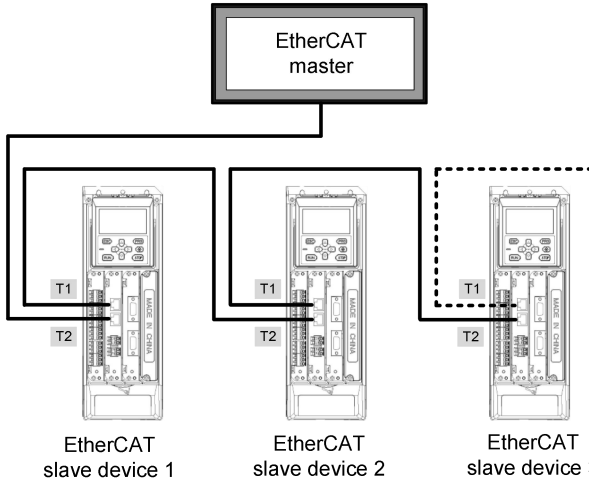


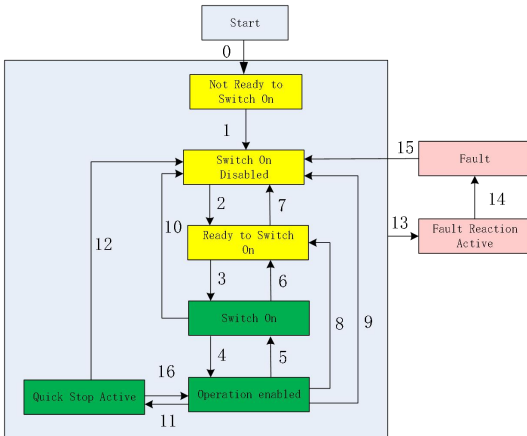
## Appendix C EtherCAT

### 1 EtherCAT Topology



### 2 CiA402 State Transitions

EtherCAT CiA402 State Transitions is used to describe the state and state transitions of slave device. Usually, the master initiates a request to slave device for state transitions, and responded by the slave device. The state transitions shown below as FSA specified for CiA402.



State	Description
Not Ready to Switch On	Drive is initializing.
Switch On Disabled	The drive has no fault or error, and the parameters can be set.
Ready to Switch On	The drive is ready, and the parameters can be set, ready to enter the Switch On state.
Switch On	The drive is ready, waiting to enable
Operation Enable	The drive enabled and runs normally.
Quick Stop Active	Stop by drive pre-set stop mode.
Fault Reaction Active	Coast to stop by fault.
Fault	Fault state, drive display fault code, can be reset by the control word 6040H = 0x80

CiA 402 finite state automation (FSA)


### 3 Control Word 6040H

Index	Object Name	Control Word					Object type	VAR	Data type	Uint16
	6040h	Access	RW	Mapping	YES	Related mode	All	Allowed values	0~65535	Preset value

The control word 6040H bits are defined as follows:

Bit	Name	Description
0	Switch on	The drive ready
1	Enable voltage	The main circuit is powered up
2	Quick stop	Quick stop
3	Enable operation	The drive is enabled
4~6	Operation mode specific	Related to the the drive operation mode
7	Fault reset	Fault reset
8	Halt	Unsupported for the time being
9	Reserved	Reserved bit
10	Positioning command	The drive performs an internal positioning function, which has the highest priority in non-torque loop mode, and is 0 for any other modes.
11~15	Manufacturer specific	Factory custom-defined, not defined

Bits 0 ... bit 3 and bit 7 (Bits for state control)

Command	Bits of the controlword					Transitions
	Bit 7	Bit 3	Bit 2	Bit 1	Bit 0	
Shutdown	0	X	1	1	0	2,6,8
Switch on	0	0	1	1	1	3
Switch on + enable operation	0	1	1	1	1	3 + 4 (NOTE)
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
NOTE Automatic transition to Enable operation state after executing SWITCHED ON state functionality.						

Bits 4 ... bit6 and bit 8 (Bits related to control mode)

Bit	Operation mode		
	Profile Position Mode	Profile velocity Mode	Homing mode
4	New set-point	Reserved	Homing operation start
5	Change set immediately	Reserved	
6	abs/rel	Reserved	
8	Halt		

## 4 Status Word 6041H

Index 6041H	Object Name	Status Word					Object type	VAR	Data type	Uint16
	Access	RO	Mapping	TPDO	Related mode	All	Allowed values	0~65535	Preset value	0

Status bits are defined as follows:

Bit	Name	Description
0	Ready to switch on	The drive without fault
1	Switched on	Waiting for the drive to enable
2	Operation enabled	The drive operation
3	Fault	The drive trips on a fault
4	Voltage enabled	Bit 4 = 1, it indicates the power supply of the main circuit is normal.
5	Quick stop	Quick stop
6	Switch on disabled	The drive is ready
7	Warning	Bit 7 = 1, it indicates that the drive has an alarm.
8	Manufacture specific	Bit8 = 0: the spindle speed $\neq$ 0. Bit 8 = 1: Spindle speed = 0.
9	Remote	Remote control
10	Target reached	Target reached. In different modes has different meanings. In PP mode, bit10 = 1: the position reaching the reference position. in CSV mode, bit10 = 1: the speed reaches the reference speed. In CSP mode, bit10 = 1: the position has reached.
11	Internal limit active	Reserved.
12~13	Operation mode specific	Related to drive mode
14~15	Manufacture specific	undefinition

Bit0 ... bit3, bit5 and bit6:

Statusword	PDS FSA state
xxxx xxxx x0xx 0000 <sub>b</sub>	Not ready to switch on
xxxx xxxx x1xx 0000 <sub>b</sub>	Switch on disabled
xxxx xxxx x01x 0001 <sub>b</sub>	Ready to switch on
xxxx xxxx x01x 0011 <sub>b</sub>	Switched on
xxxx xxxx x01x 0111 <sub>b</sub>	Operation enabled
xxxx xxxx x00x 0111 <sub>b</sub>	Quick stop active
xxxx xxxx x0xx 1111 <sub>b</sub>	Fault reaction active
xxxx xxxx x0xx 1000 <sub>b</sub>	Fault

Bit12 and bit13: In different modes, the PP mode is defined as follows:

Bit	Operation mode
	pp
12	Set-point Acknowledge
13	Following error

## 5 Drive Operation Mode

### ◆ Supported drive modes (6502H)

This object provides information on the supported drive modes.

Object name	Supported Drive Modes					Object type	VAR	Data type	Uint32
Access	RO	Mapping	TPDO	Related mode	All	Allowed values	0~4294967295	Preset value	0x381

The object 6502H reflects the operating mode supported by the drive:

Bit	Description	Support: 0 = not support, 1 = support
0	PP (Profile Position Mode)	1
1 ... 6	NA	0
7	CSP: Cyclic Sync Position Mode	1
8	CSV: Cyclic Sync Velocity Mode	1
9	CST: Cyclic Sync Torque Mode	1
10 ... 31	Reserved	0

### ◆ Modes of operation (6060H)

The object 6060H is used to set operation mode.

Object name	Modes of Operation					Object type	VAR	Data type	Int8
Access	RW	Mapping	YES	Related mode	All	Allowed values	0~7	Preset value	0

Currently, the drive provides the following 4 operation modes:

Value of 6060H	Mode
1	Profile Position Mode
8	Cyclic Synchronous Position Mode
9	Cyclic Synchronous Velocity Mode
10	Cyclic Synchronous Torque Mode

### ◆ Modes of Operation Display (6061H)

The object 6061H displays current operation mode of the drive.

Object name	Modes of Operation Display					Object type	VAR	Data type	Int8
Access	RO	Mapping	TPDO	Related mode	All	Allowed values	0~7	Preset value	0

The value definition of object 6061H is same as Mode of Operation (0x6060).

Value of 6061H	Corresponding mode
1	Profile Position Mode
8	Cyclic Synchronous Position Mode
9	Cyclic Synchronous Velocity Mode
10	Cyclic Synchronous Torque Mode

◆ **Related drive parameters**

Parameter	Name	Range	Description
P0-004	Run command selection	0 ... 5	3: EtherCAT
P0-005	Speed reference selection	0 ... 14	4: EtherCAT
C2-000	EtherCAT speed reference unit	0: RPM      1: PULSE/S	Set according to the requirements
C2-001	EtherCAT position reference smoothing cycle	1~65535 us	
C2-002	The EtherCAT clock synchronize with the drive	0: Synchronization not allowed 1: Synchronization allowed	
C2-003	EtherCAT pulse input gear ratio numerator	1~65535	
C2-004	EtherCAT pulse input gear ratio denominator	1~65535	
C2-005	EtherCAT communication enable	0: Disabled    1: Enabled	
C2-006	EtherCAT position loop reference mode	0: Relative position 1: Absolute position.	
C2-018	Probe mode	0: Encoder Z triggering 1: Encoder Z or digital input triggering	
B0-001	Position loop reference selection	0: Pulse input    1: EtherCAT	1: EtherCAT
PA-000	Torque reference and direction selection	0000 ... 0047	Ones position = 3:

◆ **Profile Position Mode**

Profile Position Mode is a point-to-point operating mode using set-points which consist of velocity, acceleration, deceleration, and target position. Once all these parameters of the drive have been set by master, the drive buffers the commands and begins executing the set-point. When using a set of set-points method, a new set-point can be sent to the drive while a previously sent set-point is still executing.

This mode is mostly used for point-to-point positioning operation, and the operation curve is planned by the drive itself. The drive automatically completes position, speed and torque control.

① **Setting steps**

- Set the drive parameter: P0-004 = 3 (EtherCAT).
- Set the drive parameter: B0-001 = 1 (EtherCAT).
- Set the drive parameter: C2-006 = 0.
- Set [6060H: Mode of Operation] = 1 [Profile Position Mode].
- Set [6081H: Profile Velocity] = Current step position command constant running speed (unit: RPM); the value should not higher than the parameter B0-003 (Position loop max. speed); (internal limit the value  $\geq$  1rpm).
- Set [6083H: Profile acceleration] = position loop acceleration time (unit: 0.01S, the time from 0 rpm to B0-003), corresponds to the drive internal parameter B0-004, range 0.00 ... 655.35. Set [6084H: Profile deceleration] = position loop deceleration time (unit: 0.01S, the time from the B0-003 to 0 rpm), corresponds to the drive internal parameter B0-005, range 0.00~655.35.
- Set position loop gear ratio [B0-006: numerator] and [B0-007: denominator].

**Note:** The gear ratio is effective when update position is relative position and ineffective when update position is absolute position.

- Set [607AH: Target Position] = the target position (unit: pulse).
- Set bit4[reset to zero], bit5[Update Mode], bit6[Position Type] of [6040H: Control Word]. E.g., write control word 6040H = 0xnF (E.g., 0x0F, 0x2F, 0x4F, 0x6F).
- The bit12 of 6041H = 0: the drive can receive new target position. Then set bit4 of 6040H triggers the target position to take effect, namely, write control word 6040H=0x (n + 1) F (E.g., 0x1F, 0x3F, 0x5F, 0x7F).

The new values of 6081H, 6083H and 6084H will take effect when the rising edge of bit4 of 6040H = 0 → 1 .

The target position 607AH is a relative position or absolute position is defined by the bit6 of 6040H. The update mode defined by the bit5 of 6040H. As shown in the following table:

Position type (bit6 Of 6040H)	Update mode (bit5 of 6040h)	6040H	607AH description
0	0	0x0F→0x1F	Absolute position, not immediate update
0	1	0x2F→0x3F	Absolute position, updated immediately
1	0	0x4F→0x5F	Relative position, not immediately update
1	1	0x0F→0x1F	Relative position, updated immediately

**Note:** When 6040h = 0xnF is enabled and the status word bit12 of 6041h = 0, the update request is executed, otherwise the position update request is not executed by the drive.

- Query the actual position feedback through 6064H (Position Actual Value).
- Obtain the drive status feedback through 6041H (Status Word).

### ② Other objects

- Obtain the position target value (unit: pulse) through [6062H: Position demand value].
- Obtain the deviation between the target position and actual position (unit: pulse) through [60F4H: Following error actual value].

### ③ List of related objects

Index	Name	Type	Attr
6040H	Control Word	U INTEGER16	RW
6041H	Status word	U INTEGER16	RO
6060H	Mode of operation	INTEGER16	RW
6061H	Modes of operation display	INTEGER16	RO
6062H	Position demand value	INTEGER32	RO
6064H	Position actual value	INTEGER32	RO
607AH	Target Position	INTEGER32	RW
6081H	Profile velocity	U INTEGER32	RW
6083H	Profile acceleration	U INTEGER32	RW
6084H	Profile deceleration	U INTEGER32	RW
60F4H	Following error actual value	INTEGER32	RO

**Note:** Refer to the CiA DS402 standard for the detailed description of each object.

● Control Word (0x6040) of Profile Position Mode

Object	Control Word					Object type	VAR	Data type	Uint16
Access	RW	Mappin	YES	Related mode	All	Allowed values	0~65535	Preset value	0
Description of the special control bit of 0x6040 in Profile Position Mode									
Bit	Bit 6			Bit 5		Bit 4			
Name	Position command type			Position command update mode		Enable the new position command (Effective when rising or falling edge)			
Value	0: The target position of 607AH is an absolute position command 1: The target position 607AH is a relative position instruction			0: Not updated immediately 1: Update immediately		0→1: Pre-enabled a new position command. Whether the new position command is success enabled depends on the drive state. Simultaneously trigger the values of 6081H, 6083H, and 6084H to take effect. 1→0: Pre-set bit12 of 6041H to 0. Whether the reset is successful depends on the drive state.			

● Status word (0x6041) of Profile Position Mode

Object	Status Word					Object type	VAR	Data type	Uint16
Access	RO	Mapping	TPDO	Related mode	All	Allowed values	0~65535	Preset value	0
Description of the special control bit of 0x6041 in Profile Position Mode									
Bit	Bit 13			Bit 12			Bit 10		
Name	Position deviation state			Receive new position command			Target position reached		
Value	0: The position deviation is within the range (6065H) 1: Position deviation out of range (6065H)			0: The drive can receive new position command 1: The drive cannot receive new position command			0: Target position is not reached 1: Target position is reached		

④ Application examples

- Set the drive parameter P0-004 = 3 (Run command: EtherCAT).
- Set the drive parameter B0-001 = 1 (Speed reference: EtherCAT).
- Set the drive parameter C2-006 = 0.
- Set 6060H = 1, select Profile Position Mode.
- Set 607AH = 10000 (e.g., 10000 pulse), set the position value.
- Set 6081H = 200 (such as 200 RPM), set the position command constant running speed (unit: RPM).
- Set 6083h = 100 (e.g., 1.00 seconds), set the planned acceleration time (unit: 0.01 seconds).  
Set 6084h=100 (e.g., 1.00 seconds), set the planned deceleration time (unit: 0.01 seconds).
- After the above parameters are set, then enable the drive: 6040H=0x0F.
- Set bit6 (position command type) and bit5 (update mode) of 6040H according to the requirement, clear bit4 of 6040H and enable. Such as set 6040H = 0x2F (absolute position, and update immediately).
- Wait for 6041H. Bit 12 = 0 (the drive can receive new position command), then set bit4 of 6040H, that is to say set 6040H = 0x3F. The drive starts executing a new position command.
- Query bit10 of 6041H to see if the target position is reached after 10ms delay.

◆ **Cyclic Synchronous Position Mode**

Cyclic Synchronous Position Mode is similar to the principle of position interpolation mode, the curve planning and interpolation of position command are completed by the master, the drive only do position follow.

The interpolation cycle defines the time interval when the Target Position update, and in this mode, the interpolation cycle is the same as that of the EtherCAT synchronization cycle.

① **Setting steps**

- Set the drive parameter P0-004 = 3 (Run command: EtherCAT).
- Set the drive parameter B0-001 = 1 (Position loop reference selection).
- Set the drive parameter C2-006 = 0 (Target position is a relative value).
- Set [6060H: Mode of operation] = 8 (Cyclic Synchronous Position Mode).
- Set the drive parameters [C2-001: EtherCAT position reference smoothing cycle] should set the same position interpolation period of the master.
- Set the drive position loop gear ratio parameters [B0-006: gear ratio numerator] and [B0-007: gear ratio denominator].
- Set [6040H: Control Word] = 0x0F to enable drive and trigger the target position to take effect.
- Set [607AH: Target Position] as the target position (unit: pulse).
- Query [6064H: Position Actual Value] query the actual position feedback.
- Query [6041H: Status Word] to obtain the drive status feedback.

② **Other objects**

- Query [6062H: Position demand value] to obtain the position target position (unit: pulse).
- Query [60F4H: Following error actual value] to obtain the following error between position command and feedback (unit: pulse).

③ **List of related objects**

Index	Name	Type	Attr
6040H	Control Word	U INTEGER16	RW
6041H	Status word	U INTEGER16	RO
6060H	Mode of operation	INTEGER16	RW
6061H	Modes of operation display	INTEGER16	RO
6062H	Position demand value	INTEGER32	RO
6064H	Position actual value	INTEGER32	RO
607AH	Target Position	INTEGER32	RW
60F4H	Following error actual value	INTEGER32	RO

**Note:** Refer to the CiA DS402 standard for a detailed description of each object

④ **Application examples**

- Set the drive parameter P0-004 = 3 (EtherCAT).
- Set the drive parameter B0-001 = 1 (EtherCAT).
- Set the drive parameter C2-006 = 0.
- Set [6060H: Mode of operation] = 8 (Cyclic Synchronous Position Mode).
- Set [6040H: Control Word] = 0x0F to enable the drive.
- Set [607AH: Target Position] as the target position (absolute position) successively.



◆ **Cyclic Synchronous Velocity Mode**

In Cyclic Synchronous Velocity Mode, the speed command curve planning is completed by the master station, and the drive executes the speed reference from the master station in real time. The interpolation cycle defines the time interval of the target speed (Target Velocity) updates, and in this mode the interpolation cycle is the same as the synchronization cycle of the EtherCAT.

① **Setting steps**

- Set the drive parameter P0-004 = 3 (Run command: EtherCAT).
- Set the drive parameter P0-005 = 4 (Speed reference: EtherCAT).
- Set the drive parameter C2-000= 0 (0: RPM, 1: pulse / s); Set the EtherCAT pulse input gear ratio [C2-003: gear ratio numerator] and [C2-004: gear ratio denominator].
- Set [6060H: Mode of operation] = 9 (Cyclic Synchronous Velocity Mode).
- Set the drive acceleration time P2-001 and deceleration time P2-002 (unit: in 0.01 seconds).
- Set the [6040H: Control Word] to enable the drive (enable when set to 0x0F).
- Set [60FFH: Target Velocity] as the target rotation speed (unit: RPM).
- Query [606CH: Velocity Actual Value] query the actual speed feedback.
- Query [6041H: Status Word] to obtain the drive status feedback.

② **Other objects**

- Query [6078H: Current actual value] to obtain the actual current (unit: 0.1A).

③ **List of related objects**

Index	Name	Type	Attr
6040H	Control Word	U INTEGER16	RW
6041H	Status word	U INTEGER16	RO
6060H	Mode of operation	INTEGER16	RW
6061H	Modes of operation display	INTEGER16	RO
60FFH	Target velocity	INTEGER32	RW
606CH	Velocity Actual Value	INTEGER32	RO
6078H	Current actual value	INTEGER 16	RO

**Note:** Refer to the CiA DS402 standard for a detailed description of each object.

④ **Application examples**

- Set the drive parameter P0-004 = 3 (Run command: EtherCAT).
- Set the drive parameter P0-005 = 4 (Speed reference: EtherCAT).
- Set the drive parameter C2-000= 0.
- Set 6060H = 9 (Mode of operation = Cyclic Synchronous Velocity Mode).
- Set 6040H = 0x0F (Control Word, 0x0F = enable the drive).
- Set 60FFH = Target velocity (unit: RPM).

◆ **Cyclic Synchronous Torque Mode**

In Cyclic Synchronous Torque Mode, the master planning reference curve, and the drive (slave device) operation in torque loop mode, torque reference sent from the master in real time.

The interpolation period defines the time interval update for the Target Torque. In this mode, the interpolation period is the same as the synchronization period of the EtherCAT.

**Note:** The stop mode of Cyclic Synchronous Torque Mode is coast to stop.

① **Setting steps**

- Set the drive parameter P0-004 = 3 (Run command: EtherCAT).
- Set the ones position of parameter PA-000 = \*\*\*3, torque reference selection is EtherCAT.
- Set 6060H = 10 (Mode of operation = Cyclic Synchronous Torque Mode).
- Set C2-001 (EtherCAT position reference smoothing cycle) is the same as the position insertion cycle of the master.
- Set the maximum speed P0-012 of the drive.
- Set the 6040H = 0x0F to enable the drive (Control Word, 0x0F = enable the drive).
- Set 6071H = Target Torque (unit: 0.1% rated torque), and the actual torque reference can be viewed on monitored parameter of the drive.
- Query [606CH: Velocity Actual Value] query the actual speed feedback.
- Query [6041H: Status Word] to obtain the drive status feedback.

② **Other objects**

- Query [6078H: Current actual value] to obtain the actual current (unit: 0.1A).
- Query [6074H: Torque demand value] to obtain the torque reference (unit: 0.1% of rated torque).
- Query [6077H: Torque actual value] to obtain the actual torque output (unit: 0.1% of rated torque).

③ **List of related objects**

Index	Name	Type	Attr
6040H	Control Word	U INTEGER16	RW
6041H	Status word	U INTEGER16	RO
6060H	Mode of operation	INTEGER16	RW
6061H	Modes of operation display	INTEGER16	RO
6071H	Target Torque	INTEGER 16	RW
6074H	Torque demand value	INTEGER 16	RO
6077H	Torque actual value	INTEGER 16	RO
6078H	Current actual value	INTEGER 16	RO

**Note:** Refer to the CiA DS402 standard for a detailed description of each object.

④ **Application examples**

- Set the drive parameter P0-004 = 3 (Run command: EtherCAT).
- Set the ones position of parameter PA-000 = \*\*\*3, torque reference selection is EtherCAT.
- Set 6060H = 10 (Mode of operation = Cyclic Synchronous Torque Mode).
- Set the 6040H = 0x0F to enable the drive (Control Word, 0x0F = enable the drive).
- Set 6071H = Target Torque (unit: 0.1% rated torque).

◆ **Touch Probe Function**

Touch Probe is a latching function to capture the position value of the encoder by sensing the edge-triggered encoder Z signal or digital input of the drive.

When C2-018 = 0 only supports the encoder Z signal as the trigger signal or event, C2-018 = 1 supports the encoder Z signal or external digital input as the trigger signal (digital input function is set to “63”) or event, and the capture result is stored at 0x60BA.

① **List of related objects**

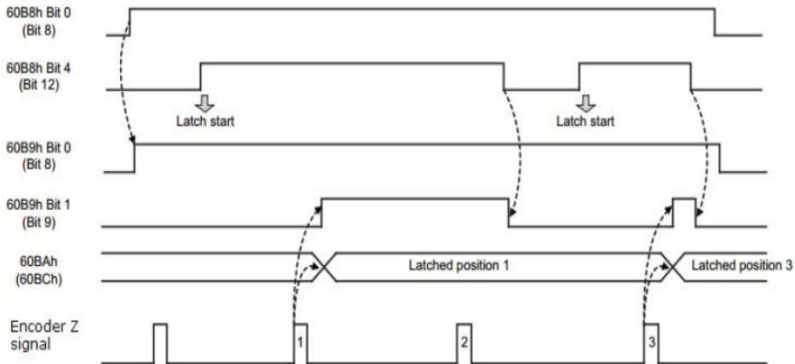
Index	Name	Type	Attr
60B8H	Touch probe function	U INTEGER16	RW
60B9H	Touch Probe Status word	U INTEGER16	R O
60BAH	Probe 1 positive edge value (Encoder zero signal)	INTEGER 32	RO

② **The control word 60B8h and the state word 60B9h description**

Bit	0x60B8	0x60B9
0	Touch probe 1 enable	Touch probe 1 enabled
1	Touch probe 1 continuous mode(reserved)	Touch probe 1 positive edge value stored
2	Touch probe 1 zero pulse	Touch probe 1 negative edge value stored
3		
4	Enable sampling at positive edge of touch probe 1	
5	Enable sampling at negative edge of touch probe 1	
6		
7		
8	Touch probe 2 enable	Touch probe 2 enabled
9	Touch probe 2 continuous mode	Touch probe 2 positive edge value stored
10	Touch probe 2 zero pulse	Touch probe 2 negative edge value stored
11		
12	Enable sampling at positive edge of touch probe 2	
13	Enable sampling at negative edge of touch probe 2	
14		
15		

**Note:** The bit 2 of 60B8h is invalid when C2-018 = 0, valid when C2-018 = 1.

The timing diagram of the control word 0x60B8 and the state word 0x60B9 is as follows:



**③ Application example (Single trigger mode)**

Acquisition Z position during operation:

- Set the drive parameters C2-018 = 0 (probe mode: Only Z signal of the encoder).
- Set 6060h = 9 (Mode of operation = Cyclic Synchronous Velocity Mode).
- Set 60FFh = 200 (Target velocity is 200 RPM).
- Set 6040h = 0x0F (Control Word = 0x0F to enable the drive).
- Set 60B8h = 0x01 (Touch probe function = 0x01 to enable Touch probe function).
- Set 60B8h = 0x11 (Touch probe function = 0x11, latch start Touch probe function).
- Query 60B9h (Touch Probe Status word), bit1 = 1, indicating the completion of the capture.
- Query 60BAh (Probe1 positive edge value) to obtain the actual value of Z position.
- Set 60B8h = 0x00: (Touch probe function = 0x00, touch probe function capture is completed).

**◆ Drive internal position positioning function**

The drive has a built-in position control function. When the drive in enabling state, set the bit10 of 6040h to 1 to active the built-in position control function. Refer to parameter group B0 for more details.

The B0-016 is used to set offset value relative to the encoder Z position, which has the highest execution priority in non-torque mode and invalid function in torque loop mode.

**① Setting steps**

- Set the drive parameter P0-004 = 3 (Run command: EtherCAT).
- Set 6060H (Mode of operation) to non-torque mode: 8 or 9.
- Set the value of B0-016 (Orientation position references 1), relative to the Z position (unit: pulse).
- Set B0-017 (Orientation start speed), B0-018 (Orientation deceleration time) and B0-019 (Orientation gain).
- Set 6040h (Control Word) Positioning operation command (execute Orientation function when set to 0x40F), this command can also be executed in CSP and CSV mode.
- Query 606Ch (Velocity Actual Value) query the actual speed feedback.
- Query 6041H (Status Word) to get the drive status feedback; after sending 0x40F positioning command, delay 10ms (ensure the drive is executing the positioning command) and query the bit10 of 6041H, then the value of bit10 of 6041h is the positioning completion flag.

**② Other objects**

- Query [6078H: Current actual value] to obtain the actual current (unit: 0.1A).
- Query [6064H: Position Actual Value] query the actual position of the motor feedback.
- Query [6062H: Position demand value] to obtain the target position (unit: pulse).
- Query [60F4H: Following error actual value] to obtain the deviation between position command and actual position feedback (unit: pulse).

③ List of related objects

Index	Name	Type	Attr
6040H	Control Word	U INTEGER16	RW
6041H	Status word	U INTEGER16	RO
6060H	Mode of operation	INTEGER16	RW
6061H	Modes of operation display	INTEGER16	RO
6062H	Position demand value	INTEGER32	RO
6064H	Position actual value	INTEGER32	RO
606CH	Velocity Actual Value	INTEGER 32	RW
6078H	Current actual value	INTEGER 16	RO
60F4H	Following error actual value	INTEGER32	RO

**Note:** Refer to the CiA DS402 standard for the detailed description of each object.

④ Application examples

- Set the drive parameter P0-004 = 3 (Run command: EtherCAT).
- Set 6060h = 9 (Mode of operation = Cyclic Synchronous Velocity Mode).
- Set the 6040h (Control Word) = 0x40F to enable the drive.

The bit10 (Target reach) of the status word 6041h is reset to 0 after start the drive internal positioning function. The bit10 (Target reach) of the status word 6041h is set to 1 after the position is reached. Note that after sending the 0x40F command; please waiting for 10ms (or longer) to ensure that the driver has executed the positioning function before taking the status value of bit 10.

## 6 Error Object

The following table is the fault corresponding to the display value of object 603FH when using EtherCAT. For more details, please check Chapter 6 fault diagnosis for other faults.

0x603F value	Fault code	F0-015 value	Fault description	Possible cause	the way to deal with a situation
0x7500	Err 1	1	External fault	Digital input fault is "ON"	Check the corresponding digital input
0x3230	Err 2	2	Drive overload	Power supply voltage too low	Check the power supply voltage
				Start when the motor is spinning	Restart after the motor at
				Overloading for a long time	Reduce overload time and
				Drive power selection is too small	Replace with a suitable drive
0x3230	Err 3	3	Motor overload	Power supply voltage too low	Check the power supply voltage
				Motor stall or load suddenly	Check motor load and drive
				V/F curve setting are not correct	Adjust V/F curve and torque
0x4210	Err 4	4	IGBT over temperature	Ambient over-temperature	Check ambient conditions
				Fan failure	Check air flow and fan operation
				Blockage of air duct	Check heatsink fins for dust pick-up
				Output current too high	Check the load and parameter Check motor power and drive power

0x603F value	Fault code	F0-015 value	Fault description	Possible cause	the way to deal with a situation
				Temperature detect circuit failure	Seek for technical support
0x3330	Err 5	5	Motor over temperature	Motor temperature too high	Improve ventilation and heat dissipation
				Thermistor resistance is abnormal	Check the thermistor
				Setting motor sensor protection threshold is improper	Check the parameter setting
0x7305	Err 6	6	Encoder fault Encoder fault	Encoder connection is incorrect	Change encoder wiring
				The encoder has no signal output	Check the encoder and power supply
				Encoder parameters are not correctly	Check the encoder parameters
				Encoder connection is incorrect	Change encoder wiring
0x2311	Err7	7	Over current	Power supply too low	Check the power supply voltage
				Load inertia is too high	Extended acceleration time
				Motor parameters are not correctly	Set motor parameters correctly
				Ramp-up time was set too short	Extended acceleration time
				The drive power mismatch	Replace with a suitable drive
				Current controller not correctly set	Set current controller parameters correctly
0x2312	Err 8	8	Module protection	Module failure	Seek out the technical support.
				U, V, W short-circuited to ground	Check whether the output wiring is short-circuited to ground
				Bus undervoltage	Check whether the input power supply is abnormal and whether the load mutation causes the bus voltage to be lowered.
				Abnormal built-in brake chopper	Seek out the technical services.
				Rectifier or module overheating	Seek out the technical services.
				The pre-charged contactor closes abnormally	Check the input power supply or seek the technical service.
				Poor contact of the internal connectors	Ask professional technicians for maintenance
0x3210	Err 9	9	Over voltage	Motor short circuit to ground	Check the motor and motor
				Start when the motor is spinning	Start after the motor at standstill
				Load inertia is too large	Use appropriate brake chopper
				Deceleration time is too short	Extend the deceleration time
				The input voltage is too high	Check the input power supply
0x3220	Err 10	10	Under voltage	The input voltage is too low	Check the input power supply
				Abnormal switching power supply	Seek for technical support

0x603F value	Fault code	F0-015 value	Fault description	Possible cause	the way to deal with a situation
0xff00	Err 11	11	Encoder lost CD phase	CD signal connection is abnormal	Check the encoder and wiring
	Err 12	12	Output phase loss	Motor failure	Replace a new motor
				Motor cable is broken	Replace a new motor cable
				Thermal relay failure (if is used)	Check thermal relay
				Output detection circuit failure	Seek for technical support
0x5530	Err 13	13	EEPROM abnormal	EEPROM read/write abnormal	Seek for technical support
0xff00	Err 14	14	Unauthorized	Unauthorized	Seek for technical support
0xff00	Err 15	15	PID feedback disconnection	PID feedback disconnection detection setting is wrong or PID feedback disconnection	Check PID feedback disconnection value and detection time. Check the PID feedback cable
0xff00	Err 16	16	PID feedback out of range	PID feedback exceeds the acceptable range	Check whether the actual feedback value exceeds the set acceptable range
0xff00	Err 17	17	EtherCAT failed	ET1100 communication failed	Seek for technical support
0xff00	Err 18	18	CAN failed	CAN communication failed	Seek for technical support
0xff00	Err 19	19	EtherCAT is disabled	EtherCAT is disabled	Seek for technical support

## 7 Position Reference Mode

C2-006 = 0 (Target position shall be a relative value)								
0x6060 (Mode of Operation)	9	8	8	8	8	8	8	8
0x6061 (Mode of Operation Display)	9	9	9	8	8	8	8	8
0x6062 (Position Demand Value)	...	...	1022	1022	1022+(d -c)	1022+(e-c)	1022+(f-c)	...
0x6064 (Position Actual Value)	...	1021	1022	1022	1022+(d -c)	1022+(e-c)	1022+(f-c)	...
0x607A (Target Position)		a	b	c	d	e	f	...
C2-006 = 1 (Target position shall be an absolute value)								
0x6060 (Mode of Operation)	9	8	8	8	8	8	8	8
0x6061 (Mode of Operation Display)	9	9	9	8	8	8	8	8
0x6062 (Position Demand Value)	...	...	1022	1022	d	e	f	...
0x6064 (Position Actual Value)	...	1021	1022	1022	d	e	f	...
0x607A (Target Position)		a	b	c	d	e	f	...
Other Parameters								
F0-070 and F-071: System reference value (0x607A).								
F0-072 and F0-073: Initial system reference value (607 AH) when switching.								
F0-003 and F0-004: Reference position value (0x6062).								
F0-016 and F0-017: Actual position value (0x6064).								

## 8 Commonly Used Objects

Index	Name	Type	Attr
603FH	Error Code	U INTEGER16	RO
6040H	Control Word	U INTEGER16	RW
6041H	Status word	U INTEGER16	RO
6060H	Mode of operation	INTEGER16	RW
6061H	Modes of operation display	INTEGER16	RO
6062H	Position demand value	INTEGER32	RO
6064H	Position actual value	INTEGER32	RO
606CH	Velocity Actual Value	INTEGER32	RO
6071H	Target Torque	INTEGER 16	RW
6074H	Torque demand value	INTEGER 16	RO
6077H	Torque actual value	INTEGER 16	RO
6078H	Current actual value	INTEGER 16	RO
607AH	Target Position	INTEGER32	RW
60B8H	Touch probe function	U INTEGER16	RW
60B9H	Touch Probe Status word	U INTEGER16	R O
60BAH	Probe 1 positive edge value (Encoder zero signal)	INTEGER 32	RO
60F4H	Following error actual value	INTEGER32	RO
60FFH	Target velocity	INTEGER32	RW
2108H	Motor Temperature	INTEGER 16	RO
2109H	IGBT Temperature	INTEGER 16	RO
210AH	Drive Error Code	INTEGER 16	RO
210BH	Custom parameter1	INTEGER 16	RO
210CH	Custom parameter2	INTEGER 16	RO
210DH	Custom parameter3	INTEGER 16	RO
210EH	Custom parameter4	INTEGER 16	RO
210FH	Custom parameter5	INTEGER 16	RO

**Note:** The parameter index = group index + parameter number in group + 1. The group index starts from 0x2000 and accumulates in order according to the parameters list, as shown in the following table.

Group	Index	Group	Index	Group	Index	Group	Index
P0	0x2000	P1	0x2001	P2	0x2002	P3	0x2003
P4	0x2004	P5	0x2005	P6	0x2006	P7	0x2007
P8	0x2008	P9	0x2009	PA	0x200A	Pb	0x200B
PC	0x200C	A0	0x200D	1	0x200E	B2	0x200F
C0	0x2010	C1	0x2011	C2	0x2012	D0	0x2013
E0	0x2014						

E.g., the index of parameter P1-000 is 0x2001: 1, the index of parameter C0-002 is 0x2010: 3.



## 9 Customized Objects

The objects 0x210B ... 0x210F are customized objects:

Parameters	Name	Range	Related Settings
C2-008	Transfer parameter address 1	0 ... F0 group parameter number maximum value	Used to select the content of the object 0x210B
C2-009	Transfer parameter address 2	0 ... F0 group parameter number maximum value	Used to select the content of the object 0x210C
C2-010	Transfer parameter address 3	0 ... F0 group parameter number maximum value	Used to select the content of the object 0x210D
C2-011	Transfer parameter address 4	0 ... F0 group parameter number maximum value	Used to select the content of the object 0x210E
C2-012	Transfer parameter address 5	0 ... F0 group parameter number maximum value	Used to select the content of the object 0x210F

E.g., if the value of F0-020 (digital input state) is read by index 0x210B, then set C2-008 = 20. If the value of F0-021 (digital output state) is read by 0x210C index, then set C2-009 = 21.