POSITAL
FRABA

ABSOLUTE ROTARY ENCODER WITH CAN-BUS INTERFACE
USER MANUAL

Alteration of Specifications reserved

Technical specifications, which are described in this manual, are subject to change due to our permanent strive to improve our products.

1. Introduction

This manual describes the implementing and configuration of an absolute rotary encoder with CANopen interface. The device fullfills the requirements of a CANopen device regarding the device specification DS406 of the CANopen user group.

1.1 Absolute rotary encoder

The basic principle of an absolute rotary encoder is the optical sampling of a transparent code disc which is fixed with the driving shaft.

The absolute rotary encoder has a maximum resolution of 65536 steps per revolution (16 Bit). The Multi-Turn version can detect up to 16384 revolutions (14 Bit). Therefore the largest resulting resolution is 30 Bit = 2^{30} = 1.073.741.824 steps. The standard Single-Turn version has 12 Bit, the standard Multi-Turn version 24 Bit.

For further information about the function principle or the setup of a CANopen network please refer http://www.posital.com/products/encoder_abc/encoder_abc.html

Open functions. The following modes can be programmed and enabled or disabled:
- Polled Mode
- Cyclic Mode
- Sync Mode

The protocol supports the programming of the following additional functions:
- Code sequence (Complement)
- Resolution per revolution
- Total revolutions
- Preset value
- Two limit switches
- Baudrate
- Node number
- velocity

The general use of absolute rotary encoders with CAN-Bus interface using the CAN Open protocol is guaranteed.

1.2 CANopen technology

CAN stands for Controller Area Network and was developed by the company Bosch for applications within the automobile area. In the meantime CAN has become increasingly used for industrial applications. CAN is a multi-masterable system, i.e. all users can access the bus at any time as long as it is free. CAN doesn?t operate with addresses but with message identifiers. Access to the bus is performed according to the CSMA/CA principle (carrier sense multiple access with collision avoidance), i.e. each user listens if the bus is free, and if so, is allowed to send messages. If two users attempt to access the bus simultaneously, the one with the highest priority (lowest identifier) receives the permission to send. Users with lower priority interrupt their data transfer and will access the bus when it is free again. Messages can be received by every participant. Controlled by an acceptance filter the participant accepts only messages that are intended for it.

CANopen

Transmission Technology:	Two-core cable
Baud rates:	20 kBaud up to 1 MBaud
Participants:	maximum 127
Cable Length:	30 m for 1 MBaud
	5000 m for 20 kBaud

The data communication is done via message telegrams. In general, telegrams can be split in a COB-Identifier and up to 8 following bytes. The

COB-Identifier, which determines the priority of the message, is made from the function code and the node number.

The node number is uniquely assigned to each user. With a FRABA rotary encoder this number is assigned with by numerical coded turn switches in the connection cap. The function code varies according to the type of message transmitted:

- Administrative messages (LMT, NMT)
- Service data objects (SDOs)
- Process data Objects (PDOs)
- pre-defined messages (synchronization, emergency messages)

PDOs (Process Data Objects) are needed for real time data exchange. Since this messages possess a high priority, the function code and therefore the identifier are low. SDOs (service data objects) are necessary for the bus node configuration (e.g. transfer of device parameters). Because these message telegrams are tranferred acyclicly (usually only while powering up the network), the priority is low.

FRABA rotary encoders with CANopen interface support all CANopen functions. The following operating modes can be programmed:

- Polled mode:
  The position value is only given upon request

- Cyclic Mode:
  The position value is written cyclically (interval adjustable) to the bus

- Sync mode:
  After receiving a sync message by the host, the encoder answers with the current process value. If a node is not required to answer after each sync message, a parameter sync counter can be programmed to skip a certain number of sync messages before answering again

- Change of state mode:
  The position value is transferred when changing

Further functions (direction of rotation, resolution,etc..) can be parameterized. FRABA rotary encoders correspond with the class 2 profile for encoder (DSP 406), whereby the characteristics of rotary encoders with CANopen interface are defined. The link to the bus is made by terminal blocks in the connection cap. In additon, the node number and Baud rate are set with turn switches. For configuration and parameterization various software tools are available from different providers. With the help of the provided EDS file (electronic datasheet) simple line-up and programming are possible.

1.3 CAN Communication Reference Model

The communication concept can be described similar to the ISO -OSI Reference Model:

Device A		Device B		Device C		Device X

ISO/OSI Layer 7: CAL

NMT	DBT	LMT	CMS

ISO/OSI Layer 2: Data Link Layer

ISO/OSI Layer 1: Physical Layer

CAN Bus
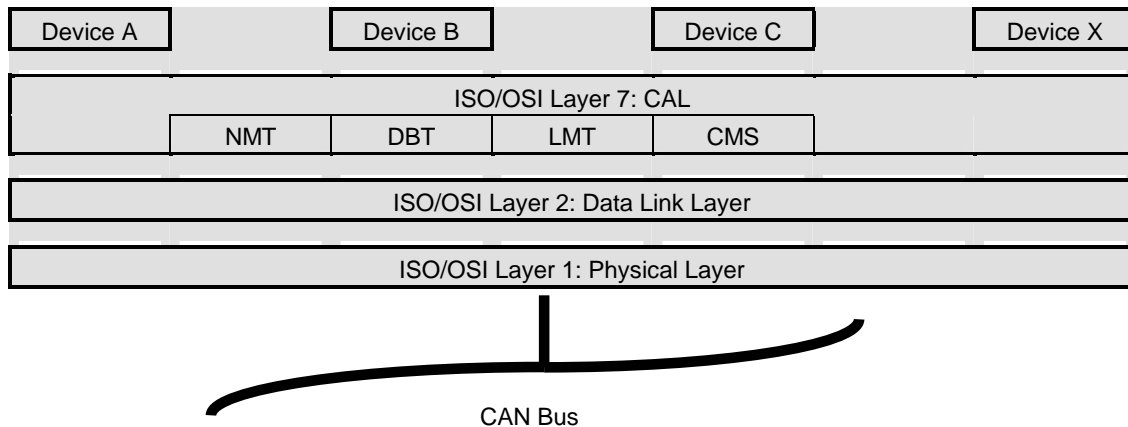
The communication model* supports synchronous and asynchronous messages. With respect to the functionality four different message objects are provided:

Administrational Messages (LMT, NMT)
Service Data Messages (SDO)
Process Data Messages (PDO)
Pre-defined Messages (Synchronisation and Emergency Messages)

Further information is available at:
CAN in Automation (CiA) International Users and Manufacturers Group e.V.
Am Weichselgarten 26
D-91058 Erlangen

(*) Reference: CAN Application Layer for Industrial Applications
    CiA Draft Standard 201 ... 207, Version 1.1
    CAL-based Communication Profile for Industrial Systems
    CiA Draft Standard 301

1.4 Definitions

CAN Controller Area Network

CAL CAN Application Layer

CMS CAN 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-Identfier. Identifies a COB uniquely in a Network. The identifier determines the
priority of that COB.

LMT Layer Management. One of the service elements of the application layer 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 layer in the CAN
Reference Model. It performs initialisation, configuration and error handling in a CAN network.

SDO Service Data Object. A data object with low priority to configure a CAN node.

PDO Process Data Object. A data object with high priority to transmit data in synchronous and
asynchronous modes.

Additionally, following abbreviations are used in the manual:

APV Absolute Position Value

CW Clockwise. Turning direction as seen on shaft.

CCW Counterclockwise. Turning direction as seen on shaft.

FC Function code. It determines the kind of message, which is sent across the CAN network.

NN Node number. It determines uniquely the CAN device.

PV Preset value

PCV Process value

2. Installation

2.1 Electrical Connection

The rotary encoder is connected by three cables. The power supply is achieved with a two-wire connection cable through one PG 9. Each one of the twisted-pair and shielded bus lines are guided in and out through two PG 9 on the right side (as seen on clamps)

Instructions to mechanically install and electrically connect the angular encoder

Do not remove or mount the connection cap while the encoder is under power!

Do not stand on the encoder!

Do not adapt the driving shaft additionally!

Avoid mechanical load!

Do not adapt the housing additionally!

Clamp	Description
⊥	Ground
+	24 V Supply voltage
-	0 V Supply voltage
CG	CAN Ground
CL	CAN Low
CH	CAN High
CG	CAN Ground
CL	CAN Low
CH	CAN High
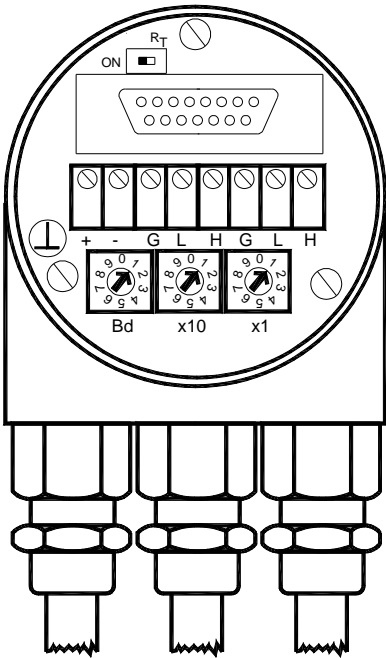
Fig. 1 Connection cap inside

BCD coded rotary switches	
	Dvice address 0...89
x1	Setting CAN-node number
x10	**Adress reserved 90…99**
Bd	Setting of the baud-rate
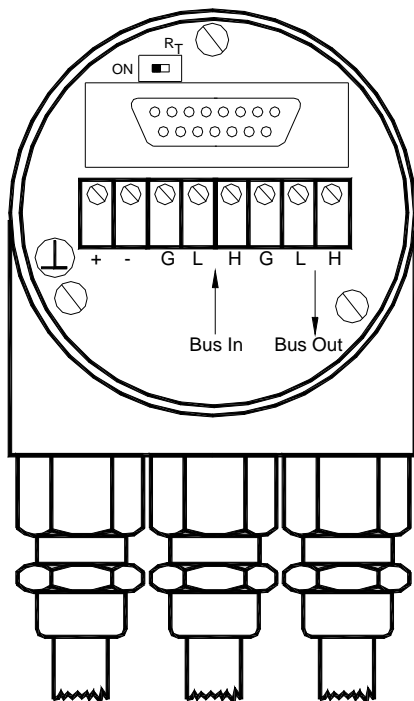
Fig. 3 Connection cap bus in and bus out
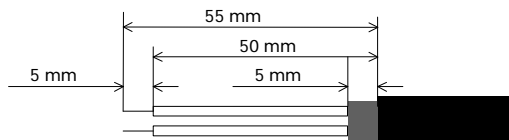
Fig. 4 Cable preparation
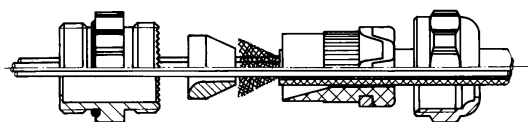
Fig. 2 Cable connection

2.1.1 Bus connection

The connection cap fulfills the function of a T-coupler. From there the wiring must be done according to the drawing on the left side. Please note the assignment of incoming and outgoing bus signals.

> ⚠ **An activated bus termination resistor will lead into a separation of bus in and bus out signals!**

2.1.2 Cable connection

Remove screw, sealing and cone from the cable gland. Remove 55 mm of the sheat and 50 mm of the shielding. About 5 mm of the wires should be de-isolated. Put screw, and sealing on the cable. The cone should be mounted under the shielding according to the figure 3. Put the whole cable into the cable gland and tighten the screw.

2.1.3 Bus Termination

If the encoder is connected at the end or beginning of the bus the termination resistor must be switched on. The termination resistor is switched on when the switch is in the ON position.

> ⚠ **Separation of Bus In and Bus Out signals if termination resistor is activated.**

There is a resistor provided in the connection cap, which must be used as a line termination on the last device.

Resistor:
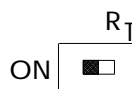
Last Device   Device X

2.2 Bus address

The setting of the node number is achieved turn-switches in the connection cap. Possible (valid) addresses lie between 0 and 89 whereby every address can only be used once. 2 LEDs on the backside of the connection cap show the operating status of the encoder.

⚠️ **The CANopen Encoder adds internal 1 to the adjusted device address.**

2.2.1 Setting of the node number
The setting of the node number is achieved by two turn-switches in the connection cap. The customer can easily remove the connection cap for installation by removing two screws at the backside of the encoder. The meaning and the positioning of the two turn-switches you can see in figure 1.

If the device has a connector or a cable exit instead of a connection cap the node number can only be adjusted via SDO objects. The default node number is in this case 32. Please regard point 4.6 for further information of setting the node number via SDO objects.

2.3 Setting of the baudrate
The adjusting of the baudrate is achieved by one turn switch in the connection cap.The following baudrates are possible:

Protocol Definition via BCD address switches	
x1	**Device address 97**
x10	Automatic protocol selection according to kind of connection cap
x1	**Device address 98**
x10	Protocol selection according to DS301-V3
x1	**Device address 99**
x10	Protocol selection according to DS301-V4

Tab. 1 Protocol definition via BCD turn switches

Baudrate in kBit/s	BCD coded rotary switches
20	0
50	1
100	2
125	3
250	4
500	5
800	6
1000	7
reserved	8..9

Tab. 2 Assignment baudrate and turn switch

If the device has a connector or a cable exit instead of a connection cap the node number can only be adjusted via SDO objects. The default baudrate is 20 kBaud. Please regard point 4.7 for further information about setting of the baudrate via SDO objects.

2.4 Meaning of the LEDs in the connection cap
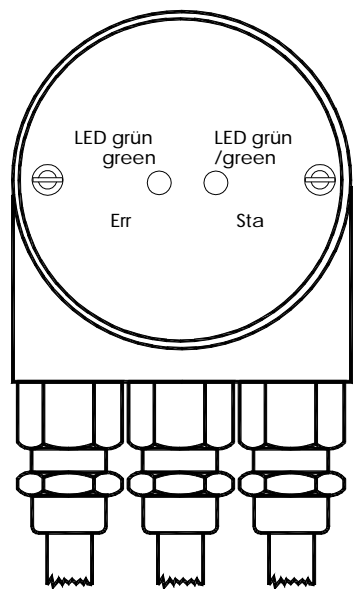
Fig. 5 Backside connection cap

Err Green LED	Sta Green LED	Meaning
off	off	No power supply
off	on	Encoder is ready, Boot Up message not sent (no further device on network, wrong baud rate) or encoder in prepared status
flashing	on	Boot Up message sent, device configuration is possible
on	on	Normal operation mode, Encoder in Operational Status

Tab. 3 Meaning status LED's

2.5 Troubleshooting

2.5.1 Power on – Encoder doesn't respond

Problem:
The bus is active but the installed encoder transmitted no boot up message.

Possible solution:
- switch of the PLC
- remove the connection cap of the encoder
- check the 2 turn-switches for th baudrate
- Assemble the connection cap
- power on

2.5.2 Malfunction of the position value during transmission

Problem:
During the transmission of the position value occasional malfunctions occurs. The CAN bus can be temporarily in the bus off state also.

Possible solution:
Check, if the last bus node has switched on the terminal resistor. If the last bus node is an encoder the terminal resistor is suited in the connection cap..

2.5.3 Too much ERROR-Frames

Problem:
The bus load is too high in case of too much error frames.

Possible solution:
Check if all bus node has the same baudrate. If one node has another baudrate error frames are produced automatically. The setting of the baudrate is described in this manual under 2.2 and 4.6.

2.5.4 Limit switches without function

Problem:
The encoder didn't transmit the bits for the limit switches.

Possible solution:
The limit switch functionality has to be activated once. Please follow the descripting you can find at 4.5.

2.5.5 Encoder without connection cap, Version C5 und C6

Notice: The changing of baudrate and node number are only valid after a new power up, NMT Reset or the store parameters command.

3. Device Configuration

3.1. CANopen data transmission

The data transmission in the CAN network is realised by message telegrams. Basically, these telegrams can be divided into the COB-ID and 8 following bytes as shown in the table below:

COB-ID	Command	Index		Subindex	Service-/Process- Data			
11 Bit	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
		Low	High		Low	→	→	High

3.1.1 The COB-ID

The 11 Bit of COB-Identifier is built as follows:

10	9	8	7	6	5	4	3	2	1	0		
Function code				Node number								
X	X	X	X	X	X	X	X	X	X	X		X: free selectable

The COB-Identifier determines uniquely the message object. It is built by the function code, identifying the message class and the node number, which determines the absolute encoder.

The node number can be adjusted by 2 rotary switches in the connection cap or optionally on customer request by a SDO.

Following function codes are available: (rx) and (tx) as seen by the master !

Object	Function Code (Binary)	Result. COB-ID	Priority Class*
NMT	0000	0	0
SYNC	0001	128	0
Emergency	0001	129 - 255	0,1
PDO (rx)	0011	385 - 511	1,2
PDO (tx)	0100	513 - 639	2
PDO (rx)	0101	641 - 767	2,3
PDO (tx)	0110	769 - 895	3,4
SDO (rx)	1011	1409 - 1535	6
SDO (tx)	1100	1537 - 1663	6,7

Tab. 4 Overview priority of the CANopen objects

*Priority: 0 = highest priority, 7 = lowest priority

3.1.2 The Command Byte

The command byte contents the kind of telegram which is sent across the CAN network. One divides three kinds of telegrams: a Set-Parameter-Telegram (Domain Download), a Request-Telegram (Domain Upload) and Warnings.

The Set-Parameter-Telegram is used to send parameter data to the encoder (node) for configuration.

The Request-Telegram is used by the master to read back stored parameters from a node.

Warnings are sent by the absolute rotary encoder to the master, if a sent telegram cannot be processed accordingly.

Command	Function	Telegram	Description
22h	Domain Download	Request	Parameter to encoder
60h	Domain Download	Confirmation	Parameter received
40h	Domain Upload	Request	Parameter request
43h, 4Bh, 4Fh (*)	Domain Upload	Reply	Parameter to Master
80 h	Warning	Reply	Transmission error

Tab. 5 Command description

(*)The value of the command byte depends on the data length of the called parameter:

Command	Data length	Data length
43h	4 Byte	Unsigned 32
4Bh	2 Byte	Unsigned 16
4Fh	1 Byte	Unsigned 8

Tab. 6 Data length against command byte

3.1.3 The Object Directory

The data transmission according to CAL is realised exclusively by object oriented data messages. The objects are classified in groups by an index record. Each index entry can be subdivided by sub-indices. The overall layout of the standard object dictionary is shown beside:

Index (hex)	Object
0000	not used
0001-001F	Static Data Types
0020-003F	Complex Data Types
0040-005F	Manufacturer Specific Data Types
0060-0FFF	Reserved for further use
1000-1FFF	Communication Profile Area
2000-5FFF	Manufacturer Specific Profile Area
6000-9FFF	Standardised Device Profile Area
A000-FFFF	Reserved for further use

Tab. 7 General object dictionary

Following objects according to the communication profile CAN OPEN (refer to DS 301) are implemented into the absolute rotary encoder:

Index	Object	Name	Data Length	Attr.
1000h	VAR	Device type	Unsigned32	const
1001h	VAR	error register	Unsigned8	ro
1002h	VAR	manufacturer status register	Unsigned32	ro
1003h	ARRAY	pre-defined error field	Unsigned32	ro
1004h		Reserved for compatibility reason		
1005h	VAR	COB-ID SYNC-message	Unsigned32	rw
1008h	VAR	device name	Vis-String	const
1009h	VAR	hardware version	Vis-String	const
100Ah	VAR	software version	Vis-String	const
100Bh		Reserved for compatibility reason		
1010h	VAR	Store parameters	Unsigned32	rw
1011h	VAR	Restor parameters	Unsigned32	rw

Tab. 8 Object dictionary according DS301

3.3.1 Manufacturer Specific Objects

Additionally, following manufacturer specific communication objects are implemented:

Index	Subindex	Object	Name	Data length	Attr.
1800h		RECORD	Communication parameter PDO 1		ro
1800h	0h	VAR	number of supp. entries	Unsigned 8	ro
1800h	1h	VAR	COB-ID used by PDO	Unsigned 32	rw
1800h	2h	VAR	transmission type	Unsigned 8	rw
1800h	3h	VAR	inhibit time	Unsigned 8	rw
1802h		RECORD	Communication parameter PDO 2		ro
1802h	0h	VAR	number of supp. entries	Unsigned 8	ro
1802h	1h	VAR	COB-ID used by PDO	Unsigned 32	rw
1802h	2h	VAR	transmission type	Unsigned 8	rw
1802h	3h	VAR	inhibit time	Unsigned 8	rw
2000h		VAR	process value	Unsigned 32	ro
2100h		VAR	operating parameters	Unsigned 16	rw
2101h		VAR	resolution/revolution	Unsigned 16	rw
2102h		VAR	total resolution	Unsigned 32	rw
2103h		VAR	preset value	Unsigned 32	rw
2104h		VAR	Limit switch, min.	Unsigned 32	rw
2105h		VAR	Limit switch, max.	Unsigned 32	rw
2200h		VAR	Cycle time	Unsigned16	rw
2300h		VAR	Store parameters	Unsigned32	wo

Tab. 9 Manufacturer specific object dictionary

Index	Subindex	Objekt	Name	Datenlänge	Attr.
3000h		VAR	Knotennummer	Unsigned 8	rw
3001h		VAR	Datenrate	Unsigned 8	rw

Tab. 10 Nodenumber and baudrate

The programmable communication objects and encoder parameters are explained in detail in the next chapter.

VAR:	Variable
RECORD:	Data field
ARRAY:	Data field
ro:	read only
rw:	read, write
wo:	write only

3.2 Operational Status

The absolute rotary encoder accesses the CAN network 4 s after power on in pre -operational status:

FC	NN	Comand	Index	Subindex	S-/P-Data	Description
1110	XXXXXXX					Boot-Up message

All values except the FC are hexadecimal

It is recommended, to set the parameters (see: 7.2 Programming) while the Encoder is in the pre-operational status. During this status activity on the network is low what makes it easier to prove the correctness of the sent/received SDOs. As it is not possible to send or receive PDOs in pre-operational status, stress for the Encoder will be reduced.

3.2.1 Status: Operational

To put one or all nodes in the operational state, following message is sent by the master:

FC	NN	Command	Index	Subindex	S-/P-Data	Description
0000 b	0 d	01 h	00			NMT-Start, all nodes
0000 b	0 d	01 h	NN			NMT-Start, NN

It is possible to put all the nodes in operational status (Index 0) or only one node (Index NN).

3.2.2 Status: Pre-Operational

To set one node in the Pre-Operational state the following telegram has to be transmitted from the master:

FC	NN	Command	Index	Subindex	S-/P-Data	Description
0000 b	0 d	80 h	NN			NMT-PreOp, NN

NN: node number

3.2.3 Reset of the absolute rotary encoder

If a node is not functioning well, it is recommended to perform a RESET:

FC	NN	Command	Index	Subindex	S-/P-Data	Description
0000 b	0 d	81 h	NN			NMT-Reset, NN

NN: node number

The notified Absolute Rotary Encoder accesses the bus in pre-operational status after resetting.

3.3 Transmission of the Actual Position

The process value is sent across the CAN network with the following telegram:

COB-ID	Process 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}

The COB-ID contains the node number and the according PDO(rx). By default the process value is sent with the function code PDO(rx) 0011 and as a response to the Sync-telegram with the function code PDO(rx) 0101.

4. Programming

The setting of parameters should be done always in pre-operational status. The monitoring of the sent and received messages becomes much easier.

It is important to follow the presented sequence of the parameter settings. If values of parameters are not changed then they can be skipped.

Following values are written in hexadecimal notation with the exception of the function code which value is given binary and the node number (decimal value).

Every parameter has a general description and an example.

4.1 Operating Parameters

As operating parameters the code sequence (Complement) can be selected and the limit switches can be turned on or off.

CMS	Index	Default value	Value range	Data length
SDO	2100h	0h	0h - Fh	Unsigned16

General parameter description

Master to Absolute Rotary Encoder: Set-Parameter

FC	NN	Command	Index		Subindex	Service/Process data			
SDO(tx)		Download	2100h			Byte 4	Byte 5	Byte 6	Byte 7
1100 b	1-90 d	22	00	21	00	**X**	00	00	00

X: Hex value of bit combination bit 0-2

The parameter code sequence (Complement) determines the counting direction, in which the output process value increases or decreases. The code sequence is determined by Bit 0 in Index 2100h:

Bit 0	Code sequence	Code
0	CW	increasing
1	CCW	increasing

Additionally, the two limit switches, Min. and Max. can be turned on or off in Index 2100h:

Bit 1	Limit switch, min.
0	turned off
1	turned on

Bit 2	Limit switch, max.
0	turned off
1	turned on

After a successful tramnsmission the encoder answered with the following confirmation telegram:

FC	NN	Command	Index		Subindex	Service/Process data			
SDO(rx)		Download	2100h			Byte 4	Byte 5	Byte 6	Byte 7
1011 b	1-90 d	60	00	21	00	00	00	00	00

4.1.1 Programming example: Operational parameter

Target: Absolute rotary encoder with direction CCW increasing and both limit switches disabled

Bitmatrix:

Bit 0 = 1   Direction increasing (CCW)

Bit 1 = 0   Limit switch min. disabled

Bit 2 = 0   Limit switch max. disabled

Result bitmatrix X = 01h

Nodenumber NN = 01

Master to Absolute Rotary Encoder: Set-Parameter

FC	NN	Command	Index		Subindex	Service/Process data			
SDO(tx)		Download	2100h			Byte 4	Byte 5	Byte 6	Byte 7
1100 b	01 d	22	00	21	00	**01**	00	00	00

Absolute Rotary Encoder to Master: Confirmation

FC	NN	Command	Index		Subindex	Service/Process data			
SDO(rx)		Download	2100h			Byte 4	Byte 5	Byte 6	Byte 7
1011 b	01 d	60	00	21	00	00	00	00	00

4.2 Resolution per Revolution

The parameter Resolution per Revolution is used to program the desired number of steps per revolution. Each value between 1 and 65536 can be realised.

CMS	Index	Default value	Value range	Data length
SDO	2101h	(*)	0h - 8000h	Unsigned16

(*) see: type sign

The following value range is valid for a resolution per revolution of 16 bit

CMS	Index	Default value	Value range	Data length
SDO	2101h	(*)	0h - 10000h	Unsigned32

(*) see: type sign

General parameter description

Master to Absolute Rotary Encoder: Set-Parameter

FC	NN	Command	Index		Subindex	Service/Process data			
SDO(tx)		Download	2101h			Byte 4	Byte 5	Byte 6	Byte 7
1100 b	1-90 d	22	01	21	00	**X**	**X**	**Y**	**Y**

X: desired resolution per revolution (>15 Bit)

Y: desired resolution per revolution (16 Bit)

If the desired value exceeds the hardware resolution of the encoder, the code will not be transmitted stepwise. So it is important, to keep the parameter in the possible value range.

After a successful tramnsmission the encoder answered with the following confirmation telegram:

FC	NN	Command	Index		Subindex	Service/Process data			
SDO(rx)		Download	2101h			Byte 4	Byte 5	Byte 6	Byte 7
1011 b	1-90 d	60	01	21	00	00	00	00	00

4.2.1 Programming example: Resolution per revolution

Target: Absolute rotary encoder with 4096 steps per revolution

Resolution per revolution: 4096 steps = 1000 h

Node Number NN = 1

Master to Absolute Rotary Encoder: Set-Parameter

FC	NN	Command	Index		Subindex	Service/Process data			
SDO(tx)		Download	2101h			Byte 4	Byte 5	Byte 6	Byte 7
1100 b	1-90 d	22	01	21	00	**X**	**X**	**Y**	**Y**

Absolute Rotary Encoder to Master: Confirmation

FC	NN	Command	Index		Subindex	Service/Process data			
SDO(rx)		Download	2101h			Byte 4	Byte 5	Byte 6	Byte 7
1011 b	1-90 d	60	01	21	00	00	00	00	00

4.3 Total resolution

This parameter is used to program the desired number of measuring units over the total measuring range. This value must not exceed the total resolution of the absolute rotary encoder, w hich is printed on the type plate of the encoder.

CMS	Index	Default value	Value range	Data length
SDO	2102h	(*)	0h - 4.000.000h	Unsigned32

(*) refer to: type plate of encoder

Attention:

Following formula letter will be used:

PGA   Physical total resolution of the encoder   (see type shield)

PAU   Physical resolution per revolution   (see type shield)

GA   Total resolution
     (customer parameter)

AU   Resolution per revolution
     (customer parameter)

If the desired resolution per revolution is less than the really physical resolution per revolution of the encoder, then the total resolution must be entered as follows:

Total resolution: $GA = \dfrac{(PGA * AU)}{PAU}, AU \leq PAU$ **Fig. 6 Calculation formula for total resolution**

Calculation example:

Customer handicap: AU = 2048,

Encoder type shield:

PGA=24 bit, PAU=12bit

$$GA = \frac{(16777216 * 2048)}{4096}$$

$$GA = 8388608$$

If the total resolution of the encoder is less than the physical total resolution, the parameter total resolution must be a multiple of the physical total resolution:

$$k = \frac{PGA}{GA}, k = \text{ganze Zahl}$$

General parameter description
Master to Absolute Rotary Encoder: Set-Parameter

FC	NN	Command	Index		Subindex	Service/Process data			
SDO(tx)		Download	2102h			Byte 4	Byte 5	Byte 6	Byte 7
1100 b	1-90 d	22	02	21	00	**X**	**X**	**X**	**X**

X: desired total resolution

After a successful transmission the encoder answered with the following confirmation telegram:

FC	NN	Command	Index		Subindex	Service/Process data			
SDO(rx)		Download	2102h			Byte 4	Byte 5	Byte 6	Byte 7
1011 b	1-90 d	60	02	21	00	00	00	00	00

4.3.1 Programming example: Total resolution
Target: Absolute rotary encoder with a total resolution of 24 bit
Total resolution 24 bit is equivalent to 1000000 h
Node number NN = 1

Master to Absolute Rotary Encoder: Set-Parameter

FC	NN	Command	Index		Subindex	Service/Process data			
SDO(tx)		Download	2102h			Byte 4	Byte 5	Byte 6	Byte 7
1100 b	01 d	22	02	21	00	**00**	**00**	**00**	**01**

X: desired total resolution

After a successful transmission the encoder answered with the following confirmation telegram:

FC	NN	Command	Index		Subindex	Service/Process data			
SDO(rx)		Download	2102h			Byte 4	Byte 5	Byte 6	Byte 7
1011 b	01 d	60	02	21	00	00	00	00	00

4.4 Preset Value

The preset value is the desired position value, which should be reached at a certain physical position of the axis. The position value is set to the desired process value by the parameter preset.

The preset value must not exceed the parameter total resolution to avoid run-time errors.

CMS	Index	Default value	Value range	Data length
SDO	2103h	0h	0h - total resolution	Unsigned32

General parameter description

Master to Absolute Rotary Encoder: Set-Parameter

FC	NN	Command	Index		Subindex	Service/Process data			
SDO(tx)		Download	2103h			Byte 4	Byte 5	Byte 6	Byte 7
1100 b	1-90 d	22	03	21	00	**X**	**X**	**X**	**X**

X: desired preset value

After a successful transmission the encoder answered with the following confirmation telegram:

FC	NN	Command	Index		Subindex	Service/Process data			
SDO(rx)		Download	2103h			Byte 4	Byte 5	Byte 6	Byte 7
1011 b	1-90 d	60	03	21	00	00	00	00	00

4.4.1 Programming example: Preset value

Target: Absolute rotary encoder with the preset value 0

Preset value 0 is equivalent to X = 0h

Node number NN = 1

Master to Absolute Rotary Encoder: Set-Parameter

FC	NN	Command	Index		Subindex	Service/Process data			
SDO(tx)		Download	2103h			Byte 4	Byte 5	Byte 6	Byte 7
1100 b	01 d	22	03	21	00	**00**	**00**	**00**	**00**

X: desired preset value

Absolute Rotary Encoder to Master: Confirmation

FC	NN	Command	Index		Subindex	Service/Process data			
SDO(rx)		Download	2103h			Byte 4	Byte 5	Byte 6	Byte 7
1011 b	01 d	60	03	21	00	00	00	00	00

4.5 Limit Switch, Min. and Max.

Two position values can be programmed as limit switches. By reaching these values one bit of the 32 bit process value is set to high. Both programmed values must not exceed the parameter total resolution to avoid run-time errors.

Bit 30 = 1: Limit Switch, Min. reached or passed under

Bit 31 = 1: Limit Switch, Max. reached or passed beyond

4.5.1 Limit switch, Min:

CMS	Index	Default value	Value range	Data length
SDO	2104h	0h	0h - total resolution	Unsigned32

The limit switch, Min sets Bit 30=1 with the next message telegram, if the process value reaches or passes under the value of the limit switch:

Function	Statusbits								Process value																							
Bit	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	0	1	0	0	0	0	0	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

General parameter description

Master to Absolute Rotary Encoder: Set-Parameter

FC	NN	Command	Index		Subindex	Service/Process data			
SDO(tx)		Download	2104h			Byte 4	Byte 5	Byte 6	Byte 7
1100 b	1-90 d	22	04	21	00	**X**	**X**	**X**	**X**

X: desired minimum value

After a successful transmission the encoder answered with the following confirmation telegram:

FC	NN	Command	Index		Subindex	Service/Process data			
SDO(rx)		Download	2104h			Byte 4			Byte 7
1011 b	1-90 d	60	04	21	00	00	00	00	00

4.5.2 Programming example: Limit switch, min.

Target: Absolute rotary encoder with limit switch min.

Limit switch ma. position: X = 1000h (is equivalent to 4096 d)

Node number: NN = 1

Master to Absolute Rotary Encoder: Set-Parameter

FC	NN	Command	Index		Subindex	Service/Process data			
SDO(tx)		Download	2104h			Byte 4	Byte 5	Byte 6	Byte 7
1100 b	01 d	22	04	21	00	**00**	**10**	**00**	**00**

X: desired maximum value

Absolute Rotary Encoder to Master: Confirmation

FC	NN	Command	Index		Subindex	Service/Process data			
SDO(rx)		Download	2104h			Byte 4	Byte 5	Byte 6	Byte 7
1011 b	01 d	60	04	21	00	00	00	00	00

4.5.3 Limit switch, max:

CMS	Index	Default value	Value range	Data length
SDO	2105h	0h	0h - total resolution	Unsigned32

The limit switch, max sets Bit 31=1 with the next
message telegram, if the process value r eaches
or passes over the value of the limit switch:

Function	Statusbits						Process value																									
Bit	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	1	0	0	0	0	0	0	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

General parameter description

Master to Absolute Rotary Encoder: Set-Parameter

FC	NN	Command	Index		Subindex	Service/Process data			
SDO(tx)		Download	2105h			Byte 4	Byte 5	Byte 6	Byte 7
1100 b	1-90 d	22	05	21	00	**X**	**X**	**X**	**X**

X: desired maximum value

After a successful transmission the encoder answered with the following confirmation telegram:

FC	NN	Command	Index	Subindex	Service/Process data

SDO(rx)		Download	2105h			Byte 4	Byte 5	Byte 6	Byte 7
1011 b	1-90 d	60	05	21	00	00	00	00	00

4.5.4 Programming example: Limit switch, Max.:

Target: Absolute rotary encoder with limit switch max.

Limit switch ma. position: X = 5000h

Node number: NN = 1

Master to Absolute Rotary Encoder: Set-Parameter

FC	NN	Command	Index		Subindex	Service/Process data			
SDO(tx)		Download	2105h			Byte 4	Byte 5	Byte 6	Byte 7
1100 b	01 d	22	05	21	00	**00**	**50**	**00**	**00**

X: desired maximum value

Absolute Rotary Encoder to Master: Confirmation

FC	NN	Command	Index		Subindex	Service/Process data			
SDO(rx)		Download	2105h			Byte 4	Byte 5	Byte 6	Byte 7
1011 b	01 d	60	05	21	00	00	00	00	00

4.6 Changing the node number

CMS	Index	Defaultvalue	Value range	Data length
SDO	3000h	20h	0h-89h	Unsigned 8

General parameter description

FC	KN	Command	Index		Subindex	Service-/Processdata			
SDO(tx)		Download	3000h			Byte 4	Byte 5	Byte 6	Byte 7
1100 b	1-90 d	22	00	30	00	**X**	00	00	00

X: 7 Bit to adjust the node number

After successful transmission the encoder answered with the following telegram:

FC	NN	Command	Index		Subindex	Service-/Processdata			
SDO(rx)		Download	3000h			Byte 4	Byte 5	Byte 6	Byte 7
1011 b	1-90 d	60	00	30	00	00	00	00	00

4.6.1 Example: Changing the node number

Target: Absolute rotary encoder with node number 5

Default node number: 32 d

The changed node number is confirmed by the encoder but only after a

- Store command (Objekt 2300 hex)
- Store command (Objekt 1010 hex) and NMT reset module or NMT reset communikation

valid.

To adjust the node number only one byte is used whereby the encoder adds one the the programmed value.

Setting node number 5:

Bit	7	6	5	4	3	2	1	0
value	-	64	32	16	8	4	2	1
example	0	0	0	0	0	1	0	0

$1*4 + 0 + 0 = 4 + 1 = 5$ node number

Master to Absolute Rotary Encoder: Set-Parameter

FC	NN	Command	Index		Subindex	Service-/Processdata			
SDO(tx)		Download	3000h			Byte 4	Byte 5	Byte 6	Byte 7
1100 b	32 d	22	00	30	00	**04**	00	00	00

X: 7 Bit to adjust the node number

Absolute Rotary Encoder to Master: Confirmation

FC	NN	Command	Index		Subindex	Service-/Processdata			
SDO(rx)		Download	3000h			Byte 4	Byte 5	Byte 6	Byte 7
1011 b	32 d	60	00	30	00	00	00	00	00

4.7 Adjusting the baudrate

CMS	Index	Defaultvalue	Value range	Data length
SDO	3001h	20h	0h-8h	Unsigned 8

General parameter description

FC	NN	Command	Index		Subindex	Service-/Processdata			
SDO(tx)		Download	3001h			Byte 4	Byte 5	Byte 6	Byte 7
1100 b	1-90 d	22	00	31	00	**X**	00	00	00

X: 3 Bit to adjust the Baudrate

After successful transmission the encoder answered with the following telegram:

FC	NN	Command	Index		Subindex	Service-/Processdata			
SDO(rx)		Download	3001h			Byte 4	Byte 5	Byte 6	Byte 7
1011 b	1-90 d	60	00	31	00	00	00	00	00

Eigth different baud rates are provided. To adjust the baudrate only one byte is used.

Adjusting Baudrate:

Baudrate in kBit/s	Bit						
	7	6	5	4	3	2	1
20	0	0	0	0	0	0	0
50	0	0	0	0	0	0	1
100	0	0	0	0	0	1	0
125	0	0	0	0	0	1	1
250	0	0	0	0	1	0	0
500	0	0	0	0	1	0	1
800	0	0	0	0	1	1	0
1000	0	0	0	0	1	1	1

Tab. 11 Bit assignment for baudrate adjustment

The changing of the baudrate is confirmed by the encoder but is only saved after a

- Store command (object 2300 hex)
- Store command (object 1010 hex) and NMT Reset Modul or NMT Reset communikation

4.7.1 Example : Adjusting the baudrate

Target: Absolute rotary encoder with a baurate of 250 kBaud

Default baudrate: 20 kBaud

Default node number: NN = 32 d

FC	NN	Command	Index		Subindex	Service-/Processdata			
SDO(tx)		Download	3001h			Byte 4	Byte 5	Byte 6	Byte 7
1100 b	32 d	22	00	31	00	**04**	00	00	00

X: 3 Bit to adjust the Baudrate

After successful transmission the encoder answered with the following teleg ram:

FC	NN	Command	Index		Subindex	Service-/Processdata			
SDO(rx)		Download	3001h			Byte 4	Byte 5	Byte 6	Byte 7
1011 b	32 d	60	00	31	00	00	00	00	00

4.8 Transmission Mode

4.8.1 Cyclic Mode

The absolute rotary encoder transmits cyclic - without being called by the host - the current process value. The cycle time can be programmed in milliseconds for values between 1 ms and 65536 ms   (e.g.: 64h = 100ms).

CMS	Index	Default value	Value range	Data length
SDO	2200h	64 h	1h - 10.000h	Unsigned16

General parameter description

Master to Absolute Rotary Encoder: Set-Parameter

FC	NN	Command	Index		Subindex	Service/Process data			
SDO(tx)		Download	2200h			Byte 4	Byte 5	Byte 6	Byte 7
1100 b	1-90 d	22	00	22	00	**X**	**X**	00	00

X: desired cycle time

Absolute Rotary Encoder to Master: Confirmation

FC	NN	Command	Index		Subindex	Service/Process data			
SDO(rx)		Download	2200h			Byte 4	Byte 5	Byte 6	Byte 7
1011 b	1-90 d	60	00	22	00	00	00	00	00

4.8.2 Disable the cyclic mode
To switch off the cyclic mode of the absolute rotary encoder the following telegram (cyclic mode disable) can be sent:

Master to Absolute Rotary Encoder: Set-parameter

FC	NN	Command	Index		Subindex	Service/Process data			
SDO(tx)		Download	2200h		0h	Byte 4	Byte 5	Byte 6	Byte 7
1100 b	1-90 d	22	00	22	00	00	00	00	00

Absolute Rotary Encoder to Master: Confirmation

FC	NN	Command	Index		Subindex	Service/Process data			
SDO(rx)		Download	2200h		0h	Byte 4	Byte 5	Byte 6	Byte 7
1011 b	1-90 d	60	00	22	00	00	00	00	00

4.8.3 Sync Mode
After reception of the SYNC-telegram by the host the absolute rotary encoder sends the actual position value. If multiple nodes are programmed for the SYNC-mode they ansering following their COB-Ids. The programming of an offset time is not applicable. It is also possible to program a number of SYNC telegrams which are ignored

CMS	Index	Subindex	Defaultwert	Value range	Data length
SDO	1802h	2h	1h	1h - 100h	Unsigned 8

General parameter description

FC	NN	Command	Index		Subindex	Service/Process data			
SDO(tx)		Download	1802h		2h	Byte 4	Byte 5	Byte 6	Byte 7
1100 b	1-90 d	22	02	18	02	**X**	0	0	0

X: number of Sync-Telegrams after which the Encoder sends the process value

Absolute Rotary Encoder to Master: Confirmation

FC	NN	Command	Index		Subindex	Service/Process data			
SDO(rx)		Download	1802h		2h	Byte 4	Byte 5	Byte 6	Byte 7
1011 b	1-90 d	60	02	18	02	00	00	00	00

Like the cyclic mode also the sync mode can be switched off the same way. To do this the PDO 2 must be addressed with the Index 1802h

4.8.4 Example: Number of Sync telegrams

Target: Absolute rotary encoder with 3 SYNC telgrams

Number of SYNC telegrams: X = 03h

Node number: NN = 01 d

FC	NN	Command	Index		Subindex	Service/Process data			
SDO(tx)		Download	1802h		2h	Byte 4	Byte 5	Byte 6	Byte 7
1100 b	01 d	22	02	18	02	**03**	0	0	0

X: number of Sync-Telegrams after which the Encoder sends the process value

Absolute Rotary Encoder to Master: Confirmation

FC	NN	Command	Index		Subindex	Service/Process data			
SDO(rx)		Download	1802h		2h	Byte 4	Byte 5	Byte 6	Byte 7
1011 b	01 d	60	02	18	02	00	00	00	00

4.8.5 Polled Mode

By a remote-transmission-request telegram the connected host calls off the current process value. The absolute rotary encoder reads the current position value, calculates eventually set -parameters and sends back the obtained process value by the same COB-ID. The PDO (rx) with the function code 0011 is used from the encoder to transmit the position value. This kind of Transmission mode must only be used in status operational.

CMS	Remote Transmission Request Bit (RTR)	Datenlänge
PDO	1	0

4.9 Memory Transfer

The parameter settings can be stored in a non-volatile Flash-EPROM. The parameter settings are stored in RAM when being programmed, because of the limited number of burn cycles of the Flash-EEPROM ($\approx$ 1.000). When all the parameters are set and proved, they can be transferred in one burn cycle to the Flash-EEPROM by the parameter memory transfer.

The stored parameters are copied after a RESET (Power on, NMT-Reset) from the Flash-EPROM to the RAM (volatile memory).

Attention: The operating mode SYNC or CYCLIC is not saved in the encoder. After a reset or power up the cyclic mode is always started as standard. To switch off the cyclic on you must deactivate the cyclic mode in the state pre-operational. After that you could start the operational state.

CMS	Index	Value	Data Type
SDO	2300h	55 AA AA 55 h	Unsigned 32

Master to absolute rotary encoder: Set-Parameter

FC	NN	Command	Index		Subindex	Service/Process data			
SDO(tx)		Download	2300h			Byte 4	Byte 5	Byte 6	Byte 7
1100	1-90 d	22	00	23	00	55	AA	AA	55

If the transfer is successful the absolute rotary encoder quotes after 4s with the pre-operational status with a Boot-Up message.

An additional possibility to store the parameter is to use the SDO object 1010. The following parameter has to transmitted to the encoder:

CMS	Index	Value:	Data length
SDO	1010h	73 61 76 65 h	Unsigned 32

Master to absolute rotary encoder: Set-Parameter

FC	NN	Command	Index		Subindex	Service-/Processdata			
SDO(tx)		Download	1010h			Byte 4	Byte 5	Byte 6	Byte 7
1100 b	1-90 d	22	10	10	00	73	61	76	65

4.10 Restore default parameters

The default parameters can be restored. The already in the non-volatile memory programmed parameters are not overwritten. Only after a new store command the default parameters are stored in the non-volatile memory. To restore the default parameter the following telegram is used.

CMS	Index	Value:	Data length
SDO	1011h	6C 6F 61 64 h	Unsigned 32

Master to absolute rotary encoder: Set-Parameter

FC	NN	Command	Index		Subindex	Service-/Processdata			
SDO(tx)		Download	1011h			Byte 4	Byte 5	Byte 6	Byte 7
1100 b	1-90 d	22	11	10	01	6C	6F	61	64

5. Technical Data

5.1. Electrical Data

Interface	Transceiver according ISO 11898, galvanically isolated by opto-couplers
Transmission rate	max. 1 MBaud
Device addressing	Adjustable by rotary switches in connection cap
Supply voltage	10 - 30 V DC (absolute limits)
Current consumption	max. 230 mA with 10 V DC, max. 100 mA with 24 V DC
Power consumption	max. 2.5 Watts
Step frequency LSB	800 kHz
Accuracy of division	± ½ LSB (12 bit), ± 2 LSB (16 bit)
EMC	Emitted interference: EN 61000-6-4
	Noise immunity: EN 61000-6-2
Electrical lifetime	> 10^5 h

Tab. 12 Electrical data

Absolute rotary encoders should be connected only to subsequent electronics whose power supplies comply with EN 50178 (protective low voltage)

5.2. Mechanical Data

Housing	Aluminum, optional stainless steel
Lifetime	Dependent on shaft version and shaft loading – refer to table
Max. shaft loading	Axial 40 N, radial 110 N
Inertia of rotor	≤ 30 gcm^2
Friction torque	≤ 3 Ncm (without shaft sealing)
RPM (continuous operation)	Singleturn: max. 12,000 RPM
	Multiturn: max. 6,000 RPM
Shock (EN 60068-2-27)	≤ 100 g (half sine, 6 ms)
Permanent shock (EN 60028-2-29)	≤ 10 g (half sine, 16 ms)
Vibration (EN 60068-2-6)	≤ 10 g (10 Hz ... 1,000 Hz)
Weight (standard version)	Singleturn: ≈ 550 g
	Multiturn: ≈ 600 g
Weight (stainless steel version)	Singleturn: $\approx 1,100$ g
	Multiturn: $\approx 1,200$ g

Flange	Synchro (S)		Clamp (C)	Hollow shaft (B)
Shaft diameter	6 mm	10 mm	10 mm	15 mm
Shaft length	10 mm	20mm	20 mm	-
hollow shaft depth min. / max.	-	-	-	15 mm / 30 mm

Tab. 13 Mechanical data

Minimum (mechanical) lifetime

Flange	Lifetime in 10^8 revolutions with F_a / F_r		
	40 N / 60 N	40 N / 80 N	40 N / 110 N
C10 (Clamp flange 10 x 20)	247	104	40
S10 (Synchro flange 10 x 20)	262	110	42
S6 (Synchro flange 6 x 10) without shaft sealing	822	347	133

Tab. 14 Mechanical durability of the encoder

S6 (Synchro flange 6 x 10) with shaft sealing: max. 20 N axial, 80 N radial

Environmental Conditions

Operating temperature	- 40 .. + 85°C*
Storage temperature	- 40 .. + 85°C*
Humidity	98 % (without liquid state)
Protection class (EN 60529)	Casing side: IP 65
	Shaft side: IP 64 (optional with shaft sealing: IP66)

Tab. 15 Environmantal conditions

* Cable exit: -30 … + 70 °C (static), -5 … + 70 °C (flexing)

5.3 Mechanical Drawings
B-flange (Blind shaft)

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Top figure

Single-Turn=83, Multi-Turn=95

30

30

10

18

1

23

Ø58
Ø53
Ø36 r7
Ø10 h8
Ø59
Ø60
63,5

3

3

15

3xM3x6
3xM4x6
3x120°
Ø48
3x120°
15°
~27
Ø5,5-9
20
20

Schlüsselweite, wrench size=17

Bottom figure

Single-Turn=82, Multi-Turn=92

30

30

10

18

1

23

Ø58
Ø53
Ø36 r7
Ø10 h8
Ø59 (Ø61)*
Ø60
63,5

3

3

* Edelstahl / Stainless steel

15

3xM3x6
3xM4x6
3x120°
Ø48
3x120°
15°
~27
Ø6,5-9
20
20

Schlüsselweite, wrench size=17

S-flange (Synchroflange)

Single-Turn=82, Multi-Turn=92

30

23

Ø58

Ø50$_{l7}$

d

l

Ø59 (Ø61)*

~32

3

3

4

* Edelstahl / Stainless steel

15

3xM4x6

3x120°

63,5

Ø60

Ø42

Ø6,5-9

20 20

Schlüsselweite, wrench size=17

Connection cap with 1 Binder connector

30

23

66

Ø60

20

15

12
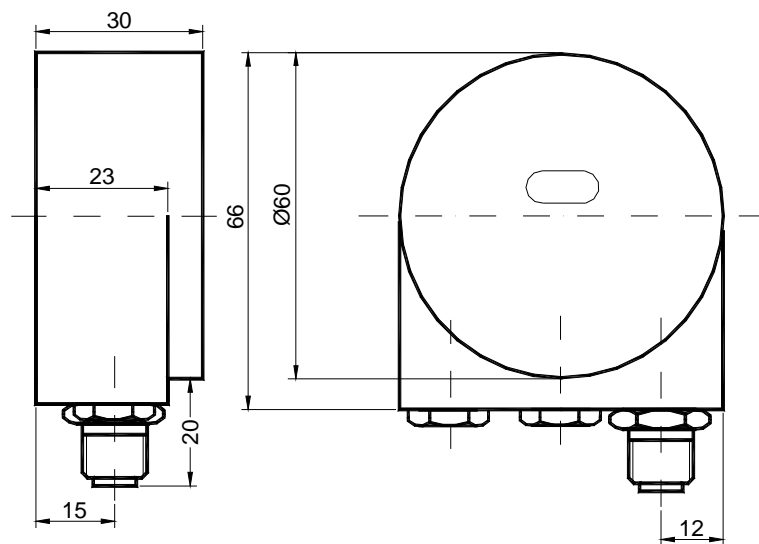
Connection with 2 Binder connector
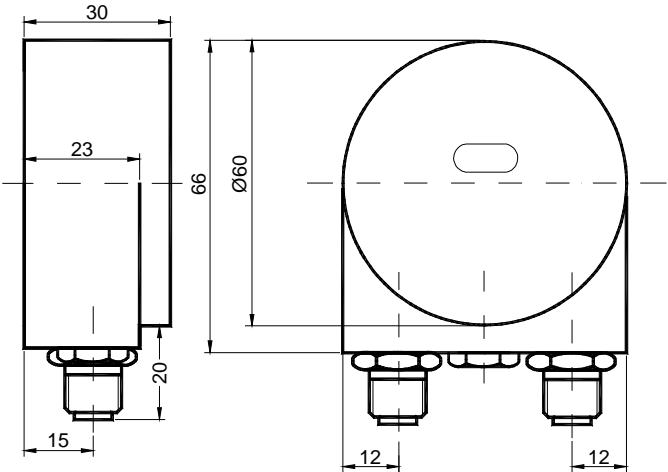
Connection cap with dot-matrix display
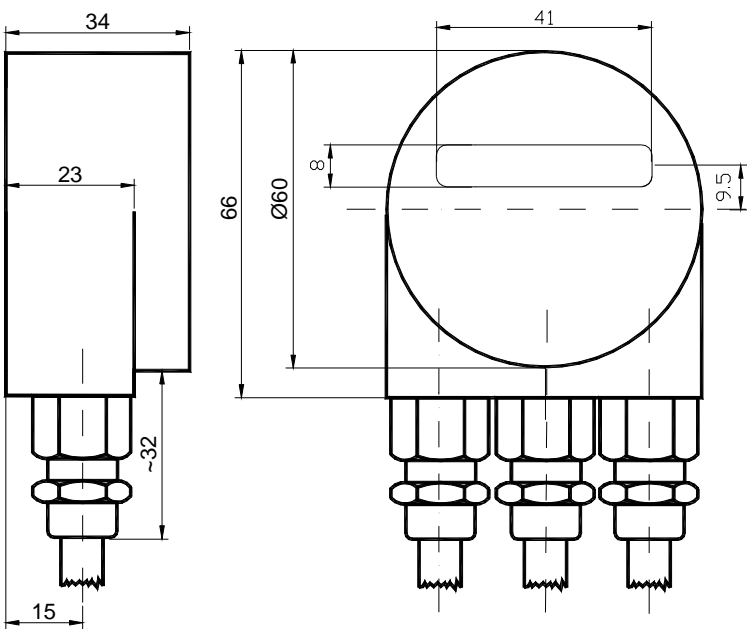
Synchroflange (S), 12 pin connector

Single-Turn=52 (53)*, Multi-Turn=79   ~60

Ø58
Ø50I7
d
l

3
3
4

~60

~20

Ø59

M4x8
Ø42
3x120°

30

*=52mm	axialer Stecker	axial connector
*=53mm	radialer Stecker	radial connector
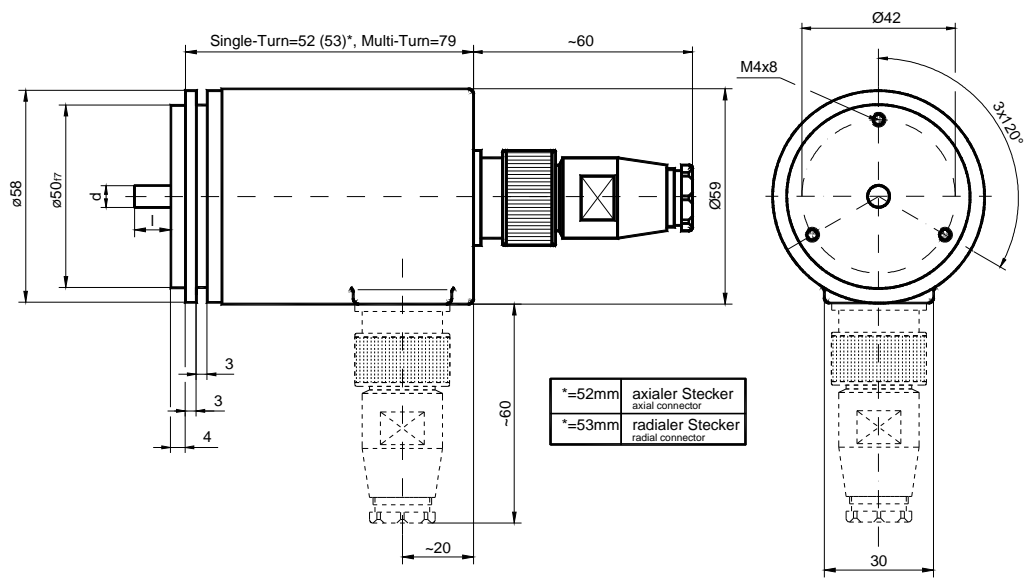
Clampflange (C), 12 pin connector

30   Single-Turn=52 (53) *, Multi-Turn=79   ~60

Ø58
Ø53I7
Ø36I7
Ø10h8
1
10
18

3
3

~60

~20

Ø59

M4x8
15°
Ø3; 8tief
Ø48
3x120°

30

*=52mm	axialer Stecker	axial connector
*=53mm	radialer Stecker	radial connector
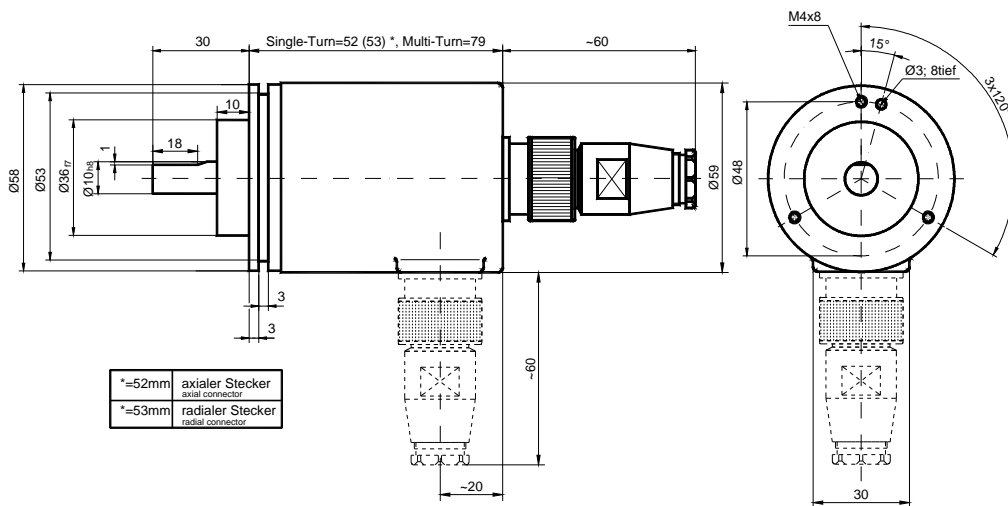
Clampflange (C), 5 pin connector
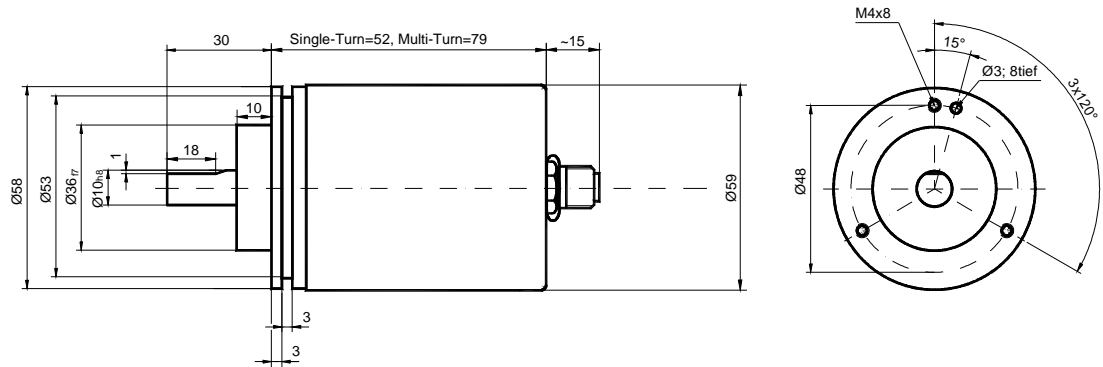
Clampflange (C), cable exit

*=52mm	axialer Kabelabgang axial cable exit
*=53mm	radialer Kabelabgang radial cable exit
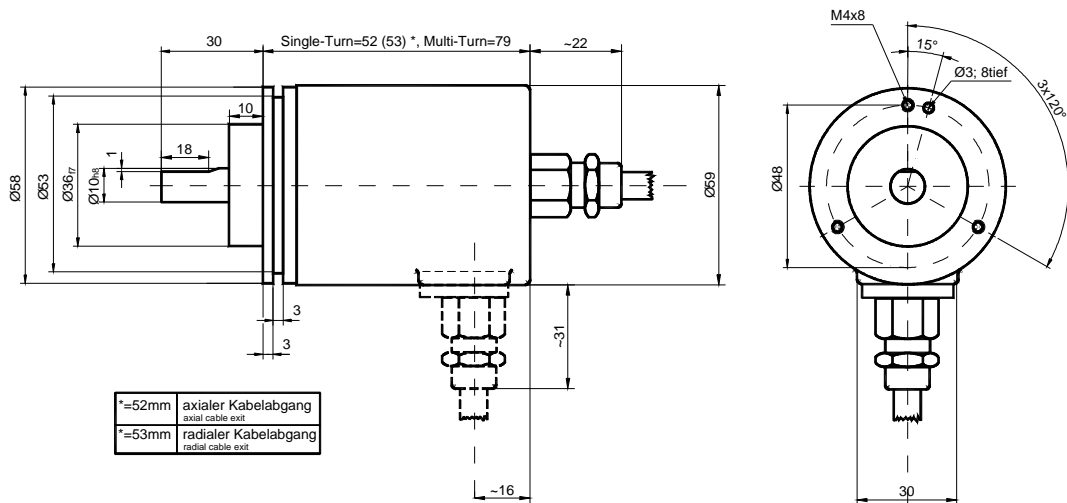
Synchroflange (S), 5 pin connector

The dimensions of encoder housing in the
versions cable exit, 12 pin circular connector and
5 pin connector from clamp flange are also valid
for the synchro flange.

Heavy Duty version

These „Outdoor encoder" are suitable for dirty industrial environment e.g. heavy construction machines. The heavy duty option for the Pure CANopen encoder provides an extended temperature range, protection elements against perspiration water inside the encoder and a heavy duty housing. Uppermost attention was laid on a high EMI. Micro style connectors for supply voltage and bus-in / bus-out connection provide an easy installation for non professional people. The parametrization of the Pure CANopen encoder is possible with all current project tools by implementation of the ESD file to the current project.

Main features
-   Compact dimensions
-   Heavy Duty housing
-   Protective element against perspiration water
-   integrated T-coupler
-   Standard protection class:
                    IP66 shaft side
                    IP67 casing side

Heavy Duty version with full shaft

Clampflange available in two versions.

Flangetype	l [mm]
Standard	10
Optional	4
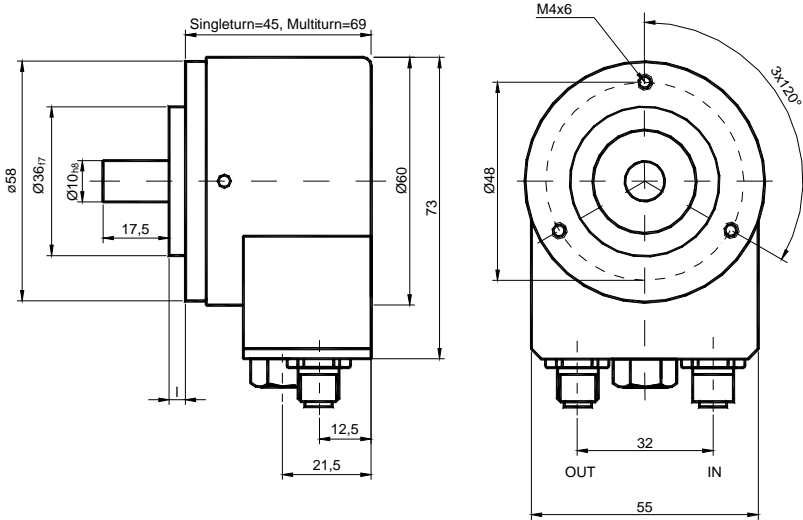
Heavy Duty version with blind shaft

Allowed shaft movement of drive element
is listed in the table.

	Axial	Radial
static	± 0,3 mm	± 0,5 mm
dynamic	± 0,1 mm	± 0,2 mm
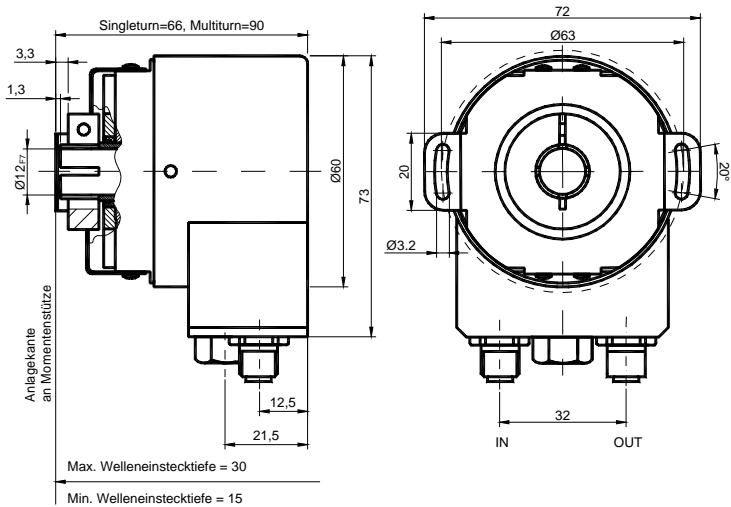
Synchroflange (S)

available in two versions
Cable exit (cable diameter= 8 mm)

Synchroflange	d / mm	l / mm
Version S06	6$_{f6}$	10
Version S10	10$_{h8}$	20
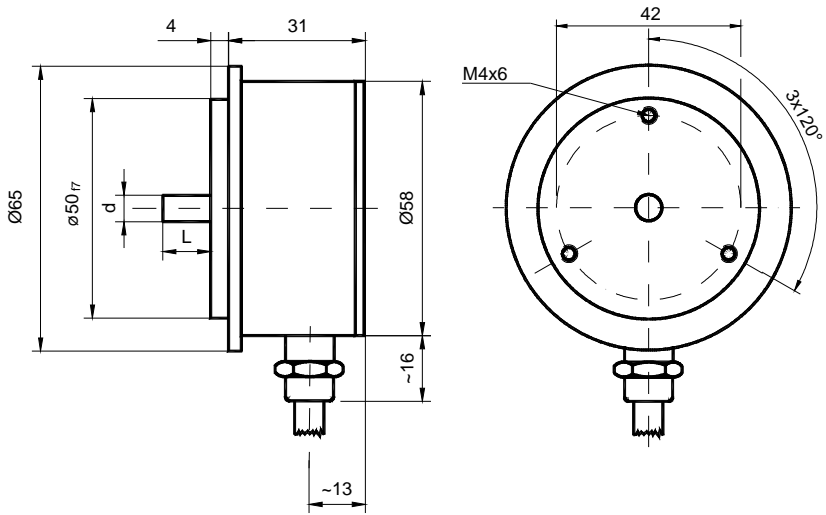
12 pin round connector (cable diameter: ø 6-9 mm)

		L
Single-Turn	axial	53
	radial	53
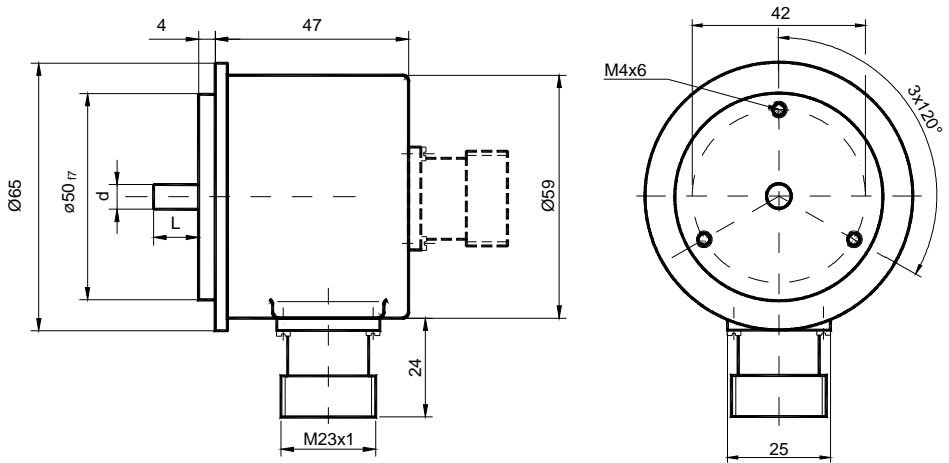
5.4 Cable and connectors

Signal	12 pin round connector pin number	5 pin round connector pin number	9 pin D-Sub connector pin number	open cable
CAN Ground	3	1	3	green
24 V supply voltage	12	2	9	white
0 V supply voltage	10	3	6	brown
CAN High	7	4	7	yellow
CAN Low	2	5	2	pink
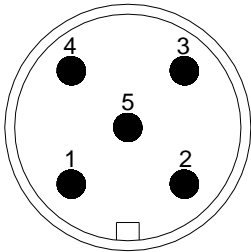
Bus in
5 pin connector male M12
connector male inlay / counterpart **soldering side**
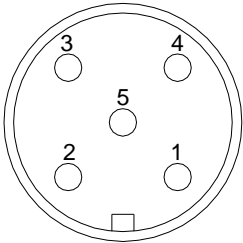
Bus out
5 pin connector female M12
connector female inlay / counterpart **soldering side**
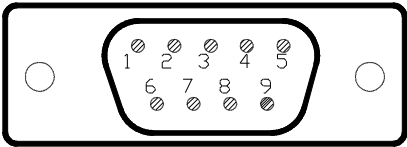
9 pin D-Sub connector
connector inlay / counterpart **soldering side**
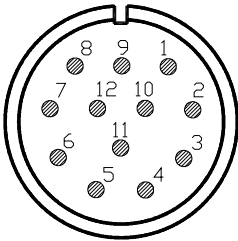
12 pin round connector
connector inlay / counterpart **soldering side**

Connection cap CAN FiberOptic
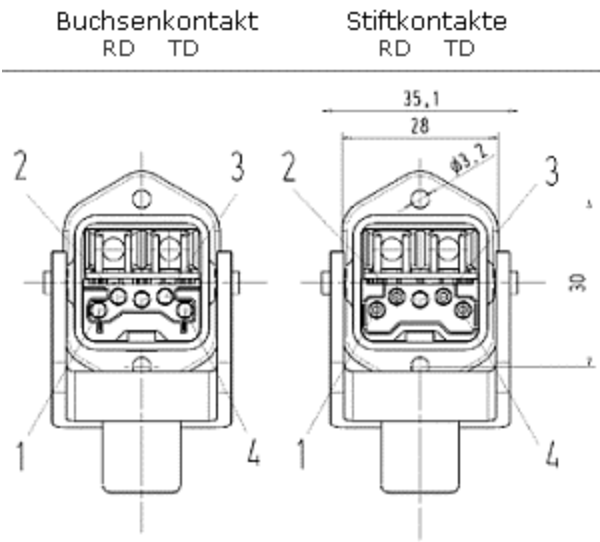
Signal	Meaning
TD	Transmit data
	Transmitting into fiber optic
RD	Receive data
	Receiving out of fiber optic
not connected	1
not connected	2
0 V supply voltage	3
10-30 V supply voltage	4

Optical elements: Laser class1

Maximum transmission length: POF 50 m, HCS 300 m

Installation hints

Both the cable shielding and the metal housings of encoders and subsequent electronics have a shielding function. The housing must have the same potential and be connected to the main signal ground over the machine chassis or by means of a separate potential compensating line. Potential compensating lines should have a minimum cross section of 6 mm2.

Do not lay signal cable in the direct vicinity of interference sources (air clearance > 100 mm (4 in.).

A minimum spacing of 200 mm (8 in.) to inductors is usually required, for example in switch-mode power supplies.

Configure the signal lines for minimum length and avoid the use of intermediate terminals.

In metal cable ducts, sufficient decoupling of signal lines from interference signal transmitting cable can usually be achieved with a grounded partition.

6. Models/Ordering Description

Description	Typekey									
Optocode	**OCD-**		_ _	B1	B -	_ _	_ _ -	_	_ _	_-	**0CC-**

Description	Typekey		
Interface	CANopen	**C2**	
	CAN FiberOptic	**CF**	
	PureCANopen	**C5**	
	MidiCAN	**C6**	
Version	C6		**00**
	C2, C5, CF		**B1**
Code	Binary		**B**

Description			
Revolutions (Bits)	Singleturn		**00**
	Multiturn		**12**
	Multiturn		14

Description			
Steps per revolution (Bits)	4096		**12**
	8192		13
	65536		16

Description			
Flange	Clampflange		**C**
	Synchroflange		**S**
	Hollow shaft		**B**

Description			
Shaft diameter	10 mm		**10**
	06 mm		**06**
	15 mm (hollow shaft)		**15**

Description			
Mechanical options	without		**0**
	shaft sealing (IP66)		S
	stainless steel version		V
	customized		C
	Heavy Duty		H

Description			
Connection	Connection cap		**0CC**
	Has to be ordered separately – see accessories		
	Connector exit, radial, 12 pin CCW		**PRL**
	Connector exit, axial, 12 pin CCW		**PAL**
	Connector exit, radial, 5 pin Micro Style M12		**PRM**
	Connector exit, axial, 5 pin Micro Style M12		**PAM**
	Cable exit 1m, radial, open cable exit		**CRW**
	Cable exit 1m, axial, open cable exit		**CAW**
	Male/ Female connector radial exit, 5 pin, M12		**PRN**
	Option protective element integrated		

Description			
Optionen	MidiCAN flange		018
	Connection cap with Dot-matrix display (siehe AH 58-B1CA-3PG-DSP)		019
	Clampflange with 4mm clamp flange length		028

Tab. 16 ordering key

not all combinations possible (refer combination matrix)

Standard = bold, further models on request

6.1 Combinationmatrix

	AH58-B1CA-3PG	AH58-B1CA-3PG-VA	AH58-B1CA-1BW	AH58-B1CA-2BW	AH58-B1CA-2M20	AH58-B1CA-3PG-DSP	AH58-B1CA-1CR	AH58-B1CA-1HW	Connector exit 12 pin radial	Connector exit 12 pinaxial	Connector exit 5 pin radial	Connector exit 9 pin D-Sub axial	Cable exit 1m radial	Cable exit 1m axial
CANopen	**1**	**1**	**1**	**1**	**1**	**1**								
CANopen FiberOptic								**1**						
Pure CANopen									**1**	**1**	**1**		**1**	**1**
Midi CANopen									**1**	**1**	**1**		**1**	**1**
CANopen Lift	**1**						**1**					**1**	**1**	**1**

Tab. 17 Possible combination of connection types

6.2 Connection caps

	Description	Type
Standard CANopen	T-coupling-functionality with integrated address setting	AH 58-B1CA-3PG
	Stainless steel configuration	AH 58-B1CA-3PG-VA
	Connection with 5 pin round connector, Micro style M12	AH 58-B1CA-1BW
Alternative version CANopen	2 cable glands for cable diameter: 9 - 13 mm	AH 58-B1CA-2M20
	Integrated LED display to indicate position value	AH 58-B1CA-3PG-DSP
	Connection with 2 pieces 5 pin round connector, male and female connector, Micro style M12	AH 58-B1CA-2BW
Standard CANopen FiberOptic	Connection cap for CAN FiberOptic	AH 58-B1CA-1HW

Tab. 18 Types of connection caps

6.3 Accessories and documentation

Description		Typ
Shaft coupling*	Drilling: 10 mm	GS 10
	Drilling: 6 mm	GS 06
Clamp disc*	4 Stück / AWC	SP 15
Clamp ring*	2 Stück / AWC	SP H
Protection cap connector male **	Protection cap for male connector, M12	SK-S
Protection cap connector female **	Protection cap for female connector, M12	SK-B
Terminal resistor **	External terminal resistor for female connector	TR-B
User manual ***	Installation and configuration manual, german	UMD-CA
User manual ***	Installation and configuration manual, english	UME-CA
EDS-File ***	Disc containing EDS-file for configuration	DK-CA
Reducing adapter****	15 mm to 12 mm	RR 12
Reducing adapter****	15 mm to 10 mm	RR 10
Reducing adapter****	15 mm to 8 mm	RR 8

Tab. 19 Accessories

*** only for hollow shaft

** needless for hollow shaft

* These can be downloaded free of charge from our Homepage www.posital.com.

We do not assume responsibility for technical inaccuracies or omissions. Specifications are subject to change without notice.

7. Appendix

7.1 History encoder generations

This chapter gives you informations about older types of absolute rotary encoder with CANopen interface. Technical changes and compatibillities between the different types are specified.

7.1.1 Encodergeneration Optocode

The encoder generation OPTOCODE replaces the encoder generation AWC. The housing legths and additional flange drillings are the mechanical changes of the new generation. The entry resolution per revolution in the object dictionary is modified and depends on the physical revolution of the device. The data length is unsigned 16 bit for a resolution per revolution of 15 bit and unsigned 32 bit for a physical revolution of 16 bit. Thus there is no change for the handling of the objects if an older encoder with a resolution per revolution of 13 bit is replaced by the same OPTOCODE encoder.

7.1.2 Encodergeneration AWC

Since the 01.03.2001 we deliver only the new encoder generation with CANopen interface. The changes of the type key, the compatibility of the devices (old/new) are composite in a feature matrix. Please use these changes in case of a new order.

Furthermore you can find details concerning changes of the CANopen protocol regarding to the newest CANopen specification (DS-301 V4.0) supported by the new devices. Please forward this information to your technical division.

Cross reference list:

Type key

Nr.	type key **old**	type key **new**	comment
1	58XX-XXXX-XBA1C203PG	58XX-XXXX-XB**B1**C203PG	encoder CAN
2	AH58-CA-3PG	AH58-**B1**CA-3PG	connection cap CAN

X: wildcard for various designs

Concerning the compatibility between old and new generation the following compatibility matrix gives further informations.

Compatibility matrix

connection cap	encoder	function
old	old	OK
old	new	OK
new	**old**	**no function**
new	new	OK

Version history connection cap

In particular the design of the connection cap is improved. Easier installation due to a new type of screw terminals inside of the connection cap. On the back of the connection cap two multicolour LEDs are implemented for easy diagnosis. The terminal resistor is hooked up via a slide switch. Thus contiuative bus connection will be cut off. The localisation of accidentally switched on terminal resistors wil be made easier. The device address and the baudrate will be adjusted via BCD switches. This made the installation easier.

Changes of the CANopen protocol

The following changes have not be relevant to you because only specific function according to the newest CANopen sepcification (DS-301 V4.0) are not supported anymore or are new implemented. If your application don't use this function, there will be no problem.

Changes of entries in object dictionary

Relevant changes applies to the boot-up message, as well as some entries in the CANopen object index not used by the common user. A complete list of these objects you can find in the following table.

object-nr. (hex)	comment	CANopen profile DS301 V3.0 58XX-XXXX-XBA1C203PG	CANopen profile DS301 V4.0 58XX-XXXX-XBB1C203PG
1004	Number of PDOs supported	supported	according to DS301-V4.0 not supported anymore
100B	Node-ID	supported	according to DS301-V4.0 not supported anymore
100E	COB-ID Guarding protocol	supported	according to DS301-V4.0 not supported anymore
1016	Consumer heartbeat time	reserved	supported
1017	Producer heartbeat time	reserved	supported
1018	Identity Object	reserved	supported

Changing transmit PDO communication parameter

In the new encoder generation the polling isn't supported anymore if the PDO is disabled. According to CANopen specification DS301-V4.0 it is neccesary to set the cyclic time (object entry [2200h]) to 0 and left the PDO switched on to poll the encoder. Important! If the PDO is switched off no communication is possible.

Polling in Pre-Operational state

The old generation has accepted polling requests in pre-operational state, but wasn't correct according to CANopen standard. In the manual for the old encoder was a hint, that the polling request is not allowed in pre-operational state, because it is not defined in the CANopen standard. So be aware that the new encoder is in general not accepting poll requests in pre-operational state independent of configution of the behaviour as new or old encoder.

Changes in boot-up sequence

If the old encoder generation is connected to the supply voltage or a NMT message (reset node, reset communication) is sent to the encoder, a

boot-up message appears. The telegram structure looks like this: identifier: 80hex + node number, data length 0 bytes

This message was not defined by the specification DS301 V3.0, but vendor specific used by some manufactures to show that the device is 'alive'.

According to DS301 V4.0 the new rotary encoder generation doesn't support this message anymore. In place of the old message a common valid boot-up message is defined. The structure looks like this:

identifier: 700hex + node number, data length 1 byte

This boot-up message also appears if the command 'reset node' and 'reset communicatio' is sent to the encoder.

Handling of spare parts

Boot-up message new encoder and old connection cap

To use the new encoder generation as spare part for the old encoder generation, the new encoder recognize the old connection cap type and support the specification DS301-V3.0 automatically as well as the appropriate boot-up message.

Changing of the default BootUp message of the B1 version

To get the same boot-up behaviour of the old encoder generation if you use the new encoder generation and the new connection cap type there will be following solution:

The needed protocol type will be activated via a defined device address. Please use the following configuration sequence:

1. Setting the needed address (s. table below).
2. Connect the connection cap to the encoder.
3. Switch on supply voltage.
4. Wait until both LEDs are red.
5. Switch off supply voltage.
6. Remove connection cap.
7. Set up the correct device address. (0-89)
8. Connect the connection cap to the encoder.
9. Switch on supply voltage.

normal operation.

protocol according to connection cap type automatically	protocol DS301-V3.0	protocol DS301-V4.0
address 97	address 98	address 99

Beside the set up via hardware there is also the possibility to set up the protocol via SDO objects. For further information please refer the manual.

7.2 List of tables

7.3 List of figures

7.4 Document history

Version	Date	Comment
1.0	10.10.03	Initial version
1.1	24.10.03	Correction of the type key. List of figures, List of tables added
2.0	06.11.03	Hint protection low voltage added
2.1	08.01.04	Hint temperature cable exit added
2.2	21.05.04	New inner diameter of the cable glances
2.3	24.09.04	SubIndex of RestoreAllParameter changed