# CANopen
# Fieldbus manual
MDrive Motion Control
Products

Schneider Electric

| CANopen Fieldbus Manual | | |
|---|---|---|
| **Date** | **Revision** | **Changes** |
| 05/12/2010 | R051211 | Initial release. This document replaces and supercedes CANopen implementation manual R050508. |
| 08/13/2018 | R051211 | Added California Proposition 65 warning |
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*CANopen Fieldbus Manual Revision R051211*

# Important information

This manual is part of the product.

Carefully read this manual and observe all instructions.

Keep this manual for future reference.

Hand this manual and all other pertinent product documentation over to all users of the product.

Carefully read and observe all safety instructions and the chapter “Before you begin - safety information”.

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# About this manual

The information provided in this manual supplements the product hardware manual.

*Source manuals*

The latest versions of the manuals can be downloaded from the Internet at:

http://www.schneider-electric-motion.us

*Source EDS files*

For easier engineering, Electronic Datasheet Files and product master data are available for download from the Internet at:

http://www.schneider-electric-motion.us

*Graphic User Interface software*

For easier prototyping and development, a Graphic User Interface (GUI) is available for use with MDrivePlus and MDrive Hybrid product in cunjunction with the optional MD-CC500-000 USB to CANopen interface cable. This software is avaialbe for download from the Internet at:

http://www.schneider-electric-motion.us

## Further reading

Recommended literature for further reading.

*CAN users and manufacturers organization*

CiA - CAN in Automation
Am Weichselgarten 26
D-91058 Erlangen

http://www.can-cia.org/

*CANopen standards*

- CiA Standard 301 (DS301)
  CANopen application layer and communication profile
- CiA Standard 402 (DSP402)
  Device profile for drives and motion control
- ISO 11898: Controller Area Network (CAN) for high speed communication
- EN 50325-4: Industrial communications subsystem based on ISO 11898 for controller device interfaces (CANopen)

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# 1 Introduction

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## 1.1 CAN bus

The CAN bus (Controller Area Network) was originally developed for fast, economical data transmission in the automotive industry. Today, the CAN bus is also used in industrial automation technology and has been further developed for communication at fieldbus level.

*Features of the CAN bus*

The CAN bus is a standardized, open bus enabling communication between devices, sensors and actuators from different manufacturers. The features of the CAN bus comprise

- Multimaster capability
  Each device in the fieldbus can transmit and receive data independently without depending on an “ordering” master functionality.
- Message-oriented communication
  Devices can be integrated into a running network without reconfiguration of the entire system. The address of a new device does not need to be specified on the network.
- Prioritization of messages
  Messages with higher priority are sent first for time-critical applications.
- Residual error probability
  Various security features in the network reduce the probability of undetected incorrect data transmission to less than $10^{-11}$.

*Transmission technology*

In the CAN bus, multiple devices are connected via a bus cable. Each network device can transmit and receive messages. Data between network devices are transmitted serially.

*Network devices*

Examples of CAN bus devices are

- Automation devices, for example, PLCs
- PCs
- Input/output modules
- Drives
- Analysis devices
- Sensors and actuators

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## 1.2 CANopen technology

### 1.2.1 CANopen description language

CANopen is a device- and manufacturer-independent description language for communication via the CAN bus. CANopen provides a common basis for interchanging commands and data between CAN bus devices.

### 1.2.2 Communication layers

CANopen uses the CAN bus technology for data communication.

CANopen is based on the basic network services for data communication as per the ISO-OSI model model. 3 layers enable data communication via the CAN bus.

- Physical Layer
- Data Link Layer
- Application Layer

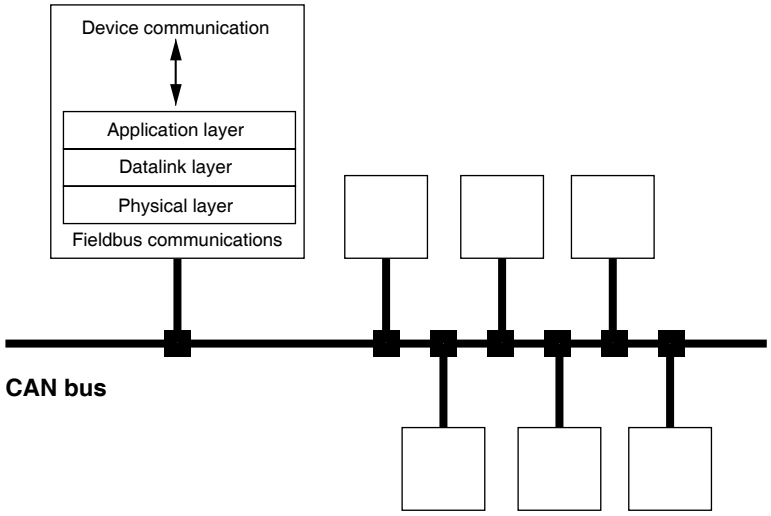


Figure 1.1 CANopen layer model

*Physical Layer* The physical layer defines the electrical properties of the CAN bus such as connectors, cable length and cable properties as well as bit coding and bit timing.

*Data Link Layer* The data link layer connects the network devices. It assigns priorities to individual data packets and monitors and corrects errors.

*Application Layer* The application layer uses communication objects (COB) to exchange data between the various devices. Communication objects are elementary components for creating a CANopen application.

### 1.2.3 Objects

Processes under CANopen are executed via objects. Objects carry out different tasks; they act as communication objects for data transport to the fieldbus, control the process of establishing a connection or monitor the network devices. If objects are directly linked to the device (device specific objects), the device functions can be used and changed via these objects.

*Object dictionary*

The object dictionary of each network device allows for communication between the devices. Other devices find the objects with which they can communicate in this dictionary.

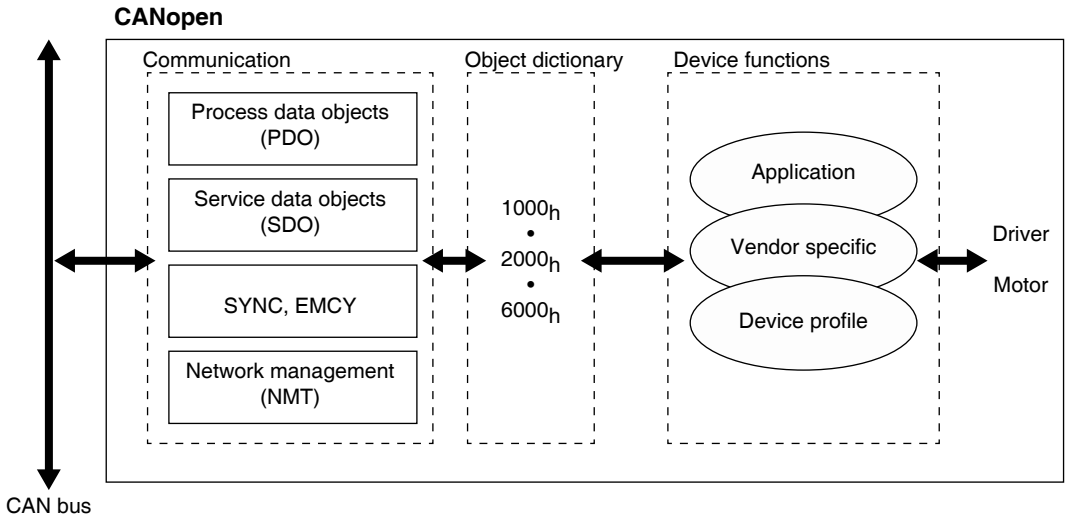


Figure 1.2 Device model with object dictionary

The object dictionary contains objects for describing the data types and executing the communication tasks and device functions under CANopen.

*Object index*

Each object is addressed by means of a 16 bit index, which is represented as a four-digit hexadecimal number. The objects are arranged in groups in the object dictionary. The following table shows an overview of the object dictionary supported by MDrive products as per the CANopen definition.

| Index range (hex) | Object group |
|---|---|
| 1000h - 1FFFh | Communications profile |
| 2000h - 5FFFh | Vendor specific objects |
| 6000h - 9FFFh | Standardized device profiles |

For a list of all CANopen objects see chapter 7 “Object dictionary”.

### 1.2.4 CANopen profiles

*Standardized profiles*

Standardized profiles describe objects that are used with different devices without additional configuration. The users and manufacturers organization CAN in Automation has standardized various profiles. These include:

- DS301 communication profile
- DSP402 device profile

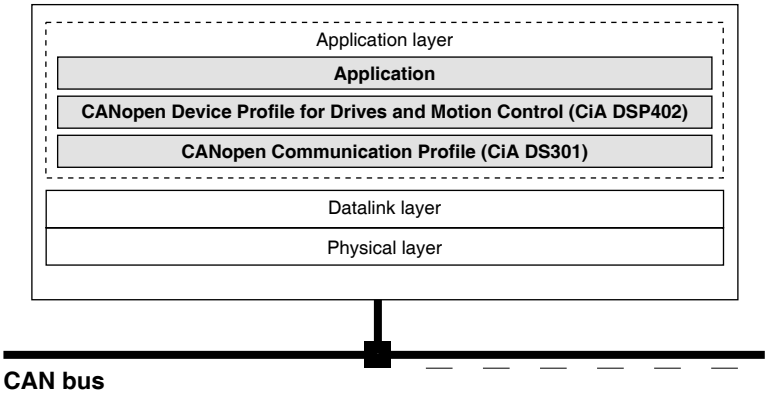


Figure 1.3 CANopen reference model

*DS301 communication profile*

The DS301 communication profile is the interface between device profiles and CAN bus. It was specified in 1995 under the name DS301 and defines uniform standards for common data exchange between different device types under CANopen.

The objects of the communication profile in the device carry out the tasks of data exchange and parameter exchange with other network devices and initialize, control and monitor the device in the network.

*DSP402 device profile*

The DSP402 device profile describes standardized objects for positioning, monitoring and settings of drives. The tasks of the objects include:

- Device monitoring and status monitoring (Device Control)
- Standardized parameterization
- Changing, monitoring and execution of operating modes

*Vendor-specific profiles*

The basic functions of a device can be used with objects of standardized device profiles. Only vendor-specific device profiles offer the full range of functions. The objects with which the special functions of a device can be used under CANopen are defined in these vendor-specific device profiles.

# 2 Before you begin - safety information

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The information provided in this manual supplements the product manual. Carefully read the product manual before using the product.

## 2.1 Qualification of personnel

Only appropriately trained persons who are familiar with and understand the contents of this manual and all other pertinent product documentation are authorized to work on and with this product. In addition, these persons must have received safety training to recognize and avoid hazards involved. These persons must have sufficient technical training, knowledge and experience and be able to foresee and detect potential hazards that may be caused by using the product, by changing the settings and by the mechanical, electrical and electronic equipment of the entire system in which the product is used.

All persons working on and with the product must be fully familiar with all applicable standards, directives, and accident prevention regulations when performing such work.

## 2.2 Intended use

The functions described in this manual are only intended for use with the basic product; you must read and understand the appropriate product manual.

The product may only be used in compliance with all applicable safety regulations and directives, the specified requirements and the technical data.

Prior to using the product, you must perform a risk assessment in view of the planned application. Based on the results, the appropriate safety measures must be implemented.

Since the product is used as a component in an entire system, you must ensure the safety of persons by means of the design of this entire system (for example, machine design).

Operate the product only with the specified cables and accessories. Use only genuine accessories and spare parts.

Any use other than the use explicitly permitted is prohibited and can result in hazards.

Electrical equipment should be installed, operated, serviced, and maintained only by qualified personnel.

The product must NEVER be operated in explosive atmospheres (hazardous locations, Ex areas).

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## 2.3 Hazard categories

Safety instructions to the user are highlighted by safety alert symbols in the manual. In addition, labels with symbols and/or instructions are attached to the product that alert you to potential hazards.

Depending on the seriousness of the hazard, the safety instructions are divided into 4 hazard categories.

**⚠ DANGER**

DANGER indicates an imminently hazardous situation, which, if not avoided, will result in death or serious injury.

**⚠ WARNING**

WARNING indicates a potentially hazardous situation, which, if not avoided, **can result** in death, serious injury, or equipment damage.

**⚠ CAUTION**

CAUTION indicates a potentially hazardous situation, which, if not avoided, **can result** in injury or equipment damage.

**CAUTION**

CAUTION used without the safety alert symbol, is used to address practices not related to personal injury (e.g. **can result** in equipment damage).

## 2.4 Basic information

**⚠ DANGER**

**UNINTENDED CONSEQUENCES OF EQUIPMENT OPERATION**

When the system is started, the drives are usually out of the operator's view and cannot be visually monitored.

• Only start the system if there are no persons in the hazardous area.

**Failure to follow these instructions will result in death or serious injury.**

**⚠ WARNING**

**LOSS OF CONTROL**

- The designer of any control scheme must consider the potential failure modes of control paths and, for certain critical functions, provide a means to achieve a safe state during and after a path failure. Examples of critical control functions are emergency stop, overtravel stop, power outage and restart.
- Separate or redundant control paths must be provided for critical functions.
- System control paths may include communication links. Consideration must be given to the implication of unanticipated transmission delays or failures of the link.
- Observe all accident prevention regulations and local safety guidelines. 1)
- Each implementation of the product must be individually and thoroughly tested for proper operation before being placed into service.

**Failure to follow these instructions can result in death or serious injury.**

1) For USA: Additional information, refer to NEMA ICS 1.1 (latest edition), "Safety Guidelines for the Application, Installation, and Maintenance of Solid State Control" and to NEMA ICS 7.1 (latest edition), "Safety Standards for Construction and Guide for Selection, Installation and Operation of Adjustable-Speed Drive Systems".

## 2.5 Standards and terminology

Technical terms, terminology and the corresponding descriptions in this manual are intended to use the terms or definitions of the pertinent standards.

In the area of drive systems, this includes, but is not limited to, terms such as “safety function”, “safe state”, “fault”, “fault reset”, “failure”, “error”, “error message”, “warning”, “warning message”, etc.

Among others, these standards include:

- IEC 61800 series: “Adjustable speed electrical power drive systems”
- IEC 61158 series: “Industrial communication networks - Fieldbus specifications”
- IEC 61784 series: “Industrial communication networks - Profiles”
- IEC 61508 series: “Functional safety of electrical/electronic/ programmable electronic safety-related systems”

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# 3 Basics

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## 3.1 Communication profile

CANopen manages communication between the network devices with object dictionaries and objects. A network device can use process data objects (PDO) and service data objects (SDO) to request the object data from the object dictionary of another device and, if permissible, write back modified values.

The following can be done by accessing the objects of the network evices

- Exchange parameter values
- Start motion functions of individual CAN bus devices
- Request status information

### 3.1.1 Object dictionary

Each CANopen device manages an object dictionary which contains the objects for communication.

*Index, subindex*

The objects are addressed in the object dictionary via a 16 bit index. One or more 8 bit subindex entries for each object specify individual data fields in the object. Index and subindex are shown in hexadecimal notation with a subscript "$_h$".

*Example*

The following table shows index and subindex entries using the example of the object Homing Speeds ($6098_h$) for specifying the fast and slow speeds for homing functions.

| Index | Subindex | Name | Meaning |
|---|---|---|---|
| $6098_h$ | $00_h$ | — | Number of data fields |
| | $01_h$ | Homing speed fast | High speed during homing |
| | $02_h$ | Homing speed slow | Low speed during homing |

Table 3.1 Example index and subindex entries

*Object descriptions in the manual*

For CAN programming of a device, the objects of the following object groups are described in detail:

$1xxx_h$ objects: Communication objects.

$2xxx_h$ objects: Vendor-specific objects required to control the IMS SEM specific functions of the device.

$6xxx_h$ objects: Standardized objects of the device profile.

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*Standardized objects*

Standardized objects allow you to use the same application program for different network devices of the same device type. This requires these objects to be contained in the object dictionary of the network devices. Standardized objects are defined in the DS301 communication profile and the DSP402 device profile.

## 3.1.2 Communication objects

*Overview*

The communication objects are standardized with the DS301 CANopen communication profile. The objects can be classified into 4 groups according to their tasks.

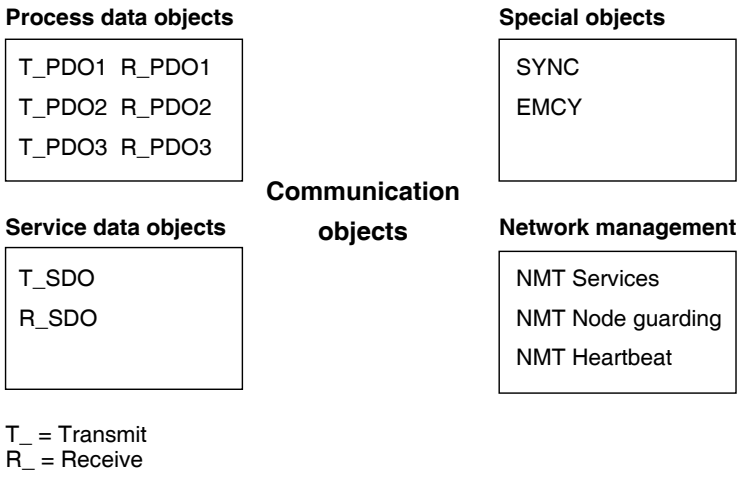


Figure 3.1 Communication objects

- PDOs (process data objects) for real-time transmission of process data
- SDOs (service data object) for read and write access to the object dictionary
- Objects for controlling CAN messages:
  1. SYNC object (synchronization object) for synchronization of networ devices
  2. EMCY object (emergency object), for signaling errors of a device or its peripherals.
- Network management services:
  1. NMT services for initialization and network control (NMT: network management)
  2. NMT Node Guarding for monitoring the network devices
  3. NMT Heartbeat for monitoring the network devices

*CAN message*

Data is exchanged via the CAN bus in the form of CAN messages. A CAN message transmits the communication object as well as numerous administration and control data.

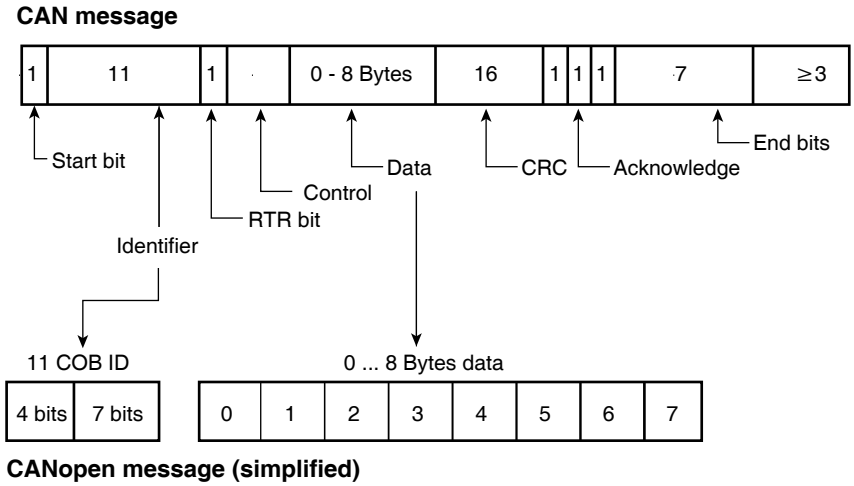


Figure 3.2 CAN message and simplified CANopen message

*CANopen message*

For work with CANopen objects and for data exchange, the CAN message can be represented in simplified form because most of the bits are used for error correction. These bits are automatically removed from the receive message by the data link layer of the OSI model, and added to a message before it is transmitted.

The two bit fields “Identifier” and “Data” form the simplified CANopen message. The “Identifier” corresponds to the “COB ID” and the “Data” field to the data frame (maximum length 8 bytes) of a CANopen message.

*COB ID*

The COB ID (**C**ommunication **OB**ject Identifier) has 2 tasks as far as controlling communication objects is concerned:

- Bus arbitration: Specification of transmission priorities
- Identification of communication objects
  An 11 bit COB identifier as per the CAN 3.0A specification is defined for CAN communication; it comprises 2 parts
- Function code, 4 bits
- Node address (node ID), 7 bits.

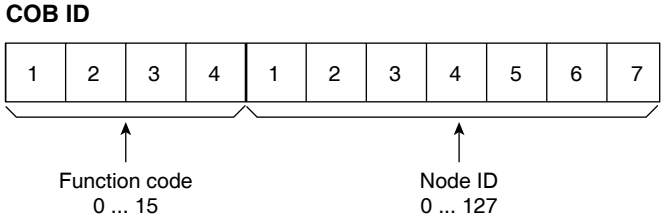


Figure 3.3 COB ID with function code and node address

*COB IDs of the communication objects*

The following table shows the COB IDs of all communication objects with the factory settings. The column «Index of object parameters» shows the index of special objects with which the settings of the communication objects can be read or modified via an SDO.

| Communications object | Function code | Node address, node ID [1...127] | COB ID decimal (hex) | Index of object parameters |
|---|---|---|---|---|
| NMT Start/Stop Service | 0 0 0 0 | 0 0 0 0 0 0 0 | 0 ($0_h$) | — |
| SYNC object | 0 0 0 1 | 0 0 0 0 0 0 0 | 128 ($80_h$) | $1005_h$....$1007_h$ |
| EMCY object | 0 0 0 1 | x x x x x x x | 128 ($80_h$) + node ID | $1014_h$, $1015_h$ |
| T_PDO1 | 0 0 1 1 | x x x x x x x | 384 ($180_h$) + node ID | $1800_h$ |
| R_PDO1 | 0 1 0 0 | x x x x x x x | 512 ($200_h$) + node ID | $1400_h$ |
| T_PDO2 | 0 1 0 1 | x x x x x x x | 640 ($280_h$) + node ID | $1801_h$ |
| R_PDO2 | 0 1 1 0 | x x x x x x x | 768 ($300_h$) + node ID | $1401_h$ |
| T_PDO3 | 0 1 1 1 | x x x x x x x | 896 ($380_h$) + node ID | $1802_h$ |
| R_PDO3 | 1 0 0 0 | x x x x x x x | 1024 ($400_h$) + node ID | $1402_h$ |
| R_SDO | — | x x x x x x x | 1408 ($580_h$) + node ID | — |
| R_SDO | — | x x x x x x x | 1536 ($600_h$) + node ID | — |
| NMT error control | 1 1 1 0 | x x x x x x x | 1792 ($700_h$) + node ID | — |
| LMT Services | 1 1 1 1 | 1 1 0 0 1 0 x | 2020 ($7E4_h$), 2021 ($7E5_h$) | — |
| NMT Identify Service | 1 1 1 1 | 1 1 0 0 1 1 0 | 2022 ($7E6_h$) | — |
| NMT Services | 1 1 1 1 | 1 1 0 1 0 0 x | 2025 ($7E9_h$), 2026 ($7EA_h$) | — |

Table 3.2 COB IDs of communication objects

*Function code*

The function code classifies the communication objects. Since the bits of the function code in the COB ID are more significant, the function code also controls the transmission priorities: Objects with a lower function code are transmitted with higher priority. For example, an object with function code “1” is transmitted prior to an object with function code “3” in the case of simultaneous bus access.

*Node address*

Each network device is configured before it can be operated on the network. The device is assigned a unique 7 bit node address (node ID) between 1 ($01_h$) and 127 ($7F_h$). The device address “0” is reserved for “broadcast transmissions” which are used to send messages to all reachable devices simultaneously.

*Example*

Selection of a COB ID

For a device with the node address 5, the COB ID of the communication object T_PDO1 is:

384+node ID = 384 (180h) + 5 = 389 (185h).

*Data frame*

The data frame of the CANopen message can hold up to 8 bytes of data. In addition to the data frame for SDOs and PDOs, special frame types are specified in the CANopen profile:

- Error data frame
- Remote data frame for requesting a message

The data frames contain the respective communication objects.

### 3.1.3 Communication relationships

CANopen uses 3 relationships for communication between network devices:

- Master-slave relationship
- Client-server relationship
- Producer-consumer relationship

*Master-slave relationship*

A network master controls the message traffic. A slave only responds when it is addressed by the master.

The master-slave relationship is used with network management objects for a controlled network start and to monitor the connection of devices.

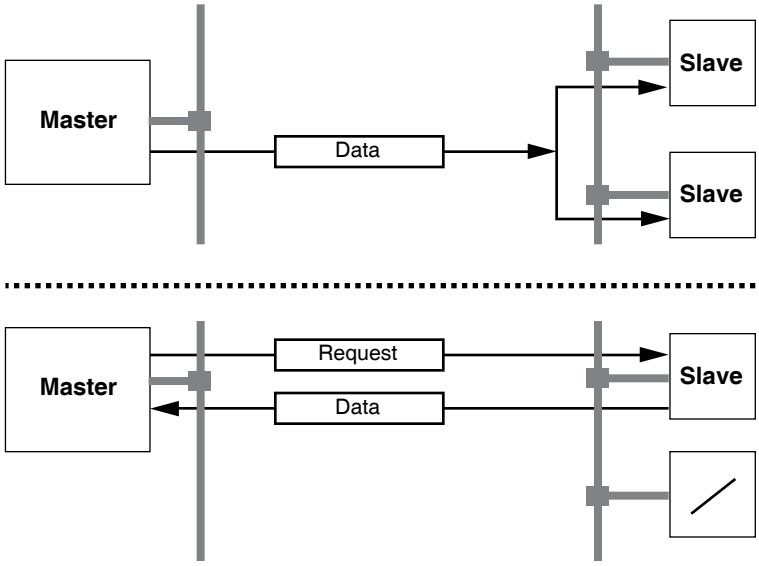


Figure 3.4 Master – slave relationship

Messages can be interchanged with and without confirmation. If the master sends an unconfirmed CAN message, it can be received by a single slave or by all reachable slaves or by no slave.

To confirm the message, the master requests a message from a specific slave, which then responds with the desired data.

*Client-server relationship*

A client-server relationship is established between 2 devices. The «server» is the device whose object dictionary is used during data exchange. The «client» addresses and starts the exchange of messages and waits for a confirmation from the server.

A client-server relationship with SDOs is used to send configuration data and long messages.

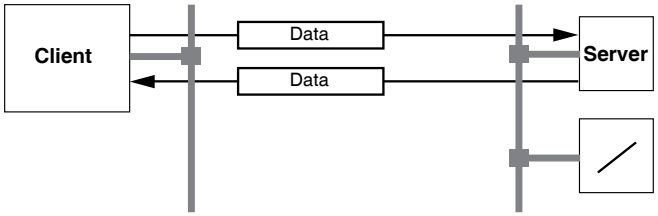


Figure 3.5 Client – server relationship

The client addresses and sends a CAN message to a server. The server evaluates the message and sends the response data as an acknowledgement.

*Producer-consumer relationship*

The producer-consumer relationship is used for exchanging messages with process data, because this relationship enables fast data exchange without administration data.

A “Producer” sends data, a “Consumer” receives data.

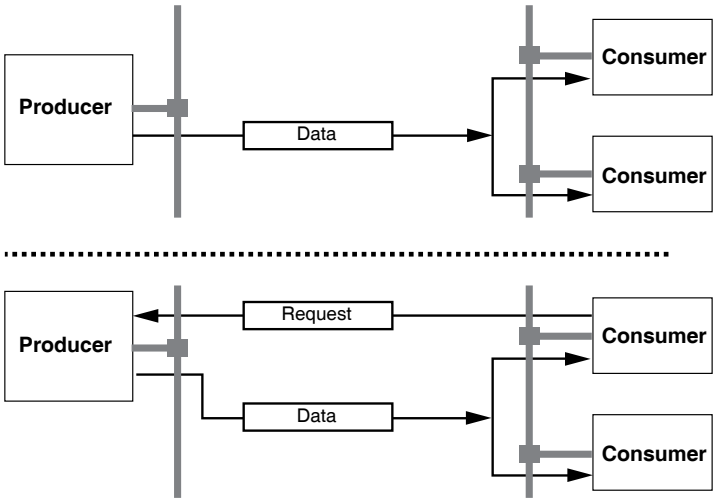


Figure 3.6 Producer – consumer relationship

The producer sends a message that can be received by one or more network devices. The producer does not receive an acknowledgement to the effect that the message was received. The message transmission can be triggered by

- An internal event, for example, “target position reached”
- The synchronization object SYNC
- A request of a consumer

See section 3.3 “Process data communication” for details on the function of the producer-consumer relationship and on requesting messages.

## 3.2 Service data communication

### 3.2.1 Overview

Service Data Objects (SDO: Service Data Object) can be used to access the entries of an object dictionary via index and subindex. The values of the objects can be read and, if permissible, also be changed.

Every network device has at least one server SDO to be able to respond to read and write requests from a different device. A client SDO is only required to request SDO messages from the object dictionary of a different device or to change them in the dictionary.

The T_SDO of an SDO client is used to send the request for data exchange; the R_SDO is used to receive. The data frame of an SDO consist of 8 bytes.

SDOs have a higher COB ID than PDOs; therefore, they are transmitted over the CAN bus at a lower priority.

### 3.2.2 SDO data exchange

A service data object (SDO) transmits parameter data between 2 devices. The data exchange conforms to the client-server relationship. The server is the device to whose object dictionary an SDO message refers.

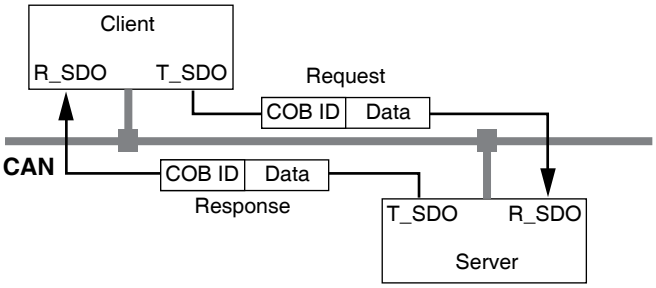


Figure 3.6 SDO message exchange with request and response

*Message types* Client-server communication is triggered by the client to send parameter values to the server or to get them from the server. In both cases, the client starts the communication with a request and receives a response from the server.

### 3.2.3 SDO message

Put simply, an SDO message consists of the COB ID and the SDO data frame, in which up to 4 bytes of data can be sent. Longer data sequences are distributed over multiple SDO messages with a special protocol.

The device transmits SDOs with a data length of up to 4 bytes. Greater amounts of data such as 8 byte values of the data type «Visible String 8» can be distributed over multiple SDOs and are transmitted successively in blocks of 7 bytes.

*Example* The following illustration shows an example of an SDO message.

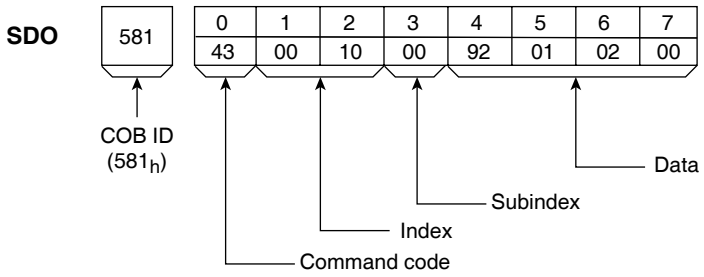


Figure 3.8 SDO message example

COB ID and data frame R_SDO and T_SDO have different COB IDs.

The data frame of an SDO messages consists of:

- Command code (ccd) which contains the SDO message type and the data length of the transmitted value
- Index and subindex which point to the object whose data is transported with the SDO message
- Data of up to 4 bytes

*Evaluation of numeric values* Index and data are transmitted left-aligned in Intel, or little endian format. If the SDO contains numerical values of more than 1 byte in length, the data must be rearranged byte-by-byte before and after a transmission.

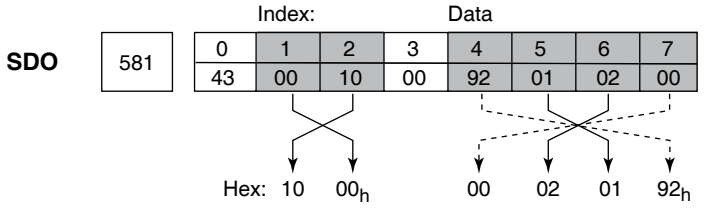


Figure 3.9 Rearranging numeric values greater than 1 byte

### 3.2.4 Reading and writing data

*Writing data*

The client starts a write request by sending index, subindex, data length and value. The server sends a confirmation indicating whether the data was correctly processed. The confirmation contains the same index andsubindex, but no data.

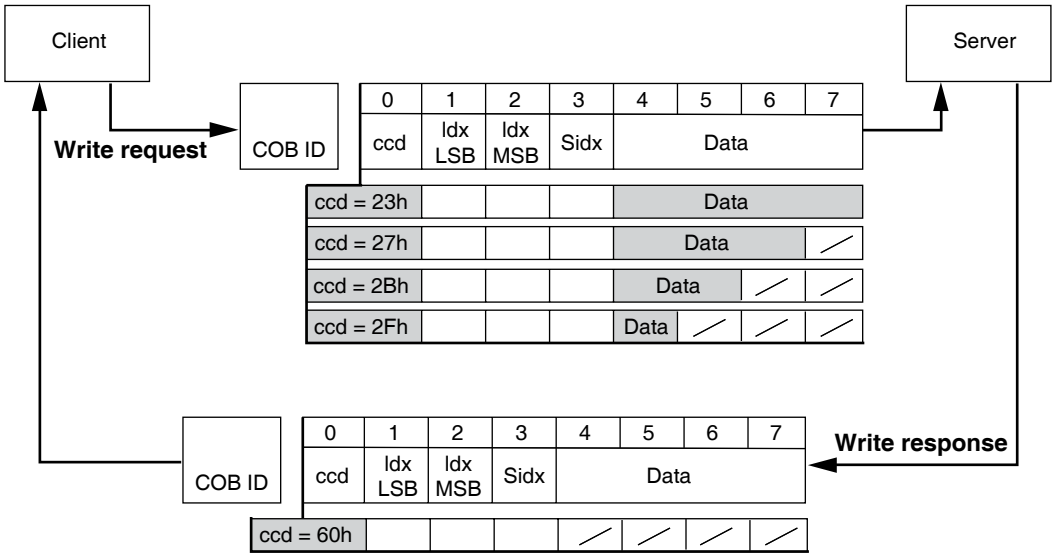


Figure 3.10 Writing parameter values

Unused bytes in the data field are shown with a slash in the graphic. The content of these data fields is not defined.

*ccd coding*

The table below shows the command code for writing parameter values. It depends on the message type and the transmitted data length.

| **Message type** | **Data length used** | | | | |
|---|---|---|---|---|---|
| | **4 byte** | **3 byte** | **2 byte** | **1 byte** | |
| Write request | $23_h$ | $27_h$ | $2B_h$ | $2F_h$ | Transmitting parameters |
| Write response | $60_h$ | $60_h$ | $60_h$ | $60_h$ | Confirmation |
| Error response | $80_h$ | $80_h$ | $80_h$ | $80_h$ | Error |

Table 3.2: Command code for writing parameter values

*Reading data*

The client starts a read request by transmitting the index and subindex that point to the object or part of the object whose value it wants to read.

The server confirms the request by sending the desired data. The SDO response contains the same index and subindex. The length of the response data is specified in the command code «ccd».

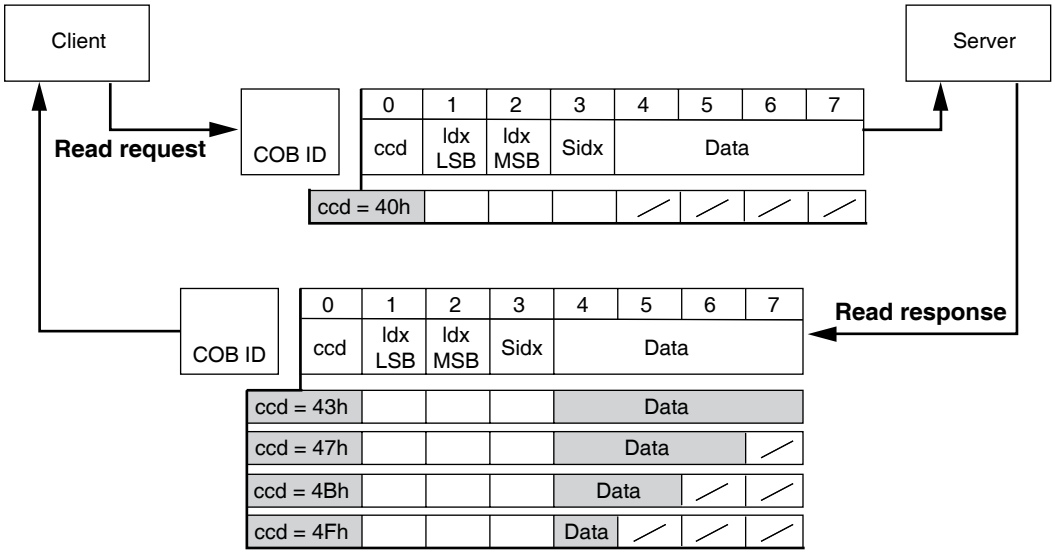


Figure 3.11 Reading a parameter value

The table below shows the command code transmitting a read value. It depends on the message type and the transmitted data length.

| **Message type** | **Data length used** | | | | |
|---|---|---|---|---|---|
| | **4 byte** | **3 byte** | **2 byte** | **1 byte** | |
| Read request | $43_h$ | $47_h$ | $4B_h$ | $4F_h$ | Request read value |
| Read response | $40_h$ | $40_h$ | $40_h$ | $40_h$ | Return read value |
| Error response | $80_h$ | $80_h$ | $80_h$ | $80_h$ | Error |

Table 3.3 Command code for transmitting a read value

*Error response*

If a message could not be evaluated, the server sends an error message. See section 7.4.3 “SDO error message ABORT” for details on the evaluation of the error message.

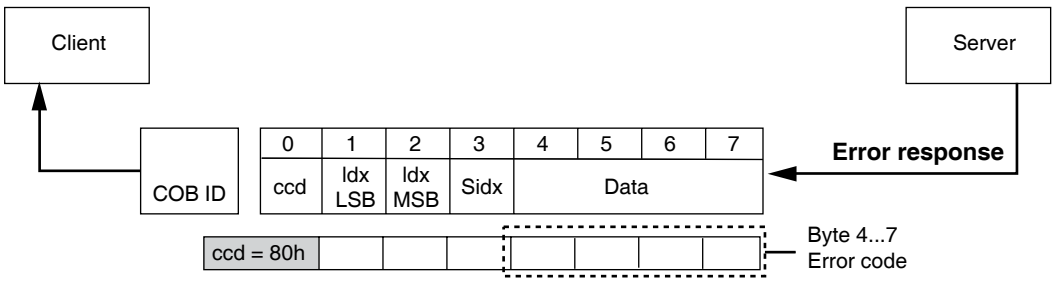


Figure 3.12 Response with error message (error response)

### 3.2.5 Reading data longer than 4 bytes

If values of more than 4 bytes are to be transmitted with an SDO message, the message must be divided into several frames. Each frame consists of 2 parts.

- Request by the SDO client,
- Confirmation by the SDO server.

The request by the SDO client contains the command code «ccd» with the toggle bit and a data segment. The confirmation frame also contains a toggle bit in the «ccd» segment. In the first frame, the toggle bit has the value «0», in the subsequent frames it toggles between 1 and 0.

*Reading data*

The client starts a read request by transmitting the index and subindex that point to the object or the object value whose value it wants to read.

The server confirms the request by transmitting index, subindex, data length and the first 4 bytes of the requested data. The command code specifies that data of more than 4 bytes are transmitted. The command code of the read response from the server to the first message is 41h.

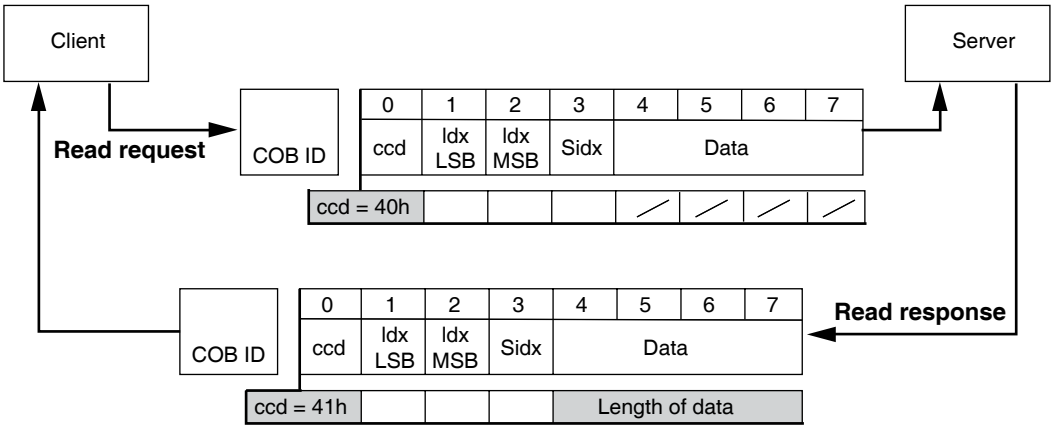


Figure 3.13 Transmitting the first message

In the next frames, the remaining data is requested and transmitted in packets of 7 bytes from the server.

*ccd coding* The table below shows the command code for transmitting a read value. It depends on the message type, the value of the toggle bit, the transmitted data length and the value of the bit that indicates the end of the entire SDO message.

| **Message type** | **Data length used** | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | **7 byte** | **6 byte** | **5 byte** | **4 byte** | **3 byte** | **2 byte** | **1 byte** | |
| Read request Toggle Bit = 0 | | $60_h$ | $60_h$ | | $60_h$ | $60_h$ | $60_h$ | Confirmation with Toggle Bit = 0 |
| Read request Toggle Bit = 1 | $70_h$ | $70_h$ | $70_h$ | $70_h$ | $70_h$ | $70_h$ | $70_h$ | Confirmation with Toggle Bit = 1 |
| Read response Toggle Bit = 0 | $00_h$ | — | — | — | — | — | — | Send parameter with Toggle Bit = 0 |
| Read response Toggle Bit = 1 | $10_h$ | — | — | — | — | — | — | Send parameter with Toggle Bit = 1 |
| Read response last message Toggle Bit = 0 | $01_h$ | $03_h$ | $05_h$ | $07_h$ | $09_h$ | $0B_h$ | $0D_h$ | Transmit parameter with last message and Toggle Bit = 0 |
| Read response last message Toggle Bit = 1 | $11_h$ | $13_h$ | $15_h$ | $17_h$ | $19_h$ | $1B_h$ | $1D_h$ | Transmit parameter with last message and Toggle Bit = 1 |
| Error response | $80_h$ | $80_h$ | $80_h$ | $80_h$ | $80_h$ | $80_h$ | $80_h$ | Error |

Table 3.4: Command code data lengths > 4 bytes

Refer to the DS301 of the CiA for additional information on this procedure.

# 3.3 Process data communication

## 3.3.1 Overview

Process data objects (PDO: Process Data Object) are used for realtime data exchange of process data such as actual and reference values or the operating state of the device. Transmission is very fast because the data is sent without additional administration data and data transmission acknowledgement from the recipient is not required.

The flexible data length of a PDO message also increases the data throughput. A PDO message can transmit up to 8 bytes of data. If only 2 bytes are assigned, only 2 data bytes are sent. The length of a PDO message and the assignment of the data fields are specified by PDO mapping. See section 3.3.4 «PDO mapping» for additional information.

PDO messages can be exchanged between devices that generate or process process data.

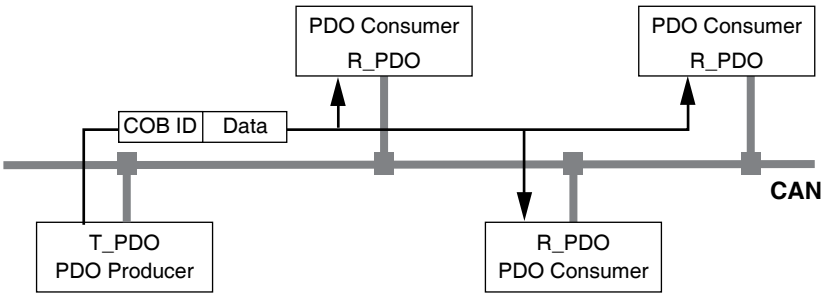


Figure 3:14 PDO data exchange

Data exchange with PDOs follows to the producer-consumer relationship and can be triggered in 3 ways:

- Synchronized
- Event-driven, asynchronous

The SYNC object controls synchronized data processing. Synchronous PDO messages are transmitted immediately like the standard PDO messages, but are only evaluated on the next SYNC. For example, several drives can be started simultaneously via synchronized data exchange.

The device immediately evaluates PDO messages that are called on request or in an event-driven way.

The transmission type can be specified separately for each PDO with subindex $02_h$ (transmission type) of the PDO communication parameter. The objects are listed in Table 3.5.

### 3.3.3 PDO message

*T_PDO, R_PDO*

One PDO each is available for sending and receiving a PDO message:

- T_PDO to transmit the PDO message (T: Transmit),
- R_PDO to receive PDO messages (R: Receive).

*The following settings for PDOs correspond to the defaults read and set via objects of the communication profile.*

The device uses 6 PDOs, 3 receive PDOs and 3 transmit PDOs. By default, the PDOs are evaluated or transmitted in an event-driven way.

*PDO settings*

The PDO settings can be read and changed with 8 communication objects:

| Object | Meaning |
|---|---|
| 1st receive PDO parameter ($1400_h$) | Settings for R_PDO1 |
| 2nd receive PDO parameter ($1401_h$) | Settings for R_PDO2 |
| 3rd receive PDO parameter ($1402_h$) | Settings for R_PDO3 |
| 1st transmit PDO parameter ($1800_h$) | Settings for T_PDO1 |
| 2nd transmit PDO parameter ($1801_h$) | Settings for T_PDO2 |
| 3rd transmit PDO parameter ($1802_h$) | Settings for T_PDO2 |

Table 3.5: Communication objects for PDO

*Activating PDOs*

With the default PDO settings, R_PDO1 and T_PDO1 are activated. The other PDOs must be activated first. A PDO is activated with bit 31 (valid bit) in subindex 01h of the respective communication object:

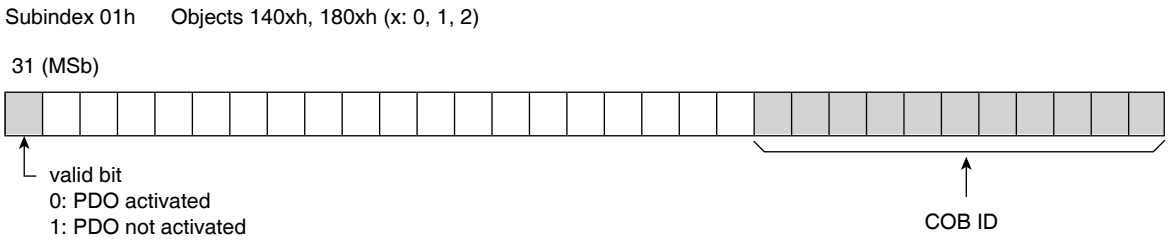


Figure 3.15 Activating PDOs via subindex $01_h$, bit 31

*Example*

**Setting for R_PDO3 in object $1402_h$**

- Subindex $01_h$ = 8000 $04xx_h$: R_PDO3 not activated
- Subindex $01_h$ = 0000 $04xx_h$: R_PDO3 activated.

Values for “x” in the example depend on the COB ID setting.

*PDO time intervals*

The time intervals «inhibit time» and «event timer» can be set for each transmit PDO.

- The time interval «inhibit time» can be used to reduce the CAN bus load, which can be the result of continuous transmission of T_ PDOs. If an inhibit time not equal to zero is entered, a transmitted PDO will only be re-transmitted after the inhibit time has elapsed. The time is set with subindex 03h.
- The time interval «event timer» cyclically triggers an event message. After the time intervals has elapsed, the device transmits the eventcontrolled T_PDO. The time is set with subindex 05h.

*Receive PDOs*

The objects for R_PDO1, R_PDO2 and R_PDO3 are preset.

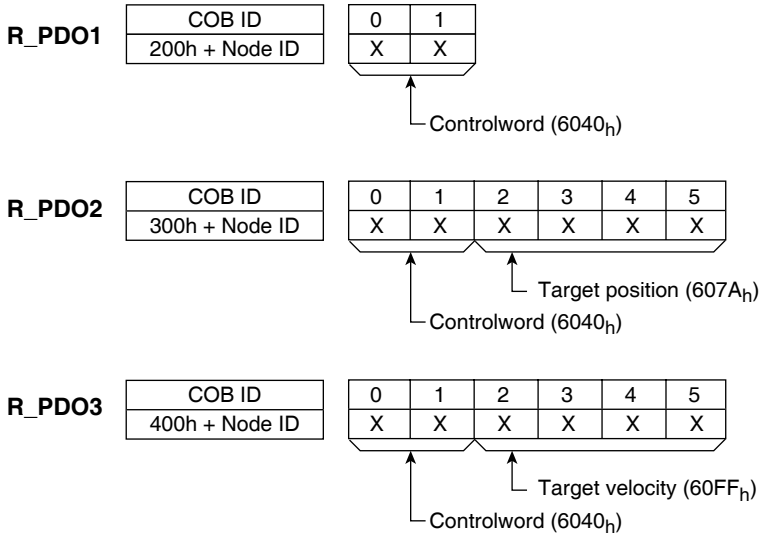


Figure 3.16 Receive PDOs

*R_PDO1*

R_PDO1 contains the control word, object `controlword (6040h)`, of the state machine which can be used to set the operating state of the device.

R_PDO1 is evaluated asynchronously, i.e. it is event-driven. R_PDO1 is preset.

*R_PDO2*

With R_PDO2, the control word and the target position of a motion command, object `target position (607Ah)`, are received for a movement in the operating mode “Profile Position”.

R_PDO2 is evaluated asynchronously, i.e. it is event-driven. R_PDO2 is preset.

For details on the SYNC object see section 3.4 “Synchronization”.

*R_PDO3*

R_PDO3 contains the control word and the target velocity, object `Target velocity (60FFh)`, for the operating mode “Profile Velocity”.

R_PDO3 is evaluated asynchronously, i.e. it is event-driven. R_PDO3 is preset.

*Transmit PDOs* The objects for T_PDO1, T_PDO2 and T_PDO3 can be changed by means of PDO mapping.

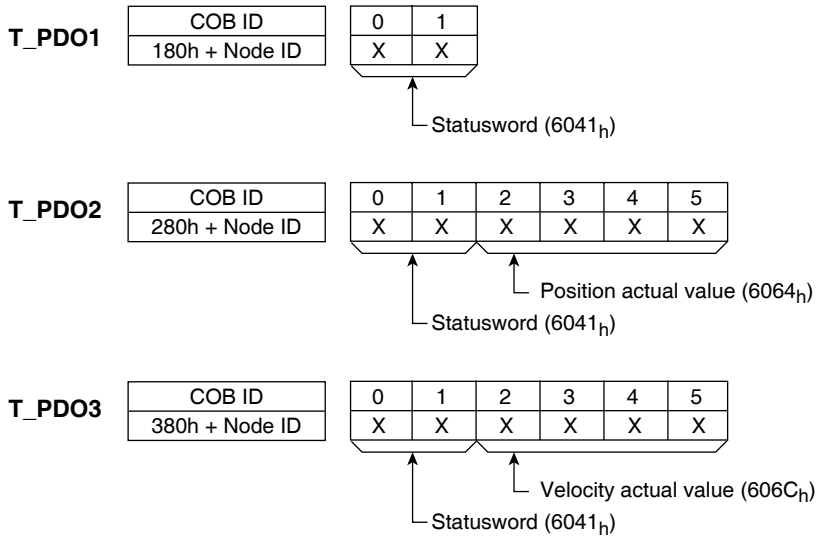


Figure 3.17 Transmit PDOs

*T_PDO1* T_PDO1 contains the status word, object `statusword (6041h)`, of the state machine.

T_PDO1 is transmitted asynchronously and in an event-driven way whenever the status information changes.

*T_PDO2* T_PDO2 contains the status word and the actual position of the motor, object `Position actual value (6064h)`, to monitor movements in the operating mode “Profile Position”.

T_PDO2 is transmitted after receipt of a SYNC object and in an event-driven way.

*T_PDO3* T_PDO3 contains the status word and the actual velocity, object `Velocity actual value (606Ch)`, for monitoring the velocity profile in the operating mode “Profile Velocity”.

T_PDO3 is transmitted asynchronously and in an event-driven way whenever the status information changes.

### 3.3.4 PDO mapping

Up to 8 bytes of data from different areas of the object dictionary can be transmitted with a PDO message. Mapping of data to a PDO message is referred to as PDO mapping.

The diagram below shows the data exchange between PDOs and object dictionary on the basis of two examples of objects in T_PDO3 and R_ PDO3 of the PDOs.

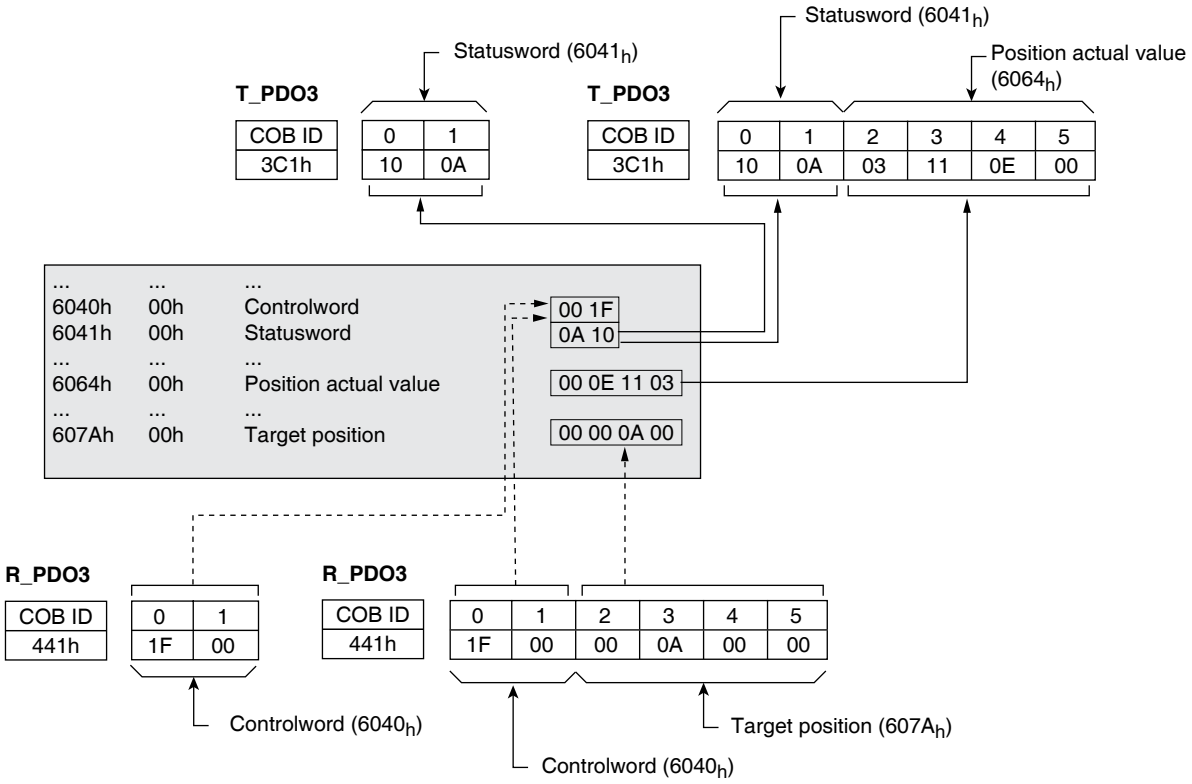


Figure 3.18 PDO mapping, in this case for a device with node address 41 (default MDrive address)

Dynamic PDO mapping

The device uses dynamic PDO mapping. Dynamic PDO mapping means that objects can be mapped to the corresponding PDO using adjustable settings.

The settings for PDO mapping are defined in an assigned communication object for each PDO.

| Object | PDO mapping for | Type |
|---|---|---|
| 1st receive PDO mapping ($1600_h$) | R_PDO1 | Dynamic |
| 2nd receive PDO mapping ($1601_h$) | R_PDO2 | Dynamic |
| 3rd receive PDO mapping ($1602_h$) | R_PDO3 | Dynamic |
| 1st transmit PDO mapping ($1A00_h$) | T_PDO1 | Dynamic |
| 2nd transmit PDO mapping ($1A01_h$) | T_PDO2 | Dynamic |
| 3rd transmit PDO mapping ($1A02_h$) | T_PDO3 | Dynamic |

Table 3.6: Dynamic PDO mapping parameters

*Structure of the entries*

Up to 8 bytes of 8 different objects can be mapped in a PDO. Each communication object for setting the PDO mapping provides 4 subindex entries. A subindex entry contains 3 pieces of information on the object: the index, the subindex and the number of bits that the object uses in the PDO.

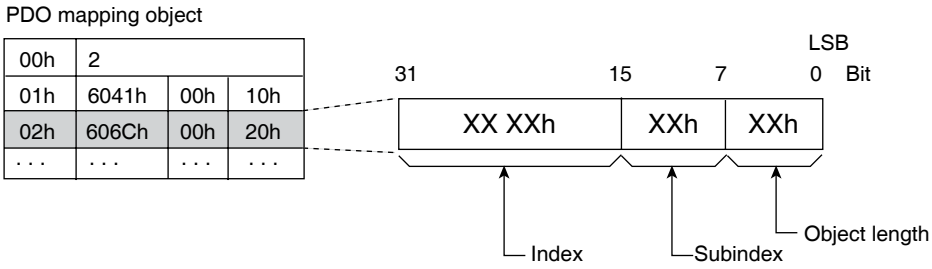


Figure 3.19 Structure of entries for PDO mapping

Subindex 00h of the communication object contains the number of valid subindex entries.

| **Object length** | **Bit value** |
|---|---|
| $08_h$ | 8 bits |
| $10_h$ | 16 bits |
| $20_h$ | 30 bits |

Table 3.7: Subindex object length entries

*PDO mapping objects*

| Index | Subindex | Object | PDO | Data type | Parameter name |
|---|---|---|---|---|---|
| $2010_h$ | 1 | Read value of analog input | T_PDO | UINT16 | Analog_In_Reading |
| $2018_h$ | 1 | Read internal temperature | T_PDO | INT8 | Temperature_Reading |
| $2033_h$ | 4 | Read captured position | T_PDO | INT32 | CaptureInPositn_user |
| $2741_h$ | 0 | Read hybrid status byte | T_PDO | UINT8 | HybridStatusByte |

| Index | Subindex | Object | PDO | Data type | Parameter name |
|---|---|---|---|---|---|
| $603F_h$ | 0 | Read error code | T_PDO | UINT16 | ErrorCode |
| $6040_h$ | 0 | Controlword | R_PDO | UINT16 | Controlword |
| $6041_h$ | 0 | Statusword | T_PDO | UINT16 | Statusword |
| $6060_h$ | 0 | Modes of operation | R_PDO | INT8 | Modes_of_operation |
| $6061_h$ | 0 | Read mode of operation | T_PDO | INT8 | Modes_of_operation_display |
| $6062_h$ | 0 | Read position value | T_PDO | INT32 | Position_demand_value_user |
| $6063_h$ | 0 | Position actual value | T_PDO | INT32 | Position_actual_value_inc |
| $6064_h$ | 0 | Position actual value | T_PDO | INT32 | Position_actual_value |
| $606C_h$ | 0 | Velocity actual value | T_PDO | INT32 | Velocity_actual_value |
| $607A_h$ | 0 | Target position | R_PDO | INT32 | Target_position |
| $607E_h$ | 0 | Polarity | R_PDO | UINT8 | Polarity |
| $6081_h$ | 0 | Profile velocity | R_PDO | UINT32 | Profile_velocity |
| $6082_h$ | 0 | End velocity | R_PDO | UINT32 | End_velocity |
| 6083h | 0 | Profile acceleration | R_PDO | UINT32 | Profile_acceleration |
| 6084h | 0 | Profile deceleration | R_PDO | UINT32 | Profile_deceleration |
| $6086_h$ | 0 | Motion profile type | R_PDO | INT16 | Motion_profile_type |
| $60FD_h$ | 0 | Digital inputs | T_PDO | UINT32 | Digital_inputs |
| $60FE_h$ | 1 | Digital outputs | R_PDO | UINT32 | Digital_outputs |
| $60FF_h$ | 0 | Target velocity | R_PDO | INT32 | Target_velocity |

Table 3.8: Supported PDO mapping objects

## 3.4 Synchronization

The synchronization object SYNC controls the synchronous exchange of messages between network devices for purposes such as the simultaneous start of multiple drives.

The data exchange conforms to the producer-consumer relationship. The SYNC object is transmitted to all reachable devices by a network device and can be evaluated by the devices that support synchronous PDOs.

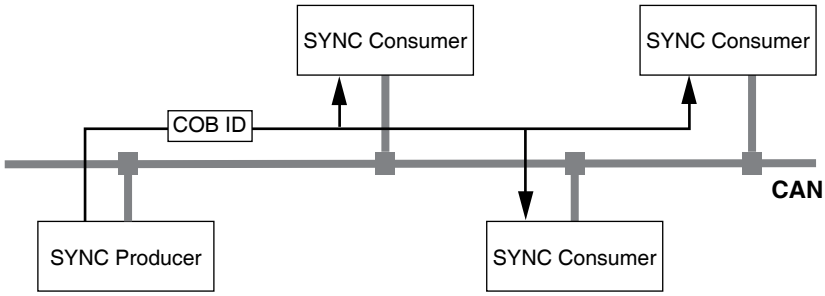


Figure 3.20 SYNC message

Time values for synchronization

Two time values define the behavior of synchronous data transmission:

- The cycle time specifies the time intervals between 2 SYNC messages. It is set with the object `Communication cycle period(1006h)`.
- The synchronous time window specifies the time span during which the synchronous PDO messages must be received and transmitted. The time window is defined with the object `Synchronous window length (1007h)`.

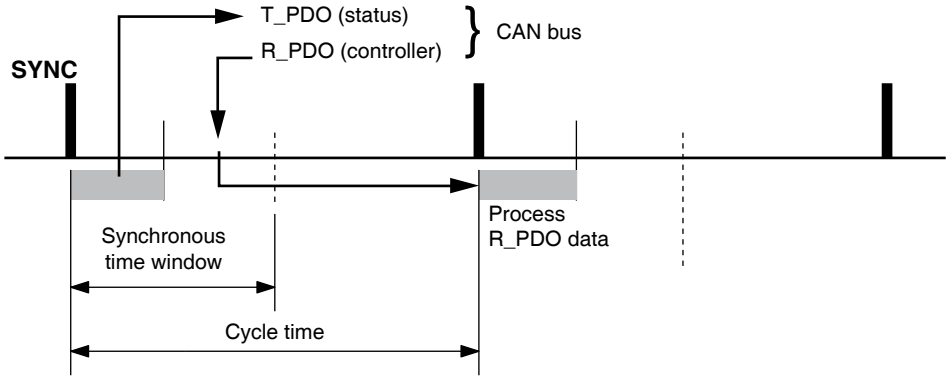


Figure 3.21 Synchronization times

*Synchronous data transmission*

From the perspective of a SYNC recipient, in one time window the status data is transmitted first in a T_PDO, then new control data is received via an R_PDO. However, the control data is only processed when the next SYNC message is received. The SYNC object itself does not transmit data.

*Cyclic and acyclic data transmission*

Synchronous exchange of messages can be cyclic or acyclic.

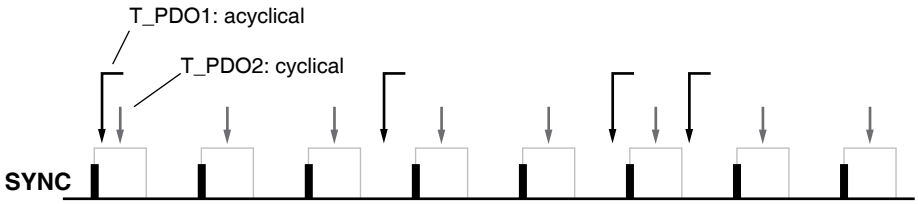


Figure 3.22 Cyclic and acyclic transmission

In the case of cyclic transmission, PDO messages are exchanged continuously in a specified cycle, for example with each SYNC message.

If a synchronous PDO message is transmitted acyclically, it can be transmitted or received at any time; however, it will not be valid until the next SYNC message.

Cyclic or acyclic behavior of a PDO is specified in the subindex transmission type (02h) of the corresponding PDO parameter, for example, in the object 1st receive PDO parameter (1400h:02h) for R_PDO1.

*COB ID, SYNC object*

For fast transmission, the SYNC object is transmitted unconfirmed and with high priority.

The COB ID of the SYNC object is set to the value 128 (80h) by default. The value can be changed after initialization of the network with the object COB-ID SYNC Message (1005h) .

*“Start” PDO*

With the default settings of the PDOs, R_PDO1 ... R_PDO4 and T_ PDO1 ... T_PDO4 are received and transmitted asynchronously. T_PDO2 ... T_PDO3 are transmitted additionally after the event timer has elapsed. The synchronization allows an operating mode to be started simultaneously on multiple devices so that, for example, the feed of a portal drive with several motors can be synchronized.

## 3.5 Emergency service

The Emergency Service signals internal device errors via the CAN bus. The error message is transmitted to the network devices with an EMCY object according to the Consumer-Producer relationship.

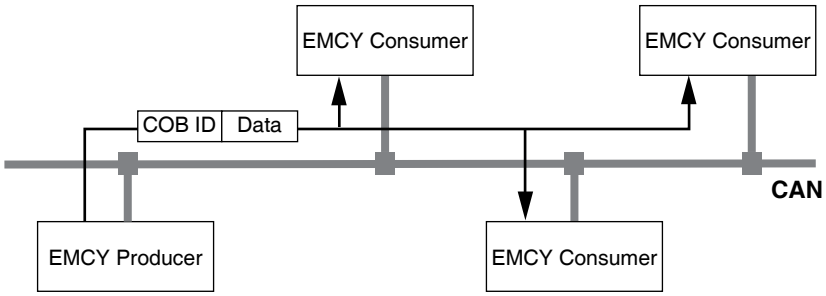


Figure 3.23 Error message via EMCY objects

*Boot-up message*

The communication profile DS301, version 3.0, defines an additional task for the EMCY object: sending a boot-up message. A boot-up message informs the network devices that the device that transmitted the message is ready for operation in the CAN network.

The boot-up message is transmitted with the COB ID 700h + node ID and one data byte (00h).

### *3.5.1 Error evaluation and handling*

EMCY message If an internal device error occurs, the device switches to the operating state 9 Fault as per the CANopen state machine. At the same time, it transmits an EMCY message with error register and error code.

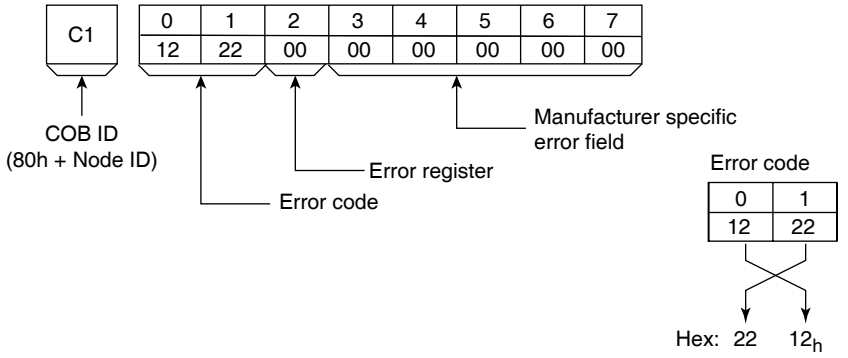


Figure 3.24 EMCY message

Bytes 0, 1 - Error code, value is also saved in the object `Error code (603Fh)`

Byte 2 - Error register, value is also saved in the object `Error register (1001h)`

Bytes 3, 4 - Reserved

Byte 5 - PDO: Number of the PDO

Bytes 6, 7 - Vendor-specific error code

*COB ID*

The COB ID for each device on the network supporting an EMCY object is determined on the basis of the node address:

COB ID = Function code EMCY object (80h) + node ID

The function code of the COB ID can be changed with the object `COBID emergency(1014h)`.

*Error register and error code*

The error register contains bit-coded information on the error. Bit 0 remains set as long as an error is active. The remaining bits identify the error type. The exact cause of error can be determined on the basis of the error code. The error code is transmitted in Intel format as a 2 byte value; the bytes must be reversed for evaluation.

See chapter 7 «Diagnostics and troubleshooting» for a list of the error messages and error responses by the device as well as remedies.

*Error memory*

The device saves the error register in the object `Error register (1001h)` and the last error that occurred in the object `Error code (603Fh)`.

## 3.6 Network management services

Network management (NMT) is part of the CANopen communication profile; it is used to initialize the network and the network devices and to start, stop and monitor the network devices during operation on the network.

NMT services are executed in a master-slave relationship. The NMT master addresses individual NMT slaves via their node address. A message with node address «0» is broadcast to all reachable NMT slaves simultaneously.

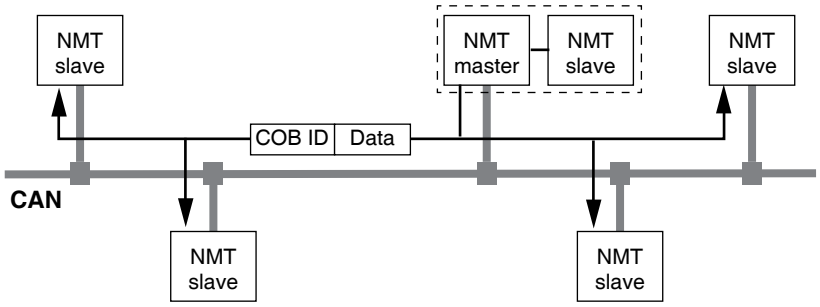


Figure 3.25 NMT services via the master-slave relationship

MDrivePlus and MDrive Hybrid devices can only take on the function of an NMT slave.

NMT services NMT services can be divided into 2 groups:

- Services for device control, to initialize devices for CANopen communication and to control the behavior of devices during operation on the network
- Services:for connection monitoring

## 3.6.1 NMT services for device control

*NMT state machine*

The NMT state machine describes the initialization and states of an NMT slave during operation on the network.

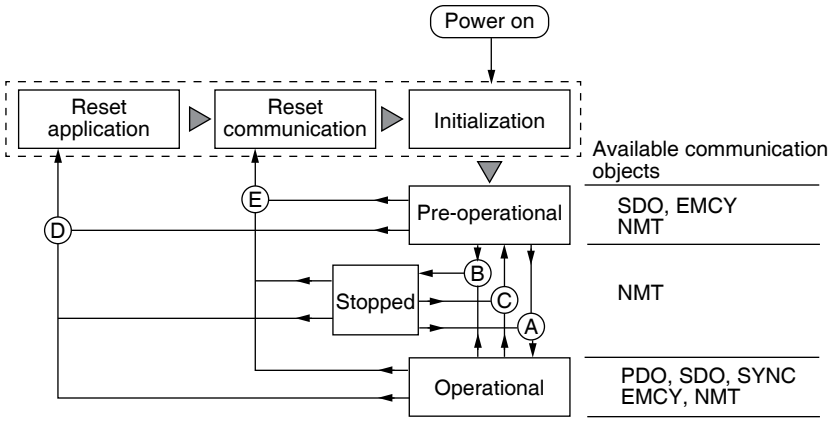


Figure 3.26 NMT state machine and available communication objects

To the right, the graphic shows the communication objects that can be used in the specific network state.

Initialization

An NMT slave automatically runs through an initialization phase after the supply voltage is switched on (power on) to prepare it for CAN bus operation. On completion of the initialization, the slave switches to the operating state “Pre Operational” and sends a boot-up message. From now on, an NMT master can control the operational behavior of an NMT slave on the network via 5 NMT services, represented in Figure 3.26 by the letters A to E.

| NMT service | Transition | Meaning |
|---|---|---|
| Start remote node (Start network node) | A | Transition to operating state “Operational” Start normal operation on the network |
| Stop remote node (Stop network node) | B | Transition to operating state “Stopped”<br>Stops communication of the network device on the network. If connection monitoring is active, it remains on. If the power stage is enabled (operating state “Operation Enabled” or “Quick Stop”), an error of error class 2 is triggered. The motor is stopped and the power stage disabled. |
| Enter Pre-Operational (Transition to “Pre-Operational”) | C | Transition to operating state “Pre-Operational” The communication objects except for PDOs can be used. The operating state “Pre-Operational” can be used for configuration via SDOs:<br>- PDO mapping<br>- Start of synchronization<br>- Start of connection monitoring |
| Reset node (Reset node) | D | Transition to operating state “Reset application” Load stored data of the device profiles and automatically switch via operating state “Reset communication” to “Pre-Operational”. |
| Reset communication (Reset communication data) | E | Transition to operating state “Reset communication” Load stored data of the communication profile and automatically transition to operating state “Pre-Operational”. If the power stage is enabled (operating state “Operation Enabled” or “Quick Stop”), an error of error class 2 is triggered. The motor is stopped and the power stage disabled. |

Table 3.9 NMT state machine transitions

*Persistent data memory*

When the supply voltage is switched on (power on), the device loads the saved object data from the non-volatile EEPROM for persistent data to the RAM.

*NMT message*

The NMT services for device control are transmitted as unconfirmed messages with the COB ID = 0 . By default, they have the highest priority on the CAN bus.

The data frame of the NMT device service consists of 2 bytes.

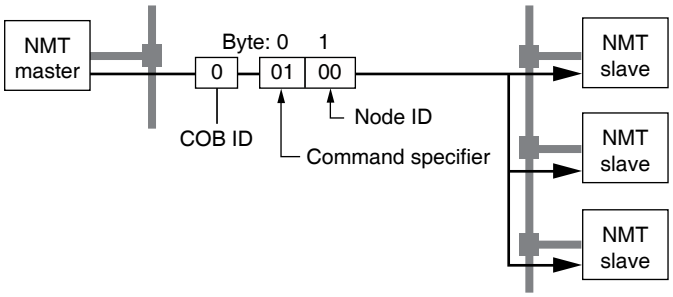


Figure 3.27 NMT message

The first byte, the “Command specifier”, indicates the NMT service used

| Command specifier | NMT service | Transition |
|---|---|---|
| 1 ($01_h$) | Start remote node | A |
| 2 ($02_h$) | Stop remote node | B |
| 128 ($80_h$) | Enter pre-operational | C |
| 129 ($81_h$) | Reset node | D |
| 130 ($82_h$) | Reset communication | E |

Table 3.10 NMT command specifiers.

The second byte addresses the recipient of an NMT message with a node address between 1 and 127 ($7F_h$). A message with node address “0” is broadcast to all reachable NMT slaves.

## 3.6.2 NMT services for connection monitoring

Connection monitoring monitors the communication status of network devices.

3 NMT services for connection monitoring are available:

- «Node guarding» for monitoring the connection of an NMT slave
- «Life guarding» for monitoring the connection of an NMT master
- «Heartbeat» for unconfirmed connection messages from network devices.

### 3.6.2.1 Node guarding / Life guarding

*COB ID*

The communication object `NMT error control (700h+node-Id)` is used for connection monitoring. The COB ID for each NMT slave is determined on the basis of the node address:

COB ID = function code `NMTerror control (700h) + node-Id.`

*Structure of the NMT message*

After a request from the NMT master, the NMT slave responds with one data byte.

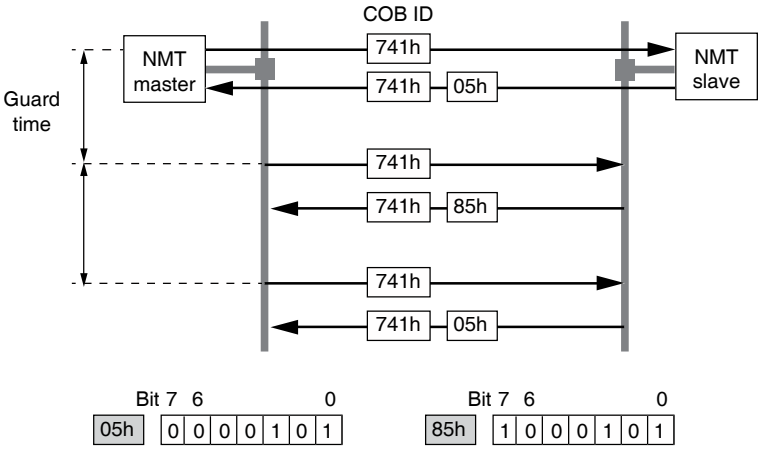


Figure 3.28 Acknowledgement of the NMT slave

Bits 0 to 6 identify the NMT state of the slave:

- 4 (04h): “Stopped”
- 5 (05h): “Operational”
- 127 (7Fh): “Pre-Operational”

After each “guard time” interval, bit 7 switches toggles between “0” and “1”, so the NMT master can detect and ignore a second response within the “guard time” interval. The first request when connection monitoring is started begins with bit 7 = 0.

Connection monitoring must not be active during the initialization phase of a device. The status of bit 7 is reset as soon as the device runs though the NMT state “Reset communication”.

Connection monitoring remains active in the NMT state “Stopped”.

*Configuration*

Node Guarding/Life Guarding is configured via:

- Guard time (100Ch)
- Life time factor (100Dh)

*Connection error*

The NMT master signals a connection error to the master program if:

- the slave does not respond within the «guard time» period
- the NMT state of the slave has changed without a request by the NMT master.

Figure 3.29 shows an error message after the end of the third cycle because of a missing response from an NMT slave.

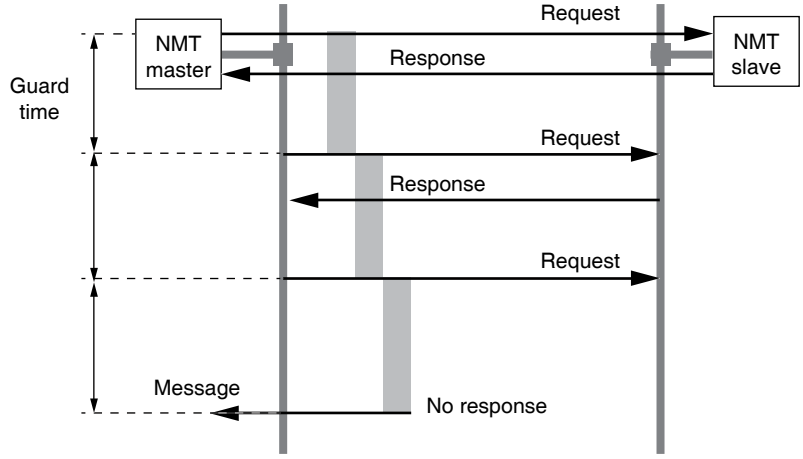


Figure 3.29 «Node Guarding» and «Life Guarding» with time intervals

### 3.6.2.2 Heartbeat

The optional Heartbeat protocol replaces the node guarding/life guarding protocol. It is recommended for new device versions.

A heartbeat producer transmits a heartbeat message cyclically at the frequency defined in the object `Producer heartbeat time (1017h)`. One or several consumers can receive this message. `Producer heartbeat time (1016h) = 0` deactivates heartbeat monitoring.

The relationship between producer and consumer can be configured with objects. If a consumer does not receive a signal within the period of time set with `Consumer heartbeat time (1016h)`, it generates an error message (heartbeat event). Consumer heartbeat time (1016h) = 0 deactivates monitoring by a consumer.

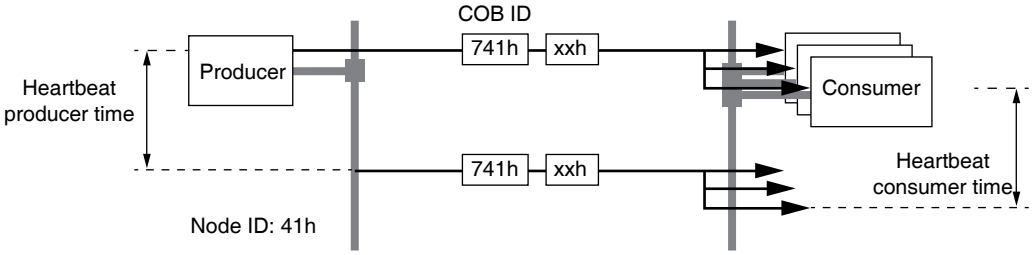


Figure 3.30 «Heartbeat» monitoring

Data byte for NMT state evaluation of the “Heartbeat” producer:

- 0 ($00_h$): “Boot-Up”
- 4 ($04_h$): “Stopped”
- 5 ($05_h$): “Operational”
- 127 ($7F_h$): “Pre-Operational”

*Time intervals*

The time intervals are set in increments of 1 ms steps; the values for the consumer must not be less than the values for the producer. Whenever the “Heartbeat” message is received, the time interval of the producer is restarted.

*Start of monitoring*

“Heartbeat” monitoring starts as soon as the time interval of the producer is greater than zero. If “Heartbeat” monitoring is already active during the NMT state transition to “Pre-Operational”, “Heartbeat” monitoring starts with sending of the boot-up message. The boot-up message is a Heartbeat message with one data byte $00_h$.

Devices can monitor each other via “Heartbeat” messages. They assume the function of consumer and producer at the same time.

Page intentionally left blank

# 4 Installation

4

**⚠WARNING**

**SIGNAL AND DEVICE INTERFERENCE**

Signal interference can cause unexpected responses of device.

- Install the wiring in accordance with the EMC requirements.
- Verify compliance with the EMC requirements.

Failure to follow these instructions can result in death, serious injury or equipment damage.

For information on installation of the device and connecting the device to the fieldbus see the product hardware manual.

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# 5 Commissioning

5

**⚠WARNING**

**LOSS OF CONTROL**

The product is unable to detect an interruption of the network link if

- Verify that connection monitoring is on.
- The shorter the time for monitoring, the faster the detection of the interruption.

**Failure to follow these instructions can result in death, serious injury or equipment damage.**

**⚠WARNING**

**UNINTENDED OPERATION**

The product is unable to detect an interruption of the network link if

- Do not write values to reserved parameters.
- Do not write values to parameters unless you fully understand the function.
- Run initial tests without coupled loads.
- Verify that the system is free and ready for the movement before changing parameters.
- Verify the use of the word sequence with fieldbus communication.
- Do not establish a fieldbus connection unless you have fully understood the communication principles.

**Failure to follow these instructions can result in death, serious injury or equipment damage.**

## 5.1 Commissioning the device

For installation in the network, the device must first be properly installed (mechanically and electrically) and commissioned. Commission the device as per product manual.

Two conditions must be fulfilled in order for a CANopen device to operate on a network:

- It must have a unique Node ID
- It must have the same communication Baud rate as all other devices on the network

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## 5.2 Address and baud rate

Up to 64 devices can be addressed in one CAN bus network branch and up to 127 devices in the extended network. Each device is identified by a unique address or Node ID. The default Node ID for an MDrivePlus or MDrive Hybrid is $41_h$.

The default baud rate is 1 MBaud (1000 kbps).

*Each device must be assigned a unique node address, i.e. any given node address may be assigned only once in the network.*

*The baud rate MUS match the baud rate setting of the network into which the device is being installed.*

## 5.3 Layer Setting Services (LSS) overview

The device must be commisioned using CAN Layer Setting Services (LSS). Reference CiA DSP305.

The scope of LSS is to allow the Node ID and communication baud rate to be read or written through the network.

### 5.3.1 Commissioning via LSS

The Node ID and baud rate must be set using LSS commands. It is recommended that the parameters be set prior to the installation of the device into a network.

LSS messages are 8 bytes in length.

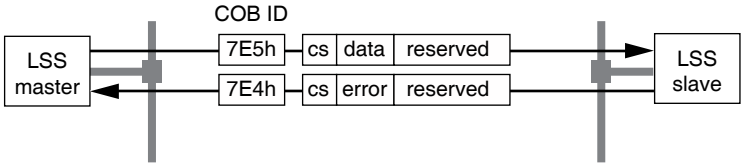



Figure 5.1: LSS message structure

The LSS message consists of a COB IDs specific toe the LSS master and LSS slave.

The command specifier identifies the action to be taken.

*COB ID* LSS commands use two specific COB IDs to request and respond to LSS commands:

- $07E5_h$ – COB ID of the LSS slave device
- $07E4_h$ – COB ID of the LSS master device to which message responses are sent

*Switch Modes*

There are two methods of initiating communications with the device to be commissioned:

- Switch mode global: can set all connected devices into configuration mode. Can be used to set the baud rate of multiple connected devices, can only be used to set the Node ID if one device is connected.
- Switch mode selective: can be used to set the parameters of a single device in the network using vendor specific objects such as the serial number to communicate directly to the device.

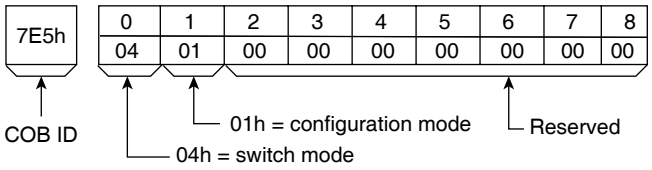
The switch mode commands are used to set the device into either and operational mode, or in configuration mode. In order to make changes to the parameters it must be in configuration mode.

## 5.4 Commissioning via switch mode global

*Procedure*

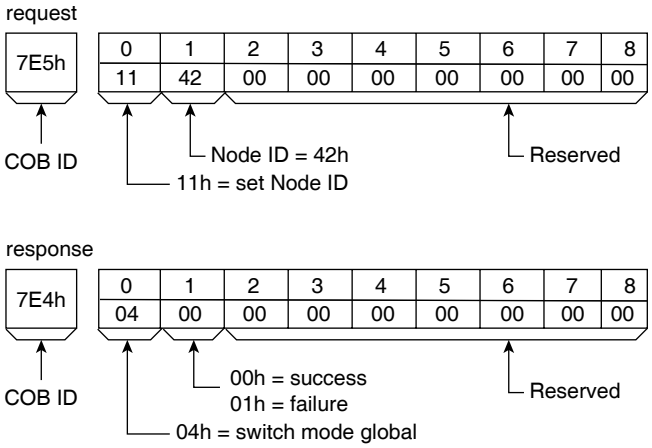
The following procedure will step through configuring the Node ID and Baud rate parameters from the perspective of a single device connected to the LSS master.

1) Transmit the command to the device setting it into switch mode global — configuration mode:




This will place the device in configuration mode. Because this is an unacknowledged LSS service there will be no response.

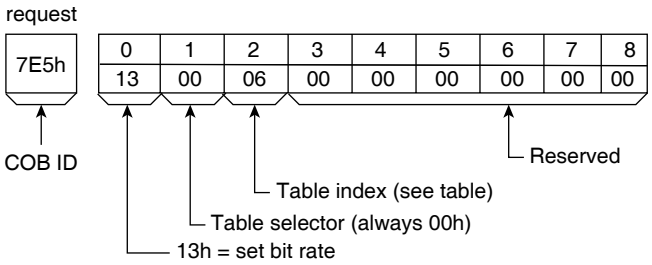
2) Set the new Node ID ($42_h$ used as an example).

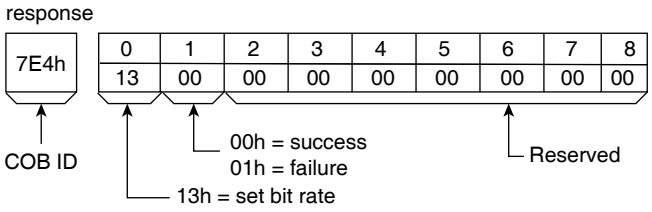


3) Set the desired baud rate using the table below as a reference, for example purposes a bitrate of 50 kbps will be used):

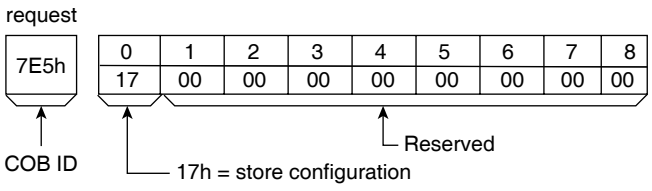
| Table index | Baud rate (kbps) |
|---|---|
| $00_h$ | 1000 (default) |
| $01_h$ | 800* |
| $02_h$ | 500 |
| $03_h$ | 250 |
| $04_h$ | 125 |
| $05_h$ | 100 |
| 06h | 50 |
| 07h | 20 |
| 08h | 10 |

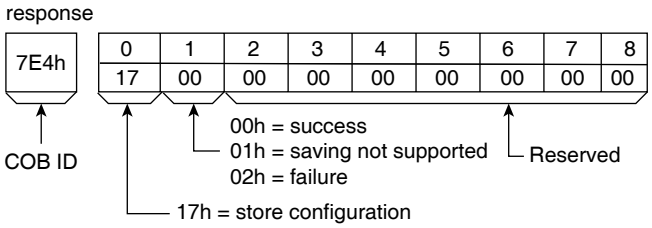
*Not available if using MD-CC500-000 USB to CANopen converter cable.



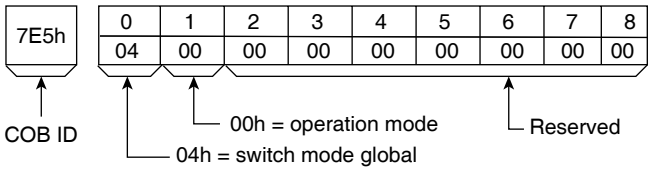




4) Save the changed parameters using the “Store configuration” service ($17_h$)



5) Change the mode from configuration to operational




6) The new Node ID is now active. To make the new bit rate active, cycle power to the device.

7) The device is now commissioned and ready to be placed in a network having a Node ID of $42_h$ and a bitrate of 50 kbps.

## 5.5 Commissioning via switch mode selective

Using switch mode selective it is possible to isolate a single unit installed on a CANopen network and commission it alone by sending out a four-part signature.

The signature consists of

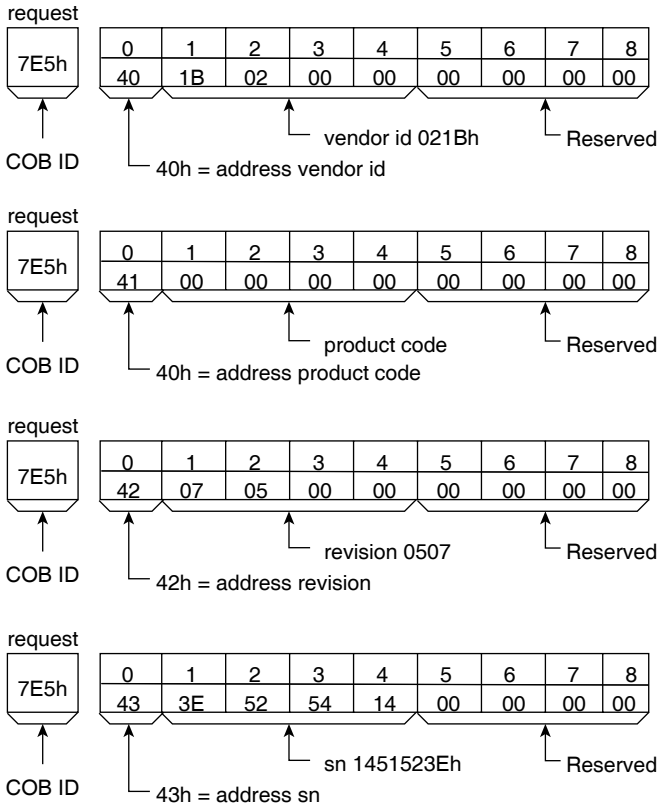
- VendorID = $0800005A_h$
- Product code = 00
- Revision number = $507_h$
- Serial number

The first three parameters are identical throughout the product line. The serial number may be retrieved from the label on the device or from the Indexes $1018_h4$ or $5002_h1$.

Using only the numeric portion of the serial, convert it to a 4 byte hex number, for example:

```
341070398 = 1454523E
```

*Procedure* 1) Send the four parameters to place the desired device in configuration mode.




2) Perform steps 2 – 7 of the Switch Mode Global procedure to commission the device.

# 6 Operation

6

**⚠WARNING**

**UNINTENDED OPERATION**

The product is unable to detect an interruption of the network link if

- Do not write values to reserved parameters.
- Do not write values to parameters unless you fully understand the function.
- Run initial tests without coupled loads.
- Verify that the system is free and ready for the movement before changing parameters.
- Verify the use of the word sequence with fieldbus communication.
- Do not establish a fieldbus connection unless you have fully understood the communication principles.

**Failure to follow these instructions can result in death, serious injury or equipment damage.**

The section “Operation” describes the basic operating states, operating modes and functions of the device.

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# 6.1 Operating states

## 6.1.1 State diagram

After switching on and when an operating mode is started, the product goes through a number of operating states.

The state diagram (state machine) shows the relationships between the operating states and the state transitions.

The operating states are monitored and influenced by internal monitoring functions and system functions such as temperature monitoring or current monitoring.

*Graphical representation* The state diagram is represented as a flowchart

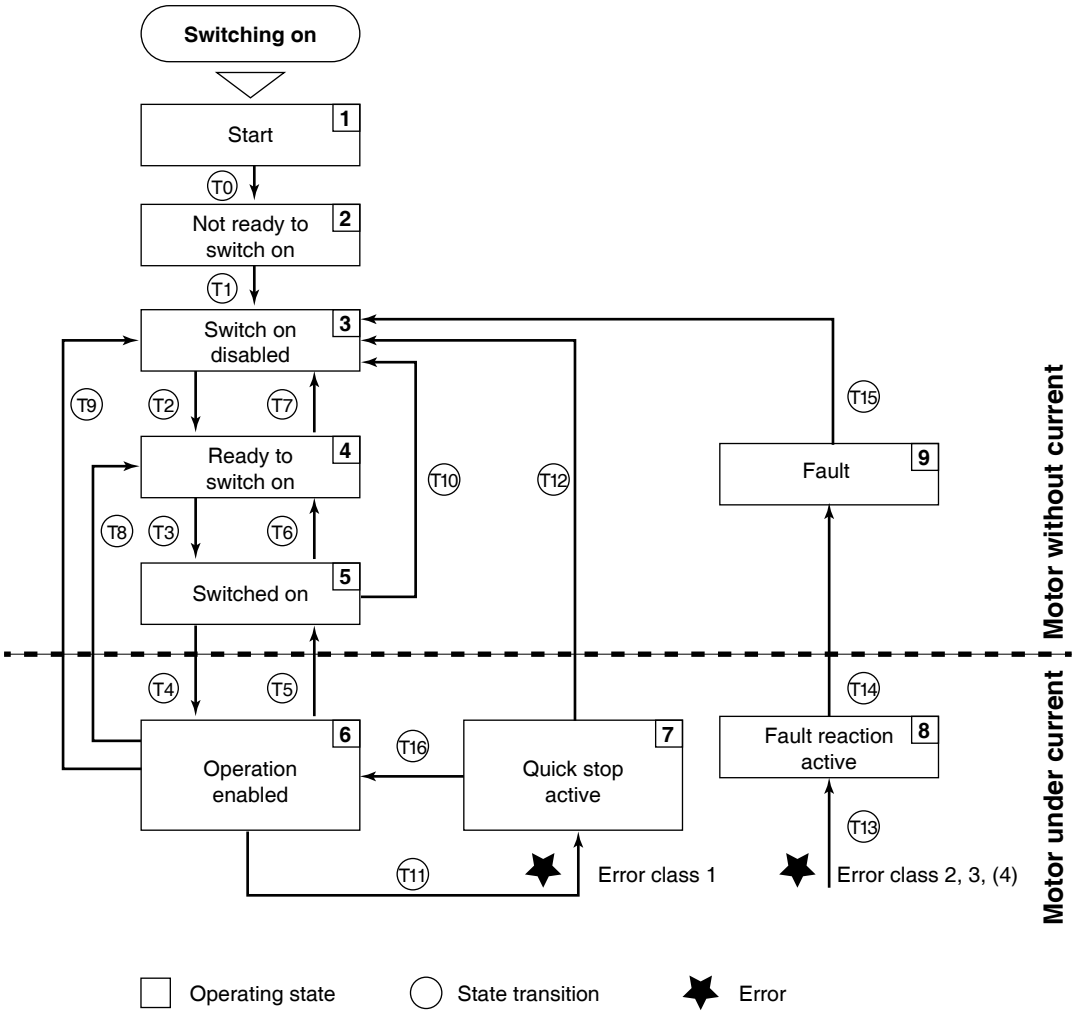



Figure 6.1: State diagram

*Operating states*

| Operating state | | Description |
|---|---|---|
| 1 | Start | Controller supply voltage switched on<br>Electronics are initialized |
| 2 | Not Ready To Switch On | The power stage is not ready to switch on |
| 3 | Switch On Disable | Impossible to enable the power stage |
| 4 | Ready To Switch On | The power stage is ready to switch on. |
| 5 | Switched On | Power stage is switched on |
| 6 | Operation Enabled | Power stage is enabled<br>Selected operating mode is active |
| 7 | Quick Stop Active | “Quick Stop” is being executed |
| 8 | Fault Reaction Active | Error response is active |
| 9 | Fault | Error response terminated<br>Power stage is disabled |

Table 6.1: Operating states

*Error class*

The product triggers an error response if an error occurs. Depending upon the severity of the error, the device responds in accordance with one of the following error classes:

| Error Class | Response | Description |
|---|---|---|
| 0 | Warning | A monitoring function has detected a problem.<br>No interruption of the movement. |
| 1 | “Quick Stop” | Motor stops with “Quick Stop”, the power stage remains enabled. |
| 2 | Qu ick Stop” with switch-off | Motor stops with “Quick Stop”, the power stage is disabled after standstill has been achieved. |
| 3 | Fatal error | The power stage is immediately disabled without stopping the motor first. |
| 4 | Uncontrolled operation | The power stage is immediately disabled without stopping the motor first. The error can only be reset by switching off the product. |

Table 6.2: Error class

*Error response*

The state transition T13 (error class 2, 3 or 4) initiates an error response as soon as an internal occurrence signals an error to which the device must react.

| Error Class | State from -> to | Description |
|---|---|---|
| 2 | x -> 8 | Stop movement with “Quick Stop”<br>Power stage is disabled |
| 3, 4 or Safety function STO | x -> 8 -> 9 | Power stage is disabled immediately, even if “Quick Stop” is still active. |

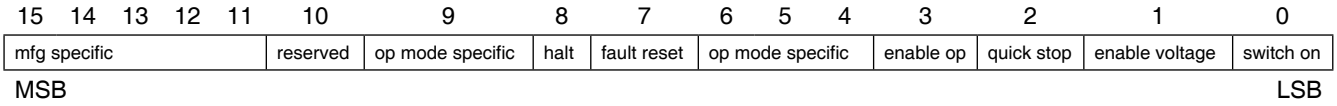
An error can be triggered by a temperature sensor, for example. The product cancels the running movement and performs an error response, for example stopping with «Quick Stop» or disabling the power stage. Subsequently, the operating state changes to 9 Fault. To exit the 9 Fault operating state, the cause of the error must be remedied and a Fault Reset must be executed.

*Resetting an error message* A “Fault Reset” resets an error message.

## 6.2 Control and status

### 6.2.1 Controlling the state machine (control word $6040_h$)

Control word $6040_h$ is a mandatory index which sets the operating states and modes of the state machine.




| Command | Bits of the control word | | | | | Transitions |
|---|---|---|---|---|---|---|
| | Bit 7 | Bit 3 | Bit 2 | Bit 1 | Bit 0 | |
| Shutdown | 0 | X | 1 | 1 | 0 | 2, 6, 8 |
| Switch on | 0 | 0 | 1 | 1 | 1 | 3 |
| Switch on + enable operation | 0 | 1 | 1 | 1 | 1 | 3 + 4 |
| Disable voltage | 0 | X | X | 0 | X | 7, 9, 10, 12 |
| Quick stop | 0 | X | 0 | 1 | X | 7, 10, 11 |
| Disable operation | 0 | 0 | 1 | 1 | 1 | 5 |
| Enable operation | 0 | 1 | 1 | 1 | 1 | 4, 16 |
| Fault reset | 0 –> 1 | X | X | X | X | 15 |

| Op mode | Bits of the control word | | | |
|---|---|---|---|---|
| | Bit 8 | Bit 6 | Bit 5 | Bit 4 |
| Profile position | Halt | Abs/rel | Change set | New setpoint |
| Profile velocity | Halt | Reserved | Reserved | Reserved |
| Homing | Halt | Reserved | Reserved | Homing start |

Table 6.3: Control word value range

*Object description*

| | |
|---|---|
| Index | $6040_h$ |
| Name | Control word |
| Object code | VAR |
| Data type | Unsigned16 |
| Category | Mandatory |

*Entry description*

| | |
|---|---|
| Sub-index | $00_h$ |
| Access | rw |
| PDO mapping | Yes |
| Value range | See table 6.3 |
| Default value | Device and operation mode specific |

## 6.2.2 Indication of the operating state (status word 6041:0h)

The status word $6041:0_h$ provides information on the operating state of the device and the processing status of the operating mode

| 15 14 | 13 12 | 11 | 10 | 9 | 8 | 7 | 6 5 | 4 | 3 2 1 0 |
|---|---|---|---|---|---|---|---|---|---|
| mfg specific | op mode specific | Int limit active | target reached | remote | mfg specific | warn | status bits | voltage enabled | status bits |

MSB LSB

*Status bits* Bit 6: Switch on disabled
Bit 5: Quick stop
Bit 3: Fault
Bit 2: Operation enabled
Bit 1: Switch on
Bit 0: Ready to switch on

| **Status** | **Bits of the status word** | | | | | |
|---|---|---|---|---|---|---|
| | **Bit 6** | **Bit 5** | **Bit 3** | **Bit 2** | **Bit 1** | **Bit 0** |
| Not Ready To Switch On | 0 | X | 0 | 0 | 0 | 0 |
| Switch On Disabled | 1 | X | 0 | 0 | 0 | 0 |
| Ready To Switch On | 0 | 1 | 0 | 0 | 0 | 1 |
| Switched On | 0 | 1 | 0 | 0 | 1 | 1 |
| Operation Enabled | 0 | 1 | 0 | 1 | 1 | 1 |
| Quick Stop Active | 0 | 0 | 0 | 1 | 1 | 1 |
| Fault Reaction Active | 0 | X | 1 | 1 | 1 | 1 |
| Fault | 0 | X | 1 | 0 | 0 | 0 |

Table 6.4: Status word status bit states

*Bit 4: Voltage Enabled*

Bit 4=1 indicates whether the DC bus voltage is correct. If the voltage is missing or is too low, the device does not transition from operating state 3 to operating state 4.

*Bit 5: Quick Stop Active*

When reset, this bit indicates that the drive is reacting on a quick stop request. Bits 0, 1 and 2 of the statusword must be set to 1 to indicate that the drive is capable to regenerate. The setting of the other bits indicates the status of the drive (e.g. the drive is performing a quick stop as result of a reaction to a non-fatal fault. The fault bit is set as well as bits 0, 1 and 2).

*Bit 7: Warning*

A drive warning is present if bit 7 is set. The cause means no error but a state that has to be mentioned, e.g. temperature limit, job refused. The status of the drive does not change. The cause of this warning may be found by reading the fault code parameter. The bit is set and reset by the device.

*Bit 8: Manufacturer Specific*

This bit may be used by a drive manufacturer to implement any manufacturer specific functionality. Not used by MDrive products.

*Bit 9: Remote*

If bit 9 is set, then parameters may be modified via the CAN-network, and the drive executes the content of a command message. If the bit remote is reset, then the drive is in local mode and will not execute the command message. The drive may transmit messages containing valid actual values like a position_actual_value, depending on the actual drive configuration. The drive will accept accesses via service data objects (SDOs) in local mode.

*Bit 10: Target Reached*

If bit 10 is set by the drive, then a setpoint has been reached (torque, speed or position depending on the modes_of_operation). The change of a target value by software alters this bit. If quickstop_option_code is 5, 6, 7 or 8, this bit must be set, when the quick stop operation is finished and the drive is halted. If Halt occured and the drive has halted then this bit is set too.

*Bit 11: Internal Limit Active*

This bit set by the drive indicates, that an internal limitation is active (e.g. position_range_limit).

*Bits 12-13: Operation Mode Specific*

| **Op mode** | **Bits of the control word** | |
|---|---|---|
| | **Bit 13** | **Bit 12** |
| Profile position | Following error | Set point acknowledge |
| Profile velocity | Max slippage error | Speed |
| Homing | Homing error | Homing attained |

Table 6.5: Operation mode status

*Bit 14-15: Unused*

## 6.3 Option code objects

### 6.3.1 Abort connection ($6007_h$)

This object shall indicate what action shall be performed when one of the following events occurs: bus-off, heartbeat, life guarding, NMT stopped state entered, reset application, and reset communication

*Object description*

| | |
|---|---|
| Index | $6007_h$ |
| Name | Abort connection |
| Object code | VAR |
| Data type | Integer16 |
| Category | Optional |

*Entry description*

| | |
|---|---|
| Sub-index | $00_h$ |
| Access | rw |
| PDO mapping | Yes |
| Value range | 0 to 3 |
| Default value | 0 |

| Value | Meaning |
|---|---|
| 0 | No action |
| 1 | Fault signal |
| 2 | Disable voltage command |
| 3 | Quick stop command |

Table 6.6: Abort Connection Option Code

### 6.3.2 Error code ($603F_h$)

This object shall provide the error code of the last error occurred in the drive device. This object provides the same information as the lower 16-bit of sub-index 01h of the pre-defined error field (1003h).

*Object description*

| | |
|---|---|
| Index | $603F_h$ |
| Name | Error code |
| Object code | VAR |
| Data type | Unsigned16 |
| Category | Optional |

*Entry description*

| | |
|---|---|
| Sub-index | $00_h$ |
| Access | rw |
| PDO mapping | Yes |
| Value range | Unsigned16 |
| Default value | 0 |

### 6.3.3 Quick stop ($605A_h$)

This object shall indicate what action is performed when the quick stop function is executed. The slow down ramp is the deceleration value of the used mode of operations.

*Object description*

| | |
|---|---|
| Index | $605A_h$ |
| Name | Quick stop |
| Object code | VAR |
| Data type | Integer16 |
| Category | Optional |

*Entry description*

| | |
|---|---|
| Sub-index | $00_h$ |
| Access | rw |
| PDO mapping | No |
| Value range | 0 to 6 |
| Default value | 2 |

| Value | Meaning |
|---|---|
| 0 | Disable drive function |
| 1 | Slow down on slow down ramp and transit into Switch On Disabled |
| 2 | Slow down on quick stop ramp and transit into Switch On Disabled |
| 3 | Slow down on current limit and transit into Switch On Disabled |
| 4 | Slow down on voltage limit and transit into Switch On Disable |
| 5 | Slow down on slow down ramp and stay in Quick Stop Active |
| 6 | Slow down on quick stop ramp and stay in Quick Stop Active |

Table 6.7: Quick stop option codes

### 6.3.4 Shutdown ($605B_h$)

This object shall indicate what action is performed if there is a transition from Operation Enabled state to Ready To Switch On state. The slow down ramp is the deceleration value of the used mode of operations.

*Object description*

| | |
|---|---|
| Index | $605B_h$ |
| Name | Shutdown |
| Object code | VAR |
| Data type | Integer16 |
| Category | Optional |

*Entry description*

| | |
|---|---|
| Sub-index | $00_h$ |
| Access | rw |
| PDO mapping | No |
| Value range | 0 to 1 |
| Default value | 0 |

| Value | Meaning |
|---|---|
| 0 | Disable drive function (Switch off the drive power stage) |
| 1 | Slow down with slow down ramp; disable of the drive function |

Table 6.8: Shutdown option codes

### 6.3.5 Disable operation ($605C_h$)

This object shall indicate what action is performed if there is a transition from Operation Enabled state to Switched on state. The slow down ramp is the deceleration value of the used mode of operation.

*Object description*

| | |
|---|---|
| Index | $605C_h$ |
| Name | Disable operation |
| Object code | VAR |
| Data type | Integer16 |
| Category | Optional |

*Entry description*

| | |
|---|---|
| Sub-index | $00_h$ |
| Access | rw |
| PDO mapping | No |
| Value range | 0 to 1 |
| Default value | 0 |

| Value | Meaning |
|---|---|
| 0 | Disable drive function (Switch off the drive power stage) |
| 1 | Slow down with slow down ramp; disable of the drive function |

Table 6.9: Disable operation option codes

### 6.3.6 Halt ($605D_h$)

Indicates what action is performed if there is a transition from Operation Enabled state to Switched on state. The slow down ramp is the deceleration value of the used mode of operations.

*Object description*

| | |
|---|---|
| Index | $605D_h$ |
| Name | Halt |
| Object code | VAR |
| Data type | Integer16 |
| Category | Optional |

*Entry description*

| | |
|---|---|
| Sub-index | $00_h$ |
| Access | rw |
| PDO mapping | No |
| Value range | 1 or 2 |
| Default value | 2 |

| Value | Meaning |
|---|---|
| 1 | Slow down on slow down ramp and stay in Operation Enabled |
| 2 | Slow down on quick stop ramp and stay in Operation Enabled |

Table 6.10: Halt option codes

### 6.3.7 Fault reaction ($605E_h$)

Indicates what action is performed when fault is detected in the PDS. The slow down ramp is the deceleration value of the used mode of operations.

*Object description*

| | |
|---|---|
| Index | $605E_h$ |
| Name | Halt |
| Object code | VAR |
| Data type | Integer16 |
| Category | Optional |

*Entry description*

| | |
|---|---|
| Sub-index | $00_h$ |
| Access | rw |
| PDO mapping | No |
| Value range | 0 to 2 |
| Default value | 2 |

| Value | Meaning |
|---|---|
| 0 | Disable drive function, motor is free to rotate |
| 1 | Slow down on slow down ramp |
| 2 | Slow down on quick stop ramp |

Table 6.11: Fault reaction option codes

## 6.4 Supported modes of operation

The function of the product depends on the selected modes of operation. It is not possible to operates the modes in parallel. The user must select a mode to operate in. An example of exclusive functions are Profile Velocity and Profile Position modes. Supported modes are:

1) Profile position
2) Homing mode
3) Profile velocity

The product allows the user to switch dynamically from operation mode to operation mode.

The mode of operation is set or read using Mode of Operation ($6060_h$) and Mode of Operation display ($6061_h$).

### 6.4.1 Mode of operation ($6060_h$)

This object shall indicate the requested operation mode.

*Object description*

| | |
|---|---|
| Index | $6060_h$ |
| Name | Mode of operation |
| Object code | VAR |
| Data type | Integer8 |
| Category | Optional |

*Entry description*

| | |
|---|---|
| Sub-index | $00_h$ |
| Access | rw |
| PDO mapping | No |
| Value range | 1, 3 or 6 |
| Default value | 1 |

| Value | Meaning |
|---|---|
| 1 | Profile Position |
| 3 | Profile Velocity |
| 6 | Homing |

Table 6.12: Mode of operation

### 6.4.2 Mode of operation display ($6061_h$)

The Modes of Operation Display shows the current mode of operation. The meaning of the returned value corresponds to that of the Modes of Operation option code (index 6060h).

*Object description*

| | |
|---|---|
| Index | $6061_h$ |
| Name | Mode of operation display |
| Object code | VAR |
| Data type | Integer8 |
| Category | Optional |

*Entry description*

| | |
|---|---|
| Sub-index | $00_h$ |
| Access | ro |
| PDO mapping | Yes |
| Value range | 1, 3 or 6 |
| Default value | 1 |

### 6.4.3 Supported drive modes ($6502_h$)

This object shall provide information on the supported drive modes.

| 31 16 | 15 10 | 9 6 | 5 | 4 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|
| Mfg specific | Reserved | Not supported | Homing | Not supported | Profile velocity | Not supported | Profile position |

MSB LSB

*Object description*

| | |
|---|---|
| Index | $6502_h$ |
| Name | Supported drive modes |
| Object code | VAR |
| Data type | Unsigned32 |
| Category | Optional |

*Entry description*

| | |
|---|---|
| Sub-index | $00_h$ |
| Access | ro |
| PDO mapping | No |
| Value range | Unsigned32 |
| Default value | $00000025_h$ |

# 6.5 Profile position mode

## 6.5.1 Overview

A `target_position` is applied to the trajectory generator. It is generating a `position_demand_value` for the position control loop described in the position control function section. These two function blocks are optionally controlled by individual parameter sets.

At the input to the trajectory generator, parameters may have optional limits applied before being normalized to internal units. Normalized parameters are denoted with an asterisk. The simplest form of a trajectory generator is just to pass through a target_position and to transform it to a `position_demand_value` with internal units (increments) only.

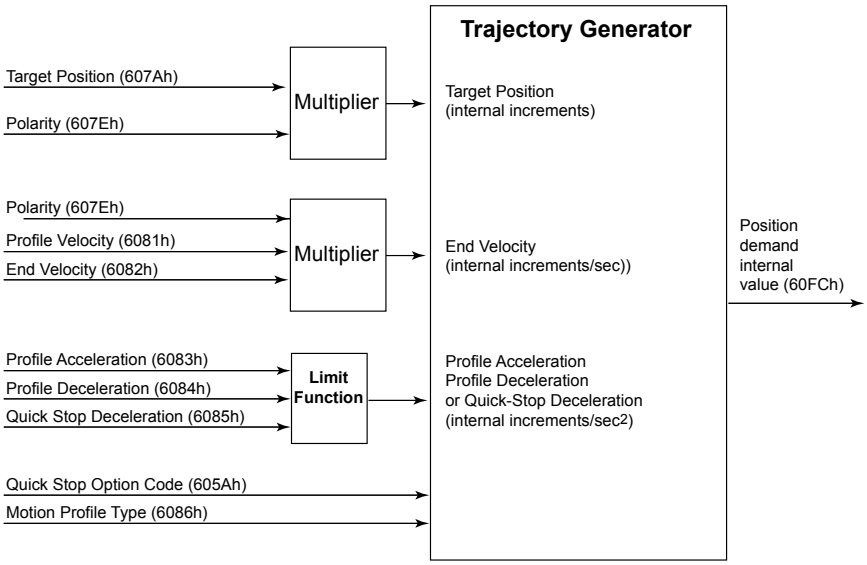



Figure 6.2: Trajectory generator for profile position block diagram

*Input data* The input data objects for profile position:

| Object | Name | Description |
|---|---|---|
| $607A_h$ | `target_position` | Defines the targeted absolute or relative position for a move |
| $607E_h$ | `polarity` | Sets the polarity for a position or speed commands |
| $6081_h$ | `profile_ velocity` | Sets the velocity for profile position motion |
| $6082_h$ | `end_velocity` | Sets the velocity upon reaching target. |
| $6083_h$ | `profile_ acceleration` | Sets the acceleration for profile posistion and profile velocity |
| $6084_h$ | `profile_ deceleration` | Sets the deceleration for profile posistion and profile velocity |
| $6085_h$ | `quick_stop_ decel` | Sets the deceleration for quick stop active |

Table 6.13: Input data objects for profile position

*Output data* The output data objects for profile position:

| Object | Name | Description |
|---|---|---|
| $607A_h$ | `position_ demand_value` | Displays the motor position |

Table 6.13: Input data objects for profile position

## 6.5.2 Functional description

There are two different ways to apply `target_positions` to a drive, are supported by this device profile.

1. Set of set-points:

   After reaching the `target_position` the drive unit immediately processes the next `target_position` which results in a move where the velocity of the drive normally is not reduced to zero after achieving a set-point.

2. Single set-point:

   After reaching the `target_position` the drive unit signals this status to a host computer and then receives a new set-point. After reaching a `target_position` the velocity normally is reduced to zero before starting a move to the next set-point.

The two modes are controlled by the timing of the bits `new_set-point` and `change_set_immediately` in the controlword and `set-point_ acknowledge` in the `statusword`.

These bits allow to set up a request-response mechanism in order to prepare a set of set-points while another set still is processed in the drive unit. This minimizes reaction times within a control program on a host computer.

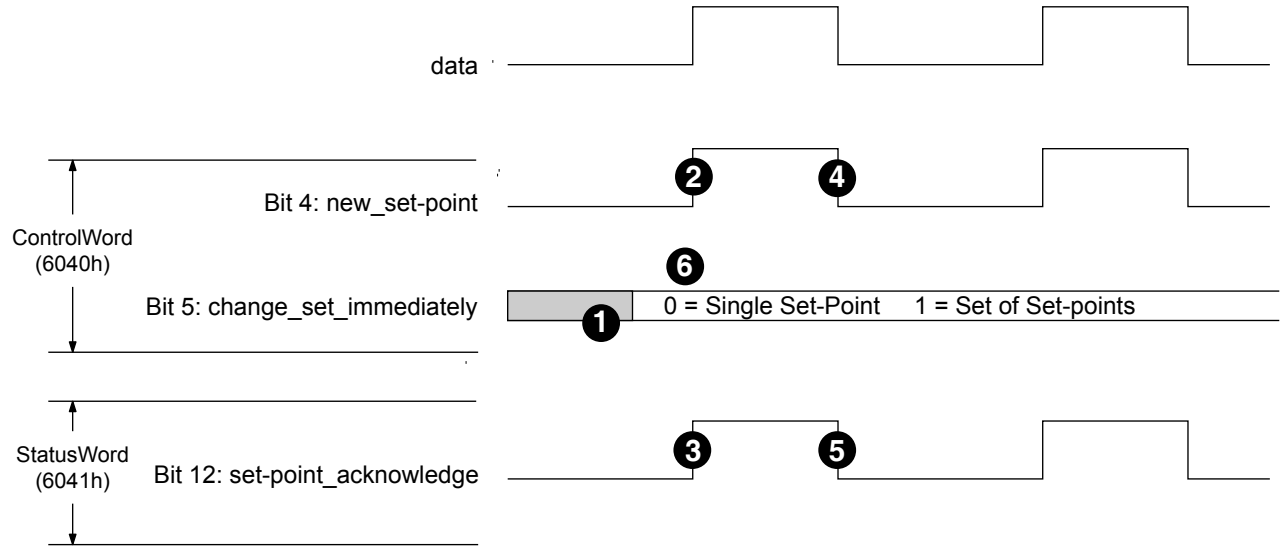



Figure 6.3: Set-point transmission from host (see table 6:14 for states)

| Bit state # | Meaning |
|---|---|
| ***(1)*** | Single set-point is expected by device |
| ***(2)*** | Host signals “data is valid” new set-point = 1 |
| ***(3)*** | Device response: sets bit 12, set-point acknowledge = 1 |
| ***(4)*** | Data is validated, host may release new set-point |
| ***(5)*** | Device response: sets bit 12, set-point acknowledge = 0<br>Device ready to receive new data |
| ***(6)*** | Indicates state of change_set_immediately = 1 |

Table 6.14: Set-point transmission from host bit states

Figure 6.3, Figure 6.4 and Figure 6.5 illustrate the difference between the “set of set-points” mode and the “single set-point” mode. The initial status of the bit `change_set_immediately` in the controlword determines which mode is used. Trapezoidal moves are used as this is the only `motion_profile_type` the MDrivePlus CANopen supports.

If the bit `change_set_immediately` is “0” (shaded area in Figure 6.3) a single set-point is expected by the drive ***(1)***. After data is applied to the drive, a host signals that the data is valid by changing the bit `new_setpoint` to “1” in the controlword ***(2)***. The drive responds with `set-point_acknowledge` set to “1” in the statusword ***(3)*** after it recognized and buffered the new valid data. Now the host may release new_set-point ***(4)*** and afterwards the drive signals with set-point_acknowledge equal “0” its ability to accept new data again ***(5)***. In Figure 6.4 this mechanism results in a velocity of zero after ramping down in order to reach a `target_position` $X_1$.at $T_1$. After signalling to the host, that the set-point is reached like described above, the next `target_position` $X_2$ is processed at $T_2$ and reached at $T_3$.

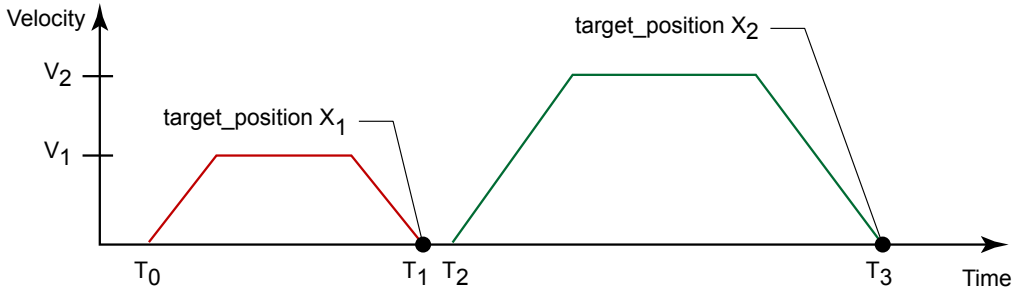



Figure 6.4: Single set-point mode (move after a move) $6040_h$ bit 5=0

With change_set_immediately set to “1” ***(6)***, symbolized by the clear area in Figure 6.3, the host advises the drive to apply a new set-point immediately after reaching the last one. The relative timing of the other signals is unchanged. This behavior causes the drive to already process the next set-point $X_2$ and to keep its velocity when it reaches the target_position $X_1$ at $T_1$. Then drive moves immediately to the already calculated next target_position $X_2$.

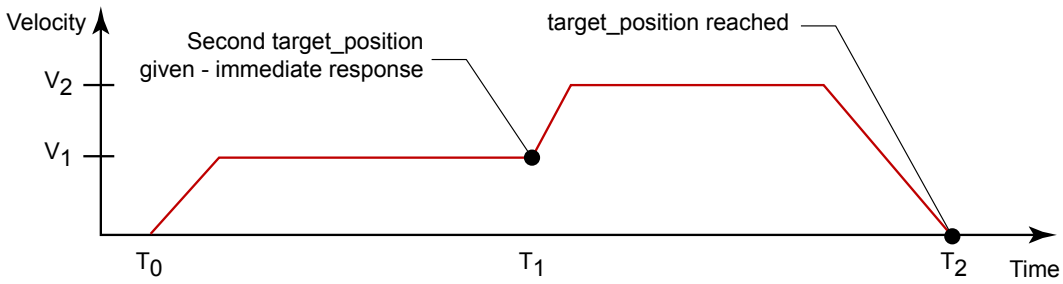



Figure 6.5: Set of set-points (move on a move) $6040_h$ bit 5=1

### 6.5.3 Control word definition for profile position

| 15 ... 9 | 8 | 7 | 6 | 5 | 4 | 3 ... 0 |
|---|---|---|---|---|---|---|
| See 6.2.1 | halt | See 6.2.1 | abs/rel | change set immediately | new set point | See 6.2.1 |

| Bit | Name | Value | Meaning |
|---|---|---|---|
| 4 | New set-point | 0 | Does not assume target position |
| | | 1 | Assume target position |
| 5 | Change set immediately | 0 | Finish the actual positioning and then start the next positioning |
| | | 1 | Interrupt the actual positioning and start the next positioning |
| 6 | abs/rel | 0 | Target position is an absolute value |
| | | 1 | Target position is a relative value |
| 8 | Halt | 0 | Execute positioning |
| | | 1 | Stop motion with profile deceleration |

Table 6.15: Profile position mode control word ($6040_h$) bit state meanings

### 6.5.4 Status word definition for profile position

| 15 ... 14 | 13 | 12 | 11 | 10 | 9 ... 0 |
|---|---|---|---|---|---|
| See 6.2.2 | following error | set-point acknowledge | See 6.2.2 | target reached | See 6.2.2 |

| Bit | Name | Value | Meaning |
|---|---|---|---|
| 10 | Target reached | 0 | Halt=0: Target position not reached<br>Halt=1: Axis decelerating |
| | | 1 | Halt=0: Target position reached<br>Halt=1: Axis velocity is 0 |
| 12 | Set-point acknowledge | 0 | Trajectory generator has not assumed the positioning values yet |
| | | 1 | Trajectory generator has assumed the positioning values |
| 13 | Following error | 0 | No following error |
| | | 1 | Following error |

Table 6.16: Profile position mode status word ($6041_h$) bit state meanings

# Position, velocity and acceleration objects

## 6.5.5 $607A_h$ Target position

The target position is the position that the drive should move to in position profile mode using parameters such as velocity, acceleration, deceleration, motion profile type etc. The target position is given in terms of 51,200 units per motor shaft revolution. The target position will be interpreted as absolute or relative depending on the absolute relative flag (bit 6) in the controlword.

*Object description*

| | |
|---|---|
| Index | $607A_h$ |
| Name | Target position |
| Object code | VAR |
| Data type | Integer32 |
| Category | Optional |

*Entry description*

| | |
|---|---|
| Sub-index | $00_h$ |
| Access | rw |
| PDO mapping | Yes |
| Value range | 8000 $0000_h$ to 7FFF $FFFF_h$ |
| Default value | 0000 $0000_h$ |

## 6.5.6 $607E_h$ Polarity

Position demand value and position actual value are multiplied by 1 or -1, depending on the value of the polarity flag.

| 7 | 6 | 5 ... 0 |
|---|---|---|
| position polarity | velocity polarity | reserved |

*Object description*

| | |
|---|---|
| Index | $607E_h$ |
| Name | Polarity |
| Object code | VAR |
| Data type | Unsigned8 |
| Category | Optional |

*Entry description*

| | |
|---|---|
| Sub-index | $00_h$ |
| Access | rw |
| PDO mapping | Yes |
| Value range | Unsigned8 |
| Default value | $00_h$ |

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### 6.5.7 $6081_h$ Profile velocity

The profile velocity is the velocity normally attained at the end of the acceleration ramp during a profiled move and is valid for both directions of motion. The profile velocity is given in steps per second.

*Object description*

| | |
|---|---|
| Index | $6081_h$ |
| Name | Profile velocity |
| Object code | VAR |
| Data type | Unsigned32 |
| Category | Optional |

*Entry description*

| | |
|---|---|
| Sub-index | $00_h$ |
| Access | rw |
| PDO mapping | Yes |
| Value range | Unsigned32 |
| Default value | $512000_d$ |

### 6.5.8 $6082_h$ End velocity

The end velocity defines the velocity which the drive must have on reaching the target position. Normally, the drive stops at the target position, i.e. the end_velocity = 0. The end velocity is given in the same units as profile velocity.

*Object description*

| | |
|---|---|
| Index | $6082_h$ |
| Name | Polarity |
| Object code | VAR |
| Data type | Unsigned32 |
| Category | Optional |

*Entry description*

| | |
|---|---|
| Sub-index | $00_h$ |
| Access | rw |
| PDO mapping | Yes |
| Value range | Unsigned32 |
| Default value | $51200_d$ |

### 6.5.9 $6083_h$ Profile acceleration

Profile acceleration is given in steps/sec$^2$

*bject description*

| | |
|---|---|
| Index | $6083_h$ |
| Name | Profile acceleration |
| Object code | VAR |
| Data type | Unsigned32 |
| Category | Optional |

*Entry description*

| | |
|---|---|
| Sub-index | $00_h$ |
| Access | rw |
| PDO mapping | Yes |
| Value range | Unsigned32 |
| Default value | $100000_d$ |

### 6.5.10 $6084_h$ Profile deceleration

Profile deceleration is given in steps/sec$^2$

*bject description*

| | |
|---|---|
| Index | $6084_h$ |
| Name | Profile deceleration |
| Object code | VAR |
| Data type | Unsigned32 |
| Category | Optional |

*Entry description*

| | |
|---|---|
| Sub-index | $00_h$ |
| Access | rw |
| PDO mapping | Yes |
| Value range | Unsigned32 |
| Default value | $100000_d$ |

### 6.5.11 $6085_h$ Quick stop deceleration

This object shall indicate the configured deceleration used to stop the motor when the quick stop function is activated and the quick stop code object ($605A_h$) is set to 2 or 6. The quick stop deceleration is also used if the fault reaction code object ($605E_h$) is 2 and the halt option code object ($605D_h$) is 2. The value shall be given in the same physical unit as profile acceleration object ($6083_h$).

*Object description*

| | |
|---|---|
| Index | $6085_h$ |
| Name | Quick stop deceleration |
| Object code | VAR |
| Data type | Unsigned32 |
| Category | Optional |

*Entry description*

| | |
|---|---|
| Sub-index | $00_h$ |
| Access | rw |
| PDO mapping | Yes |
| Value range | Unsigned32 |
| Default value | $200000_d$ |

### 6.5.12 $6086_h$ Motion profile type

The motion profile type is used to select the type of motion profile used to perform a move. The represented devices are fixed at value 0: linear ramp (trapezoidal profile)

*bject description*

| | |
|---|---|
| Index | $6085_h$ |
| Name | Motion profile type |
| Object code | VAR |
| Data type | Integer16 |
| Category | Optional |

*Entry description*

| | |
|---|---|
| Sub-index | $00_h$ |
| Access | rw |
| PDO mapping | Yes |
| Value range | $0_d$ |
| Default value | $0_d$ |

### 6.5.13 Profile position application example

The represented device(s) support relative and absolute moves to position. Using either relative or absolute moves, the user can also select (by the control word data) if the target position should be reached before another target position is allowed (finish first) or if the product should execute a newly received target position even if still in motion (immediate).

The below example sets typical motion profile commands a system would configure[1], enabling the motor power[2] and the four different move types[3] supported in profile position mode using SDOs with Node ID$41_h$.

[1] Typical motion profile commands could be set each time on power up from host or set using a configuration file and stored to NVM once.

[2] Enabling the motor power only has to be done once on power up.

[3] The Control Word data selects the move type.

All values shown are hexadecimal.

| ID | RTR | Data String | Action |
|---|---|---|---|
| **Typical motion parameters** | | | |
| 0641 | 00 | 2F 04 22 00 50 00 00 00 | Set run current to 80% |
| 0641 | 00 | 23 84 60 00 40 42 0F 00 | Set deceleration to 1M steps/sec$^2$ |
| 0641 | 00 | 23 83 60 00 40 42 0F 00 | Set acceleration to 1M steps/sec$^2$ |
| 0641 | 00 | 23 81 60 00 00 D0 07 00 | Set max velocity to 512000 steps/sec |
| **Enable motor power - DSP402 state machine** | | | |
| 0641 | 00 | 2B 40 60 00 06 00 00 00 | Ready to switch on |
| 0641 | 00 | 2B 40 60 00 07 00 00 00 | Switched on |
| 0641 | 00 | 2B 40 60 00 0F 00 00 00 | Operation enable |
| **Set to profile position mode** | | | |
| 0641 | 00 | 2F 60 60 00 01 00 00 00 | Set to profile position mode |
| Perform absolute move, finish before performing additional moves | | | |
| 0641 | 00 | 23 7A 60 00 30 75 00 00 | Set target position to 30000 steps |
| 0641 | 00 | 2B 40 60 00 1F 00 00 00 | Set control word bit 4 to 1 |
| 0641 | 00 | 2B 40 60 00 0F 00 00 00 | Set control word bit 4 to 0 |
| **Perform absolute move, move immediate** | | | |
| 0641 | 00 | 23 7A 60 00 B8 0B 00 00 | Set target position to 3000 steps |
| 0641 | 00 | 2B 40 60 00 3F 00 00 00 | Set control word bit 4 to 1 |
| 0641 | 00 | 2B 40 60 00 2F 00 00 00 | Set control word bit 4 to 0 |
| **Perform relative move, finish before performing additional moves** | | | |
| 0641 | 00 | 23 7A 60 00 A0 86 01 0 | Set target position to 100000 |
| 0641 | 00 | 2B 40 60 00 5F 00 00 00 | Set control word bit 4 to 1 |
| 0641 | 00 | 2B 40 60 00 4F 00 00 00 | Set control word bit 4 to 0 |
| **Perform relative move, move immediate** | | | |
| 0641 | 00 | 23 7A 60 00 B8 0B 00 00 | Set target position to 3000 steps |
| 0641 | 00 | 2B 40 60 00 7F 00 00 00 | Set control word bit 4 to 1 |
| 0641 | 00 | 2B 40 60 00 6F 00 00 00 | Set control word bit 4 to 0 |

Table 6.17: Profile position mode application example

# 6.6 Profile velocity mode

## 6.6.1 Overview

The profile velocity mode covers the following sub-functions:

- Demand value input via trajectory generator
- Velocity capture using position sensor or velocity sensor
- Velocity control function with appropriate input and output signals
- Monitoring of the profile velocity using a window-function
- Monitoring of velocity actual value using a threshold

## 6.6.2 Control word definition for profile velocity

| 15 ... 9 | 8 | 7 | 6 ... 4 | 3 ... 0 |
|---|---|---|---|---|
| See 6.2.1 | halt | See 6.2.1 | reserved | See 6.2.1 |

| Bit | Name | Value | Meaning |
|---|---|---|---|
| 8 | Halt | 0 | Execute the motion |
| | | 1 | Stop axis |

Table 6.18: Profile velocity mode control word ($6040_h$) bit state meanings

## 6.6.3 Status word definition for profile velocity

| 15 ... 14 | 13 | 12 | 11 | 10 | 9 ... 0 |
|---|---|---|---|---|---|
| See 6.2.2 | max slippage error | speed | See 6.2.2 | target reached | See 6.2.2 |

| Bit | Name | Value | Meaning |
|---|---|---|---|
| 10 | Target reached | 0 | Halt=0: Target position not reached<br>Halt=1: Axis decelerating |
| | | 1 | Halt=0: Target position reached<br>Halt=1: Axis velocity is 0 |
| 12 | Speed | 0 | Speed is not equal to 0 |
| | | 1 | Speed is equal to 0 |
| 13 | Max slippage error | 0 | Maximum slippage not reached |
| | | 1 | Maximum slippage reached |

Table 6.19: Profile velocity mode status word ($6041_h$) bit state meanings

# Profile velocity mode objects

## 6.6.4 $606C_h$ Velocity actual value

This object shall provide the actual velocity value derived either from the velocity sensor or the position sensor. The value shall be given in microsteps per second.

*Object description*

| | |
|---|---|
| Index | $606C_h$ |
| Name | Velocity actual value |
| Object code | VAR |
| Data type | Integer32 |
| Category | Optional |

*Entry description*

| | |
|---|---|
| Sub-index | $00_h$ |
| Access | rw |
| PDO mapping | Yes |
| Value range | Integer32 |
| Default value | $0000\ 0000_h$ |

## 6.6.5 $60F8_h$ Maximum slippage

This object shall indicate the configured maximal slippage of an asynchronous motor. When the max slippage has been reached, the corresponding bit 13 max slippage error in the statusword shall be set to 1. The reaction of the drive device, when the max slippage error occurs, is manufacturer-specific. This value shall be given in umicrosteps.

*Object description*

| | |
|---|---|
| Index | $60FF_h$ |
| Name | Maximum slippage |
| Object code | VAR |
| Data type | Integer32 |
| Category | Optional |

*Entry description*

| | |
|---|---|
| Sub-index | $00_h$ |
| Access | rw |
| PDO mapping | Yes |
| Value range | Integer32 |
| Default value | $512_d$ |

### 6.6.6 $60FF_h$ Target velocity

The Target Velocity is the input to the trajectory generator and the value is given in microsteps/second.

*Object description*

| | |
|---|---|
| Index | $60FF_h$ |
| Name | Target velocity |
| Object code | VAR |
| Data type | Integer32 |
| Category | Optional |

*Entry description*

| | |
|---|---|
| Sub-index | $00_h$ |
| Access | rw |
| PDO mapping | Yes |
| Value range | 8000 $0000_h$ to 7FFF $FFFF_h$ |
| Default value | 0000 $0000_h$ |

### 6.6.7 Profile velocity application example

The represented device(s) suppor the ability to move in velocity mode. Once in Profile Velocity Mode, any new target velocity will be executed immediately.

The below example sets typical motion profile commands a system would configure[1], enabling the motor power[2] and sending a new target velocity using SDOs with Node $ID41_h$.

[1] Typical motion profile commands could be set each time on power up from host or set using a configuration file and stored to NVM once.

[2] Enabling the motor power only has to be done once on power up.

All values shown are hexadecimal.

| ID | RTR | Data String | Action |
|---|---|---|---|
| **Typical motion parameters** | | | |
| 0641 | 00 | 2F 04 22 00 50 00 00 00 | Set run current to 80% |
| 0641 | 00 | 23 84 60 00 40 42 0F 00 | Set deceleration to 1M steps/sec$^2$ |
| 0641 | 00 | 23 83 60 00 40 42 0F 00 | Set acceleration to 1M steps/sec$^2$ |
| 0641 | 00 | 23 81 60 00 00 D0 07 00 | Set max velocity to 512000 steps/sec |
| **Enable motor power - DSP402 state machine** | | | |
| 0641 | 00 | 2B 40 60 00 06 00 00 00 | Ready to switch on |
| 0641 | 00 | 2B 40 60 00 07 00 00 00 | Switched on |
| 0641 | 00 | 2B 40 60 00 0F 00 00 00 | Operation enable |
| **Set to profile velocity mode** | | | |
| 0641 | 00 | 2F 60 60 00 03 00 00 00 | Set to profile velocity mode |
| **Send new target velocity** | | | |
| 0641 | 00 | 23 FF 60 00 50 C3 00 00 | Set target velocity 50000 steps/sec |

Table 6.20: Profile velocity mode application example

# 6.7 Homing mode

## 6.7.1 Overview

This subsection describes the method by which a drive seeks the home position (also called, the datum, reference point or zero point). There are various methods of achieving this using limit switches at the ends of travel or a home switch (zero point switch) in mid-travel, most of the methods also use the index (zero) pulse train from an incremental encoder.

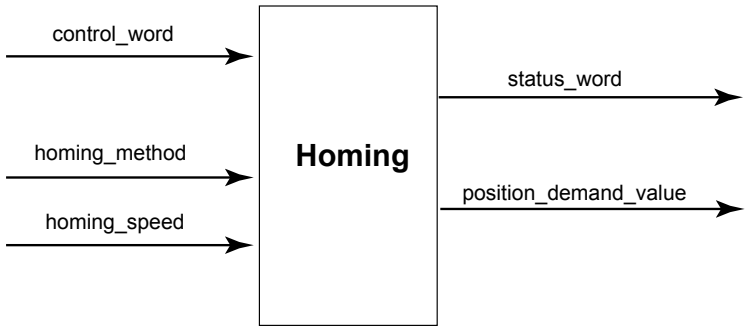


Figure 6.6: The homing function

*Input data description*

The user can specify the speeds and the method of homing. There are two homing_speeds; in a typical cycle the faster speed is used to find the home switch and the slower speed is used to find the index pulse. The manufacturer is allowed some discretion in the use of these speeds as the response to the signals may be dependent upon the hardware used.

*Output data description*

There is no output data except for those bits in the statusword which return the status or result of the homing process and the demand to the position control loops.

## 6.7.2 Control word definition for homing mode

| 15 ... 9 | 8 | 7 | 6 ... 5 | 4 | 3 ... 0 |
|---|---|---|---|---|---|
| See 6.2.1 | halt | See 6.2.1 | reserved | homing operation start | See 6.2.1 |

| Bit | Name | Value | Meaning |
|---|---|---|---|
| 4 | Homing operation start | 0 | Execute the motion |
| | | 0 ⇨ 1 | Start homing mode |
| | | 1 | Homing mode active |
| | | 1 ⇨ 0 | Interrupt homing mode |
| 8 | Halt | 0 | Execute the instruction of bit 4 |
| | | 1 | Stop axis |

Table 6.21: Homing mode control word ($6040_h$) bit state meanings

### 6.7.3 Status word definition for homing mode

| 15 ... 14 | 13 | 12 | 11 | 10 | 9 ... 0 |
|---|---|---|---|---|---|
| See 6.2.2 | homing error | homing attained | See 6.2.2 | target reached | See 6.2.2 |

| Bit | Name | Value | Meaning |
|---|---|---|---|
| 10 | Target reached | 0 | Halt=0: Target position not reached<br>Halt=1: Axis decelerating |
| | | 1 | Halt=0: Target position reached<br>Halt=1: Axis velocity is 0 |
| 12 | Homing Attained | 0 | Homing mode not yet complete |
| | | 1 | Homing mode carried out successfully |
| 13 | Following error | 0 | No homing error |
| | | 1 | Homing error |

Table 6.22: Homing mode status word ($6041_h$) bit state meanings

## Homing mode objects

### 6.7.4 $607C_h$ Homing offset

This object shall indicate the configured difference between the zero position for the application and the machine home position (found during homing). During homing the machine home position is found and once the homing is completed the zero position is offset from the home position by adding the home offset to the home position. All subsequent absolute moves shall be taken relative to this new zero position. If this object is not implemented then the home offset shall be regarded as zero. The value of this object shall be given in micro steps. Negative values shall indicate the opposite direction.

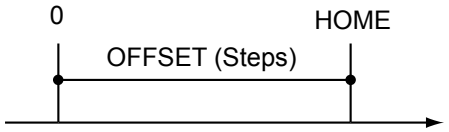


Figure 6.7: The homing offset

*Object description*

| | |
|---|---|
| Index | $607C_h$ |
| Name | Homing offset |
| Object code | VAR |
| Data type | Unsigned32 |
| Category | Optional |

*Entry description*

| | |
|---|---|
| Sub-index | $00_h$ |
| Access | rw |
| PDO mapping | Yes |
| Value range | Unsigned32 |
| Default value | $0_d$ |

## 6.7.5 $6098_h$ Homing method

The homing method object determines the method that will be used during homing.

*Object description*

| | |
|---|---|
| Index | $6098_h$ |
| Name | Homing method |
| Object code | VAR |
| Data type | Integer8 |
| Category | Optional |

*Entry description*

| | |
|---|---|
| Sub-index | $00_h$ |
| Access | rw |
| PDO mapping | Yes |
| Value range | $0_d$ (no homing) 1 – $35_d$ (method) |
| Default value | $0_d$ |

*Functional description of homing methods*

**Method 1: Homing on the negative limit switch and index pulse**

Using this method the initial direction of movement is leftward if the negative limit switch is inactive (here shown as low). The home position is at the first index pulse to the right of the position where the negative limit switch becomes inactive.

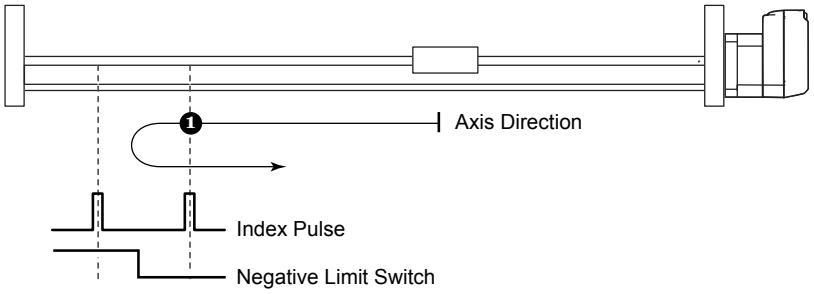


Figure 6.8: Homing on the negative limit switch and index pulse

**Method 2: Homing on the positive limit switch and index pulse**

Using this method the initial direction of movement is rightward if the positive limit switch is inactive (here shown as low). The position of home is at the first index pulse to the left of the position where the positive limit switch becomes inactive.

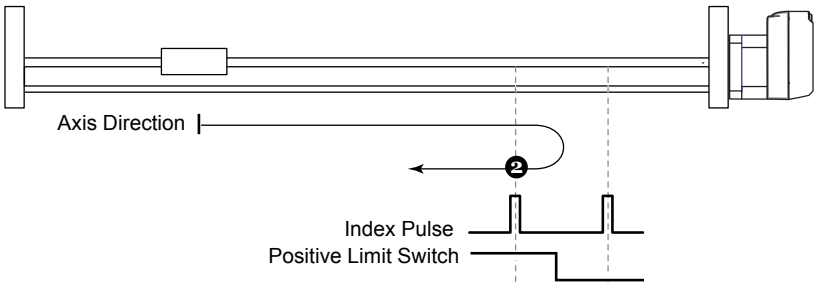


Figure 6.9: Homing on the positive limit switch and index pulse

**Methods 3 and 4: Homing on the positive home switch and index pulse**

Using methods 3 or 4 the initial direction of movement is dependent on the state of the home switch. The home position is at the index pulse to either to the left or the right of the point where the home switch changes state. If the initial position is sited so that the direction of movement must reverse during homing, the point at which the reversal takes place is anywhere after a change of state of the home switch.

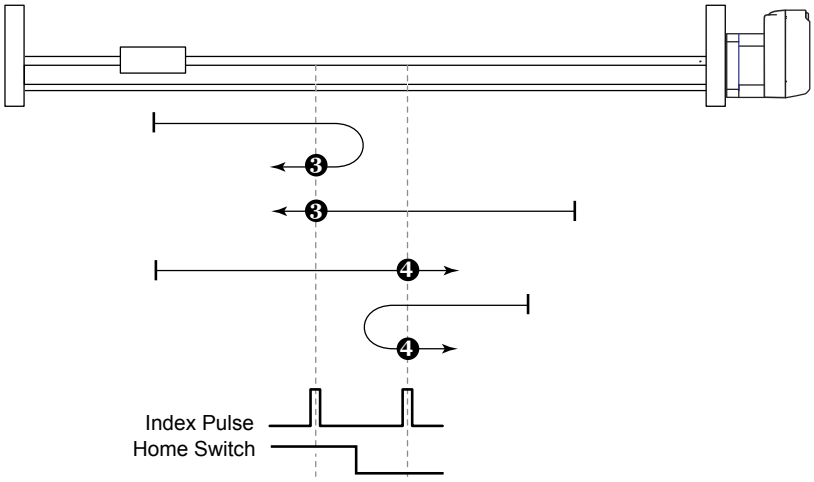


Figure 6.10: Homing on the positive home switch and index pulse

**Methods 5 and 6: Homing on the negative home switch and index pulse**

Using methods 5 or 6 the initial direction of movement is dependent on the state of the home switch. The home position is at the index pulse to either to the left or the right of the point where the home switch changes state. If the initial position is sited so that the direction of movement must reverse during homing, the point at which the reversal takes place is anywhere after a change of state of the home switch.

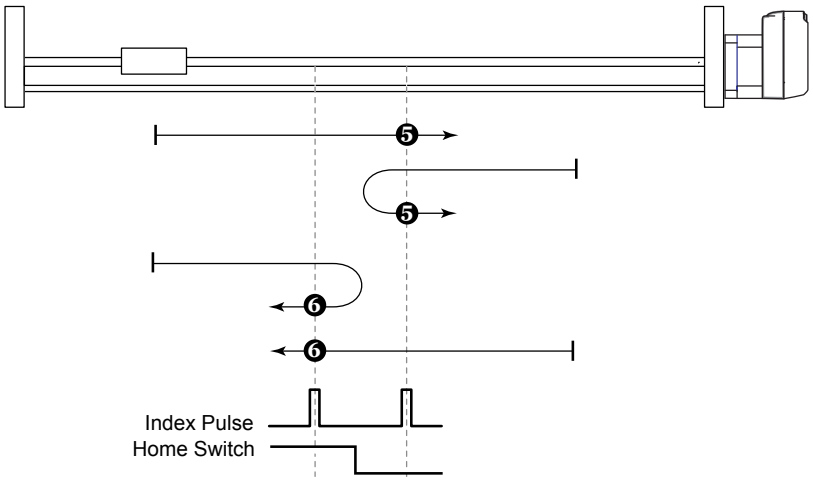


Figure 6.11: Homing on the negative home switch and index pulse

**Methods 7 to 14: Homing on the Home Switch and Index Pulse**

These methods use a home switch which is active over only portion of the travel, in effect the switch has a ‘momentary’ action as the axle`s position sweeps past the switch.

Using methods 7 to 10 the initial direction of movement is to the right, and using methods 11 to 14 the initial direction of movement is to the left except if the home switch is active at the start of the motion. In this case the initial direction of motion is Dependent on the edge being sought. The home position is at the index pulse on either side of the rising or falling edges of the home switch, as shown in the following two diagrams. If the initial direction of movement

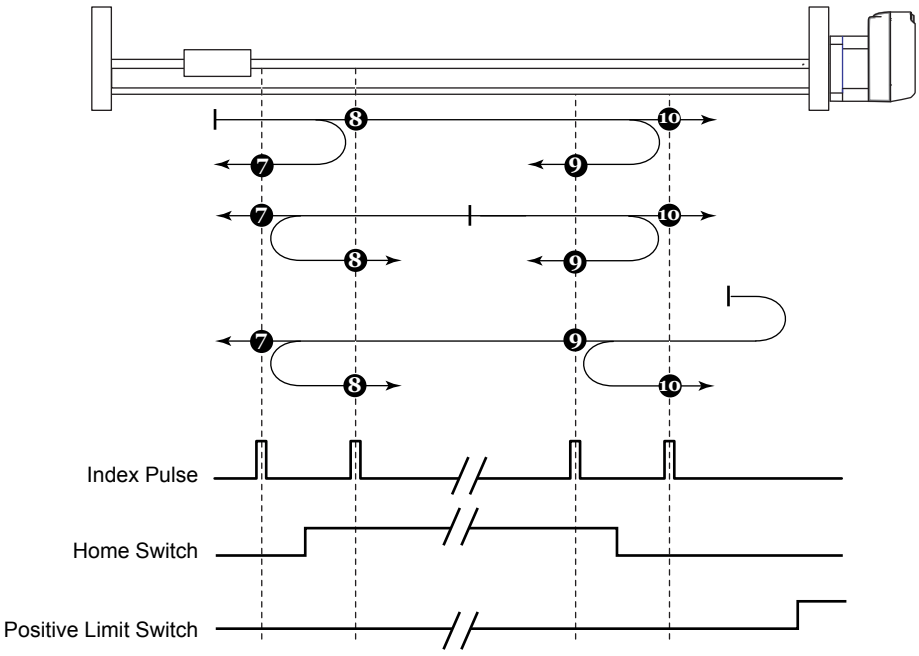


Figure 6.12: Homing on the home switch and index pulse - positive initial move

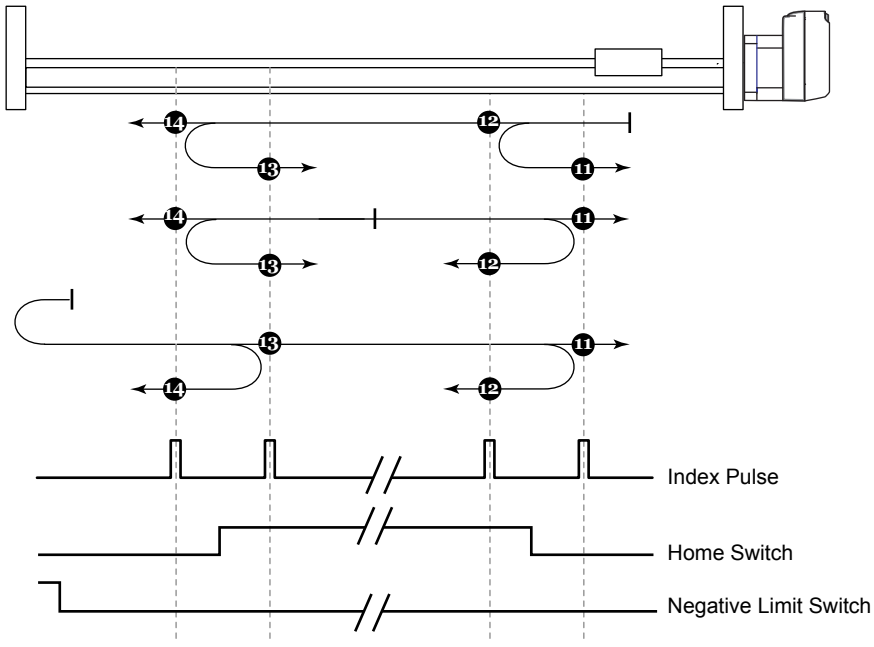


Figure 6.13: Homing on the home switch and index pulse - negative initial move

**Methods 15 and 16: Reserved**

These methods are reserved for future expansion of the homing mode.

**Methods 17 to 30: Homing without an index pulse**

These methods are similar to methods 1 to 14 except that the home position is not dependent on the index pulse but only Dependent on the relevant home or limit switch transitions. For example methods 19 and 20 are similar to methods 3 and 4 as shown in the following diagram.

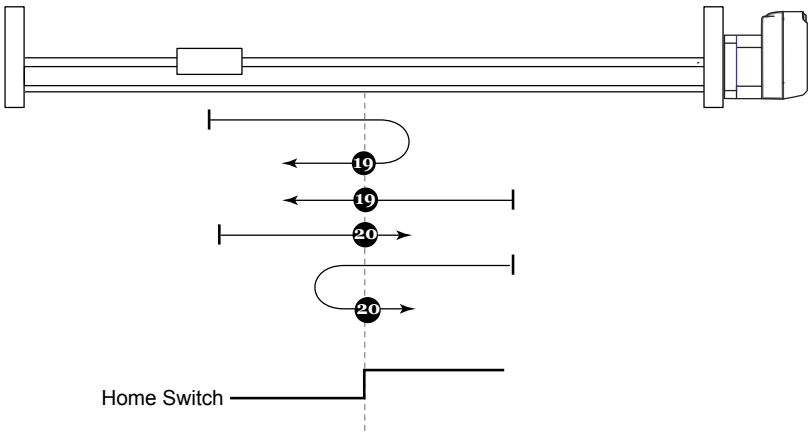


Figure 6.14: Homing without and index pulse

**Methods 31 and 32: Reserved**

These methods are reserved for future expansion of the homing mode.

**Methods 33 and 34: Homing on an index pulse**

Using methods 33 or 34 the direction of homing is negative or positive respectively. The home position is at the index pulse found in the selected direction.

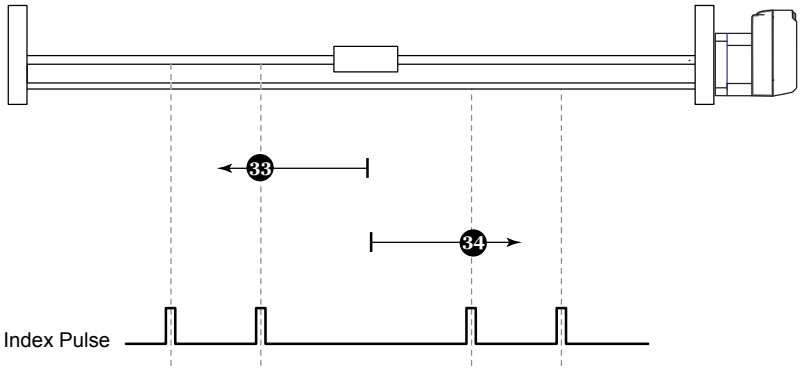


Figure 6.15: Homing on an index pulse

**Method 35: Homing on the current position**

In method 35 the current position is taken to be the home position.

### 6.7.5 $6099_h$ Homing speeds

The homing speeds object determines the fast and slow speeds that will be used during homing.

*Object description*

| | |
|---|---|
| Index | $6098_h$ |
| Name | Homing speeds |
| Object code | ARRAY |
| Data type | Unsigned32 |
| Category | Optional |

*Entry description*

| | |
|---|---|
| Sub-index | $00_h$ |
| Name | Number of entries |
| Access | ro |
| PDO mapping | — |
| Value range | — |
| Default value | $02_h$ |

| | |
|---|---|
| Sub-index | $01_h$ |
| Name | Homing speed fast |
| Access | rw |
| PDO mapping | — |
| Value range | 0000 $0000_h$ to 7FFF $FFFF_h$ |
| Default value | $102400_d$ |

| | |
|---|---|
| Sub-index | $02_h$ |
| Name | Homing speed slow |
| Access | rw |
| PDO mapping | — |
| Value range | 0000 $0000_h$ to 7FFF $FFFF_h$ |
| Default value | $6400_d$ |

### 6.7.6 Homing mode application example

Homing Mode – demonstrates home method 18 decimal using Service Data Objects (SDOs).

Devices represented by this manual support the ability to move in homing mode.

The below example sets typical motion profile commands a system would configure[1], enabling the motor power[2] and executing a homing function using SDOs with Node ID $41_h$.

[1] Typical motion profile commands could be set each time on power up from host or set using a configuration file and stored to NVM once.

[2] Enabling the motor power only has to be done once on power up.

All values shown are hexadecimal.

| ID | RTR | Data String | Action |
|---|---|---|---|
| **Typical motion parameters** | | | |
| 0641 | 00 | 2F 04 22 00 50 00 00 00 | Set run current to 80% |
| 0641 | 00 | 23 84 60 00 40 42 0F 00 | Set deceleration to 1M steps/sec$^2$ |
| 0641 | 00 | 23 83 60 00 40 42 0F 00 | Set acceleration to 1M steps/sec$^2$ |
| 0641 | 00 | 23 81 60 00 00 D0 07 00 | Set max velocity to 512000 steps/sec |
| **Enable motor power - DSP402 state machine** | | | |
| 0641 | 00 | 2B 40 60 00 06 00 00 00 | Ready to switch on |
| 0641 | 00 | 2B 40 60 00 07 00 00 00 | Switched on |
| 0641 | 00 | 2B 40 60 00 0F 00 00 00 | Operation enable |
| **Set to homing mode** | | | |
| 0641 | 00 | 2F 60 60 00 06 00 00 00 | Set to homing mode |
| **Configure I/O and homing method** | | | |
| 0641 | 00 | 22 00 20 01 00 00 00 00 | Set I/O as inputs |
| 0641 | 00 | 22 00 20 02 00 00 00 00 | Set I/O as sinking |
| 0641 | 00 | 22 00 20 04 01 00 00 00 | Set I1 as polarity |
| 0641 | 00 | 22 02 20 01 01 00 00 00 | Set I1 as home switch |
| 0641 | 00 | 22 06 20 01 0A 00 00 00 | Set I1 filter to 10ms |
| **Set homing method, offset and speeds** | | | |
| 0641 | 00 | 22 98 60 00 13 00 00 00 | Homing Method 19 decimal |
| 0641 | 00 | 2F 98 20 00 01 00 00 00 | Apply home offset to pos counter |
| 0641 | 00 | 22 7C 60 00 00 00 00 00 | Home offset = 0 |
| 0641 | 00 | 22 99 60 01 00 C8 00 00 | Home speed fast |
| 0641 | 00 | 22 99 60 02 00 14 00 00 | Home speed slow |
| **Start homing** | | | |
| 0641 | 00 | 2B 40 60 00 1F 00 00 00 | Start homing |
| After home switch toggles | | | |
| 0641 | 00 | 2B 40 60 00 00 00 00 00 | Stop homing |

Table 6.23: Homing mode application example

# 6.8 Position control function

## 6.8.1 Overview

In this section, all parameters are described which are necessary for a closed loop position control. The control loop is fed with the `position_demand_value` as one of the outputs of the Trajectory Generator and with the output of the position detection unit (`position_actual_value`) like a resolver or encoder as input parameters.

## 6.8.2 $6062_h$ Position demand actual value

This object shall provide the demanded position value. The value shall be given in motor steps.

*Object description*

| | |
|---|---|
| Index | $6062_h$ |
| Name | Position demand actual value |
| Object code | VAR |
| Data type | Integer32 |
| Category | Optional |

*Entry description*

| | |
|---|---|
| Sub-index | $00_h$ |
| Access | ro |
| PDO mapping | Yes |
| Value range | Integer32 |
| Default value | 0000 $0000_h$ |

## 6.8.3 $6063_h$ Position actual value internal

This object shall provide the actual value of the position measurement device, which shall be one of the two input values of the closed-loop position control.

*Object description*

| | |
|---|---|
| Index | $6063_h$ |
| Name | Position actual value internal |
| Object code | VAR |
| Data type | Integer32 |
| Category | Optional |

*Entry description*

| | |
|---|---|
| Sub-index | $00_h$ |
| Access | ro |
| PDO mapping | Yes |
| Value range | Integer32 |
| Default value | 0000 $0000_h$ |

### 6.8.4 $6064_h$ Position actual value

This object represents the actual value of the position measurement device microsteps.

*Object description*

| | |
|---|---|
| Index | $6064_h$ |
| Name | Position actual value |
| Object code | VAR |
| Data type | Integer32 |
| Category | Optional |

*Entry description*

| | |
|---|---|
| Sub-index | $00_h$ |
| Access | ro |
| PDO mapping | Yes |
| Value range | Integer32 |
| Default value | 0000 $0000_h$ |

### 6.8.5 $6065_h$ Following error window

This object shall indicate the configured range of tolerated position values symmetrically to the position demand value. If the position actual value is out of the following error window, a following error occurs. A following error may occur when a drive is blocked, unreachable profile velocity occurs, or at wrong closed-loop coefficients. The value shall be given in user defined position units. If the value of the following error window is FFFF $FFFF_h$, the following control shall be switched off.

*Object description*

| | |
|---|---|
| Index | $6065_h$ |
| Name | Following error window |
| Object code | VAR |
| Data type | Unsigned32 |
| Category | Optional |

*Entry description*

| | |
|---|---|
| Sub-index | $00_h$ |
| Access | rw |
| PDO mapping | No |
| Value range | Unsigned32 |
| Default value | 0000 $0512_h$ |

### 6.8.6 $6066_h$ Following error timeout

This object shall indicate the configured time for a following error condition, after that the bit 13 of the statusword shall be set to 1. The reaction of the drive when a following error occurs is manufacturer-specific. The value shall be given in milliseconds.

*Object description*

| | |
|---|---|
| Index | $6066_h$ |
| Name | Following error timeout |
| Object code | VAR |
| Data type | Unsigned16 |
| Category | Optional |

*Entry description*

| | |
|---|---|
| Sub-index | $00_h$ |
| Access | rw |
| PDO mapping | No |
| Value range | Unsigned16 |
| Default value | $0000_h$ |

### 6.8.7 $6067_h$ Position window

This object shall indicate the configured symmetrical range of accepted positions relatively to the target position. If the actual value of the position encoder is within the position window, this target position shall be regarded as reached. The target position shall be handled in the same manner as in the trajectory generator concerning limiting functions and transformation into internal machine units before it may be used with this function. The value shall be given in user-defined position units. If the value of the position window is FFFF $FFFF_h$, the position window control shall be switched off.

*Object description*

| | |
|---|---|
| Index | $6067_h$ |
| Name | Position window |
| Object code | VAR |
| Data type | Unsigned32 |
| Category | Optional |

*Entry description*

| | |
|---|---|
| Sub-index | $00_h$ |
| Access | rw |
| PDO mapping | No |
| Value range | Unsigned32 |
| Default value | 0FFF $FFFF_h$ |

### 6.8.8 $6068_h$ Position window time

This object shall indicate the configured time, during which the actual position within the position window is measured. The value shall be given in milliseconds.

*Object description*

| | |
|---|---|
| Index | $6066_h$ |
| Name | Position window time |
| Object code | VAR |
| Data type | Unsigned16 |
| Category | Optional |

*Entry description*

| | |
|---|---|
| Sub-index | $00_h$ |
| Access | rw |
| PDO mapping | No |
| Value range | Unsigned16 |
| Default value | $0000_h$ |

# 6.9 Factors

## 6.9.1 $608F_h$ Position encoder resolution

This object defines the ratio of encoder increments per motor revolution:

$$\textit{position encoder resolution} = \frac{\textit{encoder increments (sub } 01_h\textit{)}}{\textit{motor revolutions (sub } 02_h\textit{)}}$$

The default values assume a 512 line (2048 edges) encoder.

*Object description*

| | |
|---|---|
| Index | $608F_h$ |
| Name | Position encoder resolution |
| Object code | ARRAY |
| Data type | — |
| Category | Optional |

*Entry description*

| | |
|---|---|
| Sub-index | $00_h$ |
| Name | Number of entries |
| Access | ro |
| PDO mapping | — |
| Value range | — |
| Default value | $02_h$ |

| | |
|---|---|
| Sub-index | $01_h$ |
| Name | Resolution numerator |
| Access | rw |
| PDO mapping | — |
| Value range | Unsigned32 (1 to $65535_d$) |
| Default value | $2048_d$ |

| | |
|---|---|
| Sub-index | $02_h$ |
| Name | Resolution denominator |
| Access | rw |
| PDO mapping | — |
| Value range | Unsigned32 (1 to $65535_d$) |
| Default value | $1_d$ |

### 6.9.2 $6092_h$ Feed and drive shaft resolution

This object defines the ratio of user units per shaft revolution:

$$\textit{feed and drive shaft resolution} = \frac{\textit{feed user units (sub } 01_h\textit{)}}{\textit{shaft revolutions (sub } 02_h\textit{)}}$$

The default values assume a 200 step/rev motor at a step resolution of 256, or 51200 steps per rev as the factor.

*Object description*

| | |
|---|---|
| Index | $6092_h$ |
| Name | Feed and drive shaft resolution |
| Object code | ARRAY |
| Data type | — |
| Category | Optional |

*Entry description*

| | |
|---|---|
| Sub-index | $00_h$ |
| Name | Number of entries |
| Access | ro |
| PDO mapping | — |
| Value range | — |
| Default value | $02_h$ |

| | |
|---|---|
| Sub-index | $01_h$ |
| Name | Feed user units numerator |
| Access | ro |
| PDO mapping | — |
| Value range | Unsigned32 |
| Default value | $51200_d$ |

| | |
|---|---|
| Sub-index | $02_h$ |
| Name | Shaft revolutions denominator |
| Access | ro |
| PDO mapping | — |
| Value range | Unsigned32 |
| Default value | $1_d$ |

## 6.10 Optional application FE (general I/O)

### 6.10.1 $60FD_h$ Digital inputs

This object reads the digital inputs.

| 31 ... 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | 15 ... 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| X | 12 | 11 | 10 | 9 | 4 | 3 | 2 | 1 | reserved | X | home switch | + limit | – limit |
| MSB | Input points | | | | | | | | | | | | LSb |

*Object description*

| | |
|---|---|
| Index | $60FD_h$ |
| Name | Digital inputs |
| Object code | VAR |
| Data type | Unsigned32 |
| Category | Optional |

*Entry description*

| | |
|---|---|
| Sub-index | $00_h$ |
| Access | ro |
| PDO mapping | Yes |
| Value range | Unsigned32 |
| Default value | $0000\ 0000_h$ |

### 6.10.1 $60FE_h$ Digital outputs

This object reads the digital inputs.

| 31 ... 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | 15 ... 1 | 0 |
|---|---|---|---|---|---|---|---|---|---|---|
| X | 12 | 11 | 10 | 9 | 4 | 3 | 2 | 1 | reserved | brake |
| MSB | Output points | | | | | | | | | LSb |

*Object description*

| | |
|---|---|
| Index | $60FE_h$ |
| Name | Digital outputs |
| Object code | ARRAY |
| Data type | Unsigned32 |
| Category | Optional |

*Entry description*

| | |
|---|---|
| Sub-index | $00_h$ |
| Name | Number of entries |
| Access | ro |
| PDO mapping | No |
| Value range | $01_h$ |
| Default value | $01_h$ |

| | |
|---|---|
| Sub-index | $01_h$ |
| Name | Digital outputs |
| Access | rw |
| PDO mapping | Yes |
| Value range | Unsigned32 |
| Default value | $0000\ 0000_h$ |

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# 7 Diagnostics and Troubleshooting

7

## 7.1 Fieldbus communication error diagnostics

A properly operating fieldbus is essential for evaluating operating and error messages.

*Connections for fieldbus mode*

If the product cannot be addressed via the fieldbus, first check the connections. The product manual contains the technical data of the device and information on network and device installation. Check the following:

- 7 to 30 VDC power supply (MDrive Hybrid is self-powered)
- Power connections to the device
- Fieldbus cable and fieldbus wiring

*Baud rate and address*

If it is impossible to connect to a device, check the baud rate and node address.

- The baud rate must be the same for all devices in the network.
- The node address of each device must be between 1 and 127 and unique for each device.

To set the baud rate and node address see Section 5: Commissioning.

*Fieldbus function test*

After correct configuration of the transmission data, test fieldbus mode. This requires installation of a CAN configuration tool that displays CAN messages. Feedback from the product is indicated in the form of a bootup message:

- Switch the power supply off and on again.
- Observe the network messages after switching on. After initialization of the bus, the device sends a boot-up message (COB ID 700h + node ID and 1 data byte with the content 00h).
- With the factory setting 65 (41h) for the node address, the boot-up message is sent via the bus . The device can then be put into operation via NMT services.

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# 7.3 Error diagnostics via fieldbus

## 7.3.1 Message objects

A number of objects provide information on the operating state and on errors:

- Object `Statusword (6041h)` Operating states, see Section 6.2.2.
- Object `EMCY (80h+ Node-ID)` Error message from a device with error and error code.
- Object `Error register (1001h)` Error
- Object `Error code (603Fh)` Error code of the most recent error. See Section 6.3.2.

## 7.3.2 Messages on device status

Synchronous and asynchronous errors are distinguished in terms of evaluation and handling of errors.

*Synchronous errors* The device signals a synchronous error directly as a response to a message that cannot be evaluated. Possible causes comprise transmission errors or invalid data. See Section 7.4.1 “Error register” for a list of synchronous errors.

*Asynchronous errors* Asynchronous errors are signaled by the monitoring units in the device as soon as a device error occurs. An asynchronous error is signaled via bit 3, Fault, of the object `statusword (6041h)`. In the case of errors that cause an interruption of the movement, the device transmits an EMCY message.

# 7.4 CANopen error messages

CANopen error messages are signaled in the form of EMCY messages. They are evaluated via the objects `Error register (1001h)` and `Error code (603Fh)`.

CANopen signals errors that occur during data exchange via SDO with the special SDO error message ABORT.

### 7.4.1 Error register ($1001_h$)

This object is an error register for the device. The device can map internal errors in this byte. This entry is mandatory for all devices. It is a part of an Emergency object.

*Object description*

| | |
|---|---|
| Index | $1001_h$ |
| Name | Error register |
| Object code | VAR |
| Data type | Unsigned8 |
| Category | Mandatory |

*Entry description*

| | |
|---|---|
| Sub-index | $00_h$ |
| Access | ro |
| PDO mapping | Optional |
| Value range | Unsigned8 |
| Default value | — |

| Bit | M/O | Meaning |
|---|---|---|
| 0 | M | Generic Error |
| 1 | O | Current |
| 2 | O | Voltage |
| 3 | O | Temperature |
| 4 | O | Communication error (Overrun, Error State) |
| 5 | O | Device profile specific |
| 6 | O | Reserved (always 0) |
| 7 | O | Manufacturer specific |

Table 7.1 Abort Connection Option Code

### 7.4.2 Pre-defined error ($1003_h$)

The object at index 1003h holds the errors that have occurred on the device and have been signaled via the Emergency Object. In doing so it provides an error history.

1) The entry at sub-index 0 contains the number of actual errors that are recorded in the array starting at sub-index 1.
2) Every new error is stored at sub-index 1, the older ones move down the list.
3) Writing a „0“ to sub-index 0 deletes the entire error history (empties the array). Values higher than 0 are not allowed to write. This have to lead to an abort message (error code: 0609 0030h).
4) The error numbers are of type UNSIGNED32 and are composed of a 16 bit error code and a 16 bit additional error information field which is manufacturer specific. The error code is contained in the lower 2 bytes (LSB) and the additional information is included in the upper 2 bytes (MSB). If this object is supported it must consist of two entries at least. The length entry on subindex 0h and at least one error entry at sub-index 1H.

*Object description*

| | |
|---|---|
| Index | $1003_h$ |
| Name | Pre-defined error field |
| Object code | ARRAY |
| Data type | Unsigned32 |
| Category | Optional |

*Entry description*

| | |
|---|---|
| Sub-index | $00_h$ |
| Description | Number of errors |
| Access | rw |
| Entry category | Mandatory |
| PDO mapping | No |
| Value range | 0 – 254 |
| Default value | 0 |

| | |
|---|---|
| Sub-index | $01_h$ |
| Description | Standard error field |
| Access | ro |
| Entry category | Optional |
| PDO mapping | No |
| Value range | Unsigned32 |
| Default value | — |

| | |
|---|---|
| Sub-index | $02_h$ – $FE_h$ |
| Description | Standard error field |
| Access | ro |
| Entry category | Optional |
| PDO mapping | No |
| Value range | Unsigned32 |
| Default value | — |

| Error description | Add'tl info byte | Error code byte |
|---|---|---|
| No error | $0_h$ | $0000_h$ |
| CAN overrun | $0_h$ | $8110_h$ |
| Can in error passive mode | $0_h$ | $8120_h$ |
| Lifeguard or heartbeat error | $0_h$ | $8130_h$ |
| Recovered from "bus off" state | $0_h$ | $8140_h$ |
| Bus off state occurred | $0_h$ | $8141_h$ |
| PDO not processed - length error | $0_h$ | $8210_h$ |
| Over temperature error | $8_h$ | $4210_h$ |
| Pending over temperature warning | $16_h$ | $4210_h$ |
| Motor idle during commanded move | $1_h$ | $FF01_h$ |
| Motor should be idle | $2 – 8_h$ | $FF01_h$ |
| Undershot warning | $9_h$ | $FF01_h$ |

Table 7.2 Description of the error codes

# 8 Object Dictionary

8

## 8.1 Specification for the objects

*Index* The index specifies the position of the object in the object dictionary. The index value is specified as a hexadecimal value.

*Object code & data types* The object code specifies the data structure of the object.

| Object code | Meaning | Coding |
|---|---|---|
| VAR | A simple value, for example of the type Integer8 or Unsigned32 | 7 |
| ARR (ARRAY) | A data field in which the entries have the same data type. | 8 |
| REC (RECORD) | A data field that contains entries that are a combination of simple data types. | 9 |

Table 8.1 CANopen object codes

| Data type | Value range | Data length | DS301 coding |
|---|---|---|---|
| Boolean | 0 = false, 1 = true | 1 byte | 0001 |
| Integer8 | –128 ... +127 | 1 byte | 0002 |
| Integer16 | –32768 ... +32767 | 2 byte | 0003 |
| Integer32 | –2147483648 ... 2147483647 | 4 byte | 0004 |
| Unsigned8 | 0 ... 255 | 1 byte | 0005 |
| Unsigned16 | 0 ... 65535 | 2 byte | 0006 |
| Unsigned32 | 0 ... 4294967295 | 4 byte | 0007 |
| Visible String8 | ASCII chars | 8 byte | 0009 |
| Visible String168 | ASCII chars | 16 byte | 0010 |

Table 8.2 CANopen data types

*RO/RW* Indicates read and/or write values
RO: values can only be read
RW: values can be read and written.

*PDO* R_PDO: Mapping for R_PDO possible
T_PDO: Mapping for T_PDO possible
No specification: PDO mapping not possible with the object

*Min/max values* Specifies the permissible range in which the object value is defined and valid.

*Factory default* Factory default settings when the product is shipped

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## 8.2 Overview of object group $1000_h$

No objects from object group $1000_h$ are PDO mappable.

| Index | Sub-index | Name | Obj. code | Data type | Access | Description |
|---|---|---|---|---|---|---|
| $1000_h$ | | Device type | VAR | Unsigned32 | ro | Device type and profile |
| $1001_h$ | | Error register | VAR | Unsigned8 | ro | Error register |
| $1003_h$ | | Predefined error field | ARR | | rw | Error history, memory for error messages |
| | $00_h$ | Number of errors | VAR | Unsigned8 | rw | Number of error entries |
| | $01_h$ - $04_h$ | Error field | VAR | Unsigned32 | ro | Error number |
| $1005_h$ | | COB-ID SYNC | VAR | Unsigned32 | rw | Identifier of the synchronizationobject |
| $1007_h$ | | Sync window length | VAR | Unsigned32 | rw | Time window for synchronous PDOs in µS |
| $1008_h$ | | Mfg. device name | VAR | Vis String8 | ro | Manufacturer's designation |
| $1009_h$ | | Mfg. hardware version | VAR | Vis String8 | ro | Hardware version |
| $100A_h$ | | Mfg. software version | VAR | Vis String8 | ro | Software version |
| $100C_h$ | | Guard time | VAR | Unsigned16 | rw | Time span for Node Guarding [ms] |
| $100D_h$ | | Life time factor | VAR | Unsigned8 | rw | Repeat factor for Node Guarding |
| $1010_h$ | | Store parameters | ARR | Unsigned32 | | Store parameters |
| | $00_h$ | Largest sub-index | VAR | Unsigned8 | ro | Largest sub-index supported» $04_h$ |
| | $01_h$ | Save all parameters | VAR | Unsigned32 | rw | Save all parameters |
| | $02_h$ | Save communication | VAR | Unsigned32 | rw | Save Communication Parameters |
| | $03_h$ | Save application | VAR | Unsigned32 | rw | Save Application Parameters |
| | $04_h$ | Save manufacturer | VAR | Unsigned32 | rw | Save Manufacturer Parameters |
| $1011_h$ | | Restore defaults | ARR | Unsigned32 | | Restore defaults as group |
| | $00_h$ | Largest sub-index | VAR | Unsigned8 | ro | Largest sub-index supported» $04_h$ |
| | $01_h$ | Restore all defaults | VAR | Unsigned32 | rw | Restore all defaults |
| | $02_h$ | Restore communication | VAR | Unsigned32 | rw | Restore Communication defaults |
| | $03_h$ | Restore application | VAR | Unsigned32 | rw | Restore Application defaults |
| | $04_h$ | Restore manufacturer | VAR | Unsigned32 | rw | Restore Manufacturer defaults |
| $1012_h$ | | COB-ID time stamp | VAR | Unsigned32 | rw | COB-ID time stamp message |
| $1014_h$ | | COB-ID EMCY | VAR | Unsigned32 | rw | $80_h$ + Node ID |
| $1015_h$ | | Inhibit time EMCY | VAR | Unsigned16 | rw | Wait time for the repeated transmission of EMCY x 100 µS |
| $1017_h$ | | Producer Heartbeat Time | VAR | Unsigned16 | rw | Time interval for producer «Heartbeat» |
| $1018_h$ | | Identity | REC | | ro | Indentification object |
| | $00_h$ | Largest sub-index | VAR | Unsigned8 | ro | Largest sub-index supported» $04_h$ |
| | $01_h$ | Vendor ID | VAR | Unsigned32 | ro | Vendor ID |
| | $02_h$ | Product code | VAR | Unsigned32 | ro | Product code |
| | $03_h$ | Revision number | VAR | Unsigned32 | ro | Revision number |
| | $04_h$ | Serial number | VAR | Unsigned32 | ro | Serial number |
| $1400_h$ | | 1st R_PDO parameter | REC | | | 1st receive PDO parameter |
| | $00_h$ | Largest sub-index | VAR | Unsigned8 | ro | Largest sub-index supported» $05_h$ |
| | $01_h$ | COB-ID used | VAR | Unsigned32 | rw | COB-ID used: $200_h$ + Node ID |
| | $02_h$ | Transmission type | VAR | Unsigned8 | rw | Default type = 255 (asynchronous) |
| | $03_h$ | Inhibit time | VAR | Unsigned16 | rw | Default = 0 |
| | $05_h$ | Event timer | VAR | Unsigned16 | rw | Default = 0 |

| Index | Sub-index | Name | Obj. code | Data type | Access | Description |
|---|---|---|---|---|---|---|
| $1401_h$ | | 2nd R_PDO parameter | REC | | | 2nd receive PDO parameter |
| | $00_h$ | Largest sub-index | VAR | Unsigned8 | ro | Largest sub-index supported» $05_h$ |
| | $01_h$ | COB-ID used | VAR | Unsigned32 | rw | COB-ID used: $300_h$ + Node ID |
| | $02_h$ | Transmission type | VAR | Unsigned8 | rw | Default type = 255 (asynchronous) |
| | $03_h$ | Inhibit time | VAR | Unsigned16 | rw | Default = 0 |
| | $05_h$ | Event timer | VAR | Unsigned16 | rw | Default = 0 |
| $1402_h$ | | 3rd R_PDO parameter | REC | | | 3rd receive PDO parameter |
| | $00_h$ | Largest sub-index | VAR | Unsigned8 | ro | Largest sub-index supported» $05_h$ |
| | $01_h$ | COB-ID used | VAR | Unsigned32 | rw | COB-ID used: $400_h$ + Node ID |
| | $02_h$ | Transmission type | VAR | Unsigned8 | rw | Default type = 255 (asynchronous) |
| | $03_h$ | Inhibit time | VAR | Unsigned16 | rw | Default = 0 |
| | $05_h$ | Event timer | VAR | Unsigned16 | rw | Default = 0 |
| $1600_h$ | | 1st R_PDO mapping | REC | | ro | PDO mapping for R_PDO1, settings |
| | $00_h$ | # of mapped objects | VAR | Unsigned8 | rw | Number of mapped objects, range 1 – 64 |
| | $01_h$ - $08_h$ | Application Objects | VAR | Unsigned32 | rw | R_PDO1 mapping applicatiopn objects |
| $1601_h$ | | 2nd R_PDO mapping | REC | | ro | PDO mapping for R_PDO2, settings |
| | $00_h$ | # of mapped objects | VAR | Unsigned8 | rw | Number of mapped objects, range 1 – 64 |
| | $01_h$ - $08_h$ | Application Objects | VAR | Unsigned32 | rw | R_PDO2 mapping applicatiopn objects |
| $1602_h$ | | 3rd R_PDO mapping | REC | | ro | PDO mapping for R_PDO2, settings |
| | $00_h$ | # of mapped objects | VAR | Unsigned8 | rw | Number of mapped objects, range 1 – 64 |
| | $01_h$ - $08_h$ | Application Objects | VAR | Unsigned32 | rw | R_PDO3 mapping applicatiopn objects |
| $1800_h$ | | 1st T_PDO parameter | REC | | | 1st transmit PDO parameter |
| | $00_h$ | Largest sub-index | VAR | Unsigned8 | ro | Largest sub-index supported» $05_h$ |
| | $01_h$ | COB-ID used | VAR | Unsigned32 | rw | COB-ID used: $180_h$ + Node ID |
| | $02_h$ | Transmission type | VAR | Unsigned8 | rw | Default type = 255 (asynchronous) |
| | $03_h$ | Inhibit time | VAR | Unsigned16 | rw | Default = 0 |
| | $05_h$ | Event timer | VAR | Unsigned16 | rw | Default = 0 |
| $1801_h$ | | 2nd T_PDO parameter | REC | | | 2nd transmit PDO parameter |
| | $00_h$ | Largest sub-index | VAR | Unsigned8 | ro | Largest sub-index supported» $05_h$ |
| | $01_h$ | COB-ID used | VAR | Unsigned32 | rw | COB-ID used: $280_h$ + Node ID |
| | $02_h$ | Transmission type | VAR | Unsigned8 | rw | Default type = 255 (asynchronous) |
| | $03_h$ | Inhibit time | VAR | Unsigned16 | rw | Default = 0 |
| | $05_h$ | Event timer | VAR | Unsigned16 | rw | Default = 0 |
| $1802_h$ | | 3rd T_PDO parameter | REC | | | 3rd transmit PDO parameter |
| | $00_h$ | Largest sub-index | VAR | Unsigned8 | ro | Largest sub-index supported» $05_h$ |
| | $01_h$ | COB-ID used | VAR | Unsigned32 | rw | COB-ID used: $380_h$ + Node ID |
| | $02_h$ | Transmission type | VAR | Unsigned8 | rw | Default type = 255 (asynchronous) |
| | $03_h$ | Inhibit time | VAR | Unsigned16 | rw | Default = 0 |
| | $05_h$ | Event timer | VAR | Unsigned16 | rw | Default = 0 |

| Index | Sub-index | Name | Obj. code | Data type | Access | Description |
|---|---|---|---|---|---|---|
| $1A00_h$ | | 1st T_PDO mapping | REC | | ro | PDO mapping for T_PDO1, settings |
| | $00_h$ | # of mapped objects | VAR | Unsigned8 | rw | Number of mapped objects, range 1 – 64 |
| | $01_h$ - $08_h$ | Application Objects | VAR | Unsigned32 | rw | T_PDO1 mapping applicatiopn objects |
| $1A01_h$ | | 2nd T_PDO mapping | REC | | ro | PDO mapping for T_PDO2, settings |
| | $00_h$ | # of mapped objects | VAR | Unsigned8 | rw | Number of mapped objects, range 1 – 64 |
| | $01_h$ - $08_h$ | Application Objects | VAR | Unsigned32 | rw | T_PDO2 mapping applicatiopn objects |
| $1A02_h$ | | 3rd T_PDO mapping | REC | | ro | PDO mapping for T_PDO3, settings |
| | $00_h$ | # of mapped objects | VAR | Unsigned8 | rw | Number of mapped objects, range 1 – 64 |
| | $01_h$ - $08_h$ | Application Objects | VAR | Unsigned32 | rw | T_PDO3 mapping applicatiopn objects |

## 8.3 Overview of manufacturer specific objects group $2000_h$

| Index | Sub | Name | Obj. code | Data type | Access | PDO | Description |
|---|---|---|---|---|---|---|---|
| $2000_h$ | | Configure GPIO | ARR | | | | Configure the general purpose I/O points |
| | $00_h$ | Number of entries | VAR | Unsigned8 | ro | | Number of entries = $05_h$ |
| | $01_h$ | Configure as in/out | VAR | Unsigned8 | rw | | Configure the I/O point as an output or input |
| | $02_h$ | Configure sink/source | VAR | Unsigned8 | rw | | Configure the I/O point as sourcing or sinking |
| | $03_h$ | Configure as both | VAR | Unsigned8 | rw | | Configure as both sink/source or source only |
| | $04_h$ | Configure polarity in | VAR | Unsigned8 | rw | | Configure input logic polarity |
| | $05_h$ | Configure polarity out | VAR | Unsigned8 | rw | | Configure output logic polarity |
| $2002_h$ | | Configure digital inputs | ARR | | | | Configure the functions of inputs |
| | $00_h$ | Number of entries | VAR | Unsigned8 | ro | | Number of entries = $04_h$ |
| | $01_h$ | Define as Home switch | VAR | Unsigned8 | rw | | Configure input as homing switch |
| | $02_h$ | Define as positive limit | VAR | Unsigned8 | rw | | Configure input as positive limit switch |
| | $03_h$ | Define as negative limit | VAR | Unsigned8 | rw | | Configure input as negative limit switch |
| | $04_h$ | Define as inhibit switch | VAR | Unsigned8 | rw | | Configure input as inhibit switch (see $2007_h$) |
| $2004_h$ | | Input mask | ARR | | | | Configure input filter mask |
| | $00_h$ | Number of entries | VAR | Unsigned8 | ro | | Number of entries = $08_h$ |
| | $01_h$ - $08_h$ | Input filter mask | VAR | Unsigned8 | rw | | Defines inputs to apply filtering (see $2006_h$) |
| $2006_h$ | | Input filter time | ARR | | | | Configure input filter time |
| | $00_h$ | Number of entries | VAR | Unsigned8 | ro | | Number of entries = $08_h$ |
| | $01_h$ - $08_h$ | Input filter time | VAR | Unsigned8 | rw | | Defines inputs filter time in ms |
| $2007_h$ | | Inhibit switch | ARR | | | | Configure inhibit switch |
| | $00_h$ | Number of entries | VAR | Unsigned8 | ro | | Number of entries = $01_h$ |
| | $01_h$ | Input switch action | VAR | Unsigned8 | rw | | Defines the action of the inhibit switch |
| $2008_h$ | | Configure digital outputs | ARR | | | | Configure output functions |
| | $00_h$ | Number of entries | VAR | Unsigned8 | ro | | Number of entries = $02_h$ |
| | $01_h$ | Brake output defined | VAR | Unsigned8 | rw | | Defines the output(s) used for braking |
| | $02_h$ | Target reached output | VAR | Unsigned8 | rw | | Defines the output used to indicate target reached |
| $2010_h$ | | Analog input configuration | ARR | | | | Configure the analog input |
| | $00_h$ | Number of entries | VAR | Unsigned8 | ro | | Number of entries = $03_h$ |
| | $01_h$ | Analog input read value | VAR | Unsigned16 | ro | T_PDO | Analog input value |
| | $02_h$ | Analog input scale | VAR | Unsigned8 | rw | | Sets the mode as 0 - 5V, 0 - 10V or 0 - 20mA |
| | $03_h$ | Analog input filter | VAR | Unsigned8 | rw | | Defines the filtering for the analog input |
| $2018_h$ | | Temperature parameters | ARR | | | | Set the internal temperature parameters |
| | $00_h$ | Number of entries | VAR | Unsigned8 | ro | | Number of entries = $03_h$ |
| | $01_h$ | Internal temperature | VAR | Integer8 | ro | T_PDO | Internal temperature reading |
| | $02_h$ | Set temperature warning | VAR | Integer8 | rw | | Set temperature warning threshold |
| | $03_h$ | Set temperature fault | VAR | Integer8 | rw | | Set temperature fault threshold |
| $2020_h$ | | Limit reached | ARR | | | | Limit reached |
| | $00_h$ | Number of entries | VAR | Unsigned8 | ro | | Number of entries = $02_h$ |
| | $01_h$ | Limit reached flag | VAR | Unsigned8 | rw | | Indicates type of limit reached |
| | $02_h$ | Limit reached mask | VAR | Unsigned8 | rw | | Defines limits to act upon |

| Index | Sub | Name | Obj. code | Data type | Access | PDO | Description |
|---|---|---|---|---|---|---|---|
| $2022_h$ | | Software limit | ARR | | | | Actual position softwre limit |
| | $00_h$ | Number of entries | VAR | Unsigned8 | ro | | Number of entries = $02_h$ |
| | $01_h$ | Actual negative limit | VAR | Interger32 | rw | | Actual negative limit |
| | $02_h$ | Actual positive limit | VAR | Interger32 | rw | | Actual positive limit |
| $2030_h$ | | Output bridge polarity | VAR | Integer8 | rw | | Defines the polarity of the output bridge |
| $2031_h$ | | Unit options | VAR | Unsigned8 | rw | | Enable encoder, capture/trip functions |
| $2032_h$ | | Step/direction options | ARR | | | | Set option for step/direction I/O |
| | $00_h$ | Number of entries | VAR | Unsigned8 | ro | | Number of entries = $02_h$ |
| | $01_h$ | Clock type | VAR | Unsigned8 | rw | | Sets the clock type: step/dir, quadrature, up/ down or square wave out |
| | $02_h$ | Clock pulse widts | VAR | Unsigned8 | rw | | Sets the clock output pulse width |
| $2033_h$ | | Capture input parameters | REC | | | | Capture input parameters |
| | $00_h$ | Number of entries | VAR | Unsigned8 | ro | | Number of entries = $04_h$ |
| | $01_h$ | Capture input control | VAR | Unsigned8 | rw | | Enables the capture input |
| | $02_h$ | Capture input flag | VAR | Unsigned8 | rw | | Displays the status of a position capture |
| | $03_h$ | Capture input filter | VAR | Unsigned8 | rw | | Sets the filtering for the capture input |
| | $04_h$ | Captured position | VAR | Integer32 | ro | T_PDO | Stores the captured position |
| $2034_h$ | | Bridge on settle time | ARR | | | | Settling time after bridge power on |
| | $00_h$ | Number of entries | VAR | Unsigned8 | ro | | Number of entries = $01_h$ |
| | $01_h$ | Bridge settle time | VAR | Unsigned8 | rw | | Bidge settling time in msec |
| $2035_h$ | | Brake settle allow time | | | | | Settling time after brake on/off |
| | $00_h$ | Number of entries | VAR | Unsigned8 | ro | | Number of entries = $02_h$ |
| | $01_h$ | Brake on settle time | VAR | Unsigned8 | rw | | Brake on settling time in msec |
| | $02_h$ | Brake off settle time | VAR | Unsigned8 | rw | | Brake off settling time in msec |
| $2036_h$ | | Hold current delay time | VAR | Unsigned16 | rw | | Defines time in msec to transition to hold current following cessation of motion |
| $2037_h$ | | Bridge on to encoder settle time | VAR | Unsigned16 | rw | | Time between switching into operation enable to resynching the encoder position |
| $2038_h$ | | Trip output configuration | REC | | | | Trip output parameters |
| | $00_h$ | Number of entries | VAR | Unsigned8 | ro | | Number of entries = $03_h$ |
| | $01_h$ | Trip output control | VAR | Unsigned16 | rw | | Controls logic and trip points |
| | $02_h$ | 1st position of a series | VAR | Integer32 | rw | | First trip position |
| | $03_h$ | Multiple trip point spacing | VAR | Integer32 | rw | | Defines the spacing between subsequent trip points |
| $2098_h$ | | Homing configuration | VAR | Unsigned8 | rw | | Defines the counter status following a home |
| $2203_h$ | | Calibration current | VAR | Unsigned8 | rw | | Defines the current percent for calibration (Hybrid only) |
| $2204_h$ | | Run current | VAR | Unsigned8 | rw | | Sets the motor run current percent |
| $2205_h$ | | Hold current | VAR | Unsigned8 | rw | | Sets the motor hold current percent |
| $2211_h$ | | Position present point target | VAR | Integer32 | ro | | Position present point target |
| $2212_h$ | | Position final point target | VAR | Integer32 | ro | | Position final point target |
| $2401_h$ | | Gen Purpose user variable | VAR | Unsigned8 | rw | | May be used to store 8 bits of data |
| $2504_h$ | | SEM options | VAR | Unsigned8 | rw | | SEM control options for compatibility |

| Index | Sub | Name | Obj. code | Data type | Access | PDO | Description |
|---|---|---|---|---|---|---|---|
| $2701_h$ | | Hybrid enable | VAR | Unsigned8 | rw | | Enable/disable Hybrid control (Hybrid only) |
| $2702_h$ | | Make up mode | VAR | Unsigned8 | rw | | Defines Hybrid make up mode (Hybrid only) |
| $2703_h$ | | Make up velocity | VAR | Unsigned32 | rw | | Defines the velocity for make up (Hybrid only) |
| $2741_h$ | | Hybrid status | VAR | Unsigned8 | ro | T_PDO | Reads the hybrid status (Hybrid only) |

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## 8.4 Overview of assignment objects group $6000_h$

| Index | Sub | Name | Obj. code | Data type | Access | PDO | Description |
|---|---|---|---|---|---|---|---|
| $6007_h$ | | Abort connection opcode | VAR | Integer16 | rw | | Controls the process for abort connection |
| $603F_h$ | | Error code | VAR | Unsigned16 | ro | T_PDO | Stores the last error |
| $6040_h$ | | Control word | VAR | Unsigned16 | rw | R_PDO | Control word |
| $6041_h$ | | Status word | VAR | Unsigned16 | ro | T_PDO | Status word |
| $605A_h$ | | Quick stop option code | VAR | Integer16 | rw | | Defines the method for quick stop |
| $605B_h$ | | Shutdown option code | VAR | Integer16 | rw | | Defines the method for shutdown |
| $605C_h$ | | Disable operation opcode | VAR | Integer16 | rw | | Defines the method for disable operation |
| $605D_h$ | | Halt operation opcode | VAR | Integer16 | rw | | Defines the method for halt operation |
| $605E_h$ | | Fault reaction opcode | VAR | Integer16 | rw | | Defines the reaction to a fault |
| $6060_h$ | | Modes of operation | VAR | Integer8 | rw | R_PDO | Set the mode of operation |
| $6061_h$ | | Modes of operation display | VAR | Integer8 | ro | T_PDO | read the mode of operation |
| $6062_h$ | | Position demand value | VAR | Integer32 | ro | T_PDO | Read the motor position in user units |
| $6063_h$ | | Position actual value | VAR | Integer32 | ro | T_PDO | Read the motor position |
| $6064_h$ | | Position actual value | VAR | Integer32 | ro | T_PDO | Read the motor position |
| $6065_h$ | | Following error window | VAR | Unsigned32 | rw | | Defines range of tolerated positions symetrical to $6062_h$ |
| $6066_h$ | | Following error window time | VAR | Unsigned16 | rw | | Defines the timeout for the next error window |
| $6067_h$ | | Position window | VAR | Unsigned32 | rw | | Defines accepted positions relative to target |
| $6068_h$ | | Position window timeout | VAR | Unsigned16 | rw | | Defines time to indicate target reached |
| $606C_h$ | | Velocity actual value | VAR | Integer32 | ro | T_PDO | Actual velocity of the motor |
| $607A_h$ | | Profiled target position | VAR | Integer32 | rw | R_PDO | Defines target position for absolute or relative move |
| $607C_h$ | | Homing offset | VAR | Integer32 | rw | | Defines offset from homing zero position |
| $607E_h$ | | Polarity | VAR | Unsigned8 | rw | R_PDO | Sets polarity for position/speed commands |
| $6081_h$ | | Profile velocity | VAR | Unsigned32 | rw | R_PDO | Sets the velocity for the profile position motion |
| $6082_h$ | | End velocity | VAR | Unsigned32 | rw | R_PDO | Sets the terminal (max) velocity |
| $6083_h$ | | Profile acceleration | VAR | Unsigned32 | rw | R_PDO | Sets the acceleration for profile position and profile velocity motion |
| $6084_h$ | | Profile deceleration | VAR | Unsigned32 | rw | R_PDO | Sets the deceleration for profile position and profile velocity motion |
| $6085_h$ | | Quick stop deceleration | VAR | Unsigned32 | rw | | Sets the deceleration for a quick stop state |
| $6086_h$ | | Motion profile type | VAR | Integer16 | rw | R_PDO | Defines method by which profile motion is evaluated |
| $608F_h$ | | Position encoder resolution | ARR | | | | Defines relation between motor revolution and position increments |
| | $00_h$ | Number of entries | VAR | Unsigned8 | ro | | Number of entries = $02_h$ |
| | $01_h$ | Resolution numerator | VAR | Unsigned32 | rw | | # of encoder increments |
| | $02_h$ | Resolution denominator | VAR | Unsigned32 | rw | | # of motor revolutions |

| Index | Sub | Name | Obj. code | Data type | Access | PDO | Description |
|---|---|---|---|---|---|---|---|
| $6092_h$ | | Factor group feed and driveshaft | ARR | | | | Defines relation between feed user units and pdrive shaft revolutions |
| | $00_h$ | Number of entries | VAR | Unsigned8 | ro | | Number of entries = $02_h$ |
| | $01_h$ | Feed numerator | VAR | Unsigned32 | rw | | # of feed increments |
| | $02_h$ | Driveshaft denominator | VAR | Unsigned32 | rw | | # of driveshaft revolutions |
| $6098_h$ | | Homing method | VAR | Integer8 | rw | | Defines the method for homing operation |
| $6099_h$ | | Homing speed | ARR | | | | Defines the high and low speeds for homing |
| | $00_h$ | Number of entries | VAR | Unsigned8 | ro | | Number of entries = $02_h$ |
| | $01_h$ | Homing speed fast | VAR | Unsigned32 | rw | | Defines the high speed for homing |
| | $02_h$ | Homing speed slow | VAR | Unsigned32 | rw | | Defines the low speed for homing |
| $60C2_h$ | | Interpolated position time period | REC | | | | Defines time for interpolation position trajectory. |
| | $00_h$ | Number of entries | VAR | Unsigned8 | ro | | Number of entries = $02_h$ |
| | $01_h$ | Interpoltion period | VAR | Unsigned8 | rw | | Interpoltion time period |
| | $02_h$ | Interpolation factor | VAR | Integer8 | rw | | Interpolation factor |
| $60F8_h$ | | Maximum slippage | VAR | Integer32 | rw | | Maximum slippage |
| $60FD_h$ | | Digital inputs | VAR | Unsigned32 | ro | T_PDO | Reads the state of digital inputs |
| $60FE_h$ | | Digital outputs | ARR | | | | Sets the state of digital outputs |
| | $00_h$ | Number of entries | VAR | Unsigned8 | ro | | Number of entries = $01_h$ |
| | $01_h$ | Digital outputs | VAR | Unsigned32 | rw | R_PDO | Reads the state of digital inputs |
| $60FF_h$ | | Target velocity | VAR | Integer32 | rw | R_PDO | Defines the target velocity |
| $6402_h$ | | Motor types | VAR | Unsigned16 | ro | | Motor type = 9: Stepper motor |
| $6502_h$ | | Supported drive modes | VAR | Unsigned32 | ro | | Profile position, profile velocity, homing |

# 8.5 Details of object group $1000_h$

## 8.5.1 $1000_h$ Device type

The object specifies the device profile used as well as the device type.

*Object description*

| | |
|---|---|
| Index | $1000_h$ |
| Name | Device type |
| Object code | VAR |
| Data type | Unsigned32 |

*Value description*

| | |
|---|---|
| Sub-index | $00_h$, device type |
| Meaning | Device type and profile |
| Access | Read only |
| PDO mapping | — |
| Value range | — |
| Default value | 0044 $0192_h$ |
| Category | — |

*Bit coding sub-index $00_h$*

| Bit | Access | Value | Meaning |
|---|---|---|---|
| 31-16 | ro | $0044_h$ | Stepper motor |
| 15-0 | ro | $0192_h$ | Device profile DSP402 |

## 8.5.2 $1001_h$ Error register

The object specifies the error of the device. The detailed cause of error can be determined with the object `predefined error field (1003h)` and - for reasons of compatibility with devices with other fieldbus profiles - with the object `error code (603Fh)`.

Errors are signaled by an EMCY message as soon as they occur.

*Object description*

| | |
|---|---|
| Index | $1001_h$ |
| Name | Error register |
| Object code | VAR |
| Data type | Unsigned8 |

*Value description*

| | |
|---|---|
| Sub-index | $00_h$, error register |
| Meaning | Error register |
| Access | Read only |
| PDO mapping | — |
| Value range | — |
| Default value | — |
| Category | — |

*Bit coding sub-index $00_h$*

| Bit | Access | Value | Meaning |
|---|---|---|---|
| 0 | ro | — | Error (generic error) |
| 1 | ro | — | Reserved |
| 2 | ro | — | Reserved |
| 3 | ro | — | Temperature |
| 4 | ro | — | Communication profile (communication error) |
| 5 | ro | — | Reserved |
| 6 | ro | — | Reserved |
| 7 | ro | — | Manufacturer specific |

### 8.5.3 $1003_h$ Pre-defined error field

The object contains the latest error messages that were shown as EMCY messages.

- The sub-index 00h entry contains the number of saved error messages.
- The current error message is stored at sub-index 01h, older messages are moved to higher sub-index entries.
- Writing 0 to sub-index 00h resets the error list.

*Object description*

| | |
|---|---|
| Index | $1003_h$ |
| Name | Pre-defined error field |
| Object code | ARRAY |
| Data type | Unsigned32 |

*Value description*

| | |
|---|---|
| Sub-index | $00_h$, number of errors |
| Meaning | Number of error entries |
| Access | Read-write |
| PDO mapping | — |
| Value range | 0 ... 4 |
| Default value | 0 |
| Category | — |

| | |
|---|---|
| Sub-index | $01_h$ – $04_h$, error field |
| Meaning | Error number |
| Access | Read only |
| PDO mapping | — |
| Value range | — |
| Default value | 0 |
| Category | — |

*Bit coding sub-index $00_h$ ... $04_h$*

Bytes 0 ... 15: error code. Bytes 16 ... 31 additional error information, not assigned in the device.

### 8.5.4 $1005_h$ COB ID SYNC message

The object specifies the COB ID of the SYNC object and determines whether a device sends or receives SYNC messages.

The device can only receive SYNC messages.

For synchronization, a device in the network must send SYNC objects.

The COB ID can be changed in the NMT state “Pre-Operational”

*Object description*

| | |
|---|---|
| Index | $1005_h$ |
| Name | COB ID SYNC |
| Object code | VAR |
| Data type | Unsigned32 |

*Value description*

| | |
|---|---|
| Sub-index | $00_h$, COB ID SYNC |
| Meaning | Identifier of the synchronization object |
| Access | Read-write |
| PDO mapping | — |
| Value range | 0...4294967295 |
| Default value | 0000 $0080_h$ |
| Category | Yes |

*Bit coding sub-index $00_h$*

| Bit | Access | Value | Meaning |
|---|---|---|---|
| 31 | ro | $0_b$ | |
| 30 | ro | $0_b$ | |
| 29 | ro | $0_b$ | |
| 28-11 | ro | $0000_h$ | |
| 10-7 | rw | $0001_b$ | |
| 6-0 | ro | $7F_h$ | |

### 8.5.5 $1007_h$ Sync window length

Contains the length of the time window for synchronous PDOs in micro-seconds.

*Object description*

| | |
|---|---|
| Index | $1007_h$ |
| Name | Sync window length |
| Object code | VAR |
| Data type | Unsigned32 |

*Value description*

| | |
|---|---|
| Sub-index | $00_h$, Sync window length |
| Meaning | Timing for sync PDOs |
| Access | Read-write |
| PDO mapping | — |
| Value range | Unsigned32 |
| Default value | 0000 $0000_h$ |
| Category | Yes |

### 8.5.6 $1008_h$ Mfg. device name

Provides the name of the device as given by the manufacturer.

*Object description*

| | |
|---|---|
| Index | $1008_h$ |
| Name | Manufacturer device name |
| Object code | VAR |
| Data type | Visible String |

*Value description*

| | |
|---|---|
| Sub-index | $00_h$, Manufacturer device name |
| Meaning | Manufacturer device name |
| Access | Read only |
| PDO mapping | — |
| Value range | Visible String |
| Default value | CANopen MDrive Motion Control Node |
| Category | — |

### 8.5.7 $1009_h$ Mfg. hardware version

Provides the hardware version of the device as given by the manufacturer.

*Object description*

| | |
|---|---|
| Index | $1009_h$ |
| Name | Manufacturer hardware version |
| Object code | VAR |
| Data type | Visible String |

*Value description*

| | |
|---|---|
| Sub-index | $00_h$, Manufacturer hardware version |
| Meaning | Manufacturer hardware version |
| Access | Read only |
| PDO mapping | — |
| Value range | Visible String |
| Default value | V1.00 |
| Category | — |

### 8.5.8 $100A_h$ Mfg. software version

Provides the software version of the device as given by the manufacturer.

*Object description*

| | |
|---|---|
| Index | $100A_h$ |
| Name | Manufacturer software version |
| Object code | VAR |
| Data type | Visible String |

*Value description*

| | |
|---|---|
| Sub-index | $00_h$, Manufacturer software version |
| Meaning | Manufacturer software version |
| Access | Read only |
| PDO mapping | — |
| Value range | Visible String |
| Default value | V5.48 |
| Category | — |

### 8.5.9 $100C_h$ Guard time

The object specifies the time span for connection monitoring (Node Guarding) of an NMT slave.

The time span for connection monitoring of an NMT master results from the time span “guard time” multiplied by the factor “life time”, object `Life time factor(100Dh)`.

The time span can be changed in the NMT state “Pre-Operational”.

*Object description*

| | |
|---|---|
| Index | $100C_h$ |
| Name | Guard time |
| Object code | VAR |
| Data type | Unsigned16 |

*Value description*

| | |
|---|---|
| Sub-index | $00_h$, Guard time |
| Meaning | Guard time |
| Access | Read-write |
| PDO mapping | — |
| Value range | 0...65535 |
| Default value | $0000_h$ |
| Category | Yes |

## 8.5.10 $100D_h$ Life time factor

The object specifies the factor that, together with the time span “guard time”, results in the time interval for connection monitoring of an NMT master. Within this period, the NMT slave device expects a monitoring request via Node Guarding from the NMT master.

life time = guard time * life time factor

The value “0” deactivates monitoring of the NMT master.

If there is no connection monitoring through the NMT master during the time interval “life time”, the device signals an error and switches to the operating state Fault.

The time factor can be changed in the NMT state “Pre-Operational”. The time span “guard time” is set with the object `Guard time (100Ch)`.

*Object description*

| | |
|---|---|
| Index | $100D_h$ |
| Name | Life time factor |
| Object code | VAR |
| Data type | Unsigned8 |

*Value description*

| | |
|---|---|
| Sub-index | $00_h$, Life time factor |
| Meaning | Life time factor |
| Access | Read-write |
| PDO mapping | — |
| Value range | 0...255 |
| Default value | $00_h$ |
| Category | Yes |

### 8.5.10 $1010_h$ Store parameters

This object supports the saving of parameters in non volatile memory. By read access the device provides information about its saving capabilities. Several parameter groups are distinguished:

- Sub-Index 0 contains the largest Sub-Index that is supported.
- Sub-Index 1 refers to all parameters that can be stored on the device.
- Sub-Index 2 refers to communication related parameters (`Index` $1000_h$ `-` $1FFF_h$ manufacturer specific communication parameters).
- Sub-Index 3 refers to application related parameters (`Index` $6000_h$ `-` $9FFF_h$ manufacturer specific application parameters).
- Sub-index 4 refers to manufacturer specific parameters.

In order to avoid storage of parameters by mistake, storage is only executed when a specific signature is written to the appropriate Sub-Index. The signature is “save“.

| Signature ISO 8859 | MSB | | | LSB |
|---|---|---|---|---|
| ASCII | e | v | a | s |
| hex | 65h | 76h | 61h | 73h |

Figure 8.1: Storage write access signature

On reception of the correct signature in the appropriate sub-index the device stores the parameter and then confirms the SDO transmission (initiate download response). If the storing failed, the device responds with an Abort SDO Transfer (`abort code: 0606 0000`$_h$).

If a wrong signature is written, the device refuses to store and responds with Abort SDO Transfer (`abort code: 0800 002x`$_h$).

On read access to the appropriate Sub-Index the device provides information about its storage functionality with the following format:

| | Unsigned32 | | |
|---|---|---|---|
| | MSB | | LSB |
| bits | 31 ... 2 | 1 | 0 |
| | Reserved (=0) | 0/1 | 0/1 |

Figure 8.2: Storage read access structure

| Bit | Value | Meaning |
|---|---|---|
| 31 ... 2 | 0 | Reserved (=0) |
| 1 | 0 | Device does not save the parameters autonomously |
| | 1 | Device does save the parameters autonomously |
| 2 | 0 | Device does not save the parameters on command |
| | 1 | Device does save the parameters on command |

Table 8.1: Structure of read access

Autonomous saving means that a device stores the storable parameters in a non-volatile manner without user request.

*Object description*

| | |
|---|---|
| Index | $1010_h$ |
| Name | Store parameters |
| Object code | Array |
| Data type | Unsigned32 |

*Value description*

| | |
|---|---|
| Sub-index | 00h, Largest supported sub-index |
| Meaning | Largest supported sub-index |
| Access | Read only |
| PDO mapping | — |
| Value range | 1h - 4h |
| Default value | 4h |
| Category | — |

| | |
|---|---|
| Sub-index | $01_h$, Save all parameters |
| Meaning | Save all parameters |
| Access | Read-write |
| PDO mapping | — |
| Value range | Unsigned32 |
| Default value | — |
| Category | — |

| | |
|---|---|
| Sub-index | $02_h$, Save communication parameters |
| Meaning | Save communication parameters |
| Access | Read-write |
| PDO mapping | — |
| Value range | Unsigned32 |
| Default value | — |
| Category | — |

| | |
|---|---|
| Sub-index | $03_h$, Save application parameters |
| Meaning | Save application parameters |
| Access | Read-write |
| PDO mapping | — |
| Value range | Unsigned32 |
| Default value | — |
| Category | — |

| | |
|---|---|
| Sub-index | $04_h$, Save manufacturer parameters |
| Meaning | Save manufacturer parameters |
| Access | Read-write |
| PDO mapping | — |
| Value range | Unsigned32 |
| Default value | — |
| Category | — |

### 8.5.11 $1011_h$ Restore default parameters

With this object the default values of parameters according to the communication or device profile are restored. By read access the device provides information about its capabilities to restore these values. Several parameter groups are distinguished:

1) Sub-Index 0 contains the largest Sub-Index that is supported.
2) Sub-Index 1 refers to all parameters that can be restored.Sub-Index 2 refers to communication related parameters (`Index` $1000_h$ - $1FFF_h$ manufacturer specific communication parameters).
3) Sub-Index 3 refers to application related parameters (`Index` $6000_h$ - $9FFF_h$ manufacturer specific application parameters).
4) At Sub-Index 4 - 127 manufacturers may restore their individual choice of parameters.
5) Sub-Index 128 - 254 are reserved for future use.

In order to avoid the restoring of default parameters by mistake, restoring is only executed when a specific signature is written to the appropriate sub-index. The signature is “load”.

| Signature ISO 8859 | MSB | | | LSB |
|---|---|---|---|---|
| ASCII | d | a | o | l |
| hex | 64h | 61h | 6Fh | 6Ch |

Figure 8.3: Restore default parameters write access signature.

On reception of the correct signature in the appropriate sub-index the device restores the default parameters and then confirms the SDO transmission (initiate download response). If the restoring failed, the device responds with an Abort SDO Transfer (`abort code: 0606 0000`$_h$). If a wrong signature is written, the device refuses to restore the defaults and responds with an Abort SDO Transfer (`abort code: 0800 002x`$_h$).

The default values are set valid after the device is reset (reset node for sub-index $1_h$ – $4_h$, reset communication for sub-index 2h) or power cycled.

On read access to the appropriate sub-index the device provides parameter restoring capability with the following format:

Unsigned32

| | MSB | | LSB |
|---|---|---|---|
| bits | 31 ... 1 | | 0 |
| | Reserved (=0) | | 0/1 |

Figure 8.4: Restore default parameters write access structure.

| Bit | Value | Meaning |
|---|---|---|
| 31 ... 1 | 0 | Reserved (=0) |
| 1 | 0 | Device does not restore the default parameters |
| | 1 | Device does restore the default parameters |

Table 8.2: Structure of write access

*Object description*

| | |
|---|---|
| Index | $1011_h$ |
| Name | Restore default parameters |
| Object code | Array |
| Data type | Unsigned32 |

*Value description*

| | |
|---|---|
| Sub-index | 00h, Largest supported sub-index |
| Meaning | Largest supported sub-index |
| Access | Read only |
| PDO mapping | — |
| Value range | 1h - 4h |
| Default value | 4h |
| Category | — |

| | |
|---|---|
| Sub-index | $01_h$, Restore all parameters |
| Meaning | Restore all parameters |
| Access | Read-write |
| PDO mapping | — |
| Value range | Unsigned32 |
| Default value | — |
| Category | — |

| | |
|---|---|
| Sub-index | $02_h$, Restore communication parameters |
| Meaning | Restore communication parameters |
| Access | Read-write |
| PDO mapping | — |
| Value range | Unsigned32 |
| Default value | — |
| Category | — |

| | |
|---|---|
| Sub-index | $03_h$, Restore application parameters |
| Meaning | Restore application parameters |
| Access | Read-write |
| PDO mapping | — |
| Value range | Unsigned32 |
| Default value | — |
| Category | — |

| | |
|---|---|
| Sub-index | $04_h$, Restore manufacturer parameters |
| Meaning | Restore manufacturer parameters |
| Access | Read-write |
| PDO mapping | — |
| Value range | Unsigned32 |
| Default value | — |
| Category | — |

### 8.5.12 $1012_h$ COB-ID time stamp object

Index $1012_h$ defines the COB-ID of the time-stamp object (TIME). Further, it defines whether the device consumes the TIME or whether the device generates the TIME.

| | MSB | | | | LSB |
|---|---|---|---|---|---|
| Bits: | 31 | 30 | 29 | 28 ... 11 | 10 ... 0 |
| 11-bit ID | 0/1 | 0/1 | 0 | 000000000000000000 | 11-bit Indentifier |
| 29-bit ID | 0/1 | 0/1 | 1 | 29-bit Identifier | |

Figure 8.5: Structure of the COB-ID TIME entry

| Bit | Value | Meaning |
|---|---|---|
| 31 (MSB) | 0 | Device does not consume the TIME message |
| | 1 | Device consumes the TIME message |
| 30 | 0 | Device does not produce the TIME message |
| | 1 | Device produces the TIME message |
| 29 | 0 | 11-bit ID (CAN 2.0A) |
| | 1 | 29-bit ID (CAN 2.0B) |
| 28 ... 11 | 0 | If bit 29=0 |
| | X | if bit 29=1: bits 28 ... 11 of 29 bit TIME-COB-ID |
| 10 ... 0 (LSB) | X | Bits 10 ... 0 of TIME-COB-ID |

Table 8.3: Description of the TIME COB-ID entry

Bits 29, 30 may be static (not changeable). If a device is not able to generate TIME messages, an attempt to set bit 30 is responded with an abort message (`abort code: 0609 0030`$_h$). Devices supporting the standard CAN frame type only, an attempt to set bit 29 is responded with an abort message (`abort code: 0609 0030`$_h$). It is not allowed to change Bits 0-29, while the object exists (Bit 30=1).

*Object description*

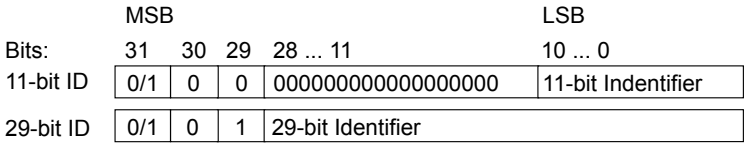
| | |
|---|---|
| Index | $1012_h$ |
| Name | COB-ID time stamp message |
| Object code | VAR |
| Data type | Unsigned32 |

*Value description*

| | |
|---|---|
| Sub-index | 00h, COB-ID time stamp message |
| Meaning | COB-ID time stamp message |
| Access | Read-write |
| PDO mapping | — |
| Value range | Unsigned32 |
| Default value | $0000\ 0100_h$ |
| Category | — |

### 8.5.13 $1014_h$ COB-ID emergency error object

Index 1014h defines the COB-ID of the Emergency Object (EMCY).



| | MSB | | | | LSB |
|---|---|---|---|---|---|
| Bits: | 31 | 30 | 29 | 28 ... 11 | 10 ... 0 |
| 11-bit ID | 0/1 | 0 | 0 | 000000000000000000 | 11-bit Indentifier |
| 29-bit ID | 0/1 | 0 | 1 | 29-bit Identifier | |

Figure 8.6: Structure of the EMCY identifier entry

| Bit | Value | Meaning |
|---|---|---|
| 31 (MSB) | 0 | EMCY exists / is valid |
| | 1 | EMCY does not exist / is not valid |
| 30 | 0 | Reserved (always 0) |
| 29 | 0 | 11-bit ID (CAN 2.0A) |
| | 1 | 29-bit ID (CAN 2.0B) |
| 28 ... 11 | 0 | If bit 29=0 |
| | X | if bit 29=1: bits 28 ... 11 of 29 bit COB-ID |
| 10 ... 0 (LSB) | X | Bits 10 ... 0 of COB-ID |

Table 8.4: Description of the COB-ID entry

Devices supporting the standard CAN frame type only, an attempt to set bit 29 is responded with an abort message (`abort code: 0609 0030`$_h$). It is not allowed to change Bits 0-29, while the object exists (Bit 31=0).

*Object description*

| | |
|---|---|
| Index | $10142_h$ |
| Name | COB-ID emergency message |
| Object code | VAR |
| Data type | Unsigned32 |

*Value description*

| | |
|---|---|
| Sub-index | 00h, COB-ID emergency message |
| Meaning | COB-ID emergency message |
| Access | Read-write |
| PDO mapping | — |
| Value range | Unsigned32 |
| Default value | $0080_h$ + node ID |
| Category | — |

### 8.5.14 $1015_h$ Inhibit time EMCY object

The inhibit time for the EMCY message can be adjusted via this entry. If this entry exists it must be writable in the object dictionary. The time has to be a multiple of 100µs

*Object description*

| | |
|---|---|
| Index | $1015_h$ |
| Name | Inhibit tme EMCY |
| Object code | VAR |
| Data type | Unsigned16 |

*Value description*

| | |
|---|---|
| Sub-index | 00h, Inhibit tme EMCY |
| Meaning | Inhibit tme EMCY |
| Access | Read-write |
| PDO mapping | — |
| Value range | Unsigned16 |
| Default value | $0000_h$ |
| Category | — |

### 8.5.15 $1017_h$ Producer heartbeat time

The producer heartbeat time defines the cycle time of the heartbeat. The producer heartbeat time is 0 if it not used. The time has to be a multiple of 1ms.

*Object description*

| | |
|---|---|
| Index | $1017_h$ |
| Name | Producer heartbeat time |
| Object code | VAR |
| Data type | Unsigned16 |

*Value description*

| | |
|---|---|
| Sub-index | 00h, Producer heartbeat time |
| Meaning | Producer heartbeat time |
| Access | Read-write |
| PDO mapping | — |
| Value range | Unsigned16 |
| Default value | $0000_h$ |
| Category | — |

## 8.5.16 $1018_h$ Identity object

The object at index $1018_h$ contains general information about the device. The Vendor ID (sub-index $1_h$) contains a unique value allocated to each manufacturer.

The manufacturer-specific Product code (sub-index $2_h$) identifies a specific device version. The manufacturer-specific Revision number (sub-index $3_h$) consists of a major revision number and a minor revision number. The major revision number identifies a specific CANopen behaviour. If the CANopen functionality is expanded, the major revision has to be incremented. The minor revision number identifies different versions with the same CANopen behaviour.

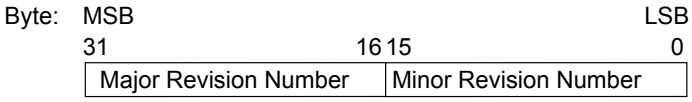



Figure 8.7: Structure of the revision number

The manufacturer-specific serial number (sub-index 4h) identifies a specific device.

*Object description*

| | |
|---|---|
| Index | $1018_h$ |
| Name | Identity object |
| Object code | Array |
| Data type | Unsigned32 |

*Value description*

| | |
|---|---|
| Sub-index | $00_h$, Largest supported sub-index |
| Meaning | Largest supported sub-index |
| Access | Read only |
| PDO mapping | — |
| Value range | $1_h$ - $4_h$ |
| Default value | $4_h$ |
| Category | — |

| | |
|---|---|
| Sub-index | $01_h$, Vendor ID |
| Meaning | Vendor ID |
| Access | Read-only |
| PDO mapping | — |
| Value range | Unsigned32 |
| Default value | 0000 $021B_h$ |
| Category | — |

| | |
|---|---|
| Sub-index | $02_h$, Product code |
| Meaning | Product code |
| Access | Read only |
| PDO mapping | — |
| Value range | Unsigned32 |
| Default value | 0000 $0000_h$ |
| Category | — |

| | |
|---|---|
| Sub-index | $03_h$, Revision number |
| Meaning | Revision number |
| Access | Read only |
| PDO mapping | — |
| Value range | Unsigned32 |
| Default value | 0000 $0507_h$ |
| Category | — |

| | |
|---|---|
| Sub-index | $04_h$, Serial number |
| Meaning | Serial number |
| Access | Read only |
| PDO mapping | — |
| Value range | Unsigned32 |
| Default value | — |
| Category | — |

### 8.5.18 1400 – 1402$_h$ Receive PDO communications parameter

Contains the communication parameters for the PDOs the device is able to receive. The type of the PDO communication parameter (20h) is described in Section 9.5.4 of CiA DS-301: CANopen Application Layer and Communications Profile. The sub-index 0h contains the number of valid entries within the communication record. Its value is at least 2. If inhibit time supported the value is 3. At sub-index 1h resides the COB-ID of the PDO. This entry has been defined as UNSIGNED32 in order to cater for 11-bit CAN Identifiers (CAN 2.0A) as well as for 29-bit CAN identifiers (CAN 2.0B).

| | MSB | | | | LSB |
|---|---|---|---|---|---|
| Bits: | 31 | 30 | 29 | 28 ... 11 | 10 ... 0 |
| 11-bit ID | 0/1 | 0/1 | 0 | 000000000000000000 | 11-bit Indentifier |
| 29-bit ID | 0/1 | 0/1 | 1 | 29-bit Identifier | |

Figure 8.8: Structure of the PDO COB-ID entry

| Bit | Value | Meaning |
|---|---|---|
| 31 (MSB) | 0 | PDO Exists/Is Valid |
| | 1 | PDO Does Not Exist/Is Not Valid |
| 30 | 0 | RTR is Allowed on this PDO |
| | 1 | RTR is Not Allowed on this PDO |
| 29 | 0 | 11-bit ID (CAN 2.0A) |
| | 1 | 29-bit ID (CAN 2.0B) |
| 28 ... 11 | 0 | If bit 29=0 |
| | X | if bit 29=1: bits 28 ... 11 of 29 bit COB-ID |
| 10 ... 0 (LSB) | X | Bits 10 ... 0 of COB-ID |

Table 8.5: Description of the PDO COB-ID entry

The PDO valid/not valid allows to select which PDOs are used in the operational state. There may be PDOs fully configured (e.g. by default) but not used, and therefore set to “not valid” (deleted). The feature is necessary for devices supporting more than 4 RPDOs or 4 TPDOs, because each device has only default identifiers for the first four RPDOs/TPDOs. Devices supporting the standard CAN frame type only or do not support Remote Frames, an attempt to set bit 29 to 1 or bit 30 to 0 is responded with an abort message (`abort code: 0609 0030`$_h$). It is not allowed to change bit 0-29 while the PDO exists (Bit 31=0).

The transmission type (sub-index 2) defines the transmission/reception character of the PDO. On an attempt to change the value of the transmission type to a value that is not supported by the device an abort message (`abort code: 0609 0030`$_h$) is generated.

| Transmission type | PDO transmission | | | | |
|---|---|---|---|---|---|
| | cyclic | acyclic | sync | async | RTR only |
| 0 | | X | X | | |
| 1 – 240 | X | | X | | |
| 241 – 251 | Reserved | | | | |
| 252 | | | X | | X |
| 253 | | | | X | X |
| 254 | | | | X | |
| 255 | | | | X | |

Table 8.6: Description of the PDO COB-ID entry

Synchronous (transmission types 0-240 and 252) means that the transmission of the PDO shall be related to the SYNC object. Preferably the devices use the SYNC as a trigger to output or actuate based on the previous synchronous Receive PDO respectively to update the data transmitted at the following synchronous Transmit PDO. Details of this mechanism depend on the device type and are defined in the device profile if applicable.

Asynchronous means that the transmission of the PDO is not related to the SYNC object. A transmission type of zero means that the message shall be transmitted synchronously with the SYNC object but not periodically. A value between 1 and 240 means that the PDO is transferred synchronously and cyclically. The transmission type indicating the number of SYNC which are necessary to trigger PDO transmissions.

Receive PDOs are always triggered by the following SYNC upon receiption of data independent of the transmission types 0 - 240. The transmission types 252 and 253 mean that the PDO is only transmitted on remote transmission request. At transmission type 252, the data is updated (but not sent) immediately after reception of the SYNC object.

At transmission type 253 the data is updated at the reception of the remote transmission request (hardware and software restrictions may apply). These value are only possible for T_PDOs.

For T_PDOs transmission type 254 means, the application event is manufacturer specific (manufacturer specific part of the Object Dictionary), transmission type 255 means, the application event is defined in the device profile. R_PDOs with that type trigger the update of the mapped data with the reception.

Sub-index $3_h$ contains the inhibit time. This time is a minimum interval for PDO transmission. The value is defined as multiple of 100µs. It is not allowed to change the value while the PDO exists (Bit 31 of sub-index 1 is 0).

Sub-index 4h is reserved. It does not have to be implemented, in this case read or write access leads to Abort SDO Transfer (a`bort code: 0609 0011`$_h$).

In mode 254/255 additionally an event time can be used for T_PDO. If an event timer exists for a T_PDO (value not equal to 0) the elapsed timer is considered to be an event. The event timer elapses as multiple

of 1 ms of the entry in sub-index $5_h$ of the T_PDO. This event will cause the transmission of this T_PDO in addition to otherwise defined events. The occurrence of the events set the timer. Independent of the transmission type the R_PDO event timer is used recognize the expiration of the R_PDO.

*Object description*

| | |
|---|---|
| Index | $1400 – 1402_h$ |
| Name | 1st, 2nd and 3rd receive PDO parameters |
| Object code | Record |
| Data type | — |

*Value description*

| | |
|---|---|
| Sub-index | $00_h$, Largest supported sub-index |
| Meaning | Largest supported sub-index |
| Access | Read only |
| PDO mapping | — |
| Value range | Unsigned8 |
| Default value | $05_h$ |
| Category | — |

| | |
|---|---|
| Sub-index | $01_h$, COB-ID used by PDO |
| Meaning | COB-ID used by PDO |
| Access | Read-write |
| PDO mapping | — |
| Value range | Unsigned32 |
| Default value | $1400_h = 0200_h$ + node ID<br>$1401_h = 0300_h$ + node ID<br>$1402_h = 0400_h$ + node ID |
| Category | Yes |

| | |
|---|---|
| Sub-index | $02_h$, Transmission type |
| Meaning | Transmission type |
| Access | Read-write |
| PDO mapping | — |
| Value range | Unsigned8 |
| Default value | 255 (asynchronous) |
| Category | Yes |

| | |
|---|---|
| Sub-index | $03_h$, Inhibit time |
| Meaning | Inhibit time |
| Access | Read-write |
| PDO mapping | — |
| Value range | Unsigned16 |
| Default value | $0000_h$ |
| Category | Yes |

| | |
|---|---|
| Sub-index | $05_h$, Event timer |
| Meaning | Event timer |
| Access | Read-write |
| PDO mapping | — |
| Value range | Unsigned16 |
| Default value | $0000_h$ |
| Category | Yes |

### 8.5.19 1600 – $1602_h$ Receive PDO mapping parameter

Contains the mapping for the PDOs the device is able to receive. The type of the PDO mapping parameter ($21_h$) is described in Section 9.5.4 of CiA DS-301: CANopen Application Layer and Communications Profile.. The sub-index $0_h$ contains the number of valid entries within the mapping record. This number of entries is also the number of the application variables which shall be transmitted/received with the corresponding PDO. The sub-indices from 1h to number of entries contain the information about the mapped application variables. These entries describe the PDO contents by their index, sub-index and length. All three values are hexadecimal coded. The length entry contains the length of the object in bit ($1..40_h$).

This parameter can be used to verify the overall mapping length. It is mandatory.

The structure of the entries from sub-index $1_h$ – $40_h$ is as follows:

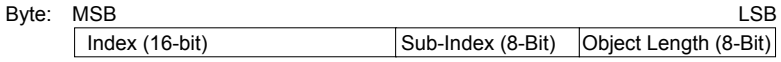



Figure 8.9: Structure of the PDO mapping entry

If the change of the PDO mapping cannot be executed (e.g. the PDO length is exceeded or the SDO client attempts to map an object that cannot be mapped) the device responds with an Abort SDO Transfer Service.

Sub-index 0 determines the valid number of objects that have been mapped. For changing the PDO mapping first the PDO has to be deleted, the sub-index 0 must be set to 0 (mapping is deactivated). Then the objects can be remapped. When a new object is mapped by writing a sub-index between 1 and 64, the device may check whether the object specified by index / sub-index exists. If the object does not exist or the object cannot be mapped, the SDO transfer must be aborted with the Abort SDO Transfer Service with one of the abort codes 0602 0000h or 0604 0041h.

After all objects are mapped sub-index 0 is set to the valid number of mapped objects. Finally the PDO will be created by writing to its communication parameter COB-ID. When sub-index 0 is set to a value >0 the device may validate the new PDO mapping before transmitting the response of the SDO service. If an error is detected the device has to transmit the Abort SDO Transfer Service with one of the abort codes 0602 0000h, 0604 0041h or 0604 0042h.

When sub-index 0 is read the actual number of valid mapped objects is returned. If data types (Index 1h-7h) are mapped they serve as „dummy entries“. The corresponding data in the PDO is not evaluated by the device. This optional feature is useful e.g. to transmit data to several devices using one PDO, each device only utilising a part of the PDO. It is not possible to create a dummy mapping for a T_PDO.

A device that supports dynamic mapping of PDOs must support this during the state PREOPERATIONAL state. If dynamic mapping during the state OPERATIONAL is supported, the SDO client is responsible for data consistency.

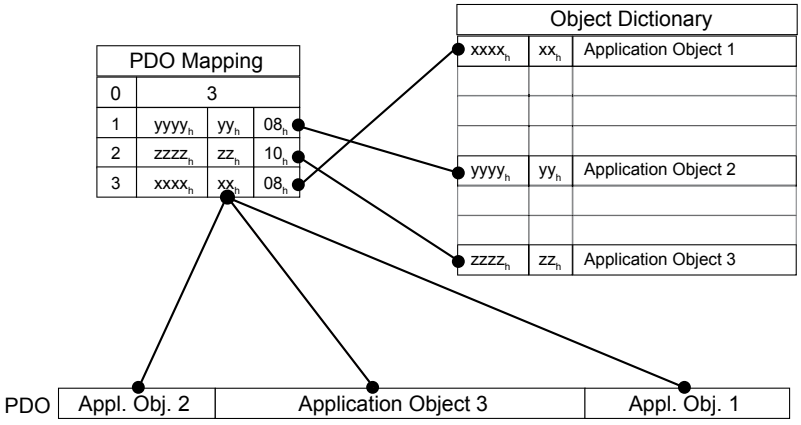



Figure 8.10: Principle of PDO mapping

*Object description*

| | |
|---|---|
| Index | 1600 – $1602_h$ |
| Name | 1st, 2nd and 3rd receive PDO mapping |
| Object code | Record |
| Data type | — |

*Value description*

| | |
|---|---|
| Sub-index | $00_h$, Number of mapped application objects |
| Meaning | Number of mapped application objects |
| Access | Read-write |
| PDO mapping | — |
| Value range | 1 – 64 |
| Default value | $1600_h$= 1<br>$1601_h$= 2<br>$1602_h$= 2 |
| Category | Yes |

| | |
|---|---|
| Sub-index | $01_h$, PDO mapping 1st application object |
| Meaning | PDO mapping 1st application object |
| Access | Read-write |
| PDO mapping | — |
| Value range | Unsigned32 |
| Default value | $1600_h$= 6040 $0010_h$<br>$1601_h$= 6040 $0010_h$<br>$1602_h$= 6040 $0010_h$ |
| Category | Yes |

| | |
|---|---|
| Sub-index | $02_h$, PDO mapping 2nd application object |
| Meaning | PDO mapping 2nd application object |
| Access | Read-write |
| PDO mapping | — |
| Value range | Unsigned32 |
| Default value | $1600_h$= 0000 $0000_h$<br>$1601_h$= 607A $0020_h$ (Profile position – target position)<br>$1602_h$= 60FF $0020_h$ (Profile velocity – target velocity) |
| Category | Yes |

| | |
|---|---|
| Sub-index | 03 – $08_h$, PDO mapping *n*th application object |
| Meaning | PDO mapping *n*th application object |
| Access | Read-write |
| PDO mapping | — |
| Value range | Unsigned32 |
| Default value | $1600_h$= 0000 $0000_h$<br>$1601_h$= 0000 $0000_h$<br>$1602_h$= 0000 $0000_h$ |
| Category | Yes |

## 8.5.20 1800 – $1802_h$ Receive PDO mapping parameter

Contains the communication parameters for the PDOs the device is able to transmit. The type of the PDO communication parameter ($20_h$) is described in 9.5.4 of CiA DS-301: CANopen Application Layer and Communications Profile. A detailed description of the entries is done in the section for the Receive PDO Communication Parameter ($1400_h$ – $1402_h$).

*Object description*

| | |
|---|---|
| Index | 1800 – $1802_h$ |
| Name | 1st, 2nd and 3rd transmit PDO parameters |
| Object code | Record |
| Data type | — |

*Value description*

| | |
|---|---|
| Sub-index | $00_h$, Largest supported sub-index |
| Meaning | Largest supported sub-index |
| Access | Read only |
| PDO mapping | — |
| Value range | Unsigned8 |
| Default value | $05_h$ |
| Category | — |

| | |
|---|---|
| Sub-index | $01_h$, COB-ID used by PDO |
| Meaning | COB-ID used by PDO |
| Access | Read-write |
| PDO mapping | — |
| Value range | Unsigned32 |
| Default value | $1800_h$= $0180_h$+ node ID<br>$1801_h$= $0280_h$+ node ID<br>$1802_h$= $0380_h$+ node ID |
| Category | Yes |

| | |
|---|---|
| Sub-index | $02_h$, Transmission type |
| Meaning | Transmission type |
| Access | Read-write |
| PDO mapping | — |
| Value range | Unsigned8 |
| Default value | 255 (asynchronous) |
| Category | Yes |

| | |
|---|---|
| Sub-index | $03_h$, Inhibit time |
| Meaning | Inhibit time |
| Access | Read-write |
| PDO mapping | — |
| Value range | Unsigned16 |
| Default value | $0000_h$ |
| Category | Yes |

| | |
|---|---|
| Sub-index | $05_h$, Event timer |
| Meaning | Event timer |
| Access | Read-write |
| PDO mapping | — |
| Value range | Unsigned16 |
| Default value | $1800_h$= 0<br>$1801_h$= 100<br>$1802_h$= 100 |
| Category | Yes |

## 8.5.21 1A00 – $1A02_h$ Transmit PDO mapping parameter

Contains the mapping for the PDOs the device is able to transmit. The type of the PDO mapping parameter ($21_h$) is described in 9.5.4 of CiA DS-301: CANopen Application Layer and Communications Profile. A detailed description of the entries is done in the Section 8.5.19 for the Receive PDO Mapping Parameter ($1600_h$ – $1602_h$).

*Object description*

| | |
|---|---|
| Index | 1A00 – $1A02_h$ |
| Name | 1st, 2nd and 3rd transmit PDO mapping |
| Object code | Record |
| Data type | — |

*Value description*

| | |
|---|---|
| Sub-index | $00_h$, Number of mapped application objects |
| Meaning | Number of mapped application objects |
| Access | Read-write |
| PDO mapping | — |
| Value range | 1 – 64 |
| Default value | $1A00_h$= 1<br>$1A01_h$= 2<br>$1A02_h$= 2 |
| Category | Yes |

| | |
|---|---|
| Sub-index | $01_h$, PDO mapping 1st application object |
| Meaning | PDO mapping 1st application object |
| Access | Read-write |
| PDO mapping | — |
| Value range | Unsigned32 |
| Default value | $1A00_h$= 6041 $0010_h$ (Status Word)<br>$1A01_h$= 6041 $0010_h$ (Status Word)<br>$1A02_h$= 6041 $0010_h$ (Status Word) |
| Category | Yes |

| | |
|---|---|
| Sub-index | $02_h$, PDO mapping 2nd application object |
| Meaning | PDO mapping 2nd application object |
| Access | Read-write |
| PDO mapping | — |
| Value range | Unsigned32 |
| Default value | $1800_h$= 0000 $0000_h$<br>$1801_h$= 6064 $0020_h$ (Profile position – position actual value)<br>$1802_h$= 606C $0020_h$ (Profile velocity – velocity actual value) |
| Category | Yes |

| | |
|---|---|
| Sub-index | $03 – 08_h$, PDO mapping *n*th application object |
| Meaning | PDO mapping *n*th application object |
| Access | Read-write |
| PDO mapping | — |
| Value range | Unsigned32 |
| Default value | $1600_h$= 0000 $0000_h$<br>$1601_h$= 0000 $0000_h$<br>$1602_h$= 0000 $0000_h$ |
| Category | Yes |

## 8.6 Details of object group $2000_h$ (Mfg specific)

The objects detailed in this section are Schneider Electric Motion USA manufacturer specific configuration objects to configure the manufacturer object specific to the MDrivePlus, MDrive Hybrid or MFroce CANopen Motion Control node.

### 8.6.1 $2000_h$ I/O configuration

This object facilitates the configuration of the I/O points available on MDrive or MForce CANopen devices. The sub-indexes set the functionality of the I/O points, which may be configured as sinking or sourcing inputs or outputs. Each bit of the sub-indices are mapped to a particular I/O point with I/O 12 being the Most Significant bit (MSb) and I/O 1 being the Least Significant bit (LSb). The configuration options are:

1) Sub-Index $01_h$: Allows configuration of the I/O points as inputs (0, default) or outputs (1).
2) Sub-Index $02_h$: Allows for the I/O to be configured as sinking (1) or sourcing (0, default) inputs or outputs.
3) Sub-Index $03_h$: This allows outputs ONLY to sink or source external devices.
4) Sub-Index $04_h$: This allows the configuration of inputs to read inverted polarity. By default this is deactivated and setting the bit to a 1 will change the invert polarity read by the input. See Optional Application FE, Object 60DF.
5) Sub-Index $05_h$: This allows the configuration of outputs to invert the output polarity. See Optional Application FE, Object 60FE.

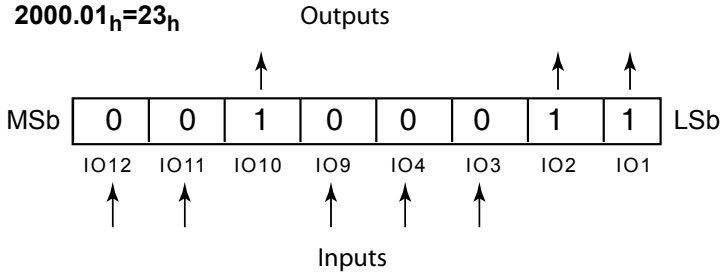



Figure 8.11: I/O structure

The I/O configuration is saved using the Store Parameters Object (1010h).

*Object description*

| | |
|---|---|
| Index | $2000_h$ |
| Name | I/O configuration |
| Object code | ARRAY |
| Data type | Unsigned8 |

*Value description*

| | |
|---|---|
| Sub-index | $00_h$, Number of entries |
| Meaning | Number of entries |
| Access | Read only |
| PDO mapping | — |
| Value range | — |
| Default value | $05_h$ |
| Category | — |

| | |
|---|---|
| Sub-index | $01_h$, Configure as input or output |
| Meaning | Configure as input or output (I/O point bit(s) = $1_b$ to select as output) |
| Access | Read-write |
| PDO mapping | — |
| Value range | 00 – $FF_h$ |
| Default value | $00_h$ (all inputs) |
| Category | Yes |

| | |
|---|---|
| Sub-index | $02_h$, Configure as sinking or sourcing |
| Meaning | Configure as sinking or sourcing (I/O point bit(s) = $1_b$ to select as sinking) |
| Access | Read-write |
| PDO mapping | — |
| Value range | 00 – $FF_h$ |
| Default value | $00_h$ (all sourcing) |
| Category | Yes |

| | |
|---|---|
| Sub-index | $03_h$, Configure as both |
| Meaning | Configure as both sinking and sourcing (I/O point bit(s) = $1_b$ to select as both) |
| Access | Read-write |
| PDO mapping | — |
| Value range | 00 – $FF_h$ |
| Default value | $00_h$ (all sourcing) |
| Category | Yes |

| | |
|---|---|
| Sub-index | $04_h$, Configure as polarity in |
| Meaning | Configure as polarity in (See object $60FD_h$ sub-index $01_h$) |
| Access | Read-write |
| PDO mapping | — |
| Value range | 00 – $FF_h$ |
| Default value | $00_h$ |
| Category | Yes |

| | |
|---|---|
| Sub-index | $05_h$, Configure as polarity out |
| Meaning | Configure as polarity out |
| Access | Read-write |
| PDO mapping | — |
| Value range | $00 – FF_h$ |
| Default value | $00_h$ (See object $60FE_h$ sub-index $01_h$) |
| Category | Yes |

### 8.6.2 $2003_h$ Configure input switches

Object 2002 facilitates the configuration of input switches. Input switches may be configured as the following types:

1) Home
2) Positive Limit
3) Negative Limit
4) Inhibit (Inhibit Switch function is configured by Object 2007h)

*Object description*

| | |
|---|---|
| Index | $2002_h$ |
| Name | Configure input switches |
| Object code | ARRAY |
| Data type | Unsigned8 |

*Value description*

| | |
|---|---|
| Sub-index | $00_h$, Number of entries |
| Meaning | Number of entries |
| Access | Read only |
| PDO mapping | — |
| Value range | — |
| Default value | $04_h$ |
| Category | — |

| | |
|---|---|
| Sub-index | $01_h$, Configure input as home |
| Meaning | Configure input as home switch (I/O point bit(s) = $1_b$ to select as home) |
| Access | Read-write |
| PDO mapping | — |
| Value range | $00 – FF_h$ |
| Default value | $00_h$ |
| Category | Yes |

| | |
|---|---|
| Sub-index | $02_h$, Configure input as positive limit |
| Meaning | Configure input as + Limit (I/O point bit(s) = $1_b$ to select as + limit) |
| Access | Read-write |
| PDO mapping | — |
| Value range | 00 – $FF_h$ |
| Default value | $00_h$ |
| Category | Yes |

| | |
|---|---|
| Sub-index | $03_h$, Configure input as negative limit |
| Meaning | Configure input as – Limit (I/O point bit(s) = $1_b$ to select as – limit) |
| Access | Read-write |
| PDO mapping | — |
| Value range | 00 – $FF_h$ |
| Default value | $00_h$ |
| Category | Yes |

| | |
|---|---|
| Sub-index | $04_h$, Configure inhibit switch |
| Meaning | Configure inhibit switch (I/O point bit(s) = $1_b$ to select as inhibit). Use object $2007_h$ to define inhibit function. |
| Access | Read-write |
| PDO mapping | — |
| Value range | 00 – $FF_h$ |
| Default value | $00_h$ |
| Category | Yes |

## 8.6.3 $2004_h$ Configure input filter mask

The Input filter mask object configure s the device to filter the selected inputs. Sub-indices $01_h$ through $07_h$ define the inputs to which filtering will be applied. Object $2006_h$ defines the filter time applied to each input.

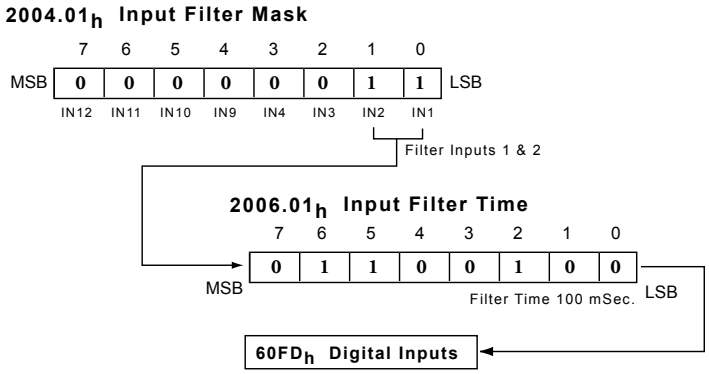



Figure 8.12: Input filter mask

*Object description*

| | |
|---|---|
| Index | $2004_h$ |
| Name | Configure input mask |
| Object code | ARRAY |
| Data type | — |

*Value description*

| | |
|---|---|
| Sub-index | $00_h$, Number of entries |
| Meaning | Number of entries |
| Access | Read only |
| PDO mapping | — |
| Value range | — |
| Default value | $08_h$ |
| Category | — |

| | |
|---|---|
| Sub-index | $01_h$, Configure mask for Input 1 |
| Meaning | Configure mask for Input 1 |
| Access | Read-write |
| PDO mapping | — |
| Value range | $00 – FF_h$ |
| Default value | $01_h$ |
| Category | Yes |

| | |
|---|---|
| Sub-index | $02_h$, Configure mask for Input 2 |
| Meaning | Configure mask for Input 2 |
| Access | Read-write |
| PDO mapping | — |
| Value range | $00 – FF_h$ |
| Default value | $02_h$ |
| Category | Yes |

| | |
|---|---|
| Sub-index | $03_h$, Configure mask for Input 3 |
| Meaning | Configure mask for Input 3 |
| Access | Read-write |
| PDO mapping | — |
| Value range | $00 – FF_h$ |
| Default value | $04_h$ |
| Category | Yes |

| | |
|---|---|
| Sub-index | $04_h$, Configure mask for Input 4 |
| Meaning | Configure mask for Input 4 |
| Access | Read-write |
| PDO mapping | — |
| Value range | $00 – FF_h$ |
| Default value | $08_h$ |
| Category | Yes |

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| | |
|---|---|
| Sub-index | $05_h$, Configure mask for Input 9 |
| Meaning | Configure mask for Input 9 |
| Access | Read-write |
| PDO mapping | — |
| Value range | 00 – $FF_h$ |
| Default value | $10_h$ |
| Category | Yes |

| | |
|---|---|
| Sub-index | $06_h$, Configure mask for Input 10 |
| Meaning | Configure mask for Input 10 |
| Access | Read-write |
| PDO mapping | — |
| Value range | 00 – $FF_h$ |
| Default value | $20_h$ |
| Category | Yes |

| | |
|---|---|
| Sub-index | $07_h$, Configure mask for Input 11 |
| Meaning | Configure mask for Input 11 |
| Access | Read-write |
| PDO mapping | — |
| Value range | 00 – $FF_h$ |
| Default value | $40_h$ |
| Category | Yes |

| | |
|---|---|
| Sub-index | $08_h$, Configure mask for Input 12 |
| Meaning | Configure mask for Input 12 |
| Access | Read-write |
| PDO mapping | — |
| Value range | 00 – $FF_h$ |
| Default value | $80_h$ |
| Category | Yes |

### 8.6.4 $2006_h$ Configure input filter time

This object sets the input filter time in milliseconds. Each sub-index applies to a specific input where sub-index 01h applies to input 1, sub-index 02h applies to input 2 and etc.

*Object description*

| | |
|---|---|
| Index | $2006_h$ |
| Name | Configure input filter |
| Object code | ARRAY |
| Data type | — |

*Value description*

| | |
|---|---|
| Sub-index | $00_h$, Number of entries |
| Meaning | Number of entries |
| Access | Read only |
| PDO mapping | — |
| Value range | — |
| Default value | $08_h$ |
| Category | — |

| | |
|---|---|
| Sub-index | $01_h$, Configure filter for Input 1 |
| Meaning | Configure filter for Input 1 |
| Access | Read-write |
| PDO mapping | — |
| Value range | $00 – FF_h$ |
| Default value | $00_h$ |
| Category | Yes |

| | |
|---|---|
| Sub-index | $02_h$, Configure filter for Input 2 |
| Meaning | Configure filter for Input 2 |
| Access | Read-write |
| PDO mapping | — |
| Value range | $00 – FF_h$ |
| Default value | $00_h$ |
| Category | Yes |

| | |
|---|---|
| Sub-index | $03_h$, Configure filter for Input 3 |
| Meaning | Configure filter for Input 3 |
| Access | Read-write |
| PDO mapping | — |
| Value range | $00 – FF_h$ |
| Default value | $00_h$ |
| Category | Yes |

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| | |
|---|---|
| Sub-index | $05_h$, Configure filter for Input 4 |
| Meaning | Configure filter for Input 4 |
| Access | Read-write |
| PDO mapping | — |
| Value range | 00 – $FF_h$ |
| Default value | $00_h$ |
| Category | Yes |

| | |
|---|---|
| Sub-index | $05_h$, Configure filter for Input 9 |
| Meaning | Configure filter for Input 9 |
| Access | Read-write |
| PDO mapping | — |
| Value range | 00 – $FF_h$ |
| Default value | $00_h$ |
| Category | Yes |

| | |
|---|---|
| Sub-index | $06_h$, Configure filter for Input 10 |
| Meaning | Configure filter for Input 10 |
| Access | Read-write |
| PDO mapping | — |
| Value range | 00 – $FF_h$ |
| Default value | $00_h$ |
| Category | Yes |

| | |
|---|---|
| Sub-index | $07_h$, Configure filter for Input 11 |
| Meaning | Configure filter for Input 11 |
| Access | Read-write |
| PDO mapping | — |
| Value range | 00 – $FF_h$ |
| Default value | $00_h$ |
| Category | Yes |

| | |
|---|---|
| Sub-index | $08_h$, Configure filter for Input 12 |
| Meaning | Configure filter for Input 12 |
| Access | Read-write |
| PDO mapping | — |
| Value range | 00 – $FF_h$ |
| Default value | $00_h$ |
| Category | Yes |

## 8.6.7 $2007_h$ Inhibit switch reaction

This object allows the user to configure different actions for an inhibit switch (See `Object 2002h, Sub-index 4h`).

This object will function through Control word overwrites and overrides. The inhibit switch reaction is set using sub-index $01_h$.

*Object description*

| | |
|---|---|
| Index | $2007_h$ |
| Name | Inhibit switch reaction |
| Object code | ARRAY |
| Data type | — |

*Value description*

| | |
|---|---|
| Sub-index | $00_h$, Number of entries |
| Meaning | Number of entries |
| Access | Read only |
| PDO mapping | — |
| Value range | — |
| Default value | $01_h$ |
| Category | — |

| | |
|---|---|
| Sub-index | $01_h$, Inhibit switch reaction |
| Meaning | Inhibit switch reaction |
| Access | Read-write |
| PDO mapping | — |
| Value range | 1 – 12 |
| Default value | 12 |
| Category | Yes |

| Value | Meaning |
|---|---|
| 0 | No action |
| 1 | Fault signal - Control word overwrite |
| 2 | Fault signal - Control word override |
| 3 | Disable voltage command - Control word overwrite |
| 4 | Disable voltage command - Control word override |
| 5 | Quick stop command - Control word overwrite |
| 6 | Quick stop command - Control word override |
| 7 | Shutdown command - Control word overwrite |
| 8 | Shutdown command - Control word override |
| 9 | Disable operation command - Control word overwrite |
| 10 | Disable operation command - Control word override |
| 11 | Halt command - Control word overwrite |
| 12 | Halt command - Control word override |

Table 8.7: Inhibit switch reactions

## 8.6.8 $2008_h$ Output definition

This object allows the user to configure one or more outputs as brake outputs. For an explanation of brake functions, see Object $2035_h$: Brake Timers

*Object description*

| | |
|---|---|
| Index | $2008_h$ |
| Name | Output definition |
| Object code | ARRAY |
| Data type | — |

*Value description*

| | |
|---|---|
| Sub-index | $00_h$, Number of entries |
| Meaning | Number of entries |
| Access | Read only |
| PDO mapping | — |
| Value range | — |
| Default value | $02_h$ |
| Category | — |

| | |
|---|---|
| Sub-index | $01_h$, Brake output defined |
| Meaning | Brake output defined |
| Access | Read-write |
| PDO mapping | — |
| Value range | Unsigned8 |
| Default value | $00_h$ |
| Category | Yes |

| | |
|---|---|
| Sub-index | $02_h$, Target reached output defined |
| Meaning | Target reached output defined |
| Access | Read-write |
| PDO mapping | — |
| Value range | Unsigned8 |
| Default value | $00_h$ |
| Category | Yes |

| Output selected | Setting |
|---|---|
| 1 | Sub-index = $01_h$ |
| 2 | Sub-index = $02_h$ |
| 3 | Sub-index = $04_h$ |
| 4 | Sub-index = $08_h$ |
| 9 | Sub-index = $10_h$ |
| 10 | Sub-index = $20_h$ |
| 11 | Sub-index = $40_h$ |
| 12 | Sub-index = $80_h$ |

Table 8.8: Brake and target reached output definition

### 8.6.9 $2010_h$ Analog input configuration

This object allows the user to configure the 10-bit Analog Input. There are 3 sub-indices that set the configuration properties for the input:

1) Sub-Index $01_h$: Analog Full Scale. This has a range of 0 to 1023 and sets the full scale of the analog input.
2) Sub-Index $02_h$: This sets the type of device the Analog Input will read. It can be set for two modes, Voltage with ranges of 0 to 5V or 0 to 10V, or Current with an input range of 0 to 20 mA.
3) Sub-Index $03_h$: This sets the filtering for the Analog Input. In the 0 (default) setting the filtering is off.

*Object description*

| | |
|---|---|
| Index | $2010_h$ |
| Name | Analog input configuration |
| Object code | ARRAY |
| Data type | — |

*Value description*

| | |
|---|---|
| Sub-index | $00_h$, Number of entries |
| Meaning | Number of entries |
| Access | Read only |
| PDO mapping | — |
| Value range | — |
| Default value | $03_h$ |
| Category | — |

| | |
|---|---|
| Sub-index | $01_h$, Analog input reading |
| Meaning | Analog input reading |
| Access | Read-only |
| PDO mapping | Yes – T_PDO |
| Value range | $0 – 1023_d$ ($0000 – 03FF_h$ – Unsigned16) |
| Default value | — |
| Category | — |

| | |
|---|---|
| Sub-index | $02_h$, Analog input configuration |
| Meaning | Analog input configuration |
| Access | Read-write |
| PDO mapping | — |
| Value range | $00_h$, $02_h$, or $08_h$ (Unsigned8) |
| Default value | $00_h$ |
| Category | Yes |

| **Sub-index $02_h$** | **Analog input mode** |
|---|---|
| $00_h$ | 0 to 5 V scale |
| $02_h$ | 4 to 20 mA scale |
| $08_h$ | 0 to 10 V scale |

| | |
|---|---|
| Sub-index | $03_h$, Analog filter level |
| Meaning | Analog filter level |
| Access | Read-write |
| PDO mapping | — |
| Value range | $00 – 31_h$ (Unsigned8) |
| Default value | $00_h$ |
| Category | Yes |

### 8.6.10 $2018_h$ Internal temperature options

This object allows the user to configure the thermal properties of the MDrivePlus or MDrive Hybrid Motion Control node. There are 3 sub-indices:

1) Sub-Index $01_h$: Read-only sub-index that reads the internal temperature of the device. May be mapped to a PDO
1) Sub-Index $02_h$: Temperature Warning parameter allows for the setting of a parameter that will generate an error (`Index 1003 - 0016 4210`$_h$) if the warning threshold is reached. the default is 80°C.
1) Sub-Index $03_h$: This sub-index sets the threshold for a temperature fault. Note that the outputs of the device will disable at 85°C regardless of the setting for this parameter. if reached, the error message will be locates at `Index 1003`$_h$. The error code is byte will read `0008 4210`$_h$.

The units for this object are degrees celcius (°C).

Note that this object is only available on the following product models:

- MDrivePlus: MDrive34Plus, MDrive34AC Plus
- MDrive Hybrid: MDrive 23 Hybrid, MDrive 34AC Hybrid
- MForce PowerDrive

*Object description*

| | |
|---|---|
| Index | $2018_h$ |
| Name | Internal temperature options |
| Object code | ARRAY |
| Data type | Signed8 |

*Value description*

| | |
|---|---|
| Sub-index | $00_h$, Number of entries |
| Meaning | Number of entries |
| Access | Read only |
| PDO mapping | — |
| Value range | — |
| Default value | $03_h$ |
| Category | — |

| | |
|---|---|
| Sub-index | $01_h$, Internal temperature reading |
| Meaning | Analog input reading |
| Access | Read-only |
| PDO mapping | Yes – T_PDO |
| Value range | — |
| Default value | — |
| Category | — |

| | |
|---|---|
| Sub-index | $02_h$, Temperature warning threshold |
| Meaning | Temperature warning threshold |
| Access | Read-write |
| PDO mapping | — |
| Value range | -50 to $+120_d$ (Signed8) |
| Default value | $80_d$ |
| Category | Yes |

| | |
|---|---|
| Sub-index | $03_h$, Temperature fault |
| Meaning | Temperature fault |
| Access | Read-write |
| PDO mapping | — |
| Value range | -50 to $+120_d$ (Signed8) |
| Default value | $85_d$ |
| Category | Yes |

## 8.6.11 $2020_h$ Software limits as hardware

This object defines the actions taken when the Position Software Limit for Object $2022_h$ is reached. It consists of 2 sub-indices.

1) Sub-index $01_h$:Limit reached flag. This flag will be set based upon the status of a limit, it will register whether the limit reached is a hardware limit or a software limit. The statusword ($6041_h$), bit 11, internal limit active will set whenever the flag is not 0. The action taken for a limit reached condition will be determined by the limit mask sub-index.

| Status | Bit 3 | Bit 4 | Bit 1 | Bit 0 |
|---|---|---|---|---|
| Negative hardware limit reached | 0 | 0 | 0 | 1 |
| Positive hardware limit reached | 0 | 0 | 1 | 0 |
| Negative software limit reached | 0 | 1 | 0 | 0 |
| Positive software limit reached | 1 | 0 | 0 | 0 |

Table 8.9: Description of limit reached flag $2020.01_h$

2) Sub-index $02_h$: Limit reached mask

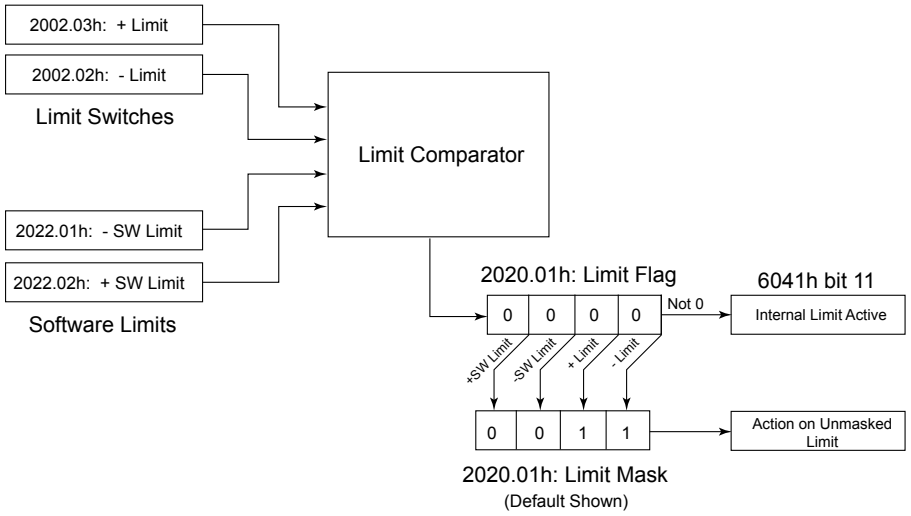


Figure 8.13: Software limits as hardware functions

*Object description*

| | |
|---|---|
| Index | $2020_h$ |
| Name | Software limits as hardware |
| Object code | ARRAY |
| Data type | Unsigned8 |

*Value description*

| | |
|---|---|
| Sub-index | $00_h$, Number of entries |
| Meaning | Number of entries |
| Access | Read only |
| PDO mapping | — |
| Value range | — |
| Default value | $02_h$ |
| Category | — |

| | |
|---|---|
| Sub-index | $01_h$, Limit reached flag |
| Meaning | Limit reached flag |
| Access | Read-write |
| PDO mapping | — |
| Value range | $00 – 0F_h$ |
| Default value | $00_h$ |
| Category | — |

| | |
|---|---|
| Sub-index | $02_h$, Limit reached mask |
| Meaning | Limit reached mask |
| Access | Read-write |
| PDO mapping | — |
| Value range | $00 – 0F_h$ |
| Default value | $03_h$ |
| Category | Yes |

## 8.6.12 $2022_h$ Actual position software limit

This object defines the software limit based on set negative and positive limits set in actual position counts. See object $2020_h$ for a description of software limit functionality and configuration.

1) Sub-index $01_h$: Actual negative limit
2) Sub-index $02_h$: Actual positive limit

*Object description*

| | |
|---|---|
| Index | $2022_h$ |
| Name | Actual position software limit |
| Object code | ARRAY |
| Data type | Signed32 |

*Value description*

| | |
|---|---|
| Sub-index | $00_h$, Number of entries |
| Meaning | Number of entries |
| Access | Read only |
| PDO mapping | — |
| Value range | — |
| Default value | $02_h$ |
| Category | — |

| | |
|---|---|
| Sub-index | $01_h$, Actual negative limit |
| Meaning | Actual negative limit |
| Access | Read-write |
| PDO mapping | — |
| Value range | Signed32 |
| Default value | 8000 $0000_h$ |
| Category | — |

| | |
|---|---|
| Sub-index | $02_h$, Actual positive limit |
| Meaning | Actual positive limit |
| Access | Read-write |
| PDO mapping | — |
| Value range | Signed32 |
| Default value | 7FFF $FFFF_h$ |
| Category | Yes |

### 8.6.13 $2030_h$ Output bridge polarity

This object defines the polarity of the output bridge where positive=clockwise and negative=counter clockwise (default). By changing this to a negative integer between -128 to -1 the polarity of the bridge, thus the default CW/CCW motor direction can be swapped.

There is no value assigned to the number, any negative integer from -128 to -1 will reverse the bridge polarity, any positive integer from 0 to 127 will reset the polarity to the default CW/CCW motor direction configuration.

*Object description*

| | |
|---|---|
| Index | $2030_h$ |
| Name | Output birdge polarity |
| Object code | VAR |
| Data type | Signed8 |

*Value description*

| | |
|---|---|
| Sub-index | $00_h$, Output birdge polarity |
| Meaning | Output birdge polarity |
| Access | Read-write |
| PDO mapping | — |
| Value range | -128 to $127_d$ |
| Default value | $0_d$ |
| Category | Yes |

### 8.6.14 $2031_h$ Unit options (encoder enable, trip/capture enable)

This object defines the configuration of the following unit options:

1) Encoder sync actions (bits 5, 4). Encoder sync will determine whether the encoder counter, position counter or -home offset will be the master counter for syncronizing the counters. If -home offset is used it will function as homing 35.
2) Encoder enable (bit 3)
3) Trip output/capture input (bit 2)

Note: Encoder functions only apply to the MDrive products. The MForce products do not have closed loop capability.

*Object description*

| | |
|---|---|
| Index | $2031_h$ |
| Name | Unit options (encoder enable, trip/capture enable) |
| Object code | VAR |
| Data type | Unsigned8 |

*Value description*

| | |
|---|---|
| Sub-index | $00_h$, Unit options (encoder enable, trip/capture enable) |
| Meaning | Unit options (encoder enable, trip/capture enable) |
| Access | Read-write |
| PDO mapping | — |
| Value range | Unsigned8 |
| Default value | $00_h$ |
| Category | Yes |

| **Bits** | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|
| **Function** | X | X | sync_action | | e/e | c/t | X | X |

| **Encoder auto-sync action (sync_action)** | | |
|---|---|---|
| Bit 5 | Bit 4 | Bits 5 and 4 control encoder sync action |
| 0 | 0 | No action |
| 0 | 1 | Position synced to encoder master |
| 1 | 0 | Encoder synced to position master |
| 1 | 1 | Position and encoder synced to –home offset |
| **Encoder enable (e/e)** | | |
| Bit 3 | 0 | Encoder not enabled |
| | 1 | Encoder operation enabled |
| **Capture/trip select (c/t)** | | |
| Bit 2 | 0 | Will operate as a capture input (configure using $2033_h$) |
| | 1 | Will operate as a trip output (configure using $2038_h$) |

Table 8.10: Description of unit options object $2031.00_h$

## 8.6.15 $2032_h$ Unit options (clock output options)

This object defines the configuration of the various clock types.

Sub-index $01_h$ controls:

1) Polarity of the step and direction output signals (bits 7,6)
2) Pulse width active/inactive (bit 4)
3) Enable as output (bit 3)
4) The output clock type as step/direction, quadrature or up/down (bits 1, 0)

Sub-index $02_h$ controls the output clock step width from 50nS to 12.7µS in 50 nS increments.

*Object description*

| | |
|---|---|
| Index | $2032_h$ |
| Name | Unit options (clock output options) |
| Object code | ARRAY |
| Data type | Signed32 |

*Value description*

| | |
|---|---|
| Sub-index | $00_h$, Number of entries |
| Meaning | Number of entries |
| Access | Read only |
| PDO mapping | — |
| Value range | — |
| Default value | $02_h$ |
| Category | — |

| | |
|---|---|
| Sub-index | $01_h$, Configure clock outputs |
| Meaning | Configure clock outputs |
| Access | Read-write |
| PDO mapping | — |
| Value range | Unsigned8 |
| Default value | $00_h$ |
| Category | Yes |

| | |
|---|---|
| Sub-index | $02_h$, Configure output clock width |
| Meaning | Configure output clock width |
| Access | Read-write |
| PDO mapping | — |
| Value range | 1 – 255 (Unsigned8) |
| Default value | $1_{d\ (50ns)}$ |
| Category | Yes |

| **Bits** | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|
| **Function** | i/d | i/s | X | p/w | e/o | X | clock_type | |

| | | |
|---|---|---|
| **Invert direction (i/d))** | | |
| Bit 7 | 0 | Direction signal not inverted |
| | 1 | Invert direction signal |
| **Invert step clock (i/s)** | | |
| Bit 6 | 0 | Step signal not inverted |
| | 1 | Invert step signal |
| **Pulse width (p/w)** | | |
| Bit 4 | 0 | Pulse width active, output pulse determined by $2032.02_h$ |
| | 1 | Pulse width inactive, output will be a square wave |
| **Enable output (e/o)** | | |
| Bit 3 | 0 | Not enabled as output |
| | 1 | Enabled as output |
| **Output clock type (clock_type)** | | |
| Bit 1 | Bit 0 | |
| 0 | 0 | Step/direction outputs |
| 0 | 1 | Quadrature outputs |
| 1 | 0 | Clock up/down |

Table 8.11: Description of clock options object $2032.01_h$

## 8.6.16 $2033_h$ Capture input parameters

This object configures the functionality of the capture input.

1) Sub-index $01_h$: Capture input control: sets a bit that will enable the capture input. Note that the capture input must also be selected using `object 2031h`.
2) Sub-index $02_h$: Position captured flag. Displays the status of a position capture by setting the least significant bit (lsb) of an 8-bit unsigned integer. Write all ones to clear the flag.
3) Sub-index $03_h$: Capture input filter time. This sub-index configures the filtering for the capture input.
4) Sub-index $04_h$: Captured position. This sub-index holds the captured position.

*Object description*

| | |
|---|---|
| Index | $2033_h$ |
| Name | Capture input parameters |
| Object code | REC |
| Data type | — |

*Value description*

| | |
|---|---|
| Sub-index | $00_h$, Number of entries |
| Meaning | Number of entries |
| Access | Read only |
| PDO mapping | — |
| Value range | — |
| Default value | $04_h$ |
| Category | — |

| | |
|---|---|
| Sub-index | $01_h$, Capture input enable |
| Meaning | Capture input enable |
| Access | Read-write |
| PDO mapping | — |
| Value range | 0/1 (Unsigned8) |
| Default value | 0 (disabled) |
| Category | Yes |

| | |
|---|---|
| Sub-index | $02_h$, Position captured flag |
| Meaning | Position captured flag |
| Access | Read-write |
| PDO mapping | — |
| Value range | 0/1 (Unsigned8) |
| Default value | 0 (no position captured) |
| Category | Yes |

| | |
|---|---|
| Sub-index | $03_h$, Capture input filter time |
| Meaning | Capture input filter time |
| Access | Read-write |
| PDO mapping | — |
| Value range | 0 – 9 (Unsigned8) |
| Default value | 0 (50ns) |
| Category | Yes |

| Value | Filter |
|---|---|
| 0 | 50ns |
| 1 | 150ns |
| 2 | 200ns |
| 3 | 300ns |

| Value | Filter |
|---|---|
| 4 | 500ns |
| 5 | 900ns |
| 6 | 1.7µs |
| 7 | 3.3µs |

| Value | Filter |
|---|---|
| 8 | 6.5µs |
| 9 | 12.9µs |

| | |
|---|---|
| Sub-index | $04_h$, Captured position |
| Meaning | Captured position |
| Access | Read-only |
| PDO mapping | — |
| Value range | Integer32 |
| Default value | 0 (no position) |
| Category | — |

### 8.6.17 $2034_h$ Bridge on settle time

Establishes the time in milliseconds that current in the bridge is allowed to stabilize after power on. This index will delay the device entering operation enabled mode by the time set (0 to 1000ms). It is also a factor in the brake logic block. See `object 2035h` for functional block diagram.

*Object description*

| | |
|---|---|
| Index | $2034_h$ |
| Name | Bridge on settle time |
| Object code | Array |
| Data type | Unsigned16 |

*Value description*

| | |
|---|---|
| Sub-index | $00_h$, Number of entries |
| Meaning | Number of entries |
| Access | Read only |
| PDO mapping | — |
| Value range | — |
| Default value | $01_h$ |
| Category | — |

| | |
|---|---|
| Sub-index | $01_h$, Bridge on settle time |
| Meaning | Bridge on settle time |
| Access | Read-write |
| PDO mapping | — |
| Value range | $0 – 1000_d$ |
| Default value | 0 |
| Category | Yes |

## 8.6.18 $2035_h$ Brake settle allow time

Establishes the time in milliseconds that the brake is allowed to settle. This object works in cooperation with `object 2034.01h`, Bridge on settle allow time. The sequence of events follows for a braking operation:

1) Bridge power turns on, `object 2034.01h` begins timing the amount of milliseconds specified in sub-index $01_h$. This will be the time between bridge power enabled and brake off. This time will also allow time for settling before initial synchronizing with encoder counts.
2) Break discrete turns off, `object 2035.02h` specifies the time delay from set brake off to allow for motor movement.
3) Device enters the operation enabled state of the state machine. Motion occurs.
4) Motion ceases, the brake engages, `object 2035.01h` specifies the time delay from set brake on to removal of bridge power.

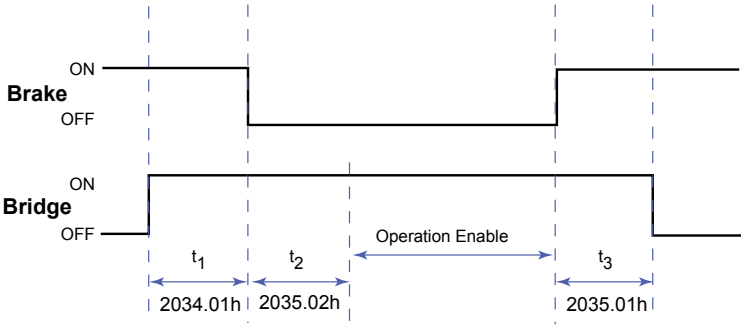


Figure 8.14: Bridge to brake timing

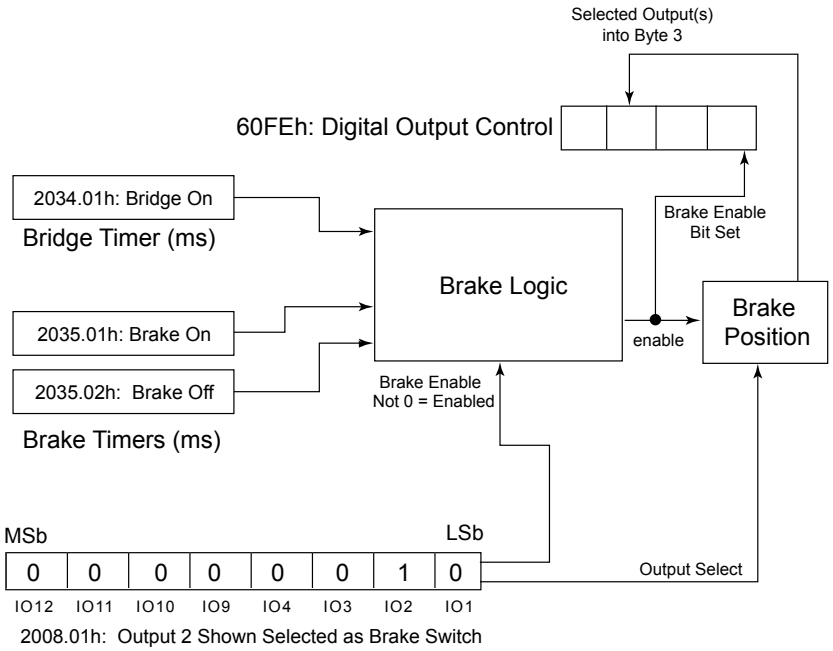


Figure 8.15: Brake functions block diagram

*Object description*

| | |
|---|---|
| Index | $2035_h$ |
| Name | Brake settle allow time |
| Object code | ARRAY |
| Data type | — |

*Value description*

| | |
|---|---|
| Sub-index | $00_h$, Number of entries |
| Meaning | Number of entries |
| Access | Read only |
| PDO mapping | — |
| Value range | — |
| Default value | $02_h$ |
| Category | — |

| | |
|---|---|
| Sub-index | $01_h$, Brake on settle time |
| Meaning | Brake on settle time |
| Access | Read-write |
| PDO mapping | — |
| Value range | $0 – 2000_d$ (ms) |
| Default value | 0 |
| Category | Yes |

| | |
|---|---|
| Sub-index | $02_h$, Brake off settle time |
| Meaning | Brake off settle time |
| Access | Read-write |
| PDO mapping | — |
| Value range | $0 – 1000_d$ (ms) |
| Default value | 0 |
| Category | Yes |

### 8.6.19 $2036_h$ Hold current delay time

Defines the delay tim in milliseconds between the device switching from the run current (`object 2204h`) to the holding current (`object 2205h`)

*Object description*

| | |
|---|---|
| Index | $2036_h$ |
| Name | Hold current delay time |
| Object code | VAR |
| Data type | Unsigned16 |

*Value description*

| | |
|---|---|
| Sub-index | $00_h$, Hold current delay time |
| Meaning | Hold current delay time |
| Access | Read-write |
| PDO mapping | — |
| Value range | $0_d$ (off) or 2 to $65535_d$ (ms) |
| Default value | $500_d$ (ms) |
| Category | Yes |

### 8.6.20 $2037_h$ Bridge on to encoder settle time

Defines the delay tim in milliseconds between the device switching into operation enable to resynching the encoder position. Only applicable on MDrive models equipped with an encoder.

*Object description*

| | |
|---|---|
| Index | $2037_h$ |
| Name | Bridge on to encoder settle time |
| Object code | VAR |
| Data type | Unsigned16 |

*Value description*

| | |
|---|---|
| Sub-index | $00_h$, Bridge on to encoder settle time |
| Meaning | Bridge on to encoder settle time |
| Access | Read-write |
| PDO mapping | — |
| Value range | $0_d$ to $3000_d$ (ms) |
| Default value | $300_d$ (ms) |
| Category | Yes |

## 8.6.21 $2038_h$ Trip output configuration

This object configures the functionality of the trip output which will pulse the output upon reaching particular position_demand_effort_position(s).

Values are in Internal Units, based on 51200/rev and not necessarily scaled to user units. Also note trip is activated on position demand effort, and not actual position or encoder position.

This definition of point(s) begins with sub-index $2038.02_h$ (1st position of a series) then add sub-index $2038.03_h$ to form the specified number of trip points.

1) Sub-index $01_h$: Trip output control: controls the logic and trip points and is used to set up one or multiple trip positions. Note that the trip output must also be selected using `object 2031h`.
2) Sub-index $02_h$: 1st trip point of a series. Defines the first trip point of a series of points.
3) Sub-index $03_h$: Capture input filter time. This sub-index configures the filtering for the capture input.
4) Sub-index $04_h$: Multiple trip point spacing. This sub-index defines the modulus, or spacing between the trip points. Scaled at 51200 steps/rev.

*Object description*

| | |
|---|---|
| Index | $2038_h$ |
| Name | Trip output configuration |
| Object code | REC |
| Data type | — |

*Value description*

| | |
|---|---|
| Sub-index | $00_h$, Number of entries |
| Meaning | Number of entries |
| Access | Read only |
| PDO mapping | — |
| Value range | — |
| Default value | $03_h$ |
| Category | — |

| | |
|---|---|
| Sub-index | $01_h$, Trip output control |
| Meaning | Trip output control |
| Access | Read-write |
| PDO mapping | — |
| Value range | Unsigned16 |
| Default value | $0000_h$ |
| Category | Yes |

| **Sub-index $01_h$ value range** | | |
|---|---|---|
| Bit: 15 (trip enable) | 14 ... 12 | Bits: 11 ... 0 (number of trip points) |
| 0= disabled, 1=enabled | 0 0 0 | 0=infinite, 1 – 4095=# trip points from start |

| | |
|---|---|
| Sub-index | $02_h$, First trip point |
| Meaning | First trip point |
| Access | Read-write |
| PDO mapping | — |
| Value range | Integer32 |
| Default value | 0000 $0000_h$ |
| Category | Yes |

| | |
|---|---|
| Sub-index | $03_h$, Multiple trip point spacing |
| Meaning | Multiple trip point spacing |
| Access | Read-write |
| PDO mapping | — |
| Value range | Integer32 |
| Default value | $5120_d$ |
| Category | Yes |

### 8.6.21 $2098_h$ Homing configuration

Determines the position or encoder counter status following a home. If 0 the position or encoder counter will clear following a home. If 0, the position and encoder counter will NOT be assigned, following a homing attained. The exception to this rule is when performing homing method 35.

If 1 (default) the device will subtract the homing offset (`object 607C`$_h$) from the counter and set the counter to the difference.

*Object description*

| | |
|---|---|
| Index | $2098_h$ |
| Name | Homing configuration |
| Object code | VAR |
| Data type | Unsigned8 |

*Value description*

| | |
|---|---|
| Sub-index | $00_h$, Homing configuration |
| Meaning | Homing configuration |
| Access | Read-write |
| PDO mapping | — |
| Value range | 0/1 |
| Default value | 1 |
| Category | Yes |

## 8.6.22 $2203_h$ Calibration current

This object sets the percentage of full current at which MDrive Hybrid calibration will occur.

This object is applicable to MDrive Hybrid products only.

*Object description*

| | |
|---|---|
| Index | $2203_h$ |
| Name | Calibration current |
| Object code | VAR |
| Data type | Unsigned8 |

*Value description*

| | |
|---|---|
| Sub-index | $00_h$, Calibration current |
| Meaning | Calibration current |
| Access | Read-write |
| PDO mapping | — |
| Value range | $1 – 100_d$ (%) |
| Default value | 50 (%) |

## 8.6.22 $2204_h$ Run current

This object sets the percentage of full current at which the device will operate.

*Object description*

| | |
|---|---|
| Index | $2204_h$ |
| Name | Run current |
| Object code | VAR |
| Data type | Unsigned8 |

*Value description*

| | |
|---|---|
| Sub-index | $00_h$, Run current |
| Meaning | Run current |
| Access | Read-write |
| PDO mapping | — |
| Value range | $1 – 100_d$ (%) |
| Default value | 50 (%) |

| **2204 – 2205$_h$ (%)** | **MDrive (All)** | **MForce Micro (Amps RMS)** | **MForce Power (Amps RMS)** |
|---|---|---|---|
| 10 | MDrive Range 0 To 100% | 0.3 | 0.5 |
| 20 | Actual Current Not required as Motor is appropriately sized to the device. | 0.6 | 1.0 |
| 30 | | 0.9 | 1.5 |
| 40 | | 1.2 | 2.0 |
| 50 | | 1.5 | 2.5 |
| 60 | | 1.8 | 3.0 |
| 70 | | 2.1 | 3.5 |
| 80 | | 2.4 | 4.0 |
| 90 | | 2.7 | 4.5 |
| 100 | | 3.0 | 5.0 |

Table 8.12: Run and hold current settings for objects $2204_h$ and $2205_h$

### 8.6.23 $2205_h$ Hold current

This object sets the percentage of full current at which the device will transition to when motion ceases.

*Object description*

| | |
|---|---|
| Index | $2204_h$ |
| Name | Hold current |
| Object code | VAR |
| Data type | Unsigned8 |

*Value description*

| | |
|---|---|
| Sub-index | $00_h$, Hold current |
| Meaning | Hold current |
| Access | Read-write |
| PDO mapping | — |
| Value range | $0 – 100_d$ (%) |
| Default value | 5 (%) |
| Category | Yes |

### 8.6.24 $2211_h$ Position present point target

This object contains the position present point target

*Object description*

| | |
|---|---|
| Index | $2211_h$ |
| Name | Position present point target |
| Object code | VAR |
| Data type | Integer32 |

*Value description*

| | |
|---|---|
| Sub-index | $00_h$, Position present point target |
| Meaning | Position present point target |
| Access | Read-only |
| PDO mapping | — |
| Value range | $\pm 2^{31}$ |
| Default value | 0 |
| Category | — |

### 8.6.25 $2212_h$ Position final point target

This object contains the position final point target

*Object description*

| | |
|---|---|
| Index | $2212_h$ |
| Name | Position final point target |
| Object code | VAR |
| Data type | Integer32 |

*Value description*

| | |
|---|---|
| Sub-index | $00_h$, Position final point target |
| Meaning | Position final point target |
| Access | Read-only |
| PDO mapping | — |
| Value range | $\pm 2^{31}$ |
| Default value | 0 |
| Category | — |

### 8.6.26 $2401_h$ General purpose user variable

This object is a general purpose user variable which can be used to store 8-bits of data.

*Object description*

| | |
|---|---|
| Index | $2211_h$ |
| Name | General purpose user variable |
| Object code | VAR |
| Data type | Integer32 |

*Value description*

| | |
|---|---|
| Sub-index | $00_h$, General purpose user variable |
| Meaning | General purpose user variable |
| Access | Read-write |
| PDO mapping | — |
| Value range | $00 – FF_h$ |
| Default value | 0 |
| Category | — |

### 8.6.27 $2504_h$ SEM options

This object allows interoperability with Schneider Electric Twido PLC's and will not ordinarily be used.

*Object description*

| | |
|---|---|
| Index | $2504_h$ |
| Name | SEM options |
| Object code | VAR |
| Data type | Integer32 |

*Value description*

| | |
|---|---|
| Sub-index | $00_h$, SEM options |
| Meaning | SEM options |
| Access | Read-write |
| PDO mapping | — |
| Value range | $00 – FF_h$ |
| Default value | 0 |
| Category | — |

### 8.6.28 $2701_h$ Hybrid enable

This object controls the enable/disable state of the Hybrid Motion Technology control circuitry.

- Disabled = $00_h$
- Enabled = $80_h$

`Object 2701h` is only avialable on MDrive Hybrid models.

*Object description*

| | |
|---|---|
| Index | $2701_h$ |
| Name | Hybrid enable |
| Object code | VAR |
| Data type | Unsigned8 |

*Value description*

| | |
|---|---|
| Sub-index | $00_h$, Hybrid enable |
| Meaning | Hybrid enable |
| Access | Read-write |
| PDO mapping | — |
| Value range | $00_h$ or $80_h$ |
| Default value | $00_h$ |
| Category | Yes |

## 8.6.29 $2702_h$ Hybrid configuration

This object sets the parameters of the Hybrid Motion Technology (HMT) operation. The following parameters are set:

1) **Fixed/variable current (bit 7):** HMT can operate using two current modes: fixed and variable. In fixed current mode the device will operate using the settings of the run (`object 2204`$_h$) and hold (`object 2205`$_h$) current set parameters. In variable current mode the device will adjust the current between the run and hold current settings to what is required to move the load at the desired velocity.
2) **Control boundaries (bits 6 ... 5):** HMT functions by closely monitoring the relationship between the rotor and stator of the motor to within set boundaries from 1.1 to 1.7 motor full steps where a lower setting gives enhanced torque performance and a higher setting deliver batter speed performance.
3) **Make-up mode (bits 1 ... 0):** If enabled, HMT control will make-up for lost steps in the move profile. This can occur at a fixed velocity of 2.5 MHz or at a speed preset using `object 2703`$_h$.

`Object 2701`$_h$ is only avialable on MDrive Hybrid models.

*Object description*

| | |
|---|---|
| Index | $2702_h$ |
| Name | Hybrid configuration |
| Object code | VAR |
| Data type | Unsigned8 |

*Value description*

| | |
|---|---|
| Sub-index | $00_h$, Hybrid configuration |
| Meaning | Hybrid configuration |
| Access | Read-write |
| PDO mapping | — |
| Value range | See Table 8.13 (Unsigned8) |
| Default value | $A2_h$ |
| Category | Yes |

| **Bits** | | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|---|
| **Function** | | cur_fv | c_bnds | | X | X | X | mu | |
| **Current mode (cur_fv)** | | | | | | | | | |
| Bit 7 | 0 | Fixed current (default) | | | | | | | |
| | 1 | Variable current | | | | | | | |
| **Control bounds (c_bnds)** | | | | | | | | | |
| Bit 6 | Bit 5 | | | | | | | | |
| 0 | 0 | 1.1 full steps (best torque perfomance) | | | | | | | |
| 0 | 1 | 1.3 full steps (default) | | | | (Best overall performance) | | | |
| 1 | 0 | 1.5 ful steps | | | | | | | |
| 1 | 1 | 1.7 full steps (best speed performance) | | | | | | | |
| **Make-up mode (mu)** | | | | | | | | | |
| Bit 1 | Bit 0 | | | | | | | | |
| 0 | 0 | Make up disabled | | | | | | | |
| 0 | 1 | reserved | | | | | | | |
| 1 | 0 | Make-up velocity = 2.5 MHz (default) | | | | | | | |
| 1 | 1 | Make-up velocity = $2703_h$ setting | | | | | | | |

Table 8.11: Description of clock options object $2032.01_h$

## 8.6.30 $2703_h$ Make-up velocity

Defines the velocity for hybrid make-up (`Object 2702h, bits 1 ... 0`) if selected. The make-up period is determind using the equation:

Frequency = (x+2) * 50ns where x is the setting of $2703_h$

e.g. (1998+2) * 50 = 100000 steps/sec

`Object 2703h` is only avialable on MDrive Hybrid models.

*Object description*

| | |
|---|---|
| Index | $2703_h$ |
| Name | Make-up velocity |
| Object code | VAR |
| Data type | Unsigned32 |

*Value description*

| | |
|---|---|
| Sub-index | $00_h$, Make-up velocity |
| Meaning | Make-up velocity |
| Access | Read-write |
| PDO mapping | — |
| Value range | Unsigned32 |
| Default value | $1998_d$ (100000 steps/sec) |
| Category | Yes |

### 8.6.30 $2741_h$ Hybrid status

Indicates the calibration status of the rotor and stator of the motor. If $00_h$, the motor is not calibrated, if $01_h$, the motor is calibrated.

Calibration will occur on two conditions:

1) Power on
2) Re-enabling the hybrid circuitry after disabling it (`Object` $2701_h$)

`Object` $2741_h$ is only avialable on MDrive Hybrid models.

*Object description*

| | |
|---|---|
| Index | $2741_h$ |
| Name | Hybrid status |
| Object code | VAR |
| Data type | Unsigned8 |

*Value description*

| | |
|---|---|
| Sub-index | $00_h$, Hybrid status |
| Meaning | Hybrid status |
| Access | Read-only |
| PDO mapping | — |
| Value range | $00_h$ – $01_h$ |
| Default value | $00_h$ (not calibrated) |
| Category | — |

## 8.7 Details of object group $5000_h$ (Mfg factory specific)

Object group $5000_h$ contains objects factory configuration and are not for end use.

## 8.8 Details of assignment objects group $6000_h$

The objects in group $6000_h$ are operation specific. See Section 6 for detailed information on these objects.

# 9 CANopen tester software

9

**⚠WARNING**

**UNINTENDED OPERATION**

The product is unable to detect an interruption of the network link if

- Do not write values to reserved parameters.
- Do not write values to parameters unless you fully understand the function.
- Run initial tests without coupled loads.
- Verify that the system is free and ready for the movement before changing parameters.
- Verify the use of the word sequence with fieldbus communication.
- Do not establish a fieldbus connection unless you have fully understood the communication principles.

**Failure to follow these instructions can result in death, serious injury or equipment damage.**

## 9.1 Overview

CANopen tester software is a GUI developed to interoperate with the MD-CC500-000 USB to CANopen communication converter cable. All of the functions of the MDrivePlus, MDrive Hybrid and MForce CANopen devices may be exercised using this tool.

It may also be used to configure parameters such as NODE ID and BAUD rate.

Use of CANopen Tester is required for field upgrading the firmware in he device.

### 9.2.1 System requirements

The following system specifications are required to use the CANopen Tester software:

- PC with Windows XP SP2 or higher
- MD-CC500-000 communication converter cable with PEAK drivers installed.

Revision R051211

## 9.2 Installation

### 9.2.1 Install MD-CC500-000 USB to CANopen communication converter

The drivers for the MD-CC500-000 are located on the PEAK CD which came with the product. The drivers may be downloaded from the web site at http://www.imshome.com/downloads/cable_drivers.html.

Setup the driver before connecting the PCAN-USB adapter to the computer for the first time.

Do the following to install the driver:

1) Make sure that you are logged in as user with administrator privileges (not needed for normal use of the MD-CC500-000 adapter later on).
2) Insert the supplied CD into the appropriate drive of the computer. Usually a navigation program appears a few moments later. If not, start the file Intro.exe from the root directory of the CD.
3) On the page English > Drivers activate the entry PCAN-USB.
4) Click on Install now. The setup program for the driver is executed.
5) Follow the instructions of the setup program.

Do the following to connect the PCAN-USB adapter and complete the initialization:

1) Connect the PCAN-USB adpater to an USB port of the computer or of a connected USB hub. The computer can remain powered on. Windows notifies that new hardware has been detected.
2) Windows XP only: A Wizard dialog box appears. Follow its instructions and select the automatic software installation.
3) Afterwards you can work as user with restricted rights again. After the initialization process is finished successfully the red LED on the PCAN-USB adapter is illuminated.

### 9.2.2 Install CANopen Tester

1) Download the latest CANopen Tester from http://www.imshome.com/downloads/software_interfaces.html to a location on your harddrive.
2) Extract the installation file set.
3) Double click “setup.exe”
4) Follow the installation prompts to complete.

## 9.3 Using CANopen Tester

### 9.3.1 Screen overview

The main screen of the CANopen Tester is organized in blocks according to function and operation.

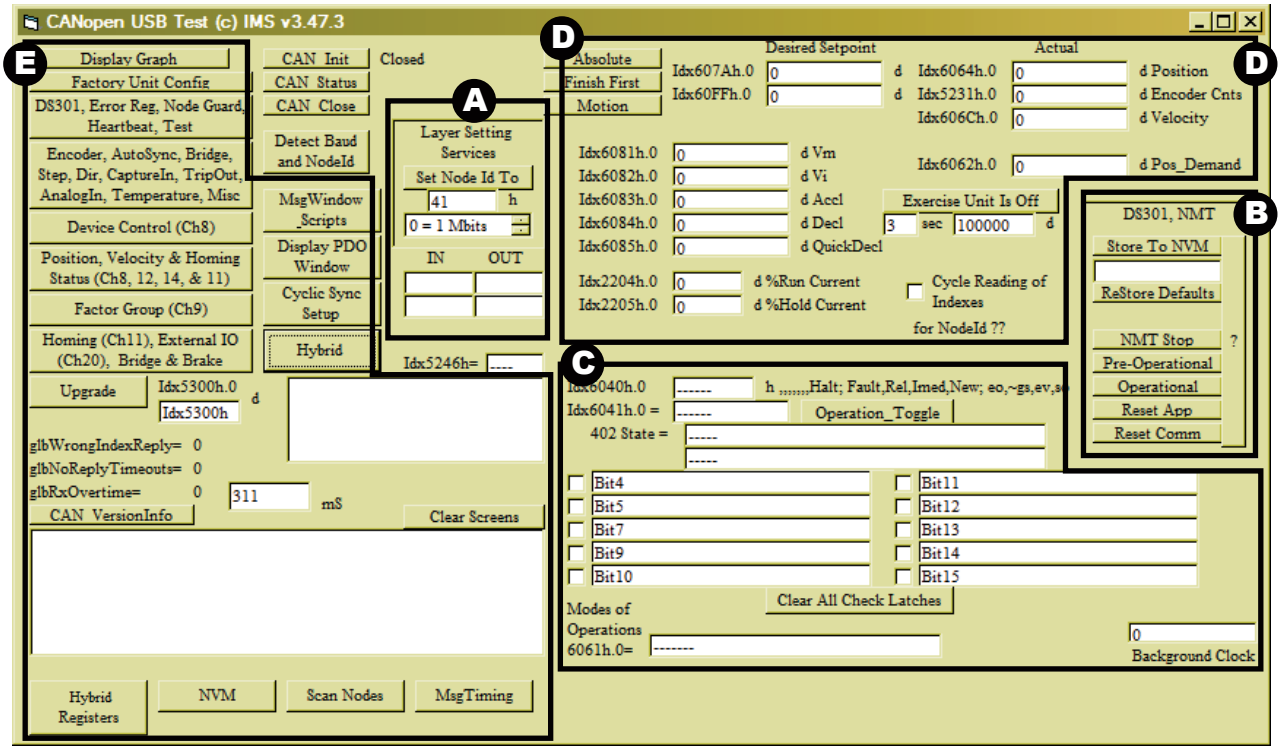


Figure 9.1: CANopen Tester main screen layout.

*Block (A)* The block labeled (A) in Figure 9.1 uses LSS (Layer Setting Services to configure the Node ID and BAUD rate. The defaults are as shown, Node ID = $41_h$ and BAUD = 1 Mbits

*Block (B)* Contains switched for controlling the NMT protocol for switching the device through the various stages of the state machine, resetting the application, communications, restoring defaults.

*Block (C)* DS-402 state specific, Control and Status word specific operation, such as selecting the operation mode, reading the check latches.

*Block (D)* Profile position and profile velocity direct motion command and parameter entry and configuration.

Block (E)

Allopws acces to dialogs fitting specific DSP-402 and mode specific and manufacturer specific objects as well as SDO and PDO entry and receipt.

### 9.3.2 CANopen Tester quick start

The following exercise will step you through the initialization, entry into operational mode, setting profile position mode and performing a point top point move.

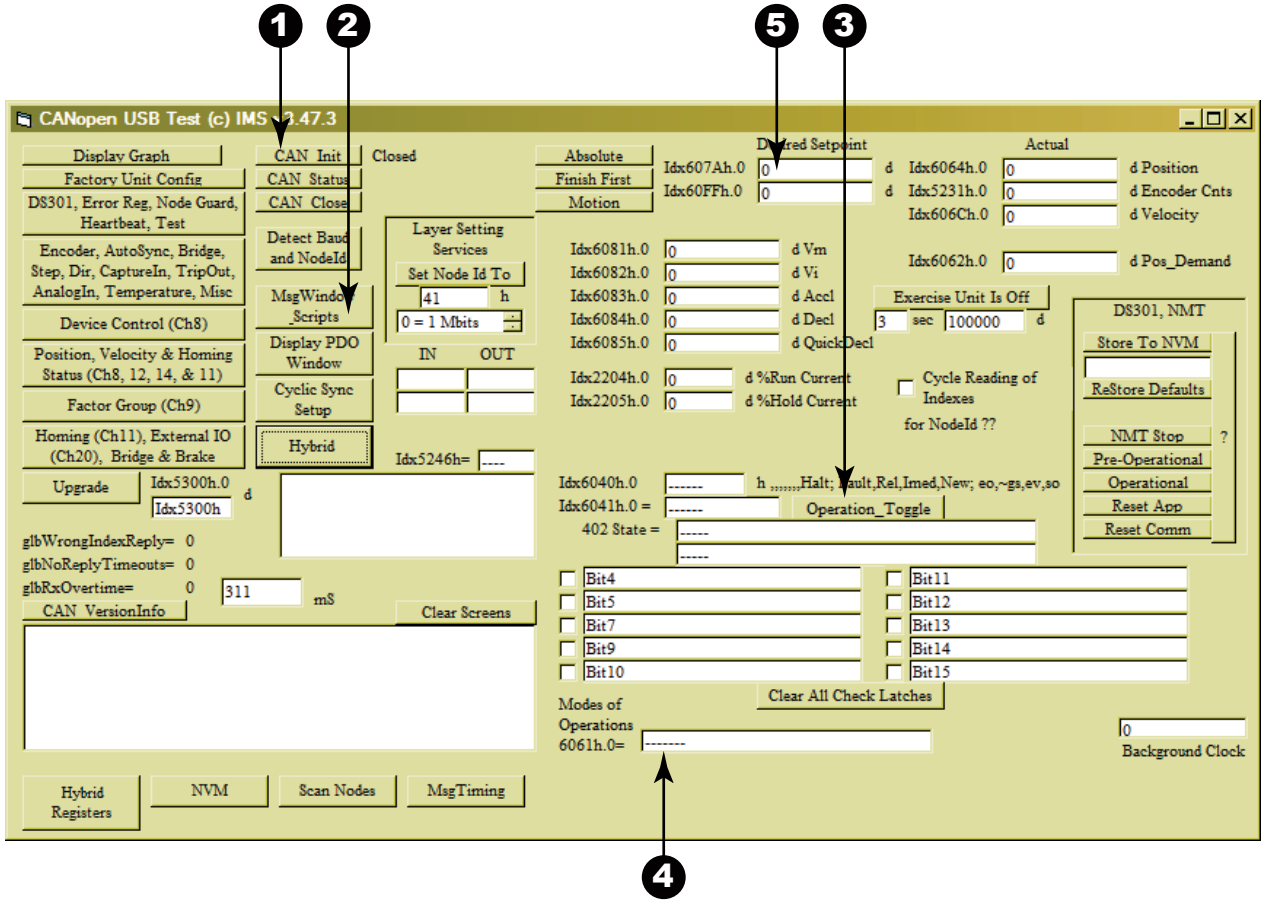


Figure 9.2: Getting started with CANopen Tester

With CANopen Tester opened and your device in a powered state, using the numbered markers in Figure 9.3 as a guide, perform the following:

1) Click CAN Init. This will open communication with the device.
2) Click Msg Window Scripts – This will open another window to allow the user to see data being sent to the device in real time.
3) Click operation_toggle three times (this steps through index $6040_h$ control word ending with operation enabled). This enables the output bridge of the driver.
4) Enter the number “1” in the modes of operations field, this places the device into profile position mode.
5) Enter 512000 into the Idx67AH field, strike the return (enter) key on your key board, the motor should move 10 revolutions.

# WARRANTY

## TWENTY-FOUR (24) MONTH LIMITED WARRANTY

IMS Schneider Electric Motion USA warrants only to the purchaser of the Product from IMS Schneider Electric Motion USA (the “Customer”) that the product purchased from IMS Schneider Electric Motion USA (the “Product”) will be free from defects in materials and workmanship under the normal use and service for which the Product was designed for a period of 24 months from the date of purchase of the Product by the Customer. Customer’s exclusive remedy under this Limited Warranty shall be the repair or replacement, at Company’s sole option, of the Product, or any part of the Product, determined by IMS Schneider Electric Motion USA to be defective. In order to exercise its warranty rights, Customer must notify Company in accordance with the instructions described under the heading “Obtaining Warranty Service”.

*NOTE: MDrive Motion Control electronics are not removable from the motor in the field. The entire unit must be returned to the factory for repair.*

This Limited Warranty does not extend to any Product damaged by reason of alteration, accident, abuse, neglect or misuse or improper or inadequate handling; improper or inadequate wiring utilized or installed in connection with the Product; installation, operation or use of the Product not made in strict accordance with the specifications and written instructions provided by IMS; use of the Product for any purpose other than those for which it was designed; ordinary wear and tear; disasters or Acts of God; unauthorized attachments, alterations or modifications to the Product; the misuse or failure of any item or equipment connected to the Product not supplied by IMS Schneider Electric Motion USA; improper maintenance or repair of the Product; or any other reason or event not caused by IMS Schneider Electric Motion USA.

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If the Product was purchased from an IMS Schneider Electric Motion USA Distributor, please contact that Distributor to obtain a Returned Material Authorization (RMA). If the Product was purchased directly from IMS Schneider Electric Motion USA, please contact Customer Service at info@imshome.com or 860-295-6102 (Eastern Time Zone).

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