EM-CAN
CANopen Protocol Instruction Manual

Revision 1.0
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Notice

Read this manual carefully before any assembling and using. Incorrect handling of products in this manual can result in injury and damage to persons and machinery. Strictly adhere to the technical information regarding installation requirements.

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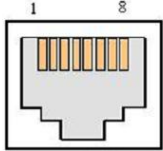## Record of Revisions

Revision	Date	Description of Release
1.0	Mar, 2017	Initial Release

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1 Port Connection and Settings

1.1 CAN Bus Connectors

EM556-CAN's CAN port adopt double couplet belt shielded RJ45 terminal (Adopt standard RJ45 norm).

RJ45 port PIN sequence definition	PIN No.	Signal	Function description
	1	CAN_H	CAN signal high
	2	CAN_L	CAN signal low
	3	CAN_GND	CAN signal earth
	4-5	NC	
	6	NC	
	7	CAN_SHLD	Reserved GND
	8	NC	

1.2 EM556-CAN Communication Parameter Setting

For different types of drives, the communication parameter setting is not the same, please refer to the product manual for details, take EM556-CAN for example.

Setting range of drive's communication address is 1-127 (Drive's communication address must set to be other value because of some master stations also need to set communication address), EM556-CAN's CAN address have 7 bits in total, low 5 bits address are defined bySW1-SW5, high 2 bits address are defined bySW1-SW5, specific definition of low 5 bits CAN address :

CAN address ID (Low 5 bits)	SW1	SW2	SW3	SW4	SW5
1	off	on	on	on	on
2	on	off	on	on	on
3	off	off	on	on	on
4	on	on	off	on	on
5	off	on	off	on	on
6	on	off	off	on	on
7	off	off	off	on	on
8	on	on	on	off	on
9	off	on	on	off	on
10	on	off	on	off	on
11	off	off	on	off	on
12	on	on	off	off	on
13	off	on	off	off	on
14	on	off	off	off	on
15	off	off	off	off	on
16	on	on	on	on	off
17	off	on	on	on	off

18	on	off	on	on	off
19	off	off	on	on	off
20	on	on	off	on	off
21	off	on	off	on	off
22	on	off	off	on	off
23	off	off	off	on	off
24	on	on	on	off	off
25	off	on	on	off	off
26	on	off	on	off	off
27	off	off	on	off	off
28	on	on	off	off	off
29	off	on	off	off	off
30	on	off	off	off	off
31	off	off	off	off	off

Baud rate can be set by external DIP switch, specific settings as below:

Baud Rate	SW6	SW7	Communica tion range
Default(100K, can use upper computer to preset value)	on	on	550m
250K	off	on	250m
500K	on	off	100m
1M(factory setting)	off	off	25m

EM556-CAN adopt built-in terminal resistance, can select by SW8, the SW8 of the drive which is at the end of bus must be switch to "on".

2　CANopen Communication

This chapter mainly introduce CANopen protocol and Leadshine CANopen drive's communication function

2.1　CANopen Protocol Overview

CAN(Controller Area Network) fieldbus only define physical layer, data link layer, but not application layer; It is not complete. Need a high-level protocol to define specific function of different data bits in the packet. Meanwhile, along with more and more widely useing of CAN bus in industrial automation. Even more urgent needs an open, standardized, high-level protocol. CANopen is a high-level protocol which is based on CAN. Is a standard protocol which defined by CiA(CAN-in-Automation), accepted widely in a short time after released. Depend on support of CANopen protocol, different factory's devices which follow CANopen standard can be network connection through CAN bus.

In the OSI mode, relationship between CAN standard and CANopen protocol as follow:

Application | Device agreemrent CIA DSP 401 | Device agreement CIA DSP 402 | Device agreement CIA DSP XXX

Application layer | CIA DS 301

Data link layer | CAN Controller | CAN 2.0A

Physical layer | + - | + - | ISO 11898

CAN Bus
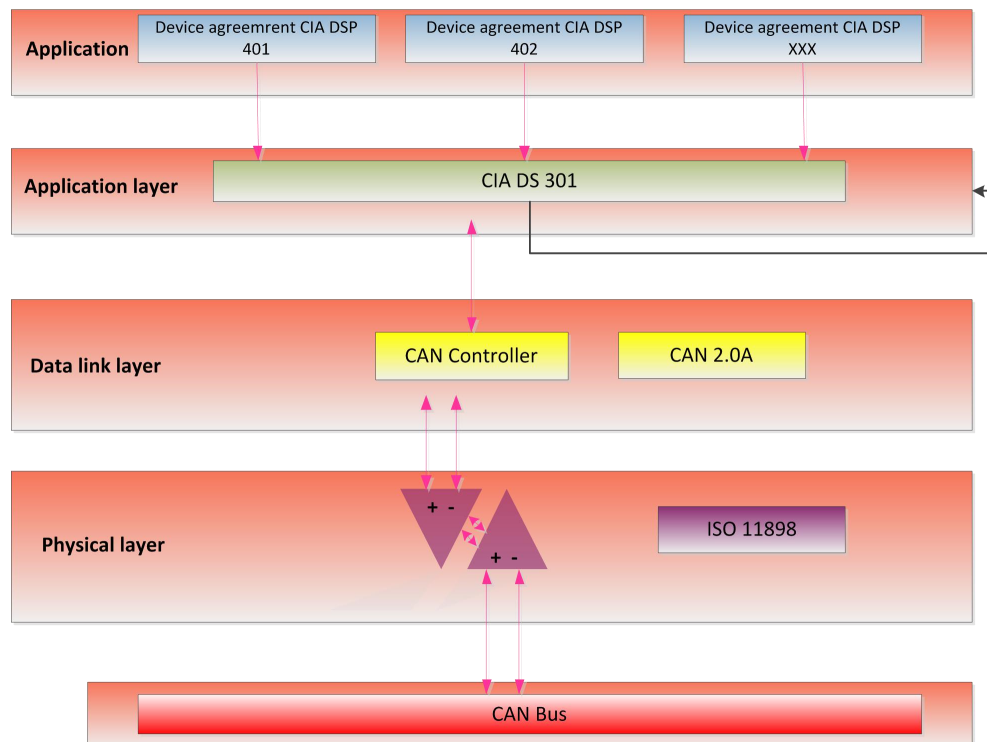
CANopen protocol provides a standard group of communication object: contains PDO(Process Data Objects), SDO(Service Data Objects) and some specific function Time Stamp, synchronous information (Sync message), E mergency message ; also formulate network management data, such as Boot-up message, network management information (NMT message) and Error Control message.

2.2　CANopen Communication Services

EM556-CAN follow CANopen norm:
◊ Fellow CAN 2.0A standard
◊ Conform to CANopen standard protocol DS 301 V4.02
◊ Conform to CANopen standard protocol DSP 402 V2.01
Leadshine's CANopen drive support service :
◊ Support NMT Slave service
◊ Equipment monitoring: Support the heartbeat packets, node guarding
◊ Support PDO service: Each slave station can configure maximum 3 TxPDO and 3 RxPDO
◊ PDO Transmission type: Support the event-trigger, time-trigger, synchronizing cycle, Synchronous acyclic
◊ Support SDO service
◊ Support Emergency Protocol

2.3　CANopen Predefined Connections Setting

In order to reduce simple network configuration work, CANopen defined compulsory default identifier distribution list. These identifier are available in pre-operational status, modifiable by dynamic assignment. CANopen device must provide identifier to its supported communication object.

11bits CAN - ID, contains 4 bits function code and 7 bits Node-ID , as shown below:

Function code				Node ID						
10	9	8	7	6	5	4	3	2	1	0

Node-ID range is 1-127(0 are not allowed to be used).

Predefined connection group defines 3 receive PDO(RXPDO), 1transmit PDO(TXPDO), 1 SDO (occupy 2 CAN-ID), 1 emergency object and 1 node error control ID. Also support don't need to be confirmed NMT Module Control service and synchronization object broadcast. Definitions are shown in table below.

CANopen predefine broadcast object of master/slave connection group			
Object	Function code	COB-ID	Object dictionary index
NMT modular control	0000	0x000	—
Synchronization	0001	0x080	1005H,1006H,1007H
CANopen Master/slave connection group equivalent object			
Object	Fuction code	COB-ID	Object dictionary index
Emergency	0001	0x081-0x0FF	1024H,1015H
TXPDO1(Transmit)	0011	0x181-0x1FF	1800H
RXPDO1(Receive)	0100	0x201-0x27F	1400H
TXPDO3(Transmit)	0111	0x381-0x3FF	1802H
RXPDO3(Receive)	1000	0x401-0x47F	1402H
TXPDO4(Transmit)	1001	0x481-0x4FF	1803H
RXPDO4(Receive)	1010	0x501-0x57F	1403H
SDO(Server transmit)	1011	0x581-0x5FF	1200H
SDO(Client transmit)	1100	0x601-0x67F	1200H
NMT Error control	1110	0x701-0x77F	1016H-1017H

Remarks:

☉ PDO/SDO transmit/receive is relative to the side of the (slave)CAN node.

☉ NMT error control contains node guarding, heartbeat and Boot-up protocol.

ID address distribution list corresponds to predefined master-slave connection group, because all the peer to peer ID is different, therefore, only one master device(know all the connection node ID) can communicate with every connected slave node in peer-to-peer manner. Two connected slave node can not communicate.

2.4 Object Directory (OD)

2.4.1 Object Dictionary Overview

Object dictionary is a well-organized object group. Each object adopt a 16 bits index to addressing, In order to allow access to single element of the data structure, at the same time defines a 8 bits sub index, the structure of the object dictionary in the following table:

Index	Object

0000H	Unused
0001H——001FH	The standard data type, such as Bool, Integer16 etc.
0020H——003FH	Complex data type, such as PDO Communication Parameters (PDOCommpar) etc.
0040H——005FH	Manufacturer defined responsible data type
0060H——007FH	Standard data type regulated by device profile
0080H——009FH	Complex data type regulated by device profile
00A0H——0FFFH	Reserved area
1000H——1FFFH	Communication protocol area, such as equipment types, PDO quantity etc.
2000H——5FFFH	Manufacturer specific profile area
6000H——9FFFH	Standard device profile area, such as DSP 402 object dictionary area
A000H——FFFFH	Reserved area

Every CANopen node in the network has object dictionary——Contains device and its network behavior description the all parameters of the r.

Node's object dictionary is described in EDS: Electronic Data Sheet. If the node describe its action strictly according to EDS, also ok. Actually, node only need to provide necessary object in the object dictionary (there are rarely required items in CANopen regulation). And other selectable, form the node part which is functional configurable object.

CANopen contains lots of profiles ; Among them, communication profile, describes chief modality of object dictionary and communication profile area's object/communication parameters of object dictionary. At the same time describes the CANopen communication object, this protocol applies to all CANopen equipment. Besides, there are lots of device profile, define the object in the object dictionary for a variety of different types of equipment. Device profile describes function/name/index/sub-index for each object which is in the object dictionary. And whether this object is necessary or selectable, this object is read only, write only or read/write, and so on. Device profile defines which object is required or selectable in the object dictionary. If the required items exceed those which can provided by device profile. Already reserved sufficient space which can provide to manufacturer in device profile.

Communication parameters parts which described in object dictionary is the same to all CANopen device(such as object is the same in object dictionary, object value does not need to keep the same). Device related parts which described in the object dictionary is different to different kinds of devices.

2.4.2 Object Dictionary Structure

DS 301 specifies the basic structure of the object dictionary, as below:

Index	Object	Name	type	Property	Required/Closeable

2.4.3 Object Type

The corresponding "object " CANopen object code in above table as follow:

Object name	Object code	Specification
NULL	0	No data
DOMAIN	2	a mass of data, Such as executable code segment

VAR	7	variable, such as Bool, Integer 8 bits etc
ARRAY	8	Array, lots of the same type of data
RECORD	9	Record, can be a lot of different types of data

2.4.4 Accessing Properties

Property	Specification
RW	read-write
WO	write only
RO	read only
CONST	Constant, read only

2.4.5 Communication Object Dictionary

EM556-CAN Communication object dictionary list as follows:

Index	Object type	Name	Data type	Accessing Properties
1000H	VAR	Device type	Integer 32 bits	RO
1001H	VAR	Error Register	Integer 8 bits	RO
1003H	ARRAY	Predefined error area	Integer 32 bits	RO
1005H	VAR	PDO synchronization ID	Integer 32 bits	RW
1006H	VAR	Communication cycle	Integer 32 bits	RW
1007H	VAR	PDO time window	Integer 32 bits	RW
1008H	DOMAIN	Device name	character string	CONST
1009H	VAR	Hardware Version	character string	CONST
100AH	VAR	Software Version	character string	CONST
1014H	VAR	Emergency message	Integer 32 bits	RW
1017H	VAR	Producer heartbeat time	Integer 16 bits	RW
1018H	RECORD	Identity object	Integer 32 bits	RO
1200H	RECORD	Server SDO parameters	SDO parameters	RO
1400H	RECORD	Transmit PDO parameters	PDO parameters	RW
1402H	RECORD	Receive PDO parameters	PDO parameters	RW
1403H	RECORD	Receive PDO parameters	PDO parameters	RW
1404H	RECORD	Receive PDO parameters	PDO parameters	RW
1405H	RECORD	Receive PDO parameters	PDO parameters	RW
1600H	RECORD	Receive PDO mapping	PDO mapping	RW
1602H	RECORD	Receive PDO mapping	PDO mapping	RW
1603H	RECORD	Receive PDO mapping	PDO mapping	RW
1604H	RECORD	Receive PDO mapping	PDO mapping	RW
1605H	RECORD	Receive PDO mapping	PDO mapping	RW
1800H	RECORD	Transmit PDO parameters	PDO parameters	RW
1802H	RECORD	Transmit PDO parameters	PDO parameters	RW
1803H	RECORD	Transmit PDO parameters	PDO parameters	RW
1804H	RECORD	Transmit PDO parameters	PDO parameters	RW
1805H	RECORD	Transmit PDO parameters	PDO parameters	RW
1A00H	RECORD	Transmit PDO mapping	PDO mapping	RW
1A02H	RECORD	Transmit PDO mapping	PDO mapping	RW
1A03H	RECORD	Transmit PDO mapping	PDO mapping	RW
1A04H	RECORD	Transmit PDO mapping	PDO mapping	RW
1A05H	RECORD	Transmit PDO mapping	PDO mapping	RW

DS 301 Communication object dictionary details

1000H: device type

Index	1000H
Name	device type
Object type	VAR

Data type	Integer 32 bits
Accessing Properties	RO
PDO mapping	Cannot mapping
Value range	0-232-1
Default Values	0x20192

1001H: Error Register

Index	1001H
Name	error register
Object Type	VAR
Data type	Integer 8 bits
Accessing Properties	RO
PDO mapping	Cannot mapping
Value range	0-28-1
Default Values	0x0

1003H: Device type

Index	1003H
Name	Predefined error area
Object Type	ARRAY
Data type	Integer 32 bits

Sub-index

Sub-index	0x0
description	Error quantity
Accessing Properties	RW
PDO mapping	Cannot mapping
Value range	0-28-1
Default Values	0x4

Sub-index

Sub-index	0x1-0x4
description	standard error area
Accessing Properties	RO
PDO mapping	Cannot mapping
Value range	0-232-1
Default Values	0x0

1005H: device type

Index	1005H
name	PDO Synchronization ID
Object Type	VAR
Data type	Integer 32 bits
Accessing Properties	RW
PDO mapping	Cannot mapping
Value range	0-232-1
Default Values	0x80

1006H: Communication cycle

Index	1006H
name	communication cycle
Object Type	VAR
Data type	Integer 32 bits
Accessing Properties	RW
PDO mapping	Cannot mapping

Value range	0-232-1
Default Values	0x0

1007H: PDO Time Window

Index	1007H
Name	PDO Time Window
Object Type	VAR
Data type	Integer 32 bits
Accessing Properties	RW
PDO mapping	Cannot mapping
Value range	0-232-1
Default Values	0x0

1008H: Device name

Index	1008H
Name	Device name
Object type	VAR
Data type	String
Accessing property	CONST
PDO mapping	Cannot mapping
Value range	Unknown
Default value	DS402 Drive-LeadShine

1009H: Hardware version

Index	1009H
Name	Hardware version
Object type	VAR
Data type	String
Accessing property	CONST
PDO mapping	Cannot mapping
Value range	Unknown
Default value	V1.04

100AH: Software version

index	100AH
Name	Software version
Object type	VAR
Data type	String
Accessing property	CONST
PDO mapping	Cannot mapping
Value range	Unknown
Default value	V1.00

1014H: Emergency message

Index	1014H
Name	Emergency message
Object type	VAR
Data type	Integer 32 bits
Accessing property	RW
PDO mapping	Cannot mapping
Value range	0-232-1
Default value	0x80000000

1017H: Producer heartbeat time

Index	1017H
Name	Producer heartbeat time
Object type	VAR

Data type	Integer 16 bits
Accessing property	RW
PDO mapping	Cannot mapping
Value range	0-216-1
Default value	0x0

1018H: Identity object

Index	1018H
Name	Identity object
Object type	RECORD
Data type	Integer 32 bits

Sub-index

Sub-index	0x0
Description	Sub-index quantity
Accessing property	RO
PDO mapping	Cannot mapping
Value range	1-4
Default value	0x4

Sub-index

Sub-index	0x1
Description	Manufacturer ID
Accessing property	R0
PDO mapping	Cannot mapping
Value range	0-232-1
Default value	0x00000331

Sub-index

Sub-index	0x2
Description	Product code
Accessing property	RO
PDO mapping	Cannot mapping
Value range	0-232-1
Default value	0x0

Sub-index

Sub-index	0x3
Description	version number
Accessing property	RO
PDO mapping	Cannot mapping
Value range	0-232-1
Default value	0x100

Sub-index

Sub-index	0x4
Description	Serial number
Accessing property	RO
PDO mapping	Cannot mapping
Value range	0-232-1
Default value	0x1

1200H: Server SDO parameters

Index	1200H
Name	Server SDO parameters
Object type	RECORD
Data type	SDO parameters

Sub-index

Sub-index	0x0
Description	Sub-index quantity
Accessing property	RO
PDO mapping	Cannot mapping
Value range	0x2
Default value	0x2

Sub-index

Sub-index	0x1
Description	COB-ID(user to server)
Accessing property	RO
PDO mapping	Cannot mapping
Value range	0-232-1
Default value	0x600+Node-ID

Sub-index

Sub-index	0x2
Description	COB-ID(server to user)
Accessing property	RO
PDO mapping	Cannot mapping
Value range	1-27-1
Default value	0x580+ Node-ID

1400H-1405H: Receive PDO parameters

Index	1400H-1405H
Name	Receive PDO parameters
Object type	RECORD
Data type	PDO parameters

Sub-index

Sub-index	0x0
Description	Sub-index quantity
Accessing property	RO
PDO mapping	Cannot mapping
Value range	0x2-0x5
Default value	0x5

Sub-index

Sub-index	0x1
Description	PDO COB-ID
Accessing property	RW
PDO mapping	Cannot mapping
Value range	0-232-1
Default value	0x1400: 0x40000200+ Node-ID 0x1402: 0x40000400+ Node-ID 0x1403: 0x40000500+ Node-ID 0x1404: 0xC0000000 0x1405: 0xC0000000

Sub-index

Sub-index	0x2
Description	Transmit type
Accessing property	RW
PDO mapping	Cannot mapping
Value range	0-28-1
Default value	255(asynchronous mode, refer to appendix B)

Sub-index

Sub-index	0x3

Description	Forbidden time
Accessing property	RW
PDO mapping	Cannot mapping
Value range	0-216-1
Default value	0

Sub-index

Sub-index	0x4
Description	Event Timer
Accessing property	RW
PDO mapping	Cannot mapping
Value range	0-216-1
Default value	0

1600H-1605H: Receive PDO mapping

Index	1400H-1405H
Name	Receive PDO mapping
Object type	RECORD
Data type	PDO mapping

Sub-index

Sub-index	0x0
Description	Mapping object quantity
Accessing property	RW
PDO mapping	Cannot mapping
Value range	1-64
Default value	0x1

Sub-index

Sub-index	0x1-0x8
Description	PDO mapping object quantity
Accessing property	RW
PDO mapping	Cannot mapping
Value range	0-232-1
Default value	0x0

1800H-1805H: Transmit PDO parameter

Index	1800H-1805H
Name	Transmit PDO parameter
Object type	RECORD
Data type	PDO parameter

Sub-index

Sub-index	0x0
Description	Sub-index quantity
Accessing property	RO
PDO mapping	Cannot mapping
Value range	0x2-0x5
Default value	0x5

Sub-index

Sub-index	0x1
Description	PDO COB-ID
Accessing property	RW
PDO mapping	Cannot mapping
Value range	0-232-1
Default value	0x1800: 0x00000180+ Node-ID

0x1802: 0x00000380+ Node-ID
0x1803: 0x00000480+ Node-ID
0x1804: 0x80000000
0x1805: 0x80000000

Sub-index

Sub-index	0x2
Description	Transmit type
Accessing property	RW
PDO mapping	Cannot mapping
Value range	$0-2^8-1$
Default value	0x1800:255(asynchronous mode, refer to appendix: 1

Sub-index

Sub-index	0x3
Description	Forbidden time
Accessing property	RW
PDO mapping	Cannot mapping
Value range	$0-2^{16}-1$
Default value	0

Sub-index

Sub-index	0x4
Description	Event Timer
Accessing property	RW
PDO mapping	Cannot mapping
Value range	$0-2^{16}-1$
Default value	0

1A00H-1A05H: Transmit PDO mapping

Index	1A00H-1A05H
Name	Transmit PDO mapping
Object type	RECORD
Data type	PDO mapping

Sub-index

Sub-index	0x0
Description	Mapping object quantity
Accessing property	RW
PDO mapping	Cannot mapping
Value range	1-64

Default value	0x1

Sub-index

Sub-index	0x1-0x8
Description	PDO Mapping object quantity
Accessing property	RW
PDO mapping	Cannot mapping
Value range	$0-2^{32}-1$
Default value	0x0

2.5 Network Management (NMT)

NMT provide network management services. This service is realized by master-slave communication mode. (have only one NMT master node).

2.5.1 NMT Modular Control

Only NMT master node can transmit NMT modular control packet, all slave node must support NMT NMT modular controlservice. Module control does not need reply. The message format is as follows:
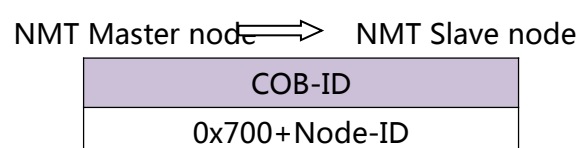
NMT Master node ⟹ NMT Slave node

COB-ID	Byte 0	Byte 1
0x000	CW	Node-ID
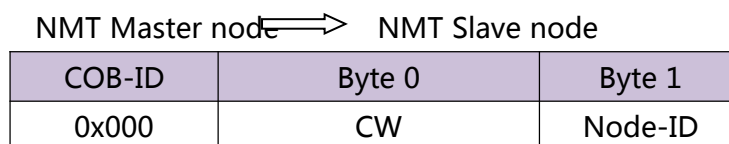
When Node-ID=0, all NMT slave node will be addressing. Corresponding relation between command word's values and service as following table:

CW	NMT service
1(01H)	Activate the remote node
2(02H)	Stop the remote node
128(80H)	Get into pre-operating state
129(81H)	Nodes reset
130(82H)	Communication reset

2.5.2 NMT Node Protection

Through this service, NMT master node can check current status of each node. The master node send a remote frame format is as follows:

NMT Master node ⟹ NMT Slave node

COB-ID
0x700+Node-ID

NMT Slave node's response packet format as below:

NMT Slave node ⟹ NMT Master node

COB-ID	Byte 0

0x700+Node-ID	Bit 6:0 status

The data includes a trigger bit(bit7),.trigger bit must set to be "0" or "1" during each time of Node protection response alternately. trigger bit must set to be "0" in the first time of node protection request. bit0-6 shows node status, The corresponding relationship of value and status are shown in below table:

Value	Status
0(00H)	Initialization
1(01H)	disconnected
2(02H)	connected
3(03H)	Ready
4(04H)	Stop
5(05H)	Operating
127(7FH)	Pre-operating

Remark: State 0 does not appear in node protection response.

A node can be configured as periodic packet which be called as Heartbeat packet.

The heartbeat producers ⇌ Consumer

COB-ID	Byte 0
0x700+Node-ID	Status

The meaning of its corresponding values shown in the following table:

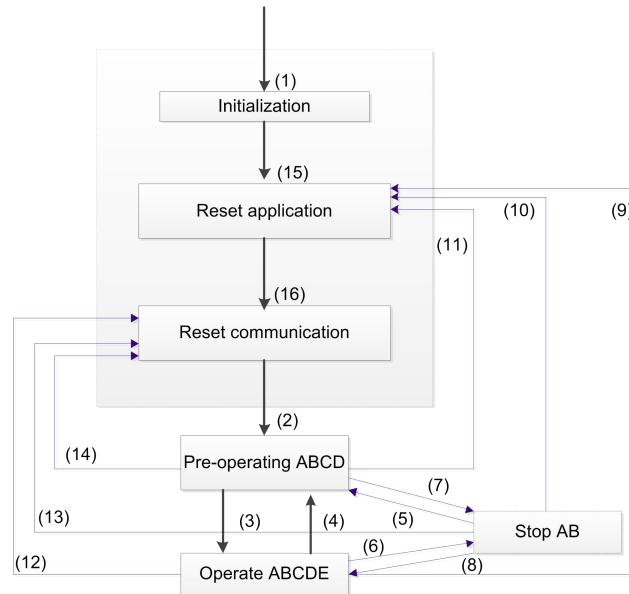| Status value	meanning
0	Boot-up
4	Stop
5	operating
127	Pre-operating

2.5.3   NMT Boot-up

NMT slave node post a Boot-up packet to inform NMT master node that it have got into the status from initialization to pre-operating.

NMT Slave node ⟹ NMT Master node

COB-ID	Byte 0
0x700+Node-ID	0

2.5.4   NMT Communication State Machine

CANopen communication state machine as shown in the figure below:

(1) After power on, enter into initialized status automatically   A: NMT

(2) Automatically enter into pre-operation status   B: Node Guard

(3) (6) Activate the remote node   C: SDO

(4) (7) Enter into pre-operation status   D: Emergency

(5) (8) Stop the remote node   E: PDO

(9) (10) (11) Reset the node   F: Boot-up

(12) (13) (14) Reset the communication

(15) Enter into reset application status automatically

(16) Enter into reset communication status automatically

Enter into pre-operation status after finish device initialization (Umbrella name of reset initialization, reset the application and communication). Device who is in this status can set parameters and distribute ID by SDO(Such as use configuration tool) . Then, node enter into pre-operation status directly.
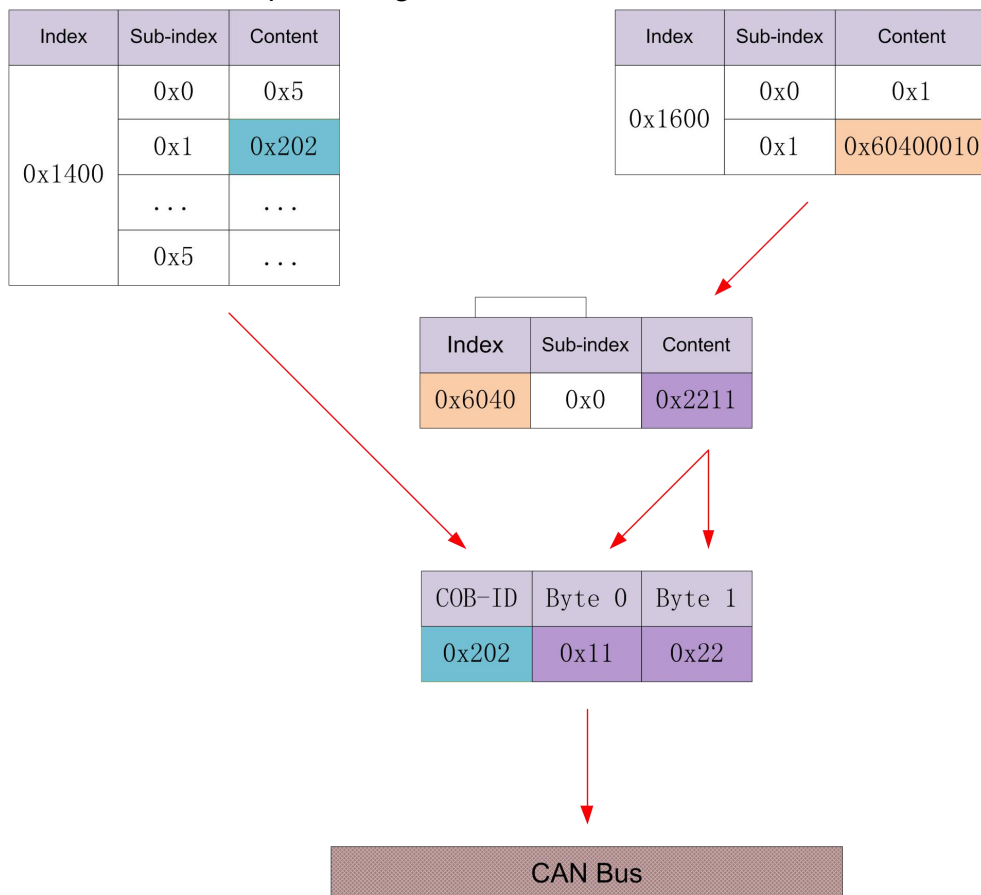
2.6 Process Data Objects (PDO)

PDO adopt producer/customer mode, PDO data transmit can be one-on-one or one-to-many manner. Each PDO packet include transmit PDo(TxPDO) and receive PDO(RxPDO) packet, its transmit style defined as PDO communication parameter index   (First group of receive PDO packet set in index 1400H,   second group of transmit PDO packet set in index 1800H).
All PDO transmit data must be mapped onto the corresponding index area through the object dictionary. Take 1600H and 1A00H which are defined in DSP 402 for example:

Remark: Value of object dictionary in the figure is only used for illustrating, does not have practical meaning.
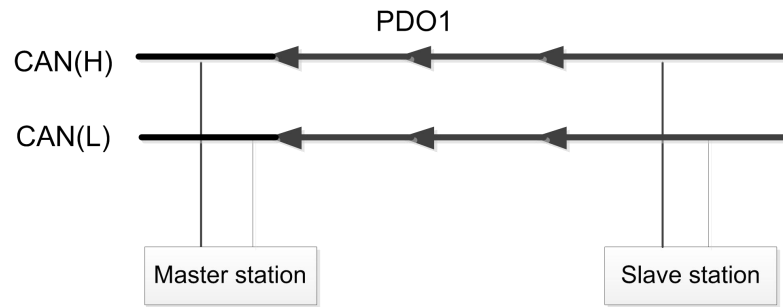

Master station transmit packet to slave station's PDO
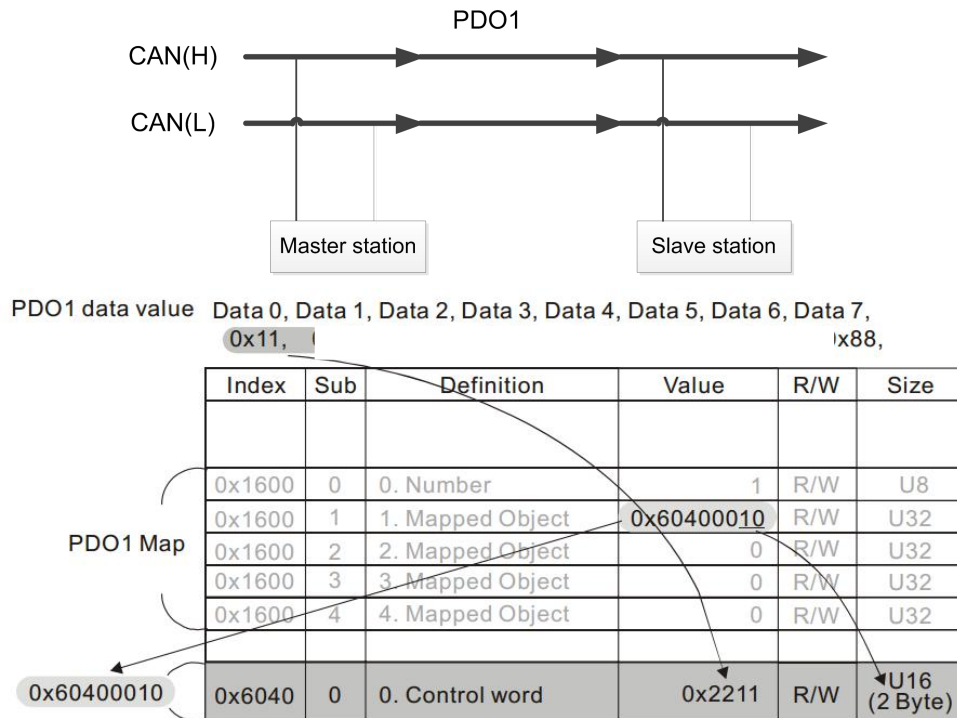
Relationship between PDO parameter(1400H) and PDO mapping(1600), PDO data's transmit process as below (Take node2 for example) . The direction of the arrow in the figure shows master station data processing direction.

The master station receive feedback packet which return from slave station:

Relationship between PDO parameter(1800H) and PDO mapping(1A00H), PDO data's transmit process as below (Take node2 for example) . The direction of the arrow in the figure shows slave station data processing direction.
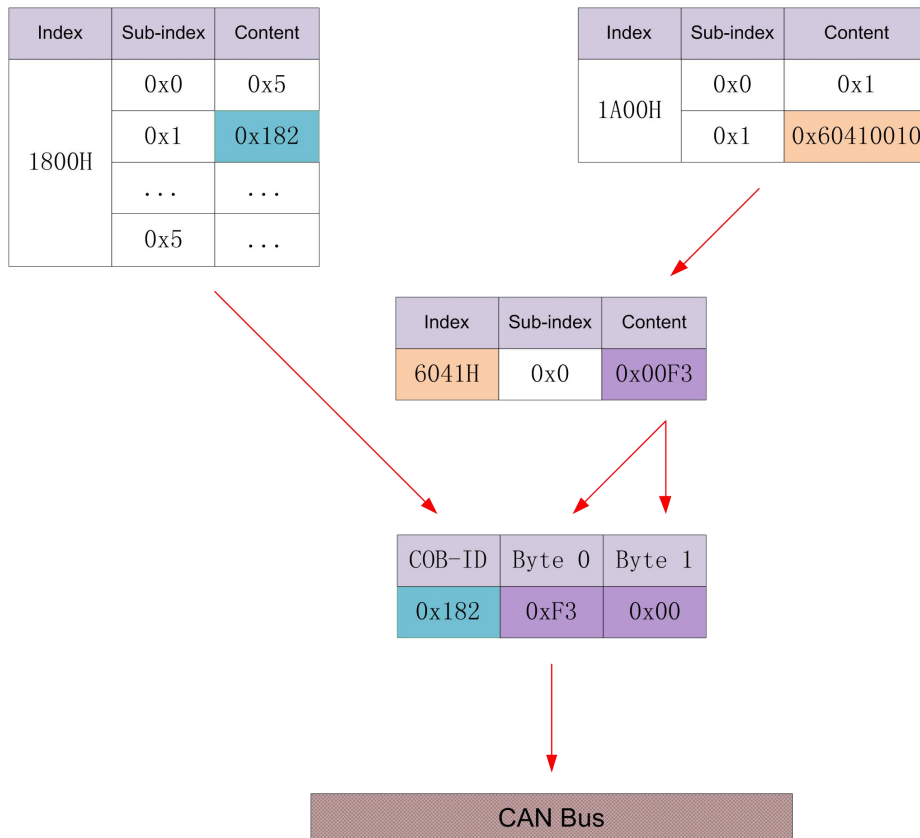
2.7 Service Data Objects (SDO)

SDO is used for accessing a device's object dictionary. The visitor is referred to as a customer(client), CANopen devices whose object dictionary been accessed and provide

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requested service are referred as server. Client's CAN packet and server's reply CAN packet always contain 8bits data.(Although, no all data bytes always have certain meaning). A client's request must have a response from the server.

Its basic structure is as follows:

Client ⟹ Server/Server ⟹ Client

Byte 0	Byte 1:2	Byte 3	Byte 4:7
SDO CW	Object Index	Object sub-index	data

For example, use SDO message write the value of 0x20F0 into ID "2", object dictionary's index is 1801H and sub-index is 3.

Client ⟹ Server

COB-ID	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
602	2B	01	18	03	F0	20	00	00

Server ⟹ Client

| 582 | 60 | 01 | 18 | 03 | 00 | 00 | 00 | 00 |

Use below SDO message, read the data of object dictionary whose index is 1810H and sub-index is 3.

Client ⟹ Server

COB-ID	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
602	40	01	18	03	00	00	00	00

Server ⟹ Client

| 582 | 4B | 01 | 18 | 03 | F0 | 20 | 00 | 00 |

SDO client or server stop SDO transmit by transmit the following format message:

Client ⟹ Server/Server ⟹ Client

Bit	7	6	5	4	3	2	1	0
	1	0	0	-	-	-	-	-

In SDO's suspended packet, data byte 0 s and 1 s signify object index. Byte 2 signify sub-index, bytes 4 to 7 contains 32-bit suspended code, it describe why suspend transmit packet. Its detailed description can refer to appendix D.

2.8 Emergency Object

Emergency instructions packet triggered by the fatal error which is inside of the device, send to other equipment by the related application equipment with the highest priority. Apply to interrupt type error alarm signal.

An emergency message consists of 8 bytes , format as follows:

Transmitting end ⟹ Receiving end

COB-ID	Byte 0:1	Byte 2	Byte 3:7
0x080+Node-ID	Emergency error code	Error register (1001H)	Manufacturers designated area

EM556-CAN supported emergency error code can be found in the appendix C
The recent emerging error will be saved in "predefined error field" object dictionary (index is 1003H); users can read these message by SDO; But if the drive power off, EM556-CAN will not store these error message. The current error type will be stored in the object dictionary errors register (index is 1001H).
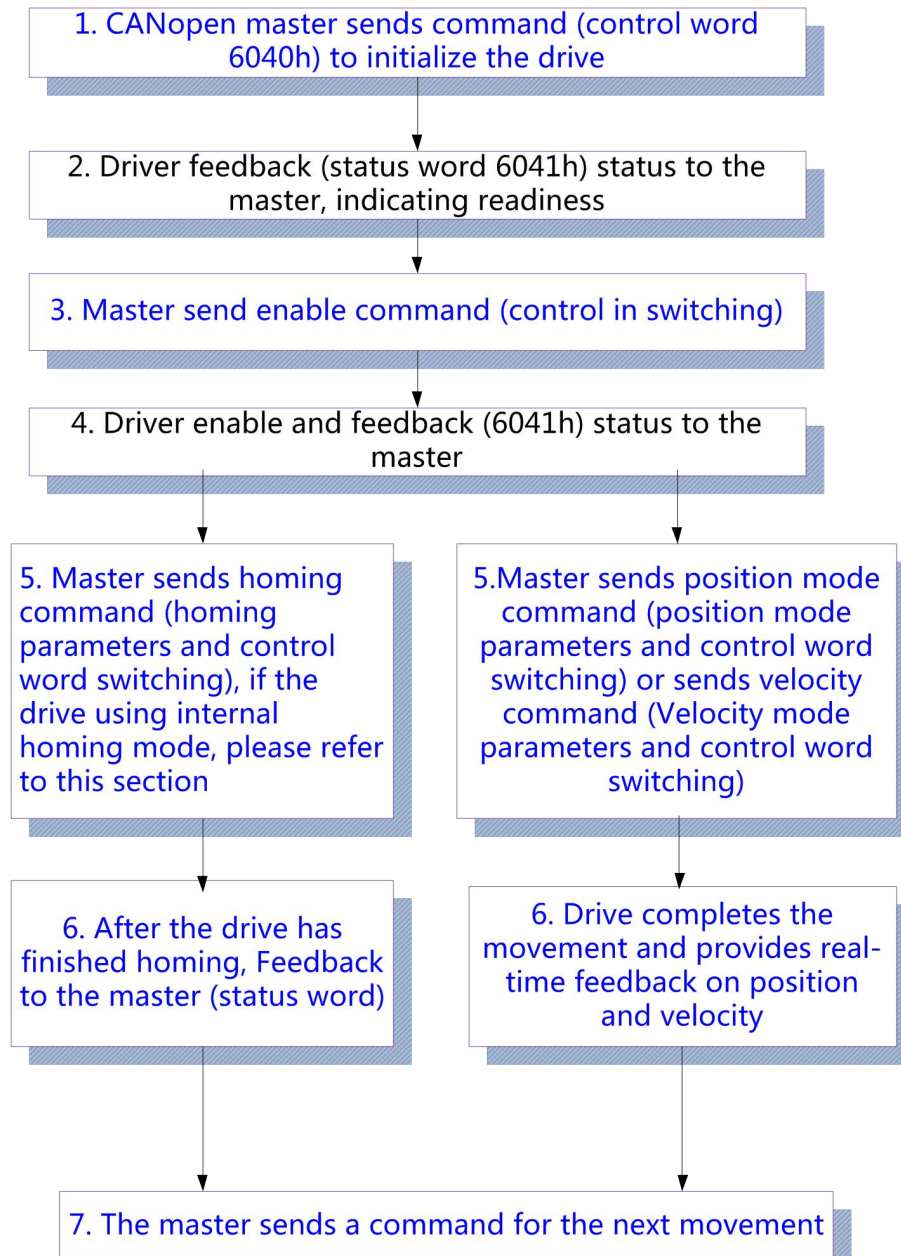
Device can map inner error into this status byte, and can quickly check the wrong type.
The table below for error register's byte definition:

Byte	Error type
0	General Error
1	Current
2	Voltage
3	Temperature
4	Communication
5	Device protocol specified error
6	Recerved
7	Manufacturer specified error

3 DS402 Control of EM-CAN

3.1 Basic Movement Steps for EM-CAN Drives

1. CANopen master sends command (control word 6040h) to initialize the drive

2. Driver feedback (status word 6041h) status to the master, indicating readiness

3. Master send enable command (control in switching)

4. Driver enable and feedback (6041h) status to the master

5. Master sends homing command (homing parameters and control word switching), if the drive using internal homing mode, please refer to this section

5.Master sends position mode command (position mode parameters and control word switching) or sends velocity command (Velocity mode parameters and control word switching)

6. After the drive has finished homing, Feedback to the master (status word)

6. Drive completes the movement and provides real-time feedback on position and velocity

7. The master sends a command for the next movement
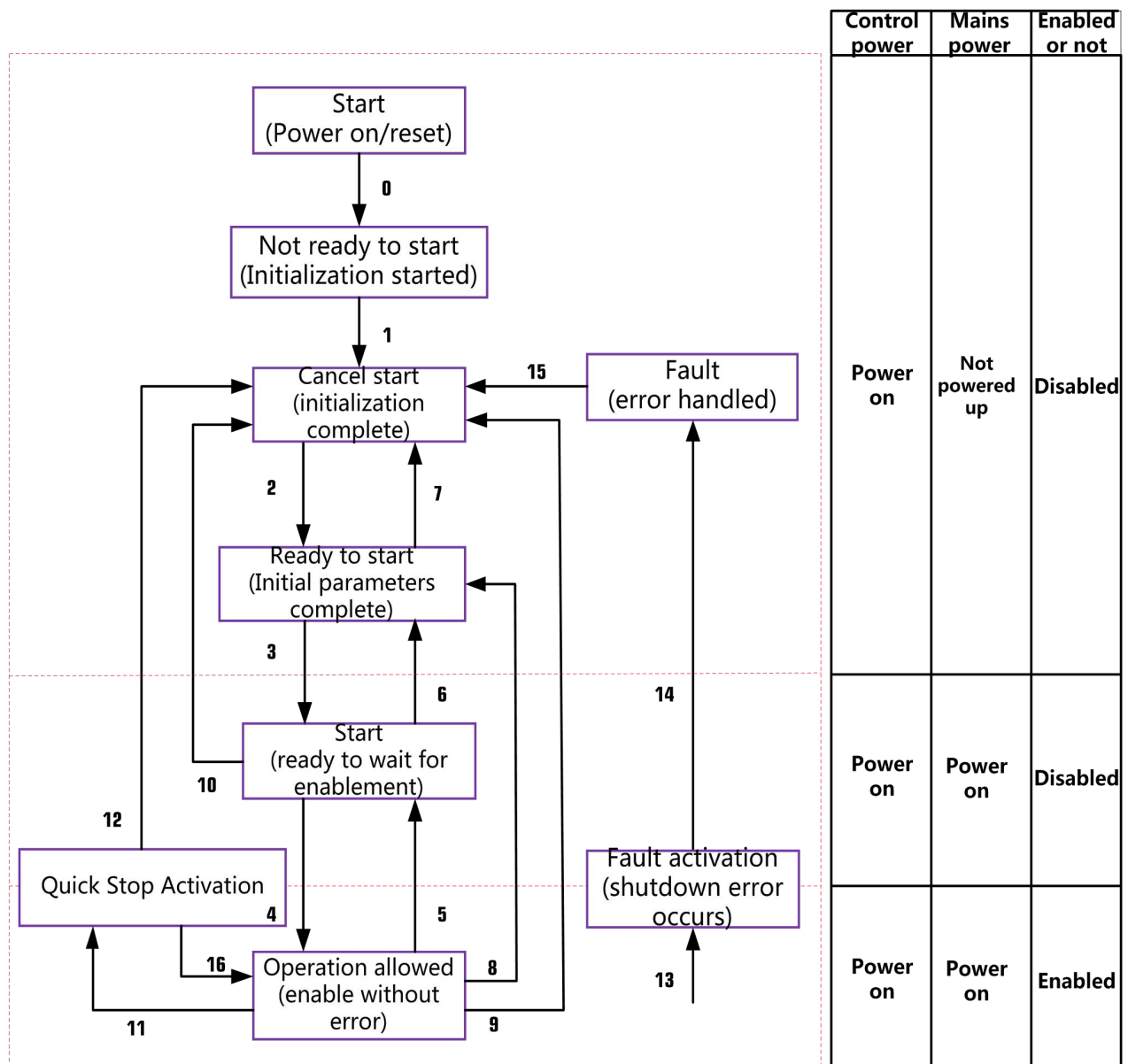
3.2 402 State Machine

Figure 3.1 The 402-state machine of the EM-CAN

Status	EM-CAN driver action
Not ready to start	The drive is powered and initialization begins; if there is a holding brake, the holding brake is locked; the axis is not enabled
Cancel start	Initialization complete, parameters initialized, no fault; axis not enabled
Ready to start	Parameter initialization complete; axis not enabled
Start	Drive ready, waiting for enable
Allowed operations	Enabled, no errors
Quick stop activation	Quick Stop Start
Fault activation	Stopped error occurred, not processed; axis not enabled
Failure	Error handled, waiting for switch 402 state machine from error (Fault) to cancel start (Switch on disabled), axis not enabled

The transition of the 402 state machine is done by relying on the master to operate the control word (6040h) of the EM-CAN stepper driver, refer to section 3.4.6 for details.

Table 3.2 Correspondence table of state transitions

	402 state conversion	Trigger conditions	6040h example *1)	Action	6041h state *2)
0	Start -> Not ready to start	control power on/reset	Automatic power-on switching without control commands	Drive self-test and initialization	0000h
1	Not ready to start -> Cancel start	Automatic conversion after initialization	No order/0000h	Communication status pre-operation and above *3)	×0h20
2	Cancel Start -> Ready to Start	Receive master power off command *4)	0006h	Drive parameter initialization in progress	23×1h
3	Ready to start -> Start	Received from the main site Start command	0007h	Main power on wait enable	×233h
4	Start -> Allow operation	Received from the main site Allow operation command	000Fh	Motor shaft enable	×7h23
5	Allow operation -> Start	Master not running operation command received	0007h	Motor shaft not enabled	×3h22
6	Start -> Ready to start	Receive master power off command	0006h	Turn off main power Control power remains on	22×1h
7	Ready to start ->	No voltage	0000h	No action	×0h26

		output command received from the master			
8	Allow operation -> Ready to start	Receive master power off command	0006h	Motor shaft not enabled Turn off main power	22×1h
9	Allow operation -> Cancel start	No voltage output command received from the master	0000h	Motor shaft not enabled Turn off main power	×0h26
10	Start -> Cancel Start	No voltage output command received from the master	0000h	Turn off main power Control power remains on	×0h26
11	Allow operation -> Quick stop activation	Received master quick stop command	0002h	Quick Stop Start	×7h30
12	Quick Stop Activation -> Cancel Activation	No voltage output command received from the master	0000h	Motor shaft not enabled Turn off main power	×0h34
13	-> Fault activation	The driver detected an error occurred	The drive will automatically switch to a fault stop state if an error occurs in any state other than "fault".	Downtime error occurred, waiting for processing	×Fh22
14	Fault activation -> Fault	Automatic changeover after fault shutdown	No order	Motor shaft not enabled Turn off main power	2×0Fh

15	Fault -> Cancel start	Fault reset command received from the master	0080h bit7 Rising edge is valid; all other commands are invalid.	If the error no longer exists, perform a fault reset action	×0h26

× means not affected by the status of this bit.

*1) The data of 6040h in this column is only used as the recommended command.

*2) The data of 6041h in this column is the state corresponding to the data of 6040h. *3) The communication state refers to the ESM state machine state in Section 2.4.

*4) It is master sending control command, not corresponding to physical power off action.

3.3 Device control object dictionary

Index	Object Type	Name	Data Type	Access Properties
6040H	VAR	Control word	Unsigned 16-bit	RW
6041H	VAR	Status word	Unsigned 16-bit	RO
6060H	VAR	Operation Mode	Signed 8-bit	RW
6061H	VAR	Operation mode display	Signed 8-bit	RO
6064H	VAR	Location Feedback	Signed 32-bit	RW
606CH	VAR	Speed Feedback	Signed 32-bit	RW
607AH	VAR	Target Location	Signed 32-bit	RW
607CH	VAR	Origin Offset	Signed 32-bit	RW
6081H	VAR	Protocol Speed	Unsigned 32-bit	RW
6082H	VAR	Position mode start/stop speed	Unsigned 32-bit	RW
6083H	VAR	Protocol acceleration	Unsigned 32-bit	RW
6084H	VAR	Protocol deceleration	Unsigned 32-bit	RW
6085H	VAR	Quick stop deceleration	Unsigned 32-bit	RW
6098H	VAR	Return to the origin method	Signed 8-bit	RW
6099H	ARRAY	Home mode speed	Unsigned 32-bit	RW
609AH	VAR	Home mode acceleration	Unsigned 32-bit	RW
60FFH	VAR	Target speed in speed mode	Signed 32-bit	RW

3.4 Operation mode setting

The EM-CAN series only supports non-synchronous modes: Protocol Position (PP) mode, Protocol Velocity (PV) mode and Home Position (HM) mode, this chapter introduces the relevant settings and operation methods of each mode.

1）Operation mode setting (6060h)

Index 6060h	Name	Object Structure	Data Type	Accessibility	Related Models	PDO Mapping	Data Range	Factory value

	Operation mode setting (target position)	VAR	Int32	RW	-	YES	$-2^7 \sim 2^7$	1

Subindex: 00

Set the operation mode, defined as follows.

1: Protocol Location Mode

3: Protocol speed mode

6: Origin mode

EM-CAN series drives currently only support these three motion modes, setting other values is not valid

2）Operation mode display (6061h)

	Name	Object Structure	Data Type	Accessibility	Related Models	PDO Mapping	Data Range	Factory value
Index 6061h	Display operation mode (target position)	VAR	Int32	RO	-	YES	$-2^7 \sim 2^7$	1

Subindex: 00

This parameter value is the same as the 6060 parameter value, and the parameter is available to read the current operation mode.

Notes:

A. Changing 6060h object data can switch the operation mode.

B. The 6061h object can be used to confirm the current mode of operation of the DM3E.

C. Switching different operation modes may require changing the mapping objects of RXPDO and TXPDO.

3.5 Common Functions in Operation Mode

3.5.1 Control word (6040H)

	Name	Object Structure	Data Type	Accessibility	Related Models	PDO Mapping	Data Range	Factory setting
Index 6040h	Control Word	VAR	Uint16	R/W	All	RPDO	0~65535	0

Subindex: 00

The control word bits are defined in the following table.

Bit(Bit)	Definition Description	Description
0	Start	0: Invalid 1: Effective
1	Voltage output	0: Invalid 1: Effective
2	Quick Stop	0: Valid 1: Invalid
3	Allowed operations	0: Invalid 1: Effective
4~6	-	These three definitions are related to the mode of operation. HM mode: Bit4 rising edge triggers home operation; Bit5,Bti6 undefined
7	Error Reset	For faults that can be reset and cleared. For a fault that can be reset and cleared, this bit changes from 0 to 1 to complete the fault reset.

		For non-clearable faults, this bit is held at 1 and other control command operations are invalid
8	Abort	PV mode, falling edge trigger operation, rising edge stop operation, repeatedly switchable operation stop
9~10	Reserved	Reserved
11~15	Manufacturer customization	Manufacturer customization

Note.

(1) Each Bit of the control word is meaningless when assigned alone, and must be used in conjunction with other bits to form an instruction.

(2) Bit4~Bit6 are related to the control mode of the driver, please see the relevant control mode of the driver for details.

3) Bit0~Bit3, and bit7 are the same in each mode. The commands must be sent in order before the drive can be converted in accordance with the CiA402 state, each command corresponds to a state, the specific combinations are shown in the following table.

Control commands	Bit7 combined with Bit3~Bit0					Device state machine transition
	Error Reset	Allowed operations	Quick Stop	Voltage output	Start	
	Bit7	Bit3	Bit2	Bit1	Bit0	
Power off	0	×	1	1	0	2;6;8
Start	0	0	1	1	1	3*
Start	0	1	1	1	1	3**
No output voltage	0	×	×	0	×	7;9;10;12
Quick Stop	0	×	0	1	×	7;10;11
Not allowed to operate	0	0	1	1	1	5
Allowed operations	0	1	1	1	1	4;16
Error Reset	Rise along	×	×	×	×	15

× means not affected by the status of this bit.

* indicates that this transition is performed in the device startup state.

** means no effect on the startup state and remains in the startup state.

3.5.2 Status word (6041H)

	Name	Object Structure	Data Type	Accessibility	Related Models	PDO Mapping	Data Range	Factory Settings
Index 6041h	Status word (Status Word)	VAR	Uint16	RO	All	TPDO	0~65535	-

Status word bit definition.

Bit(Bit)	Definition Description	Description
0	Ready to start	-
1	Start	-
2	Allowed operations	-
3	Errors, faults	-

4	Voltage output	-
5	Quick Stop	-
6	Not started	-
7	None	Reserved, undefined
8	Manufacturer customization	Reserved, undefined
9	Remote Control	0: Node invalid 1: CANopen remote control mode
10	Location Arrival	0: Not reached the target position or speed 1: Reach the target location or speed
11	Internal position overrun	0: Hardware limit is invalid 1: Set to 1 when hardware limit is valid
12~13	-	Depending on the mode of operation (see the following content description for specific definitions)
14~15	Reserved	Reserved

Note.

(1) After the control word 6040h sends the command in sequence, the drive feeds back a determined state.

(2) Status word each Bit bit read alone is meaningless, must need to be composed with other bits together to indicate the current state, the combination of bits 6 and bit0-bit3 represents the state of the device as shown in the following table for detailed definitions (× represents not affected by the status of this bit).

Bit 6 with 3:0 combination	Device Status Machine Status	Status of drive devices
××××,××××,×0××,0000	Not ready to start	The drive is powered and initialization begins; if there is a motor brake, the brake is locked; the axis is not enabled
××××,××××,×1××,0000	Cancel start	Initialization complete, parameters initialized, no fault; axis not enabled
××××,××××,×01×,0001	Ready to start	Parameter initialization complete; axis not enabled
××××,××××,×01×,0011	Start	Drive ready, waiting for enable
××××,××××,×01×,0111	Allowed operations	Enabled, no errors
××××,××××,×00×,0111	Quick stop activation	Quick Stop Start
××××,××××,×0×××,1111	Fault effect activation	Stopped error occurred, not processed; axis not enabled
××××,××××,×0×××,1000	Failure	Error handled, waiting for switch 402 state machine from Fault to Switch on disabled, axis not enabled

3) bits12~13, and bit8 are related to each operation mode (specific definitions are as follows)

Operation Mode	bit13	bit12	bit8
Protocol PP mode (PP)	Invalid	Invalid	Abnormal stop
Protocol PV mode (PV)	Invalid	Speed is 0	Invalid
HM mode (HM)	Origin finding error	Origin completion	Abnormal stop

Note: Bit 8 non-normal stop is generally valid in hardware limit or deceleration stop state.

3.5.3 Digital input and output related settings and status

The settings and status indications related to the digital IO of the EM-CAN product are described as follows.

1) Input settings

Index 2152h		Definition	Factory value	Data Type	Accessibility	Data Range
				Uint32	R/W/S	0~32768
sub-index	01	External input port IN1 function	1	Description: This parameter sets the function of the external input, as follows. 1: Origin signal 2: Positive limit 4: Negative limit 8: Quick Stop		
	02	External input port IN2 function	2			
	03	External input port IN3 function	4			
	04	External input port IN4 function	8			

Index 2153h		Definition	Factory value	Data Type	Accessibility	Data Range
				Uint32	R/W/S	50~60,000
sub-index	01	External input port IN1 filtering time	1000	Description: This parameter sets the filtering time of the external input Unit: us Note that larger number settings may result in a delay.		
	02	External input port IN2 filtering time	1000			
	03	External input port IN3 filtering time	1000			
	04	External input port IN4 filtering time	1000			

Index 2154h		Definition	Factory value	Data Type	Accessibility	Data Range
				Uint16	R/W/S	0~65535
sub-index	00	External input polarity configuration	0	Description: This parameter sets the polarity of the external input level, 0: positive logic (default low level); 1: anti-logic Bit0: corresponds to the drive's external input 1 IN1 Bit1: corresponds to the external 1 input IN2 of the drive Bit2: corresponds to the external 1 input IN3 of the drive Bit3: corresponds to input IN4 of the external 1 of the drive		

Index 60FDh	Name	Object Structure	Data Type	Accessibility	Related Models	PDO Mapping	Data Range	Factory value
	External input function status	VAR	Uint32	R	-	YES	$2^{32}-1$	-

Subindex: 00

Description: Defined by bit, it can be used to indicate the level status of the external input function, 1 means the signal is triggered, 0 means not triggered.

bit0: The current state of the negative limit

bit1: The current state of the positive limit

bit2: The current state of the origin signal

bit16: The current status of the fast stop signal (Note: the DMA882-CAN has 4 inputs to have this signal)

Bit17~bit21 corresponds to the input level of IN1~IN5 custom function

Index	Name	Object Structure	Data Type	Accessibility	Related Models	PDO Mapping	Data Range	Factory value
2155h	External input pin status	VAR	Uint16	R	-	YES	0~32768	-

Subindex: 00

Description: defined by bit, corresponding to the level status of the external input pins in turn, 1 means the signal is triggered, 0 means not triggered.

bit0: corresponds to the current state of external IN1

bit1: corresponds to the current state of external IN2

bit2: corresponds to the current state of external IN3

Bit3: corresponds to the current state of external IN4 (Note: the DMA882-CAN has 4 inputs to have this signal)

2) Input status indication

3) Output settings

Index 2005h		Definition	Factory value	Data Type	Accessibility	Data Range
				Uint16	R/W/S	0~32768
sub-index	01	External output port 1 function setting	1	Description: This parameter sets the function of the external output.		
	02	External output port 2 function setting	4	Bit0: Alarm output Bit2: In-place output Bit4: Master control output, when this state is set, the master controls the state of the output port for 60FE operation. The definition of 60FE is explained below		
Index 2008h		Definition	Factory value	Data Type	Accessibility	Data Range
				Uint16	R/W/S	0~65535
sub-index	00	External output port resistance state setting	0	Description: This parameter sets the external output configuration, 0: positive logic; 1: anti-logic Bit0: corresponds to the drive external input port 1 Bit1: corresponds to the drive external input port 2		
Index 60FEh		Definition	Factory value	Data Type	Accessibility	Data Range
				Uint32	R/W	$2^{32}-1$
sub-index	01	External output port output	0	Note: This parameter is only valid when function Bit4 of 2005+01/02 is set to 1, and is used to set the external output on. Bit16: corresponds to the external output port out1. Bit17: corresponds to the external output port out2. Other undefined bits are reserved.		
	02	External output port enable	0	Description: This parameter is only valid when function Bit4 of 2005+01/02 is set to 1, and is used to set the enable of external output. Bit16: corresponds to the external output port out1. Bit17: corresponds to the external output port out2. Other undefined bits are reserved.		

3.5.4 Rotation direction setting

Index 2051		Definition	Factory value	Data Type	Accessibility	Data Range
				Uint32	R/W	$2^{32}-1$
sub-index	00	Motor rotation direction setting	0	Description: This parameter sets the initial rotation direction of the motor 0: in the same direction as the command. 1: opposite direction to the command.		

3.5.5 Stop setting

Index 6084h		Definition	Factory value	Data Type	Accessibility	Data Range
				Uint32	R/W	$2^{32}-1$
sub-index	00	Deceleration	0	Description: This parameter is the deceleration speed in position/velocity mode When the setting is not 0, the motor decelerates and stops according to this deceleration speed when the motor is triggered to decelerate. This parameter cannot be set to 0. When set to 0, the motor cannot be decelerated to stop.		

Index 6085h		Definition	Factory value	Data Type	Accessibility	Data Range
				Uint32	R/W	$2^{32}-1$
sub-index	00	Motor emergency stop speed reduction	0	Description: This parameter sets the motor emergency stop deceleration speed When the setting is not 0, the motor decelerates and stops according to this deceleration speed when the emergency stop is triggered. When set to 0, it means the motor stops immediately.		

The motor can be stopped in several ways.

1: motor from running to non-enabled state, motor free stop (motor has no current, stops with motor inertia).

2: non-specified conditions of the trigger limit switch, the motor will be an emergency stop.

3 : Stop in different modes according to the deceleration speed of the corresponding mode, refer to the relevant settings in the relevant mode.

3.5.6 Other function settings

1) Electronic gearing / pulses per revolution

Index 2001h		Definition	Factory value	Data Type	Accessibility	Data Range
				Uint16	R/W/S	6400~51200
sub-index	00	Motor pulses per revolution Number of instructions per revolution	50000	This parameter sets the number of commands required to select one revolution of the motor. The default value is 50000.		

2) Parameter save/restore factory values

Index 1010h		Definition	Factory value	Data Type	Accessibility	Data Range
				Uint32	R/W	$0\sim2\text{-}1^{32}$
sub-index	01	Save all parameters	0	Save all parameters, as EM-CAN only supports the saving of vendor parameters, so perform the saving of this object, same function as 1010h-04, write 0x65766173		
	02	Save communication parameters	0	Invalid		
	03	Save application parameters (402 part)	0	Invalid		
	04	Save manufacturer parameters	0	Save parameters, write 0x65766173		

Index 1011h		Definition	Factory value	Data Type	Accessibility	Data Range
				Uint32	R/W	$0\sim2\text{-}1^{32}$
sub-index	01	Restore all parameters	0	Restore all parameters to factory settings, write 0x64616f6c		
	02	Save communication parameters	0	Invalid		
	03	Recovery of application parameters (part 402)	0	Invalid		
	04	Recovery of manufacturer parameters	0	Restore vendor parameters to factory settings, write 0x64616f6c		

4 Operation Modes of EM-CAN

4.1 Motor Enable Control

Example - How to enable

This section describes how to enable the motor axes controlled by the EM-CAN driver using the Control Word (6040h)/Status Word (6041h) command toggle/status judgment.

The steps are as follows.

Step 1: Write 0 (decimal) to control word 6040h, then press the bit with 0x200 whether equal to 0x200

Step 2: Write 6 (decimal) to control word 6040h, then press the bit with 30x21 whether it is equal to 0x231

Step 3: Write 7 (decimal) to control word 6040h, then press the bit with 0x233 whether it is equal to 0x233 *1)

Step 4: Write 15 (decimal) to control word 6040h, then press the bit with 0x273 whether it is equal to 0x237

The pseudo code is as follows.

```
IF (if) 6041h & (bit with) 0x23F is equal to 0x218        //judge focus on whether bit 3 is equal to 1
{
    The driver is reporting an error and error handling is required
}
ElSE                                                       // No error reported
{
    IF ENABLE is TRUE                                      //ENABLE is the enable trigger signal from the master
    {
        CASE(index)                                        //index is used to switch the enable step, default is 0
        {
            0.
                6040h write 0;
                For Index write 1;
            1:
                IF (if) 6041h & (bit with) 0x200 is equal to 0x20 0  //judge focus on whether bit 0 is equal
to 0
                    6040h write 6;
                    For Index write 2;
                ENDIF
            2:
                IF 6041h &(bit with) 0x213 is equal to 0x21 3         //judge focus on whether bit 0 is equal
to 1
                    6040h write 7;
    For Index write 3;
    ENDIF
            3:
    IF 6041h &(bit with) 0x233 is equal to 0x233           //judge focus on whether bits 0 and 1 are equal to 1
*1)
    6040h write 15(0xF);
    For Index write 4;
    ENDIF
            4:
    IF 6041h &(bit with) 0x273 is equal to 0x27 3          //judge focus on whether bits 0, 1 and 2 are equal to 1,
enable complete
                ENABLE_OK write TRUE;                      //enable completion flag output
    ENDIF
    }
    }
    ELSE                                                   //ENABLE is false, not enabled
    {
                6040h write 0;
                Write 0 to Index;                          // clear the jump amount for the next enable
                ENABLE_OK writes FALSE;
```

```
    }
}
```

Caution:

(1) In general, the motor is not enabled by default after power-up, so the motor needs to be enabled and controlled first.

(2) Before carrying out enabling control, please ensure that the current value of the drive is set reasonably and saved to avoid excessive heating of the motor or motor burnout due to excessive rated current setting, especially when matching small current motors, please pay extra attention.

This chapter mainly introduced CANopen operation mode which is supported by Leadshine.

4.2 Profile Position Mode

4.2.1 Motion Settings

☆Set the operating mode (6060H) to be Profile position mode (value is 1).

☆Set motion target position to Profile position (607AH) (unit: pulse).

☆Set maximum motion speed to Profile speed (6081H) (unit: pulse/s).

☆Set motion acceleration to Profile acceleration (6083H) (Unit: pulse/s^2).

☆Set motion deceleration to Profile deceleration (6084H) (Unit: pulse/s^2).

☆Set the control word(6040H) to the corresponding values in order to change the device control state machine and perform movement.

Remark: Control word(6040H) operation and change process under various operating mode can refer to appendix A.

4.3.2 Query Setting

▲ Can set query status word(6041H) to get motion status.

▲ Can set query position feedback to observe real-time position information of movements

▲ Can set the query speed feedback(606CH) to get the real-time speed.

4.3 Profile Velocity Mode

4.3.1 Motion Settings

☆Set the operating mode (6060H) to be Profile Velocity mode (value is 3).

☆Set motion target speed to Profile speed (60FFH) (unit: pulse/s).

☆Set motion acceleration to Profile acceleration (6083H) (Unit: pulse/s^2).

☆Set motion deceleration to Profile deceleration (6084H) (Unit: pulse/s^2).

☆Set the control word(6040H) to the corresponding values in order to change the device control state machine and perform movement.

Remark: Control word(6040H) operation and change process under various operating mode can refer to appendix A.

4.3.2 Query Settings

▲ Can set query status word(6041H) to get motion status.

▲ Can set the query speed feedback(606CH) to get the real-time speed.

4.4 Home Mode

4.4.1 Motion Settings

☆Set the operating mode (6060H) to be Profile Velocity mode (value is 6).

☆ Set the homing method(6098H).EM556-CAN is open loop drive, support partial Cia402 homing method (6098H can be set to 17-30).

☆Respectively set back to the Home with high speed [6099H(0x1)] and back to the Home with low speed [6099H(0x2)](Unit: pulse/s).

☆Set back to the Home acceleration/deceleration (609AH) (Unit: pulse/s^2).

☆Set the Home offset (607CH) (Unit: pulse).

☆Set the control word(6040H) to the corresponding values in order to change the device control state machine and perform movement.

Remark: Control word(6040H) operation and change process under various operating mode can refer to appendix A.

4.4.2 Query Settings

▲ Can set query status word(6041H) to get motion status.

Appendix　A

Control word(6040H) switchover under various operating modes:

Control word (6040H) definition under Profile position mode(operating mode 6060H is 1):

Byte	15:9	8	7	6	5	4	3	2	1	0
Definition	Null	Stop	Error reset	Absolute/relative position	Effective immediately	New set point	Enable	Quick stop	Voltage output	Start

Control word(6040H) changing process under relative position:

0x06	0x07	0x0F	0x4F	0x5F
Voltage output + Quick stop	+ Start	+ Enable	+ Relative position	+ New set point

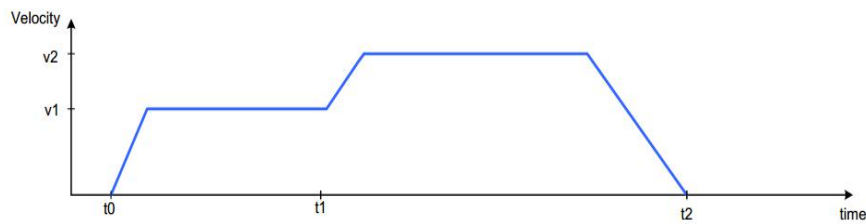Control word(6040H) changing process under absolute position:

0x06	0x07	0x0F	0x1F
Voltage output + Quick stop	+ Start	+ Enable (default absolute position)	+ New set point

　　Take relative position for example:

　　When fifth digit of control word(6040H) is zero(Single point setting), the new position of the set point is not effective immediately in the process of movement. Instead, after finish current motion, A just can starts the next movement through the new control command((6040H) fourth digit change from 0 to 1). Its motion process as diagram below:
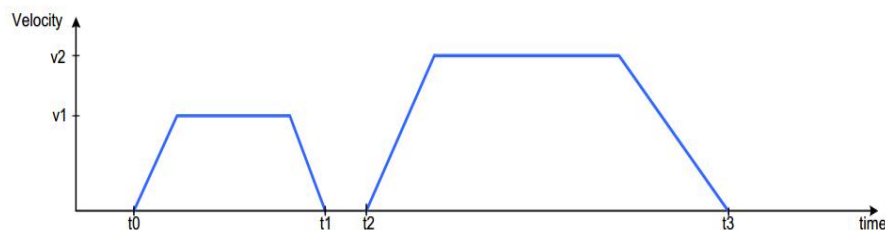
　　If after the new motion information input, the new set point effective immediately(multiple-point setting) when the fifth digit of control ward(6040H) is 1 . The new information will be superimposed on the current information, start perform motion according to new motion information. Its motion process as diagram below:

The current motion not over yet, new motion information sent to the drive, the fourth digit of control ward(6040H) change from 0 to 1 to start a multipoint motion.

Remark: PP motion of absolute position perform similar processing.

Control word(6040H) data bits' definition under Profile Velocity mode(operation mode 6060H is 3)

Bit	15:9	8	7	6:4	3	2	1	0
Definition	Null	Stop	Error reset	Null	Enable	Quick stop	Voltage output	Start

Control word(6040H) changing process under Profile Velocity mode. (Falling edge of the eighth digit execute)

0x06	0x07	0x0F	0x10F	0x00F
Voltage output + Quick stop	+ Start	+ Enable	+ Stop	execute

Control word(6040H) data bits' definition under Home mode(operation mode 6060H is 6):

Digit	15:9	8	7	6:5	4	3	2	1	0
Definition	Null	Stop	Error reset	Null	Home point movement began	Enable	Quick stop	Voltage output	Start

Control word(6040H) changing process under Home point mode:

0x06	0x07	0x0F	0x1F	0x0F
Voltage output + Quick stop	+ Start	+ Enable	+ Home point movement began	suspend

Remark: Security concerns, after power on, the first time to start the Home movement need to perform twice control word switchover from (6040H)0x0F to 0x1F.

In the process of movement, control word(6040H) write into 0x02 will perform emergency stop operation.

When drive(slave station) in the status of fault, can transmit error reset control word(6040H) to convert to cancel the startup states:

0x80
Cancel start

Appendix   B

PDO Transmission type definition table

transmission code	PDO transmission mode				
	cyclic	acyclic	synchronous	asynchronous	remote frame
0		√	√		
1-240	√		√		
241-251	reserved				
252			√		√
253				√	√
254				√	
255				√	

Transmission code 1-240 represent synchronization information quantity between 2 PDO transmission.

Transmission code 252 represent update the data immediately after receive SYNC information.

Transmission code 253 represent update the data immediately after receive RTR information.

Transmission code 254 unsupported.

Transmission code 255 represent asynchronous transmission.

Appendix C

Emergency error code table

Emergency error code	Code function description
0000H	No Error
8110H	CAN overflow
8120H	Error passive mode
8130H	Lifetime protect/heartbeat errors
8140H	Forced offline to recover fault
8141H	Forced offline
8150H	Transmit COB-ID conflict
8210H	PDO length error undisposed
8220H	PDO over length

Appendix   D

SDO suspend transmit code table

Suspend code	Code function description
0503 0000H	Trigger byte does not alternating change
0504 0000H	SDO Profile timeout
0504 0001H	Illegal/unknown command word
0504 0002H	Invalid block size (only block transmission mode)
0504 0003H	Invalid serial number (only block transmission mode)
0504 0004H	CRC error (only block transmission mode)
0504 0005H	memory overflow
0601 0000H	Object does not support access
0601 0001H	Try to read write-only object
0601 0002H	Try to write a read-only object
0602 0000H	Object not exist
0604 0041H	Object cannot map to PDO
0604 0042H	Number and length of mapped object beyond PDO length
0604 0043H	General parameters incompatible
0604 0047H	General device internal incompatible
0606 0000H	Hardware error lead to object access failure
0606 0010H	Data type mismatch, service parameters length mismatch
0606 0012H	Data type mismatch, service parameters length is too long
0606 0013H	Data type mismatch, service parameters length is too short
0609 0011H	Sub-index does not exist
0609 0030H	Beyond the value range of the parameter (During write access)
0609 0031H	Write in parameter value is too big
0609 0032H	Write in parameter value is too small
0609 0036H	The maximum value is less than the minimum value
0800 0000H	General Error
0800 0020H	Data can not transmit or saved to the application
0800 0021H	Data can not transmitted or saved to the application due to the local control
0800 0022H	Data can not transmitted or saved to the application due to current device status
0800 0023H	Object dictionary dynamic errors or object dictionary does not exist (For example, generate the object dictionary by files, but the file damage caused the error)