

CANopen® User Guide

Rev. 2.8

for ENGEL devices with CANopen® support



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.

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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:

CiA® GmbH
Kontumazgarten 3
90429 Nuremberg
Phone: +49 911 928819-0
Fax: +49 911 928819-79
E-Mail: headquarters@can-cia.org
www.can-cia.org

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:

ENGEL Elektroantriebe GmbH
Am Klingenweg 10
65396 Walluf
Germany
Phone: +49 6123 9942-0
Fax: +49 6123 9942-50
E-Mail: info@engelantriebe.de
www.engelantriebe.de

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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: 2
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 9.2.7)
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	4Fh
	2	4Bh
	3	47h
	4	43h
Write Request (Initiate Domain Download)	1	2Fh
	2	2Bh
	3	27h
	4	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
0504 0001h	Client/server command specifier not valid or unknown.
0601 0000h	Unsupported access to an 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.
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).
0800 0000h	general error

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

Note:

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 4.2.7). 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

Emergency Telegram

The emergency telegram is sent once after an error occurred. The first two data byte contains 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 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				

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)} 1-2: active
Default value	2

SUB-INDEX	1 and 2
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 and maximum 2)

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 received 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			PDO with every n-th SYNC object update data with SYNC object
1...240	x		x			
252			x		x	
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⁾ 1-2: active
Default value	2

SUB-INDEX	1 and 2
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 and maximum 2)

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
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	Position Sample	PosSamplePara	rw	O
2008h	ARRAY	User Parameter	UNSIGNED16	rw	O
200Ah	VAR	I ² t Actual Value	UNSIGNED9	ro	O
200Bh	ARRAY	Temperature	INTEGER8	ro	O
200Ch	VAR	Error Number	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 1000h: 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 1010_h: 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	1
Default value	no

Data Description:

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

Writing this signature 65766173h to **Store Parameters** (sub index 1) triggers the parameters to be saved in the non-volatile memory (EEPROM) of the device. Wait for the response before you send the next command. If you use a timeout set the value to 3 seconds. Parameter storing is not allowed in the state **Operation Enabled**.

4.2.6 Object 1014_h: 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

4.2.7 Object 1017_h: Producer Heartbeat Time

This object defines the cycle time of the heartbeat message in milliseconds. Writing zero to this object deactivates heartbeat messages.

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

4.2.8 Object 1018_h: Identity Object

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

Object description:

INDEX	1018 _h
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	2
Description	Product Code ^{*2)}
Entry category	Mandatory
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

SUB-INDEX	1
Description	Vendor ID ^{*1)}
Entry category	Mandatory
Access	ro
PDO Mapping	no
Value Range	UNSIGNED32
Default value	015B _h

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

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

*2) The Product Code contains the manufacturer specific identification of the device

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

4.2.9 Object 2000_h: 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 volat. 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

4.2.10 Object 2001_h: 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 volat. storable	yes

Valid Entries:

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

Baudrate	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

4.2.11 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	2002 _h
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 volat. storable	yes

4.2.12 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 volat. storable	no

SUB-INDEX	2
Description	Password*)
Entry category	Optional
Access	rw
PDO Mapping	no
Value Range	UNSIGNED32
Default value	no
non volat. 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 highword:

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)

4.2.13 Object 2007_h: Position Sample

The actual position of the motor can be saved by detection of an edge at one of the digital inputs DI2 or DI3. The nature of the edges, which should trigger the function, can be selected with parameter **Position Sample Settings**. After triggering by the selected edge the actual position is saved and the flag **Position Sample Flag** is set. No new value will be saved until the saved value is read out. The value can only be read out when **Position Sample Flag** is 1, because reading out the value, will reset **Position Sample Flag**.

The limit switch function must be deactivated (DSerV), if the motor is supposed to pass the switches without generating an error.

All digital inputs are debounced, which results in a signal delay of 1.5 ms.

Object description:

INDEX	2007 _h
Name	Position Sample
Object Code	RECORD
Data Type	PosSamplePara
Category	Optional

Entry description:

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

SUB-INDEX	2
Description	Position Sample Value
Entry category	Optional
Access	ro
PDO Mapping	no
Value Range	INTEGER32
Default value	0

SUB-INDEX	1
Description	Position Sample Flag
Entry category	Optional
Access	ro
PDO Mapping	no
Value Range	BOOLEAN
Default value	0

SUB-INDEX	3
Description	Position Sample Settings
Entry category	Optional
Access	rw
PDO Mapping	no
Value Range	UNSIGNED16
Default value	Stored Value

Data description:

Position Sample Settings Bits	Configuration
0000 0000 0000 0000	no sampling
0000 0000 0000 0100	DI2: positive edge
0000 0000 0000 1000	DI2: negative edge
0000 0000 0000 1100	DI2: every edge
0000 0000 0001 0000	DI3: positive edge
0000 0000 0010 0000	DI3: negative edge
0000 0000 0011 0000	DI3: every edge

Notice: Not all ENGEL devices do have the limit switch function for DI2 and DI3. Therefore **Position Sample** is only available for the following devices:

- HLI 2660
- HBI xxxx
- DSV110 / DSV112

4.2.14 Object 2008_h: User Parameter

In **User Parameter** up to 10 user specific values can be stored permanently.

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

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

4.2.15 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** ([6075_h](#), chapter 9.2.3).

Object description:

INDEX	200Ah
Name	I ² t Actual Value
Object Code	VAR
Data Type	UNSIGNED8
Category	Optional

Entry description:

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

4.2.16 Object 200B_h: Temperature

Gives the measured drive temperature in °C.

Object description:

INDEX	200B _h
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	-20...120
Default value	0

4.2.17 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	200C _h
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

4.2.18 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	607E _h
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 volat. storable	yes

Data Description:

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

4.2.19 Object 6094_h: Velocity Encoder Factor

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

Object description:

INDEX	6094 _h
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	no
Value Range	1 ... 16384 (V3.82 or higher)
Default value	1
non volat. storable	no

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

Data description:

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

4.2.20 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	60FD _h
Name	Digital Inputs
Object Code	VAR
Data Type	UNSIGNED32
Category	Optional

Entry description:

Access	ro
PDO Mapping	no
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

4.2.21 Object 60FEh: 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 (Firmware V3.72 or higher). 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	no
Value Range	UNSIGNED32
Default value	0

Data description:

applies to both sub-index 1 and sub-index 2

Bit #	Configuration
0 ... 15	reserved
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 (if 'Positive Logic' configured)
Bit n = 1:	High level output voltage at the associated digital output pin (if 'Positive Logic' configured)

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).

Please note, that output voltage levels may be reversed, if the associated digital output has been configured for 'Negative Logic' in the setup procedure. (Please see Operating Manual).

Please also 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 <u>automatic control</u> . (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 <u>user control</u> . (State of digital output will be set according to the corresponding bit value in Sub-Index 1)

4.2.22 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	6C01 _h
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 \equiv -10V ... 0V ... +10V

4.2.23 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	7004 _h
Name	Encoder Position Value
Object Code	VAR
Data Type	INTEGER16

Entry description:

Access	ro
PDO Mapping	possible
Value Range	INTEGER16
Default Value	no

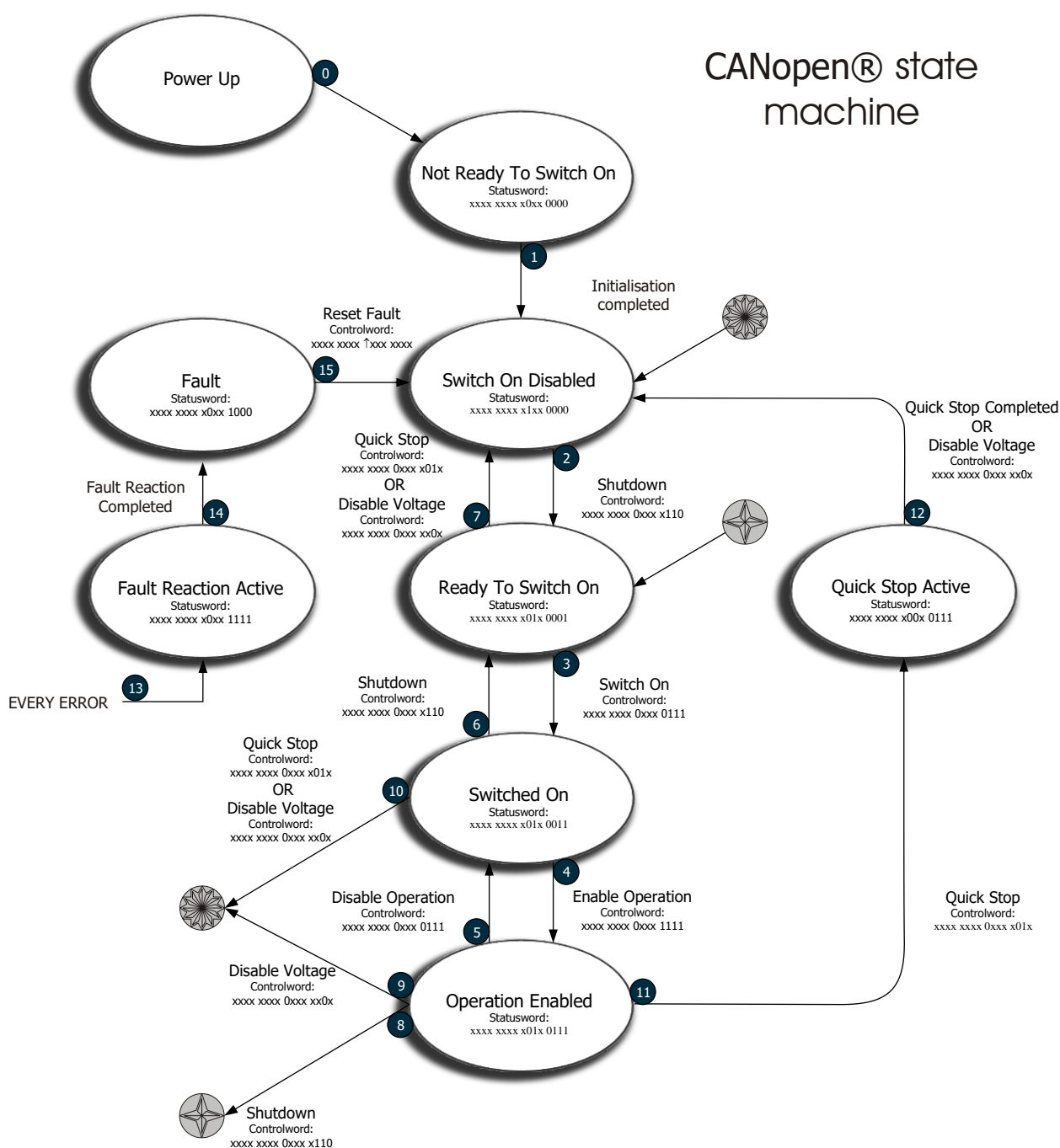
Scaling factor: $\frac{\text{Encoder Position Increments}}{\text{Revolution}} = 4 \times \frac{\text{Encoder Pulses}}{\text{Revolution}}$

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:

Transition	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 x 110b	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 x 110b	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
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

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

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). Further bits are used for positioning and activate the HALT command.

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 bidirectional) Bit=0: set position is approached clockwise Bit=1: set position 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	6041 _h
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	Manufacturer specific
9	Remote
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
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
	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 605Ah: 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 volat. 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** 6040_h, 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	605D _h
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 volat. storable	yes

Data Description:

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

5.3.5 Object 6060_h: 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** (6061_h, chapter 5.3.6).

Notice:

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

Object description:

INDEX	6060 _h
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 6061_h: Modes of Operation Display

Displays the actual mode of operation:

Object description:

INDEX	6061 _h
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* ([6060_h](#), chapter 5.3.5)

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 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 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.

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

The current scaling is device-specific: (see [scaling factor table in chapter 8.2.4](#)).

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	no
Value Range	INTEGER32
Default Value	Stored value
non volat. 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	6098 _h
Name	Homing Method
Object Code	VAR
Data Type	INTEGER8
Category	Mandatory

Entry description:

Access	rw
PDO Mapping	no
Value Range	See table
Default Value	Stored value
non volat. 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	no
Value Range	UNSIGNED32
Default value	Stored value
non volat. storable	yes

SUB-INDEX	2
Description	Speed during search for zero
Entry category	Mandatory
Access	rw
PDO Mapping	no
Value Range	UNSIGNED32
Default value	Stored value
non volat. 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	no
Value Range	lin.: 1...32767 sin ² : 16...32767
Default Value	Stored value
non volat. storable	yes

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

for linear ramp: Acceleration: $a = x \cdot 10 \text{ rpm/s}$

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

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 Notes for Turntable Positioning:

The turntable positioning range lies between zero and the value **Max Position Range Limit** ([607Bh sub2](#), chapter 7.2.7). 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 Stopp 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 6064_h: 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 6065_h: 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 volat. 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 6066_h: 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 volat. storable	yes

7.2.4 Object 6067_h: 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).

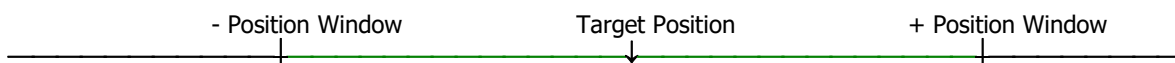
Object description:

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

Entry description:

Access	rw
PDO Mapping	no
Value Range	0..2 ³¹ -1 (7FFFFFFh)
Default Value	Stored value
non volat. storable	yes

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



7.2.5 Object 6068_h: 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	no
Value Range	0 ... 7FFFh
Default Value	Stored value
non volat. storable	yes

Scaling factor: 0.2 ms

7.2.6 Object 607A_h: 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 6060_h**, chapter 5.3.5), it substitutes object **Max Turntable Position** ([2006_h](#), 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	607B _h
Name	Position Range Limit
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	2
Default value	2

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

SUB-INDEX	2
Description	Max Position Range Limit
Entry category	Mandatory
Access	rw
PDO Mapping	no
Value Range	10,000...2,600,000,000
Default value	Stored value
non volat. storable	yes

Scaling factor: 0.0001 rev.

Notice: The **Max Position Range Limit** must not exceed the value of **Max Position Limit** ([607D_h 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** (607A_h, 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	607D _h
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	no
Value Range	INTEGER32
Default value	Stored value
non volat. storable	yes

SUB-INDEX	2
Description	Max Position Limit
Entry category	Mandatory
Access	rw
PDO Mapping	no
Value Range	INTEGER32
Default value	Stored value
non volat. storable	yes

Scaling factor: 12 Bit angle resolution, 20 Bit revolution counter, i.e. 1000h \equiv 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	6080 _h
Name	Max Motor Speed
Object Code	VAR
Data Type	UNSIGNED32
Category	Optional

Entry description:

Access	rw
PDO Mapping	no
Value Range	UNSIGNED32
Default Value	Stored value
non volat. storable	yes

Scaling factor: 2 \equiv 1rpm

7.2.10 Object 6081_h: 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 0).

Object description:

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

Entry description:

Access	rw
PDO Mapping	possible
Value Range	1 ... Max. Value (<i>see below</i>)
Default Value	no

Subindex 1 (Numerator) and Subindex 2 (Denominator) of **Velocity Encoder Factor** ([6094_h](#), chapter 4.2.19) define the Scaling Factor and limit the permissible Max. Value of **Profile Velocity** as follows:

Scaling Factor = (Numerator / Denominator) rpm

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

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

Default Scaling Factor = 0.5 rpm

Default Max. Value = 32767 (\equiv 16383.5 rpm)

7.2.11 Object 606B_h: Velocity Demand Value

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

Object description:

INDEX	606B _h
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 \equiv 1rpm

7.2.12 Object 6083_h: Profile Acceleration

Acceleration ramp used as speed ramp 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** ([6086_h](#), 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	6083 _h
Name	Profile Acceleration
Object Code	VAR
Data Type	UNSIGNED32
Category	Mandatory

Entry description:

Access	rw
PDO Mapping	possible
Value Range	lin.: 1...32767 sin ² : 16...32767
Default Value	Stored value
non volat. storable	yes

Scaling factor: depends on the used **Motion Profile Type** ([6086_h](#), chapter 7.2.15)

for linear ramp: Acceleration: $a = x \cdot 10 \text{ rpm/s}$

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

7.2.13 Object 6084_h: Profile Deceleration

Deceleration ramp used as speed ramp 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** ([6086_h](#), chapter 7.2.15).

Depending on the chosen **Motion Profile Type** the units of **Profile Deceleration** are different.

Object description:

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

Entry description:

Access	rw
PDO Mapping	possible
Value Range	
Default Value	Stored value
non volat. storable	yes

Scaling factor: see **Profile Acceleration** ([6083_h](#), chapter 7.2.12)

7.2.14 Object 6085_h: Quick Stop Deceleration

Deceleration ramp for fast stop (emergency stop).

The ramp can be switched between linear and sine-squared ramp. This is done via **Motion Profile Type** ([6086_h](#), chapter 7.2.15).

Depending on the chosen **Motion Profile Type** the units of **Quick Stop Deceleration** are different.

Object description:

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

Entry description:

Access	rw
PDO Mapping	no
Value Range	
Default Value	Stored value
non volat. storable	yes

Scaling factor: see **Profile Acceleration** ([6083_h](#), 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	6086 _h
Name	Motion Profile Type
Object Code	VAR
Data Type	INTEGER16
Category	Optional

Entry description:

Access	rw
PDO Mapping	no
Value Range	-1...1
Default Value	Stored value
non volat. 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	60F4 _h
Name	Following Error Actual Value
Object Code	VAR
Data Type	INTEGER32
Category	Optional

Entry description:

Access	ro
PDO Mapping	no
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	60FB _h
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	no

SUB-INDEX	1
Description	Proportional gain (kp_x)
Entry category	Optional
Access	rw
PDO Mapping	no
Value Range	UNSIGNED16 (0 ... 7FFFh)
Default value	Stored value
non volat. storable	yes

SUB-INDEX	2
Description	Correction speed (v_korrigier)
Entry category	Optional
Access	rw
PDO Mapping	no
Value Range	UNSIGNED16 (0 ... 7FFFh)
Default value	Stored value
non volat. storable	yes

SUB-INDEX	3
Description	step_forward (Jolt Mode)
Entry category	Optional
Access	rw
PDO Mapping	no
Value Range	UNSIGNED16
Default value	Stored value
non volat. storable	yes

SUB-INDEX	4
Description	step_backward (Jolt Mode)
Entry category	Optional
Access	rw
PDO Mapping	no
Value Range	UNSIGNED16
Default value	Stored value
non volat. 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* (607B_h, chapter 7.2.7) instead!

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

Object description:

INDEX	2006 _h
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 volat. 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 606Ch: 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 60FFh: Target Velocity

Nominal speed set-point in [Profile Velocity Mode](#).

Note: 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 4.2.19) define the Scaling Factor and limit the permissible Min. Value / Max. Value of **Target Velocity** as follows:

$$\begin{aligned}
 \text{Scaling Factor} &= (\text{Numerator} / \text{Denominator}) \text{ rpm} \\
 \text{Min. Value} &= - \text{Max. Value} \\
 \text{Max. Value} &= \frac{2^{31}-1}{\text{Numerator} \times 2^{(17-\log_2 \text{Denominator})}}
 \end{aligned}$$

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

$$\begin{aligned}
 \text{Default Scaling Factor} &= 0.5 \text{ rpm} \\
 \text{Default Min. Value} &= -32767 \quad (\equiv -16383.5 \text{ rpm}) \\
 \text{Default Max. Value} &= 32767 \quad (\equiv 16383.5 \text{ rpm})
 \end{aligned}$$

8.2.3 Object 60F9_h: Velocity Control Parameter Set

Object description:

INDEX	60F9 _h
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	no
Value Range	1...7FFF _h
Default value	Stored value
non volat. storable	yes

SUB-INDEX	2
Description	tn _n
Entry category	Optional
Access	rw
PDO Mapping	no
Value Range	1...7FFF _h
Default value	Stored value
non volat. storable	yes

Scaling factors:

kp_n = proportional gain of the speed controller: 7FFF_h ≡ 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	2004 _h
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**.

Device	Scaling factor 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
HBI2230-2	25.4A
HBI2230-4	25.4A
HBI2260-2	42.3A
HBI2260-4	25.4A
HBI2630-2	42.3A
HBI2630-4	25.4A
HBI2660-2	42.3A
HBI2660-4	25.4A
HBI3260-4	45.8A
HBI3290-4	45.8A
HBI3760-4	45.8A
HBI3790-4	45.8A
HLI2660	50.0A

^{*)} 7FFFh represents the maximum measuring range of each device.
For further information please consult the operating manual.

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
6078h	VAR	Current Actual Value	INTEGER16	ro	O
6079h	VAR	DC Link Circuit Voltage	UNSIGNED32	ro	O
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 shaft, it has to be multiplied by the torque constant of the motor and possibly by the ratio of a mounted gear.

The current scaling is device-specific: (see [scaling factor table in chapter 8.2.4](#)).

The current values are given as peak values and correlate to the specification in the motors datasheet and on the name plate.

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

Peak current of the motor according to the datasheet / name plate

The current scaling is device-specific: (see [scaling factor table in chapter 8.2.4](#))

The current values are given as peak values.

Object description:

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

Entry description:

Access	rw
PDO Mapping	no
Value Range	UNSIGNED16 ^{*)}
Default Value	Stored value
non volat. storable	yes

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

Device	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	6842h	≡ 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
HLI2660	5EB8h	≡ 37.0A

9.2.3 Object 6075_h: Motor Rated Current

Rated current of the motor according to the datasheet /name plate.

The current scaling is device-specific: (see [scaling factor table in chapter 8.2.4](#))

The current values are given as 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	no
Value Range	UNSIGNED32
Default Value	Stored value
non volat. storable	yes

9.2.4 Object 6078_h: Current Actual Value

Actual value of the torque producing current.

The current scaling is device-specific: (see [scaling factor table in chapter 8.2.4](#))

The current values are given as 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

9.2.5 Object 6079_h: DC Link Circuit Voltage

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

Object description:

INDEX	6079 _h
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

The voltage scaling is device-specific:

Device	Scaling factor 7FFF _h ^{*)} ≡
DSV110	112.0V
DSV112	112.0V
DSV130	112.0V
DSV132	112.0V
DSV133	112.0V
DSV324	500.0V
DSV562E	-----
DSV1030	102.3V
HBI2230-2	102.3V
HBI2230-4	102.3V
HBI2260-2	102.3V
HBI2260-4	102.3V
HBI2630-2	102.3V
HBI2630-4	102.3V
HBI2660-2	102.3V
HBI2660-4	102.3V
HBI3260-4	102.3V
HBI3290-4	102.3V
HBI3760-4	102.3V
HBI3790-4	102.3V
HLI2660	112.0V

^{*)} 7FFF_h represents the maximum measuring range of each device.
For further information please consult the operating manual.

9.2.6 Object 60F6h: 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 volat. 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 volat. 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:
$$T_{Ni} = \frac{32767 \cdot 100 \mu s}{tn_i}$$

9.2.7 Object 2003h: 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: $2 \equiv 1 \text{rpm}$

10 Object Dictionary Overview

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 (7FFFh = measuring range)
 ms = manufacturer specific
 [ms] = milli seconds
 [min] = minutes
 [r] = revolutions
 [s] = seconds
 ro = read only
 rw = read and write

Index	Object	Name	Type	Norm	EE	Attr.	PDO	M/O	Firmware
1000h	VAR	Device Type	U32			ro		M	
1001h	VAR	Error Register	U8			ro		M	
1003h	ARRAY	Pre-Defined Error Field	U32			ro		O	≥ V3.78
1005h	VAR	COB-ID SYNC Message	U32			rw		M	
1010h	ARRAY	Store Parameters	U32			rw		O	
1014h	VAR	COB-ID Emergency Object	U32			ro		M	
1017h	VAR	Producer Heartbeat Time	U16	[ms]		rw		M	
1018h	RECORD	Identity Object				ro		M	
1400h	RECORD	Receive PDO 1 Parameter				rw		M	
1401h	RECORD	Receive PDO 2 Parameter				rw		M	
1600h	RECORD	RPDO 1 Mapping Parameter				rw		M	
1601h	RECORD	RPDO 2 Mapping Parameter				rw		M	
1800h	RECORD	Transmit PDO 1 Parameter				rw		M	
1801h	RECORD	Transmit PDO 1 Parameter				rw		M	
1A00h	RECORD	TPDO 1 Mapping Parameter				rw		M	
1A01h	RECORD	TPDO 2 Mapping Parameter				rw		M	
2000h	VAR	Node ID	U8		•	rw		O	
2001h	VAR	CAN Bittate	U16		•	rw		O	
2002h	VAR	Limit Switch Polarity	U16		•	rw		O	
2003h	VAR	Dynamic Speed Limit	U16	[0.5 min ⁻¹]		rw	•	O	
2004h	VAR	Dynamic Torque Limit	U16	ds		rw	•	O	
2005h	RECORD	Access Memory Cell	ms			rw		O	
2006h	VAR	Max Turntable Position	I32	[1/4096 r]	•	rw		O	
6040h	VAR	Controlword	U16			rw	•	M	
6041h	VAR	Statusword	U16			ro	•	M	
605Ah	VAR	Quick Stop Option Code	I16		•	rw		O	
605Dh	VAR	Halt Option Code	I16		•	rw		O	
6060h	VAR	Modes of Operation	I8			rw	•	M	
6061h	VAR	Modes of Operation Display	I8			ro	•	M	
6064h	VAR	Position Actual Value	I32	[1/4096 r]		ro	•	M	
6065h	VAR	Following Error Window	U32	[1/4096 r]	•	rw	•	O	≥ V3.83

Index	Object	Name	Type	Norm	EE	Attr.	PDO	M/O	Firmware
6066h	VAR	Following Error Time Out	U16	[ms]	•	rw	•	O	≥ V3.83
6067h	VAR	Position Window	U32	[1/4096 r]	•	rw		O	
6068h	VAR	Position Window Time	U16	[0.2 ms]	•	rw		O	
6068h	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	
6071h	VAR	Target Torque	I16	ds		rw	•	M	
6073h	VAR	Max Current	U16	ds	•	rw		O	
6075h	VAR	Motor Rated Current	U32	ds	•	rw		O	
6078h	VAR	Current Actual Value	I16	ds		ro	•	O	
6079h	VAR	DC Link Circuit Voltage	U32	ds		ro	•	O	
607Ah	VAR	Target Position	I32	[1/4096 r]		rw	•	M	
607Bh	ARRAY	Position Range Limit	I32	[0.0001 r]	•	rw		O	≥ V3.78
607Ch	VAR	Home Offset	I32	[1/4096 r]	•	rw		O	
607Dh	ARRAY	Software Position Limit	I32	[1/4096 r]	•	rw		O	
607Eh	VAR	Polarity	U8		•	rw	•	M	
6080h	VAR	Max Motor Speed	U32	[0.5 min ⁻¹]	•	rw		O	
6081h	VAR	Profile Velocity	U32	1)		rw	•	M	
6083h	VAR	Profile Acceleration	U32	[10 min ⁻¹ s ⁻¹]	•	rw	•	M	
6084h	VAR	Profile Deceleration	U32	[10 min ⁻¹ s ⁻¹]	•	rw	•	O	
6085h	VAR	Quick Stop Deceleration	U32	[10 min ⁻¹ s ⁻¹]	•	rw		O	
6086h	VAR	Motion Profile Type	I16		•	rw		O	
6094h	ARRAY	Velocity Encoder Factor	U32			rw		O	≥ V3.77
6098h	VAR	Homing Method	I8		•	rw		M	
6099h	ARRAY	Homing Speeds	U32	[0.5 min ⁻¹]	•	rw		M	
609Ah	VAR	Homing Acceleration	U32	[10 min ⁻¹ s ⁻¹]	•	rw		O	
60F6h	RECORD	Torque Control Parameters	ms		•	rw		O	
60F9h	ARRAY	Velocity Control Parameter Set	U16		•	rw		O	
60FBh	RECORD	Position Control Parameter Set	ms		•	rw		O	
60FDh	VAR	Digital Inputs	U32			rw		O	
60FEh	ARRAY	Digital Outputs	U32			rw	•	O	≥ V3.72
60FFh	VAR	Target Velocity	I32	1)		rw	•	M	
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 4.2.19); 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