COMBIVERT

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GB	INSTRUCTION MANUAL	Encoder Interface
	Channel 1	UVW
	Channel 2	Incremental Encoder TTL-Input

KEB

Table of Contents

1. Safety Instructions

Prior to performing any work on the unit the user must familiarize himself with the unit. This includes especially the knowledge and observance of the safety and warning directions. The pictographs used in this instruction manual have following meaning:

	Danger	Refers to danger of life by electric current.

	Warning	Refers to possible danger of injury or life.

	Note	Refers to tips and additional information.

1.1 Validity

The information contained in the technical documentation, as well as any user-specific advice in spoken and written and through tests, are made to best of our knowledge and information about the application. However, they are considered for information only without responsibility. This also applies to any violation of industrial property rights of a third-party.

Inspection of our units in view of their suitability for the intended use must be done generally by the user. Inspections are particulary necessary, if changes are executed, which serve for the further development or adaption of our products to the applications (hardware, software or download lists). Inspections must be repeated completely, even if only parts of hardware, software or download lists are modified.

	Controlling by the user	Application and use of our units in the target products is outside of our control and therefore lies exclusively in the area of responsibility of the user.
	Use under special conditions	The used semiconductors and components of KEB are developed and dimensioned for the use in industrial products. If the KEB COMBIVERT is used in machines, which work under exceptional conditions or if essential functions, life-supporting measures or an extraordinary safety step must be fulfilled, the necessary reliability and security must be ensured by the machine builder.

1.2 Qualification

All operations serving transport, installation and commissioning as well as maintenance are to be carried out by skilled technical personnel (observe IEC 364 or CENELEC HD 384 or DIN VDE 0100 and national accident prevention rules!). According to this manual qualified staff means:

- those who are able to recognise and judge the possible dangers based on their technical training and experience
- those with knowledge of the relevant standards and who are familiar with the field of power transmission (VDE 0100, VDE 0160 (EN 50178), VDE 0113 (EN 60204) as well as the appropriate regulations for your area.

	Danger by high voltage	KEB electronics components contain dangerous voltages which can cause death or serious injury. In operation, drive converters, depending on their degree of protection, may have live, uninsulated, and possibly also moving and hot surfaces. In case of inadmissible removal of the required covers, of improper use, wrong installation or maloperation, there is the danger of serious personal injury and damage to property.

KEB

2. Product Description

Figure 1: Encoder interface 2MF5280-7008		Figure 2: Encoder interface 1MF5280-7008	
X3B	X3A	X3B	X3A
Channel 2	Channel 1	Channel 2	Channel 1
TTL input	UVW	TTL input	UVW

2.1 General

The available encoder interface includes an input for the connection of a UVW encoder, as well as an input for the connection of incremental encoders with TTL level. The instruction covers the installation of the interface card, the connection as well as the start-up of a suitable encoder. Further information and the parameter adjustments are described in the application manual for the inverter/servo.

2.2 Material number

xM F5 K8G Z X X X

0	installed	Z	Option, spare part

Z	UVW / TTL input

F5	Series

1M	Applicable for housing size D, E (circuit board 1MF5280-7008)
2M	Applicable for housing size G (circuit board 2MF5280-7008)

2.3 Mechanical installation

All kind of works on the inverter may be carried out by authorized personnel in accordance with the EMC and safety rules only.

- Switch inverter de-energized and await capacitor discharge time
- Pull off operator
- Remove plastic cover
- Remove fixing bolt
- Fix interface board beginning from the socket connector straightly
- Screw in fixing bolt
- Attach plastic cover

3. Description of the Interface

3.1 Voltage supply

Figure 3.1	Voltage supply of control and encoder interfaces	
U_{int}	24 VDC	Internal voltage supply of COMBIVERT.
I_{int}	140 mA	
U_{ext}	Control terminal strip (X2A) of the COMBIVERT with external voltage supply 24…30 DCV.	
24 V	Voltage output of encoder interfaces X3A and X3B for encoder supply.	
I_{24V}	Current I_{int} reduces itself by draw current to the 5 V output in accordance with the following formula: $$I_{24V} = I_{int} - \frac{5,2\,V \times I_{5V}}{U_{int}}$$	
5 V	Voltage output for encoder supply. 5,2 V are obtained from the 24 V voltage.	
I_{5V}	400 mA	Total for both encoder interfaces
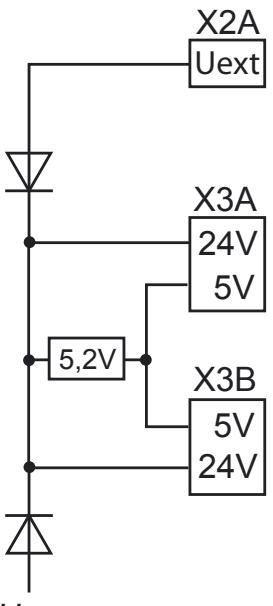
3.2   Channel 1

X3A	Socket SUB-D15
Interface type	UVW
Input signals	5 V TTL according to RS-422 / -485
Inputs / incremental tracks	A, B and N with the respective inverted signals
Absolute track	Block commutation tracks U, V, W
Limiting frequency	200 kHz
Increments per revolution	1…4096 inc (recommendation 2500 inc for speed upto 4500 rpm)
Input resistance	120 Ω
Max. line length	50 m, the value is additionally limited by the signal frequency, cable capacity and supply voltage.

3.2.1   Description of the socket X3A

Figure 3.2.1 Socket X3A	
	Attention! Plug connector only when COMBI-VERT and supply voltage are switched off!
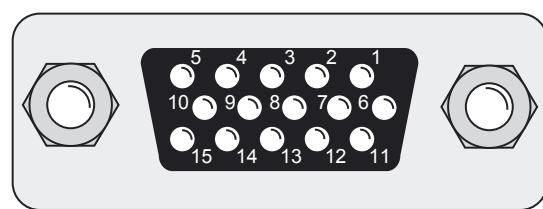
PIN	Name	Description
1	A+	Incremental encoder input track A
2	A-	Differential signal to A+
3	B+	Incremental encoder input track B
4	B-	Differential signal to B+
5	N+	Input zero track
6	N-	Differential signal to N+
7	U+	Block commutation track U
8	U-	Differential signal to U+
9	V+	Block commutation track V
10	V-	Differential signal to V+
11	W+	Block commutation track W
12	W-	Differential signal to W+
13	5V	Voltage output 5 V
14	COM	Reference potential for voltage supply
15	-	-

3.2.2   Input signals channel 1

3.2.2.1   Signal tracks
Tracks A and B are incremental signals with max. 4096 increments per revolution. The zero signal of track N is not evaluated.

Figure 1: Signal tracks A+ and B+
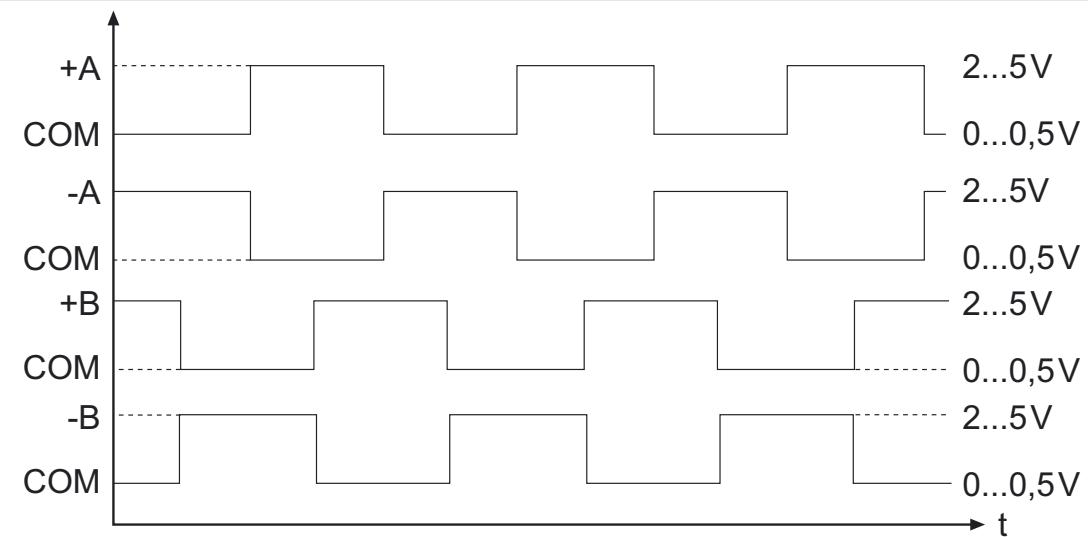
Figure 2:	The block commutation signals of tracks U, V, W are three absolute tracks; In view of the coupling (fixing) clockwise rotation.
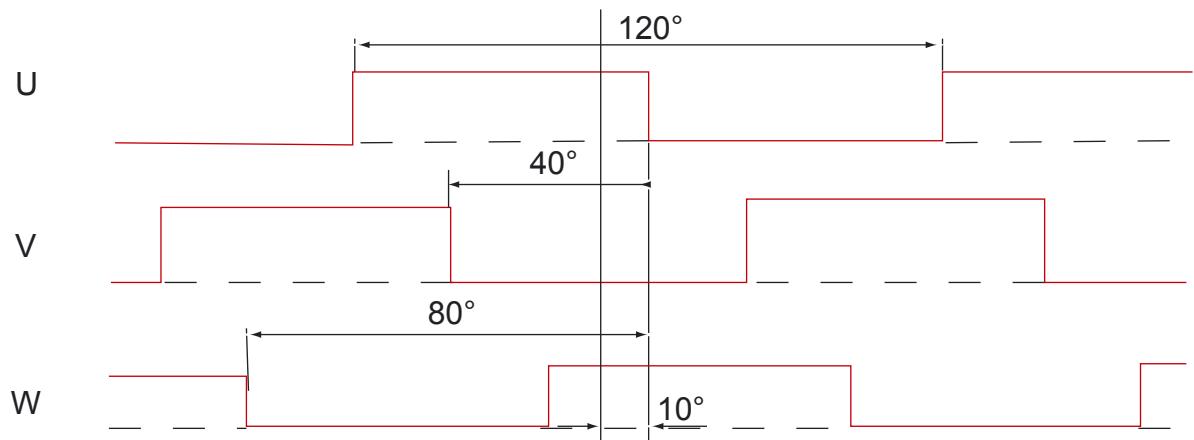
3.2.2.2   Position evaluation
The levels of the U, V ,W signals are measured after switching on and thus the absolute position of the encoder is determined within an electrical revolution of the motor (= el. revolution of the absolute tracks UVW).This position can maximally vary with 30° of the electrical revolution. The current position is first set to this start position.
If the motor starts to turn and the first rising edge at the U, V or W track is overdriven, the exact absolute position is determined and the current position is corrected to this value.
Only the rising edge of the W track is evaluated for the position correction during normal operation.
The zero signal is not evaluated for position correction and positioning. Only the encoder breakage recognition uses the error signal of the track. If the zero signal is not recognized during the initialization of the encoder, it is considered as not connected.
The pole-pair number of motor and encoder (the periods of the UVW tracks) must be equal.
After switching on the pole-pair number and the number of increments of the encoder are examined with the adjustments of the control board. During the first revolution of the encoder the number of increments per revolution and the periods of the UVW tracks are taken in account and after this revolution it is decided whether the adjustment corresponds to the encoder.The interface status displays value 70 if this is not the case.

3.2.2.3   Encoder breakage recognition channel 1
For a monitoring of the encoder and the encoder cable to channel 1 each signal track is monitored. The monitoring is switched on/off with parameter Ec.42 (Ec.20 up to V2.8). The encoder breakage recognition triggers an „error! encoder change" (value 35), if the voltage between two signal pairs is smaller than 625mV. Value 68 is displayed in parameter Ec.37 "enc.1 encoder status".

3.2.3   Encoder line length
Maximum encoder line length corresponding to the voltage drop caused by the cable resistance:

Encoder cable length = $\dfrac{U - U_{min}}{I_{max} \cdot 2 \cdot R}$	
max. encoder current I_{max}:	see encoder description
Encoder voltage U:	Voltage output
min. signal voltage U_{min}:	see encoder description
e.g. encoder cable resistance R:	$0{,}036\,\Omega/m$ at $0{,}5\,mm^2$

The maximum line length is additionally limited by the encoder frequency and cable capacity.

3.2.4   Tested encoders
The following encoders have been tested by KEB on it application:
•   Heidenhain ERN 423
However, this does not restrict the use of rotary encoder with same specifications of other manufacturers.

3.2.5   Connection of the encoder
- Encoder cable double-shielded and twisted in pairs
- Connect exterior shielding at both ends to PE/GND
- Connect interior shielding at one side to GND
- Do not connect exterior and interior shielding

Figure 2.2.5 Connection of the encoder

Socket X3A

PIN	Description
1	A+
2	A-
3	B+
4	B-
5	N+
6	N-
7	U+
8	U-
9	V+
10	V-
11	W+
12	W-
13	5V
14	COM
Housing	total shielding
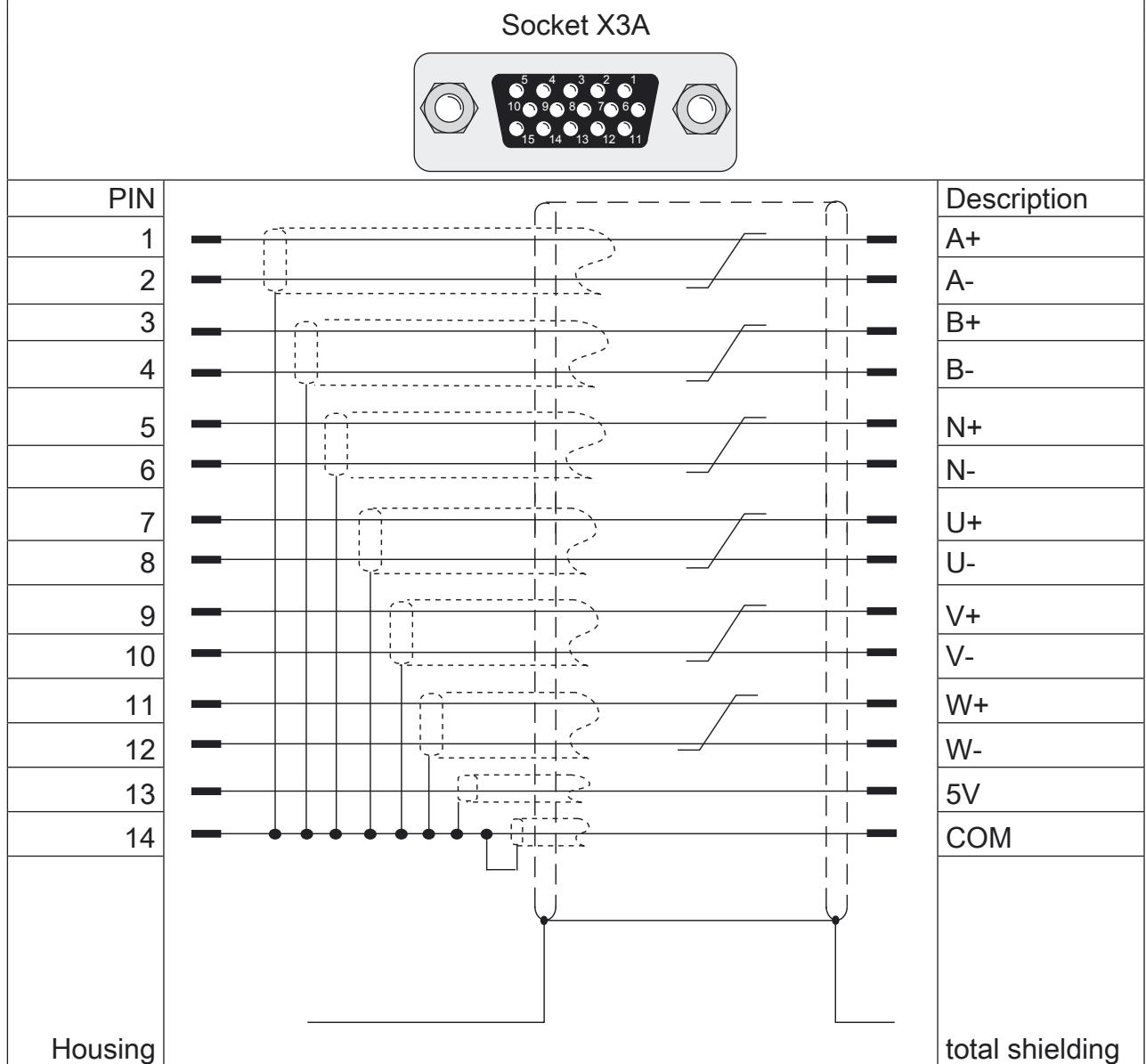
3.3 Channel 2

3.3.1 Specifications

X3B	Terminal strip 8-pole or socket SUB-D9
Interface type	Incremental encoder input
Input signals	5 V TTL according to RS485
Inputs / tracks	A, B and N with the respective inverted signals
Limiting frequency	200 kHz
Increments per revolution	1…16383 inc (recommendation 2500 inc for speed upto 4500 rpm
Input resistance	150 Ω
Max. line length	50 m, the value is additionally limited by the signal frequency, cable capacity and supply voltage.

3.3.2 Description of X3B

Figure 3.3.2 X3B as socket or terminal strip	
Figure 1	Figure 2
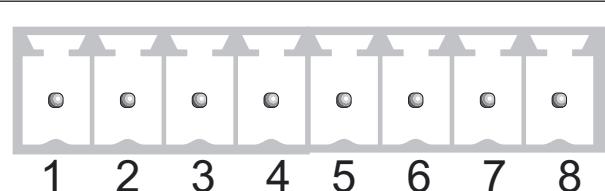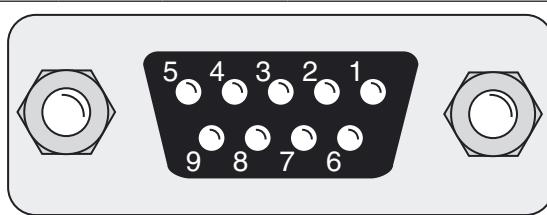
| PIN		Name	Description
Figure 1	Figure 2		
1	1	A+	Incremental encoder input track A
2	3	B+	Incremental encoder input track B
3	5	N+	Input zero track
4	7	5 V	Voltage output 5 V
5	–	24 V	Voltage output 20…30 V
6	2	A-	Differential signal to A+
7	4	B-	Differential signal to B+
8	6	N-	Differential signal to N+
9	8	COM	Reference potential for voltage supply
–	–	GND	Connection for shield at connector housing - is directly connected with the inverter earth. Connect-up external shield at the respective connector housing.

3.3.3 Input signals channel 2

3.3.3.1 Signal tracks

At this TTL input encoder interface the signals A+ and B+ are electrically phase-shifted by 90° rectangular signals with the respective inverted tracks A- and B-.

Figure 3.3.3.1	Signal tracks A+ and B+
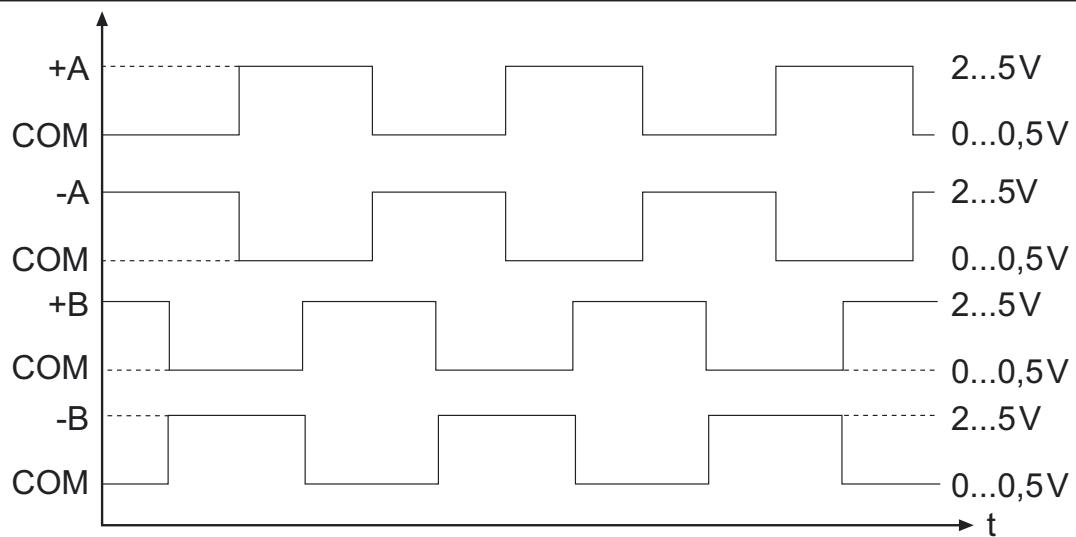
3.3.3.2 Evaluation of the zero signal

The zero impulse is required to determine valid position points. In case of pure speed controls the signal does not need to be connected. In the following signal sequence the maximum permissible length of the zero impulse of the encoder is visible. The zero signal will be acquired if A+ ,B+ and N+ are at high level. By that there is only one valid position point which is independent from the travel direction.

Figure 3.3.3.2	Evaluation of the zero signal
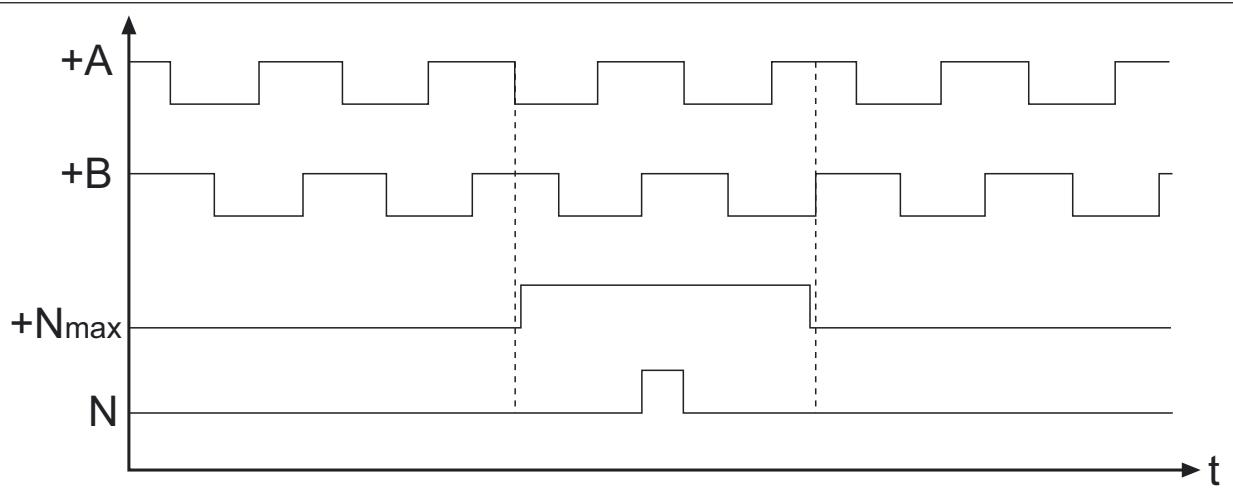
3.3.3.3 Encoder breakage recognition

For a monitoring of the encoder and the encoder cable to channel 2 the signal tracks and the zero track are monitored. If the connected encoder has no zero track, then the 5V-supply must be assigned to track N+ and COM to N- at the encoder plug. The monitoring is switched on/off with parameter Ec.42 (Ec.20 up to V2.8). The recognition of encoder breakage triggers an „error! encoder 2" (value 34), if the voltage between two signal pairs is smaller than 625 mV .

3.3.4 Connection of the encoder

3.3.4.1 Encoder cabel at SUB-D9

- Encoder cable double-shielded and twisted in pairs
- Connect exterior shielding at both ends to PE/GND
- Connect interior shieldings at one side to COM
- Don´t interconnect exterior and interior shielding

Figure 3.3.4.1   Connection of the encoder

Motor encoder plug			Socket X3B	
Name	PIN		PIN	Core color
GND	–		–	exterior shielding
A+	5		1	green
A-	6		6	yellow
B+	8		2	blue
B-	1		7	red
N+	3		3	gray
N-	4		8	pink
COM	10		9	white
5V	12		4	brown
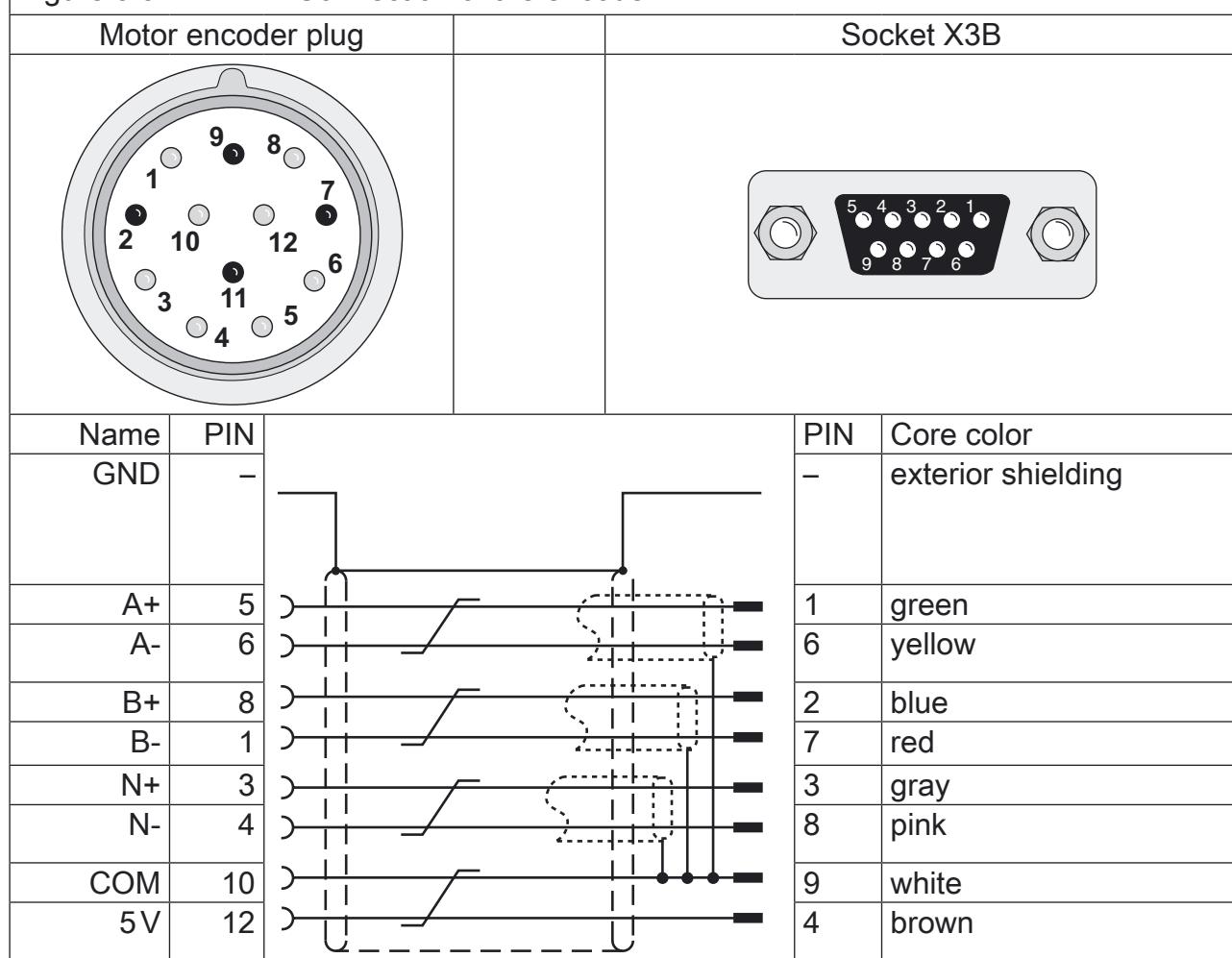
3.3.4.2 Encoder cable at terminal strip X3B

Figure 3.3.4.2	Connection of the encoder

Motor encoder plug		Socket X3B

Name	PIN		PIN	Core color
GND	–		–	exterior shielding
A+	5		1	green
A-	6		2	yellow
B+	8		3	blue
B-	1		4	red
N+	3		5	gray
N-	4		6	pink
COM	10		8	white
5 V	12		7	brown

3.3.5 Encoder cable

KEB encoder cables are corresponding to the following specification:

Signal lines	$3 \times (2 \times 0,14\,mm^2)$
Supply lines	$2 \times 0,5\,mm^2$
Particularities	trailing capable, oil-resistant
Temperature range	constant upto 80 °C
Color	orange RAL 2003

3.3.6 Encoder line length

The maximum line length for the connection line is limited by the signal frequency, cable capacity and the line resistance.

Encoder cable length $= \dfrac{U - U_{min}}{I_{max} \cdot 2 \cdot R}$	
max. encoder current I_{max}:	see encoder description
Supply voltage U:	5,2 V
min. supply voltage U_{min}:	see encoder description
KEB encoder cable resistance R:	$0,036\,\Omega/m$ at $0,5\,mm^2$

3.3.7 Tested encoders

The following TTL incremental encoders have been tested by KEB on it application:

- Heidenhain ROD 426

However, this does not restrict the use of rotary encoder with same specifications of other manufacturers.

4. Start-up

After the installation or exchange of an encoder interface some adjustments of the inverter/ servo software have to be done before operation:

- Switch on inverter
- Select application mode
- Select parameter Ec.0 and control whether value „22: UVW interface" is entered. The displayed value has to be confirmed by „ENTER" in any case.
- Select parameter Ec.10 and control whether value „1: incremental encoder input TTL In" is entered. The displayed value has to be confirmed by „ENTER" in any case.
- Select Ec.1/Ec.11 and adjust the respective increments per revolution.
- Adjust rated motor speed and frequency (e.g. at F5-S = dr.24, dr.25), because the pole-pair number of the motor and encoder must agree.
- Select Ec.42 (Ec.20 upto V2.8) and adjust the encoder breakage recognition dependent on the case of operation.

4.1 Encoder 1 status

This parameter displays, by means of different status messages, the status of encoder and interface. Dependent on the encoder only special messages are possible. All errors are only set at control release, although they are already displayed in Ec.37.

Value	Description
The following value is displayed at correct operation:	
16	The position values are transferred, no errors are located.
The following status messages trigger „Error! Encoder Change" (E.EncC) as the correct evaluation of the position is no longer guaranteed. Error E.EncC can only be reset via parameter Ec.0. Exception! An error due to wrong increments per revolution (value 70) is reset immediately, if the correct increments per revolution are adjusted (from software 2.7). Attention, the modulation is released, when the control release is still set!	
68	The encoder breakage recognition has released, the levels at least of one track are undefined.
69	The deviation between absolute position (UVW track) and current position is too high for a correction.
70	The test of pole-pair number and number of increments per revolution has determined incorrect adjustments.

5. Error Messages
Error messages and their meaning are described in chapter 9 of the application manual.

Notices

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