TR electronic

INTERBUS-S

+ K1-, K2-, K3- and TR-Profile

Absolute Encoder ZE Series

_Safety informations
_Assembly
_Commissioning
_Parameterization
_*Cause of faults and remedies*

User Manual

TR - ECE - BA - GB - 0026 - 03 04/05/2016

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

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Author:	MÜJ

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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>).

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Download pin assignments ZE encoder:

Design with 2-pole screw terminals www.tr-electronic.com/f/TR-ECE-TI-GB-0034
Design with MINI-COMBICON terminals and SSI www.tr-electronic.com/f/TR-ECE-TI-GB-0046

Download dimension drawing:

Standard type ZE encoder www.tr-electronic.com/f/04-K171-V0008

Revision index

Revision	Date	Index
First release	11/18/02	01
Parameter 0011 „Position actual value coding“: Signed dual code exchanged with Unsigned dual code.	10/11/05	02
General modifications	04/05/16	03

1 Safety

1.1 General hazard potential

The rotary encoder cannot function as a stand-alone unit, i.e. it is a component part that is intended to be installed in a complete system consisting of several such components working together. For this reason, the rotary encoder does not have a protective device of its own.

Warning

However, different error reports can be read out via the status word in the K3-profile and via the error status in the TR-profile. The error reports are classified over a malfunction code (see page 27, K3-profile and page 25/41, TR-profile). It is therefore essential to integrate the malfunction code into your **own safety system** via the evaluation software (e.g. a PLC).
The corresponding measures must be taken in order to avoid person and property damages.

All persons responsible for the assembly, start-up and operation of the device must

- be suitably qualified
- adhere strictly to this operating manual.

Your safety and the safety of your equipment depends on this!

1.2 Safety information

This operating manual contains information which must be observed in the interests of your own personal safety and that of your equipment. The safety hints are emphasised by a warning triangle and classified according to the degree of danger as follows:

Warning
means that failure to take the relevant safety precautions can lead to death, serious injury or major damage to property.

Caution
means that failure to take the relevant safety precautions can lead to minor injuries or damage to property.

Note
refers to important information and features of the product, plus tips on its application.

1.2.1 Hints on installation

Since the rotary encoder is normally used as part of a larger system, these hints are merely intended as a guide for integrating the device safely into its environment.

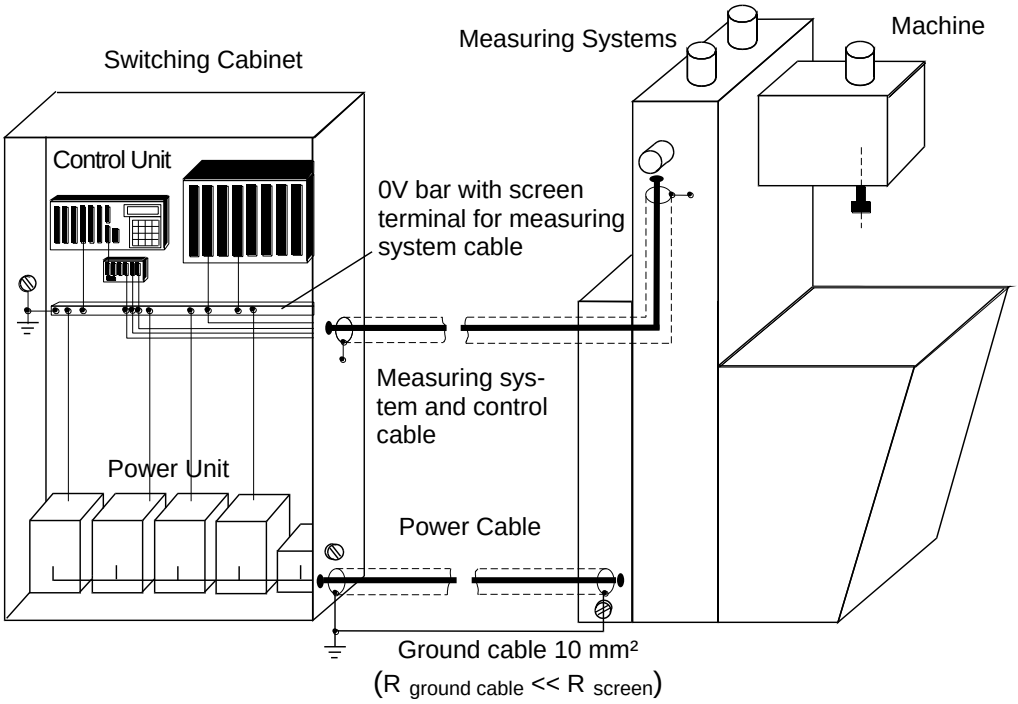
Warning

- The safety and accident prevention regulations applicable to the specific application must be observed.
- In the case of permanently installed plants or systems without an all-pole mains switch and/or fuses, one of these devices must be installed accordingly and the equipment connected to a PE conductor.
- In the case of devices which run on mains voltage, make sure the set nominal voltage range coincides with the local mains voltage before start-up.
- In the case of 24 V supplies, make sure the extra-low voltage is reliably disconnected. Only use power supply units manufactured to the standards IEC 364 - 4 - 41 / HD 384.04.41 (VDE 0100 Part 410).
- Fluctuations or deviations of the mains voltage from the nominal value must not exceed the tolerance limits stated in the specifications, otherwise operational failures and dangerous states in the electrical assemblies cannot be ruled out.
- Precautionary measures must be taken to allow an interrupted program to be properly resumed following a voltage drop or failure. Dangerous operating conditions must not be permitted to arise even for short periods. If necessary, an ***"EMERGENCY STOP"*** must be forced.
- EMERGENCY STOP devices according to EN 60204/IEC 204 (VDE 0113) must remain operational in all operating modes of the programmable controller. The release of the EMERGENCY STOP devices must not trigger an uncontrolled or undefined reactivation of the equipment.
- Connecting and signal wires must be installed in such a way as to prevent the automation functions from being hampered by inductive and capacitive interference.
- The units of the automation system and their operating elements must be installed in such a way as to ensure adequate protection against accidental actuation.
- In order to prevent a wire or strand breakage on the signal side from causing undefined states in the programmable controller, suitable hardware and software safety precautions must be taken with regard to the I/O interface.

1.2.1.1 Screening

The use of electronic sensor active systems in modern machines necessitates a consistent and correctly executed interference suppression and wiring strategy.
These conditions are the only guarantee that systems containing electronic measuring systems will function properly.

Recommended screened cable wiring



1.2.1.2 General interference suppression measures

- Route (screened) lines connecting to the encoder either a long way from or completely physically separated from energy lines that carry disturbances.
- Only use completely screened lines for data transfer and ensure they are well earthed. In the case of differential data transfer, (RS422, RS485 etc.), you must use twisted-pair lines in addition.
- Use cables with a minimum cross-section of 0.22 mm² for data transfer**.**
- Use a ground cable with a minimum cross-section of 10 mm² to avoid equipotential bonding via the screen. Please note that the ground cable resistance must be much lower than that of the screen.
- Wire the screen continuously keeping a large area in contact with special screen connecting terminals.
- Avoid crossing cables. If this is not possible, the cables should only cross at right-angles.

1.3 Intended use

The rotary encoder is used for recording angular movements and processing the measured data for a downstream control system with a INTERBUS-S fieldbus interface according to DIN 19258.

The classification of the measuring systems are defined according to following profiles:

Profile K1

The encoder supplies 16 bits process data. The position actual value (output value) of the encoder is binary coded and right aligned in the 16 bit process data word.

Profile K2

The encoder supplies 32 bits process data. The position actual value of the encoder is binary coded and right aligned in the 32 bit process data word.

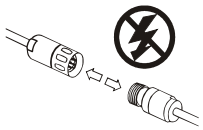
Profile K3

The encoder supplies 32 bits process data. These 32 bits contain a 25-bit position actual value and a 7 bit status bit and control bits. The position actual value of the encoder is coded binary and right aligned in the bits 0 - 24 of the process data word.

Profile TR

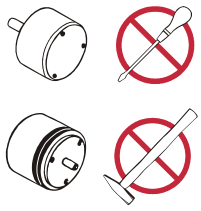
The encoder supplies 32 bits process data. These 32 bits contain a 24-bit position actual value and a 8 bit status bit and control bits. The position actual value of the encoder is coded binary and right aligned in the bits 0 - 23 of the process data word.

Warning



De-energize the system before carrying out wiring or opening and closing electrical connections!
Short-circuits, voltage peaks etc. can lead to malfunctions and uncontrolled states in the system or to serious personal injury or damage to property.

Check all electrical connections before switching on the system!
Connections that are made incorrectly can lead to system malfunctions; wrong connections may result in serious personal injury or damage to property.



Mechanical or electrical modifications to the measuring systems ***are prohibited for safety reasons!***

Caution

****Avoid excessive bearing loads due to radial and axial deviations between the encoder and the drive shaft!***
When assembling, you must use couplings that can absorb these forces.

****Protect the encoder from excessive vibrations, shocks and jolts, e.g. on presses!***
Use "shock modules" to cushion vibrations.

Note
Always follow the start-up, operating and programming instructions specified in this manual.

***** Observe the mechanical ratings on page 48.

1.4 Authorised operators

The start-up and operation of this device may only be performed by qualified personnel. In the context of the safety-related information in this document, the term "qualified personnel" refers to persons who are authorized to commission, ground and mark circuits, equipment and systems in accordance with recognized safety standards.

1.5 Safety measures at the assembly site

Warning

Do not carry out welding if the encoder has already been wired up or is switched on!
Potential fluctuations can destroy the encoder or impair its operation.

Keep to the supply voltage range: 11-27 V DC (± 5 % residual ripple)

i

Note
Ensure that the area around the assembly site is protected from corrosive media (acid, etc.)

2 Transportation / Commissioning

2.1 Transportation / Storage

Notes on transportation

Do not drop the encoder or expose it to strong strokes!
Device contains an optical system.

Only use the original packaging!
The wrong packaging material can cause damage to the device during transportation.

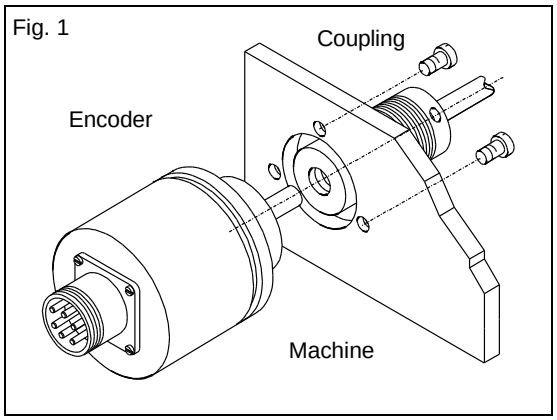
Storage

Storage temperature: -30 to +120 °C

Store in a dry place.

2.2 Assembly

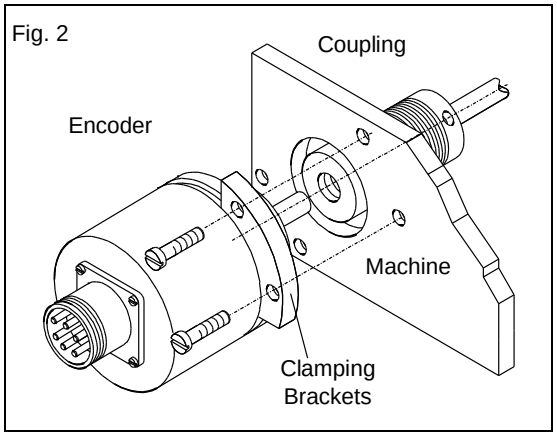
Fig. 1



Encoder shaft drive

The absolute encoders are connected to the drive shaft via an elastic coupling, which compensates for any deviations in the axial and radial direction between the encoder and drive shaft. This avoids excessive strain on the bearings. Couplings can be ordered on request.

Fig. 2

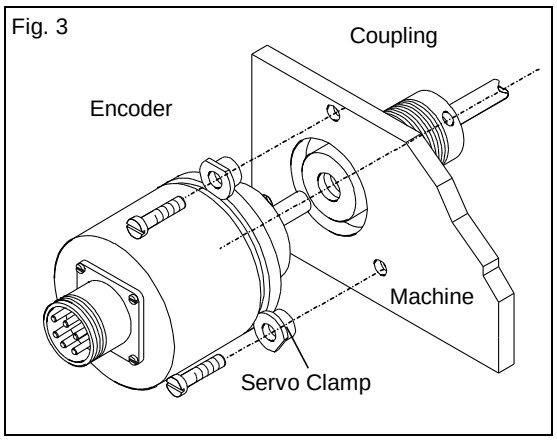


Types of mounting

Flange mounting

The centering collar with fit f7 centers the encoder in relation to the shaft. It is fixed to the machine by means of three screws in the flange (Fig. 1).

Fig. 3

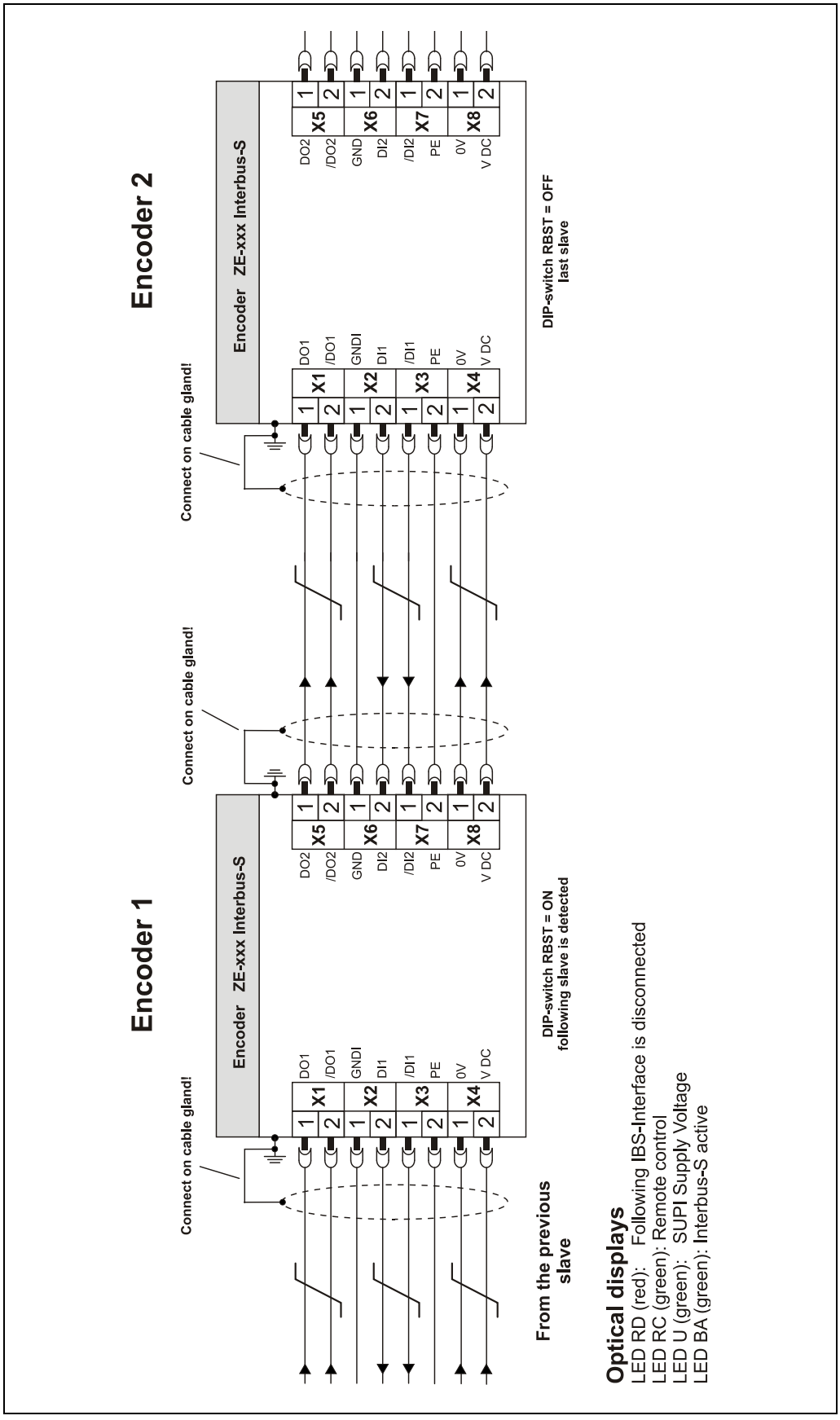


Clamping brackets / servo clamp - mounting

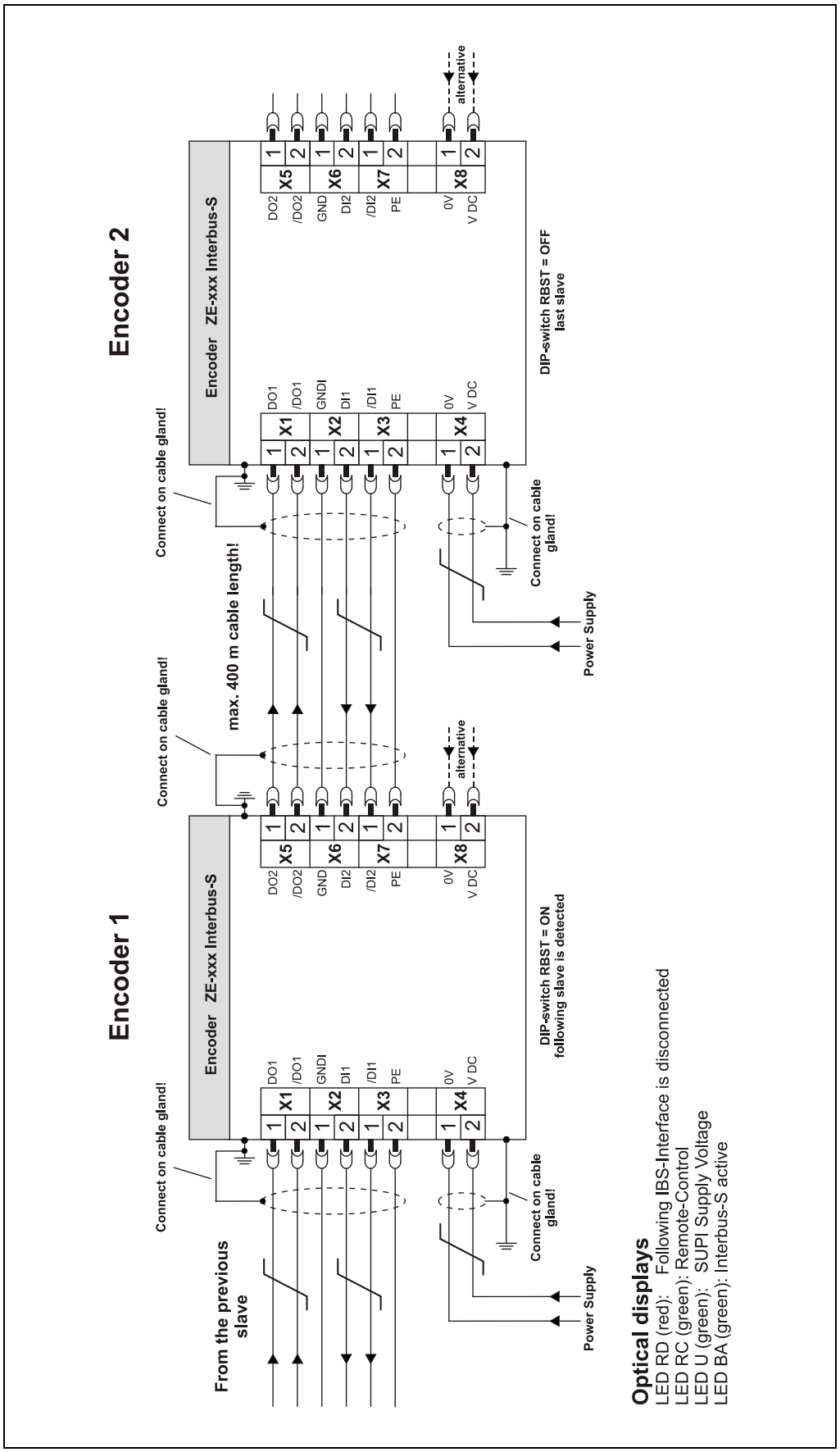
The centering collar with fit f7 centers the encoder in relation to the shaft. The encoder is fixed by means of 2 clamping brackets or 3 servo clamps (Fig. 2 and 3).

2.3 Wiring

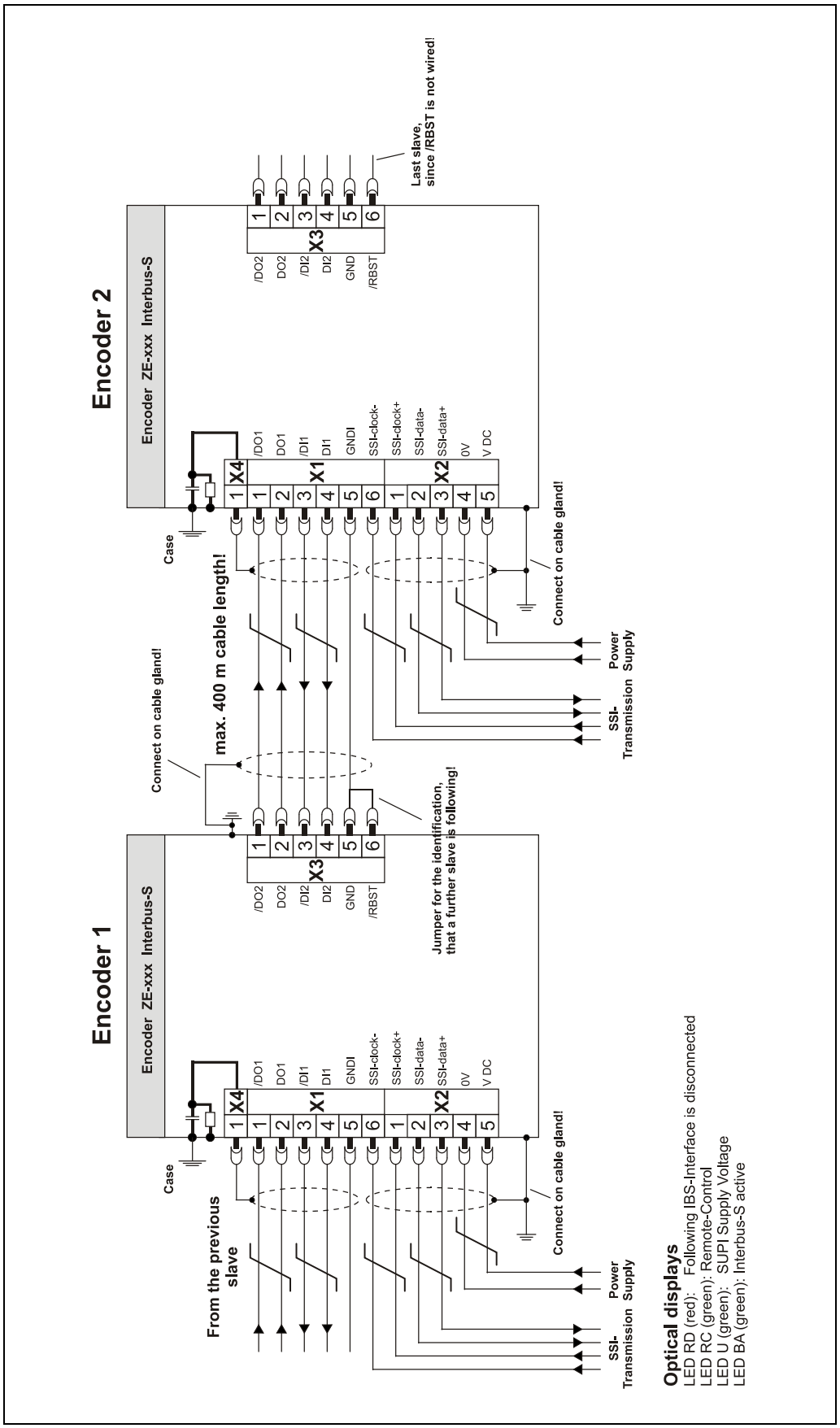
Wiring type as installation-remote-bus, pin assignment TR-ECE-TI-GB-0034



Wiring type as remote-bus, pin assignment TR-ECE-TI-GB-0034



Wiring type as remote-bus, pin assignment TR-ECE-TI-GB-0046



2.4 Encoder interface (INTERBUS-S)

The ZE-encoder with INTERBUS-S interface is designed as a remote bus module with 32 I/O data. This makes it easy to integrate in the bus ring in the same way as a PHOENIX-CONTACT bus terminal. To ensure that the protocol meets INTERBUS-S requirements, an SUPI (serial microprocessor interface) is integrated between the ZE-encoder and the INTERBUS-S and supports the profiles K1, K2, K3 and the TR-specific profile. The profile is determined by TR-Electronic and can't be changed by the user. The SUPI is an INTERBUS-S protocol chip developed by PHOENIX-CONTACT which carries out the following functions:

- BUS interfacing: Directions of reception and transmission
- CRC check
- Preset
- Transfer protocol
  etc.

At the profiles K1 and K2 no parameter setting is possible over the interbus, parameters like resolution, counting direction and code etc. are therefore adjusted according to the customer requirements by TR-Electronic.

The used profile with which the encoder applies at the interbus is recognized at the device-ID and at the input and output data capacity.

Profile	Device-ID	Data format
K1	54, 0x36	1 WORD INPUT
K2	54, 0x36	2 WORD INPUT
K3	55, 0x37	2 WORD INPUT/OUTPUT
TR	51, 0x33	2 WORD INPUT/OUTPUT

After a parameter setting over the interbus the programmed values should be read back for control, since illegal parameter values are corrected by the encoder automatically.

2.4.1 Encoder classification according to K1

In class 1 the encoder supplies 16 bits process data. The position actual value (output value) of the encoder is binary coded and right aligned in the 16 bit process data word.

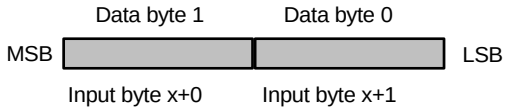
Identification

IBS-Coupling	Class	No. of Words	Interbus-Device ID-Code		ID-Code
				hex	dec.
Remote bus	K1	1 IN	0000 0001 0011 0110	0136	54

2.4.1.1 Mapping of Encoder Data in the Master (Controller)

In the master, the encoder data occupies one-word address for IN-data. The position of the data in the controller depends on the physical or logical position of the encoder within the ring. For detailed information, refer to the manual of the master (controller) used. The encoder should be considered to be a PHOENIX I/O bus terminal and the system processes it as such.

Input Word IW x



2.4.2 Encoder classification according to K2

In class 2 the encoder supplies 32 bits process data. The position actual value (output value) of the encoder is binary coded and right aligned in the 32 bit process data word.

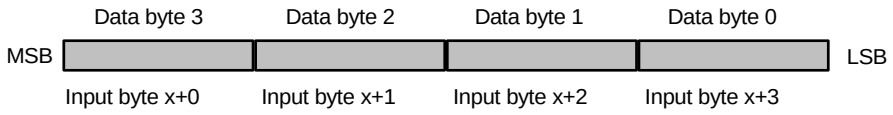
Identification

IBS-Coupling	Class	No. of Words	Interbus-Device ID-Code		ID-Code
				hex	dec.
Remote bus	K2	2 IN	0000 0010 0011 0110	0236	54

2.4.2.1 Mapping of Encoder Data in the Master (Controller)

In the master, the encoder data occupies two-word addresses for IN-data. The position of the data in the controller depends on the physical or logical position of the encoder within the ring. For detailed information, refer to the manual of the master (controller) used. The encoder should be considered to be a PHOENIX I/O bus terminal and the system processes it as such.

Input Double Word ID x



2.4.3 Encoder classification according to K3

In class 3 the encoder supplies 32 bits process data. These 32 bits contain a 25-bit position actual value and a 7 bit status bit and control bits. The position actual value of the encoder is coded binary and right aligned in the bits 0 - 24 of the process data word. Bits 25 - 31 contain the status bit and control bits. When all control bits are set to 0 and the OPERATION condition is displayed on the status bits, the encoder outputs a valid value for bits 0 to 24.

b31	b25	b24	b0
Control/Status		Position actual value	

i ***Note***

At programming, data is exchanged between the encoder and the master in binary form.

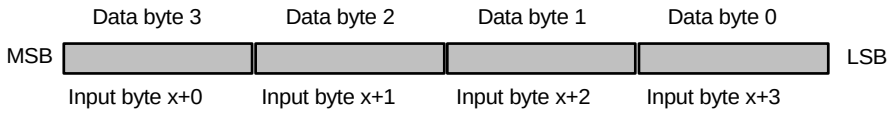
Identification

IBS-Coupling	Class	No. of Words	Interbus-Device ID-Code	hex	ID-Code dec.
Remote bus	K3	2 IN / 2 OUT	0000 0010 0011 0111	0237	55

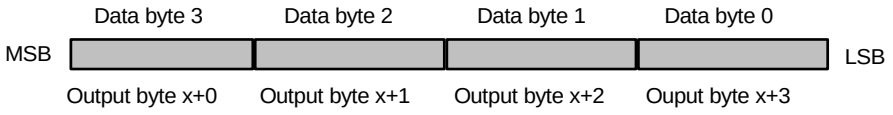
2.4.3.1 Mapping of Encoder Data in the Master (Controller)

In the master, the encoder data occupies two-word addresses for IN-data and two-word addresses for OUT-data. The position of the data in the controller depends on the physical or logical position of the encoder within the ring. For detailed information, refer to the manual of the master (controller) used. The encoder should be considered to be a PHOENIX I/O bus terminal and the system processes it as such.

Input Double Word ID x



Output Double Word OD x



2.4.3.2 Control Word (OUT-data relative to the master)

Via the control word functions activated and the operational states of the encoder are defined.

Control Word relative word address "1"

Bit	Name	mandatory	Bit No. in PD Channel
0	Reserved		16
1	Reserved		17
2	Reserved		18
3	Reserved		19
4	Reserved		20
5	Reserved		21
6	Reserved		22
7	Reserved		23
8	Reserved		24
9	Parameter no.	X	25
10	Parameter no.	X	26
11	Parameter no.	X	27
12	Parameter no.	X	28
13	Manufacturer-specific		29
14	* Set zero shift	X	30
15	Enable operation	X	31

* see page 22, "Set zero shift"

Device Control Commands

The device control commands are triggered by the following bit combinations in the control word:

DEVICE CONTROL COMMAND	Control Word (Bit)						
	Enable operation	Set zero shift	No Function	Parameter-No.			
	15	14	13	12	11	10	9
ENABLE OPERATION	0>1	0	X	0			
PARAMETERIZATION	0	0	X	1 . . . 15			

Parameter-No.

The bits 9 to 12 (D25 - D28) indicate the number of the parameter. The parameter data will transfer via the bits 0 to 24 of the process out data channel. The activation of parameter transfer is acknowledged within one second in the status word (see also "K3 - Parameter transfer", page 26).

Set zero shift

An edge change from "0" to "1" of the bit-no. 30 in the process out data channel is setting the encoder to the preselected value in parameter-no. 0100. The 'zero shift' parameter is set to the value ('preset value' – 'absolute position'), see also "Parameter Overview", page 26). If the new position actual value in the next bus cycle is not yet available, the encoder switches over into the PARAMETERIZATION state.

Manufacturer-Specific

The bits 0 - 8 are reserved. Bit 13 does not have a meaning.

2.4.3.3 Status Word (IN-data relative to the master)

Information concerning the state of the encoder and messages are shown in the status word.

Status Word, relative word address "1"

Bit	Name	mandatory	Bit No. in PD Channel
0	Reserved		16
1	Reserved		17
2	Reserved		18
3	Reserved		19
4	Reserved		20
5	Reserved		21
6	Reserved		22
7	Reserved		23
8	Reserved		24
9	Parameter no. or malfunction code	X	25
10	Parameter no. or malfunction code	X	26
11	Parameter no. or malfunction code	X	27
12	Parameter no. or malfunction code	X	28
13	Manufacturer-specific		29
14	Parameterization	X	30
15	Invalid position actual value	X	31

Device States

The device states are shown in the status word by the following bit combinations:

	Status Word (bit)						
	Invalid position actual value	Param-eterization	No Function	Parameter-No.			
STATE	15	14	13	12	11	10	9
OPERATION	0	0	X	0			
PARAMETERIZATION	1	1	X	1 . . . 15			
MALFUNCTION	1	0	X	1 . . . 15			

Parameter No. or Malfunction Code

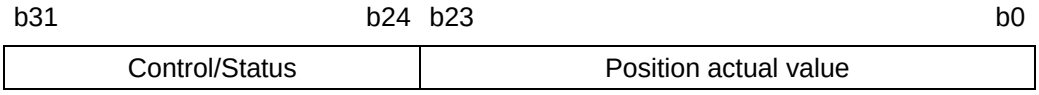
The number of the parameter which was transmitted to the encoder is acknowledged via bits 9 to 12, or a malfunction code is transmitted (in "malfunction" state), see page 27.

Manufacturer-Specific

The bits 0 - 8 are reserved. Bit 13 does not have a meaning.

2.4.4 Encoder classification according to the TR-profile

In the TR-profile the encoder supplies 32 bits process data. These 32 bits contain a 24-bit position actual value and a 8 bit status bit and control bits. The position actual value of the encoder is coded binary and right aligned in the bits 0 - 23 of the process data word. Bits 24 - 31 contain the status bit and control bits. If the service-bit 2^{31} is set to 0, the encoder outputs a valid value for bits 0 to 23.



Note

At programming, data is exchanged between the encoder and the master in binary form.

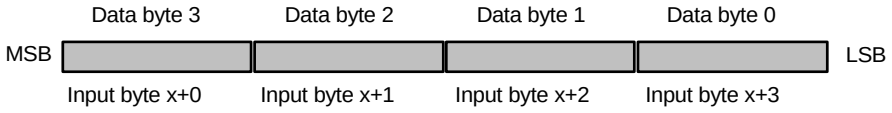
Identification

IBS-Coupling	Class	No. of Words	Interbus-Device ID-Code		ID-Code
				hex	dec.
Remote bus	TR	2 IN / 2 OUT	0000 0010 0011 0011	0233	51

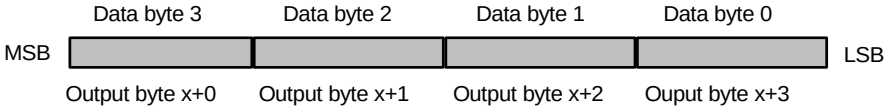
2.4.4.1 Mapping of Encoder Data in the Master (Controller)

In the master, the encoder data occupies two-word addresses for IN-data and two-word addresses for OUT-data. The position of the data in the controller depends on the physical or logical position of the encoder within the ring. For detailed information, refer to the manual of the master (controller) used. The encoder should be considered to be a PHOENIX I/O bus terminal and the system processes it as such.

Input Double Word ID x



Output Double Word OD x



Meaning of the OUT-Data (Data from the Master to the Encoder)

Normal Mode:

Service bit 2^{31} is set to “0“.
OUT-data that the master outputs to the encoder does not have any effect and the encoder does not accept it.
As a result, in normal mode the encoder only outputs its current position data.

Service Mode:

Service bit 2^{31} is set to “1“.
The encoder carries out the master's requested service (e.g. write direction of rotation or read programmed direction of rotation).
The system evaluates or ignores the remaining OUT-data 2^{23} to 2^{0} in dependence on the requested service.

Bit 2^{31}:	Service bit	0 = Normal mode 1 = Service mode
Bit 2^{30}:	Read-write bit	0 = Read data 1 = Write data
Bit 2^{29}:	Error bit	1 = Error
Bit 2^{28}:	Reserve	Always 0
Bit 2^{27} to bit 2^{24}:	Service	
Bit 2^{23} to bit 2^{0} :	Data for service if bit 2^{30} = 1, otherwise meaningless	

Meaning of the IN-Data (Data from the Encoder to the Master)

Normal Mode:

The encoder outputs the current position data and writes it to bits 2^{23} to 2^{0}. Bits 2^{31} to 2^{24} are “0“ unless there is an error; in this case, error bit 2^{29} = “1“.

Service Mode:

If the master writes data (read-write bit = 1), the system returns the OUT-data to the IN-data (bits 2^{31} to 2^{0}).
If the master reads data (read-write bit = 0), bits 2^{23} to 2^{0} contain the requested data and bits 2^{31} to 2^{24} contain the acknowledgement of the requested service.

If the system could not carry out the service without errors, the error bit is “0“. It is only possible to clear a set error bit by carrying out a data check service.

3 K3 - Parameter transfer

The parameter data can be transferred via the bits 0 to 24 of the process out data channel of the master to the encoder. To this the encoder must be set to the parameterization state. This is achieved by outputting a parameter number unequal to zero on bits 9 to 12 of the control word (bits 25 to 28 of the process out data channel).

Notes

- The output bit 2^{29} "manufacturer-specific" is always ignored
- The output bit 2^{30} "set zero shift" is not accepted during the parameter setting
- The malfunction code is deleted with beginning or aborting of the parameter setting
- In the case of the abort of the parameter setting the modified values are rejected and replaced by the values stored in the EEPROM.

Parameter Overview

Parameter No. B12 B9	Function
0 0 0 0	Position output in "operation" state
0 0 0 1	Number of steps/revolution
0 0 1 0	Measuring length in revolutions
0 0 1 1	Position actual value coding Setting of the parameters Code, Direction of rotation and Sign **1 = Unsigned dual code** ascending code in 'right' direction of rotation (clockwise when looking at the shaft) **2 = Unsigned dual code** ascending code in 'left' direction of rotation (anticlockwise when looking at the shaft) **3 = Signed dual code** ascending code in 'right' direction of rotation (clockwise when looking at the shaft) **4 = Signed dual code** ascending code in 'left' direction of rotation (anticlockwise when looking at the shaft) **5 = Unsigned gray code** ascending code in 'right' direction of rotation (clockwise when looking at the shaft) **6 = Unsigned gray code** ascending code in 'left' direction of rotation (anticlockwise when looking at the shaft)
0 1 0 0	Preselection preset value
0 1 0 1	Set zero shift
0 1 1 0	Measuring initial value (offset)
1 0 0 0	Measuring length divisor **(TR-specific profile extension)**

The encoder switches over to the "parameterization" state and indicates the successful transmission of the parameter with the return of the corresponding parameter number. The new parameter takes effect after the user has set the encoder to the 'operation' state with the 'enable operation' device control command. If it was not possible for the parameter to take effect, the encoder switches over to the 'malfunction' state –after the user has sent the 'enable operation' device control command - and outputs a malfunction number on the bits 9 to 12 of the status word (bit 25 to 28 of the process data channel).

Malfunction code

Malfunction -No. b12 b9	Meaning
0 0 0 0	No malfunction
0 0 0 1	Invalid parameters from the host (overflow)
0 0 1 0	Unknown parameter-No.
0 0 1 1	Memory error

If the encoder is in the status "operation" and position skips by the encoder are determined, independently of the set malfunction code additionally the bit 2^{31} "position actual value invalid" is set.

EXAMPLE 1: Example of a Parameter Transmission

	Host to Encoder			Encoder to Host			Comment
	Control Word			Status Word			
	D31	D25-D28	D0-D24	D30-D31	D25-D28	D0-D24	
1	0	0	X	0 0	0	Actual value	Normal operation
2	0	P.No.	Parameter	0 0	0	Actual value	Host transmits parameter to encoder, encoder does not yet react
3	0	P.No.	Parameter	0 0	0	Actual value	Host continues to wait for acknowledgement from encoder
4	0	P.No.	Parameter	1 1	1)	X	Encoder has accepted the parameter and begins processing
5	0	P.No.	Parameter	1 1	1)	X	Parameter processing still running in encoder
6	0	P.No.	Parameter	1 1	P.No.	Parameter	Processing of parameter is completed. Encoder remains in "parameterization" state
7	1	0	0	1 1	P.No.	Parameter	Device control command "enable operation" from host to the encoder. Encoder does not yet react
8	1	0	0	0 0	0	Actual value	Encoder once more in "operation" state
9	0	0	0	0 0	0	Actual value	Normal operating mode once more reached by both devices

1): The encoder detects a transmitting of a parameter of the master by the change of the parameter number. Therefore the parameter value D0-D24 must be already valid. Subsequent modifications of the parameter value are not taken over by the encoder. ***Therefore the master must set first the parameter value and afterwards the parameter number!*** The repeated transmission of the same parameter in the K3-profile is not valid without first leaving the "parameterization" state. However, by the ZE-encoder type of TR-Electronic this is possible. In this case the parameter number is kept unchanged, writes the new value and sets the reading bit 2^{31}. Subsequently, the reading bit is reset again. Here the acknowledgement of the encoder must be always waited for.

The parameter number must be consistent.
To transmit several parameters, repeat steps 4 to 6.

When invalid or inconsistent parameters are sent, the encoder goes into the "malfunction" state when trying to enable operation.

EXAMPLE 2: Sequence when Transmitting Inconsistent Parameters

	Host to Encoder			Encoder to Host			Comment
	Control Word			Status Word			
	D31	D25-D28	D0-D24	D30-D31	D25-D28	D0-D24	
1	0	0	X	0 0	1)	Actual value	Normal operation
2	0	1	500 000	0 0	1)	Actual value	Host sends the first value for programming of the resolution (No. of Steps/Revolution)
3	0	1	500 000	0 0	1)	Actual value	Host continues to wait for acknowledgement from encoder
4	0	1	500 000	1 1	1)	X	Encoder has accepted the parameter and begins processing
5	0	1	500 000	1 1	1)	X	Parameter processing still running in Encoder
6	0	1	500 000	1 1	1	500 000	Processing of parameter is completed. encoder remains in "parameterization" state
7	0	2	1	1 1	1	500 000	Host sends the second value for programming the resolution (No. of Revolutions)
8	0	2	1	1 1	1	500 000	Host continues to wait for acknowledgement from Encoder
9	0	2	1	1 1	2	1	Processing of parameter is completed. encoder remains in "parameterization" state
10	1	0	0	1 1	2	1	Device control command "enable operation" from host to the encoder. Encoder does not yet react
11	1	0	0	0 1	1	Actual value	Encoder switches to "malfunction" state, the malfunction code is "1". The position actual value is output on the process data channel.

An illegal parameter value (500 000) was programmed into line 2 for the parameter "resolution" which at first is accepted by the encoder and remains in the operational state "parameterization" furthermore.

In line 7, the number of revolutions of the encoder was then programmed (1).

In line 10, after finished programming the device control command "enable operation" was sent to the encoder.

The programmed values are checked only now (line 11) for their validity and the encoder passes into the state "malfunction". The position value is output on the process data channel. This value is possibly faulty depending on which programmed parameter was illegal.

3.1 Parameter description

Note
In the case of a value limit error, after the device control command "enable operation" the encoder is switching over into the "malfunction" state, no programming occurs.

3.1.1 Position Output

If the Encoder is in the "operation" state, the position actual value is output. In the "parameterization" state the actual value output is stopped, the malfunction code is cleared and the parameters are taken over from the EEPROM.

Position actual value: 25 bit unsigned int or
Sign + 24 bit absolute value (if coding of the position actual value was selected with sign)

Parameter-No. B12 B9	Parameter value in D0 - D24	Value range	Default
0 0 0 0	0	0	-

3.1.2 Number of Steps / Revolution (Resolution)

With setting of the number of steps per revolution the resolution of measuring system is determined.

Type of the parameter value: 25 bit unsigned int

Parameter-No. B12 B9	Parameter value in D0 - D24	Value range	Default
0 0 0 1	selectable	*1 - 33 554 431 dec	-

* Initial value + [(Steps/Rev.) * Measuring length in revolutions] ≤ 25 bit
Consider max. values on the rating plate of the encoder!

3.1.3 Measuring length in revolutions (Measuring range)

With setting of the measuring length in revolutions the measuring range of the measuring system is determined.

Type of the parameter value: 25 bit unsigned int

Parameter-No. B12 B9	Parameter value in D0 - D24	Value range	Default
0 0 1 0	selectable	*1 - 33 554 431 dec	-

* Initial value + [(Steps/Rev.) * Measuring length in revolutions] ≤ 25 bit
Consider max. values on the rating plate of the encoder!

The encoder supports the gear function for circulating applications, if the encoder is a multi-turn with 65536 revolutions (see rating plate). Otherwise the number of revolutions must be a power-of-two and can not exceed the value which is note on the rating plate.

Important Notes

If the number of revolutions is not a divisor of 65536, after switching off of the supply voltage may not be driven-on any more than 23000 revolutions. Otherwise the zero mark can be moved away and it is necessary to execute a new adjustment. In this maximum distance a safety margin is already contained. That applies to ***both*** driving directions and to ***any*** positions.

Reason:

With the integrated gear function the encoder measures directly 65536 revolutions. If the desired measuring length isn't a divisor of it, the encoder must shift the zero mark around the rest and save the zero mark permanently in time before exceeding its final value. Since the encoder in addition saves the number of shifts and is working with "Long Integer" numbers, measuring lengths up to 2147483647 (2^{31}-1) revolutions are possible.

Examples:

All powers-of-two, which are not larger than 65536, are divisors of it, e.g. 1, 4, 16, 256, 4096 or 65536 itself.
262144 is not a divisor of 65536, because the value is larger.
7 or 3600 aren't divisors of 65536, because these aren't powers-of-two.

3.1.4 Position Actual Value Coding

This parameter defines how the 'position actual value' of the encoder is coded and describes the code sequence.

Type of the parameter value: 25 bit unsigned int

Parameter-No. B12 B9	Parameter value in D0 - D24	Value range	Default
0 0 1 1	1 = Unsigned dual code ↑ 2 = Unsigned dual code ↓ 3 = Signed dual code ↑ 4 = Signed dual code ↓ 5 = Unsigned gray code ↑ 6 = Unsigned gray code ↓	1 - 6	**3**

↑ = Ascending code in 'right' direction of rotation (clockwise when looking at the shaft)
↓ = Ascending code in 'left' direction of rotation (anticlockwise when looking at the shaft)

Display of signed dual codes

PD-bit 24 Sign	PD-bit 23 . . . PD-bit 0 Dual code

If codes with sign (1 or 2) are selected, an adjusted offset-value is set automatically on the negative half total measuring length.

3.1.5 Preset Preselection

Determination of the position value on which the encoder is adjusted when the preset function is activated (see " **Control Word relative word address "1"** ", page 21 / "**Set zero shift**", page 22). The value of the parameter 'Preset value' serves for the determination of the zero shift.

Position actual value: 25 bit unsigned int or
Sign + 24 bit absolute value (if coding of the position actual value was selected with sign)

Parameter-No. B12 B9	Parameter value in D0 - D24	Value range	Default
0 1 0 0	selectable	*	0

* Initial value ≤ Preset value < Initial value + [(Steps/Rev.) * Measuring length in revolutions]

3.1.6 Set Zero Shift

With the parameter zero shift the position actual value is shifted to a desired value. The parameter zero shift contains the difference of the system zero point (machine) to the zero point of the encoder.

Note

To adjust the position actual value, either only the function **"set zero shift"** is to be used in connection with the parameter **"Preset Preselection"** or only the function **"zero shift"**.

Type of the parameter value: Sign + 24 bit absolute value

Parameter-No. B12 B9	Parameter value in D0 - D24	Value range	Default
0 1 0 1	selectable	-16 777 215 to +16 777 215 dec	0

3.1.7 Measuring Initial Value (Offset)

Determination of the measuring system initial value. The parameter "offset" is an additional opportunity to shift the position actual value.

Type of the parameter value: Sign + 24 bit absolute value

Parameter-No. B12 B9	Parameter value in D0 - D24	Value range	Default
0 1 1 0	selectable	-16 777 215 to +16 777 215 dec	0

3.1.8 Measuring Length Divisor (TR-specific profile extension)

Via this parameter also a broken (non integer) number of revolutions can be implemented. It must be noted that the measuring length divisor does not exceed 2 * measuring length in revolutions. That means, the total measuring length may not be smaller than half a revolution.

Example:

Given: Number of revolutions: = 100.33

Measuring length in revolutions = No. of revolutions * $10^{\text{No. of fractional digits}}$

= $100.33 * 10^2$

= 10033

Measuring length divisor = $10^{\text{No. of fractional digits}}$

= 100

Type of the parameter value: 25 bit unsigned int

Parameter-No. B12 B9	Parameter value in D0 - D24	Value range	Default
1 0 0 0	selectable	1 - 33 554 431 dec	1

3.2 Read Back Parameters (TR-specific)

The parameter data can be transferred via the bits 0 to 24 of the process in data channel of the encoder to the master. To this the encoder must be set to the "read back" state. This is achieved by outputting a parameter number unequal to zero on bits 9 to 12 of the control word (bits 25 to 28 of the process out data channel), additionally the output bit 2^{31} "Enable Operation" must be set.

Note

The parameter data can be read back also during the parameter setting. Is changed from read-state to the set-state (bit 2^{31} erased) at this moment, the read parameter is set to the transmitted set point!

Parameter

2^{31}	Parameter B12 B9	Function
1	0 0 0 1	Read Number of steps/revolution
1	0 0 1 0	Read Measuring length in revolutions
1	0 0 1 1	Read Position actual value coding Reading of the parameters Code, Direction of rotation and Sign **1 = Unsigned dual code** ascending code in 'right' direction of rotation (clockwise when looking at the shaft) **2 = Unsigned dual code** ascending code in 'left' direction of rotation (anticlockwise when looking at the shaft) **3 = Signed dual code (unsigned)** ascending code in 'right' direction of rotation (clockwise when looking at the shaft) **4 = Signed dual code (unsigned)** ascending code in 'left' direction of rotation (anticlockwise when looking at the shaft) **5 = Unsigned gray code** ascending code in 'right' direction of rotation (clockwise when looking at the shaft) **6 = Unsigned gray code** ascending code in 'left' direction of rotation (anticlockwise when looking at the shaft)
1	0 1 0 0	Read Preselection preset value
1	0 1 0 1	Read Set zero shift
1	0 1 1 0	Read Measuring initial value (offset)
1	1 0 0 0	Read Measuring length divisor **(TR-specific profile extension)**

3.3 Examples of parameter transfers

Set measuring length in revolutions = 4096

1. Send control word 0000 0000h --> position actual value is transferred
2. Wait, until status bit 2^{30} "Parameterization" = 0 (parameterization off)
3. Send control word 0000 1000h + 0400 0000h
4. Wait, until status word C400 1000h is received (parameterization on, actual value invalid). Received parameter-no. and value must correspond with the transmitted message.
5. If further parameters must be changed, send the parameters in the same way.
6. Send control word 8000 0000h to enable the operation
7. Wait, until status bit 2^{30} "parameterization" = 0 (parameterization ready)
8. Send control word 0000 0000h --> position actual value is transferred. The received malfunction code should be "0"

Read back measuring length in revolutions = 4096

1. Send control word 84xx xxxxh, e.g. 8400 0000h
2. Wait, until the acknowledgement is received:
   In parameterization state = C400 1000h, in output state = 8400 1000h

Execute "Set-Zero-Shift"

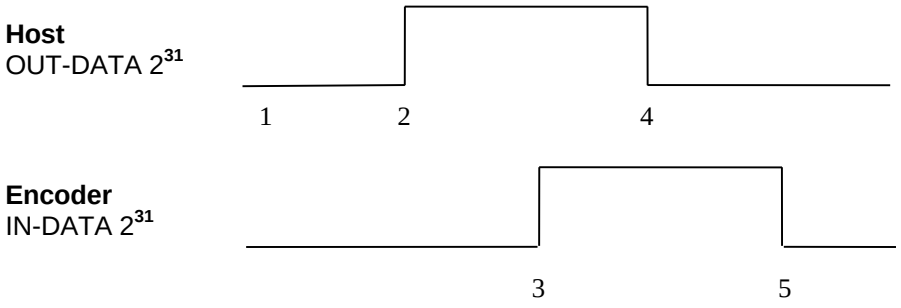
1. Send control word 0000 0000h --> position actual value is transferred
2. Wait, until status bit 2^{30} "Parameterization" = 0 (parameterization off)
3. Send control word 4000 0000h to start the zero shift
4. Wait, until status bit 2^{30} "parameterization" = 1 (parameterization on)
5. Send control word 0000 0000h to stop parameterization. However, the zero shift is executed in any case and is stored permanently
6. Wait, until status bit 2^{30} "parameterization" = 0 (parameterization ready)
7. Wait, until status bit 2^{31} "Invalid position actual value" = 0 (position is valid). If the encoder shaft was not turned during the zero shift, the position actual value corresponds exactly to the programmed preset value (Function 0100, set preselect preset value).

4 TR-Profile - Parameter transfer

4.1 Callable Services

The system processes all service requests from the host to the encoder by means of a handshake of the service bit.

Handshake of service bit 2^{31}



1. The host is in normal mode, service bit 2^{31} is 0.
   The IN-data contains the encoder's actual position.

2. The host outputs the data and the service number and sets the service bit to 1.

Note:
To guarantee data consistency between the commissioning card and the PLC, the data and the service number must be output first. One PLC cycle later, the service bit must be set from 0 to 1.
With a read service, OUT data 2^{23} to 2^{0} is meaningless.

3. The encoder detects and processes the service request, provides the appropriate data and reports back to the host system by setting service bit 2^{31}. With a read service, the system returns the OUT data to the IN data.

4. The host system detects execution and ends the service request. The system resets service bit 2^{31} and switches back to normal mode.

5. The encoder also detects the end of the service request and also switches to normal mode by resetting service bit 2^{31}. Afterwards, the system continues with the encoder's actual value output.

4.1.1 Direction of Counting/Code – Service 01 Hex

Service Request from Master (OUT Data)

2^{31} to 2^{24}	2^{23} to 2^{16}	2^{15} to 2^{8}	2^{7} to 2^{0}	
a) 81 Hex	No effect	No effect	No effect	Read data
b) C1 Hex	0 or 1 (Meaningless)	0 or 1 0 = Binary ≠ 0 = Gray	* 0 or 1 0 = CW rising ≠ 0 = CW falling	Write data

* 0 = Data rising clockwise looking towards the shaft
≠ 0 = Data falling clockwise looking towards the shaft

Service Feedback Message from Encoder (IN Data)

2^{31} to 2^{24}	2^{23} to 2^{0}	
a) 81 Hex	0 or 1	Depending on programming
b) C1 Hex	0 or 1	Depending on programming

4.1.2 Measuring Length in Steps – Service 02 Hex

Measuring length in steps = (resolution/360 degrees x measuring range in revs) **-1**

Service Request from Master (OUT Data)

2^{31} to 2^{24}	2^{23} to 2^{0}	
a) 82 Hex	No effect	Read data
b) C2 Hex	FF FF FF Hex to 10 Hex	Write data

Service Feedback Message from Encoder (IN Data)

2^{31} to 2^{24}	2^{23} to 2^{0}	
a) 82 Hex	FF FF FF Hex to 10 Hex	Depending on programming
b) C2 Hex	FF FF FF Hex to 10 Hex	Depending on programming

4.1.3 Measuring Length in Revolutions Numerator – Service 03 Hex

Service Request from Master (OUT Data)

2^{31} to 2^{24}	2^{23} to 2^{0}	
a) 83 Hex	No effect	Read data
b) C3 Hex	00 FF FF Hex to 1 Hex	Write data

Service Feedback Message from Encoder (IN Data)

2^{31} to 2^{24}	2^{23} to 2^{0}	
a) 83 Hex	00 FF FF Hex to 1 Hex	Depending on programming
b) C3 Hex	00 FF FF Hex to 1 Hex	Depending on service request

4.1.4 Preset Adjustment – Service 06 Hex

Service Request from Master (OUT Data)

2^{31} to 2^{24}	2^{23} to 2^{0}	
C6 Hex	Measuring length in steps to 0 Hex	Write data

Service Feedback Message from Encoder (IN Data)

2^{31} to 2^{24}	2^{23} to 2^{0}	
C6 Hex	Measuring length in steps to 0 Hex	Depending on service request

4.1.5 Data Check – Service 08 Hex

Service Request from Master (OUT Data)

2^{31} to 2^{24}	2^{23} to 2^{0}	
88 Hex	No effect	Read data

Service Feedback Message from Encoder (IN Data)

2^{31} to 2^{24}	2^{23} to 2^{0}	
88 Hex	2^{23} to 2^{16} always "0"	2^{15} to 2^{0} error status

4.1.6 Measuring Length in Revolutions Denominator – Service 09 Hex

Service Request from Master (OUT Data)

2^{31} to 2^{24}	2^{23} to 2^{0}	
a) 89 Hex	No effect	Read data
b) C9 Hex	0000 63 Hex to 1 Hex	Write data

Service Feedback Message from Encoder (IN Data)

2^{31} to 2^{24}	2^{23} to 2^{0}	
a) 89 Hex	0000 63 Hex to 1 Hex	Depending on programming
b) C9 Hex	0000 63 Hex to 1 Hex	Depending on service request

4.1.7 SSI-OUT Data Interface

4.1.7.1 SSI Characteristic Values – Service 0D Hex

Service Request from Master (OUT Data)

2^{31} to 2^{24}	2^{23} to 2^{16}	2^{15} to 2^{8}	2^{7} to 2^{0}	
a) 8D Hex	No effect	No effect	No effect	Read data
b) CD Hex	0 or 1 0 = without repet. ≠ 0 = with repet.	0 or 1 0 = Binary ≠ 0 = Gray	Number of data bits 08 to 20 Hex **Valid starting CW 41/ 97:** Entry 1F hex = AK-40 compatible	Write data

Service Feedback Message from Encoder (IN Data)

2^{31} to 2^{24}	2^{23} to 2^{16}	2^{15} to 2^{8}	2^{7} to 2^{0}	
a) 8D Hex	0 or 1	0 or 1	Number of data bits 08 to 20 Hex	Depending on programming
b) CD Hex	0 or 1 0 = without repet. ≠ 0 = with repet.	0 or 1 0 = Binary ≠ 0 = Gray	Number of data bits 08 to 20 Hex	Depending on service request

4.2 Brief Description of Executable Services

4.2.1 Direction of Counting/Code – Service 01 Hex

Here, you specify the direction of counting and the encoder's code:

Value 0 Hex (2^7 to 2^0) = encoder position rising clockwise (looking towards shaft)
Value ≠ 0 (2^7 to 2^0) = encoder position falling clockwise (looking towards shaft)

Value 0 Hex (2^{15} to 2^8) = data output to the INTERBUS-S in binary code
Value ≠ 0 (2^{15} to 2^8) = data output to the INTERBUS-S in Gray code

Reading and writing are possible.
The value range in each case is 0 to FF Hex.

4.2.2 Measuring Length in Steps – Service 02 Hex

Here, you specify the total length in steps:

Measuring length in steps = (measuring length /360 degrees x measuring length in revs) -1

Reading and writing are possible.
The value range is 10 Hex to FF FF FF Hex.

4.2.3 Measuring Length in Revolutions (Numerator) – Service 03 Hex, Measuring Length in Revolutions (Denominator) – Service 09 Hex

Here, you specify the number of revolutions that the encoder carries out within the total number of steps.
If the number of revolutions is an integer, you should always program the denominator to the value "1".
If the number of revolutions is a decimal number, program the denominator with the digits after the decimal point.

Example:

The encoder is intended to resolve 3.5 revolutions.

⇒ Revolutions numerator = 35 (service 03 Hex)

⇒ Revolutions denominator = 10 (service 09 Hex)

If you program a number of revolutions that is not a power of two, the zero point can be lost if the encoder traverses more than 512 revolutions in a deenergized state.

Reading and writing are possible.

Value range of numerator: 1 - FF FF Hex
Value range of denominator: 1 - 63 Hex

4.2.4 Preset Adjustment – Service 06 Hex

Using preset adjustment, you can adjust the encoder to a specific value via the INTERBUS-S ring.

Only writing is possible.

Value range: 0 to the programmed measuring length in steps (value from service 02 Hex).

4.2.5 Data Check – Service 08 Hex

After programming the encoder, you must call the data check service. This call checks the validity of the programmed data and accepts it. Without this call, the encoder continues to run with the old parameters until you switch the power off and on again.

Only reading is possible.

On 2^0 to 2^{15} of the IN data the master receives the error status as the response.
Bits 2^{16} to 2^{23} of the IN data are "0".
Bits 2^{24} to 2^{31} of the IN data feed back the requested service.

Error Status

2^0	Error reading data
2^1	Error writing data
2^2	Only reading allowed
2^3	Only writing allowed
2^4	Always 0
2^5	Always 0
2^6	Always 0
2^7	Unknown command
2^8	Always 0
2^9	Always 0
2^{10}	Always 0
2^{11}	Always 0
2^{12}	Always 0
2^{13}	Revolutions numerator = 0
2^{14}	Measuring length in steps is too high. Measuring length/360 degrees > encoder resolution same as on encoder's rating plate
2^{15}	Always 0

If an error occurs at execution of a service (error bit set in encoder's service feedback message), you can determine the error exactly by carrying out the data check service.

4.2.6 SSI-OUT Data Interface

Data Transfer
At rest, Data+ and Clock+ are +5 V (High). Data transfer starts with the MSB and is initiated by the first falling clock edge. Data is changed by a positive clock edge. Depending on the receiver, data is accepted with a rising or a falling edge.
When the clock sequence is over, the system keeps the data lines at 0 V (Low) for the duration of the mono period, t_M. Time t_M is set to 20 µs and it determines the lowest transfer frequency of approximately 50 kHz. The upper limit frequency results from the total of all the signal propagation delays and is approximately 1.1 MHz.

4.2.6.1 SSI Characteristic Values – Service 0D Hex

Reading and writing are possible.

Number of Data Bits
Using this parameter, you can shift data anywhere within the number of clock pulses. The data can be transferred right- or left-justified and with or without leading zeros. You generate leading zeros by generating a higher number of data bits than would normally be necessary for the encoder.

Value range: 08 to 20 Hex

Note (valid starting CW 41 / 97)
By programming the number of data bits to 31 (1F hex) the SSI-output format will be set automatic to the AK-40 data format:
31 data bits; binary; data bit 32 = Parity odd

Code
The code is a method for forming digital numbers. A code word is a bit pattern that expresses a numerical value. The code describes the assignments of code words and their values.
In the case of multi-step codes, changing the numerical value by 1 results in a new code word in which several bits are different from the old one. With single-step codes, only one bit changes in the code word in this case.
With decadic codes, four bits in each case are grouped together to one decimal digit.
The following codes are used:
Binary code (multi-step code)
Gray code (single-step code)

Value range: 00 to FF Hex

Repetition
Using the Repetition parameter, you choose whether the data bits in long pulse bundles are to be repeated every 26 pulses. In this connection, the system automatically sets the number of data bits to 24.

Application: Easy determination of transfer disturbances.

Value range: 00 to FF Hex

4.3 Example of Programming the Measuring Length in Steps

Specifications:

Resolution/360 degrees	= 3E8 Hex
Measuring length in revolutions numerator	= 0A Hex
Measuring length in revolutions denominator	= 1 Hex

$$\text{Measuring length in steps} = \left[\text{Resolution/360 degrees} \times \frac{\text{Measuring length in revolutions numerator}}{\text{Measuring length in revolutions denominator}} \right] \mathbf{-1}$$

$$= \text{3E8} \times \frac{\text{0A}}{1} \mathbf{-1}$$

$$= \mathbf{27\ 0F\ Hex}$$

Carry out the following steps:

Service Request from Master (OUT Data)

2^{31} to 2^{24}	2^{23} to 2^{0}	
C2 Hex	00 27 0F Hex	Write data/start of handshake

Service Feedback Message from Encoder (IN Data)

2^{31} to 2^{24}	2^{23} to 2^{0}	
C2 Hex	00 27 0F Hex	Data feedback message/confirm handshake

End Service Request from Master (OUT Data)

2^{31} to 2^{24}	2^{23} to 2^{0}
Bit 2^{31} to "0"	Rest have no effect/deactivate handshake

Service Feedback Message from Encoder (IN Data)

2^{31} to 2^{24}	2^{23} to 2^{0}
Value "0"	Current encoder position/deactivate handshake

For the system to accept the new Measuring length in steps parameter, a data check must be carried out first. If you still have other parameters to program, do not carry out the data check until you have completed programming them.

5 Disturbances

5.1 Causes of Faults and Remedies

5.1.1 K3-specific

The error causes are determined according to the malfunction code (see page 27). For resetting of the malfunction code, at first the error must be eliminated. Subsequently, the "Enable Operation" command must be transmitted to the encoder.

Disturbance	Cause	Remedy
0001 Invalid parameters from the host	Invalid parameter data, a parameter range error is available.	Check all programmed parameters after valid ranges of values (see "**Parameter Overview**", page 26 and "**Parameter description**", page 29).
0010 Unknown Parameter-No.	It was transmitted a parameter to the encoder, which is not defined.	Valid parameter-no., see "**Parameter Overview**", page 26.
0011 Memory error	Memory area in the EEPROM is defect	If the error occurs at repeated service type, the device must be replaced.
2^{31} = 1 (Status Word) Position Actual value invalid	Position skips were detected	If the error occurs repeated, the device must be replaced.

5.1.2 TR-Profile-specific

If an error occurs while one of the services is being carried out, the system sets error bit 2^{29} in the encoder's service feedback message. For resetting of the error bit, at first the error must be eliminated. Subsequently, the "Data Check Service 08 hex" must be transmitted to the encoder.
As response of the data check service the master on 2^0 to 2^{15} of the IN-data receives the error status. Thus the error cause can be specified more exactly.

Disturbance	Cause	Remedy
Error reading data (Status bit 2^0=1)	Defective memory area in the EEPROM	If the error occurs when you try to execute the service again, you must replace the encoder.
Error writing data (Status bit 2^1=1)	Defective memory area in the EEPROM	If the error occurs when you try to execute the service again, you must replace the encoder.
Only reading allowed (Status bit 2^2=1)	The system tried to carry out a write command.	Set bit 2^{30} (read-write bit) to 0.
Only writing allowed (Status bit 2^3=1)	The system tried to carry out a read command.	Set bit 2^{30} (read-write bit) to 1.
Unknown command (Status bit 2^7=1)	You entered the wrong service number.	Check the executed service number and correct it.
Revolutions numerator = 0 (Status bit 2^{13}=1)	You entered a "0" when programming the measuring length in revolutions numerator (service 03 HEX).	Allowed value range: 00 FF FF HEX to 1 HEX
Measuring length in steps too high (Status bit 2^{14}=1)	The revolutions fraction (numerator/denominator) was programmed too low.	The number of steps per revolution must not exceed the encoder resolution stated on the rating place. Program a higher setting for the revolutions fraction (numerator/denominator).

5.1.3 General

Disturbance	Cause	Remedy
Encoder step changes	Loose contacts in the wiring	Check all the cabling and wiring used for connecting the encoder.
	Severe vibrations	"Shock modules“ are used to cushion vibrations shocks and jolts on presses, for example. If the fault keeps occurring despite these measures, you must replace the encoder.
	Electrical disturbances	Insulating flanges and couplings and cables with twisted-pair wires for data and supply are useful against electrical disturbances. The cable screens should be grounded on **both** ends. You should only ground the screen on **one** end in the switching cabinet if the machine ground has more disturbances compared to the switching cabinet ground.
	Excessive axial and radial loading of the shaft or a sampling defect.	**Plastic couplings prevent mechanical loading of the shaft. If the fault keeps occurring despite these measures, you must replace the encoder.**

6 Appendix

6.1 Technical data

6.1.1 Electrical ratings

Operating voltage:	11-27 V DC (± 5% residual ripple)
Power consumption (without load):	≤ 3 watt
Output capacity:	max. 33 bit
Resolution:	1 to max. 131072 steps/revolution (17 bit)
Measurement range:	max. 65536 revolutions (16 bit)
Output code:	K1, K2 = binary, K3, TR = binary, gray (programmable)
Baud rate:	300 kbps net, 500 kbps gross (including control and status bytes)
Data refresh:	0,5 ms
Encoder interface:	Two-wire remote bus for INTERBUS-S, RS422 with galvanic isolation
Ident number:	K1, K2 = 54 dec., K3 = 55 dec., TR-profile = 51 dec.
Special features:	Programming of the following parameters via the INTERBUS-S: (K3-profile / TR-profile): - Resolution - Measuring range - Code - Direction of rotation - Sign - Preset adjustment - Offset Reading back of all parameters (TR-specific)
Operating temperature range:	-20 to +80 °C
Option:	-30 to +100 °C

6.1.2 Mechanical ratings

Mechanically permissible speed:	12 000 min^{-1}
Permissible shaft load:	40 N axial, 60 N radial (at end of shaft)
Minimum bearing lifetime:	3,9 x 10^{10} revolutions at:
Operating speed:	6000 min^{-1}
Shaft loading:	20 N axial, 30 N radial (at end of shaft)
Operating temperature:	60 °C
Max. angular acceleration:	≤ 10^4 rad/s^2
Moment of inertia:	2,5 x 10-^{6} kg m^2
Starting torque at 20 °C:	2 Ncm
Vibration, DIN IEC 68-2-6 (Sine 50-2000 Hz):	≤ 100 m/s^2 (10 g)
Shock, DIN IEC 68-2-27 (11 ms):	≤ 1000 m/s^2 (100 g)