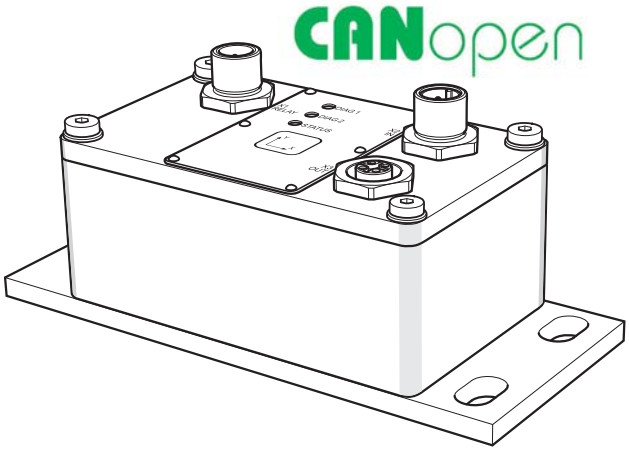
Tower oscillation monitor

Communication profile CiA 301
Device profile CiA 401

Reference

Fieldbus interface



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1 General

1.1 About these instructions

The following description covers the CANopen integration of the Turmschwingungs-sensor **OM .**

It is aimed at persons who are already familiar with the principle of operation of a Schwingungssensor and who have a basic understanding of the CANopen fieldbus interface. For further information refer to the related standards published by the org-anisation *CAN in Automation* (CiA) (www.canopen.org).

You will find information on the function and usage as well as the technical data for the Turmschwingungssensor in the product information and the technical information (available in the download area at www.heinlanz.com).

Numerical data:

Unless explicitly stated, decimal values are given as integers without any addition alinformation (e.g. 1408). Binary values are marked with a “b” (e. g. 1101b) and hex-adecimal values with an “h” (e.g. 680h) after the integers.

Abbreviations and glossary:

The term **CO x …** is part of the type code (order code) for the product and is not further stated in the following.

The terms **Sensor** and **Schwingungssensor** are used as synonyms for Turm-schwingungssensor.

1.2 Description

The Turmschwingungssensor is designed as a CANopen slave in accordance with the communication profile CiA 301 and supports a large number of the objects defined in the device profile CiA 401. You can obtain a complete specification of the individual profiles from *CAN in Automation e.V.*:

- Protocol layer: *CiA 301 V4.2.0 – CANopen application layer and communication profile, February 2011* (EN 50325-4)
- Device profile: *CiA 401 V3.0.0 – CANopen device profile for generic I/O modules, June 2008*

The communication and device properties supported as well as the functions of the Sensor are defined in the related EDS file.

The Sensor is integrated into an existing bus line using two M12 connections.

If not otherwise stipulated by the customer, the following settings apply
– Transmission rate: 500 kbit/s
– Node ID: 1

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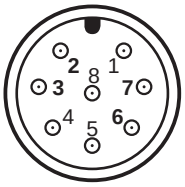
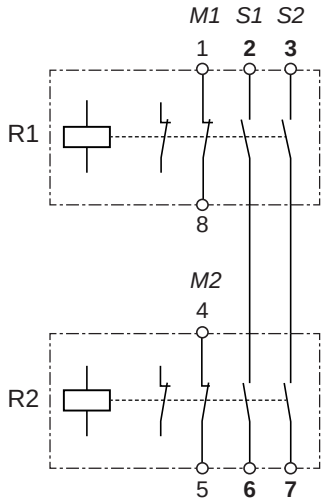
2 Connection and display elements

2.1 X1 – relay outputs

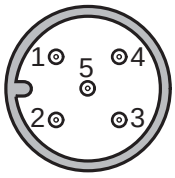
X1 – Relaisausgänge



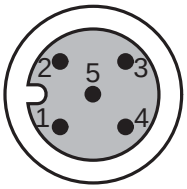


R1, R2	Relays (redundant)
M1, M2	Signalling contacts
S1, S2	Safety contacts (safety circuits 1 and 2)

2.2 X2/X3 – bus input/output



X2 IN
(male)



X3 OUT
(female)

1	Screen
2	Supply voltage $+V_S$
3	GND
4	CAN_H
5	CAN_L

2.3 Indicators (1)

DIAG 1, DIAG 2 – switch states of relays R1 and R2

Limits exceeded, safety circuit open

Within the limits, but inhibit time active, safety circuit open

Normal operation, safety circuit closed

Hardware fault in the related branch, safety circuit open

Hardware fault in the redundant branch or communication error between the two branches, safety circuit open

(1) Representation on printing in black and white: ≙ green, ≙ red; the area shown covers a duration of approx. 4 seconds

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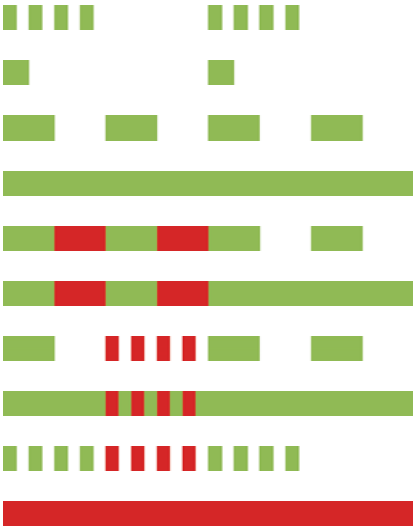
STATUS – bus state



Init

Stopped

Pre-operational

Operational

Pre-operational, bus warning

Operational, bus warning

Pre-operational, bus passive

Operational, bus passive

Init, bus passive

Bus off

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3 Object list

The object list contains all the CANopen properties supported by the Sensor. The data is in the device's non-volatile flash memory and are copied to the memory (RAM) on power-on or reset. If data in the object list is changed, the change is only made in the RAM. If the data is to be saved permanently, it must be transferred to the flash memory via the object 1010h. The original data will then be overwritten.

SDO services are used to access the object list.

The object list is divided into three areas:

- Communication parameters as per CiA 301
- Device parameters as per CiA 401
- Manufacturer-specific parameters

The entries in the object list are addressed using a 16-bit index. Each index entry can be further sub-divided using a subindex.

Information on the object list given below:

- Acc. (access type): ro = read only, rw = read and write
- (Data) type: U*xx* = Unsigned *xx* (xx = 8/16/32 → 1/2/4 bytes without sign), S*xx* = Signed *xx* (xx = 16/32 → 2/4 bytes with sign), STR = ASCII character string
- Sub = Subindex (type: U8)
- Bold (index): parameter can be saved (index 1010h) or loaded (index 1011h)

3.1 Communication parameters in accordance with CiA 301 (1xxxh)

Index	Designation	Acc.	Type	Meaning
1000h	*Device type*	ro	U32	870191h Profile 401 (191h), digital inputs/outputs + analogue inputs + manufacturer-specific PDOs (87h)
1001h	*Error register*	ro	U8	Bit 0: 1 = General error (Sensor alarm message) Bit 1–6: *Not used* Bit 7: 1 = Manufacturer-specific error

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<table>
<tr><th>Index</th><th>Designation</th><th>Acc.</th><th>Type</th><th>Meaning</th></tr>
<tr><td>1003h</td><td>Pre-defined error field</td><td>ro</td><td>U32</td><td>
<table>
<tr><th>Sub</th><th>Contents</th></tr>
<tr><td>00h</td><td>Number ≤20 (type:rw)</td></tr>
<tr><td>01h</td><td>Last error</td></tr>
<tr><td>02h</td><td>Penultimate error</td></tr>
<tr><td colspan="2">⋮</td></tr>
<tr><td>14h</td><td>First of the last 20 errors</td></tr>
</table>
Clear error memory: 00h → Subindex 0
<u>Possible errors</u>:
7300h = Sensor error
7301h = Relay error
8400h = Acceleration over alarm threshold</td></tr>
<tr><td>1008h</td><td>Manufacturer device name</td><td>ro</td><td>STR</td><td>Product name in ASCII code</td></tr>
<tr><td>1009h</td><td>Hardware version</td><td>ro</td><td>STR</td><td>E.g. “1.01”</td></tr>
<tr><td>100Ah</td><td>Software version</td><td>ro</td><td>STR</td><td>e.g. “3.05”</td></tr>
<tr><td>100Ch</td><td>Guard time – Node monitoring time</td><td>rw</td><td>U16</td><td rowspan="2">The node guarding function is obsolete; CiA recommends the usage of the heartbeat function (Consumer / Producer),→ Object 1016h / 1017h.</td></tr>
<tr><td>100Dh</td><td>Life time factor</td><td>rw</td><td>U16</td></tr>
<tr><td>1010h</td><td>Store parameters (power failure-proof)</td><td>rw</td><td>U32</td><td>
Transfer the parameter values from RAM to the flash memory

Write
Write code word “save” in reverse notation (65766173h) to the related subindex
Read
The value 1 is always output

<table>
<tr><th>Sub</th><th>Contents</th></tr>
<tr><td>00h</td><td>Number of save options = 4 (type: ro)</td></tr>
<tr><td>01h</td><td>All parameters</td></tr>
<tr><td>02h</td><td>Only communication parameters (CiA 301)</td></tr>
<tr><td>03h</td><td>Only device parameters (CiA 401), not used</td></tr>
<tr><td>04h</td><td>Only manufacturer-specific parameters, not used</td></tr>
</table>
</td></tr>
</table>

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<table>
<tr><th>Index</th><th>Designation</th><th>Acc.</th><th>Type</th><th>Meaning</th></tr>
<tr><td>1011h</td><td>Restore default parameters</td><td>rw</td><td>U32</td><td>Device parameters are reset to their factory settings, not to the values saved using object 1010h
• Write
Write code word “load” in reverse notation (64616F6Ch) to the related subindex
• Read
The value 1 is always output
<table><tr><th>Sub</th><th>Contents</th></tr><tr><td>00h</td><td>Number of reset options = 4 (type: ro)</td></tr><tr><td>01h</td><td>All parameters</td></tr><tr><td>02h</td><td>Only communication parameters (CiA 301)</td></tr><tr><td>03h</td><td>Only device parameters (CiA 401), not used</td></tr><tr><td>04h</td><td>Only manufacturer-specific parameters, not used</td></tr></table></td></tr>
<tr><td>1016h</td><td>Consumer Heartbeat time – Repetition time of the master in ms</td><td>rw</td><td>U32</td><td>The heartbeat function (1016h/1017h) should be used instead of node guarding (100Ch/100Dh) according to CiA recommendations.
<table><tr><th>Sub</th><th>Contents</th></tr><tr><td>00h</td><td>Number of values = 127 (type: ro)</td></tr><tr><td>01h
:
7Fh</td><td>Master node number (bits 23–16) and repetition time (bits 15–0)</td></tr></table>Recommended time setting: Heartbeat Consumer = 3× Heartbeat Producer (1017h)</td></tr>
<tr><td>1017h</td><td>Producer Heartbeat time – Repetition time of the device in ms</td><td>rw</td><td>U16</td><td>Value ≠ 0 deactivates node guarding</td></tr>
</table>

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<table>
<tr><th>Index</th><th>Designation</th><th>Acc.</th><th>Type</th><th>Meaning</th></tr>
<tr><td>1018h</td><td>Identity object – Object identification</td><td>ro</td><td>U32</td><td>
<table>
<tr><th>Sub</th><th>Contents</th></tr>
<tr><td>00h</td><td>Number of IDs = 4</td></tr>
<tr><td>01h</td><td>Manufacturer's ID: 1C5h</td></tr>
<tr><td>02h</td><td>Product code: 3011C0h</td></tr>
<tr><td>03h</td><td>Revision no.: e.g. 00000002h</td></tr>
<tr><td>04h</td><td>Serial no.: xxxxxxxxh</td></tr>
</table>
</td></tr>
<tr><td>1800h</td><td>1st transmit PDO parameter – TxPDO1 configuration</td><td>rw</td><td>U32</td><td>
<table>
<tr><th>Sub</th><th>Contents</th></tr>
<tr><td>00h</td><td>Number of IDs = 5 (type: ro)</td></tr>
<tr><td>01h</td><td>COB ID used by PDO (default: 180h + node ID)</td></tr>
<tr><td>02h</td><td>Transmission type for the PDO (default: 01h, cyclic)</td></tr>
<tr><td>03h</td><td>Min. waiting time for the PDO (in ms)</td></tr>
<tr><td>04h</td><td>Not used</td></tr>
<tr><td>05h</td><td>Event timer for the PDO (in ms), after the time has elapsed the PDO is sent automatically</td></tr>
</table>
</td></tr>
<tr><td>1801h</td><td>2nd transmit PDO parameter – TxPDO2 configuration</td><td>rw</td><td>U32</td><td>Only in conjunction with a second customer-specific filter; structure as before</td></tr>
<tr><td>1A00h</td><td>1st transmit PDO mapping – TxPDO1 mapping</td><td>ro</td><td>U32</td><td>
<table>
<tr><th>Sub</th><th>Contents</th></tr>
<tr><td>00h</td><td>Number of entries = 5</td></tr>
<tr><td>01h</td><td>1st application object: acceleration X axis (64010110h)</td></tr>
<tr><td>02h</td><td>2nd application object: acceleration Y axis (64010210h)</td></tr>
<tr><td>03h</td><td>3rd application object: acceleration Z axis (64010310h)</td></tr>
<tr><td>04h</td><td>4th application object: relay status (60000108h)</td></tr>
<tr><td>05h</td><td>5th application object: heartbeat counter (64000108h)</td></tr>
</table>
</td></tr>
</table>

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<table>
<tr><th>Index</th><th>Designation</th><th>Acc.</th><th>Type</th><th>Meaning</th></tr>
<tr><td>1A01h</td><td>2nd transmit PDO mapping –
TxPDO2 mapping</td><td>ro</td><td>U32</td><td>Only in conjunction with a second customer-specific filter:
<table><tr><th>Sub</th><th>Contents</th></tr><tr><td>00h</td><td>Number of entries = 5</td></tr><tr><td>01h</td><td>1st application object: Acceleration X axis (64010410h)</td></tr><tr><td>02h</td><td>2nd application object: Acceleration Y axis (64010510h)</td></tr><tr><td>03h</td><td>3rd application object: Acceleration Z axis (64010610h)</td></tr><tr><td>04h</td><td>4th application object: relay status (60000108h)</td></tr><tr><td>05h</td><td>5th application object: heartbeat counter (64000108h)</td></tr></table></td></tr>
</table>

TxPDO structure for filter 1 (1A00h)

2 bytes	2 bytes	2 bytes	1 byte	1 byte
X acceleration	Y acceleration	Z acceleration	Status	hb counter
Object 6401h Sub 1	Object 6401h Sub 2	Object 6401h Sub 3	Object 6000h Sub 1	Object 6400h Sub 2

hb = heartbeat

TxPDO structure for filter 2 (1A01h)

2 bytes	2 bytes	2 bytes	1 byte	1 byte
X acceleration	Y acceleration	Z acceleration	Status	hb counter
Object 6401h Sub 4	Object 6401h Sub 5	Object 6401h Sub 6	Object 6000h Sub 1	Object 6400h Sub 2

hb = heartbeat

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3.2 Device parameters in accordance with CiA 401 (6xxxh)

<table>
<tr><th>Index</th><th>Designation</th><th>Acc.</th><th>Type</th><th>Meaning</th></tr>
<tr><td>6000h</td><td>Relay status</td><td>ro</td><td>U8</td><td>
<table>
<tr><th>Sub</th><th>Contents</th></tr>
<tr><td>00h</td><td>Number of entries = 1</td></tr>
<tr><td>01h</td><td>Bit 0: Sensor error (1)
Bit 1: Sensor deviation (1)
Bit 2: Limit exceeded (1)
Bit 3: Relay fault (1)
Bit 4: System fault (1)
Bit 5: Safety circuit closed (1)</td></tr>
</table>
</td></tr>
<tr><td>6400h</td><td>Heartbeat counter</td><td>ro</td><td>S8</td><td>
<table>
<tr><th>Sub</th><th>Contents</th></tr>
<tr><td>00h</td><td>Number of entries = 1</td></tr>
<tr><td>01h</td><td>Heartbeat counter (0…255)</td></tr>
</table>
</td></tr>
<tr><td>6401h</td><td>Actual acceleration</td><td>ro</td><td>S16</td><td>
<table>
<tr><th>Sub</th><th>Contents</th></tr>
<tr><td>00h</td><td>Number of entries = 6</td></tr>
<tr><td>01h</td><td>In X direction (filter 1)</td></tr>
<tr><td>02h</td><td>In Y direction (filter 1)</td></tr>
<tr><td>03h</td><td>In Z direction (filter 1)</td></tr>
<tr><td>04h</td><td>In X direction (filter 2)</td></tr>
<tr><td>05h</td><td>In Y direction (filter 2)</td></tr>
<tr><td>06h</td><td>In Z direction (filter 2)</td></tr>
</table>
Values in 1/100 m/s^2
</td></tr>
</table>

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3.3 Manufacturer-specific objects (2xxxh)

<table>
<tr><th>Index</th><th>Designation</th><th>Acc.</th><th>Type</th><th colspan="2">Meaning</th></tr>
<tr><td rowspan="10">2016h</td><td rowspan="10">Trigger values (customer-specific)</td><td rowspan="10">ro</td><td rowspan="10">S16</td><th>Sub</th><th>Contents</th></tr>
<tr><td>00h</td><td>Number of entries = 8</td></tr>
<tr><td>01h</td><td>Acceleration in -X direction</td></tr>
<tr><td>02h</td><td>Acceleration in +X direction</td></tr>
<tr><td>03h</td><td>Acceleration in -Y direction</td></tr>
<tr><td>04h</td><td>Acceleration in +Y direction</td></tr>
<tr><td>05h</td><td>Acceleration in -Z direction (1)</td></tr>
<tr><td>06h</td><td>Acceleration in +Z direction (1)</td></tr>
<tr><td>07h</td><td>Limit for geometric sum</td></tr>
<tr><td>08h</td><td>Measuring characteristic:
0 = axis-related
1 = geometric sum</td></tr>
<tr><td>2017h</td><td>Relay inhibit time</td><td>ro</td><td>U16</td><td colspan="2">30 s (1Eh)</td></tr>
<tr><td>2201h</td><td>Self-test</td><td>rw</td><td>U8</td><td colspan="2">Write: 0→1 = Start</td></tr>
</table>

(1) This entry is provided for a future expansion – it always provides the value 0.

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4 SDO communication

The service data objects (SDO) form the communication channel for the transmission of device parameters. As these parameters are transmitted acyclically (e.g. only once on booting the network), the SDOs have a lower priority (high COB identifier).

Structure of the SDO message

COB ID	DLC	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8
SDO identifier	Data length	Com-mand	Index L	Index H	Subin-dex	Data 0	Data 1	Data 2	Data 3

The SDO identifier is defined as follows:

Client (control system) → Server (absolute rotary encoder):	**600**h + node ID
Server (absolute rotary encoder) → Client (control system):	**580**h + node ID

The data length (DLC) is always 8: 1 command byte + 2 index bytes (object) + 1 sub-index byte + 4 data bytes

The command defines whether data are to be written (download) or read (upload) and the number of user data bytes:

Com-mand	Description	User data	Function
22h	SDO(rx), Download Request	Undefined	Send parameters to the Sensor
23h		4 bytes	
2Bh		2 bytes	
2Fh		1 bytes	
60h	SDO(tx), Download Response	—	Confirm parameter acceptance to the client
40h	SDO(rx), Upload Request	—	Request parameters from the Sensor
42h	SDO(tx), Upload Response	Undefined	Send parameters to the client
43h		4 bytes	
4Bh		2 bytes	
4Fh		1 byte	
80h	SDO(tx), Abort Domain Transfer (abort due to error)	4 bytes	Sensor signals error code to the client

In the case of an error, an error message with the command 80h (SDO Abort Message) replaces the normal confirmation (response). Index and subindex belong to the object stated previously. The error code (Abort code) is given in bytes 5 to 8:

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Abort codes	Fault
05040001h	Command byte is not supported
06010000h	Incorrect access to an object
06010001h	Read access to a write-only object
06010002h	Write access to a read-only object
06020000h	Object is not supported
06090011h	Subindex is not supported
06090030h	Parameter value outside the limits
06090031h	Parameter value too high
06090032h	Parameter value too low
08000000h	General error
08000020h	Incorrect memory signature (“save”)
08000021h	Not possible to save parameters

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5 Emergency messages

5.1 Allgemein

In the event of a fault, an emergency telegram is output via the COB-ID EMCY message.

It consists of an 8 byte alarm object for the signaling of error messages with a 2 byte error code according to CiA 301 and the 1 byte error register.

The device-internal error list can be read out via object 1003h (predefined error field). The error register indicates the presence of a device error by a value ≠ 0 (from object 1001h).

Telegram construction

COB-ID	DLC	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8
80h+Node-ID	8	Error code		Error register	*reserved*				

5.2 Error codes

Error code	Fault
0000h	No fault
5000h	General hardware fault
5010h	Self-test failed
5030h	Sensor error
8130h	Lifeguarding fault

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6 LSS functions

Using LSS the node ID and baud rate can be set via the CAN bus. The protocol is described in CiA 305 Layer Setting Services (LSS).

Preconditions

- 1:1 connection from the device to the node
- Device has not yet received an “NMT-Start-Node”
- Node uses the same baud rate as the device.

The node address and the baud rate are set in the dialog mode. A CAN message is sent to the device via the COB ID 07E5h (2021) and the device replies with the COB ID 07E4h (2020).

After the COB ID, an LSS Command Specifier (CS) and 7 data bytes are sent.

Protocol structure:

COB ID	CS	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7

COB ID :
LSS master → LSS slave: **07E5**h
LSS slave → LSS master: **07E4**h

Switch State Global Protocol

Using this service an LSS master can communicate with an individual slave. A related LSS address does not need to be known. The slave is configured with the aid of a LSS configuration tool.

To configure the device, the Switch Mode Global Command is transferred. This command sets the device in the configuration mode.

LSS master → LSS slave

COB ID	CS	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
07E5h	**04**h	Mode	Reserved					

Mode:
0 → Operation
1 → Configuration

If the device is in the configuration mode, the node number can be set using the Configure Node-ID service. The baud rate is set using Configure Bit Timing Parameter.

Two setting parameters are transferred using Configure Bit Timing Parameter: “Table_Selector” and “Table_Index”. Table_Selector defines the baud rate table to beused. The default baud rate table from the CiA (CiA102) with the value 0 is used forreference. The required baud rate is then selected from the table using Table_Index(→ page 20).

The settings are saved using the Store Configuration service. Then you can return to the LSS state Operation. (→ page 20)

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HL-M07030110317.EN_canopen

There is no confirmation for the LSS service Switch Mode Global Command even if it has been run. Whether the baud rate for the master has been set to that of the slave can be checked, for example, using the Inquire Node-ID service (05Eh).

If the baud rate for the master and the device have been configured correctly, the node .ID is sent as a reply. If a reply is not sent, the baud rate is not set correctly or the field-bus is operating incorrectly (e.g. due to cable break or missing/faulty terminating resis-tor). If the baud rate is not known, all permissible baud rates must be tested using this service. (See bit timing table, → page 20)

6.1 Setting node number (*Configure node ID*)

LSS master → LSS slave

COB ID	CS	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
07E5h	11h	Node ID	Reserved					

LSS slave → LSS master

COB ID	CS	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
07E4h	11h	ErrCode	SpecError	Reserved				

Explanations:

Node ID: New node number for the device (1…126)

ErrCode: Error number: 0 = OK, 1 =node ID outside the range allowed, 2…254 = reserved, 255 = application-specific error

SpecCode: Application-specific error number if ErrCode = 255

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6.2 Setting baud rate (*Configure Bit Timing Parameter*)

LSS master → LSS slave

COB ID	CS	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
07E5h	13h	TableSel	TableInd	Reserved				

LSS slave → LSS master

COB ID	CS	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
07E4h	13h	ErrCode	SpecError	Reserved				

Explanations:

TableSel: Selects the bit timing table: 0 = default CiA bit timing table, 1…127 = reserved for CiA, 128…255 = manufacturer-specific tables

TableInd: Index for the required entry in the selected table (see below)

ErrCode: Error number: 0 = OK, 1 = bit timing not supported, 2 to 254 = reserved, 255 = application-specific error

SpecCode: Application-specific error number if ErrCode = 255

CiA bit timing table:

Baud rate in Kbit/s	10	20	50	100	125	250	500	800	1000
Index	8	7	6	5	4	3	2	1	0

6.3 Writing settings to the flash memory (*Store Configuration*)

LSS master → LSS slave

COB ID	CS	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
07E5h	17h	Reserved						

LSS slave → LSS master

COB ID	CS	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
07E4h	17h	ErrCode	SpecError	Reserved				

ErrCode: Error number: 0 = OK, 1 = product cannot save data, 2 = memory access error, 3 to 254 = reserved, 255 = application-specific error

SpecCode: Application-specific error number if ErrCode = 255

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