



## **ROBSTRIDE 04**

**120N.M Quasi-Direct Drive Integrated Motor Module**

**User Manual**

RobStride Dynamics

<https://www.robstride.com/>



# **RS04 instruction manual**

## **Precautions**

1. Please use according to the working parameters specified in this article, otherwise it may cause serious damage to the product!
2. Do not switch the control mode when the joint is running. If you need to switch, send the command to stop the operation before switching.
3. Check whether the parts are in good condition before use. If the parts are missing or damaged, contact technical support in time.
4. Do not disassemble the motor at will, so as to avoid unrecoverable failure.
5. Ensure that there is no short circuit when the motor is connected, and the interface is correctly connected as required.

## **Legal Statement**

Before using this product, please read this manual carefully and operate the product according to the contents of this manual. If the user violates the contents of this manual to use this product, resulting in any property damage, personal injury accident, the company does not assume any responsibility. Because this product is composed of many parts, do not allow children to touch this product to avoid accidents. In order to prolong the service life of the product, do not use this product in high temperature and high pressure environment. This manual has been printed to the extent possible to include a description of the functions and instructions for use. However, due to the continuous improvement of product functions, design changes, etc., there may still be discrepancies with the products purchased by users.

The color and appearance of this manual may differ from the actual product. Please refer to the actual product. This manual is published by Beijing Lingfoot

Times Technology Co., LTD. (hereinafter referred to as Lingfoot), and Lingfoot may at any time make necessary improvements and changes to the inaccurate and up-to-date information in this manual, or make improvements to procedures and/or equipment. Such changes will be uploaded to the company's official website in electronic format. Details can be found in the download center ([www.robstride.com](http://www.robstride.com)). All images are for reference only. Please refer to actual objects.

## After-sales Policy

The after-sales service of this product is implemented in strict accordance with the Law of the People's Republic of China on the Protection of Consumer Rights and Interests and the Product Quality Law of the People's Republic of China. The service content is as follows:

1. Warranty period and contents
  - a. Users who place orders on the online channel to purchase this product can enjoy the return service without reason within seven days from the day after signing. When returning goods, the user must present a valid proof of purchase and return the invoice. The user must ensure that the returned goods maintain the original quality and function, the appearance is intact, the trademarks and various logos of the goods themselves and accessories are complete, and if there are gifts, they should be returned together. If the goods are artificially damaged, artificially disassembled, missing packaging boxes, missing parts and accessories, they will not be returned. The logistics cost incurred during the return shall be borne by the user (see "After-sales Service Fee Standard"). If the user does not settle the logistics cost, it will be deducted from the refund amount according to the actual amount incurred. Refund the amount paid to the user within seven days from the date of receipt of the returned item. Refund method is the same as payment method. The

specific arrival date may be affected by factors such as banks and payment institutions.

- b. The warranty period of this product is 1 year.
  - c. Within 7 days after the user signs for the next day, non-human damage performance failure occurs, through the Lingzhu after-sales service center test and confirmation, for the user to handle the return business, the user must present a valid purchase voucher, and return the invoice. Any freebies should be returned.
  - d. From 7 days to 15 days after the user signs for the next day, non-human damage performance failure occurs, through the Lingfoot after-sales service center test and confirmation, for the user to replace the whole set of goods. After the replacement, the three guarantee period of the goods themselves is recalculated.
  - e. From 15 days to 365 days after the user signed the next day, after the inspection and confirmation of the Lingfoot after-sales service center, it is a quality fault of the product itself, and can provide free maintenance services. The replacement of the faulty product is owned by Lingzu Company. The product is not faulty and will be returned as is. This product has been strictly tested after the factory, if there is a quality fault other than the product itself, we will have the right to refuse the user's return demand.
2. Non-warranty regulations The following circumstances are not covered by the warranty:
    3. Exceed the warranty period specified in the warranty terms.
    4. Failure to follow the instructions, resulting in product damage caused by wrong use.
    5. Damage caused by improper operation, maintenance, installation, modification, testing and other improper use.

6. Non-quality failure caused by conventional mechanical loss, wear.
7. Damage caused by abnormal working conditions, including but not limited to falling, impact, liquid immersion, violent impact, etc.
8. Damage caused by natural disasters (such as floods, fires, lightning strikes, earthquakes, etc.) or incapacitated forces.
9. Damage caused by exceeding peak torque.
10. Damage caused by exceeding peak torque.
11. Failure or damage caused by other non-product design, technology, manufacturing, quality and other problems.
12. Use this product for commercial purposes.

In the case of the above situation, the user must pay the cost.

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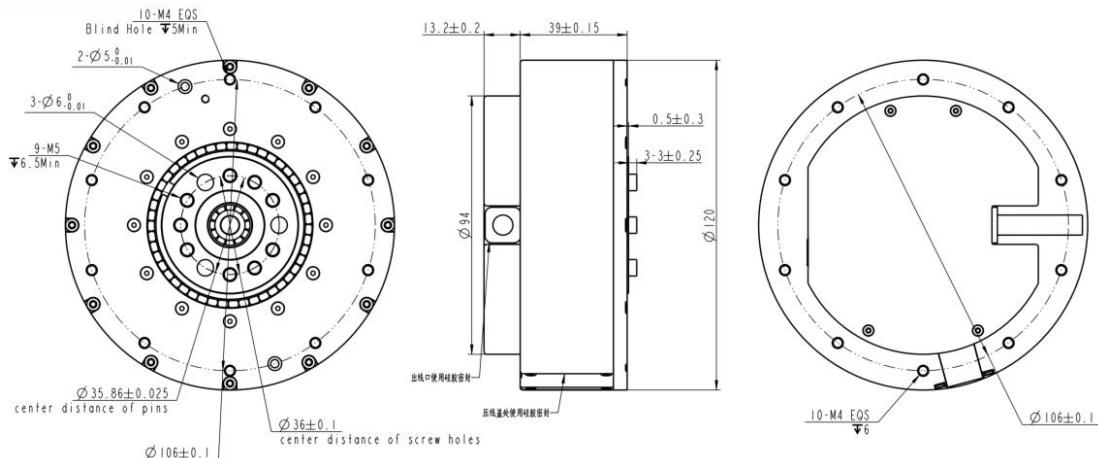
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# 1. Motor specification

## 1.1. Outline and mounting dimensions



When fixing, the screw depth should not exceed the depth of the casing thread

## 1.2. Standard service condition

1. Rated voltage: 48 VDC
2. Operating voltage range: 24V-60 VDC
3. Rated load (CW) : 40 N.m (Heat sink dimensions: 345mm×345mm) 35 N.m (Heat sink dimensions: 220mm×200mm)
4. Operation direction: CW/CCW from the direction of the exit shaft
5. Use posture: the direction of the exit axis is horizontal or vertical
6. Standard operating temperature: 25±5°C
7. Operating temperature range: -20 ~ 50°C
8. Standard operating humidity: 65%
9. Humidity range: 5 ~ 85%, no condensation

10. Storage temperature range: -30 ~ 70°C

11. Insulation Class: Class B

### 1.3. Electrical characteristics

1. No load speed: 200 rpm $\pm$ 10%

2. No load current: 2 Arms

3. Rated load: 40 N.m

4. Rated load speed: 100rpm $\pm$ 10%

5. Rated load phase current (peak) : 27A<sub>pk</sub> $\pm$ 10%

6. Peak load: 120 N.m

7. Maximum load phase current (peak) : 90A<sub>pk</sub> $\pm$ 10%

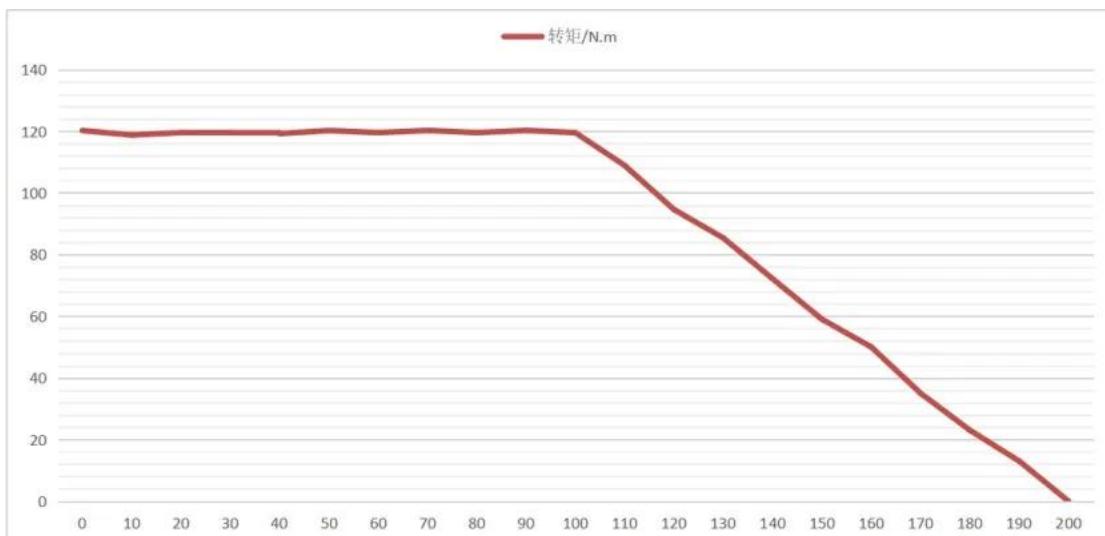
8. Insulation resistance/stator winding: DC 500VAC, 100M Ohms

9. High voltage/stator and housing: 600 VAC, 1s, 2mA

10. Motor back potential: 16.9Vrms/krpm $\pm$ 10%

11. Torque constant(Valid value): 2.1N.m/Arms

12. T-N curve

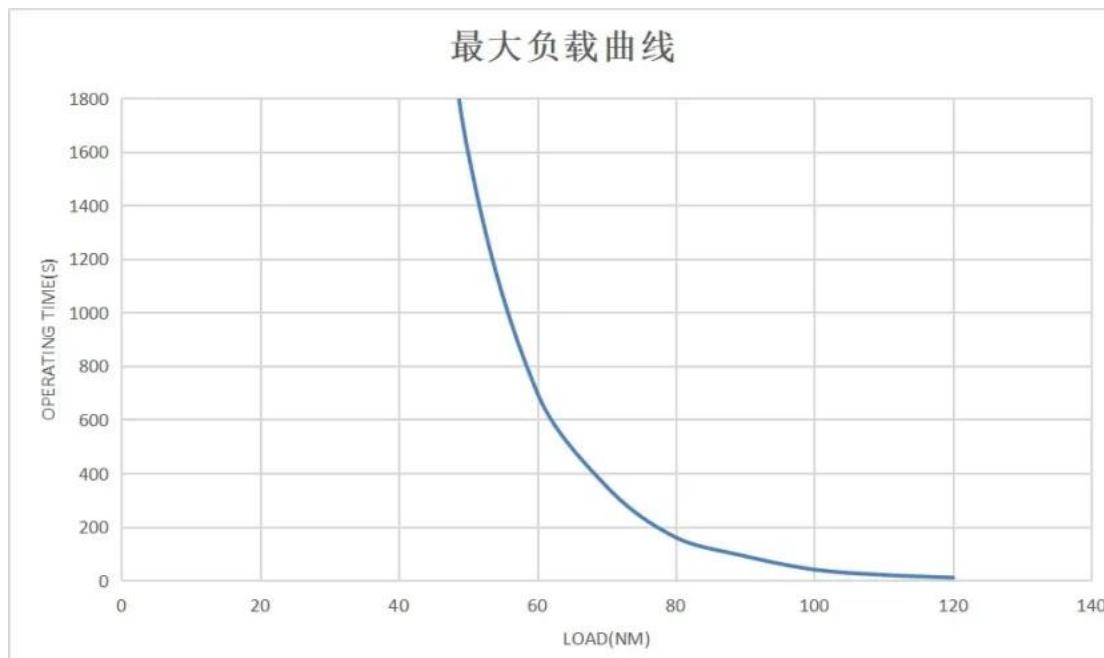


13. Maximum overload curve

Test conditions: Ambient temperature: 25°C

Winding limit temperature: 130°C (this is the constraint temperature, the actual is 180 degrees)

Speed: 24rpm



#### Test data

Load	Operatin time (S)
120	10
110	12
100	14
90	20
80	40
70	59
60	116
50	300
40	rated

#### 14. Thermal testing Test Conditions:

Heat sink size: 345mm x 345mm

Ambient temperature: 25°C

Winding protection temperature: 145°C

Test condition 1: Motor rotates at 100rpm, monitor the motor thermistor temperature, and record the time it takes for the motor thermistor temperature to rise from 25°C to 145°C.

Load	Operatin time(s)
120	10
110	12
100	14
90	20
80	40
70	59
60	116
50	300
40	rated

Motor locked-rotor condition 2: According to the current formula, the average phase current during locked-rotor is approximately 1.414 times that of rotation.

This is used to obtain the overload time table for the locked-rotor condition.

Load	Operating time(S)
120	1
110	1
100	1.5
90	3
80	6
70	10
60	33
50	74
40	130
28.5	rated

## 1.4. Mechanical characteristic

1. Weight: 1420g±20g
2. Number of poles: 42
3. Phase number: 3 phases

4. Drive mode: FOC
5. Deceleration ratio: 9:1

## 2. Driver Product Information

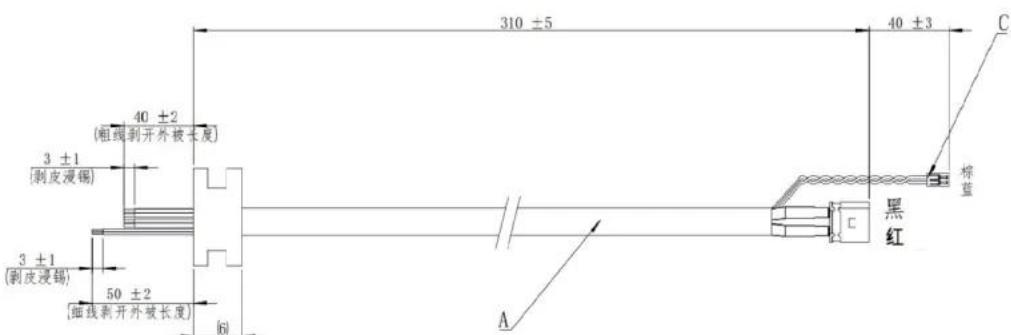
### 2.1. Driver product Specifications

project	data
The rated working voltage	48VDC
The maximum allowable voltage	60VDC
Rated working phase current	27Apk
Maximum allowable phase current	90Apk
Standby power	$\leq 40\text{mA}$
CAN bus bit rate	1Mbps
Dimensions	$\Phi 84\text{mm}$
Working environment temperature	-20°C to 50°C
The maximum allowable temperature of the control board	145°C
encoder resolution	14bit (absolute turn)

### 2.2. Driver interface definition



### 2.3. Driver harness definition



harness	Definition
blue	CAN_H
brown	CAN_L
black	GND

red	VBAT+
-----	-------

## 2.4. Driver interface recommended brand and model

board end model	brand manufacturer	line end model	brand manufacturer
XT30APW-M	AMASS (Ams)	XT30UW-F	AMASS (AMS)
GH1.25-2PWT	any	GH1.25-T	any

## 2.5. Driver function pin and device description

### 1. Power supply and CAN communication

Pin	description
1	The positive electrode of the power supply (+)
2	Negative electrode of the power supply (-)
3	CAN CAN_L
4	CAN the high side of the communication CAN_H

### 1. Download port

Pin	description
1	SWDIO (data)
2	SWCLK (clock)
3	3V3 (positive 3.3V)
4	GND

### 1. Indicator light

## 3.Upper computer instructions

Please go to [www.robstride.com](http://www.robstride.com) website download center

### 3.1. Hardware disposition

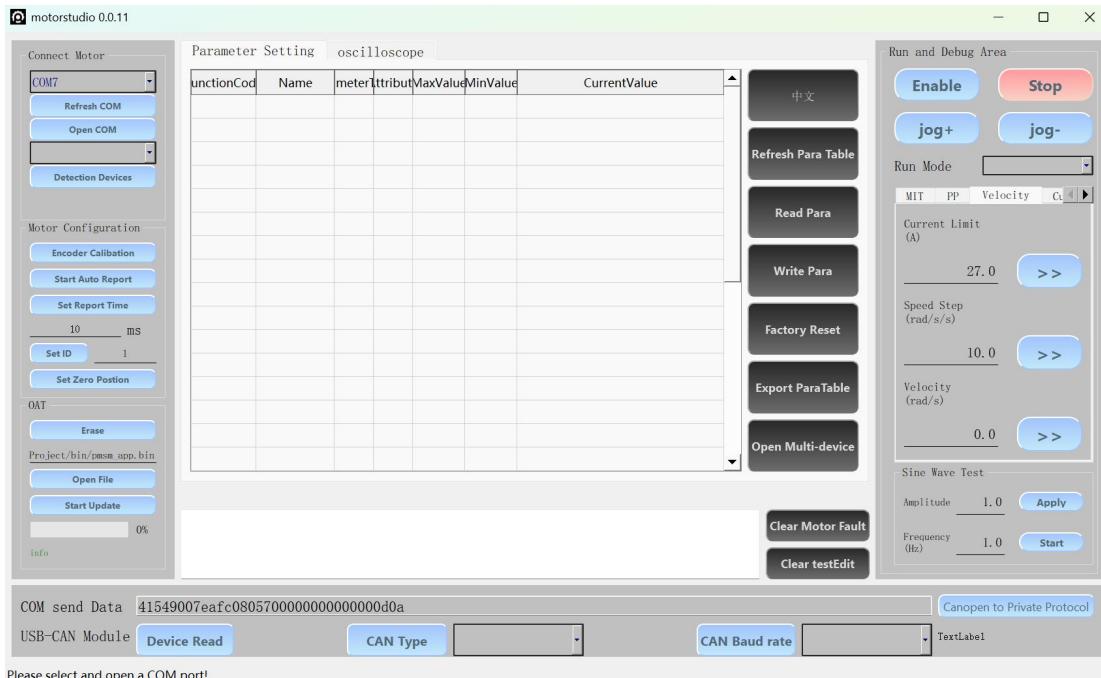
The articulated motor uses the CAN communication mode and has two communication cables. It is connected to the debugger through the can to USB tool. The debugger needs to be installed with the ch340 driver in advance and works in AT mode by default.

It should be noted that we are based on the specific can to USB tool development of the debugger, so we need to use our recommended serial port tool to debug the debugger, if you want to transplant to other debugger platform can refer to the third chapter of the instructions for development.

The CAN to USB tool is recommended to use the official USB-CAN module of Lingzu Times. The frame header of the corresponding serial port protocol is 41 54, and the frame tail is 0D 0A.

When using the CAN-to-USB module, pay attention to the settings of the DIP switches on the module: When DIP switch 1 is in the ON position, the module enters Boot mode and cannot establish a connection with the host computer. When DIP switch 2 is in the ON position, a 120Ω terminal resistor is connected to the module port, allowing normal communication with the host computer.

## 3.2. Upper computer interface and description



Please select and open a COM port!

Mainly includes:

### A. Motor Connection Module

- Refreshing the Serial Port
- Opening the Serial Port
- Testing the Device

### B. Motor Configuration Module

- Starting the Upgrade
- Opening a File
- Starting the Upgrade
- Modifying the Motor CAN ID
- Setting the Motor's Mechanical Zero Position

### C. Motor Upgrade Module

- Magnetic Encoder Calibration
- Motor Active Reporting Switch

- Setting the Motor Active Reporting Time
- Modifying the Motor CAN ID
- Setting the Motor's Mechanical Zero Position

#### D. Motor Main Interface

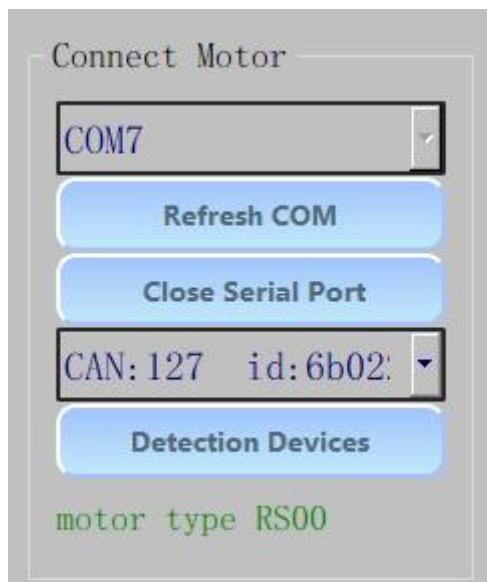
- Parameter Settings
- Motor Oscilloscope

#### E. Run and Debug Area

- Parameter Debugging Buttons
- Motor Mode Configuration and Parameter Modification
- Sine Signal Testing

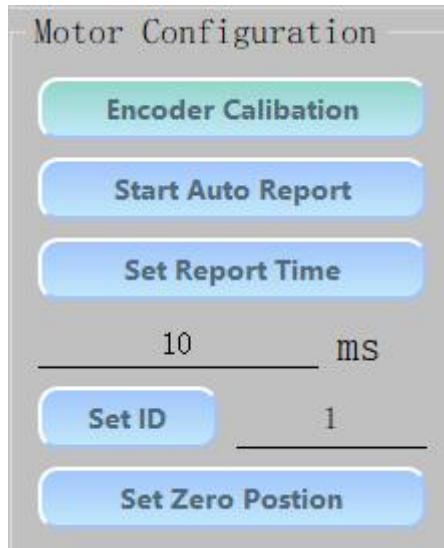
### 3.3. Motor settings

#### 3.3.1. Motor connection settings



Connect the CAN to USB tool (install the ch340 driver, which works in AT mode by default), click Refresh Serial Port, open the serial port, and click Detect Device to detect the corresponding motor. The green text below is the motor type.

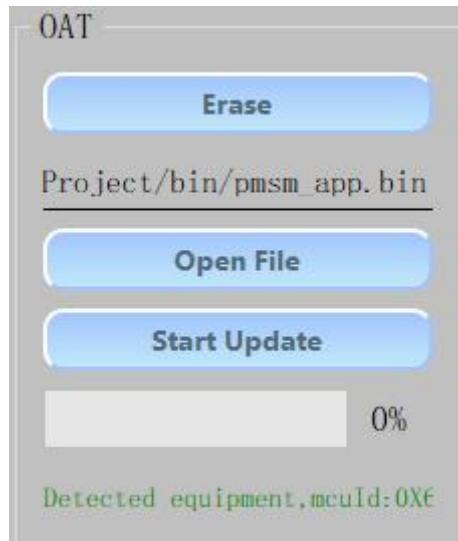
### 3.3.2. Motor configuration module



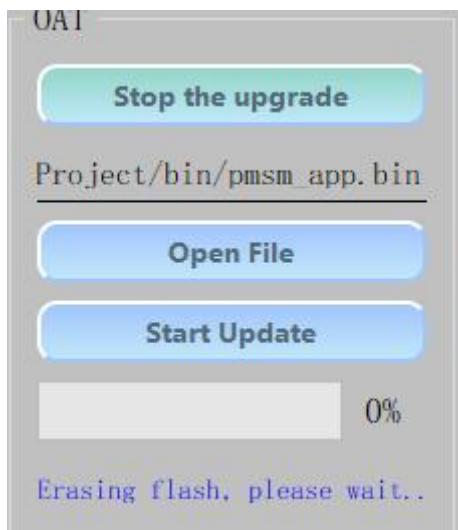
1. Recalibrate the motor magnetic encoder. Reinstalling the motor board and motor, or reconnecting the motor's three-phase wiring requires recalibrating the magnetic encoder.
2. Enable active motor reporting. Click Start Reporting to enable active motor reporting in communication type 2. You can set the interval below, with a minimum of 10ms.
3. Set ID: Set the motor's CAN ID.
4. Set Zero Position: Set the current position to 0.

### 3.3.3. Motor upgrade module

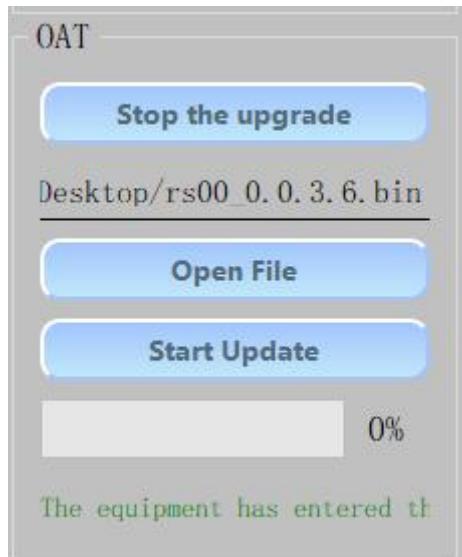
1. Click to open the file and select the firmware to upgrade. The rs-0x in the firmware name is the selected motor type.



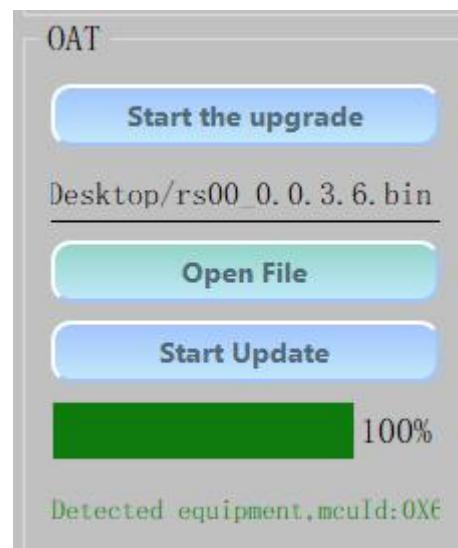
2. Click Start Upgrade, and the motor will enter the upgrade preparation stage.



3. When the green text "Device has entered upgrade mode" pops up, click to start the upgrade



4. When the green text "Upgrade Successfully" pops up, the upgrade is complete.



If the green progress bar gets stuck halfway through the upgrade, you can click to stop the upgrade, or re-power on and re-enter the upgrade process. The internal program of the motor will not be lost after the upgrade fails. Please check whether the communication environment is good before upgrading again.

### 3.3.4. Parameter settings

Parameter Setting | oscilloscope

unctionCod	Name	meter	Attribute	MaxValue	MinValue	CurrentValue	
0X0000	Name	Str...	read/ write			ÿÿÿÿÿÿÿÿÿÿÿÿÿÿ	
0X0001	BarCode	Str...	read/ write			ÿÿÿÿÿÿÿÿÿÿÿÿÿÿ	
0X1000	bootCodeV...	Str...	read- only			V	
0X1001	BootBuild...	Str...	read- only			Sep 12 2024	
0X1002	BootBuild...	Str...	read- only			14:02:13	
0X1003	ppCodeVe...	Str...	read- only			0. 0. 3. 6	
0X1004	ppGitVer...	Str...	read- only			V	
0X1005	AppBuildD...	Str...	read- only			Apr 17 2025	
0X1006	AppBuildT...	Str...	read- only			18:12:37	
0X1007	AppCodeName	Str...	read- only			motor	
0X2000	echoPara1	uin...	Setup	110	5	5	
0X2001	echoPara2	uin...	Setup	110	5	5	
0X2002	echoPara3	uin...	Setup	110	5	5	
0X2003	echoPara4	uin...	Setup	110	5	5	
0X2004	echoFrellz	uin...	read/ write	10000	1	500	
0X2005	MechOffset	float	Set	7	-7	65. 417381	
0X2006	MechPos	int	float	50	-50	0. 000000	

中文  
Refresh Para Table  
Read Para  
Write Para  
Factory Reset  
Export ParaTable  
Open Multi-device

After successfully connecting to the motor,

- Click Refresh Parameter Table. "Updated Parameter Table Successfully" will appear at the top, indicating that the motor parameters have been successfully read (Note: The parameter table must be configured while the motor is in standby mode. If the motor is running, the parameter table refresh cannot be performed). The interface will display the motor's parameters. Parameters in blue are stored internally in the motor and can be modified in the Current Value field following the corresponding parameter.
- Click Read Parameters to upload the motor parameters to the debugger. Parameters in light blue are observed parameters, which are collected and can be observed in real time.
- Click Write Parameters to download the debugger parameters to the motor.
- Click Restore Factory to restore the motor's default parameters for the latest firmware.

5. Click Export to export the current motor parameters in the parameter table.
6. Click Open Multi-Device Connection to connect the host computer to multiple motors. Note that because the parameter interfaces for different motor types vary, multi-device connection is only used for upgrades. After upgrading and debugging the motor, close multi-device connection and search for the motor again.

**Note: Please do not change the torque limit, protection temperature and overtemperature time of the motor. Our company will not bear any legal responsibility for any damage to human body or irreversible damage to joints caused by illegal operation of this product.**

function code	name	parameter type	attribute	Maximum value	Minimum value	Current value (for reference)	备注
0X0000	Name	String	Read/Write			ÿÿÿÿÿÿÿÿÿÿÿÿÿÿ	
0X0001	BarCode	String	Read/Write			ÿÿÿÿÿÿÿÿÿÿÿÿÿÿ	
0X1000	BootCode Version	String	Read only			0.1.5	
0X1001	BootBuild Date	String	Read only			Mar 16 2022	
0X1002	BootBuildTime	String	Read only			20:22:09	
0X1003	AppCodeVersion	String	Read only			0.4.1.24	Motor program version number
0X1004	AppGitVersion	String	Read only			7b844b0fM	
0X1005	AppBuildDate	String	Read only			Dec 8 2025	
0X1006	AppBuildTime	String	Read only			20:30:22	
0X1007	AppCodeName	String	Read only			Lingzu_motor	
0X2000	echoPara1	uint16	dispositio n	115	5	5	

function code	name	parameter type	attribute	Maximum value	Minimum value	Current value (for reference)	备注
0X200 1	echoPara2	uint16	dispositio n	115	5	5	
0X200 2	echoPara3	uint16	dispositio n	115	5	5	
0X200 3	echoPara4	uint16	dispositio n	115	5	5	
0X200 4	echoFreHz	uint32	Read/Wri te	10000	1	1000	
0X200 5	MechOffse t	float	Read/Wri te	50	-50	5.844083	Motor magnetic encoder Angle offset
0X200 6	chasu_offs et	float	Read/Wri te	50	-50	4.74652	Reserved parameters
0X200 7	Status1	float	Settings	10	-10	0	Torque limitation
0X200 8	I_FW_MAX	float	Read/Wri te	33	0	0	Weak magnetic current value, default 0
0X200 9	CAN_ID	uint8	Read/Wri te	127	0	127	id of this object
0X200 a	CAN_MAS TER	uint8	Read/Wri te	300	0	253	can host id
0X200 b	CAN_TIME OUT	uint32	Read/Wri te	100000	-10000	0	can timeout threshold. The default value is 0
0X200 c	status2	int16	Settings	1500	-200	0	Reserved parameter
0X200 d	status3	uint32	Settings	100000 0	1000	0	Reserved parameter
0X200 e	status4	float	Settings	64	1	0	Reserved parameter
0X200 f	status5	float	Settings	20	0	0	Reserved parameter
0X201 0	status6	uint8	Settings	1	0	0	Reserved parameter
0X201 1	cur_filt_gai n	float	Read/Wri te	1	0	0.9	Current filtering parameter
0X201 2	cur_kp	float	Read/Wri te	200	0	0.025	Current kp

function code	name	parameter type	attribute	Maximum value	Minimum value	Current value (for reference)	备注
0X2013	cur_ki	float	Read/Write	200	0	0.0258	Current ki
0X2014	spd_kp	float	Read/Write	200	0	2	Velocity kp
0X2015	spd_ki	float	Read/Write	200	0	0.021	Speed ki
0X2016	loc_kp	float	Read/Write	200	0	30	Position kp
0X2017	spd_filt_gain	float	Read/Write	1	0	0.1	Velocity filter parameter
0X2018	limit_spd	float	Read/Write	200	0	2	Location mode speed limit
0X2019	limit_cur	float	Read/Write	23	0	23	Position, Velocity mode current limit
0X201a	spd_step_value	float	Read/Write	100	0	0	Reserved parameter
0X201b	vel_max	float	Read/Write	100	0	0	Reserved parameter
0X201c	acc_set	float	Read/Write	27	0	0	High speed segment offset
0X201d	fault1	uint32	Settings	27	0	0	Reserved parameters
0X201e	fault2	uint32	Settings	150	0		Reserved parameters
0X201f	fault3	uint32	Settings	20	0		Reserved parameters
0X2020	fault4	uint32	Settings	1000	0		Reserved parameters
0X2021	fault5	uint32	Settings	100	0	0	Reserved parameters
0X2022	fault6	uint32	Settings				Reserved parameters
0X2023	fault7	uint32	Settings				Reserved parameters
0X2024	baud	uint8	Read/Write				Baud rate flag
0X202	zero_sta	uint8	Read/Write				Zero point flag

function code	name	parameter type	attribute	Maximum value	Minimum value	Current value (for reference)	备注
5			te				
0X2026	position_offset	float	Read/Write				Position offset
0X2027	protocol_1	uint8	Read/Write				Protocol flag
0X2028	damper	uint8	Read/Write				Damping switch
0X2029	add_offset	float	Read/Write				Position offset parameter
0X3000	timeUse0	uint16	Read only			5	
0X3001	timeUse1	uint16	Read only			0	
0X3002	timeUse2	uint16	Read only			10	
0X3003	timeUse3	uint16	Read only			0	
0X3004	encoderRaw	uint16	Read only			11396	Magnetic encoder sampling value
0X3005	mcuTemp	int16	Read only			337	mcu internal temperature, *10
0X3006	motorTemp	int16	Read only			333	Motor ntc temperature, *10
0X3007	encoder2raw	uint16	Read only			24195	Bus voltage
0X3008	adc1Offset	int32	Read only			2084	adc sampling channel 1 Zero current bias
0X3009	adc2Offset	int32	Read only			2084	adc sampling channel 2 Zero current bias
0X300a	adc1Raw	uint16	Read only			1232	adc sampling value 1
0X300b	adc2Raw	uint16	Read only			1212	adc sampling value 2
0X300c	VBUS	float	Read only			36	Bus voltage V
0X300d	cmdId	float	Read only			0	id ring instruction, A
0X300	cmdIq	float	Read only			0	iq ring command, A

function code	name	parameter type	attribute	Maximum value	Minimum value	Current value (for reference)	备注
e							
0X300f	cmdlocref	float	Read only			0	Position loop command, rad
0X3010	cmdspdref	float	Read only			0	Speed loop command, rad/s
0X3011	cmdspdref						
0X3012	cmdTorque	float	Read only			0	Torque instruction, nm
0X3013	cmdPos	float	Read only			0	mit Protocol Angle instruction
0X3014	cmdVel	float	Read only			0	mit Protocol Speed instruction
0X3015	rotation	int16	Read only			1	Number of turns
0X3016	modPos	float	Read only			4.363409	Motor uncounted coil mechanical Angle, rad
0X3017	mechPos	float	Read only			0.777679	Load end loop mechanical Angle, rad
0X3018	mechVel	float	Read only			0.036618	Load speed: rad/s
0X3019	elecPos	float	Read only			4.714761	Electrical Angle
0X301a	ia	float	Read only			0	U-wire current, A
0X301b	ib	float	Read only			0	V-wire current, A
0X301c	ic	float	Read only			0	W-wire current, A
0X301d	timeout	uint32	Read only			31600	Timeout counter value
0X301e	phaseOrder	uint8	Read only			0	Directional marking
0X301f	iqf	float	Read only			0	iq filter value, A
0X3020	boardTemp	int16	Read only			359	Plate temperature, *10

function code	name	parameter type	attribute	Maximum value	Minimum value	Current value (for reference)	备注
0X302_1	iq	float	Read only			0	iq Original value, A
0X302_2	id	float	Read only			0	id Original value, A
0X302_3	faultSta	uint32	Read only			0	Fault status value
0X302_4	warnSta	uint32	Read only			0	Warning status value
0X302_5	drv_fault	uint16	Read only			0	The driver chip fault value is 1
0X302_6	drv_temp	int16	Read only			48	The driver chip fault value is 2
0X302_7	Uq	float	Read only			0	Q-axis voltage
0X302_8	as_angle	float	Read only			0.08667	Magnetic encoder initial angle
0X302_9	cs_angle	float	Read only			1.547787	Differential magnetic encoder initial angle
0X302_a	chasu_angle	float	Read only			4.822069	Differential angle
0X302_b	ibus	float	Read only			0	Motor protection parameters
0X302_c	torque_fdb	float	Read only			0	Torque feedback value, Nm
0X302_d	rated_i	float	Read only			19	Motor protection parameters
0X302_e	MechPos_i_init	float	Read only			0	Motor reserved parameters
0X302_f	vel_max	float	Read only			10	Motor speed setpoint
0X303_0	loc_reff	float	Read only			0.05876	Motor speed expectation 2
0X303_1	instep	float	Read only			0	Motor position determination parameters
0X303	position	float	Read only			6.372923	Motor position

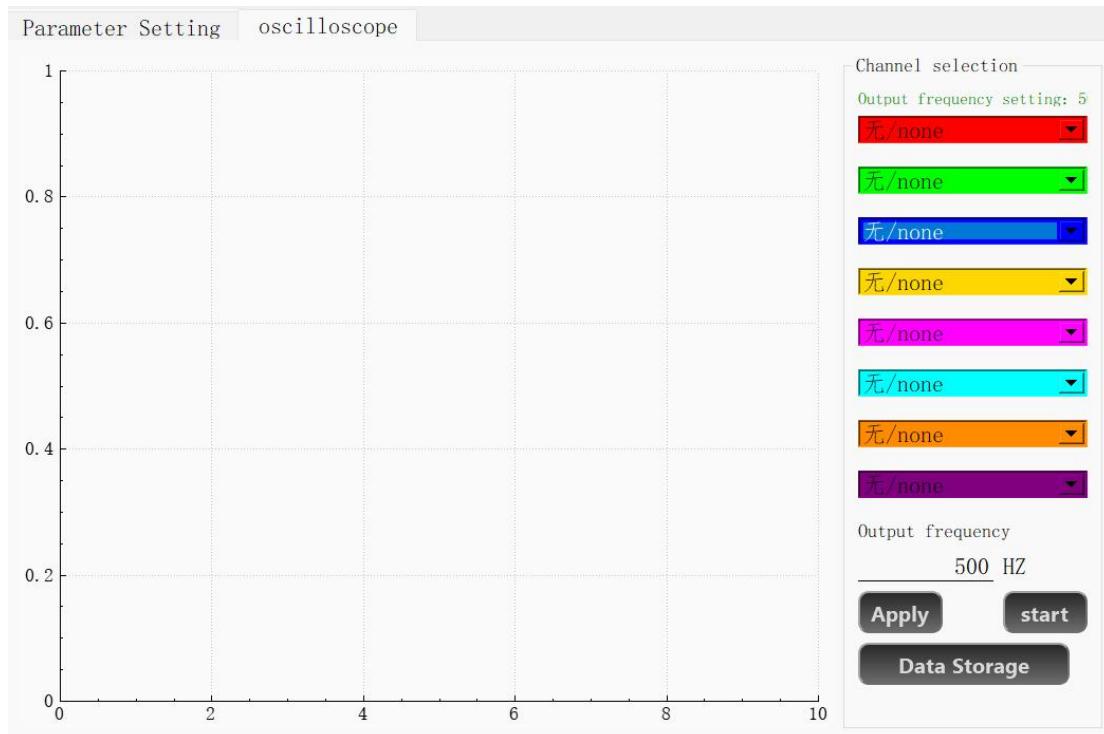
function code	name	parameter type	attribute	Maximum value	Minimum value	Current value (for reference)	备注
2							determination parameters
0X303 3	chasu_angl e_init	float	Read only			0.075549	Motor position determination parameters
0X303 4	chasu_angl e_out	float	Read only			0.679938	Motor position determination parameters
0X303 5	motormec hinit	float	Read only			0.52884	Motor position determination parameters
0X303 6	mech_angl e_init2	float	Read only			0.05876	Motor position determination parameters
0X303 7	mech_angl e_rotat	int16	Read only			0	Motor position determination parameters
0X303 8	fault1	uint32	Read only			0	Log failure
0X303 9	fault2	uint32	Read only			0	Log failure
0X303 a	fault3	uint32	Read only			0	Log failure
0X303 b	fault4	uint32	Read only			0	Log failure
0X303 c	fault5	uint32	Read only			0	Log failure
0X303 d	fault6	uint32	Read only			0	Log failure
0X303 e	fault7	uint32	Read only			0	Log failure
0X303 f	fault8	uint32	Read only			1	Log failure
0X304 0	ElecOffset	float	Read only			0	electrical Angle offset
0X304 1	mcOverTe mp	int16	Read only			0	Overtemperature threshold
0X304 2	Kt_Nm/Am p	float	Read only			0	Moment coefficient

function code	name	parameter type	attribute	Maximum value	Minimum value	Current value (for reference)	备注
0X3043	Tqcali_Type	uint8	Read only			0	Motor type
0X3044	theta_mech_1	float	Read only			0.05876	Type 2 Low-Speed Angle
0X3045	adcOffset_1	int32	Read only			2041	ADC Sampling Channel 1 Zero Current Offset
0X3046	adcOffset_2	int32	Read only			2040	ADC Sampling Channel 2 Zero Current Offset
0X3047	coder_reg	uint16	Read only			1	System Parameters
0X3048	pos_cnt1	uint16	Read only			0	System Parameters

### 3.3.5. Oscilloscope

The interface supports viewing and observing the graph generated by real-time data, including motor Id/Iq current, temperature, real-time speed at the output end, rotor (encoder) position, output end position, etc.

Click on the oscilloscope module in the analysis module, select the appropriate parameters in the channel (parameter meaning can be referred to the parameter table), set the output frequency, click on the start plot to observe the data graph, stop the plot to stop the observation graph.



The command sent is in the communication command box below



Communication box instruction example:

41 54 90 07 e8 0c 08 05 70 00 00 01 00 00 00 0d 0a

The meaning is as follows

<b>41 54</b>	<b>90 07 e8 0c</b>	<b>8</b>	<b>05 70 00 00 01 00 00</b>	<b>0d 0a</b>
--------------	--------------------	----------	-----------------------------	--------------

			<b>00</b>	
frame header	Number of data bits	extended frame	data frame	frame tail

The translation of extended frame canid into real canid requires the following transformations:

90 07 e8 0c converts to binary as 1001 0000 0000 0111 1110 1000 0000 1100, remove the 100 on the right and it becomes 1 0010 0000 0000 1111 1101 0000 0001, convert it to hexadecimal, It is 12 00 FD 01. According to the communication protocol, the meaning is as follows:

<b>12 in hexadecimal</b>	<b>0</b>	<b>FD</b>	<b>1</b>
Communication type 18 (in decimal base)	No meaning	host id	motor canid

### 3.3.6. can communication failure protection

When the value of CAN\_TIMEOUT is 0, this function is disabled

When the CAN\_TIMEOUT value is non-0, when the motor does not receive the can command within a certain period of time, the motor enters the reset mode, and 20000 is 1s

### 3.3.7. Motor fault instructions

Function code 0x3022 indicates the fault code, where

bit14:motor blocking overload algorithm protection

bit7: Encoder uncalibrated: Motor uncalibrated encoder

bit3: Overvoltage fault: the motor voltage exceeds the protection voltage by 60V

bit2: Undervoltage fault: the motor voltage is lower than the protection voltage of 12V

bit1: Driver chip failure: Motor driver chip failure reported

bit0: Motor overtemperature fault: motor thermistor temperature exceeds 145

degrees

Function code 0x3024 is driver chip fault code 1. The specific faults are as follows

**Table 11. Fault Status Register 1 Field Descriptions**

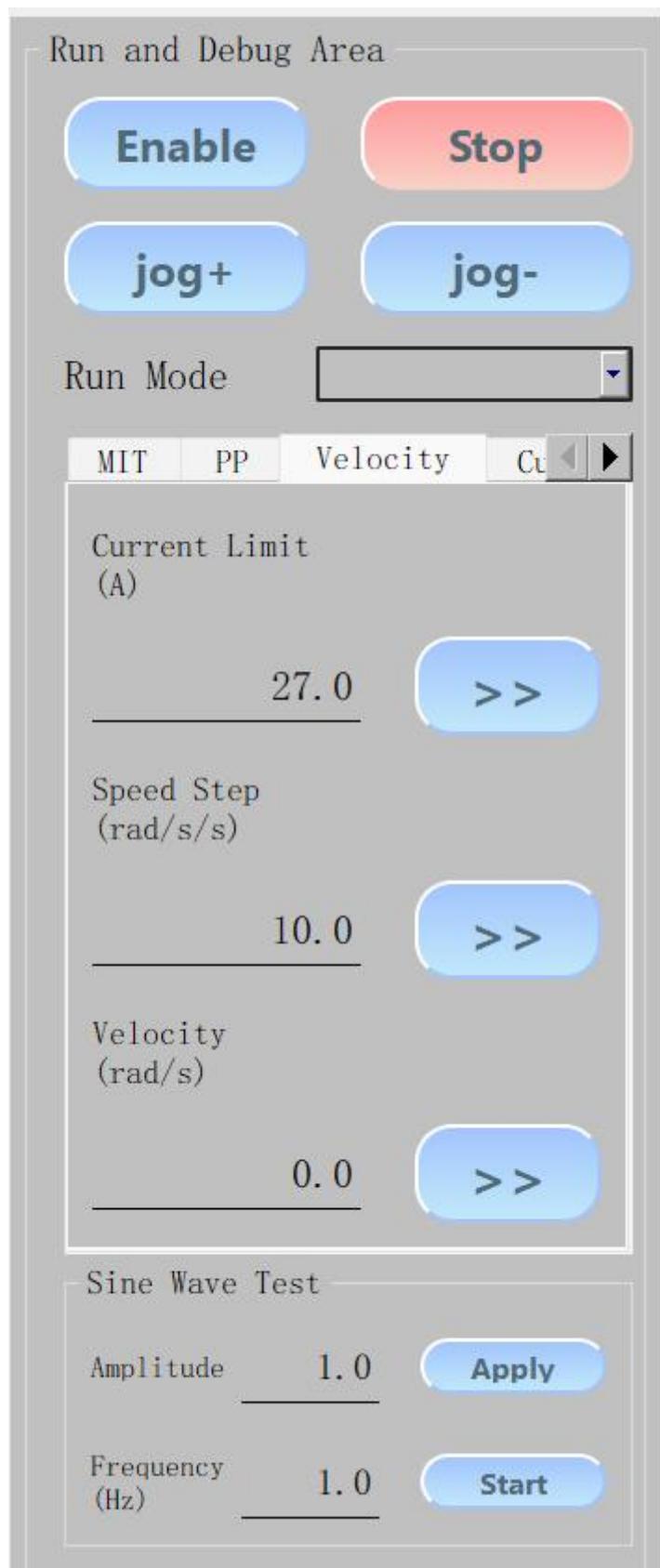
Bit	Field	Type	Default	Description
10	FAULT	R	0b	Logic OR of FAULT status registers. Mirrors nFAULT pin.
9	VDS_OCP	R	0b	Indicates VDS monitor overcurrent fault condition
8	GDF	R	0b	Indicates gate drive fault condition
7	UVLO	R	0b	Indicates undervoltage lockout fault condition
6	OTSD	R	0b	Indicates overtemperature shutdown
5	VDS_HA	R	0b	Indicates VDS overcurrent fault on the A high-side MOSFET
4	VDS_LA	R	0b	Indicates VDS overcurrent fault on the A low-side MOSFET
3	VDS_HB	R	0b	Indicates VDS overcurrent fault on the B high-side MOSFET
2	VDS_LB	R	0b	Indicates VDS overcurrent fault on the B low-side MOSFET
1	VDS_HC	R	0b	Indicates VDS overcurrent fault on the C high-side MOSFET
0	VDS_LC	R	0b	Indicates VDS overcurrent fault on the C low-side MOSFET

Function code 0x3025 is driver chip fault code 2. The specific faults are as follows

**Table 12. Fault Status Register 2 Field Descriptions**

Bit	Field	Type	Default	Description
10	SA_OC	R	0b	Indicates overcurrent on phase A sense amplifier (DRV8353xS)
9	SB_OC	R	0b	Indicates overcurrent on phase B sense amplifier (DRV8353xS)
8	SC_OC	R	0b	Indicates overcurrent on phase C sense amplifier (DRV8353xS)
7	OTW	R	0b	Indicates overtemperature warning
6	GDUV	R	0b	Indicates VCP charge pump and/or VGLS undervoltage fault condition
5	VGS_HA	R	0b	Indicates gate drive fault on the A high-side MOSFET
4	VGS_LA	R	0b	Indicates gate drive fault on the A low-side MOSFET
3	VGS_HB	R	0b	Indicates gate drive fault on the B high-side MOSFET
2	VGS_LB	R	0b	Indicates gate drive fault on the B low-side MOSFET
1	VGS_HC	R	0b	Indicates gate drive fault on the C high-side MOSFET
0	VGS_LC	R	0b	Indicates gate drive fault on the C low-side MOSFET

### 3.4. Control Demo



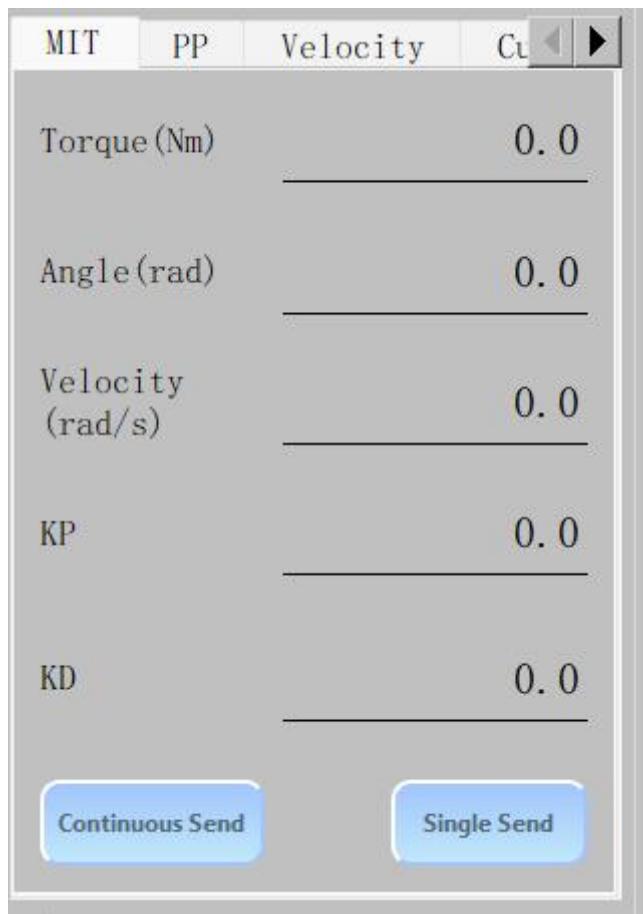
## Jog Run

Click JOG +/- to run the motor forward and reverse at a speed of 1 rad/s.

## Control Mode Switching

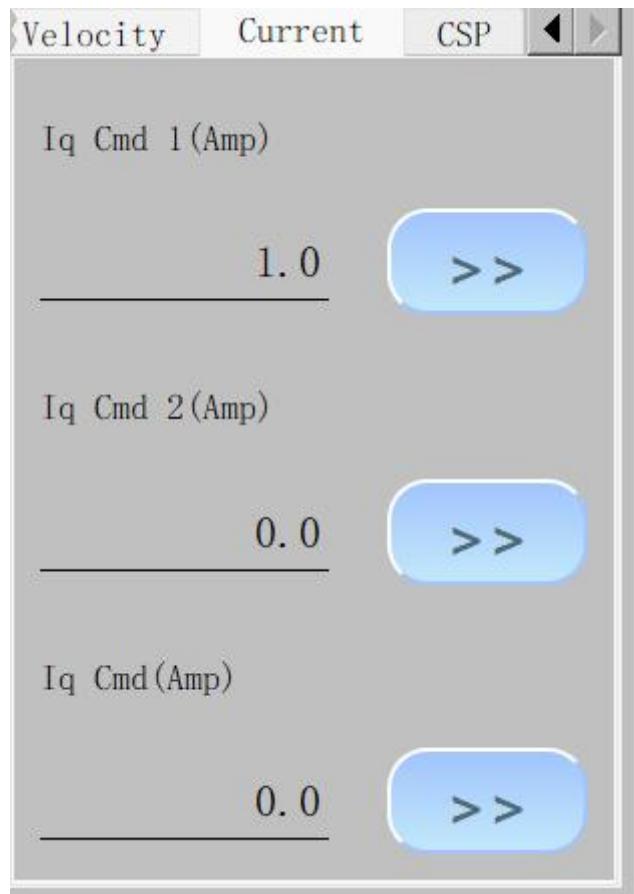
Select the desired control mode in the command box to the right of the run mode.

### 3.4.1. Operation and control mode

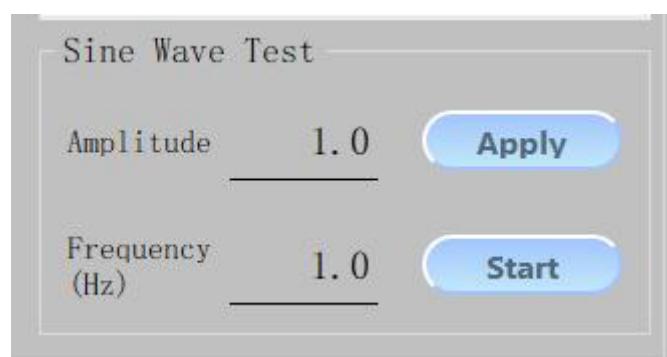


1. Switch the control mode to operation mode.
2. The motor starts running and enters motor\_mode.
3. Set five parameter values and click Start or Send continuously. The motor will return feedback frames and run according to the target command.
4. Click Stop to stop the motor and terminate the continuous sending of commands.

### 3.4.2. Current mode



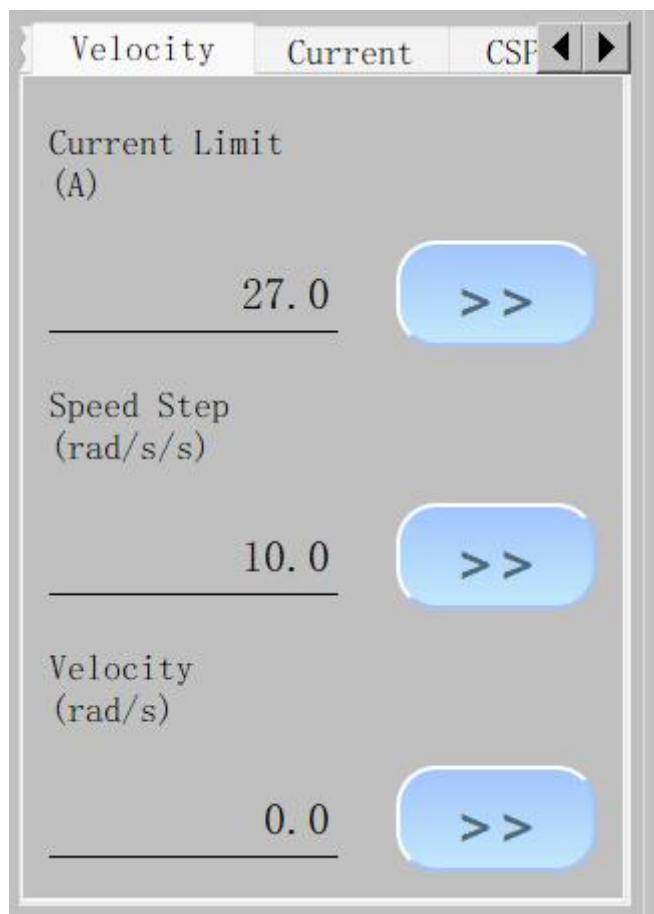
1. Switch the control mode to current mode.
2. The motor starts running and enters motor\_mode.
3. Set the current command value for Iq Command 1 (A). Click the >> button on the right. The motor will follow the current command.
4. Click Stop to stop the motor.



Motor Current Sine Test

1. Switch the control mode to current mode.
2. The motor starts running and enters motor\_mode.
3. Set the amplitude and frequency, click OK, and then click Start. The corresponding mode target command will be planned according to the sine law.
4. Click Stop to stop the motor.

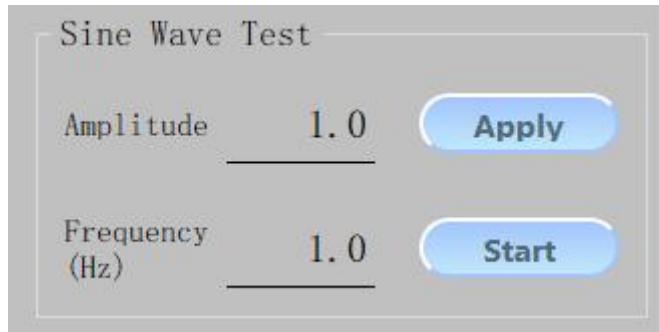
### 3.4.3. Speed Mode



1. Switch the control mode to speed mode.
2. The motor starts running and enters motor\_mode.
3. First, set the current limit (maximum phase current) and speed step value (motor acceleration). If no settings are made, the motor will operate at the default values. Finally, set the speed command (target speed). The motor will

follow the command.

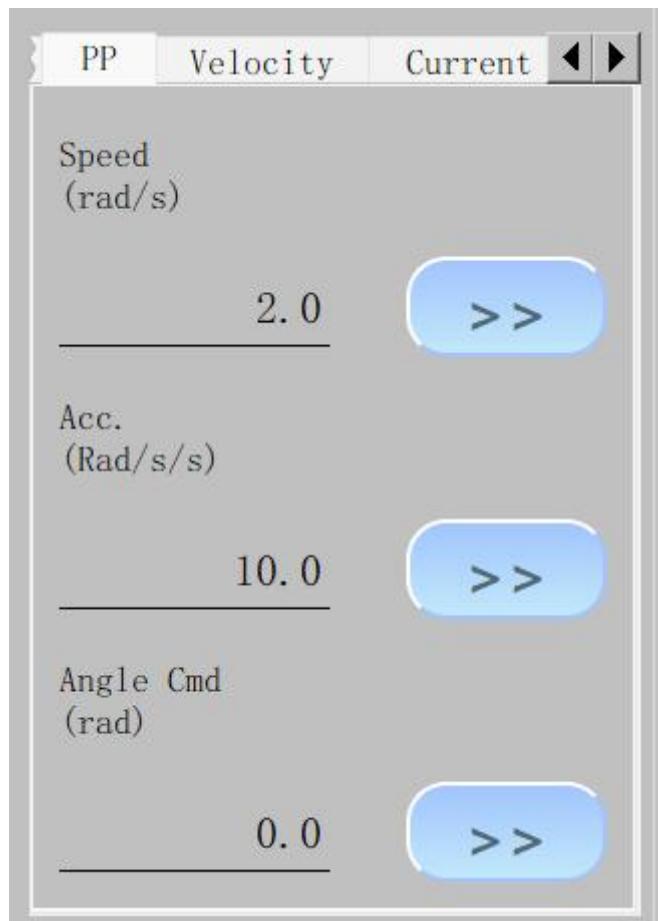
4. Click Stop to stop the motor.



### Motor Speed Sine Test

1. Switch the control mode to speed mode.
2. The motor starts running and enters motor\_mode.
3. Set the amplitude and frequency, click OK, and then click Start. The corresponding mode target command will be planned according to the sine law.
4. Click Stop to stop the motor.

### 3.4.4. Position Mode (PP)



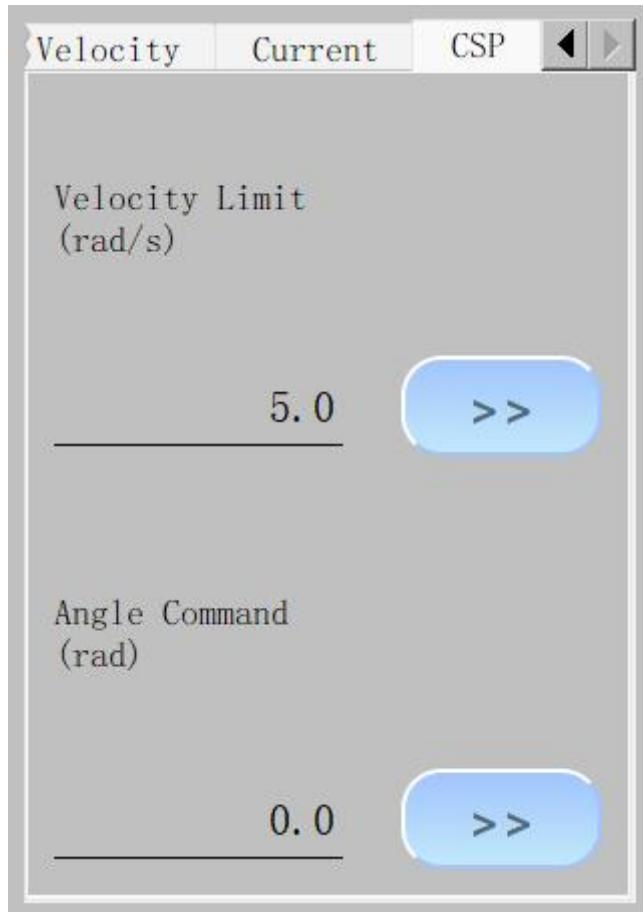
1. Switch the control mode to interpolation position mode.
2. Start the motor and enter `motor_mode`.
3. First, set the speed and acceleration. If not set, the motor will operate at the default values. Finally, set the position command (target position). The motor will follow the command.
4. Set the speed to 0 to stop the motor at the current position. To continue operation, re-issue the speed and position.
5. Click Stop to stop the motor.



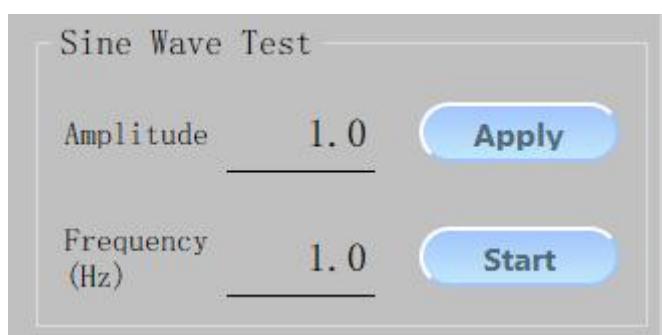
### Motor Position Sine Test

1. Switch the control mode to interpolation position mode.
2. Start the motor and enter `motor_mode`.
3. Set the amplitude and frequency, click OK, and then click Start. The corresponding mode target command will be planned according to the sine law.
4. Click Stop to stop the motor.

### 3.4.5. Position Mode (CSP)



1. Switch the control mode to position mode.
2. The motor starts running and enters `motor_mode`.
3. Set the speed first. If no speed setting is made, the motor will run at the default value. Finally, set the position command (target position). The motor will follow the command.
4. Click Stop to stop the motor.



## Motor position sinusoidal test

1. Switch the control mode to position mode.
2. The motor starts running and enters motor\_mode.
3. Set the amplitude and frequency, click OK, and then click Start. The corresponding mode target command is then sinusoidally planned.
4. Click Stop to stop the motor.

## 4. Driver protocol and instructions

The motor communication is the CAN 2.0 communication interface, the baud rate is 1Mbps, and the extended frame format is adopted as follows:

<b>data field</b>	<b>29-bit ID</b>				<b>8Byte data field</b>
Size	Bit28~bit24		bit23~8	bit7~0	Byte0~Byte7
Description	Communication type		data area 2	Destination address	data area 1

The control modes supported by the motor include:

- Operation control mode: set 5 parameters of motor operation control;
- Current mode: the specified Iq current of the given motor;
- Velocity mode: the specified running speed of the given motor;
- Position mode: Given the specified position of the motor, the motor will run to the specified position;

### 4.1. Description of the communication protocol type

#### 4.1.1. Communication type 0: Get device ID

Gets the device's ID and 64-bit MCU unique identifier

<b>data field</b>	<b>29-bit ID</b>			<b>8Byte data field</b>
Size	Bit28~bit24	bit23~8	bit7~0	Byte0~Byte7
Description	0x0	bit15~8: identifies host CAN_ID	target motor CAN_ID	0

Reply frame:

<b>data field</b>	<b>29-bit ID</b>			<b>8Byte data field</b>
Size	Bit28~bit24	bit23~8	bit7~0	Byte0~Byte7
Description	0x0	target motor CAN_ID	0XFE	64-bit MCU unique identifier

## 4.1.2. Communication Type 1: operation control mode motor control instruction

Data field	29 bit ID			8Byte data field
Size	Bit28~bit24	bit23~8	bit7~0	Byte0~Byte7
description	0x1	Byte2: Torque (0~65535) corresponds to (-120Nm~120Nm)	target motor CAN _ID	Byte0~1: target Angle [0~65535] corresponds to (-4π~4π) Byte2~3: Target angular velocity [0~65535] corresponds to (-15rad/s~15rad/s) Byte4~5: Kp [0~65535] corresponds to (0.0~5000.0) Byte6~7: Kd [0 to 65535] corresponds to the above data (0.0 to 100.0). After the conversion, the high byte is in front and the low byte is in

Response frame: Response motor feedback frame (see communication type 2)

Communication Type 2: motor feedback data

Data field	29 bit ID			8Byte data field
Size	Bit28~bit24	bit23~8	bit7~0	Byte0~Byte7
Description	0x2	Bit8~Bit15: CAN ID of the current motor bit21~16: fault information (0 none 1 has) bit21: uncalibrated bit20: Uncalibrated bit20: Gridlock overload fault bit19: magnetic coding fault bit18: overtemperature bit17: Three-phase overcurrent fault bit16: undervoltage fault bit22~23: Mode status 0: Reset mode [reset] 1: Cali mode [calibration] 2: Motor mode [Run]	host CAN _ID	Byte0~1: The current Angle [0~65535] Corresponding to (-4π~4π) Byte2~3: Current angular velocity [0~65535] corresponds to (-15rad/s~15rad/s) Byte4~5: Current torque [0~65535] corresponds to (-120Nm~120Nm) Byte6~7: Current temperature: Temp(Celsius) *10 If the value is higher than 10, the high byte is first and the low byte is last

### 4.1.3. Communication Type 3: Motor enabled to run

data field	29-bit ID			8Byte data field
Size	Bit28~bit24	bit23~8	bit7~0	Byte0~Byte7
Description	0x3	bit15~8: identifies the main CAN_ID	and target motor CAN_ID	

Response frame: Response motor feedback frame (see communication type 2)

### 4.1.4. Communication Type 4: Motor stops running

data field	29-bit ID			8Byte data field
Size	Bit28~bit24	bit23~8	bit7~0	Byte0~Byte7
description	0x4	bit15~8: used to identify the main CAN_ID	target motor CAN_ID	When the motor is running normally, 0 must be cleared in the data field. Byte[0]=1: The fault is cleared.

Response frame: Response motor feedback frame (see communication type 2)

### 4.1.5. Communication type 6: Set motor mechanical zero

data field	29-bit ID			8Byte data field
Size	Bit28~bit24	bit23~8	bit7~0	Byte0~Byte7
description	0x6	bit15~8: Identifies the main CAN_ID	and target motor CAN_ID	Byte[0]=1

Response frame: Response motor feedback frame (see communication type 2)

Communication type 7: Set motor CAN\_ID

Change the current motor CAN\_ID, effective immediately.

data field	29-bit ID			8Byte data field
Size	Bit28~bit24	bit23~8	bit7~0	Byte0~Byte7
description	0x7	bit15~8: used to identify main CAN_ID Bit16~23: preset CAN_ID	Target motor CAN_ID	

Answer frame: Answer motor broadcast frame (see communication type 0)

#### 4.1.6. Communication type 17: Single parameter read

Data field	29 bit ID			8Byte data field
Size	Bit28~bit24	bit23~8	bit7~0	Byte0~Byte7
description	0x11	bit15~8: Used to identify the main CAN_ID	target motor CAN_ID	Byte0~1: index. For details, see the readability parameter table below Byte2~3:00 Byte4~7: In data above 00, the low byte is first and the high byte is second (

Reply frame:

Data field	29 bit ID			8Byte data field
Size	Bit28~bit 24	bit23~8	bit7~0	Byte0~Byt e7
descripti on	0x11	bit15~8: indicates that the master CAN_ID Bit23~16:00 indicates that the master CAN_ID is successfully read. 01 indicates that the master can_ID	Byte0~1: Byte2~3:00 Byte4~7:Parameter data. 1 byte of data above Byte4 is preceded by low bytes and followed by high bytes at	

#### 4.1.7. Communication type 18: Single parameter write (lost in power failure)

With type 22, the parameter starting with function code 0x20 of the parameter table in the upper computer module can be saved

Data field	29 bit ID			8Byte data field
Size	Bit28~bit 24	bit23~8	bit7~ 0	Byte0~Byte7
descripti on	0x12	bit15~8: Used to identify	target moto r	Byte0~1: index. For details, see the readability parameter table below Byte2~3: 00

		the main CAN_ID	CAN_ID	Byte4~7: Parameter data In the preceding data, the low byte is in the front and the high byte is in the rear
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Response frame: Response motor feedback frame (see communication type 2)

#### 4.1.8. Communication type 21: Fault feedback frame

data field	29-bit ID			8Byte data field
Size	Bit28~bit24	bit23~8	bit7~0	Byte0~Byte7
description	0x15	bit15~8: motor CAN_ID	identifies the main CAN_ID	Byte0~3: fault value (non-0: faulty; 0: faulty). Normal) bit14: gridlock overload fault Bit 16: A-phase current sampling overcurrent Bit 14: Motor stall overload algorithm protection Bit 9: Position initialization fault Bit 8: Hardware identification fault Bit 7: Encoder uncalibrated: Motor encoder not calibrated Bit 5: C-phase current sampling overcurrent Bit 4: B-phase current sampling overcurrent bit3: overvoltage fault bit2: undervoltage fault bit1: driver chip fault bit0: motor overtemperature fault, Default 145 ° C Byte4~7: warning Value bit0: motor overtemperature warning, the default is 135 ° c

#### 4.1.9. Communication type 22: Motor data save frame

data field	29-bit ID			8Byte data field
Size	Bit28~bit24	bit23~8	bit7~0	Byte0~Byte7
Description	0x16	bit15~8: identifies the	and target	01 02 03 04 05

		main CAN_ID	motor CAN_ID	06 07 08
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Response frame: Response motor feedback frame (see communication type 2)

#### 4.1.10. Communication type 23: Motor baud rate modification frame (re-power-on effect)

Data field	29 bit ID			8Byte data field
Size	Bit28~bit24	bit23~8	bit7~0	Byte0~Byte7
description	0x17	bit15~8: used to identify the main CAN_ID	target motor CAN_ID	01 02 03 04 05 06 F_CMD Among them, the F_CMD byte is the motor baud rate Among them, 01 is 1M 02 is 500K 03 is 250K 04 is 125K

Response frame: Response motor feedback frame (see communication type 0)

#### 4.1.11. Communication type 24: The motor actively reports frames

data field	29-bit ID			8Byte data field
Size	Bit28~bit24	bit23~8	bit7~0	Byte0~Byte7
description	0x18	bit15~8: identifies the main CAN_ID	target motor CAN_ID	01 02 03 04 05 06 F_CMD Among them, the F_CMD byte is the motor reporting switch 00 is to disable active reporting (default) 01 To enable active reporting, the default reporting interval is 10ms

Response frame:

data field	29 位 ID			8Byte data field
Size	Bit28~bit24	bit23~8	bit7~0	Byte0~Byte7
description	0x18	Bit8~Bit15: CAN ID of the current motor bit21~16: fault information (0 none 1 has) bit21: uncalibrated bit20: Uncalibrated bit20: Gridlock overload fault	target motor CAN_ID	Byte0~1: The current Angle [0~65535] Corresponding to (-4π ~4π) Byte2~3: Current angular velocity [0~65535] corresponds to (-

		bit19: magnetic coding fault bit18: overtemperature bit17: Three-phase overcurrent fault bit16: undervoltage fault bit22~23: Mode status 0: Reset mode [reset] 1: Cali mode [calibration] 2: Motor mode [Run]		15rad/s~15rad/s) Byte4~5: Current torque [0~65535] corresponds to (-120Nm~120Nm) Byte6~7: Current temperature: Temp(Celsius) *10 If the value is higher than 10, the high byte is first and the low byte is last
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#### 4.1.12. Communication type 25: Motor protocol modification frame (re-power-on effect)

Data field	29 bit ID			8Byte data field
Size	Bit28~bit24	bit23~8	bit7~0	Byte0~Byte7
description	0x19	bit15~8: used to identify the main CAN_ID	target motor CAN_ID	01 02 03 04 05 06 F_CMD Among them, the F_CMD byte is the motor protocol type Among them, 0 is a private protocol (default) 1 is the Canopen protocol 2 is the MIT protocol

Response frame: Response motor feedback frame (see communication type 0)

#### 4.1.13. Communication type 26: Version number read frame

Data field	29 bit ID			8Byte data field
Size	Bit28~bit24	bit23~8	bit7~0	Byte0~Byte7
description	0x4	bit15~8: used to identify the main CAN_ID	target motor CAN_ID	Byte[0]=0x00 Byte[1]=0xC4

Response frame:

data field	29 位 ID			8Byte data field
Size	Bit28~bit24	bit23~8	bit7~0	Byte0~Byte7
description	0x2	Bit8~Bit15: CAN ID of the	target	Byte0=0x00

		current motor bit21~16: fault information (0 none 1 has) bit21: uncalibrated bit20: Uncalibrated bit20: Gridlock overload fault bit19: magnetic coding fault bit18: overtemperature bit17: Three-phase overcurrent fault bit16: undervoltage fault bit22~23: Mode status 0: Reset mode [reset] 1: Cali mode [calibration] 2: Motor mode [Run]	motor CAN_ID	Byte1=0xC4 Byte2=0x56 Byte3~6:Motor version number Order from high to low
--	--	-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------	-----------------	------------------------------------------------------------------------------------------

## 4.1.14. Read and write a single parameter list

index		Description	Type	Number of bytes		R/W Read and write permission
0X7005	run_mode	0: operation mode 1: position mode (PP) 2: Velocity mode 3: Operation mode Current mode 5: Position mode (CSP)	uint8	1		W/R
0X7006	iq_ref	Current mode Iq command	float	4	-90 to 90A	W/R
0X700A	spd_ref	Rotational Velocity mode Rotational speed command	float	4	-20to 20rad/s	W/R
0X700B	limit_torque	torque limit	float	4	0 to 120Nm	W/R
0X7010	cur_kp	Kp	float	4	The default value is 0.17	W/R
0X7011	cur_ki	Ki	float	4	The default value is 0.012	W/R
0X7014	cur_filt_gain	filt_gain	float	4	0 to 1.0, The default value is 0.1	W/R
0X7016	loc_ref	Position Mode Angle instruction	float	4	rad	W/R
0X7017	limit_spd	Location mode (CSP) speed limit	float	4	0 to 20rad/s	W/R
0X7018	limit_cur	Velocity position mode Current limitation	float	4	0 to 90A	W/R
0x7019	mechPos	Mechanical Angle of the loading coil	float	4	rad	R
0x701A	iqf	iq Filter	float	4	-90 to 90A	R
0x701B	mechVel	Speed of the load	float	4	-15 to 15rad/s	R
0x701C	VBUS	Bus voltage	float	4	V	R

<b>index</b>		<b>Description</b>	<b>Type</b>	<b>Number of bytes</b>		<b>R/W Read and write permission</b>
0x701E	loc_kp kp	at	float	4	The default value is 60	W/R
0x701F	spd_kp	Indicates the speed kp	float	4	The default value is 6	W/R
0x7020	spd_ki	ki	float	4	The default value is 0.02	W/R
0x7021	spd_filt_gain	Speed filter value	float	4	The default value is 0.1	W/R
0x7022	acc_rad	velocity mode acceleration	float	4	The default value is 15rad/s^2	W/R
0x7024	vel_max	Location mode (PP) speed	float	4	The default value is 10rad/s	W/R
0x7025	acc_set	Location mode (PP) acceleration	float	4	The default value is 10rad/s^2	W/R
0x7026	EPScan_time	Indicates the report time. 1 indicates 10ms. Plus 1 increments by 5ms	uint16	2	The default value is 1	W
0x7028	canTimeout	can The timeout threshold, 20000 is 1s	uint32	4	The default value is 0	W
0x7029	zero_sta	Indicates the zero flag bit, 0 means 0-2π and 1 means -π-π	uint8	1	The default is 0	W
0x702A	damper	Damping switch	uint8	1	The default value is 0	W/R
0x702B	add_offset	Zero offset	float	4	The default is 0	W/R

Read example:

Take reading loc\_kp as an example:

Read instruction is

Size	Bit28~bit24	bit23~8	bit7~0	Byte0~Byte7
	0x11	0x00FD	0x7F	1E 70 00 00 00 00 00 00
Description	Type 17	Host id 0xFD	Target motor CAN_ID 7F	Byte0~1: index, corresponding to loc_kp

The feedback instruction is

Size	Bit28~bit24	bit23~8	bit7~0	Byte0~Byte7
	0x11	0x007F	0xFD	1E 70 00 00 00 00 F0 41
Description	Type 17	bit15~8: Target motor CAN_ID 7F	Host id 0xFD	Byte0~1: index, corresponding to loc_kp Byte4~7:loc_kp value 30, high right byte, (32-bit single precision) hexadecimal IEEE-754 standard floating point number

## 4.2. Motor Function Description

*(If the following features are unavailable, please upgrade to the latest version via the official Git repository.)*

---

### 4.2.1. Active Reporting

- **Disabled by default.** Enable via **Type 24**.
  - Report type: **Type 2** (default interval: **10ms**). Adjust interval by modifying **EPScan\_time** via **Type 18**.
- 

### 4.2.2. Zero-Point Flag (zero\_sta)

- Modify via:
  - **Host computer**
  - **Type 18** (*requires saving via Type 22 for communication*)
- **Default flag:** 0 → Power-on position range: **0–2π**.
- **If set to 1:** Power-on position range: **π–π**.

---

### 4.2.3. Type 2 Update

- Updated to **periodic looping within  $-4\pi$ – $4\pi$**  (enables cycle counting).
  - **Note:** Position interface parameters must be adjusted:
    - P\_MIN: **12.57f**
    - P\_MAX: **12.57f**
- 

### 4.2.4. Protocol Switching (*Requires CAN adapter*)

- Methods:
    - Modify protocol\_1 via host computer.
    - Send **Type 25** command.
  - **Reboot required** after switching.
  - **Post-switch CAN commands:**
    - **CANopen**: Send extended frame (protocol switch frame).
    - **MIT Protocol**: Send standard frame (**Command 8**).
- 

### 4.2.5. Post-Power-Off Anti-Backdrive Protection

- **Default**: Motor imposes damping if rotated rapidly while powered off (prevents surge).
  - **Disable**: Set damper = 1.
-

## 4.2.6. Zero Calibration Rules

- **Supported modes:** CSP and Motion Control.
  - **PP Mode:** Zero calibration is **blocked**.
  - **Old vs. New Versions:**
    - **Old:** Zero calibration causes large deviation → motor immediately moves to target.
    - **New** (CSP/Motion Control): Target updates to 0 instantly → motor remains stationary.
- 

## 4.2.7. Position Offset (add\_offset)

- Example: If offset = 1, the current zero shifts to **(current position + 1 rad)**.
  - **Use case:** Bypass mechanical limits (e.g., set zero at 1 rad → power-on treats 1 rad as new zero).
- 

## 4.2.8. CANopen ID

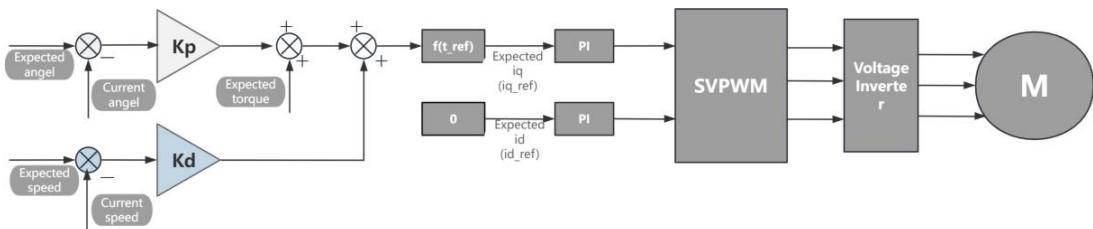
- **Old version:** Fixed to 1.
  - **New version:** Matches the **private protocol CAN ID**.
- 

## 4.2.9. Notes for Implementation

- Always **save settings** (e.g., Type 22 for zero\_sta).
- Verify **CAN adapter compatibility** for protocol switching.
- For zero offsets, ensure mechanical safety limits are respected.

## 4.3. Control mode instructions

### 4.3.1. Operation control mode

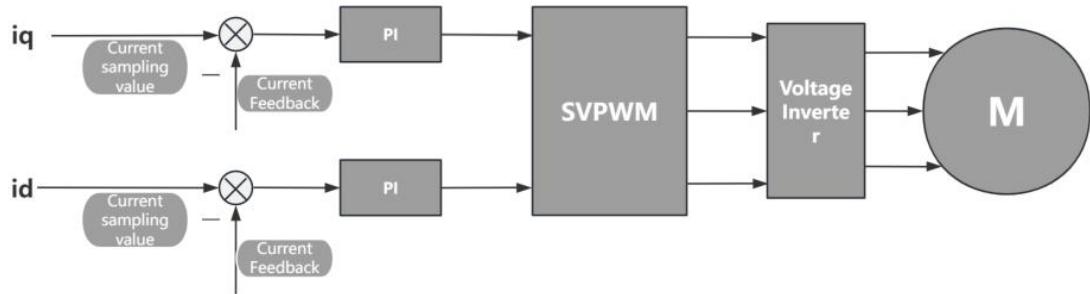


The motor is in operation control mode by default after power-on.

Send motor Enable Run frame (communication type 3) --> Send operation mode motor control command (communication type 1) --> Receive motor feedback frame (communication type 2)

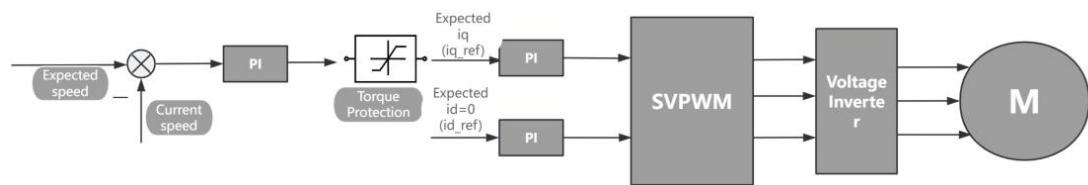
**Operation control mode description:** The control logic of the operation and control mode is  $t_{ref} = Kd * (v_{vset} - v_{actual}) + Kp * (p_{set} - p_{actual}) + t_{ff}$ .  $t_{ref}$  is converted to the expected  $i_q$  current through an internal formula and output through the current loop. Simple control demonstration: Set  $t_{ff}$  to 0,  $v_{vset}$  to 1,  $Kd$  to 1,  $p_{set}$  to 0,  $Kp$  to 0. If there is no external load on the motor, it will run at a speed of 1rad/s. If there is an external load,  $Kd$  needs to be increased to resist the external load. Set  $t_{ff}$  to 0,  $v_{vset}$  to 0,  $Kd$  to 1,  $p_{set}$  to 0,  $Kp$  to 0, the motor is in damping mode. When the motor is externally rotated, a damping is applied, which increases with the increase of  $Kd$ . It should be noted that the motor generates electricity under this condition and requires power supply to prevent overvoltage. Set  $t_{ff}$  to 0,  $v_{vset}$  to 0,  $Kd$  to 1,  $p_{set}$  to 5,  $Kp$  to 1. If there is no external load on the motor, it will run to the target position of 5. Increasing  $Kp$  will increase the force required to maintain the target position, and  $Kd$  is damping. Without  $Kd$ , the motor will sway to the target position.

### 4.3.2. Current mode



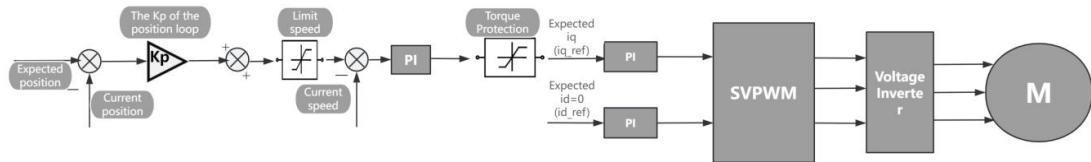
Send motor mode parameter write command (communication type 18) Set the runmode parameter to 3 --> Send motor Enable run frame (communication type 3) --> Send motor mode parameter write command (communication type 18) set the  $iq\_ref$  parameter to the default current instruction

### 4.3.3. Velocity mode



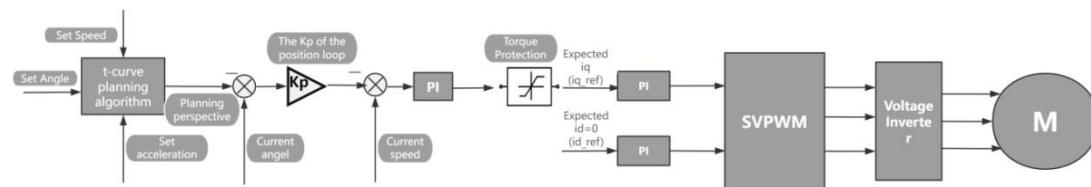
Send motor mode parameter write command (communication type 18) Set the runmode parameter to 2 --> Send motor Enable run frame (communication type 3) --> Send motor mode parameter write command (communication type 18) set limit\_cur parameter as default maximum current instruction --> Send motor mode parameter write command (communication type 18) Set acc\_rad parameter as default acceleration instruction --> Send motor mode parameter write command (communication type 18) Set spd\_ref parameter as default speed instruction

#### 4.3.4. Location Mode (CSP)



Send motor mode parameter write command (communication type 18) Set the runmode parameter to 5 --> Send motor Enable run frame (communication type 3) --> Send motor mode parameter write command (communication type 18) set limit\_spd parameter as default maximum speed instruction --> Send motor mode parameter write command (communication type 18) Sets loc\_ref parameter as default position instruction

#### 4.3.5. Location Mode (PP)



Send motor mode parameter write command (communication type 18) Set the runmode parameter to 1 --> Send motor Enable run frame (communication type 3) --> Send motor mode parameter write command (communication type 18) set The vel\_max parameter is the default maximum speed instruction --> Send motor mode parameter write command (communication type 18) Set the acc\_set parameter to the default acceleration instruction --> Send motor mode parameter write command (communication type 18) Set the loc\_ref parameter to the default position instruction

**Note: This mode does not support changing the speed and acceleration during operation. If you want to make an emergency stop, you can change vel\_max to 0 during the process, and it will stop at the current speed and acceleration plan**

### 4.3.6. Stop running

Sending motor stop frame (communication type 4)

## 4.4. Program sample

Examples of various mode control motors are provided below (take gd32f303 as an example)

The following are library, function, and macro definitions for the various instances

Plain Text

```
#define P_MIN -12.57f

#define P_MAX 12.57f

#define V_MIN -15.0f

#define V_MAX 15.0f

#define KP_MIN 0.0f

#define KP_MAX 5000.0f

#define KD_MIN 0.0f

#define KD_MAX 100.0f

#define T_MIN -120.0f

#define T_MAX 120.0f
```

```
struct exCanIdInfo{  
  
    uint32_t id:8;  
  
    uint32_t data:16;  
  
    uint32_t mode:5;  
  
    uint32_t res:3;  
  
};  
  
can_receive_message_struct rxMsg;  
  
can_trasnmit_message_struct txMsg={  
  
    .tx_sfid = 0,  
  
    .tx_efid = 0xff,  
  
    .tx_ft = CAN_FT_DATA,  
  
    .tx_ff = CAN_FF_EXTENDED,  
  
    .tx_dlen = 8,  
  
};  
  
#define txCanIdEx ((struct exCanIdInfo*)&(txMsg.tx_efid)))
```

```
#define rxCanIdEx (*((struct exCanIdInfo*)&(rxMsg.rx_efid))) //将扩展帧 id 解析为自定义数据结构

int float_to_uint(float x, float x_min, float x_max, int bits){

float span = x_max - x_min;

float offset = x_min;

if(x > x_max) x=x_max;

else if(x < x_min) x= x_min;

return (int) ((x-offset)*((float)((1<<bits)-1))/span);

}

#define can_txd() can_message_transmit(CAN0, &txMsg)

#define can_rxd() can_message_receive(CAN0, CAN_FIFO1, &rxMsg)
```

The following lists the common types of communication sent:

#### 4.4.1. Motor Enabled Run frame (communication type 3)

Plain Text

```
void motor_enable(uint8_t id, uint16_t master_id)
{
txCanIdEx.mode = 3;
```

```
txCanIdEx.id = id;  
txCanIdEx.res = 0;  
txCanIdEx.data = master_id;  
txMsg.tx_dlen = 8;  
txCanIdEx.data = 0;  
can_txd();  
}
```

#### 4.4.2. Operation control mode Motor control instruction (communication type 1)

Plain Text

```
void motor_controlmode(uint8_t id, float torque, float MechPosition, float  
speed, float kp, float kd)
```

```
{
```

```
txCanIdEx.mode = 1;
```

```
txCanIdEx.id = id;
```

```
txCanIdEx.res = 0;
```

```
txCanIdEx.data = float_to_uint(torque,T_MIN,T_MAX,16);
```

```
txMsg.tx_dlen = 8;
```

```
txMsg.tx_data[0]=float_to_uint(MechPosition,P_MIN,P_MAX,16)>>8;
```

```
txMsg.tx_data[1]=float_to_uint(MechPosition,P_MIN,P_MAX,16);
```

```
txMsg.tx_data[2]=float_to_uint(speed,V_MIN,V_MAX,16)>>8;

txMsg.tx_data[3]=float_to_uint(speed,V_MIN,V_MAX,16);

txMsg.tx_data[4]=float_to_uint(kp,KP_MIN,KP_MAX,16)>>8;

txMsg.tx_data[5]=float_to_uint(kp,KP_MIN,KP_MAX,16);

txMsg.tx_data[6]=float_to_uint(kd,KD_MIN,KD_MAX,16)>>8;

txMsg.tx_data[7]=float_to_uint(kd,KD_MIN,KD_MAX,16);

can_txd();

}
```

#### 4.4.3. Motor mode parameter write command (communication type 18, running mode switch)

Plain Text

```
void motor_reset(uint8_t id, uint16_t master_id)

{

txCanIdEx.mode = 4;

txCanIdEx.id = id;

txCanIdEx.res = 0;
```

```
txCanIdEx.data = master_id;

txMsg.tx_dlen = 8;

for(uint8_t i=0;i<8;i++)

{

txMsg.tx_data[i]=0;

}

can_txd();

}
```

#### 4.4.4. Motor mode parameter write command (communication type 18, running mode switch)

Plain Text

```
uint8_t runmode;

uint16_t index;

void motor_modechange(uint8_t id, uint16_t master_id)

{

txCanIdEx.mode = 0x12;
```

```
txCanIdEx.id = id;

txCanIdEx.res = 0;

txCanIdEx.data = master_id;

txMsg.tx_dlen = 8;

for(uint8_t i=0;i<8;i++)

{

    txMsg.tx_data[i]=0;

}

memcpy(&txMsg.tx_data[0],&index,2);

memcpy(&txMsg.tx_data[4],&runmode, 1);

can_txd();

}
```

#### **4.4.5. Motor mode parameter write command (communication type 18, control parameter write)**

Plain Text

```
uint16_t index;  
  
float ref;  
  
void motor_write(uint8_t id, uint16_t master_id)  
  
{  
  
txCanIdEx.mode = 0x12;  
  
txCanIdEx.id = id;  
  
txCanIdEx.res = 0;  
  
txCanIdEx.data = master_id;  
  
txMsg.tx_dlen = 8;  
  
for(uint8_t i=0;i<8;i++)  
  
{  
  
txMsg.tx_data[i]=0;  
  
}  
  
memcpy(&txMsg.tx_data[0],&index,2);  
  
memcpy(&txMsg.tx_data[4],&ref,4);
```

```
can_txd();  
  
}
```

# 5. Explanation of Canopen

## Communication Protocol Types

### 5.1. Introduction to CANopen Communication

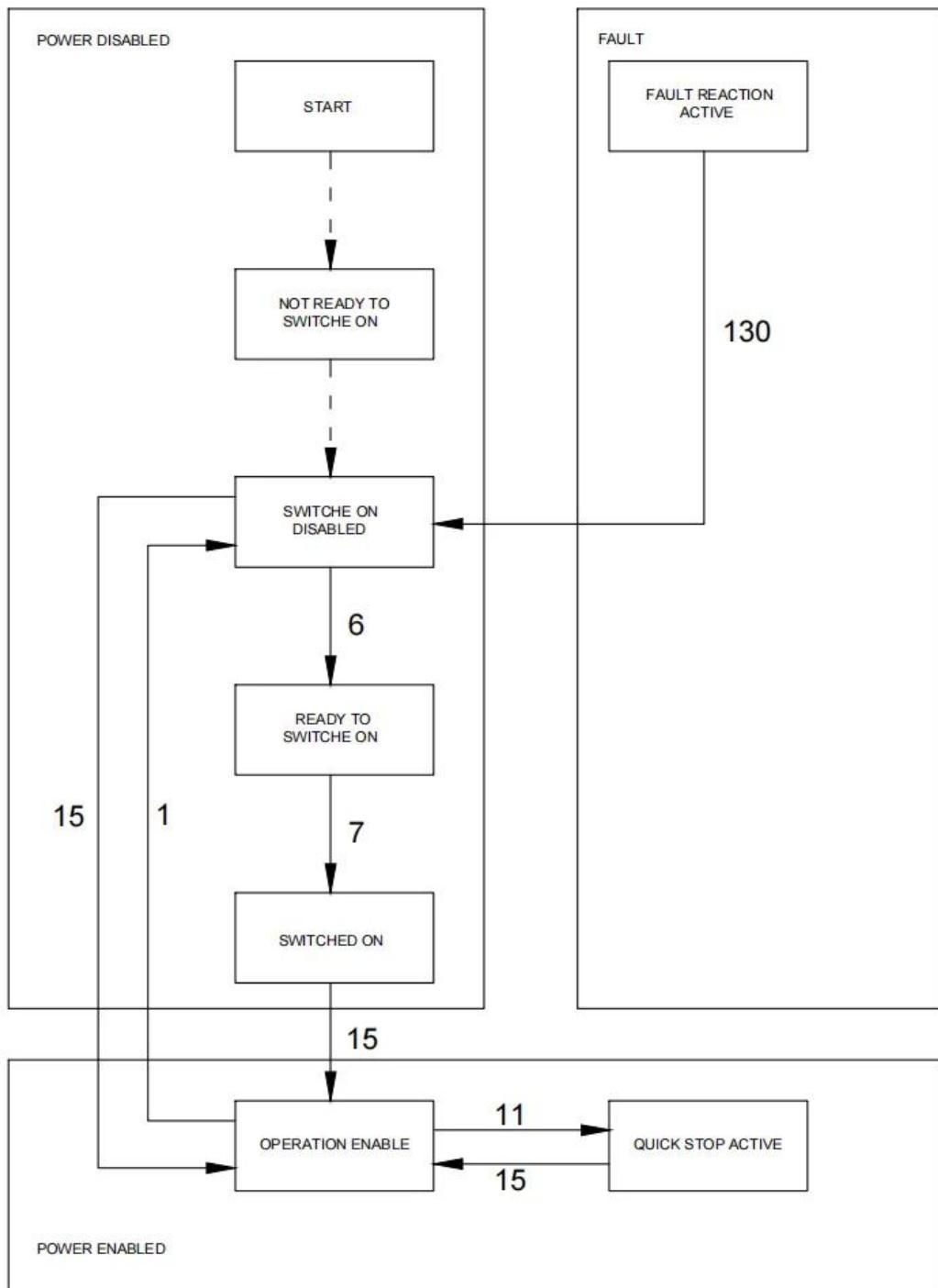
CANopen is a "higher-level protocol" based on the CAN bus. This means that the CAN bus (ISO 11898) acts like a container truck, serving as the "transportation vehicle" for CANopen information. CAN simply implements the transmission of frames with an 11-bit CAN ID, a Remote Transmission (RTR) bit, and 64 data bits (related to higher-level protocols). The CAN bus plays the same role in CANopen as it does in the J1939 protocol. CANopen implements Layer 7 of the OSI model and is compatible with other data link layer protocols besides CAN. Please download the necessary EDS files for CANopen from the official website download center at [www.robstride.com](http://www.robstride.com).

### 5.2. Canopen Protocol Message Classification

Classification	Function
NMT Network Management Messages	Manage the network and switch node states. NMT network management messages are typically sent by the master station.
SDO Service Data Object Message	Used for setting device parameters or transmitting critical data. Typically, the master station initiates an SDO message, and the slave station responds. However, a slave station can also initiate an SDO message, with the master station responding, for example, in the transmission of critical data.
PDO (Process Data Object) messages	Transmit process data from various devices, such as temperature and speed. Both the master and slave stations send these messages.
EMCY Emergency Message	Transmits fault information about the transmission equipment. Both the master and slave stations send this message.
SYNC Synchronization	Synchronization data, used to synchronize TPDO data on the slave station. Generally sent by the master station.

Classification	Function
Message	
NODE GUARDING Message	The master station requests the slave station's status; the master station queries, and the slave station responds.
Heartbeat Message	A device actively sends a heartbeat to indicate that it is online. Both the master and slave devices can send heartbeats.

## 5.3. State Machine Description



### Motor Enable:

When initially powered on, the motor defaults to the **SWITCH\_ON\_DISABLED** state. To transition to **OPERATION\_ENABLE**, modify the **Controlword (6040H)** to **6, 7, or 15** (step-by-step transition), or directly set it to **15** for immediate

enablement.

### **Stopping the Motor:**

If the motor is in **OPERATION\_ENABLE** state and needs to stop normally, modify the **Controlword (6040H)** to 1. The motor will return to the disabled state (**SWITCH\_ON\_DISABLED**).

### **Emergency Stop (Use with Caution—Risk of Voltage Surge):**

During operation, an emergency stop can be triggered by setting the **Controlword (6040H)** to 11.

### **Fault Clearance:**

If the motor enters a **FAULT** state due to protection mechanisms, modifying the **Controlword (6040H)** can clear standard errors.

### **Important Note:**

Mode changes for this motor must be performed in the **disabled state (SWITCH\_ON\_DISABLED)**. Ensure the desired mode is configured **before** enabling **OPERATION\_ENABLE** to avoid unexpected behavior.

## **5.4. Status Feedback Parameters**

Index	Name	Attribute	Type	Unit
603F	<b>Error_code</b>	Read-only	UINTEGER16	/
6041	<b>Statusword</b>	Read-only	UINTEGER16	/
6061	<b>Modes_of_operation_display</b>	Read-only	INTEGER8	/
6062	<b>Position_demand_value</b>	Read-only	INTEGER32	Pulses (1 rev = 16,384 pulses)
6064	<b>Position_actual_value</b>	Read-only	INTEGER32	Pulses (1 rev = 16,384 pulses)
606B	<b>Velocity_demand_value</b>	Read-only	INTEGER32	0.1 rpm
606C	<b>Velocity_actual_value</b>	Read-only	INTEGER32	0.1 rpm

Index	Name	Attribute	Type	Unit
6077	Torque_actual_value	Read-only	INTEGER16	0.1% load ratio (1000 = 40 N·m)
6078	Current_actual_value	Read-only	INTEGER16	mA
6079	DC_link_circuit_voltage	Read-only	INTEGER32	mV

## 5.5. Homing Mode (Zero Position Setting)

Index	Name	Attribute	Type	Unit
6040	Controlword	Read-write	UINT16	/
6060	Modes of operation	Read-write	INTEGER8	/

### Homing method:

- Set **Modes of operation** to **6** while the motor is in the **disabled state (SWITCH\_ON\_DISABLED)**. The motor will then define the current position as the zero point.
- To **hold the zero position**, modify the **Controlword** to **15**, and the motor will maintain its position at the home location.

## 5.6. Position Mode (PP - Profile Position)

Index	Name	Attribute	Type	Unit
6040	Controlword	Read-write	UINT16	/
6060	Modes of operation	Read-write	INTEGER8	/
6067	Position_window	Read-write	UINT32	Pulses (1 rev = 16,384 pulses)
6068	Position_window_time	Read-write	UINT16	ms
6071	Target_torque	Read-write	INTEGER16	0.1% load ratio (1000 = 40 N·m)
607A	Target_position	Read-write	INTEGER32	Pulses (1 rev = 16,384 pulses)
6081	Profile_velocity	Read-write	UINT32	0.1 rpm
6083	Profile_acceleration	Read-	UINT32	0.1 rpm/s

Index	Name	Attribute	Type	Unit
		write		

### Steps to Configure Position Mode (PP):

1. While the motor is in the **disabled state (SWITCH\_ON\_DISABLED)**, set

**Modes of operation** to 1.

- **Mandatory parameters:**

- **Target\_torque** (absolute max torque in position mode)

- **Profile\_velocity** (absolute speed in position mode)

- **Profile\_acceleration** (absolute acceleration in position mode)

- **Optional parameters:**

- **Position\_window** (if not set, window check is disabled)

- **Position\_window\_time** (if not set, window check is disabled)

2. Set **Controlword (6040)** to **15** to enable operation.

3. Set **Target\_position** (absolute position) to move the motor to the desired position.

## 5.7. Position Mode (CSP - Cyclic Synchronous Position)

Index	Name	Attribute	Type	Unit
6040	<b>Controlword</b>	Read-write	UINTEGER16	/
6060	<b>Modes of operation</b>	Read-write	INTEGER8	/
6067	<b>Position_window</b>	Read-write	UINTEGER32	Pulses (1 rev = 16,384 pulses)
6068	<b>Position_window_time</b>	Read-write	UINTEGER16	ms
6071	<b>Target_torque</b>	Read-write	INTEGER16	0.1% load ratio (1000 = 40 N·m)

Index	Name	Attribute	Type	Unit
607A	Target_position	Read-write	INTEGER32	Pulses (1 rev = 16,384 pulses)
6081	Profile_velocity	Read-write	UINTEGER32	0.1 rpm

### Steps to Configure Position Mode (CSP):

1. While the motor is in the **disabled state (SWITCH\_ON\_DISABLED)**, set

**Modes of operation** to 5.

- **Mandatory parameters:**
  - **Target\_torque** (absolute max torque in position mode)
  - **Profile\_velocity** (absolute speed in position mode)
- **Optional parameters:**
  - **Position\_window** (0 = disabled)
  - **Position\_window\_time** (0 = disabled)

2. Set **Controlword (6040)** to 15 to enable operation.
3. Set **Target\_position** (absolute position) to move the motor to the desired position.

## 5.8. Velocity Mode

Index	Name	Attribute	Type	Unit
6040	Controlword	Read-write	UINTEGER16	/
6060	Modes of operation	Read-write	INTEGER8	/
6071	Target_torque	Read-write	INTEGER16	0.1% load ratio (1000 = 40 N·m)
60FF	Target_velocity	Read-write	INTEGER32	0.1 rpm

### Steps to Configure Velocity Mode:

1. While the motor is in the **disabled state (SWITCH\_ON\_DISABLED)**, set

**Modes of operation** to 3.

- **Mandatory parameter:**
    - **Target\_torque** (absolute max torque in velocity mode)
2. Set **Controlword (6040)** to **15** to enable operation.
  3. Set **Target\_velocity** to reach the desired speed.
- 

## 5.9. Torque Mode

Index	Name	Attribute	Type	Unit
<b>6040</b>	<b>Controlword</b>	Read-write	UINTEGER16	/
<b>6060</b>	<b>Modes of operation</b>	Read-write	INTEGER8	/
<b>6071</b>	<b>Target_torque</b>	Read-write	INTEGER16	0.1% load ratio (1000 = 40N·m)

### Steps to Configure Torque Mode:

1. While the motor is in the **disabled state (SWITCH\_ON\_DISABLED)**, set **Modes of operation** to **4**.
  2. Set **Controlword (6040)** to **15** to enable operation.
  3. Set **Target\_torque** to output the desired torque.
- 

## 5.10. Protocol Switching (Extended Frame): Switch Motor Protocol (Takes Effect After Power Cycle)

Data Field	29-bit ID	8-Byte Data Area
<b>Size</b>	Bit 28~0	Byte 0~6
<b>Description</b>	<b>0xFFFF</b>	01 02 03 04 05 06 F_CMD

- **F\_CMD** (Byte 6) defines the motor protocol:
  - **0**: Private protocol (default)
  - **1**: CANopen protocol
  - **2**: MIT protocol

**Response Frame:**

Data Field	11-bit ID	8-Byte Data Area
<b>Size</b>	Bit 10~0	Byte 0~7
<b>Description</b>	Motor ID	64-bit MCU unique identifier

## 6. MIT Communication Protocol Description

The motor communication adopts the CAN 2.0 interface with a default baud rate of 1 Mbps. The baud rate can be modified by switching to the private protocol. The standard frame format is as follows:

Data Field	11-bit ID		8-byte Data Area
<b>Size</b>	Bit 10~8	Bit 7~0	Byte 0~7
<b>Description</b>	Mode type	ID	

- Supported Control Modes:
- **MIT Mode:** Provides five motion control parameters to the motor.
- **Velocity Mode:** Specifies the target speed for the motor.
- **Position Mode:** Specifies the target position and speed, allowing the motor to run to the designated position at the configured speed.

### 6.1. Response Command 1: Data Feedback (Motor Status)

Data Field	11-bit ID	8-byte Data Area
<b>Size</b>	Bit 10~0	Byte 0~7
<b>Description</b>	Host ID	Byte 0: Motor CAN ID Byte 1~2: The current angle [0~65535], corresponds to (-15 rad ~ 15 rad)  Byte 3 (high 8 bits),  Byte 4[7-4] (low 4 bits): The current speed [0~4096], corresponds to (-33 rad/s ~ 33 rad/s)  Byte 4[3-0] (high 4 bits),  Byte 5 (low 8 bits): The current torque [0~4096], corresponds to (-120 N·m ~ 120 N·m)  Byte 6~7: Winding temperature (in degrees): Temp(Celsius) *10

## 6.2. Response Command 2: MCU Identification

Data Field	11-bit ID	8-byte Data Area
<b>Size</b>	Bit 10~0	Byte 0~7
<b>Description</b>	Motor ID	64-bit MCU unique identifier

## 6.3. Command 1: Enable Motor Operation

Data Field	11-bit ID	8-byte Data Area
<b>Size</b>	Bit 10~0	Byte 0~7
<b>Description</b>	Target motor CAN ID	FF FF FF FF FF FF FF FC

**Response:** Response Command 1

## 6.4. Command 2: Stop Motor Operation

Data Field	11-bit ID	8-byte Data Area
<b>Size</b>	Bit 10~0	Byte 0~7
<b>Description</b>	Target motor CAN ID	FF FF FF FF FF FF FF FD

**Response:** Response Command 1

## 6.5. Command 3: MIT Dynamic Parameters

Data Field	11-bit ID	8-byte Data Area
<b>Size</b>	Bit 10~0	Byte 0~1: Target angle [0~65535], (-15 rad ~ 15 rad) Byte 2 (high 8 bits), Byte 3[7-4] (low 4 bits): Target speed [0~4096], (-33 rad/s ~ 33 rad/s) Byte 3[3-0] (high 4 bits), Byte 4 (low 8 bits): Kp [0~4096], (0~500) Byte 5 (high 8 bits), Byte 6[7-4] (low 4 bits): Kd [0~4096], (0~5) Byte 6[3-0] (high 4 bits), Byte 7 (low 8 bits): Target torque [0~4096], (-120 N·m ~ 120 N·m)

**Response:** Response Command 1

## 6.6. Command 4: Set Zero Position (Non-Position Mode)

Data Field	11-bit ID	8-byte Data Area
Size	Bit 10~0	Byte 0~7
Description	Target motor CAN ID	FF FF FF FF FF FF FF FF FE

**Response:** Response Command 1

## 6.7. Command 5: Clear Errors & Read Fault Status

Data Field	11-bit ID	8-byte Data Area
Size	Bit 10~0	FF FF FF FF FF F_CMD FBF_CMD:- 0xFF → Clear current fault- Any other value → Returns fault value in Byte 1 of the response

**Response (Fault Clear):** Response Command 1

## 6.8. Fault Status Response:

Data Field	11-bit ID	8-byte Data Area
Size	Bit 10~0	Byte 0: Motor CAN ID Byte 1~4: Fault value (Non-zero: Fault present; 0: Normal) Bit 14: Stall/I <sup>2</sup> t overload fault Bit 7: Encoder not calibrated Bit 3: Overvoltage fault Bit 2: Undervoltage fault Bit 1: Driver IC fault Bit 0: Motor overtemperature fault (Default threshold: 145°C)

## 6.9. Command 6: Set Operation Mode

Data Field	11-bit ID	8-byte Data Area
Size	Bit 10~0	FF FF FF FF FF F_CMD FCF_CMD: Mode type- 0: MIT mode (default)- 1: Position mode- 2: Velocity mode

**Response:** Response Command 1

## 6.10. Command 7: Modify Motor CAN ID

Data Field	11-bit ID	8-byte Data Area
Size	Bit 10~0	FF FF FF FF FF F_CMD FAF_CMD: Target motor CAN ID

**Response:** Response Command 2

## 6.11. Command 8: Change Communication Protocol (Takes Effect After Power Cycle)

Data Field	11-bit ID	8-byte Data Area
Size	Bit 10~0	FF FF FF FF FF F_CMD FDF_CMD: Protocol type- 0: Private protocol (default)- 1: CANopen - 2: MIT protocol

**Response:** Response Command 2

## 6.12. Command 9: Modify Host CAN ID

Data Field	11-bit ID	8-byte Data Area
Size	Bit 10~0	FF FF FF FF FF F_CMD 01F_CMD: Host CAN ID

**Response:** Response Command 2

## 6.13. Command 10: Position Mode Control Command

Data Field	11-bit ID	8-byte Data Area	
Size	Bit 10~8	Bit 7~0	Byte 0~3: Target position (rad, 32-bit float) Byte 4~7: Target speed (rad/s, 32-bit float)
Description	1	Target motor CAN ID	

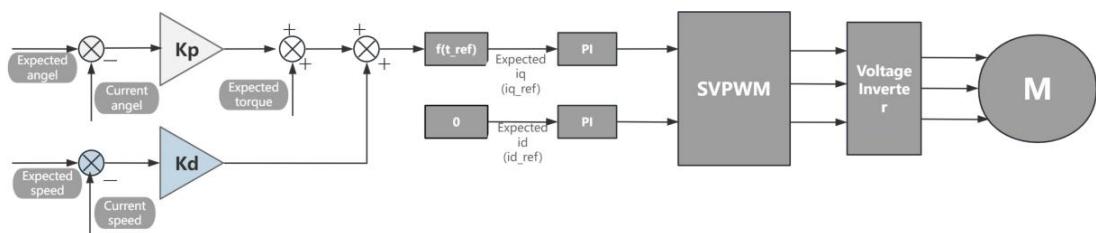
**Response:** Response Command 1

## 6.14. Command 11: Velocity Mode Control Command

Data Field	11-bit ID		8-byte Data Area
<b>Size</b>	Bit 10~8	Bit 7~0	Byte 0~3: Target speed (rad/s, 32-bit float) Byte 4~7: Current limit in speed/position mode (A, 32-bit float)
<b>Description</b>	2	Target motor CAN ID	

**Response:** Response Command 1

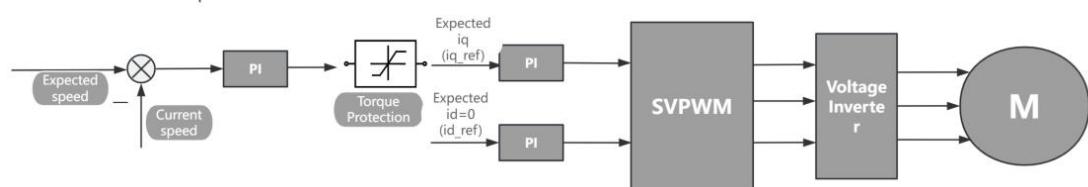
## 6.15. Motion Control Mode



The motor defaults to Motion Control Mode upon power-up.

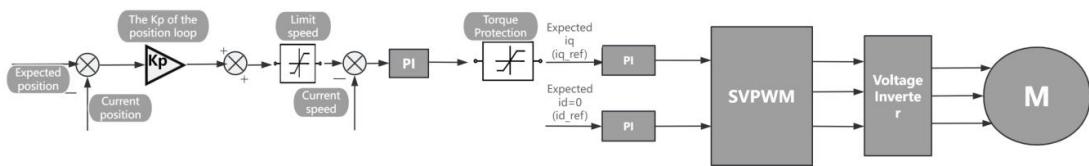
1. Send the *Motor Enable Command* (Command 1).
2. Send the *Motion Control Command* (Command 3) to activate dynamic parameter control.
3. Send the *Motor Stop Command* (Command 2) to halt operation when needed.

## 6.16. Velocity Mode



1. Configure the motor's operation mode by sending *Set Operation Mode Command* (Command 6) with **Mode = 2 (Velocity Mode)**.
  2. Send the *Motor Enable Command* (Command 1) to activate the motor.
  3. Send the *Velocity Mode Control Command* (Command 11) to set the **maximum current (absolute value)** and **target speed**.
  4. To stop, send the *Motor Stop Command* (Command 2).
- 

## 6.17. Position Mode (CSP - Cyclic Synchronous Position)



1. Configure the motor's operation mode by sending *Set Operation Mode Command* (Command 6) with **Mode = 1 (Position Mode)**.
2. Send the *Motor Enable Command* (Command 1) to activate the motor.
3. Send the *Position Mode Control Command* (Command 10) to set the **maximum speed (absolute value)** and **target position**.
4. To stop, send the *Motor Stop Command* (Command 2).

## 7. Version History

Version Number	Description	Date
1.0	Initial Release	November 25, 2025