ZLAC8015 SERVO DRIVER (SPECIAL FOR HUB SERVO MOTOR)

CANopen COMMUNICATION INSTRUCTION

Version	Description	Date
V1.00	-	2020-03-14
V1.01	-	2020-04-14
V1.02	1. Add object dictionary 0x2000 00 2. Add emergency stop command/clear fault command	2020-07-25
V1.03	1. Revise V3.5.2 routine instruction 2. Revise V2.4.6 to save PDO mapping instruction 3. Revise 2.4.5 PDO configuration routine instructions	2021-7-1
V1.06	Added power cable short circuit function after alarm (0x202F alarm PWM processing method and overload processing method)	2022-6-23

CATALOG

1.OUTLINE 3
2. CIA301 DESCRIPTION 3
2.1 CANOPEN FUNCTION DESCRIPTION 3
2.1.1 Message Classification 3
2.1.2 Object Dictionary 4
2.2 SDO MESSAGE DESCRIPTION 4
2.2.1 SDO Message Format 4
2.2.2 COB-ID Description 4
2.2.3 Command Word Description 4
2.2.4 SDO Message Routine 5
2.3.NMT MESSAGE DESCRIPTION 5
2.3.1 NMT Node Status 5
2.3.2 NMT Slave Node Online Message 5
2.3.3 NMT Slave Node Status and Heartbeat Message 5
2.3.4 NMT Node State Switching Command 6
2.3.5 NMT Heartbeat Message Configuration Routine 6
2.4. PDO MESSAGE DESCRIPTION 6
2.4.1 PDO COB-ID Definition 6
2.4.2 PDO Transmission Form 7
2.4.3 PDO Communication Parameters 7
2.4.4 PDO Mapping Parameters 7
2.4.5 PDO Configuration Routine 8
2.4.6 Save PDO Mapping 8
3. CIA402 DESCRIPTION 8
3.1. CIA402 STATE MACHINE 8
3.2. CONTROL WORD AND STATUS WORD 10
3.3. PROFILE POSITION MODE 12
3.3.1 Profile Position Mode Description 12
3.3.2 Profile Position Mode Configuration Routine 13
3.4. PROFILE VELOCITY MODE 14
3.4.1 Profile Velocity Mode Description 14
3.4.2 Profile Velocity Mode Configuration Routine 15
3.5. PROFILE TORQUE MODE 16
3.5.1 Profile Torque Mode Description 16
3.5.2 Profile Torque Mode Configuration Routine 16
4. OBJECT DICTIONARY 17

1.OUTLINE

This manual only gives a brief introduction to the most commonly used related concepts and precautions in the use of ZLAC8015, so that users can understand the normal use of ZLAC8015 series products in the shortest time.

Communication Standard followed by ZLAC8015

- CAN 2.0A Standard
- CANopen Standard protocol DS 301 V4.02
- CANopen Standard protocol DS 402 V2.01

The following description takes the driver address as 1, the baud rate as 500K.

The driver address can be set to 0-127. The address 1-3 could be set by DIP switch. When the DIP switch is set to 0, the address could be set through software, its range is 4-127, the default address is 4.
For CANopen communication, ZLAC8015 has 7 optional baud rates: 25kHz, 50kHz, 100kHz, 125kHz, 250kHz, 500kHz, 1MHz. Baud rate could be set through software, its default value is 500kHz.

2. CIA301 DESCRIPTION

2.1 CANOPEN FUNCTION DESCRIPTION

2.1.1 Message Classification

Object	Standard	Function Code
NMT(Network Management)	CiA301	0000
Sync Message	CiA301	0001
TPDO1 send process data object 1	CiA301	0011
RPDO1 receive process data object 1	CiA301	0100
TPDO2 send process data object 2	CiA301	0101
RPDO2 receive process data object 2	CiA301	0110
TPDO3 send process data object 3	CiA301	0111
RPDO3 receive process data object 3	CiA301	1000
TPDO4 send process data object 4	CiA301	1001
RPDO4 receive process data object 4	CiA301	1010
SDO service data object (Service data object response)	CiA301	1100
SDO service data object (service data object inquiry)	CiA301	1011

2.1.2 Object Dictionary

Object Dictionary is the core concept of CANopen. Every CANopen device in the network has an object dictionary. Object Dictionary is an ordered collection of data objects. These objects describe all the communication and device parameters of the device, and their positions are determined in Object Dictionary by a 16-bit index and an 8-bit subindex.

Object Dictionary supported by ZLAC8015

Index Range	Description
0x1000-0x1A03	CiA301 Communication Object Sub-Protocol Area
0x2003-0x2030	Factory Custom Area
0x603F-0x60FF	CiA402 Motion Control Sub-Protocol Area

2.2 SDO MESSAGE DESCRIPTION

SDO is mainly used by CANopen master to configure the parameters of slave nodes. Service confirmation is the biggest feature of SDO. It generates a response for each message to ensure the accuracy of data transmission. Usually CANopen takes slave node as SDO server, master node as the client (called CS communication). The SDO client could access Object Dictionary on the SDO server through index and sub-index.

2.2.1 SDO Message Format

COB-ID	Data	Description
0x600 + Node Address	Command Word + Index + Sub-Index + Data	Master station send
0x580 + Node Address		Slave station reply

2.2.2 COB-ID Description

In CANopen protocol, it is stipulated that 11 arbitration bits are divided into the high 4 bits of the Function Code and the low 7 bits of the node address (Node-ID), which is called COB-ID (Communication Object Identifier).

CANopen predefined master / slave connection set										
10	9	8	7	6	5	4	3	2	1	0
Function Code				Node-ID						

2.2.3 Command Word Description

Command	Function	Type	Data Length
2F	Setting	M->S Request	1 byte
2B	Setting	M->S Request	2 byte
27	Setting	M->S Request	3 byte
23	Setting	M->S Request	4 byte
60	Setting feedback	S->M Confirm	
40	Read	M->S Request	0 byte
4F	Read feedback	S->M Answer	1 byte
4B	Read feedback	S->M Answer	2 byte

47	Read feedback	S->M Answer	3 byte
43	Read feedback	S->M Answer	4 byte
80	Error	S->M Answer	4 byte

2.2.4 SDO Message Routine

Master Station	Slave Station	Function Description
601: 23 7A 60 00 00 10 00 00	581: 60 7A 60 00 00 00 00 00	Write target position 4096

2.3.NMT MESSAGE DESCRIPTION

2.3.1 NMT Node Status

Status	Description
Initialization	Initialize CAN controller after the node is powered on.
Application layer reset	Node application reset
Communication reset	Node CANopen communication reset
Pre-operational state	Node CANopen communication is in operation; Could communicate with SDO and NMT.
Operating state	After the node receives the start command sent by NMT master station, the node's PDO communication is activated.
Stop state	After the node receives the stop command from NMT master station, the node's PDO communication is prohibited.

2.3.2 NMT Slave Node Online Message

After any NMT slave node goes online, in order to remind the master station that it has joined the network, this slave station must send the node online message, as shown in the following table:

COB-ID	Data	Description
0x700+ Node Address	0x00	Slave node goes online

2.3.3 NMT Slave Node Status and Heartbeat Message

In order to monitor whether the CANopen node is online and the current node status. In CANopen application, it is usually required that the slave stations that are powered on and online send heartbeat messages regularly, so that the master station could confirm whether the slave station is faulty and whether it is off the network.

The heartbeat message format is as follows:

COB-ID	Data	Description
0x700 + Node Address	0x04	Stop state
0x700 + Node Address	0x05	Operation state
0x700 + Node Address	0x7F	Pre-operational state

The CANopen slave station sends the heartbeat message according to the heartbeat production time (ms) filled in 1017h in its object dictionary, and CANopen master station (NMT master station) will check according to the heartbeat consumption time filled in its 1016h. Assuming that more than a few

heartbeat consumption times, CANopen master (NMT master) has not received the heartbeat message from the slave station, it is considered that the slave station is offline or damaged.

2.3.4 NMT Node State Switching Command

In NMT network management, the core is NMT node status switching command, which is the "command" message for network management performed by NMT master station. Users must keep these commands in mind.

All COB-ID is 0x000, with the highest CAN priority, and the data is 2 bytes:

COB-ID	Data 1	Data 2	Description
0x000	0x01	0xNode address	Start command (let the node enter Operating state)
0x000	0x02	0xNode address	Stop command (let the node enter the stop state)
0x000	0x80	0xNode address	Pre-operation command (let the node enter the pre-operation state)
0x000	0x81	0xNode address	Reset the node application layer (let the node enter the application layer reset state)
0x000	0x82	0xNode address	Reset node communication (let the node enter the communication reset state)

If user wants to control all the nodes of the entire network, the node address of data 2 could be 0x00.

2.3.5 NMT Heartbeat Message Configuration Routine

Master Station	Slave Station	Function Description
601: 2B 17 10 00 00 00 E8 03	581: 60 17 10 00 00 00 00 00	Set heartbeat production time 1000*unit 0.5ms=500ms

2.4. PDO MESSAGE DESCRIPTION

PDO belongs to process data, which is used to transmit real-time data, that is, one-way transmission. It does not need to receive CAN message that node responds to confirm. From the perspective of communication terms, it belongs to the "production and consumption" model.

2.4.1 PDO COB-ID Definition

Object	Standard	COB-ID
TPDO1 send process data object 1	CiA301	0x181-0x1FF (0x180+Node address)
RPDO1 receive process data object 1	CiA301	0x201-0x27F (0x200+Node address)
TPDO2 send process data object 2	CiA301	0x281-0x2FF (0x280+ Node address)
RPDO2 receive process data object 2	CiA301	0x301-0x37F (0x300+ Node address)
TPDO3 send process data object 3	CiA301	0x381-0x3FF (0x380+ Node address)
RPD3 receive process data object 3	CiA301	0x401-0x47F (0x400+ Node address)
TPDO4 send process data object 4	CiA301	0x481-0x4FF (0x480+ Node address)
RPDO4 receive process data object 4	CiA301	0x501-0x57F (0x500+ Node address)

2.4.2 PDO Transmission Form

Type	Description
Event trigger	If the content of the object data mapped to PDO changes, the PDO transmission is triggered.
Timer trigger	PDO periodically triggers transmission at the time set by timer.

2.4.3 PDO Communication Parameters

PDO communication parameters define COB-ID, transmission type, timing period that the device uses. RPDO communication parameters are located at 0x1400 to 0x15FF in the object dictionary index, TPDO communication parameters are located at 0x1800 to 0x19FF in the object dictionary index. Each index represents a PDO communication parameter set, and the sub-indexs respectively refer to specific various parameters. As shown in the following table:

Index	Sub-Index	Description	Data type
RPDO: 0x1400-0x1403	0x00	Number of sub-indexes	U8
	0x01	COB-ID: COB-ID that sends/receives this PDO	U32
TPDO: 0x1800-1803	0x02	Transmission form: 0xFE: Event trigger 0xFF: timer trigger	U8
	0x03	Production prohibition time	U16
	0x04	Maintain	U8
	0x05	Timer trigger time	U16

Note:

Number of sub-indexes: the number of sub-indexes under this index.

COB-ID: the corresponding CAN frame ID when this PDO is sent or received.

Transmission type: this product currently supports only 2 PDO trigger methods.

Production prohibition time: restrict the minimum interval of PDO transmission to avoid dramatic increase in bus load.

Timer trigger time: this parameter defines the time of the PDO transmission form's timer trigger method.

2.4.4 PDO Mapping Parameters

Index	Sub-Index	Description	Data Type
RPDO: 0x1600-0x1603	0x00	Number of object mappings	U8
	0x01	PDO0	U32
	0x02	PDO1	U32
TPDO: 0x1A00-1A03	0x03	PDO2	U32
	0x04	PDO3	U32

Note:

Number of PDO mappings: the number of objects mapped under the current index, it's the sum of the mappings under the sub-index 1/2/3/4.

PDO1/2/3/4: fill in the information of the object dictionary to be mapped, such as index, sub-index, and data type.

2.4.5 PDO Configuration Routine

Upload when the configuration bus voltage (0x2048) changes:

Master station	Slave station	Function Description
604: 2F 00 1A 00 00 00 00 00	584: 60 00 1A 00 00 00 00 00	Clear TPDO0 mapping
604: 23 00 1A 01 10 00 29 20	584: 60 00 1A 01 00 00 00 00	Mapping 2029 00 to 1A 00 01
604： 23 00 18 01 81 01 00 00	584： 60 00 18 01 00 00 00 00	Set the COB-ID of TPDO0 to 181
604： 2F 00 18 02 FE 00 00 00	584： 60 00 18 02 00 00 00 00	Set the transmission mode of TPDO0 to event trigger
604： 2F 00 1A 00 01 00 00 00	584： 60 00 1A 00 00 00 00 00	Start TPDO0 mapping

2.4.6 Save PDO Mapping

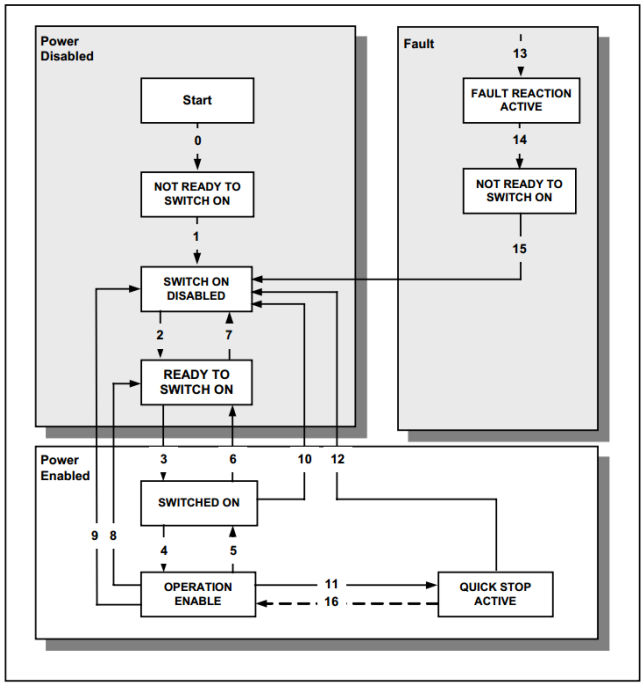
Master station	Slave station	Function Description
604: 2B 09 20 00 02 00 00 00	584: 60 09 20 00 00 00 00 00	Save the configured PDO to EEPROM

3. CIA402 DESCRIPTION

3.1. CIA402 STATE MACHINE

CiA402 protocol defines the standard state machine of motion control device, as well as various operating modes and their definitions in object dictionary.

State machine describes the state of the device and the possible control sequences of driver. The status of each step represents a specific internal or external behavior, and the status of the device also determines which commands could be received.



Driver state machine

※ **The corresponding state description of the state machine is as follows:**

State Name	Description
NOT READY TO SWITCH ON	It only supplies power to the driver chip, the driver is initializing and self-checking, the driver function is not enabled, and this state is an internal state.
SWITCH ON DISABLED	After the driver is initialized, the driver parameters are established and could be modified. This state does not supply power to the motor. This state is the lowest state that user can operate. This state is also the state that use will contact after the driver is powered on.
READY TO SWITCH ON	The driver parameters could be modified, the driver function is not enabled, waiting to enter SWITCH ON state.
SWITCH ON	Provide high voltage to the driver, the power amplifier is ready, the driver parameters could be modified, and the driver function is not enabled.
OPERATION ENABLE	If no fault is detected, the driver function is enabled, and the motor is powered on. The driver parameters could be modified. According to BP [N] parameter, it is determined whether the brake will be automatically released in this state.
QUICK STOP ACTIVE	The driver parameters could be modified, the emergency stop function is enabled, the driver function is enabled, and the motor is powered on.
FAULT REACTION ACTIVE	The driver parameters could be modified, the driver has a fault, the fault response function is enabled, and the drive function is disabled. This state cannot be entered manually. The driver will enter this state automatically when a fault occurs.

Driver state machine is controlled by bit0-bit3, bit7 of the control word (object 6040h). The specific description is as follows:

※ Control word switching state:

Command	Control Word					State Switch
	Bit7	Bit3	Bit2	Bit1	Bit0	
Shutdown	0	X	1	1	0	2,6,8
Switchon	0	0	1	1	1	3
Switchon +Enable operation	0	1	1	1	1	3+4
Disable voltage	0	X	X	0	X	7,9,10,12
Quick stop	0	X	0	1	X	7,10,11
Disable Operation	0	0	1	1	1	5
Enable Operation	0	1	1	1	1	4,16
Fault reset	↑	X	X	X	X	15
Bit marked as X is invalid.						

Each state in state machine could be displayed through bit0-bit3, bit5, bit6 of status word (object 6041h), the specific description is as follows:

※ Status word switching state

State	State word					
	Bit6	Bit5	Bit3	Bit2	Bit1	Bit0
Not ready to switch on	0	X	0	0	0	0
Switch on disabled	1	X	0	0	0	0
Ready to switch on	0	1	0	0	0	1
Switched on	0	1	0	0	1	1
Operation enabled	0	1	0	1	1	1
Quick stop active	0	0	0	1	1	1
Fault reaction active	0	X	1	1	1	1
Fault	0	X	1	0	0	0
Bit marked as X is invalid.						

3.2. CONTROL WORD AND STATUS WORD

The start and stop control commands and state description of the driver are mainly realized through the control word 6040h and the status word 6041h. Therefore, the skilled use of the control word and status word is very necessary. The following table briefly describes the definition of the control word and status word.

Control Word	Common Command	Function Description
6040h	00	Initialization step 0: At this time, the low 4-bit status of 6041 is 0000, motor is released;
	06	Initialization step 1: At this time, the low 4-bit status of 6041 is 0001, motor is released;
	07	Initialization step 2: At this time, the low 4-bit status of 6041 is 0011, motor is enabled;
	0F	Initialization step 3: At this time, the low 4-bit status of 6041 is 0111, motor is enabled;
	0F	Start command in Profile Velocity Mode (6061 = 3);
	0F->1F	Start command in Profile Torque Mode (6061 = 4); Absolute motion start command in position mode (6061 = 1);
	4F->5F	Relative motion start command in position mode (6061 = 1);

Status Word	Bit Definition	Function Description
6041h	Bit0~Bit3	6040=0： xxxx xxxx xxxx 0000 6040=6： xxxx xxxx xxxx 0001 6040=7： xxxx xxxx xxxx 0011 6040=F： xxxx xxxx xxxx 0111
	Bit7	0: driver is normal; 1: driver alarms;
	Bit8	0: torque is not completed; 1: torque has been completed;
	Bit11	0: the status of Bit4 at 6040h is 0; 1: the status of Bit4 at 6040h is 1;
	Bit13	0: motor release; 1: motor is enabled;
	Bit14	0: motor is stopped; 1: motor is running;
	Bit15	0: The motion is not in position in position mode; 1: The motion is in position in position mode;

Eg: Initialize the driver after power-on. After initialization, it enters the normal operation state. This operation is generally performed after power-on.

Master station	Slave station	Status word of slave station
00: 01 00	NMT initialization	NMT initialization
601: 2B 40 60 00 00 00 00 00	581: 60 40 60 00 00 00 00 00	6041: xxxx xxxx xxxx 0000
601: 2B 40 60 00 06 00 00 00	581: 60 40 60 00 00 00 00 00	6041: xxxx xxxx xxxx 0001
601: 2B 40 60 00 07 00 00 00	581: 60 40 60 00 00 00 00 00	6041: xxxx xxxx xxxx 0011
601: 2B 40 60 00 0F 00 00 00	581: 60 40 60 00 00 00 00 00	6041: xxxx xxxx xxxx 0111

CANopen sets the operation mode of the driver through the object 6060h (Mode of Operation) and reflects the current operation mode status of the driver through the object 6061h (Mode of operation display). ZLAC8015 series driver currently supports 3 operation modes: Profile Position Mode, Profile Velocity Mode, and Profile Torque Mode.

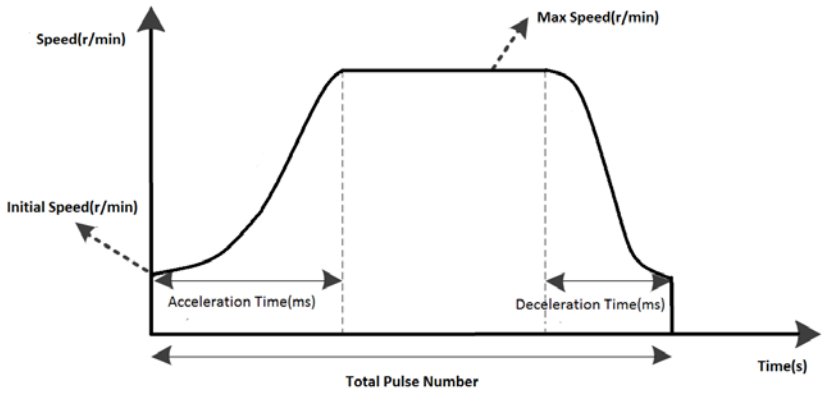
※ Driver Operation Mode:

Index	Sub-Index	Name	Type	Attribute	PDO Mapping	Parameter Range	Default
6060h	00	Operation Mode	I8	RW	NO	0: undefined 1: Profile Position Mode 3: Profile Velocity Mode 4: Profile Torque Mode	0

3.3. PROFILE POSITION MODE

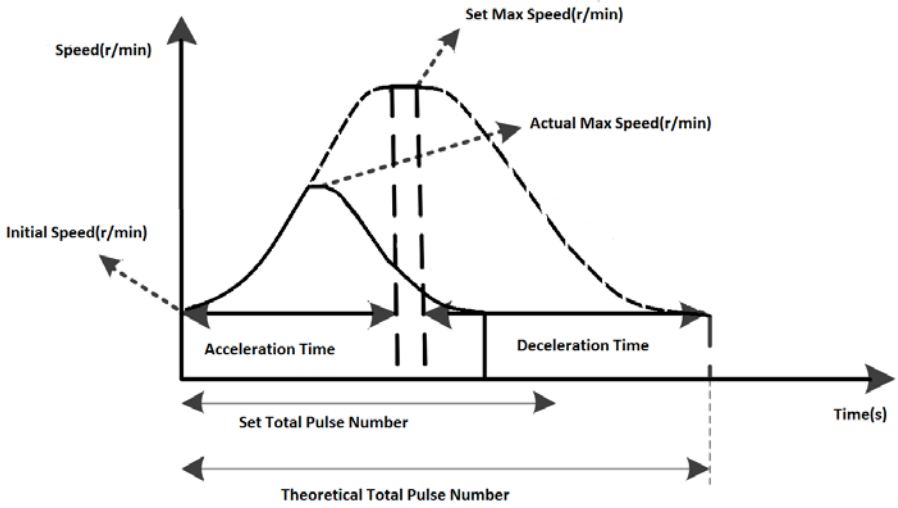
3.3.1 Profile Position Mode Description

Profile position mode is realized by an S-shaped acceleration and deceleration curve. User could set several parameters such as initial speed (address 200800h), maximum speed (address 608100h), acceleration time (address 608300h), deceleration time (address 608400h) and total pulse number (address 607A00h) through the bus to achieve precise position control. The S-shaped acceleration / deceleration curve is shown in the figure below.



Profile position mode acceleration/deceleration curve

When the total pulse number set by user is small, the motor may need to decelerate before it accelerates to the maximum speed (that is, the motor does not accelerate to the maximum speed set by the user during actual operation). The speed curve is shown in the figure below. The solid line in the figure shows the actual running curve of the motor, and the dotted line is the curve that motor needs to run, to accelerate to the set maximum speed. The theoretical total pulse number is the minimum total pulse number calculated according to the user-set parameters (initial speed, maximum speed, acceleration time, deceleration time). When the total pulse number set by the user is less than the theoretical total pulse number, the motor will run as shown by the solid line in the figure.



Profile position mode acceleration/deceleration curve (not accelerated to the set maximum speed)

※ Related Object Dictionary Content

Index	Sub-Index	Name	Type	Attribute	Parameter Range	Setting
6060h	00	Working Mode	I8	RW	0,1,3,6	1
607Ah	00	Total Pulse Number	I32	RW	-1000000~1000000	3200
200Eh	00	Initial Speed	U32	RW	2-300 r/min	5 r/min
6081h	00	Max Speed	U32	RW	5-3000 r/min	120 r/min
6083h	00	Acceleration Time	U32	RW	0-2000ms	100ms
6084h	00	Deceleration Time	U32	RW	0-2000ms	100ms

Control word and status word

The control word in Profile position mode is controlled by bit4 -bit6, bit8:

Byte	Name	Function Description
Bit4	New set-point	0: No assumed target position; 1: Assumed target position;
Bit5	Change set immediately	0: Complete the current position and then start the next position; 1: Interrupt the current position and start the next position;
Bit6	ABS/REL	0: The target position is an absolute value; 1: The target position is a relative value;
Bit8	Halt	0: Terminate current position; 1: Set deceleration to stop;
Note: According to the above table , the control word of absolute position motion command is 0x0F-> 0x1F, and the control word of relative position motion command is 0x4F-> 0x5F.		

※ Bit10, Bit12, Bit15 of status word display the driver status

Byte	Name	Function Description
Bit10	Target reached	0: Halt = 0 target position has not been reached; Halt = 1 motor is decelerating; 1: Halt = 0 reach the target position; Halt = 1 motor speed is 0;
Bit12	Set-point acknowledge	0: The target position is pending; 1: The target position has taken effect;
Bit15	Pend	0: Not in position; 1: In position.

3.3.2 Profile Position Mode Configuration Routine

Make the motor run relatively based on the parameters (acceleration time 100ms, deceleration time 100ms, maximum speed 60r / min, total pulse number 3200).

※ Assume that the slave station number of the driver is 1. CANopen instruction control is described in the following table:

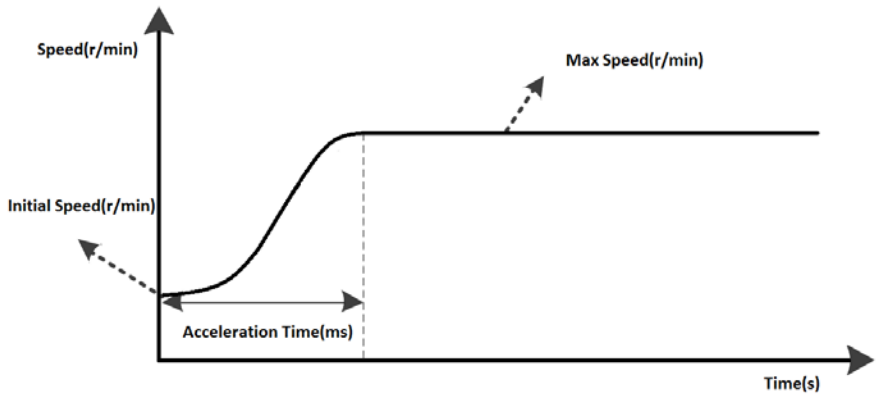
Master Station	Slave Station	Function Description
601: 2B 40 60 00 00 00 00 00	581: 60 40 60 00 00 00 00 00	Initialize the driver state machine
601: 23 83 60 00 64 00 00 00	581: 60 83 60 00 00 00 00 00	Set acceleration time to 100ms
601: 23 84 60 00 64 00 00 00	581: 60 84 60 00 00 00 00 00	Set deceleration time to 100ms
601: 23 81 60 00 3C 00 00 00	581: 60 81 60 00 00 00 00 00	Set maximum speed 60r/min
601: 23 7A 60 00 80 0C 00 00	581: 60 7A 60 00 00 00 00 00	Set the total pulse number 3200
601: 2F 60 60 00 01 00 00 00	581: 60 60 60 00 00 00 00 00	Switch operation mode 01 Profile position mode
601: 2B 40 60 00 06 00 00 00	581: 60 40 60 00 00 00 00 00	Switch the driver state machine (Refer to 402 protocol)
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	
601: 2B 40 60 00 4F 00 00 00	581: 60 40 60 00 00 00 00 00	Send relative motion command 1
601: 2B 40 60 00 5F 00 00 00	581: 60 40 60 00 00 00 00 00	Send relative motion command 2

Note: The target position must be written after the mode is set!

3.4. PROFILE VELOCITY MODE

3.4.1 Profile Velocity Mode Description

The acceleration curve in Profile velocity mode is shown in the figure below. Differ from Profile position mode, Profile velocity mode only needs to set 3 parameters: initial speed (address 200800h), target speed (address 608100h), acceleration time (address 608300h). After the motor accelerates to the maximum speed according to set 3 parameters , it will run uniformly at the maximum speed.



Profile Velocity Mode acceleration curve

※ Related Object Dictionary Content

Index	Sub-Index	Name	Type	Attribute	Parameter Range	Setting
6060h	00	Operation mode	I8	RW	0,1,3,6	3
2008h	00	Initial Speed	U16	RW	2-300 r/min	5 r/min
60FFh	00	Target Speed	I32	RW	-3000 r/min~3000 r/min	120 r/min
6083h	00	Acceleration Time	U32	RW	0-2000ms	100ms
6084h	00	Deceleration Time	U32	RW	0-2000ms	100ms

□

Control word and Status word

※Control word in profile velocity mode is controlled by bit8

Byte	Name	Function Description
Bit8	Halt	0: Implement motion; 1: Stop motion.

※ Bit10 and Bit12 of status word display driver status

Byte	Name	Function Description
Bit10	Target reached	0: Halt = 0 target speed has not been reached; Halt = 1 motor is decelerating; 1: Halt = 0 reach target speed; Halt = 1 motor speed is 0;
Bit12	Speed	0: Speed is not 0; 1: Speed is 0.

3.4.2 Profile Velocity Mode Configuration Routine

Make the motor run based on the parameters (acceleration time 100ms, deceleration time 100ms, maximum speed 60r/min).

※ Assume that the slave station number of the driver is 1. CANopen instruction control is described in the following table:

Master Station	Slave Station	Function Description
601: 2B 40 60 00 00 00 00 00	581: 60 40 60 00 00 00 00 00	Initialize the driver state machine
601: 23 83 60 00 64 00 00 00	581: 60 83 60 00 00 00 00 00	Set acceleration time to 100ms
601: 23 84 60 00 64 00 00 00	581: 60 84 60 00 00 00 00 00	Set deceleration time to 100ms
601: 23 FF 60 00 3C 00 00 00	581: 60 81 60 00 00 00 00 00	Set target speed 60rpm
601: 2F 60 60 00 03 00 00 00	581: 60 60 60 00 00 00 00 00	Switch operation mode 03 Speed mode
601: 2B 40 60 00 06 00 00 00	581: 60 40 60 00 00 00 00 00	Switch the driver state machine (Refer to 402 protocol)
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	

Note: The target speed must be written after the mode is set!

3.5. PROFILE TORQUE MODE

3.5.1 Profile Torque Mode Description

In Profile torque mode, the value of operation mode object 6060h needs to be set to 4. When the operation mode status reads the register of object 6061h as 4, the relevant operations of HM operation mode can be performed. The objects involved in this mode are as follows:

※ Related Object Dictionary Content

Index	Sub-Index	Name	Type	Attribute	Parameter Range	Setting
6060h	00	Operation mode	I8	RW	0,1,3,4	4
6071h	00	Target torque	I32	RW	-30000mA~30000 mA	0 mA
6083h	00	Acceleration time	U32	RW	0-2000ms	100ms

□

Control word and Status word

※ Control word in profile torque mode is controlled by bit8

Type	Name	Function Description
Bit8	Halt	0: Implement motion; 1: Stop motion.

※ Bit10 and Bit12 of status word display driver status

Type	Name	Function Description
Bit8	Torque attained	0: torque has not been attained; 1: attain torque;
Bit10	Target reached	0: Halt = 0 target torque has not been reached; Halt = 1 motor is acceleration; 1: Halt = 0 reach target torque; Halt = 1 motor speed is 0;

3.5.2 Profile Torque Mode Configuration Routine

Complete torque work, target torque is 100mA.

※ Assume that the slave station number of the driver is 4. CANopen instruction control is described in the following table:

Master Station	*Slave Station*	Function Description
604: 2B 40 60 00 00 00 00 00	584: 60 40 60 00 00 00 00 00	Initialize the driver state machine
604: 23 87 60 00 64 00 00 00	584: 60 9A 60 00 00 00 00 00	Set torque deceleration time to 100ms
604:	584:	Switch operation mode

2F 60 60 00 04 00 00 00	60 60 60 00 00 00 00 00	04 Profile torque mode
604: 2B 40 60 00 06 00 00 00	584: 60 40 60 00 00 00 00 00	Switch the driver state machine (Refer to 402 protocol)
604: 2B 40 60 00 07 00 00 00	584: 60 40 60 00 00 00 00 00	
604: 2B 40 60 00 0F 00 00 00	584: 60 40 60 00 00 00 00 00	
604: 2B 71 60 00 E8 03 00 00	584: 60 71 60 00 00 00 00 00	Set target torque to 1000mA

Note: the target torque must be written after the mode is set!

3.6. Emergency Stop Instruction

Master Station	Slave Station	Function Description
604: 2B 40 60 00 02 00 00 00	584: 60 40 60 00 00 00 00 00	The motor stops and keeps the shaft locked

Note: Clear the target value after emergency stop!

Release emergency stop under velocity mode:

Master Station	Slave Station	Function Description
604: 2B 40 60 00 0F 00 00 00	584: 60 40 60 00 00 00 00 00	Driver enable
604: 23 FF 60 00 3C 00 00 00	584: 60 23 FF 00 00 00 00 00	Target speed

Note: The second command rewrites the target speed!

Release emergency stop under relative position mode:

Master Station	Slave Station	Function description
604: 2B 40 60 00 0F 00 00 00	584: 60 40 60 00 00 00 00 00	Driver enable
604: 23 7A 60 00 00 7D 00 00	584: 60 7A 60 00 00 00 00 00	Set target postion 32000
604: 2B 40 60 00 4F 00 00 00	584: 60 40 60 00 00 00 00 00	Relative position operation
604: 2B 40 60 00 5F 00 00 00	584: 60 40 60 00 00 00 00 00	

Note: The target position must be sent before "Relative position operation"!

Release emergency stop under absolute position mode:

Master Station	Slave Station	Function description
604: 2B 40 60 00 0F 00 00 00	584: 60 40 60 00 00 00 00 00	Driver enable
604: 2B 40 60 00 1F 00 00 00	584: 60 40 60 00 00 00 00 00	Absolute position operation

Note: After the second command is sent, the motor will run at the last target position!

Release emergency stop under torque mode:

Master Station	Slave Station	Function description
604: 2B 40 60 00 0F 00 00 00	584: 60 40 60 00 00 00 00 00	Set target torque 1000
604: 2B 71 60 00 E8 03 00 00	584: 60 71 60 00 00 00 00 00	Driver enable

Note: The target torque must be before the enable command, otherwise the output current of the motor is 0, and the motor lock is released!

3.7 Clear the fault

Master Station	Slave Station	Function description
604: 2B 40 60 00 80 00 00 00	584: 60 40 60 00 00 00 00 00	Clear the fault

Note: Clear the target value after emergency stop!

4. OBJECT DICTIONARY

ZLAC8015 series bus type servo driver parameter register includes 3 parts: 1000h-1FFFh register defined by CIA301, 2000h-2FFFh register defined by the manufacturer and 6000h-6FFFh register defined by CIA402.

1000h-1FFFh register is CANopen related basic communication parameter defined by CIA301, including SDO, PDO, and mapping register.

2000h-2FFFh register is a manufacturer-defined register content, subdivision and current modification could be implemented within this group of parameters.

6000h-6FFFh register is motion parameter related to motion control defined by CIA402, including profile position mode, profile velocity mode, profile torque mode, other operation mode registers, and related motion parameter registers.

Index	Sub-Index	Name	Description	Type	Attribute	PDO Mapping	Default
CiA301 Basic Communication Parameter Group							
1000h	00	Equipment type	This device supports	U32	RO	NO	0X00040192

			CiA301, CiA402 protocol				
1001h	00	Error register	Driver current error status	U8	RO	NO	0
1005h	00	Synchronous message COB identifier	Synchronous message COB identifier	U32	RW	NO	0x80
1009h	00	Hardware version	Hardware version	U16	RO	NO	-
100Ah	00	Hardware version	Hardware version	U16	RO	NO	-
1014h	00	COB-ID emmergency	COB-ID emmergency	U32	RW	NO	0x80
1017h	00	Producer heartbeat interval	Producer heartbeat interval, unit: 0.5ms	U16	RW/S	NO	0
1018h	00	Manufacturer Information	Sub-index	U8	RO	NO	5
	01	Vendor ID	Vendor ID	U32	RO	NO	0x0100
	02	Product Code	Product Code	U32	RO	NO	0x0001
1200h	00	Number of sub-indexes	Number of sub-indexes	U8	RO	NO	2
	01	COB-ID (Slave station receives)	COB-ID (Slave station receives)	U32	RO	NO	600h+Node-ID
	02	COB-ID (Slave station sends)	COB-ID (Slave station sends)	U32	RO	NO	580h+Node-ID
1400h	00	Number of sub-indexes	Number of sub-indexes	U8	RO	NO	5
	01	RPDO0-COB-ID	Identifier COB-ID	U32	RO	NO	200+Node-ID
	02	Transmission type	Transmission type	U8	RW/S	NO	FFh
	03	Prohibition time	Prohibition time	U16	RW/S	NO	0
	04	Maintain	Maintain	U8	RW	NO	0
	05	Event timer	Event timer	U16	RW/S	NO	0
1401h	00	Number of sub-indexes	Number of sub-indexes	U8	RO	NO	5
	01	RPDO1-COB-ID	Identifier COB-ID	U32	RO	NO	300+Node-ID
	02	Transmission type	Transmission type	U8	RW/S	NO	FFh
	03	Prohibition time	Prohibition time	U16	RW/S	NO	0
	04	Maintain	Maintain	U8	RW	NO	0
	05	Event timer	Event timer	U16	RW/S	NO	0
1402h	00	Number of sub-indexes	Number of sub-indexes	U8	RO	NO	5
	01	RPDO2-COB-ID	Identifier COB-ID	U32	RO	NO	400+Node-ID
	02	Transmission type	Transmission type	U8	RW/S	NO	FFh
	03	Prohibition time	Prohibition time	U16	RW/S	NO	0
	04	Maintain	Maintain	U8	RW	NO	0
	05	Event timer	Event timer	U16	RW/S	NO	0
1403h	00	Number of sub-indexes	Number of sub-indexes	U8	RO	NO	5
	01	RPDO3-COB-ID	Identifier COB-ID	U32	RO	NO	500+Node-ID
	02	Transmission type	Transmission type	U8	RW/S	NO	FFh
	03	Prohibition time	Prohibition time	U16	RW/S	NO	0
	04	Maintain	Maintain	U8	RW	NO	0
	05	Event timer	Event timer	U16	RW/S	NO	0

1600h	00	Number of sub-indexes	Number of sub-indexes	U8	RO	NO	1
	01	RPDO0-mapping 1	Map to 6040h register	U32	RW/S	NO	60400010h
	02	RPDO0-mapping 2	Not mapped	U32	RW/S	NO	-
	03	RPDO0-mapping 3	Not mapped	U32	RW/S	NO	-
	04	RPDO0-mapping 4	Not mapped	U32	RW/S	NO	-
1601h	00	Number of sub-indexes	Number of sub-indexes	U8	RO	NO	0
	01	RPDO1-mapping 1	Not mapped	U32	RW/S	NO	-
	02	RPDO1-mapping 2	Not mapped	U32	RW/S	NO	-
	03	RPDO1-mapping 3	Not mapped	U32	RW/S	NO	-
	04	RPDO1-mapping 4	Not mapped	U32	RW/S	NO	-
1602h	00	Number of sub-indexes	Number of sub-indexes	U8	RO	NO	0
	01	RPDO2-mapping 1	Not mapped	U32	RW/S	NO	-
	02	RPDO2-mapping 2	Not mapped	U32	RW/S	NO	-
	03	RPDO2-mapping 3	Not mapped	U32	RW/S	NO	-
	04	RPDO2-mapping 4	Not mapped	U32	RW/S	NO	-
1603h	00	Number of sub-indexes	Number of sub-indexes	U8	RO	NO	0
	01	RPDO3-mapping 1	Not mapped	U32	RW/S	NO	-
	02	RPDO3-mapping 2	Not mapped	U32	RW/S	NO	-
	03	RPDO3-mapping 3	Not mapped	U32	RW/S	NO	-
	04	RPDO3-mapping 4	Not mapped	U32	RW/S	NO	-
1800h	00	Number of sub-indexes	Number of sub-indexes	U8	RO	NO	5
	01	TPDO0-COB-ID	Identifier COB-ID	U32	RO	NO	180+Node-ID
	02	Transmission type	Transmission type	U8	RW/S	NO	FFh
	03	Prohibition time	Prohibition time	U16	RW/S	NO	0
	04	Maintain	Maintain	U8	RW	NO	0
	05	Event timer	Event timer	U16	RW/S	NO	0
1801h	00	Number of sub-indexes	Number of sub-indexes	U8	RO	NO	5
	01	TPDO1-COB-ID	Identifier COB-ID	U32	RO	NO	280+Node-ID
	02	Transmission type	Transmission type	U8	RW/S	NO	FFh
	03	Prohibition time	Prohibition time	U16	RW/S	NO	0
	04	Maintain	Maintain	U8	RW	NO	0
	05	Event timer	Event timer	U16	RW/S	NO	0
1802h	00	Number of sub-indexes	Number of sub-indexes	U8	RO	NO	5
	01	TPDO2-COB-ID	Identifier COB-ID	U32	RO	NO	380+Node-ID
	02	Transmission type	Transmission type	U8	RW/S	NO	FFh
	03	Prohibition time	Prohibition time	U16	RW/S	NO	0
	04	Maintain	Maintain	U8	RW	NO	0
	05	Event timer	Event timer	U16	RW/S	NO	0
1803h	00	Number of sub-indexes	Number of sub-indexes	U8	RO	NO	5
	01	TPDO3-COB-ID	Identifier COB-ID	U32	RO	NO	480+Node-ID
	02	Transmission type	Transmission type	U8	RW/S	NO	FFh
	03	Prohibition time	Prohibition time	U16	RW/S	NO	0

	04	Maintain	Maintain	U8	RW	NO	0
	05	Event timer	Event timer	U16	RW/S	NO	0
1A00h	00	Number of sub-indexes	Number of sub-indexes	U8	RO	NO	0
	01	RPDO1-mapping 1	Not mapped	U32	RW/S	NO	-
	02	RPDO1-mapping 2	Not mapped	U32	RW/S	NO	-
	03	RPDO1-mapping 3	Not mapped	U32	RW/S	NO	-
	04	RPDO1-mapping 4	Not mapped	U32	RW/S	NO	-
1A01h	00	Number of sub-indexes	Number of sub-indexes	U8	RO	NO	0
	01	RPDO1-mapping 1	Not mapped	U32	RW/S	NO	-
	02	RPDO1-mapping 2	Not mapped	U32	RW/S	NO	-
	03	RPDO1-mapping 3	Not mapped	U32	RW/S	NO	-
	04	RPDO1-mapping 4	Not mapped	U32	RW/S	NO	-
1A02h	00	Number of sub-indexes	Number of sub-indexes	U8	RO	NO	0
	01	RPDO2-mapping 1	Not mapped	U32	RW/S	NO	-
	02	RPDO2-mapping 2	Not mapped	U32	RW/S	NO	-
	03	RPDO2-mapping 3	Not mapped	U32	RW/S	NO	-
	04	RPDO2-mapping 4	Not mapped	U32	RW/S	NO	-
1A03h	00	Number of sub-indexes	Number of sub-indexes	U8	RO	NO	0
	01	RPDO3-mapping 1	Not mapped	U32	RW/S	NO	-
	02	RPDO3-mapping 2	Not mapped	U32	RW/S	NO	-
	03	RPDO3-mapping 3	Not mapped	U32	RW/S	NO	-
	04	RPDO3-mapping 4	Not mapped	U32	RW/S	NO	-
Factory Custom Parameter Group							
2000h	00	Communication offline time	Driver and host communication offline time setting. Unit: ms Range: 0-32767;	U16	RW/S	YES	1000
2003h	00	Input signal status	2 input signal level status; Bit0-Bit1: X0-X1 input level status;	U16	RO	YES	0
2004h	00	Output signal status	2 output signal level status; Bit0-Bit1: Y0-Y1 output status;	U16	RO	YES	0
2005h	00	Clear feedback position	Used to clear feedback position in profile position mode 0: invalid; 1: clear the feedback position; Not saved.	U16	RW	YES	0
2006h	00	In absolute position	Used to clear the current	U16	RW	YES	0

		mode, clear the current position	position in absolute position mode 0: invalid; 1: clear the current position;				
2007h	00	Limit packing mode	0: stop; 1: emergency stop; 2: invalid;	U16	RW/S	YES	0
2008h	00	Initial speed	The initial speed at which the movement begins; Unit: r/min; Range: 1-300 r/min;	U16	RW/S	YES	1r/min
2009h	00	Register parameter setting	0: invalid; 1: restore factory settings; 2: save all RW attribute parameters to EEPROM;	U16	RW	YES	0
200Ah	00	Maximum speed of motor	Maximum motion speed of the motor Unit: r/min; Range: 1-1000 r/min;	U16	RW/S	YES	1000
200Bh	00	Encoder wire setting	0-4096	U16	RW/S	YES	1024
200Ch	00	Motor pole pairs	4-64	U16	RW/S	YES	15
200Dh	00	CAN custom driver node number	When the external DIP switch is 0, CAN address could be set to 4-127;	U16	RW/S	YES	4
200Eh	00	CAN custom communication high baud rate	0：1000 Kbit/s 1：500 Kbit/s 2：250 Kbit/s 3：125 Kbit/s 4：100 Kbit/s 5：50 Kbit/s 6：25 Kbit/s	U16	RW/S	YES	1
200Fh	00	Shaft lock method when power-on	0: not enable, not lock the shaft; 1: not enable, lock the shaft;	U16	RW/S	YES	0
2010h	00	Whether save RW/S parameters in EEPROM synchronously	Whether the communication write function code value will be updated to EEPROM. 0: Parameters with attribute RW/S will be updated to EEPROM synchronously;	U16	RW	YES	0

			1: Not update;				
2011h	00	Offset angle of motor and Hall	Unit: 1°; Range: -360~+360.	I16	RW/S	YES	0
2012h	00	Overload factor	Range 0-300, Unit: %;	U16	RW/S	YES	200
2013h	00	Motor temperature protection threshold	Unit: 0.1°C; Range: 0-1200 (* 0.1)	U16	RW/S	YES	800
2014h	00	Rated current	The rated current output by the driver Unit: 0.1A; Range: 0-150.	U16	RW/S	YES	150
2015h	00	Maximum current	Maximum current output by the driver Unit: 0.1A; Range: 0-300.	U16	RW/S	YES	300
2016h	00	Overload protection time	Driver overload protection time Unit: 10ms; Range: 0-6553.	U16	RW/S	YES	300
2017h	00	Out-of-tolerance alarm threshold	Encoder out-of-tolerance threshold Unit: *10counts; Range: 1-6553.	U16	RW/S	YES	409
2018h	00	Velocity smoothing factor	0-30000	U16	RW/S	YES	1000
2019h	00	Current loop proportional coefficient	0-30000	U16	RW/S	YES	600
201Ah	00	Current loop integral gain	0-30000	U16	RW/S	YES	300
201Bh	00	Feedforward output smoothing coefficient	0-30000	U16	RW/S	YES	100
201Ch	00	Torque output smoothing factor	0-30000	U16	RW/S	YES	100
201Dh	00	Speed proportional gain Kp	0-30000	U16	RW/S	YES	500
201Eh	00	Speed integral gain Ki	0-30000	U16	RW/S	YES	100
201Fh	00	Speed feedforward gain Kf	0-30000	U16	RW/S	YES	1000
2020h	00	Position proportional gain Kp	0-30000	U16	RW/S	YES	50
2021h	00	Position feedforward gain Kf	0-30000	U16	RW/S	YES	200
2022h	00	RS485 custom driver node number	When the external DIP switch is 0, CANopen address could be set to	U16	RW/S	YES	4

			4-127; When the external DIP switch is 1-3, this bit is invalid.				
2023h	00	RS485 custom communication high baud rate	0：256000bps 1：128000bps 2：115200bps 3：57600bps 4：38400bps 5：19200bps 6：9600bps	U16	RW/S	YES	2
2025h	00	Software version	Factory default	U16	RO	NO	-
2026h	00	Motor temperature	Unit: 0.1°C; Range: 0-120°C	U16	RO	YES	800
2027h	00	Motor status register	Driver controls motor movement 0: motor is stationary; 1: motor is running;	U16	RO	YES	0
2028h	00	Hall input status	0-7; If 0 or 7 appears, there is Hall error.	U16	RO	YES	0
2029h	00	Bus voltage	Unit: 0.01V	U16	RO	YES	0
202Fh	00	Number of sub-indexes	Number of sub-indexes	U16	RO	YES	2
	01	Alarm PWM processing method	0: close; 1: open	U16	RW	YES	0
	02	Overload processing method	0: close; 1: open	U16	RW	YES	0
2030h	00	Number of sub-indexes	Number of sub-indexes	U16	RO	NO	16
	01	Input terminal effective level	Bit0: input terminal X0 control bit; Bit1: input terminal X1 control bit; Bit2 ~ Bit15: maintain; 0: default; 1: level reversal; The driver defaults that the input terminal level rising edge or high level is effective;	U16	RW/S	YES	0
	02	Input terminal X0 terminal function selection	0: undefined; 1-6: NC; 9: emergency stop signal;	U16	RW/S	YES	9
	03	Input terminal X1 terminal function		U16	RW/S	YES	0

		selection					
	04	NC		U16	RW/S	YES	0
	05	NC		U16	RW/S	YES	0
	0C	Output terminal effective level	Bit0: output terminal Y0 control bit; Bit1: Y1 control bit of output terminal; 0: default; 1: level inversion; The driver's default input terminal level rising edge or high level is valid;	U16	RW/S	YES	0
	0D	Output terminal Y0 terminal function selection	0: undefined 1: alarm signal; 2: drive status signal; 3: NC; 4: In position signal;	U16	RW/S	YES	1
	0E	Output terminal Y1 terminal function selection	Holding brake open/close 0: open 1: close;	U16	RW	YES	0
CiA 402 Parameter Group							
603Fh	00	Driver last fault code	Factory-defined drive error conditions. 0000h: no errors; FF01h: overvoltage; FF02h: undervoltage; FF04h: overcurrent; 0008h: overload; 0010h: current out-of-tolerance; 0020h: encoder out-of-tolerance; 0040h: speed out-of-tolerance; 0080h：reference voltage error; FF10h: EEPROM read and write errors; 0200h: Hall error;	U16	RO	YES	0
6040h	00	Control word	Control word	U16	RW	YES	0
6041h	00	Status word	Status word	U16	RO	YES	0
605Ah	00	Quick stop code	Driver processing method after quick stop command 5: stop normally, maintain	I16	RW	NO	5

			quick stop state; 6: decelerate suddenly to stop, maintain quick stop state; 7: emergency stop, maintain quick stop state;				
605Bh	00	Close operation code	Driver processing method after close command 0: invalid; 1: stop normally, turn to ready to switch on state;	I16	RW	NO	1
605Ch	00	Disable operation code	Driver processing method after disable operation command 0: Invalid; 1: stop normally , switch to switched on state;	I16	RW	NO	1
605Dh	00	Halt control register	Driver processing method after the control word Halt command 0: stop normally, maintaining Operation Enabled state; 2: decelerate suddenly stop, maintain Operation Enabled state; 3: emergency stop, maintain Operation Enabled state;	I16	RW	NO	1
6060h	00	Operating mode	0: undefined; 1: profile position mode; 3: profile velocity mode; 6: profile torque mode;	I8	RW	YES	0
6061h	00	Operating mode status	0: undefined; 1: profile position mode; 3: profile velocity mode; 6: profile torque mode;	I8	RO	YES	0
6064h	00	Actual position feedback	Actual position feedback, unit: counts;	I32	RO	YES	0
606Ch	00	Actual speed feedback	Current motor speed, Unit: 0.1r/min	I32	RO	YES	0
6071h	00	Target torque	Unit: mA; Range: -30000~30000;	I16	RW	YES	0
6074h	00	Real-time target torque	Unit: mA;	I16	RO	YES	0

			Range:-30000~30000;				
6077h	00	Real-time torque feedback	Unit: 0.1A; Range: -300~300;	I16	RO	YES	0
607Ah	00	Target position	Total number of pulses in profile position mode; Range: -1000000~1000000;	I32	RW	YES	0
6081h	00	Max speed	Speed in profile position mode; Range: 1-1000r/min;	U32	RW	YES	120r/min
6082h	00	Start / stop speed in profile position mode	Start / stop speed in profile position mode; Range: 1-1000r/min;	U32	RW	YES	1r/min
6083h	00	S-shaped acceleration time	acceleration time; Range: 0-32767ms;	U32	RW	YES	500ms
6084h	00	S-shaped deceleration time	Deceleration time; Range: 0-32767ms;	U32	RW	YES	500ms
6085h	00	Emergency stop deceleration time	Deceleration time; Range: 0-32767ms;	U32	RW	YES	10ms
6087h	00	Torque slope	Current/1000/second; Unit: mA/s;	U32	RW	YES	300ms
60FFh	00	Target speed	Target speed in profile velocity mode; Range: -1000~1000r/min;	I32	RW	YES	0

Note:

- U16 means unsigned 16 bits; I16 means signed 16 bits; U32 means unsigned 32 bits; I32 means signed 32 bits.

Notice:

Alarm PWM processing method: After the driver enters the alarm state, the upper tube is turned off and the lower tube is turned on (short-circuit motor 3 power cables).

Overload processing method: for example, the motor I^2t time is 20s, the duration of double overload is 6 seconds, and the duration of triple overload is 4 seconds.