HJL series

Linear Actuators

泰科机器人
TECH ROBOTS

Operation instruction

PREFACE

Thank you for purchasing and using the HJL series robot joint modules of our company. We will provide you with high - quality product services.

About the HJL Series Robot Joint Modules

The HJL series joint modules are humanoid robot joints launched by our company. They are designed based on the modular concept, featuring strong thrust and high precision. The integrated HJL not only has a compact structure, is easy to install, and offers high cost - effectiveness, saving you the costs invested in various links such as the design and assembly of humanoid robots. At the same time, we continuously upgrade, optimize, and provide customized services for the products, offering a richer product selection to enable you to design your robots more freely and flexibly.

About This Manual

This manual is intended for the users, commissioning personnel, and maintenance personnel of the robot joint modules.

The Main Contents Of This Manual Include:

1. Safety precautions and warranty information for the HJL series joint modules;

2. Introduction of the HJL series joint modules;

3. Installation of the HJL series joint modules;

4. Testing of the HJL series joint modules;

5. Troubleshooting and handling methods for common faults of the HJL series joint modules.

More Information

If you need to know more information and materials about our company and other products, the contact information is as follows:

- Company full name: Techrobots (Shenzhen) Co., Ltd.,

- Address: 2nd Floor, Building 12, Nangang NO.2 Industrial Park, 1026 Songbai Road, Nanshan District, Shenzhen, China

- Tel: +86 (755) 26712958

- After sales Technology: +86 189 2524 7616

- Email：tech@techsoft-robots.com

- Website: www.tech - robots.com

Copyright Notice

The copyright of this manual belongs to Techrobots (Shenzhen) Co., Ltd.,((referred to as "Techrobots"). Without the permission of Techrobots, the content of this manual shall not be reproduced or copied in any way. This document is for user reference only. The content in the document is intended to be accurate and reliable, but errors and omissions are inevitable. If you find any errors, please feel free to let us know. Techrobots reserves the right to modify and improve this document at any time. If you have any questions, please consult us. Thank you.

Except as explicitly stated in this manual, nothing in this manual should be construed as any guarantee or warranty made by Techrobots regarding personal loss, property damage, and specific applicability, etc.

Table of Contents

Chapter 1 Safety Information

Before installing and using the HJL joint module, please carefully read the informations in this chapter. The following lists the necessary safety information for using the HJL joint module. This information is intended to protect you, the drive, and related equipment when you use the product. Incorrect use may lead to personal injury or property damage.

Warning! Danger signs that pose a risk to human safety during operation, as well as instructions for use to prevent such situations from occurring.

Attention! Danger signs indicating that the drive may damage the product or equipment, as well as the usage instructions to avoid such situations.

Attention! This area is indicated to be sensitive to static electricity, and it is required to handle it in an environment with static electricity protection.

1.1 Warnings

Warning! The voltage of the driver may cause an electric shock! When the power is turned on, do not directly touch the live parts.

Warning! To avoid the risk of arc discharge, do not connect or disconnect the wiring between the driver and the power supply when the power is turned on!

Warning! The surface of the driver may get hot during operation.

Warning! During the operation of the driver, the controlled motor is in motion. Please keep away from all

moving parts to avoid injury.

Special Warning!

1.2 Precautions

Attention! To be operated by professionals

Only professionals with corresponding qualifications are permitted to carry out tasks such as transportation, assembly, setting, and maintenance. Qualified professionals refer to those who are familiar with the transportation, installation, assembly, commissioning, and operation of the motor and possess the relevant minimum qualifications required to fulfill their duties:

■ Transportation: It can only be carried out by personnel with knowledge of handling electrostatic - sensitive components.

■ Mechanical installation: It can only be carried out by personnel qualified in mechanics.

■ Electrical installation: It can only be carried out by personnel qualified in electrical engineering.

■Setting: It can only be carried out by qualified personnel with knowledge of electrical engineering and drive technology.

Qualified personnel must be aware of and comply with IEC60364/IEC60664 and national accident prevention regulations.

Read the documents: Read the corresponding documents before installation and commissioning. Incorrect use of the motor may cause harm to people or property damage. Therefore, the operator must ensure that all personnel working on the motor have read and understood this manual and comply with the safety instructions in this manual.

Attention! Comply with technical data and specifications

Comply with the technical data and specifications regarding connection conditions (please refer to the nameplate and relevant sections in this document). Exceeding the permitted voltage or current values may damage the motor, such as causing overheating.

Attention! Conduct a Risk Assessment

Machine manufacturers must conduct a risk assessment of the machine and take appropriate measures to ensure that unexpected movement does not cause any personal injury or property damage. Through

the risk assessment, additional requirements may be imposed on professionals.

⚠ Attention! Safe Transportation

Only use lifting tools to lift and move equipment weighing over 20kg. Lifting without assistance may cause back injuries.

⚠ Attention! Beware of High Surface Temperatures

During operation, depending on their protection class, the surfaces of the motors can become extremely hot. Be cautious of burns when touching them.

⚠ Attention! Joint Stroke Limit

The HJL joint module can only operate within its stroke range. When used for multi - axis coordinated operation, the operation should be carried out in combination with the specific working conditions.

Chapter 2 Product Warranty

2.1 Product Quality Assurance

The HJL joint module comes with a 12 - month limited warranty.

If within 12 months after the joint module is put into use, defects occur due to poor manufacturing or materials, Techrobots shall provide necessary spare parts for replacement or repair of the relevant components. However, if the equipment defects are caused by improper handling or failure to follow the relevant information stated in the user guide, this product quality assurance shall become invalid.

Without violating the principles of this product quality assurance, if the product is beyond the warranty period, Techrobots reserves the right to charge the customer for replacement or repair costs.

The ownership of the replaced equipment or components returned to Techrobots shall belong to Techrobots.

Outside the warranty period, if the equipment shows defects, Tech - Robots Intelligent shall not be liable for any damages or losses caused thereby, including but not limited to production losses or damage to other production equipment.

2.2 Disclaimer

Techrobots is committed to continuously improving product reliability and performance, and thus reserves the right to upgrade products without prior notice. Techrobots endeavors to ensure the accuracy and reliability of the content in this manual, but shall not be held responsible for any errors or omissions therein.

Failures resulting from the following situations are not covered by this warranty:

1. Installation, wiring, or connection to other control devices not in accordance with the requirements of the user manual.

2. Use beyond the specifications or standards indicated in the user manual.

3. Product damage caused by improper transportation.

4. Damage caused by accidents or collisions.

5. Natural disasters such as fires, earthquakes, tsunamis, lightning strikes, strong winds, and floods.

6. Failures caused by reasons other than the liability of Tech - Robots Intelligent apart from the above - mentioned situations.

Chapter 3 Introduction of HJL Series Joint Modules

3.1 Overview of HJL Joint Modules
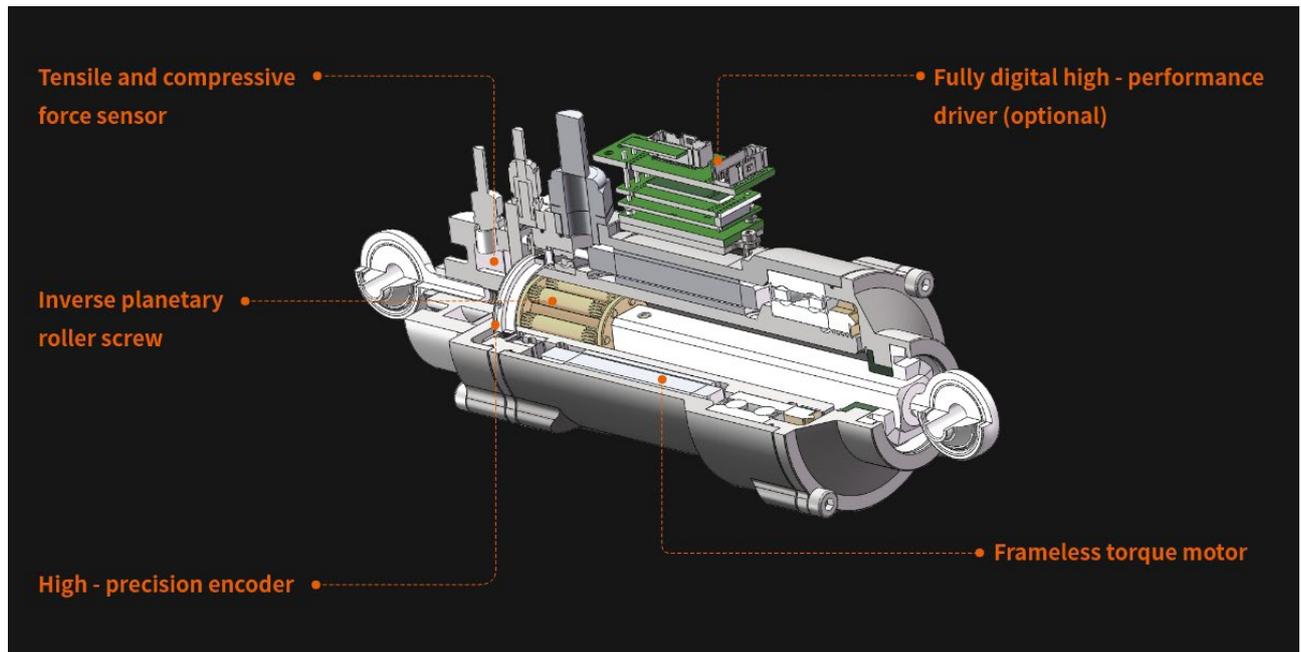
Figure 3.1-1 Cross-sectional diagram

The HJL joint module integrates a tensile and compressive force sensor, a frameless torque motor, an absolute encoder, and a servo driver. It features a compact structure, which makes it easy to install. Closed - loop control is achieved by using self - developed servo drivers and encoders. The HJL series joint modules are available in three models: HJL08, HJL12, and HJL15, making robot development simpler, more convenient, and more flexible.

Tensile and compressive force sensor

According to the requirements of the usage scenario, higher force - controlled flexible operation is achieved through the force sensor.

Inverse planetary roller screw

It has strong pushing and pulling force and high load - bearing capacity. It features high precision and smooth output, as well as low noise and low vibration. With a long service life, it is suitable for applications with high - speed operation, variable loads, and shock resistance.

Frameless torque motor

The hollow, ultra - thin design with a large aperture can reduce the size of robot joints and the weight of the robot. It has low torque ripple, low moment of inertia, and high - torque - density output. It also features high precision, high rigidity, and better response speed, thus improving the operational efficiency of the robot.

Servo driver

The HJL joint module comes with a servo driver, eliminating the need for users to equip an additional one. To make the equipment system more compact, the servo driver provided with the HJL module can be integrated onto the joint module, or placed externally as required.

Encoder

The HJL uses a 17-bit/16-bit multi-turn absolute encoder, which can precisely control the motion trajectory. It features an ultra-thin design and a compact structure.

3.2 Packing List of HJL Joint Module

Packing List for EtherCAT Type:

- HJL Joint Module Motor (with matching driver) * 1 unit
- Serial Port Cable * 1 piece
- 5 - pin Dual - ended Driver EtherCAT Cable * 1
- One - end RJ45 and One - end 5 - pin EtherCAT Network Cable * 1
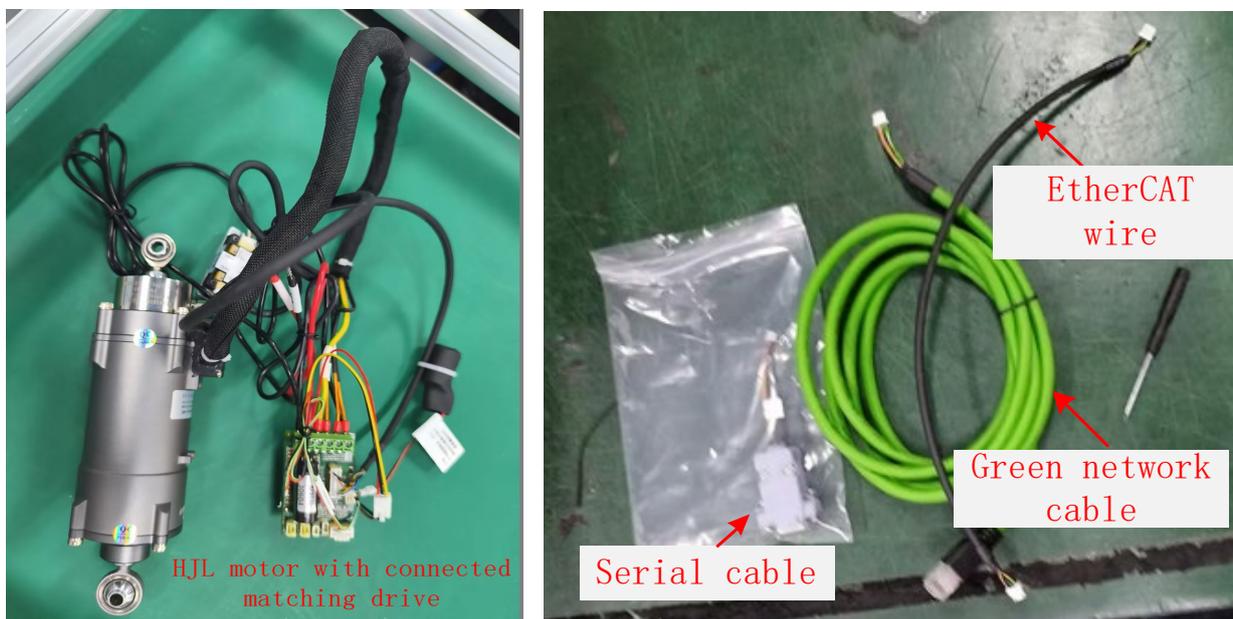
Figure 3.2-1 Packing List for EtherCAT Type

Packing List for CANopen Type

- HJL Joint Module Motor (with matching driver) × 1 unit
- Serial port cable × 1 piece
- 5 - pin dual - ended driver CAN cable × 1
- 5 - pin single - ended CAN cable × 1
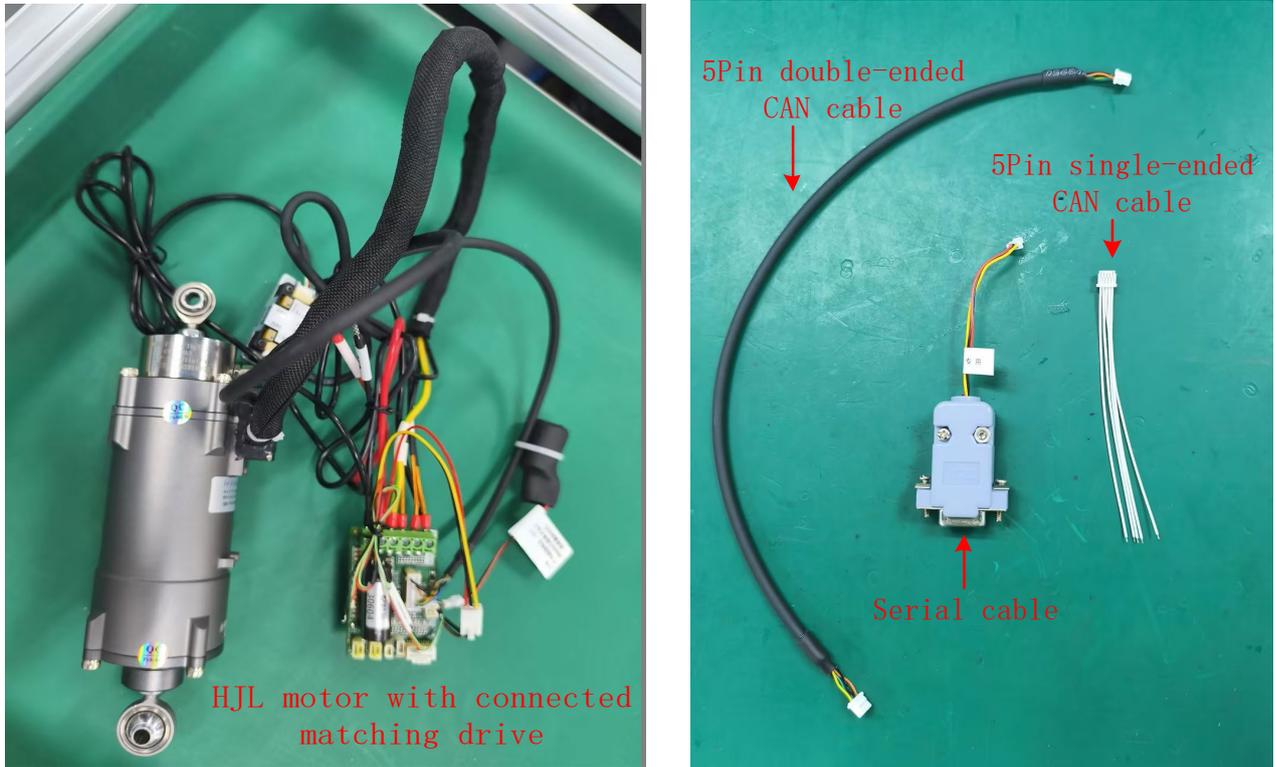
Figure 3.2-2 Packing List for CANopen Type

3.3 Model Description of HJL Joint Module

HJL	12.5.72			KN4300		MA1716	D7	E	-RevB1
Series	Screw Parameter			Module Parameter		Absolute Value Encode	Drive Model	Default Communication Config.	Version Number
	Model	Screw lead	Route	Maximum Thrust	Maximum Speed				
linear planetary roller screw actuators	8	3.5	38	600N	300	S:Single Turn M:Multi-Turn A:Absolute Value 17/16:Encoder Single-Turn Resolution	D7：DGT (for 08 &12) D8：DGB (for 15)	E：EtherCAT C：CANopen R: 485 communication	B1：Design Version Number
	12	2	72	4000N	120				
		5	72	4000N	300				
	15	2	96	8000N	120				
		6.5	96	8000N	400				

Sample：HJL12.5.72-4KN300-MA1716-D7E-RevB1

3.4 HJL Technical Parameters of Joint Modules

parameter type	Name	unit	HJL08	HJL12	HJL15
mechanical parameter	Screw types	--	Linear planetary roller screw		
	Lead	mm	3.5	2/5	2/6.5
	Maximum thrust	N	600	4000	8000
	Maximum speed	mm/s	300	120/300	120/400
	Maximum range	mm	38	72	96
Servo system	Rated voltage	VDC	48	48	48
	Rated current	A(rms)	4	9.2	25.3
	Rated rotational speed	rpm	5000	3500	3500

	Peak torque	N.m	0.9	4	11.5
	Absolute encoder	Bit	17/16 - bit multi - turn		
	Communication protocol	--	CANopen / EtherCAT		
boundary dimension	Maximum diameter	mm	49	62	86
	Maximum length	mm	139.9	226.9	286.6
	Joint weight	kg	0.5	1.3	2.8
Sensor type	--		Tensile and Compressive Force Sensor		
IP rating	--		IP40		
Working environment	--		Operating temperature : 0～40°C(-40～60°C Optional) Storage temperature : -40～80°C Environmental humidity : 90% Relative humidity (No condensing)		

Chapter 4 HJL Installation of Series Joint Modules

4.1 Mechanical installation

Please conduct structural design and assembly in combination with the drawings of various models of modules provided by our company.

4.2 Electrical Installation

The standard shipping status of the joint module is as follows:
Each joint module is equipped with a corresponding model of drive configuration, and all the connections between the motor and the drive are properly adapted.

Joint Module Specifications	Drive specification model (the model suffix is determined according to customer requirements)
HJL08	TGM-10D100-AE：Rated current 10A,Peak current 20A,Power supply voltage range 24~80Vdc
HJL12	TGM-N70D100-AE：Rated current 70A,Peak current 70A,Power supply voltage range 24~80Vdc
HJL15	TGB-N140D100-AE：Rated current 140A,Peak current 140A,Power supply voltage range 24~80Vdc

Figure 4.2-1 List of drive specifications for HJL joint modules

After users receive the product, they need to do the following:

1、Connect the power supply.
2、Connect the STO signal.
3、Check that the motor power cable and encoder cable are well - connected.
4、Check that the force sensor circuit is well - connected.
5、Use an RS232 communication cable to connect to the PC debugging software for control, or use a bus to connect to the master station for control.

This chapter mainly expands on the above five - step process with further descriptions.

4.2.1 Power Supply Connection of Joint Modules and Selection of Power Supply Specifications

The rated operating voltage of HJL is 48VDC, and the power supply connection ports are the two terminals VP and PR of the driver. Generally, a DC power supply with transformer isolation is used for the driver's power supply, and the supply voltage shall not exceed the maximum voltage rating of the driver.

Note: If a switching power supply is used, to ensure the safe and efficient operation of the driver, an anti - electromotive force absorption device should be installed between VP and PR. The connection of the anti - electromotive force absorption device (referred to as the discharge module for short) is shown in the figure below.
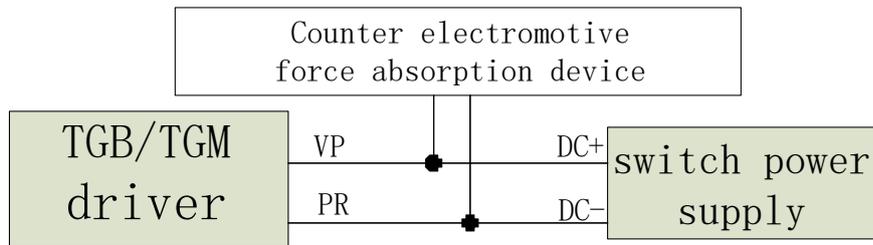
Figure 4.2.1-1 Schematic Diagram of Power Supply Connection for Switching Power Supply

- For detailed information about discharge module, please refer to the introduction in Section 6.4 of this manual.

- For information such as driver interfaces, please refer to the introduction in Section 6 of this manual.

The power rating of the power supply depends on the power transmitted from the driver to the load. Users need to adapt and select the power supply according to the actual operating conditions. The following lists the typical power consumption of HJL for reference.

Model	Power supply voltage（VDC）	Average current (A)	Peak current（A）
HJL08	48	4	11.5
HJL12	48	9.2	37.6
HJL15	48	24	98

Figure 4.2.1-2 List of Typical Power Consumption of HJL

Power Wiring of Joint Modules
The specifications of the power cables equipped for the joint modules at the factory are as follows:

Function name		Wire color	Wire specification		
			HJL08	HJL12	HJL15
Power cable	48VDC+	Red	20AWG	16AWG	14AWG
	48VDC-	Black	20AWG	16AWG	14AWG

Figure 4.2.1-3 List of HJL Power Cable Specifications

CANopen / EtherCAT communication wiring

The specifications of the EtherCAT cables equipped for the joint modules at the factory are as follows:

	A	Standard RJ45 network port, used to connect to the controller or PC side
	B	EtherCAT communication port, connecting to the EtherCAT port of the joint module

4.2.2 STO connection on the driver

Safe Torque Off (STO) is a safety function that can prevent the driver from transmitting energy to the motor to generate torque.

According to the requirements of IEC61800-5-2 and ISO13849-1 Category 3 for the STO input signal level,

the STO function must be controlled by two fully redundant inputs. The motor can only be activated when both STO inputs are normal. If one of the STO inputs is activated, the driver will stop supplying power to the motor. In this case, the motor will be in "free-running" mode and come to a stop under the action of its own inertia and friction.

The default configuration of the HJL joint module is a 5V STO input type. Users need to connect the STO signal according to the following schematic diagram.
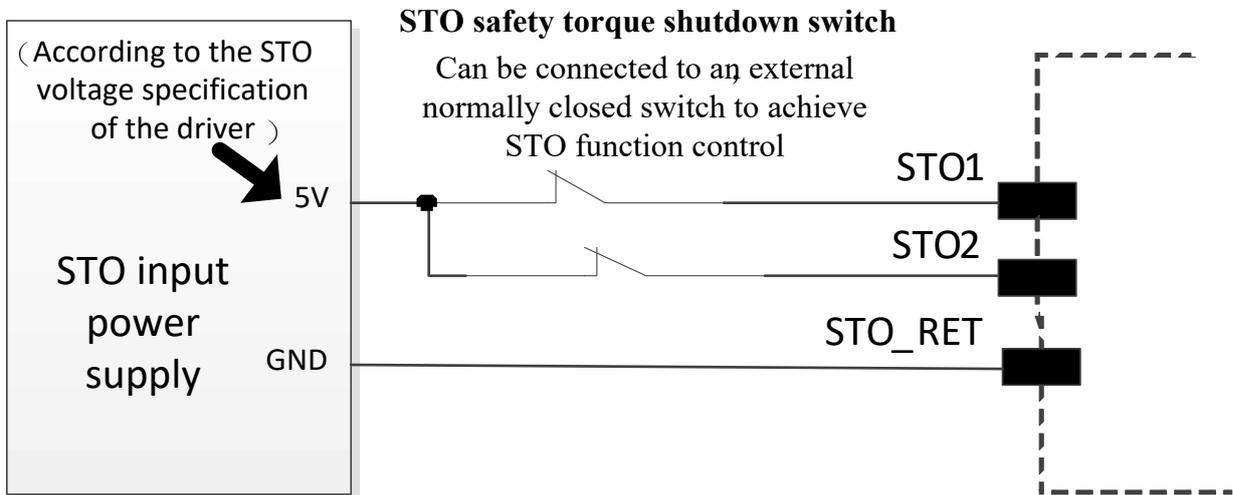
Figure 4.2.2-1 Schematic Diagram of STO Input Function Wiring

4.2.3 Connection of motor power cable and encoder cable
The motor power cables and encoder cables are pre - wired and connected at the factory. Users do not need to make further electrical connections. Please refer to the overall wiring diagram of the HJL joint module in the appendix of this manual for verification.

4.2.4 Force sensor connection
The motor power cables and encoder cables are pre - wired and connected during factory production. Users do not need to make further electrical connections. Please refer to the overall wiring diagram of the HJL joint module in the appendix of this manual for verification.

4.2.5 Connection of driver communication cable

1）RS232 connection
The driver communicates with the PC debugging software through the RS232 port to configure parameters and control the operation of the HJL joint module.

Document version：V1.0
13
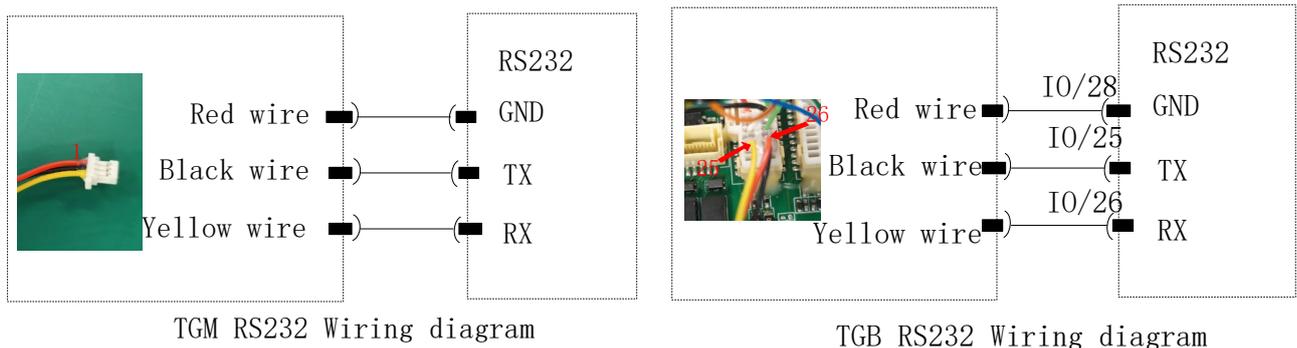
2）EtherCAT Communication cable connection
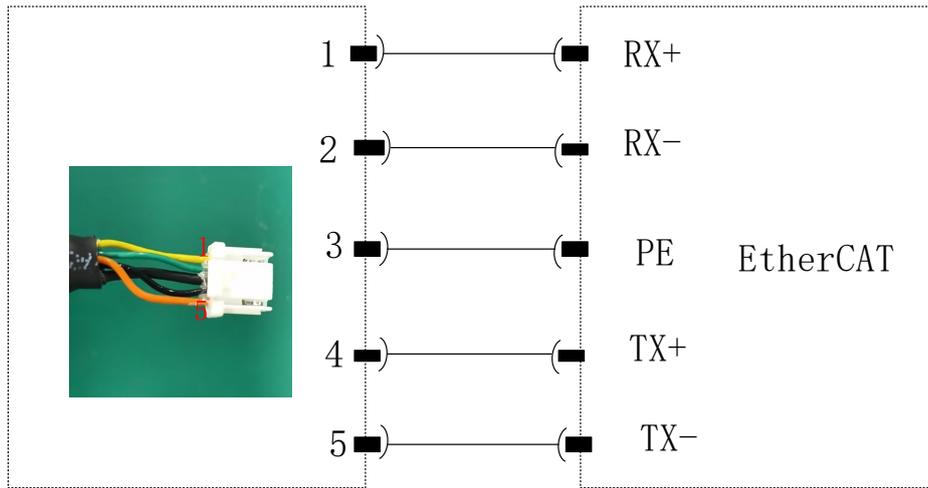
TGM/TGB EtherCAT Wiring diagram

1	—	RX+
2	—	RX-
3	—	PE
4	—	TX+
5	—	TX-

EtherCAT

3）CANopen Communication cable connection
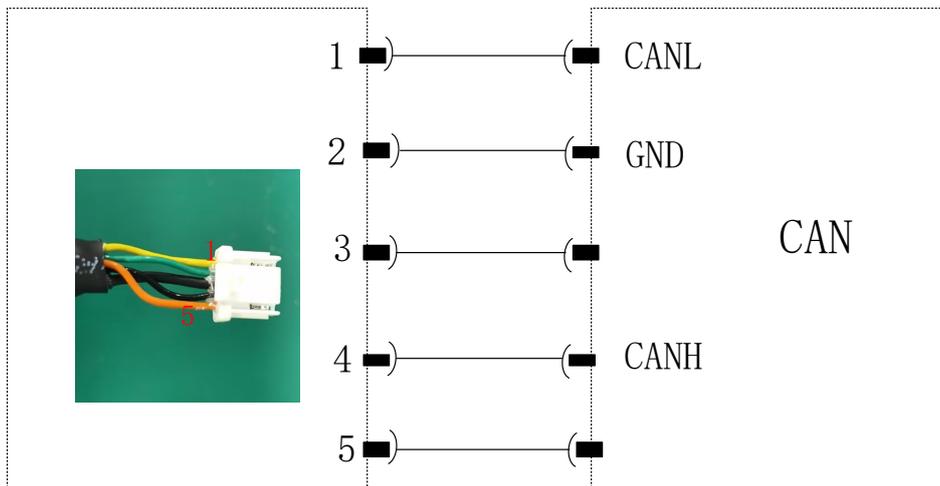
TGM/TGB CAN Wiring diagram

1	—	CANL
2	—	GND
3	—	
4	—	CANH
5	—	

CAN

Chapter 5 Control of HJL Series Joint Modules

5.1 PC Control operations of the debugging software

This section describes the debugging operation steps of the HJL joint module when connected to a PC via the RS232 serial port.

Step 1: Circuit Connection and Power Supply
Connect the RS232 port of the computer to the RS232 terminal port of the joint module driver through RS232 accessories. Power on the system, and note that the STO signal should also be supplied with normal power.

Step 2: Communication Connection Operation

Double - click the PC debugging software provided by our company TKServostudio.exe , enter the following interface. In the communication type drop - down box, select RS232. Select the serial port number corresponding to the connected driver, the serial port baud rate, and then click the "Connect" button in the upper - right corner of the software.
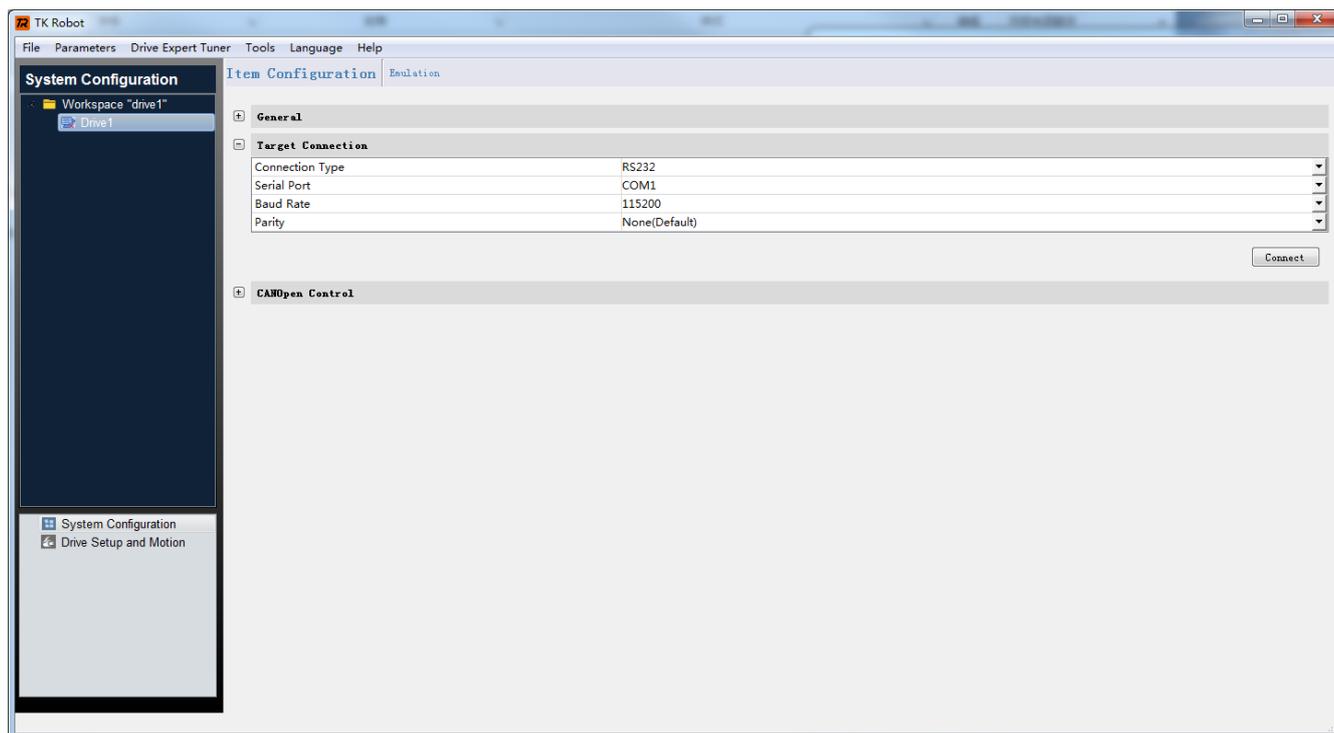
Figure 5.1-1 Communication Connection

Step 3: Motor Enable Operation on the Control Panel Interface
As shown in the figure below, enter the single - axis motion control interface and click the "Start" button. After the enable operation is successful, the status indicator of "Disabled" will change to the green "Start" status indicator, indicating that the motor enable operation is successful.
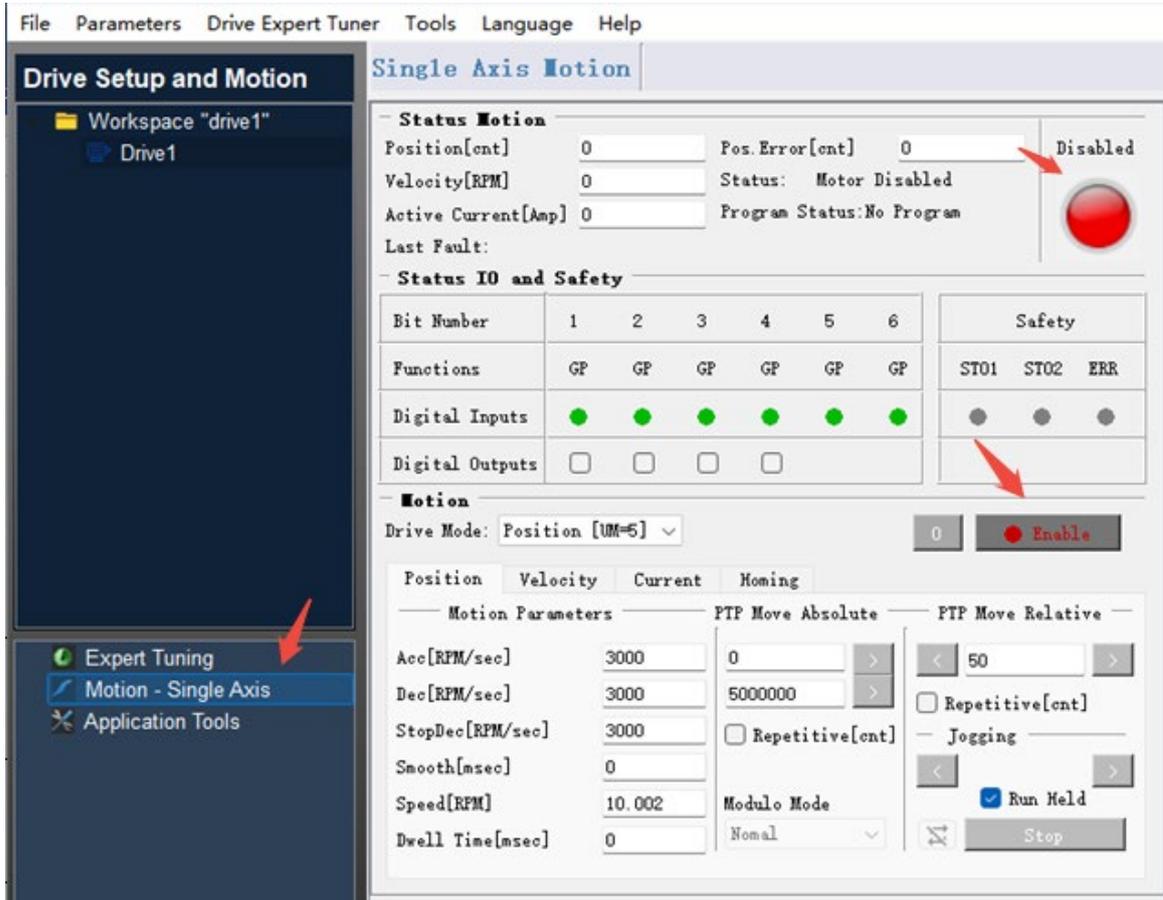
Figure 5.1-2 Motor Enable Operation
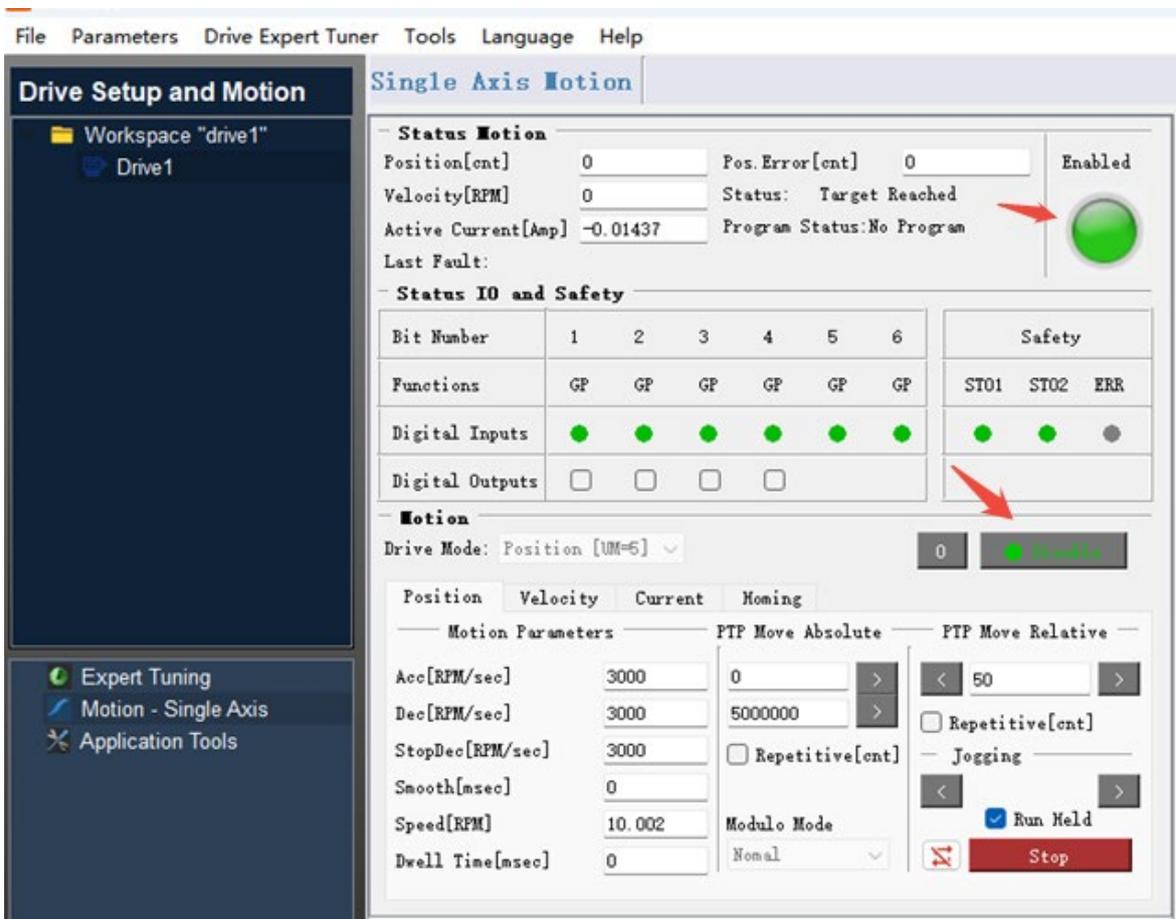
Figure 5.1-3 Motor enabled successfully

Step 4: Operate the motor to run reciprocally on the single - axis motion control interface.

After the motor is enabled, input the motion parameters as shown in the interface below.
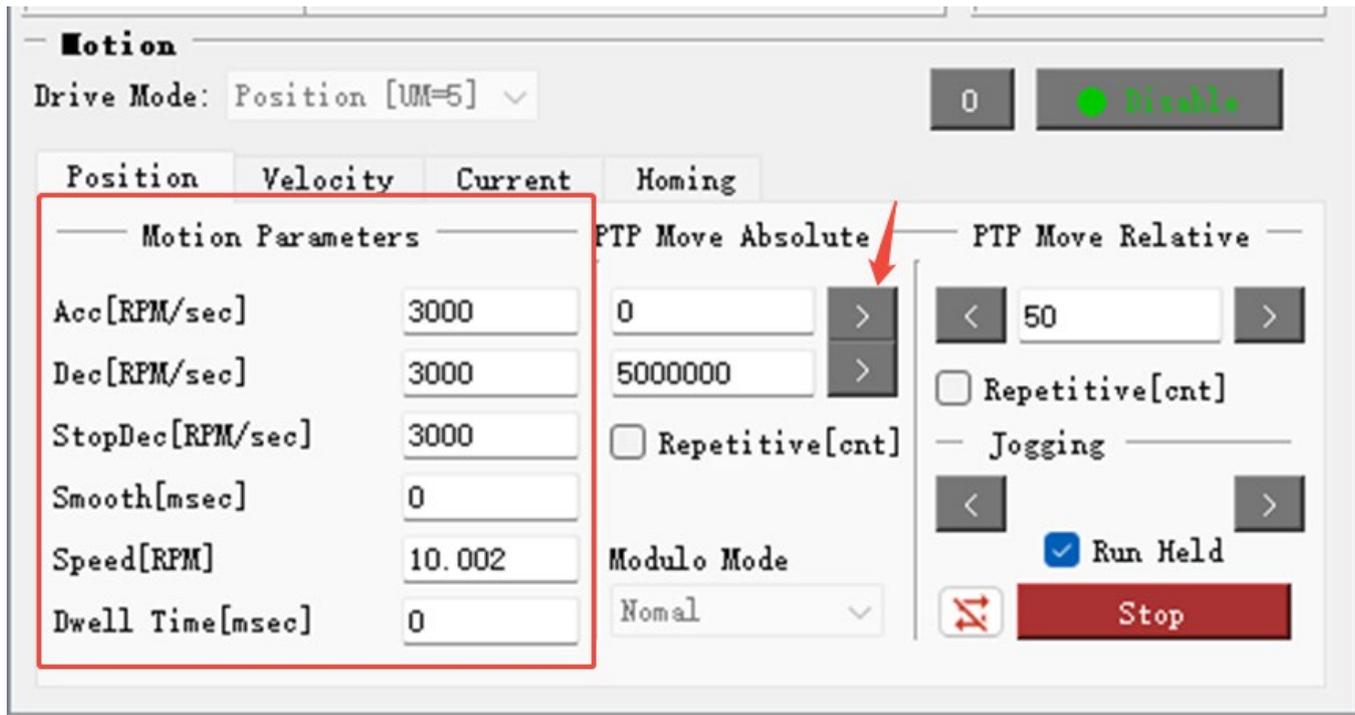
Figure 5.1-4 Reciprocal operation of the motor

Input the acceleration, deceleration, and motor speed, paying attention to the units. By default, the units are for rotary motors (speed in rpm, position in counts, acceleration and deceleration in rpm/s). For the position in counts, an increment of 131072 corresponds to a linear displacement increment of the joint module equal to the lead of the lead - screw.

Suggested parameter input ranges:

- Speed: Typical values range from 10 rpm to 3500 rpm. It is recommended to start testing from the minimum value.

- Acceleration (Acc), deceleration (Dec), and emergency stop deceleration (stop dec): Typical values are 5000 - 20000 rpm/s (affected by factors such as load conditions and the capacity of the power supply. It is recommended to start testing from the minimum value).

After configuring the motion parameters, input two positions for PTP absolute motion. As shown in Figure 5.1-4, they are the 0 - position point and the 1800000 - counts position point. Pls noted that the pulse readings of the two positions for reciprocal operation must be set within the stroke range of the joint module and should not exceed the stroke.

By clicking the arrows under PTP absolute motion as shown in Figure 5.1-4, the joint module starts to operate. After checking the "Cycle" checkbox under PTP absolute motion, the motor will run reciprocally between the two pulse - point positions of 0 and 1800000.

For the operation of other functions in the PC debugging software, relevant information can be obtained by referring to the online documentation in the software installation directory.

5.2 TwinCAT master station control operation

This section describes the operation steps for controlling the motor of the HJL joint module (EtherCAT driver version) using the TwinCAT master station. Take the connection of a single HJL12 joint module to TWINCAT as an example.

Step 1: Circuit Connection and Power Supply
Connect the network port of the TwinCAT computer to the joint module system via an EtherCAT network cable (the green network cable in the accessories, with one end being RJ45 and the other end a 5 - PIN EtherCAT connector for the driver). Power on the joint module system. Pls noted that the STO signal should also be supplied with normal power.

Step 2: Master - Slave Connection Operation
Create a new TwinCAT project. Note that TWINCAT needs to be in the configuration mode. Click "SCAN" under "Devices" as shown in the figure to scan for slave stations. The operations are as follows in sequence:
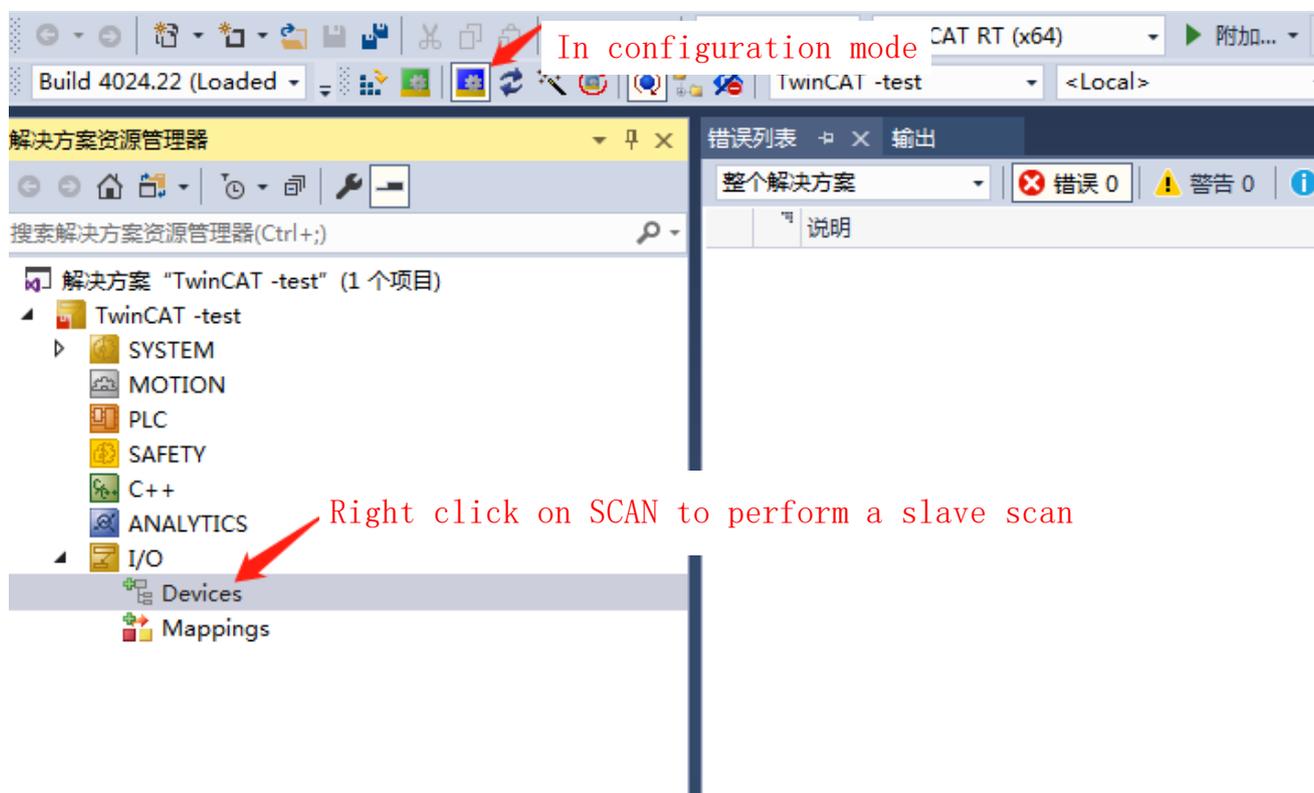
Figure 5.2 - 1 Create a new TwinCAT project
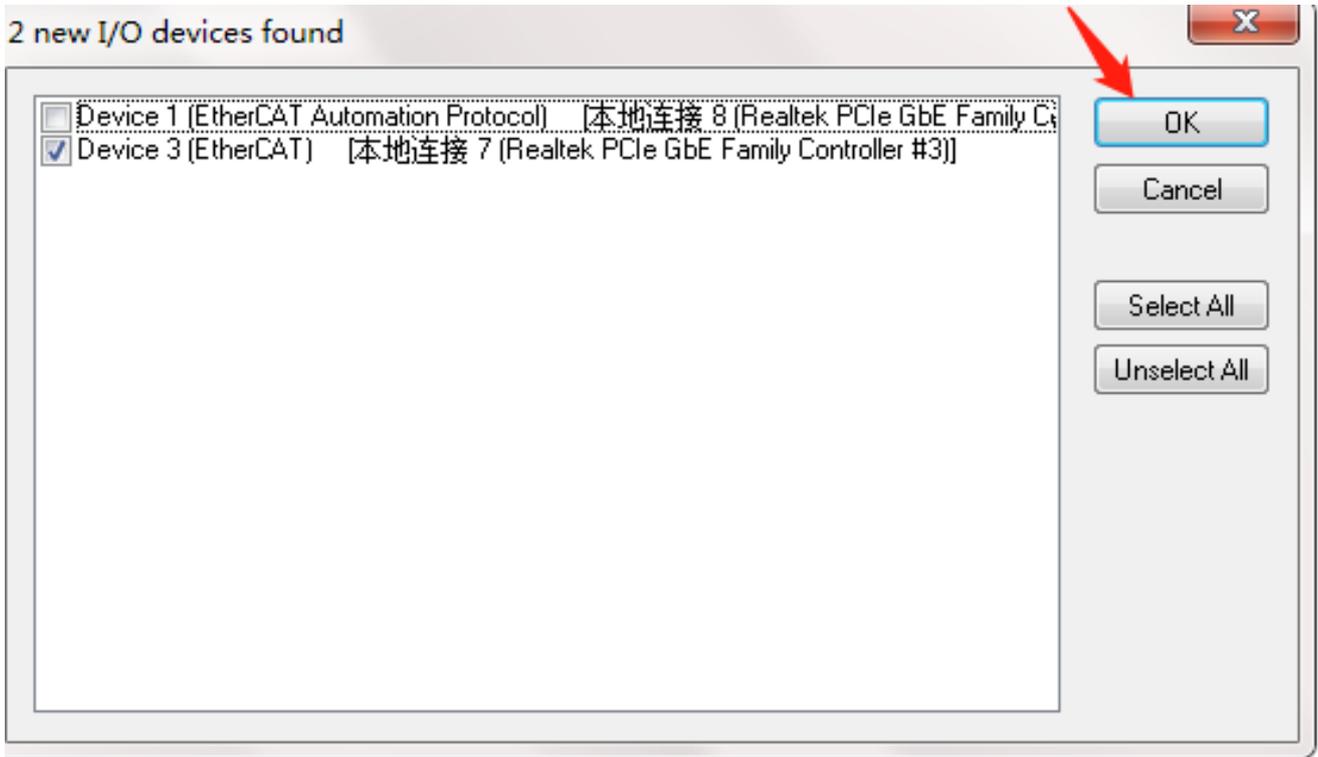
Figure 5.2 - 2 Click OK
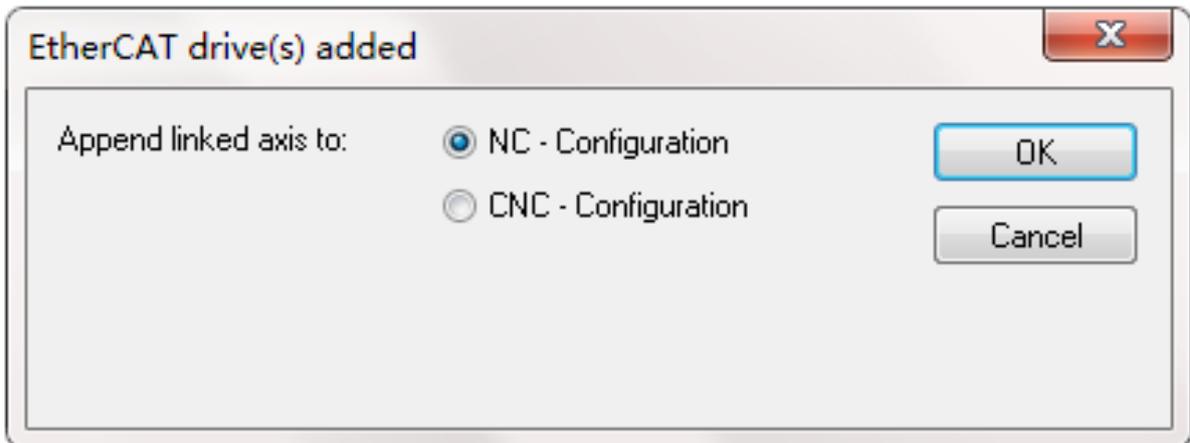
Figure 5.2 - 3 Click OK
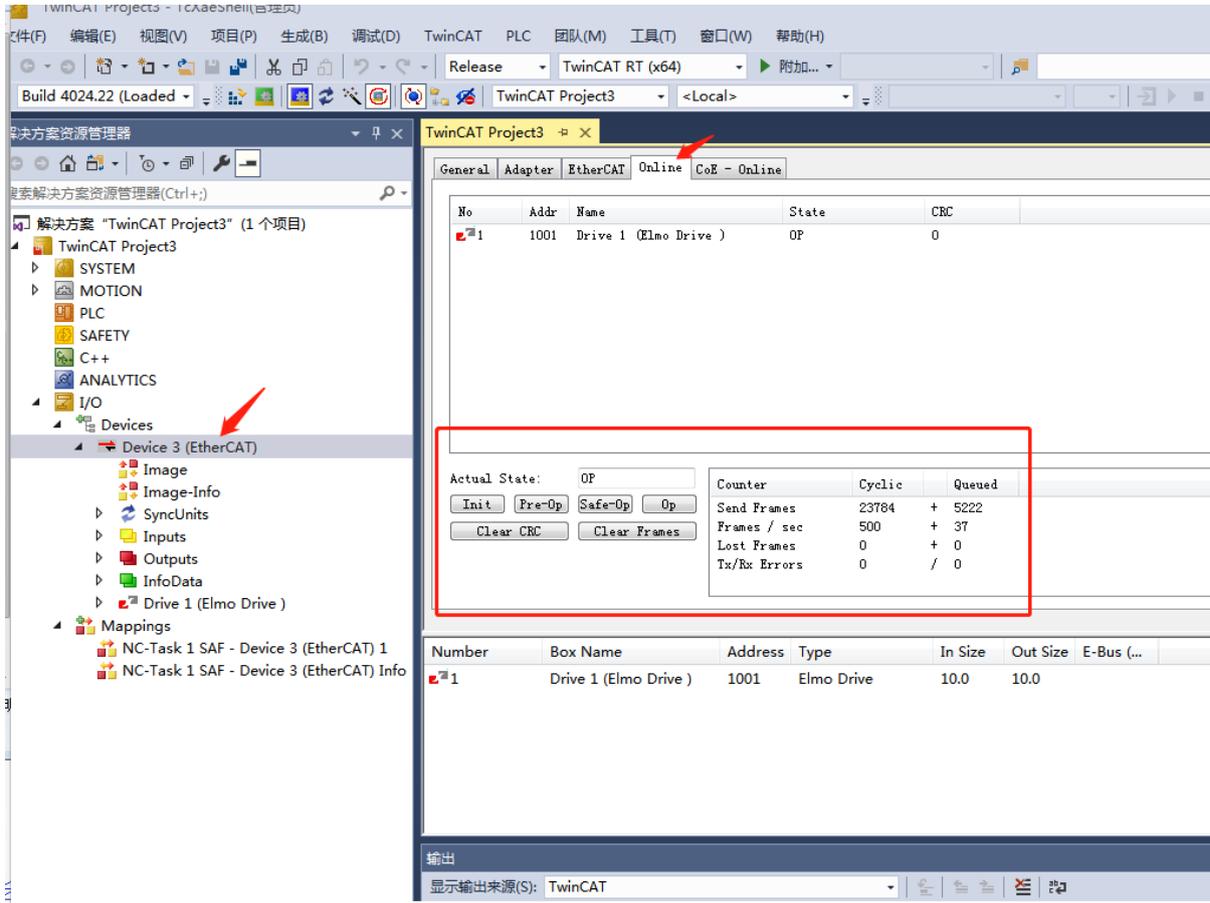
Figure 5.2-4 Slave station scanned out

Check the online interface shown in Figure 5.2-4. The slave station status is normal (OP is normal), and the network packet loss data is normal. At this step, the master-slave connection has been successfully established. Next proceed to the relevant control configuration in step 3).

Step 3 Parameter Configuration

1）Encoder Scale Factor Configuration
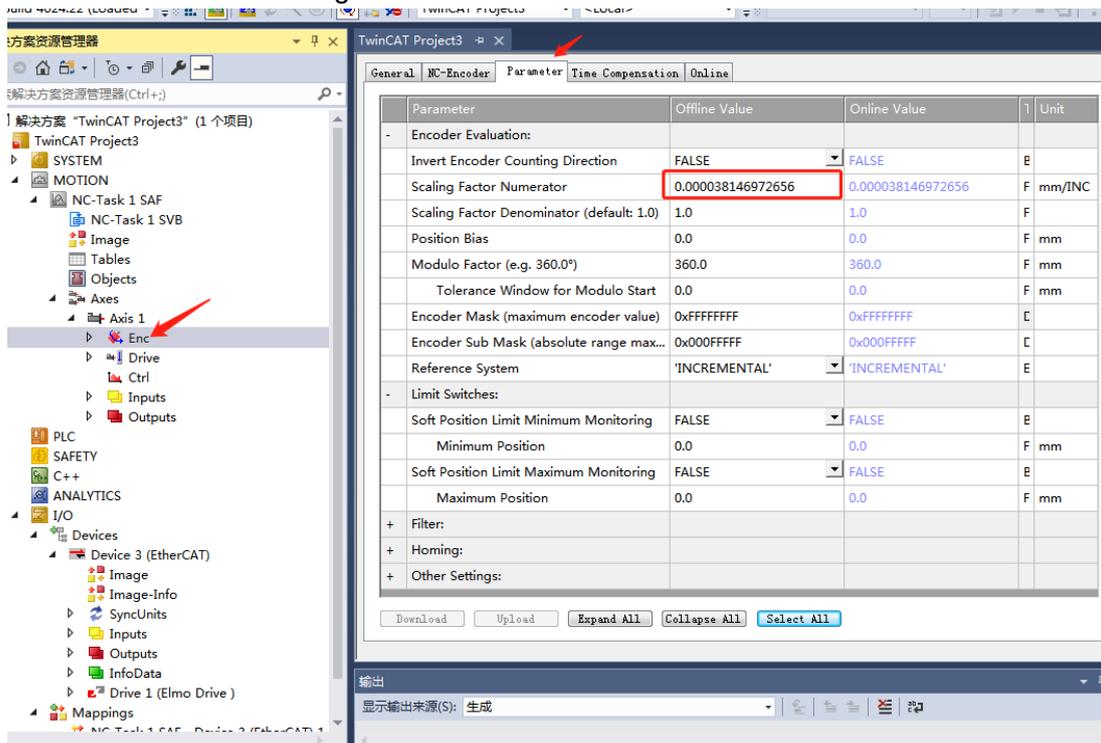
Figure 5.2-5 Encoder Scale Factor Configuration

The configuration value of 0.000038146972656 in Figure 5.2-5 is for the HJL12.5.72-4KN300 joint module. Configuration method: The encoder resolution is 131072 pulses per revolution of the motor, and the lead screw pitch is 5 mm. 5 / 131072 = 0.000038146972656. Configure the parameter value for other models in a similar way.

2）Speed Parameter Configuration
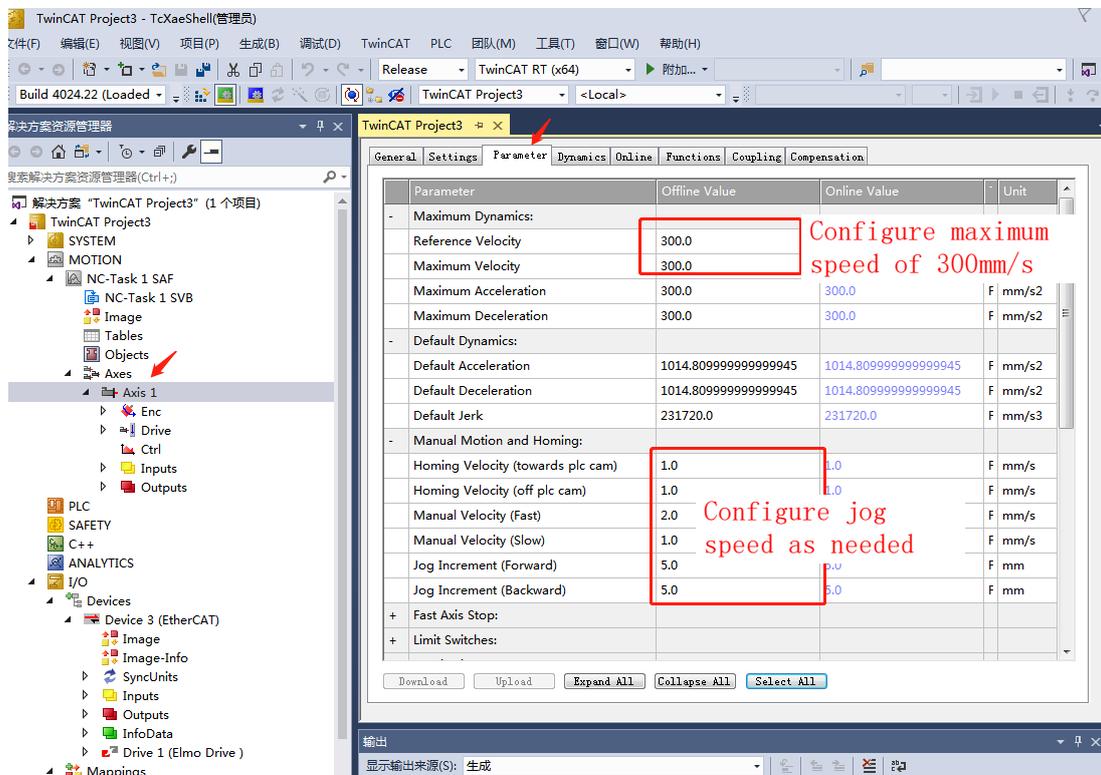
Figure 5.2-6 Speed Parameter Configuration

3）Position Following Error Configuration
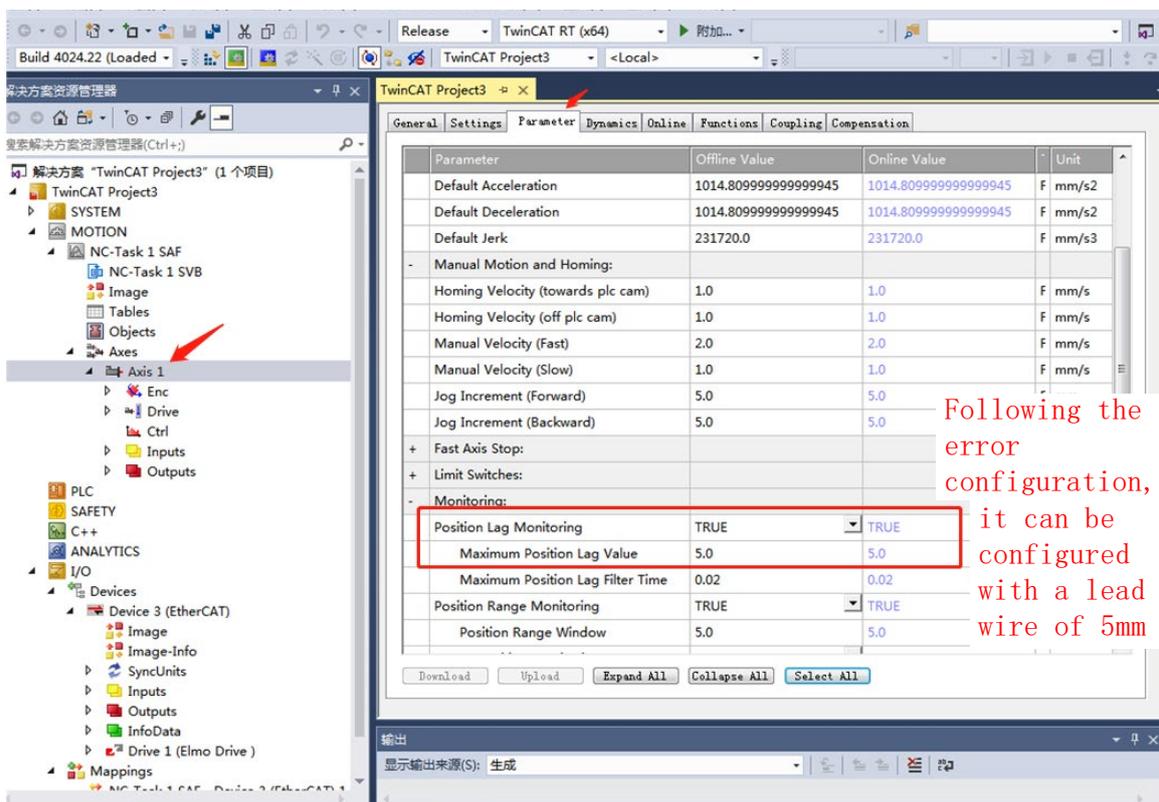
Figure 5.2-7 Position Following Error Configuration

4）Acceleration and Deceleration Time Configuration
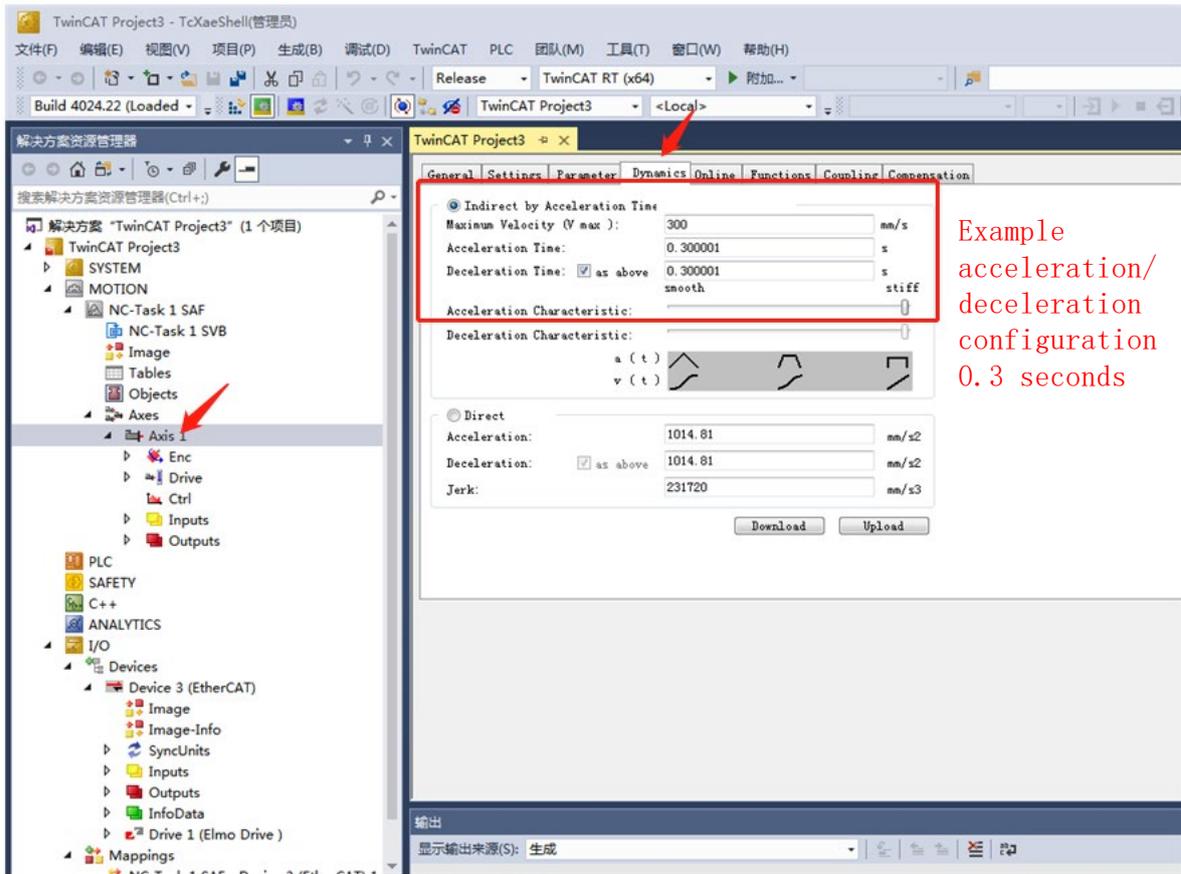
Figure 5.2-8 Acceleration and Deceleration Time Configuration

Step 4 Operation Control

1）Enable the motor.
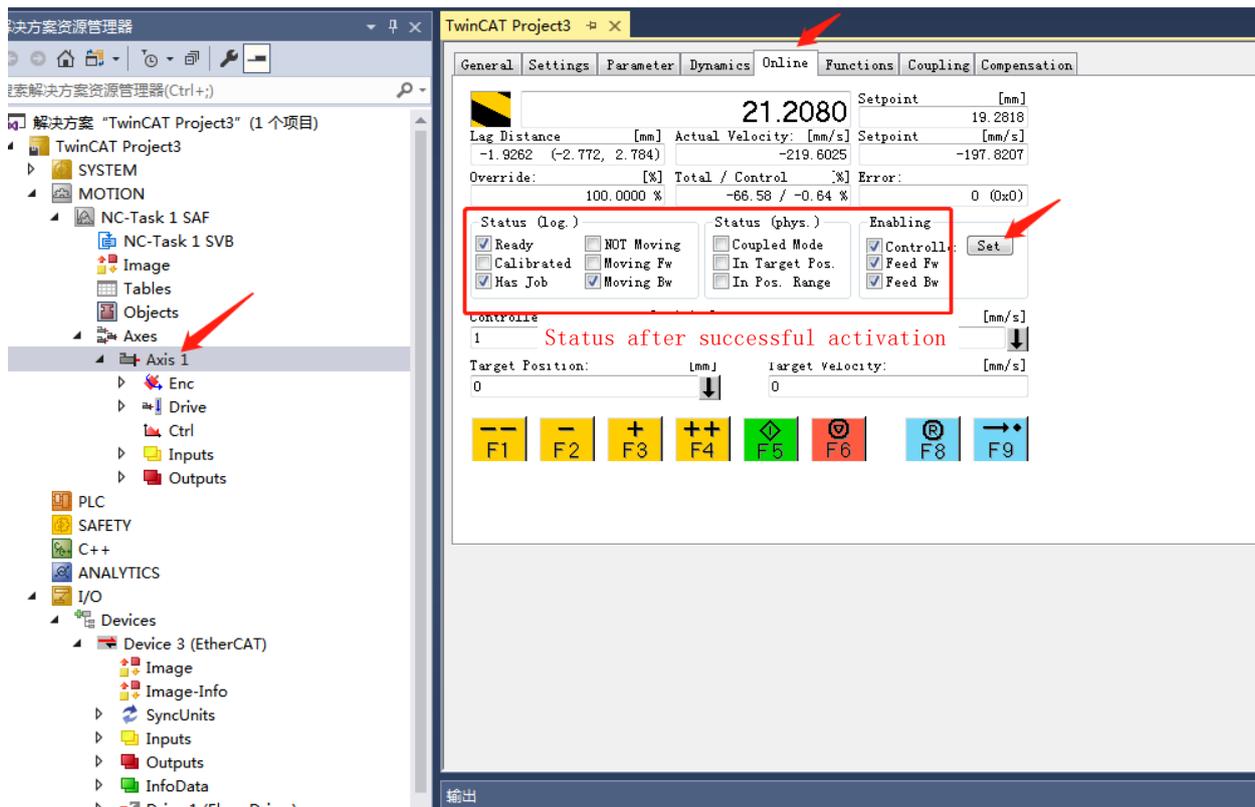
Figure 5.2-9 Motor Enable Operation

2）Jog operation of the motor
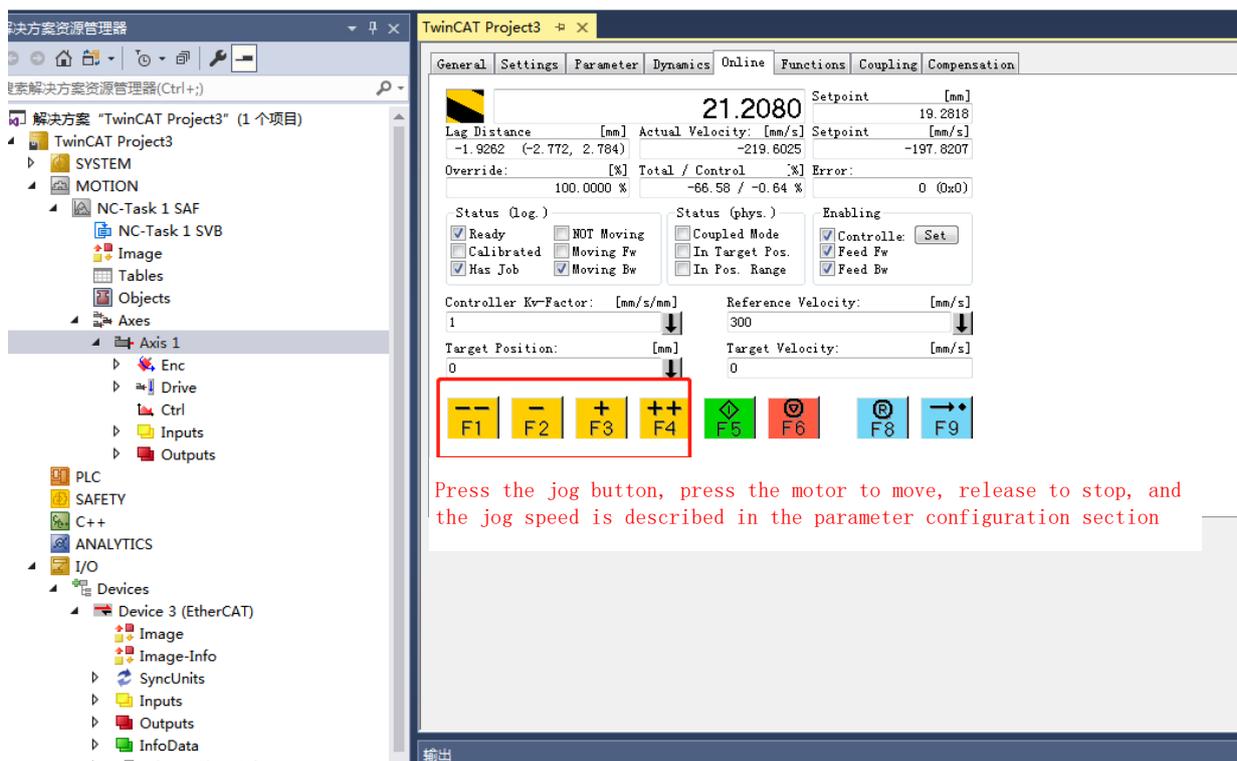
Figure 5.2-10 Jog Operation of the Motor

3）Reciprocating operation test of the motor
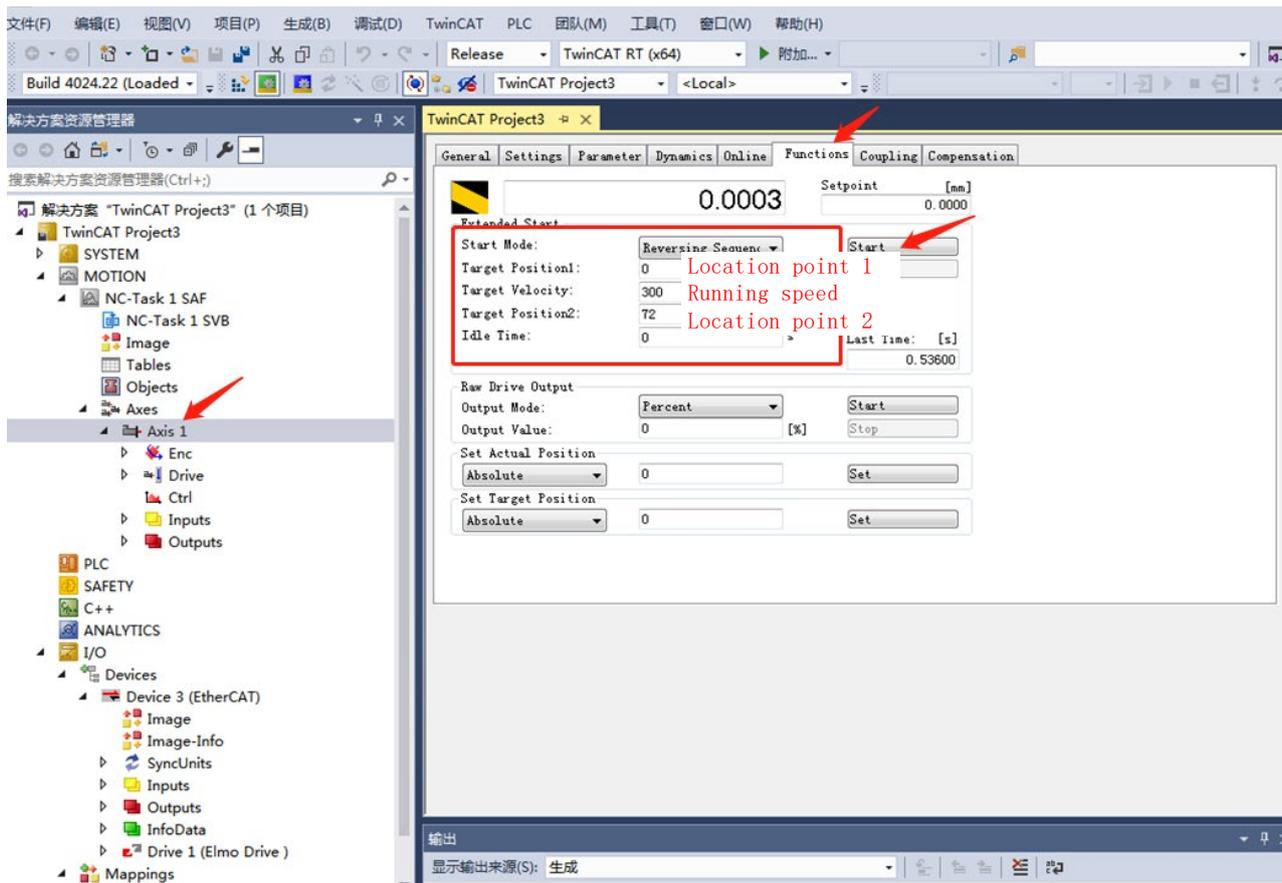
Figure 5.2-11 Reciprocating Operation Test of the Motor

5.3 CANopen control operation

This section describes the message operation steps for motor control of the HJL joint module (CANopen driver version) using a standard CANopen master station (such as the ZLG CAN master station device). (The joint CANopen protocol driver is compatible with the standard DS402 slave station protocol. The CANOPEN master station can control it according to the standard slave station. This section only provides a simple message control example in the position PP mode for users' reference).

Step 1: Circuit Connection and Power Supply
The CANopen master station is connected to the joint module driver for networking through CAN wiring. Note that the STO signal should also be powered normally.

Step 2: Configuration of CAN Slave Station ID and Baud Rate
1）Connect the driver to the PC debugging software, enter the page shown in the following figure, and configure the CAN slave station ID and baud rate.
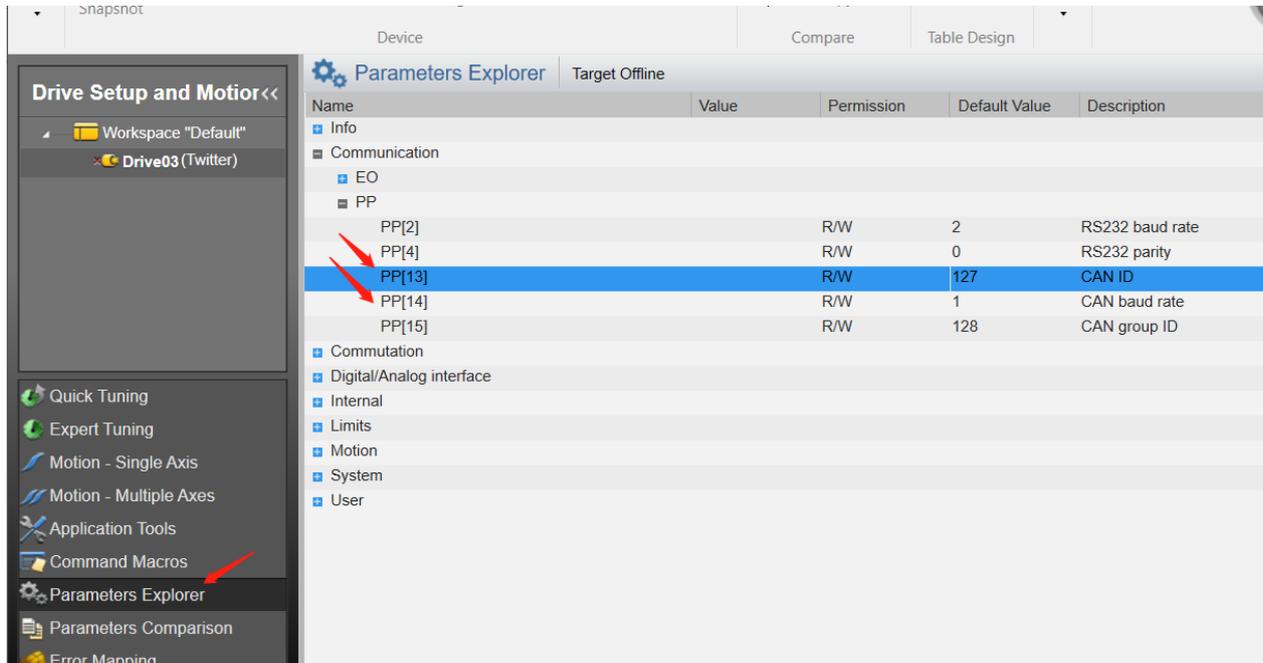
Figure 5.3-1 Configuration of ID and Baud Rate

2）After the configuration is completed, perform the save operation.
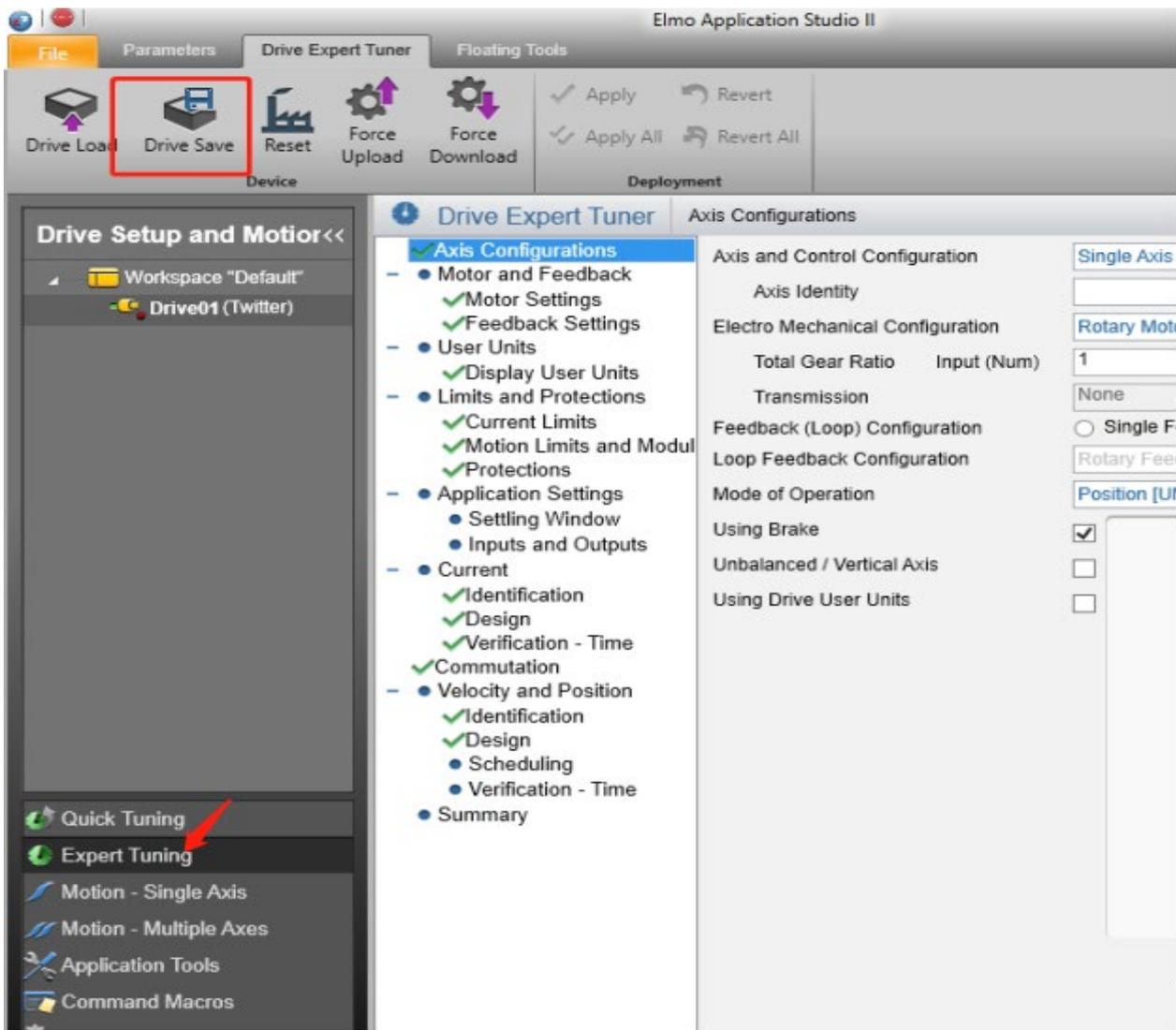
Figure 5.3-2 Save Parameters

25

Step 3 Instructions for Relevant Message Operations (Taking ID1 as an Example)

1）Power-on Startup Frame

When the driver is powered on, the slave station will automatically upload it to the CAN bus during startup.

	Message	DLC	Data	Cycle Time	Count
Receive	702h	1	00		1

2) Position PP mode

① Start Slave Station Frame

COB	000
Data	01 01

② Configure the position mode

COB	601
Data	2F 60 60 00 01 00 00 00

③ Enable the control word. Send the control words 6, 7, and 15 in sequence.

COB	601
Data	2B 40 60 00 06 00 00 00

COB	601
Data	2B 40 60 00 07 00 00 00

COB	601
Data	2B 40 60 00 0F 00 00 00

④ Send the target speed of the position trajectory, the target position, and the configuration parameters of the trajectory acceleration and deceleration.

Target speed 0x6081

COB	601
Data	23 81 60 00 E8 03 00 00

Target position 0x607A

COB	601
Data	23 7A 60 00 E8 03 00 00

Trajectory acceleration 0x6083

COB	601
Data	23 83 60 00 E8 03 00 00

Trajectory deceleration 0x6084

COB	601
Data	23 84 60 00 E8 03 00 00

⑤ Send the control word to start the absolute position operation.

COB	601
Data	2B 40 60 00 1F 00 00 00

The motor will operate at the speed set in parameter 6081 to reach the target position 607A, and it will stop automatically upon arrival.

5.4 Instructions for the Use of the Force Sensor

The joint is internally equipped with a tension and compression force sensor (referred to as the force sensor for short). The signal of the force sensor is connected to the analog input port of the joint driver through the force sensor amplifier. The output analog voltage range of the force sensor amplifier is 0~10V.

5.5 Instructions for Zeroing the Joint

Note: The type of the encoder built into the joint is a battery-powered multi-turn encoder.
The zero position of the joint has been set at the factory. Under normal circumstances, there is no need to perform the joint zeroing operation.

If necessary, refer to the following steps for the zeroing method:
Move the motor to the zero position required by the machinery, cut off the power supply, remove the battery and wait for a few seconds (to ensure that the multi-turn data has been cleared), then reinstall the battery, power on, read the current single-turn position of the encoder through the PC debugging software, take the negative value of the encoder offset data of this single turn and write it into the "position offset" configuration item on the encoder configuration page of the driver, and then download and save it.

Chapter 6 Introduction to HJL Series Joint Drivers

6.1 HJL08、HJL12 Schematic Diagram and Definitions of the Interface between the Joint and the TGM Driver
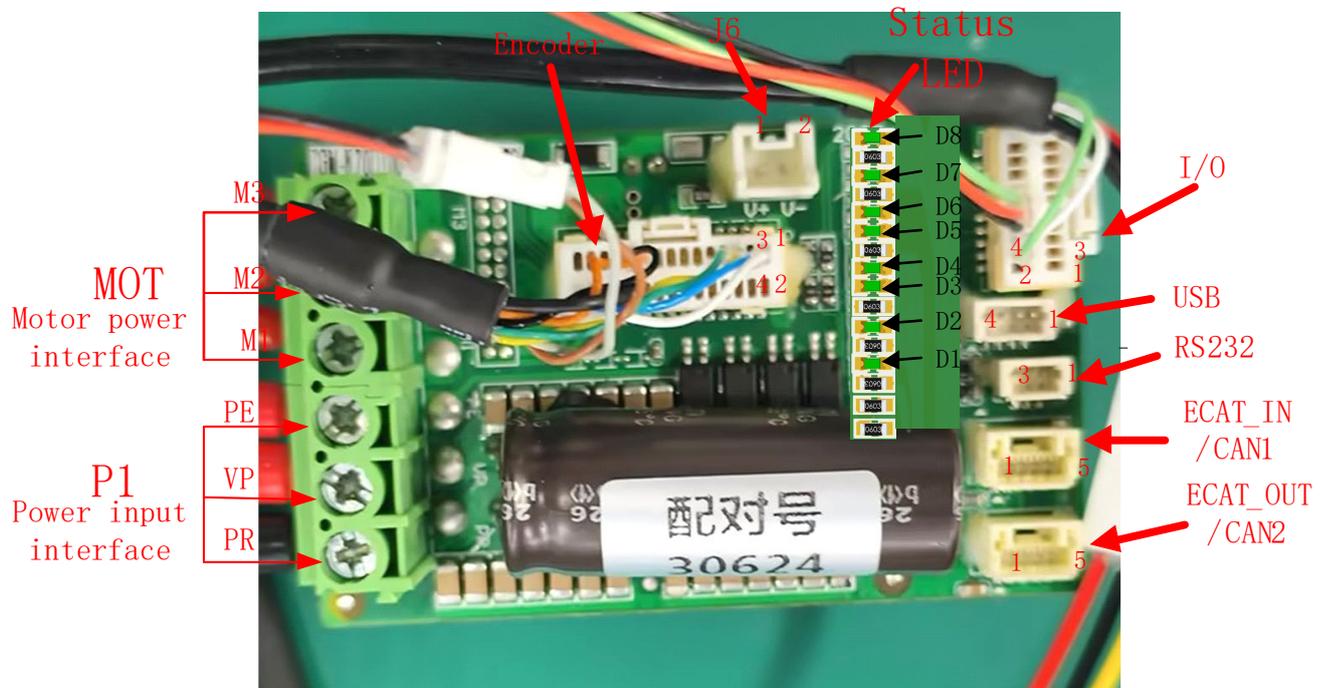
ENC Encoder interface			
Pin	Name	Function Description	Type
Pin1	Port_A_ENC_A+/ABS_CLK+	Incremental differential encoder A+/Positive of the absolute encoder clock signal	input
Pin2	Port_B_ENC_A-/SIN-	Incremental differential encoder A-/ Sinusoidal negative feedback of the rotary encoder	input
Pin3	Port_A_ENC_A-/ABS_CLK-	Incremental differential encoder A-/Negative of the absolute encoder clock signal	input
Pin4	Port_B_ENC_A+/SIN+	Incremental differential encoder A+/ Sinusoidal positive feedback of the rotary encoder	input
Pin5	Port_A_ENC_B+/ABS_DATA+	Incremental differential encoder B+/Positive of the absolute encoder data signal	input
Pin6	Port_B_ENC_B-/COS-	Incremental differential encoder B-/ Cosine negative feedback of the rotary encoder	input
Pin7	Port_A_ENC_B-/ABS_DATA-	Incremental differential encoder B-/Negative of the absolute encoder data signal	input
Pin8	Port_B_ENC_B+/COS+	Incremental differential encoder B+/ Cosine positive feedback of the rotary encoder	input
Pin9	Port_A INDEX+	Incremental differential encoder Z+	input

Pin	Name	Function Description	Type
Pin10	Port_B_ENC_INDEX-/ANALOG_I-	Incremental differential encoder Z-/ Analog quantity I-	input
Pin11	Port_A INDEX-	Incremental differential encoder Z-	input
Pin12	Port_B_ENC_INDEX+/ ANALOG_I+	Incremental differential encoder Z+/Analog quantity I+	input
Pin13	HA	Hall signal A	input
Pin14	Port_C_ENC_A-	Differential A-	input
Pin15	HB	Hall signal B	input
Pin16	Port_C_ENC_A+	Differential A+	input
Pin17	HC	Hall signal C	input
Pin18	Port_C_ENC_B-	Differential B-	Output
Pin19	ENC_+5V	5V Logic power supply (provided internally)，<=300mA	Output
Pin20	Port_C_ENC_B+	Differential B+	Output
Pin21	GND	GND	-
Pin22	Port_C_ENC_Z-	Differential Z-	Output
Pin23	GND	GND	-
Pin24	Port_C_ENC_Z+	Differential Z+	Output
Pin25	GND	GND	-
Pin26	ENC_+5V	5V Logical power supply (provided internally)，<=300mA	Output
Pin27	GND	GND	-
Pin28	PE	PE	GND
Pin29	unconnected	-	-
Pin30	unconnected	-	-
I/O Interface			
Pin	Name	Function Description	Type
Pin1	IN4	IN4	input
Pin2	GND	GND	-
Pin3	IN3	IN3	input
Pin4	ANALOG-	Analog Input -	input
Pin5	IN2	IN2	input
Pin6	ANALOG1+	Analog Input -	input
Pin7	IN1	IN1	input
Pin8	STO_RET	STO Grounding return current (this function is shielded in the standard model)	-
Pin9	DI_COM	Input common terminal	input
Pin10	STO1	STO Channel 1 (This function is shielded in the standard model)	input
Pin11	unconnected	unconnected	-
Pin12	STO2	STO Channel 2 (This function is shielded in the standard model)	input
Pin13	OUT1_OUTPUT	OUT1	Output
Pin14	+VLOG	+VLOG	

Pin15	OUT1_OUTPUT	OUT1	Output
Pin16	+VLOG	+VLOG	
Pin17	OUT2_OUTPUT	OUT2	Output
Pin18	+VLOG	+VLOG	
Pin19	OUT2_OUTPUT	OUT2	Output
Pin20	+VLOG	+VLOG	
		MOT / Motor power supply interface				

Pin	Name	Function Description	Type	Pin	Name	Function Description	Type
Pin1	PR	Negative of power input	input	Pin1	M3	W phase of the three-phase motor; Negative terminal of the brushed motor	Output
Pin2	VP	Positive of power input	input	Pin2	M2	V phase of the three-phase motor; Positive terminal of the brushed motor	Output
Pin3	PE	PE	--	Pin3	M1	U phase of the three-phase motor	Output

RS232 interface			USB interface（EtherCATThe version type is valid and is only for internal testing within the product factory.）		
Pin	Name	Function Description	Pin	Name	Function Description
Pin1	GND	GND	Pin1	USB_VBUS	USB_VBUS
Pin2	RS232_TX	RS232_TX	Pin2	GND	GND
Pin3	RS232_RX	RS232_RX	Pin3	USB+	USB-
			Pin4	USB-	USB-
EtherCAT_IN / EtherCAT_OUT/ CAN1 / CAN2 * For the hardware of EtherCAT and Can versions, only one of them can be used. Users are not allowed to change this setting after the product leaves the factory.					
Pin	EtherCAT_IN/ EtherCAT_OUT		CAN1/CAN2		
Pin1	RX+		CANL		
Pin2	RX-		GND		
Pin3	PE		-		
Pin4	TX+		CANH		
Pin5	TX-		-		

J6 (IO Power input） * For application scenarios where the logical power supply and the power supply for power need to be separated, after completing the hardware modification configuration inside the driver, the logical power supply is input through this port.		
Pin	**Name**	**Pin**
Pin1	+VLOG	Pin1
Pin2	VLOG_GND	Pin2

Status indicator light	
Motion status indication D1	When the motor is in the enabled state, this indicator light stays green constantly; when the motor is in the disabled state, this indicator light will flash.
Drive error status indication D2	When the driver is in an error-reporting state, this indicator light will turn red; when there is no error, this indicator light will go out.
EtherCAT Status indication D3,4,D5,D6,D7.D8	Indicate the EtherCAT status D3:ET_RUN ECAT In the running state D4:ET_ERR ECAT Fault indicator light D5:OUT_SPEED ECAT Output speed indication D6:IN_SPEED ECAT Input speed indication D7:OUT_LINK_ACT ECAT Output display D8:IN_LINK_ACT ECAT Input display

6.2 HJL15 Schematic Diagram and Definition of the Interface of the TGB Driver for Joint Adaptation

ENC encoder interface			
Pin	Name	Function Description	Type
Pin1	Port_A_ENC_A+/ ABS_CLK+	Port_A Incremental Differential Encoder A+/Positive of the Absolute Encoder Clock Signal	Input
Pin2	Port_B_ENC_A-	Port_B Incremental differential encoder A-	Input
Pin3	Port_A_ENC_A-/ABS_CLK-	Port_A Incremental differential encoder A-/Negative of the absolute encoder clock signal	Input
Pin4	Port_B_ENC_A+	Port_B Incremental differential encoder A+	Input
Pin5	Port_A_ENC_B+/ABS_DATA+	Port_A Incremental differential encoder B+/ Positive of the absolute encoder data signal	Input
Pin6	Port_B_ENC_B-	Port_B Incremental differential encoder B-	Input
Pin7	Port_A_ENC_B-/ABS_DATA-	Port_A Incremental differential encoder B-/Negative of the absolute encoder data signal	Input
Pin8	Port_B_ENC_B+	Port_B Incremental differential encoder B+	Input
Pin9	Port_A INDEX+	Port_A Incremental differential encoder Z+	Input
Pin10	Port_B_ENC_INDEX-	Port_B Incremental differential encoder Z-	Input
Pin11	Port_A INDEX-	Port_A Incremental differential encoder Z-	Input
Pin12	Port_B_ENC_INDEX+	Port_B Incremential differential encoder Z+	Input
Pin13	HA	Hall signal A	Input

Pin14	Port_C_ENC_A-	Port_C Differential A-	Input
Pin15	HB	Hall signal B	Input
Pin16	Port_C_ENC_A+	Port_C Differential A+	Output
Pin17	HC	Hall signal C	Input
Pin18	Port_C_ENC_B-	Port_C Differential B-	Output
Pin19	ENC_+5V	5V Logic power supply (provided internally)，<=300mA	Output
Pin20	Port_C_ENC_B+	Port_C Differential B+	Output
Pin21	GND	GND	-
Pin22	Port_C_ENC_Z-	Port_C Differential Z-	Output
Pin23	GND	GND	-
Pin24	Port_C_ENC_Z+	Port_C Differential Z+	Output
Pin25	GND	GND	-
Pin26	ENC_+5V	5V Logic power supply (provided internally)，<=300mA	Output
Pin27	GND	GND	-
Pin28	PE	PE	GND
Pin29	VL-	Negative of the logic power supply	
Pin30	VL+	Positive of the logic power supply (<100VDC)	

I/O Interface			
Pin	Name	Function Description	Type
Pin1	IN1	High-speed programmable digital input IN1, opto-isolated type (isolated from COMRET)	Input
Pin2	IN2	High-speed programmable digital input IN2, opto-isolated type (isolated from COMRET)	-
Pin3	IN3	High-speed programmable digital input IN3, opto-isolated type (isolated from COMRET)	Input
Pin4	IN4	High-speed programmable digital input IN4, opto-isolated type (isolated from COMRET)	Input
Pin5	IN5	High-speed programmable digital input IN5, opto-isolated type (isolated from COMRET)	Input
Pin6	IN6	High-speed programmable digital input IN6, opto-isolated type (isolated from COMRET)	Input
Pin7	DI_COM	Common terminal of input DI	Input
Pin8	DI_COM	Common terminal of input DI	Input
Pin9	OUT1	Programmable digital output OUT1 (isolated from COMRET)	
Pin10	OUT2	Programmable digital output OUT2 (isolated from COMRET)	
Pin11	OUT3	Programmable digital output OUT3 (isolated from COMRET)	
Pin12	OUT4	Programmable digital output OUT4 (isolated from COMRET)	
Pin13	OUT_COM	Common terminal of output OUT	
Pin14	OUT_COM	Common terminal of output OUT	
Pin15	STO1	STO1 input (isolated from COMRET)	
Pin16	STO2	STO2 input (isolated from COMRET)	

Pin17	STO_RET	The return terminal of the STO signal. The two STO input signals are isolated from other signals of the driver, and the two STO input signals share the same STO_RET return terminal.	
Pin18	STO_RET	The return terminal of the STO signal	
Pin19	COMRET	Common terminal	
Pin20	GPIO5 ANALOG IN		
Pin21	ANALOG1+	Differential input of analog signal +	
Pin22	ANALOG1-	Differential input of analog signal -	
Pin23	COMRET	Common terminal	
Pin24	COMRET	Common terminal	
Pin25	RS232_TX	RS232 send	
Pin26	RS23_RX	RS232 receive	
Pin27	USB_VBUS	Positive of the USB power supply (only for drivers of the EtherCAT version)	
Pin28	COMRET	Common terminal	
Pin29	USB D+	Positive of the USB data (only for drivers of the EtherCAT version)	
Pin30	USB D-	Negative of the USB data (only for drivers of the EtherCAT version)	

Status indicator light	
Motion status indication D1	When the motor is in the enabled state, this indicator light stays green; when the motor is in the disabled state, this indicator light flashes.
Drive error status indication D2	When the driver is in an error-reporting state, this indicator light turns red; when there is no error, this indicator light goes out.
EtherCAT status indication D3, 4, D5, D6, D7, D8	Indicate the EtherCAT status D3: ET_RUN. The ECAT is in the running state D4: ET_ERR. The ECAT fault indicator light D5:OUT_SPEED ECAT Output speed indication D6:IN_SPEED ECAT Input speed indication D7:OUT_LINK_ACT ECAT Output display D8:IN_LINK_ACT ECAT Input display

EtherCAT_IN/ EtherCAT_OUT/CAN1/CAN2

Only one of the EtherCAT version hardware and the Can version hardware can be used. Users are not allowed to change this setting after the product leaves the factory.

Pin	EtherCAT_IN/ EtherCAT_OUT	CAN1/CAN2
Pin1	RX+	CANL
Pin2	RX-	GND
Pin3	PE	-
Pin4	TX+	CANH
Pin5	TX-	-

6.3 Main technical parameters of the joint driver

Model	TGM-10D100-AE	TGM-N70D100-AE	TGB-140D100-AE
Power supply voltage	10-95V	10-95V	12-95V
Rated current	10A	70A	140A
Peak current	20A	70A	140A
Maximum power	5000W		11kW
External dimensions	60.5*38*0.84mm		76*55.5*27mm
Communication mode	EtherCAT / CANopen、RS232、USB（Only the EtherCAT version models are supported.）		
Digital IO	4 channels of digital quantity input, with optocoupler isolation 2 channels of digital quantity output, without isolation		6 channels of digital quantity input, with optocoupler isolation 4 channels of digital quantity output, with optocoupler isolation
Analog quantity IO	1 channel of 0-10V analog quantity input		1 channel of ±10V analog differential input 1 channel of 0-3V analog single-ended input
Feedback mode	Orthogonal incremental encoder, digital Hall, Tamagawa absolute encoder, BISS C/SSI absolute encoder		
Temperature	Normal operation: -40°C to 65°C, Storage: -55°C to 85°C		
Humidity	0%~95%，No condensation		
Pollution	Pollution degree 2		
Drop test	IEC68-2: 1990		

6.4 Regarding the discharge module

When operating and using the HJL joint module, a regenerative energy absorption module needs to be externally connected. If the regenerative energy is not processed and the excessive regenerative energy during the operation of the joint causes damage to the joint module, our company will not assume responsibility for this.

6.4.1 Regenerative resistance theory

When the load accelerates, electrical energy will be converted into mechanical energy. During the deceleration period, the opposite process occurs: mechanical energy is converted into electrical energy. This is called regeneration. Part of the regenerative energy will be dissipated due to the friction of the mechanical system. More energy will be consumed by the components in the motor windings, cables, and the driver, dissipating in the form of heat (I^2R). The remaining energy will be returned to the bus in the driver.

When there is a capacitor on the bus, the energy added to the capacitor will charge it. If too much energy is superimposed on the capacitor, the voltage across the capacitor will rise to the overvoltage protection point of the driver, causing the driver to turn off the output.

To prevent this from happening, when the voltage rises to a certain level, a regenerative circuit is required to divert the energy to an external resistor, which is what we commonly know as the regenerative resstor.

6.4.2 Relief Module (Relief Plate)

When using the HJL joint module, connect the 48V switching power supply, the 48V power cord of the joint module, and the positive and negative terminals of this relief plate in parallel respectively. The physical appearance of the relief module configured by our company is shown in the following figure:

Power status indicator:
1.Green on: The release board is powered on.
2.Green off :The release board is not power on.

Connect to the 48VDC power supply

Connect to the negative terminal of the 48VDC power supply

Discharge status indication:
1.If the light is on, the energy is slipping.
2.If the light is off, no energy leakage is taking place .
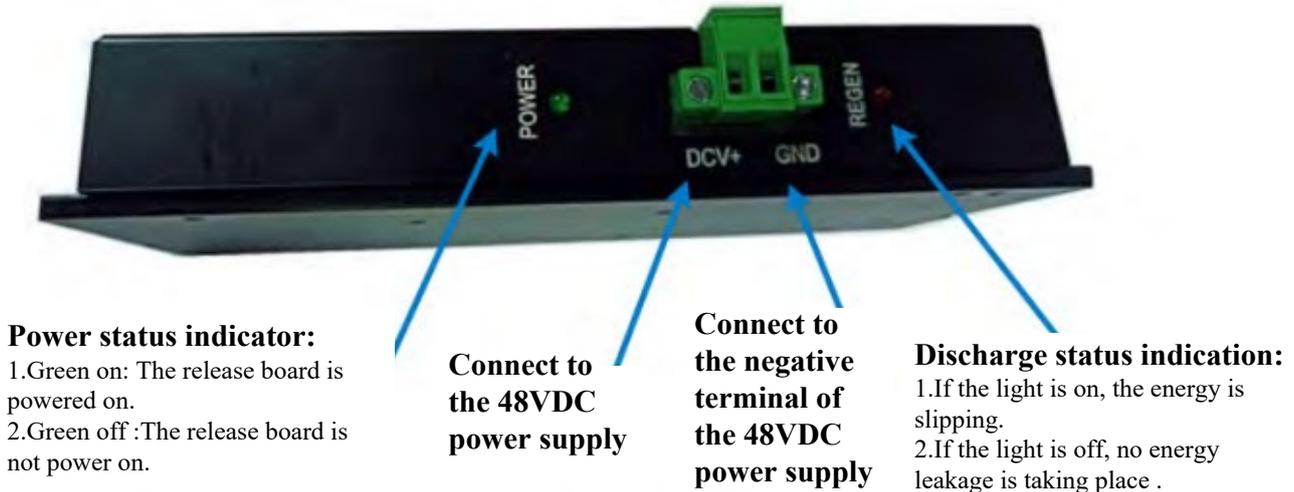
Figure 6.4.2-1 Relief module

Model	XFB_56V_6A V2.0
Resistance value of the regenerative resistor	10 ohms
Power of the regenerative resistor	100W
Turn - on voltage	56V. If you need other specifications of the turn-on voltage, please contact our company's technical personnel.

Figure 6.4.2-2 Specification Sheet of the Relief Plate

Attention

If the continuous power is too high under the working conditions, the surface of the resistor may become extremely hot during use (there is even a risk of the resistor being burned out). Do not touch the regenerative resistor directly to prevent burns.
When using the regenerative resistor, heat dissipation measures for it should be taken into consideration.
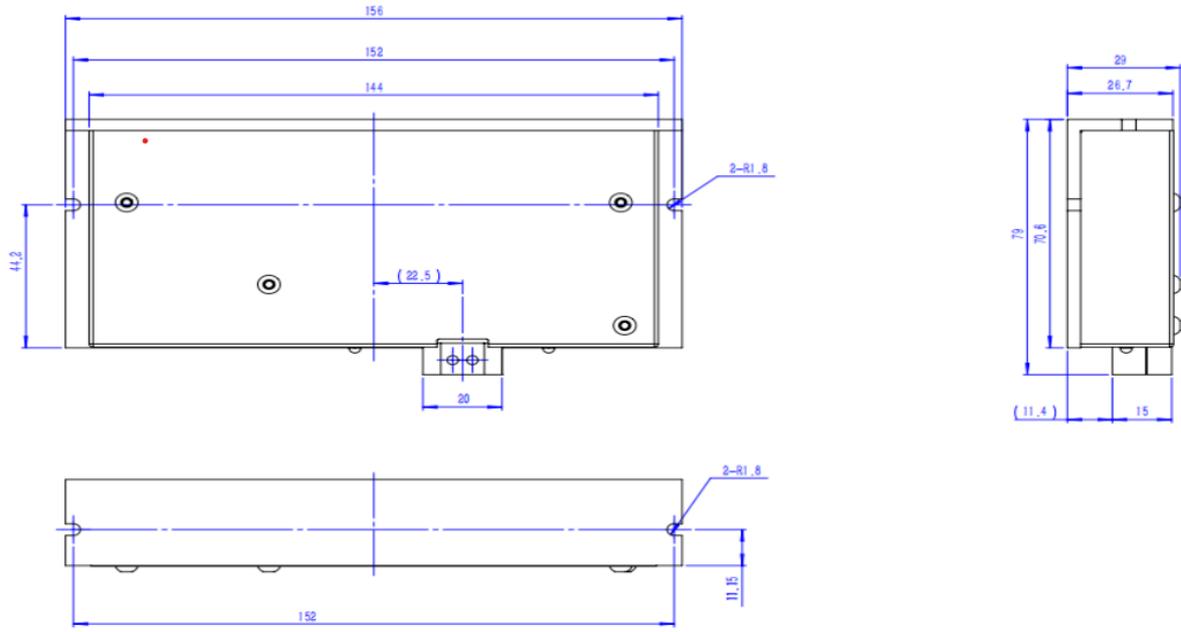
Figure 6.4.2-3 Installation Dimension Diagram of the Relief Plate

Chapter 7 Troubleshooting and Handling Methods for Common Faults of HJL Series Joint Modules

Number	Problem Information	Possible reasons	Solution method
1	The joint module does not power on normally when the power supply is connected.	There is a short circuit, or the V+ and V- terminals are connected reversely.	Check for any short circuits. Check whether the V+/V- terminals of the power supply of the joint module are connected reversely.
2	Communication anomaly	The communication cable or the communication terminal has poor contact.	Check whether there is any cold soldering on the communication terminal, or re-plug the communication cable.
3	Following error	It exceeds the following error set by the user.	Reset the following error.
4	The encoder reading is abnormal.	The encoder wiring is loose. The encoder is damaged.	Reinsert the encoder wiring firmly. Replace the encoder.
5	You can turn the robot joint by hand before powering it on.	Fault of the brake of the joint module	Replace the brake.
6	There is a jump in the encoder reading.	At present, the joint module uses a single-turn absolute encoder. When the value exceeds the range of the encoder, the encoder reading will return to the normal range of the encoder after powering off and restarting.	When using it, try to keep it within the single-turn range of the encoder or save the position in the host computer.

The meanings of the common error codes of the driver are shown in the following table:

Number	Fault code (Hex)	Fault information
1	3120	Under-voltage
2	3130	Phase loss
3	3240	Short circuit
4	3310	Overvoltage
5	4310	The driver is overheated
6	7121	The motor is stuck
7	7300	Feedback error
9	7382	The commutation process fails when the motor is powered on
10	8311	Exceeding the peak current
11	8480	Speed tracking error

12	8481	Exceed the speed limit
13	8611	Position tracking error
14	8680	Exceed the position limit
15	FF20	STO (Safe Torque Off) is activated

Appendix 1 HJL08、HJL12 Overall Wiring Diagram of the Motor
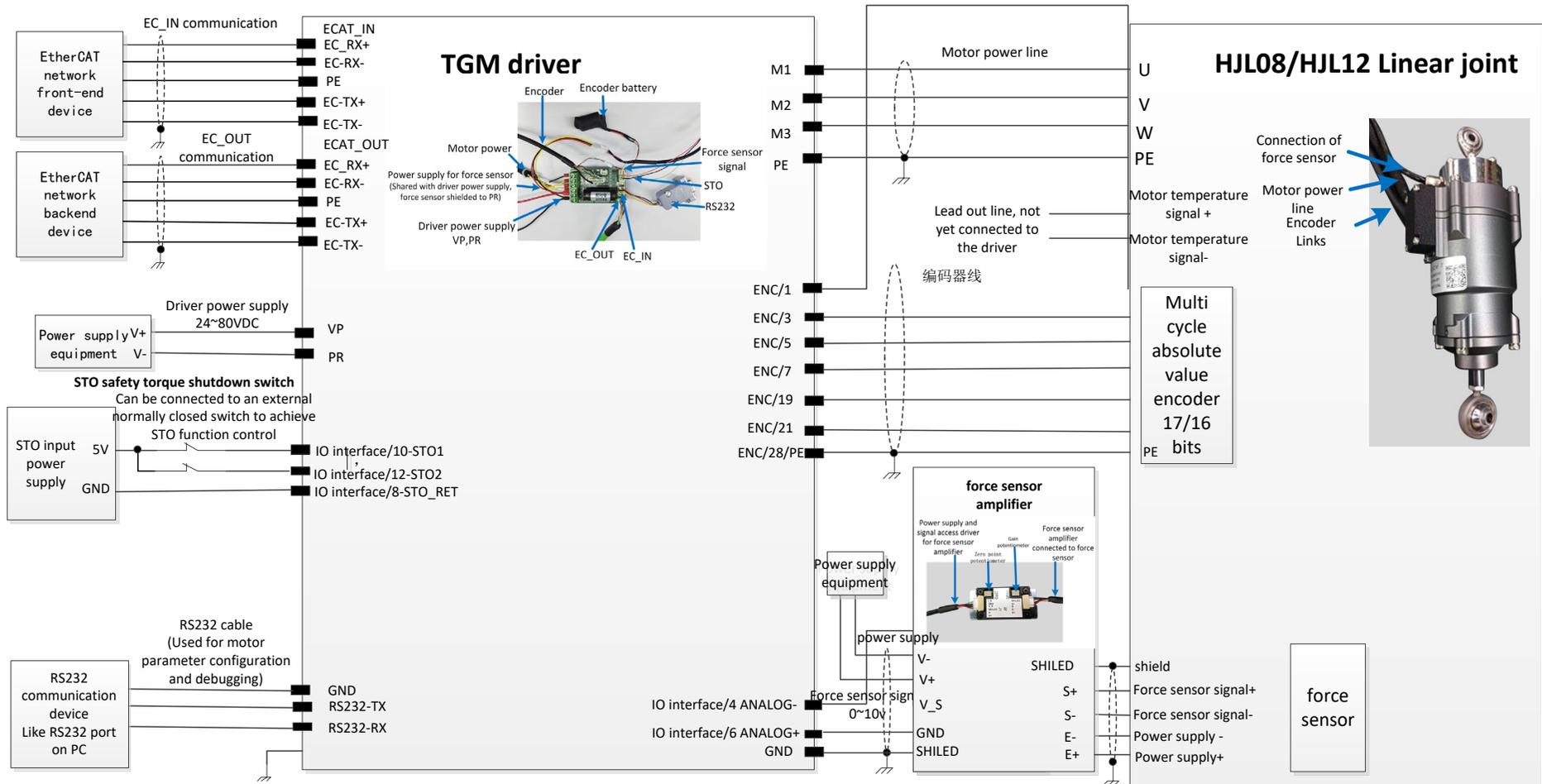
Appendix 2 HJL15 Overall Wiring Diagram of the Motor