



General

- ▶ Absolute encoder with a total resolution up to 28 bit
- ▶ Measuring scale: metallic code disc
- ▶ Evaluation: nonius-principle

Features

- ▶ High resolution 28 bit
- ▶ Mechanical gear
- ▶ High accuracy $\pm 0,08^\circ$
- ▶ SSI, PROFIBUS DP, CANopen, 4 to 20 mA
- ▶ Sin/Cos differential signal
- ▶ ATEX zone 2/22 and stainless steel versions

Advantages

- ▶ Compact design
- ▶ Dew-point-proof
- ▶ Operating temperature from -40°C up to $+105^\circ\text{C}$
- ▶ Protection class up to IP 67

Fields of application

- ▶ General engineering
- ▶ Renewable energy
- ▶ Mobile work machine

General informationen

General

The absolute rotary encoder series GEL 235 delivers for each angular position a unique position value via a digital interface with a resolution up to 28 bit. The absolute rotary encoder series includes Singleturn (ST) with up to 16 bit and Multiturn (MT) with 12 bit resolution via a mechanical gear.

Compact design

With a standard flange size of 58 mm the housing length for ST and MT with mechanical gear is less than 50 mm.

Robuste construction

- ▶ Resilient anodised aluminium housing, double-bearings
- ▶ The 12 mm steel encoder shaft and the steel code disc form a single robust unit
- ▶ The temperature coefficient of all rotating parts is uniform
- ▶ Withstands high shock and vibration levels and high acceleration rates

Nonius-Algorithm (Vernier-Algorithm)

The measurement principle of the GEL 235 is based on the magnetic scanning of a code disc made of ferro-magnetic steel, the so called nonius-disc. Magneto-Resistive sensors scan three tracks and deliver three corresponding sinusoidal signals. The phase relation of those three sinusoidal signals is unique with one revolution. Based of the Nonius-principle this phase relation is evaluated and delivers with high resolution and accuracy the absolute position.

Magnetic measuring principle

The magneto-resistive scanning of a ferro-magnetic steel-disc offers significant advantages:

- ▶ suitable for all standard application and furthermore for Real-Heavy-Duty use
- ▶ withstands high shock / vibration level
- ▶ not influenced by dirt or oil mist
- ▶ long term stable temperature characteristics
- ▶ full functionality in the presence of condensation:
dew-point-proof
- ▶ no aging of the magnetic sensor elements
- ▶ withstand aggressive media

Interface

The absolute rotary encoder supplies the position values in a binary or gray code by use of a fast SSI-interface. In addition high interpolateable Sin/Cos differential signals with 1 V_{pp} are delivered. The programming of code, resolution, counting direction and Preset values is optionally possible. With 28 bit resolution and a high data rate up to 2 MHz for SSI mode even highly dynamic motion processes are well controllable. A connectable bus-cap enables the profiles CANopen DS 406 and PROFIBUS DP ENCODER PROFIL V1.1. Integrated rotary selectors for the encoder ID and data rate, a switchable on terminal resistor and diagnostic LEDs supports a fast startup.



With additional bus caps all mechanical variants of the GEL 235 can be used for the fieldbus profiles CANopen and PROFIBUS DP.

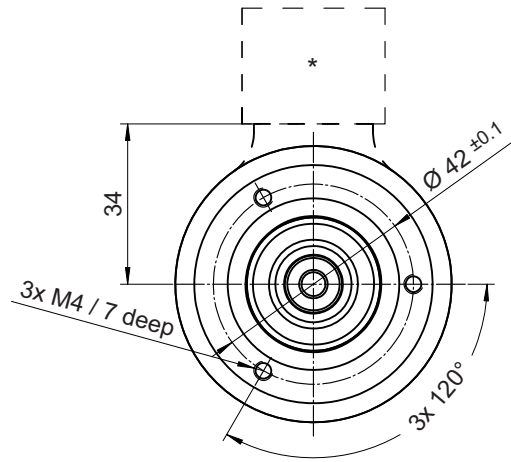
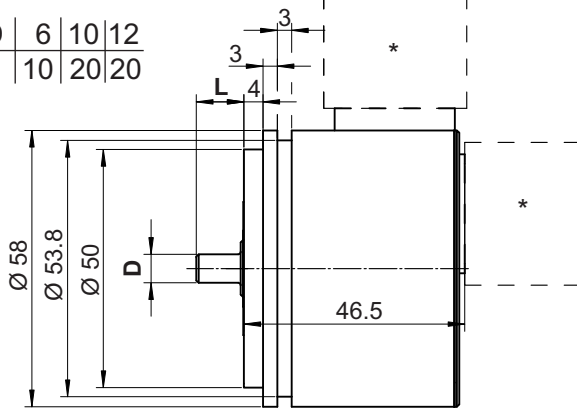
Technical data

General	
Incremental deviation	< 0.01°
Accuracy	± 0.08°
Electrical data	
Operating voltage	10 to 30 V DC with reverse voltage protection (option: 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, CANopen Encoder Profile DS406, 4–20 mA
Analogue output signal	Sin/Cos difference signal 1 V _{pp} , 64 periods per resolution
Mechanical data	
Moment of inertia of the rotor	611.8·10 ⁻⁶ kgm ²
Clamping flange	Distance contact point : 5 mm Shaft load (radial/axial) at 1,000 min ⁻¹ = 160 N / 80 N, at 6,000 min ⁻¹ = 100 N / 80 N
Synchro flange	Distance contact point: 10 mm 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	Distance contact point: 1 mm Shaft load (radial/axial) at 1,000 min ⁻¹ = 100 N / 20 N, at 6,000 min ⁻¹ = 40 N / 20 N
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 time)
Operating torque	< 3 Ncm
Bearing life cycle	> 10 ⁶ bei 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 +100 °C
Operating temperature range	-40 °C to +105 °C (120 °C short time)
Storage temperature range	-40 °C to +85 °C (depending on packing)
Protection class	IP 64, IP 67 (optional)
Vibration protection (IEC 68, 2-6)	200 m/s ² , 10 to 2,000 Hz
Shock protection (IEC 68, 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.	100 %
Condensation permissible	yes

Dimensioned drawing basic encoder GEL 235

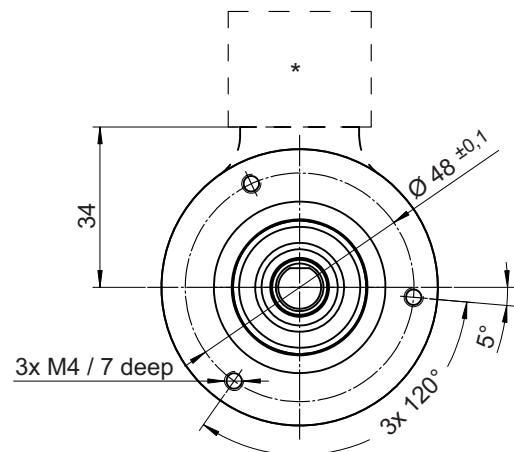
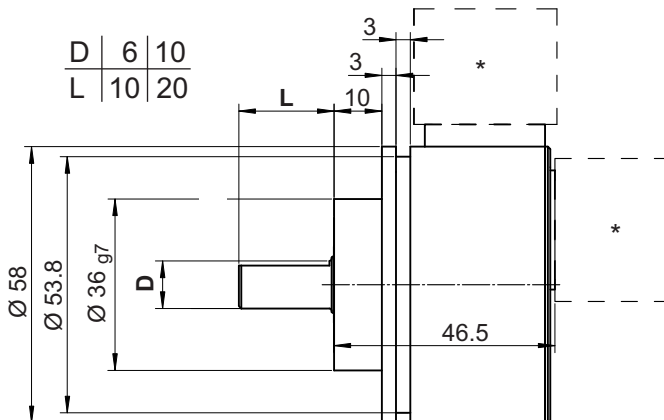
Synchro flange

D	6	10	12
L	10	20	20

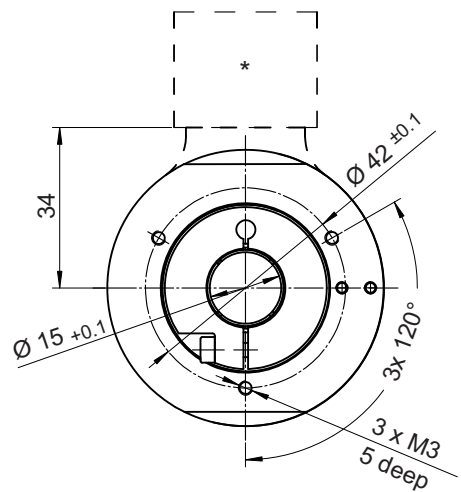
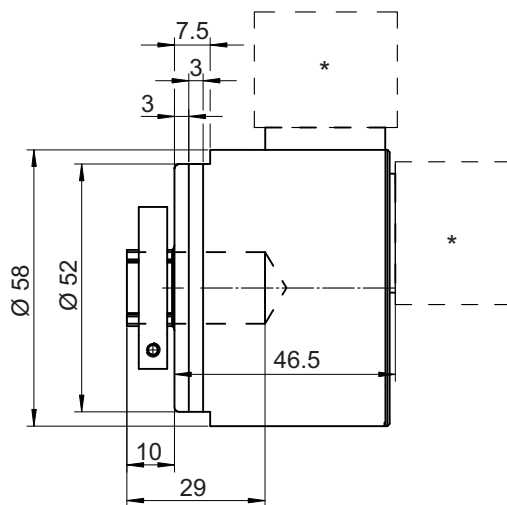


Clamping flange

D	6	10
L	10	20



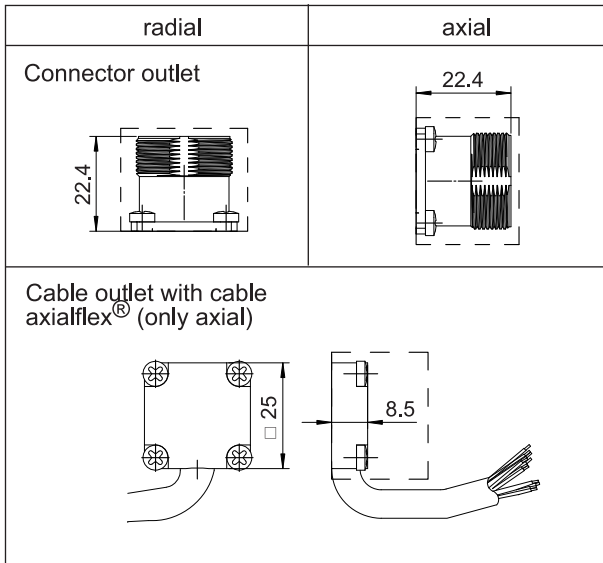
Semi hollow shaft



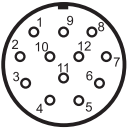
* see connection variants of the next page.

Pin layout SSI, Sin/Cos

Connector- or cable outlet



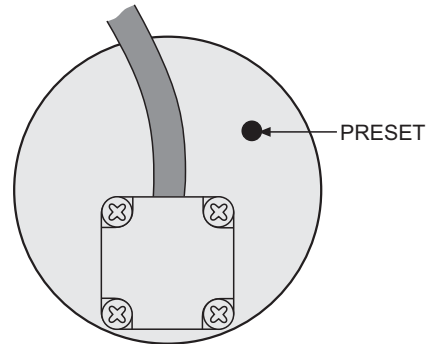
Connector- or cable layout



Pin	Signal	Colour (Cable outlet)	Description
1	GND	blue	Mground connection
2	Data+	brown	difference data signal according to RS 485
3	Clock+	grey / pink	difference data signal according to RS 485
4	-Sin	yellow	64 periods / 360° difference signal 1 V _{PP}
5	+Sin	green	
6	-Cos	violet	
7	+Cos	black	
8	V _S	red	operating voltage
9	Preset	pink	electronic adjustment V _S ; t > 100 ms
10	Data-	white	difference data signal according to RS 485
11	Clock-	red / blue	difference data signal according to RS 485
12	CW/CCW	grey	counting direction CW = GND (Default) CCW = V _S
	Shield		

PRESET adjustment SSI

At any given rotary position the output signals can be set to preset values. As default the singleturn is to set 2^{n-1} and the multiturn is set to half of its maximum value. The preset can be set electrically by applying V_S to the Preset line for t > 100 ms (do not apply permanently). Alternatively, a preset push-button is optionally available, recessed in the encoder base (IP 67). This is to be pushed with a blunt pin for t > 100 ms. By using the optional parameter kit, the preset values can be freely defined.

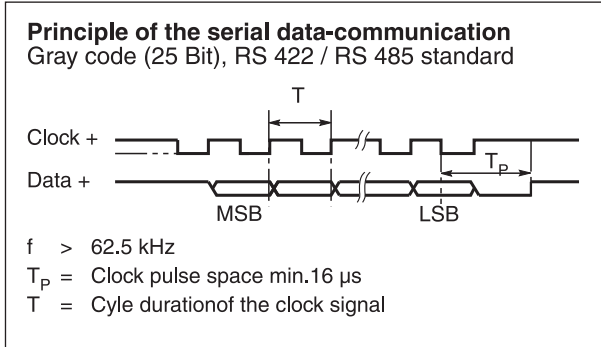


Counting direction

With view on the encoder shaft the position value increases by rotating the shaft clockwise (CW) (default setting). By applying V_S permanently to the CW/CCW line the position value will increase when rotating the shaft counter-clockwise.

- CCW = increasing position values while turning the encoder shaft clockwise
- CW = increasing position values while turning the encoder shaft counter-clockwise

The absolute rotary encoder GEL 235 transmits its position data via a fast Synchron-Seriell-Interface (SSI) with up to 2 MHz data rate using binary or Gray Code. With increasing data rate the allowed cable length using the SSI mode decreases (see table cable length) and a minimum pause time of 16 μ s is necessary before the next request for position data can be started.



Cable length

Using SSI protocol the allowed data rates are reduced as the cable length increases. It is recommended that the wires of Clock \pm and Data \pm are each in twisted pair configuration each while the cable is shielded.

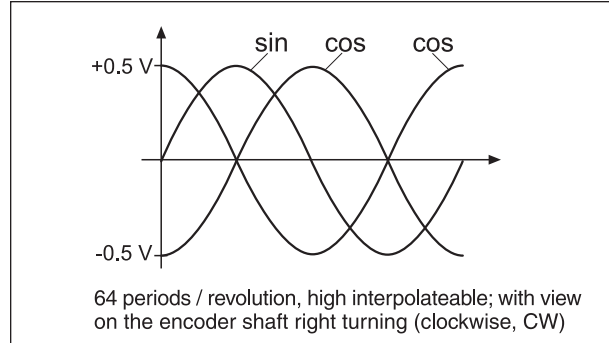
cable length / m	clock rate / kHz
< 50	< 400
< 100	< 300
< 200	< 200
< 400	< 100

Technical data SSI

Output code	binary, gray
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)

Sin/Cos differential signal

For realtime control high interpolateable Sin/Cos differential signals 1 V_{pp} are supported.



Temperature range

The storage temperature of -40°C up to 85°C is restricted by the packaging material. A operating temperature range from -40°C up to 100°C is permissible, in which a mounted encoder is not allowed to exceed this temperature range. Within the allowed operating temperature range the functionality of the absolute rotary encoder is assured (DIN 32878), specifically when the temperature is measured at the encoder housing.

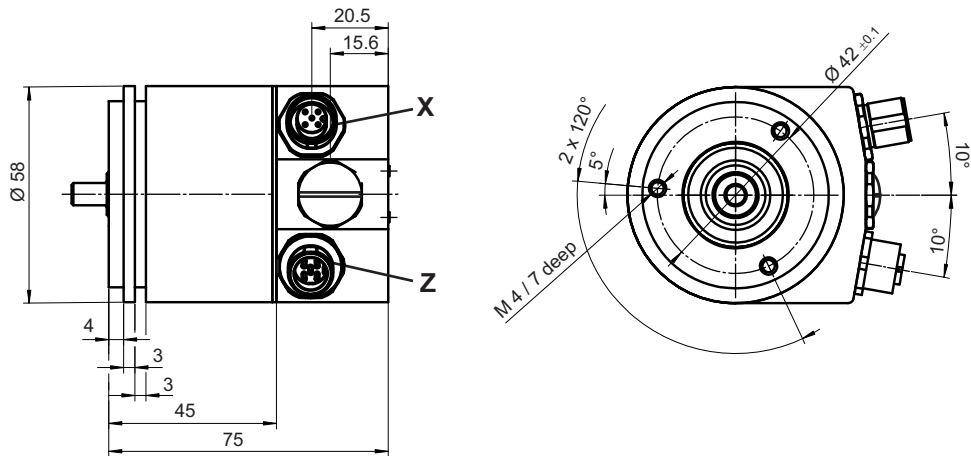
The encoder temperature is affected by the installation conditions (thermal conduction, thermal radiation), the self-heating (bearing friction, electrical power dissipation) and the environmental temperature.

Depending on the operating conditions of the encoder, the working temperature of the encoder can be higher than the environmental temperature.

Depending on the power supply from 5 V DC to 30 V DC a self-heating of up to 10°C can occur. At high rotation speeds $> 5000 \text{ min}^{-1}$ a self-heating caused by bearing friction of up to 20°C is possible. If the encoder is operated close to its maximum permissible specifications several parameters can affect encoder self-heating. In this case the environmental temperature has to be reduced by suitable methods (cooling) to ensure that the maximum permissible working temperature is not exceeded.

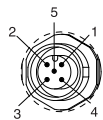
GEL 235 Bus cap for CANopen

(Example: Synchro flange with connector outlet; other flange and cable gland analogue)



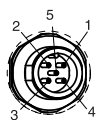
Pin layout CANopen M12 connector and cable outlet

Detail X
M 2 : 1
coded A

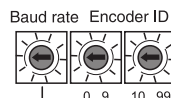


Detail X connector connection	
Pin	BUS OUT
1	Screen
2	+U _B _OUT
3	GND
4	CAN_H
5	CAN_L

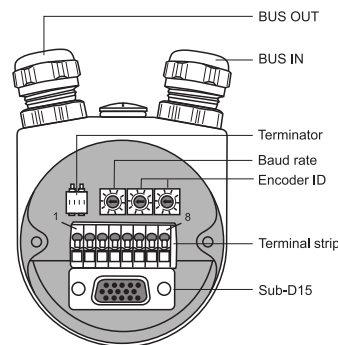
Detail Z
M 2 : 1
coded A



Detail Z socket connection	
Pin	BUS IN
1	Screen
2	+U _B _IN
3	GND
4	CAN_H
5	CAN_L



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



Terminal strip	Signal
1	CAN-H
2	CAN-L
3	GND
4	+U _B _OUT
5	CAN-H
6	CAN-L
7	GND
8	+U _B _IN

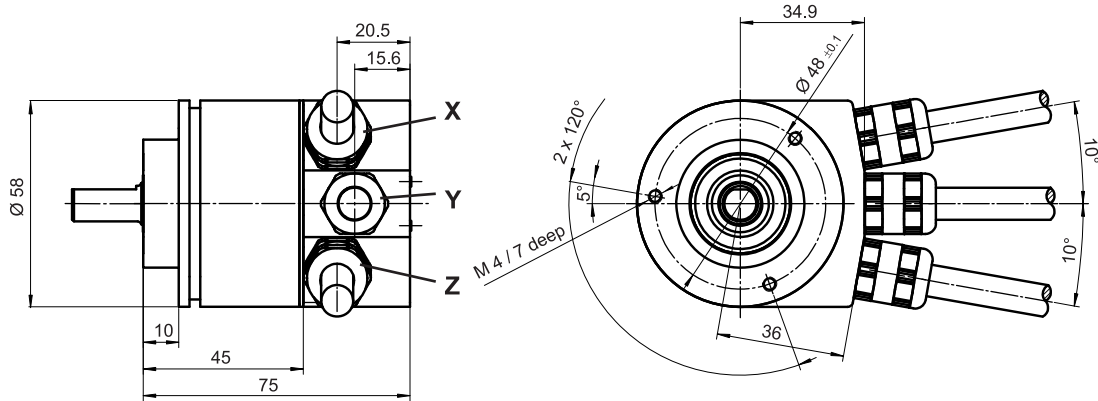
Technical data CANopen

Interface	CANopen DS 406 with additional function
Cable diameter	8 mm
Connection	Via bus cap as T-Connector, alternatively cable gland or M12 plug, diagnostics LED, I/O DC-isolated (inductive coupling)
Programmable function	Resolution, Preset, offset, counting direction, speed output, acceleration output, output of work areas relative to determined values, scalable step number (decimal/binary)
Output code	binary
Data rate	50 kBit/s to 1 MBit/s adjustable via bus master or rotary selector
Sensor-ID	0 to 99 adjustable via bus master
Terminal resistor	Switchable via bus cap (both DIP-switches at ON)
Operating temperature	-40 °C to 85 °C (short time 100 °C)

PROFIBUS DP

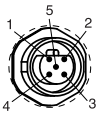
GEL 235 Bus cap for PROFIBUS DP

(Example: clamping flange with cable gland; other flange and M12 connector comparable)



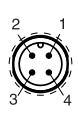
Pin layout PROFIBUS DP with M12-connector

Detail X
M 2 : 1
coded B



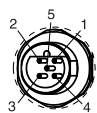
Pin	BUS OUT
1	-
2	A
3	-
4	B
5	Shield

Detail Y
M 2 : 1
coded A

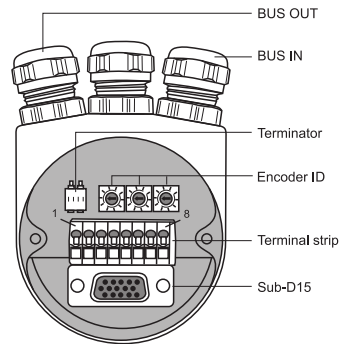


Pin	POWER
1	+V _S
2	-
3	GND
4	-

Detail Z
M 2 : 1
coded B

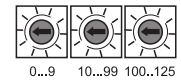


Pin	BUS IN
1	-
2	A
3	-
4	B
5	Shield



terminal strip	signal
1	B OUT
2	A OUT
3	GND
4	+U _B OUT
5	B IN
6	A IN
7	GND
8	+U _B IN

Encoder ID



Technical data PROFIBUS DP

Interface	PROFIBUS DP , Encoder Profile V 1.1
Cable diameter	8 mm
Connection	Via bus cap as T-Connector, alternatively cable gland or M12 plug, diagnostics LED, I/O DC-isolated (inductive coupling)
Programmable function	Resolution, Preset, offset, counting direction, speed output, acceleration output, output of work areas relative to determined values, scalable step number (decimal/binary)
Output code	Binary
Data rate	9.6 kBit/s up to 12 MBit/s adjustable via bus master
Sensor-ID	1 to 125 adjustable via rotary selector
Terminal resistor	Switchable via bus cap (both DIP-Switchers at ON)
Operating temperature	-40 °C to 85 °C (for short time 100°C)

Analogue interface 4 to 20 mA

Counting direction

With view on the encoder shaft the position value increases by rotating the shaft clockwise (CW).

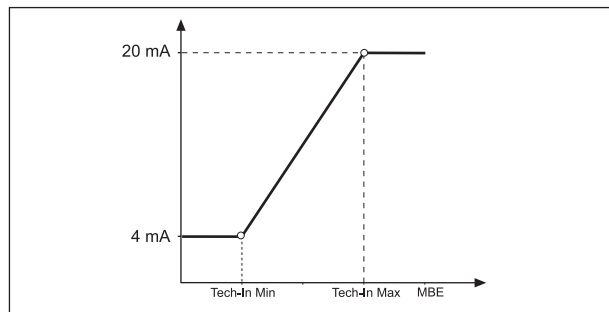
Note: The counting direction can not be changed by the user. If a different counting directing is necessary for the application please contact Lenord + Bauer or you local sales contact.

Teach-In function

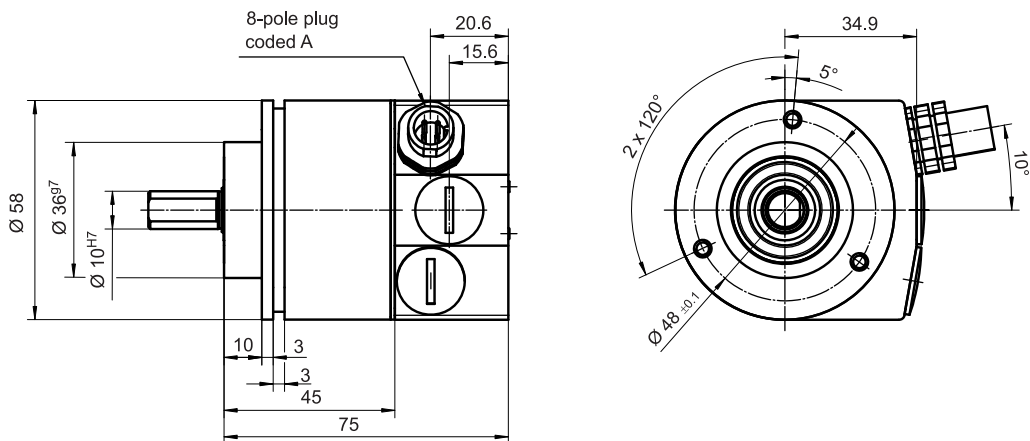
The Teach-In function is a special start-up function that can optionally be provided on the GEL 235. It can be used to position the entire measurement range between two freely chosen points. You specify the signal limits by applying a high signal for at least 100 ms to the appropriate signal inputs at the Teach-In min and Teach-In max positions.

These positions are then permanently stored in the encoder.

Pins that do not carry a signal must remain open or be earthed.



GEL 235 Bus cup for analogue interface



Technical data analogue interface

Resolution internal	65,536 step per revolution, 4,096 revolutions
Interface resolution	16 bit (0.244 μ A) in the range 4 to 20 mA
Measuring range	max. 28 bit
Interface accuracy	$\pm 15 \mu$ A typical (25 °C)

Pin assignment

PIN	Signal	Description
1	GND	Ground
2	n. c.	
3	T-Low	Teach-In Min.
4	T-High	Teach-In Max.
5	AOUT	Analogue output (current)
6	GND A	Analogue ground
7	VS	Operating voltage
8	n. c.	

GEL 235 Ex

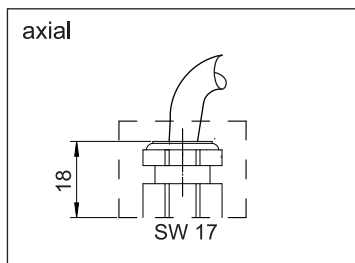
General information GEL 235 Ex

The absolute rotary encoder GEL 235 may be used only in zones 2 and 22. The mechanical and electrical values stipulated in the GEL 235 operating instructions – quantities such as temperature, maximum load current, maximum voltage and mechanical load – may on no account be exceeded. The GEL 235 may be operated only within its approved protection rating. The plant operator is obliged to perform a risk assessment, for which he or she will need to know the minimum flashpoint of any dust and dust/air mixtures that may be present.

The following evidence must be furnished: the maximum surface temperature of the plant may not exceed 2/3 of the minimum flashpoint of the ambient dust/air mixture. The maximum surface temperature of the equipment may not rise to within 75 K of the glow temperature of a thick layer of dust. Provided that all the mechanical and electrical values stipulated for the GEL 235 are complied with, the surface temperature of the housing will not be higher than +85°C. The maximum surface temperature measured at the cable connection is 80°C.

Mechanical data	
Material	anodised aluminium
Weight Singleturn	300 g
Weight Multiturn	310 g
Operating speed (limit value) Singleturn	6,000 min ⁻¹
Operating speed (limit value) Multiturn	6,000 min ⁻¹
Umgebungsdaten	
Working temperature range	-20 °C to 50 °C
Operating temperature range	-20 °C to 50 °C
Storage temperature range	-20 °C to 50°C
Explosion control	Ex II 3G Ex nA II T6 Ex II 3D Ex td A22 IP67 T85°C -20 °C ≤ Ta ≤ 50 °C

Cable connection (SSI interface)



Reduction of type code

Features	Possible variations
Interface	SG, SB, CO, DP
Resolution per revolution	no reduction
Revolution Multiturn	no reduction
Flange, Shaft	no reduction
Outlet, Position	B, K, Q
Cable length	no reduction
IP class, pushbutton	3, 4

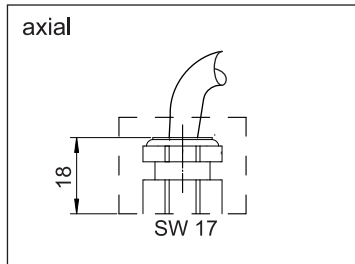
The significance of the type codes may be seen from the code overview provided. Explosion proof encoders must always have a 1 in the last position of the type code.

GEL 235 stainless steel

Technical data GEL 235 stainless steel

Mechanical data	
Material	stainless steel 1.4104
Weight singleturn	600 g
Weight multiturn	620 g

Cable connection (SSI interface)



Reduction of type code by stainless steel

Features	Possible variations
Interface	SG, SB, CO, DP
Resolution per revolution	no reduction
Revolution multiturn	no reduction
Flange, shaft	B, D, E, F
Outlet, position	B, K, Q
Cable length	no reduction
IP class, pushbutton	3, 4 (only SG, SB)

The significance of the type codes may be seen from the code overview provided. The stainless steel encoders must always have a **2** in the last position of the type code. The dimension drawing of stainless steel variants conform to standard variant.

Type code GEL 235

235	Interface	
	AN	Analogue output
	CO	CANopen DS 406
	DP	PROFIBUS DP
	SG	SSI Gray
	SB	SSI binary
	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	
Electrical interface		
A	Cable cap axialflex®, axial	
B	Cable gland, axial	
D	12-pole connector outlet, Typ M 23, axial	
E	12-pole connector outlet, Typ M 23, radial	
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	
Connector/Cable		
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	
1	Ex zone 2/22	
2	Edelstahl	

Reduction of type code by explosion proof

Features	Possible variations
Interface	SG, SB, CO, DP
Resolution per revolution	no reduction
Revolution Multiturn	no reduction
Flange, Shaft	no reduction
Outlet, Position	B, K, Q
Cable length	no reduction
IP class, pushbutton	3, 4

The significance of the type codes may be seen from the code overview provided. Explosion proof encoders must always have a **1** in the last position of the type code.

Reduction of type code by stainless steel

Features	Possible variations
Interface	SG, SB, CO, DP
Resolution per revolution	no reduction
Revolution multiturn	no reduction
Flange, shaft	B, D, E, F
Outlet, position	B, K, Q
Cable length	no reduction
IP class, pushbutton	3, 4 (only SG, SB)

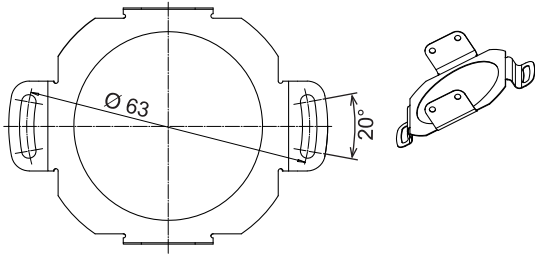
The significance of the type codes may be seen from the code overview provided. The stainless steel encoders must always have a **2** in the last position of the type code. The dimension drawing of stainless steel variants conform to standard variant.

Reduction of type code by GEL 235 (standard)

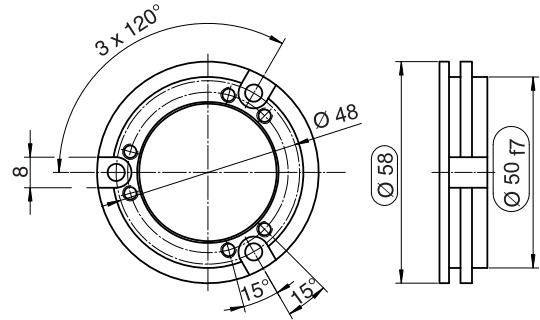
Features	Possible variations
PRESET pushbutton	SG, SB, TB, TG

Accessories GEL 235

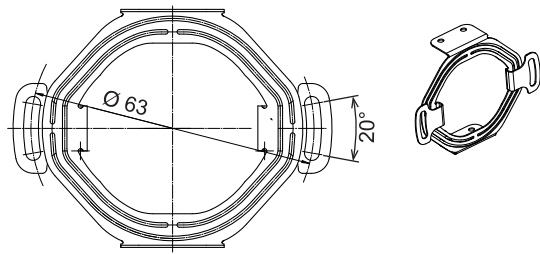
Torque support FB23504



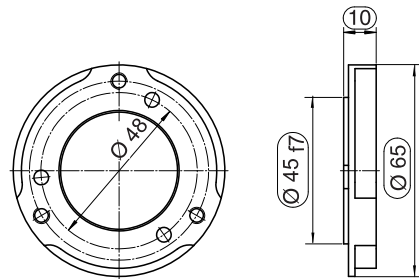
Mounting flange MF23501
(Adapter for 15° turned radial outlet)



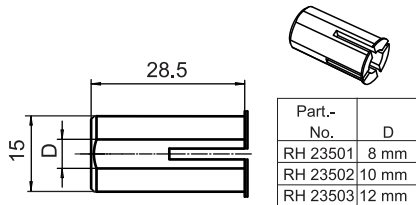
Torque support FB23505



Mounting flange MF23502
(Adapter for 65 mm flange size)



Bushing RH23501/23502/23503



Type code for GEL-235-specific/mounting material

Part number	Description
FB23504	Torque support, hard ¹
FB23505	Torque support, soft ¹
RH23501	Bushing, 8 mm, POM
RH23502	Bushing, 10 mm, POM
RH23503	Bushing, 12 mm, POM
RH23504	Bushing, 8 mm, brass
RH23505	Bushing, 10 mm, brass
RH23505	Bushing, 12 mm, brass
MF23501	Mounting flange
MF23502	Mounting flange
GG126	12-pole counter-connector for SSI, straight
upon request	12-pole counter-connector for SSI, 90° offset
upon request	8-pole M12 counter-connector for analogue interface

¹The GEL 235 with the flange option semi hollow shaft will be always delivered with the torque support FB 23505. If an alternative torque support (e.g. FB 23504) is needed it has to be mentioned on the order form.
For further accessories please look at our technical information for the encoder accessories program.

CANopen and PROFIBUS DP accessories

Order number	Description
BK 2100	CANopen connection cable 10 m, 5-pol. connector, open cable end with end splice
BK 2101	CANopen connection cable 2 m, 5-pol. connector, open cable end with end splice
BK 2102	CANopen connection cable 10 m, 5-pol. socket, open cable end with end splice
BK 2103	CANopen connection cable 2 m, 5-pol. socket, open cable end with end splice
BK 2104	CANopen connection cable 10 m, 5-pol. socket/connector
BK 2105	CANopen connection cable 2 m, 5-pol. socket/connector
FS 3016	Mating connector, 5-pol. socket, PROFIBUS DP, B-coded
FS 3017	Mating connector, 5-pol. connector, PROFIBUS DP, B-coded
FS 3020	Mating connector, 5-pol. socket, CANopen, A-coded
FS 3021	Mating connector, 5-pol. connector, CANopen, A-coded
FS 3024	PROFIBUS DP connection cable 10 m, 5-pol. connector, open cable end with end splice
FS 3025	PROFIBUS DP connection cable 10 m, 5-pol. socket, open cable end with end splice
FS 3026	PROFIBUS DP connection cable 2 m, 5-pol. connector, open cable end with end splice
FS 3027	PROFIBUS DP connection cable 2 m, 5-pol. socket, open cable end with end splice
FS 3028	PROFIBUS DP connection cable 2 m, 5-pol. Socket / connector
FS 3040	Terminal resistance CANopen M12

Subject to technical modifications and typographical errors.
The latest version can be downloaded at www.lenord.de.

