CANopen® User Guide

Rev. 2.9

for ENGEL devices with CANopen® support

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Underlying Specifications

The CANopen interface of all ENGEL CANopen devices is based on the CANopen standards and specifications which are published by the CANopen user and manufacturer organisation CiA (CAN in Automation). The intention of this guide is not to replace the specification; it only describes the implementation of the standard in ENGEL devices. Thus, knowledge of the specification is assumed.

Actual status by the draft of this guide:

CiA® Standards and Specifications CD-ROM, Version 5.1

As far as possible, the functionality of the devices complies with the specifications:

CiA® DS 301 V 4.01: Application layer and communication profile

CiA® DSP 402 V 2.0: CANopen device profile drives and motion control

Deviating definitions are explained in this guide.

The standards can be purchased from:

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For further information about the functionality of the ENGEL devices, their installation, setup procedure and operation, please check the operating manuals on our website:

ENGEL - Products

All operating manuals are available for download on our homepage or can be ordered directly at:

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Document History

Document	Date (dd/mm/yy)	Rev	Changes
CANopen Benutzerhandbuch V1_1	17/02/04	1.1	1st revision during implementation
CANopen Benutzerhandbuch V2_0	08/03/06	2.0	complete revision / valid for DSV/BSI firmware from V3.20
CANopen Benutzerhandbuch V2_1	02/06/06	2.1	Homing, Polarity, quick_stop, DC_Link_circuit_voltage added Object Dictionary abstract added, dynamic_torque_limit and target_torque, transition 3 of the statemachine revised, bitrate 1000kbit/s, SDO description valid for DSV/BSI firmware from V3.21
CANopen User Guide V2_2	01/04/08	2.2	english version, new objects Access Memory Cell (2005h), Max Turntable Position (2006h) and Motion Profile Type (6086h) and functionality (new homing methods, sine-squared ramps, **Turntable Mode**) added valid for all firmware versions from EL V3.40
CANopen User Guide V2_3	29/07/08	2.3	1st revision of English version
CANopen User Guide V2_4	27/10/10	2.4	New objects: Digital Outputs (60FEh), Analogue Inputs (6C01h), valid for firmware version V3.72 or higher
CANopen® User Guide V2_5	10/08/11	2.5	New objects: Encoder Position Value (7004h); Velocity Encoder Factor (6094h); Position Range Limit (607Bh); Pre-Defined Error Field (1003h); Velocity Demand Value (606Bh) valid for firmware version V3.80 or higher
CANopen® User Guide V2_6	15/02/12	2.6	New objects: Following Error Window (6065h); Following Error Time Out (6066h) valid for firmware version V3.83 or higher
CANopen® User Guide V2_7	11/11/14	2.7	New device DSV1030 + minor textual changes.
CANopen® User Guide V2_8	19/08/15	2.8	- deletion of transition mode 16 - revision of layout - addition of chapter Getting Started - new objects: Position Sample (2007h), User Parameter (2008h), Current Limit Homing (2009h), I²t Actual Value (200Ah), Temperature (200Bh), Following Error Actual Value (60F4h), Error number (200Ch) valid for firmware version V4.00 - revision of Error code table

Document	Date (dd/mm/yy)	Rev	Changes
CANopen® User Guide V2_9	10/06/20	2.9	valid for firmware version V4.02 or higher: - additional information to Store Parameters (1010h) - complementation of Object Dictionary Overview - scaling of all currents to Motor Rated Current (6075h) valid for firmware version V4.40 or higher: - new error codes 13 and 14 - the following objects can be mapped to PDO now: 6094h, 60FEh, 607Ch, 6098h, 6099h, 609Ah, 6067h, 6068h, 607Bh, 607Dh, 6080h, 6085h, 6086h, 60F4h, 60FBh, 60F9h, 6073h, 6075h - renaming of Object 2007h from "Position Sample" to "Capture Object" + rework of the chapter - new objects: Power Consumption (200Dh), Fieldbus Options (200Eh), Functional Safety (200Fh), Supported Drive Modes (6502h), Torque Slope (6087h) - max. number of mapped objects per PDO changes from 2 to 8

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Device Groups

ENGEL devices can be divided into 2 groups, which have slightly different functionality. This means that some objects or features are not available for both groups. The following table shows which product belongs to which group. In the Object Dictionary Overview (Chapter 10) you can also look up which objects are available for which group.

Device group 1	Device group 2
DSV110	DSV1030
DSV112	DSV1032
DSV130	HFI2230-X200
DSV132	HFI2230-X400
DSV133	HFI2260-X200
DSV324	HFI2260-X400
DSV562E	HFI2630-X200
HBI2230-2	HFI2630-X400
HBI2230-4	HFI2660-X200
HBI2260-2	HFI2660-X400
HBI2260-4	HFI3260-X200
HBI2630-2	HFI3260-X400
HBI2630-4	HFI3290-X400
HBI2660-2	HFI3760-X400
HBI2660-4	HFI3790-X400
HBI3260-4	
HBI3290-4	
HBI3760-4	
HBI3790-4	
HLI2660	

1 CANopen Features

All ENGEL CANopen devices support the following features:

CAN bitrates	10,20,50,125,250,500,800 kbit/s	1000 kbit/s (V3.80 or higher)
CAN identifier	standard 11 bit	according to "predefined connection set"
Node-ID	1…127	configurable via EEPROM-parameter
NMT service	slave	
SDO communication	1 server	no segment transfer
PDO communication	RPDO1: asynchronous, synchronous TPDO1: asynchronous, synchronous RPDO2: asynchronous, synchronous TPDO2: asynchronous, synchronous	
PDO Mapping	dynamic	max. PDO-Mapping quantity: Device group 1: 2 mapped objects Device group 2: 8 mapped objects (max. 64 bits per PDO)
SYNC	consumer	
Time Stamp	no	
Emergency Message	producer	
Node Guarding	no	
Heartbeat	producer	
Non-volatile Storage	yes	
Firmware Download	no	

The drives support the following functions:

Modes of Operation	Value	Description
Profile Position Mode	1	time optimised positioning with trapezoidal or sine-squared velocity characteristic
Profile Velocity Mode	3	speed control mode
Profile Torque Mode	4	current/torque control mode
Homing Mode	6	referencing to a home position
Profile Velocity Mode with dynamic current limitation	-3	speed control mode with current/torque limitation limit value: object ***Dynamic Torque Limit*** (2004h, chapter 8.2.4)
Profile Torque Mode with dynamic speed limitation	-4	current/torque control mode with speed limitation limit value: object ***Dynamic Speed Limit*** (2003h, chapter 9.2.9)
Turntable Mode	-5	normal positioning with a turnover, when the actual position exceeds or under-runs the position range limit value: object ***Max Turntable Position*** (2006h, chapter 7.2.18; obsolete) OR object ***Position Range Limit*** (607Bh, chapter 7.2.7) for V3.78 or higher

2 CANopen Introduction

This chapter gives a short introduction about CANopen. For further information please consult the standards DS301 and DSP402.

CANopen allows standardised application for distributed industrial automation systems based on CAN. Therefore, necessary mechanisms of communication are defined by the standard DS301. Based on this, device profiles like the DSP402 **Device profile drives and motion control** define and standardise the applications for corresponding devices.

An essential element of the CANopen standard is the description of the device functionality with an object dictionary. It is subdivided into various logical categories and consists of objects to access the devices functions and parameters. These objects are addressed by means of a 16bit index and an 8bit sub index.

The attributes of a CANopen device are described by an electronic data sheet (EDS), which is available to the CAN master. CANopen distinguishes between two mechanisms of data transmission, fast data exchange of process data via **Process Data Objects (PDO)** and the access to all objects in the object dictionary via **Service Data Objects (SDO).**

2.1 Process Data Object PDO

Fast communication with the device is performed by means of PDOs. There are two kinds of PDOs, which allow controlling (Transmit-PDO, TPDO) and monitoring (Receive-PDO, RPDO) of the drive.

A PDO can transmit up to 8 data byte from a maximum of two objects. All ENGEL CANopen devices feature a set of predefined PDOs which cover all common monitoring functions and allow switching the operation mode or giving nominal values. Objects assigned to PDOs can be changed dynamically during operation.

TPDOs are distinguished between synchronous, i.e. triggered by the occurrence of a synchronous object, and asynchronous, i.e. event triggered, Transmission.

Objects, like "Transmit PDO Communication Parameter" and "Transmit PDO Mapping Parameter", are used to define PDOs via SDO.

PDOs are active, only when the device (CAN node) is in the state **OPERATIONAL** (see NMT).

2.2 Service Data Object SDO

SDOs provide access to all objects in the object dictionary and serve for configuration and initialisation purpose of the CANopen device. The receiving slave device always acknowledges an SDO request with a response SDO.

SDO communication is possible when the device (CAN node) is in the NMT state **PRE-OPERATIONAL** or **OPERATIONAL**.

SDOs are sent with COB-ID [600h + Node-ID] by the network master, a slave answers with COB-ID [580h + Node-ID].

An SDO message is always 8 bytes in length, comprising a 4 byte data field, regardless of the object's actual data size.

command specifier	Index		Sub-Index	Data			
	(low)	(high)		(LSB)			(MSB)

The **command specifier** defines whether the access is receiving or a transmitting and how many bytes are sent or received. The following table lists commonly used command specifiers:

Access mode	Number of data bytes	Command specifier
Read Request (Initiate Domain upload)	-	40h
Read Response(Initiate Domain upload)	1 2 3 4	4Fh 4Bh 47h 43h
Write Request (Initiate Domain Download)	1 2 3 4	2Fh 2Bh 27h 23h
Write Response (Initiate Domain Download)	-	60h
Error Response (SDO abort)	-	80h

Index and **sub index** identify the parameter in the object dictionary. For single Object Dictionary entries such as an UNSIGNED8, BOOLEAN, INTEGER32 etc. the value for the sub-index is always zero.

2.2.1 Abort SDO Transfer Protocol

SDO access errors are reported by the Abort SDO Transfer Protocol:

Error code	Description
0503 0000h	Toggle bit not alternated.
0504 0000h	SDO protocol timed out.
0504 0001h	Client/server command specifier not valid or unknown.
0504 0002h	Invalid block size (block mode only).
0504 0003h	Invalid sequence number (block mode only).
0504 0004h	CRC error (block mode only).
0504 0005h	Out of memory.
0601 0000h	Unsupported access to an object.
0601 0001h	Attempt to read a write only object.
0601 0002h	Attempt to write a read only object.
0602 0000h	Object does not exist in the object dictionary.
0604 0041h	Object cannot be mapped to the PDO.
0604 0042h	The number and length of the objects to be mapped would exceed PDO length.
0604 0043h	General parameter incompatibility reason.
0604 0047h	General internal incompatibility in the device.
0606 0000h	Access failure due to a hardware error.
0607 0010h	Data type does not match, length of service parameter does not match.
0607 0012h	Data type does not match, length of service parameter too high.
0607 0013h	Data type does not match, length of service parameter too low.
0609 0011h	Sub-index does not exist.
0609 0030h	Value range of parameter exceeded (only for write access).
0609 0031h	Value of parameter written too high (only for write access).
0609 0032h	Value of parameter written too low (only for write access).
0609 0036h	Maximum value is less than minimum value.
060A 0023h	Resource not available: SDO connection
0800 0000h	general error
0800 0020h	Data cannot be transferred or stored to the application.
0800 0021h	Data cannot be transferred or stored to the application because of local control.
0800 0022h	Data cannot be transferred or stored to the application because of the present device state.
0800 0023h	Object dictionary dynamic generation fails or no object dictionary is present.
0800 0024h	No data available.

2.3 Network Management NMT

The network management provides a set of cross-system services to control the communication status of CANopen devices. After start-up, a CANopen device passes through the state **INITIALISING** and then automatically switches to the state **PRE-OPERATIONAL**. With the NMT service Start Remote Node, an NMT master can set the state of a selected slave to **OPERATIONAL**.

The communication via SDO is possible for the states **PRE-OPERATIONAL** and **OPERATIONAL**.
The communication via PDO is only possible for the state **OPERATIONAL**.

NMT Services:

The services of the network management use the COB-ID 000h. The table below shows the NMT services available:

NMT service	1. data byte	2. data byte	Description
Start Remote Node	01	Node-ID	switches the addressed slave to the state **OPERATIONAL**
Stop Remote Node	02	Node-ID	switches the addressed slave to the state **STOPPED**
Enter Pre-Operational	128	Node-ID	switches the addressed slave to **PRE-OPERATIONAL**
Reset Node	129	Node-ID	initiates a software reset of the addressed slave
Reset Communication	130	Node-ID	initialises the communication of the addressed slave

Notice:
With Node-ID = 1…127, only the corresponding NMT slave will be addressed.
With Node-ID = 0, **all** NMT slaves will be addressed simultaneously.

Boot up

After the initialisation is finished, the CAN slave switches to the state **PRE-OPERATIONAL** and in the meantime transmits a **boot up** message with COB-ID 700h + Node-ID. The boot up message contains the data byte 00h.

Sync Telegram

The sync telegram of the NMT master has the COB-ID 80h. It has synchronising purpose and is used to trigger synchronous TPDOs.

Heartbeat Telegram

The device supports the generation of heartbeat telegrams (heartbeat producer). The repetition cycles are defined by the object ***Producer Heartbeat Time*** (1017h, chapter 4.2.8). The heartbeat telegram has the COB-ID 700h + Node-ID and contains the communication status in the data byte:

Bit 0…6	state of the heartbeat producer
0	**BOOTUP**
4	**STOPPED**
5	**OPERATIONAL**
0x7Fh	**PRE-OPERATIONAL**

A heartbeat toggle bit, BIT 8 of ***Statusword*** (6041h, chapter 5.3.2), can supplement or replace the heartbeat telegram. To configure the heartbeat behaviour use object ***Fieldbus Options*** (200Eh, chapter 4.2.20).

Emergency Telegram

The emergency telegram is sent once after an error occurred. The first two data bytes contain the emergency error code (see Error Codes in Chapter 5.1.2) and the content of the object ***Error Register*** (1001h, chapter 4.2.2).
The emergency telegram is also sent after an error is deleted via Bit 7 of ***Controlword*** (6040h, chapter5.3.1). In this case the emergency telegram contains either the next error code, if another error is active, or 8 zero bytes.

The emergency telegram has the COB-ID 080h + Node-ID.

Byte	0	1	2	3	4	5	6	7
Content	Emergency Error Code		Error Register	Manufacturer Specific Error Field				

2.4 Overview of pre-defined COB-IDs

Identifier	Service	Direction	COB-ID calculation	Note
000_h	NMT	Receive	-	fixed
080_h	SYNC	Receive / Transmit	-	variable, Index 1005_h
081_h ... $0FF_h$	EMERGENCY	Transmit	080_h + Node-ID	variable, Index 1014_h
181_h ... $1FF_h$	TPDO1	Transmit	180_h + Node-ID	variable, Index 1800_h
201_h ... $27F_h$	RPDO1	Receive	200_h + Node-ID	variable, Index 1400_h
281_h ... $2FF_h$	TPDO2	Transmit	280_h + Node-ID	variable, Index 1801_h
301_h ... 37F	RPDO2	Receive	300_h + Node-ID	variable, Index 1401_h
581_h ... $57F_h$	SDO	Transmit	580_h + Node-ID	fixed
601_h ... $67F_h$	SDO	Receive	600_h + Node-ID	fixed
701_h ... $77F_h$	HEARTBEAT/BOOT UP	Transmit	700_h + Node-ID	fixed

3 Process Data Objects

3.1 Receive PDO

Two Receive PDOs (RPDO) are available. Their parameters are defined in the objects 1400h and 1401h. The assignment of the data to be received is defined in the mapping objects 1600h and 1601h.

3.1.1 Receive PDO Communication Parameter

Object description:

INDEX	1400h and 1401h
Name	receive PDO parameter
Object Code	RECORD
Data Type	PDO CommPar
Category	Mandatory
non-volatile storable	no

Entry description:

SUB-INDEX	0
Description	Number of entries
Entry category	Mandatory
Access	ro
PDO Mapping	no
Value Range	2…5
Default value	5

SUB-INDEX	1
Description	COB-ID used by PDO
Entry category	Mandatory
Access	rw
PDO Mapping	no
Value Range	UNSIGNED32 *3) *4)
Default value	1400h: 200h + Node-ID *3) 1401h: 300h + Node-ID

SUB-INDEX	2
Description	Transmission type
Entry category	Mandatory
Access	rw
PDO Mapping	no
Value Range	UNSIGNED8
Default value	0FFh

SUB-INDEX	3	
Description	Inhibit Time*1)	
Entry category	Optional	
Access	rw	
PDO Mapping	no	
Value Range	UNSIGNED16	[100µs]
Default value	0	

SUB-INDEX	4
Description	Compatibility entry *2)
Entry category	Optional
Access	rw
PDO Mapping	no
Value Range	UNSIGNED8
Default value	0

SUB-INDEX	5	
Description	Event timer *1)	
Entry category	Optional	
Access	rw	
PDO Mapping	no	
Value Range	UNSIGNED16	[ms]
Default value	0	

*1) Inhibit time and Event timer are without function for RPDOs.
*2) Compatibility entry without function
*3) The entry includes additional control bits:
Bit 31: 0= PDO existing/valid 1= PDO invalid/disregarded
Bit 29: 0= 11 Bit ID (CAN2.0A) 1= 29Bit ID (CAN2.0B)
Bit 11…28 are 0 for 11Bit ID
*4) The following COB-IDs (in steps of 80h) are allowed:
180h + Node-ID,
200h + Node-ID,
280h + Node-ID,
…
500h + Node-ID.
It is important not to set up duplicate COB-IDs for different PDOs.
Related objects: 1400h/1401h (RPDOs) and 1800h/1801h (TPDOs).

3.1.2 Receive PDO Mapping Parameter

Object description:

INDEX	1600h and 1601h
Name	RPDO mapping Parameter
Object Code	RECORD
Data Type	PDO Mapping
Category	Mandatory
non-volatile storable	no

Entry description:

SUB-INDEX	0
Description	Number of mapped objects
Entry category	Mandatory
Access	rw
PDO Mapping	no
Value Range	0: inactive *1) 1-8: active
Default value	2

SUB-INDEX	1, 2 ... 8
Description	PDO mapping
Entry category	conditional
Access	rw
PDO Mapping	no
Value Range	UNSIGNED32
Default value	(see table)

*1) defines the number of mapped objects (default 2); the maximum depends on the device group:
Group 1: 2 objects
Group 2: 8 objects (Firmware ≥ V4.40)

Default mapping of the Receive PDOs (RPDO):

Index	Sub	Name	Default value *)
1600h	1	Controlword	6040 0010h
	2	Modes of Operation	6060 0008h
1601h	1	Controlword	6040 0010h
	2	Target Position	607A 0020h

*) data structure: 16bit Index + 8bit sub index + 8Bit object- length
Description of the object-length in bit, e.g. Controlword U16 = 16bit = 10h

Notice:
To change the mapping, the PDO has to be deactivated by writing a 0 in the sub index 0 (**Number of mapped objects**). After new mapping entries (**PDO mapping**) are set, the PDO has to be activated again by writing the number of sub-indexes in **Number of mapped objects.**

Please also note, that communication via PDO is only possible after NMT has been switched to state **OPERATIONAL**. For details, please refer to Network Management NMT (chapter 2.3).

3.2 Transmit PDO

Two Transmit PDOs (RPDO) are available. Their parameters are defined by the objects 1800h and 1801h. The assignment of the data to be transmitted is defined by the mapping objects 1A00h and 1A01h.

3.2.1 Transmit PDO Communication Parameter

Object description:

INDEX	1800h and 1801h
Name	transmit PDO parameter
Object Code	RECORD
Data Type	PDO CommPar
Category	mandatory
non-volatile storable	no

Entry description:

SUB-INDEX	0
Description	Number of entries
Entry category	Mandatory
Access	ro
PDO Mapping	no
Value Range	2…5
Default value	5

SUB-INDEX	1
Description	COB-ID used by PDO
Entry category	Mandatory
Access	rw
PDO Mapping	no
Value Range	UNSIGNED32 *3) *4)
Default value	1800h: 180h + Node-ID *3) 1801h: 280h + Node-ID

SUB-INDEX	2
Description	Transmission type
Entry category	Mandatory
Access	rw
PDO Mapping	no
Value Range	UNSIGNED8
Default value	0FFh

SUB-INDEX	3	
Description	Inhibit Time *5)	
Entry category	Optional	
Access	rw	
PDO Mapping	no	
Value Range	UNSIGNED16	[100µs]
Default value	0	

SUB-INDEX	4
Description	Compatibility entry *2)
Entry category	Optional
Access	rw
PDO Mapping	no
Value Range	UNSIGNED8
Default value	0

SUB-INDEX	5	
Description	Event timer	
Entry category	Optional	
Access	rw	
PDO Mapping	no	
Value Range	UNSIGNED16	[ms]
Default value	0	

*2) Compatibility entry without function

*3) The entry includes additional control bits:
Bit 31: 0= PDO existing/valid 1= PDO invalid/disregarded
Bit 30: 0= RTR allowed 1= RTR not allowed
Bit 29: 0= 11 Bit ID (CAN2.0A) 1= 29Bit ID (CAN2.0B)
Bit 11…28 are 0 for 11Bit ID
RTR = Remote Transmission Request
If RTR is allowed, the requested PDO is always transmitted immediately after the reception of the RTR frame.

*4) The following COB-IDs (in steps of 80h) are allowed:
180h + Node-ID,
200h + Node-ID,
280h + Node-ID,
…
500h + Node-ID.
It is important not to set up duplicate COB-IDs for different PDOs.
Related objects: 1400h/1401h (RPDOs) and 1800h/1801h (TPDOs).

*5) Must not be changed, while PDO exists (Bit 31 = 0)

The transmission type entry defines the transmission characteristic of the PDO. It distinguishes between synchronous (in connection with a SYNC object) and asynchronous transmission.

Transmission Type	PDO Transmission					Description
	cyclic	acyclic	synchronous	asynchronous	RTR only	
0		x	x			
1…240	x		x			PDO with every n-th SYNC object
252			x		x	update data with SYNC object
253				x	x	
254				x		
255				x		after occurrence of an event (event timer)

Asynchronous TPDOs (Transmission type= 254 and 255) are triggered with every data change.
The inhibit time suppresses frequent sending for values that change constantly (e.g. velocity or position)
The event timer (Transmission type= 255) triggers cyclical events to enable static data to be sent frequently (e.g. statusword).

3.2.2 Transmit PDO Mapping Parameter

Object description:

INDEX	1A00h and 1A01h
Name	TPDO mapping Parameter
Object Code	RECORD
Data Type	PDO Mapping
Category	Mandatory
non-volatile storable	no

Entry description:

SUB-INDEX	0
Description	Number of mapped objects
Entry category	Mandatory
Access	rw
PDO Mapping	no
Value Range	0: inactive*1) 1-8: active
Default value	2

SUB-INDEX	1, 2 ..., 8
Description	PDO mapping
Entry category	conditional
Access	rw
PDO Mapping	no
Value Range	UNSIGNED32
Default value	(see table)

*1) defines the number of mapped objects (default 2); the maximum depends on the device type:
Group 1: 2 objects
Group 2: 8 objects (Firmware ≥ V4.40)

Default Mapping of the Transmit PDOs (TPDO):

Index	Sub	Name	Default value *)
1A00h	1	Statusword	6041 0010h
	2	Modes of Operation Display	6061 0008h
1A01h	1	Statusword	6041 0010h
	2	Position Actual Value	6064 0020h

*) data structure: 16bit Index + 8bit sub index + 8Bit object- length
Description of the object-length in bit, e.g. Controlword U16 = 16bit = 10h

Notice:
To change the mapping, the PDO has to be deactivated by writing a 0 in the sub index 0 (**Number of mapped objects**). After new mapping entries (**PDO mapping**) are set, the PDO has to be activated again by writing the number of sub-indexes in **Number of mapped objects.**

Please also note, that communication via PDO is only possible after NMT has been switched to state **OPERATIONAL**. For details, please refer to Network Management NMT (chapter 2.3).

4 Common Objects

4.1 Object Dictionary Entries

Index	Object	Name	Type	Attr.	M/O
1000h	VAR	Device Type	UNSIGNED32	ro	M
1001h	VAR	Error Register	UNSIGNED8	ro	M
1003h	ARRAY	Pre-Defined Error Field	UNSIGNED32	rw/ro	O
1005h	VAR	COB-ID SYNC Message	UNSIGNED32	rw	M
1008h	VAR	Manufacturer Device Name	VISIBLE_STRING	ro	O
1010h	Array	Store Parameters	UNSIGNED32	rw	O
1014h	VAR	COB-ID Emergency Object	UNSIGNED32	ro	M
1017h	VAR	Producer Heartbeat Time	UNSIGNED16	rw	M
1018h	RECORD	Identity Object	Identity	ro	M
2000h	VAR	Node ID	UNSIGNED8	rw	O
2001h	VAR	CAN Bitrate	UNSIGNED16	rw	O
2002h	VAR	Limit Switch Polarity	UNSIGNED16	rw	O
2005h	RECORD	Access Memory Cell	mem_access_para	rw	O
2007h	RECORD	Capture Object	PosSamplePara	rw	O
2008h	ARRAY	User Parameter	UNSIGNED16	rw	O
200Ah	VAR	I^2t Actual Value	UNSIGNED8	ro	O
200Bh	ARRAY	Temperature	INTEGER8	ro	O
200Ch	VAR	Error Number	UNSIGNED16	ro	O
200Dh	ARRAY	Power Consumption	INTEGER16	ro	O
200Eh	VAR	Fieldbus Options	UNSIGNED16	rw	O
200Fh	RECORD	Functional Safety	UNSIGNED16	ro	O
607Eh	VAR	Polarity	UNSIGNED8	rw	M
6094h	ARRAY	Velocity Encoder Factor	UNSIGNED32	rw	O
60FDh	VAR	Digital Inputs	UNSIGNED32	rw	O
7004h	VAR	Encoder Position Value	INTEGER16	ro	O

4.2 Object Description

4.2.1 Object 1000_h: Device Type

Contains information about the device type and the use of a device profile.

Object description:

INDEX	1000h
Name	Device Type
Object Code	VAR
Data Type	UNSIGNED32
Category	Mandatory

Entry description:

Access	ro
PDO Mapping	no
Value Range	UNSIGNED32
Default Value	0002 0192h

Entry Description:

Additional Information																Device Profile Number															
Mode Bits								Type								0192_h = DSP402															
*	*	*	*	*	*	*	*	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	1	0	0	1	0	0	1	0
31							24	23							16	15														0	

The specified entries characterise the device as a servo controller, the corresponding device profile is described in the specification DSP402.

4.2.2 Object 1001_h: Error Register

If an error occurs, ***Error Register*** contains information about the error. It is sent in an emergency telegram combined with the emergency error code.

Object description:

INDEX	1001h
Name	Error Register
Object Code	VAR
Data Type	UNSIGNED8
Category	Mandatory

Entry description:

Access	ro
PDO Mapping	no
Value Range	UNSIGNED8
Default Value	no

Structure of Error Register:

Bit	Meaning
0	generic error
1	current *)
2	voltage *)
3	temperature *)
4	communication error (overrun, error state) *)
5	device profile specific *)
6	reserved (always 0) *)
7	manufacturer specific *)

*) The actual ENGEL firmware does only support bit0, the complete error information is transmitted by the emergency telegram.

4.2.3 Object 1003_h: Pre-Defined Error Field

This object holds the last error that has occurred on the device and has been signalled via the Emergency Object. If sub-index 0 is zero, no error has occurred yet.

Object description:

INDEX	1003h
Name	Pre-Defined Error Field
Object Code	ARRAY
Data Type	UNSIGNED32
Category	Optional

Entry description:

SUB-INDEX	0
Description	Number of errors
Entry category	Mandatory
Access	rw
PDO Mapping	no
Value Range	0 … 1
Default value	0

SUB-INDEX	1
Description	Standard error field
Entry category	Optional
Access	ro
PDO Mapping	no
Value Range	UNSIGNED32
Default value	no

(see Error Codes in Chapter 5.1.2)

4.2.4 Object 1005_h: COB-ID SYNC Message

Defines the COB-ID used by the Synchronisation Object (SYNC).
Also defines whether the device can produce SYNC telegrams or not. Please note, that ENGEL drives may act as SYNC consumers only.

Object description:

INDEX	1005h
Name	COB-ID Sync Message
Object Code	VAR
Data Type	UNSIGNED32
Category	Mandatory

Entry description:

Access	rw
PDO Mapping	no
Value Range	UNSIGNED32
Default Value	0000 0080h *)

*) Bit 30 (read-only): 0 = device does not generate SYNC telegrams
Bit 29 (read-only): 0 = device uses 11-bit ID (CAN 2.0A)
Bit 10...0 (r/w): COB-ID used by SYNC message

4.2.5 Object 1008h: Manufacturer Device Name

This object shall provide the name of the device as given by the manufacturer.

Object description:

INDEX	1008h
Name	Manufacturer Device Name
Object Code	VAR
Data Type	VISIBLE_STRING
Category	Optional

Entry description:

Access	ro
PDO Mapping	no
Value Range	VISIBLE_STRING
Default Value	Manufacturer-specific

Data Description:

Device	Value*
DSV1030	DSV␣
DSV1032	DSV␣
HFIXXXX-X200	HFI2
HFIXXXX-X400	HFI4

*) The VISIBLE_STRING contains 4 characters. Take notice of the space character (␣).

For the numeric part of the device name, refer to Object 1018h: Identity Object, sub-index 2, "Product Code".

4.2.6 Object 1010h: Store Parameters

Object description:

INDEX	1010h
Name	Store Parameters
Object Code	ARRAY
Data Type	UNSIGNED32
Category	Optional

Entry description:

SUB-INDEX	0
Description	Number of entries
Entry category	Mandatory
Access	ro
PDO Mapping	no
Value Range	1
Default value	no

SUB-INDEX	1
Description	save all parameters
Entry category	Mandatory
Access	rw
PDO Mapping	no
Value Range	65766173h
Default value	no

Data Description:

Signature	MSB			LSB
ASCII	e	v	a	s
HEX	65h	76h	61h	73h

Notices:

Writing this signature 65766173h to ***Store Parameters*** (sub index 1) triggers the complete set of parameters to be saved in the non-volatile memory (EEPROM) of the device. Only this value will be accepted. With every writing process of the value the saving process will be performed.

After sending a ***Store Parameter*** SDO Write Request, wait for the corresponding SDO Write Response before you send the next SDO request. Alternatively, use a timeout greater than 3 seconds.

Parameter storing is not allowed in the state **Operation Enabled**. Otherwise, the command will not be accepted and a failure message is sent (0x08000022 = "Other Error).

Please note, that only objects marked as "non-volatile storable" relate to parameters and will be stored.

4.2.7 Object 1014h: COB ID Emergency Object

Defines the COB-ID of the emergency object.

Object description:

INDEX	1014h
Name	COB-ID Emergency Object
Object Code	VAR
Data Type	UNSIGNED32
Category	Mandatory

Entry description:

Access	ro
PDO Mapping	no
Value Range	UNSIGNED32
Default Value	80h + Node ID

4.2.8 Object 1017h: Producer Heartbeat Time

This object defines the cycle time of the heartbeat messages. It also defines the toggle interval of Bit 8 of the ***Statusword*** (6041h, chapter 5.3.2) in milliseconds.
Writing zero to this object deactivates heartbeat messages and the toggling of Bit 8. See also ***Fieldbus Options*** (200Eh, chapter 4.2.20).

Object description:

INDEX	1017h
Name	Producer Heartbeat Time
Object Code	VAR
Data Type	UNSIGNED16
Category	Mandatory

Entry description:

Access	rw
PDO Mapping	no
Value Range	UNSIGNED16
Default Value	0

Scaling factor: 1ms

4.2.9 Object 1018_h: Identity Object

Describes the identity of the device as a node in a CANopen network.

Object description:

INDEX	1018h
Name	Identity Object
Object Code	RECORD
Data Type	Identity
Category	Mandatory

Entry description:

SUB-INDEX	0
Description	Number of entries
Entry category	Mandatory
Access	ro
PDO Mapping	no
Value Range	1…4
Default value	no

SUB-INDEX	1
Description	Vendor ID*1)
Entry category	Mandatory
Access	ro
PDO Mapping	no
Value Range	UNSIGNED32
Default value	015Bh

SUB-INDEX	2
Description	Product Code*2)
Entry category	Mandatory
Access	ro
PDO Mapping	no
Value Range	UNSIGNED32
Default value	no

SUB-INDEX	3
Description	Firmware Revision *3)
Entry category	Optional
Access	ro
PDO Mapping	no
Value Range	UNSIGNED32
Default value	no

SUB-INDEX	4
Description	Serial Number
Entry category	Optional
Access	ro
PDO Mapping	no
Value Range	UNSIGNED32
Default value	no

*1) The ENGEL Elektroantriebe GmbH Vendor ID is 015Bh.

*2) The Product Code contains the manufacturer specific identification of the device. For ENGEL drives the Product Code is the numeric part of the device name (e. g. DSV110 → Product Code: 110_d or HBI2660 → Product Code: 2660_d)

*3) The upper 16bit contain the major revision number, the lower 16bit contain the minor revision number.

4.2.10 Object 2000h: Node ID

Node-ID of the device. For a new Node-ID to become valid, all parameters have to be stored and the device must be reset.

Object description:

INDEX	2000h
Name	Node ID
Object Code	VAR
Data Type	UNSIGNED8
Category	Optional

Entry description:

Access	rw
PDO Mapping	no
Value Range	1...127
Default Value	Stored value
non-volatile storable	yes

To change the Node-ID follow these steps:

1. Disable Operation (Obj. ***Controlword*** 6040h, chapter 5.3.1)
2. Set the new Node-ID
3. Store Parameters (Obj. ***Store Parameters*** 1010h, chapter 4.2.5; pay attention on the processing time)
4. NMT Reset Node

4.2.11 Object 2001h: CAN Bitrate

CAN bitrate of the device. For a new bitrate to be valid all parameters have to be stored and the device must be reset.

Warning: Operating devices with different bitrates in one CAN network can cause serious problems in the whole network. Therefore, change all devices to one bitrate before connecting to the network.

Object description:

INDEX	2001h
Name	CAN Bitrate
Object Code	VAR
Data Type	UNSIGNED16
Category	Optional

Entry description:

Access	rw
PDO Mapping	no
Value Range	UNSIGNED16
Default Value	Stored value
non-volatile storable	yes

Valid Entries:

Baud rate	Entry
10 kbit/s	0Ah
20 kbit/s	14h
50 kbit/s	32h
125 kbit/s	7Dh

Baud rate	Entry
250 kbit/s	00FAh
500 kbit/s	01F4h
800 kbit/s	0320h
1000 kbit/s*)	03E8h

*) Firmware V3.80 or higher

To change the CAN Bitrate follow these steps:

1. Disable Operation (Obj. ***Controlword*** 6040h, chapter 5.3.1)
2. Set the new CAN Bitrate
3. Store Parameters (Obj. ***Store Parameters*** 1010h, chapter 4.2.5; pay attention on the processing time)
4. NMT Reset Node

4.2.12 Object 2002_h: Limit Switch Polarity

Configures the polarity of the limit switches:
0: normally closed contacts (active low)
1: normally open contacts (active high)

Object description:

INDEX	2002h
Name	Limit Switch Polarity
Object Code	VAR
Data Type	UNSIGNED16
Category	Optional

Entry description:

Access	rw
PDO Mapping	no
Value Range	UNSIGNED16
Default Value	Stored value
non-volatile storable	yes

4.2.13 Object 2005_h: Access Memory Cell

Access to internal RAM cells. This object is not intended for general use.

Object description:

INDEX	2005h
Name	Access Memory Cell
Object Code	RECORD
Data Type	mem_access_para
Category	Optional

Entry description:

SUB-INDEX	0
Description	Number of entries
Entry category	Mandatory
Access	ro
PDO Mapping	no
Value Range	2
Default value	2

SUB-INDEX	1
Description	Access memory cell
Entry category	Optional
Access	rw
PDO Mapping	no
Value Range	UNSIGNED32
Default value	no
non-volatile storable	no

SUB-INDEX	2
Description	Password*)
Entry category	Optional
Access	rw
PDO Mapping	no
Value Range	UNSIGNED16
Default value	no
non-volatile storable	no

*) only for extended address space

Access Memory Cell provides read- and write access to the device-internal RAM cells and parameters. The object allows unrestricted memory access to the addresses 0800h to 8FFh. Other address spaces are password protected (sub-index 2) against unintended modification.

The 32bit value (sub-index 1) is divided in 16bit for addressing (high word) and 16bit for the data (low word). To read a parameter, the object (sub-index 1) with the address and data=0 has to be sent to the device. When reading the object now, it contains the address and the desired data.

Examples:

Read a memory cell:
Access Memory Cell Sub-Index 1 => 0x083E0000 (SDO write: send address 083Eh to the device)
Access Memory Cell Sub-Index 1 <= 0x083E00C8 (SDO read: read address and data, here 083Eh: 00C8h)

To write a memory cell, set bit 15 of the high word:
Access Memory Cell Sub-Index 1 => 0x883E00FF (SDO write: send address 083Eh with data 00FFh to the device)
Access Memory Cell Sub-Index 1 <= 0x083E00FF (SDO read: check written data, here 00FFh)

4.2.14 Object 2007_h: Capture Object

Saves the actual position and / or time that has elapsed since the last setting of ***Controlword / Bit 4*** *(New setpoint)*. Data is captured with a transition at one of the drive's limit switch inputs.

Object description:

INDEX	2007h
Name	Capture Object
Object Code	RECORD
Data Type	manufacturer specific
Category	Optional

Entry description:

SUB-INDEX	0
Description	Number of entries
Entry category	Mandatory
Access	ro
PDO Mapping	no
Value Range	3, 4
Default value	4

SUB-INDEX	1
Description	Capture Event Flags
Entry category	Optional
Access	ro
PDO Mapping	no
Value Range	UNSIGNED8
Default value	0

SUB-INDEX	2
Description	Captured Position Value
Entry category	Optional
Access	ro
PDO Mapping	no
Value Range	INTEGER32 [1/4096 U]
Default value	0

SUB-INDEX	3
Description	Capture Conditions
Entry category	Optional
Access	rw
PDO Mapping	no
Value Range	UNSIGNED16
Default value	Stored Value

SUB-INDEX	4
Description	Captured Time Value
Entry category	Optional
Access	ro
PDO Mapping	no
Value Range	UNSIGNED32 [100µs]
Default value	0

Data description:
With a switching edge at the digital limit switch inputs a storage of the position and / or time value can be triggered. When using the capture function, the limit switch function must be deactivated (DSerV).

The type of the edge (positive or negative), which triggers the function, can be selected with Sub3 ***Capture Conditions***. A logical OR combination of the digital inputs is possible. Every capture condition can be used for a synchronous storage of the position and time value.

After triggering by the selected edge the position value is saved to Sub2 ***Captured Position Value*** and the time value is saved to Sub4 ***Captured Time Value***. If the values are valid, the appropriate flags of Sub1 ***Capture Event Flags*** are set. No new values will now be saved until the already saved values are read out. The values can only be read out when the appropriate flags in ***Capture Event Flags*** are 1. Reading out the values, will reset the flags in ***Capture Event Flags*** to 0 again. → First check ***Capture Event Flags*** then read out the Values!

Sub1 (Capture Event Flags)

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	0	0	0	0	0	Time Captured	Pos Captured

Sub3 (Capture Conditions)

Bit 15	Bit 14	Bit 13	Bit 12	Bit 11	Bit 10	Bit 9	Bit 8
0	0	0	0	0	0	d	d
						Time Capture, limit switch left	
Bit 7	**Bit 6**	**Bit 5**	**Bit 4**	**Bit 3**	**Bit 2**	**Bit 1**	**Bit 0**
c	c	b	b	a	a	0	0
Time Capture, limit switch right		Position Capture, limit switch left		Position Capture, limit switch right			

Values for aa, bb, cc, dd:

00: no capture
01: capture at positive edge*)
10: capture at negative edge*)
11: capture at every edge

*) is not influenced by ***Limit Switch Polarity*** (2002h, chapter 4.2.12)

Notices:

- Not all ENGEL devices do have the limit switch function
- All digital inputs are debounced, which results in a signal delay of 1.5 ms
- Every transition 0→1 of ***Controlword / Bit 4*** sets the internal timer back to zero and starts it anew, independently from the mode of operation
- If the internal timer is running, when the *Time Capture Condition* is fulfilled, it will be stopped and the value will be copied to ***Captured Time Value*** and the *Time Capture Flag* is set. If the internal timer is not running, when the *Time Capture Condition* is met, no action will be taken.
- If the internal timer is not stopped, it runs up to 0xFFFFFFFF and stays there. No overflow takes place.

4.2.15 Object 2008_h: User Parameter

In ***User Parameter*** up to 10 user specific values can be stored permanently. For non-volatile storage ***Store Parameters*** (1010h, chapter 4.2.5) must be used.

Object description:

INDEX	2008h
Name	User Parameter
Object Code	ARRAY
Data Type	UNSIGNED16
Category	Optional

Entry description:

SUB-INDEX	0
Description	Number of entries
Entry category	Mandatory
Access	ro
PDO Mapping	no
Value Range	10
Default value	10

SUB-INDEX	1
Description	User Parameter 1
Entry category	Optional
Access	rw
PDO Mapping	no
Value Range	UNSIGNED16
Default value	Stored Value

SUB-INDEX	2…10
Description	User Parameter [2…10]
Entry category	Optional
Access	rw
PDO Mapping	no
Value Range	UNSIGNED16
Default value	Stored Value

4.2.16 Object 200A$_h$: I²t Actual Value

Gives the actual I²t-value in percent. If the value reaches 100%, the current will be reduced to ***Motor Rated Current*** (6075h, chapter 9.2.3)**.**

Object description:

INDEX	200Ah
Name	I²t Actual Value
Object Code	VAR
Data Type	UNSIGNED8
Category	Optional

Entry description:

Access	ro
PDO Mapping	no
Value Range	0…100
Default Value	0

4.2.17 Object 200B$_h$: Temperature

Gives the measured drive temperature in °C.

Object description:

INDEX	200Bh
Name	Temperature
Object Code	ARRAY
Data Type	INTEGER8
Category	Optional

Entry description:

SUB-INDEX	0
Description	Number of entries
Entry category	Mandatory
Access	ro
PDO Mapping	no
Value Range	1
Default value	1

SUB-INDEX	1
Description	Drive Temperature
Entry category	Mandatory
Access	ro
PDO Mapping	no
Value Range	-128…127*)
Default value	0

*) in the range of -20°C…+100°C the highest precision will be achieved

4.2.18 Object 200C$_h$: Error Number

Gives the actual error number which corresponds to the LED-Code (see Error Codes in Chapter 5.1.2). If no error is active the value is 0.

Object description:

INDEX	200Ch
Name	Error Number
Object Code	VAR
Data Type	UNSIGNED16
Category	Optional

Entry description:

Access	ro
PDO Mapping	possible
Value Range	UNSIGNED16
Default Value	no

Example: over-current failure → ***Error number*** = 7

4.2.19 Object 200Dh: Power Consumption

Monitors the electrical current / electrical power that the drive's power stage is drawing from the DC link circuit (Firmware V4.40 or higher).

For DC supplied drives, the supply's output current is mostly identical to the drive's *Power Stage Input Current*. However, especially at light loads, the two current profiles may differ slightly due to DC link buffering inside the drive. Furthermore current profiles may differ dramatically in generator mode, if the DC power supply has only limited energy absorption capacity or is blocking negative currents by means of a diode or rectifier.

Current and power values are not measured directly, but are instead derived from other values measured inside the drive. Please note, that the drive's quiescent current is not taken into account, which may lead to reduced precision at light loads.

Both values are available as unfiltered, instantaneous values with a refresh rate of 100µs or as filtered (averaged) values with a time constant of approx. 50ms.

Object description:

INDEX	200Dh
Name	Power Consumption
Object Code	ARRAY
Data Type	INTEGER16
Category	Optional

Entry description:

SUB-INDEX	0
Description	Number of entries
Entry category	Mandatory
Access	ro
PDO Mapping	no
Value Range	4
Default value	4

SUB-INDEX	1
Description	Power Stage Input Current (unfiltered)
Entry category	Optional
Access	ro
PDO Mapping	possible
Value Range	INTEGER16
Default value	0

SUB-INDEX	2
Description	Power Stage Input Current (filtered)
Entry category	Optional
Access	ro
PDO Mapping	possible
Value Range	INTEGER16
Default value	0

SUB-INDEX	3
Description	Power Stage Input Power (unfiltered)
Entry category	Optional
Access	ro
PDO Mapping	possible
Value Range	INTEGER16
Default value	0

SUB-INDEX	4
Description	Power Stage Input Power (filtered)
Entry category	Optional
Access	ro
PDO Mapping	possible
Value Range	INTEGER16
Default value	0

Scaling factor:
Positive values represent an electrical current / electrical power *consumed* by the motor.
Negative values represent an electrical current / electrical power *generated* by the motor.

In order to determine the ***Power Stage Input Current*** [A] and the ***Power Stage Input Power*** [W], the integer values of the objects need to be multiplied by the following factors (values for customer specific devices only on request):

Device	Power Stage Input Current Scaling factor[1)]	Power Stage Input Power Scaling factor[2)]
DSV110	16.5A / 32767 = **0.0005036 A**	112.0V * 16.5A / 32767 = **0.056398 W**
DSV112	50.0A / 32767 = **0.0015259 A**	112.0V * 50.0A / 32767 = **0.170904 W**
DSV130	103.1A / 32767 = **0.0031465 A**	112.0V * 103.1A / 32767 = **0.352403 W**
DSV132	63.5A / 32767 = **0.0019379 A**	112.0V * 63.5A / 32767 = **0.217048 W**
DSV133	63.5A / 32767 = **0.0019379 A**	112.0V * 63.5A / 32767 = **0.217048 W**
DSV324	16.5A / 32767 = **0.0005036 A**	500.0V * 16.5A / 32767 = **0.251778 W**
DSV562E	9.9A / 32767 = **0.0003021 A**	-----
DSV1030	103.1A / 32767 = **0.0031465 A**	102.3V * 103.1A / 32767 = **0.321883 W**
DSV1032	103.1A / 32767 = **0.0031465 A**	102.3V * 103.1A / 32767 = **0.321883 W**
HBI2230-2	25.4A / 32767 = **0.0007752 A**	102.3V * 25.4A / 32767 = **0.079300 W**
HBI2230-4	25.4A / 32767 = **0.0007752 A**	102.3V * 25.4A / 32767 = **0.079300 W**
HBI2260-2	42.3A / 32767 = **0.0012909 A**	102.3V * 42.3A / 32767 = **0,132062 W**
HBI2260-4	25.4A / 32767 = **0.0007752 A**	102.3V * 25.4A / 32767 = **0.079300 W**
HBI2630-2	42.3A / 32767 = **0.0012909 A**	102.3V * 42.3A / 32767 = **0,132062 W**
HBI2630-4	25.4A / 32767 = **0.0007752 A**	102.3V * 25.4A / 32767 = **0.079300 W**
HBI2660-2	42.3A / 32767 = **0.0012909 A**	102.3V * 42.3A / 32767 = **0,132062 W**
HBI2660-4	25.4A / 32767 = **0.0007752 A**	102.3V * 25.4A / 32767 = **0.079300 W**
HBI3260-4	45.8A / 32767 = **0.0013977 A**	102.3V * 45.8A / 32767 = **0.142990 W**
HBI3290-4	45.8A / 32767 = **0.0013977 A**	102.3V * 45.8A / 32767 = **0.142990 W**
HBI3760-4	45.8A / 32767 = **0.0013977 A**	102.3V * 45.8A / 32767 = **0.142990 W**
HBI3790-4	45.8A / 32767 = **0.0013977 A**	102.3V * 45.8A / 32767 = **0.142990 W**
HFI2230-X200	27.5A / 32767 = **0.0008393 A**	102.3V * 27.5A / 32767 = **0.085856 W**
HFI2230-X400	13.8A / 32767 = **0.0004212 A**	102.3V * 13.8A / 32767 = **0.043084 W**
HFI2260-X200	55.0A / 32767 = **0.0016785 A**	102.3V * 55.0A / 32767 = **0.171712 W**
HFI2260-X400	27.5A / 32767 = **0.0008393 A**	102.3V * 27.5A / 32767 = **0.085856 W**
HFI2630-X200	55.0A / 32767 = **0.0016785 A**	102.3V * 55.0A / 32767 = **0.171712 W**
HFI2630-X400	27.5A / 32767 = **0.0008393 A**	102.3V * 27.5A / 32767 = **0.085856 W**
HFI2660-X200	55.0A / 32767 = **0.0016785 A**	102.3V * 55.0A / 32767 = **0.171712 W**
HFI2660-X400	27.5A / 32767 = **0.0008393 A**	102.3V * 27.5A / 32767 = **0.085856 W**
HFI3260-X200	75.0A / 32767 = **0.0022889 A**	102.3V * 75.0A / 32767 = **0.234153 W**
HFI3260-X400	75.0A / 32767 = **0.0022889 A**	102.3V * 75.0A / 32767 = **0.234153 W**
HFI3290-X400	75.0A / 32767 = **0.0022889 A**	102.3V * 75.0A / 32767 = **0.234153 W**
HFI3760-X400	75.0A / 32767 = **0.0022889 A**	102.3V * 75.0A / 32767 = **0.234153 W**
HFI3790-X400	75.0A / 32767 = **0.0022889 A**	102.3V * 75.0A / 32767 = **0.234153 W**
HLI2660	50.0A / 32767 = **0.0015259 A**	112.0V * 50.0A / 32767 = **0.170904 W**

1) Scaling Factor = Current Measuring Range / 32767
2) Scaling Factor = Voltage Measuring Range * Current Measuring Range / 32767

4.2.20 Object 200E$_h$: Fieldbus Options

Via ***Fieldbus Options*** certain features on the fieldbus can be activated / deactivated and these are:

- A heartbeat toggle bit, BIT 8 of ***Statusword*** (6041h, chapter 5.3.2), can supplement or replace the heartbeat telegram. The toggle-interval is given by the object ***Producer Heartbeat Time*** (1017h, chapter 4.2.8).
- The scaling of certain CANopen objects[1)] can be changed.
- Drive errors can be suppressed on the fieldbus.

Object description:

INDEX	200Eh
Name	Fieldbus Options
Object Code	VAR
Data Type	UNSIGNED16
Category	optional

Entry description:

Access	rw
PDO Mapping	no
Value Range	UNSIGNED16
Default Value	Stored value
non-volatile storable	yes

Data description:

Bit #	Configuration
Bit 0	0: Heartbeat Toggle Bit is deactivated 1: Heartbeat Toggle Bit is activated
Bit 1	0: Heartbeat Telegram is active 1: Heartbeat Telegram is suppressed on the bus (only effective, if Toggle-Bit is activated)
Bit 2	0: standard compliant scaling 1: legacy scaling
Bit 3	0: drive errors are active on the fieldbus 1: drive errors are suppressed on the fieldbus
Bit 4	
…	reserved
Bit 15	

1) List of affected objects:

- ***Motor Rated Current*** (6075h, chapter 9.2.3)
- ***Dynamic Torque Limit*** (2004h, chapter 8.2.4)
- ***Current Limit Homing*** (2009h, chapter 6.2.1)
- ***Target Torque*** (6071h, chapter 9.2.1)
- ***Max Current*** (6073h, chapter 9.2.2)
- ***Current Actual Value*** (6078h, chapter 9.2.5)
- ***DC Link Circuit Voltage*** (6079h, chapter 9.2.6)

4.2.21 Object 200F$_h$: Functional Safety

Monitors the parameters of the STO-module.

Object description:

INDEX	200Fh
Name	Functional Safety
Object Code	RECORD
Data Type	INTEGER16
Category	Optional

Entry description:

SUB-INDEX	0
Description	Number of entries
Entry category	Mandatory
Access	ro
PDO Mapping	no
Value Range	4
Default value	4

SUB-INDEX	1
Description	Status
Entry category	Optional
Access	ro
PDO Mapping	possible
Value Range	UNSIGNED16
Default value	0

SUB-INDEX	2
Description	Temperature
Entry category	Optional
Access	ro
PDO Mapping	possible
Value Range	INTEGER8
Default value	0

SUB-INDEX	3
Description	Internal Voltage STO1
Entry category	Optional
Access	ro
PDO Mapping	possible
Value Range	UNSIGNED16
Default value	0

SUB-INDEX	4
Description	Internal Voltage STO2
Entry category	Optional
Access	ro
PDO Mapping	possible
Value Range	UNSIGNED16
Default value	0

Data description:

Sub1 (Status):
The upper 8 Bits of Sub1 resemble STO channel 2 and the lower 8 Bits STO channel 1. When Bit 0 and Bit 8 contain a zero, the STO-function is active (this means the drive cannot be operated). When both Bits contain a one the STO-function is inactive (normal operation). When only one Bit contains a zero, only one channel is active (this means the drive cannot be operated).

Bit 15	Bit 14	Bit 13	Bit 12	Bit 11	Bit 10	Bit 9	Bit 8
0	0	0	0	0	0	0	STO2
Bit 7	**Bit 6**	**Bit 5**	**Bit 4**	**Bit 3**	**Bit 2**	**Bit 1**	**Bit 0**
0	0	0	0	0	0	0	STO1

Sub2 (Temperature): Contains the temperature of the STO module in °C.

Sub3/4 (Internal Voltage STO 1/2): Contains the internal STO-voltage in mV.

4.2.22 Object 607E$_h$: Polarity

Polarity defines the polarity of the position range and the sign of the set-point values ***Target Torque*** (6071h, chapter 9.2.1) and ***Target Velocity*** (60FFh, chapter 8.2.2).

Definition:

With a view to the output shaft: positive sense of rotation when rotating the motor shaft clockwise (cw).

***Polarity* = 0:** Increasing position values for a positive sense of rotation.
Positive value for ***Target Velocity*** results in positive sense of rotation (cw).
Positive value for ***Target Torque*** results in clockwise development of torque (cw).

***Polarity* ≠ 0:** Decreasing position values for positive sense of rotation.
Positive value for ***Target Velocity*** results in negative sense of rotation (ccw).
Positive value for ***Target Torque*** results in counter-clockwise development of torque (ccw).

Object description:

INDEX	607Eh
Name	Polarity
Object Code	VAR
Data Type	UNSIGNED8
Category	mandatory

Entry description:

Access	rw
PDO Mapping	possible
Value Range	UNSIGNED8
Default Value	Stored value
non-volatile storable	yes

Data Description:
Contrary to the standard, there is no bit-wise meaning assigned. Any value unequal to 0 changes the polarity.

4.2.23 Object 6094$_h$: Velocity Encoder Factor

Velocity Encoder Factor determines the resolution of the objects ***Target Velocity*** (60FFh, chapter 8.2.2) and ***Profile Velocity*** (6081h, chapter 7.2.10) (Firmware V3.77 or higher).

Object description:

INDEX	6094h
Name	Velocity Encoder Factor
Object Code	ARRAY
Data Type	UNSIGNED 32
Category	Optional

Entry description:

SUB-INDEX	0
Description	Number of entries
Entry category	Mandatory
Access	ro
PDO Mapping	no
Value Range	2
Default value	2

SUB-INDEX	1
Description	Numerator
Entry category	Mandatory
Access	rw
PDO Mapping	yes
Value Range	1 … 16384 (V3.82 or higher)
Default value	1
non-volatile storable	no

SUB-INDEX	2
Description	Denominator
Entry category	Mandatory
Access	rw
PDO Mapping	yes
Value Range	2,4,8,16,32,64,128,…,32768
Default value	2
non-volatile storable	no

Data description:

The resolution of ***Target Velocity*** and ***Profile Velocity*** is $\frac{Numerator}{Denominator}$ rpm

With the default values (1/2) the resolution is 0.5 rpm.

Example 1:

Desired Velocity: **600 rpm**
Desired Scaling: **32768 = 600 rpm**

Settings:

Velocity Encoder Factor Sub-index 1 (Numerator) = 600
Velocity Encoder Factor Sub-index 2 (Denominator) = 32768
Target Velocity = Desired Velocity * Denominator / Numerator = 600.0 * 32768 / 600 = **32768**

Example 2:

Desired Target speed: **600 rpm**
Desired Resolution: **(1/512) rpm** ≈ 0.002 rpm

Settings:

Velocity Encoder Factor Sub-index 1 (Numerator) = 1 (default)
Velocity Encoder Factor Sub-index 2 (Denominator) = **512**
Target Velocity = 600 rpm * 512 = **307200**

Notice: Changing Sub1 or Sub2 will not immediately effect the actual velocity. The change will take effect on the next writing of the objects ***Target Velocity*** or ***Profile Velocity***.

4.2.24 Object 60FD$_h$: Digital Inputs

The low word contains the states of the digital inputs as defined by the CANopen profile.
The high word displays the states of all digital inputs.

Object description:

INDEX	60FDh
Name	Digital Inputs
Object Code	VAR
Data Type	UNSIGNED32
Category	Optional

Entry description:

Access	ro
PDO Mapping	possible
Value Range	UNSIGNED32

Data description:

Bit #	Configuration
0	negative limit switch
1	positive limit switch
2	free
3	free
4… 15	reserved
16	Digital Input DI1
17	Digital Input DI2
18	Digital Input DI3
19	Digital Input DI4
20	Digital Input DI5
21	Digital Input DI6
22	Digital Input DI7
23	Digital Input DI8
24	Digital Input DI9
25	Digital Input DI10

4.2.25 Object 60FE$_h$: Digital Outputs

This object allows to read the state of the drive's digital outputs. Furthermore, it also allows to configure individual digital outputs for user control.

Under user control it is possible to directly set or reset the digital outputs, as opposed to automatic control, where the digital outputs are switched automatically when a predefined condition is met (e.g. Target Reached condition).

Object description:

INDEX	60FEh
Name	Digital Outputs
Object Code	ARRAY
Data Type	UNSIGNED32
Category	Optional

Entry description:

SUB-INDEX	0
Description	Number of entries
Entry category	Mandatory
Access	ro
PDO Mapping	no
Value Range	1…2
Default value	no

SUB-INDEX	1
Description	Physical outputs
Entry category	Mandatory
Access	rw
PDO Mapping	Possible
Value Range	UNSIGNED32
Default value	0

SUB-INDEX	2
Description	Bit Mask
Entry category	Optional
Access	rw
PDO Mapping	yes
Value Range	UNSIGNED32
Default value	0

Data description:
applies to both sub-index 1 and sub-index 2

Bit #	Configuration
0	
..	reserved
15	
16	Digital Output DO1
17	Digital Output DO2
18	.
..	.
31	.

The actual number of available digital outputs is device-dependent. For more information, please see the specific device's Operating Manual.

Sub-Index 1 represents the voltage level of the digital outputs according to the following table:

Bit n = 0:	Low level output voltage at the associated digital output pin
Bit n = 1:	High level output voltage at the associated digital output pin

For those digital outputs, that have been selected for user control (see below), the associated bit can be read or written to (rw). When under automatic control, the associated bit is read-only (ro).

With automatic control, configuring a digital output for 'Negative Logic' in the setup procedure will invert the result of the selected digital output function before it is placed in Sub1. (e. g. Target Reached condition + Negative Logic → Sub1 / Bit n = 0 when target is reached)

For Firmware Versions ≥ 4.59:
With user control, 'Negative Logic' does not affect the digital outputs in any way.

Firmware Versions < 4.59:
With user control, 'Negative Logic' will invert the voltage level assignment for the associated digital output, e. g. Sub1 / Bit n= 0 will apply a high level voltage and Sub1 / Bit n = 1 will apply a low level voltage to the output.

Please note, that ENGEL drives usually have open-collector-style digital outputs. Therefore, a pull-up or pull-down resistor may be required to provide the complementary voltage level. (Please see Operating Manual).

The bit mask specified in **Sub-Index 2** allows to select individual digital outputs for automatic control or user control:

Bit n = 0:	Associated digital output selected for automatic control. (State of digital output will automatically be set according to the digital output function assigned in the setup procedure.)
Bit n = 1:	Associated digital output selected for user control. (State of digital output will be set according to the corresponding bit value in Sub-Index 1)

4.2.26 Object 6C01$_h$: Analogue Inputs 16-Bit

Allows to read the values of the drive's analogue inputs (Firmware V3.72 or higher).

Object description:

INDEX	6C01h
Name	Read Analogue Input 16-Bit
Object Code	ARRAY
Data Type	INTEGER16
Category	Conditional: Device with analogue input

Entry description:

SUB-INDEX	0
Description	Number of Analogue Inputs 16-Bit
Entry category	Mandatory
Access	ro
PDO Mapping	no
Value Range	1…2
Default value	no

SUB-INDEX	1
Description	Analogue Input 1
Entry category	Mandatory
Access	ro
PDO Mapping	Possible
Value Range	INTEGER16
Default value	no

SUB-INDEX	2
Description	Analogue Input 2
Entry category	Optional
Access	ro
PDO Mapping	Possible
Value Range	INTEGER16
Default value	no

Scaling factor: 8000h ... 0000h ... 7FFFh ≡ -10V ... 0V ... +10V

4.2.27 Object 7004_h: Encoder Position Value

Incremental encoder counter (Firmware V3.74 or higher).
This object is only valid for ENGEL devices with incremental encoder interface.

As part of the setup procedure, an incremental encoder may be configured as feedback device for the internal control loop. In those cases, where a different feedback device (e.g. a resolver) is configured, the incremental encoder interface will still remain operational and may serve as an independent position counter.

Object description:

INDEX	7004h
Name	Encoder Position Value
Object Code	VAR
Data Type	INTEGER16

Entry description:

Access	ro
PDO Mapping	possible
Value Range	INTEGER16
Default Value	no

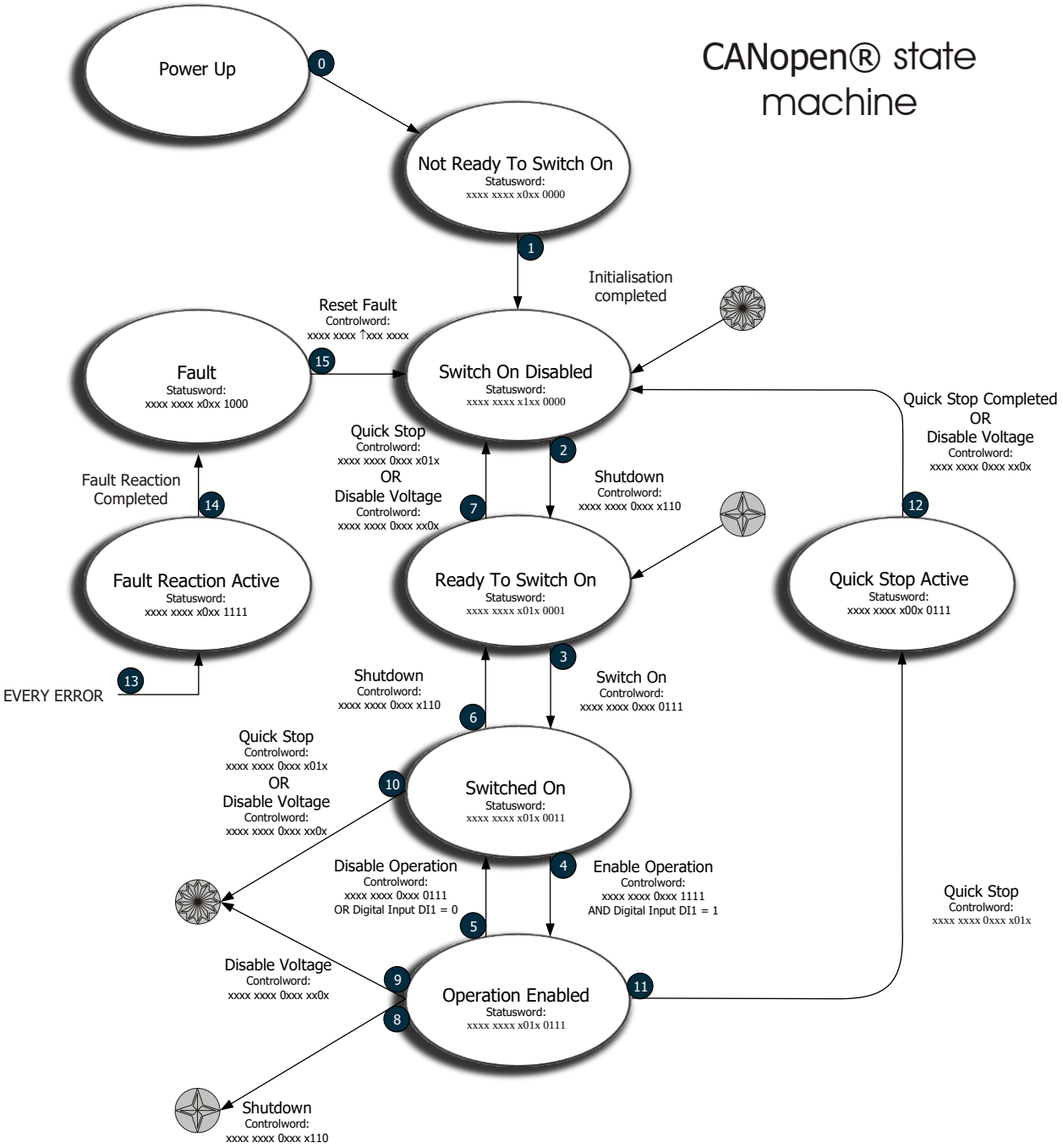
Scaling factor: $\frac{Encoder\ Position\ Increments}{Revolution} = 4\ x\ \frac{Encoder\ Pulses}{Revolution}$

Please note that ***Encoder Position Value*** will overflow / underflow at the boundaries of the 16-Bit integer range.

5 Device Control

5.1 State Machine

The device control is performed by a state machine according to DSP402. State changes are triggered by internal events such as the occurrence of an error or external demand by means of ***Controlword*** (6040h, chapter 5.3.1). ***Statusword*** (6041h, chapter 5.3.2) gives feedback about the actual state. After power-up and initialisation, the drive switches to the state **Switch On Disabled** automatically. In the state **Operation Enabled**, the drive is fully operational.



There is no functional difference between the states **Switch On Disabled**, **Ready To Switch On** and **Switched On** for all ENGEL CANopen devices.

5.1.1 State Transitions

State transitions are either triggered by internal events of the device (e.g. error) or externally by means of the ***Controlword*** (6040h, chapter 5.3.1). The following state transitions are possible:

Tran-sition	from... ➔ to...	command controlword	Event	Action
0	START ➔ NOT READY TO SWITCH ON	-	reset, start up	initialisation of the drive
1	NOT READY TO SWITCH ON ➔ SWITCH ON DISABLED	-	initialisation finished	communication active
2	SWITCH ON DISABLED ➔ READY TO SWITCH ON	**Shutdown** xxxx xxxx 0xxx x110b	shutdown-command	none
3	READY TO SWITCH ON ➔ SWITCHED ON	**Switch On** xxxx xxxx 0xxx 0111b	switch on-command	none
4	SWITCHED ON ➔ OPERATION ENABLE *1)	**Enable Operation** xxxx xxxx 0xxx 1111b	enable-command	enable power stage
5	OPERATION ENABLE ➔ SWITCHED ON *1)	Disable Operation xxxx xxxx 0xxx 0111b	disable-command	disable power stage
6	SWITCHED ON ➔ READY TO SWITCH ON	**Shutdown** xxxx xxxx 0xxx x110b	shutdown-command	none
7	READY TO SWITCH ON ➔ SWITCH ON DISABLED	**Disable Voltage** xxxx xxxx 0xxx xx0xb OR **Quick Stop** xxxx xxxx 0xxx x01xb	disable- or quick stop command	none
8	OPERATION ENABLE ➔ READY TO SWITCH ON	**Shutdown** xxxx xxxx 0xxx x110b	shutdown-command	disable power stage
9	OPERATION ENABLE ➔ SWITCH ON DISABLED	**Disable Voltage** xxxx xxxx 0xxx xx0xb	disable-command	disable power stage
10	SWITCHED ON ➔ SWITCH ON DISABLED	**Disable Voltage** xxxx xxxx 0xxx xx0xb OR **Quick Stop** xxxx xxxx 0xxx x01xb	disable-command	none
11	OPERATION ENABLE ➔ QUICK STOP ACTIVE	**Quick Stop** xxxx xxxx 0xxx x01xb	quick stop-command	executing quick stop function
12	QUICK STOP ACTIVE ➔ SWITCH ON DISABLED	-	quick stop finished	remove enable, disable power stage
13	All states ➔ FAULT REACTION ACTIVE	-	error	executing fault reaction
14	FAULT REACTION ACTIVE ➔ FAULT	-	fault reaction finished	remove enable, disable power stage
15	FAULT ➔ SWITCH ON DISABLED	**Fault Reset** xxxx xxxx ↑xxx xxxxb *2)	reset-command	reset fault

*1) the state changes 4 and 5 enable and disable the power stage. The state transition 4, enable power stage, is only possible when the enable input DI1 is set. Like **Disable Operation**, resetting DI1 will trigger the state transition 5 and disable the power stage.

*2) Bit7 **Fault Reset** must change from low to high. If the cause of error is removed, the error will be reset. The 'Fault Reset'-Bit has to be reset by the master after leaving the state **Fault**.

5.1.2 State Fault: Error Codes

The following table gives an overview of possible errors. It shows the associated CANopen error code and also the blinking code, which will be displayed via the device's red status LED.

The CANopen error code is sent to the master by an emergency message only once, but is also stored in object ***Pre-Defined Error Field*** (1003h, chapter 4.2.3).

Error code	LED-Code	Error description
1000h	10	common error
2310h	7	over-current
3130h	6	phase failure (undervoltage)
3210h	4	DC link over-voltage
4210h	2	temperature device
4310h	1	temperature motor
5114h	3	auxiliary voltage failure
5530h	8	non-volatile data memory
6320h	9	parameter error
7303h	5	resolver error
8110h	12	CAN overrun [1)]
8120h	12	CAN in Error Passive Mode
8140h	12	recovered from bus-off
8180h	12	CAN buffer overflow [2)]
8190h	12	CAN power supply
81A0h	12	CAN reset communication [3)]
81B0h	12	CAN stopped [4)]
8210h	12	CAN RPDO length error (Message too short)
8611h	11	Following error
F080h	13	Generic STO-error
F081h	13	undervoltage STO-channel 1
F082h	13	overvoltage STO-channel 1
F083h	13	temperature STO
F084h	13	undervoltage STO-channel 2
F085h	13	undervoltage STO-channel 1+2
F086h	13	overvoltage STO-channel 1 + undervoltage STO-channel 2
F087h	13	overvoltage STO-channel 2
F088h	13	undervoltage STO-channel 1 + overvoltage STO-channel 2
F089h	13	overvoltage STO-channel 1+2
FF01h	11	actual position < minimum
FF02h	11	actual position > maximum
FF03h	11	set position < minimum
FF04h	11	set position > maximum
FF05h	11	positioning parameter error
FF06h	11	limit switch error
FF07h	11	homing error
FF08h	14	forbidden speed value

1) Receive message lost due to Rx mailbox overrun.
2) Rx or Tx buffer overflow.
3) Triggered by NMT command *Reset Communication*.
4) Triggered by NMT command *Stop Remote Node* or *Stop All Nodes*.

5.2 Object Dictionary Entries

Index	Object	Name	Type	Attr.	M/O
6040h	VAR	Controlword	UNSIGNED16	rw	M
6041h	VAR	Statusword	UNSIGNED16	ro	M
605Ah	VAR	Quick Stop Option Code	INTEGER16	rw	O
605Dh	VAR	Halt Option Code	INTEGER16	rw	O
6060h	VAR	Modes of Operation	INTEGER8	rw	M
6061h	VAR	Modes of Operation Display	INTEGER8	ro	M
6502h	VAR	Supported Drive Modes	UNSIGNED32	ro	M

5.3 Object description

5.3.1 Object 6040h: Controlword

The master uses ***Controlword*** to control the drive. The state machine is switched by the commands described in State Transitions (chapter 5.1.1). Furthermore, Controlword contains a set of dedicated bits used to activate several operating mode specific functions (e. g. Start Homing, HALT, ...).

Object description:

INDEX	6040h
Name	Controlword
Object Code	VAR
Data Type	UNSIGNED16
Category	Mandatory

Entry description:

Access	rw
PDO Mapping	Possible (default)
Value Range	UNSIGNED16
Default Value	no

Description of Controlword bits:

15…13	12…11	10…9	8	7	6…4	3	2	1	0
-	Turntable mode	reserved	HALT	Fault reset	Operation mode specific	Enable operation	Quick Stop	Enable voltage	Switch on

MSB LSB

Valid commands are restricted to the bit patterns listed in the State Transition Table (chapter 5.1.1)!

Operation mode specific bits:

Bit #	Turntable Mode	Profile Position Mode	Profile Velocity Mode	Profile Torque Mode	Homing Mode
4	New set-point	New set-point	reserved	reserved	Homing operation start
5	Change set immediately	Change set immediately	reserved	reserved	reserved
6	abs/rel	abs/rel	reserved	reserved	reserved

ENGEL specific bits:

Bit #	Turntable Mode	Profile Position Mode	Profile Velocity Mode	Profile Torque Mode	Homing Mode
11	directional/optimal	reserved	reserved	reserved	reserved
12	cw/ccw	reserved	reserved	reserved	reserved

Data Description:

Bit #	Function	Description
4	New set-point Homing operation start	**Profile Position Mode**: transition 0 → 1 starts the positioning **Homing Mode:** transition 0 → 1 starts the homing
5	Change set immediately	**Profile Position Mode**: Bit=0: A new positioning process does not start until the preceding one is finished (target_reached=1) Bit=1: A new positioning process starts instantly; a preceding one will be cancelled
6	abs/rel	Bit=0: ***Target Position*** (607Ah, chapter 7.2.6) is absolute Bit=1: ***Target Position*** (607Ah, chapter 7.2.6) is relative to the previous target position value
8	HALT	**Profile Position Mode**: Bit=1: The drive decelerates down to the speed 0 and holds the achieved position. Bit=0: A cancelled positioning process can be started over by setting Bit 4 (It is not allowed to reset Bit 8 and to set Bit 4 simultaneously). **Profile Velocity Mode and Profile Torque Mode:** Bit=1: The drive decelerates down to the speed 0 and holds the achieved position. Bit=0: The drive continues the movement.
11	directional/optimal	(**Turntable Mode** only; Bit6=0 absolute positions) Bit=0: ***Target Position*** (607Ah, chapter 7.2.6) is approached as defined in Bit 12 (cw/ccw) Bit=1: ***Target Position*** (607Ah, chapter 7.2.6) is approached on the shortest path
12	cw/ccw	(**Turntable Mode** only; Bit6=0 absolute positions; Bit11=0 directional) Bit=0: ***Target Position*** (607Ah, chapter 7.2.6) is approached clockwise Bit=1: ***Target Position*** (607Ah, chapter 7.2.6) is approached counter-clockwise

5.3.2 Object 6041_h: Statusword

Statusword shows the state of the drive, the meaning of the single bits can be seen in the CANopen state diagram (chapter 5.1).

Object description:

INDEX	6041h
Name	Statusword
Object Code	VAR
Data Type	UNSIGNED16
Category	Mandatory

Entry description:

Access	ro
PDO Mapping	Possible (default)
Value Range	UNSIGNED16
Default Value	no

Description of Statusword bits:

Bit	Description
0	Ready to switch on
1	Switched on
2	Operation enabled
3	Fault
4	Voltage enabled
5	Quick Stop (0 = Quick Stop)
6	Switch on disabled
7	Warning
8	Heartbeat Toggle Bit (see Heartbeat_Telegram chapter 2.3)
9	Remote (always 1, when in fieldbus mode)
10	Target reached
11	Internal limit active
12	Operation mode specific
13	Operation mode specific
14	Manufacturer specific
15	Manufacturer specific

Operation mode specific bits:

Bit	Profile Position Mode	Profile Velocity Mode	Profile Torque Mode	Homing Mode
12	Set-point acknowledge	Speed	reserved	Homing attained
13	Following Error	Max Slippage Error	reserved	Homing Error

Device status according to the state machine:

Value (binary)	State
xxxx xxxx x0xx 0000b	Not Ready To Switch On
xxxx xxxx x1xx 0000b	Switch On Disabled
xxxx xxxx x01x 0001b	Ready To Switch On
xxxx xxxx x01x 0011b	Switched On
xxxx xxxx x01x 0111b	Operation Enabled
xxxx xxxx x00x 0111b	Quick Stop Active
xxxx xxxx x0xx 1111b	Fault Reaction Active
xxxx xxxx x0xx 1000b	Fault

Data Description:

Bit #	Function	Description
10	Target reached	**Quick Stop** is set Bit = 0: always **Halt** is set Bit = 0: n_actual > threshold (typ. 50 rpm) Bit = 1: n_actual < threshold **Profile Torque Mode** Bit = 0: I_target - I_actual > threshold (typ. 2% of the current range) Bit = 1: I_target - I_actual < threshold. **Profile Position Mode** Bit = 0: Start of new positioning process or the actual position leaves the ***Position Window*** (see 6067h, chapter 7.2.4). Bit = 1: Is set at the end of braking ramp, when the actual position stays in ***Position Window*** for ***Position Window Time*** (see 6068h, chapter 7.2.5). **Profile Velocity Mode** Bit = 0: n_target - n_actual > threshold (typ. 50 rpm) Bit = 1: n_target – n_actual < threshold. **Homing Mode** Bit = 0: Start of new homing process. Bit = 1: Is set together with Bit 12 (Homing attained) after successful homing process.
11	Internal limit active	Always 0.
12	Set-point acknowledge	**Profile Position Mode** Bit = 0: Previous set-point already processed, waiting for new set-point Bit = 1: Previous set-point still in process
	Speed	**Profile Velocity Mode** Bit = 0: Speed is not equal 0 Bit = 1: Speed is equal 0
	Homing attained	**Homing Mode** Bit = 0: Homing not attained Bit = 1: Homing attained
13	Following Error	**Profile Position Mode** Bit = 0: No Following Error Bit = 1: Following Error (related objects: 6065h, 6066h)
	Max Slippage Error	**Profile Velocity Mode** Bit = 0: Max slippage not reached Bit = 1: Max slippage reached
	Homing Error	**Homing Mode** Bit = 0: No Homing Error Bit = 1: Homing Error

5.3.3 Object 605A$_h$: Quick Stop Option Code

Specifies the behaviour of the device, when it is switched to the state **Quick Stop Active** by the master.

Object description:

INDEX	605Ah
Name	Quick Stop Option Code
Object Code	VAR
Data Type	INTEGER16
Category	Optional

Entry description:

Access	rw
PDO Mapping	no
Value Range	1…2
Default Value	Stored value
non-volatile storable	yes

In state **Quick Stop Active**, the drive decelerates speed controlled as specified in ***Quick Stop Option Code*** until stop and switches to the state **Switch On Disabled** (power stage disabled).

Data description:

Value	Description
1	deceleration with ***Quick Stop Deceleration*** (6085h, chapter 7.2.14)
2	deceleration with maximum deceleration = 0x7FFF

5.3.4 Object 605D$_h$: Halt Option Code

Specifies the behaviour of the drive, when the HALT-bit (Bit 8 of ***Controlword*** 6040h, chapter 5.3.1) is set. Independent of the mode of operation, the drive stops as selected and holds the achieved position.

Notice: Positioning processes interrupted by the HALT-bit have to be restarted for further processing!

Object description:

INDEX	605Dh
Name	Halt Option Code
Object Code	VAR
Data Type	INTEGER16
Category	Optional

Entry description:

Access	rw
PDO Mapping	no
Value Range	1…2
Default Value	Stored value
non-volatile storable	yes

Data Description:

Value	Description
0	(not supported)
1	deceleration with the ***Profile Deceleration*** (6084h, chapter 7.2.13)
2	emergency stop, maximum deceleration = 0x7FFF

5.3.5 Object 6060h: Modes of Operation

To switch the actual chosen operation mode, the master has to write the corresponding value to this object. The drive acknowledges the transition by writing the new mode to ***Modes of Operation Display*** (6061h, chapter 5.3.6).

Notice:
Changing the mode of operation is not allowed, when the HALT-bit (Bit 8 of ***Controlword*** 6040h, chapter 5.3.1) is set!

Object description:

INDEX	6060h
Name	Modes of Operation
Object Code	VAR
Data Type	INTEGER8
Category	Mandatory

Entry description:

Access	rw
PDO Mapping	Possible (default)
Value Range	See table
Default Value	1 (Profile Position Mode)

Data Description:

Data	Mode of operation
-5	Turntable Mode
-4	Profile Torque Mode (current control) with dynamic speed limitation
-3	Profile Velocity Mode (speed control) with dynamic current limitation
-1	Jolt Mode
0	reserved
1	Profile Position Mode
3	Profile Velocity Mode
4	Profile Torque Mode
6	Homing Mode

5.3.6 Object 6061h: Modes of Operation Display

Displays the actual mode of operation:

Object description:

INDEX	6061h
Name	Modes of Operation Display
Object Code	VAR
Data Type	INTEGER8
Category	Mandatory

Entry description:

Access	ro
PDO Mapping	Possible (default)
Value Range	See table
Default Value	1 (Profile Position Mode)

Data description, see ***Modes of Operation*** (6060h, chapter 5.3.5)

5.3.7 Object 6502$_h$: Supported Drive Modes

This object provides information on the supported drive modes.

Object description:

INDEX	6502h
Name	Supported Drive Modes
Object Code	VAR
Data Type	UNSIGNED32
Category	Mandatory

Entry description:

Access	ro
PDO Mapping	Possible
Value Range	UNSIGNED32
Default Value	0…0101101

Description of Supported Drive Modes bits:

31…16	15…10	9	8	7	6	5	4	3	2	1	0
Manufacturer-specific	r	cst	csv	csp	ip	hm	r	tq	pv	vl	pp
MSB											LSB

r = reserved
cst = Cyclic Synchronous Torque Mode
csv = Cyclic Synchronous Velocity Mode
csp = Cyclic Synchronous Position Mode
ip = Interpolated Position Mode
hm = Homing Mode
tq = Torque Mode
pv = Profile Velocity Mode
vl = Velocity Mode
pp = Profile Position Mode

6 Homing Mode

During the homing process, the drive operates speed controlled to find a home position for further positioning purpose. Therefore, the following homing methods are available:

- Homing on the negative limit switch (***Homing Method*** = 17, 6098h, chapter 6.2.3)
  The drive moves with a negative speed set-point according to ***Speed during search for switch*** (6099h sub1, chapter 6.2.4) until the switch is activated. Then the drive reverses and moves with reduced speed, ***Speed during search for zero*** (6099h sub2, chapter 6.2.4)**,** until the switch goes inactive. This position is applied as home position.
- Homing on the positive limit switch (***Homing Method*** = 18, 6098h, chapter 6.2.3)
  The drive moves with a positive speed set-point according ***Speed during search for switch*** (6099h sub1, chapter 6.2.4) until the switch is activated. Then the drive reverses and moves with reduced speed, ***Speed during search for zero*** (6099h sub2, chapter 6.2.4)**,** until the switch goes inactive. This position is applied as home position.
- Homing against a mechanical stop in negative direction (***Homing Method*** = -17, 6098h, chapter 6.2.3)
  The drive moves with a negative speed set-point according to ***Speed during search for switch*** (6099h sub1, chapter 6.2.4), until it is halted by a mechanical stop. The rising current is used to detect the homing position. The corresponding current limit is set by ***Current Limit Homing*** (2009h, chapter 6.2.1). The homing process is considered successful, when the current limit was up for 250ms with speed = 0.
- Homing against a mechanical stop in positive direction (***Homing Method*** = -18, 6098h, chapter 6.2.3)
  The drive moves with a positive speed set-point according to ***Speed during search for switch*** (6099h sub1, chapter 6.2.4), until it is halted by a mechanical stop. The rising current is used to detect the homing position. The corresponding current limit set by ***Current Limit Homing*** (2009h, chapter 6.2.1). The homing process is considered successful, when the current limit was up for 250ms with speed = 0.
- Homing on the negative limit switch and index pulse (***Homing Method*** = 1, 6098h, chapter 6.2.3)
  The drive moves with a negative speed set-point according to ***Speed during search for switch*** (6099h sub1, chapter 6.2.4) until the switch is activated. Then the drive reverses and moves with reduced speed, ***Speed during search for zero*** (6099h sub2, chapter 6.2.4)**,** until the switch goes inactive. The next full revolution is applied as the home position.
- Homing on the positive limit switch and index pulse (***Homing Method*** = 2, 6098h, chapter 6.2.3)
  The drive moves with a negative speed set-point according to ***Speed during search for switch*** (6099h sub1, chapter 6.2.4) until the switch is activated. Then the drive reverses and moves with reduced speed, ***Speed during search for zero*** (6099h sub2, chapter 6.2.4)**,** until the switch goes inactive. The last full revolution is applied as the home position.
- Homing on the current position (***Homing Method*** = 35, 6098h, chapter 6.2.3).
  The current position is applied as the home position.

If the limit switch position does not correspond to the zero position of the position range, the homing position can be provided with a ***Home Offset*** (607Ch, chapter 6.2.2).

After selecting the **Homing Mode** in ***Modes of Operation*** (6060h, chapter 5.3.5), the homing starts by the 0 → 1 transition of Bit 4 (homing operation start) in ***Controlword*** (6040h, chapter 5.3.1).

Writing 0 to Bit 4 (homing operation start) interrupts the current homing process.
Bit 12 (homing attained) in ***Statusword*** (6041h, chapter 5.3.2) reports a successful homing process.
Bit 13 (homing error) in ***Statusword*** reports a homing error. After a new successful homing process the bit is reset.

Notice:
After finishing a homing process, the drive has speed controlled behaviour and tends to drift. To avoid drifting switch the drive to **Profile Position Mode** or set Bit 8 (HALT-bit) in ***Controlword*** (6040h, chapter 5.3.1).

6.1 Object Dictionary Entries

Index	Object	Name	Type	Attr.	M/O
2009h	VAR	Current Limit Homing	UNSIGNED16	rw	O
607Ch	VAR	Home Offset	INTEGER32	rw	O
6098h	VAR	Homing Method	INTEGER8	rw	M
6099h	ARRAY	Homing Speeds	UNSIGNED32	rw	M
609Ah	VAR	Homing Acceleration	UNSIGNED32	rw	O

6.2 Object description

6.2.1 Object 2009_h: Current Limit Homing

Current Limit for ***Homing Method*** (6098h, chapter 6.2.3) = -17 or -18.

For products belonging to **Device Group 1** (see chapter Device Groups) the current scaling is device specific and **non**-compliant to the CANopen standard.
For products belonging to **Device Group 2** the current scaling is compliant to the CANopen standard. This means that the current is scaled to 1/1000 of ***Motor Rated Current*** (6075h, chapter 9.2.3). The device specific scaling can still be activated via ***Fieldbus Options*** (200Eh, chapter 4.2.20).

Object description:

INDEX	2009h
Name	Current Limit Homing
Object Code	VAR
Data Type	UNSIGNED16
Category	Optional

Entry description:

Access	rw
PDO Mapping	no
Value Range	UNSIGNED16
Default Value	Stored value

6.2.2 Object $607C_h$: Home Offset

Offset between limit switch position and the zero position.

Object description:

INDEX	607Ch
Name	Home Offset
Object Code	VAR
Data Type	INTEGER32
Category	Optional

Entry description:

Access	rw
PDO Mapping	yes
Value Range	INTEGER32
Default Value	Stored value
non-volatile storable	yes

Scaling factor: 12 Bit angle resolution, 20 Bit revolution counter, i.e. 1000h ≡ 1 revolution

6.2.3 Object 6098_h: Homing Method

Selected homing method, see chapter 6.

Object description:

INDEX	6098h
Name	Homing Method
Object Code	VAR
Data Type	INTEGER8
Category	Mandatory

Entry description:

Access	rw
PDO Mapping	yes
Value Range	See table
Default Value	Stored value
non-volatile storable	yes

Data description:

Value	Description
17	Homing on the negative limit switch
18	Homing on the positive limit switch
-17	Homing against a mechanical stop in negative direction
-18	Homing against a mechanical stop in positive direction
1	Homing on the negative limit switch and index pulse
2	Homing on the positive limit switch and index pulse
35	Homing on the current position

6.2.4 Object 6099$_h$: Homing Speeds

Speeds during homing process.

Object description:

INDEX	6099h
Name	Homing Speeds
Object Code	ARRAY
Data Type	UNSIGNED32
Category	Mandatory

Entry description:

SUB-INDEX	0
Description	Number of entries
Entry category	Mandatory
Access	ro
PDO Mapping	no
Value Range	2
Default value	2

SUB-INDEX	1
Description	Speed during search for switch
Entry category	Mandatory
Access	rw
PDO Mapping	yes
Value Range	UNSIGNED32
Default value	Stored value
non-volatile storable	yes

SUB-INDEX	2
Description	Speed during search for zero
Entry category	Mandatory
Access	rw
PDO Mapping	yes
Value Range	UNSIGNED32
Default value	Stored value
non-volatile storable	yes

Scaling factor: 2 ≡ 1rpm

6.2.5 Object 609A$_h$: Homing Acceleration

Acceleration/deceleration during homing process.

Object description:

INDEX	609Ah
Name	Homing Acceleration
Object Code	VAR
Data Type	UNSIGNED32
Category	Optional

Entry description:

Access	rw
PDO Mapping	yes
Value Range	lin.: 1...32767 sin²: 16...32767
Default Value	Stored value
non-volatile storable	yes

Scaling factor: depends on the used ***Motion Profile Type*** (6086h, chapter 7.2.15)

for linear ramp: Acceleration: a = x · 10 rpm/s

for sine-squared ramp: Acceleration Time $T_a = \frac{10^5}{x} ms = \frac{100}{x} s$

Notice:
Using very small values for ***Homing Acceleration***, causes the drive to decelerate very slowly and thus to exceed the position of the limit switch.

7 Profile Position Mode

In the **Profile Position Mode**, the drive performs time-optimised point-to-point positioning with trapezoidal or sine-squared speed profile. Acceleration, speed and deceleration of the speed profile are adjustable.

The parameters ***Position Window*** (6067h, chapter 7.2.4) and ***Position Window Time*** (6068h, chapter 7.2.5) define whether a target position is considered achieved or not.

Bits 5 (change set immediately) and 6 (abs/rel) in ***Controlword*** (6040h, chapter 5.3.1) determine, whether or not a set target is handled as an absolute or relative set-point and if a currently running positioning can be interrupted.

To compensate for following errors, the speed set-point is added/subtracted by the parameter ***v_korrigier*** (60FBh sub2, chapter 7.2.17).

A positioning process is started by a 0 → 1 transition of Bit 4 (new set-point) in ***Controlword*** (6040h, chapter 5.3.1). The achieved position is reported by Bit 10 (target reached) in ***Statusword*** (6041h, chapter 5.3.2).

Additional Notices for Turntable Positioning:

The turntable positioning range lies between zero and the value ***Max Position Range Limit*** (607Bh sub2, chapter7.2.7). Since the position turns over when reaching the minimum or maximum turntable range, this operation mode allows "endless" positioning.

Relative positioning is handled the same way as for the regular positioning mode.
For absolute positioning, Bit 12 (cw/ccw) in ***Controlword*** (6040h, chapter 5.3.1) defines whether the ***Target Position*** (607Ah, chapter 7.2.6) is approached clockwise or counter-clockwise. If Bit 11 (directional/optimal) is set to 1, the drive will move to the set position by the shortest distance.
For a detailed description of the **Turntable Mode**, please see the drive's operating manual.

7.1 Object Dictionary Entries

Index	Object	Name	Type	Attr.	M/O
6064h	VAR	Position Actual Value	INTEGER32	ro	M
6065h	VAR	Following Error Window	UNSIGNED32	rw	O
6066h	VAR	Following Error Time Out	UNSIGNED16	rw	O
6067h	VAR	Position Window	UNSIGNED32	rw	O
6068h	VAR	Position Window Time	UNSIGNED16	rw	O
607Ah	VAR	Target Position	INTEGER32	rw	M
607Bh	ARRAY	Position Range Limit	INTEGER32	rw	O
607Dh	ARRAY	Software Position Limit	INTEGER32	rw	O
6080h	VAR	Max Motor Speed	UNSIGNED32	rw	O
6081h	VAR	Profile Velocity	UNSIGNED32	rw	M
606Bh	VAR	Velocity Demand Value	INTEGER32	ro	M
6083h	VAR	Profile Acceleration	UNSIGNED32	rw	M
6084h	VAR	Profile Deceleration	UNSIGNED32	rw	O
6085h	VAR	Quick Stop Deceleration	UNSIGNED32	rw	O
6086h	VAR	Motion Profile Type	UNSIGNED32	rw	O
60F4h	VAR	Following Error Actual Value	INTEGER32	ro	O
60FBh	RECORD	Position Control Parameter Set	(manufacturer specific)	rw	O
2006h	VAR	Max Turntable Position (obsolete)	INTEGER32	rw	O

7.2 Object Description

7.2.1 Object 6064h: Position Actual Value

Actual position in user defined units.

Object description:

INDEX	6064h
Name	Position Actual Value
Object Code	VAR
Data Type	INTEGER32
Category	Mandatory

Entry description:

Access	ro
PDO Mapping	possible (default)
Value Range	INTEGER32
Default Value	no

Scaling factor: 12 Bit angle resolution, 20 Bit revolution counter, i.e. 1000h ≡ 1 revolution

7.2.2 Object 6065h: Following Error Window

Following Error Window defines a range of tolerated position values symmetrically to the position demand value. If the difference between ***Position Actual Value*** (6064h, chapter 7.2.1) and position demand value is out of the ***Following Error Window***, a following error occurs (Firmware V3.83 or higher). A following error will not be signalled, before the corresponding ***Following Error Time Out*** (6066h, chapter 7.2.3) has elapsed.

A following error might occur when
- a motor is blocked,
- unreachable ***Profile Velocity*** (6081h, chapter 7.2.10) occurs, or
- at wrong closed loop coefficients.

Object description:

INDEX	6065h
Name	Following Error Window
Object Code	VAR
Data Type	UNSIGNED32
Category	Optional

Entry description:

Access	rw
PDO Mapping	possible
Value Range	UNSIGNED32
Default Value	Stored value
non-volatile storable	yes

Scaling factor: 12 Bit angle resolution, 20 Bit revolution counter, i.e. 1000h ≡ 1 revolution

If the value of ***Following Error Window*** is greater than 2^{31}-1, the following control is switched off.

7.2.3 Object 6066h: Following Error Time Out

When a following error occurs longer than the defined value of the time-out given in multiples of milliseconds, the corresponding Bit 13 (following error) in ***Statusword*** (6041h, chapter 5.3.2) will be set. Additional reaction of the drive, when a following error occurs, is configurable in DSerV (Firmware V3.83 or higher).

Object description:

INDEX	6066h
Name	Following Error Time Out
Object Code	VAR
Data Type	UNSIGNED16
Category	Optional

Entry description:

Access	rw
PDO Mapping	possible
Value Range	UNSIGNED16
Default Value	Stored value
non-volatile storable	yes

7.2.4 Object 6067h: Position Window

Defines a tolerance range around the set position. ***Target Position*** (607Ah, chapter 7.2.6) is considered reached, when the actual position is within the tolerance range for the period of ***Position Window Time*** (6068h, chapter 7.2.5).

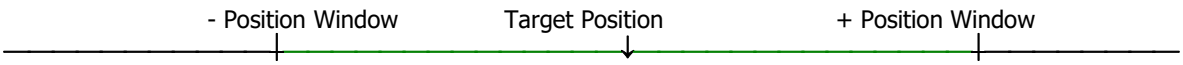
Object description:

INDEX	6067h
Name	Position Window
Object Code	VAR
Data Type	UNSIGNED32
Category	optional

Entry description:

Access	rw
PDO Mapping	yes
Value Range	$0..2^{31}$-1 (7FFFFFFFh)
Default Value	Stored value
non-volatile storable	yes

Scaling factor: 12 Bit angle resolution, 20 Bit revolution counter, i.e. 1000h ≡ 1 revolution



7.2.5 Object 6068h: Position Window Time

The ***Target Position*** (607Ah, chapter 7.2.6) is considered reached, when the actual position lies within the tolerance range of ***Position Window*** (6067h, chapter 7.2.4) for the specified ***Position Window Time***.

Object description:

INDEX	6068h
Name	Position Window Time
Object Code	VAR
Data Type	UNSIGNED16
Category	Optional

Entry description:

Access	rw
PDO Mapping	yes
Value Range	0 … 7FFFh
Default Value	Stored value
non-volatile storable	yes

Scaling factor: 0.2 ms

7.2.6 Object 607Ah: Target Position

Target Position = set value for the target position. The target is approached according to the specified parameters ***Profile Velocity*** (6081h, chapter 7.2.10), ***Profile Acceleration*** (6083h, chapter 7.2.12) and ***Profile Deceleration*** (6084h, chapter 7.2.13). Depending on Bit6 (abs/rel) in ***Controlword*** (6040h, chapter 5.3.1), ***Target Position*** is considered absolute or relative.

Object description:

INDEX	607Ah
Name	Target Position
Object Code	VAR
Data Type	INTEGER32
Category	Mandatory

Entry description:

Access	rw
PDO Mapping	Possible (default)
Value Range	INTEGER32
Default Value	no

Scaling factor: 12 Bit angle resolution, 20 Bit revolution counter, i.e. 1000h ≡ 1 revolution

7.2.7 Object 607B$_h$: Position Range Limit

Position Range Limit is only valid in **Turntable Mode** (see ***Modes of Operation*** 6060h, chapter 5.3.5), it substitutes object ***Max Turntable Position*** (2006h, chapter 7.2.18). ***Position Range Limit*** contains two sub-parameters, ***Min Position Range Limit*** and ***Max Position Range Limit***. These limit the numerical range of the position value. On reaching or exceeding these limits, the input value automatically wraps to the other end of the range (Firmware V3.78 or higher).

Object description:

INDEX	607Bh
Name	Position Range Limit
Object Code	ARRAY
Data Type	INTEGER32
Category	Optional

Entry description:

SUB-INDEX	0
Description	Number of entries
Entry category	Mandatory
Access	ro
PDO Mapping	no
Value Range	2
Default value	2

SUB-INDEX	1
Description	Min Position Range Limit
Entry category	Mandatory
Access	ro
PDO Mapping	yes
Value Range	0
Default value	0
non-volatile storable	no

SUB-INDEX	2
Description	Max Position Range Limit
Entry category	Mandatory
Access	rw
PDO Mapping	yes
Value Range	10,000…1,000,000,000
Default value	Stored value
non-volatile storable	yes

Scaling factor: 0.0001 rev.

Notice: The ***Max Position Range Limit*** must not exceed the value of ***Max Position Limit*** (607Dh sub2, chapter 7.2.8)!

7.2.8 Object 607D$_h$: Software Position Limit

The parameter ***Min Position Limit*** and ***Max Position Limit*** define the absolute limits of the positioning range. Every new ***Target Position*** (607Ah, chapter 7.2.6) is compared with these limits. After the homing procedure the actual position is also compared with these limits. If the value is not in the defined range or the ***Min Position Limit*** is greater than the ***Max Position Limit*** an error will be signalled (see Error Codes FF01h - FF05h in Chapter 5.1.2).

Object description:

INDEX	607Dh
Name	Software Position Limit
Object Code	ARRAY
Data Type	INTEGER32
Category	Optional

Entry description:

SUB-INDEX	0
Description	Number of entries
Entry category	Mandatory
Access	ro
PDO Mapping	no
Value Range	2
Default value	2

SUB-INDEX	1
Description	Min Position Limit
Entry category	Mandatory
Access	rw
PDO Mapping	yes
Value Range	INTEGER32
Default value	Stored value
non-volatile storable	yes

SUB-INDEX	2
Description	Max Position Limit
Entry category	Mandatory
Access	rw
PDO Mapping	yes
Value Range	INTEGER32
Default value	Stored value
non-volatile storable	yes

Scaling factor: 12 Bit angle resolution, 20 Bit revolution counter, i.e. 1000h ≡ 1 revolution

7.2.9 Object 6080$_h$: Max Motor Speed

Maximum motor speed as specified by the data sheet or name plate of the drive in rpm. The object ***Max Motor Speed*** is used only in the CANopen layer; writing has no effect on the drives behaviour.

Object description:

INDEX	6080h
Name	Max Motor Speed
Object Code	VAR
Data Type	UNSIGNED32
Category	Optional

Entry description:

Access	rw
PDO Mapping	yes
Value Range	UNSIGNED32
Default Value	Stored value
non-volatile storable	yes

Scaling factor: 2 ≡ 1rpm

7.2.10 Object 6081h: Profile Velocity

Nominal speed set-point in **Profile Position Mode** (see chapter 7).

Notice: This object does *not* take effect in **Profile Velocity Mode** (Firmware V3.93 or higher, see chapter 8).

Object description:

INDEX	6081h
Name	Profile Velocity
Object Code	VAR
Data Type	UNSIGNED32
Category	Mandatory

Entry description:

Access	rw
PDO Mapping	possible
Value Range	1 … Max. Value *(see below)*
Default Value	no

Subindex 1 (Numerator) and Subindex 2 (Denominator) of ***Velocity Encoder Factor*** (6094h, chapter 4.2.23) define the Scaling Factor and limit the permissible Max. Value of ***Profile Velocity*** as follows:

Scaling Factor = (Numerator / Denominator) rpm

Max. Value = $$\frac{2^{31}}{Numerator \times 2^{(17-\log_2 Denominator)}} - 1$$

With Numerator = 1 and Denominator = 2, the default values are:

Default Scaling Factor = 0.5 rpm
Default Max. Value = 32767 (≡ 16383.5 rpm)

7.2.11 Object 606Bh: Velocity Demand Value

Current speed set-point of the trajectory generator. (Firmware V3.80 or higher).

Object description:

INDEX	606Bh
Name	Velocity Demand Value
Object Code	VAR
Data Type	INTEGER32
Category	Mandatory

Entry description:

Access	ro
PDO Mapping	possible
Value Range	INTEGER32
Default Value	no

Scaling factor: 2 ≡ 1rpm

7.2.12 Object 6083h: Profile Acceleration

Acceleration ramp used in **Profile Velocity Mode** and **Profile Position Mode**.
The ramp can be switched between linear and sine-squared ramp. This is done via ***Motion Profile Type*** (6086h, chapter 7.2.15).
Depending on the chosen ***Motion Profile Type*** the units of ***Profile Acceleration*** are different:
Linear ramp => speed change per time [10rpm/sec]
Sine-squared ramp => ramp time [ms]

Object description:

INDEX	6083h
Name	Profile Acceleration
Object Code	VAR
Data Type	UNSIGNED32
Category	Mandatory

Entry description:

Access	rw
PDO Mapping	possible
Value Range	lin.: 1...32767 sin²: 16...32767
Default Value	Stored value
non-volatile storable	yes

Scaling factor: depends on the used ***Motion Profile Type*** (6086h, chapter 7.2.15)

for linear ramp: Acceleration: a = x · 10 rpm/s

for sine-squared ramp: Acceleration Time $T_a = \frac{10^5}{x} ms = \frac{100}{x} s$

7.2.13 Object 6084h: Profile Deceleration

Deceleration ramp used in **Profile Velocity Mode** and **Profile Position Mode**.

Object description:

INDEX	6084h
Name	Profile Deceleration
Object Code	VAR
Data Type	UNSIGNED32
Category	Optional

Entry description:

Access	rw
PDO Mapping	possible
Value Range	lin.: 1...32767 sin²: 16...32767
Default Value	Stored value
non-volatile storable	yes

Scaling factor: see ***Profile Acceleration*** (6083h, chapter 7.2.12)

7.2.14 Object 6085h: Quick Stop Deceleration

Deceleration ramp used for quick stop (emergency stop), i. e. when the CANopen statemachine has been switched to state QuickStopActive (see CANopen state diagram chapter 5.1) and the corresponding ***Quick Stop Option Code*** (605Ah, chapter 5.3.3) is set.

Object description:

INDEX	6085h
Name	Quick Stop Deceleration
Object Code	VAR
Data Type	UNSIGNED32
Category	Optional

Entry description:

Access	rw
PDO Mapping	yes
Value Range	lin.: 1...32767 sin²: 16...32767
Default Value	Stored value
non-volatile storable	yes

Scaling factor: see ***Profile Acceleration*** (6083h, chapter 7.2.12)

7.2.15 Object 6086_h: Motion Profile Type

This object is used to select the motion profile used for positioning and speed control mode.

Object description:

INDEX	6086h
Name	Motion Profile Type
Object Code	VAR
Data Type	INTEGER16
Category	Optional

Entry description:

Access	rw
PDO Mapping	yes
Value Range	-1…1
Default Value	Stored value
non-volatile storable	yes

Data description:

Value	Description
-1	ramps deactivated (invalid in **Profile Position Mode**)
0	linear ramp (trapezoidal speed profile)
1	sine-squared ramp (jerk-limited profile)

7.2.16 Object $60F4_h$: Following Error Actual Value

Gives the actual value of the following error.

Object description:

INDEX	60F4h
Name	Following Error Actual Value
Object Code	VAR
Data Type	INTEGER32
Category	Optional

Entry description:

Access	ro
PDO Mapping	yes
Value Range	INTEGER32
Default Value	0

Scaling factor: 12 Bit angle resolution, 20 Bit revolution counter, i.e. 1000h ≡ 1 revolution

7.2.17 Object 60FB$_h$: Position Control Parameter Set

For detailed description of these parameters see the operating manual.

Object description:

INDEX	60FBh
Name	Position Control Parameter Set
Object Code	RECORD
Data Type	manufacturer specific
Category	Optional

Entry description:

SUB-INDEX	0
Description	Number of entries
Entry category	Mandatory
Access	ro
PDO Mapping	no
Value Range	4
Default value	0x04

SUB-INDEX	1
Description	Proportional gain (kp_x)
Entry category	Optional
Access	rw
PDO Mapping	yes
Value Range	UNSIGNED16 (0 … 7FFFh)
Default value	Stored value
non-volatile storable	yes

SUB-INDEX	2
Description	Correction speed (v_korrigier)
Entry category	Optional
Access	rw
PDO Mapping	yes
Value Range	UNSIGNED16 (0 … 7FFFh)
Default value	Stored value
non-volatile storable	yes

SUB-INDEX	3
Description	step_forward (**Jolt Mode**)
Entry category	Optional
Access	rw
PDO Mapping	yes
Value Range	UNSIGNED16
Default value	Stored value
non-volatile storable	yes

SUB-INDEX	4
Description	step_backward (**Jolt Mode**)
Entry category	Optional
Access	rw
PDO Mapping	yes
Value Range	UNSIGNED16
Default value	Stored value
non-volatile storable	yes

Scaling factors:
v_korrigier: 2 ≡ 1rpm
Step_forward: 12 Bit angle resolution, 20 Bit revolution counter, i.e. 1000h ≡ 1 revolution
Step_backward: 12 Bit angle resolution, 20 Bit revolution counter, i.e. 1000h ≡ 1 revolution

7.2.18 Object 2006_h: Max Turntable Position (obsolete)

This object defines the maximum turntable range for turntable positioning.
For new designs use object *Position Range Limit* (607Bh, chapter 7.2.7) instead!

Notice: The turntable range must not exceed the range of ***Max Position Limit*** (607Dh, chapter 7.2.8)!

Object description:

INDEX	2006h
Name	Max Turntable Position
Object Code	VAR
Data Type	INTEGER32
Category	Optional

Entry description:

Access	rw
PDO Mapping	no
Value Range	4096…1064960000*)
Default Value	Stored value
non-volatile storable	yes

*) 260000 rev · 4096

Scaling factor: 12 Bit angle resolution, 20 Bit revolution counter, i.e. 4096 ≡ 1 revolution

8 Profile Velocity Mode

In **Profile Velocity Mode** (speed control mode), the drive moves with a set-point ***Target Velocity*** (60FFh, chapter 8.2.2). If a gear is mounted to the drive, the speed at the output shaft is associated with the motor speed via the gear ratio.

The speed follows its set-point with the given programmable values for acceleration and deceleration. Depending on the object ***Motion Profile Type*** (6086h, chapter 7.2.15) the drive accelerates and decelerates with either linear or sine-squared ramps.

For **speed control with dynamic current limitation (*Modes of Operation* = -3)**, the output torque is adjustable by the dynamic torque threshold ***Dynamic Torque Limit*** (2004h, chapter 8.2.4).

Notice:
Acceleration and deceleration are set in the objects ***Profile Acceleration*** (6083h, chapter 7.2.12) and ***Profile Deceleration*** (6084h, chapter 7.2.13).

8.1 Object Dictionary Entries

Index	Object	Name	Type	Attr.	M/O
606Ch	VAR	Velocity Actual Value	INTEGER32	ro	M
60FFh	VAR	Target Velocity	INTEGER32	rw	M
60F9h	ARRAY	Velocity Control Parameter Set	UNSIGNED16	rw	O
2004h	VAR	Dynamic Torque Limit	UNSIGNED16	rw	O

8.2 Object Description

8.2.1 Object 606C$_h$: Velocity Actual Value

Actual motor speed. If a gear is mounted to the drive, the output speed is associated with the motor speed via the gear ratio.

Object description:

INDEX	606Ch
Name	Velocity Actual Value
Object Code	VAR
Data Type	INTEGER32
Category	Mandatory

Entry description:

Access	ro
PDO Mapping	Possible
Value Range	INTEGER32
Default Value	no

Scaling factor: 2 ≡ 1rpm

8.2.2 Object 60FF$_h$: Target Velocity

Nominal speed set-point in **Profile Velocity Mode**.

Notice: This object does *not* take effect in **Profile Position Mode**.

The drive follows the speed set-point according to the acceleration and deceleration ramp.
If Bit 8 (HALT-Bit) in ***Controlword*** (6040h, chapter 5.3.1) is set, ***Target Velocity*** is written to 0.

Object description:

INDEX	60FFh
Name	Target Velocity
Object Code	VAR
Data Type	INTEGER32
Category	Mandatory

Entry description:

Access	rw
PDO Mapping	Possible
Value Range	Min. Value … Max. Value (see below)
Default Value	no

Subindex 1 (Numerator) and Subindex 2 (Denominator) of ***Velocity Encoder Factor*** (6094h, chapter 4.2.23) define the Scaling Factor and limit the permissible Min. Value / Max. Value of ***Target Velocity*** as follows:

Scaling Factor = (Numerator / Denominator) rpm

Min. Value = - Max. Value

Max. Value = $$\frac{2^{31}}{Numerator \times 2^{(17-\log_2 Denominator)}} - 1$$

With Numerator = 1 and Denominator = 2, the default values are:

Default Scaling Factor = 0.5 rpm
Default Min. Value = -32767 (≡ -16383.5 rpm)
Default Max. Value = 32767 (≡ 16383.5 rpm)

8.2.3 Object 60F9$_h$: Velocity Control Parameter Set

Object description:

INDEX	60F9h
Name	Velocity Control Parameter Set
Object Code	ARRAY
Data Type	UNSIGNED16
Category	Optional

Entry description:

SUB-INDEX	0
Description	Number of entries
Entry category	Mandatory
Access	ro
PDO Mapping	no
Value Range	2
Default value	no

SUB-INDEX	1
Description	kp_n
Entry category	Optional
Access	rw
PDO Mapping	yes
Value Range	1…7FFFh
Default value	Stored value
non-volatile storable	yes

SUB-INDEX	2
Description	tn_n
Entry category	Optional
Access	rw
PDO Mapping	yes
Value Range	1…7FFFh
Default value	Stored value
non-volatile storable	yes

Scaling factors:
kp_n = proportional gain of the speed controller: $7FFF_h \equiv 1.00$

tn_n = integral gain of the speed controller: $$T_{Nn} = \frac{32767 \cdot 100\mu s}{tn\_n}$$

Example:

tn_n = 3276 $\Rightarrow$ $$T_{Nn} = \frac{32767 \cdot 100\,\mu s}{3276} = 1ms$$

8.2.4 Object 2004_h: Dynamic Torque Limit

Torque limit for operation mode -3 (speed control with torque limitation).

Object description:

INDEX	2004h
Name	Dynamic Torque Limit
Object Code	VAR
Data Type	UNSIGNED16
Category	Optional

Entry description:

Access	rw
PDO Mapping	Possible
Value Range	UNSIGNED16 (0 … 7FFFh)
Default Value	0

Notice:
Dynamic Torque Limit must not exceed the set maximum current ***Max Current*** (6073h, chapter 9.2.2).
Higher values will be limited to ***Max Current***.

For products belonging to **Device Group 1** (see chapter Device Groups) the current scaling is device specific and **non**-compliant to the CANopen standard.
For products belonging to **Device Group 2** the current scaling is compliant to the CANopen standard. This means that the current is scaled to 1/1000 of ***Motor Rated Current*** (6075h, chapter 9.2.3). The device specific scaling can still be activated via ***Fieldbus Options*** (200Eh, chapter 4.2.20).

Example for compliant and non-compliant scaling:

HFI2230-X200:

Motor rated current (datasheet) = 9500mA

Dynamic Torque Limit (example, unscaled) = 4000mA

Non-compliant scaling factor = 27.5A/32767 (see table below)

Compliant scaling: Dynamic Torque Limit (scaled) = 4000mA/(9500mA/1000) = 421

Non-Compliant scaling: Dynamic Torque Limit (scaled) = 4A/(27.5A/32767) = 4766

Device	compliant devices	non-compliant scaling factors 7FFFh*) ≡
DSV110		16.5A
DSV112		50.0A
DSV130		103.1A
DSV132		63.5A
DSV133		63.5A
DSV324		16.5A
DSV562E		9.9A
DSV1030	•	103.1A
DSV1032	•	103.1A
HBI2230-2 HBI2230-4		25.4A 25.4A
HBI2260-2 HBI2260-4		42.3A 25.4A
HBI2630-2 HBI2630-4		42.3A 25.4A
HBI2660-2 HBI2660-4		42.3A 25.4A
HBI3260-4		45.8A
HBI3290-4		45.8A
HBI3760-4		45.8A
HBI3790-4		45.8A
HFI2230-X200 HFI2230-X400	•	27.5A 13.8A
HFI2260-X200 HFI2260-X400	•	55.0A 27.5A
HFI2630-X200 HFI2630-X400	•	55.0A 27.5A
HFI2660-X200 HFI2660-X400	•	55.0A 27.5A
HFI3260-X200 HFI3260-X400	•	75.0A 75.0A
HFI3290-X400	•	75.0A
HFI3760-X400	•	75.0A
HFI3790-X400	•	75.0A
HLI2660		50.0A

*) 7FFFh represents the maximum measuring range of each device. For further information please refer to the operating manual.
Note: Values for customer specific devices only on request.

9 Profile Torque Mode

In the **Profile Torque Mode** (torque/current control mode), the drives torque producing current follows a given current set-point. The torque at the output shaft is proportional to the drives torque producing current. It is defined by the torque constant of the motor and the gear ratio, if available.

The drives current follows the set-point ***Target Torque*** (6071h, chapter 9.2.1) without a ramp function; the rising current is only limited by the electrical time constant of the drive.

9.1 Object Dictionary Entries

Index	Object	Name	Type	Attr.	M/O
6071h	VAR	Target Torque	INTEGER16	rw	M
6073h	VAR	Max Current	UNSIGNED16	rw	O
6075h	VAR	Motor Rated Current	UNSIGNED32	rw	O
6077h	VAR	Torque Actual Value	INTEGER16	ro	O
6078h	VAR	Current Actual Value	INTEGER16	ro	O
6079h	VAR	DC Link Circuit Voltage	UNSIGNED32	ro	O
6087h	VAR	Torque Slope	UNSIGNED32	rw	M
60F6h	RECORD	Torque Control Parameters	(manufacturer specific)	rw	O
2003h	VAR	Dynamic Speed Limit	UNSIGNED16	rw	O

9.2 Object Description

9.2.1 Object 6071$_h$: Target Torque

Target Torque is the torque set-point, which is given here as the torque producing current i_q. To convert the current into the available torque at the motor shaft, it has to be multiplied by the torque constant of the motor. The current values are given as sine peak values and correlate to the specification in the motors datasheet and on the name plate.

For products belonging to **Device Group 1** (see chapter Device Groups) the current scaling is device specific and **non**-compliant to the CANopen standard (see table of non-compliant scaling factors, chapter 8.2.4).
For products belonging to **Device Group 2** the current scaling is compliant to the CANopen standard. This means that the current is scaled to 1/1000 of ***Motor Rated Current*** (6075h, chapter 9.2.3). The device specific scaling can still be activated via ***Fieldbus Options*** (200Eh, chapter 4.2.20).

Object description:

INDEX	6071h
Name	Target Torque
Object Code	VAR
Data Type	INTEGER16
Category	Mandatory

Entry description:

Access	rw
PDO Mapping	possible
Value Range	INTEGER16
Default Value	0

Notice:
Target Torque must not exceed the set ***Motor Rated Current*** (6075h, chapter 9.2.3); higher values will be limited to ***Motor Rated Current***.

9.2.2 Object 6073_h: Max Current

Maximum current of the motor according to the datasheet / name plate. The current values are given as sine peak values.

Object description:

INDEX	6073h
Name	Max Current
Object Code	VAR
Data Type	UNSIGNED16
Category	Optional

Entry description:

Access	rw
PDO Mapping	yes
Value Range	UNSIGNED16*)
Default Value	Stored value
non-volatile storable	yes

*) The current values must not exceed the specification in the motor's **and** drive's datasheet / name plate.

For products belonging to **Device Group 1** (see chapter Device Groups) the current scaling is device specific and **non**-compliant to the CANopen standard (see table of non-compliant scaling factors, chapter 8.2.4).
For products belonging to **Device Group 2** the current scaling is compliant to the CANopen standard. This means that the current is scaled to 1/1000 of ***Motor Rated Current*** (6075h, chapter 9.2.3). The device specific scaling can still be activated via ***Fieldbus Options*** (200Eh, chapter 4.2.20).

Device	non compliant max. value	compliant max. value	Max Current
DSV110	60F8h	-	12.5A
DSV112	5FFFh	-	37.5A
DSV130	634Bh	-	80.0A
DSV132	64D9h	-	50.0A
DSV133	2857h	-	20.0A
DSV324	45D1h	-	9.0A
DSV562E	40A5h	-	5.0A
DSV1030	6849h	0BB8h	84.0A
DSV1032	6849h	0BB8h	84.0A
HBI2230-2	4912h	-	14.5A
HBI2230-4	24C9h	-	7.3A
HBI2260-2	3896h	-	18.7A
HBI2260-4	2F5Eh	-	9.4A
HBI2630-2	489Ch	-	24.0A
HBI2630-4	3EFDh	-	12.5A
HBI2660-2	5E68h	-	31.2A
HBI2660-4	4E9Dh	-	15.6A
HBI3260-4	43E9h	-	24.3A
HBI3290-4	5808h	-	31.5A
HBI3760-4	56EAh	-	31.1A
HBI3790-4	7011h	-	40.1A
HFI2230-X200	5AC3h	0805h	19.5A
HFI2230-X400	5B3Ah	07FAh	9.8A
HFI2260-X200	3A2Eh	07F1h	25.0A
HFI2260-X400	3A2Eh	07E0h	12.5A
HFI2630-X200	3DACh	07D8h	26.5A
HFI2630-X400	3FC4h	07DFh	13.7A
HFI2660-X200	5745h	082Fh	37.5A
HFI2660-X400	561Bh	081Fh	18.5A
HFI3260-X200	57E4h	07F4h	51.5A
HFI3260-X400	2DBDh	07A4h	26.8A
HFI3290-X400	4369h	082A	39.5A
HFI3760-X400	4444h	0823	40.0A
HFI3790-X400	58BEh	0880	52.0A
HLI2660	5EB8h	-	37.0A

Note: Values for customer specific devices only on request.

9.2.3 Object 6075h: Motor Rated Current

Rated current of the motor according to the datasheet /name plate.
The current values are given as sine peak values and must not exceed the specification in the motor and drive datasheet and on the name plate.

Object description:

INDEX	6075h
Name	Motor Rated Current
Object Code	VAR
Data Type	UNSIGNED32
Category	Optional

Entry description:

Access	rw
PDO Mapping	yes
Value Range	UNSIGNED32
Default Value	Stored value
non-volatile storable	yes

For products belonging to **Device Group 1** (see chapter Device Groups) the current scaling is device specific and **non**-compliant to the CANopen standard (see table of non-compliant scaling factors, chapter 8.2.4).

For products belonging to **Device Group 2** the current scaling is compliant to the CANopen standard. This means that the ***Motor Rated Current*** is given directly in **mA** and all objects, which are listed below, are scaled to 1/1000 of the ***Motor Rated Current***:

- ***Dynamic Torque Limit*** (2004h, chapter 8.2.4)
- ***Current Limit Homing*** (2009h, chapter 6.2.1)
- ***Target Torque*** (6071h, chapter 9.2.1)
- ***Max Current*** (6073h, chapter 9.2.2)
- ***Current Actual Value*** (6078h, chapter 9.2.5)

The device specific scaling can still be activated via ***Fieldbus Options*** (200Eh, chapter 4.2.20).

Example for compliant and non-compliant scaling of ***Motor Rated Current***:

HFI2230-X200:

Motor rated current (datasheet, unscaled) = 9500mA

non-compliant scaling factor = 27.5A/32767 (table of non-compliant scaling factors, chapter 8.2.4).

Compliant scaling	Motor Rated Current (scaled) =	9500
Non-Compliant scaling	Motor Rated Current (scaled) = 9.5A/(27.5A/32767) =	11319

9.2.4 Object 6077h: Torque Actual Value

Here the same as ***Current Actual Value*** (6078h, chapter 9.2.5).

Object description:

INDEX	6077h
Name	Torque Actual Value
Object Code	VAR
Data Type	INTEGER16
Category	Optional

Entry description:

Access	ro
PDO Mapping	Possible
Value Range	INTEGER16
Default Value	0

9.2.5 Object 6078h: Current Actual Value

Actual value of the torque producing current. The current values are given as sine peak values.

Object description:

INDEX	6078h
Name	Current Actual Value
Object Code	VAR
Data Type	INTEGER16
Category	Optional

Entry description:

Access	ro
PDO Mapping	Possible
Value Range	INTEGER16
Default Value	0

For products belonging to **Device Group 1** (see chapter Device Groups) the current scaling is device specific and **non**-compliant to the CANopen standard (see table of non-compliant scaling factors, chapter 8.2.4).
For products belonging to **Device Group 2** the current scaling is compliant to the CANopen standard. This means that the current is scaled to 1/1000 of ***Motor Rated Current*** (6075h, chapter 9.2.3). The device specific scaling can still be activated via ***Fieldbus Options*** (200Eh, chapter 4.2.20).

9.2.6 Object 6079h: DC Link Circuit Voltage

Intermediate circuit voltage of the converter (not available for DSV562E).

Object description:

INDEX	6079h
Name	DC Link Circuit Voltage
Object Code	VAR
Data Type	UNSIGNED32
Category	Optional

Entry description:

Access	ro
PDO Mapping	Possible
Value Range	UNSIGNED32
Default Value	0

For products belonging to **Device Group 1** (see chapter Device Groups) the voltage scaling is device specific and **non**-compliant to the CANopen standard (see table below).
For products belonging to **Device Group 2** the voltage scaling is compliant to the CANopen standard. This means that the voltage is given in **mV**. The device specific scaling can still be activated via ***Fieldbus Options*** (200Eh, chapter 4.2.20).

Example for compliant and non-compliant scaling:

HFI2230-X200:

DC Link Circuit Voltage (example, unscaled) = 24 000 mV

non-compliant scaling factor = 102.3V/32767 (see table below)

Compliant scaling	Dc Link Circuit Voltage (scaled) =	24000
Non-Compliant scaling	Dc Link Circuit Voltage (scaled) = 24V/(102.3V/32767) =	7687

Device	compliant devices	non-compliant scaling factors 7FFFh*) ≡
DSV110		112.0V
DSV112		112.0V
DSV130		112.0V
DSV132		112.0V
DSV133		112.0V
DSV324		500.0V
DSV562E		---------
DSV1030	•	102.3V
DSV1032	•	102.3V
HBI2230-X200		102.3V
HBI2230-X400		102.3V
HBI2260-X200		102.3V
HBI2260-X400		102.3V
HBI2630-X200		102.3V
HBI2630-X400		102.3V
HBI2660-X200		102.3V
HBI2660-X400		102.3V
HBI3260-X400		102.3V
HBI3290-X400		102.3V
HBI3760-X400		102.3V
HBI3790-X400		102.3V
HFI2230-X200	•	102.3V
HFI2230-X400		102.3V
HFI2260-X200	•	102.3V
HFI2260-X400		102.3V
HFI2630-X200	•	102.3V
HFI2630-X400		102.3V
HFI2660-X200	•	102.3V
HFI2660-X400		102.3V
HFI3260-X200	•	102.3V
HFI3260-X400		102.3V
HFI3290-X400	•	102.3V
HFI3760-X400	•	102.3V
HFI3790-X400	•	102.3V
HLI2660		112.0V

*) 7FFFh represents the maximum measuring range of each device. For further information please refer to the operating manual.
Note: Value for customer specific devices only on request.

9.2.7 Object 6087$_h$: Torque Slope

This object shall indicate the configured rate of change of torque. The value shall be given in units of per thousand of rated torque per second.

Object description:

INDEX	6087h
Name	Torque Slope
Object Code	VAR
Data Type	UNSIGNED32
Category	Mandatory

Entry description:

Access	rw
PDO Mapping	Possible
Value Range	UNSIGNED32
Default Value	0xFFFFFFFF

9.2.8 Object 60F6$_h$: Torque Control Parameters

Object description:

INDEX	60F6h
Name	Torque Control Parameters
Object Code	RECORD
Data Type	manufacturer specific
Category	Optional

Entry description:

SUB-INDEX	0
Description	Number of entries
Entry category	Mandatory
Access	ro
PDO Mapping	no
Value Range	2
Default value	no

SUB-INDEX	1
Description	kp_i
Entry category	Optional
Access	rw
PDO Mapping	no
Value Range	1…7FFFh
Default value	Stored value
non-volatile storable	yes

SUB-INDEX	2
Description	tn_i
Entry category	Optional
Access	rw
PDO Mapping	no
Value Range	1…7FFFh
Default value	Stored value
non-volatile storable	yes

Scaling factors:
kp_i = proportional gain of the current controller: $7FFF_h \equiv 1.00$

tn_i = integral gain of the current controller: $$T_{Ni} = \frac{32767 \cdot 100\mu s}{tn\_i}$$

9.2.9 Object 2003$_h$: Dynamic Speed Limit

Speed limit for operation mode -4 (current control with speed limitation).

Object description:

INDEX	2003h
Name	Dynamic Speed Limit
Object Code	VAR
Data Type	UNSIGNED16
Category	Optional

Entry description:

Access	rw
PDO Mapping	Possible
Value Range	0 … 7FFFh
Default Value	0

Scaling factor: 2 ≡ 1rpm

10 Object Dictionary Overview

G1, G2 = device group 1, device group 2
Norm = scaling factor
EE = storable parameter
Attr. = access attributes for data objects
PDO = PDO Mapping possible
M/O = according to DSP402 Mandatory / Optional
ds = device specific with non-compliant scaling (7FFFh = measuring range)
ms = manufacturer specific
[ms] = milliseconds
[min] = minutes
[r] = revolutions
[s] = seconds
ro = read only
rw = read and write

Index	Object	Name	Type	Norm	EE	Attr.	PDO	M/O	G1 G2 Firmware
1000h	VAR	Device Type	U32			ro		M	☒ ☒ ≥ V3.00
1001h	VAR	Error Register	U8			ro		M	☒ ☒ ≥ V3.00
1003h	ARRAY	Pre-Defined Error Field	U32			ro		O	☒ ☒ ≥ V3.78
1005h	VAR	COB-ID SYNC Message	U32			rw		M	☒ ☒ ≥ V3.00
1008h	VAR	Manufacturer Device Name				ro		O	☐ ☒ ≥ V4.67
1010h	ARRAY	Store Parameters	U32			rw		O	☒ ☒ ≥ V3.00
1014h	VAR	COB-ID Emergency Object	U32			ro		M	☒ ☒ ≥ V3.00
1017h	VAR	Producer Heartbeat Time	U16	[ms]		rw		M	☒ ☒ ≥ V3.00
1018h	RECORD	Identity Object				ro		M	☒ ☒ ≥ V3.00
1400h	RECORD	Receive PDO 1 Parameter				rw		M	☒ ☒ ≥ V3.00
1401h	RECORD	Receive PDO 2 Parameter				rw		M	☒ ☒ ≥ V3.00
1600h	RECORD	RPDO 1 Mapping Parameter				rw		M	☒ ☒ ≥ V3.00
1601h	RECORD	RPDO 2 Mapping Parameter				rw		M	☒ ☒ ≥ V3.00
1800h	RECORD	Transmit PDO 1 Parameter				rw		M	☒ ☒ ≥ V3.00
1801h	RECORD	Transmit PDO 1 Parameter				rw		M	☒ ☒ ≥ V3.00
1A00h	RECORD	TPDO 1 Mapping Parameter				rw		M	☒ ☒ ≥ V3.00
1A01h	RECORD	TPDO 2 Mapping Parameter				rw		M	☒ ☒ ≥ V3.00

Index	Object	Name	Type	Norm	EE	Attr.	PDO	M/O	G1 G2 Firmware
2000h	VAR	Node ID	U8		•	rw		O	☒ ☒ ≥ V3.00
2001h	VAR	CAN Bitrate	U16		•	rw		O	☒ ☒ ≥ V3.00
2002h	VAR	Limit Switch Polarity	U16		•	rw		O	☒ ☒ ≥ V3.00
2003h	VAR	Dynamic Speed Limit	U16	[0.5 min^{-1}]		rw	•	O	☒ ☒ ≥ V3.00
2004h	VAR	Dynamic Torque Limit	U16	ds		rw	•	O	☒ ☒ ≥ V3.00
2005h	RECORD	Access Memory Cell	ms			rw		O	☒ ☒ ≥ V3.40
2006h	VAR	Max Turntable Position	I32	[1/4096 r]	•	rw		O	☒ ☒ ≥ V3.40
2007h	RECORD	Capture Object	ms			rw		O	☒ ☒ ≥ V4.00
2008h	ARRAY	User Parameter	U16			rw		O	☒ ☒ ≥ V4.00
2009h	VAR	Current Threshold Homing	U16			rw		O	☒ ☒ ≥ V4.00
200Ah	VAR	I^2t Actual Value	U8			ro		O	☒ ☒ ≥ V4.00
200Bh	ARRAY	Temperature	I8			ro		O	☒ ☒ ≥ V4.00
200Ch	VAR	Error Number	U16			ro		O	☒ ☒ ≥ V4.00
200Dh	ARRAY	Power Consumption	I16			ro	•	O	☒ ☒ ≥ V4.40
200Eh	VAR	Fieldbus Options	U16			rw		O	☐ ☒ ≥ V4.40
200Fh	RECORD	Functional Safety	U16			ro	•	O	☐ ☒ ≥ V4.40
6040h	VAR	Controlword	U16			rw	•	M	☒ ☒ ≥ V3.00
6041h	VAR	Statusword	U16			ro	•	M	☒ ☒ ≥ V3.00
605Ah	VAR	Quick Stop Option Code	I16		•	rw		O	☒ ☒ ≥ V3.00
605Dh	VAR	Halt Option Code	I16		•	rw		O	☒ ☒ ≥ V3.00
6060h	VAR	Modes of Operation	I8			rw	•	M	☒ ☒ ≥ V3.00
6061h	VAR	Modes of Operation Display	I8			ro	•	M	☒ ☒ ≥ V3.00
6064h	VAR	Position Actual Value	I32	[1/4096 r]		ro	•	M	☒ ☒ ≥ V3.00
6065h	VAR	Following Error Window	U32	[1/4096 r]	•	rw	•	O	☒ ☒ ≥ V3.83
6066h	VAR	Following Error Time Out	U16	[ms]	•	rw	•	O	☒ ☒ ≥ V3.83

Index	Object	Name	Type	Norm	EE	Attr.	PDO	M/O	G1 G2 Firmware
6067h	VAR	Position Window	U32	[1/4096 r]	•	rw	•	O	☒ ☒ ≥ V3.00
6068h	VAR	Position Window Time	U16	[0.2 ms]	•	rw	•	O	☒ ☒ ≥ V3.00
606Bh	VAR	Velocity Demand Value	I32	[0.5 min^{-1}]		ro	•	M	☒ ☒ ≥ V3.80
606Ch	VAR	Velocity Actual Value	I32	[0.5 min^{-1}]		ro	•	M	☒ ☒ ≥ V3.00
6071h	VAR	Target Torque	I16	ds		rw	•	M	☒ ☒ ≥ V3.00
6073h	VAR	Max Current	U16	ds	•	rw	•	O	☒ ☒ ≥ V3.00
6075h	VAR	Motor Rated Current	U32	ds	•	rw	•	O	☒ ☒ ≥ V3.00
6077h	VAR	Torque Actual Value	I16	ds		ro	•	O	☒ ☒ ≥ V3.00
6078h	VAR	Current Actual Value	I16	ds		ro	•	O	☒ ☒ ≥ V3.00
6079h	VAR	DC Link Circuit Voltage	U32	ds		ro	•	O	☒ ☒ ≥ V3.00
607Ah	VAR	Target Position	I32	[1/4096 r]		rw	•	M	☒ ☒ ≥ V3.00
607Bh	ARRAY	Position Range Limit	I32	[0.0001 r]	•	rw	•	O	☒ ☒ ≥ V3.78
607Ch	VAR	Home Offset	I32	[1/4096 r]	•	rw	•	O	☒ ☒ ≥ V3.00
607Dh	ARRAY	Software Position Limit	I32	[1/4096 r]	•	rw	•	O	☒ ☒ ≥ V3.00
607Eh	VAR	Polarity	U8		•	rw	•	M	☒ ☒ ≥ V3.00
6080h	VAR	Max Motor Speed	U32	[0.5 min^{-1}]	•	rw	•	O	☒ ☒ ≥ V3.00
6081h	VAR	Profile Velocity	U32	1)		rw	•	M	☒ ☒ ≥ V3.00
6083h	VAR	Profile Acceleration	U32	[10 min^{-1} s^{-1}]	•	rw	•	M	☒ ☒ ≥ V3.00
6084h	VAR	Profile Deceleration	U32	[10 min^{-1} s^{-1}]	•	rw	•	O	☒ ☒ ≥ V3.00
6085h	VAR	Quick Stop Deceleration	U32	[10 min^{-1} s^{-1}]	•	rw	•	O	☒ ☒ ≥ V3.00
6086h	VAR	Motion Profile Type	I16		•	rw	•	O	☒ ☒ ≥ V3.00
6087h	VAR	Torque Slope	U32			rw	•	M	☐ ☒ ≥ V4.40
6094h	ARRAY	Velocity Encoder Factor	U32			rw	•	O	☒ ☒ ≥ V3.77
6098h	VAR	Homing Method	I8		•	rw	•	M	☒ ☒ ≥ V3.00
6099h	ARRAY	Homing Speeds	U32	[0.5 min^{-1}]	•	rw	•	M	☒ ☒ ≥ V3.00
609Ah	VAR	Homing Acceleration	U32	[10 min^{-1} s^{-1}]	•	rw	•	O	☒ ☒ ≥ V3.00

Index	Object	Name	Type	Norm	EE	Attr.	PDO	M/O	G1 G2 Firmware
60F4h	VAR	Following Error	I32			ro	•	O	☒ ☒ ≥ V4.92
60F6h	RECORD	Torque Control Parameters	ms		•	rw		O	☒ ☒ ≥ V3.00
60F9h	ARRAY	Velocity Control Parameter Set	U16		•	rw	•	O	☒ ☒ ≥ V3.00
60FBh	RECORD	Position Control Parameter Set	ms		•	rw	•	O	☒ ☒ ≥ V3.00
60FDh	VAR	Digital Inputs	U32			rw	•	O	☒ ☒ ≥ V3.00
60FEh	ARRAY	Digital Outputs	U32			rw	•	O	☒ ☒ ≥ V3.72
60FFh	VAR	Target Velocity	I32	1)		rw	•	M	☒ ☒ ≥ V3.00
6502h	VAR	Supported Drive Modes	U32			ro	•	M	☐ ☒ ≥ V4.40
6C01h	ARRAY	Analogue Inputs 16-Bit	I16			ro	•	M	☒ ☒ ≥ V3.72
7004h	VAR	Encoder Position Value	I16	[1/2^{16} r]		ro	•	O	☒ ☒ ≥ V3.74

1) Scaling factor depends on ***Velocity Encoder Factor*** (6094h, chapter 4.2.23); default: [0.5 min^{-1}]

11 Appendix

11.1 Getting Started

In this chapter the typical course of action is shown to launch a CANopen-drive in Profile Velocity Mode (see chapter 8).

Step	Action	Controlword 6040h	Statusword 6041h	Description
1	Power On		xxxx xxxx x1xx 0000	After power-up and initialisation, the drive switches to the state **Switch On Disabled** automatically.
2	shutdown-command	xxxx xxxx 0xxx x110	xxxx xxxx x01x 0001	Transition to **Ready To Switch On.**
3	switch on-command	xxxx xxxx 0xxx x111	xxxx xxxx x01x 0011	Transition to **Switched On.**
4	***Modes of Operation*** (6060h, chapter 5.3.5) = 3		xxxx xxxx x01x 0011	***Modes of Operation*** is switched to Profile Velocity Mode
5	***Target Velocity*** (60FFh, chapter 8.2.2) = 1000		xxxx xxxx x01x 0011	***Velocity Demand Value*** (606Bh, chapter 7.2.11) is 1000 = 500 rpm
6	Set Digital Input DI1 to +24V		xxxx xxxx x01x 0011	Additional condition before enable-command
7	enable-command	xxxx xxxx 0xxx 1111	xxxx xxxx x01x 0111	Transition to **Operation Enabled.** Drive will be enabled. Motor speed is 500 rpm.
8	***Target Velocity*** = 4000		xxxx xxxx x01x 0111	New setpoint for velocity: 4000 = 2000 rpm
9	disable-command	xxxx xxxx 0xxx x111	xxxx xxxx x01x 0011	Transition to **Switch On**. Motor stops