction commands are shown in Table 2.12 below.

Table 2.12 Initialization Direction

Function	Address	Description	Write to	Read
Initialization direction	0x0301	Configuration initialization direction	0: open; 1: close; (default: 0)	Read the current setting value

This command can be used to configure the gripper initialization direction to open or close, the default is 0 open.

When a 0 is written, the gripper run to their maximum open position and serve

as the initial starting point.

When a 1 is written, the gripper will run to the minimum closed position and serve as the initial starting point.

Set the initialization direction to off (write operation):

Send: 01 06 03 01 00 01 19 8E

Return: 01 06 03 01 00 01 19 8E

Write to save (write operation):

Send: 01 06 03 00 00 01 48 4E

Return: 01 06 03 00 00 01 48 4E

2.3.3.10 Device ID

This command is the command related to setting the gripper device ID for the gripper at 0x0302. Details of the specific set device ID commands are shown in Table 2.13 below.

Table 2.13 Device ID

Function	Address	Description	Write to	Read
Device ID	0x0302	Configure gripper Modbus ID	1-247 (Default: 1)	Reading the gripper Modbus ID

Device ID can be used to configure the gripper Modbus ID, the default is 1. When there are multiple devices using Modbus-RTU protocol, multiple devices can be controlled simultaneously by changing the ID, the specific set gripper ID command is as follows:

Set the device ID to 1 (write operation):

Send: 01 06 03 02 00 01 E9 8E

Return: 01 06 03 02 00 01 E9 8E

Write to save (write operation):

Send: 01 06 03 00 00 01 48 4E

Return: 01 06 03 00 00 01 48 4E

2.3.3.11 Baud rate

This command is a gripper configuration baud rate related command at 0x0303 . Details of the specific baud rate configuration are shown in Table 2.14 below.

Table 2.14 Baud rate setting

Function	Address	Description	Write to	Read
Baud rate	0x0303	0-5: 115200, 57600, 38400, 19200, 9600, 4800 (0: default)	0; 1; 2; 3; 4; 5	Read Baud Rate

The baud rate command can be used to modify the baud rate size, the default is 115200, the recommended default. The specific set baud rate command is as follows:

Set the gripper baud rate to 115200 (write operation):

Send: 01 06 03 03 00 00 79 8E

Return: 01 06 03 03 00 00 79 8E

Write to save (write operation):

Send: 01 06 03 00 00 01 48 4E

Return: 01 06 03 00 00 01 48 4E

2.3.3.12 Stop bits

This command is related to the stop bit configuration of the gripper, and the address is 0x0304. The details of setting the stop bit are shown in Table 2.15 below.

Table 2.15 Stop Bit Settings

Function	Address	Description	Write to	Read
Stop bit	0x0304	Configure gripper Modbus stop bit	0: 1 stop bit; 1: 2 stop bits	Read stop bit

The stop bit command can be used to modify the number of stop bits, the default is 1 stop bit, the recommended default. The specific set stop bit command is as follows:

Set the gripper stop bit to 1 (write operation):

Send: 01 06 03 04 00 00 C8 4F

Return: 01 06 03 04 00 00 C8 4F

Write to save (write operation):

Send: 01 06 03 00 00 01 48 4E

Return: 01 06 03 00 00 01 48 4E

2.3.3.13 Checksum bits

This command is the command related to the configuration of the check digit

for the gripper, and the address is 0x0305. The details of setting the checksum bit are shown in Table 2.16 below.

Table 2.16 Check Bit Settings

Function	Address	Description	Write to	Read
Check digit	0x0305	Configure gripper Modbus check bits	0: no parity; 1: odd parity; 2: even parity	Read parity bits

The parity bit command can be used to modify the parity bit, the default is no parity bit, and the default is recommended. The specific set parity bit command is as follows:

Set the gripper parity bit to no parity (write operation):

Send: 01 06 03 05 00 00 99 8F

Return: 01 06 03 05 00 00 99 8F

Write to save (write operation):

Send: 01 06 03 00 00 01 48 4E

Return: 01 06 03 00 00 01 48 4E

2.3.3.14 IO parameter testing

This command controls the 4 sets of set IO parameters of the gripper via Modbus-RTU protocol for the gripper at address 0x0400. Details of the specific IO control are shown in Table 2.17 below.

Table 2.17 IO control

Function	Address	Description	Write to	Read
IO parameter testing	0x0400	Control 4 groups of IOs by sending data	1; 2; 3; 4	Read IO control

IO parameter test can be used to directly run the set 4 groups of IO parameters, even if the power is off, the force position and speed of the 4 groups of IO parameters will not change, so the device can be executed to the running state as soon as possible. Specific IO control commands are shown below:

Set the gripper to the first group IO state (write operation):

Send: 01 06 04 00 00 01 49 3A

Return: 01 06 04 00 00 01 49 3A

Attention
-If you need to use Modbus-RTU to control 4 groups of IO parameters, you need to turn off the IO mode switch.

2.3.3.15 IO mode switch

This command is related to setting IO mode switch, address is 0x0402. The details of specific IO mode switches are shown in Table 2.18 below.

Table 2.18 IO mode switches

Function	Address	Description	Write to	Read
IO mode switch	0x0402	Whether to turn on the IO function	0: off, 1: on	Read the set value

The IO mode switch is a switch used to turn on the IO mode or not, and has two states, 0 and 1. The corresponding control ranges for the two states are shown in Table 2.19 below.

Table 2.19 IO mode switch correspondence range

Front-end switch status	Corresponding status	Modbus-RTU control	IO Control
0	IO mode off	Yes	No
1	IO mode on	No	Yes

Set the IO mode switch to Off (write operation):
Send : 01 06 04 02 00 00 29 3A
Return : 01 06 04 02 00 00 29 3A
Write to save (write operation):
Send : 01 06 03 00 00 01 48 4E
Return : 01 06 03 00 00 01 48 4E

2.3.3.16 IO parameter configuration

This command configures 4 sets of IO parameter-related commands for the gripper at addresses 0x0405-0x0410. Details of the specific IO parameters configuration are shown in Table 2.20 below.

Table 2.20 IO parameter configuration

Function	High Byte	Low Byte	Description	Write to	Read
Group 1 IO parameter setting	0x04	0x05	Group 1 position	0-1000, thousandths ratio	Retrieve the current value
		0x06	Group 1 force value	20-100, percentage	
		0x07	Group 1 speed	1-100, percentage	
Group 2 IO parameter setting		0x08	Group 2 position	0-1000, thousandths ratio	
		0x09	Group 2 force values	20-100, percentage	
		0x0A	Group 2 speed	1-100, percentage	
Group 3 IO parameter setting		0x0B	Group 3 position	0-1000, thousandths ratio	
		0x0C	Group 3 force values	20-100, percentage	
		0x0D	Group 3 speed	1-100, percentage	
Group 4 IO parameter setting		0x0E	Group 4 position	0-1000, thousandths ratio	
		0x0F	Group 4 force values	20-100, percentage	
		0x10	Group 4 speed	1-100, percentage	

IO parameter configuration can be used to configure IO parameters. As an example, set the first set of target position to 300, target force to 30% and target speed to 30%:

Set the first set of states in I/O mode (write operation):

Send: 01 06 04 05 01 2C 98 B6 (target position 300)

Return: 01 06 04 05 01 2C 98 B6

Send: 01 06 04 06 00 1E E8 F3 (30% of target force value)

Return: 01 06 04 06 00 1E E8 F3

Send: 01 06 04 07 00 1E B9 33 (target speed 30%)
Return: 01 06 04 07 00 1E B9 33

2.3.3.17 Automatic initialization

This command sets whether the gripper are automatically initialized or not, and the specific control details are shown in Table 2.21 below.

Table 2.21 Automatic initialization

Function	Address	Description	Write to	Read
Automatic initialization	0x0504	Automatic power-up initialization configuration	0: No initialization at power-up; 1: Automatic initialization at power-up (0: default)	Read the current setting value (need to write 01 at 0x300, effective for re-powering)

This command is used to set whether the gripper are automatically initialized after power is applied. After power on, the gripper will automatically send 01 initialize to initialize, you can check the explanation of 01 initialize in *2.3.3.1 Initializing thegripper.*

Set the gripper to be initialized automatically (write operation):

Send: 01 06 05 04 00 01 09 07
Return: 01 06 05 04 00 01 09 07

Send again: 01 06 03 00 00 01 48 4E
Return: 01 06 03 00 00 01 48 4E

3 IO control

IO mode is a common control method in industry to control the gripper in the form of hardware wiring. When using IO control, you need to set the gripper to IO mode in advance and set the 4 groups of IO states of the gripper.

3.1 IO configuration

The 4 states of IO mode can be configured through the serial software, or the parameters of the gripper can be configured through our debugging software, please refer to the following diagram for the specific wiring and configuration methods:

Gripper signal definition	Control devices
Input 1	DO /D-Out / Digital Output
Input 2	DO /D-Out / Digital Output
Output1	DI /D-In / Digital Input
Output2	DI /D-In / Digital Input
24V	24V/24V+
0 V	0V/24V-/GND

Once the four sets of parameters are configured, the gripper can be controlled by setting the INPUT 1 and INPUT 2 pins status, and the gripper status can be obtained by detecting the output pins OUTPUT 1 and OUTPUT 2.

The specific configuration is shown in the following figure:

Figure 3.1 IO settings

Switching IO mode steps
-①**Open IO mode**: Open IO mode first.
-②**Configuration of 4 groups of IO parameters**: 4 groups of parameters for clamping jaws, including position, force and speed are set
-③**Save**: Click the Save button to write the parameters to the internal Flash registers, and reboot to control.
-④**Restart**: After restarting, it is switched to IO mode successfully, you can control the jaws according to the INPUT signal, and the operation status will be fed back through OUTPUT.

The gripper are controlled by setting the INPUT 1 and INPUT 2 pin states (0V and high resistance (off) state). Since each INPUT pin recognizes two input states, it can be set to four gripper states (00 10 01 11). The specific pin states correspond as shown in Table 3.1.

Table 3.1 INPUT1 INPUT2 corresponding IO state table

INPUT 1	INPUT 2	Pin Status	I/O Status	Execute action
High resistance (disconnected)	High resistance (disconnected)	0 0	Group 1 Status	Target position 1, target force 1, target speed 1
0V	High resistance (disconnected)	1 0	Group 2 status	Target position 2, target force 2, target speed 2
High resistance (disconnected)	0V	0 1	Group 3 status	Target position 3, target force 3, target speed 3
0V	0V	1 1	Group 4 Status	Target position 4, target force 4, target speed 4

Note: The high resistance state is the state of great resistance value, corresponding to the state when the gripper are not wired, the same below.

The current status of the gripper can be obtained by detecting the output pins OUTPUT 1 and OUTPUT 2. The gripper can be read in four gripper states during operation. The details are shown in Table 3.2.

Table 3.2 OUTPUT1 OUTPUT2 Feedback status table

OUTPUT 1	OUTPUT 2	Pin Status	Command content
High resistance (disconnected)	High resistance (disconnected)	0 0	Gripper in motion
0V	High resistance (disconnected)	1 0	The gripper are not clamped to the object and are in place
High resistance (disconnected)	0V	0 1	Gripping object detected by gripper
0V	0V	1 1	Dropped object detected by gripper

Note: When the workpiece size and error are set, OUTPUT outputs 1 1 when the clamping position is greater than the set error value.

Attention

-The default input and output of digital IO are NPN type, and the input and output are valid for 0V. (Low-level valid prohibits the connection of 24V, resulting in damage to the jaws at their own expense)

-Input and output can be configured. If you need to change to PNP type, that is, the input and output 24V valid (high level valid prohibit ground or 0V, resulting in damage to the jaws of the consequences), you need to communicate with our company in advance.

3.2 IO Usage

When the parameters are configured, 24V, GND, INPUT 1, INPUT 2, OUTPUT 1, OUTPUT 2 need to be connected on the hardware.

Connect the INPUT and OUPUT to the corresponding devices, confirm that the wiring is correct and restart, and the gripper will be initialized automatically. Then the gripper will be controlled according to the INPUT signal. The operation status will be fed back through OUTPUT.

4 Gripper communication format and IO details

4.1 Gripper wiring method

The gripper use the standard Modbus-RTU communication protocol with RS-485 interface communication.

The wiring method is half-duplex wiring, as shown in Figure 4.1:

Figure 4.1 Wiring

USB to 485 module facing up, the power indicator lights up red after the USB to 485 module is powered on;

The upper interface at the right 2 interfaces for 485A/B line. **Demonstration gripper** color is **green A**, **blue B.** Please refer to the **line label for the** gripper signal line color definition.

4.2 Gripper communication format in detail

The default communication format of the gripper is: ***115200 baud rate***; ***data length 8***; ***stop bit 1***, ***no parity check***. The communication format of the host computer and the gripper should be consistent. If inconsistency cannot be communicated, please modify the communication format of the host computer or the gripper, and *restart the communication format of the gripper after modification. Please refer to the corresponding gripper manual to modify the communication format of the gripper.*

4.2.1 485 Instruction 03 Function Code Explanation

The hardware adopts RS-485, master-slave half-duplex communication, the master calls the slave and the slave answers the communication.

Note: All 485 commands are in hexadecimal; please refer to the command overview inside the **gripper manual for** register addresses.

Gripper commonly used function code for 03, 06 two function codes, the following table 4.1 for 03 function code use profile.

Example instruction: **01 03 01 03 00 01 75F6**

03 Function code: Read register value

1	2	3	4	5	6	7	8
ID	Function Code	Start register high byte	Start register low byte	Number of registers high byte	Number of registers low byte	CRC check digit low byte	CRC check digit high byte
01	03	01	03	00	01	75	F6

Table 4.1 Introduction to the use of function codes

The first byte is the slave ID range (1 to 254);
The second byte is function code 03H to read the value in the register;
The 3rd and 4th bytes are the start registers to be read; the start address of the register
The 5th and 6th bytes are the number of registers to be read 00 01 means that only the current 0103 register is to be read;
The 7th and 8th bytes are CRC check digits Calculate the CRC16 check digits for bytes 1~6.

Example Instruction Description: The master reads the slave ID as 1 and returns the value of 0001 registers starting from 0103 register to the master.

Caution:

If the number of read registers is changed to 0002, it is to read two registers starting from 0103, 0103 and 0104. It should be noted that the number of reads is read in order down, and cannot be read in jumps. For example, 0104 register and 0106 register, you need to pass two read instructions. Or the number of reads is changed to 0003, and the value of the three registers, 0104 0105 0106, is read. You cannot read 0104 and 0106 by one instruction alone.

Slave return command: *01 03 02 03 E8 B8 FA*

Table 4.2 Introduction to the use of function codes

1	2	3	4	5	6	7
ID	Function Code	Back Total number of bytes	Register current data1	Register current data2	CRC check digit low byte	CRC check digit high byte
01	03	02	03	E8	B8	FA

The first byte is the slave ID	Range (1 to 254);
The 2nd byte is function code 03H read by the master;	The return of the value
The 3rd byte is the length of the returned data length;	Return of 2 bytes of data
The 4th and 5th bytes are the returned data content content is 03E8;	The returned data
The 6th and 7th bytes are CRC check digits CRC16 check digit.	Calculate 1~6 byte

Return instruction description:
The master sends read command 0103 0103 0001 75F6 to the slave, and the slave returns command 0103 02 03E8 B8FA to the master.
Explanation:
The slave with ID 1 returns 2 bytes length data 03E8 (hexadecimal), which is converted to 1000 in decimal. 0103 register address represents the position register inside the gripper setting. The returned data represents that the current gripper is at position 1000.

4.2.2 485 Instruction 06 Function Code Explanation

Example instruction: **0106 0103 03E8 78 88**

06 Function code: Write a single register value

Table 4.3 Introduction to the use of function codes

1	2	3	4	5	6	7	8
ID	Function Code	Register address high byte	Register address low byte	Write data high byte	Write data low byte	CRC check digit low byte	CRC check digit high byte
01	06	01	03	03	E8	78	88

The first byte is the slave ID range (1 to 254);
The 2nd byte is function code 06H the master writes the value to the slave register;
The 3rd and 4th bytes are register addresses the address of the individual register to which the data is written;
The 5th and 6th bytes are write data 03E8 is converted to 1000 in decimal;
The 7th and 8th bytes are CRC check digits Calculate the CRC16 check digits for bytes 1~6.

Example command description:
The master writes data to the single register 0103 of the slave with ID 1. The written data is 03E8. 0103 is the position register, and this instruction indicates that the control gripper moves to position 1000.
Caution:
Write data using function code 06, when the slave accepts it correctly, it will return the same command and check code, indicating that the command is accepted correctly. For example, the **Master sends: 0106 0103 03E8 7888**
Return from station: 0106 0103 03E8 7888 .

4.3 Gripper IO input Output details

4.3.1 Gripper IO input details

Note: The IO input of the gripper is controlled by two NPN type IO control lines for the 4 states of thegripper. Please refer to *the IO control chapter* of the relevant gripper manual for specific IO parameter settings. Only the **output input principle of NPN type is** described here. Gripper IO input line is two, **line sequence definition reference line label**. Each of the two IO lines has two states, corresponding to 0 1 . The two lines have a total of four inputs. **INPUT** represents the input as shown in Table 4 below.

Table 4.4 IO states

INPUT 1	INPUT 2	Pin Status	I/O Status	Execute action
High resistance(0)	High resistance(0)	0 0	Group 1 Status	Target position 1, target force 1, target speed 1
0 V (1)	High resistance(0)	1 0	Group 2 status	Target position 2, target force 2, target speed 2
High resistance(0)	0 V (1)	0 1	Group 3 status	Target position 3, target force 3, target speed 3
0 V (1)	0 V (1)	1 1	Group 4 Status	Target position 4, target force 4, target speed 4

Table 4 INPUT1, 2 Explanation:

As each line has two output states 0 and 1, the high resistance state represents 0 in the gripper setting; NPN is valid at 0V, so 0V represents NPN transistor circuit conduction, which represents 1 in the gripper setting. one IO line can only output one state at a time, which is a 0 or 1, ***two lines combined with each other have a total of four input states***, representing four types of gripper input signal.

High resistance with 0V explained:

The NPN triode is 0V active, as opposed to the PNP triode which is 24V active. The NPN triode is explained below using pictures.

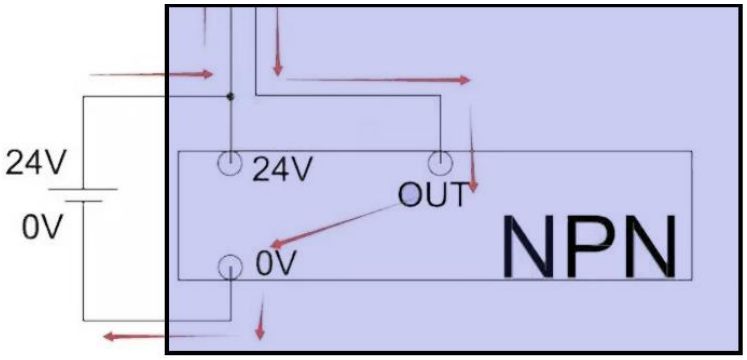


Figure 4.2 NPN illustration

NPN triode explained:

The black box indicates the internal circuit of PCB board, 24V is the power input to the gripper, after NPN transistor becomes 0V output, when the gripper input INPUT IO line is connected to 0V voltage, NPN transistor is on, input current to PCB board, PCB board senses the current output of transistor, determine the INPUT for state 1 at this time; when the gripper INPUT is disconnected from 0V , the NPN transistor disconnected, the resistance value is infinite, set the state of high resistance, that is, disconnected, at this time INPUT input for 0.

4.3.2 Gripper IO Output Details

Note: IO output and input are NPN. IO output is OUTPUT . Please refer to **the line label for line sequence color definition.**

The gripper will only output signals to the IO output signal line if the gripper IO control is turned on.

Turning on IO control, the gripper will output the current gripper operation status to the IO line. This is shown in Table 4.5 below.

Table 4.5 OUTPUT1, OUTPUT2 Feedback status

OUTPUT 1	OUTPUT 2	Pin Status	Command content
High resistance (0)	High resistance (0)	0 0	Gripper in motion
0V (1)	High resistance (0)	1 0	The gripper are not clamped to the object and are in place
High resistance (0)	0V (1)	0 1	Gripping object detected by gripper
0V (1)	0V (1)	1 1	Dropped object detected by gripper

Table 5 OUTPUT Explanation:

When the gripper are in motion, the two IO output lines do not output signal for high resistance (disconnected) state, the NPN transistor does not conduct, the resistance is infinite; when the gripper are in place, the PCB controls the NPN transistor of IO output line 1 to conduct to output 0V to the host computer or PLC. IO output line 2 is still high resistance (disconnected) state, generating 1 / 0 signal input to the host computer or PLC. The two IO points of the upper computer or PLC can distinguish the gripper state through the two IO output lines.

NPN triode output explained:

NPN triode circuit diagram please refer to Fig.2. the gripper are NPN output, the connected *PLC or host computer should be NPN type. the input IO common of NPN type PLC or host computer is 24V.* the gripper IO output line is connected to the input IO point of PLC or host computer. When the IO output signal of gripper are 0V, the common terminal of IO of PLC or upper computer is 24V, and a voltage difference of 24V is generated, and the IO point of PLC or upper computer is on. 0V signal of gripper are received by PLC or upper computer. On the contrary, **when the gripper are high resistance (disconnected), the IO point of PLC or upper computer and the IO output signal line of the gripper are disconnected. When the gripper is 0V, the PLC and the IO point of the upper computer and the IO output signal line of the gripper are on.**

4.4 Gripper IO input and output test method

Prepare tools: multimeter, 24vDC power supply, to be tested on the large oneworld gripper.
Preparation: Use DH-Robotics to connect the gripper and open IO mode. Set up IO parameters for easy testing.

4.4.1 Gripper IO input test method

When the gripper IO mode is turned on, **INPUT1 is connected to the 24V power supply 0V** interface and **INPUT2 is suspended**, at this time the gripper input signal is (1 0) will operate according to the second group of parameters in the IO setting.

Table 4.6 IO parameters-2

INPUT 1	INPUT 2	Pin Status	I/O Status	Execute action
0 V (1)	High resistance(0)	1 0	Group 2 Status	Target position 2, target force 2, target speed 2

When the **gripper INPUT1 is disconnected from 0V and then suspended**, **INPUT2 is connected to 24V power supply 0V**. At this time, the gripper input signal is (0 1), and the gripper will operate according to the 3rd group of parameters within the IO setting.

Table 4.7 IO parameters-3

INPUT 1	INPUT 2	Pin Status	I/O Status	Execute action
0V(1)	0V(1)	1 1	Group 4 Status	Target position 4, target force 4, target speed 4

Table 4.8 IO parameters-4

INPUT 1	INPUT 2	Pin Status	I/O Status	Execute action
High resistance(0)	0V(1)	0 1	Group 3 status	Target position 3, target force 3, target speed 3

When the **gripper INPUT1 and INPUT2 are both connected to the 24V power supply 0 V**. At this time, the gripper input signal is (1 1) and the gripper will operate according to the fourth group of parameters within the IO settings.

Table 4.9 IO parameters-1

INPUT 1	INPUT 2	Pin Status	I/O Status	Execute action
High resistance (0)	High resistance (0)	0 0	Group 1 Status	Target position 1, target force 1, target speed 1

When the gripper INPUT1 and INPUT2 are both disconnected at 0V, the gripper input signal is (0 0) and the gripper will operate according to the first set of parameters in the IO settings.

Test the above four IO parameters, if the gripper can all act correctly, it means the grippergripper input IO is normal.

4.4.2 Gripper IO output test method

Note: In the open IO mode, the IO output will only have signal feedback when the IO input method is used to control the gripper.

First, use a multimeter to connect the positive pole of 24V power supply, and the other end to connect one of the output IO lines of the gripper. When the output IO line outputs a signal of 0V, there is a voltage difference of 24V with the positive terminal of 24V power supply at this time, and the voltage difference of 24V is used to judge whether the IO has output the correct signal.

Turn on the IO control and set the IO parameters, you can refer to Figure 3 for IO settings. Connect the multimeter and gripper.

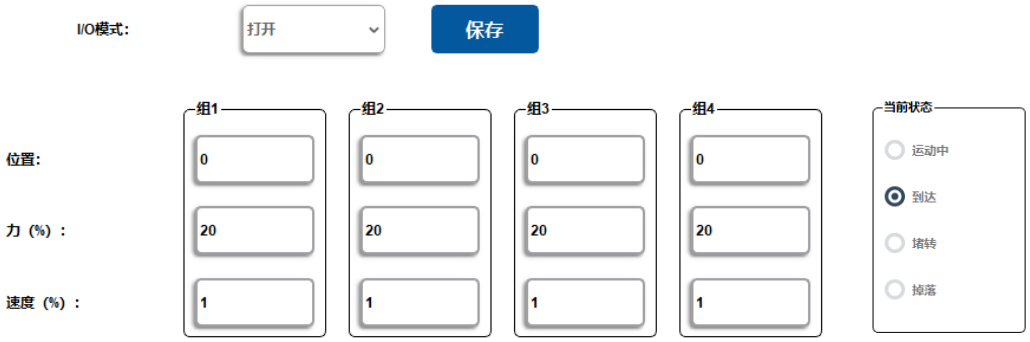


Figure 4.3 IO settings Figure 4.4 Clamping status

Table 4.6 IO parameters

OUTPUT 1	OUTPUT 2	Pin Status	Command content
High resistance (0)	High resistance (0)	0 0	Gripper in motion
0V (1)	High resistance (0)	1 0	The gripper are not clamped to the object and are in place
High resistance (0)	0V (1)	0 1	Gripping object detected by gripper
0V (1)	0V (1)	1 1	Dropped object detected by gripper

Connect the input INPUT1 of the gripper to 0V, the gripper will move to the second group IO parameter position, after the gripper shows in place in Figure 4, test the voltage of OUTPUT1 and OUTPUT2, the voltage of OUTPUT1 shows 24V and the voltage of OUTPUT2 shows about 0V as correct.

Explanation: Why does OUTPUT1 show 24V but 0V in the table?
Because the output of OUTPUT1 is 0V, the other end of the multimeter is connected to 24V, and there is 24V voltage difference with OUTPUT1. When the multimeter shows 24V, it means OUTPUT1 is outputting 0V, so 0V is shown on Table 6.
Explanation: Why does OUTPUT2 show 0V but shows high resistance (disconnected) in the table?
As mentioned in the previous "*Input IO test method*", **the high resistance is the disconnected state**, so the power supply 24V and OUTPUT2 are disconnected, no voltage is generated, and the multimeter shows 0V.

For other output status test methods, refer to the above test in place signal output.