

DAMIAOAO | 达妙科技

DM-J4310P-2EC Geared Motor

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Disclaimer

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Precautions

1. The motor must be operated strictly within the specified working environment and maximum allowable temperature range of the windings; otherwise, permanent irreversible damage may occur to the product.
2. Prevent foreign objects from entering the rotor, as this may cause abnormal rotor operation.
3. Before use, check all components for integrity. If any parts are missing, aged, or damaged, stop using the device.
4. Ensure proper wiring and secure, correctly installed motor.
5. Do not touch the electronic rotor during operation to prevent accidents. The motor may overheat when delivering high torque, so take precautions to avoid burns.
6. Users must not disassemble the motor without authorization, as this may compromise its control accuracy or even cause malfunction.

Motor Features

1. Dual encoder with single-turn absolute position output, ensuring position accuracy even during power loss.
2. The motor and driver are integrated, which has compact structure and high integration degree.
3. Supports visual debugging on host computer and CAN parameter read/write.
4. The CAN bus can be used to feedback the motor speed, position, torque, and temperature.
5. It has the function of double temperature protection.
6. Supports CAN upgrade.

Specifications

Use the motor properly according to the following parameters.

Motor Parameters	Rated voltage	24V
	Rated phase/power current	4.9A/3.1A@24V;
	Peak phase/power current	16A/15.38A@24V; 0.8 Overcurrent 20A/16.44A@24V; 0.98 Overcurrent
	Rating torque	3.5NM
	Peak torque	11NM 0.8 Overcurrent 12.5NM 0.98 Overcurrent
	Rated speed	120rpm
	No-load maximum speed	200rpm
Motor Characteristics	Reduction gear ratio	10: 1
	Number of pole-pairs	14
	Phase inductance	Approximately 320uH
	Phase resistance	Approximately 580 mΩ
Structure and Weight	External diameter	57mm
	Altitude	46mm
	Motor weight	Approximately 325 grams
Encoder	Encoder bit count	16-bit
	Number of encoders	2
	Encoder type	Magnetic winding (single turn)
Communication	Control interface	CAN@1Mbps
	Parameter passing interface	UART@921600bps
		MIT pattern

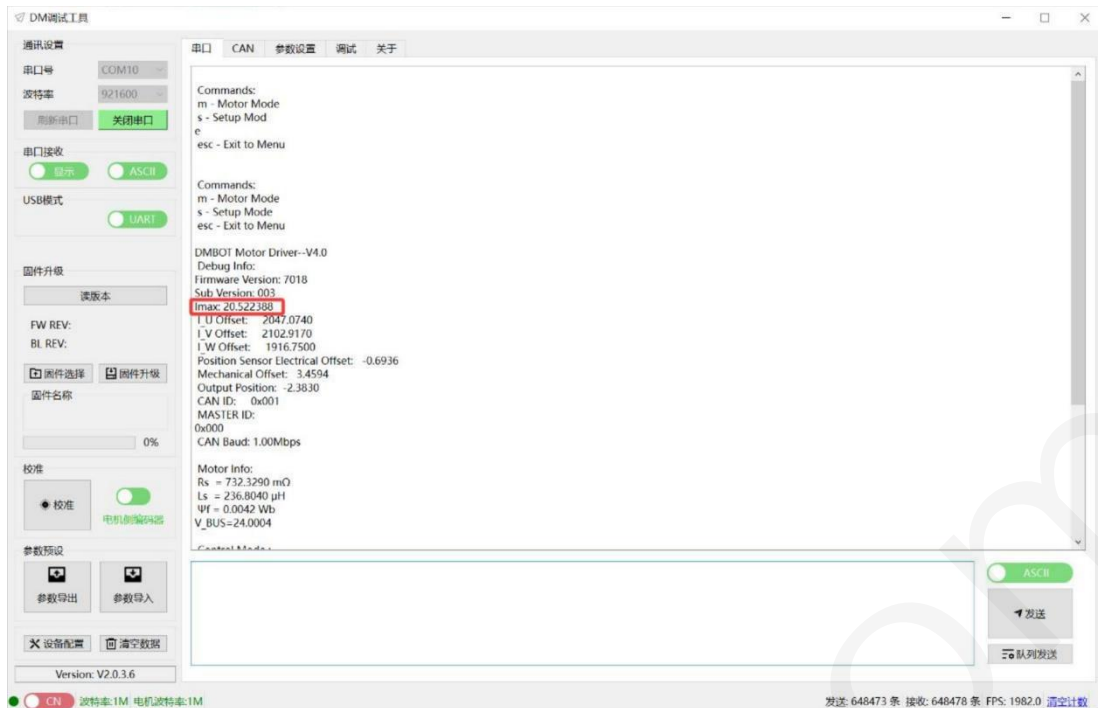
Control and protection	Control model	Speed mode	
		Position mode	
	Protect	Enable over-temperature protection with a protection temperature of 120°C. The motor will exit the enable mode if overheated.	
		Motor over-temperature protection. Set according to usage requirements, recommended not exceeding 100°C. The motor will exit the 'enabled mode' if overheated.	
		Motor overvoltage protection. Set according to usage requirements, recommended not to exceed 32V. Overvoltage will exit the 'enabled mode'.	
		Communication loss protection. If no CAN commands are received within the set period, the system will automatically exit the enable mode.	
		Motor overcurrent protection. Set according to usage requirements, recommended not to exceed 9.8A. Overcurrent will exit the 'enabled mode'.	
Motor under-voltage protection: If the power supply voltage drops below the set threshold, the system will exit the enable mode. The recommended minimum power supply voltage is 15V.			

Operating Voltage

The operating voltage range is 24V-48V. Avoid hot plugging when exceeding 36V. The minimum operating voltage is 20V, and the maximum is 65V.

Maximum Phase Current

The maximum phase current of the corresponding drive can be queried by printing information through the serial port during power-on.



You can set the maximum phase current percentage to limit the operation through the debug assistant. The default value is 0.8, which is 80% of the maximum current that can be sampled. It is recommended that this value does not exceed 98%.

Maximum Speed

The maximum rotational speed is constrained by multiple factors, including power supply voltage (V_{BUS}), magnetic flux density (ψ_f), and gear ratio (GR). The upper limit can typically be calculated using the following formula.

$$V_{MAX}(rad/s) = 0.57735 * \frac{V_{BUS}}{N_{pp} * GR * \psi_f} (rad/s)$$

in the formula

V_{BUS} is the power supply voltage.

N_{pp} is the number of motor pole pairs.

ψ_f denotes the rotor magnetic flux.

Torque Constant

The torque coefficient of the motor can be considered constant within its rated range. When combined with the gearbox, the calculation can be performed using the following formula:

$$K_t = 1.5 * N_{pp} * \psi_f * GR * GREF$$

among ,

Npp: number of pole-pairs

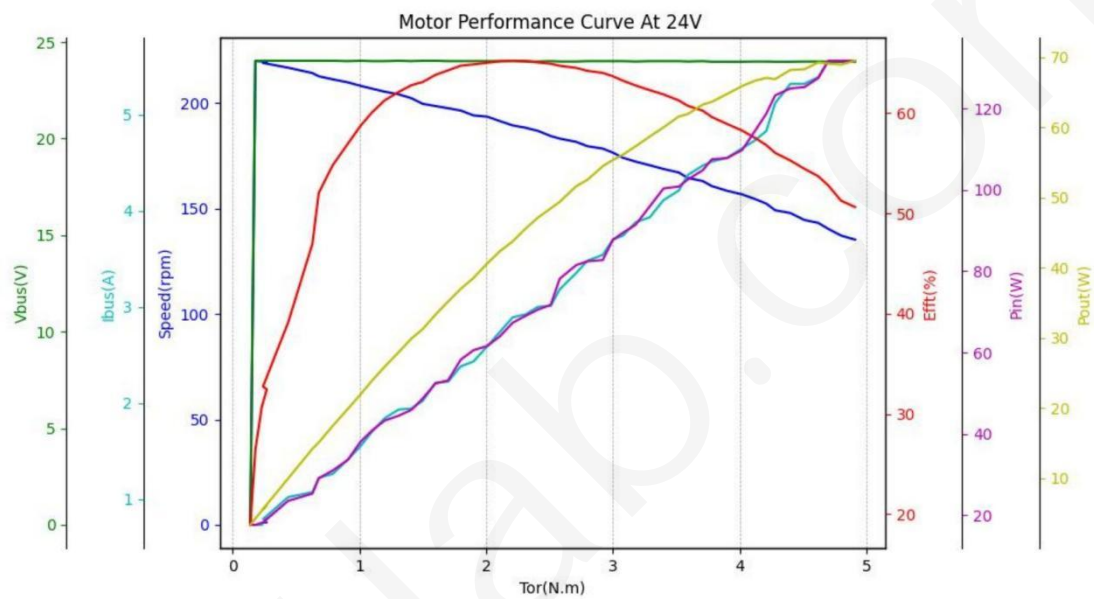
ψ_f : rotor flux

GR: Motor reduction ratio

GRF: Torque transfer coefficient of gearbox

TN curve

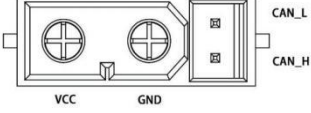
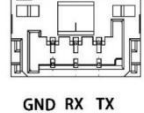
The measured performance curve for the 24V version at a constant speed of 120rpm and room temperature of 25°C:



Package Contents

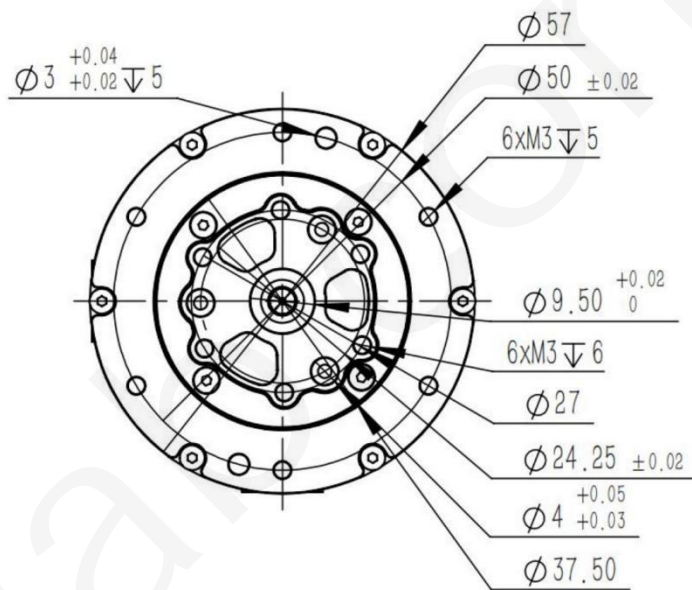
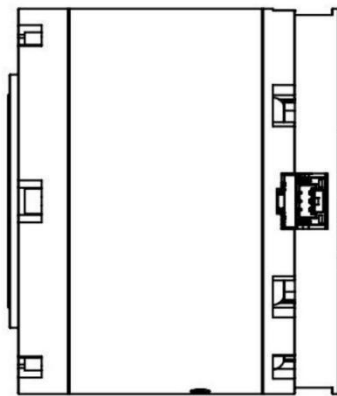
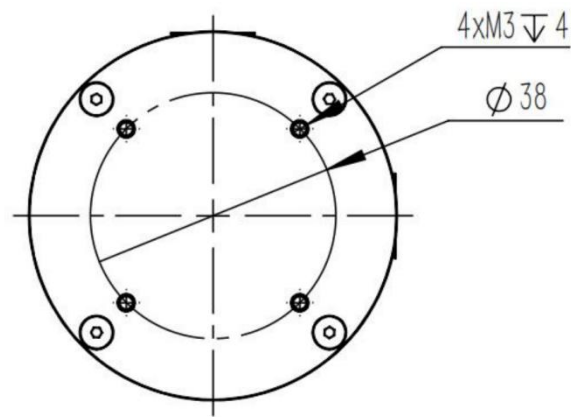
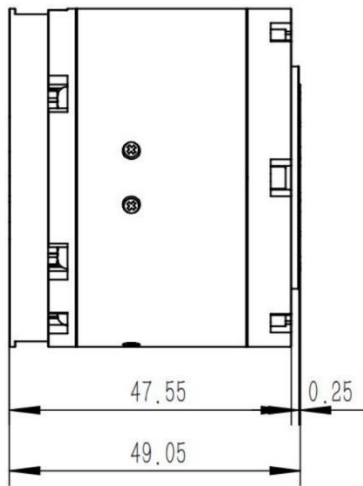
1. Motor (including drive) × 1
2. Power supply (including CAN communication terminals)
Connection cable: XT30 (2+2) -F single-ended connector cable (100mm) × 1
3. Debugging the serial signal line: GH1.25 3-pin connector (crossed, 300mm) × 1

Interface and Wire Sequence Description

Designation - No.	Interface Label	Description
Power Port-1 (including CAN communication terminals)		<p>1. Connect the power supply to the motor via the XT30 (2+2) -F plug's power cable, rated at 24V.</p> <p>2. The system connects to external control devices via CAN communication terminals, receiving CAN control commands and transmitting motor status data.</p>
Power Port-2 (including CAN communication terminals)		<p>3. The motor features two power interfaces, each of which can be used independently or connected in series for multiple units, facilitating wiring.</p>
Debug Serial Port-3		<p>Connect the motor to the PC using the GH1.25 cable (3-pin) with a USB-to-CAN diagnostic tool (or a universal USB-to-serial module), then configure parameters and perform firmware upgrades via DAMIAOAO Technology's diagnostic assistant.</p>

Motor size and installation

Refer to the motor mounting hole dimensions and positions to install the motor on the corresponding equipment.



Indicator Status

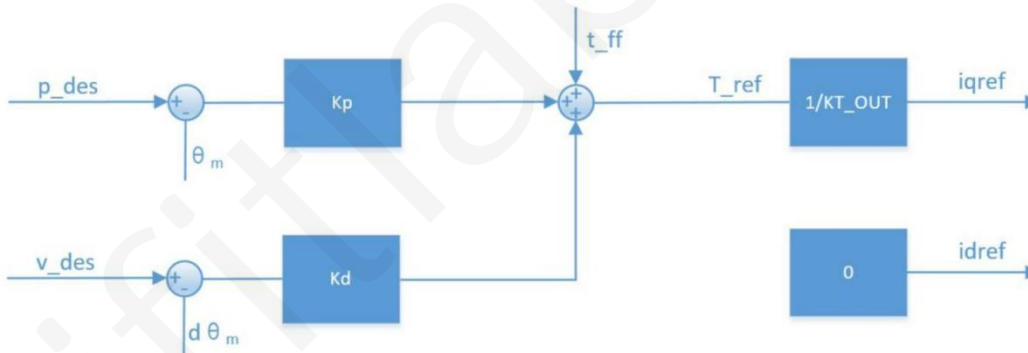
Normal Status	Green LED steady on.	The ERR bit is 1, indicating the enabled mode and normal operating state.
	Red LED steady on.	The ERR bit is 0, indicating disabled mode
Abnormal Status	Red LED flashing	<p>indicates a fault, corresponding to the following fault type:</p> <ul style="list-style-type: none"> 3. Output shaft calibration error; 4. Sensor output error; 5. Motor encoder calibration error. 8-over pressure; 9-under pressure; A—Overcurrent; B—MOS Overtemperature; C-Motor coil overheating;

		<p>D-Communication loss; E—— overload ; You can check the fault through the feedback frame or the DAMIAO Technology Debug Assistant interface.</p>
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Operating Modes

MIT Mode

The MIT mode is designed to be compatible with the original MIT mode, enabling seamless switching while allowing flexible control range settings (P_MAX, V_MAX, T_MAX). The electric controller converts received CAN data into control variables, calculates torque values, and provides current setpoints for the current loop. The current loop then adjusts according to its regulation rules to ultimately achieve the desired torque current. The control block diagram is shown below:



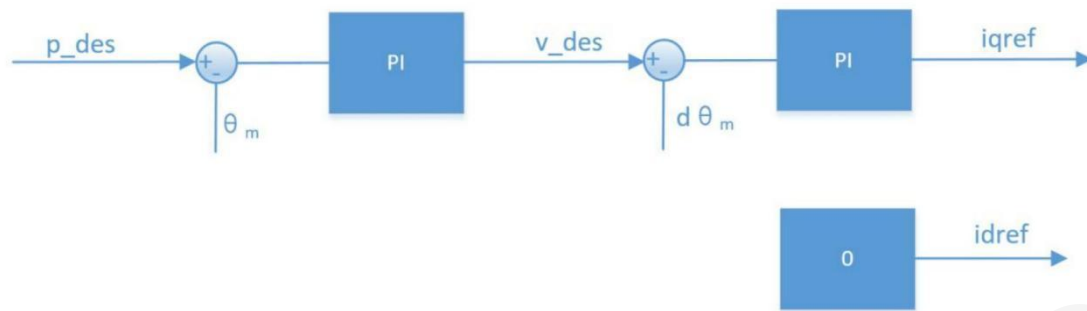
The MIT model can be adapted to various control configurations. For instance, when $k_p=0$ and $k_d \neq 0$, a constant-speed rotation can be achieved by setting v_des . Similarly, when $k_p=0$ and $k_d=0$, torque output can be controlled by setting t_ff .

Note: When controlling position, do not set k_d to 0, as this may cause motor oscillation or even loss of control.

Position-Speed Mode

The position cascade control mode employs a three-loop series configuration. The outermost position loop provides the speed loop's setpoint, while the inner

current loop receives the speed loop's output to regulate actual current. The control block diagram is shown below:



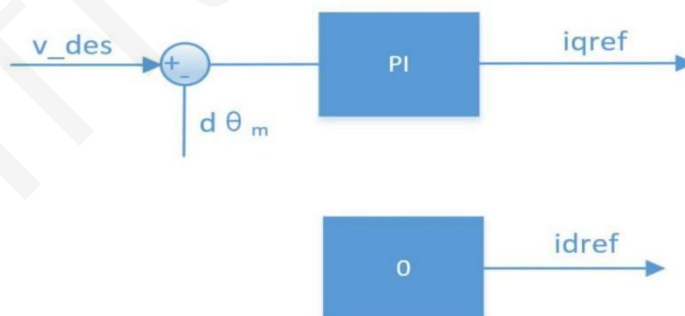
p_des is the target position for control, while v_des defines the maximum absolute speed during motion.

When the cascade mode is controlled using the parameters recommended by the debugging assistant, it achieves better control accuracy and a smoother process, though with a longer response time. In addition to v_des , other configurable parameters include acceleration/deceleration settings. If additional oscillations occur during control, increasing acceleration/deceleration can mitigate them.

Note: p_des and v_des are measured in rad and rad/s respectively, with data type float. The damping factor must be set to a positive non-zero value. Refer to the speed mode precautions.

Speed mode

The speed mode enables the motor to operate stably at the set speed, as shown in the control block diagram below.



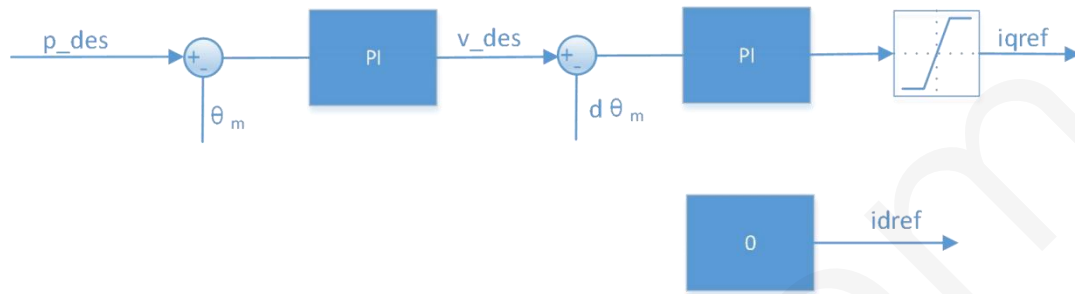
Note: v_des is measured in rad/s and is a float data type. To use the debug assistant for automatic parameter calculation, you need

Set the damping factor to a non-zero positive number, typically ranging from 2.0 to 10.0. A too small damping factor may cause speed oscillations and excessive

overshoot, while an excessively large damping factor can result in prolonged rise time. The recommended setting is 4.0.

Hybrid mode of power and position control

The position-force hybrid control mode dynamically adjusts the output torque based on position-speed mode control, as shown in the control block diagram below:



The current loop is limited to a given range by adding a current command saturation link after the output command of the speed loop.

Edit Mode

The mode can be set via the host computer's serial port. Simply select the desired mode and click 'Write Parameters'. After successful configuration, the motor will reset automatically. The mode is stored in the motor driver and remains intact upon power-on.

Additionally, modifications can be made via the CAN interface to update the mode register settings, as detailed in the 'Mode Switching' section of the next chapter. This configuration will prevent motor reset but will reset the following five variables to zero:

Position command value

② Speed command value

③ Torque command value (MIT mode)

④ k_p (MIT pattern)

⑤ k_d (MIT pattern)

The mode will not be saved without sending the "Save parameters" command. It will be lost after a power outage and loaded after a power-on last saved mode.

CAN communication

After completing motor calibration, parameter setting, and configuration, the system becomes operational. It uses CAN standard frame (STD) format with a default baud rate of 1Mbps, which can be adjusted to different rates via commands as detailed in the CAN baud rate modification section. Functionally, frames are categorized into receiving frames and feedback frames. Receiving frames contain control data for motor command execution, while feedback frames transmit status data from the motor to the upper controller. The feedback mechanism operates on an inquiry-based principle: when the driver receives a frame ID matching the motor's configured CAN ID (with low 8 bits for parity check and high 3 bits ignored), it sends the current status data to the bus. Although receiving frame formats and IDs vary by motor mode, the feedback frames remain consistent across all operational modes.

Change baud rate

The baud rate can be configured via the host computer's serial port. Simply select the desired baud rate and click 'Write Parameters'. After successful setup, the motor will automatically reset, with the baud rate stored in the motor driver for permanent retention during power cycles.

Another method involves modifying the baud rate via the CAN interface by writing the value into the baud rate register, as detailed in the 'CAN Baud Rate Modification' section of this chapter.

Note: Modifying the baud rate via CAN may fail if multiple devices are connected to the bus. Exercise caution and configure the baud rate before use.

Feedback frame

The feedback frame ID is set by the debug assistant (Master ID), with a default value of 0. It primarily provides feedback on the motor's position, speed, and torque. The frame format is defined as:

feedback message	D[0]	D[1]	D[2]	D[3]	D[4]	D[5]	D[6]	D[7]
MST_ID	ID ERR<<4	POS[15:8]	POS[7:0]	VEL[11:4]	VEL[3:0] T[11:8]	T[7:0]	T_MOS	T_Rotor

among :

ID indicates the controller's ID, with the lower 8 bits of CAN_ID (ERR) representing the status, corresponding to the following status types:

0-Disability;

1—Enable;

8—overpressure;

9-Under-voltage;

A— excess current ;

B—MOS overtemperature;

C-Motor coil overheating;

D-Communication loss;

E— overload ;

POS indicates the motor's position information

VEL indicates the motor speed information

T represents the torque information of the motor

T_MOS is the average temperature of the upper MOS, in °C

T_Rotor is the average temperature of the motor's internal coils, measured in °C

The position, speed and torque are converted to signed fixed-point data by linear mapping, where the position is 16-bit, and the speed and torque are 12-bit.

Control frame in MIT mode

control message	D[0]	D[1]	D[2]	D[3]	D[4]	D[5]	D[6]	D[7]
ID	p_des [15:8]	p_des [7:0]	v_des [11:4]	v_des[3:0] Kp[11:8]	Kp [7:0]	Kd [11:4]	Kd[3:0] t_ff[11:8]	t_ff[7:0]

The frame ID matches the set CAN ID value

P_des: Position given

V_des: Speed given

Kp: Position Ratio Coefficient

Kd: Positional differential coefficient

T_ff: Torque setpoint

All parameters adhere to the mapping relationships specified in the previous section. The values of p_des, v_des, and t_ff can be configured via the debugging assistant, while Kp ranges from 0 to 500 and Kd ranges from 0 to 5.

A standard CAN data frame is 8 bytes long. MIT's control command format encodes five parameters—Position, Velocity, Kp, Kd, and Torque—into 8 bytes using bit combinations. Specifically: Position occupies 2 bytes (16 bits), Velocity 12 bits, Kp 12 bits, and Kd 12 bits.

Control frame in position velocity mode

control message	D[0]	D[1]	D[2]	D[3]	D[4]	D[5]	D[6]	D[7]
0x100+ID	p_des				v_des			

The frame ID is the set CAN ID value plus an offset of 0x100.

P_des: Position given, floating-point type, with the lower bit first and the higher bit last

V_des: Speed given, floating-point, lower bits first, higher bits last

The CAN ID for the command is 0x100+ID. The given speed is the maximum speed under trapezoidal acceleration, i.e., the speed value during the constant speed phase.

Control frame in speed mode

control message	D[0]	D[1]	D[2]	D[3]
0x200+ID	v_des			

The frame ID is the set CAN ID value plus an offset of 0x200.

V_des: A floating-point variable with fixed speed, where the lower bit is first and the higher bit is last. The CAN ID for this command is 0x200+ID.

Control frame in position and force hybrid control mode

control message	D[0]	D[1]	D[2]	D[3]	D[4]	D[5]	D[6]	D[7]
0x300+ID	p_des			v_des		i_des		

P_des: Position given, in radians, floating-point type with least significant bit first and most significant bit last;

V_des: Speed limit value in rad/s, scaled by 100x, 16-bit unsigned (LSB first, MSB last), range 0-10000 (clamped to 10000), corresponding to actual speed limit of 0-100 rad/s.

I_des: The torque current limit is set to a 10,000x magnitude, using an unsigned 16-bit type with the lower bit first and the higher bit last. The range is 0-10,000, and it is capped at 10,000 if exceeded. The corresponding actual current limit is 0-1.0.

Current magnitude: The actual current value divided by the maximum phase current value.

Enable

After the power-on self-test is completed, the 'Enable' command must be sent to initiate control. The 'Enable' frame is a control frame. As mentioned earlier, the frame ID remains consistent, but the data segment differs. Regardless of the mode, the data definition for 'Enable' is identical, as shown below:

D[0]	D[1]	D[2]	D[3]	D[4]	D[5]	D[6]	D[7]
0xFF	0xFF	0xFF	0xFF	0xFF	0xFF	0xFF	0xFC

Disability

Disabling is the default state for motor power-on, where all three-phase terminal voltages are identical, each being a 50% modulated wave of the supply voltage. The 'disabling' frame is a control frame with the specified ID, and its data segment is defined as follows:

D[0]	D[1]	D[2]	D[3]	D[4]	D[5]	D[6]	D[7]
0xFF	0xFF	0xFF	0xFF	0xFF	0xFF	0xFF	0xFD

Save position zero

The 'Save Position Zero Point' frame is a control frame. This command sets the current output axis position to zero and provides the position.

Set the value to 0. The frame ID is as described above, and the data segment is defined as follows:

D[0]	D[1]	D[2]	D[3]	D[4]	D[5]	D[6]	D[7]
0xFF	0xFF	0xFF	0xFF	0xFF	0xFF	0xFF	0xFE

Clear errors

When the motor experiences overheating or other faults, sending a 'Clear' command can resolve the issue. The 'Clear' frame is a control frame, with the frame ID as previously described and the data segment defined as follows:

D[0]	D[1]	D[2]	D[3]	D[4]	D[5]	D[6]	D[7]
0xFF	0xFF	0xFF	0xFF	0xFF	0xFF	0xFF	0xFB

Read parameters

message ID	attribute	D[0]	D[1]	D[2]	D[3]
0x7FF	STD	CANID_L	CANID_H	0x33	RID

RID is the register address, see Appendix <Register List and Range>

After successful read, the data of the register is returned, with the frame format as follows:

message ID	attribute	D[0]	D[1]	D[2]	D[3]	D[4]	D[5]	D[6]	D[7]
MST_ID	STD	CANID_L	CANID_H	0x33	RID	data			

The data is either floating-point or unsigned integer, occupying 32 bits (4 bytes), with D4 as the least significant bit and D7 as the most significant bit, and so on.

In parameter

message ID	attribute	D[0]	D[1]	D[2]	D[3]	D[4]	D[5]	D[6]	D[7]
0x7FF	STD	CANID_L	CANID_H	0x55	RID	data			

As described above, the RID returns the written data upon successful completion, with the frame format identical to the original sent data.

message ID	attribute	D[0]	D[1]	D[2]	D[3]	D[4]	D[5]	D[6]	D[7]
MST_ID	STD	CANID_L	CANID_H	0x55	RID	data			

Writing register data takes effect immediately but cannot be stored. The data is lost after power failure. To write all modified parameters into the chip, a command to send storage parameters must be sent.

Storage parameters

message ID	attribute	D[0]	D[1]	D[2]	D[3]
0x7FF	STD	CANID_L	CANID_H	0xAA	0x01

After successful write, the return format is:

message ID	attribute	D[0]	D[1]	D[2]	D[3]
MST_ID	STD	CANID_L	CANID_H	0xAA	0x01

note:

1. The storage parameters are only effective in the disabled mode.
2. All parameters will be stored in one go.
3. This operation writes parameters to the on-chip flash memory, with each operation lasting up to 30ms. Ensure you allow sufficient time.
4. The flash memory can withstand approximately 10,000 erase cycles. Avoid frequent transmission of the "storage parameters" command.

Mode switch

Supports switching between multiple modes. The supported control modes are:

Encoding	Mode
1	MIT
2	Velocity of position
3	Velocity
4	Hybrid control of position and force

By adjusting the mode register (0x0A), the operating mode can be modified. During mode switching, the motor first resets all command values, including position, speed, and the torque feedforward and KP/KD parameters in MIT mode.

To prevent shock during mode switching from position control to another mode, it is recommended to first read the precise position (value of register 0x50) before considering the switch, and to perform the switch when the motor is at zero speed.

The modified mode will not be saved to flash memory and will be lost after power loss. Upon power restoration, the control mode will revert to the last saved configuration in flash.

CAN baud rate modification

The current CAN communication baud rate can be modified by writing specific data to the baud rate register (address 0x23), supporting customized baud rate settings. The supported baud rates are as follows:

Encoding	Baud rate
0	125K
1	200K
2	250K
3	500K
4	1M
5	2M
6	2.5M
7	3.2M
8	4M
9	5M

After successfully modifying the baud rate, the driver initially transmits data at the original baud rate before switching to the new rate. Upon power-on, the motor first checks the stored baud rate. If it exceeds 5Mbps, the system automatically defaults to 1Mbps. For rates above 1Mbps (excluding 1Mbps), the motor switches to CAN FD mode. If the baud rate is ≤ 1 Mbps, it automatically switches to CAN 2.0B. Motors configured as CAN FD can still receive CAN 2.0B data frames but use CAN FD for feedback transmission, causing the upper-layer controller to miss feedback data and triggering continuous driver error reports. Controllers using CAN 2.0B can revert to the original baud rate by issuing a baud rate modification command after missetting the ID.

Register list and range

Address (HEX)	Address (DEC)	Variable	Description	Read-write	Scope	Type
0x00	0	UV_Value	Low voltage protection value	RW	(10.0, fmax]	float

0x01	1	KT_Value	Torque coefficient	RW	[0.0,fmax]	float
0x02	2	OT_Value	Over temperature protection value	RW	[80.0,200)	float
0x03	3	OC_Value	Overcurrent protection value	RW	(0.0, 1.0)	float
0x04	4	ACC	Accelerated speed	RW	(0.0,fmax)	float
0x05	5	DEC	Deceleration	RW	[-fmax,0.0)	float
0x06	6	MAX_SPD	Maximum speed	RW	(0.0,fmax]	float
0x07	7	MST_ID	Feedback ID	RW	[0,0x7FF]	uint32
0x08	8	ESC_ID	Receive ID	RW	[0,0x7FF]	uint32
0x09	9	TIMEOUT	Timeout alert time	RW	[0,2^32-1]	uint32
0x0A	10	CTRL_MODE	Control model	RW	[0,4]	uint32
0x0B	11	Damp	Motor viscosity coefficient	RO	/	float
0x0C	12	Inertia	Rotating inertia of motor	RO	/	float
0x0D	13	hw_ver	Continue to have	RO	/	uint32
0x0E	14	sw_ver	Software version	RO	/	uint32
0x0F	15	SN	Continue to have	RO	/	uint32
0x10	16	NPP	Number of pole pairs of motor	RO	/	uint32
0x11	17	Rs	Motor phase resistance	RO	/	float
0x12	18	Ls	Motor phase inductance	RO	/	float
0x13	19	Flux	Motor flux linkage	RO	/	float
0x14	20	Gr	Gear reduction ratio	RO	/	float
0x15	21	PMAX	Position mapping range	RW	(0.0,fmax]	float
0x16	22	VMAX	Velocity mapping range	RW	(0.0,fmax]	float
0x17	23	TMAX	Torque mapping range	RW	(0.0,fmax]	float
0x18	24	I_BW	Current loop control bandwidth	RW	[100.0, 1.0e4]	float
0x19	25	KP_ASR	Speed ring Kp	RW	[0.0,fmax]	float
0x1A	26	KI_ASR	Speed ring Ki	RW	[0.0,fmax]	float
0x1B	27	KP_APR	Position loop Kp	RW	[0.0,fmax]	float
0x1C	28	KI_APR	Position loop Ki	RW	[0.0,fmax]	float
0x1D	29	OV_Value	Overvoltage protection value	RW	TBD	float
0x1E	30	GRES	Gear torque efficiency	RW	(0.0, 1.0]	float
0x1F	31	Deta	Speed loop damping coefficient	RW	[1.0,30.0]	float
0x20	32	V_BW	Speed loop filter bandwidth	RW	(0.0,500.0)	float

0x21	33	IQ_c1	Current loop enhancement factor	RW	[100.0, 1.0e4]	float
0x22	34	VL_c1	Speed loop enhancement coefficient	RW	(0.0, 1.0e4]	float
0x23	35	can_br	CAN baud rate code	RW	[0,4]	uint32
0x24	36	sub_ver	Subversion number	RO	/	uint32
0x25	37	Boot_ver	Boot version number	RO	/	uint32
0x37	55	dir	Drection	RO	/	float
0x38	56	m_off	Motor side angular offset	RO	/	float
0x3B	59	Imax	Maximum current of drive board	RO	/	float
0x3C	60	VBus	Supply voltage	RO	/	float
0x3D	61	Tpcb	Drive board temperature	RO	/	float
0x3E	62	Tmtr	Motor temperature	RO	/	float
0x3F	63	Iu_off	U-phase current bias	RO	/	float
0x40	64	Iv_off	V-phase current bias	RO	/	float
0x41	65	Iw_off	W-phase current offset	RO	/	float
0x50	80	p_m	Motor current position	RO	/	float
0x51	81	xout	Output shaft position	RO	/	float

pour :

1.RW: Read-Only.

2. RO: Read-only.

3. The motor output shaft position refers to the rotor position converted to the output shaft, measured in radians (rad).

4. The output shaft position is the position calculated using the motor output shaft encoder, measured in radians (rad).

Motor commissioning process

Use a host computer version V2.0.0.0 or later for debugging. The following demonstrates the debugging process with V2.0.3.4.

Interface

First, connect the motor's serial port, CAN port, and power interface. On the computer, open the Debug Assistant software, select the corresponding serial port device, and enable the serial port.



When power is supplied to the motor, the serial port will display the following information. Control Mode: indicates the current drive mode. Different modes use different command formats (refer to the CAN Communication section).

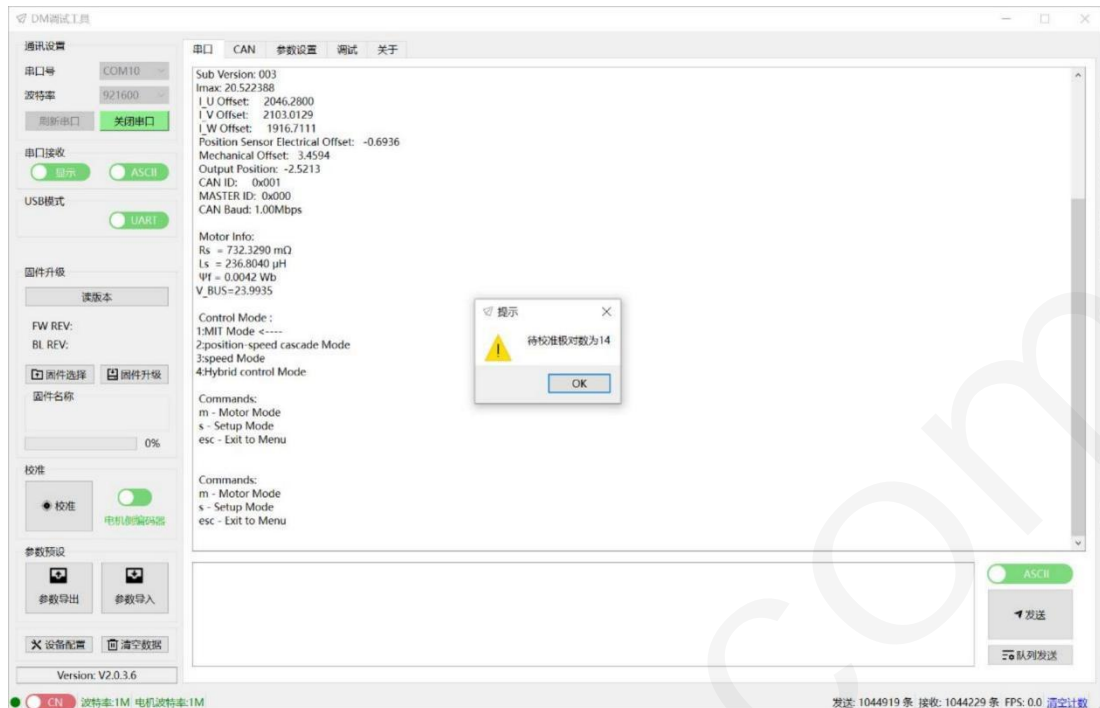


Motor-side encoder calibration

The primary purpose of motor encoder calibration is to correct sensor installation errors. During calibration, the motor rotates one full rotor cycle in both directions. Ensure the motor can rotate freely, preferably under no-load conditions, as this may cause calibration failure. The motor has undergone factory calibration and the parameters are stored internally. Unless abnormal conditions occur, the motor can be used directly without additional calibration. Below are the calibration steps. For abnormal conditions such as driver board replacement or unusual vibrations, calibration should be performed before operation.

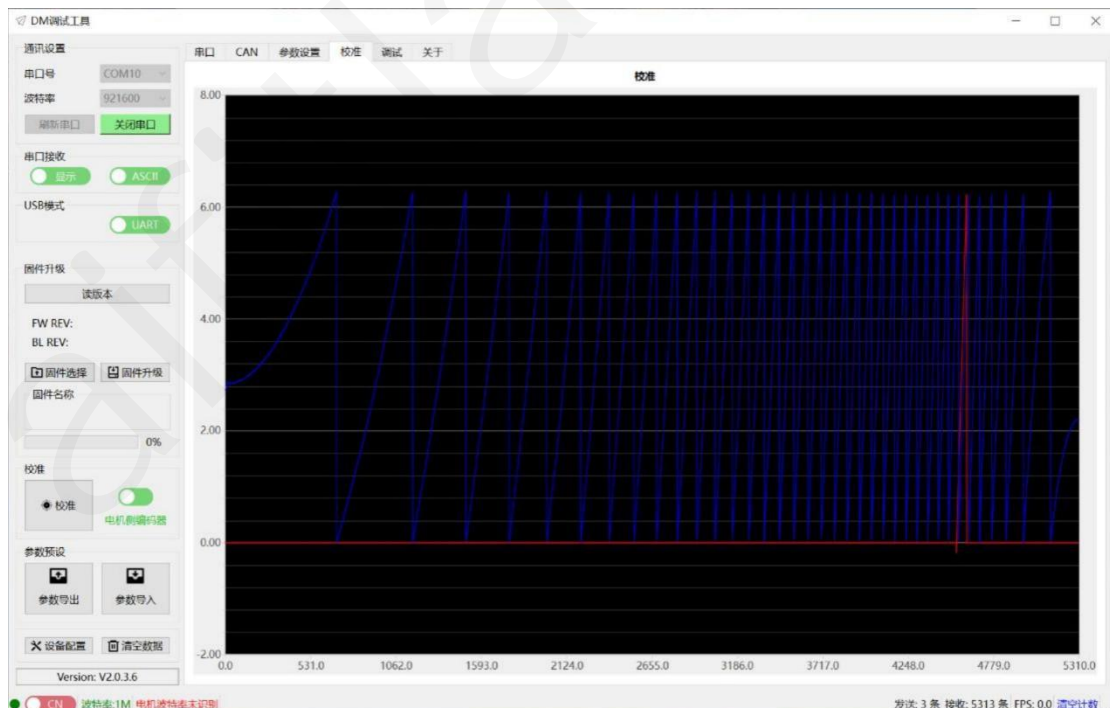
Step 1: Motor-side encoder calibration

Click Calibrate. The motor will rotate first, and the pole pairs will be returned to the debugging assistant after rotation.



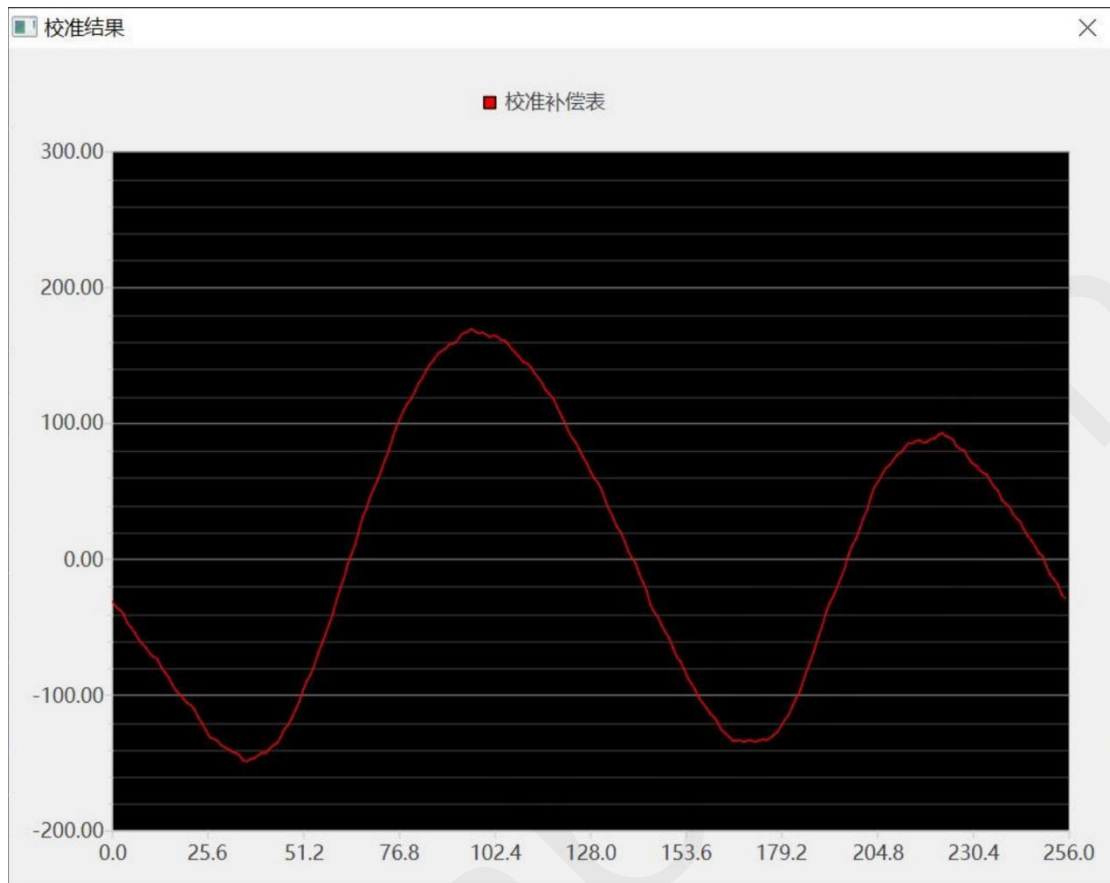
The motor will automatically recognize parameters first, during which it may rotate. Please ensure the motor is securely fastened to prevent accidents.

After parameter recognition, the motor automatically calibrates the sensor and displays its waveform, as shown below:



Note: The red curve must not significantly exceed the blue curve in maximum value, otherwise it will fail. Re-calibrate after failure.

Step 2: After calibration is completed, the values will be automatically uploaded. For example:



Step 3: Calibration Data Screening and Storage

Special attention should be paid to the value of "Compensation Data Compensation", and it is recommended not to exceed ± 300 . If it exceeds 300, there may be several reasons:

- 1 logarithmic error;
- 2 The motor's excessive resistance causes lagging.
3. Irregular sensor installation;

Step 4: Check the above points.

Parameter calibration

Parameter calibration primarily identifies critical motor parameters including phase resistance, phase inductance, and magnetic flux. The motor undergoes calibration during production (and is already calibrated) and has the parameters stored internally, enabling direct use without re-calibration. Below are the calibration steps:

Click the "Parameter Settings" tab, then click the "Parameter Calibration" button to initiate the driver's identification process. During this time, the motor will rotate; ensure it remains unloaded and securely fastened.

电机参数	
相电阻 (R) :	732.329 mR
相电感 (L) :	236.804 uH
磁链 (λ) :	0.00423874 Wb
粘滞系数:	7.33163e-05
转动惯量:	1.94486e-05 kg*m2

After recognition, the results will be uploaded automatically.

The viscosity coefficient is only for reference and can be calibrated many times.

[Note] All parameters except the viscosity coefficient must be positive. If negative values occur, verify the motor status before recalibration.

Output shaft encoder calibration

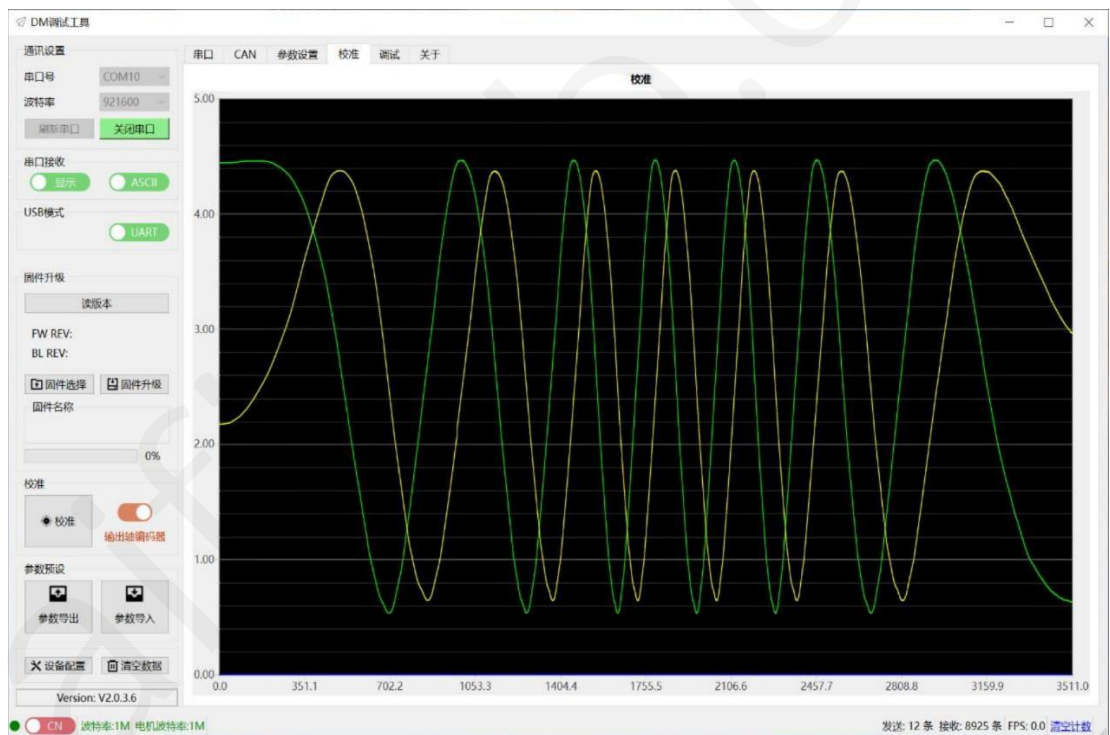
The dual encoder motor requires output shaft encoder calibration to enhance accuracy. During calibration, the motor must complete one full forward rotation. Ensure the motor rotates freely and operates under no-load conditions to prevent excessive calibration errors. The motor comes with factory-calibrated output shaft encoders pre-programmed in the drive circuitry. Under normal conditions, these encoders can be used directly without additional calibration. Below are the standard calibration procedures. For abnormal conditions such as driver board replacement or output position changes, perform the encoder calibration first before operation.

Step 1: Output shaft encoder calibration

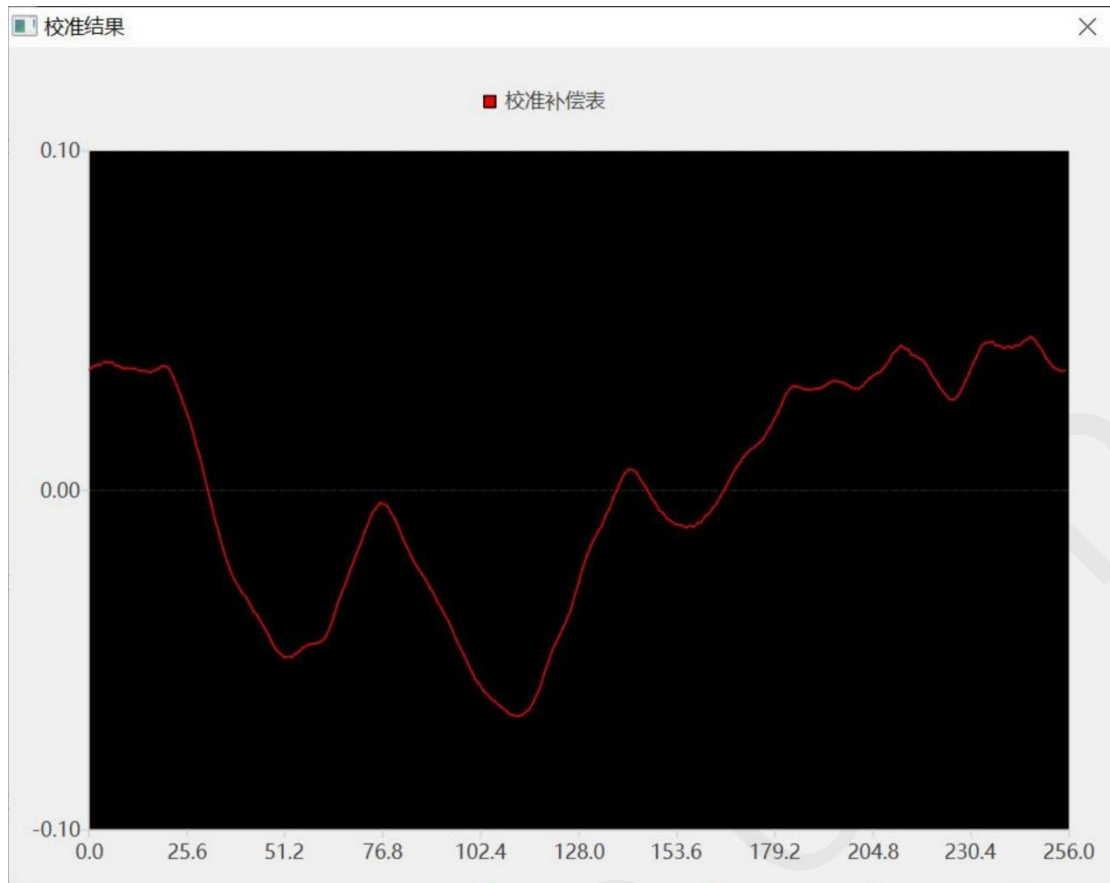
Click the slider next to the calibration button to display the "Output Shaft Encoder" status, then click Calibrate



The motor completes one full rotation and uploads the encoder's raw data waveform, as shown in the figure below.



Step 2: After calibration is completed, the system will automatically upload and display the calibration value as shown below:



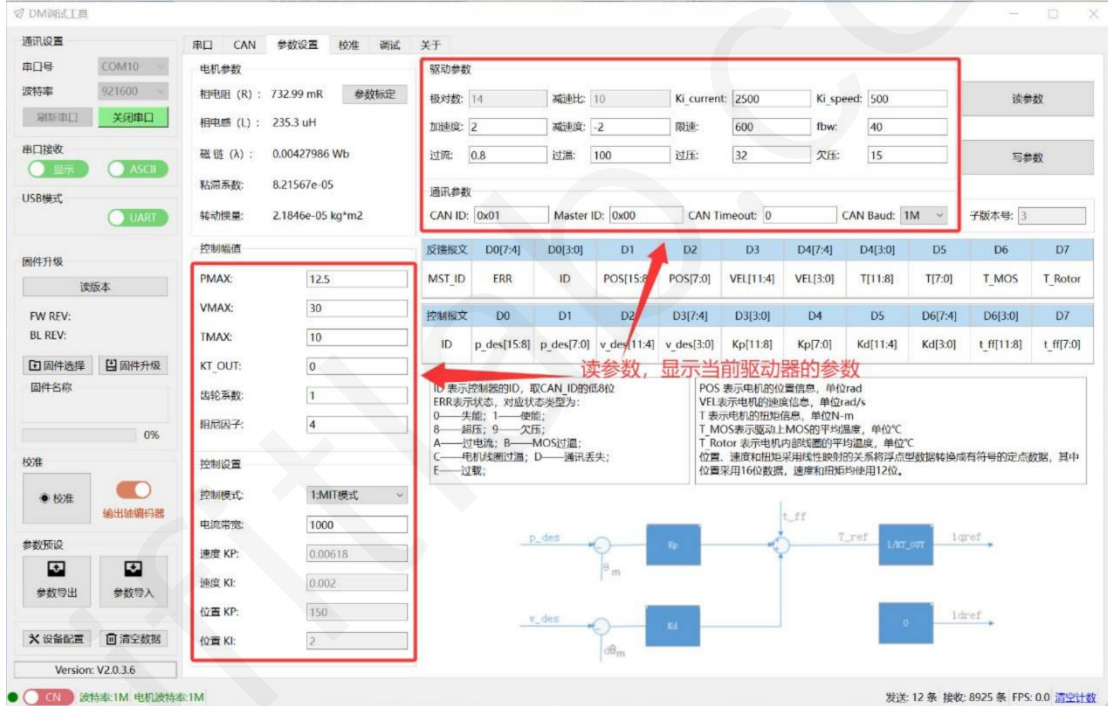
Step 3: Calibrate data validation

After calibration, the drive automatically performs data verification. If the deviation is too large, an error (type 3) will be reported with a red light flashing. This error usually occurs due to an output shaft encoder malfunction. Contact after-sales service for assistance.

Serial port read/write parameters

1. Read parameters

Under the Parameters tab, click the Read Parameters button. The driver will upload the parameters used for storage to the Debug Assistant. Check the parameters carefully.



The read parameters include:

(1) Drive Parameters: The parameter settings section for driving

Pole Pair Count: The motor's pole pair count is automatically determined through calibration and must not be modified.

Under-voltage: If the power supply voltage falls below the set value, the driver cannot control the motor operation. The default value is 20V.

Overvoltage: This parameter defines the maximum operating voltage for the driver. During startup, the motor's power supply voltage is measured. If the detected voltage exceeds this threshold, the driver triggers an error and deactivates the enable function. Should overvoltage occur during startup, the driver will maintain error reporting indefinitely.

Acceleration/Deceleration: This parameter is used in non-MIT mode to regulate the drive unit's acceleration/deceleration and motor rotor parameters, measured in Krad/s^2 , where deceleration values are negative.

Reducer ratio: The motor's reducer ratio primarily determines its output speed and position, which indirectly affects torque feedback. Do not modify it.

Overtemperature: The motor coil temperature protection threshold is configurable based on operational requirements, with a recommended maximum of 100°C . When exceeded, the driver will deactivate, enter an inoperative state, and trigger an error.

CAN_ID: The driver ID number used for CAN commands, expressed in hexadecimal. It is recommended to set it below 16 to avoid conflicts with error codes.

Master ID: The frame ID used by the driver for feedback, in hexadecimal format;

CAN Timeout: A 32-bit integer setting that defines the duration (in $50\mu\text{s}$ cycles) after which no CAN command is detected, triggering motor protection. This setting applies only when the motor is enabled.

Speed limit: This function is only available in speed mode and sets the maximum operating speed of the motor rotor (before deceleration), measured in radians per second (rad/s).

Overcurrent: A percentage setting that limits the motor's maximum phase current.

CAN baud rate: Configure the CAN baud rate, supporting 125Kbps to 5Mbps

Current loop enhancement factor: Auxiliary control parameter for current loop. Modification is not recommended.

Speed loop filter bandwidth: the speed filter bandwidth, measured in Hz.

Subversion: The firmware subversion number

Speed Loop Enhancement Coefficient: A speed loop auxiliary control parameter, with an adjustable range recommended between 200-800. Note: Upon successful parameter

reading, the debugging interface parameters (e.g., PMAX, ID) will be updated automatically.

(2) Motor Parameters: Section on Motor Parameters

These parameters are automatically identified by the driver. When replacing the driver board, recalibration is required, and the parameters are automatically saved to the driver.

(3) Control amplitude: Set the parameter range of the drive command

MAX: In MIT mode, it is the mapped value for receiving motor commands, while in other modes, it serves as the mapped value for motor feedback. For mapping rules, refer to the CAN communication section.

VMAX: Same as PMAX;

TMAX: Same as PMAX;

KT_OUT: The torque coefficient of the motor, set to 0 when the motor parameters are accurately identified.

Gear coefficient: The gear torque transmission coefficient, with a value ≤ 1.0 .

damping factor: The bandwidth ratio between current loop and speed loop control is not utilized.

(4) Control Settings

Control modes: MIT mode, position velocity mode, velocity mode, and force-position hybrid mode.

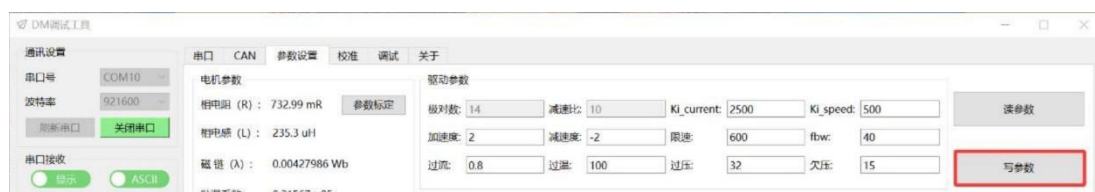
current bandwidth: Set the gain coefficient of the current loop, default is 1000.

Velocity KP/KI and Position KP/KI: parameters for the velocity loop and position loop.

2. Write parameters

Check the drive parameters, control amplitude, and control settings. Modify the parameters as needed, then click 'Write Parameters' to save the changes to the drive.

Clicking the 'Write Parameters' button will reset the chip automatically. To prevent safety hazards, ensure the motor is in the 'Disengaged' state when using this function.



Note:

- ① Do not modify the parameters of the logarithmic pole and the speed reduction ratio.
- ② After clicking "Write Parameters", the driver will automatically restart without requiring external power.
- ③ The "temporary storage" button only applies to controller parameters and will be lost after power loss.

Shakedown test

This function is available only when a CAN interface is connected. It can debug a single motor only. Connect the CAN cable to the driver board before operation. Before debugging, confirm the wiring sequence and current control mode, then select the appropriate sub-label card in the debugging page based on the mode.

1. Selection and Confirmation of Control Modes

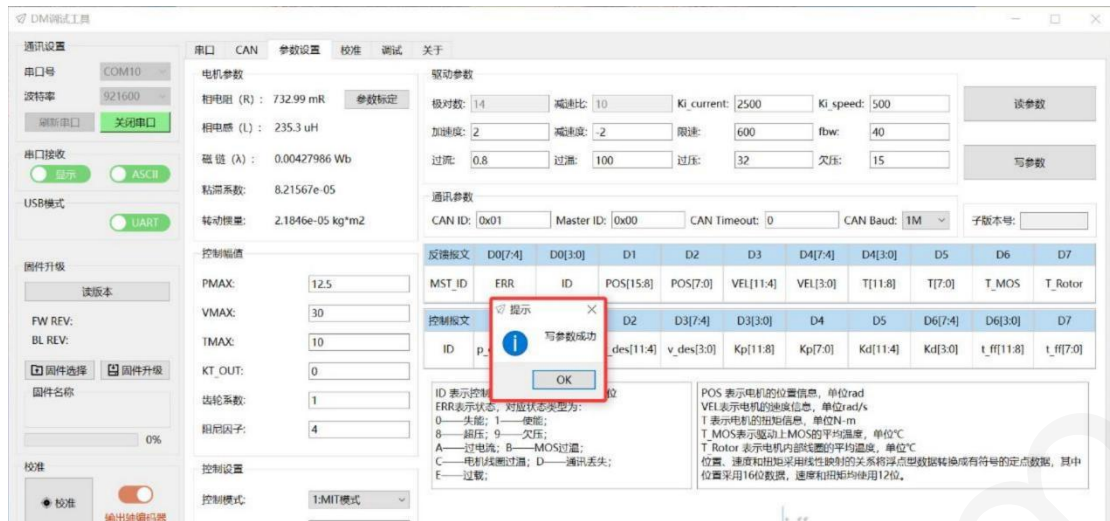
In the Debug Assistant, go to 'Parameter Settings' and select 'Control Mode' under Control Settings. You can choose from four modes: MIT mode, speed-position mode, speed mode, or force-position hybrid control. Then click 'Write Parameters' to configure the control mode.

The screenshot shows the DM Debug Tool interface with the following details:

- Tab Selection:** The '参数设置' (Parameter Settings) tab is selected, indicated by a red circle '1'.
- Control Mode Selection:** The '控制模式' (Control Mode) dropdown menu is open, showing a list of modes. The first two options are '1-MIT模式', and the others are '2-位置速度模式', '3-速度模式', '4-PVT模式', '5-周期位置模式', '6-周期速度模式', and '7-周期扭矩模式'. A red circle '2' points to this dropdown.
- Write Parameters:** The '写参数' (Write Parameters) button is highlighted with a red box, and a red circle '3' points to it.
- Motor Parameters:** Parameters like 相电阻 (R), 相电感 (L), 磁链 (λ), 粘滞系数, and 转动惯量 are listed.
- Control Values:** Parameters like PMAX, VMAX, TMAX, and KT_OUT are listed.
- Communication Settings:** CAN ID, Master ID, CAN Timeout, and CAN Baud are listed.
- Block Diagram:** A block diagram shows the control loop with inputs p_des, v_des, and outputs i_ref, t_ref.

When you change the control mode, a prompt window will appear: "Parameter written successfully!"

The "Write Parameters" function resets automatically, so you don't need to power the drive again.



(1) The control mode is determined by analyzing the serial port print data from the upper power supply; the mode indicated by the arrow represents the current active control mode.

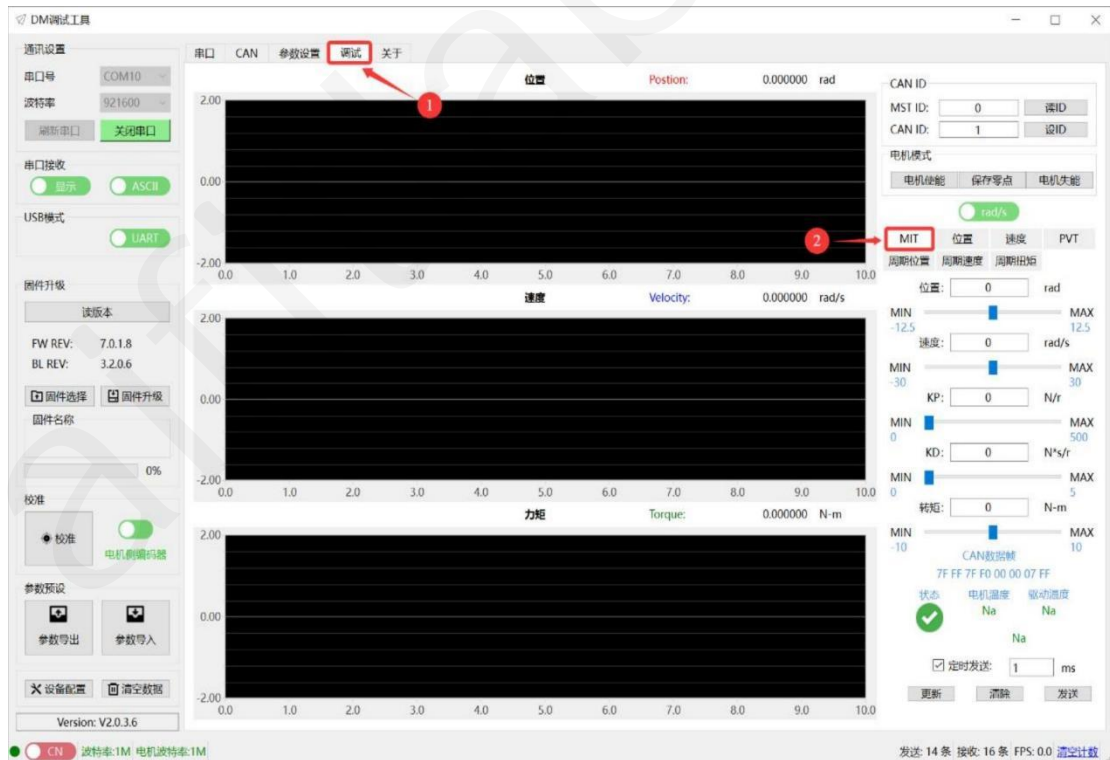


(2) Alternatively, the drive's control mode can be determined by checking the displayed information after re-reading parameters on the parameter setting page.



2. MIT pattern

(1) Reference: Select and confirm the control mode. Set the current mode to MIT, then choose the corresponding MIT sub-tab in the debugging interface.



(2) Verify the CAN ID is correct (available through serial port printing, parameter settings, or debugging)

Try page reading and button settings



(3) The MIT mode features three control methods: speed, position, and torque.

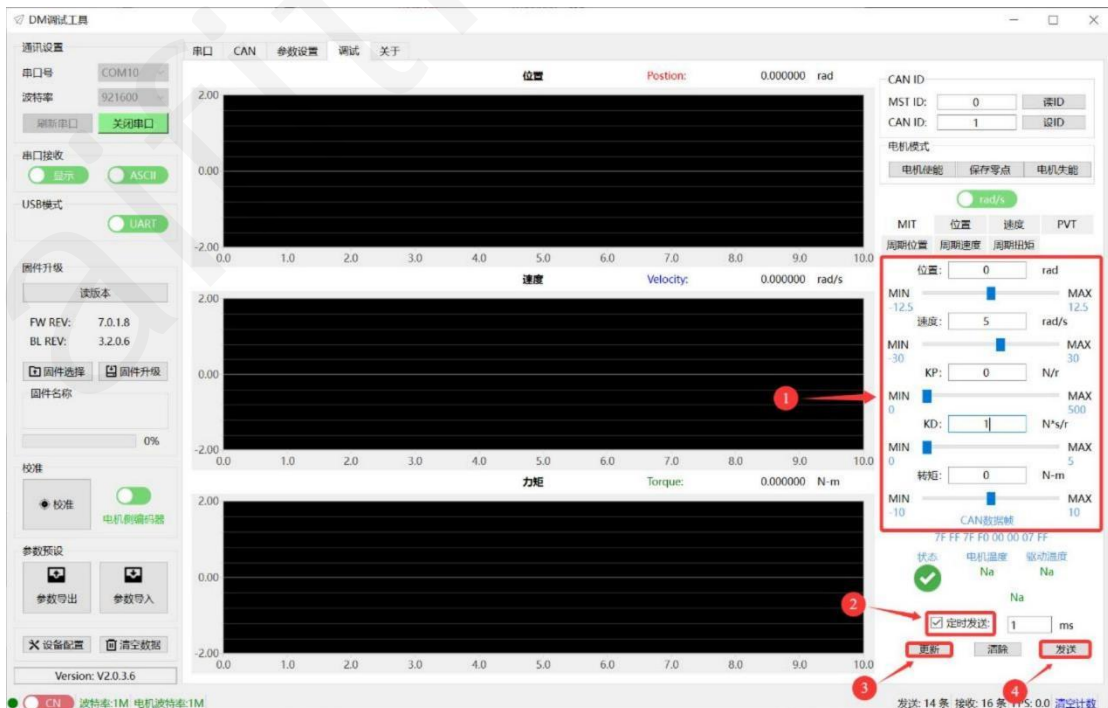
1. speed control

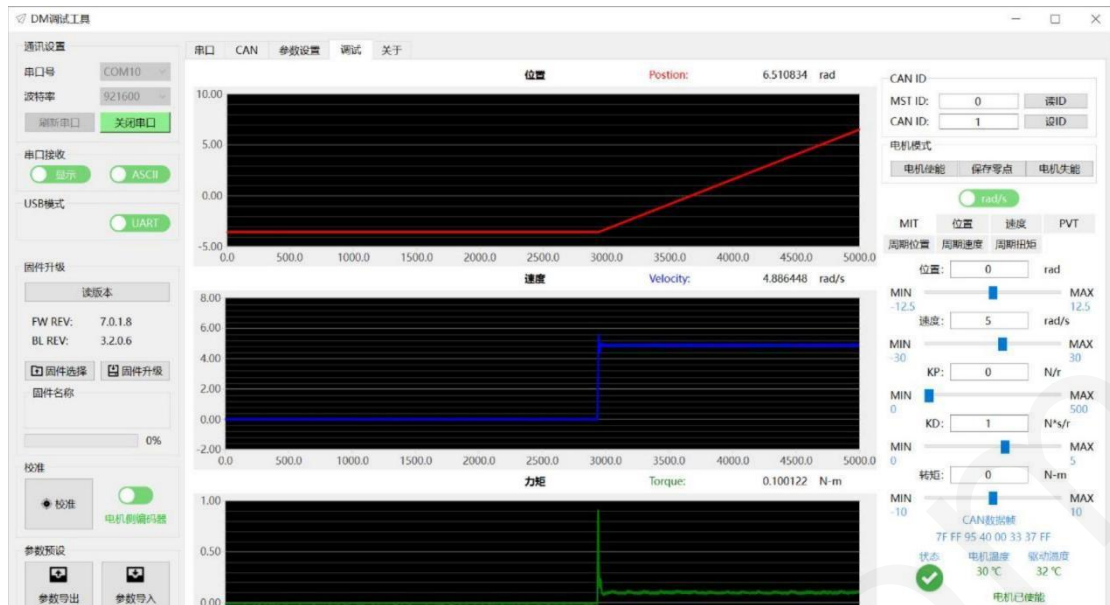
Step 1: Click the Enable button in the motor mode bar. The driver's green light will turn on, indicating the motor is enabled.



Step 2: Set the motor to operate at the specified speed.

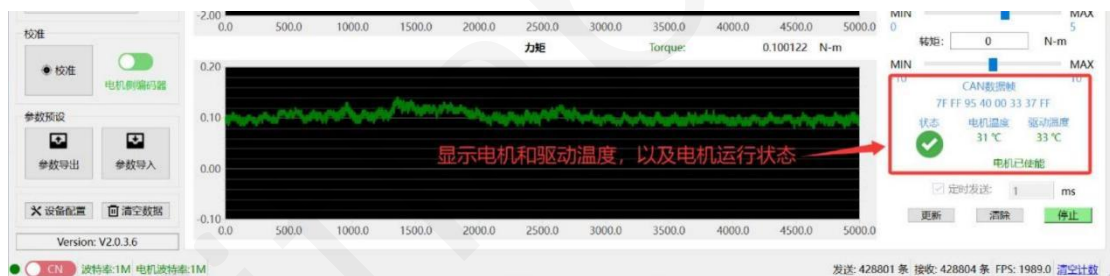
For example: Set the speed to 5 rad/s, KD to 1 N·s/r, and all other parameters to 0. Check the 'Scheduled Send' box, then click 'Update' and 'Send' buttons in sequence. The parameter curve changes can be viewed in the debugging interface. Note: Keep the motor stationary.



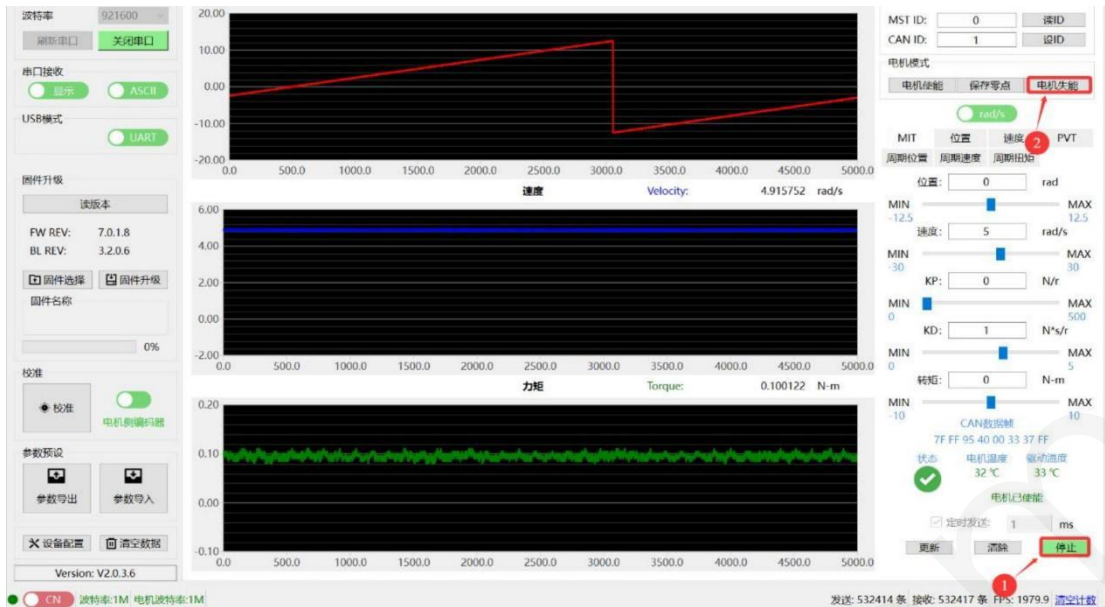


To debug, modify control parameters and view changes. Edit parameters directly in the original interface, keep 'Scheduled Send' checked, then click 'Update' to proceed.

The debugging assistant interface displays real-time temperature data and operational status of the motor and drive. The feedback frame can also be viewed for this information. For details on the feedback frame format and status types, please refer to the '4.1 Feedback Frame' section.

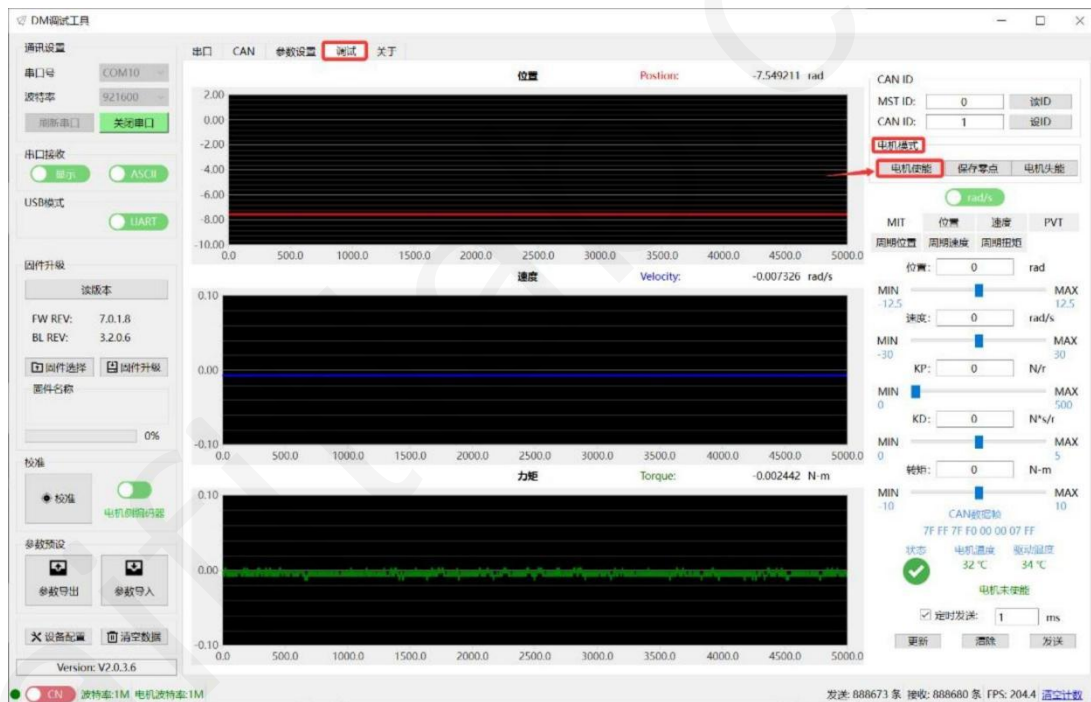


Step 3: To exit debug mode, click the "Stop" and "Disable" buttons in sequence. The red light on the drive will turn on, indicating the motor mode has been exited.



2. position control

Step 1: Click the Enable button in the motor mode bar. The driver's green light will turn on, indicating the motor is enabled.



Step 2: Rotate the motor to the specified position.

When setting the 'position' parameter in the control parameters, ensure it closely matches the motor's initial position to prevent excessive deviation that could cause motor shock.

To set the motor's current position as zero, click 'Save Zero Point' in the command bar for easy position parameter configuration.



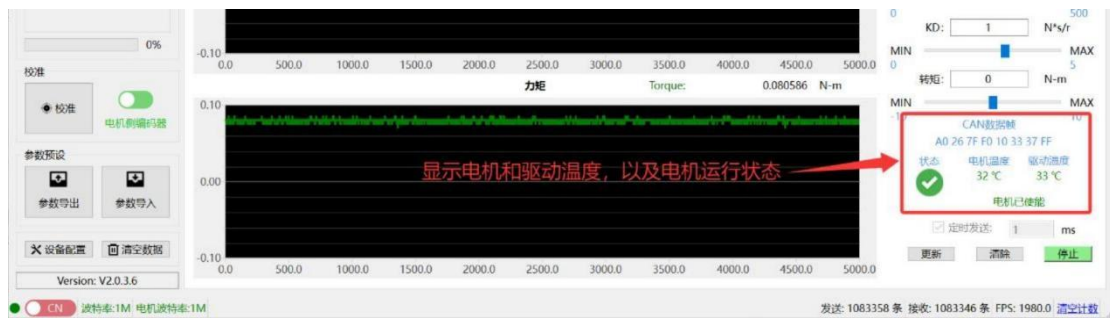
For example, given the parameters: position given 3.14 rad, KP given 2N/r, KD given 1N*s/r, and all others given 0, and check

Select the "Scheduled Send" box, then click the "Update" button followed by the "Send" button to view the parameter curve changes in the debugging interface. Note to fix the motor.

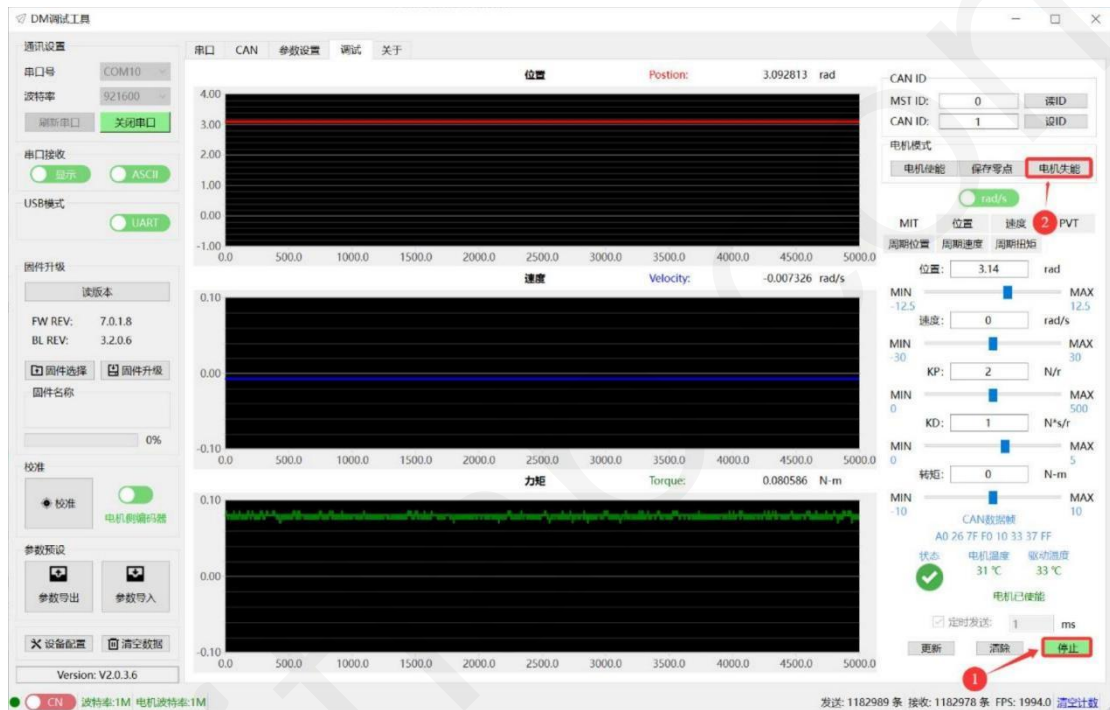


To debug, modify control parameters and view changes. Edit parameters directly in the original interface, keep 'Scheduled Send' checked, then click 'Update' to proceed.

The debugging assistant interface displays real-time temperature data and operational status of the motor and drive. You can also view this information through the feedback frame. For details on the feedback frame format and status types, refer to the 'Feedback Frame' section.



Step 3: To exit debug mode, first stop the motor, then sequentially press the "Stop" and "Disable" buttons. The driver's red light will illuminate, indicating the motor mode has been exited.



3. MIT Torque Control

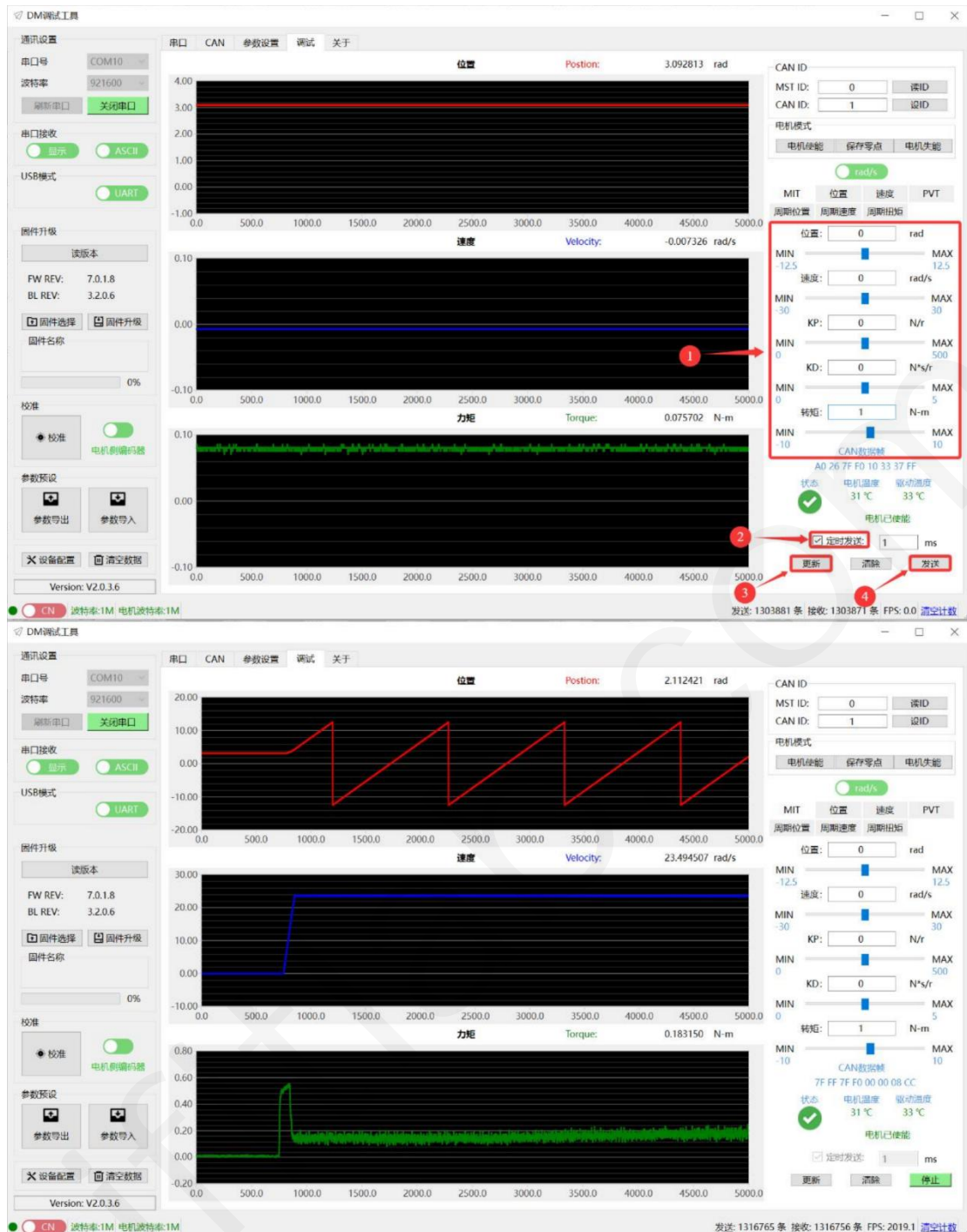
Step 1: Click the Enable button in the motor mode bar. The driver's green light will turn on, indicating the motor is enabled.



Second, the motor is debugged with given torque.

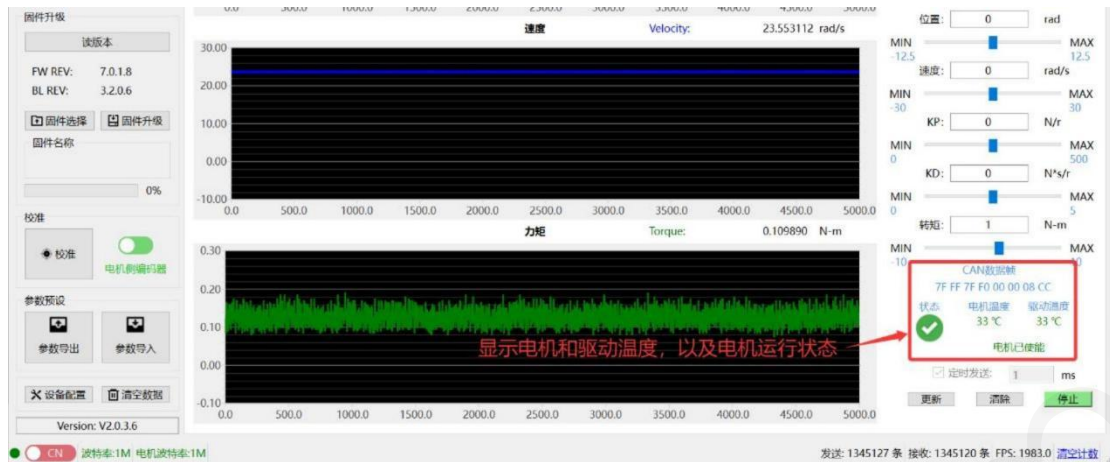
Note: When unloaded, the motor will accelerate to maximum speed even with a minimal torque.

For example, set the torque to 1N-m with all other parameters at 0, check the 'Scheduled Send' box, then click 'Update' and 'Send' buttons in sequence. The parameter curve changes will appear in the debugging interface. Note: Keep the motor stationary.

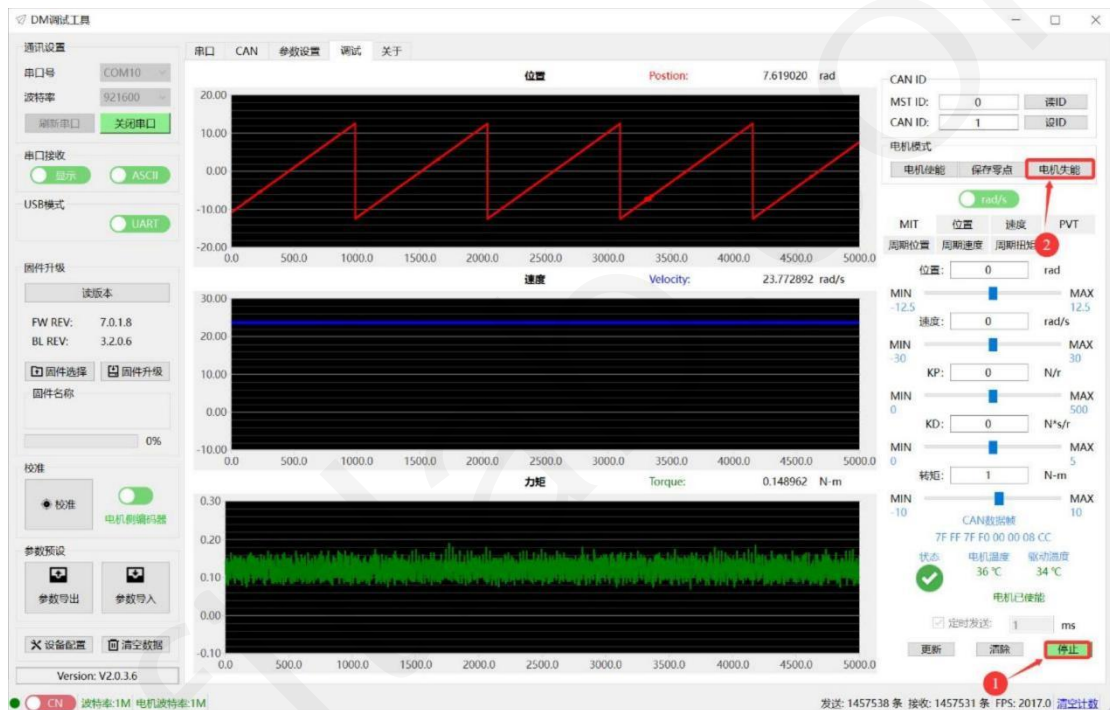


To debug, modify the control parameters to view changes. Edit parameters directly in the original interface, keep the 'Scheduled Send' option checked, and click the 'Update' button to proceed.

The debugging assistant interface displays real-time temperature data and operational status of the motor and drive. You can also view this information through the feedback frame. For details on the feedback frame format and status types, refer to the 'Feedback Frame' section.



Step 3: To exit debug mode, click the "Stop" and "Enable" buttons in sequence. The red light on the drive will turn on, indicating the motor mode has been exited.



3. Position Velocity Mode

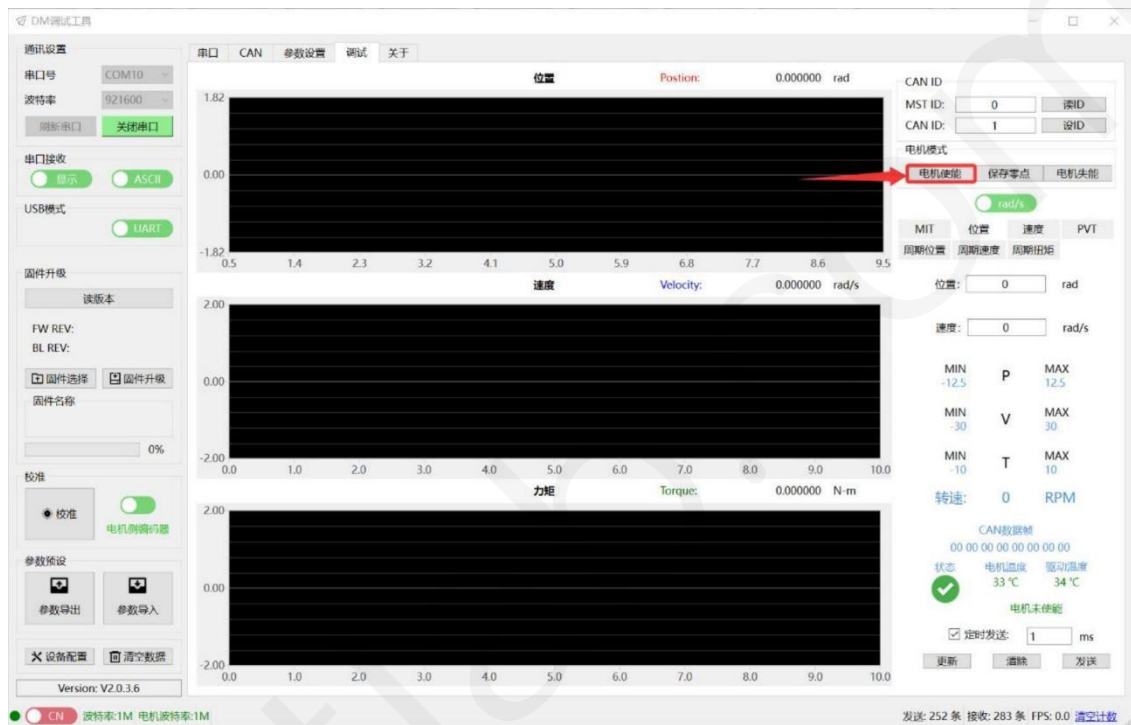
(1) To debug the position-speed mode, switch the motor mode to position-speed mode on the parameter page, then click 'Write Parameters' to apply the changes. Select the corresponding 'Position' sub-tab in the debugging interface.



(2) Verify the CAN ID is correct (available through serial port printing, parameter settings, or debugging) try page reading and button settings



(3) Click the "Enable" button in the motor mode section. The driver's green light will illuminate, indicating the motor is now enabled.

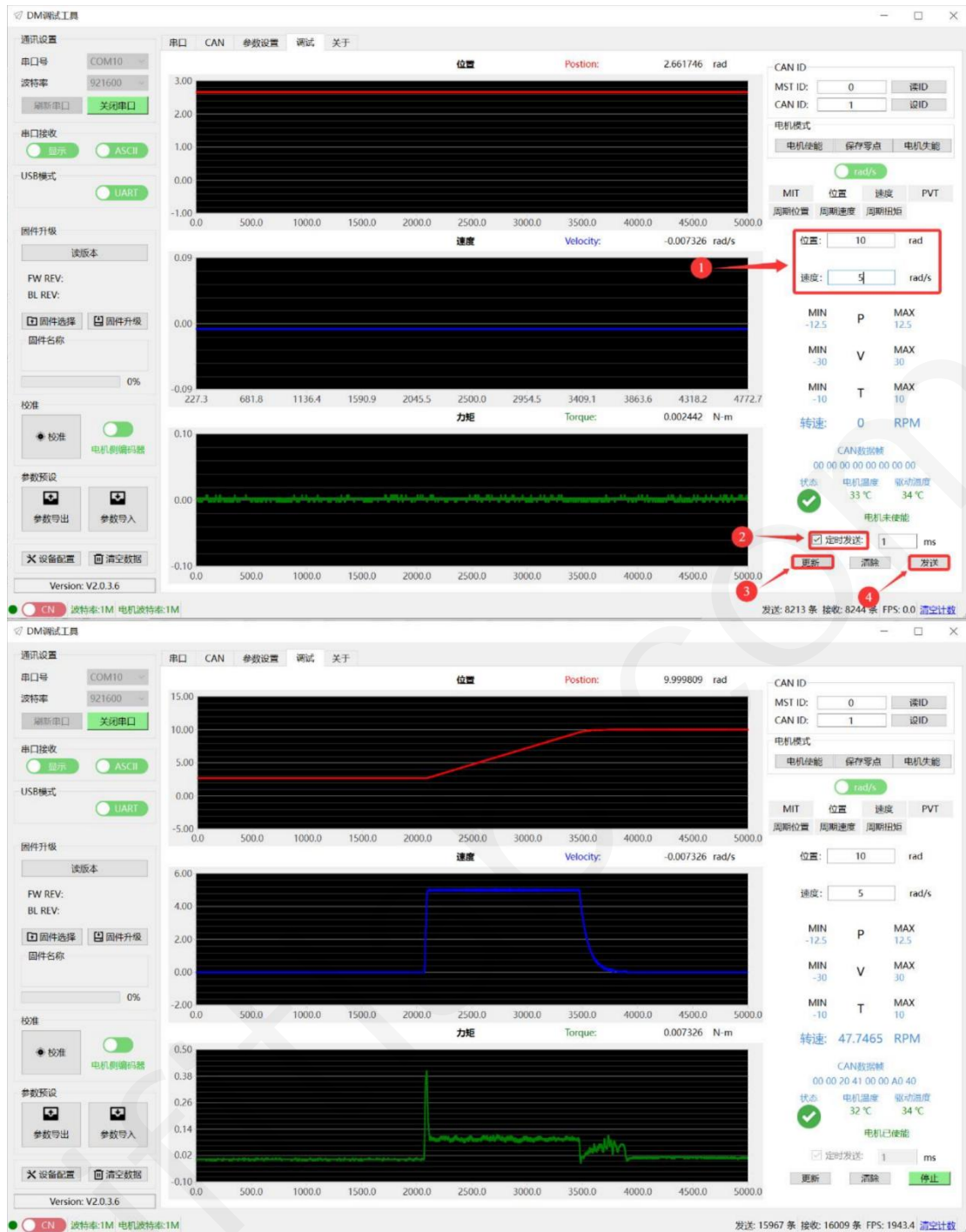


(4) Set the parameters, then the motor will run at the preset speed to the designated position.

Before setting parameters, note the motor's initial position to use as a reference.

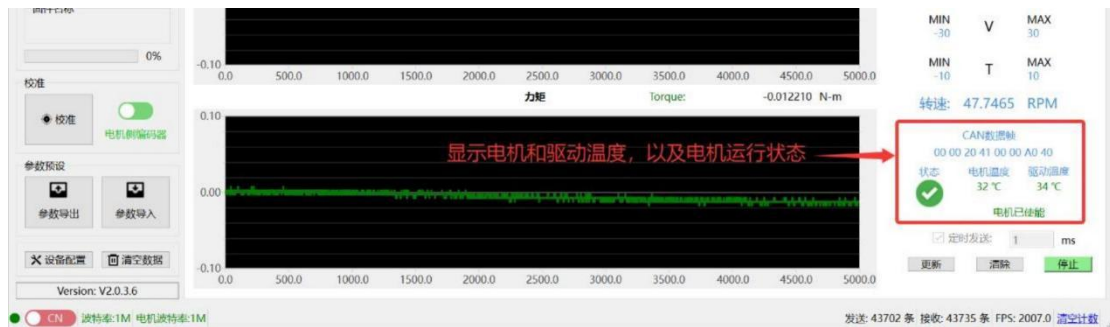


For example, set the parameters: position at 10 rad, speed at 5 rad/s. Check the 'Scheduled Send' box, then click 'Update' and 'Send' buttons in sequence to view the parameter curve changes in the debugging interface. Note: Keep the motor stationary.

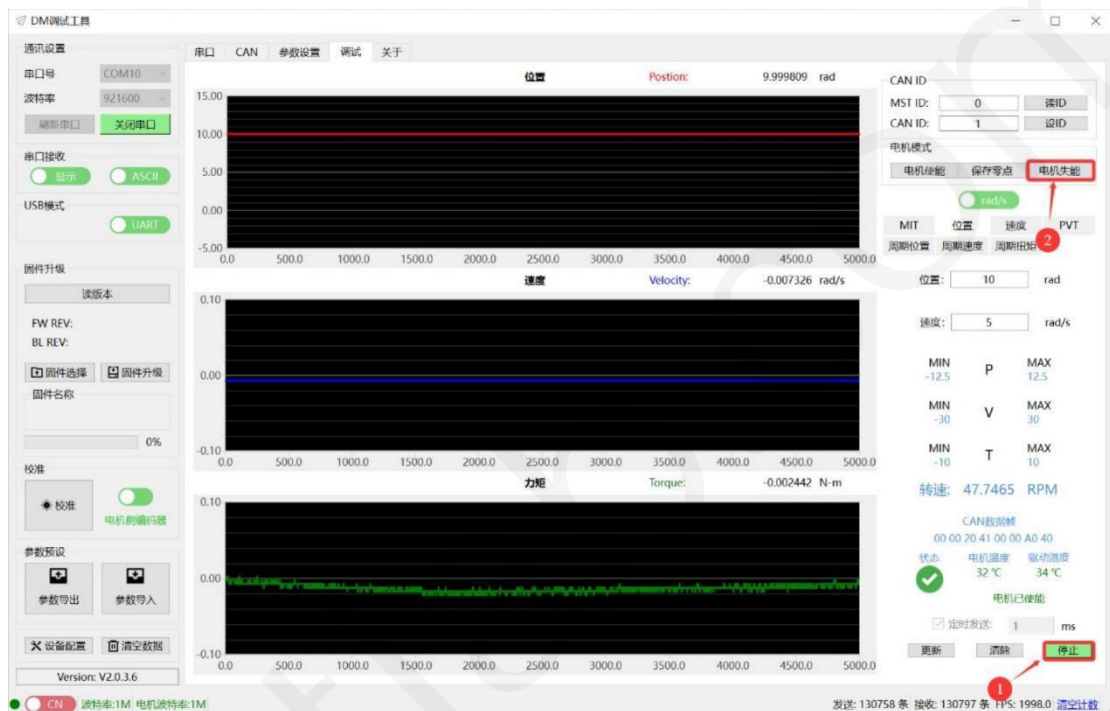


To debug, modify control parameters and view changes. Edit parameters directly in the original interface, keep 'Scheduled Send' checked, then click 'Update' to proceed.

The debugging assistant interface displays real-time temperature data and operational status of the motor and drive. You can also view this information through the feedback frame. For details on the feedback frame format and status types, refer to the 'Feedback Frame' section.



(5) To exit debug mode, press the "Stop" and "Disable" buttons in sequence. The driver's red light will illuminate, indicating the motor mode has been exited.



4. Speed Mode

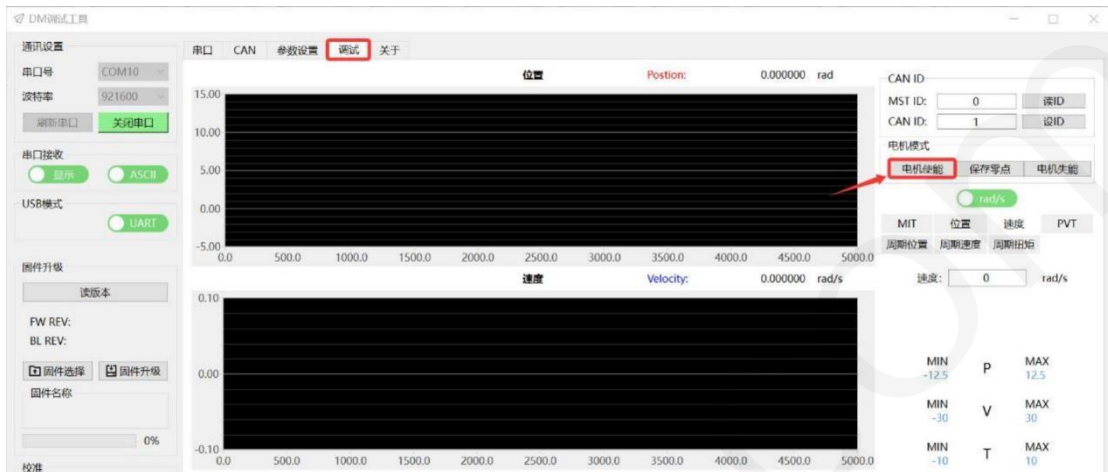
(1) Select the speed mode by choosing the reference control mode and confirming the current control mode. Then, select the corresponding 'Speed' sub-tab card on the debugging page.



(2) Verify the CAN ID is correct (available through serial port printing, parameter settings, or debugging interface settings)

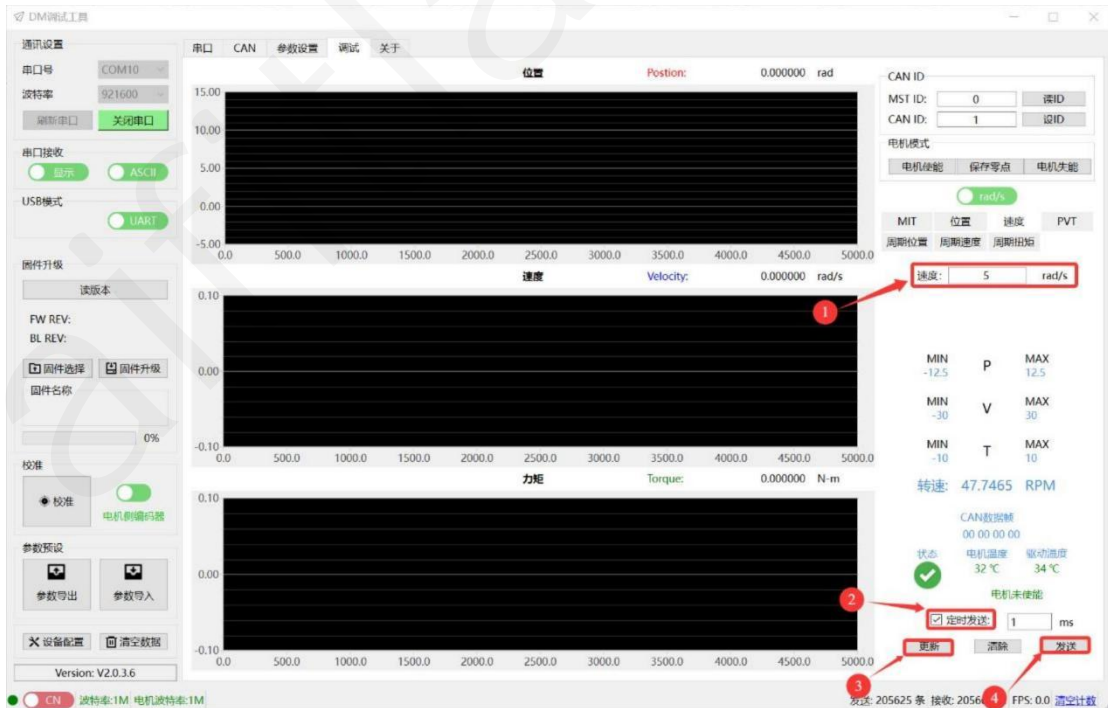


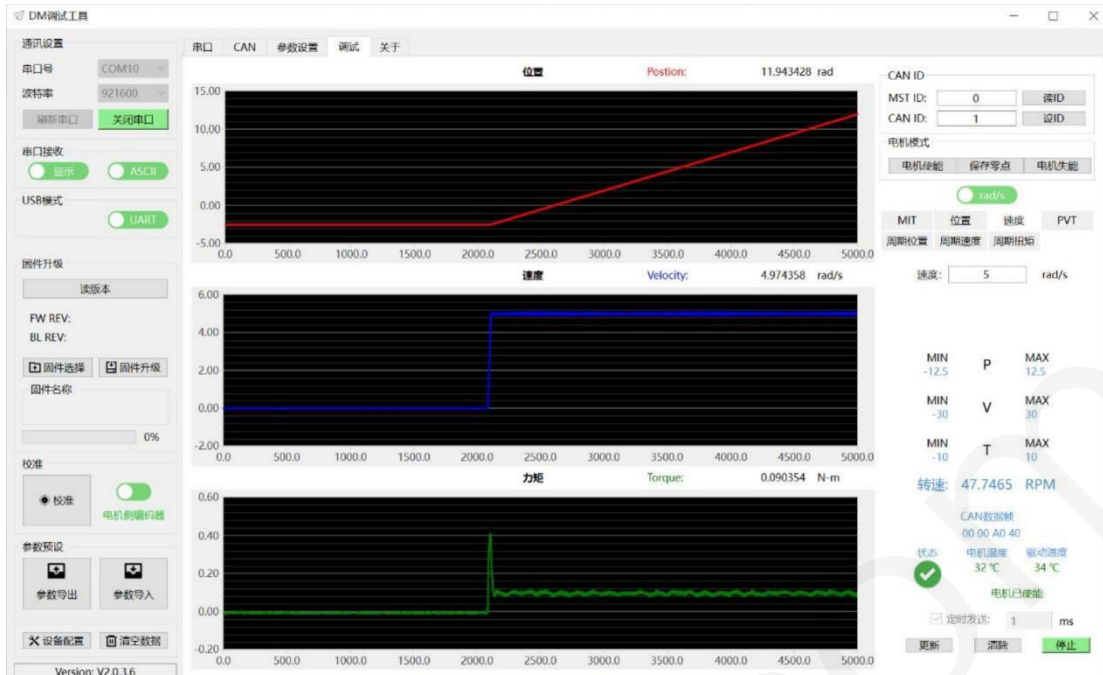
(3) Click the "Enable" button in the motor mode section. The driver's green light will illuminate, indicating the motor is now enabled.



(4) Set the parameters, and the motor will operate at the preset speed.

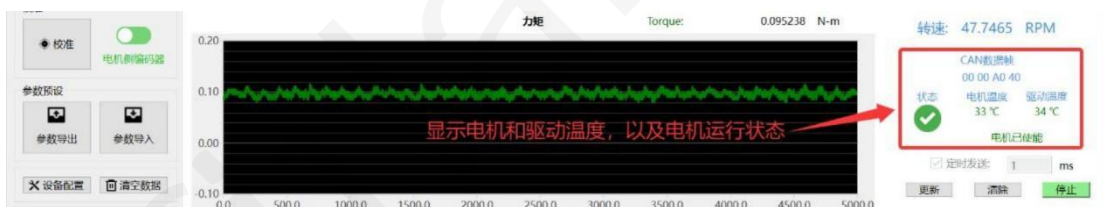
For example, set the parameter to 5 rad/s. Check the 'Scheduled Send' box, then click the 'Update' and 'Send' buttons in sequence to view the parameter curve changes in the debugging interface. Note: Keep the motor stationary.



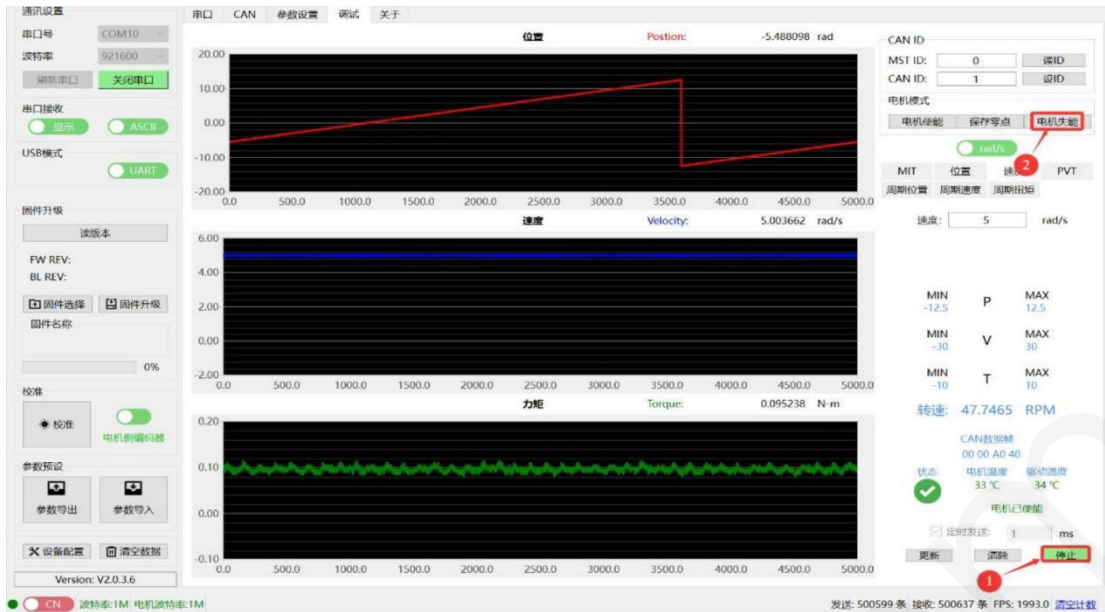


To debug, modify control parameters and view changes. Edit parameters directly in the original interface, keep 'Scheduled Send' checked, then click 'Update' to proceed.

The debugging assistant interface displays real-time temperature data and operational status of the motor and drive. You can also view this information through the feedback frame. For details on the feedback frame format and status types, refer to the 'Feedback Frame' section.

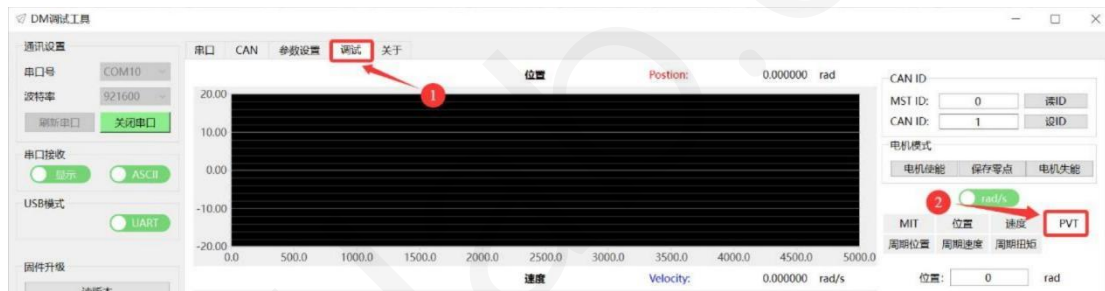


(5) To exit debug mode, first set the speed to 0 to stop the motor, then sequentially press the "Stop" and "Disable" buttons. The driver's red light will illuminate, indicating the motor mode has been exited.

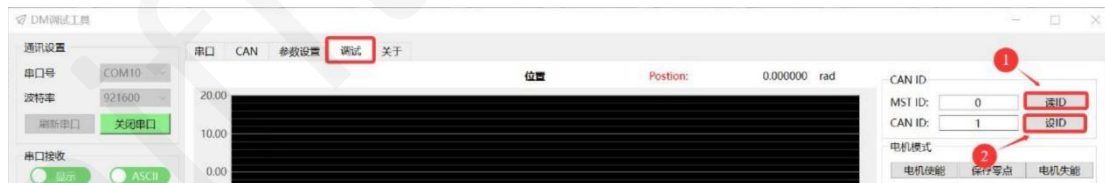


5. Force-position hybrid control mode

(1) To debug the force-position hybrid control mode, switch the motor mode to PVT mode on the parameter page, then click 'Write Parameters' to apply the changes. Select the corresponding 'Position' sub-tab in the debugging interface.



(2) Verify the CAN ID is correct (available through serial port printing, parameter settings, or debugging interface settings)



(3) Click the "Enable" button in the motor mode section. The driver's green light will illuminate, indicating the motor is now enabled.



(4) Set the parameters, then the motor will run at the preset speed to the designated position.

Before setting parameters, note the motor's initial position to use as a reference.

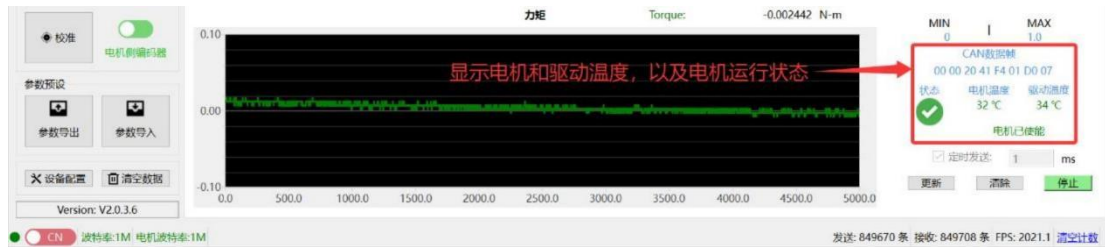


For example, set the parameters as follows: position 10 rad, speed 5 rad/s, and current 20%. Check the 'Scheduled Send' box, then click the 'Update' and 'Send' buttons in sequence to view the parameter curve changes in the debugging interface. Note: Keep the motor stationary.

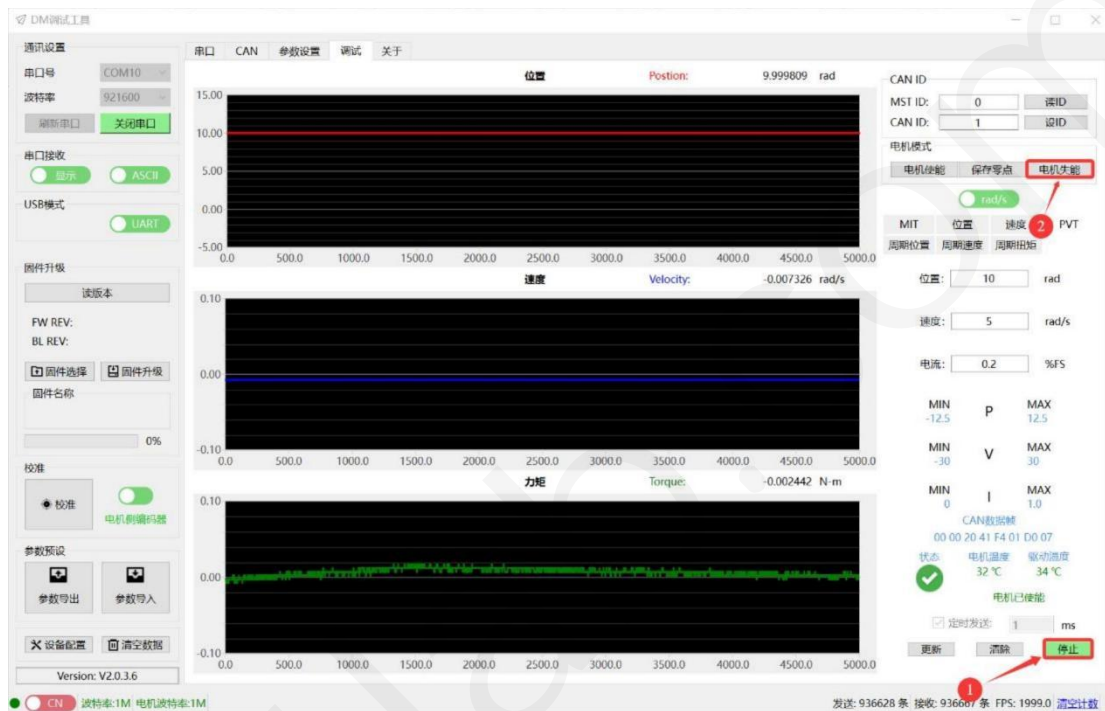


To debug, modify control parameters and view changes. Edit parameters directly in the original interface, keep 'Scheduled Send' checked, then click 'Update' to proceed.

The debugging assistant interface displays real-time temperature data and operational status of the motor and drive. You can also view this information through the feedback frame. For details on the feedback frame format and status types, refer to the 'Feedback Frame' section.



(5) To exit debug mode, first ensure the motor stops, then sequentially press the "Stop" and "Disable" buttons. The driver's red light will illuminate, indicating the motor mode has been exited.



View and upgrade firmware version

Version view

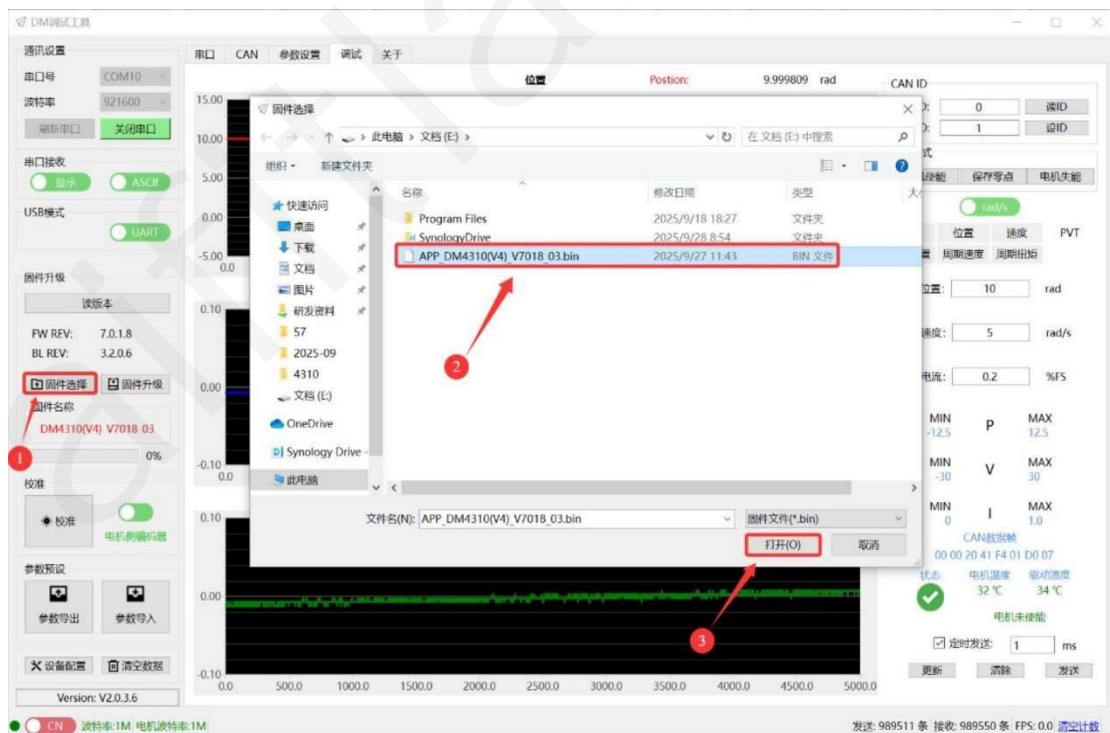
Connect the motor's serial port, CAN port, and power interface. Select the appropriate serial port device and enable it. Click 'Read Version' to view the current driver software version number.

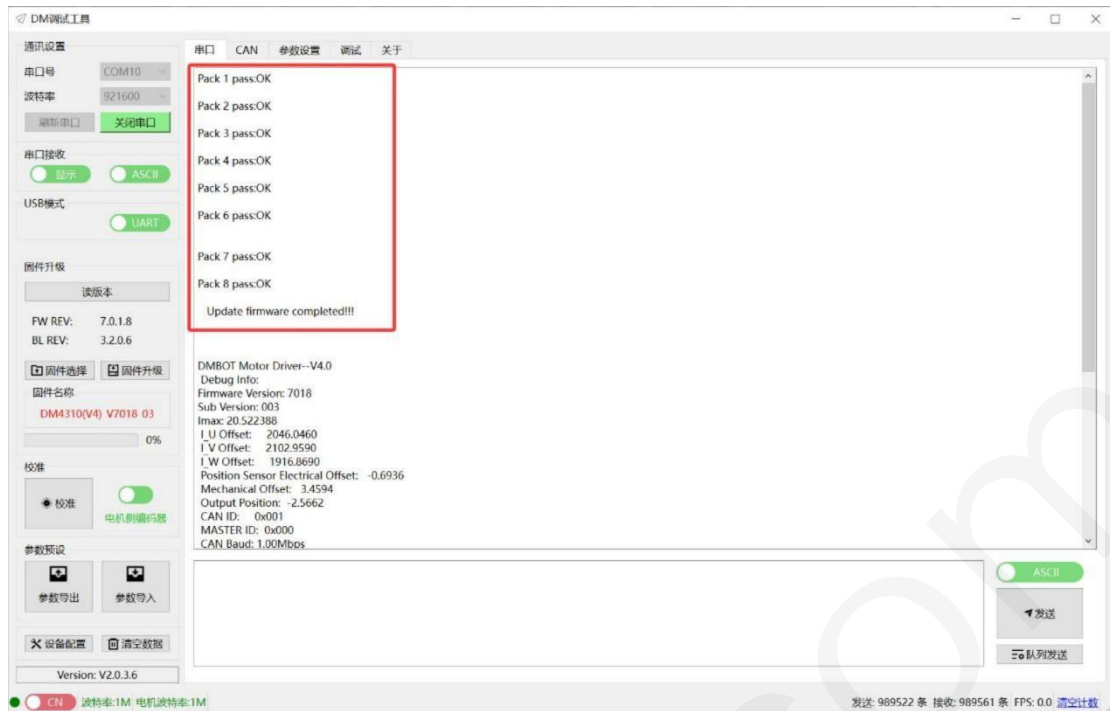
Before upgrading the firmware, read the current version. Unless otherwise specified, select firmware with a version number starting with 72 for upgrading. Otherwise, unknown issues may occur, causing unnecessary trouble.



Serial firmware upgrade

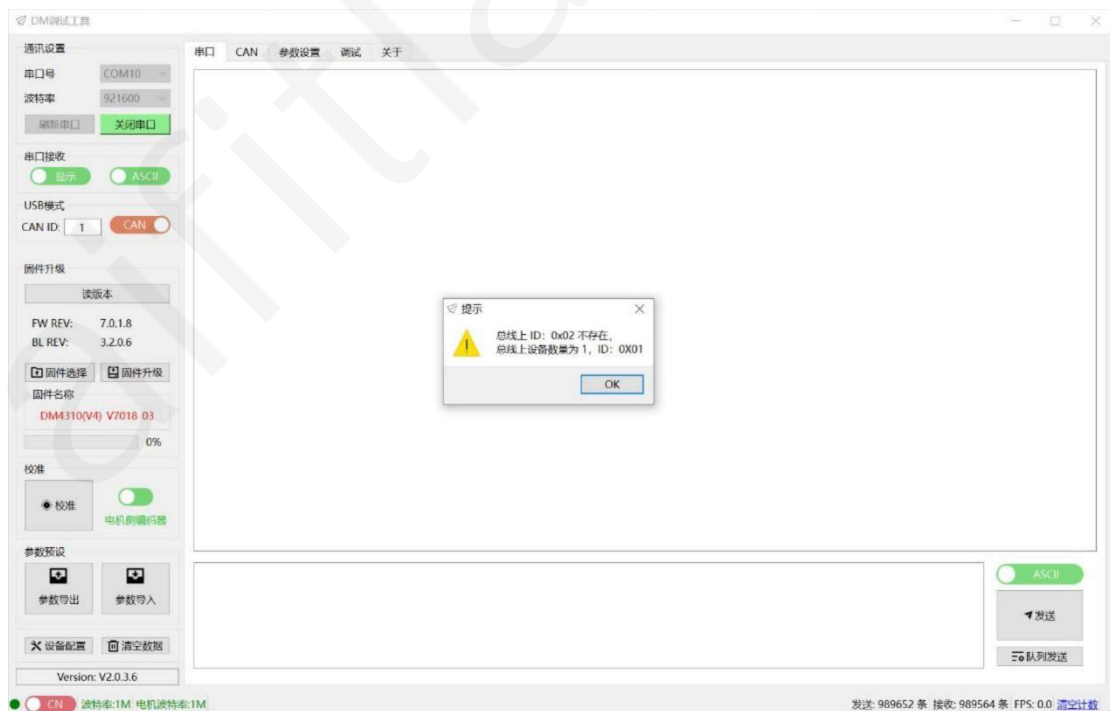
When new firmware features are added or bug fixes are released, users can perform upgrades via the serial port to resolve issues and access new functionalities. First, connect the serial port and select the desired firmware by clicking "Firmware Selection". The firmware name will appear in the name field after selection. Confirm the name is correct, then click the firmware upgrade button. Wait for the progress bar to complete, or monitor the upgrade status through the serial port interface.





CAN firmware upgrade

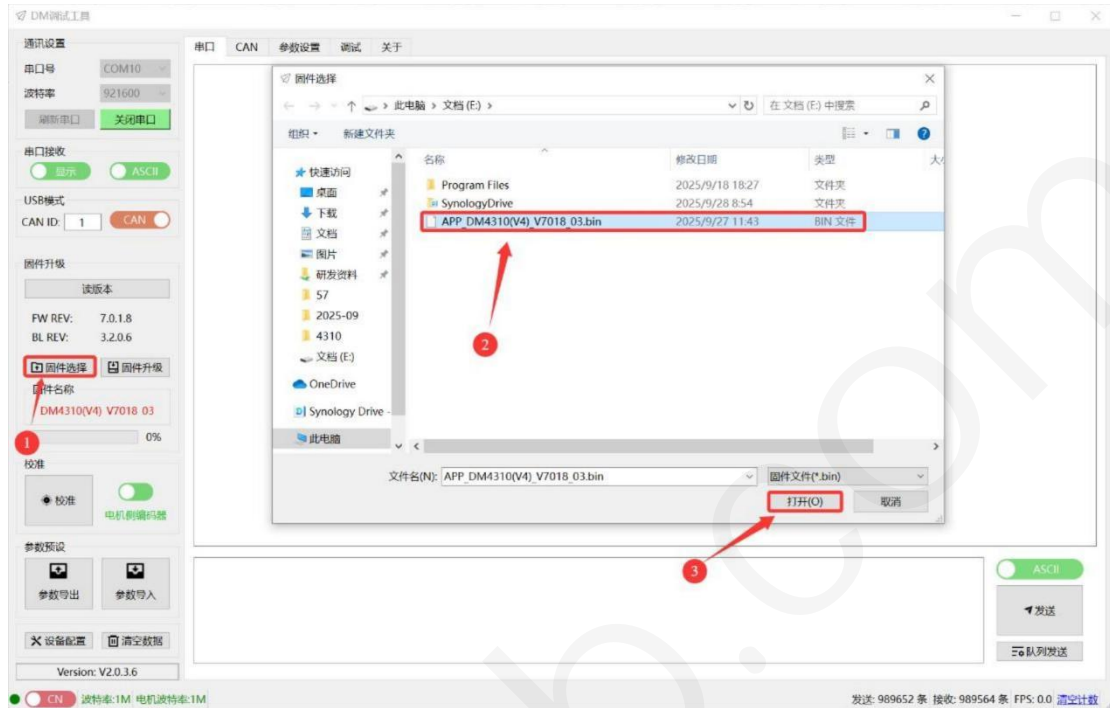
Bootloader version 3.2.0.5 and above supports CAN-based firmware upgrades at the driver board's configured baud rate, though USB-to-CAN conversion is currently the only supported method. Before use, connect the CAN bus to verify communication. Switch the UART to CAN mode in USB settings, then enter the motor ID to be upgraded in the left field. If the bus is unavailable, the system will display the following error message:



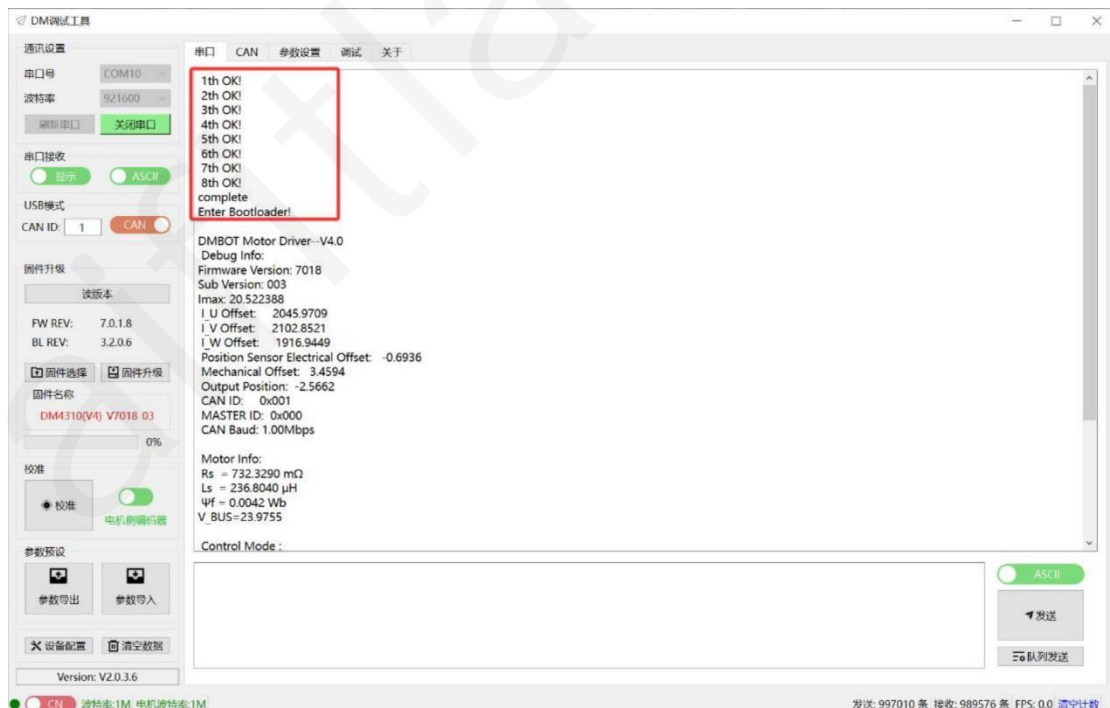
No prompt is displayed if the connection is successful.

Next, click 'Firmware Selection' to choose the appropriate firmware. After clicking to open, the firmware name will appear in the name field.

After confirming everything is correct, click the firmware upgrade button and wait for the progress bar to complete. You can also check the upgrade status through the serial interface.



After the upgrade is complete, the serial interface will display the corresponding prompt:



Use DAMIAOAO Technology Debug Assistant

Use DAMIAOAO Technology's USB-to-CAN debugging tool to connect the computer and motor, then configure motor parameters and upgrade firmware via DAMIAOAO Technology Assistant.

The motor's debugging serial port connects to the PC via a GH1.253-pin cable. The CAN communication terminal on the motor's power interface is linked to a USB-to-CAN debugging tool using an XT30 (2+2) F-type connector. The DAMIAOAO Technology Debug Assistant is employed to configure motor parameters and perform firmware upgrades.

After connecting the motor's serial port, CAN port, and power interface, launch the DAMIAOAO Technology Debug Assistant on your computer. Select the corresponding serial port device and enable the serial port. When powering the motor, the serial port will display information, with the Control Mode indicating the current driving mode.

Detailed debugging process reference: Debug Assistant User Manual (DAMIAO Driver Control Protocol) V1.4.pdf

Download link :

<https://gitee.com/kit-miao/DAMIAOAO-document/blob/master/%E8%B0%83%E8%AF%95%E5%8A%A9%E6%89%8B%E4%BD%BF%E7%94%A8%E8%AF%B4%E6%98%8E%E4%B9%A6%EF%BC%88%E8%BE%BE%E5%A6%99%E9%A9%B1%E5%8A%A8%E6%8E%A7%E5%88%B6%E5%8D%8F%E8%AE%AE%EF%BC%89V1.4.pdf>