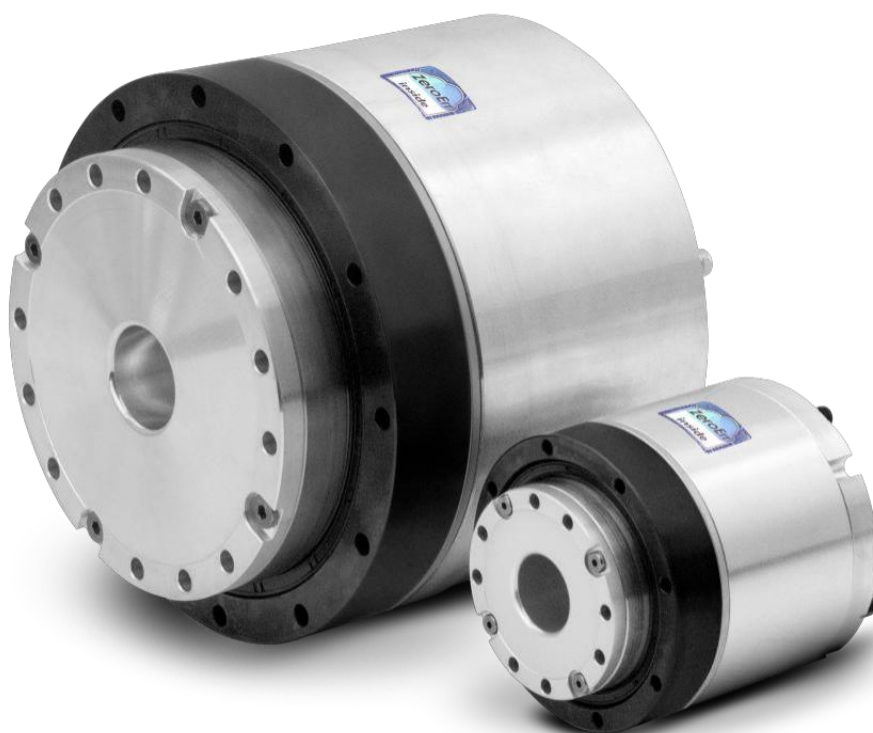




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eRob CANopen and EtherCAT 用户手册 V1.9

eRob CANopen and EtherCAT User Manual V1.9



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第一章 介绍

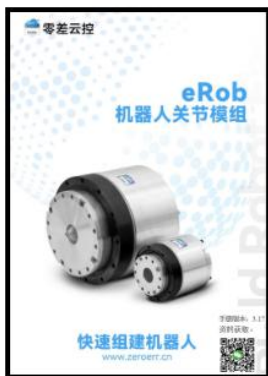
Chapter 1 Introduction

本手册阐述了 eRob 关节模组支持的 CANopen DS 301 与 DSP 402 协议。它提供了对 eRob 关节模组的描述和基于 CiA CANopen 协议实现通信的方法。大多数 eRob 关节模组功能都是根据 CiA DS 301 V4.2、DSP402（专有）为标准的。本手册并没有包含所有相关的 CiA 信息，虽然对大部分实现的对象进行了说明，但并未记录在这个文档中。

This manual explains how to implement CANopen DS 301 and DSP 402 communication with eRob. It provides a description of eRob and the means of implementing communication based on the CiA CANopen protocols. Most eRob functionality is standard, according to CiA documents DS 301 version 4.2, DSP 402 (proprietary). The manual does not contain all relevant CiA information, indicating that many objects are implemented, but are not documented here in.

1.1 相关文档

Relevant Documentation



eRob Rotary Actuator User Manual



eRob Modbus-RTU Communication User Manual

图 1-1 eRob 关节模组文档集

Figure 1-1 The eRob documentation set

本手册只是 eRob 关节模组文档集中的一部分，除了本文档外，eRob 关节模组文档集还包括：

- 1、《eRob 机器人关节模组用户手册》；
- 2、《eRob Modbus-RTU 通信应用手册》。

This manual is part of the eRob documentation set, in addition to this document, the eRob documentation set includes:

1. <eRob Rotary Actuator User Manual>;
2. <eRob Modbus-RTU Communication User Manual>.



1.2 参考文档

Documentation

Document Name	Author	Source
CAN Implementation Guidelines	Gruhler G. and Drier B.	STA Reutlingen
CiA DS 302 V3.0: CANopen Framework for Programmable Devices		CiA
CiA DSP 402 V 2.0: CANopen Device Profile		CiA
CiA DS 202-2 V1.1: CAN Application Layer (CAL) - CMS Protocol Specification		CiA
CiA301 V4.2.0: CANopen Application Layer and Communication Profile		CiA
CiA 402 Part 1: Device Profile for Drives and Motion Control, General Definitions		CiA
CiA 402 Part 2: Device Profile for Drives and Motion Control, Operation Modes and Application Data		CiA
CiA 402 Part 3: Device Profile for Drives and Motion Control, PDO Mapping		CiA
IEC 61800-7-1: Adjustable Speed Power Drive Systems		ETG
IEC 61800-7: ETG Implementation Guideline for the CiA402 Drive Profile		ETG

1.3 术语和缩写

Terms and Abbreviations

本手册使用了以下术语和缩写。

The following terms and abbreviations are used in this manual.

表 1-1 手册缩写

Table 1-1 The document abbreviations

Abbreviations	Description
CAN	Controller Area Network.
CiA	CAN in Automation.
CMS	CAN message specification .
IEC	International Electro technical Commission.
ETG	EtherCAT Technology Group.



NMT	Network Management; one of the service elements of the CAN Application Layer in the CAN Reference Model. It performs initialisation, configuration and error handling on a CAN network.
COB-ID	A binary bit-field that includes the ID of the server with which the master talks, and the type of COB.
SDO	Service Data Object.
PDO	Process Data Object.
Receive	In this manual, “received” data is sent from the control equipment to the servo drive.
Transmit	In this manual, “transmitted” data is sent from the servo drive to the other equipment.
RxPDO	Receive Process Data Object.
TxPDO	Transmit Process Data Object.
plus	Defines the resolution of the digital incremental encoder. The value is given in [pulses/revolution].
EDS	Electronic data sheet; a standard form of all CAN objects supported by a device. The EDS is used by external CAN configurators.
CSP	Cyclic Synchronous Position mode.
PP	Profile Position mode.
CSV	Cyclic Synchronous Velocity mode.
PV	Profile Velocity mode.
CST	Cyclic Synchronous Torque mode.
PT	Profile Torque mode.
HM	Homing mode.
IP	Interpolated Position mode.
Object	A CAN message with a meaningful functionality and/or data. Objects are referenced according to addresses in the object dictionary.
LSB	Least Significant Bit (or Byte).
MSB	Most Significant Bit (or Byte).
ESI	EtherCAT Slave Information.
DC	Distributed Clocks mode.
ESC	EtherCAT Slave Controller.
SM	SYNC manager.
eRob	eRob Rotary Actuator.

第二章 系统概述

Chapter 2 System Overview

2.1 设备架构

Device Architecture

eRob 关节模组通信接口符合以下标准：

The eRob communication interface conforms to the following standards:

CiA 301 V4.2: CANopen 应用层和通信配置协议。

CiA 301 V4.2: CANopen Application Layer and Communication Profile.

CiA 402 V4.0: 伺服驱动与运动控制子协议。

CiA 402 V4.0: CANopen device profile for drives and motion control.

ETG.1000 V1.0.4: EtherCAT 协议规范。

ETG.1000 V1.0.4: EtherCAT Specification.

ETG.1020 V1.2.0: EtherCAT 协议补充说明。

ETG.1020 V1.2.0: EtherCAT Protocol Enhancements Specification.

ETG.2000 V1.0.9: 以太网从站信息（ESI）规范。

ETG.2000 V1.0.9: EtherCAT Slave Information(ESI) Specification.

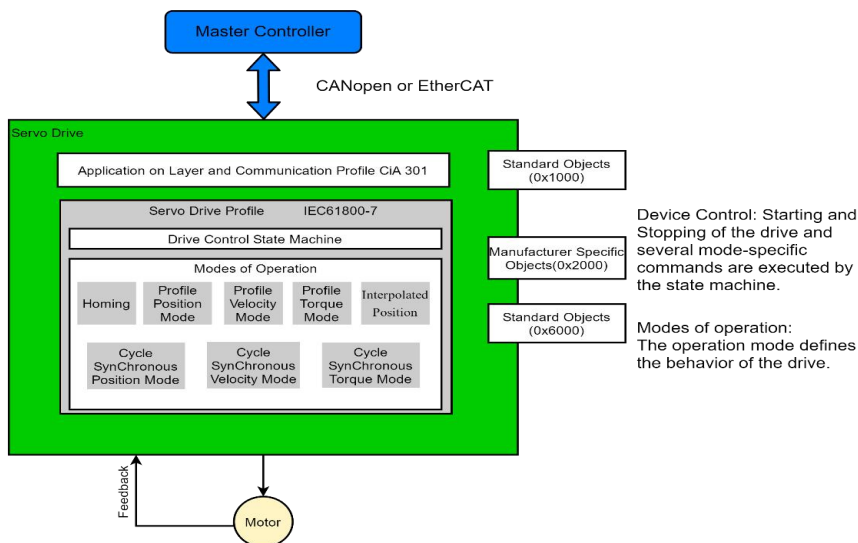


图 2-1 设备架构

Figure 2-1 Device architecture



第三章 CANopen 通信协议

Chapter 3 CANopen Communication Protocol

3.1 基本配置

Basic Configuration

3.1.1. 支持的功能

Support functions

eRob 关节模组支持的 CANopen 功能:

- CANopen 通讯协议: NMT、SYNC、SDO、PDO、EMCY;
- SDO 传输: 非周期性数据交换, 供读写参数和通讯相关配置;
- PDO 的发送/接收: 通过时间触发、事件触发、同步发送 (周期);
- 节点保护(Node Guarding);
- 心跳保护(Heartbeat)。

The CANopen functions supported by the eRob:

- CANopen communication objects: NMT, SYNC, SDO, PDO, EMCY;
- SDO transmission: acyclic data exchange for reading and writing parameters and communication related settings;
- PDO transmission/reception: time-trigger, event-trigger, synchronous-transmission (cycle);
- Node Guarding;
- Heartbeat.

3.1.2. 通信连接

Communication connection

请参考《eRob 机器人关节模组用户手册》第 5.2 章节 CAN 通信接口和第 6.2 章节 CAN/CANopen 通信接线图。

Defined according to < eRob Rotary Actuator User Manual> section 5.2 CAN communication interface. And section 6.2 CAN/CANopen communication wiring diagram.

3.2 NMT 状态机

NMT State Machine

NMT 状态机如图 3-1 所示。伺服驱动器在完成初始化 (Initialization)后，即进入预操作 (Pre-Operational) 状态。NMT 状态机决定通信功能的是否可以使用，如 PDO 通信仅在 Operational 状态下使用。

The NMT state machine is shown as follows figure 3-1. After the servo drive completes the initialization, it enters the Pre-Operational state. The NMT state machine determines the behavior of the communication objects, such as PDO functions only in the Operational state.

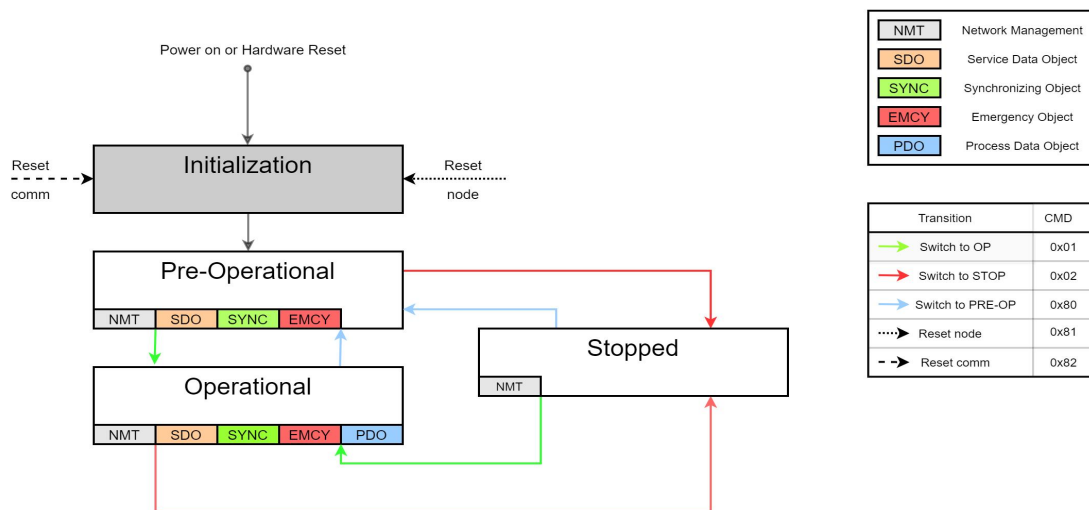


图 3-1 NMT 状态机

Figure 3-1 NMT state machine

“Network Management” 报文的 CAN-ID 为 0x000。报文的长度始终为两个字节，并具有以下结构：

The “Network Management” message has CAN-ID to 0x000. A message is always two bytes long and has the following structure:

表 3-1 NMT 报文格式

Table 3-1 The NMT message format

NMT message(NMT-Master → NMT-Slave)		
COB-ID	Data	
	Byte0	Byte1
0x000	CMD	Node ID

表 3-2 NMT 状态机状态

Table 3-2 NMT state machine status

Status	Description
初始化 Initialization	驱动器在上电后成功初始化，无任何错误发生。此状态中无法发送封包。 The servo drive successfully completes initialization after being powered on without errors occurring. The packets can not yet be transmitted in this state.
预操作 Pre-Operational	可经由 SDO 交换数据。若伺服驱动器发生报错，将会发送一帧紧急报文通知上位机。 Data can be exchanged with SDOs. If an alarm occurs in the servo drive, an emergency message is sent to the controller.
停止 Stopped	伺服只响应 NMT 对象（包括 heartbeats）。 Servo drive can respond only to NMT objects (including heartbeats).
运行状态 Operational	此状态可进行所有的数据交换，包括 SDO 和 PDO (TxPDO 和 RxPDO)。 All data exchanges including SDOs and PDOs (TxPDOs and RxPDOs) are allowed.

表 3-3 说明各通信状态所能使用的通信对象：

The following table 3-3 shows the available communication objects in each communication state:

表 3-3 NMT 状态机各状态允许的通信对象

Table 3-3 The communication object allowed by the NMT state machine state

Communication object	Initialization	Pre-Operational	Operational	Stopped
PDO	-	-	Active	-
SDO	-	Active	Active	-
SYNC	-	Active	Active	-
EMCY	-	Active	Active	-
BOOT-UP	Active	-	-	-
NMT	-	Active	Active	Active

3.3 NMT 启动报文

NMT Boot-up

Boot-up 用于表示 NMT 从站在 NMT 初始化状态后进入 NMT 预操作状态。此协议与心跳协议使用相同的 COB-ID。

The Boot-up is used to signify that a NMT slave has entered the NMT state Pre-Operational after the NMT state initialization. This protocol uses the same COB-ID as the heartbeat protocol.

表 3-4 Boot-up 格式

Table 3-4 The Boot-up messages format

COB-ID	Data
	Byte0
0x700 + Node ID	00

3.4 同步对象 (SYNC)

Synchronization Object (SYNC)

SYNC 协议可以实现网络信息同步。SYNC 消费者启动其特定的程序接收循环发送的 SYNC 报文，该程序与 SYNC 消息的接收紧密相关。同一个 CAN 网络中只允许有一个激活的同步发生器。图 3-2 表示 SYNC 协议报文传输。

Network message synchronization can be achieved using the SYNC protocol. A looped SYNC message indicates that the consumer has launched their specific application, which is closely related to the receipt of the SYNC message. In one CAN, only one activated synchronization generator is allowed. The figure 3-2 shows the SYNC message transmission for the SYNC protocol.

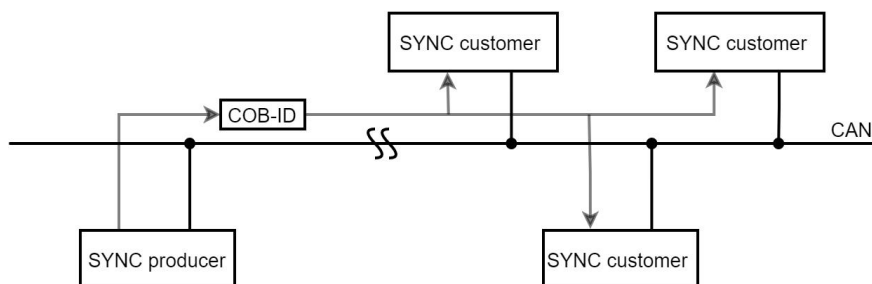


图 3-2 SYNC 架构

Figure 3-2 SYNC architecture

SYNC 被赋予了非常高优先级的 CAN-ID，目的在于保证能够及时访问网络，同步运行的 CANopen 设备可以使用 SYNC 对象来使自己的时间与 SYNC 生产者的时间同步。

In order to guarantee timely access to the network the SYNC is given a very high priority CAN-ID. CANopen devices that operate synchronously may use the SYNC object to synchronize their own timing with that of the SYNC object producer.

表 3-5 SYNC 报文内容

Table 3-5 SYNC message content

Bits	Value	Meaning
Bit 31(MSB)	x	Do not case
Bit 30	0	Device does not generate SYNC message
	1	Device generate SYNC message
Bit 29	0	11-bit ID (CAN-2.0A)
	1	29-bit ID (CAN-2.0B)
Bit 28-11	0	If bit 29=0
	x	If bit 29=1,bit 28-11 of 29-bit SYNC COB-ID
Bit 10-0 (LSB)	x	Bit 10-0 of SYNC COB-ID

两个连续 SYNC 封包之间的时间段称为同步循环周期，可以在 SYNC 生产者的对象字典（0x1006）中进行配置。

同步发送 PDO 在接收到 SYNC 封包后的指定时间范围内开始发送。此时间范围称为同步窗口长度，可在 SYNC 消费者的对象字典（0x1007）中进行配置。

图 3-3 表示同步窗口长度和通讯循环周期。

The period of time between two consecutive SYNC messages is called the communication cycle period and can be adjusted in the SYNC producer's object dictionary (0x1006).

Synchronous transport PDO begins transmission within the specified time frame after receiving the SYNC message. This time range, called the synchronization window length. It can be configured in the object dictionary (0x1007) of SYNC consumer.

The figure 3-3 shows the synchronous window length and communication cycle period.

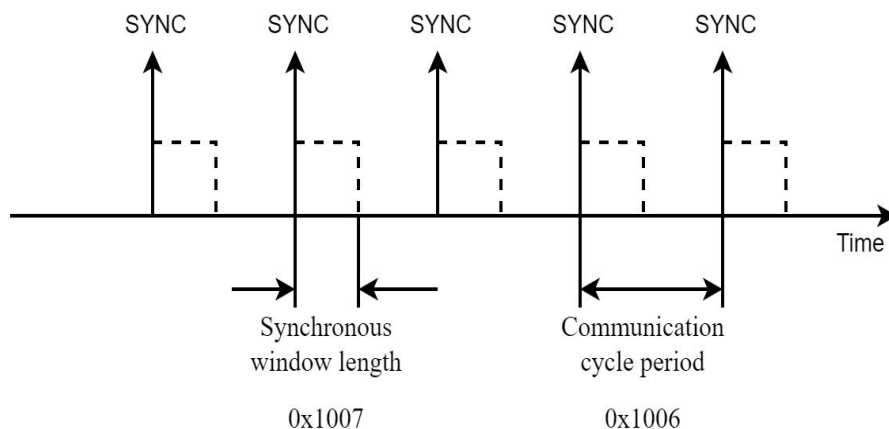


图 3-3 同步窗口长度和循环周期

Figure3-3 The synchronous window length and the communication cycle period

3.5 紧急对象（EMCY）

Emergency Object (EMCY)

当 CANopen 节点出现错误时，按照标准化机制，节点会发送一帧紧急报文。紧急报文遵循的是生产者—消费者模型，节点紧急报文发出后，CAN 网络中其他节点可选择处理该错误。eRob 关节模组只作为紧急报文生产者，不处理其他节点紧急报文。

When an error occurs in a CANopen node, according to the standardized mechanism, the node will send an emergency message. The emergency message follows the producer-consumer model. After a node emergency message is sent, other nodes in the CAN network can choose to deal with the error. eRob only acts as an emergency message producer, and does not process emergency messages from other nodes.

表 3-6 紧急报文格式

Table 3-6 The emergency message format

EMCY				
COB-ID	Message			
	Byte0-Byte1	Byte2	Byte3	Byte4~Byte7
0x80 + Node ID	Emergency error code	Error register (object 0x1001)	Reserved	<0>

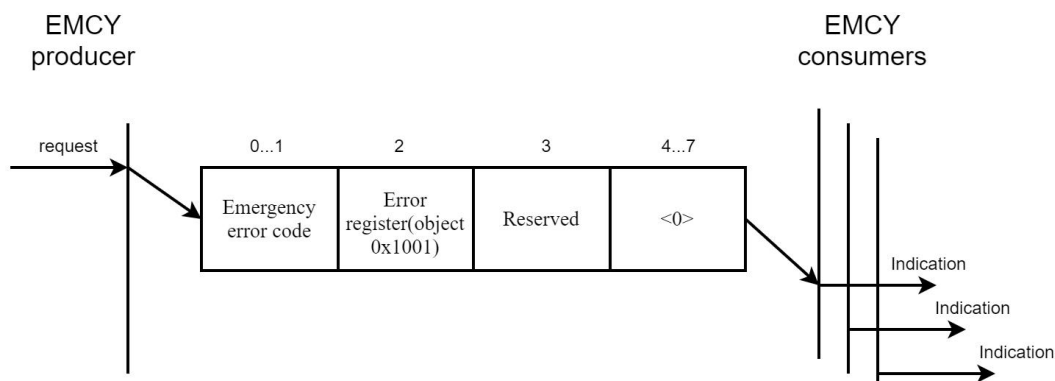


图 3-4 EMCY 模型

Figure3-4 EMCY model

与总是作为响应请求发送的同步服务请求错误代码不同，紧急错误（故障）代码是异步的。无论用户使用什么指令，紧急错误事件可以在任何时候发生（例如，温度过高）。

在检测到设备内部错误后，驱动器将使用 COB-ID EMCY 通过 CANopen 网络发送紧急报文，每个错误事件只发送一次紧急报文，由错误代码和错误寄存器的实际状态组成。当驱动器在中出现错误状态时，驱动器通过对象 0x603F 发送错误代码到主站设备。

Unlike the synchronous service request error (abort) codes which are always sent as response to a request, the emergency error (fault) codes are asynchronous. These events can occur at any time regardless of the user command (for example, temperature is too high).

Upon detection of device-internal errors, the drive will transmit emergency message frames over the CANopen network using COB-ID EMCY. An emergency message frame will be transmitted only once per error event and consists of the error code and the actual state of the Error Register object. When an illegal state occurs in the drive, the drive sends the code to the master device as object 0x603F (Error Code).



3.6 服务数据对象（SDO）

Service Data Objects (SDO)

通过服务数据对象(SDO)，用户可写入或读取对象 (Object)。SDO 报文格式主要是由 COB-ID 与 SDO 数据所组成，SDO 数据最大可发送 4 bytes。

With service data objects (SDOs), you can write or read objects. The SDO message format is mainly composed of COB-ID and SDO packets, SDO packets can transmit up to 4 bytes.

表 3-7 SDO 报文说明

Table 3-7 Meaning of SDO message

Byte	Function
Byte0	Command code
Byte1- Byte2	Object index
Byte3	Object sub-index
Byte4- Byte7	Data

3.6.1. 写 SDO 数据

Write SDO data

上位机若需要使用 SDO 写入报文，需依照 SDO 格式写入：指令码、索引、子索引、数据。eRob 关节模组依据上位机写入的数据，响应相应的信息。

To use an SDO to write data with the controller, you need to write the command code, index, sub-index and data according to the SDO format. The eRob then returns the corresponding message based on the written data.

表 3-8 为上位机 SDO 写入的报文格式：

The table 3-8 shows the packet format when the controller sends the SDO for writing data:



表 3-8 写 SDO 报文格式

Table 3-8 Write SDO message format

		COB-ID	Data							
			Byte0	Byte1	Byte2	Byte3	Byte4	Byte5	Byte6	Byte7
Client →	Normal	0x600+ Node ID	23h	Index		Sub- index	Data			
			27h				Data			-
			2Bh				Data		-	-
			2Fh				Data	-	-	-
Server ←	Normal	0x580+	60h	Index		Sub- index	-	-	-	-
Exception	Node ID	80h	Abort codes							

举例说明：以伺服 ID=1 为例

For example: Take servo ID=1

Operate	COB-ID	Message
运行模式设置为轮廓位置模式	601	2F 60 60 00 01 00 00 00
The modes of operation set to profile position mode	581	60 60 60 00 00 00 00 00
控制字设置为 7	601	2B 40 60 00 07 00 00 00
Control word set to 7	581	60 40 60 00 00 00 00 00
目标位置设置为 5566 plus	601	23 7A 60 00 BE 15 00 00
Write target position set to 5566 plus	581	60 81 60 00 00 00 00 00

3.6.2. 读 SDO 数据

Read SDO data

上位机若需要使用 SDO 读取信息，需依照 SDO 格式写指令码、索引和子索引。eRob 关节模组再依照上位机需要读取的对象，反馈该对象的数据。

To use an SDO to read data with the controller, you need to write the command code,index and sub-index according to the SDO format. The eRob then returns the objects data based on the object to be read.

表 3-9 为上位机 SDO 读取的封包格式：

The following table 3-9 shows the packet format returned when the controllers sends the SDO for reading data:

表 3-9 读 SDO 报文格式

Table 3-9 Read SDO message format

		COB-ID	Data							
			Byte0	Byte1	Byte2	Byte3	Byte4	Byte5	Byte6	Byte7
Client →		0x600+ Node ID	40h	Index		Sub- index	-	-	-	-
Server ←	Normal	0x580+ Node ID	43h	Index		Sub- index	Data			
			47h				Data			-
			4Bh				Data			-
			4Fh				Data	-	-	-
	Exception	80h	Abort codes							

举例说明：以伺服 ID=1 为例

For example: Take servo ID=1

Operate	COB-ID	Message
读取当前运行模式	601	40 61 60 00 00 00 00 00
Read out the current operating mode	581	4F 61 60 00 01 00 00 00
读取状态字反馈	601	40 41 60 00 00 00 00 00
Read the status word feedback	581	4B 41 60 00 22 01 00 00
读取当前位置	601	40 64 60 00 00 00 00 00
Read the actual position value	581	43 64 60 00 00 00 00 00

3.7 过程数据对象（PDO）

Process Data Object (PDO)

通过 PDO 可以实现数据的实时(real-time)传输。PDO 可分成两种：发送的 TxPDO 和接收的 RxPDO。此定义是从 eRob 关节模组（从站）角度来看，例如发送 TxPDO 是指 eRob 关节模组发送至上位机的信息。使用 PDO 必须配置通讯参数与映射参数，如表 3-10 所示，CANopen 版本的 eRob 关节模组支持 4 个 RxPDO 和 4 个 TxPDO，每个 PDO 可映射长度最大为 8 个字节。

- Real-time data transmission can be achieved with process data objects(PDOs). There are two types of PDOs: transmit PDOs(TxPDOs) and receive PDOs(RxPDOs). This definition is from the perspective of the eRob, for example, the TxPDO refers to



the object that the eRob transmit to the controller. Set the communication parameters and mapping parameters as shown in table 3-10 to use the PDOs. The CANopen eRob joint module supports four RXPDos and four TXPDos, each of which can map up to eight bytes in length.

表 3-10 PDO 通讯与映射对象

Table 3-10 The PDO communication index and mapping index

PDOs	Communication object	Communication object index	Mapping object index	COB-ID
RxPDOs	RxPDO1	0x1400	0x1600	0x200+Node_ID
	RxPDO2	0x1401	0x1601	0x300+Node_ID
	RxPDO3	0x1402	0x1602	0x400+Node_ID
	RxPDO4	0x1403	0x1603	0x500+Node_ID
TxPDOs	TxPDO1	0x1800	0x1A00	0x180+Node_ID
	TxPDO2	0x1801	0x1A01	0x280+Node_ID
	TxPDO3	0x1802	0x1A02	0x380+Node_ID
	TxPDO4	0x1803	0x1A03	0x480+Node_ID

PDO 的映射参数格式为:

The format of PDO mapping parameter is:

Bit	Function
Bit0-Bit7	Object data length
Bit8-Bit15	Object sub-index
Bit17-Bit31	Object index

3.7.1. 传输类型

Transmission types

TxPDO 和 RxPDO 数据的传输是由 PDO 通信参数定义的传输类型决定的：在 0x1800-0x1803(TxPDO)的子索引 0x02 和 0x1400-1403(RxPDO)的子索引 0x02 中定义相应传输类型，PDO 的传输类型如下：

The transmission of a TxPDO and RxPDO is triggered by an event, which is defined by the PDO communication parameters: sub-index 2 of objects 0x1800 to 0x1803 (TxPDO) and sub-index 2 of objects 0x1400 to 1403 (RxPDO). These object dictionary entries are transmission types. PDO transmission types can be one of the following:

transmission types	transmission mode	TxPDO	RxPDO
0	Synchronous non-periodic	如果映射数据发生改变，且接收到 1 个同步帧，则发送该 TxPDO。 If the mapping data changes and 1 synchronization frame is received, the TxPDO is sent.	只要接收到 1 个同步帧则将该 RxPDO 数据更新到应用。 The RxPDO data is updated to the application whenever one synchronization frame is received.
N=1...240	Synchronous cycle	接收到相应个数 N 的同步帧，则发送该 TxPDO。 Receiving the corresponding number of synchronous frames N, the TxPDO is sent.	
254-255	Asynchronous mode	当映射数据发生改变或事件计时器到达时，则发送该 TxPDO。 The TxPDO is sent when the mapping data changes or the event timer arrives.	将接收到的数据直接更新到应用。 Update the received data directly to the application.

3.7.2. RxPDO 映射示例

RxPDO mapping example

在 RxPDO1 内映射 3 个对象，分别为 0x6040、0x6071、0x607A，映射如图 3-5 所示：

Set the first group of RxPDOs to mapping 3 objects: 0x6040, 0x6071 and 0x607A, as shown in figure 3-5:

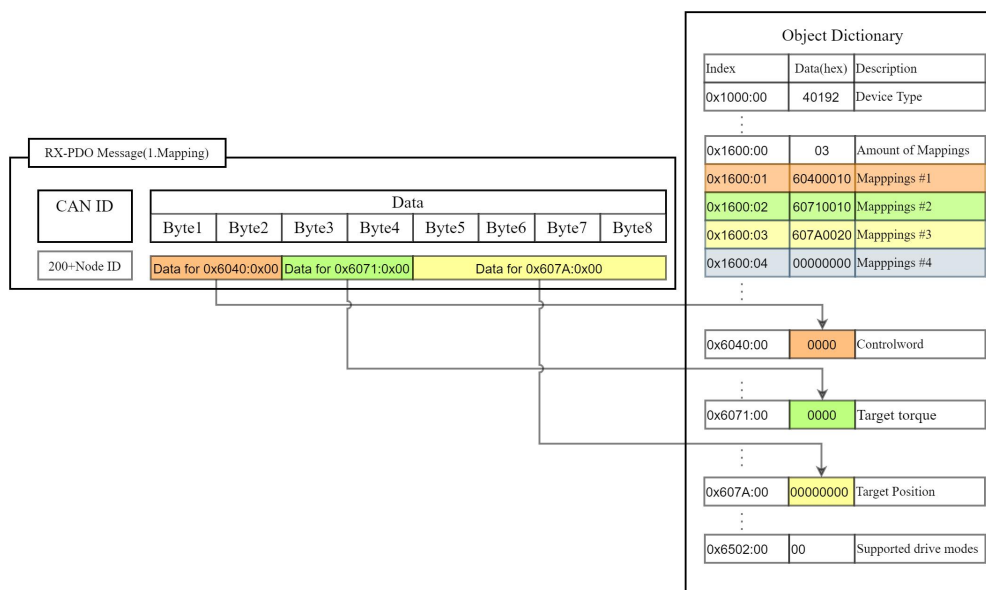


图 3-5 RxPDO 映射配置

Figure3-5 The RxPDO mapping configuration

3.7.3. TxPDO 映射示例

TxPDO mapping example

在 TxPDO1 内映射 2 个 PDO，分别为 0x6041 与 0x6064，映射如图 3-6 所示：

Set the first group of TxPDOs to mapping 2 objects: 0x6041 and 0x6064, as shown in figure 3-6:

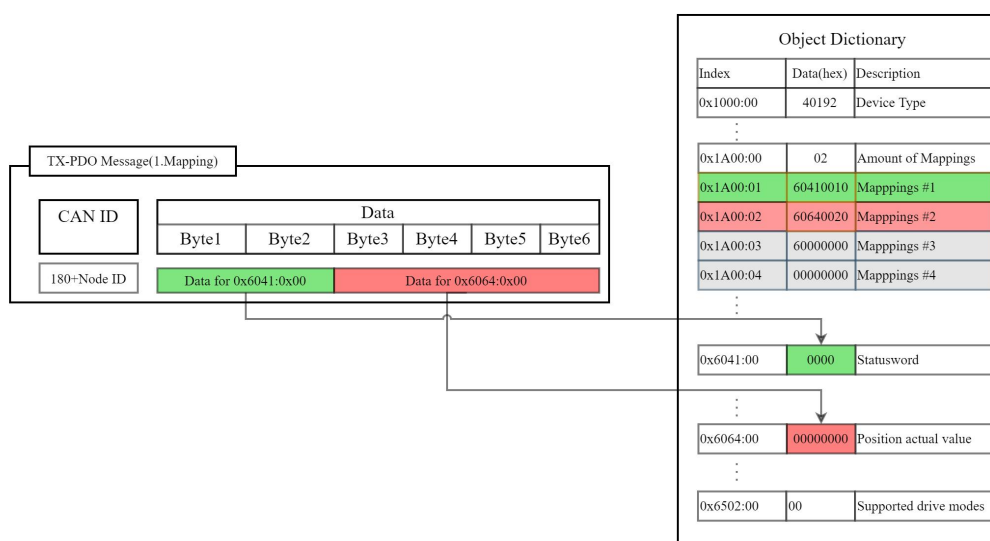


图 3-6 TxPDO 映射配置

Figure 3-6 The TxPDO mapping configuration

3.8 心跳保护

Heartbeat

心跳保护（Heartbeat）的机制主要是指 Heartbeat 生产者周期性地发送封包给 Heartbeat 消费者。Heartbeat 生产者可为上位机或 eRob 关节模组,相对的，上位机或 eRob 关节模组亦可作为 Heartbeat 消费者。

若需要将 eRob 关节模组作为 Heartbeat 消费者使用，由上位机发送 Heartbeat，用户需对 eRob 关节模组设定 Consumer heartbeat time(0x1016)。当 eRob 关节模组在接收时间内未收到心跳信号时，触发上位机定义的心跳事件相对应的报警。Consumer heartbeat time(0x1016)定义为 eRob 关节模组预计收到 Heartbeat 的时间。在配置上，Consumer heartbeat time(0x1016) 必须大于 Producer heartbeat time(0x1017)。Producer heartbeat time(0x1017)由上位机配置。由于在发送 Heartbeat

报文上会有延迟及其他不可控的在外在因素，因此必须保留一个容差时间。使用上，先设定 Consumer heartbeat time(0x1016)，之后只需让上位机发送 Heartbeat 报文，即启动 Heartbeat 机制。

The heartbeat mechanism is mainly to enable the heartbeat producer to send packets to the heartbeat consumer periodically. The heartbeat producer can be a controller or the eRob, on the other hand, a controller or the eRob can also be the heartbeat consumer.

If you use the controller to send the heartbeat and the eRob as the heartbeat consumer, you need to set the consumer heartbeat time (0x1016) for the eRob. When the eRob does not receive the heartbeat signal within the receiving time, it triggers the heartbeat event which corresponds to the alarm defined by the controller. Consumer heartbeat time (0x1016) is defined as the time the eRob expects to receive a heartbeat. To start the heartbeat mechanism, set the consumer heartbeat time (0x1016) and then have the controller send the heartbeat signal. The consumer heartbeat time (0x1016) must be greater than the producer heartbeat time (0x1017) which is set by the controller. Since there are delays and other uncontrollable external factors in transmitting the heartbeat message, you must retain a tolerance time for the transmission. In use, first set the consumer heartbeat time (0x1016), and then just let the controller send the heartbeat message, and then start the heartbeat mechanism.

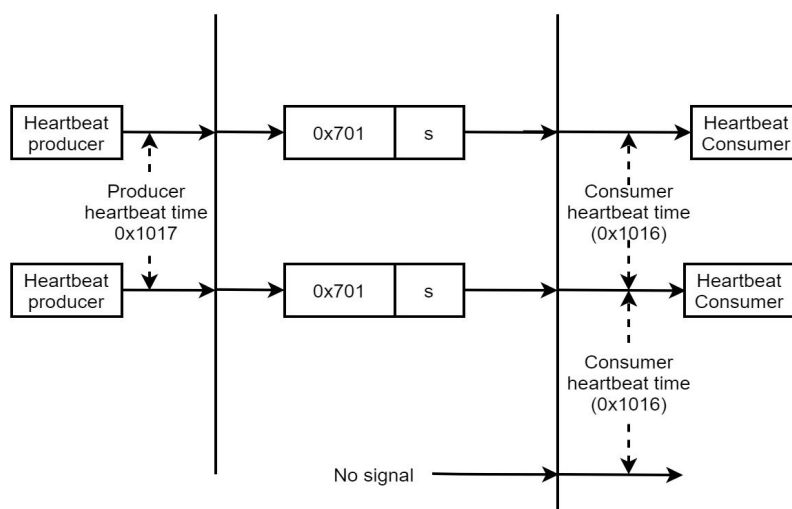


图 3-7 Heartbeat 模型

Figure 3-7 Heartbeat model



S 代码说明如下:

The S code is described as follows:

S	State
0	Boot-up
4	Stopped
5	Operational
127	Pre-Operational

若需要将 eRob 关节模组作为 Heartbeat 生产者使用, Heartbeat 则由 eRob 关节模组发送。用户需设定 Producer heartbeat time (0x1017)。Consumer heartbeat time(0x1016)则设定于上位机, 且该时间需大于 Producer heartbeat time (0x1017)。当上位机在接收时间内未收到心跳信号时, 触发上位机定义的心跳事件报警。

eRob 关节模组可同时扮演两个角色, Heartbeat 生产者和 Heartbeat 消费者, 需同时设定 0x1016 与 0x1017。且上位机也须同时设定 0x1016 与 0x1017 作为 Heartbeat 生产者和 Heartbeat 消费者。

If you want to use the eRob as the heartbeat producer, then the heartbeat is sent by the eRob. You need to set the producer heartbeat time(0x1017) for the controller. Consumer heartbeat time(0x1016) must be greater than the consumer heartbeat time which is set by the controller. When the controller does not receive the heartbeat signal within the receiving time,it triggers the heartbeat event which corresponds to the alarm defined by the controller.

The eRob can be the heartbeat consumer and the heartbeat producer simultaneously. In that case,you need to set 0x1016 and 0x1017 at the same time, and the controller must be set as the heartbeat producer and the heartbeat consumer as well.

3.9 节点保护

Node guarding

Node/Life Guarding 的机制与 Heartbeat 雷同。两者差异主要在 Heartbeat 仅单方面由接收端判断有无封包, 发送端不做判断。Node/Life Guarding 的机制主要建立在主从站, 双向的关系。主站会周期性发送封包给从站, 且从站需在设定的

Guard Time (0x100C) 内回复封包给主站，否则将会报错。从站则必须设定 Life Time，且主站需在 Guard Time 时间内发送封包。Life Time 的设定是通过 Guard Time(0x100C)乘上一个倍率值 Life Time Factor (0x100D)获得。

The Node/Life guarding mechanism is similar to the heartbeat mechanism. The main difference between the two is that heartbeat only uses the consumer but not the producer to judge whether there are packets or not. The mechanism of node guarding is mainly based on the two-way relationship between the master and slave. The master periodically sends packets to the slave, and the slave must return the packets to the master within the set guard time(0x100C) ,otherwise an error occurs. You must set the life time for the slave and the master must send the packets within the guard time. Life time is set by multiplying the guard time(0x100C) by a life time factor(0x100D) .

Node/Life guarding 架构如图 3-8 所示：

The Node/Life guarding architecture is as figure 3-8:

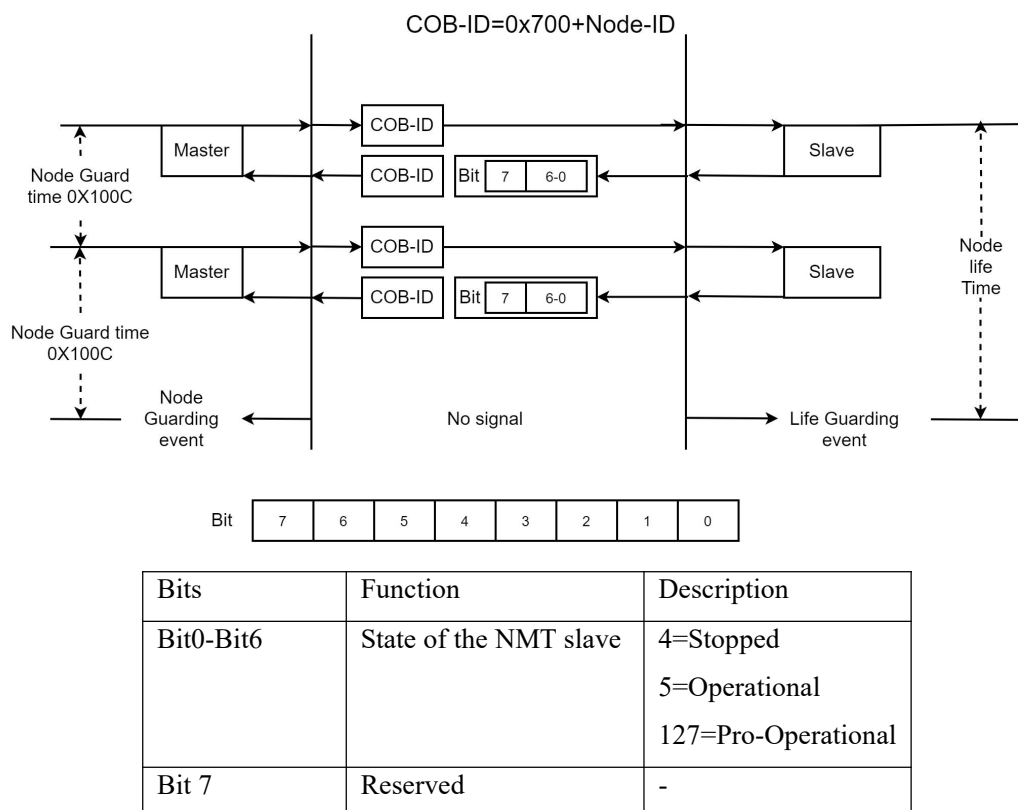


图 3-8 节点保护结构

Figure 3-8 Node guarding architecture



第四章 EtherCAT 通信协议

Chapter 4 EtherCAT Communication Protocol

4.1 EtherCAT 系统组成

EtherCAT Communication System

EtherCAT 是一种实时以太网技术，由一个主站设备和多个从站设备组成。主站设备使用标准的以太网控制器，具有良好的兼容性，任何具有网络接口的计算机和具有以太网控制的嵌入式设备都可以作为 EtherCAT 的主站。对于 PC 端计算机而言，主站控制器多采用 Beckhoff 开发的 TwinCAT3 软件。EtherCAT 从站使用专门的从站控制器(ESC)，如专用集成芯片 ET1100 和 ET1200，或者是利用 FPGA 集成 EtherCAT 通信功能的 IP-Core。EtherCAT 物理层使用标准的以太网物理层设备，如传输媒介通常使用 100BASE-TX 规范的 5 类 UTP 线缆。

EtherCAT 是一种开放的运动控制总线，EtherCAT 主站需要使用 ESI(EtherCAT Slave Information) 文件来为每个从属设备配置功能和相关的对象属性。通常，ESI 文件是一个 XML 文件。将从设备的 ESI 文件导入到主站控制器软件中，使主站控制器能够根据 ESI 文件中的配置来识别和控制每个从站。一个 ESI 文件可以包含多个从站的数据。

EtherCAT is a real-time Ethernet technology consisting of a master device and multiple slave devices. The master device uses a standard Ethernet controller with good compatibility, and any computer with a network interface card and an embedded device with Ethernet control can act as a master for EtherCAT. For PC computers, the master controller mostly uses TwinCAT3 software developed by Beckhoff. EtherCAT slaves use specialized slave controller (ESC), such as dedicated integrated chips ET1100 and ET1200, or IP-Cores that use FPGAs to integrate EtherCAT communication functions. The EtherCAT physical layer uses standard Ethernet physical layer devices, such as transmission media typically using 100BASE-TX specification Category 5 UTP cable.

EtherCAT is an open motion control bus that requires using the ESI (EtherCAT Slave Information) file to configure the functions and related object properties for each slave device. Generally, the ESI file is an XML file. Import the ESI file of the slave

device to the controller software, so the controller can recognize and control each slave device according to the configuration in the ESI file. An ESI file may contain data of multiple devices.

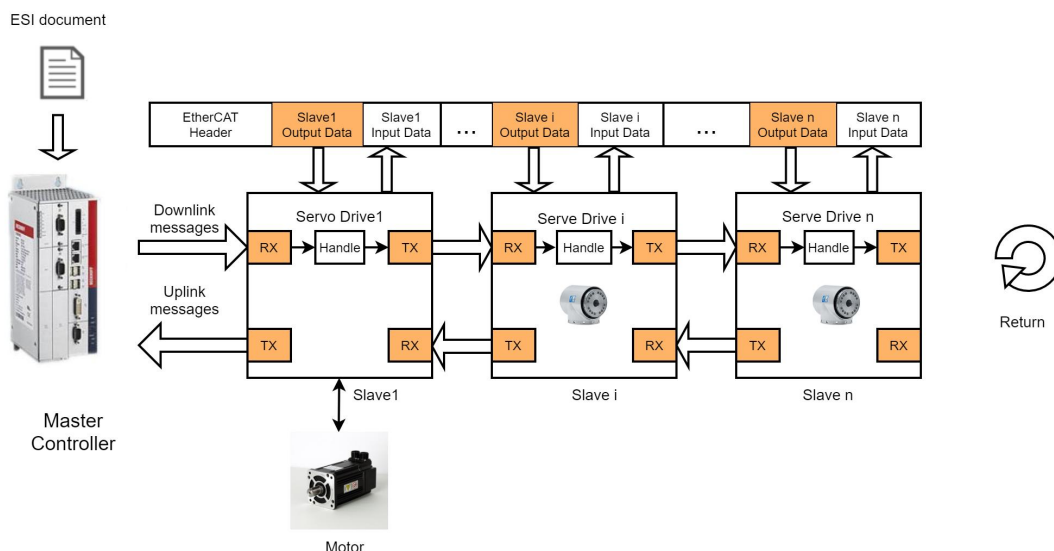


图 4-1 EtherCAT 工作原理

Figure 4-1 EtherCAT operational principle

EtherCAT 运行原理为如图 4-1 所示：在一个通讯周期内，主站发送以太网数据帧给各个从站，数据帧到达从站后，每个从站根据寻址从数据帧内提取相应的数据，并把它反馈的数据写入数据帧。当数据帧发送到最后一个从站后返回，并通过第一个从站返回至主站。这种传输方式不仅能够在一个周期内实现数据通讯，还改善了带宽利用率，数据有效利用率最大达 90%以上。

The operating principle of EtherCAT is shown in the figure 4-1: in a communication cycle, the master sends Ethernet data frames to each slave, and after the data frames arrive at the slaves, each slave extracts the corresponding data from the data frame according to addressing and writes its feedback data to the data frame. Returns when the data frame is sent to the last slave and returns to the master through the first slave. This transmission method can realize data communication in one cycle, and also improves bandwidth utilization, with a maximum effective data utilization rate of more than 90%.



4.2 基本配置

Basic Configuration

4.2.1. 通信连接

Communication connection

硬件相关配置请参考《eRob 机器人关节模组用户手册》第 5.3 章节 EtherCAT 通信接口和第 6.3 章节 EtherCAT 通信接线图。

For hardware-related configurations, defined according to <eRob Rotary Actuator User Manual > section 5.3 EtherCAT communication interface. And section 6.3 EtherCAT communication wiring diagram.

4.2.2. ESI 文件导入

The ESI file is imported

eRob 的 XML(ESI)配置文件名称为:

The XML(ESI) configuration file of eRob is named:

ZeroErr Driver3.2.0.xml;

Beckhoff TwinCAT3 的 XML(ESI)文件存放路径如下:

The XML(ESI) file storage path for the Beckhoff TwinCAT3 is as follows:

C:\TwinCAT\3.1\Config\Io\EtherCAT.

4.3 EtherCAT 状态机 (ESM)

EtherCAT State Machine (ESM)

在 EtherCAT 通讯中, 伺服具有以下几种状态:

In EtherCAT communication, the servo drive's state machine can be in the following states:

表 4-1 ESM 状态

Table 4-1 ESM status

Status	Meaning
Init	初始化状态，简称为 I。 Initialized state, abbreviation as I.
Pre-Operational	预操作状态，简称为 P。 Pre-Operational status, abbreviation as P.
Safe-Operational	安全操作状态，简称为 S。 Safe-Operational status, abbreviation as S.
Operational	运行状态，简称为 O。 Operational status, abbreviation as O.
Bootstrap	引导状态，简称为 B。 Bootstrap status, abbreviation as B.

主站控制器会根据实际状态来对从站伺服进行控制。控制器需按照图 4-2 的指定流程依序来设定驱动器的配置。在控制器完成通信的初始化后，从站伺服会处于 Operational 状态，并等待用户的命令来进行运动控制。

The controller(master) controls the servo(slave) based on the actual state. The controller needs to configure the servo drive according to the designated flow in the figure 4-2. After the controller completes the initialization of communication, the servo(slave) is in the operational state and waits for the user's command to perform motion control.

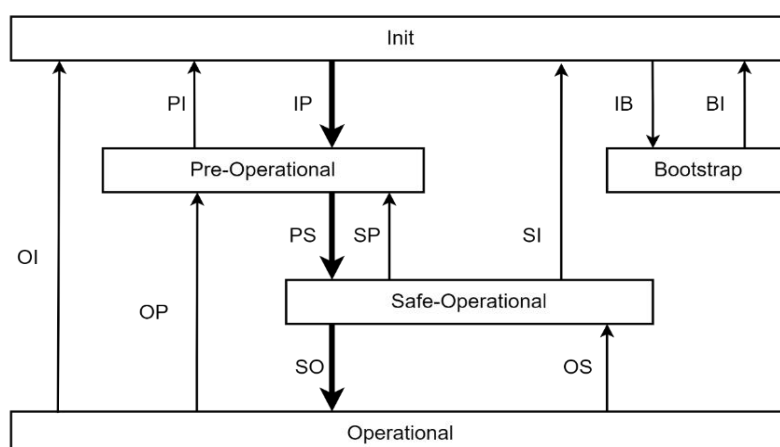


图 4-2 EtherCAT 状态机

Figure 4-2 EtherCAT state machine

表 4-2 ESM 状态

Table 4-2 The ESM state

State	Operate
初始化状态 Init state	“Init”状态定义了应用层中主站和从站之间的基本通信关系。在应用层中，主站和从站之间无法直接通信。 主站使用“Init”状态来初始化从站配置。 当从站支持邮箱服务时，相应的 SM 设置也将在“Init”状态下执行。 “Init” state defines basic communication relations between the master and slaves in the application layer. Direct communication between the master and slaves is not possible in the application layer. The master uses the “Init” state to initialize the setting for the configuration of the slaves. When the slaves support the mailbox service, the corresponding SM settings will also be executed in “Init” state.
预操作状态 Pre-Operational state	当从站支持邮箱通信时，可在“Pre-Operational”状态执行邮箱通信。主站和从站都可以使用邮箱来初始化程序规范和更改参数，在此状态下无法进行数据通信。 The mailbox communication can be performed in the “Pre-Operational” state when the slaves support the optional mailbox. Both master and slaves can use the mailbox to initialize application specifications and to change parameters. Process data communication can not be executed in this state.
安全操作状态 Safe-Operational state	在“Safe-Operational”状态下，从站传输实际的输入数据，但不传输可能无法处理的输出数据。输出必须设置为安全状态。 In “Safe-Operational” state, slave applications transfer the actual input data, but not the output data that may not be available for processing. The output must be set in Safe state.
运行状态 Operational state	在“Operational”状态下，从站传输实际输入数据，主站传输实际输出数据。 In “Operational” state slave applications transfer the actual input data and the master application transfers the actual output data.
引导状态 Bootstrap state	在“Bootstrap”状态下，从站可以接收下载到 FoE（通过 EtherCAT 访问文件）协议的新固件。 In the “Bootstrap” state, slave applications can receive new firmware downloaded to the FoE (File access Over EtherCAT) protocol.



表 4-3 本地服务管理

Table4-3 Local management service

Transition symbol	Direction=>	Local management service
IP	INIT TO PREOP	开始邮箱通信 Start mailbox communication
PI	PREOP TO INIT	停止邮箱通信 Stop mailbox communication
PS	PREOP TO SAFEOP	开始输入更新 Start input update
SP	SAFEOP TO PREOP	停止输入更新 Stop input update
SO	SAFEOP TO OP	开始输出更新 Start output update
OS	OP TO SAFEOP	停止输出更新 Stop output update
OP	OP TO PREOP	停止输入更新，停止输出更新 Stop input update, stop output update
SI	SAFEOP TO INIT	停止输入更新，停止邮箱通信 Stop input update, stop mailbox communication
OI	OP TO INIT	停止输入更新，停止输出更新，停止邮箱通信 Stop input update, stop output update, stop mailbox communication
IB	INIT TO BOOT	启动固件更新（FoE），启动引导模式 Start firmware update(FoE) , start bootstrap mode
BI	BOOT TO INIT	启动固件更新（FoE），重启设备 Start firmware update(FoE) , restart device

4.4 通信对象

Communication Objects

4.4.1. 数据服务通信

Service data communication

服务数据对象（SDO）提供对 EtherCAT 设备对象字典的直接访问。由于这些对象中包含任意大小和数据类型的数据，所以 SDO 用于将多个数据集（每个数据集包含任意的大块数据）在客户端到服务器的相互传输。客户端通过多路控制器（对象字典的索引和子索引）控制数据集的传输。数据集的内容在对象字典中定义。

通常，SDO 通过一系列传输段传输。在传输段之前，有一个初始化阶段，客户端和服务端准备传输段。对于 SDO，还可以在初始化阶段传输最多四个字节的数据集。此机制称为 SDO 快速传输。

客户端始终为 SDO 提供任何类型的传输。访问对象字典的所有者是 SDO 的服务器。客户端或服务端都可以主动中止 SDO 的传输。

通过 SDO，在两个 EtherCAT 设备之间建立点对点通信通道。一个 CANopen 设备支持多个 SDO。但必须有一个受支持的 SDO 服务器（Default SDO）。

Service data objects (SDOs) provide direct access to object entries in the EtherCAT device object dictionary. As these object entries contain data of arbitrary size and data type, the SDOs are used to transfer multiple data sets (each containing an arbitrary large block of data) from a client to a server and vice versa. The client controls, via a multiplexer (index and sub-index of the object dictionary), which data set is transferred. The content of the data set is defined within the object dictionary.

In general, an SDO is transferred as a sequence of segments. Prior to transferring the segments there is an initialization status in which client and server prepare for transferring the segments. For SDOs, it is also possible to transfer a data set of up to four bytes during the initialization status. This mechanism is called SDO expedited transfer.



The client always initiates an SDO transfer for any type of transfer. The owner of the accessed object dictionary is the server of the SDO. Either the client or the server can take the initiative to abort the transfer of an SDO.

By means of an SDO, a point-to-point communication channel between two CANopen devices is established. A EtherCAT device supports more than one SDO. One supported Server-SDO is the default case (Default SDO).

4.4.2. 过程数据通信

Process data communication

eRob 系列 EtherCAT 可映射的 TxPDO、RxPDO 最大字节数各为 76 字节。

0x1600 到 0x1606 之间的对象彼此排斥，一次只能选择一个。

0x1A00 到 0x1A04 之间的对象彼此排斥，一次只能选择一个。

其中仅 0x1600 映射 RxPDO 支持任意 mapping 配置，包括但不限于 TxPDO: 0x6041、0x6064、0x606C、0x6061 等。

其中仅 0x1A00 映射 TxPDO 支持任意 mapping 配置，包括但不限于 RxPDO: 0x6040、0x607A、0x6065、0x6060 等。

因 ESC 芯片特性，如果 0x1600 (RxPDO0) 映射了 0x6060 或 0x1A00 (TxPDO0) 映射了 0x6061，则还需添加映射一个 8bit 长度的对象（此对象必须位于最后一个子索引），使 PDO 总长度为偶数字节（16bit）对齐，否则 PDO 配置将无法生效，ESC 会报错 SM 配置无效。

The maximum number of bytes that can be mapped by eRob series EtherCAT TxPDO and RxPDO is 76 bytes each.

Objects between 0x1600 and 0x1606 are exclusive of each other and can only be selected at a time.

Objects between 0x1A00 and 0x1A04 are mutually exclusive and can only be selected at a time.

Among them only 0x1600 mapping RxPDO supports arbitrary mapping configuration, but limited to TxPDO: 0x6041, 0x6064, 0x606C, 0x6061, etc.

Among them only 0x1A00 mapping TxPDO supports arbitrary mapping configurations, but limited to RxPDO: 0x6040, 0x607A, 0x6065, 0x6060, etc.

Due to the characteristics of the ESC chip, If the 0x1600 (RxPDO0) map contains 0x6060 or 0x1A00 (TxPDO0) map contains 0x6061, you also need to add an 8-bit object (this object must be in the last subindex) so that the total PDO length is aligned with an even number of bytes (16bit). Otherwise, the PDO configuration cannot take effect, and the ESC reports an error message indicating that the SM configuration is invalid.

4.4.3. RxPDO 映射 (Outputs)

Receive PDO mapping (Outputs)

这里定义了一个对象列表，其中包括主站到从站的数据。所有 RxPDO 都位于索引 0x1600 到 0x17FF 的对象字典中。

This defines a list of objects that include data from the master to the slave. All RxPDOs are located in the object dictionary from index 0x1600 to 0x17FF.

表 4-4 RxPDO 映射配置

Table4-4 Receive PDO mapping configuration

Sub-Index	Description	Data type	Access	PDO mapping	Value
0	Number of object in this PDO	UINT	RW, mandatory	NO	0-254 Writable if variable mapping is supported
1	First output object to be mapped	UINT	RO,depends upon setting	NO	Bit0-7:length of the mapped objects in bits Bit8-15:sub index of the mapped object
...					
N	Last output object to be mapped	UINT	RO,depends upon setting	NO	

表 4-5 描述了 eRob 关节模组 RxPDO 的对象：

The following table 4-5 describes the objects for the eRob RxPDO:

表 4-5 RxPDO 映射对象

Table 4-5 The RxPDO mapping objects

PDO index	Sub-index	Default value	Bit length	Description	Function group	Exclude
0x1600	01h	0x607A	32	Target position	Position	0x1601-0x1606
	02h	0x60FE	32	Digital outputs		
	03h	0x6040	16	Control word		
0x1601	01h	0x60FF	32	Target velocity	Velocity	0x1600, 0x1602-0x1606
	02h	0x6040	16	Control word		
0x1602	01h	0x6071	16	Target torque	Torque	0x1600-0x1601, 0x1603-0x1606
	02h	0x6040	16	Control word		
0x1603	01h	0x607A	32	Target position	Position	0x1600-0x1602, 0x1604-0x1606
	02h	0x60FE	32	Digital outputs		
	03h	0x60B1	32	Velocity offset		
	04h	0x6040	16	Control word		
0x1604	01h	0x607A	32	Target position	Position, Velocity	0x1600-0x1603, 0x1605-0x1606
	02h	0x60FF	32	Target velocity		
	03h	0x6072	16	Max torque		
	04h	0x6040	16	Control word		
0x1605	01h	0x607A	32	Target position	Position, Velocity, Torque	0x1600-0x1604, 0x1606
	02h	0x60FF	32	Target velocity		
	03h	0x6071	16	Target torque		
	04h	0x6072	16	Max torque		
	05h	0x6040	16	Control word		
	06h	0x6060	8	Modes of operation		
0x1606	01h	0x607A	32	Target position	Position, Velocity	0x1600-0x1605
	02h	0x60FE	32	Digital outputs		
	03h	0x60FF	32	Target velocity		
	04h	0x60B1	32	Velocity offset		
	05h	0x60B2	16	Torque offset		
	06h	0x6040	16	Control word		
0x1607	01h	0x6040	16	Control word		
	02h	0x607A	32	Target position		
	03h	0x6060	8	Modes of operation		
0x1608	01h	0x6040	16	Control word		
	02h	0x6071	16	Target torque		
	03h	0x607A	32	Target position		



	04h	0x6080	32	Max motor speed		
	05h	0x60FF	32	Target velocity		
	06h	0x6060	8	Modes of operation		
0x1609	01h	0x6040	16	Control word		
	02h	0x6072	16	Max torque		
	03h	0x607A	32	Target position		
	04h	0x60FF	32	Target velocity		
	05h	0x6060	8	Modes of operation		
0x160A	01h	0x6040	16	Control word		
0x160B	01h	0x6060	8	Modes of operation		
0x160C	01h	0x6071	16	Target torque		
0x160D	01h	0x6072	16	Max torque		
0x160E	01h	0x6073	16	Max current		
0x160F	01h	0x607A	32	Target position		
0x1611	01h	0x6081	32	Profile velocity		
0x1612	01h	0x6082	32	End velocity		
0x1613	01h	0x6083	32	Profile acceleration		
0x1614	01h	0x6084	32	Profile deceleration		
0x1615	01h	0x6087	16	Torque slope		
0x1616	01h	0x60B0	32	Position offset		
0x1617	01h	0x60B1	32	Velocity offset		
0x1618	01h	0x60B2	16	Torque offset		
0x161C	01h	0x60FF	32	Target velocity		
0x161D	01h	0x60FE	32	Digital outputs		
0x161F	01h	0x6085	32	Quick stop deceleration		



4.4.4. TxPDO 映射 (Inputs)

Transmit PDO mapping(Inputs)

这里定义了一个包含从站到主站数据的对象列表。所有 TxPDO 都位于索引 0x1A00 到 0x1BFF 的对象字典中。

This defines a list of objects that include data from the slave to the master. All TxPDOs are located in the object dictionary from index 0x1A00 to 0x1BFF.

表 4-6 TxPDO 映射配置

Table4-6 Transmit PDO mapping configuration

Sub-Index	Description	Data type	Access	PDO mapping	Value
0	Number of object in this PDO	UINT	RW, mandatory	NO	0-254 writable if variable mapping is supported
1	First output object to be mapped	UINT	R,depends upon setting	NO	Bit0-7:length of the mapped objects in bits Bit8-15:sub index of the mapped object
...					
N	Last output object to be mapped	UINT	R,depends upon setting	NO	

表 4-7 描述了 eRob 关节模组 TxPDO 的对象：

The following table 4-7 describes the objects for the eRob TxPDO:

表 4-7 TxPDO 对象

Table 4-7 The TxPDO objects

PDO Index	Sub-Index	Default value	Bit length	Description	Function group	Exclude
0x1A00	01h	0x6064	32	Position actual value	Position	0x1A01-0x1A04
	02h	0x60FD	32	Digital inputs		
	03h	0x6041	16	Status word		
0x1A01	01h	0x6064	32	Position actual value	Position	0x1A00, 0x1A02-0x1A04
	02h	0x606B	32	Velocity demand value		
	03h	0x6074	16	Torque demand value		
	04h	0x6041	16	Status word		
0x1A02	01h	0x6064	32	Position actual value	Position, Torque	0x1A00-0x1A01, 0x01A03-0x1A04
	02h	0x6077	16	Torque actual value		
	03h	0x6041	16	Status word		
	04h	0x6061	8	Modes of operation display		
0x1A03	01h	0x6064	32	Position actual value	Position, Velocity	0x1A00-0x1A02, 0x1A04
	02h	0x60FD	32	Digital inputs		
	03h	0x606C	32	Velocity actual value		
	04h	0x6041	16	Status word		
0x1A04	01h	0x6064	32	Position actual value	Position, Torque	0x1A00-0x1A03
	02h	0x60F4	32	Position following error		
	03h	0x6077	16	Torque actual value		
	04h	0x6041	16	Status word		
	05h	0x6061	8	Modes of operation display		
0x1A05	01h	0x603F	16	Error code		
	02h	0x6041	16	Status word		
	03h	0x6064	32	Position actual value		
	04h	0x60F4	32	Position following error		
	05h	0x6061	8	Modes of operation display		
0x1A06	01h	0x603F	16	Error code		
	02h	0x6041	16	Status word		
	03h	0x6064	32	Position actual value		

	04h	0x606C	32	Velocity actual value		
	05h	0x6077	16	Torque actual value		
	06h	0x6061	8	Modes of operation display		
0x1A07	01h	0x20A0	32	Auxiliary position actual value		
0x1A0A	01h	0x6041	16	Status word		
0x1A0B	01h	0x6061	8	Modes of operation display		
0x1A0C	01h	0x6062	32	Position demand value[plus]		
0x1A0D	01h	0x6063	32	Actual position [plus]		
0x1A0E	01h	0x6064	32	Position actual value		
0x1A0F	01h	0x6069	32	Velocity sensor actual value [plus/s]		
0x1A10	01h	0x606B	32	Velocity demand [plus/s]		
0x1A11	01h	0x606C	32	Velocity actual value		
0x1A12	01h	0x6074	16	Torque demand value		
0x1A13	01h	0x6077	16	Torque actual value		
0x1A18	01h	0x6079	32	DC link circuit voltage		
0x1A19	01h	0x60F4	32	Following error actual value		
0x1A1C	01h	0x60FC	32	Position demand value [plus]		
0x1A1D	01h	0x60FD	32	Digital inputs		
0x1A1F	01h	0x6078	16	Current actual value		

4.5 DC 模式-同步于 Sync0

Distributed Clocks (DC Mode) -Synchronous with SYNC0

从站的应用程序与基于分布式时钟单元的 SYNC0 事件同步，以确保所有现场总线设备的时间同步。主站和从站的周期时间配置完全同步于网络中的第一个从站，该从站使用 SYNC0 信号作为参考时钟。然后，使用该时钟来同步其他设备和控制器的从站时钟。

The Slave's application is synchronized to the SYNC0 event, which is based on the distributed clock unit to ensure that the time on all field bus devices is synchronized.

Configuration of the Master and Slave cycle times are fully synchronized to the first Slave in the network that is used as a reference clock with the SYNC0 signal. This is then used to synchronize the slave clocks of the other devices and the controller.

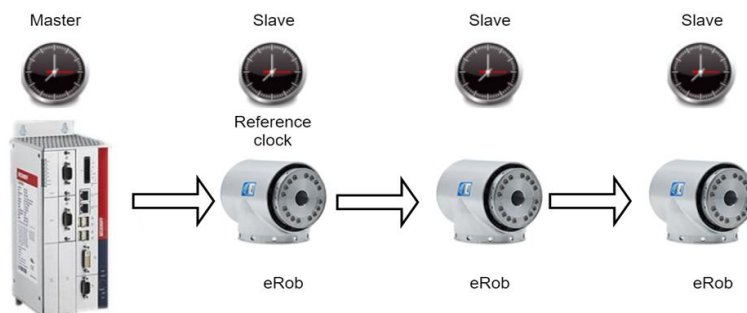


图 4-3 时钟同步架构

Figure 4-3 Clock synchronization architecture

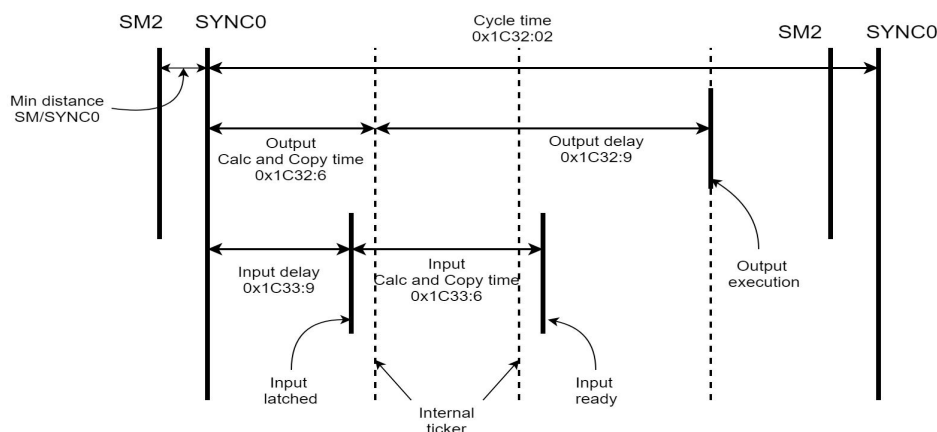


图 4-4 DC 模式时序图

Figure 4-4 DC mode timing diagram

图 4-4 详细介绍了 DC 同步模式的时序，其中 Min distance SM/SYNC0 是 SM2 到达和 DC 时钟之间的最短时间，未能达到此时间会导致输出延时；Output Calc and Copy time 是检测到 AL 事件到达并从 ESC 中获取数据所需要的时间；Output delay 定义为应用程序执行输出所需的时间。Input delay 是从站接收 SYNC0 信号和实际输入 SYNC0 信号之间的时间；Inputs Calc and Copy time 是将输入数据复制到 ESC 所需的时间。所有从站都可以配置最大为 500 us（最高 2 KHz）的输入延时，Master cycle time 应该是该值的倍数（例如 1x500us, 2x500us, 3x500us...nx500us）。

The figure 4-4 details the DC mode timing, where the Min distance SM/SYNC0 is the minimum time between SM2 arrival and the DC clock. Failing to attain this time cause a delay in the output execution; The Output Calc and Copy time is the time required to detect that AL arriving and obtain the relevant data from the ESC; Output delay is defined as the time required for the application to perform the output. The Input delay is the time from the SYNC0 signal until the actual inputs capture; and the Inputs Calc and Copy time is the time taken to copy the inputs to the ESC. All slaves can be configured to a maximum of 500 us (up to 2 KHz) and the Master cycle time should be a multiple of that value (e.g. 1x500us, 2x500us, 3x500us... nx500us).

4.5.1. 同步模式选择

Synchronization mode selection

在以下窗口可以选择 DC-Synchron:

- 1、TwinCAT3 左侧选择 Drive1 (ZeroErr Driver)。
- 2、用户可在右侧选择 DC-Synchron (同步模式) 作为运行模式。

Follow these steps to select DC-Synchron:

- 1、Select Drive1(ZeroErr Driver) in the left column of the TwinCAT system message window.
- 2、Under the DC tab in the right column,select DC-Synchron as operation mode.

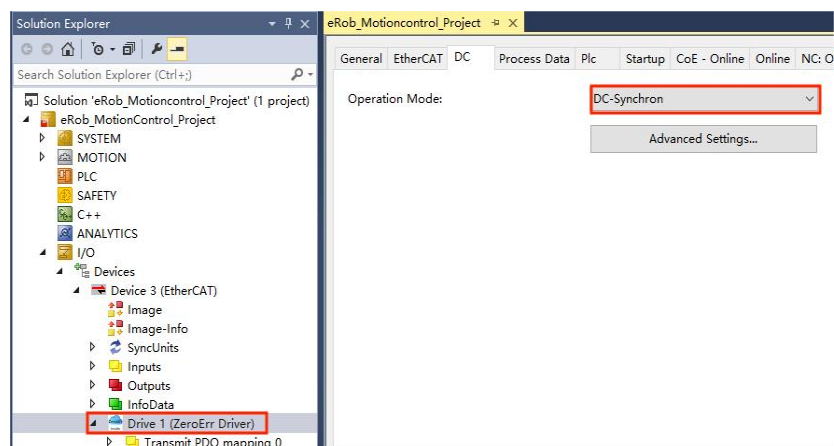


图 4-5 DC mode 选择界面

Figure 4-5 The DC mode selection interface

4.5.2. 最小通信周期时间

Minimum communication cycle time

基于 TwinCAT3 测试，eRob 支持的最小通信周期时间为 500us，EtherCAT 网络支持连接至少 6 个从站节点。

Based on the TwinCAT3 test, the minimum communication cycle time supported by eRob is 500us, and the EtherCAT network supports the connection of at least six slave nodes.

通信周期时间的配置步骤如下：

- 1、TwinCAT3 左侧的项目窗口选择 “Real-Time” 。
- 2、在右侧设置界面选择 Base Time 为 500us，如图 4-6 所示。
- 3、TwinCAT3 左侧的项目窗口选择 “NC-Task 1 SAF” 。
- 4、在右侧 Task 界面选择 Cycle ticks 为 1，即设置 Cycle time 为 0.5ms，如图 4-7 所示。

Follow these steps to configure the communication cycle time:

- 1、Select "Real-Time" in the project window on the left of TwinCAT3.
- 2、Set the Base Time to 500us in the right "Setting" interface, as shown in Figure 4-6.
- 3、Select "NC-Task 1 SAF" in the project window on the left of TwinCAT3.
- 4、In the right "Task" interface, set "Cycle ticks" to 1, that is, set Cycle time to 0.5ms, as shown in Figure 4-7.

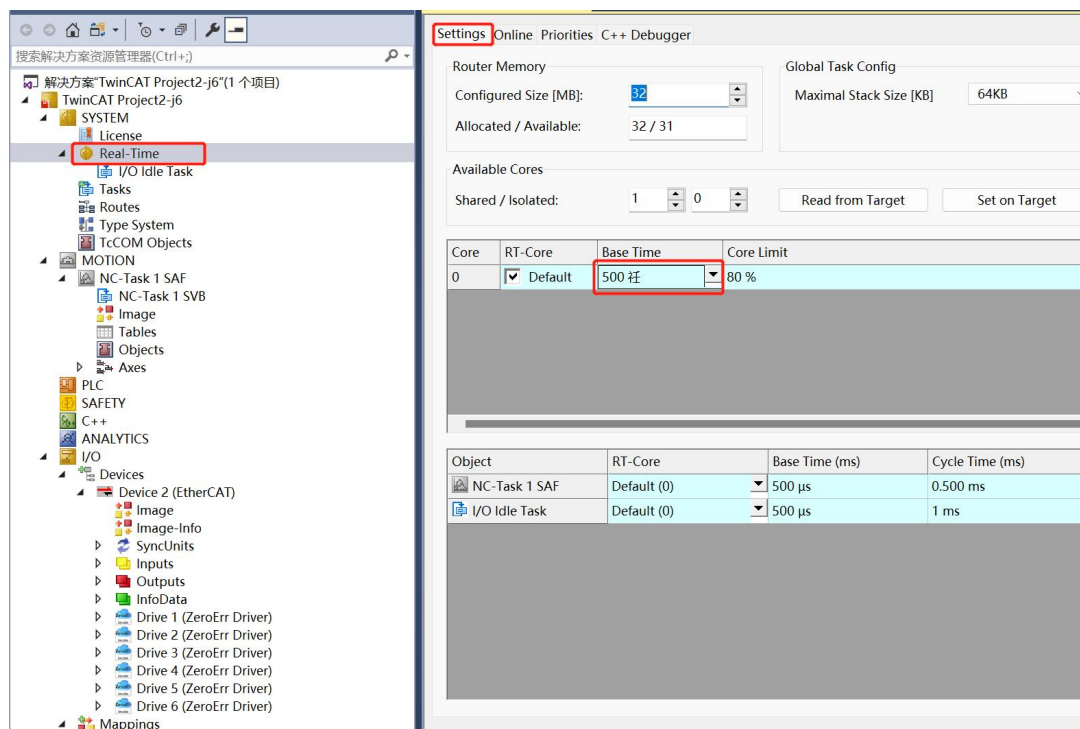


图 4-6 Real-Time 设置界面

Figure 4-6 Real-Time setting interface

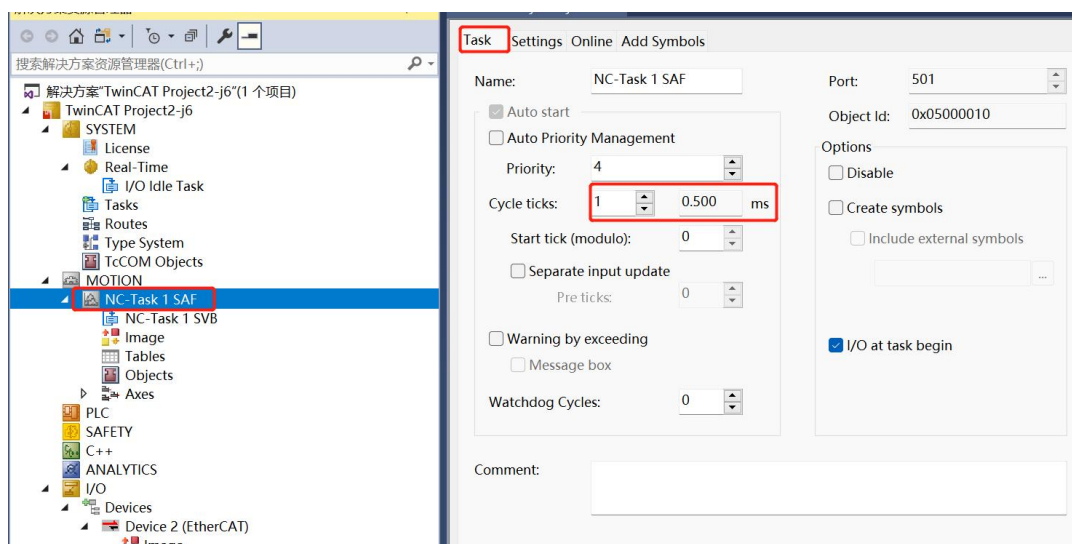


图 4-7 Cycle time 设置界面

Figure 4-7 Cycle time setting interface

第五章 运动控制

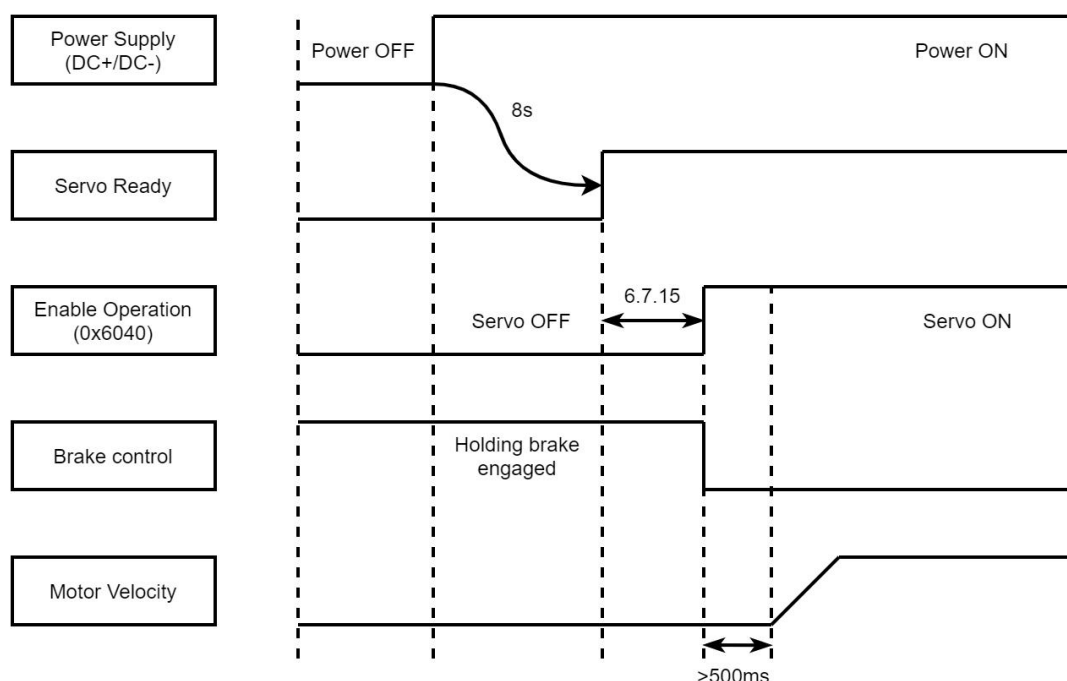
Chapter 5 Motion Control

5.1 操作时序

Operation Sequence

5.1.1. 从电源打开到伺服使能操作时序

Operation sequence from power on to servo on



注 1：请确保使能后，等待至少 500ms 以上再发送运动指令。

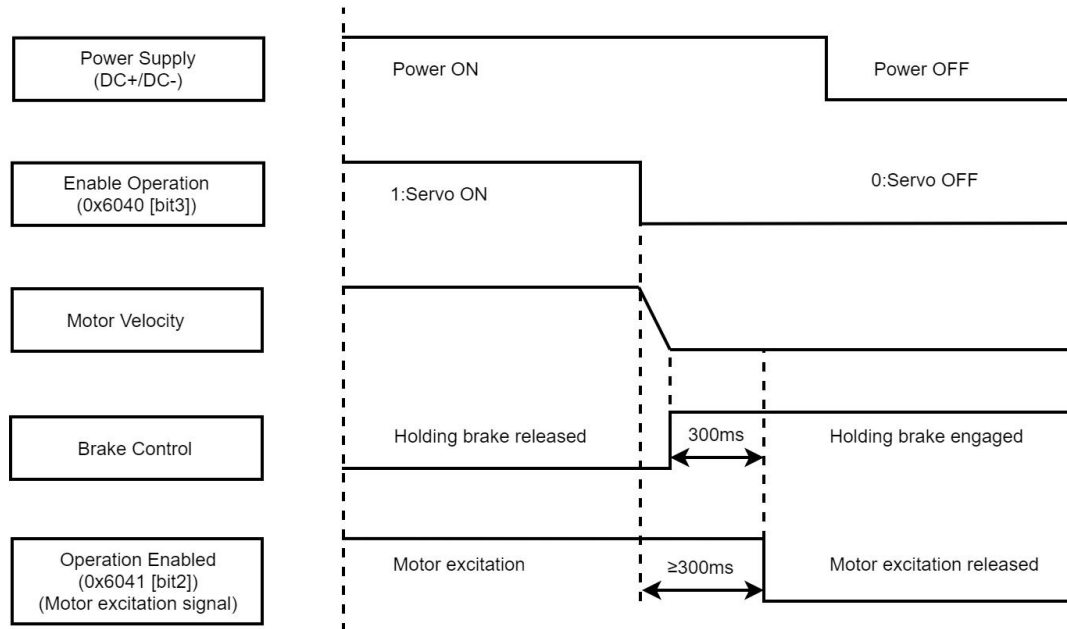
Note1: Make sure to wait at least 500ms after servo on before sending the motion command.

注 2：从 X4012911X 版本开始，将上电至伺服完全准备好的时间由 8 秒调整为 5 秒。

Note2: Starting from version X4012911X, the time required for the servo ready after power-on has been reduced from 8 seconds to 5 seconds.

5.1.2. 从伺服使能到伺服下使能操作时序

Operation sequence from servo on to servo off



注：正常上下使能间隔需大于 300ms。

Note: Normally, enabling and disabling intervals should be greater than 300ms.

5.2 控制环路

Control Loops

5.2.1. 全闭环位置控制

Full-closed Loop Position Control

如图 5-1 所示，eRob 关节模组采用内置绝对值双编码器的全闭环控制策略，无磨损精度，实时补偿减速机传动误差和齿隙。

As shown in Figure 5-1, the eRob uses a full-closed loop control with built-in dual absolute encoder, no friction accuracy, and real-time compensation for the transmission error and backlash of the reducer.

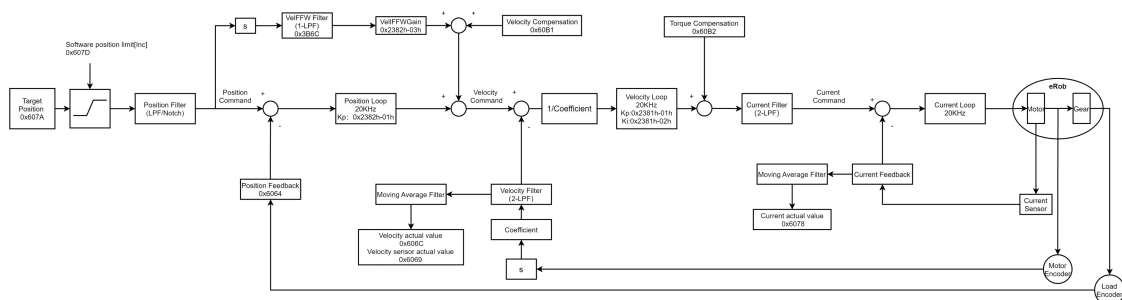


图 5-1 全闭环位置控制框图

Figure 5-1 Full-closed Loop Position Control

其中：

$$Coefficient = \frac{1}{\text{减速机的齿轮比}} * \frac{\text{负载端单圈编码器的分辨率}}{\text{电机端单圈编码器的分辨率}}$$

$$Coefficient = \frac{1}{\text{reduction gear}} * \frac{\text{the Resolution ratio of Load encoder}}{\text{the Resolution ratio of Motor encoder}}$$

负载端单圈编码器的分辨率：524288

the Resolution ratio of Load encoder: 524288

电机端单圈编码器的分辨率：131072

the Resolution ratio of Motor encoder: 131072



5.3 运行模式

Operation Mode

5.3.1. 运行模式

Operation Mode

使用运行模式对象（0x6060）来设置所需的运行模式。

The modes of operation (0x6060) is used to set the desired operating mode.

表 5-1 运行模式（0x6060）

Table 5-1 Modes of operation (0x6060)

Modes of operation (0x6060)		
Value	Modes of operation	Data type R/W
0x01	轮廓位置模式 Profile Position mode	Integer 8 Read/write
0x03	轮廓速度模式 Profile Velocity mode	
0x04	轮廓扭矩模式 Profile Torque mode	
0x06	回零模式（暂不支持） Homing mode (Not support)	
0x07	位置插补模式（暂不支持） Interpolated Position mode (Not support)	
0x08	周期同步位置模式 Cyclic Synchronous Position mode	
0x09	周期同步速度模式 Cyclic Synchronous Velocity mode	
0x0A	周期同步扭矩模式 Cyclic Synchronous Torque mode	
更改参数立即激活 Changed settings become active immediately		



使用运行模式显示对象（0x6061）读取当前的运行模式。

The modes of operation display (0x6061) can be used to read the current operating mode.

表 5-2 运行模式显示（0x6061）

Table 5-2 Modes of operation display (0x6061)

Modes of operation display (0x6061)		
Value	Modes of operation display	Data type R/W
0x01	轮廓位置模式	Integer 8 Only read
	Profile Position mode	
0x03	轮廓速度模式	
	Profile Velocity mode	
0x04	轮廓扭矩模式	
	Profile Torque mode	
0x06	回零模式（暂不支持）	
	Homing mode(Not support)	
0x07	位置插补模式（暂不支持）	
	Interpolated Position mode(Not support)	
0x08	周期同步位置模式	
	Cyclic Synchronous Position mode	
0x09	周期同步速度模式	
	Cyclic Synchronous Velocity mode	
0x0A	周期同步扭矩模式	
	Cyclic Synchronous Torque mode	
更改参数立即激活		
Changed settings become active immediately		

5.3.2. 运行模式切换

Operation Mode Switch

运行模式切换注意事项

Operation mode switch note

- 1) 关于运行模式切换，目前支持在使能静止状态下切换运行模式。
- 2) 从其他运行模式切换至位置模式（PP、CSP）之前，需将实际位置 0x6064 的值赋予目标位置 0x607A。
 - 1) As for the operation mode switching, at present support switching in the operation enabled state.
 - 2) Before switching from another operation mode to position mode (PP, CSP), assign the actual position 0x6064 to the target position 0x607A.

5.4 PDS FSA

PDS FSA

伺服驱动器使用 CANopen 状态机（Finite State Automation, FSA）来定义其状态和相应的伺服控制功能。主站利用控制字(0x6040)来控制从站 FSA 的状态切换，从站使用状态字（0x6041）反馈从站当前状态来响应主站。图 5-2 为状态机的切换流程图，状态机的描述可参考表 5-3。

Servo drives use the CANopen finite state automation (FSA) to define their state and corresponding servo control functions. The master uses control words (0x6040) to control the slave state switching of the drive, and the slave drive uses the status word (0x6041) to feedback to the current state of the master's drive. The following figure 5-2 is the switching flow chart of the finite state machine, and the description of each state machine can be referred to table 5-3.

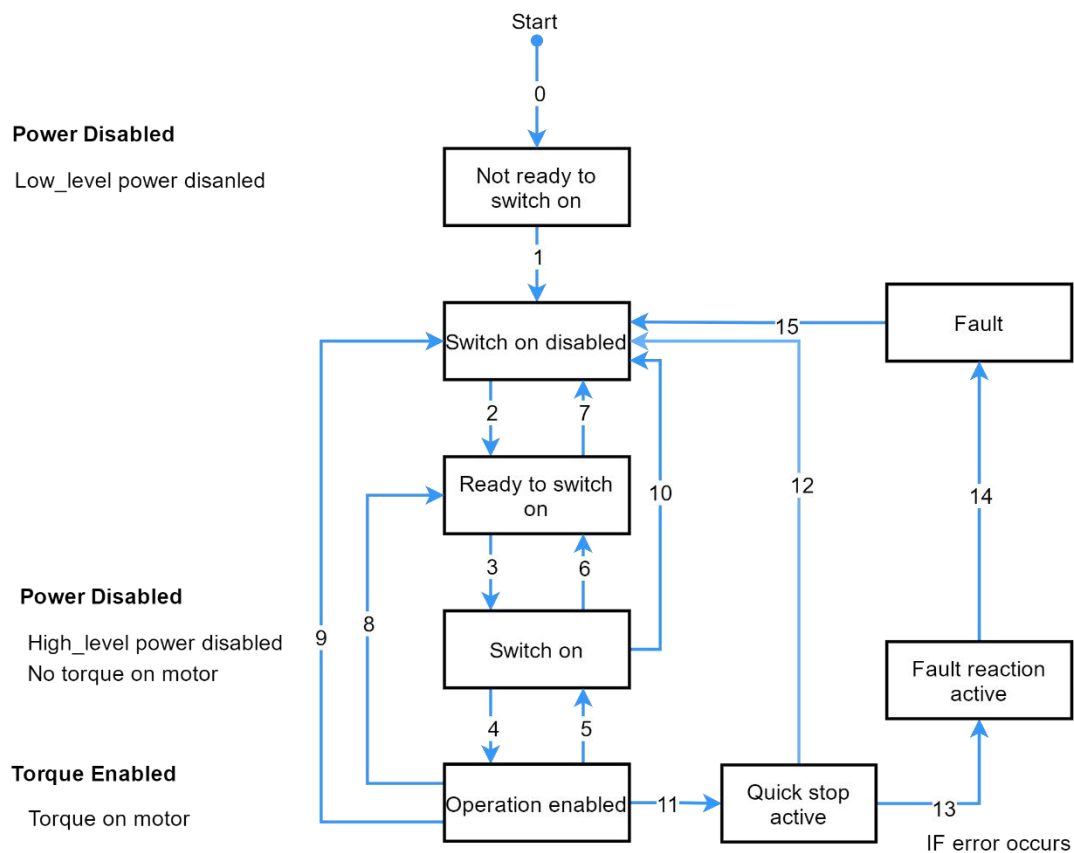


图 5-2 设备状态机

Figure 5-2 Device state machine

状态字（0x6041）提供了有关运行状态的信息。

The status word (0x6041) provide information on the operating state.

表 5-3 状态字信息

Table 5-3 Status word information

Operation state	Bit7~ Bit 15	Bit 6: Switch on disabled	Bit 5: Quick stop	Bit 4: Voltage enabled	Bit3: Fault	Bit2: Operation enabled	Bit1: Switched on	Bit0: Ready to switch on	Description
初始化 Not ready to switch on	xxxx xxxx	0	0	x	0	0	0	0	驱动功能已禁用。 Drive function is disabled.
伺服无故障 Switch on disabled	xxxx xxxx	1	0	x	0	0	0	0	初始化完成。 驱动器参数可以修改。 驱动功能已禁用。 Drive initialization is complete. Drive parameters maybe changed. Drive function is disabled.
伺服准备好 Ready to switch on	xxxx xxxx	0	1	x	0	0	0	1	驱动器参数可以修改， 驱动器功能已禁用。 Drive parameters maybe changed, Drive function is disabled.
等待打开伺服使能 Switched on	xxxx xxxx	0	1	x	0	0	1	1	驱动器功能已禁用。 驱动器等待打开伺服使能。 Drive function is



									disabled. Current offset calibration done.
伺服运行 Operation enabled	xxxx xxxx	0	1	x	0	1	1	1	未检测到故障。 启用驱动功能，电机使能。 No faults have been detected. Drive function is enabled and power is applied to the motor.
快速停机 Quick stop active	xxxx xxxx	0	0	x	0	1	1	1	正在执行快速停机功能。 启用驱动功能，电机使能。 Quick stop function is being executed. Drive function is enabled and power is applied to the motor.
故障停机 Fault reaction active	xxxx xxxx	0	0	x	1	1	1	1	驱动器出现故障，伺服正在执行故障停机过程。 A fault has occurred in the drive. Selected fault reaction is being executed.
故障 Fault	xxxx xxxx	0	0	x	1	0	0	0	驱动器出现故障。 驱动器参数可以修改，驱动功能已禁用。



									A fault has occurred in the drive. Drive parameters may have changed drive function is disabled.
--	--	--	--	--	--	--	--	--	--

说明:

Bit 4: Bit 4=1 表示母线电压正常。如果电压欠压或电压过高, 不能从 Switched on 转换到 Operation enabled。

Bit 7: 如果状态字的 Bit 7 (警告) 为 1, 则表示存在警告事件。警告不是错误或故障, PDS FSA 的状态不会改变。警告原因会在警告代码对象 (0x3B68) 中给出。

Bit 9: 如果设置了 Bit 9, 设备执行现场总线命令。如果 Bit 9 被重置, 则设备将通过不同的接口进行控制。在这种情况下, 仍然可以通过现场总线读取或写入参数。

Bit 10: 到达目标:

- 1) 当状态字 Bit 10 置为 1 时, 表示电机到达预设值。
- 2) 在运行模式修改时, Bit 10 置为 1。

Bit 12~15: 详见第 5.4.1 章节表 5-4。

Description:

Bit 4:Bit 4=1 indicates whether the DC bus voltage is correct. If the voltage is missing or is too low, the device does not transition from switched on to operation enabled.

Bit 7 :If bit 7 (warning) of the status word is 1, it indicates a warning event exists.Warning is not an error or fault. The status of the PDS FSA does not change. The cause of the warning may be given in the Warning code object (0x3B68).

Bit 9: If bit 9 is set, the device carries out commands via the fieldbus. If Bit 9 is reset, the device is controlled via a different interface. In such a case, it is still possible to read or write parameters via the fieldbus.

Bit 10: Target reached:

- 1)When bit10 (Target reached) of status word is 1,Indicates that the motor reached the preset value.
- 2)It is set to "1" when an operation mode is changed.

Bit 12~15: See Table 5-4 in Chapter 5.4.1.



5.4.1. 状态字 0x6041

Status word 0x6041

表 5-3 状态字

Table5-3 Status word

状态字（0x6041） Status word(0x6041)		
Bits	Name	Description
0	准备打开伺服使能 Ready to switch on	1-有效，0-无效 1-valid, 0-invalid
1	伺服使能 Switched on	1-有效，0-无效 1-valid, 0-invalid
2	伺服运行 Operation enabled	1-有效，0-无效 1-valid, 0-invalid
3	故障 Fault	1-有效，0-无效 1-valid, 0-invalid
4	接通主回路电 Voltage enabled	1-有效，0-无效 1-valid, 0-invalid
5	快速停机 Quick stop	1-有效，0-无效 1-valid, 0-invalid
6	伺服无故障 Switch on disabled	1-有效，0-无效 1-valid, 0-invalid
7	警告 Warning	1-有效，0-无效 1-valid, 0-invalid
8	厂家自定义 Manufacturer-specific	未定义 No define
9	远程控制 Remote	1-有效（默认），0-无效 1-valid(Defaulted), 0-invalid
10	目标到达 Target reach	1-有效，0-无效 1-valid, 0-invalid
11	软件内部位置超限 Internal limit active	1-有效，0-无效 1-valid, 0-invalid
12~13	特定的运行模式 Operation mode specific	与各伺服运行模式相关 Related to each servo operation mode
14~15	厂家自定义 Manufacturer-specific	未定义 No define



表 5-4 各运行模式的状态字

Table 5-4 Status words for each operation mode

Status word for the operating mode-specific settings.						
Operation mode	Bit8	Bit10	Bit12	Bit13	Bit14	Bit15
PP	Reserved	Target reached	Set-point acknowledge	following error (not support)	Reserved	Reserved
PV	Reserved	Target reached	Reserved	Reserved	Reserved	Reserved
PT	Reserved	Target reached	Reserved	Reserved	Reserved	Reserved
HM	Not support					
IP	Not support					
CSP	Reserved	Reserved	Drive follows command value(not support)	following error (not support)	Reserved	Reserved
CSV	Reserved	Reserved	Drive follows command value(not support)	Reserved	Reserved	Reserved
CST	Reserved	Reserved	Drive follows command value(not support)	Reserved	Reserved	Reserved

5.4.2. 控制字 0x6040

Control word 0x6040

控制字可用于切换运行状态。

The parameter control word can be used to switch between operating states.

表 5-5 控制字

Table 5-5 Control word

Control word(0x6040)		
Bit	Name	Description
0	伺服使能 Switch on	1-有效, 0-无效 1-valid, 0-invalid
1	接通主回路电 Enable voltage	1-有效, 0-无效 1-valid, 0-invalid
2	快速停机 Quick stop	0-有效, 1-无效 0-valid, 1-invalid
3	伺服运行 Enable operation	1-有效, 0-无效 1-valid, 0-invalid
4~6	特定运行模式 Operation mode specific	与各伺服运行模式相关 Related to each servo operation mode
7	故障复位 Fault reset	Bit7: 上升沿有效 Bit7: Valid rising edge
8	停止 Halt	0: 默认值 1: 使用停止选项代码 (0x605D) 停止移动 0:default 1:Stop movement with halt option code (0x605D)
9	特定运行模式 Operation mode specific	与各伺服运行模式相关 Related to each servo operation mode
10	保留 Reserve	未定义 No define
11~15	厂家自定义 Manufacturer-specific	厂家设定 Manufacturer specific

表 5-6 各运行模式的控制字

Table5-6 Control word for each operation mode

Control word for the operating mode-specific settings.						
Operation mode	Bit4	Bit5	Bit6	Bit8	Bit9	Bit11~Bit15
PP	new set-point	change set immediately	absolute/relative	Halt	reserved	reserved
PV	reserved	reserved	reserved	Halt	reserved	reserved
PT	reserved	reserved	reserved	Halt	reserved	reserved
HM	not support					
IP	not support					
CSP	reserved	reserved	reserved	reserved	reserved	reserved
CSV	reserved	reserved	reserved	reserved	reserved	reserved
CST	reserved	reserved	reserved	reserved	reserved	reserved

5.5 周期同步位置模式

Cyclic Synchronous Position Mode

当对象字典 0x6060 的值设置为 8 时，eRob 关节模组工作在周期同步位置模式。

When the value of the object dictionary 0x6060 is set to 8, eRob is operated by cyclic synchronous position mode.

在周期同步位置控制模式中，主站控制器实现轨迹规划并且在每个 EtherCAT/CAN 通信周期发送目标位置指令给 eRob 关节模组，在 eRob 关节模组内部执行位置控制、速度控制、扭矩控制。

In the Cyclic Synchronous Position mode, the master controller generate trajectory and transmit the target position to the eRob at each EtherCAT/CAN communication cycle, and the eRob performs position control, velocity control and torque control.

图 5-3 说明了驱动器控制功能的输入与输出变量，输入值是来自控制器输出的目标位置（0x607A）指令，以及可选的用于前馈控制的速度偏移值（0x60B1）与扭矩偏移值（0x60B2）。限制功能可用于位置范围的限制，以避免意外发生。

目标位置被理解为绝对位置，实际位置值作为强制输出值，同时可以选择输出实际速度值与实际扭矩值，位置偏差（The following error actual value）被用作一个附加的参数。

The figure 5-3 shows the inputs and outputs of the drive control function. The input values (from the master controller) are the target position(0x607A) as well as an optional velocity offset (0x60B1) and an optional torque offset(0x60B2) used for feed forward control. Limit functions can be used to restrict the range of values to avoid unintended positions.

The target position is interpreted as absolute value. The position actual value is used as mandatory output to the control device. Further outputs are the velocity actual value and torque actual value. The following error actual value is used as an additional parameter.

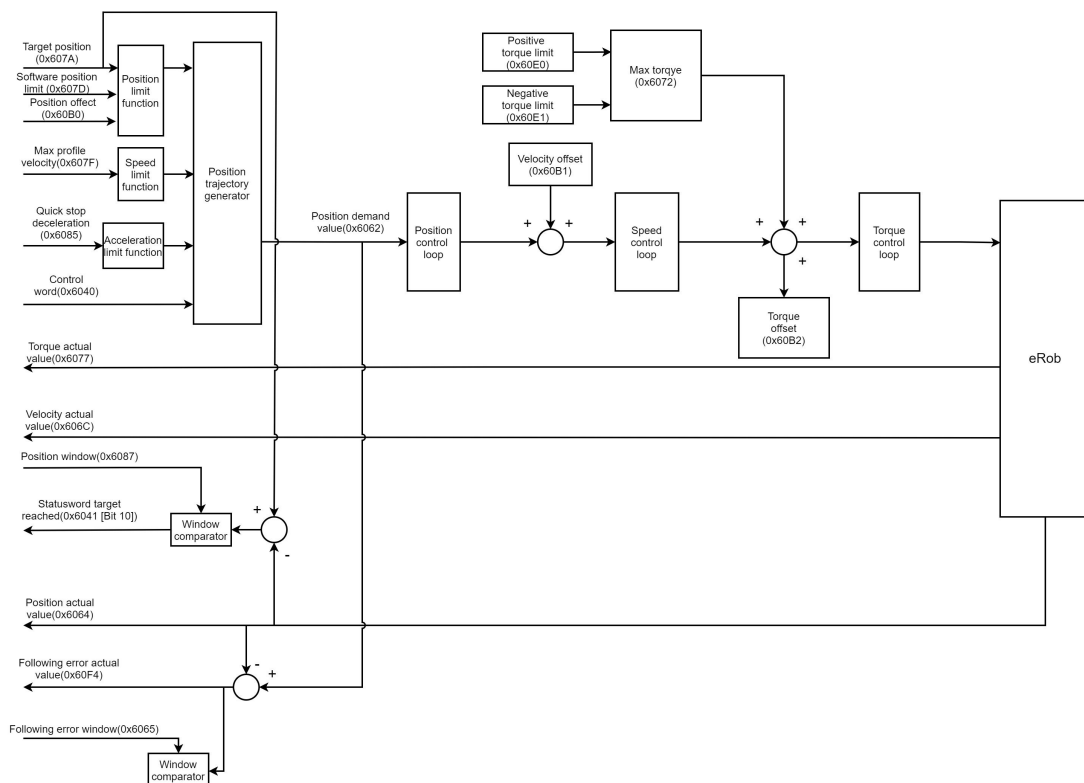


图 5-3 CSP 模式的功能

Figure 5-3 The function of CSP mode

操作步骤 Operate steps:

- 1) 设定模式, 0x6060=08h, 周期同步位置模式;

Set 0x6060 to 08h to set the mode as the cyclic synchronous position mode;

- 2) 读取实际位置 0x6064, 设置目标位置 0x607A 等于当前实际位置值;

Read the actual position 0x6064, set the target position 0x607A equal to the current actual position value;

3) 设置控制命令 0x6040, 请按照以下步骤操作。

Set the control word (0x6040). Follow these steps for operation.

Steps	Control word					Meaning
	Bit4	Bit 3	Bit 2	Bit 1	Bit 0	
1	0	0	1	1	0	Shutdown (关闭)
2	0	0	1	1	1	Switch on (准备使能)
3	0	1	1	1	1	Enable operation (使能)

4)主站控制器将规划好的目标位置点通过 0x607A 这个对象字典周期性地发送给 eRob 关节模组。

- The master controller periodically sends the planned target location points to the eRob joint module via the object dictionary 0x607A.

表 5-7 CSP 模式的状态字相关位

Table5-7 CSP mode dependent bits of the status word

Parameter value	Meaning
Bit10 = 目标到达 Bit10 = Target reached	如果实际位置在位置窗口时间的持续时间内停留在目标位置±位置窗口的范围内, 则该位设置为 1。 0 = 未达到目标位置 1 = 达到目标位置 The bit is set to 1 if the actual position stays in the window of the target position ± position window for a duration of position window time. 0 = Target position not reached 1 = Target position reached
Bit11 = 软件内部速度、位置超限 Bit11 = Internal limit active	最大电机速度 0x6080 限制速度需求值 0x606B 和轮廓速度 0x6081。 软件位置限制值 0x607D 限制位置需求值 0x6062。 Max motor speed 0x6080 limits velocity demand value 0x606B and profile velocity 0x6081. Software position limit 0x607D limits position demand value 0x6062.
Bit12 =忽略目标位置 Bit12 = Target position ignored	
Bit13-15	N/A

相关的对象字典 Associated Objects

表 5-8 与 CSP 模式关联的对象

Table5-8 Objects associated with CSP mode

Index	Sub -Index	Name	Unit	Data type	Access	PDO mapping
0x6040	00h	Control word	-	UINT	RW	RxPDO
0x6041	00h	Status word	-	UINT	RO	TxPDO
0x6060	00h	Modes of operation	-	INT	RW	RxPDO
0x6061	00h	Modes of operation display	-	INT	RO	TxPDO
0x6062	00h	Position demand value	plus	INT	RO	NO
0x6064	00h	Position actual value	plus	INT	RO	TxPDO
0x6065	00h	Following error window	plus	UINT	RW	NO
0x6067	00h	Position window	plus	UINT	RW	NO
0x6068	00h	Position window time	0.05ms	UINT	RW	NO
0x6081	00h	Profile velocity	plus/s	UINT	RW	TxPDO
0x6083	00h	Profile acceleration	plus/s ²	UINT	RW	TxPDO
0x6084	00h	Profile deceleration	plus/s ²	UINT	RW	TxPDO
0x607A	00h	Target position	plus	INT	RW	RxPDO
0x607D	01h	Software position limit: Min position limit	plus	INT	RW	NO
	02h	Software position limit: Max position limit	plus	INT	RW	NO
0x60F4	00h	Following error actual value	plus	INT	RO	TxPDO



5.5.1. CANopen PDO 通信控制报文

CANopen PDO communication message control

以伺服 ID=1 为例

Take the servo ID=1, for example

CSP pattern	Steps		COB-ID	Data
停止节点，配置相关参数	关闭远程节点 Stop remote node		00	02 01
Stop the node and configure the relevant parameters	复位节点 Reset communication		00	82 01
			701	00
	设置为周期同步位置模式 Set the cyclic synchronous position mode		601	2F 60 60 00 08 00 00 00
			581	60 60 60 00 00 00 00 00
	核对运行模式为 CSP 模式 Check operating mode to CSP pattern		601	40 61 60 00 00 00 00 00
			581	4F 60 60 00 08 00 00 00
	关闭同步发生器 Disable sync		601	23 05 10 00 80 00 00 00
			581	60 05 10 00 00 00 00 00
	通信周期设置为 1000us Set communication cycle period (1000us)		601	23 06 10 00 E8 03 00 00
		581	60 06 10 00 00 00 00 00	
PDO 映射配置流程 The PDO mapping configuration process	TxPDO1 配置流程 The TxPDO1 configuration process	关闭 TxPDO1 Disable TxPDO1	601	23 00 18 01 81 01 00 80
			581	60 00 18 01 00 00 00 00
		设置传输类型 Defines the transmission type	601	2F 00 18 02 01 00 00 00
			581	60 00 18 02 00 00 00 00
		清除原有映射 Defines the number of valid entries in the mapping record	601	2F 00 1A 00 00 00 00 00
			581	60 00 1A 00 00 00 00 00
		0x1A00: 01h 映射 0x60410010 (状态字) 0x1A00:01h maps 0x60410010 (status word)	601	23 00 1A 01 10 00 41 60
			581	60 00 1A 01 00 00 00 00
		0x1A00: 02h 映射 0x60640020 (实际位置) 0x1A00:02h maps 0x60640020 (actual position)	601	23 00 1A 02 20 00 64 60
			581	60 00 1A 02 00 00 00 00
		0x1A00: 00h 写入映射对象个数: 2 0x1A00:00h: the number	601	2F 00 1A 00 02 00 00 00
			581	60 00 1A 00 00 00 00 00



		of valid entries in the mapping		
		打开 TxPDO1 Enable TxPDO1	601 581	23 00 18 01 81 01 00 00 60 00 18 01 00 00 00 00
	RxPDO1 配置流程 The RxPDO1 configuration process	关闭 RxPDO1 Disable RxPDO1	601 581	23 00 14 01 01 02 00 80 60 00 14 01 00 00 00 00
		设置传输类型 Defines the transmission type	601 581	2F 00 14 02 01 00 00 00 60 00 14 02 00 00 00 00
		清除原有映射 Defines the number of valid entries in the mapping record	601 581	2F 00 16 00 00 00 00 00 60 00 16 00 00 00 00 00
		0x1600: 01h 映射 0x60400010 (控制字) 0x1600:01h maps 0x60400010(control word)	601 581	23 00 16 01 10 00 40 60 60 00 16 01 00 00 00 00
		0x1600: 02h 映射 0x607A0020 (目标位置) 0x1600:02h maps 0x607A0020 (target position)	601 581	23 00 16 02 20 00 7A 60 60 00 16 02 00 00 00 00
		0x1600: 00h 写映射对象 个数: 2 0x1600:00h:the number of valid entries in the mapping record: 2	601 581	2F 00 16 00 02 00 00 00 60 00 16 00 00 00 00 00
		打开 RxPDO1 Enable RxPDO1	601 581	23 00 14 01 01 02 00 00 60 00 14 01 01 00 00 00
	启动节点 Start the node	NMT 启动节点 NMT start remote node	0	01 01
		读 0x6064 获取当前实际位置 Read 0x6064 to get the actual position	601 581	40 64 60 00 00 00 00 00 43 64 60 00 00 00 00 00
		写 0x607A 等于当前实际位置 Write 0x607A equal to the actual position	601 581	23 7A 60 00 00 00 00 00 60 7A 60 00 00 00 00 00
	周期发送 RxPDO1 Cycle to send RxPDO1	电机清除报错 Motor clear error 控制字设置为 128; 目标位置设置为 0 plus。 Control word set to 128; Target position set to 0 plus.	201	80 00 00 00 00 00 00



		发送同步帧	080	
		Send sync frame	181	40 12 00 00 00 00
	电机使能 Enable	控制字设置为 6; 目标位置设置为 0 plus。 Control word set to 6; Target position set to 0 plus.	201	06 00 00 00 00 00
		发送同步帧	080	
		Send sync frame	181	21 12 04 F8 4F 00
		控制字设置为 7; 目标位置设置为 0 plus。 Control word set to 7; Target position set to 0 plus.	201	07 00 00 00 00 00
		发送同步帧	080	
		Send sync frame	181	33 12 00 00 00 00
		控制字设置为 15; 目标位置设置为 0 plus。 Control word set to 15; arget position set to 0 plus.	201	0F 00 00 00 00 00
		发送同步帧	080	
		Send sync frame	181	37 16 00 00 00 00
	设置目标位置 Set the target position	控制字设置为 31; 目标位置设置为 10 plus。 Control word set to 31; Target position set to 10 plus.	201	1F 00 0A 00 00 00
		发送同步帧	080	
		Send sync frame	181	37 16 0A 00 00 00

5.6 轮廓位置模式

Profile Position Mode

当对象字典 0x6060 的值设置为 1 时，eRob 关节模组工作在轮廓位置模式。

When the value of the object dictionary 0x6060 is set to 1, eRob is operated by profile position mode.

在轮廓位置模式中，接收来自主站控制器的目标位置、轮廓加速度、轮廓减速度、轮廓速度而执行相应的运动。轮廓位置模式多用于点到点定位运行，运行曲线由伺服驱动器自身规划。

In the Profile Position mode, the eRob executes a movement according to a target position, acceleration, deceleration and velocity values sent from the master controller. The profile position mode is mostly used for point-to-point positioning operation, and the running curve is planned by the servo drive itself.

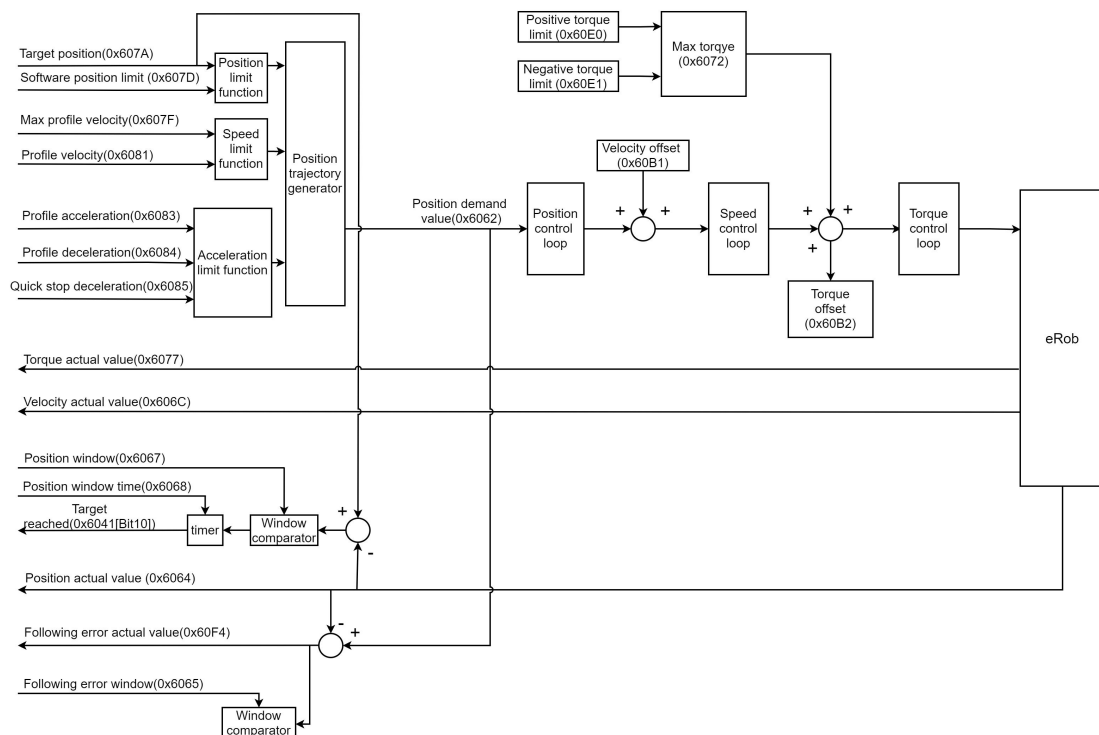


图 5-4 PP 模式的功能

Figure 5-4 The function of PP mode

操作步骤 Operate steps:

- 1) 设定运行模式，0x6060= 01h，轮廓位置模式；

Set 0x6060 to 01h to set the mode as the PP mode.

2) 设置目标位置 0x607A;

Set target position 0x607A;

3) 设置轮廓速度 0x6081;

Set profile velocity 0x6081;

4) 设置轮廓加速度 0x6083;

Set profile acceleration 0x6083;

5) 设置轮廓减速度 0x6084;

Set profile deceleration 0x6084;

6) 设置控制字 0x6040, 请按照以下步骤操作。

Set the control word (0x6040), follow these steps for operation.

Steps	Control word					Meaning
	Bit4	Bit 3	Bit 2	Bit 1	Bit 0	
1	0	0	1	1	0	Shutdown (关闭)
2	0	0	1	1	1	Switch on (准备使能)
3	0	1	1	1	1	Enable operation (使能)
4	1	1	1	1	1	Command triggered (命令触发)

7) 在完成一段运动命令后, 若需要执行下一段运动命令需要再设置目标位置, 速度等条件。

After the servo completes the first motion command, the servo sets the target position and velocity, and other conditions to execute the next motion command.

8) 设置控制指令 0x6040, 由于控制命令触发为上升沿触发, 因此必须将控制字 bit4 值切换为 off 再切至 on, 伺服才会再次运动。

Set the control word (0x6040). Since the command is rising-edge triggered, switch bit 4 to off first and then to on.

Steps	Control word					Meaning
	Bit4	Bit 3	Bit 2	Bit 1	Bit 0	
1	0	1	1	1	1	Enable operation (使能)
2	1	1	1	1	1	Command triggered (命令触发)

控制字（0x6040）中的第 4-6 位和第 8 位控制开始移动

Bits 4-6 and bit 8 in the Control word (0x6040) start a movement

表 5-9 PP 模式的控制字相关位

Table 5-9 PP mode dependent bits of the control word

Parameter value		Meaning
Bit5: Change set point immediately	Bit4: New target value	
0:Non-immediate update	0=>1	开始向目标位置移动。 如果未启用立即生效指令，当前的运动命令正在执行时（尚未完成），即使接收到新的触发命令（Bit4:0=>1），伺服也会继续执行当前的运动命令，只有在当前运动命令完成后(在当前目标位置停止)，才会确认并执行新的运动命令。 Starts a movement to a target position. If the command is not enabled to take immediate effect, when the current motion command is in execution (not yet complete), the servo continues to execute the current motion command even if a new command is triggered (Bit4:0=>1) . The new command is acknowledged and executed only after the current command is complete(The movement is stopped at the current target position) .
1:Immediate update	0=>1	开始向目标位置移动。 如果启用立即生效指令，当前的运动命令正在执行时（尚未完成），伺服一旦接收到新的触发命令（Bit4:0=>1），就会立即中断当前运动指令并执行新的运动命令。 Starts a movement to a target position. If the command is enabled to take immediate effect, when the current motion command is in execution (not yet complete), the servo immediately interrupts the current command and executes the new command once receiving the new triggered command (Bit4:0=>1) .
Bit6 =绝对运动/相对运动 Bit6 = Absolute/Relative		0: 绝对运动 1: 相对运动（不支持） 0:Absolute movement 1:Relative movement (Not Support)
Bit8 =停止 Bit8 = Halt		0: 默认值 1: 使用停止选项代码（0x605D）停止移动 0:default 1:Stop movement with halt option code (0x605D)

关于当前的运动信息可通过状态字（0x6041）获得。

Information on the current movement is available in the status word(0x6041).

表 5-10 PP 模式的状态字相关位

Table5-10 PP mode dependent bits of the status word

Parameter value	Meaning
Bit10 = 目标到达 Bit10 = Target reached	0=未到达的目标位置 1=到达目标位置 0 = Target position not reached 1 = Target position reached
Bit11 = 软件内部速度、位置超限 Bit11 = Internal limit active	最大电机速度 0x6080 限制速度需求值 0x606B 和轮廓速度 0x6081。软件位置限制值 0x607D 限制位置需求值 0x6062。 Max motor speed 0x6080 limits velocity demand value 0x606B and Profile velocity 0x6081. Software position limit 0x607D limits position demand value 0x6062.
Bit12 = 目标位置确认 Bit12 = Target value acknowledge	0 = 接受新的设定值，确认并再次开始生成目标 1 = 不接受新的设定值 0 = Accept a new set-point acknowledge and start generating target again 1= No accept a new set-point acknowledge
Bit13-15	N/A

相关的对象字典 Associated Objects

表 5-11 与 PP 模式相关联的对象

Table5-11 Objects associated with PP mode

Index	Sub-Index	Name	Unit	Data type	Access	PDO mapping
0x6040	00h	Control word	-	UINT	RW	RxPDO
0x6041	00h	Status word	-	UINT	RO	TxPDO
0x6060	00h	Modes of operation	-	INT	RW	RxPDO
0x6061	00h	Modes of operation display	-	INT	RO	TxPDO
0x6062	00h	Position demand value	plus	INT	RO	NO
0x6064	00h	Position actual value	plus	INT	RO	TxPDO
0x6065	00h	Following error window	plus	UINT	RW	NO
0x6067	00h	Position window	plus	UINT	RW	NO
0x6068	00h	Position window time	0.05ms	UINT	RW	NO
0x6081	00h	Profile velocity	plus/s	UINT	RW	TxPDO
0x6083	00h	Profile acceleration	plus/s ²	UINT	RW	TxPDO

0x6084	00h	Profile deceleration	plus/s ²	UINT	RW	TxPDO
0x607A	00h	Target position	plus	INT	RW	RxPDO
0x607D	01h	Software position limit:Min position limit	plus	INT	RW	NO
	02h	Software position limit:Max position limit	plus	INT	RW	NO
0x60F4	00h	Following error actual value	plus	INT	RO	TxPDO

5.6.1. 立即更新型（0x6040：bit5=1）

Immediate update（0x6040:bit5=1）

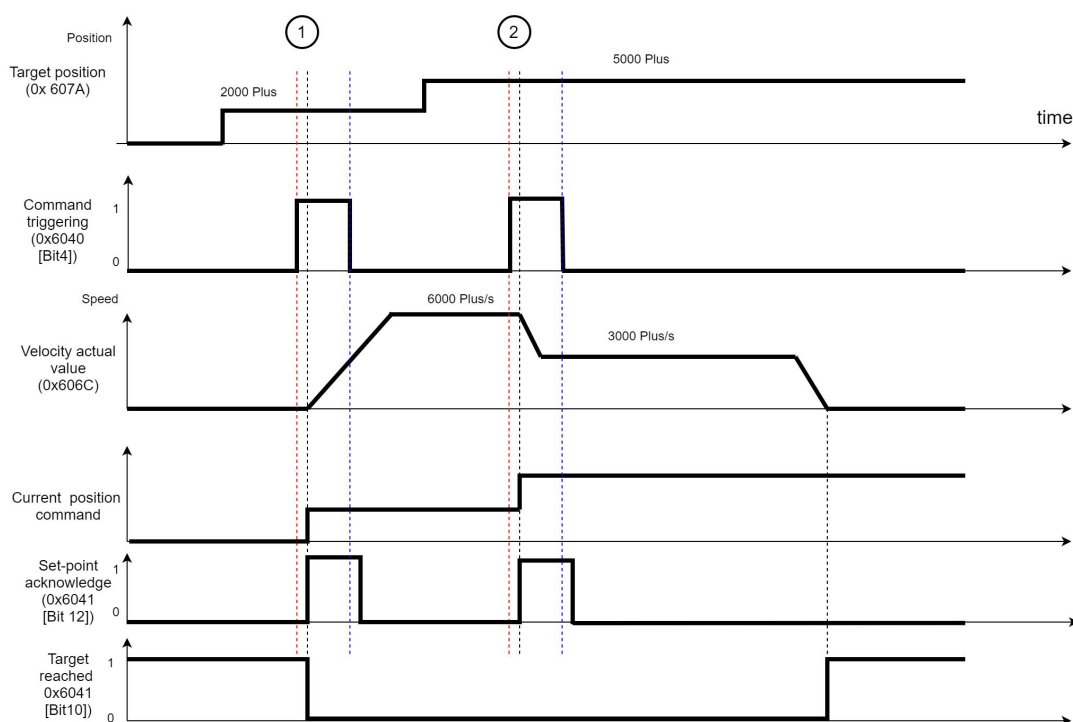


图 5.5 立即更新模式时序图

Figure 5.5 Immediate update mode timing diagram

1) 上位机首先更新位置指令的其他属性(轮廓速度 0x6081，轮廓加速度 0x6083，轮廓减速度 0x6084，目标位置 0x607A)。

2) 上位机将控制字 0x6040 的 bit4 由 0 置 1，提示从站有新的位置指令需要使能。



3) 从站在接收到控制字 0x6040 的 bit4 的上升沿后,对是否可接收该新的位置指令做出判断:若控制字 0x6040 的 bit5 的初始状态为 1,且此时状态字 0x6041 的 bit12 为 0,表明从站可接收新的位置指令①;从站接收新的位置指令后,将状态字 0x6041 的 bit12 由 0 置 1,表明新的位置指令①已接收,且当前从站处于不能继续接收新的位置指令状态。

立刻更新模式下,新的位置指令一旦被接收(0x6041 的 bit12 由 0 变为 1),伺服立刻执行该位置指令。

4) 上位机接收到从站的状态字 0x6041 的 bit12 变为 1 后,才可以释放位置指令数据,并将控制字 0x6040 的 bit4 由 1 置 0,表明当前无新的位置指令。

由于控制字 0x6040 的 bit4 为上升沿变化有效,因此,此操作不会中断正在执行的位置指令。

5) 从站检测到控制字 0x6040 的 bit4 由 1 变为 0 时,可以将状态字 0x6041 的 bit12 由 1 置 0,表明从站已准备好可以接收新的位置指令。

立刻更新模式下,当从站检测到控制字 0x6040 的 bit4 由 1 变为 0 时,总是会将状态字 0x6041 的 bit12 清零。

立刻更新模式下,当前段位置指令①执行过程中,接收了新的位置指令②,对于绝对位置指令,第二段位置指令(新的位置指令②)定位完成后,用户绝对位置=②的目标位置 0x607A。

注:目前不支持相对位置指令。

1) The controller first updates other properties of the position command (profile velocity 0x6081, profile acceleration 0x6083, profile deceleration 0x6084,target position 0x607A) .

2) The controller sets the bit4 of control word 0x6040 from 0 to 1, indicating that the slave has a new position command that needs to be enabled.

3) After receiving the rising edge of bit4 of control word 0x6040 from the station, make a judgment on whether the new position command can be received: if the initial state of bit5 of control word 0x6040 is 1, and the bit12 of the status word 0x6041 at this time is 0, indicating that the slave can receive a new position command ①; After the slave receives the new position command, the status word 0x6041 bit12 is set from 0 to



1, indicating that the new position command ① has been received, and the current slave is in a state where it cannot continue to receive new position commands.

In immediate update mode, once a new position command is received (the status 0x6041 bit12 changes from 0 to 1), the servo immediately executes the position command.

4) After the controller receives the status word 0x6041 bit12 of the slave station becomes 1, it can release the position command data, and set the bit4 of the control word 0x6040 from 1 to 0, indicating that there is no new position command at present.

Since bit4 of the control word 0x6040 is valid for rising edge changes, this operation does not interrupt the position command being executed.

5) When the slave detects that bit4 of the control word 0x6040 changes from 1 to 0, it can set the bit12 of the status word 0x6041 from 1 to 0, indicating that the slave is ready to receive new position commands.

In the immediate update mode, when the slave detects that bit4 of the control word 0x6040 changes from 1 to 0, the bit12 of the status word 0x6041 is always cleared.

In the immediate update mode, the current segment position command ① is executed during the execution, a new position command ② is received, for absolute position instruction, after the second segment position command is positioned, the user's absolute position = ② target position 0x607A.

Note: Relative position command are currently not supported.

5.6.2. 非立即更新型 (0x6040: bit5=0)

Non-immediate update (0x6040:bit5=0)

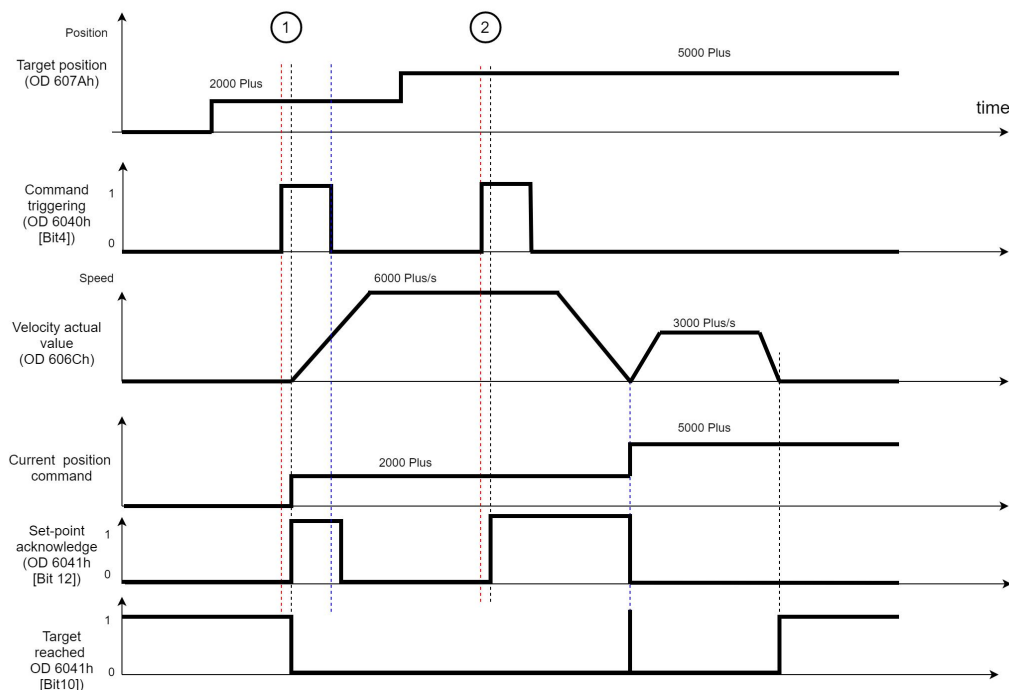


图 5.6 非立即更新模式时序图

Figure 5.6 Non-immediate update mode timing diagram

1) 上位机首先更新位置指令的其他属性(轮廓速度 0x6081, 轮廓加速度 0x6083, 轮廓减速度 0x6084, 目标位置 0x607A)。

2) 上位机将控制字 0x6040 的 bit4 由 0 置 1, 提示从站有新的位置指令需要使能。

3) 从站在接收到控制字 0x6040 的 bit4 的上升沿后, 对是否可接收该新的位置指令做出判断:

若控制字 0x6040 的 bit5 的初始状态为 0, 且此时状态字 0x6041 的 bit12 为 0, 表明从站可接收新的位置指令①; 从站接收新的位置指令后, 将状态字 0x6041 的 bit12 由 0 置 1, 表明新的位置指令①已接收, 且当前从站处于不能继续接收新的位置指令状态。

4) 上位机接收到从站的状态字 0x6041 的 bit12 变为 1 后, 才可以释放位置指令数据, 并将控制字 0x6040 的 bit4 由 1 置 0, 表明当前无新的位置指令。

由于控制字 0x6040 的 bit4 为上升沿变化有效，因此，此操作不会中断正在执行的位移指令。

5) 从站检测到控制字 0x6040 的 bit4 由 1 变为 0，在当前段定位完成后，释放 0x6041 的 bit12，表明从站已准备好可以接收新的位置指令。非立刻更新模式下，当前段正在运行期间，伺服不可接收新的位置指令。当前段位移完成后，伺服可接收新的位置指令，一旦接收新的位置指令(状态字 0x6041 的 bit12 由 0 变为 1)，伺服立刻执行该位置指令。

1) The controller first updates other properties of the position command (profile velocity 0x6081, profile acceleration 0x6083, profile deceleration 0x6084, target position 0x607A).

2) The controller sets the bit4 of the control word 0x6040 from 0 to 1, indicating that the slave has a new position command that needs to be enabled.

3) After the control word 0x6040 rising edge of bit4 received from the station, make a judgment on whether the new position command can be received:

If the initial state of bit5 of the control word 0x6040 is 0, and the bit12 of the status word 0x6041 at this time is 0, it indicates that the slave can receive a new position command ①; After the slave receives the new position command, the status word 0x6041 bit12 is set from 0 to 1, indicating that the new position instruction① has been received, and the current slave is in a state where it cannot continue to receive new position commands.

4) After the controller receives the status word 0x6041 bit12 of the slave station becomes 1, it can release the position command data, and set the bit4 of the control word 0x6040 from 1 to 0, indicating that there is no new position command at present.

Since bit4 of the control word 0x6040 is valid for rising edge changes, this operation does not interrupt the displacement command being executed.

5) The slave detects that bit4 of the control word 0x6040 changes from 1 to 0, and after the positioning of the current segment is completed, release the status word 0x6041 bit12, indicating that the slave is ready to receive new position commands. In non-immediate update mode, the servo cannot receive new position commands while the current segment is running. After the current segment displacement is completed,



the servo can receive a new position command, and once the new position command is received (bit12 of the status word 0x6041 changes from 0 to 1), the servo immediately executes the position command.

5.6.3. CANopen PDO 通信控制报文

CANopen PDO communication message control

以伺服 ID=1 为例

Take the servo ID=1, for example

PP pattern	Steps	COB-ID	Message
停止节点, 配置相关参数 Stop the node and configure the relevant parameters	关闭远程节点 Stop remote node	00	02 01
	复位节点 Reset communication	00	82 01
		701	00
	设置为轮廓位置模式 Set the profile position mode	601	2F 60 60 00 01 00 00 00
		581	60 60 60 00 00 00 00 00
	核对运行模式为 PP 模式 Check operating mode to PP pattern	601	40 61 60 00 00 00 00 00
		581	4F 60 60 00 01 00 00 00
	轮廓速度设置为 5566 plus/s Set the profile velocity to 5566 plus/s	601	23 81 60 00 BE 15 00 00
		581	60 81 60 00 00 00 00 00
	轮廓加速度设置为 5566 plus/s ² Set profile acceleration to 5566 plus/s ²	601	23 83 60 00 BE 15 00 00
		581	60 83 60 00 00 00 00 00
	轮廓减速度设置为 5566 plus/s ² Set profile deceleration to 5566 plus/s ²	601	23 84 60 00 BE 15 00 00
		581	60 84 60 00 00 00 00 00
	关闭同步发生器 Disable sync	601	23 05 10 00 80 00 00 00
		581	60 05 10 00 00 00 00 00
	通信周期设置为 1000us Set communication cycle period (1000us)	601	23 06 10 00 E8 03 00 00
		581	60 06 10 00 00 00 00 00
PDO 映射配置流程 The PDO mapping configuration process	TxPDO1 配置流程 Disable TxPDO1	601	23 00 18 01 81 01 00 80
		581	60 00 18 01 00 00 00 00
	设置传输类型 Defines the transmission type	601	2F 00 18 02 01 00 00 00
		581	60 00 18 02 00 00 00 00
	清除原有映射 Defines the number of valid entries in the mapping	601	2F 00 1A 00 00 00 00 00
		581	60 00 1A 00 00 00 00 00

		record		
		0x1A00: 01h 映射	601	23 00 1A 01 10 00 41 60
		0x60410010(状态字)	581	60 00 1A 01 00 00 00 00
		0x1A00:01h maps		
		0x60410010(status word)		
		0x1A00: 02h 映射	601	23 00 1A 02 20 00 64 60
		0x60640020 (实际位置)	581	60 00 1A 02 00 00 00 00
		0x1A00:02h maps		
		0x60640020 (actual position)		
		0x1A00: 00h 写入映射对象个数: 2	601	2F 00 1A 00 02 00 00 00
		0x1A00:00h:the number of valid entries in the mapping record:2	581	60 00 1A 00 00 00 00 00
		打开 TxPDO1	601	23 00 18 01 81 01 00 00
		Enable TxPDO1	581	60 00 18 01 00 00 00 00
	RxPDO1 配置流程 The RxPDO1 configuration process	关闭 RxPDO1	601	23 00 14 01 01 02 00 80
		Disable RxPDO1	581	60 00 14 01 00 00 00 00
		设置传输类型	601	2F 00 14 02 01 00 00 00
		Defines the transmission type	581	60 00 14 02 00 00 00 00
		清除原有映射	601	2F 00 16 00 00 00 00 00
		Defines the number of valid entries in the mapping record	581	60 00 16 00 00 00 00 00
		0x1600: 01h 映射	601	23 00 16 01 10 00 40 60
		0x6040010 (控制字)	581	60 00 16 01 00 00 00 00
		0x1600:01h maps		
		0x60400010 (control word)		
		0x1600: 02h 映射	601	23 00 16 02 20 00 7A 60
		0x607A0020 (目标位置)	581	60 00 16 02 00 00 00 00
		0x1600:02h maps		
		0x607A0020 (target position)		
		0x1600: 00h: 写映射对象个数: 2	601	2F 00 16 00 02 00 00 00
		0x1600:00h:the number of valid entries in the mapping record:2	581	60 00 16 00 00 00 00 00
		打开 RxPDO1	601	23 00 14 01 01 02 00 00
		Enable RxPDO1	581	23 00 14 01 01 02 00 00



启动节点 Start the node	NMT 启动节点 NMT start remote node	0	01 01
	获取实际位置 Get the actual position	601	40 64 60 00 00 00 00 00
		581	43 64 60 00 00 00 00 00
	发送同步帧 Send sync frame	080 181	 37 12 76 9B 50 00

非立即生效指令控制报文 (0x6040: Bit5=0)

Non-immediate update message control (0x6040:Bit5=0)

PP pattern	Steps		COB -ID	Message
周期发送 RxPDO1 Cycle to send RxPDO1	电机使能 Enable	控制字设置为 6; 目标位置设置为 0 plus。 Control word set to 6; Target position set to 0 plus.	201	06 00 00 00 00 00
		发送同步帧 Send sync frame	080 181	 21 12 69 BA 50 00
		控制字设置为 7; 目标位置设置为 0 plus。 Control word set to 7; Target position set to 0 plus.	201	07 00 00 00 00 00
		发送同步帧 Send sync frame	080 181	 33 12 67 BA 50 00
		控制字设置为 15; 目标位置设置为 0 plus。 Control word set to 15; Target position set to 0 plus.	201	0F 00 00 00 00 00
		发送同步帧 Send sync frame	080 181	 37 16 69 BA 50 00
	目标位置 Set target position	控制字设置为 31; 目标位置设置为 1000 plus。 Control word set to 31; Target position set to 1000 plus.	201	1F 00 E8 03 00 00
		发送同步帧 Send sync frame	080 181	 37 12 76 9B 50 00



立即生效指令控制报文 (0x6040: Bit5=1)

Immediate update message control(0x6040:Bit5=1)

PP pattern	Steps		COB-ID	Message
周期发送 RxPDO1 Cycle to send RxPDO1	电机使能 Enable	控制字设置为 38; 目标位置设置为 0 plus。 Control word set to 38; Target position set to 0 plus.	201	26 00 00 00 00 00
		发送同步帧	080	
		Send sync frame	181	21 12 B4 C3 F8 04
		控制字设置为 39; 目标位置设置为 0 plus。 Control word set to 39; Target position set to 0 plus.	201	27 00 00 00 00 00
		发送同步帧	080	
		Send sync frame	181	33 12 B3 C3 F8 04
		控制字设置为 47; 目标位置设置为 0 plus。 Control word set to 47; Target position set to 0 plus.	201	2F 00 00 00 00 00
		发送同步帧	080	
		Send sync frame	181	37 12 C6 67 F1 04
	目标位置 Set target position	控制字设置为 63; 目标位置设置为 1000 plus。 Control word set to 63; Target position set to 1000 plus.	201	3F 00 E8 03 00 00
		发送同步帧	080	
		Send sync frame	181	37 12 C5 67 F1 04



5.6.4. CANopen SDO 通信控制报文

CANopen SDO communication message control

以伺服 ID=1 为例

Take the servo ID=1, for example

PP pattern	Steps	COB-ID	Message
	设置轮廓位置模式: 0x6060 设置为 1	601	2F 60 60 00 01 00 00 00
	Set the profile position mode: 0x6060 set to 1	581	60 60 60 00 00 00 00 00
	核对运行模式为 PP 模式	601	40 61 60 00 00 00 00 00
	Check operating mode to PP pattern	581	4F 61 60 00 01 00 00 00
	运行轮廓速度设置为 5566 plus/s	601	23 81 60 00 BE 15 00 00
	Set the profile velocity to 5566 plus/s	581	60 81 60 00 00 00 00 00
	运行轮廓加速度设置为: 5566 plus/s ²	601	23 83 60 00 BE 15 00 00
	Set the profile acceleration to 5566 plus / s ²	581	60 83 60 00 00 00 00 00
	运行轮廓减速度设置为 5566 plus/s ²	601	23 84 60 00 BE 15 00 00
	Set the profile deceleration to 5566 plus/s ²	581	60 84 60 00 00 00 00 00
	电机清除报错 0x6040 设置为 128	601	2B 40 60 00 80 00 00 00
	Motor to clear the error reported 0x6040 set to 128	581	60 40 60 00 00 00 00 00

非立即生效指令控制报文 (0x6040: Bit5=0)

Command is disabled to take immediate effect message control (0x6040:Bit5=0)

PP pattern	Steps		COB-ID	Message
	电机使能 Enable	0x6040 设置为 6	601	2B 40 60 00 06 00 00 00
		0x6040 set to 6	581	60 40 60 00 00 00 00 00
		0x6040 设置为 7	601	2B 40 60 00 07 00 00 00
		0x6040 set to 7	581	60 40 60 00 00 00 00 00
		0x6040 设置为 15	601	2B 40 60 00 0F 00 00 00
		0x6040 set to 15	581	60 40 60 00 00 00 00 00
	设置目标位置 Set the target position	目标位置设置为 55660 plus	601	23 7A 60 00 6C D9 00 00
		Target position set to 55660 plus	581	60 7A 60 00 00 00 00 00
	电机运行 Operation	0x6040 设置为 31	601	2B 40 60 00 1F 00 00 00
		0x6040 set to 31	581	60 40 60 00 00 00 00 00



立即生效指令控制报文（0x6040: Bit5=1）

Command is enabled to take immediate effect message control(0x6040:Bit5=1)

PP pattern	Steps		COB-ID	Message
	电机使能 Enable	0x6040 设置为 38	601	2B 40 60 00 26 00 00 00
		0x6040 set to 38	581	60 40 60 00 00 00 00 00
		0x6040 设置为 39	601	2B 40 60 00 27 00 00 00
		0x6040 set to 39	581	60 40 60 00 00 00 00 00
		0x6040 设置为 47	601	2B 40 60 00 2F 00 00 00
		0x6040 set to 47	581	60 40 60 00 00 00 00 00
	设置目标位置 Set the target position	目标位置设置为 55660 plus Target position set to 55660 plus	601	23 7A 60 00 6C D9 00 00
			581	60 7A 60 00 00 00 00 00
	电机运行 Operation	0x6040 设置为 63 0x6040 set to 63	601	2B 40 60 00 3F 00 00 00
			581	60 40 60 00 00 00 00 00

5.7 周期同步速度模式

Cyclic Synchronous Velocity Mode

当对象字典 0x6060 的值设置为 9 时,eRob 关节模组工作在周期同步速度模式。

When the value of the object dictionary 0x6060 is set to 9,eRob is operated by cyclic synchronous velocity mode.

在周期同步速度模式下,主站控制器生成轨迹规划曲线,并且周期性地发送目标速度指令给 eRob 关节模组,eRob 关节模组执行速度控制与扭矩控制,速度偏移量与扭矩偏移量作为可选项提供给控制系统。

In the Cyclic Synchronous Velocity mode, the master controller generates trajectory and transmits the Target velocity to the slave at each EtherCAT/CAN cycle, and the slave performs velocity control and torque control. Optionally, a velocity offset and a torque offset may be provided by the control system in order to allow a second source for velocity and/or a torque feed forward.

轮廓加速度 0x6083 与轮廓减速度 0x6084 只有在停止与快速停止功能开启时才起作用。

When the profile acceleration and deceleration 0x6083,0x6084 are used,they function only for halt and quick stop operations.

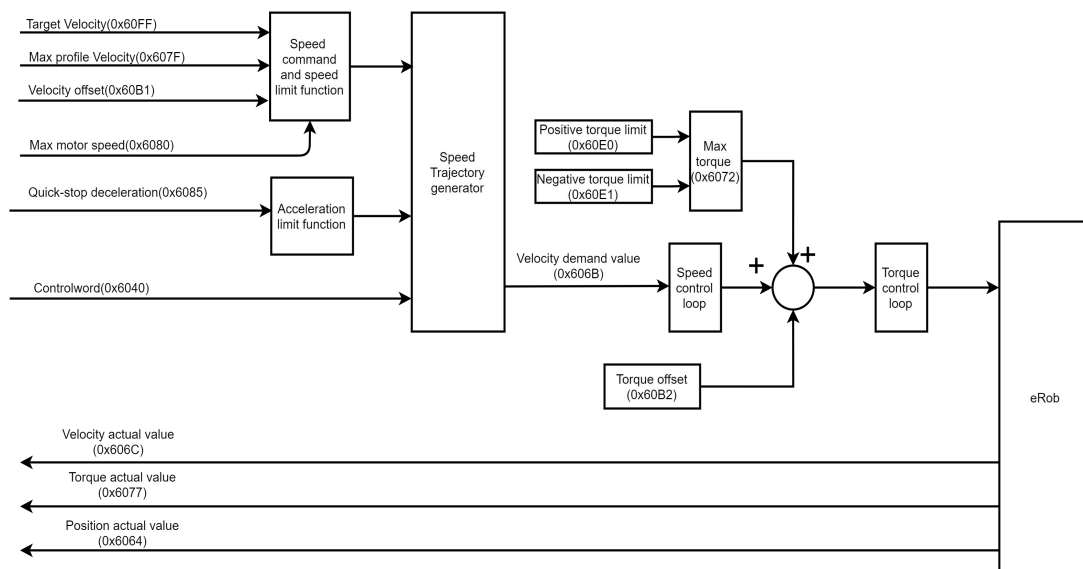


图 5-7 CSV 模式的功能

Figure 5-7 The function of CSV mode

操作步骤 Operate steps:

1) 设定模式, 0x6060 = 09h, 周期同步速度模式;

Set 0x6060 to 09h to set the mode as the CSV mode;

2) 设置目标速度 0x60FF=0 plus/s, 由于周期同步速度模式下, 一旦切换到使能状态, 伺服电机开始运转, 因此设定 0x60FF=0 plus/s 保证伺服在使能后速度为 0plus/s。

Set the target velocity 0x60FF to 0 plus/s.In the CSV mode,the servo target velocity takes effect once the servo drive is switched to servo on ,therefore,set the target to 0 plus/s is to ensure that the motor maintains at 0 plus/s at the moment of servo on.

3) 设定控制命令 0x6040, 请按照以下步骤操作。

Set the control word (0x6040). Follow these steps for operation.

Steps	Control word					Meaning
	Bit4	Bit 3	Bit 2	Bit 1	Bit 0	
1	0	0	1	1	0	Shutdown (关闭)
2	0	0	1	1	1	Switch on (准备使能)
3	0	1	1	1	1	Enable operation (使能)

6) 设置目标速度 0x60FF。

Set target velocity 0x60FF.

表 5-12 CSV 模式的控制字相关位

Table5-12 CSV mode dependent bits of the control word

Parameter value	Meaning
Bit4= 保留 Bit4= Reserved	与此运行模式无关 Not relevant for this operating mode
Bit5= 保留 Bit5= Reserved	与此运行模式无关 Not relevant for this operating mode
Bit6= 保留 Bit6= Reserved	与此运行模式无关 Not relevant for this operating mode
Bit8 = 停止 Bit8 = Halt	停止移动 Stop movement with halt
Bit9 = 修改设置值 Bit9 = Change on setpoint	与此运行模式无关 Not relevant for this operating mode

表 5-13 CSV 模式的状态字相关位

Table5-13 CSV mode dependent bits of the status word

Parameter value	Meaning
Bit10 = 目标到达 Bit10 = Target reached	如果实际速度在速度窗口时间的持续时间内停留在目标速度窗口±速度窗口的窗口中，则设置该位为 1。 0 = 未达到目标速度 1 = 达到目标速度 The bit is set if the actual velocity stays in the window of target velocity ± velocity window for a duration of Velocity window time. 0 = Target velocity not reached 1 = Target velocity reached
Bit11 = 软件内部速度超限 Bit11 = Internal limit active	最大电机速度 0x6080 限制目标速度 0x60FF 和速度偏移量 0x60B1。 Max motor speed 0x6080 limits target velocity 0x60FF and velocity offset 0x60B1.
Bit12 = 忽略目标速度 Bit12 = Target velocity ignored	0 = 可能的新目标速度 1 = 新接收的目标速度 0 = New velocity possible 1 = New target velocity accepted
Bit13-15	N/A

相关的对象字典 Associated objects

表 5-14 与 CSV 模式关联的对象

Table5-14 Objects associated with CSV mode

Index	Sub-Index	Name	Unit	Data type	Access	PDO Mapping
0x6040	00h	Control word	-	UINT	RW	RxPDO
0x6041	00h	Status word	-	UINT	RO	TxPDO
0x6060	00h	Modes of operation	-	INT	RW	RxPDO
0x6061	00h	Modes of operation display	-	INT	RO	TxPDO
0x606C	00h	Velocity actual value	plus/s	INT	RW	RxPDO
0x6078	00h	Current actual value	per thousand of rated current	INT	RO	TxPDO
0x607D	01h	Software position limit: Min position limit	plus	INT	RW	NO
	02h	Software position limit: Max position limit	plus	INT	RW	NO
0x607F	00h	Max profile velocity	plus/s	UINT	RW	RxPDO
0x60FF	00h	Target velocity	plus/s	INT	RW	RxPDO

5.7.1. CANopen PDO 通信控制报文

CANopen PDO communication message control

以伺服 ID=1 为例

Take the servo ID=1, for example

CSV pattern	Steps	COB-ID	Message
停止节点, 配置相关参数 Stop the node and configure the relevant parameters	关闭远程节点 Stop remote node	00	02 01
	复位节点 Reset communication	00	82 01
		701	00
	设置为周期同步速度模式 Set the cyclic synchronous velocity mode	601	2F 60 60 00 09 00 00 00
		581	60 60 60 00 00 00 00 00
	核对运行模式为 CSV 模式 Check operating mode to CSV pattern	601	40 61 60 00 00 00 00 00
		581	4F 60 60 00 09 00 00 00
	轮廓加速度设置为 5566 plus/s ² Set profile acceleration to 5566 plus/s ²	601	23 83 60 00 BE 15 00 00
		581	60 83 60 00 00 00 00 00
	轮廓减速度设置为 5566 plus/s ² Set profile deceleration to 5566 plus/s ²	601	23 84 60 00 BE 15 00 00
		581	60 84 60 00 00 00 00 00
	关闭同步发生器 Disable sync	601	23 05 10 00 80 00 00 00
		581	60 05 10 00 00 00 00 00

PDO 映射配置流程 The PDO mapping configuration process		通信周期设置为 1000us	601	23 06 10 00 E8 03 00 00
		Set communication cycle period (1000us)	581	60 06 10 00 00 00 00 00
	TxPDO1 配置流程 The TxPDO1 configuration process	禁用 TxPDO1	601	23 00 18 01 81 01 00 80
		Disable TxPDO1	581	60 00 18 01 00 00 00 00
		设置传输类型	601	2F 00 18 02 01 00 00 00
		Defines the transmission type	581	60 00 18 02 00 00 00 00
		清除原有映射	601	2F 00 1A 00 00 00 00 00
		Defines the number of valid entries in the mapping record	581	60 00 1A 00 00 00 00 00
		0x1A00: 01h 映射 0x60410010(状态字)	601	23 00 1A 01 10 00 41 60
		0x1A00:01h maps 0x60410010(status word)	581	60 00 1A 01 00 00 00 00
		0x1A00: 02h 映射 0x606C0020 (实际速度)	601	23 00 1A 02 20 00 6C 60
		0x1A00:02h maps 0x606C0020 (actual velocity)	581	60 00 1A 02 00 00 00 00
		0x1A00: 00h 写入映射 对象个数: 2	601	2F 00 1A 00 02 00 00 00
		0x1A00:00h:the number of valid entries in the mapping record:2	581	60 00 1A 00 00 00 00 00
		打开 TxPDO1	601	23 00 18 01 81 01 00 00
		Enable TxPDO1	581	60 00 18 01 00 00 00 00
	RxPDO1 配置流程 The RxPDO1 configuration process	关闭 RxPDO1	601	23 00 14 01 01 02 00 80
		Disable RxPDO1	581	60 00 14 01 00 00 00 00
		设置传输类型	601	2F 00 14 02 01 00 00 00
		Defines the transmission type	581	60 00 14 02 00 00 00 00
		清除原有映射	601	2F 00 16 00 00 00 00 00
		Defines the number of valid entries in the mapping record	581	60 00 16 00 00 00 00 00
		0x1600: 01h 映射 0x60400010 (控制字)	601	23 00 16 01 10 00 40 60
		0x1600:01h maps 0x60400010 (control word)	581	60 00 16 01 00 00 00 00



		0x1600: 02h 映射 0x60FF0020 (目标速度)	601	23 00 16 02 20 00 FF 60
		0x1600:02h maps 0x60FF0020 (target velocity)	581	60 00 16 02 00 00 00 00
		0x1600: 00h 写映射对象 个数:2	601	2F 00 16 00 02 00 00 00
		0x1600:00h:the number of valid entries in the mapping record: 2	581	60 00 16 00 00 00 00 00
		打开 RxPDO1	601	23 00 14 01 01 02 00 00
		Enable RxPDO1	581	23 00 14 01 01 02 00 00
启动节点 Start the node	NMT 启动节点 NMT start remote node		0	01 01
	获取实际速度 Get the actual velocity		601	40 6C 60 00 00 00 00 00
			581	43 6C 60 00 00 00 00 00
周期发送 RxPDO1 Cycle to send RxPDO1	电机清除报 错 Motor clear error	控制字设置为 128; 目标速度设置为 0 plus/s。 Control word set to 128; Target velocity set to 0 plus/s.	201	80 00 00 00 00 00 00
		发送同步帧 Send sync frame	080	
			181	21 02 00 00 00 00 00
	电机使能 Enable	控制字设置为 6; 目标速度设置为 0 plus/s。 Control word set to 6; Target velocity set to 0 plus/s.	201	06 00 00 00 00 00 00
		发送同步帧 Send sync frame	080	
			181	21 02 00 00 00 00 00
		控制字设置为 7; 目标速度设置为 0 plus/s。 Control word set to 7; Target velocity set to 0 plus/s.	201	07 00 00 00 00 00 00
		发送同步帧 Send sync frame	080	
			181	33 02 00 00 00 00 00



		控制字设置为 15; 目标速度设置为 0 plus/s。 Control word set to 15; Target velocity set to 0 plus/s.	201	0F 00 00 00 00 00
		发送同步帧	080	
		Send sync frame	181	37 06 00 00 00 00
	目标速度设置 Set target velocity	控制字设置为 15; 目标速度设置为 55660 plus/s。 Control word set to 15; Target velocity set to 56600 plus/s.	201	0F 00 6C D9 00 00
		发送同步帧	080	
		Send sync frame	181	37 06 AE 14 00 00

5.8 轮廓速度模式

Profile Velocity Mode

当对象字典 0x6060 的值设置为 3 时，eRob 关节模组工作在轮廓速度模式。

When the value of the object dictionary 0x6060 is set to 3, eRob is operated by profile velocity mode.

在轮廓速度模式下，eRob 关节模组接收来自主站控制器的目标速度，加速度、减速度来规划运动。

In the Profile Velocity mode, the eRob executes a movement according to a target velocity and acceleration/deceleration values sent from the master controller.

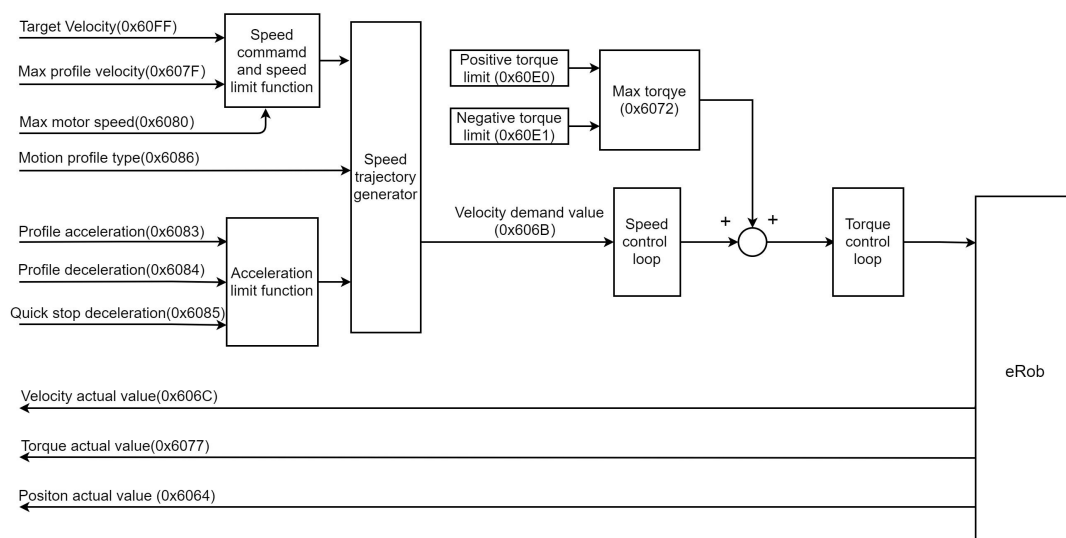


图 5.8 PV 模式的功能

Figure 5-8 The function of PV mode

操作步骤 Operate steps:

1) 设定模式，0x6060 = 03h，轮廓速度模式；

Set 0x6060 to 03h to set the mode as PV mode;

2) 设定轮廓加速度 0x6083；

Set profile acceleration 0x6083;

3) 设置轮廓减速度 0x6084；

Set profile deceleration 0x6084;



4) 设置目标速度 0x60FF=0 plus/s，由于轮廓速度模式下，一旦切换到使能状态，伺服开始运转，因此设定 0x60FF=0 plus/s 保证伺服在使能后速度为 0 plus/s。

Set the target velocity (0x60FF) to 0 plus/s. In PV mode, the servo target velocity takes effect once the servo drive is switched to servo on, therefore, set the target to 0 plus/s is to ensure that the motor maintains at 0 plus/s at the moment of servo on.

5) 设定控制命令 0x6040，请按照以下步骤操作。

Set the control word (0x6040). Follow these steps for operation.

Steps	Control word					Meaning
	Bit4	Bit 3	Bit 2	Bit 1	Bit 0	
1	0	0	1	1	0	Shutdown (关闭)
2	0	0	1	1	1	Switch on (准备使能)
3	0	1	1	1	1	Enable operation (伺服使能)

6) 设置目标速度 0x60FF。

Set target velocity 0x60FF.

表 5-15 PV 模式的控制字相关位

Table 5-15 PV mode dependent bits of the control word

Parameter value	Meaning
Bit4=保留 Bit4= Reserved	与此运行模式无关 Not relevant for this operating mode
Bit5= Reserved Bit5=保留	与此运行模式无关 Not relevant for this operating mode
Bit6= Reserved Bit6=保留	与此运行模式无关 Not relevant for this operating mode
Bit8 = Halt Bit8 =停止	值 0: 执行运动，驱动器加速（使用指定的轮廓加速度加速），直到达到速度或停止位设置为 1 值 1: 停止运动，驱动器减速（使用指定的轮廓减速度减速），直到速度 = 0 或停止位重置为 0 Value 0: Motion is executed, the drives accelerates (with the specified Profile acceleration) until either the velocity is reached or halt bit is set to 1 Value 1: Motion is stopped, the drive decelerates (with the specified Profile deceleration) until either velocity = 0 or halt bit is reset to 0

Bit9 = 修改设定值 Bit9 = Change on setpoint	与此运行模式无关 Not relevant for this operating mode
---	--

表 5-16 PV 模式的状态字相关位

Table5-16 PV mode dependent bits of the status word

Parameter value	Meaning
Bit10 = 目标到达 Bit10 = Target reached	如果实际速度在速度窗口时间的持续时间内停留在目标速度窗口±速度窗口的窗口中，则设置该位。 0 = 未到达目标速度 1 = 到达目标速度 The bit is set if the actual velocity stays in the window of target velocity ± velocity window for a duration of velocity window time. 0 = Target velocity not reached 1 = Target velocity reached
Bit11 = 软件内部速度超限 Bit11 = Internal limit active	最大电机速度 0x6080 限制目标速度 0x60FF 和速度偏移量 0x60B1。 Max motor speed 0x6080 limits target velocity 0x60FF and velocity offset 0x60B1.
Bit12 = 忽略目标速度 Bit12 = Target velocity ignored	0=可能的新目标速度 1=新接收的目标速度 0 = New velocity possible 1 = New target velocity accepted
Bit13-15	N/A

相关的对象字典 Associated objects

表 5-17 与 PV 模式关联的对象

Table5-17 Objects associated with PV mode

Index	Sub-Index	Name	Unit	Data Type	Access	PDO Mapping
0x6040	00h	Control word	-	UINT	RW	RxPDO
0x6041	00h	Status word	-	UINT	RO	TxPDO
0x6060	00h	Modes of operation	-	INT	RW	RxPDO
0x6061	00h	Modes of operation display	-	INT	RO	TxPDO
0x606C	00h	Velocity actual value	plus/s	INT	RW	RxPDO



0x6078	00h	Current actual value	per thousand of rated current	INT	RO	TxPDO
0x607D	01h	Software limit:Min position limit	plus position	INT	RW	NO
	02h	Software limit:Max position limit	plus position	INT	RW	NO
0x607F	00h	Max velocity profile	plus/s	UINT	RW	RxPDO
0x60FF	00h	Target velocity	plus/s	INT	RW	RxPDO

5.8.1. CANopen PDO 通信控制报文

CANopen PDO communication message control

以伺服 ID=1 为例

Take the servo ID=1, for example

PV pattern	Steps		COB-ID	Message
停止节点, 配置相关参数 Stop the node and configure the relevant parameters	关闭远程节点 Stop remote node		00	02 01
	复位节点 Reset communication		00	82 01
			701	00
	设置为轮廓速度模式 Set the profile velocity mode		601	2F 60 60 00 03 00 00 00
			581	60 60 60 00 00 00 00 00
	核对运行模式为 PV 模式 Check operating mode to PV pattern		601	40 61 60 00 00 00 00 00
			581	4F 60 60 00 03 00 00 00
	轮廓加速度设置为 5566 plus/s ² Set profile acceleration to 5566 plus/s ²		601	23 83 60 00 BE 15 00 00
			581	60 83 60 00 00 00 00 00
	轮廓减速度设置为 5566 plus/s ² Set profile deceleration to 5566 plus/s ²		601	23 84 60 00 BE 15 00 00
			581	60 84 60 00 00 00 00 00
	关闭同步发生器 Disable sync		601	23 05 10 00 80 00 00 00
			581	60 05 10 00 00 00 00 00
	通信周期设置为 1000us Set communication cycle period (1000us)		601	23 06 10 00 E8 03 00 00
			581	60 06 10 00 00 00 00 00
PDO 映射配置流程 The PDO mapping configuration process	TxPDO1 配置流程 The TxPDO1 configuration process	禁用 TxPDO1 Disable TxPDO1	601	23 00 18 01 81 01 00 80
			581	60 00 18 01 00 00 00 00
		设置传输类型 Defines the transmission type	601	2F 00 18 02 01 00 00 00
			581	60 00 18 02 00 00 00 00
		清除原有映射 Defines the number of	601	2F 00 1A 00 00 00 00 00
			581	60 00 1A 00 00 00 00 00

		valid entries in the mapping record		
		0x1A00: 01h 映射	601	23 00 1A 01 10 00 41 60
		0x60410010 (状态字)	581	60 00 1A 01 00 00 00 00
		0x1A00:01h maps		
		0x60410010 (status word)		
		0x1A00: 02h 映射	601	23 00 1A 02 20 00 6C 60
		0x606C0020 (实际速度)	581	60 00 1A 02 00 00 00 00
		0x1A00:02h maps		
		0x606C0020 (actual velocity)		
		0x1A00h-00h 写入映射	601	2F 00 1A 00 02 00 00 00
		对象个数: 2	581	60 00 1A 00 00 00 00 00
		0x1A00h-00h:the number of valid entries in the mapping record: 2		
	RxPDO1 配置流程 The RxPDO1 configuration process	打开 TxPDO1	601	23 00 18 01 81 01 00 00
		Enable TxPDO1	581	60 00 18 01 00 00 00 00
		关闭 RxPDO1	601	23 00 14 01 01 02 00 80
		Disable RxPDO1	581	60 00 14 01 00 00 00 00
		设置传输类型	601	2F 00 14 02 01 00 00 00
		Defines the transmission type	581	60 00 14 02 00 00 00 00
		清除原有映射	601	2F 00 16 00 00 00 00 00
		Defines the number of valid entries in the mapping record	581	60 00 16 00 00 00 00 00
		0x1600: 01h 映射	601	23 00 16 01 10 00 40 60
		0x60400010 (控制字)	581	60 00 16 01 00 00 00 00
		0x1600:01h maps		
		0x60400010 (control word)		
		0x1600: 02h 映射	601	23 00 16 02 20 00 FF 60
		0x60FF0020 (目标速度)	581	60 00 16 02 00 00 00 00
		0x1600:02h maps		
		0x60FF0020 (target velocity)		
		0x1600: 00h 写映射对象个数:2	601	2F 00 16 00 02 00 00 00
		0x1600:00h:the number of valid entries in the mapping record: 2	581	60 00 16 00 00 00 00 00
		打开 RxPDO1	601	23 00 14 01 01 02 00 00
		Enable RxPDO1	581	60 00 14 01 00 00 00 00



启动节点 Start the node	NMT 启动节点 NMT start remote node		0	01 01
	获取实际速度 Get the actual velocity		601	40 6C 60 00 00 00 00 00
			581	43 6C 60 00 00 00 00 00
周期发送 RxPDO1 Cycle to send the RxPDO1	电机清除 报错 Motor clear error	控制字设置为 128; 目标速度设置为 0 plus/s。 Control word set to 128; Target velocity set to 0 plus/s.	201	80 00 00 00 00 00
		发送同步帧 Send sync frame	080	
			181	40 12 00 00 00 00
	电机使能 Enable	控制字设置为 6; 目标速度设置为 0 plus/s。 Control word set to 6; Target velocity set to 0 plus/s.	201	06 00 00 00 00 00
		发送同步帧 Send sync frame	080	
			181	21 12 00 00 00 00
		控制字设置为 7; 目标速度设置为 0 plus/s。 Control word set to 7; Target velocity set to 0 plus/s.	201	07 00 00 00 00 00
		发送同步帧 Send sync frame	080	
			181	33 12 00 00 00 00
		控制字设置为 15; 目标速度设置为 0 plus/s。 Control word set to 15; Target velocity set to 0 plus/s.	201	0F 00 00 00 00 00
		发送同步帧 Send sync frame	080	
			181	37 16 00 00 00 00
	目标速度 设置 Set target velocity	控制字设置为 15; 目标速度设置为 55660 plus/s。 Control word set to 15; Target velocity set to 56600 plus/s.	201	0F 00 6C D9 00 00
		发送同步帧 Send sync frame	080	
			181	37 16 2A 73 00 00

5.8.2. CANopen SDO 通信控制报文

CANopen SDO communication message control

以伺服 ID=1 为例

Take the servo ID=1, for example

PV pattern	Steps	COB-ID	Message
	设置为轮廓速度模式 Set the profile velocity mode	601	2F 60 60 00 03 00 00 00
		581	60 60 60 00 00 00 00 00
	核对运行模式为 PV 模式 Check operating mode to PV pattern	601	40 61 60 00 00 00 00 00
		581	4F 61 60 00 03 00 00 00
	轮廓加速度设置为 5566 plus/s ² Set the profile acceleration to 5566 plus/s ²	601	23 83 60 00 BE 15 00 00
		581	60 83 60 00 00 00 00 00
	轮廓减速度设置为 5566 plus/s ² Set the profile deceleration to 5566 plus/s ²	601	23 84 60 00 BE 15 00 00
		581	60 84 60 00 00 00 00 00
	电机清除报错 0x6040 设置为 128 Motor to clear the error reported 0x6040 set to 128	601	2F 40 60 00 80 00 00 00
		581	60 40 60 00 00 00 00 00
	电机使能 Enable 0x6040 设置为 6 0x6040 set to 6	601	2B 40 60 00 06 00 00 00
		581	60 40 60 00 00 00 00 00
		601	2B 40 60 00 07 00 00 00
		581	60 40 60 00 00 00 00 00
		601	2B 40 60 00 0F 00 00 00
		581	60 40 60 00 00 00 00 00
	设置目标速度 Set the target velocity	601	23 FF 60 00 BE 15 00 00
		581	60 FF 60 00 00 00 00 00

5.9 周期同步扭矩模式

Cyclic Synchronous Torque Mode

当对象字典 0x6060 的值设置为 10 时，eRob 关节模组工作在周期同步扭矩模式。

When the value of the object dictionary 0x6060 is set to 10, eRob is operated by cyclic synchronous torque mode.

上位机在周期同步扭矩模式 (Cyclic Synchronous Torque Mode) 下规划扭矩，并周期性的发送 PDO 至伺服驱动器。在此模式中，上位机每发送一次 PDO，会同时传送目标扭矩 (Target torque) 和控制指令 (Control word) 的数据至驱动器。此外，扭矩偏移值 (Torque offset) 可作为扭矩前馈控制设定。

The controller plans the torque in Cyclic Synchronous Torque mode (CST) and transmits PDOs to the servo drive periodically. In this mode, when the controller transmit PDO, it simultaneously transmits the target torque and control word data to the servo drive. The torque offset can be used as the torque feed forward control setting.

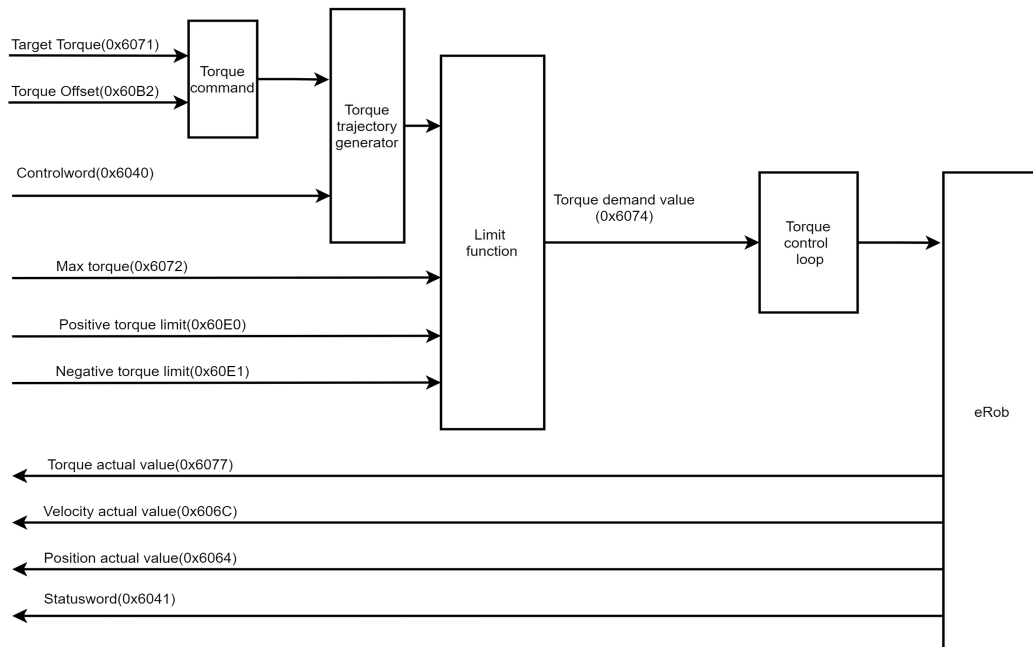


Figure 5-9 CST 模式的功能

Figure 5-9 The function of CST mode



操作步骤 Operate steps:

1) 设定模式，0x6060 = 0Ah，周期同步扭矩模式。

Set 0x6060 to 0Ah to set the mode as cyclic synchronous torque mode.

2) 设定目标扭矩，0x6071 = 0。由于扭矩模式下，一旦使能，伺服目标扭矩即作用，因此先设定为 0，以确保安全。

Set the target torque (0x6071) to 0. In cyclic synchronous torque mode, the servo target torque takes effect once the servo drive is switched to servo on, therefore, set the target to 0 for safety reasons.

3) 设定控制指令 0x6040，请依照以下步骤操作。

Set the control word (0x6040). Follow these steps for operation.

Steps	Control word					Meaning
	Bit4	Bit 3	Bit 2	Bit 1	Bit 0	
1	0	0	1	1	0	Shutdown (关闭)
2	0	0	1	1	1	Switch on (准备使能)
3	0	1	1	1	1	Enable operation (使能)

4) 设定目标扭矩 0x6071。

Set 0x6071 to the target torque.

表 5-18 CST 模式的控制字相关位

Table 5-18 CST mode dependent bits of the control word

Parameter value	Meaning
Bit4= 保留 Bit4= Reserved	与此运行模式无关 Not relevant for this operating mode
Bit5= 保留 Bit5= Reserved	与此运行模式无关 Not relevant for this operating mode
Bit6= 保留 Bit6= Reserved	与此运行模式无关 Not relevant for this operating mode
Bit8 = 停止 Bit8 = Halt	启用停止位或将目标扭矩设置为零都将根据扭矩斜率（0x6087）逐渐降低施加到电机的扭矩。在斜坡的尽头，不会对电机施加扭矩，从而使轴自由移动。 Both enabling the halt bit or setting the target torque to zero will ramp down the torque applied to the motor according to the torque slope object (0x6087). At the end of the slope, no torque will be applied to the motor, allowing the shaft to move freely.
Bit9 = 修改设定值 Bit9 = Change on setpoint	与此运行模式无关 Not relevant for this operating mode

表 5-19 CST 模式的状态字相关位

Table 5-19 CST mode dependent bits of the status word

Parameter value	Meaning
Bit10=目标到达 Bit10 = Target reached	0 = 未达到目标扭矩 1 = 达到目标扭矩 如果实际扭矩在扭矩窗口时间的持续时间内保持在目标扭矩±扭矩窗口值的范围内，则设置该位。 0 = Target torque not reached 1 = Target torque reached The bit is set if the actual torque stays in the window of target torque ± torque window value for a duration of torque window time.
Bit11=软件内部扭矩超限 Bit11 =Internal limit active	最大扭矩 0x6072 限制扭矩需求值 0x6074、目标扭矩 0x6071 和扭矩偏移 0x60B2。 Max torque 0x6072 limits torque demand value 0x6074, target torque 0x6071 and torque offset 0x60B2.

相关的对象字典 Associated Objects

表 5-20 与 CST 模式相关联的对象

Table5-20 Objects associated with CST mode

Index	Sub-Index	Name	Unit	Data type	Access	PDO mapping
0x6040	00h	Control word	-	UINT	RW	RxPDO
0x6041	00h	Status word	-	UINT	RO	TxPDO
0x6060	00h	Modes of operation	-	INT	RW	RxPDO
0x6061	00h	Modes of operation display	-	INT	RO	TxPDO
0x6071	00h	Target torque	per thousand of rated current	INT	RW	RxPDO
0x6072	00h	Max torque	per thousand of rated current	UINT	RW	NO
0x6073	00h	Max current	per thousand of rated current	INT	RW	NO
0x6074	00h	Torque demand value	per thousand of rated current	INT	RO	NO
0x6075	00h	Motor rated current	mA	UINT	RW	NO
0x6076	00h	Motor rated torque	mNm	UINT	RW	NO
0x6077	00h	Motor actual torque	per thousand of rated current	INT	RO	TxPDO



0x6078	00h	Motor actual current	per thousand of rated current	INT	RO	TxPDO
0x6087	00h	Torque slop	per thousand of rated current	UINT	RW	NO
0x60B2	00h	Torque offset	per thousand of rated current	INT	RW	RxPDO
0x60E0	00h	Positive torque limit value	mA	UINT	RW	RxPDO
0x60E1	00h	Negative torque limit value	mA	UINT	RW	RxPDO

5.9.1. CANopen PDO 通信控制报文

CANopen PDO communication message control

以伺服 ID=1 为例

Take the servo ID=1, for example

CST pattern	Steps		COB-ID	Message
停止节点，配置相关参数 Stop the node and configure the relevant parameters	关闭远程节点 Stop remote node		00	02 01
	复位节点 Reset communication		00	82 01
	设置为周期同步扭矩模式 Set the cyclic synchronous torque mode		701	00
			601	2F 60 60 00 0A 00 00 00
	核对运行模式为 CST 模式 Check operating mode to CST pattern		581	60 60 60 00 00 00 00 00
			601	40 61 60 00 00 00 00 00
	关闭同步发生器 Disable sync		581	4F 60 60 00 0A 00 00 00
			601	23 05 10 00 80 00 00 00
	通信周期设置为 1000us Set communication cycle period (1000us)		581	60 05 10 00 00 00 00 00
			601	23 06 10 00 E8 03 00 00
PDO 映射配置流程 The PDO mapping configuration process	TxPDO1 配置流程	禁用 TxPDO1	601	23 00 18 01 81 01 00 80
		Disable TxPDO1	581	60 00 18 01 00 00 00 00
	The TxPDO1 configuration process	设置传输类型	601	2F 00 18 02 01 00 00 00
		Defines the transmission type	581	60 00 18 02 00 00 00 00
		清除原有映射	601	2F 00 1A 00 00 00 00 00
		Defines the number of valid entries in the mapping record	581	60 00 1A 00 00 00 00 00
		0x1A00: 01h 映射	601	23 00 1A 01 10 00 41 60
		0x60410010 (状态字)	581	60 00 1A 01 00 00 00 00

		0x1A00:01h maps 0x60410010 (status word)		
		0x1A00: 02h 映射 0x60770010 (实际扭矩 值)	601	23 00 1A 02 10 00 77 60
		0x1A00:02h maps 0x60770010 (actual torque)	581	60 00 1A 02 00 00 00 00
		0x1A00: 03h 映射 0x60780010 (实际电流 值)	601	23 00 1A 02 10 00 78 60
		1A00:02h maps 0x60780010 (actual current)	581	60 00 1A 02 00 00 00 00
		0x1A00: 00h 写入映射对 象个数: 3	601	2F 00 1A 00 03 00 00 00
		0x1A00:00h:the number of valid entries in the mapping record: 3	581	60 00 1A 00 00 00 00 00
		打开 TxPDO1	601	23 00 18 01 81 01 00 00
		Enable TxPDO1	581	60 00 18 01 00 00 00 00
	RxPDO1 配置 流程 The RxPDO1 configuration process	关闭 RxPDO1	601	23 00 14 01 01 02 00 80
		Disable RxPDO1	581	60 00 14 01 00 00 00 00
		设置传输类型	601	2F 00 14 02 01 00 00 00
		Defines the transmission type	581	60 00 14 02 00 00 00 00
		清除原有映射	601	2F 00 16 00 00 00 00 00
		Defines the number of valid entries in the mapping record	581	60 00 16 00 00 00 00 00
		0x1600: 01h 映射 0x60400010 (控制字)	601	23 00 16 01 10 00 40 60
		0x1600:01h maps 0x60400010 (control word)	581	60 00 16 01 00 00 00 00
		0x1600: 02h 映射 0x60710010 (目标扭矩)	601	23 00 16 02 10 00 71 60
		0x1600:02h maps 0x60710010 (target torque)	581	60 00 16 02 00 00 00 00
		0x1600: 00h 写映射对象 个数: 2	601	2F 00 16 00 02 00 00 00
		0x1600:00h:the number of valid entries in the mapping record: 2	581	60 00 16 00 00 00 00 00



		打开 RxPDO1 Enable RxPDO1	601	23 00 14 01 01 02 00 00
			581	23 00 14 01 01 02 00 00
启动节点 Start the node	NMT 启动节点 NMT start remote node		0	01 01
	获取实际扭矩值 Get the actual torque		601	40 77 60 00 00 00 00 00
周期发送 RxPDO1 Cycle to send RxPDO1	电机清除报错 Motor clear error	控制字设置为 128; 目标扭矩设置为 0。 Control word set to 128; Target torque set to 0.	201	80 00 00 00
		发送同步帧 Send sync frame	080	
			181	40 02 00 00 00 00 00
	电机使能 Enable	控制字设置为 6; 目标扭矩设置为 0。 Control word set to 6; Target torque set to 0.	201	06 00 00 00
		发送同步帧 Send sync frame	080	
			181	21 02 00 00 00 00 00
		控制字设置为 7; 目标扭矩设置为 0。 Control word set to 7; Target torque set to 0.	201	07 00 00 00
		发送同步帧 Send sync frame	080	
			181	33 02 00 00 00 00 00
		控制字设置为 15; 目标扭矩设置为 0。 Control word set to 15; Target torque set to 0.	201	0F 00 00 00 00 00 00
		发送同步帧 Send sync frame	080	
			181	37 06 00 00 00 00 00
	设置目标扭矩 Set target torque	控制字设置为 15; 目标扭矩设置为 100。 Control word set to 15; Target torque set to 100 .	201	0F 00 64 00
		发送同步帧 Send sync frame	080	
			181	37 06 63 00 63 00

5.10 轮廓扭矩模式

Profile Torque Mode

当对象字典 0x6060 的值设置为 4 时，eRob 关节模组工作在轮廓扭矩模式。

When the value of the object dictionary 0x6060 is set to 4, eRob is operated by profile torque mode.

在轮廓扭矩模式下，主站控制器生成轨迹规划，并且发送目标扭矩指令给 eRob 关节模组，eRob 关节模组通过循环模式或非循环模式进行扭矩控制。

In the Profile Torque mode, the master controller generates trajectory and transmits Target torque to the eRob to make control torque by cyclic mode or non-cyclic mode.

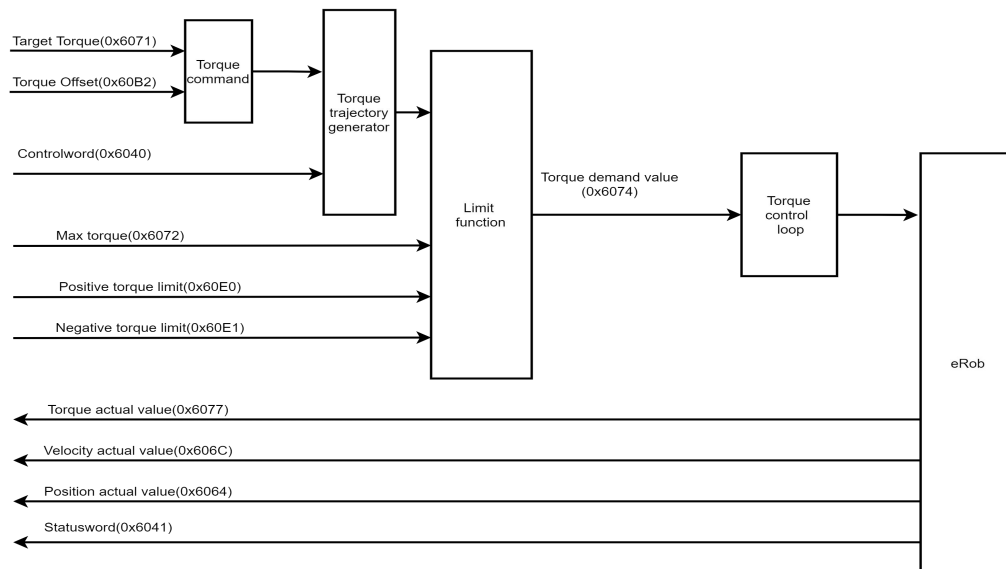


图 5-10 PT 模式的功能

Figure 5-10 The function of PT mode

操作步骤 Operate steps:

1) 设定模式，0x6060 = 04h，轮廓扭矩模式。

Set 0x6060 to 04h to set the mode as profile torque mode.

2) 设定目标扭矩，0x6071 = 0。由于扭矩模式下，一旦使能，伺服目标扭矩即作用，因此先设定目标扭矩 0，以确保安全。

Set the target torque (0x6071) to 0. In profile torque mode, the servo target torque takes effect once the servo drive is switched to servo on, therefore, set the target to 0 for safety reasons.

设定控制指令 0x6040，请依照以下步骤操作。

Set the control word (0x6040), follow these steps for operation.

Steps	Control word					Meaning
	Bit4	Bit 3	Bit 2	Bit 1	Bit 0	
1	0	0	1	1	0	Shutdown (关闭)
2	0	0	1	1	1	Switch on (准备使能)
3	0	1	1	1	1	Enable operation (使能)

3) 设定目标扭矩 0x6071。

Set 0x6071 for the target torque.

表 5-21 PT 模式的控制字相关位

Table 5-21 PT mode dependent bits of the control word

Parameter value	Meaning
Bit4= 保留 Bit4= Reserved	与此运行模式无关 Not relevant for this operating mode
Bit5= 保留 Bit5= Reserved	与此运行模式无关 Not relevant for this operating mode
Bit6= 保留 Bit6= Reserved	与此运行模式无关 Not relevant for this operating mode
Bit8= 停止 Bit8 = Halt	启用停止位或将目标扭矩设置为零都将根据扭矩斜率对象（0x6087）逐渐降低施加到电机的扭矩。在斜坡的尽头，不会对电机施加扭矩，从而使轴自由移动。 Both enabling the halt bit or setting the target torque to zero will ramp down the torque applied to the motor according to the torque slope object (0x6087). At the end of the slope, no torque will be applied to the motor, allowing the shaft to move freely.
Bit9 =更改设定值 Bit9 = Change on setpoint	与此运行模式无关 Not relevant for this operating mode

表 5-22 PT 模式的状态字相关位

Table 5-22 PT mode dependent bits of the status word

Parameter value	Meaning
Bit10 = 目标到达 Bit10 = Target reached	0 = 未到达目标扭矩 1 = 到达目标扭矩 如果实际扭矩在扭矩窗口时间的持续时间内保持在目标扭矩±扭矩窗口值的窗口中，则设置该位。 0 = Target torque not reached 1 = Target torque reached The bit is set if the actual torque stays in the window of target torque ± torque window value for a duration of torque window time.
Bit11 = 软件内部扭矩超限 Bit11 = Internal limit active	最大扭矩 0x6072 限制扭矩需求值 0x6074、目标扭矩 0x6071 和扭矩偏移 0x60B2。 Max torque 0x6072 limits torque demand 0x6074, target torque 0x6071 and torque offset 0x60B2.

相关的对象字典 Associated objects

表 5-23 与 PT 模式关联的对象

Table 5-23 Objects associated with PT mode

Index	Sub-Index	Name	Unit	Data type	Access	PDO mapping
0x6040	00h	Control word	-	UINT	RW	RxPDO
0x6041	00h	Status word	-	UINT	RO	TxPDO
0x6060	00h	Modes of operation	-	INT	RW	RxPDO
0x6061	00h	Modes of operation display	-	INT	RO	TxPDO
0x6071	00h	Target torque	per thousand of rated current	INT	RW	RxPDO
0x6072	00h	Max torque	per thousand of rated current	UINT	RW	NO
0x6073	00h	Max current	per thousand of rated current	INT	RW	NO
0x6074	00h	Torque demand value	per thousand of rated current	INT	RO	NO
0x6075	00h	Motor rated current	mA	UINT	RW	NO
0x6076	00h	Motor rated torque	mNm	UINT	RW	NO
0x6077	00h	Motor actual torque	per thousand of rated current	INT	RO	TxPDO



0x6078	00h	Motor actual current	per thousand of rated current	INT	RO	TxPDO
0x6087	00h	Torque slop	per thousand of rated current	UINT	RW	NO
0x60B2	00h	Torque offset	per thousand of rated current	INT	RW	RxPDO
0x60E0	00h	Positive torque limit value	mA	UINT	RW	RxPDO
0x60E1	00h	Negative torque limit value	mA	UINT	RW	RxPDO

5.10.1. CANopen PDO 通信控制报文

CANopen PDO communication message control

以伺服 ID=1 为例

Take the servo ID=1, for example

PT pattern	Steps		COB-ID	Message
停止节点, 配置相关参数 Stop the node and configure the relevant parameters	关闭远程节点 Stop remote node		00	02 01
	复位节点 Reset communication		00	82 01
			701	00
	设置为轮廓扭矩模式 Set the profile torque mode		601	2F 60 60 00 04 00 00 00
			581	60 60 60 00 00 00 00 00
	核对运行模式为 PT 模式 Check operating mode to PT pattern		601	40 61 60 00 00 00 00 00
			581	4F 60 60 00 04 00 00 00
	关闭同步发生器 Disable sync		601	23 05 10 00 80 00 00 00
			581	60 05 10 00 00 00 00 00
	通信周期设置为 1000us Set communication cycle period (1000us)		601	23 06 10 00 E8 03 00 00
			581	60 06 10 00 00 00 00 00
PDO 映射配置流程 The PDO mapping configuration process	TxPDO1 配置流程 The TxPDO1 configuration process	禁用 TxPDO1 Disable TxPDO1	601	23 00 18 01 81 01 00 80
			581	60 00 18 01 00 00 00 00
		设置传输类型 Defines the transmission type	601	2F 00 18 02 01 00 00 00
			581	60 00 18 02 00 00 00 00
		清除原有映射 Defines the number of valid	601	2F 00 1A 00 00 00 00 00
			581	60 00 1A 00 00 00 00 00

		entries in the mapping record		
		0x1A00: 01h 映射	601	23 00 1A 01 10 00 41 60
		0x60410010 (状态字)	581	60 00 1A 01 00 00 00 00
		0x1A00:01h maps		
		0x60410010 (status word)		
		0x1A00: 02h 映射	601	23 00 1A 02 10 00 77 60
		0x60770010 (实际扭矩值)	581	60 00 1A 02 00 00 00 00
		0x1A00:02h maps		
		0x60770010 (actual torque)		
		0x1A00: 00h 写入映射对象个数: 2	601	2F 00 1A 00 02 00 00 00
		0x1A00:00h:the number of valid entries in the mapping record: 2	581	60 00 1A 00 00 00 00 00
	RxPDO1 配置流程 The RxPDO1 configuration process	打开 TxPDO1	601	23 00 18 01 81 01 00 00
		Enable TxPDO1	581	60 00 18 01 00 00 00 00
		关闭 RxPDO1	601	23 00 14 01 01 02 00 80
		Disable RxPDO1	581	60 00 14 01 00 00 00 00
		设置传输类型	601	2F 00 14 02 01 00 00 00
		Defines the transmission type	581	60 00 14 02 00 00 00 00
		清除原有映射	601	2F 00 16 00 00 00 00 00
		Defines the number of valid entries in the mapping record	581	60 00 16 00 00 00 00 00
		0x1600: 01h 映射	601	23 00 16 01 10 00 40 60
		0x60400010 (控制字)	581	60 00 16 01 00 00 00 00
		0x1600:01h maps		
		0x60400010 (control word)		
		0x1600: 02h 映射	601	23 00 16 02 10 00 71 60
		0x60710010(目标扭矩)	581	60 00 16 02 00 00 00 00
		0x1600:02h maps		
		0x60710010(target torque)		
		0x1600: 00h 写映射对象个数: 2	601	2F 00 16 00 02 00 00 00
		0x1600:00h:the number of valid entries in the mapping record: 2	581	60 00 16 00 00 00 00 00
		打开 RxPDO1	601	23 00 14 01 01 02 00 00
		Enable RxPDO1	581	23 00 14 01 01 02 00 00



启动节点 Start the node	NMT 启动节点 NMT start remote node		0	01 01
	获取实际扭矩值 Get the actual torque		601	40 77 60 00 00 00 00 00
			581	4B 77 60 00 00 00 00 00
周期发送 RxPDO1 Cycle to send the RxPDO1	电机清除报 错 Motor clear error	控制字设置为 128; 目标扭矩设置为 0。 Control word set to 128; Target torque set to 0.	201	80 00 00 00
		发送同步帧 Send sync frame	080	
			181	40 02 00 00
	电机使能 Enable	控制字设置为 6; 目标扭矩设置为 0。 Control word set to 6; Target torque set to 0.	201	06 00 00 00
		发送同步帧 Send sync frame	080	
			181	21 02 00 00
		控制字设置为 7; 目标扭矩设置为 0。 Control word set to 7; Target torque set to 0.	201	07 00 00 00
		发送同步帧 Send sync frame	080	
			181	33 02 00 00
		控制字设置为 15; 目标扭矩设置为 0。 Control word set to 15; Target torque set to 0.	201	0F 00 00 00 00 00
		发送同步帧 Send sync frame	080	
			181	37 06 00 00
	设置目标扭 矩 Set target torque	控制字设置为 15; 目标扭矩设置为 100。 Control word set to 15; Target torque set to 100.	201	0F 00 64 00
		发送同步帧 Send sync frame	080	
			181	37 06 63 00



5.10.2. CANopen SDO 通信控制报文

CANopen SDO communication message control

以伺服 ID=1 为例

Take the servo ID=1, for example

PT pattern	Steps		COB-ID	Message
	设置为轮廓扭矩模式		601	2F 60 60 00 04 00 00 00
	Set the profile torque mode		581	60 60 60 00 00 00 00 00
	核对运行模式为 PT 模式		601	40 61 60 00 00 00 00 00
	Check operating mode to PT pattern		581	4F 61 60 00 04 00 00 00
	电机清除报错 0x6040 设置为 128		601	2B 40 60 00 80 00 00 00
	Motor to clear the error reported 0x6040 set to 128		581	60 40 60 00 00 00 00 00
	电机使能 Enable	0x6040 设置为 6	601	2B 40 60 00 06 00 00 00
		0x6040 set to 6	581	60 40 60 00 00 00 00 00
		0x6040 设置为 7	601	2B 40 60 00 07 00 00 00
		0x6040 set to 7	581	60 40 60 00 00 00 00 00
		0x6040 设置为 15	601	2B 40 60 00 0F 00 00 00
		0x6040 set to 15	581	60 40 60 00 00 00 00 00
	设置目标扭矩 Set target torque	目标扭矩设置为 100	601	2B 71 60 00 64 00 00 00
		Target torque set to 100	581	60 71 60 00 00 00 00 00



第六章 TwinCAT 主站控制

Chapter 6 TwinCAT Master Control

本章主要介绍基于 Beckhoff TwinCAT3 主站对 ZeroErr EtherCAT 从站设备进行 PDO 配置以及运动控制的方法和步骤。

This chapter mainly introduces the methods and steps of PDO configuration and motion control of ZeroErr EtherCAT slave devices by TwinCAT3 master based on Beckhoff.

6.1 软件安装

Software Installation

在 Beckhoff 官网下载最新版本 TwinCAT3 软件 TC31-FULL-Setp.3.1.4024.35, 根据安装向导进行安装。

Download the latest version of TwinCAT3 software TC31-FULL-Setp.3.1.4024.35 on the official website of Beckhoff and install it according to the installation wizard.

6.2 ESI 文件放置

The ESI File Placement

eRob 的 XML(ESI)配置文件名称为:

The XML(ESI) configuration file of eRob is named:

ZeroErr Driver3.2.0.xml.

Beckhoff TwinCAT3 的 XML(ESI)文件存放路径如下:

The XML(ESI) file storage path for the Beckhoff TwinCAT3 is as follows:

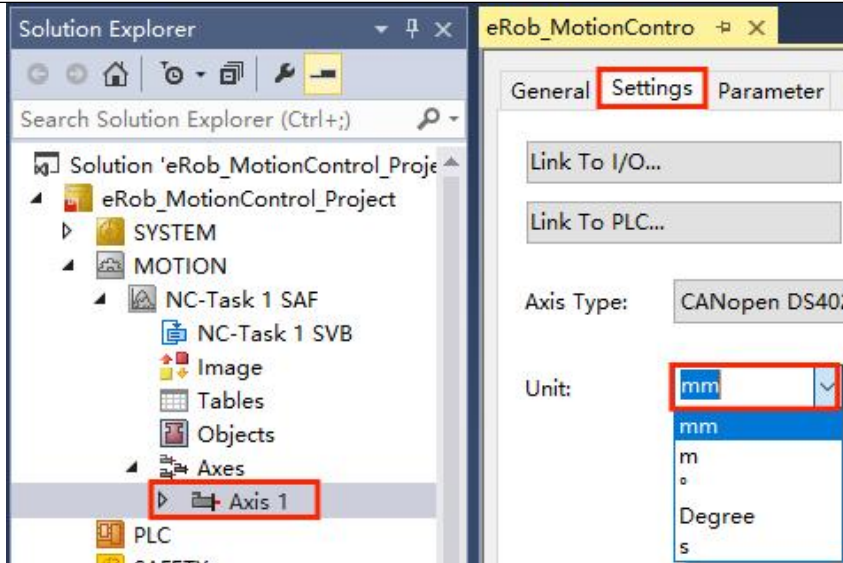
C:\TwinCAT\3.1\Config\Io\EtherCAT.

6.3 新建工程

Parameter Configuration

为确保 axis 轴能够正常运动，需要对 axis 轴的参数进行配置。

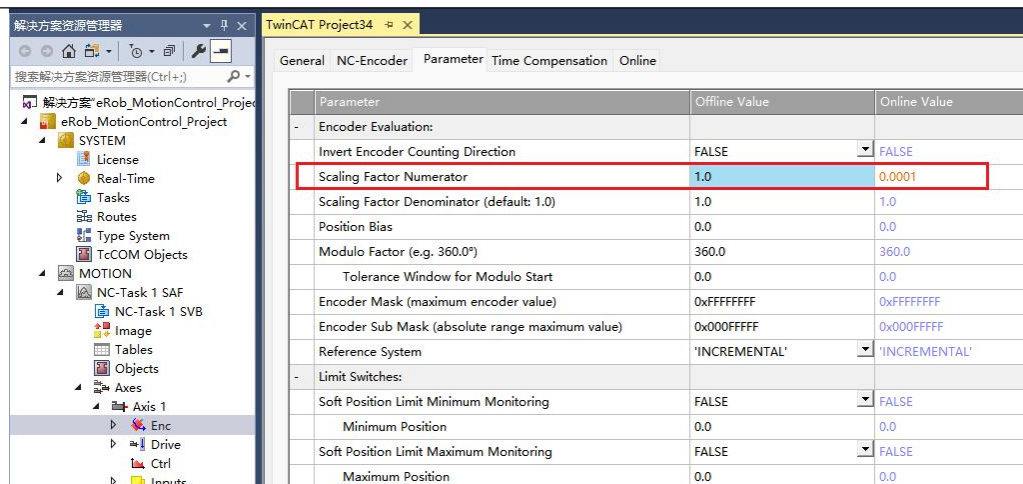
It is necessary to configure the parameters of each axis to ensure the correct movement.

NO.	Action
1	单位配置： Unit configuration 在左边的导航目录中：TwinCAT project > NC-Task 1-SAF > Axes > Axis 1。 1)单击右侧的“settings”选项卡。 2)选择轴的单位。 In the navigation directory on the left go to the TwinCAT project > NC-Task 1-SAF > Axes > Axis 1 . he settings tab on the right. the desired unit of the axis. 
2	Enc 参数设置： Enc Parameter configuration 在左边的导航目录中：TwinCAT project > NC-Task 1 SAF > Axes > Axis 1 > Enc。 1)单击右侧的“Parameter”选项卡。 2)单击“Encoder Evaluation”以查看这些选项。比例因子分子“The Scale Factor Numerator”和分母“The Scale Factor Denominator”的值可以在 Offline Value 中进行更改。将 Scaling Factor Numerator 和 scaling Factor Denominator 值均设置为 1，即主站 NC 轴控制时发送 1 个单位，从站伺服走 1 个编码器脉冲位置（plus）。

In the navigation directory on the left go to the TwinCAT project > NC-Task 1-SAF > Axes > Axis 1 > Enc.

1) Click the Parameter tab on the right.

2) Click the “Encoder Evaluation” arrow to view the options. The Scale Factor Numerator and Denominator values can be changed under the Offline Value. Set both Scaling Factor Numerator and Scaling Factor Denominator to 1, that is, when the master is under NC axis control, it sends 1 unit, and the slave servo moves 1 encoder pulse position (plus).



Parameter	Offline Value	Online Value
Encoder Evaluation:		
Invert Encoder Counting Direction	FALSE	FALSE
Scaling Factor Numerator	1.0	0.0001
Scaling Factor Denominator (default: 1.0)	1.0	1.0
Position Bias	0.0	0.0
Modulo Factor (e.g. 360.0°)	360.0	360.0
Tolerance Window for Modulo Start	0.0	0.0
Encoder Mask (maximum encoder value)	0xFFFFFFFF	0xFFFFFFFF
Encoder Sub Mask (absolute range maximum value)	0x000FFFFF	0x000FFFFF
Reference System	'INCREMENTAL'	'INCREMENTAL'
Limit Switches:		
Soft Position Limit Minimum Monitoring	FALSE	FALSE
Minimum Position	0.0	0.0
Soft Position Limit Maximum Monitoring	FALSE	FALSE
Maximum Position	0.0	0.0

3

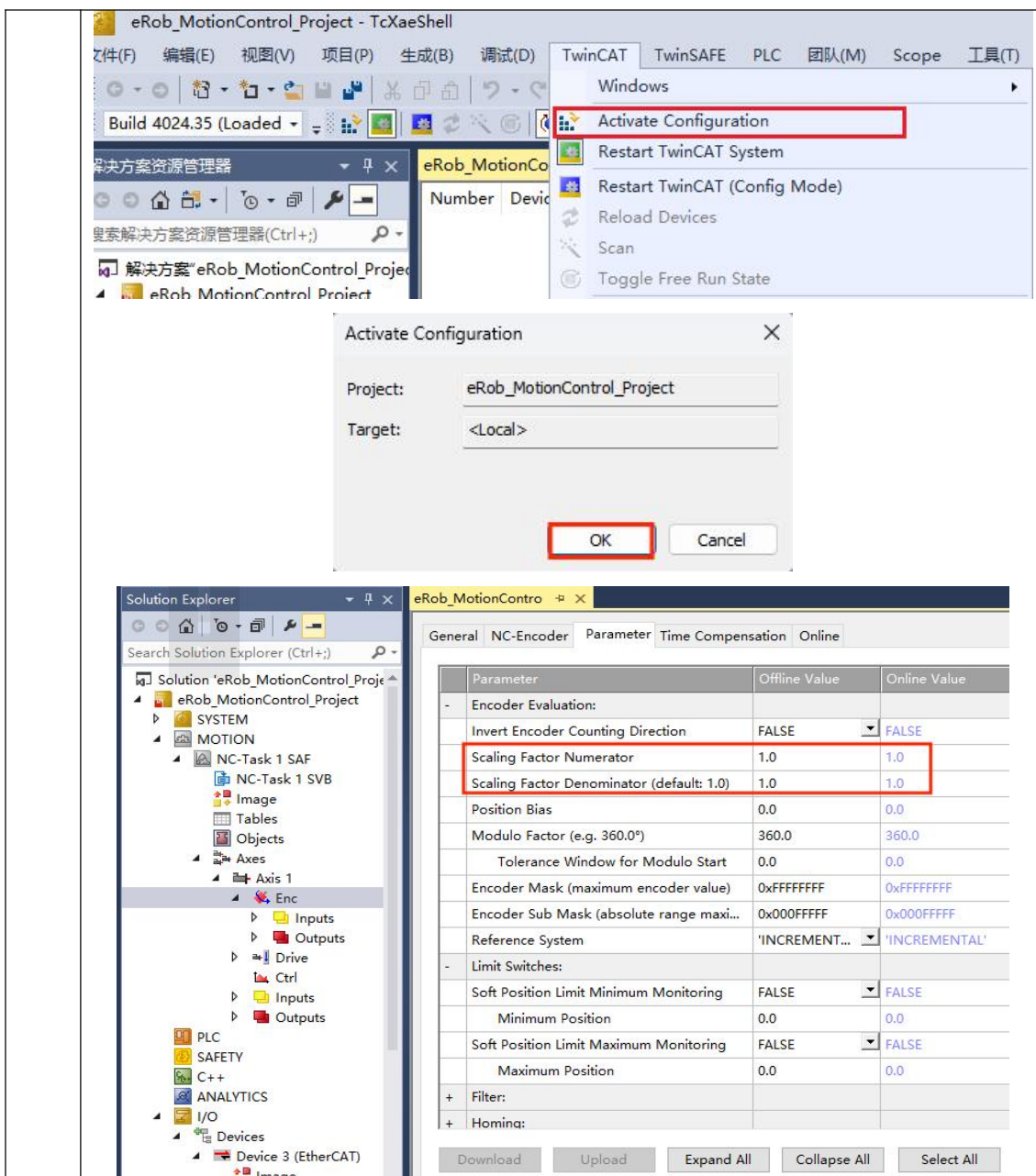
参数激活:

The parameters are activated

点击菜单栏 TwinCAT->Activate Configuration, 然后会弹出提示框, 点击 “OK” 即可。

参数激活后 Online Value 显示为修改后的值。

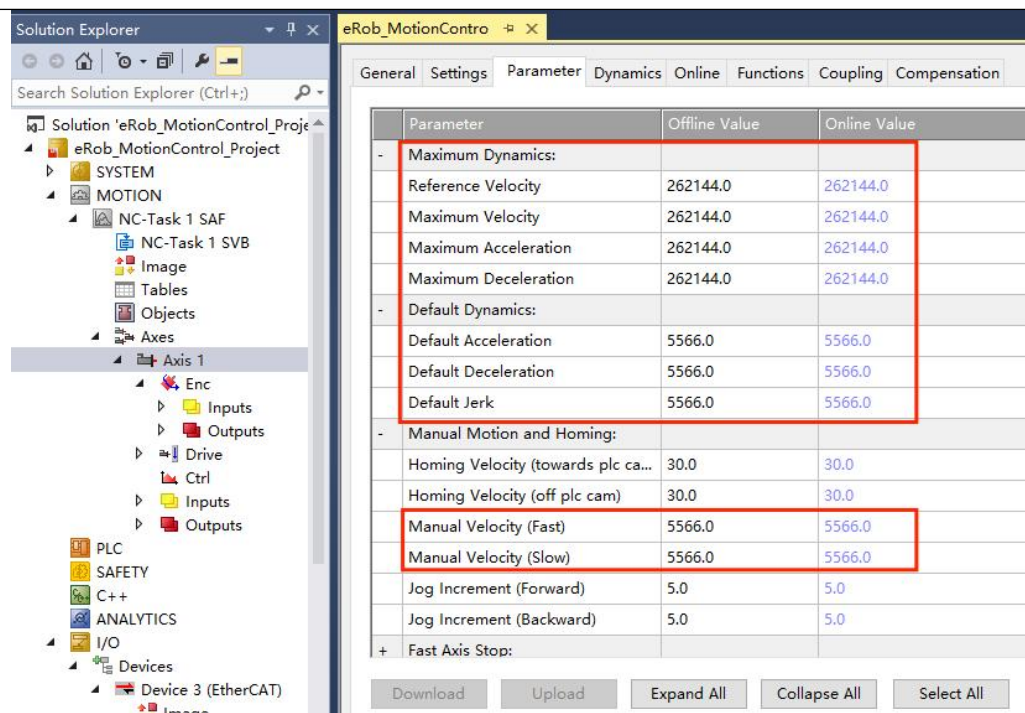
Click on the menu bar TwinCAT->Activate Configuration, and a prompt box will pop up, click “OK”. Online Value displays the modified value.



- 4 运动参数配置
- Motion parameter configuration
- 在左边的导航目录中：The TwinCAT project > MOTION > NC-Task 1 SAF > Axes > Axis 1。
- 1)单击右侧的“Parameter”选项卡。
 - 2)单击“Maximum Dynamics”、“Default Dynamics”和“Manual Motion and Homing”以查看选项。
 - 3)在“Offline value”中修改相应的值。

In the navigation directory on the left go to the TwinCAT project > NC-Task 1-SAF > Axes > Axis 1.

- 1) Click the “Parameter” tab on the right.
- 2) Click the, “Maximum Dynamics”, “Default Dynamics” and “Manual Motion and Homing” arrow to view the options.
- 3) Modify value in the “Offline value”.



Parameter	Offline Value	Online Value
Maximum Dynamics:		
Reference Velocity	262144.0	262144.0
Maximum Velocity	262144.0	262144.0
Maximum Acceleration	262144.0	262144.0
Maximum Deceleration	262144.0	262144.0
Default Dynamics:		
Default Acceleration	5566.0	5566.0
Default Deceleration	5566.0	5566.0
Default Jerk	5566.0	5566.0
Manual Motion and Homing:		
Homing Velocity (towards plc ca...)	30.0	30.0
Homing Velocity (off plc cam)	30.0	30.0
Manual Velocity (Fast)	5566.0	5566.0
Manual Velocity (Slow)	5566.0	5566.0
Jog Increment (Forward)	5.0	5.0
Jog Increment (Backward)	5.0	5.0
Fast Axis Stop:		

- 5 Monitoring 参数配置
- Monitoring Parameter configuration
- 在左边的导航目录中：The TwinCAT project > MOTION > NC-Task 1 SAF > Axes > Axis 1。

- 1)单击右侧的 “Parameter” 选项卡。
- 2)单击 “Monitoring” 以查看这些选项。
- 3)在 “Offline value” 中将 “Monitoring ” 参数修改为 “False” 。

In the navigation directory on the left go to the TwinCAT project > NC-Task 1-SAF > Axes > Axis 1.

- 1) Click the Parameter tab on the right.
- 2) Click the Monitoring arrow to view the options.
- 3) In Offline value, modify the Monitoring parameter to False.

General Settings Parameter Dynamics Online Functions Coupling Compensation			
Parameter	Offline Value		Online Value
+ Default Dynamics:			
+ Manual Motion and Homing:			
+ Fast Axis Stop:			
+ Limit Switches:			
- Monitoring:			
Position Lag Monitoring	FALSE	▼	FALSE
Maximum Position Lag Value	5.0		5.0
Maximum Position Lag Filter Time	0.02		0.02
Position Range Monitoring	FALSE	▼	FALSE
Position Range Window	5.0		5.0
Target Position Monitoring	FALSE	▼	FALSE
Target Position Window	2.0		2.0
Target Position Monitoring Time	0.02		0.02
In-Target Alarm	FALSE	▼	FALSE
In-Target Timeout	5.0		5.0
Motion Monitoring	FALSE	▼	FALSE
Motion Monitoring Window	0.1		0.1
Motion Monitoring Time	0.5		0.5
+ Setpoint Generator:			

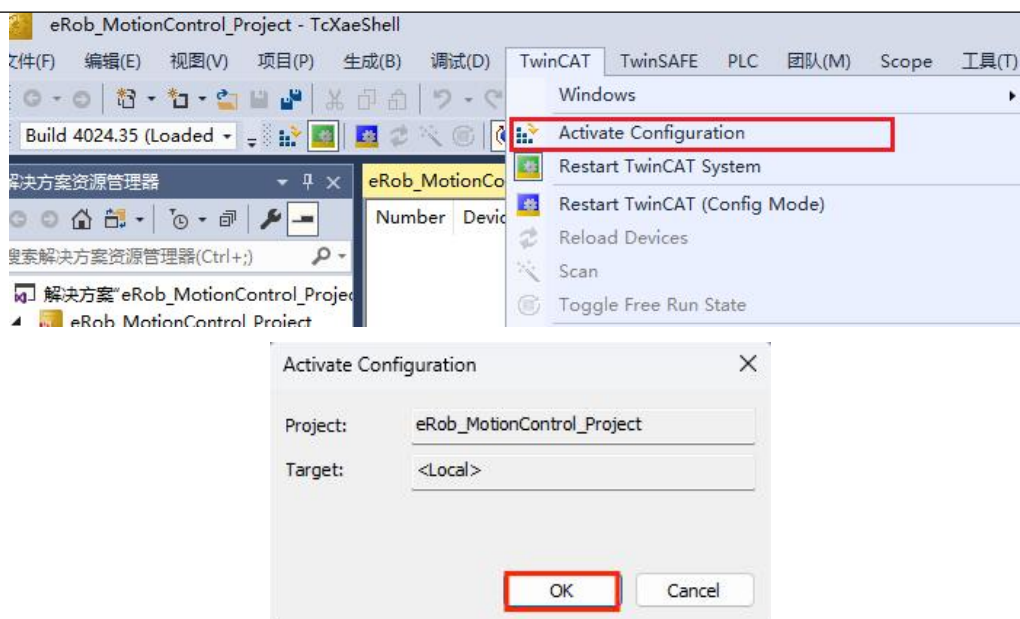
参数激活:

The parameters are activated

点击菜单栏 TwinCAT->Activate Configuration, 然后会弹出提示框, 点击确定即可。

Online Value 显示为修改后的值。

Click on the menu bar TwinCAT->Activate Configuration, and a prompt box will pop up, click OK. Online Value displays the modified value.

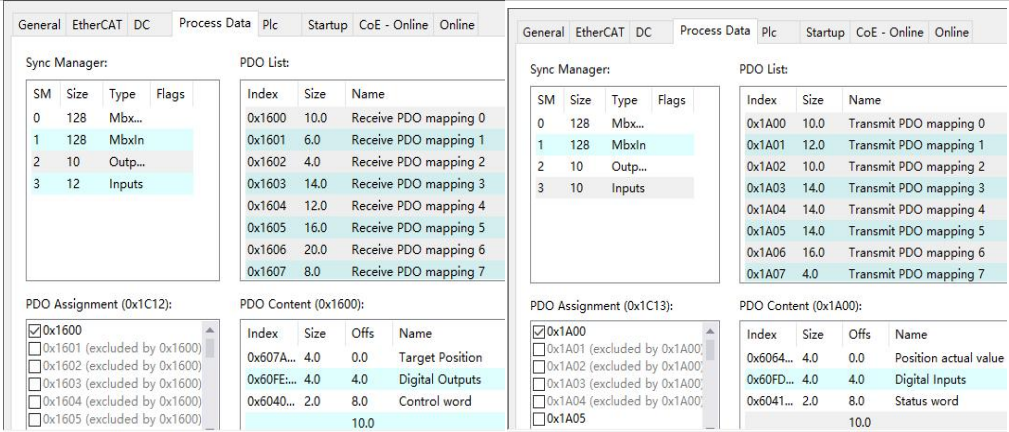


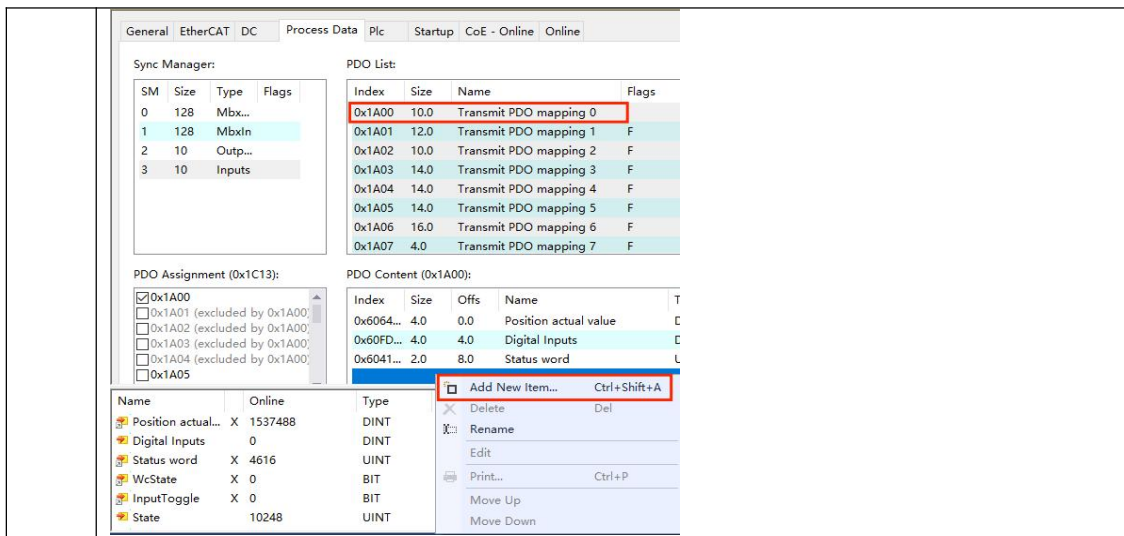
6.4 PDO 配置

PDO Configuration

本章节基于 Beckhoff TwinCAT3 主站对 PDO 动态配置具体操作步骤如下。

The specific operation steps of dynamic configuration of PDO by TwinCAT3 master based on Beckhoff in this section are as follows.

NO.	Action
1	The cyclic data 在 “PDO-assignment” 窗口的输入和输出的 PDO 分配窗口中可见。默认配置使用的动态 PDO 有：“0x1600-RxPDO 映射参数，0x1A00-TxPDO 映射参数。” The cyclic data is visible in the PDO-assignment window for the Inputs and Outputs of the Sync Managers. The default PDO settings use the dynamic PDOs:“0x1600- RxPDO mapping parameter, 0x1A00-TxPDO mapping parameter.”  The screenshot displays the TwinCAT3 configuration interface for PDOs. It is divided into two main sections: RxPDO (left) and TxPDO (right). Each section contains a 'Sync Manager' table, a 'PDO List' table, a 'PDO Assignment' table, and a 'PDO Content' table. The RxPDO side shows mappings for 0x1600 to 0x1607, while the TxPDO side shows mappings for 0x1A00 to 0x1A07. The 'PDO Content' tables show the specific data being mapped, such as 'Target Position', 'Digital Outputs', 'Position actual value', 'Digital Inputs', and 'Status word'.
2	TxPDO 配置 TxPDO configuration 可以通过选择 TxPDO (0x1A00) 并在 “PDO content” 窗口中右键单击来更改 TxPDO 映射。可以更改或删除现有映射对象，新映射对象可以插入到现有或附加到末尾。 The TxPDO maps can be changed by selecting the desired TxPDO(0x1A00) and right clicking in the PDO content window. Existing entries can be changed or deleted, and new entries can be inserted between existing or appended to the end.



General EtherCAT DC Process Data Plc Startup CoE - Online Online

Sync Manager:

SM	Size	Type	Flags
0	128	Mbx...	
1	128	MbxIn	
2	10	Outp...	
3	10	Inputs	

PDO List:

Index	Size	Name	Flags
0x1A00	10.0	Transmit PDO mapping 0	
0x1A01	12.0	Transmit PDO mapping 1	F
0x1A02	10.0	Transmit PDO mapping 2	F
0x1A03	14.0	Transmit PDO mapping 3	F
0x1A04	14.0	Transmit PDO mapping 4	F
0x1A05	14.0	Transmit PDO mapping 5	F
0x1A06	16.0	Transmit PDO mapping 6	F
0x1A07	4.0	Transmit PDO mapping 7	F

PDO Assignment (0x1C13):

PDO Content (0x1A00):

Index	Size	Offs	Name	T
0x6064...	4.0	0.0	Position actual value	C
0x60FD...	4.0	4.0	Digital Inputs	C
0x6041...	2.0	8.0	Status word	L

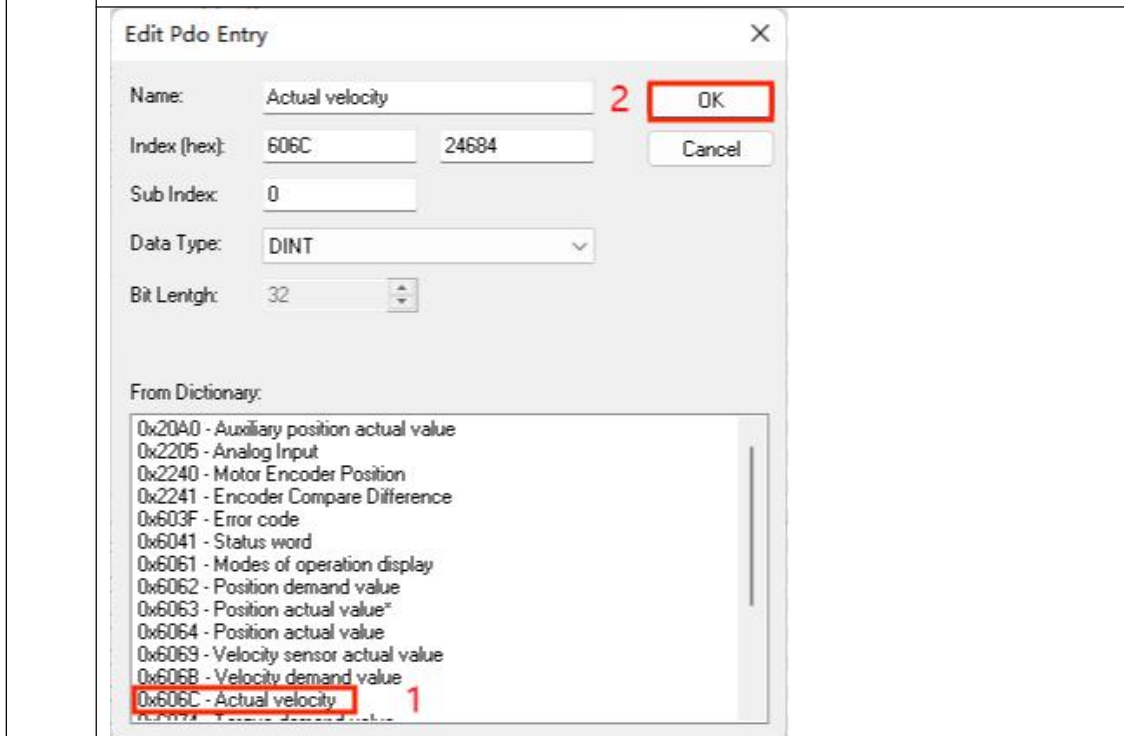
☒ 0x1A00
☐ 0x1A01 (excluded by 0x1A00)
☐ 0x1A02 (excluded by 0x1A00)
☐ 0x1A03 (excluded by 0x1A00)
☐ 0x1A04 (excluded by 0x1A00)
☐ 0x1A05

Name	Online	Type
Position actual...	X 1537488	DINT
Digital Inputs	0	DINT
Status word	X 4616	UINT
WcState	X 0	BIT
InputToggle	X 0	BIT
State	10248	UINT

☐ Add New Item... Ctrl+Shift+A
☒ Delete Del
☒ Rename
☒ Edit
☒ Print... Ctrl+P
☒ Move Up
☒ Move Down

3 下图表示一个可映射对象列表。该列表仅显示可以按被更改的映射方向进行映射的对象。例如，在输入 PDO 0x1A00 上插入一个对象，列表只显示可以沿从站驱动器到主站控制器的方向映射的对象。

A list of mappable objects is shown. The list only shows objects that can be mapped in the direction of the map being changed. For example, attempting to insert an object on the input PDO 0x1A00 only shows objects that can be mapped in the direction from the slave drive to the master controller.



Edit Pdo Entry

Name: Actual velocity 2 OK

Index (hex): 606C 24684 Cancel

Sub Index: 0

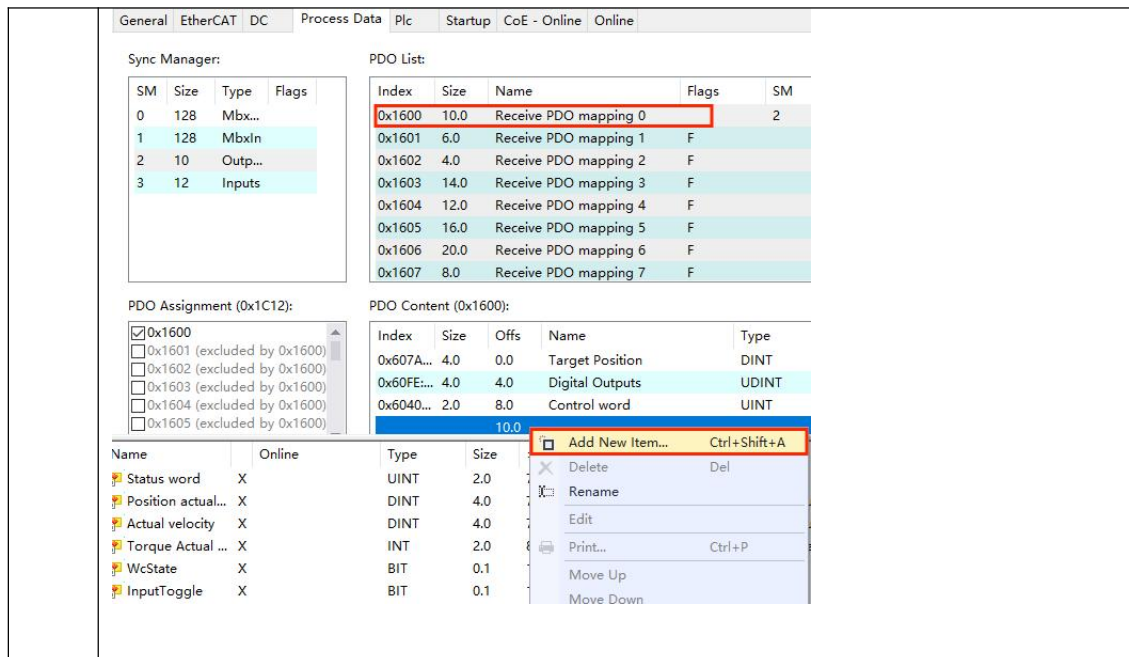
Data Type: DINT

Bit Length: 32

From Dictionary:

- 0x20A0 - Auxiliary position actual value
- 0x2205 - Analog Input
- 0x2240 - Motor Encoder Position
- 0x2241 - Encoder Compare Difference
- 0x603F - Error code
- 0x6041 - Status word
- 0x6061 - Modes of operation display
- 0x6062 - Position demand value
- 0x6063 - Position actual value*
- 0x6064 - Position actual value
- 0x6069 - Velocity sensor actual value
- 0x606B - Velocity demand value
- 0x606C - Actual velocity 1
- 0x606D - Position demand value

	Microsoft Visual Studio ? Process data of 'Drive 1 (ZeroErr Driver)' may changed. Relink with axis 'Axis 1' YES NO 是(Y) 否(N)																																																																												
4	PDO Content(0x1A00) 中显示已插入的对象。 The inserted object appears in the PDO Content (0x1A00). GeneralEtherCATDCProcess DataPlcStartupCoE - OnlineOnline Sync Manager: <table><tr><th>SM</th><th>Size</th><th>Type</th><th>Flags</th></tr><tr><td>0</td><td>128</td><td>Mbx...</td><td></td></tr><tr><td>1</td><td>128</td><td>MbxIn</td><td></td></tr><tr><td>2</td><td>10</td><td>Outp...</td><td></td></tr><tr><td>3</td><td>12</td><td>Inputs</td><td></td></tr></table> PDO List: <table><tr><th>Index</th><th>Size</th><th>Name</th><th>Flag</th></tr><tr><td>0x1A00</td><td>12.0</td><td>Transmit PDO mapping 0</td><td></td></tr><tr><td>0x1A01</td><td>12.0</td><td>Transmit PDO mapping 1</td><td>F</td></tr><tr><td>0x1A02</td><td>10.0</td><td>Transmit PDO mapping 2</td><td>F</td></tr><tr><td>0x1A03</td><td>14.0</td><td>Transmit PDO mapping 3</td><td>F</td></tr><tr><td>0x1A04</td><td>14.0</td><td>Transmit PDO mapping 4</td><td>F</td></tr><tr><td>0x1A05</td><td>14.0</td><td>Transmit PDO mapping 5</td><td>F</td></tr><tr><td>0x1A06</td><td>16.0</td><td>Transmit PDO mapping 6</td><td>F</td></tr><tr><td>0x1A07</td><td>4.0</td><td>Transmit PDO mapping 7</td><td>F</td></tr></table> PDO Assignment (0x1C13): ☒ 0x1A00 ☐ 0x1A01 (excluded by 0x1A00) ☐ 0x1A02 (excluded by 0x1A00) ☐ 0x1A03 (excluded by 0x1A00) ☐ 0x1A04 (excluded by 0x1A00) ☐ 0x1A05 PDO Content (0x1A00): <table><tr><th>Index</th><th>Size</th><th>Offs</th><th>Name</th></tr><tr><td>0x6041...</td><td>2.0</td><td>0.0</td><td>Status word</td></tr><tr><td>0x6064...</td><td>4.0</td><td>2.0</td><td>Position actual value</td></tr><tr><td>0x606C...</td><td>4.0</td><td>6.0</td><td>Actual velocity</td></tr><tr><td>0x6077...</td><td>2.0</td><td>10.0</td><td>Torque Actual Value</td></tr></table>	SM	Size	Type	Flags	0	128	Mbx...		1	128	MbxIn		2	10	Outp...		3	12	Inputs		Index	Size	Name	Flag	0x1A00	12.0	Transmit PDO mapping 0		0x1A01	12.0	Transmit PDO mapping 1	F	0x1A02	10.0	Transmit PDO mapping 2	F	0x1A03	14.0	Transmit PDO mapping 3	F	0x1A04	14.0	Transmit PDO mapping 4	F	0x1A05	14.0	Transmit PDO mapping 5	F	0x1A06	16.0	Transmit PDO mapping 6	F	0x1A07	4.0	Transmit PDO mapping 7	F	Index	Size	Offs	Name	0x6041...	2.0	0.0	Status word	0x6064...	4.0	2.0	Position actual value	0x606C...	4.0	6.0	Actual velocity	0x6077...	2.0	10.0	Torque Actual Value
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0x6077...	2.0	10.0	Torque Actual Value																																																																										
5	RxPDO 配置 RxPDO configuration 选择 RxPDO (0x1600) 并在“PDO Content”窗口中右键单击来更改 RxPDO 映射。可以更改或删除现有映射对象，新映射对象可以插入到当前位置或附加到末尾。 The RxPDO maps can be changed by selecting the desired RxPDO(0x1600) and right clicking in the PDO content window. Existing entries can be changed or deleted, and new entries can be inserted between existing or appended to the end.																																																																												



General EtherCAT DC Process Data Plc Startup CoE - Online Online

Sync Manager:

SM	Size	Type	Flags
0	128	Mbx...	
1	128	MbxIn	
2	10	Outp...	
3	12	Inputs	

PDO List:

Index	Size	Name	Flags	SM
0x1600	10.0	Receive PDO mapping 0		2
0x1601	6.0	Receive PDO mapping 1	F	
0x1602	4.0	Receive PDO mapping 2	F	
0x1603	14.0	Receive PDO mapping 3	F	
0x1604	12.0	Receive PDO mapping 4	F	
0x1605	16.0	Receive PDO mapping 5	F	
0x1606	20.0	Receive PDO mapping 6	F	
0x1607	8.0	Receive PDO mapping 7	F	

PDO Assignment (0x1C12):

PDO Content (0x1600):

Index	Size	Offs	Name	Type
0x607A...	4.0	0.0	Target Position	DINT
0x60FE...	4.0	4.0	Digital Outputs	UDINT
0x6040...	2.0	8.0	Control word	UINT

10.0

Add New Item... Ctrl+Shift+A

Delete Del

Rename

Edit

Print... Ctrl+P

Move Up

Move Down

Name Online Type Size

Status word X UINT 2.0

Position actual... X DINT 4.0

Actual velocity X DINT 4.0

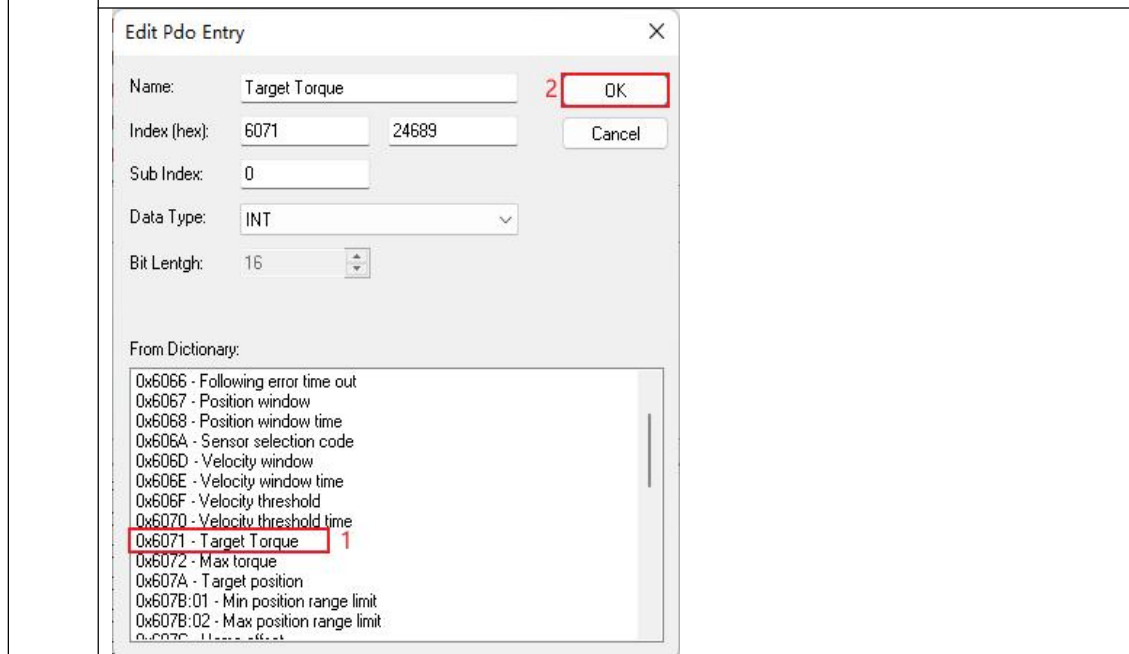
Torque Actual ... X INT 2.0

WcState X BIT 0.1

InputToggle X BIT 0.1

6 下图表示了一个可映射的对象列表，这个列表只显示了按照被更改方向进行映射的对象，例如，在输出 PDO 0x1600 中尝试插入一个对象，列表只显示可以从主站控制器到从站驱动器方向映射的对象。

A list of mappable objects is shown. The list only shows objects that can be mapped in the direction of the map being changed. For example, attempting to insert an object on the output PDO 0x1600 only shows objects that can be mapped in the direction from the controller to the drive.



Edit Pdo Entry

Name: Target Torque

Index (hex): 6071 24689

Sub Index: 0

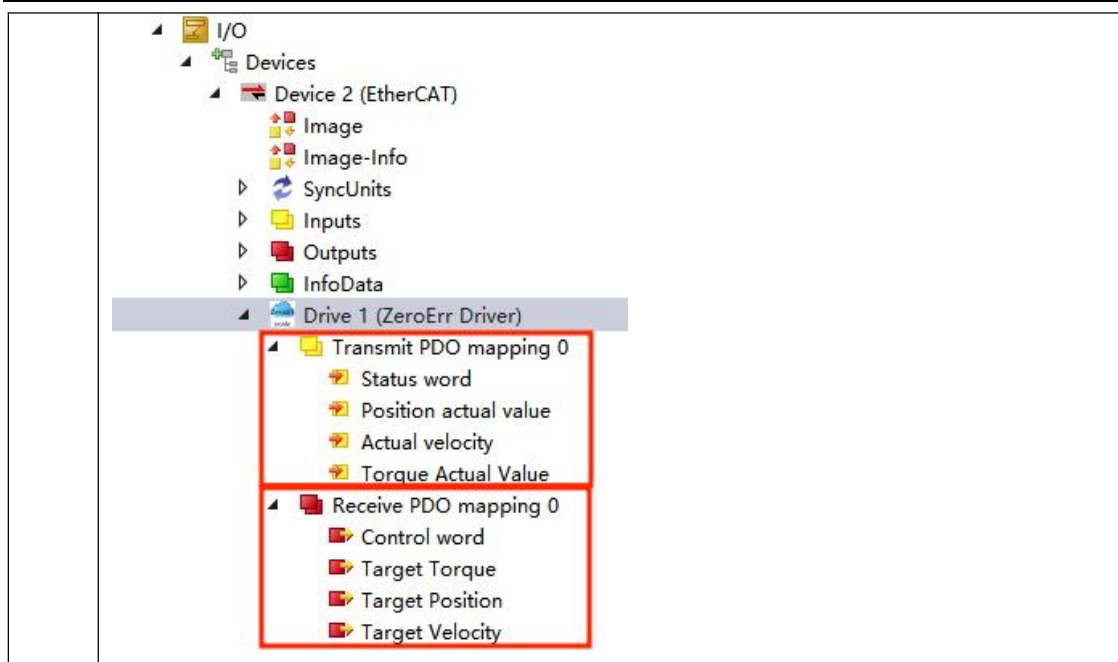
Data Type: INT

Bit Length: 16

From Dictionary:

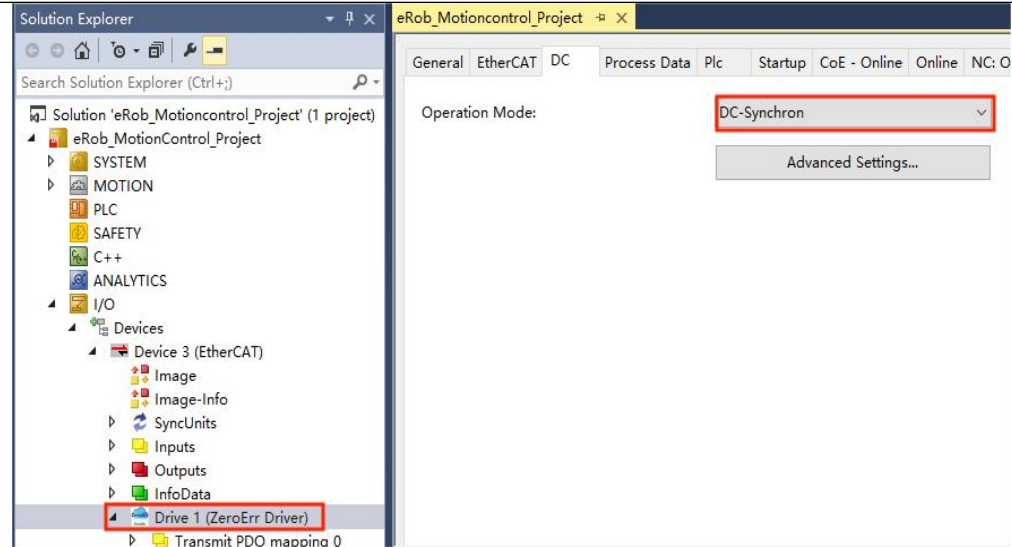
- 0x6066 - Following error time out
- 0x6067 - Position window
- 0x6068 - Position window time
- 0x606A - Sensor selection code
- 0x606D - Velocity window
- 0x606E - Velocity window time
- 0x606F - Velocity threshold
- 0x6070 - Velocity threshold time
- 0x6071 - Target Torque
- 0x6072 - Max torque
- 0x607A - Target position
- 0x607B:01 - Min position range limit
- 0x607B:02 - Max position range limit
- 0x607C - Home offset

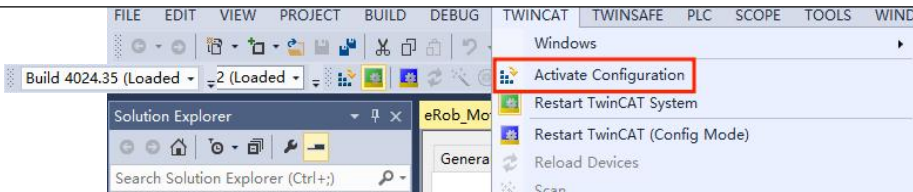
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0x60FF...	4.0	8.0	Target Velocity																																																																										
8	当 PDO 映射被更改时, TwinCAT 会自动更新启动脚本, 以便在 PREOP=>OP 时发送到从站驱动器。按照 DSP402 标准协议, 映射对象自动链接到使用标准对象的轴。其他映射对象需要手动连接 PDO。 As the PDO map is changed, the startup script is automatically updated by TwinCAT to send to the slave drive during the PREOP to OP transition.The automatic link of the DSP402 standard entries is only executed for axes which use standard object. With other modes of operation it is necessary to link the PDO's manually.																																																																												



6.5 运动控制

Motion Control

NO.	Action
1	EtherCAT 接口的操作模式必须在“SM-synchron”或“DC-synchron”之间进行选择。在本例中，选择了“DC-synchron”。 The operation mode of EtherCAT interface has to be selected between “SM-synchron” or “DC-synchron”. In this example “DC-synchron” is selected. 

2	通过单击 “ Activate configuration” 来激活配置。 Activate the configuration by clicking “ Activate configuration” . 
3	点击“YES”。 Click YES. 
4	1) 双击 Driver1(ZeroErr Driver), 进入 “NC:Online” 界面, 点击 “Set” 来启用功能。 2) 单击 “All” 启用设置。 1) Double click on the Driver1(ZeroErr Driver) . Navigate to “NC-Online” and click on “Set” in the Enabling menu. 2) Click on “All” to set the enables.

General
EtherCAT
DC
Process Data
Plc
Startup
CoE - Online
Online
NC: Online



1537489.0000

Setpoint Position: mm]

1537488.0000

Lag Distance (min/max): mm]

0.0000 (0.000, 0.000)

Actual Velocity: [mm/s]

72.3593

Setpoint Velocity: [mm/s]

0.0000

Override: [%]

0.0000 %

Total / Control Output: [%]

0.00 / 0.00 %

Error:

0 (0x0)

Status (log.)

☐ Ready
☒ NOT
☐ Calibrated
☐ Mov
☐ Has Job
☐ Mov

Set Enabling

☐ Controller
☐ Feed Fw
☐ Feed Bw

OK

Cancel

Override [%]:

0

2

All

Enabling

☐ Controller 1
☒ Set
☐ Feed Fw
☐ Feed Bw

Controller Kv-Factor:

1

262144

Target Position: [mm]

0

Target Velocity: [mm/s]

0

F1

F2

F3

F4

F5

F6

F8

F9

5 现在输入目标位置和目标速度，用“F5”按钮将轴移动到目标位置。点击“F1、F2、F3、F4”按钮可手动控制电机快速或者慢速正反转，点击“F8”清除错误。

Now input a target position and a target velocity and move the axis with the “F5”button to the target position.click “F1, F2, F3, F4” to manually control the motor to run forward or reverse at a fast or slow velocity. Click “F8” to clear the error.

General	EtherCAT	DC	Process Data	Plc	Startup	CoE - Online	Online	NC: Online
 1537487.0000		Setpoint Position: mm		1537488.0000				
Lag Distance (min/max): mm		Actual Velocity: [mm/s]		Setpoint Velocity: [mm/s]				
1.0000 (-2.000, 3.000)		11.3306		0.0000				
Override: [%]		Total / Control Output: [%]		Error:				
100.0000 %		0.00 / 0.00 %		0 (0x0)				
Status (log.)		Status (phys.)		Enabling				
☒ Ready ☐ Calibrated ☐ Has Job		☒ NOT Moving ☐ Moving Fw ☐ Moving Bw		☐ Coupled Mode ☐ In Target Pos. ☐ In Pos. Range				
				☒ Controller Set ☒ Feed Fw ☒ Feed Bw				
Controller Kv-Factor: [mm/s/mm]		Reference Velocity: [mm/s]						
1		262144						
Target Position: [mm]		Target Velocity: [mm/s]						
0		0						
-- F1 - F2 + F3 ++ F4 ◇ F5 ⊗ F6 ® F8 → F9								

第七章 错误处理

Chapter 7 Error Handling

7.1 CANopen 通信错误 (Abort Codes)

CANopen Communication Error (Abort Codes)

Abort code	Name	Meaning
0x00000000	无错误 No abort	通信成功 Communication successful
0x05030000	切换错误 Toggle error	触发位没有切换 Toggle bit not alternated
0x05040000	SDO 超时 SDO timeout	SDO 协议超时 SDO protocol timed out
0x05040001	未知命令 Command unknown	非法或未知的客户端 / 服务器命令字 Command specifier unknown
0x05040004	CRC 校验错误 CRC error	CRC 校验失败 CRC check failed
0x06010000	访问错误 Access error	对象不支持访问 Unsupported access to an object
0x06010001	只读错误 Write only error	试图读只写对象 Read command to a write only object
0x06010002	只写错误 Read only error	试图写只读对象 Write command to a read only object
0x06010003	子索引不能写入 Subindex can not be written	无法写入子索引, 子索引必须为“0”时才能写入 Subindex can not be written, subindex must be“0”(zero) for write access
0x06010004	不支持 SDO 访问 SDO complete access not supported	不能通过完全访问来访问该对象 The object can not be accessed via complete access
0x06020000	访问对象不存在 Object does not exist error	对象字典中对象不存在 Last read or write command had wrong object index or subindex



0x06040041	PDO 映射错误 PDO mapping error	对象不能映射到 PDO Object is not mappable to the PDO
0x06040042	PDO 长度错误 PDO length error	映射的对象的数目和长度超出 PDO 长度 Number and length of objects to be mapped would exceed PDO length
0x06040043	一般性参数错误 General parameter error	一般性参数不兼容 General parameter incompatibility
0x06040047	一般性设备内部错误 General internal incompatibility error	一般性设备内部不兼容 General internal in compatibility in device
0x06060000	硬件错误 Hardware error	硬件错误导致对象访问失败 Access failed due to hardware error
0x06070010	服务参数错误 Service parameter error	数据类型不匹配，服务参数长度不匹配 Datatype does not match, length or service parameter do not match
0x06070013	服务参数太短导致错误 Service parameter too short error	数据类型不匹配，服务参数长度太短 Datatype does not match, length of service parameter too low
0x06090011	子索引错误 Subindex error	子索引不存在 Last read or write command had wrong object subindex
0x06090030	参数数值范围错误 Value range error	超出参数数值的值范围 Value range of parameter exceeded
0x08000000	一般性错误 General error	一般性错误 General error
0x08000020	发送保存错误 Transferor store error	数据不能发送或保存到应用 Data can not be transferred or stored
0x08000022	设备状态错误 Wrong device state error	当前设备状态导致数据不能发送或保存到应用 Data can not be transferred or stored to application because of present device state
0x0F00FFBE	密码错误 Password error	密码错误 Password is incorrect
0x0F00FFBF	非法指令错误 Illegal command error	非法（不存在）的指令代码 Command code is illegal(does not exist)
0x0F00FFC0	NMT 状态错误 Wrong NMT state error	设备处于错误的 NMT 状态 Device is in wrong NMT state



7.2 设备报错

Device Error

0x603F Error Code Hex(Dec)	Message
<u>0x0000(0)</u>	伺服准备好 (Ready to switch on)
<u>0x2214(8724)</u>	电机电流过流(Motor current is over current)
<u>0x2250(8786)</u>	电机三相电流和超限 (Sum of motor three phase current exceed the limit)
<u>0x2341(9025)</u>	U 相过流 (The U phase over current)
<u>0x2342(9026)</u>	V 相过流 (The V phase over current)
<u>0x2343(9027)</u>	W 相过流 (The W phase over current)
<u>0x3210(12816)</u>	母线电压过压 (The bus voltage is overvoltage)
<u>0x3220(12832)</u>	母线电压欠压 (The bus voltage is undervoltage)
<u>0x4110(16656)</u>	功率部分温度过高 (The temperature of the power component is too high)
<u>0x7121(28961)</u>	电机堵转 (Blocked motor rotation)
<u>0x7305(29445)</u>	负载端单圈编码器读取的数据出错 (The data read from the single-turn encoder at the load side is incorrect)
<u>0x7306(29446)</u>	电机端单圈编码器读取的数据出错 (The data read from the single-turn encoder at the motor side is incorrect)
<u>0x730D(29453)</u>	电池警告错误 (Battery warning error)
<u>0x730F(29455)</u>	电池电压低 (Battery low voltage)
<u>0x7311(29457)</u>	采样的电机端位置误差超限 (The position error of the sampled motor end exceeds the limit)
<u>0x7314(29460)</u>	检测到多圈计数用电池重新接入过，重置负载端编码器清除该报警 (Detection of multiple revolutions count battery reconnection. Reset the load end encoder to clear this alarm)
<u>0x7315(29461)</u>	采样的负载端位置误差超限 (The sampling load position error exceeds the upper limit)
<u>0x7350(29520)</u>	电机端编码器类型不支持 (Motor side encoder type is not supported)
<u>0x7374(29556)</u>	多圈位置错误 (Multi-turn position error)
<u>0x7377(29559)</u>	检测到复位引脚的报错信息 (Error message for reset pin detected)
<u>0x737A(29562)</u>	负载端单圈编码器启动错误 (Error in startup of single-turn encoder at the load side)
<u>0x737E(29566)</u>	电机端单圈编码器启动错误 (Error in startup of single-turn encoder at the motor side)



<u>0x8130(33072)</u>	CAN 心跳错误 (CAN Heartbeat error)
<u>0x8400(33792)</u>	速度误差超出限制值 (The velocity error exceeds the limit value)
<u>0x8401(33793)</u>	电机速度过高 (Motor velocity exceeds the limit value)
<u>0x8500(34048)</u>	位置误差超出限制值 (The position error exceeds the limit value)
<u>0xA000(40960)</u>	主站掉线 (The master station goes offline)
<u>0xF004(61444)</u>	EtherCAT 初始化错误 (EtherCAT initialization error)
<u>0xF005(61445)</u>	STO 功能被激活 (The STO function is activated)
<u>0xF006(61446)</u>	多圈计数错误 (Multi-turn circle count error)
<u>0xF008(61448)</u>	母线电压低于允许的最小供电电压 (19V) (The bus voltage is lower than the minimum allowable supply voltage 19V)

7.2.1. 0x0000(0): 伺服准备好 (Ready to switch on)

0x603F Error Code (Hex):0x0 0x603F Error Code (Dec):0 CAN, MODBUS Error Code (Dec):0	提示信息	伺服准备好
	Message	Ready to switch on
	直接原因	该系统工作正常, 无任何错误
	The immediate causes	The system works properly without any error
	可能原因	—
	Possible causes	—
	排查建议	—
	suggestions	

7.2.2. 0x2214(8724): 电机电流过流(Motor current is over current)

0x603F Error Code (Hex):0x2214 0x603F Error Code (Dec):8724 CAN, MODBUS Error Code (Dec):1016	提示信息	电机电流过流
	Message	Motor current is over current
	直接原因	检测到电机电流超过最大电机电流 (关断) 设置
	The immediate causes	Motor current exceeds maximum motor current (shut off) setting is detected
	可能原因	1. 电流回路中 Kp 和 Ki 的设置不合理 2. 最大电机电流 (关断) 设置不合理 3. 载荷过重、冲击过大 (机械碰撞、机械突然加重、机械变形) 4. 电机电源线之间或电机电源线与壳体之间短路
	Possible causes	1. Unreasonable setting of Kp and Ki in current loop 2. Unreasonable maximum motor current (shut off) setting

		3. load too heavy,excessive impact (mechanical collision, mechanical sudden aggravation, mechanical distortion) 4.Short circuit between the motor power lines or between motor power line and housing
	排查建议 suggestions	1. 检查参数是否为出厂参数（电流回路的 Kp 和 Ki，最大电机电流（关断）） 2. 排除负载影响，空载测试，查看是否仍报此错误 1. Check whether the parameters are factory parameters (Kp and Ki of current loop, maximum motor current off) 2. Exclusion of load effects, no-load test, and see if this error is still reported

7.2.3. 0x2250(8786): 电机三相电流和超限 (Sum of Motor three phase current exceed the limit)

0x603F Error Code (Hex):0x2250 0x603F Error Code (Dec):8784 CAN,MODBUS Error Code (Dec):6000	提示信息	电机三相电流和超限
	Message	Sum of Motor three phase current exceed the limit
	直接原因	检出三相电流和误差超过阈值
	The immediate causes Possible causes	Three- phase current error exceeds the threshold is detected 1.不合理的电流回路 Kp、Ki 设置 2.不合理的三相电流和误差设置 3.负载过重，过冲击（机械碰撞、机械突然加重、机械扭曲） 4.电机接线错误，断线 1.Improper setting of Kp and Ki in current loop 2.Unreasonable three-phase current and error setting 3.Heavy load, excessive impact (mechanical collision, mechanical sudden aggravation, mechanical distortion) 4.Motor wiring error, disconnected
	排查建议 suggestions	1.检查电流回路 Kp、Ki 设置（查看 eTuner 上位机电流回路界面） 2.检查三相电流和误差设置(查看 eTuner 上位机安全电源界面)，设置等于最大电机电流（关断）即可，建议不要修改出厂值。 3.减轻负载，排除机械故障（润滑油干涩、轴承卡壳、机械锈死等） 4.正确连接电机三相线 1. Check the Kp and Ki settings of the current loop (check the interface of the eTuner controller flow loop) 2.Check the three-phase current and error settings (check the



		eTuner safety power supply interface of the controller), and set it equal to the maximum motor current (off). It is recommended not to change the factory value. 3.Reduce load and eliminate mechanical faults (dry lubricating oil, bearing jam, mechanical rust, etc.) 4. Correctly connect the three-phase wire of the motor
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7.2.4. 0x2341(9025): U 相过流 (The U phase over current)

0x603F Error Code (Hex):0x2341 0x603F Error Code (Dec):9025 CAN, MODBUS Error Code (Dec):1013	提示信息	U 相过流
	Message	The U phase over current
	直接原因	U 相电流超过最大单相电流 (关断)
	The immediate causes	U-phase current exceeds maximum single-phase current (off)
	可能原因	1. 不合理的电流回路 Kp、Ki 设置 2. 不合理的最大单相电流 (关断) 设置 3. 负载过重, 过冲击 (机械碰撞、机械突然加重、机械扭曲) 4. 电机动力线之间或与外壳短路 1. Improper setting of Kp and Ki in current loop 2. Unreasonable maximum single-phase current (off) setting 3. Heavy load, excessive impact (mechanical collision, mechanical sudden aggravation, mechanical distortion) 4. Short circuit between the motor power lines or with the housing
	Possible causes	
	排查建议	1. 检查电流回路 Kp、Ki 设置 (查看 eTuner 上位机电流回路界面) 2. 检查单相电流设置 (查看 eTuner 上位机安全电源界面), 应大于等于最大电机电流 (关断) 3. 减轻负载, 排除机械故障 (润滑油干涩、轴承卡壳、机械锈死等) 4. 检查外部接线 1. Check the Kp and Ki settings of the current loop (check the interface of the eTuner controller flow loop) 2. Check the setting of single-phase current (check the safe power supply interface of eTuner PC), which should be greater than or equal to the maximum motor current (off). 3. Reduce load and eliminate mechanical faults (dry lubricating oil, bearing jam, mechanical rust, etc.) 4. Check the external cables
	suggestions	



7.2.5. 0x2342(9026): V 相过流 (The V phase over current)

0x603F Error Code (Hex):0x2342 0x603F Error Code (Dec):9026 CAN, MODBUS Error Code (Dec):1014	提示信息	V 相过流
	Message	The V phase over current
	直接原因	V 相电流超过最大单相电流（关断）
	The immediate causes	V-phase current exceeds maximum single-phase current (off)
	可能原因	1. 不合理的电流回路 Kp、Ki 设置 2. 不合理的最大单相电流（关断）设置 3. 负载过重，过冲击（机械碰撞、机械突然加重、机械扭曲） 4. 电机动力线之间或与外壳短路
	Possible causes	1. Improper setting of Kp and Ki in current loop 2. Unreasonable maximum single-phase current (off) setting 3. Heavy load, excessive impact (mechanical collision, mechanical sudden aggravation, mechanical distortion) 4. Short circuit between the motor power lines or with the housing
	排查建议	1. 检查电流回路 Kp、Ki 设置（查看 eTuner 上位机电流回路界面） 2. 检查单相电流设置（查看 eTuner 上位机安全电源界面），应大于等于最大电机电流（关断） 3. 减轻负载，排除机械故障（润滑油干涩、轴承卡壳、机械锈死等） 4. 检查外部接线
	suggestions	1. Check the Kp and Ki settings of the current loop (check the interface of the eTuner controller flow loop) 2. Check the setting of single-phase current (check the safe power supply interface of eTuner PC), which should be greater than or equal to the maximum motor current (off). 3.Reduce load and eliminate mechanical faults (dry lubricating oil, bearing jam, mechanical rust, etc.) 4. Check the external cables



7.2.6. 0x2343(9027): W 相过流 (The W phase over current)

0x603F Error Code (Hex):0x2343 0x603F Error Code (Dec):9027 CAN, MODBUS Error Code (Dec):1015	提示信息	W 相过流
	Message	The W phase over current
	直接原因	W 相电流超过最大单相电流（关断）
	The immediate causes	W-phase current exceeds maximum single-phase current (off)
	可能原因	1. 不合理的电流回路 Kp、Ki 设置 2. 不合理的最大单相电流（关断）设置 3. 负载过重，过冲击（机械碰撞、机械突然加重、机械扭曲） 4. 电机动力线之间或与外壳短路
	Possible causes	1. Improper setting of Kp and Ki in current loop 2. Unreasonable maximum single-phase current (off) setting 3. Heavy load, excessive impact (mechanical collision, mechanical sudden aggravation, mechanical distortion) 4. Short circuit between the motor power lines or with the housing
	排查建议	1. 检查电流回路 Kp、Ki 设置（查看 eTuner 上位机电流回路界面） 2. 检查单相电流设置（查看 eTuner 上位机安全电源界面），应大于等于最大电机电流（关断） 3. 减轻负载，排除机械故障（润滑油干涩、轴承卡壳、机械锈死等） 4. 检查外部接线
	suggestion	1. Check the Kp and Ki settings of the current loop (check the interface of the eTuner controller flow loop) 2. Check the setting of single-phase current (check the safe power supply interface of eTuner PC), which should be greater than or equal to the maximum motor current (off). 3. Reduce load and eliminate mechanical faults (dry lubricating oil, bearing jam, mechanical rust, etc.) 4. Check the external cables



7.2.7. 0x3210(12816): 母线电压过压 (The bus voltage is overvoltage)

0x603F Code (Hex):0x3210	Error	提示信息 Message	母线电压过压 The bus voltage is overvoltage
0x603F Code (Dec):12816	Error	直接原因 The immediate causes	母线电压高于最高允许电压设置 The bus voltage is higher than the maximum allowable voltage setting
CAN, MODBUS Error Code (Dec):1008		可能原因 Possible causes	1. 电源电压过高 2. 不合理的最高允许电压设置 3. 重负载下速度过大.电机受力方向与运行方向相同时,工作在回馈制动状态 4. 动态制动导致母线电压升高 1.The power supply voltage is too high 2. The maximum allowable voltage is set improperly 3. High velocity under heavy load. The force direction of the motor is the same as the running direction, and it works in the feedback braking state 4. Dynamic braking causes the bus voltage to rise
		排查建议 suggestion	1. 检查电源 2. 检查最高允许电压设置 (查看 eTuner 上位机安全电源界面) 3. 减轻负载、降低速度或使用电源泄放模块 4. 使用电源泄放模块 1. Check the power supply 2. Check the maximum allowable voltage setting (check the eTuner PC safety power supply interface) 3. Reduce the load, velocity, or use the power release module 4. Use the power release module

7.2.8. 0x3220(12832): 母线电压欠压 (The bus voltage is undervoltage)

0x603F Code (Hex):0x3220	Error	提示信息 Message	母线电压欠压 The bus voltage is undervoltage
0x603F Code	Error	直接原因 The immediate causes	母线电压低于最低允许电压设置 The bus voltage is lower than the minimum allowable voltage setting



(Dec):12832 CAN, MODBUS Error Code (Dec):1009	可能原因 Possible causes	1. 电源电压过低 2. 不合理的最低允许电压设置 3. 电源功率不足 4. 电机动力线之间或与外壳短路 5. 重负载下启动加速度过大，瞬间启动电流过大 6. 过载或结构卡滞，导致瞬间启动电流过大 1. The power supply voltage is too low 2. The minimum allowable voltage is set improperly 3. The power supply is insufficient 4. Short circuit between the motor power lines or with the housing 5. Under heavy load, the startup acceleration is too large, and the instantaneous startup current is too large 6. Overload or structure stuck, resulting in excessive instantaneous starting current
	排查建议 suggestion	1. 检查电源功率输出是否满足实际运行的要求。 2. 打开 eTuner 上位机的安全电源界面，查看最小允许母线电压是否设置合理。 3. 检查关节电源接线，确认是否存在多个 eRob 模组串联接线，如果存在多个 eRob 模组串联接线，也可能引起母线电压欠压报警，请参考 eRob 机器人关节模组用户手册《5.1.电源接线方式说明》。 4. 减轻负载，降低加速度。 5. 减轻负载，移除干涉部分。 1. Check if the power supply power output meets the requirements for actual operation. 2. Open the safe power interface of the eTuner and check if the minimum allowable bus voltage is set reasonably. 3. Check the power supply wiring of the joints to confirm if there are multiple eRob series connections. If there are multiple eRob series connections, it may also cause undervoltage alarms in the bus voltage. Please refer to the eRob Robot Joint Module User Manual, section 5.1 'Power Wiring Instructions' for more information. 4. Reduce load and acceleration. 5. Reduce the load and remove the interference part.



7.2.9. 0x4110(16656): 功率部分温度过高 (The temperature of the power component is too high)

0x603F Error Code (Hex):0x4110 0x603F Error Code (Dec):16656 CAN, MODBUS Error Code (Dec):1018	提示信息	功率部分温度过高
	Message	The temperature of the power component is too high
	直接原因	功率器件温度传感器超过最高允许温度
	The immediate causes	The temperature sensor of the power device exceeds the maximum permissible temperature
	可能原因	1. 散热不良 2. 不合理的最高工作温度设置 3. 环境温度较高 4. 额定功率不足以驱动负载，长时间过载导致电流持续维持在很大的值，造成温度快速上升 1. The heat dissipation is poor 2. Unreasonable maximum operating temperature setting 3. The ambient temperature is high 4. The rated power is not enough to drive the load, and long-term overload will cause the current to continue to maintain a large value, resulting in rapid temperature rise
	Possible causes	
	排查建议	1. 加强散热（如安装在大面积金属板上、加装散热风扇） 2. 检查最高工作温度设置（查看 eTuner 上位机安全电源界面），应小于 85℃ 3. 查看《eRob 机器人关节模组用户手册》安全事项说明的安全使用环境 4. 检查电机电流，选择合适的电机、驱动器、负载 1. Strengthen heat dissipation (such as installing on a large area of metal plate and installing heat dissipation fan) 2. Check the setting of maximum working temperature (check the eTuner PC safety power supply interface), should be less than 85 °C 3. Check the safety environment in the safety instructions of <eRob Rotary Actuator User Manual> 4. Check the motor current and select the appropriate motor, driver and load
	suggestion	



7.2.10. 0x7121(28961): 电机堵转 (Blocked motor rotation)

0x603F Error Code (Hex):0x7121 0x603F Error Code (Dec):28961 CAN, MODBUS Error Code (Dec):1007	Error	提示信息	电机堵转
		Message	Blocked motor rotation
		直接原因	电机运行状态触发电机堵转设置： 电机电流大于堵转电流且电机速度小于堵转速度且持续时间大于堵转时间 Motor running state trigger motor blocking setting: The motor current is greater than the stop-turn current and The motor velocity is less than the stoppage velocity and the duration is longer than the stoppage time
		可能原因	1. 负载过重，机械卡死，运行阻力过大 2. 不合理的持续电流设置 3. 不合理的堵转保护设置 4. 错误的电角度补偿值 1. The load is too heavy, the machine is stuck, and the running resistance is too large 2. Unreasonable continuous current settings 3. Improper blocking protection settings 4. Wrong electrical angle compensation value
		排查建议	1. 检查机械结构，核算电机力矩 2. 检查持续电流设置（查看 eTuner 上位机安全电源界面） 3. 检查堵转保护设置（查看 eTuner 上位机堵转保护界面） 4. 正确的设置电角度补偿值 1. Check the mechanical structure and calculate the motor torque 2. Check the continuous current settings (check the eTuner PC safety power supply interface) 3. Check the fail-safe settings (see the eTuner controller fail-safe interface) 4. Correctly set the electrical angle compensation value

7.2.11. 0x7305(29445): 负载端单圈编码器读取的数据出错 (The data read from the single-turn encoder at the load side is incorrect.)

0x603F Error Code	Error	提示信息	负载端单圈编码器读取的数据出错。
		Message	The data read from the single-turn encoder at the load



(Hex):0x7305		side is incorrect.
0x603F Error Code (Dec):29445	直接原因 The immediate causes	发送读取负载端单圈编码器位置信息的命令时返回的数据出错。 When sending the command to read the position information from the single-turn encoder at the load side, the returned data is incorrect.
CAN, MODBUS Error Code (Dec):3105	可能原因 Possible causes	1.供电电压不稳, 母线电压跌落至 19V 以下时导致编码器无法正常工作, 从而导致返回的信息出错。 The unstable power supply voltage, which causes the bus voltage to drop below 19V, is likely the reason for the encoder's malfunction and the resulting incorrect information being returned.
	排查建议 suggestion	1.检查电源工作状态并测量电压是否稳定。 Please check the power supply's operational status and measure the voltage to determine if it is stable. 2.请更新至最新固件 Please update to the latest firmware

7.2.12. 0x7306(29446): 电机端单圈编码器读取的数据出错 (The data read from the single-turn encoder at the motor side is incorrect)

0x603F Error Code (Hex):0x7306	提示信息 Message	电机端单圈编码器读取的数据出错。 The data read from the single-turn encoder at the motor side is incorrect.
0x603F Error Code (Dec):29446	直接原因 The immediate causes	发送读取电机端单圈编码器位置信息的命令时返回的数据出错。 When sending the command to read the position information from the single-turn encoder at the motor side, the returned data is incorrect.
CAN, MODBUS Error Code (Dec):3005	可能原因 Possible causes	1.供电电压不稳, 母线电压跌落至 19V 以下时导致编码器无法正常工作, 从而导致返回的信息出错。 The unstable power supply voltage, which causes the bus voltage to drop below 19V, is likely the reason for the encoder's malfunction and the resulting incorrect information being returned.
	排查建议 suggestion	1.检查电源工作状态并测量电压是否稳定。 Please check the power supply's operational status and measure the voltage to determine if it is stable. 2.请更新至最新固件 Please update to the latest firmware



7.2.13. 0x730D(29453): 电池警告错误 (Battery warning error)

0x603F Error Code (Hex):0x730D 0x603F Error Code (Dec):29453 CAN, MODBUS Error Code (Dec):3109	Error	提示信息	电池警告错误
		Message	Battery warning error
		直接原因	负载端编码器多圈保持用电池电压低于警告电压 3.15V
		The immediate causes	Load side encoder multi-turn hold battery voltage is lower than the warning voltage 3.15V
		可能原因	1. 电池正常消耗至警告电压报警 2. 使用了错误的电池 3. 电池线路异常导致过快的损耗
		Possible causes	1.The alarm voltage is generated when the battery is normally consumed 2. Using the wrong battery 3. The battery circuit is abnormal, resulting in excessive loss
		排查建议	1. 更换新电池并参照《eRob 机器人关节模组用户手册 9.4 使用多圈功能的关节位置和注意事项》执行复位操作, 并确认设备零点
		suggestion	2. 更换正确的电池并执行正确的复位操作, 并确认设备零点 3. 检查线缆, 更换新电池并执行正确的复位操作, 并确认设备零点 1. Replace the battery and reset the battery by referring to <eRob Rotary Actuator User Manual chapter9.4 Joint Positions and Precautions with Multi-Turn Function>, and confirm the zero point of the device 2. Replace the correct battery, reset the battery correctly, and check the zero point of the device 3. Check the cables, replace the battery, reset the battery correctly, and check the zero point of the device

7.2.14. 0x730F(29455): 电池电压低 (Battery low voltage)

0x603F Error Code (Hex):0x730F	Error	提示信息	电池电压低
		Message	Battery low voltage
0x603F Error Code	Error	直接原因	负载端编码器多圈保持用电池电压低于工作电压 3.05V
		The immediate causes	Load side encoder multi-turn holding battery voltage is 3.05V lower than operating voltage



(Dec):29455 CAN, MODBUS Error Code (Dec):3110	可能原因 Possible causes	1. 电池消耗至低压报警后并继续使用消耗至错误报警电压 2. 使用了错误的电池 3. 多圈电池接口松动。 4. 未连接电池 1. After the battery is consumed to the low voltage alarm, continue to use the voltage consumed to the wrong alarm 2. Using the wrong battery 3. The battery interface is loose 4. The battery is not connected
	排查建议 suggestion	1. 更换新电池并参照《eRob 机器人关节模组用户手册 9.4.使用多圈功能的关节位置和注意事项》执行复位操作，并确认设备零点 2. 更换正确的电池并执行正确的复位操作，并确认设备零点 3. 检查线缆，更换新电池并执行正确的复位操作，并确认设备零点 4. 安装电池并执行正确的复位操作，并确认设备零点 1. Replace the battery and reset the battery by referring to <eRob Robot Joint Module User Manual chapter9.4 Joint Positions and Precautions with Multi-Turn Function>, and confirm the zero point of the device 2. Replace the correct battery, reset the battery correctly, and check the zero point of the device 3. Check the cables, replace the battery, reset the battery correctly, and check the zero point of the device 4. Install the battery, reset the battery correctly, and check the zero point of the device

7.2.15. 0x7311(29457): 采样的电机端位置误差超限 (The position error of the sampled motor end exceeds the limit)

0x603F Error Code (Hex):0x7311	提示信息 Message	采样的电机端位置误差超限 The position error of the sampled motor end exceeds the limit.
	直接原因 The immediate causes	相邻两个采样周期读取的电机端编码器反馈位置的差值过大 The difference between the feedback position of the motor encoder read by two adjacent sampling periods is too large.



CAN, MODBUS Error Code (Dec):3121	可能原因 Possible causes	1. 电源快速的跌落或者波动，导致编码器供电不稳定，进而导致读数异常。 2. 错误的电机端编码器配置（类型、参数、分辨率等）。 3. 编码器硬件电路故障。 4. 码盘安装异常。 1. The rapid drop or fluctuation of the power supply leads to the instability of the encoder power supply, further leads to abnormal reading data. 2. Wrong Motor encoder configuration (type, parameter, resolution, etc.). 3. Encoder hardware circuit failure. 4. magnetic ring installation exception.
	排查建议 suggestion	1.检查电源工作状态并测量电压是否稳定。 2.是否是快速断电上电时出现此报错（最新固件已修复此问题）。 3. 电机失能情况下，通过 eTuner 上位机示波器采集“电机转角”查看是否存在较大的跳变。 4. 运动过程中触发此报错，则检查是否存在异响 1. Please check the power supply's operational status and measure the voltage to determine if it is stable. 2. Does this error occurred with rapid Power on power (The latest firmware has fixed this issue). 3. When the motor is disabled, use the eTuner oscilloscope to collect the "motor angle" to see if there is a large jump. 3. If this error is triggered during movement, check if there is any abnormal noise

7.2.16. 0x7314(29460): 检测到多圈计数用电池重新接入过，重置负载端编码器清除该报警（Detection of multiple revolutions count battery reconnection. Reset the load end encoder to clear this alarm.）

0x603F Error Code (Hex):0x7314	提示信息 Message	检测到多圈计数用电池重新接入过，重置负载端编码器清除该报警 Detection of multiple revolutions count battery reconnection. Reset the load end encoder to clear this alarm.
0x603F Error Code (Dec):29460	直接原因 The immediate causes	负载编码器多圈保持用电池电压高于工作电压 3.05V 以上情况下负载编码器经历过电池更换 The load encoder has undergone battery replacement when



CAN, MODBUS Error Code (Dec):3111	可能原因 Possible causes	the battery voltage is 3.05V higher than the operating voltage 1. 负载编码器经历过电池更换，安装电池后未执行负载端编码器复位 2. 多圈电池接口松动 1. The load encoder is not reset after the battery is installed because the battery has been replaced 2. The Multi-turn battery interface is loose
	排查建议 suggestion	参照《eRob 机器人关节模组用户手册 9.4 使用多圈功能的关节位置和注意事项》执行复位操作，并确认设备零点 Reset the device by referring to <the eRob Robot Joint Module User Manual chapter9.4 Joint Positions and Precautions with Multi-Turn Function>, and confirm the zero point of the device

7.2.17. 0x7315(29461): 采样的负载端位置误差超限 (The sampling load position error exceeds the upper limit)

0x603F Error Code (Hex):0x7315 0x603F Error Code (Dec):29461 CAN, MODBUS Error Code (Dec):3120	提示信息 Message	采样的负载端位置误差超限 The sampling load position error exceeds the upper limit
	直接原因 The immediate causes	相邻两个采样周期读取到的负载端编码器差值过大 The difference of the load encoder between two adjacent sampling periods is too large
	可能原因 Possible causes	1. 电源快速的跌落或者波动，导致编码器供电不稳定，进而导致读数异常。 2. 错误的负载端编码器配置（类型、参数、分辨率等） 3. 编码器硬件电路故障 4. 码盘安装异常 1. The rapid drop or fluctuation of the power supply leads to the instability of the encoder power supply, further leads to abnormal reading data. 2. Wrong load encoder configuration (type, parameter, resolution, etc.). 3. Encoder hardware circuit failure. 4. magnetic ring installation exception.
	排查建议 suggestion	1.检查电源工作状态并测量电压是否稳定。 2.是否是快速断电上电时出现此报错（最新固件已修复此问题）



		3. 正常上电后，静止时，通过 eTuner 上位机“编码器”界面检查负载端编码器读数是否存在较大的跳动 4 运动过程中触发此报错，则检查是否存在异响 1. Check the working status of the power supply and measure whether the voltage is stable. 2. Does this error occurred with rapid Power on power (The latest firmware has fixed this issue). 3. After normal enabled, check whether there is a large runout in the encoder reading at the load end through the "encoder" interface of the eTuner controller when Stationary. 4. If this error is triggered during movement, check if there is any abnormal noise.
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7.2.18. 0x7374(29556): 多圈位置错误 (Multi-turn position error)

0x603F Error Code (Hex):0x7374 0x603F Error Code (Dec):29556 CAN, MODBUS Error Code (Dec):3138	提示信息 Message	多圈位置错误 Multi-turn position error
	直接原因 The immediate causes	负载编码器多圈保持用电池电压高于工作电压 3.05V 以上情况下负载编码器经历过电池更换 The load encoder has undergone battery replacement when the battery voltage is 3.05V higher than the operating voltage
	可能原因 Possible causes	1. 负载编码器经历过电池更换，安装电池后未执行负载端编码器复位 2. 多圈电池接口松动 1.The load encoder is not reset after the battery is installed because the battery has been replaced 2. Multi-turn battery interface is loose
	排查建议 suggestion	参照《eRob 机器人关节模组用户手册 9.4 使用多圈功能的关节位置和注意事项》执行复位操作，并确认设备零点 Reset the device by referring to <the eRob Robot Joint Module User Manual chapter9.4 Joint Positions and Precautions with Multi-Turn Function>, and confirm the zero point of the device



7.2.19. 0x7377(29559): 检测到复位引脚的报错信息 (Error message for reset pin detected)

0x603F Error Code (Hex):0x7377 0x603F Error Code (Dec):29559 CAN, MODBUS Error Code (Dec):3137	提示信息	检测到复位引脚的报错信息。
	Message	Error message for reset pin detected.
	直接原因 The immediate causes	上电初始化时多圈编码器的复位引脚检测到一个高电平。 During power-up initialization, the reset pin of the multi-turn encoder detected a high level.
	可能原因 Possible causes	1. 电源快速的跌落或者波动, 导致编码器供电不稳定, 进而导致读数异常。 2. 编码器硬件电路故障。 1. The rapid drop or fluctuation of the power supply leads to the instability of the encoder power supply, further leads to abnormal reading data. 2. Encoder hardware circuit failure.
	排查建议 suggestion	1.检查电源工作状态并测量电压是否稳定。 1. Check the working status of the power supply and measure whether the voltage is stable.

7.2.20. 0x737A(29562): 负载端单圈编码器启动错误 (Error in startup of single-turn encoder at the load side)

0x603F Error Code (Hex):0x737A 0x603F Error Code (Dec):29562 CAN, MODBUS Error Code (Dec):3136	提示信息	负载端单圈编码器启动错误
	Message	Error in startup of single-turn encoder at the load side.
	直接原因 The immediate causes	上电初始化时读取负载端编码器的返回信息出错。 Error occurred while reading the feedback information from the load encoder during power-up initialization.
	可能原因 Possible causes	1. 电源快速的跌落或者波动, 导致编码器供电不稳定, 进而导致读数异常。 2. 编码器硬件电路故障。 1. The rapid drop or fluctuation of the power supply leads to the instability of the encoder power supply, further leads to abnormal reading data. 2. Encoder hardware circuit failure.
	排查建议 suggestion	1.检查电源工作状态并测量电压是否稳定。 Please check the power supply's operational status and measure the voltage to determine if it is stable. 2.请更新至最新固件 Please update to the latest firmware



7.2.21. 0x7350(29520): 电机端编码器类型不支持 (Motor side encoder type is not supported)

0x603F Error Code (Hex):0x7350 0x603F Error Code (Dec):29520 CAN, MODBUS Error Code (Dec):3122	提示信息	电机端编码器类型不支持
	Message	Motor side encoder type is not supported
	直接原因	电机端编码器类型不支持
	The immediate causes	Motor side encoder type is not supported
	可能原因	1. 未配置电机端编码器
	Possible causes	2. 配置的电机端编码器类型不支持 1. Motor end encoder is not configured 2. The configured encoder type on the motor end is not supported
	排查建议	检查编码器配置
	suggestion	Checking the encoder configuration

7.2.22. 0x737E(29566):电机端单圈编码器启动错误 (Error in startup of single-turn encoder at the motor side)

0x603F Error Code (Hex):0x737E 0x603F Error Code (Dec):29566 CAN, MODBUS Error Code (Dec):3142	提示信息	电机端单圈编码器启动错误
	Message	Error in startup of single-turn encoder at the motor side.
	直接原因	上电初始化时读取电机端编码器的返回信息出错。
	The immediate causes	Error occurred while reading the feedback information from the motor encoder during power-up initialization.
	可能原因	1. 电源快速的跌落或者波动, 导致编码器供电不稳定, 进而导致读数异常。
	Possible causes	2. 编码器硬件电路故障。 1. The rapid drop or fluctuation of the power supply leads to the instability of the encoder power supply, further leads to abnormal reading data. 2. Encoder hardware circuit failure.
	排查建议	1.检查电源工作状态并测量电压是否稳定。
	suggestion	Please check the power supply's operational status and measure the voltage to determine if it is stable. 2.请更新至最新固件 Please update to the latest firmware.



7.2.23. 0x8130(33072): CAN 心跳错误 (CAN Heartbeat error)

0x603F Error Code (Hex):0x8130	提示信息 Message	CAN 心跳错误 CAN heartbeat error
0x603F Error Code (Dec):33072 CAN, MODBUS Error Code (Dec):4003	直接原因 The immediate causes	使能情况下,“心跳消费者”在配置的时间内没有检测到“心跳生产者”的“心跳”报文。如果“消费者心跳时间”等于 0,心跳消费者将被禁用。 In case of enable, a "Heartbeat consumer" does not detect "Heartbeat" messages by the "Heartbeat producer" within a configured period of time 。 Heartbeat Consumers will be disabled if Consumer heartbeat time = 0.
	可能原因 Possible causes	1. 主站未正确配置消费者的心跳超时时间。 2. CAN 通信掉线。 1. The master does not correctly configure the consumer's heartbeat timeout. 2. CAN communication is disconnected.
	排查建议 suggestions	1. 检查“心跳消费者”的心跳超时时间配置是否大于“心跳生产者”发送的“心跳”报文的 2 倍,否则易误报从机认为主机掉站。 2. 检查 CAN 通信线缆是否可靠连接。 1. Check whether the heartbeat timeout configuration of the "heartbeat consumer" is greater than twice the "heartbeat" message sent by the "heartbeat producer", otherwise it is easy to mistakenly report that the slave thinks that the master is down. 2. Check whether the CAN communication cable is connected reliably.

注: 匹配 X3071220X 版本及以上固件。

Note: Match firmware the X3071220X version and above.



7.2.24. 0x8400(33792): 速度误差超出限制值 (The velocity error exceeds the limit value)

0x603F Error Code (Hex):0x8400 0x603F Error Code (Dec):33792 CAN, MODBUS Error Code (Dec):1021	提示信息	速度误差超出限制值
	Message	The velocity error exceeds the limit value
	直接原因	速度误差大于允许最大误差
	The immediate causes	The velocity error is greater than the maximum allowed error
	可能原因	1. 不合适的速度环增益、积分参数 2. 不合适的位置环增益 3. 最大允许速度过低 4. 持续电流、峰值电流过低 5. 电机扭矩/功率不足 6. 最大允许误差不合理 7. 不合适的目标位置或目标速度 8. 负载惯量/阻力过大 9. 电流环参数不合理 10. 输入电源电压过低，电源输出功率不足 11. 错误的电角度补偿值 1. Improper velocity loop gain and integral parameters 2. Improper position loop gain 3. The maximum allowable velocity is too low 4. The continuous current and peak current are too low 5. Insufficient motor torque/power 6. The maximum allowable error is unreasonable 7. Inappropriate target position or target velocity 8. The load inertia/resistance is too large 9. Current ring parameters are unreasonable 10. The input voltage is too low and the output power is insufficient 11. Incorrect electrical angle compensation value
	Possible causes	
	排查建议	1. 调节速度环，使之正确跟随（查看 eTuner 上位机 PID 设置界面） 2. 调节位置环，使之正确跟随（查看 eTuner 上位机 PID 设置界面） 3. 设置合适的最大允许速度（>1.2 倍期望速度）（查看
	suggestion	



		eTuner 上位机安全速度界面) 4. 设置更大的合适的持续电流、峰值电流 (查看 eTuner 上位机安全电源界面) 5. 检查电机的反转电流、极对数设置是否正确 6. 设置合适的最大允许误差 (查看 eTuner 上位机安全位置、安全速度界面) 7. 检查伺服指令是否合理 8. 检查负载情况, 施加的负载是否超过电机所能输出的最大负载 9. 核对电流环, 使之正确跟随 10. 检查电源电压, 确认电源功率 11. 正确的设置电角度补偿值 1. Adjust the velocity ring and make it follow correctly (check the PID setting interface of eTuner controller) 2. Adjust the position ring and make it follow correctly (check the PID setting interface of eTuner controller) 3. Set the appropriate maximum allowable velocity (> 1.2 times the expected velocity) (Check the eTuner PC safety velocity interface) 4. Set larger appropriate continuous current and peak current (check the eTuner PC safety power supply interface) 5. Check whether the reverse current and poles log of the motor are set correctly 6. Set the appropriate maximum allowable error (check the eTuner safe position and safe velocity interface) 7. Check whether the servo instruction is reasonable 8. Check the load. Whether the applied load exceeds the maximum allowable output load of the motor 9. Check the current loop and make it follow correctly 10. Check the power supply voltage 11. Correctly set the electrical angle compensation value
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7.2.25. 0x8401(33793): 电机速度过高 (Motor velocity exceeds the limit value)

0x603F Error Code (Hex):0x8401 0x603F Error Code (Dec):33793 CAN, MODBUS Error Code (Dec):1019	提示信息	电机速度过高
	Message	Motor velocity exceeds the limit value
	直接原因	电机转速超过最大允许速度 25%
	The immediate causes	Motor velocity exceeds maximum allowable velocity by 25%
	可能原因	1. 错误的编码器配置 (类型、参数、分辨率等) 2. 错误的速度环增益、积分 3. 错误的最大允许速度设置
	Possible causes	1. Wrong encoder configuration (type, parameter, resolution, etc.) 2. Wrong velocity loop gain and integration 3. The maximum allowable velocity is incorrectly set
	排查建议	1. 检查编码器设置 2. 重新调节速度环参数 (查看 eTuner 上位机 PID 设置界面) 3. 检查最大允许速度设置 (查看 eTuner 上位机安全速度界面)
	suggestions	1. Check the encoder settings 2. Adjust the velocity ring and make it follow correctly (check the PID setting interface of eTuner controller) 3. Check the maximum allowable velocity setting (view the eTuner controller safe velocity interface)



7.2.26. 0x8500(34048): 位置误差超出限制值 (The position error exceeds the limit value)

0x603F Error Code (Hex):0x8500 0x603F Error Code (Dec):34048 CAN, MODBUS Error Code (Dec):1020	提示信息	位置误差超出限制值
	Message	Position error exceeds the limit
	直接原因	位置误差大于允许最大误差
	The immediate causes	Position error is larger than the permissible maximum error
	可能原因	1. 不合适的速度环增益、积分参数 2. 不合适的位置环增益 3. 最大允许速度过低 4. 持续电流、峰值电流过低 5. 电机扭矩/功率不足 6. 最大允许误差不合理 7. 不合适的目标位置或目标速度 8. 负载惯量/阻力过大 9. 电流环参数不合理 10. 投入电源电压过低，电源输出功率不足 11. 错误的电角度补偿值
	Possible causes	1. Unsuitable speed loop gain, integral parameters 2. Unsuitable position loop gain 3. Maximum permissible speed is too low 4. Continuous current/ peak current is too low. 5. Insufficient torque/ power 6. Improper maximum permissible error 7. Unsuitable target position or target speed 8. Load inertia/resistance is too large 9. Improper current loop parameter 10. Supply power voltage is too low, and the output power of 11. power supply is insufficient. Improper zero offset value.
	排查建议 suggestion	1. 调节速度环，使之正确跟随（查看 eTuner 上位机 PID 设置界面） 2. 调节位置环，使之正确跟随（查看 eTuner 上位机 PID 设置界面） 3. 设置合适的最大允许速度（>1.2 倍期望速度）（查看

		eTuner 上位机安全速度界面) - 设置更大的合适的持续电流、峰值电流 (查看 eTuner 上位机安全电源界面) - 检查电机的反转电流、极对数是否设置正确 - 设置合适的最大允许误差 (查看 eTuner 上位机安全位置、安全速度界面) - 检查伺服指令是否合理 - 检查负载情况, 施加的负载是否超过电机所能输出的最大负载 - 核对电流环, 使之正确跟随 - 检查电源电压, 确认电源功率 - 正确的设置电角度补偿值 - Adjust the velocity ring and make it follow correctly (check the PID setting interface of eTuner controller) - Adjust the position ring and make it follow correctly (check the PID setting interface of eTuner controller) - Set the appropriate maximum allowable velocity (> 1.2 times the expected velocity) (Check the eTuner PC safety velocity interface) - Set larger appropriate continuous current and peak current (check the eTuner PC safety power supply interface) - Check whether the reverse current and poles log of the motor are set correctly - Set the appropriate maximum allowable error (check the eTuner safe position and safe velocity interface) - Check whether the servo instruction is reasonable - Check the load. Whether the applied load exceeds the maximum allowable output load of the motor - Check the current loop and make it follow correctly - Check the power supply voltage - Correctly set the electrical angle compensation value
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7.2.27. 0xA000 (40960) EtherCAT 总线通信异常 (EtherCAT communication abnormal)

0x603F Error Code (Hex):0xA000 0x603F Error Code (Dec):40960 CAN, MODBUS Error Code (Dec):4004	提示信息 Message	主站掉线或退出 OP 至非 OP 状态 The master station goes offline or exits the OP to a non-OP state
	直接原因 The immediate causes	使能情况下, 发生 EtherCAT 通信中断或通信正常情况下发生 EtherCAT 切换至非 Op 状态。 In case of enable, EtherCAT communication interruption occurs or EtherCAT switchover to non-Op state occurs in case of normal communication.
	可能原因 Possible causes	1. 正常使能情况下, 发生了控制器断电或程序关闭, 导致 EtherCAT 状态机从 OP 切换至非 Op 状态。 2. 正常使能情况下, 发生了控制器程序关闭, 导致 EtherCAT 状态机从 OP 切换至非 Op 状态。 3. 正常使能情况下, 发生了控制器程序运行异常, 导致 EtherCAT 状态机从 OP 切换至非 Op 状态。 4. 正常使能情况下, 发生了 EtherCAT 通讯线断开或接触不良。 1. A controller power failure or program shutdown occurs under normal enable conditions, causing the EtherCAT state machine to switch from OP to a non-Op state. 2. a controller program shutdown has occurred under normal enable conditions, causing the EtherCAT state machine to switch from OP to non-Op. 3. In the normal enable condition, a controller program operation abnormality occurs, causing the EtherCAT state machine to switch from OP to non-Op state. 4. A disconnection or poor contact of the EtherCAT communication cable has occurred under normal enable conditions.
	排查建议 suggestions	1. 检查并处理 EtherCAT 网线连接确保连接可靠。 2. 检查上位机 EtherCAT 主站运行是否正常。 3. 检查 EtherCAT 主站是否满足实时性的要求, 更换实时性更强的上位机。 1. Check the connections of the EtherCAT cables to ensure that they are reliable. 2. Check that the EtherCAT master of the host computer is running normally. 3. Check whether the EtherCAT master meets the real-time requirements, and replace the host computer with a more real-time capability.

注: 匹配 X3071220X 版本及以上固件。

Note: Match firmware version X3071220X and above.

7.2.28. 0xF004(61444): EtherCAT 初始化错误 (EtherCAT initialization error)

0x603F Error Code (Hex):0xF004 0x603F Error Code (Dec):61444 CAN, MODBUS Error Code (Dec):4001	提示信息	EtherCAT 初始化错误
	Message	EtherCAT initialization error
	直接原因	EtherCAT 程序初始化自检未通过
	The immediate causes	The EtherCAT program initialization self-test failed
	可能原因	1. 烧录了错误的驱动器固件
	Possible causes	2. 烧录了错误的 EtherCAT XML 配置文件 3. EtherCAT 相关硬件故障
	排查建议	1. The wrong drive firmware was burned
	suggestions	2. An incorrect EtherCAT XML configuration file was burned 3. EtherCAT hardware is faulty
	排查建议	1. 检查驱动器烧录固件版本
	suggestions	2. 检查烧录的 EtherCAT XML 配置文件 3. 更换驱动器
	排查建议	1. Check the driver burning firmware version
	suggestions	2. Check the burned EtherCAT XML configuration file 3. Replace the drive

7.2.29. 0xF005(61445): STO 功能被激活 (The STO function is activated)

0x603F Error Code (Hex):0xF005 0x603F Error Code (Dec):61445 CAN, MODBUS Error Code (Dec):1022	提示信息	STO 功能被激活
	Message	The STO function is activated
	直接原因	STO 接口输入信号 switch on
	The immediate causes	The STO interface input signal is switch on
	可能原因	STO 接口输入信号 switch on
	Possible causes	The STO interface input signal is switch on
	排查建议	STO 接口输入信号 switch off 后可以清除该错误
	suggestions	The error can be cleared after the STO interface input signal is switch off

7.2.30. 0xF006(61446): 多圈计数错误 (Multi-turn circle count error)

0x603F Error Code (Hex):0xF006 0x603F Error Code (Dec):61446 CAN, MODBUS Error Code (Dec):3154	提示信息	多圈计数错误
	Message	Multi-turn circle count error
	直接原因 The immediate causes	1. 在断电重启过程中,eRob 关节模组未完全断电 (Power 指示灯未完全熄灭) 立即重新上电 2. 多圈模组重置负载端编码器 1. During the power off restart process, the eRob is not completely power off (the Power indicator light is not completely off) and the power is immediately back on 2. Multi-turn eRob reset the load end encoder
	可能原因 Possible causes	1. 在断电重启过程中,eRob 关节模组未完全断电 (Power 指示灯未完全熄灭) 立即重新上电 2. 多圈模组重置负载端编码器 1. During the power off restart process, the eRob is not completely power off (the Power indicator light is not completely off) and the power is immediately back on 2. Multi-turn eRob reset the load end encoder
排查建议 suggestions		请更新至最新固件 Please update to the latest firmware

7.2.31. 0xF008(61448): 母线电压低于允许的最小供电电压 (19V)

(The bus voltage is lower than the minimum allowable supply voltage 19V)

0x603F Error Code (Hex):0xF008 0x603F Error Code (Dec):61448 CAN, MODBUS Error Code (Dec):1005	提示信息	母线电压低于允许的最小供电电压 (19V)
	Message	The bus voltage is lower than the minimum allowable supply voltage (19V)
	直接原因 The immediate causes	检测到当前模组的供电电压跌落到低于 19V。 The current power supply voltage for the joint module has been detected to drop below 19V.
	可能原因 Possible causes	1. 运动过程中由于特殊工况导致供电电源电压跌落 During the motion process, the power supply voltage drops due to special operating conditions
排查建议 suggestions		1. 检查电源工作状态并测量电压是否稳定。 Check the power supply's operational status and measure the voltage to determine if it is stable. 2. 更换适合当前运行工况的电源 Replace the power supply with one suitable for the current operating conditions. 3. 请更新至最新固件 Please update to the latest firmware

第八章 对象字典

Chapter 8 Object Dictionary

8.1 概述

Overview

8.1.1. 对象字典

Object dictionary

对象字典本质上是可以通过接收和发送 SDO 访问的一组对象。该对象的一部分可以以映射的方式发送和接收 PDO。

下表说明对象字典对象的分布。

The object dictionary is essentially a grouping of objects that are accessible via receive and transmit SDOs. Part of the object can be mapped to transmit and receive PDOs (TxPDO and RxPDO, respectively) in a predefined manner.

The following table describes the distribution of the object dictionary objects.

Index(Hex)	Object
0x0000	未使用 Not used
0x0001 -0x001F	静态数据类型 Static data type
0x0020 -0x003F	复杂数据类型 Complex data type
0x0040 -0x005F	制造商特定的数据类型 Manufacturer-specific data type
0x0060 - 0x0FFF	保留 Reserved
0x1000 - 0x1FFF	通信配置区域 Communication profile area
0x2000 - 0x5FFF	制造商特定的配置区域 Manufacturer-specific profile area
0x6000 - 0x6FFF	标准化设备配置区域 Standardized device profile area
0xA000 - 0xFFFF	保留 Reserved

8.1.2. 数据类型

Object data types

Index	Name	Base type	Description	Size[bits]	Range
0x0001	BOOLEAN	BOOL	False/True	1	0,1
0x0002	INTEGER8	SINT	Short integer	8	$-2^7 \dots 2^7 - 1$
0x0003	INTEGER16	INT	Integer	16	$-2^{15} \dots 2^{15} - 1$
0x0004	INTEGER32	DINT	Double integer	32	$-2^{31} \dots 2^{31} - 1$
0x0015	INTEGER64	LINT	Long integer	64	$-2^{63} \dots 2^{63} - 1$
0x0005	UNSIGNED8	USINT	Unsigned Short integer	8	$0 \dots 2^8 - 1$
0x0006	UNSIGNED16	UINT	Unsigned Integer	16	$0 \dots 2^{16} - 1$
0x0007	UNSIGNED32	UDINT	Unsigned Double integer	32	$0 \dots 2^{32} - 1$
0x001B	UNSIGNED64	ULINT	Unsigned Long integer	64	$0 \dots 2^{64} - 1$
0x0009	VISIBLE_STRING	STRING (n)	Visible String (loctet per chaRacter)	8*n	—
0x000A	OUTET_STRUNG	ARRAY [0...n] of USINT	Squence of octets (data type USINT)	8*(n+1)	—
0x0021	PDO_MAPPING	—	PDO Mapping Parameter Record	—	—
0x0023	IDENTITY	—	Identity Parameter Record	—	—

8.1.3. 对象访问类型

Object access types

Access type	Description
RW	Read and write access
RO	Readonly access
WO	Write only access
CONST	Readonly access value is constant

8.1.4. 对象代码

Object codes

Object code	Object name
0x0007	VAR
0x0008	ARRAY
0x0009	RECORD

8.1.5. 映射对象标志

Object flags

Flags	Code	Description
PDO mapping	TXPDO,RXPDO	条目可以映射为 TxPDO 或 RxPDO。 Entry can be mapped as TxPDO or as RxPDO.
Backup	YES/NO	条目是否可以存储在保持性内存中。 Entry can be stored/not stored in non-volatile memory.

8.1.6. 对象字典目录

Object dictionary directory

Index	Name	Object code	CANopen	EtherCAT
<u>0x1000</u>	Device type	VAR	√	√
<u>0x1001</u>	Error register	VAR	√	√
<u>0x1003</u>	Pre-Defined error field	ARRAY	√	√
<u>0x1005</u>	COB-ID SYNC message	VAR	√	×
<u>0x1006</u>	Communication cycle period	VAR	√	×
<u>0x1007</u>	Synchronous window Length	VAR	√	×
<u>0x1008</u>	Manufacturer device name	VAR	√	√
<u>0x1009</u>	Manufacturer hardware version	VAR	√	√
<u>0x100A</u>	Manufacturer software version	VAR	√	√
<u>0x100B</u>	Node-ID	VAR	√	√
<u>0x100C</u>	Guard Time	VAR	√	×
<u>0x100D</u>	Life Time Factor	VAR	√	×
<u>0x1010</u>	Save parameters	ARRAY	√	√
<u>0x1014</u>	COB-ID EMCY	VAR	√	×
<u>0x1016</u>	Consumer heartbeat time	ARRAY	√	×
<u>0x1017</u>	Producer heartbeat time	VAR	√	×
<u>0x1018</u>	Identity object	RECORD	√	√
<u>0x1200</u>	SDO server parameter	RECORD	√	×
<u>0x1400</u>	Receive PDO 1 parameter	RECORD	√	×
<u>0x1401</u>	Receive PDO 2 parameter	RECORD	√	×
<u>0x1402</u>	Receive PDO 3 parameter	RECORD	√	×
<u>0x1403</u>	Receive PDO 4 parameter	RECORD	√	×
<u>0x1600</u>	Receive PDO 1 mapping	RECORD	√	√
<u>0x1601</u>	Receive PDO 2 mapping	RECORD	√	√
<u>0x1602</u>	Receive PDO 3 mapping	RECORD	√	√
<u>0x1603</u>	Receive PDO 4 mapping	RECORD	√	√
<u>0x1800</u>	Transmit PDO 1 parameter	RECORD	√	×
<u>0x1801</u>	Transmit PDO 2 parameter	RECORD	√	×
<u>0x1802</u>	Transmit PDO 3 parameter	RECORD	√	×
<u>0x1803</u>	Transmit PDO 4 parameter	RECORD	√	×



<u>0x1A00</u>	Transmit PDO 1 mapping	RECORD	√	√
<u>0x1A01</u>	Transmit PDO 2 mapping	RECORD	√	√
<u>0x1A02</u>	Transmit PDO 3 mapping	RECORD	√	√
<u>0x1A03</u>	Transmit PDO 4 mapping	RECORD	√	√
<u>0x1C00</u>	SYNC manager communication type	ARRAY	×	√
<u>0x1C12</u>	SYNC manager 2 PDO assignment	ARRAY	×	√
<u>0x1C13</u>	SYNC manager 3 PDO assignment	ARRAY	×	√
<u>0x1C32</u>	SYNC manager 2 parameter	RECORD	×	√
<u>0x1C33</u>	SYNC manager 3 parameter	RECORD	×	√
<u>0x200A</u>	Locked-rotor parameter set	ARRAY	√	√
<u>0x20A0</u>	Load-side encoder position	VAR	√	√
<u>0x2205</u>	Analog input	VAR	√	√
<u>0x2240</u>	Motor encoder position	VAR	√	√
<u>0x2241</u>	Dual encoder difference value	VAR	√	√
<u>0x2242</u>	Reset load side encoder	VAR	√	√
<u>0x22A2</u>	Drive temperature	VAR	√	√
<u>0x2380</u>	Current loop parameter	ARRAY	√	√
<u>0x2381</u>	Velocity loop parameter	ARRAY	√	√
<u>0x2382</u>	Position loop gain	ARRAY	√	√
<u>0x2420</u>	Prepare download	VAR	×	√
<u>0x2421</u>	Hardware version number	VAR	×	√
<u>0x2422</u>	Firmware version number	VAR	×	√
<u>0x2423</u>	Firmware length	VAR	×	√
<u>0x3000</u>	Max integral	VAR	×	√
<u>0x3B59</u>	Velocity offset switch	VAR	×	√
<u>0x3B60</u>	Velocity following error window	VAR	×	√
<u>0x3B61</u>	Soft velocity following error window	VAR	×	√
<u>0x3B62</u>	Soft position following error window	VAR	×	√



<u>0x3B64</u>	Filter 1: Filter window value	VAR	×	√
<u>0x3B67</u>	Soft locked-rotor parameter set	VAR	×	√
<u>0x3B68</u>	Warning code	VAR	×	√
<u>0x3B69</u>	Torque sensor	VAR	√	√
<u>0x3B6A</u>	Torque sensor ratio	VAR	√	√
<u>0x3B6B</u>	Torque mode maximum velocity limit	VAR	√	√
<u>0x3B6C</u>	Feedforward filter coefficient of velocity	VAR	√	√
<u>0x4602</u>	Release brake	VAR	√	√
<u>0x603F</u>	Error code	VAR	√	√
<u>0x6040</u>	Control word	VAR	√	√
<u>0x6041</u>	Status word	VAR	√	√
<u>0x605A</u>	Quick stop option code	VAR	√	√
<u>0x605B</u>	Shutdown option code	VAR	√	√
<u>0x605C</u>	Disable operation option code	VAR	√	√
<u>0x605D</u>	Halt option code	VAR	√	√
<u>0x605E</u>	Fault reaction option code	VAR	√	√
<u>0x6060</u>	Modes of operation	VAR	√	√
<u>0x6061</u>	Modes of operation display	VAR	√	√
<u>0x6062</u>	Position demand value	VAR	√	√
<u>0x6064</u>	Position actual value	VAR	√	√
<u>0x6065</u>	Following error window	VAR	√	√
<u>0x6066</u>	Following error time out	VAR	√	√
<u>0x6067</u>	Position window	VAR	√	√
<u>0x6068</u>	Position window time	VAR	√	√
<u>0x6069</u>	Velocity sensor actual value	VAR	√	√
<u>0x606B</u>	Velocity demand value	VAR	√	√
<u>0x606C</u>	Velocity actual value	VAR	√	√
<u>0x606D</u>	Velocity window	VAR	√	√
<u>0x606E</u>	Velocity window time	VAR	√	√
<u>0x606F</u>	Velocity threshold	VAR	√	√
<u>0x6070</u>	Velocity threshold time	VAR	√	√
<u>0x6071</u>	Target torque	VAR	√	√



<u>0x6072</u>	Max torque	VAR	√	√
<u>0x6073</u>	Max current	VAR	√	√
<u>0x6074</u>	Torque demand value	VAR	√	√
<u>0x6075</u>	Motor rated current	VAR	√	√
<u>0x6076</u>	Motor rated torque	VAR	√	√
<u>0x6077</u>	Torque actual value	VAR	√	√
<u>0x6078</u>	Motor actual current	VAR	√	√
<u>0x6079</u>	DC link circuit voltage	VAR	√	√
<u>0x607A</u>	Target position	VAR	√	√
<u>0x607B</u>	Position range limit	ARRAY	√	√
<u>0x607C</u>	Home offset	ARRAY	√	√
<u>0x607D</u>	Software position limit	ARRAY	√	√
<u>0x607E</u>	Polarity (velocity & position)	ARRAY	×	×
<u>0x607F</u>	Max profile velocity	VAR	√	√
<u>0x6080</u>	Max motor speed	VAR	√	√
<u>0x6081</u>	Profile velocity	VAR	√	√
<u>0x6082</u>	End velocity	VAR	√	√
<u>0x6083</u>	Profile acceleration	VAR	√	√
<u>0x6084</u>	Profile deceleration	VAR	√	√
<u>0x6085</u>	Quick stop deceleration	VAR	√	√
<u>0x6086</u>	Motion profile type	VAR	√	√
<u>0x6087</u>	Torque slope	VAR	√	√
<u>0x6093</u>	Position factor	VAR	×	×
<u>0x6094</u>	Velocity encoder factor	VAR	×	×
<u>0x6095</u>	Velocity factor 1	VAR	×	×
<u>0x6097</u>	Acceleration factor	VAR	×	×
<u>0x6098</u>	Homing method	VAR	×	×
<u>0x6099</u>	Home velocity	VAR	×	×
<u>0x609A</u>	Homing acceleration	VAR	×	×
<u>0x60B0</u>	Position offset	VAR	√	√
<u>0x60B1</u>	Velocity offset	VAR	√	√
<u>0x60B2</u>	Torque offset	VAR	√	√
<u>0x60C0</u>	interpolated position mode	VAR	√	√
<u>0x60C1</u>	interpolated data record	VAR	×	×



<u>0x60C2</u>	interpolated time period	VAR	×	×
<u>0x60C5</u>	Max acceleration	VAR	√	√
<u>0x60C6</u>	Max deceleration	VAR	√	√
<u>0x60E0</u>	Positive torque limit value	VAR	√	√
<u>0x60E1</u>	Negative torque limit value	VAR	√	√
<u>0x60F2</u>	Position option code	VAR	×	×
<u>0x60F4</u>	Following error actual value	VAR	√	√
<u>0x60FC</u>	Position demand value	VAR	√	√
<u>0x60FD</u>	Digital inputs	VAR	√	√
<u>0x60FE</u>	Digital outputs	VAR	√	√
<u>0x60FF</u>	Target velocity	VAR	√	√
<u>0x6502</u>	Supported drive modes	VAR	√	√

8.2 对象字典

Object Dictionary

8.2.1. 0x1000:00h 设备类型 (Device type)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
UDINT	0x00020192	0xFFFFFFFF	0x00000000	\	RO	NO	\	NO

说明：包含有关设备类型和功能信息。它由一个 16 字段设备描述的配置文件编号和另一个 16 位字段的附加说明组成，该对象提供有关设备可选功能的其他信息。

Description: Contains information about the device type and functionality. It is comprised of a 16 bit field that describes the device profile used, and a second 16 bit field that gives additional information about optional functionality of the device.

MSB LSB

Byte4	Byte3	Byte2	Byte1
Additional information		Device profile number	

8.2.2. 0x1001:00h 错误寄存器 (Error register)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
USINT	0x00	0xFF	0x00	\	RO	NO	\	NO

说明：定义了一个 8 位的错误寄存器，寄存器的每个位都定义一种特定的错误类型，如果某一位置 1，则表示发生了相应错误。

Description: A field of 8 bits, each of which indicates a particular type of error. If a bit is set to 1, the specified error has occurred.

Bits	Error
Bit 0	一般性错误 (Generic error)
Bit 1	电流错误 (Current)
Bit 2	电压错误 (Voltage)
Bit 3	温度错误 (Temperature)
Bit 4	通讯错误 (数据溢出、错误) Communication error (overflow, error state)
Bit 5	配置文件错误 (Device profile specific)
Bit 6	保留 (Reserved)
Bit 7	厂商自定义 (Manufacturer specific)

8.2.3. 0x1003:00h 预定义错误字段 (Pre-Defined error field)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
UDINT	0x00000000	0xFFFFFFFF	0x00000000	\	RO	NO	\	NO
说明：保存设备中发生的错误，并通过紧急事件对象发出信号。 Description: Holds errors that occurred in the device and have been signaled via the Emergency object. MSB LSB								
Bits24..31			Bit16... 23			15...0		
Manufacturer-specific error code			Error register			Error code		

8.2.4. 0x1005:00h 同步报文 COB-ID (COB-ID SYNC message)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
UDINT	0x00000080	0xFFFFFFFF	0x00000001	\	RW	NO	\	NO

说明：定义同步对象（SYNC）的 COB-ID。它还定义了设备是否生成 SYNC 报文。该对象的结构如下。

Description: Defines the COB-ID of the synchronization object (SYNC).It also defines whether or not the device generates the SYNC.The structure of the object is as follows.

MSB

LSB

Bits	31	30	29	28-11	10-0
11-bit-ID	x	0/1	0	000000000000000000	11-bit identifier

SYNC COB-ID 描述（Description of SYNC COB-ID entry）

Bits	Value	Meaning
Bit 31(MSB)	x	Do not case
Bit 30	0	Device does not generate SYNC message
	1	Device generate SYNC message
Bit 29	0	12-bit ID（CAN-2.0A）
	1	29-bit ID（CAN-2.0B）
Bit 28-11	0	If bit 29=0
	x	If bit 29=1,bit 28-11 of 29-bit SYNC COB-ID
Bit 10-0	x	Bit 10-0 of SYNC COB-ID

8.2.5. 0x1006:00h 同步循环周期（Communication cycle period）

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
UDINT	0x00000000	0xFFFFFFFF	0x00000000	us	RW	NO	\	NO
说明：这个对象仅与 SYNC 生产者相关，定义了以微秒为单位的同步周期时间间隔，如果设置为 0，则禁用 SYNC 功能。 Description: This object is relevant for SYNC Producers only. This object provides the communication cycle period. This period defines the SYNC interval in microseconds. If the value is set to 0, the transmission of SYNC messages is disabled.								

8.2.6. 0x1007:00h 同步窗口长度（Synchronous window length）

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
UDINT	0x00000000	0xFFFFFFFF	0x00000000	us	RW	NO	\	NO
说明：定义了同步周期时间窗口的长度。 Description: Defines the length of the time window for synchronous messages.								

8.2.7. 0x1008:00h 制造商设备名称（Manufacturer device name）

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
STRING	eDriver-E	\	\	\	RO	NO	\	NO
说明：此对象包含由制造商分配的设备名称，例如“eRob”。 Description: This object contains the manufacturer device name, such as “eRob”.								

8.2.8. 0x1009:00h 制造商硬件版本（Manufacturer hardware version）

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
STRING	HW2070.02.05.01	\	\	\	RO	NO	\	NO
说明：此对象包含由制造商指定的硬件版本号。 Description: This object contains the version number of the manufacturer's hardware.								

8.2.9. 0x100A:00h 制造商软件版本 (Manufacturer software version)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
STRING	3.2.0	\	\	\	RO	NO	\	NO

说明：此对象包含制造商软件的版本号。

Description: This object contains the version identification of the manufacturer's software.

8.2.10. 0x100B:00h 节点 ID 设置 (Node ID)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
USINT	0x01	0x7F	0x00	\	RW	NO	Power restart	NO

说明：此对象包含了 Node ID，如果 Node ID 被修改，只有在发送了重置通信和开始通信的 NMT 报文后，对象才会返回更新的值。

Description: This object contains the Node ID of the drive.If the Node ID is changed, the object will return the updated value only after reset communication and start communication NMT message have been sent.

8.2.11. 0x100C:00h 节点保护时间 (Guard time)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
UINT	0x0000	0xFFFF	0x0000	ms	RW	NO	\	NO

说明：此对象提供从网络主机发送到伺服的节点保护请求的时间。伺服将通过调整伺服内部状态来响应节点保护报文的每个请求。如果未使用，则该值设置为 0。

Description: This object gives the time between node-guarding requests that are sent from the network master to this servo. The servo will respond to each request with a node-guarding message indicating the internal state of the servo. Value is 0 if not used.



8.2.12. 0x100D:00h 寿命因子 (Life time factor)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
USINT	0x00	0xFF	0x00	ms	RW	NO	\	NO

说明：此对象提供节点保护时间的倍数。伺服在保护时间和寿命因子的乘积定义的时间段内收到节点保护请求。如果伺服在此时间段内未收到节点保护请求，则会将此情况视为错误。如果未使用，则该值设置为 0。

Description: This object gives a multiple of the Guard Time. The servo expects to receive a node-guarding request within the time period defined by the product of the guard time and the lifetime factor. If the servo has not received a node-guarding request within this time period, it treats this condition as a fault. Value is 0 if not used.

8.2.13. 0x1010: 01h 保存参数 (Save parameters)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
UDINT	0x00000000	0xFFFFFFFF	0x00000000	\	RW	YES	Immediately	NO

说明：此对象用于将参数保存到非易失性内存中。写入值：0x65766173("save"指令)时保存生效并返回值为 1，等待 3s 后保存完成并返回值为 2，写入其他值无效（返回值为 0）。

注意：保存过程中请勿断电，否则将会导致保存失败甚至参数丢失。

Description: When the value 0x65766173("save" instruction) is written to this object, the save parameter is executed and the return value is 1, about 3sec later, the save is complete and the return value is 2. It is invalid if other values are written (the return value is 0).

Note: Do not power off during the parameter saving. Otherwise, the storage may fail or parameters may be lost.



8.2.14. 0x1014:00h 紧急状态对象 COB-ID (COB-ID EMCY)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
UDINT	0x00000000	0x65766173	0x00000000	\	RW	YES	Immediately	NO

说明：定义紧急状态对象（EMCY）的 COB-ID，该对象的结构如下：

Description: Defines the COB-ID of the Emergency object (EMCY), The structure of the object is as follows:

MSB

LSB

Bits	Bit 31	Bit 30	Bit 29	Bit 28-11	Bit 10-0
11-Bit ID	0/1	0	0	00000000000000000000	11-Bit identifier
29-Bit ID	0/1	0	1	29-Bit identifier	

EMCY COB-ID 说明：

Description of EMCY COB-ID entry:

Bit number	Value	Meaning
Bit 31(MSB)	0	EMCY exists / is valid
	1	EMCY does not exist / is invalid
Bit 30	0	Reserved (always 0)
Bit 29	0	11-bit ID (CAN 2.0A)
	1	29-bit ID (CAN 2.0B)
Bit 28-11	0	If bit 29 = 0
	x	If bit 29 = 1: bits 28 - 11 of 29-bit EMCY COB-ID
Bit 10-0 (LSB)	x	Bits 10 - 0 of EMCY COB-ID

8.2.15. 0x1016 消费者心跳时间 (Consumer heartbeat time)

Name	Index	Object Codes	Highest subindex supported
Consumer heartbeat time	0x1016	ARRAY	1

0x1016:00h 子索引个数 (Number of subindexes)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
USINT	0x01	0x7F	0x01	\	RO	YES	\	NO

说明：子索引的个数

Description: Number of subindexes

0x1016:01h 消费者心跳时间 1 (Consumer heartbeat time 1)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
UDINT	0x00000000	0xFFFFFFFF	0x00000000	ms	RW	YES	\	NO

说明：

1) 此参数包含受监控的节点 ID 和设置的心跳时间两个部分，消费者心跳时间必须大于相应节点的生产者心跳时间（毫秒），一个节点不能设置两个不同的消费者心跳时间，建议消费者心跳时间至少比生产者心跳时间大 2 倍。

2) 在收到第一条心跳报文后开始监视。如果消费者心跳时间为 0，则禁用此功能。

This parameter content is as follows.

Bit31...24	Bit23...16	Bit15...0
Reserved(0)	Node-ID	Heartbeat time

Description:

1) Includes Node-ID and the heartbeat time. The consumer heartbeat time must be longer than the heartbeat producer time (ms) of the corresponding node. Two different consumer time cannot be set for one node. We recommend that the consumer heartbeat time value be at least 2 times larger than the producer's heartbeat time.

2) Monitoring starts after the reception of the first heartbeat. If the consumer heartbeat time is 0, this function is disabled.

8.2.16. 0x1017:00h 生产者心跳时间 (Producer heartbeat time)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
UINT	0x03E8	0xFFFF	0x0000	ms	RW	YES	\	NO

说明：定义心跳的周期时间，它必须是 1ms 的倍数。如果不使用，则为 0。

Description: Defines the cycle time of the heartbeat, which must be a multiple of 1 millisecond. It is 0 if not used.

8.2.17. 0x1018: 设备对象描述 (Identity object)

0x1018:01h 厂商 ID (Vendor ID)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
UDINT	0x5A65726F	0xFFFFFFFF	0x00000000	\	RO	NO	\	NO

说明：包含分配给每个制造商的唯一值。

Description: Contains a unique value allocated each manufacturer.

0x1018:02h 产品代码 (Product code)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
UDINT	0x26483052	0xFFFFFFFF	0x00000000	\	RO	NO	\	NO

说明：标识制造商特定的产品代码（设备版本）。

Description: Identifies the manufacturer specific product code (device version).

0x1018:03h 修订号 (Revision)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
UDINT	0x00020111	0xFFFFFFFF	0x00000000	\	RO	NO	\	NO

说明：包含修订号。

Description: Contains the revision number.

Bits	Meaning
Bit 31-16	主要修订编号 (major revision number)
Bit 15-0	次要修订编号 (minor revision number)

0x1018:04h 序列号 (Serial number)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
UDINT	0x00000000	0xFFFFFFFF	0x00000000	\	RO	NO	\	NO
说明：制造商特定的序列号。 Description: Identifies a manufacturer specific serial number.								

8.2.18. 0x1200：服务器 SDO 参数 (Server SDO parameter)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
UDINT	\	\	\	\	RO	NO	\	NO
说明：包含该设备作为服务器的 SDO 的参数。 Description: Contains the parameters for the SDOs for which the device is the server.								

8.2.19. 0x1400-0x1403：RxPDO 通信参数 (Receive PDO communication parameter)

0x1400-0x1403:00h PDO 映射数量 (the number of PDO parameters)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
USINT	0x03	0x05	0x02	\	RO	YES	ESM changed	NO
说明：定义 PDO 映射数量。 Description: Defines the number of PDO parameters implemented.								

0x1400-0x1403:01h PDO 使用的 COB-ID (COB-ID used by PDO)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
UDINT	0x00000200	0xFFFFFFFF	0x00000001	\	RO	YES	ESM changed	NO
说明：定义 COB-ID。如果设置了第 31 位，则禁用 PDO。 Description: Defines the COB-ID. If bit 31 is set, the PDO is disabled.								

0x1400-0x1403:02h 传输类型 (Transmission type)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
USINT	0xFF	0xFF	0x00	\	RO	YES	ESM changed	NO

说明：此对象控制在接收到新 PDO 的行为，为接收 PDO 定义了以下参数：

Description: This object controls the behavior of the PDO when new data is received. The following codes are defined for receive PDOs:

Code	Behavior
0-240	接收到的 PDO 数据将一直保存直到下一个 SYNC 周期，当 SYNC 报文被接收，之前接收到的 PDO 数据将被应用。 The received data is held until the next SYNC message. When the SYNC message is received the data is applied.
241-253	保留 Reserved.
254-255	接收到的 PDO 数据将立即应用于其映射的对象。 The received data is applied to its mapped objects immediately upon reception.

0x1400-0x1403:03h 停止时间 (Inhibit time)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
UINT	0x0000	0xFFFF	0x0000	100us	RO	YES	ESM changed	NO

说明：对于传输类型 253，PDO 仅在远程传输请求 (RTR) 时进行传输。对于传输类型 255，如果数据改变，则传输 PDO。因此，停止时间定义了一个最小的时间间隔。

Description: With transmission type 253, the PDO is only transmitted on remote transmission request (RTR). With transmission type 255, the PDO is transmitted if the data changes its value. Therefore, the inhibit time defines a minimum interval.

8.2.20. 0x1600-0x161F: RxPDO (Receive process data object)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
UDINT	\	\	\	\	RW	YES	\	NO

说明：包含设备能够接收到的 PDO 映射。

Description: Contains the mapping for the PDOs the device is able to Receive.

8.2.21. 0x1600-0x1603: RxPDO 映射参数 (Receive PDO mapping parameter)

0x1600-0x1603:00h RxPDO 映射个数 (Number of RxPDO maps)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
USINT	0x02	0x06	0x00	\	RO	YES	\	NO

说明：定义映射字典中的有效映射的数量。这个映射的数量也是通过相应的 PDO 接收到的应用程序变量的数量。

Description: Defines the number of valid entries in the mapping record. This number of entries is also the number of the application variables that are received with the corresponding PDO.

0x1600-0x1603:01h 对象字典映射条目 1 (Mapping entry1)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
UDINT	0x60400010	0xFFFFFFFF	0x00000000	\	RO	YES	ESM changed	NO

说明：包含有关已映射的变量的信息。这些条目通过其索引(16 位)、子索引 (8 位) 和数据长度 (8 位) 来描述 PDO 内容。

Description: Contain information about the mapped application variables. These entries describe the PDO contents by their index (16 bit), sub-index (8 bit) and length (8 bit).

0x1600-0x1603:02h 对象字典映射条目 2 (Mapping entry1)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
UDINT	0x60600010	0xFFFFFFFF	0x00000000	\	RO	YES	ESM changed	NO

说明：包含有关已映射的变量的信息。这些条目通过其索引(16 位)、子索引 (8 位) 和数据长度 (8 位) 来描述 PDO 内容。

Description: Contain information about the mapped application variables. These entries describe the PDO contents by their index (16 bit), sub-index (8 bit) and length (8 bit).

0x1600-0x1603:03h-06h 对象字典映射条目 3-6 (Mapping entry3-6)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
UDINT	0x00000000	0xFFFFFFFF	0x00000000	\	RO	YES	ESM changed	NO

说明：包含有关已映射的变量的信息。这些条目通过其索引(16 位)、子索引 (8 位) 和数据长度 (8 位) 来描述 PDO 内容。

Description: Contain information about the mapped application variables. These entries describe

the PDO contents by their index (16 bit), sub-index (8 bit) and length (8 bit).

8.2.22. 0x1800-0x1803:TxPDO 通信参数 (Transmit PDO communication parameter)

0x1800-0x1803:01h PDO 使用的 COB-ID (COB-ID used by PDO)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
UDINT	0x80000180	0xFFFFFFFF	0x00000001	\	RW	NO	ESM changed	NO

说明: COB-ID 存储在此处。对于 PDO 映射 1-4, CAN-ID 是固定的, 具体取决于 node-ID, 并且只能在 COB-ID 中设置有效位 (bit31)。在控制器或通信重新启动之前, COB-ID 更改不会生效。

Description: The COB-ID is stored here. For PDO mappings 1-4, the CAN-ID is fixed depending on the node-ID and only the valid bit (bit 31) can be set in the COB-ID. A COB-ID change does not take effect until the controller or communication is restarted.

0x1800-0x1803:02h 传输类型 (Transmission type)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
USINT	0x01	0xFF	0x00	\	RW	NO	ESM changed	NO

说明: 此对象定义了接收到新 PDO 的行为, 为接收 PDO 定义了以下参数:

Description: This object controls the behavior of the PDO when new data is received. The following codes are defined for receive PDOs:

Code	Behavior
0-240	接收到的 PDO 数据将一直保存直到下一个 SYNC 周期, 当 SYNC 报文被接收, 之前接收到的 PDO 数据将被应用。 The received data is held until the next SYNC message. When the SYNC message is received the data is applied.
241-253	保留 Reserved.
254-255	接收到的 PDO 数据将立即应用于其映射的对象。 The received data is applied to its mapped objects immediately upon reception.

0x1800-0x1803:03h 停止时间（Inhibit time）

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
UINT	0x03E8	0xFFFF	0x0000	100us	RW	NO	ESM changed	NO

说明：对于传输类型 253，PDO 仅在远程传输请求（RTR）时进行传输。对于传输类型 255，如果数据改变，则传输 PDO。因此，停止时间定义了一个最小的时间间隔。

Description: With transmission type 253, the PDO is only transmitted on remote transmission request (RTR). With transmission type 255, the PDO is transmitted if the data changes its value. Therefore, the inhibit time defines a minimum interval.

0x1800-0x1803:04h 保留（reserved）

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
USINT	0x01	0xFF	0x00	\	RO	NO	ESM changed	NO

说明：此子索引没有功能，仅出于兼容性原因而存在。

Description: This subindex has no function and exists only for compatibility reasons.

0x1800-0x1803:05h 事件定时器（Event timer）

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
UINT	0x0001	0xFFFF	0x0000	ms	RW	NO	ESM changed	NO

说明：此时间（以毫秒为单位）可用于触发处理数据复制和 PDO 发送的事件。

Description: This time (in ms) can be used to trigger an Event which handles the copying of the data and the sending of the PDO.

8.2.23. 0x1A00-0x1A1F:TxPDO（Transmit process data object）

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
UDINT	\	\	\	\	RW	YES	\	NO

说明：包含设备能够发送的 PDO 映射。

Description: Contains the mapping for the PDOs the device is able to transmit.



8.2.24. 0x1A00-0x1A03:TxPDO 映射参数(Transmit PDO mapping parameter)

0x1A00-0x1A03:00h TxPDO 映射个数 (Number of TxPDO maps)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
USINT	0x03	0x06	0x00	\	RO	YES	ESM changed	NO

说明：定义映射对象中有效条目的数量。这个条目的数量也是相应的 PDO 发送到应用程序变量的数量。

Description: Defines the number of valid entries in the mapping record. This number of entries is also the number of the application variables that are transmitted with the corresponding PDO.

0x1A00-0x1A03:01h 对象字典映射条目 1 (Mapping entry1)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
UDINT	0x60410010	0xFFFFFFFF	0x00000000	\	RO	YES	ESM changed	NO

说明：包含有关已映射的应用程序变量的信息。这些条目通过其索引、子索引和长度来描述 PDO 的内容。

Description: Contain information about the mapped application variables. These entries describe the PDO contents by their index, sub-index and length.

0x1A00-0x1A03:02h-04h 对象字典映射条目 2-4 (Mapping entry2-4)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
UDINT	0x00000000	0xFFFFFFFF	0x00000000	\	RO	YES	ESM changed	NO

说明：包含有关已映射的应用程序变量的信息。这些条目通过其索引、子索引和长度来描述 PDO 的内容。

Description: Contain information about the mapped application variables. These entries describe the PDO contents by their index, sub-index and length.

8.2.25. 0x1C00:00h SYNC 通信类型 (SYNC manager communication type)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
USINT	0x04	0x12	0x00	\	RO	NO	\	NO

说明：默认参数配置如下：

Description: The default configuration is the following:

Value	default configuration
1	邮箱接收 (Mailbox receive)
2	邮箱发送 (Mailbox send)
3	过程数据输出 (Process data output)
4	过程数据输入 (Process data input)

8.2.26. 0x1C12:00h SM2 PDO 分配 (SYNC manager 2 PDO assignment)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
REC	0x04	0x04	0x00	\	RW	YES	ESM changed	NO

说明：当收到 PDO 报文时，通过 PDO 报文传递的数据（最多 8 个字节）用于更新映射到 PDO 的对象。

Description: When a PDO message is received, the data passed with the PDO message (up to 8 bytes) is used to update the objects mapped to the PDO.

8.2.27. 0x1C13h:00h SM3 PDO 分配 (SYNC manager 3 PDO assignment)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
REC	0x04	0x04	0x00	\	RW	YES	ESM changed	NO

说明：当收到 PDO 报文时，通过 PDO 报文传递的数据（最多 8 个字节）用于更新映射到 PDO 的对象。

Description: When a PDO message is received, the data passed with the PDO message (up to 8 bytes) is used to update the objects mapped to the PDO.

8.2.28. 0x1C32:SM2 参数 (Sync manager 2 parameter)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
UDINT	\	\	\	\	RO	NO	\	NO
说明: DC 同步模式设置对象 0x1C32: 01h=0x2; 周期同步时间设置对象 0x1C32: 0Ah (单位为 ns, 推荐设置 1ms 或 2ms)。 Description: DC Synchronization Mode setting object 0x1C32:01h=0x2; Setting object 0x1C32:0Ah (The units are ns, with a recommended setting of 1ms or 2ms).								

0x1C32:01h 同步类型 (Synchronization type)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
UINT	0x0002	0x0003	0x0000	\	RW	NO	ESM changed	NO
说明 Description:								
Value		Operate mode						
0x00		Free run						
0x01		SM2 Sync						
0x02		DC Mode, Synchron with SYNC0 event						
0x03		DC Mode, Synchron with SYNC1 event						

0x1C32:02h 循环周期 (Cycle time)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
UDINT	0x00000000	0xFFFFFFFF	0x00000000	ns	RO	NO	\	NO
说明: 显示输入参数的循环时间。在 Sync Manager 同步模式下, 测量该值, 而在 DC 同步模式下, 该值从 Sync0 周期时间寄存器中获取。以[ns]为单位给出。 Description: Displays the cycle time of the input parameters. In Sync Manager synchronous mode, the value is measured while in Distributed Clock synchronous mode, the value is taken from the Sync0 cycle time register. The value is given in [ns].								



0x1C32:03h 轮换时间（Shift time）

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
UINT	0x0000	0xFFFF	0x0000	ns	RO	NO	\	NO

说明：硬件输出的有效操作与相关事件之间的时间。

Description: Time between hardware output effective operation and related event.

0x1C32:04h 支持的同步类型（Synchronization types supported）

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
UINT	0x0005	0xFFFF	0x0000	\	RO	NO	\	NO

说明：显示输出参数所支持的同步类型

Description: Displays the supported synchronization modes of the output parameters.

Bit	Description
0	FreeRun supported 0:Un-supported 1:FreeRun Mode support
1	SyncManager Synchronous Support 0:Un-supported 1: SyncManager
2-4	DC Type Support 000:Un-supported 001: DC SYNC0 Event Sync Support 010: DC SYNC1 Event Sync Support 100: Synchronization by Slave Application Cycle
5-6	Out Shift Support 00:Un-supported 01:Shift Support to Local Timer 10: Shift Support to SYNC1
7-15	Reserved

注：匹配 X3071220X 版本及以上固件。

Note:Match firmware the X3071220X version and above.



0x1C32:05h 最小周期时间 (Minimum cycle time)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
UDINT	0x00000000	0xFFFFFFFF	0x00000000	ns	RO	NO	\	NO

说明：从站支持的最小周期时间。（本地循环最大时间）

Description: The minimum cycle time is supported by slave. (Maximum time of local cycle)

0x1C32:06h 计算和复制时间 (Calc and copy time)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
UDINT	0x000003E8	0xFFFFFFFF	0x00000000	ns	RO	NO	\	NO

说明：应用控制器将数据从同步管理器复制到本地内存以及在必要时执行计算所需的时间。该值以 ns 为单位给出。

Description: The time needed by the application controller to copy the process data from the Sync Manager to the local memory and to perform calculations, if necessary, before the data is sent to the process. The value is given in [ns].

0x1C32:08h 循环时间采集 (Get cycle time)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
UINT	0x0000	0x0001	0x0000	\	RW	NO	\	NO

说明：循环时间采集

0：停止本地循环时间测量；

1：开始进行本地循环时间测量。

Description: Get Cycle Time

0:Stops local cycle time measurement;

1:Starts local cycle time measurement.

0x1C32:09h 延时时间 (Delay time)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
UDINT	0x000003E8	0xFFFFFFFF	0x00000000	ns	RO	NO	\	NO

说明：从站的硬件延迟时间。从接收触发器（Sync0 或 Sync1 事件）到驱动输出值到它们在进程中生效的时间，该值以 ns 为单位给出。

Description: The hardware delay time of the slave. The time from receiving the trigger (Sync0 or



Sync1 Event) to drive output values to the time until they become valid in the process. The value is given in [ns].

0x1C32:0Ah Sync 循环周期 (Sync0 cycle time)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
UDINT	0x000003E8	0xFFFFFFFF	0x00000000	ns	RO	NO	\	NO

说明：当应用需要 SYNC 固定周期时间时，它是两个 Sync 信号之间的时间。

Description: When SYNC fixed cycle time is required of application, it is the time between two Sync0 signals.

0x1C32:0Bh SM 事件丢失 (SM-event missed)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
UINT	0x0000	0xFFFF	0x0000		RO	NO	\	NO

说明：当应用程序需要 SM 事件且无法接收它时，此错误计数器将递增。因此，可能无法再复制之前数据。

Description: This error counter is incremented when application demands SM event and cannot receive it. As a result, data may be unable to be copied any more.

0x1C32:0Ch 短循环周期 (Cycle time short)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
UINT	0x0000	0xFFFF	0x0000		RO	NO	\	NO

说明：当循环时间太短，因为本地周期无法完成或下一个 SM 事件无法准备输入数据时，此错误计数器就会增加。

Description: This error counter is incremented when cycle time is too short as local cycle cannot be completed or input data cannot prepare by the next SM event.

0x1C32:20h 同步错误 (Sync error)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
Bool	0x00	0x01	0x00		RO	NO	\	NO

说明：显示同步错误信息。

Description: Displays the sync error information.

8.2.29. 0x1C33: SM3 参数 (Sync manager 3 parameter)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
UDINT	\	\	\	\	RO	NO	\	NO
说明: DC 同步模式设置对象 0x1C33: 01h=0x2。 Description: DC synchronization mode setting object 0x1C33:01h=0x2.								

0x1C33:01h 同步类型 (Synchronization type)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
UINT	0x00002	0x0003	0x0000	\	RW	NO	ESM changed	NO
说明 Description:								
Value		Operate mode						
0x00		Free run						
0x01		Reserved						
0x02		DC Mode SYNC0						
0x03		DC Mode SYNC1						
0x04-0x21		Reserved						
0x22		SM2 Event Synchronization (When output is transmitted by Safe-OP and OP						

0x1C33:02h 循环周期 (Cycle time)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
UDINT	0x00000000	0xFFFFFFFF	0x00000000	ns	RO	NO	\	NO
说明: 显示输入参数的循环时间。在 Sync Manager synchronous 同步模式下, 测量该值, 而在 DC 同步模式下, 该值从 Sync0 周期时间寄存器中获取。以 [ns] 为单位给出。 Description: Displays the cycle time of the input parameters. In Sync Manager synchronous mode, the value is measured while in Distributed Clock synchronous mode, the value is taken from the Sync0 cycle time register. The value is given in [ns].								



0x1C33:03h 轮换时间 (Shift time)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
UINT	0x0000	0xFFFF	0x0000		RO	NO	\	NO

说明：硬件输出的有效操作与相关事件之间的时间。

Description: Time between hardware output effective operation and related event.

0x1C33:04h 支持的同步类型 (Synchronization types supported)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
UINT	0x0005	0xFFFF	0x0000	\	RO	NO	\	NO

说明：显示输出参数所支持的同步类型

Description: Displays the supported synchronization modes of the output parameters

Bit	Description
0	FreeRun supported 0:Un-supported 1:FreeRun Mode support
1	SyncManager Synchronous Support 0:Un-supported 1: SyncManager
2-4	DC Type Support 000:Un-supported 001: DC SYNC0 Event Sync Support 010: DC SYNC1 Event Sync Support 100: Synchronization by Slave Application Cycle
5-6	Out Shift Support 00:Un-supported 01:Shift Support to Local Timer 10: Shift Support to SYNC1
7-15	Reserved

注：匹配 X3071220X 版本及以上固件。

Note:Match firmware the X3071220X version and above.



0x1C33:05h 最小循环时间 (Minimum cycle time)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
UDINT	0x00000000	0xFFFFFFFF	0x00000000	ns	RO	NO	\	NO

说明：从站支持的最小循环时间（本地循环最大时间）

Description: The minimum cycle time is supported by slave. (Maximum time of local cycle)

0x1C33:06h 计算和复制时间 (Calc and copy time)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
UDINT	0x000003E8	0xFFFFFFFF	0x00000000	ns	RO	NO	\	NO

说明：应用控制器将数据从同步管理器复制到本地内存以及在必要时执行计算所需的时间。该值以 ns 为单位给出。

Description: The time needed by the application controller to copy the process data from the Sync Manager to the local memory and to perform calculations, if necessary, before the data is sent to the process. The value is given in [ns].

0x1C33:08h 循环时间采集 (Get cycle time)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
UINT	0x0000	0x0001	0x0000	\	RW	NO	\	NO

说明：循环时间采集

0: 停止本地循环时间测量；

1: 开始进行本地循环时间测量。

Description: Get Cycle Time

0:Stops local cycle time measurement;

1:Starts local cycle time measurement.

0x1C33:09h 延时时间 (Delay time)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
UDINT	0x000003E8	0xFFFFFFFF	0x00000000	ns	RO	NO	\	NO

说明：从站的硬件延迟时间。从接收触发器（Sync0 或 Sync1 事件）到驱动输出值到它们在进程中生效的时间，该值以 ns 为单位给出。

Description: The hardware delay time of the slave. The time from receiving the trigger (Sync0 or



Sync1 Event) to drive output values to the time until they become valid in the process. The value is given in [ns].

0x1C33:0Ah Sync0 循环周期 (Sync0 cycle time)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
UDINT32	0x000003E8	0xFFFFFFFF	0x00000000	ns	RO	NO	\	NO

说明：当应用需要 SYNC0 固定周期时间时，它是两个 Sync0 信号之间的时间。

Description: When SYNC0 fixed cycle time is required of application, it is the time between two Sync0 signals.

0x1C33:0Bh SM 事件丢失 (SM-event missed)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
UINT	0x0000	0xFFFF	0x0000	\	RO	NO	\	NO

说明：当应用程序需要 SM 事件且无法接收它时，此错误计数器将递增。因此，可能无法再复制之前数据。

Description: This error counter is incremented when application demands SM event and cannot receive it. As a result, data may be unable to be copied any more.

0x1C33:0Ch 短循环周期 (Cycle time short)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
UINT	0x0000	0xFFFF	0x0000	\	RO	NO	\	NO

说明：当循环时间太短，因为本地周期无法完成或下一个 SM 事件无法准备输入数据时，此错误计数器就会增加。

Description: This error counter is incremented when cycle time is too short as local cycle cannot be completed or input data cannot prepare by the next SM event.

0x1C33:20h 同步错误 (Sync error)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
Bool	0x00	0x01	0x00	\	RO	NO	\	NO

说明：显示同步错误信息。

Description: Displays the sync error information.

8.2.30. 0x200A: 堵转参数设置 (Locked-rotor parameter set)

0x200A:01h 电机堵转电流 (Motor locked-rotor current)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
UDINT	0x00000000	0xFFFFFFFF	0x00000000	mA	RW	YES	Immediately	NO

说明：对应上位机堵转保护界面：堵转电流

ECAT 读取值=上位机设定值×电机持续电流，例如：电机持续电流 5000mA，上位机设定堵转电流为 120%，则 ECAT 读取堵转电流为 5000×120%=6000mA。

Description: Corresponding to Struck Protection interface of controller: “Struck Current”

ECAT reading value = controller set value× motor continuous current, for example: motor continuous current 5000mA, upper set blocking current is 120%, ECAT read blocking current is 5000×120%=6000mA.

0x200A:02h 电机堵转时间 (Motor locked-rotor time)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
UDINT	0x00004E20	0xFFFFFFFF	0x00000000	0.05 ms	RW	YES	Immediately	NO

说明：对应上位机堵转保护界面：堵转时间。

ECAT 读取值=上位机设定值×20，例如：上位机设定堵转时间为 1000ms，则 ECAT 读取堵转时间为 1000×20=20000。

Description: Corresponding to Struck Protection interface of controller: Struck time.

ECAT read value = controller set value ×20, for example, upper computer set blocking time is 1000ms, then ECAT read blocking time is 1000×20=20000.

0x200A:03h 电机堵转速度 (Motor locked-rotor speed)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
UDINT	0x0000020C	0xFFFFFFFF	0x00000000	plus/s	RW	YES	Immediately	NO

说明：对应上位机堵转保护界面：堵转转速。

Description: Corresponding to Struck Protection interface of controller: Struck speed.

8.2.31. 0x20A0:00h 负载端编码器位置 (Load-side encoder position)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
DINT	0x00000000	0xFFFFFFFF	0x00000000	plus	RO	NO	\	TxPDO

说明：此对象表示负载端编码器反馈的位置实际值。

Description: This object represents the position actual value of the load-side encoder position feedback.

8.2.32. 0x2205:00h 模拟输入 (Analog input)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
INT	0x0004	0x2710	0xFC18	mV	RO	NO	\	TxPDO

说明：输入范围：-10000~10000mV。

Description: Input range: -10000~10000mV.

8.2.33. 0x2240:00h 电机编码器位置 (Motor encoder position)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
DINT	\	0x7FFFFFFF	0x80000000	plus	RO	NO	\	TxPDO

说明：不断电时为累计多圈位置反馈，断电重启后恢复单圈位置反馈。

Description: When the power is uninterrupted, it is accumulated multi-turn position feedback, and the single-turn position feedback is restored after the power is restarted.

8.2.34. 0x2241:00h 双编码器差值 (Dual encoder difference value)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
DINT	\	\	\	plus	RO	NO	\	TxPDO

说明：负载端折算至电机端的编码器反馈位置的差值，该值可以反映出减速机的弹性形变。

Description: The difference between the load side and the encoder feedback position at the motor end reflects the elastic deformation of the gear unit.

8.2.35. 0x2242:00h 重置负载端编码器（Reset load side encoder）

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
UINT	0x0000	0x0001	0x0000	\	RW	YES	Immediately	NO

说明：当发生多圈电池相关报警时（单圈型号的关节无此报警），排除故障后，写 1 重置负载端编码器并清除报警。请注意：若其他情况发送此命令，将会清除编码器多圈值。

Description: When a multi-turn battery-related alarm occurs (the joint of the single-turn model does not have this alarm), after troubleshooting, write 1 to reset the load-side encoder and clear the alarm. Note that sending this command in other cases will clear the encoder multiturn value.

8.2.36. 0x22A2:00h 驱动温度（Drive temperature）

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
UINT	\	0x0096	0xFFD8	°C	RO	NO	\	NO

说明：感应温度范围-40~150°C，工作温度范围-30~60°C，在上位机安全电源界面设置最高工作温度保护值，超出保护值则报警停机。

Description: Induction temperature range -40~150°C, working temperature range -30~60°C, set the maximum working temperature protection value in the safety power interface of the controller, and alarm shutdown if the protection value is exceeded.

8.2.37. 0x2380:电流环参数（Current loop parameter）

0x2380:01h 电流环增益（Current loop gain）

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
UINT	\	0xFFFF	0x0000	\	RW	NO	\	NO

说明：电流环增益乘以当前的电流误差值。电流误差是期望电流与实际电流的差。

Description: This gain value is multiplied by the current error value. The current error is the difference between the desired current and the actual current.

0x2380:02h 电流环积分 (Current loop integral)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
UINT	\	0xFFFF	0x0000	\	RW	NO	\	NO

说明：电流环积分乘以电流误差的积分。
Description: This gain value is multiplied by the integral of current error.

8.2.38. 0x2381: 速度环参数 (Velocity loop parameter)

0x2381:01h 速度环增益 (Velocity loop gain)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
UINT	\	0xFFFF	0x0000	\	RW	YES	Immediately	NO

说明：速度环增益乘以速度回路误差，速度回路误差是期望电机速度和实际电机速度之间的差。
Description: This gain value is multiplied by the velocity loop error. The velocity loop error is the difference between the desired and actual motor speed.

0x2381:02h 速度环积分 (Velocity loop integral)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
UINT	\	0xFFFF	0x0000	\	RW	YES	Immediately	NO

说明：这个增益值乘以速度回路误差的积分。
Description: This gain value is multiplied by the integral of the velocity loop error.

8.2.39. 0x2382:01h 位置环增益 (Position loop gain)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
UINT	\	0xFFFF	0x0000	\	RW	YES	Immediately	NO

说明：此增益值乘以位置回路误差。位置循环误差是位置需求值指数 0x6062 和位置实际值指数 0x6064 之间的差值。
Description: This gain value is multiplied by the position loop error. The position loop error is the difference between the Position Demand Value - Index 0x6062 and the Position Actual Value - Index 0x6064 .



8.2.40. 0x2382-03 速度前馈增益 (Velocity Feed Forward Gain)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
UINT	0x4000	0xFFFF	0x0000	\	RW	YES	Immediately	NO

说明：此增益按 1/16384 进行标定。因此，将此增益设置为 0x4000（16384）表示目标位置的微分计算的速度乘以 1.0（100%），并将结果添加到位置环路的输出中（如图 5-1 全闭环位置控制框图所示）。另外也可通过 eTuner_V13.72 上位机软件的 PID 设置界面读写速度前馈增益。

Description: This gain is scaled by 1/16384. Therefore, setting this gain to 0x4000 (16384) would cause the input velocity to be multiplied by 1.0 (100%), and the result added to the output of the position loop (The closed-loop position control block diagram shown in Figure 5-1 is as follows)。In addition, Velocity Feed Forward can also be read and written through the PID settings interface of the eTuner_V13.72 PC software.

8.2.41. 0x2383 使用总线调节 PID (Bus regulation of PID)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
UDINT	0x0000	0x0001	0x0000	\	RW	YES	Immediately	NO

说明：动态修改 PID 参数（2381h: 01h（速度环增益）、2381h: 02h（速度环积分）、2382h:01h（位置环增益））的开关变量,设置为 1 时开启总线修改 PID 参数，设置为 0 时关闭总线修改 PID 参数。

Description: Dynamic modification of PID parameters (2381h:01h (velocity loop gain), 2381h:02h (velocity loop integral), 2382h:01h (position loop gain)) switch variable. Setting it to 1 enables bus modification of PID parameters, while setting it to 0 disables bus modification of PID parameters.

8.2.42. 0x2420:00h 准备下载 (Prepare download)

Data	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO
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type								mapping
UDINT	0x00000000	0x00000001	0x00000000	\	RW	YES	Immediately	NO
说明 Description:								
Value		meaning						
0		默认值 (Default data)						
1		准备下载 (Prepare download)						

8.2.43. 0x2421:00h 硬件版本号 (Hardware version number)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
UDINT	0x00000000	0xFFFFFFFF	0x00000000	\	RW	YES	Immediately	NO
说明：对应上位机连接界面：硬件版本号。 Description: Corresponding to the controller connection interface: hardware version number.								
Value		Hardware version						
1001		2837x						
1002		2838x						

8.2.44. 0x2422:00h 伺服固件版本号 (Firmware version number)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
DINT	\	0x7FFFFFFF	0x80000000	\	RO	NO	\	NO
说明：伺服固件版本号。 Description: Firmware version number (extended).								

8.2.45. 0x2423:00h 固件长度 (Firmware length)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
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UDINT	0x00000000	0xFFFFFFFF	0x00000000	Bits	RW	YES	Immediately	NO
说明：定义伺服固件的长度。 Description: Defines the length of the servo firmware.								

8.2.46. 0x3000:00h 积分上限 (Max integral)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
UDINT	0x00001F40	0x00001F40	0x00000000	mA	RW	YES	Immediately	NO
说明：设置速度环积分上限值，如设置为 0，则速度环积分作用消除。 Description: Set the upper limit value of velocity ring integration, if it is set to 0, the velocity ring integration effect is eliminated.								

8.2.47. 0x3B60:00h 速度跟随误差窗口 (Velocity following error window)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
UDINT	0x0000A410	0xFFFFFFFF	0x00000000	plus/s	RW	YES	Immediately	NO
说明：对应上位机安全速度界面：最大允许速度误差。 Description: Corresponding to the safe speed interface of the controller: max motor speed error.								

8.2.48. 0x3B61:00h 软速度跟随误差窗口 (Soft velocity following error window)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
UDINT	0x00000000	0xFFFFFFFF	0x00000000	plus/s	RW	YES	Immediately	NO
说明：对应上位机安全速度界面：软速度误差。 Description: Corresponding to the safe speed interface of the controller: soft speed error.								



8.2.49. 0x3B62:00h 软位置跟随误差窗口 (Soft position following error window)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
UDINT	0x00000000	0xFFFFFFFF	0x00000000	plus	RW	YES	Immediately	NO

说明：对应上位机位置保护界面：软位置误差。

Description: Corresponding to pos limit interface of the controller: soft pos error.

8.2.50. 0x3B63:00h 警告清除 (Clear the warning)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
UDINT	0x00000000	0x00000001	0x00000000	-	RW	NO	Immediately	NO

说明：写 1 时清除警告代码与状态字的警告位 (bit7)

Description: Clear the warning bit (bit 7) in the warning code and status word when writing 1.

8.2.51. 0x3B64:00h 滤波器 1：滤波窗口值 (Filter 1: Filter window value)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
UDINT	0x00000000	0xFFFFFFFF	0x00000000	\	RW	YES	Immediately	NO

说明：值为 0~8, 当值为 0 时关闭此滤波器功能。

Description: The value is 0~8, when the value is 0, turn off this filter function.



8.2.52. 0x3B67: 软堵转参数设置 (Soft motor locked-rotor parameter set)

0x3B67:01h 软堵转电流 (Soft motor locked-rotor current)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
UDINT	\	0xFFFFFFFF	0x00000000	mA	RW	YES	Immediately	NO

说明：对应上位机堵转保护界面：软堵转电流，

ECAT 读取值=上位机设定值×电机持续电流，例如：电机持续电流 5000mA，上位机设定堵转电流为 90%，则 ECAT 读取堵转电流为 5000×90%=4500mA。

Description:Corresponding to Struck Protection interface of controller: soft struck current,

ECAT reading value = controller setting value× motor continuous current, for example: motor continuous current 5000mA, upper computer set stall current is 90%, then ECAT read stall current is 5000×90% = 4500mA.

0x3B67:02h 软堵转时间 (Soft motor locked-rotor time)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
UDINT	0x00004E20	0xFFFFFFFF	0x00000000	0.05ms	RW	YES	Immediately	NO

说明：对应上位机堵转保护界面：软堵转时间，

ECAT 读取值=上位机设定值×20，例如：上位机设定堵转时间为 500ms，则 ECAT 读取堵转时间为 500×20=10000。

Description: Corresponding to Struck Protection interface of controller: soft struck time,

ECAT reading value = upper computer set value ×20, for example, if the upper computer sets the stall time to 500ms, the ECAT read stall time is 500×20=10000.

0x3B67:03h 软堵转速度 (Soft motor locked-rotor velocity)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
UDINT	0x0000020C	0xFFFFFFFF	0x00000000	plus/s	RW	YES	Immediately	NO

说明：对应上位机堵转保护界面：软堵转转速。

Description: Corresponding to Struck Protection interface of controller: soft struck speed.

8.2.53. 0x3B68:00h 警告代码 (Warning code)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
UDINT	0x00000000	0xFFFFFFFF	0x00000000	\	RO	NO	\	TxPDO

说明：警告信息写入 0x3B68 中，定义代码如下：

Description: The warning message is written to 0x3B68, and the definition code is as follows:

警告信息 (The warning message)	定义代码 (definition code)
软速度误差警告 (Soft velocity error warning)	0xFF00
软位置误差警告 (Soft position error warning)	0xFF01
软堵转保护警告 (Soft locked-rotor protection warning)	0xFF02

8.2.54. 0x3B69:00h 扭矩传感器值 (Torque sensor)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
DINT	0x00000000	0xFFFFFFFF	0x00000000	mN·m	RO	NO	\	TxPDO

说明：此对象仅带扭矩传感器的关节型号支持。

Description: This object is only supported for joint models with torque transducers.

8.2.55. 0x3B6A:00h 扭矩传感器比率 (Torque sensor ratio)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
INT	0x00000000	0x7FFFFFFF	0x80000000	0.1%	RO	NO	\	TxPDO

说明：以额定扭矩千分比给出：0x3B69 实际扭矩 (mN·m) = 0x3B6A 值 * 0x6076 值 / 1000。

Description: The value of this object is given in per thousand of rated torque: 0x3B69 actual sensor (mN·m) = 0x3B6A value * 0x6076 value / 1000.

8.2.56. 0x3B6B:00h 扭矩模式最大速度限制 (Torque mode maximum velocity limit)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
DINT	0x00000000	0x00000040	0x00000000	/	RO	YES	\	NO

说明：对应上位机堵转保护界面：“最大速度限制”。

Description: Corresponding to Struck Protection interface of controller: “max speed limit”.



8.2.57. 0x3B6C:00h 速度前馈滤波系数 (Feedforward filter coefficient of velocity)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
DINT	0x00000005	0x00000040	0x00000000	/	RO	YES	\	NO

说明: 对速度前馈进行一阶低通滤波, 计算公式如下所示, 其中 $X(n)$ 代表的是速度前馈, $Y(n)$ 代表的是经过一阶低通滤波之后的值, $Velffwfilt$ 代表速度前馈滤波系数。

$$Y(n) = (Velffwfilt * X(n) + (64 - Velffwfilt)Y(n-1)) >> 6$$

$Velffwfilt$ is 0x3B6C, Value is 0~64

Description: Apply a first-order low-pass filter to the feedforward velocity using the following formula: $X(n)$ represents the feedforward velocity, $Y(n)$ represents the value after the first-order low-pass filtering, and $Velffwfilt$ represents the feedforward filter coefficient.

8.2.58. 0x4602:00h 释放刹车 (Release brake)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
UDINT	0x00000000	0x00000010	0x00000000	\	RW	YES	Immediately	NO

Value	Meaning
0	启用刹车: 制动器 (如果有配置) 将闭合 (制动状态)。 Enable Brake: The brake (if equipped) will engage(braking state) .
1	释放刹车: 制动器 (如果有配置) 将释放 (非制动状态)。 Release brake: The brake(if equipped) will disengage(non-braking state) .

说明: 此对象用于单独控制刹车状态。主站控制器通过控制字 (0x6040) 对 eRob 关节模组 (从站) 上使能或下使能时, 由 eRob 关节模组内部自动控制刹车状态, 不需要使用此对象。

注意: 不可在使能状态下操作此命令, 确保在停机且非使能状态下进行释放刹车的操作。操作释放刹车后制动器松开, 此时无制动力矩, 如果关节输出端有负载重力扭矩将无法保持位置锁定状态, 请务必先扶住负载或卸下部分负载后再操作释放刹车, 以防止掉落。

Description: This object is used to individually control the brake status. When the master controller enables or disables the eRob module (slave) through the control word (0x6040), the braking status is automatically controlled within the eRob module, and this object is not required to use.

Note: This command cannot be operated in the enabled state.Ensure that the machine is stopped and the motor is not enabled before performing the brake release operation. After releasing the brake, the braking force is disengaged, and there is no braking torque. If there is a load gravity torque at the output end of the joint, it will not be able to maintain the position lock state. Please make sure to support the load or unload part of the load before releasing the brake to prevent it from falling.

8.2.59. 0x603F:00h 错误代码 (Error code)

Data type	Default data	Max data	Min data	unit	Access	Backup	Update	PDO mapping
UINT	0x0000	0xFFFF	0x0000	\	RO	NO	\	TxPDO

说明：提供在驱动器中发生的最后一个错误的错误代码。

Description: Provides the error code of the last error that occurred in the drive.

8.2.60. 0x6040:00h 控制字 (Control word)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
UINT	0x0000	0xFFFF	0x0000	\	RW	YES	Immediately	RxPDO

说明：通过设置状态机的状态和模式来控制 CiA-402 FSA、CiA-402 模式和 eRob 关节模组。

此对象按位控制的。这些位有如下定义：

Description:Used to control the CiA-402 FSA, CiA-402 modes and eRob.Sets the operating states and modes of the state machine. This object is organized bit-wise. The bits have the following meaning.

Bit	Meaning
Bit0	伺服使能 (Switch on)
Bit1	接通主回路电 (Enable voltage)
Bit2	快速停机 (Quick stop)
Bit3	伺服运行 (Operation enable)
Bit4-6	特定的运行模式 (Mode specific)
Bit7	故障复位 (Fault reset)
Bit8	停止 (Halt)
Bit9	特定的运行模式 (Mode specific)
Bit10	保留 (Reserved)
Bit11-15	厂家自定义 (Manufacturer specific)

8.2.61. 0x605A:00h 快速停止选项代码 (Quick stop option code)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
INT	0x0002	0x7FFF	0x0000	\	RW	NO	Immediately	NO

说明：此对象决定在执行快速停止功能时要采取的操作。在两种情况下确定快速停机：

- 1) 主站服务器请求从伺服运行状态切换到快速停机状态。
- 2) 由中止选项代码定义的通信错误，导致状态机从伺服运行状态切换到快速停机状态。

Description: This object determines the action to take if the quick stop function is executed. Quick stop is determined in two cases:

- 1) Request from the master to switch from operation enable to quick stop state.
- 2) A communication error which is defined by the abort option code causing an auto stated machine transition from operation Enable to quick stop .

8.2.62. 0x6041:00h 状态字 (Status word)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
UINT	0x0000	0xFFFF	0x0000	\	RO	NO	\	TxPDO

说明：指示 FSA 的当前状态、运行模式。

此对象按位反馈的。这些位具有以下含义：

Description: Indicates the current state of the FSA, the operation mode.

This object is organized bit-wise. The bits have the following meaning:

Bit	Meaning
Bit0	准备打开伺服使能 (Ready to switch on)
Bit1	伺服使能 (Switched on)
Bit2	伺服运行 (Operation enabled)
Bit3	故障 (Fault)
Bit4	接通主回路电 (Voltage enabled)
Bit5	快速停机 (Quick stop)
Bit6	伺服无故障 (Switch on disabled)
Bit7	警告 (Warning)
Bit8	厂家自定义 (Manufacturer specific)
Bit9	远程控制 (Remote)

Bit10	目标到达 (Target reached)
Bit11	软件内部限制超限 (Internal limit active)
Bit12-13	特定的运行模式 (Operation mode specific)
Bit14-15	厂家自定义 (Manufacturer specific)

8.2.63. 0x605B:00h 关机代码 (Shutdown option code)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
INT	0x0000	0xFFFF	0x0000	\	RW	NO	\	NO
说明：此参数确定在过渡时应采取的操作：伺服运行 => 准备使能，这些值有如下定义。 Description: This parameter determines which action should be taken in case of the transition: operation enable => ready to stwitch on, The following values are defined:								
Value	Description							
0	禁用伺服输出。 Disabled the servo control outputs.							
1	使用正常减速值进行减速，然后禁用输出。 Slow down using the normal move deceleration value , then disable outputs.							

8.2.64. 0x605C:00h 禁用操作选项代码 (Disable operation option code)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
INT	0x0000	0x0001	0xFFFF	\	RW	NO	Immediately	NO
说明：此对象定义驱动器状态从“设备运行”变为“伺服使能”时驱动器的行为。 Description: This object defines the behavior of the amplifier when the amplifier's state is changed from “operation enabled” to “switched on” .								

8.2.65. 0x605D:00h 停止选项代码 (Halt option code)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
INT	0x0001	0xFFFF	0x0000	\	RW	NO	Immediately	NO

说明：此对象确定在控制字中的第 8 位（停止）处于活动状态时应采取的操作。

Description: This parameter determines which action should be taken if bit 8 (halt) in the control word is active.

Value	Meaning
0	禁用驱动功能（Disable drive function）
1	慢速减速（Slow down on slow-down ramp）
2	快速减速（Slow down on quick-stop ramp）
3	降低电流减速（仅在扭矩模式适用） Slow down on current limit (only for PT mode)
4-32768	Reserved

8.2.66. 0x605E:00h 故障反应选项代码 (Fault reaction option code)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
INT	0x0001	0x0001	0xFFFF	\	RW	NO	\	NO
说明：此对象定义了发生故障时的行为，驱动器在运行状态下（伺服已使能）发生严重冲突时，驱动器会进入故障状态。在任何情况下处入故障状态，伺服都会发送一帧 EMCY 报文，在状态字 0x6041 中显示错误状态。 Description: This object defines the behavior when a fault occurs, The drive enters a fault state when a critical violation occurs during operation enabled state (servo is enabled). In any situation of a fault state, the drive will transmit an EMCY message and will inform the Fault state in object 0x6041.								

8.2.67. 0x6060:00h 运行模式（Modes of operation）

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
SINT	0x08	0x0A	0x00	\	RW	YES	Immediately	RxPDO

说明：此对象指示下一个请求的运行模式，下列值生效。

Description:This Object indicates the next requested operation mode.The following values are valid.

Value	Operating mode
0x01	轮廓位置模式（Profile position mode）
0x03	轮廓速度模式（Profile velocity mode）
0x04	轮廓扭矩模式（Profile position mode）
0x06	回零模式（暂不支持）Homing mode（Not support）
0x07	位置插补模式（暂不支持）Interpolated position mode(Not support)
0x08	周期同步位置模式（Cyclic synchronous position mode）
0x09	周期同步速度模式（Cyclic synchronous velocity mode）
0x0A	周期同步扭矩模式（Cyclic synchronous torque mode）

8.2.68. 0x6061:00h 运行模式显示 (Modes of operation display)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
SINT	0x08	0x0A	0x00	\	RO	NO	\	TxPDO

说明：该对象显示当前的运行模式。

Description: This object displays the current mode of operation.

Value	Operating mode
0x01	轮廓位置模式 (Profile position mode)
0x03	轮廓速度模式 (Profile velocity mode)
0x04	轮廓扭矩模式 (Profile position mode)
0x06	回零模式 (暂不支持) Homing mode (Not support)
0x07	位置插补模式 (暂不支持) Interpolated position mode(Not support)
0x08	周期同步位置模式 (Cyclic synchronous position mode)
0x09	周期同步速度模式 (Cyclic synchronous velocity mode)
0x0A	周期同步扭矩模式 (Cyclic synchronous torque mode)

8.2.69. 0x6062:00h 用户位置指令 (Position demand value)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
DINT	0x00000000	0x7FFFFFFF	0x80000000	plus	RO	NO	\	TxPDO

说明：提供在位置限制 (0x607D) 后发送到位置控制器的位置值，该值用作位置控制器的输入，对于轮廓运动而言，该值由轮廓轨迹发生器生成。

Description: Provides the value of the position sent to the position controller after position limits (0x607D) are checked. Used as input for the position controller. For profiled motions, the value is generated by the profile generator.

8.2.70. 0x6063:00h 实际位置（内部单位）（Actual position internal units）

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
DINT	0x00000000	0x7FFFFFFF	0x80000000	plus	RO	NO	\	TxPDO
说明：位置测量装置的实际值，是闭环位置控制的两个输入值之一。数据单位被定义为增量。 Description: The actual value of the position measurement device is one of the two input values of the closed loop position control. The data unit is defined as increments.								

8.2.71. 0x6064:00h 实际位置（Actual position value）

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
DINT	0x00000000	0x7FFFFFFF	0x80000000	plus	RO	NO	\	TxPDO
说明：此对象表示输出端编码器反馈的位置实际值，反馈电机位置的反馈值。 Description: This object represents the position actual value of the output encoder feedback. It returns the motor position feedback value.								

8.2.72. 0x6065:00h 位置跟随误差窗口（Position following error window）

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
UDINT	0x00000001	0xFFFFFFFF	0x00000000	plus	RW	YES	\	NO
说明：对应上位机安全位置界面：最大允许位置误差。允许的位置范围被设置为相对于位置指令值。如果位置实际值超出位置误差窗口，一个跟随错误就发生了。 Description: Corresponding to the secure position interface of the controller: the max position error. The range of tolerated position values around the position demand value. If the position actual value is out of the following error window, a following error occurs.								

8.2.73. 0x6066:00h 位置跟随误差超时 (Position following error time out)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
UINT	0x0000	0xFFFF	0x0000	ms	RW	YES	\	NO

说明：当发生错误并持续超过定义的时间阈值时，状态字中相应的 Bit 13 跟随误差设置为 1，表示出现相应错误。

Description: When a following error occurs and continues longer than the defined value of the timeout, the corresponding bit 13 following error in the Status word is set to 1 indicating a following error threshold violation.

8.2.74. 0x6067:00h 位置窗口 (Position window)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
UDINT	0x00000000	0xFFFFFFFF	0x00000000	plus	RW	YES	Immediately	NO

说明：设置作为判断目标条件到达的阈值，当位置编码器测量的实际值在位置窗口内，表明已到达目标位置。

Description: Sets up the range permissible as target position attainment. When position actual value of position encoder is in position window means arriving at target position.

8.2.75. 0x6068:00h 位置窗口时间 (Position window time)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
UINT	0x000A	0xFFFF	0x0000	ms	RW	YES	\	NO

说明：表示到达目标位置设置的位置窗口时间，如果在设置的时间中，实际位置在位置窗口内，则状态字的 Bit10（目标到达）将被置为 1。

Description: Indicates the configured position window time for the target reached condition. If the actual position is within the Position window during the set time, the corresponding bit 10 (target reached) in the Statusword will be set to "1".

8.2.76. 0x6069:00h 速度传感器实际值 (Velocity sensor actual value)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
DINT	0x00000000	0x7FFFFFFF	0x80000000	plus/s	RO	NO	\	TxPDO

说明：此对象定义了从速度传感器读取到的实际值。

Description: This object defines the value read from a velocity encoder.

8.2.77. 0x606B:00h 速度指令值 (Velocity demand value)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
DINT	0x00000000	0x7FFFFFFF	0x80000000	plus/s	RO	NO	\	TxPDO

说明：此对象定义了由轨迹发生器所反映的速度命令的值。

Description: This object defines the value of the velocity command as reflected by the trajectory generator.

8.2.78. 0x606C:00h 速度实际值 (Actual velocity)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
DINT	0x00000000	0x7FFFFFFF	0x80000000	plus/s	RO	NO	\	TxPDO

说明：此对象以速度为单位与速度控制器输入的速度耦合。

Description: This object is represented in velocity units and is coupled with the velocity used as input to the velocity controller.

8.2.79. 0x606D:00h 速度窗口 (Velocity window)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
UINT	0x0000	0xFFFF	0x0000	plus/s	RW	NO	Immediately	NO

说明：该对象监测在最终的加速或减速（制动）阶段后是否达到了所需的速度。

Description: This object monitors whether the required process velocity has been achieved after an eventual acceleration or deceleration (braking) phase.

8.2.80. 0x606E:00h 速度窗口时间（Velocity window time）

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
UINT	0x0000	0xFFFF	0x0000	ms	RW	NO	\	NO

说明：配置速度传感器在速度窗口的时间来判断是否到达。当速度窗口判断实际速度到达目标速度且停留时间超过速度窗口时间时，设置状态字的目标到达位 bit10 被置为 1，速度窗口时间以 ms 的倍数给出。

Description: Configures the time the velocity controller needs to be within the velocity window to consider it having reached the target. The corresponding bit 10 set to 1 target reached is set in the Statusword when the difference between the target velocity and the velocity actual value is within the velocity window longer than the velocity window time. The value of the velocity window time is given in multiples of milliseconds.

8.2.81. 0x606F:00h 速度阈值（Velocity threshold）

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
UINT	0x0000	0xFFFF	0x0000	plus/s	RW	NO	\	NO

说明：当速度阈值实际值小于或等于速度阈值时间后的速度阈值时，状态字 Bit 12 “速度为零”设置为 1，表示轴是静止的。否则，此位设置为 0。

Description: When the velocity actual value is less or equal to the velocity threshold after the velocity threshold time, bit 12, “speed is zero”, is set to 1 in the Status word, indicating that the axis is stationary. Otherwise this bit is set to 0.

8.2.82. 0x6070:00h 速度阈值时间（Velocity threshold time）

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
UINT	0x0000	0xFFFF	0x0000	ms	RW	NO	\	NO

说明：配置在电机开始移动之前，实际速度超过速度阈值所需的时间。

Description: Configures the time required for the actual velocity to rise above the velocity threshold before the motor is considered to be moving.

8.2.83. 0x6071:00h: 目标扭矩 (Target torque)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
INT	0x0000	0x7FFF	0x8000	per thousand of rated current	RW	YES	Immediately	RxPDO

说明：通过此对象设定周期同步扭矩模式或轮廓扭矩模式的目标输入指令，以额定电流（通过对象字典 0x6075 获取）千分比给定，即目标电流（mA）=0x6071 给定值 x（0x 6075 值）/1000

Description: This object sets the target input instruction for the Cycle Sync Torque Mode or Profile Torque Mode with the rated current (obtained via object dictionary 0x6075) given by the millage ratio, i.e., the target current (mA) = 0x6071 given value x (0x6075 value) / 1000

8.2.84. 0x6072:00h 最大扭矩 (Max torque)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
UINT	0x0000	0xFFFF	0x0000	0.1%	RW	YES	Immediately	RxPDO

说明：设定允许峰值电流，为电机额定电流的倍数，对应上位机安全电源界面：最大输出力矩；通过此值来设定“峰值电流”，计算公式：峰值电流=（最大扭矩/1000）×持续电流。

Description: Set the allowable peak current, which is a multiple of the rated current of the motor, corresponding to the safety power interface of the eTuner: max output torque; Set the “peak current” with this value, and the calculation formula is: peak current =(max torque/1000)* continuous current.

8.2.85. 0x6073:00h 最大电流 (Max current)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
UINT	0x0000	0x7FFF	0x8000	0.1%	RO	YES	Immediately	RxPDO

说明：该值表示电机中产生最大容许扭矩的电流，以额定电流的千分比为单位。

Description: This value represents the maximum permissible torque creating current in the motor and is given in units of per thousand of rated current.

8.2.86. 0x6074:00h 扭矩需求值 (Torque demand value)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
INT	0x0000	0x7FFF	0x8000	per thousand of rated current	RO	NO	\	TxPDO

说明：提供扭矩轨迹发生器的输出，以额定电流的千分比为单位。

Description: Provides the output value of the torque trajectory generator. The units are per thousand of rated current.

8.2.87. 0x6075:00h 电机额定电流 (Motor rated current)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
UDINT	0x00000000	0xFFFFFFFF	0x00000000	mA	RW	YES	\	NO

说明：对应上位机安全电源界面：持续电流。电机额定电流，它取自电机基本参数。

Description: Corresponding to the safety power interface of the controller: continuous current. The motor rated current. It is taken from the basic parameters of the motor.

8.2.88. 0x6076:00h 电机额定扭矩 (Motor rated torque)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
UDINT	0x00000000	0xFFFFFFFF	0x00000000	0.001Nm	RW	YES	\	NO

说明：该值取自电机基本参数，以 mNm 的倍数输入。所有相对扭矩数据均参考此值。

Description: This value is taken from the basic parameters of the motor and is entered as a multiple of mNm. All relative torque data refer to this value.

8.2.89. 0x6077:00h 实际扭矩 (Torque actual value)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
INT	0x0000	0x7FFF	0x8000	0.1%	RO	NO	\	TxPDO

说明：扭矩实际值对应驱动电机中的瞬时扭矩，以额定电流的千分比为单位。数值含义同 0x6078。

Description: The torque actual value corresponds to the instantaneous torque in the drive motor. The value is given in units of per thousand of rated current. The value same as 0x6078.

8.2.90. 0x6078:00h 电机实际电流 (Motor actual current)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
INT	0x0000	0x7FFF	0x8000	0.1%	RO	NO	\	TxPDO

说明：电流实际值为驱动电机内的瞬时电流，以额定电流的千分比为单位。电机实际电流为实时采样电机的三相电流的瞬时值合成计算得到的电流值，以额定电流（通过对象字典 0x6075 获取）千分比给出，即电机实际电流 (mA) = 0x6078 值 × (0x6075 值) / 1000。

Description: The current actual value refers to the instantaneous current in the drive motor. The value is given in units of per thousand of rated current. The motor actual current is the value obtained by calculating the sum of momentary three-phase current value of the motor when sampling. The value of this object is given in per thousand of rated current (obtained by object dictionary 0x6075). That is, the motor actual current (mA) = 0x6078 value × (0x6075 value) / 1000.

8.2.91. 0x6079:00h 直流链路电压 (DC link circuit voltage)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
UDINT	0x00000000	0x0000DAC0	0x00000000	mV	RO	NO	\	TxPDO

说明：由伺服上的传感器测量的母线电压。表示驱动设备上的瞬时直流链路电压。

Description: The bus voltage measured by sensors on the servo. Indicates the instantaneous DC link circuit voltage at the drive device.

8.2.92. 0x607A:00h 目标位置 (Target position)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
DINT	0x00000000	0x7FFFFFFF	0x80000000	plus	RW	YES	Immediately	RxPDO

说明：目标位置是驱动器在轮廓位置模式或周期同步位置模式下应该移动到的设定位置。
Description: The commanded position the drive will move to in position profile mode or cyclic synchronous position mode.

8.2.93. 0x607B: 位置范围限制 (Position range limit)

0x607B:01h 最小位置范围限制 (Min position range limit)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
DINT	0x80000000	0x7FFFFFFF	0x80000000	plus	RW	YES	Immediately	NO

说明：通过定义最小位置范围限制来限制位置指令值。
Description: Defines the minimum position range limit by limiting the position demand value.

0x607B:02h 最大位置范围限制 (Max position range limit)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
DINT	0x7FFFFFFF	0x7FFFFFFF	0x80000000	plus	RW	YES	Immediately	NO

说明：通过定义最大位置范围限制来限制位置指令值。
Description: Defines the maximum position range limit by limiting the position demand value.

8.2.94. 0x607C:00h 原点补偿值 (Home offset)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
DINT	0x00000000	0x7FFFFFFF	0x80000000	plus	RW	NO	\	NO

说明：定义伺服的零点和机器零点之间的差值。
Description: Defines the difference between the zero position for the application and the machine home position.

8.2.95. 0x607D: 软件位置限制 (Software position limit)

0x607D:01h 最小软件位置限制 (Min software position limit)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
DINT	0x80000000	0x7FFFFFFF	0x80000000	plus	RW	YES	Immediately	NO
说明：此对象包含位置指令值和位置实际值的最小绝对位置限制。 Description: This object holds minimum absolute position limits for the position demand value and position actual value.								

0x607D:02h 最大软件位置限制 (Max software position limit)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
DINT	0x7FFFFFFF	0x7FFFFFFF	0x80000000	plus	RW	YES	Immediately	NO
说明：此对象包含位置指令值和位置实际值的最大绝对位置限制。 Description: This object holds the maximum absolute position limits for the position demand value and position actual value.								

8.2.96. 0x607E:00h 极性 (速度和位置) Polarity (velocity & position)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
USINT	0x00	0xFF	0x00	\	RW	NO	ESM changed	NO
说明：保留，暂不支持。 Description: Reserved, not supported at this time.								

8.2.97. 0x607F:00h 最大轮廓速度 (Max profile velocity)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
UDINT	0x00000000	0xFFFFFFFF	0x00000000	plus/s	RW	YES	Immediately	NO
说明：对应上位机安全速度界面：最大允许速度。最大轮廓速度是在轮廓模式运动期间任意方向上允许的最大速度。 Description: Corresponding to the safe speed interface of the controller: the max motor speed. The max profile velocity is the maximum speed allowed in either direction during a profiled move.								

8.2.98. 0x6080:00h 最大电机速度 (Max motor speed)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
UDINT	0x00000000	0xFFFFFFFF	0x00000000	plus/s	RW	NO	\	NO

说明：电机在任何一个方向上所允许的最大速度。

Description: The maximum velocity allowed for the motor in either direction.

8.2.99. 0x6081:00h 轮廓速度 (Profile velocity)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
UDINT	0x00000000	0xFFFFFFFF	0x00000000	plus/s	RW	YES	Immediately	RxPDO

说明：对应上位机运动界面：速度。该对象是在轮廓模式移动过程中，加速度斜坡末端到达的最终速度。这个参数对正向反向运动都有效。

Description: Corresponding to the motion interface of the controller: speed. This object is the velocity normally attained at the end of the acceleration ramp during a profiled move and is valid for both directions of motion.

8.2.100. 0x6082:00h 结束速度 (End velocity)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
UDINT	0x00000000	0xFFFFFFFF	0x00000000	plus/s	RW	NO	\	RxPDO

说明：该对象表示驱动器在到达目标位置时应具有的目标速度。

Description: This object indicates the targeted velocity that the drive shall have upon reaching the target position.

8.2.101. 0x6083:00h 轮廓加速度 (Profile acceleration)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
UDINT	0x00000000	0xFFFFFFFF	0x00000000	plus/s ²	RW	YES	Immediately	RxPDO

说明：该参数定义了轮廓位置，轮廓速度模式下的电机加速度。

Description: Parameters to decide the gradient at the time of motor acceleration during profile position, profile velocity mode.

8.2.102. 0x6084:00h 轮廓减速度 (Profile deceleration)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
UDINT	0x00000000	0xFFFFFFFF	0x00000000	plus/s ²	RW	YES	Immediately	RxPDO
说明：该参数定义了轮廓位置模式和轮廓速度模式下的电机减速度。 Description: The profile deceleration defines the deceleration limits for the profile position and profile velocity modes.								

8.2.103. 0x6085:00h 急停减速度 (Quick stop deceleration)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
UDINT	0x00000000	0xFFFFFFFF	0x00000000	plus/s ²	RW	YES	Immediately	RxPDO
说明：对应上位机安全速度界面：急停速度。快速停止减速时，当给出了快速停止命令，并且将快速停止选项代码（0x605A）设置为 2 时，用于停止电机的减速度。 Description: Corresponding to the safe speed interface of the controller: emergency stop speed. The quick stop deceleration is the deceleration used to stop the motor if the Quick Stop command is given and the quick stop option code (see 0x605A) is set to 2.								

8.2.104. 0x6086:00h 运动轮廓类型 (Motion profile type)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
INT	0x00000000	0xFFFFFFFF	0x00000000	\	RW	NO	\	NO
说明：此对象用于在轮廓位置模式运行时选择使用的运动轮廓类型。 Description: This object selects the type of trajectory profile to use when running in profile position mode.								

8.2.105. 0x6087:00h 扭矩斜坡 (Torque slope)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
UDINT	0x00000000	0xFFFFFFFF	0x00000000	/	RW	NO	Immediately	RxPDO
说明：设置轮廓转矩模式下的转矩指令的加速度，其意义为：每秒转矩指令增量。设置为 0，则禁用斜率限制，以获得即时响应。 Description: It sets the acceleration of the torque reference in profile torque mode, that is, torque increment per second. Set to zero to disable slope limiting for instant response.								

注：匹配 X3071220X 版本及以上固件。

Note: Match firmware the X3071220X version and above.

8.2.106. 0x6093:00h 位置因子 (Position factor)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
UDINT	0x00000000	0xFFFFFFFF	0x00000000	\	RO	NO	\	NO
说明：保留，暂不支持。 Description: Reserved, not supported at this time.								

8.2.107. 0x6094:00h 速度编码器系数 (Velocity encoder factor)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
UDINT	0x00000000	0xFFFFFFFF	0x00000000	\	RO	NO	\	NO
说明：保留，暂不支持。 Description: Reserved, not supported at this time.								

8.2.108. 0x6095:00h 速度系数 1 (Velocity factor 1)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
UDINT	0x00000002	0x00000002	0x00000000	\	RO	NO	\	NO
说明：保留，暂不支持。 Description: Reserved, not supported at this time.								

8.2.109. 0x6097:00h 加速度因子 (Acceleration factor)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
UDINT	0x00000000	0xFFFFFFFF	0x00000000	\	RW	NO	\	NO
说明：保留，暂不支持。 Description: Reserved, not supported at this time.								

8.2.110. 0x6098:00h 回零方式 (Homing method)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
SINT	0x00	0xFF	0x00	\	RW	NO	\	NO
说明：保留，暂不支持。 Description: Reserved, not supported at this time.								

8.2.111. 0x6099:00h 回零速度 (Home velocity)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
UDINT	0x00000000	0xFFFFFFFF	0x00000000	plus/s	RW	NO	\	NO
说明：保留，暂不支持。 Description: Reserved, not supported at this time.								

8.2.112. 0x609A:00h 回零加速度 (Homing acceleration)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
UDINT	0x00000000	0xFFFFFFFF	0x00000000	plus/s ²	RW	NO	\	NO
说明：保留，暂不支持。 Description: Reserved, not supported at this time.								

8.2.113. 0x60B0:00h 位置偏移值 (Position offset)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
DINT	0x00000000	0x7FFFFFFF	0x80000000	plus	RW	YES	Immediately	RxPDO

说明：此对象定义了目标位置的偏移值。表示电机停止时目标位置与实际位置之间的位置偏移值。

Description: This object defines the offset of the target position.Target position and actual position shift for the amount of position offset value when motor stop.

8.2.114. 0x60B1:00h 速度偏移值 (Velocity offset)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
DINT	0x00000000	0x7FFFFFFF	0x80000000	plus/s	RW	YES	Immediately	RxPDO

说明：速度偏移值。从主机控制器中获取速度指令值，并将其添加到速度环的速度命令中。在 CSP 模式中，速度偏移值包含速度前馈的输入值。在 CSV 模式中，它包含驱动器设备速度指令的偏移量。

Description: Velocity offset value. Takes a commanded velocity value from the host controller and adds it to the velocity command entering the velocity loop.In CSP mode this object contains the input value for velocity feed forward.In CSV mode it contains the commanded offset of the drive device.

8.2.115. 0x60B2:00h 扭矩偏移值 (Torque offset)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
INT	0x0000	0x7FFF	0x8000	per thousand of rated current	RW	YES	Immediately	RxPDO

说明：扭矩偏移值。从主控制器获取命令的扭矩值，并将其添加到电流环的电流指令中。在 CSP 模式中，该对象包含扭矩前馈的输入值。在 CST 模式中，该对象包含驱动器指令的附加扭矩，然后添加到目标扭矩中。

Description: Torque offset value. Takes a commanded current value from the host controller and adds it to the current command entering the current loop. In CSP, the object contains the input value for torque feed forward.In CST, the object contains the commanded additive torque of the drive which is then added to the target torque.

8.2.116. 0x60C0:00h 插补子模式 (interpolated position mode)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
INT	0x0000	0x7FFF	0x8000	\	RW	NO	\	NO
说明：保留，暂不支持。 Description: Reserved, not supported at this time.								

8.2.117. 0x60C1:00h 插补数据记录 (interpolated data record)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
REC	0x00000000	0x7FFFFFFF	0x80000000	\	RW	NO	\	NO
说明：此对象表示需要执行插值算法数据字段。 Description: This object indicates the number of data words, which are needed for execution of the interpolation algorithm.								

8.2.118. 0x60C2:00h 插补周期 (interpolated time period)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
USINT	0x01	0xFF	0x00	\	RW	NO	\	NO
说明：保留，暂不支持。 Description: Reserved, not supported at this time.								

8.2.119. 0x60C5:00h 最大加速度 (Max acceleration)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
UDINT	0x00000000	0xFFFFFFFF	0x00000000	plus/s ²	RW	NO	\	NO
说明：它用于将加速度限制在一个可接受的值内，以防止电机和移动的机械被损坏。 Description: It is used to limit the acceleration to an acceptable value in order to prevent the motor and the moved mechanics from being damaged.								

8.2.120. 0x60C6:00h 最大减速度 (Max deceleration)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
UDINT	0x00000000	0xFFFFFFFF	0x00000000	plus/s ²	RW	NO	\	NO

说明：它用于将减速度限制在一个可接受的值内，以防止电机和移动的机械被损坏。

Description: It is used to limit the deceleration to an acceptable value in order to prevent the motor and the moved mechanics from being damaged.

8.2.121. 0x60E0:00h 正扭矩限制 (Positive torque limit value)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
UINT	0x03E8	0x1F40	0x0000	mA	RW	YES	Immediately	RxPDO

说明：设定正向力矩输出允许最大值，对应上位机堵转保护界面正向门限，通过总线设置，需将力控模式设置为总线通信。

Description: Set the maximum allowable value of the forward torque output, corresponding to the forward threshold of the controller block interface, and the force control mode needs to be set to bus communication through bus settings.

8.2.122. 0x60E1:00h 负扭矩限制 (Negative torque limit value)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
UINT	0x03E8	0x1F40	0x0000	mA	RW	YES	Immediately	RxPDO

说明：设定反向力矩输出允许最大值，对应上位机堵转保护界面反向门限，通过总线设置，需将力控模式设置为总线通信。

Description: Set the maximum allowable maximum value of reverse torque output, corresponding to the reverse threshold of the block interface of the controller, and set the force control mode to bus communication through bus setting.

8.2.123. 0x60F2:00h 位置选项代码 (Position option code)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
UINT	0x0000	0xFFFF	0x0000	\	RW	NO	\	NO

说明：保留，暂不支持。

Description: Reserved, not supported at this time.



8.2.124. 0x60F4:00h 跟随误差实际值 (Following error actual value)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
DINT	0x00000000	0x7FFFFFFF	0x80000000	plus	RO	NO	\	TxPDO

说明：此对象定义了位置跟随误差的实际值，是位置指令值(0x6062)和位置反馈值（0x6064）之间的差值。

Description: The object defines the position following error actual value. The following error is the difference between the position demand values (0x6062) and the position feedback values(0x6064) .

8.2.125. 0x60FC:00h 电机位置指令 (Position demand value)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
DINT	0x00000000	0x7FFFFFFF	0x80000000	plus	RO	NO	\	TxPDO

说明：在轮廓位置模式下的轨迹发生器的输出，是一个使用增量的内部值。

Description: This output of the trajectory generator in profile position mode is an internal value using increments.

8.2.126. 0x60FD:00h 数字输入 (Digital inputs)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
UDINT	0x00000000	0xFFFFFFFF	0x00000000	\	RO	NO	\	TxPDO

说明：指示数字输入的状态。该数字输入对象有 32 位。

Description: Indicates the state of the digital inputs. The digital inputs object has 32 bits.

Bits	Meaning
Bit 0 to 15	Reserved
Bit 16	0: Switched off 1: Switched on
Bit 17	0: Switched off 1: Switched on
Bit 18-31	Reserved

8.2.127. 0x60FE:00h 数字输出 (Digital outputs)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
UDINT	0x00000000	0xFFFFFFFF	0x00000000	\	RW	YES	Immediately	RxPDO

说明：指示数字输出的状态。该数字输出对象有 32 位。

Description: Indicates the state of the digital outputs. The digital outputs object has 32 bits.

Bits	meaning
Bit 0	Set Brake (0=Engage, 1=Disengage)
Bit 1 to 15	Reserved
Bit 16	0: Digital output off 1: Digital output on
Bit 17	0: Digital output off 1: Digital output on
Bit 18 to 31	Reserved

8.2.128. 0x60FF:00h 目标速度 (Target velocity)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO mapping
DINT	0x00000000	0x7FFFFFFF	0x80000000	plus/s	RW	YES	Immediately	RxPDO

说明：该对象表示已配置的目标速度，用作轨迹发生器的输入。

Description: The object indicates the configured target velocity and is used as input for the trajectory generator.



8.2.129. 0x6502:00h 支持伺服运行模式 (Supported drive modes)

Data type	Default data	Max data	Min data	Unit	Access	Backup	Update	PDO Mapping
UDINT	0x00000000	0xFFFFFFFF	0x00000000	\	RO	NO	\	NO

说明：该对象提供了伺服支持的运行模式的信息，此对象是逐位控制的，这些位有如下定义：

Description: This object provides information on the supported drive modes.

This object is organized bit-wise. The bits have the following meaning:

Bit	Meaning
Bit0	轮廓位置模式 (Profile position mode)
Bit1	保留 (Reserved)
Bit2	轮廓速度模式 (Profile velocity mode)
Bit3	轮廓扭矩模式 (Profile torque mode)
Bit4	保留 (Reserved)
Bit5	回零模式 (暂不支持), Homing mode (not supported)
Bit6	位置插补模式 (暂不支持) Interpolated position mode (not supported)
Bit7	周期同步位置模式 (Cyclic synchronous position mode)
Bit8	周期同步速度模式 (Cyclic synchronous velocity mode)
Bit9	周期同步扭矩模式 (Cyclic synchronous torque mode)
Bit10	保留 (Reserved)
Bit14-15	厂家自定义 (Manufacturer specific)



总部 Head Office

深圳市零差云控科技有限公司

Zeroerr Control Co.,Ltd.

地 址 Address: 中国广东省深圳市宝安区沙井街道坐岗社区中日龙路 10 号 3 楼

3/F, No.10, Zhongrilong Road, Bogang Community, Shajing Street, Bao'an District,
ShenZhen City, Guangdong Province, P.R.China

售前咨询 Sales support: 134 8079 6208

136 0260 7132

邮 箱 Email: sales@zeroerr.cn

Sales Email: marketingdirector@zeroerr.cn

售后支持 Technical support: 178 2067 6603

400 893 0660

投诉建议 Advice: network@zeroerr.cn

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