



General

The tandem encoder GEL 290 was specially developed for applications with high requirements on redundancy. Several independently operating encoders are mounted on the drive shaft as one unit. The length of the encoder system is reduced to a minimum by design measures. The tandem encoder is made up for each specific application.

The measuring scale on the rotary encoder used is of robust design so that it can even withstand extreme impacts and vibration. The magnetic sensors are resistant to harsh environmental conditions such as dirt, oil, humidity or condensation due to temperature differences. The rotary encoder contains bearings that ensure maintenance-free, durable operation in the harshest operating conditions.

Features

- ▶ Modular design
- ▶ Max. 3 systems
- ▶ Combination of incremental rotary encoder and absolute rotary encoder
- ▶ Resolution
 - Incremental rotary encoder 266240 increments per turn
 - Absolute rotary encoder 65536 steps per turn
- ▶ Degree of Protection (overall system) IP66

Advantages

- ▶ Solution individually tailored to the specific application
- ▶ Various signals redundant due to flexible design
- ▶ Maintenance-free, durable operation in harshest ambient conditions due to selected bearing and measuring systems

Field of application

- ▶ General mechanical engineering
- ▶ Process automation
- ▶ Wind power / regenerative energies

Description

Concept

The concept of the tandem encoder foresees the mounting of several independently operating encoders on one shaft. For this purpose, the encoders have been equipped with a continuous shaft or hollow shaft. In this way the requirements from process automation and process data acquisition for checking and safeguarding processes at the same time can be realised. The length of the encoder system has been kept as short as possible to permit trouble-free usage in practice.

Modular design

The tandem solution allows assembly of different encoders in a relatively short set.

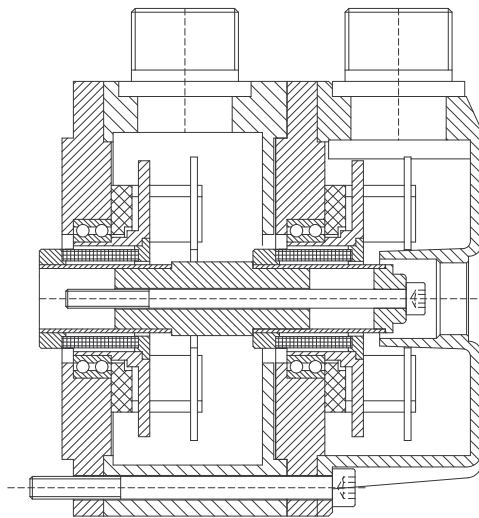
A central element of the tandem encoder is the incremental rotary encoder GEL 292, this device must be included at least once in each tandem system. The incremental rotary encoders are equipped with a flexibly mounted hollow shaft into which coupling elements with an accurate fit are inserted; in this way space is saved on fitting together the encoders.

The terminating element on a tandem encoder can be an incremental encoder with hollow shaft GEL 293 or an absolute rotary encoder with synchro-flange GEL 235.

The absolute rotary encoder GEL 235 is available with various interfaces and bus covers (see [Absolute rotary encoder GEL 235 – interfaces](#)).

The incremental rotary encoders GEL 292 and GEL 293 are technically identical and vary only in the housing design.

Various accessories are available for mounting the system (see [Accessories](#)).



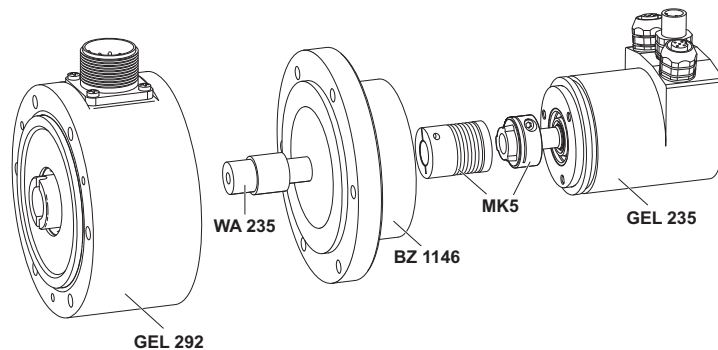
Sectional view of a tandem encoder with basic module GEL 292 and incremental rotary encoder GEL 293

Ordering information

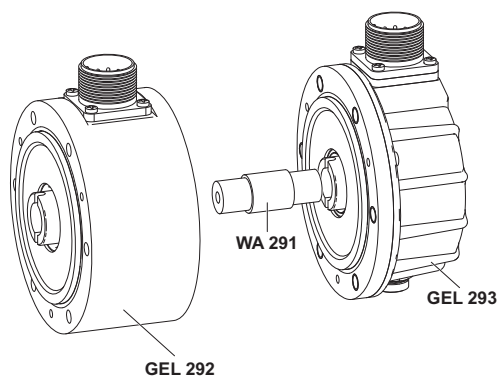
The type codes for the combined encoders must be stated on ordering the tandem (see [Type code](#)).

System combinations

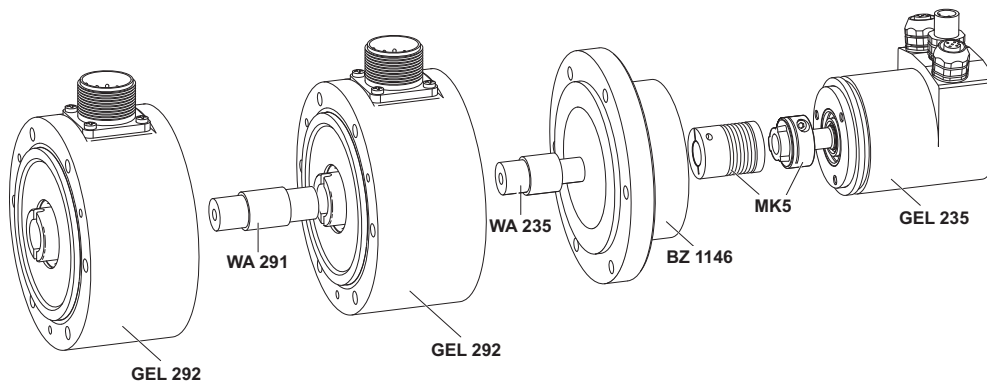
GEL 292 and GEL 235 inclusive accessories kit ZB2922



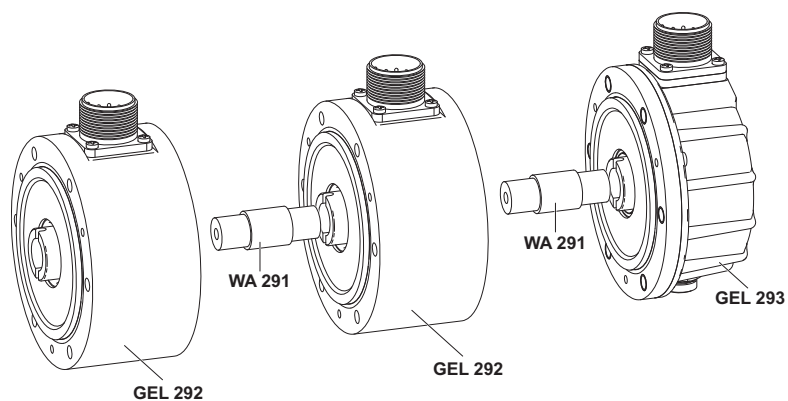
GEL 292 and GEL 293 inclusive accessories kit ZB2921



GEL 292, GEL 292 and GEL 235 inclusive accessories kit ZB2924



GEL 292, GEL 292 and GEL 293 inclusive accessories kit ZB2923



MK Coupling
WA Shaft adapter
BZ Intermediate flange

Technical data

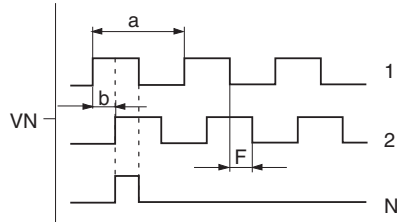
Technical data – incremental rotary encoder GEL 292 / 293

	T, TN	U, UN	S, SN	V, VN	X, XN
General					
Measuring range	40 to 266240 steps				
Accuracy	0.005°				
Electrical data					
Supply voltage V _S	5 V DC ± 5%	10 to 30 V DC			
Power consumption	≤ 1.3 W, without load				
Logik level	TTL		HTL		
Output level high	≥ V _S - 1.00 V at I = 10 mA; ≥ V _S - 1.20 V at I = 30 mA	4.00 V at I = 10 mA; ≥ 3.85 V at I = 30 mA	≥ V _S - 1.80 V at I = 10 mA; ≥ V _S - 2.20 V at I = 30 mA		
Output level low	≤ 0.75 V at I = 10 mA; ≤ 1.00 V at I = 30 mA		≤ 1.15 V at I = 10 mA; ≤ 1.55 V at I = 30 mA		
Mechanical data					
Moment of inertia of rotor	8 · 10 ⁻⁵ kgm ²				
Max. operating speed (r.p.m.)	8,000 min ⁻¹				
Weight	0.7 kg per system				
Admissible coupling offset axial radial	±1 mm ±0.5 mm				
Bearing life cycle at axial load	> 1.5 · 10 ⁹ revolutions				
Housing	stainless steel, X12CrMoS17-1,4104				
Ambient data					
Working temperature range	-20 °C to +85 °C				
Operating temperature range	-20 °C to +85 °C				
Storage temperature range	-40 °C to +105 °C				
Degree of Protection (EN 60529)	IP 66				
Vibration protection (DIN EN 60068-2-6)	100 m/s ² , 10 to 2000 Hz				
Shock protection (DIN EN 60068-2-27)	1000 m/s ² , 11 ms				
EMC	EN 61000-6-1 to 4				
Insulation strength (DIN EN 60439-1)	Ri > 1 MΩ at 500 V AC				

Output signals

Signal pattern V, VN

The "V" signal pattern refers to two tracks with square-wave signals offset by 90°. On the third track N a reference signal of defined length is output once per turn.

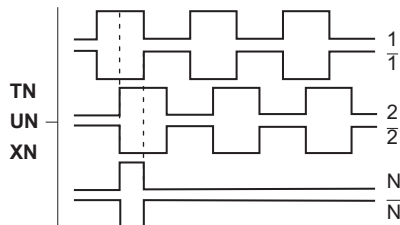


- a 360° electrical
- b 90° phase offset
- F Time between edges (at an output frequency of 200 kHz the time between the edges is $F > 0.6 \mu\text{s}$)

	$V_S^{(1)}$	$V_{out}^{(2)}$
V, VN	10 to 30 V DC	HTL

Signal pattern T, TN, U, UN, X, XN

The two pulse outputs and the reference signal are output as inverse signals.

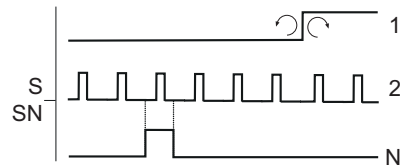


	$V_S^{(1)}$	$V_{out}^{(2)}$
T, TN	+ 5 V DC \pm 5 %	TTL
U, UN	10 to 30 V DC	TTL
X, XN	10 to 30 V DC	HTL

Signal pattern S, SN

Pulses independent of the direction of rotation and of constant duration are derived from the square-wave signals as per signal pattern V and output on the 2nd track. In addition, a signal dependent on the direction of rotation is obtained from the signal pattern (counting direction); it is output on the 1st track. On the third track N (option) a reference signal is output once per turn.

The pulses follow a possible change in the direction of rotation with a short delay so that any downstream counting circuit can be set to the counting direction prior to the pulse. The signal dependent on the direction of rotation can be inverted using a switch accessible from the exterior (switch 1).



	$V_S^{(1)}$	$V_{out}^{(2)}$
S, SN	10 to 30 V DC	HTL

Output signal level

The signal patterns S, SN, V, VN, X and XN have HTL levels, the signal patterns T, TN, U and UN have TTL levels. All outputs have a push-pull power amplifier and have sustained short circuit-protection. The peak output current for discharging the cable capacitance is 100 mA.

(1) Supply voltage

(2) Signal voltage

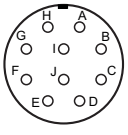
Technical data

Technical data – absolute rotary encoder GEL 235

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, 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
Weight Singleturn	300 g
Weight Multiturn	310 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	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 +100 °C
Storage temperature range	-40 °C to +85 °C
Degree of Protection (acc. to DIN 60529)	IP 67
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
Synchro flange	
Shaft load (radial/axial)	at 1,000 min ⁻¹ = 70 N / 50 N, at 6,000 min ⁻¹ = 50 N / 40 N

Incremental rotary encoder GEL 292 / 293 – interfaces

Connection assignment

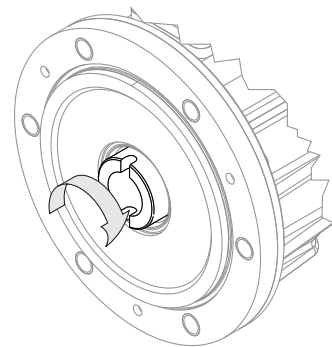
Signal	with plug connection type L	Description
	10-pin 	
U_B	F	Supply voltage
GND	A	Earth
1	C	Track 1
/1	H	Track 1, inverse
2	B	Track 2
/2	G	Track 2, inverse
N	D	Reference signal
/N	I	Reference signal, inverse
A/B/C	E	Current output
	J	Inversion of the direction

Inversion of the direction

The polarity of the current output option A can be reversed by the connection of pin J or green core. For encoders with signal pattern S, by reversing the measuring current the direction-dependent S signal is also reversed.

Polarity of the direction-dependent measurement current by clockwise rotation the shaft

Pin J / green core wired with		Polarity of current output A	S pattern (Track 1)
Low (GND)	Standard	positive	High
High (+ U_B)	Inversion of the direction	negative	Low



Absolute rotary encoder GEL 235 – interfaces

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

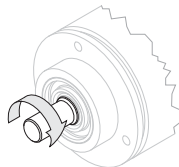
Standard:

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.

Connection assignment

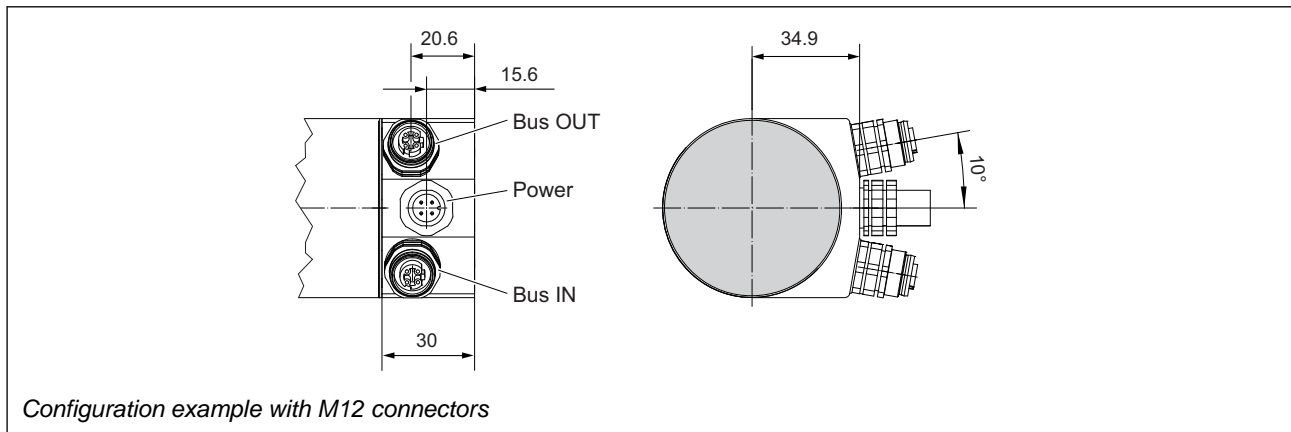
	Pin	Signal	Description
	1	GND	Earth
	2	DATA+	Output: Differential data signal in accordance with RS 485
	3	CLOCK+	Input: Differential clock signal in accordance with RS 485
	4	SIN–	Output: 64 periods / 360° differential signal 1 V_{pp}
	5	SIN+	
	6	COS–	
	7	COS+	
	8	V_S	Supply voltage
	9	Preset	Set measuring range zero or centre
	10	DATA–	Output: Differential data signal in accordance with RS 485
	11	CLOCK–	Input: Differential clock signal in accordance with RS 485
	12	CW/CCW	Direction of rotation; default = GND; reversal= V_S
	Screen		

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 or optional with pushbutton

Absolute rotary encoder GEL 235 – interfaces

Bus cover for EtherCAT



Pin layout – EtherCAT

M12 connector

D-coded

Socket layout

Pin	Bus IN	Bus OUT
1	Transmission Data+	Transmission Data+
2	Receive Data+	Receive Data+
3	Transmission Data-	Transmission 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)

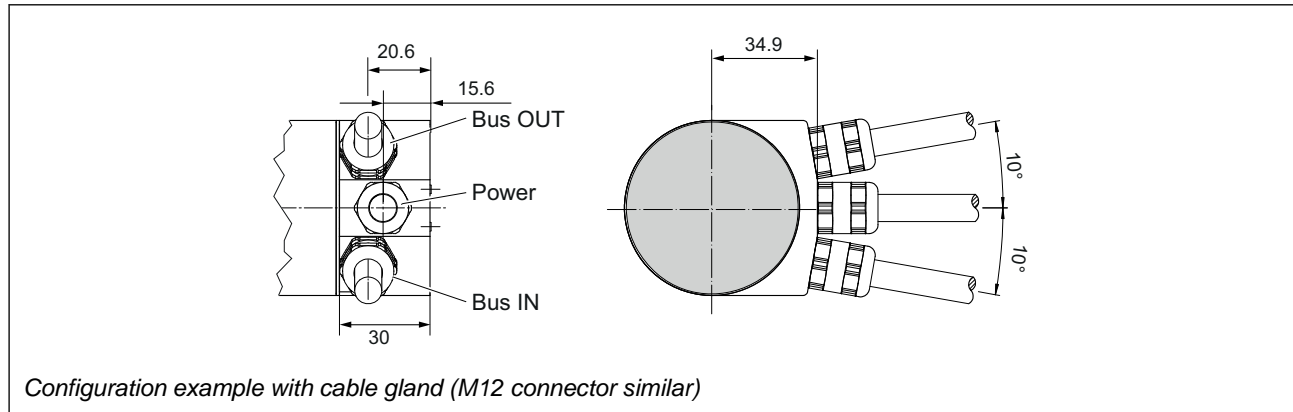
7 Bus IN connector

Technical data EtherCAT

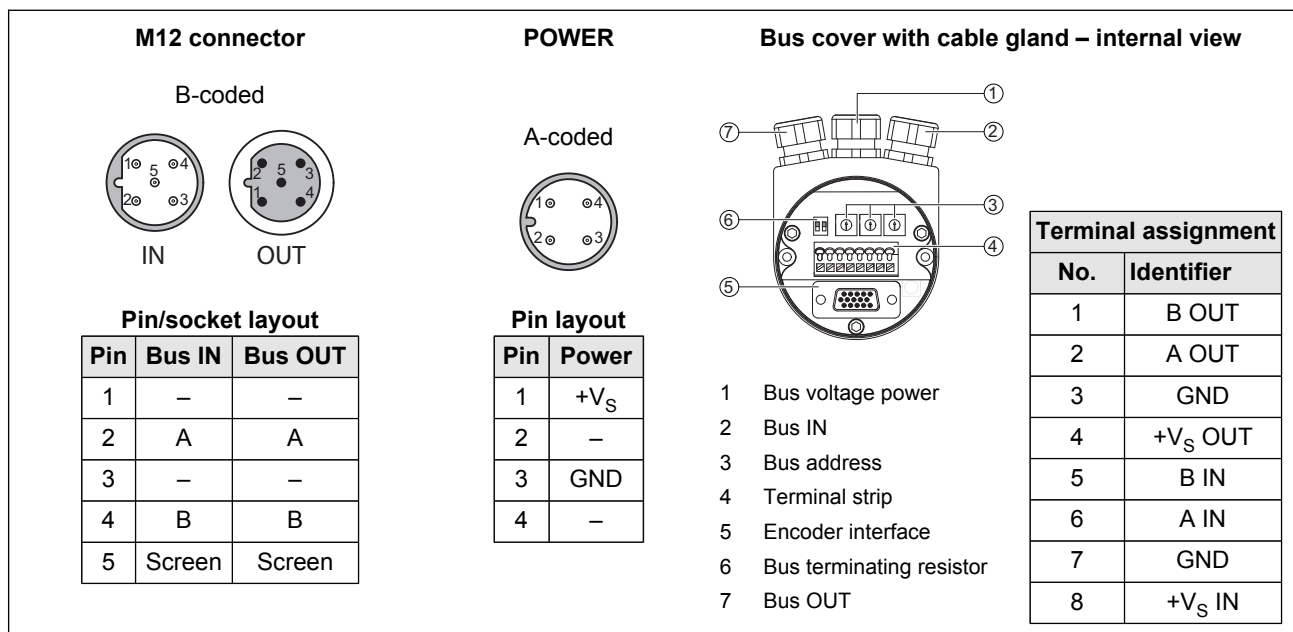
Device profile	CoE (CANopen over EtherCAT) DS 406
Connection	Bus cover as T-coupler with D-coded M12 connectors and diagnostics LED
Programmable parameters	Scaling PRESET Speed and acceleration
Sensor ID	Automatic address assignment
Operating temperature	-40 to +85 °C

Absolute rotary encoder GEL 235 – interfaces

Bus cover for PROFIBUS-DP



Pin layout – PROFIBUS-DP

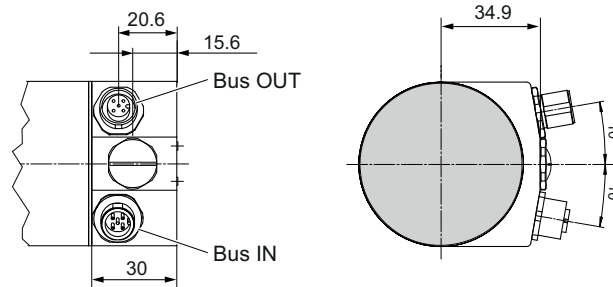


Technical data PROFIBUS-DP

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)

Absolute rotary encoder GEL 235 – interfaces

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

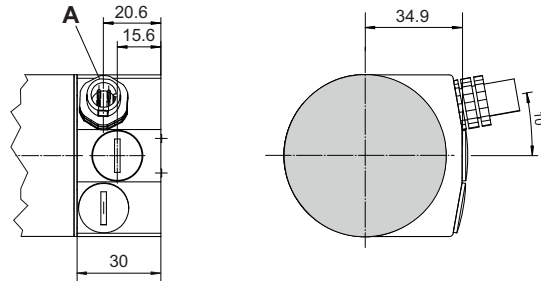
Technical data CANopen

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)

Absolute rotary encoder GEL 235 – interfaces

Connection cover for analogue interface

Analogue interface 4 ... 20 mA



Configuration example 8-pin connector

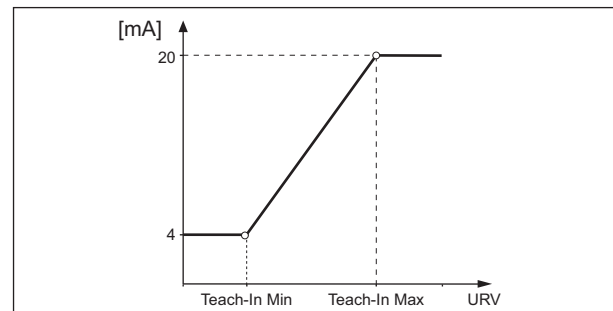
Direction of rotation

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 8](#)).

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	GNDA	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)

Type code – incremental rotary encoder GEL 292 / 293

292	Current output									
	– without									
	A -20 mA to + 20 mA									
	B 0 mA to + 20 mA									
	C +4 mA to + 20 mA									
	Signal pattern									
	S Output of constant pulses independent of the direction of rotation and a signal for counting direction (HTL)									
	V 2 square-wave signals shifted by 90° (HTL)									
	X 2 square-wave signals shifted by 90° and their inversed signals (HTL)									
	U 2 square-wave signals shifted by 90° and their inversed signals (TTL)									
	T 2 square-wave signals shifted by 90° and their inversed signals (TTL)									
	Reference signal									
	– without									
	N with reference signal									
	Possible pulse numbers per revolution									
	0000 00040 to 266240									
	Connector / cable outlet									
	L 10-pole connector, straight									
	Shaft design									
	0 Standard (16 mm hollow shaft)									
	Protection of electronics									
	3 moisture and vibration protection									
	Temperature range									
	2 -20 °C to +85 °C ⁽¹⁾									

Mating connector GG 106 is included in the scope of supply depending on the rotary encoder configuration.

Connection accessories

Description	Item number
GG 106 Mating connector ⁽²⁾ , 1 1/8-18UNEF-2A thread, 10 pole, straight, IP 65	BS 1112
GW 106 Mating connector, 1 1/8-18UNEF-2A thread, 10 pole, angled, IP 65	FS 1132

⁽¹⁾ Extended temperature range possible on request.

⁽²⁾ Included in the scope of supply of encoder

Type code

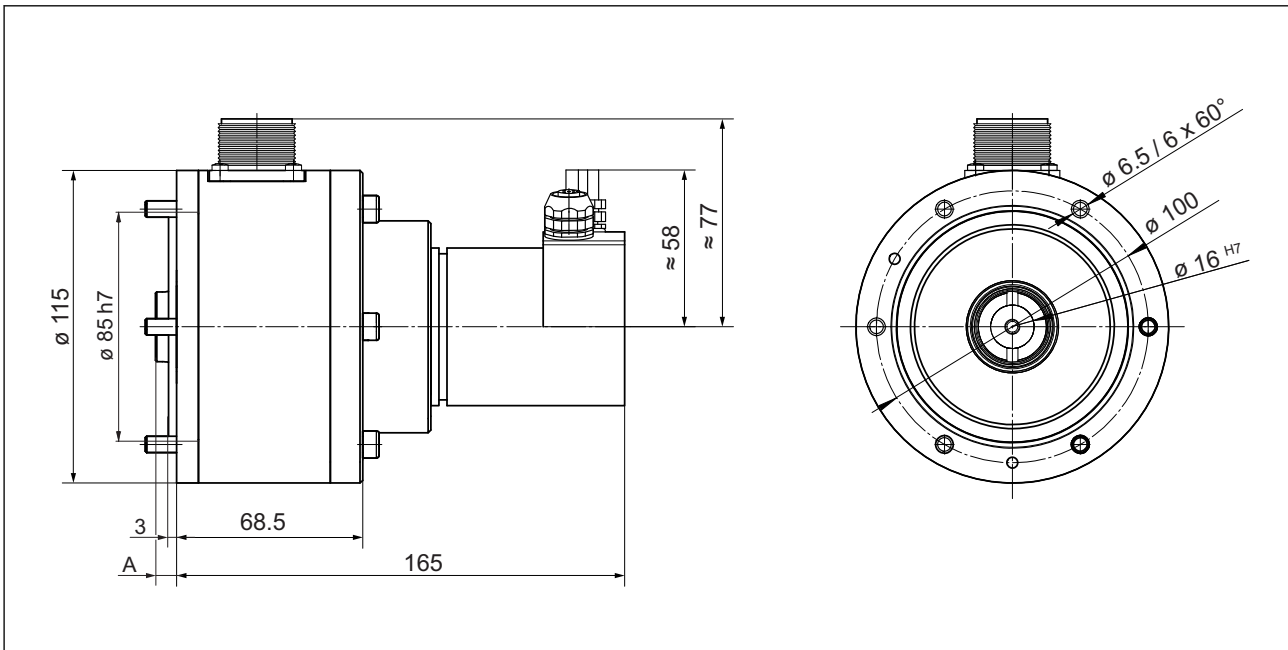
Type code – absolute rotary encoder GEL 235

	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	Singleturn (ST)
04	04 bit, 16 revolutions
08	08 bit, 256 revolutions
12	12 bit, 4096 revolutions
	Flange, Shaft
D	Synchro flange, D = 10 / L = 20 mm
	Electrical interface
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
P	PROFIBUS DP, bus cap with connector outlet
Q	PROFIBUS DP, bus cap with cable gland
S	Connection cap, 4 to 20 mA with M12-connector outlet
T	EtherCAT, bus cap with M12-connector outlet
	Connector/Cable
S	Connector outlet / without cable
	Protection class, Preset-pushbutton
4	Protection class IP 67, Preset-pushbutton
	Option
0	None

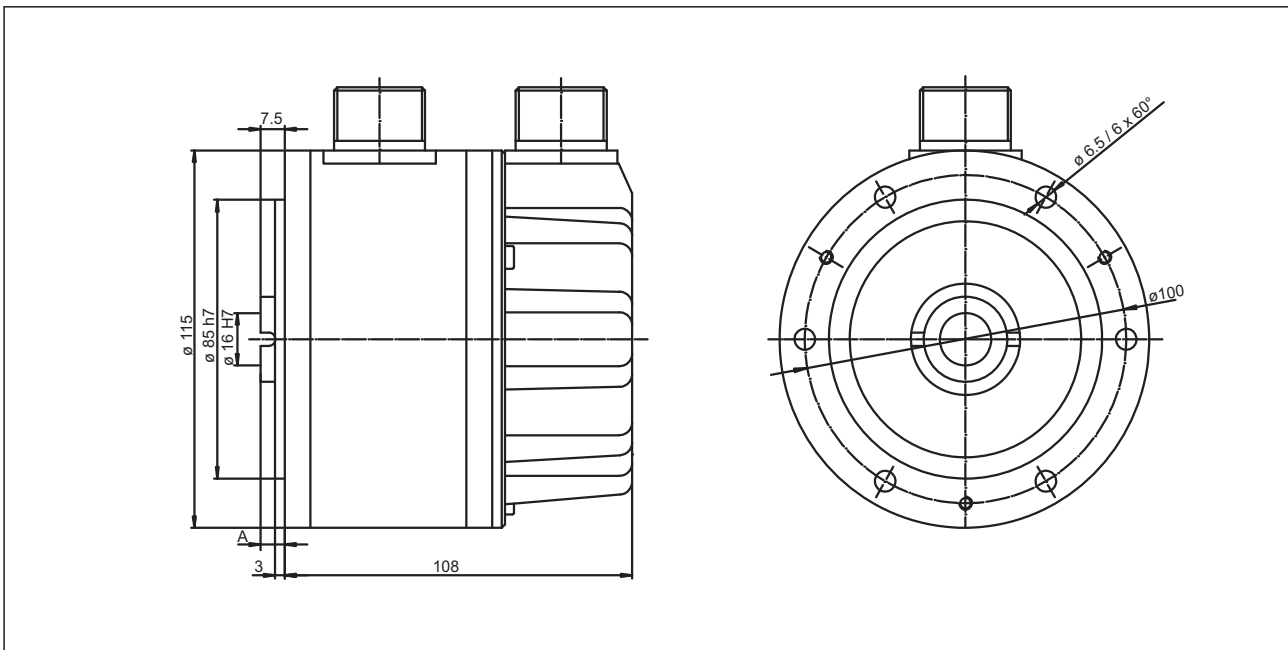
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Dimensional drawings

Tandem encoder with incremental rotary encoder GEL 292 and absolute rotary encoder GEL 235



Tandem encoder with incremental rotary encoder GEL 292 and GEL 293



Dimension A⁽¹⁾

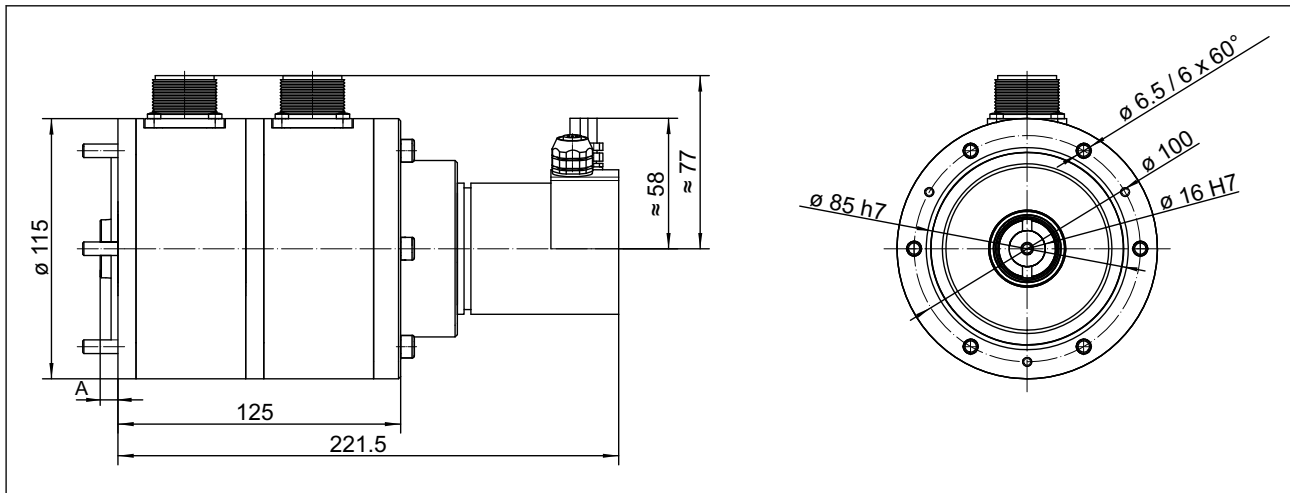
Max. axial shaft motion [mm]	Min. dimension A [mm]
1	7.5
2	8.5
3	9.5

All dimensions in mm (\approx Approximate dimension)
General tolerance DIN ISO 2768 medium

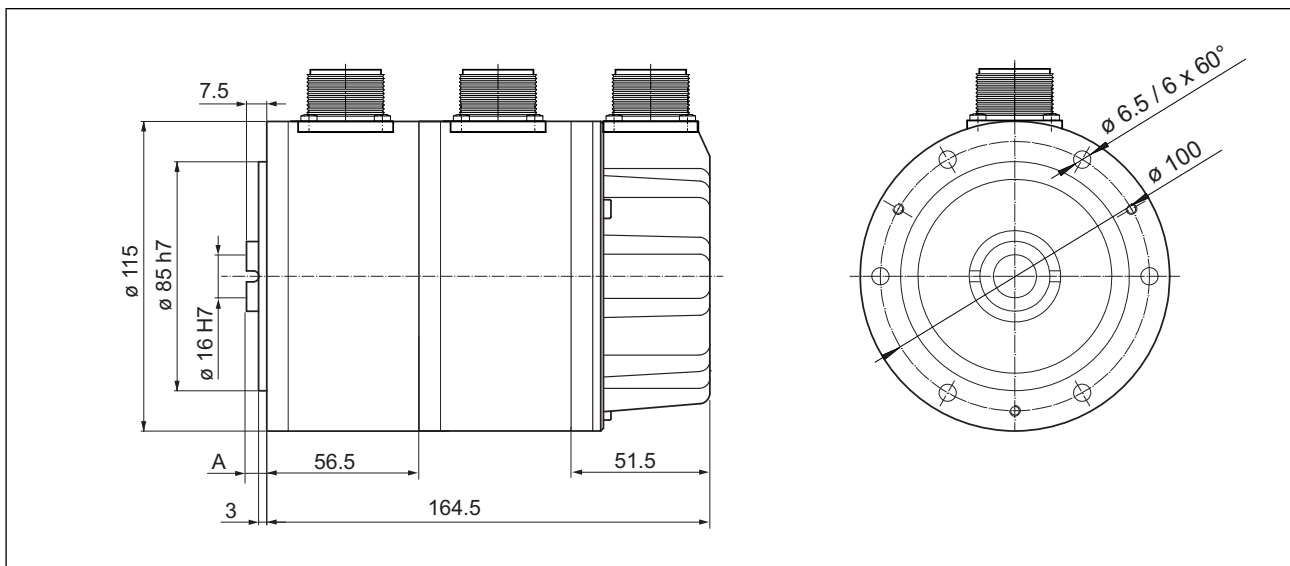
⁽¹⁾ Dimension A includes the minimum pre-load on the coupling of 1.5 mm with an axial shaft motion of 1 mm.

Dimensional drawings

Tandem encoder with two incremental rotary encoders GEL 292 and absolute rotary encoder GEL 235



Tandem encoder with two incremental rotary encoders GEL 292 and GEL 293



Dimension A⁽¹⁾

Max. axial shaft motion [mm]	Min. dimension A [mm]
1	7.5
2	8.5
3	9.5

All dimensions in mm (≈ Approximate dimension)
General tolerance DIN ISO 2768 medium

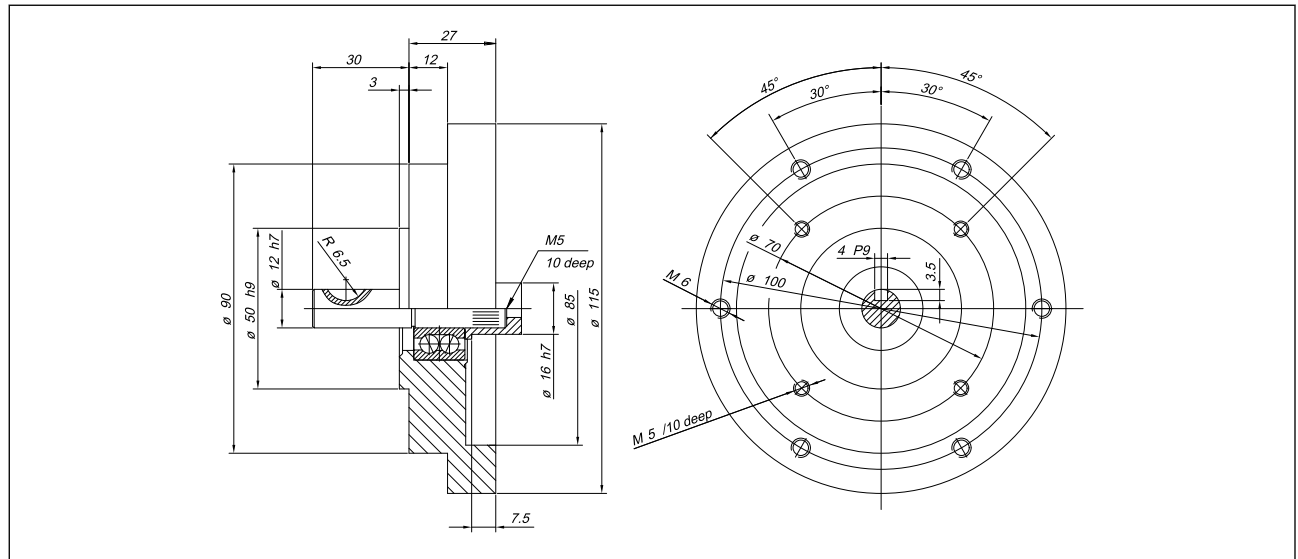
⁽¹⁾ Dimension A includes the minimum pre-load on the coupling of 1.5 mm with an axial shaft motion of 1 mm.

Mounting accessories

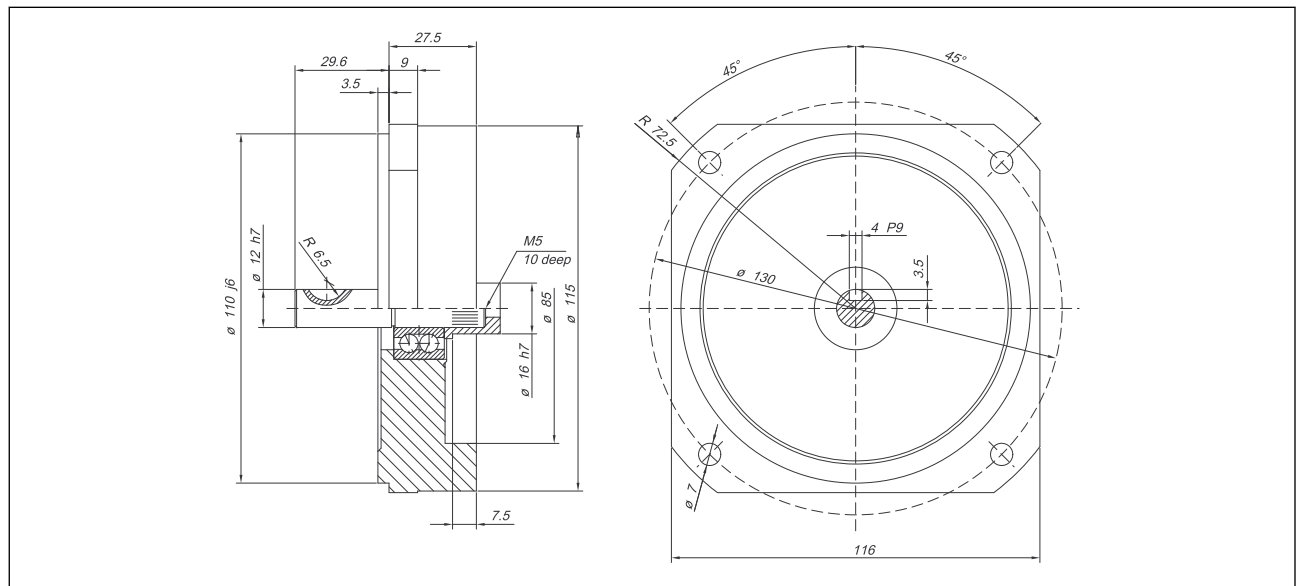
Description	Item number
BF 292 mounting flange round ⁽¹⁾	BF 1325
BR 292 mounting flange rectangular ⁽¹⁾	BF 1310

Special flanges with customised dimensions are available on request.

Dimensional drawing mounting flange BF 292



Dimensional drawing mounting flange (rectangular) BR 292



All dimensions in mm (≈ Approximate dimension)
General tolerance DIN ISO 2768 medium

⁽¹⁾ Mounting with measuring arm MA 262 or measuring wheel MRG 500/MRM 500 possible.

Accessories

Connection accessories GEL 235

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
GG 126 mating connector for SSI, 12-pin, straight	FS 1139
GW 126 mating connector for SSI, 12-pin, angled	FS 1136
8-pin M12 mating connector for analogue interface	FS 1352

⁽¹⁾ e.g. EtherCAT, PROFIBUS-DP