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Technical Information

GEL 2475FD

CombiCODER - Flat-Spot Detector

Highly Integrated Speed Sensor, Vibration Sensor, and Temperature Sensor with Integrated Evaluation

D-51T-2475FD | Status 2026-09-15

LENORD +BAUER

Finding solutions.
Founding trust.

Motion sensors and integrated drive technology

General Information

- 1-/2-channel Hall-effect Speed Sensor with integrated dead-spot detection and temperature monitoring
- Reliable detection of high rotational speeds down to creeping movements (0 Hz…20 kHz)
- Reliable detection of flat spots, welded-on sections, and rail joints
- Temperature monitoring via NTC thermistor: -55 °C to +150 °C
- Perfectly suited for condition monitoring and predictive maintenance



Features

- Rotational speed, vibration, and temperature measurement in a single housing
- Vibration measurement using state-of-the-art MEMS technology in 3 axes
- Integrated evaluation algorithms output the severity of flat spots and weld buildup in discrete levels via a PWM signal
- The use of multiple flat spot detectors enables the detection of rail joints
- Galvanically isolated signals for reliable evaluation in various control systems
- Configuration flexibility through freely selectable cable outlets, cable protection, and connector options
- Type-tested according to DIN EN 50155 for safe use in railway applications
- Fire-protected by cables and cable protection in accordance with DIN EN 45545-2 up to HL3
- Highest product quality with optional certification according to DNV and many other standards

Do you have specific requirements regarding the flange shape, tube length, number of channels, cable protection, cable outlet, connector assembly, or the EMC design? Please contact us. Our experts can create the optimal solution for your application from an extensive modular system and will be happy to advise you on the most cost-effective custom adaptation.

support@lenord.de or +49(0)208 9963-215

Advantages

- Maximum compatibility
- Maintenance-free and wear-free
- Flat spot detection works regardless of the sensor's installation orientation
- Extremely simple evaluation via an analog PWM signal
- Simultaneous condition monitoring of the vehicle and infrastructure
- Maximizes the efficiency of maintenance planning
- Easy integration
- Easy to install
- Galvanically isolated measurement systems
- High signal quality

Applications

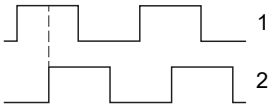
Railway Technology & Transportation
Rail Vehicle Industry: ▪ Traction control, skid control, motor speed, anti-slip control, Automatic Train Protection, odometry
Condition Monitoring in Rail Vehicles: ▪ Automatic, objective detection and evaluation of flat spots

Technical Data: Voltage Output

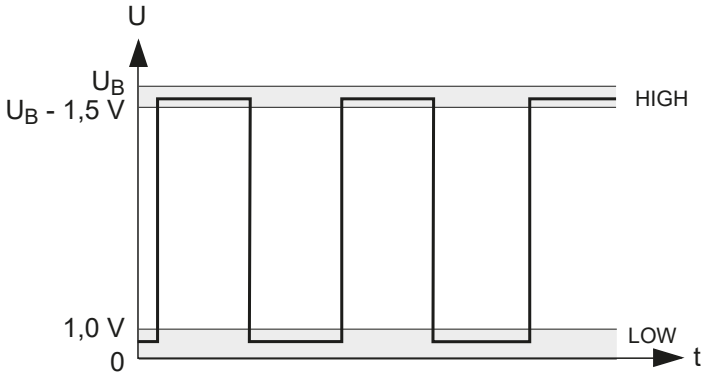
Signal Pattern	E-	V-	EM	VM
Electrical Data				
Supply voltage U_B (reverse polarity protected)	10 ... 30 V DC		10 ... 20 V DC	
Current consumption I_B (no load)	≤ 30 mA		≤ 25 mA	
Output signal (short-circuit-proof)	Square-wave signals			
Output signal level (High) (1)	≥ U_B - 1.5 V		≥ U_B - 1.8 V	
Output signal level (Low) (2)	≤ 1.0 V		≤ 1.5 V	
Output current per channel	≤ 20 mA		≤ 10 mA	
Frequency range	0 ... 20 kHz		0 ... 8 kHz	
Duty cycle	50% ± 20% (2)			
phase offset	–	typ. 90°	–	typ. 90°
Electrical Data for PWM Signal				
Supply voltage U_B (reverse polarity protected)	10 ... 30 V DC			
Output signal level (High) (1)	≥ U_B - 1.5 V			
Output signal level (Low) (1)	≤ 1.0 V			
Output current	≤ 20 mA			
Frequency	1 kHz			
Electrical Data for NTC Thermistor				
Measuring resistance	1 to 100 kOhm at 25 °C			
Measurement range	-55 °C to +70 °C (max. 100 mW) -55 °C to 150 °C (max. 1 mW)			
Measurement tolerance	1% at 25 °C			
Mechanical Data				
Sensor tube material	Stainless steel			
Flange material	Stainless steel			
Sensor weight (including 2 m cable)	500 g			
Environmental testing				
Working and operating temperature	-40 °C ... +120 °C			
Storage temperature	-40 °C ... +120 °C			
Dielectric Strength	500 V AC / 750 V DC (DIN EN 50155:2022-06)			
Electromagnetic compatibility (3)	DIN EN 50121-3-2:2017-11			
Degree of protection on the measurement side (4)	IP 68			
Vibration resistance	DIN EN 61373:2011-04 Cat. 3			
Shock resistance	DIN EN 61373-2011-04 Cat. 3			
Fire protection	DIN EN 45545-2:2023-12 NFPA 130 upon request			
MTTF value (rotational speed)	> 2,000,000 h at 55 °C			
MTTF value (flat spot)	> 950,000 h at 55 °C			

(1) Depends on output current and temperature
(2) Applies to operation at rated air gap and with teeth according to DIN 867
(3) Follow the EMC instructions in the installation and operating manual
(4) The Degree of protection on the cable outlet side depends on the cable gland or cable protection

Output Signals and Connectors

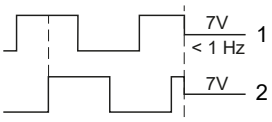
Signal Patterns for Voltage Output (E-, V-)			
Output Signals		**Supply Voltage**	**Pulse diagram**
E-	1 channel square-wave signal	10 ... 30 V DC	
V-	2-channel square-wave signals with a 90° phase offset	10 ... 30 V DC	

Output Signal Level – Voltage Output (E-, V-)

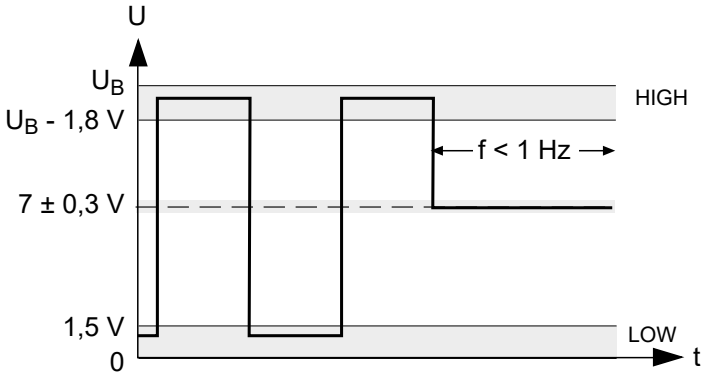


Pin Assignment – Voltage Output (E-, V-)		
Signal	**E-**	**V-**
Rotational speed, Channel 1	YE	YE
Rotational speed, Channel 2	-	WH
GND (0 V)	BU	BU
$+U_B$	RD	RD
PWM U_B	PK	PK
PWM GND	GY	GY
PWM Channel 1	BK	BK
PWM Channel 2	BN	BN
NTC+	RD-BU	RD-BU
NTC-	PK-BU	PK-BU
Cables / Shields	1 / 1	1 / 1
Cable shield directly attached to the sensor or optionally capacitively attached Wire color coding: **BK** black, **BN** brown, **BU** blue, **GY** gray, **PK** pink, **RD** red, **WH** white, **YE** yellow		

Output Signals and Connectors

Signal Patterns with Standstill Voltage (EM, VM)			
Output Signals		**Supply Voltage**	**Pulse diagram**
EM	1 channel square-wave signal and Standstill Voltage	10 ... 20 V DC	
VM	2-channel square-wave signals with 90° phase offset and Standstill Voltage	10 ... 20 V DC	

Output Signal Level – Voltage Output (EM, VM)



Pin Assignment – Voltage Output (EM, VM)		
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 Channel 1	BK	BK
PWM Channel 2	BN	BN
NTC+	RD-BU	RD-BU
NTC-	PK-BU	PK-BU
Cables / Shields	1 / 1	1 / 1
Cable shield directly attached to the sensor or optionally capacitively attached Wire color coding: **BK** black, **BN** brown, **BU** blue, **GY** gray, **PK** pink, **RD** red, **WH** white, **YE** yellow		

Flat-spot detector

How the Flat Spot Detector Works
Periodically occurring shock loads are evaluated internally and output at the corresponding sensor output as a pulse-width-modulated (PWM) signal with a fundamental frequency of 1 kHz. The duty cycle of the PWM signal can vary depending on the selected option.
Flat Spot and Shock Intensity—Option 1 (see model code)
see „2-Channel PWM - Valley and Peak Intensity - Option 1“, page 6
Intensity and Probability of a Flat Spot—Option 2 (see model code)
see „2-Channel PWM - Intensity and Probability of a Dip - Option 2“, page 7

2-Channel PWM - Valley and Peak Intensity - Option 1

Duty Cycle Channel 1 - Intensity of a Flat Spot	
10% (±4%)	The current vehicle speed does not allow for evaluation, or the measured values are too low to draw any conclusions.
20% (±4%)	The current vehicle speed is within the permissible evaluation range. There is no evidence of a flat spot.
30% (±4%)	The current vehicle speed is within the permissible evaluation range. A periodic event was detected, but it cannot be definitively attributed to a flat spot.
40% to 80% (±4%)	**The current vehicle speed is within the permissible evaluation range.** **A dip is detected:** 40% lower threshold—mild dip ... 80% Upper Threshold – very severe dip The thresholds for “mild” and “severe” can be customized, as the installation location (suspended/non-suspended) has a significant impact on the measured intensity.
90% (±4%)	An error condition is indicated. The flat spot detector has detected an internal hardware issue.

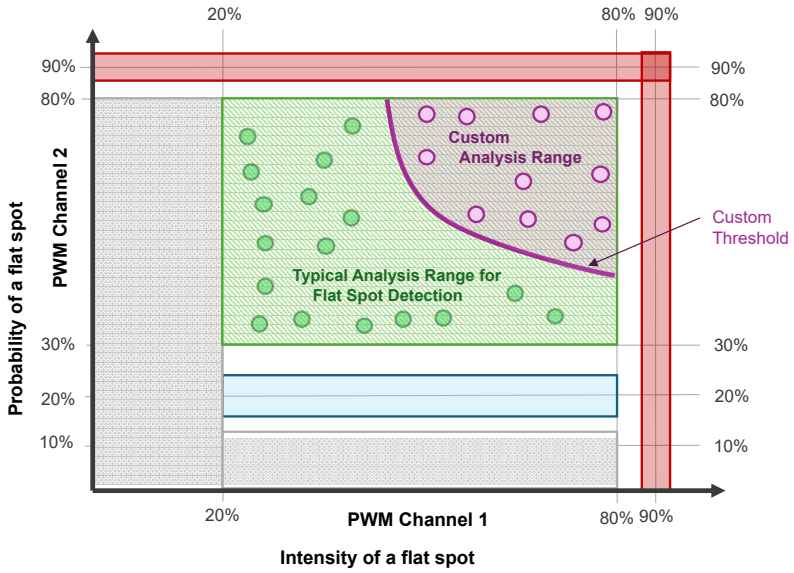
Duty cycle, **Channel 2** – Detection of rail damage (when using multiple flat spot detectors)	
When multiple flat spot detectors are used, impacts that occur sequentially rather than periodically along the measurement section (e.g., rail damage) can be detected.	
below 20% (±4%)	The current vehicle speed does not allow for evaluation, or the measured values are too low to draw any conclusions.
20% to 80% (±4%)	**The current vehicle speed is within the permissible evaluation range.** **An event is detected:** 20% Lower Threshold – Minor Event ... 80% Upper Threshold – very strong event The thresholds for “mild” and “severe” can be customized, as the installation location (suspended / unsuspended) has a significant impact on the measured intensity.
90% (±4%)	An error condition is signaled. The flat-panel detector has detected an internal hardware problem.

2-Channel PWM - Intensity and Probability of a Dip - Option 2

Duty cycle, **Channel 1**—Intensity of a flat spot	
less than 20% (±4%)	The current vehicle speed does not allow for an evaluation, or the measured values are too low to draw a conclusion.
20% to 80% (±4%)	**The current vehicle speed is within the permissible evaluation range.** **A dip is detected:** 20% lower threshold—slight dip ... 80% Upper Threshold – very severe dip The threshold values for “mild” and “severe” can be customized, as the installation location (suspended / unsuspended) has a significant impact on the measured intensity.
90% (±4%)	An error condition is indicated. The flat spot detector has detected an internal hardware problem.

Duty cycle, **Channel 2** — Probability that a flat spot was detected	
10% (±4%)	The current vehicle speed does not allow for evaluation, or the measured values are too low to draw a conclusion.
20% (±4%)	The current vehicle speed is within the permissible evaluation range. There is no indication of a flat spot.
30% to 80% (±4%)	**The current vehicle speed is within the permissible evaluation range.** **A flat spot is detected:** 30% lower threshold—low probability of a flat spot ... 80% Upper threshold—high probability of a flat spot
90% (±4%)	An error condition is indicated. The flat spot detector has detected an internal hardware problem.

Events are evaluated based on the combined signal components from PWM channel 1 and PWM channel 2 within the defined evaluation range. For flat spot detection, a customer-specific threshold can be set, above which events are classified as relevant and evaluated further. This allows detection to be flexibly adapted to the customer’s specific operational requirements, empirical data, and desired sensitivity levels.



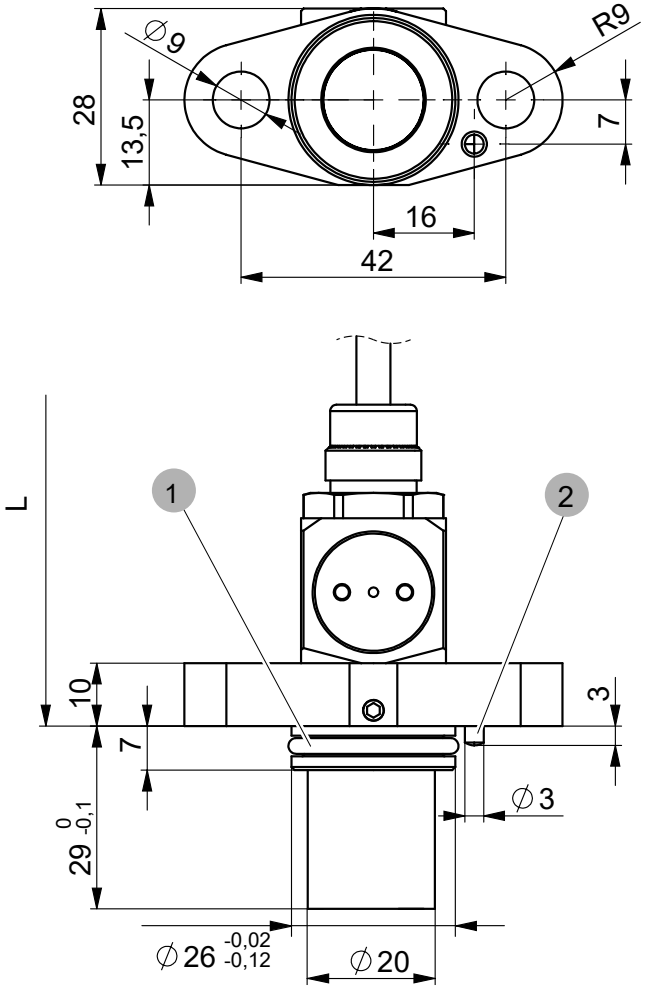
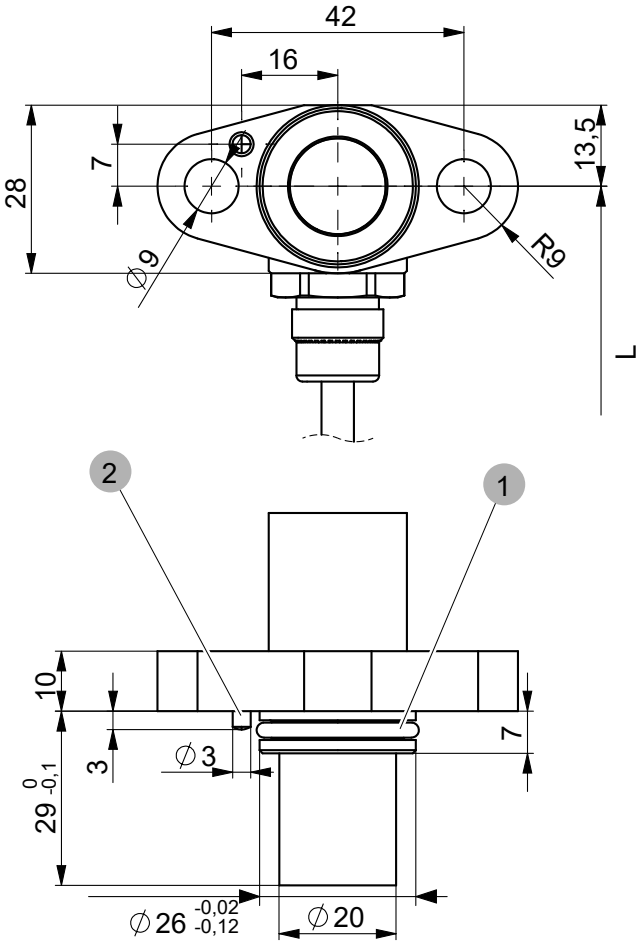
Mechanical Properties

Measuring Gear	
Requirements for the measuring gear	
Material	ferromagnetic steel
Tooth Profile	▪ Involute gearing per DIN 867 (see type code) ▪ Rectangular teeth, typically 1:1 (other ratios available upon request)
Width	≥ 15 mm (smaller widths available upon request)
Module m	Selection can be made in 0.25 increments from 1.00 to 3.50 (see model code)
Air gap (nominal air gap)	0.2 ... 1.5 mm (0.7 mm)

Shielding concept	
Selection of shield support	**Shield mounting on the encoder housing**
Option **SD**—directly mounted (see model code)	Directly connected to the sensor housing
Option **SC** – capacitively mounted (see model code)	Capacitively connected to the sensor housing
Option **SI** – isolated from the housing (see model code)	Isolated from the housing
Despite its high immunity to interference, the sensor must be integrated into a shielding concept to ensure EMC compliance.	

If the electromagnetic environment requires special shielding concepts, Lenord+Bauer provides extensive knowledge and experience to assist with integrating the sensor into the application's shielding concept.

Follow the EMC guidelines in the accompanying documents.

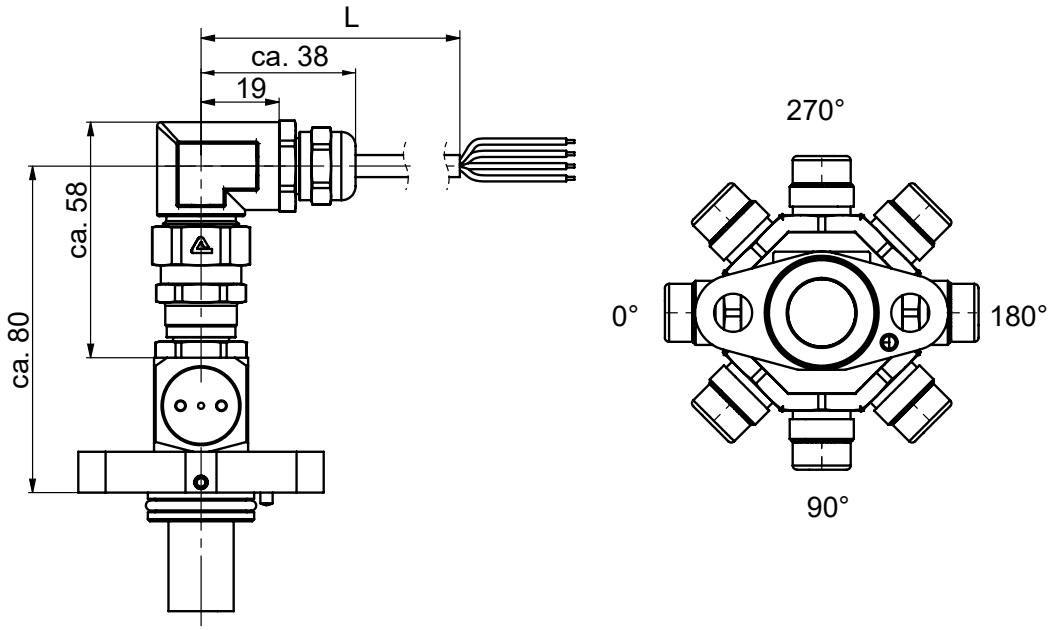
Cable outlet	
Straight cable outlet Option **S** (see Type Code)	**Side cable outlet** Option **L** (see Type Code)
Additionally, the straight cable outlet can be connected at an angle: *„**Straight Cable Exit with Angle**“, page 10*	Additionally, the side cable outlet can be connected using an angle: *„**Side cable outlet with angle**“, page 10*
	

1	Sealing ring: O-ring 21 x 2.5 mm; NBR
2	Index pin
L	Cable length **L** is determined by the Type Code (Tolerance depends on the assembled cable length)

Straight Cable Exit with Angle

Straight cable outlet with angle – When option **S** is selected for the cable outlet (see Type Code)

The selection can be made in 45° increments: 000°; 045°; 090°; 135°; 180°; 225°; 270°; 315° (tolerance ± 10°) (see Type Code).

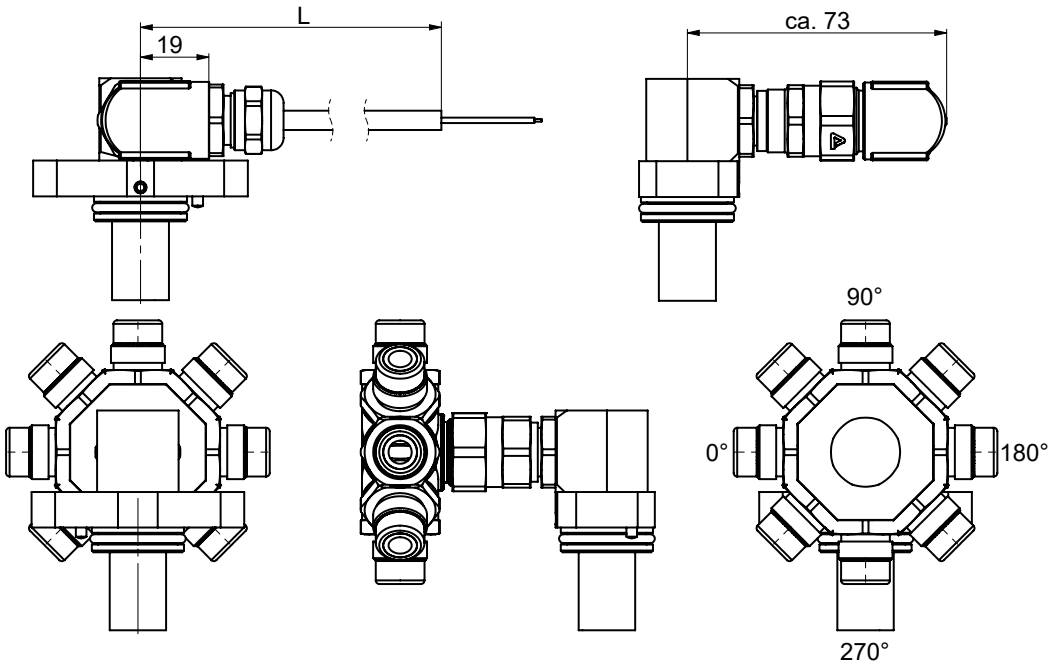


Cable length **L** is determined by the Type Code
(tolerance depends on the assembled cable length)

Side cable outlet with angle

Side cable outlet with angle – When selecting option **L** for the cable outlet (see Type Code)

The selection can be made in 45° increments: 000°; 045°; 090°; 135°; 180°; 225°; 270°; 315° (tolerance ± 10°) (see Type Code).



Cable length **L** is determined by the Type Code
(tolerance depends on the assembled cable length)

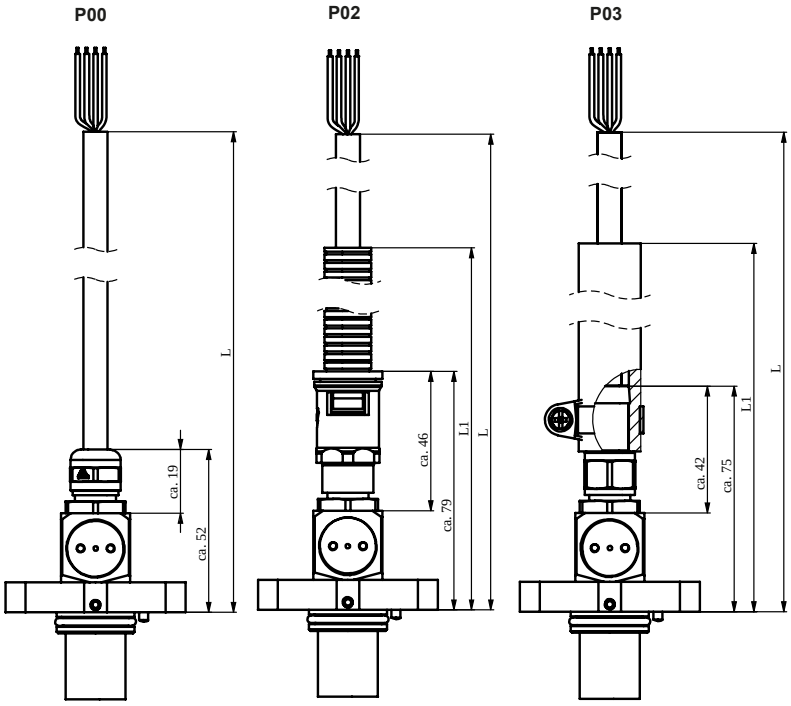
Cable Protection at the Cable Outlet	
The GEL 2475FD can be equipped with various types of cable protection at the cable outlet, as needed.	
▪ Dimensional drawings for straight cable outlet: *„**Straight cable outlet**“, page 11* ▪ Dimension drawings for side cable outlet: *„**Side Cable Exit**“, page 12*	
Selection **P00**	Without cable protection
Option **P02**	Corrugated tube NW12
Option **P03**	Hydraulic hose DN12

Technical Data for Cable Protection			
Option	**P00**	**P02**	**P03**
Type	12 × 0.34 mm²	Corrugated tube NW12	Hydraulic hose DN12
Material	halogen-free (specifications available upon request)	Polyamide, halogen-free	Rubber compound
Outer diameter	8.0 ± 0.3 mm	15.8 mm	19.5 ± 0.5 mm
Minimum bending radius	24 mm (static) 40 mm (dynamic)	35 mm (static) 80 mm (dynamic)	70 mm

Straight cable outlet

Cable protection for straight cable outlet—when option **S** is selected for the cable outlet (see Type Code)

The design depends on the cable protection option at the cable outlet: *„**Cable Protection at the Cable Outlet**“, page 11*

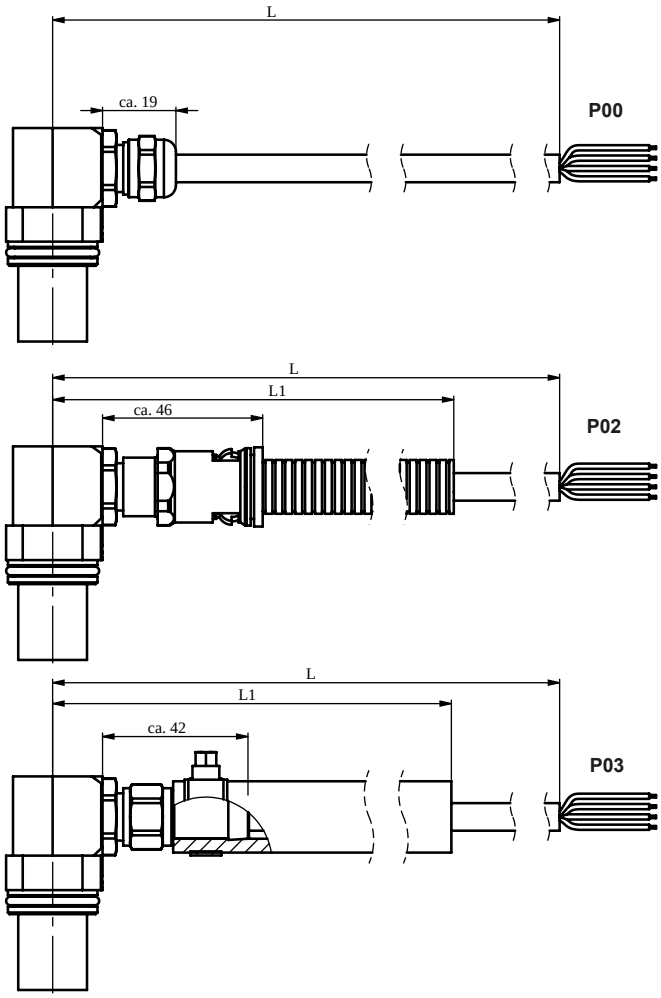


P00	Without cable protection
P02	Corrugated tube NW12
P03	Hydraulic hose DN12
L	Cable length **L** is determined by the Type Code (Tolerance depends on the assembled cable length)
L1	Protective hose length L1; depending on the cable connection and assembly, the protective hose length L1 corresponds to the cable length L minus 100 mm

Side Cable Exit

Cable protection for side cable outlet—when option **L** is selected for the cable outlet (see Type Code)

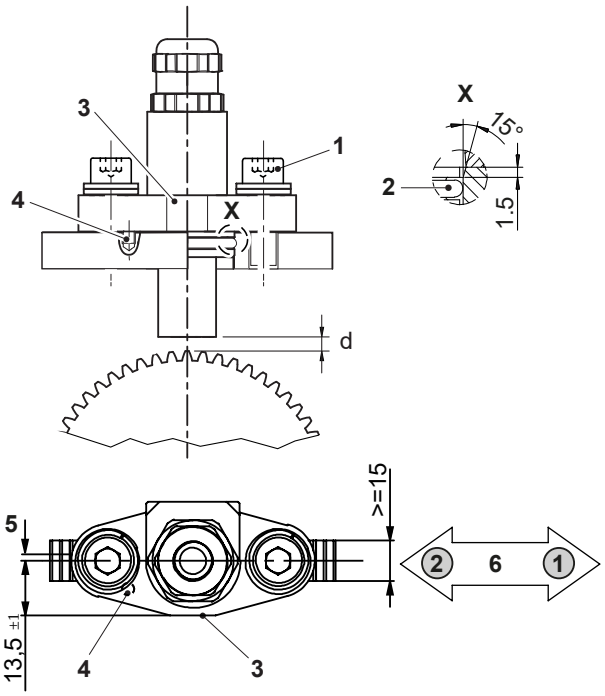
The design depends on the cable protection option at the cable outlet: *„**Cable Protection at the Cable Outlet**“, page 11*



P00	Without cable protection
P02	Corrugated tube NW12
P03	Hydraulic hose DN12
L	Cable length **L** is determined by the Type Code (Tolerance depends on the assembled cable length)
L1	Protective hose length L1; depending on the cable connection and assembly, the protective hose length L1 corresponds to the cable length L minus 100 mm

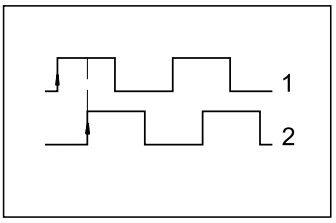
Installation Drawing

All dimensions in mm; general tolerance DIN ISO 2768 mK

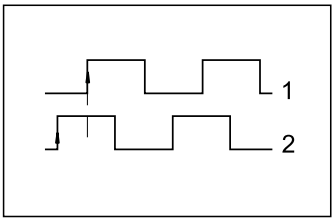


X Entry chamfer
d Air gap: 0.2 ... 1.5 mm
Nominal air gap: 0.7 mm maximum
Permissible runout: ± 0.3 mm
1 Mounting screw (recommended: M8 x 20, DIN EN ISO 4762)
2 Sealing ring
3 Reference surface
4 Index pin
5 Axial offset
6 Direction of rotation of the Target wheel

Signal for direction of rotation 1



Signal for direction of rotation 2



Other mounting orientations (such as rotated by 45°) are available upon request.

The reference surface (3) or the index pin (4) are used to determine the direction of rotation.

Index pin

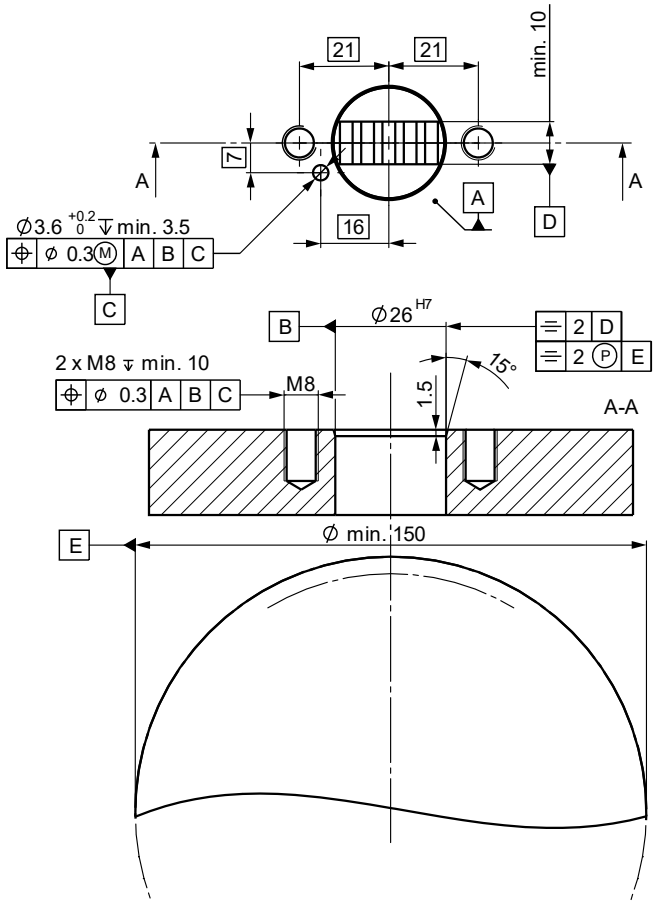
- If the Target wheel rotates from the index pin toward the center of the sensor, this is **rotation direction 1**.
- If the Target wheel rotates from the sensor center toward the index pin, this is **rotation direction 2**.

Reference surface

- If the Target wheel rotates clockwise when viewed from the reference surface, this is **rotation direction 1**.
- If the Target wheel rotates counterclockwise when viewed from the reference surface, this is **rotation direction 2**.

Drilling Pattern

All dimensions in mm; general tolerance per DIN ISO 2768 mK



Type Code GEL 2475FD

2475FD	Product Type									
	Signal Pattern									
	E-	1-channel square-wave signals								
	V-	2-Channel Square-Wave Signals with 90° phase offset								
	EM	1-Channel Square-Wave Signal and Standstill Voltage								
	VM	2-channel square-wave signals with 90° phase offset and Standstill Voltage								
		Condition Monitoring Interface								
		1	2-Channel PWM - Valley and Peak Intensity - Option 1							
		2	2-Channel PWM - Intensity and Probability of a Dip - Option 2							
			Screen Support							
			SD	directly attached						
			SC	capacitively attached						
			SI	isolated from the housing						
				Module		**Module**				
				M01	m = 1.00, steel, involute	**M12**	m = 1.00, steel, rectangular			
				M02	m = 1.25, steel, involute	**M13**	m = 1.25, steel, rectangular			
				M03	m = 1.50, steel, involute	**M14**	m = 1.50, steel, rectangular			
				M04	m = 1.75, steel, involute	**M15**	m = 1.75, steel, rectangular			
				M05	m = 2.00, steel, involute	**M16**	m = 2.00, steel, rectangular			
				M06	m = 2.25, steel, involute	**M17**	m = 2.25, steel, rectangular			
				M07	m = 2.50, steel, involute	**M18**	m = 2.50, steel, rectangular			
				M08	m = 2.75, steel, involute	**M19**	m = 2.75, steel, rectangular			
				M09	m = 3.00, steel, involute	**M20**	m = 3.00, steel, rectangular			
				M10	m = 3.25, steel, involute	**M21**	m = 3.25, steel, rectangular			
				M11	m = 3.50, steel, involute	**M22**	m = 3.50, steel, rectangular			
					Cable outlet					
					S	Straight cable outlet				
					L	Side cable outlet				
						angle				
						0	without angle			
						1	With angle, 0 degrees	**5**	with angle, 180 degrees	
						2	with angle, 45 degrees	**6**	with angle, 225 degrees	
						3	with angle, 90 degrees	**7**	with angle, 270 degrees	
						4	with angle, 135 degrees	**8**	with angle, 315 degrees	
							Cable protection			
							P00	None		
							P02	Corrugated tube NW12		
							P03	Hydraulic hose DN12		
								Cable length L		
								L2	2000 mm	
								L3	3000 mm	
								L4	4,000 mm	
									Tooth edge	
									XXX	Number of teeth on the gear
▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	
2475FD	__	__	__	___	_	_	___	__	___	**◄ Product code**

Accessories

ZB247XM8	2 M8 x 20 screws (EN ISO 4762) with washer and spring washer

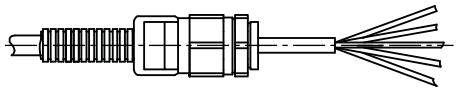
A Y-number is assigned for customer-specific designs. Custom designs are manufactured according to drawings or application descriptions and may differ from the standard technical specifications.

Examples of Preferred Types

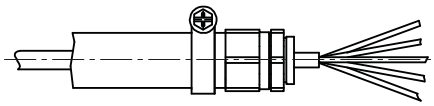
We can assemble the following for you upon request:

In addition to the extensive selection of cable exits and cable protection options (see Type Code), various configurations are also available for the cable end.

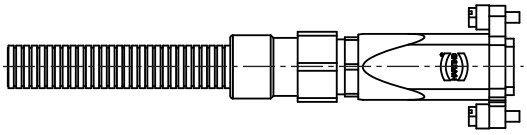
Examples of cable ends, preferred models



Corrugated tube and flying lead

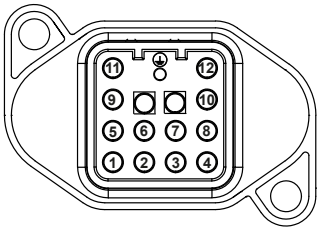


Rubber hose and flying lead



Corrugated tube with Harting HAN HPR connector

Pin assignment for Harting HAN HPR connector, preferred type



PIN	E-	V-	EM	VM
1	PWM Channel 1	PWM Channel 1	PWM Channel 1	PWM Channel 1
2	PWM Channel 2	PWM Channel 2	PWM Channel 2	PWM Channel 2
3				
4	-	Rotational speed Channel 2	-	Rotational speed Channel 2
5	GND (0V)	GND (0V)	GND (0V)	GND (0V)
6	$+U_B$	$+U_B$	$+U_B$	$+U_B$
7				
8	PWM GND	PWM GND	PWM GND	PWM GND
9	PWM U_B	PWM U_B	PWM U_B	PWM U_B
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 us assemble our Speed Sensors with cable protection and connectors, we recommend using the preferred types shown here. The necessary materials have been field-tested in large quantities and are always in stock. This allows us to achieve the fastest delivery times thanks to optimal material availability and the lowest retail prices due to large purchasing volumes. If you need assistance defining your desired product, please contact our sales team atsupport@lenord.deor +49(0)208 9963-215.

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