DAMIAO | 达妙科技

DM-J4310P-2EC

Geared Motor

User Manual V1.3 2026-09-14

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Revision History

Date	Version	Changes
2025-10-22	V1.0	Initial Release
2025-11-24	V1.1	Document Updated
2026-09-08	V1.2	The overcurrent coefficient was corrected to “⩽ 0.98”
2026-09-14	V1.3	Weight corrected

Disclaimer

Thank you for choosing the DAMIAO DM-J4310P-2EC Gear Motor (hereinafter referred to as the "Motor") from DAMIAO Technology.

Before using this product, please read this manual and all safety precautions provided by DAMIAO Technology and follow them strictly. Failure to do so may result in personal injury, product damage, or damage to surrounding property. By using this product, you acknowledge that you have read, understood, and agreed to all terms and conditions in this document and all related documentation. You agree to use this product only for lawful and intended purposes. You assume full responsibility for the use of this product and any consequences arising from it. DAMIAO Technology shall not be liable for any direct or indirect damage, injury, or legal liability arising from the use of this product.

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Safety Precautions

1. Operate the motor strictly within the specified environmental conditions and maximum winding temperature limits. Failure to do so may result in permanent damage.

2. Prevent foreign objects from entering the rotor. Otherwise, abnormal operation may occur.

3. Inspect all components before use.Do not operate the motor if any components are missing, worn, or damaged.

4. Ensure correct wiring and proper, secure motor installation.

5. Do not touch the rotating or energized parts during operation to avoid injury. High torque operation may generate heat. Avoid contact to prevent burns.

6. Do not disassemble the motor. Unauthorized disassembly may affect control accuracy or cause malfunction.

Motor Features

1. Dual encoders provide single-turn absolute position feedback at the output shaft, ensuring position information is retained even after power loss.

2. Integrated motor and driver design offers compact structure with high integration.

3. Supports PC-based configuration, monitoring, and firmware upgrades.

4. Provides real-time feedback of motor Velocity, position, torque, and temperature via CAN bus.

5. Features dual temperature protection mechanisms.

6. Supports firmware upgrade via CAN.

Naming Conventions

Joint Motor

Separable Motor

DM - J 43 40 X - 2EC VX.X (48V)

(Brand)Damiao Technology

Product Line

J：Joint Motor Series
S：Separable Motor Series

Stator Diameter（mm）

35、43、60、62、80、100

Gear Ratio

06、07、09、10、19、40、48 etc.

Output Bearing/ Special Versions

X represents: letters such as L, P, etc.
Default: Deep groove ball bearing
P: Crossed roller bearing
L: Lite version(not related to bearing type)

Encoder

Default: Single encoder
1EC: Single encoder, CAN communication
2EC: Dual encoders (single-turn absolute,output shaft), CAN communication
1EE: Single encoder, EtherCAT communication
2EE: Dual encoders (single-turn absolute,output shaft), EtherCAT communication

Motor Version

VX.X: Upgrade version (X = 0–9), Version omitted = V1.0

Drive rated voltage

Default: 24V drive
48V: 48V drive

Specifications

Please operate the motor within the specifications listed below.

Motor Specifications	Model	DM-J4310P-2EC	DM-J4310P-2EC（48V）
	Rated Voltage	24V	48V
	Rated Phase Current / Rated Supply Current	4.9A/3.1A@24V	4.8A/1.6A@48V
	Peak Phase Current/ Peak Supply Current	20A/16.5A@24V	20A/12.8A@48V
	Rated Torque	3.5NM	
	Peak Torque	12.5NM	
	Rated Speed	120rpm	
	Maximum No-Load Speed	200rpm	450rpm
Motor characteris -tics	Reduction Ratio	10: 1	
	Pole Pairs	14	
	Phase Inductance	~320uH	
	Phase Resistance	~580mΩ	
Mechanical & Physical	Outer Diameter	57mm	
	Height	49.05mm	
	Weight	~ 330g	
Encoder	Resolution (bits)	16 bits	
	Number Of Encoders	2	
	Type	Magnetic Encoder (Single-turn)	
Communica -tion Interfaces	Control Interface	CAN@1Mbps	
	Configuration Interface	UART@921600bps	
Control & Protection	Control Modes	MIT Mode	
		Position-Velocity Mode	
		Velocity Mode	
		Force-Position Hybrid Mode	
	Protection	Drive over-temperature protection: shutdown at 120° C; the motor exits Enable Mode when triggered.	
		Motor over-temperature protection (configurable, recommended ⩽ 100° C); the motor exits Enable Mode when triggered.	
		Over-voltage protection (configurable, recommended ⩽ 32V); exits Enable Mode when triggered.	Over-voltage protection (configurable, recommended ⩽ 60V); exits Enable Mode when triggered.
		Communication Loss Protection: the motor exits Enable Mode if no CAN command is received within the specified timeout period.	

		Over-current protection (configurable,recommended ⩽ 0.98); exits Enable Mode when triggered.	
		Under-voltage protection: the motor exits Enable Mode if supply voltage falls below the threshold (recommended ⩾ 15V).	Under-voltage protection: the motor exits Enable Mode if supply voltage falls below the threshold (recommended ⩾ 20V).

◈ Operating Voltage

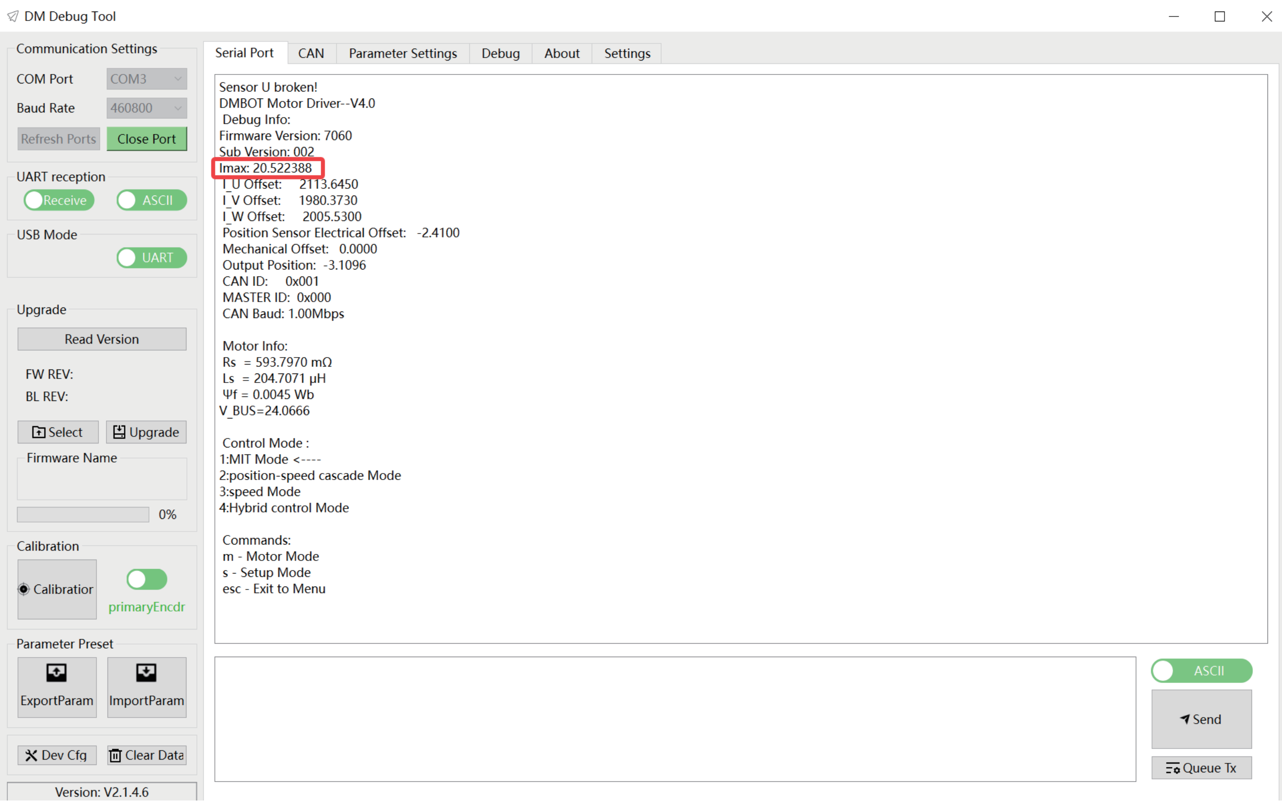
The operating voltage range for the 24V motor driver is 24V–28V, with a minimum operating voltage of 20V and a maximum of 28V.

For the 48V motor driver, the operating voltage range is 24V–48V, with a minimum operating voltage of 20V and a maximum of 58V.Hot-plugging is recommended to be avoided when the voltage exceeds 36V.

◈ Maximum Phase Current

Correction: The baud rate in the communication settings in the PC software shown in the screenshot below has been updated to 921600.

The maximum phase current of the driver can be obtained from the startup serial output:



The maximum phase current percentage can be limited by setting a percentage in the configuration tool. The default value is 0.8 (i.e., 80% of the measurable maximum current). It is recommended that this value not exceed 98%.

◈ Maximum Rotational Speed

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

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

where V_{BUS} is the supply voltage, Npp is the number of pole pairs, and ψ_f is the rotor flux linkage.

◈ Torque Constant

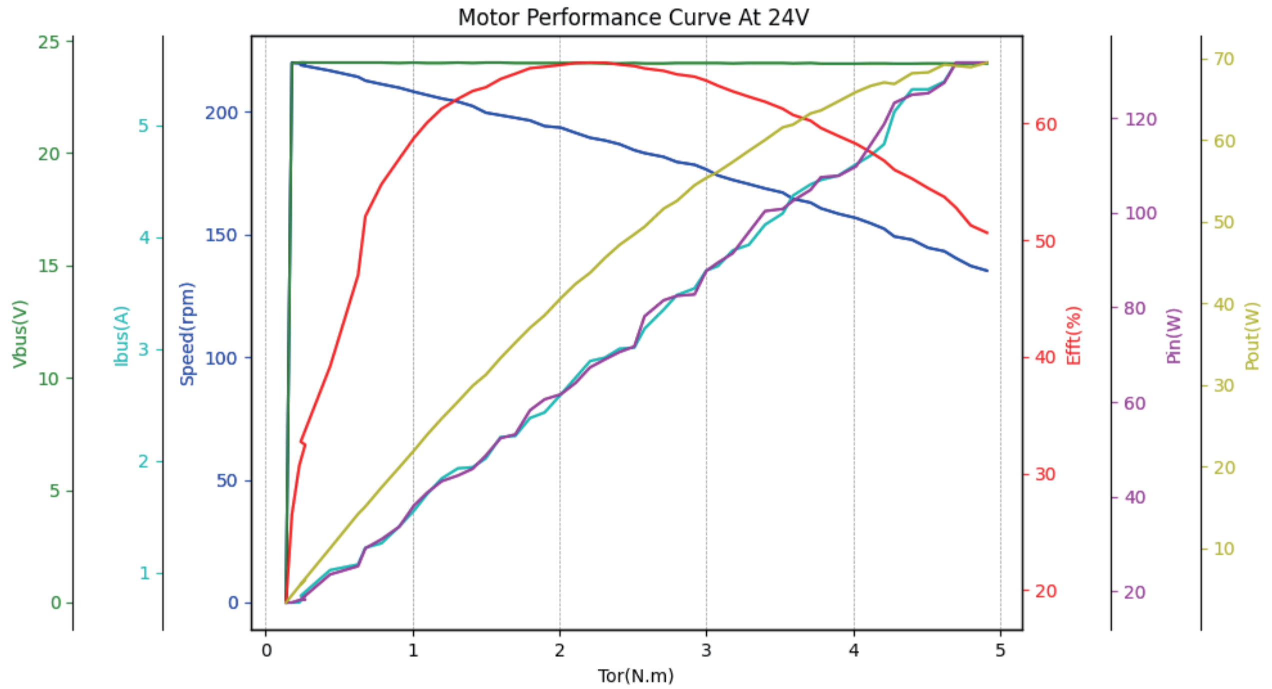
The torque constant of the motor can be considered constant within its rated range. With a gearbox, it can be calculated using the following formula:

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

Where N_{pp} is the number of pole pairs, ψ_f is the rotor flux linkage, GR is the gear ratio, and GREF is the gearbox torque transmission coefficient.

Torque–Speed (T–N) Curve

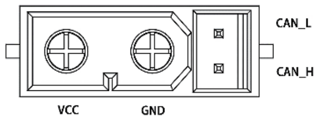
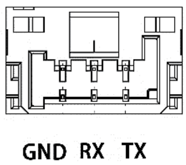
The following curve shows the measured performance at 24 V, a constant speed of 120 rpm, and an ambient temperature of 25° C:



Packing List

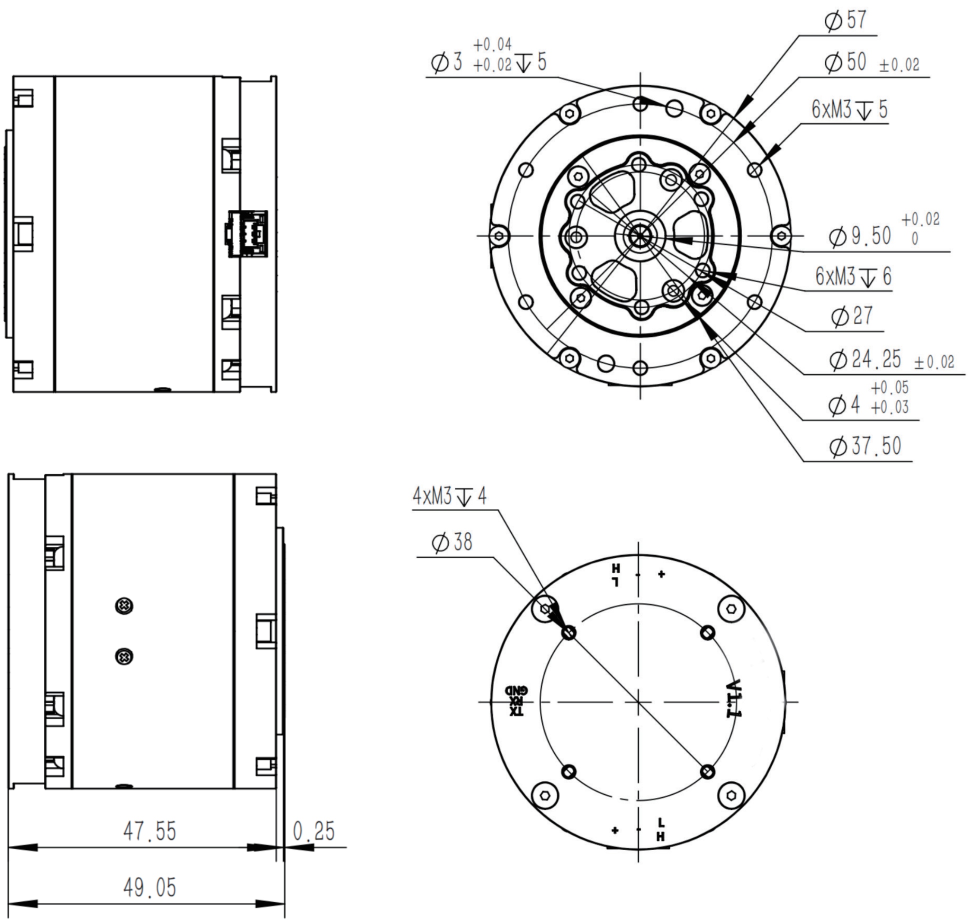
1. Motor (with integrated driver) ×1
2. Power cable (with CAN interface) : XT30(2+2)-F connector, single-ended(100mm)×1
3. Debug serial cable: GH1.25 3-pin cable (reverse-side connector, 300mm) ×1

Interface & Pin Description

Interface / Pin No.	Interface Diagram (Pinout)	Instruction
Power Interface-1 (with CAN interface) Power Interface-2 (with CAN interface)		1. Connect the power supply via the XT30(2+2)-F cable. The rated voltage is 24 V. 2. Connect external controller via the CAN communication interface to receive CAN control commands and transmit motor status feedback. 3. The motor features two power interfaces. Either interface can be used independently , or multiple motors can be daisy-chained for convenient wiring.
Debug Serial Interface (Port 3)		Connect to a PC via the GH1.25 3-pin cable using a USB-to-CAN adapter (or USB-to-serial module) for parameters configuration and firmware upgrades.

Motor Dimensions and Mounting

Please install the motor onto the target equipment according to the motor mounting hole dimensions and layout.



LED Status

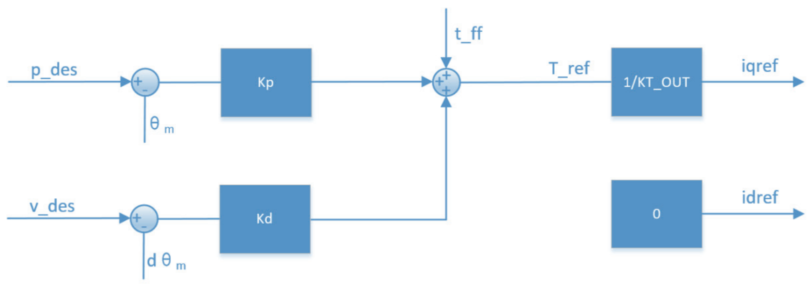
Normal Status	Solid Green	Enable Mode (ERR = 1), normal operation
	Solid Red	Disable Mode (ERR = 0) (Default state after power-on)
Fault Status	Flashing Red	Fault codes and fault conditions: 3——Output shaft calibration error; 4——Sensor output error; 5——Motor encoder calibration error; 8——Over-voltage; 9——Under-voltage; A——Over-current; B——MOS over-temperature; C——Motor winding over-temperature; D——Communication loss; E——Overload; Fault conditions can be identified via the feedback frames or displayed in the the Damiao configuration software.

Operating Modes

◈ MIT Mode

The MIT mode is compatible with the standard MIT control method, enabling seamless switching while allowing flexible configuration of control limits (P_MAX, V_MAX, T_MAX).

CAN commands are converted into torque values. The torque is then used as the reference for current control. See block diagram below.

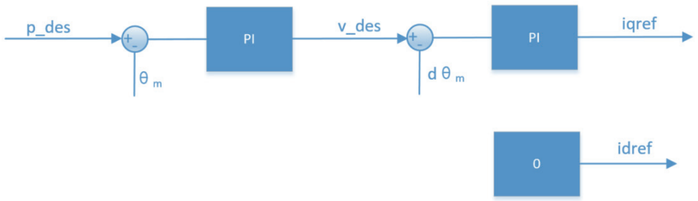


Based on the MIT model, various control strategies can be derived. For instance, when kp=0 and kd ≠ 0, a constant rotational speed can be achieved by setting v_des. When kp=0 and kd=0, a torque output is applied directly by setting t_ff.

Note: When controlling position, kd must not be set to zero, as this may cause motor oscillation or even loss of control.

◈ Position-Velocity Mode

This mode uses three control loops: position, velocity, and current(torque). The position loop sets the target for the velocity loop. The velocity loop then sets the target for the current loop. See block diagram below.



p_des represents the target position, while v_des limits the maximum absolute velocity during motion.

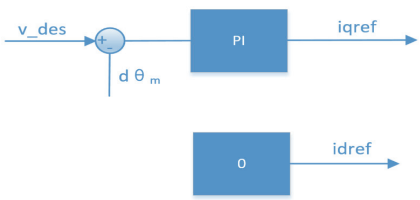
When tuned using recommended parameters from the configuration tool, this mode provides high accuracy and smooth motion, at the cost of slower response time.

In addition to v_des, acceleration and deceleration can also be configured. If additional oscillations occur, increasing acceleration/deceleration may help stabilize the system.

Note: The units of p_des and v_des are rad and rad/s respectively, and both are of type float. The damping factor must be set to a non-zero positive value. Refer to the notes for velocity mode.

◈ Velocity Mode

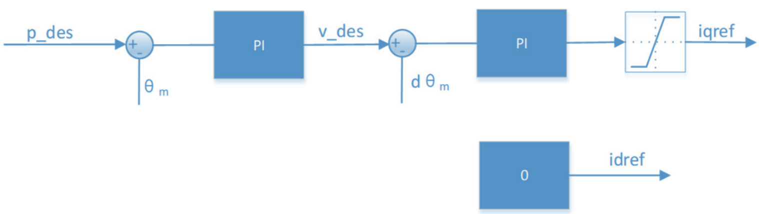
This mode keeps the motor running at the target velocity. See block diagram below.



Note: The unit of v_des is rad/s, and its data type is float. To enable automatic parameter calculation via the configuration tool, the damping factor must be set to a non-zero positive value, typically between 2.0 and 10.0. An excessively low damping factor may cause velocity oscillations and significant overshoot, while an excessively high damping factor may increase the rise time. The recommended value is 4.0.

◈ Force-Position Hybrid Mode

The force-position hybrid control mode is based on position-velocity control, with additional torque adjustment. Allows control of both position and output torque at the same time. See block diagram below.



A current command saturation stage is added after the velocity loop output command. This limits the current loop reference within the specified range.

◈ Mode Switching

Mode switching can be configured via the host PC over a serial port. Simply select the desired mode and click "Write Parameters". Once applied, the motor will automatically reset, and the selected mode is stored in the motor driver.It will be retained after power cycling.

Alternatively, modification can be changed via the CAN interface by updating the mode register. For details, refer to the "Mode Switching" section in the next chapter.

When using the CAN method,the motor will not reset,but the following five variables will be cleared to zero:

- Position command value
- Velocity command value
- Torque command value (MIT mode)
- kp (MIT mode)
- kd (MIT mode)

Note:If the"Save Parameters" command is not issued, the mode will not be stored. It will be lost after power loss and will load the last saved mode upon power-up.

CAN Communication

After calibration, parameter identification, and parameter configuration are completed, the motor is ready for operation.

Control is performed using CAN standard frames (STD). The default baud rate is 1 Mbps, which can be modified via commands. Refer to the "CAN Baud Rate" section for details.

Frame Types:

CAN communication is divided into two types:

- Command Frames

Frames received by the driver, used to send control commands to the motor.

- Feedback Frames

Frames transmitted by the driver to the upper-level controller, containing motor status data.

Feedback Mechanism:

Feedback operates in a request-response manner. When the driver receives a CAN frame whose ID matches the configured motor CAN ID:

① The lower 8 bits are used for validation.

② The upper 3 bits are ignored.

Once a match is detected, the driver will transmit the current motor status to the CAN bus.

Frame Format:

The command frame format and frame ID vary depending on the selected control mode. The feedback frame format remains the same across all control modes.

◈ CAN Baud Rate Configuration

The CAN baud rate can be configured in two ways:

1. Configuration via Serial Interface

The baud rate can be set through the host PC software via the serial interface.

① Select the desired baud rate.

② Click "Write Parameters" to apply.

After the setting is successfully written:

① The motor will automatically reboot.

② The baud rate will be stored in the driver.

③ The setting will persist after power cycling.

2. Configuration via CAN Interface

The baud rate can also be modified via the CAN interface by writing to the corresponding baud rate register. See "CAN Baud Rate" in this chapter for details.

Note: When modifying the baud rate via CAN, the operation may fail if multiple devices are present on the bus.

Use this method with caution. It is strongly recommended to configure the baud rate before connecting multiple devices.

◈ Feedback Frames

The feedback frame ID is set via the configuration tool (Master ID), with a default value of 0. It primarily reports the motor position, velocity, and torque with the frame format defined as follows:

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

- ID: Controller ID, using the lower 8 bits of CAN_ID
- ERR: Status code, with the following meanings
- 0——Disabled（Default state after power-on）
- 1——Enabled
- 8——Over-voltage
- 9——Under-voltage
- A——Over-current
- B——MOSFET over-temperature
- C——Motor coil over-temperature

- D——Communication Lost
- E——Overload
- POS: Motor position
- VEL: Motor velocity
- T: Motor torque
- T_MOS: Average MOSFET temperature on the driver (℃)
- T_Rotor: Average motor coil temperature (℃)

Position, velocity, and torque are are converted from floating-point data to signed fixed-point data using a linear mapping:

①Position: 16-bit signed fixed-point representation.

②Velocity: 12-bit signed fixed-point representation.

③Torque: 12-bit signed fixed-point representation.

◈ 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]

- Frame ID: Equals the configured CAN ID
- P_des: Desired position
- V_des: Desired velocity
- Kp: Position proportional gain
- Kd: Position derivative gain
- T_ff: Feedforward torque

All parameter follows the mapping rules described in the previous section. The ranges for p_des, v_des, and t_ff can be configured via the configuration tool. Kp range: [0,500], Kd range: [0,5].

A standard CAN frame contains 8 bytes. In MIT mode, the control command packs Position, Velocity, Kp, Kd, and Torque into these 8 bytes:

- Position: 16 bits (2 bytes)
- Velocity: 12 bits
- Kp: 12 bits
- 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			

・Frame ID :equals the configured CAN ID plus an offset of 0x100.

・P_des: Desired position, float type, little-endian (low byte first, high byte last).

・V_des: Desired velocity, float type, little-endian (low byte first, high byte last).

The CAN ID used to send commands here is 0x100 + ID. The velocity command represents the maximum velocity during trapezoidal acceleration, i.e., the constant velocity segment.

◈ Control Frame in Velocity Mode

Control Message	D[0]	D[1]	D[2]	D[3]
0x200+ID	v_des			

・Frame ID equals the configured CAN ID plus an offset of 0x200.

・V_des: Desired velocity, float type, little-endian (low byte first, high byte last).

The CAN ID used to send commands here is 0x200 + ID.

◈ Control Frame in Force-Position Hybrid 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: Desired position, in radians, float type, little-endian (low byte first, high byte last).

・V_des: Velocity limit, in rad/s, scaled by 100, unsigned 16-bit, little-endian (low byte first, high byte last). Valid range: 0–10000. Values exceeding 10000 are capped at 10000, corresponding to an actual velocity limit range of 0~100 rad/s.

・I_des: Torque current limit (per-unit), scaled by 10000, unsigned 16-bit type, little-endian (low byte first, high byte last). Valid range: 0-10000. Values exceeding 10000 are capped at 10000, corresponding to an actual current limit amplitude of 0-1.0.

・Per-unit current: Actual current divided by the maximum phase current.

◈ Enable

After power-up self-test, an "Enable" command must be sent to allow motor control. The "Enable" frame is a control frame, with the frame ID as described above. The data payload is identical across all modes as follows:

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

◈ Disable

The default power-on state of the motor is "Disable." In this state, the three-phase terminal voltages are identical, each being a 50% modulation of the power supply voltage. The "Disable" frame is a control frame, with the frame ID as described above. The data payload is defined as follows:

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

◈ Set Zero Position

The "Set Zero Position" frame is a control frame. This command sets the current output shaft position as the zero reference and resets the position command value to 0. The frame ID follows the definition above, and the data payload is defined as follows:

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

◈ Clear Faults

When faults such as overheating, sending a "Clear" can be sent to reset the fault state. The "Clear" frame is a control frame. The frame ID follows the definition above, and the data payload is defined as follows:

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

◈ Read Parameters

Message ID	Attribute	D[0]	D[1]	D[2]	D[3]
0x7FF	STD	CANID_L	CANID_H	0x33	RID

RID represents the register address; refer to the "Register Map" section for details in this manual.

Upon successful read, the value of the register is returned. The frame format is 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 a floating-point value or an unsigned integer, occupying 32 bits (4 bytes) in total. The least significant bit is D4, and the most significant bit is D7. The same convention applies below.

◈ Write Parameters

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			

RID is defined as above. Upon successful write, the written value is returned. The frame format is identical to the transmitted frame.

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 are not stored; They will be lost upon power-off unless a "Save Parameters" command is issued to store them in internal memory.

◈ Save Parameters

Message ID	Attribute	D[0]	D[1]	D[2]	D[3]
0x7FF	STD	CANID_L	CANID_H	0xAA	0x01

Upon successful execution, the return frame 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 "Save Parameters" command is only effective in Disabled Mode.

② All parameters are stored simultaneously during this operation.

③ This operation writes parameters to the on-chip flash memory. The maximum execution time is 30ms; please allow sufficient time.

④ The flash memory supports approximately 10,000 erase/write cycles. Avoid frequent execution of the "Save Parameters" command.

◈ Mode Switching

Multiple control modes are supported and can be switched as follows:

Code/ID	Mode
1	MIT
2	Position -Velocity
3	Velocity
4	Force-Position Hybrid Control

The mode can be changed by modifying the mode register (0x0A). During switching, the motor resets all command values to zero, including position, velocity, and torque feed-forward, KP, and KD in MIT mode.

When switching to a position control mode, to avoid impact, it is recommended to first read the precise position (value in register 0x50) and perform the switch when the motor is at zero speed whenever possible.

Mode changes are not saved to flash memory and will be lost after power-off. Upon restart, the motor loads the last mode stored in flash.

◈ CAN Baud Rate Configuration

By writing specific value to the baud rate register (address 0x23), the current CAN communication baud rate can be modified. Supported baud rates are listed below:

Code/ID	Baud Rate
0	125K
1	200K
2	250K
3	500K
4	1M
5	2M
6	2.5M
7	3.2M
8	4M
9	5M

Baud Rate Switching Behavior:

After a successful update, the driver first transmits feedback using the original baud rate and then switch to communication using the new baud rate.

Baud Rate Handling at Power-Up:

At power-up, the driver determines the communication mode based on the stored baud rate.

- If the stored baud rate exceeds 5Mbps, the baud rate is reset to 1Mbps by default.
- If the baud rate is greater than 1 Mbps (excluding 1 Mbps), the driver operates in CAN FD mode.
- If the baud rate is ⩽ 1 Mbps, the driver operates in CAN 2.0B mode.

CAN FD Compatibility Note:

A motor configured in CAN FD mode can still receive CAN 2.0B data frames. However, feedback frames are transmitted using CAN FD. As a result, if the upper-level controller only supports CAN 2.0B, it will not receive feedback data, the driver may continuously report communication errors.

Recovery Note:

For controllers operating in CAN 2.0B mode, even if the CAN ID is incorrectly configured, the baud rate can still be restored by sending a baud rate configuration command.

◈ Register Map

Address (HEX)	Address (DEC)	Name	Description	Access	Range	Type
0x00	0	UV_Value	Undervoltage Threshold	RW	(10.0,fmax]	float
0x01	1	KT_Value	Torque Constant	RW	[0.0,fmax]	float
0x02	2	OT_Value	Over-temperature Threshold	RW	[80.0,200)	float
0x03	3	OC_Value	Overcurrent Threshold	RW	(0.0,1.0)	float
0x04	4	ACC	Acceleration	RW	(0.0,fmax)	float
0x05	5	DEC	Deceleration	RW	[-fmax,0.0)	float
0x06	6	MAX_SPD	Max Velocity	RW	(0.0,fmax]	float
0x07	7	MST_ID	Master ID	RW	[0,0x7FF]	uint32
0x08	8	ESC_ID	Command CAN ID	RW	[0,0x7FF]	uint32
0x09	9	TIMEOUT	Timeout Threshold	RW	[0,2^32-1]	uint32
0x0A	10	CTRL_MODE	Control Mode	RW	[0,4]	uint32
0x0B	11	Damp	Viscous Damping	RO	—	float
0x0C	12	Inertia	Rotor Inertia	RO	—	float
0x0D	13	hw_ver	Reserved	RO	—	uint32
0x0E	14	sw_ver	Firmware Version	RO	—	uint32
0x0F	15	SN	Reserved	RO	—	uint32
0x10	16	NPP	Number of Pole Pairs	RO	—	uint32
0x11	17	Rs	Phase Resistance	RO	—	float
0x12	18	Ls	Phase Inductance	RO	—	float
0x13	19	Flux	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 Bandwidth	RW	[100.0,1.0e4]	float
0x19	25	KP_ASR	Velocity Loop Kp	RW	[0.0,fmax]	float

Address (HEX)	Address (DEC)	Name	Description	Access	Range	Type
0x1A	26	KI_ASR	Velocity Loop 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 Threshold	RW	TBD	float
0x1E	30	GREF	Gear Torque Efficiency	RW	(0.0,1.0]	float
0x1F	31	Deta	Velocity Loop Damping Coefficient	RW	[1.0,30.0]	float
0x20	32	V_BW	Velocity Loop Filter Bandwidth	RW	(0.0,500.0)	float
0x21	33	IQ_c1	Iq Gain	RW	[100.0, 1.0e4]	float
0x22	34	VL_c1	Velocity Loop Gain Factor	RW	(0.0,1.0e4]	float
0x23	35	can_br	CAN Baud Rate	RW	[0,9]	uint32
0x24	36	sub_ver	Sub-version	RO	—	uint32
0x25	37	Boot_ver	Bootloader Version	RO	—	uint32
0x37	55	dir	Direction	RO	—	float
0x38	56	m_off	Motor-Side Angle Offset	RO	—	float
0x3B	59	Imax	Driver Current Limit	RO	—	float
0x3C	60	VBus	Bus Voltage	RO	—	float
0x3D	61	Tpcb	PCB Temperature	RO	—	float
0x3E	62	Tmtr	Motor Temperature	RO	—	float
0x3F	63	I_U_OFF	Phase U Current Offset	RO	—	float
0x40	64	I_V_OFF	Phase V Current Offset	RO	—	float
0x41	65	I_W_OFF	Phase W Current Offset	RO	—	float
0x50	80	p_m	Motor Position	RO	—	float
0x51	81	xout	Output Shaft Position	RO	—	float

Notes:

① RW: Read/Write.

② RO: Read-Only.

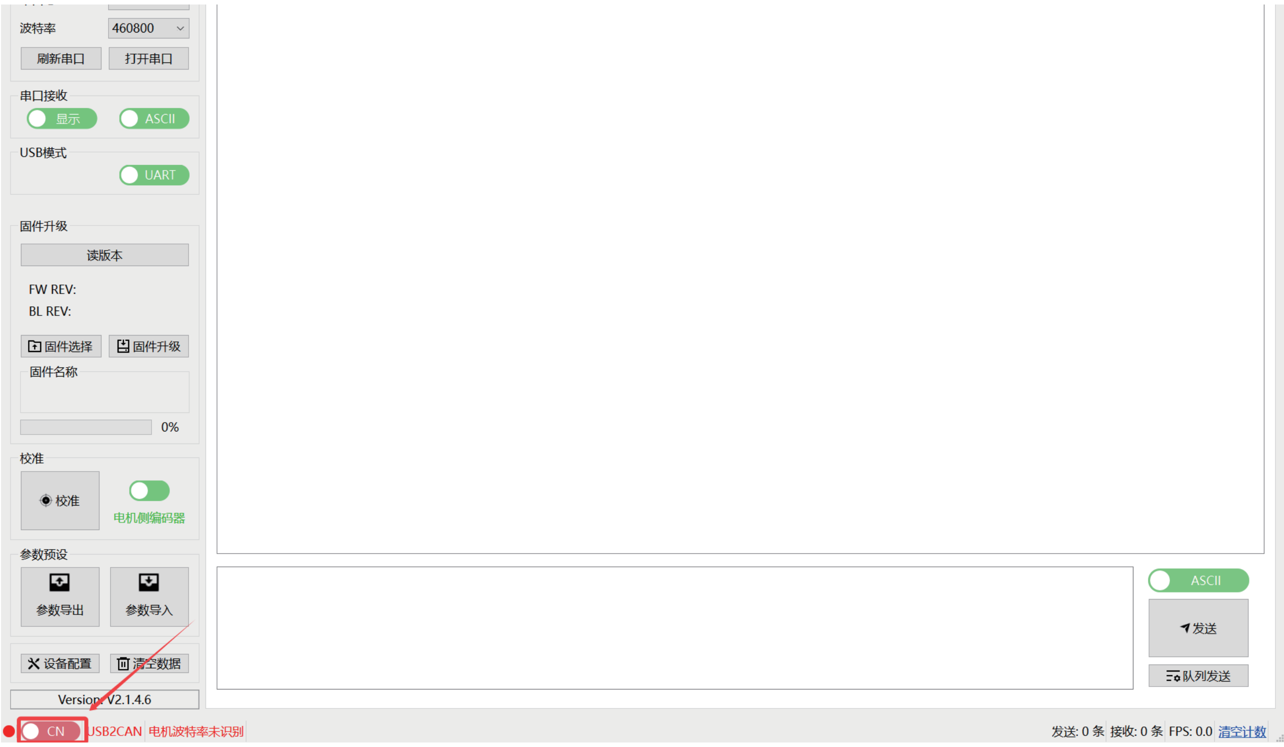
③ Motor output shaft position is calculated form the rotor position, in radians (rad).

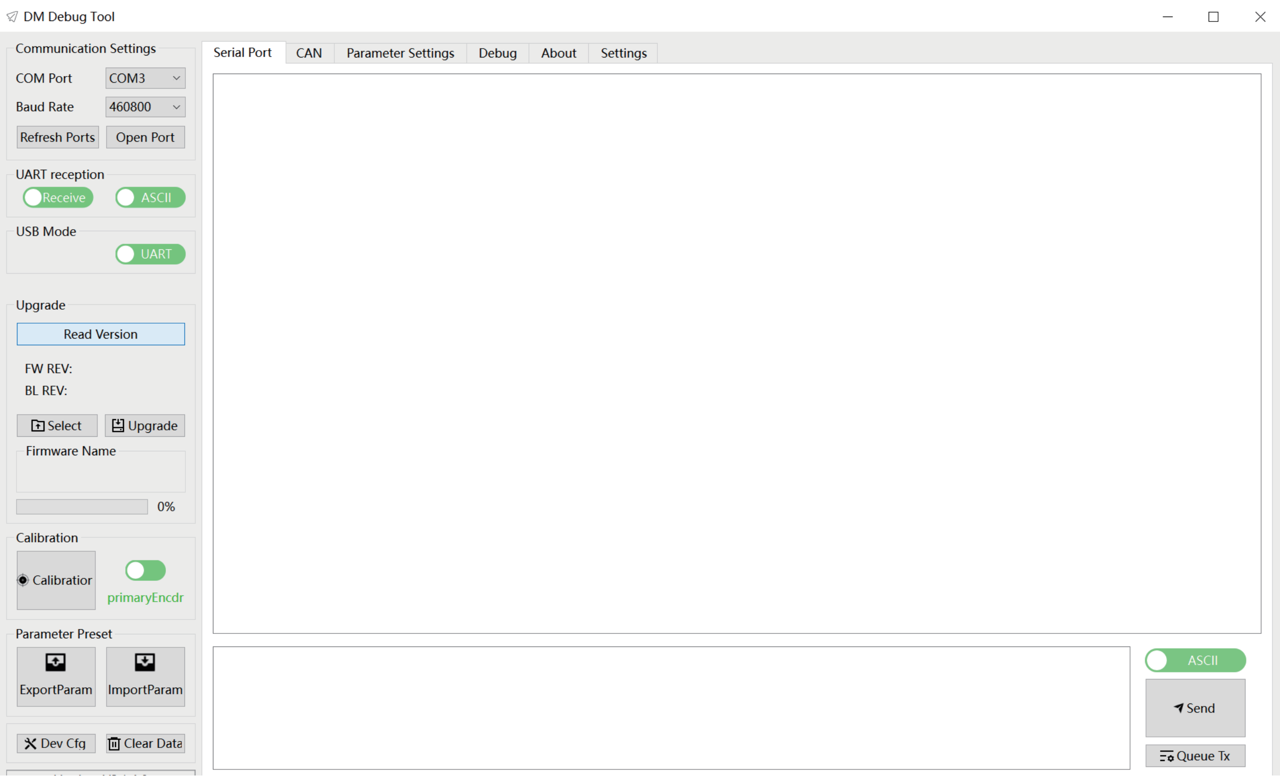
④ Output shaft position refers is measured directly by the output shaft encoder, in radians (rad).

Motor Debugging Procedure

Please use version the configuration software version V2.0.0.0 or above for debugging. This guide uses version V2.1.4.6 as an example. The procedures shown are based on the 4340P model in the 43 series and apply to other motors in the same family.

Before use, first locate the Chinese-English switch button in the lower-left corner of the interface, as shown below:



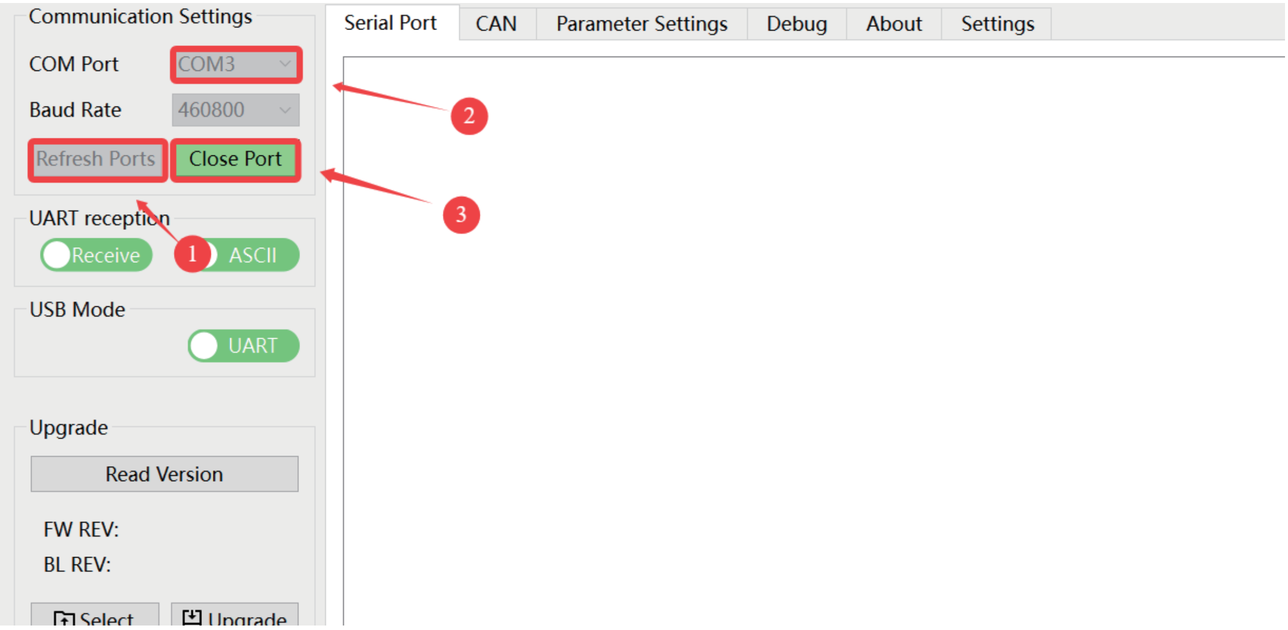


◈ Device Connection

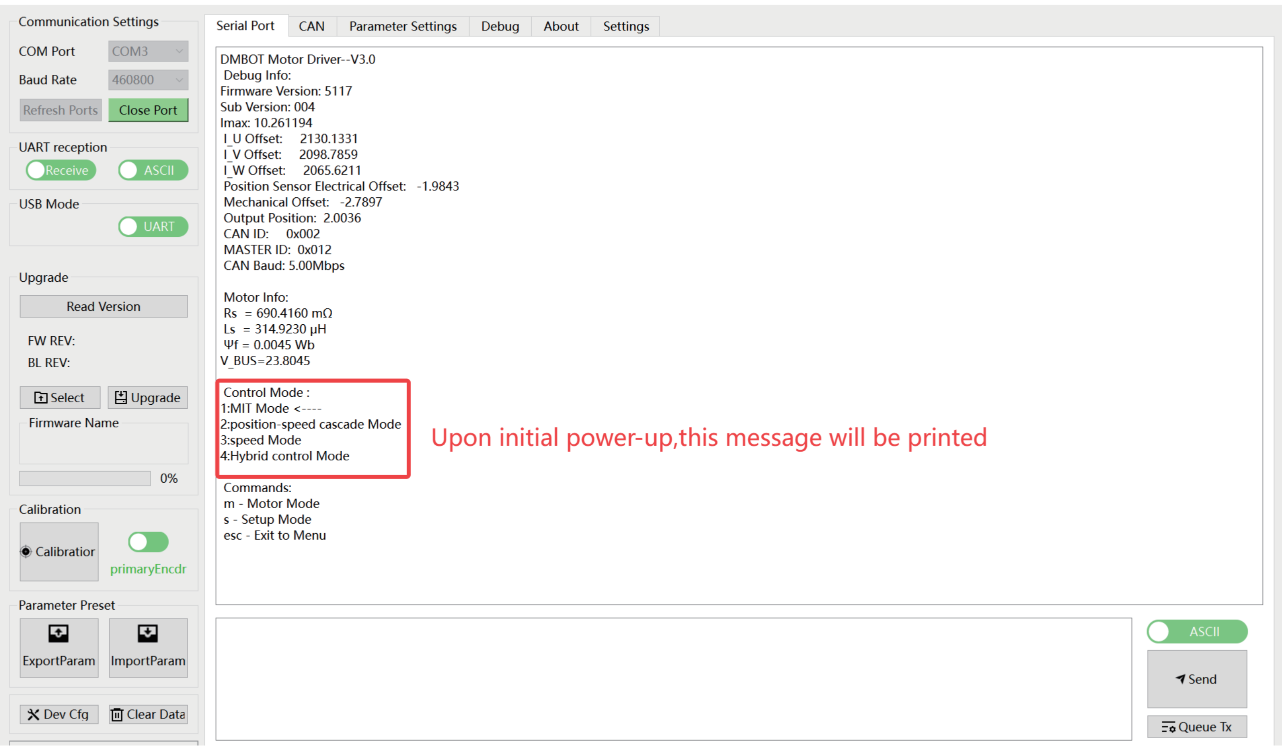
Connect the following interfaces:

- UART interface
- CAN interface
- Power supply

Open the configuration software on the PC, select the correct serial port, and open the connection.



Once powered on, the motor will output status information via UART. "Control Mode" indicates the current control mode of the drive. Different modes use different command formats see CAN Communication).



◈ Motor-side Encoder Calibration

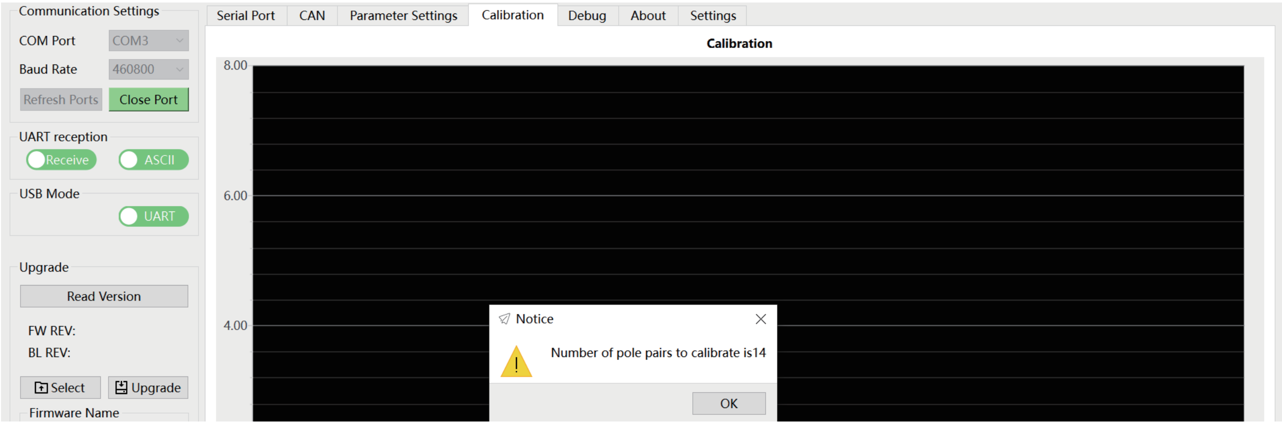
Motor encoder calibration compensates for installation offsets.

During calibration, the motor will rotate forward and backward for one electrical cycle. Ensure the motor can rotate freely, preferably under no-load conditions, to prevent calibration failure. Motors are factory-calibrated. Recalibration is only required after hardware changes or abnormal behavior.

Procedure:

Step 1: Motor-side Encoder Calibration.

Click "Calibration" to start. The motor will rotate and report the number of pole pairs.

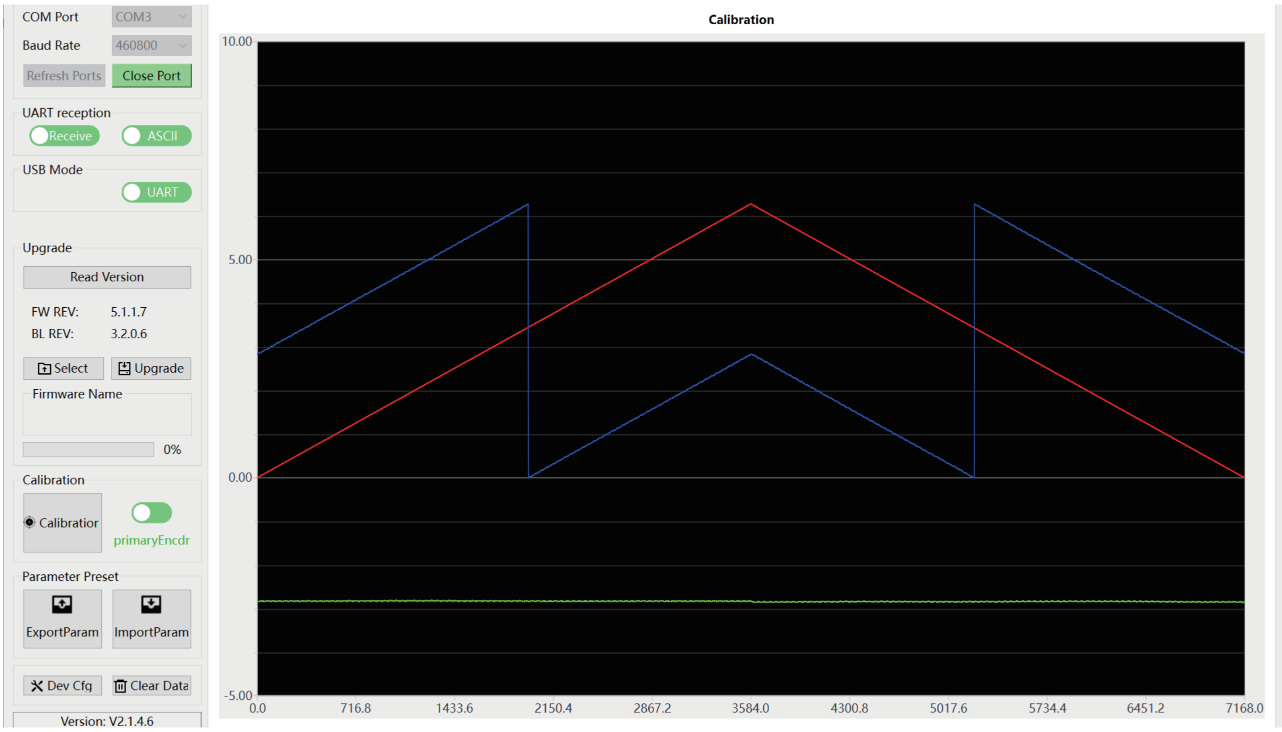


It will then automatically perform parameter identification, followed by encoder calibration.

During this process:

- The motor will move.
- Secure the motor to prevent movement .

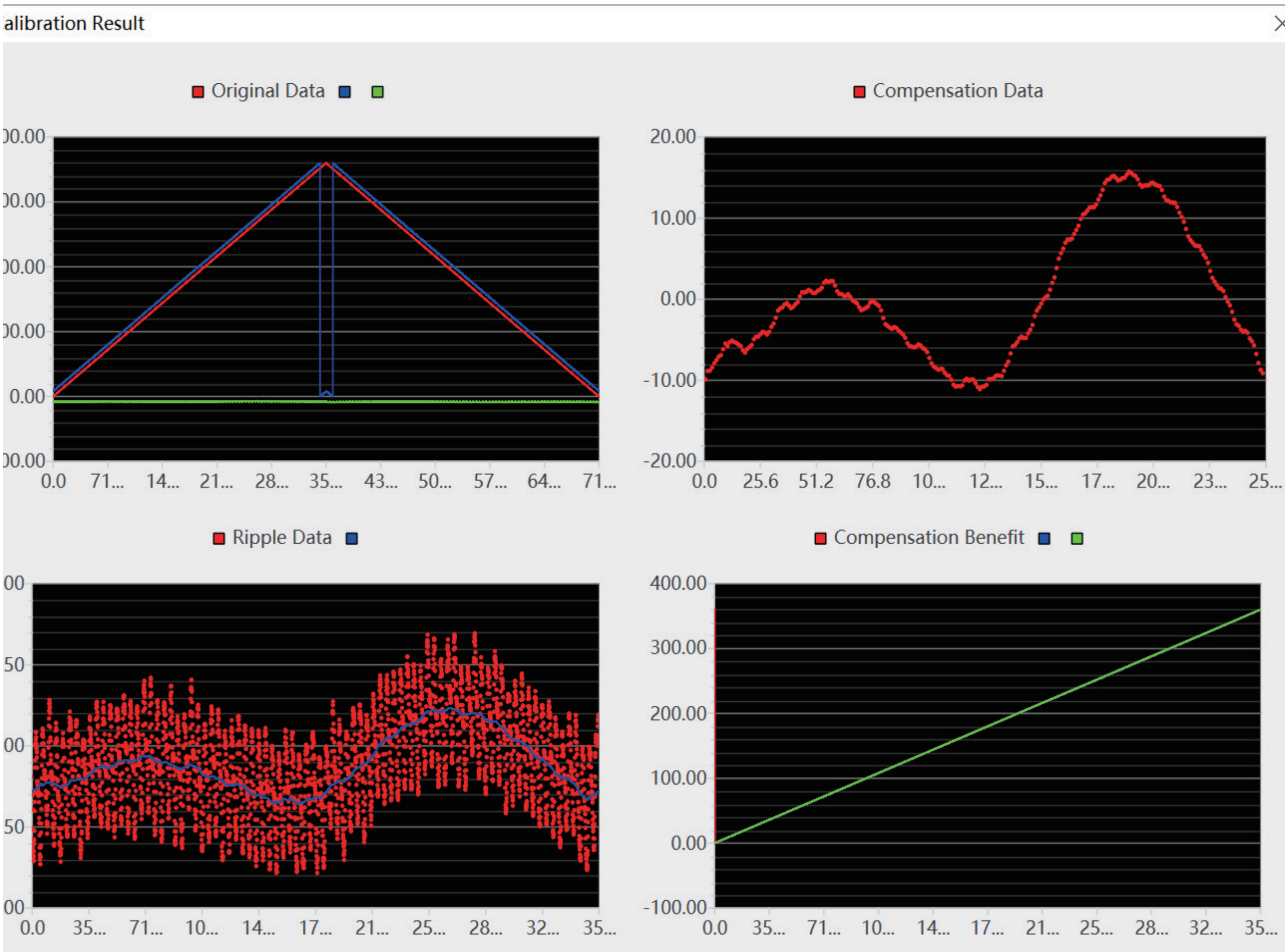
A wave form will be displayed after calibration:



Validation guideline: The peak of the red curve should not significantly exceed the blue curve. If it does, calibration may fail, then please repeat the process.

Result Verification:

Step 2: Calibration data is uploaded automatically. An example is shown below:



Step 3: Calibration Data Check and Storage.

Pay close attention to the value of Compensation Data. Recommended range: ±300.

Out-of-range values may indicate:

- Incorrect pole pair identification.
- Excessive mechanical resistance unstable rotation.
- Improper sensor installation.

Step 4: Troubleshooting

Check and resolve the issue based on the possible causes listed above.

◈ Parameter Identification

This process identifies key motor parameters:

- Phase resistance
- Phase inductance

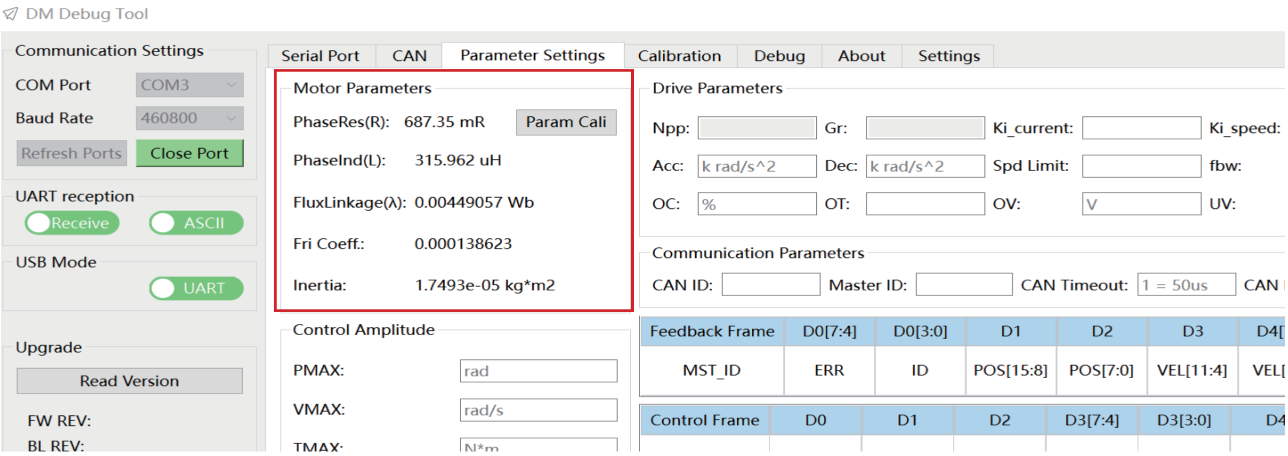
- Flux linkage

These values are pre-calibrated at the factory and stored internally. It is ready for immediate use without requiring recalibration.

Procedure:

Go to Parameter Settings, click "Parameter Identification".The driver will initiate the identification process.

The motor will rotate during identification. Make sure no load is applied, and the motor is secured .



Results are uploaded automatically after completion.

Notes:

①Viscous coefficient is for reference only.

②Multiple runs may yield different results.

③All parameters (except viscous coefficient) must be non-negative. If negative values occur, verify the motor status before proceeding with calibration.

◈ Output Shaft Encoder Calibration (Dual Encoder Motors)

Required for motors equipped with an output shaft encoder to enhance encoder accuracy.

Important Notes Before Calibration:

- During calibration, the motor will rotate forward one full revolution.
- Ensure the motor can rotate freely and operate under no load,otherwise, excessive calibration errors may occur.
- Motors are pre-calibrated at the factory, and the calibration data is stored in the motor. Under normal conditions, no additional calibration is required.

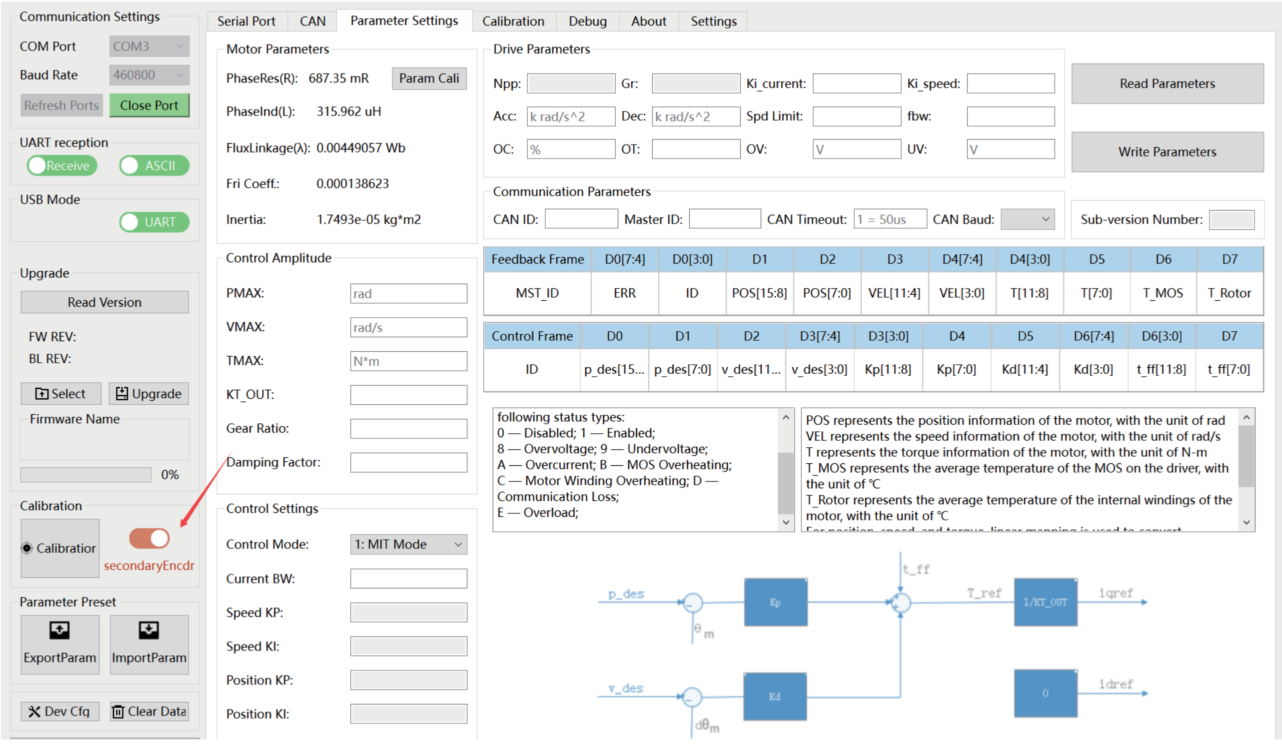
Output shaft encoder calibration should be performed if:

- The motor's driver board has been replaced.
- The output position has changed.
- Other abnormal conditions occur.

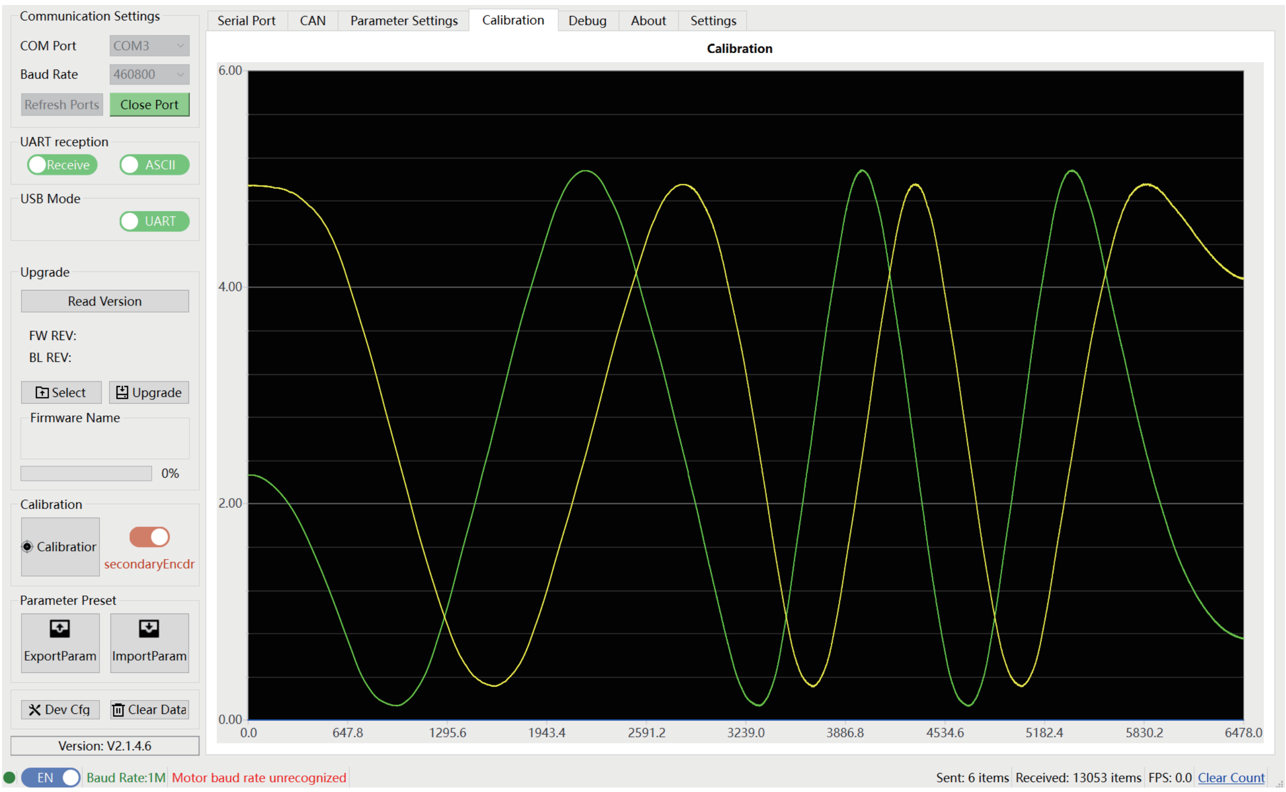
Performing calibration in these cases will ensure accurate motor operation. The following outlines the output shaft encoder calibration procedure.

Step 1: Output Shaft Encoder Calibration.

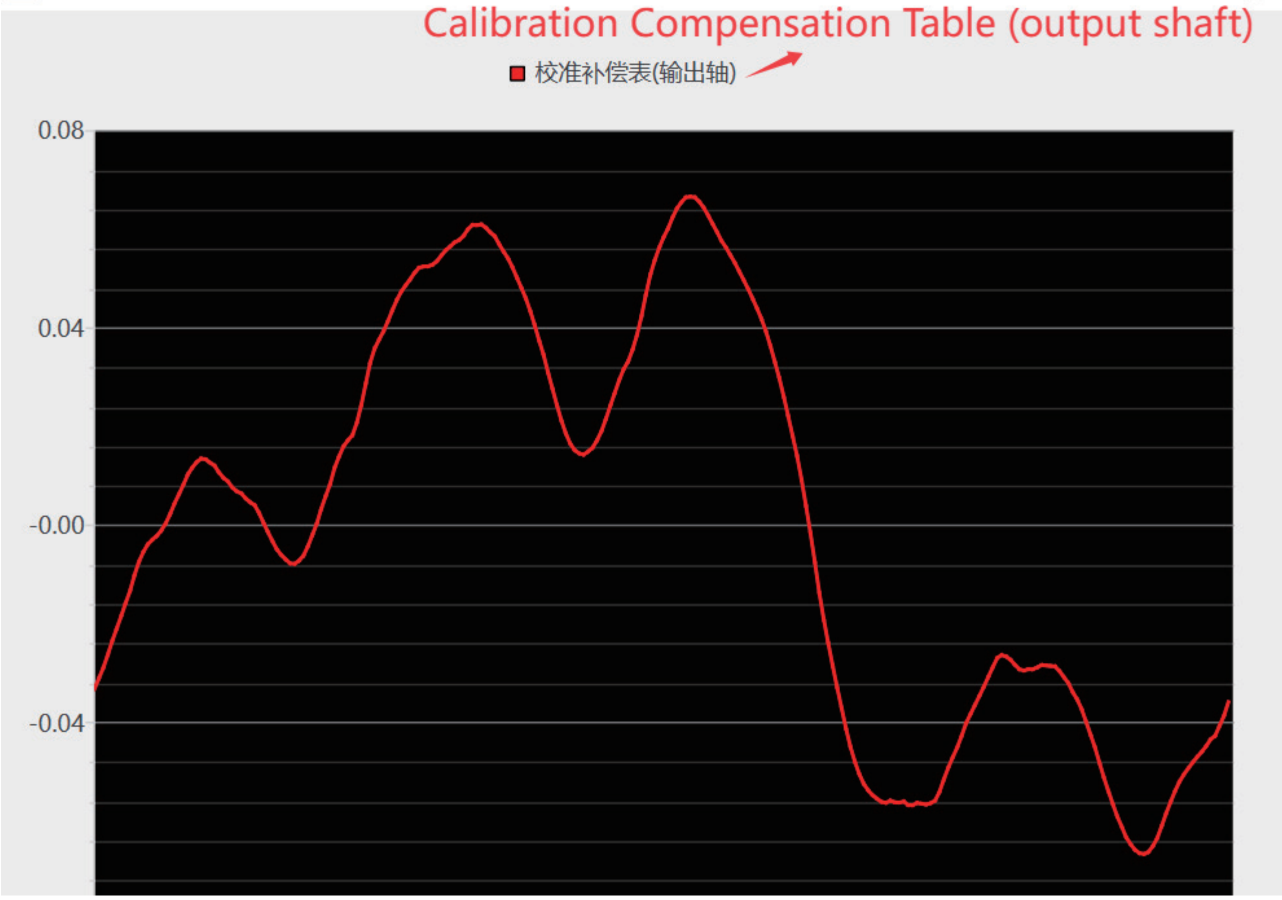
Click the slider next to the Calibration button until "Output Shaft Encoder" status is displayed, then click "Calibration".



The motor begins rotating one full revolution and uploads the raw encoder data waveform, as shown below:



Step 2: Calibration results are uploaded automatically:



Step 3: Calibration Data Verification.

The driver performs internal validation:

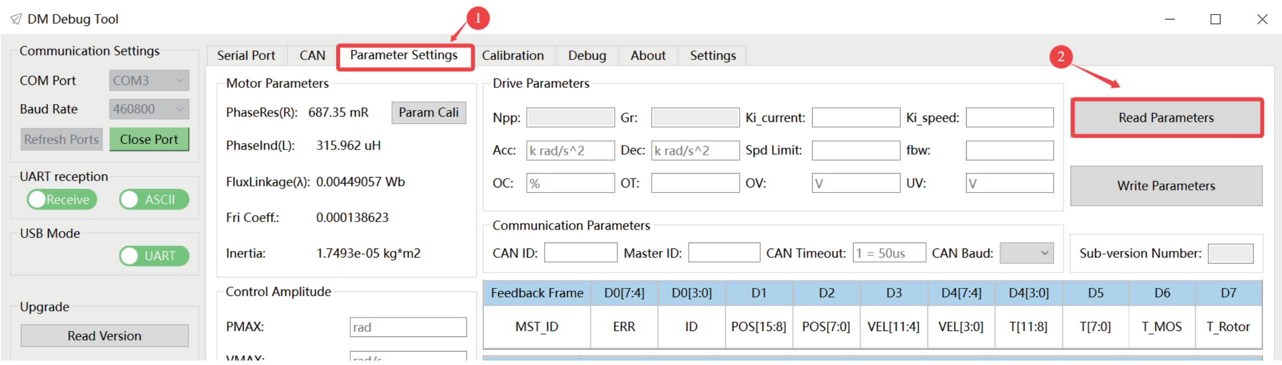
- If deviation is excessive, please see Error Code 3.
- Red LED will flash.

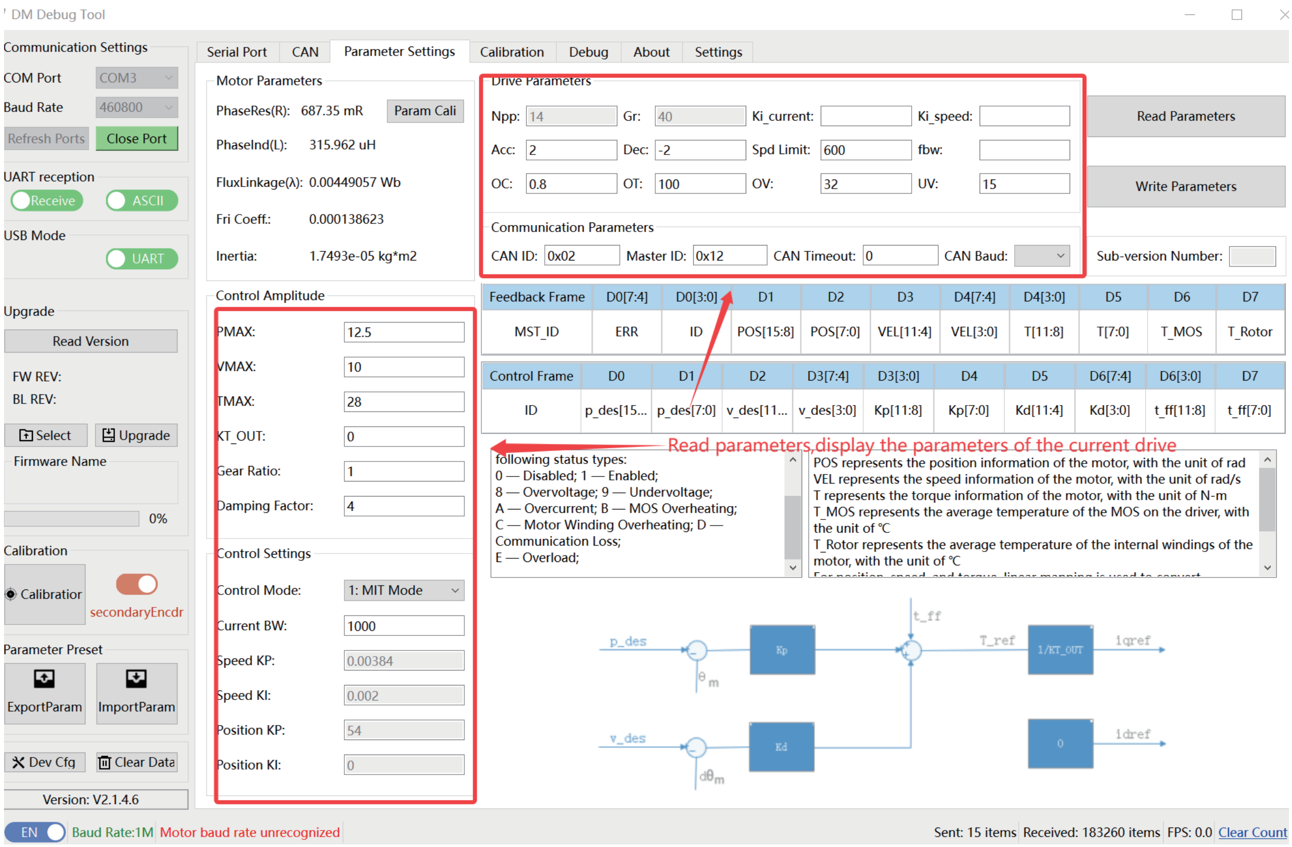
This typically indicates an encoder issue. Contact after-sales support for resolution.

◈ Parameter Management

1. Read parameters

Go to "Parameter Settings" tab, click "Read Parameters". The drive will upload all stored parameters. Please carefully check the parameters.





Parameter Categories:

(1) Drive Parameters: Settings for the driver

- **Pole Pairs**

Auto-detected. Do not modify.

- **Undervoltage Threshold**

Default: 20 V

If the supply voltage falls below this set value, the driver will disable motor control to prevent unstable operation.

- **Overvoltage Threshold**

Defines the upper limit of the supply voltage.

If exceeded, the driver will report a fault and exit the enabled state.

If overvoltage is detected at power-up, the fault will persist.

- **Acceleration/Deceleration**

Limits the rate of change of motor velocity in non-MIT modes.

Unit: Krad/s^2.

Deceleration is represented as a negative value.

- **Reduction Ratio**

Defines the mechanical transmission ratio.

Affects output velocity, position scaling, and torque feedback.

This parameter is preconfigured. Do not modify.

- **Overtemperature Threshold**

Temperature protection threshold for motor windings.

Recommended ⩽ 100° C.

When exceeded, the driver will disable output and report a fault.

- **CAN_ID:**

Identifier used for command frames (hexadecimal format).

Must be unique on the CAN bus.

Recommended value: < 16 to avoid conflict with system-reserved IDs.

- **Master ID**

Feedback CAN ID used for feedback frames transmitted by the driver, hexadecimal;

- **CAN Timeout:**

Defines the communication timeout period.

If no valid CAN command is received within the specified time, the driver will trigger motor protection.

Time base: 50 µs per count.

Only effective when the motor is enabled.

- **Velocity Limit:**

Used only in velocity mode to prevent overspeed of the motor rotor (before deceleration). Unit: rad/s.

- **Current Limit**

Limits the maximum phase current as a percentage of rated current. Used for torque protection and safe operation.

- **CAN Baud Rate**

Configures the communication data rate (bps) of the CAN bus, supporting 125Kbps-5Mbps.

- **Ki_current (Current Loop Gain)**

Auxiliary parameter for current loop control.

Typically pre-tuned and not recommended for manual adjustment.

- **fbw (Velocity Loop Filter Bandwidth)**

Defines the bandwidth of the velocity signal filter.

Unit: Hz.

- **Minor Version**

Firmware minor version number.

- **Ki_speed (Velocity Loop Gain)**

Auxiliary gain for velocity loop control. Recommended adjustable range: 200-800.

Note: After a successful parameter read, the values in the debugging interface will be updated automatically(e.g., PMAX, ID).

(2) Motor Parameters

Motor parameters are automatically identified during calibration and stored in the driver(Recalibration is required when replacing the driver board).

(3) Control Limits: These parameters define the valid range for command input and feedback scaling.

· **PMAX / VMAX / TMAX**

Define the mapping range for position, velocity, and torque.

In MIT mode:

Used to scale incoming command values.

In other modes:

Used to scale feedback data.

Refer to the "CAN Communication" section for mapping rules.

· **KT_OUT**

Motor torque constant. Set to 0 when motor parameter identification is accurate.

· **Torque Ratio**

Defines the torque transmission efficiency of the gearbox.

Value range: (0, 1].

· **Damping factor**

Ratio of current loop bandwidth to velocity loop bandwidth ratio, Currently not used.

(4) Control settings

· **Control Mode**

The driver supports the following modes:

MIT Mode, Position-Velocity Mode, Velocity Mode, Force-Position Hybrid Mode.

· **Current Bandwidth**

Defines the response speed of the current control loop, default 1000.

· **Velocity Loop Gains (KP / KI)**

Control parameters for velocity regulation.

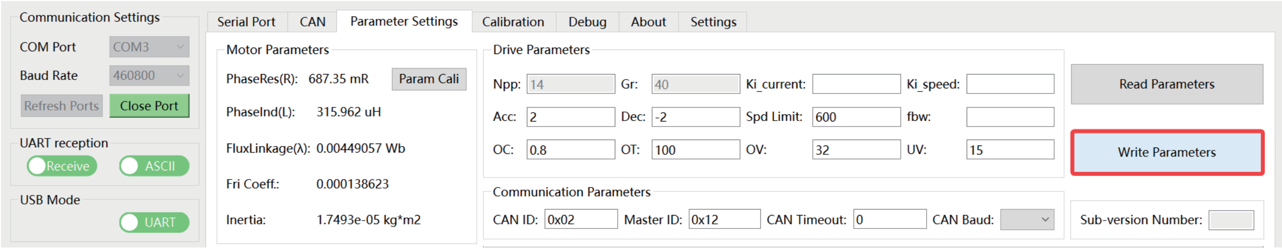
· **Position Loop Gains (KP / KI)**

Control parameters for position tracking.

2. Write parameters

Verify parameters such as drive parameters, control amplitude, and control settings. Modify parameters as required, then click "Write Parameters" to save them to the driver.

After writing: the driver will automatically reboot, updated parameters take effect immediately.



[Notes]:

①The motor must be in disabled state before writing parameters.

②No manual power cycle is required.

③Writing parameters during operation may cause unexpected behavior.

◈ Debugging via CAN

Debugging is available only when the CAN interface is connected.

- Only one motor can be debugged at a time.
- Ensure correct CAN wiring before operation.

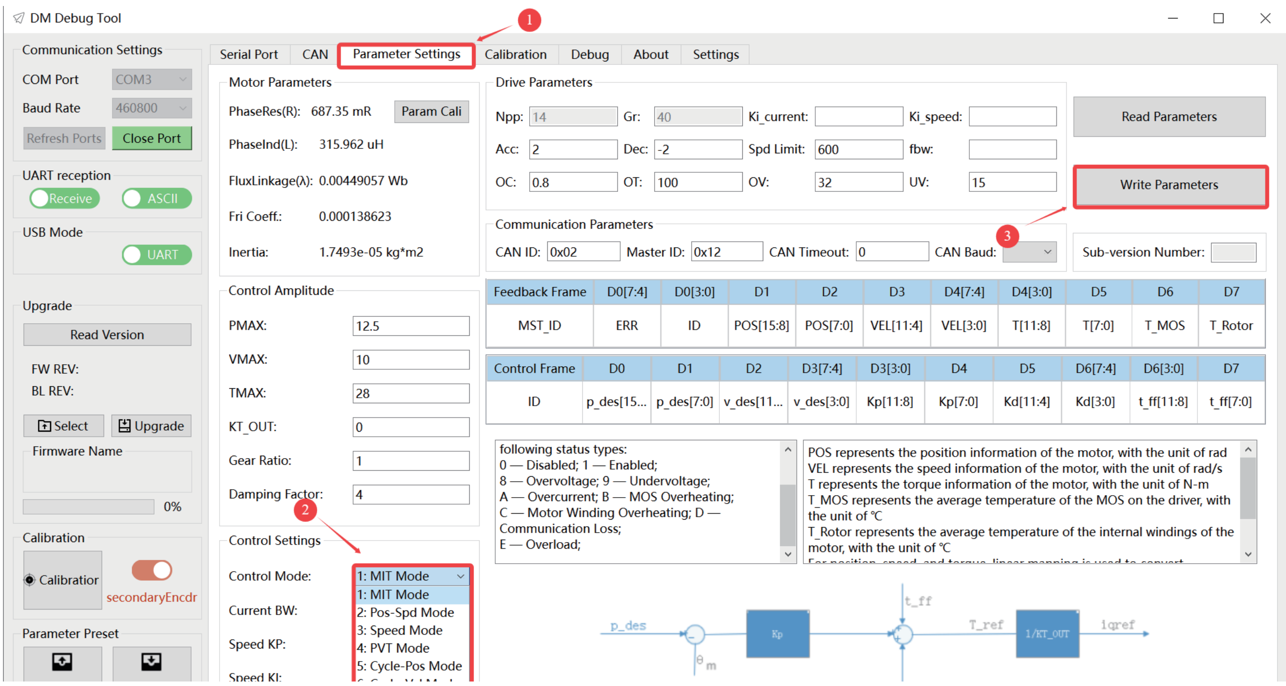
Before Starting:

- Verify wiring connections.
- Confirm the active control mode.
- Ensure CAN IDs are correctly configured.

1. Control Mode Selection and Verification

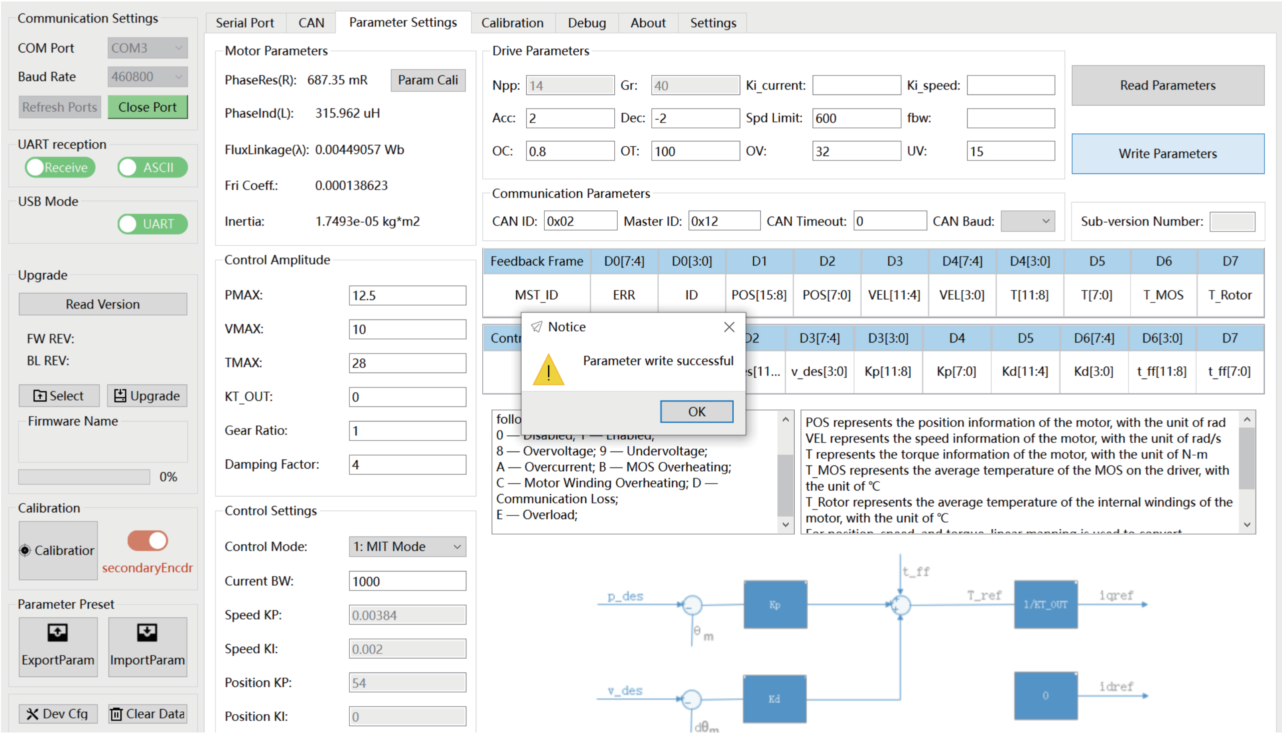
Control Mode Selection:

Go to "Parameter Settings" , click "Control Mode" and select one of the following: MIT Mode, Position-velocity Mode, velocity Mode, or Force-Position Hybrid Mode.



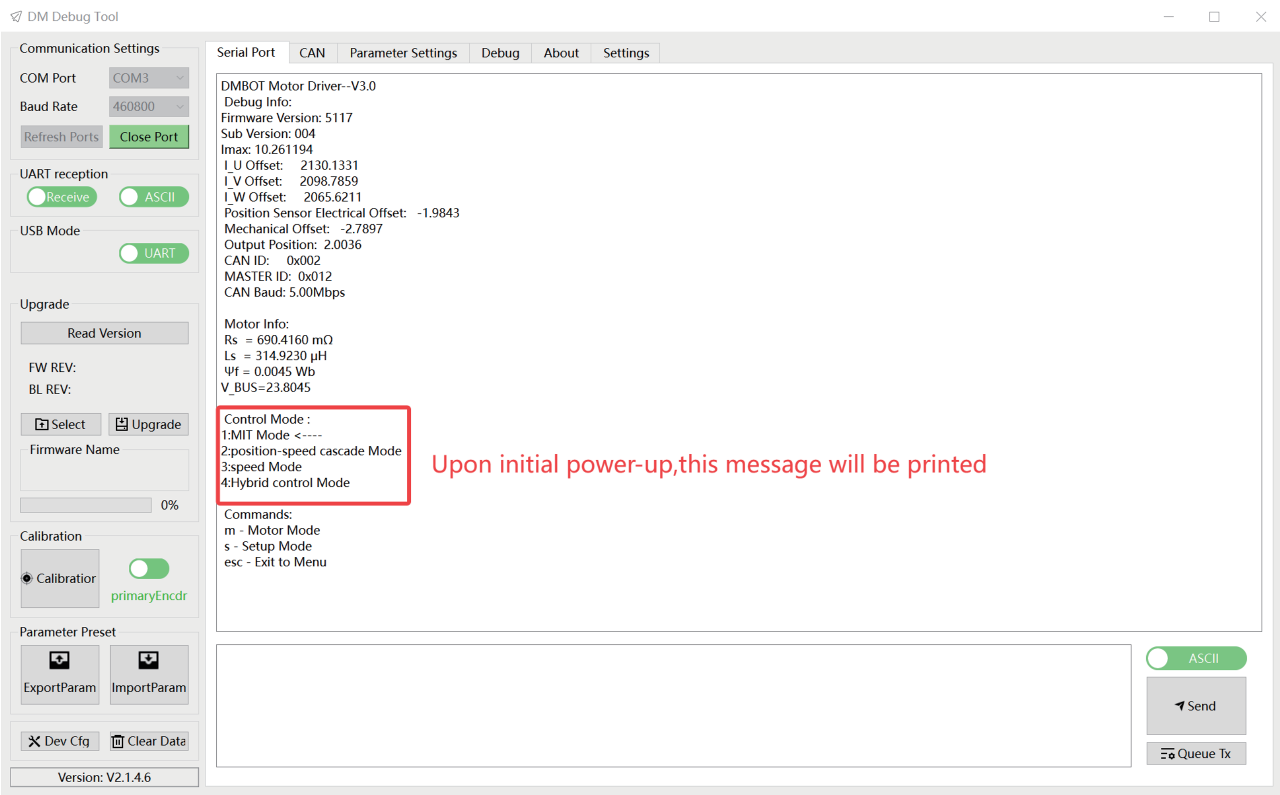
Click "Write Parameters" to apply the selected control mode. A confirmation message "Parameter write successful!" will appear.

Note: After writing, the driver will reboot automatically, and the selected mode becomes active.

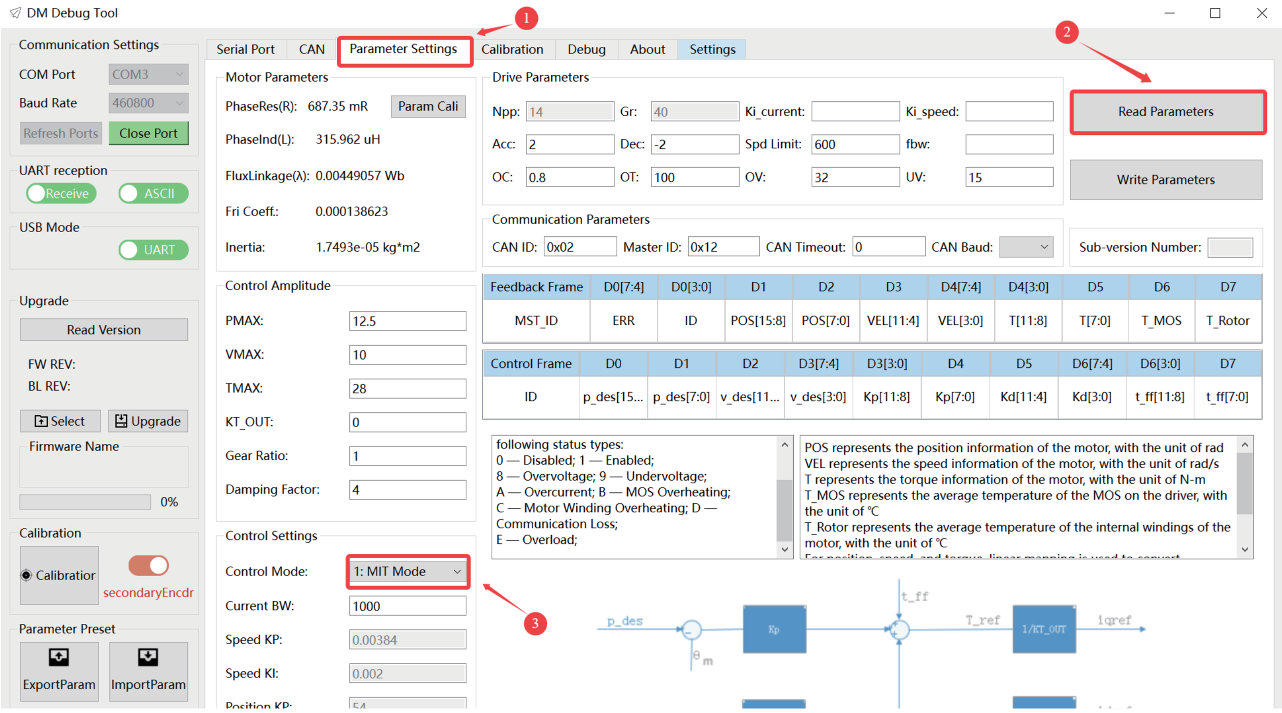


Control Mode Verification:

Option 1: Check the serial output at power-on. The mode indicated by the arrow is the currently active control mode.

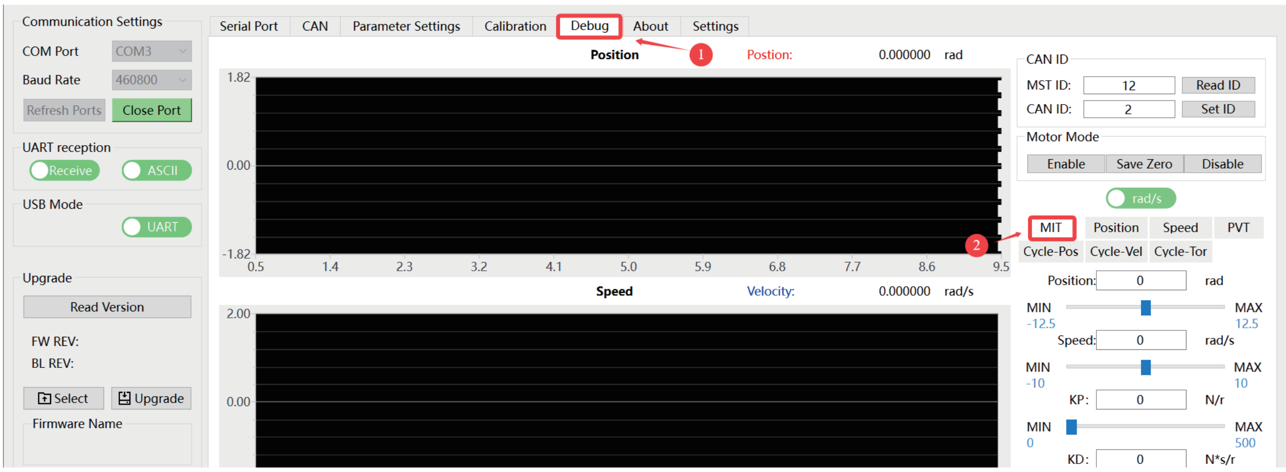


Option 2: Refresh the parameter page and read the displayed information to verify the control mode.

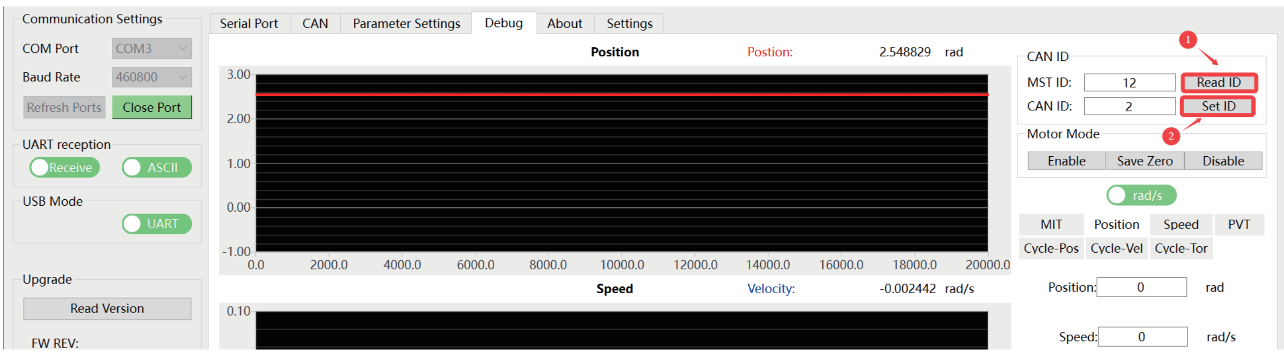


2. MIT Mode

(1) Mode Selection:In the debugging page, select MIT mode as described in Control Mode Selection & Verification. Confirm the current control mode and open the corresponding MIT tab.



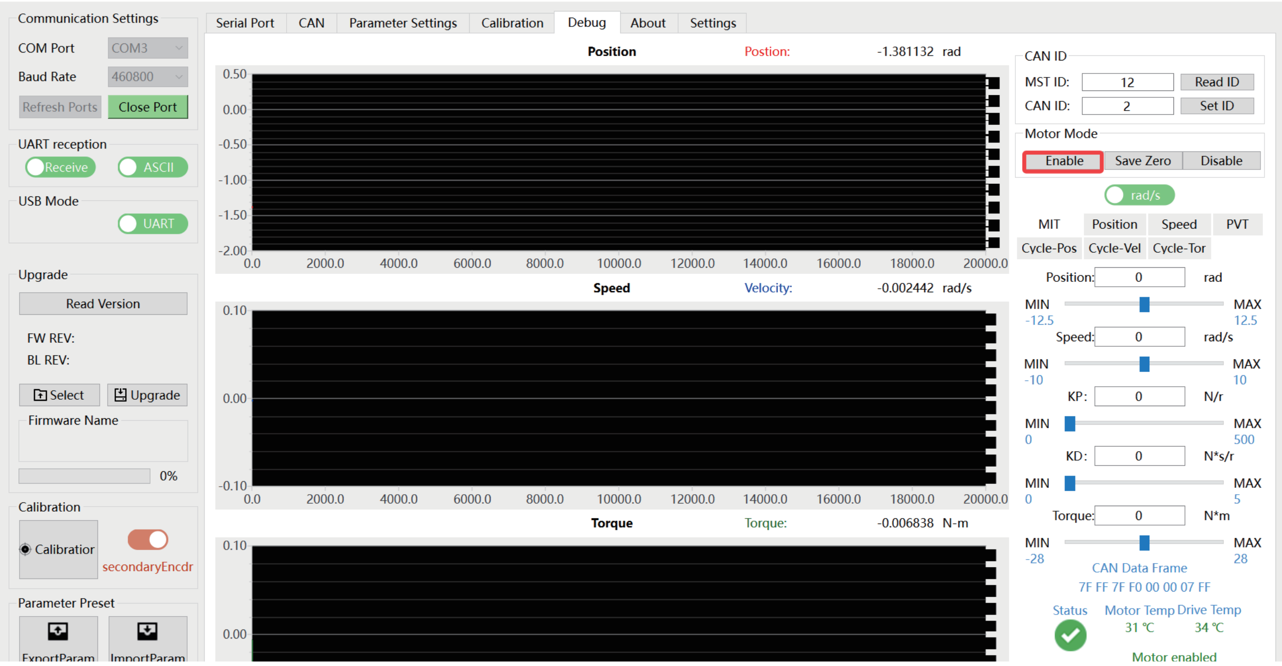
(2) CAN ID: Ensure the CAN ID is correct (obtainable via serial port printouts, parameter settings page, or read/set buttons in the debugging interface).



(3) Control Options: The MIT model supports three control methods: velocity, position, and torque.

① Velocity Control

Step 1: Click "Enable" in the Motor Mode section. The driver's green LED will light (motor enabled).

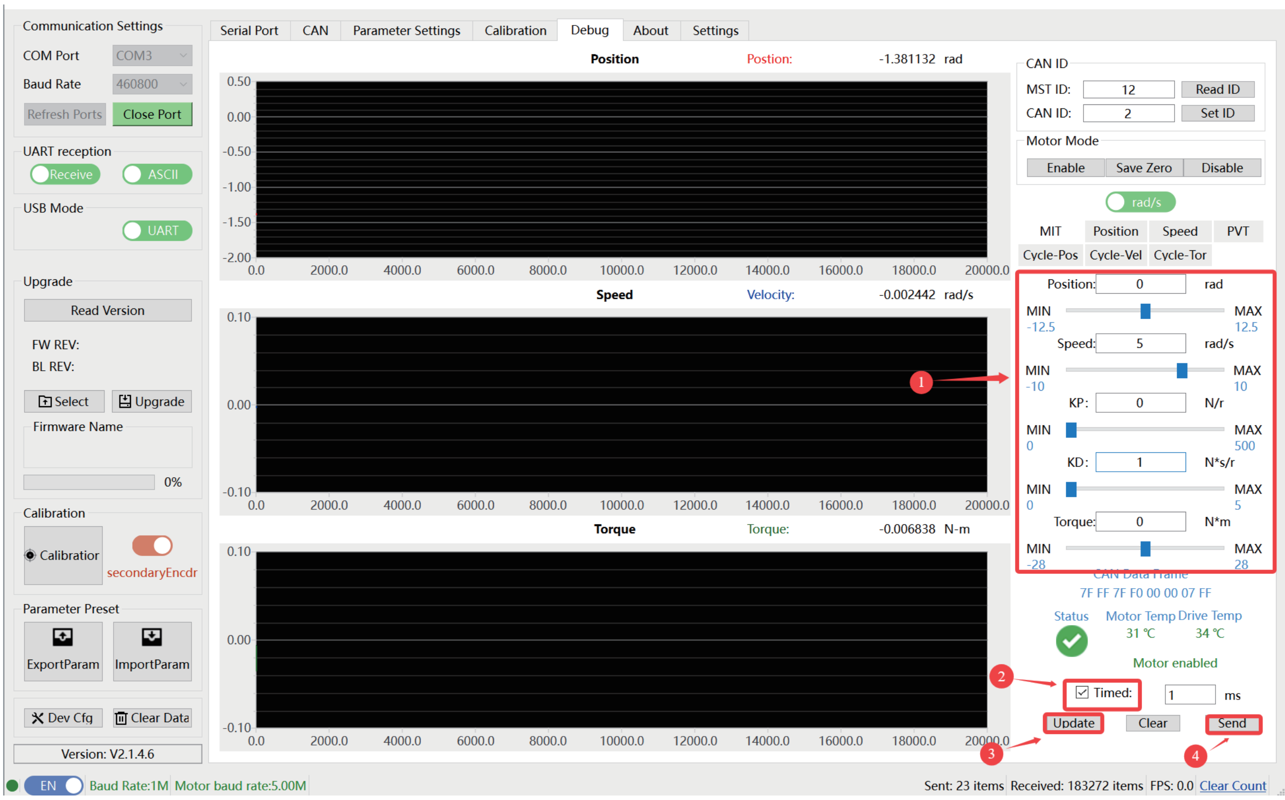


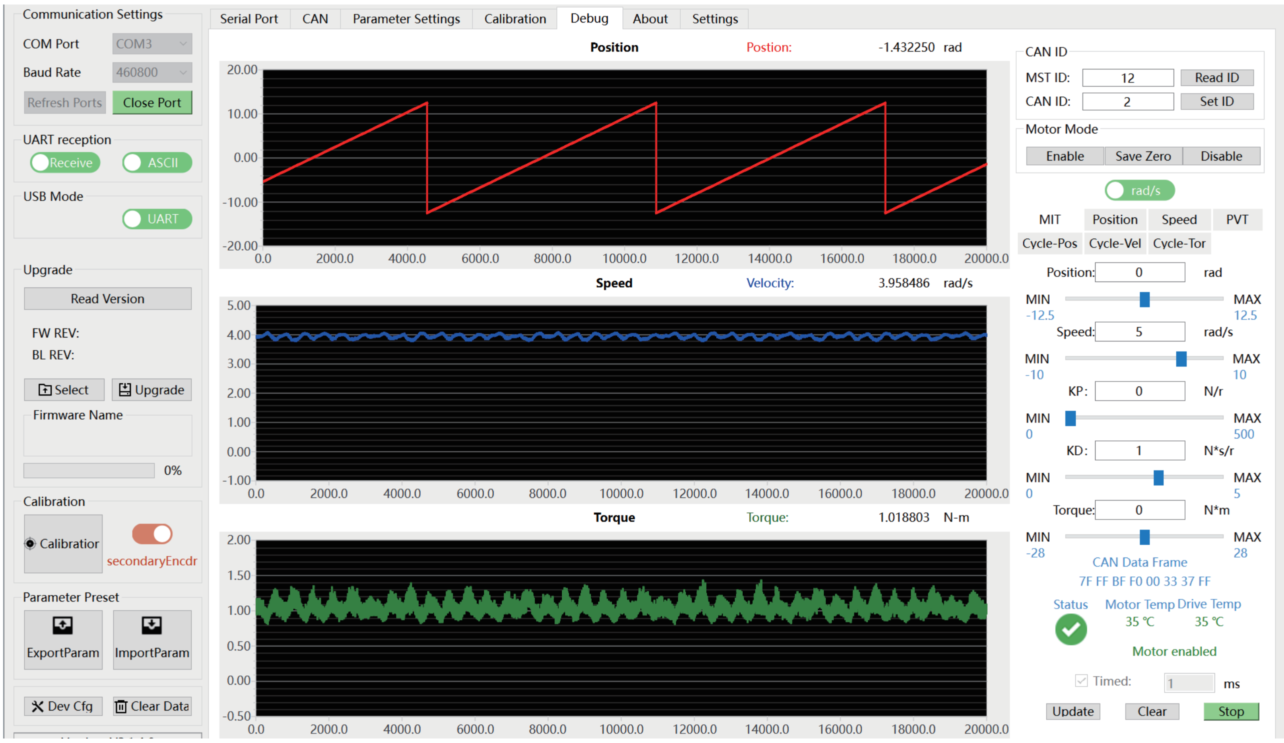
Step 2: Set the target velocity.

Example: Velocity = 5 rad/s, KD = 1 N*s/r, other gains = 0.

Enable "Timed" for periodic send, then click "Update" and "Send".

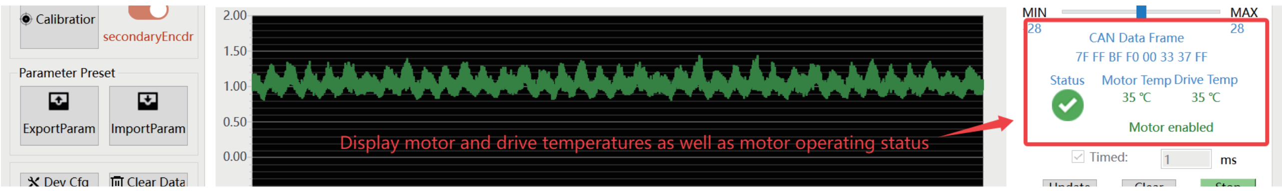
Monitor parameter curves in the debugging interface.



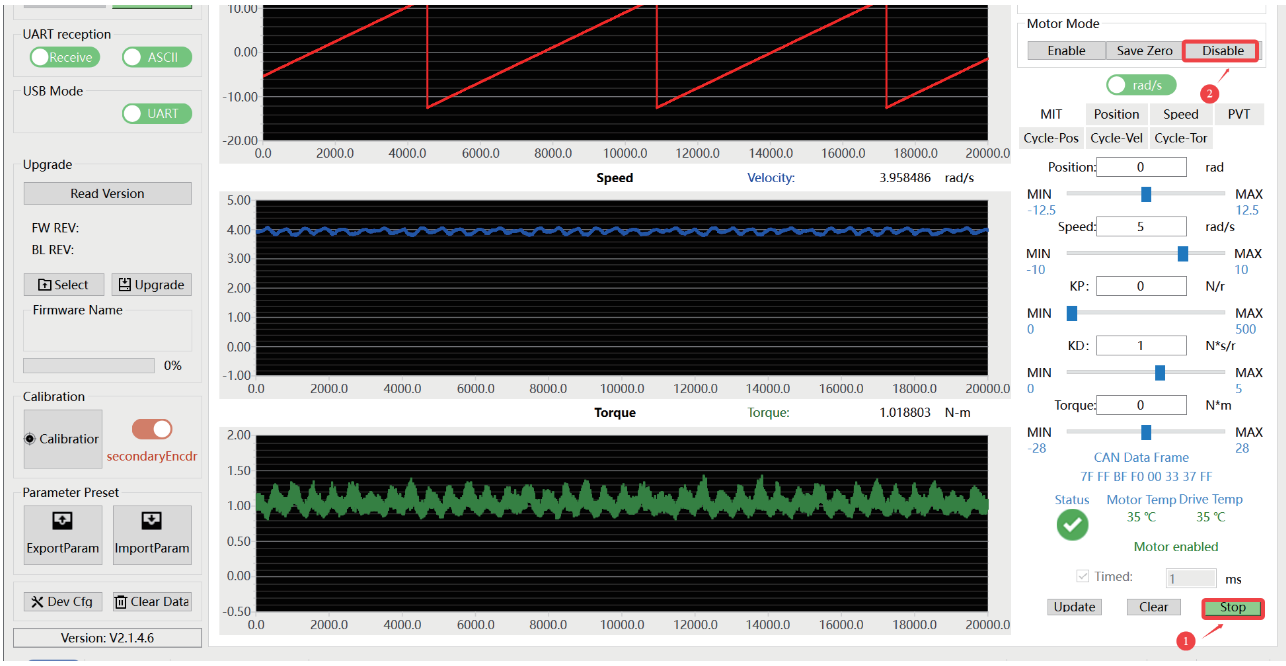


Adjust control parameters as needed while testing. Keep "Timed" for periodic send enabled and click "Update" to apply changes.

Monitor real-time motor and driver temperature, status, and feedback frames. For frame format and status types,refer to the "Feedvack Frames" section for details.

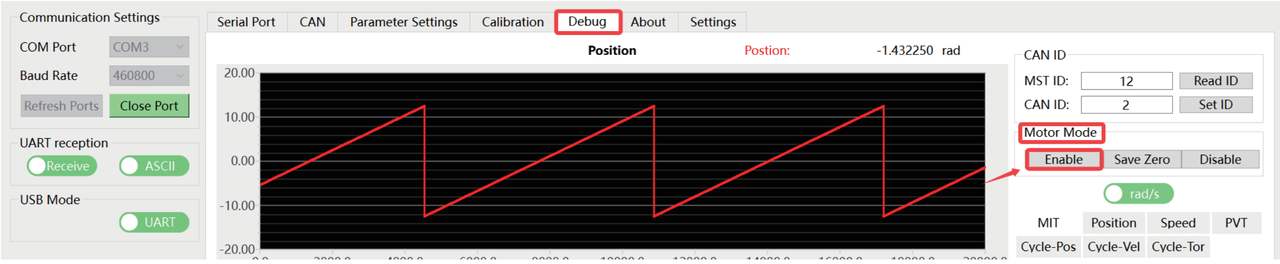


Step 3: Exit procedure: Click "Stop", then "Disable", the Red LED ON (motor disabled).



② Position Control

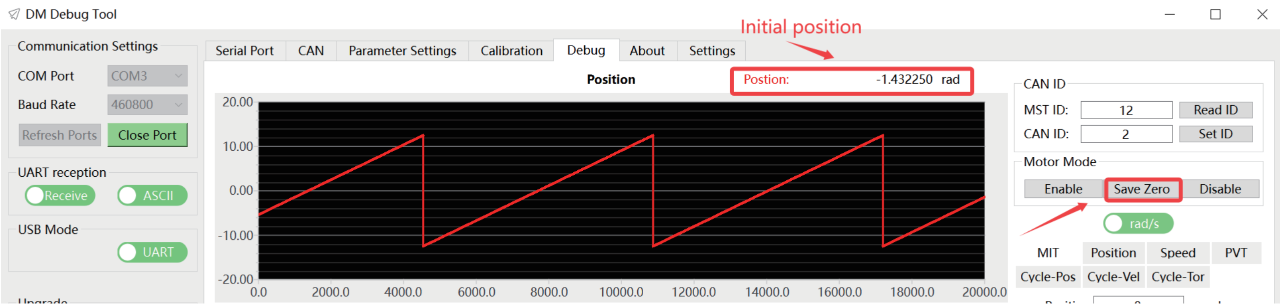
Step 1: Click "Enable" in the Motor Mode section. The driver’s green LED will light (motor enabled).



Step 2: Set the target position.

Consider the motor’s initial position; avoid large deviations to prevent impact.

Use "Save Zero" in the command section to set the current position as the zero reference.

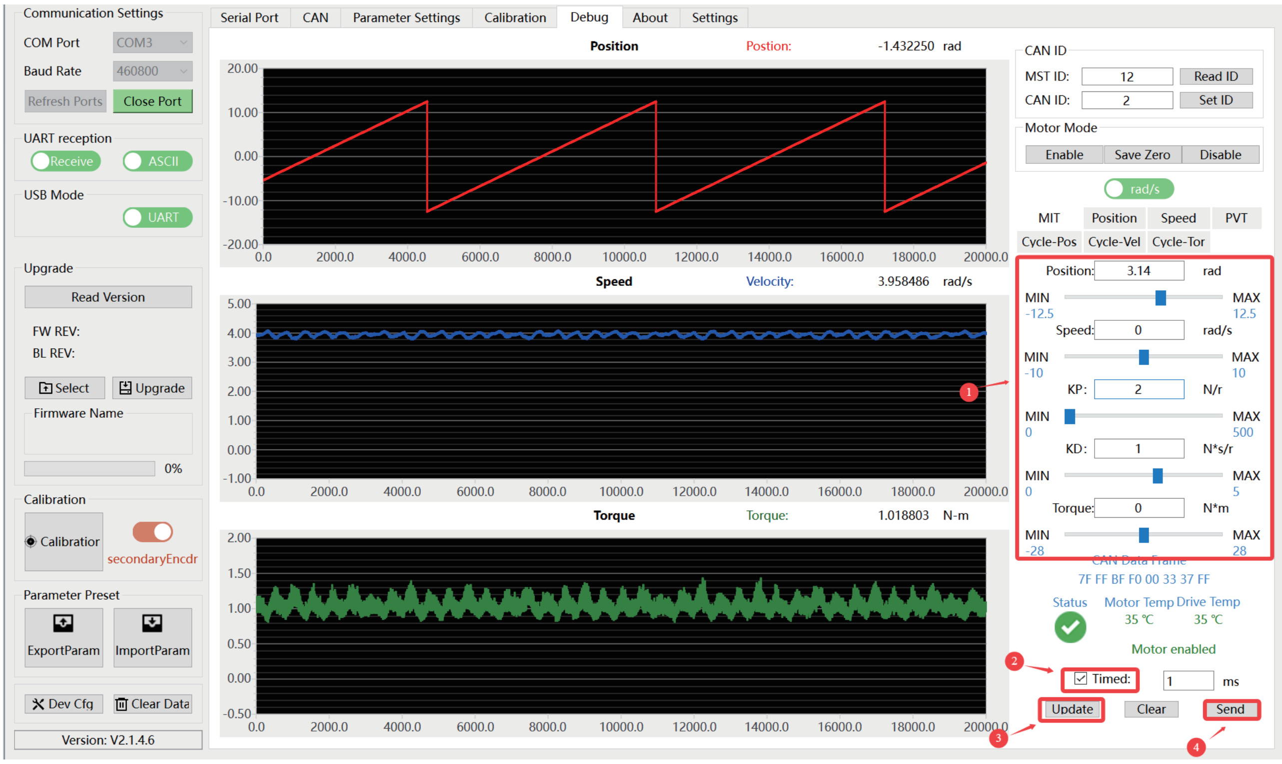


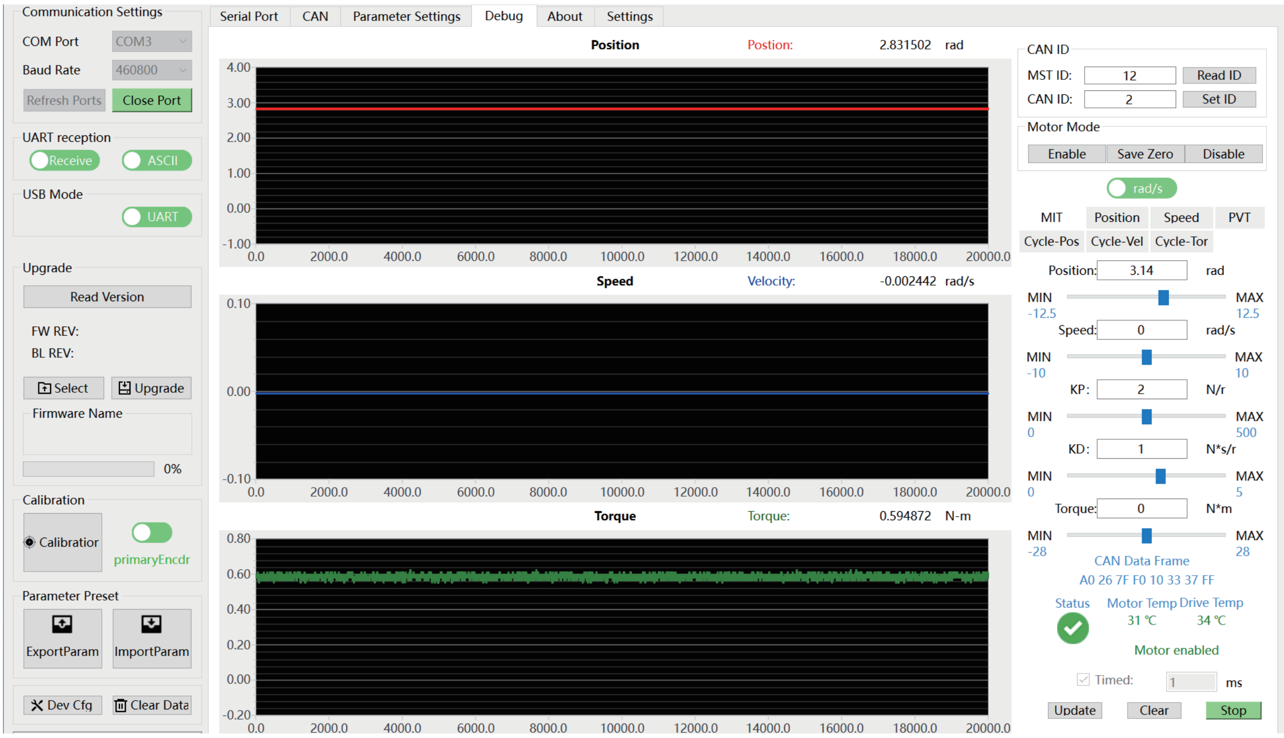
Example: Position = 3.14 rad, KP = 2 N/r, KD = 1 N*s/r, others = 0.

Enable "Timed" for periodic send, then click "Update" and "Send".

Monitor parameter curves in the debugging interface.

Ensure the motor is physically fixed.





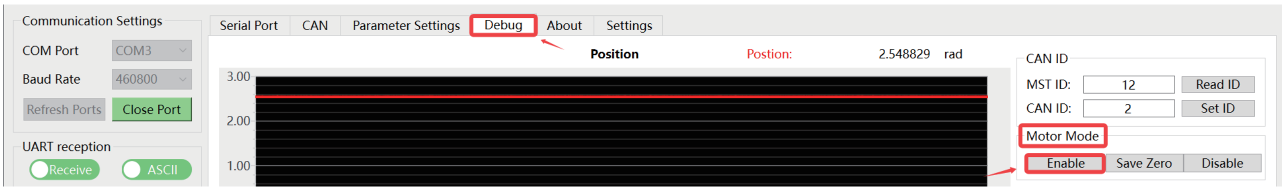
Adjust control parameters as needed while testing. Keep "Timed" for periodic send enabled and click "Update" to apply changes.

Monitor real-time motor and driver temperature, status, and feedback frames. For frame format and status types,see "Feedback Frames" for details.

Step 3: Exit procedure: Click "Stop", then "Disable", the Red LED ON (motor disabled).

③ Torque Control

Step 1: Click "Enable" in the Motor Mode section. The driver’s green LED will light (motor enabled).



Step 2: Set the target torque.

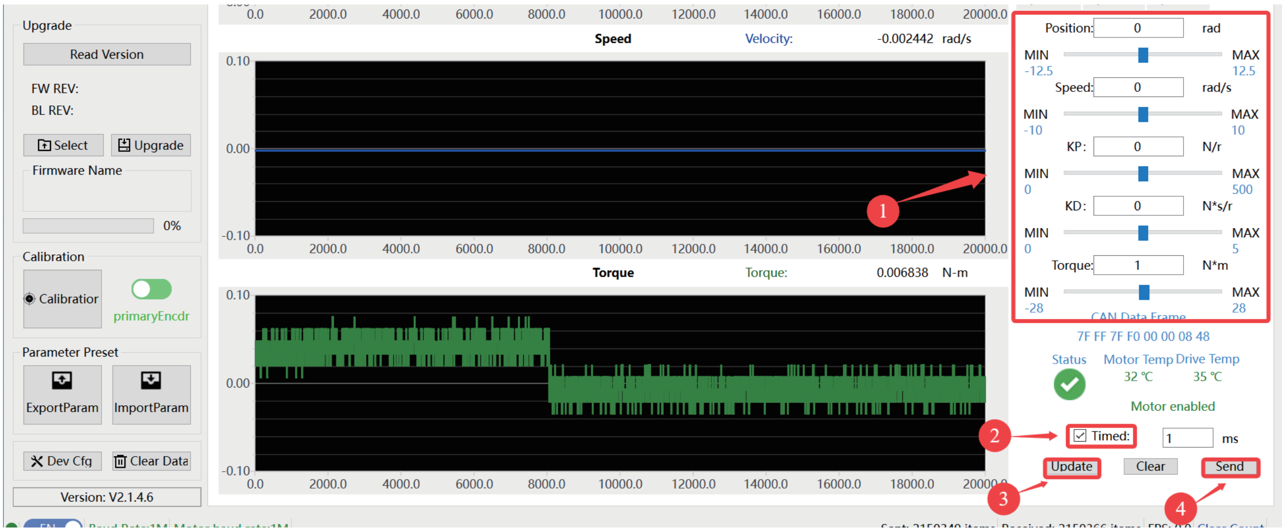
Note: Even small torque commands can accelerate the motor to max speed if unloaded.

Example: Torque = 1 N*m, others = 0.

Enable "Timed" for periodic send, then click "Update" and "Send".

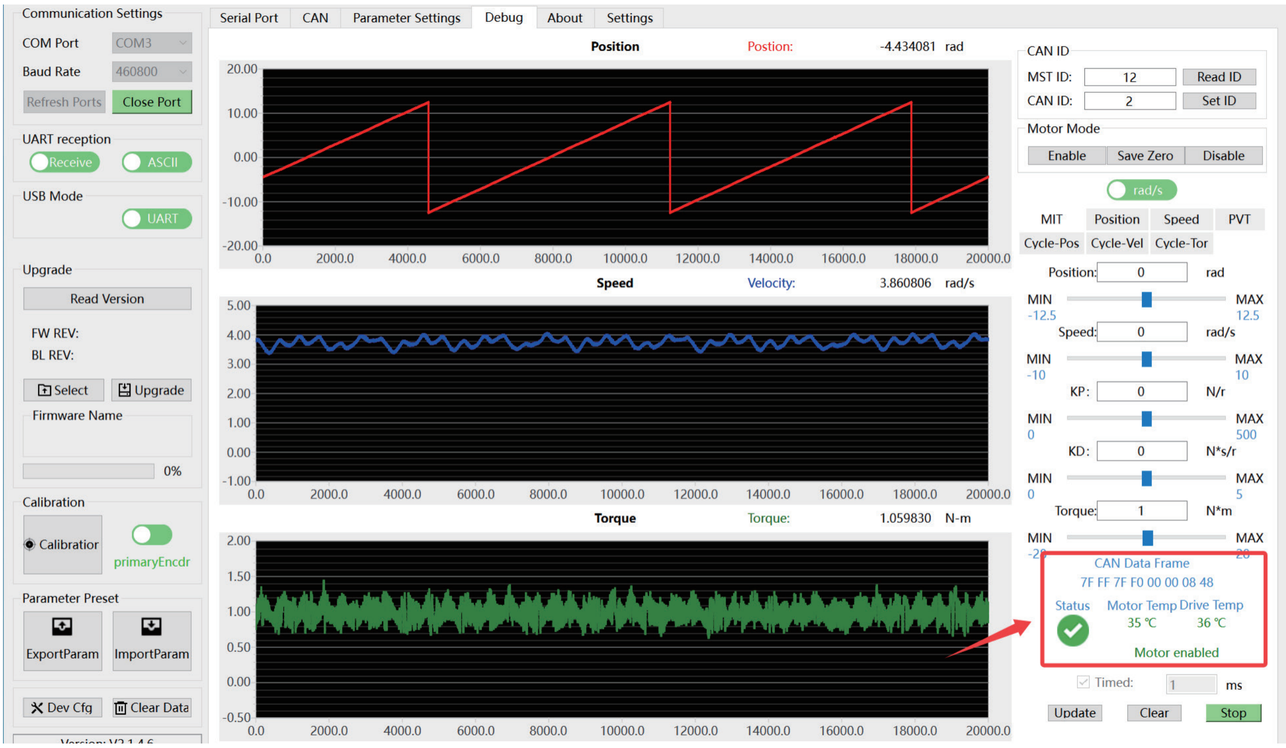
Monitor parameter curves in the debugging interface.

Ensure the motor is physically fixed.

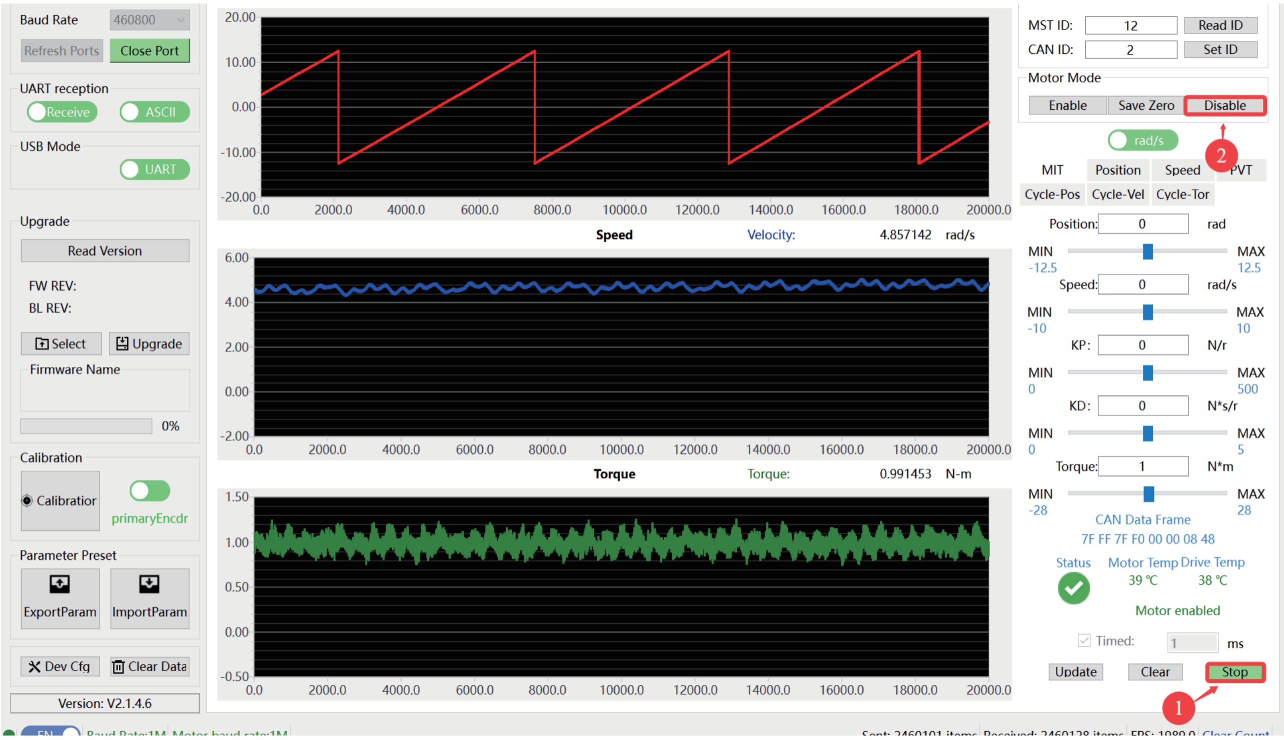


Adjust control parameters as needed while testing. Keep "Timed" for periodic send enabled and click "Update" to apply changes.

Monitor real-time motor and driver temperature, status, and feedback frames. For frame format and status types,see "Feedback Frames" for details.



Step 3: Exit procedure: Click "Stop", then "Disable", the Red LED ON (motor disabled).

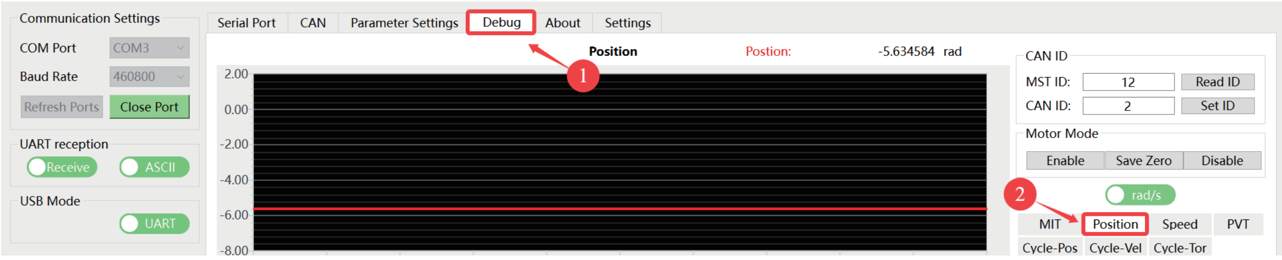


3. Position Velocity Mode

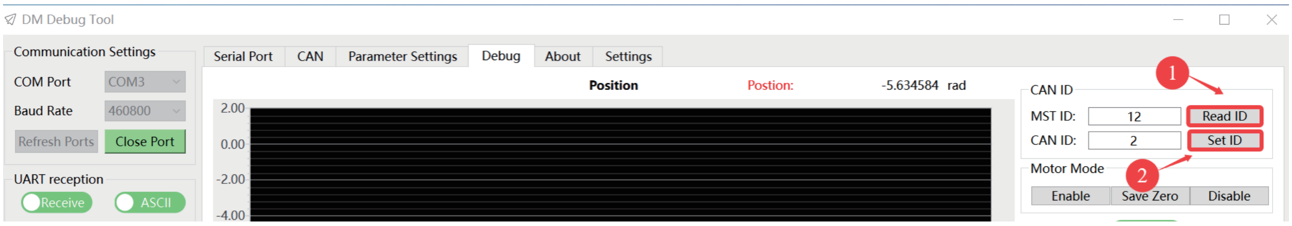
（1）Mode Selection:

In the debugging page, select Position Velocity mode as described in Control Mode.

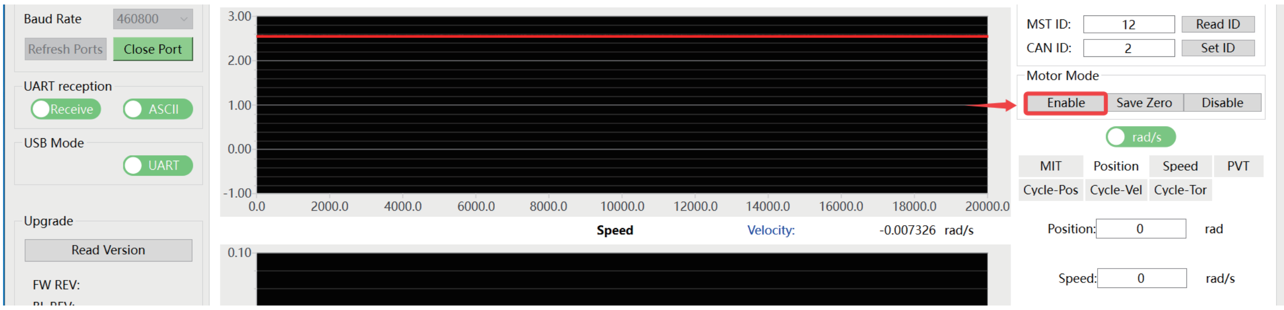
Confirm the current control mode and open the corresponding "Position" tab.



(2) CAN ID: Ensure the CAN ID is correct (obtainable via serial port printouts, parameter settings page, or read/set buttons in the debugging interface).

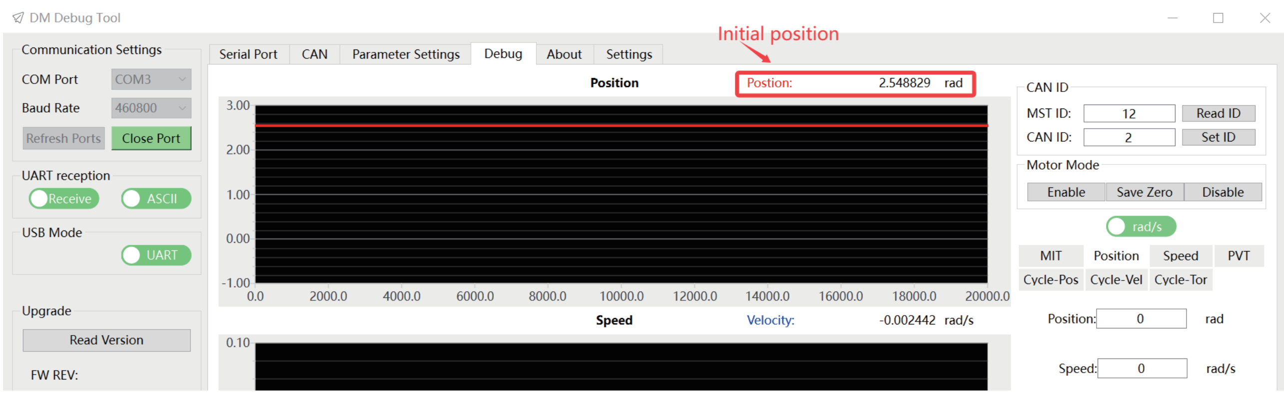


(3) Click "Enable" in the Motor Mode section. The driver's green LED will light (motor enabled).



(4) Set the command parameters so that the motor moves to the target position at the specified velocity.

Before setting the parameters, check the motor's initial position and use it as a reference.

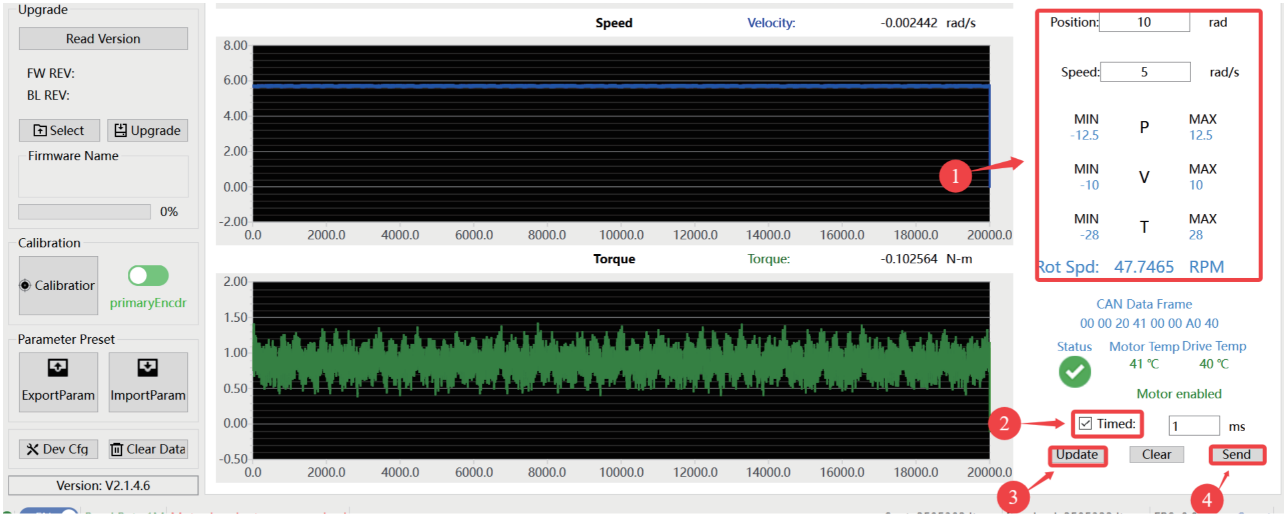


Example: Position = 10 rad, Velocity = 5 rad/s.

Enable "Timed" for periodic send, then click "Update" and "Send".

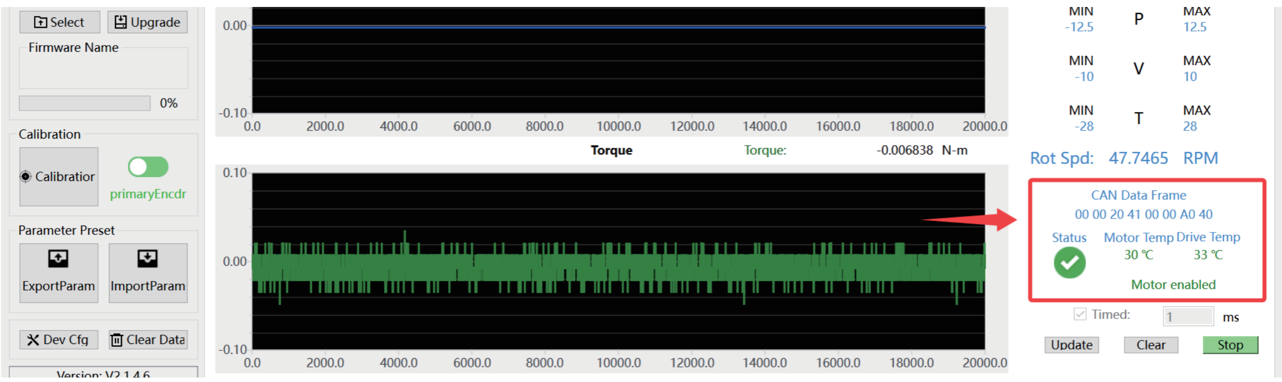
Monitor parameter curves in the debugging interface.

Ensure the motor is physically fixed.

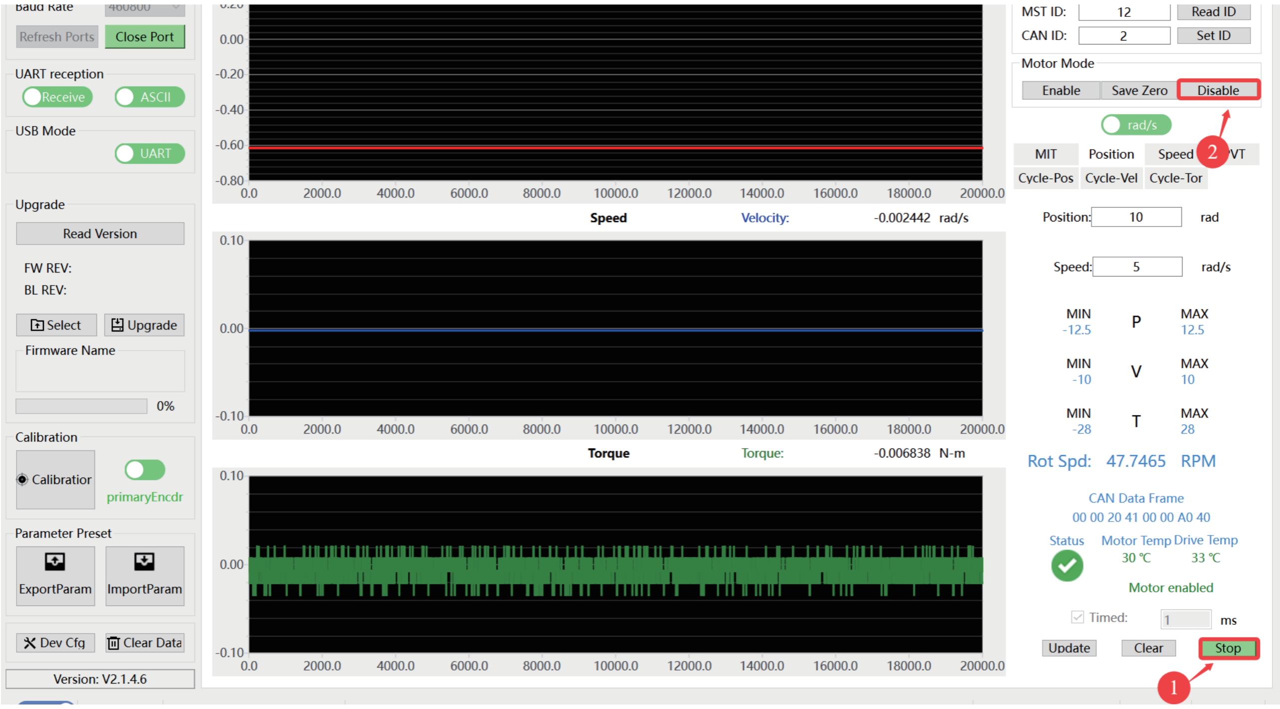


Adjust control parameters as needed while testing. Keep "Timed" enabled and click "Update" to apply changes.

Monitor real-time motor and driver temperature, status, and feedback frames. For frame format and status types,see "Feedback Frames" for details.

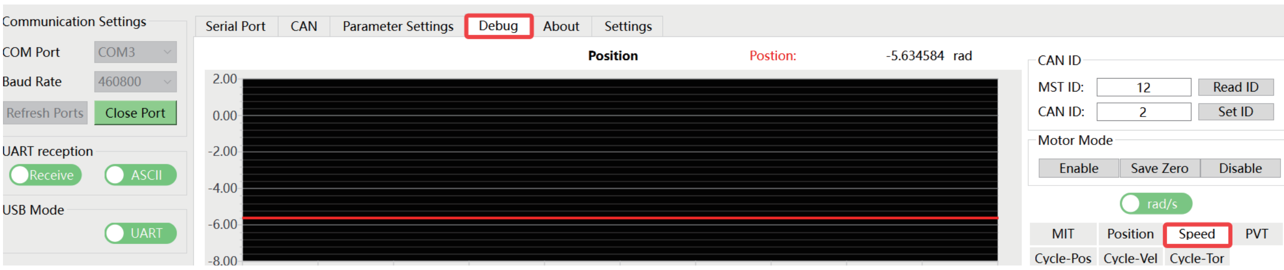


(5) Exit procedure: Click "Stop", then "Disable", the Red LED ON (motor disabled).

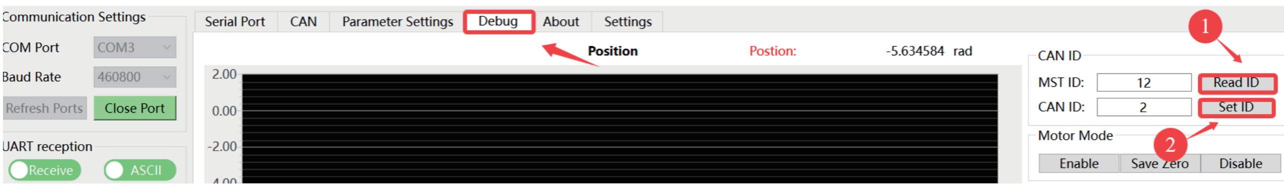


4. Velocity Mode

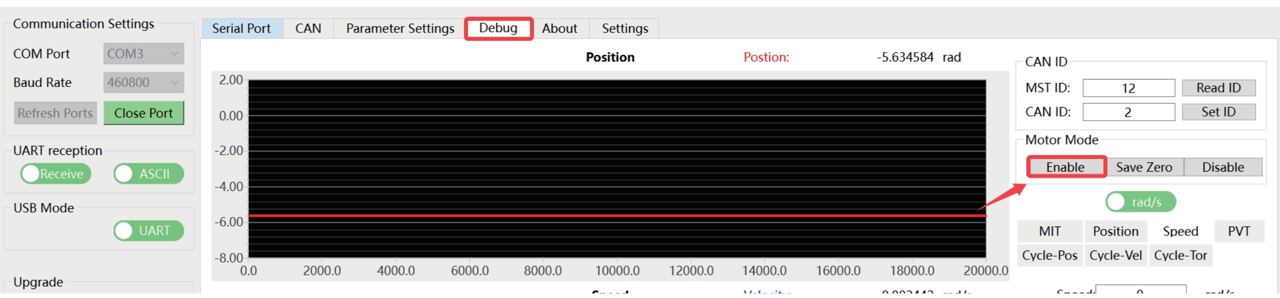
(1) In the debugging page, select Velocity mode as described in Control Mode. Confirm the current control mode and open the corresponding "Speed" tab.



(2) Ensure the CAN ID is correct (obtainable via serial port printouts, parameter settings page, or read/set buttons in the debugging interface).



(3) Click "Enable" in the Motor Mode section. The driver's green LED will light (motor enabled).



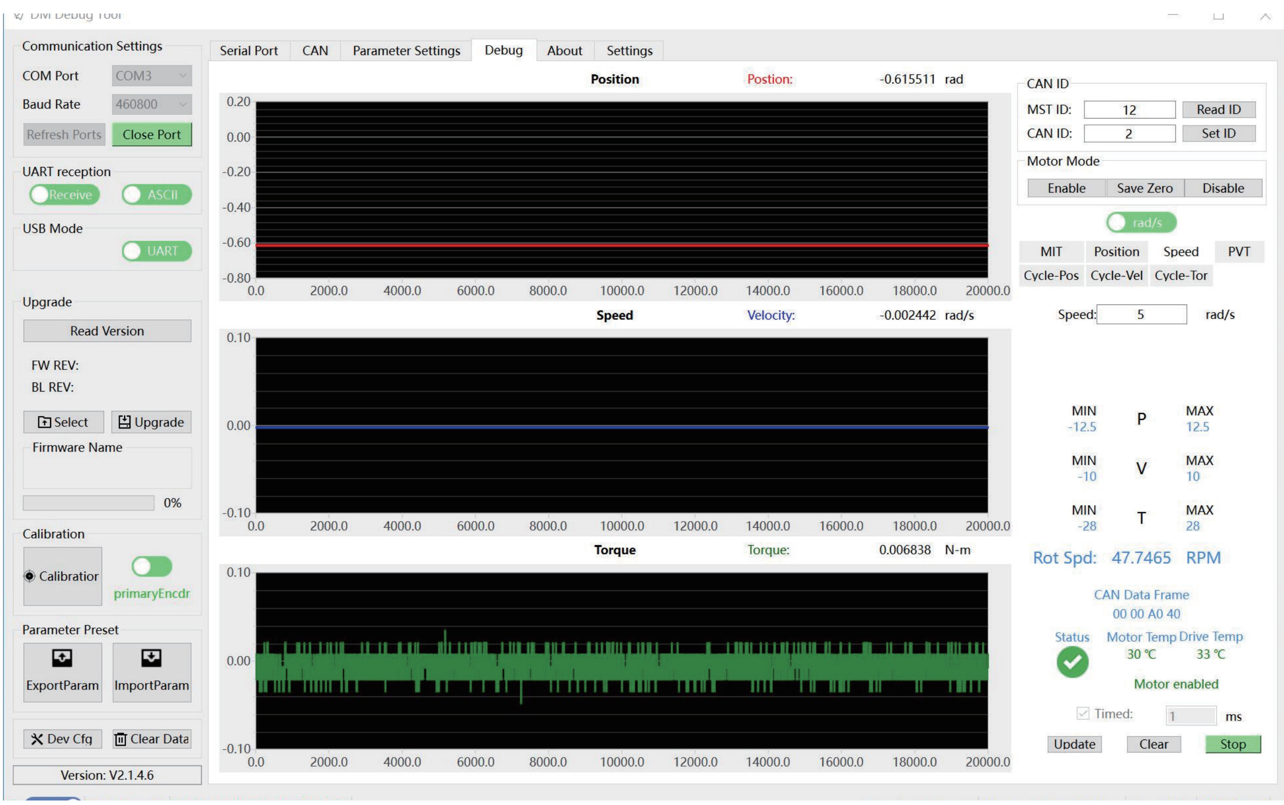
(4) Set the target speed

Example: Speed = 5 rad/s.

Enable "Timed" for periodic send, then click "Update" and "Send".

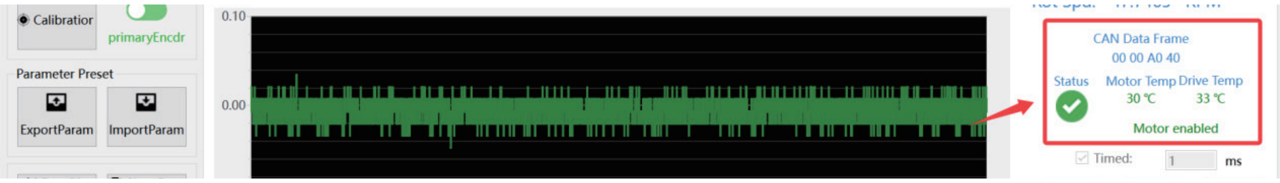
Monitor parameter curves in the debugging interface.

Ensure the motor is physically fixed.



Adjust control parameters as needed while testing. Keep "Timed" for periodic send enabled and click "Update" to apply changes.

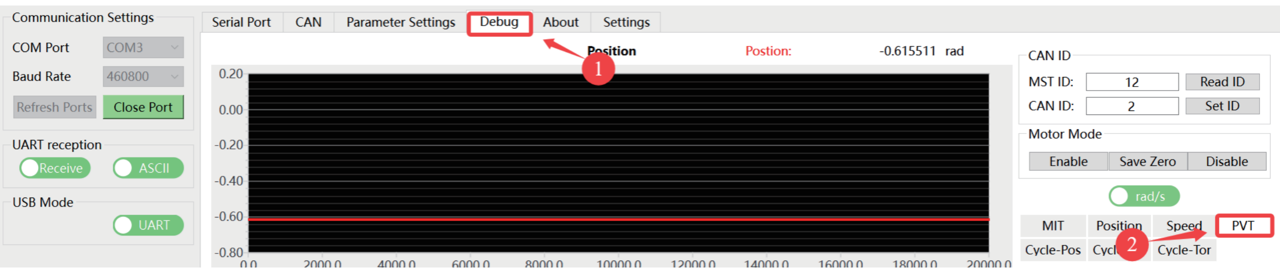
Monitor real-time motor and driver temperature, status, and feedback frames. For frame format and status types,see "Feedback Frames" for details.



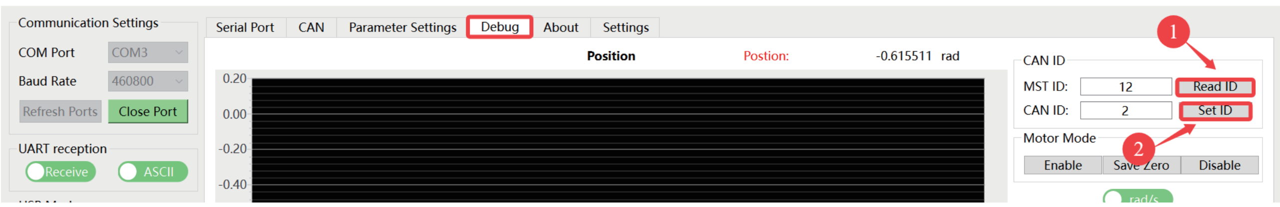
(5) Exit procedure: Click "Stop", then "Disable", the Red LED ON (motor disabled).

5. Force-Position Hybrid Control Mode

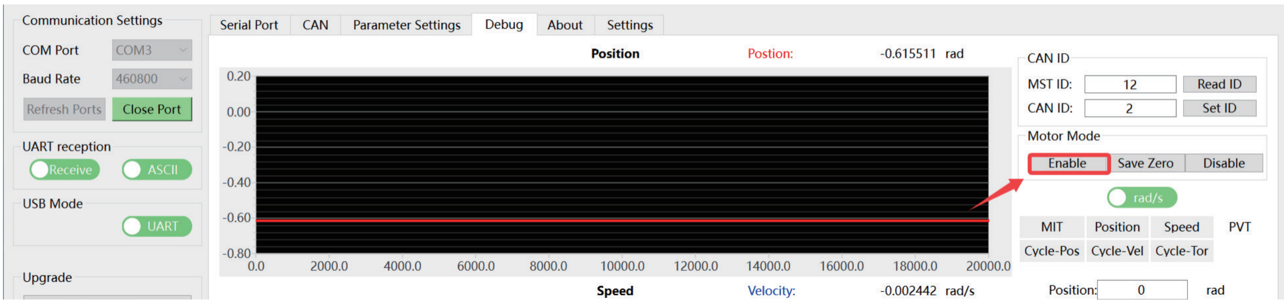
(1) In the debugging page, select Force-Position Hybrid Control Mode as described in Control Mode Confirm the current control mode and open the corresponding "PVT" tab.



(2) Ensure the CAN ID is correct (obtainable via serial port printouts, parameter settings page, or read/set buttons in the debugging interface).

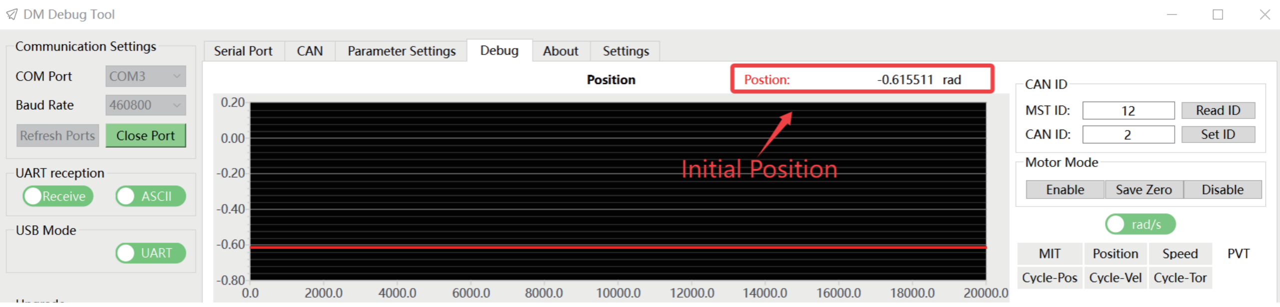


(3) Click "Enable" in the Motor Mode section. The driver's green LED will light (motor enabled).



(4) Set the command parameters so that the motor moves to the target position at the specified velocity.

Before setting the parameters, check the motor's initial position and use it as a reference.

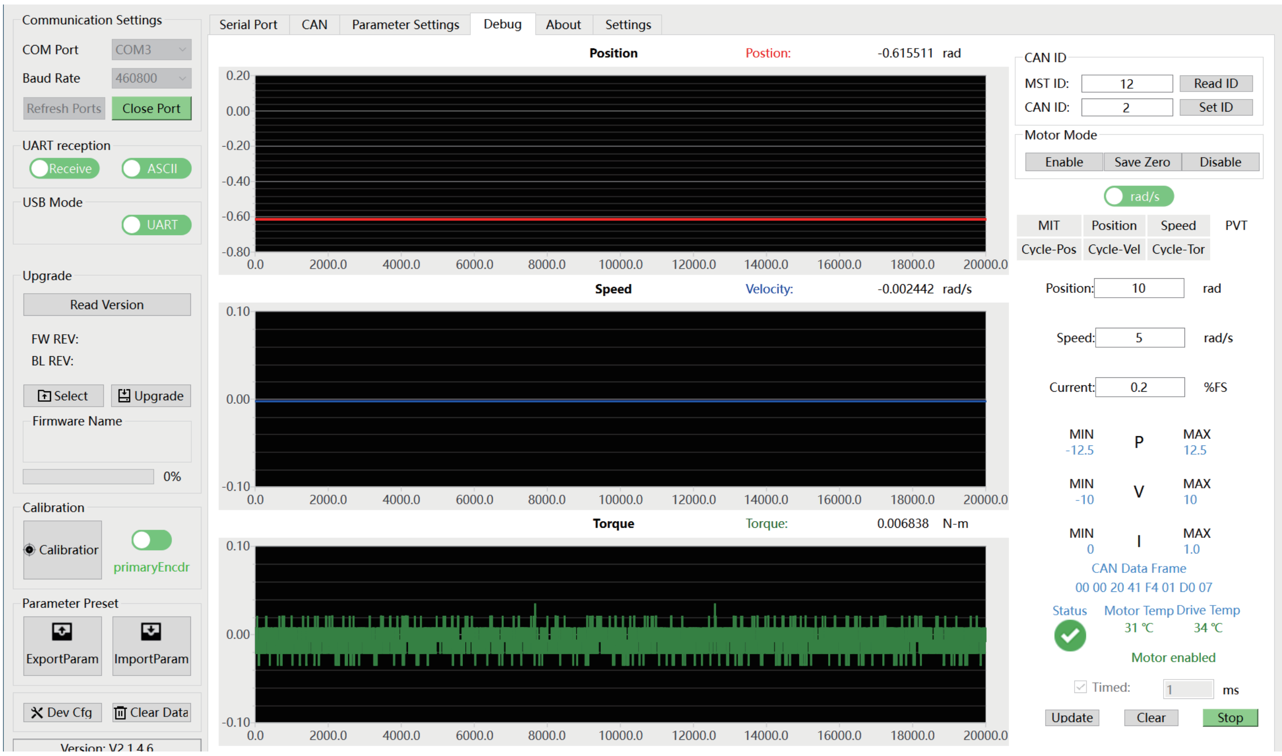


Example: Position = 10 rad, Speed = 5 rad/s, current = 0.2%FS.

Enable "Timed" for periodic send, then click "Update" and "Send".

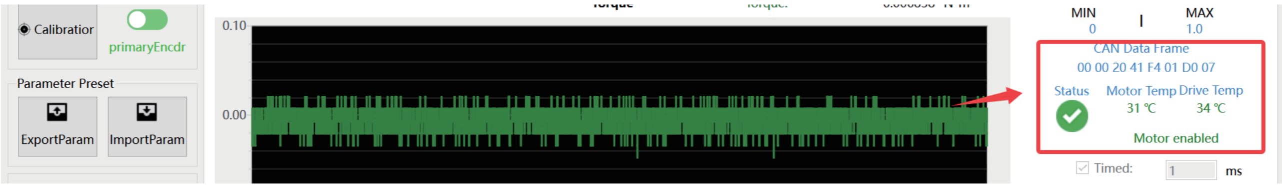
Monitor parameter curves in the debugging interface.

Ensure the motor is physically fixed.



Adjust control parameters as needed while testing. Keep "Periodic Send" enabled and click "Update" to apply changes.

Monitor real-time motor and driver temperature, status, and feedback frames. For frame format and status types,see "Feedback Frames" for details.



(5) Exit procedure: Click "Stop", then "Disable", the Red LED ON (motor disabled).

Firmware Version Check and Upgrade

◈ Version Check

Connect the motor via serial port, CAN port, and power supply.

Select the correct serial port on the PC and open it.

Click "Read Version" to display the current firmware version of the driver.

Before performing any firmware upgrade, always read and confirm the current version. Unless otherwise specified, select firmware versions with a prefix of "70" for upgrading.

Using an incorrect firmware version may cause unexpected issues.

◈ Firmware Upgrade via Serial Port

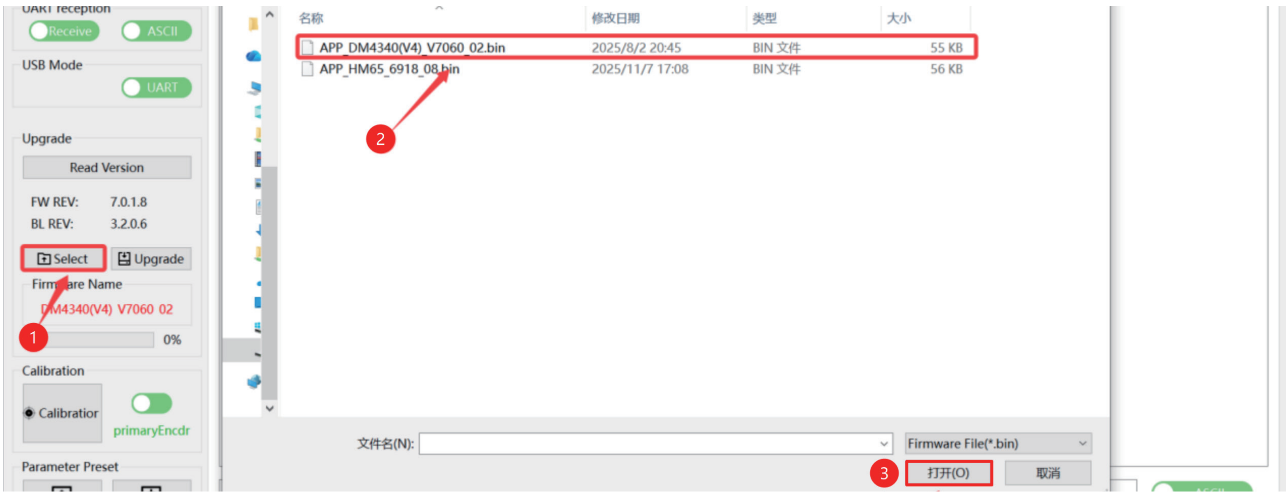
When new features are released or bug fixes are available, the firmware can be upgraded via the serial interface.

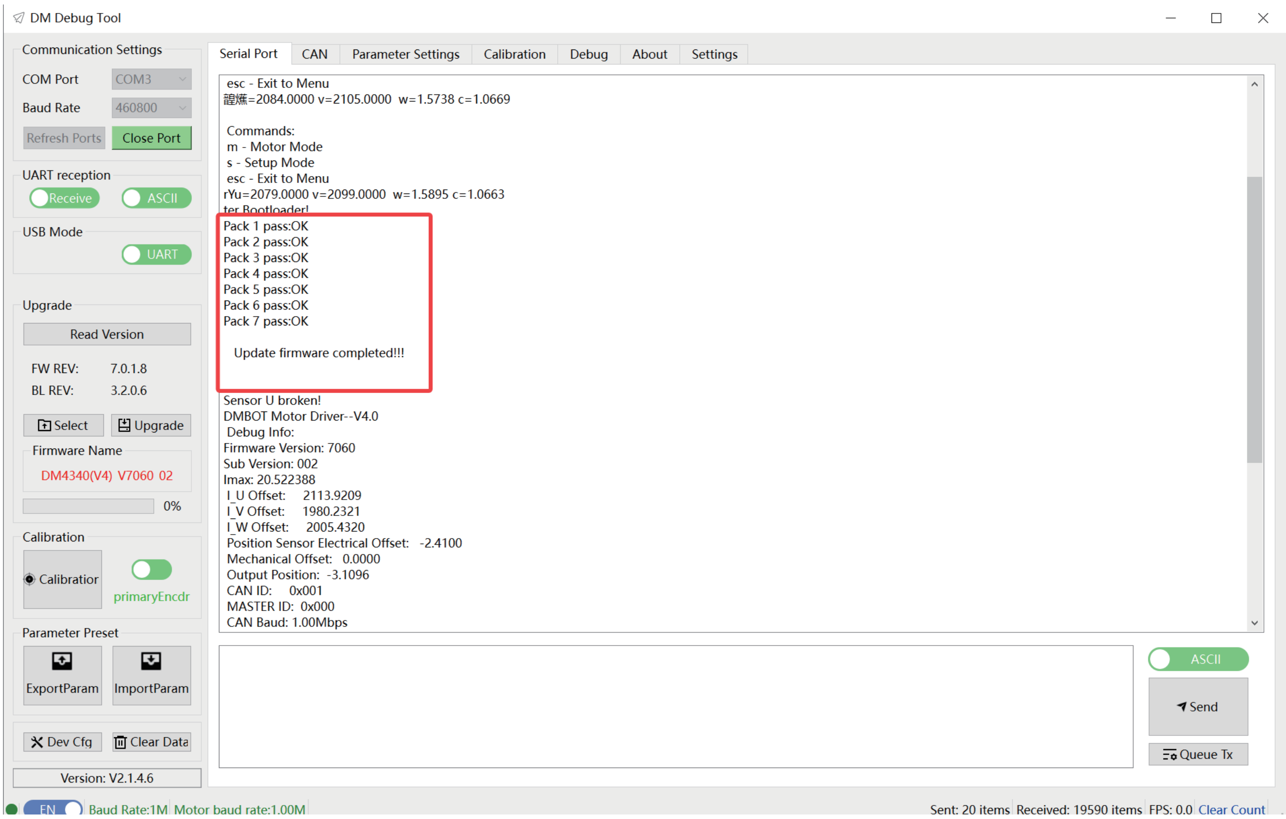
Before upgrading, ensure the serial connection is established.

Upgrade Procedure:

- Click "Select" and choose the appropriate firmware file .
- After loading, the firmware name will be displayed in the interface.
- Verify the firmware is correct, then click "Upgrade Firmware".
- Wait for the progress bar to complete.

The upgrade status can also be monitored through the serial interface.





◈ CAN Firmware Upgrade

Firmware upgrade via CAN is supported forBootloader version 3.2.0.5 and above. The CAN baud rate must match the one configured on the driver board.

Currently, firmware upgrade is supported only via a USB-to-CAN adapter.

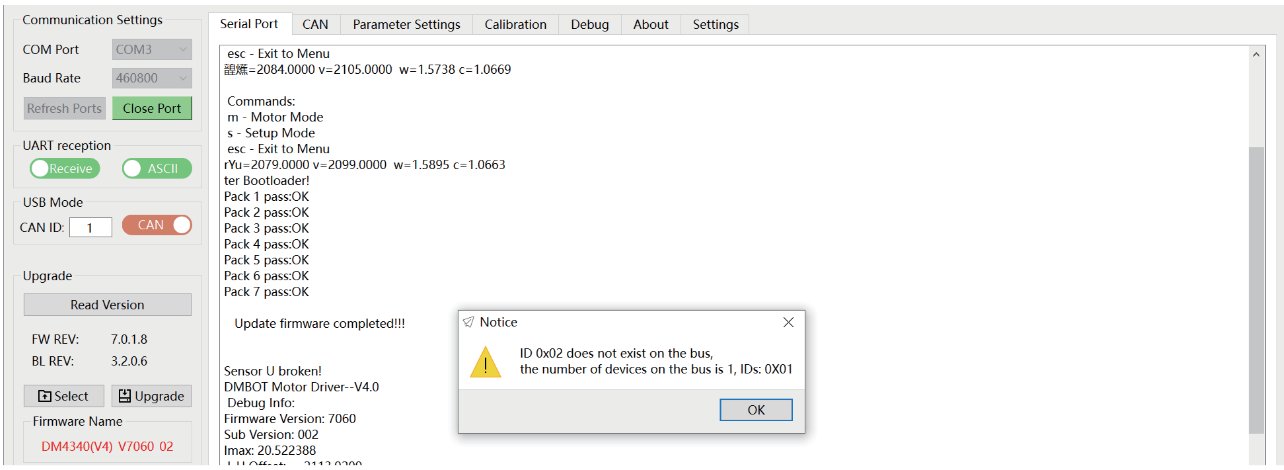
Preparation:

Before starting, connect the CAN interface and ensure communication is functioning properly.

Then, in the interface:

- Switch the communication mode from UART to CAN.
- Enter the target motor CAN ID in the left panel.

If the CAN bus is not detected, a prompt will be displayed as shown below:

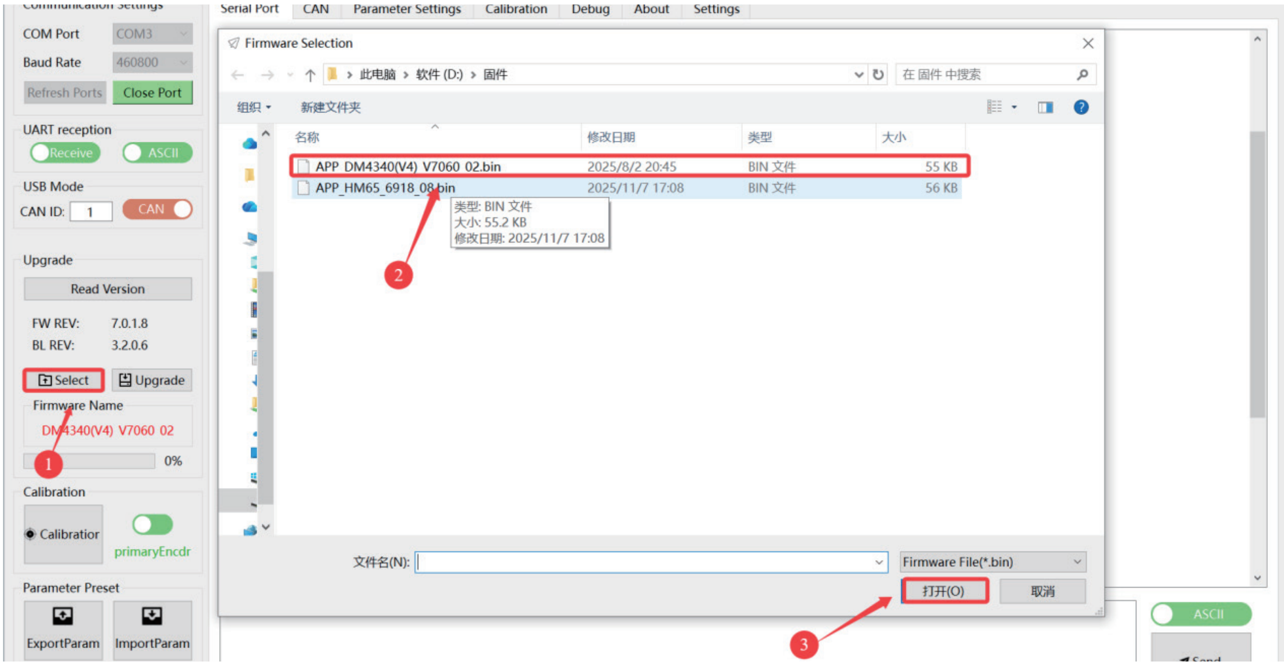


If the connection is successful, no message will be displayed.

Upgrade Procedure:

- Click "Select" and choose the desired firmware file.
- After loading, the firmware name will be displayed in the interface.
- Verify the firmware is correct, then click "Upgrade ".
- Wait for the progress bar to complete .

The upgrade status can also be monitored through the serial interface.



Once the upgrade is complete, a confirmation message will be displayed in the serial interface: