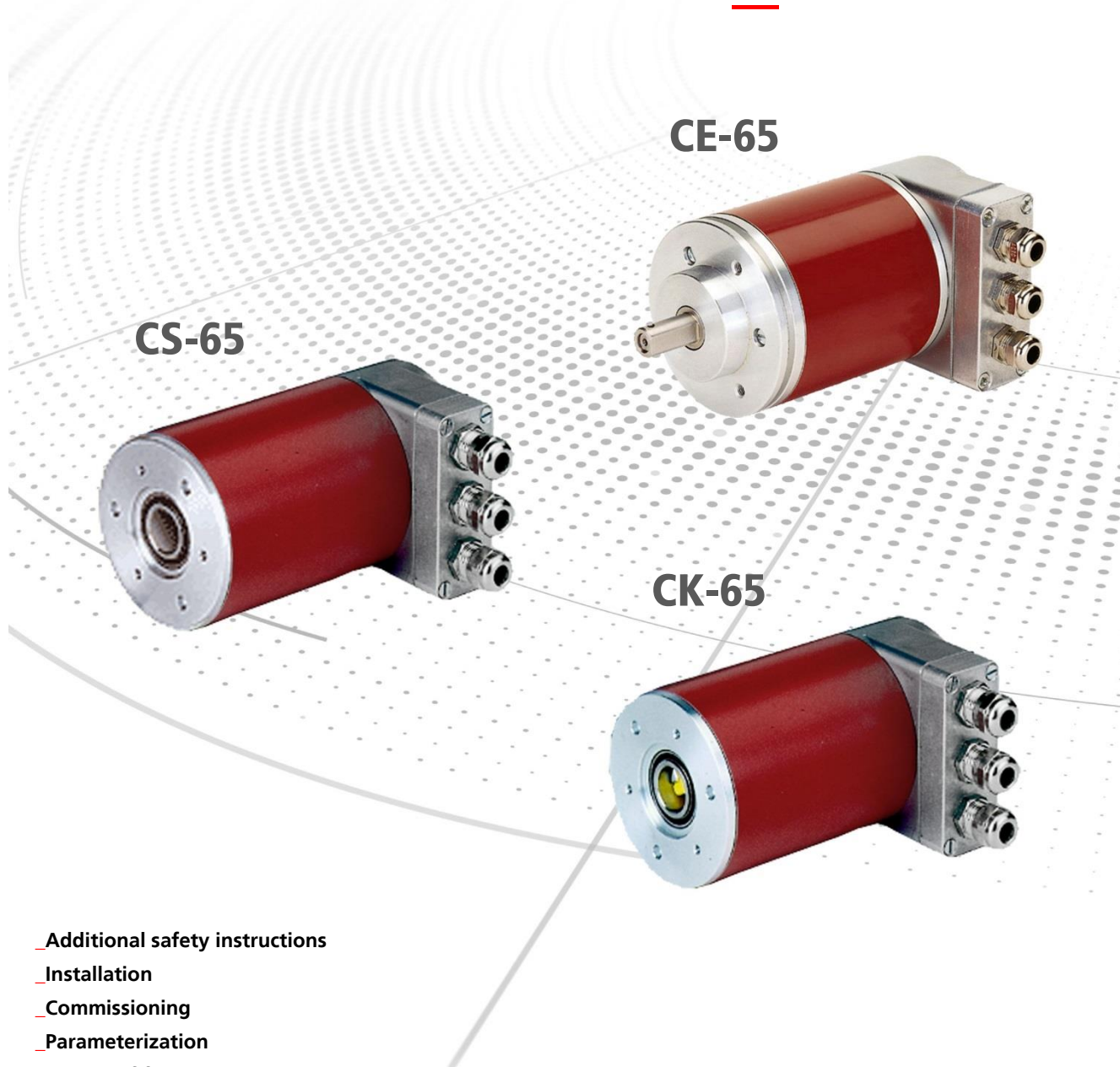


DeviceNet™

- +Preset
- +Adjustment

Absolute-Encoder C_-65



- _Additional safety instructions
- _Installation
- _Commissioning
- _Parameterization
- _Causes of faults and remedies

User Manual

TR-Electronic GmbH

D-78647 Trossingen

Eglishalde 6

Tel.: (0049) 07425/228-0

Fax: (0049) 07425/228-33

email: info@tr-electronic.de

www.tr-electronic.com

Copyright protection

This Manual, including the illustrations contained therein, is subject to copyright protection. Use of this Manual by third parties in contravention of copyright regulations is not permitted. Reproduction, translation as well as electronic and photographic archiving and modification require the written content of the manufacturer. Violations shall be subject to claims for damages.

Subject to modifications

The right to make any changes in the interest of technical progress is reserved.

Document information

Release date / Rev. date:	03/11/2016
Document / Rev. no.:	TR - ECE - BA - GB - 0027 - 03
File name:	TR-ECE-BA-GB-0027-03.docx
Author:	MÜJ

Font styles

Italic or **bold** font styles are used for the title of a document or are used for highlighting.

`Courier` font displays text, which is visible on the display or screen and software menu selections.

" < " > " indicates keys on your computer keyboard (such as <RETURN>).

Brand names

DeviceNet is a trademark of ODVA, Inc.

Contents

Contents	3
Revision index	5
1 General information	6
1.1 Applicability	6
1.2 Abbreviations used / Terminology	7
2 Additional safety instructions	8
2.1 Definition of symbols and instructions	8
2.2 Additional instructions for proper use	8
2.3 Organizational measures	9
3 Technical data.....	10
3.1 Electrical characteristics	10
4 DeviceNet™ information.....	11
5 Installation / Preparation for start-up	13
5.1 Connection.....	14
5.2 Bus termination	14
5.3 Identifier (MAC-ID)	14
5.4 Baud rate	14
5.5 Shield cover	15
6 Commissioning.....	17
6.1 CAN interface.....	17
6.1.1 Bus status	17
6.1.2 EDS file	18
6.1.3 Messages.....	18
6.1.4 Classes	18
6.1.5 I/O Instance (polled IO)	19
7 Parameterization and configuration	21
7.1 Configuration Assembly Data Attribute Format	21
7.1.1 Assembly Object 04h	21
7.2 Parameter Object Instances	23
7.2.1 Parameter Object 0Fh.....	23
7.2.2 GET DATA CHECK - command	24

7.3 Parameters / Range of values	24
7.3.1 Direction	24
7.3.2 Output Code	24
7.3.3 Scaling parameters	25
7.3.4 Adjust Absolute Value	28
7.3.5 Auxiliary Outputs 1 - 7	28
7.3.5.1 Definition of the operating- and safety-range	29
7.3.6 Value for Preset 1 and 2	30
8 Causes of faults and remedies	31
8.1 Error and over-range messages (I/O communication port)	31
8.2 Parameterization errors	31
8.3 Other faults	33
 Pin assignment downloads	
With galvanic isolation	www.tr-electronic.com/f/TR-ECE-TI-GB-0036
Without galvanic isolation	www.tr-electronic.com/f/TR-ECE-TI-GB-0056

Revision index

Revision	Date	Index
First release	25/01/02	00
General modifications	03/17/10	01
New design	12/17/15	02
DeviceNet TM logo and trademark updated	03/11/16	03

1 General information

This interface-specific User Manual includes the following topics:

- Safety instructions in addition to the basic safety instructions defined in the Assembly Instructions
- Electrical characteristics
- Installation
- Commissioning
- Parameterization
- Causes of faults and remedies

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

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

1.1 Applicability

This User Manual applies exclusively to the following measuring system models with **CAN DeviceNet™** interface:

- CE-65
- CS-65
- CK-65

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

The following documentation therefore also applies:

- the operator's operating instructions specific to the system,
- this User Manual,
- and the assembly instructions [TR-ECE-BA-DGB-0046](#), which is enclosed when the device is delivered

1.2 Abbreviations used / Terminology

CAN	C ontroller A rea N etwork (manufacturer independent, open field bus standard)
CiA	CAN in Automation (CAN User Organization, "Holding organization")
CE	Absolute Encoder with optical scanning unit, Solid Shaft
CK	Absolute Encoder with optical scanning unit, Integrated Claw Coupling
CS	Absolute Encoder with optical scanning unit, Blind Shaft
DeviceNet™	CAN protocol, defined in the Application Layer (layer 7)
DUP- MAC-ID-Test	DUPLICATE-MAC-ID-Test Checking the master for duplicates of slave MAC-IDs. Each address of the connected slaves may occur only once.
EMC	E lectro M agnetic C ompatibility
EDS	E lectronic- D ata- S heet
MAC-ID	M edia A ccess C ontrol I dentifier (node address)
ODVA™	O pen D eviceNet V endor A ssociation (CAN User Organization, especially for DeviceNet™)

2 Additional safety instructions

2.1 Definition of symbols and instructions



means that death or serious injury can occur if the required precautions are not met.



means that minor injuries can occur if the required precautions are not met.

NOTICE

means that damage to property can occur if the required precautions are not met.



indicates important information or features and application tips for the product used.

2.2 Additional instructions for proper use

The measurement system is designed for operation with CAN DeviceNet™ networks according to the International Standard ISO/DIS 11898 and 11519-1 up to max. 500 kbit/s.

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



Proper use also includes:

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

2.3 Organizational measures

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

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

3 Technical data

3.1 Electrical characteristics

Supply voltage	11-27 V DC, twisted in pairs and shielded
Current load	< 200 mA at 11 V DC, < 110 mA at 27 V DC (unloaded)
Total resolution	≤ 24 bit (optional 25 bit)
Number of steps / revolution	≤ 8.192
Measurement range	
Standard	≤ 4.096 revolutions (12 bit)
Expanded	≤ 256.000 revolutions
Baud rate (adjustable)	125 kBaud, line length up to 500 m 250 kBaud, line length up to 250 m 500 kBaud, line length up to 100 m
Station addresses	0 – 63, adjustable via DIP switches
Transmission	twisted in pairs and shielded copper cable
CAN DeviceNet™ interface	CAN field bus interface (opto-isolated)
Data transmission	CAN bus driver (ISO/DIS 11898)
Terminating resistor	121 ohm, selectable via DIP switches
Special features	Programming of the following parameters via the CAN-BUS: - Direction of rotation - Output code (binary, gray) - Measuring length in steps - Measuring length in revolutions - Preset adjustment via bus - Adjustment - Preset value 1 - Preset value 2 - 7 special outputs
EMC	
Immunity to disturbance	DIN EN 61000-6-2
Transient emissions	DIN EN 61000-6-3

4 DeviceNet™ information

DeviceNet™ was developed by Rockwell Automation and the ODVA™ as an open field bus standard, based on the CAN protocol and is standardized in the European standard EN 50325. Specification and maintenance of the DeviceNet standard is regulated by the ODVA™. DeviceNet™, along with ControlNet™ and EtherNet/IP™, belongs to the family of CIP™-based networks. The CIP™ (Common Industrial Protocol) forms a common application layer for these 3 industrial networks. DeviceNet™, ControlNet™ and EtherNet/IP™ are therefore well matched to one another and present the user with a graduated communication system for the physical layer (EtherNet/IP™), cell layer (ControlNet™) and field layer (DeviceNet™). DeviceNet™ is an object-oriented bus system and works according to the producer/consumer model.

DeviceNet™ Protocol

The DeviceNet™ protocol is an object-oriented protocol. It is typically used for networking sensors and actuators with the superordinate automation devices (PLC, IPC).

DeviceNet™ Data Link Layer

Layer 2 (Data Link Layer) is based on the Controller Area Network (CAN), which was originally designed for use in motor vehicles.

DeviceNet™ Network and Data Transport Layer

The link is set up with the Group 2 Unconnected Port. Selected CAN identifiers are used for the link set-up. A link, once set up, can be used for transmitting explicit messages or for setting up additional I/O links. As soon as an I/O link has been set up, I/O data can be exchanged between the DeviceNet™ users. The 11 bit identifier is used exclusively for coding I/O data. The 8-byte wide CAN data field is fully available for user data.

DeviceNet™ Application Layer – CIP™ Protocol

The CIP™ (Common Industrial Protocol) forms the application layer for DeviceNet™. The CIP™ defines the exchange of I/O data in realtime via I/O messages (I/O messaging or implicit messaging), as well as the exchange of data required for configuration, diagnosis and management via explicit messages (explicit messaging). The communication between two devices always takes place according to a connection-oriented communication model, either via a point-to-point or a multicast-V1 connection. This allows both master/slave and multi-master systems to be realized. Data are known as objects and are logged in the object directory of each device.

Predefined Master-Slave Connection Set

The so-called "Predefined Master/Slave Connection Set" is used for the DeviceNet™ measuring system. This subset of the DeviceNet™ protocol simplifies the transmission of I/O data between an automation system (PLC) and the decentralized peripheral devices (slaves): Only "Group2 Messages" are supported, with the exception of "Group1 Message for Slave I/O Poll Response".

DeviceNet™ Device Profiles

Beyond the specification of the pure communication functions, DeviceNet™ also includes the definition of device profiles. These profiles define the respective device types for minimally available objects and communication functions. The device type number 08hex was defined for the DeviceNet™ measuring system.

Vendor ID

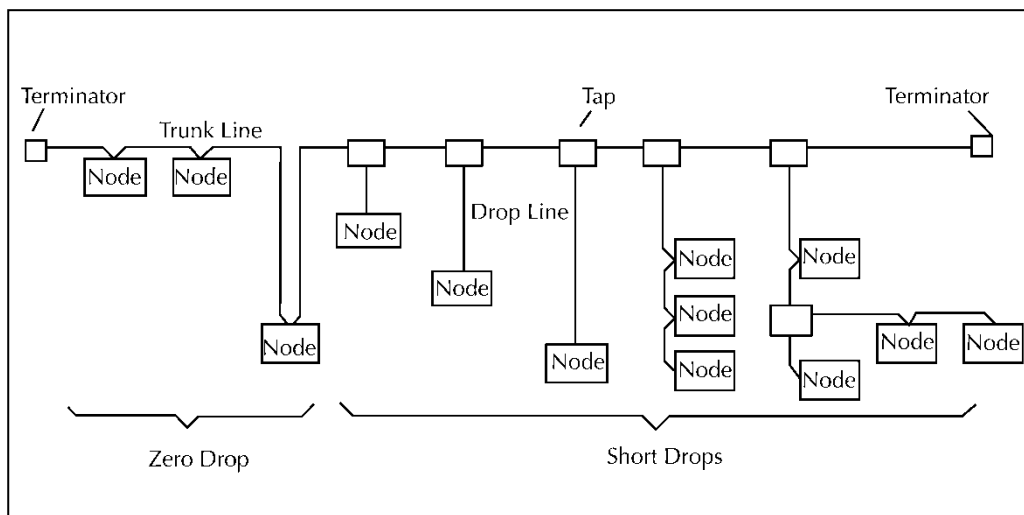
The vendor IDs (manufacturer's identifiers) are assigned and administrated by the ODVA™. The TR-Electronic vendor ID for DeviceNet™ is "134" (dec).

You can obtain further information on DeviceNet™ from the Open DeviceNet Vendor Association (ODVA) or the following Internet addresses:

<http://www.odva.org>
e-mail: <mailto:odva@odva.org>

5 Installation / Preparation for start-up

Up to 64 bus users can communicate with each other in a DeviceNet™ network with Baud rates of 125, 250 or 500 kbit/s. The DeviceNet™ cable provides both signals for CAN-L and CAN-H data transmission, as well as two lines for the 24 Volt operating voltage supply of the DeviceNet™ bus users. The maximum length of the DeviceNet™ cable is dependent on the type of cable selected and the Baud rate. Installation takes place in a bus topology – with or without taps – and terminators at both ends. The terminators have a resistance value of 120 Ohm.



Bus lines

The bus lines for the DeviceNet™ system are laid down in the DeviceNet™ specification. According to this specification, the maximum extent of a DeviceNet™ system is dependent on the Baud rate:

Cable length	125 kbit/s	250 kbit/s	500 kbit/s
Total length with thick cable	500 m	250 m	100 m
Total length with thin cable	100 m	100 m	100 m
Max. drop line length	6 m	6 m	6 m
Max. length of all drop lines	156 m	78 m	39 m



The DeviceNet™-specification and other applicable standards and guidelines are to be observed to insure safe and stable operation.

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

5.1 Connection

The connection hood must first be removed from the measuring system to undertake connection.

The pin assignments with view on the switches etc. are attached in the rear part of this document.



For the supply shielded cables with twisted core pairs and min. 0.5 mm² have to be used !

5.2 Bus termination

If the measuring system is the last slave in the CAN segment, the bus is to be terminated with the termination switch = ON. In this state, the subsequent CAN-bus is decoupled.

5.3 Identifier (MAC-ID)

The identifier (measuring system address) 0 – 63 is adjusted via 6 DIP-switches. The adjusted address may be assigned only once in the CAN bus.

5.4 Baud rate

The baud rate is adjusted via 2 DIP-switches.

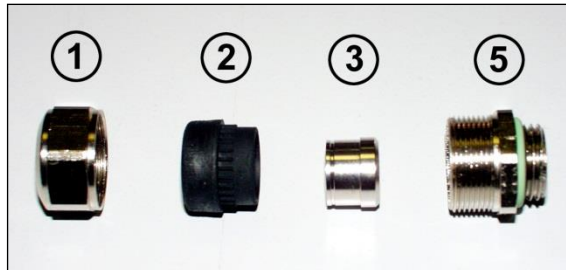
Following baud rates are possible:

- 125 kBaud
- 250 kBaud
- 500 kBaud

5.5 Shield cover

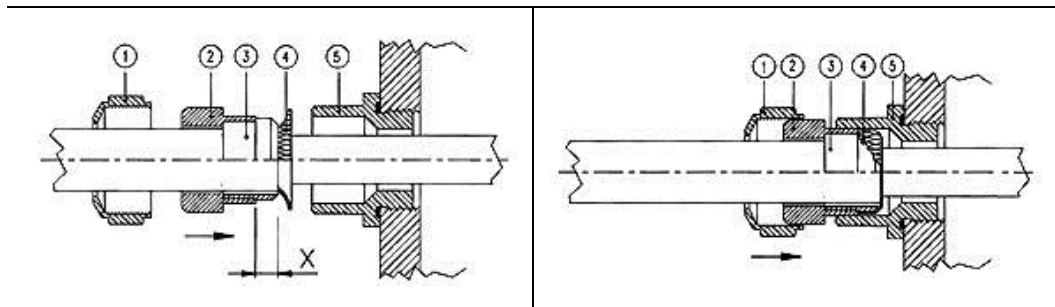
The shield cover is connected with a special EMC cable gland, whereby the cable shielding is fitted on the inside.

Cable gland assembly, variant A

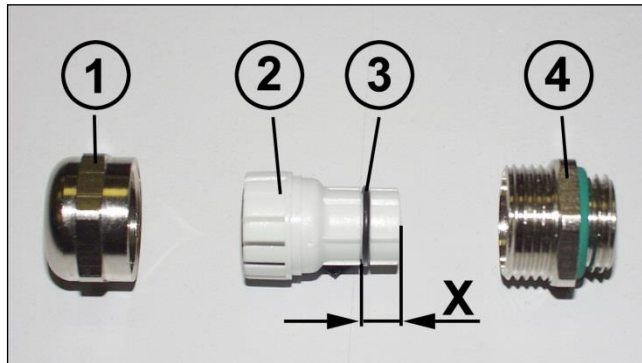


- Pos. 1 Nut
- Pos. 2 Seal
- Pos. 3 Contact bush
- Pos. 5 Screw socket

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

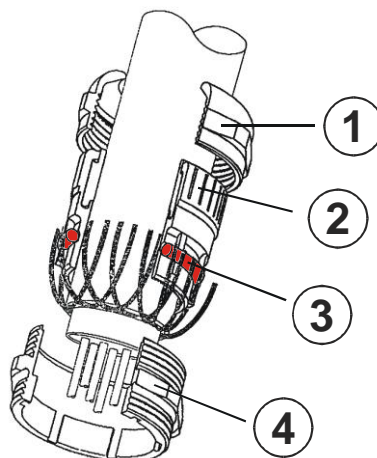


Cable gland assembly, variant B



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

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



6 Commissioning

6.1 CAN interface

The CAN field bus interface (separated via optoelectronics with CAN-BUS-Driver PCA82C250T) in the measuring system is determined according to the international standard ISO/DIS 11898 and covers the two lower layers of the ISO/OSI reference module.

The transformation of measuring system information into the CAN protocol occurs by the protocol chip PCA82C200. The function of the protocol chip is monitored by a watchdog.

The **PREDEFINED MASTER/SLAVE CONNECTION SET** is used for the measuring system who only works as a slave. It will be used only the **Group 2 Messages** with the exception of the **Group 1 Message For Slave I/O Poll Response**.

Establishing or breakdown of a connection must occur via **Group 2 Only Unconnected Explicit Request Message**.

The measuring system contains an **I/O Communication Port** and an **Explicit Message Communication Port**. The I/O communication port is used for polling the measuring system position and must be made accessible by setting the watchdog (after the I/O connection master/slave was set up before). Is the I/O port not retrIGGERED (polled) punctually the connection is interrupted and the red LED flashes. The connection for the I/O port must be installed again.



During programming, data is exchanged between the measuring system and the master in binary form.

6.1.1 Bus status

● = ON ○ = OFF ⊙ = FLASHING	
○	Measuring system is not online - no DUP-MAC-ID test - Device may not be powered
● green	Online, with connections in the established state - Device is allocated to a master
⊙ green	DUP-MAC-ID test successful - No allocation to a master
⊙ red	Recoverable faults e.g. I/O-connections are in the time-out state
● red	- Turn off system --> turn on system - Replace measuring system device

6.1.2 EDS file

The EDS (electronic datasheet) contains all information on the measuring system-specific parameters and the measuring system's operating modes. The EDS file is integrated using the DeviceNet™ network configuration tool to correctly configure or operate the measuring system. The EDS file has the file name "1.EDS".

"...\10.COD" for multi-turn measuring systems with max. 4096 steps/revolution

"...\11.COD" for multi-turn measuring systems with max. 8192 steps/revolution

Download:

- 10.COD: www.tr-electronic.de/f/TR-ECE-ID-MUL-0024
- 11.COD: www.tr-electronic.de/f/TR-ECE-ID-MUL-0025

6.1.3 Messages

Following messages are supported by the measuring system:

I/O Poll Command / Respond Message

This message is sent directly by the master to the desired slave (point-to point). For every slave which is polled the master must send an own poll command message. As response on a Poll Command the slave sends back to the master the Poll Response I/O Message.

Explicit Response / Request Message

Explicit Request Messages are used for processing of WRITE/READ-attribute's. Explicit Response Messages contains the result of an Explicit Request Message Service.

Group 2 Only Unconnected Explicit Request Message

Group 2 Only Unconnected Explicit Request Message serves for the establishing or breakdown of connections for the Predefined Master/Slave Connection Set.

Duplicate MAC ID Check Message

After switch-on the measuring system it reports Duplicate MAC ID Messages.

6.1.4 Classes

The communication objects are divided into classes. The measuring system supports the following classes:

Object Class	Number of instances
01h: Identity	1
02h: Message Router	1
03h: DeviceNet	1
05h: Connection	2
04h: Assembly	2
0Fh: Parameter	21
23h: Position Sensor	1

6.1.5 I/O Instance (polled IO)

Input Instance

Number	Name
1	Position value

Input Data Format

Instance	Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
1	0	D07	Low Byte Position value						D00
	1	D15	.						D08
	2	D23	.						D16
	3	High Byte Position value							
		7. AO	6. AO	5. AO	4. AO	3. AO	2. AO	1. AO	D24

AO = Auxiliary Output

Output Instance

Number	Name
1	Preset / Adjustment

Output Data Format

Instance	Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
1	0	D07	Low Byte Adjustment value						D00
	1	D15	.						D08
	2	D23	.						D16
	3	D31 Adjustment	D30 Preset 2	D29 Preset 1	X	X	X	X	D24

⚠ WARNING

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

NOTICE

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

To adjust the encoder to the internal stored preset 1 value, bit D29 of the out-byte 3 has to be set to "1". The out-bytes 0 to 2 are without importance.

To adjust the encoder to the internal stored preset 2 value, bit D30 of the out-byte 3 has to be set to "1". The out-bytes 0 to 2 are without importance.

To adjust the encoder to the position value submitted in the out-bytes 0 to 3 (D00-D24), bit D31 must be set to "1".

If the bits D29 - D31 are set to "1" at the same time, no preset and no adjustment is performed.

For a new preset-adjustment or a direct-adjustment each of the bits has to be reset to "0" for at least one polling cycle. Adjustment- or preset-cycles lower than 500 ms are not allowed.

7 Parameterization and configuration

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

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

⚠ WARNING

NOTICE

- Ensure that the quotient of **Revolutions Numerator / Revolutions Denominator** for a multi-turn measuring system is an exponent of 2 of the group $2^0, 2^1, 2^2 \dots 2^{12}$ (1, 2, 4...4096).
or
- Ensure that every positioning in the de-energized state for a multi-turn measuring system is within 512 revolutions.

7.1 Configuration Assembly Data Attribute Format

7.1.1 Assembly Object 04h

Instance	Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Service
42	0	<i>Direction</i>								r/w
	1	<i>Output Code</i>								
	2 to 5	Low Byte <i>Total Number of Steps</i>								
	6 to 9	High Byte <i>Total Number of Steps</i>								
	10	<i>Revolutions Numerator</i>								
	11 to 14	Low Byte <i>Revolutions Numerator</i>								
	15 to 18	High Byte <i>Revolutions Numerator</i>								
	19	<i>Revolutions Denominator</i>								
	20 to 23	Low Byte <i>Lower Safety Limit</i>								
	24 to 27	High Byte <i>Lower Safety Limit</i>								
	28 to 31	Low Byte <i>Lower Operating Limit</i>								
	32 to 35	High Byte <i>Lower Operating Limit</i>								
	36 to 39	Low Byte <i>Upper Operating Limit</i>								
	40 to 43	High Byte <i>Upper Operating Limit</i>								

Continuation, see following page

Continuation "Configuration Assembly Data Attribute Format"

Instance	Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Service
42	27	Auxiliary Output 1								r/w
	28	Auxiliary Output 2								
	29	Auxiliary Output 3								
	30	Auxiliary Output 4								
	31	Auxiliary Output 5								
	32	Auxiliary Output 6								
	33	Auxiliary Output 7								
	34 to 37	Low Byte Value for Preset1 High Byte Value for Preset1								
	38 to 41	Low Byte Value for Preset2 High Byte Value for Preset2								
	42	Preset 2 out of range	0	0	0	0	0	Write-error	Read-error	
	43	0	Steps/Rev. exceeded	³⁾ TNOS/Rev. =0	upper ¹⁾ SL out of range	upper ²⁾ OL out of range	lower ²⁾ OL out of range	lower ¹⁾ SL out of range	Preset 1 out of range	

While programming the parameters via the "Assembly-Class" the measuring system returns as response at reading the programmed values with an error status in byte 42 and 43 to the master. In this case altogether 44 bytes are transferred to the master. The Data Check is performed automatically.

A set error bit in byte 42 or 43 is reset as soon as a parameter programming could be executed successfully. The ranges of values of the individual parameters are defined in chapter "Parameters / Range of values" starting from page 24.

-
- ¹⁾ SL = Safety Limit
²⁾ OL = Operating Limit
³⁾ TNOS = Total Number of Steps

7.2 Parameter Object Instances

7.2.1 Parameter Object 0Fh

Instance	Name	Data Type	Service	Attribute
1	Direction	USINT	r/w	1
2	Output Code	USINT	r/w	1
3	Total Number of Steps	UDINT	r/w	1
4	Revolutions Numerator	UDINT	r/w	1
5	Revolutions Denominator	USINT	r/w	1
6	Lower Safety Limit	UDINT	r/w	1
7	Lower Operating Limit	UDINT	r/w	1
8	Upper Operating Limit	UDINT	r/w	1
9	Upper Safety Limit	UDINT	r/w	1
10	Auxiliary Output 1	USINT	r/w	1
11	Auxiliary Output 2	USINT	r/w	1
12	Auxiliary Output 3	USINT	r/w	1
13	Auxiliary Output 4	USINT	r/w	1
14	Auxiliary Output 5	USINT	r/w	1
15	Auxiliary Output 6	USINT	r/w	1
16	Auxiliary Output 7	USINT	r/w	1
17	Value for Preset1	UDINT	r/w	1
18	Value for Preset2	UDINT	r/w	1
19	Data-Check	UINT	r/w	1
20	Read: Position / Write: Adjustment	UDINT	r/w	1
21	Software version	UDINT	ro	1

7.2.2 GET DATA CHECK - command

Instance 19, r/w

If the parameters are programmed via the "Parameter-Class", for taking over and test the data, a Data-Check must be performed subsequently. The result (2 bytes) of the SET DATA-CHECK can be read with GET DATA-CHECK. Are all bits of the returned UINT value "0", no error is available. The possible errors are indicated in following table:

GET DATA-CHECK:

Bit7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Low Byte Error Receive Buffer Master							
Preset 2 out of range	0	0	0	0	0	Write-error	Read-error
High Byte Error Receive Buffer Master							
0	Steps/Rev. exceeded	³⁾ TNOS/Rev. =0	upper ¹⁾ SL out of range	upper ²⁾ OL out of range	lower ²⁾ OL out of range	lower ¹⁾ SL out of range	Preset 1 out of range

An error bit can only then be reset when the data is corrected and a DATA-CHECK command is executed.

- 1) SL = Safety Limit
- 2) OL = Operating Limit
- 3) TNOS = Total Number of Steps

7.3 Parameters / Range of values

7.3.1 Direction

Instance	Service	Value	Description	Default
1	r/w	= 0	Position increasing clockwise (view onto the shaft)	X
		≠ 0	Position decreasing clockwise (view onto the shaft)	

7.3.2 Output Code

Instance	Service	Value	Description	Default
2	r/w	= 0	Binary code	X
		≠ 0	Gray code	

7.3.3 Scaling parameters

The scaling parameters can be used to change the physical resolution of the measuring system. The measuring system supports the gearbox function for round axes.

This means that the **Measuring units per revolution** and the quotient of **Revolutions Numerator / Revolutions Denominator** can be a decimal number. In order that the measuring system can process this number, the measuring system must include the option "**gearbox 1/100**" (see nameplate). Measuring systems without this option may only have a decimal in the **Measuring units per revolution**. The quotient of **Revolutions Numerator / Revolutions Denominator** must be an **exponent of 2**.

The position value output is calculated with a zero point correction, the count direction set and the gearbox parameter entered.

Total Number of Steps (Instance 3, r/w)

Defines the **total number of steps** of the measuring system before the measuring system restarts at zero.

	EDS-file 8192	EDS-file 4096
lower limit	16 steps	16 steps
upper limit	33554432 steps (25 bit)	16777216 steps (24 bit)
default	33554432	16777216

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

$$\text{Total Number of Steps} = \text{Measuring units per revolution} * \text{Number of revolutions}$$

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

Revolutions Numerator / Revolutions Denominator (Instance 4 and 5, r/w)

Together, these two parameters define the **Number of revolutions** before the measuring system restarts at zero.

As decimal numbers are not always finite (as is e.g. 3.4), but they may have an infinite number of digits after the decimal point (e.g. 3.43535355358774...)) the number of revolutions is entered as a fraction.

numerator lower limit	1
numerator upper limit	256 000
default numerator	4096

denominator lower limit	1
denominator upper limit	99
default denominator	1

Formula for gearbox calculation:

$$\text{Total Number of Steps} = \text{Measuring units per revolution} * \frac{\text{Number of Revolutions Numerator}}{\text{Number of Revolutions Denominator}}$$

If it is not possible to enter parameter data in the permitted ranges of numerator and denominator, the attempt must be made to reduce these accordingly. If this is not possible, it may only be possible to represent the decimal number affected approximately. The resulting minor inaccuracy accumulates for real round axis applications (infinite applications with motion in one direction).

A solution is e.g. to perform adjustment after each revolution or to adapt the mechanics or gearbox accordingly.

*The parameter "**Measuring units per revolution**" may also be decimal number, however the "**Total Number of Steps**" may not. The result of the above formula must be rounded up or down. The resulting error is distributed over the total number of revolutions programmed and is therefore negligible.*

Preferably for linear axes (forward and backward motions):

*The parameter "**Revolutions Denominator**" can be programmed as a fixed value of "1". The parameter "**Revolutions Numerator**" is programmed slightly higher than the required number of revolutions. This ensures that the measuring system does not generate a jump in the actual value (zero transition) if the distance travelled is exceeded. To simplify matters the complete revolution range of the measuring system can also be programmed.*

The following example serves to illustrate the approach.

Given:

- Measuring system with 4096 steps/rev. and max. 4096 revolutions
- Resolution 1/100 mm

- Ensure the measuring system is programmed in its full resolution and total measuring length (4096x4096):
Total Number of Steps = 16777216,
Revolutions Numerator = 4096
Revolutions Denominator = 1
Set the mechanics to be measured to the left stop position
- Set measuring system to "0" using the adjustment
- Set the mechanics to be measured to the end position
- Measure the mechanical distance covered in mm
- Read off the actual value of the measuring system from the controller connected

Assumed:

- Distance covered = 2000 mm
- Measuring system actual position after 2000 mm = 607682 steps

Derived:

$$\begin{aligned}\text{Number of revolutions covered} &= 607682 \text{ steps} / 4096 \text{ steps/rev.} \\ &= \underline{\underline{148.3598633 \text{ revolutions}}}\end{aligned}$$

$$\text{Number of mm / revolution} = 2000 \text{ mm} / 148.3598633 \text{ revs.} = \underline{\underline{13.48073499 \text{ mm / rev.}}}$$

For 1/100 mm resolution this equates to a **Measuring units per revolution** of 1348.073499

Required programming:

$$\begin{aligned}\text{Number of Revolutions Numerator} &= \underline{\underline{4096}} \\ \text{Number of Revolutions Denominator} &= \underline{\underline{1}}\end{aligned}$$

$$\begin{aligned}\text{Total Number of Steps} &= \text{Measuring units per revolution} * \frac{\text{Number of Revolutions Numerator}}{\text{Number of Revolutions Denominator}} \\ &= 1348,073499 \text{ steps / rev.} * \frac{4096 \text{ Revolutions Numerator}}{1 \text{ Revolutions Denominator}} \\ &= \underline{\underline{5521709 \text{ steps}}} \text{ (rounded off)}\end{aligned}$$

7.3.4 Adjust Absolute Value

⚠ WARNING

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

NOTICE

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

Instance 20, r/w

With the adjustment function, the measuring system is set to the desired absolute position value.

Is the adjustment performed via the "Parameter Class", the required position value is set with the "SET-service" and can read as position value with the "GET-service". After adjustment, no DATA-CHECK is necessary.

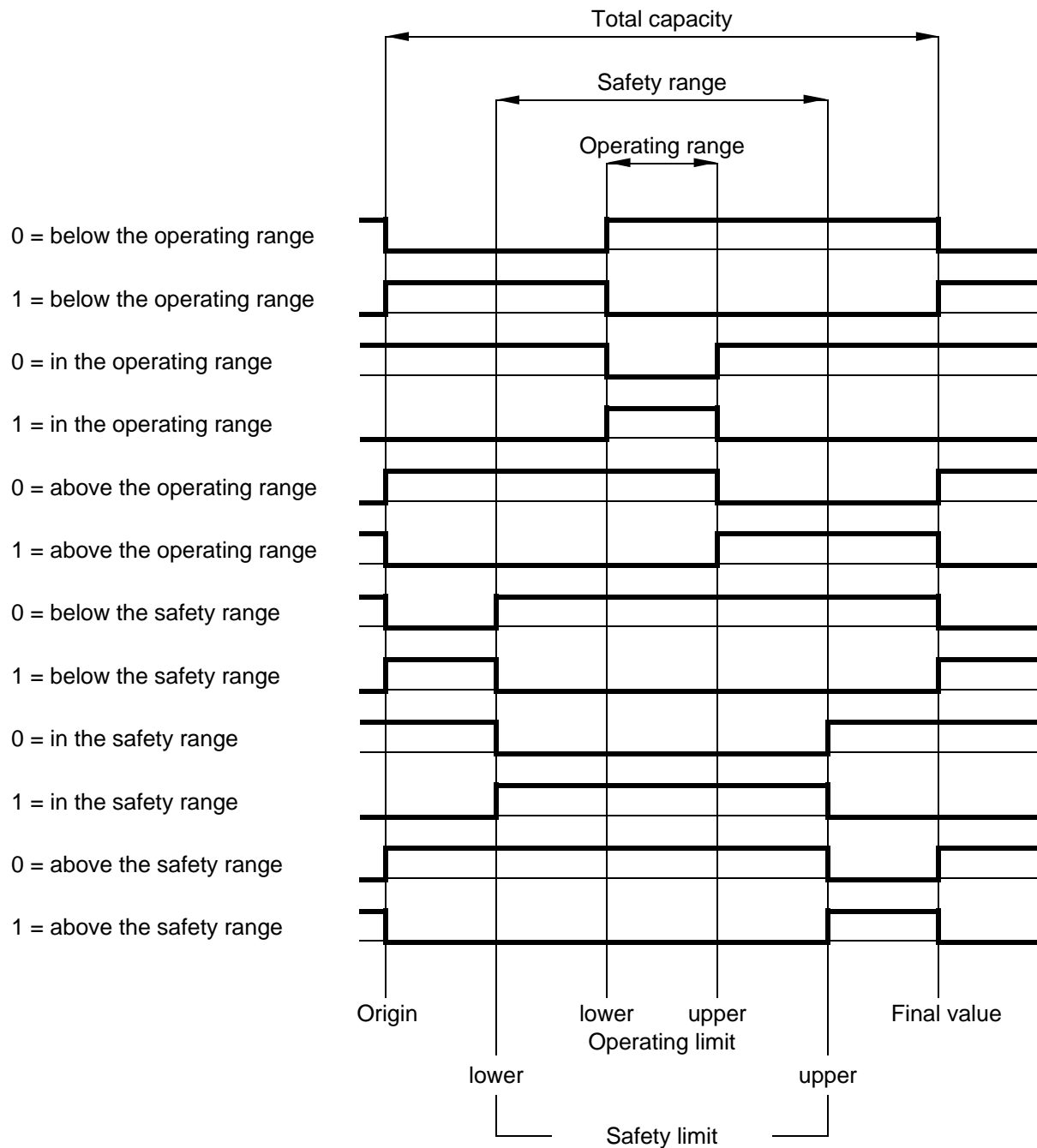
$0 \leq \text{Adjustment} < \text{Total Number of Steps}$

7.3.5 Auxiliary Outputs 1 - 7

Function	Description	Programming value
logical "0"	Output is always "0"	0
0 = error	Output in the case of an error "0"	1
1 = error	Output in the case of an error "1"	2
0 = below the operating range	see chap. "7.3.5.1", page 29	3
1 = below the operating range	"	4
0 = in the operating range	"	5
1 = in the operating range	"	6
0 = above the operating range	"	7
1 = above the operating range	"	8
0 = below the safety range	"	9
1 = below the safety range	"	10
0 = in the safety range	"	11
1 = in the safety range	"	12
0 = above the safety range	"	13
1 = above the safety range	"	14

Auxiliary Output 1 - 7	
Instance	10 – 16, r/w
lower limit	0
upper limit	14
default	0

7.3.5.1 Definition of the operating- and safety-range



	Operating limits / Safety limits	
	EDS-file 8192	EDS-file 4096
lower limit	1	1
upper limit	33554430	16777214
default	1	1

7.3.6 Value for Preset 1 and 2

Instance 17 and 18, r/w

Specification of the position value, on which the measuring system is adjusted when the preset function is executed (see "I/O Instance (polled IO)" on page 19).

$0 \leq \text{Preset value} < \text{Total Number of Steps}$

8 Causes of faults and remedies

8.1 Error and over-range messages (I/O communication port)

In order that messages can be transmitted via the I/O communication port to the master, the auxiliary outputs 1-7 reserved there must be (see **"Input Data Format"**, byte 3 page 19) preconfigured with the appropriate functions (see "Auxiliary Outputs 1 - 7" page 28). To obtain the full range of messages, it is therefore advisable to distribute all the possible functions on an auxiliary output.

Error	Cause	Remedy
Auxiliary output set for "Error" function	- Memory area in internal EEPROM defective	Possibly shut-off measuring system voltage then switch on again. If the error recurs despite this measure, the measuring system must be replaced.
Auxiliary outputs set for the functions "Operating range" and "Safety range"	The switching points programmed for the operating and safety range were exceeded.	These messages are not error messages, but simply over-range messages. The use of these functions and the associated responses to violation of the set limits are regulated by the operator.

8.2 Parameterization errors

If an error occurs during parameter programming or in the READ/WRITE processes of the internal EEPROM, an error occurring can be read in two ways:

- In "Assembly Class" programming, the measuring system automatically returns an error status (the last two bytes), as well as the programmed values to the master (see page 21 onwards).
- If programming is undertaken with the "Parameter Class", an error status of 2 bytes is sent to the master (see page 23 onwards) through the GET DATA-CHECK command.

The possible errors and their avoidance are described as follows:

	Bit	Description	Cause	Remedy
Low Byte	$2^0 = 1$	Error reading data	Memory area in the EEPROM is defective	If the error occurs during further command execution, the measuring system must be replaced
	$2^1 = 1$	Error writing data	Memory area in the EEPROM is defective	If the error occurs during further command execution, the measuring system must be replaced

Continuation, see following page

Continuation "Parameterization errors"

	Bit	Description	Cause	Remedy
Low Byte	$2^7 = 1$	Preset 2 out of range	While programming the predefined preset value2, the permissible range was exceeded	Carry out new programming Permissible range: $0 \leq \text{Preset value 2} < \text{Total Number of Steps}$
	$2^0 = 1$	Preset 1 out of range	While programming the predefined preset value1, the permissible range was exceeded	Carry out new programming Permissible range: $0 \leq \text{Preset value 1} < \text{Total Number of Steps}$
High Byte	$2^1 = 1$	Lower safety limit out of range	While programming the switching point, the permissible range was exceeded	Carry out new programming Permissible range: $1 \leq \text{lower safety limit} \leq \text{lower operating limit} \leq \text{upper operating limit} \leq \text{upper safety limit} \leq \text{Total Number of Steps} - 2$
	$2^2 = 1$	Lower operating limit out of range	While programming the switching point, the permissible range was exceeded	Carry out new programming Permissible range: $1 \leq \text{lower safety limit} \leq \text{lower operating limit} \leq \text{upper operating limit} \leq \text{upper safety limit} \leq \text{Total Number of Steps} - 2$
	$2^3 = 1$	Upper operating limit out of range	While programming the switching point, the permissible range was exceeded	Carry out new programming Permissible range: $1 \leq \text{lower safety limit} \leq \text{lower operating limit} \leq \text{upper operating limit} \leq \text{upper safety limit} \leq \text{Total Number of Steps} - 2$
	$2^4 = 1$	Upper safety limit out of range	While programming the switching point, the permissible range was exceeded	Carry out new programming Permissible range: $1 \leq \text{lower safety limit} \leq \text{lower operating limit} \leq \text{upper operating limit} \leq \text{upper safety limit} \leq \text{Total Number of Steps} - 2$
	$2^5 = 1$	Revolutions Numerator = 0	While programming the measuring length in revolutions numerator, a "0" was programmed.	Valid range: Measuring length in revolutions numerator $1 \leq \text{Measuring length in revolutions numerator} \leq 256\,000$ Measuring length in revolutions denominator $1 \leq \text{Measuring length in revolutions denominator} < 100$
	$2^6 = 1$	Steps per revolution out of range	The max resolution of the measuring system was exceeded (see rating plate)	Valid range: $\left[\frac{\text{Total Number of Steps}}{\text{Number of revolutions}} \right] \leq \text{Hardware steps per revolution (rating plate)}$

8.3 Other faults

Fault	Cause	Remedy
Position skips of the measuring system	Loose contacts in the wiring	Check all the cabling and wiring used for connecting the encoder.
	Strong vibrations	Vibrations, impacts and shocks, e.g. on presses, are dampened with "shock modules". If the error recurs despite these measures, the measuring system must be replaced.
	Electrical faults EMC	Perhaps isolated flanges and couplings made of plastic help against electrical faults, as well as cables with twisted pair wires for data and supply. Shielding and wire routing must be performed according to the DeviceNet™-specification.
	Extreme axial and radial load on the shaft may result in a scanning defect.	Couplings prevent mechanical stress on the shaft. If the error still occurs despite these measures, the measuring system must be replaced.