Chapter 15 CANopen Overview

The built-in CANopen function is a kind of remote control. You can control the AC motor drive by using CANopen protocol. CANopen is a CAN-based higher layer protocol that provides standardized communication objects, including real-time data (Process Data Objects, PDO), configuration data (Service Data Objects, SDO), and special functions (Time Stamp, Sync message, and Emergency message). It also has network management data, including Boot-up message, NMT message, and Error Control message. Refer to the CiA website http://www.can-cia.org/ for details. The content of this instruction sheet may be revised without prior notice. Consult our distributors or download the most updated version at http://www.delta.com.tw/industrialautomation

Delta CANopen supporting functions:

- Supports CAN2.0A Protocol
- Supports CANopen DS301 V4.02
- Supports DS402 V2.0.

Delta CANopen supporting services:

- PDO (Process Data Objects): PDO1–PDO4
- SDO (Service Data Objects):
  Initiate SDO Download;
  Initiate SDO Upload;
  Abort SDO;
  You can use the SDO message to configure the slave node and access the Object Dictionary in every node.
- SOP (Special Object Protocol):
  Support default COB-ID in Predefined Master/Slave Connection Set in DS301 V4.02;
  Support SYNC service;
  Support Emergency service.
- NMT (Network Management):
  Support NMT module control;
  Support NMT Error control;
  Support Boot-up.

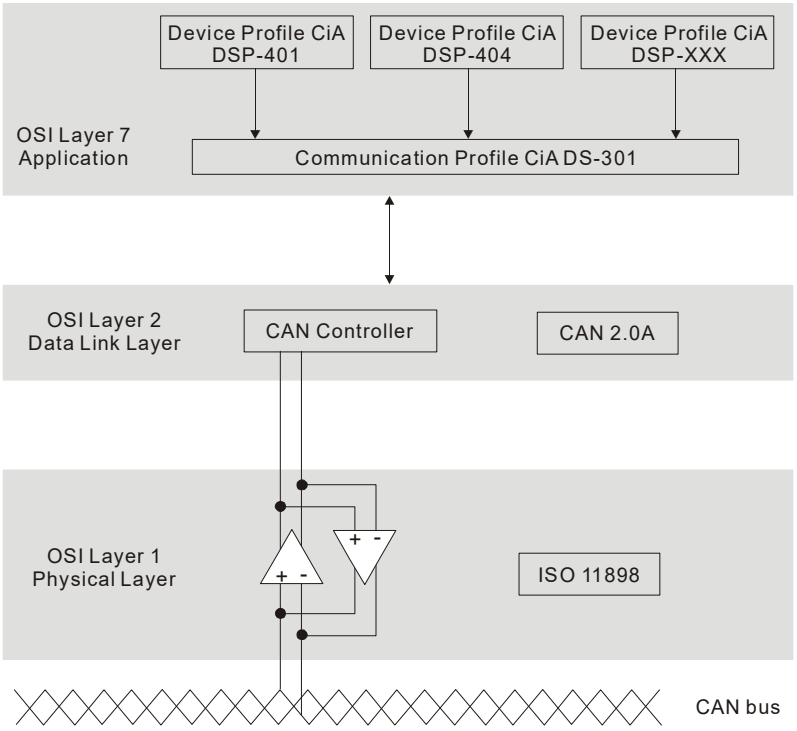
Delta CANopen not supporting service:

- Time Stamp service

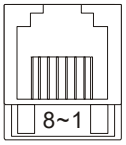
15-1 CANopen Overview

CANopen Protocol

CANopen is a CAN-based higher layer protocol, and was designed for motion-oriented machine control networks such as handling systems. Version 4.02 of CANopen (CiA DS301) is standardized as EN50325-4. The CANopen specifications cover the application layer and communication profile (CiA DS301), as well as a framework for programmable devices (CiA DS302), recommendations for cables and connectors (CiA DS303-1), SI units, and prefix representations (CiA DS303-2).



RJ45 Pin Definition



plug

PIN	Signal	Description
1	CAN_H	CAN_H bus line (dominant high)
2	CAN_L	CAN_L bus line (dominant low)
3	CAN_GND	Ground / 0V /V-
6	CAN_GND	Ground / 0V /V-

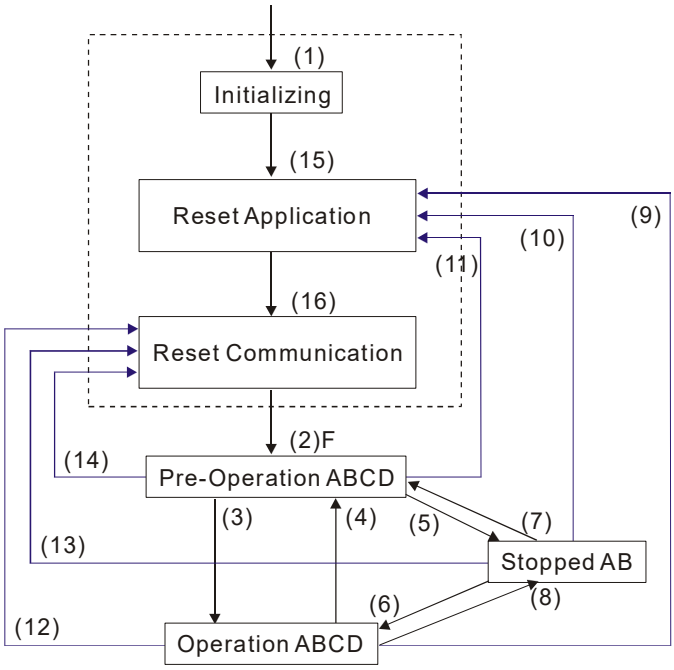
CANopen Communication Protocol

It has services as follows:

- NMT (Network Management Object)
- SDO (Service Data Objects)
- PDO (Process Data Object)
- EMCY (Emergency Object)

NMT (Network Management Object)

The Network Management (NMT) follows a Master/Slave structure for executing NMT service. A network has only one NMT master, and the other nodes are slaves. All CANopen nodes have a present NMT state, and the NMT master can control the state of the slave nodes. Following shows the state diagram of a node:



(1) After power is applied, start in the auto-initialization state
(2) Automatically enter the pre-operational state
(3) (6) Start remote node
(4) (7) Enter the pre-operational state
(5) (8) Stop remote node
(9) (10) (11) Reset node
(12) (13) (14) Reset communication
(15) Automatically enter the reset application state
(16) Automatically enter the reset communication state

A: NMT
B: Node Guard
C: SDO
D: Emergency
E: PDO
F: Boot-up

	Initializing	Pre-Operational	Operational	Stopped
PDO			○	
SDO		○	○	
SYNC		○	○	
Time Stamp		○	○	
EMCY		○	○	
Boot-up	○			
NMT		○	○	○

SDO (Service Data Objects)

Use SDO to access the Object Dictionary in every CANopen node using the Client/Server model. One SDO has two COB-IDs (request SDO and response SDO) to upload or download data between two nodes. There is no data limit for SDOs to transfer data, but it must transfer data by segment when the data exceeds four bytes with an end signal in the last segment.

The Object Dictionary (OD) is a group of objects in a CANopen node. Every node has an OD in the system, and OD contains all parameters describing the device and its network behavior. The access path in the OD is the index and sub-index; each object has a unique index in the OD, and has a sub-index if necessary.

PDO (Process Data Objects)

PDO communication can be described by the producer/ consumer model. Each node of the network listens to the messages of the transmission node and distinguishes whether the message has to be processed or not after receiving the message. A PDO can be transmitted from one device to one another device or to many other devices. Every PDO has two PDO services: a TxPDO and an RxPDO. PDOs are transmitted in a non-confirmed mode. All transmission types are listed in the following table:

Type Number	PDO				
	Cyclic	Acyclic	Synchronous	Asynchronous	RTR only
0		○	○		
1–240	○		○		
241–251	Reserved				
252			○		○
253				○	○
254				○	
255				○	

- Type number 0 indicates the synchronous aperiodic message between two PDO transmissions.
- Type number 1–240 indicates the number of SYNC message between two PDO transmissions.
- Type number 252 indicates the data is updated (but not sent) immediately after receiving SYNC.
- Type number 253 indicates the data is updated immediately after receiving RTR.
- Type number 254: Delta CANopen does not support this transmission format.
- Type number 255 indicates the data is an asynchronous aperiodic transmission.

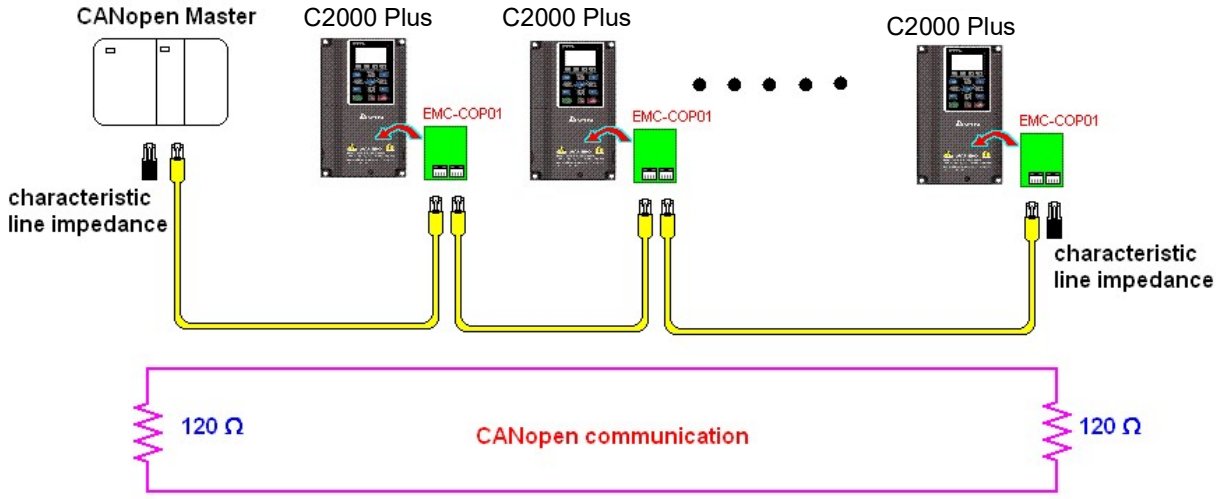
All PDO transmission data must be mapped to index via Object Dictionary.

EMCY (Emergency Object)

When errors occur inside the hardware, an emergency object is triggered. An emergency object is only sent when an error occurs. As long as there is nothing wrong with the hardware, there is no emergency object warning of an error message.

15-2 Wiring for CANopen

Use an external adapter card EMC-COP01 for CANopen wiring to connect the CANopen to the drive. The link uses a RJ45 cable. You must wire the two farthest ends with 120 Ω terminating resistors as shown in the picture below.



15-3 CANopen Communication Interface Descriptions

15-3-1 CANopen Control Mode Selection

There are two control modes for CANopen: the DS402 standard (Pr.09-40 set to 1) is the default, and the Delta's standard setting (Pr.09-40 set to 0). There are two control modes according to Delta's standard. One is the old control mode (Pr.09-30 = 0); this control mode can only control the motor drive under the speed control. The other mode is a new standard (Pr.09-30 = 1); this new control mode allows the motor drive to be controlled under multiple modes. The C2000 Plus currently supports speed, torque, position and home mode. The following table shows the control mode definitions:

CANopen Control Mode Selection	Control Mode							
	Speed		Torque		Position		Home	
	Index	Description	Index	Description	Index	Description	Index	Description
DS402 Standard Pr.09-40=1	6042-00	Target Rotating Speed (RPM)	6071-00	Target Torque (%)	607A-00	Target Position	-----	-----
	-----	-----	6072-00	Max. Torque Limit (%)	-----	-----	-----	-----
Delta Standard (Old definition) Pr.09-40=1, Pr.09-30=0	2020-02	Target Rotating Speed (Hz)	-----	-----	-----	-----	-----	-----
Delta Standard (New definition) Pr.09-40=0, Pr.09-30=1	2060-03	Target Rotating Speed (Hz)	2060-07	Target Torque (%)	2060-05	Target Position	-----	-----
	2060-04	Torque Limit (%)	2060-08	Speed Limit (Hz)	-----	-----	-----	-----

CANopen Control Mode Selection	Operation Control	
	Index	Description
DS402 Standard Pr.09-40=1	6040-00	Operation Command
	-----	-----
Delta Standard (Old definition) Pr.09-40=1, Pr.09-30=0	2020-01	Operation Command
Delta Standard (New definition) Pr.09-40=0, Pr.09-30=1	2060-01	Operation Command
	-----	-----

CANopen Control Mode Selection	Others	
	Index	Description
DS402 Standard Pr.09-40=1	605A-00	Quick stop processing mode
	605C-00	Disable operation processing mode
Delta Standard (Old definition) Pr.09-40=1, Pr.09-30=0	-----	-----
Delta Standard (New definition) Pr.09-40=0, Pr.09-30=1	-----	-----
	-----	-----

You can use some indices in either DS402 or Delta's standard.

For example:

1. Indices that are defined as RO attributes.
2. The corresponding index of available parameter groups: (2000-00–200B-XX)
3. Acceleration / Deceleration Index: 604F 6050

15-3-2 DS402 Standard Control Mode

15-3-2-1 Related settings for an AC motor drive (following the DS402 standard)

If you want to use the DS402 standard to control the motor drive, follow these steps:

1. Wire the hardware (refer to Section 15-2 Wiring for CANopen)
2. Set the operation source: set Pr.00-21 to 3 for CANopen communication card control. (Run/ stop, forward/ reverse run…etc.)
3. Set the frequency source: set Pr.00-20 to 6. Choose the source for the Frequency command from the CANopen setting.
4. Set the torque source: set Pr.11-33. Choose the source for the Torque command from the CANopen setting.
5. Set the position source: set Pr.11-40. Choose the source for the Position command from the CANopen setting.
6. Set DS402 as the control mode: Pr.09-40=1
7. Set the CANopen station: set Pr.09-36; the range is between 1–127. When Pr.09-36 = 0, the CANopen slave function is disabled. Note that if an error appears (station address error CAdE or CANopen memory error CFrE) when you finish the station setting, set Pr.00-02 = 7 to reset.
8. Set the CANopen baud rate: set Pr.09-37 (CANBUS Baud Rate: 1Mbps(0), 500Kbps(1), 250Kbps(2), 125Kbps(3), 100Kbps(4) and 50Kbps(5))
9. Set the multiple input functions to Quick Stop. You can also choose enable or disable; the default setting is disabled. If it is necessary to enable the function, set MI terminal to 53 in one of the following parameters: Pr.02.01–Pr.02.08 or Pr.02.26–Pr.02.31. (Note: This function is available in DS402 only.)

15-3-2-2 The status of the motor drive (following the DS402 standard)

According to the DS402 definition, the motor drive is divided into 3 blocks and 9 statuses as described below.

3 blocks

1. Power Disable: without PWM output
2. Power Enable: with PWM output
3. Fault: One or more errors have occurred.

9 statuses

1. Start: Power On
2. Not ready to switch on: the motor drive is initiating.
3. Switch On Disable: occurs when the motor drive finishes initiating.
4. Ready to Switch On: warming up before running.
5. Switch On: the motor drive has the PWM output, but the reference command is not effective.
6. Operation Enable: able to control normally.
7. Quick Stop Active: when there is a Quick Stop request, stop running the motor drive.
8. Fault Reaction Active: the motor drive detects conditions that might trigger error(s).
9. Fault: One or more errors have occurred in the motor drive.

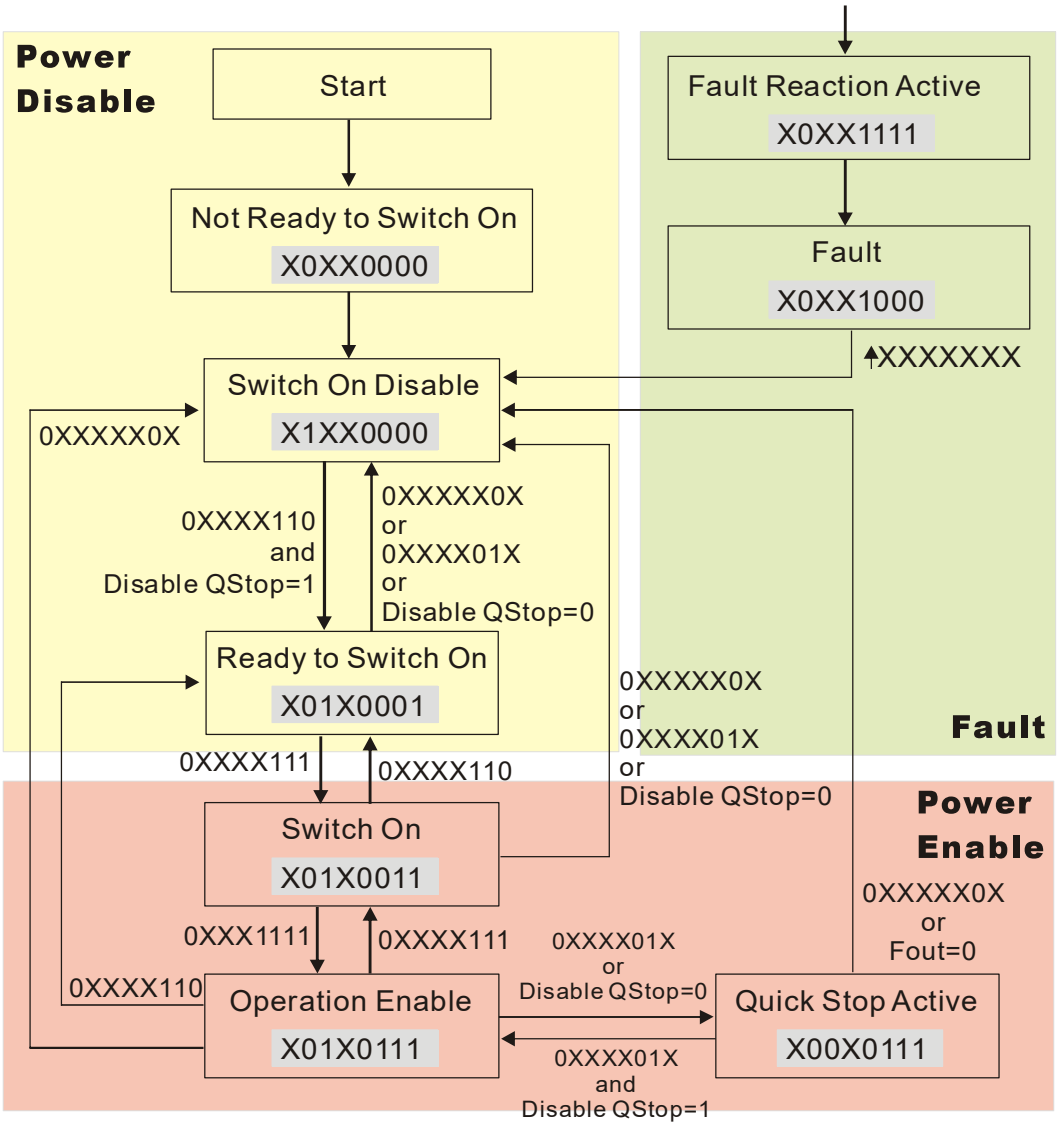
When the motor drive turns on and finishes the initiation, it remains in Ready to Switch On status. To control the operation of the motor drive, change to Operation Enable status. To do this, set the control word's bit0–bit3 and bit7 of the Index 6040H and pair with Index Status Word (Status Word 0X6041). The control steps and index definition are described below.

Index 6040

15–9	8	7	6~4	3	2	1	0
Reserved	Halt	Fault Reset	Operation	Enable operation	Quick Stop	Enable Voltage	Switch On

Index 6041

15–14	13–12	11	10	9	8	7	6	5	4	3	2	1	0
Reserved	Operation	Internal limit active	Target reached	Remote	Reserved	Warning	Switch on disabled	Quick stop	Voltage enabled	Fault	Operation enable	Switch on	Ready to switch on



Set command 6040=0xE, and then set another command 6040=0xF. Then you can switch the motor drive to Operation Enable. The Index 605A determines the lines from Operation Enable when the control mode changes from Quick Stop Active. When the setting value is 1–3, both direction lines are active, but when the setting value of 605A is not 1–3, once the motor drive is switched to Quick Stop Active, it is not able to switch back to Operation Enable.)

Index	Sub	Definition	Default	R/W	Size	Unit	PDO Map	Mode	note
605Ah	0	Quick stop option code	2	RW	S16		No		0: Disable drive function 1: Slow down on slow down ramp 2: Slow down on quick stop ramp 5: Slow down on slow down ramp and stay in QUICK STOP 6: Slow down on quick stop ramp and stay in QUICK STOP 7: Slow down on the current limit and stay in Quick stop

When the control block switches from Power Enable to Power Disable, use 605C to define the stop method.

Index	Sub	Definition	Default	R/W	Size	Unit	PDO Map	Mode	note
605Ch	0	Disable operation option code	1	RW	S16		No		0: Disable drive function 1: Slow down with slow down ramp; disable the drive function

15-3-2-3 Various mode control method (following the DS402 standard)

The control mode of C2000 Plus currently supports speed, torque, position and home control, and are described as below:

Speed mode

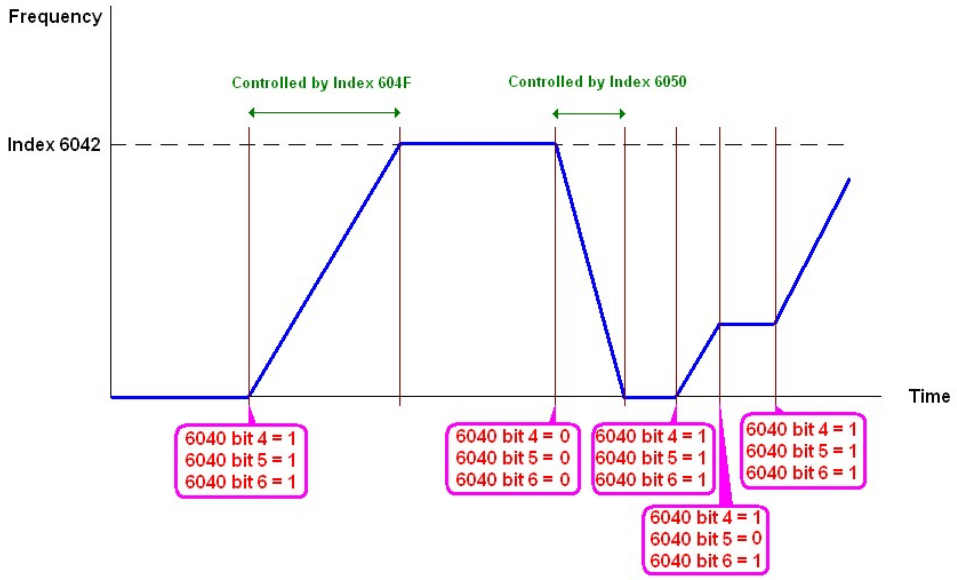
1. Set C2000 Plus to speed control mode: set Index 6060 to 2.
   (The Index 6071 is available for torque limit under the speed control mode)
2. Switch to Operation Enable mode: set 6040=0xE, and then set 6040 = 0xF.
3. Set the target frequency: Set target frequency of 6042. Since the operation unit of 6042 is rpm, a conversion is required:

   $$n = f \times \frac{120}{p}$$

   n: rotation speed (rpm) (revolutions /minute)
   p: number of poles of the motor (Pole)
   f: rotation frequency (Hz)

   For example:
   Set 6042H = 1500 (rpm), if the number of poles for the drive is 4 (Pr.05-04 or Pr.05-16), then the motor drive's operation frequency is 1500/(120/4)=50Hz. The 6042 is defined as a signed operation. The plus or minus sign means to rotate clockwise or counter-clockwise
4. To set acceleration and deceleration: Use 604F (Acceleration) and 6050 (Deceleration).
5. Trigger an ACK signal: in the speed control mode, control the bit 6–4 of Index 6040. It is defined as below:

	Index 6040			Result
	bit 6	bit 5	bit 4	
Speed mode (Index 6060=2)	1	0	1	Locked at the current frequency.
	1	1	1	Run to reach the target frequency.
	Other			Decelerating to 0Hz.



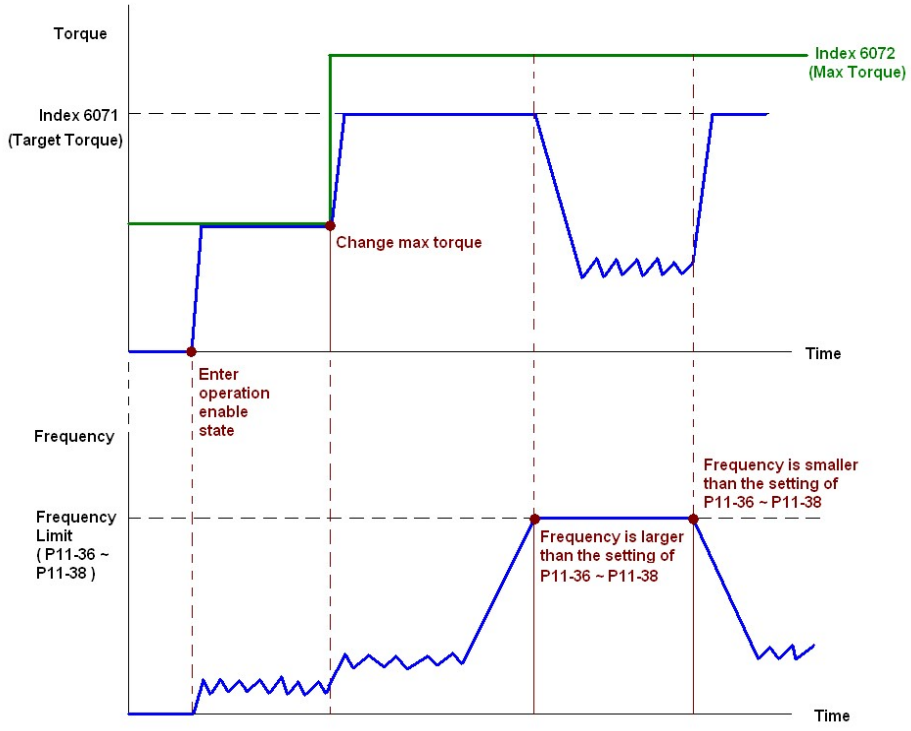
NOTE 01: Read 6043 to get the current rotation speed. (Unit: rpm)

NOTE 02: Read bit 10 of 6041 to check if the rotation speed has reached the targeting value. (0: Not reached; 1: Reached)

Torque mode

1. Set AC motor drive to the torque mode: set Index 6060 = 4.
   (The Index 6042 is available for speed limit under the torque control mode)
2. Switch to Operation Enable mode: set 6040 = 0xE, and then set 6040 = 0xF.
3. To set targeting torque: set 6071 as targeting torque and 6072 as the largest output torque.

Torque mode (Index 6060=4)	Index 6040			SUM
	bit6	bit5	bit4	
	X	X	X	RUN to reach the targeting torque.



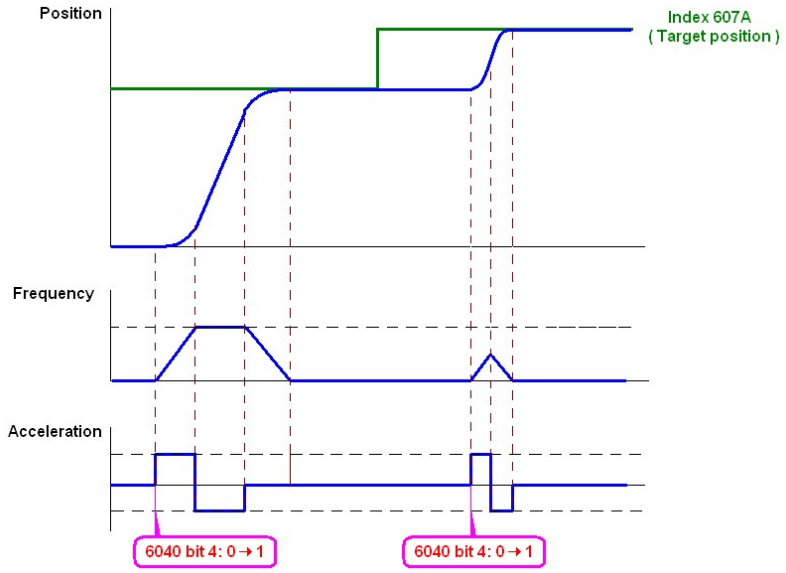
NOTE: The standard DS402 does not regulate the maximum speed limit. Therefore, if the motor drive defines the control mode of DS402, the highest speed will go with the setting of Pr.11-36 to Pr.11-38.

NOTE 01: Read 6077 to get the current torque. (Unit: 0.1%).

NOTE02: Read bit10 of 6041 to find if the torque has reached the targeting value. (0: Not reached; 1: Reached)

Position mode

1. Set the parameter of a trapezium curve to define position control (Pr.11-43 Max. Frequency of Point-to-Point Position Control, Pr.11-44 Accel. Time of Point-to-Point Position Control and Pr.11-45 Decel. Time of Point-to-Point Position Control)
2. Set C2000 to position control mode: set Index 6060 = 1.
3. Switch to Operation Enable mode: set 6040 = 0xE, and then set 6040 = 0xF.
4. Set targeting position: set 607A as the targeting position.
5. Trigger an ACK signal: set 6040 = 0x0F, and then set 6040 = 0x1F. (Pulse On).



NOTE 01: Read 6064 to get the current position.

NOTE 02: Read bit10 of 6041 to find if the position reaches the targeting position. (0: Not reached, 1: reached)

NOTE 03: Read bit11 of 6041 to find if the position is over the limited area. (0: in the limit, 1: over the limit)

Home mode

1. Set Pr.00-12 to choose a home method.
2. Set the left and right limits correspond to the position of MI terminal.
3. Switch to Home mode: set Index 6060 = 6.
4. Switch to Operation Enable mode: set 6040 = 0xE, and then set 6040 = 0xF.
5. To trigger an ACK signal: set 6040 = 0x0F, and then set 6040 = 0x1F (Pulse On, and the motor drive will be back to home.)

NOTE 01: Read bit12 of 6041 to find if the home mode is completed. (0: Not reached, 1: reached)

15-3-3 Using the Delta Standard (Old definition, only supports speed mode)

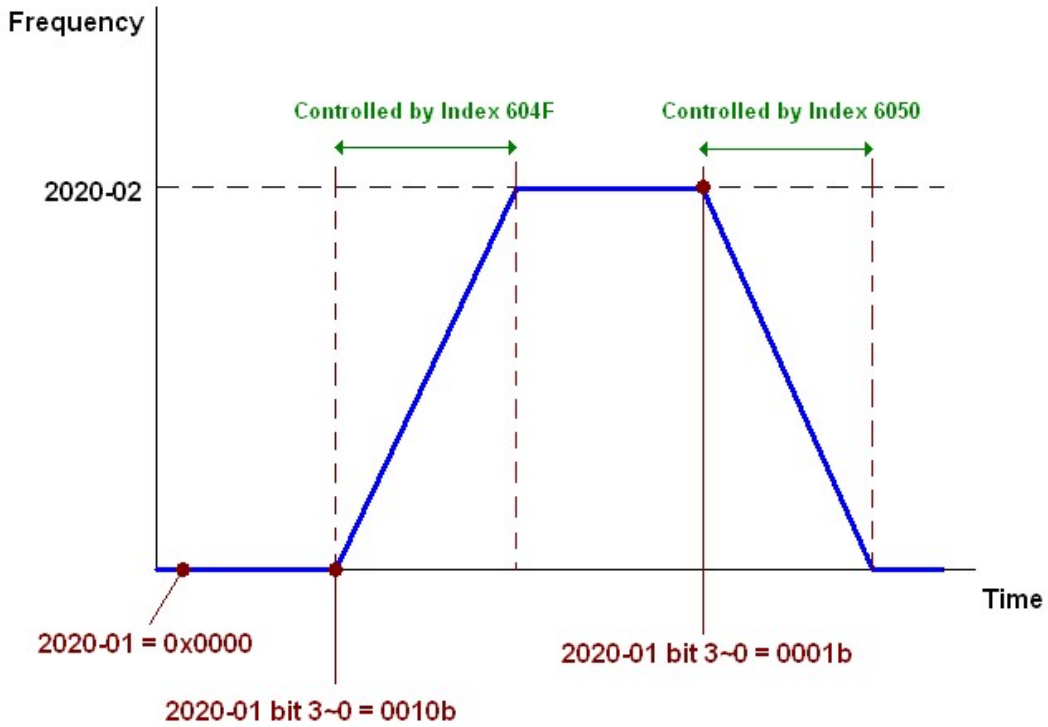
15-3-3-1 Various mode control method (following the Delta old standard)

If you want to use the Delta old standard to control the motor drive, follow these steps:

1. Wire the hardware (refer to Section 15-2 Wiring for CANopen).
2. Set the operation source: set Pr.00-21 to 3 for CANopen communication card control. (Run/ stop, Forward/ reverse run…., etc.)
3. Set the frequency source: set Pr.00-20 to 6. Choose source for the Frequency command from the CANopen setting.
4. Set Delta Standard (Old definition, only supports speed mode) as the control mode: Pr.09-40 = 0 and Pr.09-30 = 0.
5. Set the CANopen station: set Pr.09-36; the range is among 1–127. When Pr.09-36=0, the CANopen slave function is disabled. Note: If an error appears (station address error CAdE or CANopen memory error CFrE) when you finish the station setting, set Pr.00-02 = 7 to reset.
6. Set the CANopen baud rate: set Pr.09-37 (CANBUS Baud Rate: 1Mbps(0), 500Kbps(1), 250Kbps(2), 125Kbps(3), 100Kbps(4) and 50Kbps(5))

15-3-3-2 The control method under speed mode

1. Set the target frequency: set 2020-02, the unit is Hz, with 2 decimal places. For example, 1000 is 10.00Hz.
2. Operation control: set 2020-01 = 0002H for running, and set 2020-01 = 0001H for stopping.



15-3-4 By Using Delta Standard (New Definition)

15-3-4-1 Related settings for an AC motor drive (Delta New Standard)

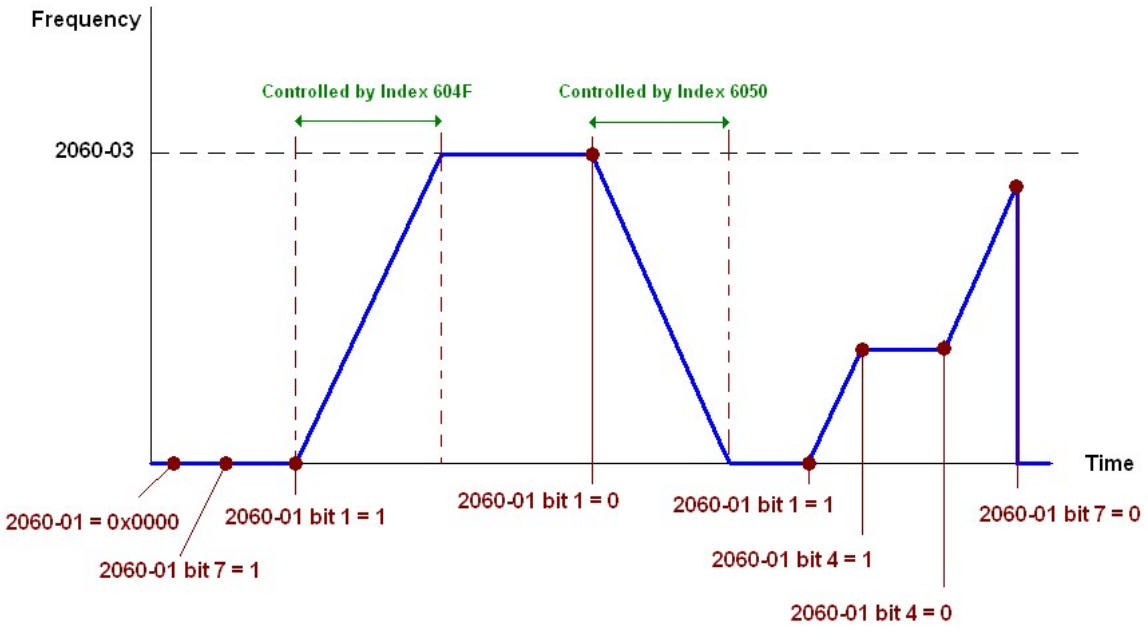
If you want to use the Delta new standard to control the motor drive, follow these steps:

1. Wire the hardware (refer to Section 15-2 Wiring for CANopen).
2. Set the operation source: set Pr.00-21 to 3 for CANopen communication card control. (Run/ stop, Forward/ reverse run…., etc.)
3. Set the frequency source: set Pr.00-20 to 6. Choose the source of the Frequency Command from CANopen setting.
4. Set the torque source: set Pr.11-33. Choose the source of the Torque Command from CANopen setting.)
5. Set the position source: set Pr.11-40=3. Choose the source of the Position Command from CANopen setting.)
6. Set Delta Standard (New definition) as the control mode: Pr.09-40 = 0 and Pr.09-30 = 0.
7. Set the CANopen station: set Pr.09-36; the range is among 1–127. When Pr.09-36=0, the CANopen slave function is disabled. (Note: If an error appears (station address error CAdE or CANopen memory error CFrE) when you finish the station setting, set Pr.00-02 = 7 to reset.
8. Set the CANopen baud rate: set Pr.09-37 (CANBUS Baud Rate: 1Mbps(0), 500Kbps(1), 250Kbps(2), 125Kbps(3), 100Kbps(4) and 50Kbps(5))

15-3-4-2 Various mode control method (Delta New Standard)

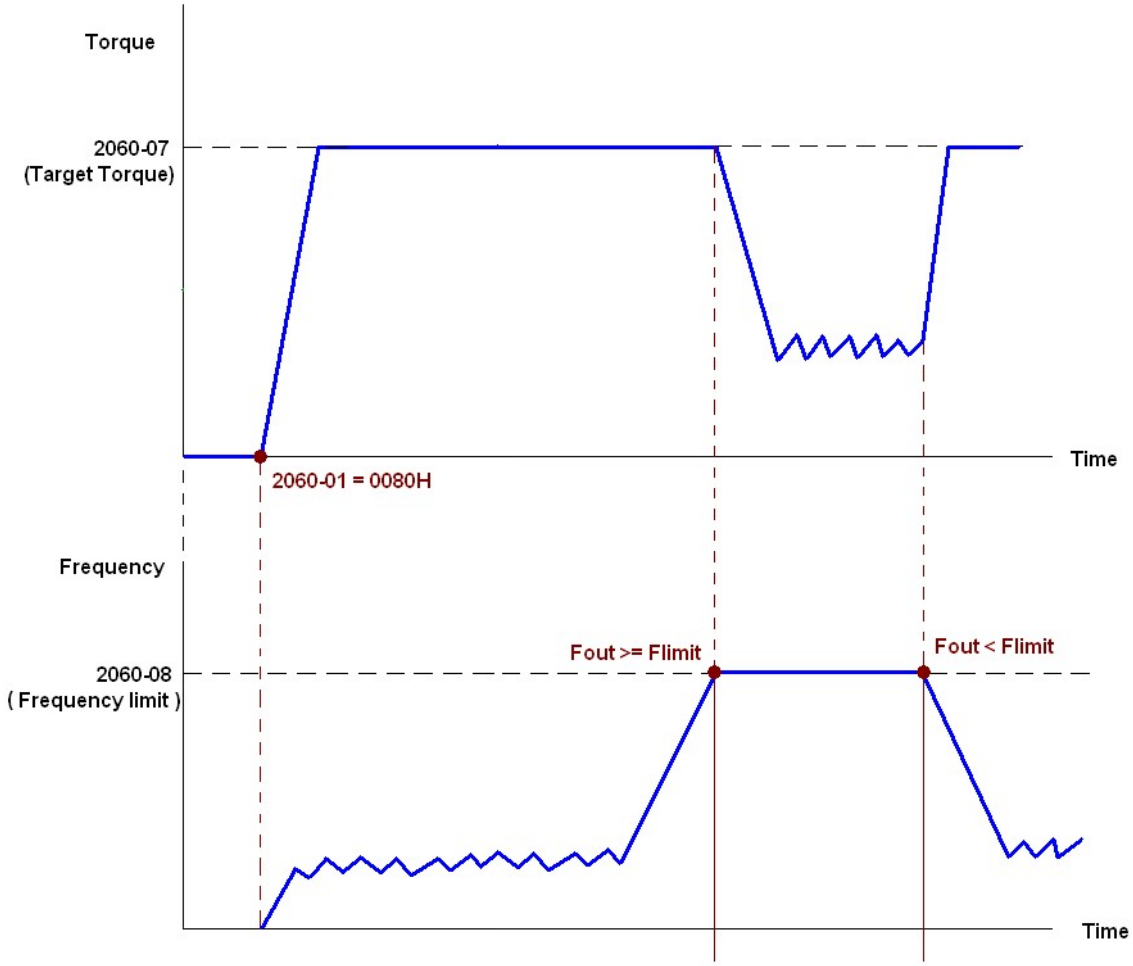
Speed Mode

1. Set C2000 to speed control mode: set Index6060 = 2.
2. 2. Set the target frequency: set 2060-03, unit is Hz, with 2 decimal places. For example, 1000 is 10.00Hz.
3. Operation control: set 2060-01 = 008H for Server on, and set 2060-01 = 0081H for running.



Torque Mode

1. Set C2000 to torque control mode: set Index 6060 = 4.
2. Set the target torque: set 2060-07, unit as %, and the value is one decimal place. For example, 100 is 10.0%.
3. Operation control: set 2060-01 = 0080H starts excitation, and the drive immediately runs at the target torque.



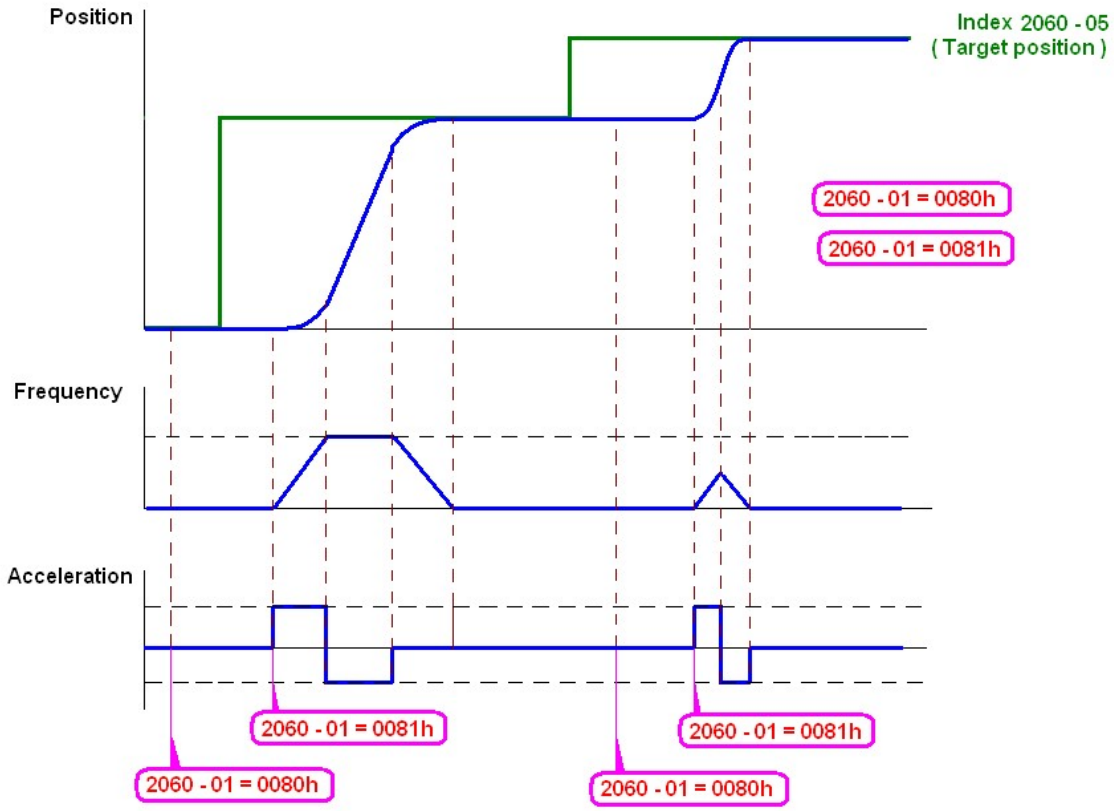
Note01: Read 2061-07 for the current torque (unit is 0.1%).

Note02: Read bit0 of 2061-01 to find if the torque has reached the set value (0: Not reached, 1: Reached).

Note 03: If the speed of the drive reaches the speed limit when torque outputs, you may reduce the output torque in order to ensure that the speed stays within the limits.

Position Mode

1. Set the parameter of a trapezium curve to define position control (Pr.11-43 Max. Position Control Frequency), Pr.11-44 Accel. Time of Position Control, Pr.11-45 Decel. Time of Position Control)
2. Set C2000 to position control mode, set Index 6060 = 1.
3. Set 2060-01 = 0080h, then motor drive starts excitation.
4. Set target position: set 2060-05 = target position.
5. Set 2060-01 =0081h to trigger the motor drive runs to the target position.
6. Repeat step 3 to step 5 to move to another position.



NOTE01: Read 2061-05 to get the current position.

NOTE02: Read bit0 of 2061 to find if the position has reached to the target position. (0: Not reached, 1: Reached).

Home Mode

1. Set Pr.00-12 to choose the method to return home.
2. 2. Set the left and right limits correspond to the position of MI terminal.
3. 3. Switch to home mode: set Index 6060 = 6.
4. 4. Set 2060-01 = 0080h, then the motor drive starts excitation.
5. 5. Set the ACK signal: set 2060-01 = 0081h, then the motor drive starts to go back home.

NOTE 01: Read bit12 of 6041 to find if returning home is completed. (0: Not reached, 1: Reached).

15-3-5 Control DI / DO / AI / AO through CANopen

To control the DO and AO of the motor drive through CANopen, follow the steps below:

1. Define the DO to be controlled by CANopen. For example, set Pr.02-14 to control RY2.
2. Define the AO to be controlled by CANopen. For example, set Pr.03-23 to control AFM2.
3. Control the Index mapped by CANopen. To control DO, use control index 2026-41. To control AO, you will need to control 2026-AX. To set RY2 as ON, set bit1 of Index 2026-41 =1, then RY2 outputs 1. To control AFM2 output = 50.00%, set Index 2026-A2 =5000, then AFM2 outputs 50%.

The following table shows the mapping of CANopen DI / DO / AI / AO:

DI:

Terminal	Related Parameters	R/W	Mapping Index
FWD	==	RO	2026-01 bit0
REV	==	RO	2026-01 bit1
MI1	==	RO	2026-01 bit2
MI2	==	RO	2026-01 bit3
MI3	==	RO	2026-01 bit4
MI4	==	RO	2026-01 bit5
MI5	==	RO	2026-01 bit6
MI6	==	RO	2026-01 bit7
MI7	==	RO	2026-01 bit8
MI8	==	RO	2026-01 bit9
MI10	==	RO	2026-01 bit10
MI11	==	RO	2026-01 bit11
MI12	==	RO	2026-01 bit12
MI13	==	RO	2026-01 bit13
MI14	==	RO	2026-01 bit14
MI15	==	RO	2026-01 bit15

DO:

Terminal	Related Parameters	R/W	Mapping Index
RY1	Pr.02-13 = 50	RW	2026-41 bit0
RY2	Pr.02-14 = 50	RW	2026-41 bit1
MO1	Pr.02-16 = 50	RW	2026-41 bit3
MO2	Pr.02-17 = 50	RW	2026-41 bit4
MO10	Pr.02-36 = 50	RW	2026-41 bit5
RY10			2026-41 bit5
MO11	Pr.02-37 = 50	RW	2026-41 bit6
RY11			2026-41 bit6
RY12	Pr.02-38 = 50	RW	2026-41 bit7
RY13	Pr.02-39 = 50	RW	2026-41 bit8
RY14	Pr.02-40 = 50	RW	2026-41 bit9
RY15	Pr.02-41 = 50	RW	2026-41 bit10

AI:

Terminal	Related Parameters	R/W	Mapping Index
AVI	==	RO	Value of 2026-61
ACI	==	RO	Value of 2026-62
AUI	==	RO	Value of 2026-63

AO:

Terminal	Related Parameters	R/W	Mapping Index
AFM1	Pr.03-20 = 20	RW	Value of 2026-A1
AFM2	Pr.03-23 = 20	RW	Value of 2026-A2

15-4 CANopen Supported Index

C2000 Supported Parameter Index:

The parameter index corresponds as shown in this example:

Index	**sub-Index**
2000H + Group	member+1

For example:

Pr.10-15 (Encoder Stall and Slip Error Action)

Group		**member**
10(0AH)	-	15(0FH)

Index = 2000H + 0AH = 200A

Sub Index = 0FH + 1H = 10H

C2000 Supported Control Index:

Delta Standard Mode (Old Definition)

Index	Sub	Definition	Default	R/W	Size	Note	
2020H	0	Number	3	R	U8		
	1	Control word	0	RW	U16	bit1–0	00B: Disable
							01B: Stop
							10B: Disable
							11B: JOG Enable
						bit3–2	Reserved
						bit5–4	00B:disable
							01B: Direction forward
							10B: Reverse
							11B: Switch Direction
						bit7–6	00B: 1st step Accel. /Decel.
							01B: 2nd step Accel. /Decel.
							10B: 3rd step Accel. /Decel.
							11B: 4th step Accel. /Decel.
						bit11–8	0000B: Master speed
							0001B: 1st step speed
							0010B: 2nd step speed
							0011B: 3rd step speed
							0100B: 4th step speed
							0101B: 5th step speed
							0110B: 6th step speed
							0111B: 7th step speed
							1000B: 8th step speed
							1001B: 9th step speed
							1010B: 10th step speed
							1011B: 11th step speed
							1100B: 12th step speed
							1101B: 13th step speed
							1110B: 14th step speed
							1111B: 15th step speed
						bit12	1: Enable the function of bit6-11
						bit 15	Reserved
	2	Freq. command (XXX.XXHz)	0	RW	U16		

Index	Sub	Definition	Default	R/W	Size	Note	
	3	Other trigger	0	RW	U16	bit0	1: E.F. ON
						bit1	1: Reset
						bit2	1: Base Block (B.B) ON
						bit15–3	Reserved
2021H	0	Number	10	R	U8		
	1	Error code	0	R	U16	High byte: Warning Code Low byte: Error Code	
	2	AC motor drive status	0	R	U16	bit1–0	00B: stop
							01B: decelerate to stop
							10B: waiting for operation command
							11B: in operation
						bit2	1: JOG command
						bit4–3	00B: Run forward
							01B: switch from run in reverse to run forward
							10B: switch from run forward to run in reverse
							11B: Run in reverse
						bit7–5	Reserved
						bit8	1: Master Frequency command controlled by communication interface
						bit9	1: Master Frequency command controlled by analog signal input
						bit10	1: Operation command controlled by communication interface
						bit11	1: Parameter lock
						bit12	1: Enable the digital keypad copy parameter function
						bit15–13	Reserved
	3	Freq. command (XXX.XXHz)	0	R	U16		
	4	Output freq. (XXX.XXHz)	0	R	U16		
	5	Output current (XX.XA)	0	R	U16		
	6	DC bus voltage (XXX.XV)	0	R	U16		
	7	Output voltage (XXX.XV)	0	R	U16		
	8	The current step run by the multi- step speed commend	0	R	U16		
	9	Reserved	0	R	U16		
	A	Display counter value（c）	0	R	U16		
	B	Display output power factor angle (XX.X°)	0	R	U16		
	C	Display output torque (XXX.X%)	0	R	U16		
	D	Display actual motor speed (rpm)	0	R	U16		
	E	Number of PG feedback pulses (0–65535)	0	R	U16		
	F	Number of PG2 pulse commands (0–65535)	0	R	U16		
	10	Power output (X.XXXkWh)	0	R	U16		
	17	Multi-function display (Pr.00-04)	0	R	U16		
2022H	0	Reserved	0	R	U16		
	1	Display the drive's output current	0	R	U16		
	2	Counter value	0	R	U16		

Index	Sub	Definition	Default	R/W	Size	Note
	3	Actual output frequency (XXX.XXHz)	0	R	U16	
	4	DC bus voltage (XXX.XV)	0	R	U16	
	5	Output voltage (XXX.XV)	0	R	U16	
	6	Power factor angle (XX.X°)	0	R	U16	
	7	Display the output power of U, V, W in kW	0	R	U16	
	8	Display the motor speed estimated by the drive or encoder feedback in rpm	0	R	U16	
	9	Display the positive / negative output torque estimated by the drive (+0.0: positive torque; -0.0: negative torque)	0	R	U16	
	A	Display PG feedback	0	R	U16	
	B	Display the PID feedback value after enabling PID function in %	0	R	U16	
	C	Display the AVI analog input terminal signal, 0–10 V corresponds to 0.00–100.00% (see Explanation 2 in Pr.00-04)	0	R	U16	
	D	Display the ACI analog input terminal signal, 4–20 mA / 0–10 V corresponds to 0–100% (2.) (see Explanation 2 in Pr.00-04)	0	R	U16	
	E	Display the AUI analog input terminal signal, -10–10V corresponds to -100–100% (see Explanation 2 in Pr.00-04)	0	R	U16	
	F	IGBT temperature of the power module in °C	0	R	U16	
	10	Display the temperature of capacitance in °C	0	R	U16	
	11	The digital input status (ON / OFF), refer to Pr.02-12 (see Explanation 3 in Pr.00-04)	0	R	U16	
	12	The digital output status (ON / OFF), refer to Pr.02-18 (see Explanation 4 in Pr.00-04)	0	R	U16	
	13	Current step for the multi-step speed operation	0	R	U16	
	14	The corresponding CPU digital input pin status (d.) (see Explanation 3 in Pr.00-04)	0	R	U16	
	15	The corresponding CPU digital output pin status (O.) (see Explanation 4 in Pr.00-04)	0	R	U16	

Index	Sub	Definition	Default	R/W	Size	Note
	16	Number of actual motor revolutions (PG1 of PG card). Starts from 9 when the actual operation direction is changed, or the keypad display at stop is 0. Max. is 65535	0	R	U16	
	17	Pulse input frequency (PG2 of the PG card)	0	R	U16	
	18	Pulse input position (PG card PG2), maximum setting is 65535.	0	R	U16	
	19	Position command tracing error	0	R	U16	
	1A	Counter value of overload (0.00–100.00%)	0	R	U16	
	1B	Display GFF in %	0	R	U16	
	1C	Display DC bus voltage ripples (Unit: V_{DC})	0	R	U16	
	1D	PLC register D1043 data	0	R	U16	
	1E	Magnetic field area of the synchronous motor	0	R	U16	
	1F	User page displays the value in physical measure	0	R	U16	
	20	Output Value of Pr.00-05	0	R	U16	
	21	Number of motor turns when drive operates	0	R	U16	
	22	Operation position of motor	0	R	U16	
	23	Fan speed of the drive	0	R	U16	
	24	Control mode of the drive 0: speed mode 1: torque mode	0	R	U16	
	25	Carrier frequency of the drive	0	R	U16	
	26	Reserved				
	27	Motor status				
	28	Output positive/ negative torque of motor drive calculation				
	29	Torque command				
	2A	kWh display				
	2B	PG2 pulse input low-word				
	2C	PG2 pulse input high-word				
	2D	Motor actual position low-word				
	2E	Motor actual position high-word				
	2F	PID target value				
	30	PID offset				
	31	PID output frequency				

CANopen Remote IO Mapping

Index	Sub	R/W	Definition
2026H	01h	R	Each bit corresponds to the different input terminals
	02h	R	Each bit corresponds to the different input terminals
	03h–40h	R	Reserved
	41h	RW	Each bit corresponds to the different output terminals
	42h–60h	R	Reserved
	61h	R	AVI proportional value (%)
	62h	R	ACI proportional value (%)
	63h	R	AUI proportional value (%)
	64h–6Ah	R	Reserved

Index	Sub	R/W	Definition
	6Bh	R	Extension card AI10, 0.0–100.0% (EMC-A22A)
	6Ch	R	Extension card AI11, 0.0–100.0% (EMC-A22A)
	6Dh–A0h	R	Reserved
	A1h	RW	AFM1 output proportional value (%)
	A2h	RW	AFM2 output proportional value (%)
	A3h–AAh	RW	Reserved
	ABh	RW	Extension card AO10, 0.0–100.0% (EMC-A22A)
	ACh	RW	Extension card AO11, 0.0–100.0% (EMC-A22A)

Index 2026-01	bit0	bit1	bit2	bit3	bit4	bit5	bit6	bit7	bit8	bit9	bit10	bit11	bit12	bit13	bit14	bit15
1	FWD	REV	MI1	MI2	MI3	MI4	MI5	MI6	MI7	MI8						
2											MI10	MI11	MI12	MI13	MI14	MI15
3											MI10	MI11	MI12	MI13		

1: Control broad I/O (Standard)

2: Add external card, EMC-D611A

3: Add external card, EMC-D42A

Index 2026-41	bit0	bit1	bit2	bit3	bit4	bit5	bit6	bit7	bit8	bit9	bit10	bit11	bit12	bit13	bit14	bit15
1	RY1	RY2		MO1	MO2											
2						MO10	MO11									
3						RY10	RY11	RY12	RY13	RY14	RY15					

1: Control broad I/O (Standard)

2: Add external card, EMC-D42A

3: Add external card, EMC-R6AA

Delta Standard Mode (New Definition)

Index	sub	R/W	Size	Descriptions			Speed Mode	Position Mode	Home Mode	Torque Mode
				bit	Definition	Priority				
2060h	00h	R	U8						0: Stop Homing	
	01h	RW	U16	0	Ack	4	0: fcmd =0 1: fcmd = Fset(Fpid)	Pulse 1: Position control	Pulse 1: Return to home	
				1	Dir	4	0: FWD run command 1: REV run command			
				2				0: Relative move 1: Absolute move		
				3	Halt	3	0: drive run till target speed is attained 1: drive stop by deceleration setting			The torque target of internal decoding is set as 0, but the display of outside torque target will remain its outside setting.
				4	Hold	4	0: drive run till target speed is attained 1: frequency stop at current frequency			
				5	JOG	4	0: JOG OFF Pulse 1: JOG RUN			
				6	Qstop	2	Quick Stop	Quick Stop	Quick Stop	Quick Stop
				7	Power	1	0: Power OFF 1: Power ON	0: Power OFF 1: Power ON	0: Power OFF 1: Power ON	0: Power OFF 1: Power ON
				8	Reserved					

Index	sub	R/W	Size	Descriptions			Speed Mode	Position Mode	Home Mode	Torque Mode
				bit	Definition	Priority				
				9	Ext Cmd2	4	0→1: Absolute position cleared	0->1: Absolute position cleared	0->1: Absolute position cleared	0->1: Absolute position cleared
				10–14	Reserved					
				15	RST		Pulse 1: Fault code cleared	Pulse 1: Fault code cleared	Pulse 1: Fault code cleared	Pulse 1: Fault code cleared
	02h	RW	U16		Mode Cmd		0: Speed mode	1: P2P position mode	3: Home mode	2: Torque mode
	03h	RW	U16				Speed command (unsigned decimal)			
	04h	RW	U16							
	05h	RW	S32					Position command		
	06h	RW								
	07h	RW	U16							Torque command (signed decimal)
	08h	RW	U16							Speed limit (unsigned decimal)
2061h	01h	R	U16	0	Arrive		Frequency command reached	Position attained	Homing complete	Torque attained
				1	Dir		0: Motor FWD run 1: Motor REV run	0: Motor FWD run 1: Motor REV run	0: Motor FWD run 1: Motor REV run	0: Motor FWD run 1: Motor REV run
				2	Warn		Warning occurs	Warning	Warning	Warning
				3	Error		Error detected	Error detected	Error detected	Error detected
				4						
				5	JOG		JOG	JOG	JOG	JOG
				6	Qstop		Quick stop	Quick stop	Quick stop	Quick stop
				7	Power On		Switch ON	Switch ON	Switch ON	Switch ON
				15–8						
	02h	R								
	03h	R	U16				Actual output frequency	Actual output frequency	Actual output frequency	Actual output frequency
	04h	R								
	05h	R	S32				Actual position (absolute)	Actual position (absolute)	Actual position (absolute)	Actual position (absolute)
	06h	R								
	07h	R	S16				Actual torque	Actual torque	Actual torque	Actual torque

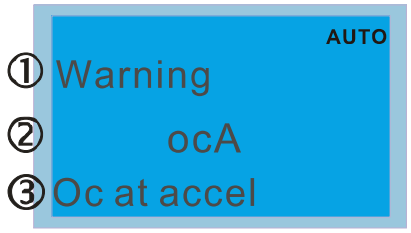
CANopen built-in PLC register D mapping（from D900–D999 mapping to 3000H–3063H）

Index	Sub	Property	Definition
3000	0	RW	PLC D900
3001	0	RW	PLC D901
3002	0	RW	PLC D902
…	…	RW	…
3063	0	RW	PLC D999

DS402 Standard

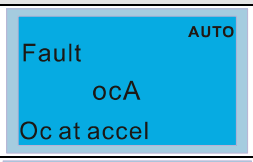
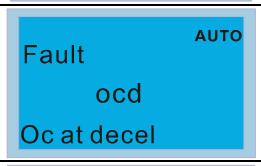
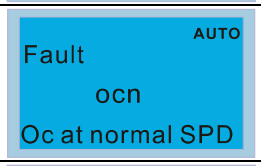
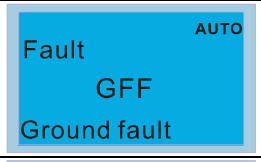
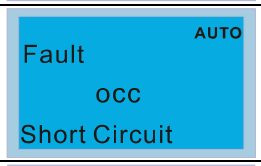
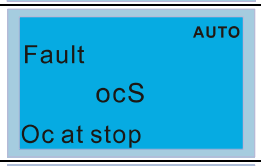
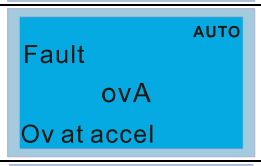
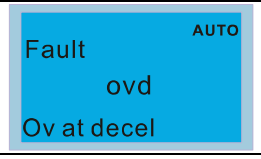
Index	Sub	Definition	Default	R/W	Size	Unit	PDO Map	Mode	Note
6007H	0	Abort connection option code	2	RW	S16		Yes		0：No action 2：Disable Voltage 3：quick stop
603FH	0	Error code	0	R0	U16		Yes		
6040H	0	Control word	0	RW	U16		Yes		
6041H	0	Status word	0	R0	U16		Yes		
6042H	0	vl target velocity	0	RW	S16	rpm	Yes	vl	
6043H	0	vl velocity demand	0	RO	S16	rpm	Yes	vl	
6044H	0	vl control effort	0	RO	S16	rpm	Yes	vl	
604FH	0	vl ramp function time	10000	RW	U32	ms	Yes	vl	Unit must be 100 ms, and check if the setting is 0.
6050H	0	vl slow down time	10000	RW	U32	ms	Yes	vl	
605AH	0	Quick stop option code	2	RW	S16		No		0：disable drive function 1：slow down on slow down ramp 2：slow down on quick stop ramp 5：slow down on slow down ramp and stay in QUICK STOP 6：slow down on quick stop ramp and stay in QUICK STOP
605CH	0	Disable operation option code	1	RW	S16		No		0：Disable drive function 1：Slow down with slow down ramp; disable of the drive function
6060H	0	Mode of operation	2	RW	S8		Yes		1：Profile Position Mode 2：Velocity Mode 4：Torque Profile Mode 6：Homing Mode
6061H	0	Mode of operation display	2	RO	S8		Yes		Same as above
6062H	0	Position demand value	0	RO	S32	pulse	Yes		
6064H	0	Position actual value	0	RO	S32	pulse	Yes		
6065H	0	Following error window	1000	RW	U32	pulse	Yes		
6067H	0	Position window	10	RW	U32	pulse	Yes		
6068H	0	Position window time	500	RW	U16	ms	Yes		
6071H	0	Target torque	0	RW	S16	0.1%	Yes	tq	Valid unit: 1%
6072H	0	Max torque	1500	RW	U16	0.1%	Yes	tq	Valid unit: 1%
6075H	0	Motor rated current	0	RO	U32	mA	No	tq	
6077H	0	Torque actual value	0	RO	S16	0.1%	Yes	tq	
6078H	0	Current actual value	0	RO	S16	0.1%	Yes	tq	
6079H	0	DC link circuit voltage	0	RO	U32	mV	No	tq	
607AH	0	Target position	0	RW	S32	pulse	Yes		
607CH	0	Home offset	0	RW	S32	pulse	Yes		
607DH	1	Min position limit	-72000000	RW	S32	pulse	Yes		
607DH	2	Max position limit	72000000	RW	S32	pulse	Yes		
6081H	0	Profile velocity	72000	RW	U32	pulse/sec	Yes		
6083H	0	Profile acceleration	72000	RW	U32	pulse/sec²	Yes		
6084H	0	Profile deceleration	72000	RW	U32	pulse/sec²	Yes		
6085H	0	Quick stop deceleration	72000	RW	U32	pulse/sec²	Yes		
6098H	0	Homing method	35	RW	S8		Yes		
6099H	1	Homing speed during search for switch	9600	RW	U32	pulse/sec	Yes		
6099H	2	Homing speed during search for zero	2400	RW	U32	pulse/sec	Yes		
609AH	0	Homing acceleration	960	RW	U32	pulse/sec²	Yes		
60F4H	0	Following error actual value	0	RW	S16	pulse	Yes		

15-5 CANopen Fault Code

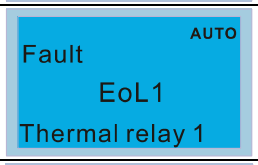
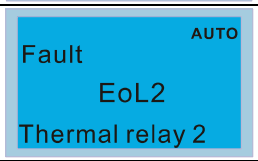
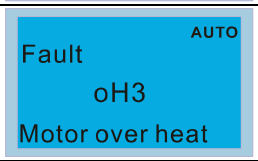
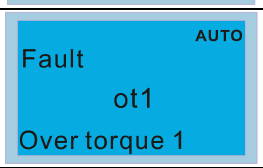
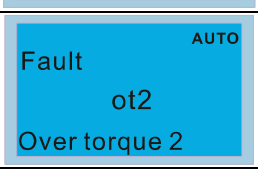
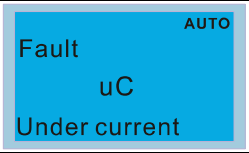
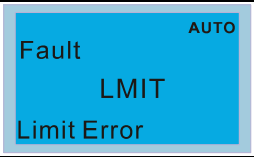
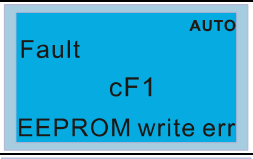
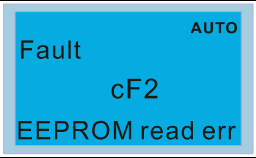
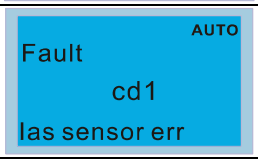


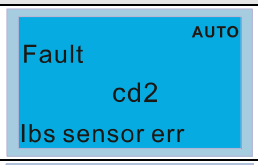
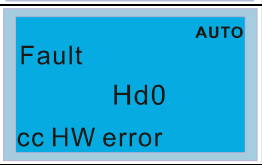
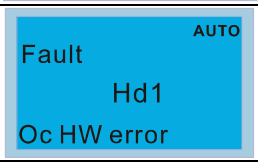
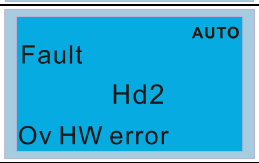
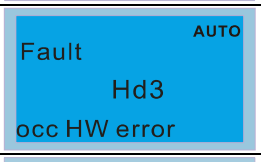
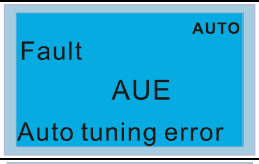
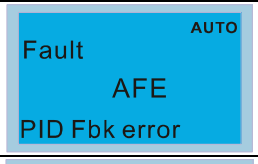
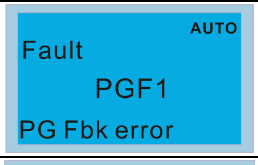
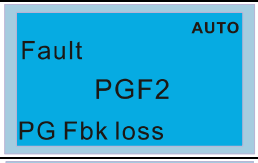
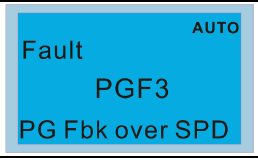
① Display error signal
② Abbreviate error code
③ Display error description

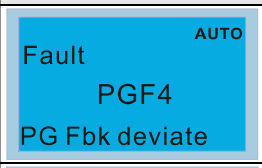
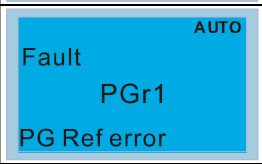
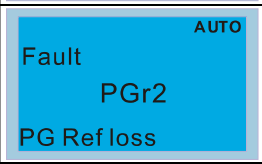
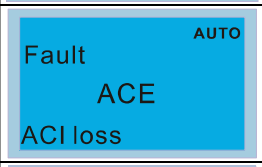
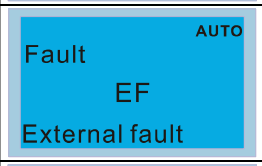
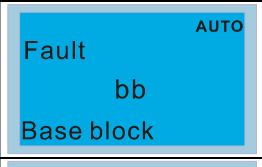
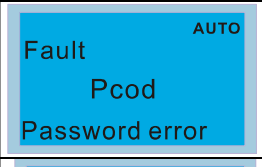
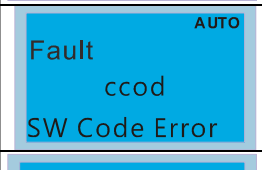
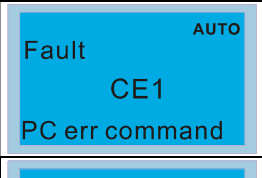
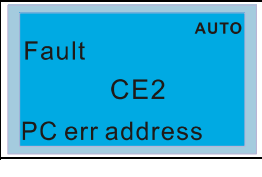
- Refer to settings for Pr.06-17–Pr.06-22
- Refer to Chapter 14 Fault Codes and Descriptions for detailed descriptions.

Setting *	Display	Fault code	Description	CANopen fault register (bit 0–7)	CANopen fault code
1		0001H	Over-current during acceleration	1	2213H
2		0002H	Over-current during deceleration	1	2213H
3		0003H	Over-current during steady operation	1	2314H
4		0004H	Ground fault	1	2240H
5		0005H	IGBT short circuit between upper bridge and lower bridge	1	2250H
6		0006H	Over-current at stop	1	2214H
7		0007H	Over-voltage during acceleration	2	3210H
8		0008H	Over-voltage during deceleration	2	3210H

Setting *	Display	Fault code	Description	CANopen fault register (bit 0–7)	CANopen fault code
9	AUTO Fault ovn Ov at normal SPD	0009H	Over-voltage at constant speed	2	3210H
10	AUTO Fault ovS Ov at stop	000AH	Over-voltage at stop	2	3210H
11	AUTO Fault LvA Lv at accel	000BH	Low-voltage during acceleration	2	3220H
12	AUTO Fault Lvd Lv at decel	000CH	Low-voltage during deceleration	2	3220H
13	AUTO Fault Lvn Lv at normal SPD	000DH	Low-voltage at constant speed	2	3220H
14	AUTO Fault LvS Lv at stop	000EH	Low-voltage at stop	2	3220H
15	AUTO Fault OrP Phase lacked	000FH	Phase loss protection	2	3130H
16	AUTO Fault oH1 IGBT over heat	0010H	IGBT overheating	3	4310H
17	AUTO Fault oH2 Heat Sink oH	0011H	Heatsink overheating	3	4310H
18	AUTO Fault tH1o Thermo 1 open	0012H	IGBT temperature detection failure	3	FF00H
19	AUTO Fault tH2o Thermo 2 open	0013H	Capacitor hardware error	3	FF01H

Setting *	Display	Fault code	Description	CANopen fault register (bit 0–7)	CANopen fault code
21		0015H	Over load	1	2310H
22		0016H	Electronic thermal relay 1 protection	1	2310H
23		0017H	Electronic thermal relay 2 protection	1	2310H
24		0018H	Motor overheating	3	FF20H
26		001AH	Over torque 1	3	8311H
27		001BH	Over torque 2	3	8311H
28		001CH	Under current	1	8321H
29		001DH	Limit Error	1	7320H
30		001EH	EEPROM write error	5	5530H
31		001FH	EEPROM read error	5	5530H
33		0021H	U-phase error	1	FF04H

Setting *	Display	Fault code	Description	CANopen fault register (bit 0–7)	CANopen fault code
34		0022H	V-phase error	1	FF05H
35		0023H	W-phase error	1	FF06H
36		0024H	cc hardware error	5	FF07H
37		0025H	oc hardware error	5	FF08H
38		0026H	ov hardware error	5	FF09H
39		0027H	occ hardware error	5	FF0AH
40		0028H	Auto-tuning error	1	FF21H
41		0029H	PID loss ACI	7	FF22H
42		002AH	PG feedback error	7	7301H
43		002BH	PG feedback loss	7	7301H
44		002CH	PG feedback stall	7	7301H

Setting *	Display	Fault code	Description	CANopen fault register (bit 0–7)	CANopen fault code
45		002DH	PG slip error	7	7301H
46		002EH	PGr1 PG ref input error (applied to 575V / 690V)	7	FF23H
47		002FH	PGr2 PG ref killed line (applied to 575V / 690V)	7	FF24H
48		0030H	ACI loss	1	FF25H
49		0031H	External fault	5	9000H
50		0032H	Emergency stop	5	9000H
51		0033H	External base block	5	9000H
52		0034H	Password is locked	5	FF26H
53		0035H	SW Code Error	5	6100H
54		0036H	Illegal command	4	7500H
55		0037H	Illegal data address	4	7500H

Setting *	Display	Fault code	Description	CANopen fault register (bit 0–7)	CANopen fault code
56	AUTO Fault CE3 PC err data	0038H	Illegal data value	4	7500H
57	AUTO Fault CE4 PC slave fault	0039H	Data is written to read-only address	4	7500H
58	AUTO Fault CE10 PC time out	003AH	Modbus transmission time-out	4	7500H
60	AUTO Fault bF Braking fault	003CH	Brake transistor error	5	7110H
61	AUTO Fault ydc Y-delta connect	003DH	Y-connection / Δ-connection switch error	2	3330H
62	AUTO Fault dEb Dec. Energy back	003EH	Deceleration energy backup error	2	FF27H
63	AUTO Fault oSL Over slip error	003FH	Over slip error	7	FF28H
64	AUTO Fault ryF MC Fault	0040H	Electric valve switch error	5	7110H
65	AUTO Fault PGF5 PG HW Error	0041H	Hardware error of PG card	5	FF29H
68	AUTO Fault SdRv SpdFbk Dir Rev	0044H	Reverse direction of the speed feedback	0	8400H
69	AUTO Fault SdOr SpdFbk over SPD	0045H	Over speed rotation feedback	0	8400H

Setting *	Display	Fault code	Description	CANopen fault register (bit 0–7)	CANopen fault code
70	AUTO Fault SdDe SpdFbk deviate	0046H	Large deviation of speed feedback	0	8400H
71	AUTO Fault WDTT Watchdog	0047H	Watchdog (applied to 230V / 460V)	1	6010H
72	AUTO Fault STL1 STO Loss 1	0048H	STO Loss 1	5	FF30H
73	AUTO Fault S1 S1-emergy stop	0049H	Emergency stop for external safety	5	FF2AH
75	AUTO Fault Brk EXT-Brake Error	004BH	External brake error (applied to 230V / 460V)	5	7110H
76	AUTO Fault STO STO	004CH	STO	5	FF31H
77	AUTO Fault STL2 STO Loss 2	004DH	STO Loss 2	5	FF32H
78	AUTO Fault STL3 STO Loss 3	004EH	STO Loss 3	5	FF33H
82	AUTO Fault OPHL U phase lacked	0052H	Output phase loss U phase	2	2331H
83	AUTO Fault OPHL V phase lacked	0053H	Output phase loss V phase	2	2332H
84	AUTO Fault OPHL W phase lacked	0054H	Output phase loss W phase	2	2333H

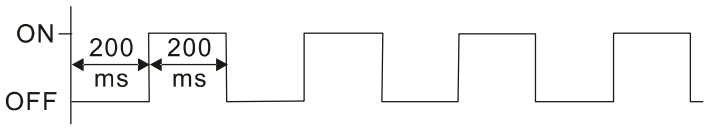
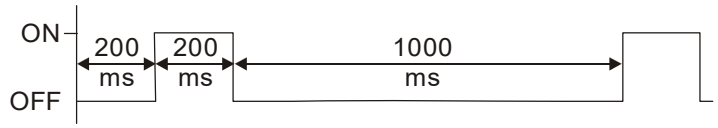
Setting *	Display	Fault code	Description	CANopen fault register (bit 0–7)	CANopen fault code
85	AUTO Fault AboF PG ABZ Line off	0055H	PG ABZ line off	7	7301H
86	AUTO Fault UvoF PG UVW Line off	0056H	PG UVW line off	7	7301H
87	AUTO Fault oL3 Derating Error	0057H	Overload protection at low frequency	0	8A00H
89	AUTO Fault RoPd Rotor Pos. Error	0059H	Rotor position detection error	0	8A00H
90	AUTO Fault Fstp Force Stop	005AH	Force to stop	7	FF2EH
92	AUTO Fault LEr Pul. Tun. L Err	005CH	Pulse Tuning Inductance (L) Error	n/a	0
93	AUTO Fault TRAP CPU Trap 0 error	005BH	CPU error 0 (applied to 230V / 460V)	7	6000H
101	AUTO Fault CGdE Guarding T-out	0065H	CANopen guarding error	4	8130H
102	AUTO Fault CHbE Heartbeat T-out	0066H	CANopen heartbeat error	4	8130H
104	AUTO Fault CbFE Can bus off	0068H	CANopen bus off error	4	8140H
105	AUTO Fault CIdE Can bus Index Err	0069H	CANopen index error	4	8100H

Setting *	Display	Fault code	Description	CANopen fault register (bit 0–7)	CANopen fault code
106	AUTO Fault CAdE Can bus Add. Err	006AH	CANopen station address error	4	8100H
107	AUTO Fault CFrE Can bus off	006BH	CANopen memory error	4	8100H
111	AUTO Fault ictE InrCom Time Out	006FH	InrCOM time-out error	4	7500H
112	AUTO Fault SfLK PMLess Shaft Lock	0070H	PMLess shaft lock	0	8A00H
142	AUTO Fault AUE1 Auto tuning Err	008EH	Auto-tune error 1 (applied to 230V / 460V)	1	FF3DH
143	AUTO Fault AUE2 Auto tuning Err	008FH	Auto-tune error 2 (applied to 230V / 460V)	1	FF3EH
144	AUTO Fault AUE3 Auto tuning Err	0090H	Auto-tune error 3 (applied to 230V / 460V)	1	FF3FH
148	AUTO Fault AUE4 Auto tuning Err	0094H	Auto-tune error 4 (applied to 230V / 460V)	1	FF43H
171	AUTO Fault oPEE Over Pos Err Lim	00ABh	Over Position Error Limit	n/a	0

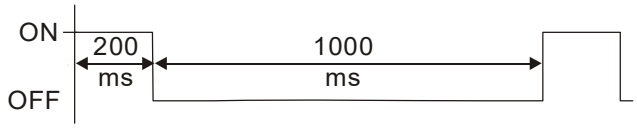
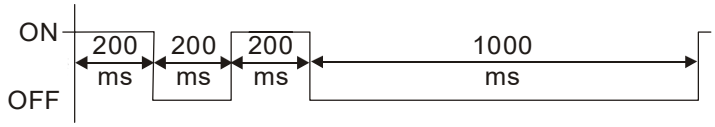
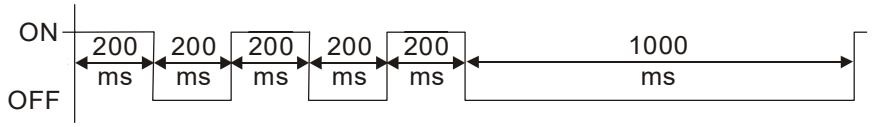
15-6 CANopen LED Function

There are two CANopen flash signs: RUN and ERR.

RUN LED:

LED status	Condition	CANopen State
OFF	OFF	Initial
Blinking		Pre-Operation
Single flash		Stopped
ON	ON	Operation

ERR LED:

LED status	Condition / Status
OFF	No Error
Single flash	At least one CANopen packet failure 
Double flash	Guarding failure or heartbeat failure 
Triple flash	SYNC failure 
ON	Bus off