Play-free electronic digital switching cam encoder
with electromagnetic absolute encoder / ***SSI*** **output**
Model **NOCE**

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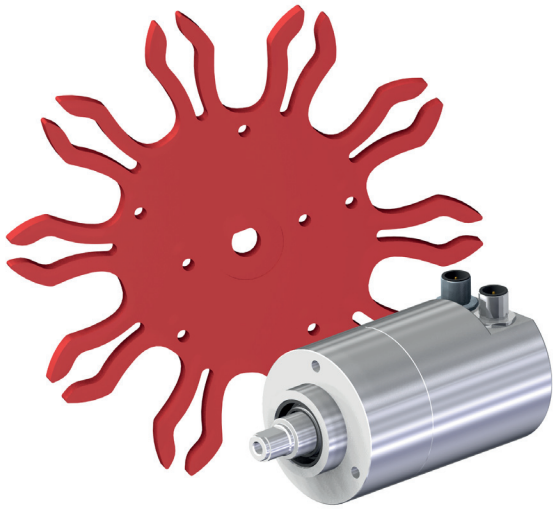

- **Play-free version for use instead of electromechanical switching cam encoders**
- **For use in stationary and mobile machines and systems, particularly for power plants, wind turbines, cranes, etc.**
- **Up to four electronically controlled switching outputs consisting of**
  - 2 x PhotoMOS
  - 2 x Relay: Changeover contacts
- **Integrated absolute multiturn encoder with *SSI* interface and resolution up to 13 bits**
- ***SSI* position signal and switching outputs can be preset via preset inputs**
- **High vibration and shock resistance thanks to the robust design**

Contents

Design

Robust housing in dual-chamber design in aluminium (AlMg-Si1) or stainless steel (1.4305 resp. 1.4404). Shaft with radial shaft seal and ball bearing mounted in the prechamber. Electronics housed in the sealed main chamber.

Version:

Ø 64 mm (standard) with clamping collar and M6 threaded holes plus two device connectors and two switching outputs.

Ø 79 mm (on request) with short housing length and up to 6 switching contacts

Shaft diameter 12 mm. Electrical connection for voltage supply, switching outputs and analogue data via M12 connectors or cables. The number of connectors or cables varies (up to a maximum of two) depending on version or customer specifications.

The **NOCE64** has four switching contacts (6 at model NOCE79 possible).

The version with two contacts contains two mechanical relays with changeover contacts.

The version with four contacts contains two additional semiconductors (PhotoMOS) which represent a NO contact each.

Each semiconductor switching contact is separated by an Opto - Isolator from the rest potential of the NOCE, so that these switching outputs - as well as the relays – are galvanically isolated. The PhotoMOS units can switch AC and DC.

All four switching contacts (NO - normally open contacts - by the relays) are closed during normal operation, thus providing a constant current flow. When a contact switching value (shaft position) is reached the appropriate contact opens. All limit values are separately adjustable for each contact. Also, contacts are open when the cam switch is not connected to power supply.

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Electronic digital switching cam encoder model NOCE

Description

General functional principle

This involves a play-free electronic switching cam encoder (abbreviated to: NOCE) with a maximum of four galvanically separated switching outputs, which can be set by the customer and which are activated or deactivated depending on the relevant position of the drive shaft. A parameterisable multiturn absolute encoder with SSI interface plus the switching cam encoder printed circuit board with separate controller are integrated into the compact housing. The SSI interface can be preset, the code direction can be set and the switching outputs can be preset.

Absolute encoder

The absolute encoder has an SSI interface. Its resolution is 12 bits / 360° (optionally 13 bits) with a measuring range of 4096 revolutions. The SSI position value can be referenced using pins in the connector. The signal path (CW/CCW) can be set.

256 or 16 revolutions are possible as the measuring range on request.

Switching outputs (cams)

The electronically activated cams can be used to control potential-free, galvanically separated switching processes. The switching outputs are implemented using relays with long service lives resp. wear-free PhotoMOS semicondutors which are as well galvanically separated.

The switching information for the cams is taken from the absolute encoder. In comparison with an electromechanical switching cam encoder, switching output activation and deactivation is carried out electronically without play or wear.

The cams of the individual switching outputs are programmed in the factory in accordance with the customer's specifications if they are to deviate from the standard setting (cam diagram on page 7). The precise NOCE measuring range point at which the relays are to switch (switching flank) can be set using preset inputs (pages 7/8).

Each of the two cam relays has a changeover contact, which is routed out via an M12 connector. The contacts of the PhotoMOS semiconductors are routed out via two pins each (NO behaviour). With all switching outputs direct- and alternating current can be switched. Different connector assignments are possible on request by the customer.

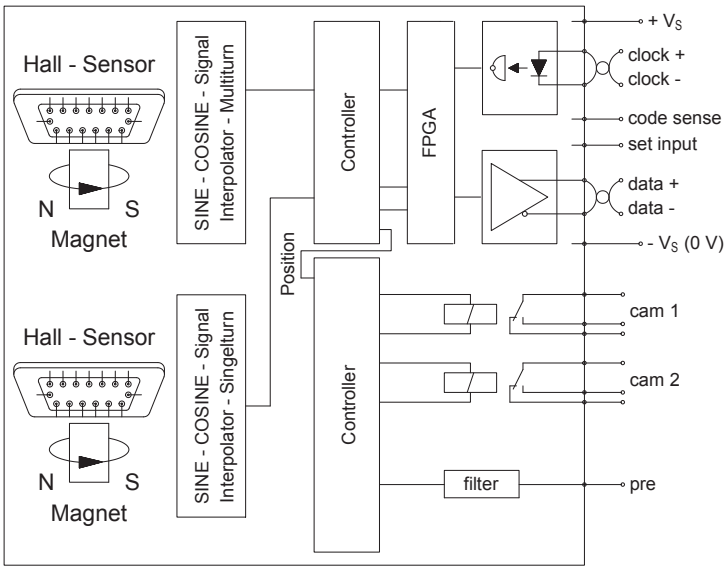
The changeover function enables normally closed contact, normally open contact or changeover functions to be implemented by the customer per switching output (cam).

If operating voltage is missing, the cams do not switch.

Principle circuit diagram

Principle circuit diagram 1

Version with two switching contacts and one preset input for both SSI and cams.

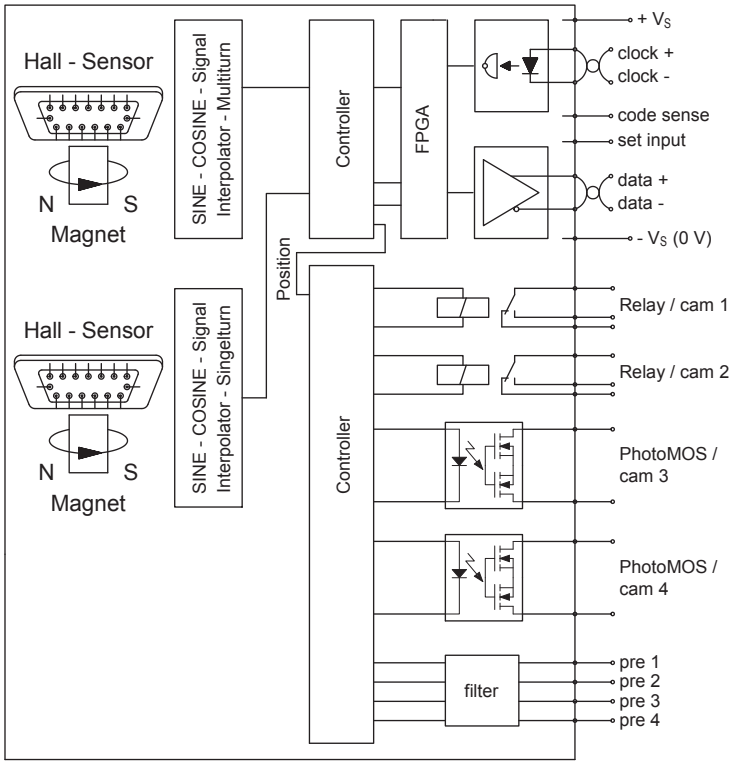


Electronic digital switching cam encoder model NOCE

Principle circuit diagram

Principle circuit diagram 2

Version with four switching contacts and five separate preset inputs for SSI and cams.



Technical Data

Mechanical data

- Shaft diameter: 12 mm with flattened area on one side, 11 mm
- Operating speed: 1000 rpm max.
- Angular acceleration: 10^5 rad/s² max.
- Moment of inertia (rotor): 20 gcm²
- Operating torque: ≤ 8 Ncm (at speed 500 rpm)
- Starting torque: ≤ 4 Ncm
- Perm. shaft load: 250 N axial
250 N radial
- Bearing service life: ≥ 10^9 revolutions
- Weight: Approx. 0.8 kg

Environmental data

- Operating temperature range: - 40 °C bis + 85 °C
- Storage temperature range: - 45 °C to + 85 °C
- Resistance:
  - ☐ To shock: (DIN EN 60068-2-27) 250 m/s², 6 ms, 100 x each in 3 axes
  - ☐ To vibration: (DIN EN 60068-2-6) 100 m/s², 5 Hz ... 2000 Hz, 1 h each in 3 axes

  (Higher values optional)
- Protection type: (DIN EN 60529) IP66

Electronic digital switching cam encoder model NOCE

Technical data

Electrical data

- Sensor system: ASIC with HALL elements
- Operating voltage range: 11 VDC to 28 VDC
- Power consumption: < 2.5 W
- Resolution: 4096 steps / 360° (12-bits), optionally 8192 steps / 360° (13 bits)
- Measuring range: 4096 revolutions (option 256 or 16 revs.)
- Output code: Binary (optionally Gray)
- Absolute accuracy: ± 0.25 % / 360°
- Repeatability: ± 0.1 % / 360°
- Code path: CW (parameterisable)
- Temperature drift: ± 20 ppm / K typ.
- EMC standards:
  Interference emission: EN 61000-6-4
  Interference immunity: EN 61000-6-2
- Serial output SSI: Differential data output (RS 422)
- Clock input SSI: Differential data input via optical coupler (RS 422)
- Monoflop time: 16 ± 10 µs (standard)
- Clock rate: Max. 1 MHz
- Electrical connection: max. 3 x connector M12
  Option: cable

Switching output relay electrical data

- Maximum switching current: 1.0 A at 30 VDC / VAC
- Maximum switching voltage: 60 VDC / VAC
  Note: The effective maximum voltage is dependent on the connector into which the switching contacts are integrated: M12, 12-pin: max. 30 VDC, M12, 8-pin: max. 60 VDC.
- Response time: 3 ms (ON and OFF)
- Relay service life: 20 FIT ** with 10^5 switching cycles / year
- Switching hysteresis: 10 digits (~1°)

** FIT = Failure In Time, 1 FIT = 1 failure in 10^9 years

PhotoMOS output electrical data (@ 25 °C)

- Maximum load current: 0.5 A (continuous) / 1.5 A (peak)
- Maximum load voltage: 60 VDC / VAC
  Note: The effective maximum voltage is dependent on the connector into which the switching contacts are integra ted: M12, 12-pin: max. 30 VDC, M12, 8-pin: max. 60 VDC.
- Maximum power dissipation: 300 mW
- On resitance: 0.83 Ω typ.
- Maximum OFF state leakage current: 1 µA
- Turn ON / OFF time (90 % of final value):
  ON: 0.65 ms typ. / 2 ms max.
  OFF: 0.04 ms typ. / 0.2 ms max.
- I/O capacitance: 1.5 pF max.
- Switching hysteresis: 10 digits (~1°)

Electronic digital switching cam encoder model NOCE

Order code number

NOCE	64	-	K	A	2	-	4096	R	4096	S	E	01	→ Standard version

Electrical and mechanical variants *
01 Standard

Absolute encoder interface:
E *SSI*

Electrical connections:
S Device connector M12
K Cable connection

Measuring range:
16
256 Revolutions
4096

Code:
R Binary / G Gray

Resolution:
4096 Steps / 360°, 8192 steps / 360° at maximum

Number of switching outputs:
2 2 Switching outputs, 4 at maximum (6 at model NOCE79)

Housing material:
A Aluminium
S Stainless steel 1.4305
V Stainless steel 1.4404

Flange:
K Clamped flange

Design form:
64 ø 64 mm
(Other flange designs on request, i.e. ø 58 mm or 79 mm)

NOCE Electronic digital switching cam encoder with *SSI* 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.

Mating connector

(EMC-resistant, metal version, straight)

M12, 4-pin, female:	**STK4GS60**
M12, 5-pin, female:	**STK5GS56**
M12, 8-pin, female:	**STK8GS54**
M12, 12-pin, female:	**STK12GS93**
M12, 4-pin, male:	**STK4GP50** (plastic version)
M12, 5-pin, male:	**STK5GP90**
M12, 8-pin, male:	**STK8GP99**
M12, 12-pin, male:	**STK12GP108**

Note: With connector M12, 12-pin, the recommended maximum voltage at the pins is 30 V. At higher voltages, we recommend M12 connectors with fewer pins, if possible.

Electronic digital switching cam encoder model NOCE

SSI interface

Function

To precisely register and output the angle or the position of the shaft, the contactless electromagnetic sensor system is equipped with serial SSI interface, with the result that the measurement variable is available as a digital, serial datum.

The absolute angle information present in the absolute encoder is serially and synchronously transmitted to the receiver electronics within one cycle.

The essential advantages of this are the low number of data cables and extensive protection against interference (an exhaustive description of the *SSI* interface is contained in TWK's *SSI* 10630 pamphlet).

This model is set to a measuring range of 4096 revolutions in the factory (optional 256 and 16 revs.).

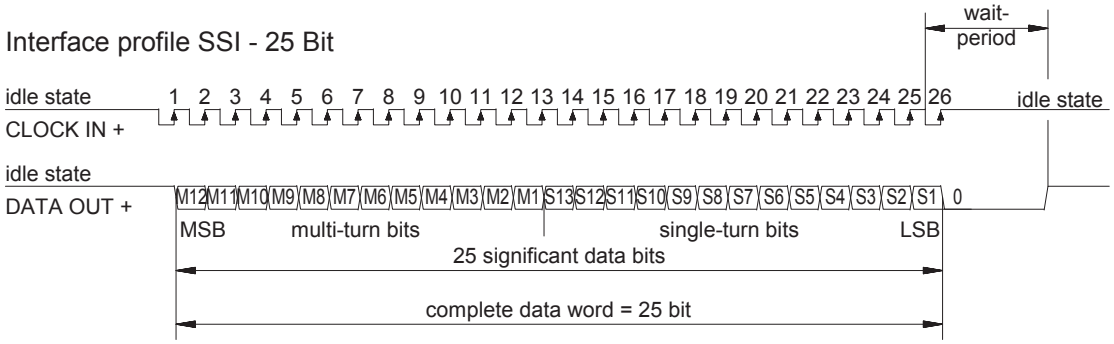
The entire measuring range is always output with the full resolution of 4096 steps per revolution (optionally 8192 steps) with the corresponding number of revolutions (measuring range). At 4096 revolutions, this is 4096 x 4096 = 16,777,216 steps.

A preset value specified in the factory can be called up via a pin in the connector, e.g. the middle of the measuring range, and the code direction CW/CCW can be set.

The information on the shaft's precise angular position is additionally used to control the two switching outputs (cams).

Interface profile *SSI* - 25-bit / binary / left-aligned

(Example : 4096 steps / 360° - 4096 revolutions)



Maximum data rates

- The data rate is limited by the following variables:
  - Up to approx. 40 m max. clock frequency 1 MHz
  - Between 40 m and 150 m delay of the overall electronics:

    $t_{GV} = t_C + 2t_K + t_E$

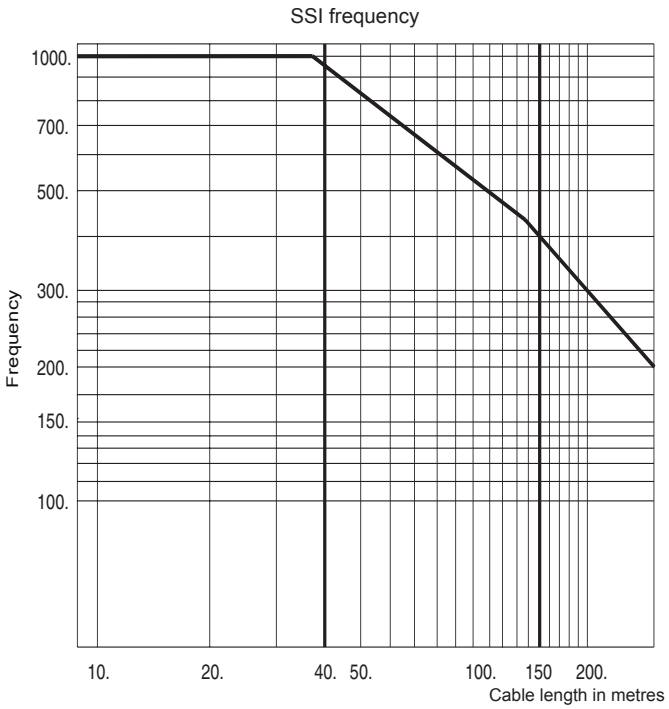
    t_{GV}: Overall delay time
    t_C: Delay time of the coding electronics (here e.g. ≤ 300 ns)
    t_K: Delay time of the cable (depending on the cable length and type. Delay time e.g. 6.5 ns/m)
    t_E: Delay time of the receiving electronics (e.g. 150 ns)

    The following result is obtained with a safety gap of 50 ns between the cycle duration of cycle tT and the overall delay time t_{GV}:

    $t_T = t_{GV} + 50\ ns = 500\ ns + 2t_K$

    On calculation of the max. clock frequency, he following connection applies: $f_{max.} = 1 / t_T$
  - As of 150 m according to RS 422 specifications

With the above specified values, e.g. the adjacent limit value curve is obtained.



Electronic digital switching cam encoder model NOCE

Switching outputs

Function

The function of the switching outputs is implemented by means of relays and PhotoMOS semiconductors. The relays have changeover contacts. Each changeover contact is routed out via the relevant switching cam encoder connector for use by the customer. The contacts are galvanically separated in terms of operating voltage and the SSI output signal. The PhotoMOS semiconductors are as well galvanically separated. Two contacts of each PhotoMOS are routed out.

The information regarding when which relay is to pick up and drop off again is made available to the relay control system by the internal controller. The same is valid for the semicoductors when to close and open. It receives the shaft position data from the NOCE's absolute encoder.

The switching flanks of all switching outputs are set to a certain angle setting with regard to the shaft. See cam diagram on this page. The measuring angle is represented in ° and in revolutions with regard to an arbitrary shaft reference point.

The switching length L ex-works is 4320° = 12 revolutions.

The cams may also be pre-programmed according to the customer's specifications in the factory. E.g. several cams per switching output are also possible.

The precise location of the switching flanks, i.e. calibration of the cams, can be carried out on-site using the preset function by the customer. Preset pins PRE are provided for this purpose.

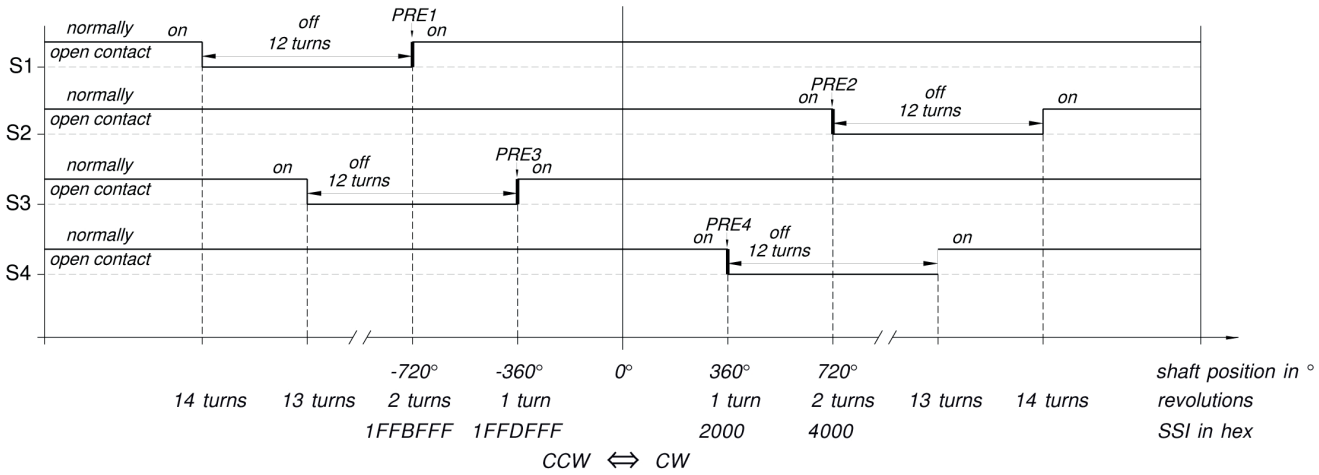
NOCE version with two cams: Activating the switching outputs' preset function does influence the SSI output signal and the two cams simultaneously: Both cams are shifted en bloc to the desired location.

NOCE version with four cams: Each of the four switching outputs can be preseted. The SSI position signal can be preseted separately. The cams will change their position if the SSI preset function is used, due to the fact that the cams refer to the SSI position signal.

To avoid undesired switching back and forth (flutter) on the part of the relays when the shaft is stationary or as a result of slight shaft vibrations on the switching flank, a switching hysteresis of 10 digits (approx. 1°) is pre-programmed.

Cam diagram

(Factory setting)
Measuring angle 0° = *SSI* step 0. Version NOCE with two cams: S3 and S4 are omitted.



Preset function - 2 switching putputs

SSI position signal and both cams are presetted via 1 preset pin simultaneously (The cams refer to the SSI position signal). The relative position / distance between cam one and two is adjusted ex works by customers choice and not changeable.

Preset input for NOCE 64 with 2 switching outputs		
Function	**PRE 1**	**Remark**
Set SSI and switching output 1 and 2 preset	1	Set pin PRE to logical 1 for the duration of ~4 s
Normal operation		PRE open or set to $-U_B$

Electronic digital switching cam encoder model NOCE

Preset function - 4 switching putputs

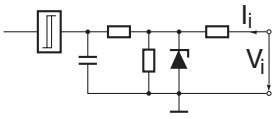
On activation of the preset function for the switching outputs in accordance with the table, the relevant switching flank (see cam diagram) is set precisely at the current shaft position. It can be ascertained that the switching output switches at this point by rotating the shaft around this position. On use of the programmer PMA-NOC-03, this can be recognised by the fact that the LED comes on and goes off. The switching contact (or LED) does not necessarily react immediately to the preset process without a shaft position change.

Note: The switching flanks of the individual cams always refer to the SSI position values (e.g. the flank of cam 4 switches at SSI step 2000hex = 360° shaft rotation). If the SSI position signal is set to zero via the preset pin PRESET SSI, and the position output value is thus changed with the same shaft position, the positions of all switching flanks are also changed/ shifted accordingly.

Preset- and control inputs of NOCE 64 with 4 switching outputs	
Function	**Remark**
Set switching output 1 preset (Relay 1 / falling flank)	Set pin PRE 1 to logical 1 for the duration of ~4 s
Set switching output 2 preset (Relay 2 / rising flank)	Set pin PRE 2 to logical 1 for the duration of ~4 s
Set switching output 3 preset (PhotoMOS 1 / falling flank)	Set pin PRE 3 to logical 1 for the duration of ~4 s
Set switching output 4 preset (PhotoMOS 2 / rising flank)	Set pin PRE 4 to logical 1 for the duration of ~4 s
SSI signal preset to zero (cams will change their position)	Set pin PRESET SSI to logical 1 for the duration of ~4 s
SSI signal: Select code sense (CW / CCW)	CW: Connect Pin Code sense to logical 0 (or leave open) CCW: Connect Pin Code sense to logical 1
Normal operation	Preset inputs open oder logical 0 (except Code sense, see above)
Logical 0 = $-U_B$ or open. Logical 1 = 11 VDC ... $+U_B$	

Input circuit for preset input (PRE): E1

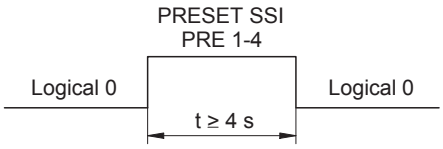
Input E1 active "high"



Log 0 < 5 V or not connected
Log 1 = 11 ... Vs
E1 specification

Timing diagram for PRE settings

Set PRE inputs individually

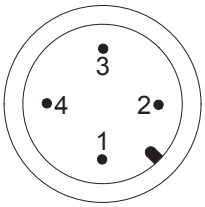


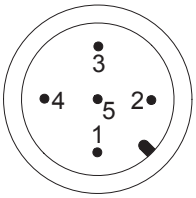
Connectors - contact numbering

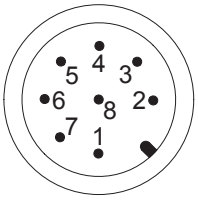
Contact arrangement and numbering

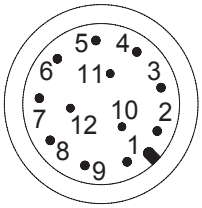
Viewed looking at the PIN side of the connector installed in the NOCE.
Different M12 connector combinations or assignments are possible at the request of the customer.
Please observe connection assignment TY enclosed with each device.

Connector, 4, 5, 8 and 12 pin









With M12, 12-pin, the recommended maximum voltage at the individual pins is 30 V.

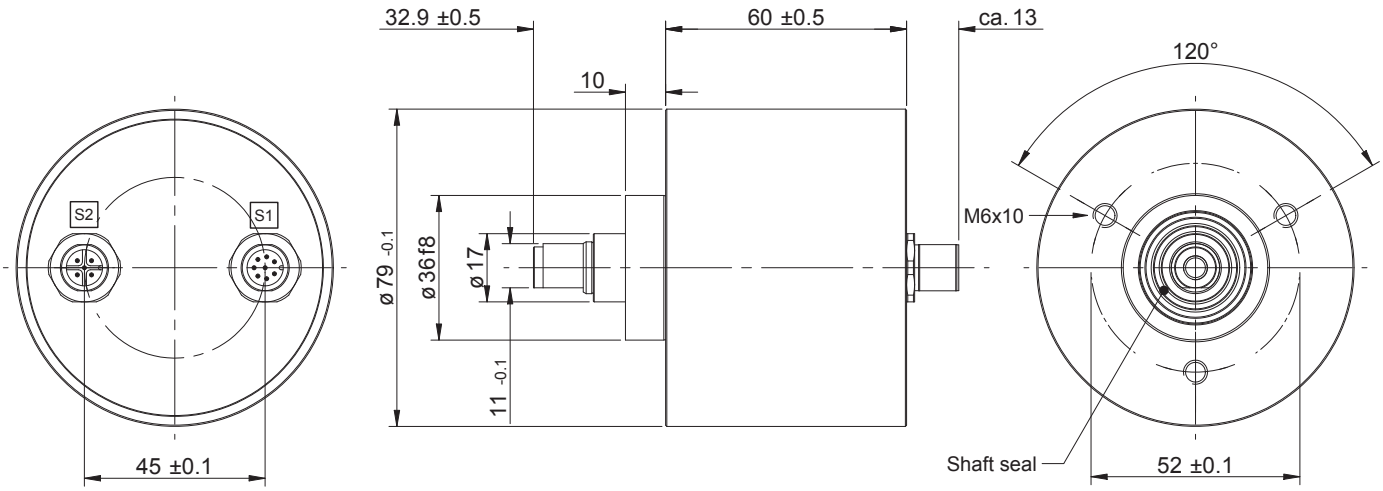
Electronic digital switching cam encoder model NOCE

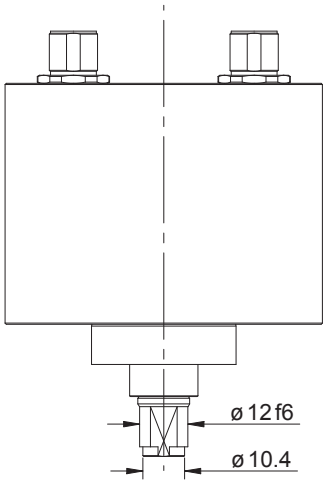
Installation drawings

Special version NOCE79 on request

Model NOCE79-KZ (2 connectors axial)

Dimensions in mm





Materials used

Aluminium housing:	AlMgSi1
Stainless steel shaft:	1.4305
Connector:	Ms, nickel plated
Shaft sealing ring:	NBR
Sealing rings:	NBR

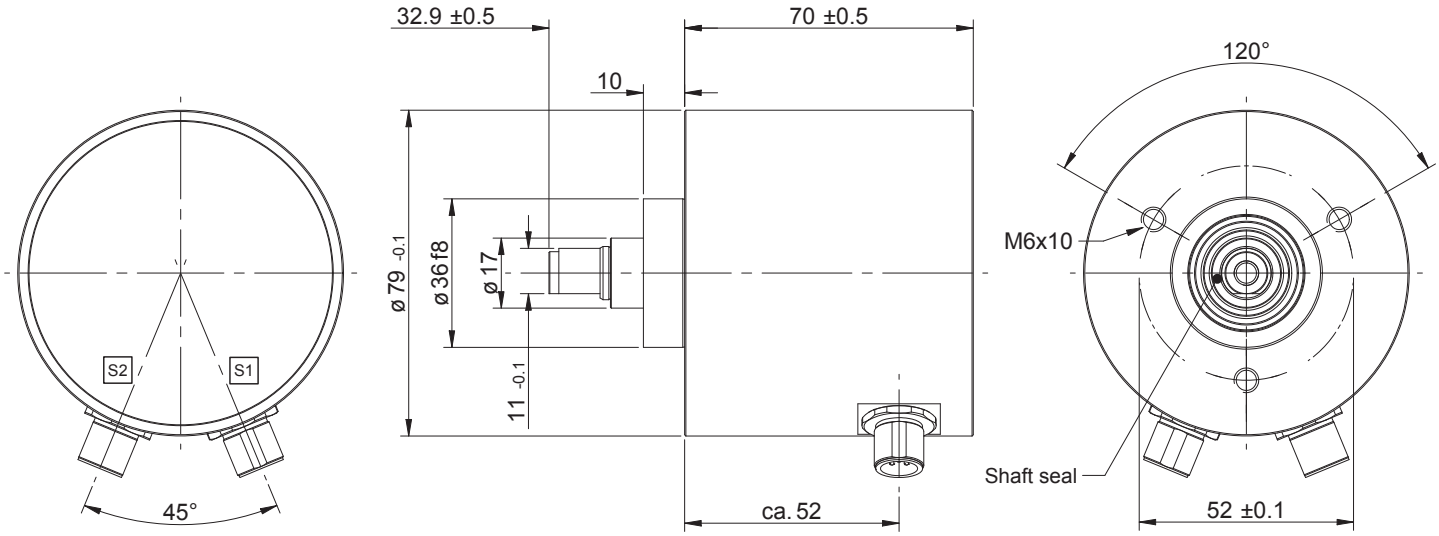
Electronic digital switching cam encoder model NOCE

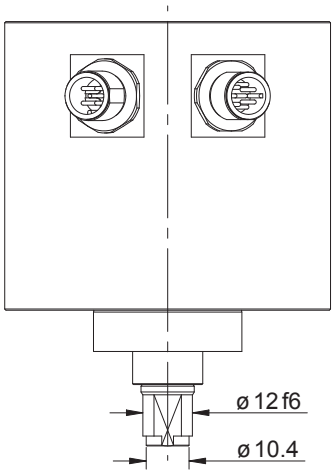
Installation drawings

Special version NOCE79 on request

Model NOCE79-KZ (2 connectors radial)

Dimensions in mm





Materials used

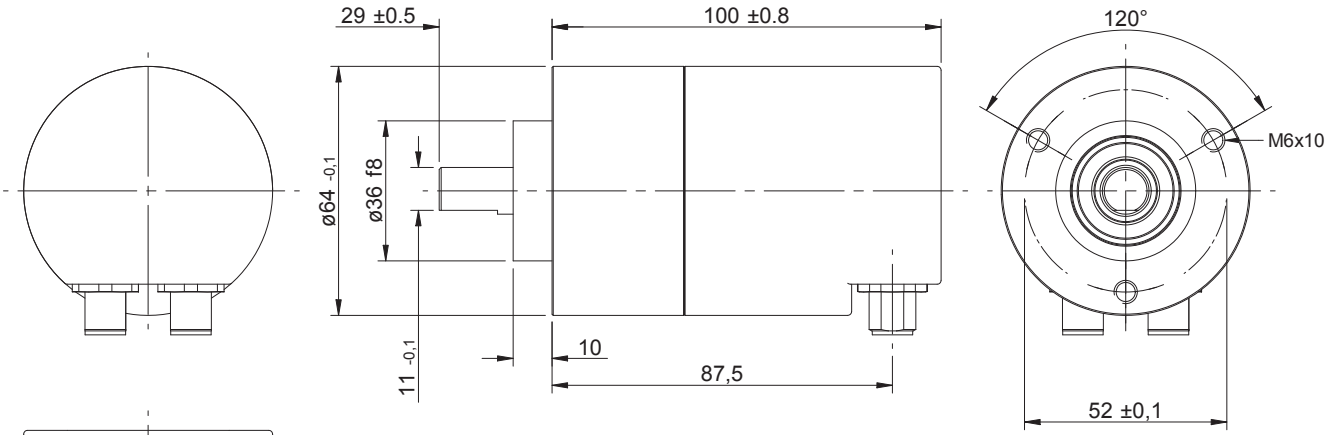
Aluminium housing:	AlMgSi1
Stainless steel shaft:	1.4305
Connector:	Ms, nickel plated
Shaft sealing ring:	NBR
Sealing rings:	NBR

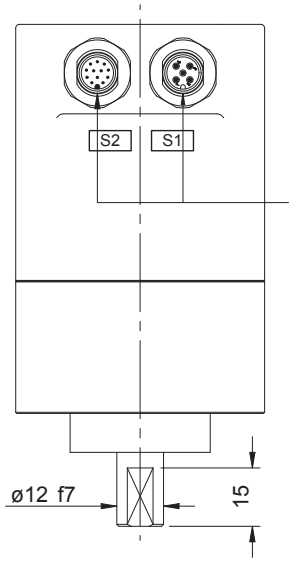
Electronic digital switching cam encoder model NOCE

Installation drawing

Model NOCE 64

Dimension in mm





Exemplary connector selection

S1 = sensor connector M12 (5-pin)
S2 = sensor connector M12 (12-pin)

Coding pin aligned towards the shaft

Materials used

Aluminium housing:	AlMgSi1
Stainless steel shaft:	1.4305
Connector:	Ms, nickel plated
Shaft sealing ring:	NBR
Sealing rings:	NBR

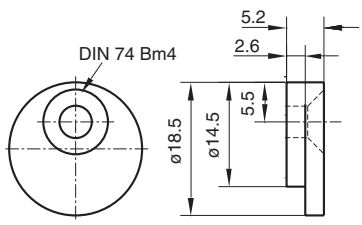
Alignable device connectors (S1 and S2) can also be optionally fitted in the factory.

Accessories

Series KL 58-2 securing clamps

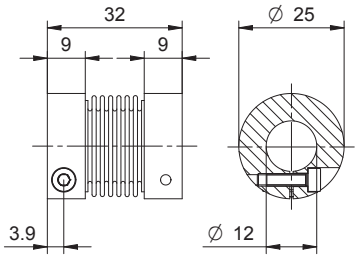
(See data sheet MZ 10111)

- Pitch diameter: 140 $^{+0.5}$ mm
- Material: Nickel-plated brass
- Required screws: (3 units required) M4 countersunk head with hexagon socket DIN 7991



Folding bellows coupling BKK 32/x-y

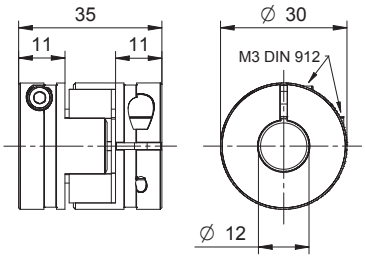
(See data sheet BKK 11840)



Stainless steel, 1.4301

Clamp coupling KK14S/x-y

(See data sheet KK 12301)



Aluminium / plastic

The couplings are also available with bores for other shaft diameters.

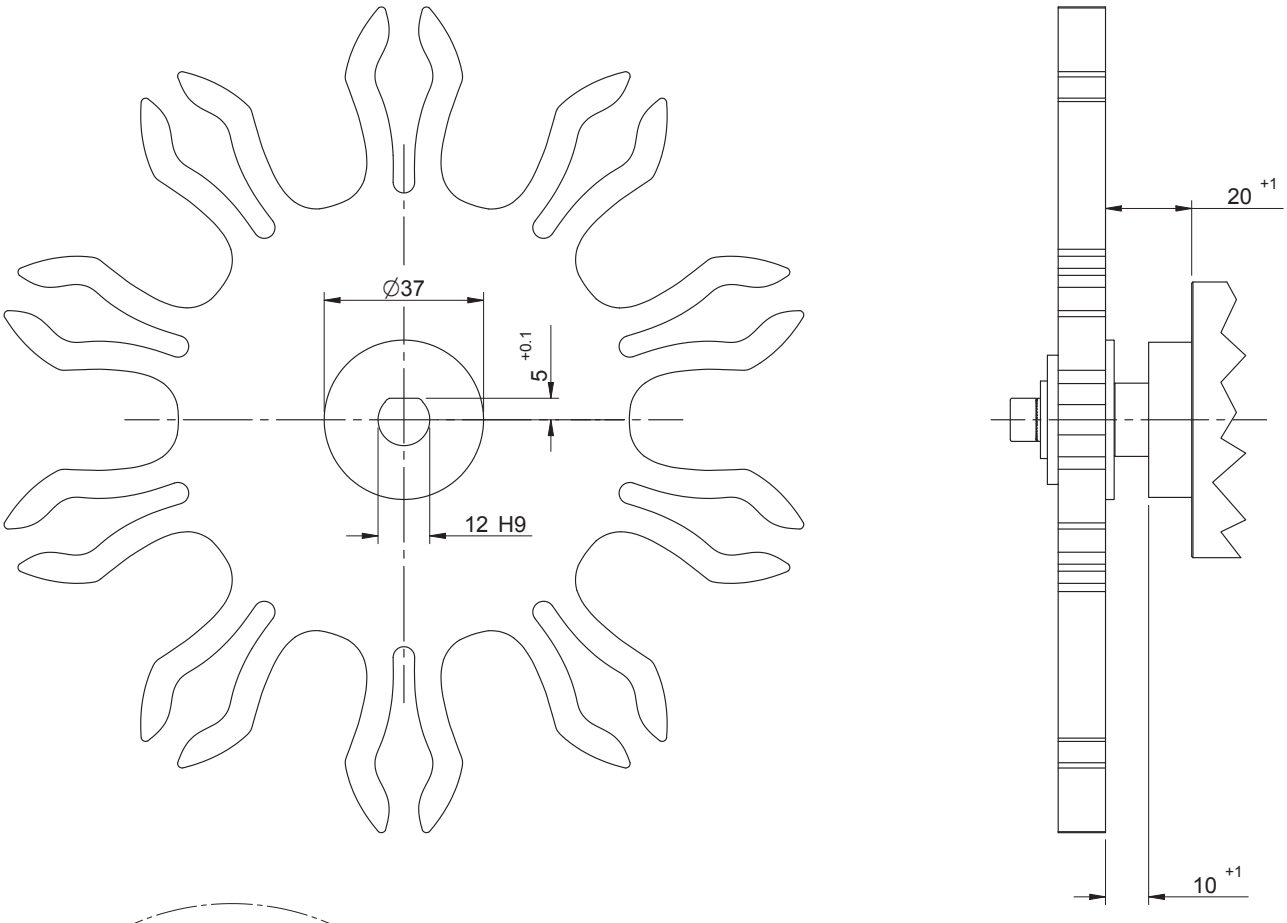
Electronic digital switching cam encoder model NOCE

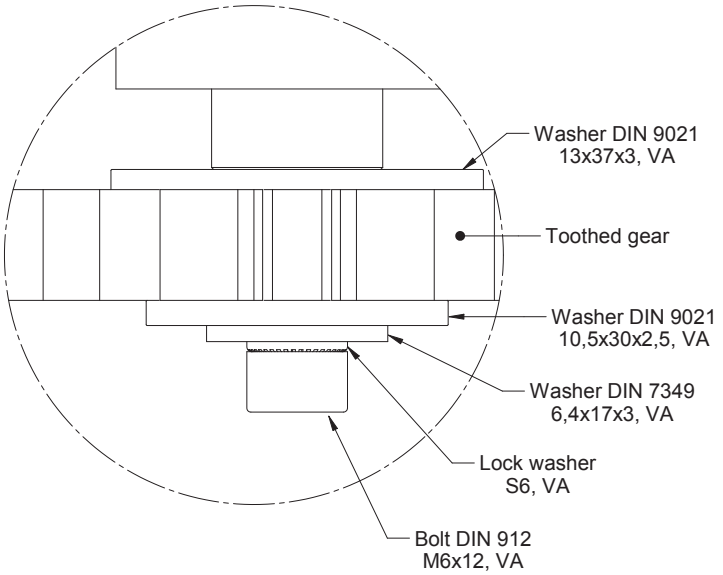
Play-compensating toothed gear ZRS

(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

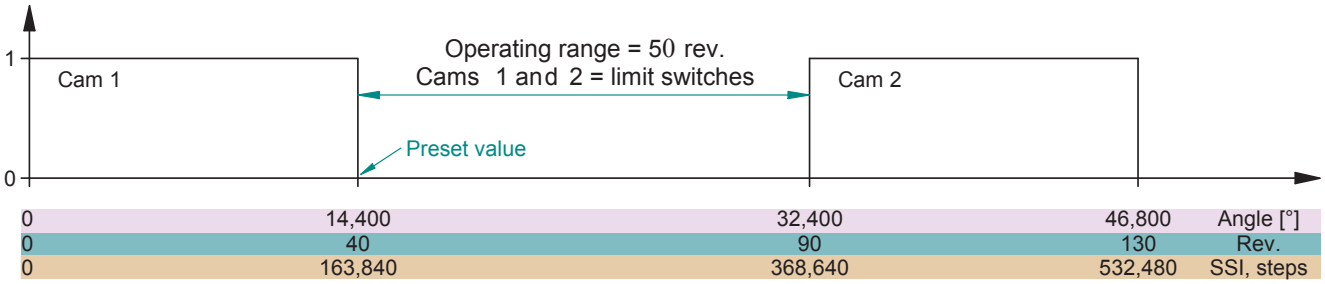
**: Please contact our technical support to select the required measuring gear.

Electronic digital switching cam encoder model NOCE

Programming example for *SSI* signal and relays / cams

Example programming for relay 1 and relay 2, *SSI*: resolution 4096 S/R							
The *SSI* output signal has the following offset at an angle reference value of 0: 0° (e.g. 1000): 0							
Output value	Rotation direction	Relay **1** Flank **1** = relay ON	Relay **1** Flank **2** = relay OFF		Relay **2** Flank **1** = relay ON	Relay **2** Flank **2** = relay OFF	
Angle value [°]	cw	0	14,400		32,400	46,800	
No. of revolutions	“	0	40		90	130	
***SSI* [step]**	“	0	163,840		368,640	532,840	
Preset value [step]	163.840						

Example programming for cams 1 and 2, output signal *SSI*



Note for version with two switching outputs: On activation of the preset function, the *SSI* signal and therefore also the switching outputs are set. The cams are assigned to specific *SSI* position values in the factory. In this example, the *SSI* output value is preset to 163,840 and thus also the two cams‘ four flanks, which lie at 0, 163,840, 368,640 and 532,480.

The procedure for cam 2 is the same. The preset function always refers to the *SSI* output signal and the cams at the same time.

NOCE with four switching outputs: Four cams and the SSI position signal are presettable separately. The cams refer to the SSI position signal. Therefore if the preset function of the SSI signal is used, the cams will be influenced concerning their position as well.

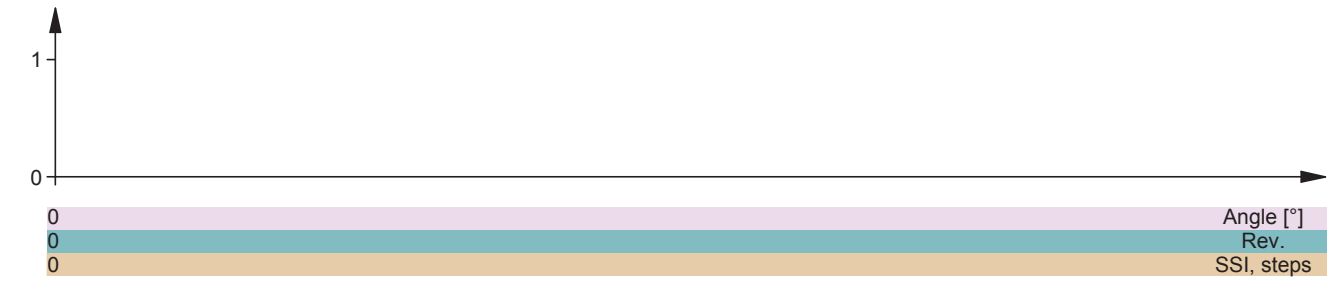
Electronic digital switching cam encoder model NOCE

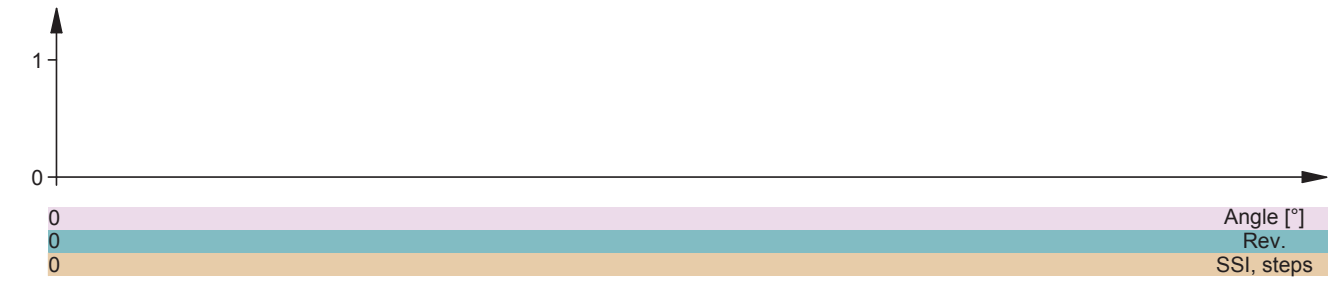
Table for factory programming according to customer specifications

Please enter your desired pre-programming for the switching outputs in the table. A maximum of three cams (switching on/off processes) in the measuring range per switching output. Enter the values (*SSI* steps) at which the switching flanks are to lie. Delivery from the factory is then carried out with this programming.

On digital output of the rotary encoder signal, the resolution is always 4096 steps per revolution (optionally 8192) over the entire measuring range (16 or 256 or 4096 revolutions).

Programming as desired by the customer							
The *SSI* output signal has the following offset at an angle reference value of 0° (e.g. 1000):							
Output value	Rotation direction	Relay ___ Flank ___	Relay ___ Flank ___	Relay ___ Flank ___	Relay ___ Flank ___	Relais ___ Flank ___	Relay ___ Flank ___
Angle value [°]							
No. of revolutions							
***SSI* [step]**							
Preset value [step]							





In the above charts you can enter how the cam switch should be programmed.