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* **Disclaimer**

Thank you for purchasing the M15 series permanent magnetic synchronous motor (hereinafter referred to as "motor") from Dongguan Direct Drive Technology Co., Ltd. (hereinafter referred to as Direct Drive Tech). This manual has been published to guide the use of this product.

Before starting operation, please be sure to read through this manual carefully and follow the relevant instructions to avoid injury or damage. By using this product, you are deemed to have accepted all the terms and contents of the specification and all relevant documents of this product. You promise to use this product only for legitimate purposes and take full responsibility for the possible consequences of using this product. Direct Drive Tech shall not be responsible for any damage, injury, or legal liability caused by the direct or indirect use of this product.

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Direct Drive Tech Co., Ltd. reserves the right for the modification and final interpretation of this product and all documents of its specification, and Direct Drive Tech may modify the information of this specification without prior notice when it obtains new information, knowledge, or experience.

* **Safety Precautions**
1. Before starting operation, make sure whether the working voltage is the one specified in this manual.
2. Make sure the motor is used within the specified ambient temperature range.
3. Avoid soaking the motor in water. Failure to do this may result in abnormal operation or damage to the motor.
4. Before starting operation, be sure to correctly and securely perform the cable to avoid loose contact.
5. Before starting operation, refer to the installation guidelines to make sure the motor is installed correctly and securely.
6. Before starting operation, refer to the installation guidelines to make sure the external output part of the motor is installed correctly and securely.
7. During operation, avoid damaging the cables. Failure to do this may result in abnormal operation or damage to the motor.
8. During operation, do not touch the rotating parts of the motor. This may result in injury.
9. When the motor produces high torque output with heat generation, do not touch the motor. This may result in scald.
10. Do not disassemble the motor without permission. This may result in abnormal operation or damage to the motor and bring protentional safety hazards.

* **Introduction**

M15 series motor is an independently developed product by Direct Drive Technology Co., Ltd. This product is a highly reliable permanent magnet synchronous motor, integrating external rotor BLDC motors, encoder, and servo system based on the concept of integration development. It has compact structure, ease of installation, stability in operation, small size and large torque, which is especially suitable for the following direct drive fields: robots, AGVs, automation equipment, warehousing logistics, etc. By optimizing the number of poles and wedges, wedge shape, air gap, permanent magnet materials, etc., the motor can ensure larger torque output, less torque fluctuations, and provides high-performance direct drive application solutions. The motor driver embeds the field-oriented control (FOC) algorithm. Together with the high-precision sensor, the motor achieves great control accuracy and nice mute effect. The drive has a complete and reliable motor OBD monitoring and protection mechanism to ensure the safe and reliable operation of the motor.

* **Product Features**

1. Integrated design of motor and motor driver.

2. Small size and high torque, ultra-low velocity supported.

3. CAN communication mode supported.

4. Special design in structure allows the sensor to measure the overall temperature of motor.

5. Angle, velocity, current, fault value and other information of the motor can be obtained through communication.

6. Equipped with complete monitoring mechanism and protection.

7. High Ingress Protection Rating.

* **Product List**

1. Motor Assembly

 

* **Motor Driver Interface and Cable Instructions**

Cable Diagram：



|  |  |  |
| --- | --- | --- |
| **Index** | **Name** | **Instruction** |
| 1 | Power Positive (Red) | Rated Voltage 24V |
| 2 | Power Negative (Blue) | GND |
| 3 | CAN Bus High (Yellow) | This interface is a non-isolated CAN interface. When connecting, please make sure the motor driver and the bus are connected correctly |
| 4 | CAN Bus Low (Green） |

* **Installation Guidelines**

Please refer to the size and position of the motor mounting holes to install the motor on the custom device.

**1. Motor installation interface**

  

Bottom View Side View

 

 Vertical View

**2. Cautions**

2.1 It is recommended that the indicator light is unobstructed.

2.2 Avoid pulling the cable.

2.3 Carefully select the screws with proper length and shape to avoid unreliable installation.

* **M1502A\_112** **Motor Driver Instructions**

The driver is able to perform close-loop control of the motor’s angle, velocity or current according to the user’s target instructions, and feeds back the motor’s real time angle, velocity, current, temperature and other information, through the CAN bus.

**Description of CAN ID Indicator Light：**

|  |  |
| --- | --- |
| ID | Description of Indicator Light |
| 1 | Green light flashes once every 5s |
| 2 | Green light flashes twice every 5s |
| 3 | Green light flashes 3 times every 5s |
| 4 | Green light flashes 4 times every 5s |
| 5 | Green light flashes 5 times every 5s |
| 6 | Green light flashes 6 times every 5s |
| 7 | Green light flashes 7 times every 5s |

**Descriptions of Fault Indicator Light, Buzzer and Related Protection Regulations:**

|  |  |
| --- | --- |
| Fault Description | Description of Fault Indicator Light and Buzzer |
| Under voltage1（voltage is higher than 18V and lower than 22V） | The red light is always on |
| Under voltage2（voltage is lower than18V） | The buzzer keeps beeping, and the motor shuts down |
| Over voltage（voltage is higher than 63V） | The buzzer keeps beeping, and the motor shuts down |
| Over current（greater than 15A） | The buzzer keeps beeping, and the motor shuts down |
| Over velocity（Greater than the maximum velocity of the motor） | The red light is always on |
| Over heat 1（temperature of motor winding>80℃） | The yellow light flashes every 2s to corresponding ID |
| Over heat 2（temperature of motor winding >120℃） | The yellow light is always on, and the motor powers down |
| Angle sensor failure | The red light is always on, and the motor shuts down |
| Abnormal signal of angle sensor | The red light flashes to corresponding ID |
| Cannot access the motor | Long beep followed by short beep from the buzzer, and the motor shuts down |
| Phase loss | Three short beeps from buzzer, and the motor shuts down |

**The correspondence between CAN communication identifiers is as follows:**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Motor ID | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| Feedback Identifier | 0x97 | 0x98 | 0x99 | 0x9A | 0x9B | 0x9C | 0x9D | 0x9E |
| Control Identifier | 0x32 | 0x33 |

#

* **CAN Communication Protocol**

Rate: 500kbps

Frame type: Standard frame

Data length: 8 bytes

**Open-loop mode:** The set value -32767 ~ 0 ~ -32767 corresponds from the reverse maximum velocity to the maximum velocity

**Current loop mode:** The set value is - 32767 ~ 32767 corresponds to -33A ~ 33A

**Velocity loop mode:** The set value is -210 ~ 210 corresponds to -210 ~ 210rpm

**Angle loop mode:** 0 ~ 32767 corresponds to 0o ~ 360o

Data feedback method includes **active reporting** and **polling**.

Motor identifier range: 0x32 ~ 0x500

Operation steps:

1. Set the feedback method (polling method or active reporting method, default in active reporting method at 1kHz)
2. Set motor mode (open loop, current loop, velocity loop, angle loop, default in open loop)
3. Send the set value.

**1. Command in open-loop mode (format of other modes is the same):**

**Open-loop command, range: -32767 ~ 32767.**

|  |
| --- |
| **Command** |
| Identifier | **0x32** |
| Data field | DATA[0] | DATA[1] | DATA[2] | DATA[3] | DATA[4] | DATA[5] | DATA[6] | DATA[7] |
| Descrip-tion | Open loop set high 8 bits | Open loop set low 8 bits | Open loop set high 8 bits | Open loop set low 8 bits | Open loop set high 8 bits | Open loop set low 8 bits | Open loop set high 8 bits | Open loop set low 8 bits |
| Motor ID | 1 | 2 | 3 | 4 |

|  |
| --- |
| **Command** |
| Identifier | **0x33** |
| Data field | DATA[0] | DATA[1] | DATA[2] | DATA[3] | DATA[4] | DATA[5] | DATA[6] | DATA[7] |
| Description | Open loop set high 8 bits | Open loop set low 8 bits | Open loop set high 8 bits | Open loop set low 8 bits | Open loop set high 8 bits | Open loop set low 8 bits | Open loop set high 8 bits | Open loop set low 8 bits |
| Motor ID | 5 | 6 | 7 | 8 |

**Feedback value**

|  |
| --- |
| **Feedback, at frequency 1KHZ** |
| Identif-ier | **0x96+Motor ID** |
| Data field | DATA[0] | DATA[1] | DATA[2] | DATA[3] | DATA[4] | DATA[5] | DATA[6] | DATA[7] |
| Descri-ption | Velocity measurement set high 8 bits | Velocity measurement set low 8 bits | current value set high 8 bits | Torque current value set low 8 bits | Angle value set high 8 bits | Angle value set low 8 bits | Fault value | Motor mode |

Velocity range: -210 ~ 210RPM

Current range: -32767~32767，corresponds to -33A~33A

Angle value range 0 ~ 32767 corresponds to 0~360°。

Fault value and corresponding fault description:

|  |  |
| --- | --- |
| Fault value | Fault description |
| 0x00 | No fault |
| 0x01 | Undervoltage 1 (voltage higher than 18V and lower than 22V) |
| 0x02 | Undervoltage 2 (voltage below 18V) |
| 0x03 | Over-voltage (voltage higher than 63v) |
| 0x0A | Over-current (greater than 15a) |
| 0x14 | Over velocity (greater than the maximum velocity of motor) |
| 0x1E | Over-temperature 1 (motor winding temperature > 80 ℃) |
| 0x1F | Over-temperature 2 (greater than 120 ℃) |
| 0x2A | Angle sensor failure |
| 0x2B | Abnormal angle sensor signal |
| 0x3C | Unable to access the motor |
| 0x51 | Phase loss of three-phase line |

**2、Example of setting the sending mode and feedback mode**

|  |
| --- |
| **Set mode** |
| Identifier | **0x105** |
| Data field | DATA[0] | DATA[1] | DATA[2] | DATA[3] | DATA[4] | DATA[5] | DATA[6] | DATA[7] |
| Description | Mode value | Mode value | Mode value | Mode value | Mode value | Mode value | Mode value | Mode value |
| Motor ID | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| **Feedback content** |
| Identifier | **0x200+Motor ID** |
| Data field | DATA[0] | DATA[1] | DATA[2] | DATA[3] | DATA[4] | DATA[5] | DATA[6] | DATA[7] |
| Description | Mode value | 0xFF | 0xFF | 0xFF | 0xFF | 0xFF | 0xFF | 0xFF |

|  |  |
| --- | --- |
| Mode value： | Description |
| 0X00 | Voltage open loop |
| 0x01 | Set to current loop |
| 0x02 | Set to velocity loop |
| 0x03 | Set to angle loop |
| 0x09 | Disabled motor |
| 0x0A | Enable motor (default enable) |

|  |
| --- |
| **Set feedback method** |
| Identifier | **0x106** |
| Data field | DATA[0] | DATA[1] | DATA[2] | DATA[3] | DATA[4] | DATA[5] | DATA[6] | DATA[7] |
| Description | method | method | method | method | method | method | method | method |
| Motor ID | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| **Feedback content** |
| Identifier | **0x264+ Motor ID** |
| Data field | DATA[0] | DATA[1] | DATA[2] | DATA[3] | DATA[4] | DATA[5] | DATA[6] | DATA[7] |
| Description | method | 0xFF | 0xFF | 0xFF | 0xFF | 0xFF | 0xFF | 0xFF |

**Method: The highest bit of the 8-bit data is set as the active reporting or polling (1: polling, 0: active reporting). The lower 7 bits are the reporting frequency under the active reporting method, range: 1 ~ 127ms.**

E.g. Data 0b1000 0000 -- indicates that the polling method is set.

Data 0b0100 0000 - indicates that the data is reported once in 64ms, in active reporting method.

Note:

Under the polling mode, the setting of reporting frequency is invalid.

If the feedback mode is not set, it is the active reporting method for every 1ms, by default.

**3、Operations in polling method**

|  |
| --- |
| **Command** |
| Identif-ier | **0x107** |
| Data field | DATA[0] | DATA[1] | DATA[2] | DATA[3] | DATA[4] | DATA[5] | DATA[6] | DATA[7] |
| Description | Motor ID | Target content 1 | Target content 2 | Target content 3 | Custom-ized value | Reserved | Reserved | Reserved |
| **Feedback content** |
| Identif-ier | **0x96+Motor ID** |
| Data field | DATA[0] | DATA[1] | DATA[2] | DATA[3] | DATA[4] | DATA[5] | DATA[6] | DATA[7] |
| Descri-ption | Target content 1 high 8 bits | Target content 1 low 8 bits | Target content 2 high 8 bits | Target content 2 low 8 bits | Target content 3 high 8 bits | Target content 3 low 8 bits | Custom-ized value | Reserved |

Target content value：

0x01: Velocity

0x02: Current

0x03: Temperature

0x04: Angle

0x05: Fault value

0x06: Control mode

Customized value: Any values ranging from 0 to 255. The value can be used to distinguish the feedback frames.

Reserved: Any value

**E.g. The motor receives the following frame**：

**Identifier 0x107**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Data field | DATA[0] | DATA[1] | DATA[2] | DATA[3] | DATA[4] | DATA[5] | DATA[6] | DATA[7] |
| Description | 0x01 | 0x01 | 0x03 | 0x04 | 0xAA | Reserved | Reserved | Reserved |

**Feedback content as：**

**Identifier 0x97**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Data field | DATA[0] | DATA[1] | DATA[2] | DATA[3] | DATA[4] | DATA[5] | DATA[6] | DATA[7] |
| Description | Velocity high 8 bits | Velocity low 8 bits | Temper-ature high 8 bits | Temper-ature low 8 bits | Angle high 8 bits | Angle low 8 bits | 0xAA | Reserved |

**4、Motor ID setting：**

|  |
| --- |
| **Command** |
| Identifier | **0x108** |
| Data field | DATA[0] | DATA[1] | DATA[2] | DATA[3] | DATA[4] | DATA[5] | DATA[6] | DATA[7] |
| Descri-ption | Motor ID | Reserved | Reserved | Reserved | Reserved | Reserved | Reserved | Reserved |
| **Feedback content** |
| Identifier | **0x96+Motor ID** |
| Data domain | DATA[0] | DATA[1] | DATA[2] | DATA[3] | DATA[4] | DATA[5] | DATA[6] | DATA[7] |
| Descri-ption | Motor ID | 0xFF | 0xFF | 0xFF | 0xFF | 0xFF | 0xFF | 0xFF |

Note: Only one motor ID can be set for each power on, and whether the setting is successful can be judged by the feedback identifier.

**5、CAN terminal resistor setting：**

**Identifier：0x109**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Data field | DATA[0] | DATA[1] | DATA[2] | DATA[3] | DATA[4] | DATA[5] | DATA[6] | DATA[7] |
| Description | 0/1 | 0/1 | 0/1 | 0/1 | 0/1 | 0/1 | 0/1 | 0/1 |
| Motor ID | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |

0: Disconnect the terminal resistor

1: Connect the terminal resistor

The terminal resistor is disconnected by default.

* **Firmware Update**

Special software tool can be used for updating. If required, please contact the official after-sales service.

* **Motor parameters**

|  |
| --- |
| Motor parameters with M15 built-in driver |
| Unload velocity | 210rpm±10rpm |
| Unload current | ≤0.25A |
| Rated velocity | 115rpm |
| Rated torque | 9.6Nm |
| Rated current | 12A |
| Maximum efficiency | ≥76% |
| Stall torque | 17Nm |
| Stall current | ≤15.5A |
| Rated voltage | 24VDC |
| Torque constant | 0.8Nm/A（在额定转速下测得） |
| Velocity constant | 8.7rpm/V |
| Ambient temperature | -20℃~45℃ |
| Motor weight | 2.3kg |
| Encoder resolution | 16384  |
| Absolute accuracy | 8192  |
| Ingress protection rating | IP55 |
| Noise level**Note: the above parameters are measured under 24VDC** | ≤52dB |

