DAMIAO | DM-J4310-2EC V1.1 reduction motor

User Manual V1.0 2023.11.16

date	Version	Changes
2023.11.16	V1.0	First version creation

Disclaimer

Before using this product, please read and follow all safety instructions in this document carefully. Failure to do so may result in personal injury, harm to others, or damage to the product and surrounding property.

By using this product, you confirm that you have read, understood, and accepted the terms and conditions outlined in this document and all related materials.

You agree to use this product only for lawful purposes and take full responsibility for its use and any resulting consequences.

We shall not be held liable for any damage, injury, or legal responsibility arising directly or indirectly from the use of this product.

Precautions

1. Use the motor strictly within the specified working environment and within the maximum allowable winding temperature range. Failure to do so may cause permanent and irreversible damage to the product.
2. Prevent any foreign objects from entering the rotor, as this may lead to abnormal operation.
3. Before use, carefully inspect the motor and its components. Do not operate if any parts are missing, worn, or damaged.
4. Ensure all wiring is connected correctly and that the motor is installed securely and properly.
5. Do not touch the rotor or electronic parts while the motor is running. High torque output may cause the motor to heat up—handle with care to avoid burns.
6. Unauthorized disassembly of the motor is strictly prohibited. Doing so may compromise control accuracy and lead to abnormal operation.

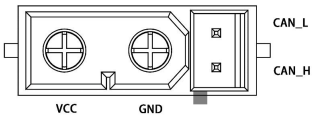
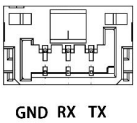
Motor Features

1. Dual encoders with single-turn absolute position on the output shaft—ensures no position loss even after power failure.
2. Integrated motor and driver design, offering a compact structure with high integration.
3. Supports PC-based visual debugging and firmware upgrades.
4. Provides feedback via CAN bus, including motor speed, position, torque, and temperature.
5. Equipped with dual temperature protection.
6. Supports trapezoidal acceleration and deceleration in position mode.

Item List

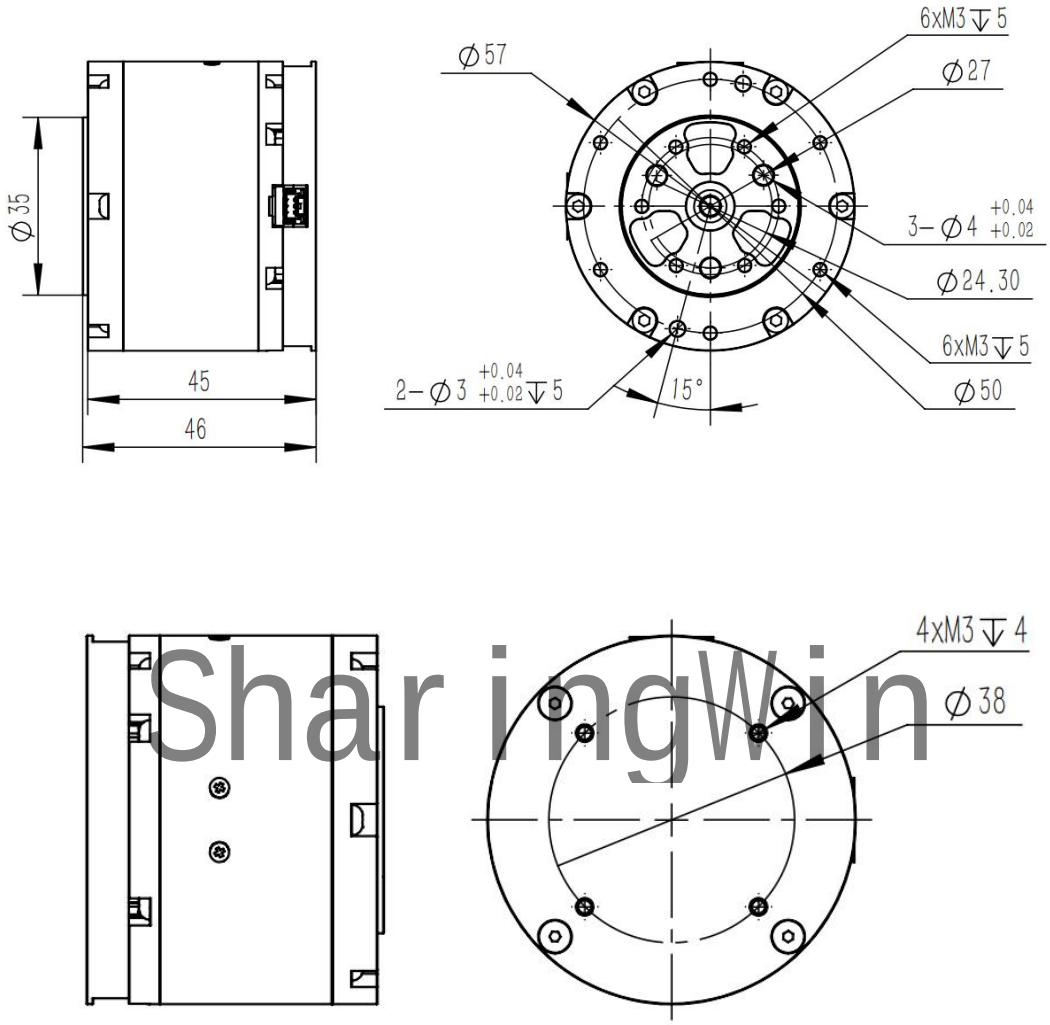
1. Motor (with integrated driver) ×1
2. Power supply connection cable (with CAN communication terminal): XT30 (2+2) -F, single-ended, 100 mm ×1
3. Debug serial signal cable: GH1.25, 3-pin, opposite side, 300 mm ×1

Interface and line sequence description

Specific name-serial number	Interface annotation	Illustrate
Power interface-1 (IncludingCANcommunication terminal)		1. Power Connection (XT30 2+2 – F Plug) Connects to the external power supply (rated voltage 24 V) to provide power to the motor. 2. CAN Communication Terminal Connects to external control equipment for receiving CAN control commands and transmitting feedback information such as status signals. 3. Dual Power Supply Interfaces The motor is equipped with two power supply ports, which can be used individually or connected in series for easier wiring and routing.
Power interface-2 (IncludingCANcommunication terminal)		
Debug serial port-3		Debug Interface (GH1.25, 3-pin) Connects via USB-to-CAN debugging tool (or a general USB-to-Serial module) to a PC. Through the Damiao Debug Assistant, users can configure motor parameters, perform debugging, and carry out firmware upgrades.

Motor size and installation

Please refer to the motor mounting hole size and position to install the motor to the corresponding equipment.



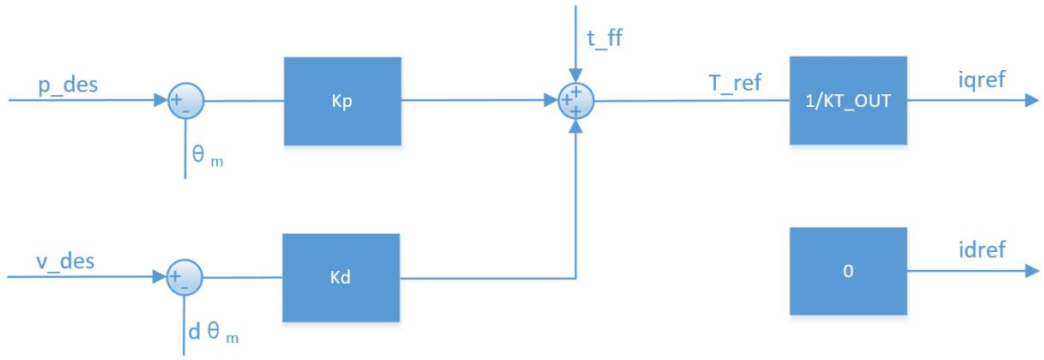
Indicator status

Normal state	Green light is always on	The ERR bit is 1, indicating the enable mode and normal working status
	Red light is on	The ERR bit is 0, indicating disabled mode
Abnormal status	Flashing red light	Indicates a fault. The corresponding fault types are: 8——Overpressure; 9——Undervoltage; A——Overcurrent; B——MOSOverheating; C——Motor coil overheating; D——Loss of communication; E——Overload; You can check the type of fault through the feedback frame or through the Damiao Technology debugging assistant interface.

Working Mode

MIT Mode

The MIT mode is designed to be compatible with the original MIT control scheme, allowing seamless switching while enabling flexible configuration of the control ranges (P_MAX, V_MAX, T_MAX). In this mode, the ESC receives CAN bus data and converts it into control variables. The calculated torque value is then used as the reference input for the current loop, which adjusts itself to achieve the target torque output according to its control law. The corresponding control schematic diagram is shown below.



Derived Control Modes from MIT Mode
Based on MIT mode, multiple control modes can be derived:

- When kp = 0 and kd ≠ 0, applying v_des enables smooth and stable constant-speed rotation.
- When kp = 0 and kd = 0, applying t_ff allows direct torque output.

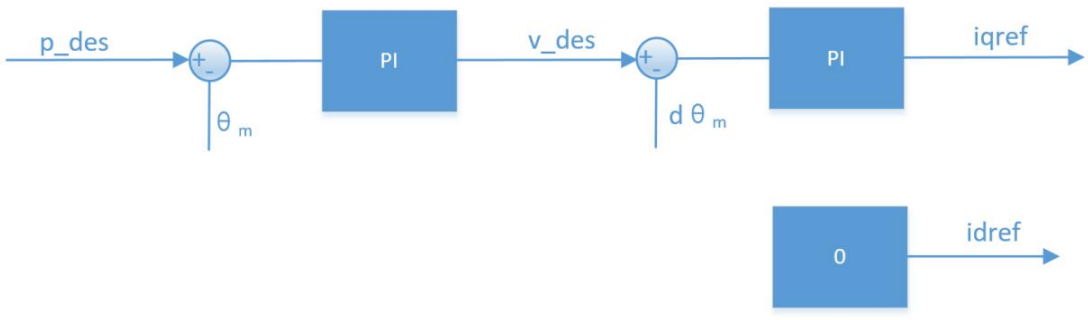
Note: In position control, kd must not be set to 0. Otherwise, the motor may vibrate or even lose control.

Position-Speed Cascade Mode:

The position-speed cascade mode adopts a three-loop series control structure:

- The position loop serves as the outer loop, with its output fed into the speed loop.
- The speed loop output then acts as the reference input for the inner current loop.
- Finally, the current loop regulates the actual current output to achieve precise control.

The control schematic diagram is shown below:



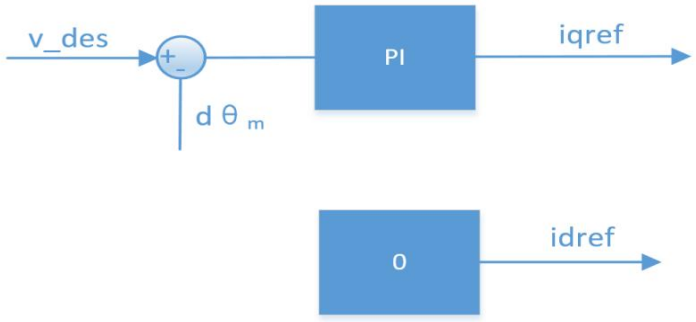
Position Cascade Mode:

In this mode, p_des represents the target position, while v_des sets the maximum allowable absolute speed during motion. When using the control parameters recommended by the Debugging Assistant, the system can achieve better accuracy with smooth operation, although the response time may be relatively long. Acceleration and deceleration can also be configured; if oscillations occur during operation, increasing these values can help improve stability.

Notice: p_des and v_des are expressed in rad and rad/s respectively, with a data type of float. The damping factor must be set to a positive value greater than zero. Please also refer to the precautions for speed mode.

Speed Mode:

Speed mode enables the motor to run steadily at a defined speed. The corresponding control diagram is shown below.



Notice
v_des is expressed in rad/s, with a data type of float. When using the Debugging Assistant for automatic parameter calculation, the damping factor must be set to a non-zero positive value, typically within the range of 2.0–10.0. A value that is too small may cause speed fluctuations and excessive overshoot, while a value that is too large may lead to a slower rise time. The recommended setting is 4.0.

use

CAN Communication
The motor uses the standard CAN frame format with a fixed baud rate of 1 Mbps. Frames are divided into two types: receiving frames and feedback frames. The receiving frame carries control data sent from the host controller to execute motor commands, while the feedback frame is used by the motor to report its operating status back to the host.

Depending on the selected control mode, the definitions of frame format and frame ID for the receiving frames will differ. However, the feedback frame format remains consistent across all modes.

Feedback Frame
The feedback frame ID is configured through the Debug Assistant (default 0, corresponding to the Master ID). It primarily provides information on motor position, speed, and torque, with the 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

Field Description

- ID
  Represents the controller ID, corresponding to the lower 8 bits of the CAN_ID.

- ERR
  Indicates the motor status, with the following definitions:

Code Status Description
0 Disabled
1 Enabled
8 Overvoltage
9 Undervoltage

A Overcurrent
B MOSFET Overheating
C Motor Coil Overheating
D Communication Loss
E Overload

Feedback Frame Field Description
POS: Represents the motor position.
VEL: Represents the motor speed.
T: Represents the motor output torque.
T_MOS: Indicates the average temperature of the drive MOSFET, in °C.
T_Rotor: Indicates the average temperature of the motor ’ s internal coil, in °C.
Position, speed, and torque values use linear mapping, where floating-point data is converted into signed fixed-point representation. Position uses 16-bit data, while speed and torque both use 12-bit data.

MIT Mode Control Frame:

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 corresponds to the configured CAN ID value. The MIT control frame includes the following parameters:
P_des: Target position
V_des: Target velocity
Kp: Position proportional gain
Kd: Position derivative gain
T_ff: Torque feedforward value
Each parameter follows the mapping rules described in the previous section. The ranges for p_des, v_des, and t_ff can be configured through the Debugging Assistant. Kp can be set within [0, 500], and Kd within [0, 5].

Since a standard CAN frame contains only 8 bytes, the MIT control command format packs five parameters—Position, Velocity, Kp, Kd, and Torque—bit by bit into the 8-byte data field. Among these, Position occupies 2 bytes (16 bits), while Velocity, Kp, and Kd each occupy 12 bits.

Control Frame in Position-Speed 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			

In this control mode, the frame ID is defined as the configured CAN ID value plus an offset of 0x100. The parameters include P_des, which represents the target position, and V_des, which represents the target velocity. Both are floating-point values, transmitted in little-endian format (low byte first, high byte last). The command is therefore sent with a CAN ID of 0x100 + ID. The velocity setting (V_des) specifies the maximum speed used during trapezoidal acceleration, corresponding to the velocity of the constant-speed segment.

Control frame in speed mode:

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

In this mode, the frame ID is defined as the configured CAN ID value plus an offset of 0x200. The parameter V_des represents the target velocity and is expressed as a floating-point value, transmitted in little-endian format (low byte first, high byte last). The command is therefore sent with a CAN ID of 0x200 + ID.

Using Damiao Technology Debugging Assistant

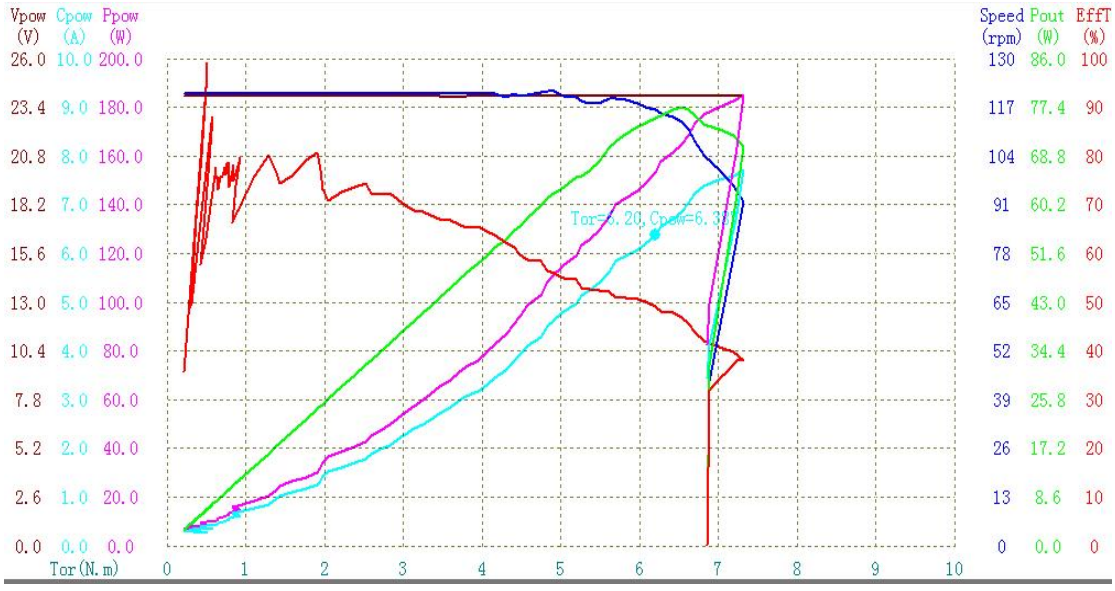
1. Connection Setup
Use the Damiao Technology USB-to-CAN debugging tool to connect the motor to a PC. The motor ' s debugging serial port is linked to the PC through a GH1.25 3-pin cable, while the power interface and CAN communication terminal are connected to the USB-to-CAN tool using an XT30 (2+2)-F plug cable.

2. Software Operation
After completing all connections (serial port, CAN port, and power interface), open the Damiao Technology Debugging Assistant on the PC and select the corresponding serial port.

3. Power-On and Monitoring
Power on the motor. The serial port will then output information, including the Control Mode, which indicates the current drive mode.

Motor parameters

Constant speed120rpm, room temperature25℃, the performance curve measured:



Characteristic parameters

Please use the motor reasonably according to the following parameters.

Motor parameters	Rated voltage	24V
	Rated current	2.5A
	Peak current	7.5A
	Rated torque	3NM
	Peak torque	7NM
	Rated speed	120rpm
	Maximum no-load speed	200rpm
Motor characteristic values	reduction ratio	10: 1
	Polepairs	14
	Phase inductance	340uH
	Phase resistance	650mΩ
Structure and weight	outer diameter	56mm
	high	46mm
	Motor weight	About 300g
encoder	Encoder bit number	14-bit
	Number of encoders	2
	Encoder type	Magnetic encoding (single turn)
communication	Control interface	CAN@1Mbps
	Parameter adjustment interface	UART@921600bps
Control and protection	Control Mode	MIT Model
		Speed Mode
		Position Mode
	Protect	Drive over-temperature protection, protection temperature: 120℃, over-temperature motor will exit "enable mode"
		Motor over-temperature protection, set according to usage requirements, it is recommended not to exceed 100℃, over temperature motor will exit "enable mode"
		Motor overvoltage protection, according to the use Demand setting, it is recommended not to exceed 32V,overvoltage will exit the "enable model"
		Communication loss protection,If no CAN command is received within the set period,the Exit "Enable Mode"
		Motor overcurrent protection is set according to usage requirements and is recommended not to exceed 9.8A, overcurrent will exit "enable mode"
		Motor undervoltage protection, if the power If the pressure is lower than the set value,exit "Enable Mode", it is recommended to power Voltage not less than 15V