

EtherCAT Optional Interface Card OPC-ETC2

Product Specifications

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1. Overview

OPC-ETC2 enables the seamless transfer of information between FRENIC-Ace inverters and Ethernet-based fieldbus network EtherCAT with minimal configuration requirements. The interface is mounted directly on the inverter and has two RJ-45 jacks with 10BASE-T / 100BASE-TX Ethernet switches for connecting to an Ethernet network.

This specification describes the OPC-ETC2 EtherCAT specification. In particular, the specifications related to CiA 301 and CiA 402 are described.

2. Applicable inverter

Table 2.1 Applicable Inverter

Series	Type	Capacity	ROM version
FRENIC-Ace	FRN□□□E2□-2□□ FRN□□□E2□-4□□ FRN□□□E2□-7□□	All	0300 or later

* □ stands for alphabets or numbers indicating the inverter capacity, protective structure, destination, etc.

3. Operating environment

Table 3.1 Operating environment

Item	Description
Operating environment	Refer to user's or instruction manual for FRENIC-Ace
Operating temperature	Refer to user's or instruction manual for FRENIC-Ace
Storage temperature	Refer to user's or instruction manual for FRENIC-Ace
Humidity	20 ~ 90%RH (No condensation)
Vibration	Refer to user's or instruction manual for FRENIC-Ace
Cooling method	Self-cooling

4. Installing OPC- ETC2

OPC- ETC2 is installed in FRENIC-Ace using an option adapter (OPC-E2-ADP1 / 2/3) as shown in Figure 4.1.

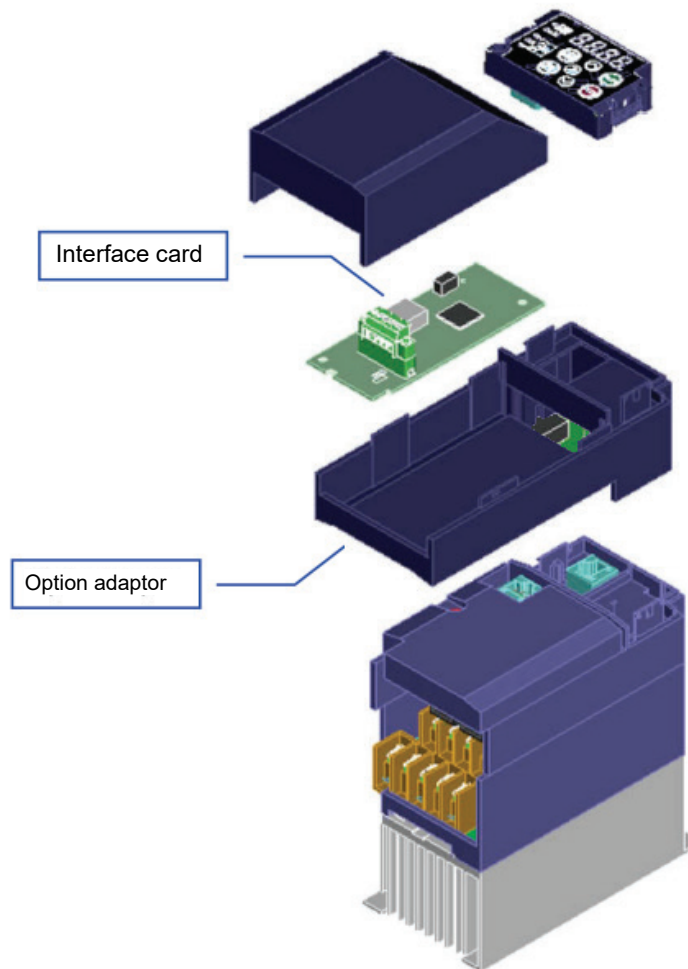


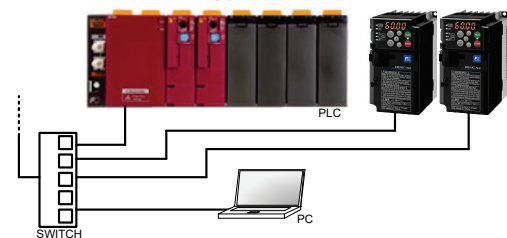
Figure 4.1 OPC- ETC2 installation

5. Ethernet hardware specifications

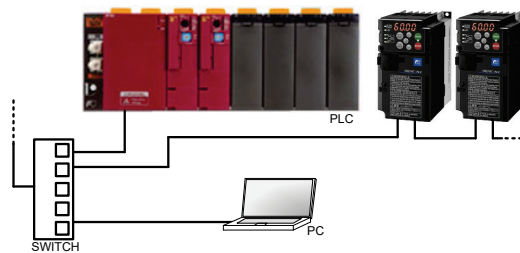
Table 5.1 Ethernet hardware specifications

Item	Description
Number of ports	2(Internal switch)
Standard	IEEE 802.3 10BASE-T/100BASE-TX Ethernet compliant
Communication speed and Duplex	100Mbps full duplex (Auto sense optimal speed and duplex)
Connector type	RJ-45 with shield
Auto MDI-X	Available (Supports all straight-through and cross-over cable.)
Cable type	CAT5 8-conductor UTP Patch cables
Cable length	Maximum100m /segment
Topology	Star/Tree, Linear/Bus/daisy chain, Ring(MRP) Refer to Figure 5.1.

Star/Tree topology



Linier/Bus/Daisy-chain topology



Ring topology

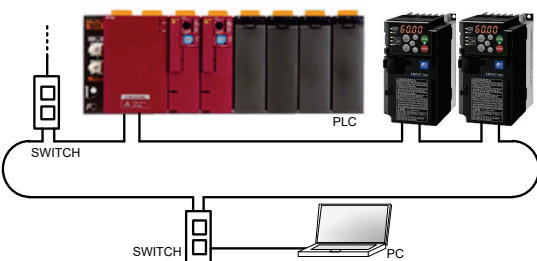


Figure 5.1 Example of Topology

6. LED indicators of EtherCAT

This interface card has the following four display LEDs.

Link/Activity indicator LED (L/A OUT)
RUN indicator LED (RUN)
Link/Activity indicator LED (L/A IN)
ERROR indicator LED (ERR)



Figure 6.1 LED indicators

6.1. RUN indicator LED (RUN)

Table 6.1 RUN indicator LED (RUN) states

LED (Green) indicator states	Slave state	Description
Off	INITIALIZATION	The device is in state INITIALISATION, or Power OFF.
Blinking	PRE-OPERATIONAL	The device is in state PRE-OPERATIONAL.
Single Flash	SAFE-OPERATIONAL	The device is in state SAFE-OPERATIONAL.
On	OPERATIONAL	The device is in state OPERATIONAL.
Flickering	INITIALISATION or BOOTSTRAP	Entered the INIT state or the device is in state BOOTSTRAP. Firmware download operation in progress

6.2. ERROR indicator LED (ERR)

Table 6.2 ERROR indicator LED (ERR) states

LED (RED) indicator states	Slave state	Description
Off	No error or power supply for the option card is off.	Inverter power supply is OFF or the EtherCAT communication is in working condition.
Flickering	Booting Error	Booting Error was detected. INIT state reached, but Error Indicator bit is set to 1 in AL Status register or Check sum error in Application controller flash memory.
On	Application controller failure	A critical communication or application controller error has occurred.
Double Flash	Process Data Watchdog Time out/EtherCAT Watchdog Timeout	An application watchdog timeout has occurred.
Single Flash	Local Error	Slave device application has changed the EtherCAT state autonomously due to local error. Error bit is set to 1 in AL status register.
Blinking	Invalid Configuration	General Configuration Error

6.3. Link/Activity indicator LED

Table 6.3 Link/Activity indicator LED States

LED (Green) indicator states	Condition	Description
On	Port open	Link is established: Communication is possible on this port.
Off	Port closed	Link is not established: Communication is impossible on this port.
Flickering	Port open	Packets are being sent or received on this port.

7. ID Selector

The master can read the settings (000h to FFFh) of the three rotary switches shown in Figure 7.1 from ESC register 0012h (Configured Station Alias) or 0134h (AL status) and can be used for device identification.

The values read from ESC register 0012h are as shown in Table 7.1, depending on the rotary switch setting. Refer to ETG.1020 18.4.1 Requesting ID for how to read from ESC register 0134h.

Table 7.1 Readout value of ESC register 0012h

How to set	Function	Factory default	Setting range	Description
3-rotary switch	Configured station alias	000h	000h to FFFh	000h: Readout value from EEPROM (Configured Station Alias in SII) 001h to FFFh: Readout setting value of the rotary switch

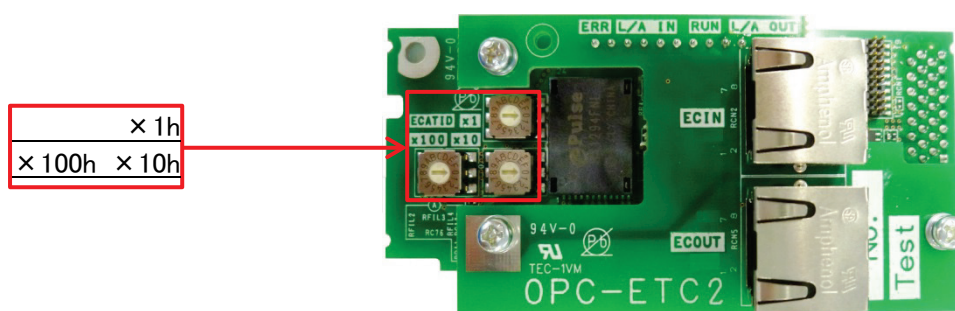


Figure 7.1 ID Selector rotary switch

8. Related function code

Table 8.1 and

Table 8.2 show a list of inverter function codes related to EtherCAT communication. Details of function codes o27 and o28 are shown in Table 8.3.

Table 8.1 Related function code

Func. code	Func. code name	Related object			Factory default	Setting range	Description
		Index	Sub-index	Object name			
F03 /A01	Max. Frequency 1/2	-	-	-	60.0Hz	25.0 to 500.0Hz	Sets max. frequency 1/2.
F15	Frequency limiter (Upper)	6046h	02h	v/ velocity max amount	70.0Hz	0.0 to 500.0Hz	$F15 = (6046\ 02h) * (604D\ 00h) / 120 * v/$ dimension factor
F16	Frequency (Lower)	6046h	01h	v/ velocity min amount	0.0Hz	0.0 to 500.0Hz	$F16 = (6046\ 01h) * (604D\ 00h) / 120 * v/$ dimension factor
S08 (F07)	Acc. Time 1	6048h	01h	v/ velocity acceleration (Delta speed)	6.00s or 20.0s (Depends on inverter capacity)	0.00 to 6000s	$S08(F07) = (F03\ or\ A01) / f * (6048\ 02h)$ Where $f = (6048\ 01h) * (604D\ 00h) / 120 * v/$ dimension factor Note: Use F03 if Motor 1 selected and A01 if Motor 2 selected
			02h	v/ velocity acceleration (Delta time)			
S09 (F08)	Dec. time 1	6049h	01h	v/ velocity deceleration (Delta speed)	6.00s or 20.0s (Depends on inverter capacity)	0.00 to 6000s	$S09(F08) = (F03\ or\ A01) / f * (6049\ 02h)$ Where $f = (6049\ 01h) * (604D\ 00h) / 120 * v/$ dimension factor Note: Use F03 if Motor 1 selected and A01 if Motor 2 selected.
			02h	v/ velocity deceleration (Delta time)			
P01 /A15	Motor 1/2 (Pole number)	604Dh	00h	v/ pole number	4	2 to 22	Object 604D 00h is stored in P01 or A15 depending on motor selection. Note: Use P01 if Motor 1 selected and A15 if Motor 2 selected.
H56	Dec. time for forced stop	604Ah	01h	v/ velocity quick stop (Delta speed)	6.00s or 20.0s (Depends on inverter capacity)	0.00 to 6000s	$H56 = (F03\ or\ A01) / f * (604A\ 02h)$ Where $f = (604A\ 01h) * (604D\ 00h) / 120 * v/$ dimension factor Note: Use F03 if Motor 1 selected and A01 if Motor 2 selected.
			02h	v/ velocity quick stop (Delta speed)			

Table 8.1 Related function code (Continued)

Func. code	Func. code name	Related object			Factory default	Setting range	Description
		Index	Sub-index	Object name			
S19	Speed command	6042h	00h	v/ target velocity	0	-32,768 to 32,767	S19= (6042 00h) * v/ set-point factor * v/ dimension factor
o27	Response error (Operation mode selection)	-	-	EtherCAT fault Mode	0	0 to 15	Refer to Table 8.3.
o28	Response error (Timer)	-	-	EtherCAT fault timer	0.0s	0.0 to 60.0s	Refer to Table 8.3.

Table 8.2 Other related function codes

Func. code	Func. code name	Index Sub index	Related object name	Factory Default	Setting range	Description
o40	Write function code assignment 1	5E00 01h	Write code 01	0	0 to FFFFh	Sets object assigned to RxPDO 3 [Group number (Refer to Table 8.4)]*100h +[Lower 2 digits of function code] Ex.) Function code E01⇒ 0501h
o41	Write function code assignment 2	5E00 02h	Write code 02	0	0 to FFFFh	
o42	Write function code assignment 3	5E00 03h	Write code 03	0	0 to FFFFh	
o43	Write function code assignment 4	5E00 04h	Write code 04	0	0 to FFFFh	
o48	Readout function code assignment 1	5E01 01h	Read code 01	0	0 to FFFFh	Sets object assigned to TxPDO 3 [Group number (Refer to Table 8.4)]*100h +[Lower 2 digits of function code] Ex.) Function code E01⇒ 0501h
o49	Readout function code assignment 2	5E01 02h	Read code 02	0	0 to FFFFh	
o50	Readout function code assignment 3	5E01 03h	Read code 03	0	0 to FFFFh	
o51	Readout function code assignment 4	5E01 04h	Read code 04	0	0 to FFFFh	
y98	Bus link function (Mode selection)	-	-	0	0 to 3	Freq. setting/Operation cmd. selection Freq. setting Ope. Cmd. 0: Inverter Inverter 1: OPC-ETC2 Inverter 2: Inverter OPC-ETC2 3: OPC-ETC2 OPC-ETC2

Table 8.3 Details of function code o27 and o28

Func. code setting		Inverter Reactions to EtherCAT Network Breaks	H81 assign
o27	o28		
0, 4 to 9	Invalid	Immediately coast to a stop and trip with E_rS .	Immediately $\angle -F_L$ (no trip)
1	0.0 to 60.0 s	After the time specified by o28, coast to a stop and trip with E_rS .	After the time specified by o28. $\angle -F_L$ (no trip)
2	0.0 to 60.0 s	If the inverter receives any data within the time specified by o28, ignore the communications error. After the timeout, coast to a stop and trip with E_rS .	Same as above
3,13 to 15	Invalid	Keep the current operation, ignoring the communications error (no E_rS trip).	No stop, no trip and no $\angle -F_L$
10	Invalid	Immediately decelerate to a stop. (*) Issue E_rS after stopping.	Immediately $\angle -F_L$ (no stop)
11	0.0 to 60.0 s	After the time specified by o28, decelerate to a stop. Issue E_rS after stopping. (*)	After the time specified by o28. $\angle -F_L$ (no stop)
12	0.0 to 60.0 s	If the inverter receives any data within the time specified by o28, ignore the communications error. After the timeout, decelerate to a stop and trip with E_rS . (*)	Same as above

* Specify the deceleration time by the inverter function code F08.

Table 8.4 Function code type vs. Group code conversion table

Function code type	Group code hex (dec)		Group code name	Function code type	Group code hex (dec)		Group code name
S	2	02h	Command·Func. data	W2	24	18h	Monitor 4
M	3	03h	Monitor 1	W3	25	19h	Monitor 5
F	4	04h	Basic function	X1	26	1Ah	Alarm3
E	5	05h	Terminal functions	X2	27	1Bh	Reserved
C	6	06h	Control function	Z1	28	1Ch	Reserved
P	7	07h	Motor 1 parameter	K	29	1Dh	Keypad function
H	8	08h	High level function	T	30	1Eh	Timer function
A	9	09h	Motor 2 parameters	E1	31	1Fh	Reserved
o	10	0Ah	Option functions	H1	32	20h	High level function 1
U	13	0Dh	Customizable logic	o1	33	21h	Option functions 1
J	14	0Eh	Application function 1	U1	34	22h	Customizable logic
y	15	0Fh	Link function	M1	35	23h	Reserved
W	16	10h	Monitor 2	J1	36	24h	PID control 1
X	17	11h	Alarm 1	J2	37	25h	PID control 2
Z	18	12h	Alarm 2	J4	39	27h	Reserved
b	19	13h	Motor control parameter 3	J5	40	28h	External PID control 1
r	12	0Ch	Motor control parameter 4	J6	41	29h	External PID control 2,3
d	20	14h	Application function 2	d1	42	2Ah	Reserved
W1	23	17h	Monitor 3	L	11	0Bh	Special application func.

9. CoE Communications (CAN® application protocol over EtherCAT)

9.1. Supported services

This interface card is an EtherCAT slave and supports the following CAN® application protocol over EtherCAT (CoE) services shown in Table 9.1.

Table 9.1 Supported services on CoE

Item	Service	Remark
PDO	- Two of RxPDO and two of TxPDO are available. - RxPDO1 and TxPDO1 are variable mapping.	
SDO	- Expedited and Segmented protocol are supported	Block protocol is not supported.

9.2. EtherCAT communication states

This card makes the following state transitions as an EtherCAT slave. All state transitions are performed in response to requests from the master.

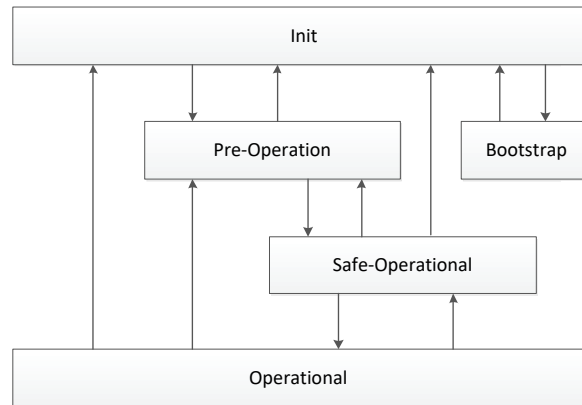


Figure 9.1 Communication state transitions

Table 9.2 Description of each communication state

Item	State	EtherCAT communication
Init	Initializing after power on	State under EtherCAT setting by the master After finishing the setting, transit to Pre-operational. ErrS never occurs as communication breaks cannot be detected by the slave.
Pre-Operational	State before Operational	SDO is possible and PDO is not possible. PDO mappings are configured using SODs. ErrS never occurs as communication breaks cannot be detected by the slave. But ErrS may be detected if the slave is connected one-to-one with the master or is connected next to the master
Safe-Operational	データ不確定状態	EtherCAT communications are possible using SDO、PDO but inverter outputs are fixed to safe state. ErrS may occur as the slave can detect communication breaks.
Operational	State of operational	EtherCAT communications are possible using SDO、PDO but inverter outputs follows the command from the master. ErrS may occur as the slave can detect communication breaks.
Bootstrap	Updating the firmware	EtherCAT communications don't work. ErrS never occurs as communication breaks cannot be detected by the slave.

When transiting from Operational to Pre-Operational, PDO communication stops, but PDO data is stored, so when returning to Operational, PDO communication is performed using the stored PDO data.

9.3. CiA 402 DRIVE and MOTION CONTROL DEVICE PROFILE

Velocity mode of CiA 402 drive and motion control device profile is supported, and Figure 9.2 shows the supported objects.

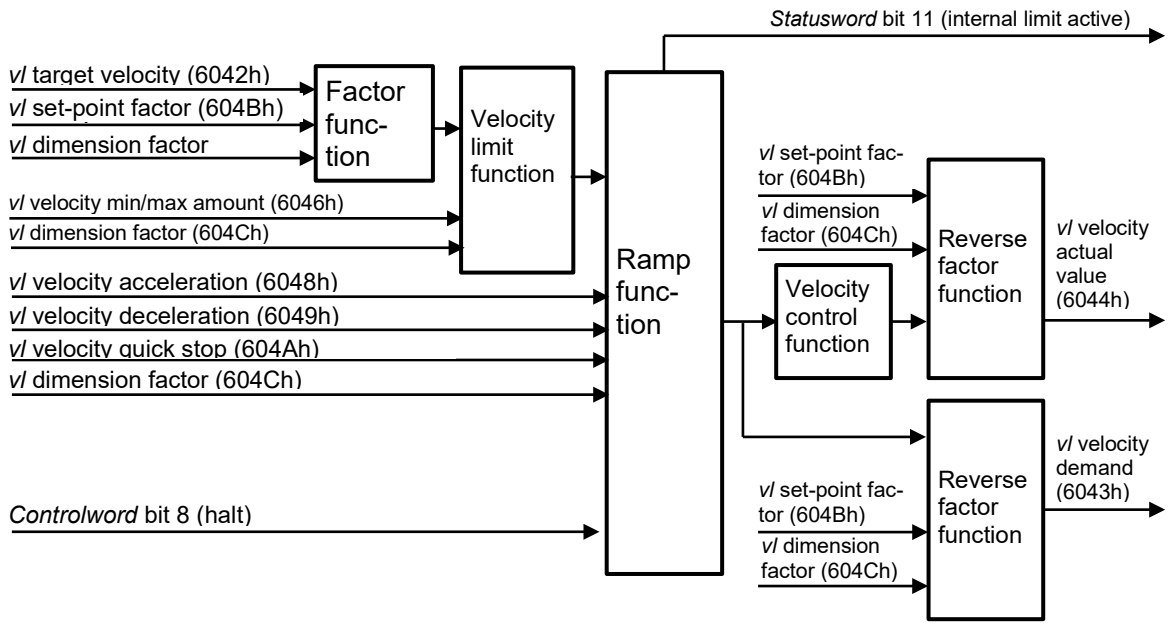


Figure 9.2 Supported objects in Velocity mode

9.4. PDO (Process Data Object)

The PDO protocol is used to constantly exchange processing data (e.g. Drive-Control or Speed-Monitor) between the inverter and the EtherCAT master. This product supports the following PDO. Remapping is possible for RPDO 1 and TPDO 1.

(1) RxPDO (Master -> Slave)

Table 9.3 shows the RxPDO mapping at factory default.

Table 9.3 RxPDO mapping parameters

PDO No.	PDO mapping		Factory default	Description	Access	Data Type	PDO mapping	Remapping
	Index	Sub Index						
1	1600h	00h	02h	Highest sub-index supported Setting range: 01h to 20h	RW	USS8	N/A	AV
		01h	60400010h (Control word)	Drive control (Controls CiA402 state machine)	RW	UNS32		
		02h	60420010h (v target velocity)	Speed command (r/min)	RW	UNS32		
		03h	Assigned object 3 (Optional)	Not assigned at factory default	RW	UNS32		
		~	~					
		20h	Assigned object 32 (Optional)		RW	UNS32		
3	1602h	00h	04h	Highest sub-index supported (Fixed)	R	USS8	N/A	N/A
		01h	5E02 01 10h (Write parameter assigned by o40)	Specifies writing data to the function codes assigned by o40 to o43 or index 5E00h	R	UNS32		
		02h	5E02 02 10h ((Write parameter assigned by o41)		R	UNS32		
		03h	5E02 03 10h ((Write parameter assigned by o42)		R	UNS32		
		04h	5E02 04 10h ((Write parameter assigned by o43)		R	UNS32		

(2) TxPDOs (Slave -> Master)

Table 9.3 shows the RxPDO mapping at factory default

Table 9.4 TxPDO mapping parameters

PDO No.	PDO mapping		Factory default	Description	Access	Data Type	PDO mapping	Remapping
	Index	Sub Index						
1	1A00h	00h	02h	Highest sub-index supported Setting range: 01h to 20h	RW	UNS8	N/A	AV
		01h	60410010h (Status word)	Monitors status of CiA 402 state machine	RW	UNS32		
		02h	6044 0010h (v/ velocity actual value)	Speed monitor	RW	UNS32		
		03h	Assigned object 3 (Optional)	Not assigned at factory default	RW	UNS32		
		~	~					
		20h	Assigned object 32 (Optional)		RW	UNS32		
3	1A02h	00h	04h	Highest sub-index supported(Fixed)	R	UNS8	N/A	N/A
		01h	5E03 01 10h (Read out parameter assigned by o48)	Reads out data assigned by o48~o51 or Index 5E01h	R	UNS32		
		02h	5E03 02 10h (Read out parameter assigned by o49)		R	UNS32		
		03h	5E03 03 10h (Read out parameter assigned by o50)		R	UNS32		
		04h	5E03 04 10h (Read out parameter assigned by o51)		R	UNS32		

9.5. SDO (Service Data Object)

SDO protocol is used as a setting and adjustment. SDO is not suitable for real-time performance, but can access all the parameters described in section 9.6. If the access by SDO is wrong, the error codes listed in Table 9.5 are returned.

Table 9.5 SDO error code at access error

Abort code	Description
0503 0000h	Error in segmented transfer: Toggle bit not toggled.
0504 0000h	SDO timed out.
0601 0001h	Read request on write-only parameter.
0601 0002h	Write request on read-only parameter.
0602 0000h	Object does not exist.
0604 0041h	Object cannot be mapped to the PDO.
0604 0042h	The number and length of the objects to be mapped would exceed PDO length.
0606 0000h	Access failed due to a H/W error.
0607 0010h	Data type unmatched.
0607 0012h	Data type does not match; length of service parameter too high.
0607 0013h	Data type does not match; length of service parameter too low.
0609 0011h	Sub-Index does not exist.
0609 0030h	Attempted to write a value out of range.
0609 0031h	Value of parameter written too high.
0609 0032h	Value of parameter written too low.
0800 0000h	General error
0800 0021h	Error in writing into an inverter's function code (attempted to write into S01, S05, or S06 via EtherCAT network when the RS-485 communications link of the inverter exists).
0800 0022h	Not allowed to write into an inverter's function code (when the inverter is running or writing, or when any digital input terminal is ON).

9.6. OBJECT DESCRIPTIONS

The objects supported by this product are shown below. All objects can be accessed via the SDO protocol. For objects other than those described in this specification, refer to Object Dictionary SRD11795.

(1) CiA 402 STANDARD OBJECTS

CiA 402 Standard objects are shown in Table 9.6.

Table 9.6 CiA 402 Standard objects

Index	Sub index	Object name	Description	Access	Data type	PDO mapping
6007h	00h	Communication abort behavior	Selects behavior at EtherCAT communication error	RW	INT16	N/A
603Fh	00h	Error code	Latest alarm code	R	UNS16	AV
6040h	00h	Controlword	Controls drive (CiA402 state machine)	RW	UNS16	AV
6041h	00h	Statusword	Monitors status of CiA402 state machine	R	UNS16	AV
6042h	00h	v/ target velocity	Speed command (r/min)	RW	INT16	AV
6043h	00h	v/ velocity demand	Speed monitor (r/min)	R	INT16	AV
6044h	00h	v/ velocity actual value	Ditto	R	INT16	
6046h	00h	v/ velocity min/max amount	Upper or lower limiter for output speed	R	UNS8	N/A
	01h	v/ velocity min amount	Lowest speed output (r/min)	RW	UNS32	AV
	02h	v/ velocity max amount	Highest speed output (r/min)	RW	UNS32	AV
6048h	00h	v/ velocity acceleration	Specifies the slope of the acceleration ramp	R	UNS8	N/A
	01h	Delta speed		RW	UNS32	AV
	02h	Delta time		RW	UNS16	AV
6049h	00h	v/ velocity deceleration	Specifies the slope of the deceleration ramp	R	UNS8	N/A
	01h	Delta speed		RW	UNS32	AV
	02h	Delta time		RW	UNS16	AV
604Ah	00h	v/ velocity quick stop	Specifies the slope of the deceleration ramp for quick stop	R	UNS8	N/A
	01h	Delta speed		RW	UNS32	AV
	02h	Delta time		RW	UNS16	AV
604Bh	00h	v/ set-point factor	Modifies the resolution or setting range of the specified set-point	R	UNS8	N/A
	01h	Numerator		RW	INT16	AV
	02h	Denominator		RW	INT16	AV
604Ch	00h	V/ dimension factor	Includes gear ratio in calculations or scale to frequency or user specific unit	R	UNS8	N/A
	01h	Numerator		RW	INT32	AV
	02h	Denominator		RW	INT32	AV
604Dh	00h	v/ pole number	Specifies pole number of the motor	RW	UNS8	AV
6060h	00h	Modes of Operation	Selects the mode of CiA402 Fixed to 2 and only "Velocity mode" is possible	RW	INT8	AV
6061h	00h	Modes of Operation display	Monitors the selection of the mode Fixed to 2 and shows "Velocity mode"	R	INT8	AV
6077h	00h	Torque actual value	Monitors the torque of the motor 1/1000th of rated torque	R	INT16	AV
6078h	00h	Current actual value	Monitors the current of the motor 1/1000th of the inverter rated current	R	INT16	AV
6502h	00h	Supported drive modes	Monitors the selection of the mode Fixed to 2 and shows "Velocity mode"	R	UNS32	AV

(2) CiA 402 Manufacture specific objects
Table 9.7 shows CiA402 manufacture specific objects.

Table 9.7 CiA 402 Manufacture specific objects

Index	Sub index	Object name	Description	Access	Data type	PDO mapping
5E00h	-	Assign function code written by RxPDO No.3 *1			-	N/A
	00h	Highest sub-index supported	Fixed to 04h	R	UNS8	
	01h	Function code 1	Assigns function code 1 written by RxPDO No.3 Default: Setting value of o40	RW	UNS16	
	02h	Function code 2	Assigns function code 2 written by RxPDO No.3 Default: Setting value of o41	RW		
	03h	Function code 3	Assigns function code 3 written by RxPDO No.3 Default: Setting value of o42	RW		
	04h	Function code 4	Assigns function code 4 written by RxPDO No.3 Default: Setting value of o43	RW		
5E01h	-	Assign function code read out by TxPDO No.3 *1			-	N/A
	00h	Highest sub-index supported	Fixed to 04h	R	UNS8	
	01h	Function code 1	Assigns function code 1 written by TxPDO No.3 Default: Setting value of o48	RW	UNS16	
	02h	Function code 2	Assigns function code 2 written by TxPDO No.3 Default: Setting value of o49	RW		
	03h	Function code 3	Assigns function code 3 written by TxPDO No.3 Default: Setting value of o50	RW		
	04h	Function code 4	Assigns function code 4 written by TxPDO No.3 Default: Setting value of o51	RW		

Table 9.7 CiA 402 (Continued)

Index	Sub index	Object name	Description	Access	Data type	PDO mapping
5E02h	-	Written data by RxPDO No.3			-	-
	00h	Highest sub-index supported	Fixed to 04h	R	UNS8	N/A
	01h	Written data 1	Written data to the function code specified by 5E00 01h	RW	UNS16	AV
	02h	Written data 2	Written data to the function code specified by 5E00 02h	RW	UNS16	
	03h	Written data 3	Written data to the function code specified by 5E00 03h	RW	UNS16	
	04h	Written data 4	Written data to the function code specified by 5E00 04h	RW	UNS16	
5E03h	-	Read out data by TPDO No.3			-	-
	00h	Highest sub-index supported	Fixed to 04h	R	UNS8	N/A
	01h	Read out data 1	Read out data from the function code specified by 5E01 01h	R	UNS16	AV
	02h	Read out data 2	Read out data from the function code specified by 5E01 02h	R	UNS16	
	03h	Read out data 3	Read out data from the function code specified by 5E01 03h	R	UNS16	
	04h	Read out data 4	Read out data from the function code specified by 5E01 04h	R	UNS16	
5F02h to 5FFFh	00h, 01h to 64h	FRENIC' s function code	Specifies the inverter function code to be accessed [How to specify the function code] Index = 5F□□, Sub-index= xx □□ : Group code(Refer to Table 8.4) xx : Number + 1 e.g. E01-> Index 5F05, Sub 02	R RW	UNS16	AV

*1: The index 5E00h and 5E01h settings return to the values of function codes o40 to o43 and o48 to o51 when the inverter power is off then on.

(3) Communication area objects

Table 9.8 shows the supported objects in the communication area.

Table 9.8 Supported object in the communication area

Index	Sub index	Object name	Description	Access	Data Type	PDO mapping
1000h	00h	Device type	Fixed to 00410192h	R	UNS32	N/A
1001h	00h	Error register	00h : No error 01h : Error	R	UNS8	N/A
1003h	-	Pre-defined error field		-	-	N/A
	00h	Error number		RW	UNS8	
	01h-04h	Standard error field	Refer to Table 9.12 for the error codes	R	UNS32	
1008h	00h	Manufacturer device name	OPC- ETC2(ASCII)	R	VISIBLE STRING	N/A
1009h	00h	Manufacturer software version	Monitors Manufacturer's software version	R	VISIBLE STRING	N/A
100Ah	00h	Manufacturer's software version	Monitors Manufacturer's software version	R	VISIBLE STRING	N/A
1010h	-	Store parameters		-	-	N/A
	00h	highest sub-index supported	Highest sub-index supported	R	UNS8	
	01h	Refers to all parameters	Stores all parameters (Manufacture's specific parameters)	RW	UNS32	
	02h	Refers to communication parameters	Stores communication parameters (Manufacture's specific communication parameters of Index 1000h to 1A02h)	RW	UNS32	
	03h	Refers to the application parameters	Stores the application parameters (Manufacture's specific application parameters of Index 6000h to 6502h)	RW	UNS32	
1011h	-	Restore default parameter		-	-	N/A
	00h	highest sub-index supported	Highest sub-index supported	R	UNS8	
	01h	Refers to all parameters	Restores all parameters (Manufacture's specific parameters)	RW	UNS32	
	02h	Refers to communication parameters	Restores communication parameters (Manufacture's specific communication parameters of Index 1000h to 1A02h)	RW	UNS32	
	03h	Refers to the application parameters	Restores the application parameters (Manufacture's specific application parameters of Index 6000h to 6502h)	RW	UNS32	
1018h	-	Identity object	Provides general identification information for the device.	-	-	N/A
	00h	highest sub-index supported	04h fixed	R	UNS8	
	01h	Vendor-ID	0000025Eh (Fuji)	R	UNS32	
	02h	Product code	00000003h	R	UNS32	
	03h	Revision number	00000000h	R	UNS32	
	04h	Serial number	00000000h	R	UNS32	

Table 9.8 Supported object in the communication area (Continued)

Index	Sub-index	Object name	Description	Access	Data Type	PDO mapping
1600h 1602h	-	RxPDO mapping parameter	Refer to section 9.4. for details.	R,RW	-	N/A
	00h	number of mapped application objects in PDO			UNS8	
	01h to N	1st application object to Nth application object			UNS32	
1A00h 1A02h	-	TxPDO mapping parameter	Refer to section 9.4. for details	R,RW	-	N/A
	00h	number of mapped application objects in PDO			UNS8	
	01h to N	1st application object to Nth application object			UNS32	
1C00h	-	Sync Manager Communication Type	Refer to ETG.1020. *1	R	-	N/A
	00h	Number of used Sync Manager channels			UNS8	
	01h	Communication Type Sync Manager 0			UNS8	
	02h	Communication Type Sync Manager 1			UNS8	
	03h	Communication Type Sync Manager 2			UNS8	
	04h	Communication Type Sync Manager 3			UNS8	
1C12h	-	Sync Manager PDO Assignment2	Refer to ETG.1000.6 *1	RW	-	N/A
	00h	Number of assigned TxPDOs			UNS8	
	01h	PDO Mapping object index of assigned PDO			UNS16	
	02h				UNS16	
1C13h	-	Sync Manager PDO Assignment 3	Refer to ETG.1000.6 *1	RW	-	N/A
	00h	Number of assigned TxPDOs			UNS8	
	01h	PDO Mapping object index of assigned PDO			UNS16	
	02h				UNS16	
1C32h	-	Output Sync Manager Parameter	Refer to ETG.1020 *1	-	-	N/A
	00h	Number of Synchronization Parameters		R	UNS8	
	01h	Synchronization Type		RW	UNS16	
	02h	Cycle Time		R	UNS32	
	03h	Shift Time		R	UNS32	
	04h	Synchronization Types supported		R	UNS16	
	05h	Minimum Cycle Time		R	UNS32	
	06h	Calc and Copy Time		R	UNS32	
	08h	Get Cycle Time		RW	UNS16	
	09h	Delay Time		R	UNS32	
	0Ah	Sync0 Cycle Time		RW	UNS32	
	0Bh	SM-Event Missed		R	UNS16	
	0Ch	Cycle Time Too Small		R	UNS16	
	0Dh	Shift Time Too Short		R	UNS16	
	0Eh	RxPDO Toggle Failed		R	UNS16	
	20h	Sync Error		R	BOOL	

Table 9.8 Supported object in the communication area(続)

Index	Sub-index	Object name	Description	Access	Data Type	PDO mapping
1C33h	-	Input Sync Manager Parameter	Refer to ETG.1020. *1	-	-	N/A
	00h	Number of Synchronization Parameters		R	UNS8	
	01h	Synchronization Type		RW	UNS16	
	02h	Cycle Time		R	UNS32	
	03h	Shift Time		R	UNS32	
	04h	Synchronization Types supported		R	UNS16	
	05h	Minimum Cycle Time		R	UNS32	
	06h	Calc and Copy Time		R	UNS32	
	08h	Get Cycle Time		RW	UNS16	
	09h	Delay Time		R	UNS32	
	0Ah	Sync0 Cycle Time		RW	UNS32	
	0Bh	SM-Event Missed		R	UNS16	
	0Ch	Cycle Time Too Small		R	UNS16	
	0Dh	Shift Time Too Short		R	UNS16	
	0Eh	RxPDO Toggle Failed		R	UNS16	
	20h	Sync Error		R	BOOL	

*1 The master and OPC-ETC2 are synchronized, but the OPC-ETC2 and the inverter are asynchronous.

9.7. Driving with CANopen Drive Profile (CiA 402)

(1) CiA 402 State machine

Figure 9.3 shows the state machine, operating the state machine (the state transition flow) stipulated in the CiA 402 to drive the inverter. Controlword (CTW in the figure) causes the state transition of the state machine, and Statusword (STW in the figure) monitors the state.

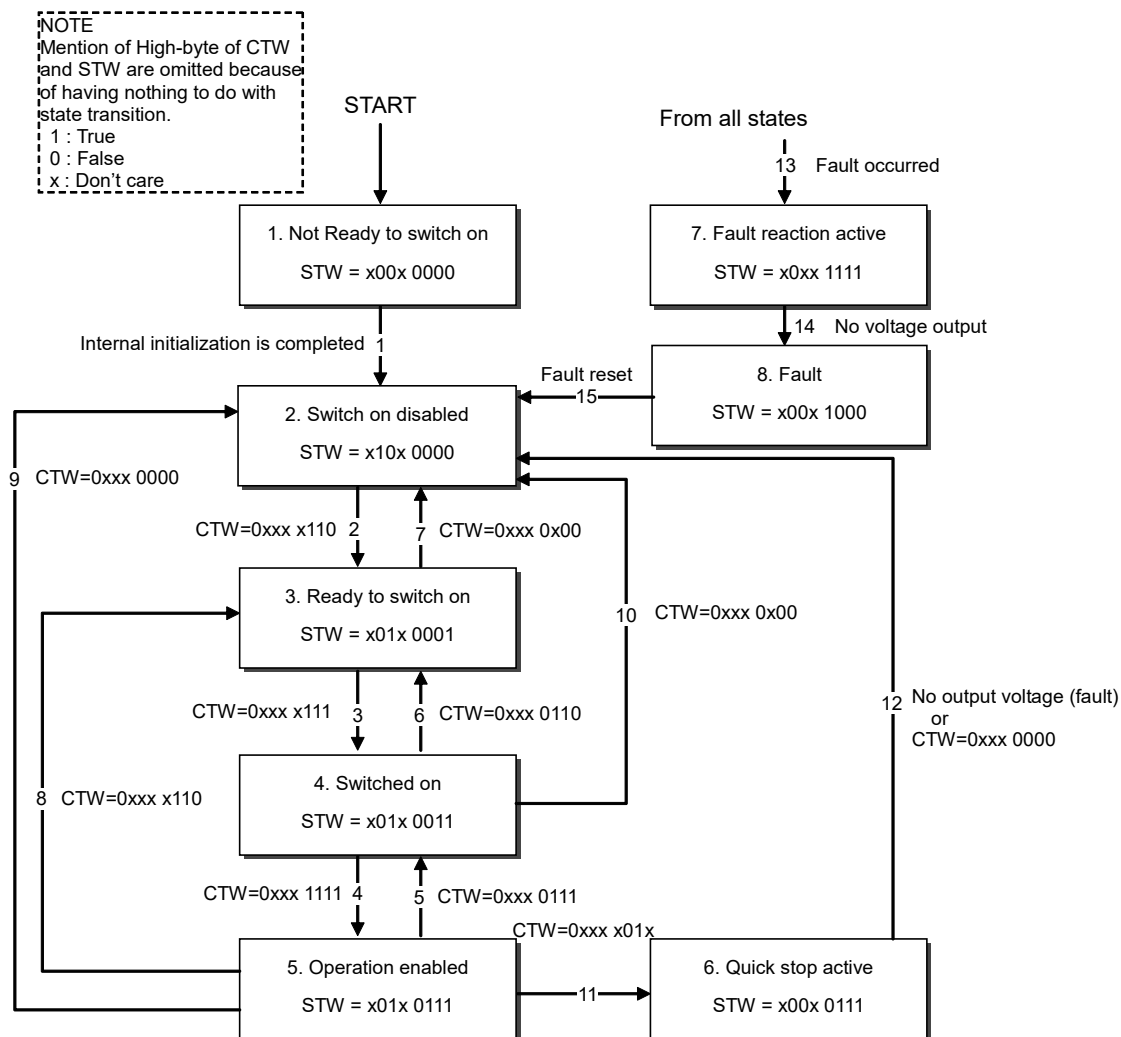


Figure 9.3 State Machine

(2) Controlword (Object 6040h)

bit7	bit6	bit5	bit4	bit3	bit2	bit1	bit0
Fault reset	0	0	0	Enable operation	Quick stop	Enable Voltage	Switch on

bit15	bit14	bit13	bit12	bit11	bit10	bit9	bit8
X4	X3	X2	X1	Reverse	0	0	Halt

Bits 0 to 3 : Control the state machine for state transition. See Figure 9.3.
 bit 7 Fault reset : Change from 0 to 1 to reset an alarm.
 bit 8 Halt : 1 = Fix the inverter's output speed at 0 r/min
 bit 11 Reverse : Specify the rotational direction. 0 = Forward, 1 = Reverse.
 bits 12 to 15 : Turn digital input terminals [X1] to [X4] OFF or ON. 0 = OFF, 1 = ON

Stausword (Object 6041h)

bit7	bit6	bit5	bit4	bit3	bit2	bit1	bit0
Warning	Switch on disable	Quick stop	Voltage enabled	Fault	Operation enabled	Switched On	Ready to switch on

bit15	bit14	bit13	bit12	bit11	bit10	bit9	bit8
Direction of rotation	0	0	0	Internal limit active	Target reached	Remote	0

bits 0 to 2, 5 and 6	:	Status display of the state machine. See Figure 9.3.
bit 3 Fault	:	1 = Tripped
bit 4 Voltage enabled	:	1 = Voltage applied to the main circuit
bit 7 Warning	:	Not used. Fixed at 0.
bit 9 Remote	:	1 = Either one of speed and run commands via EtherCAT is valid.
bit 10 Target reached	:	1 = Reference speed reached
bit 11 Internal limit active	:	1 = Torque, voltage, or current limiter activated
bit 15 Direction of rotation	:	0 = Forward or stop, 1 = Reverse

9.8. INVERTER REACTIONS TO EtherCAT NETWORK BREAKS

Determine behavior of the inverter when this communications card detects EtherCAT communications breaks by setting following related objects and inverter codes.

Table 9.9 Objects and function codes related to network breaks

No	Object Index Sub-index	Function code	Description
1	6007h Sub-index 00h	-	Abort connection option code. Setting the behavior when a communication error occurs.
2	-	o27,o28	Error reaction (inverter side). Setting the behavior when a communication error occurs.
3	-	H81	Assigned minor failure (inverter side). Setting if it is treated as a minor failure when error occurs.

Table 9.10 Network breaks detection by object 6007h set value

6007h setting (hex)	Description
0(0000)	[no action] Ignoring the communications error.
1(0001)	[malfunction]
-1(FFFF)	Immediately coast to a stop and trip with $\overline{E_r S}$. (*)
2(0002)	[Device control command 'Disable Voltage']
-2(FFFE)	CTW=Disable voltage [no $\overline{E_r S}$. trip]
3(0003)	[Device control command 'Quick Stop']
-3(FFFD)	CTW= Quick stop [no $\overline{E_r S}$. trip]
-4(FFFC)	[malfunction manufacturer specific] (*)
-5(FFFB)	Refer to Table 9.11.

* If $\overline{E_r S}$ is assigned to a minor fault using the function code [H81] of the inverter, it will not cause an error and will not trip.

Table 9.11 Inverter Reactions to EtherCAT Network Breaks (o27/o28)

o27	o28	Inverter Reactions to EtherCAT Network Breaks	H81 assign
0, 4 to 9	Invalid	Immediately coast to a stop and trip with E_{r-5} .	Immediately L_{-F_L} (no trip)
1	0.0 to 60.0 s	After the time specified by o28, coast to a stop and trip with E_{r-5} .	After the time specified by o28. L_{-F_L} (no trip)
2	0.0 to 60.0 s	If the inverter receives any data within the time specified by o28, ignore the communications error. After the timeout, coast to a stop and trip with E_{r-5} .	Same as above
3, 13 to 15	Invalid	Keep the current operation, ignoring the communications error (no E_{r-5} trip).	No stop, no trip and no L_{-F_L}
10	Invalid	Immediately decelerate to a stop. (*) Issue E_{r-5} after stopping.	Immediately L_{-F_L} (no stop)
11	0.0 to 60.0 s	After the time specified by o28, decelerate to a stop. Issue E_{r-5} after stopping. (*)	After the time specified by o28. L_{-F_L} (no stop)
12	0.0 to 60.0 s	If the inverter receives any data within the time specified by o28, ignore the communications error. After the timeout, decelerate to a stop and trip with E_{r-5} . (*)	Same as above

* Specify the deceleration time by the inverter function code F08.

9.9. LIST OF INVERTER ALARM CODES

There are the following two ways to read out alarm codes generated when the inverter itself trips, via the EtherCAT network.

- 1) Read out alarm codes stipulated in EtherCAT from Index 1003 Sub-index 1 Standard error field or Index 603Fh Error code.
- 2) Read out alarm codes using inverter's function codes M16, M17, M18, and M19 (latest, last, 2nd last, and 3rd last alarm codes).

Table 9.12 lists alarm codes available.

Table 9.12 Alarm Codes

Error code	Description		Fuji's alarm code (M16 to M19)
0000h	NO alarm	-	0
2310h	Overcurrent (During acceleration)	<i>OC 1</i>	1
	Overcurrent (During deceleration)	<i>OC 2</i>	2
	Overcurrent (during constant speed)	<i>OC 3</i>	3
2330h	Earth fault	<i>EF</i>	5
3130h	Input phase loss	<i>L in</i>	11
3210h	Overvoltage (During acceleration)	<i>OU 1</i>	6
	Overvoltage (During deceleration)	<i>OU 2</i>	7
	Overvoltage (During constant speed)	<i>OU 3</i>	8
3220h	Undervoltage	<i>LU</i>	10
3221h	Data saving error during undervoltage	<i>ErF</i>	51
3300h	Output phase loss	<i>OPL</i>	46
4110h	Inverter overload	<i>OLU</i>	25
4210h	Heat sink overheat	<i>OH 1</i>	17
	Inverter internal overheat	<i>OH 3</i>	19
	Charging resistor overheat	<i>OH 6</i>	70
	Braking resistor overheat	<i>dbH</i>	22
4310h	Motor protection (PTC/NTC thermistor)	<i>OH 4</i>	20
	Overload of motor 1	<i>OL 1</i>	23
	Overload of motor 2	<i>OL 2</i>	24
5220h	CPU Error	<i>Er 3</i>	33
	Hardware error	<i>Er H</i>	54
5400h	DB transistor failure	<i>dbA</i>	59
5430h	Enable circuit error	<i>ECF</i>	57
5440h	Charge circuit fault	<i>PbF</i>	16
5450h	Fuse blown	<i>FUS</i>	14
5500h	Memory error	<i>Er 1</i>	31
6320h	Customizable logic error	<i>ECL</i>	65
7120h	Step-out detection	<i>Er d</i>	42
7200h	Tuning error	<i>Er 7</i>	37
	PID feedback wire break	<i>CoF</i>	58
7301h	PG wire break	<i>PG</i>	28
7310h	Overspeed protection	<i>OS</i>	27

Table 9.12 Alarm Codes (Continued)

Error code	Description		Fuji's alarm code (M16 to M19)
7510h	EtherCAT communication error	<i>Er4</i>	34
	RS-485 communication error (COM port1)	<i>ErB</i>	38
	(COM port2)	<i>ErP</i>	53
7520h	Keypad communication error	<i>Er2</i>	32
8100h	Option error (OPC- ETC2)	<i>ErS</i>	35
8400h	Speed inconsistency / Excessive speed deviation	<i>ErE</i>	47
8500h	Positioning control error	<i>ErO</i>	56
9000h	External alarm	<i>OH2</i>	18
F004h	Operation error	<i>ErG</i>	36
FF00h	mock alarm	<i>Err</i>	254

10. Revisions

Index.	Page	Description	Date	Drawn	Checked	Approved
-	-	First edition	2021-1-28	—	—	—