



GEL 235 with synchronous serial interface (SSI)



GEL 235 with bus cover

General

- ▶ Absolute rotary encoder with a maximum total resolution of 28 bits in a compact design
- ▶ Encoder series includes single turn variants with up to 16-bit resolution and multiturn variants with up to 12-bit resolution
- ▶ Magneto-resistive scanning of a ferromagnetic steel disc provides unambiguous position values at every angular position via digital interfaces
- ▶ Evaluation based on Vernier principle
- ▶ Optionally with stainless steel housing

Features

- ▶ 28-bit total resolution
- ▶ Mechanical gear
- ▶ High accuracy $\pm 0.08^\circ$
- ▶ SSI, analogue interface 4 to 20 mA
- ▶ PROFIBUS-DP, CANopen, EtherCAT
- ▶ Sin/cos signals
- ▶ Operating temperature -40°C to $+100^\circ\text{C}$
- ▶ Protection class up to IP 67

Advantages

- ▶ Suitable for all standard applications and also for real heavy-duty applications
- ▶ Full function in case of condensation:
dew-point resistant!
- ▶ Extremely resilient housing made of anodised aluminium, stainless steel variant available
- ▶ Not affected by dirt or oil mist
- ▶ Withstands very high shock and vibration loads as well as acceleration forces

Field of application

- ▶ General mechanical engineering
- ▶ Regenerative energies
- ▶ Mobile machines

Description

Construction and design

The resilient encoder housing with a standard flange size of 58 mm is made of anodised aluminium and can be supplied alternatively in stainless steel. Due to the compact design, the housing length for the single turn and multiturn variants is only 50 mm (encoder with synchronous serial interface).

The double-bearing encoder shaft forms a robust mechanical unit with the metal code disc. The multiturn variant operates with a mechanical gear.

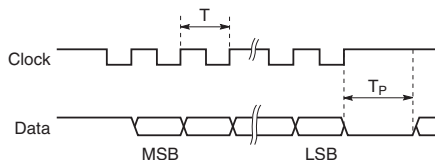
A uniform temperature coefficient on all rotating components ensures the temperature behaviour of the absolute rotary encoder is stable over the long-term.

Sensing principle

The GEL 235 is based on contactless magnetic scanning of a ferromagnetic steel code disc, the so-called contour disc. Magnetoresistive (MR) sensors scan three tracks, delivering corresponding sinusoidal signals. The phase position of the three sinusoidal signals is unambiguous within a single turn. The phase position is evaluated on the Vernier principle, providing the absolute position with high resolution and accuracy.

The basic encoder supplies the position values in binary or gray code via a synchronous serial interface, (SSI).

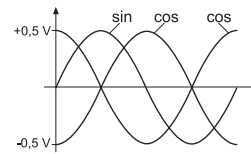
The synchronous serial interface transfers the position data at a clock frequency of up to 2 MHz. Prior to further position sampling, a minimum clock pulse space of 16 μ s must be met.



Principle of the serial data transmission [gray code (25 bits), RS 422 / RS 485 standard]

- f > 62.5 kHz
- T Length of the clock signal period (= 1/clock frequency)
- T_p Clock pulse space, between the clock sequences T_p At least 16 μ s

In addition, for real-time control sin/cos differential signals that can be highly interpolated with 1 V_{pp} signal level are output.



Sin/cos differential signal with 64 periods/turn that can be highly interpolated, clockwise looking at the encoder shaft

Temperature ranges

High precision SMD components are used in the absolute rotary encoder. Despite careful selection, thermal ageing of these components cannot be excluded. For this reason the encoder should be stored at a temperature from -40 °C to +85 °C.

Operating temperatures of -40 °C to +105 °C are allowed, an installed absolute rotary encoder is not allowed to exceed this temperature range. The function of the absolute rotary encoder is ensured within the operating temperature range allowed, (DIN 32878); here it is the temperature at the encoder housing that applies.

The temperature of the absolute rotary encoder is affected by the installation situation (thermal conductance, thermal radiation), the heating caused by the absolute rotary encoder (bearing friction, electrical power loss) and the ambient temperature. The operating temperature may be higher than the ambient temperature depending on the operation of the absolute rotary encoder.

Depending on the supply voltage the heating caused by the encoder can be up to 10 °C. At high operating speeds > 5,000 min⁻¹ the heating caused by the encoder can be up to 20 °C due to the bearing friction.

If the absolute rotary encoder is operated close to the limits of the specifications allowed, the ambient temperature must be reduced by suitable means (cooling) such that the operating temperature range allowed is not exceeded.

Interfaces

With the aid of the attachment of bus covers, the absolute rotary encoder can be incorporated into a CANopen, EtherCAT, or PROFIBUS-DP network. Integrated rotary selection switches for encoder ID and data rate, a terminating resistor that can be switched in as required, as well as diagnostics LEDs aid quick commissioning.

It is also possible to output current signals via a configurable 4 to 20 mA interface in a bus cover.

CANopen

EtherCAT®

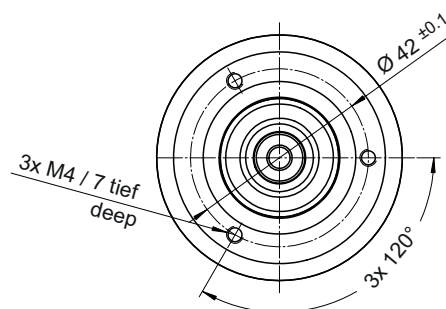
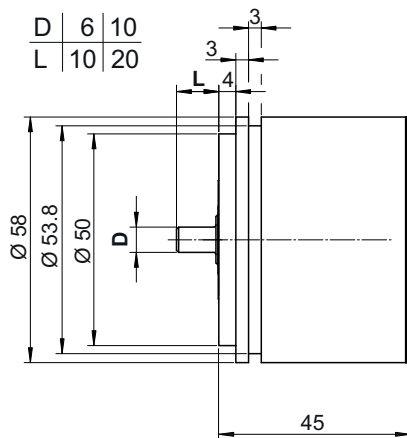
PROFI®
PROCESS FIELD BUS
BUS

General	
Incremental deviation	< 0.01°
Accuracy	± 0.08°
Electrical data	
Supply voltage (with reverse voltage protection)	10 to 30 V DC; optional 5 V - 5%, +25%
Power consumption	< 1.6 W, without load
Resolution Singleturn (ST)	8, 9, 10 to 16 Bit (measuring steps over 360°)
Resolution Multiturn (MT)	4, 8, 12 Bit (revolution, mechanical gear)
Interface	SSI, PROFIBUS Encoder Profile V 1.1, EtherCAT (CoE), CANopen Encoder Profile DS406, analogue 4 to 20 mA
Analogue output signal	Sin/Cos difference signal 1 V _{PP} , 64 periods per resolution
Mechanical data	
Moment of inertia of rotor	611.8 · 10 ⁻⁶ kgm ²
Material	anodised aluminium, stainless steel 1.4104
Weight Singleturn	aluminium: 300 g; stainless steel: 600 g
Weight Multiturn	aluminium: 310 g; stainless steel: 620 g
Operating speed (limit value) Singleturn	12,000 min ⁻¹
Operating speed (limit value) Multiturn	10,000 min ⁻¹ , 12,000 min ⁻¹ (short-term)
Operating torque	< 3 Ncm
Bearing life cycle	> 10 ⁵ at 1000 min ⁻¹
Shaft sealing ring (optional)	Material: Viton, protection class: IP 67, reduced operating speed: max. 6,000 min ⁻¹
Ambient data	
Working temperature range	-40 °C to +85 °C
Operating temperature range	-40 °C to +105 °C
Storage temperature range	-40 °C to +85 °C
Protection class	IP 64, IP 67 (optional)
Vibration protection (DIN EN 60068-2-6)	200 m/s ² , 10 to 2,000 Hz
Shock protection (DIN EN 60068-2-27)	2000 m/s ² , 11 ms
EMC	EN 61000-6-1 to -4
Insulation strength	Ri > 1 MΩ at 500 V AC
Relative humidity of air max.	99 %
Condensation	permissible, according to DIN EN 60068-2-30 Part 2 of 1999
Clamping flange	
Shaft load (radial/axial)	at 1,000 min ⁻¹ = 160 N / 80 N, at 6,000 min ⁻¹ = 100 N / 80 N
Synchro flange	
Shaft load (radial/axial)	at 1,000 min ⁻¹ = 70 N / 50 N, at 6,000 min ⁻¹ = 50 N / 40 N
Semi hollow shaft	
Shaft load (radial/axial)	at 1,000 min ⁻¹ = 100 N / 20 N, at 6,000 min ⁻¹ = 40 N / 20 N

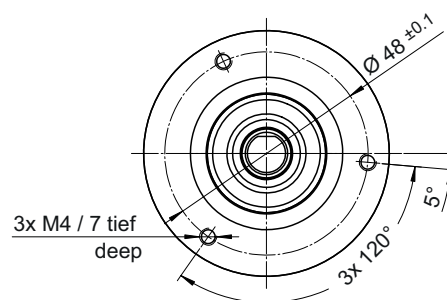
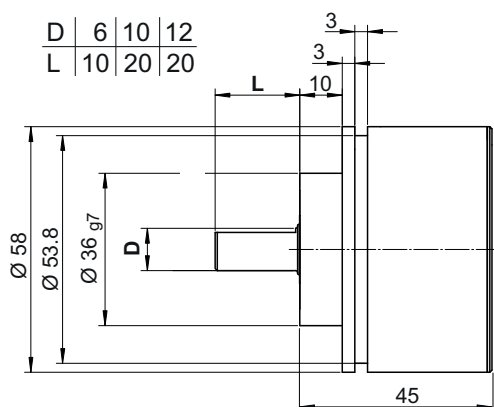
Dimensional drawings

Dimensional drawings GEL 235 – flange versions

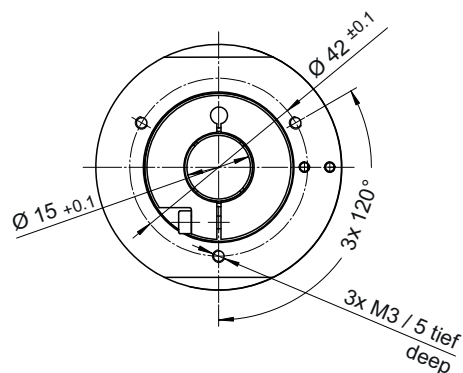
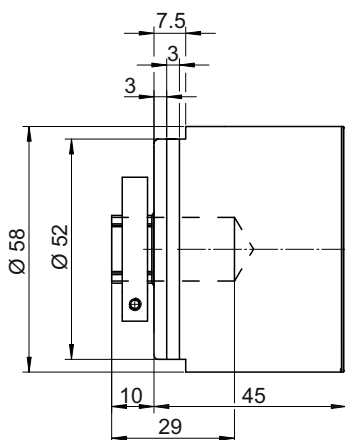
Synchro flange



Clamping flange



Semi hollow shaft ⁽¹⁾



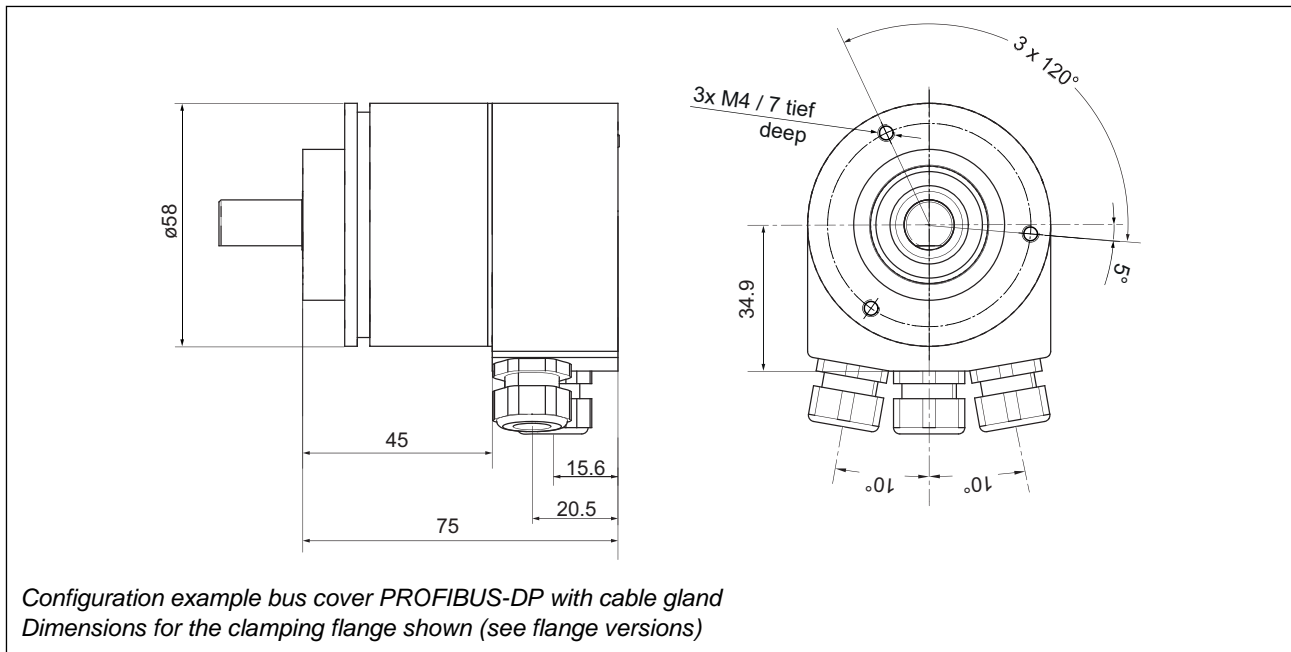
all dimensions stated in mm

For encoders with synchronous serial interface the external dimensions will vary depending on the electrical interface (see [Dimensions of the electrical connections for synchronous serial interface encoders](#)).

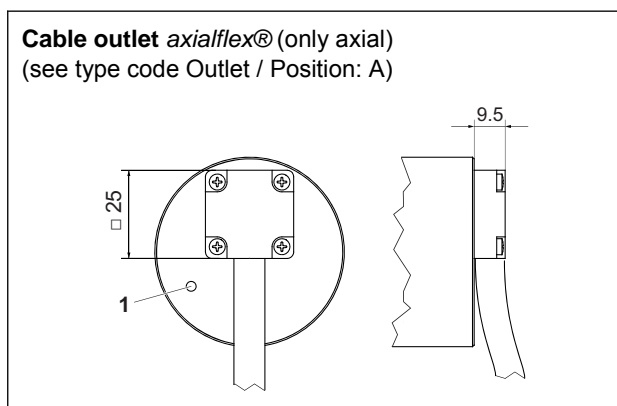
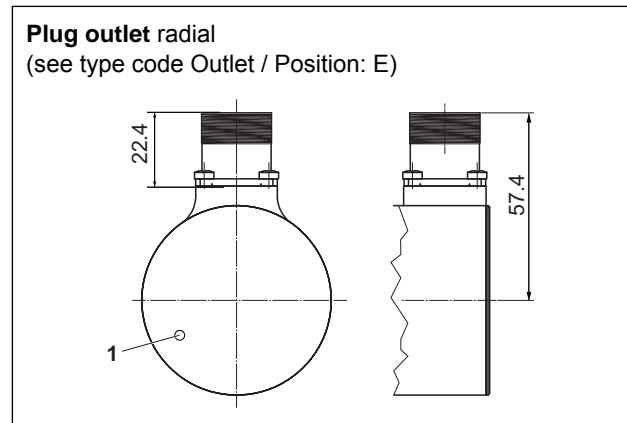
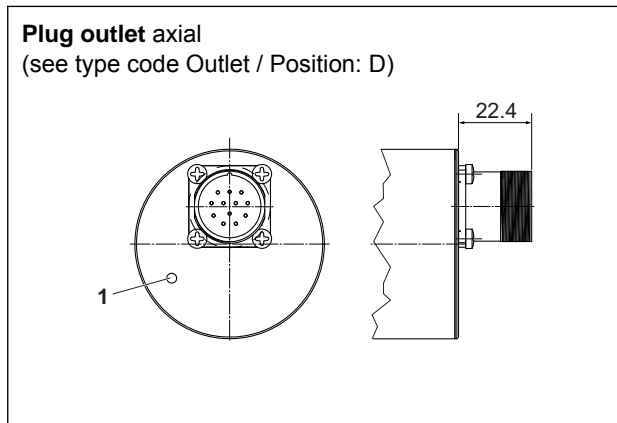
⁽¹⁾ Diameter of drive shaft: 15 f7

Dimensional drawings

Dimensional drawing GEL 235 with bus cover



Dimensions of the electrical connections for synchronous serial interface encoders



1 PRESET push-button (for synchronous serial interface)

Encoder with synchronous serial interface (SSI)

Synchronous serial interface

Direction of rotation

The encoder can output increasing position values on the clockwise or counter clockwise rotation of the shaft. The direction of rotation can be selected by using the CW/CCW input (counting direction).

Position values on the clockwise rotation of the shaft

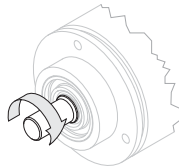
Standard:

GND on CW/CCW

or not connected: Increasing pos. ↑

Inverse:

V_S on CW/CCW: Reducing pos. ↓



Cable length

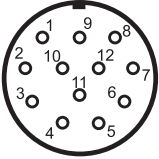
With the synchronous serial interface protocol the transmission rate allowed drops with increasing cable length. A screened, twisted pair cable is recommended for the signal cables (\pm CLOCK and \pm DATA).

Cable length [m]	< 50	< 100	< 200	< 400
Clock frequency [kHz]	< 400	< 300	< 200	< 100

PRESET function

The output signals can be set to a PRESET value from any position. As supplied the encoder is set to half the maximum resolution. The PRESET is set electronically if the supply voltage V_S is briefly $t > 100$ ms applied to the PRESET input (do NOT apply continuously). As an alternative there is a PRESET push-button recessed into the base of the housing (IP 67). The PRESET push-button can be operated using a pin ($t > 100$ ms). Other PRESET values are available on request.

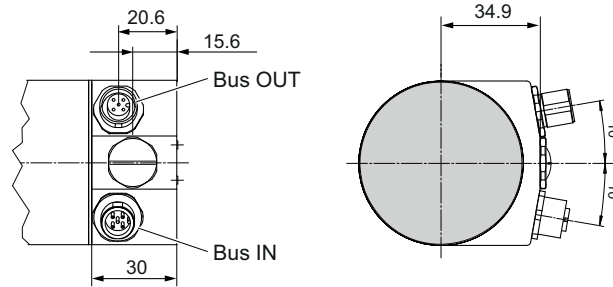
Pin layout

	Pin	Cable	Signal	Description
	1	blue	GND	Earth
	2	brown	DATA+	Output: Differential data signal in accordance with RS 485
	3	grey-pink	CLOCK+	Input: Differential clock signal in accordance with RS 485
	4	yellow	SIN-	Output: 64 periods / 360° differential signal 1 V_{pp}
	5	green	SIN+	
	6	violet	COS-	
	7	black	COS+	
	8	red	V_S	supply voltage
	9	pink	Preset	Set measuring range zero or centre
	10	white	DATA-	Output: Differential data signal in accordance with RS 485
	11	red-blue	CLOCK-	Input: Differential clock signal in accordance with RS 485
	12	grey	CW/CCW	Direction of rotation (CW = GND (default); CCW = V_S)
	Screen			

Technical data SSI

Output code	binary, gray
Driver	RS 485 compatible
Clock frequency	max. 2 MHz
Transmission	Max. 1,200 m depending on transmission rate
The immunity to interference	high immunity to interference via symmetrical transmission
Direction of rotation	adjustable, standard clockwise (CW) with view on the encoder shaft, increasing position values
Preset	about input level, optional with pushbutton
Cable	halogen-free PUR (6 x 2 AWG, shielded)

Bus cover for CANopen



Configuration example with M12 connector (cable gland similar)

Pin layout – CANopen

M12 connector

A-coded

IN OUT

Pin/socket layout

Pin	Bus IN	Bus OUT
1	Screen	Screen
2	+V _S IN	+V _S OUT
3	GND	GND
4	CAN_H	CAN_H
5	CAN_L	CAN_L

Settings

Baud rate	Position
1 Mbit/s	9
800 kbit/s	8
500 kbit/s	7
250 kbit/s	6
125 kbit/s	5
100 kbit/s	4
50 kbit/s	3
—	2
—	1
Autobaud	0

Bus cover with cable gland – internal view

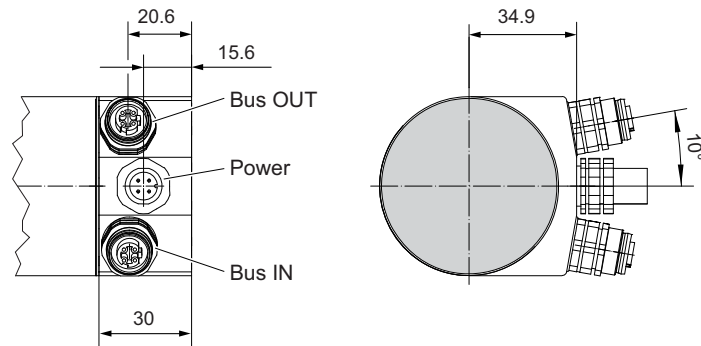
- 1 Bus IN
- 2 Baud rate
- 3 Bus address
- 4 Terminal strip
- 5 Encoder interface
- 6 Bus terminating resistor
- 7 Bus OUT

No.	Identifier
1	CAN_H
2	CAN_L
3	GND
4	+V _S OUT
5	CAN_H
6	CAN_L
7	GND
8	+V _S IN

Technical data CANopen

Device profile	CANopen DS406 with additional function
Cable diameter	8 mm
Connection	Bus cover as T-coupler either with cable gland or M12 connector, diagnostics LED, I/O electrically isolated (inductive coupling)
Programmable parameters	Resolution, PRESET, offset, counting direction, speed, acceleration and rotational speed output, range output referred to pre-defined values, scalable number of steps (decimal/binary)
Output code	Binary
Baud rate	50 kbit/s to 1 Mbit/s can be set via bus master or rotary selection switch
Sensor ID	0 ... 99, can be set via rotary selection switch
Terminating resistor	Switchable via bus cover (both DIP switches set to ON)
Operating temperature	-40 to +85 °C (shorttime 100 °C)

Bus cover for EtherCAT

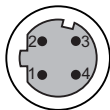


Configuration example with M12 connectors

Pin layout – EtherCAT

M12 connector

D-coded

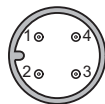


Socket layout

Pin	Bus IN	Bus OUT
1	Transmis- sion Data+	Transmis- sion Data+
2	Receive Data+	Receive Data+
3	Transmis- sion Data-	Transmis- sion Data-
4	Receive Data-	Receive Data-

POWER

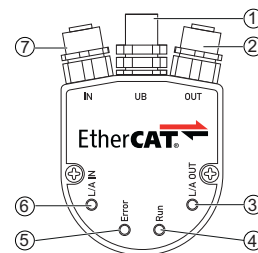
A-coded



Pin layout

Pin	Power UB
1	+V _S
2	–
3	GND
4	–
Pin 2 is GND	

Rear view

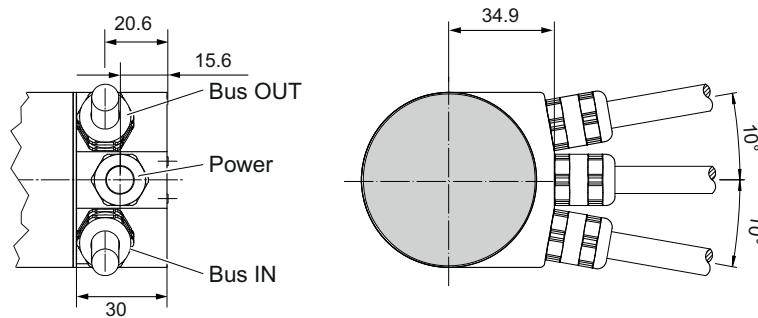


- 1 Power connector
- 2 Bus OUT connector
- 3 (Green) bus output function LED
- 4 Ready LED (green)
- 5 Absolute rotary encoder operating state LED (green/red)
- 6 Bus input function LED (green)
- 7 Bus IN connector

Technical data EtherCAT

Device profile	CoE (CANopen over EtherCAT) DS 406
Connection	Bus cover as T-coupler with D-coded M12 connectors and diagnostics LED
Programmable parameters	Scaling PRESET Speed and acceleration
Sensor ID	Automatic address assignment
Operating temperature	-40 to +85 °C

Bus cover for PROFIBUS-DP



Configuration example with cable gland (M12 connector similar)

Pin layout – PROFIBUS-DP

M12 connector

B-coded

IN OUT

Pin	Bus IN	Bus OUT
1	–	–
2	A	A
3	–	–
4	B	B
5	Screen	Screen

POWER

A-coded

Pin	Power
1	+V _S
2	–
3	GND
4	–

Bus cover with cable gland – internal view

1 Bus voltage power

2 Bus IN

3 Bus address

4 Terminal strip

5 Encoder interface

6 Bus terminating resistor

7 Bus OUT

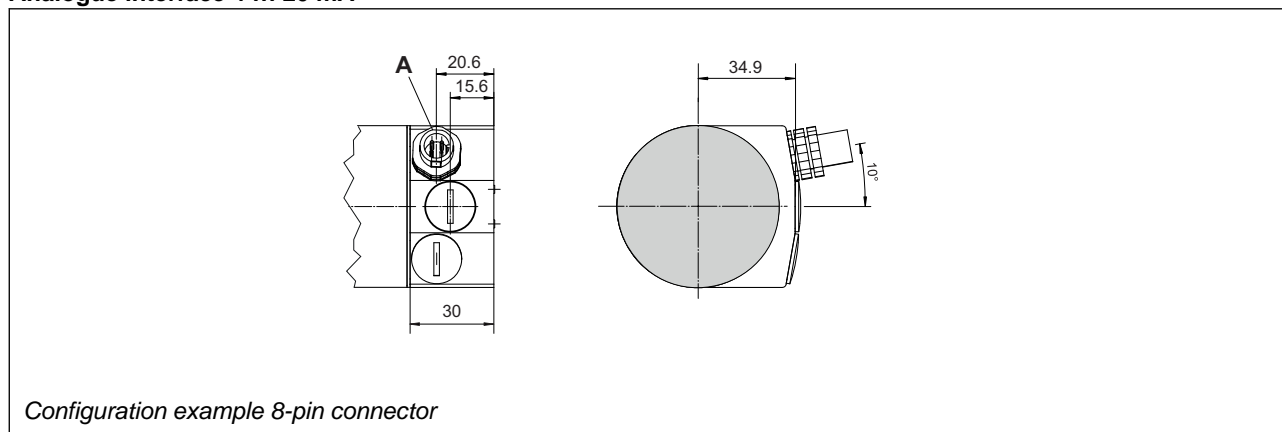
No.	Identifier
1	B OUT
2	A OUT
3	GND
4	+V _S OUT
5	B IN
6	A IN
7	GND
8	+V _S IN

Technical data PROFIBUS-DP

Device profile	Encoder profile V 1.1
Cable diameter	8 mm
Connection	Bus cover as T-coupler either with cable gland or M12 connector, diagnostics LED, I/O electrically isolated (inductive coupling)
Programmable parameters	Resolution, PRESET, offset, counting direction, speed, acceleration and rotational speed output, scalable number of steps
Output code	Binary
Baud rate	9.6 kbit/s to 12 Mbit/s can be set via bus master
Sensor ID	Automatic address assignment
Terminating resistor	Switchable via bus cover (both DIP switches set to ON)
Operating temperature	-40 to +85 °C (shorttime 100 °C)

Connection cover for analogue interface

Analogue interface 4 ... 20 mA



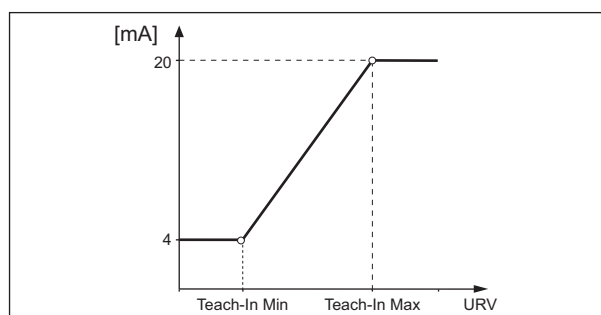
Direction of rotation

The encoder can output increasing current values on the clockwise or counter clockwise rotation of the shaft. The counting direction can be determined by using the CW/CCW input (see SSI interface → [page 6](#)).

To define the signal, on reaching the teach-in min. and the teach-in max. position a supply voltage is applied to the related signal inputs for min. 100 ms. These positions are saved in non-volatile memory in the rotary encoder.

Teach-in function

The teach-in function is the commissioning function for the GEL 235 with analogue interface. Using this function the entire measuring range (EMR) can be defined between two freely configurable min. and max. points.



Pin layout – analogue interface

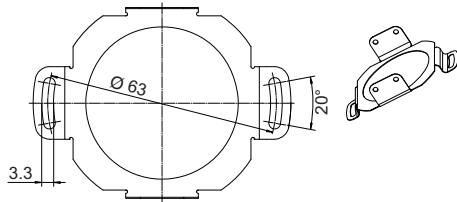
Pin	Signal	Note
1	GND	Earth connection
2	n. c.	
3	T-Low	Teach-in min.
4	T-High	Teach-in max.
5	AOUT	Analogue output (current)
6	GND A	Analogue earth
7	V _S	Supply voltage
8	CW/CCW	Direction of rotation (CW = GND (default); CCW = V _S)

8-pin connector A-coded

Technical data analogue interface

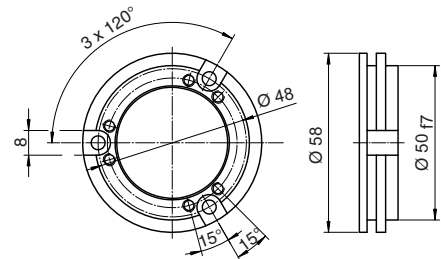
Internal resolution	65,536 steps per turn, 4,096 turns
Resolution of the interface	16 bits (0.244 μ A) in the range 4 to 20 mA
Measuring range	Max. 28 bits
Accuracy of the interface	15 μ A typical (25 °C)

Torque support FB23504



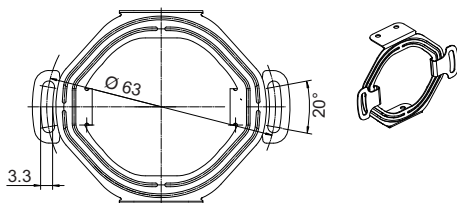
Mounting flange MF23501

(adapter for radial outlet rotated by 15°)



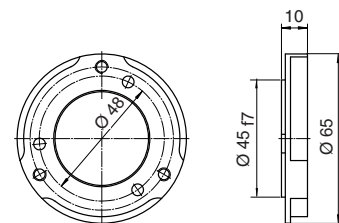
Torque support FB23505

(standard with semi hollow shaft)

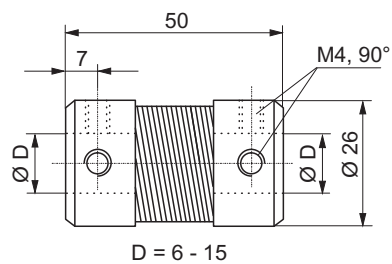


Mounting flange MF23502

(adapter on 65 mm flange)

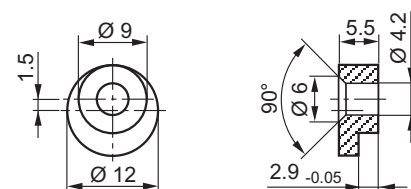


Metal coupling MK12

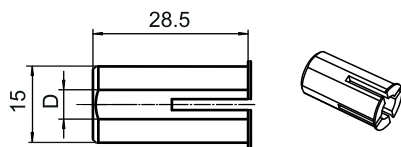


Clamping elements KL200

(3 pieces)

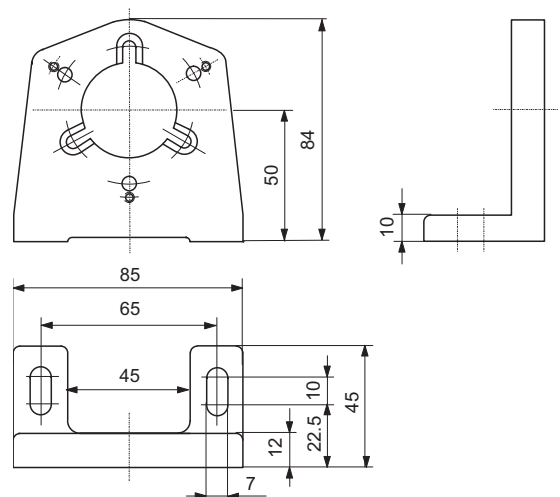


Bushing



Order no.		D
POM	Brass	
RH 23501	RH 23504	8 mm
RH 23502	RH 23505	10 mm
RH 23503	RH 23506	12 mm

Mounting bracket MW 52



Accessories

Ordering overview for mounting accessories

Description	Item number
Torque support, hard ¹	FB 23504
Torque support, soft ¹	FB 23505
Bushing, 8 mm, POM (polyoxymethylene)	RH 23501
Bushing, 10 mm, POM (polyoxymethylene)	RH 23502
Bushing, 12 mm, POM (polyoxymethylene)	RH 23503
Bushing, 8 mm, brass	RH 23504
Bushing, 10 mm, brass	RH 23505
Bushing, 12 mm, brass	RH 23506
Mounting flange	MF 23501
Mounting flange	MF 23502
Metal coupling (St), inside diameter: 6 to 15 mm (state shaft diameter)	MK 12
Mounting bracket for rotary encoder	MW 52

⁽¹⁾ As standard the semi hollow shaft for the GEL 235 is supplied with a soft torque support FB23505 mounted. If the alternative torque support FB23504 is to be mounted, this must be stated on the order.

Ordering overview for connection accessories

Description	Item number
CANopen connection cable 10 m, 5-pin plug / flying lead with ferrules	BK 2100
CANopen connection cable 2 m, 5-pin plug / flying lead with ferrules	BK 2101
CANopen connection cable 10 m, 5-pin socket / flying lead with ferrules	BK 2102
CANopen connection cable 2 m, 5-pin socket / flying lead with ferrules	BK 2103
CANopen connecting cable 10 m, 5-pin socket/plug	BK 2104
CANopen connecting cable 2 m, 5-pin socket/plug	BK 2105
PROFIBUS-DP, mating connector 5-pin socket, B-coded	FS 3016
PROFIBUS-DP, mating connector 5-pin plug, B-coded	FS 3017
PROFIBUS-DP Bus power connection cable 2 m, 4-pin plug A-coded / flying lead with ferrules	FS 3018
PROFIBUS-DP Bus power connection cable 10 m, 4-pin plug A-coded / flying lead with ferrules	FS 3019
CANopen, mating connector 5-pin socket, A-coded	FS 3020
CANopen, mating connector 5-pin plug, A-coded	FS 3021
PROFIBUS-DP connection cable 10 m, 5-pin plug / flying lead with ferrules	FS 3024
PROFIBUS-DP connection cable 10 m, 5-pin socket / flying lead with ferrules	FS 3025
PROFIBUS-DP connection cable 2 m, 5-pin plug / flying lead with ferrules	FS 3026
PROFIBUS-DP connection cable 2 m, 5-pin socket / flying lead with ferrules	FS 3027
PROFIBUS-DP connecting cable 2 m, 5-pin socket/plug	FS 3028
CANopen terminating resistor M12	FS 3040
EtherCAT, mating connector 4-pin plug, D-coded	FS 3039
Power supply bus cover ⁽¹⁾ , mating connector M12, 4-pin. socket, A-coded	FS 3056
12-pin mating connector for SSI, straight	GG 126
12-pin mating connector for SSI, angled	GW 126
8-pin M12 mating connector for analogue interface	FS 1352

⁽¹⁾ e.g. EtherCAT, PROFIBUS-DP

Type code GEL 235

	Interface
AN	Analogue output
CO	CANopen DS 406
DP	PROFIBUS DP
EC	EtherCAT
SB	SSI binary
SG	SSI Gray
TB	SSI binary 5 V
TG	SSI Gray 5 V
	Resolution per revolution
08	8 bit, 256 steps/revolution
09	9 bit, 512 steps/revolution
10	10 bit, 1024 steps/revolution
11	11 bit, 2048 steps/revolution
12	12 bit, 4096 steps/revolution
13	13 bit, 8192 steps/revolution
14	14 bit, 16384 steps/revolution
15	15 bit, 32768 steps/revolution
16	16 Bit, 65536 steps/revolution
	Number of revolutions
00	Only singleturn (ST)
04	04 bit, 16 revolutions
08	08 bit, 256 revolutions
12	12 bit, 4096 revolutions
	Flange, Shaft
A	Clamping flange, D = 6 / L = 10 mm
B	Clamping flange, D = 10 / L = 20 mm
C	Synchro flange, D = 6 / L = 10 mm
D	Synchro flange, D = 10 / L = 20 mm
E	Semi hollow shaft, D = 15 / T 25 mm
F	Clamping flange, D = 12 / L = 20 mm
	Outlet / Position (electrical interface)
A	Cable cap axialflex®, axial (SSI)
D	12-pole connector outlet, Typ M 23, axial (SSI)
E	12-pole connector outlet, Typ M 23, radial (SSI)
K	CANopen, bus cap with cable gland
L	CANopen, bus cap with connector outlet
Q	PROFIBUS DP, bus cap with cable gland
P	PROFIBUS DP, bus cap with connector outlet
S	Connection cap, 4 to 20 mA with M12-connector outlet
T	EtherCAT, bus cap with M12-connector outlet
	Cable length
B	1 meter cable length
C	3 meter cable length
D	5 meter cable length
E	10 meter cable length
S	Connector outlet / without cable
	Protection class, Preset-pushbutton
1	Protection class IP 64
2	Protection class IP 64, Preset-pushbutton
3	Protection class IP 67
4	Protection class IP 67, Preset-pushbutton
	Option
0	None
2	Stainless steel

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Restriction of the type code for stainless steel

Feature	Possible variant
Interface	SG, SB, CO, DP
Resolution per turn	No restriction
Number of turns multiturn	No restriction
Flange, shaft	B, D, E, F
Outlet / Position (electrical interface)	K, Q
Cable length	No restrictions
IP class, PRESET push-button	3, 4 (only SG, SB)

You will find the significance of the code in the type code overview. Stainless steel rotary encoders must always have a '2' as the last character of the type code. The dimensional drawings for the stainless steel variants are the same as the standard variants.

Restriction of the type code for GEL 235 (standard)

Feature	Possible variant
PRESET push-button	SG, SB, TB, TG
Resolution per turn with EtherCAT	Single turn 16 bits Multiturn 0 or 12 bits



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