

**INCREMENTAL  
SAFETY**

**SIL3** FUNCTIONAL  
IEC 61508 SAFETY  
SENSOR

**PLe** FUNCTIONAL  
ISO 13849 SAFETY  
SENSOR

- SIL3 / PLe (CAT4) certification
- UL® certification on request
- Robust mechanical construction with high vibration and shock resistance
- Housing: Design form 90,
  - Aluminium, powder coated aluminium
  - AISI 303 stainless steel
- Shaft type: Through hollow shaft, AISI 303 stainless steel, 30 mm diameter
- Output:
  - Digital TTL (RS422) or HTL
  - SIN/COS 1 Vpp
- Resolution: 1024 or 2048 counts / 360°
- Operating temperature: - 20 °C to + 85 °C
- Protection grade: IP65 or IP66
- Suitable for safe motor feedback systems

## 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 of 90 mm diameter made of aluminium and aluminium with powder coating with protection grade IP65 or made of stainless steel (1.4305/AISI 303) with protection grade IP66.

Optionally a UL® certificate can be provided.

- Design form 90 with through hollow shaft 30 mm diameter
- Suitable for safe motor feedback according to IEC 61800-5-2
- Radial electrical connection via connectors M12, M23 or cable
- Reduction hubs available for hollow shaft diameter 20 mm or 25 mm
- Adapted anti-rotation system available (stator coupling, tether arm)

### 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
- 1024 or 2048 counts per 360° (other values on request)

**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 connector M12, M23 or cable - radial

**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 $\mu s$ 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 $\mu s$ typical
Phasing tolerance	$90^\circ \pm 10^\circ$
Harmonics	$< -45$ db
Amplitude tolerance per signal	500 mVpp $\pm 20\%$
Amplitude difference between signals	$\leq 50$ mV
Offset value per signal	2.5 V $\pm 500$ mV
Offset difference between signals	$\leq 50$ mV

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

**TECHNICAL DATA**

**MECHANICAL DATA**

**VERSION WITH ALUMINIUM HOUSING**

Operating speed max.	6000 rpm
Operation speed cont.	3000 rpm
Static torque	0.03 Nm
Dynamic torque	0.3 Nm
Shaft inertia	< 1200 gcm <sup>2</sup>
Perm. shaft load	25 N axial 50 N radial
Theoretical mechanical lifetime L <sub>10</sub> h	18 x 10 <sup>9</sup> turns / 100,000 hours *
Material	Body: aluminium Cover: powder coated aluminium Shaft: stainless steel 1.4305 (AISI 303)
Bearings	6807 series - sealed
Mass	~0.65 kg

**VERSION WITH STAINLESS STEEL HOUSING**

Operating speed max.	3000 rpm
Operation speed cont.	1500 rpm
Static torque	0.25 Nm
Dynamic torque	0.6 Nm
Shaft inertia	< 1250 gcm <sup>2</sup>
Perm. shaft load	25 N axial 50 N radial
Theoretical mechanical lifetime L <sub>10</sub> h	9 x 10 <sup>9</sup> turns / 100,000 hours *
Material	Body: stainless steel 1.4305 (AISI 303) Shaft: stainless steel 1.4305 (AISI 303)
Bearings	6807 series - sealed
Mass	~1.3 kg

**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 <sup>2</sup> (EN 60068-2-27, during 6 ms)
Resistance against vibration	≤ 200 m/s <sup>2</sup> (EN 60068-2-6, 55 ... 2000 Hz)
Protection grade	IP65 for version with aluminium housing IP66 for version with stainless steel housing
Isolation	1000 V <sub>eff</sub>
EMC immunity test	EN 61000-6-2, increased levels
EMC emission test	EN 61000-6-4, increased levels
Salt spray test	96 h (EN 60068-2-11, part 2) for version with aluminium housing 168 h (EN 60068-2-11, part 2) for version with stainless steel housing

\* Continuous max. speed – ½ max. load – according to ISO 281: 1990, L<sub>10</sub>

**TECHNICAL DATA**
**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

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

Vs = 5 VDC (± 5 %):  
 PFD (IEC 61508, 1/h) . . . . .  $7.51 \times 10^{-5}$   
 PFH (IEC 61508, 1/h) . . . . .  $8.58 \times 10^{-10}$   
 MTTFd (ISO 13849, years) . . . . . 1331  
 DC . . . . . 99 %

Vs = 11 to 30 VDC:  
 PFD (IEC 61508, 1/h) . . . . .  $9.52 \times 10^{-5}$   
 PFH (IEC 61508, 1/h) . . . . .  $1.09 \times 10^{-9}$   
 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

Vs = 5 VDC (± 5 %):  
 PFD (IEC 61508, 1/h) . . . . .  $4.29 \times 10^{-5}$   
 PFH (IEC 61508, 1/h) . . . . .  $4.90 \times 10^{-10}$   
 MTTFd (ISO 13849, years) . . . . . 2328  
 DC . . . . . 99 %

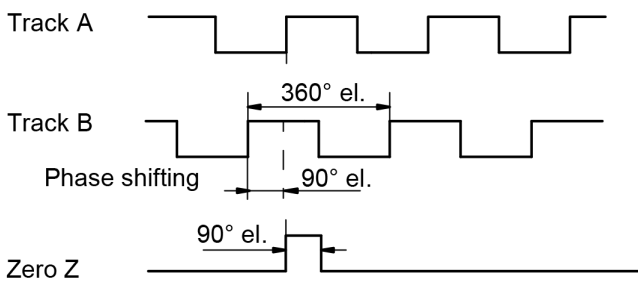
Vs = 11 to 30 VDC:  
 PFD (IEC 61508, 1/h) . . . . .  $6.60 \times 10^{-5}$   
 PFH (IEC 61508, 1/h) . . . . .  $7.53 \times 10^{-10}$   
 MTTFd (ISO 13849, years) . . . . . 1515  
 DC . . . . . 99 %

**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/.

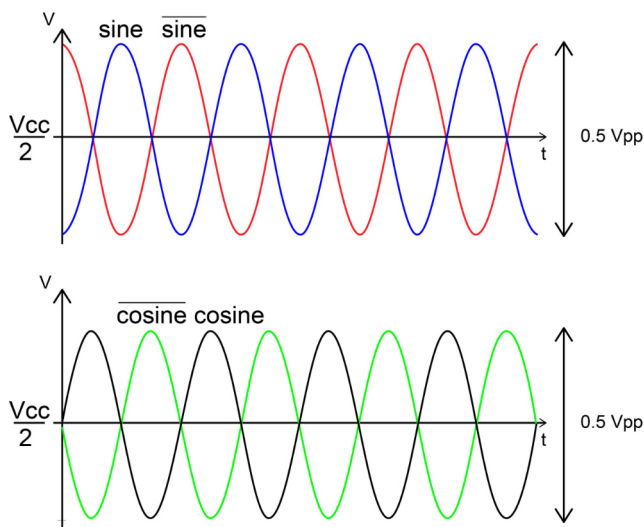
**SQUARE-WAVE PULSES**

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



**SIN/COS**

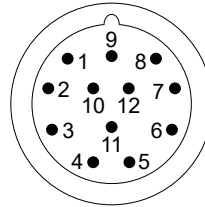
Channel 2 (cosine) before channel 1 (sine) (90° period phase shift), clockwise shaft rotation viewed from flange side.



**ELECTRICAL CONNECTION - PINOUT**

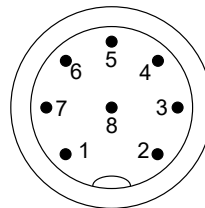
**CONNECTOR OUTPUT M23, 12-PIN, MALE, CCW**

<b>PIN</b>	<b>Function</b>
1	A/ or S/
2	+ V <sub>S</sub>
3	Z
4	Z/
5	B or C
6	B/ or C/
7	n.c.
8	A or S
9	n.c.
10	- V <sub>S</sub> (0 V / GND)
11	- V <sub>S</sub> (0 V / GND)
12	+ V <sub>S</sub>
Connector body	Ground



**CONNECTOR OUTPUT M12, 8-PIN, MALE, A-CODED**

<b>PIN</b>	<b>Function</b>
1	- V <sub>S</sub> (0 V / GND)
2	+ V <sub>S</sub>
3	A or S
4	B or C
5	Z
6	A/ or S/
7	B/ or C/
8	Z/
Connector body	Ground



**ELECTRICAL CONNECTION CABLE OUTPUT - PVC, 8-WIRES, 8230 / 020 (FURTHER CABLES ON REQUEST)**

<b>Colour</b>	<b>Function</b>
WH white	- V <sub>S</sub> (0 V / GND)
BN brown	+ V <sub>S</sub>
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**

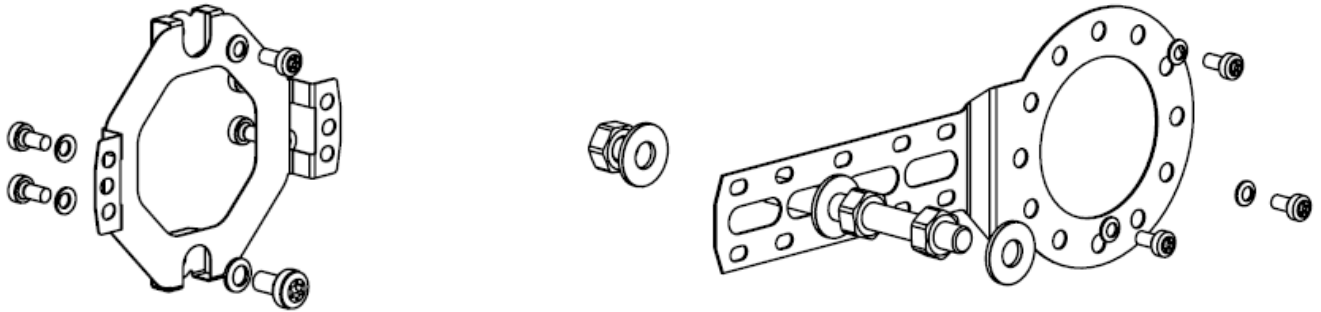
**SOI** | **90** | **T** | **30** | **1** | **1** | **0** | **A** | **1024** | **2** | **6** | **S3** | **H** | **01** | **STANDARD VERSION**

SOI	Incremental rotary encoder - SIL3 / PLe/CAT4		
<b>90</b>	Design form Ø	90	Design form 90
<b>T</b>	Flange	T	Flange with through hollow shaft
<b>30</b>	Hollow shaft Ø	20 25 30	20 mm (with reduction hub) 25 mm (with reduction hub) 30 mm (standard diameter) (other values, e.g. 25.4 mm with reduction hub on request)
<b>1</b>	Protection grade	1 2	IP65 for version with aluminium housing IP66 for version with stainless steel housing
<b>1</b>	Electrical connection	1 4 5	1 x connector M23, CCW, radial 1 x cable, PVC, 8-wire, radial (further cables on request) 1 x connector M12, radial
<b>0</b>	Cable length	0 2 5 10	Insert 0 at connector output 2 m 5 m 10 m (e.g. 0,15 for 15 cm or 1,5 for 1.5 m)
<b>A</b>	Housing material	A V	Aluminium, powder coated aluminium Stainless steel 1.4305 (AISI 303)
<b>1024</b>	Resolution	1024 2048	Square-wave pulses or nr. of SIN/COS per 360° (other values on request)
<b>2</b>	Supply voltage	1 2	5 VDC (±5 %) 11 to 30 VDC
<b>6</b>	Output signal	6	A, A/, B, B/, Z, Z/ (signal form T or H) or S, S/, C, C/, Z, Z/ (signal form S)
<b>S3</b>	Profile (Certificate)	S3	SIL3 and PLe/CAT4 certified as specified in this data sheet
<b>H</b>	Signal form	T H S	TTL (RS422) HTL (only at Vs = 11 to 30 VDC) SIN / COS (1 Vpp)
<b>01</b>	Electrical and mechanical variants*	01	Standard version

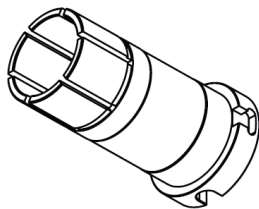
\* The basic versions according to the data sheet bear the number 01. Deviations are identified with a variant number and are documented in the factory.

## ACCESSORIES (SELECTION)

### STATOR COUPLING AND TETHER ARM FOR DESIGN FORM SOI90-T - ON REQUEST



### REDUCTION HUB (SLEEVE) TO CREATE 20 MM, 25 MM AND 25.4 MM FOR DESIGN FORM SOI90T...A OR V - ON REQUEST



### CONNECTING CABLE FOR CONNECTORS M12, 8-PIN, A-CODED AND M23, 12-PIN, CCW - ON REQUEST

Please ask our technical staff for detailed drawings for the accessories.

## DOCUMENTATION

The following documents can be found in the Internet under [www.twk.de](http://www.twk.de) in the documentation area, model SOI90-T/S3.

Data sheet . . . . .	<a href="#">SOI17174</a>
Manual . . . . .	<a href="#">SOI17141</a>
Installation instructions . . . . .	<a href="#">AN16169</a>
SIL3 / PLe certificate . . . . .	<a href="#">SOI17204</a>
EC Declaration of Conformity . . . . .	<a href="#">ZE17199</a>
Reach compliant . . . . .	<a href="#">QS15286</a>
RoHS compliant . . . . .	<a href="#">QS13284</a>



**INSTALLATION DRAWINGS**

**MODEL SOI90T30210V102426S3H01**

Dimensions in mm

