Technical Guide

SV-DA200 Series

AC Servo Drive

——EtherCAT

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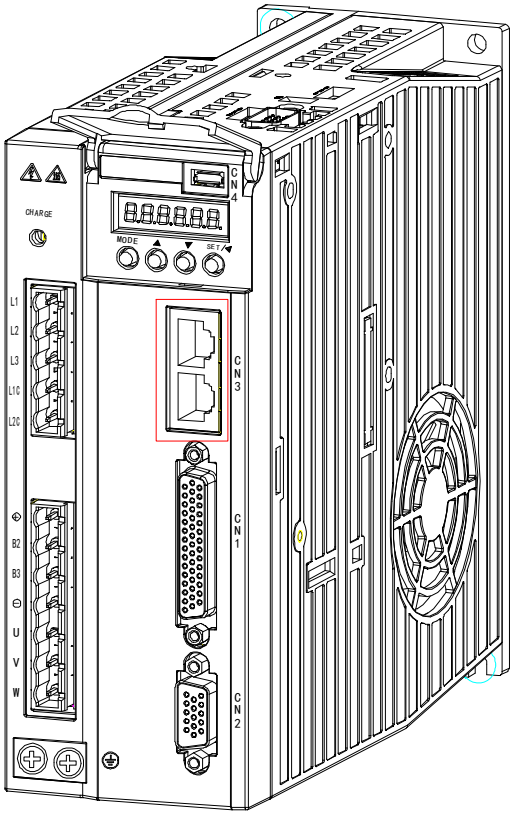
Content

1 Hardware configuration

1.1 Terminal wiring

The EtherCAT communication card of SV-DA200 servo drive adopts external connection mode. The front view of the communication card is shown as below. CN3 terminal is the connection terminal of EtherCAT. The Line connecting mode of CN3 terminal is top-in and bottom-out.



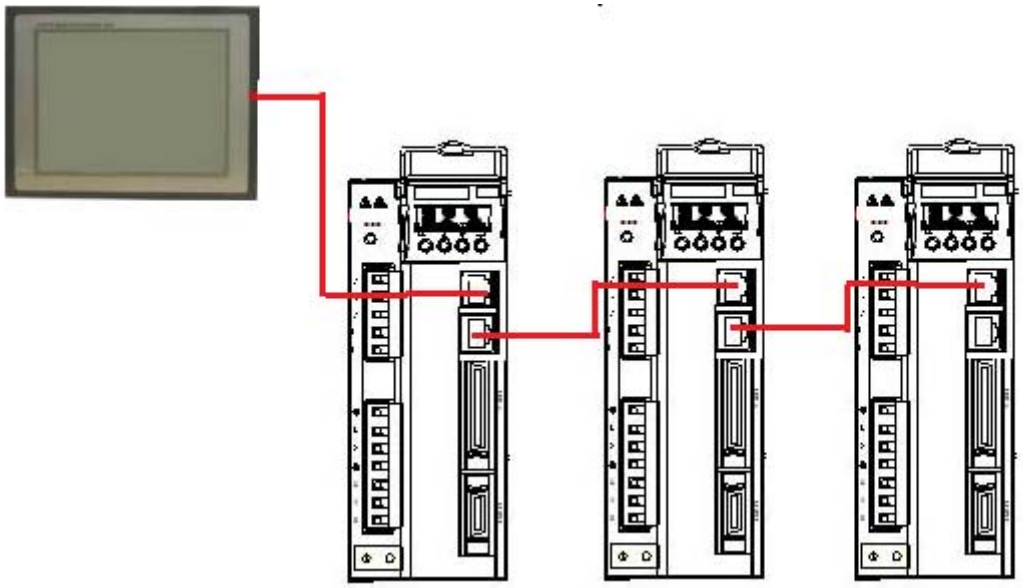
Pins assignment of RJ45 connectors

Pin no.	Signal name	Abbreviation	Signal direction
1	Send data+	TD+	Output
2	Send data-	TD-	Output
3	Receive data+	RD+	Input
4	-	NC*	-
5	-	NC	-
6	Receive data-	RD-	Input
7	-	NC	-
8	-	NC	-

*:NC is unused.

1.2 Drive wiring

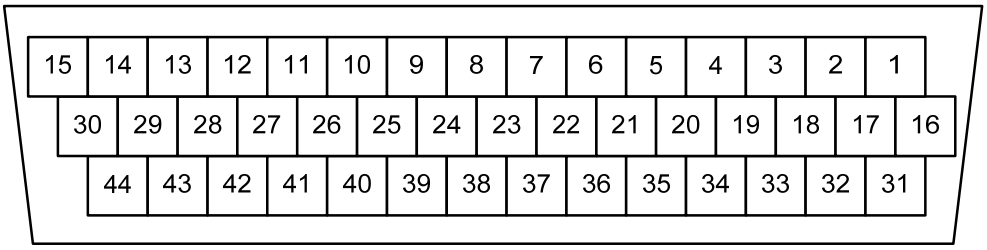
EtherCAT network is normally comprised of one master (IPC or CNC) and multiple slaves (servo drive or bus extension terminal). Each EtherCAT slave carries two standard Ethernet interfaces. The wiring diagram is shown below:



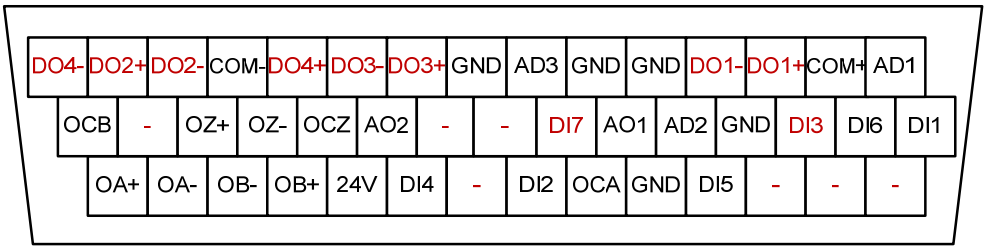
1.3 CN1 Terminal Definition and Wiring

The IO of the DA200 EtherCAT type is different from the standard type, the pin of the medium power range (7.5kW~22kW) CN1 terminal (DB44) is defined as follows (red font for the difference to the standard type), the CN1 terminal pin 1 of the small power range (0.1kW~5.5kW) of the EtherCAT type is reserved, the other pins are in agreement with the medium power range.

引脚号	符号	功能名称	引脚号	符号	功能名称
1	AD1	Analog input 1	23	-	（Reserved）
2	COM+	DI input common port	24	-	（Reserved）
3	DO1+	Digital output 1+	25	AO2	Analog output 2
4	DO1-	Digital output 1-	26	OCZ	Open collector output of Z phase
5	GND	Analog signal ground	27	OZ-	Differential output - of Z phase
6	GND	Analog signal ground	28	OZ+	Differential output + of Z phase
7	AD3	Analog input 3	29	-	（Reserved）
8	GND	Analog signal ground	30	OCB	Open collector output of B phase
9	DO3+	Digital output 3+	31	-	（Reserved）
10	DO3-	Digital output 3-	32	-	（Reserved）
11	DO4+	Digital output 4+	33	-	（Reserved）
12	COM-	DO output common port	34	DI5	Digital input 5
13	DO2-	Digital output 2-	35	GND	Analog signal ground
14	DO2+	Digital output 2+	36	OCA	Open collector output of A phase
15	DO4-	Digital output 4-	37	DI2	Digital input 2
16	DI1	Digital input 1	38	-	（Reserved）
17	DI6	Digital input 6	39	DI4	Digital input 4
18	DI3	Digital input 3	40	+24V	Internal 24V power supply
19	GND	Analog signal ground	41	OB+	Differential output + of B phase
20	AD2	Analog input 2	42	OB-	Differential output - of B phase
21	AO1	Analog output 1	43	OA-	Differential output - of A phase
22	DI7	Digital input 7	44	OA+	Differential output + of A phase



CN1 pin arrangement

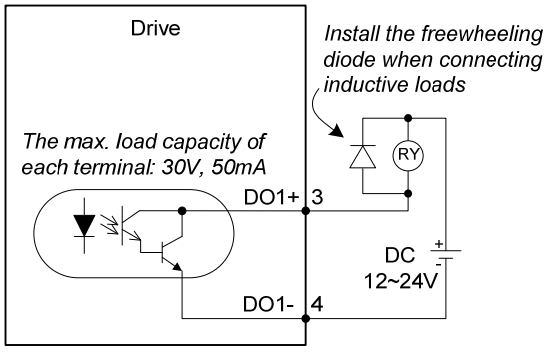


CN1 signal arrangement

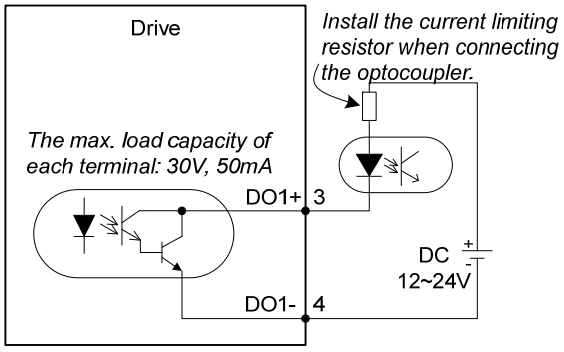
EtherCAT type have 3 analog inputs (AD1 is a 16 bit analog input, however, the small power range does not have this input, so the pin 1 of the CN1 is reversed); 2 analog outputs; 7 adigital inputs; 4 4 groups of differential adigital output. The external wiring of the analog inputs/outputs and the adigital inputs is similar to standard type, please refer to the 4.5 chapter of the DA200 manual for details.

The external wiring of the adigital inputs outputs is connected as follows, taking DO1 for example:

Connection diagram when the power supply is self-provided by user:

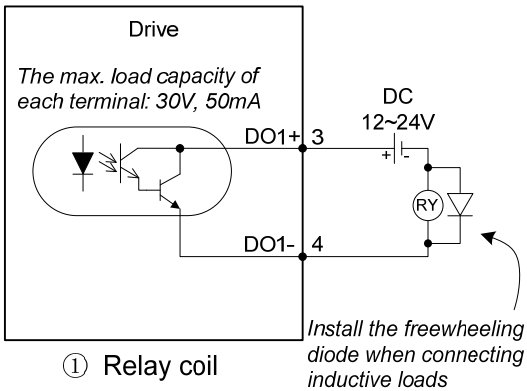


① Relay coil

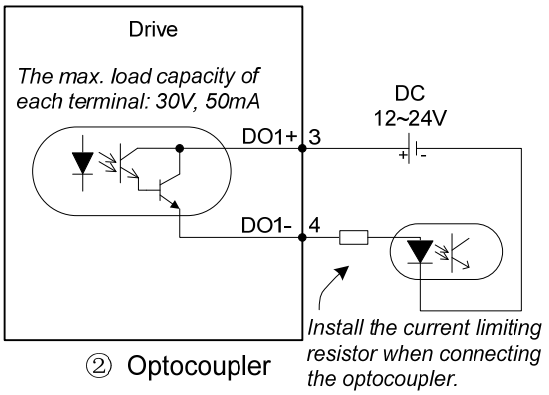


② Optocoupler

also connect as follows:

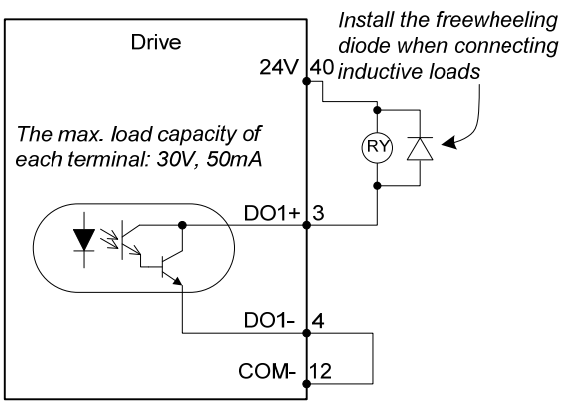


① Relay coil

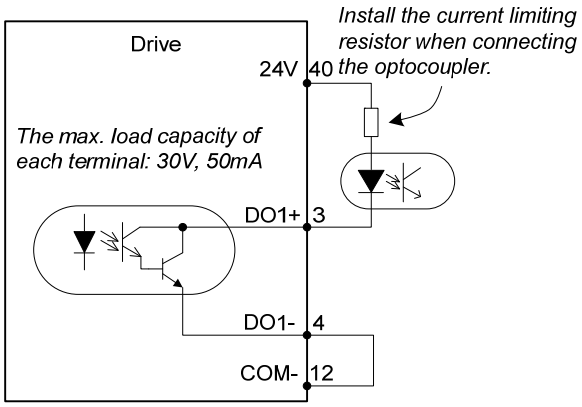


② Optocoupler

Connection method when the local power supply is used:

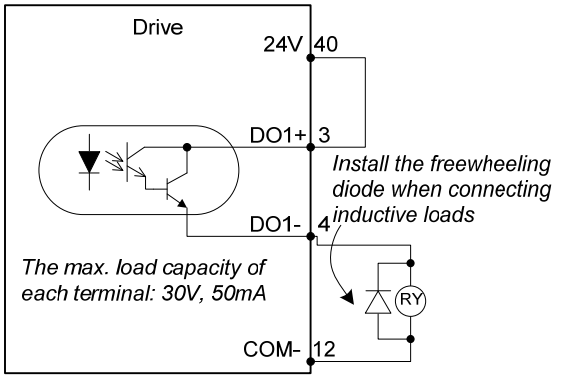


① Relay coil

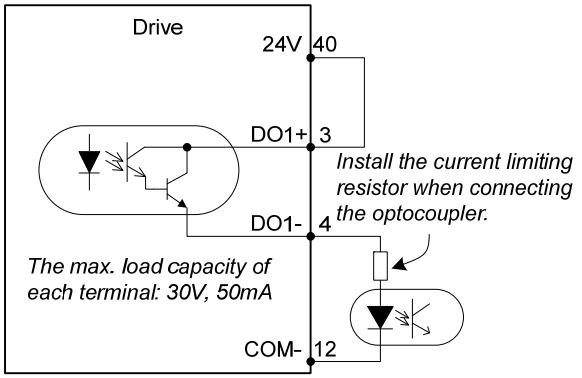


② Optocoupler

also connect as follows:



① Relay coil



② Optocoupler

2 Software configuration

2.1 Basic setup of EtherCAT application

It is necessary to configure the following parameters before conducting EtherCAT application with SV-DA200 servo drive:

1. Set P0.03[control mode] to 8 [EtherCAT mode] via LED panel or ServoPlorer;
2. Set P4.08 [EtherCAT synchronization type] via LED panel or ServoPlorer (0: Free-Run; 2: DC Sync0);
3. Set P4.07 [EtherCAT synchronization cycle] via LED panel or ServoPlorer (0:250us; 1:500us; 2:1ms; 3:2ms; 4:4ms; 5:8ms);
4. Set P4.09 [EtherCAT fault detection time] via LED panel or ServoPlorer (Set the detection time of offline fault or PDO data loss fault as needed);
5. Set P4.25 [EtherCAT control unit type] via LED panel or ServoPlorer (0: Manufacturer mode; 1: CIA402 Unit; 2: CIA402 OMRON);
6. Set P4.26 [EtherCAT PDO input offset] via LED panel or ServoPlorer (0-63, unit: 125us);
7. Set P4.27 [compensation value of EtherCAT position interpolation mode] via LED panel or ServoPlorer(0-10);

Note:

1. As the first four configuration parameters can only be effective at next startup, a re-power on or soft reset is necessary after modification. The last three parameters are instantly effective;
2. When control mode (0x6040) is set to position Interpolation mode (8), P4.07 [EtherCAT sync cycle] is the same with CNC interpolation cycle;
3. The meaning of P4.25 [EtherCAT control unit type]:
   0: Manufacturer mode: support twincat NC function of Beckhoff;
   Position unit is pulse, speed unit is rpm, acceleration unit is ms (the time needed for accelerating from zero speed to rated motor speed);
   Support the touch probe of z SIGNAL. The capture value of external IO is stored in manufacturer parameters.
   1: CIA402 Unit: support most of motion controllers eg. CodeSys, BaoYuan and ACS EtherCAT master;
   Position unit is pulse, speed unit is pulse/s and acceleration unit is pulse/s²;
   Support touch probe of z signal and standard touch probe 1 IO capture.
   2: CIA402 OMRON: support OMRON NJ controller;
   Modify 0x6041 status word feedback parameters to satisfy OMRON NJ requirement on status word.
4. The default pulse per revolution of DA200 is 10000, which can be modified by P0.22 [pulse per revolution of motor] or by modifying P0.25 [numerator of electric gear ratio] and P0.26 [denominator of electric gear ratio] after setting P0.22 to 0. Please note that the modification of P0.22 will be effective after reset and the value defined with P0.22 should not exceed the actual resolution rate of the encoder.
5. P4.26 and P4.27 need to be modified only when master cycle is unstable or packet loss or other problems occurred to communication;
6. P4.26 [EtherCAT PDO input offset] is used to adjust the time from receiving DC signal to processing PDO, thus PDO input time can be in the middle of master cycle, reducing the data loss caused by unstable master clock; this parameter needs to be set according to the cycle of P4.07. If P4.07 is 1ms, then the range of P4.26 is 0-7; 0 means no offset; 7 means 7*125us offset; the actual set value should be based on actual conditions with the purpose of achieving stable data-receiving.
7. P4.27 [compensation value of EtherCAT position interpolation mode] is effective only when it is under DC mode and control mode is position interpolation mode (8), this is to ensure that

position command smoothing effect can be achieved by adding position command forecast function if one or multiple cycle position command are lost, with precondition that P4.26 is set properly. If it is set to non-zero, compensation will be made based on previous position increment when position command loss occurred, and the compensation cycle is equal to the value defined with P4.27;

8. The torque limit parameters in PDO parameter list in EtherCAT xml configuration file of DA200, if any, should be set to non-zero, otherwise the servo torque will be limited to 0 and cause malfunction or alarm. For instance, the unit for positive torque limit, negative torque limit and max torque is 1‰ of rated torque, when these parameters were set to 1000, it means 100% of rated torque. Torque limit parameters are effective in all control modes.
9. The max profile speed parameter in EtherCAT xml configuration files of DA200, if any, means the max speed limit under torque loop, and the unit is related to P4.25. For instance, the unit is rmp if P4.25 is manufacturer unit and puu/s if P4.25 is set to other values. Set this parameter to a non-zero value if torque loop operation is required.
10. Transceiving of PDO can be configured dynamically by the master, however, the max number of each PDO parameter is 10, exceeds which the slave will be unable to enter op status.
11. The connecting mode of network cables should adopt top-in and bottom-out, otherwise some nodes may be unable to enter op status;
12. This instruction manual applies to versions later than V2.53. Some functions are excluded in previous versions.

2.2 EtherCAT communication

2.2.1 CANopen over EtherCAT (CoE) reference model

The network model of CANopen over EtherCAT (CoE) of DA200 drive is shown below.

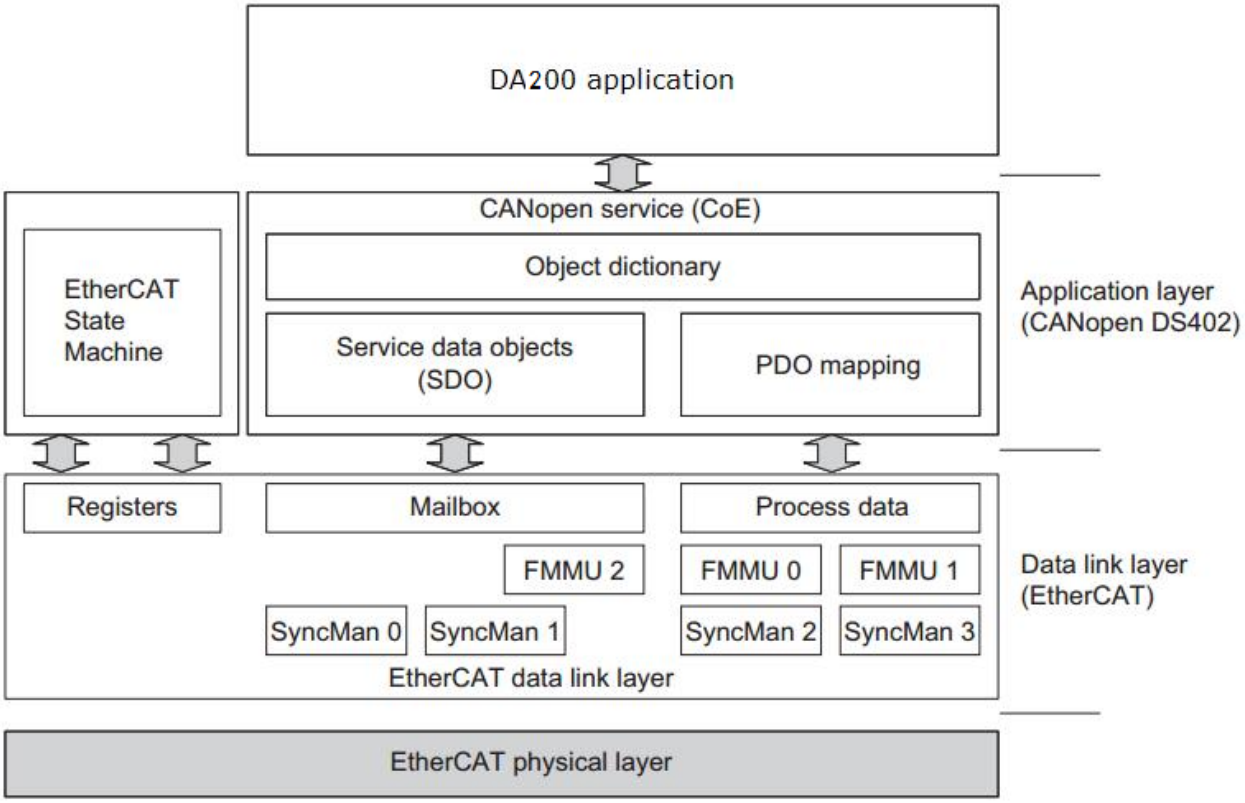


Fig 2-1 CoE reference model

EtherCAT (CoE) network reference model consists of data link layer and application layer. Data link layer is in charge of EtherCAT communication protocol while application layer is embedded with CANopen drive Profile (DS402) communication protocol. The object dictionary in CoE contains parameters, application data and PDO mapping configuration information.

Process data object (PDO) is constituted by objects which can conduct PDO mapping in object dictionary. The content in PDO data is defined by PDO mapping. The R/W of PDO data is cyclic, thus removing the need to look up the object dictionary; while service data object (SDO) is acyclic communication and requires a look-up in object dictionary during R/W.

Note: It is necessary to configure FMMU and Sync Manager to ensure SDO and PDO data can be properly analyzed in EtherCAT data link layer, as shown in the table below:

Sync Manager	Assignment(Fixed)	Size	Start Address(Fixed)
Sync Manager 0	Assigned to Receive Mailbox	40 ~ 512Byte	0x1000
Sync Manager 1	Assigned to Transmit Mailbox	40 ~ 512Byte	0x1200
Sync Manager 2	Assigned to Receive PDO	1 ~ 128Byte	0x1400
Sync Manager 3	Assigned to Transmit PDO	1 ~ 128Byte	0x1480

FMMU setup

FMMU	Settings
FMMU 0	Mapped to Receive PDO
FMMU 1	Mapped to Transmit PDO
FMMU 2	Mapped to Fill Status of Transmit Mailbox

2.2.2 EtherCAT slave information

EtherCAT slave information file (xml file) is used for master reading and building the configuration between master and slave. XML file contains information required by EtherCAT communication setup. INVT provides “INVT_DA200_CoE.xml” file for DA200 drive.

2.2.3 EtherCAT state machine

EtherCAT state machine is used to describe the state and state change of slave application. The request of state change is usually initiated by master and responded by slave. The state transition mode is shown as below:

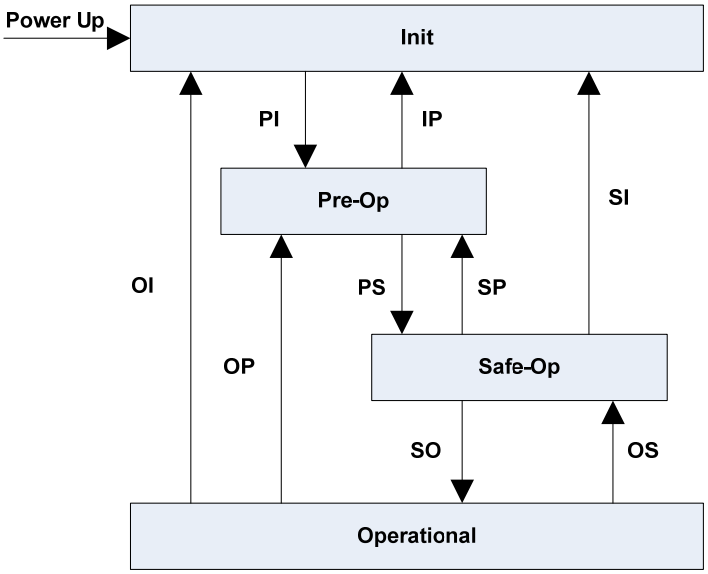


Fig 2-2 Diagram of slave state machine

Table 2-2 State instruction

State	Description
Init	● Mail communication is unavailable ● PDO communication is unavailable
Init → Pre-Op	● Master configures link layer address and SM channel, and initiates mail communication ● Master initializes DC clock synchronization ● Master requests transferring to Pre-Op state ● Master sets AL control register

State	Description
	● Slave determines whether mail is initialized normally
Pre-Operation (Pre-Op)	● Mail communication is activated ● Process data (PDO) communication is unavailable
Pre-Op → Safe-Op	● Master is process data configuration sync manager channel and FMMU channel ● Master configures PDO data mapping and Sync manager PDO parameter setup via SOD ● Master requests Safe-Op state transition ● Slave checks whether the Sync Manager configuration in charge of PDO data is correct. If the slave sends requests to initiate synchronization, check whether the distributed clock is set correctly
Safe-Operation (Safe-Op)	● The slave application program will transmit actual input data and no operation will be performed on output. ● Output is set to “safe state”
Safe-Op → Op	● Master sends valid output data ● Master requests transferring to Op state
Operational (Op)	● Mail communication is available ● PDO communication is available

2.2.4 PDO process data mapping

Process data of EtherCAT slave is constituted by sync manager channel objects, with each object describing the uniform region of EtherCAT process data and containing multiple object data objects. The EtherCAT slave equipped with application control function should support PDO mapping and R/W of SM PDOs Assign objects.

PDO mapping:

PDO mapping designs the mapping relation between the object dictionary to PDOs application object. Index 0x1600 and 0x1A00 in the object dictionary are stored in RxPDO and TxPDO mapping table respectively.

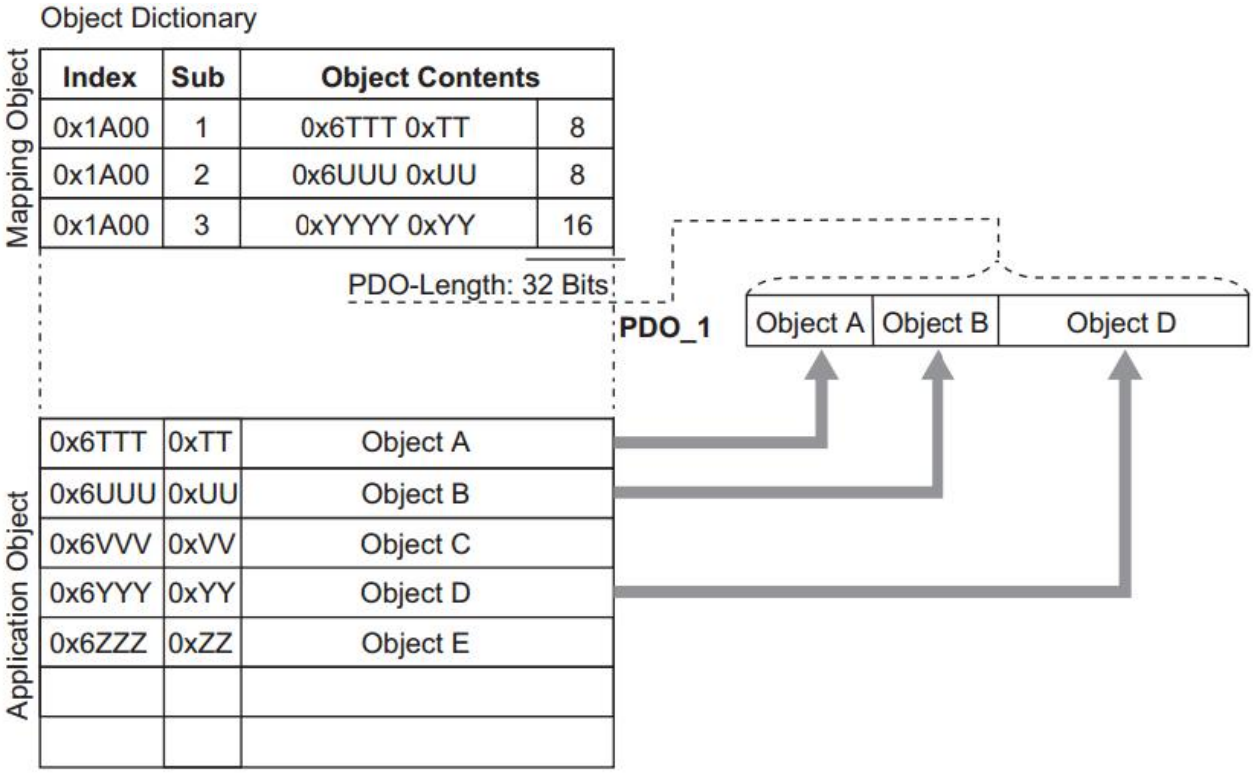


Fig 2-3 Example of PDO mapping

PDO distribution:

In order to realize process data interaction of EtherCAT communication, it is necessary to distribute PDOs to Sync Manager; Sync Manager PDO distributes objects (Sync Manager PDO Assign objects: 0x1C12, 0x1C13) to establish the relationship between PDOs and Sync Manager, as shown below.

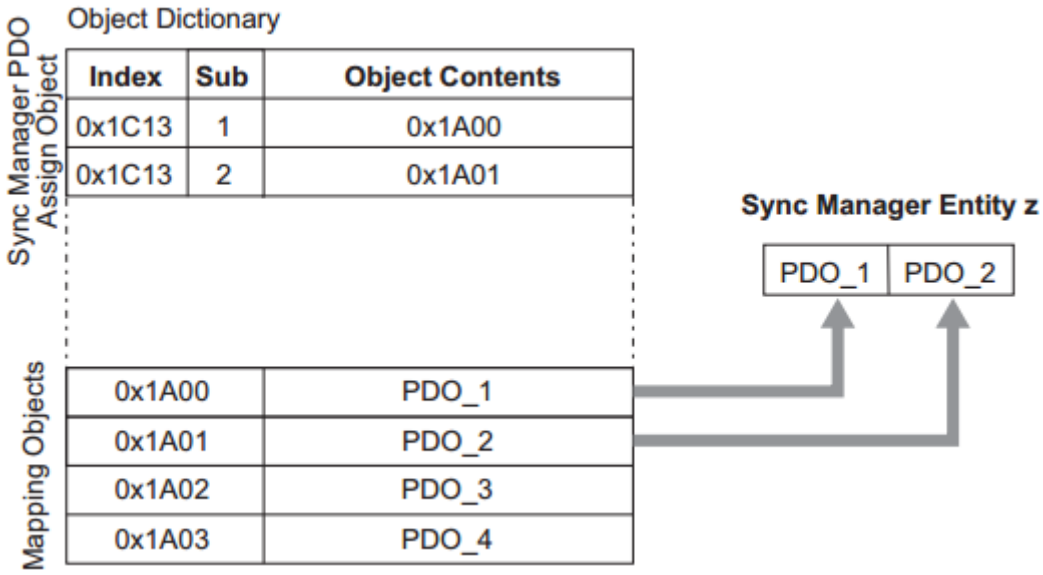


Fig 2-4 Example of PDO distribution

Note:

PDO mapping object (0x1600~0x1603, 0x1A00~0x1A03) and SM PDO Assign object (0x1C12, 0x1C13) can only be effective in write operation under Pre-Op state.

Operation steps of PDO mapping:

1. Stop PDO distribution function (Set the sub-index 0 of 0x1C12 and 0x1C13 to 0);
2. Stop PDO mapping function (Set the sub-index 0 of 0x1600~0x1603 and 0x1A00~0x1A03 to 0);
3. Set the mapping entry of PDO mapping object (0x1600~0x1603 and 0x1A00~0x1A03);
4. Set the value of mapping entry of PDO mapping object (0x1600~0x1603 and 0x1A00~0x1A03);
5. Set PDO distribution object (Set sub-index 1 of 0x1C12 and 0x1C13);
6. Re-open PDO distribution function (set sub-index 0 of 0x1C12 and 0x1C13 to 1)

Default PDO mapping (Position, Speed, Torque, Torque limit, Touch probe):

RxPDO (0x1600)	Controlword (0x6040)	Target Position (0x607A)	Target Speed (0x60FF)	Mode of Operation (0x6060)	Touch Probe Function (0x60B8)	Target torque (0x6071)	Touch probe control (0x60B8)	Positive torque limit (0x60E0)	Negative torque limit(0x60E1)	Max profile speed(0x607F)
TxPDO (0x1A00)	Statusword (0x6041)	Position Actual Value (0x6064)	Speed Actual Value (0x606C)	Torque Actual Value (0x6077)	Operation Mode Display (0x6061)	Current Actual Value (0x6078)	Touch Probe Status (0x60B9)	Touch Probe Value (0x60BA)	Digital inputs (0x60FD)	Digital outputs (0x60FE)

Note: For detailed PDO mapping information, see xml file.

2.2.5 Network synchronization based on distributed clock

Distributed clock can make all EtherCAT device use the same system time, thus controlling the sync execution of each device tasks. Among the slave clock connected to the master, EtherCAT network takes the first slave clock equipped with distributed clock function as the reference clock for the whole network, and the remaining slaves and masters take the reference clock as their basis for synchronization.

DA200 EtherCAT communication card adopts the following sync modes, in which sync mode can be switched by configuring sync control register (ESC 0x980, 0x981).

- Free-Run (ESC* register: 0x980 = 0x0000, P4.08 = 0)
  In this mode, the local application program cycle, communication cycle and master cycle of the servo drive are independent of each other;

- DC mode (ESC register: 0x980 = 0x0300, P4.08 = 2)
  In this mode, local application program is sync with Sync0 time.

*Note: ESC is the abbreviation of EtherCAT Slave Controller

Index	Sub	Name	Access	PDO Mapping	Type	Value
0x1C32	Sync Manager channel 2 (process data output) Synchronization					
	1	Sync type	RO	No	UINT	Current status of DC mode 0:Free-run 2:DC Mode(Synchronous with Sync0)
	2	Cycle time	RO	No	UDINT	Sync0 event cycle[ns](This value is set by master via ESC register) range:12500 * n(n = 2,4,8,16)[ns]
0x1C33	Sync Manager channel 2 (process data input) Synchronization					
	3	Shift time	RO	No	UINT	-
	6	Calc and copy time	RO	No	UINT	-

Time sequence diagram of DC mode is shown below:

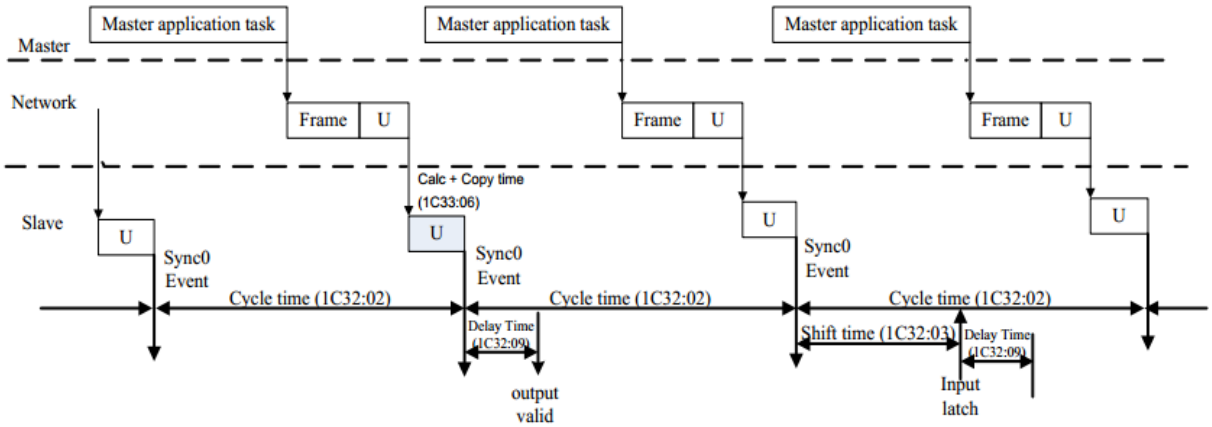


Fig 2-5 Time sequence diagram of DC mode

2.2.6 Emergency Messages

When the drive alarms, CoE will initiate an Emergency message, informing users of the error information of present drive.

Emergency Object:

Byte	0	1	2	3	4	5	6	7
Content	Emergency Error Code		Error register	Panel Error Code		N/A		

Users can visit 0x4000 (16-bit) via SDO to read present fault code information. The format of fault code is:

Bits	Meaning
15~8	Master code of fault code*
7~4	Reserved
3~0	Sub-code of fault code

*: For detailed information of master code and sub-code, see chapter 5.

2.3 Compatible communication protocol

EtherCAT communication	**Applicable communication standard**	IEC 61158 Type12, IEC 61800-7 CiA402 Drive Profile
	Physical layer	100BASE-TX (IEEE802.3)
	Bus connection	CN7 (RJ45) : EtherCAT Signal IN CN8 (RJ45) : EtherCAT Signal OUT
	Cable	CAT5
	SyncManager	SM0: output mail, SM1: input valid SM2: output process data, SM3: input process data
	FMMU	FMMU0: mapping to process data (RxPDO) output area FMMU1: mapping to process data (RxPDO) output area FMMU2: mapping to mail state
	PDO data	Dynamic PDO mapping
	Mailbox (CoE)	Emergency, SDO request, response, SDO information Note: Do not support TxPDO/RxPDO and remote TxPDO/TxPDO
	Distributed clock (DC)	Free-run, DC mode (activate via parameters) Supported DC cycle: 250us~2ms
	Slave Information IF	256Bytes (read-only)
	LED indicator	EtherCAT Link/Activity indicator(L/A) × 2 EtherCAT Status indicator × 1 EtherCAT Error indicator × 1
CiA402 Drive Profile		● Homing mode(6) ● Profile position mode(1) ● Profile speed mode(3) ● Cyclic synchronous position mode(8) ● Cyclic synchronous speed mode(9) ● Cyclic synchronous torque mode(10) ● Touch probe function

3 CiA402 device protocol

The master controls DA200 servo drive via Controlword (control word, 0x6040) and acquires present drive status by reading Statusword (status word, 0x6041). The servo drive achieves motor control function according to master control commands.

3.1 CANopen over EtherCAT(CoE) state machine

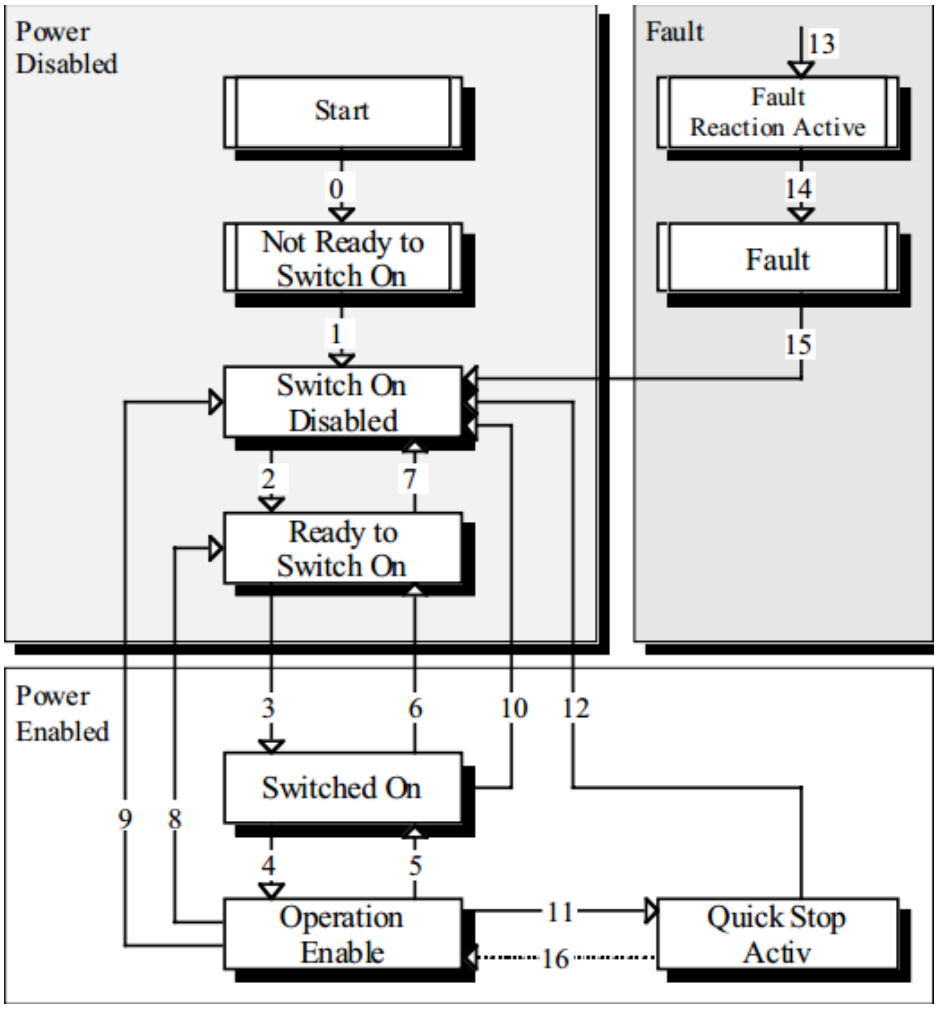


Fig 3-1 CANopen over EtherCAT state machine

State name	Instruction
Not Ready to Switch On	Drive initializing.
Switch On Disabled	Drive initialization completed.
Ready to Switch On	Drive waiting to enter Switch On state, motor unexcited.
Switched On	Drive is ready and main circuit power is normal.
Operation Enable	Drive enabled, motor is controlled based on control mode.
Quick Stop Active	Drive stops based on the set mode.
Fault Reaction Active	Drive detects an alarm and stops according to the set mode, motor still has excitation signal.
Fault	Drive in fault state, motor has no excitation signal.

3.1.1 Detail of Control word (0x6040)

6040_h control work contains the following contents:

1. Bits used for status control;
2. Bits related to control mode;
3. Control bits defined by the manufacturer.

Introduction to each 6040_h bit:

15 11	10 9	8	7	6 4	3	2	1	0
manufacturer specific	reserved	halt	Fault reset	Operation mode specific	Enable operation	Quick stop	Enable voltage	Switch on
O	O	O	M	O	M	M	M	M

MSB LSB

Among which: MSB: Most Significant Bit; LSB: Least Significant Bit; O: Optional; M; Mandatory

BITS 0 - 3 AND 7 (bits used for status control);

Command	Bit of the *controlword*					Transitions
	Fault reset	Enable operation	Quick stop	Enable voltage	Switch on	
Shutdown	0	X	1	1	0	2,6,8
Switch on	0	0	1	1	1	3*
Switch on	0	1	1	1	1	3**
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

Among which: X is irrelevant;  is rising edge jump

BITS 4, 5, 6 AND 8 (bits related to control mode):

Bit	Operation mode		
	Profile position mode	Profile speed mode	Homing mode
4	New set-point	reserved	Homing operation start
5	Change set immediately	reserved	reserved
6	abs/rel	reserved	reserved
8	Halt	Halt	Halt

BITS 9, 10: Reserved

BITS 11 - 15: Defined by manufacturer

3.1.2 Detail of Status word (0x6041)

6041_h status word contains the following content:

1. Present status bit of the drive;
2. Status bits related to control mode;
3. Status bits defined by the manufacturer.

Introduction to each 6041_h bit is shown below:

Bit	Description	M / O
0	Ready to switch on	M
1	Switched on	M
2	Operation enabled	M
3	Fault	M
4	Voltage enabled	M
5	Quick stop	M
6	Switch on disabled	M

Bit	Description	M / O
7	Warning	O
8	Manufacture specific	O
9	Remote	M
10	Target reached	M
11	Internal limit active	M
12 – 13	Operation mode specific	O
14 – 15	Manufacturer specific	O

BIT 0 – 3, 5, AND 6:

Value (binary)	State
xxxx xxxx x0xx 0000	Not ready to switch on
xxxx xxxx x1xx 0000	Switch on disabled
xxxx xxxx x01x 0001	Ready to switch on
xxxx xxxx x01x 0011	Switched on
xxxx xxxx x01x 0111	Operation enabled
xxxx xxxx x00x 0111	Quick stop active
xxxx xxxx x0xx 1111	Fault reaction active
xxxx xxxx x0xx 1000	Fault

Among which: X is irrelevant

BIT 4: Voltage enabled, when this bit is 1, it means main circuit power is normal;

BIT 7: Warning, when this bit is 1, it means drive releases an alarm;

BIT 8: DC Calibration Status, when this bit is 1, it means the drive clock is synchronized with DC Sync0;

BIT 9: Remote, when this bit is 1, it means the slave is in OP state, and the master can control the drive via PDO remotely;

BIT 10: Target reached, this bit differs in meaning under different control modes. When this bit is 1, in pp mode, it means target position reached, while in pv mode, it means reference speed reached; in hm mode, it means homing completed; if Halt is started, it means motor speed is 0;

BIT 11: Internal limit active, when this bit is 1, in pp mode, it means position limit reached, in pv mode, it means internal torque exceeds the set value.

BIT 12 AND 13: These two bits differ in meaning under different control modes.

Bit	Operation mode		
	pp	pv	hm
12	Set-point Acknowledge	Speed	Homing attained
13	Following error	Max slippage error	Homing error

BIT 14: When this bit is 1, it means motor zero-speed status.

BIT 15: Reserved.

3.2 Profile Position Mode

3.2.1 Basic description

The servo drive (slave) receives the position command sent by upper pc (master) and such command, after being converted using electric gear ratio, will be taken by the servo drive as the target position for internal position control.

Position command encoder unit=position command user unit * numerator of actual gear ratio / denominator of actual gear ratio;

For detailed gear ratio setup, see chapter 2.1.

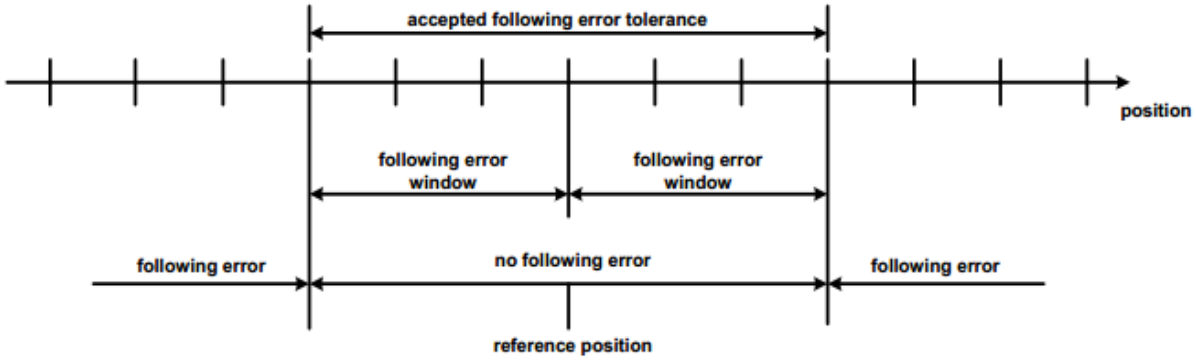
3.2.2 Operation mode

1. Set[6060_h: Mode of operations]to **1** (Profile position mode);
2. Set [6081_h: Profile speed] as scheduled speed (the unit is relative to P4.25); the corresponding parameter of the drive is P5.21 (in user unit);

3. Set [6083_h: Profile acceleration] as scheduled speed (the unit is relative to P4.25); Note: Under this mode, both 6083_h and 6084_h correspond to P5.37 in the drive (in user unit);
4. Set [$607A_h$: Target position] as target position (unit: user unit); correspond to P6.01 in the drive;
5. Set [6040_h: Control word] to enable servo drive and trigger target position to be effective (set to 0x0F to enable, refer to section 4.5 for other bits);
6. Check [6064_h: Position actual value] to acquire actual motor position feedback;
7. Check [6041_h: Status word] to acquire status feedback of servo drive (following error, set-point acknowledge, target reached and internal limit active);

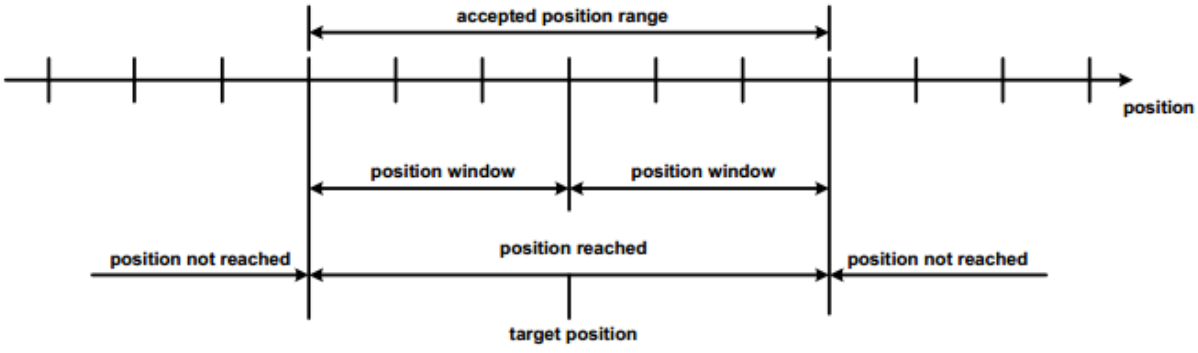
3.2.3 Other objects

1. Check [6064_h: Position actual value] to acquire actual position feedback of motor (unit: user unit);
2. Check [6063_h: Position actual value*] to acquire actual position feedback increment of motor (unit: user unit);
3. Set [6065_h: Following error window] to modify position out-of-tolerance range (unit: user unit)
4. Check [$60F4_h$: Following error actual value] to acquire actual motor position deviation (unit: user unit);



Reference position

5. Set [6065_h: Following error window] to modify positioning completion range (unit: user unit);



Position reached

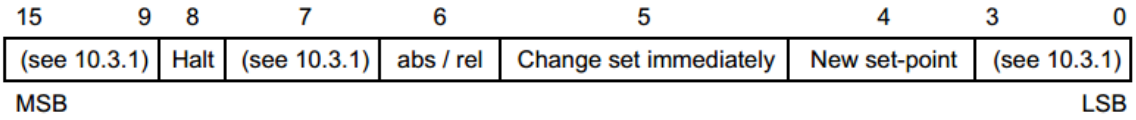
3.2.4 Mode-related object list

Index	Name	Type	Attr.
6040_h	Control word	UNSIGNED16	RW
6041_h	Status word	UNSIGNED16	RO
6060_h	Modes of operation	INTEGER8	RW
6061_h	Modes of operation display	INTEGER8	RO
6063_h	Position actual value*	INTEGER32	RO
6064_h	Position actual value	INTEGER32	RO

Index	Name	Type	Attr.
6065_h	Following error window	UNSIGNED32	RW
6067_h	Position window	UNSIGNED32	RW
$607A_h$	Target position	INTEGER32	RW
6081_h	Profile speed	UNSIGNED32	RW
6083_h	Profile acceleration	UNSIGNED32	RW
6093_h	Position factor	UNSIGNED32	RW
$60F4_h$	Following error actual value	INTEGER32	RO

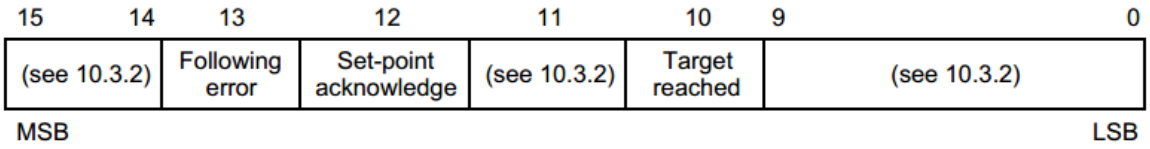
Note: For detailed description of each object, see CiADS402.

3.2.5 Control word (0x6040) of Profile Position Mode



Name	Value	Description
New set-point	0	Does not assume *target position*
	1	Assume *target position*
Change set immediately	0	Finish the actual positioning and then start the next positioning
	1	Interrupt the actual positioning and start the next positioning
abs / rel	0	*Target position* is an absolute value
	1	*Target position* is a relative value
Halt	0	Execute positioning
	1	Stop axle with *profile deceleration* (if not supported with *profile acceleration*)

3.2.6 Status word (0x6041) of Profile Position Mode



Name	Value	Description
Target reached	0	Halt = 0: *Target position* not reached Halt = 1: Axle decelerates
	1	Halt = 0: *Target position* reached Halt = 1: Velocity of axle is 0
Set-point acknowledge	0	Trajectory generator has not assumed the positioning values (yet)
	1	Trajectory generator has assumed the positioning values
Following error	0	No following error
	1	Following error

3.2.7 Application examples

1. Set 6060_h to 1, select Profile Position Mode;
2. Set 6040_h to enable the drive and trigger position command to be effective;

a) Single set-point:

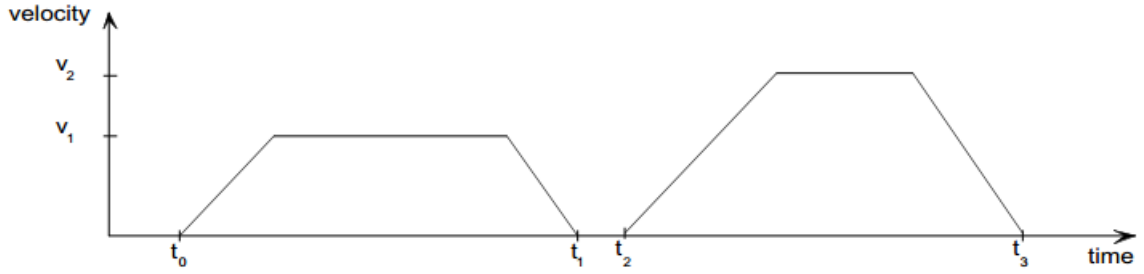


Diagram of single set-point

The following steps are necessary if the target position transmitted is increment mode:
1): Set 6040h to 0x4F (in which bit6 is to set increment mode, bit3~bit0 is to enable drive);
2): Set 607Ah as target position command;
3): Set 6040h to 0x5F, trigger position command to be effective (in which 0->1 jump edge of bit4 is to trigger target position command to be effective);
4): The drive sets 6041h.bit12 after receiving 6040h.bit4 = 1, and then the master clears bit4 of 6040h to be ready to send next target position command.
The following steps are necessary if the target position transmitted is absolute mode:
1): Set 6040_h to 0x0F;
2): Set $607A_h$ as target position command;
3): Set 6040_h to 0x1F, trigger position command to be effective;
4): The drive sets 6041_h.bit12 after receiving 6040_h.bit4 = 1, and the master clears bit4 of 6040h to be ready for transmitting next target position command.

b): Change set immediately mode:

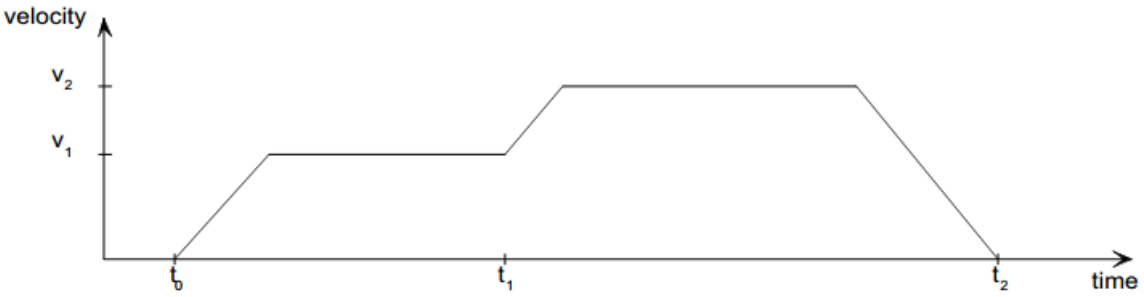


Diagram for change set immediately

The following steps are necessary it the target position transmitted is increment mode:
1): Set 6040h to 0x6F (in which bit6 is for setting increment mode, bit5 is for setting immediate effective mode, bit3~bit0 is for enabling the drive);
2): Set 607Ah as target position command;
3): Set 6040h to 0x7F, trigger position command to be effective (in which 0->1 jump edge of bit4 is for triggering target position command to be effective)
4): The drive sets 6041_h.bit12 after receiving 6040_h.bit4 = 1, and then the master clears bit4 of 6040_h to be ready for transmitting next target position command.
The following steps are necessary if the target position transmitted is absolute mode:
1): Set 6040h to 0x2F (set immediate-effective by bit5, enable the drive by bit3~bit0);
2): Set $607A_h$ as target position command;
3): Set 6040_h to 0x3F, trigger position command to be effective;
4): The drive sets 6041_h.bit12 after receiving 6040_h.bit4 = 1, and then the master clears bit4 of 6040_h to be ready for transmitting next target position command.

c): Repeat step 2 if multiple targets need to be transmitted.
Note: SV-DA200 supports 8-level target position buffering.

3.3 Cyclic Synchronous Position Mode

3.3.1 Basic description

The theory of cyclic synchronous position mode is similar to that of position interpolation mode. Interpolation of position command is achieved by the master while the master also offers additional speed feedforward commands and torque feedforward commands.

Interpolation cycle defines the update interval of target position. Under this mode, interpolation cycle is the same with EtherCAT synchronization cycle.

3.3.2 Operation mode

1. Set [6060_h: Mode of operations] to **8** (Cyclic synchronous position mode) ;
2. Set [P4.07: EtherCAT sync cycle] to the same position interpolation cycle with that of the master and re-power on;
3. Set [6040_h: Control word] to enable servo drive (set to 0x0F to enable, refer to section 4.5 for other bits);
4. Set [$607A_h$: Target position] as target position (unit: user unit); the corresponding parameter of the drive is P4.12;
5. Check [6064_h: Position actual value] to acquire actual motor position feedback;
6. Check [6041_h: Status word] to acquire status feedback of servo drive (following error, target reached and internal limit active);

3.3.3 Mode-related objects list

Index	Name	Type	Attr.
6040_h	Control word	UNSIGNED16	RW
6041_h	Status word	UNSIGNED16	RO
6060_h	Modes of operation	INTEGER8	RW
6061_h	Modes of operation display	INTEGER8	RO
6064_h	Position actual value	INTEGER32	RO
6065_h	Following error window	UNSIGNED32	RW
6067_h	Position window	UNSIGNED32	RW
6093_h	Position factor	UNSIGNED32	RW
$60F4_h$	Following error actual value	INTEGER32	RO

Note: For detailed description of each object, see CiA DS402.

3.3.4 Application examples

1. Set 6060_h to **8**, select Cyclic Synchronous Position Mode;
2. Set 6040_h to enable the drive, send **0x0F**;
3. Set $607A_h$ as target position (absolute position) gradually to conduct position control.

3.4 Homing Mode

3.4.1 Basic description

Under homing mode, the drive finds the origin position by itself. Users can set the running speed of Homing mode.

Note: Under this mode, it is required to connect the limit switch and origin switch signal to digital input terminal CN1 of the drive. If the limit switch signal is connected to the upper PC or PLC, it is necessary to apply the homing process conducted by upper PC.

3.4.2 Operation mode

1. Set [6060_h: Mode of operations] to **6** (homing mode);
2. Set [6098_h: Homing method], setting range is 1~35 (refer to DS402 standard for details);
3. Set [$607C_h$: Homing offset], set origin offset, correspond to P5.14 of the drive;
4. Set [6099_h Sub-1: Homing speeds], modify the speed in finding limit switch during homing (the unit is related to P4.25), corresponding to P5.12 of the drive;
5. Set [6099_h Sub-2: Homing speeds], modify the speed in finding zero position during homing (the unit is related to P4.25), corresponding to P5.13 of the drive;

6. Set [6040_h: Control word] to enable servo drive, Homing operation starts (Bit4) from the change of **0->1** and interrupts homing process from the change of **1->0**.
7. Motor searches for limit switch and Home switch to complete Homing action;
8. Check [6041_h: Status word] to acquire status feedback of servo drive (Homing error, Homing attained, Target reached);

3.4.3 Mode-related objects list

Index	Name	Type	Attr.
6040_h	Control word	UNSIGNED16	RW
6041_h	Status word	UNSIGNED16	RO
6060_h	Modes of operation	INTEGER8	RW
6061_h	Modes of operation display	INTEGER8	RO
$607C_h$	Homing offset	INTEGER32	RW
6098_h	Homing method	UNSIGNED32	RW
6099_h	Homing speeds	ARRAY	RW

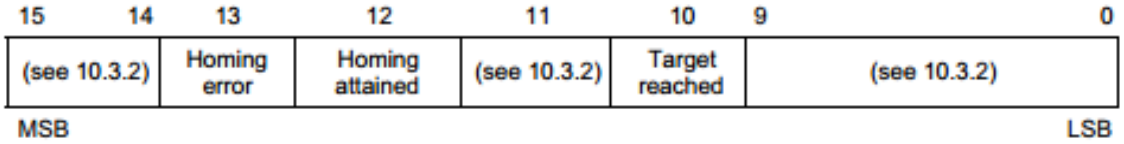
Note: For detailed description of each object, see CiA DS402.

3.4.4 Application examples

The following steps are necessary when Homing mode is applied:

1. Set 6060_h to **6**, select Homing Mode;
2. Set 6098_h, select the Homing mode to be used;
3. Set 6040_h to enable drive and trigger Homing action: send 0x0F first, then send 0x1F to trigger Homing;
4. Homing will be interrupted if 0x0F is sent, and the drive will be disabled if 0x0 is sent.
5. Check the completion of Homing by bit12 of 6041_h, and check whether fault occurred during Homing by bit13.

3.4.5 Status word of homing mode



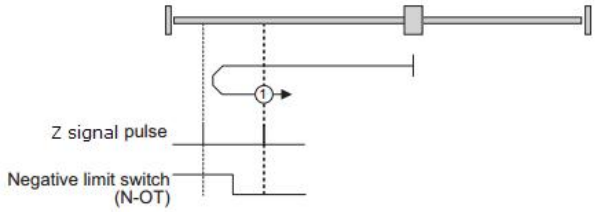
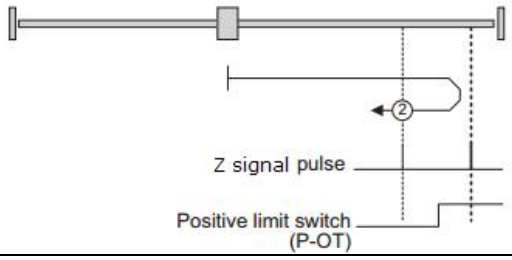
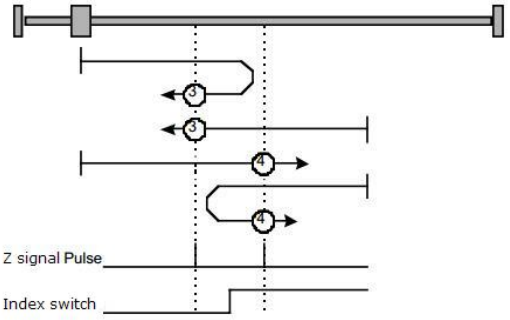
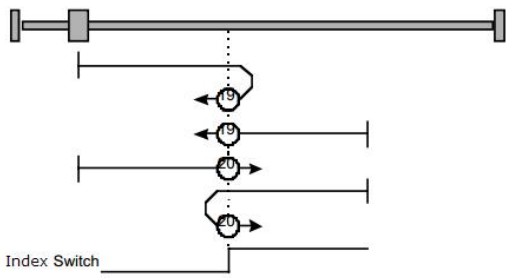
Name	Value	Description
Target reached	0	Halt = 0: Home position not reached Halt = 1: Axle decelerates
	1	Halt = 0: Home position reached Halt = 1: Axle has velocity 0
Homing attained	0	Homing mode not yet completed
	1	Homing mode carried out successfully
Homing error	0	No homing error
	1	Homing error occurred; Homing mode carried out not successfully; The error cause is found by reading the error code

3.4.6 Introduction to homing mode

There are four kinds of signals related to homing mode, they are: positive limit switch (POT), negative limit switch (NOT), reference point switch (index) and encoder Z signal (C-phase).

Definition of homing mode:

Homing mode (DS402)	Start direction	Target position	Reference point position	Homing mode (P5.10)	Detailed introduction
1	Negative	NOT	Z pulse	1	Use Z pulse and negative limit switch: the drive moves towards negative limit switch at high speed,

<table>
<tr><th>Homing mode (DS402)</th><th>Start direction</th><th>Target position</th><th>Reference point position</th><th>Homing mode (P5.10)</th><th>Detailed introduction</th></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td>then returns at low speed and searches for target zero position (the first encoder Z pulse position after leaving NOT) after reaching NOT.
 
</td></tr>
<tr><td>2</td><td>Positive</td><td>POT</td><td>Z pulse</td><td>0</td><td>Use Z pulse and positive limit switch: the drive moves towards positive limit switch at high speed, then returns at low speed and searches for target zero position (the first encoder Z pulse position after leaving NOT) after reaching POT.
 
</td></tr>
<tr><td>3</td><td>Negative</td><td>Index</td><td>Z pulse</td><td>2</td><td rowspan="2">The initial direction movement of the drive depends on the switch state of the reference point. The target zero position is the first Z pulse position on the left or right side of the Index.
 
</td></tr>
<tr><td>4</td><td>Positive</td><td>Index</td><td>Z pulse</td><td>12</td></tr>
<tr><td>17</td><td>Negative</td><td>NOT</td><td>NOT</td><td>21</td><td rowspan="4">These four types of homing methods are similar to 1~4 phase except that the target zero position is related to the change of limit switch or Index switch rather than using Z pulse. The figure below is diagram for 19 and 20, which are similar to method 3 and 4.
 
</td></tr>
<tr><td>18</td><td>Positive</td><td>POT</td><td>POT</td><td>20</td></tr>
<tr><td>19</td><td>Negative</td><td>Index</td><td>Index</td><td>22</td></tr>
<tr><td>20</td><td>Positive</td><td>Index</td><td>Index</td><td>22</td></tr>
<tr><td>35</td><td>-</td><td>Present position</td><td>Present position</td><td>8</td><td>Present position is the system zero point.</td></tr>
</table>

3.5 Profile Speed Mode

3.5.1 Basic description

Under Profile speed mode, the drive receives the speed command sent by the master and conducts speed planning according to the acceleration planning parameters.

3.5.2 Operation mode

1. Set [6060_h: Mode of operations] to **3** (Profile speed mode);
2. Set [6083_h: Profile acceleration] to modify acceleration curve (the unit is related to P4.25), it corresponds to P0.54 of the drive;
3. Set [6084_h: Profile deceleration] to modify deceleration curve (the unit is related to P4.25), it corresponds to P0.55 of the drive;
4. Set [6040_h: Control word] to enable servo drive and start the motor;
5. Set [$60FF_h$: Target speed] to set target speed (the unit is related to P4.25), it corresponds to P4.13 of the drive;
6. Check[6041_h: Status word]to acquire status feedback of servo drive (Speed zero, Max slippage error, Target reached, Internal limit active)

3.5.3 Other objects

Check [$606C_h$: Speed actual value] to acquire actual speed feedback (the unit is related to P4.25);

3.5.4 Mode-related objects list

Index	Name	Type	Attr.
6040_h	Control word	UNSIGNED16	RW
6041_h	Status word	UNSIGNED16	RO
6060_h	Modes of operation	INTEGER8	RW
6061_h	Modes of operation display	INTEGER8	RO
$606C_h$	Speed actual value	INTEGER32	RO
6083_h	Profile acceleration	UNSIGNED32	RW
6084_h	Profile deceleration	UNSIGNED32	RW
$60FF_h$	Target speed	INTEGER32	RW

Note: For detailed description of each object, see CiA DS402 standard.

3.5.5 Application examples

The following steps are necessary when Profile Speed is used:

1. Set 6060_h to **3**, select Profile Speed Mode;
2. Set 6040_h to enable the drive. Send 0x0F to enable or 0x0 to disable;
3. Set $60FF_h$ to modify target speed command;
4. Set 6083_h and 6084_h to modify acceleration time and deceleration time.

3.6 Cyclic Synchronous Speed Mode

3.6.1 Basic description

Cyclic synchronous speed mode is basically the same as Profile speed mode except that the speed command interpolation of the former is completed by the master, and the master can provide additional torque feedforward command.

Interpolation cycle defines update interval of target speed. Under this mode, the interpolation cycle is the same with EtherCAT sync cycle.

3.6.2 Operation mode

1. Set [6060_h: Mode of operations] to **9** (Cyclic synchronous speed mode) ;
2. Set [6083_h: Profile acceleration] to modify acceleration curve (the unit is related to P4.25), corresponding to P0.54 of the drive;
3. Set [6084_h: Profile deceleration] to modify deceleration curve (the unit is related to P4.25), corresponding to P0.55 of the drive;
4. Set [6040_h: Control word] to enable servo drive and start the motor;
5. Set [$60FF_h$: Target speed] to set target speed (the unit is related to P4.25), corresponding to

P4.13 of the drive;

6. Check [6041_h: Status word] to acquire status feedback of the servo motor (Speed zero, Max slippage error, Target reached, Internal limit active);

3.6.3 Other objects

Check [$606C_h$: Speed actual value] to acquire actual speed feedback (the unit is related to P4.25);

3.6.4 Mode-related objects list

Index	Name	Type	Attr.
6040_h	Control word	UNSIGNED16	RW
6041_h	Status word	UNSIGNED16	RO
6060_h	Modes of operation	INTEGER8	RW
6061_h	Modes of operation display	INTEGER8	RO
$606C_h$	Speed actual value	INTEGER32	RO
6083_h	Profile acceleration	UNSIGNED32	RW
6084_h	Profile deceleration	UNSIGNED32	RW
$60FF_h$	Target speed	INTEGER32	RW

Note: For detailed description of each object, see CiA DS402 standard.

3.6.5 Application examples

The following procedures are required when Profile Speed mode is used:

1. Set 6060_h to **9**, select Cyclic synchronous speed mode;
2. Set 6040_h to enable drive, send 0x0F to enable or 0x0 to disable;
3. Set $60FF_h$ to modify target speed command;
4. Set 6083_h and 6084_h to modify acceleration time and deceleration time.

3.7 Cyclic Synchronous Torque Mode

3.7.1 Basic description

Cyclic synchronous torque mode is basically the same as Profile torque mode except that the torque command interpolation is completed by the master. The interpolation cycle defines update interval of target torque. Under this mode, the interpolation cycle is the same as EtherCAT sync cycle.

3.7.2 Operation mode

1. Set [6060_h: Mode of operations] to **10** (Cyclic synchronous torque mode)
2. Set [6040_h: Control word] to enable servo drive and starts the motor;
3. Set [6071_h: Target torque] to set target torque (unit: 0.1% rated torque), corresponding to P4.14 of the drive;
4. Set [$607F_h$: Max Profile Speed] to set the max speed (the unit is related to P4.25);
5. Set [$60E0_h$: Positive torque limit] to set positive torque limit (unit: 0.1% rated torque);
6. Set [$60E1_h$: Negative torque limit] to set reverse torque limit (unit: 0.1% rated torque);
7. Set [6072_h: Max torque] to set the max torque limit (unit: 0.1% rated torque);
8. Check [6041_h: Status word] to acquire status feedback of servo drive (target reached);

3.7.3 Other objects

1. Set [6072h: Max torque]to modify max torque limit (unit: 0.1% rated torque);
2. Check [6074h: Torque demand value] to acquire actual internal torque command (unit: 0.1% rated torque);
3. Check [6076h: Motor rated torque] to acquire rated motor torque (unit: mNm);
4. Check [6077h: Torque actual value] to acquire actual torque feedback (unit: 0.1% rated torque);
5. Check [6078h: Current actual value] to acquire actual output current (unit: mA);

3.7.4 Mode-related objects list

Index	Name	Type	Attr.
6040_h	Control word	UNSIGNED16	RW
6041_h	Status word	UNSIGNED16	RO

Index	Name	Type	Attr.
6060_h	Modes of operation	INTEGER8	RW
6061_h	Modes of operation display	INTEGER8	RO
6071_h	Target torque	INTEGER16	RO
6072_h	Max torque	UNSIGNED16	RW
6073_h	Max current	UNSIGNED16	RO
6075_h	Motor rated current	UNSIGNED32	RO
6076_h	Motor rated torque	UNSIGNED32	RO
6077_h	Torque actual value	INTEGER16	RO
6078_h	Current actual value	INTEGER16	RO
6079_h	DC link circuit voltage	UNSIGNED32	RO
$607F_h$	Max Profile Speed	UNSIGNED32	RW

Note: For detailed description of each object, see CiA DS402 standard.

3.7.5 Application examples

The following steps are necessary when cyclic synchronous Torque is used:

1. Set 6060_h to **10**, select Cyclic synchronous Torque Mode;
2. Set 6040_h to enable the drive, send 0x0F to enable or 0x0 to disable;
3. Set 6071_h to modify target torque command;
4. Set 6087_h to modify torque gradient time.

3.8 Touch Probe Function

3.8.1 Basic description

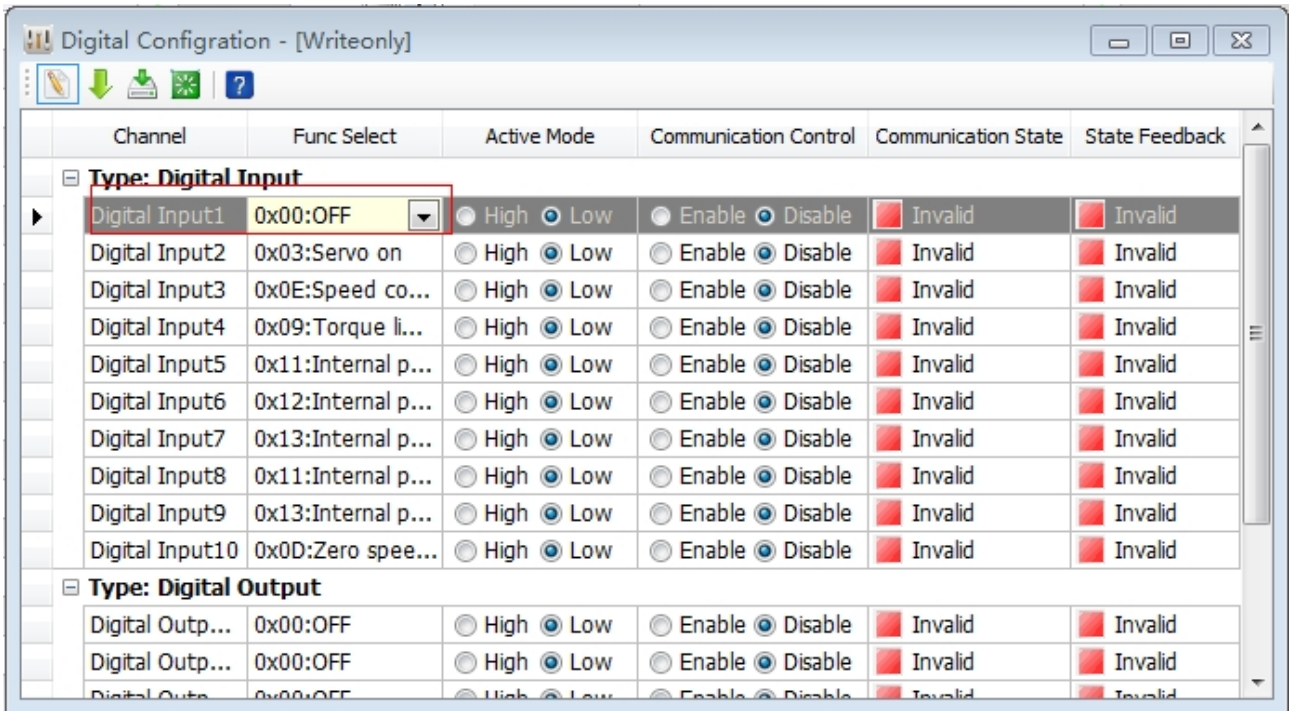
Touch probe function is used to latch the position feedback when trigger signal or event occurred. For DA200, only the encoder Z signal (C-phase) and touch probe1 can be used as trigger signal.

When encoder Z signal is used as trigger signal, only the rising edge of Z signal can be captured and the captured result is stored in $60BA_h$.

Rising edge capture is available when touch probe1 is used and the capture result is stored in $60BA_h$. The result of falling edge is stored in $60BB_h$.

By default, digital input 1 of CN1 is used as trigger input port of touch probe1.

It is necessary to set digital input as invalid by upper PC ServoPlorer or by setting P3.00 to 0. The setting will be effective after restart.



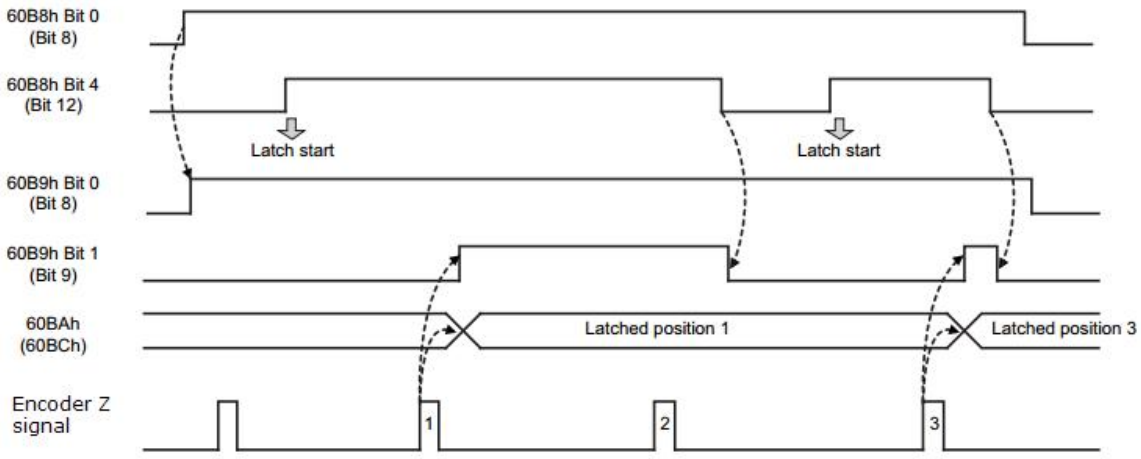
3.8.2 Mode-related objects list

Index	Name	Type	Attr.
$60B8_h$	Touch Probe Control word	UNSIGNED16	RW
$60B9_h$	Touch Probe Status word	UNSIGNED16	RW
$60BA_h$	Probe 1 positive edge value (Encoder zero signal)	INTEGER32	RO
$60BB_h$	Probe 2 positive edge value (Encoder zero signal)	INTEGER32	RO

3.8.3 Description of control word & status word

Bit	$60B8_h$	$60B9_h$
0	Probe 1 enable	Probe 1 enabled
1	Probe 1 continuous mode	Probe 1 positive edge value stored
2	Probe 1 zero pulse	Probe 1 negative edge value stored
3	-	-
4	Probe 1 enable latch on positive edge(used also for encode zero signal)	-
5	Probe 1 enable latch on negative edge	-
6	-	Probe 1 positive edge value stored (continuous mode only, bit toggles if latch status changed)
7	-	Probe 1 negative edge value stored (continuous mode only, bit toggles if latch status changed)
8	Probe 2 enable	Probe 2 enabled
9	Probe 2 continuous mode	Probe 2 positive edge value stored
10	Probe 2 zero pulse	Probe 2 negative edge value stored
11	-	-
12	Probe 2 enable latch on positive edge(used also for encode zero signal)	-
13	Probe 2 enable latch on negative edge	-
14	-	Probe 2 positive edge value stored (continuous mode only, bit toggles if latch status changed)
15	-	Probe 2 negative edge value stored (continuous mode only, bit toggles if latch status changed)

3.8.4 Application examples (Single trigger mode)



4 Object dictionary

4.1 Object specification

4.1.1 Object type

Object name	Definition
VAR	Individual variable value eg UNSIGNED8, Boolean, float, INTEGER16, etc.
ARRAY	An array of multiple data constituted by basic variables of the same type. Sub-index 0 is UNSIGNED8 type which indicates the number of data in the array. Sub-index is not taken as part of the ARRAY data.
RECORD	A structure which is comprised of basic variables of the same or differing type. Sub-index 0 is UNSIGNED8 type which indicates the number of data in the array. Sub-index is not taken as part of the RECORD data.

4.1.2 Data type

See CANopen Standard 301.

4.2 Overview of Object Group 1000_h

Index	Object Type	Name	Data Type	Access	Mappable
CANopen DS301					
1000_h	VAR	Device type	UNSIGNED32	RO	N
1001_h	VAR	Error register	UNSIGNED8	RO	Y
1008_h	VAR	Manufacturer device name	STRING	RO	N
1009_h	VAR	Manufacturer hardware version	STRING	RO	N
$100A_h$	VAR	Manufacturer software version	STRING	RO	N
1018_h	RECORD	Identity Object	IDENTITY	RO	N
1600_h~03_h	RECORD	Receive PDO mapping	PDOMAPPING	RW	N
$1A00_h$~03_h	RECORD	Transmit PDO mapping	PDOMAPPING	RW	N
$1C00_h$	RECORD	Sync manager type	UNSIGNED8	RW	N
$1C12_h$	ARRAY	Receive PDO assign	UNSIGNED16	RW	N
$1C13_h$	ARRAY	Transmit PDO assign	UNSIGNED16	RW	N
$1C32_h$	RECORD	Sync manager output para.	SMPAR	RW	N
$1C33_h$	RECORD	Sync manager input para.	SMPAR	RW	N

4.3 Overview of Object Group 6000_h

Index	Object Type	Name	Data Type	Access	Mappable
CANopen DS402					
6040_h	VAR	Control word	UNSIGNED16	RW	Y
6041_h	VAR	Status word	UNSIGNED16	RO	Y
6042_h	VAR	vl target speed	INTEGER16	RW	N
6043_h	VAR	vl speed demand	INTEGER16	RO	N
6044_h	VAR	vl control effort	INTEGER16	RO	N
6046_h	ARRAY	vl speed min max amount	UNSIGNED32	RW	N
6047_h	ARRAY	vl speed min max	UNSIGNED32	RW	N
$605D_h$	VAR	Halt option code	INTEGER16	RW	N
6060_h	VAR	Mode of operation	INTEGER8	RW	Y
6061_h	VAR	Mode of operation display	INTEGER8	RO	Y
6063_h	VAR	Position actual value*	INTEGER32	RO	N

Index	Object Type	Name	Data Type	Access	Mappable
6064_h	VAR	Position actual value	INTEGER32	RO	Y
6065_h	VAR	Following error window	UNSIGNED32	RW	N
6066_h	VAR	Following error time out	UNSIGNED16	RW	N
$606C_h$	VAR	Speed actual value	INTEGER32	RO	Y
6071_h	VAR	Target torque	INTEGER16	RW	Y
6072_h	VAR	Max torque	UNSIGNED16	RW	Y
6073_h	VAR	Max current	UNSIGNED16	RO	N
6075_h	VAR	Motor rated current	UNSIGNED32	RO	N
6076_h	VAR	Motor rated torque	UNSIGNED32	RO	N
6077_h	VAR	Torque actual value	INTEGER16	RO	Y
6079_h	VAR	DC link circuit voltage	UNSIGNED32	RO	N
$607A_h$	VAR	Target position	INTEGER32	RW	Y
$607B_h$	ARRAY	Position range limit	INTEGER32	RW	N
$607C_h$	VAR	Home offset	INTEGER32	RW	N
$607F_h$	VAR	Max profile speed	UNSIGNED32	RW	Y
6081_h	VAR	Profile speed	UNSIGNED32	RW	Y
6083_h	VAR	Profile acceleration	UNSIGNED32	RW	Y
6084_h	VAR	Profile deceleration	UNSIGNED32	RW	Y
6091_h	ARRAY	Gear ratio	UNSIGNED32	RW	N
6093_h	ARRAY	Position factor	UNSIGNED32	RW	N
6098_h	VAR	Homing method	INTEGER8	RW	N
6099_h	ARRAY	Homing speeds	UNSIGNED32	RW	N
$60B8_h$	VAR	Touch probe control value	UNSIGNED16	RW	Y
$60B9_h$	VAR	Touch probe status value	UNSIGNED16	RO	Y
$60BA_h$	VAR	Touch probe latch value	INTEGER32	RO	Y
$60E0_h$	VAR	Positive Torque Limit	UNSIGNED16	RW	Y
$60E1_h$	VAR	Negative Torque Limit	UNSIGNED16	RW	Y
$60F4_h$	VAR	Following error actual value	INTEGER32	RO	Y
$60FD_h$	VAR	Digital inputs	UNSIGNED32	RO	Y
$60FE_h$	VAR	Digital outputs	UNSIGNED32	RO	Y
$60FF_h$	VAR	Target speed	INTEGER32	RW	Y
6502_h	VAR	Support drive mode	UNSIGNED32	RO	N

4.4 Overview of Object Group 2000_h- 4000_h

Index	Object Type	Name	Data Type	Access	Mappable
SV-DA200 manufacture parameter					
2300_h	ARRAY	drive parameters	UNSIGNED32	RW	N
$300D_h$	VAR	Encoder Feedback	INTEGER32	RO	N
3019_h	VAR	multi number of turns	INTEGER16	RO	N
3020_h	VAR	Encoder Feedback Cap	INTEGER32	RO	N
3021_h	VAR	multi number of turns Cap	INTEGER16	RO	N
4000_h	VAR	Error code	UNSIGNED16	RO	N
4001_h	VAR	Drive temperature	INTEGER16	RO	N
4002_h	VAR	Parameter save	INTEGER16	RW	N
4003_h	VAR	Parameter restore	INTEGER16	RW	N

4.5 Encoder Feedback

$300D_h$ encoder feedback value, corresponds to R0.31.

3019_h number of multi turns, corresponding to R0.25.
The following two parameters will store the capture value only when P4.25 is set to factory unit.
3020_h Encoder Feedback Cap value, it is used to store the encoder position during touch probe1 capture.
3021_h multi number of turns Cap value, it is used to store the encoder multi-turn value during touch probe1 capture.

4.6 Drive parameters

0x2300 drive parameter carries three indices, this object can be used to set and read factory parameters.
Subindex 1 is parameter address, 32-bit unsigned data.
Subindex 2 is parameter value, 32-bit unsigned data.
Subindex 3 is operation result, 32-bit unsigned data.

Read:

a): Write subindex 1 to the data address to be read.
b): Read subindex 2 and get parameter value.
c): Read subindex3 and get the reading result which should be 0.

Set:

a): Write subindex 1 to the parameter address to be set.
b): Write subindex 2 to the value to be set.
c): Read subindex 3 and get the set result which should be 4.

The parameter address has referred to CANopen address of DA200. Take P0.05 as example, the index of CANopen is 0x2005, the subindex is 0, so the address parameter should be 0x200500.
The result of twincat reading is shown as below:

2300:0	driver paramets	RO	> 3 <
2300:01	index	RW	0x00200500 (2098432)
2300:02	value	RW	0x000000C8 (200)
2300:03	status	RO	0x00000000 (0)

5 Fault and diagnosis

5.1 EtherCAT communication faults and remedies

Fault code	Fault name	Fault cause	Solution
Er24-8	EtherCAT fault – initialization fault	Poor contact of EtherCAT chip	Replace the servo
Er24-9	EtherCAT fault – EEPROM fault	EtherCAT EEPROM has no data or data reading failed	Download xml file to EtherCAT EEPROM with TwinCAT or other tools;
Er24-a	EtherCAT fault -DC Sync0 signal is abnormal	Set to DC sync operation mode, DC Sync0 interruption signal is not detected during a period of time.	Check whether data loss occurred due to interference; Check whether EtherCAT master works normally;
Er24-b	EtherCAT fault-offline fault	Network cable is inserted improperly or EtherCAT master operation is abnormal.	Check whether network cable is connected properly which should be top-in and bottom-out; Check if there is interference; Check EtherCAT master operates normally.
Er24-c	EtherCAT fault-PDO data loss fault	No PDO data is received after the drive is enabled for a period of time.	Check EtherCAT master operates normally; Check if data loss is caused by interference.

5.2 SV-DA200 servo faults and fault codes

Fault code	Fault name	Fault cause	Solution
Er01-0	IGBT fault	The actual drive output current exceeds the specified value. 1. Drive fault (drive circuit, IGBT fault). 2. Motor cable U, V, W is short circuited; motor cable is grounded or suffers poor contact. 3. Motor burnt down. 4. Phase sequence of motor cable U, V and W is connected reversely. 5. Parameters are inappropriate and cause system divergence. 6. ACC/DEC time is too short during start/stop. 7. Momentary load is too big.	1. Disassemble motor cable and enable the drive, if fault persists, replace the drive; 2. Check motor cable and wiring is in good condition. 3. Decrease P0.10 and P0.11 to lower the max output torque. 4. Adjust the loop parameter to stabilize the system, reduce the value of P0.12. 5. Prolong ACC/DEC time properly. 6. Replace with a drive with larger power. 7. Replace the motor.
Er01-1	Brake tube fault (7.5kW and above models)	Brake unit fault	Replace the drive
Er02-0	Encoder fault-encoder offline	1. Encoder is not connected; 2. Encoder plug is loosened; 3. Any one of the encoder	1. Connect encoder according to the wiring mode. Check encoder plug is removed properly.

Fault code	Fault name	Fault cause	Solution
Er02-1	Encoder fault-encoder feedback error is too large	signal cable U, V, W, A, B and Z phase is disconnected; 4. Encoder A/B phase reversal occur; 5. Communication interruption or data abnormal caused by noise; 6. Encoder communication is normal, but communication data is abnormal. 7. The FPGA in charge of communication with encoder reports communication timeout.	Replace the encoder cable if cable is disconnected. 2. Check encoder power voltage is normal. 3. Reduce the interference source of encoder cable to the minimum extent. Route the encoder cables and motor cables separately and connect the shielded wire of encoder cable to FG.
Er02-2	Encoder fault-ODD/EVEN check error		
Er02-3	Encoder fault-CRC check error		
Er02-4	Encoder fault-frame error		
Er02-5	Encoder fault-short frame error		
Er02-6	Encoder fault-encoder reports timeout		
Er02-7	Encoder fault-FPGA reports timeout		
Er02-8	Encoder fault-encoder battery low voltage alarm	When multi-turn absolute encoder is used, the voltage of external encoder battery should be between 3.0V~3.2V.	1. Check the battery connection in the encoder cable is in good condition; 2. Check if the external battery voltage of encoder is less than 3.2V, if yes, replace the battery; 3. Ensure the drive is powered on during battery replacement, otherwise the encoder absolute data may be lost.
Er02-9	Encoder fault-encoder battery undervoltage fault	When multi-turn absolute encoder is used, the voltage of external encoder battery should be between 2.5V~3.0V.	1. Check the battery connection in the encoder cable is in good condition; 2. Check if the external battery voltage of encoder is less than 3.0V, if yes, replace the battery; 3. Ensure the drive is powered on during battery replacement, otherwise the encoder absolute data may be lost.
Er02-a	Encoder fault-encoder overheat	The encoder feedback temp is higher than the set overheat protection value.	1. Ensure the encoder overheat protection value is set correctly. 2. Stop the motor and cool down the encoder.
Er02-b	Encoder fault-encoder EEPROM write error	For the motor equipped with communication encoder, communication transmission error or data check error occur when the drive updates	1. Check if encoder is wired properly, reduce the interference source of the encoder communication; 2. If write operation fails

Fault code	Fault name	Fault cause	Solution
		data to encoder EEPROM.	constantly, replace the motor.
Er02-c	Encoder fault-no encoder EEPROM data	For the motor equipped with communication encoder, there is no data when reading encoder EEPROM during power up.	1. Select present motor model via P0.00, then execute encoder EEPROM parameter write operation via P4.97; 2. Mask this fault via P4.98 and perform initialization accordingly using the motor parameters in the drive EEPROM.
Er02-d	Encoder fault-encoder EEPROM data check error	For the motor equipped with communication encoder. Data check error occurs when reading encoder EEPROM during power up.	1. Check encoder is wired properly and reduce the interference source of the encoder communication; 2. Select present motor model via P0.00, then write encoder EEPROM parameters via P4.97, and update the data in encoder EEPROM; 3. Mask this fault via P4.98, and perform initialization accordingly using the motor parameters in the drive EEPROM.
Er03-0	Current sensor fault-U phase current sensor fault	1. Current sensor or detection circuit is abnormal; 2. Power is applied when motor shaft is in non-static state.	Re-power on when the motor is in static state. Replace the drive if fault is reported many times.
Er03-1	Current sensor fault-V phase current sensor fault		
Er03-2	Current sensor fault-W phase current sensor fault		
Er04-0	System initialization fault	Self-test failed after system power-on initialization completes.	1. Re-power on; 2. If the fault occurred many times, replace the drive.
Er05-1	Setting fault-motor model does not exist	P0.00 parameter setting is wrong	1. Ensure motor model setting is correct; 2. Ensure motor parameter model matches drive power class.
Er05-2	Setting fault-motor model does not match drive model		
Er05-3	Setting fault-software limit setting fault	Software limit value is set improperly. The value of P0.35 (forward position control software limit) is no more than that of P0.36 (reverse position control	Reset P0.35 and P0.36.

Fault code	Fault name	Fault cause	Solution
		software limit)	
Er05-4	Setting fault-homing mode setting fault	P5.10 sub-mode setting is wrong	Set P5.10 correctly based on detailed parameter instructions.
Er05-5	Setting fault-jogging control travel overflow fault	Single increment of jogging spare travel exceeds (2^{31}-1)	Single travel should not exceed (2^{31}-1) under absolute position mode.
Er07-0	Regenerative discharge overload fault	1. Brake resistor power is too small. 2. Motor speed is too high or the deceleration is too fast, regenerative energy cannot be fully absorbed in the specified time; 3. Action limit of external brake resistor is limited to 10% duty ratio.	1. Change the internal brake resistor to external brake resistor and enlarge the power; 2. Modify deceleration time and lower the regenerative discharge action rate; 3. Reduce motor speed; 4. Improve the capacity of motor and drive.
Er08-0	Analog input overvoltage fault-analog input 1	The voltage inputted to analog input 1 port exceeds the value defined with P3.22.	1. Set P3.22; P3.25 and P3.75 properly; 2. Check terminal wiring is in good condition; 3. Set P3.22; P3.25 and P3.75 to 0 to void the protection function.
Er08-1	Analog input overvoltage fault-analog input 2	The voltage inputted to analog input 2 port exceeds the value defined with P3.25.	
Er08-2	Analog input overvoltage fault-analog input 3	The voltage inputted to analog input 3 port exceeds the value defined with P3.75.	
Er09-0	EEPROM fault-R/W fault	Data in the parameter storage area is damaged when reading data from EEPROM. EEPROM write operation is interfered.	1. Re-try after power up again; 2. Replace the drive if the fault occurred constantly.
Er09-1	EEPROM fault-data check fault	The data read from EEPROM differs from the data being written.	1. Reset all the parameters; 2. Replace the drive if the fault occurred many times.
Er10-0	Hardware fault - FPGA fault	FPGA chip fault	1. Repower on 2. If the problem reoccurs for many times, change the drive
Er10-1	Hardware fault - Communication card fault	External communication card fault	1. Repower on 2. If the problem reoccurs for many times, change the communication card
Er10-2	Hardware fault - Ground short circuit fault	During the earth test after power on, one of motor cables V,W is short-circuited to the ground	1. Check the connection of the motor cables 2. Change the motor cable or test whether the motor insulation aging or not

Fault code	Fault name	Fault cause	Solution
Er10-3	Hardware fault-external input fault	This fault occurred when digital terminal configured as external fault input function acts.	1. Remove external fault input, enable fault clearance. 2. Re-power on the drive.
Er10-4	Hardware fault-emergency stop fault	This fault occurs when E-stop button acts (digital terminal configured as E-stop function)	1. Remove E-stop input, enable fault clearance. 2. Re-power on the drive.
Er10-5	Hardware fault–485 communication fault	Strong EMI of 485 communication circuit causes drive serial communication alarms	1. Use twisted shielded pairs for 485 communication; 2.Wiring communication cables and motor power cables separately.
Er11-1	Software fault-reentry of motor control task	1. CPU load of DSP software is too high; 2. DSP software is defective.	1. Reduce some unnecessary software function; 2. Contact customer service, update drive DSP software.
Er11-1	Software fault-reentry of cycle task		
Er11-2	Software fault-illegal operation		
Er12-0	IO fault- repeated assignment of digital input	Two or more digital inputs are configured to the same function.	Reset P3.00~P3.09 and ensure there is no repeated setting.
Er12-1	IO fault-repeated assignment of analog input	Analog input 3 is configured as speed command when the drive is standard model.	Configure P3.70 (analog input 3 function) to other values.
Er13-0	Main circuit overvoltage fault	The drive detects the main circuit DC voltage exceeds the specified value. 1. Grid voltage is too high; 2. The brake resistor, brake tube or brake resistor is damaged under brake working condition; 3. DEC time is too short during stop; 4. DC voltage detection current inside the drive is damaged.	1. Check whether grid input voltage exceeds the allowed value. 2. Check whether the shorting link of built-in brake resistor is loosened or built-in/external brake resistor is damaged. 3. Increase the value of DEC time. 4. Monitor whether R0.07 is normal when the drive is not enabled. If it is abnormal and does not match grid input voltage, replace the drive.
Er13-1	Main circuit undervoltage fault	The drive detects main circuit DC voltage is lower than the specified value. 1. Grid voltage is too low. 2. Power-on buffer relay is not closed. 3. Drive output power is too large. 4. Internal DC voltage	1. Detect whether the grid input voltage is lower than the allowed value. 2. Re-power on and check whether there is any sound when noise when power-on buffer relay closes. 3. Monitor whether R0.07 is normal when the drive is not

Fault code	Fault name	Fault cause	Solution
		detection circuit of the drive is damaged.	enabled, if it is abnormal and does not match the grid input voltage, replace the drive.
Er14-0	Control power undervoltage fault	The drive detects control power DC voltage is lower than the specified value. 1. The grid voltage is too low. 2. Internal control power DC voltage detection circuit of the drive is damaged.	1. Detect whether grid input voltage is lower than the allowed value. 2. Monitor whether R0.08 is normal when the drive is not enabled, if it is abnormal and does not match the grid input voltage, replace the drive.
Er17-0	Drive overload fault	Short-time load of the drive is too heavy	1.The load is too heavy which causes drive overload; 2.Check whether phase dislocation or phase loss occurred to UVW wiring of the motor, and check whether encoder is correct; 3.Check whether the motor is compatible with the drive.
Er18-0	Motor overload fault	1. Long-term overload running; 2. The load is too heavy during short time.	1. Replace with the drive and motor with larger power.
Er18-1	Motor overtemp fault	Motor temp exceeds the protection value	1.Replace with the motor of larger power; 2.Check whether UVW phase sequence is correct.
Er19-0	Speed fault-overspeed fault	The absolute value of motor speed exceeds the value defined with P4.32. 1. Motor overspeed, U, V and W phase are connected reversely. 2. Electronic gear ratio or motor speed loop control parameters are set improperly. 3. The value defined with P4.32 is less than P4.31 (max speed limit). 4. Encoder feedback signal is interfered.	1. Check electronic gear ratio parameters are set properly. 2. Check the setting of speed loop control parameters. 3. Check motor cable phase sequence is correct. 4. Check motor encoder is wired properly. 5. Replace with a motor of higher rotating speed.
Er19-1	Speed fault-FWD overspeed fault	Speed feedback exceeds the value of P4.40 by more than 20ms.	1.Check whether encoder is normal; 2.Check whether P4.40 parameter is set properly.
Er19-2	Speed fault-REV overspeed fault	Speed feedback exceeds the value of P4.41 by more than 20ms.	1.Check whether encoder is normal; 2.Check whether P4.41 is set properly.
Er19-3	Speed fault-Overspeed parameter setup	The value of P4.40 is less than 0 or P4.41 is larger than 0.	1.Check whether encoder is connected reliably; 2.Check whether P4.40 and

Fault code	Fault name	Fault cause	Solution
	is wrong		P4.41 are set improperly.
Er20-0	Speed out-of-tolerance fault	In non-torque mode, the deviation between motor speed and speed command exceeds the value defined with P4.39. 1. Motor U, V and W phase are connected reversely or motor cable is not connected. 2. Motor load is too heavy and causes motor stall. 3. The drive force is insufficient and causes motor stall. 4. Speed loop control parameters are set improperly. 5. The value defined with P4.39 is too small.	1. Check motor cable phase sequence and ensure the wiring is correct. 2. Check whether the transmission belt or chain is too tight, or the workbench reaches edges or encounters obstacles. 3. Check whether the loop control parameters are set properly or the drive has been damaged, or the servo system model is appropriate. 4. Increase the value defined with P4.39. 5. Set P4.39 to 0 to void speed out-of-tolerance fault detection.
Er21-0	Position overtravel-FWD overtravel	Under position mode or fully-closed loop mode, the FWD limit switch is touched or the accumulated feedback pulse exceeds P0.35.	1.Check whether FWD limit switch signal is correct; 2.Check whether P0.35 is set properly.
Er21-1	Position overtravel-REV overtravel	Under position mode or fully-closed loop mode, the FWD limit switch is touched or the accumulated feedback pulse exceeds P0.36.	1.Check whether REV limit switch signal is correct; 2.Check whether P0.36 is set properly.
Er22-0	Out-of-tolerance fault- Position out of tolerance	1. Residual pulse value exceeds the value defined with P4.33 due to slow response time. 2. The motor load is too heavy and causes motor stall. 3. Pulse input frequency is too high, which exceeds the highest speed capacity of the motor. 4. Position command input step variation quantity exceeds the value defined with P4.33.	1. Check whether the transmission belt or chain is too tight, or the workbench reaches edges or encounters obstacles. 2. Increase position loop gain parameter or speed feedforward gain, or increase P4.33. 3. Modify electric gear ratio. 4. Reduce position command input variation quantity.
Er22-1	Out-of-tolerance fault- mixed control deviation is too large	In full close loop control, the deviation between feedback position of the grating ruler and that of the encoder exceeds the value defined with P4.64.	1. Check the connection between motor and load. 2. Check the connection between grating ruler and the drive. 3. Check the numerator and denominator of the grating ruler (P4.60, P4.61); check grating ruler direction reversal (P4.62) is set correctly.

Fault code	Fault name	Fault cause	Solution
Er22-2	Position gain overflow fault	Position command's single variation quantity after converted by electric gear ratio exceeds 2^{31}-1.	1. Reduce the single variation quantity of position command; 2. Modify electric gear ratio to appropriate range.
Er23-0	Drive overtemp fault	1. The ambient environment of the drive exceeds the specified value. 2. Drive overload.	1. Lower the ambient temp of the drive and improve ventilation condition; 2. Replace with the servo system of larger power; 3. Prolong ACC/DEC time and reduce the load.
Er24-0	PROFIBUS-DP fault -PWK ID error	PWK ID error	Read the manual , ensure the ID of PWK corresponds to the parameter ID
Er24-1	PROFIBUS-DP fault –PWK exceed the range	The setting of PWK exceed the range allowed by the corresponding parameter	Read the manual , ensure the PWK setting of PWK is in the range allowed by the corresponding parameter
Er24-2	PROFIBUS-DP fault –read-only PWK parameter	PWK parameter performs write operation to read-only parameters.	Read the manual , ensure the parameter can be read and written
Er24-3	PROFIBUS-DP fault –PZD does not exist	The selected ID is not right	Read the manual , ensure the ID corresponds to the corresponding parameter ID
Er24-4	PROFIBUS-DP fault –PZD not matching	The parameter is not valid instantly	Read the manual , ensure the parameter is valid instantly
Er25-4	Application fault–encoder offset angle test failed	Abnormity occurred during encoder offset angle test.	Check whether the motor shaft can rotate freely, then repower on and carry out
Er25-5	Application fault–encoder offset angle test failed	The current feedback wave fluctuate violently during encoder offset angle test.	Reduce P4.53 parameter setting, then repower on and carry out
Er25-6	Application fault-homing beyond limit	Encounters limit switches or software limit during homing.	Modify P5.10 and execute again after repower-on.
Er25-7	Application fault-inertia identification failure	1. The vibration lasts for more than 3.5s when inertia identification motor stops rotating; 2. Actual ACC time is too short; 3. Identification speed is lower than 150r/min.	1. Improve the mechanical rigidness properly if vibration occurred when motor stops running; 2. Increase ACC time constant P1.07. 3. Increase movable range P1.06.

5.3 Give instructions without action

If the PDO mapping has torque limit parameters eg Max Torque, Negative Torque Limit and Positive Torque Limit, the default PDO value is 0, under which situation, the motor will not run after the drive is enabled, unless a torque limit value is defined. The unit of torque limit value is generally 0.1% of rated torque, for instance, if the torque limit value is 3000, it means 300% of rated torque.

6 Reference

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