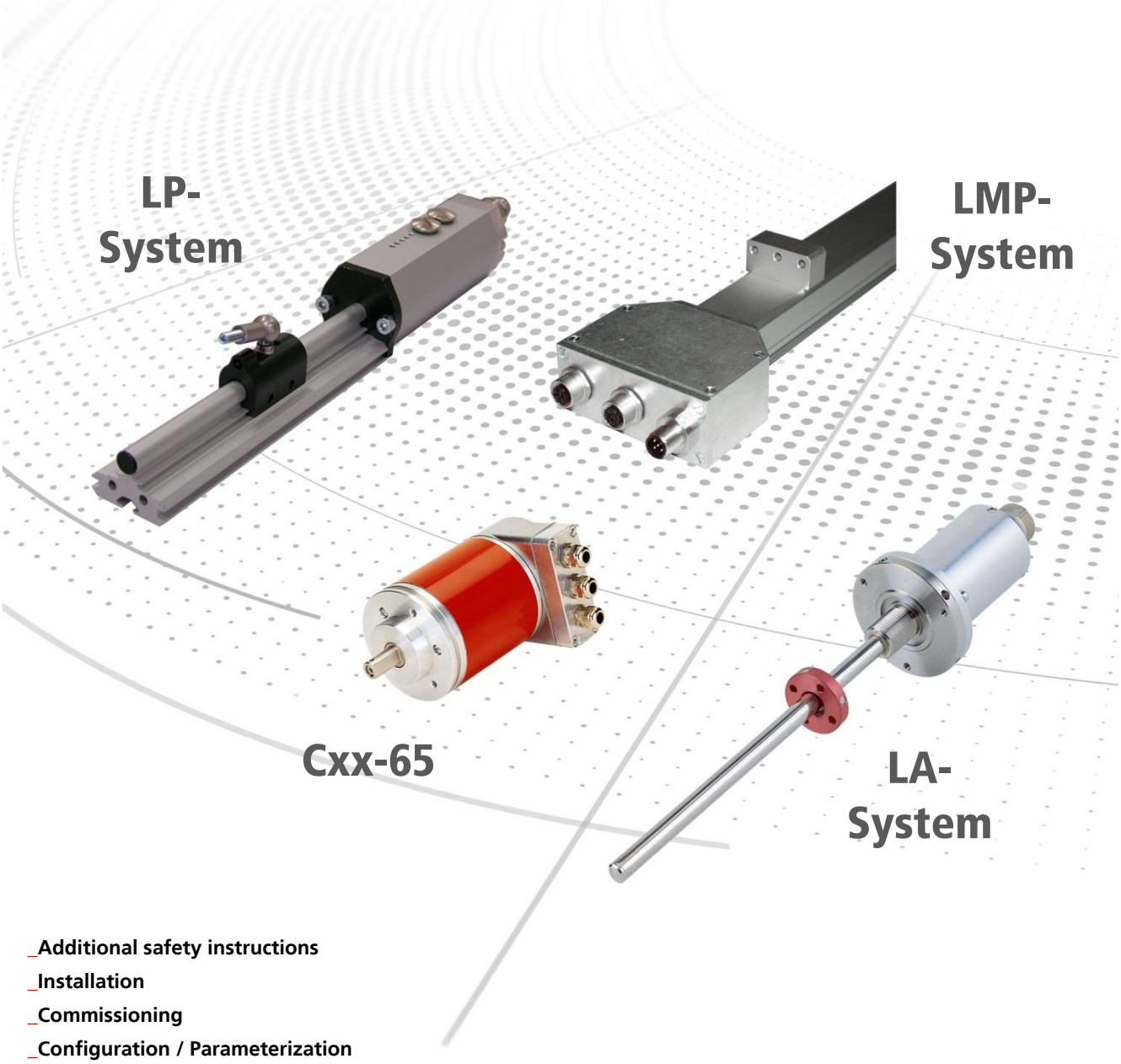
TR electronic

CANopen®

Absolute linear encoder LA/LP/LMP and absolute encoder Cxx-65



_Additional safety instructions
_Installation
_Commissioning
_Configuration / Parameterization
_Cause of faults and remedies

User Manual

TR - E - TI - GB - 0016 - 07 01/15/2016

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Document information

Release date / Rev. date:	01/15/2016
Document / Rev. no.:	TR - E - TI - GB - 0016 - 07
File name:	TR-E-TI-GB-0016-07.docx
Author:	MÜJ

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 Printed in the Federal Republic of Germany

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First release	05/27/97	00
Complete revision and finishing	11/21/97	01
Parameter modification to "CIA Draft Standard Proposal 406, Version 2.0"	02/08/99	02
Internal administrative conditioned revision	02/23/05	03
Correction of the object data types	01/11/06	04
Identity Object 1018 added	10/24/07	05
- General technical modifications, layout modifications - Implementation of the LMT services, CiA DS-205-1 and DS-205-2	02/12/08	06
New design	15/01/16	07

1 General information

The User Manual includes the following topics:

- Safety instructions in additional to the basic safety instructions defined in the Assembly Instructions
- Electrical characteristics
- Installation
- Commissioning
- Configuration / parameterization
- Causes of faults and remedies

As the documentation is arranged in a modular structure, this User Manual is supplementary to other documentation, such as product datasheets, dimensional drawings, leaflets and the assembly instructions etc.

The User Manual may be included in the customer's specific delivery package or it may be requested separately.

1.1 Applicability

This User Manual applies exclusively to the following measuring system models with ***CANopen*** interface:

- LA
- LP
- LMP
- CE-65, CEV-65
- CS-65, CES-65
- CK-65

The products are labelled with affixed nameplates and are components of a system.

The following documentation therefore also applies:

- the operator's operating instructions specific to the system,
- this User Manual,
- and the assembly instructions
  – **TR-ECE-BA-DGB-0046, for rotative measuring systems**
  – **TR-ELA-BA-DGB-0004, for linear measuring systems**
  which is enclosed when the device is delivered

1.2 References

1.	ISO 11898: Road Vehicles Interchange of Digital Information - Controller Area Network (CAN) for high-speed Communication, November 1993	
2.	Robert Bosch GmbH, CAN Specification 2.0 Part A and B, September 1991	
3.	CiA DS-201	V1.1, CAN in the OSI Reference Model, February 1996
4.	CiA DS-202-1	V1.1, CMS Service Specification, February 1996
5.	CiA DS-202-2	V1.1, CMS Protocol Specification, February 1996
6.	CiA DS-202-3	V1.1, CMS Encoding Rules, February 1996
7.	CiA DS-203-1	V1.1, NMT Service Specification, February 1996
8.	CiA DS-203-2	V1.1, NMT Protocol Specification, February 1996
9.	CiA DS-204-1	V1.1, DBT Service Specification, February 1996
10.	CiA DS-204-2	V1.1, DBT Protocol Specification, February 1996
11.	CiA DS-205-1	V1.1, LMT Service Specification, February 1996
12.	CiA DS-205-2	V1.1, LMT Protocol Specification, February 1996
13.	CiA DS-206	V1.1, Recommended Layer Naming Conventions, February 1996
14.	CiA DS-207	V1.1, Application Layer Naming Conventions, February 1996
15.	CiA DS-301	V3.0, CANopen Communication Profile based on CAL, October 1996
16.	CiA DS-406	V2.0, CANopen Profile for Encoder, May 1998

1.3 Abbreviations and definitions

LA	Linear-Absolute Measuring System, type with tube-housing
LP	Linear-Absolute Measuring System, type with profile-housing
LMP	Linear-Absolute Measuring System, type with profile-housing
CE, CEV	Absolute Encoder with optical scanning unit, Solid Shaft
CK	Absolute Encoder with optical scanning unit, Integrated Claw Coupling
CS, CES	Absolute Encoder with optical scanning unit, Blind Shaft
EC	***E***uropean ***C***ommunity
EMC	***E***lectro ***M***agnetic ***C***ompatibility
ESD	***E***lectro ***S***tatic ***D***ischarge
IEC	***I***nternational ***E***lectrotechnical ***C***ommission
VDE	German Electrotechnicians Association

CAN specific

CAL	CAN Application Layer. The application layer for CAN-based networks as specified by CiA in Draft Standard 201 ... 207.
CAN	Controller Area Network. Data link layer protocol for serial communication as specified in ISO 11898.
CiA	CAN in Automation international manufacturer and user organization e.V.: non-profit association for Controller Area Network (CAN).
CMS	CAN-based Message Specification. One of the service elements of the application layer in the CAN Reference Model.
COB	Communication Object. (CAN Message) A unit of transportation in a CAN Network. Data must be sent across a Network inside a COB.
COB-ID	COB-Identifier. Identifies a COB uniquely in a Network. The identifier determines the priority of that COB in the MAC sub-layer too.
DBT	Distributor. One of the service elements of the application in the CAN Reference Model. It is the responsibility of the DBT to distribute COB-ID´s to the COB´s that are used by CMS.
EDS	***E***lectronic-***D***ata-***S***heet
LMT	Layer Management. One of the service elements of the application in the CAN Reference Model. It serves to configure parameters of each layer in the CAN Reference Model.
NMT	Network Management. One of the service elements of the application in the CAN Reference Model. It performs initialization, configuration and error handling in a CAN network.
PDO	Process Data Object. Object for data exchange between several devices.
SDO	Service Data Object. Peer to peer communication with access to the Object Dictionary of a device.

2 Additional safety instructions

2.1 Definition of symbols and instructions

⚠ WARNING	means that death or serious injury can occur if the required precautions are not met.
⚠ CAUTION	means that minor injuries can occur if the required precautions are not met.
NOTICE	means that damage to property can occur if the required precautions are not met.
	indicates important information or features and application tips for the product used.

2.2 Additional instructions for proper use

The measurement system is designed for operation with CANopen networks according to the International Standard ISO/DIS 11898 and 11519-1 up to max. 1 Mbit/s. The profile corresponds to the ***"CANopen Device Profile for Encoder CiA DS-406 V2.0A"***.

The technical guidelines for the structure of the CANopen network from the CAN User Organization CiA are always to be observed in order to ensure safe operation.

Proper use also includes:

- observing all instructions in this User Manual,
- observing the assembly instructions. The ***"Basic safety instructions"*** in particular must be read and understood prior to commencing work.

2.3 Organizational measures

- This User Manual must always kept accessible at the site of operation of the measurement system.
- Prior to commencing work, personnel working with the measurement system must have read and understood
  - the assembly instructions, in particular the chapter ***"Basic safety instructions"***,
  - and this User Manual, in particular the chapter "Additional safety instructions".

This particularly applies for personnel who are only deployed occasionally, e.g. at the parameterization of the measurement system.

3 Technical data

3.1 Electrical characteristics

3.1.1 Rotative Measuring systems

Supply voltage: ..... 11…27 V DC, twisted in pairs and shielded

Current consumption without load: ... < 400 mA

*** Total resolution:** ..... ≤ 25 bit

*** Number of steps / revolution:** ..... ≤ 8.192

Number of revolutions: ..... ≤ 4.096

CANopen: ..... EN 50325-4
- Bus connection:..... ISO 11898-1, ISO 11898-2
- CAN Specification 2.0 A:..... 11-Bit Identifier
- Device Profile for Encoder: ..... CiA DS 406
- Node-ID:..... 1…64, by means of DIP-switches
- Baud rate:..... 20 kbit/s, 125 kbit/s, 500 kbit/s, 1 Mbit/s, DIP-switches
- Output code:..... Binary
- Transmission:..... twisted in pairs and shielded copper cable
- Terminating resistor: ..... 121 ohm, adjustable by means of DIP-switches

Special features: ..... Programming of the following parameters via the CAN-BUS:
- Code sequence
- Number of measuring steps per revolution
- Measuring range in steps
- Preset value

EMC:..... DIN EN 61000-6-2/DIN EN 61000-4-2/DIN EN 61000-4-4

* parameterizable via CANopen

3.1.2 Linear Measuring systems

Supply voltage: ..... 19…27 V DC, twisted in pairs and shielded

Current consumption without load: ... < 350 mA

Measuring principle: ..... magnetostrictive

*** Resolution:** ..... 0.01 mm / 0.005 mm, see nameplate

Output capacity: ..... ≤ 24 bit

Cycle time internally, LA-41/LA-65/LP-38

≤ 0.75 m ..... 1.4 ms
≤ 1.00 m ..... 1.8 ms
≤ 1.50 m ..... 2.7 ms
≤ 2.00 m ..... 3.6 ms
≤ 2.50 m ..... 4.5 ms
≤ 3.00 m ..... 5.4 ms

Cycle time internally, LA-46/LMP-30/LP-46

≤ 1.00 m ..... 1.0 ms
≤ 1.50 m ..... 1.5 ms
≤ 2.00 m ..... 2.0 ms
≤ 2.50 m ..... 2.5 ms
> 2.50 m ..... 3.0 ms

CANopen: ..... EN 50325-4
Bus connection: ..... ISO 11898-1, ISO 11898-2
CAN Specification 2.0 A: ..... 11-Bit Identifier
Device Profile for Encoder: ..... CiA DS 406
[1] Node-ID: ..... 1…64, by means of DIP-switches
[1] Baud rate: ..... 20 kbit/s, 125 kbit/s, 500 kbit/s, 1 Mbit/s, DIP-switches
Output code: ..... Binary
Transmission: ..... twisted in pairs and shielded copper cable
Terminating resistor: ..... 121 ohm, adjustable by means of DIP-switches or jumper

Special features: ..... Programming of the following parameters via the CAN-BUS:
- Code sequence
- Measuring range in steps
- Preset value

EMC: ..... DIN EN 61000-6-2/DIN EN 61000-4-2/DIN EN 61000-4-4

* parameterizable via CANopen

[1] LMP-30, LA-41 without DIP-switches: programmable with LMT services acc. to CiA DS 205-1 and 205-2

4 CANopen information

CANopen was developed by the CiA and is standardized since at the end of 2002 in the European standard EN 50325-4.

As communication method CANopen uses the layers 1 and 2 of the CAN standard which was developed originally for the use in road vehicles (ISO 11898-2). In the automation technology these are extended by the recommendations of the CiA industry association with regard to the pin assignment and transmission rates.
In the area of the application layer CiA has developed the standard CAL (CAN Application Layer).

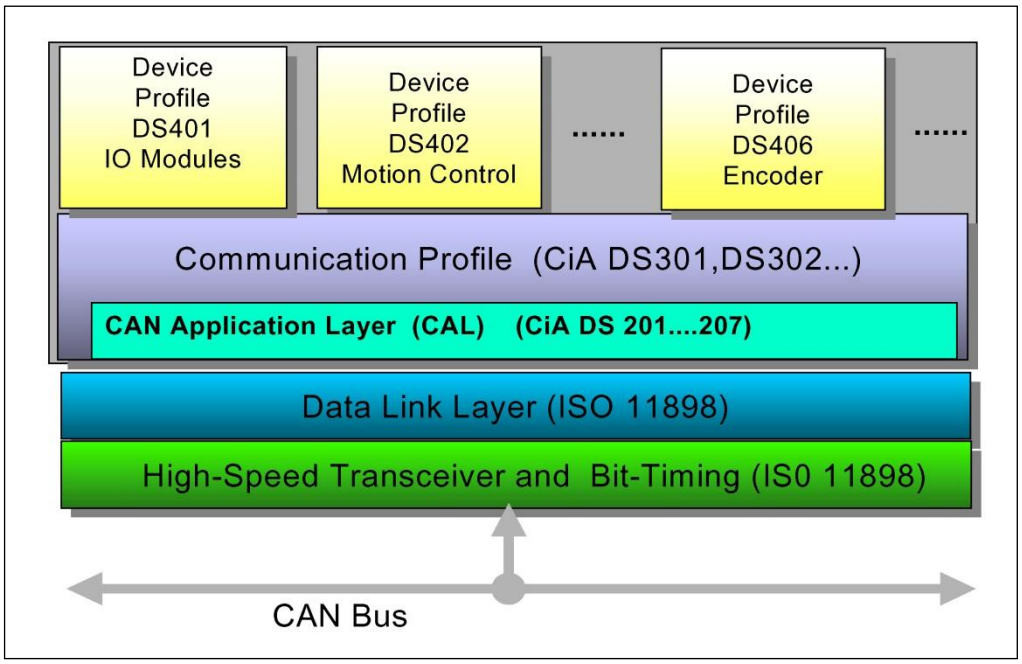

Figure 1: CANopen classified in the ISO/OSI reference model

In case of CANopen at first the communication profile as well as a "Build instructions" for device profiles was developed, in which with the structure of the object dictionary and the general coding rules the common denominator of all device profiles is defined.

4.1 CANopen – Communication profile

The CANopen communication profile (defined in CiA DS-301) regulates the devices data exchange. Here real time data (e.g. position value) and parameter data (e.g. code sequence) will be differentiated. To the data types, which are different from the character, CANopen assigns respectively suitable communication elements.

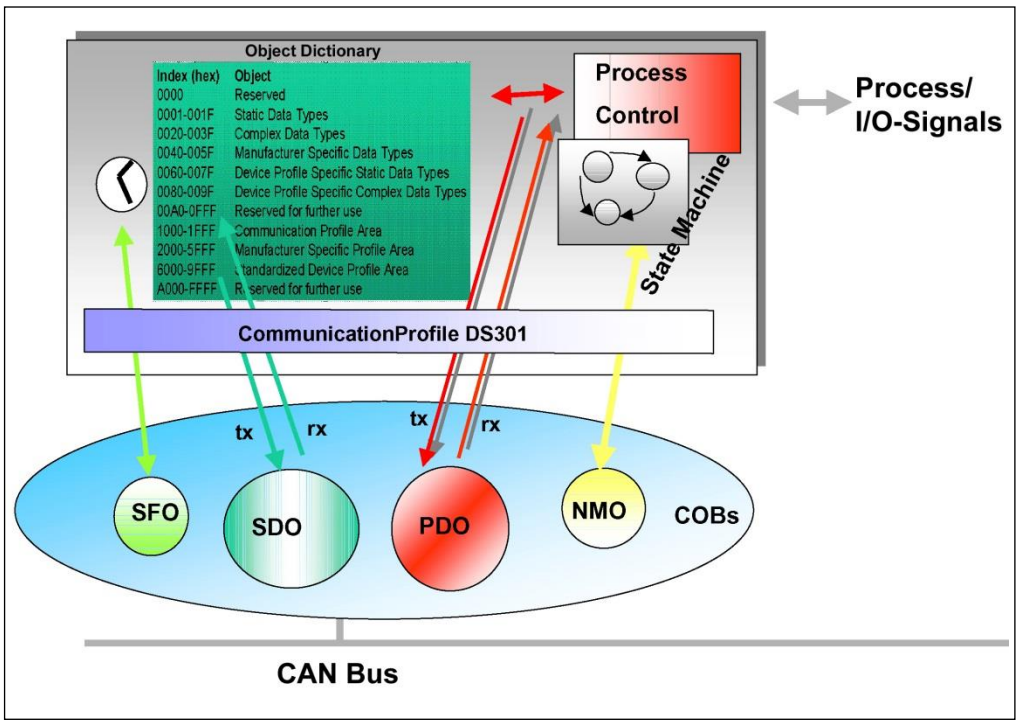

Figure 2: Communication profile

Special **F**unction **O**bject **(SFO)**

- Synchronization (SYNC)
- Emergency (EMCY) Protocol

Network **M**anagement **O**bject **(NMO)**

e.g.

- Life / Node-Guarding
- Boot-Up,…
- Error Control Protocol

4.2 Process- and Service-Data-Objects

Process-Data-Object (PDO)

Process-Data-Objects manage the process data exchange, e.g. the cyclical transmission of the position value.
The process data exchange with the CANopen PDOs is "CAN pure", therefore without protocol overhead. All broadcast characteristics of CAN remain unchanged. A message can be received and evaluated by all devices at the same time.
From the measuring system the two transmitting process data objects 1800h for asynchronous (event-driven) position transmission and 1802h for the synchronous (upon request) position transmission are used.

Service-Data-Object (SDO)

Service-Data-Objects manage the parameter data exchange, e.g. the non-cyclical execution of the Preset function.
For parameter data of arbitrary size with the SDO an efficient communication mechanism is available. For this between the configuration master and the connected devices a service data channel for the parameter communication is available. The device parameters can be written with only one telegram handshake into the object dictionary of the devices or can be read out from this.

Important characteristics of the SDO and PDO

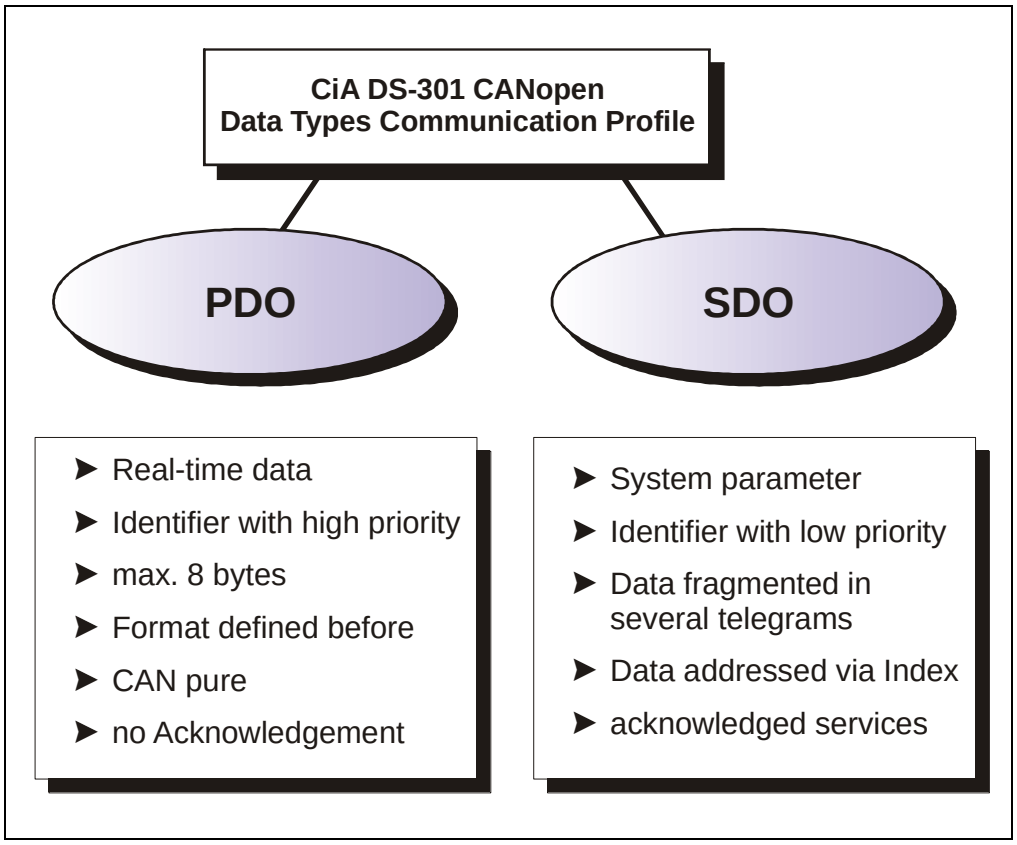

Figure 3: Comparison of PDO/SDO characteristics

4.3 Object Dictionary

The object dictionary structures the data of a CANopen device in a clear tabular arrangement. It contains all device parameters as well as all current process data, which are accessible thereby also about the SDO.

Index	Object	
0000_h	not used	Common to all devices
0001_h - $025F_h$	Data type definitions	
0260_h - $0FFF_h$	Reserved	
1000_h - $1FFF_h$	Communication profile area	
2000_h - $5FFF_h$	Manufacturer specific profile area	Device specific
6000_h - $9FFF_h$	Standardized device profile area	
$A000_h$ - $BFFF_h$	Standardized interface profile area	
$C000_h$ - $FFFF_h$	Reserved	

Figure 4: Structure of the Object Dictionary

4.4 CANopen default identifier

CANopen devices can be used without configuration in a CANopen network. Just the setting of a bus address and the baud rate is required. From this node address the identifier allocation for the communication channels is derived.

COB-Identifier = Function Code + Node-ID

10										0
1	2	3	4	1	2	3	4	5	6	7
Function Code				Node-ID = Adjustment of the address switches + 1						

Examples

Object	Function Code	COB-ID	Index Communication Parameter
NMT	0000bin	0	–
SYNC	0001bin	80h	1005
PDO1 (tx)	0011bin	181h – 1FFh	1800h

4.5 Transmission of SDO messages

The transmission of SDO messages is done by the CMS “Multiplexed Domain” protocol (CIA DS202-2).
With SDOs objects from the object dictionary can be read or written. It is an acknowledged service. The so-called ***SDO client*** specifies in its request the parameter, the access method (read/write) and if necessary the value. The so-called ***SDO server*** performs the write or read access and answers the request with a response. In the error case an error code gives information about the cause of error. Transmit-SDO and Receive-SDO are distinguished by their function codes.

The measuring system (slave) corresponds to the SDO server and uses the following function codes:

Function codes	COB-ID	Meaning
11 (1011 bin)	0x580 + Node ID	**Slave → SDO Client**
12 (1100 bin)	0x600 + Node ID	**SDO Client → Slave**

Table 1: COB-IDs for Service Data Object (SDO)

4.5.1 SDO message format

The data field with max. 8 byte length of a CAN message is used by a SDO as follows:

CCD	Index		Sub-Index	Data			
Byte 0	Byte 1 Low	Byte 2 High	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7

Table 2: SDO message

The ***command code*** (***CCD***) identifies whether the SDO is to be read or written. In addition with a writing order, the number of bytes which can be written is encoded in the CCD.
At the SDO response the CCD reports whether the request was successful. In the case of a reading order the CCD gives additionally information about the number of bytes, which could be read:

CCD	Meaning	Valid for
0x23	Write 4 bytes	SDO Request
0x2B	Write 2 bytes	SDO Request
0x2F	Write 1 byte	SDO Request
0x60	Writing successfully	SDO Response
0x80	Error	SDO Response
0x40	Reading request	SDO Request
0x43	4 byte data read	SDO response upon reading request
0x4B	2 byte data read	SDO response upon reading request
0x4F	1 byte data read	SDO response upon reading request

Table 3: SDO command codes

In the case of an error (SDO response CCD = 0x80) the data field contains a 4-byte error code, which gives information about the error cause. Meaning of the error codes see table Table 10 on page 65.

Segment Protocol, Data segmentation

Some objects contain data which are larger than 4 bytes. To be able to read these data, the "Segment Protocol" must be used.
As a usual SDO service, at first the read operation is started with the command code = 0x40. About the response the number of data segments and the number of bytes to be read is reported. With following reading requests the individual data segments can be read. A data segment consists respectively of 7 bytes.

Example of reading a data segment:

Telegram 1

CCD	Meaning	Valid for
0x40	Reading request, initiation	SDO Request
0x41	1 data segment available The number of bytes which can be read is indicated in the bytes 4 to 7.	SDO Response

Telegram 2

CCD	Meaning	Valid for
0x60	Reading request	SDO Request
0x01	No further data segment available. The bytes 1 to 7 contain the requested data.	SDO Response

4.5.2 Read SDO

Initiate Domain Upload

Request Protocol format:

COB-Identifier = 600h + Node-ID

Read SDO´s								
Byte	0	1	2	3	4	5	6	7
Contents	Code	Index		Sub-Index	Data 0	Data 1	Data 2	Data 3
	40h	Low	High	Byte	0	0	0	0

The Read SDO telegram has to be send to the slave.

The slave answers with the following telegram:

Response Protocol format:

COB-Identifier = 580h + Node-ID

Read SDO´s								
Byte	0	1	2	3	4	5	6	7
Contents	Code	Index		Sub-Index	Data 0	Data 1	Data 2	Data 3
	4xh	Low	High	Byte	Data	Data	Data	Data

Format Byte 0:

MSB LSB

7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	1	0	0	n		1	1

n = number of data bytes (bytes 4-7) that does not contain data

If only 1 data byte (Data 0) contains data the value of byte 0 is "4FH".

If byte 0 = 80h the transfer has been aborted.

4.5.3 Write SDO

Initiate Domain Download

Request Protocol format:

COB-Identifier = 600h + Node-ID

Write SDO´s								
Byte	0	1	2	3	4	5	6	7
Contents	Code	Index		Sub-Index	Data 0	Data 1	Data 2	Data 3
	2xh	Low	High	Byte	0	0	0	0

Format Byte 0:

MSB LSB

7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	0	1	0	n		1	1

n = number of data bytes (bytes 4-7) that does not contain data.

If only 1 data byte (Data 0) contains data the value of byte 0 is "2FH".

The Write SDO telegram has to be send to the slave.

The slave answers with the following telegram:

Response Protocol format:

COB-Identifier = 580h + Node-ID

Read SDO´s								
Byte	0	1	2	3	4	5	6	7
Contents	Code	Index		Sub-Index	Data 0	Data 1	Data 2	Data 3
	60h	Low	High	Byte	0	0	0	0

If byte 0 = 80h the transfer has been aborted.

4.6 Network management, NMT

The network management supports a simplified Boot-Up of the net. With only one telegram for example all devices can be switched into the Operational condition.

After Power on the measuring system is first in the "Pre-Operational" condition (2).

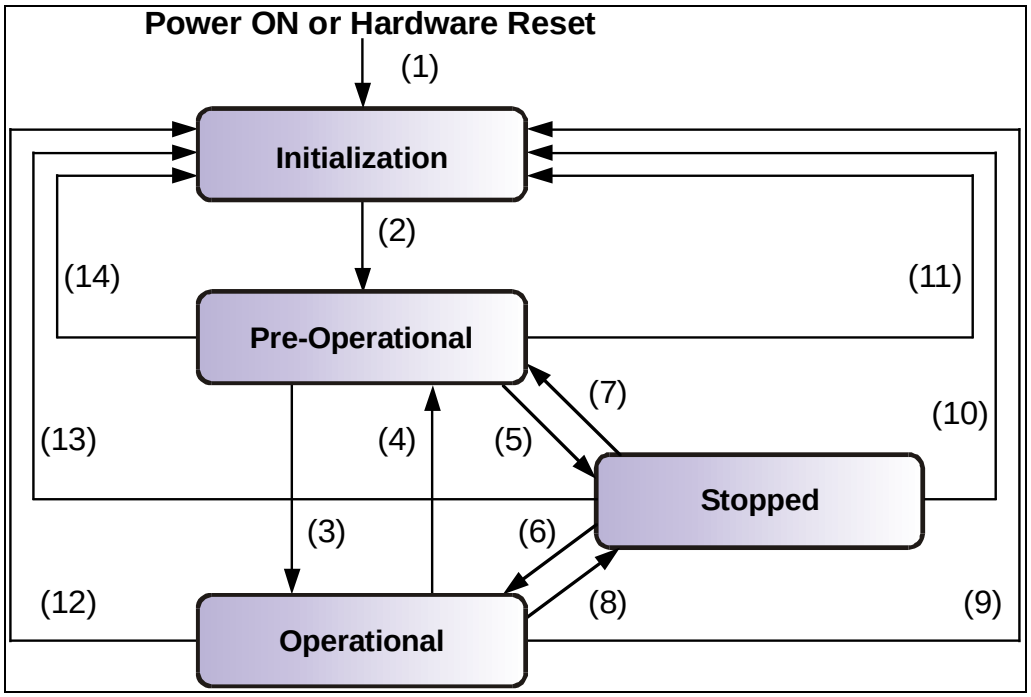

Figure 5: Boot-Up mechanism of the network management

State	Description
(1)	At Power on the initialization state is entered autonomously
(2)	Initialization finished - enter PRE-OPERATIONAL automatically
(3),(6)	Start_Remote_Node --> Operational
(4),(7)	Enter_PRE-OPERATIONAL_State --> Pre-Operational
(5),(8)	Stop_Remote_Node
(9),(10),(11)	Reset_Node
(12),(13),(14)	Reset_Communication

4.6.1 Network management services

The ***network management*** (***NMT***) has the function to initialize, start, stop and monitor nodes of a CANopen network.

NMT services are initiated by a ***NMT master***, which identifies individual nodes (***NMT slave***) about their Node-ID. A NMT message with the Node ID 0 refers to **all** NMT slaves.

The measuring system corresponds to a NMT slave.

4.6.1.1 NMT device control services

The NMT services for device control use the **COB-ID 0** and get thus the highest priority.

By the data field of the CAN message only the first two bytes are used:

CCD	Node ID
Byte 0	Byte 1

The following commands are defined:

CCD	Meaning	State
-	At Power on the initialization state is entered autonomously	(1)
-	Initialization finished - enter PRE-OPERATIONAL automatically	(2)
0x01	**Start Remote Node** Node is switched into the OPERATIONAL state and the normal net-operation is started.	(3),(6)
0x02	**Stop Remote Node** Node is switched into the STOPPED state and the communication is stopped. An active connecting monitoring remains active.	(5),(8)
0x80	**Enter PRE-OPERATIONAL** Node is switched into the PRE-OPERATIONAL state. All messages can be used, but no PDOs.	(4),(7)
0x81	**Reset Node** Set values of the profile parameters of the object on default values. Afterwards transition into the RESET COMMUNICATION state.	(9),(10), (11)
0x82	**Reset Communication** Node is switched into the RESET COMMUNICATION state. Afterwards transition into the INITIALIZATION state, first state after Power on.	(12),(13), (14)

Table 4: NMT device control services

4.6.1.2 NMT Node / Life guarding services

With the Node/Life guarding a NMT master can detect the failure of a NMT slave and/or a NMT slave can detect the failure of a NMT master:

- **Node Guarding and Life Guarding:**
  With these services a NMT master monitors a NMT slave

At the **Node Guarding** the NMT master requests the state of a NMT slave in regular intervals. The toggle bit 2^7 in the “Node Guarding Protocol” toggles after each request:

Example:
0x85, 0x05, 0x85 … --> no error
0x85, 0x05, 0x05 … --> error

Additionally if the **Life Guarding** is active, the NMT slave requests the state of a NMT master in regular intervals, otherwise the slave changes into the PRE-OPERATIONAL state.

The NMT services for Node/Live guarding use the function code **`1110 bin`: COB-ID 0x700+Node ID**.

Index	Description	
0x100C	**Guard Time [ms]**	At termination of the time interval **Life Time = Guard Time x Life Time Factor [ms]** the NMT slave expects a state request by the master. Guard Time = 0: No monitoring active Life Time = 0: Life guarding disabled
0x100D	**Life Time Factor**	

Table 5: Parameter for NMT services

4.7 Layer management services (LMT) and protocols

[2] The LMT-services and protocols, documented in CiA DS-205-1 and DS-205-2, are used to inquire or to change the settings of certain parameters of the local layers of a LMT slave by a LMT master via the CAN network.

Following parameters are supported:

- Node-ID
- Baud rate
- LMT-address

Thus it isn't necessary to adjust the Node-ID or Baud rate by means of DIP-switches. Access to the LMT slave is made thereby by its LMT address, consisting of:

- Manufacturer-Name
- Product-Name
- Serial-Number

The measuring system supports the following services:

Switch mode services

- Switch mode selective
- Switch mode global

Configuration services

- Configure NMT-address
- Configure bit timing parameters
- Activate bit timing parameters
- Store configured parameters

Inquiry services

- Inquire LMT-address

Identification services

- LMT identify remote slave
- LMT identify slave

[2] available only in case of LMP-30 and LA-41 without DIP-switches

4.7.1 LMT Modes and Services

By means of LMT Modes the behavior of a LMT slave is defined. The state behavior is controlled by LMT COBs produced by the LMT master.

The LMT Modes support the following states:

LMT operation: In this state, all services are supported as defined below

LMT configuration: In this state, all services are supported as defined below

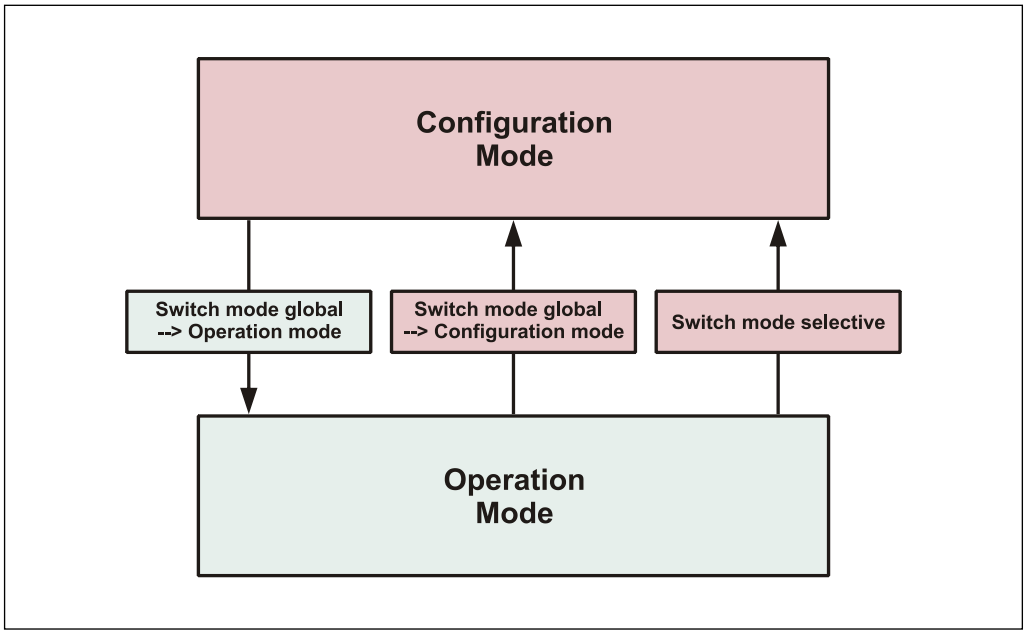

Figure 6: LMT Modes

State behavior of the supported services

Services	Operation	Configuration
Switch mode global	Yes	Yes
Switch mode selective	Yes	No
Activate bit timing parameters	No	Yes
Configure bit timing parameters	No	Yes
Configure NMT-address	No	Yes
Store configured parameters	No	Yes
Inquire LMT-address	No	Yes
LMT identify remote slave	Yes	Yes
LMT identify slave	Yes	Yes

4.7.2 Transmission of LMT services

By means of LMT services, the LMT master requests services to be performed by the LMT slave. Communication between LMT master and LMT slave is made by means of implemented LMT protocols.
Similar as in the case of SDO transmitting, also here two COB-IDs for sending and receiving are used:

COB-ID	Meaning
0x7E4	LMT slave → LMT master
0x7E5	LMT master → LMT slave

Table 6: COB-IDs for LMT services

4.7.2.1 LMT message format

The data field with max. 8 byte length of a CAN message is used by a LMT service as follows:

CS	Data						
Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7

Table 7: LMT message

Byte 0 contains the ***Command-Specifier*** (CS), afterwards 7 byte data are following.

4.7.3 Switch mode protocols

4.7.3.1 Switch mode global protocol

The given protocol has implemented the *Switch mode global service* and controls the state behavior of the LMT slave. By means of the LMT master all LMT slaves in the network can be switched into *Operation Mode* or *Configuration Mode*.

LMT-Master --> LMT-Slave

0	1	2	3	4	5	6	7

COB-ID	CS	Mode	Reserved by CiA
0x7E5	04	0 = Operation mode 1 = Configuration mode	

4.7.3.2 Switch mode selective protocol

The given protocol has implemented the *Switch mode selective service* and controls the state behavior of the LMT slave. By means of the LMT master only this LMT slave in the network can be switched into *Configuration Mode*, whose LMT address attributes equals the LMT address.

LMT-Master --> LMT-Slave

0	1	2	3	4	5	6	7

COB-ID	CS	Manufacturer-Name					
0x7E5	01	LSB					MSB

0	1	2	3	4	5	6	7

COB-ID	CS	Product-Name					
0x7E5	02	LSB					MSB

0	1	2	3	4	5	6	7

COB-ID	CS	Serial-No.					
0x7E5	03	LSB					MSB

4.7.4 Configuration protocols

4.7.4.1 Configure NMT-address protocol

The given protocol has implemented the *Configure NMT-address service*. By means of the LMT master the Node-ID of a single LMT slave in the network can be configured. Only one device is to be switched into *Configuration Mode*. For storage of the new Node-ID the *Store configuration protocol* must be transmitted to the LMT slave.

LMT-Master --> LMT-Slave

0	1	2	3	4	5	6	7
COB-ID	**CS**	**Node-ID**	Reserved by CiA				
0x7E5	17	1…127					

LMT-Slave --> LMT-Master

0	1	2	3	4	5	6	7
COB-ID	**CS**	**Error Code**	**Spec. Error**	Reserved by CiA			
0x7E4	17						

Error Code
- 0: Protocol successfully completed
- 1…254: reserved
- 255: application specific error occurred

Specific Error
if Error Code = 255 --> application specific error occurred,
otherwise reserved by CiA

4.7.4.2 Configure bit timing parameters protocol

The given protocol has implemented the *Configure bit timing parameters service*. By means of the LMT master the Baud rate of a single LMT slave in the network can be configured. Only one device is to be switched into *Configuration Mode*. For storage of the new Baud rate the *Store configuration protocol* must be transmitted to the LMT slave.

LMT-Master --> LMT-Slave

	0	1	2	3	4	5	6	7
COB-ID	**CS**	**Table Selector**	**Table Index**	Reserved by CiA				
0x7E5	19	0	0…7					

LMT-Slave --> LMT-Master

	0	1	2	3	4	5	6	7
COB-ID	**CS**	**Error Code**	**Spec. Error**	Reserved by CiA				
0x7E4	19							

Table Selector
- 0: Standard CiA Baud rate table

Table Index
- 0: 1 Mbit/s
- 1: 800 kbit/s
- 2: 500 kbit/s
- 3: 250 kbit/s
- 4: 125 kbit/s
- 5: 50 kbit/s
- 6: 20 kbit/s
- 7: 10 kbit/s

Error Code
- 0: Protocol successfully completed
- 1: selected Baud rate not supported
- 2…254: reserved
- 255: application specific error occurred

Specific Error
if Error Code = 255 --> application specific error occurred,
otherwise reserved by CiA

4.7.4.3 Activate bit timing parameters protocol

The given protocol has implemented the *Activate bit timing parameters service*. The protocol activates the Baud rate which was configured about the *Configure bit timing parameters protocol* and is performed with all LMT slaves in the network which are in the *Configuration Mode*.

LMT-Master --> LMT-Slave

0	1	2	3	4	5	6	7
COB-ID	**CS**	**Switch Delay [ms]**		Reserved by CiA			
0x7E5	21	LSB	MSB				

Switch Delay

The parameter *Switch Delay* defines the length of two delay periods (D1, D2) with equal length. These are necessary to avoid operating the bus with differing Baud rate parameters.
After the time D1 and an individual processing duration, the switching internally in the LMT slave is performed. After the time D2 the LMT slave responses with CAN-messages and the new configured Baud rate.

It is necessary:
Switch Delay > longest occurring processing duration of a LMT slave

4.7.4.4 Store configuration protocol

The given protocol has implemented the *Store configuration service*. By means of the LMT master the configured parameters of a single LMT slave in the network can be stored into the non-volatile memory. Only one device is to be switched into *Configuration Mode*.

LMT-Master --> LMT-Slave

0	1	2	3	4	5	6	7
COB-ID	**CS**	Reserved by CiA					
0x7E5	23						

LMT-Slave --> LMT-Master

0	1	2	3	4	5	6	7
COB-ID	**CS**	**Error Code**	**Spec. Error**	Reserved by CiA			
0x7E4	23						

Error Code

0:	Protocol successfully completed
1:	*Store configuration* not supported
2…254:	reserved
255:	application specific error occurred

Specific Error

if Error Code = 255 --> application specific error occurred,
otherwise reserved by CiA

4.7.5 Inquire LMT address protocols

4.7.5.1 Inquire Manufacturer-Name protocol

The given protocol has implemented the *Inquire LMT address service*. By means of the LMT master the Manufacturer-Name of a single LMT slave in the network can be read-out. Only one device is to be switched into *Configuration Mode*.

LMT-Master --> LMT-Slave

	0	1	2	3	4	5	6	7
COB-ID	**CS**	Reserved by CiA						
0x7E5	36							

LMT-Slave --> LMT-Master

	0	1	2	3	4	5	6	7
COB-ID	**CS**	**Manufacturer-Name** (ASCII)						
0x7E4	36	M1	M2	M3	M4	M5	M6	M7

Manufacturer-Name = „TR-ELEC“
M1…M7 = 0x54, 0x52, 0x2D, 0x45, 0x4C, 0x45, 0x43

4.7.5.2 Inquire Product-Name protocol

The given protocol has implemented the *Inquire LMT address service*. By means of the LMT master the Product-Name of a single LMT slave in the network can be read-out. Only one device is to be switched into *Configuration Mode*.

LMT-Master --> LMT-Slave

	0	1	2	3	4	5	6	7
COB-ID	**CS**	Reserved by CiA						
0x7E5	37							

LMT-Slave --> LMT-Master

	0	1	2	3	4	5	6	7
COB-ID	**CS**	**Product-Name** (ASCII)						
0x7E4	37	P1	P2	P3	P4	P5	P6	P7

Product-Name = „LMP30“ or “LA_41”
P1…P7 = 0x4C, 0x4D, 0x50, 0x33, 0x30, 0x00, 0x00 or
0x4C, 0x41, 0x5F, 0x34, 0x31, 0x00, 0x00

4.7.5.3 Inquire Serial-Number protocol

The given protocol has implemented the *Inquire LMT address service*. By means of the LMT master the Serial-No. of a single LMT slave in the network can be read-out. Only one device is to be switched into *Configuration Mode*.

LMT-Master --> LMT-Slave

	0	1	2	3	4	5	6	7
COB-ID	**CS**	Reserved by CiA						
0x7E5	38							

LMT-Slave --> LMT-Master

	0	1	2	3	4	5	6	7
COB-ID	**CS**	**Serial-No.** (BCD)						
0x7E4	38	S1	S2	S3	S4	S5	S6	S7

Serial-No. = e.g. LMP-30: „**322**00044 0021“ or LA-41: „**304**00044 0021“
S1…S7 = 32, 20, 00, 44, 00, 21, 00 or
30, 40, 00, 44, 00, 21, 00

4.7.6 Identification protocols

4.7.6.1 LMT identify remote slave protocol

The given protocol has implemented the *LMT identify remote slaves service*. By means of the LMT master LMT slaves in the network can be identified within a certain range. All LMT slaves with matching Manufacturer-Name, Product-Name and Serial-No. Range, response with the *LMT identify slave protocol*.

LMT-Master --> LMT-Slave

	0	1	2	3	4	5	6	7
COB-ID	**CS**	**Manufacturer-Name**						
0x7E5	05	LSB						MSB

	0	1	2	3	4	5	6	7
COB-ID	**CS**	**Product-Name**						
0x7E5	06	LSB						MSB

	0	1	2	3	4	5	6	7
COB-ID	**CS**	**Serial-No. LOW**						
0x7E5	07	LSB						MSB

	0	1	2	3	4	5	6	7
COB-ID	**CS**	**Serial-No. HIGH**						
0x7E5	08	LSB						MSB

4.7.6.2 LMT identify slave protocol

The given protocol has implemented the *LMT identify slave service*. All LMT slaves with matching LMT attributes given in the *LMT identify remote slaves protocol*, response with this protocol.

LMT-Slave --> LMT-Master

	0	1	2	3	4	5	6	7
COB-ID	**CS**	Reserved by CiA						
0x7E4	09							

4.8 Device profile

The CANopen device profiles describe the "what" of the communication. In the profiles the meaning of the transmitted data is unequivocal and manufacturer independently defined. So the basic functions of each device class

e.g. for encoder: ***CiA DS-406***

can be responded uniformly. On the basis of these standardized profiles CANopen devices can be accessed in an identical way over the bus. Therefore devices which support the same device profile are exchangeable with each other.

You can obtain further information on CANopen from the ***CAN in Automation*** User- and Manufacturer Association:

CAN in Automation
Am Weichselgarten 26
DE-91058 Erlangen

Tel. +49-9131-69086-0
Fax +49-9131-69086-79

Website: www.can-cia.org
e-mail: headquarters@can-cia.org

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5 Installation / Preparation for start-up

The CANopen system is wired in bus topology with terminating resistors (120 ohms) at the beginning and at the end of the bus line. If it is possible, drop lines should be avoided. The cable is to be implemented as shielded twisted pair cable and should have an impedance of 120 ohms and a resistance of 70 mΩ/m. The data transmission is carried out about the signals CAN-H and CAN-L with a common GND as data reference potential. Optionally also a 24 V supply voltage can be carried.

In a CANopen network max. 127 slaves can be connected. [3] The measuring system supports the Node-ID range from 1-64. The transmission rate can be adjusted via DIP-switches and supports the baud rates 20 kbit/s, 125 kbit/s, 500 kbit/s and 1 Mbit/s.

The length of a CANopen network is depending on the transmission rate and is represented in the following:

Cable cross section	20 kbit/s	125 kbit/s	500 kbit/s	1 Mbit/s
0.25 mm^2 – 0.34 mm^2	2500 m	500 m	100 m	25 m

The

- *ISO 11898,*
- *the recommendations of the CiA DR 303-1 (CANopen cabling and connector pin assignment)*
- *and other applicable standards and guidelines are to be observed to insure safe and stable operation!*

In particular, the applicable EMC directive and the shielding and grounding guidelines must be observed!

[3] LMP-30, LA-41 without DIP-switches: programmable with LMT services acc. to CiA DS 205-1 and 205-2

5.1 Connection

The connection can be made with device specific pin assignment which is enclosed when the device is delivered.

For the supply shielded cables with twisted core pairs have to be used !

5.2 DIP-switch – settings

- *The switch position is read-in only in the power-on state, therefore following modifications can be not recognized!*
- *LMP-30, LA-41 without DIP-switches: Node-ID and Baud rate programmable with LMT services according to CiA DS 205-1 and 205-2.*

5.2.1 Bus termination

If the measuring system is the last slave in the CAN segment, the bus is to be terminated with the termination switch or a jumper, see pin assignment.

5.2.2 Node-ID

The Node-ID 1…64 is adjusted by means of DIP-switches, see pin assignment. The adjusted address may be assigned only once in the CAN bus.

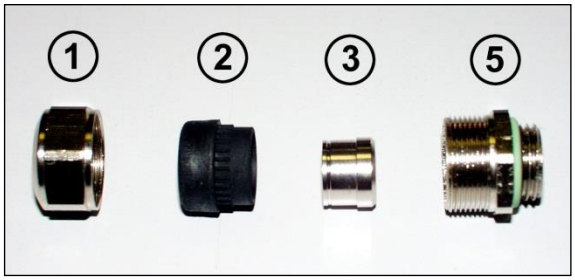
5.2.3 Baud rate

The baud rate 20 kbit/s, 125 kbit/s, 500 kbit/s or 1 Mbit/s is adjusted by means of DIP-switches, see pin assignment.

5.3 Shield cover, type with cable outlet

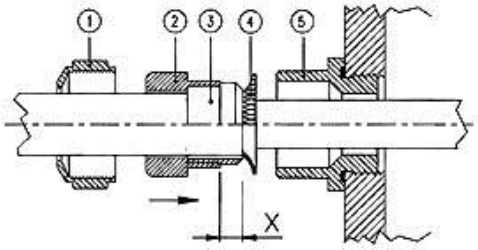
The shield cover is connected with a special EMC cable gland, whereby the cable shielding is fitted on the inside.

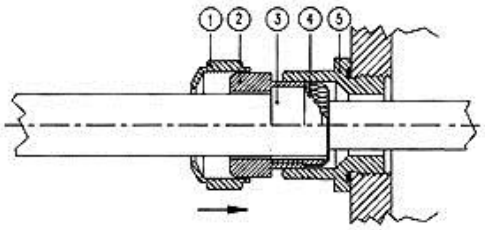
Cable gland assembly, variant A



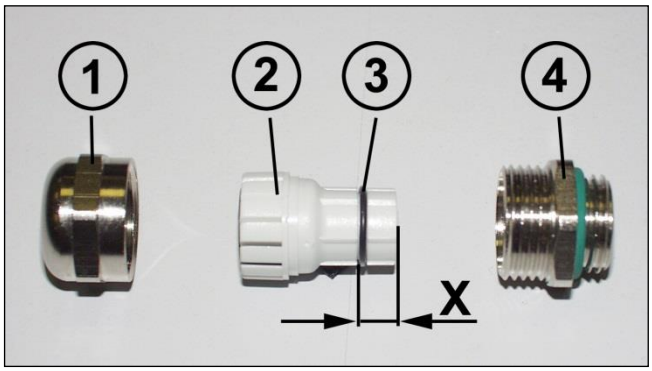
Pos. 1 Nut
Pos. 2 Seal
Pos. 3 Contact bush
Pos. 5 Screw socket

1. Cut shield braid / shield foil back to ***dimension "X"***.
2. Slide the nut (1) and seal / contact bush (2) + (3) over the cable.
3. Bend the shield braining / shield foil to 90° (4).
4. Slide seal / contact bush (2) + (3) up to the shield braining / shield foil.
5. Assemble screw socket (5) on the housing.
6. Push seal / contact bush (2) + (3) flush into the screw socket (5).
7. Screw the nut (1) to the screw socket (5).



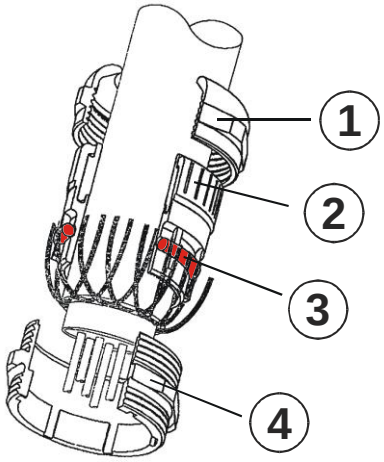


Cable gland assembly, variant B



Pos. 1 Nut
Pos. 2 Clamping ring
Pos. 3 Inner O-ring
Pos. 4 Screw socket

1. Cut shield braid / shield foil back to dimension ***"X" + 2mm***.
2. Slide the nut (1) and clamping ring (2) over the cable.
3. Bend the shield braining / shield foil to approx. 90°.
4. Push clamping ring (2) up to the shield braid / shield foil and wrap the braiding back around the clamping ring (2), such that the braiding goes around the inner O-ring (3), and is not above the cylindrical part or the torque supports.
5. Assemble screw socket (4) on the housing.
6. Insert the clamping ring (2) in the screw socket (4) such that the torque supports fit in the slots in the screw socket (4).
7. Screw the nut (1) to the screw socket (4).



5.4 Switching on the supply voltage

After the connection and all settings have been carried out, the supply voltage can be switched on.

After power on and finishing the initialization, the measuring system goes into the PRE-OPERATIONAL state. In case of rotative measuring systems this status is acknowledged by the Boot-Up message “**COB-ID 0x700+Node ID**”. If the measuring system detects an internal error, an emergency message with the error code will be transmitted (see chapter "Emergency Message", page 62).

In the PRE-OPERATIONAL state first only a parameter setting about Service-Data-Objects is possible. But it is possible to configure PDOs with the help of SDOs. If the measuring system was transferred into the OPERATIONAL state, also a transmission of PDOs is possible.

5.5 [4] Setting the Node-ID and Baud rate by means of LMT services

5.5.1 Configuration of the Node-ID, sequence

Assumption:

- LMT address unknown
- only one LMT slave should be in the network
- the Node-ID 12 dec. shall be adjusted

Procedure:

- Perform service 04 *Switch mode global protocol*,
  Mode = 1, to switch the LMT slave into *Configuration Mode*.
- Perform service 17 *Configure Node-ID protocol*, Node-ID = 12.
  --> Wait for acknowledgement and check successfully execution,
  --> Error Code = 0.
- Perform service 23 *Store configuration protocol*.
  --> Wait for acknowledgement and check successfully execution,
  --> Error Code = 0.
- Switch the supply voltage of the LMT slave OFF and then ON again. Now the new configuration is activated.

[4] available only in case of LMP-30 and LA-41 without DIP-switches

5.5.2 Configuration of the Baud rate, sequence

Assumption:

- LMT address unknown
- only one LMT slave should be in the network
- the Baud rate 125 kbit/s shall be adjusted

Procedure:

- Perform NMT service *Stop Remote Node* (0x02), to switch the LMT slave into *Stopped state*. The LMT slave shouldn't sent any CAN-messages
  --> Heartbeat switched off.
- Perform service 04 *Switch mode global protocol*,
  Mode = 1, to switch the LMT slave into *Configuration Mode*.
- Perform service 19 *Configure bit timing parameters protocol*,
  Table Selector = 0, Table Index = 4
  --> Wait for acknowledgement and check successfully execution,
  --> Error Code = 0.
- Perform service 21 *Activate bit timing parameters protocol*, to switch the new Baud rate active.
- Perform service 23 *Store configuration protocol*.
  --> Wait for acknowledgement and check successfully execution,
  --> Error Code = 0.
- Switch the supply voltage of the LMT slave OFF and then ON again. Now the new configuration is activated.

6 Commissioning

6.1 CAN – interface

The CAN-Bus-Interface is defined by the international norm ISO/DIS 11898 and specifies the two lowest layers of the ISO/DIS CAN Reference Model.

The CAN-BUS-Interface with the BUS-Driver PCA82C251 is galvanic isolated of the measuring system electronic and becomes the power over internal DC/DC-converter. There is no external power supply necessary for the CAN-BUS-Driver.

The conversion of the measuring system information to the CAN message format (CAN 2.0A) is done by the CAN-controller SJA1000. The function of the CAN-controller is controlled by a watchdog.

The CANopen Communication Profile (CIA standard DS 301) is a subset of CAN Application Layer (CAL) and describes, how the services are used by devices. The CANopen Profile allows the definition of device profiles for decentralized I/O.

The measuring system with CANopen-protocol support the Device Profile for Encoder (CIA Draft Standard Proposal 406, Version 2.0). **The measuring systems support the extended functions in Class C2 .**

The communication functionality and objects, which are used in the encoder profile, are described in a EDS-File (Electronic Data Sheet).
When using a CANopen Configuration Tool (e.g.: CANSETTER), the user can read the objects of the measuring system (SDOs) and program the functionality.

The selection of transmission rate and node number is done by hardware (switches).

6.1.1 EDS file

The EDS (electronic datasheet) contains all information on the measuring system-specific parameters and the measuring system's operating modes. The EDS file is integrated using the CANopen network configuration tool to correctly configure or operate the measuring system.

Download:

- "CE_CANOP.EDS" for rotative measuring systems
  www.tr-electronic.de/f/TR-ECE-ID-MUL-0027
- "LA_CANOP.EDS" for linear measuring systems
  www.tr-electronic.de/f/TR-ELA-ID-MUL-0010

6.1.2 Bus status

Depending on the device type the bus status is indicated by means of a green LED:

● = ON ○ = OFF ◉ = FLASHING	
○	No supply voltage, hardware error
●	OK, OPERATIONAL
◉	No allocation to a master

Corresponding measures in case of an error see chapter “Optical displays”, page 65.

7 The communication profile

Two process data objects (PDO) are implemented in the device. One is used for asynchronous transmission and the other one for the cyclic transmission functions.

The output position value is transmitted in binary code:

COB-ID	Output Position Value			
11 Bit	Byte 0	Byte 1	Byte 2	Byte 3
	2^7 to 2^0	2^{15} to 2^8	2^{23} to 2^{16}	2^{31} to 2^{24}

7.1 1st transmit Process-Data-Object (asynchronous)

This PDO transmit the position value of the measuring system in an asynchronous way. The cyclic timer is stored in index 6200h.

Index	Sub-Index	Comment	Default value	Attr.
1800h	0	number of supported entries	3	ro
	1	COB-ID used by PDO 1	180h + Node-ID	ro
	2	transmission type	254	ro
	3	inhibit time	0	rw
1A00h	0	number of mapped objects	1	ro
	1	Position value	60040020h	ro

7.2 2nd transmit Process-Data-Object (cyclic)

This PDO transmit the position value of the measuring system in a cyclic way (on request). Request by remote frame and/or sync telegrams.

Index	Sub-Index	Comment	Default value	Attr.
1802h	0	number of supported entries	3	ro
	1	COB-ID used by PDO 2	280 + Node-ID	ro
	2	transmission type	1	ro
	3	inhibit time	0	rw
1A02h	0	number of mapped objects	1	ro
	1	Position value	60040020h	ro

8 Communication specific standard objects (CiA DS-301)

Following table gives an overview on the supported indices in the Communication Profile Area:

M = Mandatory
O = Optional

Index (h)	Object	Name	Type	Attr.	M/O	Page
1000	VAR	Device type	Unsigned32	ro	M	46
1001	VAR	Error register	Unsigned8	ro	M	46
1002	VAR	Manufacturer status register	Unsigned32	ro	O	47
1003	ARRAY	Pre-defined error field	Unsigned32	rw	O	47
1004	ARRAY	Number of supported PDO´s	Unsigned32	ro	O	47
1005	VAR	COB-ID SYNC message	Unsigned32	rw	O	48
[5] 1008	VAR	Device name	Vis-String	const	O	49
[5] 1009	VAR	Hardware version	Vis-String	const	O	49
[5] 100A	VAR	Software version	Vis-String	const	O	49
100B	VAR	Node-ID	Unsigned32	ro	O	49
100C	VAR	Guard time	Unsigned16	rw	O	50
100D	VAR	Life time factor	Unsigned8	rw	O	50
100E	VAR	COB-ID guarding protocol	Unsigned32	ro	O	50
1010	ARRAY	Store parameters	Unsigned32	rw	O	51
[6] 1018	ARRAY	Identity Objekt	Unsigned32	ro	O	52

Table 8: Communication specific standard objects

[5] segmented reading
[6] available only in case of LMP-30

8.1 Object 1000h: Device type

Contains information about the device type. The object at index 1000h describes the type of device and its functionality. It is composed of a 16 bit field which describes the device profile that is used (Device Profile Number 406 = 196h) and a second 16 bit field which gives information on the type of encoder.

Unsigned32

Device Type			
Device Profile Number		Encoder Type	
Byte 0	Byte 1	Byte 2	Byte 3
196h		2^7 to 2^0	2^{15} to 2^8

Encoder Type

Code	Definition
01	Single-Turn absolute rotary encoder
02	Multi-Turn absolute rotary encoder
08	Absolute linear encoder
09	Absolute linear encoder with cyclic coding

8.2 Object 1001h: Error register

This object contains the error register for the device. If an alarm bit is set (object 6503), bit 5 is set in the error register.

Unsigned8

Bit	Meaning
0	generic error, rotative measuring systems only
1	0
2	0
3	0
4	0
5	device profile specific
6	0
7	0

8.3 Object 1002h: Manufacturer status register

This object is not used by the measuring system, by read access the value is always "0".

8.4 Object 1003h: Pre-defined error field

This object saves the measuring system error occurred last and displays the error via the Emergency object. Each new error overwrites an error which was stored before in sub-index 1. Sub-index 0 contains the number of the occurred errors. Meaning of the error codes see Table 11, page 67.

Index	Sub-Index	Comment	Type
1003h	0	number of errors	Unsigned8
	1	standard error field	Unsigned32

Sub-index 0: The entry at sub-index 0 contains the number of errors that have occurred and recorded in sub-index 1.

Sub-index 1: The error are composed of a 16 bit error code and a 16 bit additional error information.

Unsigned32

Standard Error Field			
Byte 0	Byte 1	Byte 2	Byte 3
Error code		Additional Information	

8.5 Object 1004h: Number of PDOs supported

This object contains information about the maximum number of PDOs supported by the measuring system.

Index	Sub-Index	Comment	Type
1004h	0	number of PDOs supported	Unsigned32
	1	number of synchronous PDOs	Unsigned32
	2	number of asynchronous PDOs	Unsigned32

- Sub-index 0 describes the total number of PDOs supported (synchronous and asynchronous).
- Sub-index 1 describes the number of synchronous PDOs supported by the measuring system.
- Sub-index 2 describes the number of asynchronous PDOs supported by the measuring system.

Number of PDOs			
Byte 0	Byte 1	Byte 2	Byte 3
Transmit PDOs		Receive PDOs	

Sub-index 0: Transmit PDOs = 2, Receive PDOs = 0
Sub-index 1: Transmit PDOs = 1, Receive PDOs = 0
Sub-index 2: Transmit PDOs = 1, Receive PDOs = 0

8.6 Object 1005h: COB-ID SYNC message

This object defines the COB-ID of the Synchronization Object (SYNC). Further, it defines whether the device consumes the SYNC or whether the device generates the SYNC. However, the measuring system supports only the processing of SYNC-messages and uses the 11-bit identifier.

Unsigned32
MSB LSB

31	30	29	28-11	10-0
1	0	0	0	00 1000 0000

Bit 31 = 1, Device processes the SYNC message
Bit 30 = 0, Device does not generate the SYNC message
Bit 29 = 0, 11-bit ID (CAN 2.0A)
Bit 28 –11 = 0
Bit 10 – 0 = 11-bit SYNC-COB-IDENTIFIER, default value = 080H

If a SYNC-telegram with the identifier, defined in this object (080H), and data length = 0 has been received by the device, the position value of the measuring system is transmitted by the 2nd Transmit PDO (object 1802h), non-recurrent triggering.

Object	Function Code	COB-ID
SYNC	0001	80h

8.7 Object 1008h: Device name

Contains the manufacturer device name (visible string), transmission via “Segment Protocol”.

8.8 Object 1009h: Hardware version

Contains the manufacturer hardware version (visible string), transmission via “Segment Protocol”.

8.9 Object 100Ah: Software version

Contains the manufacturer software version (visible string), transmission via “Segment Protocol”.

8.10 Object 100Bh: Node-ID

This object contains the Node-ID (device address).

[7] The value is selected by means of 6 DIP-switches and cannot be changed using SDO services.

Unsigned32

Node_ID			
Byte 0	Byte 1	Byte 2	Byte 3
Node-ID	reserved	reserved	reserved

The value range is: 1 - 64.

The Node-ID is the selected hardware address by the DIP-switches + 1, see chapter "Node-ID", page 37.

[7] LMP-30, LA-41 without DIP-switches: programmable with LMT services acc. to CiA DS 205-1 and 205-2

8.11 Object 100Ch: Guard time

The objects at index 100CH and 100DH include the guard time in milli-seconds and the life time factor. The life time factor multiplied with the guard time gives the live time for the Node Guarding Protocol. Default value = 0.

Unsigned16

Guard Time	
Byte 0	Byte 1
2^7 to 2^0	2^{15} to 2^8

8.12 Object 100Dh: Life time factor

The life time factor multiplied with the guard time gives the life time for the node guarding protocol. Default value = 0.

Unsigned8

Life Time Factor
Byte 0
2^7 to 2^0

8.13 Object 100Eh: COB-ID guarding protocol

The identifier is used for the node guarding and the life guarding procedure.

Unsigned32

MSB LSB

31	30	29	28-11	10-0
reserved		0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	11 bit Identifier

Bit 10 - 0 = 11 bit identifier, value = 700h + Node-ID

8.14 Object 1010h: Store parameters

This object supports the saving of parameters in non volatile memory (EEPROM).

Index	Sub-Index	Comment	Type
1010h	0	largest supported Sub-Index	Unsigned8
	1	save all parameters	Unsigned32

Sub-Index0 (only read): The entry at sub-index 0 contains the largest Sub-Index that is supported. Value = 1.

Sub-Index1: Contains the save command.

Unsigned32

MSB LSB

Bits	31-2	1	0
Value	= 0	0	1

By read access the device provides information about its saving capability.

Bit 0 = 1, the device saves parameters only on command. That means, if parameters have been changed by the user and no "Store Parameter Command" had been executed, at the next power on, the parameters will have there old values.

In case of write access the device stores the parameters to the non volatile memory. This procedure takes approx. 3s. In this time the measuring system isn't accessible at the bus.

In order to avoid storage of parameters by mistake, storage is only executed when a specific signature is written to the object. The signature is "save".

Unsigned32

MSB LSB

e	v	a	s
65h	76h	61h	73h

On reception of the correct signature, the device stores the parameters. If the storing failed, the device responds with abort domain transfer, error class 6, error code 6 (hardware fault). See also object 6503h.

If a wrong signature is written, the device refuses to store and responds with abort domain transfer, error class 8, error code 0.

8.15 Object 1018h: Identity Object

[8] This object provides general identification information of the CANopen device.

Index	Sub-Index	Comment	Type
1018h	0	highest sub-index supported	Unsigned32
	1	Vendor-ID	Unsigned32
	2	Product-Code	Unsigned32
	3	Order-No.	Unsigned32
	4	Serial-No.	Unsigned32

Sub-index0: The entry at sub-index 0 contains the largest Sub-Index that is supported: Value = 4.

Sub-index1: Contains the Vendor-ID of the manufacturer. The Vendor-ID for TR-Electronic is 212d = 0xD4h.

Sub-index2: Provides information about the product code with the associated device profile.

Sub-index3: Provides information about the order number.

Sub-index4: Provides information about the serial number.

[8] available only in case of LMP-30

9 Parameterization and configuration

9.1 Standardized encoder profile area (CiA DS-406)

Each encoder shares the dictionary entries from 6000h to 65FFh. These entries are common to encoders.

The overview of all common entries is shown below:

M = Mandatory
C2 = Device class C2

Index (h)	Object	Name	Data length	Attr.	C2	Page
Parameter						
[1)] 6000	VAR	Operating parameters	Unsigned16	rw	M	54
[2)] 6001	VAR	Measuring units per revolution	Unsigned32	rw	M	54
[2)] 6002	VAR	Total measuring range in measuring units	Unsigned32	rw	M	55
[1)] 6003	VAR	Preset value	Unsigned32	rw	M	56
6004	VAR	Position value	Unsigned32	ro	M	56
[1)] 6200	VAR	Cyclic timer	Unsigned16	rw	M	57
Diagnostics						
6500	VAR	Operating status	Unsigned16	ro	M	57
6501	VAR	Single-Turn resolution	Unsigned32	ro	M	57
6502	VAR	Number of distinguishable revolutions	Unsigned16	ro	M	58
6503	VAR	Alarms	Unsigned16	ro	M	59
6504	VAR	Supported alarms	Unsigned16	ro	M	60
6505	VAR	Warnings	Unsigned16	ro	M	60
6506	VAR	Supported warnings	Unsigned16	ro	M	60
6507	VAR	Profile and software version	Unsigned32	ro	M	61
6508	VAR	Operating time	Unsigned32	ro	M	61
6509	VAR	Offset value	Signed32	ro	M	61
650A	ARRAY	Manufacturer offset value	Signed32	ro	M	61
650B	VAR	Serial number	Unsigned32	ro	M	61

Table 9: Encoder profile area

[1)] is immediately active after a write command and is stored in the EEPROM durably

[2)] is only actively and stored durably, if the object **"1010, Store parameters"** is executed

9.1.1 Object 6000h - Operating parameters

The Operating Parameters contain the functions for code sequence and scaling function control.

Unsigned16

Bit	Function	Bit = 0	Bit = 1
0	Code Sequence	increasing	decreasing
1	Reserved for further use		
2	Scaling function control	disabled	enabled
3 - 15	Reserved for further use		

Code sequence:
The code sequence defines whether increasing or decreasing position values are output when the measuring system shaft rotates clockwise or counter clockwise as seen on the shaft. For linear measuring systems it means increasing or decreasing position values to the end of the rod.

Scaling function control:
With the scaling function the measuring system numerical value is converted in software to change the physical resolution of the measuring system.
The parameters "Measuring units per revolution" and "Total measuring range in measuring units" are the scaling parameters. The scaling function bit is set in the operating parameters. If the scaling function bit is cleared, the scaling function is disabled and the two parameters return to their standard values.
Before writing the "Measuring units per revolution" and "Total measuring range in measuring units" to the measuring system, the scaling function bit has to be set.
After writing the parameters, the Store Parameter command has to be executed to save the new parameter values.

9.1.1.1 Object 6001h – Measuring units per revolution

The parameter "Measuring units per revolution" sets the number of steps per revolution.

Unsigned32

Measuring units per revolution			
Byte 0	Byte 1	Byte 2	Byte 3
2^{7} to 2^{0}	2^{15} to 2^{8}	2^{23} to 2^{16}	2^{31} to 2^{24}

lower limit	1 step / revolution
upper limit	8192 steps per revolution (max. value see nameplate)
default	**4096**

Linear measuring system: Value = “1”, unchangeable

9.1.1.2 Object 6002h - Total measuring range in measuring units

⚠ WARNING

NOTICE

Danger of personal injury and damage to property exists if the measuring system is restarted after positioning in the de-energized state by shifting of the zero point!

If the number of revolutions is not an exponent of 2 or is >4096, it can occur, if more than 512 revolutions are made in the de-energized state, that the zero point of the multi-turn measuring system is lost!

- Ensure that the ***Number of revolutions*** for a multi-turn measuring system is an exponent of 2 of the group 2^0, 2^1, 2^2…2^{12} (1, 2, 4…4096).

  or

- Ensure that every positioning in the de-energized state for a multi-turn measuring system is within 512 revolutions.

The parameter "Total measuring range in measuring units" sets the number of steps about the total measuring range.

Unsigned32

Total measuring range in measuring units			
Byte 0	Byte 1	Byte 2	Byte 3
2^7 to 2^0	2^{15} to 2^8	2^{23} to 2^{16}	2^{31} to 2^{24}

Rotative measuring system:

lower limit	16 steps
upper limit	33554432 steps (25 bit)
default	**16777216**

The actual upper limit for the Total measuring range in measuring units to be entered is dependent on the measuring system version and can be calculated with the formula below. As the value "0" is already counted as a step, the end value = Total measuring range in measuring units – 1.

Total measuring range in measuring units = Steps per revolution * Number of revolutions

To calculate, the parameters ***Steps per revolution*** and the ***Number of revolutions*** can be read on the measuring system nameplate.

Linear measuring system:

lower limit	1 step
upper limit	16 777 216 steps (24 bit)

Standard value:
The given measuring length on the rating plate multiplied with 100 corresponding to the resolution of 0.01 mm or multiplied with 200 corresponding to the resolution of 0.005 mm

$$\text{Total measuring range in measuring units} = \frac{\text{Measuring length}}{\text{Resolution in mm}}$$

9.1.2 Object 6003h - Preset value

⚠ WARNING

NOTICE

Risk of injury and damage to property by an actual value jump when the Preset adjustment function is performed!

- The preset adjustment function should only be performed when the measuring system is at rest, otherwise the resulting actual value jump must be permitted in the program and application!

The Preset Function can be used to adjust the measuring system to any position value within a range of 0 to measuring length in increments –1.
The output position value is set to the parameter "Preset value" when writing to this object.

Unsigned32

Preset value			
Byte 0	Byte 1	Byte 2	Byte 3
2^7 to 2^0	2^{15} to 2^8	2^{23} to 2^{16}	2^{31} to 2^{24}

9.1.3 Object 6004h - Position value

The object 6004h "Position value" defines the output position value for the communication objects 1800h and 1802h.

Unsigned32

Position value			
Byte 0	Byte 1	Byte 2	Byte 3
2^7 to 2^0	2^{15} to 2^8	2^{23} to 2^{16}	2^{31} to 2^{24}

9.1.4 Object 6200h - Cyclic timer

Defines the parameter "Cyclic timer". A Cyclic transmission of the position value is set, when the cyclic timer is programmed > 0. Values between 1 ms and 65535 ms can be selected. Default value = 0.

e.g.: 1 ms = 1 h
256 ms = 100 h

When the measuring system is started with the NODE START Command and the value of the cyclic timer is > 0, the 1st transmit PDO (object 1800h) transmit the measuring system position.

9.1.5 Measuring system diagnostics

9.1.5.1 Object 6500h - Operating status

This object contains the operating status of the measuring system. It gives information on measuring system internal programmed parameters.

Unsigned16

Bit	Function	Bit = 0	Bit = 1
0	Code Sequence	increasing	decreasing
1	Reserved for further use		
2	Scaling function control	disabled	enabled
3 - 15	Reserved for further use		

9.1.5.2 Object 6501h - Single-Turn resolution, rotative

The object 6501h contains the number of measuring steps per revolution which can be output by the measuring system.

Unsigned32

Single-Turn resolution			
Byte 0	Byte 1	Byte 2	Byte 3
2^7 to 2^0	2^{15} to 2^8	2^{23} to 2^{16}	2^{31} to 2^{24}

Standard value: 4096 = 1000h steps per revolution (depending on capacity-marked on nameplate), if no scaling.

When the scaling function is enabled (object 6000h), the value is the programmed number of steps per revolution.

9.1.5.3 Object 6501h - Measuring step, linear

For linear measuring systems object 6501h indicates the measuring step that is output by the measuring system. The measuring step is given in nm (0.001µm).
E.g.: 1µm = 00 00 03 E8 h

Unsigned32

Measuring step			
Byte 0	Byte 1	Byte 2	Byte 3
2^7 to 2^0	2^{15} to 2^8	2^{23} to 2^{16}	2^{31} to 2^{24}

Standard value: 2710 h = 10 000 = 0.01 mm

9.1.5.4 Object 6502h - Number of distinguishable revolutions

This object contains the number of distinguishable revolutions that the measuring system can output.

For a Multi-Turn measuring system the number of distinguishable revolutions and the Single-Turn resolution gives the measuring range according to the formula below. The maximum number of distinguishable revolutions is 65.536 (16 bits).

Measuring range = Number of distinguishable revolutions x Single-Turn resolution

Standard value: 4096 = 1000h revolutions (depending on capacity - marked on rating plate), if no scaling.

When scaling function is enabled (object 6000h), the value is the programmed number of revolutions.

Linear measuring system: Value = “1”, unchangeable

9.1.5.5 Object 6503h - Alarms

Additionally to the emergency message, object 6503h provides further alarm messages. An alarm is set if a malfunction in the measuring system could lead to an incorrect position value. If an alarm occurs, the according bit is set to logical high until the alarm is cleared and the measuring system is able to provide an accurate position value.

Unsigned16

Bit	Function	Bit = 0	Bit = 1
0	Position error	No	Yes
1	Reserved for further use		
2	Reserved for further use		
3	Reserved for further use		
4	Reserved for further use		
5	Reserved for further use		
6	Reserved for further use		
7	Reserved for further use		
8	Reserved for further use		
9	Reserved for further use		
10	Reserved for further use		
11	Reserved for further use		
12	EE-PROM Error	OK	Error
13	Parameter Error	OK	Error
14	Manufacturer specific functions		
15	Manufacturer specific functions		

Position error

The bit is set, if the rotative measuring system detects a malfunction of the system or no magnet is detected in case of a linear measuring system.

EE-PROM error, rotative only

The measuring system detects a wrong checksum in the EEProm area or a write process into the EEProm could not be finished successfully.

Parameter Error, rotative only

The value of a transmitted parameter is out of range. The check will be done after receiving the Store Parameter command.

9.1.5.6 Object 6504h - Supported alarms

Object 6504h contains the information on supported alarms by the measuring system.

Unsigned16

Bit	Function	Bit = 0	Bit = 1
0	Position error	No	Yes
1	Reserved for further use		
2	Reserved for further use		
3	Reserved for further use		
4	Reserved for further use		
5	Reserved for further use		
6	Reserved for further use		
7	Reserved for further use		
8	Reserved for further use		
9	Reserved for further use		
10	Reserved for further use		
11	Reserved for further use		
12	EE-PROM Error	No	Yes
13	Parameter Error	No	Yes
14	Manufacturer specific functions		
15	Manufacturer specific functions		

9.1.5.7 Object 6505h - Warnings

This object is not supported.
By read access the value is always "0".

9.1.5.8 Object 6506h - Supported warnings

This object is not supported.
By read access the value is always "0".

9.1.5.9 Object 6507h - Profile and software version

This object contains in the 1st 16 bits the profile version which is implemented in the measuring system. It is combined to a revision number and an index.

e.g.:	Profile version:	1.40	
	Binary code:	0000 0001	0100 0000
	Hexadecimal:	1	40

The 2nd 16 bits contain the software version which is implemented in the measuring system. Only the last 4 digits are available.

e.g.:	Software version:	5022.01	
	Binary code:	0010 0010	0000 0001
	Hexadecimal:	22	01

The complete software version is contained in object 100Ah, see page 49.

Unsigned32

Profile version		Software version	
Byte 0	Byte 1	Byte 2	Byte 3
2^7 to 2^0	2^{15} to 2^8	2^7 to 2^0	2^{15} to 2^8

9.1.5.10 Object 6508h - Operating time

This object is not supported.

The operating time function is not used the operating time value is set to the maximum value (FF FF FF FF h).

9.1.5.11 Object 6509h - Offset value

This object contains the offset value calculated by the preset function. The offset value is stored and can be read from the measuring system.

9.1.5.12 Object 650Ah - Manufacturer offset value

This object is not supported.
By read access the offset value is "0".

9.1.5.13 Object 650Bh - Serial number

This object is not supported.

The parameter serial number is not used the value is set to maximum value FF FF FF FF h.

10 Emergency Message

Emergency messages are triggered by the occurrence of a device internal malfunction and are transmitted from the concerned application device to the other devices with highest priority.

Emergency Message								
Byte	0	1	2	3	4	5	6	7
Contents	Emergency Error Code Object 1003h, Byte 0-1		Error Register Object 1001h	0	0	0	0	0

COB-Identifier = 080h + Node-ID

If the measuring system detects an internal error, an emergency message will be transmitted with the error code of object 1003h (pre-defined error field) and the error register object 1001h. Additionally to the emergency object the according bit in the Alarm object 6503h is set.

If the error disappears, the measuring system transmits an emergency message with error code "0" (reset error / no error) and error register "0".

11 Transmission of the measuring system position value

Before the measuring system position can be transferred the measuring system has to be started with the “Node Start” command.

Node-Start Protocol

COB-Identifier = 0	
Byte 0	Byte 1
1	Node-ID

Node Start command with the Node-ID of the measuring system (slave) starts only this device.

Node Start command with **Node-ID = 0** starts all slaves connected to the bus.

After the Node Start command the measuring system transmit the position value one time with the COB-ID of object 1800h.

Now the measuring system position value can be transmitted in different ways:

1. Asynchronous Transmission

The 1st transmit PDO (object 1800h) transmit the position value of the measuring system. The cyclic time is defined by the value of the cyclic timer (object 6200H). This transmission starts automatically after the Node Start command and the value of the cyclic timer is > 0.

The default value of the COB-ID is 180h + Node-ID.

Object	Function Code	COB-ID	Index Communication Parameter
PDO1 (tx)	0011bin	181h – 1FFh	1800h

In order to stop the transmission of the measuring system position temporarily, the output can be interrupted by timer value = 0, in object 6200h.

2. Cyclic Transmission

The 2nd transmit PDO (object 1802) transmit the position value of the measuring system on request (remote / sync), non-recurrent triggering.

- The measuring system receives a remote frame with the COB-ID (default value 280h + Node-ID)

Object	Function Code	COB-ID	Index Communication Parameter
PDO2 (tx)	0101bin	281h – 2FFh	1802h

- The measuring system receives a sync telegram with the COB-ID (default value 080h) defined in object 1005h. All slaves with this SYNC-COB-ID will transmit the position value.

Object	Function Code	COB-ID	Index Communication Parameter
SYNC	0001bin	80h	1005

12 Causes of faults and remedies

12.1 Optical displays

Green LED	Cause	Remedy
Off	Voltage supply absent or was fallen below	- Check voltage supply wiring - Does the voltage supply is in the permitted range?
	Bus hood not correctly connected and screwed on	Check bus hood for correct fitting
	Bus hood defective	Replace bus hood
	Hardware fault, measuring system defective	Replace measuring system
Flashing	No allocation to a master - exchanged CAN lines - interrupted CAN lines - duplicated NODE-ID in the network	- Adjusted baud rate must agree with the master baud rate! - Check CAN lines - Make sure that each NODE-ID is present only once in the network
On	Measuring system ready for operation	-

12.2 SDO Error codes

In the case of an error (SDO response CCD = 0x80) the data field contains a 4-byte error code. By the measuring system the following error codes are supported:

Error code	Meaning	Remedy
0x0600 0006	EE-PROM error	Possibly shut-off measuring system voltage then switch on again. If the error recurs despite this measure, the measuring system must be replaced.
0x0601 0000	Unsupported access to an object	Check which attribute for the corresponding object is valid: - rw: read- and write access - wo: write only access - ro: read only access - Const: read only access Overview of the objects see Table 8 and Table 9 on page 45 and 53.
0x0609 0011	Sub-index does not exist	Check which sub-indices the corresponding object supports.
0x0800 0000	General error	Wrong signature written when storing the parameters, see Object 1010h: Store parameters, page 51.

Table 10: SDO Error codes

12.3 Emergency Error codes

Emergency objects are triggered by the occurrence of a device internal error situation, transmission format see chapter “Emergency Message”, page 62.

The error indication is carried out about the objects

- Error register 0x1001, page 46 and
- Pre-defined error field 0x1003, page 47

12.3.1 Object 1001h: Error register

The error register displays bit coded the error state of the measuring system. Also several errors at the same time can be displayed by a set bit. The error code of the error occurred last is stored in object 0x1003, sub-index 1, the number of errors in sub-index 0. An error is signaled at the moment of the occurrence by an EMCY-message. By reading of the object 1001h the error stored last in object 0x1003, sub-index 0, is cleared. Each further read request clears a further error from the list. With the clearing of the last error the error register is set back and an EMCY-message with error code "0x000" is transferred.

Bit	Meaning
0	generic error, rotative measuring systems only
1	0
2	0
3	0
4	0
5	device profile specific
6	0
7	0

12.3.2 Object 1003h: Pre-defined Error field, bits 0 – 15

About the Emergency object only the error occurred last is indicated. For each EMCY-message which could be deleted an EMCY-report with error code "0x0000" is transmitted. The result can be taken from object 0x1003. If no more error is present, the error register indicates also no more error.

The error list in object 0x1003 can be deleted in different ways:

1. Writing a “0” to sub-index 0 in object 0x1003
2. Execution of the NMT-service “Reset Communication”, command 0x82
3. Reading the object 0x1001, after the last error was deleted

Error code	Meaning	Remedy
0x0000	reset error / no error	-
0x8100	Communication errors, which are triggered by the CAN-controller.	- Reset node with command 0x81, after that start the node again with command 0x01. - Switch off; switch on again the supply voltage of the measuring system.

Table 11: Emergency Error codes

12.4 Alarm messages

About the object 6503h additionally to the EMCY-message further alarm messages are output. The corresponding error bit is deleted, if the error is present no more.

Error	Cause	Remedy
Bit 0 = 1, Position error	Failure of scanning elements in the measuring system Measuring system has detected no magnet.	**Rotative measuring systems:** Possibly shut-off measuring system voltage then switch on again. If the error recurs despite this measure, the measuring system must be replaced. **Linear measuring systems:** Slide magnet into measuring range.
Bit 12 = 1, EE-PROM error	Memory area in internal EE-PROM defective	Possibly shut-off measuring system voltage then switch on again. If the error recurs despite this measure, the measuring system must be replaced.
Bit 13 = 1, Parameter error	Programmed parameter out of range.	Check min. and max. values of each parameter.

12.5 Other faults

Fault	Cause	Remedy
Position skips of the measuring system	Strong vibrations	Vibrations, impacts and shocks, e.g. on presses, are dampened with "shock modules". If the error recurs despite these measures, the measuring system must be replaced.
	Electrical faults EMC	Perhaps isolated flanges and couplings made of plastic help against electrical faults, as well as cables with twisted pair wires for data and supply. Shielding and wire routing must be performed according to the respective field-bus system construction guidelines.
	Extreme axial and radial load on the shaft or a defective scanning unit.	Couplings prevent mechanical stress on the shaft. If the error still occurs despite these measures, the measuring system must be replaced.