

OPERATING INSTRUCTIONS

EN

Translation of the Original

ETHERCAT

Optional module for converter

Dear customer,

Thank you for choosing a Pfeiffer Vacuum product. Your new Pfeiffer Vacuum accessory should support you in your individual application with full performance and without malfunctions. The name Pfeiffer Vacuum stands for high-quality vacuum technology, a comprehensive and complete range of top-quality products and first-class service. With this expertise, we have acquired a multitude of skills contributing to an efficient and secure implementation of our product.

Knowing that our product must not interfere with your actual work, we are convinced that our product offers you the solution that supports you in the effective and trouble-free execution of your individual application.

Please read these operating instructions before putting your product into operation for the first time. If you have any questions or suggestions, please feel free to contact info@pfeiffer-vacuum.de.

Further operating instructions from Pfeiffer Vacuum can be found in the [Download Center](#) on our website.

Disclaimer of liability

These operating instructions describe all models and variants of your product. Note that your product may not be equipped with all features described in this document. Pfeiffer Vacuum constantly adapts its products to the latest state of the art without prior notice. Please take into account that online operating instructions can deviate from the printed operating instructions supplied with your product.

Furthermore, Pfeiffer Vacuum assumes no responsibility or liability for damage resulting from the use of the product that contradicts its proper use or is explicitly defined as foreseeable misuse.

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We reserve the right to make changes to the technical data and information in this document.

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1 About this manual



IMPORTANT

Read carefully before use.
Keep the manual for future consultation.

1.1 Validity

These operating instructions are a customer document of Pfeiffer Vacuum. The operating instructions describe the functions of the named product and provide the most important information for the safe use of the device. The description is written in accordance with the valid directives. The information in these operating instructions refers to the product's current development status. The document shall remain valid provided that the customer does not make any changes to the product.

1.1.1 Applicable documents

Operating instructions	Number
Converter operating instructions	PT 0730 BN

You can find this document in the [Pfeiffer Vacuum Download Center](#).

1.2 Target group

These operating instructions are aimed at all persons performing the following activities on the product:

- Transportation
- Setup (Installation)
- Usage and operation
- Decommissioning
- Maintenance and cleaning
- Storage or disposal

The work described in this document is only permitted to be performed by persons with the appropriate technical qualifications (expert personnel) or who have received the relevant training from Pfeiffer Vacuum.

1.3 Conventions

1.3.1 Instructions in the text

Usage instructions in the document follow a general structure that is complete in itself. The required action is indicated by an individual step or multi-part action steps.

Individual action step

A horizontal, solid triangle indicates the only step in an action.

- ▶ This is an individual action step.

Sequence of multi-part action steps

The numerical list indicates an action with multiple necessary steps.

1. Step 1
2. Step 2
3. ...

1.3.2 Pictographs

Pictographs used in the document indicate useful information.



Note



Tip

1.3.3 Abbreviations

Abbreviation	Meaning in this document
AI / AO	Analog Input / Analog Output
DCU	Display Control Unit
DI / DO	Digital Input / Digital Output
EC	EtherCAT® interface
f	Rotation speed value of a vacuum pump (frequency, in rpm or Hz)
FE	Functional earth
HPU	Handheld Programming Unit
LED	Light emitting diode
P	Power
[P:xxx]	Electronic drive unit parameter with number
PE	Protective earth (earthed conductor)
t	Time
TM	Turbopump electronic drive unit (turbo controller) and magnetic bearing controller
TPS	Voltage supply (turbo power supply)

Tbl. 1: Abbreviations used in this document

1.3.4 Trademark proof



- EtherCAT® is a trademark and patented technology, licensed by Beckhoff Automation GmbH, Germany.

2 Safety

2.1 Safety precautions

**Duty to provide information on potential dangers**

The product holder or user is obliged to make all operating personnel aware of dangers posed by this product.

Every person who is involved in the installation, operation or maintenance of the product must read, understand and adhere to the safety-related parts of this document.

**Infringement of conformity due to modifications to the product**

The Declaration of Conformity from the manufacturer is no longer valid if the operator changes the original product or installs additional equipment.

- Following the installation into a system, the operator is required to check and re-evaluate the conformity of the overall system in the context of the relevant European Directives, before commissioning that system.

General safety precautions when handling the product

- ▶ Use only power supply packs that comply with the applicable safety regulations.
- ▶ Observe all applicable safety and accident prevention regulations.
- ▶ Check that all safety measures are observed at regular intervals.
- ▶ Recommendation: Establish a secure connection to the grounded conductor (PE); protection class I or III.
- ▶ Never disconnect plug connections during operation.
- ▶ Keep lines and cables away from hot surfaces (> 70 °C).
- ▶ Do not carry out your own conversions or modifications on the unit.
- ▶ Observe the unit protection degree prior to installation or operation in other environments.

2.2 Proper use

The EtherCAT option is used exclusively for the operation of Pfeiffer Vacuum vacuum pumps and their accessories in an EtherCAT system.

2.3 Foreseeable improper use

Improper use of the product invalidates all warranty and liability claims. Any use that is counter to the purpose of the product, whether intentional or unintentional, is regarded as improper use; in particular:

- Unauthorized installation, removal, conversion, or replacement

3 Product description

3.1 Manual control elements

3.1.1 Manual control elements

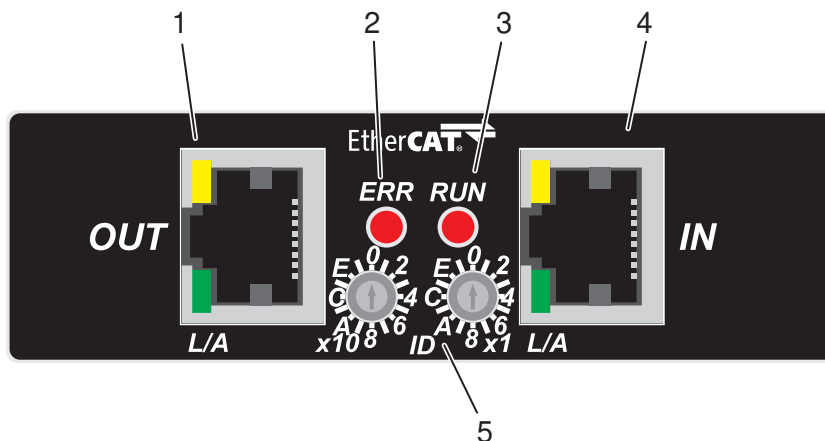


Fig. 2: EtherCAT option

- 1 OUT connection with status LED
- 2 LED Error
- 3 LED Run
- 4 IN connection with status LED
- 5 Rotary coding switch





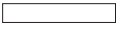

3.1.2 Connections

	Pin	Assignment
	1	Rx+
	2	Rx-
	3	Tx+
	4	n.c.
	5	n.c.
	6	Tx-
	7	n.c.
	8	n.c.

Tbl. 2: EtherCAT interface, connection assignment

3.1.3 Operating mode display via LED

Display	L/A (green) Connection	RUN (green) EtherCAT status	ERR (red) EtherCAT error
Off 	No connection	"INIT": <ul style="list-style-type: none"> Initialization, no process or service data 	No error
Rapid flashing 	–	"SAFE OPERATIONAL": <ul style="list-style-type: none"> Process input data (unit --> control) is valid Output data (control --> unit) in a safe state 	Spontaneous status change
Flashing 2x 	–	–	Connection lost

Display	L/A  (green) Connection	RUN  (green) EtherCAT status	ERR  (red) EtherCAT error
Flashing 	–	"PRE_OPERATIONAL": <ul style="list-style-type: none"> • Service data only, no process data 	Invalid configuration
Permanently on 	Connection to next device, no activity	"OPERATIONAL": <ul style="list-style-type: none"> • Process input and output data is valid 	Bootstrap
Flickering 	Connection active	"BOOTSTRAP"	Booting error

Tbl. 3: Behavior and meaning of the LEDS of the EtherCAT interface

4 Commissioning

4.1 Defining device ID

EtherCAT devices are always addressed using their position in the bus. There is no need to make conventional address settings.



Additional identification in the bus

Under certain conditions, it may be beneficial to perform additional (manual) identification, e.g., if there is a risk of mixing up multiple similar devices through incorrect cabling. Various configuration options exist for this.



Fig. 3: Hexadecimal coding switch

Explicit device identification

Recommended method as no additional configuration programs are required.

1. Take the rubber plug off the address selector switches.
2. Select this identification in the projection.
3. Set the device ID to the projected value.
 - Hexadecimal 00h to FFh corresponds to decimal 2 to 255.
 - The new value is transferred from "Voltage on/off".
4. After replacing a device, use the ID of the older device.
5. Position the rubber plugs straight and as deep as possible to achieve the stated protection degree.

Station alias

A suitable configuration program must be used as a prerequisite.

1. Select this identification in the projection.
2. Allocate the device online "Station alias".
 - This new value applies after a "Reset".
3. Repeat this procedure after replacing a device.

4.2 Making connections

Integration into an EtherCAT bus system is possible with the "OUT" and "IN" connections. The interface is galvanically safe and is isolated from the maximum supply voltage.

5 Operation

5.1 Operating multi-stage roots pump A 200 L via EtherCAT

5.1.1 Process data: A 200 L

Process output data

Process output data are:

- Default RxPDO (control --> A 200 L, "output"), CoE 1600h.1 – 4 (1 Byte)

Byte.Bit	CoE ¹⁾	Meaning
0.0	0x7000.0x01: Roughing start/stop	Pumping station (0: off, 1: on)
0.1	0x7000.0x04: Low speed (idle/green mode)	No function
0.2 – 7.		Reserved

Tbl. 4: Process output data

Process input data

Process input data are:

- Default TxPDO (A 200 L --> control, "input"), CoE 1A00h.1 – 11 (7 Byte)

Byte.Bit	CoE ²⁾	Meaning
0.0	0x6000.0x01: Roughing run/stop	Pumping station (0: off, 1: on)
0.1	0x6000.0x02: Booster run/stop	Constant 0
0.2	0x6000.0x04: Low speed (idle/green mode)	Constant 0
0.3	0x6000.0x05: Remote/Local	0: ECAT, 1: Local
0.4	0x6000.0x09: Warning	0: No warning, 1: Warning
0.5	0x6000.0x0A: Alarm	0: No alarm, 1: Alarm
0.6	0x6000.0x0B: Emergency Off	0: Normal, 1: Stop
0.7	0x6000.0x0C: N2 flow low	0: Normal, 1: N2 flow low
1st – 2.	0x6001.0x02: N2 flow	Constant 0
3. – 4.	0x6001.0x03: Exhaust pressure	Constant 0
5. – 6.	0x6001.0x05: Roughing case temperature	Constant 0
7. – 8.	0x6001.0x09: Roughing current	0.1 A
9. – 10.	0x6001.0x0A: Roughing power	0.1 kW
11. – 12.	0x6001.0x0B: Roughing speed	0.1% of rated speed
13. – 14.	0x6002.0x05: Booster case temperature	Constant 0
15. – 16.	0x6002.0x09: Booster current	Constant 0
17. – 18.	0x6002.0x0A: Booster power	Constant 0
19. – 20.	0x6002.0x0B: Booster speed	Constant 0

Tbl. 5: Process input data

Compile process data alternative from CoE objects

1. Always conduct the state "PRE-OPERATIONAL".
2. Describe the object 1601h.0 or 1A01h.0 with 0.
3. Describe the object 1601h.1-n or 1A01h.1-n with corresponding CoE indices.
4. Use only objects marked with "P".
5. Assign the sub-index 1-n on a sequential basis only and without gaps.
6. Make sure that the data yields a total number of bytes (use pad bits if needed) and start with whole bytes (exception BOOL).

1) Hexadecimal

2) Hexadecimal

7. Describe maximum 12 objects per PDO.
8. Describe the object 1601h.0 or 1A01h.0 with the number n of objects to be used.
9. Change object 1C12h.1 to 1601h or 1C13h.1 to 1A01h.
10. In the process data, select the corresponding PDO assignment 1601h or 1A01h.

Sync Manager:

SM	Size	Type	Flags
0	128	MbxOut	
1	128	MbxIn	
2	3	Outputs	
3	7	Inputs	

PDO List:

Index	Size	Name	Flags	SM
0x1A00	7.0	Default TxPDO (input)	F	
0x1A01	7.0	User TxPDO (input)		3
0x1600	1.0	Default RxPDO (output)	F	
0x1601	3.0	User RxPDO (output)		2

PDO Assignment (0x1C12):

0x1600 (excluded by 0x1601)

0x1601

PDO Content (0x1601):

Index	Size	Ofs	Name	Type
0x7000:01	0.1	0.0	Turbo Start Stop	BOOL
0x7000:03	0.1	0.1	Turbo Low Speed	BOOL
0x3005:11	0.1	0.2	Vnt. Enable	BOOL
0x3005:21	0.1	0.3	Sig. Enable	BOOL
...	0.4	0.4
0x8000:03	2.0	1.0	Normal Speed Setpoint	UINT
		3.0		

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PDO Assignment

PDO Configuration

Sync Manager:

SM	Size	Type	Flags
0	128	MbxOut	
1	128	MbxIn	
2	3	Outputs	
3	7	Inputs	

PDO List:

Index	Size	Name	Flags	SM
0x1A00	7.0	Default TxPDO (input)	F	
0x1A01	7.0	User TxPDO (input)		3
0x1600	1.0	Default RxPDO (output)	F	
0x1601	3.0	User RxPDO (output)		2

PDO Assignment (0x1C12):

0x1A00 (excluded by 0x1A01)

0x1A01

PDO Content (0x1A01):

Index	Size	Ofs	Name	Type
0x6000:09	0.1	0.0	Alarm	BOOL
0x6000:0A	0.1	0.1	Warning	BOOL
0x2001:88	0.1	0.2	Ready for Process	BOOL
...	0.5	0.3
0x2001:81	1.0	1.0	Status	USINT
0x2001:82	1.0	2.0	Actual Speed (rel.)	SINT
0x2002:13	2.0	3.0	Power	INT
0x2002:88	2.0	5.0	Pmp. Temperature	INT
		7.0		

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PDO Assignment

PDO Configuration

Output data including 4 pad bits

Input data including 5 pad bits

Tbl. 6: Example for a process data configuration

5.1.2 Service data: A 200 L

Type	Description
BOOL	Binary value (yes/no)
BYTE()	Single byte number
STRING()	Character string
USINT	Positive integer, 8 bit
UINT	Positive integer, 16 bit
UDINT	Positive integer, 32 bit
ULINT	Positive integer, 64 bit
SINT	Integer, 8 bit
INT	Integer, 16 bit
DINT	Integer, 32 bit
REAL	Floating point value, single precision

Tbl. 7: Data types of the service data

The following CoE objects are available for access to individual data objects (e.g., for configuration):

Administrative data (information about the device, communication)

Idx ³⁾	sIdx	Name	Type	Access ⁴⁾	Description
1000		Device type	UDINT	RO	Bit 0-15: Device profile number (5003). NOTE: Representation is hexadecimal (i.e. 5003dec -> 0x138B) Bit 16-31: 0x0000 sub-profile number is defined in 0xF010 bit 15..0
1008		Manufacturer device name	STRING(n)	RO	Name of the device as non-zero terminated string.
1009		Manufacturer hardware version	STRING(n)	RO	Hardware version of the device as non-zero terminated string.
100 A		Manufacturer software version	STRING(n)	RO	Software version of the device as non-zero terminated string.

3) Idx = Index, sIdx = Sub-index, Hexadecimal

4) RO = read only, RW = read/write, P = suitable for process data

Idx ³⁾	sIdx	Name	Type	Access ⁴⁾	Description
100B		Manufacturer boot-loader version	STRING(n)	RO	Bootloader version of the device as non-zero terminated string.
1018		Identity object	IDENTITY	RO	
	01	Vendor ID	UDINT	RO	
	02	Product code	UDINT	RO	
	03	Revision number	UDINT	RO	
	04	Serial number	UDINT	RO	
10F8		Timestamp object	ULINT	RO	Local timestamp of the device in ns.
1600		SDP default RxPDO			
	01h				0x7000.0x01: Roughing start/stop
	02h				0x7000.0x04: Low speed (idle/green mode)
	03h				
1601		User RxPDO			
1A00		SDP default TxPDO			
	01h				0x6000.0x01: Roughing run/stop
	02h				0x6000.0x02: Booster run/stop
	03h				0x6000.0x04: Low speed (idle/green mode)
	04h				0x6000.0x05: Remote/local
	05h				0x6000.0x09: Warning
	06h				0x6000.0x0A: Alarm
	07h				0x6000.0x0B: Emergency off
	08h				0x6000.0x0C: N2 flow low
	09h				0x6001.0x02: N2 flow
	0Ah				0x6001.0x03: Exhaust pressure
	0Bh				0x6001.0x05: Roughing case temperature
	0Ch				0x6001.0x09: Roughing current
	0Dh				0x6001.0x0A: Roughing power
	0Eh				0x6001.0x0B: Roughing speed
	0Fh				0x6002.0x05: Booster case temperature
	10h				0x6002.0x09: Booster current
	11h				0x6002.0x0A: Booster power
	12h				0x6002.0x0B: Booster speed
1A01		User TxPDO			
1C00		Sync manager type			
1C10		Sync manager 0 PDO assignment			
1C11		Sync manager 1 PDO assignment			
1C12		RxPDO assign (sync manager 2 PDO assignment)			
1C13		TxPDO assign (sync manager 3 PDO assignment)			

3) Idx = Index, sIdx = Sub-index, Hexadecimal

4) RO = read only, RW = read/write, P = suitable for process data

Idx ³⁾	sIdx	Name	Type	Access ⁴⁾	Description
1C32	Partial	Output sync manager parameter		RO	
	01h	Synchronization type	UINT	RO	
1C33	Partial	Input sync manager parameter		RO	
	01h	Synchronization type		RO	

Tbl. 8: Communication area – administrative data (information about the device, communication)

Input data (A 200 L --> control)

Idx ⁵⁾	sIdx	Name	Type	Access ⁶⁾	Description
2000	Partial	In identity/status		RO	
	01	Manufacturer (main)	STRING(n)	RO	
	02	Device name (main)	STRING(n)	RO	
	03	Serial number (main)	STRING(n)	RO	
	04	Hardware version (main)	STRING(n)	RO	
	05	Firmware version (main)	STRING(n)	RO	
	08	Status code (main)	UINT	RO	PV485 error code. Warnings have an offset of 1000; i.e.: 1001 -> Warning 1
	22	Device name (interface)	STRING(n)	RO	
	24	Hardware version (interface)	STRING(n)	RO	
	25	Firmware version (interface)	STRING(n)	RO	
2001	Partial	In operation		RO	
	01	Status (main)	UDINT	RO	
2003	Partial	In diagnostic		RO	
	08	Error details (main)	UDINT	RO	
	09	Warning details (main)	UDINT	RO	

Tbl. 9: Input data

Input data (A 200 L --> control)

Idx ⁷⁾	sIdx	Name	Type	Access ⁸⁾	Description
6000		Roughing and booster status		RO	
	01	Roughing run/stop	BOOL	RO	1: Run 0: Stop
	04	Low speed (idle/sleep/green mode)	BOOL	RO	1: Low speed (idle /sleep / green mode) 0: Normal
	05	Remote/local	BOOL	RO	1: Local. Hand control enabled 0: Remote. E-cat control enabled

3) Idx = Index, sIdx = Sub-index, Hexadecimal

4) RO = read only, RW = read/write, P = suitable for process data

5) Idx = Index, sIdx = Sub-index, Hexadecimal

6) RO = read only, RW = read/write, P = suitable for process data

7) Idx = Index, sIdx = Sub-index, Hexadecimal

8) RO = read only, RW = read/write, P = suitable for process data

Idx ⁷⁾	sIdx	Name	Type	Access ⁸⁾	Description
	07	Pump interlock	BOOL	RO	1: OK, process may proceed 0: Process must not run
	09	Warning	BOOL	RO	1: Warning 0: Normal
	0 A	Alarm	BOOL	RO	1: Alarm 0: Normal
	0B	Emergency off	BOOL	RO	1: Stop 0: Normal
	0C	N2 flow low	BOOL	RO	1: N2 flow low 0: Normal
6001		Roughing analog inputs			
	02	N2 flow	INT	RO	0.1 [slm]
	03	Exhaust pressure	INT	RO	Gauge pressure (not absolute) - 1 [kPa]
	05	Roughing case temperature	INT	RO	Degrees Celsius
	09	Roughing current	INT	RO	0.1 [A]
	0 A	Roughing power	INT	RO	0.1 [kW]
	0B	Roughing speed	INT	RO	1000 (100.0%): Rated speed 0 (0.0%): 0 rotation, 0.1 [%]
6002		Booster analog inputs		RO	
	05	Booster case temperature	INT	RO	Degrees Celsius
	09	Booster current	INT	RO	0.1 [A]
	0 A	Booster power	INT	RO	0.1 [kW]
	0B	Booster speed	INT	RO	1000 (100.0%): Rated speed 0 (0.0%): 0 rotation, 0.1 [%]

Tbl. 10: Input area

Output data (control --> A 200 L)

Idx ⁹⁾	sIdx	Name	Type	Access ¹⁰⁾	Description
7000		Roughing and booster control		RO	
	01	Roughing start/stop	BOOL	RW	1: Run 0: Stop (roughing pump exists)
	04	Low speed (idle / sleep / green mode)	BOOL	RW	1: Low speed (idle / sleep / green mode) 0: Normal

Tbl. 11: Output area

7) Idx = Index, sIdx = Sub-index, Hexadecimal
 8) RO = read only, RW = read/write, P = suitable for process data
 9) Idx = Index, sIdx = Sub-index, Hexadecimal
 10) RO = read only, RW = read/write, P = suitable for process data

Configuration data (control --> A 200 L)

Idx ¹¹⁾	sIdx	Name	Type	Access ¹²⁾	Description
8001		Roughing and booster configuration		RO	
	01	Safe state	UINT	RW	0: Maintain state (hold last state) (default) 1: Go to default state (power up/reset state) - pumps stop 2: Maintain state, exit low speed (idle/sleep mode) = 0 (normal speed)

Tbl. 12: Configuration area**Information data (A 200 L --> control)**

Idx ¹³⁾	sIdx	Name	Type	Access ¹⁴⁾	Description
9000		Roughing and booster information		RO	
	01	Roughing exists	BOOL	RO	0: not available 1: available
	02	Booster exists	BOOL	RO	0: not available 1: available
	03	Booster 2 exists	BOOL	RO	0: not available 1: available
	11	Roughing and booster running time	UDINT	RO	Running time since manufacture or service - 1 [hours]

Tbl. 13: Information area**Semiconductor device profile area**

Idx ¹⁵⁾	sIdx	Name	Type	Access ¹⁶⁾	Description
F000		Semiconductor device profile		RO	
	01	Index distance	UINT		
	02	Maximum number of modules	UINT		
F010		Module profile list		RO	
	01		UDINT	RO	

Tbl. 14: Semiconductor device profile area

11) Idx = Index, sIdx = Sub-index, Hexadecimal

12) RO = read only, RW = read/write, P = suitable for process data

13) Idx = Index, sIdx = Sub-index, Hexadecimal

14) RO = read only, RW = read/write, P = suitable for process data

15) Idx = Index, sIdx = Sub-index, Hexadecimal

16) RO = read only, RW = read/write, P = suitable for process data

Exception handling

Idx ¹⁷⁾	sldx	Name	Type	Access ¹⁸⁾	Description
F380		Active exception status	USINT	RO	A condensed summary byte describing the collection of active device exceptions after corresponding masks (0xF3Ax) were applied.
		Bit0: Device warning			Bit0: Device warning
		Bit1: Manufacturer warning			Bit1: Manufacturer warning
		Bit2: Device error			Bit2: Device error
		Bit3: Manufacturer error			Bit3: Manufacturer error
		Bit4: Reserved			Bit4: Reserved
		Bit5: Reserved			Bit5: Reserved
		Bit6: Reserved			Bit6: Reserved
		Bit7: Reserved			Bit7: Reserved
F381		Roughing and booster 1 to 255: Active warning detail		RO	
	01		UDINT	RO	Expanded details of the device warning exceptions. For each bit: 1: Occur 0: Normal/Not available
		Bit0: EMO			Bit0: EMO
		Bit1: Water leak			Bit1: Water leak
		Bit2: Power fail open phase			Bit2: Power fail open phase
		Bit3: Reverse phase			Bit3: Reverse phase
		Bit4: Coolant flow			Bit4: Coolant flow
		Bit5: N2 flow			Bit5: N2 flow
		Bit6: Exhaust pressure			Bit6: Exhaust pressure
		Bit7: Exhaust temp.			Bit7: Exhaust temp.
		Bit8: Main controller err/batt low			Bit8: Main controller err/batt low
		Bit9: Roughing case temp			Bit9: Roughing case temp
		Bit10: Roughing motor temp			Bit10: Roughing motor temp
		Bit11: Roughing current			Bit11: Roughing current
		Bit12: Roughing speed			Bit12: Roughing speed
		Bit13: Roughing lock rotor			Bit13: Roughing lock rotor
		Bit14: Roughing motor driver err			Bit14: Roughing motor driver err
		Bit15: Booster case temp.			Bit15: Booster case temp
		Bit16: Booster motor temp.			Bit16: Booster motor temp
		Bit17: Booster current			Bit17: Booster current
		Bit18: Booster speed			Bit18: Booster speed
		Bit19: Booster lock rotor			Bit19: Booster lock rotor
		Bit20: Booster motor driver err			Bit20: Booster motor driver err
		Bit21: Booster 2 case temp.			Bit21: Booster 2 case temp.
		Bit22: Booster 2 motor temp.			Bit22: Booster 2 motor temp.
		Bit23: Booster 2 current			Bit23: Booster 2 current
		Bit24: Booster 2 speed			Bit24: Booster 2 speed
		Bit25: Booster 2 lock rotor			Bit25: Booster 2 lock rotor

17) Idx = Index, sldx = Sub-index, Hexadecimal

18) RO = read only, RW = read/write, P = suitable for process data

Idx ¹⁷⁾	sidx	Name	Type	Access ¹⁸⁾	Description
		Bit26: Booster 2 motor driver err			Bit26: Booster 2 motor driver err
		Bit27: Gate valve err			Bit27: Gate valve err
		Bit28: Future use			Bit28: Future use
		Bit29: Future use			Bit29: Future use
		Bit30: Future use			Bit30: Future use
		Bit31: Others			Bit31: Others
F383		Roughing and booster 1 to 255: Active error (alarm) detail		RO	
	01		UDINT	RO	Expanded details of the device warning exceptions. For each bit: 1: Occur 0: Normal/not available
		Bit0: EMO			Bit0: EMO
		Bit1: Water leak			Bit1: Water leak
		Bit2: Power fail open phase			Bit2: Power fail open phase
		Bit3: Reverse phase			Bit3: Reverse phase
		Bit 4: Coolant flow			Bit 4: Coolant flow
		Bit5: N2 flow			Bit5: N2 flow
		Bit6: Exhaust pressure			Bit6: Exhaust pressure
		Bit7: Exhaust temp.			Bit7: Exhaust temp.
		Bit8: Main controller err/batt low			Bit8: Main controller err/batt low
		Bit9: Roughing case temp			Bit9: Roughing case temp
		Bit10: Roughing motor temp			Bit10: Roughing motor temp
		Bit11: Roughing current			Bit11: Roughing current
		Bit12: Roughing speed			Bit12: Roughing speed
		Bit13: Roughing lock rotor			Bit13: Roughing lock rotor
		Bit14: Roughing motor driver err			Bit14: Roughing motor driver err
		Bit15: Booster case temp.			Bit15: Booster case temp.
		Bit16: Booster motor temp.			Bit16: Booster motor temp.
		Bit17: Booster current			Bit17: Booster current
		Bit18: Booster speed			Bit18: Booster speed
		Bit19: Booster lock rotor			Bit19: Booster lock rotor
		Bit20: Booster motor driver err			Bit20: Booster motor driver err
		Bit21: Booster 2 case temp.			Bit21: Booster 2 case temp.
		Bit22: Booster 2 motor temp.			Bit22: Booster 2 motor temp.
		Bit23: Booster 2 current			Bit23: Booster 2 current
		Bit24: Booster 2 speed			Bit24: Booster 2 speed
		Bit25: Booster 2 lock rotor			Bit25: Booster 2 lock rotor
		Bit26: Booster 2 motor driver err			Bit26: Booster 2 motor driver err
		Bit27: Gate valve err			Bit27: Gate valve err
		Bit28: Future use			Bit28: Future use
		Bit29: Future use			Bit29: Future use
		Bit30: Future use			Bit30: Future use

17) Idx = Index, sidx = Sub-index, Hexadecimal

18) RO = read only, RW = read/write, P = suitable for process data

Idx ¹⁷⁾	sidx	Name	Type	Access ¹⁸⁾	Description
		Bit31: Others			Bit31: Others
F390		Latched exception status	USINT	RO	A condensed summary byte describing the collection of device exceptions after corresponding masks (0xF3Ax) were applied.
		Bit0: Device warning			Bit0: Device warning
		Bit1: Manufacturer warning			Bit1: Manufacturer warning
		Bit2: Device error			Bit2: Device error
		Bit3: Manufacturer error			Bit3: Manufacturer error
		Bit4: Reserved			Bit4: Reserved
		Bit5: Reserved			Bit5: Reserved
		Bit6: Reserved			Bit6: Reserved
		Bit7: Reserved			Bit7: Reserved
F391		Roughing and booster 1 to 255: Latched warning detail		RO	
	01		UDINT	RO	Expanded details of the device warning exceptions. For each bit: 1: Occur 0: Normal/Not available
		Bit0: EMO			Bit0: EMO
		Bit1: Water leak			Bit1: Water leak
		Bit2: Power fail open phase			Bit2: Power fail open phase
		Bit3: Reverse phase			Bit3: Reverse phase
		Bit4: Coolant flow			Bit4: Coolant flow
		Bit5: N2 flow			Bit5: N2 flow
		Bit6: Exhaust pressure			Bit6: Exhaust pressure
		Bit7: Exhaust temp.			Bit7: Exhaust temp.
		Bit8: Main controller err/batt low			Bit8: Main controller err/batt low
		Bit9: Roughing case temp			Bit9: Roughing case temp
		Bit10: Roughing motor temp			Bit10: Roughing motor temp
		Bit11: Roughing current			Bit11: Roughing current
		Bit12: Roughing speed			Bit12: Roughing speed
		Bit13: Roughing lock rotor			Bit13: Roughing lock rotor
		Bit14: Roughing motor driver err			Bit14: Roughing motor driver err
		Bit15: Booster case temp.			Bit15: Booster case temp.
		Bit16: Booster motor temp.			Bit16: Booster motor temp.
		Bit17: Booster current			Bit17: Booster current
		Bit18: Booster speed			Bit18: Booster speed
		Bit19: Booster lock rotor			Bit19: Booster lock rotor
		Bit20: Booster motor driver err			Bit20: Booster motor driver err
		Bit21: Booster 2 case temp.			Bit21: Booster 2 case temp.
		Bit22: Booster 2 motor temp.			Bit22: Booster 2 motor temp.
		Bit23: Booster 2 current			Bit23: Booster 2 current
		Bit24: Booster 2 speed			Bit24: Booster 2 speed
		Bit25: Booster 2 lock rotor			Bit25: Booster 2 lock rotor

17) Idx = Index, sidx = Sub-index, Hexadecimal

18) RO = read only, RW = read/write, P = suitable for process data

Idx ¹⁷⁾	sidx	Name	Type	Access ¹⁸⁾	Description
		Bit26: Booster 2 motor driver err			Bit26: Booster 2 motor driver err
		Bit27: Gate valve err			Bit27: Gate valve err
		Bit28: Future use			Bit28: Future use
		Bit29: Future use			Bit29: Future use
		Bit30: Future use			Bit30: Future use
		Bit31: Others			Bit31: Others
F393		Roughing and booster 1 to 255: Latched error (alarm) detail		RO	
	01		UDINT	RO	Expanded details of the device warning exceptions. For each bit: 1: Occur 0: Normal/Not available
		Bit0: EMO			Bit0: EMO
		Bit1: Water leak			Bit1: Water leak
		Bit2: Power fail open phase			Bit2: Power fail open phase
		Bit3: Reverse phase			Bit3: Reverse phase
		Bit4: Coolant flow			Bit4: Coolant flow
		Bit5: N2 flow			Bit5: N2 flow
		Bit6: Exhaust pressure			Bit6: Exhaust pressure
		Bit7: Exhaust temp.			Bit7: Exhaust temp.
		Bit8: Main controller err/batt low			Bit8: Main controller err/batt low
		Bit9: Roughing case temp			Bit9: Roughing case temp
		Bit10: Roughing motor temp			Bit10: Roughing motor temp
		Bit11: Roughing current			Bit11: Roughing current
		Bit12: Roughing speed			Bit12: Roughing speed
		Bit13: Roughing lock rotor			Bit13: Roughing lock rotor
		Bit14: Roughing motor driver err			Bit14: Roughing motor driver err
		Bit15: Booster case temp.			Bit15: Booster case temp.
		Bit16: Booster motor temp.			Bit16: Booster motor temp.
		Bit17: Booster current			Bit17: Booster current
		Bit18: Booster speed			Bit18: Booster speed
		Bit19: Booster lock rotor			Bit19: Booster lock rotor
		Bit20: Booster motor driver err			Bit20: Booster motor driver err
		Bit21: Booster 2 case temp.			Bit21: Booster 2 case temp.
		Bit22: Booster 2 motor temp.			Bit22: Booster 2 motor temp.
		Bit23: Booster 2 current			Bit23: Booster 2 current
		Bit24: Booster 2 speed			Bit24: Booster 2 speed
		Bit25: Booster 2 lock rotor			Bit25: Booster 2 lock rotor
		Bit26: Booster 2 motor driver err			Bit26: Booster 2 motor driver err
		Bit27: Gate valve err			Bit27: Gate valve err
		Bit28: Future use			Bit28: Future use
		Bit29: Future use			Bit29: Future use
		Bit30: Future use			Bit30: Future use

17) Idx = Index, sidx = Sub-index, Hexadecimal

18) RO = read only, RW = read/write, P = suitable for process data

Idx ¹⁷⁾	sidx	Name	Type	Access ¹⁸⁾	Description
		Bit31: Others			Bit31: Others
F3A1		Roughing and booster 1 to 255: Warning mask		RO	
	01		UDINT	RW	Bitmask to include the corresponding device warning exception bits (as defined in the device warning details) in the active and latched exception status objects (0xF380 bit 0 and 0xF390 bit 0), if the corresponding bit is TRUE.
F3A3		Roughing and booster 1 to 255: Error (alarm) mask		RO	
	01		UDINT	RW	Bitmask to include the corresponding device error exception bits (as defined in the device error details) in the active and latched exception status objects (0xF380 bit 2 and 0xF390 bit 2), if the corresponding bit is TRUE.
F6F0		Input latch local timestamp		RO	
	01	Input latch local timestamp	UDINT	RO	Local controller time corresponding to the input latch time in microseconds. It starts at zero on device power-up.

Tbl. 15: Exception handling

CDP-specific information data

Idx ¹⁹⁾	sidx	Name	Type	Access ²⁰⁾	Description
F9F0		Manufacturer serial number	STRING(n)	RO	String representing the manufacturer's serial number for the device.
F9F1		CDP functional generation number		RO	
	01		UDINT	RO	Common device profile functional generation number
F9F2		SDP functional generation number		RO	
	01		UDINT	RO	SDP functional generation number.
F9F3		Vendor name	STRING(n)	RO	
F9F4		SDP device name		RO	
	01		STRING(n)	RO	String identifying the device type.
F9F5		Output identifier		RO	
	01		USINT	RW	Output identifier. The controller can then read this value back through the TxPDO to ensure the RxPDO was received.
F9F6		Time since power on	UDINT	RO	This is the time the device has currently been powered on, in seconds.

17) Idx = Index, sidx = Sub-index, Hexadecimal

18) RO = read only, RW = read/write, P = suitable for process data

19) Idx = Index, sidx = Sub-index, Hexadecimal

20) RO = read only, RW = read/write, P = suitable for process data

Idx ¹⁹⁾	sidx	Name	Type	Access ²⁰⁾	Description
F9F7		Total time powered	UDINT	RO	Operating hours of pump [s]
F9F8		Firmware update: functional generation number	UDINT	RO	Firmware update of functional generation number supported by the device.

Tbl. 16: CDP-specific information data

CDP command objects

Idx ²¹⁾	sidx	Name	Type	Access ²²⁾	Description
FBF0		Device reset command		RO	Execution of this command causes the device to emulate a complete power cycle. This includes an ESC reset. There are two versions of this command: Device reset: Backup parameters will not change as a result of this reset. All setting parameters will revert to power-on defaults as a result of the reset. Factory reset: All backup parameters will be changed to their as-shipped defaults. All setting parameters will revert to power-on defaults as a result of the reset.
	01	Command	ARRAY[0..5] OF BYTE	RW	A device reset is initiated when the following byte sequence is sent: Byte 0: 0x74 Byte 1: 0x65 Byte 2: 0x73 Byte 3: 0x65 Byte 4: 0x72 Byte 5: Device standard reset = 0x00, factory reset = 0x66
	02	Status	USINT	RO	Supported values: 0: Default value if the command has not been initiated. Not a supported value otherwise. 1: Reserved 2: Last command completed, error, no response.
	03	Response	ARRAY[0..1] OF BYTE	RO	Byte 0: See subindex 2 Byte 1: Unused - shall be zero
FBF1		Exception reset command		RO	Execution of this command clears the latched exceptions.
	01	Command	ARRAY[0..4] OF BYTE	RW	A latched exception reset is initiated when the following byte sequence is sent: Byte 0: 0x74 Byte 1: 0x65 Byte 2: 0x73 Byte 3: 0x65 Byte 4: 0x72

19) Idx = Index, sidx = Sub-index, Hexadecimal

20) RO = read only, RW = read/write, P = suitable for process data

21) Idx = Index, sidx = Sub-index, Hexadecimal

22) RO = read only, RW = read/write, P = suitable for process data

Idx ²¹⁾	sidx	Name	Type	Access ²²⁾	Description
	02	Status	USINT	RO	Supported values: 0: Last command completed, no error, no response 1: Reserved 2: Last command completed, error, no response
	03	Response	ARRAY[0..1] OF BYTE	RO	Byte 0: See subindex 2 Byte 1: Unused.
FBF2		Store parameters command		RO	Execution of this command will store all parameters to non-volatile memory.
	01	Command	ARRAY[0..3] OF BYTE	RW	Read: Bit 0 = 1: Device saves the non-volatile parameters when writing 0xFBFB2:01 with 0x65766173 Bit 1 = 1: Device saves the non-volatile parameters automatically when they are written Bit 2-31: Reserved, shall be 0 Write: All writable, non-volatile values will be stored in non-volatile memory when the following is sent: Byte 0: 0x73 Byte 1: 0x61 Byte 2: 0x76 Byte 3: 0x65
	02	Status	USINT	RO	Supported values: 0: Default value if the command has not been initiated. Not a supported value otherwise. 1: Last command completed, no error, reply there 2: Last command completed, error, no response.
	03	Response	ARRAY[0..1] OF BYTE	RO	Byte 0: See Subindex 2 Byte 1: Unused
FBF3		Calculate checksum command		RO	Execution of this command will calculate a checksum for all writable, non-volatile parameters as currently stored in non-volatile memory.

21) Idx = Index, sidx = Sub-index, Hexadecimal

22) RO = read only, RW = read/write, P = suitable for process data

Idx ²¹⁾	sidx	Name	Type	Access ²²⁾	Description
	01	Command	ARRAY[0..3] OF BYTE	RW	<p>Read: Returns information about the supported checksum type</p> <p>Bit 0 = 0: No non-volatile parameters supported Bit 0 = 1: Non-volatile parameters supported Bit 1 = 1: CRC-32 Bit 2 = 1: MD5 Bit 3 = 1: SHA-1 Bit 4-6: Reserved, shall be 0 Bit 7 = 1: Other algorithm.</p> <p>Write: Checksum type selection and start calculation. A write access to this subindex shall only set one bit true in Bit[0...7].</p> <p>Bit 0 = 1: Use default checksum algorithm of the device Bit 1 = 1: CRC-32 Bit 2 = 1: MD5 Bit 3 = 1: SHA-1 Bit 4-6: Reserved, shall be 0 Bit 7 = 1: Other algorithm Bit 8...31: Reserved.</p>
	02	Status	USINT	RO	<p>Supported values:</p> <p>0: Default value if the command has not been initiated. Not a supported value otherwise. 1: Last command completed, no error, reply there 2: Last command completed, error, no response</p>
	03	Response	ARRAY[0..n] OF BYTE	RO	<p>Byte 0: See subindex 2 Byte 1: Unused - shall be zero Byte 2-n: Checksum return value. Size varies depending on checksum type used. The maximum length is 64 bytes.</p>
FBF4		Load parameters command		RO	<p>Execution of this command will load all parameters from non-volatile memory.</p>
	01	Command	ARRAY[0..3] OF BYTE	RW	<p>Read:</p> <p>Bit 0 = 1: Device loads the non-volatile parameters when writing 0xFB4:01 with 0x64616F6C Bit 1 = 1: Device saves the non-volatile parameters automatically when they are written.</p> <p>Write:</p> <p>All writable, non-volatile parameters will be loaded from non-volatile memory when the following is sent:</p> <p>Byte 0: 0x6C Byte 1: 0x6F Byte 2: 0x61 Byte 3: 0x64.</p>

21) Idx = Index, sidx = Sub-index, Hexadecimal

22) RO = read only, RW = read/write, P = suitable for process data

Idx ²¹⁾	sidx	Name	Type	Access ²²⁾	Description
	02	Status	USINT	RO	Supported values: 0: Last command completed, no error, no response 1: Reserved 2: Last command completed, error, no response
	03	Re-sponse	AR-RAY[0..1] OF BYTE	RO	Byte 0: See Subindex 2 Byte 1: Unused

Tbl. 17: CDP command objects

5.2 Operating Series 4 multi-stage roots pumps via EtherCAT

5.2.1 Process data: Series 4

Process output data

Process output data are:

- Default RxPDO (control --> Series 4, "output"), CoE 1600h.1 – 4 (1 Byte)

Byte.Bit	CoE ²³⁾	Meaning
0.0	0x7000.0x01: Roughing start/stop	Pumping station (0: off, 1: on)
0.1	0x7000.0x04: Low speed (idle/green mode)	0: Normal, 1: Low speed mode
0.2 – 7.		Reserved

Tbl. 18: Process output data

Process input data

Process input data are:

- Default TxPDO (Series 4 --> control, "input"), CoE 1A00h.1 – 11 (7 Byte)

Byte.Bit	CoE ²⁴⁾	Meaning
0.0	0x6000.0x01: Roughing run/stop	Pumping station (0: off, 1: on)
0.1	0x6000.0x02: Booster run/stop	Roots pump on/off (0: on, 1: off)
0.2	0x6000.0x04: Low speed (idle/green mode)	Idle mode (0: deactivated, 1: activated)
0.3	0x6000.0x05: Remote/Local	0: ECAT, 1: Local
0.4	0x6000.0x09: Warning	0: No warning, 1: Warning
0.5	0x6000.0x0A: Alarm	0: No alarm, 1: Alarm
0.6	0x6000.0x0B: Emergency Off	0: Normal, 1: Stop
0.7	0x6000.0x0C: N2 flow low	0: Normal, 1: N2 flow low
1st – 2.	0x6001.0x02: N2 flow	0.1 l/min
3. – 4.	0x6001.0x03: Exhaust pressure	kPa
5. – 6.	0x6001.0x05: Roughing case temperature	°C
7. – 8.	0x6001.0x09: Roughing current	0.1 A
9. – 10.	0x6001.0x0A: Roughing power	0.1 kW
11. – 12.	0x6001.0x0B: Roughing speed	0.1% of rated speed
13. – 14.	0x6002.0x05: Booster case temperature	°C
15. – 16.	0x6002.0x09: Booster current	0.1 A

21) Idx = Index, sidx = Sub-index, Hexadecimal

22) RO = read only, RW = read/write, P = suitable for process data

23) Hexadecimal

24) Hexadecimal

Byte.Bit	CoE ²⁴⁾	Meaning
17. – 18.	0x6002.0x0A: Booster power	0.1 kW
19. – 20.	0x6002.0x0B: Booster speed	0.1% of rated speed

Tbl. 19: Process input data

Compile process data alternative from CoE objects

1. Always conduct the state "PRE-OPERATIONAL".
2. Describe the object 1601h.0 or 1A01h.0 with 0.
3. Describe the object 1601h.1-n or 1A01h.1-n with corresponding CoE indices.
4. Use only objects marked with "P".
5. Assign the sub-index 1-n on a sequential basis only and without gaps.
6. Make sure that the data yields a total number of bytes (use pad bits if needed) and start with whole bytes (exception BOOL).
7. Describe maximum 12 objects per PDO.
8. Describe the object 1601h.0 or 1A01h.0 with the number n of objects to be used.
9. Change object 1C12h.1 to 1601h or 1C13h.1 to 1A01h.
10. In the process data, select the corresponding PDO assignment 1601h or 1A01h.

The screenshot shows a software interface for configuring PDOs. It includes a 'Sync Manager' table with columns for SM, Size, Type, and Flags. Below it is a 'PDO List' table with columns for Index, Size, Name, Flags, and SM. The 'PDD Assignment (0x1C12)' section has checkboxes for 0x1600 (excluded) and 0x1601 (checked). The 'PDD Content (0x1601)' table lists various parameters like Turbo Start Stop, Turbo Low Speed, Vrit. Enable, and Normal Speed Setpoint with their respective indices, sizes, offsets, and data types (BOOL, UINT).

Output data including 4 pad bits

The screenshot shows a software interface for configuring PDOs. It includes a 'Sync Manager' table with columns for SM, Size, Type, and Flags. Below it is a 'PDO List' table with columns for Index, Size, Name, Flags, and SM. The 'PDD Assignment (0x1C12)' section has checkboxes for 0x1A00 (excluded) and 0x1A01 (checked). The 'PDD Content (0x1601)' table lists various parameters like Alarm, Warning, Ready for Process, Status, Actual Speed (rel.), Power, and Pmp. Temperature with their respective indices, sizes, offsets, and data types (BOOL, USINT, SINT, INT).

Input data including 5 pad bits

Tbl. 20: Example for a process data configuration

5.2.2 Service data: Series 4

Type	Description
BOOL	Binary value (yes/no)
BYTE()	Single byte number
STRING()	Character string
USINT	Positive integer, 8 bit
UINT	Positive integer, 16 bit
UDINT	Positive integer, 32 bit
ULINT	Positive integer, 64 bit
SINT	Integer, 8 bit
INT	Integer, 16 bit
DINT	Integer, 32 bit
REAL	Floating point value, single precision

Tbl. 21: Data types of the service data

The following CoE objects are available for access to individual data objects (e.g., for configuration):

24) Hexadecimal

Administrative data (information about the device, communication)

Idx ²⁵⁾	sIdx	Name	Type	Access ²⁶⁾	Description
1000		Device type	UDINT	RO	Bit 0-15: Device profile number (5003). NOTE: Representation is hexadecimal (i.e. 5003dec -> 0x138B) Bit 16-31: 0x0000, sub-profile number is defined in 0xF010 bit 15..0
1008		Manufacturer device name	STRING(n)	RO	Name of the device as non-zero terminated string.
1009		Manufacturer hardware version	STRING(n)	RO	Hardware version of the device as non-zero terminated string.
100 A		Manufacturer software version	STRING(n)	RO	Software version of the device as non-zero terminated string.
100B		Manufacturer bootloader version	STRING(n)	RO	Bootloader version of the device as non-zero terminated string.
1018		Identity object	IDENTITY	RO	
	01	Vendor ID	UDINT	RO	
	02	Product code	UDINT	RO	
	03	Revision number	UDINT	RO	
	04	Serial number	UDINT	RO	
10F8		Timestamp object	ULINT	RO	Local timestamp of the device in ns.
1600		SDP default RxPDO			
	01h				0x7000.0x01: Roughing start/stop
	02h				0x7000.0x04: Low speed (idle/green mode)
	03h				
1601		User RxPDO			
1A00		SDP default TxPDO			
	01h				0x6000.0x01: Roughing run/stop
	02h				0x6000.0x02: Booster run/stop
	03h				0x6000.0x04: Low speed (idle/green mode)
	04h				0x6000.0x05: Remote/local
	05h				0x6000.0x09: Warning
	06h				0x6000.0x0A: Alarm
	07h				0x6000.0x0B: Emergency Off
	08h				0x6000.0x0C: N2 flow low
	09h				0x6001.0x02: N2 flow
	0Ah				0x6001.0x03: Exhaust pressure
	0Bh				0x6001.0x05: Roughing case temperature
	0Ch				0x6001.0x09: Roughing current
	0Dh				0x6001.0x0A: Roughing power
	0Eh				0x6001.0x0B: Roughing speed
	0Fh				0x6002.0x05: Booster case temperature
	10h				0x6002.0x09: Booster current
	11h				0x6002.0x0A: Booster power
	12h				0x6002.0x0B: Booster speed

25) Idx = Index, sIdx = Sub-index, Hexadecimal

26) RO = read only, RW = read/write, P = suitable for process data

Idx ²⁵⁾	sidx	Name	Type	Access ²⁶⁾	Description
1A01		User TxPDO			
1C00		Sync manager type			
1C10		Sync manager 0 PDO assignment			
1C11		Sync manager 1 PDO assignment			
1C12		RxPDO assign (sync manager 2 PDO assignment)			
1C13		TxPDO assign (sync manager 3 PDO assignment)			

Tbl. 22: Communication area – administrative data (information about the device, communication)

Input data (S4 --> control)

Idx ²⁷⁾	sidx	Name	Type	Access ²⁸⁾	Description
6000		Roughing and booster status		RO	
	01	Roughing run/stop	BOOL	RO	1: Run 0: Stop
	02	Booster run/stop	BOOL	RO	1: Run 0: Stop
	03	Booster 2 run/stop			1: Run 0: Stop
	04	Low speed (idle/sleep/ green mode)	BOOL	RO	1: Low speed (idle /sleep / green mode) 0: Normal
	05	Remote/local	BOOL	RO	1: Local. Hand control enabled 0: Remote, E-cat control enabled
	06	Inlet gate valve	BOOL	RO	1: Open 0: Closed Mandatory if inlet gate valve fitted
	07	Pump interlock	BOOL	RO	1: OK, process may proceed 0: Process must not run
	08	N2 level ready	BOOL	RO	1: OK (high level) 0: Not ready (low level)
	09	Warning	BOOL	RO	1: Warning 0: Normal
	0 A	Alarm	BOOL	RO	1: Alarm 0: Normal
	0B	Emergency off	BOOL	RO	1: Stop 0: Normal
	0C	N2 flow low	BOOL	RO	1: N2 flow low 0: Normal
	11	Multiple sleep (green) level setting	UINT	RO	0: Idle/sleep level 0 (default) 1- 255: Sleep (green) modes

25) Idx = Index, sidx = Sub-index, Hexadecimal

26) RO = read only, RW = read/write, P = suitable for process data

27) Idx = Index, sidx = Sub-index, Hexadecimal

28) RO = read only, RW = read/write, P = suitable for process data

Idx ²⁷⁾	sidx	Name	Type	Access ²⁸⁾	Description
6001		Roughing analog inputs			
	01	Coolant flow	INT	RO	0.1 [l/min]
	02	N2 flow	INT	RO	0.1 [slm]
	03	Exhaust pressure	INT	RO	Gauge pressure (not absolute) - 1 [kPa]
	05	Roughing case temperature	INT	RO	Degrees Celsius
	06	Roughing optional temperature	INT	RO	Degrees Celsius
	09	Roughing current	INT	RO	0.1 [A]
	0 A	Roughing power	INT	RO	0.1 [kW]
	0B	Roughing speed	INT	RO	1000 (100.0%): Rated speed 0 (0.0%): 0 Rotation, 0.1 [%]
6002		Booster analog inputs		RO	
	05	Booster case temperature	INT	RO	Degrees Celsius
	09	Booster current	INT	RO	0.1 [A]
	0 A	Booster power	INT	RO	0.1 [kW]
	0B	Booster speed	INT	RO	1000 (100.0%): Rated speed 0 (0.0%): 0 Rotation, 0.1 [%]
6003		Booster 2 analog inputs		RO	
	05		INT	RO	Degrees Celsius
	09	Booster 2 current	INT	RO	0.1 [A]
	0 A	Booster 2 power	INT	RO	0.1 [kW]
	0B	Booster 2 speed	INT	RO	1000 (100.0%): Rated speed 0 (0.0%): 0 Rotation, 0.1 [%]

Tbl. 23: Input area

Output data (control --> S4)

Idx ²⁹⁾	sidx	Name	Type	Access ³⁰⁾	Description
7000		Roughing and booster control		RO	
	01	Roughing start/stop	BOOL	RW	1: Run 0: Stop
	02	Booster start/stop	BOOL	RW	1: Run 0: Stop
	03	Booster 2 start/stop	BOOL	RW	1: Run 0: Stop
	04	Low speed (idle/sleep/green mode)	BOOL	RW	1: Low speed (idle/sleep/green mode) 0: Normal
	06	N2 ballast valve	BOOL	RW	1: Open ballast valve 0: Close ballast valve

27) Idx = Index, sidx = Sub-index, Hexadecimal

28) RO = read only, RW = read/write, P = suitable for process data

29) Idx = Index, sidx = Sub-index, Hexadecimal

30) RO = read only, RW = read/write, P = suitable for process data

Idx ²⁹⁾	sidx	Name	Type	Access ³⁰⁾	Description
	07	Inlet gate valve	BOOL	RW	1: Open gate valve 0: Close gate valve
	11	Multiple sleep (green) level setting	UINT	RW	0: Idle/sleep level 0 (default) 1-255: Sleep (green) levels.

Tbl. 24: Output area

Configuration data (control --> S4)

Idx ³¹⁾	sidx	Name	Type	Access ³²⁾	Description
8001		Roughing and booster configuration		RO	
	01	Safe state	UINT	RW	0: Maintain state (hold last state) (default) 1: Go to default state (power up/reset state) - pumps stop
	02	Booster and booster 2 control mode setting	UINT	RW	0: Co-ordinated mode (default) 1: Independent mode
	03	Gate valve control mode setting	UINT	RW	0: Co-ordinated mode (default) 1: Independent mode

Tbl. 25: Configuration area

Information data (S4 --> control)

Idx ³³⁾	sidx	Name	Type	Access ³⁴⁾	Description
9000		Roughing and booster information		RO	
	01	Roughing exists	BOOL	RO	0: Not available 1: Available
	02	Booster exists	BOOL	RO	0: Not available 1: Available
	03	Booster 2 exists	BOOL	RO	0: Not available 1: Available
	11	Roughing and booster running time	UDINT	RO	Running time since manufacture or service - 1 [hours]
9001		Sleep level wake-up time		RO	
	01		UINT	RO	Wake-up time. Unit: Seconds

Tbl. 26: Information area

29) Idx = Index, sidx = Sub-index, Hexadecimal

30) RO = read only, RW = read/write, P = suitable for process data

31) Idx = Index, sidx = Sub-index, Hexadecimal

32) RO = read only, RW = read/write, P = suitable for process data

33) Idx = Index, sidx = Sub-index, Hexadecimal

34) RO = read only, RW = read/write, P = suitable for process data

Semiconductor device profile area

Idx ³⁵⁾	sldx	Name	Type	Access ³⁶⁾	Description
F000		Semiconductor device profile		RO	
	01	Index distance	UINT		
	02	Maximum number of modules	UINT		
F010		Module profile list		RO	
	01		UDINT	RO	

Tbl. 27: Semiconductor device profile area

Exception handling

Idx ³⁷⁾	sldx	Name	Type	Access ³⁸⁾	Description
F380		Active exception status	USINT	RO	A condensed summary byte describing the collection of active device exceptions after corresponding masks (0xF3Ax) were applied.
		Bit0: Device warning			Bit0: Device warning
		Bit1: Manufacturer warning			Bit1: Manufacturer warning
		Bit2: Device error			Bit2: Device error
		Bit3: Manufacturer error			Bit3: Manufacturer error
		Bit4: Reserved			Bit4: Reserved
		Bit5: Reserved			Bit5: Reserved
		Bit6: Reserved			Bit6: Reserved
		Bit7: Reserved			Bit7: Reserved
F381		Roughing and booster 1 to 255: Active warning detail		RO	
	01		UDINT	RO	Expanded details of the device warning exceptions. For each bit: 1: Occur 0: Normal/not available
		Bit2: Power fail open phase			Bit2: Power fail open phase
		Bit4: Coolant flow			Bit4: Coolant flow
		Bit5: N2 flow			Bit5: N2 flow
		Bit6: Exhaust pressure			Bit6: Exhaust pressure
		Bit8: Main controller err/batt low			Bit8: Main controller err/batt low
		Bit9: Roughing case temp			Bit9: Roughing case temp
		Bit10: Roughing motor temp			Bit10: Roughing motor temp
		Bit11: Roughing current			Bit11: Roughing current
		Bit12: Roughing speed			Bit12: Roughing speed
		Bit13: Roughing lock rotor			Bit13: Roughing lock rotor
		Bit14: Roughing motor driver err			Bit14: Roughing motor driver err
		Bit15: Booster case temp.			Bit15: Booster case temp.
		Bit16: Booster motor temp.			Bit16: Booster motor temp.
		Bit17: Booster current			Bit17: Booster current
		Bit18: Booster speed			Bit18: Booster speed

35) Idx = Index, sldx = Sub-index, Hexadecimal
 36) RO = read only, RW = read/write, P = suitable for process data
 37) Idx = Index, sldx = Sub-index, Hexadecimal
 38) RO = read only, RW = read/write, P = suitable for process data

Idx ³⁷⁾	sidx	Name	Type	Access ³⁸⁾	Description
		Bit19: Booster lock rotor			Bit19: Booster lock rotor
		Bit20: Booster motor driver err			Bit20: Booster motor driver err
		Bit21: Booster 2 case temp.			Bit21: Booster 2 case temp.
		Bit23: Booster 2 current			Bit23: Booster 2 current
		Bit24: Booster 2 speed			Bit24: Booster 2 speed
		Bit25: Booster 2 lock rotor			Bit25: Booster 2 lock rotor
		Bit26: Booster 2 motor driver err			Bit26: Booster 2 motor driver err
		Bit27: Gate valve err			Bit27: Gate valve err
		Bit31: Others			Bit31: Others
F383		Roughing and booster 1 to 255: Active error (alarm) detail		RO	
	01		UDINT	RO	Expanded details of the device warning exceptions. For each bit: 1: Occur 0: Normal/not available
		Bit0: EMO			Bit0: EMO
		Bit2: Power fail open phase			Bit2: Power fail open phase
		Bit3: Reverse phase			Bit3: Reverse phase
		Bit 4: Coolant flow			Bit 4: Coolant flow
		Bit5: N2 flow			Bit5: N2 flow
		Bit6: Exhaust pressure			Bit6: Exhaust pressure
		Bit8: Main controller err/batt low			Bit8: Main controller err/batt low
		Bit9: Roughing case temp			Bit9: Roughing case temp
		Bit10: Roughing motor temp			Bit10: Roughing motor temp
		Bit11: Roughing current			Bit11: Roughing current
		Bit12: Roughing speed			Bit12: Roughing speed
		Bit13: Roughing lock rotor			Bit13: Roughing lock rotor
		Bit14: Roughing motor driver err			Bit14: Roughing motor driver err
		Bit15: Booster case temp.			Bit15: Booster case temp.
		Bit16: Booster motor temp.			Bit16: Booster motor temp.
		Bit17: Booster current			Bit17: Booster current
		Bit18: Booster speed			Bit18: Booster speed
		Bit19: Booster lock rotor			Bit19: Booster lock rotor
		Bit20: Booster motor driver err			Bit20: Booster motor driver err
		Bit21: Booster 2 case temp.			Bit21: Booster 2 case temp.
		Bit23: Booster 2 current			Bit23: Booster 2 current
		Bit24: Booster 2 speed			Bit24: Booster 2 speed
		Bit25: Booster 2 lock rotor			Bit25: Booster 2 lock rotor
		Bit26: Booster 2 motor driver err			Bit26: Booster 2 motor driver err
		Bit27: Gate valve err			Bit27: Gate valve err
		Bit31: Others			Bit31: Others

37) Idx = Index, sidx = Sub-index, Hexadecimal

38) RO = read only, RW = read/write, P = suitable for process data

Idx ³⁷⁾	sidx	Name	Type	Access ³⁸⁾	Description
F390		Latched exception status	USINT	RO	A condensed summary byte describing the collection of device exceptions after corresponding masks (0xF3Ax) were applied. See CDP for additional information.
		Bit0: Device warning			Bit0: Device warning
		Bit1: Manufacturer warning			Bit1: Manufacturer warning
		Bit2: Device error			Bit2: Device error
		Bit3: Manufacturer error			Bit3: Manufacturer error
		Bit4: Reserved			Bit4: Reserved
		Bit5: Reserved			Bit5: Reserved
		Bit6: Reserved			Bit6: Reserved
		Bit7: Reserved			Bit7: Reserved
F391		Roughing and booster 1 to 255: Latched warning detail		RO	
	01		UDINT	RO	Expanded details of the device warning exceptions. For each bit: 1: Occur 0: Normal/not available
		Bit0: EMO			Bit0: EMO
		Bit1: Water leak			Bit1: Water leak
		Bit2: Power fail open phase			Bit2: Power fail open phase
		Bit3: Reverse phase			Bit3: Reverse phase
		Bit4: Coolant flow			Bit4: Coolant flow
		Bit5: N2 flow			Bit5: N2 flow
		Bit6: Exhaust pressure			Bit6: Exhaust pressure
		Bit7: Exhaust temp.			Bit7: Exhaust temp.
		Bit8: Main controller err/batt low			Bit8: Main controller err/batt low
		Bit9: Roughing case temp			Bit9: Roughing case temp
		Bit10: Roughing motor temp			Bit10: Roughing motor temp
		Bit11: Roughing current			Bit11: Roughing current
		Bit12: Roughing speed			Bit12: Roughing speed
		Bit13: Roughing lock rotor			Bit13: Roughing lock rotor
		Bit14: Roughing motor driver err			Bit14: Roughing motor driver err
		Bit15: Booster case temp.			Bit15: Booster case temp.
		Bit16: Booster motor temp.			Bit16: Booster motor temp.
		Bit17: Booster current			Bit17: Booster current
		Bit18: Booster speed			Bit18: Booster speed
		Bit19: Booster lock rotor			Bit19: Booster lock rotor
		Bit20: Booster motor driver err			Bit20: Booster motor driver err
		Bit21: Booster 2 case temp.			Bit21: Booster 2 case temp.
		Bit22: Booster 2 motor temp.			Bit22: Booster 2 motor temp.
		Bit23: Booster 2 current			Bit23: Booster 2 current
		Bit24: Booster 2 speed			Bit24: Booster 2 speed
		Bit25: Booster 2 lock rotor			Bit25: Booster 2 lock rotor

37) Idx = Index, sidx = Sub-index, Hexadecimal

38) RO = read only, RW = read/write, P = suitable for process data

Idx ³⁷⁾	sidx	Name	Type	Access ³⁸⁾	Description
		Bit26: Booster 2 motor driver err			Bit26: Booster 2 motor driver err
		Bit27: Gate valve err			Bit27: Gate valve err
		Bit28: Future use			Bit28: Future use
		Bit29: Future use			Bit29: Future use
		Bit30: Future use			Bit30: Future use
		Bit31: Others			Bit31: Others
F393		Roughing and booster 1 to 255: Latched error (alarm) detail		RO	
	01		UDINT	RO	Expanded details of the device warning exceptions. For each bit: 1: Occur 0: Normal/not available
		Bit0: EMO			Bit0: EMO
		Bit1: Water leak			Bit1: Water leak
		Bit2: Power fail open phase			Bit2: Power fail open phase
		Bit3: Reverse phase			Bit3: Reverse phase
		Bit4: Coolant flow			Bit4: Coolant flow
		Bit5: N2 flow			Bit5: N2 flow
		Bit6: Exhaust pressure			Bit6: Exhaust pressure
		Bit7: Exhaust temp.			Bit7: Exhaust temp.
		Bit8: Main controller err/batt low			Bit8: Main controller err/batt low
		Bit9: Roughing case temp			Bit9: Roughing case temp
		Bit10: Roughing motor temp			Bit10: Roughing motor temp
		Bit11: Roughing current			Bit11: Roughing current
		Bit12: Roughing speed			Bit12: Roughing speed
		Bit13: Roughing lock rotor			Bit13: Roughing lock rotor
		Bit14: Roughing motor driver err			Bit14: Roughing motor driver err
		Bit15: Booster case temp.			Bit15: Booster case temp.
		Bit16: Booster motor temp.			Bit16: Booster motor temp.
		Bit17: Booster current			Bit17: Booster current
		Bit18: Booster speed			Bit18: Booster speed
		Bit19: Booster lock rotor			Bit19: Booster lock rotor
		Bit20: Booster motor driver err			Bit20: Booster motor driver err
		Bit21: Booster 2 case temp.			Bit21: Booster 2 case temp.
		Bit22: Booster 2 motor temp.			Bit22: Booster 2 motor temp.
		Bit23: Booster 2 current			Bit23: Booster 2 current
		Bit24: Booster 2 speed			Bit24: Booster 2 speed
		Bit25: Booster 2 lock rotor			Bit25: Booster 2 lock rotor
		Bit26: Booster 2 motor driver err			Bit26: Booster 2 motor driver err
		Bit27: Gate valve err			Bit27: Gate valve err
		Bit28: Future use			Bit28: Future use
		Bit29: Future use			Bit29: Future use
		Bit30: Future use			Bit30: Future use

37) Idx = Index, sidx = Sub-index, Hexadecimal

38) RO = read only, RW = read/write, P = suitable for process data

Idx ³⁷⁾	sidx	Name	Type	Access ³⁸⁾	Description
		Bit31: Others			Bit31: Others
F3A1		Roughing and booster 1 to 255: Warning mask		RO	
	01		UDINT	RW	Bitmask to include the corresponding device warning exception bits (as defined in the device warning details) in the active and latched exception status objects (0xF380 bit 0 and 0xF390 bit 0), if the corresponding bit is TRUE.
F3A3		Roughing and booster 1 to 255: Error (alarm) mask		RO	
	01		UDINT	RW	Bitmask to include the corresponding device error exception bits (as defined in the device error details) in the active and latched exception status objects (0xF380 bit 2 and 0xF390 bit 2), if the corresponding bit is TRUE.
F6F0		Input latch local timestamp		RO	
	01	Input latch local timestamp	UDINT	RO	Local controller time corresponding to the input latch time in microseconds. It starts at zero on device power-up.

Tbl. 28: Exception handling

CDP-specific information data

Idx ³⁹⁾	sidx	Name	Type	Access ⁴⁰⁾	Description
F9F0		Manufacturer serial number	STRING(n)	RO	String representing the manufacturer's serial number for the device. NOTE: This may have the same value as 0x1018:04.
F9F1		CDP functional generation number		RO	
	01		UDINT	RO	Common device profile functional generation number 2
F9F2		SDP functional generation number		RO	
	01		UDINT	RO	SDP functional generation number of nn-th module shall be specified by each SDP.2
F9F3		Vendor name	STRING(n)	RO	This string identifies the supplier of the device.
F9F4		SDP device name		RO	
	01		STRING(n)	RO	String identifying the device type of nn-th module as defined by the SDP.
F9F5		Output identifier		RO	

37) Idx = Index, sidx = Sub-index, Hexadecimal

38) RO = read only, RW = read/write, P = suitable for process data

39) Idx = Index, sidx = Sub-index, Hexadecimal

40) RO = read only, RW = read/write, P = suitable for process data

Idx ³⁹⁾	sidx	Name	Type	Access ⁴⁰⁾	Description
	01		USINT	RO	Output identifier of nn-th module. This value can be mapped to both the RxPDO and TxPDO. The required function of the device is to store the value in memory as written by the host. The controller can then read this value back through the TxPDO to ensure the RxPDO was received.
F9F6		Time since power on	UDINT	RO	This is the time the device has currently been powered on, in seconds, regardless of communication presence.
F9F8		Firmware update: functional generation number	UDINT	RO	Firmware update of functional generation number supported by the device. Value shall be specified by the Firmware Update Profile (ETG.5003-2)0x00000000: FW update according to ETG.5003-2 not supported. A device cannot return this value and still be compliant with ETG.5003.1, as ETG.5003-2 compliance is mandatory.

Tbl. 29: CDP-specific information data

CDP command objects

Idx ⁴¹⁾	sidx	Name	Type	Access ⁴²⁾	Description
FBF0		Device reset command		RO	Execution of this command causes the device to emulate a complete power cycle. This includes an ESC reset. There are two versions of this command: Device reset: Backup parameters will not change as a result of this reset. All setting parameters will revert to power-on defaults as a result of the reset. Factory reset: All backup parameters will be changed to their as-shipped defaults. All setting parameters will revert to power-on defaults as a result of the reset.
	01	Command	ARRAY[0..5] OF BYTE	RW	A device reset is initiated when the following byte sequence is sent: Byte 0: 0x74 Byte 1: 0x65 Byte 2: 0x73 Byte 3: 0x65 Byte 4: 0x72 Byte 5: Device standard reset = 0x00, factory reset = 0x66
	02	Status	USINT	RO	Supported values: 0: Default value if the command has not been initiated. Not a supported value otherwise. 1: Reserved 2: Last command completed, error, no response.
	03	Response	ARRAY[0..1] OF BYTE	RO	Byte 0: See subindex 2 Byte 1: Unused - shall be zero

39) Idx = Index, sidx = Sub-index, Hexadecimal

40) RO = read only, RW = read/write, P = suitable for process data

41) Idx = Index, sidx = Sub-index, Hexadecimal

42) RO = read only, RW = read/write, P = suitable for process data

Idx ⁴¹⁾	sidx	Name	Type	Access ⁴²⁾	Description
FBF1		Exception reset command		RO	Execution of this command clears the latched exceptions.
	01	Command	ARRAY[0..4] OF BYTE	RW	A latched exception reset is initiated when the following byte sequence is sent: Byte 0: 0x74 Byte 1: 0x65 Byte 2: 0x73 Byte 3: 0x65 Byte 4: 0x72
	02	Status	USINT	RO	Supported values: 0: Last command completed, no error, no response 1: Reserved 2: Last command completed, error, no response
	03	Response	ARRAY[0..1] OF BYTE	RO	Byte 0: See subindex 2 Byte 1: Unused.
FBF2		Store parameters command		RO	Execution of this command will store all parameters to non-volatile memory.
	01	Command	ARRAY[0..3] OF BYTE	RW	Read: Bit 0 = 1: Device saves the non-volatile parameters when writing 0xFB2:01 with 0x65766173 Bit 1 = 1: Device saves the non-volatile parameters automatically when they are written Bit 2-31: Reserved, shall be 0 Write: All writable, non-volatile values will be stored in non-volatile memory when the following is sent: Byte 0: 0x73 Byte 1: 0x61 Byte 2: 0x76 Byte 3: 0x65
	02	Status	USINT	RO	Supported values: 0: Default value if the command has not been initiated. Not a supported value otherwise. 1: Last command completed, no error, reply there 2: Last command completed, error, no response.
	03	Response	ARRAY[0..1] OF BYTE	RO	Byte 0: See Subindex 2 Byte 1: Unused
FBF3		Calculate checksum command		RO	Execution of this command will calculate a checksum for all writable, non-volatile parameters as currently stored in non-volatile memory.

41) Idx = Index, sidx = Sub-index, Hexadecimal

42) RO = read only, RW = read/write, P = suitable for process data

Idx ⁴¹⁾	sidx	Name	Type	Access ⁴²⁾	Description
	01	Command	ARRAY[0..3] OF BYTE	RW	<p>Read: Returns information about the supported checksum type</p> <p>Bit 0 = 0: No non-volatile parameters supported Bit 0 = 1: Non-volatile parameters supported</p> <p>Bit 1 = 1: CRC-32 Bit 2 = 1: MD5 Bit 3 = 1: SHA-1 Bit 4-6: Reserved, shall be 0 Bit 7 = 1: Other algorithm.</p> <p>Write: Checksum type selection and start calculation. A write access to this subindex shall only set one bit true in Bit[0...7].</p> <p>Bit 0 = 1: Use default checksum algorithm of the device Bit 1 = 1: CRC-32 Bit 2 = 1: MD5 Bit 3 = 1: SHA-1 Bit 4-6: Reserved, shall be 0 Bit 7 = 1: Other algorithm Bit 8...31: Reserved.</p>
	02	Status	USINT	RO	<p>Supported values:</p> <p>0: Default value if the command has not been initiated. Not a supported value otherwise. 1: Last command completed, no error, reply there 2: Last command completed, error, no response</p>
	03	Response	ARRAY[0..n] OF BYTE	RO	<p>Byte 0: See subindex 2 Byte 1: Unused - shall be zero Byte 2-n: Checksum return value. Size varies depending on checksum type used. The maximum length is 64 bytes.</p>
FBF4		Load parameters command		RO	Execution of this command will load all parameters from non-volatile memory.
	01	Command	ARRAY[0..3] OF BYTE	RW	<p>Read:</p> <p>Bit 0 = 1: Device loads the non-volatile parameters when writing 0xFBf4:01 with 0x64616F6C Bit 1 = 1: Device saves the non-volatile parameters automatically when they are written.</p> <p>Write:</p> <p>All writable, non-volatile parameters will be loaded from non-volatile memory when the following is sent:</p> <p>Byte 0: 0x6C Byte 1: 0x6F Byte 2: 0x61 Byte 3: 0x64.</p>

41) Idx = Index, sidx = Sub-index, Hexadecimal

42) RO = read only, RW = read/write, P = suitable for process data

Idx ⁴¹⁾	sidx	Name	Type	Access ⁴²⁾	Description
	02	Status	USINT	RO	Supported values: 0: Last command completed, no error, no response 1: Reserved 2: Last command completed, error, no response
	03	Re-sponse	AR-RAY[0..1] OF BYTE	RO	Byte 0: See Subindex 2 Byte 1: Unused

Tbl. 30: CDP command objects

5.3 Operating Ultidry multi-stage roots pumps via EtherCAT

5.3.1 Process data: UltiDry

Process output data

Process output data are:

- Default RxPDO (control --> UltiDry, "output"), CoE 1600h.1 – 4 (1 Byte)

Byte.Bit	CoE ⁴³⁾	Meaning
0.0	0x7000.0x01: Roughing start/stop	Pumping station (0: off, 1: on)
0.1	0x7000.0x04: Low speed (idle/green mode)	0: Normal, 1: Low speed mode
0.2 – 7.		Reserved

Tbl. 31: Process output data

Process input data

Process input data are:

- Default TxPDO (UltiDry --> control, "input"), CoE 1A00h.1 – 11 (7 Byte)

Byte.Bit	CoE ⁴⁴⁾	Meaning
0.0	0x6000.0x01: Roughing run/stop	Pumping station (0: off, 1: on)
0.1	0x6000.0x02: Booster run/stop	Roots pump on/off (0: on, 1: off)
0.2	0x6000.0x04: Low speed (idle/green mode)	Idle mode (0: deactivated, 1: activated)
0.3	0x6000.0x05: Remote/Local	0: ECAT, 1: Local
0.4	0x6000.0x09: Warning	0: No warning, 1: Warning
0.5	0x6000.0x0A: Alarm	0: No alarm, 1: Alarm
0.6	0x6000.0x0B: Emergency Off	0: Normal, 1: Stop
0.7	0x6000.0x0C: N2 flow low	0: Normal, 1: N2 flow low
1st – 2.	0x6001.0x02: N2 flow	0.1 l/min
3. – 4.	0x6001.0x03: Exhaust pressure	kPa
5. – 6.	0x6001.0x05: Roughing case temperature	°C
7. – 8.	0x6001.0x09: Roughing current	0.1 A
9. – 10.	0x6001.0x0A: Roughing power	0.1 kW
11. – 12.	0x6001.0x0B: Roughing speed	0.1% of rated speed
13. – 14.	0x6002.0x05: Booster case temperature	°C
15. – 16.	0x6002.0x09: Booster current	0.1 A

41) Idx = Index, sidx = Sub-index, Hexadecimal

42) RO = read only, RW = read/write, P = suitable for process data

43) Hexadecimal

44) Hexadecimal

Byte.Bit	CoE ⁴⁴⁾	Meaning
17. – 18.	0x6002.0x0A: Booster power	0.1 kW
19. – 20.	0x6002.0x0B: Booster speed	0.1% of rated speed

Tbl. 32: Process input data

Compile process data alternative from CoE objects

1. Always conduct the state "PRE-OPERATIONAL".
2. Describe the object 1601h.0 or 1A01h.0 with 0.
3. Describe the object 1601h.1-n or 1A01h.1-n with corresponding CoE indices.
4. Use only objects marked with "P".
5. Assign the sub-index 1-n on a sequential basis only and without gaps.
6. Make sure that the data yields a total number of bytes (use pad bits if needed) and start with whole bytes (exception BOOL).
7. Describe maximum 12 objects per PDO.
8. Describe the object 1601h.0 or 1A01h.0 with the number n of objects to be used.
9. Change object 1C12h.1 to 1601h or 1C13h.1 to 1A01h.
10. In the process data, select the corresponding PDO assignment 1601h or 1A01h.

The screenshot shows a software interface for configuring PDOs. It includes a 'Sync Manager' table with columns for SM, Size, Type, and Flags. Below it is a 'PDD List' table with columns for Index, Size, Name, Flags, and SM. The 'PDD Assignment (0x1C12)' section shows a list of objects with checkboxes, where 0x1601 is selected. The 'PDD Content (0x1601)' table lists various parameters like Turbo Start Stop, Turbo Low Speed, Vrit. Enable, and Normal Speed Setpoint with their respective indices, sizes, and offsets.

Output data including 4 pad bits

The screenshot shows a software interface for configuring PDOs. It includes a 'Sync Manager' table with columns for SM, Size, Type, and Flags. Below it is a 'PDD List' table with columns for Index, Size, Name, Flags, and SM. The 'PDD Assignment (0x1C12)' section shows a list of objects with checkboxes, where 0x1A01 is selected. The 'PDD Content (0x1601)' table lists various parameters like Alarm, Warning, Ready for Process, Status, Actual Speed (rel.), Power, and Pmp. Temperature with their respective indices, sizes, and offsets.

Input data including 5 pad bits

Tbl. 33: Example for a process data configuration

5.3.2 Service data: UltiDry

Type	Description
BOOL	Binary value (yes/no)
BYTE()	Single byte number
STRING()	Character string
USINT	Positive integer, 8 bit
UINT	Positive integer, 16 bit
UDINT	Positive integer, 32 bit
ULINT	Positive integer, 64 bit
SINT	Integer, 8 bit
INT	Integer, 16 bit
DINT	Integer, 32 bit
REAL	Floating point value, single precision

Tbl. 34: Data types of the service data

The following CoE objects are available for access to individual data objects (e.g., for configuration):

44) Hexadecimal

Administrative data (information about the device, communication)

Idx ⁴⁵⁾	sIdx	Name	Type	Access ⁴⁶⁾	Description
1000		Device type	UDINT	RO	Bit 0-15: Device profile number (5003). NOTE: Representation is hexadecimal (i.e. 5003dec -> 0x138B) Bit 16-31: 0x0000, sub-profile number is defined in 0xF010 bit 15..0
1008		Manufacturer device name	STRING(n)	RO	Name of the device as non-zero terminated string.
1009		Manufacturer hardware version	STRING(n)	RO	Hardware version of the device as non-zero terminated string.
100 A		Manufacturer software version	STRING(n)	RO	Software version of the device as non-zero terminated string.
100B		Manufacturer boot-loader version	STRING(n)	RO	Bootloader version of the device as non-zero terminated string.
1018		Identity object	IDENTITY	RO	
	01	Vendor ID	UDINT	RO	
	02	Product code	UDINT	RO	
	03	Revision number	UDINT	RO	
	04	Serial number	UDINT	RO	
10F8		Timestamp object	ULINT	RO	Local timestamp of the device in ns.
1600		SDP default RxPDO			
	01h				0x7000.0x01: Roughing start/stop
	02h				0x7000.0x04: Low speed (idle/green mode)
	03h				
1601		User RxPDO			
1A00		SDP default TxPDO			
	01h				0x6000.0x01: Roughing run/stop
	02h				0x6000.0x02: Booster run/stop
	03h				0x6000.0x04: Low speed (idle/green mode)
	04h				0x6000.0x05: Remote/local
	05h				0x6000.0x09: Warning
	06h				0x6000.0x0A: Alarm
	07h				0x6000.0x0B: Emergency Off
	08h				0x6000.0x0C: N2 flow low
	09h				0x6001.0x02: N2 flow
	0Ah				0x6001.0x03: Exhaust pressure
	0Bh				0x6001.0x05: Roughing case temperature
	0Ch				0x6001.0x09: Roughing current
	0Dh				0x6001.0x0A: Roughing power
	0Eh				0x6001.0x0B: Roughing speed
	0Fh				0x6002.0x05: Booster case temperature
	10h				0x6002.0x09: Booster current
	11h				0x6002.0x0A: Booster power
	12h				0x6002.0x0B: Booster speed

45) Idx = Index, sIdx = Sub-index, Hexadecimal

46) RO = read only, RW = read/write, P = suitable for process data

Idx ⁴⁵⁾	sidx	Name	Type	Access ⁴⁶⁾	Description
1A01		User TxPDO			
1C00		Sync manager type			
1C10		Sync manager 0 PDO assignment			
1C11		Sync manager 1 PDO assignment			
1C12		RxPDO assign (sync manager 2 PDO assignment)			
1C13		TxPDO assign (sync manager 3 PDO assignment)			

Tbl. 35: Communication area – administrative data (information about the device, communication)

Input data (UltiDry --> control)

Idx ⁴⁷⁾	sidx	Name	Type	Access ⁴⁸⁾	Description
6000		Roughing and booster status		RO	
	01	Roughing run/stop	BOOL	RO	1: Run 0: Stop
	02	Booster run/stop	BOOL	RO	1: Run 0: Stop
	03	Booster 2 run/stop			1: Run 0: Stop
	04	Low speed (idle/sleep/ green mode)	BOOL	RO	1: Low speed (idle /sleep / green mode) 0: Normal
	05	Remote/local	BOOL	RO	1: Local. Hand control enabled 0: Remote, E-cat control enabled
	06	Inlet gate valve	BOOL	RO	1: Open 0: Closed Mandatory if inlet gate valve fitted
	07	Pump interlock	BOOL	RO	1: OK, process may proceed 0: Process must not run
	08	N2 level ready	BOOL	RO	1: OK (high level) 0: Not ready (low level)
	09	Warning	BOOL	RO	1: Warning 0: Normal
	0 A	Alarm	BOOL	RO	1: Alarm 0: Normal
	0B	Emergency off	BOOL	RO	1: Stop 0: Normal
	0C	N2 flow low	BOOL	RO	1: N2 flow low 0: Normal
	11	Multiple sleep (green) level setting	UINT	RO	0: Idle/sleep level 0 (default) 1- 255: Sleep (green) modes

45) Idx = Index, sidx = Sub-index, Hexadecimal

46) RO = read only, RW = read/write, P = suitable for process data

47) Idx = Index, sidx = Sub-index, Hexadecimal

48) RO = read only, RW = read/write, P = suitable for process data

Idx ⁴⁷⁾	sidx	Name	Type	Access ⁴⁸⁾	Description
6001		Roughing analog inputs			
	01	Coolant flow	INT	RO	0.1 [l/min]
	02	N2 flow	INT	RO	0.1 [slm]
	03	Exhaust pressure	INT	RO	Gauge pressure (not absolute) - 1 [kPa]
	05	Roughing case temperature	INT	RO	Degrees Celsius
	06	Roughing optional temperature	INT	RO	Degrees Celsius
	09	Roughing current	INT	RO	0.1 [A]
	0 A	Roughing power	INT	RO	0.1 [kW]
	0B	Roughing speed	INT	RO	1000 (100.0%): Rated speed 0 (0.0%): 0 Rotation, 0.1 [%]
6002		Booster analog inputs		RO	
	05	Booster case temperature	INT	RO	Degrees Celsius
	09	Booster current	INT	RO	0.1 [A]
	0 A	Booster power	INT	RO	0.1 [kW]
	0B	Booster speed	INT	RO	1000 (100.0%): Rated speed 0 (0.0%): 0 Rotation, 0.1 [%]
6003		Booster 2 analog inputs		RO	
	05		INT	RO	Degrees Celsius
	09	Booster 2 current	INT	RO	0.1 [A]
	0 A	Booster 2 power	INT	RO	0.1 [kW]
	0B	Booster 2 speed	INT	RO	1000 (100.0%): Rated speed 0 (0.0%): 0 Rotation, 0.1 [%]

Tbl. 36: Input area

Output data (control --> UltiDry)

Idx ⁴⁹⁾	sidx	Name	Type	Access ⁵⁰⁾	Description
7000		Roughing and booster control		RO	
	01	Roughing start/stop	BOOL	RW	1: Run 0: Stop
	02	Booster start/stop	BOOL	RW	1: Run 0: Stop
	03	Booster 2 start/stop	BOOL	RW	1: Run 0: Stop
	04	Low speed (idle/sleep/green mode)	BOOL	RW	1: Low speed (idle/sleep/green mode) 0: Normal
	06	N2 ballast valve	BOOL	RW	1: Open ballast valve 0: Close ballast valve

47) Idx = Index, sidx = Sub-index, Hexadecimal

48) RO = read only, RW = read/write, P = suitable for process data

49) Idx = Index, sidx = Sub-index, Hexadecimal

50) RO = read only, RW = read/write, P = suitable for process data

Idx ⁴⁹⁾	sidx	Name	Type	Access ⁵⁰⁾	Description
	07	Inlet gate valve	BOOL	RW	1: Open gate valve 0: Close gate valve
	11	Multiple sleep (green) level setting	UINT	RW	0: Idle/sleep level 0 (default) 1-255: Sleep (green) levels.

Tbl. 37: Output area

Configuration data (control --> UltiDry)

Idx ⁵¹⁾	sidx	Name	Type	Access ⁵²⁾	Description
8001		Roughing and booster configuration		RO	
	01	Safe state	UINT	RW	0: Maintain state (hold last state) (default) 1: Go to default state (power up/reset state) - pumps stop
	02	Booster and booster 2 control mode setting	UINT	RW	0: Co-ordinated mode (default) 1: Independent mode
	03	Gate valve control mode setting	UINT	RW	0: Co-ordinated mode (default) 1: Independent mode

Tbl. 38: Configuration area

Information data (UltiDry --> control)

Idx ⁵³⁾	sidx	Name	Type	Access ⁵⁴⁾	Description
9000		Roughing and booster information		RO	
	01	Roughing exists	BOOL	RO	0: Not available 1: Available
	02	Booster exists	BOOL	RO	0: Not available 1: Available
	03	Booster 2 exists	BOOL	RO	0: Not available 1: Available
	11	Roughing and booster running time	UDINT	RO	Running time since manufacture or service - 1 [hours]
9001		Sleep level wake-up time		RO	
	01		UINT	RO	Wake-up time. Unit: Seconds

Tbl. 39: Information area

49) Idx = Index, sidx = Sub-index, Hexadecimal

50) RO = read only, RW = read/write, P = suitable for process data

51) Idx = Index, sidx = Sub-index, Hexadecimal

52) RO = read only, RW = read/write, P = suitable for process data

53) Idx = Index, sidx = Sub-index, Hexadecimal

54) RO = read only, RW = read/write, P = suitable for process data

Semiconductor device profile area

Idx ⁵⁵⁾	sldx	Name	Type	Access ⁵⁶⁾	Description
F000		Semiconductor device profile		RO	
	01	Index distance	UINT		
	02	Maximum number of modules	UINT		
F010		Module profile list		RO	
	01		UDINT	RO	

Tbl. 40: Semiconductor device profile area

Exception handling

Idx ⁵⁷⁾	sldx	Name	Type	Access ⁵⁸⁾	Description
F380		Active exception status	USINT	RO	A condensed summary byte describing the collection of active device exceptions after corresponding masks (0xF3Ax) were applied.
		Bit0: Device warning			Bit0: Device warning
		Bit1: Manufacturer warning			Bit1: Manufacturer warning
		Bit2: Device error			Bit2: Device error
		Bit3: Manufacturer error			Bit3: Manufacturer error
		Bit4: Reserved			Bit4: Reserved
		Bit5: Reserved			Bit5: Reserved
		Bit6: Reserved			Bit6: Reserved
		Bit7: Reserved			Bit7: Reserved
F381		Roughing and booster 1 to 255: Active warning detail		RO	
	01		UDINT	RO	Expanded details of the device warning exceptions. For each bit: 1: Occur 0: Normal/not available
		Bit2: Power fail open phase			Bit2: Power fail open phase
		Bit4: Coolant flow			Bit4: Coolant flow
		Bit5: N2 flow			Bit5: N2 flow
		Bit6: Exhaust pressure			Bit6: Exhaust pressure
		Bit8: Main controller err/batt low			Bit8: Main controller err/batt low
		Bit9: Roughing case temp			Bit9: Roughing case temp
		Bit10: Roughing motor temp			Bit10: Roughing motor temp
		Bit11: Roughing current			Bit11: Roughing current
		Bit12: Roughing speed			Bit12: Roughing speed
		Bit13: Roughing lock rotor			Bit13: Roughing lock rotor
		Bit14: Roughing motor driver err			Bit14: Roughing motor driver err
		Bit15: Booster case temp.			Bit15: Booster case temp.
		Bit16: Booster motor temp.			Bit16: Booster motor temp.
		Bit17: Booster current			Bit17: Booster current
		Bit18: Booster speed			Bit18: Booster speed

55) Idx = Index, sldx = Sub-index, Hexadecimal

56) RO = read only, RW = read/write, P = suitable for process data

57) Idx = Index, sldx = Sub-index, Hexadecimal

58) RO = read only, RW = read/write, P = suitable for process data

Idx ⁵⁷⁾	sidx	Name	Type	Access ⁵⁸⁾	Description
		Bit19: Booster lock rotor			Bit19: Booster lock rotor
		Bit20: Booster motor driver err			Bit20: Booster motor driver err
		Bit21: Booster 2 case temp.			Bit21: Booster 2 case temp.
		Bit23: Booster 2 current			Bit23: Booster 2 current
		Bit24: Booster 2 speed			Bit24: Booster 2 speed
		Bit25: Booster 2 lock rotor			Bit25: Booster 2 lock rotor
		Bit26: Booster 2 motor driver err			Bit26: Booster 2 motor driver err
		Bit27: Gate valve err			Bit27: Gate valve err
		Bit31: Others			Bit31: Others
F383		Roughing and booster 1 to 255: Active error (alarm) detail		RO	
	01		UDINT	RO	Expanded details of the device warning exceptions. For each bit: 1: Occur 0: Normal/not available
		Bit0: EMO			Bit0: EMO
		Bit2: Power fail open phase			Bit2: Power fail open phase
		Bit3: Reverse phase			Bit3: Reverse phase
		Bit 4: Coolant flow			Bit 4: Coolant flow
		Bit5: N2 flow			Bit5: N2 flow
		Bit6: Exhaust pressure			Bit6: Exhaust pressure
		Bit8: Main controller err/batt low			Bit8: Main controller err/batt low
		Bit9: Roughing case temp			Bit9: Roughing case temp
		Bit10: Roughing motor temp			Bit10: Roughing motor temp
		Bit11: Roughing current			Bit11: Roughing current
		Bit12: Roughing speed			Bit12: Roughing speed
		Bit13: Roughing lock rotor			Bit13: Roughing lock rotor
		Bit14: Roughing motor driver err			Bit14: Roughing motor driver err
		Bit15: Booster case temp.			Bit15: Booster case temp.
		Bit16: Booster motor temp.			Bit16: Booster motor temp.
		Bit17: Booster current			Bit17: Booster current
		Bit18: Booster speed			Bit18: Booster speed
		Bit19: Booster lock rotor			Bit19: Booster lock rotor
		Bit20: Booster motor driver err			Bit20: Booster motor driver err
		Bit21: Booster 2 case temp.			Bit21: Booster 2 case temp.
		Bit23: Booster 2 current			Bit23: Booster 2 current
		Bit24: Booster 2 speed			Bit24: Booster 2 speed
		Bit25: Booster 2 lock rotor			Bit25: Booster 2 lock rotor
		Bit26: Booster 2 motor driver err			Bit26: Booster 2 motor driver err
		Bit27: Gate valve err			Bit27: Gate valve err
		Bit31: Others			Bit31: Others

57) Idx = Index, sidx = Sub-index, Hexadecimal

58) RO = read only, RW = read/write, P = suitable for process data

Idx ⁵⁷⁾	sldx	Name	Type	Access ⁵⁸⁾	Description
F390		Latched exception status	USINT	RO	A condensed summary byte describing the collection of device exceptions after corresponding masks (0xF3Ax) were applied. See CDP for additional information.
		Bit0: Device warning			Bit0: Device warning
		Bit1: Manufacturer warning			Bit1: Manufacturer warning
		Bit2: Device error			Bit2: Device error
		Bit3: Manufacturer error			Bit3: Manufacturer error
		Bit4: Reserved			Bit4: Reserved
		Bit5: Reserved			Bit5: Reserved
		Bit6: Reserved			Bit6: Reserved
		Bit7: Reserved			Bit7: Reserved
F391		Roughing and booster 1 to 255: Latched warning detail		RO	
	01		UDINT	RO	Expanded details of the device warning exceptions. For each bit: 1: Occur 0: Normal/not available
		Bit0: EMO			Bit0: EMO
		Bit1: Water leak			Bit1: Water leak
		Bit2: Power fail open phase			Bit2: Power fail open phase
		Bit3: Reverse phase			Bit3: Reverse phase
		Bit4: Coolant flow			Bit4: Coolant flow
		Bit5: N2 flow			Bit5: N2 flow
		Bit6: Exhaust pressure			Bit6: Exhaust pressure
		Bit7: Exhaust temp.			Bit7: Exhaust temp.
		Bit8: Main controller err/batt low			Bit8: Main controller err/batt low
		Bit9: Roughing case temp			Bit9: Roughing case temp
		Bit10: Roughing motor temp			Bit10: Roughing motor temp
		Bit11: Roughing current			Bit11: Roughing current
		Bit12: Roughing speed			Bit12: Roughing speed
		Bit13: Roughing lock rotor			Bit13: Roughing lock rotor
		Bit14: Roughing motor driver err			Bit14: Roughing motor driver err
		Bit15: Booster case temp.			Bit15: Booster case temp.
		Bit16: Booster motor temp.			Bit16: Booster motor temp.
		Bit17: Booster current			Bit17: Booster current
		Bit18: Booster speed			Bit18: Booster speed
		Bit19: Booster lock rotor			Bit19: Booster lock rotor
		Bit20: Booster motor driver err			Bit20: Booster motor driver err
		Bit21: Booster 2 case temp.			Bit21: Booster 2 case temp.
		Bit22: Booster 2 motor temp.			Bit22: Booster 2 motor temp.
		Bit23: Booster 2 current			Bit23: Booster 2 current
		Bit24: Booster 2 speed			Bit24: Booster 2 speed
		Bit25: Booster 2 lock rotor			Bit25: Booster 2 lock rotor

57) Idx = Index, sldx = Sub-index, Hexadecimal

58) RO = read only, RW = read/write, P = suitable for process data

Idx ⁵⁷⁾	sidx	Name	Type	Access ⁵⁸⁾	Description
		Bit26: Booster 2 motor driver err			Bit26: Booster 2 motor driver err
		Bit27: Gate valve err			Bit27: Gate valve err
		Bit28: Future use			Bit28: Future use
		Bit29: Future use			Bit29: Future use
		Bit30: Future use			Bit30: Future use
		Bit31: Others			Bit31: Others
F393		Roughing and booster 1 to 255: Latched error (alarm) detail		RO	
	01		UDINT	RO	Expanded details of the device warning exceptions. For each bit: 1: Occur 0: Normal/not available
		Bit0: EMO			Bit0: EMO
		Bit1: Water leak			Bit1: Water leak
		Bit2: Power fail open phase			Bit2: Power fail open phase
		Bit3: Reverse phase			Bit3: Reverse phase
		Bit4: Coolant flow			Bit4: Coolant flow
		Bit5: N2 flow			Bit5: N2 flow
		Bit6: Exhaust pressure			Bit6: Exhaust pressure
		Bit7: Exhaust temp.			Bit7: Exhaust temp.
		Bit8: Main controller err/batt low			Bit8: Main controller err/batt low
		Bit9: Roughing case temp			Bit9: Roughing case temp
		Bit10: Roughing motor temp			Bit10: Roughing motor temp
		Bit11: Roughing current			Bit11: Roughing current
		Bit12: Roughing speed			Bit12: Roughing speed
		Bit13: Roughing lock rotor			Bit13: Roughing lock rotor
		Bit14: Roughing motor driver err			Bit14: Roughing motor driver err
		Bit15: Booster case temp.			Bit15: Booster case temp.
		Bit16: Booster motor temp.			Bit16: Booster motor temp.
		Bit17: Booster current			Bit17: Booster current
		Bit18: Booster speed			Bit18: Booster speed
		Bit19: Booster lock rotor			Bit19: Booster lock rotor
		Bit20: Booster motor driver err			Bit20: Booster motor driver err
		Bit21: Booster 2 case temp.			Bit21: Booster 2 case temp.
		Bit22: Booster 2 motor temp.			Bit22: Booster 2 motor temp.
		Bit23: Booster 2 current			Bit23: Booster 2 current
		Bit24: Booster 2 speed			Bit24: Booster 2 speed
		Bit25: Booster 2 lock rotor			Bit25: Booster 2 lock rotor
		Bit26: Booster 2 motor driver err			Bit26: Booster 2 motor driver err
		Bit27: Gate valve err			Bit27: Gate valve err
		Bit28: Future use			Bit28: Future use
		Bit29: Future use			Bit29: Future use
		Bit30: Future use			Bit30: Future use

57) Idx = Index, sidx = Sub-index, Hexadecimal

58) RO = read only, RW = read/write, P = suitable for process data

Idx ⁵⁷⁾	sidx	Name	Type	Access ⁵⁸⁾	Description
		Bit31: Others			Bit31: Others
F3A1		Roughing and booster 1 to 255: Warning mask		RO	
	01		UDINT	RW	Bitmask to include the corresponding device warning exception bits (as defined in the device warning details) in the active and latched exception status objects (0xF380 bit 0 and 0xF390 bit 0), if the corresponding bit is TRUE.
F3A3		Roughing and booster 1 to 255: Error (alarm) mask		RO	
	01		UDINT	RW	Bitmask to include the corresponding device error exception bits (as defined in the device error details) in the active and latched exception status objects (0xF380 bit 2 and 0xF390 bit 2), if the corresponding bit is TRUE.
F6F0		Input latch local timestamp		RO	
	01	Input latch local timestamp	UDINT	RO	Local controller time corresponding to the input latch time in microseconds. It starts at zero on device power-up.

Tbl. 41: Exception handling

CDP-specific information data

Idx ⁵⁹⁾	sidx	Name	Type	Access ⁶⁰⁾	Description
F9F0		Manufacturer serial number	STRING(n)	RO	String representing the manufacturer's serial number for the device. NOTE: This may have the same value as 0x1018:04.
F9F1		CDP functional generation number		RO	
	01		UDINT	RO	Common device profile functional generation number 2
F9F2		SDP functional generation number		RO	
	01		UDINT	RO	SDP functional generation number of nn-th module shall be specified by each SDP.2
F9F3		Vendor name	STRING(n)	RO	This string identifies the supplier of the device.
F9F4		SDP device name		RO	
	01		STRING(n)	RO	String identifying the device type of nn-th module as defined by the SDP.
F9F5		Output identifier		RO	

57) Idx = Index, sidx = Sub-index, Hexadecimal

58) RO = read only, RW = read/write, P = suitable for process data

59) Idx = Index, sidx = Sub-index, Hexadecimal

60) RO = read only, RW = read/write, P = suitable for process data

Idx ⁵⁹⁾	sidx	Name	Type	Access ⁶⁰⁾	Description
	01		USINT	RO	Output identifier of nn-th module. This value can be mapped to both the RxPDO and TxPDO. The required function of the device is to store the value in memory as written by the host. The controller can then read this value back through the TxPDO to ensure the RxPDO was received.
F9F6		Time since power on	UDINT	RO	This is the time the device has currently been powered on, in seconds, regardless of communication presence.
F9F8		Firmware update: functional generation number	UDINT	RO	Firmware update of functional generation number supported by the device. Value shall be specified by the Firmware Update Profile (ETG.5003-2)0x00000000: FW update according to ETG.5003-2 not supported. A device cannot return this value and still be compliant with ETG.5003.1, as ETG.5003-2 compliance is mandatory.

Tbl. 42: CDP-specific information data

CDP command objects

Idx ⁶¹⁾	sidx	Name	Type	Access ⁶²⁾	Description
FBF0		Device reset command		RO	Execution of this command causes the device to emulate a complete power cycle. This includes an ESC reset. There are two versions of this command: Device reset: Backup parameters will not change as a result of this reset. All setting parameters will revert to power-on defaults as a result of the reset. Factory reset: All backup parameters will be changed to their as-shipped defaults. All setting parameters will revert to power-on defaults as a result of the reset.
	01	Command	ARRAY[0..5] OF BYTE	RW	A device reset is initiated when the following byte sequence is sent: Byte 0: 0x74 Byte 1: 0x65 Byte 2: 0x73 Byte 3: 0x65 Byte 4: 0x72 Byte 5: Device standard reset = 0x00, factory reset = 0x66
	02	Status	USINT	RO	Supported values: 0: Default value if the command has not been initiated. Not a supported value otherwise. 1: Reserved 2: Last command completed, error, no response.
	03	Response	ARRAY[0..1] OF BYTE	RO	Byte 0: See subindex 2 Byte 1: Unused - shall be zero

59) Idx = Index, sidx = Sub-index, Hexadecimal

60) RO = read only, RW = read/write, P = suitable for process data

61) Idx = Index, sidx = Sub-index, Hexadecimal

62) RO = read only, RW = read/write, P = suitable for process data

Idx ⁶¹⁾	sidx	Name	Type	Access ⁶²⁾	Description
FBF1		Exception reset command		RO	Execution of this command clears the latched exceptions.
	01	Command	ARRAY[0..4] OF BYTE	RW	A latched exception reset is initiated when the following byte sequence is sent: Byte 0: 0x74 Byte 1: 0x65 Byte 2: 0x73 Byte 3: 0x65 Byte 4: 0x72
	02	Status	USINT	RO	Supported values: 0: Last command completed, no error, no response 1: Reserved 2: Last command completed, error, no response
	03	Response	ARRAY[0..1] OF BYTE	RO	Byte 0: See subindex 2 Byte 1: Unused.
FBF2		Store parameters command		RO	Execution of this command will store all parameters to non-volatile memory.
	01	Command	ARRAY[0..3] OF BYTE	RW	Read: Bit 0 = 1: Device saves the non-volatile parameters when writing 0xFB2:01 with 0x65766173 Bit 1 = 1: Device saves the non-volatile parameters automatically when they are written Bit 2-31: Reserved, shall be 0 Write: All writable, non-volatile values will be stored in non-volatile memory when the following is sent: Byte 0: 0x73 Byte 1: 0x61 Byte 2: 0x76 Byte 3: 0x65
	02	Status	USINT	RO	Supported values: 0: Default value if the command has not been initiated. Not a supported value otherwise. 1: Last command completed, no error, reply there 2: Last command completed, error, no response.
	03	Response	ARRAY[0..1] OF BYTE	RO	Byte 0: See Subindex 2 Byte 1: Unused
FBF3		Calculate checksum command		RO	Execution of this command will calculate a checksum for all writable, non-volatile parameters as currently stored in non-volatile memory.

61) Idx = Index, sidx = Sub-index, Hexadecimal

62) RO = read only, RW = read/write, P = suitable for process data

Idx ⁶¹⁾	sidx	Name	Type	Access ⁶²⁾	Description
	01	Command	AR-RAY[0..3] OF BYTE	RW	<p>Read: Returns information about the supported checksum type</p> <p>Bit 0 = 0: No non-volatile parameters supported Bit 0 = 1: Non-volatile parameters supported</p> <p>Bit 1 = 1: CRC-32 Bit 2 = 1: MD5 Bit 3 = 1: SHA-1 Bit 4-6: Reserved, shall be 0 Bit 7 = 1: Other algorithm.</p> <p>Write: Checksum type selection and start calculation. A write access to this subindex shall only set one bit true in Bit[0...7].</p> <p>Bit 0 = 1: Use default checksum algorithm of the device Bit 1 = 1: CRC-32 Bit 2 = 1: MD5 Bit 3 = 1: SHA-1 Bit 4-6: Reserved, shall be 0 Bit 7 = 1: Other algorithm Bit 8...31: Reserved.</p>
	02	Status	USINT	RO	<p>Supported values:</p> <p>0: Default value if the command has not been initiated. Not a supported value otherwise. 1: Last command completed, no error, reply there 2: Last command completed, error, no response</p>
	03	Response	AR-RAY[0..n] OF BYTE	RO	<p>Byte 0: See subindex 2 Byte 1: Unused - shall be zero Byte 2-n: Checksum return value. Size varies depending on checksum type used. The maximum length is 64 bytes.</p>
FBF4		Load parameters command		RO	Execution of this command will load all parameters from non-volatile memory.
	01	Command	AR-RAY[0..3] OF BYTE	RW	<p>Read:</p> <p>Bit 0 = 1: Device loads the non-volatile parameters when writing 0xFBf4:01 with 0x64616F6C Bit 1 = 1: Device saves the non-volatile parameters automatically when they are written.</p> <p>Write:</p> <p>All writable, non-volatile parameters will be loaded from non-volatile memory when the following is sent:</p> <p>Byte 0: 0x6C Byte 1: 0x6F Byte 2: 0x61 Byte 3: 0x64.</p>

61) Idx = Index, sidx = Sub-index, Hexadecimal

62) RO = read only, RW = read/write, P = suitable for process data

Idx ⁶¹⁾	sidx	Name	Type	Access ⁶²⁾	Description
	02	Status	USINT	RO	Supported values: 0: Last command completed, no error, no response 1: Reserved 2: Last command completed, error, no response
	03	Re-sponse	AR-RAY[0..1] OF BYTE	RO	Byte 0: See Subindex 2 Byte 1: Unused

Tbl. 43: CDP command objects

5.4 Operating HiLobe roots pump via EtherCAT

5.4.1 Process data: HiLobe

Process output data

Process output data are:

- Default RxPDO (control --> HiLobe, "output"), CoE 1600h.1 – 4 (1 Byte)

Byte.Bit	CoE ⁶³⁾	Meaning
0.0	0x7000.0x01: Roughing start/stop	Pumping station (0: off, 1: on)
0.1	0x7000.0x04: Low speed (idle/green mode)	Standby (0: off, 1: on)
0.2 – 7.		Reserved

Tbl. 44: Process output data

Process input data

Process input data are:

- Default TxPDO (HiLobe --> control, "input"), CoE 1A00h.1 – 11 (7 Byte)

Byte.Bit	CoE ⁶⁴⁾	Meaning
0.0	0x6000.0x01: Roughing run/stop	Pumping station (0: off, 1: on)
0.1	0x6000.0x02: Booster run/stop	Constant 0
0.2	0x6000.0x04: Low speed (idle/green mode)	Standby (0: off, 1: on)
0.3	0x6000.0x05: Remote/Local	0: Local, 1: EtherCAT
0.4	0x6000.0x09: Warning	0: No warning, 1: Warning
0.5	0x6000.0x0A: Alarm	0: No alarm, 1: Alarm
0.6	0x6000.0x0B: Emergency Off	Constant 0
0.7	0x6000.0x0C: N2 flow low	Constant 0
1st – 2.	0x6001.0x02: N2 flow	Constant 0
3. – 4.	0x6001.0x03: Exhaust pressure	Constant 0
5. – 6.	0x6001.0x05: Roughing case temperature	Constant 0
7. – 8.	0x6001.0x09: Roughing current	0.1 A
9. – 10.	0x6001.0x0A: Roughing power	0.1 kW
11. – 12.	0x6001.0x0B: Roughing speed	0.1% of rated speed
13. – 14.	0x6002.0x05: Booster case temperature	Constant 0
15. – 16.	0x6002.0x09: Booster current	Constant 0

61) Idx = Index, sidx = Sub-index, Hexadecimal

62) RO = read only, RW = read/write, P = suitable for process data

63) Hexadecimal

64) Hexadecimal

Byte.Bit	CoE ⁶⁴	Meaning
17. – 18.	0x6002.0x0A: Booster power	Constant 0
19. – 20.	0x6002.0x0B: Booster speed	Constant 0

Tbl. 45: Process input data

Compile process data alternative from CoE objects

1. Always conduct the state "PRE-OPERATIONAL".
2. Describe the object 1601h.0 or 1A01h.0 with 0.
3. Describe the object 1601h.1-n or 1A01h.1-n with corresponding CoE indices.
4. Use only objects marked with "P".
5. Assign the sub-index 1-n on a sequential basis only and without gaps.
6. Make sure that the data yields a total number of bytes (use pad bits if needed) and start with whole bytes (exception BOOL).
7. Describe maximum 12 objects per PDO.
8. Describe the object 1601h.0 or 1A01h.0 with the number n of objects to be used.
9. Change object 1C12h.1 to 1601h or 1C13h.1 to 1A01h.
10. In the process data, select the corresponding PDO assignment 1601h or 1A01h.

The screenshot shows the 'Sync Manager' interface. On the left, the 'PDO List' table is visible with columns: SM, Size, Type, Flags. It lists four entries: SM 0 (Size 128, Type MbxOut, Flags F), SM 1 (Size 128, Type MbxIn, Flags F), SM 2 (Size 3, Type Outputs, Flags F), and SM 3 (Size 7, Type Inputs, Flags F). Below this, the 'PDO Assignment (0x1C12)' section shows a table for 'PDO Content (0x1601)' with columns: Index, Size, Offs, Name, Type. The table lists several parameters like Turbo Start Stop, Turbo Low Speed, Vrt. Enable, and Normal Speed Setpoint. The 'Download' section has checkboxes for 'PDO Assignment' and 'PDO Configuration', both of which are checked.

Output data including 4 pad bits

The screenshot shows the 'Sync Manager' interface. On the left, the 'PDO List' table is visible with columns: SM, Size, Type, Flags. It lists four entries: SM 0 (Size 128, Type MbxOut, Flags F), SM 1 (Size 128, Type MbxIn, Flags F), SM 2 (Size 3, Type Outputs, Flags F), and SM 3 (Size 7, Type Inputs, Flags F). Below this, the 'PDO Assignment (0x1C12)' section shows a table for 'PDO Content (0x1A01)' with columns: Index, Size, Offs, Name, Type. The table lists parameters like Alarm, Warning, Ready for Process, Status, Actual Speed (rel.), Power, and Pmp. Temperature. The 'Download' section has checkboxes for 'PDO Assignment' and 'PDO Configuration', both of which are checked.

Input data including 5 pad bits

Tbl. 46: Example for a process data configuration

5.4.2 Service data: HiLobe

Type	Description
BOOL	Binary value (yes/no)
BYTE()	Single byte number
STRING()	Character string
USINT	Positive integer, 8 bit
UINT	Positive integer, 16 bit
UDINT	Positive integer, 32 bit
ULINT	Positive integer, 64 bit
SINT	Integer, 8 bit
INT	Integer, 16 bit
DINT	Integer, 32 bit
REAL	Floating point value, single precision

Tbl. 47: Data types of the service data

The following CoE objects are available for access to individual data objects (e.g., for configuration):

64) Hexadecimal

Administrative data (information about the device, communication)

Idx ⁶⁵⁾	sIdx	Name	Type	Access ⁶⁶⁾	Description
1000		Device type	UDINT	RO	Bit 0-15: Device profile number (5003). NOTE: Representation is hexadecimal (i.e. 5003dec -> 0x138B) Bit 16-31: 0x0000, sub-profile number is defined in 0xF010 bit 15..0
1008		Manufacturer device name	STRING(n)	RO	Name of the device as non-zero terminated string.
1009		Manufacturer hardware version	STRING(n)	RO	Hardware version of the device as non-zero terminated string.
100 A		Manufacturer software version	STRING(n)	RO	Software version of the device as non-zero terminated string.
100B		Manufacturer bootloader version	STRING(n)	RO	Bootloader version of the device as non-zero terminated string.
1018		Identity object	IDENTITY	RO	
	01	Vendor ID	UDINT	RO	
	02	Product code	UDINT	RO	
	03	Revision number	UDINT	RO	
	04	Serial number	UDINT	RO	
10F8		Timestamp object	ULINT	RO	Local timestamp of the device in ns.
1600		SDP default RxPDO			
	01h				0x7000.0x01: Roughing start/stop
	02h				0x7000.0x04: Low speed (idle/green mode)
	03h				
1601		User RxPDO			
1A00		SDP default TxPDO			
	01h				0x6000.0x01: Roughing run/stop
	02h				0x6000.0x02: Booster run/stop
	03h				0x6000.0x04: Low speed (idle/green mode)
	04h				0x6000.0x05: Remote/local
	05h				0x6000.0x09: Warning
	06h				0x6000.0x0A: Alarm
	07h				0x6000.0x0B: Emergency Off
	08h				0x6000.0x0C: N2 flow low
	09h				0x6001.0x02: N2 flow
	0Ah				0x6001.0x03: Exhaust pressure
	0Bh				0x6001.0x05: Roughing case temperature
	0Ch				0x6001.0x09: Roughing current
	0Dh				0x6001.0x0A: Roughing power
	0Eh				0x6001.0x0B: Roughing speed
	0Fh				0x6002.0x05: Booster case temperature
	10h				0x6002.0x09: Booster current
	11h				0x6002.0x0A: Booster power
	12h				0x6002.0x0B: Booster speed

65) Idx = Index, sIdx = Sub-index, Hexadecimal

66) RO = read only, RW = read/write, P = suitable for process data

Idx ⁶⁵⁾	sIdx	Name	Type	Access ⁶⁶⁾	Description
1A01		User TxPDO			
1C00		Sync manager type			
1C10		Sync manager 0 PDO assignment			
1C11		Sync manager 1 PDO assignment			
1C12		RxPDO assign (sync manager 2 PDO assignment)			
1C13		TxPDO assign (sync manager 3 PDO assignment)			

Tbl. 48: Communication area – administrative data (information about the device, communication)

Input data (HiLobe --> control)

Idx ⁶⁷⁾	sIdx	Name	Type	Access ⁶⁸⁾	Description
2000	Partial	In identity/status		RO	
	01	Manufacturer	STRING()	RO	
	02	Device name (main)	STRING()	RO	
	04	Hardware version (main)	STRING()	RO	
	05	Firmware version (main)	STRING()	RO	
	08	Status code (main)	UINT	RO	
	22	Device name (interface)	UDINT	RO P	
	24	Hardware version (interface)	STRING()	RO	
	25	Firmware version (interface)	STRING(n)	RO	
2001	Partial	In operation		RO	
	86	Nominal value abs (pump)	UDINT	RO	Rpm
2002	Partial	Pump power/temperature		RO	
	11	Voltage (power)	INT	RO	0.1 V
	92	Current (motor)	INT	RO	0.1 A
	A8	Temperature (bearing L)	INT	RO	°C
	C8	Temperature (bearing F)	INT	RO	°C
2006	Partial	In component power/temperature			°C
	88	Temperature (cooling water)	INT	RO	°C

Tbl. 49: Input data

Output data (control --> HiLobe)

Idx ⁶⁹⁾	sIdx	Name	Type	Access ⁷⁰⁾	Description
3001	Partial				
	083	Setpoint enable (pump)	BOOL	RW	
3005	Partial	Out component operation			

65) Idx = Index, sIdx = Sub-index, Hexadecimal

66) RO = read only, RW = read/write, P = suitable for process data

67) Idx = Index, sIdx = Sub-index, Hexadecimal

68) RO = read only, RW = read/write, P = suitable for process data

69) Idx = Index, sIdx = Sub-index, Hexadecimal

70) RO = read only, RW = read/write, P = suitable for process data

Idx ⁶⁹⁾	sIdx	Name	Type	Access ⁷⁰⁾	Description
	31	Enable (brake)	BOOL	RW	
	71	Enable (fan)	BOOL	RW	

Tbl. 50: Manufacturer-specific outputs

Manufacturer-specific configuration data

Idx ⁷¹⁾	sIdx	Name	Type	Access ⁷²⁾	Description
4001	Partial	Cfg pump operation			
	8B	Default setpoint (pump)	USINT	RW	
4009	Partial	Cfg interface operation			
	21	Configuration (DO1)	USINT	RW	
	31	Configuration (DO2)	USINT	RW	

Tbl. 51: Manufacturer-specific configuration data

Input area

Idx ⁷³⁾	sIdx	Name	Type	Access ⁷⁴⁾	Description
6000		Roughing and booster status		RO	
	01	Roughing run/stop	BOOL	RO	1: Run 0: Stop
	04	Low speed (idle/sleep/green mode)	BOOL	RO	1: Low speed (idle /sleep / green mode) 0: Normal
	05	Remote/local	BOOL	RO	1: Local, hand control enabled 0: Remote, E-cat control enabled
	09	Warning	BOOL	RO	1: Warning 0: Normal
	0 A	Alarm	BOOL	RO	1: Alarm 0: Normal
	0B	Emergency off	BOOL	RO	1: Stop 0: Normal
	0C	N2 flow low	BOOL	RO	1: N2 flow low 0: Normal
6001		Roughing analog inputs			
	04	Exhaust temperature	INT	RO	Degrees Celsius, mandatory if exhaust temperature measurement device fitted
	08	Roughing pump motor driver temperature	INT	RO	Degrees Celsius
	09	Roughing current	INT	RO	0.1 [A]

69) Idx = Index, sIdx = Sub-index, Hexadecimal
 70) RO = read only, RW = read/write, P = suitable for process data
 71) Idx = Index, sIdx = Sub-index, Hexadecimal
 72) RO = read only, RW = read/write, P = suitable for process data
 73) Idx = Index, sIdx = Sub-index, Hexadecimal
 74) RO = read only, RW = read/write, P = suitable for process data

Idx ⁷³⁾	sidx	Name	Type	Access ⁷⁴⁾	Description
	0 A	Roughing power	INT	RO	0.1 [kW]
	0B	Roughing speed	INT	RO	1000 (100.0%): Rated speed 0 (0.0%): 0 rotation, 0.1 [%]

Tbl. 52: Input area

Output area

Idx ⁷⁵⁾	sidx	Name	Type	Access ⁷⁶⁾	Description
7000		Roughing and booster control		RO	
	01	Roughing start/stop	BOOL	RW	1: Run 0: Stop
	04	Low speed (idle/sleep/green mode)	BOOL	RW	1: Low speed (idle / sleep / green mode) 0: Normal
	05	Reset pump	BOOL	RW	1: Reset alarm 0: No action
7001		Roughing analog control		RO	
	01	Roughing real-time normal speed setpoint	UINT	RW	1000 (100.0%): Rated speed 0 (0.0%): No rotation, minimum speed restrictions apply.

Tbl. 53: Output area

Configuration data (control --> HiLobe)

Idx ⁷⁷⁾	sidx	Name	Type	Access ⁷⁸⁾	Description
8001		Roughing and booster configuration		RO	
	01	Safe state	UINT	RW	0: Maintain state (hold last state) (default) 1: Go to default state (power up/ reset state) - pumps stop
8002		Roughing pump configuration		RO	
	01	Roughing low speed (multiple sleep level = 0) setting		RW	1000 (100.0%): Rated speed 0 (0.0%): No rotation, minimum speed restrictions apply, 0.1 [%]

Tbl. 54: Configuration area

73) Idx = Index, sidx = Sub-index, Hexadecimal

74) RO = read only, RW = read/write, P = suitable for process data

75) Idx = Index, sidx = Sub-index, Hexadecimal

76) RO = read only, RW = read/write, P = suitable for process data

77) Idx = Index, sidx = Sub-index, Hexadecimal

78) RO = read only, RW = read/write, P = suitable for process data

Information data (HiLobe --> control)

Idx ⁷⁹⁾	sldx	Name	Type	Access ⁸⁰⁾	Description
9000		Roughing and booster information		RO	
	01	Roughing exists	BOOL	RO	0: Not available 1: Available
	03	Booster 2 exists	BOOL	RO	0: Not available 1: Available
	11	Roughing and booster running time	UDINT	RO	Running time since manufacture or service - 1 [hours]

Tbl. 55: Information area

Semiconductor device profile area

Idx ⁸¹⁾	sldx	Name	Type	Access ⁸²⁾	Description
F000		Semiconductor device profile		RO	
	01	Index distance	UINT		
	02	Maximum number of modules	UINT		
F010		Module profile list		RO	
	01		UDINT	RO	

Tbl. 56: Semiconductor device profile area

Exception handling

Idx ⁸³⁾	sldx	Name	Type	Access ⁸⁴⁾	Description
F380		Active exception status	USINT	RO	A condensed summary byte describing the collection of active device exceptions after corresponding masks (0xF3Ax) were applied.
		Bit0: Device warning			Bit0: Device warning
		Bit1: Manufacturer warning			Bit1: Manufacturer warning
		Bit2: Device error			Bit2: Device error
		Bit3: Manufacturer error			Bit3: Manufacturer error
		Bit4: Reserved			Bit4: Reserved
		Bit5: Reserved			Bit5: Reserved
		Bit6: Reserved			Bit6: Reserved
		Bit7: Reserved			Bit7: Reserved
F381		Roughing and booster 1 to 255: Active warning detail		RO	
	01		UDINT	RO	Expanded details of the device warning exceptions. For each bit: 1: Occur 0: Normal/Not available
		Bit0: EMO			Bit0: EMO
		Bit1: Water leak			Bit1: Water leak

79) Idx = Index, sldx = Sub-index, Hexadecimal
 80) RO = read only, RW = read/write, P = suitable for process data
 81) Idx = Index, sldx = Sub-index, Hexadecimal
 82) RO = read only, RW = read/write, P = suitable for process data
 83) Idx = Index, sldx = Sub-index, Hexadecimal
 84) RO = read only, RW = read/write, P = suitable for process data

Idx ⁸³⁾	sidx	Name	Type	Access ⁸⁴⁾	Description
		Bit2: Power fail open phase			Bit2: Power fail open phase
		Bit3: Reverse phase			Bit3: Reverse phase
		Bit4: Coolant flow			Bit4: Coolant flow
		Bit5: N2 flow			Bit5: N2 flow
		Bit6: Exhaust pressure			Bit6: Exhaust pressure
		Bit7: Exhaust temp.			Bit7: Exhaust temp.
		Bit8: Main controller err/batt low			Bit8: Main controller err/batt low
		Bit9: Roughing case temp			Bit9: Roughing case temp
		Bit10: Roughing motor temp			Bit10: Roughing motor temp
		Bit11: Roughing current			Bit11: Roughing current
		Bit12: Roughing speed			Bit12: Roughing speed
		Bit13: Roughing lock rotor			Bit13: Roughing lock rotor
		Bit14: Roughing motor driver err			Bit14: Roughing motor driver err
		Bit15: Booster case temp.			Bit15: Booster case temp
		Bit16: Booster motor temp.			Bit16: Booster motor temp
		Bit17: Booster current			Bit17: Booster current
		Bit18: Booster speed			Bit18: Booster speed
		Bit19: Booster lock rotor			Bit19: Booster lock rotor
		Bit20: Booster motor driver err			Bit20: Booster motor driver err
		Bit21: Booster 2 case temp.			Bit21: Booster 2 case temp.
		Bit22: Booster 2 motor temp.			Bit22: Booster 2 motor temp.
		Bit23: Booster 2 current			Bit23: Booster 2 current
		Bit24: Booster 2 speed			Bit24: Booster 2 speed
		Bit25: Booster 2 lock rotor			Bit25: Booster 2 lock rotor
		Bit26: Booster 2 motor driver err			Bit26: Booster 2 motor driver err
		Bit27: Gate valve err			Bit27: Gate valve err
		Bit28: Future use			Bit28: Future use
		Bit29: Future use			Bit29: Future use
		Bit30: Future use			Bit30: Future use
		Bit31: Others			Bit31: Others
F383		Roughing and booster 1 to 255: Active error (alarm) detail		RO	
	01		UDINT	RO	Expanded details of the device warning exceptions. For each bit: 1: Occur 0: Normal/not available
		Bit0: EMO			Bit0: EMO
		Bit1: Water leak			Bit1: Water leak
		Bit2: Power fail open phase			Bit2: Power fail open phase
		Bit3: Reverse phase			Bit3: Reverse phase
		Bit 4: Coolant flow			Bit 4: Coolant flow
		Bit5: N2 flow			Bit5: N2 flow
		Bit6: Exhaust pressure			Bit6: Exhaust pressure

83) Idx = Index, sidx = Sub-index, Hexadecimal

84) RO = read only, RW = read/write, P = suitable for process data

Idx ⁸³⁾	sidx	Name	Type	Access ⁸⁴⁾	Description
		Bit7: Exhaust temp.			Bit7: Exhaust temp.
		Bit8: Main controller err/batt low			Bit8: Main controller err/batt low
		Bit9: Roughing case temp			Bit9: Roughing case temp
		Bit10: Roughing motor temp			Bit10: Roughing motor temp
		Bit11: Roughing current			Bit11: Roughing current
		Bit12: Roughing speed			Bit12: Roughing speed
		Bit13: Roughing lock rotor			Bit13: Roughing lock rotor
		Bit14: Roughing motor driver err			Bit14: Roughing motor driver err
		Bit15: Booster case temp.			Bit15: Booster case temp.
		Bit16: Booster motor temp.			Bit16: Booster motor temp.
		Bit17: Booster current			Bit17: Booster current
		Bit18: Booster speed			Bit18: Booster speed
		Bit19: Booster lock rotor			Bit19: Booster lock rotor
		Bit20: Booster motor driver err			Bit20: Booster motor driver err
		Bit21: Booster 2 case temp.			Bit21: Booster 2 case temp.
		Bit22: Booster 2 motor temp.			Bit22: Booster 2 motor temp.
		Bit23: Booster 2 current			Bit23: Booster 2 current
		Bit24: Booster 2 speed			Bit24: Booster 2 speed
		Bit25: Booster 2 lock rotor			Bit25: Booster 2 lock rotor
		Bit26: Booster 2 motor driver err			Bit26: Booster 2 motor driver err
		Bit27: Gate valve err			Bit27: Gate valve err
		Bit28: Future use			Bit28: Future use
		Bit29: Future use			Bit29: Future use
		Bit30: Future use			Bit30: Future use
		Bit31: Others			Bit31: Others
F390		Latched exception status	USINT	RO	A condensed summary byte describing the collection of device exceptions after corresponding masks (0xF3Ax) were applied.
		Bit0: Device warning			Bit0: Device warning
		Bit1: Manufacturer warning			Bit1: Manufacturer warning
		Bit2: Device error			Bit2: Device error
		Bit3: Manufacturer error			Bit3: Manufacturer error
		Bit4: Reserved			Bit4: Reserved
		Bit5: Reserved			Bit5: Reserved
		Bit6: Reserved			Bit6: Reserved
		Bit7: Reserved			Bit7: Reserved
F391		Roughing and booster 1 to 255: Latched warning detail		RO	
	01		UDINT	RO	Expanded details of the device warning exceptions. For each bit: 1: Occur 0: Normal/Not available
		Bit0: EMO			Bit0: EMO
		Bit1: Water leak			Bit1: Water leak

83) Idx = Index, sidx = Sub-index, Hexadecimal

84) RO = read only, RW = read/write, P = suitable for process data

Idx ⁸³⁾	sidx	Name	Type	Access ⁸⁴⁾	Description
		Bit2: Power fail open phase			Bit2: Power fail open phase
		Bit3: Reverse phase			Bit3: Reverse phase
		Bit4: Coolant flow			Bit4: Coolant flow
		Bit5: N2 flow			Bit5: N2 flow
		Bit6: Exhaust pressure			Bit6: Exhaust pressure
		Bit7: Exhaust temp.			Bit7: Exhaust temp.
		Bit8: Main controller err/batt low			Bit8: Main controller err/batt low
		Bit9: Roughing case temp			Bit9: Roughing case temp
		Bit10: Roughing motor temp			Bit10: Roughing motor temp
		Bit11: Roughing current			Bit11: Roughing current
		Bit12: Roughing speed			Bit12: Roughing speed
		Bit13: Roughing lock rotor			Bit13: Roughing lock rotor
		Bit14: Roughing motor driver err			Bit14: Roughing motor driver err
		Bit15: Booster case temp.			Bit15: Booster case temp.
		Bit16: Booster motor temp.			Bit16: Booster motor temp.
		Bit17: Booster current			Bit17: Booster current
		Bit18: Booster speed			Bit18: Booster speed
		Bit19: Booster lock rotor			Bit19: Booster lock rotor
		Bit20: Booster motor driver err			Bit20: Booster motor driver err
		Bit21: Booster 2 case temp.			Bit21: Booster 2 case temp.
		Bit22: Booster 2 motor temp.			Bit22: Booster 2 motor temp.
		Bit23: Booster 2 current			Bit23: Booster 2 current
		Bit24: Booster 2 speed			Bit24: Booster 2 speed
		Bit25: Booster 2 lock rotor			Bit25: Booster 2 lock rotor
		Bit26: Booster 2 motor driver err			Bit26: Booster 2 motor driver err
		Bit27: Gate valve err			Bit27: Gate valve err
		Bit28: Future use			Bit28: Future use
		Bit29: Future use			Bit29: Future use
		Bit30: Future use			Bit30: Future use
		Bit31: Others			Bit31: Others
F393		Roughing and booster 1 to 255: Latched error (alarm) detail		RO	
	01		UDINT	RO	Expanded details of the device warning exceptions. For each bit: 1: Occur 0: Normal/Not available
		Bit0: EMO			Bit0: EMO
		Bit1: Water leak			Bit1: Water leak
		Bit2: Power fail open phase			Bit2: Power fail open phase
		Bit3: Reverse phase			Bit3: Reverse phase
		Bit4: Coolant flow			Bit4: Coolant flow
		Bit5: N2 flow			Bit5: N2 flow
		Bit6: Exhaust pressure			Bit6: Exhaust pressure

83) Idx = Index, sidx = Sub-index, Hexadecimal

84) RO = read only, RW = read/write, P = suitable for process data

Idx ⁸³⁾	sidx	Name	Type	Access ⁸⁴⁾	Description
		Bit7: Exhaust temp.			Bit7: Exhaust temp.
		Bit8: Main controller err/batt low			Bit8: Main controller err/batt low
		Bit9: Roughing case temp			Bit9: Roughing case temp
		Bit10: Roughing motor temp			Bit10: Roughing motor temp
		Bit11: Roughing current			Bit11: Roughing current
		Bit12: Roughing speed			Bit12: Roughing speed
		Bit13: Roughing lock rotor			Bit13: Roughing lock rotor
		Bit14: Roughing motor driver err			Bit14: Roughing motor driver err
		Bit15: Booster case temp.			Bit15: Booster case temp.
		Bit16: Booster motor temp.			Bit16: Booster motor temp.
		Bit17: Booster current			Bit17: Booster current
		Bit18: Booster speed			Bit18: Booster speed
		Bit19: Booster lock rotor			Bit19: Booster lock rotor
		Bit20: Booster motor driver err			Bit20: Booster motor driver err
		Bit21: Booster 2 case temp.			Bit21: Booster 2 case temp.
		Bit22: Booster 2 motor temp.			Bit22: Booster 2 motor temp.
		Bit23: Booster 2 current			Bit23: Booster 2 current
		Bit24: Booster 2 speed			Bit24: Booster 2 speed
		Bit25: Booster 2 lock rotor			Bit25: Booster 2 lock rotor
		Bit26: Booster 2 motor driver err			Bit26: Booster 2 motor driver err
		Bit27: Gate valve err			Bit27: Gate valve err
		Bit28: Future use			Bit28: Future use
		Bit29: Future use			Bit29: Future use
		Bit30: Future use			Bit30: Future use
		Bit31: Others			Bit31: Others
F3A1		Roughing and booster 1 to 255: Warning mask		RO	
	01		UDINT	RW	Bitmask to include the corresponding device warning exception bits (as defined in the device warning details) in the active and latched exception status objects (0xF380 bit 0 and 0xF390 bit 0), if the corresponding bit is TRUE.
F3A3		Roughing and booster 1 to 255: Error (alarm) mask		RO	
	01		UDINT	RW	Bitmask to include the corresponding device error exception bits (as defined in the device error details) in the active and latched exception status objects (0xF380 bit 2 and 0xF390 bit 2), if the corresponding bit is TRUE.

83) Idx = Index, sidx = Sub-index, Hexadecimal

84) RO = read only, RW = read/write, P = suitable for process data

Idx ⁸³⁾	sidx	Name	Type	Access ⁸⁴⁾	Description
F6F0		Input latch local timestamp		RO	
	01	Input latch local timestamp	UDINT	RO	Local controller time corresponding to the input latch time in microseconds. It starts at zero on device power-up.

Tbl. 57: Exception handling

CDP-specific information data

Idx ⁸⁵⁾	sidx	Name	Type	Access ⁸⁶⁾	Description
F9F0		Manufacturer serial number	STRING(n)	RO	String representing the manufacturer's serial number for the device.
F9F1		CDP functional generation number		RO	
	01		UDINT	RO	Common device profile functional generation number
F9F2		SDP functional generation number		RO	
	01		UDINT	RO	SDP functional generation number.
F9F3		Vendor name	STRING(n)	RO	
F9F4		SDP device name		RO	
	01		STRING(n)	RO	String identifying the device type.
F9F5		Output identifier		RO	
	01		USINT	RW	Output identifier. The controller can then read this value back through the TxPDO to ensure the RxPDO was received.
F9F6		Time since power on	UDINT	RO	This is the time the device has currently been powered on, in seconds.
F9F7		Total time powered	UDINT	RO	Operating hours of pump [s]
F9F8		Firmware update: functional generation number	UDINT	RO	Firmware update of functional generation number supported by the device.

Tbl. 58: CDP-specific information data

83) Idx = Index, sidx = Sub-index, Hexadecimal

84) RO = read only, RW = read/write, P = suitable for process data

85) Idx = Index, sidx = Sub-index, Hexadecimal

86) RO = read only, RW = read/write, P = suitable for process data

CDP command objects

Idx ⁸⁷⁾	sIdx	Name	Type	Access ⁸⁸⁾	Description
FBF0		Device reset command		RO	Execution of this command causes the device to emulate a complete power cycle. This includes an ESC reset. There are two versions of this command: Device reset: Backup parameters will not change as a result of this reset. All setting parameters will revert to power-on defaults as a result of the reset. Factory reset: All backup parameters will be changed to their as-shipped defaults. All setting parameters will revert to power-on defaults as a result of the reset.
	01	Command	ARRAY[0..5] OF BYTE	RW	A device reset is initiated when the following byte sequence is sent: Byte 0: 0x74 Byte 1: 0x65 Byte 2: 0x73 Byte 3: 0x65 Byte 4: 0x72 Byte 5: Device standard reset = 0x00, factory reset = 0x66
	02	Status	USINT	RO	Supported values: 0: Default value if the command has not been initiated. Not a supported value otherwise. 1: Reserved 2: Last command completed, error, no response.
	03	Response	ARRAY[0..1] OF BYTE	RO	Byte 0: See subindex 2 Byte 1: Unused - shall be zero
FBF1		Exception reset command		RO	Execution of this command clears the latched exceptions.
	01	Command	ARRAY[0..4] OF BYTE	RW	A latched exception reset is initiated when the following byte sequence is sent: Byte 0: 0x74 Byte 1: 0x65 Byte 2: 0x73 Byte 3: 0x65 Byte 4: 0x72
	02	Status	USINT	RO	Supported values: 0: Last command completed, no error, no response 1: Reserved 2: Last command completed, error, no response
	03	Response	ARRAY[0..1] OF BYTE	RO	Byte 0: See subindex 2 Byte 1: Unused.
FBF2		Store parameters command		RO	Execution of this command will store all parameters to non-volatile memory.

87) Idx = Index, sIdx = Sub-index, Hexadecimal

88) RO = read only, RW = read/write, P = suitable for process data

Idx ⁸⁷⁾	sidx	Name	Type	Access ⁸⁸⁾	Description
	01	Command	ARRAY[0..3] OF BYTE	RW	<p>Read:</p> <p>Bit 0 = 1: Device saves the non-volatile parameters when writing 0xFB2:01 with 0x65766173</p> <p>Bit 1 = 1: Device saves the non-volatile parameters automatically when they are written</p> <p>Bit 2-31: Reserved, shall be 0</p> <p>Write: All writable, non-volatile values will be stored in non-volatile memory when the following is sent:</p> <p>Byte 0: 0x73 Byte 1: 0x61 Byte 2: 0x76 Byte 3: 0x65</p>
	02	Status	USINT	RO	<p>Supported values:</p> <p>0: Default value if the command has not been initiated. Not a supported value otherwise.</p> <p>1: Last command completed, no error, reply there</p> <p>2: Last command completed, error, no response.</p>
	03	Response	ARRAY[0..1] OF BYTE	RO	<p>Byte 0: See Subindex 2</p> <p>Byte 1: Unused</p>
FBF3		Calculate checksum command		RO	Execution of this command will calculate a checksum for all writable, non-volatile parameters as currently stored in non-volatile memory.
	01	Command	ARRAY[0..3] OF BYTE	RW	<p>Read: Returns information about the supported checksum type</p> <p>Bit 0 = 0: No non-volatile parameters supported</p> <p>Bit 0 = 1: Non-volatile parameters supported</p> <p>Bit 1 = 1: CRC-32</p> <p>Bit 2 = 1: MD5</p> <p>Bit 3 = 1: SHA-1</p> <p>Bit 4-6: Reserved, shall be 0</p> <p>Bit 7 = 1: Other algorithm.</p> <p>Write: Checksum type selection and start calculation. A write access to this subindex shall only set one bit true in Bit[0...7].</p> <p>Bit 0 = 1: Use default checksum algorithm of the device</p> <p>Bit 1 = 1: CRC-32</p> <p>Bit 2 = 1: MD5</p> <p>Bit 3 = 1: SHA-1</p> <p>Bit 4-6: Reserved, shall be 0</p> <p>Bit 7 = 1: Other algorithm</p> <p>Bit 8...31: Reserved.</p>
	02	Status	USINT	RO	<p>Supported values:</p> <p>0: Default value if the command has not been initiated. Not a supported value otherwise.</p> <p>1: Last command completed, no error, reply there</p> <p>2: Last command completed, error, no response</p>

87) Idx = Index, sidx = Sub-index, Hexadecimal

88) RO = read only, RW = read/write, P = suitable for process data

Idx ⁸⁷⁾	sidx	Name	Type	Access ⁸⁸⁾	Description
	03	Re- sponse	AR- RAY[0..n] OF BYTE	RO	Byte 0: See subindex 2 Byte 1: Unused - shall be zero Byte 2-n: Checksum return value. Size varies depending on checksum type used. The maximum length is 64 bytes.
FBF4		Load pa- rameters com- mand		RO	Execution of this command will load all param- eters from non-volatile memory.
	01	Com- mand	AR- RAY[0..3] OF BYTE	RW	Read: Bit 0 = 1: Device loads the non-volatile param- eters when writing 0xFB4:01 with 0x64616F6C Bit 1 = 1: Device saves the non-volatile param- eters automatically when they are written. Write: All writable, non-volatile parameters will be load- ed from non-volatile memory when the following is sent: Byte 0: 0x6C Byte 1: 0x6F Byte 2: 0x61 Byte 3: 0x64.
	02	Status	USINT	RO	Supported values: 0: Last command completed, no error, no re- sponse 1: Reserved 2: Last command completed, error, no response
	03	Re- sponse	AR- RAY[0..1] OF BYTE	RO	Byte 0: See Subindex 2 Byte 1: Unused

Tbl. 59: CDP command objects

5.5 Operating turbopump with TC 80 via EtherCAT

5.5.1 Process data: TC 80

Process output data

Process output data are:

- Default RxPDO (control --> TC 80, "output"), CoE 1600h.1 – 4 (1 Byte)

Byte.Bit	CoE ⁸⁹⁾	Meaning
0.0	7000.01 Turbo Start Stop	Pumping station (0: off, 1: on)
0.1	7000.02 Turbo Reset Alarm	0 --> 1: Malfunction acknowledgement
0.2	7000.03 Turbo Low Speed	Stand-by (0: off, 1: on)

Tbl. 60: Process output data

Process input data

Process input data are:

- Default TxPDO (TC 80 --> control, "input"), CoE 1A00h.1 – 11 (7 Byte)

87) Idx = Index, sidx = Sub-index, Hexadecimal

88) RO = read only, RW = read/write, P = suitable for process data

89) Hexadecimal

Byte.Bit	CoE ⁹⁰⁾	Meaning
0.0	6000.01 Rotation	Pump rotates > 60 rpm(0: no, 1: yes)
0.1	6000.02 Normal	Normal operation (0: no, 1: yes)
0.2	6000.03 Acceleration	Pump accelerates (0: no, 1: yes)
0.3	6000.04 Deceleration (includes braking)	Pump decelerates (0: no, 1: yes)
0.4	6000.05 Remote / Local	Control via EtherCAT (0: yes, 1: no)
0.5	6000.07 Turbo Low Speed	Stand-by (0: off, 1: on)
0.6	6000.09 Alarm	0: no 1: yes
0.7	6000.0A Warning	0: no 1: yes
1st – 2.	6000.11 Turbo Speed	0.1% of rated speed
3. – 4.	6000.12 Turbo Current	0.1 A
5. – 6.	6000.13 Turbo Pump Temperature	°C

Tbl. 61: Process input data

Compile process data alternative from CoE objects

1. Always conduct the state "PRE-OPERATIONAL".
2. Describe the object 1601h.0 or 1A01h.0 with 0.
3. Describe the object 1601h.1-n or 1A01h.1-n with corresponding CoE indices.
4. Use only objects marked with "P".
5. Assign the sub-index 1-n on a sequential basis only and without gaps.
6. Make sure that the data yields a total number of bytes (use pad bits if needed) and start with whole bytes (exception BOOL).
7. Describe maximum 12 objects per PDO.
8. Describe the object 1601h.0 or 1A01h.0 with the number n of objects to be used.
9. Change object 1C12h.1 to 1601h or 1C13h.1 to 1A01h.
10. In the process data, select the corresponding PDO assignment 1601h or 1A01h.

The image shows two side-by-side screenshots of a configuration tool. The left screenshot shows the configuration for output data (SM 0-3) and PDD Content (0x7000-0x8000). The right screenshot shows the configuration for input data (SM 0-3) and PDD Content (0x6000-0x2002). Both screenshots include sections for Sync Manager, PDO List, PDD Assignment (0x1C12), and PDD Content (0x1601).

Output data including 4 pad bits

Input data including 5 pad bits

Tbl. 62: Example for a process data configuration

5.5.2 Service data: TC 80

Type	Description
BOOL	Binary value (yes/no)
BYTE()	Single byte number
STRING()	Character string
USINT	Positive integer, 8 bit
UINT	Positive integer, 16 bit
UDINT	Positive integer, 32 bit

90) Hexadecimal

Type	Description
ULINT	Positive integer, 64 bit
SINT	Integer, 8 bit
INT	Integer, 16 bit
DINT	Integer, 32 bit
REAL	Floating point value, single precision

Tbl. 63: Data types of the service data

The following CoE objects are available for access to individual data objects (e.g., for configuration):

Administrative data (information about the device, communication)

Idx ⁹¹⁾	sIdx	Name	Type	Access ⁹²⁾	Description
1000		Device type	UDINT	RO	Bit 0-15: device profile number (5003). NOTE: Representation is hexadecimal (i.e. 5003dec -> 0x138B) Bit 16-31: 0x0000, sub-profile number is defined in 0xF010 bit 15..0
1008		Manufacturer device name	STRING(n)	RO	Name of the device as non-zero terminated string.
1009		Manufacturer hardware version	STRING(n)	RO	Hardware version of the device as non-zero terminated string.
100 A		Manufacturer software version	STRING(n)	RO	Software version of the device as non-zero terminated string.
100B		Manufacturer bootloader version	STRING(n)	RO	Bootloader version of the device as non-zero terminated string.
1018		Identity object	IDENTITY	RO	
	01	Vendor ID	UDINT	RO	
	02	Product code	UDINT	RO	
	03	Revision number	UDINT	RO	
	04	Serial number	UDINT	RO	
10F8		Timestamp object	ULINT	RO	Local timestamp of the device in ns.
1600		SDP default RxPDO			
	01h				0x7000.0x01: Turbo start/stop
	02h				0x7000.0x02: Turbo reset alarm
	03h				0x7000.0x03: Turbo low speed
	04h				0x0000.0x00:5
1601		User RxPDO			
1A00		SDP default TxPDO			
	01h				0x6000.0x01: Rotation
	02h				0x6000.0x02: Normal
	03h				0x6000.0x03: Acceleration
	04h				0x6000.0x04: Deceleration (includes braking)
	05h				0x6000.0x05: Remote/local
	06h				0x6000.0x07: Turbo low speed
	07h				0x6000.0x09: Alarm
	08h				0x6000.0x0A: Warning
	09h				0x6000.0x11: Turbo speed

91) Idx = Index, sIdx = Sub-index, Hexadecimal

92) RO = read only, RW = read/write, P = suitable for process data

Idx ⁹¹⁾	sidx	Name	Type	Access ⁹²⁾	Description
	0Ah				0x6000.0x12: Turbo current
	0Bh				0x6000.0x13: Turbo pump temperature
1A01		User TxPDO			
1C00		Sync manager type			
1C12		RxPDO assign (sync manager 2 PDO assignment)			
1C13		TxPDO assign (sync manager 3 PDO assignment)			

Tbl. 64: Communication area – administrative data (information about the device, communication)

Input data (TC 80 --> control)

Idx ⁹³⁾	sidx	Name	Type	Access ⁹⁴⁾	Description
2000	Partial	In identity/status		RO	
	08	Status code (main)	UINT	RO	"000000"->0, "ErrXXX"->XXX, "WrnXXX"->XXX +1000
	0 A	Operating hours (main)	UDINT	RO	
	24	Hardware version (interface)	STRING(n)	RO	
	25	Firmware version (interface)	STRING(n)	RO	
	86	ID (pump)	UINT	RO	
	8 A	Operating hours (pump)	UDINT	RO	
	8D	Cycles (pump)	UDINT	RO	
2001	Partial	In operation		RO	
	83	Actual value (abs) (pump)	UDINT	RO	
	86	Nominal value abs (pump)	UDINT	RO	rpm
	88	Ready for process (pump)	BOOL	RO	Speed switchpoint attained
2002	Partial	In pump power/temperature		RO	
	08	Temperature (main)	INT	RO	°C
	11	Voltage (power)	INT	RO	0.1 V
	13	Power (power)	INT	RO	W
	18	Temperature (power)	INT	RO	°C
	98	Temperature (motor)	INT	RO	°C
	B8	Temperature (rotor)	INT	RO	
2004	Partial	In component identity/status		RO	
	52	Device name (pressure 1)	STRING(n)	RO	
	62	Device name (pressure 2)	STRING(n)	RO	
2005	Partial	In component operation		RO	
	53	Actual value (abs) (pressure 1)		RO	hPa
	63	Actual value (abs) (pressure 2)		RO	hPa

Tbl. 65: Input data

91) Idx = Index, sidx = Sub-index, Hexadecimal

92) RO = read only, RW = read/write, P = suitable for process data

93) Idx = Index, sidx = Sub-index, Hexadecimal

94) RO = read only, RW = read/write, P = suitable for process data

Output data (control --> TC 80)

Idx ⁹⁵⁾	sldx	Name	Type	Access ⁹⁶⁾	Description
3005	Partial	Out component operation		RO	
	01	Enable (heating)	BOOL	RW	
	11	Enable (venting)	BOOL	RW	
	21	Enable (sealing gas)	BOOL	RW	
	51	Enable (pressure)	BOOL	RW	

Tbl. 66: Manufacturer-specific outputs

Manufacturer-specific configuration data

Idx ⁹⁷⁾	sldx	Name	Type	Access ⁹⁸⁾	Description
4001	Partial	Cfg pump operation		RO	
	12	Setpoint 1/on (power)	UINT	RW	mV, power out voltage (V)
	13	Setpoint 2/off (power)	UINT	RW	W, power out threshold (W)
	84	Nominal value (abs) (pump)	UDINT	RW	rpm
	85	Process configuration (pump)	USINT	RW	Gas mode
	86	Cfg. ready for process (pump)	USINT	RW	Cfg. speed switchpoint
	87	Switchpoint 1/on (pump)	USINT	RW	%, speed switchpoint 1 (% fN)
	88	Switchpoint 2/off (pump)	USINT	RW	%, speed switchpoint 2 (% fN)
	89	Cfg. run-up timer (pump)	BOOL	RW	
	8 A	Run-up time (pump)	USINT	RW	Min
	8B	Temperature mode	USINT	RW	
4002	Partial	Cfg power		RO	
	11	Max. power (power)	USINT	RW	%
4005	Partial	Cfg component operation		RO	
	11	Configuration (venting)	USINT	RW	
	12	Setpoint 1/on (venting)	USINT	RW	%, venting speed (% fN)
	13	Setpoint 2/off (venting)	UINT	RW	s, venting time
	41	Configuration (backing pump)	USINT	RW	
	42	Setpoint 1/on (backing pump)	UINT	RW	W
	43	Setpoint 2/off (backing pump)	UINT	RW	W
	55	Process configuration (pressure 1)	REAL	RW	Correction factor 1
	57	Switchpoint 1/on (pressure 1)	REAL	RW	hPa
	65	Process configuration (pressure 2)	REAL	RW	Correction factor 2
	67	Switchpoint 1/on (pressure 2)	REAL	RW	hPa
	72	Setpoint 1/on (fan)	USINT	RW	°C
	81	Configuration (accessory A1)	USINT	RW	
	91	Configuration (accessory B1)	USINT	RW	
	C1	Configuration (accessory C1)			
	D1	Configuration (accessory D1)			
4009	Partial	Cfg interface operation		RO	

95) Idx = Index, sldx = Sub-index, Hexadecimal
 96) RO = read only, RW = read/write, P = suitable for process data
 97) Idx = Index, sldx = Sub-index, Hexadecimal
 98) RO = read only, RW = read/write, P = suitable for process data

Idx ⁹⁷⁾	sidx	Name	Type	Access ⁹⁸⁾	Description
	01	Configuration (DI1)	USINT	RW	
	11	Configuration (DI2)	USINT	RW	
	41	Configuration (DO1)	USINT	RW	
	51	Configuration (DO2)	USINT	RW	
	A1	Configuration (AO1)	USINT	RW	

Tbl. 67: Manufacturer-specific configuration data

Input area

Idx ⁹⁹⁾	sidx	Name	Type	Access ¹⁰⁰⁾	Description
6000		Turbo status and sensor value		RO	
	01	Rotation	BOOL	RO	1: Under normal operation 0: Not normal
	02	Normal	BOOL	RO	1: Under normal operation 0: Not normal
	03	Acceleration	BOOL	RO	1: Accelerating 0: Not accelerating
	04	Deceleration (includes braking)	BOOL	RO	1: Decelerating 0: Not decelerating
	05	Remote/local	BOOL	RO	1: Local. Hand control enabled 0: Remote. E-cat control enabled
	06	Coast (motor off)	BOOL	RO	Conditional where supported by the turbo controller 1: Coast mode ON 0: OFF
	07	Turbo low speed	BOOL	RO	1: Low speed mode ON 0: OFF
	09	Alarm	BOOL	RO	1: Alarm 0: Not alarm
	0 A	Warning	BOOL	RO	1: Warning 0: Not warning
	11	Turbo speed	INT	RO	1000 (100.0%): Rated speed - 0.1 [%] 0 (0.0%): No rotation
	12	Turbo current	INT	RO	0.1 [A]
	13	Turbo pump temperature	INT	RO	Celsius - 1 [°C]

Tbl. 68: Input area

Output area

Idx ¹⁰¹⁾	sidx	Name	Type	Access ¹⁰²⁾	Description
7000		Turbo control		RO	
	01	Turbo start/stop	BOOL	RW	1: Run 0: Stop

97) Idx = Index, sidx = Sub-index, Hexadecimal

98) RO = read only, RW = read/write, P = suitable for process data

99) Idx = Index, sidx = Sub-index, Hexadecimal

100) RO = read only, RW = read/write, P = suitable for process data

101) Idx = Index, sidx = Sub-index, Hexadecimal

102) RO = read only, RW = read/write, P = suitable for process data

Idx ¹⁰¹⁾	sidx	Name	Type	Access ¹⁰²⁾	Description
	02	Turbo reset alarm	BOOL	RW	1: Reset alarm 0: No action
	03	Turbo low speed	BOOL	RW	1: Low speed mode ON 0: OFF
	04	Coast (motor off)	BOOL	RW	Conditional where supported by the turbo controller, 1: Coast mode ON 0: OFF

Tbl. 69: Output area

Configuration data (control --> TC 80)

Idx ¹⁰³⁾	sidx	Name	Type	Access ¹⁰⁴⁾	Description
8001		Turbo parameter setting		RO	
	01	Turbo safe state	UINT	RW	0: Maintain state (hold last state) (default) 1: Go to default state (power up/reset state) - turbo stops 2: Maintain state exit low speed/coast (go to normal speed)
	02	Turbo low speed setpoint	UINT	RW	1000 (100.0%): Rated speed 0 (0.0%): No rotation, minimum speed restrictions apply, 0.1 [%]
	03	Turbo normal speed setpoint	UINT	RW	1000 (100.0%): Rated speed 0 (0.0%): No rotation, minimum speed restrictions apply, 0.1 [%]

Tbl. 70: Configuration area

Semiconductor device profile area

Idx ¹⁰⁵⁾	sidx	Name	Type	Access ¹⁰⁶⁾	Description
F000		Semiconductor device profile		RO	
	01	Index distance	UINT	RO	
	02	Maximum number of modules	UINT	RO	
F010		Module profile list		RO	
	01		UDINT	RO	

Tbl. 71: Semiconductor device profile area

101) Idx = Index, sidx = Sub-index, Hexadecimal
 102) RO = read only, RW = read/write, P = suitable for process data
 103) Idx = Index, sidx = Sub-index, Hexadecimal
 104) RO = read only, RW = read/write, P = suitable for process data
 105) Idx = Index, sidx = Sub-index, Hexadecimal
 106) RO = read only, RW = read/write, P = suitable for process data

Exception handling

Idx ¹⁰⁷⁾	sIdx	Name	Type	Access ¹⁰⁸⁾	Description
F380		Active exception status	USINT	RO	A condensed summary byte describing the collection of active device exceptions after corresponding masks (0xF3Ax) were applied.
		Bit0: Device warning			Bit0: Device warning
		Bit1: Manufacturer warning			Bit1: Manufacturer warning
		Bit2: Device error			Bit2: Device error
		Bit3: Manufacturer error			Bit3: Manufacturer error
		Bit4: Reserved			Bit4: Reserved
		Bit5: Reserved			Bit5: Reserved
		Bit6: Reserved			Bit6: Reserved
		Bit7: Reserved			Bit7: Reserved
F381		Active device warning details		RO	
	01		UDINT	RO	Expanded details of the device warning exceptions. For each bit: 1: Occur 0: Normal/not available
		Bit0: Power fail			Bit0: Power fail
		Bit1: Pump overtemperature			Bit1: Pump overtemperature
		Bit2: Overspeed			Bit2: Overspeed
		Bit3: Motor overcurrent			Bit3: Motor overcurrent
		Bit4: Driver overtemperature			Bit4: Driver overtemperature
		Bit5: Driver overcurrent			Bit5: Driver overcurrent
		Bit6: Driver overvoltage			Bit6: Driver overvoltage
		Bit7: Driver fail			Bit7: Driver fail
		Bit8: Controller fail			Bit8: Controller fail
		Bit9: Cannot start			Bit9: Cannot start
		Bit10: Accel. overtime			Bit10: Accel. overtime
		Bit11: Brake overtime			Bit11: Brake overtime
		Bit12: Bearing err			Bit12: Bearing err
		Bit13: Bearing sensor err			Bit13: Bearing sensor err
		Bit14: TC over temperature			Bit14: TC over temperature
		Bit15: TC sensor error			Bit15: TC sensor error
		Bit16: TC heater err			Bit16: TC heater err
		Bit17: TC valve err			Bit17: TC valve err
		Bit18: Other (not in the above)			Bit18: Other (not in the above)
		Bit19: Reserved			Bit19: Reserved
		Bit20: Reserved			Bit20: Reserved
		Bit21: Reserved			Bit21: Reserved
		Bit22: Reserved			Bit22: Reserved
		Bit23: Reserved			Bit23: Reserved
		Bit24: Reserved			Bit24: Reserved

107) Idx = Index, sIdx = Sub-index, Hexadecimal

108) RO = read only, RW = read/write, P = suitable for process data

Idx ¹⁰⁷⁾	sidx	Name	Type	Access ¹⁰⁸⁾	Description
		Bit25: Reserved			Bit25: Reserved
		Bit26: Reserved			Bit26: Reserved
		Bit27: Reserved			Bit27: Reserved
		Bit28: Reserved			Bit28: Reserved
		Bit29: Reserved			Bit29: Reserved
		Bit30: Reserved			Bit30: Reserved
		Bit31: Reserved			Bit31: Reserved
F383		Active device error details		RO	
	01		UDINT	RO	Expanded details of the device warning exceptions. For each bit: 1: Occur 0: Normal/not available
		Bit0: Power fail			Bit0: Power fail
		Bit1: Pump overtemperature			Bit1: Pump overtemperature
		Bit2: Overspeed			Bit2: Overspeed
		Bit3: Motor overcurrent			Bit3: Motor overcurrent
		Bit4: Driver overtemperature			Bit4: Driver overtemperature
		Bit5: Driver overcurrent			Bit5: Driver overcurrent
		Bit6: Driver overvoltage			Bit6: Driver overvoltage
		Bit7: Driver fail			Bit7: Driver fail
		Bit8: Controller fail			Bit8: Controller fail
		Bit9: Cannot start			Bit9: Cannot start
		Bit10: Accel. overtime			Bit10: Accel. overtime
		Bit11: Brake overtime			Bit11: Brake overtime
		Bit12: Bearing err			Bit12: Bearing err
		Bit13: Bearing sensor err			Bit13: Bearing sensor err
		Bit14: TC over temperature			Bit14: TC over temperature
		Bit15: TC sensor error			Bit15: TC sensor error
		Bit16: TC heater err			Bit16: TC heater err
		Bit17: TC valve err			Bit17: TC valve err
		Bit18: Other (not in the above)			Bit18: Other (not in the above)
		Bit19: Reserved			Bit19: Reserved
		Bit20: Reserved			Bit20: Reserved
		Bit21: Reserved			Bit21: Reserved
		Bit22: Reserved			Bit22: Reserved
		Bit23: Reserved			Bit23: Reserved
		Bit24: Reserved			Bit24: Reserved
		Bit25: Reserved			Bit25: Reserved
		Bit26: Reserved			Bit26: Reserved
		Bit27: Reserved			Bit27: Reserved
		Bit28: Reserved			Bit28: Reserved
		Bit29: Reserved			Bit29: Reserved
		Bit30: Reserved			Bit30: Reserved
		Bit31: Reserved			Bit31: Reserved

107) Idx = Index, sidx = Sub-index, Hexadecimal

108) RO = read only, RW = read/write, P = suitable for process data

Idx ¹⁰⁷⁾	sidx	Name	Type	Access ¹⁰⁸⁾	Description
F390		Latched exception status	USINT	RO	A condensed summary byte describing the collection of device exceptions after corresponding masks (0xF3Ax) were applied.
		Bit0: Device warning			Bit0: Device warning
		Bit1: Manufacturer warning			Bit1: Manufacturer warning
		Bit2: Device error			Bit2: Device error
		Bit3: Manufacturer error			Bit3: Manufacturer error
		Bit4: Reserved			Bit4: Reserved
		Bit5: Reserved			Bit5: Reserved
		Bit6: Reserved			Bit6: Reserved
		Bit7: Reserved			Bit7: Reserved
F391		Latched device warning details		RO	
	01		UDINT	RO	Expanded details of the device warning exceptions. For each bit: 1: Occur 0: Normal/not available
		Bit0: Power fail			Bit0: Power fail
		Bit1: Pump overtemperature			Bit1: Pump overtemperature
		Bit2: Overspeed			Bit2: Overspeed
		Bit3: Motor overcurrent			Bit3: Motor overcurrent
		Bit4: Driver overtemperature			Bit4: Driver overtemperature
		Bit5: Driver overcurrent			Bit5: Driver overcurrent
		Bit6: Driver overvoltage			Bit6: Driver overvoltage
		Bit7: Driver fail			Bit7: Driver fail
		Bit8: Controller fail			Bit8: Controller fail
		Bit9: Cannot start			Bit9: Cannot start
		Bit10: Accel. overtime			Bit10: Accel. overtime
		Bit11: Brake overtime			Bit11: Brake overtime
		Bit12: Bearing err			Bit12: Bearing err
		Bit13: Bearing sensor err			Bit13: Bearing sensor err
		Bit14: TC over temperature			Bit14: TC over temperature
		Bit15: TC sensor error			Bit15: TC sensor error
		Bit16: TC heater err			Bit16: TC heater err
		Bit17: TC valve err			Bit17: TC valve err
		Bit18: Other (not in the above)			Bit18: Other (not in the above)
		Bit19: Reserved			Bit19: Reserved
		Bit20: Reserved			Bit20: Reserved
		Bit21: Reserved			Bit21: Reserved
		Bit22: Reserved			Bit22: Reserved
		Bit23: Reserved			Bit23: Reserved
		Bit24: Reserved			Bit24: Reserved
		Bit25: Reserved			Bit25: Reserved
		Bit26: Reserved			Bit26: Reserved
		Bit27: Reserved			Bit27: Reserved

107) Idx = Index, sidx = Sub-index, Hexadecimal

108) RO = read only, RW = read/write, P = suitable for process data

Idx ¹⁰⁷⁾	sidx	Name	Type	Access ¹⁰⁸⁾	Description
		Bit28: Reserved			Bit28: Reserved
		Bit29: Reserved			Bit29: Reserved
		Bit30: Reserved			Bit30: Reserved
		Bit31: Reserved			Bit31: Reserved
F393		Latched device error details		RO	
	01		UDINT	RO	Expanded details of the device warning exceptions. For each bit: 1: Occur 0: Normal/not available
		Bit0: Power fail			Bit0: Power fail
		Bit1: Pump overtemperature			Bit1: Pump overtemperature
		Bit2: Overspeed			Bit2: Overspeed
		Bit3: Motor overcurrent			Bit3: Motor overcurrent
		Bit4: Driver overtemperature			Bit4: Driver overtemperature
		Bit5: Driver overcurrent			Bit5: Driver overcurrent
		Bit6: Driver overvoltage			Bit6: Driver overvoltage
		Bit7: Driver fail			Bit7: Driver fail
		Bit8: Controller fail			Bit8: Controller fail
		Bit9: Cannot start			Bit9: Cannot start
		Bit10: Accel. overtime			Bit10: Accel. overtime
		Bit11: Brake overtime			Bit11: Brake overtime
		Bit12: Bearing err			Bit12: Bearing err
		Bit13: Bearing sensor err			Bit13: Bearing sensor err
		Bit14: TC over temperature			Bit14: TC over temperature
		Bit15: TC sensor error			Bit15: TC sensor error
		Bit16: TC heater err			Bit16: TC heater err
		Bit17: TC valve err			Bit17: TC valve err
		Bit18: Other (not in the above)			Bit18: Other (not in the above)
		Bit19: Reserved			Bit19: Reserved
		Bit20: Reserved			Bit20: Reserved
		Bit21: Reserved			Bit21: Reserved
		Bit22: Reserved			Bit22: Reserved
		Bit23: Reserved			Bit23: Reserved
		Bit24: Reserved			Bit24: Reserved
		Bit25: Reserved			Bit25: Reserved
		Bit26: Reserved			Bit26: Reserved
		Bit27: Reserved			Bit27: Reserved
		Bit28: Reserved			Bit28: Reserved
		Bit29: Reserved			Bit29: Reserved
		Bit30: Reserved			Bit30: Reserved
		Bit31: Reserved			Bit31: Reserved
F3A1		Device warning mask		RO	

107) Idx = Index, sidx = Sub-index, Hexadecimal

108) RO = read only, RW = read/write, P = suitable for process data

Idx ¹⁰⁷⁾	sidx	Name	Type	Access ¹⁰⁸⁾	Description
	01		UDINT	RW	Bitmask to include the corresponding device warning exception bits (as defined in the device warning details) in the active and latched exception status objects (0xF380 bit 0 and 0xF390 bit 0), if the corresponding bit is TRUE.
F3A3		Device error mask		RO	
	01		UDINT	RO	Bitmask to include the corresponding device error exception bits (as defined in the device error details) in the active and latched exception status objects (0xF380 bit 2 and 0xF390 bit 2), if the corresponding bit is TRUE.

Tbl. 72: Exception handling

CDP device-specific inputs

Idx ¹⁰⁹⁾	sidx	Name	Type	Access ¹¹⁰⁾	Description
F6F0		Input latch local timestamp		RO	
	01	Input latch local timestamp	UDINT	RO	Local controller time corresponding to the input latch time in microseconds. It starts at zero on device power-up.

Tbl. 73: Device-specific inputs

CDP-specific information data

Idx ¹¹¹⁾	sidx	Name	Type	Access ¹¹²⁾	Description
F9F0		Manufacturer serial number	STRING(n)	RO	String representing the manufacturer's serial number for the device. NOTE: This may have the same value as 0x1018:04.
F9F1		CDP functional generation number		RO	
	01		UDINT	RO	Common device profile functional generation number 2, see ETG.5003.2050
F9F2		SDP functional generation number		RO	
	01		UDINT	RO	SDP functional generation number of nn-th module shall be specified by each SDP.2, see ETG.5003.2050
F9F3		Vendor name	STRING(n)	RO	This string identifies the supplier of the device.
F9F4		SDP device name		RO	

107) Idx = Index, sidx = Sub-index, Hexadecimal

108) RO = read only, RW = read/write, P = suitable for process data

109) Idx = Index, sidx = Sub-index, Hexadecimal

110) RO = read only, RW = read/write, P = suitable for process data

111) Idx = Index, sidx = Sub-index, Hexadecimal

112) RO = read only, RW = read/write, P = suitable for process data

Idx ¹¹¹⁾	sIdx	Name	Type	Access ¹¹²⁾	Description
	01		STRING(n)	RO	String identifying the device type of nn-th module as defined by the SDP, see ETG.5003.2050
F9F5		Output identifier		RO	
	01		USINT	RW	Output identifier of nn-th module. This value can be mapped to both the RxPDO and TxPDO. The required function of the device is to store the value in memory as written by the host. The controller can then read this value back through the TxPDO to ensure the RxPDO was received.
F9F6		Time since power on	UDINT	RO	This is the time the device has currently been powered on, in seconds, regardless of communication presence.
F9F7		Total time powered	UDINT	RO	This is the cumulative amount of time the device has been powered on, in seconds. It shall be stored automatically as non-volatile. Accuracy shall be equal or better to one hour.
F9F8		Firmware update: functional generation number	UDINT	RO	Firmware update of functional generation number supported by the device. Value shall be specified by the Firmware Update Profile (ETG.5003-2)0x00000000: FW update according to ETG.5003-2 not supported. A device cannot return this value and still be compliant with ETG.5003.1, as ETG.5003-2 compliance is mandatory.

Tbl. 74: CDP-specific information data

CDP command objects

Idx ¹¹³⁾	sIdx	Name	Type	Access ¹¹⁴⁾	Description
FBF0		Device reset command		RO	Execution of this command causes the device to emulate a complete power cycle. This includes an ESC reset. Some devices may require this reset to maintain a specific state not matching power cycle behavior for proper operation, per the SDP.NOTE: As a consequence of an ESC reset, all of the subsequent devices are disconnected from the network. There are two versions of this command: Device reset: Backup parameters will not change as a result of this reset. All setting parameters will revert to power-on defaults as a result of the reset. Factory reset: All backup parameters will be changed to their as-shipped defaults. All setting parameters will revert to power-on defaults as a result of the reset.
	01	Command	ARRAY[0..5] OF BYTE	RW	A device reset is initiated when the following byte sequence is sent: Byte 0: 0x74Byte 1: 0x65Byte 2: 0x73 Byte 3: 0x65Byte 4: 0x72Byte 5: Device standard reset = 0x00, factory reset = 0x66

111) Idx = Index, sIdx = Sub-index, Hexadecimal
 112) RO = read only, RW = read/write, P = suitable for process data
 113) Idx = Index, sIdx = Sub-index, Hexadecimal
 114) RO = read only, RW = read/write, P = suitable for process data

Idx ¹¹³⁾	sIdx	Name	Type	Access ¹¹⁴⁾	Description
	02	Status	USINT	RO	Supported values: 0: Default value if the command has not been initiated. Not a supported value otherwise. 1: Reserved 2: Last command completed, error, no response 3: Reserved 3-99: Reserved, 100-200: indicates how much of the command has been executed (in %, 100 = 0%, 200 = 100%) 201-254: Reserved, 255: command is executing (if the percentage display is not supported)
	03	Response	ARRAY[0..1] OF BYTE	RO	Byte 0: see Subindex 2 Byte 1: Unused - Shall be zero
FBF1		Exception reset command		RO	Execution of this command clears the latched exceptions. Execution of this command may also optionally acknowledge device or SDP-specific exceptions (if specified) that would otherwise require a separate acknowledgment action to resume normal operation. If this is required, it shall be noted in the SDP or device documentation.
	01	Command	ARRAY[0..4] OF BYTE	RW	A Latched Exception Reset is initiated when the following byte sequence is sent: Byte 0: 0x74 Byte 1: 0x65 Byte 2: 0x73 Byte 3: 0x65 Byte 4: 0x72
	02	Status	USINT	RO	Supported values: 0: Last command completed, no error, no response 1: Reserved 2: Last command completed, error, no response 3: Reserved 3-99: Reserved, 100-200: indicates how much of the command has been executed (in %, 100 = 0%, 200 = 100%) 201-254: Reserved, 255: command is executing (if the percentage display is not supported)
	03	Response	ARRAY[0..1] OF BYTE	RO	Byte 0: see Subindex 2 Byte 1: Unused - Shall be zero
FBF2		Store parameters command		RO	Execution of this command will store all parameters to non-volatile memory. If a device automatically saves all non-volatile parameters at the time they are written, this command will not take any action. In the event that this command may interfere with the safe or expected functional operation of a device, it may be optionally restricted to functioning only in certain functional conditions while in OPERATIONAL state. If the command cannot be performed due to this operating condition, the Abort Code "0x08 00 00 21" shall be returned. In this case, documentation shall be supplied detailing the proper condition to execute this command. All devices shall be able to execute this command in PREOP without restriction.
	01	Command	ARRAY[0..3] OF BYTE	RW	Read: Bit 0 = 1: Device saves the non-volatile parameters when writing 0xFB2:01 with 0x65766173 Bit 1 = 1: Device saves the non-volatile parameters automatically when they are written Bit 2-31: Reserved, shall be 0 Write: All writable, non-volatile values will be stored in non-volatile memory when the following is sent: Byte 0: 0x73 Byte 1: 0x61 Byte 2: 0x76 Byte 3: 0x65 If other values are written, the Abort Code "0x06040043 General parameter incompatibility reason" shall be returned.

113) Idx = Index, sIdx = Sub-index, Hexadecimal

114) RO = read only, RW = read/write, P = suitable for process data

Idx ¹¹³⁾	sIdx	Name	Type	Access ¹¹⁴⁾	Description
	02	Status	USINT	RO	Supported values: 0: Last command completed, no error, no response 1: Reserved 2: Last command completed, error, no response 3-99: Reserved, 100-200: indicates how much of the command has been executed (in %, 100 = 0%, 200 = 100%) 201-254: Reserved, 255: command is executing (if the percentage display is not supported)
	03	Response	ARRAY[0..1] OF BYTE	RO	Byte 0: see Subindex 2 Byte 1: Unused - Shall be zero
FBF3		Calculate checksum command		RO	Execution of this command will calculate a checksum for all writable, non-volatile parameters as currently stored in non-volatile memory. In the event that this calculation may interfere with the safe or expected functional operation of a device, it may be optionally restricted to functioning only in certain functional conditions while in OPERATIONAL state. If the checksum cannot be calculated, the Abort Code "0x08 00 00 21" shall be returned. In this case, documentation shall be supplied detailing the proper condition to execute this command. All devices shall be able to calculate the checksum in PREOP without restriction. Even if the manufacturer chooses to store the checksum itself in non-volatile or volatile memory, the device shall perform the calculation at the time of executing this command and return this calculated value. This command shall therefore not return a value calculated prior to executing this command.
	01	Command	ARRAY[0..3] OF BYTE	RW	Read: Returns information about the supported checksum type Bit 0 = 0: no non-volatile parameters supported. Bit 0 = 1: non-volatile parameters supported, at least 1 of the defined bits 1-7 shall be set. Bit 1 = 1: CRC-32 Bit 2 = 1: MD5 Bit 3 = 1: SHA-1 Bit 4-6: Reserved, shall be 0. Bit 7 = 1: other algorithm. Bit 8...31: Reserved, shall be 0. Write: Checksum type selection and start calculation. A write access to this subindex shall only set one bit true in Bit[0...7]. If other values are written, the Abort Code "0x06040043 Parameter is incompatible" shall be returned. Bit 0 = 1: Use default checksum algorithm of the device. Bit 1 = 1: CRC-32 Bit 2 = 1: MD5 Bit 3 = 1: SHA-1 Bit 4-6: Reserved, shall be 0. Bit 7 = 1: other algorithm. Bit 8...31: Reserved, shall be 0
	02	Status	USINT	RO	Supported values: 0: Default value if the command has not been initiated. Not a supported value otherwise. 1: Last command completed, no error, reply there. 2: Last command completed, error, no response. 3: Reserved 3-99: Reserved, 100-200: indicates how much of the command has been executed (in %, 100 = 0%, 200 = 100%) 201-254: Reserved, 255: command is executing (if the percentage display is not supported)
	03	Response	ARRAY[0..n] OF BYTE	RO	Byte 0: see Subindex 2 Byte 1: Unused - Shall be zero. Byte 2-n: Checksum return value. Size varies depending on checksum type used. The maximum length shall be 64 bytes.

113) Idx = Index, sIdx = Sub-index, Hexadecimal

114) RO = read only, RW = read/write, P = suitable for process data

Idx ¹¹³⁾	sidx	Name	Type	Access ¹¹⁴⁾	Description
FBF4		Load parameters command		RO	Execution of this command will load all parameters from non-volatile memory. If a device automatically saves all non-volatile parameters at the time they are written, this command will not take any action. In the event that this command may interfere with the safe or expected functional operation of a device, it may be optionally restricted to functioning only in certain functional conditions while in OPERATIONAL state. If the command cannot be performed due to this operating condition, the Abort Code "0x08 00 00 21" shall be returned. In this case, documentation shall be supplied detailing the proper condition to execute this command. All devices shall be able to execute this command in PREOP without restriction.
	01	Command	ARRAY[0..3] OF BYTE	RW	Read: Bit 0 = 1: Device loads the non-volatile parameters when writing 0xFBFB4:01 with 0x64616F6C Bit 1 = 1: Device saves the non-volatile parameters automatically when they are written Bit 2-31: reserved, shall be 0 Write: All writable, non-volatile parameters will loaded from non-volatile memory when the following is sent: Byte 0: 0x6CByte 1: 0x6FByte 2: 0x61 Byte 3: 0x64 If other values are written, the Abort Code "0x06040043 General parameter incompatibility reason" shall be returned.
	02	Status	USINT	RO	Supported values: 0: Last command completed, no error, no response 1: Reserved 2: Last command completed, error, no response 3-99: Reserved, 100-200: indicates how much of the command has been executed (in %, 100 = 0%, 200 = 100%) 201-254: Reserved, 255: command is executing (if the percentage display is not supported)
	03	Response	ARRAY[0..1] OF BYTE	RO	Byte 0: see Subindex 2 Byte 1: Unused - Shall be zero ETG5003_

Tbl. 75: CDP command objects

113) Idx = Index, sidx = Sub-index, Hexadecimal

114) RO = read only, RW = read/write, P = suitable for process data

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