Special documentation

Force sensors with CANopen interface

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Examples

WIKA

Part of your business

Prior to starting any work, read the installation instructions!
Keep for later use!

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1. General information

1.1 Force sensor with CANopen output

The CANopen sensor is a force transducer providing force measurements through a CANopen interface implementing device profile DS404.

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1.2 Features

Sample rate: 1 ms

1.3 CANopen feature summary

Description	Value
CANopen type	NMT Slave
Bitrate	From 20 kBit/s to 1 Mbit/s
Number of transmit PDOs	4
PDO mapping	Dynamic
PDO triggering events	Synchronous, asynchronous
Heartbeat protocol	Supported
Emergency messages	Supported
Device profile	CiA 404
Layer setting services (LSS)	Supported
Default settings	
Node-ID	127
Bitrate	250 kBit/s
Supported Bitrates	1.000 kBit/s, 800 kBit/s, 500 kBit/s, 250 kBit/s, 125 kBit/s, 100 kBit/s, 50 kBit/s, 20 kBit/s

1.4 CAN frames

The force transducer supports standard CAN frames with 11-bit identifier. Extended frames with 29-Bit identifier are not supported but tolerated.

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2. Quick start guide

2.1 Quick start introduction

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This chapter describes setting the sensor up using a simple CAN-software without specialised CANopen support. The sensor may be configured entirely using raw CAN telegrams. We recommend to use a software with build-in CANopen support.

Please do note this is only a couple of possible configurations, for full details, please refer to the official CANopen specification.

2.2 Connecting and powering the device

First setup the sensor:

- Connect the CAN interface to your PC (e.g. PEAK PCAN-USB, Ixxat USB-to-CAN) and to the sensor and start the CAN-Software (e.g. PEAK PCAN-View, Ixxat canAnalyser3 Mini). Ensure you use the correct Bitrate and Node-ID of the force sensor.
- When the sensor is powered up it sends a boot-up message.

ID	DLC	Byte0
700h + Node-ID	1	00h

The sensor is now in **PRE-OPERATIONAL** mode and ready to be configured by **SDO** (if necessary).

2.3 Configuring the device

The sensor is now ready to be configured and started.
Choose one of the following transmission methods:

- **Acyclic synchronous transmission** (transmission type = 0)
  - triggered when the SYNC message is received and one of the mapped process data has changed its value after the last transmission.
- **Cyclic synchronous transmission** (transmission type = 1 ... 240) (default = 1)
  - triggered when a SYNC message is received (type = 1), each second SYNC message received (type = 2), etc.
- **Asynchronous event/timer triggered**
  - timer triggered (transmission type = 254) adjustable in ms (via Object 1800h.5)
  - event triggered (transmission type = 254/255) if the measured value falls below or exceeds an adjustable limit. If the measured value has changed by more than a delta value compared to the last transferred measured value.

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In order to change the transmission type object 1800h.2 must be changed to the appropriate transmission type using SDO write access (see chapter 2.5 Quick start guide “Service data object (SDO)”).

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2.4 Starting the device

The configured device must now be started by the master:
In order to send **PDO**-messages the sensor has to be set to **OPERATIONAL** mode.

Master transmits:

ID	DLC	Byte0	Byte1
00h (0 = all nodes)	2	01h	Node-ID

The sensor is now in **OPERATIONAL** mode

- Depending on the previously selected transmission type the master needs to send the **SYNC** object.

Master transmits:

ID	DLC
80h	0

- The received data now looks like (depending on configuration):

ID	DLC	Byte0	Byte1
180h + Node-ID	4	LSB 7130h subinex	MSB 7130h subinex

This data is called **TPDO**.

2.5 Service data object (SDO)

2.5.1 SDO read object

- The SDO read object to read a dictionary entry:

Master transmits:

ID	DLC	Byte0	Byte1	Byte2	Byte3	Byte4	Byte5	Byte6	Byte7
600h + Node-ID	8	CS = 40h	LSB	MSB	Subindex	00h	00h	00h	00h
			Index						

Sensor replies:

ID	DLC	Byte0	Byte1	Byte2	Byte3	Byte4	Byte5	Byte6	Byte7
580h + Node-ID	8	CS	LSB	MSB	Subindex	LSB			MSB
			Index			Data			

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CS	Number of valid bytes
4Fh	1 (byte 4)
4Bh	2 (byte 4 - byte 5)
47h	3 (byte 4 - byte 6)
43h	4 (byte 4 – byte 7)

2.5.2 SDO write object

- The SDO read object to write data to a dictionary entry:

Master transmits:

ID	DLC	Byte0	Byte1	Byte2	Byte3	Byte4	Byte5	Byte6	Byte7
600h + Node-ID	8	CS	LSB	MSB	Subindex	LSB			MSB
			Index			Data			

CS	Number of valid bytes
2Fh	1 (byte 4)
2Bh	2 (byte 4 - byte 5)
27h	3 (byte 4 - byte 6)
23h	4 (byte 4 – byte 7)

Sensor replies:

ID	DLC	Byte0	Byte1	Byte2	Byte3	Byte4	Byte5	Byte6	Byte7
580h + Node-ID	8	CS = 60h	LSB	MSB	Subindex	00h	00h	00h	00h
			Index						

Other values for CS than 60h are abort codes, indicating a failed SDO write (see chapter 3 CANopen communication, point 3.3 “Service data object (SDO)”).

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3. CANopen communication

3.1 CANopen introduction

CANopen is a communication protocol using the CAN bus to provide sensor access and measurements.

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All CANopen data is stored in the CANopen dictionary. CANopen supports a couple of different objects to access the object dictionary entries:

- SDO (**S**ervice **D**ata **O**bject):
  Used to access any object of the object dictionary.
  Offers read and write functionality.
  Usually used to indentify and configure the sensor.
- TPDO (**T**ransmit **P**rocess **D**ata **O**bject):
  Provides status and measurement information with a low communication overhead.
  Usually used to retrieve the measured data.

The CANopen dictionary contains all data the sensor provides. It consists of multiple entries with the following properties (in excerpts):

- Index: the 16 bit object index, usually written in hexadecimal, e.g.: 1000h.
- Subindex: Each object may contain up to 255 subobjects. If no subobjects are supported a subindex of 0 is used. In case of existing subobjects subindex 0 provides a UNSIGEND8 value indicating the number of provided subobjects.
- Data type: the data type, e.g.: UNSIGNED32 (unsigned 32 bit integer).
- Access: the permitted dictionary access, e.g.: RW (ReadWrite), RO (Read Only).
- Default value: the default value of an object after CANopen device initialization.
- PDO mapping: when yes, the object may be transmitted by TPDO (depending on TPDO configuration (see chapter 3.4.1 “TPDO mapping”).

In the following document objects and subobjects are referenced by following nomenclature: “object.subobject” (e.g. 1A00h.01 means object index 1A00h, subobject 01h). All indices are given as hex numbers.
CANopen devices implement different device profiles, which provide different functioniality and object entries.

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3.2 Device profile 404

The sensor implements the CANopen device profile 404 for measuring devices. This adds a couple of object dictionary entries, ranging from 6110h to 9140h.

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The measurement values are called analog input process values. Mainly they are provided through the entries 7130h and 9130h (Analog input PV).

A couple of objects, like the analog input PV exist in 2 ways, distinguished by the first character:

- 7xxxh - the resulting data type is INTEGER16
- 9xxxh - the resulting data type is INTEGER32

Entries like these are often referred to in a form like x130h, which means ‘any kind of analog input’.

3.3 Service data object (SDO)

Service data objects are used to access the entries of the transmitters object dictionary. Therefore the dictionary entries are accessed by index and subindex.

Therefore the master sends a specific request message followed by a reply from the sensor.

3.3.1 SDO read object

- The SDO read object to read a dictionary entry:

Master transmits:

ID	DLC	Byte0	Byte1	Byte2	Byte3	Byte4	Byte5	Byte6	Byte7
600h + Node-ID	8	CS = 40h	LSB	MSB	Subindex	00h	00h	00h	00h
			Index						

Sensor replies:

ID	DLC	Byte0	Byte1	Byte2	Byte3	Byte4	Byte5	Byte6	Byte7
580h + Node-ID	8	CS	LSB	MSB	Subindex	LSB			MSB
			Index			Data			

CS	Number of valid bytes
4Fh	1 (byte 4)
4Bh	2 (byte 4 - byte 5)
47h	3 (byte 4 - byte 6)
43h	4 (byte 4 – byte 7)

3.3.2 SDO write object

■ The SDO read object to write data to a dictionary entry:

Master transmits:

ID	DLC	Byte0	Byte1	Byte2	Byte3	Byte4	Byte5	Byte6	Byte7
600h + Node-ID	8	CS = 60h	LSB	MSB	Subindex	LSB			MSB
			Index			Data			

CS	Number of valid bytes
2Fh	1 (byte 4)
2Bh	2 (byte 4 - byte 5)
27h	3 (byte 4 - byte 6)
23h	4 (byte 4 – byte 7)

Sensor replies:

ID	DLC	Byte0	Byte1	Byte2	Byte3	Byte4	Byte5	Byte6	Byte7
580h + Node-ID	8	CS = 60h	LSB	MSB	Subindex	00h	00h	00h	00h
			Index						

Other values for CS than 60h are abort codes, indicating a failed SDO write (see chapter 3.3 “Service data object (SDO)”).

3.3.3 Abort SDO transfer

■ If an error occurred while reading or writing an object, the transmitter answers:

ID	DLC	Byte0	Byte1	Byte2	Byte3	Byte4	Byte5	Byte6	Byte7
580h + Node-ID	8	CS = 80h	LSB	MSB	Subindex	LSB			MSB
			Index			Abort codes			

3.3.4 SDO abort codes

Possible SDO abort codes are:

Abort code	Description
0503 0000h	Toggle bit not altered
0504 0000h	SDO protocol timed out
0504 0001h	Client/server command specifier not valid or unknown
0504 0002h	Invalid block size (block mode only)
0504 0003h	Invalid block sequence number (block mode only)
0504 0004h	Invalid block CRC value (block mode only)
0504 0005h	Out of memory

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Abort code	Description
0601 0000h	Unsupported access to an object
0601 0001h	Attempt to read a write only object
0601 0002h	Attempt to write a read only object
0602 0000h	Object does not exist in the object dictionary
0604 0041h	Object cannot be mapped to the PDO
0604 0042h	The number and length of the objects to be mapped would exceed PDO length
0604 0043h	General parameter incompatibility reason
0604 0047h	General internal incompatibility in the device
0606 0000h	Access failed due to a hardware error
0607 0010h	Data type does not match, length of service parameter does not match
0607 0012h	Data type does not match, length of service parameter too high
0607 0013h	Data type does not match, length of service parameter too low
0609 0030h	Invalid value for parameter (download only)
0609 0031h	Value of parameter written too high (download only)
0609 0032h	Value of parameter written too low (download only)
0609 0036h	Maximum value is less than minimum value
060a 0023h	Resource not available: SDO connection
0800 0000h	General error
0800 0020h	Data cannot be transferred or stored to the application
0800 0021h	Data cannot be transferred or stored to the application because of local control
0800 0022h	Data cannot be transferred or stored to the application because of the present device state
0800 0023h	Object dictionary dynamic generation fails or no object dictionary is present (e.g. object dictionary is generated from file and generation fails because of an file error).
0800 0024h	No data available

3.4 Transmit process data object (TPDO)

Transit process data objects are used by the sensor to frequently transmit measured data with low protocol overhead. A TPDO may contain up to 8 bytes of measurement or status data. The data mapped to the TPDO may be changed through the TPDO mapping.

All TPDO transmission requires the sensor to be in NMT state ‘OPERATIONAL’ (see chapter 3.5 ”Network management (NMT)”).

TPDO data is transmitted using the CAN-ID: 1800h.1 (COB-ID) + Node-ID, data length as big as needed by the data.

3.4.1 TPDO mapping

Object entries marked as 'mappable' may be mapped into either TPDO. The TPDO mapping may be accessed through the object 1A00 and 1A03 (the first one defines the content of TPDO1 the latter of TPDO4).

Subindex 0 contains the number of used entries (up to 8, excluding subindex 0).

The other subindex contain the object dictionary entries index and subindex encoded as a 32bit integer. The information is encoded as follows:

Bits 24..31	Bits 16..23	Bits 8..15	Bits 0..7
Index (high byte)	Index (low byte)	Subindex	Data length in bits

Please note, that the data length needs to match the entries data size from the object dictionary.

Example:

The value 0x91300120h will map the object 9130h (AI input PV) subindex 01 (force value as INTEGER32) to the PDO. Since the size of INTEGER32 is 32 bit, data length needs to be set to 0x20h.

When mapping multiple entries to a TPDO, the data is mapped from subindex 1 to 8.

Example:

The PDO1 with the mapping:
1800h.0 = 2
1800h.1 = 0x91300120
1800h.2 = 0x10010008
would look like:

ID	DLC	Byte0	Byte1	Byte2	Byte3	Byte4
180h + Node-ID	5	LSB			MSB	1001h
		9130h subindex 1				

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3.4.2 Changing the TPDO mapping

In order to change the TPDO mapping a couple of steps need to be executed in the right order:

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- Set TPDO invalid by switching bit 31 in the COB-ID (e.g. 1800h.1)
- Set TPDO mapping invalid by setting the mapping index (e.g. 1A00h.0) to 0
- Change TPDO mapping entries
- Set TPDO mapping index top number of used entries
- Set TPDO valid by switching bit 31 back.

Example:

- Set TPDO invalid by setting bit “valid” to 1b (1800h.1)

ID	DLC	Byte0	Byte1	Byte2	Byte3	Byte4	Byte5	Byte6	Byte7
601h	8	23h	00h	18h	01h	81h	01h	00h	C0h
			Index			Data			

- Disable mapping by setting index 1A00.0 to 00h

ID	DLC	Byte0	Byte1	Byte2	Byte3	Byte4	Byte5	Byte6	Byte7
601h	8	2Fh	00h	1Ah	00h	00h	00h	00h	00h
			Index			Data			

- Modify mapping by changing the values of the corresponding sub-indices, e.g. change mapped object to 7130.1

ID	DLC	Byte0	Byte1	Byte2	Byte3	Byte4	Byte5	Byte6	Byte7
601h	8	23h	00h	1Ah	01h	20h	01h	30h	71h
			Index			Data			

- Enable mapping by setting sub-index 00h to the number of mapped objects (1).

ID	DLC	Byte0	Byte1	Byte2	Byte3	Byte4	Byte5	Byte6	Byte7
601h	8	2Fh	00h	1Ah	00h	01h	00h	00h	00h
			Index			Data			

- Set TPDO valid by setting bit ‘valid‘ to 0b (1800.1)

ID	DLC	Byte0	Byte1	Byte2	Byte3	Byte4	Byte5	Byte6	Byte7
601h	8	23h	00h	18h	01h	81h	01h	00h	40h
			Index			Data			

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3.4.3 TPDO transmission types

The PDO transmission types can be configured via objects 1800h/1801h subindex 2.

Synchronous transmission (cyclic, acyclic)

A transmission type of 0 means that the PDO is triggered acyclic when a SYNC message is received and one of the mapped process data has changed its value after the last transmission.

A transmission type of n (1 … 240) means that the PDO is triggered cyclic with every n-th SYNC message.

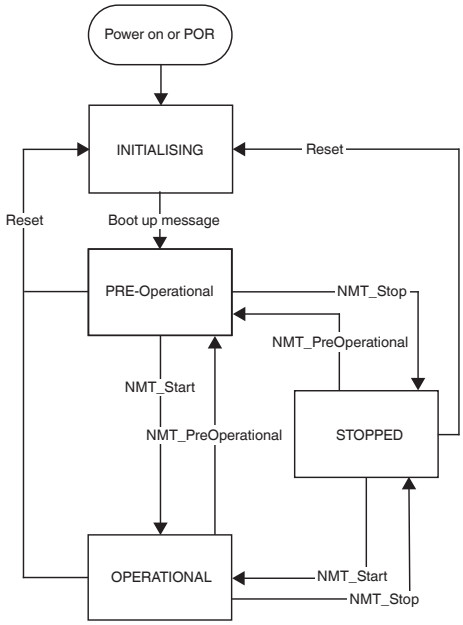
Asynchronous transmission

A transmission type of 254 means that the PDO is triggered after the event timer elapses. The event timer can be configured via objects 1800h/1801h subindex 5.

A transmission type of 254/255 means that the message will be sent if the measured value falls below or exceeds an adjustable limit and also if the measured value has changed by more than a delta value compared to the last transferred measured value. The interrupt limits can be configured via entries x133h/x134h/x135h/x136h.

3.5 Network management (NMT)

Every CANopen device has an internal state machine as shown in figure 1:



After POR all devices enter the state 'INITIALISING'. The initial state is left automatically after finishing the initialisation. Leaving the initialisation state is indicated by sending the bootup message (see chapter 3.5.3 " Bootup service").

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After leaving 'INITIALISING' the device enters the pre-operational state. The PRE-OPERATIONAL is a kind of idle state, this is the go-to state to configure the device. In order to obtain TPDOs from the sensor, the sensor must be started via NMT command from the master (see chapter 3.5.1 "Module control protocol").

It is possible to configure the sensor to enter the state operational without NMT command, for more information please refer to chapter 4.1.16 "Object 1F80h: NMT startup".

In case of an EMCY the device stays in its current state.

3.5.1 Module control protocol

NMT Master request:

ID	DLC	Byte0	Byte1
00h	2	CS	Node-ID (0 = all nodes)

CS: NMT command specifier
NMT services are unconfirmed

CS	
01h	Start remote node
02h	Stop remote node
80h	Enter pre-operational
81h	Reset node
82h	Reset communication

3.5.2 Error control services

Through error control services the NMT detects failures in a CAN-based protocol. The heartbeat mechanism for a device is established through cyclically transmitting a message by a heartbeat producer. One or more devices in the network are aware of this heartbeat message. If the heartbeat cycle fails for the heartbeat producer the local application on the heartbeat consumer will be informed about that event.
(see chapter 4.1 Object dictionary - communication profile area, point 4.1.11 "Object 1017h: producer heartbeat time").

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3.5.3 Bootup service

Through this service, the NMT slave indicates that a local state transition occurred from the state 'INITIALISING' to the state 'PRE-OPERATIONAL'. The protocol uses the same identifier as the error control protocols.

ID	DLC	Byte0
700h + Node-ID	1	00h

3.6 Emergency object (EMCY)

In case of an EMCY the sensor sends an EMCY object:
Sensor transmits:

ID	DLC	Byte0	Byte1	Byte2	Byte3	Byte4	Byte5	Byte6	Byte7
80h + Node-ID	8	LSB	MSB	Error register (1001h)	Manufacturer specific error field				
		Emergency error code							

For detailed error behaviour description and supported error codes please refer to chapter 4.1 Object dictionary - communication profile area**,** point 4.1.2 „Object 1001h: Error register".

4. Object dictionary

4.1 Object dictionary – Communication profile area

4.1.1 Object 1000h: Device type

The device type describes the type of device and its functionality. The lower 16-bit field describes the device profile number (404) and the upper 16-bit field contains additional information (analogue input block, manufacturer-specific PDO mapping).

Description	Value
Index	1000h
Parameter name	Device type
Object type	Var
Data type	Unsigned32
Access	Read only (ro)
Default value	0002 0194h
PDO mapping	No

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4.1.2 Object 1001h: Error register

This object is an error register for the device. The device maps internal errors in this byte. It is a part of an emergency object.

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Supported error bits:

- Bit 0: Generic error (always set at any error situation)
- Bit 5: Device profile specific, always 0b for DS 404
- Bit 4: Communication error (overrun, error state)
- Bit 7: Manufacturer-specific

The detailed information of each error is described in 5 Emergency object (EMCY).

Description	Value
Index	1001h
Parameter name	Error register
Object type	Var
Data type	Unsigned8
Default value	00h
Access	Read only (ro)
PDO mapping	No

4.1.3 Object 1003h: Predefined error field

This object holds errors that have occurred on the transmitter and have been signalled via Emergency object. It represents an error history containing up to 4 errors. For a list of possible error entries please refer to chapter 5 “Emergency object (EMCY)“.

In case that any error is in the history the values have the following meaning:

32	18	15	0
Additional information		**Error code**	
MSB		**LSB**	

For detailed description of error code see chapter 5 “Emergency Object (EMCY)”.

The bits 16 to 23 (1 Byte) is byte 4 in the EMCY message
The bits 24 to 31 (1 Byte) is byte 3 in the EMCY message

Writing to sub index 0 deletes the entire error history.

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Description	Value
Index	1003h
Parameter name	Predefined error field
Object type	Array
Sub-index	0
Parameter name	Number of errors
Object type	Var
Data type	Unsigned8
Access	Read/write (rw)
Default value	0
PDO mapping	No
Sub-index	1
Parameter name	Standard error field
Object type	Var
Data type	Unsigned32
Access	Read only (ro)
Default value	0
PDO mapping	No

4.1.4 Object 1005h: COB-ID SYNC message

This index defines the COB-ID of the Synchronisation object (SYNC).

Description	Value
Index	1005h
Parameter name	Cob ID Sync
Data type	Unsigned32
Access	Read/write (rw)
Default value	00 00 00 80h
PDO mapping	No

4.1.5 Object 1008h: Manufacturer device name

Contains the manufacturer device name.

Description	Value
Index	1008
Parameter name	Manufacturer device name
Data type	Visible_string
Access	Read only (ro)
PDO mapping	No

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4.1.6 Object 1009h: Manufacturer hardware version

Contains the manufacturer hardware version description.

Description	Value
Index	1009h
Parameter name	Manufacturer hardware version
Data type	Visible_string
Access	Read only (ro)
PDO mapping	No

4.1.7 Object 100Ah: Manufacturer software version

Contains the manufacturer software version description.

Description	Value
Index	100Ah
Parameter name	Manufacturer software version
Data type	Visible_string
Access	Read only (ro)
PDO mapping	No

4.1.8 Object 1010h: Store parameter field

This entry supports saving of parameters in non-volatile memory.

With a read access the device provides information about its saving capabilities.

- Sub-index 1: All parameters

For saving the signature “save” (0x65766173) must be written.

Description	Value
Index	1010h
Parameter name	Store parameter field
Object type	Array
Sub-index	00h
Parameter name	Number of entries
Object type	Var
Data type	Unsigned8
Lower limit	0x0
Higher limit	0x7F
Access	Read only (ro)
Default value	01h
PDO mapping	No

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Description	Value
Sub-index	01h
Parameter name	Save all parameters
Object type	Var
Data type	Unsigned32
Access	Read/write (rw)
PDO mapping	No

On reception of the correct signature in sub-index 1 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 0000h).

4.1.9 Object 1014h: Cob ID Emcy

COB-ID used for emergency message (Emergency producer)

Description	Value
Index	1014h
Parameter name	Cob ID Emcy
Object type	Var
Data type	Unsigned32
Lower limit	0x00000001
Higher limit	0xFFFFFFFF
Access	Read only (ro)
Default value	80h + node-ID
PDO mapping	No

4.1.10 Object 1015h: Inhibit time emergency

The inhibit time emergency defines the inhibit time for the EMCY message.

Description	Value
Index	1015h
Parameter name	Inhibit time emergency
Object type	Var
Data type	Unsigned16
Access	Read/write (rw)
Default value	0
PDO mapping	No

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4.1.11 Object 1017h: Producer heartbeat time

The producer heartbeat time defines the cycle time of the heartbeat in milliseconds. The producer heartbeat time is 0 if it is not used.

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The time has to be a multiple of 1 millisecond.

Description	Value
Index	1017h
Parameter name	Producer heartbeat time
Object type	Var
Data type	Unsigned16
Access	Read/write (rw)
Default value	0
PDO mapping	No

Changed parameters are not automatically stored, but they have to be stored via object 1010h store parameters.

4.1.12 Object 1018h: Identity object

This object contains general information about the device.

- Sub-index 1: CANopen Vendor ID - unique value allocated to each manufacturer (WIKA 47h)
- Sub-index 2: Manufacturer specific product code - identifies device version (Product label: P#)
- Sub-index 3: Revision number - consists of major revision number and minor revision number
- Sub-index 4: Manufacturer specific serial number - identifies specific device (Product label: S#)

Description	Value
Index	1018h
Parameter name	Identity object
Object type	Record
Sub-index	00h
Parameter name	Number of entries
Object type	Var
Data type	Unsigned8
Lower limit	1
Higher limit	4
Access	Read only (ro)
Default Value	04h
PDO Mapping	No

Description	Value
Sub-Index	01h
Parameter name	Vendor ID
Object type	Var
Data type	Unsigned32
Access	Read only (ro)
PDO mapping	No
Sub-index	02h
Parameter name	Product code
Object type	Var
Data type	Unsigned32
Access	Read only (ro)
PDO mapping	No
Sub-index	03h
Parameter name	Revision number
Object type	Var
Data type	Unsigned32
Access	Read only (ro)
PDO mapping	No
Sub-index	04h
Parameter name	Serial number
Object type	Var
Data type	Unsigned32
Access	Read only (ro)
PDO mapping	No

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4.1.13 Object 1029h: Error behaviour

Defines the NMT behaviour in case of an emergency. The sensor behaves as follows:

- 1029h.01 = 0: Enter PRE-OPERATIONAL (only if in OPERATIONAL)
- 1029h.01 = 1: No change of NMT state
- 1029h.01 = 2: Enter STOPPED

Description	Value
Index	1018h
Parameter Name	Error behaviour
Object Type	Record
Sub-index	0
Parameter name	Number of entries
Object type	Var
Data type	Unsigned8
Access	Read only (ro)
Default value	1
PDO mapping	No
Sub-index	1
Parameter name	Vendor ID
Object type	Var
Data type	Unsigned8
Access	Read/write (rw)
Default value	0
PDO mapping	No

4.1.14 Object 1800h to 1803: Transmit PDO communication parameter

This object contains the communication parameters for the PDOs the CANopen device is able to transmit.

- Sub-index 0: Number of PDO parameters implemented
- Sub-index 1: COB-ID
- Sub-index 2: Transmission type
- Sub-index 3: Inhibit time
- Sub-index 5: Event timer
- Sub-index 6: SYNC start value

Description	Value
Index	1800h to 1803h
Parameter Name	Transmit PDO communication parameter
Object Type	Record

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Description	Value
Sub-index	00h
Parameter name	Number of entries
Object type	Var
Data type	Unsigned8
Access	Read only (ro)
Default value	04h
PDO mapping	No
Sub-index	01h
Parameter name	Cob ID used by PDO
Object type	Var
Data type	Unsigned32
Lower limit	0x00000001
Higher limit	0xFFFFFFFF
Access	Read/write (rw)
Default value	180h + Node-ID
PDO mapping	No
Sub-index	02h
Parameter name	Transmission type
Object type	Var
Data type	Unsigned8
Lower limit	0
Higher limit	255
Access	Read/write (rw)
Default value	01h
PDO mapping	No
Sub-index	05h
Parameter name	Event timer
Object type	Var
Data type	Unsigned16
Access	Read/write (rw)
Default value	0
PDO Mmapping	No

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4.1.15 Object 1A00h to 1A03h: Transmit PDO mapping parameter

Contains the mapping for the PDO the device is able to transmit.
The sub-index 0h 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 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 hexa-decimal coded. The length entry contains the length of the object in bits (1...40h)

Possible entries for PDO mapping:

- 0x1001 00 08 - Error register
- 0x7130 01 10 - Process value as int16
- 0x7140 01 10 - Tared process value as int16
- 0x9130 01 20 - Process value as int32
- 0x9140 01 20 - Tared process value as int32

Description	Value
Index	1A00h to 1A03h
Parameter name	Transmit PDO mapping parameter
Object type	Record
Sub-index	00h
Parameter name	Number of entries
Object type	Var
Data type	Unsigned8
Lower limit	0
Higher limit	8
Access	Read only (ro)
PDO mapping	No
Sub-index	01h
Parameter name	PDO mapping entry
Object type	Var
Data type	Unsigned32
Access	Read/write (rw)
Default value	2090 00 20 h
PDO mapping	No

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Description	Value
Sub-index	2
Parameter name	PDO mapping entry_2
Object type	Var
Data type	Unsigned32
Access	Read/write (rw)
PDO mapping	No
Sub-index	3
Parameter name	PDO mapping entry_3
Object tType	Var
Data type	Unsigned32
Access	Read/write (rw)
PDO mapping	No
Sub-index	4
Parameter name	PDO mapping entry_4
Object type	Var
Data type	Unsigned32
Access	Read/write (rw)
PDO mapping	No
Sub-index	5
Parameter name	PDO mapping entry_5
Object type	Var
Data Type	Unsigned32
Access	Read/write (rw)
PDO mapping	No
Sub-index	6
Parameter name	PDO mapping entry_6
Object type	Var
Data type	Unsigned32
Access	Read/write (rw)
PDO mapping	No
Sub-index	7
Parameter name	PDO mapping entry_7
Object type	Var
Data type	Unsigned32
Access	Read/write (rw)
PDO mapping	No

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Description	Value
Sub-index	8
Parameter name	PDO mapping entry_8
Object type	Var
Data type	Unsigned32
Access	Read/write (rw)
PDO mapping	No

4.1.16 Object 1F80h: NMT startup

This object configures the startup behaviour of a CANopen device.

Allowed values:

- 0000 0000h: the NMT master shall start the NMT slave
- 0000 0008h: the NMT master shall not start the NMT slave and the application may start the NMT slave

Description	Value
Index	1F80h
Parameter name	NMT startup
Object type	Var
Data type	Unsigned32
Access	Read/write (rw)
PDO mapping	No

4.2 Object Dictionary – Device Profile area

Disclaimer:

The setting of the data format for the output of the force values must be entered when ordering and cannot be changed afterwards. Accordingly, the objects 7xxx are used for an integer16 and the objects 9xxx for an integer32.

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4.2.1 Object 6110h: AI sensor type

Specifies the type of sensor, which is connected to the analogue input.

Description	Value
Index	6110h
Parameter name	AI sensor type
Object type	Array
Sub-index	00h
Parameter name	Number of entries
Object type	Var
Data type	Unsigned8
Access	Read only (ro)
Default value	01h
PDO mapping	No
Sub-index	01h
Parameter name	AI sensor type 1
Object type	Var
Data type	Unsigned16
Access	Read only (ro)
Default value	0x0110
PDO mapping	No

4.2.2 Object 6112h: AI operating mode

This object indicates the operating modes of the analogue input channels:

- 0: Channel off (not operating)
- 1: Normal Operation

Description	Value
Index	6112h
Parameter name	AI operating mode
Object type	Array
Sub-index	0
Parameter name	Number of entries
Object type	Var
Data type	Unsigned8
Access	Read only (ro)
Default value	1
PDO mapping	No

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Description	Value
Sub-index	1
Parameter name	AI operating mode 1
Object type	Var
Data type	Unsigned8
Access	Read only (ro)
Default value	1
PDO mapping	No

4.2.3 Object 6114h: AI ADC sample rate

This value has to be the conversion rate used by the AD converter. The value is given in multiples of microseconds.

Description	Value
Sub-index	00h
Parameter name	Number of entries
Data type	Unsigned8
Access	Read only (ro)
Default value	01h
PDO mapping	No
Sub-index	01h
Parameter name	AI ADC sample rate
Data type	Unsigned32
Access	Read only (ro)
Default value	1000
PDO mapping	No

4.2.4 Object 6131h: AI physical unit PV

This object provides the physical unit of the transmitter according to CiA 404.

Description	Value
Index	6131h
Parameter name	AI physical unit PV
Object type	Array
Sub-index	0
Parameter name	Number of entries
Object type	Var
Data type	Unsigned8

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Description	Value
Access	Read only (ro)
Default value	1
PDO mapping	No
Sub-index	1
Parameter name	AI physical unit PV 1
Object type	Var
Data type	Unsigned32
Access	Read only (ro)
PDO mapping	No
Default value	0x3210000 = kN

4.2.5 Object 6132h: AI decimal digits PV

This object offers the possibility to configure a scaling factor, which has effect on the process values.

Example:

Measurement range = 0... 10 kN / decimal digits = 2 / physical unit = „kN“
A process value of 924 corresponds to 9.24 kN.

Please note:

Depending on the settings of object 6132 (AI decimal digits PV), object 6131 (AI physical unit PV), scaling settings and the current value of object 7100/9100 (AI input FV) the value for object 7130 might reach its maximum resulting in a corresponding emergency object being send.

Description	Value
Index	6132h
Parameter name	AI decimal digits PV
Object type	Array
Sub-index	0
Parameter name	Number of entries
Object type	Var
Data type	Unsigned8
Access	Read only (ro)
Default value	1
PDO mapping	No

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Description	Value
Sub-index	1
Parameter name	AI decimal digits PV 1
Object type	Var
Data type	Unsigned8
Access	Read/write (rw)
PDO mapping	No

4.2.6 Object 7100h: AI input FV

This object represents the compensated force value, which is not yet scaled to the physical unit of the quantity being measured.

Description	Value
Index	7100h
Parameter Name	AI input FV
Object Type	Array
Sub-Index	00h
Parameter Name	Number of entries
Object Type	Var
Data Type	Unsigned8
Access	Read only (ro)
Default Value	01h
PDO Mapping	No
Sub-Index	01h
Parameter Name	AI input FV 1
Object Type	Var
Data Type	Integer16
Access	Read only (ro)
PDO Mapping	No

4.2.7 Object 7120h: AI input scaling 1 FV

Indicates the first input calibration point for the scaling from field value to process value.

Description	Value
Index	7120h
Parameter Name	AI input scaling 1 FV
Object Type	Array

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Description	Value
Sub-index	00h
Parameter name	Number of entries
Object type	Var
Data type	Unsigned8
Access	Read only (ro)
Default value	01h
PDO mapping	No
Sub-index	01h
Parameter name	AI input scaling 1 FV
Object type	Var
Data type	Integer16
Default value	10000
Access	Read only (ro)
PDO mapping	No

4.2.8 Object 7121h: AI input scaling 1 PV

Indicates the first output calibration point for the scaling from field value to process value.

Description	Value
Index	7121h
Parameter name	AI Input scaling 1 PV
Object type	Array
Sub-index	00h
Parameter name	Number of entries
Object type	Var
Data type	Unsigned8
Access	Read only (ro)
Default value	01h
PDO mapping	No
Sub-index	01h
Parameter name	AI input scaling 1 PV
Object type	Var
Data type	Integer16
Access	Read only (ro)
PDO mapping	No

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4.2.9 Object 7122h: AI input scaling 2 FV

Indicates the second input calibration point for the scaling from field value to process value.

Description	Value
Index	7122h
Parameter name	AI input scaling 2 FV
Object type	Array
Sub-index	00h
Parameter name	Number of entries
Object type	Var
Data type	Unsigned8
Access	Read only (ro)
Default value	01h
PDO mapping	No
Sub-index	01
Parameter name	AI Input scaling 2 FV1
Object type	Var
Data type	Integer16
Access	Read/write (rw)
PDO mapping	No

4.2.10 Object 7123h: AI input scaling 2 PV

Inidicates the second output calibration point for the scaling from field value to process value.

Description	Value
Index	7123h
Parameter name	AI input scaling 2 PV
Object type	Array
Sub-index	00h
Parameter name	Number of entries
Object type	Var
Data type	Unsigned8
Access	Read only (ro)
Default value	01h
PDO mapping	No
Sub-index	01h
Parameter name	AI input scaling 2 PV1
Object type	Var

Description	Value
Data type	Integer16
Access	Read/write (rw)
PDO mapping	No

4.2.11 Object 7130h: AI input PV

The analog input process value in INTEGER16 format.

Description	Value
Index	7130h
Parameter name	AI input PV
Object type	Array
Sub-Index	00h
Parameter name	Number of entries
Object type	Var
Data type	Unsigned8
Access	Read only (ro)
Default value	1
PDO mapping	No
Sub-Index	01h
Parameter name	AI input PV 1
Object type	Var
Data type	Integer16
Access	Read only (ro)
PDO mapping	Yes

4.2.12 Object 7138h: AI tare zero

Indicates the configured tare zero offset.
Subindex 1 contains the offset of the force measurement value.

Description	Value
Index	7138h
Parameter name	AI input PV
Object type	Array
Sub-index	0
Parameter name	Number of entries
Object type	Var
Data type	Unsigned8

Description	Value
Access	Read only (ro)
Default value	1
PDO mapping	No
Sub-index	1
Parameter name	AI tare zero
Object type	Var
Data type	Integer16
Access	Read only (ro)
PDO mapping	No

4.2.13 Object 7140h: AI net PV

Provides the tared force value.

Description	Value
Index	7140h
Parameter name	AI net PV
Object type	Array
Sub-index	0
Parameter name	Number of entries
Object type	Var
Data type	Unsigned8
Access	Read only (ro)
Default value	1
PDO mapping	No
Sub-index	1
Parameter name	AI net PV
Object type	Var
Data type	Integer16
Access	Read only (ro)
PDO mapping	Yes

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4.2.14 Object 7149h: AI span end

This value specifies the upper limit where process values are expected.

Description	Value
Sub-index	00h
Parameter name	Number of entries
Object type	Var
Data type	Unsigned8
Access	Read only (ro)
Default value	01h
PDO mapping	No
Sub-index	1
Parameter name	AI span end 1
Object type	Var
Data type	Float
Access	Read only (ro)
PDO mapping	Yes

4.2.15 Object 9100h: AI input FV

The measured analog input raw values, ranging from 0 (measuring range start) to 10,000 (measuring range end).

Description	Value
Index	9100h
Parameter name	AI input FV
Object type	Array
Sub-Index	0
Parameter name	Number of entries
Object type	Var
Data type	Unsigned8
Access	Read only (ro)
Default value	1
PDO mapping	No
Sub-Index	1
Parameter name	AI input FV 1
Object type	Var
Data type	Integer32
Access	Read only (ro)
PDO mapping	Yes

4.2.16 Object 9120h: AI input scaling 1 FV

Indicates the first input calibration point for the scaling from field value to process value.

Description	Value
Index	9120h
Parameter name	AI input scaling 1 FV
Object type	Array
Sub-Index	0
Parameter name	Number of entries
Object type	Var
Data type	Unsigned8
Access	Read only (ro)
Default value	1
PDO mapping	No
Sub-index	1
Parameter name	AI input scaling 1 FV
Object type	Var
Data type	Integer32
Access	Read only (ro)
PDO mapping	Yes

4.2.17 Object 9121h: AI input scaling 1 PV

Indicates the first output calibration point for the scaling from field value to process value.

Description	Value
Index	9121h
Parameter name	AI input scaling 1 PV
Object type	ARRAY
Sub-index	0
Parameter name	Number of entries
Object type	Var
Data type	Unsigned8
Access	Read only (ro)
Default value	1
PDO mapping	No
Sub-index	1
Parameter name	AI input scaling 1 PV

Description	Value
Object type	Var
Data type	Integer32
Access	Read only (ro)
PDO mapping	Yes

4.2.18 Object 9122h: AI input scaling 2 FV

Indicates the second input calibration point for scaling from field value to process value.

Description	Value
Index	9122h
Parameter name	AI input scaling 2 FV
Object type	Array
Sub-index	0
Parameter name	Number of entries
Object type	Var
Data type	Unsigned8
Access	Read only (ro)
Default value	1
PDO mapping	No
Sub-index	1
Parameter name	AI input scaling 2 FV
Object type	Var
Data type	Integer32
Access	Read only (ro)
PDO mapping	Yes

4.2.19 Object 9123h: AI input scaling 2 PV

Indicates the second output calibration point for the scaling from field value to process value.

Description	Value
Index	9123h
Parameter name	AI input scaling 2 PV
Object type	Array
Sub-index	0
Parameter name	Number of entries
Object type	Var

Description	Value
Data type	Unsigned8
Access	Read only (ro)
Default value	1
PDO mapping	No
Sub-Index	1
Parameter name	AI input scaling 2 PV
Object type	Var
Data type	Integer32
Access	Read only (ro)
PDO mapping	Yes

4.2.20 Object 9130h: AI input PV

The analog input process value in INTEGER32 format.

Description	Value
Index	9130h
Parameter name	AI input PV
Object type	Array
Sub-index	0
Parameter name	Number of entries
Object type	Var
Data type	Unsigned8
Access	Read only (ro)
Default value	1
PDO mapping	No
Sub-index	1
Parameter name	AI input FV 1
Object type	Var
Data type	Integer32
Access	Read only (ro)
PDO mapping	Yes

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4.2.21 Object 9138h: AI tare zero

Indicates the configured tare zero offset.
Subindex 1 contains the offset of the force measurement value.

Description	Value
Index	9138h
Parameter name	AI input PV
Object type	Array
Sub-index	0
Parameter name	Number of entries
Object type	Var
Data type	Unsigned8
Access	Read only (ro)
Default value	1
PDO mapping	No
Sub-index	1
Parameter name	AI tare zero
Object type	Var
Data type	Integer32
Access	Read only (ro)
PDO mapping	No

4.2.22 Object 9140h: AI net PV

Provides the tared focus value.

Description	Value
Index	9140h
Parameter name	AI net PV
Object type	Array
Sub-index	0
Parameter name	Number of entries
Object type	Var
Data type	Unsigned8
Access	Read only (ro)
Default value	1
PDO mapping	No

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Description	Value
Sub-index	1
Parameter name	AI net PV
Object type	Var
Data type	Integer32
Access	Read only (ro)
PDO mapping	Yes

4.3 Object Dictionary – Manufacturer specific area

4.3.1 Object 2320h: Node-ID

In addition to the LSS Services, the Node-ID can also be configured via this object. Changes take effect after executing the Store Parameters object 1010h and a following node reset or power on reset (POR).

Description	Value
Index	2320h
Parameter name	Node-ID
Object type	Var
Data type	Unsigned8
Access	Read/write (rw)
PDO mapping	No

4.3.2 Object 2321h: Bitrate

In addition to the LSS services, the bitrate can also be configured via this object. To prevent accidental adjustments, the signature „set“ (‚s‘=0x73; ‚e‘ = 0x65; ‚t‘ = 0x74) needs to be added to the transmitted value.
Example: to set the bitrate to 250 kBit/s, the following value needs to be written to the object: 0x74657303
Changes take effect after executing the store parameters object 1010h and a following reset All Nodes or power on reset. Restoring the default parameters via Object 1011h has no effect to the Node-ID, that means the Node-ID remains untouched.

Following bitrate settings are supported:

- 0: 1 MBaud
- 1: 800 kBaud
- 2: 500 kBaud
- 3: 250 kBaud
- 4: 125 kBaud
- 5: 100 kBaud
- 6: 50 kBaud
- 7: 20 kBaud

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Please do note, in case of automatic bitrate detection the object 2321h will contain the detected bitrate code (instead of 9 for automatic bitrate detection).

Description	Value
Index	2321h
Parameter name	Bitrate
Object type	Var
Data type	Unsigned8
Access	Read/write (rw)
PDO mapping	No

5. Emergency object (EMCY)

If updating the measured force value is not possible due to errors, the last valid measurement will be transmitted and an error counter will be increased. When the counter reaches its limit, the emergency object will be triggered.
The emergency objects are automatically transmitted as long as an error is active. As soon as the error disappears the emergency object will no longer be transmitted. In the case that an Emergency Error Code is sent the correspondent bit in the Error Register (1001h) will be set.

The following emergency error codes are supported:

Emergency error code	Description	Affected bit error register (1001h)
0000h	Error Reset or No Error	
1000h	Generic Error	Bit 0 (Generic Error)
6310h	Calibration Error	Bit 0 (Generic Error)
8100h	Communication – generic	Bit 4 (Communication error)
8110h	CAN overrun (objects lost)	Bit 4 (Communication error)
8120h	CAN in error passive mode	Bit 4 (Communication error)
8140h	CAN recovered from bus off	Bit 4 (Communication error)
8150h	CAN-ID collision	Bit 4 (Communication error)
8240h	Unexpected SYNC data length	Bit 4 (Communication error)

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Detailed emergency error code description:

- **1000h – Generic error:**
  Internal device error during start up or runtime. Please restart the device (power off → power on). If the error is still present, please exchange the device.

Manufacturer specific error field:

Byte3	Byte4	Byte5	Byte6	Byte7
0	0	0	0	0

- CS[0] = Timeout error occurred
- CS[1] = ADC connection error
- CS[2] = ADC connection crc error
- CS[3] = Flash error
- CS[4] = Underflow error occured
- CS[5] = Overflow error occured
- CS[6] = reserved
- CS[7] = reserved

- **6310h – Calibration error:**
  Initial calibration failed during start-up. Please restart the device (power off - power on). If the error is still present, please exchange the device.

Manufacturer specific error field:

Byte3	Byte4	Byte5	Byte6	Byte7
0	0	0	0	0

- **8100h – Communication – generic:**
  The CAN Controller goes into the warning state. Please check the bus connection, baudrate, termination, etc.

Manufacturer specific error field:

Byte3	Byte4	Byte5	Byte6	Byte7
CAN error state (see table below)	CAN error type (see table below)	CAN error receive counter	CAN error transmit counter	0

- **8110h – CAN overrun (objects lost):**
  Not all CAN messages could be received because of a buffer overflow

Manufacturer specific error field:

Byte3	Byte4	Byte5	Byte6	Byte7
0	0	0	0	0

■ **8120h – CAN in error passive mode:**
The CAN Controller entered the passive state. Please check the bus connection, baudrate, termination, etc.

Manufacturer specific error field:

Byte3	Byte4	Byte5	Byte6	Byte7
CAN error state (see table below)	CAN error type (see table below)	CAN error receive counter	CAN error transmit counter	0

■ **8140h - CAN recovered from bus off:**
The CAN controller was in the bus off state and is now active again. Please check the bus connection, baudrate, termination, etc.

Manufacturer specific error field:

Byte3	Byte4	Byte5	Byte6	Byte7
0	0	0	0	0

■ **8150h - CAN-ID collision:**

Manufacturer specific error field:

Byte3	Byte4	Byte5	Byte6	Byte7
Number of message buffer	0	0	0	0

■ **8240h - Unexpected SYNC data length:**
The data length code of the SYNC message is wrong or have a not expected value.

Manufacturer specific error field:

Byte3	Byte4	Byte5	Byte6	Byte7
0	0	0	0	0

CAN error states:

CAN error state number	Description
0	CAN controller is in STOPPED mode
1	CAN controller is in SLEEP mode
2	CAN controller has errors detected (ACTIVE mode)
3	CAN controller has errors detected (ACTIVE mode, but warning level is reached)
4	CAN controller has errors detected (PASSIVE mode)
5	CAN controller went into Bus-Off
10	General failure of physical layer detected
11	Fault on CAN-H detected (Low Speed CAN)
12	Fault on CAN-L detected (Low Speed CAN)

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CAN error types:

CAN error type number	Description
0	No error
1	Bit 0 error
2	Bit 1 error
3	Stuff bit error
4	Format error
5	CRC error
6	Acknowledge error

6. References

Type	Description
CiA 301 V 4.2.0	CANopen application layer and communication profile
CiA 303-1 V1.9.0	CANopen recommendation: cabling and connector pin assignment
CiA 303-2 V1.5.0	CANopen recommendation: representation of SI units and prefixes
CiA 404-1 V2.1.0	Device profile for measuring devices and closed-loop controllers Part 1: generic objects and generic PDO mapping
CiA 305 V3.0.0	Layer setting services (LSS) and protocols

7. Change Log

Document version	Reason for change	Date
.01	Initial draft	18.10.2022

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