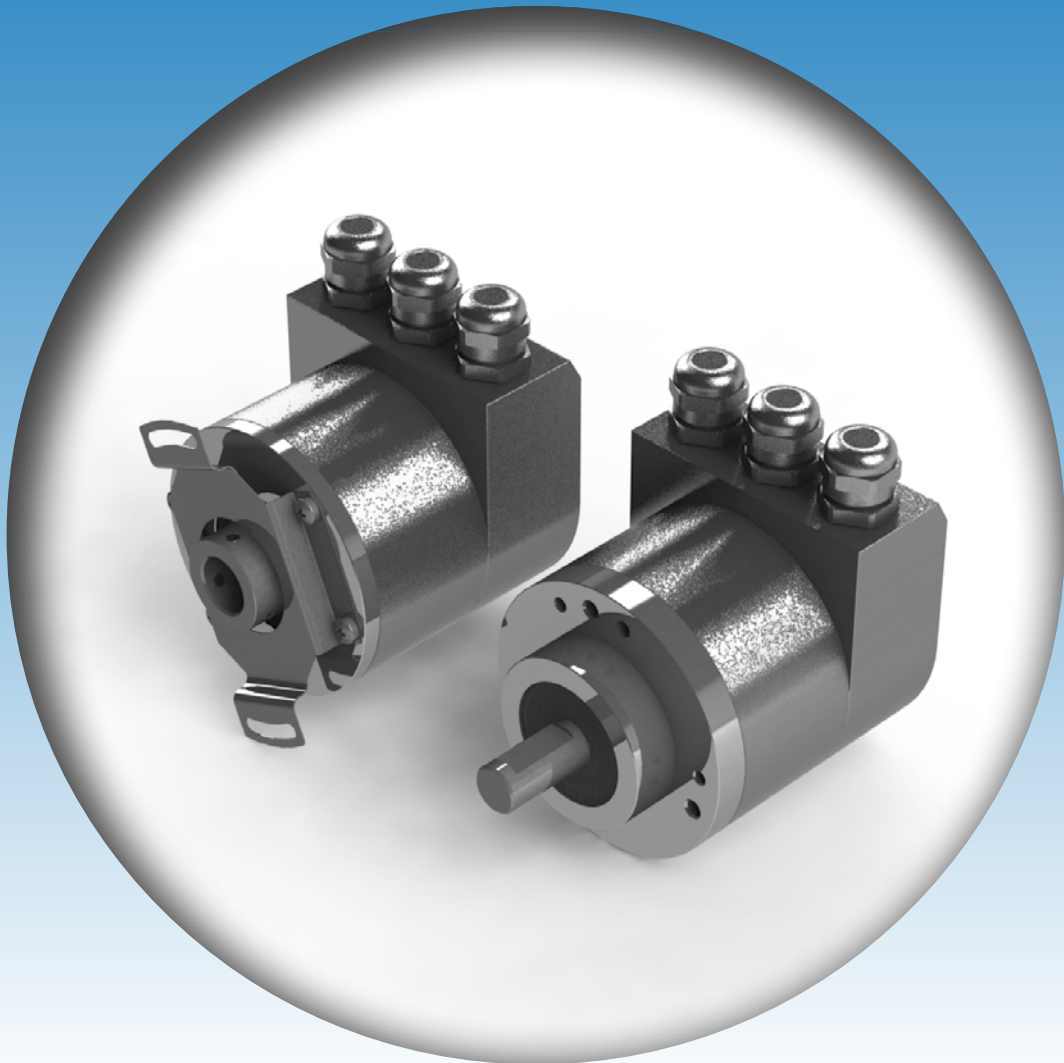# hohner

Elektrotechnik Werne

Technical Manual

Absolute Shaft Encoder
ACURO® industry with **DeviceNet**

DeviceNet®
CONFORMANCE TESTED

Your partner for standard and special designs
- precise, reliable and fast -

Contents

1 Definitions

This technical manual describes the software, parameter setting and initial operation of the shaft encoder.

Explanation of symbols:

Passages to which special attention should be paid in order to ensure the correct use and to avoid **dangers** are marked by this symbol.

This Symbol indicates important directions for the **proper use** of the shaft encoder.
The non-observance of these instructions may lead to malfunctions in the shaft encoder or its surrounding parts.

This symbol indicates instructions for action.

List of abbreviations used

LSB Least Significant Bit/Byte

MSB Most Significant Bit/Byte

COS Change of State

Miscellaneous:

Numerical data Unless indicated explicitly, decimal values are represented as figures without additional features (e.g. 1408), binary values are marked **b** (e.g. 1101b), hexadecimal values **h** (e.g. 680h) at the end of the figures.

2 Safety and Operating Instructions

The ACURO model series' absolute shaft encoders are quality products that have been manufactured according to recognized electrical engineering regulations. The devices have left the manufacturing company's premises meeting all relevant safety requirements.

<u>**Therefore:**</u>

- In order to preserve this condition and to ensure an interference-free Operation of the encoders, the technical specifications presented in this documentation must be observed.
- Electrical appliances may only be installed by skilled electricians!
- The devices may only be operated within the limits defined in the technical data.
- The maximum operating voltages must not be exceeded!!
  The devices have been constructed according to DIN EN 61010 Part 1, protection class III. In order to avoid dangerous electric shocks, the devices have to be operated with safety extra-low voltage (SELV) and be situated in a field with equipotent bonding.
- For better protection use an external fuse (see chapter electrical data)
- Field of application: industrial processes and control systems.
  Over voltages at the connection terminals have to be restricted to over voltage category II values.
- Shock effects on the housing, especially on the encoder shaft, as well as axial and radial overloading of the encoder shaft should be avoided.
- Only in case an appropriate coupling is used can the maximum precision and life time be guaranteed.
- The proper electromagnetic compatibility values (EMC[*]) are only valid for standard cables and plugs. In the case of screened cables, the screen has to be connected on both sides as well as on large surface to ground. The lines for power supply should also be entirely screened. If this is not possible, appropriate filter methods should be applied.
- The neighboring parts as well as the installation of the cable system have got a significant influence on the electromagnetic compatibility of the shaft encoder. As a consequence, the electrician has to ensure the EMC of the entire system (device).
- In regions endangered by electrostatic discharges, a good ESD protection for the plugs and the cable to be connected should be provided when installing the shaft encoder..

*electromagnetic compatibility

3 General Information

3.1 Introduction

The ACURO industry is an absolute shaft encoder (encoder, angle encoder). The version described in this technical manual sends its current position to another station via the "CAN - bus" " transmission medium (physically: screened and twisted-pair).

The bus coupler is standardized according to the international standard ISO-DIS 11898 (CAN High Speed) standard. The most significant feature of the CAN-protocol is its high level of transmission reliability (Hamming distance = 6).

3.2 Field of Application

In systems, where the position of a drive or of any other part of a machine has to be recorded and signaled to the control system, the ACURO industry can assume this function. The ACURO industry can resolve, for instance, positioning tasks by sending the check-back signal concerning the present drive position via DeviceNet to the positioning unit.

4 DeviceNet basics

History & Technology

History

- Base Technology developed by Allen-Bradley
- Introduced March, 1994
- Technology transferred to ODVA in April, 1995

Technology

- CAN messaging layer 2 (data link layer) - ISO 11898 and 11519-1
- DeviceNet is layer 7 (application layer) and layer 1 (physical layer) designed for industrial automation

Key Benefits

- Reduced Wiring and Installation Cost
- Reduced Start-Up Time
- Reduced Downtime
- Rapid Troubleshooting
- Removal, insertion and replacement of devices on the network under power
- Interchangeability of devices from multiple vendors
- Configuration of devices over the network (set-up or runtime)

Linear Bus Topology (trunk line-drop line)
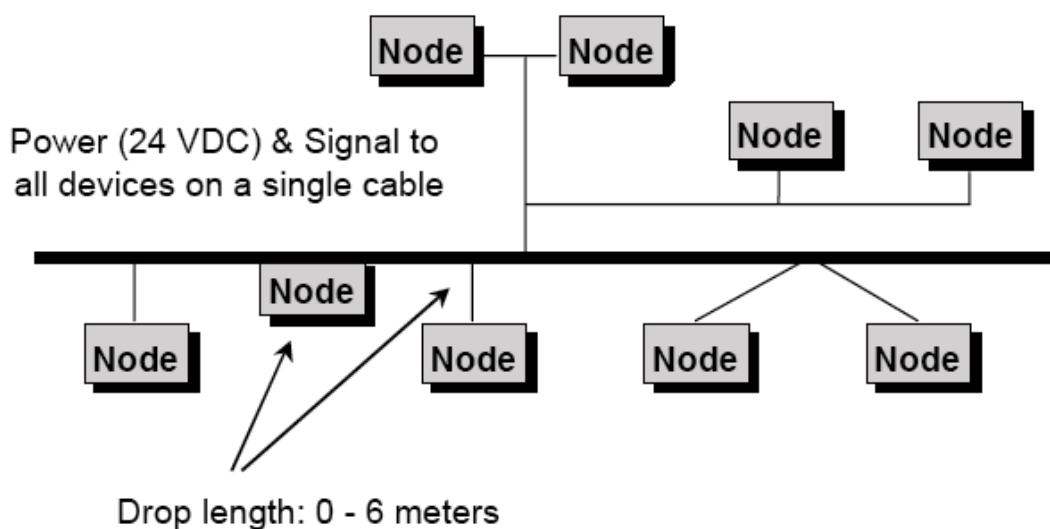
Network Specifications

Network Power
- 24VDC power to devices
- Thick trunk rated to 8 amps
- Thin wire rated at 3 amps

Maximum Devices
64 Nodes per Network

Physical Media
(Shielded Twisted Pair)
Communications and Power
- Thick - Trunk wire
- Thin - Trunk or Drop

Trunk line Distance and Baud rate
100m Max. with Thin cable
500m @ 125Kbaud (thick)
250m @ 250Kbaud (thick)
100m @ 500Kbaud (thick)
(4Km with Repeaters)

Device Connections
T-Taps
Zero-drop

Terminating Resistors
121 Resistors at both network trunkline ends

Messaging Services
Producer/Consumer
- High-speed I/O
- Programming
- Configuration
- Diagnostics

Drop-line wiring
- Single drop
- Daisy-chaining off drop
- Branching off drop

Cumulative Drop-line Budget
156m @ 125Kbaud
78m @ 250Kbaud
39m @ 500Kbaud
(Maximum of 6m each)

5 The Encoder Device Profile

5.1 Introduction

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

- Polled mode

- Bit strobe

ℹ Polled mode and Bit strobe can be used at the same time. COS und cyclic should be used separately

- Change of State

- Cyclic

The encoder supports the programming of following functions:

- Code sequence
- Measuring units per revolution
- Total measuring range
- Preset value

Status information are readable:

- Physical resolution
- Alarm flag
- Encoder type
- Profile and Software version
- Offset value

5.2 Object Model

The Object Model in Figure 1 represents an encoder. The table below indicates:
- the object classes
- whether or not the class is required
- the number of instances present in each class

Object class	Number of instances
01h: Identity	1
02h: Message Router	1
03h: DeviceNet	1
05h: Connection	1 Explicit, 3 E/Q
04h: Assembly	2
64h: Producer specific	1
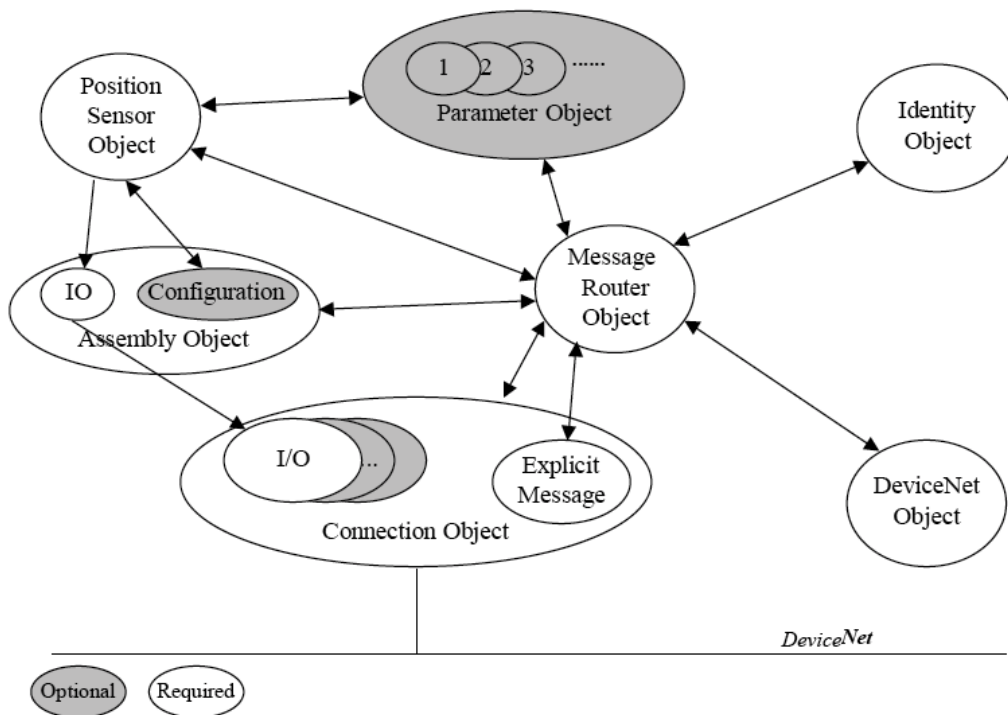
5.3 I/O Assembly Instances

The following table identifies the I/O Assembly instances which are supported by the encoder.

Number	Type	Name
1	Input	Position value
2	Input	Position value and alarm flag

5.4 I/O Assembly Data Attribute Format

The I/O assembly data Attributes have the format shown below.

5.5 Object Definition

Class Code: 64 hex

5.5.1 Class Attributes

Attribute ID	Access Rule	Name	Data Type *	Description of Attribute	Semantics of Values
1	Get	Revision	UINT	Revision of this object NOTE: All class definitions are required to include this attribute.	The current value assigned to this attribute is (01). If up-dates that required and increase in this value are made, then the value of this attribute increases by 1.
2	Get	Max. Instance	UINT	Maximum instance number of an object currently created in this class level of the device.	The largest instance number of a created object at this class hierarchy level.

*Declaration of the data types

Data type	Data length	Description
BOOL	1 Bit	Boolean
SINT	1 Byte	Signed Short Integer
USINT	1 Byte	Unsigned Short Integer
DINT	4 Byte	Signed double Integer
UDINT	4 Byte	Unsigned double Integer
INT	2 Byte	Integer
UINT	2 Byte	Unsigned Integer

5.5.2 Instance Attributes

The Instance Attributes are divided into two sections because of the different functionality.

The first section contains parameter to calculate the detected physical position and control functions (attributes 100-108). Within attribute range (109-113) diagnostic functions are integrated.

Attribute ID	Access Rule	Name	Data Type	Description of Attribute	Semantics of Values
100	Get	No. of Attributes	USINT	Number of Attributes supported	
102	Get / Set	Code Sequence	BOOL	Direction control for counting	0 = CW 1 = CCW
103	Get/Set	Scaling function control	BOOL	Physical resolution is converted in software to a numerical value	0 = OFF 1 = ON
104	Get/Set	Measuring units per revolution	UDINT	Number of distinguishable steps per revolution. Less than physical resolution	
105	Get/Set	Total Measuring range in measuring units	UDINT	Steps over the total measuring range	
106	Get/Set	Preset Value	UDINT	Output position value is set to Preset Value	
107	Get	Position Value	UDINT	Current position	
108	Get	Single-Turn resolution (rotary)	UDINT	For rotary encoder: Number of steps per revolution	
109	Get	Number of distinguishable revolutions	UINT	distinguishable revolutions the encoder can output	
110	Get	Alarm Flag	BOOL	Indicates if an alarm error occurs	0 = OK 1 = Alarm error
111	Get	Encoder Type	UINT	specifies the encoder type	
112	Get	Profile and Software version	UDINT	Low word: Profile version High word: Software version	
113	Get	Offset value	DINT	The Offset value is calculated by the preset function. Shift position value with the calculated value	

5.6   Description of Parameters

ⓘ **Sequence of parameter transfer with scaling activated:**
Before using the preset or offset parameters (Attr. 106), the scaling parameters (Attr. ID 104 und 105) have to be transferred beforehand (only if the scaling is to be set).The preset function may only be used if the encoder is at standstill.

5.6.1 No. of Attributes (Attr. 100)

This parameter returns the total number of all installed attributes in the device.

5.6.2 Code sequence (Attr. 102)

The code sequence defines whether increasing or decreasing position values are output when the encoder shaft rotates clockwise or counterclockwise as seen on the shaft.

ⓘ Standard setting: bit = 0 - ascending code sequence for clockwise shaft rotation

5.6.3 Scaling Function Control (Attr. 103)

With the scaling function the encoder numerical value is converted in software to change the physical resolution of the encoder.
The parameters "Measuring units per revolution" and "Total measuring range in measuring units" are the scaling parameters. If the scaling function bit is set to zero, the scaling function is disabled.

ⓘ **For the scaling function bit = 0, the scaling function is not activated.**
To activate the scaling, the scaling function bit has to be set.
Standard setting: bit = 0 - scaling disabled

5.6.4 Measuring units per revolution (Attr. 104)

The parameter "Measuring units per revolution" sets the number of distinguishable steps ($\leq$ physical resolution) per revolution. The encoder internally calculates the respective scaling factor.

ⓘ **The "total measuring range " is set by Attr. 105**
The resulting scaling factor SCF (by which the physical value of position is multiplied) can be calculated according to the following equation:

$$\text{SCF} = \frac{\text{Measuring units per revolution (Attr. 104)}}{\text{Singleturn resolution (Attr. 108)}}$$

Data contents:

Byte 0	Byte 1	Byte 2	Byte 3
$2^7 ... 2^0$	$2^{15} ... 2^8$	$2^{23} ... 2^{16}$	$2^{31} ... 2^{24}$

Value range: 0 ... (max. phys. resolution per revolution)
Standard value = physical resolution per revolution

5.6.5 Total Measuring Range in Measuring Units (Attr. 105)

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

The measuring units per revolution (resolution) are set via Attr. 104.
If the total number of measuring steps is being modified, a possibly programmed preset value will be deleted.
In case the encoder is used in continuous operation, the „Total Measuring range" must be a multiple of „Measuring steps per revolution„:
$2^x \cdot$ **Measuring steps per revolution (104)   (with x=1 ... 12).**

Data contents:

Byte 0	Byte 1	Byte 2	Byte 3
$2^7 ... 2^0$	$2^{15} ... 2^8$	$2^{23} ... 2^{16}$	$2^{31} ... 2^{24}$

Value range: 0 ... (max. total resolution)
standard value = total resolution

5.6.6 Preset Value (Attr. 106)

The Preset function supports adaptation of the encoder zero point to the mechanical zero point of the system.
The output position value is set to the parameter "Preset value" and the offset from the position value is calculated and stored in the encoder.

The preset value will be deleted if the code sequence is modified or the scaling is activated or modified (see Attr. 102, 103, 104 + 105).
In the encoder, the preset value will be converted into a respective offset value and will be added to the position value (Offset = Preset - Position).

Data contents:

Byte 0	Byte 1	Byte 2	Byte 3
$2^7 ... 2^0$	$2^{15} ... 2^8$	$2^{23} ... 2^{16}$	$2^{31} ... 2^{24}$

Value range: 0 ... (programmed total resolution)

standard value = FFFF FFFFh, i.e. "No Preset/Offset"

ℹ By writing the value FFFF FFFFh, the preset value will be deleted (calculated offset value will be set to 0)!

5.6.7 Position Value (Attr. 107)

The current position value (settled up against the scaling factor, preset, and offset) is read out by the encoder.

Data contents:

Byte 0	Byte 1	Byte 2	Byte 3
$2^7 ... 2^0$	$2^{15} ... 2^8$	$2^{23} ... 2^{16}$	$2^{31} ... 2^{24}$

5.6.8 Singleturn Resolution (Attr. 108)

The object shows the physical resolution per revolution (number of position values on the single turn code disk). The value depends on the encoder type.

Data contents:

Byte 0	Byte 1	Byte 2	Byte 3
$2^7 ... 2^0$	$2^{15} ... 2^8$	$2^{23} ... 2^{16}$	$2^{31} ... 2^{24}$

5.6.9 Number of Distinguishable Revolutions (Attr. 109)

The object displays the number of revolutions which can be received by the multi turn encoder. The value depends on the encoder type.

Data contents:

Byte 0	Byte 1
$2^7 ... 2^0$	$2^{15} ... 2^8$

5.6.10 Alarm Flag (Attr. 110)

The Alarm Flag bit indicates if any of the defined alarms is active.

5.6.11 Encoder Type (Attr. 111)

Code	Definition
01	Singleturn absolute rotary encoder
02	Multiturn absolute rotary encoder

5.6.12 Profile and software version (Attr. 112)

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

e.g.: Profile version: 1.00
　　　Binary code: 00000001 00000000
　　　Hexadecimal: 01h 00h

The following 16 bits contain the software version which is implemented in the encoder. It is combined to a revision number and an index.

e.g.: Software version: 1.20
　　　Binary code: 00000001 00100000
　　　Hexadecimal: 01h 20h

STRUCTURE OF PARAMETER

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

5.6.13 Offset Value (Attr. 113)

Attribute 113 contains the parameter offset value. The offset value is calculated by the preset function (see Attr. 106) and shifts the position value with the calculated value. The offset value is stored and can be read from the encoder.

5.7 Common Services

The Encoder Position Object provides the following common services.

Service Code	Implementation		Service Name	Description
	Class	Instance		
0x0E	Required	Required	Get_Attribute_Single	Returns the contents of a single specified attribute
0x10	Optional	Optional	Set_Attribute_Single	Modifies a single specified attribute
0x05	Optional	N/a	Reset	Resets all parameter values to the factory default
0x15	Optional	N/a	Restore	Restores all parameter values from non-volatile storage
0x16	Optional	N/a	Save	Saves all parameter to non-volatile storage

6 Connecting the Encoder to the bus

6.1   Warnings

⚠ The proper EMC-values are only valid for DeviceNet specified cables .

⚠ Transient peaks on power supply leads have to be limited by the connected power unit to a maximum of 1000V. The DeviceNet cable must be grounded in the power tap.

⚠ At the power input the screen of the DeviceNet cable must be grounded galvanic. At the encoder end, the screen must be separated and may not have a galvanic connection to the encoder
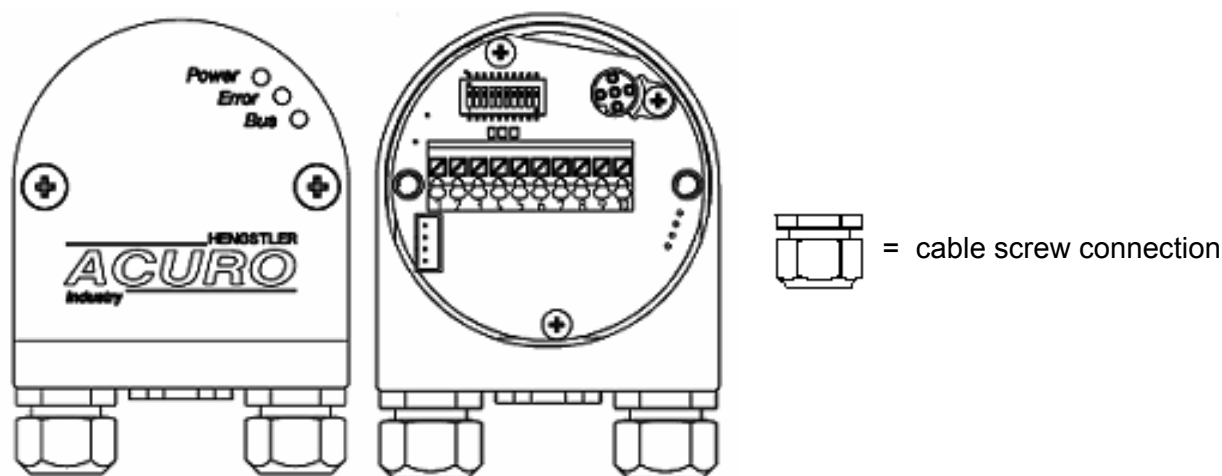
⚠ The continuous CAN bus between CAN_H and CAN_L has to terminated at both ends with an active termination resistance.

6.2   Connection types

There are three different connection types available. The following chapters are describing how to connect each connection type.

Connection type	page
Bus terminal box with two cable screw connetions	20
Bus terminal box with two cable screw connections and M12 connector	21
Bus terminal box with M12x1-Connector 5-Pole	22

6.2.1 Bus terminal box with two cable screw connections

= cable screw connection

⇒ Loosen the screws and draw off the bus terminal box from the encoder.

⇒ **View: into the open bus terminal box**

Lead the incoming DeviceNet cable through the left screw connection and connect it to terminal 1 (UB in (10...30V)), terminal 2 (0V in), terminal 3 (CAN-L), terminal 4 (CAN-H) and terminal 5 (Drain). (see connection diagramm, page 23). Isolate the cable screen on the PG screw connection (see cable connection diagram, page 23).

The DRAIN wire must be connected to the bus terminal box. The encoder flange has to be connected to ground. The screen must be separated and may not have galvanic connection to the encoder.

⇒ In case there are no other devices following in the same trunk bus line:
Activate the bus termination resistor in the bus terminal box (DIP switches 9 and 10 from S1 to "ON")
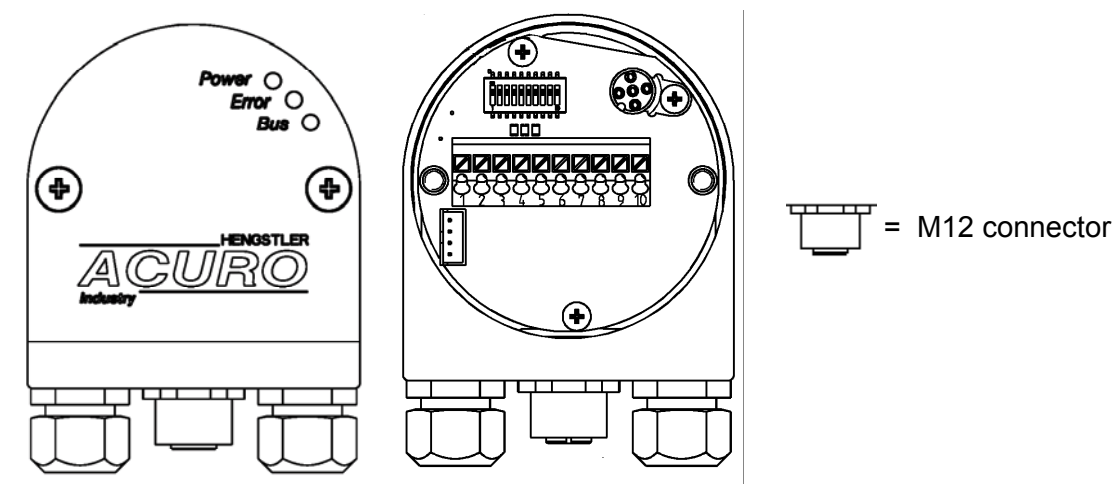***Replace right cable screw connection by screw plug to ensure the encoder is sealed!***.

⇒ In case there are other devices following in the same trunk bus line:
Lead the continuing cable trough the right cable screw connection and connected it to terminal 6 (Drain), terminal 7 (CAN-H), terminal 8 (CAN-L), terminal 9 (0V out) and terminal 10 (UB out (10…30V)) (see connection diagramm, page 23). Isolate the cable screen on the PG screw connection (see cable connection diagram, page 23).

⇒ Attach terminal box at the encoder and tighten the screws.

6.2.2 Bus terminal box with two cable screw connections and a M12 connector

= M12 connector

$\Rightarrow$ Loosen the screws and draw off the bus terminal box from the encoder.

$\Rightarrow$ **View: into the open bus terminal box.**

$\Rightarrow$ Lead the incoming DeviceNet cable through the left screw connection and connect it to terminal 1 (UB in (10...30V)), terminal 2 (0V in), terminal 3 (CAN-L), terminal 4 (CAN-H) and terminal 5 (Drain). (see connection diagramm, page 23). Isolate the cable screen on the PG screw connection (see cable connection diagram, page 23).

> ⚠ The DRAIN wire must be connected to the bus terminal box. The encoder flange has to be connected to ground. The screen must be separated and may not have galvanic connection to the encoder.

$\Rightarrow$ In case there are no other devices following in the same trunk bus line:
Activate the bus termination resistor in the bus terminal box (DIP switches 9 and 10 from S1 to "ON")
***Replace right cable screw connection by screw plug to ensure the encoder is sealed!***.

$\Rightarrow$ In case there are other devices following in the same trunk bus line:
Lead the continuing cable trough the right cable screw connection and connected it to terminal 6 (Drain), terminal 7 (CAN-H), terminal 8 (CAN-L), terminal 9 (0V out) and terminal 10 (UB out (10…30V)) (see connection diagramm, page 23). Isolate the cable screen on the PG screw connection (see cable connection diagram, page 23).

$\Rightarrow$ Attach terminal box at the encoder and tighten the screws.
.

$\Rightarrow$ Connect Tico-Display (see 7.3) with M12 connector.

6.2.3 Bus terminal box with M12x1 connector 5 pole
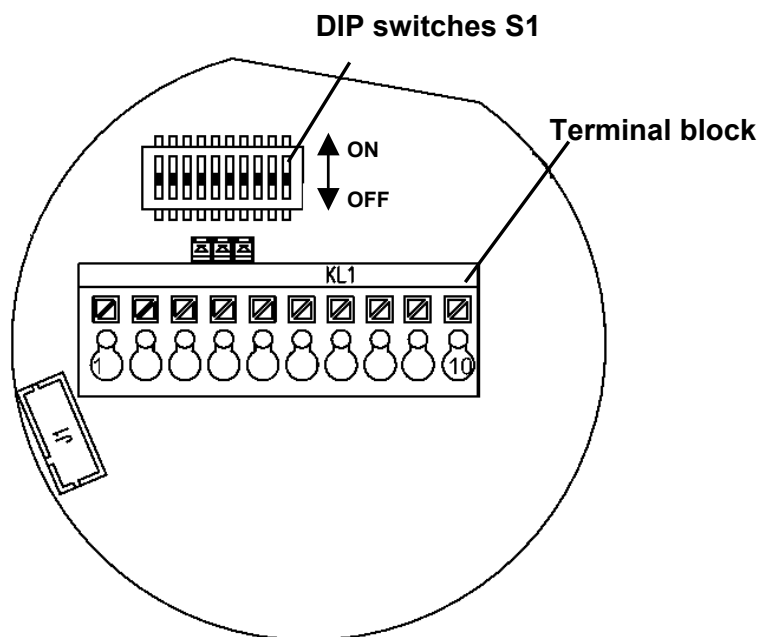

= M12x1 connector, 5 pole
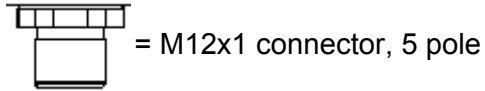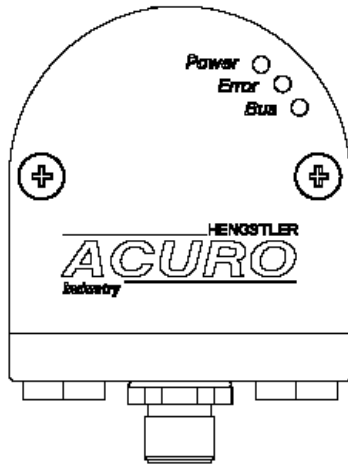
$\Rightarrow$ Connect the encoder to the bus trunk via a drop line

Terminal assignment:

PIN	Plug
1	DRAIN
2	UB in (10...30V)
3	0V in
4	CAN-H
5	CAN-L

6.3   Connection Diagram

Terminal assignment:

DIP switches S1

Terminal block

Terminal block KL 1 (10 pole)	
No.	Signal name
1	UB in (10…30V)
2	0V in
3	CAN-L
4	CAN-H
5	DRAIN
6	DRAIN
7	CAN-H
8	CAN-L
9	0V out
10	UB out (10…30V)

6.4   Cable connection diagram

ℹ remove screen

screwing   sealing   screw-down nut
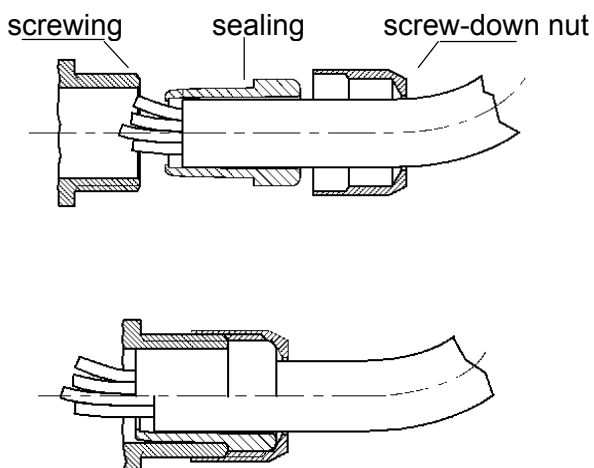
7 Control and display elements

7.1 DIP switches (S1)
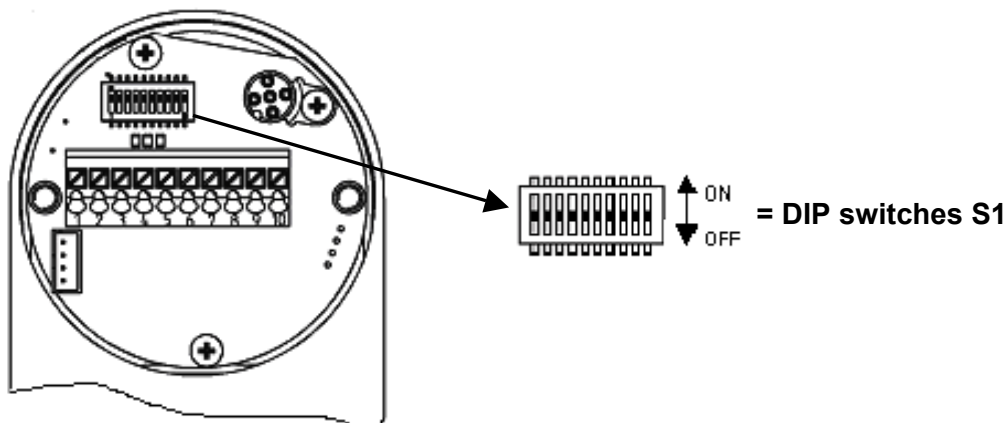
⇒ **The DIP switches are accessible after bus terminal box has been drawn off.**

The DIP switches:

- 1 to 6 from S1 set the MAC-ID,
- 7 and 8 from S1 set the Baud Rate,
- 9 and 10 from S1 activate the bus termination resistor.

ℹ The DIP switches will only be evaluated when running up the encoder (after Reset or Power up). A modification of the switch position has no effect until the next Reset/ Power up.

7.1.1 Setting the MAC-ID

The 6-Bit-MAC-ID is set by means of hardware via the DIP switches 1 to 6:

DIP switches	1	2	3	4	5	6
	MSB					LSB
value	32	16	8	4	2	1

DIP switch position: ON = 1, OFF = 0

ℹ **The permissible MAC-Id's range from 0 through 63.**
Each MAC-ID is to be used only once within the network!
Standard setting: DIP switches "ON", that means MAC-ID = 63.

7.1.2 Setting the Baud Rate

The baud rate is set over the DIP switches 7 and 8:

DIP switches (ON = 1, 0FF = 0)		Baud rate in KBit/s
DIP7	DIP8	
OFF	OFF	125
OFF	ON	250
ON	OFF	500
ON	ON	500 (Default)

● **The standard setting for the baud rate is**
ℹ **500 Kbit/s (DIP 7+8 = ON)**

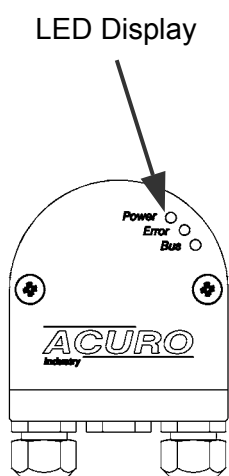### 7.1.3 Activating the bus terminal resistor

⟹ In case there are no other devices following in the same trunk bus line, set DIP switches 9 and 10 to "ON".

● Using an external termination resistor please note following requirements:
ℹ 120 Ohm, Metallfilm, min 0,25 W

● Using an external termination resistor the intern termination resistor has to be
ℹ deactivated (DIP switches 9 and 10 = OFF)

7.2 LED Display

LED Display

	LED	Meaning	Potential reasons
Power (green)	OFF	No Voltage supply	-under-voltage
	ON	Voltage supply OK	
Error (red)	OFF	Encoder provides correct position data	
	blinking	Encoder provides wrong position data	- Bus to encoder connection interrupted - Valid LED current regulation range exceeded
Bus (green)	OFF	Connection to master interrupted	- Data line interrupted - Data line misconnected
	blinking	Connection to Master; „Duplicate MAC ID check successful" ; Status: "no explicit connection"	
	ON	Connection to Master; Status: "explicit connection"	

7.3 Tico display

With the version bus terminal box an M12 connector a Tico display can be delivered

7.3.1 Display with proper connection

⇒ Connect Tico bus display with M12 connector
⇒ Switch on

⇒ On the display appears every three seconds:

1. `Fr. 15.0 1.03.` Software-Permit-Date
For ex. 15.01.03

2. `d_NEt` Bus type (DeviceNet)

3. `NodE: 002` Node
For ex. 002

7.3.2 Error messages
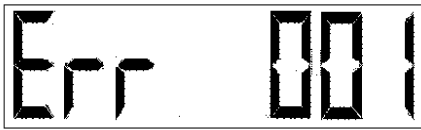
 Communication problem of the encoder and the bus interface
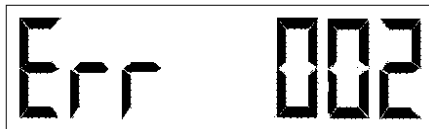
 Encoder reports a hardware failure

7.3.3 Pin out

Encoder:

PIN	description
1	UB + (supply for Tico)
2	Clock (Count input)
3	0V
4	Data (reset input)
5	n.c.

Tico:

PIN	description
4	Data
3	Clock
2	UB -
1	UB +

8 Initial Operation Procedure

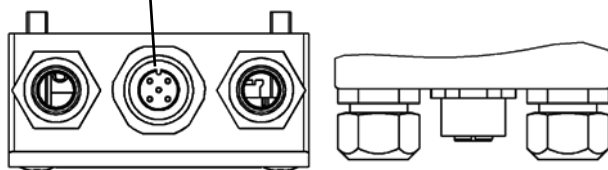Requirements: The encoder has to be properly connected, the MAC-ID and the Baud Rate have been correctly set (see chapter 7.1 und 7.2).

8.1 Switching on the Supply Voltage

After having switched on the supply voltage, the shaft encoder will be initialized and will be set to the status pre-operational.
The parameters of the object directory will be loaded from the EEPROM into the encoder's main memory (RAM) by the initializing routine.

If the encoder has not yet been programmed, all parameters are set to standard values.
If the encoder has already been programmed, the encoder uses the last-stored values in the EEPROM.

8.2 Programming the Encoder

The so-called EDS-file (Electronic Data Sheet Specification) serves as an aid for the application of standard DeviceNet tools and is either available an disk under Item no. 1 543 083 or as download file on our homepage.
The EDS-file contains the available encoder parameters.

Example for the initial operation procedure and programming using the standard DeviceNet-tools and the EDS-file.
(here: DeviceNet Manager of Allen-Bradley):
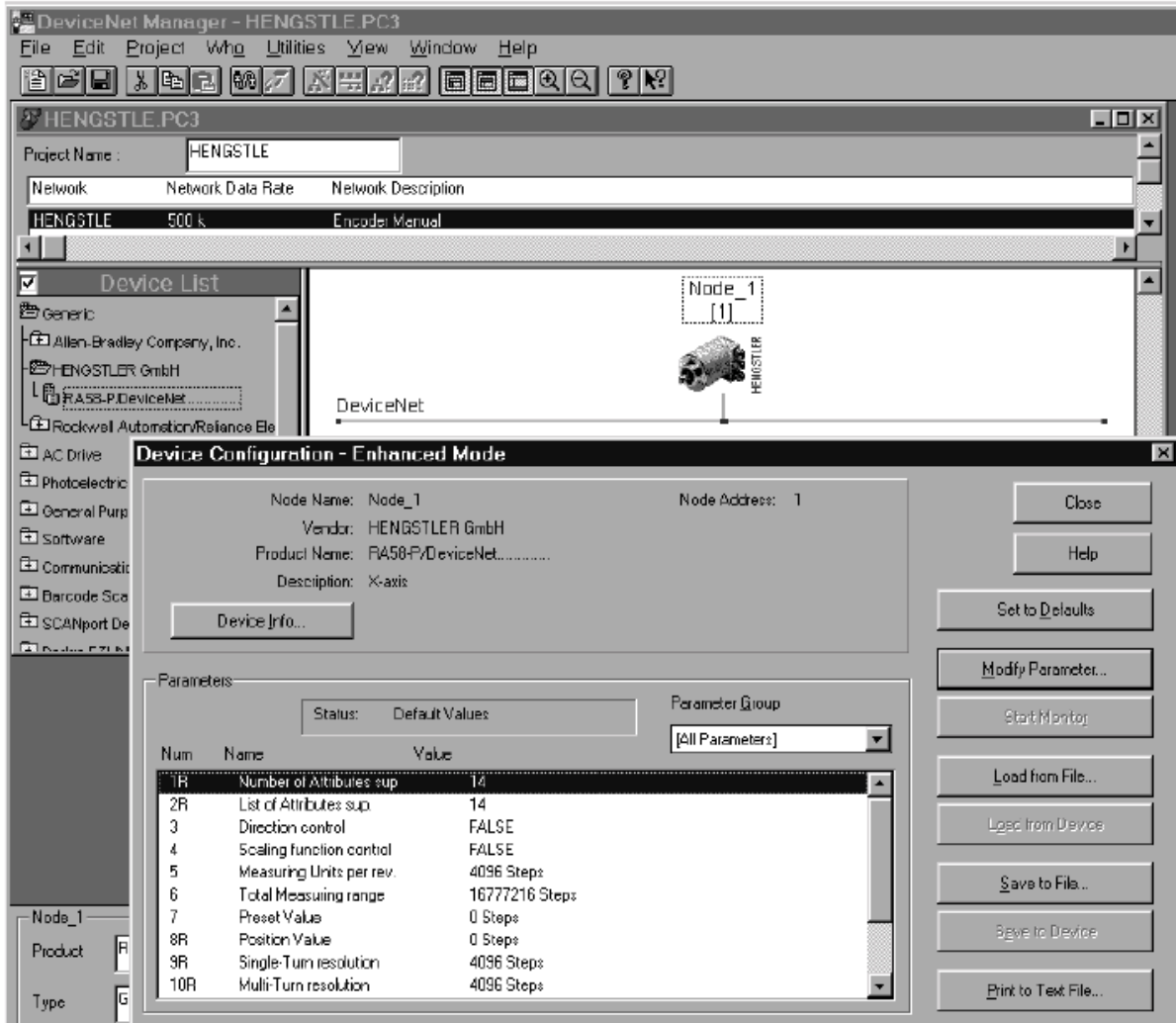
Pushing the "Save to device"-button the edited parameters will be transmitted to the encoder. Notice that all the transmitted values will be lost by switching off and switching on because the values are saved in the RAM of the encoder.

If you have found the right parameters the parameters can be saved in the EEPROM by selecting the menu entry "Utilities"➔ "Basic Device Configuration". The selected node number of the Encoder must be registered in the field "Device Node Address". as well as following specific parameters (see screenshots next page):

Command "save parameters to the EEPROM:"

Put in device node address

Class: 100
Instance: 0
Attribute: 0

Service Code Save: 22

Send command via the "save to
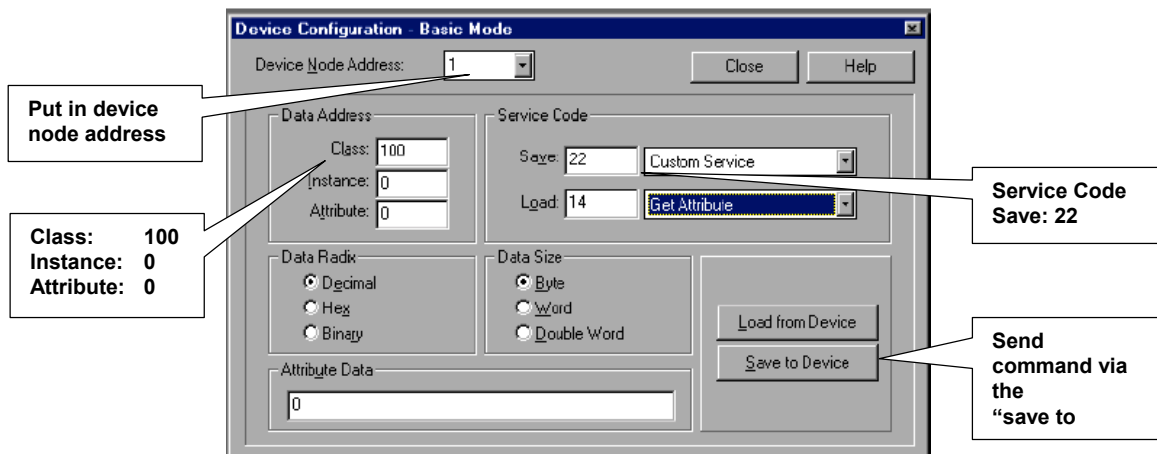
Command "Reset the encoder RAM to default setting:"

Put in device node address

Class: 1
Instance: 1
Attribute: 1

Service Code Save: 5

Send command via the "save to
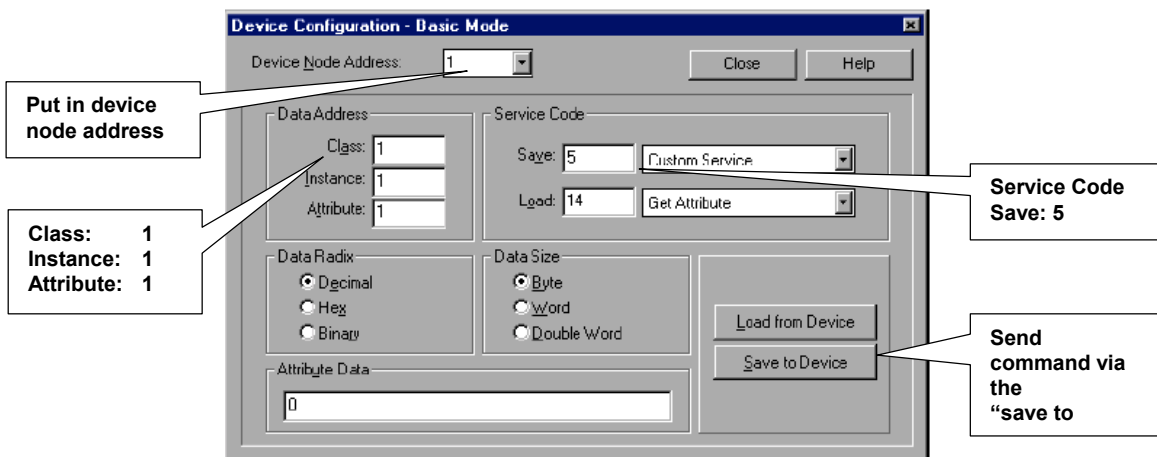
Command "Set the encoder RAM to EEPROM values:"

Put in device node address

Class: 1
Instance: 1
Attribute: 0

Service Code Save: 5

Send command via the "save to
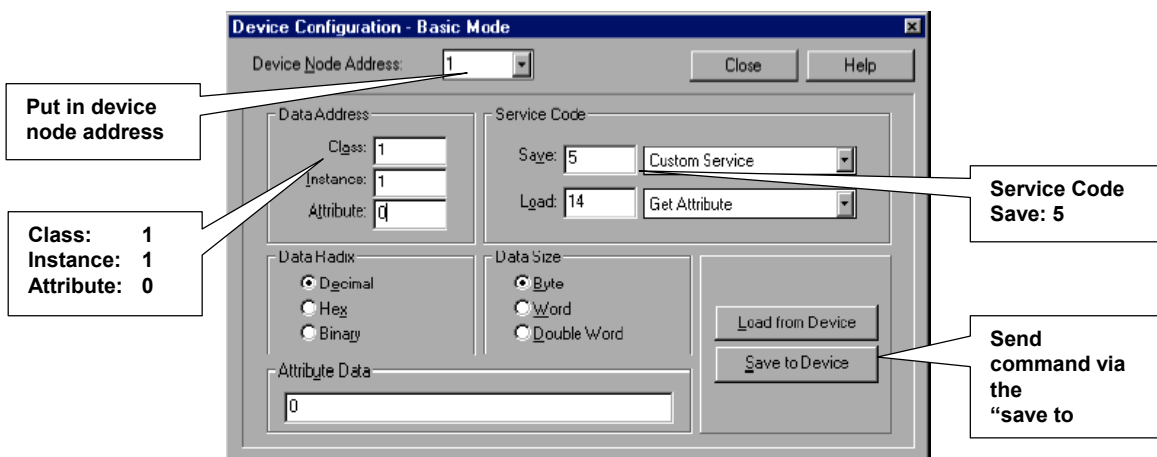
8.2.1 Overview Standard Values

In order to administer the identifiers more easily DeviceNet uses the „Predefined Master/Slave Connection Set".

However, the following parameters can be reprogrammed via Explicit Messaging Service according to the customers' needs

Attribute ID	Name	Standard Values
102	Code Sequence	0 = CW
103	Scaling function control	Bit = 0, scaling disabled
104	Measuring units per revolution	Physical resolution per revolution
105	Total measuring range	Physical total resolution
106	Preset value	No preset

ℹ **In order to save the modified parameters with no-volt protection, they have to be transferred to EEPROM via code 22 (0x16h) (see page 28).**

The original standard values (Default values on delivery) can be reloaded by means of service code 5 (0x505h) (see page 28).

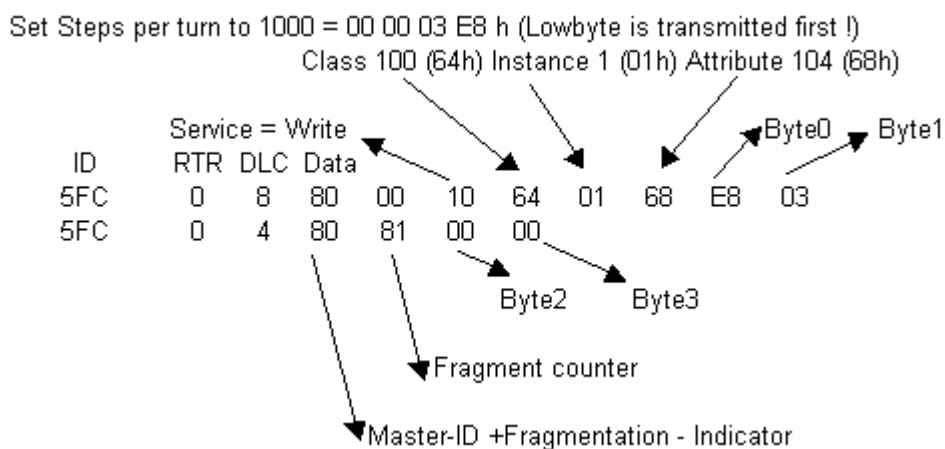**Attention: The data previously stored in the encoder RAM will be overwritten by this procedure!**
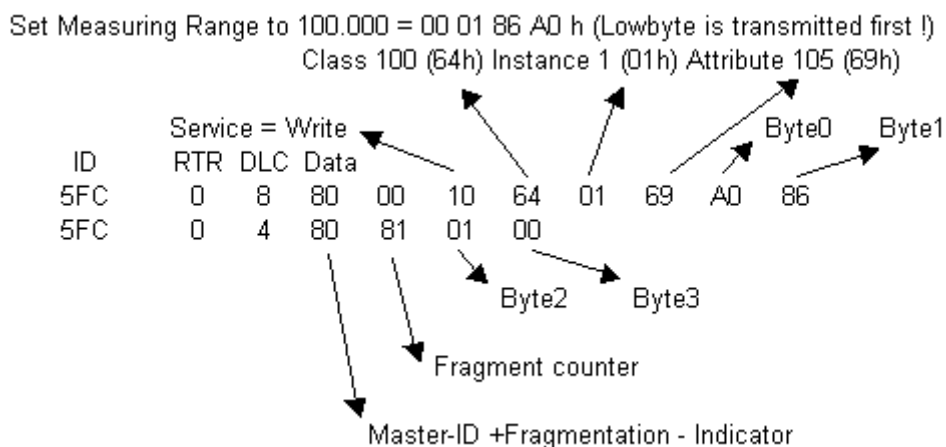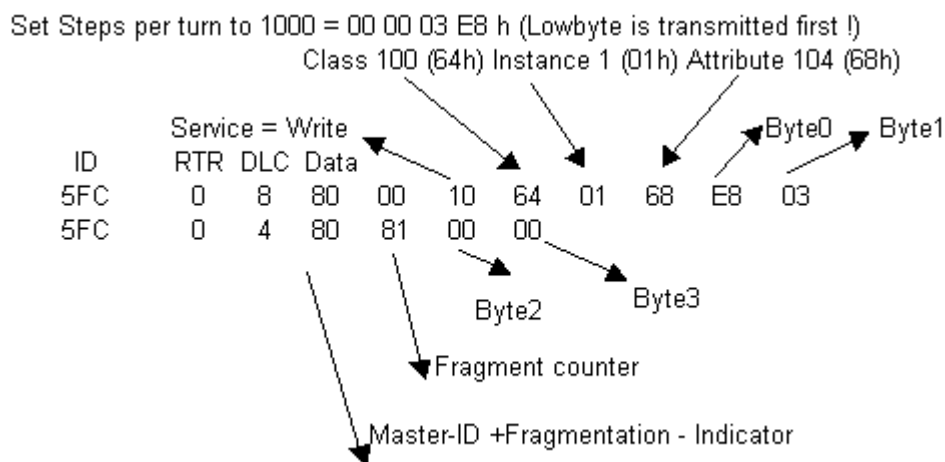
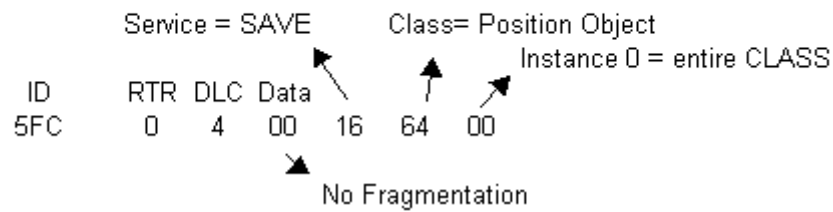## 8.3 Example for scaling and storing to EEPROM

Master MAC - ID = 0
Slave MAC - ID = 63   (Note: All data values in HEX)

Enable Scaling: Set Class 100 (64h) Instance 1 (01h) Attribute 103 (67h) to 01h

```
     ID     RTR  DLC  Data
     5FC     0    6   00  10  64  01  67  01
```

Service = Write

Lower 6 Bits is Master ID

Set Steps per turn to 1000 = 00 00 03 E8 h (Lowbyte is transmitted first !)
Class 100 (64h) Instance 1 (01h) Attribute 104 (68h)

Service = Write   Byte0   Byte1

ID	RTR	DLC	Data						
5FC	0	8	80	00	10	64	01	68	E8	03
5FC	0	4	80	81	00	00

Byte2   Byte3

Fragment counter

Master-ID +Fragmentation - Indicator

Set Measuring Range to 100.000 = 00 01 86 A0 h (Lowbyte is transmitted first !)
Class 100 (64h) Instance 1 (01h) Attribute 105 (69h)

Service = Write   Byte0   Byte1

ID	RTR	DLC	Data						
5FC	0	8	80	00	10	64	01	69	A0	86
5FC	0	4	80	81	01	00

Byte2   Byte3

Fragment counter

Master-ID +Fragmentation - Indicator

Set Steps per turn to 1000 = 00 00 03 E8 h (Lowbyte is transmitted first !)
Class 100 (64h) Instance 1 (01h) Attribute 104 (68h)

Service = Write   Byte0   Byte1

ID	RTR	DLC	Data						
5FC	0	8	80	00	10	64	01	68	E8	03
5FC	0	4	80	81	00	00

Byte2   Byte3

Fragment counter

Master-ID +Fragmentation - Indicator

Save Parameters nonvolatile to EEPROM:

Service = SAVE   Class= Position Object

Instance 0 = entire CLASS

ID   RTR DLC Data
5FC   0   4   00   16   64   00

No Fragmentation

Set encoder RAM to EEPROM values:

Service = RESTORE   Class= Position Object

Instance 0 = entire CLASS

ID   RTR DLC Data
5FC   0   4   00   15   64   00

No Fragmentation
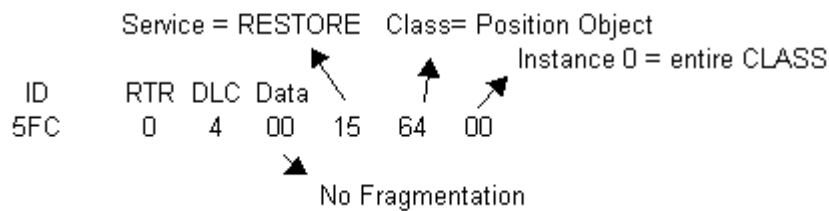
Reset encoder RAM to factory defaults:

Service = RESET   Class= Position Object

Instance 0 = entire CLASS

ID   RTR DLC Data
5FC   0   4   00   5   64   00

No Fragmentation
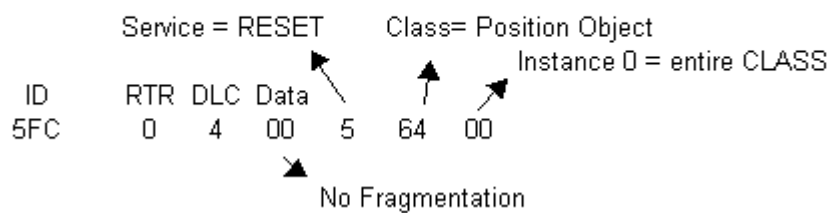
9 Technical data

9.1 Mechanical

Max. shaft load	axial 20 N, radial 40 N (6 mm shaft) axial 40 N, radial 60 N (10 mm shaft)
Max. revolution per minute	12000 min^{-1} (short-time), 10000 min^{-1} (permanent operation)
Torque	$\leq$ 0.5 Ncm
Moment of inertia	Synchro flange: 14 gcm^2; clamping flange: 20 gcm^2
Protection class (EN 60529)	IP 64, IP67
Operating temperature	-40... +85 °C
Storage temperature	-40... +85 °C
Vibration resistance (IEC 68-2-6)	100 m/s^2 (10 - 500 Hz)
Shock resistance (IEC 68-2-27)	1000 m/s^2 (6 ms)
Connections	Bus terminal box with • 2 x screw connections • 2 x screw connections + M 12 connector for Tico • M12x1 connector, 5 pole
Material steel	High-grade steel
Material housing	Aluminium
Weight	Multiturn approx. 400 g ., Singleturn approx. 350 g .

9.2   Electrical

The encoder contains a non-isolated physical layer.
The encoder is an isolated node, which means that there is no current flow between V and earth ground. The drain connection is connected through a parallel R-C to the device enclosure.

General design	According to EN 61010-Teil 1, protection class III, contamination level 2, over voltage category II
Voltage supply	10 ... 30 V DC (SELV)
Induced current absorption	Max. 0,2 A;
Recommended external fuse	T 0,25 A
Current for fed-through supply voltage; recommended external fuse	3A via V+ und V- T 3 A
EMC*	Interference emission according to EN 50081-2 Interference immunity according to EN 50082-2
Interface	CAN High-Speed according to ISO/DIS 11898 CAN specification 2.0 B (11- und 29-Bit-Identifier)
Protocol	DeviceNet according to Rev. 2.0, programmable encoder

* Important notice :

1. EMC values are only valid in case the instructions for screening have been observed (see chapter 2 und 6.4)

2. The encoder is designed to be connected to a power supply unit. In case that the encoder is connected to DC voltage, it has to be protected against surge voltage.

3. In an environment with strong pulsed interferences a validity check of the position values is recommended

Continuation of electrical data

Physical resolution**	1024 Increments (10 Bit) single turn 4096 Increments (12 Bit) single turn 8192 Increments (13 Bit) single turn 16384 Increments (14 Bit) single turn 4096 Schritte/4096 Umdrehungen (24 Bit) multi turn 8192 Schritte/4096 Umdrehungen (25 Bit) multi turn 16384 Schritte/4096 Umdrehungen (26 Bit) multi turn
Linearity	$\pm$ ½ LSB ($\pm$ 1 LSB at a resolution 13, 14, 25, 26 Bit)
Type of code	Binary
Updating the values	Each 5 milliseconds
MAC-ID	Set via DIP switches
Baudrate	Set via DIP switches to 125, 250, 500 Kbit/s
Busablschlusswiderstand	Set via DIP switches

** resolution of the encoder disk; in addition, the desired resolution can be minimized by programming the encoder.
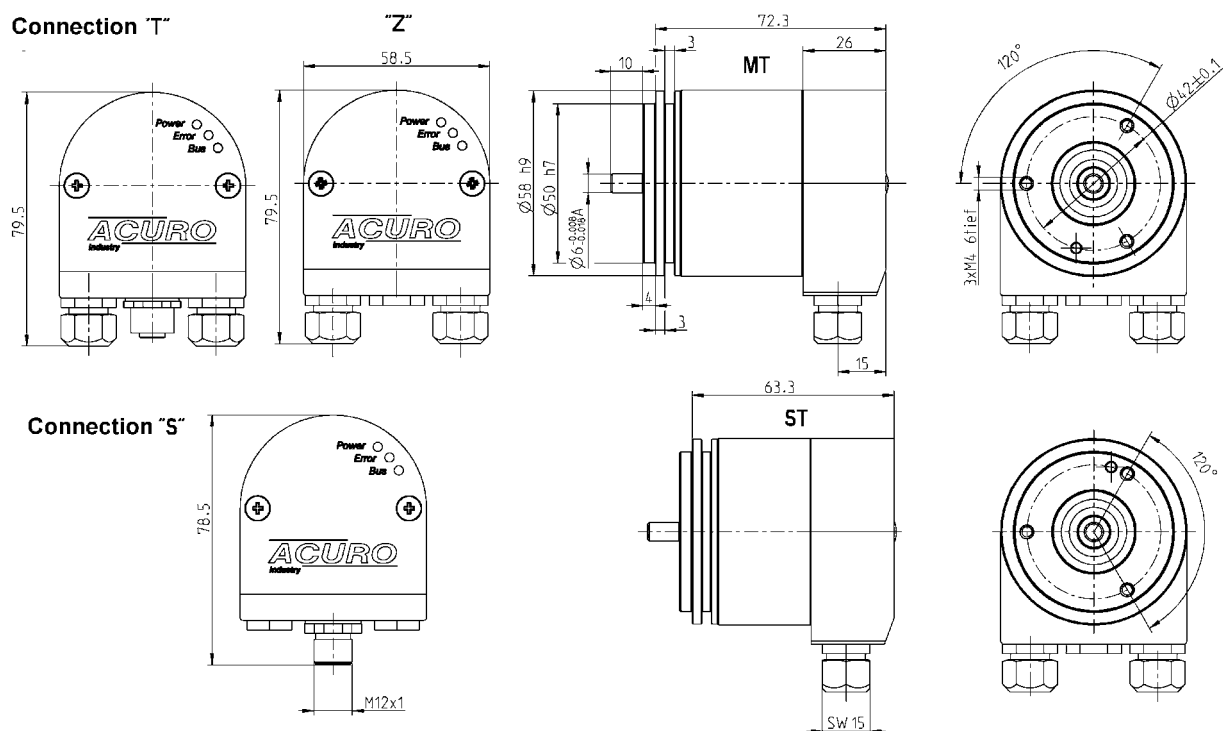
10   Dimensioned drawings

10.1   Synchro flange

S Bus terminal box with M12 5 pole, radial
Z Bus terminal box with 2 x cable screw connectors
T Bus terminal box with 4 pole M12 for "Tico" indicator + 2 x cable screw connectors

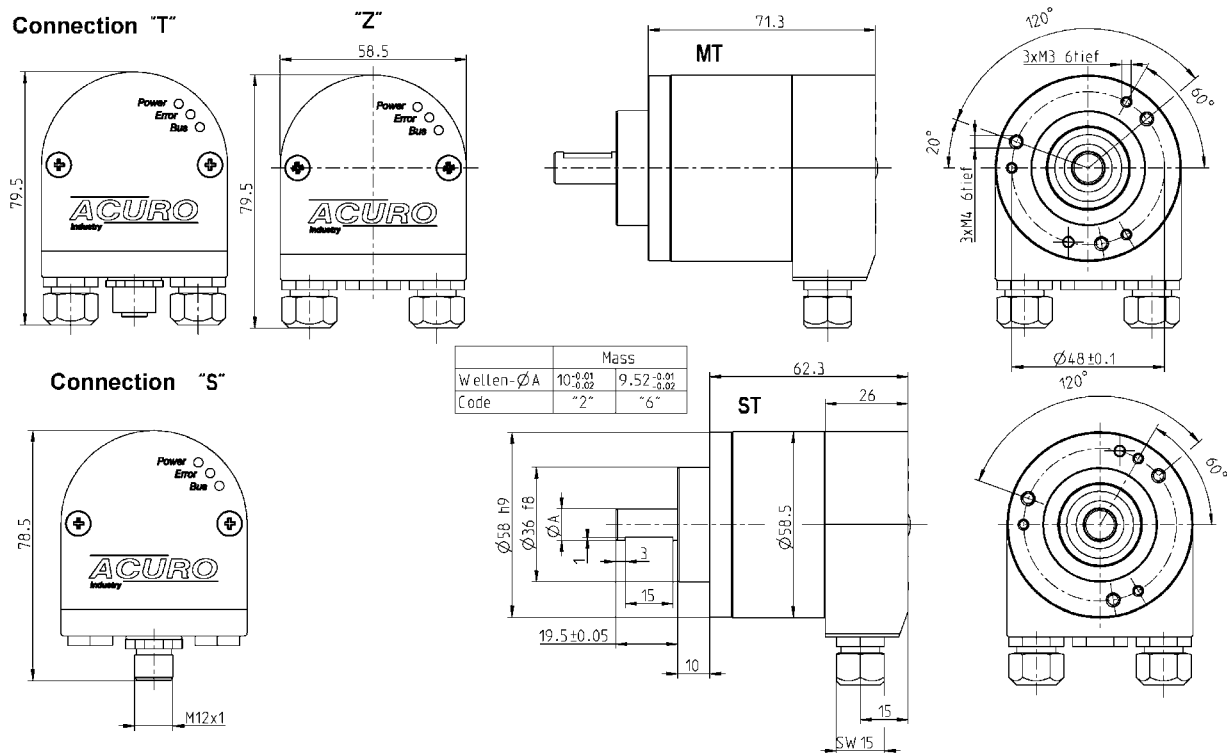**i** The cable screw connections require cable diameters in a range from:
7.0…7.4 mm.

i Bus cables with a diameter of 7.9…8.7 mm can be used, if the standard sealing are
replaced by the enclosed sealing, which have a larger diameter.

10.2 Clamping flange

S Bus terminal box with M12 5 pole, radial
Z Bus terminal box with 2 x cable screw connectors
T Bus terminal box with 4 pole M12 for "Tico" indicator + 2 x cable screw connectors

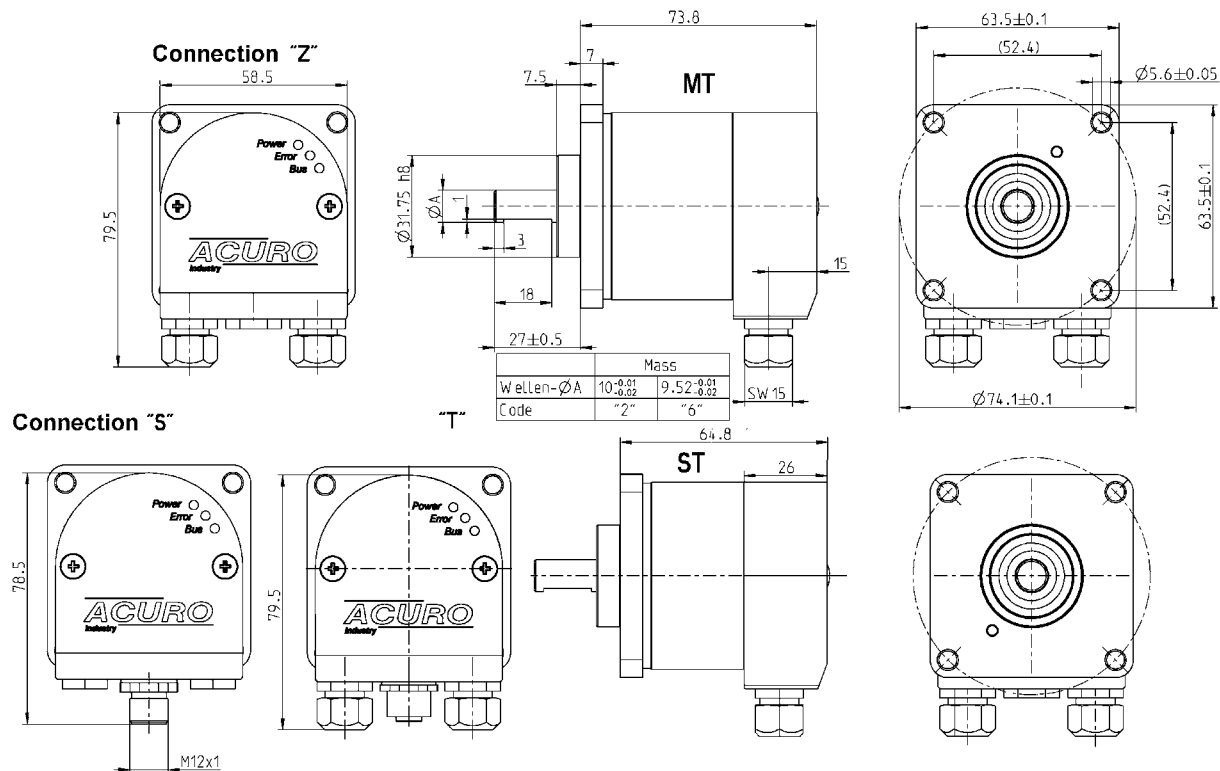The cable screw connections require cable diameters in a range from:
7.0…7.4 mm.

Bus cables with a diameter of 7.9…8.7 mm can be used, if the standard sealing are
replaced by the enclosed sealing, which have a larger diameter.

10.3 Quadrat flange

S Bus terminal box with M12 5 pole, radial
Z Bus terminal box with 2 x cable screw connectors
T Bus terminal box with 4 pole M12 for "Tico" indicator + 2 x cable screw connectors

	Mass	
Wellen-ØA	10 $^{-0.01}_{-0.02}$	9.52 $^{-0.01}_{-0.02}$
Code	"2"	"6"

> ℹ The cable screw connections require cable diameters in a range from: 7.0…7.4 mm.

> ℹ Bus cables with a diameter of 7.9…8.7 mm can be used, if the standard sealing are replaced by the enclosed sealing, which have a larger diameter.