DAMIAO | 达妙科技

DM-H3510 Hub Motor

User Manual V1.0 2025.1.2

Disclaimer

Thank you for purchasing the DAMIAO DM-H3510 Wheel Hub Motor (hereinafter referred to as "the Motor"). Before using this product, please carefully read and comply with this document and all safety guidelines provided by DAMIAO Technology. Failure to do so may cause harm to you or others, or damage the product or surrounding items. By using this product, you acknowledge that you have read, understood, and accepted all terms and conditions of this document and any related materials. You agree to use the product solely for legitimate purposes and assume full responsibility for its use and any resulting consequences. DAMIAO Technology shall not be liable for any damages, injuries, or legal liabilities arising from the direct or indirect use of this product.

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 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. The motor and driver are integrated in a compact design with high integration.

2. The CAN bus can be used to feedback the motor speed, position, torque, and temperature.

3. It has the function of double temperature protection.

4. Visual parameter adjustment on the host computer, ready to use with simple configuration.

5. Supports CAN FD with a maximum baud rate of 5Mbps.

6. Low speed, high torque.

7. Multiple control modes can be flexibly switched.

Package Contents

Class	Inventory
Any power-generating or power-driven machine (Include driver)	1. Motor (including drive) × 1 2. Power supply and CAN communication terminal connection cable: SH1.08-pin cable (200mm) ×1 3. Debugging the serial port signal line: SH1.0 connection cable-3-pin (200mm) ×1 We recommend purchasing a dedicated adapter board: the SH1.0 3pin+8pin to XT30+GH1.25 converter, as the motor lacks a compatible adapter.
Any power-generating or power-driven machine + USB to CAN	1. Motor (including drive) × 1 2. Power supply and CAN communication terminal connection cable: SH1.08-pin cable (200mm) ×1 3. Debugging the serial port signal line: SH1.0 connection cable-3-pin (200mm) ×1 4. USB to CAN Debugging Tool × 1 We recommend purchasing a dedicated adapter board: the SH1.0 3pin+8pin to XT30+GH1.25 converter, as the motor lacks a compatible adapter.
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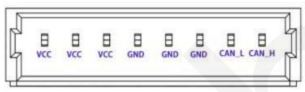
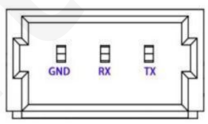
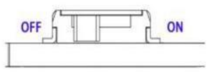
+ conversion board	4. USB to CAN Debugging Tool × 1 5. Conversion board (SH1.0 3-pin/8-pin to XT30 +GH1.25)
Any power-generating or power-driven machine + conversion board	1. Motor (including drive) × 1 2. Power supply and CAN communication terminal connection cable: SH1.08-pin cable (200mm) ×1 3. Debugging the serial port signal line: SH1.0 connection cable-3-pin (200mm) ×1 4. Conversion board (SH1.0 3-pin/8-pin to XT30 +GH1.25)

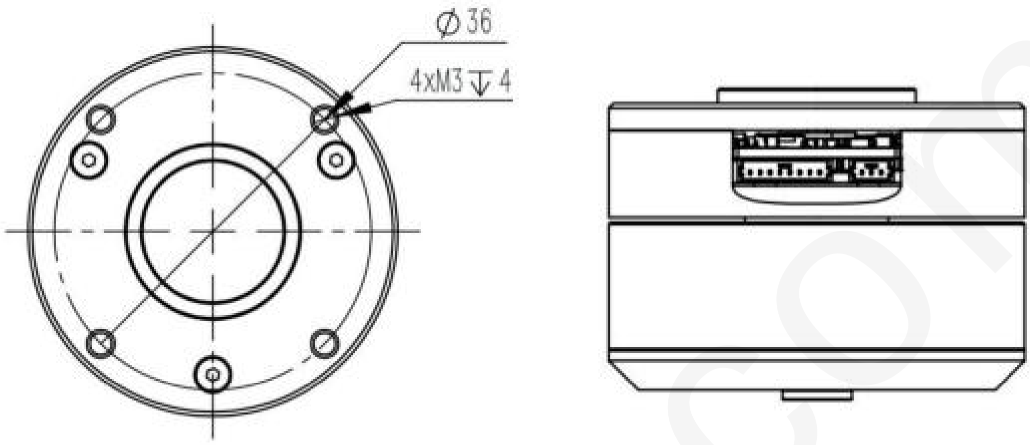
Interface and Wire Sequence Description

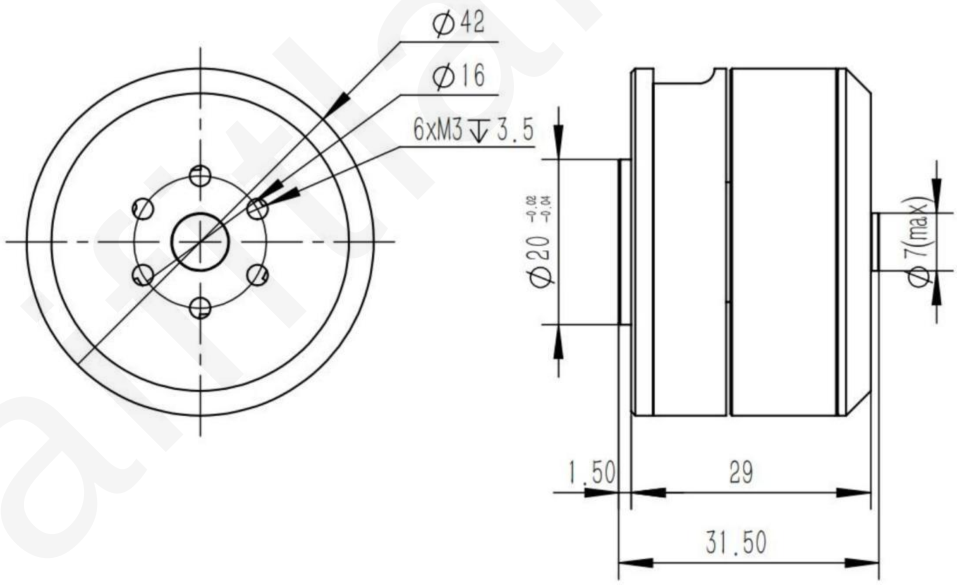
Specific Name-Number	Interface annotation	Explain
Power Supply + CAN Communication Terminal		1. Connect the power supply via the SH1.0 8-pin cable, rated at 24V (operating within 24-30V range) to power the motor. 2. The system connects to external control devices via CAN communication terminals, receiving CAN control commands and transmitting motor status data.
Debugging serial port		Connect the SH1.0 connector (3-pin) to the intermediate transition board (SH1.0 3-pin + 8-pin to XT30 + GH1.25), then use the USB-to-CAN diagnostic tool (or a universal USB-to-serial module) to connect to the PC. Use DAMIAO Technology's diagnostic assistant to configure motor parameters and perform firmware upgrades.
Terminal resistance switch		The terminal resistance of the motor configuration is enabled by default.

Note: When connecting the cable to the motor port, ensure the terminals are correctly oriented to prevent pin misalignment or damage.

Motor size and installation

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

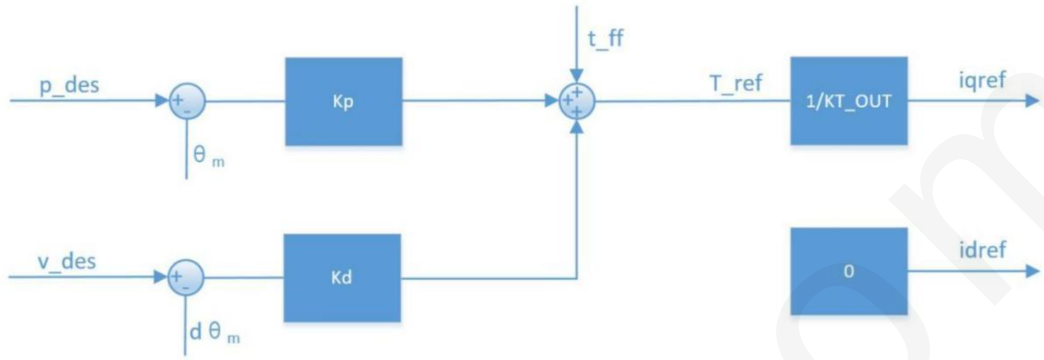




Work pattern

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:

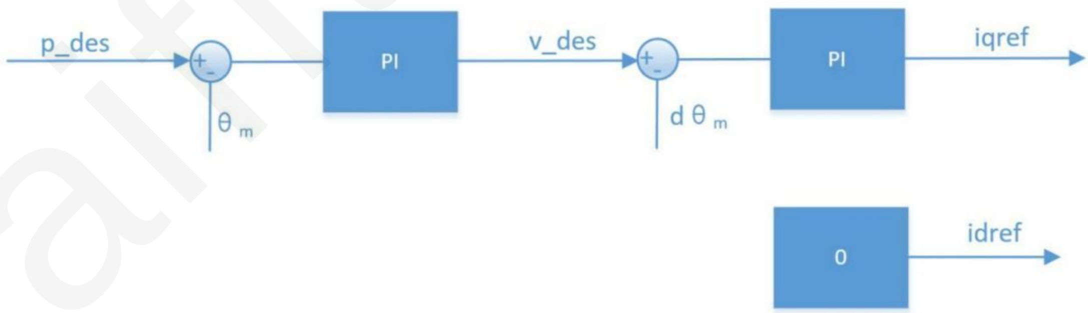


The MIT model can be adapted to various control configurations. For instance, when kp=0 and kd≠0, a constant-speed rotation can be achieved by setting v_des. Similarly, when kp=0 and kd=0, torque output can be controlled by setting t_ff.

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

Velocity Position 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:



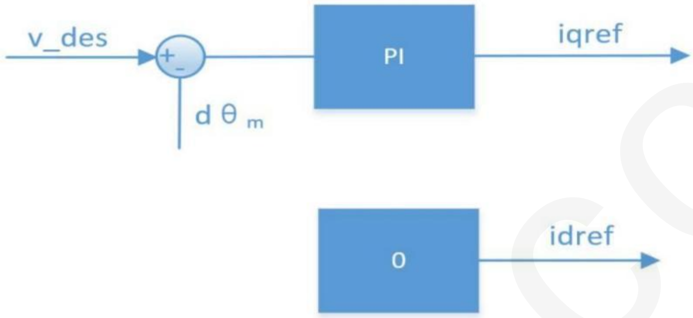
p_des is the target position for control, while v_des defines the maximum absolute speed during motion.

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 the 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

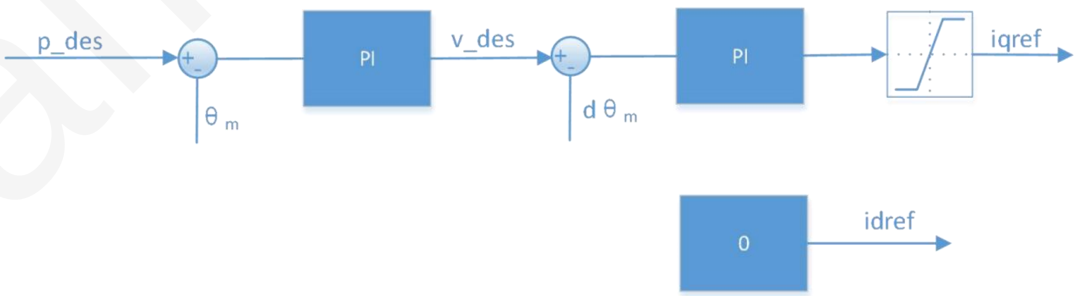
The speed mode enables the motor to operate stably at the set speed, as shown in the control block diagram below.



Note: v_des is measured in rad/s and stored as a float. To enable the debugging assistant to automatically calculate parameters, set the damping factor to a non-zero positive value (typically 2.0–10.0). A low damping factor may cause speed oscillations and excessive overshoot, while a high damping factor may 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 its 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.

Direction for use

The control system employs CAN standard frame formats with a fixed baud rate of 1Mbps. Functionally, these frames are categorized into receiving frames and feedback frames. Receiving frames contain control data for motor command execution, while feedback frames transmit real-time motor status data to the upper-level controller. Although the specific frame formats and IDs vary depending on the selected motor mode, the feedback frames remain consistent across all operational modes.

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:

<table>
<tr><th>feedback message</th><th>D[0]</th><th>D[1]</th><th>D[2]</th><th>D[3]</th><th>D[4]</th><th>D[5]</th><th>D[6]</th><th>D[7]</th></tr>
<tr><td>MST_ID</td><td>ID|ERR<<4</td><td>POS[15:8]</td><td>POS[7:0]</td><td>VEL[11:4]</td><td>VEL[3:0]|T[11:8]</td><td>T[7:0]</td><td>T_MOS</td><td>T_Rotor</td></tr>
</table>

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 ℃

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

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

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 limit during motor operation, 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, measured in rad/s, with a 100x magnification. It is a 16-bit unsigned number (LSB first, MSB last) ranging from 0 to 10000. If the value exceeds 10000, it is capped at 10000, meaning the actual speed limit ranges from 0 to 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 varies. 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 frame ID as previously defined 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	0xFD

Save position zero

The "Save Position Zero Point" frame is a control frame that resets the current output axis to zero position and sets the position value to 0. As mentioned earlier, the frame ID and data segment definition are 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, the 'Clear' command can be sent to resolve the issue. The 'Clear' frame is a control frame, with the frame ID as previously described. The data segment is defined as follows:

D[0]	D[1]	D[3]	D[4]	D[5]	D[6]	D[7]
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. A command to send storage parameters is required to write all modified parameters into the chip.

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

pay attention to：

1. Storage parameters are only valid in disabled mode.

2. All parameters are retained when storing them.

3. This operation writes parameters to the on-chip flash memory, with each operation taking 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 values 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.

After modifying the mode, it won't be saved to the flash memory and will be lost if the power is cut. Upon power restoration, the control mode will revert to the last saved configuration in the 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 first 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 ≤1Mbps, 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
0x0A	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	GREF	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
0x32	50	u_off	u phase offset	RO	/	float
0x33	51	v_off	v phase offset	RO	/	float
0x34	52	k1	Compensation Factor 1	RO	/	float
0x35	53	k2	Compensation Factor 2	RO	/	float
0x36	54	m_off	Angle offset	RO	/	float
0x37	55	dir	Direction	RO	/	float
0x50	80	p_m	Motor current position	RO	/	float
0x51	81	xout	Output shaft position	RO	/	float

RW: Read-write.

RO: Read Only.

Use DAMIAO Technology Debug Assistant

Use DAMIAO Technology's USB-to-CAN debugging tool to connect the computer and motor, then configure motor parameters and perform firmware upgrades via DAMIAO 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 DAMIAO 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 DAMIAO 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 (Dami Driver Control Protocol) V1.4.pdf

Download link：

https://gitee.com/kit-miao/DAMIAO/tree/master/%E5%85%B3%E8%8A%82%E7%94%B5%E6%9C%BA/%E6%8E%A7%E5%88%B6%E5%8D%8F%E8%AE%AE

Characteristic parameter

Use the motor properly according to the following parameters.

Motor Parameters	Rated voltage	24V
	Rated current	1.1A
	Peak point current	3.2A
	Rating torque	0.18NM
	Peak torque	0.45NM
	Rated speed	500rpm
	No-load maximum speed	1800rpm;
Motor Characteristics	Reduction gear ratio	1： 1
	Number of pole-pairs	7
	Phase inductance	1.67uh
	Phase resistance	2.25Ω
Structure and Weight	External diameter	42mm
	Altitude	31.5mm
	Motor weight	make an appointment g
Encoder	Encoder type	magnetic compilation
Communication	Control interface	CAN@1Mbps、CANFD@5Mbps
	Parameter passing interface	UART@921600bps
Control and protection	Control model	MIT pattern
		Speed mode
		position mode
		hybrid mode of power and position control
	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 30V. 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, configured 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 exits the enable

		mode. The minimum required voltage is 15V.