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DEVICE NET USER MANUAL

Absolute Rotary Encoder
with DEVICE NET Interface

MHM510-DNET-001
MHK515-DNET-001

User Manual

a company of Schneider Electric

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1. Introduction

Absolute rotary encoders provide a definite value for every possible position. All these values are reflected on one or more code discs. The beams of infrared LEDs are sent through code discs and detected by Opto-Arrays. The output signals are electronically amplified and the resulting value is transferred to the interface.

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 = 1.073.741.824 steps. The standard Single-Turn version has 12 Bit, the standard Multi-Turn version 24 Bit.

The integrated CAN-Bus interface of the absolute rotary encoder supports all of the DeviceNet functions. The following modes can be programmed and enabled or disabled:

- Polled Mode
- Change of State

The protocol supports the programming of the following additional functions:
Code sequence (Complement)
Resolution per revolution
Total resolution
Preset value

The general use of absolute rotary encoders with DeviceNet interface is guaranteed.

2. Data Transmission

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

CAN-ID	Message Header	Message Body
11 Bit	1 Byte	7 Byte

2.1. The Object Dictionary

Instance Attribute of the Position Sensor Objects

Class Code: 23 hex

Attribute ID	Access	Name	Data Type	Description
1 hex	Get	Number of Attributes	USINT	Number of supported Attributes
2 hex	Get	Attribute	Array of USINT	List of supported Attribute
3 hex	Get	Position value	DINT	current position
0B hex	Get / Set	Code sequence	Boolean	Controls the code sequence clockwise or counterclockwise
2C hex	Get / Set	resolution per revolution	INT	resolution for one revolution
2D hex	Get / Set	total resolution	DINT	total measurable resolution
2E hex	Get / Set	preset value	DINT	setting a defined position value

Get / Set: : read, write

3. Programmable Parameters

3.1. Encoder parameters

3.1.1. Operating Parameter

The operating parameter can be used to select the code sequence.

Attribute ID	Default value	Value range	Data Type
0 b hex	1 hex	0 hex - 1hex	Boolean

The parameter code sequence (complement) defines the counting direction of the process value **as seen on the shaft** whether clockwise or counter clockwise. The counting direction is defined in the attribute 0b hex:

Bit 0	Drehrichtung	Ausgabecode
1	CW	Steigend
0	CCW	Fallend

3.1.2. Resolution per revolution

The parameter resolution per revolution is used to program the encoder to set a desired number of steps per revolution. Each value between 1 and the maximum (see type shield) can be realised

Attribute ID	Default value	Value range	Data Type
2C hex	(*)	0hex - 2000hex	Unsigned Integer16

(*) see type shield, Maximum resolution:
12/24 Bit Encoder: 1,000 hex (4096)
13/25 Bit Encoder: 2,000 hex (8192)

When the value is set larger than 4096 (8192 for a 13/25 Bit encoder), the process value of the encoder will not be single stepped and values will be skipped while rotating the shaft. So, it is recommended, to keep the measuring steps per revolution below 4096 (8192) measuring steps.

3.1.3. Total resolution

This value is used to program the desired number of measuring steps over the total measuring range. This value must not exceed the total resolution of the encoder with 24 bit = 16,777,216 steps (25 bit = 33,554,432 steps). Please note the value written on the type shield.

Attribute ID	Default value	Value range	Data Type
2D hex	(*)	0h - 2,000,000h	Unsigned Integer 32

(*) see type shield
Maximum total resolution
24 Bit Encoder: 1,000,000 hex
25 Bit Encoder: 2,000,000 hex

Attention:
The following formula letters 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 physical resolution per revolution of the encoder, then the total resolution must be entered as follows:

Total resolution
GA = PGA * AU / PAU, if AU < PAU
Example: Customer requirement: AU = 2048, Encoder type shield: PGA=24 bit, PAU=12 bit

GA = 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 = PGA / GA
- k = integer

3.1.4. 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 of the encoder is set to the desired process value by the parameter preset. The preset value must not exceed the parameter total measuring units

Attribute ID	Default value	Value range	Data Type
2E hex	0 hex	0hex - total measuring range	Unsigned Integer 32

4. Operating Mode

4.1. Polled Mode

For switching the polled mode on the following telegrams are needed. Further it is assumed in the following example a master MAC ID of 0A hex and a slave MAC ID of 03 hex.

Allocate Master / Slave Connection Set

1. Allocate Polling

Byte Offset	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Frag [0]	XID	MAC ID					
1	R/R [0]	Service [4B]						
	Class ID [03]							
	Instance ID [01]							
	Allocation Choice [03]							
	0	0	Allocator MAC ID					

Example:

CAN-ID	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5
41E	0A	4B	03	01	03	0A

1. Setting the Expected_packet_rate of the Explicit Message Connection on 0:
Example:

CAN-ID	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6
41C	0A	10	05	01	09	00	00

1. Setting the Expected_packet_rate of the Polling Connection on 0:n:
Example:

CAN-ID	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6
41C	0A	10	05	02	09	00	00

Release Master / Slave Connection Set

Release Polling

Byte Offset	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Frag [0]	XID	MAC ID					
1	R/R [0]	Service [4C]						
	Class ID [03]							
	Instance ID [01]							
	Release Choice [03]							

Example:

CAN-ID	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4
41E	0A	4C	03	01	03

4.2. Change of State Mode

The absolute rotary encoder sends data, without any request from the host, when the actual process value is changing. No telegram will occur when the position value is not changing. This results in a reduced bus loading.

Allocate Master / Slave Connection Set

Allocate COS

Byte Offset	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Frag [0]	XID	MAC ID					
1	R/R [0]	Service [4B]						
	Class ID [03]							
	Instance ID [01]							
	Allocation Choice [51]							
	0	0	Allocator MAC ID					

Example:

CAN-ID	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5
41E	0A	4B	03	01	51	0A

2. Setting Expected_packet_rate of the Explicit Message Connection on 0:
Example:

CAN-ID	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6
41C	0A	10	05	01	09	00	00

3. Setting Expected_packet_rate of the Change of State Connection on 0:
Example:

CAN-ID	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6
41C	0A	10	05	04	09	00	00

Release Master / Slave Connection Set

Release COS

Byte Offset	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Frag [0]	XID	MAC ID					
1	R/R [0]	Service [4C]						
	Class ID [03]							
	Instance ID [01]							
	Release Choice [51]							

Example:

CAN-ID	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4
41E	0A	4C	03	01	51

4.3. Saving Parameter

The parameters of the absolute rotary encoder are saved in a non-volatile FLASH memory. Because of a limited number of writing cycles (≈ 1,000), it is useful to transmit the modified parameter in the first step only in the RAM area. After adjusting and examination, those values can be saved in the FLASH memory. After successful saving of the parameter the encoder sends his MAC-ID on the bus. To get the process value a new allocation of the slave is required.

Byte Offset	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Frag [0]	XID	MAC ID					
1	R/R [0]	Service [32]						
	Class ID [23]							
	Instance ID [01]							

Example:
(MAC-ID Master: 0A hex, MAC-ID Slave: 03 hex)

CAN-ID	Byte 0	Byte 1	Byte 2	Byte 3
41C	0A	32	23	01

5. Transmission of the actual position

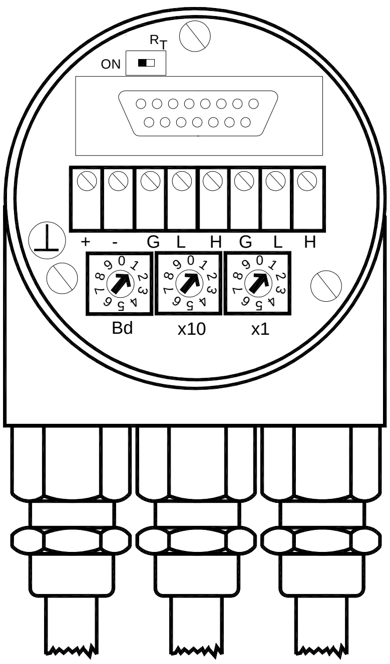
The process value is transmitted according to the following table.

CAN-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}

6. Installation

6.1. Electrical connection

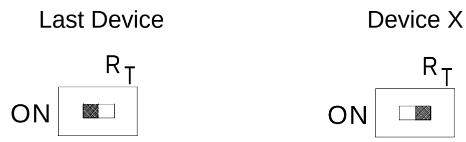
The rotary encoder is connected by three cables. The power supply is achieved with a two-wire connection cable through one PG 9. Each one of the twisted-pair and shielded bus lines are guided in and out through two PG 9 on the right side (as seen on clamps)



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

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

Resistor:



The setting of the node number is achieved by 2 turn-switches in the connection cap. Possible addresses lie between 0 and 63 whereby every address can only be used once. 2 LEDs

DeviceNet Devices BCD coded rotary switches	
x1 10	Device adress 0...63 Setting CAN-node number
Bd	Setting of the baud-rate

on the backside of the connection cap show the operating status of the encoder.

6.2. Setting of the baudrate

Baudrate in kBit/s	BCD coded rotary switches
125	0
250	1
500	2
125	3
reserved	4...9

7. Power On

7.1. Operating Mode

After power on the absolute rotary encoder sends two times his MAC ID telegram on the bus.

7.2. Programming

If some parameters should not be modified you can skip over this chapter.
The following numbers are given in hexadecimal format. In the examples, the CAN ID and MAC ID are 0A (hex) and for the slave 03 (hex).
The changeable values are written in an italics.

7.2.1. Operating Parameter

Master to absolute rotary encoder: Set-Parameter

CAN ID	MAC ID	Service Code	Class ID	Instance ID	Attribute ID	Data		
	Byte 0	Byte1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
41C	*0A*	10	23	01	0b	X	-	-

X: 1 hex for CW (Default)
0 hex for CCW

Absolute Rotary Encoder to Master:Confirmation

CAN ID	MAC ID	Service Code
	Byte 0	Byte 1
41B	*0A*	90

7.2.2. Resolution per revolution

Master to Absolute Rotary Encoder:Set-Parameter

CAN ID	MAC ID	Service Code	Class ID	Instance ID	Attribute ID	Data		
	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
41C	*0A*	10	23	01	2C	X	*X*	-

X: desired resolution per revolution

Absolute rotary encoder to master: Confirmation

CAN ID	MAC ID	Service Code
	Byte0	Byte1
41B	0A	90

7.2.3. Total resolution

A fragmented transmission is needed, when the total resolution must be sent to the encoder. So here are more messages necessary.

Master to Absolute Rotary Encoder:Set-Parameter

CAN ID	MAC ID	Fragment	Service Code	Class ID	Instance ID	Attribute ID		
	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
41C	*8A*	00	10	23	01	2D	X	X

Absolute Rotary Encoder to Master:Confirmation

CAN ID	MAC ID		
	Byte0	Byte 1	Byte 2
41B	8A	C0	00

Master to Absolute Rotary Encoder:Set-Parameter

CAN ID	MAC ID	Frag-ment						
	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
41C	*8A*	81	X	X	-	-	-	-

X: desired total resolution

Absolute Rotary Encoder to Master:Confirmation

CAN ID	MAC ID		
	Byte0	Byte 1	Byte 2
41B	*8A*	C1	00

Absolute Rotary Encoder to Master:Confirmation

CAN ID	MAC ID	Service Code
	Byte0	Byte1
41B	*0A*	90

7.2.4. Preset Value

Master to Absolute Rotary Encoder:Set-Parameter

CAN ID	MAC ID	Fragment	Service Code	Class ID	Instance ID	Attribute ID		
	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
41C	*8A*	00	10	23	01	2E	X	X

X: desired preset value

Absolute Rotary Encoder to MasterConfirmation

CAN ID	MAC ID		
	Byte0	Byte 1	Byte 2
41B	*8A*	C0	00

Master to Absolute Rotary Encoder:Set-Parameter

CAN ID	MAC ID	Fragment						
	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
41C	*8A*	81	X	X	-	-	-	-

X: desired preset value

Absolute Rotary Encoder to MasterConfirmation

CAN ID	MAC ID		
	Byte0	Byte 1	Byte 2
41B	*8A*	C1	00

Absolute Rotary Encoder to Master:Confirmation

CAN ID	MAC ID	Service Code
	Byte0	Byte1
41B	*0A*	90

7.2.5. Parameter Saving

Master to Absolute Rotary Encoder: Set-Parameter

CAN ID	MAC ID	Service Code	Class ID	Instance ID
	Byte0	Byte1	Byte 2	Byte 3
		32	23	01

If the transfer has been successful, the absolute rotary encoder responds after 3-4s with the Duplicate MAC-ID. After that the master must reallocate the slave.
If the transfer is not successful, an error message will be sent. The service code used to save the parameter set is manufacturer specific.

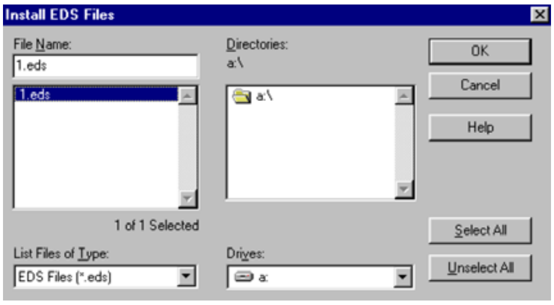
7.3 Configuration with DeviceNet Manager

Figure 1 EDS File

The EDS File contains information about device specific parameters as well as possible operating modes of the encoder. With this file you have a data sheet in an electronic format, which can be used to configure the device in the network, for example with DeviceNet Manager from Allen Bradley.

To install the EDS (Electronic Data Sheet) file you need a disc with this file. Further you must choose from the menu the entry UTILITIES and the sub menu INSTALL EDS FILES.

After that a window will open , where a drive and the file is selected. Like shown in figure 1, the file 1.EDS has been chosen. At the bottom of the window more information is displayed like manufacturer, product type and version number.



After a successful installation the user can assign a bitmap to the encoder. The file with the name AWC58xx.bmp is the right one.

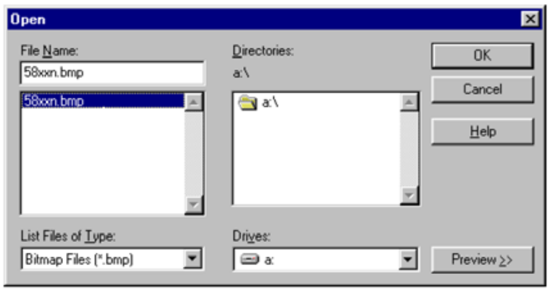


Figure 2 Selection of Bitmap File

Encoder Installation in the Network

To configure the encoder in the network you have the following two possibilities:

1. Offline
2. Online

To create a network online it is necessary to select the topic START ONLINE BUILD in the menu UTILITIES. After that the network is scanned and the encoder is automatically shown in the main window, if an encoder is installed. For the detailed proceedings please look in the manual of the software DeviceNet Manager.

If the network is built up offline you must create a new project. After configuration of network specific information such as baudrate and description, a window with an empty network and device list on the left side is shown. Under the window device list you will find the encoder in the area: GENERIC- Sensorsysteme. Use the mouse pointer to drag and drop the symbol and move it to the line network. Additionally you must edit the device description and the node number. Please be careful to edit the same node number (MAC-ID) in the software tool as configured in the connection cap of the encoder.

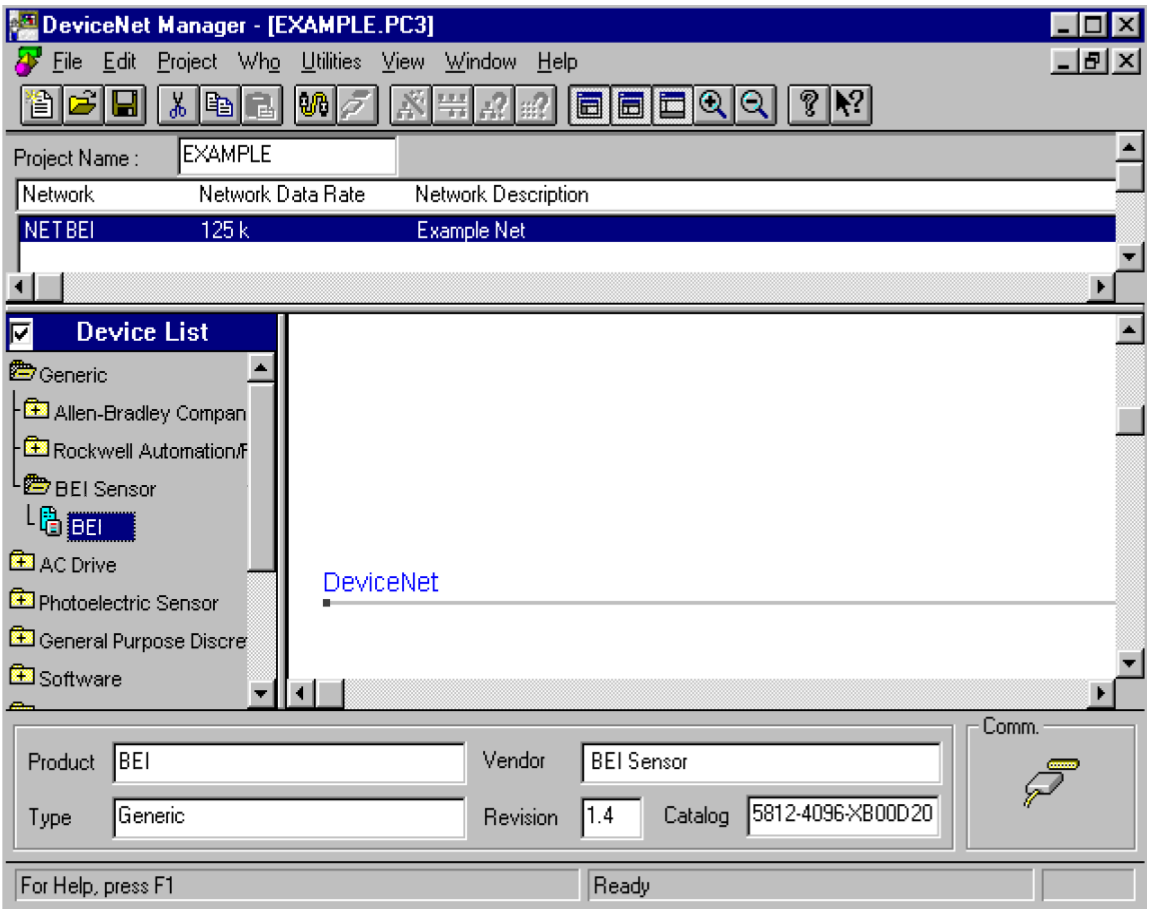


Figure 3 Select encoder from device list

After successful execution of the before described steps the network may look figure 4.

When a double click is made on the encoder symbol a parameter window will open.

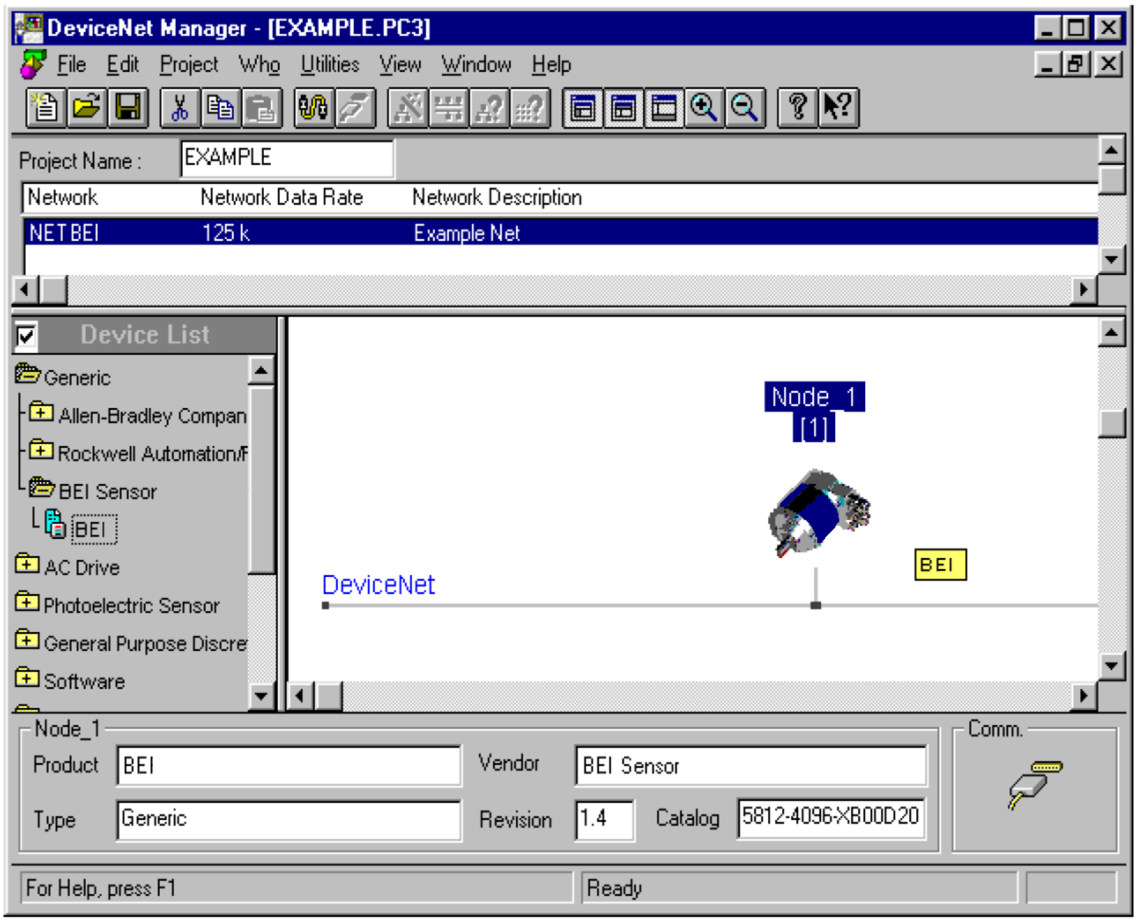


Figure 4 Installation of network

This parameter masks makes it possible to edit different parameters like monitoring the position value. The adjustable parameters are marked with the number 1-4. The 5th entry displays the actual position value, when the function monitoring is activated with the button start monitor.
The button Load from Device makes it possible to download the device specific parameter in the configuration software. So it is very easy to check the parameter or programming a replacement device with the same parameter.

In the same way the control button Save to Device transmits the edited parameters to the encoder. Please notice that the transmitted values are saved in the RAM area. By power off and on you will loose these parameters. After checking the parameters they can be saved in the FLASH memory by selecting the menu entry UTILITIES-BASIC DEVICE CONFIGURATION .

The entered values in the mask are taken from the following figure. This prevent a mistake through over taking wrong parameters.

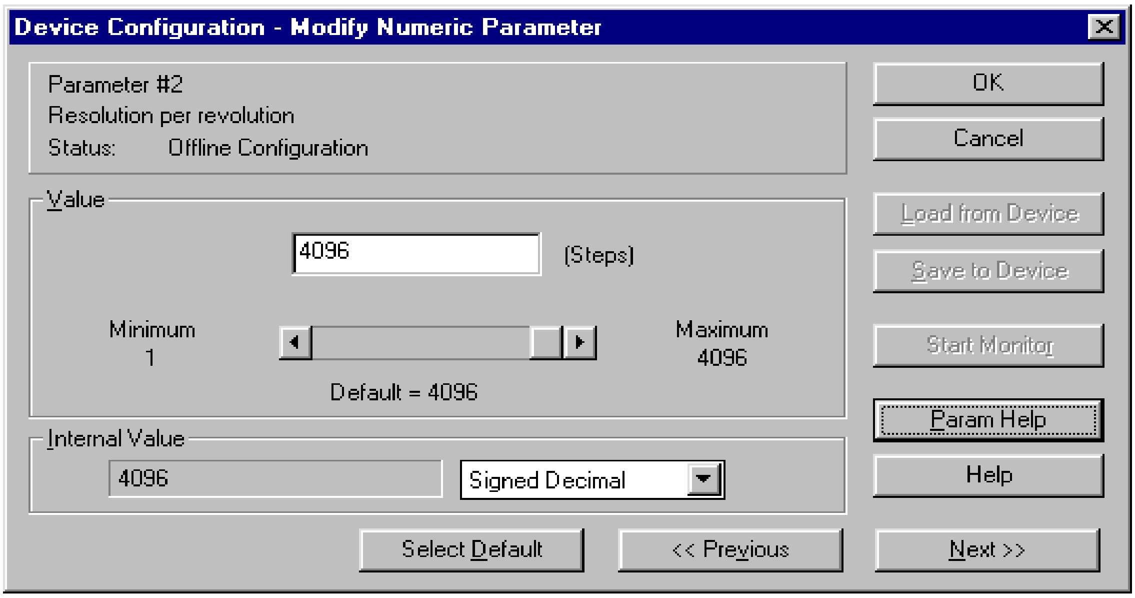


Figure 5 Parameter mask

By a double click on each parameter a further window opens to edit the value directly via keyboard or scroll bar. A transmission of the parameter into the RAM memory is secured with the Save to Device Button. A short description about each parameter is displayed using the function Parameter Help.

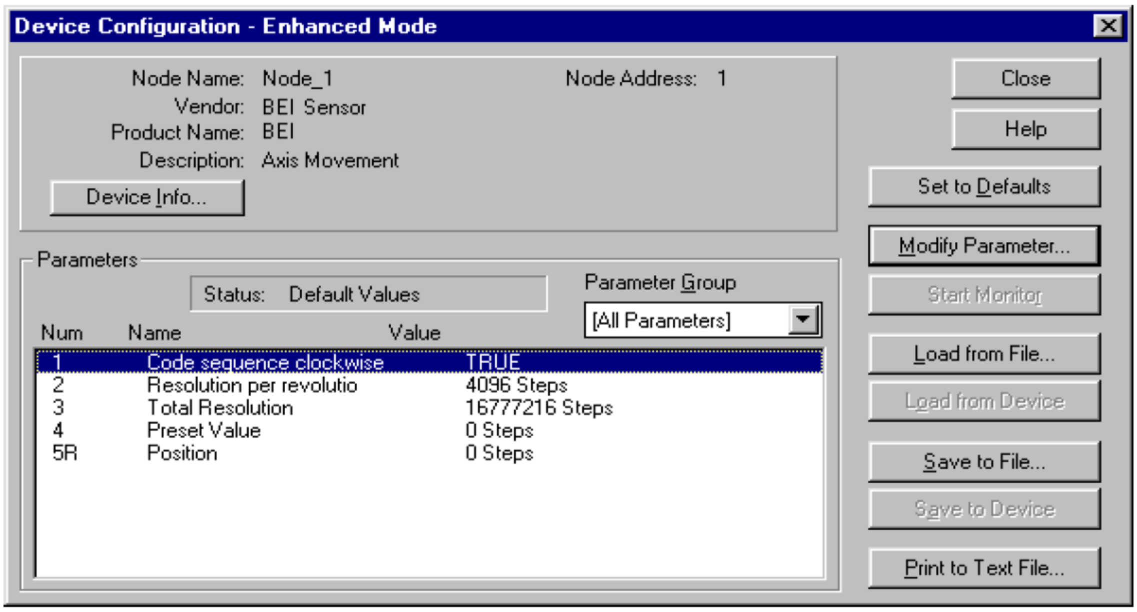
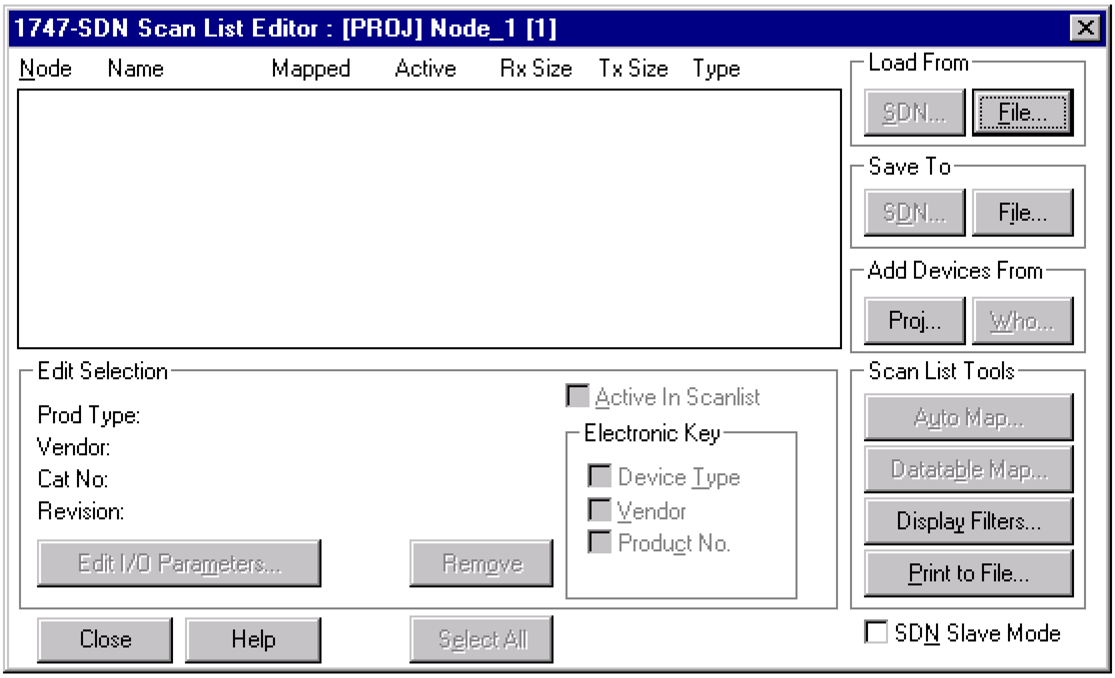


Figure 6 Parameter mask

Saving Parameter by activated Scanner

((only necessary when firmware of Allen Bradley scanner is lower 4.001)



Picture 7 Scanner Mask

following described steps are not necessary when the firmware of the AB scanner is 4.001 or higher. A update of the scanner is very easy to execute. Please contact AB for further information. When the parameter should be transmitted from the DeviceNet Manager to the encoder via the button SAVE to DEVICE, the entry Active In Scanlist must be deactivated. The mapped process values could be placed further. After configuration of parameters the encoder could be set active in the scanlist again. If there are only encoders mentioned in the scanlist you could alternately select all devices with SELECT ALL and set then the state Active in Scanlist.
Another way is to select each encoder with the mouse pointer.

If you don't follow the description, the error message - 'Target device did not respond to connection based request.' - is possible from DeviceNet manager and also in the scanner display.

7.4. Store Parameters

For saving the encoder parameter into FLASH memory you must select the menu item UTILITIES and the entry BASIC DEVICE CONFIGURATION. The selected node number of the device must be entered into the field Device-Node-Address as well as some other parameters listed in the following figure 7. To store the parameter please select the button SAVE.

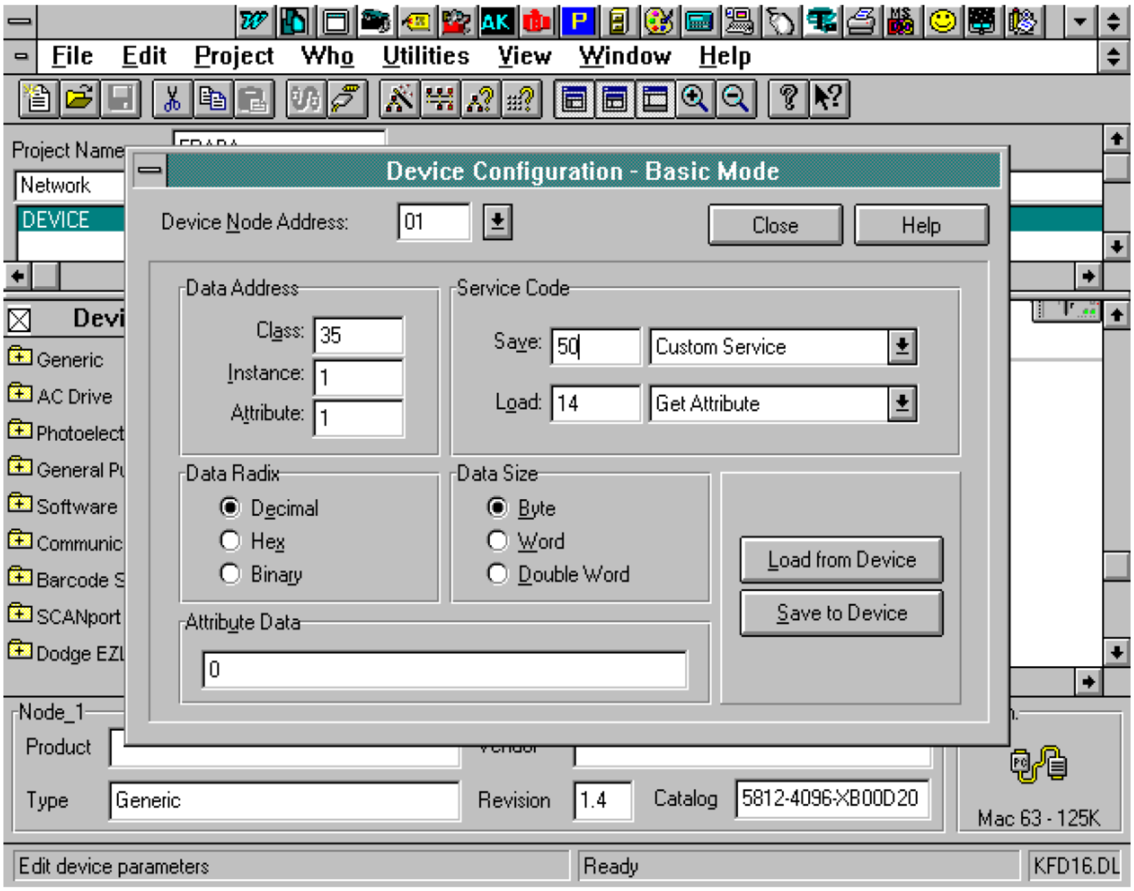


Figure 7 Saving parameters in FLASH memory

Use the following values for the parameter:

Class	35
Instance & Attribute	1
Data Size	Byte
SAVE Service Code	50, Custom Service
Instance	1
Attribute Data:	0
Data:	Decimal

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8. Technical Data

8.1 Electrical Data

Interface	Transceiver according ISO/DIS 11898, up to 64 nodes galvanically isolated by opto-couplers
Transmission rate	150 kBaud, 250 kBaud, 500kBaud
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

8. 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 gcm²			
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)	≤ 30 g (halfsine, 11 ms)			
Permanent shock (EN 60028-2-29)	≤ 10 g (halfsine, 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: ≈ 1,100 g			
	Multiturn: ≈ 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

8.3 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

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

8. 4 Environmental Conditions

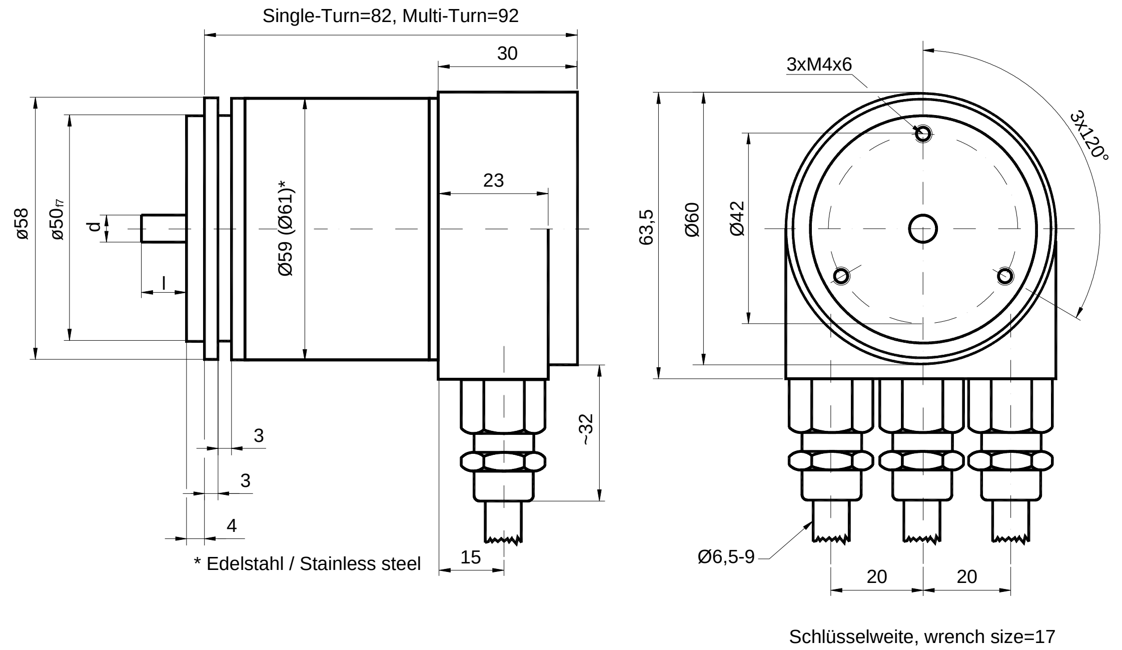
Operating temperature	– 40 .. +85°C
Storage temperature	- 40 .. + 85 °C
Humidity	98 % (without liquid state)
Protection class (EN 60529)	Casing side: IP 65
	Shaft side: IP 64 (optional with shaft sealing: IP66)

9. Mechanical Drawings

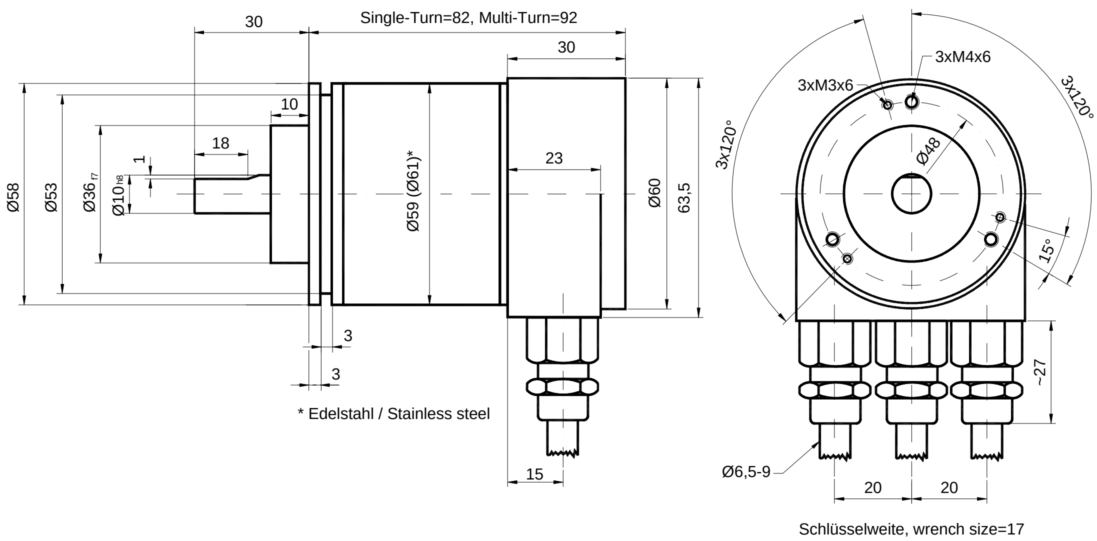
Synchro flange (S)

available in 2 versions

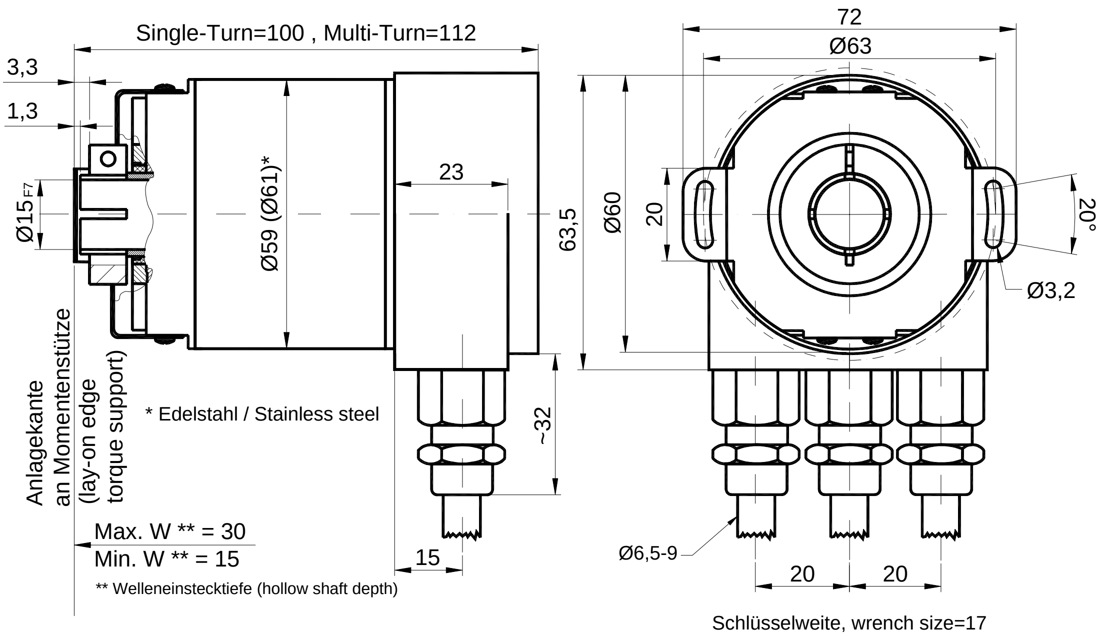
Synchro flange	d / mm	l / mm
Version S06	6f6	10
Version S10	10h8	20



Clamp flange (C)



Hollow shaft (B)



Mounting instructions

The clamp ring may only be tightened if the shaft of the driving element is in the hollow shaft.

The diameter of the hollow shaft can be reduced to 12mm, 10 mm or 8 mm by using an adapter (this reducing adapter can be pushed into the hollow shaft).

Allowed shaft movements of the drive element are listed in the table.

	axial	radial
static	± 0,3 mm	± 0,5 mm
dynamic	± 0,1 mm	± 0,2 mm

10. Versions / Order Description

Description	Type Key										
Reference	**MHM5_**	D2	B1	B -	_ _	_ _-	_	_ _	_-	0CC
Interface	DeviceNet	**D2**								
Version			**B1**							
Code	Binary			**B**						
Revolutions (Bits)	Singleturn				00					
	Multiturn (4096 revolutions)				**12**					
	Multiturn (16384 revolutions)				14					
Steps per revolution (Bits)	4096					12				
	8192					**13**				
	65536					16				
Flange	Clamp flange						**C**			
	Synchro flange						S			
	Hollow shaft						**B**			
	Square flange						Q			
Shaft diameter	10 mm							**10**		
	06 mm							06		
	15 mm (hollow shaft)							**15**		
Mechanical options	Without								**0**	
	Shaft sealing (IP66)								S	
	Stainless steel version								V	
	Customized								C	
Connection	Connection Cap									**0CC**

Standard = bold, further models on request

Ordering reference for a 10mm solid shaft absolute multiturn encoder :
MHM5 D2 B1 B 12 13 C 10 0 0CC : **MHM510-DNET-001**

Ordering reference for a 15mm blind shaft absolute multiturn encoder :
MHK5 D2 B1 B 12 13 B 15 0 0CC : **MHK515-DNET-001**

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Accessories and Documentation

Description		Type
Reducing adapter *	15 mm to 12 mm	RR12
Reducing adapter *	15 mm to 10 mm	RR10
Reducing adapter *	15 mm to 8 mm	RR8

* only for hollow shaft