Laifual®

Rotary Actuator

Low-voltage Series

User Manual

Zhejiang Laifual Drive Co., Ltd.

Preface

Thank you very much for using our low-voltage series products.

Incorrect operation and improper use of this product may lead to accidents and shorten the product's lifespan. To ensure long-term and safe use of this product, please read this manual carefully before use.

Our company reserves the right to change the contents of this manual without notice.

Company names and product names mentioned in this manual are generally registered trademarks or trademarks of their respective companies.

Please keep this manual properly. Make sure to deliver this manual to the end user.

Safety Precautions for Safe Use

To ensure the safe and correct use of this product, please read the "Safety Precautions for Safe Use" and the main text thoroughly before use, and fully understand the contents.

Symbol Explanation

The safety-related warnings provided here are important. Please be sure to follow them diligently.

 Warning	Indicates that incorrect operation may result in death or serious injury.
 Caution	Indicates that incorrect operation may result in injury or property damage.
Warning	Indicates measures that should be taken or avoided to prevent malfunction,

Usage Restrictions

This product is not recommended for the following applications. If necessary, please consult with our company in advance.

·Aerospace equipment	· Aircraft equipment	· Nuclear equipment	· Vacuum equipment
· Automotive equipment	· Gaming facilities	· Equipment directly affecting the human body	
· Household equipment and appliances		· Equipment intended for transporting people	
· Equipment for special environments			

Precautions for Using Actuators

● Usage Precautions

 Caution	**Use Only Within the Specified Operating Environment** The actuator is designed for indoor use. Please follow the conditions below: Operating temperature: ● -10 to 55˚C (standard grease) ● -30 to 55˚C (low-temperature grease) ● Storage temperature: ● -20 to 80˚C(standard grease) ● -40 to 80˚C (low-temperature grease) ● Ambient humidity: 20–80% RH (non-condensing) ● Vibration: 25 m/s² or below Avoid exposure to water, oil, or similar liquids. ● Ensure no corrosive or explosive gases are present. **Install the Actuator Using the Specified Methods** ● Follow the technical documentation to properly align the actuator with the driven mechanical components. ● Any misalignment of the center axis may cause vibration or damage to the output shaft.

● Usage Precautions

 Caution	**Safety Precautions** ● Do not exceed the allowable torque. ● Do not apply torque beyond the maximum rated torque. ● Do not mount a robotic arm or any structure directly onto the output shaft. ● Collisions or impact on the arm may result in loss of control of the output shaft. ● Do not plug the actuator directly into a power outlet. ● Without the dedicated driver, the actuator will not operate. ● Directly connecting it to commercial AC power will damage the actuator and ● may cause a fire. ● Do not strike or hit the actuator.

	● Since the actuator is directly connected to the encoder, impacts from tools such as wooden hammers may damage the encoder. ● Encoder failure can lead to loss of control of the actuator. ● Do not pull or apply excessive force to the cables. ● Doing so may damage the connectors and result in actuator malfunction or loss of control. ● Precautions for Free-Running Operation (No Load) ● The joint can generate heat even when operating without load. If the module has not yet been installed in its intended structure, the lack of heat dissipation may cause the temperature to rise gradually until thermal protection is triggered. Please test with caution. ● Overheating under high-speed continuous free-running conditions does not indicate a module malfunction. ● Once properly installed, the module will dissipate heat normally, and no additional cooling components are required. ● Precautions Against Metal Chip Intrusion ● Before installation, thoroughly clean the mounting surfaces and ensure the working environment is free of metal chips. Common sources include: ● Metal shavings produced during screw tightening or removal during robot installation ● Burrs or chips from machining component mating surfaces ● Copper wire fragments generated during cable assembly ● During installation and wiring, ensure that no metal chips fall into the electrical interface gaps on the rear cover of the joint (including CAN, EtherCAT, RS485, IO, multi-turn battery interface, power interface, and their respective openings). ● Also ensure no chips fall into the through-holes or the hollow shaft area (where the output-side encoder disk is installed). Otherwise, communication failures or electrical faults may occur. ● Do Not Connect or Disconnect the Power Cable While Energized ● Make sure the Power LED indicator is completely off before performing any wiring or inspection. ● Do Not Connect or Disconnect CAN or EtherCAT Cables While Energized ● When the master controller and the joint are not connected, the CAN_GND or EtherCAT_GND levels may differ. ● The instantaneous voltage difference when connecting the cables may damage the CAN or EtherCAT GND interface. **Note:** ● The above “ hot-plugging “ conditions include plugging or unplugging cables

	while the device, joint, control card, or other relevant equipment is powered on.

Disposal Instructions

 Caution	**Please dispose of this product in accordance with industrial waste disposal standards.** When discarding the product, disassemble it as much as possible. Components with material markings should be sorted according to their labels and disposed of following the appropriate industrial waste regulations.

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Content

Chapter 1 Overview

The low-voltage series comprises servo rotary modules that deliver high torque and precise rotational movements. These modules are composed of FHG-type reducers, motors, and encoders, available in models ranging from 70 to 170.

These products are widely used in the following fields:CNC machine tools,Laser processing,Electronics and semiconductors,Factory automation,Medical devices,Robotics,Logistics automation,Solar photovoltaic systems,LED equipment,Testing devices,Printing machinery,Precision measuring instruments,Aerospace equipment,Aircraft-related applications,FPD (Flat Panel Display) manufacturing equipment. Advantages:

Power Supply Voltage

- DC48V

Excellent Environmental Adaptability

- IP54 protection rating
- Compliance with neutral salt spray requirements

Operating temperature

- Standard grease: -10 to 55° C: 0～40 ℃
- Low-temperature grease: -30 to 55° C

Storage Temperature:

- Standard grease: -20 to 80° C
- Low-temperature grease: -40 to 80° C
- Alternating damp heat

Highly Integrated Product Design

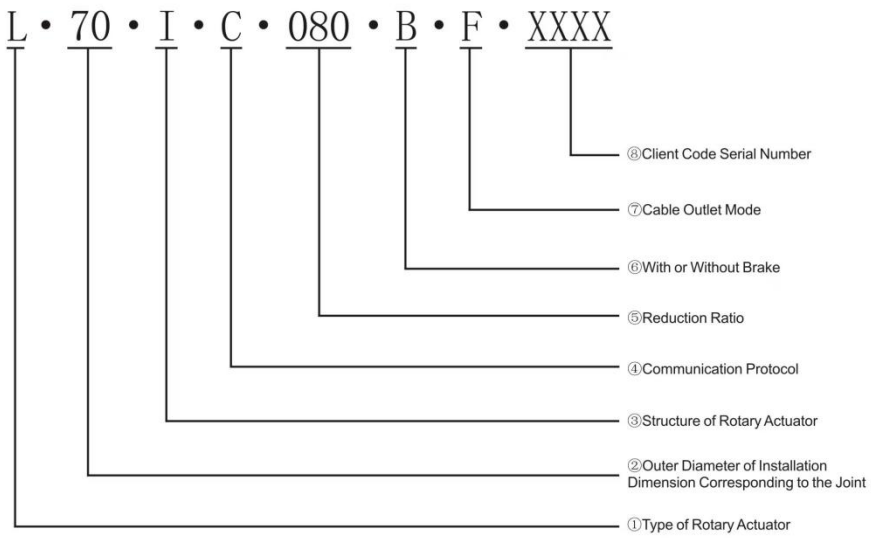
- Combines harmonic reducer, motor, encoder, and driver
- Extra-large hollow hole for easy wiring, piping, and laser routing
- Flange mounting structure

Outstanding Product Performance

- More than 20% torque increase in the same volume
- Excellent dynamic performance with very low noise and vibration
- Maintenance-free throughout the entire usage period
- Ultra-high product precision

Chapter 2 Model Naming Rules

Naming Rule



Rule Description：

① Joint module Type:

L:Low voltage

② Joint mounting Outer Diameter：

52：Joint 52	62：Joint 62	70：Joint 70	80：Joint 80
90：Joint 90	110：Joint 110	142：Joint 142	170：Joint 170

③ Module structure：

I:Low voltage I joint (Dual encoder, built-in driver with brake)	T:Low voltage T joint (Dual encoder, built-in driver with brake)

④ Communication Protocol：

C:CANopen	F:CAN FD	E：EtherCAT

⑤ Ratio：

030：31:1	050：51:1	080：81:1
100：101:1	120：121:1	160：161:1

⑥ Brake：

B ： With Brake	F ： Without Brake

⑦ Cable outlet type：

F： End-face cable exit

⑧ Customer and Serial number：

XXXX：Customised products only

Module Parameters

The performance specifications of the low-voltage series modules are as follows:

Model		L52I	
Reduction Ratio		51	101
Input Voltage	V	48（±10%）	
Maximum Torque	N ·m	11.5	17.5
	kgf ·m	1.17	1.79
Permissible Continuous Torque	N ·m	3.5	6.2
	kgf ·m	0.36	0.63
Peak Starting Torque	N ·m	5.8	7.7
	kgf ·m	0.59	0.79
Maximum Speed	r/min	117.6	59.4
Rated Speed	r/min	78.4	39.6
Torque Constant	N ·m/A	0.035	0.035
	kgf ·m/A	0.0035	0.0035
Maximum Current	A	3.29	2.20
Permissible Continuous Current	A	1.98	1.77
Back EMF Constant	V/Krpm	4.61	
Phase Resistance(20℃)	Ω	0.62	
Phase Inductance	mH	0.32	

Moment of Inertia	$GD^2/4$	kg ·mm²	12.5
	J	kgf ·cm ·s²	12.5*10^-4
Repeatability*1		Arc-sec	20
Positioning Accuracy*2		Arc-sec	60
Bus Communication Protocol		/	CANopen/CAN FD
Encoder Resolution		Single-turn Detector	17bit（131072pulses per revolution）
		Multi-turn Detector	16bit（-32768~32767turns）
Output Shaft Resolution		Pulses per Revolution	6684672 / 13238272
Mass		kg	0.55KG
Ambient Conditions			Operating Temperature:Standard grease: -10 to 55°C; Low-temperature grease: -30 to 55°C Storage Temperature:Standard grease: -20 to 80°C Low-temperature grease: -40 to 80°C Operating/Storage Humidity: 20–80% RH (non-condensing) Vibration Resistance: 25m/s²(Frequency：10～400Hz) Shock Resistance：300m/s² No dust, metal powder, corrosive gases, flammable gases, or oil mist Indoor use, avoid direct sun light Altitude below 1000m
Design Life (H)			10000
Motor Insulation			Insulation Resistance：Above 500 M Ω Withstand Voltage：AC1500 V / 1 min Insulation Class : Class F (155 °C)
Installation Direction			Can be installed in a ll direct ions
Protection Level			Totally enclosed, self-cooling type (IP54)

Model		L62I	
Reduction Ratio		51	101
Input Voltage	V	48（±10%）	
Maximum Torque	N ·m	17	25
	kgf ·m	1. 73	2. 55
Permissible Continuous Torque	N ·m	5. 5	8. 9
	kgf ·m	0. 56	0. 91
Peak Starting Torque	N ·m	8. 3	11
	kgf ·m	0. 85	1. 12
Maximum Speed	r/min	117. 6	59. 4

Rated Speed		r/min	98	49. 5
Torque Constant		N ·m/A	0. 044	0. 044
		kgf ·m/A	0. 0045	0. 0045
Maximum Current		A	3. 68	2. 46
Permissible Continuous Current		A	2. 44	1. 99
Back EMF Constant		V/Krpm	5. 43	
Phase Resistance(20℃)		Ω	0. 53	
Phase Inductance		mH	0. 23	
Moment of Inertia	GD²/4	kg ·mm²	15. 5	
	J	kgf ·cm ·s²	15. 5*10^-4	
Repeatability*1		Arc-sec	20	
Positioning Accuracy*2		Arc-sec	60	
Bus Communication Protocol		/	CANopen/CAN FD	
Encoder Resolution		Single-turn Detector	17bit（131072pulses per revolution）	
		Multi-turn Detector	16bit（-32768~32767turns）	
Output Shaft Resolution		Pulses per Revolution	6684672	13238272
Mass		kg	0.63KG	
Ambient Conditions			Operating Temperature:Standard grease: -10 to 55°C; Low-temperature grease: -30 to 55°C Storage Temperature:Standard grease: -20 to 80°C Low-temperature grease: -40 to 80°C Operating/Storage Humidity: 20–80% RH (non-condensing) Vibration Resistance: 25m/s²(Frequency：10～400Hz) Shock Resistance：300m/s² No dust, metal powder, corrosive gases, flammable gases, or oil mist Indoor use, avoid direct sun light Altitude below 1000m	
Design Life (H)			10000	
Motor Insulation			Insulation Resistance：Above 500 M Ω Withstand Voltage：AC1500 V / 1 min Insulation Class : Class F (155 °C)	
Installation Direction			Can be installed in a ll direct ions	
Protection Level			Totally enclosed, self-cooling type (IP54)	

Model			L70I		
Reduction Ratio			51	81	101
Input Voltage		V	48（±10%）		
Maximum Torque		N ·m	46	61	70
		kgf ·m	4.69	6.22	7.14
Permissible Continuous Torque		N ·m	9	14	14
		kgf ·m	0.92	1.43	1.43
Peak Starting Torque		N ·m	23	30	36
		kgf ·m	2.35	3.06	3.67
Maximum Speed		r/min	107.8	67.9	54.5
Rated Speed		r/min	58.8	37.0	29.7
Torque Constant		N ·m/A	0.08	0.08	0.08
		kgf ·m/A	0.0082	0.0082	0.0082
Maximum Current		A	8.25	6.77	6.52
Permissible Continuous Current		A	3.23	3.16	2.53
Back EMF Constant		V/Krpm	6.15		
Phase Resistance(20℃)		Ω	0.39		
Phase Inductance		mH	0.3		
Moment of Inertia	GD²/4	kg ·mm²	37.6		
	J	kgf ·cm ·s²	37.6*10^-4		
Repeatability*1		Arc-sec	20		
Positioning Accuracy*2		Arc-sec	60		
Bus Communication Protocol		/	CANopen/CAN FD/EtherCAT		
Encoder Resolution		Single-turn Detector	17bit（131072pulses per revolution）		
		Multi-turn Detector	16bit（-32768~32767turns）		
Output Shaft Resolution		Pulses per Revolution	6684672	10616832	13238272
Mass		kg	1.0KG		
Ambient Conditions			Operating Temperature:Standard grease: -10 to 55° C; Low-temperature grease: -30 to 55° C Storage Temperature:Standard grease: -20 to 80° C Low-temperature grease: -40 to 80° C Operating/Storage Humidity: 20 – 80% RH (non-condensing)		

	Vibration Resistance: 25m/s²(Frequency：10～400Hz) Shock Resistance：300m/s² No dust, metal powder, corrosive gases, flammable gases, or oil mist Indoor use, avoid direct sun light Altitude below 1000m
Design Life (H)	10000
Motor Insulation	Insulation Resistance：Above 500 M Ω Withstand Voltage：AC1500 V / 1 min Insulation Class : Class F (155 °C)
Installation Direction	Can be installed in a ll direct ions
Protection Level	Totally enclosed, self-cooling type (IP54)

Model			L80I			
Reduction Ratio			51	81	101	121
Input Voltage		V	48 (±10%)			
Maximum Torque		N ·m	91	113	143	112
		kgf ·m	9.29	11.53	14.59	11.43
Permissible Continuous Torque		N ·m	34	35	51	51
		kgf ·m	3.47	3.57	5.20	5.20
Peak Starting Torque		N ·m	44	56	70	70
		kgf ·m	4.49	5.71	7.14	7.14
Maximum Speed		r/min	98.04	61.73	49.50	41.32
Rated Speed		r/min	58.82	37.04	29.70	24.79
Torque Constant		N ·m/A	0.09	0.09	0.09	0.09
		kgf ·m/A	0.0092	0.0092	0.0092	0.0092
Maximum Current		A	13.48	10.80	10.83	9.04
Permissible Continuous Torque		A	10.42	6.75	7.89	6.59
Back EMF Constant		V/Krpm	6.67			
Phase Resistance(20˚C)		Ω	0.14			
Phase Inductance		mH	0.3			
Moment of Inertia	GD²/4	kg ·mm²	58			
	J	kgf ·cm ·s²	58*10^-4			
Repeatability *1		Arc-sec	20			
Positioning Accuracy *2		Arc-sec	60			

Bus Communication Protocol	/	CANopen/CAN FD/EtherCAT			
Encoder Resolution	Single-turn Detector	17bit（1310722 pulses per revolution）			
	Multi-turn Detector	16bit（-32768~32767turns）			
Output Shaft Resolution	Pulses per Revolution	6684672	10616832	13238272	15859712
Mass	kg	1.6KG			
Ambient Conditions		Operating Temperature:Standard grease: -10 to 55°C; Low-temperature grease: -30 to 55°C Storage Temperature:Standard grease: -20 to 80°C Low-temperature grease: -40 to 80°C Operating/Storage Humidity: 20 -80% RH (non-condensing) Vibration Resistance: 25m/s²(Frequency：10～400Hz) Shock Resistance：300 m/s² No dust, metal powder, corrosive gases, flammable gases, or oil mist Indoor use, avoid direct sunlight Altitude below 1000m			
Design Life (H)		10000			
Motor Insulation		Insulation Resistance：Above 500 MΩ Withstand Voltage：AC1500 V / 1 min Insulation Class: Class F (155°C)			
Installation Direction		Can be installed in all directions			
Protection Level		Totally enclosed, self-cooling type (IP54)			

Model		L90I			
Reduction Ratio		51	81	101	121
Input Voltage	V	48 (±10%)			
Maximum Torque	N ·m	127	165	191	191
	kgf ·m	12.96	16.84	19.49	19.49
Permissible Continuous Torque	N ·m	44	61	64	64
	kgf ·m	4.49	6.22	6.53	6.53
Peak Starting Torque	N ·m	73	96	107	113
	kgf ·m	7.45	9.80	10.92	11.53
Maximum Speed	r/min	78.4	49.4	39.6	33.1
Rated Speed	r/min	58.8	37.0	29.7	24.8

Torque Constant		N ·m/A	0.10	0.11	0.11	0.11
		kgf ·m/A	0.0112	0.0112	0.0112	0.0112
Maximum Current		A	19.59	15.15	13.54	11.94
Permissible Continuous Current		A	11.81	9.63	8.10	6.76
Back EMF Constant		V/Krpm	6.78			
Phase Resistance(20℃)		Ω	0.11			
Phase Inductance		mH	0.24			
Moment of Inertia	GD²/4	kg·mm²	106.3			
	J	kgf·cm·s²	106.3*10^-4			
Repeatability*1		Arc-sec	20			
Positioning Accuracy*2		Arc-sec	60			
Bus Communication Protocol		/	CANopen/CAN FD/EtherCAT			
Encoder Resolution		Single-turn Detector	17bit（131072 pulses per revolution）			
		Multi-turn Detector	16bit（-32768~32767turns）			
Output Shaft Resolution		Pulses per Revolution	6684672	10616832	13238272	15859712
Mass		kg	2KG			
Ambient Conditions			Operating Temperature:Standard grease: -10 to 55°C; Low-temperature grease: -30 to 55°C Storage Temperature:Standard grease: -20 to 80°C Low-temperature grease: -40 to 80°C Operating/Storage Humidity: 20 -80% RH (non-condensing) Vibration Resistance: 25m/s²(Frequency：10～400Hz) Shock Resistance：300 m/s² No dust, metal powder, corrosive gases, flammable gases, or oil mist Indoor use, avoid direct sunlight Altitude below 1000 m			
Design Life (H)			10000			
Motor Insulation			Insulation Resistance：Above 500 MΩ Withstand Voltage：AC1500 V / 1 min Insulation Class: Class F (155°C)			
Installation Direction			Can be installed in all directions			
Protection Level			Totally enclosed, self-cooling type (IP54)			

Model			L110I			
Reduction Ratio			51	81	101	121
Input Voltage		V	48 (±10%)			
Maximum Torque		N ·m	242	332	369	395
		kgf ·m	24.69	33.88	37.65	40.31
Permissible Continuous Torque		N ·m	72	113	140	140
		kgf ·m	7.35	11.53	14.29	14.29
Peak Starting Torque		N ·m	127	178	204	217
		kgf ·m	12.96	18.16	20.82	22.14
Maximum Speed		r/min	78.4	49.4	39.6	33.1
Rated Speed		r/min	58.8	37.0	29.7	24.8
Torque Constant		N ·m/A	0.11	0.11	0.11	0.11
		kgf ·m/A	0.0112	0.0112	0.0112	0.0112
Maximum Current		A	32.42	28.61	26.30	23.35
Permissible Continuous Current		A	18.38	18.16	18.05	15.07
Back EMF Constant		V/Krpm	6.88			
Phase Resistance(20℃)		Ω	0.033			
Phase Inductance		mH	0.11			
Moment of Inertia	GD²/4	kg ·mm²	201			
	J	kgf ·cm ·s²	201*10^-4			
Repeatability[*1]		Arc-sec	20			
Positioning Accuracy[*2]		Arc-sec	60			
Bus Communication Protocol		/	CANopen/CAN FD/EtherCAT			
Encoder Resolution		Single-turn Detector	17bit（131072 pulses per revolution）			
		Multi-turn Detector	16bit（-32768~32767turns）			
Output Shaft Resolution		Pulses per Revolution	6684672	10616832	13238272	15859712
Mass		kg	3.1KG			
Ambient Conditions			Operating Temperature:Standard grease: -10 to 55°C; Low-temperature grease: -30 to 55°C Storage Temperature:Standard grease: -20 to 80°C Low-temperature grease: -40 to 80°C Operating/Storage Humidity: 20 -80% RH (non-condensing) Vibration Resistance: 25m/s²(Frequency：10～400Hz) Shock Resistance：300 m/s²			

	No dust, metal powder, corrosive gases, flammable gases, or oil mist Indoor use, avoid direct sunlight Altitude below 1000 m
Design Life (H)	10000
Motor Insulation	Insulation Resistance：Above 500 MΩ Withstand Voltage：AC1500 V / 1 min Insulation Class: Class F (155℃)
Installation Direction	Can be installed in all directions
Protection Level	Totally enclosed, self-cooling type (IP54)

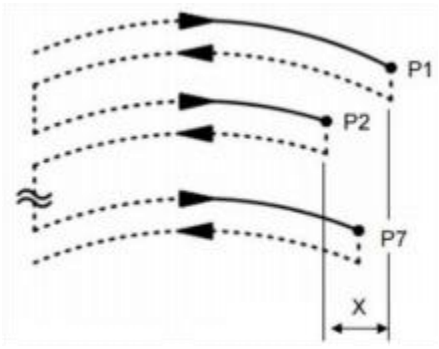
Model			L142I			
Reduction Ratio			51	81	101	121
Input Voltage		V	48 (±10%)			
Maximum Torque		N ·m	497	738	841	892
		kgf ·m	50.71	75.31	85.82	91.02
Permissible Continuous Torque		N ·m	140	217	281	281
		kgf ·m	14.29	22.14	28.67	28.67
Peak Starting Torque		N ·m	281	395	433	459
		kgf ·m	28.67	40.31	44.18	46.84
Maximum Speed		r/min	58.8	37.0	29.7	24.8
Rated Speed		r/min	39.2	24.7	19.8	16.5
Torque Constant		N ·m/A	0.17	0.17	0.17	0.17
		kgf ·m/A	0.0173	0.0173	0.0173	0.0173
Maximum Current		A	38.93	34.45	30.29	26.80
Permissible Continuous Current		A	19.40	18.93	19.66	16.41
Back EMF Constant		V/Krpm	11.2			
Phase Resistance(20℃)		Ω	0.036			
Phase Inductance		mH	0.12			
Moment of Inertia	GD²/4	kg ·mm²	625			
	J	kgf ·cm ·s²	625*10^-4			
Repeatability[*1]		Arc-sec	20			
Positioning Accuracy[*2]		Arc-sec	60			
Bus Communication Protocol		/	CANopen/CAN FD/EtherCAT			

Encoder Resolution	Single-turn Detector	17bit（131072 pulses per revolution）			
	Multi-turn Detector	16bit（-32768~32767turns）			
Output Shaft Resolution	Pulses per Revolution	6684672	10616832	13238272	15859712
Mass	kg	5.3KG			
Ambient Conditions		Operating Temperature:Standard grease: -10 to 55°C; Low-temperature grease: -30 to 55°C Storage Temperature:Standard grease: -20 to 80°C Low-temperature grease: -40 to 80°C Operating/Storage Humidity: 20 -80% RH (non-condensing) Vibration Resistance: 25m/s²(Frequency：10～400Hz) Shock Resistance：300 m/s² No dust, metal powder, corrosive gases, flammable gases, or oil mist Indoor use, avoid direct sunlight Altitude below 1000 m			
Design Life (H)		10000			
Motor Insulation		Insulation Resistance：Above 500 MΩ Withstand Voltage：AC1500 V / 1 min Insulation Class: Class F (155℃)			
Installation Direction		Can be installed in all directions			
Protection Level		Totally enclosed, self-cooling type (IP54)			

Model		L170I			
Reduction Ratio		51	81	101	121
Input Voltage	V	48 (±10%)			
Maximum Torque	N ·m	892	1270	1400	1530
	kgf ·m	91.02	129.59	142.86	156.12
Permissible Continuous Torque	N ·m	225	369	484	586
	kgf ·m	22.96	37.65	49.39	59.80
Peak Starting Torque	N ·m	523	675	738	802
	kgf ·m	53.37	68.88	75.31	81.84
Maximum Speed	r/min	49.0	30.9	24.8	20.7
Rated Speed	r/min	39.2	24.7	19.8	16.5
Torque Constant	N ·m/A	0.17	0.17	0.17	0.17
	kgf ·m/A	0.0173	0.0173	0.0173	0.0173
Maximum Current	A	84.01	68.27	59.86	54.30

Permissible Continuous Current		A	40.96	37.32	39.26	39.67
Back EMF Constant		V/Krpm	11.56			
Phase Resistance(20℃)		Ω	0.014			
Phase Inductance		mH	0.067			
Moment of Inertia	GD²/4	kg·mm²	/			
	J	kgf·cm·s²	/			
Repeatability*1		Arc-sec	20			
Positioning Accuracy*2		Arc-sec	60			
Bus Communication Protocol		/	CANopen/CAN FD/EtherCAT			
Encoder Resolution		Single-turn Detector	17bit（131072pulses per revolution）			
		Multi-turn Detector	16bit（-32768~32767 turns）			
Output Shaft Resolution		Pulses per Revolution	6684672	10616832	13238272	15859712
Mass		kg	9.48kg			
Ambient Conditions			Operating Temperature:Standard grease: -10 to 55°C; Low-temperature grease: -30 to 55°C Storage Temperature:Standard grease: -20 to 80°C Low-temperature grease: -40 to 80°C Operating/Storage Humidity: 20 -80% RH (non-condensing) Vibration Resistance: 25m/s²(Frequency：10～400Hz) Shock Resistance：300 m/s² No dust, metal powder, corrosive gases, flammable gases, or oil mist Indoor use, avoid direct sunlight Altitude below 1000m			
Design Life (H)			10000			
Motor Insulation			Insulation Resistance：Above 500 MΩ Withstand Voltage：AC1500 V / 1 min Insulation Class: Class F (155℃)			
Installation Direction			Can be installed in all directions			
Protection Level			Totally enclosed, self-cooling type (IP54)			

*1 Repeatability: Refers to the precision with which the output shaft can return to a specific position after performing seven repeated positioning operations from the same direction. This measurement is taken at four different positions on the output shaft, and the maximum difference among these positions is calculated.



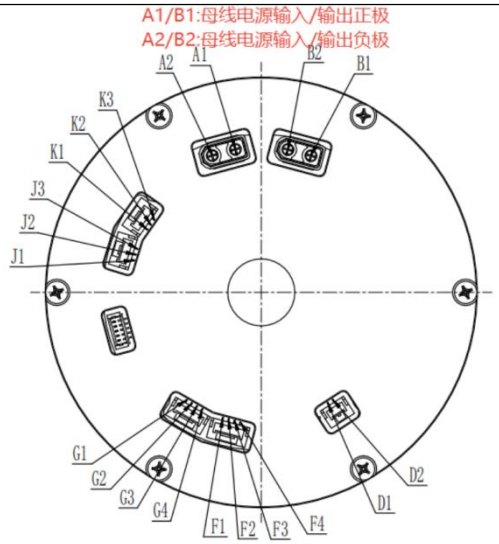
*2Positioning Accuracy: Refers to the precision of positioning in a fixed rotational direction. At each position, the difference between the actual rotational angle and the intended rotational angle relative to a reference position is calculated. The maximum value of these differences within one full rotation is then recorded.

Chapter 3 Input Power Specifications, Electrical Interfaces, and Cables

Power Specifications

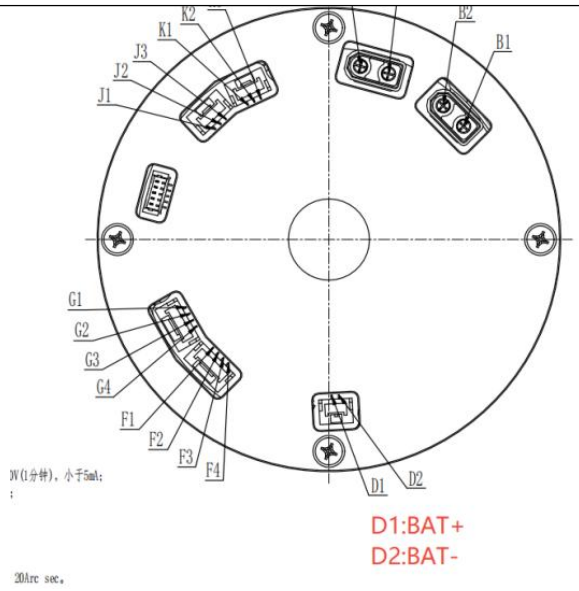
48V power supply interface

Pin	Terminal Label	Terminal function
1	DC+	Positive Power Supply
2	DC-	Negative terminal of Power Supply

Pin position	Connector
	
Connector Information	Wiring Terminal Information
Model：XT30UPB-M	Brands：ams Model：XT30U-F
Specifications：Straight legs, leg spacing 5mm, leg length 2mm, 2-Pin	Specifications：foot spacing 5mm 2Pin

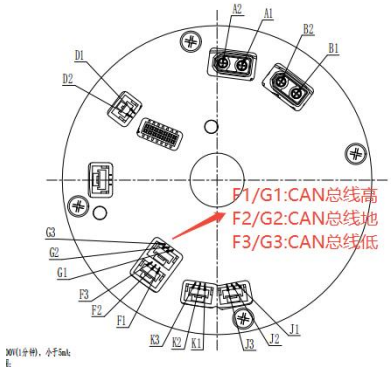
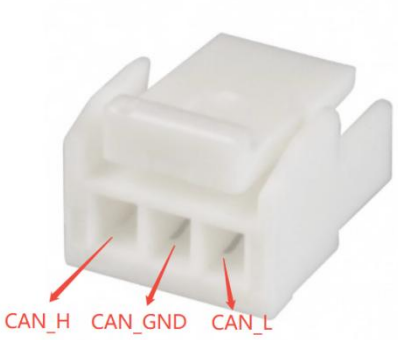
Multi-turn power supply battery interface

Pin	Terminal Label	Terminal function
1	BAT+	Multi-turn encoder backup battery positive terminal
2	BAT-	Multi-turn encoder backup battery negative terminal

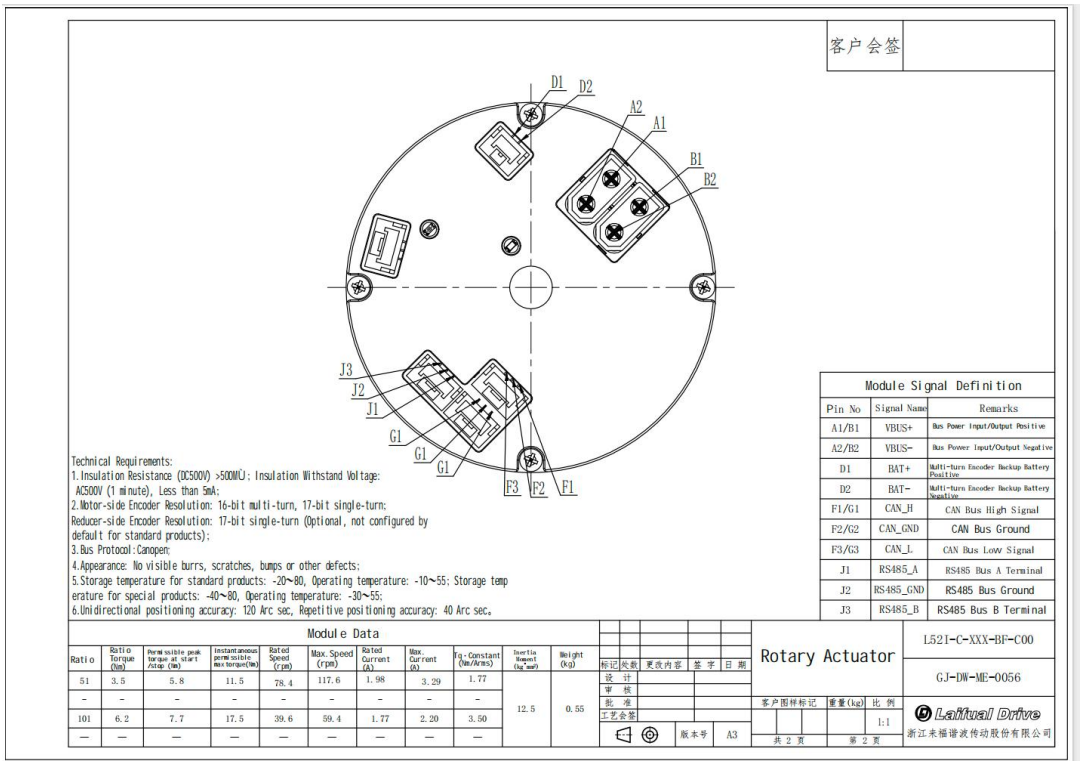
Pin Position	Connector
	
Connector information	Wiring terminal information
Model:BM02B-GHS-TBT	Brand:JST Housing model:GHR-02V-S Terminal model:SSHL-002T-P0.2
Specifications:Single row,1.25mm spacing,2 pins	Specifications:JST single-ended terminal block,1.25mm pitch,2 pins

Electrical Interfaces and Instructions

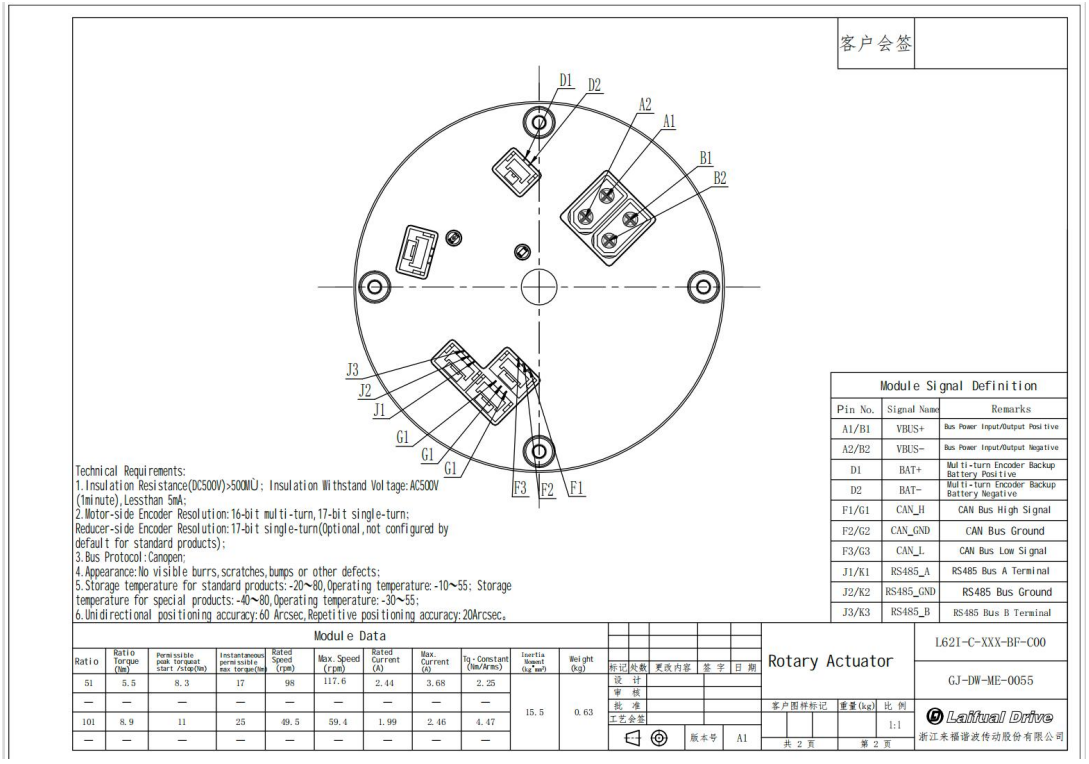
CAN communication interface

Pin	Terminal label	Terminal function
1	CAN_H	CAN bus high
2	CAN_GND	CAN bus ground
3	CAN_L	CAN bus low
Pin Position		Connector
		
Connector information		Wiring terminal information
Model:BM03B-GHS-TBT		Brand:JST Housing model:GHR-03V-S Terminal model:SSHLL-002T-P0.2 (or equivalent)
Specifications:Single row,1.25mm spacing,3 pins		Specifications:JST single-ended terminal block,1.25mm pitch,3-pin

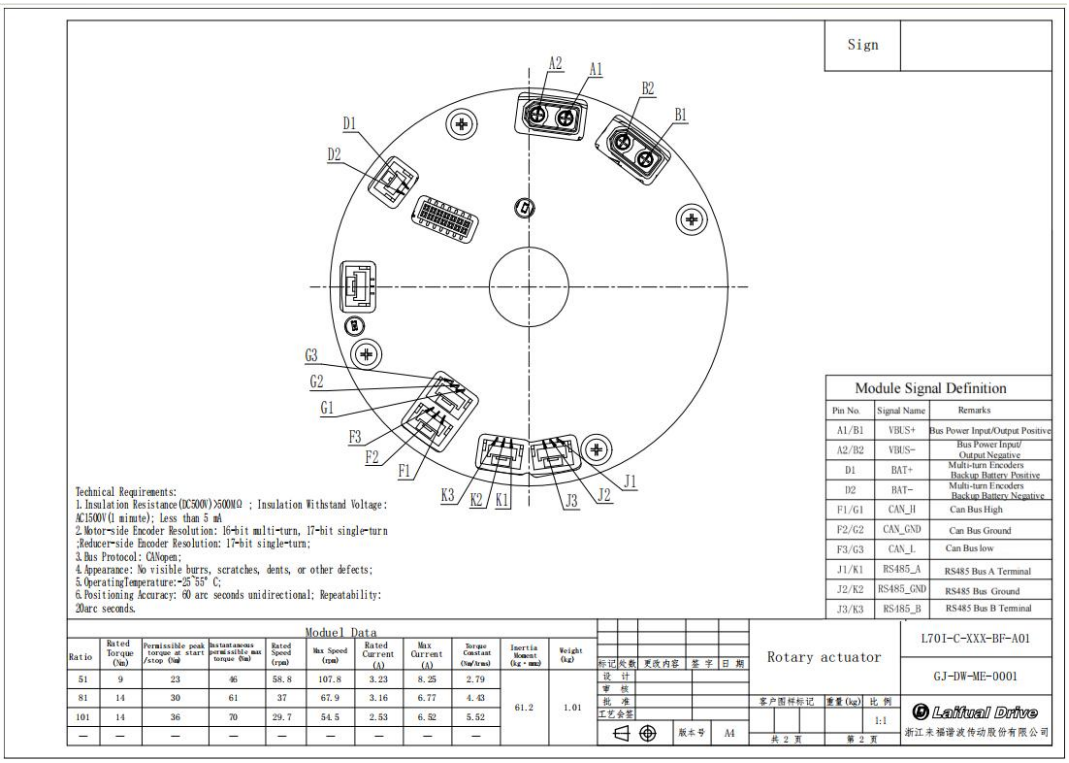
L52I-C/F



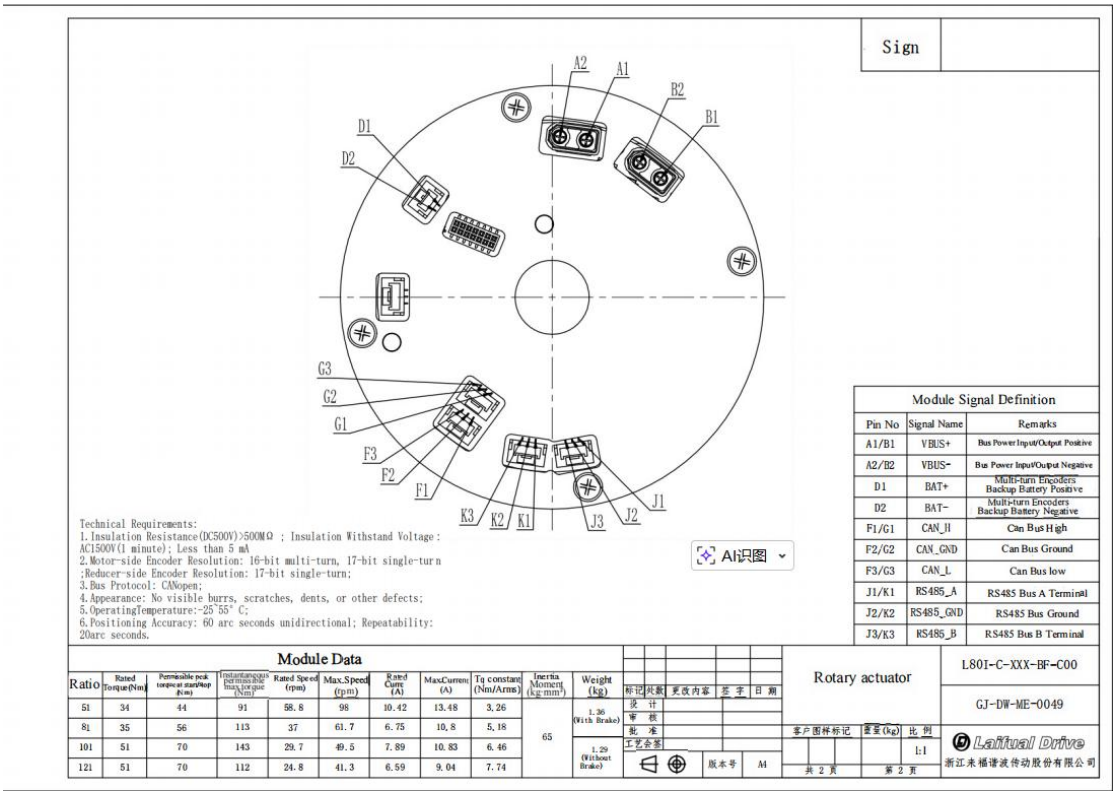
L62I-C/F



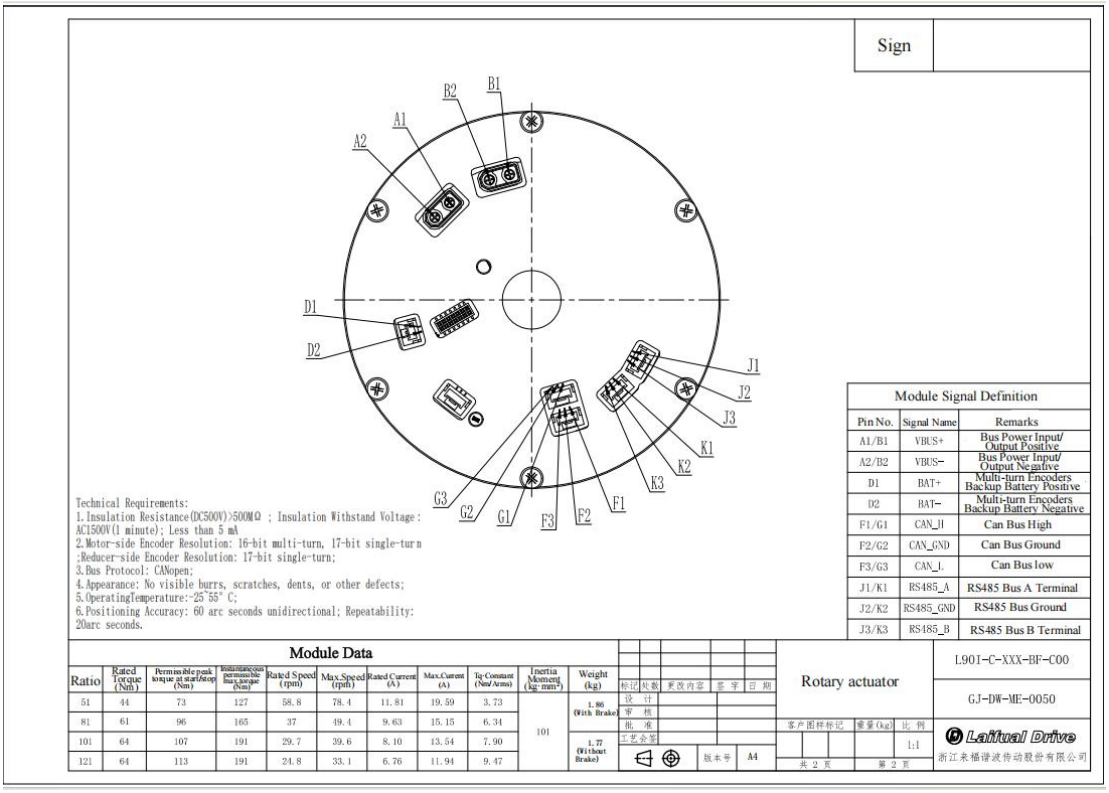
L70I-C/F



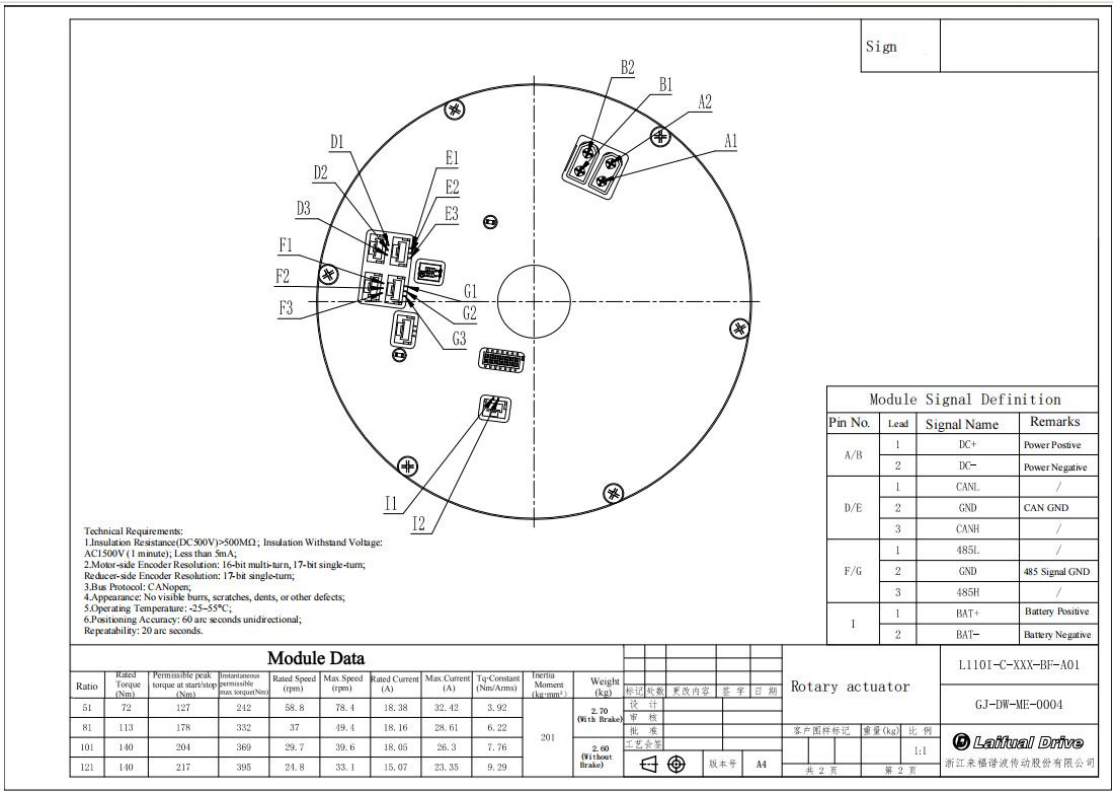
L80I-C/F



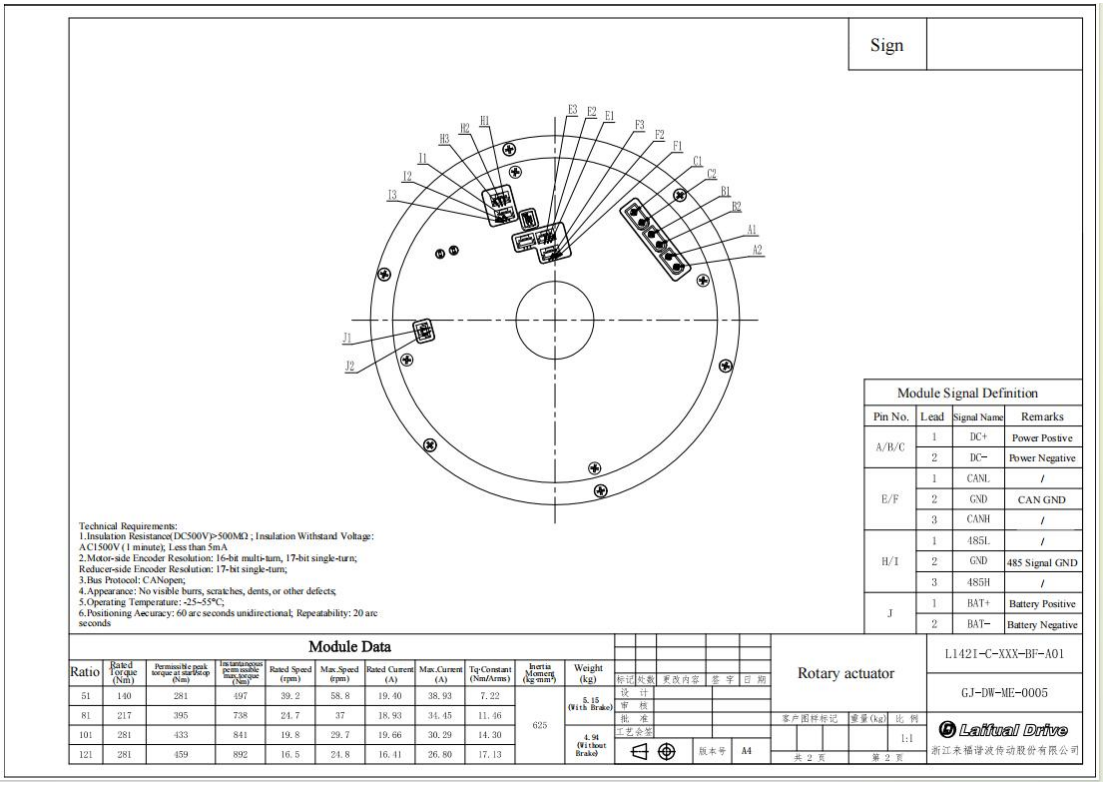
L90I-C/F



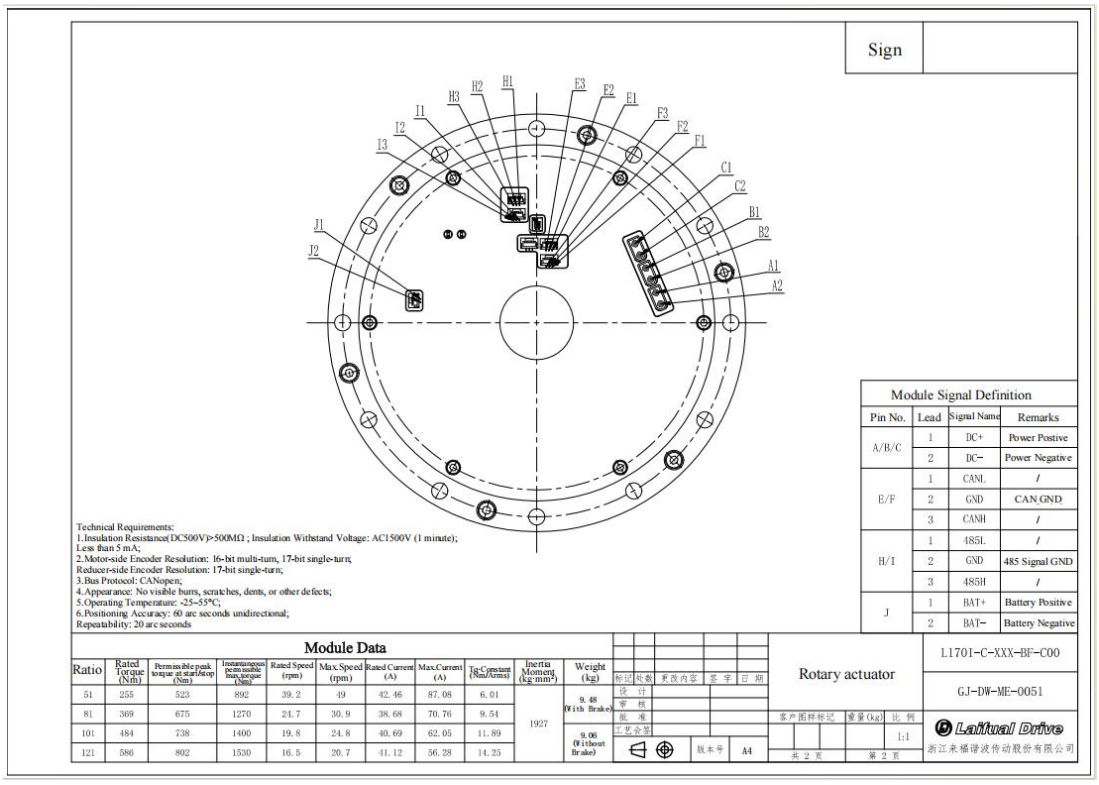
L110I-C/F



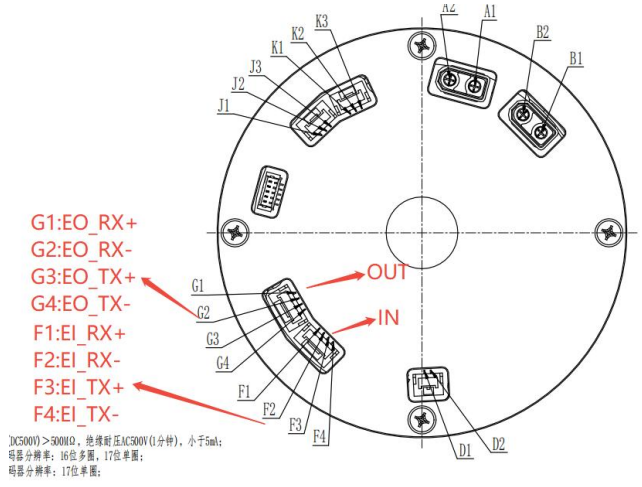
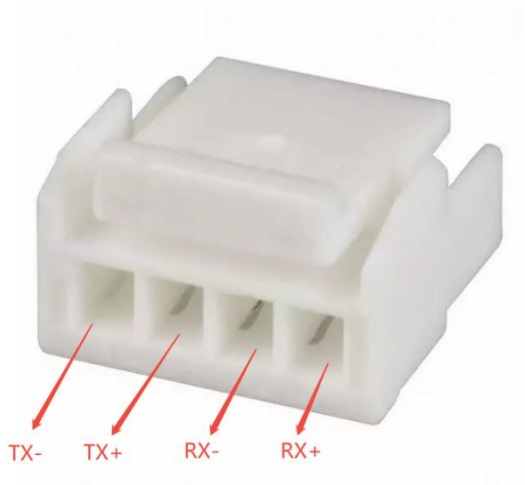
L142I-C/F



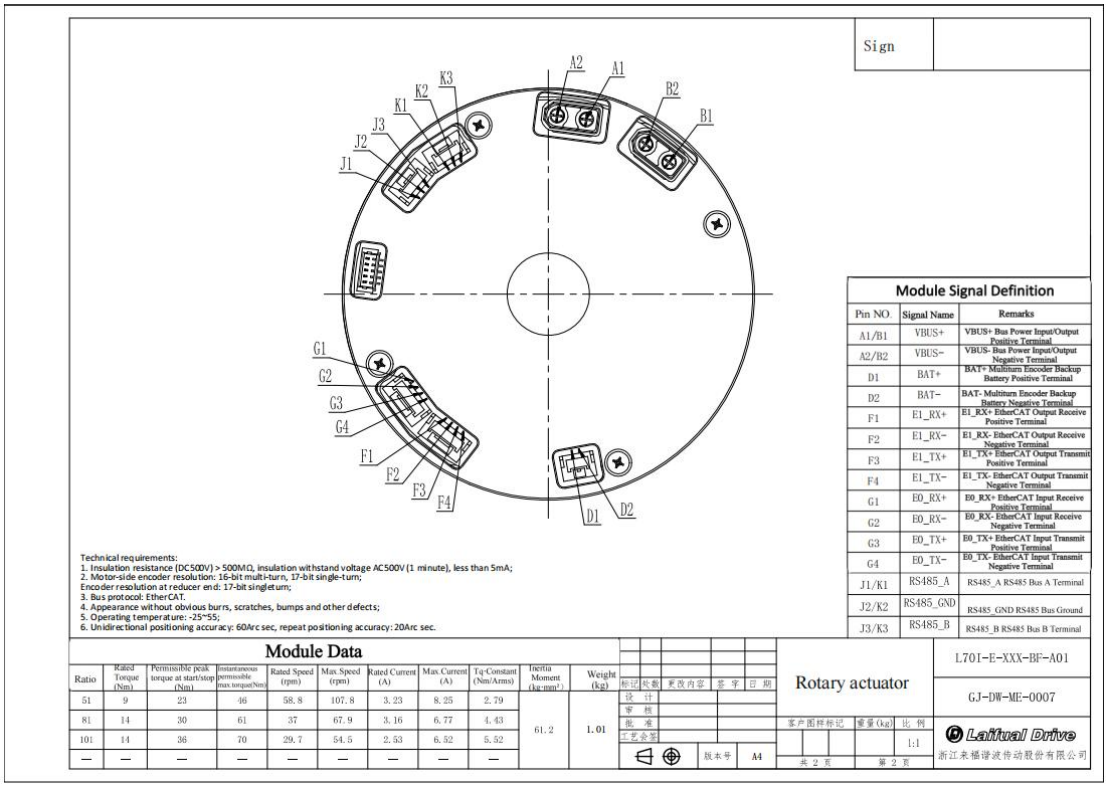
L170I-C/F



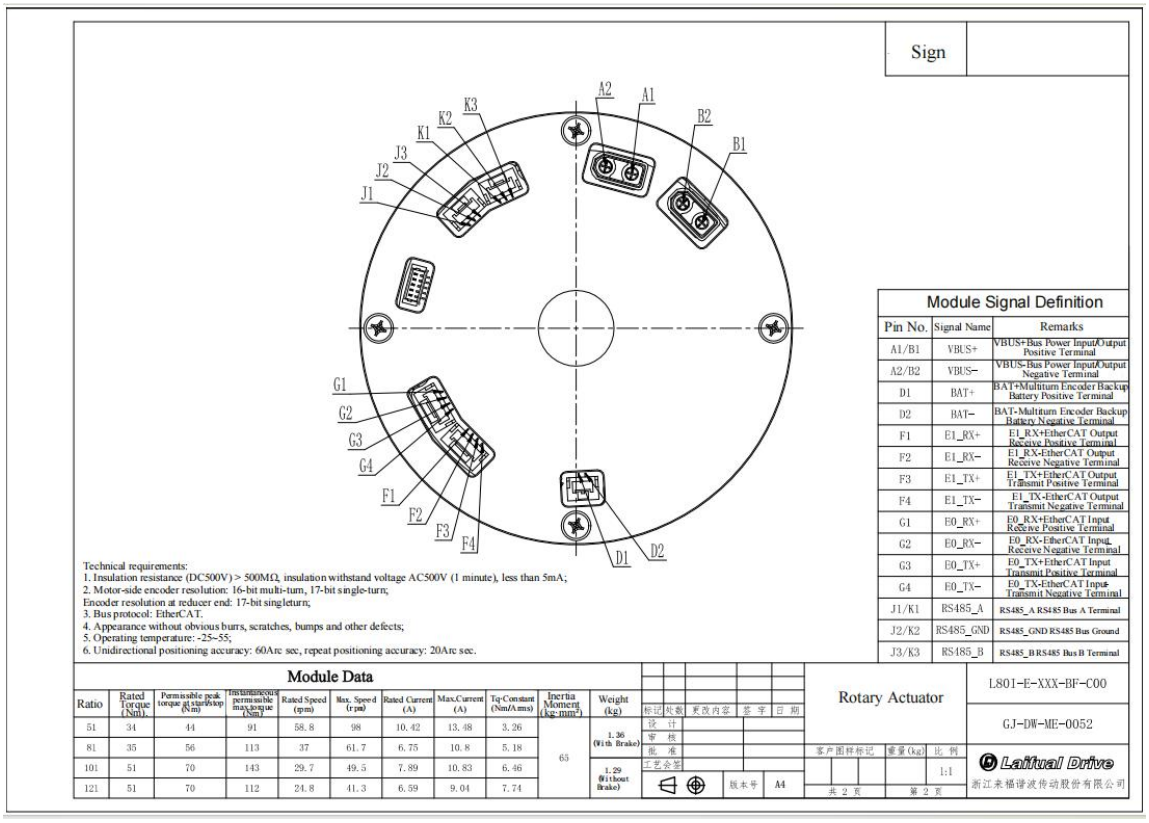
EtherCAT communication interface

	ECAT In		ECAT Out	
Pin	Terminal markings	Terminal function	Terminal markings	Terminal function
1	E I_T X -	EtherCAT Input Send -	E O_T X -	EtherCAT output transmission -
2	E I_T X +	EtherCAT input send +	E O_T X +	EtherCAT output transmission +
3	EI_RX-	EtherCAT input reception -	EO_RX-	EtherCAT output and reception -
4	EI_RX+	EtherCAT input receiver +	EO_RX+	EtherCAT output and reception +
Pin Position		Terminal blocks		
				
Connector information			Wiring terminal information	
Model：BM04B-GHS-TBT			Brand：JST Housing model：GHR-04V-S Terminal model：SSHL-002T-P0.2	
Specifications：Singlerow.1.25mm spacing.4pins			Specifications：JST single-ended terminal, pitch 1.25mm, 4-Pin	

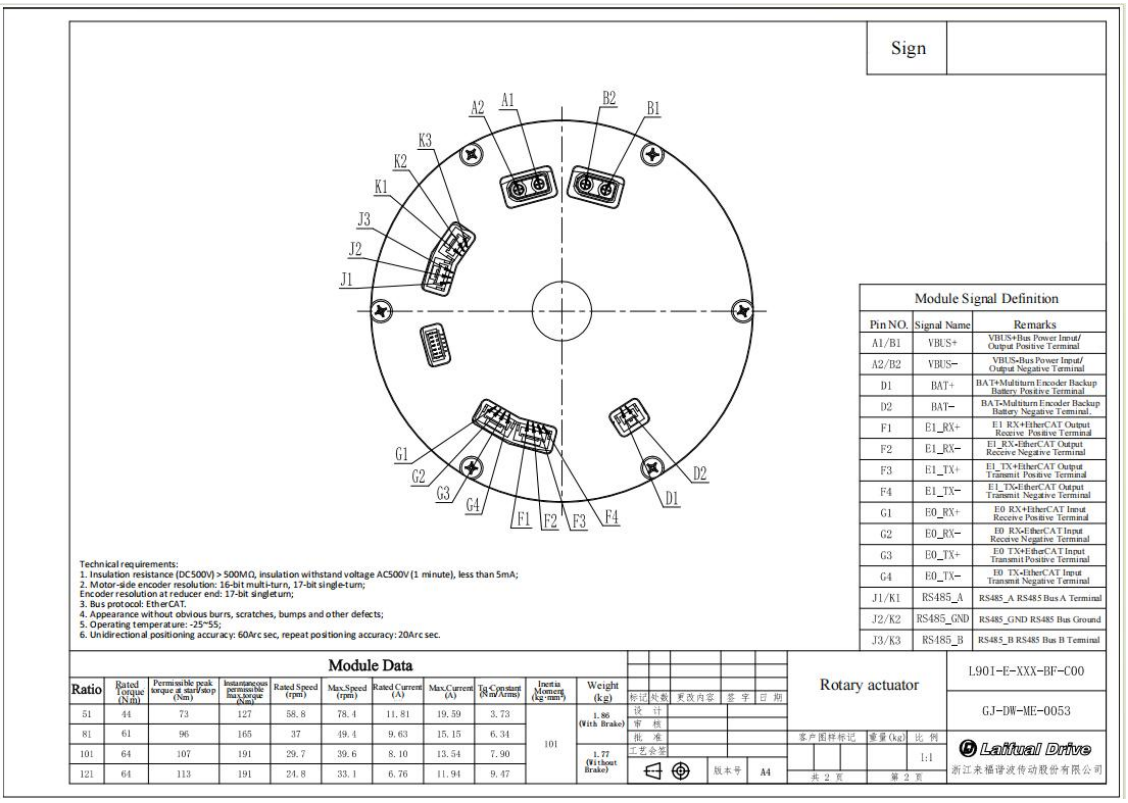
L70I-E


Sign
A2
A1
B2
B1
K3
K2
K1
J3
J2
J1
G1
G2
G3
G4
F1
F2
F3
F4
D1
D2
Technical requirements:
1. Insulation resistance (DC500V) > 500MΩ, insulation withstand voltage AC500V (1 minute), less than 5mA;
2. Motor-side encoder resolution: 16-bit multi-turn, 17-bit single-turn;
Encoder resolution at reducer end: 17-bit singleturn;
3. Bus protocol: EtherCAT.
4. Appearance without obvious burrs, scratches, bumps and other defects;
5. Operating temperature: -25~55;
6. Unidirectional positioning accuracy: 60Arc sec, repeat positioning accuracy: 20Arc sec.
Module Signal Definition
Pin NO. | Signal Name | Remarks
A1/B1 | VBUS+ | VBUS+ Bus Power Input/Output Positive Terminal
A2/B2 | VBUS− | VBUS- Bus Power Input/Output Negative Terminal
D1 | BAT+ | BAT+ Multiturn Encoder Backup Battery Positive Terminal
D2 | BAT− | BAT- Multiturn Encoder Backup Battery Negative Terminal
F1 | E1_RX+ | E1_RX+ EtherCAT Output Receive Positive Terminal
F2 | E1_RX− | E1_RX- EtherCAT Output Receive Negative Terminal
F3 | E1_TX+ | E1_TX+ EtherCAT Output Transmit Positive Terminal
F4 | E1_TX− | E1_TX- EtherCAT Output Transmit Negative Terminal
G1 | E0_RX+ | E0_RX+ EtherCAT Input Receive Positive Terminal
G2 | E0_RX− | E0_RX- EtherCAT Input Receive Negative Terminal
G3 | E0_TX+ | E0_TX+ EtherCAT Input Transmit Positive Terminal
G4 | E0_TX− | E0_TX- EtherCAT Input Transmit Negative Terminal
J1/K1 | RS485_A | RS485_A RS485 Bus A Terminal
J2/K2 | RS485_GND | RS485_GND RS485 Bus Ground
J3/K3 | RS485_B | RS485_B RS485 Bus B Terminal
Module Data
Ratio | Rated Torque (Nm) | Permissible peak torque at start/stop (Nm) | Instantaneous permissible max.torque(Nm) | Rated Speed (rpm) | Max. Speed (rpm) | Rated Current (A) | Max.Current (A) | Tq-Constant (Nm/Arms) | Inertia Moment (kg·mm²) | Weight (kg)
51 | 9 | 23 | 46 | 58.8 | 107.8 | 3.23 | 8.25 | 2.79 | 61.2 | 1.01
81 | 14 | 30 | 61 | 37 | 67.9 | 3.16 | 6.77 | 4.43
101 | 14 | 36 | 70 | 29.7 | 54.5 | 2.53 | 6.52 | 5.52
— | — | — | — | — | — | — | — | —
Rotary actuator
L70I-E-XXX-BF-A01
GJ-DW-ME-0007
Laifual Drive
浙江来福谐波传动股份有限公司

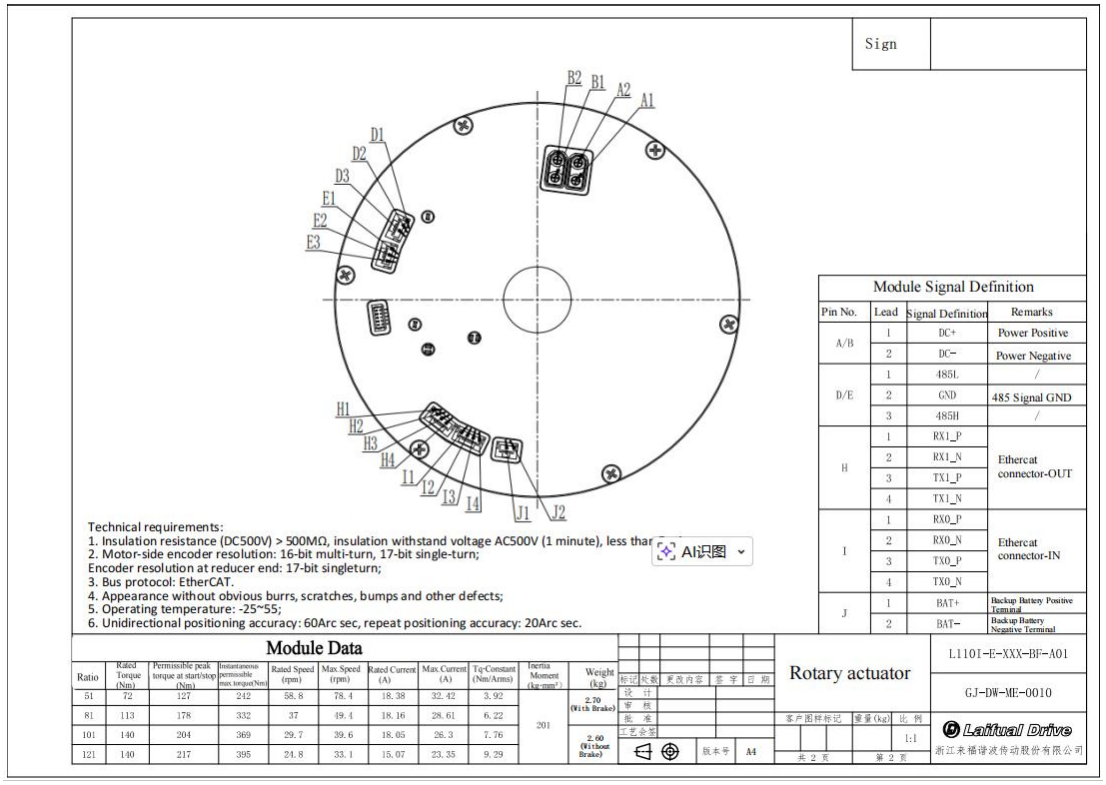
L80I-E


Sign
A2
A1
B2
B1
K3
K2
K1
J3
J2
J1
G1
G2
G3
G4
F1
F2
F3
F4
D1
D2
Technical requirements:
1. Insulation resistance (DC500V) > 500MΩ, insulation withstand voltage AC500V (1 minute), less than 5mA;
2. Motor-side encoder resolution: 16-bit multi-turn, 17-bit single-turn;
Encoder resolution at reducer end: 17-bit singleturn;
3. Bus protocol: EtherCAT.
4. Appearance without obvious burrs, scratches, bumps and other defects;
5. Operating temperature: -25~55;
6. Unidirectional positioning accuracy: 60Arc sec, repeat positioning accuracy: 20Arc sec.
Module Signal Definition
Pin No. | Signal Name | Remarks
A1/B1 | VBUS+ | VBUS+Bus Power Input/Output Positive Terminal
A2/B2 | VBUS− | VBUS-Bus Power Input/Output Negative Terminal
D1 | BAT+ | BAT+Multiturn Encoder Backup Battery Positive Terminal
D2 | BAT− | BAT-Multiturn Encoder Backup Battery Negative Terminal
F1 | E1_RX+ | E1_RX+EtherCAT Output Receive Positive Terminal
F2 | E1_RX− | E1_RX-EtherCAT Output Receive Negative Terminal
F3 | E1_TX+ | E1_TX+EtherCAT Output Transmit Positive Terminal
F4 | E1_TX− | E1_TX-EtherCAT Output Transmit Negative Terminal
G1 | E0_RX+ | E0_RX+EtherCAT Input Receive Positive Terminal
G2 | E0_RX− | E0_RX-EtherCAT Input Receive Negative Terminal
G3 | E0_TX+ | E0_TX+EtherCAT Input Transmit Positive Terminal
G4 | E0_TX− | E0_TX-EtherCAT Input Transmit Negative Terminal
J1/K1 | RS485_A | RS485_A RS485 Bus A Terminal
J2/K2 | RS485_GND | RS485_GND RS485 Bus Ground
J3/K3 | RS485_B | RS485_B RS485 Bus B Terminal
Module Data
Ratio | Rated Torque (Nm) | Permissible peak torque at start/stop (Nm) | Instantaneous permissible max.torque (Nm) | Rated Speed (rpm) | Max. Speed (rpm) | Rated Current (A) | Max.Current (A) | Tq-Constant (Nm/Arms) | Inertia Moment (kg·mm²) | Weight (kg)
51 | 34 | 44 | 91 | 58.8 | 98 | 10.42 | 13.48 | 3.26 | 65 | 1.36 (With Brake)
81 | 35 | 56 | 113 | 37 | 61.7 | 6.75 | 10.8 | 5.18
101 | 51 | 70 | 143 | 29.7 | 49.5 | 7.89 | 10.83 | 6.46
121 | 51 | 70 | 112 | 24.8 | 41.3 | 6.59 | 9.04 | 7.74
1.29 (Without Brake)
Rotary Actuator
L80I-E-XXX-BF-C00
GJ-DW-ME-0052
Laifual Drive
浙江来福谐波传动股份有限公司

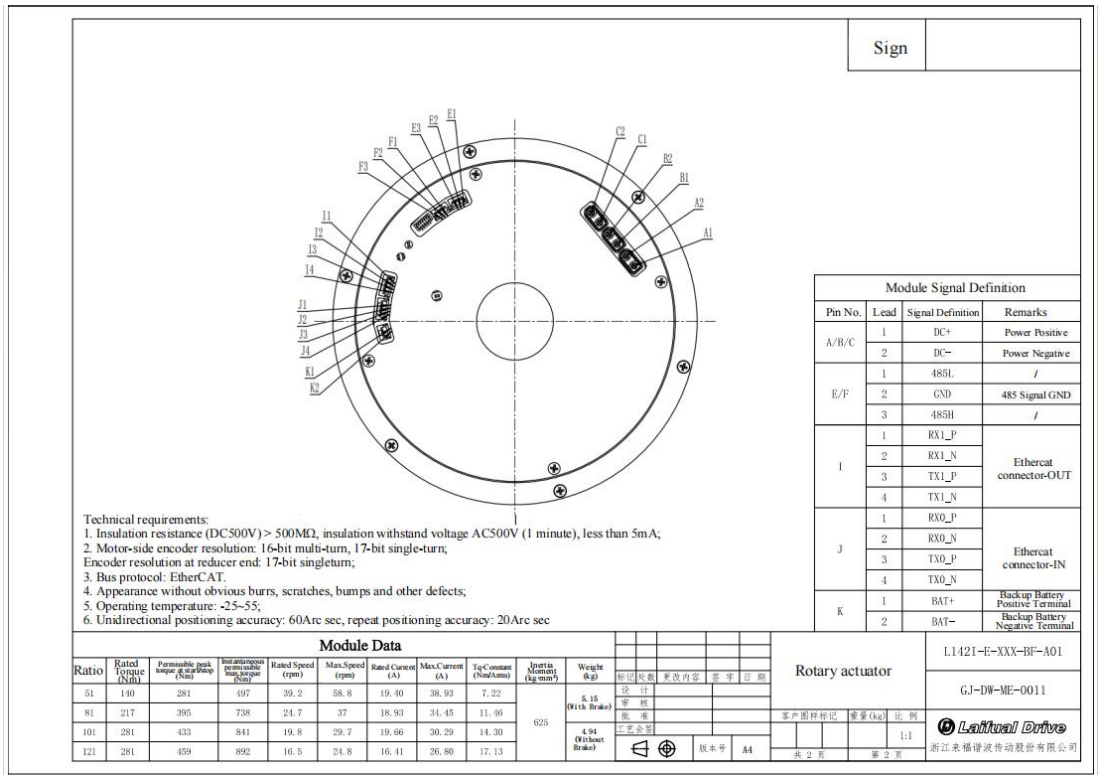
L90I-E



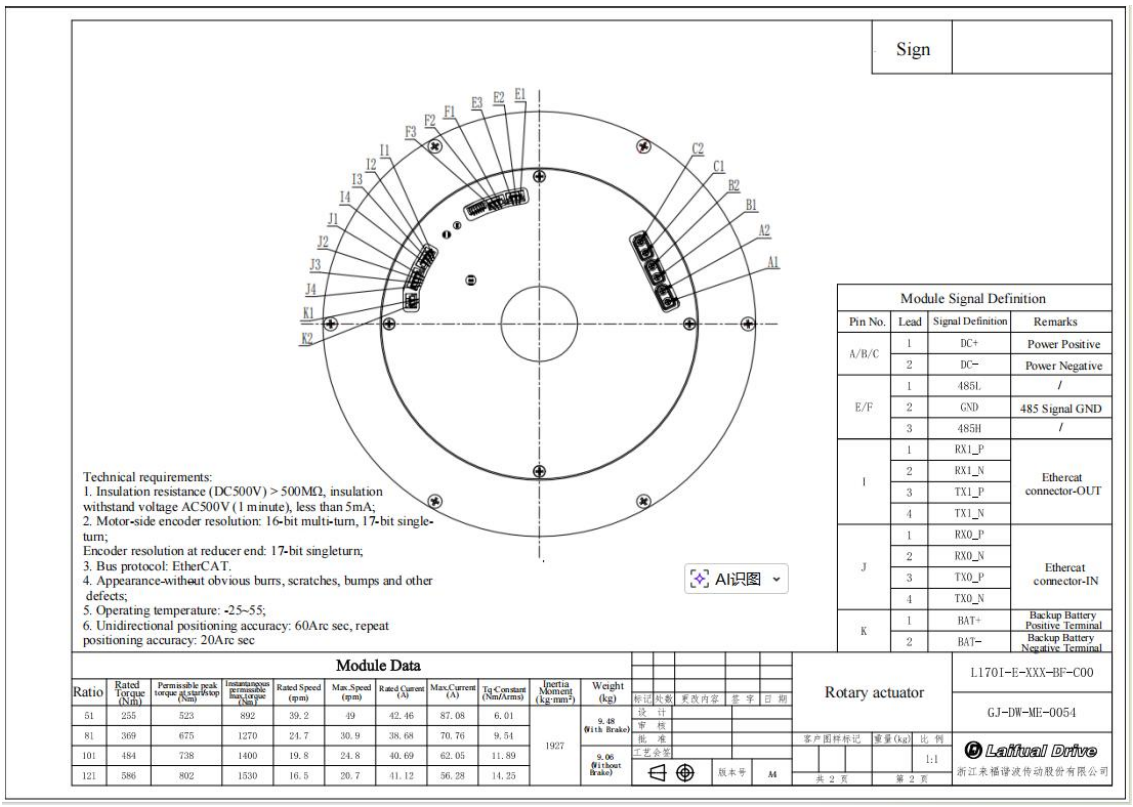
L110I-E



L142I-E

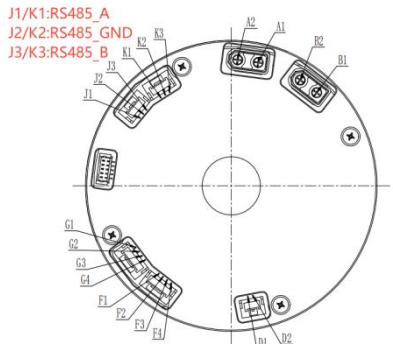
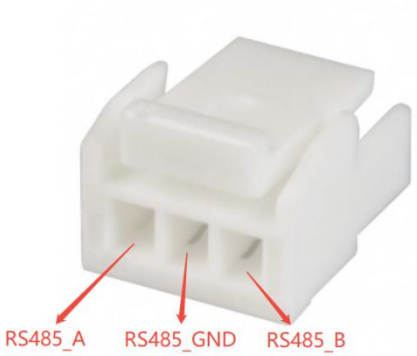


L170I-E



485 communication interface

Pin	Terminal Lable	Terminal Function
1	RS485_A	RS485 bus A end
2	RS485_GND	RS485 bus ground
3	RS485_B	RS485 bus B end

Pin Position	Terminal blocks
	
Connector information	Wiring terminal information
Model：BM03B-GHS-TBT	Brand：JST Housing model：GHR-03V-S Terminal model：SSHL-002T-P0.2 （or equivalent specifications）
Specifications：Singlerow.1.25mm spacing.3pins	Specifications：JST single-ended terminal, pitch 1.25mm, 3-Pin

Cable Specification

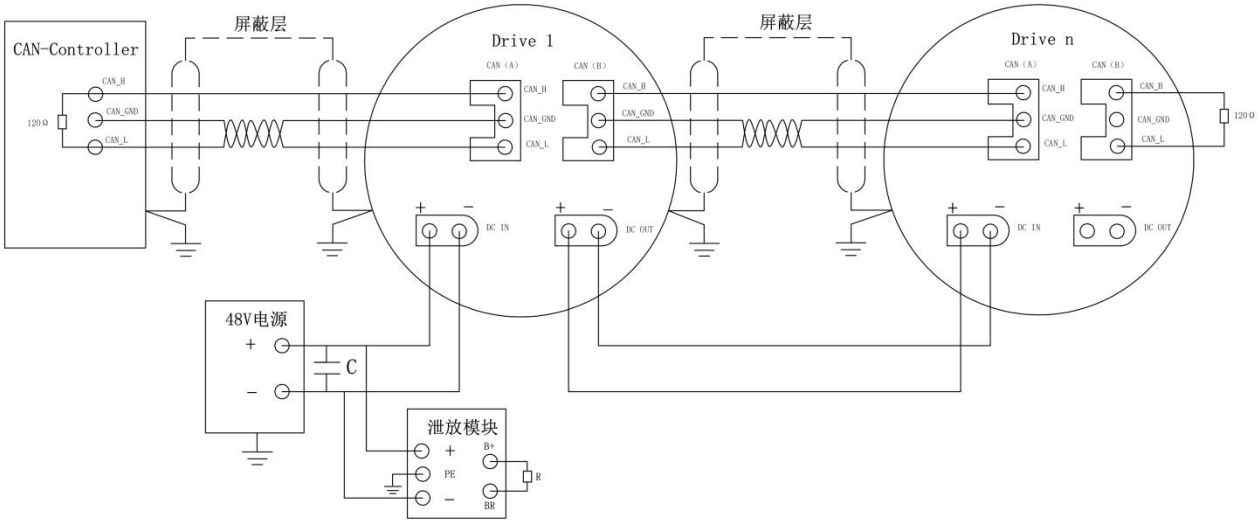
The specifications for the selection of various signal interface cables for the joint are detailed in the table.

Module Number	Signal interface	Number of lines	Applicablewire specifications		Wiringclearance（mm）
			Cross-sectiona Area（mm²）	AWG#	
Full Series	CAN communication interfaces: CAN(A)CAN(B)	3P*2	0.05~0.13	30~26	10
	EtherCAT communication interfaces:EI,EO	4P*2	0.05~0.13	30~26	10
	Multi-turn power supply battery interface:BAT	2P*1	0.05~0.13	30~26	10
L70	48V power supply interface:DC in	2P*2	0.5	20	15
L80		2P*2	0.75	19	15
L90		2P*2	1.0	18	15
L110		2P*2	1.25	17	15
L142		2P*2	1.5	16	15
L170		2P*2	1.5	16	15

Chapter 4 Multi-Joint Connection Configuration

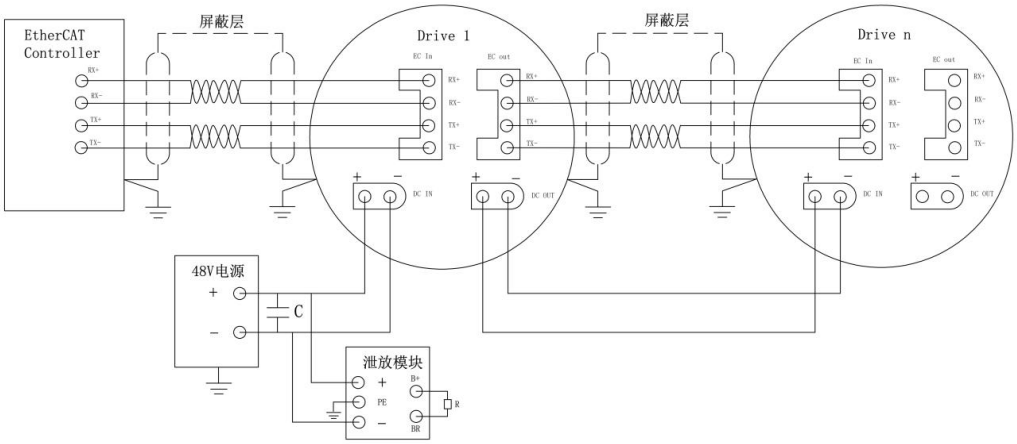
CANopen/CAN FD Communication Wiring Diagram

The CAN communication line uses individually shielded twisted-pair cable. The communication rate of the joint module can be set to 1 kbps. The maximum communication distance between the two farthest nodes on the CAN bus can reach 25 meters. A 120Ω terminal resistor shall be connected in parallel to each CAN interface of the controller and the end servo.



EtherCAT Communication Wiring Diagram

EtherCAT communication cables shall be selected as individually shielded twisted pairs. The wiring sequence of EC_In and EC_Out between joint modules must not be reversed; otherwise, it will cause inconsistency between the communication logic sequence of the EtherCAT master controller and the servo axes and the actual physical wiring sequence.


EtherCAT
Controller
屏蔽层
Drive 1
屏蔽层
Drive n
48V电源
C
泄放模块

Chapter 5 Brake

Brake Precautions

（1）The brake does not require an additional power supply. When the module is powered on and enabled, the system will automatically energize the brake according to the configured brake type: （P0-01 = 0: Electromagnetic brake, P0-01 = 1: Permanent magnet brake)

（2）Do not disable the module abruptly at high speed. Under no circumstances should the enable signal be suddenly turned off during high-speed operation. Sudden emergency braking may cause irreversible damage to the module body, gearbox, and brake.

（3）Avoid strong magnetic fields. The brake is an magnetoelectric device. Do not use the module in strong magnetic fields to prevent brake malfunction. Magnetic shielding can be applied to the module body if necessary.

（4）Brake holding torque limitations. The brake has a maximum holding torque. Even when the brake is engaged, forces exceeding the holding torque may still move the module. Do not apply the module in situations where the torque exceeds the rated torque or the brake 's holding torque, to avoid brake failure or module damage.

The holding torque of brakes for different module models is listed in the table below:

Module	Holding Torque
L70	0.6N ·m
L80	0.71N ·m
L90	1N ·m
L110	2.2N ·m
L142	4N ·m
L170	8.5N ·m

（5）Due to the physical limitations of the brake, ensure that the interval between two enable commands is at least 300 ms. After enabling the module, do not send motion commands immediately; delay 500 ms before issuing the first motion command.

（6）Avoid prolonged enable in unloaded conditions. Do not keep the module enabled or operate it for long periods in a suspended, no-load state. In such cases, the brake will remain energized without proper contact cooling, which may lead to module overheating. Overheating under these conditions is normal and does not indicate a quality issue.

Brake Lifetime

≥ 2,000,000 engage/disengage cycles

≥ 1 hour of break-in dragging

Forced Brake Release

To forcibly release the brake, set P5.14 = 4 via the upper-level controller through the RS -485 connection.

Caution: Ensure there is no risk of falling or uncontrolled motion.

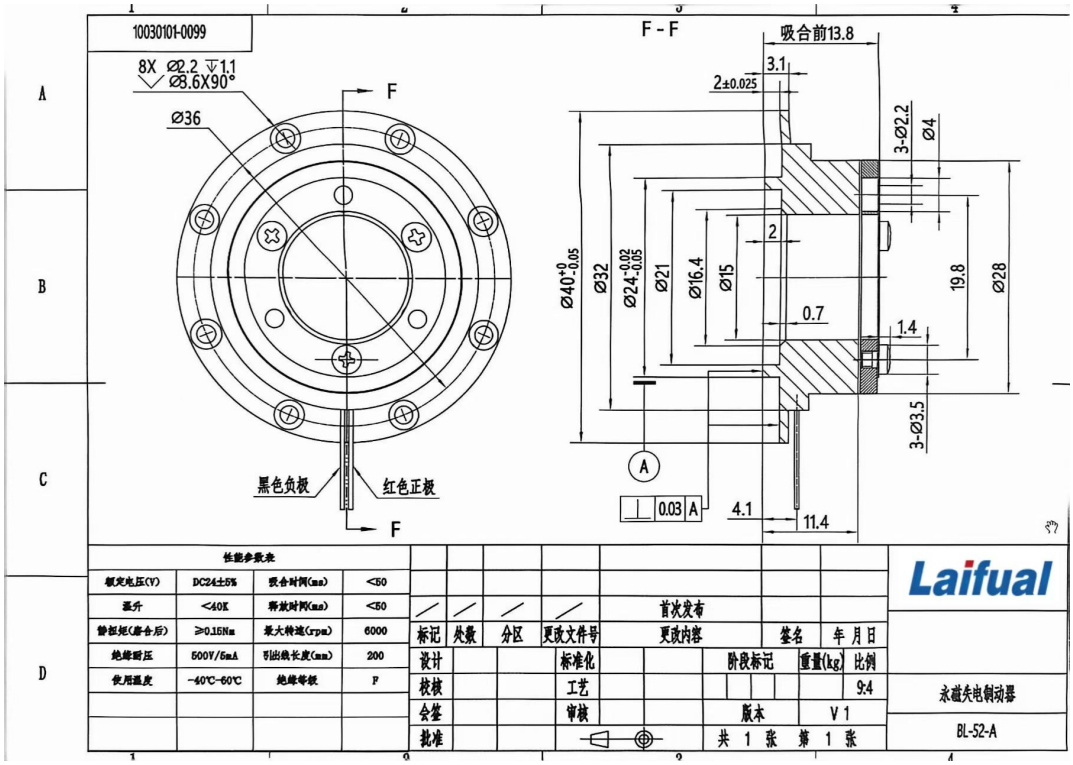
After testing, promptly restore P5.14 to its normal value to prevent accidental situations.

Brake Power

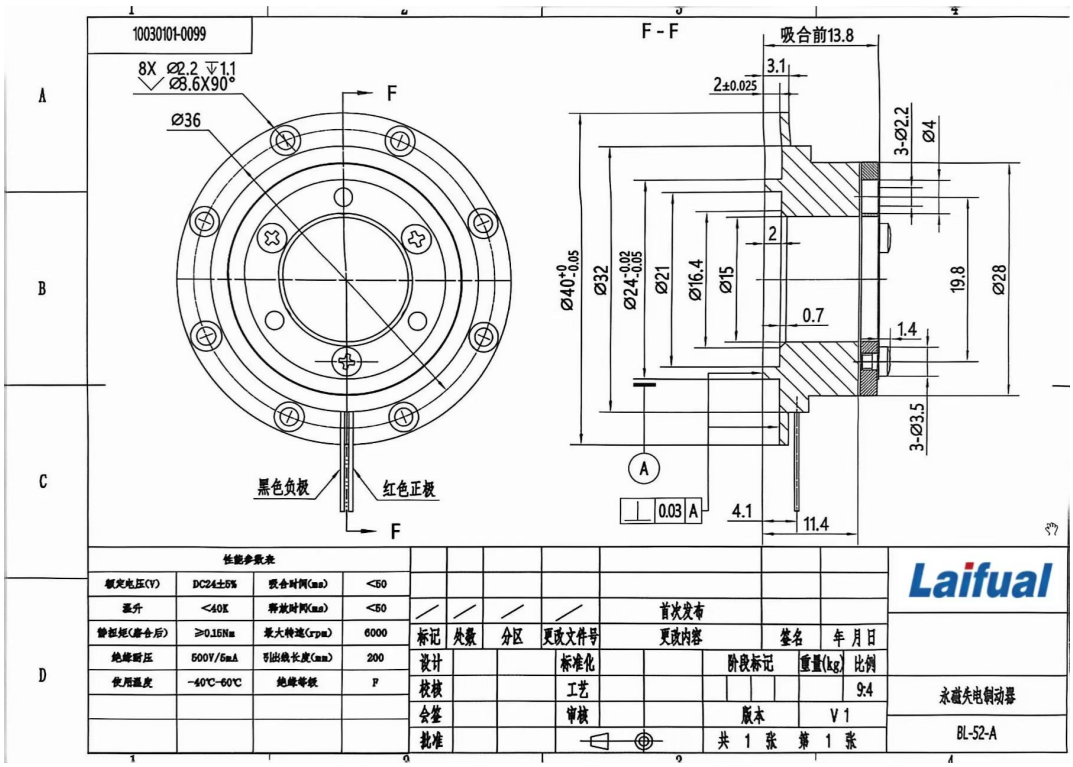
Module	Power	Current
L70	Startup / Holding Power 13.5W/3.4W	0.56A/0.28A
L80	3.4W	0.14A
L90	4.5W	0.19A
L110	9.1W	0.38A
L142	7.6W	0.32A
L170	9.35W	0.39A

Brake Drawing

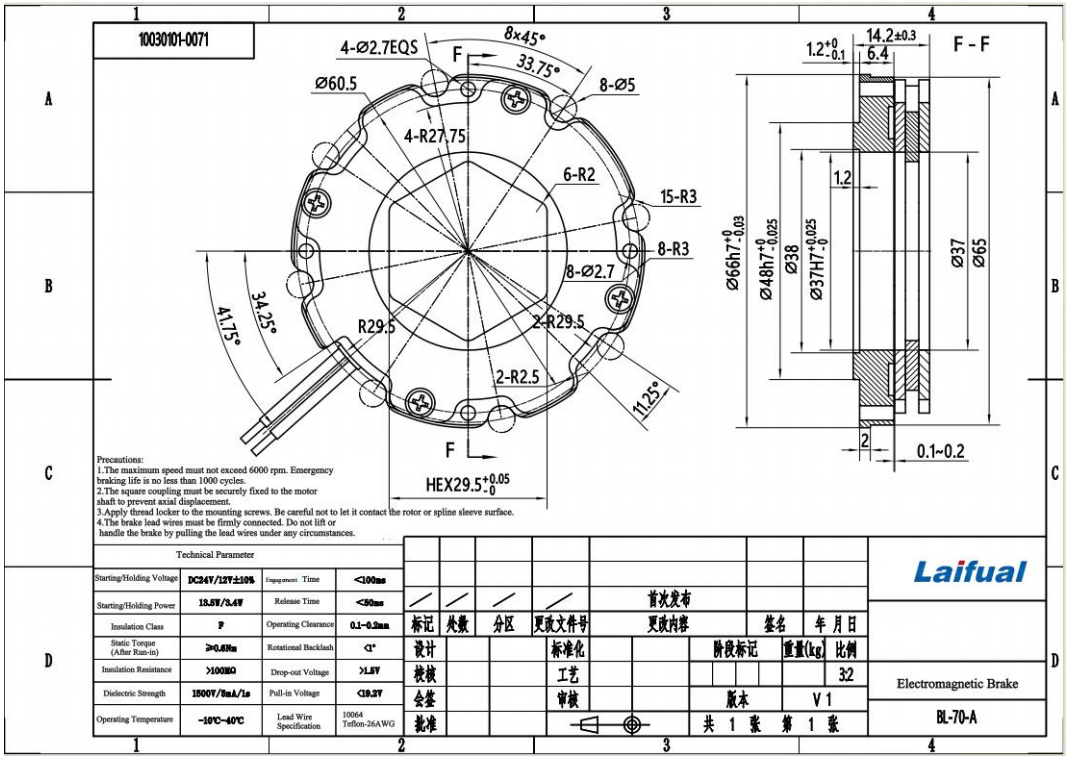
BL-52-A



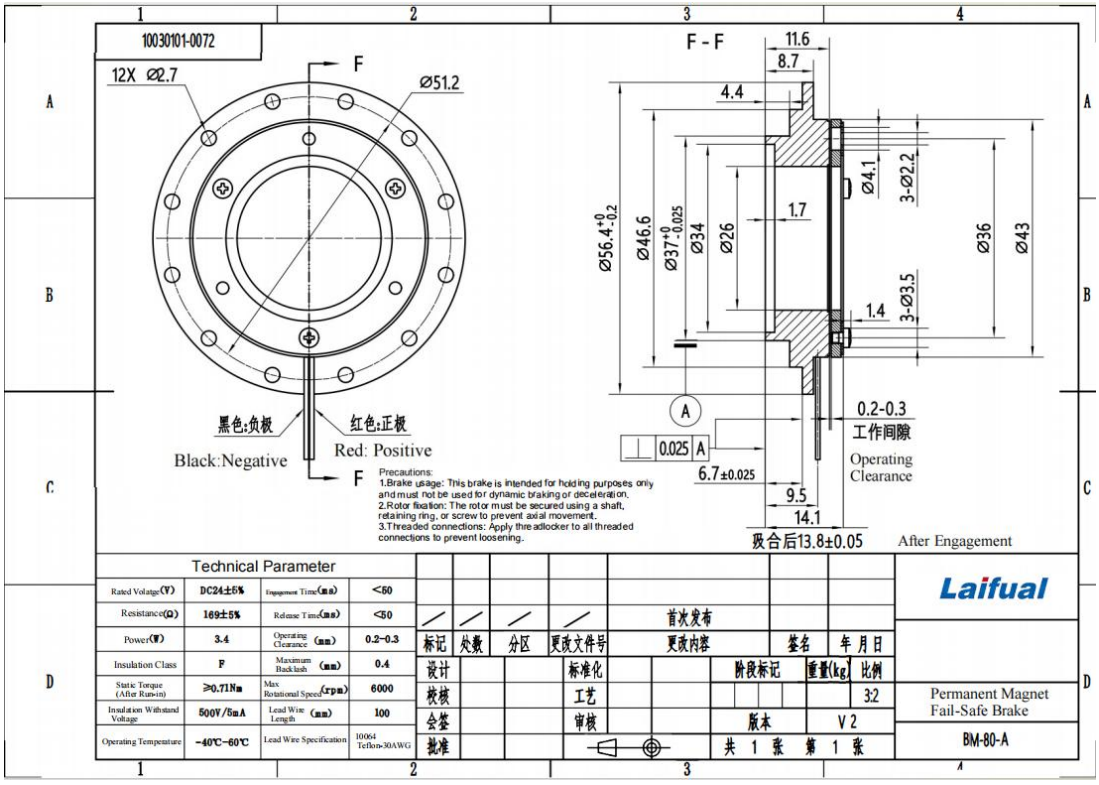
BL-62-A



BL-70-A


10030101-0071
4-Ø2.7EQS
8×45°
33.75°
Ø60.5
8-Ø5
4-R27.75
6-R2
15-R3
8-R3
8-Ø2.7
2-R29.5
R29.5
2-R2.5
34.25°
41.75°
11.25°
HEX29.5+0.05 0
F - F
1.2+0 0.1
14.2±0.3
6.4
1.2
Ø66h7+0 -0.03
Ø48h7+0 -0.025
Ø38
Ø37H7+0.025 0
Ø37
Ø65
2
0.1~0.2
Precautions:
1.The maximum speed must not exceed 6000 rpm. Emergency braking life is no less than 1000 cycles.
2.The square coupling must be securely fixed to the motor shaft to prevent axial displacement.
3.Apply thread locker to the mounting screws. Be careful not to let it contact the rotor or spline sleeve surface.
4.The brake lead wires must be firmly connected. Do not lift or handle the brake by pulling the lead wires under any circumstances.
Technical Parameter
Starting/Holding Voltage DC24V/12V±10%
Engagement Time <100ms
Starting/Holding Power 18.5W/3.4W
Release Time <50ms
Insulation Class F
Operating Clearance 0.1~0.2mm
Static Torque (After Run-in) ≥0.6Nm
Rotational Backlash <1°
Insulation Resistance >100MΩ
Drop-out Voltage >1.5V
Dielectric Strength 1500V/5mA/1s
Pull-in Voltage <10.2V
Operating Temperature -10℃~40℃
Lead Wire Specification 10064 Teflon-26AWG
标记 处数 分区 更改文件号 更改内容 签名 年 月 日
首次发布
设计 标准化 阶段标记 重量(kg) 比例
校核 工艺 3:2
会签 审核 版本 V 1
批准 共 1 张 第 1 张
Laifual
Electromagnetic Brake
BL-70-A

BM-80-A


10030101-0072
12X Ø2.7
Ø51.2
黑色:负极
Black:Negative
红色:正极
Red: Positive
F - F
11.6
8.7
4.4
Ø4.1
3-Ø2.2
1.7
Ø56.4+0 -0.2
Ø46.6
Ø37+0 -0.025
Ø34
Ø26
Ø36
Ø43
1.4
3-Ø3.5
0.025 A
6.7±0.025
0.2-0.3
工作间隙
Operating Clearance
9.5
14.1
吸合后13.8±0.05
After Engagement
Precautions:
1.Brake usage: This brake is intended for holding purposes only and must not be used for dynamic braking of deceleration.
2.Rotor fixation: The rotor must be secured using a shaft, retaining ring, or screw to prevent axial movement.
3.Threaded connections: Apply thread adlocker to all threaded connections to prevent loosening.
Technical Parameter
Rated Voltage(V) DC24±5%
Engagement Time(ms) <50
Resistance(Ω) 169±5%
Release Time(ms) <50
Power(W) 3.4
Operating Clearance (mm) 0.2~0.3
Insulation Class F
Maximum Backlash (mm) 0.4
Static Torque (After Run-in) ≥0.71Nm
Max Rotational Speed (rpm) 6000
Insulation Withstand Voltage 500V/5mA
Lead Wire Length (mm) 100
Operating Temperature -40℃~60℃
Lead Wire Specification 10064 Teflon-30AWG
标记 处数 分区 更改文件号 更改内容 签名 年 月 日
首次发布
设计 标准化 阶段标记 重量(kg) 比例
校核 工艺 3:2
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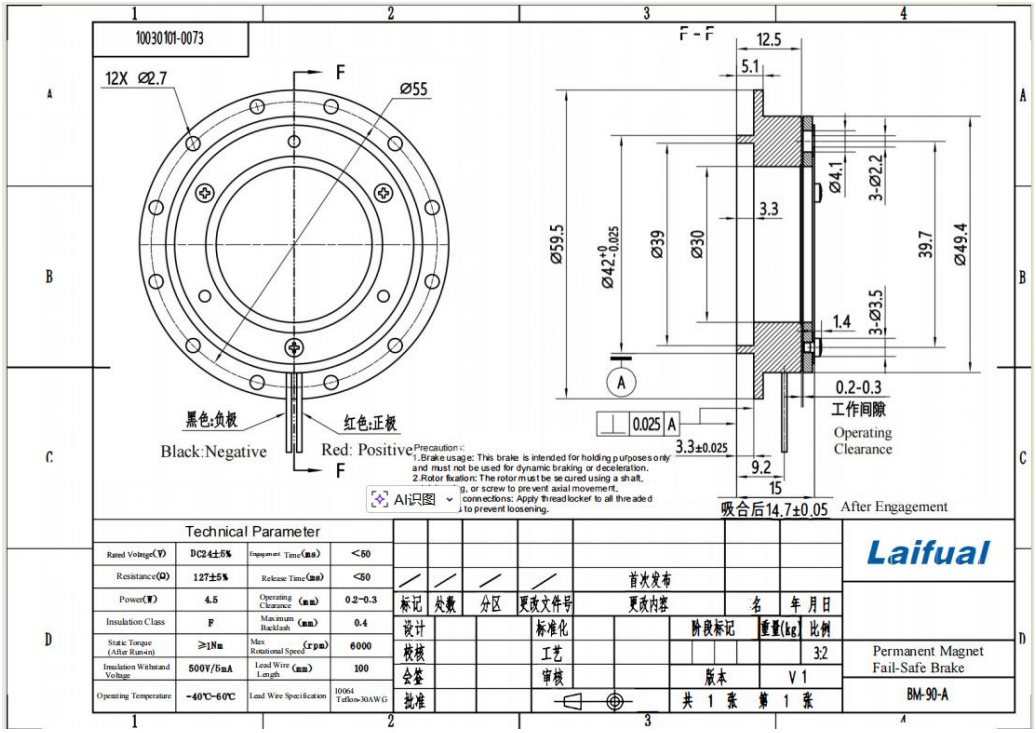
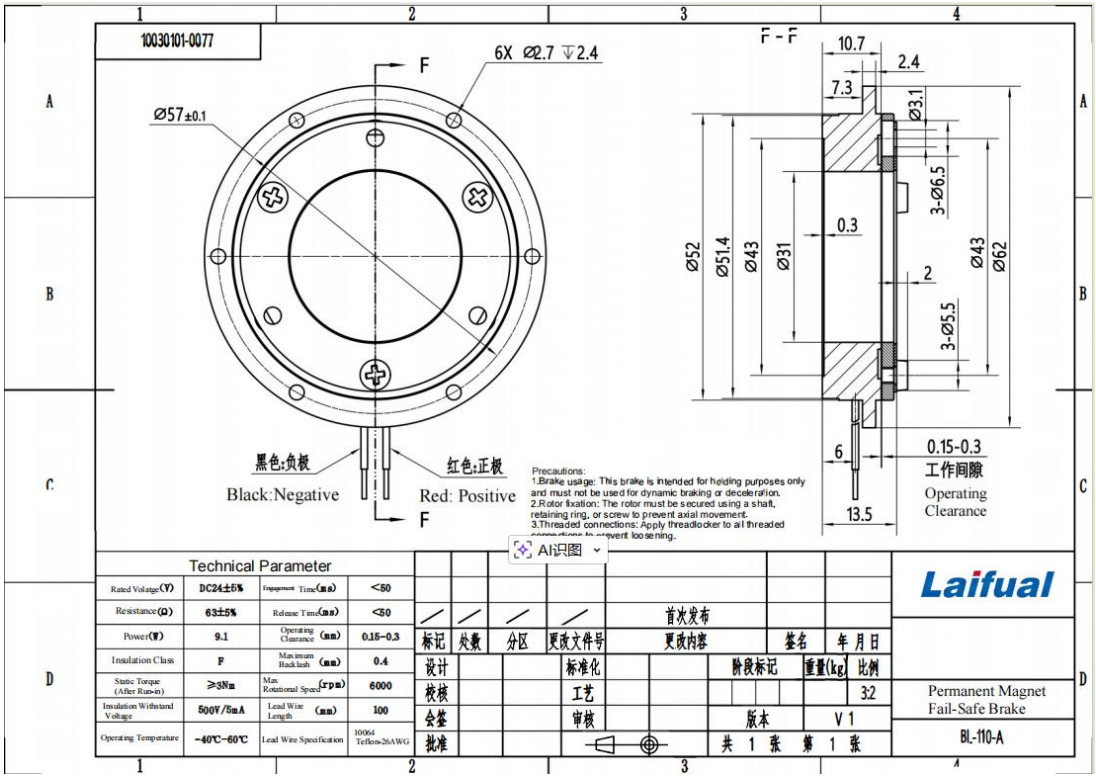
批准 共 1 张 第 1 张
Laifual
Permanent Magnet Fail-Safe Brake
BM-80-A

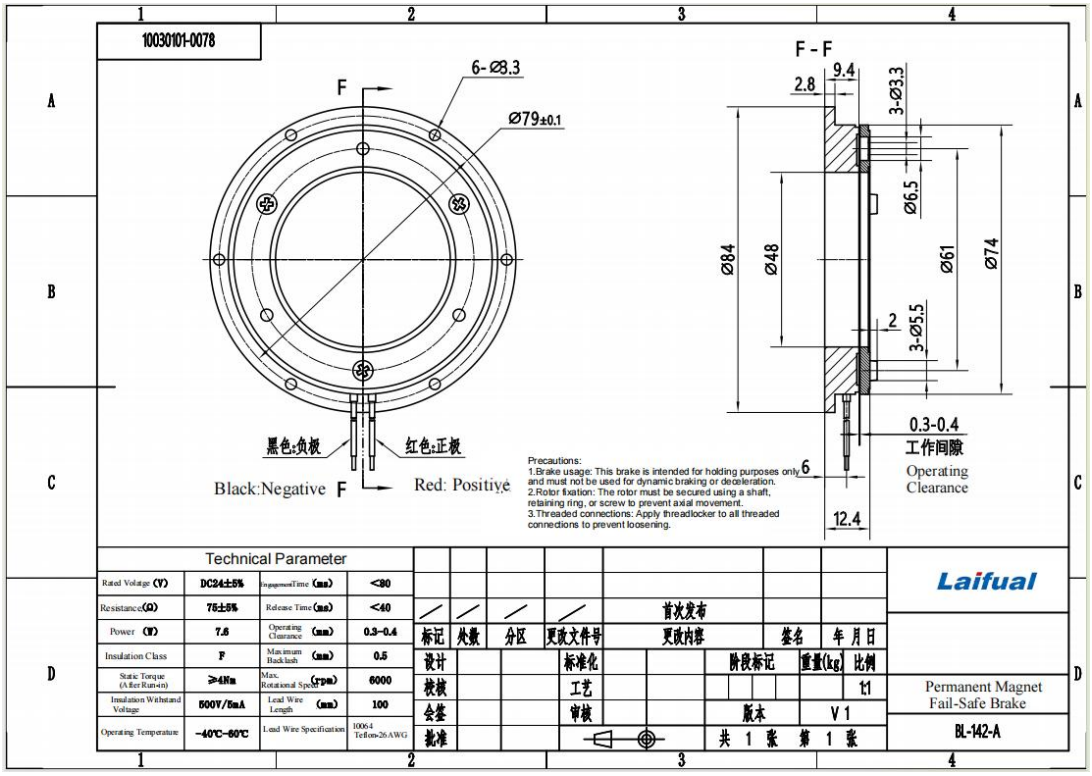
BM-90-A



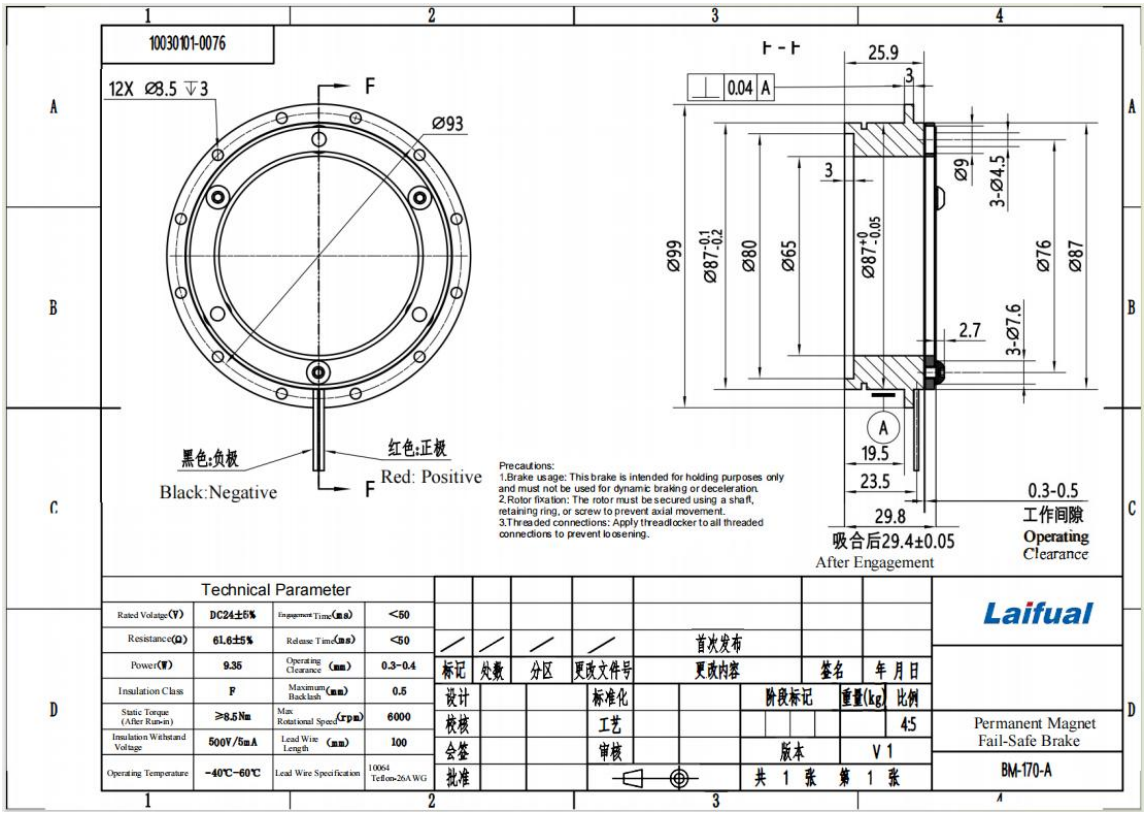
BL-110-A



BL-142-A



BM-170-A



Chapter 6 Encoder Specifications

The built-in encoder in the low-voltage series is a multi-turn absolute encoder capable of recording absolute positions and absolute rotation counts. It consists of a single-turn detector (17-bit) for detecting the motor shaft's rotational position and a multi-turn detector (16-bit) for detecting the number of rotations.

This encoder continuously detects the mechanical absolute position, regardless of the power ON/OFF status of the driver and external controller, and utilizes battery backup for data preservation. As long as the origin positioning is performed during mechanical installation, there is no need for origin resetting upon each power-up. It is also easy to restore after power outages or malfunctions.

The encoder communicates directly with the internal drive board, eliminating the need for any additional configuration operations.

Specifications

Type	Magnetic sensor / electronic battery backup system
Single-turn Detector	2^{17}:131072puleses
Multi-turn Detector	2^{16}:65536(-32768～32767)
Maximum Permissible Encoder Speed	7000 r/min*1
Safety and Redundancy	Matching detection method based on dual single-turn detectors Matching detection method based on dual cumulative rotation counters
External Battery Backup Duration	5 years (when not powered) *2

*1 :The maximum speed at which the encoder can rotate, which is distinct from the speed at which the motor can drive.

*2 :This value applies when the motor shaft is not moving. If the shaft rotates frequently while the system is unpowered, the external battery will deplete more quickly

Output Shaft Resolution

Encoder Resolution		17bit(217:131072Pulses)					
Reduction Ratio		1:31	1:51	1:81	1:101	1:121	1:161
Output Shaft Resolution	Pulses per Revolution	4063232	6684672	10616832	13238272	15859712	21102592
Single Pulse Angle	seconds	approx 0.3	approx 0.2	approx 0.12	approx 0.1	approx 0.082	approx 0.061

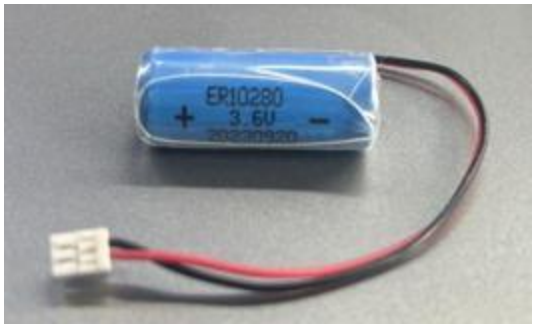
Absolute Position Data Conversion

"Absolute Position" refers to the absolute position of the motor shaft in one rotation, while "Multiple Rotations" refers to the number of rotations of the motor. The position of the output shaft of the transmission device can be calculated using the formula below.

Transmission Device Output Shaft Position= (Absolute Position + Multi-turn Rotation × Encoder Resolution) ÷ Reducer Ratio

Multi-turn Encoder Backup Battery

For joints equipped with a multi-turn version, a 3.6 V battery provides power to the multi-turn encoder when the module loses main power. This allows the encoder to retain its multi-turn position, preventing robots or other devices from losing the zero reference.



3.6V battery

Precautions for Using Our Multi-turn Backup Battery：

（1）Do not alter the original wiring sequence；

（2）Do not use wires or other conductive materials to directly short the positive and negative terminals of the battery.

（3）Ensure correct insertion：Insert the battery in the correct orientation. After insertion, fix the battery body to prevent the Connection Terminal from being pulled or shaken..

（4）Battery replacement procedure：When removing the Connection Terminal, do not pull it out directly. First, release the latch at the front of the terminal, then gently remove it.

Chapter 7 Environment and Installation

Operating Environment

The operating conditions for the low-voltage series modules are as follows:

- Operating Temperature ：-10～55 ℃ (for normal-temperature grease) and -30～55 ℃ (for low-temperature grease)

  The temperature inside the cabinet may be higher than the ambient temperature, depending on the power loss of the external equipment and the size of the cabinet. Plan the cabinet size, heat dissipation system and equipment layout to ensure that the ambient temperature is maintained at 55 ℃ or below.

- Operating Humidity：20%-80%

  Ensure no condensation. Note that condensation may occur with significant day-to-night temperature changes or frequent starting and stopping of actuators.

- Vibration ：24.5 m/s² （2.5G）（10-400Hz）

  The module cannot operate in applications subjected to continuous shock.

- Operating Environment：No dust, condensation, metal powder, corrosive gases, water, oil mist, etc.
- Protection Rating：IP54
- Altitude: Below 1000 meters
- Leakage Measures：

Oil seals in rotating and sliding areas cannot completely prevent lubricant leakage. If the actuator is used in clean rooms or similar environments, additional oil leakage prevention measures should be provided.

- Installation Location:

Should be installed indoors or in protected outdoor areas, avoiding direct exposure to sunlight.

Installation Steps

When installing the module, do not hit the module with a hammer. The module's reducer is a precision mechanism , and the module is equipped with an encoder. Excessive impact may damage the reduction mechanism and the encoder.

1.Align the Module Output and Load Shaft Precisely.

Note: Perform this alignment carefully, especially when using rigid couplings. Even slight misalignment can cause the actuator to exceed the allowable load, leading to damage to the output shaft.

2.Use flat washers and high-strength bolts to secure the module flange to the load end,Tighten them with a torque wrench to control the tightening torque.

The tightening torque is shown in the table below：

Module / Item	L-70-I		L-80-I		L-90-I		L-110-I		L-142-I		L-170-I	
	Output shaft	Flange	Output shaft	Flange	Output shaft	Flange	Output shaft	Flange	Output shaft	Flange	Output shaft	Flange
Bolt Specifications	M3	M3	M3	M3	M3	M4	M4	M4	M5	M5	M6	M6
Hole Depth	15（Threaded Portion Depth: 6）	7.5	16.5（Threaded Portion Depth: 6）	7.5	17.5（Threaded Portion Depth: 6）	10	22（Threaded Portion Depth: 8）	10	27.5（Threaded Portion Depth: 8）	10	34（Threaded Portion Depth: 10）	50（Through-Hole）
Clamping Force	2.4N·m	2.4N·m	2.4N·m	2.4N·m	2.4N·m	5.4N·m	5.4N·m	5.4N·m	10.8N·m	10.8N·m	18.4N·m	18.4N·m

3. Proper Connection of Motor Power and Encoder Cables

Do not pull the cables forcefully, as this may damage the terminals at the connection points.

Keep the cables slack to avoid applying tension to the module.When bending the cables, maintain a sufficient bending radius (R=40mm or more) to prevent excessive bending that could cause cable breakage.

Discharge Module Description

1. Product Description

(1)The power discharge module is a dedicated component for handling the regenerative braking kinetic energy of robot joint modules operating under high-speed and heavy-load conditions, thereby preventing the bus voltage overvoltage alarm and shutdown caused by the surge in power supply voltage due to regenerative energy feedback.

(2) When the joint module is powered by a 48V switching power supply, the operating circuit with the added power discharge module can be simplified and equivalent to the diagrams shown in Figure 1-1 and Figure 1-2.

(3) The discharge resistor functions to dissipate excess energy through resistance when the circuit loop is in the kinetic energy recovery process, thus avoiding the power supply voltage surge induced by regenerative energy feedback. However, the discharge resistor cannot be connected to the circuit for an extended period; otherwise, it will continuously generate excessive heat, leading to component damage, circuit malfunctions and unnecessary power consumption. Therefore, it is recommended to design a

reliable control logic for the discharge resistor connection. When the joint module is powered by a 48V switching power supply, the control logic for the discharge resistor connection of the power discharge module is as follows: the resistor is disconnected when VDC ⩽ 52V (see Figure 1-1), and the power supply only outputs electric energy to the motor at this time; the resistor is connected when VDC ⩾ 55V (see Figure 1-2), and the excess electric energy is dissipated through the resistor at this time.

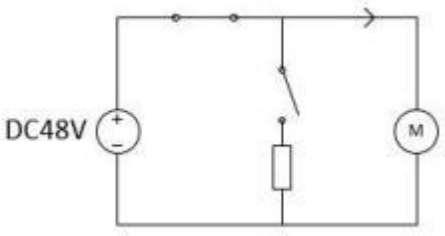


Figure 1-1 Resistor off (V_{DC} ⩽52V)

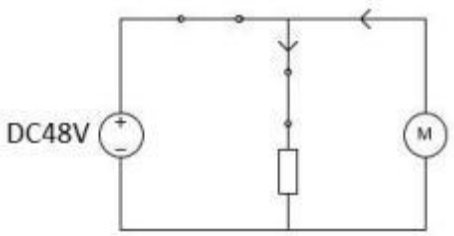


Figure 1-2 Resistor on (V_{DC} ⩾55V)

2. Technical Information

2.1 Electrical Characteristics

Table 2-1 Electrical Characteristics

Electrical Characteristics	
Input Voltage (VDC)	24-65
External Braking Resistor	See Table 3-2 and Table 3-3
Capacitance (μF)	1000

2.2 Adjustment of Regenerative Braking Resistor for Start/Shutdown

The discharge module is equipped with two DIP switches, and the discharge voltage value can be adjusted via the DIP switches as detailed in the following table:

Table 2-2 Technical Data

Supply Voltage (DC)	SW1	SW2	Start Regeneration (V)	Stop Regeneration (V)	Description
≤ 50 V	OFF	OFF	55	51	Activates the regenerative braking resistor when VDC ≥ 55 V; Deactivates the regenerative braking resistor when VDC ≤ 52 V.
> 50 V ≤ 58 V	OFF	ON	64	60	Activates the regenerative braking resistor when VDC ≥ 64 V;

					Deactivates the regenerative braking resistor when VDC ≤ 60 V.
> 50 V ≤ 58 V	ON	OFF	64	60	Activates the regenerative braking resistor when VDC ≥ 64 V; Deactivates the regenerative braking resistor when VDC ≤ 60 V.
> 58 V ≤ 65 V	ON	ON	73	68	Activates the regenerative braking resistor when VDC ≥ 73 V; Deactivates the regenerative braking resistor when VDC ≤ 68 V.

Notes

1.Do not allow the module supply voltage to exceed the regenerative braking resistor activation voltage. Exceeding this voltage will cause the discharge module and braking resistor to operate continuously, resulting in overheating.

2.The voltage error for the regenerative braking resistor activation/deactivation voltage is less than 1.5%.

2.3 LED Indicator Description

This module is equipped with 2 LED indicators, whose functions are described as follows:

Table 2-2 LED Indicator Description

Color	Function	Description	Troubleshooting Notes
Yellow	Power Indicator	Solid on when power is normal; Off or flashing when power is abnormal.	If the light remains off or flashes after power-on, check whether the input voltage of the module is normal and if the power screw terminals are tightened securely.
Green	Brake Resistor Indicator	1.Solid on when powered on normally; 2.Off or flashing when regenerative braking resistor is activated.	1.Discharge powered, module not running: If the LED indicator is off or flashing: ①Check if the brake resistor screw terminals are securely tightened or if the brake resistor is open-circuited. ② Check if the supply voltage exceeds the discharge voltage. 2.Discharge powered, module running: If the LED indicator is solid on: ① The supply voltage rises due to the module's kinetic energy feedback but is lower than the regenerative braking resistor activation voltage. This is normal if the activation/deactivation voltage settings are appropriate.

			② The supply voltage rises due to the module's kinetic energy feedback and exceeds the regenerative braking resistor activation voltage, indicating module damage.

Notes

1.Do not allow the module supply voltage to exceed the regenerative braking resistor activation voltage. Exceeding this voltage will cause the discharge module and braking resistor to operate continuously, resulting in overheating.

2.The voltage error for the regenerative braking resistor activation/deactivation voltage is less than 1.5%.

2.4 Environmental Conditions

Table 2-4 Environmental Conditions

Feature	Specification
Operating Temperature	-20 ~ 60°C
Storage Temperature	-30 ~ 60°C
Protection Class	IP30
Operating & Storage Humidity	20% ~ 80% RH (non-condensing)

Note

Please ensure the operating environment is free of dust, metal powder, corrosive gases, flammable gases, oil mist, and other contaminants.

3. Wiring

3.1 Electrical Interface Definition

The electrical interface of the power discharge module is shown in Figure 3-1, and the interface definitions are detailed in Table 3-1.

Table 3-1 Electrical Interface Definition

Category	Pin No.	Pin Label	Pin Function	Part No.	Terminal Specifications
Power Input	1	PE	Connect to module housing (ground)	DB910-6.35-3P-GN-P	Screw terminal Wire gauge: 10–14 AWG Tool: M3 Phillips screwdriver
	2	48-	Connect to 48 VDC power negative		
	3	48+	Connect to 48 VDC power positive		

Brake Resistor	1	BR+	Connect to brake resistor	DB910-6.35-2P-GN-P	
	2	BR-			

3.2 Wiring and Operation Instructions

The wiring diagram of the 48V DC power supply with the power discharge module and joint module is shown in Figure 3-2. The DC+ and DC- terminals of the discharge module must be directly connected to the DC+ and DC- terminals of the module respectively.The recommended specifications for the DC48V power supply and braking resistor R corresponding to each joint model are listed in Table 3-2.The recommended accessory specifications for the power discharge module matched with each robotic arm model are listed in Table 3-3.

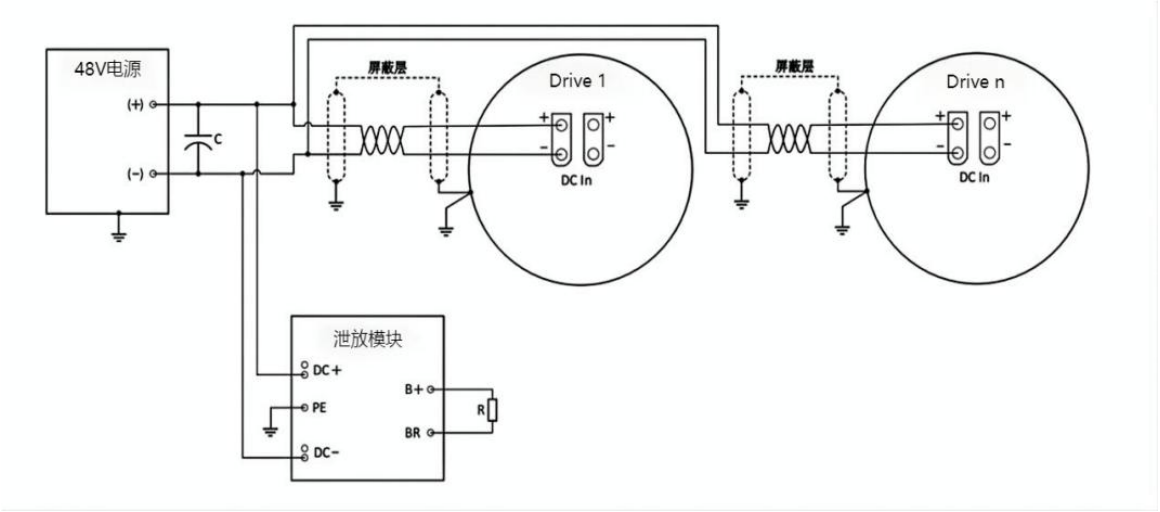


Figure 3-2 Wiring Diagram of Power Discharge Module

Table 3-2 Recommended Accessory Specifications for Each Joint Model

Joint Model	DC Power Supply Specification	Braking Resistor Specification	Electrolytic Capacitor Specification
08	100W 、48VDC	50W、10Ω	12000 μ F、80V
11	150W 、48VDC	50W、10Ω	12000 μ F、80V
70	200W 、48VDC	50W、10Ω	12000 μ F、80V
80	600W 、48VDC	200W、5Ω	36000 μ F、80V
90	800W 、48VDC	200W、5Ω	96000 μ F、80V
110	1200W 、48VDC	200W、5Ω	96000 μ F、80V
142	1500W 、48VDC	300W、3Ω	96000 μ F、80V
170	3000W 、48VDC	300W、3Ω	96000 μ F、80V

Table 3-3 Recommended Accessory Specifications for Each Robotic Arm Model

Robotic Arm Model	DC Power Supply Specification	Braking Resistor Specification
7kg Robotic Arm	2000W / 48VDC	200W / 5Ω
12kg Robotic Arm	2500W / 48VDC	300W / 3Ω
20kg Robotic Arm	5000W / 48VDC	300W / 3Ω

4. Mounting Method

The power discharge module generates heat during operation, and the resistor may even become hot to the touch. Do not touch it directly.The power discharge module and discharge resistor shall be mounted in an environment with good ventilation and heat dissipation conditions, such as on a large-area metal plate or in an electrical cabinet equipped with a cooling fan.

Chapter 8 Debugging and Operation

Introduction

This manual describes the usage, precautions, and related information for the AthDrive firm ware developed, designed, and implemented by Laifual Drive. Please read it carefully before operating the software.

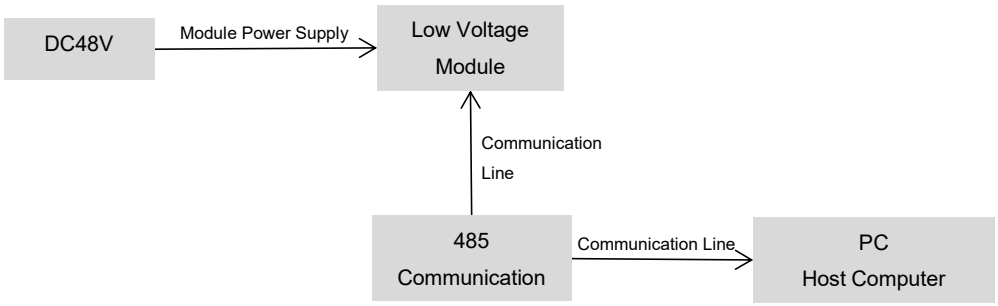
AthDrive is a dedicated host PC application specifically developed for the Laifual low-voltage series modules. The software provides a range of features — including parameter configuration, phase-finding (commutation alignment), jog testing, and more — presented in a clean, well-organized interface. It is easy to use and enables users to quickly commission, debug, and operate the low-voltage modules.

Installation

Please download our host PC software from the official website www.laifualdrive.com under “Service & Support ”→ “Download Center. ”For the USB-to-RS485 serial driver, please download version 323 from the following link::https://www.zily-tech.com/driver/

Hardware Connection Block Diagram

Solution Overview:
The module is powered by a 48 V power supply, and RS-485 communication is used to connect the module with the PC firm ware. Module parameter values can be modified through the firm ware .
The hardware wiring diagram is shown below：



Steps to Connect to the firm ware

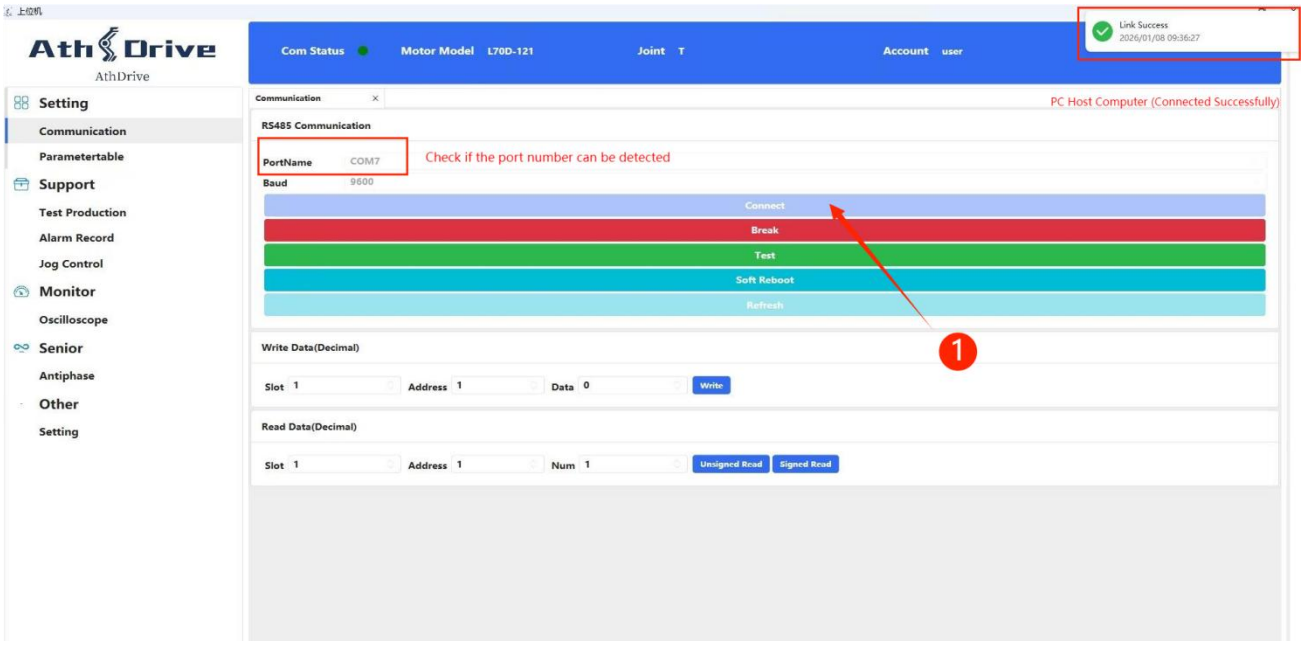
1.Connect the RS-485 communication cable.

For the communication cable provided by our company: Red wire A → T+/A, Yellow wire B → T-/B, Black wire G → GND

The RS-485 adapter is shown in the figure below：

2.Open the firm ware . If the port cannot be detected, first check the connection of the communication cables. If the cables are in good condition, please download and install the USB-to-RS485 serial driver. The specific download link is provided in the “ Installation ” section.

As shown in the figure below, follow the steps to connect to the firm ware .

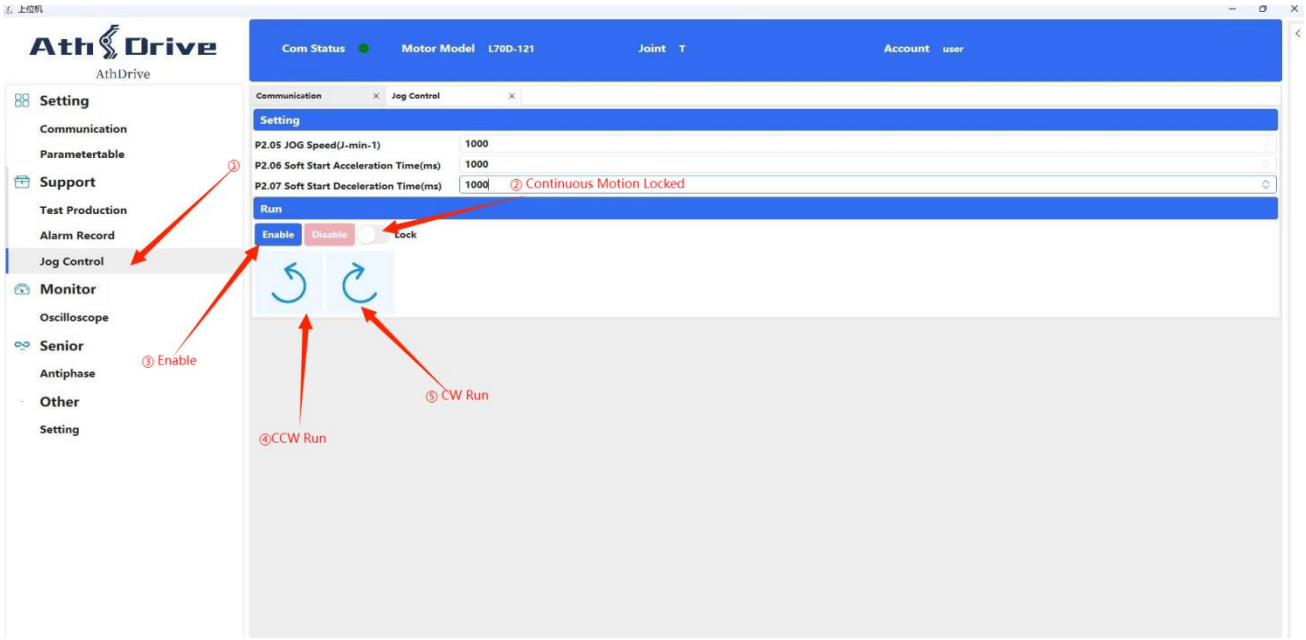


Chapter 9 JOG Test Run

JOG control

Open “JOG Control ” and click “Start ” to enable the servo. Confirm that the brake has been released (a clicking sound “click ” indicates the brake is open).

Click the rotation arrow on the right (press and hold the left mouse button for 8 seconds before releasing) to perform a rotation test.



The program JOG

In the “AthDrive PC software” - “Parameter Table”, modify the following parameters in order to enable the JOG program.

For example: if the module is required to run at a speed of 2000 rpm with an acceleration of 100 ms², and the motor needs to rotate 100 turns forward and 100 turns in reverse repeatedly, the parameters can be set as follows.

1. **P7.00** Bus Mode 0 (No Bus)
2. **P0.05** Control Module 12
3. **P6.00** JPOS0 Position Control Pulse (High) 1310

(Set the value of the first position, where the value multiplied by 10000 and added to the low-value will give the target position pulse.)

P6.01 JPOS0 Position Control Pulse (Low) 7200

P6.02 JPOS1 Position Control Pulse (High) -1310

(Set the value of the second position, where the value multiplied by 10000 and added to the low-value will give the target position pulse.)

P6.03 JPOS1 Position Control Pulse (Low) -7200

P6.20 JPOS0 Position Speed Control 2000 (Speed control for the first position, in rpm)

P6.21 JPOS1 Position Speed Control 2000 (Speed control for the second position, in rpm)

P6.30 JPOS0 Position Filter Time 1000 (Filter time for the first position, in 0. 1ms)

P6.31 JPOS1 Position Filter Time 1000 (Filter time for the second position, in 0.1ms)

P6.40 JPOS0 Position Stop Time 20 (Stop time from the current position to the next position, in 50ms)

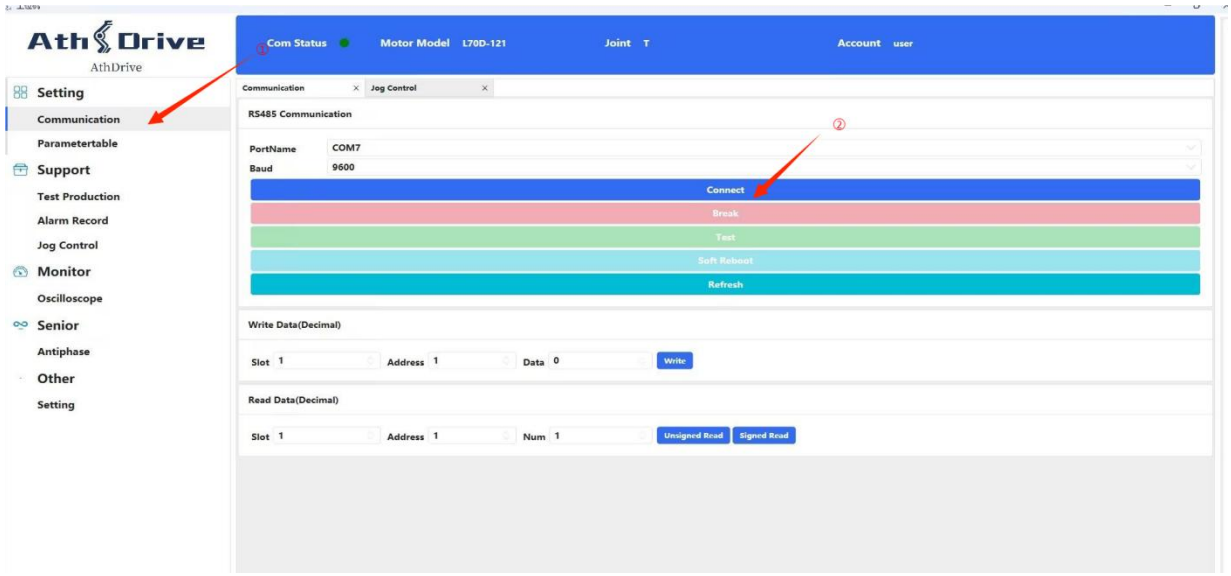
P6.41 JPOS1 Position Stop Time 20 (Stop time from the current position to the next position, in 50ms)

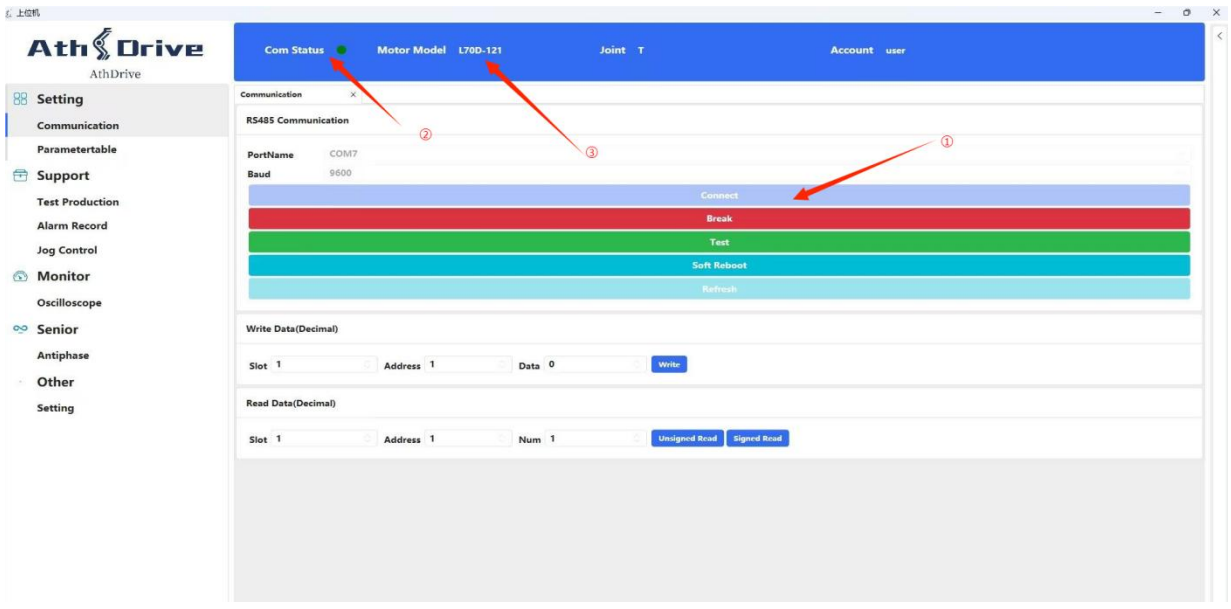
4. **P4.18** Servo ON Wait Time 0

5. **P5.01** Set to 1 to start the operation

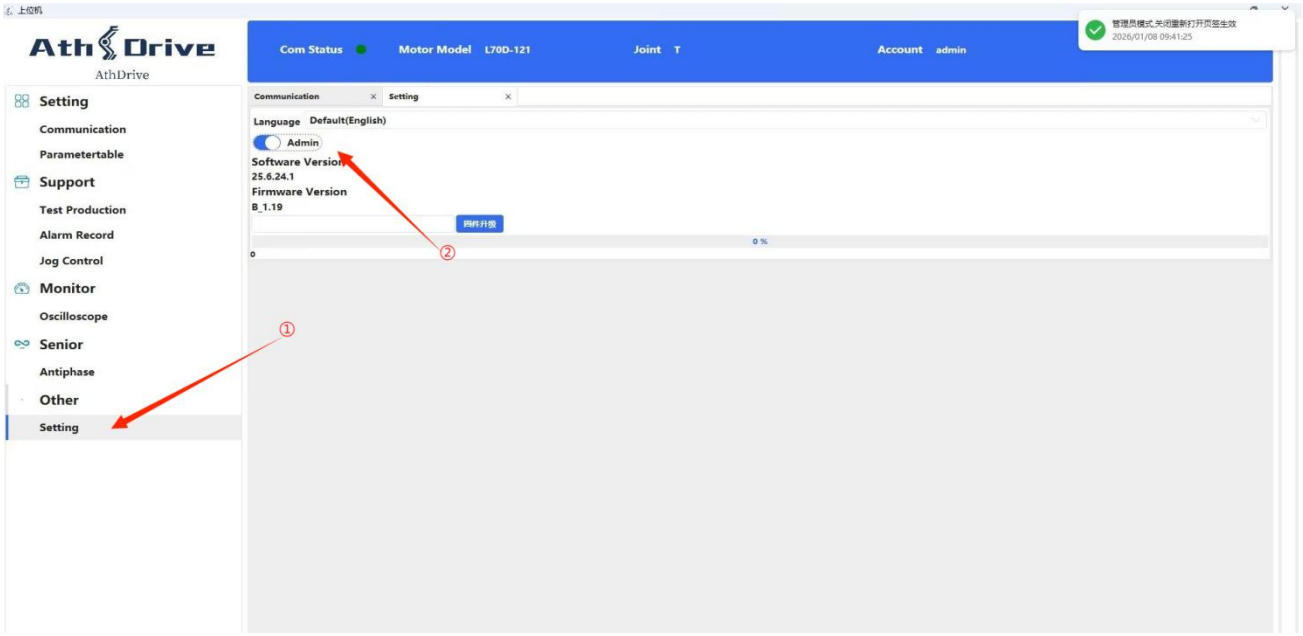
Chapter 10 Key Parameter Verification and Rigidity Adjustment

1.Open the firm ware and select “Settings → Communication. ”
Click the “Connect ” button. Once the connection is successful, the “Connection Status ” will change from red to green, and the corresponding module model will be displayed.
(If “Failed to Open Port ” appears, please unplug and reinsert the USB interface, then try connecting again.)



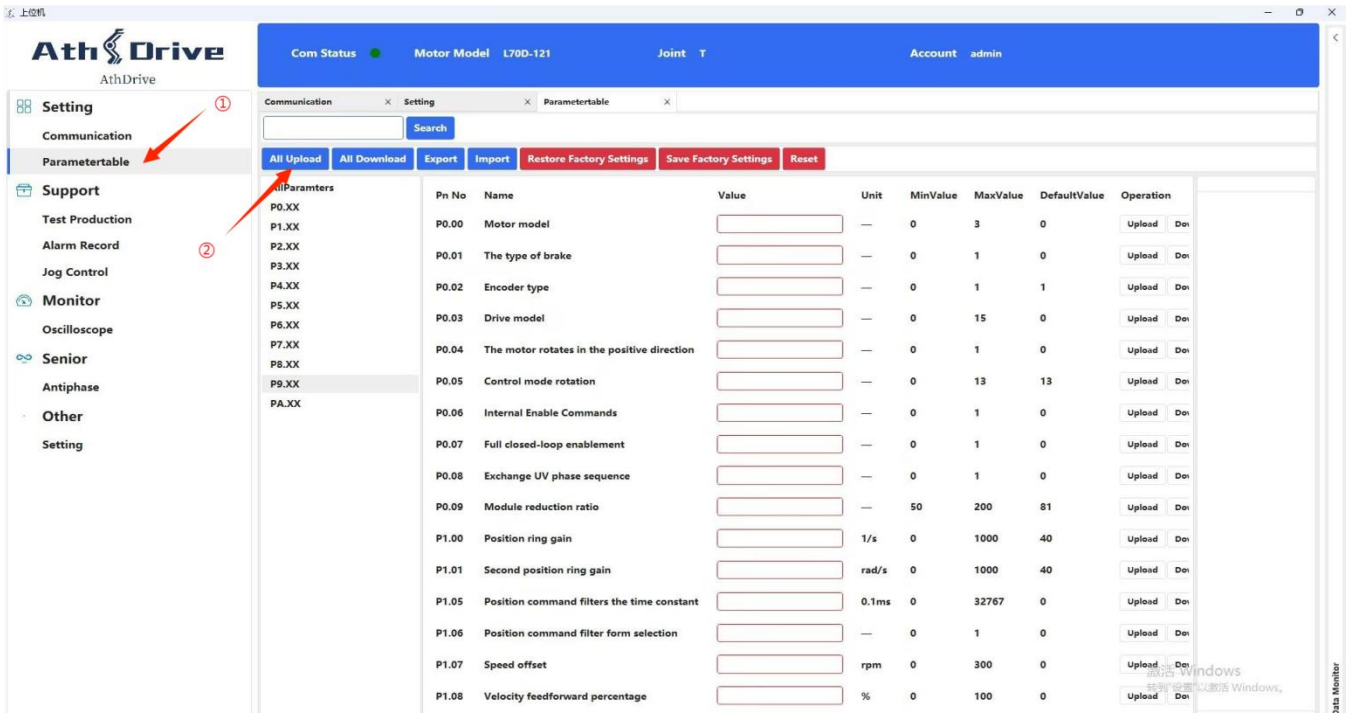


2.Click “Others → Settings ” and select the “Administrator ” button. The top-right corner will indicate that you have entered Administrator Mode.



Parameter confirmation

1.Open “Parameter Table ” and click the “Upload All ” button to upload the motor parameters.



2. Parameter

Joint Module	Key Parameter					
L-70-I-XX	Ratio		50	80	100	120
	P0.00	Motor Model	1	0	2	
	P0.01	Motor Type	0	0	0	
	P0.03	Drive Model	0	0	0	
	P0.07	Full closed-loop enable	0	0	0	
	P0.08	UV phase sequence	1	1	1	
	P0.09	Module ratio	51	81	101	
	PA.03	Pole pairs	8	8	8	
	PA.04	Rated current	323	316	253	
	PA.05	Maximum current	82.5	67.7	65.2	
L-80-I-XX	Ratio		50	80	100	120
	P0.00	Motor Model	1	0	2	3
	P0.01	Motor Type	1	1	1	1
	P0.03	Drive Model	1	1	1	1
	P0.07	Full closed-loop enable	0	0	0	0
	P0.08	UV phase sequence	1	1	1	1
	P0.09	Module ratio	51	81	101	121
	PA.03	Pole pairs	8	8	8	8
	PA.04	Rated current	1042	675	789	659
	PA.05	Maximum current	134.8	108	108.3	90.4
L-90-I-XX	Ratio		50	80	100	120
	P0.00	Motor Model	1	0	2	3
	P0.01	Motor Type	1	1	1	1
	P0.03	Drive Model	3	3	3	3
	P0.07	Full closed-loop enable	0	0	0	0
	P0.08	UV phase sequence	1	1	1	1
	P0.09	Module ratio	51	81	101	121

	PA.03	Pole pairs	8	8	8	8
	PA.04	Rated current	1181	963	810	676
	PA.05	Maximum current	195.9	151.5	135.4	119.4
L-110-I-XX	Ratio		50	80	100	120
	P0.00	Motor Model	1	0	2	3
	P0.01	Motor Type	1	1	1	1
	P0.03	Drive Model	2	2	2	2
	P0.07	Full closed-loop enable	0	0	0	0
	P0.08	UV phase sequence	1	1	1	1
	P0.09	Module ratio	51	81	101	121
	PA.03	Pole pairs	10	10	10	10
	PA.04	Rated current	1838	1816	1805	150.7
	PA.05	Maximum current	324.2	286.1	263	233.5
L-142-I-XX	Ratio		50	80	100	120
	P0.00	Motor Model	1	0	2	3
	P0.01	Motor Type	1	1	1	1
	P0.03	Drive Model	4	4	4	4
	P0.07	Full closed-loop enable	0	0	0	
	P0.08	UV phase sequence	1	1	1	1
	P0.09	Module ratio	51	81	101	121
	PA.03	Pole pairs	10	10	10	10
	PA.04	Rated current	1940	1893	1966	1641
	PA.05	Maximum current	389.3	344.5	302.9	268
L-170-I-XX	Ratio		50	80	100	120
	P0.00	Motor Model	1	0	2	3
	P0.01	Motor Type	1	1	1	1
	P0.03	Drive Model	5	5	5	5
	P0.07	Full closed-loop enable	0	0	0	0
	P0.08	UV phase sequence	1	1	1	1
	P0.09	Module ratio	51	81	101	121

	PA.03	Pole pairs	10	10	10	10
	PA.04	Rated current	4246	3868	4069	4112
	PA.05	Maximum current	870.8	707.6	620.5	562.8
	P0.09	Module ratio	51	81	101	121
	PA.03	Pole pairs	10	10	10	10
	PA.04	Rated current	4096	3732	3926	3967
	PA.05	Maximum current	840.1	682.7	598.6	543

Rigidity Adjustment

Rigidity adjustment requires appropriate modification of five parameters in the firm ware . The specific parameters are: P1.00 - Position Loop Gain, P1.08 - Velocity Feedforward Gain, P2.00 - Speed Loop Proportional Gain, P2.01 - Speed Loop Integral Time Constant, P2.0C - Load Inertia Percentage

1.Position Loop Gain (P1.00)

Function: Determines how accurately the system follows the commanded position. Higher position loop gain increases system response speed and stiffness, and reduces position lag.

Setting Method:

Initial Setting:

- Set as high as possible while ensuring the motor operates quietly. You may refer to the value obtained from self-learning.

Adjustment Steps:

- Gradually increase the position loop gain and observe whether the system exhibits vibration or overshoot.

If vibration or overshoot occurs, reduce the gain slightly until the system stabilizes.

2. Position Feedforward Gain (P1.08)

Function: Improves high-speed response of the control system and reduces position lag.

Setting Method:

Initial Setting:

- Usually set to 0 if high response performance is not required.

Adjustment Steps:

- Gradually increase the position feedforward gain and observe whether the system becomes unstable or exhibits vibration.

If the system remains stable, the gain can be further increased until the desired response speed is

achieved.

3.Speed Loop Proportional Gain (P2.00)

Function: Affects the motor's speed response and stiffness. Higher proportional gain increases system stiffness and accelerates response speed.

Setting Method:

Initial Setting:

- Determined according to the specific servo drive model and load conditions. In general, larger load inertia requires a higher gain setting.

Adjustment Steps:

- Set the integral gain and derivative gain to zero.
- Gradually increase the speed proportional gain and observe whether vibration occurs when the motor stops.

If vibration occurs, slightly reduce the gain until the system stabilizes.

4.Speed Loop Integral Time Constant (P2.01)

Function: Influences the steady-state speed error and the stability of the speed loop. A smaller integral time constant results in faster integration.

Setting Method:

Initial Setting:

- Determined according to the specific servo drive model and load conditions. Larger load inertia typically requires a larger value.

Adjustment Steps:

- Gradually decrease the speed integral time constant while observing the system for vibration.

If vibration occurs, slightly increase the time constant until the system stabilizes.

General Tuning Procedure:

Set an appropriate rotor inertia ratio, referencing the value obtained from self-learning.

Set the speed loop integral time constant to a relatively large value to ensure initial system stability.

Gradually increase the speed loop proportional gain and observe the system. If vibration occurs, slightly reduce the gain.

Gradually decrease the speed loop integral time constant and observe the system. If vibration occurs, slightly increase the value.

Gradually increase the position loop gain and observe the system. If vibration occurs, slightly reduce the gain.

If mechanical resonance occurs, adjust the torque low-pass filter or notch filter to suppress resonance. To achieve shorter positioning time and smaller position tracking error, the position feedforward gain can be increased appropriately, but should not exceed 80%.

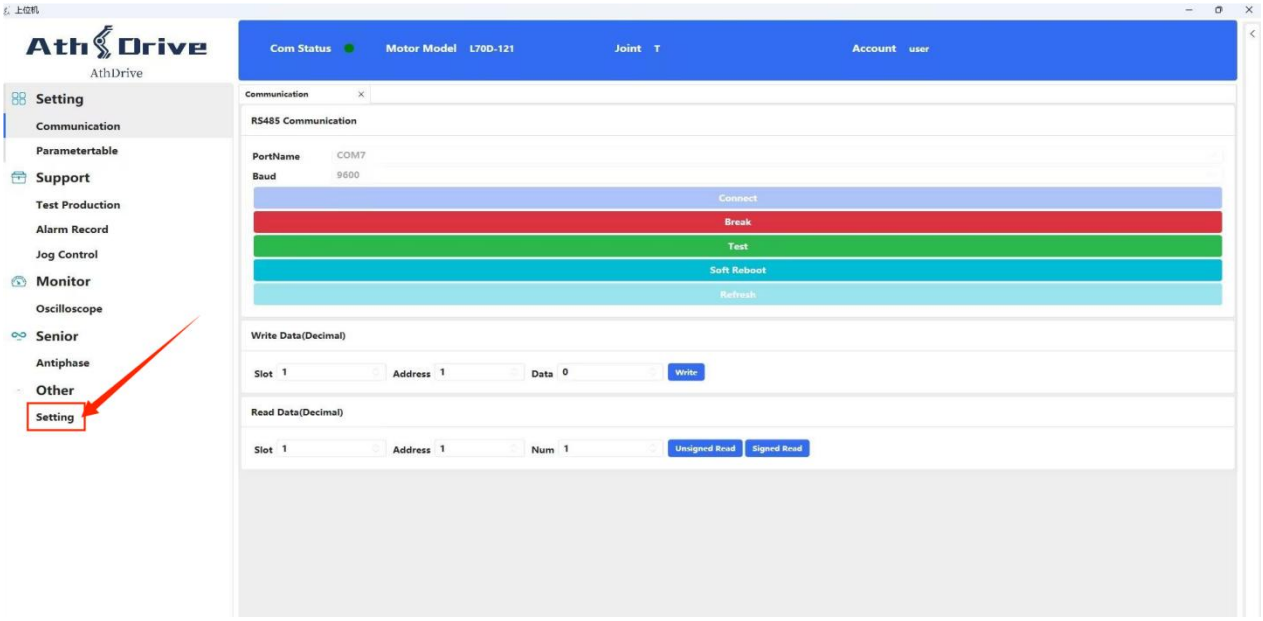
After setting all gain parameters, perform a stability test to observe whether the motor exhibits instability or vibration. If any issues appear, readjust the gain parameters until stable operation is achieved.

By following these steps, the servo motor gain parameters can be gradually tuned to ensure high response speed, high accuracy, and stable operation.

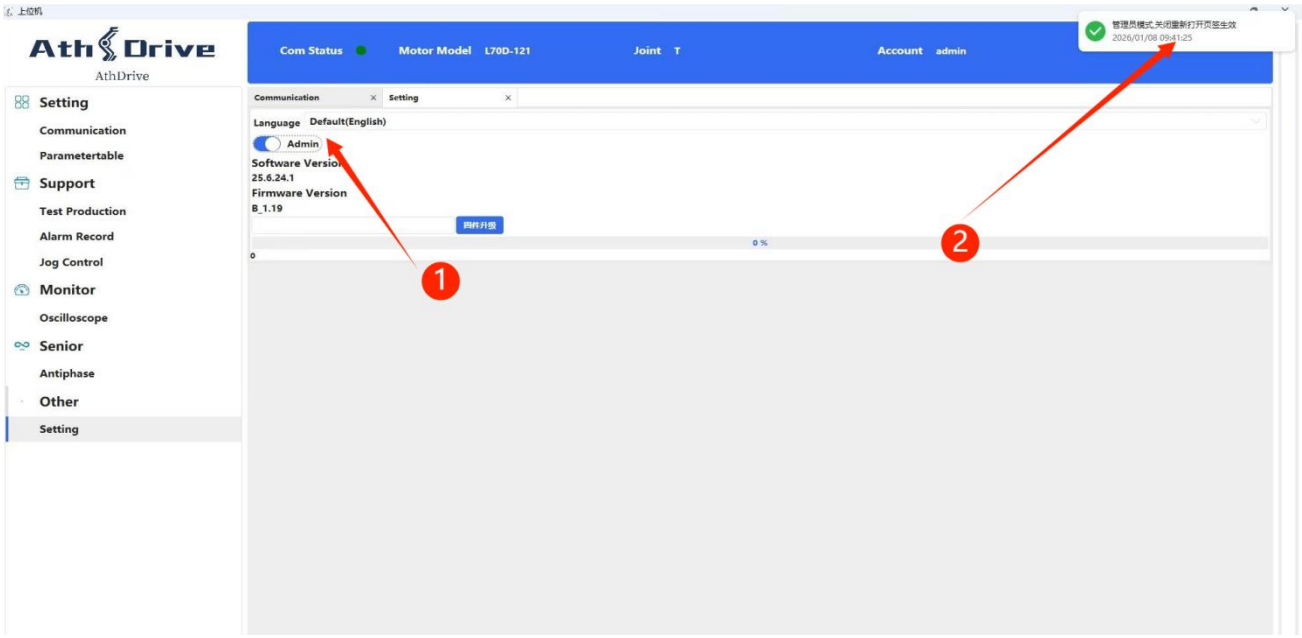
Chapter 11 Firmware Upgrade and Initialization

Upgrade via RS-485 Firmware

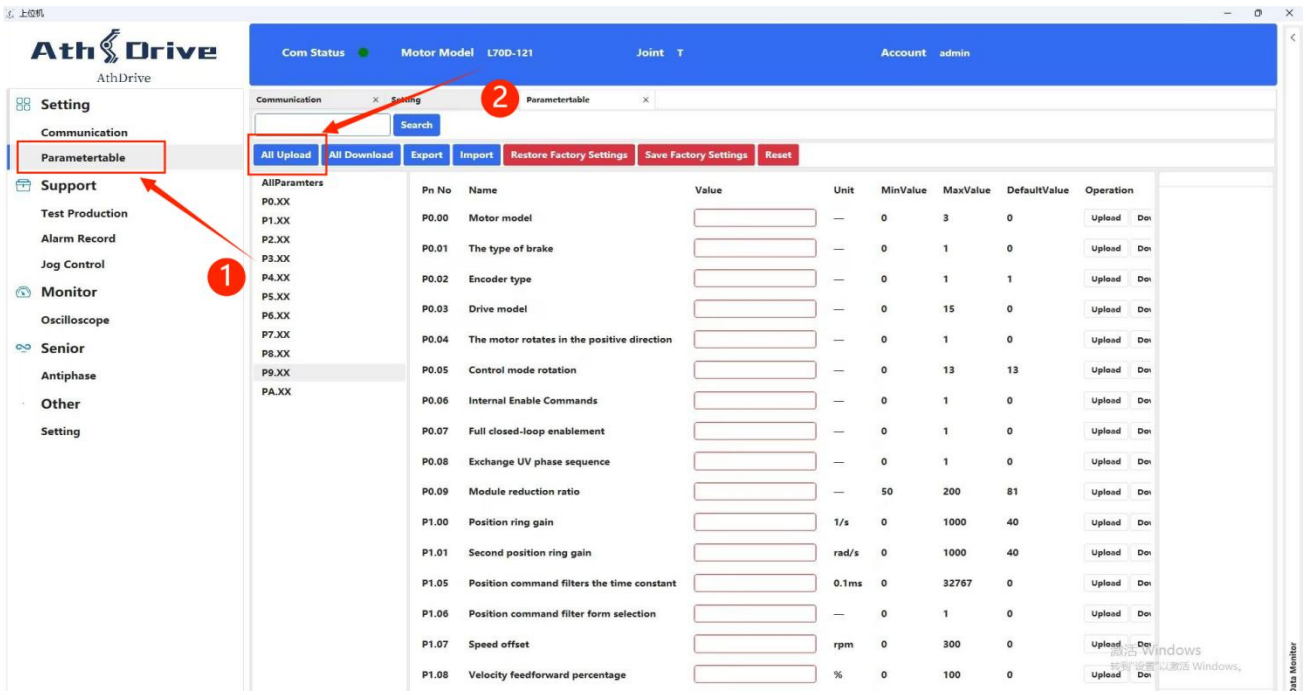
After connecting the module to the firm ware via RS-485, click the “Settings ” button at the bottom of the left-hand function panel.



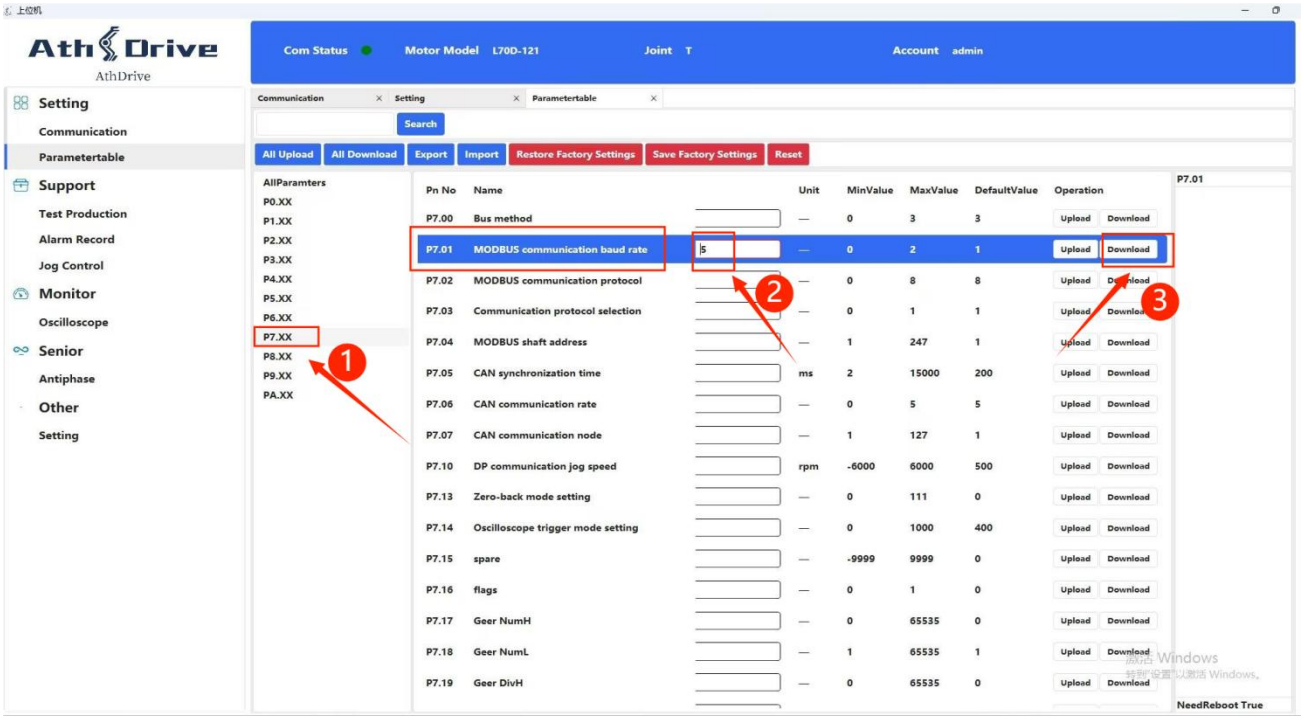
Open Administrator Mode. A window indicating that Administrator Mode is active will appear in the top-right corner.



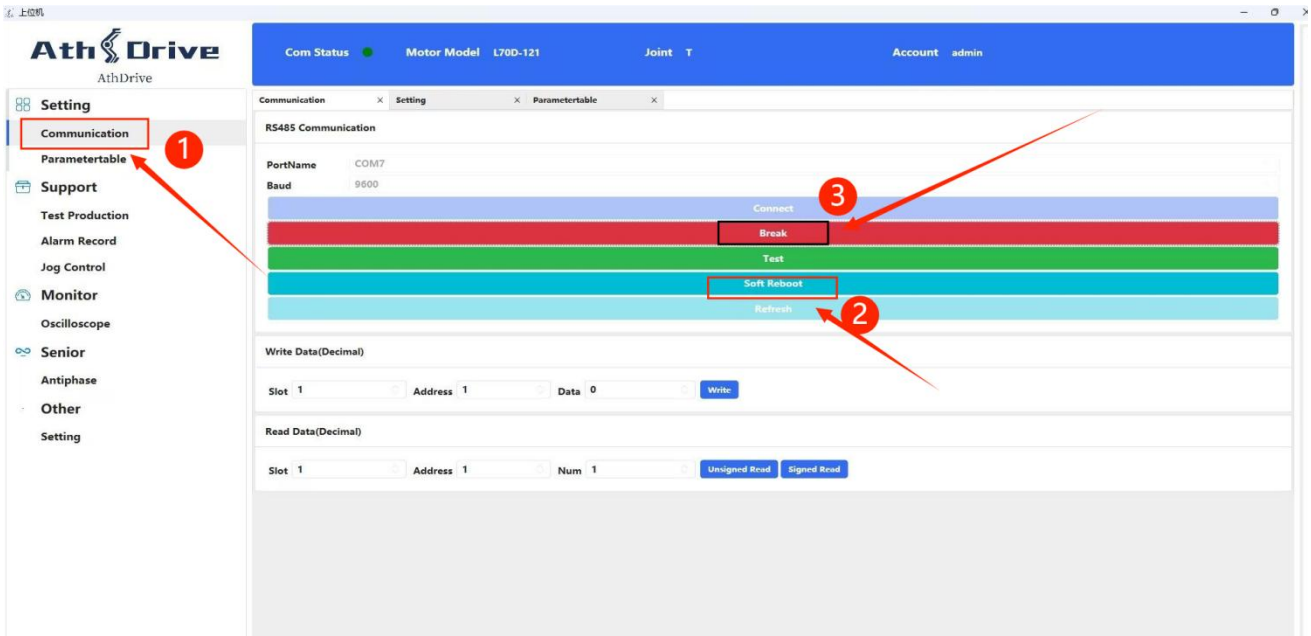
Click “Parameter Table ” in the left-hand function panel, then click the “Upload All” button at the top.



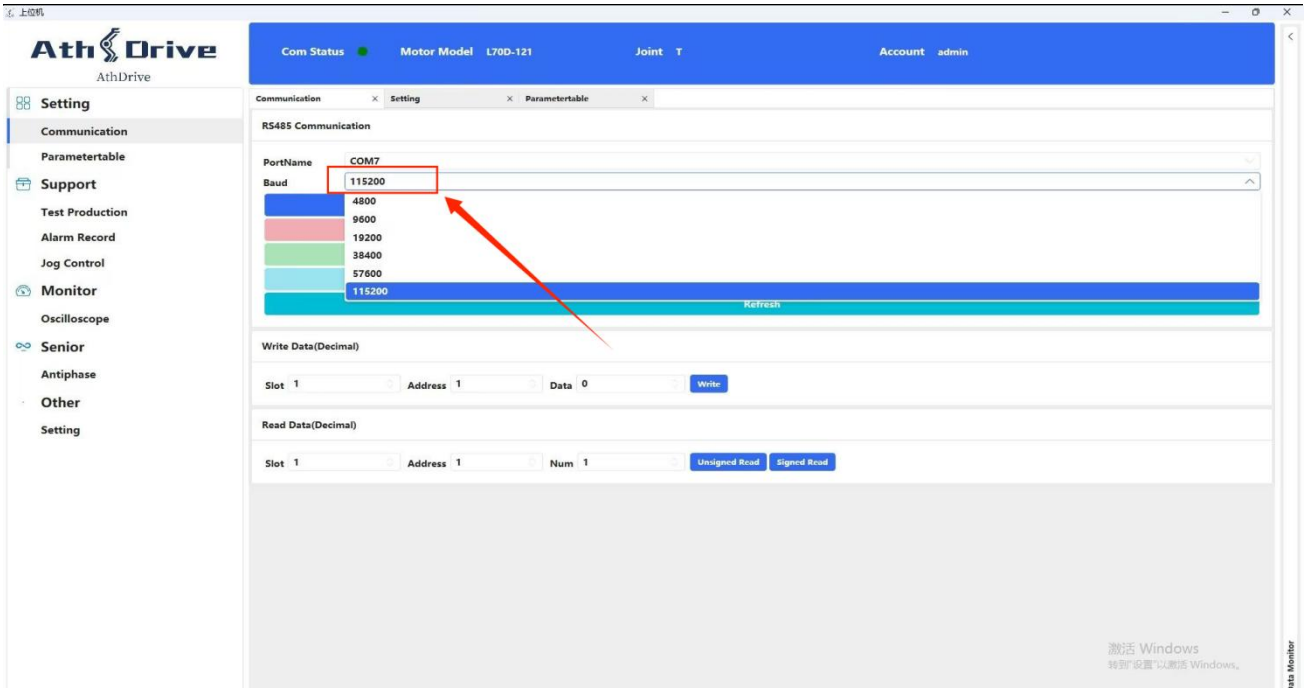
Next, locate the P7.01 “MODBUS Communication Baud Rate” parameter and change its value to “5 ”. Click the “Download” button on the right to download the parameter.



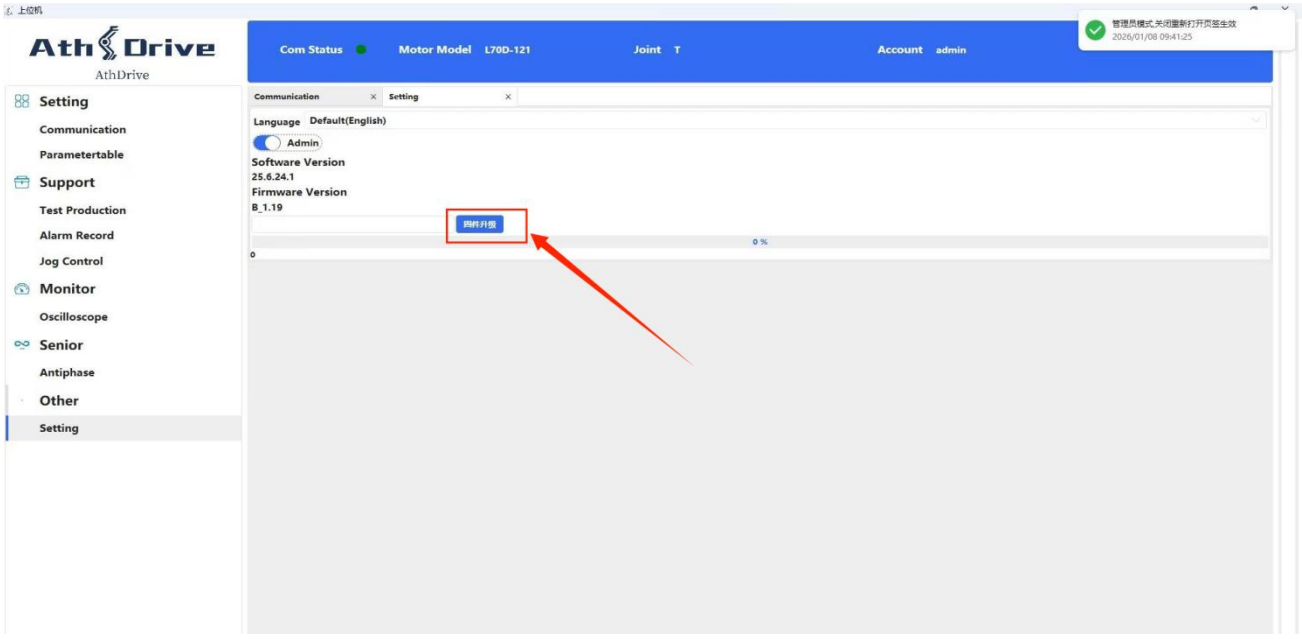
After the download is complete, switch back to the Communication interface and click the dark blue “Soft Restart” button. Once the soft restart is finished, click the red “Disconnect” button to disconnect.



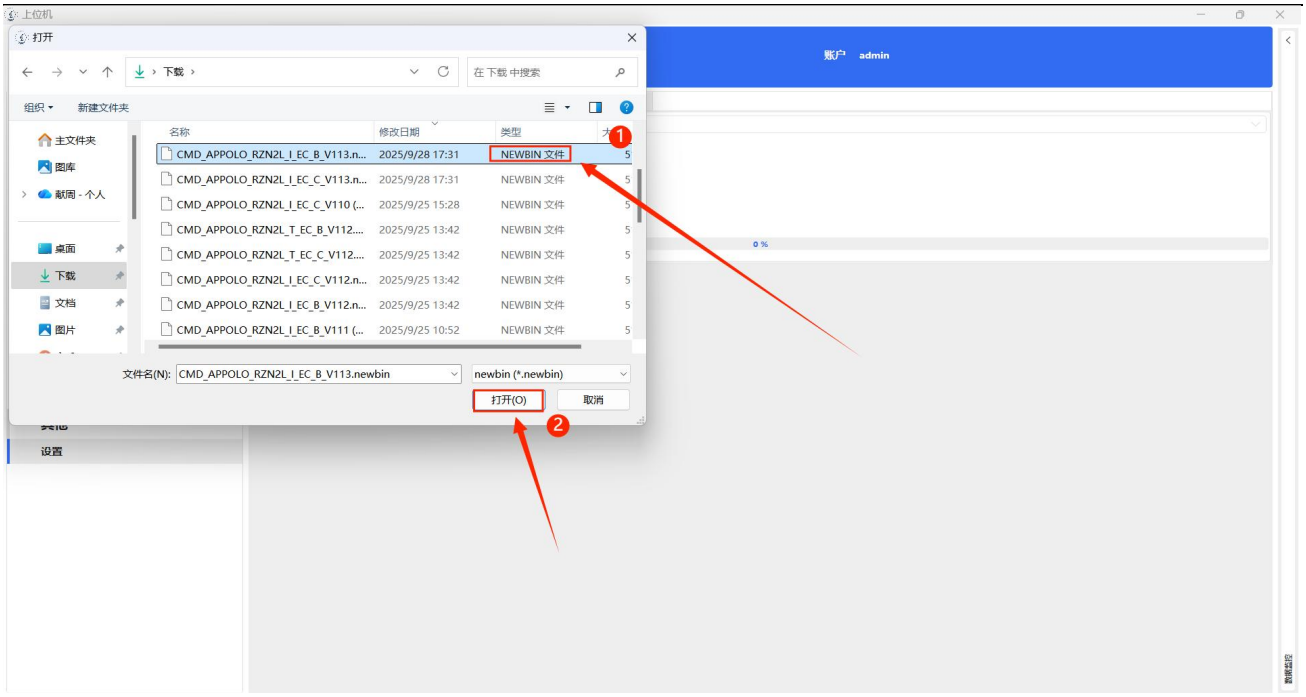
Finally, reselect the 115200 baud rate and click the “Connect” button again.



After connecting, click the Settings tab on the left-hand panel, then click the dark blue “Firmware Upgrade” button.



Select the firmware file to upgrade (485 upgrade requires a .newbin file), then click Open.

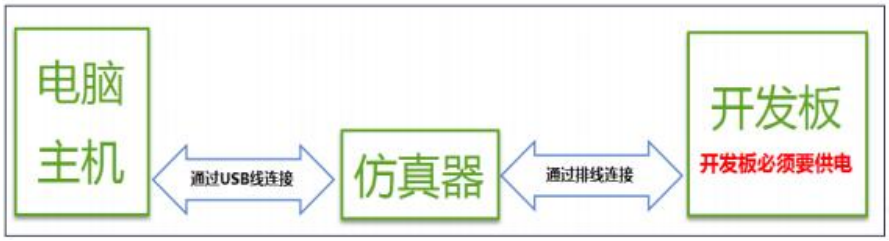


When the blue progress bar reaches 99%, wait for one minute, then power off and restart the module. The firmware upgrade is now complete.

Firmware Upgrade via J-LINK

1. Preparation

1. Hardware Preparation: Prepare the J-Link debugger.

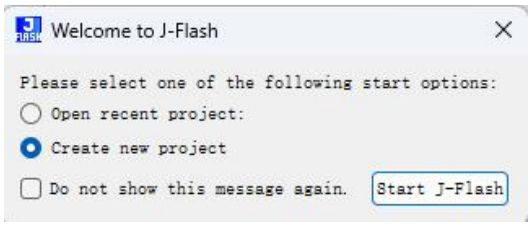


2. Software Preparation: Go to the software center and install the flashing tool J-Link V6.20H.

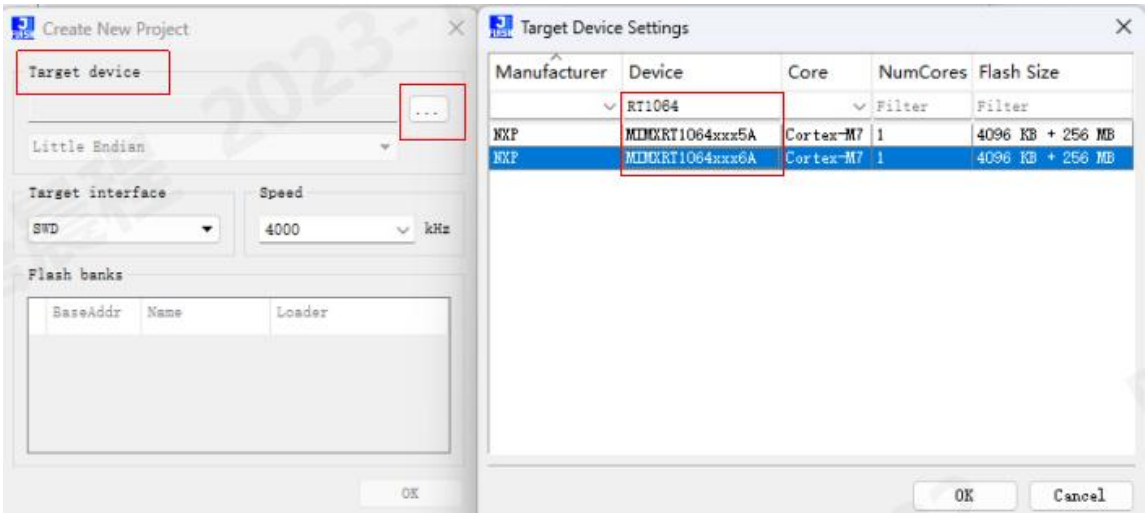
2. Initial Programming Procedure

1. After installation, open the J-Link Flash application.

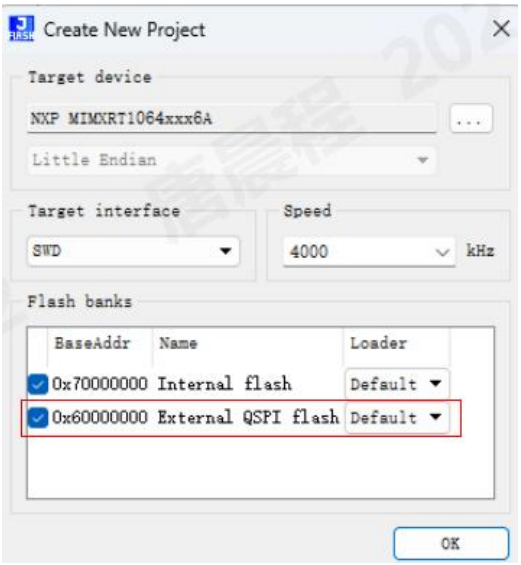
2. Create a new project.



3. Select the corresponding MCU model as required. In this example, choose “MIMXRT1064xxx6A. ”

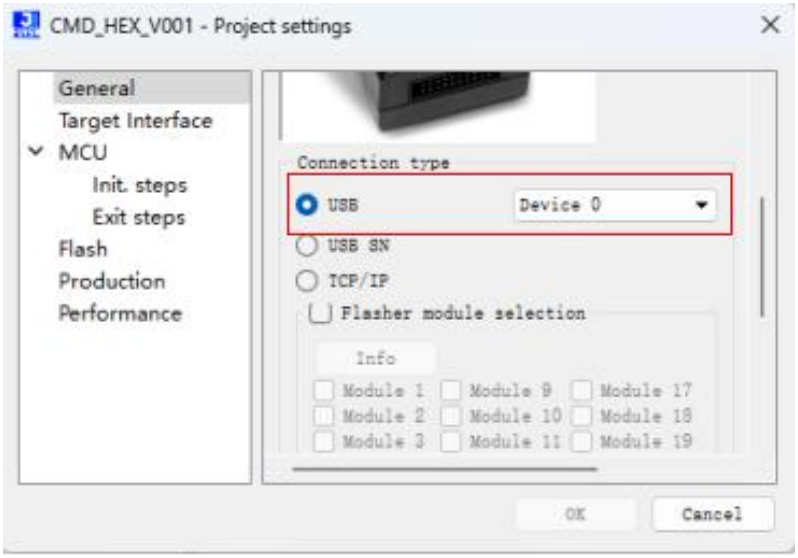


Select“External”Flash

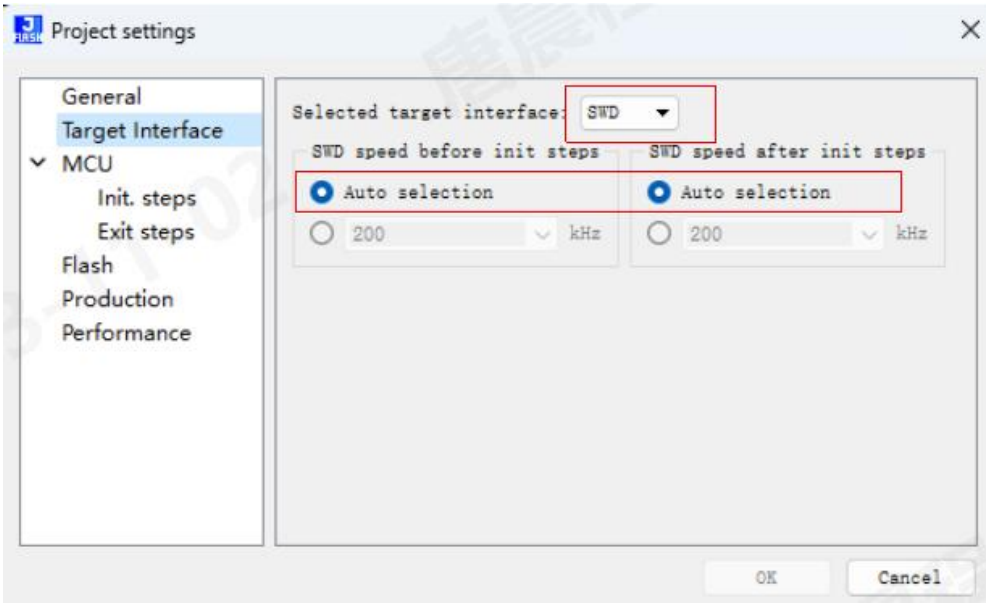


4. Click “Options” > “Project settings” to open the configuration interface.

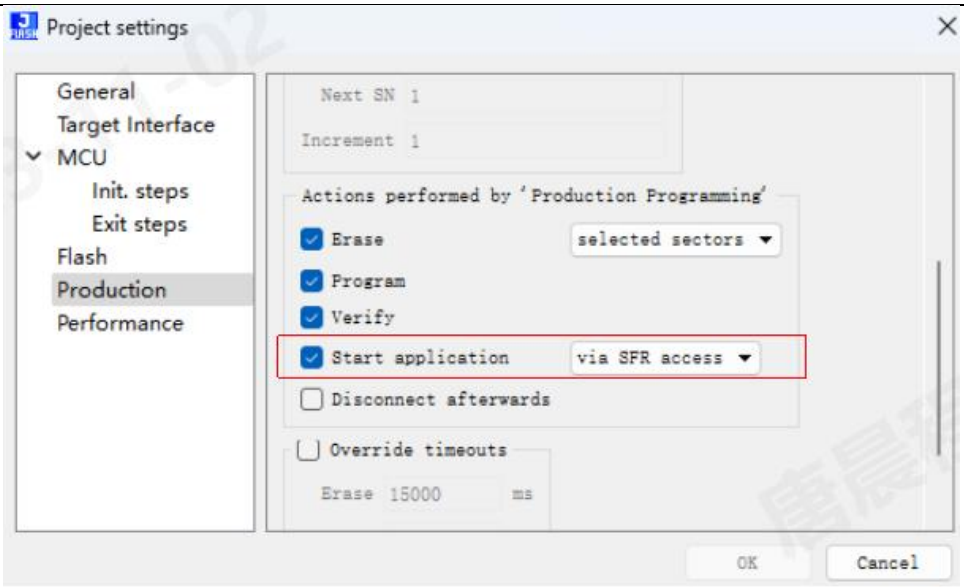
5. Go to the “General” tab and set the connection method to “USB.”



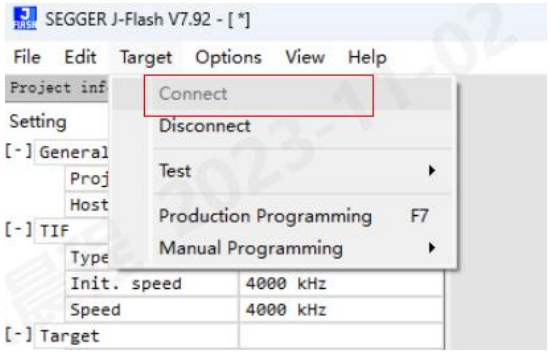
6. Navigate to the “Target Interface ”tab, select “SWD ” as the debugging interface, and set the speed to “AUTO.”



7. Go to the “Production ” tab and check “Start application” to enable automatic reset, allowing the program to run automatically after flashing.

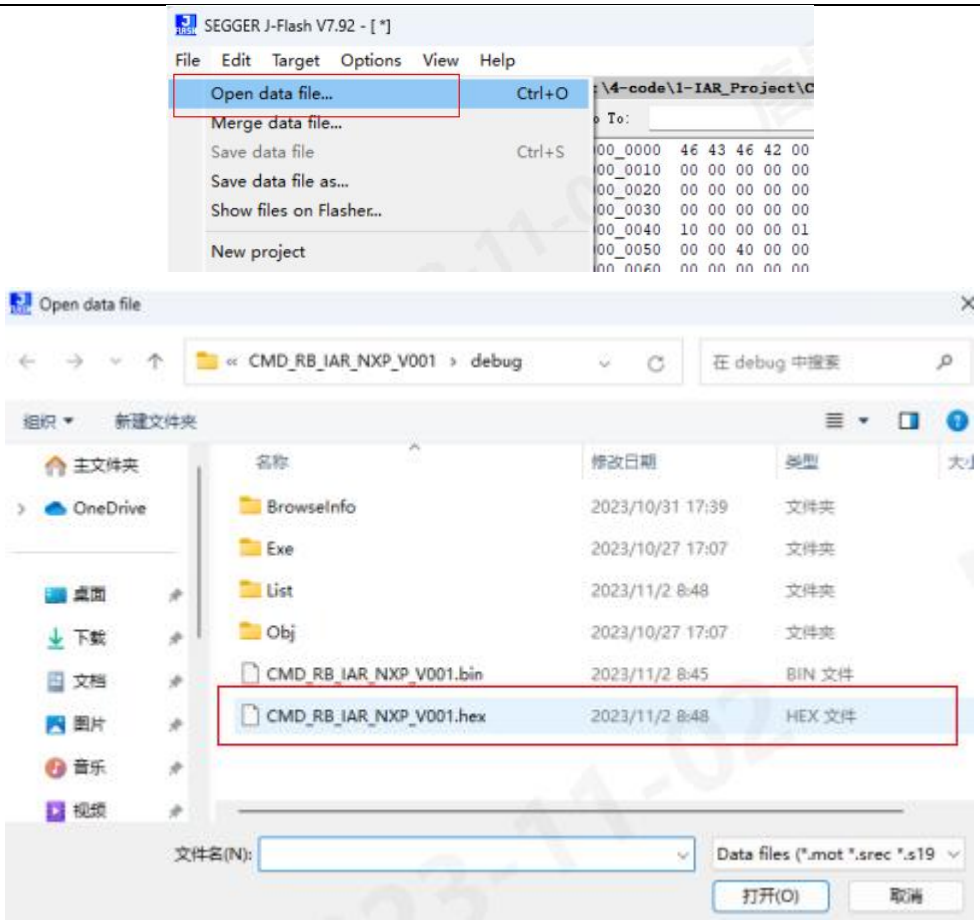


8. After completing the above configuration, exit the settings interface. Then click “Target ” > “Connect ” to establish the connection between the J-Link emulator and the MCU.

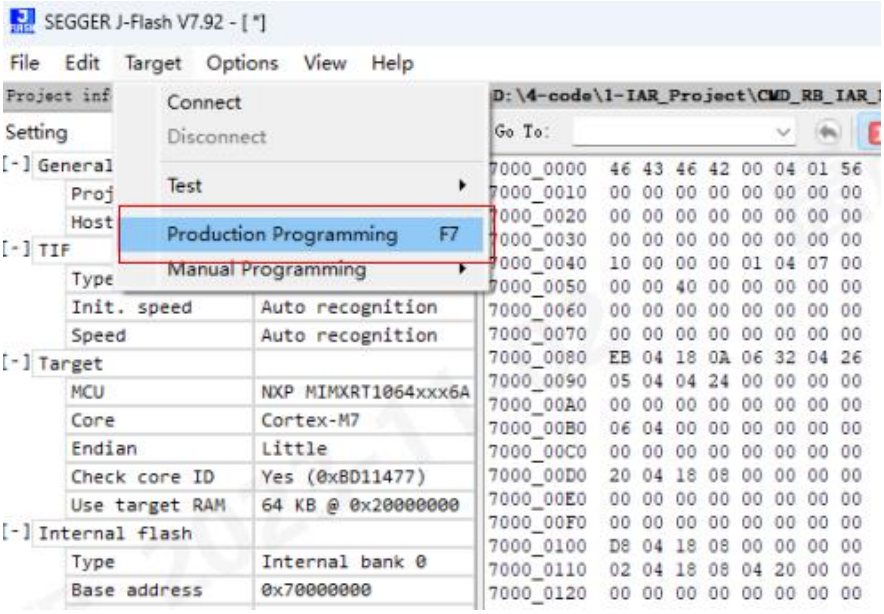


Once the connection is successful, the LOG window will display “successfully. ”

9. After the connection is established, click “File ” > “Open data file” to load the HEX file you want to flash into the project.

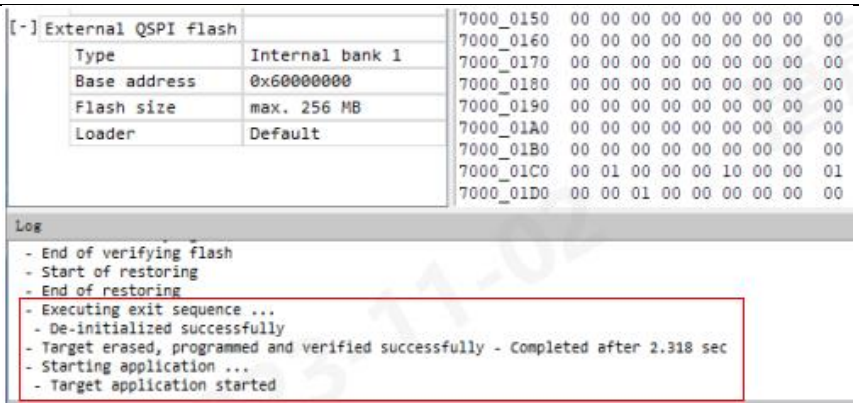


10.After the file is loaded, click “Target”> “Production Programming” to begin flashing the program.



11.Check the flashing result

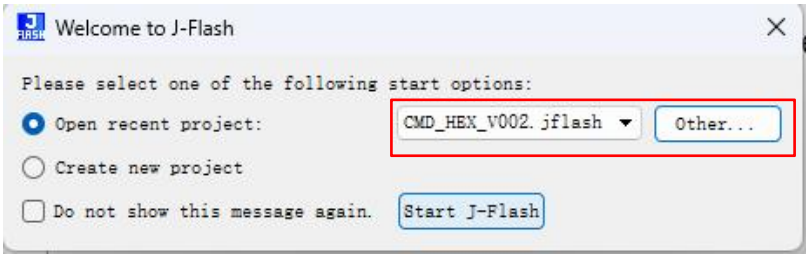
Once the program is successfully downloaded, the LOG window will display “successfully.” If any additional dialog windows pop up, simply close them.



At this point, the flashing process is complete.

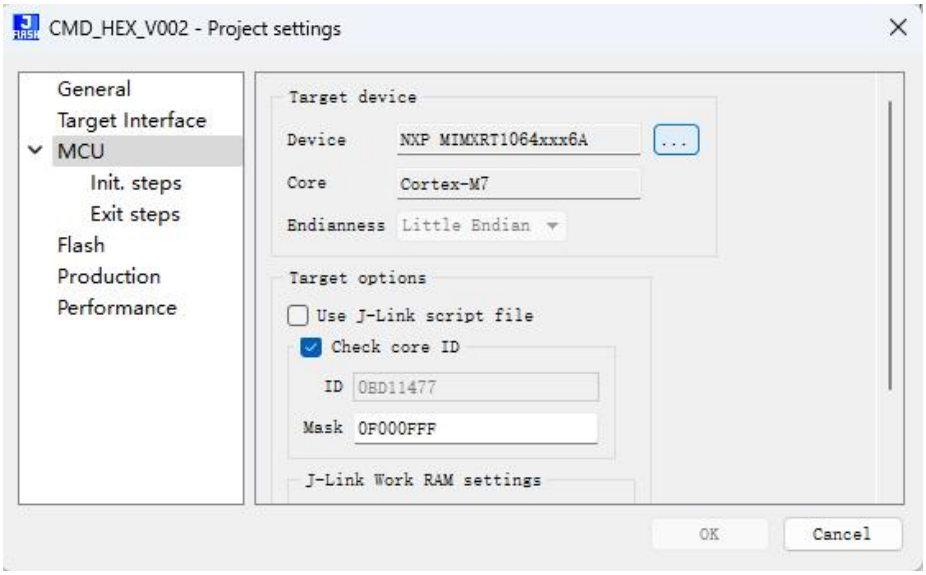
3. Flashing Using a .jflash File

For easier future programming, you may save the above project as a .jflash file.



By opening the .jflash file directly in J-Link Flash, you can connect and flash the program without repeating the configuration steps.

If it is necessary to change the MCU model, open the configuration interface to select the corresponding MCU, and execute step 9 above to update the HEX file.



Note:If any issues occur during the flashing process—such as connection failures—you may unplug and reconnect the J-Link cable or power-cycle the development board, then try connecting again.

Chapter 12 Communication Configuration Example

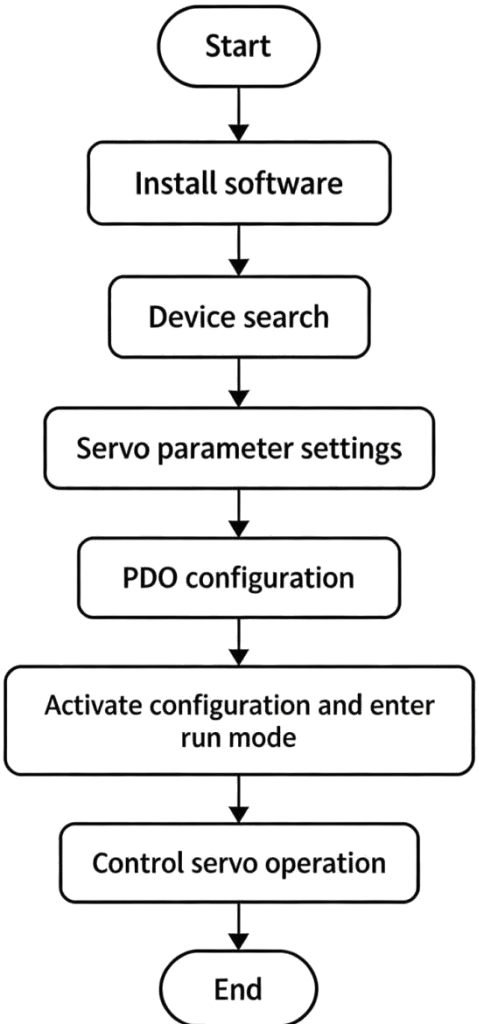
Operation example with Beckhoff controller

Notes:

If you are not using a Beckhoff physical PLC, you will need a computer equipped with an Intel network card that supports Beckhoff TwinCAT 3 software.

You can find the list of network card models compatible with TwinCAT at the link below:

https://infosys.beckhoff.com/english.php?content=../content/1033/tc3_overview/9309844363.html&id=14896984407450360 69



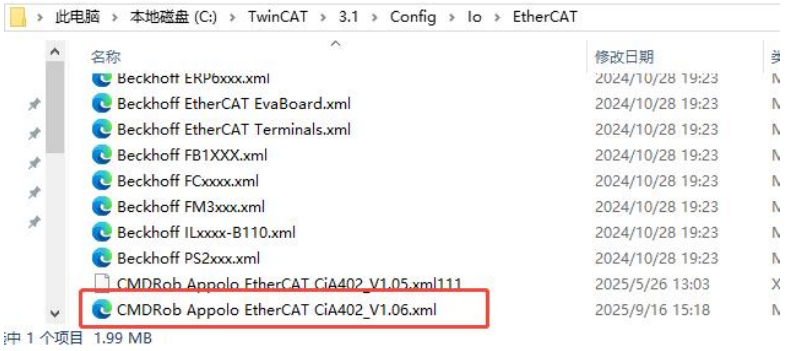
Beckhoff Controller Module Configuration Flowchart

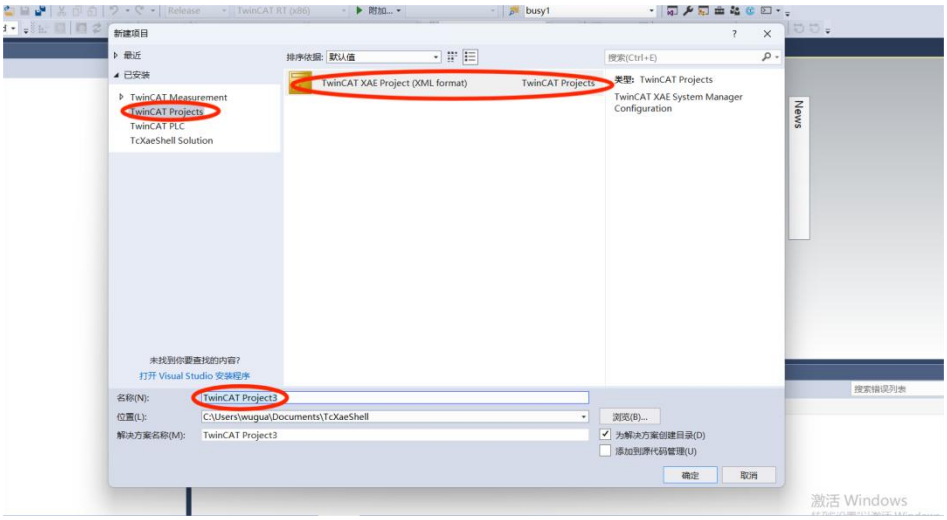
Installing TwinCAT Software

The TwinCAT 3 software can be downloaded from the Beckhoff official website. It supports Windows 7, Windows 10, and Windows 11 operating systems.

- Copy the module's EtherCAT configuration file (XML) into the TwinCAT installation directory: TwinCAT\3.1\Config\Io\EtherCAT
- Open TwinCAT 3 and create a New TwinCAT Project.

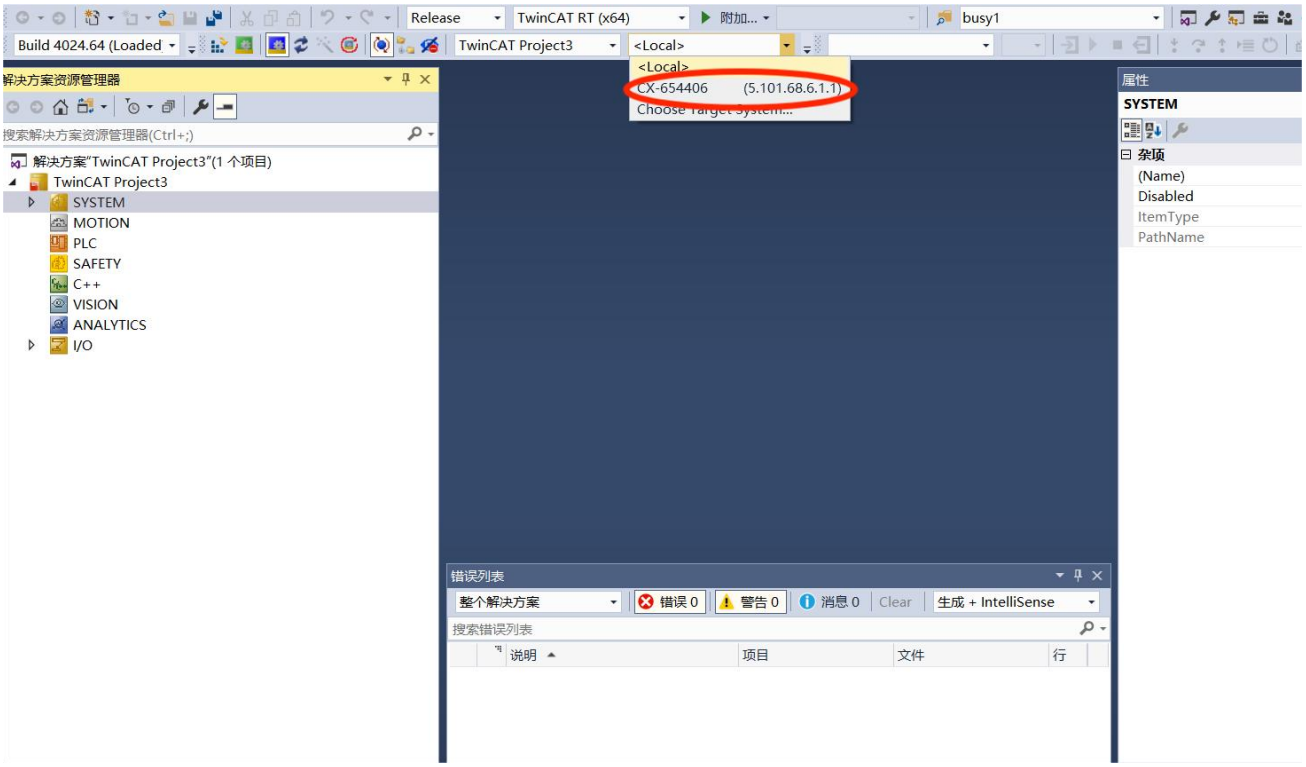
After installation is complete, ensure that the XML file has been added to the TwinCAT configuration path. The default path is: C:\TwinCAT\3.1\Config\Io\EtherCAT



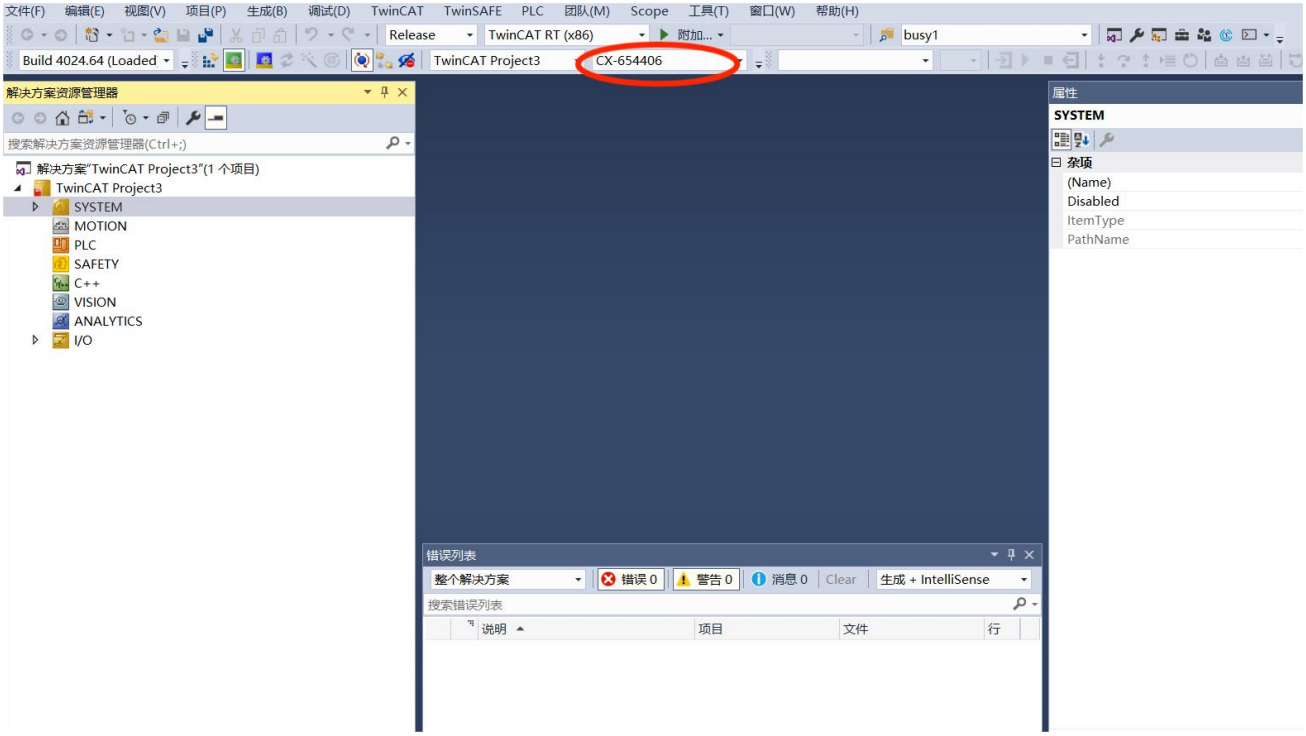


Device Search

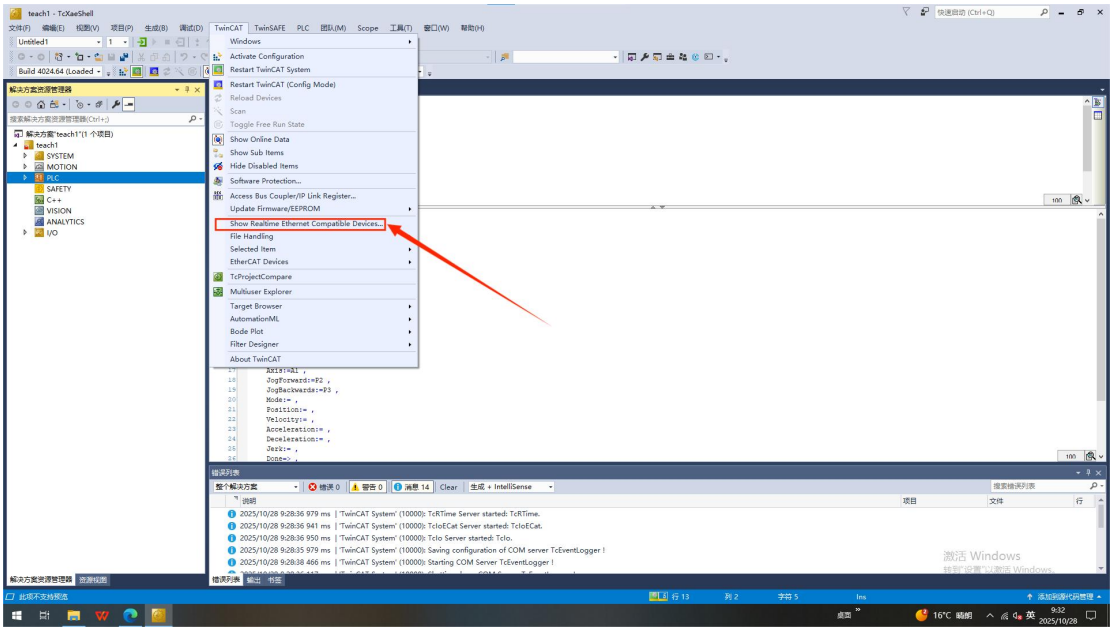
1. Connecting to the Beckhoff Controller (If you do not have a Beckhoff physical PLC, you may skip this step.)

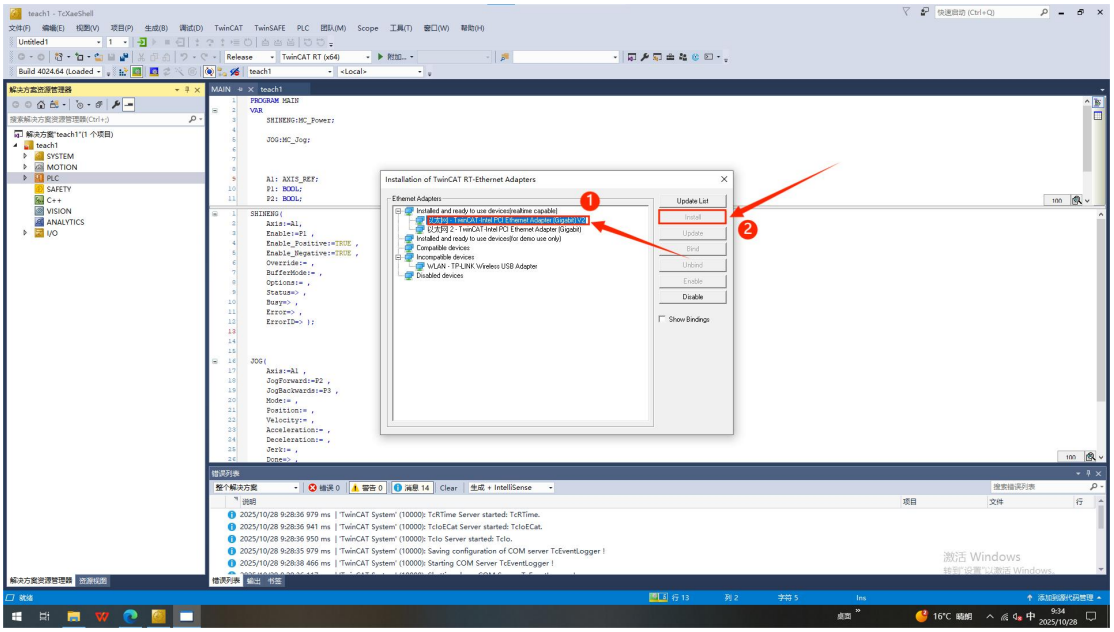


2. Connected successfully as below

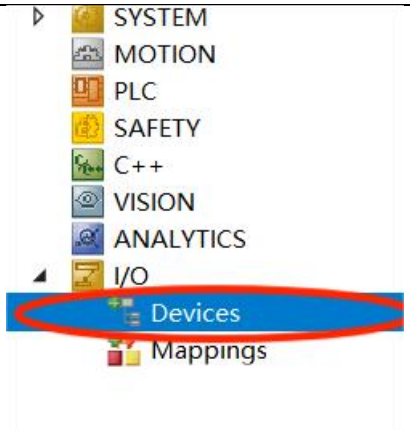


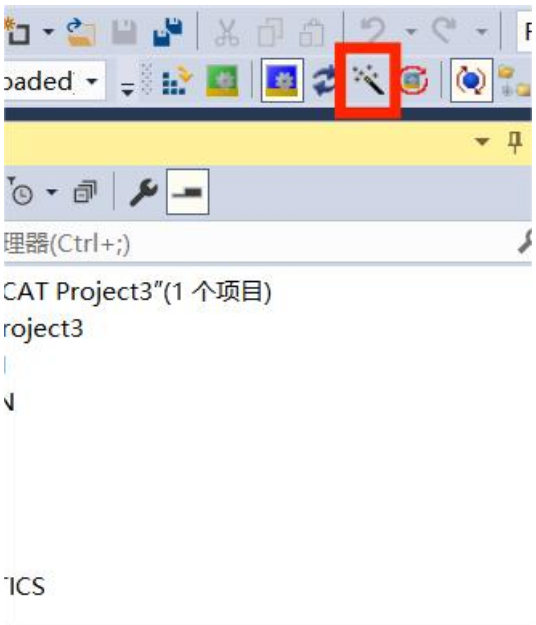
3. Follow the steps below to install the network card driver. In the pop-up window, select the driver corresponding to your network card model, then click “ Install ” to complete the installation.



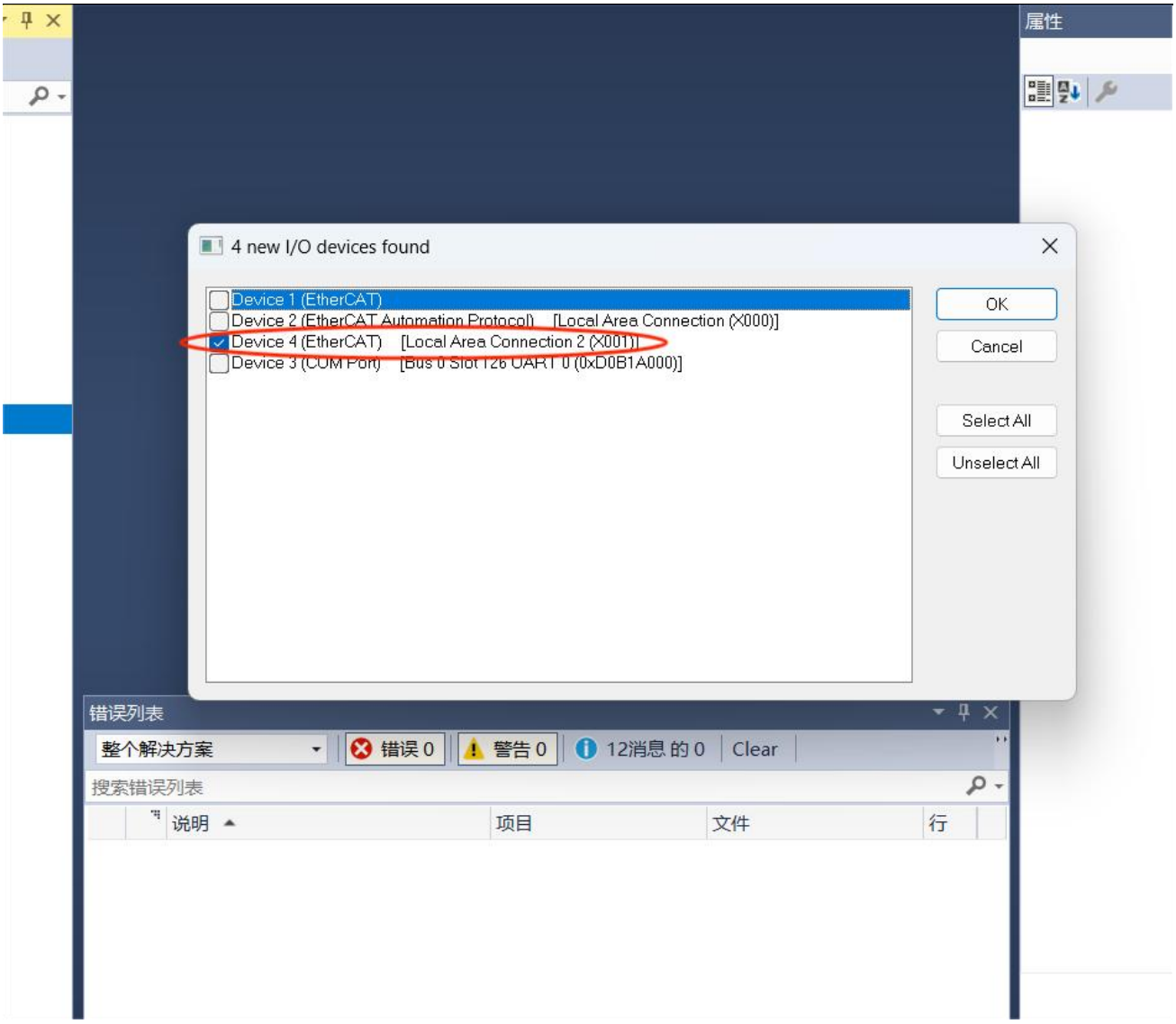


4. Starting Search

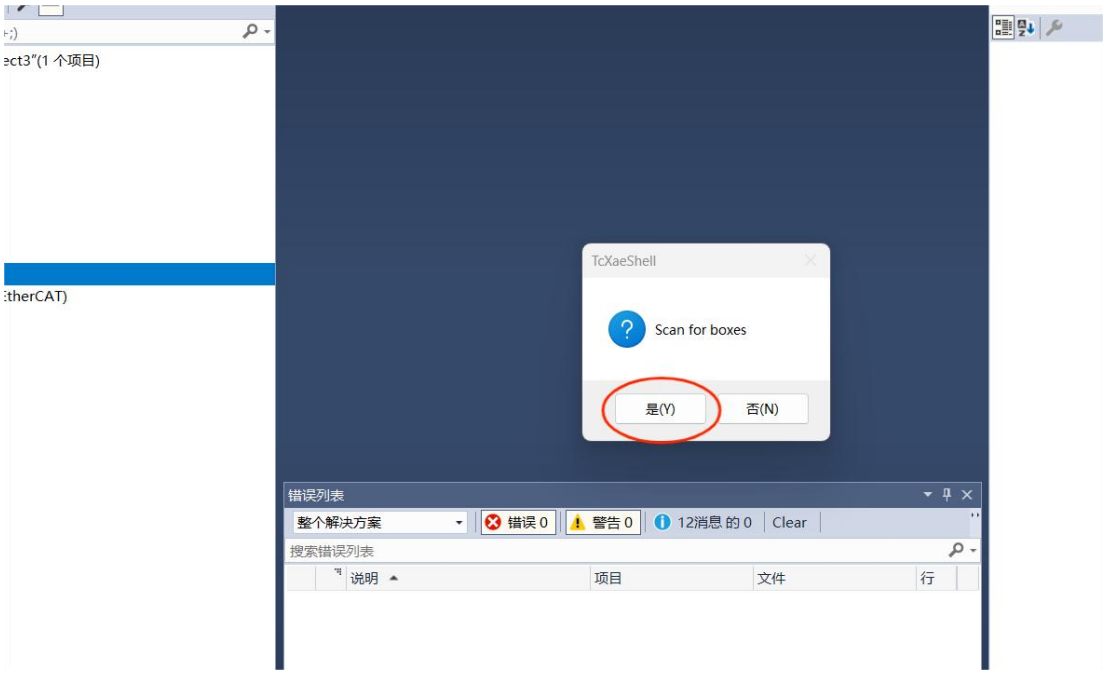




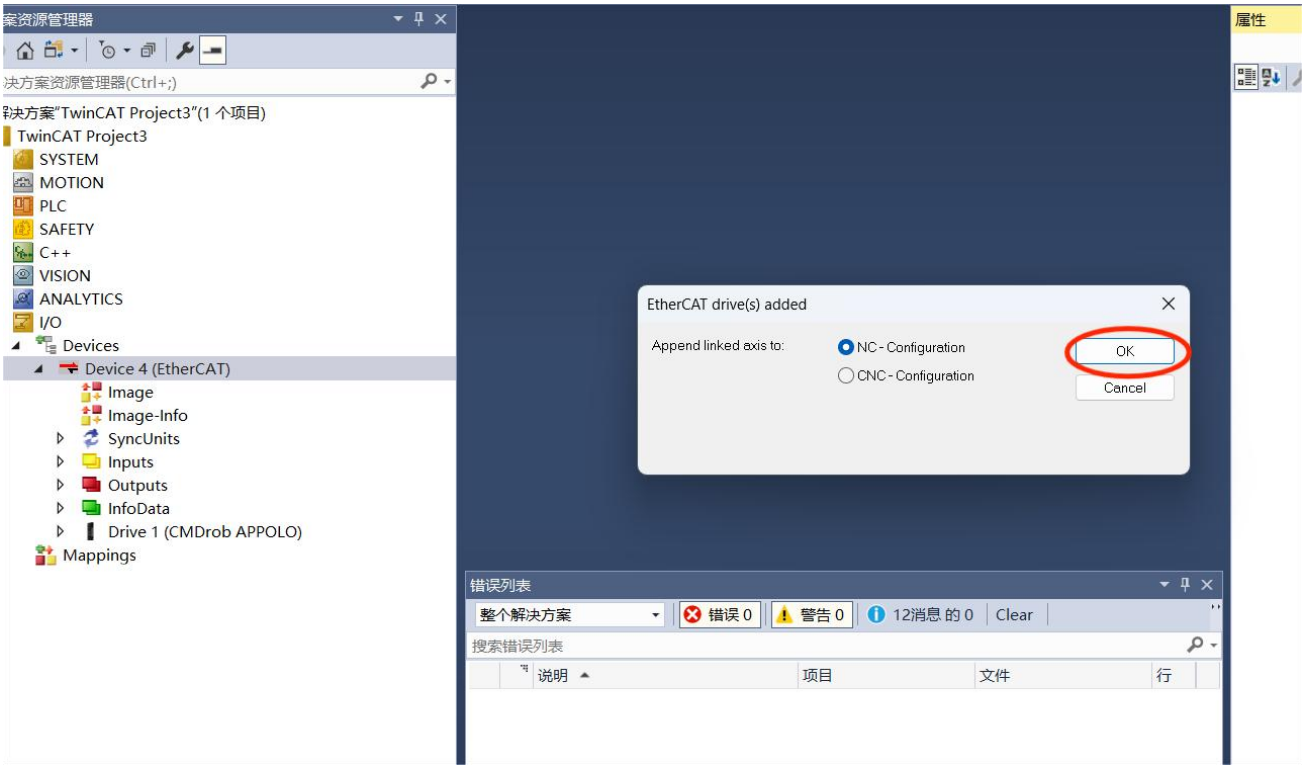
5. Check the master port, such as Device4 (EtherCAT), which corresponds to the port used to connect the module to the controller.


属性
4 new I/O devices found
Device 1 (EtherCAT)
Device 2 (EtherCAT Automation Protocol) [Local Area Connection (X000)]
Device 4 (EtherCAT) [Local Area Connection 2 (X001)]
Device 3 (COM Port) [Bus 0 Slot 126 UART 0 (0xD0B1A000)]
OK
Cancel
Select All
Unselect All
错误列表
整个解决方案
错误 0
警告 0
12消息 的 0
Clear
搜索错误列表
说明
项目
文件
行

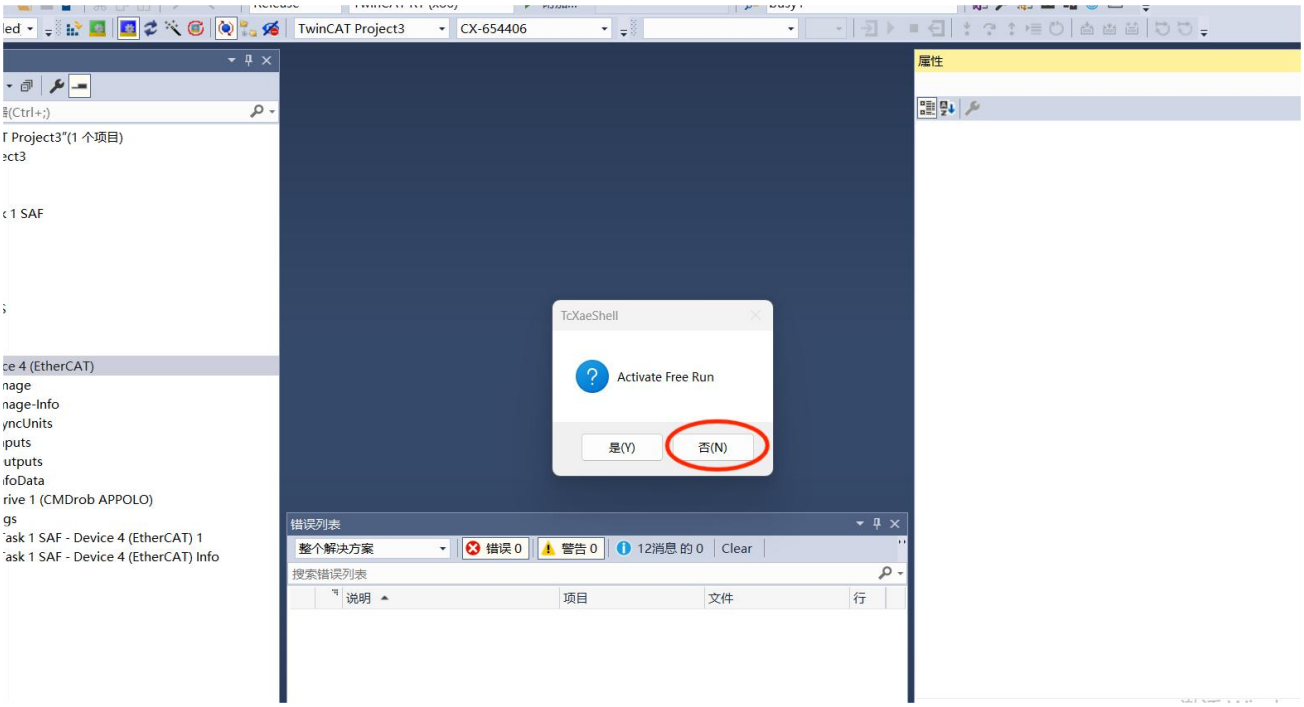
6. Click“Yes ”



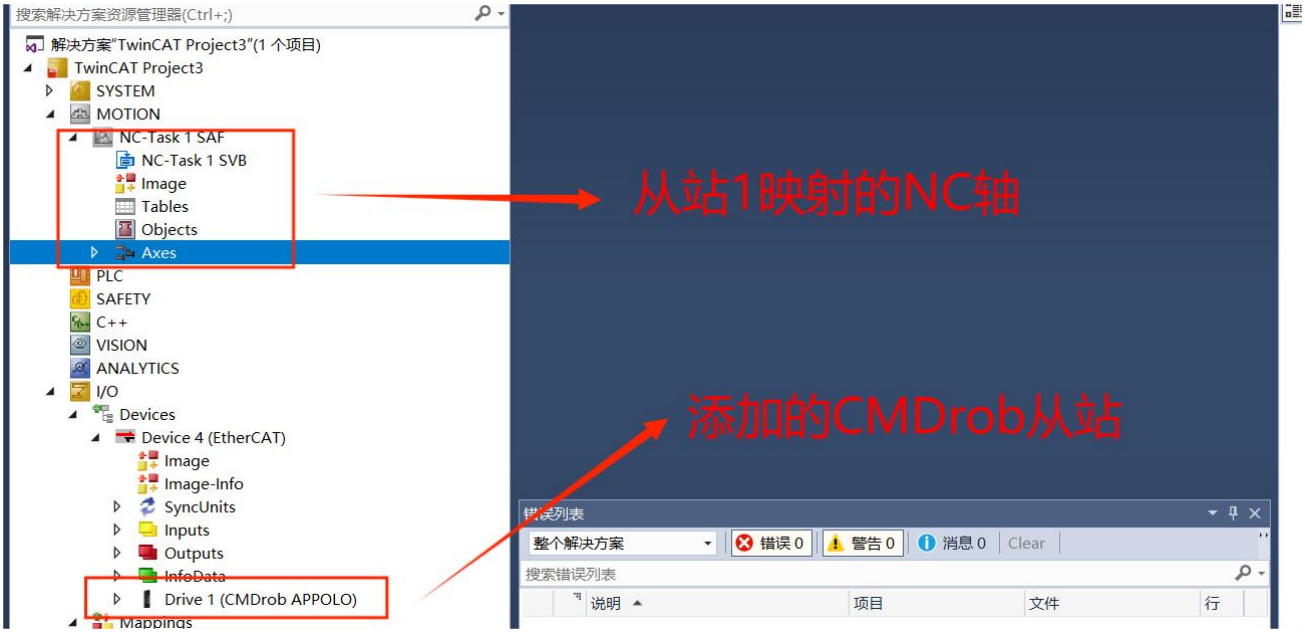
7. Click“OK ”



8. Click“No ”

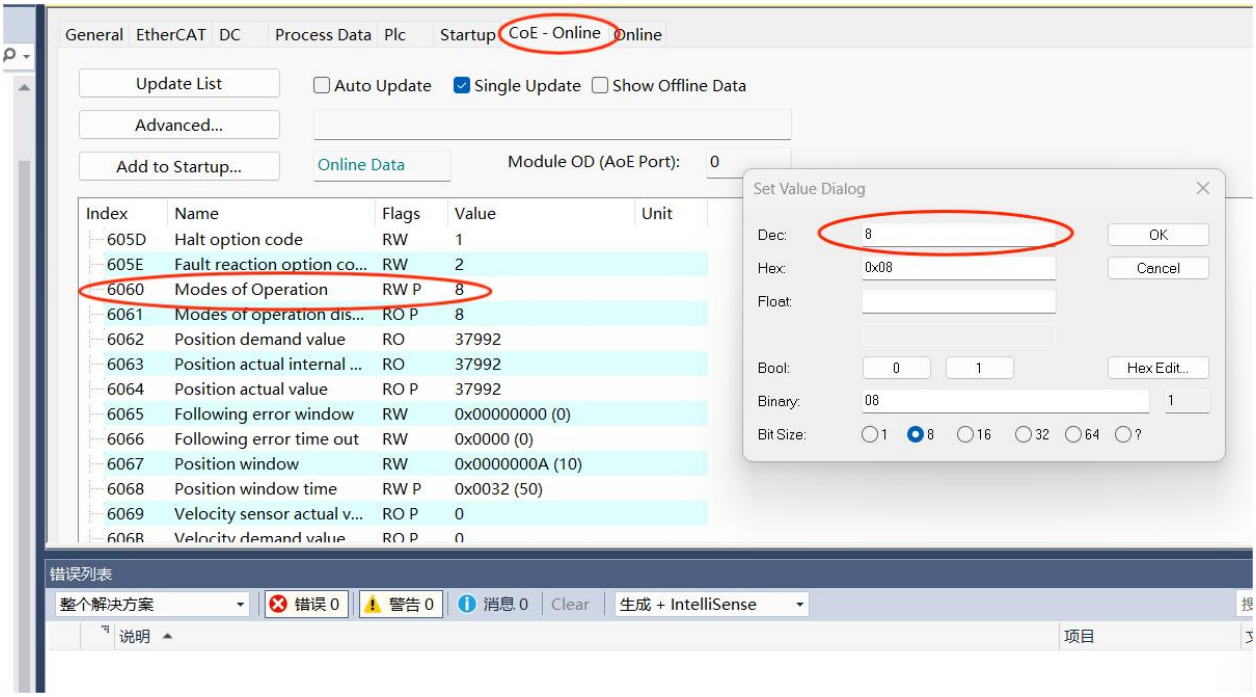


9. Device addition is complete, as shown in the figure below.



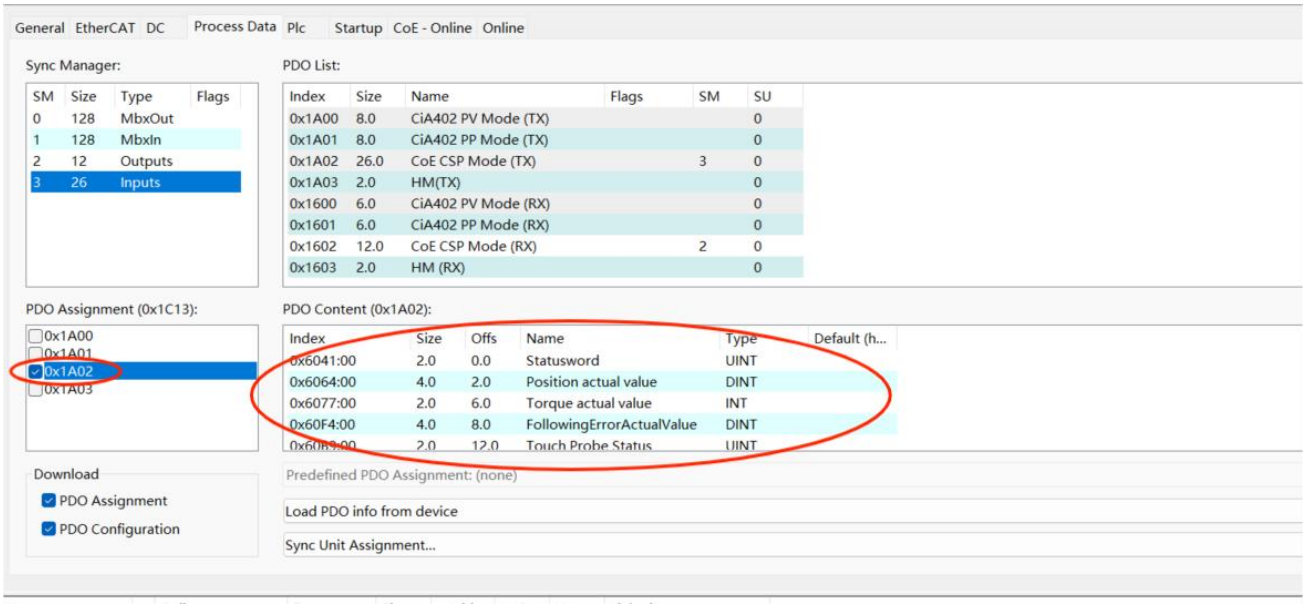
Servo Parameter Configuration

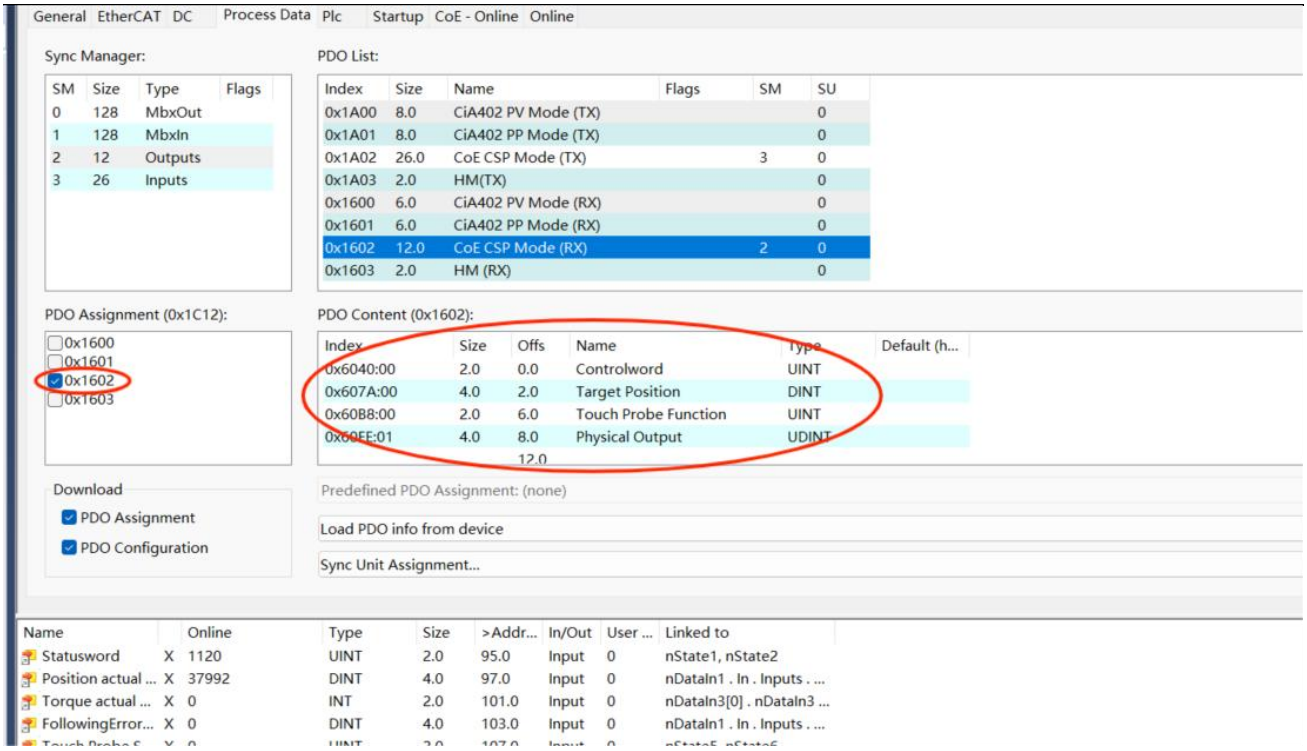
In the "CoE-Online" interface, set the parameters through SDO communication. For example, change 6060h to Sync Position Mode (8), and the steps are as follows:

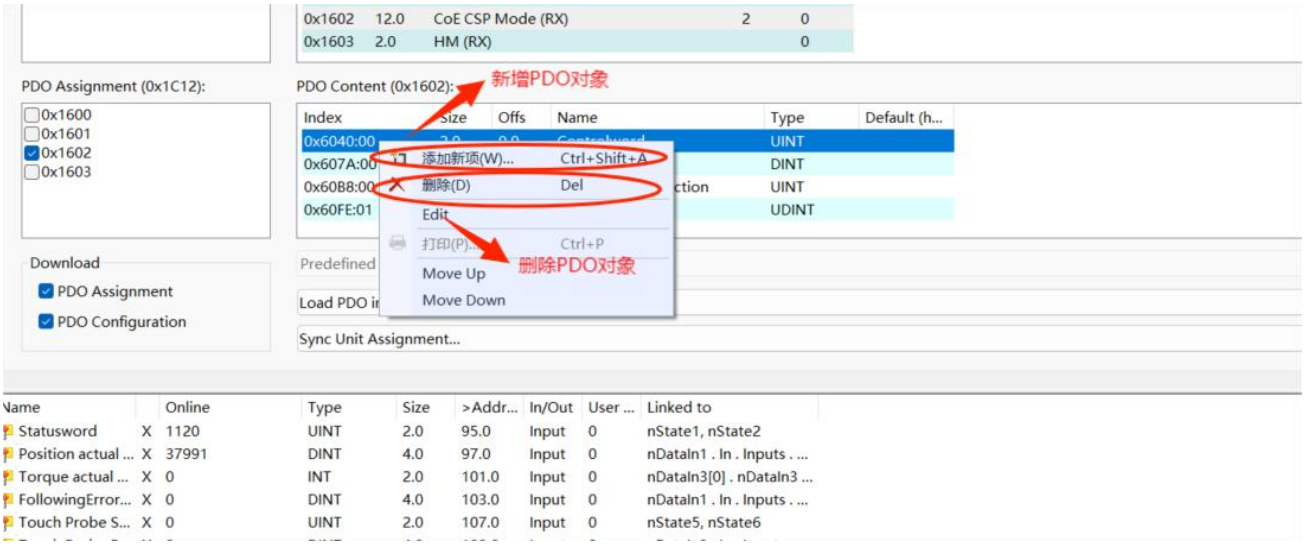


PDO Configuration

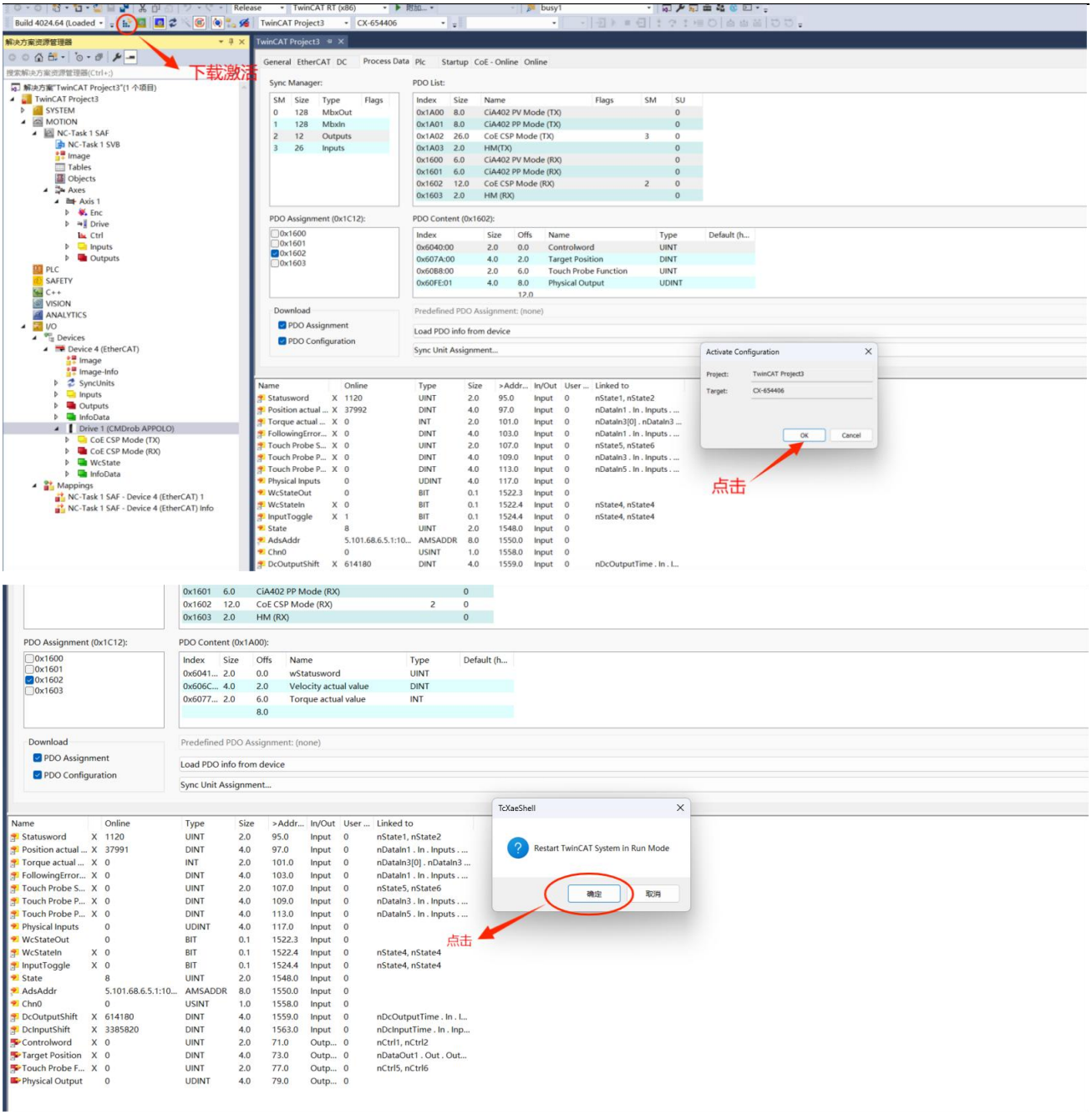
As shown in the figure, check 0x1602 and 0x1A02 for the axis. If the current PDO meets your requirements, there is no need to change it. Otherwise, you need to modify the PDO list to fit your mode. If you need to modify it, right-click in the PDOContent window, select "Del" to delete the unnecessary default PDOs, and "Add New Item" to add the required PDO.



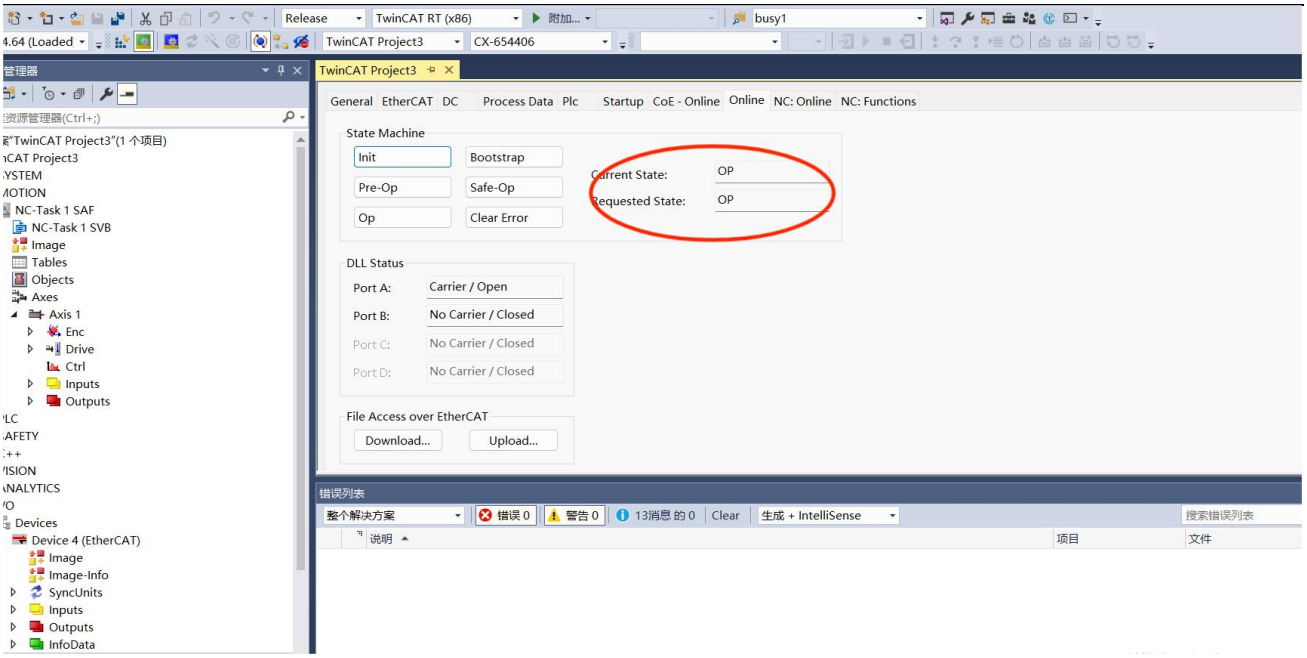




Activate Configuration and Switch to Run Mode



After completing the configuration, you can observe that the device enters the OP state in the "Online" interface.



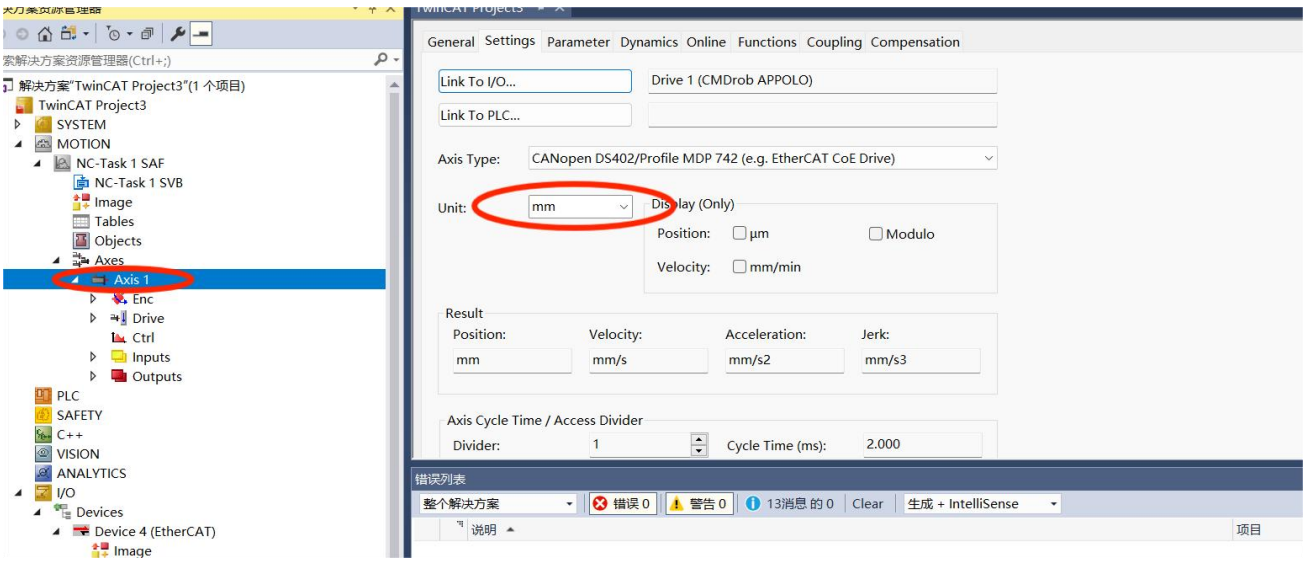
Control Servo Operation

Control the servo via NC:

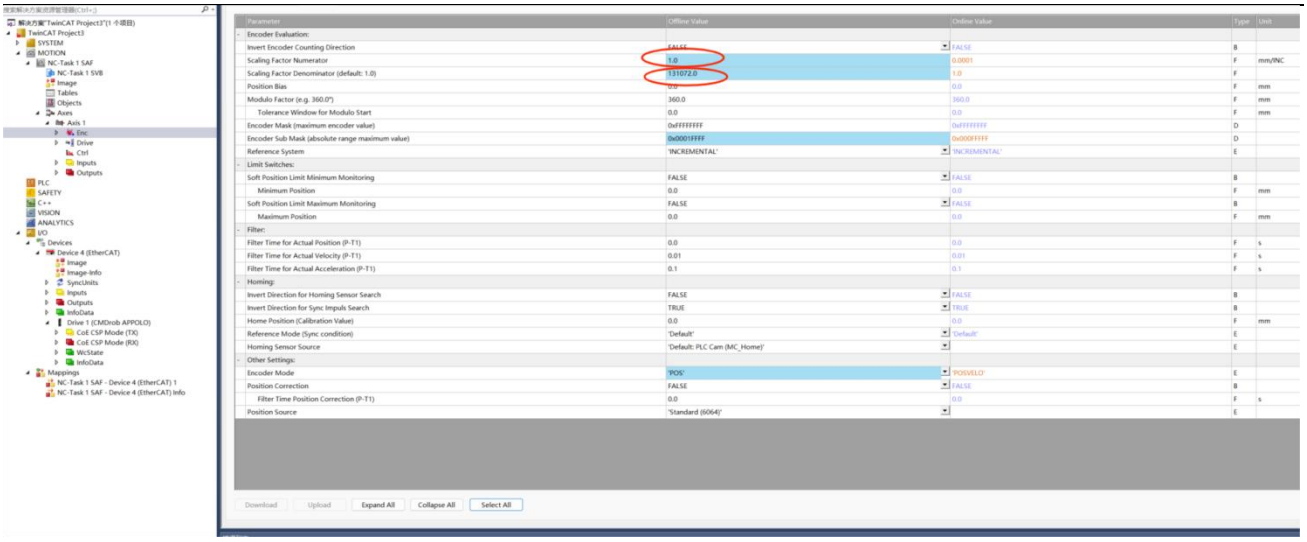
1.The servo operates in Cyclic Synchronous Position Mode.

a. Set Units

For testing, choose the unit as: mm.



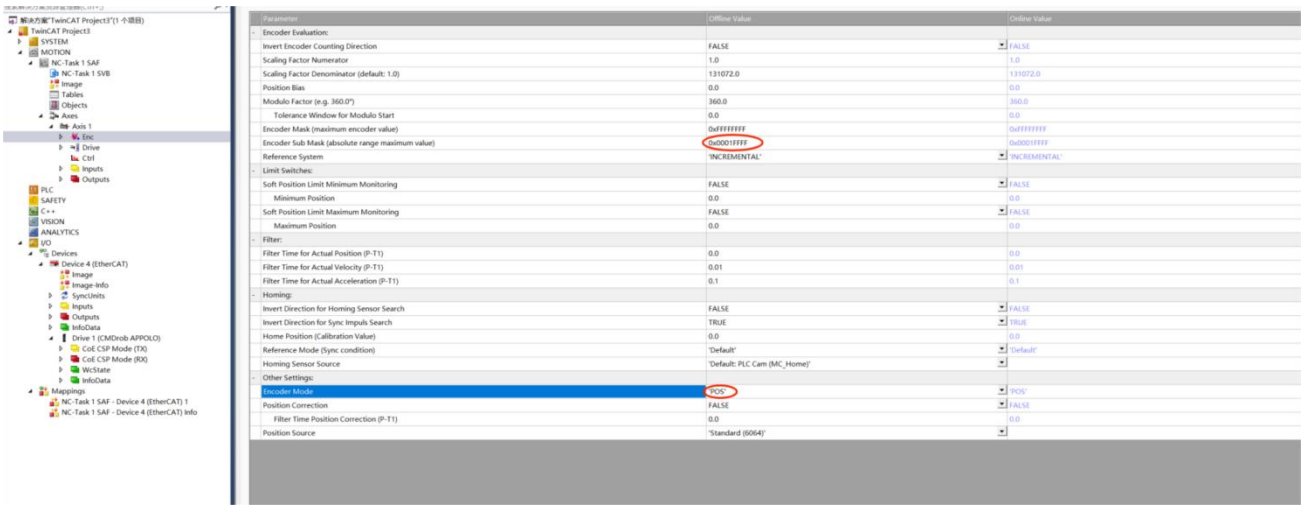
b. Set Quantization Factor



ScalingFactor: The distance corresponding to each position feedback pulse from the encoder.

For example, if the motor rotates 131072 pulses per revolution, and one revolution corresponds to 1mm, then the Scaling Factor Numerator should be 1 mm/Inc, and the Scaling Factor Denominator (default 1.0) should be 131072.

c. Set Encoder Feedback Mode to Pos



Encoder Sub Mask (absolute range maximum value): Based on the encoder's single-turn resolution of 131072, set it to 1FFFF.

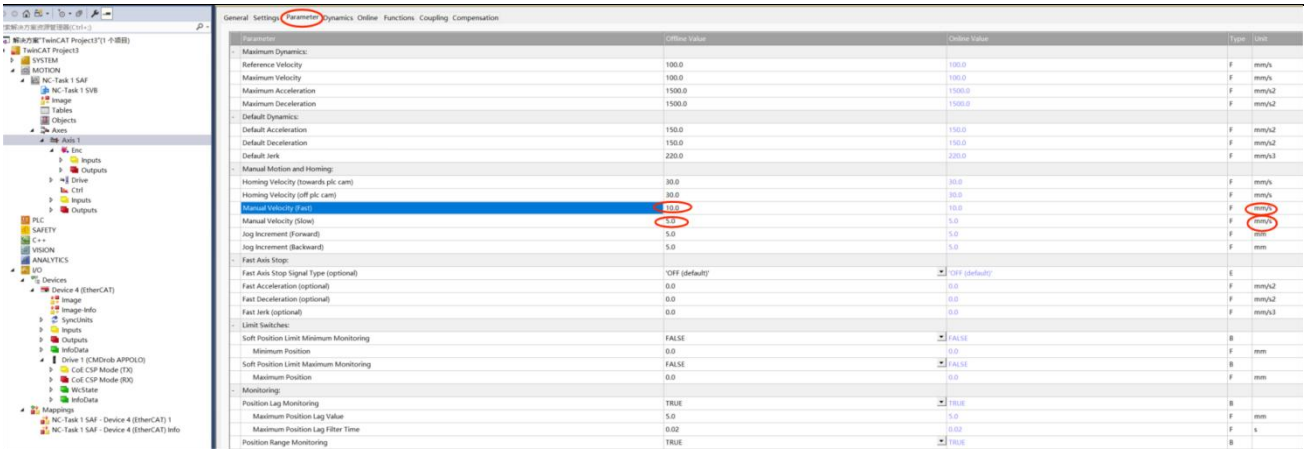
Other Settings Description:

EncoderMode: Encoder mode, with the following three options:

Pos: Encoder is used only for position calculation when the position loop is inside the servo driver.

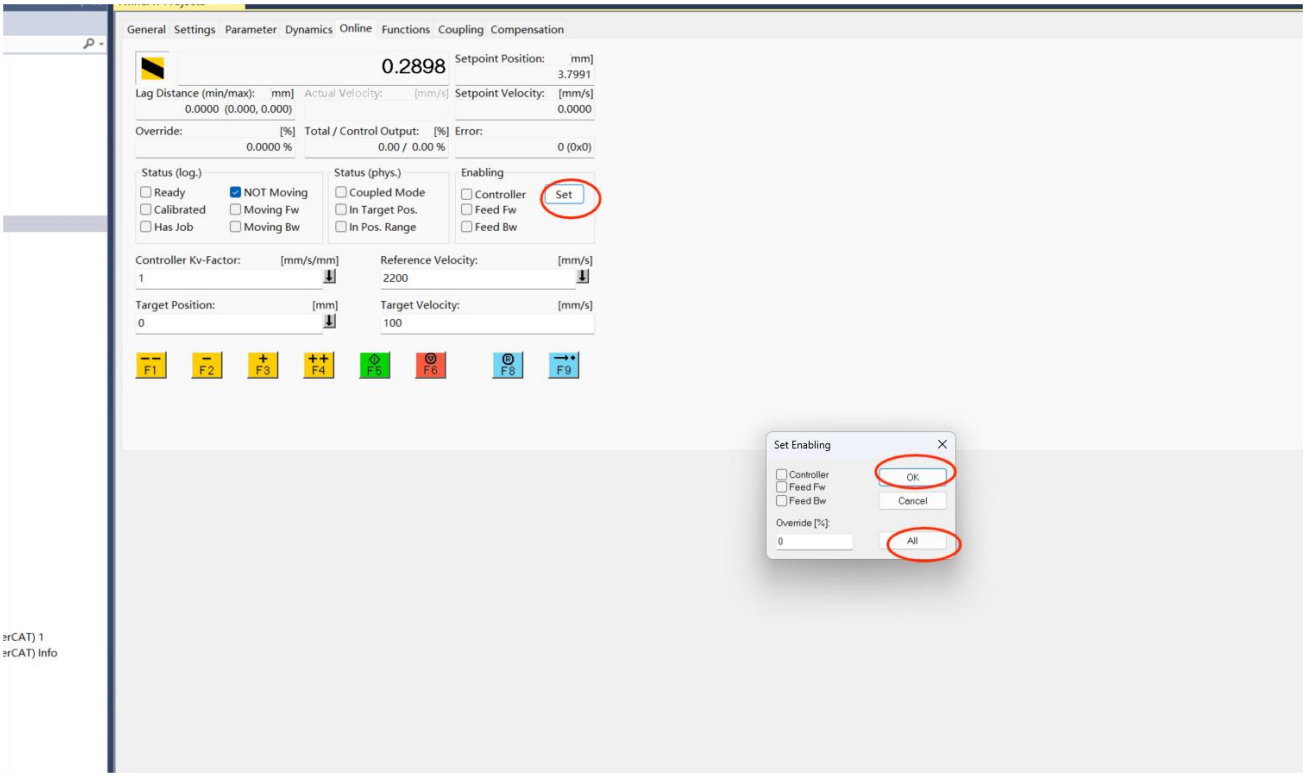
PosVelo: Encoder is used for both position and velocity calculation when the position loop is inside TwinCAT NC.

d. Set Jog Speed



Set the "Manual Velocity (Fast)" jog speed to 10 mm/s and "Manual Velocity (Slow)" to 5 mm/s.

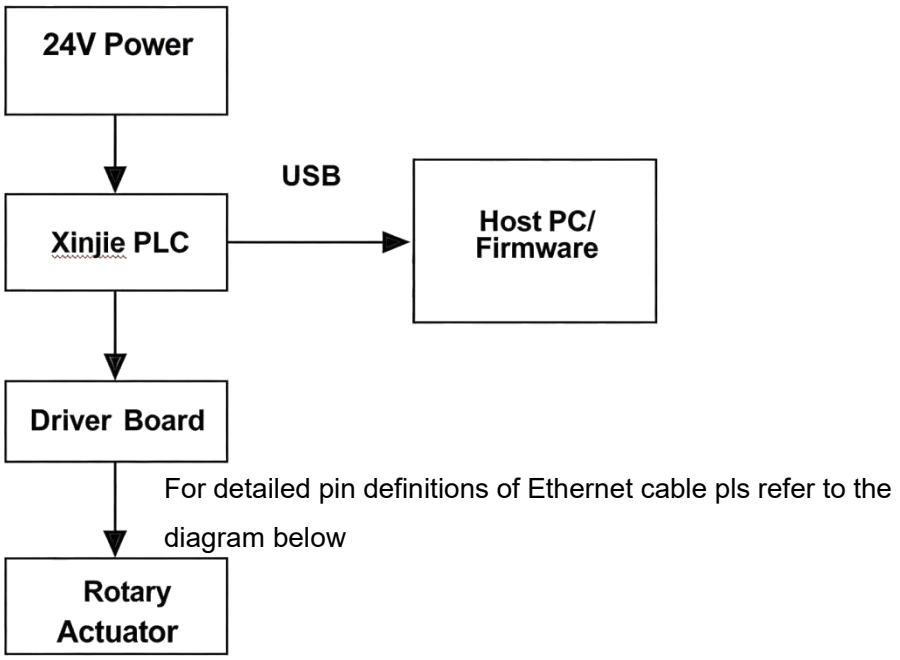
e. Jog Test



Click "Set" to open the dialog, then click "All". At this point, the servo driver is enabled. Jogging operation can be performed using F1~F4.

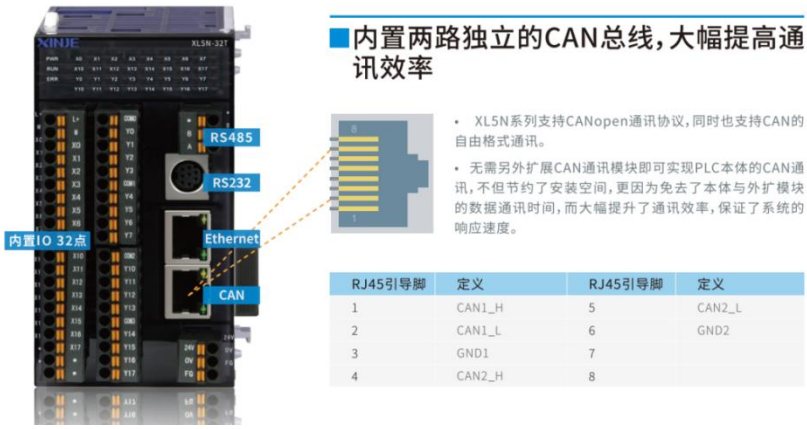
Application Example Using Xinje Controller

Below is a simple usage and configuration example of the robot joint module using Xinje's XL series PLC as the CANopen master. The wiring diagram is shown below:

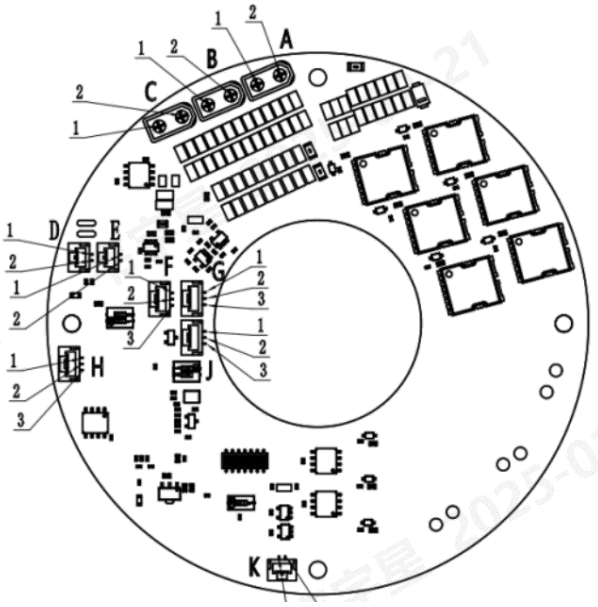


Wiring Diagram for Configuring the Module with Xinje Controller

Xinje PLC Ethernet Port Pin Definition:



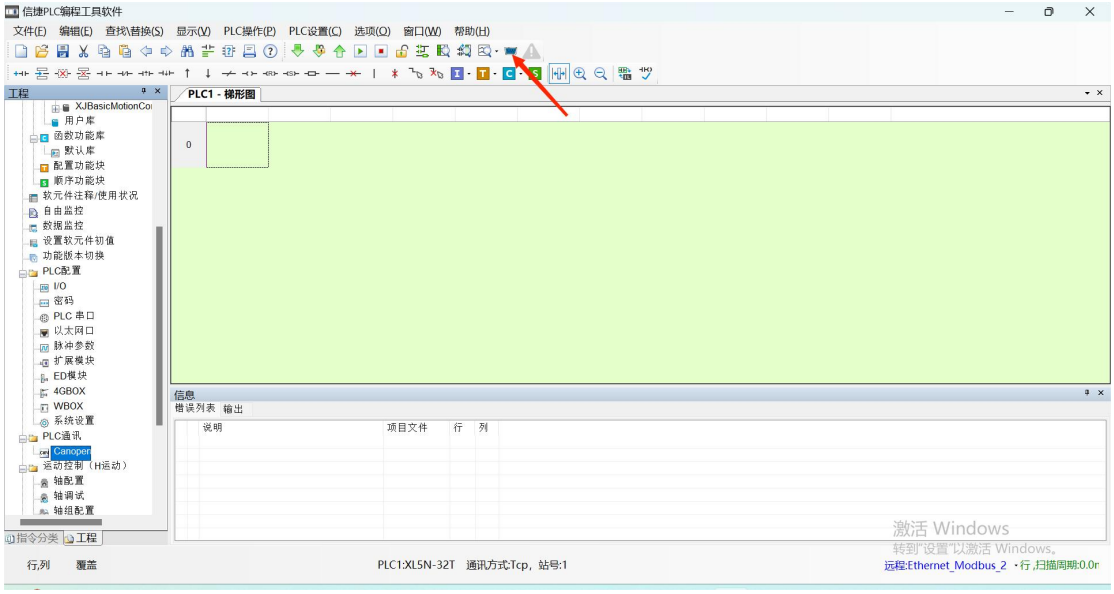
CANopen Interface Pin Definition of the Module Driver Board (taking the 142 model as an example; for others, see Chapter 8):

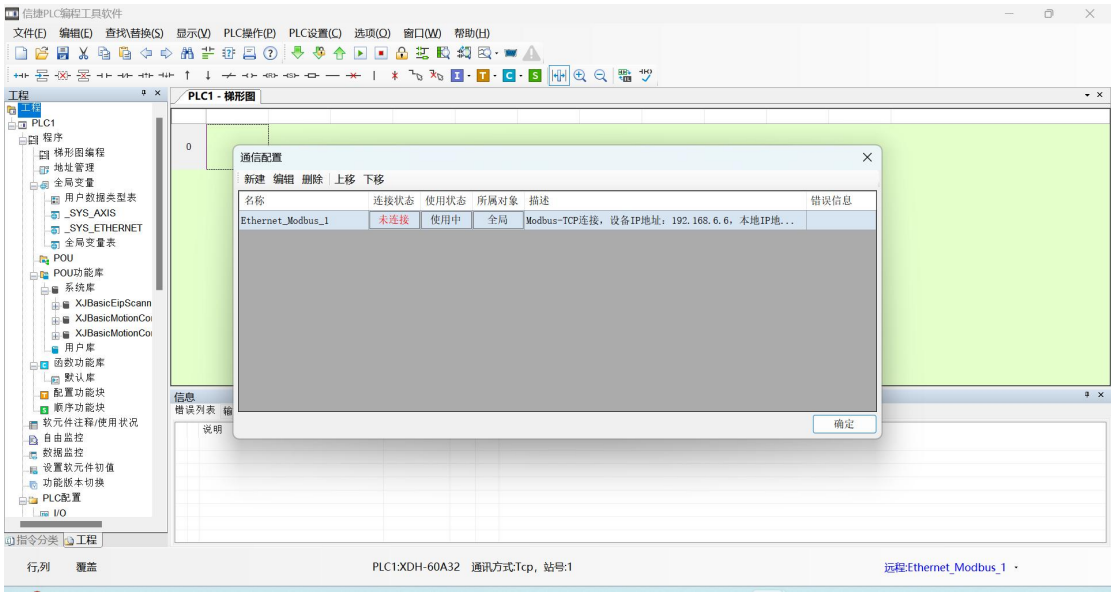


F/G	1	CANL	CAN bus Low
	2	GND	CAN bus Ground
	3	CANH	CAN bus High

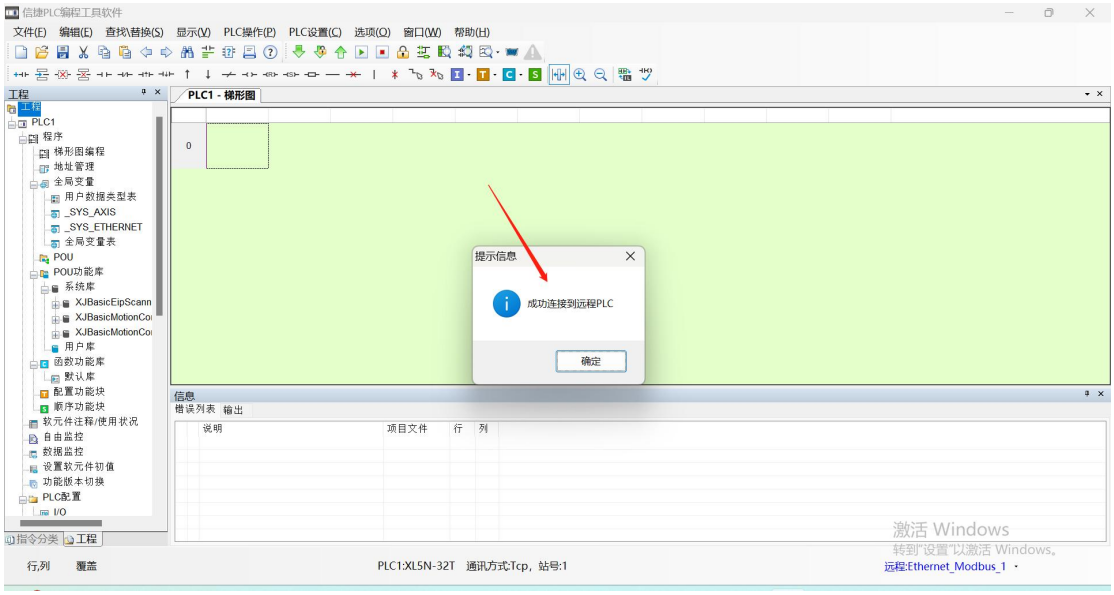
CANopen Configuration:

1. Open the software and click "Serial Port Settings" in the "Menu" as shown below:

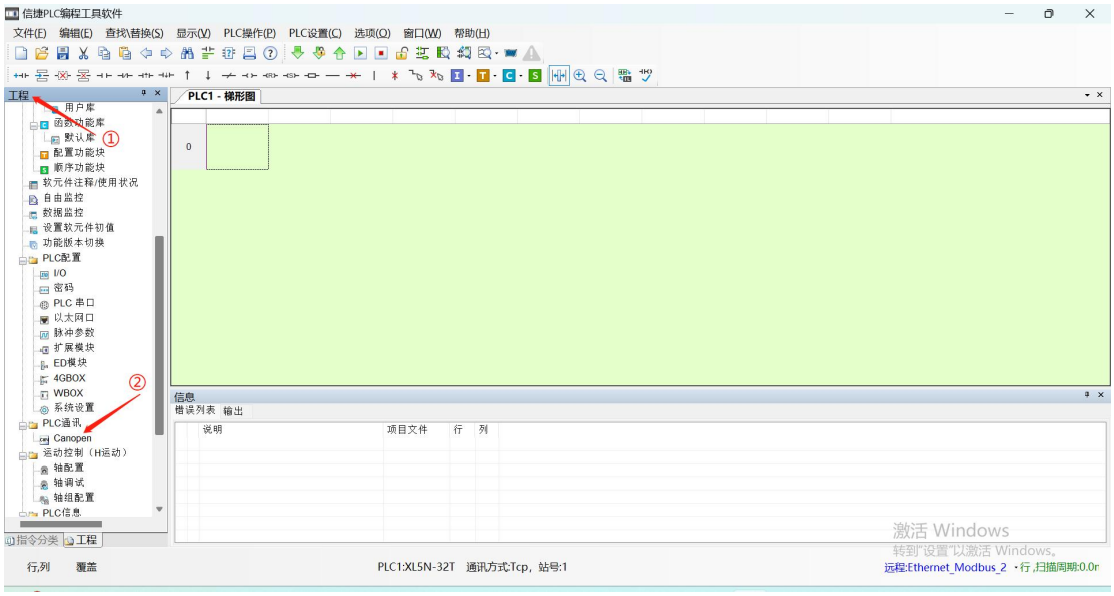


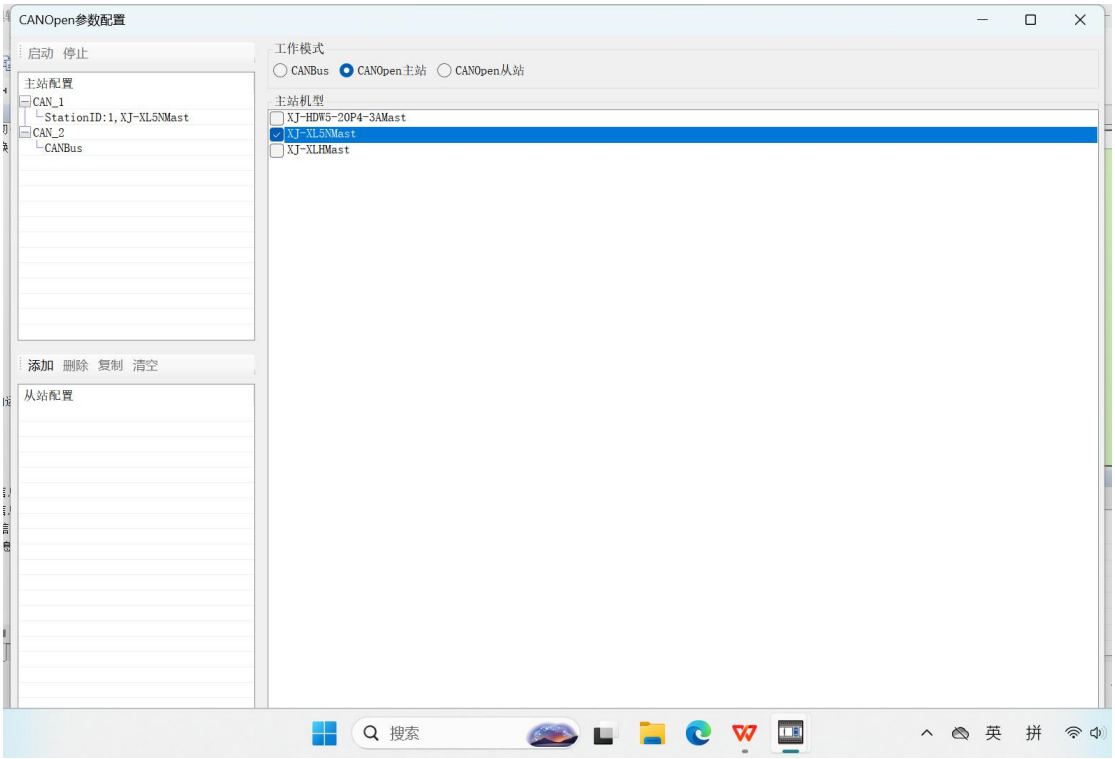


2. Create a new communication project and connect to the PLC.

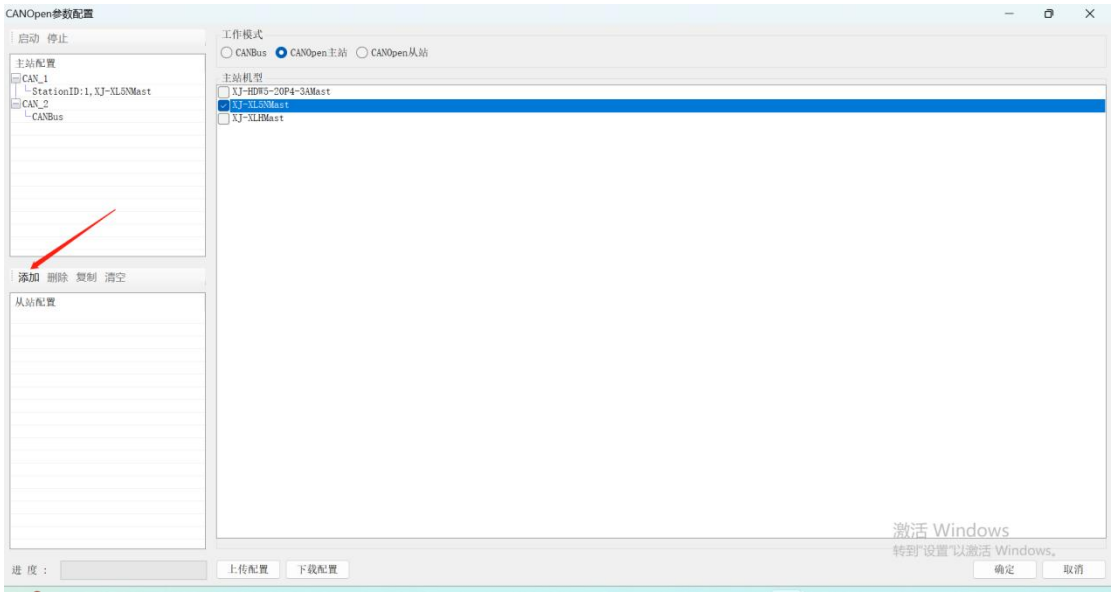


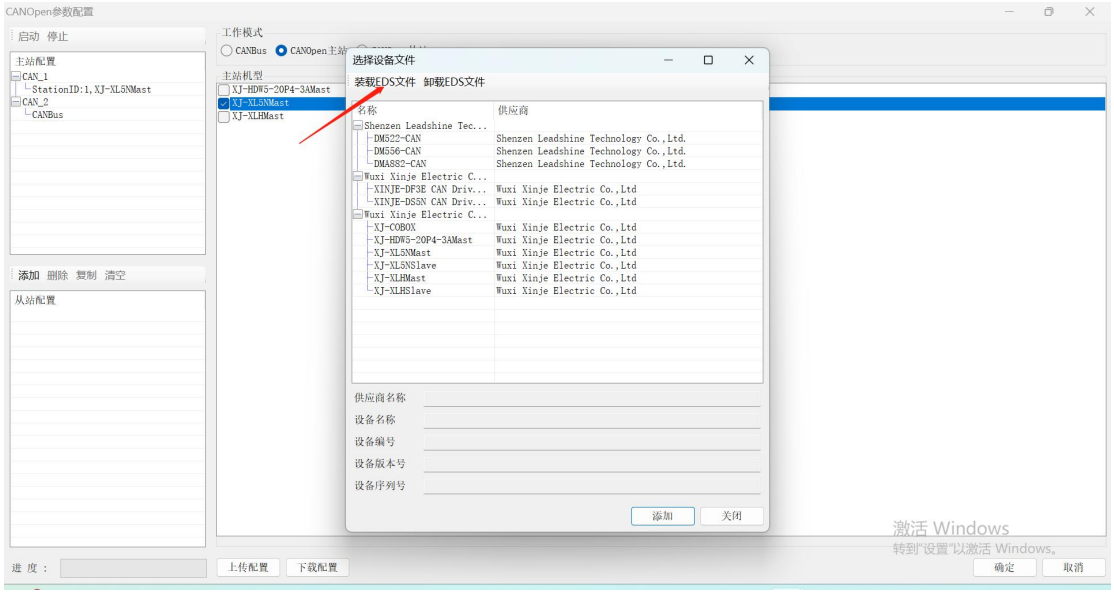
3. Once connected successfully, the software will automatically return to the main page. Locate and click " CANopen" under “PLC Communication” in the “Project” section on the left, and the “CANopen Parameter Configuration” window will appear.

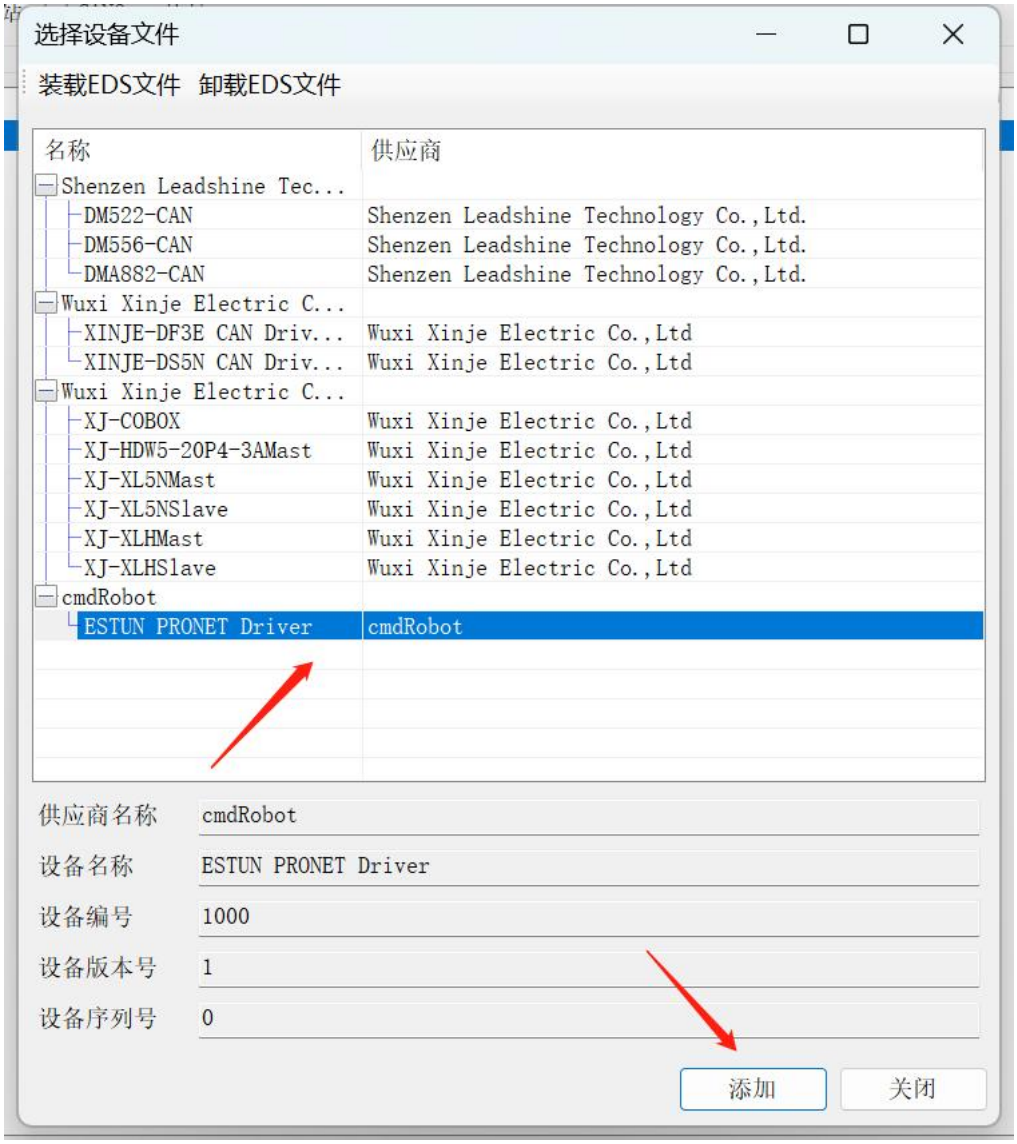




4. In the “CANopen Parameter Configuration” window, click “Add” to configure a slave device. The “Select Device File” window will appear. Click “Load EDS File,” select the appropriate EDS file, and then click “Add.”


CANOpen参数配置
启动 停止
主站配置
CAN_1
StationID:1,XJ-XL5NMast
CAN_2
CANBus
工作模式
CANBus
CANOpen主站
CANOpen从站
主站机型
XJ-HDW5-20P4-3AMast
XJ-XL5NMast
XJ-XLHMast
添加 删除 复制 清空
从站配置
进 度 :
上传配置
下载配置
确定
取消
激活 Windows
转到"设置"以激活 Windows。


CANOpen参数配置
选择设备文件
装载EDS文件 卸载EDS文件
名称
供应商
Shenzen Leadshine Tec...
DM522-CAN Shenzen Leadshine Technology Co.,Ltd.
DM556-CAN Shenzen Leadshine Technology Co.,Ltd.
DMA882-CAN Shenzen Leadshine Technology Co.,Ltd.
Wuxi Xinje Electric C...
XINJE-DF3E CAN Driv... Wuxi Xinje Electric Co.,Ltd
XINJE-DS5N CAN Driv... Wuxi Xinje Electric Co.,Ltd
Wuxi Xinje Electric C...
XJ-COBOX Wuxi Xinje Electric Co.,Ltd
XJ-HDW5-20P4-3AMast Wuxi Xinje Electric Co.,Ltd
XJ-XL5NMast Wuxi Xinje Electric Co.,Ltd
XJ-XL5NSlave Wuxi Xinje Electric Co.,Ltd
XJ-XLHMast Wuxi Xinje Electric Co.,Ltd
XJ-XLHSlave Wuxi Xinje Electric Co.,Ltd
供应商名称
设备名称
设备编号
设备版本号
设备序列号
添加
关闭
激活 Windows
转到"设置"以激活 Windows。

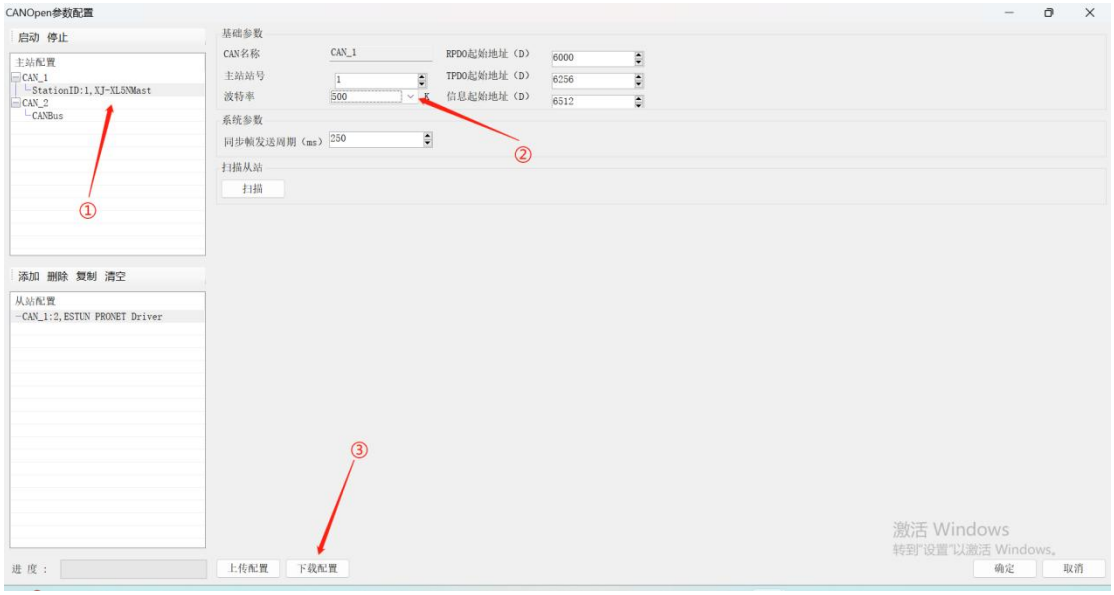


5. Return to the “CANopen Parameter Configuration” window. Click on “StationID:1, XJ-XL5NMast” under the master “CAN_1” to enter the “Basic Parameters” section. Set the baud rate to 500K and click “Download Configuration.”

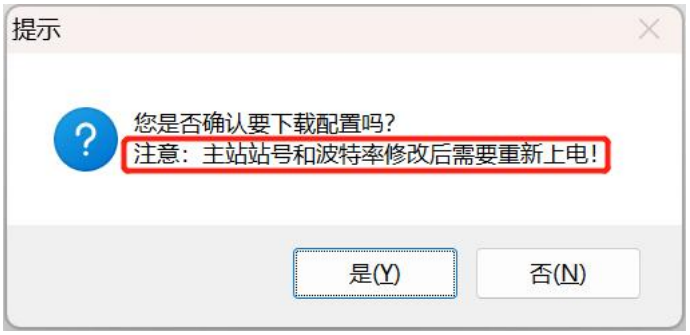
(Note:

① Modified master station number and baud rate require a power cycle and re-establishment of communication connection.

② The master’s baud rate must match that of the third-party device.)



Click “Yes” when the following confirmation window appears.

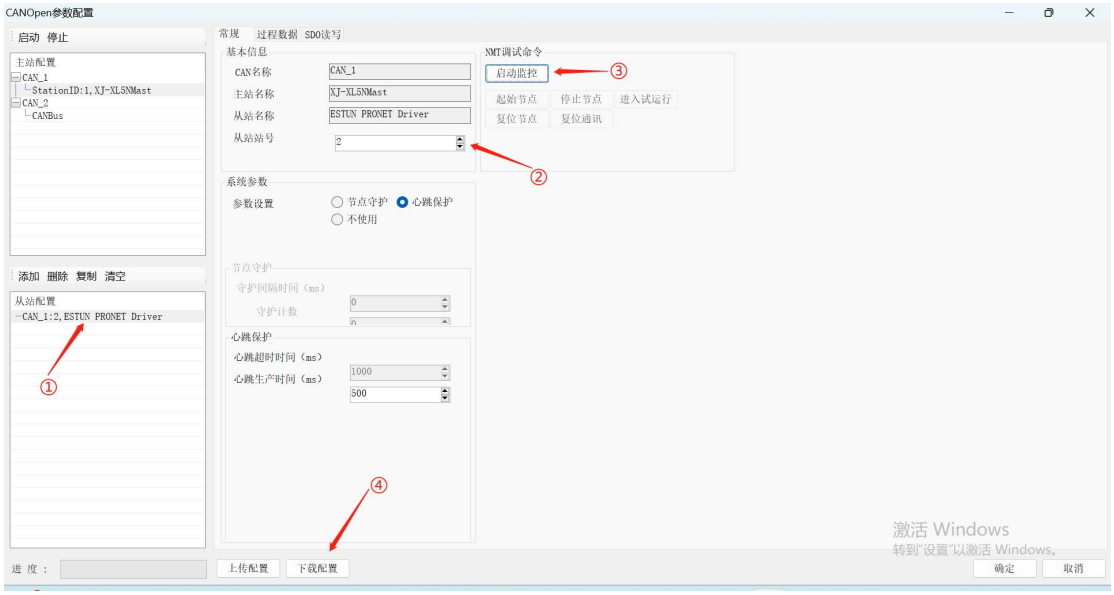


After reconnecting, the master’s baud rate will be updated to 1000K. Then click on “CAN_1:2, XXXX” under “ Slave Configuration,” go to the “General” tab to check the slave station ID, click “Start Monitoring,” and then click “Download Configuration.”

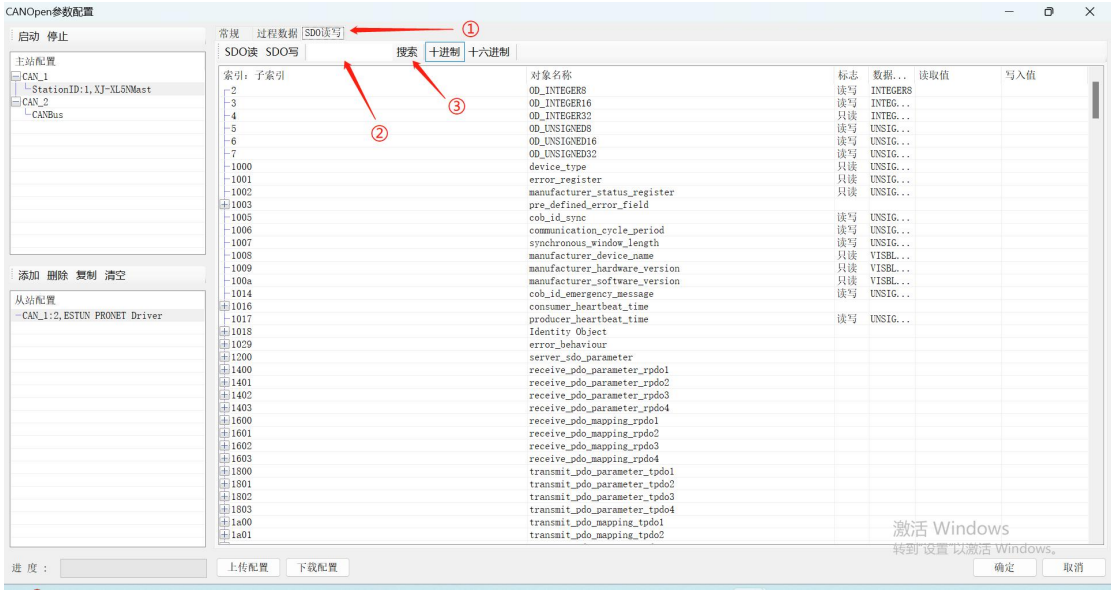
(Note:

① The slave station ID must match the communication node of the third-party driver and should start from ID 3.

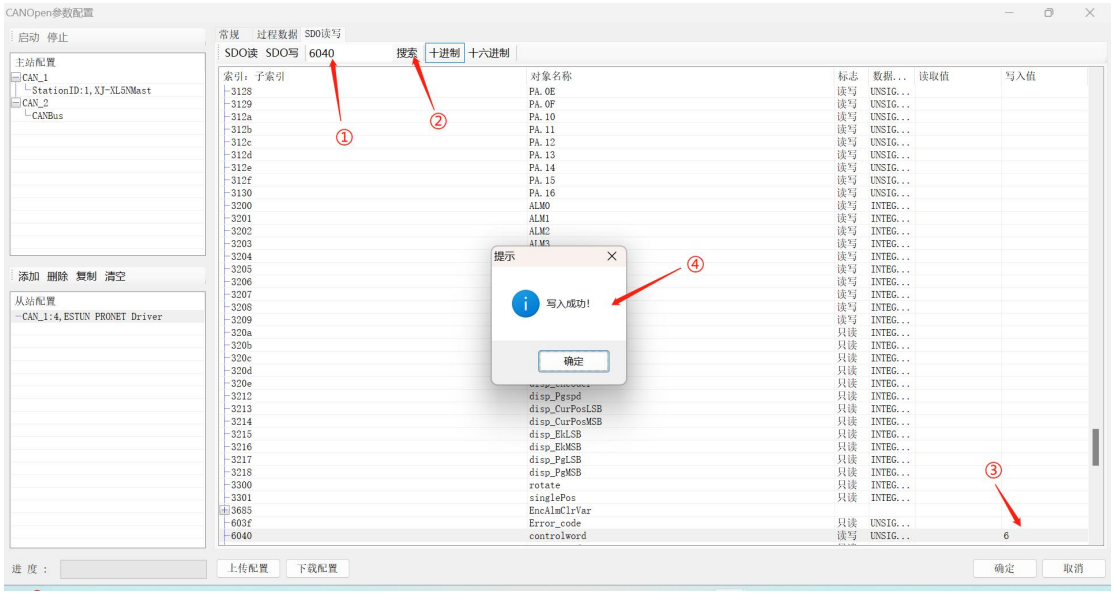
② After changing the communication node of the third-party driver, it must be powered off and restarted.)



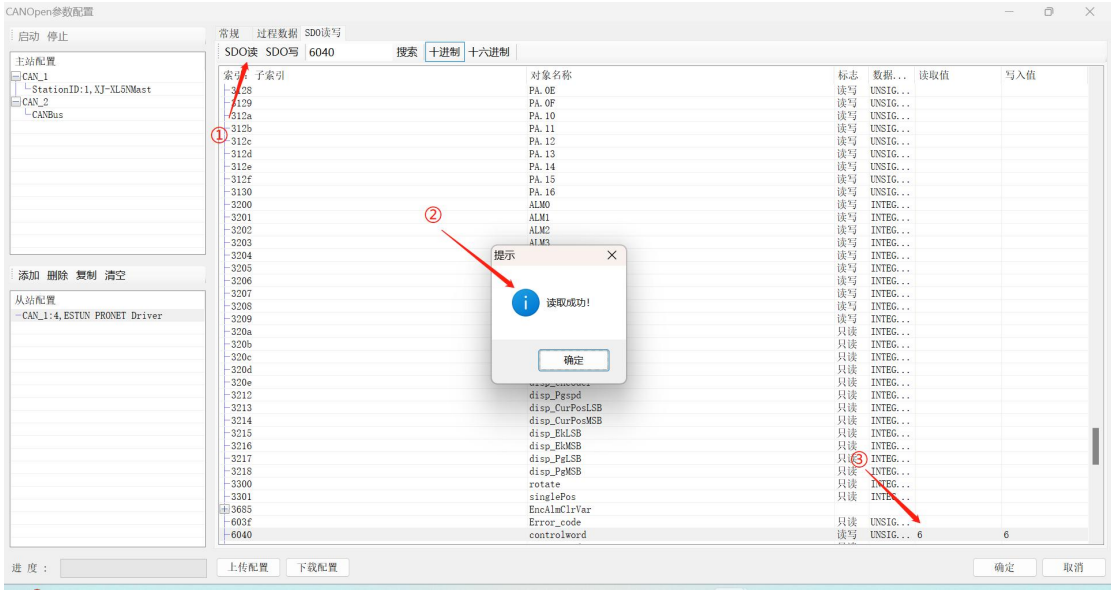
6. Click “SDO Read/Write,” enter the relevant index in the search box, and click “Search.”



7. In the “SDO Read/Write” window, enter “6040,” click “Search,” select “6040,” and then enter “6” in the “ Write Value” field. Click “SDO Write,” and a “Success” prompt will appear.



Click “SDO Read,” and a “Success” prompt will confirm that the value “6” has been correctly read back in the “Read Value” column for “6040.”



Repeat the process to write values “7” and “15.” Once completed, the motor connected to the driver will be enabled, indicating that the PLC and the driver have been successfully connected via CANopen.

CAN FD Message Description

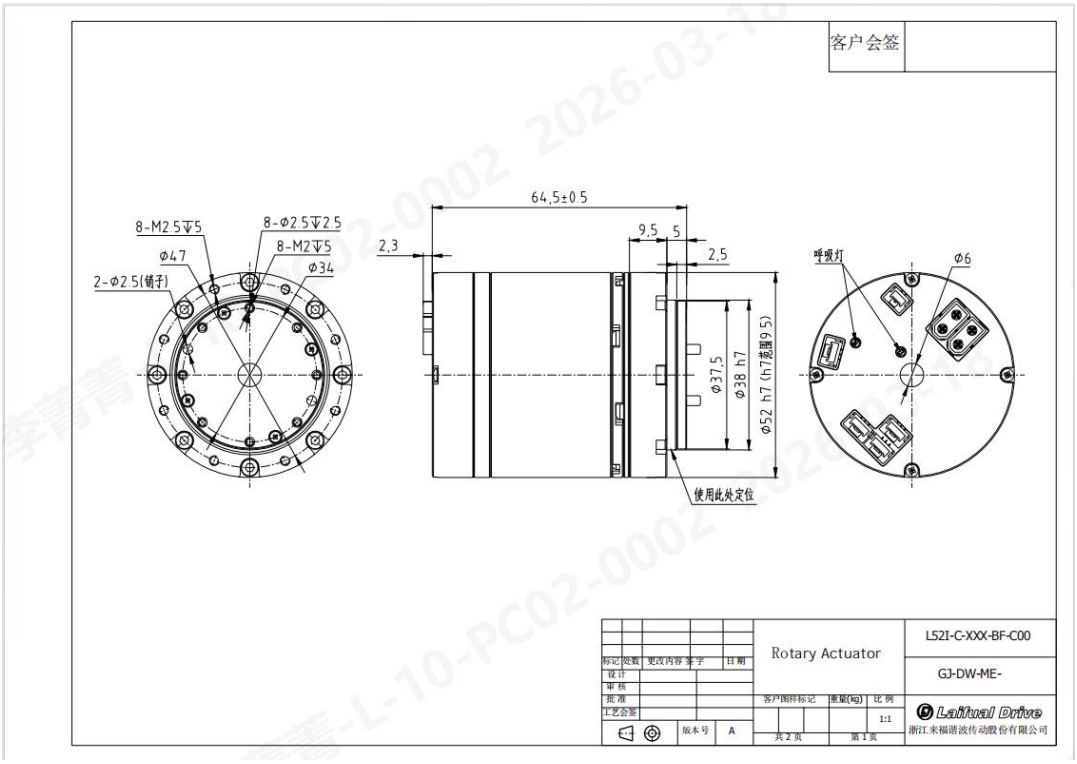
	Tx (Master → Slave)	Rx (Master ← Slave)
0	CRC Value High Byte	CRC Value High Byte
1	CRC Value Low Byte	CRC Value Low Byte
2	Counter High Byte	Counter High Byte
3	Counter Low Byte	Counter Low Byte
4	Reserved	Reserved
5	Reserved	Reserved
6	Reserved	Reserved
7	Reserved	Reserved
8	Speed Loop P High Byte	Speed Loop P High Byte
9	Speed Loop P Low Byte	Speed Loop P Low Byte
10	Speed Loop I High Byte	Speed Loop I High Byte
11	Speed Loop I Low Byte	Speed Loop I Low Byte
12	Position Loop P High Byte	Position Loop P High Byte
13	Position Loop P Low Byte	Position Loop P Low Byte
14	bit0: Speed Loop Setting (0/1) bit1: Write to ROM/RAM bit2: Position Loop Setting (0/1) bit3: Write to ROM/RAM bit4: Encoder Zero Offset Setting (0/1) bit5: Write to ROM/RAM	Reserved
15	Position Planning Acceleration High 2	Position Planning Acceleration High 2
16	Position Planning Acceleration High 1	Position Planning Acceleration High 1
17	Position Planning Acceleration Low 1	position Planning Acceleration Low 1
18	Position Planning Acceleration Low 2	Position Planning Acceleration Low 2
19	Position Planning Deceleration High 2	Position Planning Deceleration High 2
20	Position Planning Deceleration High 1	Position Planning Deceleration High 1
21	Position Planning Deceleration Low 1	Position Planning Deceleration Low 1
22	Position Planning Deceleration Low 2	Position Planning Deceleration Low 2
23	Speed Planning Acceleration High 2	Speed Planning Acceleration High 2
24	Speed Planning Acceleration High 1	Speed Planning Acceleration High 1
25	Speed Planning Acceleration Low 1	Speed Planning Acceleration Low 1
26	Speed Planning Acceleration Low 2	Speed Planning Acceleration Low 2
27	Speed Planning Deceleration High 2	Speed Planning Deceleration High 2
28	Speed Planning Deceleration High 1	Speed Planning Deceleration High 1
29	Speed Planning Deceleration Low 1	Speed Planning Deceleration Low 1
30	Speed Planning Deceleration Low 2	Speed Planning Deceleration Low 2
31	bit0: Position Acceleration Setting (0/1) bit1: Write to ROM/RAM bit2: Position Deceleration Setting (0/1) bit3: Write to ROM/RAM bit4: Speed Acceleration Setting (0/1)	Reserved

	Tx (Master → Slave)	Rx (Master ← Slave)
	bit5: Write to ROM/RAM bit6: Speed Deceleration Setting (0/1) bit7: Write to ROM/RAM	
32	Multi-turn Encoder Zero Offset Command High 2	Multi-turn Encoder Homing Command 35 High 2
33	Multi-turn Encoder Zero Offset Command High 1	Multi-turn Encoder Homing Command 35 High 1
34	Multi-turn Encoder Zero Offset Command Low 1	Multi-turn Encoder Homing Offset Command 35 Low 1
35	Multi-turn Encoder Zero Offset Command Low 2	Multi-turn Encoder Homing Offset Command 35 Low 2
36	Command: Write Current Multi-turn Position to ROM as Motor Zero (0/1)	Motor Temperature
37	Motor Enable Control	Voltage Value
38	Motor Stop Command: Speed = 0, Keep Enabled	
39	Control Command 1: Torque Closed-Loop Control 2: Speed Closed-Loop Control 3: Absolute Position Closed-Loop Control 4: Relative Position Closed-Loop Control	Motor Operation Mode1: Torque Closed-Loop Control2: Speed Closed-Loop Control3: Absolute Position Closed-Loop Control4: Relative Position Closed-Loop Control
40	Torque Current Control Value High Byte (Unit: ‰ of Rated)	Torque Current High Byte
41	Torque Current Control Value Low Byte	Torque Current Low Byte
42	Speed Command High Byte (Unit: 0.1 rpm)	Motor Speed High Byte
43	Speed Command Low Byte	Motor Speed Low Byte
44	Speed Limit High Byte (Position Control Mode, Unit: 0.1 rpm)	Error Code
45	Speed Limit Low Byte (Position Control Mode)	
46	Position Command High Byte 2	Multi-turn Encoder Position Command High Byte 2
47	Position Command High Byte 1	Multi-turn Encoder Position Command High Byte 1
48	Position Command Low Byte 1	Multi-turn Encoder Position Command Low Byte 1
49	Position Command Low Byte 2	Multi-turn Encoder Position Command Low

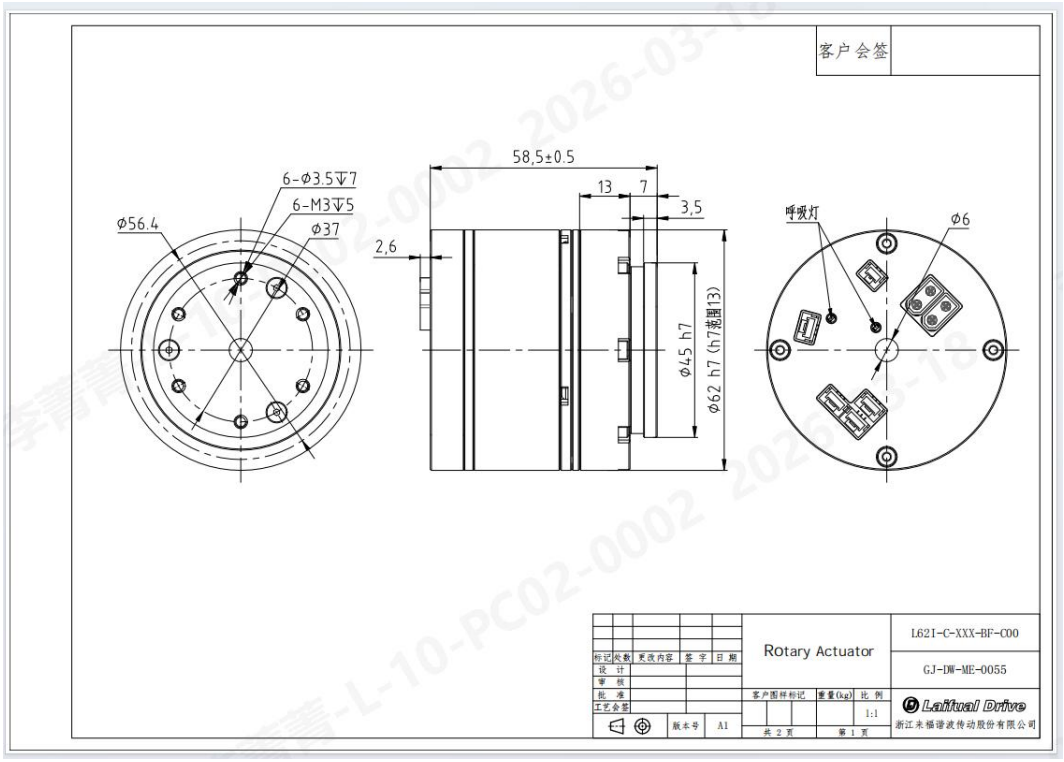
	Tx (Master → Slave)	Rx (Master ← Slave)
		Byte 2
50	Brake Command 0: Brake Release 1:Brake Clamp 2:Brake Release	Brake Status
51	CAN ID Setting	
52	Positive Position Limit Command High Byte 2	Multi-turn Encoder Raw Position Command High Byte 2
53	Positive Position Limit Command High Byte 1	Multi-turn Encoder Raw Position Command High Byte 1
54	Positive Position Limit Command Low Byte 1	Multi-turn Encoder Raw Position Command Low Byte 1
55	Positive Position Limit Command Low Byte 2	Multi-turn Encoder Raw Position Command Low Byte 2
56	Negative Position Limit Command High Byte 2	Software Version High Byte
57	Negative Position Limit Command High Byte 1	Software Version Low Byte
58	Negative Position Limit Command Low Byte 2	Motor Model I/T/S
59	Negative Position Limit Command Low Byte 1	
60	Error Reset Command	

Appendix 1 Module Dimension Drawing

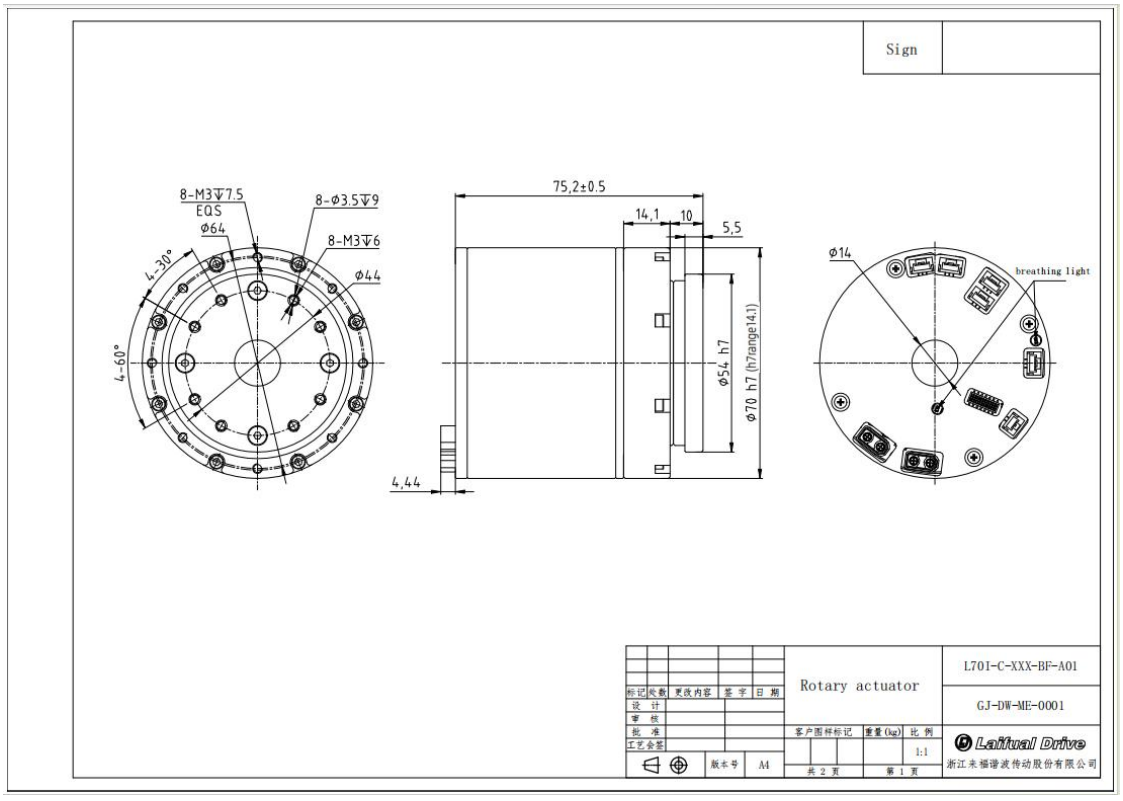
L-52-I-XX



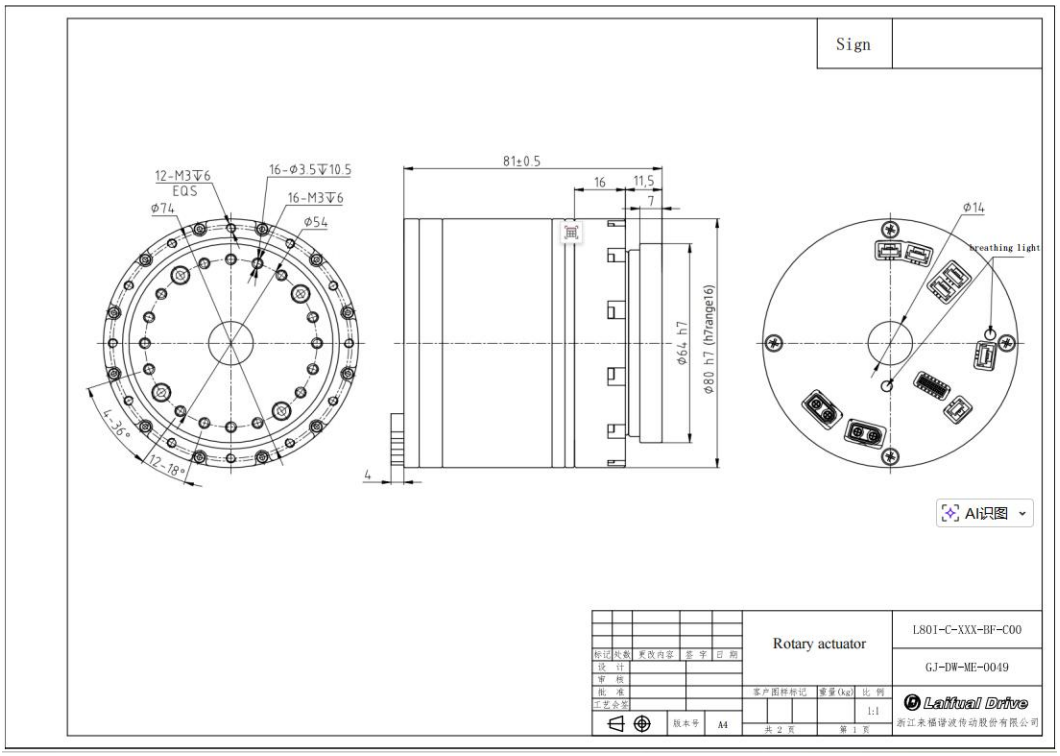
L-62-I-XX



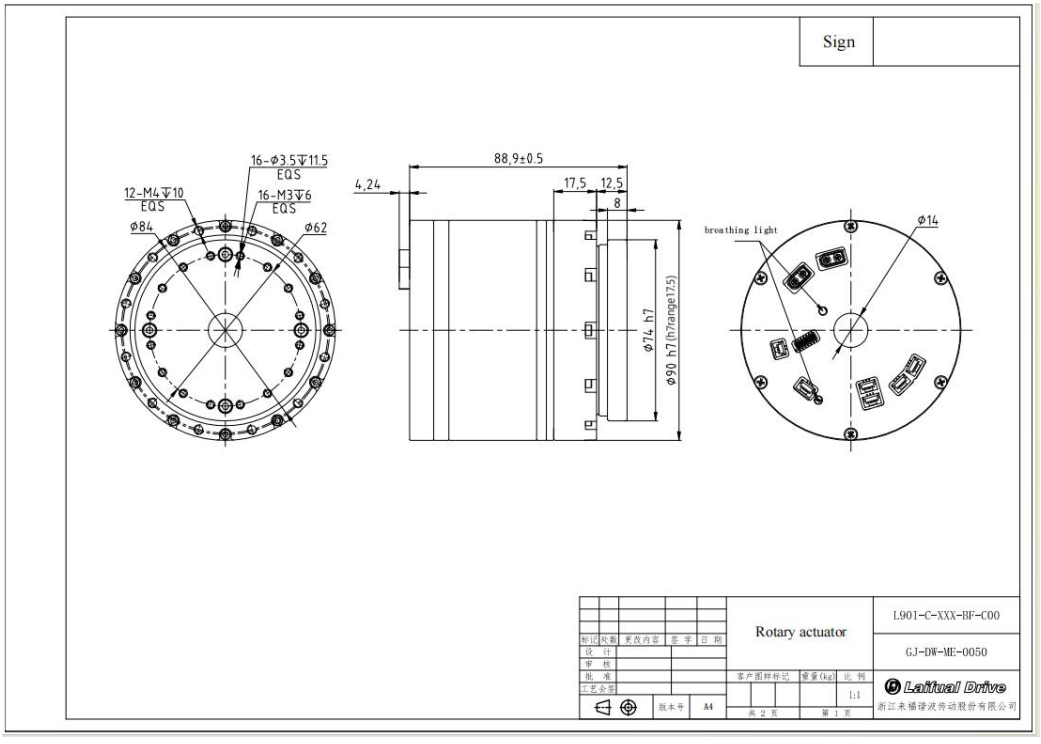
L-70-I-XX



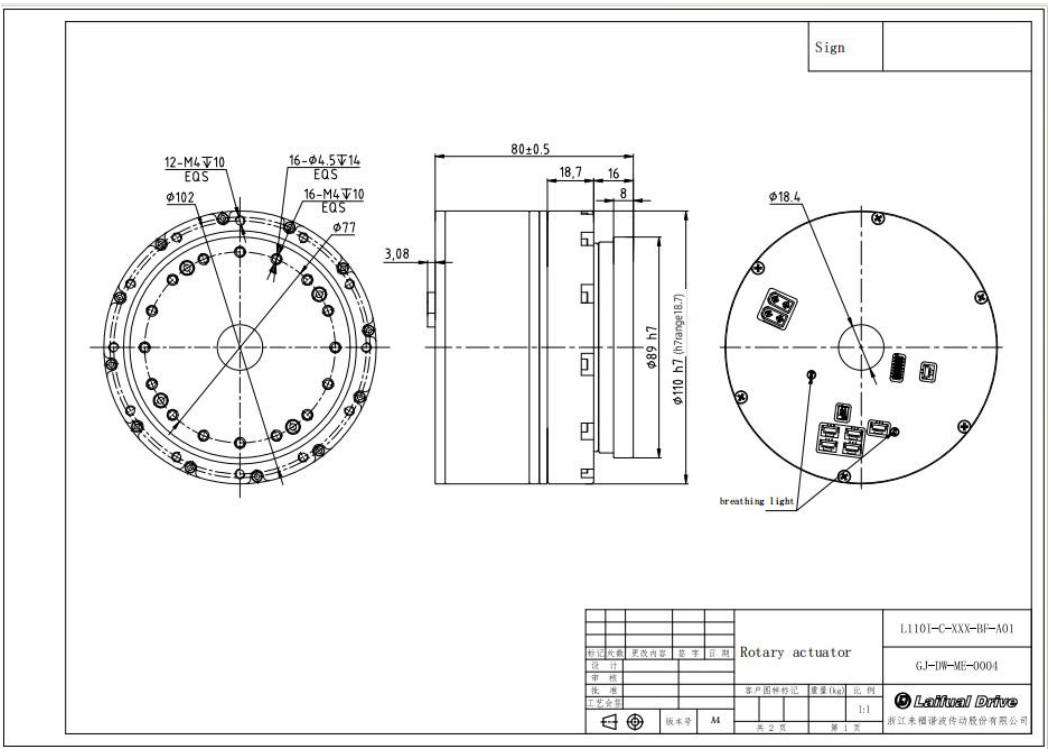
L-80-I-XX



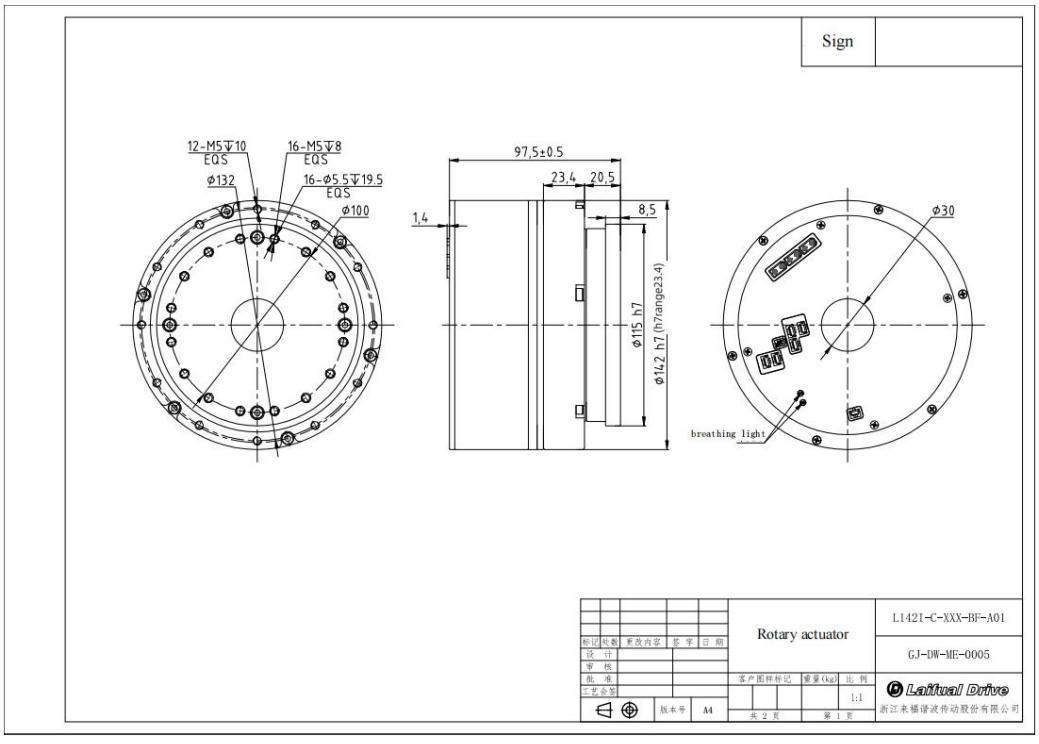
L-90-I-XX



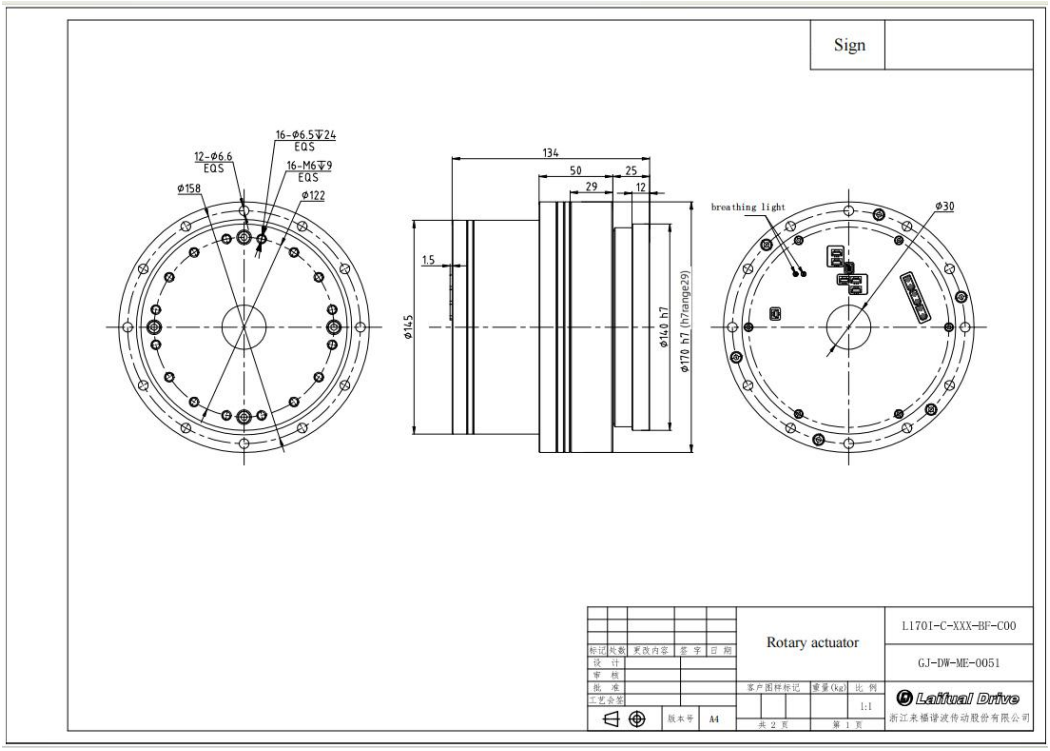
L-110-I-XX



L-142-I-XX



L-170-I-XX



Note: Please check the attached drawing for confirmation or contact us for any unshown dimensional tolerances.

Appendix 2 Parameters

Firmware Parameters

Parameter No.	Object Dictionary Address	Communication Protocol	Parameter Name	Parameter Description	Parameter Unit	Minimum Value	Maximum Value	Default Value	Effective After Restart
P0.00	0x3000	CANOpen&EtherCAT	Motor Type	[0] 81Ratio [1] 51Ratio [2] 101Ratio [3] 121Ratio	—	0	3	0	NEEDRE BOOT
P0.01	0x3001	CANOpen&EtherCAT	Motor Type	Selected Motor Parameter table [0] T Joint [1] I Joint	—	0	3	0	NEEDRE BOOT
P0.02	0x3002	CANOpen&EtherCAT	Encoder Type	[0] Signle-turn [1] Signle-turn+ Multi-turn	—	0	1	1	NEEDRE BOOT
P0.03	0x3003	CANOpen&EtherCAT	Drive Type	[0] 14 [1] 17 [2] 20 [3] 25 [4] 32 [5] 40	—	0	15	0	NEEDRE BOOT
P0.04	0x3004	CANOpen&EtherCAT	Motor Positive Rotation Direction	[0]Counterclockwise Positive Rotation Direction [1] Clockwise Positive Rotation Direction。	—	0	1	0	NEEDRE BOOT
P0.05	0x3005	CANOpen&EtherCAT	Control mode rotation	[C] Position control (contact command) [D] Speed control (parameter command)	—	0	13	13	NEEDRE BOOT
P0.06	0x3006	CANOpen&EtherCAT	Internal enable command	[0]External S-ON valid [1] External S-ON invalid — motor excitation signal will be automatically activated after S-RDY output.	—	0	1	0	NEEDRE BOOT
P0.07	0x3007	CANOpen&EtherCAT	Full closed-loop enable	Full closed-loop enable	—	0	1	0	NEEDRE BOOT
P0.08	0x3008	CANOpen&EtherCAT	UV commutation	Swap the UV phase sequence.	—	0	1	0	NEEDRE BOOT
P0.09	0x3009	CANOpen&EtherCAT	Module ratio	Reducer Ratio	—	50	200	81	NEEDRE BOOT
P1.00	0x300A	CANOpen&EtherCAT	Position loop gain	This value determines the gain	1/s	0	1000	40	NOREBO OT

				of the position loop. Increasing it enhances servo stiffness in position control, but excessive gain may cause oscillation。					
P1.05	0x300F	CANOpen&EtherCAT	Position command filter time constant	This value is used for smoothing the input pulses. A larger value results in better smoothing effect, but an excessively large value will cause signal lag. Unit: 0.1 ms	0.1ms	0	32767	0	NOREBO OT
P1.06	0x3010	CANOpen&EtherCAT	Position command filter type selection	[0]: First-order filter [1]: Second-order filter	—	0	1	0	NEEDRE BOOT
P1.07	0x3011	CANOpen&EtherCAT	Speed bias	This value is set to shorten positioning time. However, if set too high or not properly coordinated with Pn112, it may cause vibration. It is related to the speed command, deviation counts, and Pn500 (positioning error).	rpm	0	300	0	NOREBO OT
P1.08	0x3012	CANOpen&EtherCAT	Velocity feedforward percentage	Used to set the position feedforward value. A higher value results in faster position response and smaller position deviation. Setting this value too high may cause overshoot and oscillation.	%	0	100	0	NOREBO OT
P1.09	0x3013	CANOpen&EtherCAT	Velocity feedforward filter time	Mechanical shock caused by smooth torque feedforward.	0.1ms	0	640	0	NOREBO OT
P1.0A	0x3014	CANOpen&EtherCAT	Deviation counter reset method	[0]Deviation counter resets when S-OFF; does not reset on overtravel. [1] Deviation counter does not reset. [2] Deviation counter resets on S-OFF or overtravel (except zero clamp).	—	0	2	0	NEEDRE BOOT
P1.0B	0x3015	CANOpen&EtherCAT	Deviation counter overflow alarm	When the deviation counter value exceeds this setting, it is considered an	256puls	1	32767	1024	NOREBO OT

				overflow and triggers an alarm signal.					
P1.0C	0x3016	CANOpen	Positioning time	This value sets the time required to complete positioning. Unit: 0.1 ms	0.1ms	0	60000	30000	NOREBO OT
P2.00	0x3017	CANOpen&EtherCAT	Velocity loop gain	This value determines the gain of the velocity loop. Ensure Pn106 (load inertia percentage) is set correctly.	rad/s	1	4000	500	NOREBO OT
P2.01	0x3018	CANOpen&EtherCAT	Velocity loop integration time	Reducing this value can shorten positioning time and improve velocity response.	0.1ms	1	4096	400	NOREBO OT
P2.04	0x301B	CANOpen	Parameter speed	This parameter can be set positive or negative. When control mode Pn005.1 = D, it determines the motor speed. Unit: rpm	rpm	-6000	6000	50	NOREBO OT
P2.05	0x301C	CANOpen	JOG speed	Sets the speed during JOG operation; the direction is determined by the button. Unit: rpm	rpm	0	6000	50	NOREBO OT
P2.06	0x301D	CANOpen	Soft start acceleration time	Time required to accelerate 1000 rpm under ramped speed command. Unit: ms	ms	0	10000	100	NOREBO OT
P2.07	0x301E	CANOpen	Soft start deceleration time	Time required to decelerate 1000 rpm under ramped speed command. Unit: ms	ms	0	10000	100	NOREBO OT
P2.08	0x301F	CANOpen	Velocity filtering time constant	Speed command primary filter time constant. Unit: ms	ms	0	10000	0	NOREBO OT
P2.09	0x3020	CANOpen	Speed command curve form	Speed command curve form [0] ramp [1] S-curve [2]first-order filte [3] second-order filte	—	0	3	0	NEEDRE BOOT
P2.0A	0x3021	CANOpen	S-curve selection	This value determines the transition curve of the S-curve.	—	0	3	0	NOREBO OT
P2.0B	0x3022	CANOpen	S-curve rise time	The time required to transition from one velocity point to another in an S-curve manner.	ms	0	10000	0	NOREBO OT

P2.0C	0x3023	CANOpen	Percentage of load inertia	load inertia to motor rotor inertia. Setpoint = (Load inertia / Rotor inertia) * 100	%	0	20000	0	NOREBO OT
P2.0D	0x3024	CANOpen &EtherCAT	Torque feedforward form	[0]General torque feedforward. [2] High-speed torque feedforward is used.	—	0	3	0	NEEDRE BOOT
P2.0E	0x3025	CANOpen &EtherCAT	Torque feedforward percentage	This is used to set the torque feedforward value to improve speed response. To use this function in manual tuning mode, please correctly set the load moment of inertia ratio Pn106.	%	0	100	0	NOREBO OT
P2.0F	0x3026	CANOpen &EtherCAT	Torque feedforward filter time	Mechanical shock caused by smooth torque feedforward.	0.1ms	0	640	0	NOREBO OT
P2.10	0x3027	CANOpen	Low-speed speed measurement filter	This value setting is used for filtering during low-speed speed measurement. If this value is set too high, the speed measurement will lag during low-speed speed measurement.	0.1ms	0	100	0	NOREBO OT
P2.11	0x3028	CANOpen	Zero clamp speed	When the input analog speed is less than this value, the motor will be locked at the current position.	rpm	0	3000	10	NOREBO OT
P3.01	0x3031	CANOpen &EtherCAT	Torque command filter constant	Setting up torque filtering can eliminate or reduce mechanical vibration, but improper settings can sometimes introduce mechanical vibration.	0.01ms	0	2500	0	NOREBO OT
P3.05	0x3035	CANOpen	Forward internal torque limit	Motor output torque limit value (parameter setting range is based on actual overload capacity).	%	0	400	200	NOREBO OT
P3.06	0x3036	CANOpen	Reverse internal torque limit	—	%	0	400	200	NOREBO OT
P4.07	0x3044	CANOpen	Save the torque	Save the torque	—	0	9999	0	NOREBO OT

			when enabled	when disable					
P4.08	0x3045	CANOpen	Enable torque function under masking and saving	The function to disable and save the enable torque can effectively solve the problem of the robotic arm falling off after being enabled.	—	0	9999	0	NOREBO OT
P4.18	0x3055	CANOpen &EtherCAT	Servo On Waiting Time	These parameters are only effective when the port output parameters are configured to have /BK output. These parameters control the timing of the holding brake (to prevent gravity-induced slippage or continuous external force acting on the motor).	ms	-2000	2000	-1000	NOREBO OT
P4.19	0x3056	CANOpen &EtherCAT	Basic waiting process	—	10ms	0	500	20	NOREBO OT
P4.1A	0x3057	CANOpen &EtherCAT	Braking waiting speed	—	rpm	10	100	100	NOREBO OT
P4.1B	0x3058	CANOpen &EtherCAT	Braking waiting time	—	10ms	0	100	0	NOREBO OT
P4.1C	0x3059	CANOpen	Dynamic braking time	—	ms	50	2000	1250	NOREBO OT
P5.14	0x3070	CANOpen	Brake test	This bit is used for testing. When this parameter is set to 4, the brake is enabled [4]: the brake is released [other].	—	0	11	1	NEEDRE BOOT
P5.1B	0x3077	CANOpen	Positioning error	If the deviation counter value is less than this value, the positioning is considered to have been achieved.	puls	0	5000	100	NOREBO OT
P5.1C	0x3078	CANOpen	Same speed error	If the error between the speed command value and the speed feedback value is less than the set value of this parameter, then the speed is considered to have been reached.	rpm	0	100	10	NOREBO OT
P5.1D	0x3079	CANOpen	Rotary detection speed	When the motor speed exceeds this value, the motor is considered to have stabilized and is	rpm	0	3000	20	NOREBO OT

				rotating.					
P6.00	0x307F	CANOpen	JPOS0 Point control position pulse (high level)	—	10000 pulses	-9999	9999	0	NOREBO OT
P6.01	0x3080	CANOpen	JPOS0 Point control position pulse (low bit)	—	puls	-9999	9999	0	NOREBO OT
P6.20	0x309F	CANOpen	JPOS0 Point Control Speed	—	rpm	0	6000	500	NOREBO OT
P6.30	0x30AF	CANOpen	JPOS0 point control filter time	—	0.1ms	0	32767	0	NOREBO OT
P6.40	0x30BF	CANOpen	JPOS0 Point Control Stop Time	—	50ms	0	300	10	NOREBO OT
P6.4F	0x30CE	CANOpen	JPOS15 Point Control Stop Time	—	50ms	0	300	10	NOREBO OT
P6.50	0x30CF	CANOpen	Choose between single-cycle and loop-based options, and select the start/reference point.	Select Single/Loop [0] Looping [1] When running a single multi-point loop, after the step change is completed at the end point, the next step change will start from the starting point; when running a multi-point single, the point control program will not perform a step change when it reaches the end point.	—	0	3	0	NOREBO OT
P6.51	0x30D0	CANOpen	Step change and start-up methods	Step change and start-up methods [0]Delayed step change, no start signal required, delayed start after S-ON [2] Delayed step change, start signal required, canceling the start signal can immediately shut down the internal pulse, and return to the program start point during restart.	—	0	3	0	NOREBO OT
P6.52	0x30D1	CANOpen	Step-change input signal mode	Step-change input signal valid mode [0]Step-change input signal level mode [1] Step-change input signal pulse mode	—	0	1	0	NOREBO OT

P6.53	0x30D2	CANOpen	Programming method	Programming methods [0]: Incremental programming [1]: Absolute value programming Incremental programming: relative displacement (position from the current position to the next point) programming; Absolute value programming: absolute displacement (displacement between the worktable and the reference point) programming.	—	0	1	0	NOREBO OT
P6.54	0x30D3	CANOpen	Programming Start Steps		—	0	15	0	NOREBO OT
P6.55	0x30D4	CANOpen	Programming termination step		—	0	15	1	NOREBO OT
P6.56	0x30D5	CANOpen	Search trip speed	Under position contact control, this is the "search travel speed"; under position zeroing control, it's the "speed when finding a reference point".	rpm	0	3000	1500	NOREBO OT
P6.57	0x30D6	CANOpen	Exit limit switch speed	Under position contact control, it refers to the "speed when leaving the limit switch"; under position zeroing control, it refers to the "speed when finding the reference point".	rpm	0	200	30	NOREBO OT
P7.01	0x30D8	CANOpen	MODBUS communication baud rate	[0]4800 [1]9600 [2]19200	—	0	2	1	NEEDRE BOOT
P7.04	0x30DB	CANOpen	MODBUS axis address		—	1	247	1	NEEDRE BOOT
P7.05	0x30DC	CANOpen	CAN synchronization time	Change according to the communication time set by the controller	ms	2	15000	200	NEEDRE BOOT
P7.06	0x30DD	CANOpen	CAN communication rate	[0]50 kbps [1]100 kbps [2]125 kbps [3]250 kbps [4] 500 kbps [5]1000 kbps	—	0	5	5	NEEDRE BOOT

P7.07	0x30DE	CANOpen	CAN communication node		—	1	127	1	NEEDRE BOOT
P7.14	0x30EB	CANOpen	Oscilloscope pre-trigger point setting	In the oscilloscope settings, specify the number of sampling points before the trigger condition is met.	—	0	1000	400	NOREBO OT
P9.04	0x310F	CANOpen	Over-tolerance alarm enable	[0]Out-of-tolerance alarm disabled [1] Out-of-tolerance alarm enabled, alarm when the deviation counter value is greater than the value corresponding to Pn504.	—	0	3	0	NEEDRE BOOT
P9.06	0x3111	CANOpen & EtherCAT	Encoder-related alarm masking	Encoder-related alarm masking bit [0] Detects Encoder alarms [1] Shield alarm	—	0	1	1	NEEDRE BOOT
P9.07	0x3112	CANOpen &EtherCAT	A 14 Alarm Shielding	Low voltage alarm shield bit [0]No alarm shielding [1]Shield alarm	—	0	1	0	NEEDRE BOOT
P9.08	0x3113	CANOpen &EtherCAT	A 13 alarm shielding	Overvoltage alarm (A13\A15) Shield bit [0] Unshield alarm [1] Shield alarm	—	0	1	1	NEEDRE BOOT
P9.09	0x3114	CANOpen &EtherCAT	CAN communication related alarm shielding	Communication alarm related shielding bit [0]Detects A66, A67, A68, A69 [1] Detects A68, A69, shields A66, A67 [2] Detects A66, A67, shields A68, A69 [3] Shields all CAN alarms	—	0	3	3	NEEDRE BOOT
P9.0A	0x3115	CANOpen &EtherCAT	Hardware detection alarm shielding	Hardware alarm enable bit [0]: Do not mask hardware-related alarms: A15, A13, A14 [1] : Shield hardware-related alarms: A15, A13, A14	—	0	1	0	NEEDRE BOOT
P9.0C	0x3117	CANOpen &EtherCAT	A 18 alarm shielding	CPU over-temperature alarm masking [0]Enable A18 alarm	—	0	1	0	NEEDRE BOOT

				detection [1]Shield A18 alarm detection					
P9.0D	0x3118	CANOpen &EtherCAT	A19 alarm shielding	NTC over-temperature alarm shield [0]Enable A19 alarm detection [1]Shield A19 alarm detection	—	0	1	0	NEEDRE BOOT
P9.0E	0x3119	CANOpen &EtherCAT	Overload alarm threshold		%	100	150	100	NOREBO OT
P9.0F	0x311A	CANOpen &EtherCAT	A18 temperature threshold		℃	50	180	95	NOREBO OT
PA.00	0x311B	CANOpen	Motor automatic recognition function enable position	[0] Disable automatic identification function [1] Enable automatic identification function (automatically obtain Drive Motor , EncoderType , and load servo parameters based on these Types , without reading Motor parameters from Pn parameters at this time .)	—	0	1	0	NEEDRE BOOT

CANopen Alarm Code

Servo error alarm numbers and descriptions (CANopen)				
Alarm number	Alarm Name	Alarm Description	Solutions	Shielding position
A.01	Parameter out of range	Parameter out of range		
A.03	speeding	Exceeding the rated speed		
A.04	Motor stall alarm	Motor stall alarm		P3.08=0 shielding
A.05	Position deviation counter overflow	Error counter overflow		
A.06	Excess overflow			P9.04=0 shielding
A.07	Electronic gear ratio setting error	The electronic gear ratio setting is unreasonable.		

A.08	U-phase current detection abnormal	U-phase current sampling voltage reference abnormal		
A.09	abnormal V-phase current detection	V-phase current sampling voltage reference abnormal		
A.10	U-phase overcurrent	Phase U is outside the sampling range		
A.11	V-phase overcurrent	Phase V is outside the sampling range.		
A.12	Overcurrent	IPM module current is too high		
A.13	Overvoltage warning	Bus voltage > 55V		P9.08=1 can be shielded
A.14	undervoltage	Bus voltage <40V		P9.08=1 can be shielded
A.15	Overvoltage alarm	Bus voltage > 80V		P9.08=1 can be shielded
A.18	Motor overheat alarm	The MCU temperature is too high, exceeding the value of parameter P9.0F.		P9.0C=1 can be shielded
A.46	Encoder Multi-turn position error	Magnetic ring displacement		P9.06=1 can be shielded
A.47	Encoder low battery alarm	Encoder battery voltage <3.05V		P9.06=1 can be shielded
A.48	Encoder Low Battery Warning	Encoder battery voltage <3.15V		P9.06=1 can be shielded
A.49	First (Motor-side) Encoder exception	Encoder SPI communication timeout	Confirm whether SW1 is ON	
A.50	Second (reducer end) Encoder exception	Encoder SPI communication timeout	Confirm whether SW1 is ON	
A.54	Encoder verification configuration error	Data configuration bit width error	Re-verify Encoder	
A.66	CAN communication error	CAN communication errors caused by connection abnormalities or interference	P9.09=0, 2 can be enabled	P9.09=3 can be shielded
A.67	Heart bit timeout		P9.09=0, 2 can be enabled	P9.09=3 can be shielded
A.68	Synchronization frames too early		P9.09=0, 1 can be enabled	P9.09=3 can be shielded
A.69	Synchronization frame timeout		P9.09=0, 1 can be enabled	P9.09=3 can be shielded
A.133	Firmware incompatibility	Motor Type and Drive Type do not match		

CAN FD Alarm Code

Servo error alarm numbers and descriptions (CAN FD)				
Alarm number	Alarm Name	Alarm Description	Solutions	Shielding position
A.01	Parameter out of range	Parameter out of range		
A.03	speeding	Exceeding the rated speed		
A.04	Motor stall alarm	Motor stall alarm		P3.08=0 shielding
A.05	Position deviation counter overflow	Error counter overflow		
A.06	Excess overflow			P9.04=0 shielding
A.07	Electronic gear ratio setting error	The electronic gear ratio setting is unreasonable.		
A.08	U-phase current detection abnormal	U-phase current sampling voltage reference abnormal		
A.09	abnormal V-phase current detection	V-phase current sampling voltage reference abnormal		
A.10	U-phase overcurrent	Phase U is outside the sampling range		
A.11	V-phase overcurrent	Phase V is outside the sampling range.		
A.12	Overcurrent	IPM module current is too high		
A.13	Overvoltage warning	Bus voltage > 55V		P9.08=1 can be shielded
A.14	undervoltage	Bus voltage <40V		P9.08=1 can be shielded
A.15	Overvoltage alarm	Bus voltage > 80V		P9.08=1 can be shielded
A.18	Motor overheat alarm	The MCU temperature is too high, exceeding the value of parameter P9.0F.		P9.0C=1 can be shielded
A.46	Encoder Multi-turn position error	Magnetic ring displacement		P9.06=1 can be shielded
A.47	Encoder low battery alarm	Encoder battery voltage <3.05V		P9.06=1 can be shielded
A.48	Encoder Low Battery Warning	Encoder battery voltage <3.15V		P9.06=1 can be shielded
A.49	First (Motor-side) Encoder exception	Encoder SPI communication timeout	Confirm whether SW1 is ON	
A.50	Second (reducer end) Encoder exception	Encoder SPI communication timeout	Confirm whether SW1 is ON	

A.54	Encoder verification configuration error	Data configuration bit width error	Re-verify Encoder	
A.56	Encoder value error	Encoder value error	Power off and restart	
A.133	Firmware incompatibility	Motor Type and Drive Type do not match		
A.100	Message value out of range	Message value out of range	Check the message value	

EtherCAT Alarm Code

Servo error alarm numbers and descriptions (EtherCAT)				
Alarm number	Alarm Name	Possible reasons	Solutions	Shielding position
A.01	Parameter error	Storage application parameter error		
A.02	watchdog Timeout Alarm	watchdog Timeout Alarm	Restart	
A.03	speeding	Exceeding the rated speed		
A.04	Overload or Stalling	Stalling		P3.08=0 can be shielding
A.05	Position deviation counter overflow	Error counter overflow		
A.06	Excess overflow			P9.04=0 can be shielding
A.07	Electronic gear ratio setting error	The electronic gear ratio setting is unreasonable.		
A.08	U-phase current detection abnormal	U-phase current sampling voltage reference abnormal		
A.09	abnormal V-phase current detection	V-phase current sampling voltage reference abnormal		
A.10	U-phase overcurrent	Phase U is outside the sampling range		
A.11	V-phase overcurrent	Phase V is outside the sampling range.		
A.12	Hardware overcurrent	IPM module current is too high		
A.13	Overvoltage warning	Bus voltage > 55V		P9.08=1 can be shielded
A.14	undervoltage	Bus voltage <40V		P9.07=1 can be shielded
A.15	Overvoltage alarm	Bus voltage > 80V		P9.08=1 can be shielded
A.18	Motor overheat alarm	The MCU temperature exceeds the value of parameter P9.0F.		P9.0C=1 Can be shielded

A.19	NIC overheating	NTC temperature exceeds 85 degrees Celsius		P9.0D=1 Can be shielded
A.46	Encoder Multi-turn position error	Magnetic ring displacement		P9.09=1/3 can be shielded
A.47	Encoder low battery alarm	Encoder battery voltage <3.05V		P9.09=2/3 can be shielded
A.48	Encoder Low Battery Warning	Encoder battery voltage <3.15V		P9.09=2/3 can be shielded
A.49	First (Motor-side) Encoder exception	Encoder SPI communication timeout	Confirm whether SW1 is ON	
A.50	Second (reducer end) Encoder exception	Encoder SPI communication timeout	Confirm whether SW1 is ON	
A.54	Encoder Calibration Configuration Abnormality	Data configuration bit width error	Re-verify Encoder	
A.56	Encoder Communication Abnormality			Restart
A.67	DC synchronization error			
A.68	Synchronization event timeout			
A.133	Firmware incompatibility	Motor Type and Drive Type do not match		

Appendix 3 Battery Safety Precautions

1. Do not place batteries arbitrarily to avoid short circuits.
2. Do not heat batteries or expose them to temperatures above 85°C.
3. Do not attempt to charge the batteries.
4. Do not disassemble or dissect the batteries.
5. Do not reverse the battery polarity.
6. Do not solder directly onto the battery surface or expose it to high-temperature objects.
7. Do not perform compression, impact, or other environmental/safety tests without proper protection.
8. Do not immerse batteries in water, or use/store them unprotected in humid environments.
9. If the battery becomes hot, emits odor, changes color, deforms, or shows any other abnormality during use or storage, stop using it immediately.
10. Dispose of batteries according to local environmental regulations; do not bury them underground or soak them in saltwater.
11. If battery liquid comes into contact with skin, eyes, or clothing, rinse immediately with plenty of water and seek medical attention.
12. Keep batteries away from static environments during use and storage.
13. Store batteries away from heat sources, corrosive gases, and direct sunlight; ensure storage areas are clean, cool, dry, and well-ventilated.
14. During transport, avoid exposure to sunlight, fire, rain, or water, and keep batteries away from corrosive substances.
15. Minimize impacts and vibrations during handling and transport.
16. For long-distance transportation by ship, keep batteries away from engines; in summer, avoid storing them for long periods in non-ventilated areas.

Appendix 4 Frequently Asked Questions (FAQ)

Q: What is the difference between T-type and I-type low-voltage modules?
A: The difference lies in their appearance and installation method.

Q: What is the acceptable power supply range for low-voltage modules?
A: 48V ± 10% (43.2–52.8V)

Q: How can parameters of low-voltage modules be modified?
A: First, connect the module ’s 485 communication port to a PC via a 485-USB converter. Then, use the CMD Athena PC software to upload the parameter table and modify the corresponding parameters.

Q: Does the encoder currently support embedding into the control board?
A: No, it is not supported at present.

Q: Do low-voltage joint modules support 24V, or can a custom 24V version be provided?
A: Currently, 24V supply is not supported. A transformer or other method can be used to step up the voltage to 48V for use.

Q: Can dual encoders retain single-turn values without power and without a battery?
A: The single-turn encoder is absolute, so it will not lose its single-turn position without a battery. However, since the encoder is mounted on the motor side, the motor ’s single-turn movement corresponds to a very small range at the output. It is recommended to use a battery to store multi-turn positions.

Q: How can the firmware software and user manual be obtained?
A: They can be downloaded from the official website: www.laifualdrive.com

Chapter 13 Document Revision Record

Document Revision Record

Revision Previous Version	Page No.	Chapter	Revision Summary	Revision Date
V1.00	Total Pages: 70	Total Chapters: 11	First Edition	2025/05/06
V1.01	Total Pages: 75	Total Chapters: 12	Added Upper Computer Parameter Table and Error Code Table Added Key Parameter Confirmation Table	2025/08/01
V1.02	Total Pages: 75	Total Chapters: 12	Format Revision	2025/09/28
V1.03	Total Pages: 80	Total Chapters: 12	Added Discharge Module Selection, Connection, Electrical Interface and Instructions	2025/10/20
V1.04	Total Pages: 83	Total Chapters: 12	Revised Upper Computer Operation Process for Key Parameters	2025/10/22
V1.05	Total Pages: 112	Total Chapters: 13	Added Multi-Joint Connection Configuration, Brake, Encoder	2025/11/13

			Description, Rigidity, and Common Problems QA	
V1.06	Total Pages: 112	Total Chapters: 13	Added Alarm Codes	2025/12/8
V1.07	Total Pages: 113	Total Chapters: 13	Selection and Connection of Additional Discharging Module	2026/1/28
V1.08	Total Pages: 120	Total Chapters: 13	Added parameters and technical drawings for L52I and L62I modules, multi-joint connection configuration diagram, and CAN FD related content.	2026/3/10

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