

Absolute encoder

Models NOCN / S3 with SIL2 Certificate / CANopen

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- **2 Versions SIL2:**
 - Rotary encoder singleturn
 - Rotary encoder multiturn
- **For use in stationary and mobile machines and systems, particularly for wind turbines, power plants, cranes, etc.**
- **Interface CANopen Safety**
- **Speed in digits/ms with variable gate time**
- **Protection type IP 67**
(higher protection types up to IP 69K possible)
- **Parameterisable via CANopen bus**
- **Option:**
 - Special slewing ring software for non-reversing operation
 - Draw wire version with integrated encoder: NOCN125-D

Design

- Robust housing manufactured from seawater-proof aluminium (AlMgSi1) or stainless steel (material: 1.4305 optionally 1.4404).
- Shaft fitted with ball bearings bears the magnet for recording the angular position and the drive gear of the multiturn transmission for absolute revolution counting.
- Shaft and transmission are located in the prechamber. Sealed off from this, the main chamber contains all electronic components for position recording, evaluation and output.
- Position recording and evaluation are of a redundant design to implement a reliable position value.
- A network in/out module with transient filtering, voltage supply and output driver unit form the electrical interface.
- Electrical connection via two M12X1 connectors, 5-pin, pin and socket for Bus-In / Bus-Out.
- Output via SRDO and PDO possible. PDO is independently adjustable. The NOCN behaviour is like a CANopen Standard device when using PDO.
- Special version available: Draw wire device with integrated SIL2 absolute encoder NOCN: NOCN125-D. See datasheet [125-D13794](#) for mechanical design and order code number in this document.

Function

A positive mechanical connection between the customer and sensor shaft ensures that the sensor shaft magnet precisely reflects the customer shaft's rotations. With the run-down absolute gear box, the rotary encoder achieves a measuring range of up to 4096 revolutions. Two autonomously operating, redundant sensor units record the angular position and the revolutions of the customer's shaft. A sensor unit consists of angular position and revolution sensors, an interpolator and a microcontroller. In each unit, the signals of the angular position and the revolution sensors are comprised to form a consistent position value. Sampling errors are evaluated.

A further microcontroller compares the position values of both sensor units with each other, evaluates any error messages and then forwards the validated position values to the CAN interface.

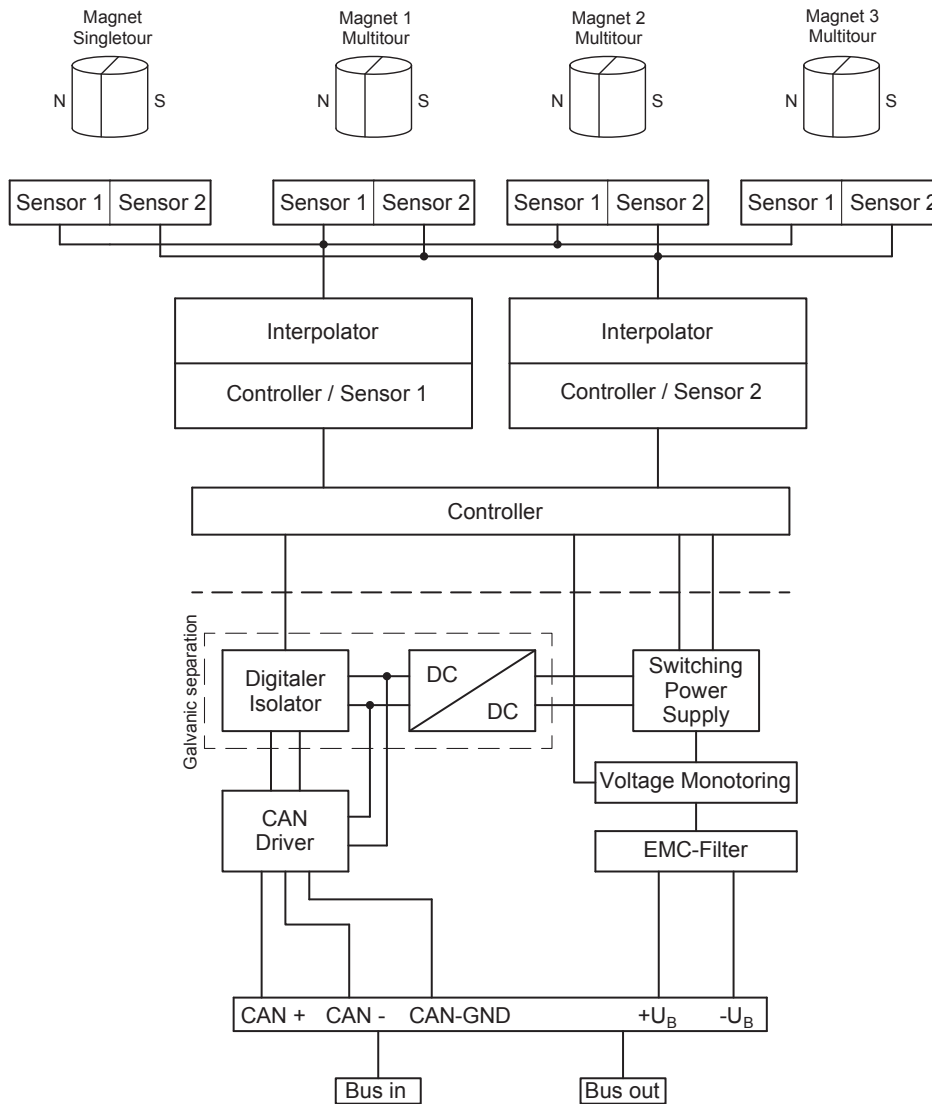
The CAN interface outputs the validated position values via the CANopen Safety protocol within an SRDO (Safety Relevant Data Object) using two messages (normal and inverted).

The rotary encoder meets the conditions of safety level SIL2 according to IEC 61508.

Encoders with slewing ring software convert the sensor shaft's position value into the slewing ring position. Any number of slewing ring revolutions are permissible. This software can be pre-programmed for the specific application by the customer or the factory. This enables the slewing ring encoder to be used for all types of slewing ring.

Model NOCN / S3

Principle circuit diagram



Technical data

Mechanical data

- Operating speed: 1000 rpm (option 2000 rpm)
(Remark: Shaft with sealing ring: max. 1000 rpm. Else use Nilos ring)
- Angular acceleration: $10^5 \text{ rad/s}^2 \text{ max.}$
- Moment of inertia (shaft): 20 gcm^2
- Operating torque: $\leq 8 \text{ Ncm}$ (at speed 500 rpm)
- Starting torque: $\leq 4 \text{ Ncm}$
- Perm. shaft load: 250 N axial
250 N radial
- Bearing service life: 10^9 revolutions
- Weight: Approx. 0.7 kg

Model NOCN / S3

Technical data

Electrical data

- Sensor system: ASIC with HALL elements
- Operating voltage range: + 9 VDC to + 36 VDC
- Power consumption: < 2.5 W
- Resolution: 4096 steps / 360° - 12-bit
or 8192 steps / 360° - 13-bit
- Measuring range: 4096 revolutions, (option 16 or 4096 revs.)
- Absolute accuracy: ± 0.25 % / 360°
- Temperature drift: ± 0,02° -40 °C bis 85 °C
- Output code: Binary
- Code path: CW / CCW, parameterisable
- Reference value: 0 - (total No. of steps -1)
- Overvoltage protection and galvanic separation power supply - CANopen - housing
- CAN interface: According to ISO/DIS 11898
- Address setting: Via LMT / LSS
- Terminating resistor: To be implemented separately
- Max.transmission length: 200 m with no galvanic separation (also see CiA, DS 301)
- EMC standards:
 - Interference emission: acc. to EN 61000-6-4
 - Interference immunity: acc. to EN 61000-6-2
- Electrical connection: 1 x connector M12
2 x connector M12 - (In addition BUS OUT)
Optional: cable
- CAN IC voltage rating: Maximum common mode voltage -7 to +12 V
Maximum allowed voltage at pins ± 36 V
- Electrical supply circuit: Reverse battery protection and protection against too high voltage
Suppression of AC components in the DC power supply

Environmental data

- Operating temperature range: - 40 °C to + 85 °C
- Storage temperature range: - 45 °C to + 85 °C
- Maximum relative humidity: 100 %
- Resistance:
 - To shock: 250 m/s², 6 ms,
(DIN EN 60068-2-27) 100 x each in 3 axes
 - To vibration: 100 m/s², 5 Hz ... 2000 Hz,
(DIN EN 60068-2-6) 1 h each in 3 axes
- Protection type: IP67, optional IP69K (Cable oder special connector M12)
(DIN EN 60529)

System in general and Safety

- Power on time due to power supply coming up: 500 ms (10 % bis 90 %)
- Rate of messages: up to 10 000 messages / s
- Time of storage cycles: 3 s per storage cycle
- Setup Time: ~ 2 s @ T ≥ +20 °C
> 20 s @ T ≤ -30 °C
- Time between error recognition and alarm (emergency message): 100 ms (power supply)
5 s (RAM test, single bit error)
2 s (ROM test during setup time)
- Number of the certificate: 44 799 13172907
- Safety-norms: EN 51508, 1 - 7: 2010
EN 62061: 2005
EN ISO 13849-1: 2008
EN 60947-5-1: 2004 + A1: 2009
- Maximum service life: 20 years

Model NOCN / S3

Slewing ring functionality

(Code 'S' in order code number)

In some applications it is necessary to get directly the angle of the slewing unit.

A rotary encoder is coupled via a gear to a toothed gear or with a worm gear / gear units mounted on the worm shaft.

This results in a certain ratio due to the number of teeth.

The software in the encoder can be set (by the factory or the customer) in a way that the output signal of the encoder is the angle position of the slewing unit. The angle resolution can be set for example to 0.1° (i.e. 3600 steps per 360° of the encoder). Meaning if the slewing unit turns 360° the output of the encoder will also only turn by 360° (3600 → 0 steps).

In case the slewing unit turns constantly only in one direction the output will not be affected. Meaning the output signal will continue to give angle values between 0 and 360° even for infinite revolutions.

S makes the slewing ring functionality in the order code.

For this kind of code (S) a resolution of 8192 steps / 360° (13 Bits) and a measuring range of 4096 revolutions is generally used ex works: NOCN...-8192S4096... ..

Note: When power supply of NOCN with code S is switched off it is not recommended to turn the shaft more than 500 turns in the same direction. Otherwise the safety slewing ring position may not be correct any more. In this case an error message is transmitted to the master by the NOCN for the user can recognize this issue.

Adjustable parameters	from	to
Code sequence	CW	CCW
Number of teeth - slewing ring	1	65536
Number of teeth - pinion of NOCN	1	65536
Resolution position	1	8192* x i
Resolution for speed	1	8192* x i
Gate time [ms] (for speed)	10	1000

* Maximum resolution of encoder

i = Gear ratio *Number of teeth - slewing ring* to *Number of teeth - pinion of NOCN*

Comparison of some characteristics when the encoder is coupled to the slewing ring.

Characteristic	Encoder	Slewing ring
Resolution	8192 steps	Adjustable, max. 8192 x i steps
Accuracy	± 0.25 %	± 0.25 % x $\frac{1}{i}$
Measuring range	4096 revolutions	Revolution repeatable ∞ times
Reproducibility	± 0.02 %	± 0.02 % x $\frac{1}{i}$
Temperature drift	< 0.02°	< 0.02° x $\frac{1}{i}$

All of the values specified in this table (except the measuring range) refer to one sensor shaft or slewing ring revolution.

Model NOCN / S3

Order code number

NOCN	58	-	KP	A	-	4096	R	4096	S3	S2	V1	N	01	→ Standard version
<p>Electrical and mechanical variants *</p> <p>01 Standard</p> <p>Interface:</p> <p>N CANopen</p> <p>Galvanic separation †. (See page 8):</p> <p>V1 $-V_S \neq \text{CAN_GND} \neq$ screening/housing → Recommended</p> <p>V2 $-V_S = \text{CAN_GND} \neq$ screening/housing</p> <p>V3 $-V_S = \text{CAN_GND} =$ screening/housing</p> <p>Electrical connections (see remark on page 8):</p> <p>→ Combine any kind and number of desired connection</p> <p>1 1 x Device connector or cable</p> <p>2 2 x Device connector or cable</p> <p>S Device connector(s) M12 radial</p> <p>T Device connector(s) M12 axial (choose T for draw wire version)</p> <p>K Cable(s), 1 m, radial (other length on request)</p> <p>L Cable(s), 1 m, axial (other length on request)</p> <p>Profile:</p> <p>S3 CANopen safety profile SIL2 certified</p> <p>Measuring range: (Don't fill this space for operation as a monoturn NOCN)</p> <p>16</p> <p>256 Different measuring ranges for operation as a multiturn NOCN</p> <p>4096</p> <p>X Length in meter for draw wire version, i.e. 5 or 6.3 (10 at maximum)</p> <p>Code:</p> <p>R Binary</p> <p>S Position of slewing ring, output binary</p> <p>→ Standard resolution in steps / 360° for code S: 8192 = 13 Bits and 4096 revolutions measuring range</p> <p>Resolution in steps / 360° resp. at draw wire: steps / drum circumference (248.03 mm):</p> <p>4096 = 12 Bits</p> <p>8192 = 13 Bits (Standard for code S - see above)</p> <p>2500 = Customer specific value (especially for draw wire version)</p> <p><i>If switching outputs are needed, they can be specified at this point. See data sheet 'Electronic cam switch' NOC13099.</i></p> <p>Housing material:</p> <p>A Aluminium</p> <p>S Stainless steel 1.4305</p> <p>V Stainless steel 1.4404</p> <p>Flange:</p> <p>58 K Clamped flange Shaft 10 mm with flat</p> <p>KP Clamped flange Shaft 10 mm with parallel key</p> <p>KZ Clamped flange Shaft 12 mm for play-compensating toothed gear ZRS</p> <p>SN Synchro flange Clamping shaft 12 mm with notch</p> <p>ST Synchro flange Shaft 6 mm with flat</p> <p>64 K Clamped flange Shaft 12 mm with flat</p> <p>KP Clamped flange Shaft 12 mm with parallel key</p> <p>KZ Clamped flange Shaft 12 mm for play-compensating toothed gear ZRS</p> <p>KN Clamped flange Clamping shaft 12 mm with notch</p> <p>65 SP Synchro flange Shaft 12 mm with parallel key</p> <p>66 K Clamped flange Shaft 10 mm with flat</p> <p>KP Clamped flange Shaft 10 mm with parallel key</p> <p>125 D Draw wire version with integrated NOCN rotary encoder **. Reference datasheet 125-D13794</p> <p>Design form:</p> <p>Flange: \varnothing in mm</p>														

NOCN Electronic switching cam encoder with CANopen / CANopen Safety interface

* 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.

** See remark on page 6: Safety restriction due to draw wire.

Model NOCN / S3

Remark for draw wire version with integrated encoder

Model NOCN125-D

Notification:

The safety certificate is only valid for the integrated rotary encoder. The validity of the certificate ends at the shaft of the rotary encoder. A safe length measurement is therefore only possible in combination with monitoring measures in a safe control unit. Please contact us for further information.

Order Code format - Mating connector

(to be ordered separately)

All of the mating connectors listed in the following table are M12X1, 5-pin, A-coded, with screw clamp connection, with protection type IP 67, with screening on the housing and the maximum connection cross-section is 0.75 mm².

Order number	Contact design	Connector design	Housing material	Cable Ø (mm)
STK5GS56	Socket	Straight	Nickel-plated brass	4 - 6
STK5GP90	Pin	Straight	Nickel-plated brass	4 - 6
STK5WS58	Socket	Angled	Nickel-plated brass	4 - 6
STK5WP102	Pin	Angled	Nickel-plated brass	4 - 6
STK5GS107	Socket	Straight	Stainless steel	5.5 – 8.6
STK5GP106	Pin	Straight	Stainless steel	5.5 – 8.6

Please note: if angled mating connectors are used, please notify us so that the device connectors can be aligned accordingly.

Safety-Parameters

Norm EN 13849-1:2008

Rotary encoder

- Kategorie: 2
- MTTFd (Jahre): 151
- CCF: fulfilled
- DC [%]: 91.7
- PL: d

Norm EN 61508:2010 and EN 62061

Rotary encoder

- HFT: 0
- T1[s]: 8760
- SFF [%]: 95.1
- PFH [1/h]: 6,24 x 10⁻⁸
- SIL: 2

Remark: If you wish the NOCN with cams, separate safety parameters are valid for this cam function, due to the fact that this feature works like an actor. See data sheet [NOC13099](#).

Model NOCN / S3

Interface CANopen Safety

Function

A CAN controller at the output enables integration into the CANopen network. According to "CANopen Application Layer and Communication Profile, CiA Draft Standard 301, Version 4.1" and according to "Device Profile for Encoders CiA Draft Standard Proposal 406 Version 4.01" and "CANopen Layer Setting Services and Protocol (LSS), CiA DSP 305".

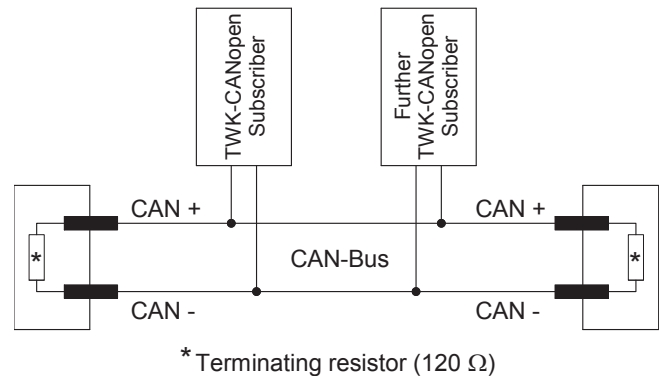
Parameters for the absolute encoder's position signal, which is output via the process data objects (PDO), can be parameterised via the bus in order to adapt the NOCN to the application. The details of the CANopen profile are exhaustively described in the NOC 13100 specifications.

The bootloader function can be used to update the NOCN's firmware at the customer's premises.

CANopen specifications

- NMT Master: no
- NMT-Slave: yes
- Maximum Boot up: no
- Minimum Boot up: yes
- COB ID Distribution: Default, SDO
- Node ID Distribution: via Index 2000 oder LSS
- No of PDOs: 2 Tx
- PDO-Modes: sync, async, cyclic, acyclic
- Variables PDO-Mapping: no
- Emergency Message: yes
- Heartbeat: yes
- No. of SDOs: 1 Rx / 1 Tx
- Device Profile: CiA DSP 406 Version 4.01

Bus activation according to ISO / DIS 11898



CANopen data profile

SRDO1 (position) - normal and bitinverted

Byte 3								Byte 2								Byte 1								Byte 0							
7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0
0	0	0	0	0	0	0	0	MSB	Position data																LSB						

Byte 3								Byte 2								Byte 1								Byte 0							
7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0
1	1	1	1	1	1	1	1	MSB	Position data inverted																LSB						

SRDO2 (speed) - normal and bitinverted

Byte 1								Byte 0								
7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0	
MSB								Speed								LSB

Byte 1								Byte 0								
7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0	
MSB								Speed inverted								LSB

Interface according to the following specifications

- CiA DS301 CANopen Application Layer and Communication Profile, Version 4.1
- EN 50325-5 CANopen Framework for safety-relevant communication, Version 1.0.1
- CiA DS305 CANopen - Layer Setting Services and Protocol (LSS)
- CiA DS406 CANopen - Device Profile for Encoders, Version 4.01

Model NOCN / S3

Connector assignment and versions of galvanic separation Example is valid for standard version

Attention: The description of the different versions of galvanic separation, V1 to V3, refers only to the relationships of the individual potentials (-UB, CAN_GND and housing/shield) to one another. I.e. whether they are galvanically connected or not. The connection plug pin assignments shown below are independent of this and only describe the standard pin assignment. Other variants may reveal a different pin assignment. The connection assignment (TYxxxx) which is enclosed with each device or can be requested must always be observed.

Note: The recommended version is V1 with full galvanic separation. This offers maximum EMC resistance, maximum CANopen data transfer security and thus maximum operating safety.

Versions V2 and V3 are special versions which must be compatible with the structure (topology) of the CANopen bus system in the customer application (→ control system and other CANopen subscribers). Operating safety or data transfer security may otherwise be affected.

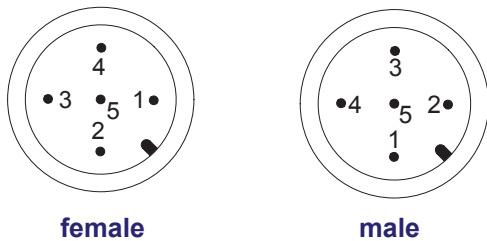
Different M12 connector combinations or assignments are possible at the request of the customer.

For the following description and pictorials is valid:

Viewed looking at the PIN side of the connector installed in the NOCN.
 There is one connector for Bus-In and Bus-Out each for the NOCN / S3.
 If there is only Bus-In, the female connector Bus-Out is omitted.

Version 1 (V1): CAN_GND and -UB galvanically separated (≠). Screening galvanically separated (≠)

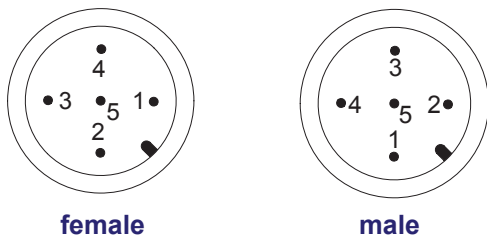
This recommended version provides complete galvanic separation. Power supply and CAN_GND is galvanically separated. The housing and the screening of the cable is galvanically separated as well. The screening of the cable comes to the housing of the NOCN via the housing of the mating plug.



PIN	Function for standard version
1	CAN GND
2	Operating voltage + U _B
3	Operating voltage - U _B
4	CAN_H
5	CAN_L

Version 2 (V2): CAN_GND and -UB not galvanically separated (=). Screening galvanically separated (≠)

This version provides partly galvanic separation. Power supply and CAN_GND are not galvanically separated. The housing and the screening of the cable are galvanically separated from power supply and CAN_GND. The screening of the cable comes to the housing of the NOCN via the housing of the mating plug and/or Pin 1 of the connector. Please note the maximum voltage rating of the CAN interface IC on [page 3](#).



PIN	Function for standard version
1	Screen (Cable / housing)
2	Operating voltage + U _B
3	Operating voltage - U _B and CAN_GND
4	CAN_H
5	CAN_L

Vers. 3 (V3): CANGND and -UB not galvanically separated (=). Screening not galvanically separated (=)

This version provides no galvanic separation. Power supply and CAN_GND are not galvanically separated. The housing and the screening of the cable are not galvanically separated from power supply and CAN_GND. The screening of the cable comes to the housing of the NOCN via the housing of the mating plug and/or Pin 1 of the connector. Please note the maximum voltage rating of the CAN interface IC on [page 3](#).

This version is recommended if ready made industrial cable are used by customer (Twisted pair and shielded).



PIN	Function for standard version
1	Screen (Cable / housing) - shorted to pin 3 -
2	Operating voltage + U _B
3	Operating voltage - U _B and CAN_GND - shorted to pin 1 -
4	CAN_H
5	CAN_L

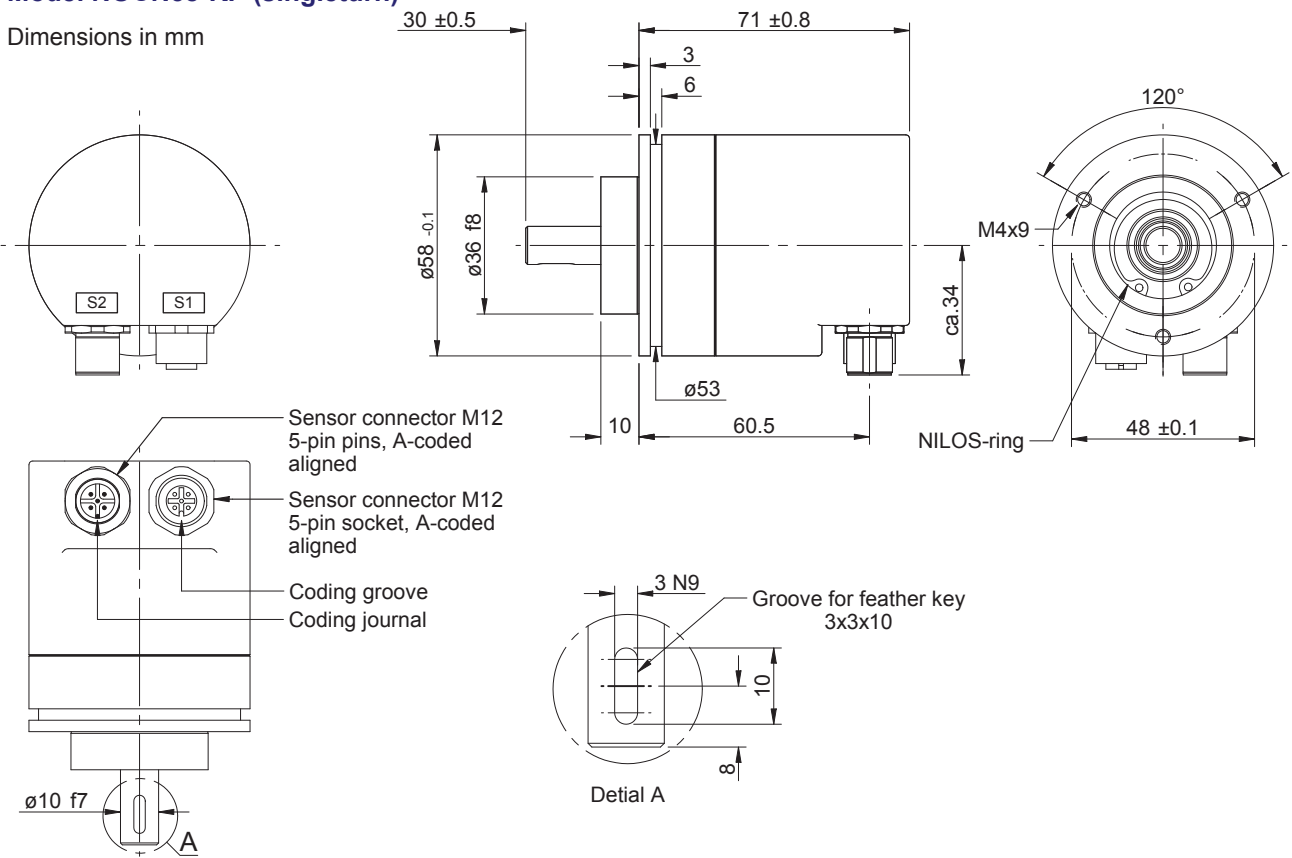
Model NOCN / S3

Installation drawings

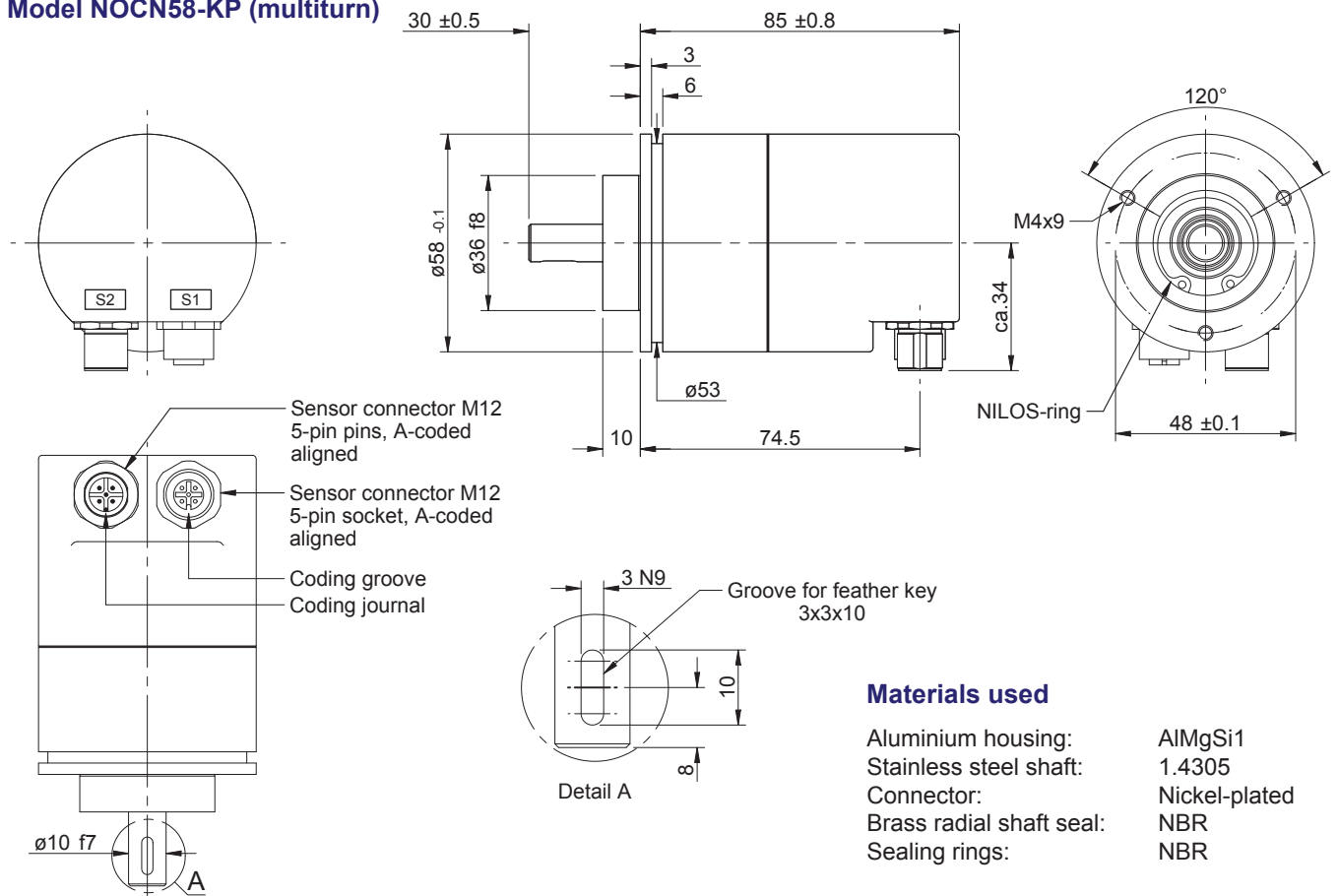
(further installation drawings on request)

Model NOCN58-KP (singleturn)

Dimensions in mm



Model NOCN58-KP (multiturn)



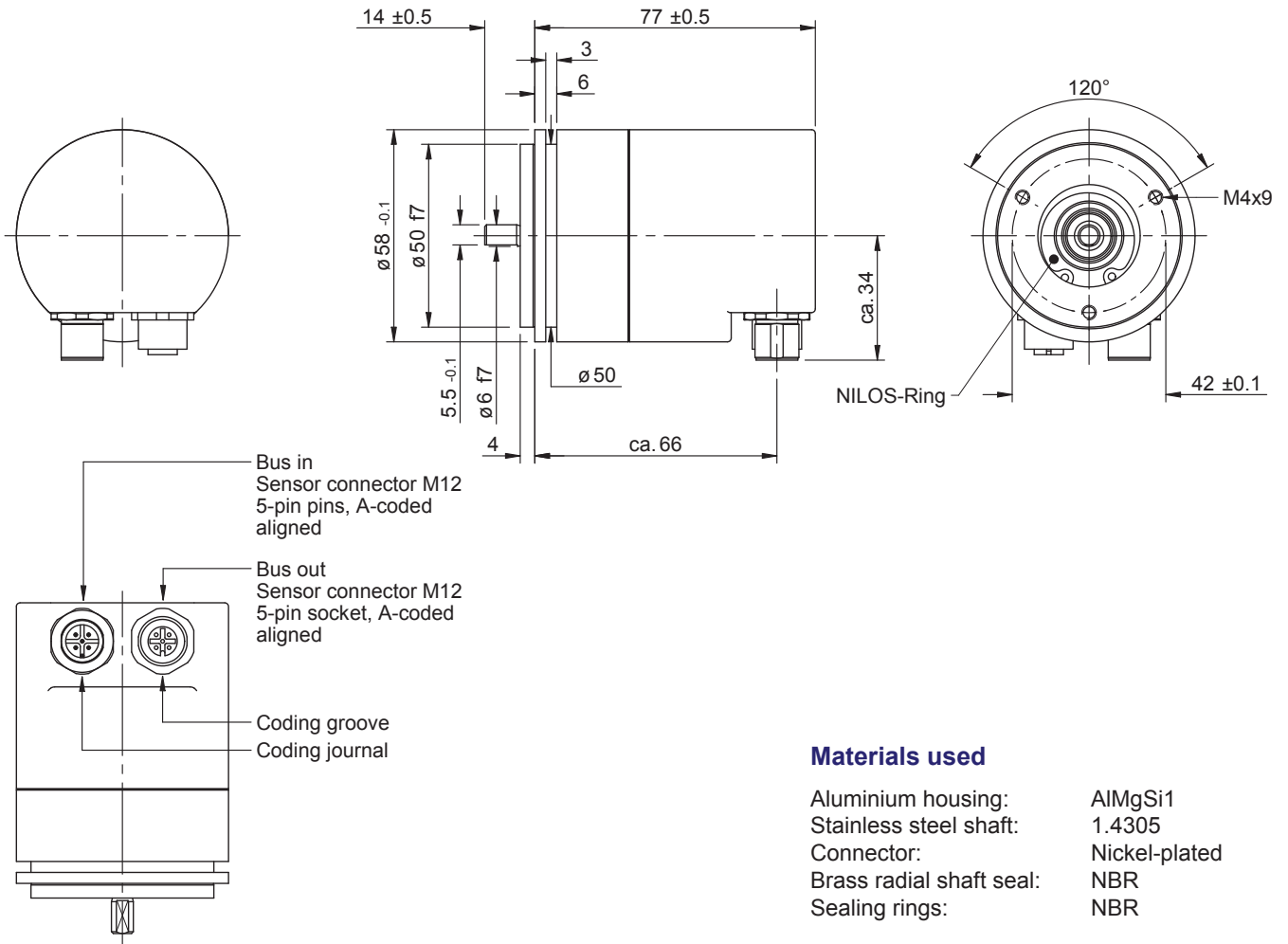
Model NOCN / S3

Installation drawings

(further installation drawings on request)

Modell NOCN58-ST (singleturn)

Dimensions in mm



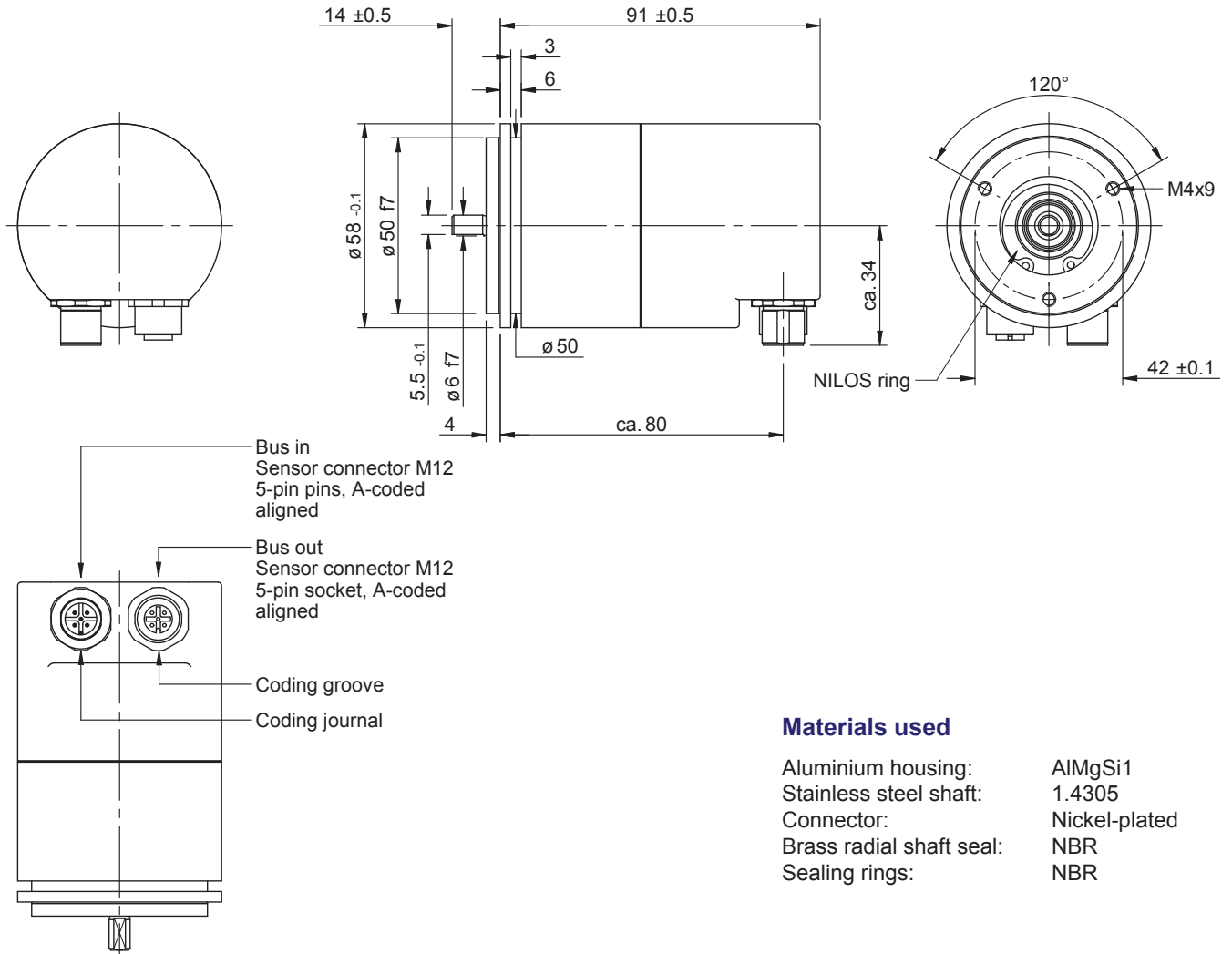
Model NOCN / S3

Installation drawings

(further installation drawings on request)

Modell NOCN58-ST (multiturn)

Dimensions in mm



Materials used

Aluminium housing:	AlMgSi1
Stainless steel shaft:	1.4305
Connector:	Nickel-plated
Brass radial shaft seal:	NBR
Sealing rings:	NBR

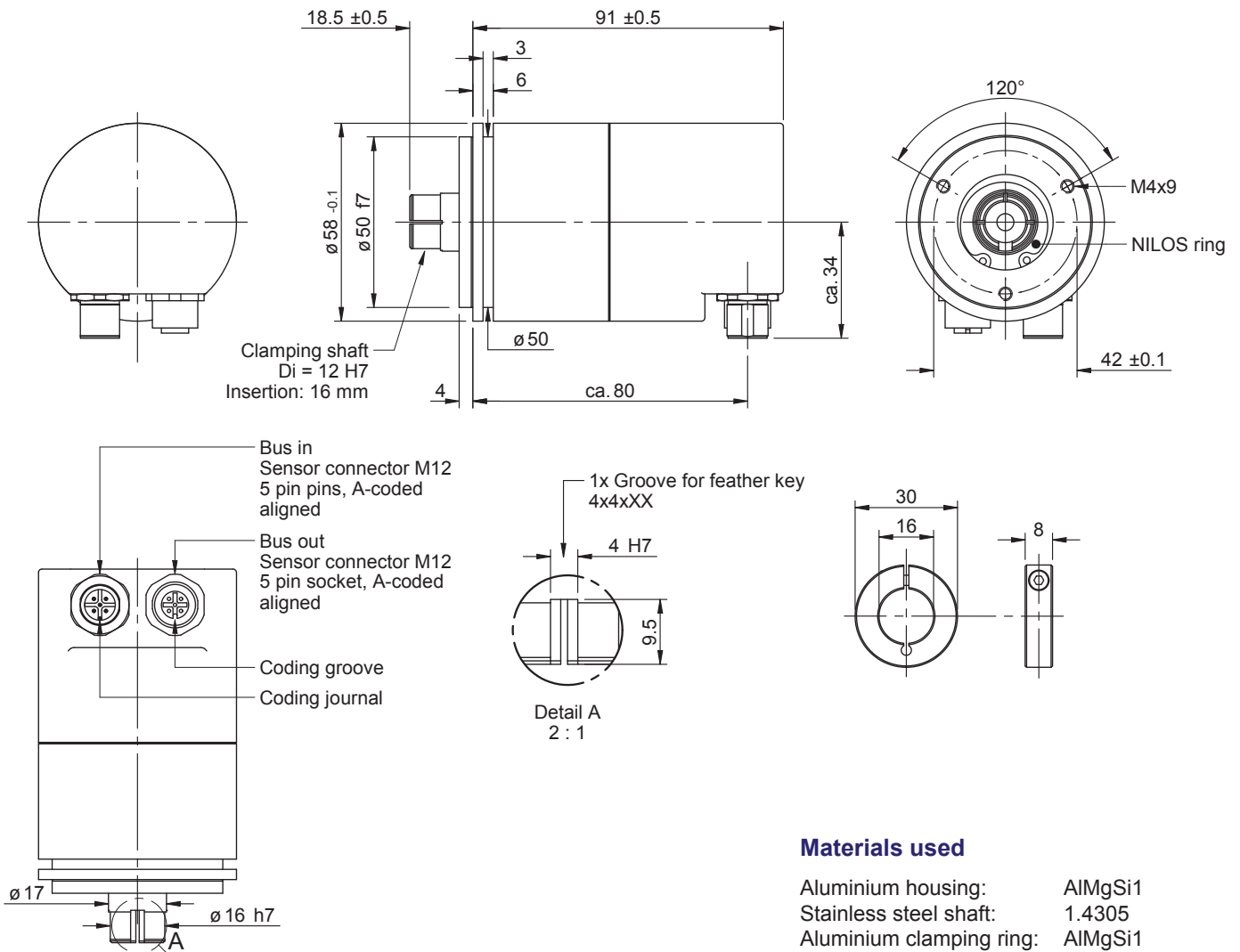
Model NOCN / S3

Installation drawings

(further installation drawings on request)

Model NOCN58-SN (multiturn)

Dimensions in mm



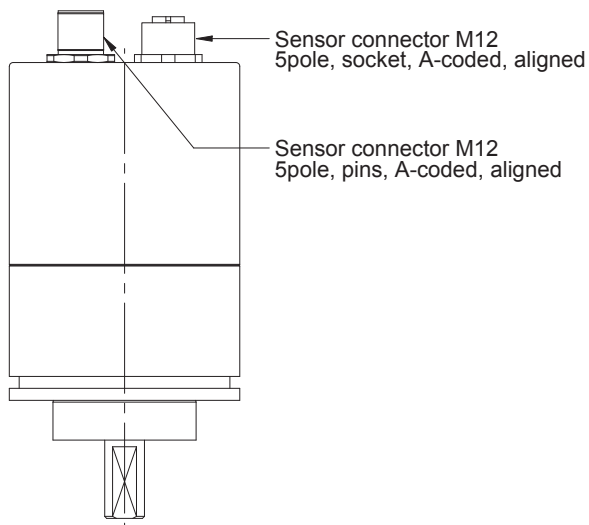
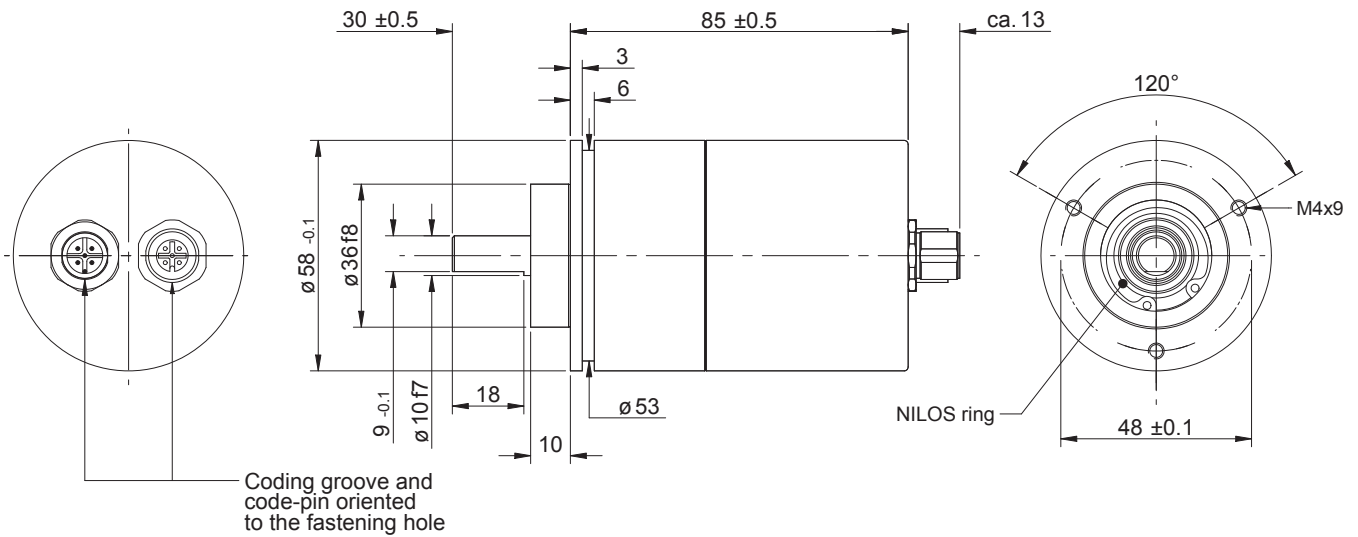
Model NOCN / S3

Installation drawings

(further installation drawings on request)

Modell NOCN58-K (multiturn, 2 connectors axial)

Dimensions in mm



Materials used

Aluminium housing:	AlMgSi1
Stainless steel shaft:	1.4305
Connector:	Nickel-plated
Brass radial shaft seal:	NBR
Sealing rings:	NBR

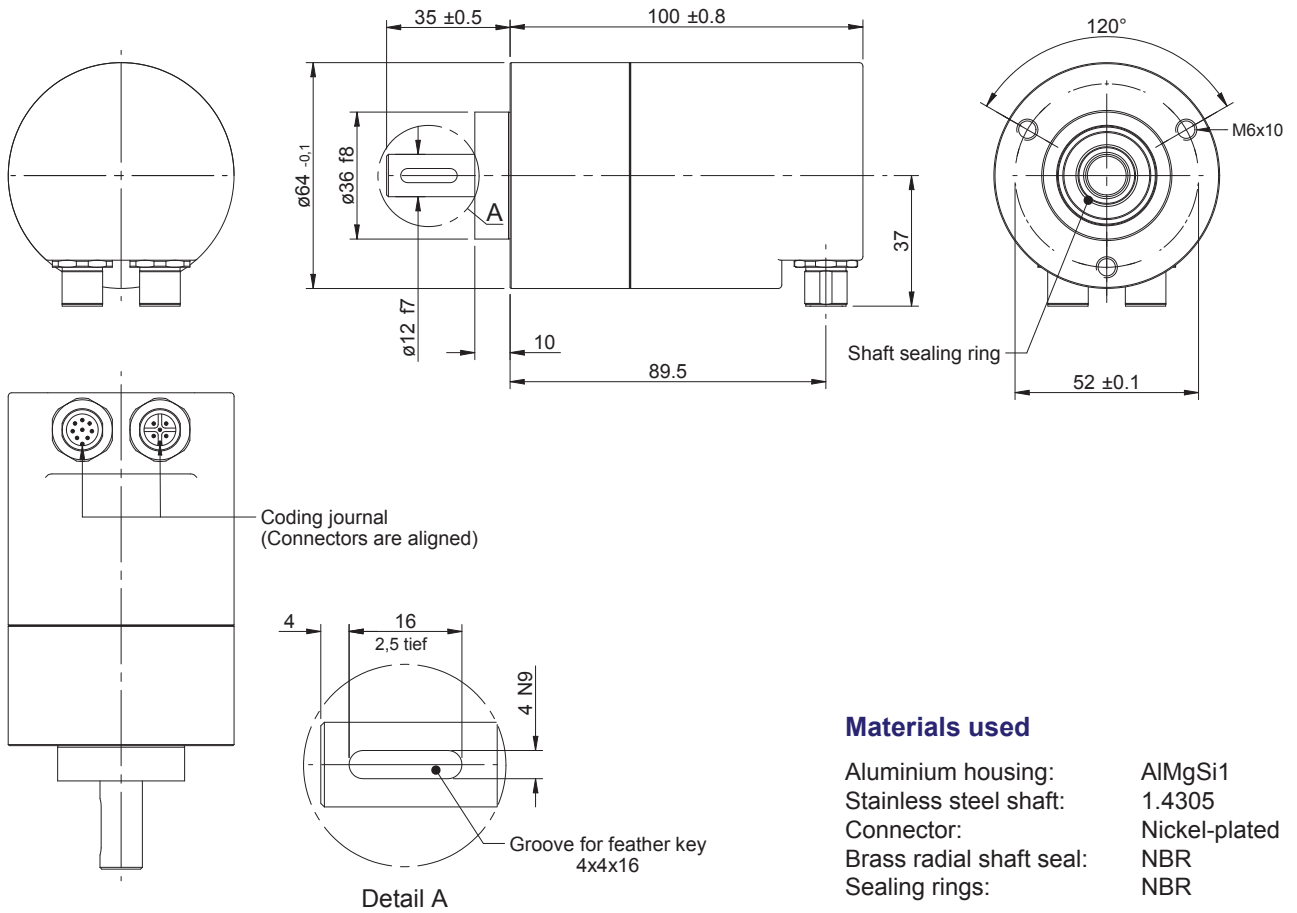
Model NOCN / S3

Installation drawings

(further installation drawings on request)

Model NOCN64-KP (multiturn)

Dimensions in mm



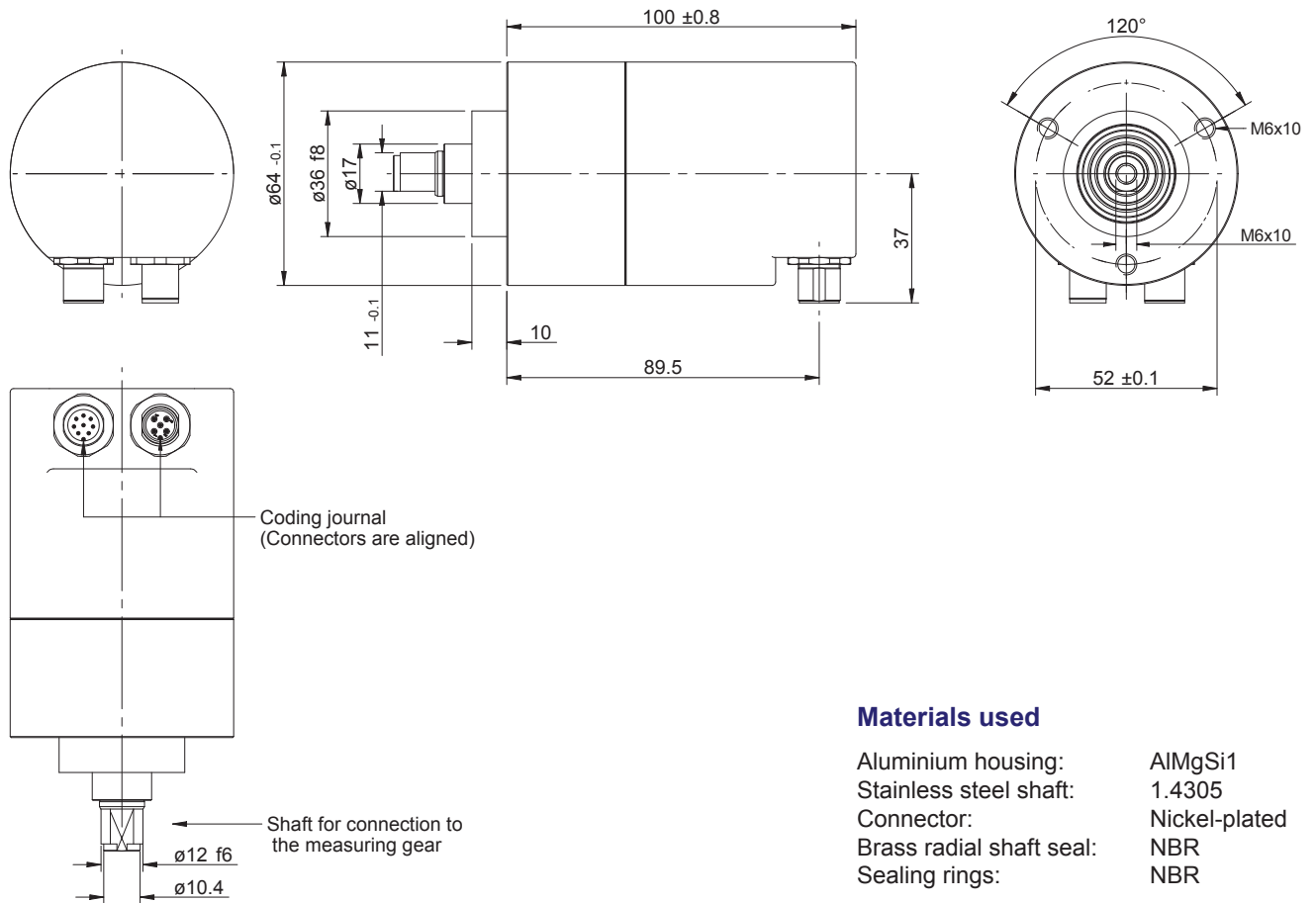
Model NOCN / S3

Installation drawings

(further installation drawings on request)

Model NOCN64-KZ with shaft for TWK play-compensating toothed gear ZRS

Dimensions in mm



Materials used

Aluminium housing:	AlMgSi1
Stainless steel shaft:	1.4305
Connector:	Nickel-plated
Brass radial shaft seal:	NBR
Sealing rings:	NBR

Model NOCN / S3

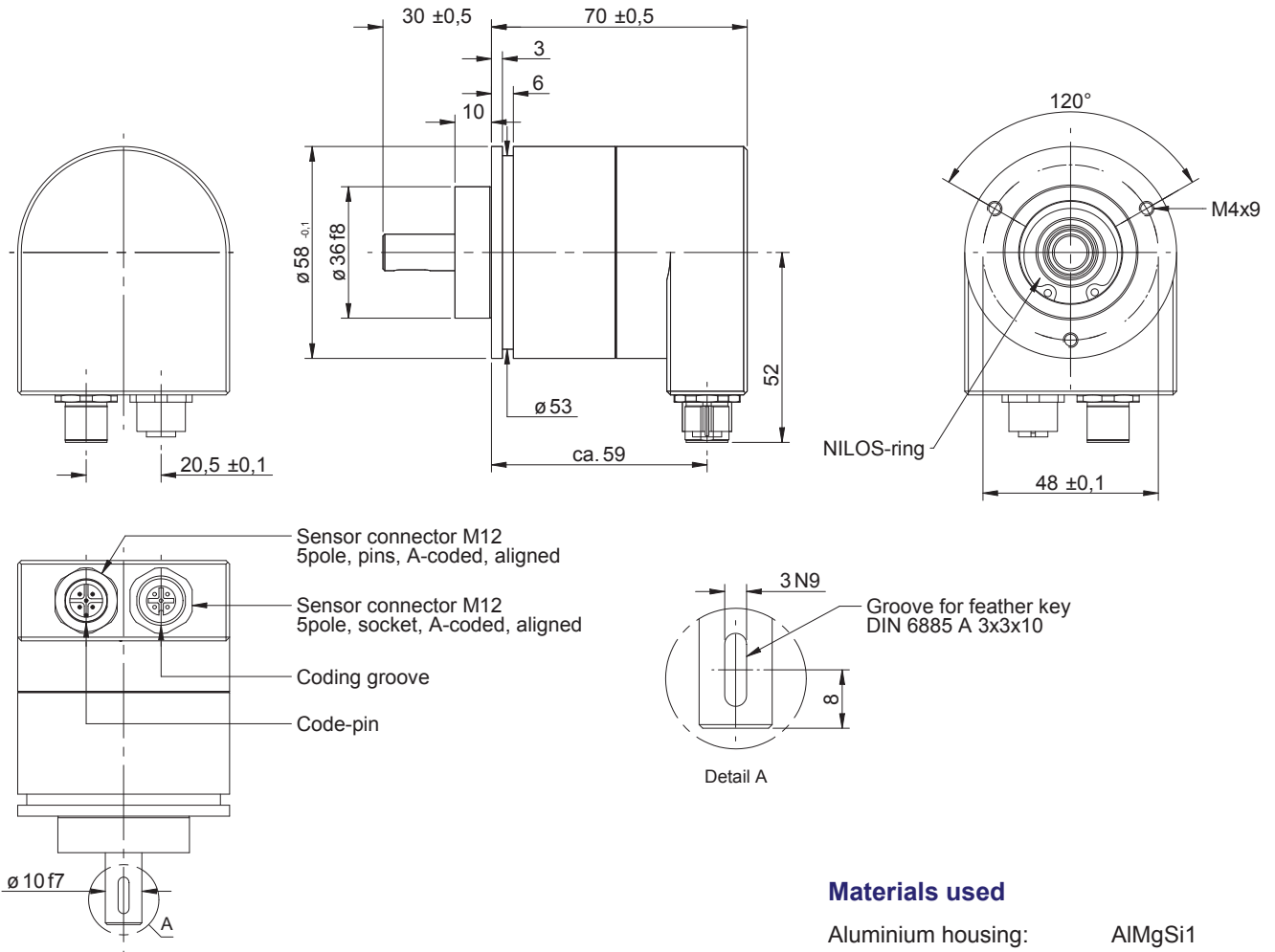
Installation drawings

(further installation drawings on request)

Model NOCN58-KP with short length design and connectors radial

This version is available on request.

Dimensions in mm



Materials used

Aluminium housing:	AlMgSi1
Stainless steel shaft:	1.4305
Connector:	Nickel-plated
Brass radial shaft seal:	NBR
Sealing rings:	NBR

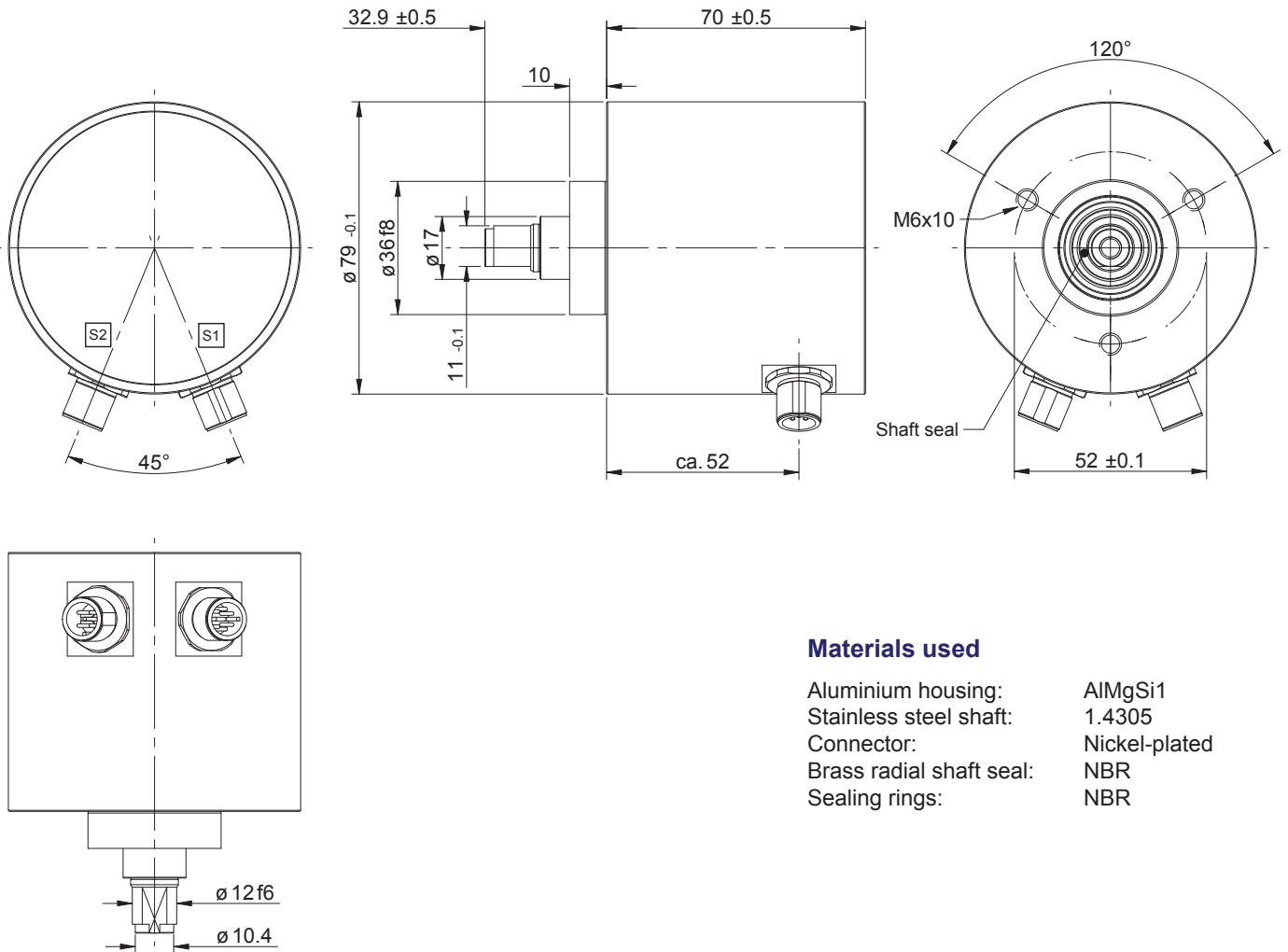
Model NOCN / S3

Installation drawings

Special version NOCN79 on request

Model NOCN79-KZ (2 connectors radial)

Dimensions in mm



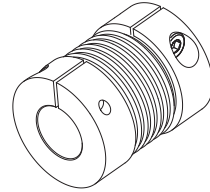
Model NOCN / S3

Accessories

Play free bellows coupling BKK 32 / x - y

x and y: bore diameter for shaft mounting

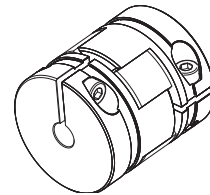
See data sheet [BKK 11840](#)



Play free clamp coupling KK14S / x - y (without notch)

x and y: bore diameter for shaft mounting

See data sheet [KK 12301](#)

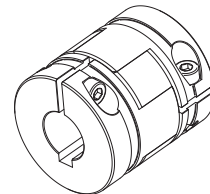


Play free clamp coupling KK14N / x - y (with notch)

x and y: bore diameter for shaft mounting

With groove for keyway according to DIN 6885 Bl. 1 – JS9.

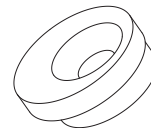
See data sheet [KK 12301](#)



KL 66-2-S

Mounting brackets for mounting encoders.

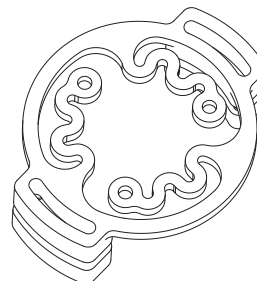
See data sheet [MZ 10111](#)



ZMS58

Torque arm / stator. Can be used as encoder shaft holder for version 'clamp shaft' to compensate for radial and axial play of the drive shaft.

See data sheet [ZMS 12939](#)



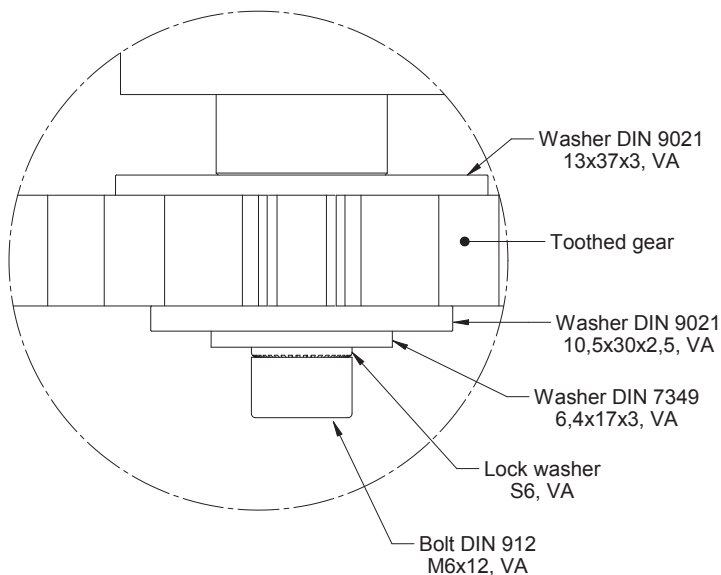
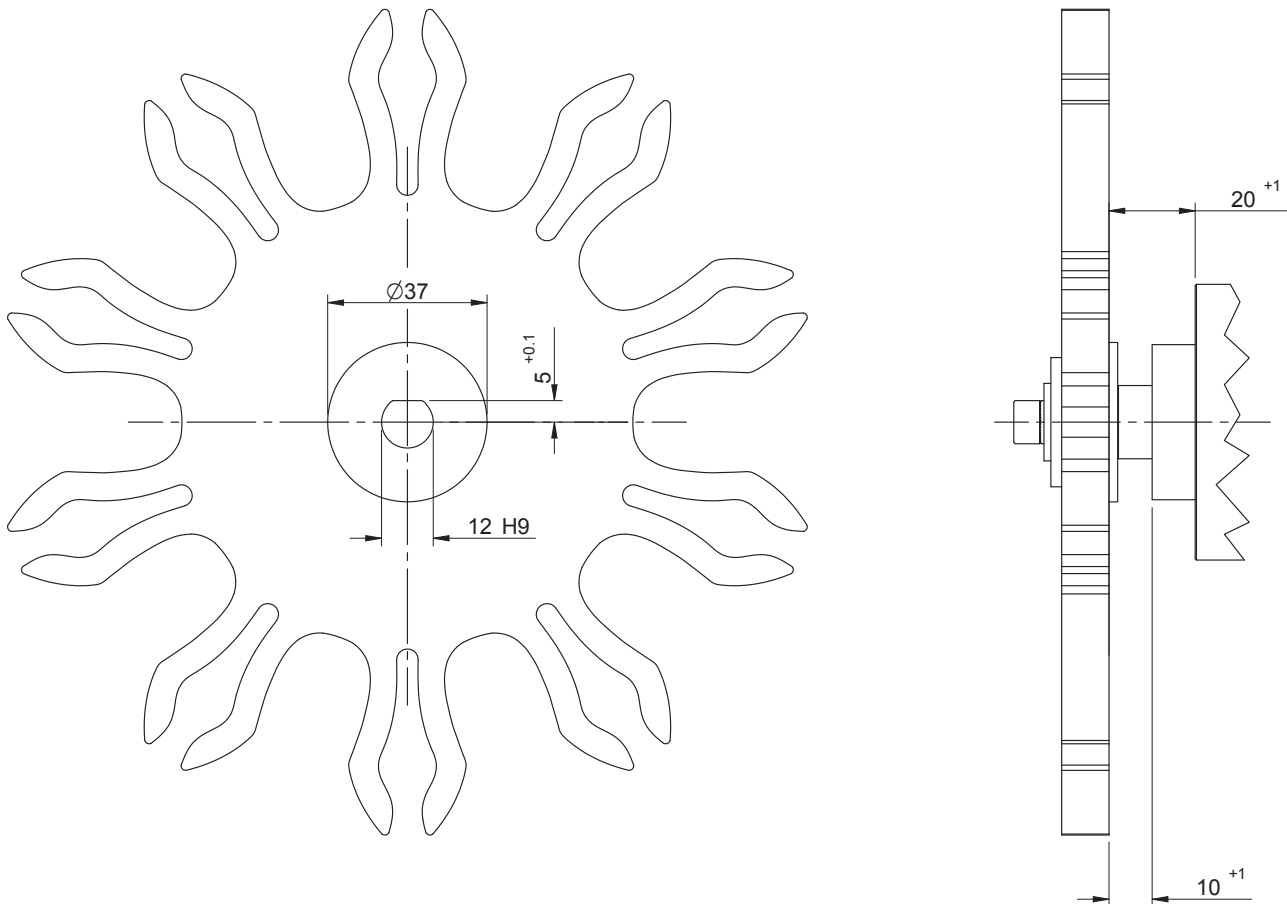
Model NOCN / S3

Play-compensating toothed gear ZRS

(Subject to TWK utility model protection)

A 'play-compensating toothed gear' ZRS is available to mechanically drive the switching cam encoder shaft on a ring gear (slewing ring) or a rack without play. Different modules and numbers of teeth are available. ZRS material: polyamide. Also see data sheet [ZRS 11877](#). Mechanical connection necessitates a specific shaft version.

Installation recommendation: Tighten 6 mm bolt to a torque of 6 Nm and secure with Loctite (medium adhesive strength).



Order code number

ZRS - 12 - 10 - A 01

Variants **:

A 01 Standard

Teeth:

10 No. of ZRS teeth *

Module:

12 5 to 24 *

Model:

ZRS toothed gear, play-compensating model

*: Other values on request

** : Please contact our technical support to select the required measuring gear.