

### Description

The **CombiCODER** combines the already familiar speed signals based on the tried and tested interference-resistant magnetic scanning with state-of-the-art MEMS technology. The two systems discussed use supply voltages that are independent of one another and entirely without feedback.

The flat spot detector accurately identifies flat spots and welds on the wheel and indicates the severity in clear, defined phases. This means that workshop visits can be planned early and efficiently without causing disruption to operational processes. If several flat spot detectors are used, rail joints can also be detected.

Temperature measurement is using an integrated NTC Thermistor.

Thanks to the compatible sensor housing, existing speed sensors can be replaced with the GEL 2475FD with minimal effort. The flat spot detector signal output is an analog PWM signal with HTL output levels. It can be read with conventional analog input stages.

### Advantages

- Replaces existing speed sensors with compatible housing
- Simple evaluation through analog pulse-width modulated signal
- Flat spot detection works regardless of the installation position of the sensor housing on the vehicle.
- When retrofitting existing control systems, they continue to be supplied with the necessary, independent speed signals.
- Insulation coordination and development in accordance with EN50155

### Field of application

- Rail vehicle industry
  - Traction monitoring
  - Anti-slip protection
  - Motor speed
  - Wheel slide protection
  - Automatic Train Protection
  - Odometry

Do you have special requirements regarding flange shape, shaft length, number of channels, cable protection, cable outlet, connector assembly or EMC concept?

Talk to us. Our experts can design the optimal solution for your application from an extensive modular system and will be pleased to advise you how to customize your solution in the most cost-efficient way.

Write to [support@lenord.de](mailto:support@lenord.de) or call +49 208 9963-215.



# Technical data

Signal pattern for speed system	E-	V-	EM	VM
<b>Electrical data speed system</b>				
Supply voltage $U_B$ (reverse polarity protected)	10 to 30 V DC		10 to 20 V DC	
Current consumption $I_B$ (without load)	$\leq 30$ mA		$\leq 12$ mA per channel	
Output signal (short-circuit-proof)	Square-wave signals			
Output signal level High <sup>(1)</sup>	$\geq U_B - 1.5$ V		$\geq U_B - 1.8$ V	
Output signal level Low <sup>(1)</sup>	$\leq 1.0$ V		$\leq 1.5$ V	
Output current per channel	$\leq 20$ mA		$\leq 10$ mA	
Frequency range	0 to 20 kHz	0 to 20 kHz	0 to 8 kHz	
Duty cycle	50 % $\pm$ 10 % <sup>(2)</sup>			
Phase offset	–	typ. 90°	–	typ. 90°
<b>Electrical data PWM signal</b>				
Supply voltage $U_B$ (reverse polarity protected)	10 to 30 V DC			
Output signal level High <sup>(1)</sup>	$\geq -1.5$ V			
Output signal level Low <sup>(1)</sup>	$\leq 1.0$ V			
Output current	$\leq 20$ mA			
Frequency	1 kHz			
<b>Electrical data NTC Thermistor</b>				
Measuring resistor	1 to 100 kOhm at 25 °C			
Measuring range	-55 °C to +70 °C (max. 100 mW) -55 °C to +150 °C (max. 1 mW)			
Measuring tolerance	1 % at 25 °C			
<b>Mechanical data</b>				
Sensor tube material	Stainless steel			
Flange material	Stainless steel			
Sensor weight (incl. 2 m cable)	approx. 500 g			
<b>Environmental tests</b>				
Working and operating temperature	-40 °C to +120 °C			
Storage temperature	-40 °C to +120 °C			
Dielectric strength	500 V AC/750 V DC (DIN EN 50155:2022-06)			
Electromagnetic compatibility <sup>(3)</sup>	DIN EN 50121-3-2:2017-11; DIN EN 50121-3-2/A1:2020-11			
Degree of protection on measuring side <sup>(4)</sup>	IP 68			
Vibration resistance	DIN EN 61373:2011-04 cat. 3			
Shock resistance	DIN EN 61373-2011-04 cat. 3			
MTTF value (rotational speed)	2,000,000 h at 55 °C			
MTTF value (flat spot)	950,000 h at 55 °C			

(1) depending on output current and temperature


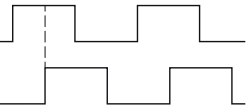
(2) applies to operation with nominal air gap and toothing as per DIN 867

(3) Observe EMC notes in the mounting/operating instructions

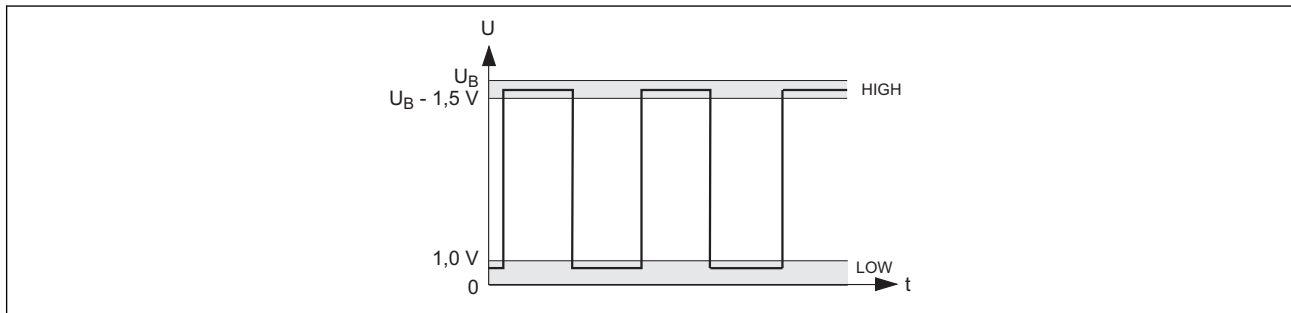
(4) Degree of protection on the cable outlet side depends on cable gland or cable protection

# Output signals and connection

## Signal pattern for voltage output (E-, V-)

Output signals		Supply voltage	Pulse diagram
<b>E-</b>	1-channel square-wave signal	10 to 30 V DC	
<b>V-</b>	2-channel square-wave signals with 90° phase offset	10 to 30 V DC	

## Output signal level – voltage output (E-, V-)



## Assignment – voltage output (E-, V-)

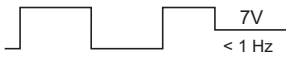
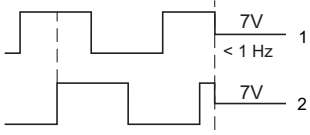
Signal	E-	V-
Rotational speed channel 1	YE	YE
Rotational speed channel 2		WH
GND (0 V)	BU	BU
+ $U_B$	RD	RD
PWM $U_B$	PK	PK
PWM GND	GY	GY
PWM flat spot	BK	BK
PWM rail joint	BN	BN
NTC+	RD-BU	RD-BU
NTC-	PK-BU	PK-BU
Cables/Screens	1/1	1/1

Cable screen is connected directly or, as an option, capacitively in the sensor

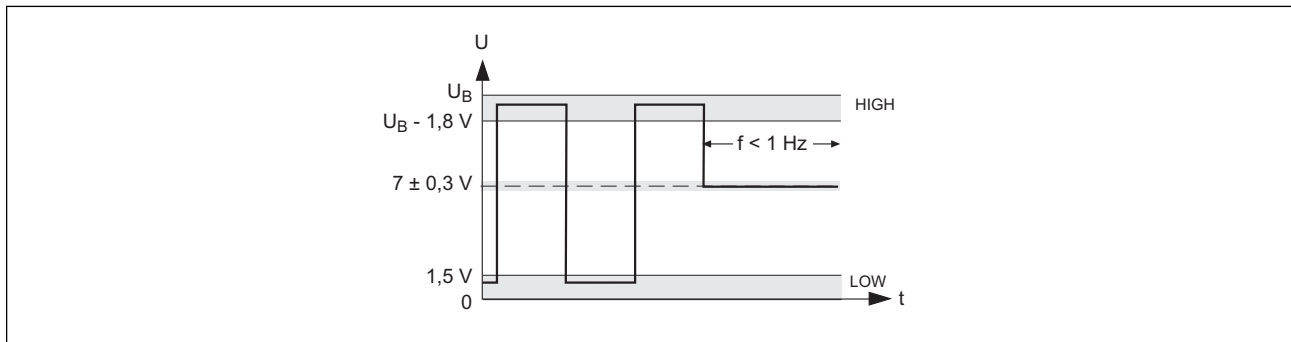
Core identifier: **BK** black, **BN** brown, **BU** blue, **GY** gray, **PK** pink, **RD** red, **WH** white, **YE** yellow

# Output signals and connection

## Signal pattern with standstill voltage (EM, VM)

Output signals		Supply voltage	Pulse diagram
<b>EM</b>	1-channel square-wave signal and standstill voltage	10 to 20 V DC	
<b>VM</b>	2-channel square-wave signals with 90° phase offset and standstill voltage	10 to 20 V DC	

## Output signal level – voltage output (EM, VM)



## Assignment – voltage output (EM, VM)

Signal	EM	VM
Rotational speed channel 1	YE	YE
Rotational speed channel 2		WH
GND (0 V)	BU	BU
+ $U_B$	RD	RD
PWM $U_B$	PK	PK
PWM GND	GY	GY
PWM flat spot	BK	BK
PWM rail joint	BN	BN
NTC+	RD-BU	RD-BU
NTC-	PK-BU	PK-BU
Cables/Screens	1/1	1/1

Cable screen is connected directly or, as an option, capacitively in the sensor

Core identifier: **BK** black, **BN** brown, **BU** blue, **GY** gray, **PK** pink, **RD** red, **WH** white, **YE** yellow

# Flat spot detector

## Functionality of flat spot detector

Periodically occurring shock loads are already evaluated internally and output at the corresponding sensor output as a pulse-width modulated (PWM) signal with a basic frequency of 1 kHz. The duty cycle of the PWM signal corresponds to the degree of severity of the flat spot.	
Duty cycle of 10 % ( $\pm 4$ %)	The current vehicle speed does not permit evaluation or the measured values are too low to be able to make a statement.
Duty cycle of 20 % ( $\pm 4$ %)	The current vehicle speed is within the permissible evaluation window. There are no signs of a flat spot.
Duty cycle of 30 % to 80 % ( $\pm 4$ %)	The current vehicle speed is within the permissible evaluation window. A flat spot is detected:  30 % Lower threshold - slight flat spot  to 80 % Upper threshold - very severe flat spot  The threshold values for 'light' and 'severe' can be customized for each customer, as the installation location (sprung/unsprung) has a significant effect on the measured intensity.
Duty cycle of 90 % ( $\pm 4$ %)	An error status is signaled. The flat spot detector has detected an internal hardware problem.

## Rail joint function (when using several flat spot detectors)

When several flat spot detectors are used, bumps that do not occur on a regular basis but rather sequentially over the measuring section, such as track joints, can be recorded. An additional PWM output is available for this purpose.	
Duty cycle below 20 % ( $\pm 4$ %)	The current vehicle speed does not permit evaluation or the measured values are too low to be able to make a statement.
Duty cycle of 20 % to 80 % ( $\pm 4$ %)	The current vehicle speed is within the permissible evaluation window. A rail joint is detected:  20 % Lower threshold - slight rail joint  to 80 % Upper threshold - very severe rail joint  The threshold values for 'light' and 'severe' can be customized for each customer, as the installation location (sprung/unsprung) has a significant effect on the measured intensity.
Duty cycle of 90 % ( $\pm 4$ %)	An error status is signaled. The flat spot detector has detected an internal hardware problem.

# Mechanical properties

## Target wheel

Requirements for the target wheel	
Material	Ferromagnetic steel
Tooth form	<ul style="list-style-type: none"><li>▪ Involute gear teeth as per DIN 867 (see type code)</li><li>▪ Square gear teeth (see type code)</li></ul>
Width	≥ 15 mm (smaller upon request)
Module m	The selection can be made in 0.25 increments from 1.00 to 3.50 (see type code).
Air gap (nominal air gap)	0.2 to 1.5 mm (0.7 mm)

## Screening concept

Selection of screen connection	Screen connection at encoder housing
Option SD - connected directly (see type code)	Directly connected to sensor housing
Option SC - connected capacitively (see type code)	Connected capacitively to the sensor housing
Option SI - insulated to the housing (see type code)	insulated to the housing
Despite the high electromagnetic immunity, integration into a screening concept is required for the sensor to ensure EMC stability.	
<b>i</b> Should the electromagnetic environment require special screening concepts, Lenord+Bauer offers support based on extensive knowledge and experience in integrating the sensor into the screening concept of the application.	
<b>i</b> Observe EMC notes in the relevant documents.	

# Mechanical properties

## Cable outlet

<b>Cable outlet straight</b> Option S (see type code)	<b>Cable outlet at side</b> Option L (see type code)
The straight cable outlet can also be connected via an angle: → <a href="#">page 8</a>	The side cable outlet can also be connected via an angle: → <a href="#">page 8</a>
<p>1 Sealing ring: O-ring 21 x 2.5 mm; NBR</p> <p>2 Index pin (exclusively for versions V- and VM; there is no index pin for versions E- and EMI)</p> <p>L Cable length L<sup>(1)</sup> depending on type code (see type code)</p>	

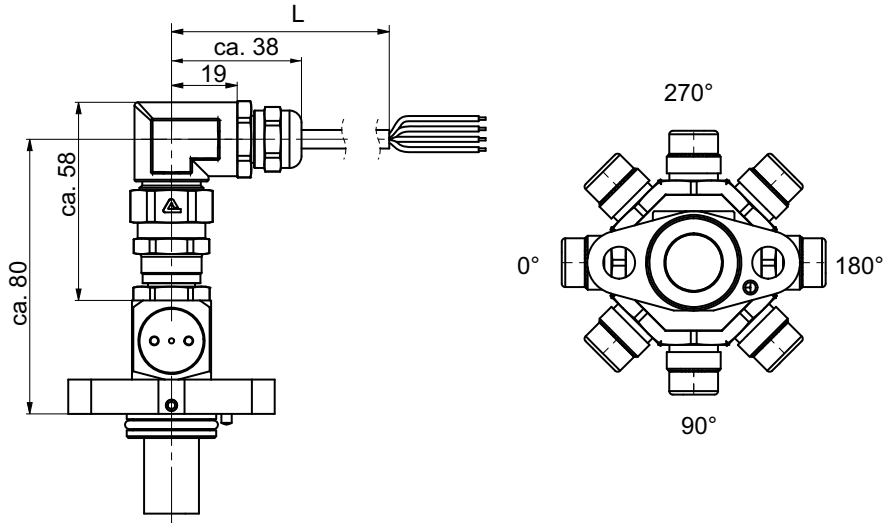
(1) Tolerance ± 50 mm

# Mechanical properties

## - Cable outlet straight with angle

Straight cable outlet with angle - if option S is selected for cable outlet (see type code)

Selection can be in 45° steps (000°; 045°; 090°; 135°; 180°; 225°; 270°; 315°)<sup>(1)</sup> (see type code).

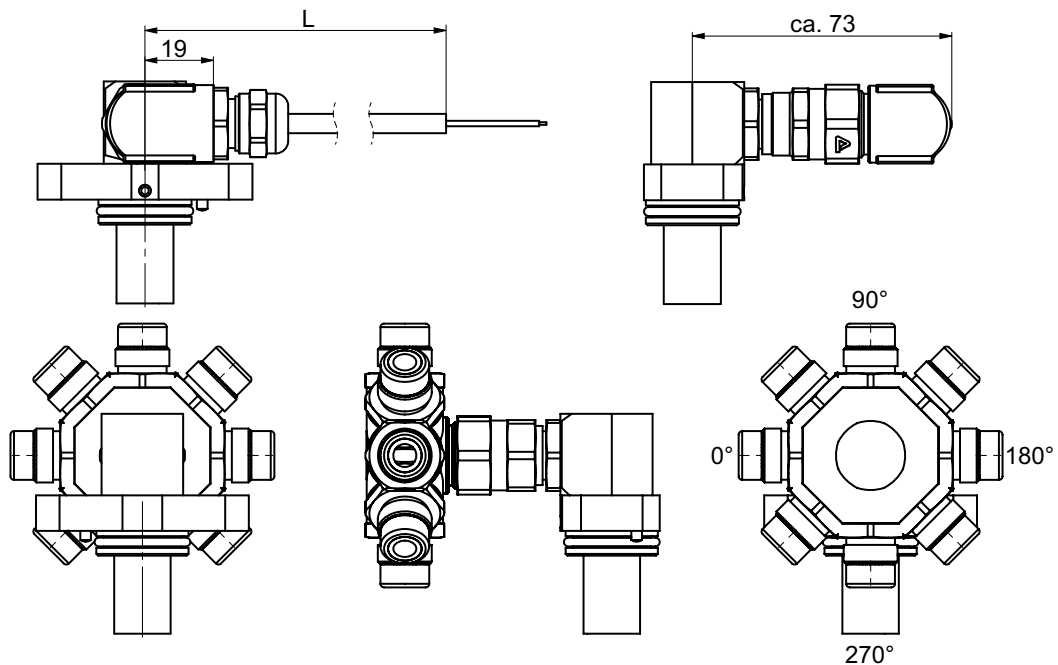


Cable length L<sup>(2)</sup> depending on type code (see type code)

## Cable outlet at side with angle

Side cable outlet with angle - if option L is selected for cable outlet (see type code)

Selection can be in 45° steps (000°; 045°; 090°; 135°; 180°; 225°; 270°; 315°)<sup>(1)</sup> (see type code).



Cable length L<sup>(2)</sup> depending on type code (see type code)

(1) Tolerance ± 10°

(2) Tolerance ± 50 mm



# Mechanical properties

## Cable protection at cable outlet

The GEL 2475FD can be equipped with different types of cable protection at the cable outlet as required.	
<ul style="list-style-type: none"> <li>▪ Dimensional drawings for straight cable outlet: → <a href="#">page 9</a></li> <li>▪ Dimensional drawings for cable outlet at side: → <a href="#">page 10</a></li> </ul>	
Selection P00	Without cable protection
Selection P02	Flexible conduit NW12
Selection P03	Hydraulic hose DN12

## Technical data for cable protection

Option	P00	P02	P03
Type	12 × 0.34 mm <sup>2</sup>	Flexible conduit NW12	Hydraulic hose DN12
Material	halogen-free <sup>(1)</sup>	Polyamid, halogen-free	Rubber compound
Outside diameter	8.0 ± 0.3 mm	15.8 mm	20.0 mm
Minimum bending radius	24 mm (static) 40 mm (dynamic)	35 mm (static) 80 mm (dynamic)	70 mm

## Cable outlet straight

Cable protection straight cable outlet - if option S is selected for cable outlet (see type code)
The design depends on the cable protection option at the cable outlet: → <a href="#">page 9</a>
<p><b>P00</b> Without cable protection  <b>P02</b> Flexible conduit NW12  <b>P03</b> Hydraulic hose DN12</p> <p><b>L</b> Cable length L<sup>(2)</sup> depending on type code (see type code)  <b>L1</b> Protective sleeve length L1;          depending on the cable connection and assembly, the protective sleeve length L1 corresponds to the cable length L - 100 mm</p>

(1) Specification upon request

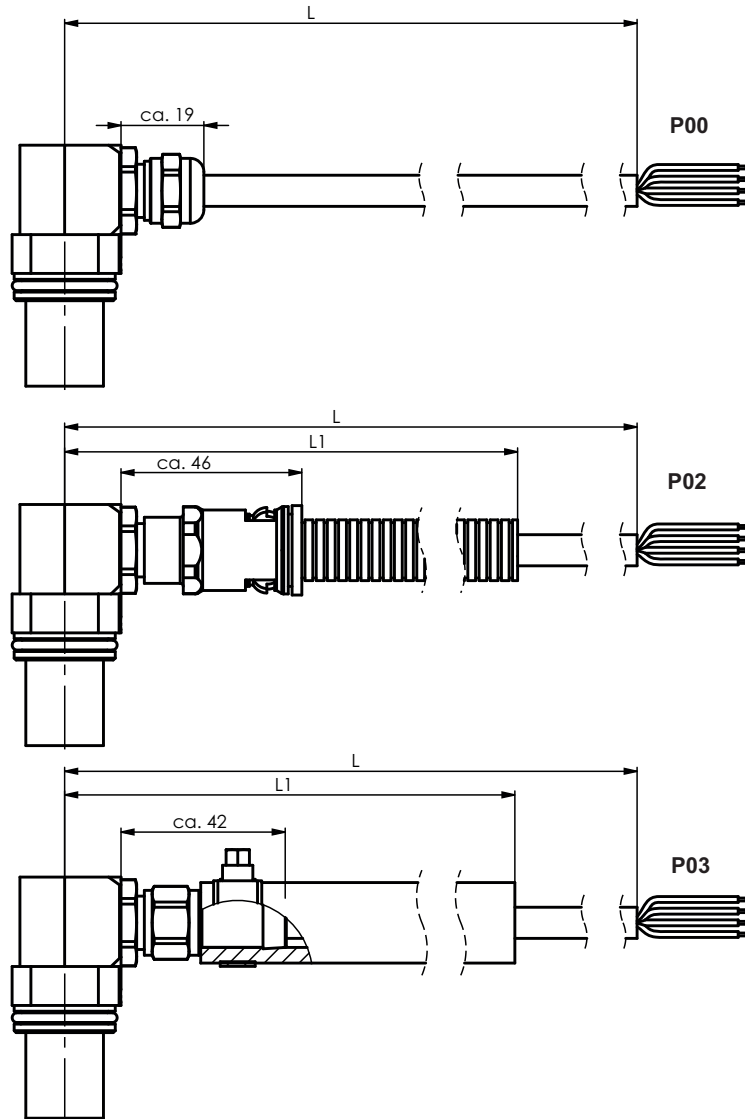
(2) Tolerance ± 50 mm

# Mechanical properties

## Cable outlet at side

Cable protection side cable outlet - if option L is selected for cable outlet (see type code)

The design depends on the cable protection option at the cable outlet: → [page 9](#)



**P00** Without cable protection

**P02** Flexible conduit NW12

**P03** Hydraulic hose DN12

**L** Cable length L<sup>(1)</sup> depending on type code (see type code)

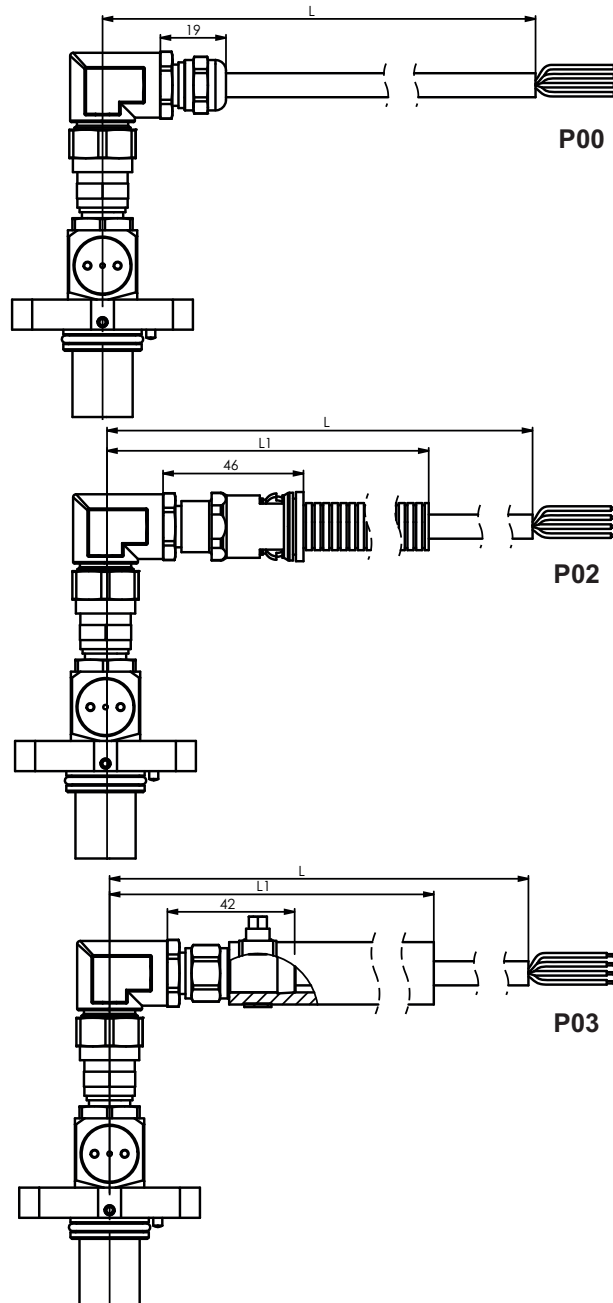
**L1** Protective sleeve length L1;  
depending on the cable connection and assembly, the protective sleeve length L1 corresponds to the cable length L - 100 mm

<sup>(1)</sup> Tolerance  $\pm 50$  mm

## Cable outlet at side with angle

The cable outlet can also be fitted with an angle. (see type code)

The design depends on the cable protection option at the cable outlet: → [page 9](#)



**P00** Without cable protection

**P02** Flexible conduit NW12

**P03** Hydraulic hose DN12

**L** Cable length  $L^{(1)}$  depending on type code (see type code)

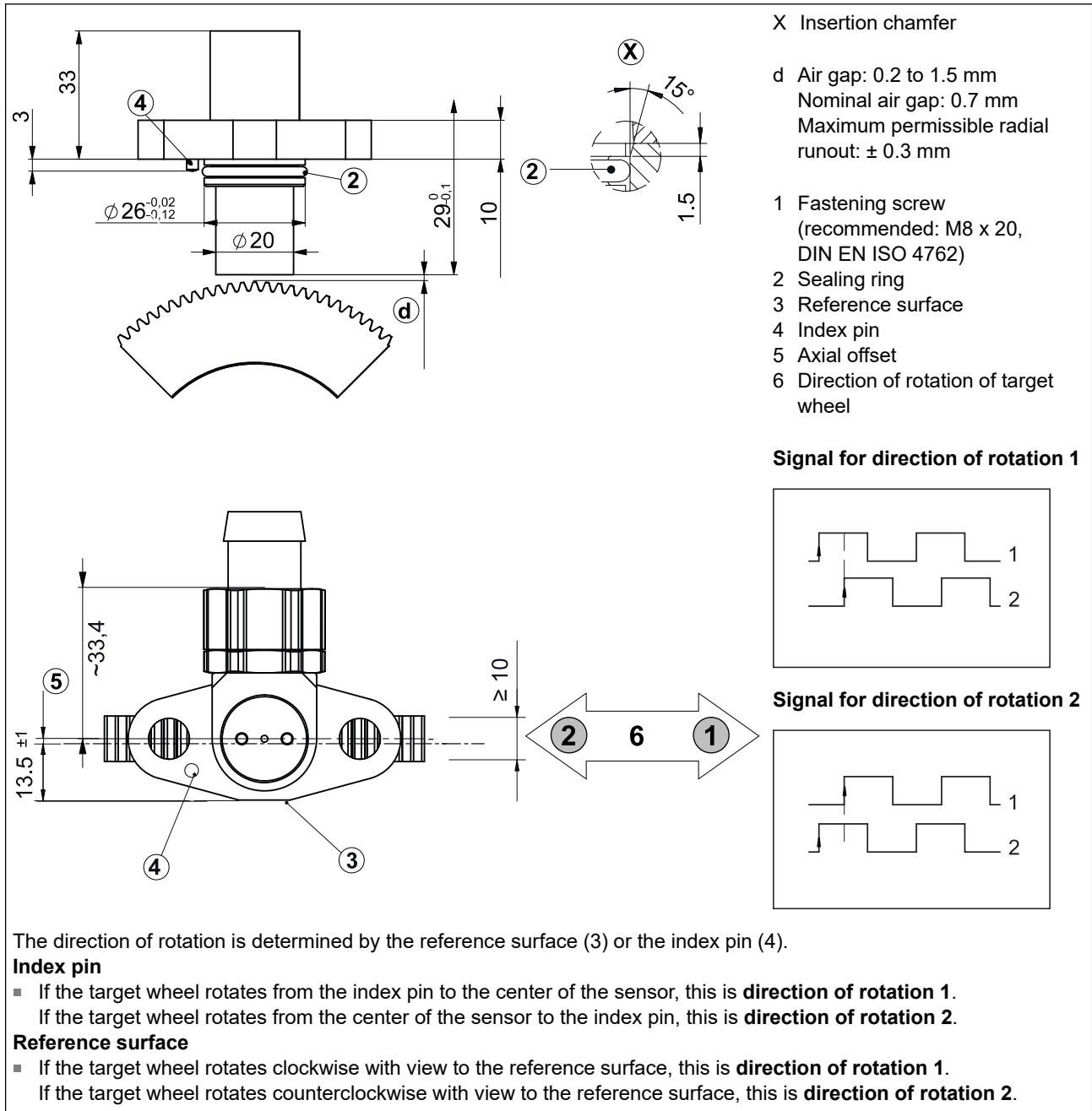
**L1** Protective sleeve length  $L1$ ;

depending on the cable connection and assembly, the protective sleeve length  $L1$  corresponds to the cable length  $L - 100$  mm

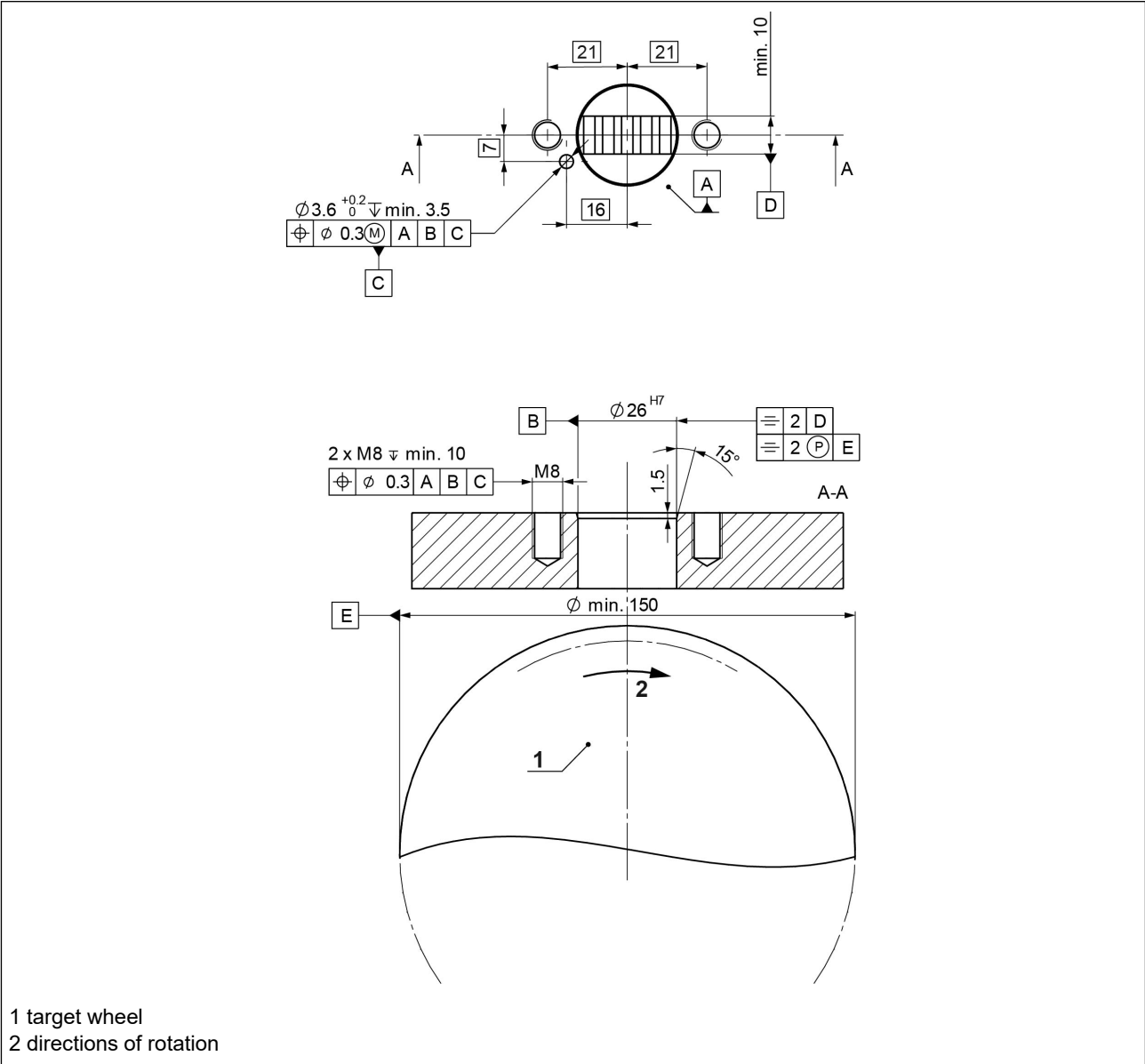
<sup>(1)</sup> Tolerance  $\pm 50$  mm

# Mechanical properties

## Assembly drawing



## Hole pattern



1 target wheel  
2 directions of rotation

# Type code GEL 2475

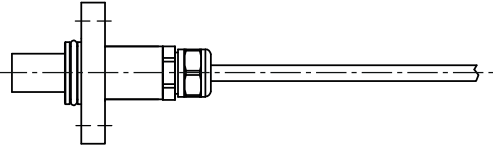
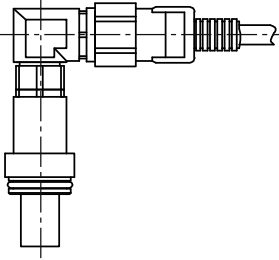
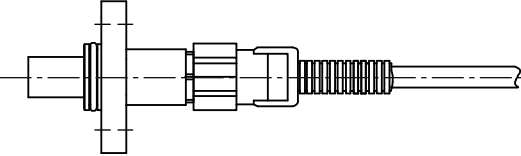
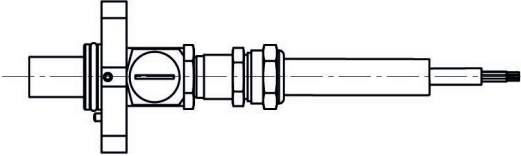
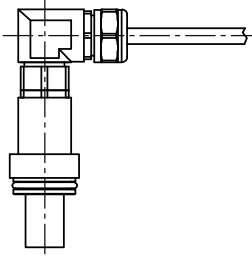
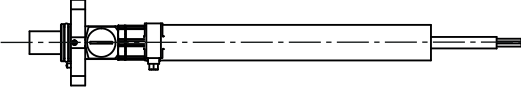
## Type code GEL 2475

<b>2475FD</b>	<b>Signal pattern</b>		
	<b>E-</b>	1-channel square-wave signal	
	<b>V-</b>	2-channel square-wave signals with 90° phase offset	
	<b>EM</b>	1-channel square-wave signal and standstill voltage	
	<b>VM</b>	2-channel square-wave signals with 90° phase offset and standstill voltage	
	<b>Screen connection</b>		
	<b>SD</b>	connected directly	
	<b>SC</b>	connected capacitively	
	<b>SI</b>	insulated to the housing	
	<b>Module</b>		
<b>M01</b>	m= 1.00, steel, involute		
<b>M02</b>	m= 1.25, steel, involute		
<b>M03</b>	m= 1.50, steel, involute		
<b>M04</b>	m= 1.75, steel, involute		
<b>M05</b>	m= 2.00, steel, involute		
<b>M06</b>	m= 2.25, steel, involute		
<b>M07</b>	m= 2.50, steel, involute		
<b>M08</b>	m= 2.75, steel, involute		
<b>M09</b>	m= 3.00, steel, involute		
<b>M10</b>	m= 3.25, steel, involute		
<b>M11</b>	m= 3.50, steel, involute		
<b>M12</b>	m= 1.00, steel, rectangular		
<b>M13</b>	m= 1.25, steel, rectangular		
<b>M14</b>	m= 1.50, steel, rectangular		
<b>M15</b>	m= 1.75, steel, rectangular		
<b>M16</b>	m= 2.00, steel, rectangular		
<b>M17</b>	m= 2.25, steel, rectangular		
<b>M18</b>	m= 2.50, steel, rectangular		
<b>M19</b>	m= 2.75, steel, rectangular		
<b>M20</b>	m= 3.00, steel, rectangular		
<b>M21</b>	m= 3.25, steel, rectangular		
<b>M22</b>	m= 3.50, steel, rectangular		
<b>Cable outlet</b>			
<b>S</b>	Cable outlet straight		
<b>L</b>	Cable outlet at side		
<b>Angle</b>			
<b>0</b>	without angle		
<b>1</b>	with angle, 0 degree		
<b>2</b>	with angle, 45 degree		
<b>3</b>	with angle, 90 degree		
<b>4</b>	with angle, 135 degree		
<b>5</b>	with angle, 180 degree		
<b>6</b>	with angle, 225 degree		
<b>7</b>	with angle, 270 degree		
<b>8</b>	with angle, 315 degree		
<b>Cable protection</b>			
<b>P00</b>	without		
<b>P02</b>	Flexible conduit NW12		
<b>P03</b>	Hydraulic hose DN12		
<b>Cable length L</b>			
<b>L2</b>	2000 mm		
<b>L3</b>	3000 mm		
<b>L4</b>	4000 mm		
<b>Target wheel</b>			
<b>XXX</b>	Number of the target wheel teeth		

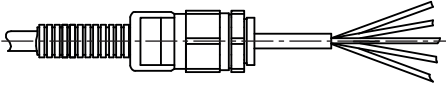
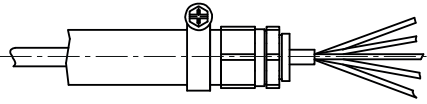
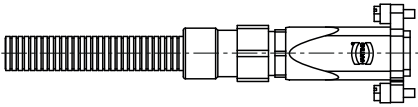
**Note:** A Y-number is assigned for a customer-specific special version. A special design GEL 2475FDYxxx is manufactured according to drawing or application description.

# We can manufacture according to your specifications:

## Examples for the sensor side, preferred types

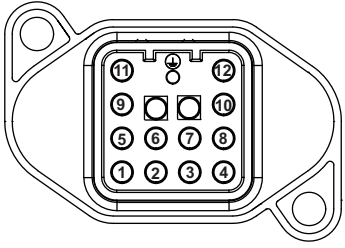
 <p>Standard, cable outlet straight</p>	 <p>Cable outlet with 90° angle and flexible conduit</p>
 <p>ABB flexible conduit, cable outlet straight Type XPCST-12BG</p>	
 <p>Anaconda Sealite, cable outlet straight Type HFX-V0 348.010.1 5/16"</p>	 <p>Cable outlet with 90° angle</p>
 <p>Hansaflex-protective sleeve, cable outlet straight TE 213 rail</p>	

## Examples for the flying lead, preferred types

 <p>Flexible conduit and flying lead</p>	 <p>Rubber sleeve and flying lead</p>
 <p>Flexible conduit with Harting connector HAN HPR</p>	

# Examples

## Assignment Harting connector HAN HPR, preferred type



PIN	E-	V-	EM	VM
1	PWM flat spot	PWM flat spot	PWM flat spot	PWM flat spot
2	PWM GND	PWM GND	PWM GND	PWM GND
3				
4	-	Rotational speed channel 2	-	Rotational speed channel 2
5	GND (0 V)	GND (0 V)	GND (0 V)	GND (0 V)
6	+U <sub>B</sub>	+U <sub>B</sub>	+U <sub>B</sub>	+U <sub>B</sub>
7				
8	PWM rail joint	PWM rail joint	PWM rail joint	PWM rail joint
9	PWM U <sub>B</sub>	PWM U <sub>B</sub>	PWM U <sub>B</sub>	PWM U <sub>B</sub>
10	NTC+	NTC+	NTC+	NTC+
11	Rotational speed channel 1	Rotational speed channel 1	Rotational speed channel 1	Rotational speed channel 1
12	NTC-	NTC-	NTC-	NTC-

If you decide to have our speed sensors assembled with cable protection and connectors, we recommend using the preferred types shown in the figure. The required materials are field-tested in large quantities and are always in stock. This guarantees the fastest delivery times with the best material availability and the lowest prices due to large purchasing volumes.

If you need help in finding the product you need, please contact our internal sales team at [support@lenord.de](mailto:support@lenord.de) or call +49 208 9963-215.









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