# 关节电机说明书
Joint motor manual

1 关节规格参数
1 Joint parameter

外形及安装尺寸
Outline and mounting dimensions

1.2 标准使用状态

1.2 Standard service condition

额定电压： 24 VDC
使用电压范围： 16V—28 VDC
运转方向： CW/CCW 从出轴方向看
使用姿势：出轴方向为水平或者垂直
标准使用温度：25±5℃
使用温度范围：-20～50℃
标准使用湿度：65%
使用湿度范围：5～85%,无凝露
保存温度范围：-30～70℃
绝缘等级：Class B

Rated voltage：24 VDC
Service voltage range：16V—28 VDC
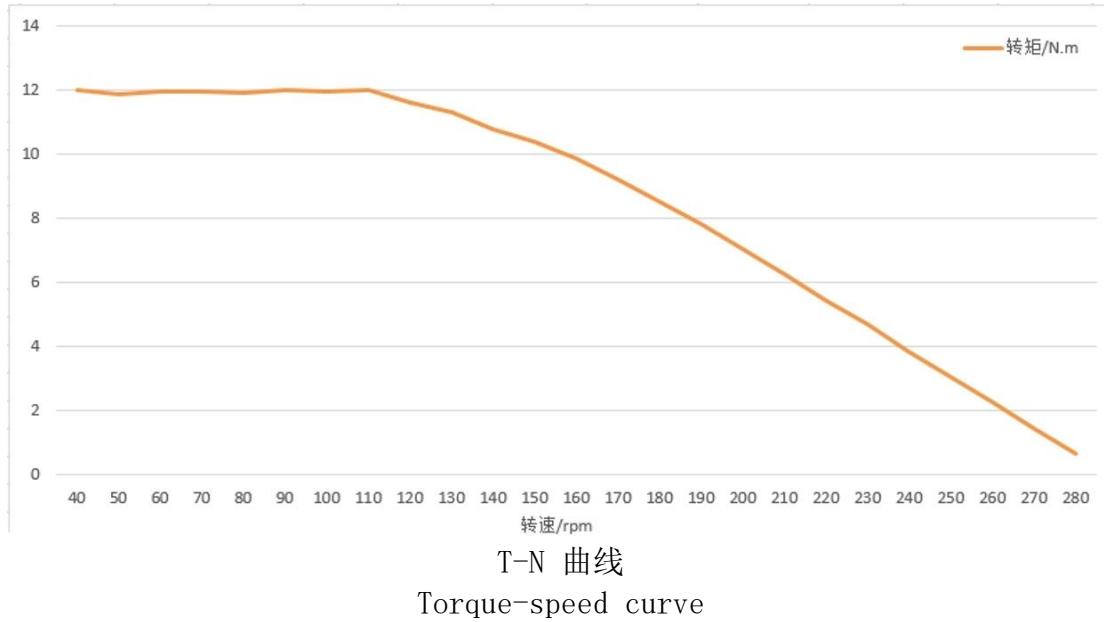
Running direction：CW/CCW
Use position： Horizontal or vertical
Standard operating temperature：25±5℃
Service temperature range：-20～50℃
Standard service humidity：65%
Service humidity range：5～85%,No condensation
Storage temperature range：-30～70℃
Insulation class：Class B

1.3 电气特性

1.3 Electrical characteristic

额定力矩： 4 N.m
峰值力矩：12 N.m
空载转速：296 rpm±10%
额定负载转速：240rpm±10%
空载电流：0.5 Arms
额定负载电流：6.5A±10%
峰值电流：23A±10%
绝缘电阻/定子绕组：DC 500VAC, 100M Ohms
耐高压/定子与机壳： 600 VAC, 1s, 2mA
电机反电势：0.054-0.057Vrms/rpm
线电阻：0.45Ω±10%
转矩常数：0.87N.m/Arms
电机电感：187-339μH

Rated moment：4 N.m
Peak moment：12 N.m
No-load speed：296 rpm±10%
No-load current：0.5 Arms
Rated load speed：240rpm±10%
Rated load current：6.5A±10%
Peak current：23A±10%
Insulation resistance/stator winding：DC 500VAC, 100M Ohms
High pressure/stator and housing：600 VAC, 1s, 2mA
Back potential of the motor：0.054-0.057Vrms/rpm
Line resistance：0.45Ω±10%
Torque constant：0.87N.m/Arms
Inductance of motor：187-339μH

T-N 曲线
Torque-speed curve

1.4 最大过载曲线

1.4 Maximum overload curve

测试条件：
环境温度：25℃
绕阻极限温度：120℃
转速：24rpm

Test condition：
Ambient temperature：25℃
Winding limit temperature：120℃
Rotational speed：24rpm
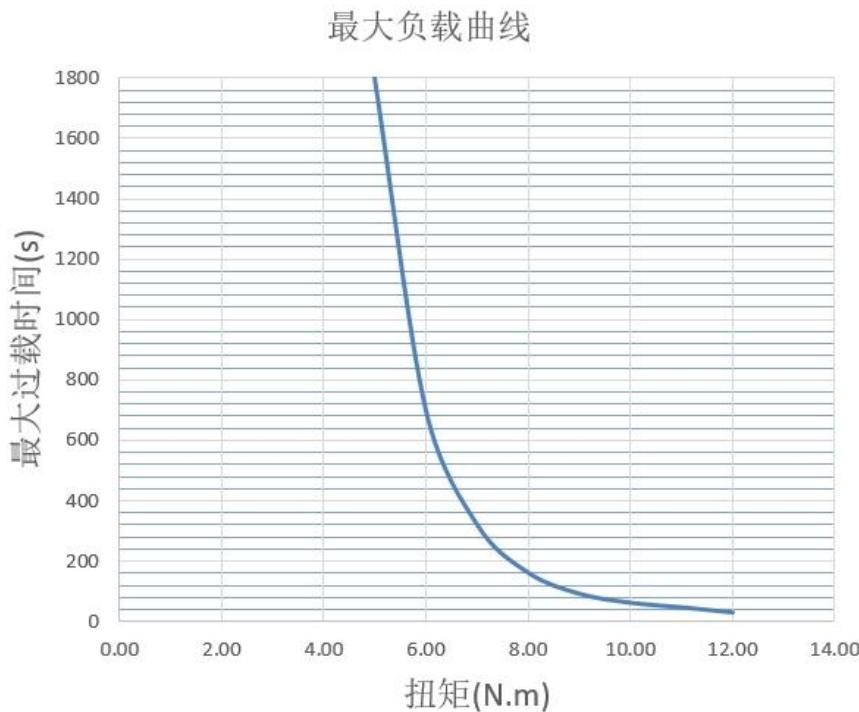
Load	Operating time(s)
12.00	28
11.00	45
10.00	60
9.00	90
8.00	160
7.00	320
6.00	700
5.00	1800
4.50	2500
4.00	rated

测试数据
Test data

最大负载曲线

1.5 机械特性

1.5 Mechanical characteristic

重量：317g±3g
极数：28 极
相数：3 相
驱动方式：FOC
减速比：7.75：1

Weight：317g±3g
Number of poles：28P
Phase number：3
Driving mode：FOC
Reduction ratio：7.75：1
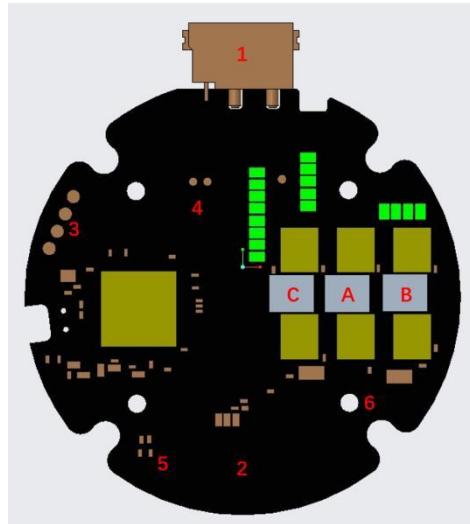
2 驱动器
2 Driver

2.1 驱动器外观简介&规格

2.1 Driver Appearance & Specifications

驱动器
Driver

1.XT30(2+2)连接器
2.硬件测试点
3.MCU 下载口
4.CAN 通信测试点
5.指示灯
6.安装孔
7."C、A、B"是三相绕组焊接点

1.XT30(2+2) connector
2.Hardware test point
3.MCU download port
4.CAN communication test point
5.Pilot lamp
6.Mounting hole
7."C, A, B" Welding point of three-phase winding

Driver specification	
Rated operating voltage	24VDC
Allowable maximum voltage	28VDC
Rated working current	6.5A
Maximum allowable current	23A
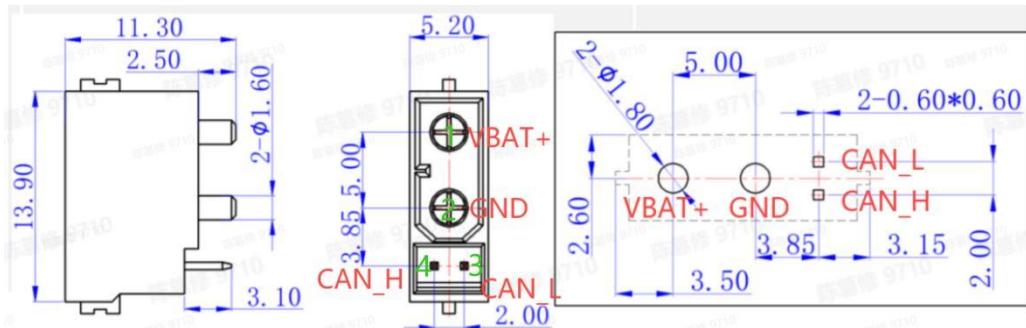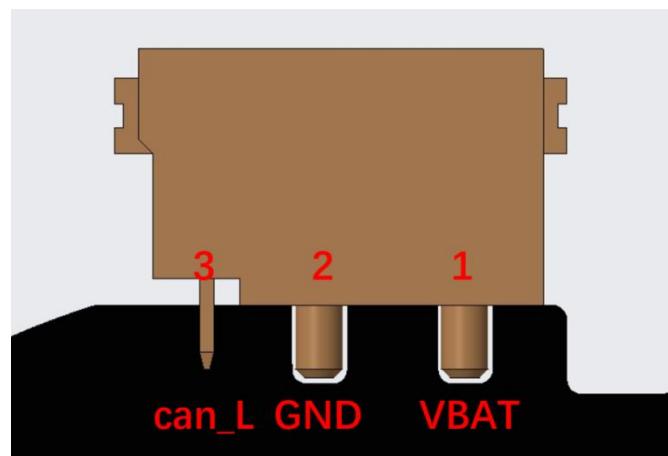
Standby power consumption	≤18mA
CAN bus baud rate	1Mbps
Dimension	Φ58mm
Operating ambient temperature	-20℃至 50℃
The maximum allowable temperature of the control panel	80℃
Encoder resolution	14bit（Absolute value of a turn）

2.2 驱动器接口定义

2.2 Driver Interface Definition

2.2.1 驱动器接口图

2.2.1 Driver interface diagram

3 调试器使用说明
3 Debugger usage instructions

3.1 硬件配置

3.1 Hardware Configuration

关节调试工具请使用公司提供的 USB-CAN 模块，关节电机采用 CAN 通信方式，驱动器已设计 120 欧姆电阻无需额外增加，调试器需要提前安装 CH340 串口驱动，默认工作在 AT 模式，对应串口协议的帧头为 41 54，帧尾为 0D 0A。
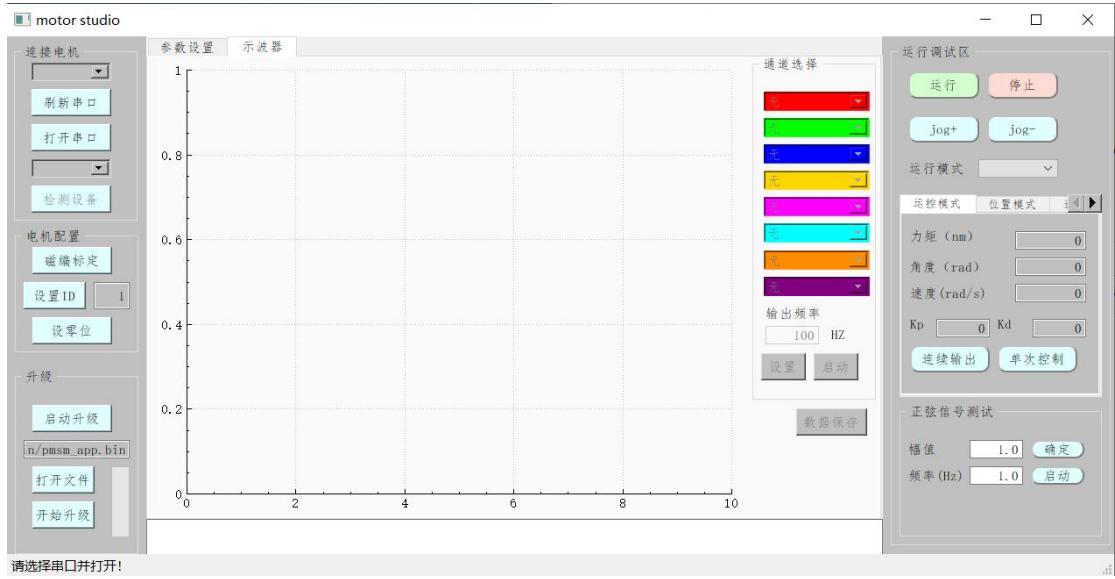
需要注意的是，我们是根据特定的 can 转 USB 工具开发的调试器，因此需要用我们推荐的串口工具来进行调试器调试，如果想要移植到其他调试器平台可以参照说明书的第三章进行开发。

Joint debugging tool please use the USB-CAN module provided by the company, joint motor adopts CAN communication mode, the driver has been designed 120 ohm resistance without additional increase, the debugger needs to install CH340 serial port driver in advance, the default work in AT mode, the corresponding serial port protocol frame header is 41 54. The frame tail is 0D 0A.

It should be noted that we developed the debugger according to a specific can to USB tool, so we need to use our recommended serial port tool to debug the debugger. If you want to transplant to other debugger platforms, you can refer to the third chapter of the instructions for development.

3.2 调试器界面及说明

3.2 Debugger Interface and Description

3.2.1 左侧配置区域

3.2.1 Configuration area on the left

可连接电机设备，设置 CAN_ID，固件升级等，第一步：刷新串口；第二步：打开串口；第三步：检测设备，即可建立通信连接。

（1）按需要，多个电机可修改不同的 CAN_ID 号

（2）磁编标定，关节出厂前已标定，拆装后需重新标定可使用该功能。

（3）设置零位（掉电丢失），设置当前位置为 0

（4）程序升级，当关节程序有更新时，点击升级按钮选中升级文件即可进行升级

Can connect the motor device, set CAN_ID, firmware upgrade, etc. Step 1: refresh the serial port; Step 2: Open the serial port; Step 3: Detect the device to establish a communication connection.

(1) As required, multiple motors can be modified with different CAN_ID numbers

(2) Magnetic coding calibration, the joint has been calibrated before the factory, and it needs to be re-calibrated after disassembly to use this function.

(3) Set zero (power loss), set the current position to 0

(4) Program upgrade, when the joint program is updated, click the upgrade button to select the upgrade file

Row Upgrade

3.2.2 中间显示区域

参数设置模块：

• 参数表，可以查看并修改电机参数

- 上传参数，可以将电机中参数上传到参数表中
- 下载参数，可以将参数表中数据下载到电机中
- 导出参数，可以将参数表中数据下载到本地
- 恢复出厂，可以将参数表中数据恢复出厂设置

Parameter setting module:

Parameter table, you can view and modify the motor parameters

Upload parameters, the parameters in the motor can be uploaded to the parameter table

Download parameters, you can download the data in the parameter table to the motor

To export parameters, you can download the data in the parameter table to a local computer

You can restore data in the parameter table to factory defaults

示波器模块：
- 示波器，可以查看参数随时间变化曲线
- 频率，可以调整查看数据的频率
- 信道，可以配置查看的数据
- 开始、停止绘图
- 输出波形数据到本地

Oscilloscope module:

Oscilloscope, you can view the parameter change curve with time

Frequency, you can adjust the frequency of viewing data

The channel can be configured to view the data

Start and stop drawing

Output waveform data to local

3.2.3 右侧调试区域

3.2.3 Right Debug area

- JOG 可实现对关节的正反转点动
- 运行模式，选择相应模式，点击运行，设置相关控制参数关节即运动，停止关节即停止运动
- 正弦信号测试，可以设置正弦参数进行测试

JOG can achieve positive and negative rotation of the joint

Run mode, select the corresponding mode, click Run, set the relevant control parameters: the joint is the movement, stop the joint is the movement

Sine signal test, you can set the sine parameters to test

3.3 参数表

3.3 Parameter Table

成功连接电机后，点击配置模块中的参数表模块，日志中会显示全部参数加载成功，说明成功读取到电机相关参数（注：参数表需要在电机处于待机状态下进行配置，如果电机处于运行状态则无法进行参数表刷新）界面会显示电机的相

关参数，蓝色的参数为电机内部的存储参数，可以在相应参数后面的当前值栏进行修改，点击下载参数可以将调试器中参数下载到电机中，点击上传参数可以将电机中的参数上传到调试器中，电机恢复绿色参数为观测参数，为采集得到的参数，可进行实时观测。

注：电机的转矩限制、保护温度、过温时间请勿随意更改。因违规操作本 产品导致对人体造成伤害，或对关节造成不可逆的损伤，我司将不承担任何法律责任。

After the motor is successfully connected, click the parameter table module in the configuration module, and the log will show that all parameters are successfully loaded, indicating that the relevant parameters of the motor are successfully read (Note: The parameter table needs to be configured when the motor is in standby state. If the motor is in running state, the parameter table cannot be refreshed) The interface will display the relevant parameters of the motor. The parameters in blue are the stored parameters in the motor, which can be modified in the current value bar after the corresponding parameters. Click Upload parameter to upload the parameters in the motor to the debugger. The green parameter of the motor is the observation parameter, and the collected parameter can be observed in real time.

Note: Please do not change the torque limit, protection temperature and overtemperature time of the motor. Our company will not bear any legal responsibility for any damage to human body or irreversible damage to joints caused by illegal operation of this product

功能码	名称	参数类型	属性	最大值	最小值	当前值	备注
0X0000	Name	String	R/W			ÿÿÿÿÿÿÿÿÿÿ	
0X0001	BarCode	String	R/W			ÿÿÿÿÿÿÿÿÿÿ	
0X1000	BootCodeVersion	String	R			V	
0X1001	BootBuildDate	String	R			Oct 27 2023	
0X1002	BootBuildTime	String	R			17:50:36	
0X1003	AppCodeVersion	String	R			0.3.3.2	
0X1004	AppGitVersion	String	R			V	
0X1005	AppBuildDate	String	R			Oct 27 2023	
0X1006	AppBuildTime	String	R			17:50:41	
0X1007	AppCodeName	String	R			robot_motor	
0X2000	echoPara1	uint16		74	5	5	
0X2001	echoPara2	uint16		74	5	5	
0X2002	echoPara3	uint16		74	5	5	
0X2003	echoPara4	uint16		74	5	5	
0X2004	echoFreHz	uint32	R/W	10000	1	500	

0X2005	MechOffset	float	SET	7	-7	0.483204	
0X2006	MechPos_init	float	R/W	50	-50	0	
0X2007	limit_torque	float	R/W	30	0	12	
0X2008	I_FW_MAX	float	R/W	33	0	0	
0X2009	motor_index	uint8	SET	20	0	8	
0X200a	CAN_ID	uint8	SET	127	0	3	
0X200b	CAN_MASTER	uint8	SET	127	0	0	
0X200c	CAN_TIMEOUT	uint32	R/W	100000	0	0	
0X200d	motorOverTemp	int16	R/W	1500	0	800	
0X200e	overTempTime	uint32	R/W	1000000	1000	20000	
0X200f	GearRatio	float	R/W	64	1	7.75	
0X2010	Tq_caliType	uint8	R/W	1	0	1	
0X2011	cur_filt_gain	float	R/W	1	0	0.1	
0X2012	cur_kp	float	R/W	200	0	0.125	
0X2013	cur_ki	float	R/W	200	0	0.0158	
0X2014	spd_kp	float	R/W	200	0	1	
0X2015	spd_ki	float	R/W	200	0	0.002	
0X2016	loc_kp	float	R/W	200	0	30	
0X2017	spd_filt_gain	float	R/W	1	0	0.1	
0X2018	limit_spd	float	R/W	200	0	2	
0X2019	limit_cur	float	R/W	27	0	nan	
0X3000	timeUse0	uint16	R			4	
0X3001	timeUse1	uint16	R			0	
0X3002	timeUse2	uint16	R			10	
0X3003	timeUse3	uint16	R			0	
0X3004	encoderRaw	int16	R			641	
0X3005	mcuTemp	int16	R			311	
0X3006	motorTemp	int16	R			279	
0X3007	vBus(mv)	uint16	R			24157	
0X3008	adc1Offset	int32	R			2089	
0X3009	adc2Offset	int32	R			2084	

0X300a	adc1Raw	uint16	R			1243	
0X300b	adc2Raw	uint16	R			1216	
0X300c	VBUS	float	R			24.157	
0X300d	cmdId	float	R			0	
0X300e	cmdIq	float	R			0	
0X300f	cmdlocref	float	R			0	
0X3010	cmdspdref	float	R			0	
0X3011	cmdTorque	float	R			0	
0X3012	cmdPos	float	R			0	
0X3013	cmdVel	float	R			0	
0X3014	rotation	int16	R			0	
0X3015	modPos	float	R			0.656927	
0X3016	mechPos	float	R			0.022416	
0X3017	mechVel	float	R			65.698036	
0X3018	elecPos	float	R			3.848944	
0X3019	ia	float	R			0	
0X301a	ib	float	R			0	
0X301b	ic	float	R			0	
0X301c	timeout	int32	R			95357	
0X301d	phaseOrder	uint8	R			1	
0X301e	iqf	float	R			0	
0X301f	boardTemp	int16	R			293	
0X3020	iq	float	R			0	
0X3021	id	float	R			0	
0X3022	faultSta	uint32	R			0	
0X3023	warnSta	uint32	R			0	
0X3024	drv_fault	uint16	R			0	
0X3025	drv_temp	int16	R			38	
0X3026	Uq	float	R			0	
0X3027	Ud	float	R			0	
0X3028	dtc_u	float	R			0	
0X3029	dtc_v	float	R			0	
0X302a	dtc_w	float	R			0	
0X302b	v_bus	float	R			24.157	
0X302c	ElecOffset	float	R			−5.348038	
0X302d	torque_fdb	float	R			0	
0X302e	rated_i	float	R			8	
0X302f	limit_i	float	R			nan	

4 驱动器通信协议及使用说明
4 Driver communication protocol and instructions for use

通信采用 CAN 2.0 协议，波特率 1Mbps，数据格式如下所示：
The communication adopts CAN 2.0 protocol with 1Mbps baud rate, and the data format is as follows：

Data field	29bit_ID			8ByteData area
Size	bit0~7	bit8~23	Bit24~bit28	Byte0~Byte7
Description	Destination address	Data area2	Communication type	Data area1
Instructions	Communication is sent to the target ID Motor ID range: 1~127 Motion control host(SPIE)：0 Debugging host: 253(0XFD) Broadcast address：254(0XFE)	Extended data area	Indicates the type of the communication frame Radius：0~31	Main data area, 8bytes, can be combined with data area 2 to form 10 bytes

电机支持的控制模式包括：
运控模式：给定电机运控 5 个参数，同时控制速度，位置，力矩；
电流模式：给定电机指定的 Iq 电流；
速度模式：给定电机指定的运行速度；
位置模式：给定电机指定的位置，电机将运行到该指定的位置；

The control modes supported by the motor include:
Operation control mode: given 5 parameters of motor operation control, while controlling speed, position, torque;
Current mode: the specified Iq current of a given motor;
Speed mode: the specified running speed of the given motor;
Position mode: Given the specified position of the motor, the motor will run to the specified position;

4.1 通信协议类型说明

4.1 Description of communication protocol Types

4.1.1 获取设备 ID（通信类型 0）;获取设备的 ID 和 64 位 MCU 唯一标识符

4.1.1 Obtaining the device ID (communication type 0); Gets the ID of the device and the 64-bit MCU unique identifier

master->dev

Data field	29bit_ID			8ByteData area
Size	bit0~7	bit8~23	Bit24~bit28	Byte0~Byte7
Description	Dev canId	Master canId	0	
Instructions	Dev CAN_ID	Bit8~15:Master CAN_ID		

Dev->master & Dev->Bus (power-on will automatically broadcast the address)

Data field	29bit_ID			8ByteData area
Size	bit0~7	bit8~23	Bit24~bit28	Byte0~Byte7
Description	0XFE	Dev canId	0	MCU id
Instructions	masterAddress Broadcast Address:254	Bit8~15:equipment CAN_ID		64Bit MCU unique identifier

4.1.2 运控模式电机控制指令（通信类型 1）用来向电机发送控制指令

4.1.2 Motor control instructions (communication type 1) are used to send control instructions to the motor

master->dev

Data field	29bit_ID			8ByteData area
Size	bit0~7	bit8~23	Bit24~bit28	Byte0~Byte7
Description	Dev canId	Control instruction	1	Control instruction

Instructions	Dev_CAN_ID	Byte8~9:Moment (0~65535) range（-24Nm~24Nm）		Byte0~1: Target Angle[0~65535] range(-4π~4π) Byte2~3: Target angular velocity[0~65535] range(-45rad/s~45rad/s) Byte4~5：Kp Byte6~7：Kd

4.1.3 电机反馈数据 （通信类型 2） 用来向主机反馈电机运行状态

4.1.3 Motor feedback data (communication type 2) is used to feedback the running state of the motor to the host

dev->master

Data field	29bit_ID			8ByteData area
Size	bit0~7	bit8~23	Bit24~bit 28	Byte0~Byte7
Description	Master canId	Dev canId&Fault information	2	Feedback information
Instructions	Master CAN ID	Bit8~Bit15 Current device CAN ID Fault information（0/1） BIT16: Undervoltage fault BIT17: overcurrent BIT18: overtemperature BIT19: Magnetic coding fault BIT20: HALLCoding fault BIT21: uncalibrated Mode state（BIT22~23） 0 : ResetMode 1 : Cali Mode 2 : Motor Mode 3 : Brake Mode		Byte0~1: Current Angle[-32768~32767] range(-4π~4π) Byte2~3: Current angular velocity[-32768~32767] range(-45rad/s~45rad/s) Byte4~5:Current moment(-32768~32767) range（-24Nm~24Nm）

4.1.4 电机使能运行 （通信类型 3）

4.1.4 Motor operation Enabled (Communication type 3)

master->dev

Data field	29bit_ID			8ByteData area
Size	bit0~7	bit8~23	Bit24~bit28	Byte0~Byte7
Description	Dev canId	Master canId	3	
Instructions	Dev_CAN_ID	Bit8~15:Master CAN_ID		

4.1.5 电机停止运行 （通信类型 4）

4.1.5 Motor stops running (Communication Type 4)

master->dev

Data field	29bit_ID			8ByteData area
Size	bit0~7	bit8~23	Bit24~bit28	Byte0~Byte7
Description	Dev canId	Master canId	4	
Instructions	Dev CAN_ID	Bit8~15:Master CAN_ID		

4.1.6 设置电机机械零位（通信类型 6）会把当前电机位置设为机械零位（掉电丢失）

4.1.6 Setting the mechanical zero position of the motor (communication type 6) will set the current motor position to the mechanical zero position (power loss)

master->dev

Data field	29bit_ID			8ByteData area
Size	bit0~7	bit8~23	Bit24~bit28	Byte0~Byte7
Description	Dev canId	Master canId	6	

Instructions	目标电机 CAN_ID	Bit8~15:Master canId		

4.1.7 设置电机 CAN_ID（通信类型 7）更改当前电机 CAN_ID ， 立即生 效。

4.1.7 Setting Motor CAN_ID (Communication type 7) Change the current motor CAN_ID to take effect immediately

master->dev

Data field	29bit_ID			8ByteData area
Size	bit0~7	bit8~23	Bit24~bit28	Byte0~Byte7
Description	Dev canId	Master canId	7	
Instructions	Dev CAN_ID	Bit8~15:Master canId Bit16~23: Set ID		Set MCU ID

4.1.8 单个参数读取（通信类型 17）

4.1.8 Reading a single Parameter (Communication type 17)

master->dev

Data field	29bit_ID			8ByteData area
Size	bit0~7	bit8~23	Bit24~bit28	Byte0~Byte7
Description	Dev canId	Master CanId	17	Feedback information
Instructions	Dev CAN_ID	Bit8~15:Master CAN_ID		Byte0~1: index Byte2~3: sub-index Byte4~7:

dev->master

Data field	29bit_ID			8ByteData area
Size	bit0~7	bit8~23	Bit24~bit28	Byte0~Byte7
Description	Master CanId	Dev canId	17	Feedback information

Instructions	Master CAN_ID	Bit8~15:Dev CAN_ID Bit16~23:Read state 0: Successful return 1: Failed - No function code (still return current value)		Byte0~1: index Byte2~3: sub-index Byte4~7: Parameter data

4.1.9 单个参数写入（通信类型 18）（掉电丢失）

4.1.9 Writing a Single Parameter (Communication Type 18) (Lost due to power failure)

master->dev

Data field	29bit_ID			8ByteData area
Size	bit0~7	bit8~23	Bit24~bit28	Byte0~Byte7
Description	Dev canId	Master CanId	18	Feedback information
Instructions	Dev CAN_ID	Bit8~15:Master CAN_ID		Byte0~1: index Byte2~3: sub-index Byte4~7: Parameter data

Response frame: Response motor feedback frame (see communication type 2)

4.1.10 故障反馈帧（通信类型 21）

4.1.10 Fault Feedback Frame (Communication type 21)

dev->master

Data field	29bit_ID			8ByteData area
Size	bit0~7	bit8~23	Bit24~bit28	Byte0~Byte7
Description	Master CanId	Dev canId	21	Feedback information
Instructions	Master CanId	Bit8~15: Dev CAN_ID		Byte0~3: fault Non-0: faulty. 0: normal） bit16:A Phase current sampling overcurrent bit15~bit8:Overload fault bit7:Encoder uncalibrated bit5:C Phase current sampling overcurrent

				bit4:B Phase current sampling overcurrent
				bit3:Overvoltage fault
				bit2:Undervoltage fault
				bit1:Driver chip failure
				bit0:Motor overtemperature fault, default 80 degrees Byte4~7: warning value
				bit0：Motor overtemperature warning, default 75 degrees

4.2 控制模式使用说明

4.2 Usage of Control Mode

4.2.1 程序样例

4.2.1 Program Example

以下提供各种模式控制电机实例（以 gd32f303 为例） 下面为各种实例调用库，函数与宏定义

The following provides examples of various mode control motors (gd32f303 as an example) The following call libraries, functions and macro definitions for various instances

```
#define P_MIN -12.5f
#define P_MAX 12.5f
#define V_MIN -30.0f
#define V_MAX 30.0f
#define KP_MIN 0.0f
#define KP_MAX 500.0f
#define KD_MIN 0.0f
#define KD_MAX 5.0f
#define T_MIN -12.0f
#define T_MAX  12.0f

#define txCanIdEx    (*((struct exCanIdInfo*)&(txMsg.tx_efid)))
#define rxCanIdEx    (*((struct exCanIdInfo*)&(rxMsg.rx_efid)))

#define can_txd()    can_message_transmit(CAN0, &txMsg)
#define can_rxd()    can_message_receive(CAN0, CAN_FIFO1, &rxMsg)
```

```c
int float_to_uint(float x, float x_min, float x_max, int bits);

struct exCanIdInfo{
        uint32_t id:8;
        uint32_t data:16;
        canComMode mode:5;
        uint32_t res:3;
};

can_receive_message_struct   rxMsg;
can_trasnmit_message_struct  txMsg={
    .tx_sfid = 0,
    .tx_efid = 0xff,
    .tx_ft   = CAN_FT_DATA,
    .tx_ff   = CAN_FF_EXTENDED,
    .tx_dlen = 8,
};
```

下面列举常见的通信类型发送：
The following lists the common types of communication sent:

1、电机使能运行帧（通信类型 3）
1、Motor Enabled Run frame (communication type 3)

```c
void motor_enable(uint8_t id, uint16_t master_id)
{
    txCanIdEx.mode = 3;
    txCanIdEx.id = id;
    txCanIdEx.res = 0;
    txCanIdEx.data = master_id;
    txMsg.tx_dlen = 8;
    txCanIdEx.data = 0;
    can_txd();
}
```

2、运控模式电机控制指令（通信类型 1）
2、Operation control mode Motor control instruction (communication type 1)
```c
void motor_controlmode(uint8_t id, float torque,

float MechPosition, float speed, float kp, float kd)
{
```

```
    txCanIdEx.mode = 1;
    txCanIdEx.id = id;
    txCanIdEx.res = 0;
    txCanIdEx.data = float_to_uint(torque,T_MIN,T_MAX,16);
    txMsg.tx_dlen = 8;
    txMsg.tx_data[0]=float_to_uint(MechPosition,P_MIN,P_MAX,16)>>8;
    txMsg.tx_data[1]=float_to_uint(MechPosition,P_MIN,P_MAX,16);
    txMsg.tx_data[2]=float_to_uint(speed,V_MIN,V_MAX,16)>>8;
    txMsg.tx_data[3]=float_to_uint(speed,V_MIN,V_MAX,16);
    txMsg.tx_data[4]=float_to_uint(kp,KP_MIN,KP_MAX,16)>>8;
    txMsg.tx_data[5]=float_to_uint(kp,KP_MIN,KP_MAX,16);
    txMsg.tx_data[6]=float_to_uint(kd,KD_MIN,KD_MAX,16)>>8;
    txMsg.tx_data[7]=float_to_uint(kd,KD_MIN,KD_MAX,16); can_txd();
}
```

3、电机停止运行帧（通信类型 4）
3、Motor stop frame (communication type 4)

```
void motor_reset(uint8_t id, uint16_t master_id)
{
    txCanIdEx.mode = 4;
    txCanIdEx.id = id;
    txCanIdEx.res = 0;
    txCanIdEx.data = master_id;
    txMsg.tx_dlen = 8;
    for(uint8_t i=0;i<8;i++)
    {
        txMsg.tx_data[i]=0;
    }
        can_txd();
}
```

4、电机模式参数写入命令（通信类型 18，运行模式切换）
4、Motor mode parameter write command (communication type 18, operation mode switch)

```
uint8_t runmode;
uint16_t index;
void motor_modechange(uint8_t id, uint16_t master_id)
{
    txCanIdEx.mode = 0x12;
    txCanIdEx.id = id;
    txCanIdEx.res = 0;
    txCanIdEx.data = master_id;
```

```
    txMsg.tx_dlen = 8;
    for(uint8_t i=0;i<8;i++)
    {
        txMsg.tx_data[i]=0;
    }
    memcpy(&txMsg.tx_data[0],&index,2);
    memcpy(&txMsg.tx_data[4],&runmode, 1);
    can_txd();
}
```

5、电机模式参数写入命令（通信类型 18，控制参数写入）
5、motor mode parameter write command (communication type 18, control parameter write)
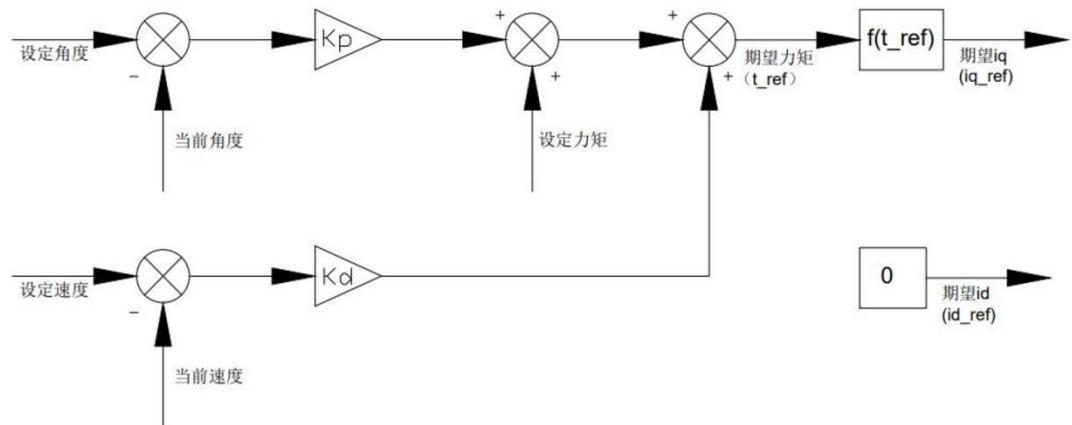
```
uint16_t index;
float ref;
void motor_write(uint8_t id, uint16_t master_id)
{
    txCanIdEx.mode = 0x12;
    txCanIdEx.id = id;
    txCanIdEx.res = 0;
    txCanIdEx.data = master_id;
    txMsg.tx_dlen = 8;
    for(uint8_t i=0;i<8;i++)
    {
        txMsg.tx_data[i]=0;
    }
    memcpy(&txMsg.tx_data[0],&index,2);
    memcpy(&txMsg.tx_data[4],&ref,4); can_txd();
}
```

4.2.2 运控模式

4.2.2 Operation and control mode

电机上电后默认处于运控模式； 发送电机使能运行帧（通信类型 3）-->发送运控模式电机控制指令（通信类型 1）-->收到电机反馈帧（通信类型 2）

The motor is in operation control mode by default after power-on. Send motor Enable Run frame (communication type 3) --> Send operation mode motor control command (communication type 1) --> Receive motor feedback frame (communication type 2)

4.2.3 电流模式
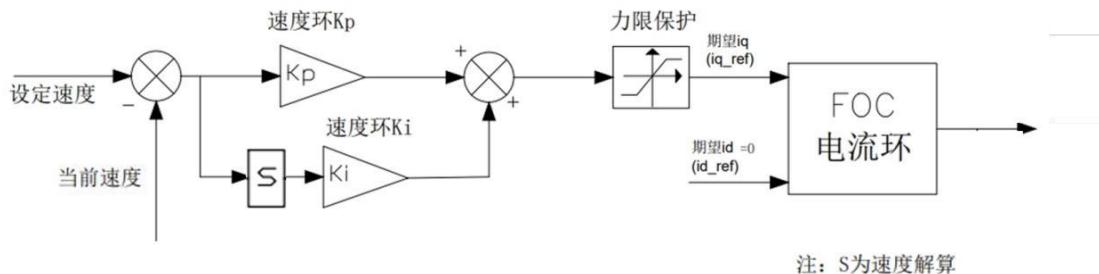
4.2.3 Current Mode

发送电机模式参数写入命令（通信类型 18）设置 runmode 参数为 3 --->发送 电机使能运行帧（通信类型 3）--> 发送电机模式参数写入命令（通信类型 18）设置 iq_ref 参数为预设电流指令

Send motor mode parameter write command (communication type 18) Set the runmode parameter to 3 --> Send motor Enable run frame (communication type 3) --> Send motor mode parameter write command (communication type 18) set the iq_ref parameter to the default current instruction

4.2.4 速度模式

4.2.4 Speed Mode

注：S为速度解算
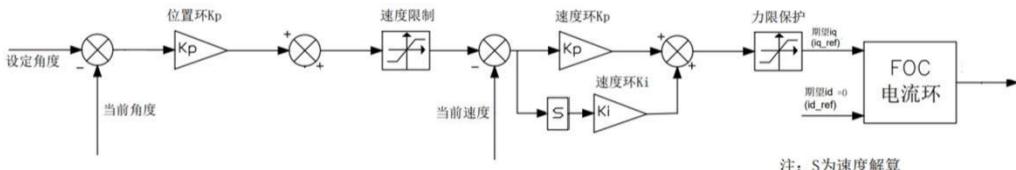
发送电机模式参数写入命令（通信类型 18）设置 runmode 参数为 2 --->
发送 电机使能运行帧（通信类型 3）--> 发送电机模式参数写入命令（通信类
型 18）设置 limit_cur 参数为预设最大电流指令-->发送电机模式参数写入命
令 （通信类型 18）设置 spd_ref 参数为预设速度指令

Send motor mode parameter write command (communication type 18) Set
runmode parameter to 2 --> Send motor Enable run frame (communication type
3) --> Send motor mode parameter write command (communication type 18)
set limit_cur Parameter is preset Maximum Current Instruction --> Send
motor Mode parameter Write command (communication type 18) Set spd_ref
parameter to preset speed instruction

4.2.5 位置模式

4.2.5 Location Mode

注：S为速度解算

发送电机模式参数写入命令（通信类型 18）设置 runmode 参数为 1 --> 发
送电 机使能运行帧（通信类型 3）--> 发送电机模式参数写入命令（通信类型 18）
设置 limit_spd 参数为预设最大速度指令-->发送电机模式参数写入命令（通
信类型 18）设置 loc_ref 参数为预设位置指令

Send motor mode parameter write command (communication type 18) Set
the runmode parameter to 1 --> Send motor Enable run frame (communication
type 3) --> Send motor mode parameter write command (communication type
18) set limit_spd Parameter to Default Maximum speed Instruction --> Send
motor Mode parameter Write command (communication type 18) Set loc_ref
parameter to default position instruction

4.2.6 停止运行

4.2.6 Stopping the Running

発送电机停止运行帧（通信类型 4）
Sending motor stop frame (communication type 4)

注意事项

1、请按照本文规定的工作参数使用，否则会对本产品造成严重的损坏！
2、在关节运行时不可切换控制方式，如需切换需要发送停止运行命令后再做切换。
3、使用前请检查各部件是否完好，如发生部件缺失、损坏请及时联系技术支 持。
4、请勿随意拆卸电机，以免出现无法恢复的故障。
5、确保电机连接时无短路，接口按要求正确连接。

Matters needing attention

1, please use according to the working parameters specified in this article, otherwise it will cause serious damage to the product!

2. Do not switch the control mode when the joint is running. If you need to switch, you need to send the command to stop running before switching.

3. Please check whether the parts are in good condition before use. If the parts are missing or damaged, please contact technical support in time.

4, do not disassemble the motor at will, so as to avoid failure that cannot be recovered.

Ensure that there is no short circuit when the motor is connected and that the interfaces are properly connected as required.

法律声明

在使用本产品前，请用户务必仔细阅读本手册，按照本手册内容操作本产品。如用户违反本手册内容使用本产品，造成的任何财产损失、人身伤害事故，本公司不承担任何责任。 因本产品由众多零部件构成，切勿让儿童接触本产品，以免发生意外事故。为延长产品使用寿命，请勿在高温、高压环境中使用本产品。本手册在印刷时已尽可能的包含各项功能介绍和使用说明。但由于产品功能不断完善、设计变更等，仍可能与用户购买的产品有不符之处。本手册与实际产品在颜色、外观等方面可能有所偏差，请以实际产品为准。本手册由公司出版，公司随时可能对本手册中的印刷错误、不准确的最新信息进行必要的改进和更改，或对程序和/或设备进行改进，恕不另行通知。此类更改将上传到本手册的新版本中，请扫描本手册二维码进行获取。所有图片仅供功能说明参考，请以实物为准。

Legal statement

Before using this product, please read this manual carefully and operate the product according to the contents of this manual. If the user violates the contents of this manual to use this product, resulting in any property damage, personal injury accident, the company does not assume any

responsibility. Because this product is composed of many parts, do not allow children to touch this product to avoid accidents. In order to prolong the service life of the product, do not use this product in high temperature and high pressure environment. This manual has been printed to the extent possible to include a description of the functions and instructions for use. However, due to the continuous improvement of product functions, design changes, etc., there may still be discrepancies with the products purchased by users. The color and appearance of this manual may differ from the actual product. Please refer to the actual product. This manual is published by the Company, and the Company may at any time, without notice, make necessary improvements and changes to the current information contained in this manual with typographical errors and inaccuracies, or to procedures and/or equipment. Such changes will be uploaded to the new version of this manual, please scan the QR code of this manual to obtain. All images are for reference only. Please refer to actual objects.

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本产品售后服务严格依据《中华人民共和国消费者权益保护法》、《中华人民共和国产品质量法》实行售后服务。

服务内容如下：
（1）自用户签收次日起 7 天内，发生非人为损坏性能故障，经由检测确认后，为用户办理退货业务，退货时用户须出示有效购买凭证，并 退回发票。如有赠品需一并退回。

（2）自用户签收次日起 7 天后至 15 天内，发生非人为损坏性能故障，经由检测确认后，为用户办理换货业务，更换整套商品。

（3）自用户签收次日起 15 天后至 365 天内，经由检测确认后，属于产品本身质量故障，可免费提供维修服务。更换的故障产品归公司所有。无故障产品，将原样返回。本产品经过各项严格检测后出厂，如有非产品本身质量故障，我们将有权拒绝用户的退换货需求。
（4）本手册售后政策若与店铺售后政策不一致的，以店铺的售后政策为准。

非保修条例以下情况不属于保修范围：
1. 超出保修条款所限定的保修期限。
2. 未按照说明书要求，错误使用造成的产品损坏损毁。
3. 不当的操作、维修、安装、改装、测试等不正当使用造成的损坏损毁。
4. 非质量故障引起的常规机械损耗、磨损。
5. 非正常工况下造成的损坏，包括但不限于跌落、撞击、液体浸入、剧烈撞击 等。
6. 天灾（如水灾、火灾、雷击、地震等）或不可抗击力造成的损坏。
7. 超过峰值扭矩使用造成的损坏。

8. 非原装正品或无法提供合法购买凭证。
9. 其他非产品的设计、技术、制造、质量等问题导致的故障或损坏。
10. 将本产品应用于商业用途。 如果出现上述情况，用户需自行支付维修费用。

After-sales policy

The after-sales service of this product is strictly implemented in accordance with the Law of the People's Republic of China on the Protection of Consumer Rights and Interests and the Product Quality Law of the People's Republic of China.

The services are as follows:
(1) Within 7 days from the day after the user signs for the failure of non-human damage performance, after the detection and confirmation, the user shall handle the return business for the user, the user shall present the valid purchase voucher at the time of return, and return the invoice. Any freebies should be returned.

(2) Within 7 days to 15 days from the day after the user signs for the failure of non-human damage performance, after detection and confirmation, for the user to replace the whole set of goods.

(3) From 15 days to 365 days after the user signed the next day, after the inspection and confirmation, it is a quality fault of the product itself, can provide free maintenance services. The replacement of faulty products belongs to the company. The product is not faulty and will be returned as is. This product has been strictly tested after the factory, if there is a quality fault other than the product itself, we will have the right to refuse the user's return demand.
(4) If the after-sales policy of this manual is inconsistent with the after-sales policy of the store, the after-sales policy of the store shall prevail.

The following conditions are not covered by the warranty:
1. Exceed the warranty period specified in the warranty terms.
2. Failure to follow the instructions, resulting in product damage caused by wrong use.
3. Damage caused by improper operation, maintenance, installation, modification, testing and other improper use.
4. Non-quality failure caused by conventional mechanical loss, wear.
5. Damage caused by abnormal working conditions, including but not limited to falling, impact, liquid immersion, violent impact, etc.
6. Damage caused by natural disasters (such as floods, fires, lightning strikes, earthquakes, etc.) or incapacitated forces.

7. Damage caused by exceeding peak torque.
8. It is not authentic or cannot provide legal purchase proof.
9. Failure or damage caused by other non-product design, technology, manufacturing, quality and other problems.
10. Use this product for commercial purposes. If the above situation occurs, the user must pay the repair cost.