

### General

- Magnetic multiturn absolute rotary encoder with electronic gear
- Mounting kit without bearings in two designs for direct installation in motors
- With SSI or BiSS interface
- Additional analogue output sin/cos differential signals 1 V<sub>pp</sub> 128 periods per turn

### Features

#### Design A (open scanning unit with mounting plate)

- SSI data transmission 29 bits
  - 17 bits single turn
  - 12 bits multiturn
- Wear-free electronic gear; alternatively with
  - High-performance built-in buffer battery
  - Solder pads for connection of external battery
- Hollow shaft diameter 18, 23, 25 mm

#### Design B (scanning unit in housing)

- SSI data transmission: 32 bits
  - 30 bits data, 1 error bit (E), 1 warning bit (W)
  - 17 bits single turn
  - 13 bits multiturn
- Plug socket for external battery
- Battery monitoring via SSI data transmission
- Hollow shaft diameter 40, 50, 65, 78 mm

### Advantages

- Extended temperature range -40 °C to +120 °C
- High resolution
- Wear-free due to magnetic scanning
- Mounting kit with variable hollow shaft diameters

### Field of application

- Drive technology
- Robotics



Assembled rotary encoder including contour disc design B (left) and design A (right)

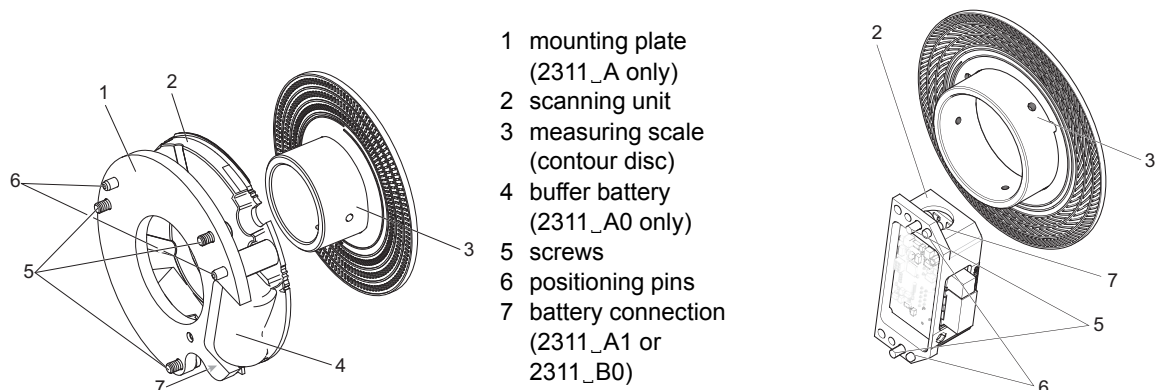
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# Description

## Construction and design

Each built-in rotary encoder in the series GEL 2311 comprises a ferromagnetic measuring scale and an electronic scanning unit.

They provide the position data via the synchronous-serial interface according to SSI protocol as binary or gray code or using the BiSS protocol. In addition to the SSI or BiSS signals, analogue signals are output.



### Design A

The open scanning unit provides an integrated buffer battery or solder pads for separate battery connection. The scanning unit is mounted on the drive via a mounting flange and 3 screws. 2 positioning pins safeguard the position of the scanning unit. The measuring scale is mounted on the drive shaft using a clamping ring. On mounting, the correct distance between the measuring scale and the scanning unit is ensured by 3 distance gauges.

### Design B

The closed scanning unit is equipped with a socket for connecting an external battery and provides a battery monitoring via SSI. The electronic scanning unit is mounted on the drive via a mounting flange and 2 screws. 2 positioning pins safeguard the position of the scanning unit. The measuring scale is mounted on the drive shaft using two screws and a dowel pin. On mounting, the correct distance between the measuring scale and the scanning unit is ensured by 3 spacers.

## Type code of design A

2311	Interface			
	A	SSI gray and sin/cos signal		
	B	SSI binary and sin/cos signal		
	C	BiSS and sin/cos signal		
	Design			
	A	Open scanning unit with mounting plate		
	Option			
	0	Standard: Built-in battery		
	1	Solder pads for external battery		
	Measuring scale			
	A	Contour disc A with shaft adapter		
	Shaft diameter			
018	18 mm shaft diameter			
023	23 mm shaft diameter			
025	25 mm shaft diameter			

## Type code of design B

	<b>Interface</b>
	<b>A</b> SSI gray and sin/cos signal
	<b>B</b> SSI binary and sin/cos signal
	<b>C</b> BiSS and sin/cos signal
	<b>Design</b>
	<b>B</b> Scanning unit with housing
	<b>Option</b>
	<b>0</b> Standard: Socket for external battery
	<b>Measuring scale</b>
	<b>B</b> Contour disc B with shaft adapter
	<b>Shaft diameter</b>
	<b>040</b> 40 mm shaft diameter
	<b>050</b> 50 mm shaft diameter
	<b>065</b> 65 mm shaft diameter
	<b>078</b> 78 mm shaft diameter
2311	

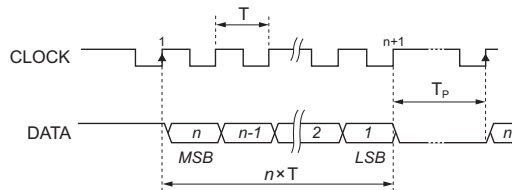
## Sensing principle and function

The sensing principle is based on the magnetic scanning of a ferromagnetic measuring scale. The rotary encoders provide an unambiguous position value for each angular position with a total resolution of 29 bits for type A and 30 bits data for type B.

The multiturn stage is based on an electronic gear that stores the number of revolutions without mechanical wear. The function of the rotary encoder is ensured even in the event of a power failure by an integrated buffer battery or an externally connected battery. If the rotary encoder shaft is rotated during the de-energised state, the current position value is accurately output immediately after power is switched on.

## Serial data transmission

The synchronous serial interface transfers the position data at a clock frequency of up to 2 MHz. Prior to further position request, a minimum pause time  $T_p$  must be met.



*Principle of serial data transmission [RS 422 / RS 485 standard]*

- f Clock frequency (> 62.5 kHz)
- T Clock signal period (1/clock frequency)
- $T_p$  Pause time, between the clock sequences  $T_p$  at least 16  $\mu$ s
- n Number of bits

Design A 29 bits data

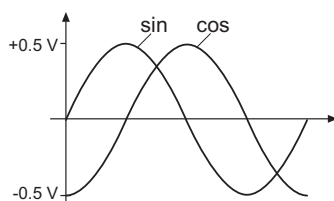
Design B 32 bits

30 bits data data,

1 error bit (E), 1 warning bit (W)

## Analogue output

For realtime control the encoder provides sin/cos differential signals suitable for a high degree of interpolation with a signal level of 1 V<sub>pp</sub>. 128 periods are generated per revolution.



## Structure of SSI data word for design B (32 clocks)

Clock	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
Bit	13 MSB	12	11	10	9	8	7	6	5	4	3	2	1	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1 LSB	E	W
Data	number of revolutions													steps per revolution																		

## PRESET input

The output signals can be set to a PRESET value from any position value. The behavior of the PRESET depends on encoder design.

### Design A

The PRESET is set electronically when the supply voltage  $U_B$  is applied to the PRES input for a short time (at least 0.1 s; do NOT apply continuously).

### Design B

The PRESET is set by software command. The required hardware is available on request.

The error and warning bit of the battery monitoring are reset via the PRES input. The reset occurs when GND is applied to the PRES input for 2 to 5 seconds.

## SSI battery monitoring (design B only)

### Warning bit

The warning bit is set or reset when the supply voltage is applied. There is no self-adjustment during operation.

W = 1 when the battery voltage  $U_{Bat}$  drops below the value  $U_{Bat\_Min}$

W = 0 when the battery voltage  $U_{Bat}$  is in normal range

### Error bit

Applying the supply voltage  $U_B$  changes the error bit.

There is no self-adjustment during operation. The error bit must be reset by the operator.

E = 1 when the battery voltage  $U_{Bat}$  was faulty

E = 0 when the battery voltage  $U_{Bat}$  is in normal range



As long as the encoder is supplied with voltage, its function is not affected by a faulty battery voltage.

A change of the external battery is possible even while the power supply to the encoder is switched on.

# Technical data

## Technical data design A

Shaft diameter	018	023	025
General			
Steps per revolution	17131,072		
Number of revolutions	4096		
Absolute accuracy <sup>(1)</sup>	0.2°		
Repeat accuracy <sup>(1)</sup>	0.05°		
Electrical data			
Supply voltage (U <sub>B</sub> )	5 to 30 V DC ± 5%		
Power consumption	< 0.1 W, no-load on output		
Power-On time	< 100 ms		
Life of integrated buffer battery	2 to 12 years <sup>(2)</sup>		
Capacity of external battery	≥ 2000 mAh		
Analogue output signals	sin/cos differential signals 1 V <sub>pp</sub> 128 periods per turn		
Synchronous serial interface			
Protocol	SSI (gray / binary), BiSS		
Data transmission	29 bits		
Single turn resolution	17 bits		
Multiturn resolution	12 bits		
Maximum clock frequency	2 MHz		
Mechanical data			
Hollow shaft diameter	18 mm	23 mm	25 mm
Measuring scale	contour disc with shaft adapter		
Moment of inertia of rotor	41.6 × 10 <sup>-6</sup> kg m <sup>2</sup>	45.0 × 10 <sup>-6</sup> kg m <sup>2</sup>	42.0 × 10 <sup>-6</sup> kg m <sup>2</sup>
Maximum operating speed	10,000 min <sup>-1</sup>		
Axial shaft motion <sup>(3)</sup>	± 50 µm		
Radial shaft motion <sup>(3)</sup>	± 50 µm		
Permissible axial runout <sup>(4)</sup>	0.1 mm		
Weight	220 g <sup>(5)</sup>		
Ambient data			
Assured operating temperature range	-40 °C to +100 °C		
Operating temperature range	-40 °C to +120 °C		
Storage temperature range <sup>(6)</sup>	-40 °C to +100 °C		
Vibration resistance	50 m/s <sup>2</sup> (5g), 10 to 2000 Hz (EN 60068-2-6)		
Shock resistance	350 m/s <sup>2</sup> (35g), 11 ms (EN 60068-2-27)		
MTTF value	2,934,600 h at 55°C		
EMC	EN 61000-6-1 to 4		
Insulation strength	Ri > 1 MΩ, at a test voltage of 500 V AC		
Max. relative humidity of air	99 %		
Condensation	permissible, according to DIN EN 60068-2-30:1999 Part 2		

<sup>(1)</sup> Depending on mounting tolerances

<sup>(2)</sup> The battery life is reduced significantly from a temperature of around 60 °C. For this reason batteries should be stored at a temperature as low as possible.

<sup>(3)</sup> Maximum permissible shaft motion over the entire temperature range

<sup>(4)</sup> Maximum permissible axial runout of assembled contour disc

<sup>(5)</sup> Scanning unit with mounting plate and measuring scale including shaft adapter

<sup>(6)</sup> without packaging

## Technical data design B

Shaft diameter	040	050	065	078
General				
Steps per revolution	131,072			
Number of revolutions	8192			
Absolute accuracy <sup>(1)</sup>	0.1°		0.3°	
Repeat accuracy <sup>(1)</sup>	0.05°			
Electrical data				
Supply voltage (U <sub>B</sub> )	5 to 30 V DC ± 5%			
Power consumption	< 0.1 W, no-load on output			
Power ON time <sup>(2)</sup>	< 1 s			
Battery connection	3.6 V			
Capacity of external battery	≥ 2000 mAh			
Analogue output signals	sin/cos differential signals 1 V <sub>pp</sub> 128 periods per turn			
Synchronous serial interface				
Protocol	SSI (gray / binary), BiSS			
Data transmission	32 bits			
Single turn resolution	17 bits			
Multiturn resolution	13 bits			
Battery monitoring	1 error bit (E), 1 warning bit (W)			
Maximum clock frequency	2 MHz			
Mechanical data				
Hollow shaft diameter	40 mm	50 mm	65 mm	78 mm
Measuring scale	contour disc with shaft adapter			
Outside diameter of contour disc	89 mm	109 mm	115.9 mm	128.9 mm
Moment of inertia of rotor	in kg m <sup>2</sup>			
	119.5 x 10 <sup>-6</sup>	282 x 10 <sup>-6</sup>	408 x 10 <sup>-6</sup>	638 x 10 <sup>-6</sup>
Maximum operating speed	10,000 min <sup>-1</sup>			
Axial shaft motion <sup>(3)</sup>	± 50 µm			
Radial shaft motion <sup>(3)</sup>	± 50 µm			
Permissible axial runout <sup>(4)</sup>	0.1 mm			
Weight	150 g <sup>(5)</sup>	225 g <sup>(5)</sup>	279 g <sup>(5)</sup>	319 g <sup>(5)</sup>

<sup>(1)</sup> Depending on mounting tolerances

<sup>(2)</sup> At start from the energy saving mode

<sup>(3)</sup> Maximum permissible shaft motion over the entire temperature range

<sup>(4)</sup> Maximum permissible axial run-out of assembled contour disc, determined at ø 85 mm (040); ø 105 mm (050); ø 112 mm (065); ø 125 mm (078)

<sup>(5)</sup> Scanning unit and measuring scale including shaft adapter

# Technical data

Shaft diameter	040	050	065	078
<b>Ambient data</b>				
Assured operating temperature range	-40 °C to +100 °C			
Operating temperature range	-40 °C to +120 °C			
Storage temperature range <sup>(1)</sup>	-40 °C to +100 °C			
Vibration resistance	50 m/s <sup>2</sup> (5g), 10 to 2000 Hz (EN 60068-2-6)			
Shock resistance	350 m/s <sup>2</sup> (35g), 11 ms (EN 60068-2-27)			
MTTF value	1,524,240 h at 55°C			
Electro magnetic compatibility	EN 61000-6-1 to 4			
Insulation strength	Ri > 1 MΩ, at a test voltage of 500 V AC			
Max. relative humidity of air	99 %			
Condensation	permissible, according to DIN EN 60068-2-30:1999 Part 2			

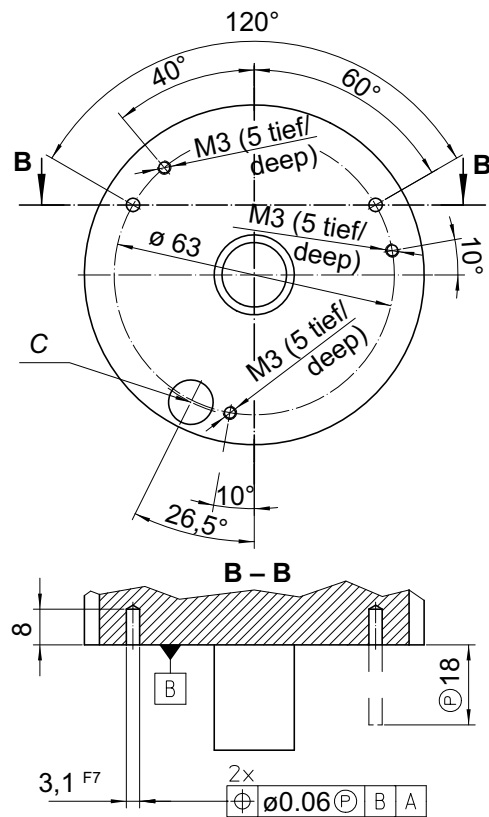
<sup>(1)</sup> without packaging

# Dimensional drawings

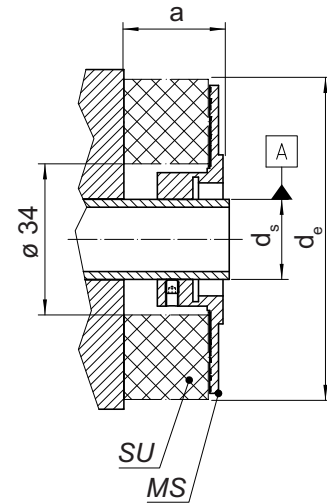
All dimensions stated in mm; general tolerance DIN ISO 2768 -mK

## Dimensional drawing design A

### Hole pattern



### Installation dimensions



- B-B section
- C motor cable outlet
- MS measuring scale
- SU scanning unit with mounting plate

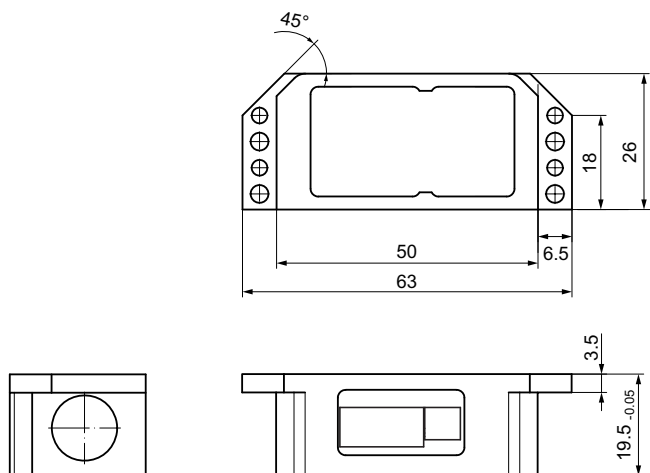
Shaft type	Shaft diameter $d_s$	Inside diameter $d_i$	Max. encoder diameter $d_e$	Maximum mounting depth $a$
018	18h6	18H6	73	23
023	23h6	23H6	73	23
025	25h6	25H6	73	23

# Dimensional drawings

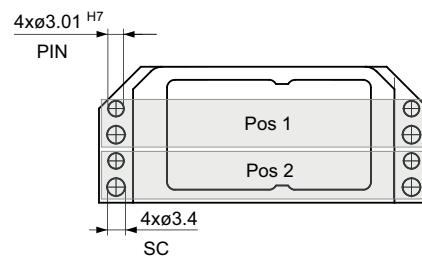
All dimensions stated in mm; general tolerance DIN ISO 2768 -mK

## Dimensional drawing design B

### Dimensions of scanning unit

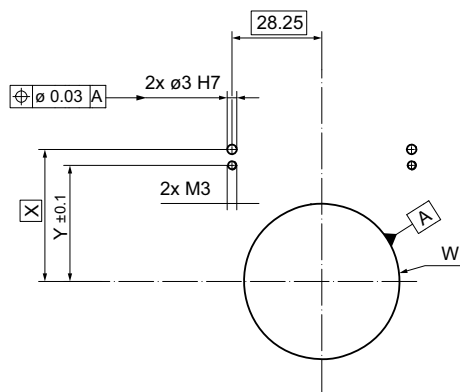


### Mounting positions



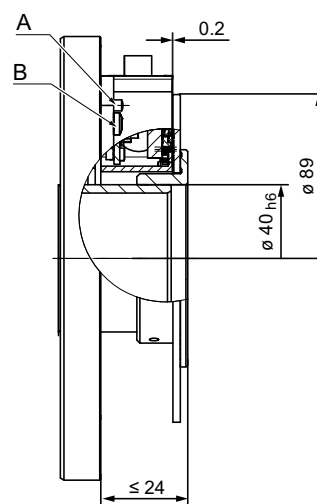
- Pos 1 pairs of holes for mounting position 1
- Pos 2 pairs of holes for mounting position 2
- PIN hole for positioning pin
- SC hole for mounting screw

### Hole pattern



W shaft

### Assembly example (ZB2311B40)



- A positioning pin 3 m6
- B screw M3 x 8 (ISO 8734)

### Dimension X / Y in dependence of mounting position and measuring scale

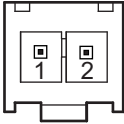
Measuring scale (contour disc with shaft adapter)			Pos 1		Pos 2	
Item number	Inside diameter	Outside diameter	X [mm]	Y [mm]	X [mm]	Y [mm]
ZB2311B40	40 mm	89 mm	41.55	36.55	31.55	26.55
ZB2311B50	50 mm	109 mm	51.55	46.55	41.55	36.55
ZB2311B65	65 mm	115.9 mm	55.00	50.00	45.00	40.00
ZB2311B78	78 mm	128.9 mm	61.50	56.50	51.50	46.50

All dimensions stated in mm; general tolerance DIN ISO 2768 -mK



# Connection assignment

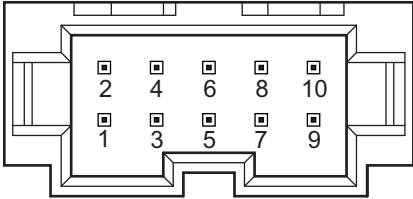
## Socket – power supply

Plug-in contacts 2-pole	Pin	Signal identifier	
	1	GND	Ground
	2	U <sub>B</sub>	Supply voltage

Mating connector not included in the scope of supply.

Recommendation: Connector manufactured by Samtec IPD1-02-S-K, with crimp contacts: CC79L-2024-01-L

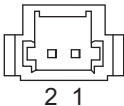
## Socket – signals

Plug-in contacts 10-pin	Pin	Signal identifier	
	1	PSOUT	Differential signal +SIN
	2	PCOUT	Differential signal +COS
	3	NSOUT	Differential signal -SIN
	4	NCOUT	Differential signal -COS
	5	CLOCK+	Clock signal in accordance with RS 485
	6	Reserved	<b>Do not use!</b>
	7	CLOCK–	Clock signal in accordance with RS 485
	8	PRES	Preset input
	9	DATA–	SSI differential data signal in accordance with RS 485
	10	DATA+	

Mating connector not included in the scope of supply.

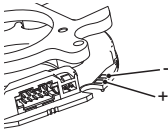
Recommendation: Connector manufactured by: Samtec ISD2-05-D-M, with crimp contacts: CC81-2426-01-L

## Socket – battery connection (2311\_B0\_\*\*\*\*)

Plug-in contacts 2-pin	Pin	Signal identifier	
	1	GND	Ground
	2	U <sub>Bat</sub>	Battery voltage

Recommendation: Connector manufactured by *TE Connectivity*, item number 353293-2

## Solder pads – battery connection (2311\_A1\_\*\*\*\*)

Solder contacts 2-pole	Pole	Signal identifier	
	+	U <sub>Bat</sub>	Battery voltage
	-	GND	Ground

**Notes:**

**Notes:**



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