

- SIL3 / PLe (CAT4) certification
- UL® certification on request
- Robust mechanical construction with high vibration and shock resistance
- Housing: Design form 59, AISI 316 stainless steel
- Shaft type: Solid shaft, AISI 316 stainless steel, 10 mm diameter
- Output:
 - Digital TTL (RS422) or HTL
 - SIN/COS 1 Vpp
- Resolution: 250 to 2500 counts / 360°
- Operating temperature: - 20 °C to + 85 °C
- Protection grade: IP68 / IP69K
- Suitable for safe motor feedback systems

INCREMENTAL SAFETY

SIL3 FUNCTIONAL SAFETY SENSOR
IEC 61508

PLe FUNCTIONAL SAFETY SENSOR
ISO 13849

KEY INFORMATION OVERVIEW

DESIGN & FUNCTION

Sensing the angle position and signal processing including the generation of the SIN/COS signals or the square-wave pulses respectively. Digital signals TTL and HTL are computed from sine/cosine signals.

The safety function ensured by the device is to convert a mechanical rotation into secured electrical information readable by electronics.

Functional safety design due to IEC 61508: SIL3 and ISO 13849: PLe (CAT4) in a robust housing made of stainless steel (1.4401/ AISI 316) with a high protection grade of IP68 / IP69K.

Optionally a UL® certificate can be provided.

- Design form 59 with solid shaft and clamped flange
- Suitable for safe motor feedback according to IEC 61800-5-2
- Electrical connection via cable
- Suitable for food processing equipment

INTERFACE FEATURES

- Output: square-wave pulses A, A/, B, B/, Z, Z/
- Level: TTL (RS422) or HTL
- Output: Sine / Cosine S, S/, C, C/, Z, Z/
- Level SIN/COS: 1 Vpp
- 250 to 2500 counts per 360°

TECHNICAL DATA
ELECTRICAL DATA

Operating voltage	5 VDC ($\pm 5\%$) or 11 to 30 VDC, reverse polarity protected and short-circuit proof *
Supply type	Power supply according to Class 2 LPS or SELV/PELV limited energy source $\leq 60V$
Supply ripple max.	250 mV
Electrical connection	Via cable - axial

OUTPUT: PULSES

Supply current max.	100 mA with no load 220 mA with load
Output current max.	40 mA by pair
Output	Digital TTL (RS422) Digital HTL (only $V_s = 11$ to 30 VDC)
Output signal frequency	300 kHz depending on cable length
Load @ TTL	100 to 240 ohms
Load @ HTL	750 to 3000 ohms @ 30 VDC 600 to 3000 ohms @ 24 VDC 275 to 3000 ohms @ 11 VDC
Response time	4 μs typical
Phasing tolerance	$90^\circ \pm 10^\circ$
Duty cycle	50% $\pm 5\%$
Jitter	$< 2\%$
Output voltage levels TTL	Low: min. 0 V, typ. 0.5 V, max. 2.5 V High: min. 3.5 V, typ. 4.8 V ($+V_s - 0.5 V @ 5 VDC$), max. 5.4 V ($+V_s @ 5 VDC$)
Output voltage levels HTL	Low: min. 0 V, typ. 0.5 V, max. 2.5 V High: min. $+V_s - 3V$, typ. $+V_s - 0.5 V$, max. $+V_s$

OUTPUT: SIN/COS

Supply current max.	70 mA with no load 100 mA with load
Output current max.	10 mA by pair
Output	SIN/COS with 1 Vpp
Output signal frequency	300 kHz depending on cable length
Load	100 to 240 ohms
Response time	2 μs typical
Phasing tolerance	$90^\circ \pm 10^\circ$
Harmonics	< -45 db
Amplitude tolerance per signal	500 mVpp $\pm 20\%$
Amplitude difference between signals	≤ 50 mV
Offset value per signal	2.5 V ± 500 mV
Offset difference between signals	≤ 50 mV

MECHANICAL DATA

Operating speed max.	6000 rpm
Operation speed cont.	3000 rpm
Static torque	0.01 Nm
Dynamic torque	0.045 Nm
Shaft inertia	< 25 gcm ²
Perm. shaft load	100 N axial 200 N radial
Theoretical mechanical lifetime $L_{10}h$	4.71×10^9 turns / 26,150 hours **
Material	Body: stainless steel 1.4401 (AISI 316) Shaft: stainless steel 1.4401 (AISI 316)
Bearings	6000 series - protected by hybrid rotary seal
Mass	~ 0.75 kg

 * Not to $+V_s$ at TTL and SIN/COS @ 11 to 30 VDC each. $V_s = 5 VDC (\pm 5\%)$ must be monitored

 ** Continuous max. speed – $\frac{1}{2}$ max. load – according to ISO 281: 1990, L_{10}

TECHNICAL DATA
ENVIRONMENTAL DATA

Operating temperature	-20 to +85 °C (encoder T°)
Storage temperature	-20 to +85 °C
Humidity	93 % @ 65 °C (EN 60068-2-38)
Resistance against shock	≤ 500 m/s ² (EN 60068-2-27, during 6 ms)
Resistance against vibration	≤ 200 m/s ² (EN 60068-2-6, 10 ... 2000 Hz)
Protection grade	IP68 / IP69K
Isolation	1000 V _{eff}
EMC immunity test	EN 61000-6-2, increased levels
EMC emission test	EN 61000-6-4, increased levels
Salt spray test	168 h (EN 60068-2-11, part 2)

SAFETY DATA

Z and Z/ are not safety signals (@ pulses and SIN/COS)

Applied functional safety standards	IEC 61508 IEC 62061 ISO 13849-1 IEC 61800-5-2
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Maximum operating life 20 years

Further safety data See handbook [SOI17141](#)

OUTPUT: SQUARE-WAVE PULSES FOR POSITION SENSING APPLICATIONS (@+40 °C, SINGLE CHANNEL)

Time for output signal initialization after power on	~30 ms
Time for internal monitoring activation after power on	250 ms (560 ms max.)
Time to switch off outputs in case of error	<200 ms
High impedance output leakage current	±10 µA

V_s = 5 VDC (± 5 %):

PFD (IEC 61508, 1/h)	7.51x10 ⁻⁵
PFH (IEC 61508, 1/h)	8.58x10 ⁻¹⁰
MTTFd (ISO 13849, years)	1331
DC	99 %

V_s = 11 to 30 VDC:

PFD (IEC 61508, 1/h)	9.52x10 ⁻⁵
PFH (IEC 61508, 1/h)	1.09x10 ⁻⁹
MTTFd (ISO 13849, years)	1050
DC	99 %

OUTPUT: SINCOS FOR POSITION SENSING APPLICATIONS (@+40 °C, SINGLE CHANNEL)

Time for output signal initialization after power on	~30 ms
Time for internal monitoring activation after power on	~30 ms
Time to switch off outputs in case of error	<50 µs
High impedance output leakage current	±1 µA

V_s = 5 VDC (± 5 %):

PFD (IEC 61508, 1/h)	4.29x10 ⁻⁵
PFH (IEC 61508, 1/h)	4.90x10 ⁻¹⁰
MTTFd (ISO 13849, years)	2328
DC	99 %

V_s = 11 to 30 VDC:

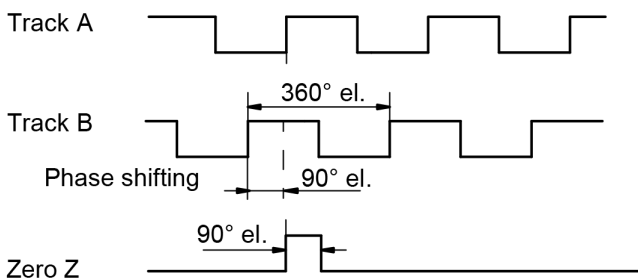
PFD (IEC 61508, 1/h)	6.60x10 ⁻⁵
PFH (IEC 61508, 1/h)	7.53x10 ⁻¹⁰
MTTFd (ISO 13849, years)	1515
DC	99 %

PRODUCT CHARACTERISTICS - SIGNAL OUTPUT

First safety channel with signal A or S and inverted signal A/ or S/. Second safety channel with signal B or C and inverted signal B/ or C/. Third channel not for safety with signal Z and inverted signal Z/.

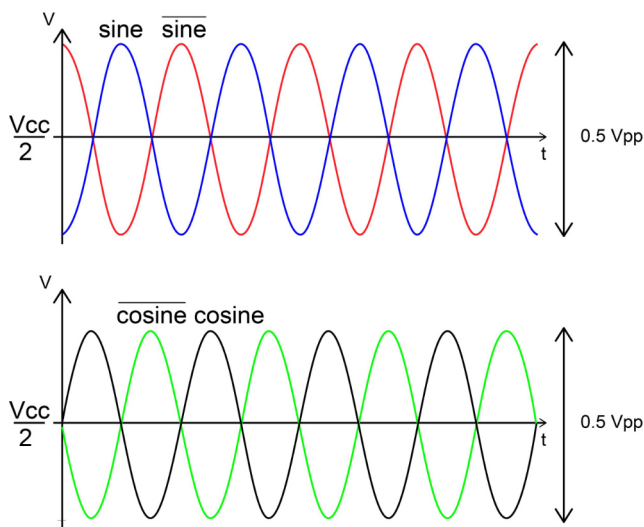
SQUARE-WAVE PULSES

Channel 2 (B) before channel 1 (A) (90° period phase shift), clockwise shaft rotation viewed from flange side.



SIN/COS

Channel 2 (cosine) before channel 1 (sine) (90° period phase shift), clockwise shaft rotation viewed from flange side.



ELECTRICAL CONNECTION - PINOUT

ELECTRICAL CONNECTION CABLE OUTPUT - SILICONE, 8-WIRES, 8230 / 005

Colour	Function
WH white	- V _S (0 V / GND)
BN brown	+ V _S
GN green	A or S
YE yellow	B or C
GY grey	Z
PK pink	A/ or S/
BU blue	B/ or C/
RD red	Z/
General shielding . . .	Ground

ORDER CODE FORMAT

SOI | **59** | **K** | **10** | **3** | **3** | **2** | **V** | **1024** | **2** | **6** | **S3** | **H** | **01** | **STANDARD VERSION**

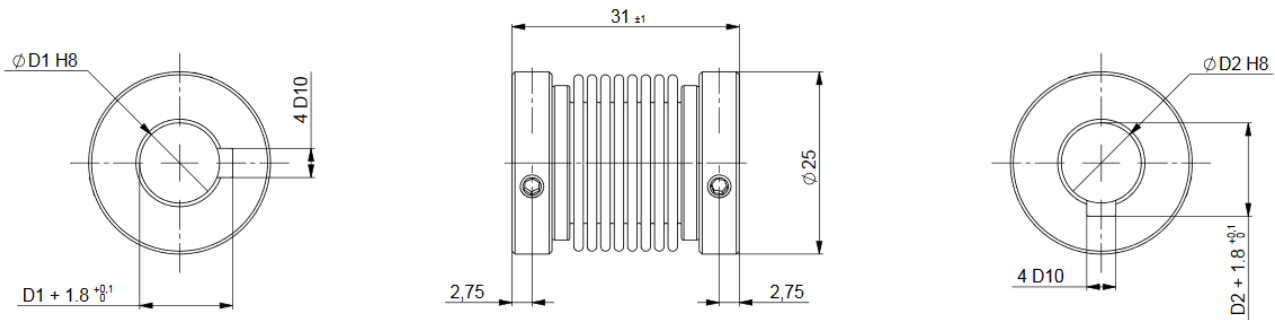
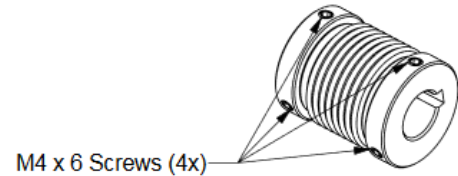
SOI	Incremental rotary encoder - SIL3 / PLe/CAT4		
59	Design form Ø	59	Design form 59
K	Flange	K	Clamped flange with solid shaft
10	Solid shaft Ø	10	10 mm with flattening 9,5 mm
3	Protection grade	3	IP68 / IP69K
3	Electrical connection	3	1 x cable, Silicone, 8-wire, axial
2	Cable length	2 5 10	2 m 5 m 10 m (e.g. 0,15 for 15 cm or 1,5 for 1.5 m)
V	Housing material	V	Stainless steel 1.4401 (AISI 316)
1024	Resolution	250 256 360 500 512 1000 1024 1500 2000 2048 2500	Square-wave pulses or nr. of SIN/COS per 360°
2	Supply voltage	1 2	5 VDC (±5 %) 11 to 30 VDC
6	Output signal	6	A, A/, B, B/, Z, Z/ (signal form T or H) or S, S/, C, C/, Z, Z/ (signal form S)
S3	Profile (Certificate)	S3	SIL3 and PLe/CAT4 certified as specified in this data sheet
H	Signal form	T H S	TTL (RS422) HTL (only at Vs = 11 to 30 VDC) SIN / COS (1 Vpp)
01	Electrical and mechanical variants*	01	Standard version

* The basic versions according to the data sheet bear the number 01. Deviations are identified with a variant number and are documented in the factory.

ACCESSORIES (SELECTION)

SAFETY BELLOWS COUPLING FOR 10 MM SHAFT SSK31/10-10-A01

Bore diameter	.....	D1 = D2 = 10 mm
Fixing of shaft	.....	via screws (2 on each side)
Max. speed	.....	10,000 min ⁻¹
Max. torque	.....	200 Ncm
Radial misalignment	.....	±0.35 mm
Axial misalignment	.....	±0.45 mm
Angular misalignment	.....	±4°
Torsional spring stiffness	.....	183 Nm/rad
Moment of inertia	.....	17.8 gcm ²
Max. clamping torque	.....	150 Ncm
Temperature range	.....	-30 to +120 °C
Mass	.....	18 g



DOCUMENTATION

The following documents can be found in the Internet under www.twk.de in the documentation area, model SOI59/S3.

- Data sheet [SOI17172](#)
- Manual [SOI17141](#)
- Installation instructions [AN16169](#)
- SIL3 / PLe certificate [SOI17204](#)
- EC Declaration of Conformity [ZE17199](#)
- Reach compliant [QS15286](#)
- RoHS compliant [QS13284](#)

INSTALLATION DRAWING

MODEL SOI59K10332V102426S3T01

Dimensions in mm

