2 Electrical Data

2.1 General Design

Protection Degree III
Pollution Degree 2
Over voltage Category II

according DIN EN 61010 part 1 (03.94)/ EN 61010-1/A2 (05.96) (VDE 0411)

2.2 Supply Voltage (SELV)

DC 5 V –5%/ +10%
DC 7…30 V

2.3 Intrinsic current consumption (w/o output current)

Singleturn: at DC 5 V ≤ 45 mA
Multiturn: at DC 5 V ≤ 85 mA

2.4 Resolution and Accuracy

Incremental Signals (A, B)
2048 Periods / Revolution

Absolute accuracy	≤ ± 0,01°$_{mechanical}$	(± 36“)
Repeatability	≤ ± 0,002°$_{mechanical}$	(± 7,2“)

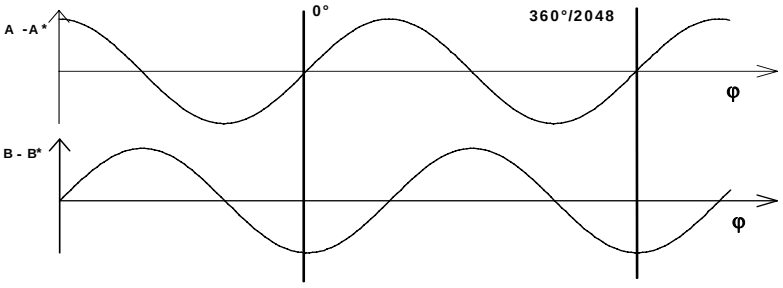
2.5 Output signals

2.5.1 Incremental Signals A, B

Track A leads B by 90° at rotation and view on shaft end.

$A = U_M + \hat{u}_A \sin(z\varphi_{mech.})$
$A^* = U_M - \hat{u}_A \sin(z\varphi_{mech.})$
$B = U_M - \hat{u}_B \cos(z\varphi_{mech.})$
$B^* = U_M + \hat{u}_B \cos(z\varphi_{mech.})$

z: No. Of signal periods (2048)



- Signal

Amplitudes:[1) 2)] $\hat{u}_{(A-A^*;\,B-B^*)}$ = 0,5V - 25% / + 20% (f ≤ 1kHz)
$\hat{u}_{(A-A^*;\,B-B^*)}$ = 0,35V ... 0,6V (f > 1kHz)

- Limiting frequency f_{gr} = 500 kHz
- Amplitudes difference [1)] $\hat{u}_{(A-A^*)} = \hat{u}_{(B-B^*)} \pm 10\ \%$
- Degree of modulation (mech.) [4)] $m \leq 0{,}1$
- Offset $|U_{off\,(A-A^*;\,B-B^*)}| < 0{,}1\ \hat{u}_{(A,A^*;\,B,B^*)}$
- Phase A to B [6)] $\varphi = 90° \pm 3°$
- Harmonic distortion [3)] k < 2 % (typ. 1 %)
- DC Offset [5)] U_M = 2,5 V ± 20 %

[1)] : measured with 120 Ω termination resistor at encoder output
[2)] : at f = 1 kHz (corresponds to 30 U/min)

[3)] $k = \dfrac{\sqrt{U1^2 + U2^2 + \ldots + Un^2}}{\sqrt{U0^2 + U1^2 \ldots Un^2}}$ *U0: Basic Signal , U1 ... Un : harmonics*

[4)] $m = \dfrac{\Delta u}{u}$

[5)] U_M same for A and A and for B and B* signals.*
[6)] Average

2.5.2 Absolute Position-Information over SSI

Resolution standard SSI (25 data bits)

Singleturn	17 Bit
Multiturn	12 Bit

Optional: Resolution SSI with extendable data length (> 25 data bits)

Singleturn	max 19 Bit
Multiturn	12 Bit
*Singleturn in 25-Bit MT-Model	programmable up to 19 Bit

Transmission via SSI bidirectional and synchronous

No. of wires and direction	4 unidirectional (2 for clock and 2 for data)
Driver according to	RS422
Transmission speed	70kHz –2 MHz according to SSI - definition

Data format

MSB first	Monoflop – Timeout 10µs ≤ tm ≤ 14µs

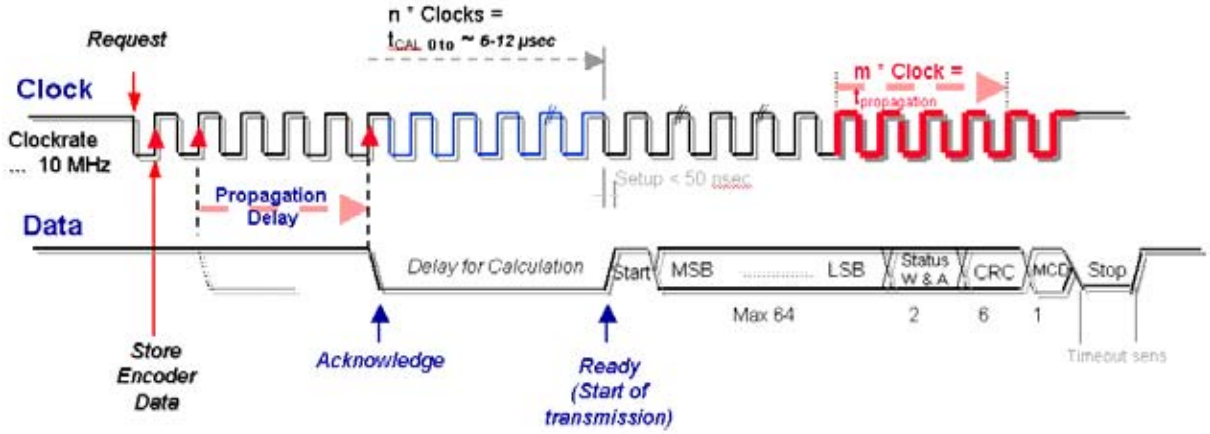
2.5.3 Absolute Position-Information over BiSS (Sensor-Mode)

Digital coded absolute information

Resolution Singleturn w/IPO	up to 19 Bit
Resolution Multiturn	12 Bit

Transmission via BiSS - bidirectional und synchronous

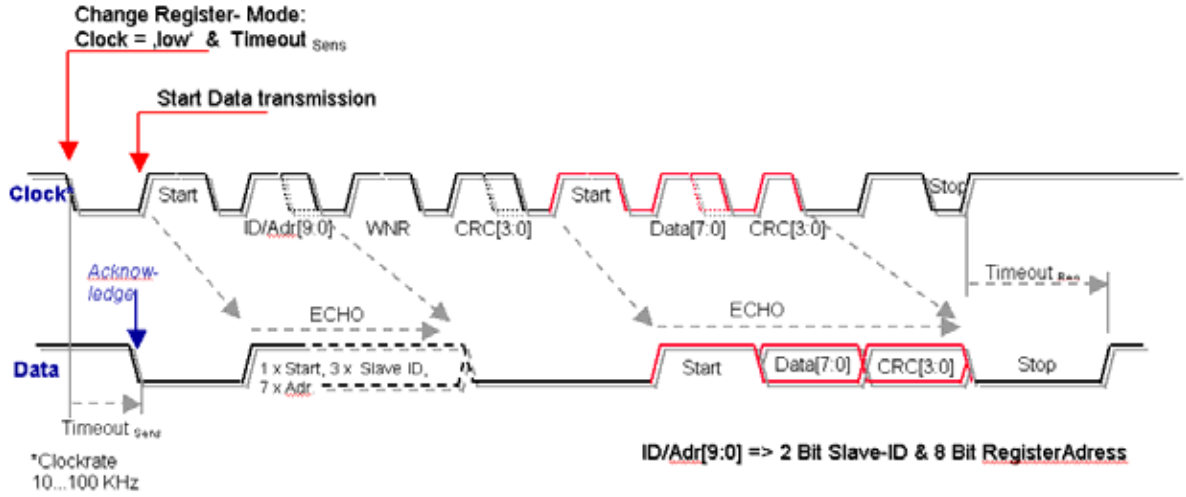
Signals	Clock unidirectional (from master to encoder) Data unidirectional (from encoder to master)
Driver according to	RS422
No. of wires and direction	4 unidirectional (2 for clock and 2 for data)
Transmission speed	70 kHz – 10 MHz
Transmission security	1 Start Bit, 1 Stop Bit, 6 Bit CRC
Multicycle data (MCD)	8 Bit Sensor temperature (s. Documentation www.biss-interface.com/files/BiSS_b1ds.pdf)
Timeout Sens	12 µsec
Timeout Reg	51 µsec
Delay for Calculation	≤ 14 Bit ST resolution 0 µs ≥15 Bit ST resolution 5 µs



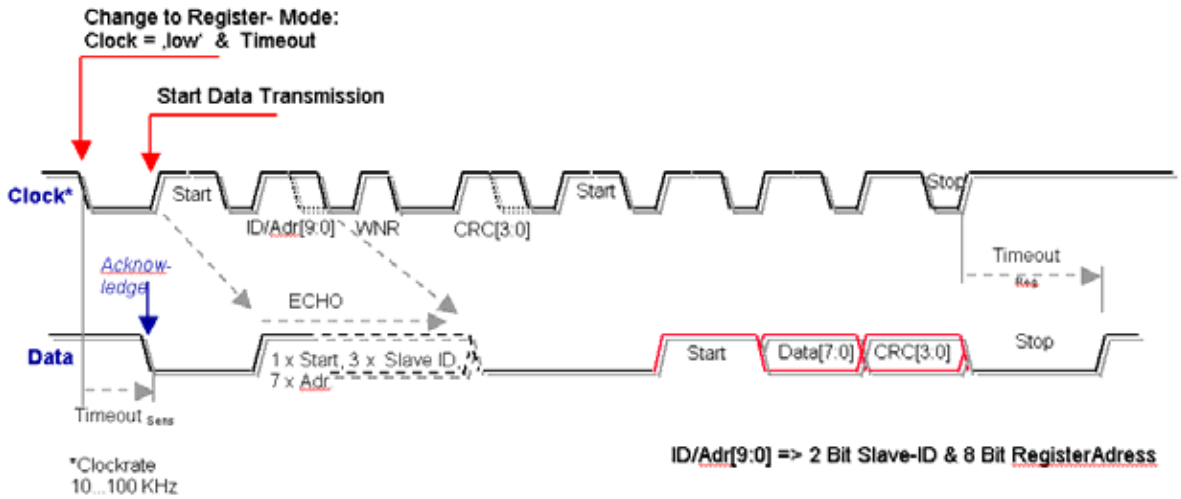
2.5.4 Parametrization, diagnostic function and data storage (BiSS - Register Mode)

Transmission over BiSS: Bidirectional and synchronous in PWM format.
Several encoder parameters are set here. In addition to detailed information for warning and alarm also the latest encoder temperature can be read. For storage of data a memory of 128 byte is available by default. More memory space can be provided on request.

Write register



Read register



Address room

Address	R/W-Protection			Bank 0	1
0x00 ... 0x09	high security	RAM configuration data	128 Byte	configuration data	OEM
0x0A ... 0x0F					
0x010 ... 0x2F	high security				
0x30 ... 0x31	low security				
0x32 0x33 ... 0x5F		encoder identification		identification OEM	
0x60 ... 0x69		position-and status data			
0x6A ... 0x77					
0x78 ... 0x7F	low security	ROM BiSS-identification		EEPROM BiSS-identification OEM	
0x80 ... 0xFE			128 Byte	OEM	
0xFF		Bank Select			

Register assignment (Blank 0)

		high security				high security	
		low security				low security	
ADR	**Content**			**ADR**	**Content**		
0x00		X		0x30			X
0x01		X		0x31			X
0x02		X		0x32			X
0x03		X		0x33	Encoder identification		X
0x04		X		...			
0x05		X					
0x06		X					
0x07		X					
0x08		X					
0x09		X					
0x0A	Preset-Multiturn Part 1						
0x0B	Preset-Multiturn Part 2						
0x0C	Preset-Multiturn Part 3						
0x0D	Preset-SingleturnPart 1			0x5F			
0x0E	Preset-SingleturnPart 2 + Interpolator Part 1						
0x0F	Preset-Interpolator Part 2			0x60	Instruction register/ Status register		
0x10		X		0x61	Position data register (Multiturn)		
0x11		X		0x62	Position data register (Multiturn)		
0x12		X		0x63	Position data register (Multiturn)		
0x13		X		0x64	Position data register (Singleturn)		
0x14		X		0x65	Position data register (Singleturn, Interpolator)		
0x15		X		0x66	Position data register (Singleturn)		
0x16		X		0x67	Temperature value		
0x17		X		0x68	Failure register		
0x18		X		0x69	Version register		
0x19		X		0x6A			
0x1A		X		...			
0x1B		X		0x77			
0x1C				0x78	BiSS identification		X
...				...			
0x2D		X		0x7F			
				0x80	External EEPROM data		
				...			
0x2E		X		0xFE			
0x2F		X		0xFF	Bank-Select		

Address	Bits	Value	ASCII	Meaning
0x78	7:0	0x41	A	Product identification
0x79	7:0	0x43	C	ACURO
0x7A	7:0	0x3A		
0x7B	7:5	0b000		no Multiturn
		0b001		12 Bit Multiturn
		0b010		16 Bit Multiturn
		0b011		20 Bit Multiturn
		0b100		24 Bit Multiturn
	4:0	0b01001		9 Bit Singleturn
		0b01010		10 Bit Singleturn
		0b01011		11 Bit Singleturn
		0b01100		12 Bit Singleturn
		0b01101		13 Bit Singleturn
		0b01110		14 Bit Singleturn
		0b01111		15 Bit Singleturn
		0b10000		16 Bit Singleturn
		0b10001		17 Bit Singleturn
		0b10010		18 Bit Singleturn
		0b10011		19 Bit Singleturn
		0b10100		20 Bit Singleturn
		0b10101		21 Bit Singleturn
		0b10110		22 Bit Singleturn
		0b10111		23 Bit Singleturn
		0b11000		24 Bit Singleturn
0x7C	7:0	0x00		free
0x7D	7:0	0x00		free
0x7E	7:0	0x48	H	producer identification
0x7F	7:0	0x45	E	Hengstler

Example for BiSS identification of absolute encoders:
Singleturn 19 Bit:
41 43 3A 13 00 00 48 45

Multiturn 12 Bit MT + 17 Bit ST:
41 43 3A 31 00 00 48 45

© Hengstler GmbH Uhlandstraße 49 78554 Aldingen / Germany
☎ 07424/89-0 Fax 07424/89-500
email: info@hengstler.de Internet: www.hengstler.com

Function Preset:
A preset function is set if the value 0x02h is written to the register address 0x60h. With this action preset value is set and the corresponding offset value is saved to EPROM.
Initial situation: preset value = 0

Read temperature value:
In the register 0x67h the temperature is stored and updated. Reading the register a 8 Bit absolute temperature value is received.

Diagnostic function:
If programmable limits are exceeded or under run this is indicated over warning and alarm bits.

Read error status:
If the alarm bit or the warning bit is set within the protocol “read position data” (SSI or BiSS) the cause of the error can be determined over the register 0x68h. Reading this register an 8 bit value is received.

Meaning:
Bit 0 = LED current out of control range
Bit 1 = External Multiturn Error
Bit 2 = Position Code Error (Single Step Error)
Bit 3 = Failure configuration interface
Bit 4 = Position data not valid
Bit 5 = Serial interface failure
Bit 6 = External failure over NERR
Bit 7 = Temperature out of defined range

Reaction on error message
Error messages can be acknowledged in different ways. The message can be displayed one time in the protocol. Alternatively the message can be transmitted until it has been acknowledged via command. The way the error message is acknowledged is set in the register 0x1B Bit 2 and is factory configured according to the OEM customer’s preference.

Function in detail:
Error message one time (monostable):
If one of the error conditions occurs, the alarm bit will be set (logical “1” in the protocol telegram). Reading the position data will reset the alarm bit. Depending on the further presence of the error condition the alarm bit will set again to”1” or stay on “0” in the following cycle.

Error message static (bistable):
If one of the error conditions occurs, the alarm bit will be set (logical “1” in the protocol telegram). Independant on the further presence of the error condition the alarm bit will stay on ”1” until it is reset through reading of the error register (Error register 0x68).

Error conditions
LED current out of defined range
This condition can be caused by critical conditions with respect to:
- Pollution
- Condensation
- Over temperature
- Ageing of LED

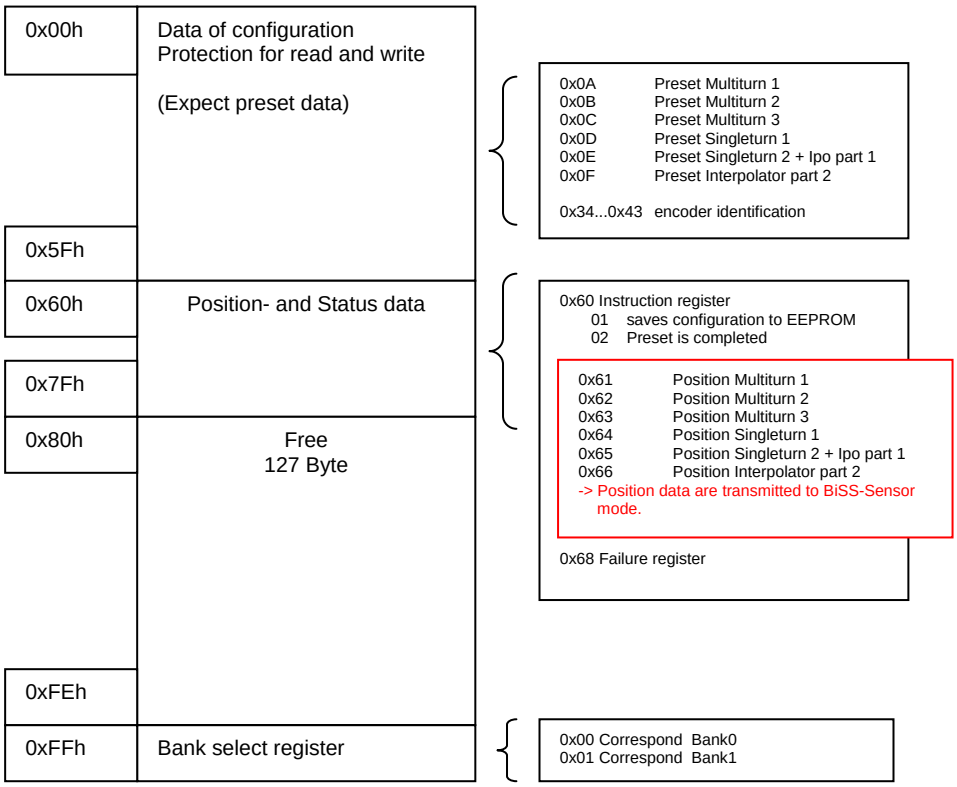
Code-Plausibility check error
This can be caused by:
- Disk pollution or disk damage
- mechanical overload

Temperature value out of range
- Warning if user defined temperature range is exceeded

© Hengstler GmbH Uhlandstraße 49 78554 Aldingen / Germany
☎ 07424/89-0 Fax 07424/89-500
email: info@hengstler.de Internet: www.hengstler.com

Reading and writing of the freely accessable memory
From the register address 0x80h to 0xFEh (0xFF is reserved for bank select register) 127 byte can be used in the bank “0” and 255 byte can be used in the bank “1”.
The bank select is activated via the register 0xFFh. If bank “0” is required than the value 0x00h has to be written in the address 0xFFh and if bank “1” is required then 0x01h has to be written in the address 0xFFh. With “read register” and “write register” memory access is performed.

Memory allocation (Memory Map)

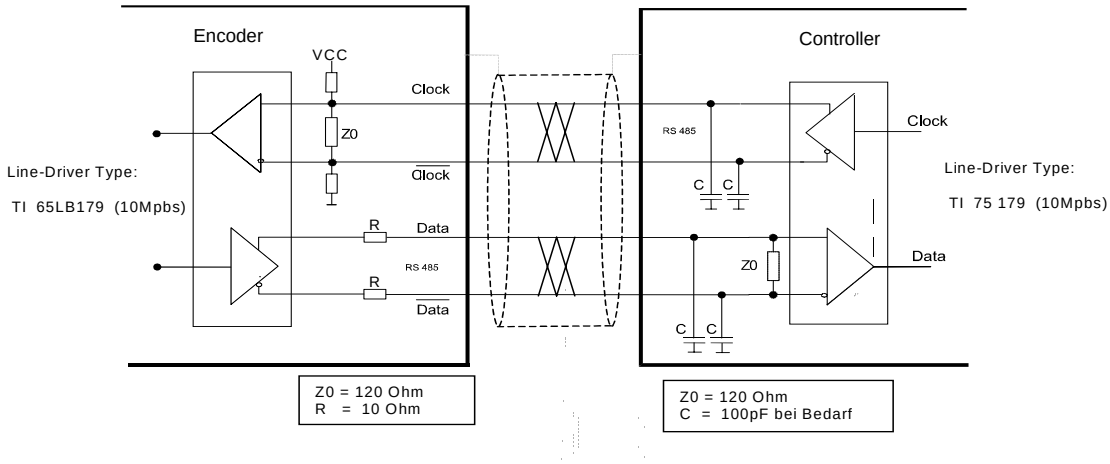


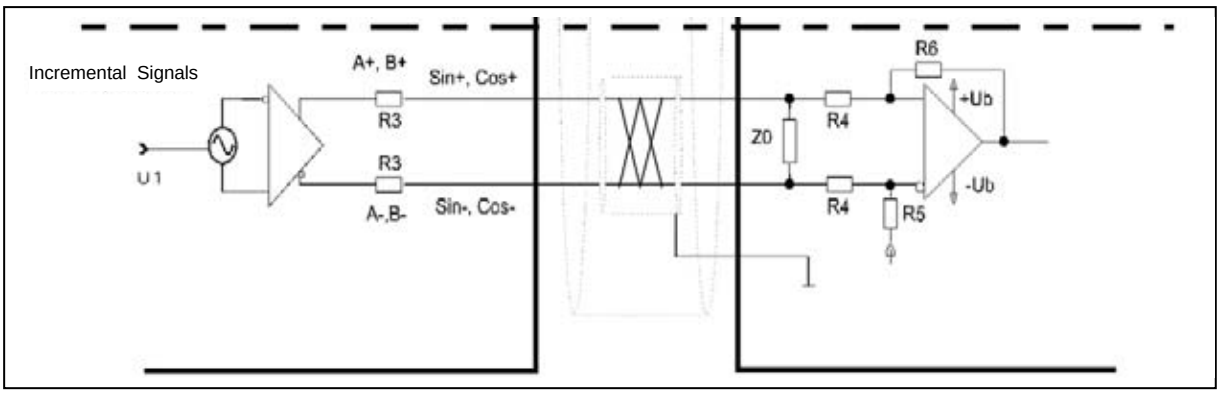
© Hengstler GmbH Uhlandstraße 49 78554 Aldingen / Germany
☎ 07424/89-0 Fax 07424/89-500
email: info@hengstler.de Internet: www.hengstler.com

Encoder Identification (Manufacturing data, Resolution)

Reg. Addr.	Description	Length	Format	1.	2.	3.	4.
Reg. 0x34	Serial number	4 Byte	Ser.-No. BCD format	SS	SS	SS	LL
Reg. 0x38	Date of manufacture	4 Byte	Date BCD format	DD	MM	YY	YY
Reg. 0x3C	Article code	4 Byte	Article code BCD format	XX	XX	XX	0
Reg. 0x40	MT-Resolution	1 Byte	MT BCD format (0...12-Bit)	12			
Reg. 0x41	ST-Resolution	1 Byte	ST BCD format (9...13-Bit)	14			
Reg. 0x42	IPO-Resolution	1 Byte	IPO BCD format (0...11-Bit)	3			
Reg. 0x43	SinCos Periods	2 Byte	SinCos BCD format	20	48		

2.5.5 Recommended input circuit Standard SSI or BiSS to 10 MHz clock rate





2.5.6 Recommended input circuit with incremental track 1 Vpp

Dimensions:
R1 = 91 Ω , R2 = 100 Ω , R3 = 10 Ω , R4 = 10kΩ ,R5 = R4*, Z0 = 120 Ω
C1 = 1nF

U1 = 2,5 V ± 0,5V (relating to supply voltage).
*1) Alternative mounting for high transmission rates (> 2MHz) and for operating with several encoders simultaneously (i.e. shared clock, split data line).

2.6 CE-Compliance

2.6.1 EMC- Immunity

ENV 50140	Class 3, 10 V/m
EN 61000-4-2	Class 4, 15 kV (air discharge), 8kV (contact discharge)
ENV 50141	Class 3, 10 V
ENV 61000-4-4	Class 4, 4000 V *

* Remark: *Direct coupling on the power supply needs limitation of the distortion pulses to max. 1000V*

Test standard: EN 50082-2

Cover:

ENV 50140	Electromagnetic HF-Field, amplitude modulated
ENV 50140	Electromagnetic HF-Field, pulse modulated
EN 61000-4-2	Electrostatic Discharge (ESD)

Terminations:

ENV 50141	High frequency, non symmetric, amplitude modulated
EN 61000-4-4	Transients (Burst) Mains input and outputs Data-, measuring-, control lines

2.6.2 EMC Emission

Class B

Test standard: EN 50081-2

Cover:

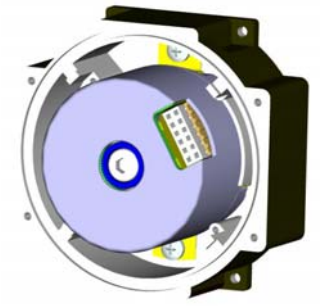
EN 55011	Radio frequency emission

2.7 Pinout PCB – Connector

Row b	**5 or 7-30 V** (U_B) gr/pk	**Clock** wt	**B-** rd	**0V (U_N)** wt/gn	**A-** ye	**Data** bk
Row a	**Data/** vio	**A+** gn	**0V Sens** bn/gn	**B+** bl	**Clock/** bn	**5 V Sens** rd/bl
PIN	1	2	3	4	5	6

Hint :
5 V (U_B) → 5 V Sens
0 V (U_N) → 0 V Sens

Connection on encoder side over
12-pin PCB connector,
Manufacturer Berg, Type: Minitek.



2.8 Cable

SSI: max. cable length	100 m (70KHz...2 MHz)
BiSS (CAT5 cable):	Cable capacity ≤ 100 pF/m
max. cable length	100 m (0...10 MHz)

© Hengstler GmbH Uhlandstraße 49 78554 Aldingen / Germany
☎ 07424/89-0 Fax 07424/89-500
email: info@hengstler.de Internet: www.hengstler.com

3 Mechanical Data

3.1 Shaft variants

8 mm – through hollow shaft
8 mm –hub shaft

3.2 Max. shaft load / Bearing life expectancy

axial ≤ 5 N
radial ≤ 10 N
Above values are the max. worst case forces to the encoder bearings through the flexible torque support
(Fixing point of torque support is 10mm towards the encoder referring the diameter 9,25 mm)
Bearing Live at constant speed of 8.000 1/min and above mentioned loads > 20.000 h.

3.3 Max . speed

Continuous 12.000 min^{-1}
Short term 15.000 min^{-1} ST

The peak max. speed considers eventual oscillations in the speed loop and may occur only for a short time (max. 1 second).

3.4 Starting torque

≤ 1 Ncm

3.5 Moment of inertia

2,5 x 10^{-6} kgm^2
Inclusive central shaft screw

3.6 IP - Protection

IP40
Mounted on motor with cable and cover

Test standard: IEC 529, EN 60529 resp. DIN VDE 0470 T1 (11.92) and DIN 40053 T5 (7.80)

© Hengstler GmbH Uhlandstraße 49 78554 Aldingen / Germany
☎ 07424/89-0 Fax 07424/89-500
email: info@hengstler.de Internet: www.hengstler.com

3.7 Operating temperature range

Environmental air of encoder:	-15°C ... +120°C
Motor shaft at encoder connection point:	-15°C ... 160°C
Connection points of torque support and motor:	-15°C ... 140°C

3.8 Storage temperature range

-20°C ... +85°C (due to packaging)

3.9 Humidity

Humidity F (KUF annual average 75% rel. humidity; non condensing)

Test standard: IEC 68 part 2-38 „temperature, humidity, cycle“ (04.79)
Test condition adjusted to humidity F (DIN 4040)

3.10 Vibration resistance

100 m/s^2 (10 ... 2000 Hz)

Test standard: DIN EN 60068-2-6 / 05.96
Test Fc: Vibration, sinusoidal

3.11 Shock resistance

1000 m/s^2 (6 ms)

Test standard: DIN EN 60068-2-27 / 03.95
Test Ea and guideline: shock

3.12 Materials

Flange:	Aluminum
Shaft:	Stainless steel
Cover:	Aluminum
Mass:	Singleturn app. 80 g
	Multiturn app.130 g

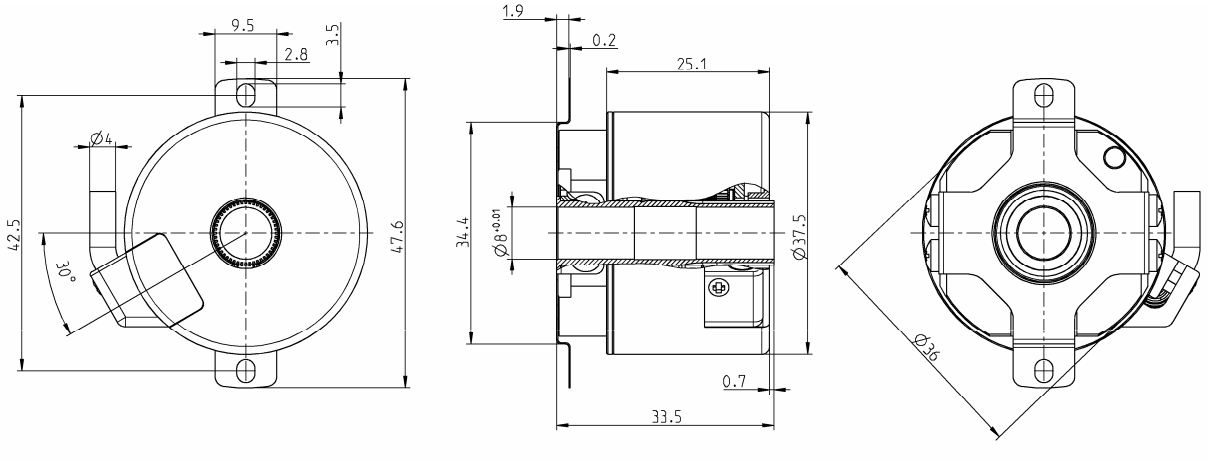
3.13 Spring tether

Tolerance axial	± 0,5 mm
Tolerance radial	± 0,05 mm
Resonance frequency	> 2 kHz

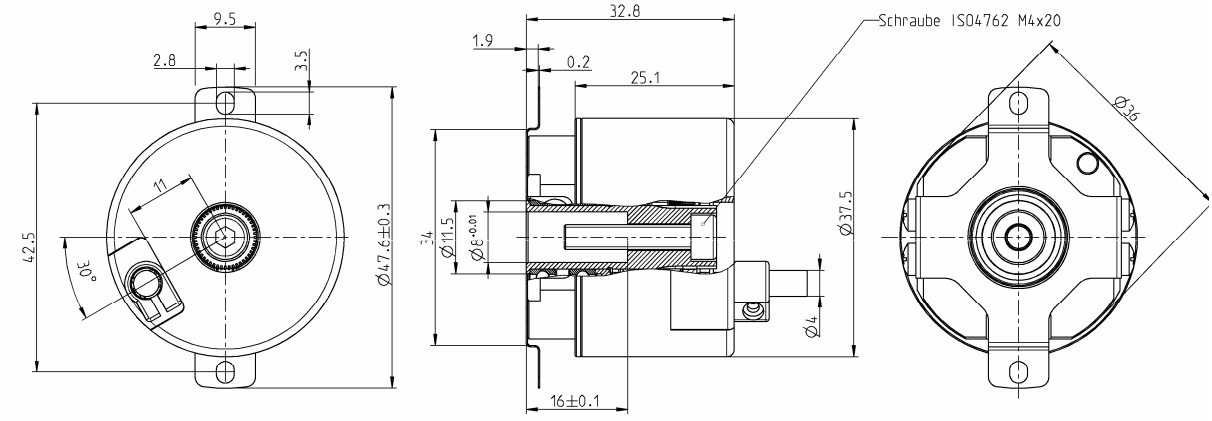
© Hengstler GmbH Uhlandstraße 49 78554 Aldingen / Germany
☎ 07424/89-0 Fax 07424/89-500
email: info@hengstler.de Internet: www.hengstler.com

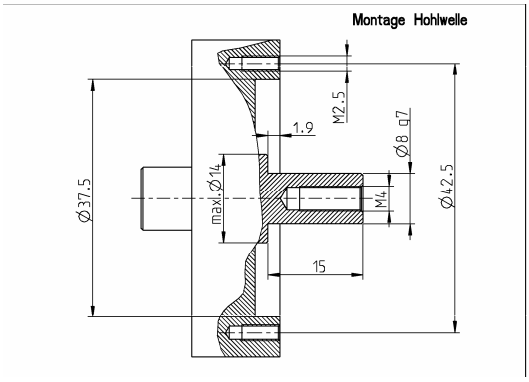
3.14 Dimensioned drawings

3.14.1 Through hollow shaft



3.14.2 Hub shaft





4 Ordering data

Type	Resolution	Supply voltage	Flange, Protection, Shaft	Interface	Connection
AD 36	**0012** 12 Bit ST **0013** 13 Bit ST **0014** 14 Bit ST **0017** 17 Bit ST **0019** 19 Bit ST (BiSS) **1213** 12 Bit MT +13 Bit ST **1217** 12 Bit MT +17 Bit ST **1219** 12 Bit MT +19 Bit ST (BiSS)	**A** DC 5V **E** DC 7-30V	**F.OC** Spring tether, IP40, 8mm through hollow shaft **F.OR** Spring tether, IP40, 8mm hub shaft	**SC** SSI Gray + 1Vss **BI** BiSS (1 Vss redundant optional)	**0** PCB-connector, 12-pin **B** Cable radial, 0,5 m

HENGSTLER

HENGSTLER GmbH
Uhlandstr. 49
78554 Aldingen / Germany
Tel. +49 (0) 7424-89 0
Fax +49 (0) 7424-89 500
E-Mail: info@hengstler.com
www.hengstler.com

DANAHER SENSORS & CONTROLS