Made in Germany

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Technical Information

GEL 2449

MiniCODER Bearingless Rotary Encoder

Rotational Speed and Position Sensor with Sin/Cos Interface

D-51T-2449 | Status 2026-08-04

LENORD +BAUER

Finding solutions.
Founding trust.

Motion sensors and integrated drive technology

Overview

General Information

- Non-contact magnetic sensing for maximum service life
- Compact construction type fits into the smallest installation spaces with the harshest environmental conditions
- Compatible replacement solution for standard sensors on target wheels with module 0.4
- Fast, error-free parameterization and efficient commissioning with the GEL 211 Mobile Service Unit
- Integrated operating hours meter records rotational speed and temperature ranges during runtime

Features

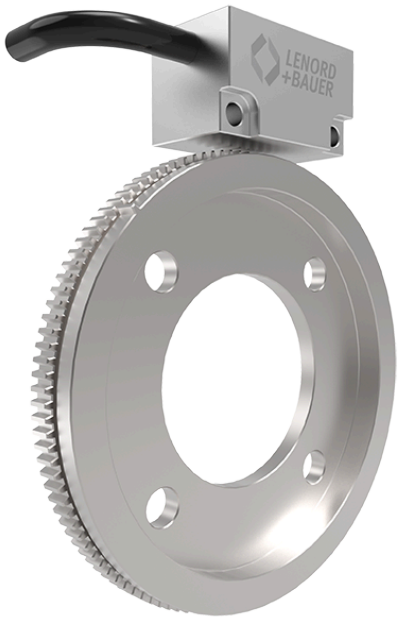
- Non-contact measurement for wear-free operation
- Low temperature drift and high signal quality
- Fully shielded metal housing
- Integrated operating hours meter
- Non-contact scanning of target wheels
- Compact, high-resolution construction type
- Safety Integrated
- Frequency range: up to 200 kHz
- Degree of protection: IP68
- Operating temperature range: -30 °C … +120 °C [-22 °F … 248 °F]

Advantages

- Maintenance-free electronics and wear-free mechanics
- High measurement stability and low error tolerances
- High immunity to interference
- Reliable operation even under extreme temperature fluctuations
- Easy integration into tight installation spaces
- Measurement of very high rotational speeds
- High shock and vibration resistance
- Resistant to environmental influences
- Easy commissioning and maintenance thanks to smart programming functions
- Robust alternative to sensitive pole-wheel sensors, pole-band systems, and expensive optical systems

Applications

- Position and speed measurement in machine tool manufacturing



MiniCODER with tangential cable outlet

Description

Product construction

The MiniCODERs are designed for non-contact measurement of rotational or linear motion, primarily in machines, gearboxes, motors, or high-speed spindles. They are manufactured using state-of-the-art microsystem technology and are fully encapsulated, making them particularly resistant to shocks and vibrations.

Measuring system

The measuring system consists of a MiniCODER and a target wheel. The system does not require its own bearings, as the target wheel is mounted directly on the machine shaft.

The measuring system operates non-contact, is wear-free, and requires no electrical maintenance. It detects the direction of rotation, rotational speed, and position of a rotating machine shaft.

The target wheel is made of ferromagnetic material and must be ordered separately.

The MiniCODER generates a magnetic field that is altered by the rotating target wheel. The sensors detect the change in the magnetic field, and the integrated electronics convert this into corresponding output signals. An external evaluation unit can read the output signals and determine the direction of rotation, rotational speed, and position of the machine shaft.

A defined air gap between the target wheel and the MiniCODER is required for non-contact measurement. To facilitate installation, a corresponding distance gauge is included with the MiniCODER.

Reference mark

The MiniCODER can determine the position of a machine shaft by detecting a reference mark.

The output is a rectangular differential reference signal (reference track N).

The MiniCODER evaluates the following reference marks:
Tooth (**Z**)

Module

Selectable modules:
- 1.0
- 0.4

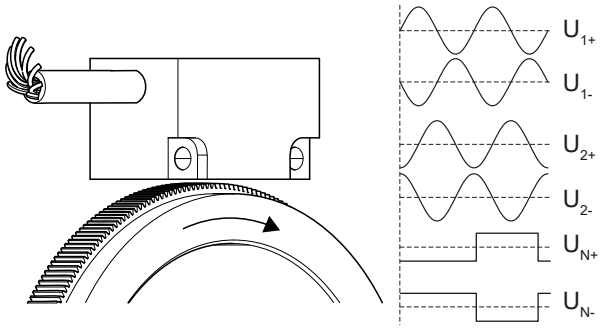
The MiniCODER must be ordered to match the reference mark design and the module of the target wheel.

Signal Pattern

Signal Pattern K

The output signals consist of two sine waves phase-shifted by 90° for direction detection (tracks 1 and 2) and their inverse signals.

The signal sequences depend on the direction of rotation.

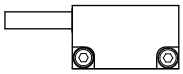


Output signals for clockwise rotation

U_{N*} Reference signal (reference track N)

MiniCODER cable outlets

The MiniCODER is available with the following cable outlets:



Tangential left (**L**)

Optional features for Signal Pattern K

Parameterizable (P)

The MiniCODER can be adjusted, analyzed, and configured using the GEL 211CS0 Mobile Service Unit.

Configuring the MiniCODER via the connector
- Adjustment of sine/cosine amplitudes without mechanical readjustment of the air gap
- Elimination of offset and amplitude errors to compensate for mounting tolerances
- Defining 7 speed ranges to activate the speed histogram in the MiniCODER
- Entering a spindle serial number (drive assignment)

In addition, various data are stored in the MiniCODER and can be read out:
- Speed histogram for analyzing the drive's operating conditions
- Number of ramp-ups
- Minimum/maximum temperature of the MiniCODER
- Item number and serial number of the MiniCODER
- Total operating time and time since the last configuration

Technical Data

GEL 2449

Electrical Data	
Supply Voltage U_B (reverse-polarity protected, overvoltage protected)	5 V DC ± 5%
Current consumption (no load)	≤ 50 mA
Output signal	Two sine waves offset by 90° and their inverse signals, short-circuit-proof; square-wave reference signal
Output signal level	1 V_{PP} Differential signal
Output frequency	0 … 200 kHz (1)
Power consumption without load	≤ 0.3 W
Mechanical Data	
Housing material	Die-cast zinc
Weight	100 g [3.53 oz]
Cable Data (Cable design —)	
Cable Construction (Number of Conductors × Conductor Cross-Section)	9 × 0.15 mm² [25 AWG]
Cable diameter	5 mm [0.20 in]
Minimum bend radius	25 mm [0.98 in]
Maximum allowable cable length	100 m [328.08 ft] (2)
Ambient Data	
Working temperature range	0 °C … +70 °C [32 °F … 158 °F]
Operating and storage temperature range	-30 °C … +120 °C [-22 °F … 248 °F]
Degree of protection at the cable outlet of the MiniCODER housing (3)	IP68
Dielectric strength	500 V AC / 1 min
Electromagnetic compatibility	Emission DIN EN 61000-6-4; DIN EN 61000-6-3 Immunity DIN EN 61000-6-2; DIN EN 61000-6-1
Vibration Resistance	200 m/s² [656.17 ft/s²], in accordance with EN 60068-2-6
Shock resistance	2000 m/s² [2187.23 yd/s²], in accordance with EN 60068-2-27
MTTF FIT	4,405,286 h at 55 °C [131 °F] 227 × 10^{-9} h^{-1} at 55 °C [131 °F]
Approvals	
European Economic Area	Compliance with EMC Directive 2014/30/EU CE

(1) With a line capacitance of 5 nF
(2) Note the voltage drop across the power supply cable
(3) Degree of protection specification for connectors in connection types **J**, **M**, **N**, **U**, **Z**: Upon request

Measuring system

Module	1	4
Target wheel		
Material	Ferromagnetic steel	
Width	≥ 8.6 mm [0.34 in]	
Reference mark	Tooth (**T**)	
Module m (1)	1.0	0.4
Nominal air gap	0.50 mm ± 0.02 mm [19.69 mil ± 0.79 mil]	0.20 mm ± 0.01 mm [7.87 mil ± 0.39 mil]

(1) Additional modules available upon request

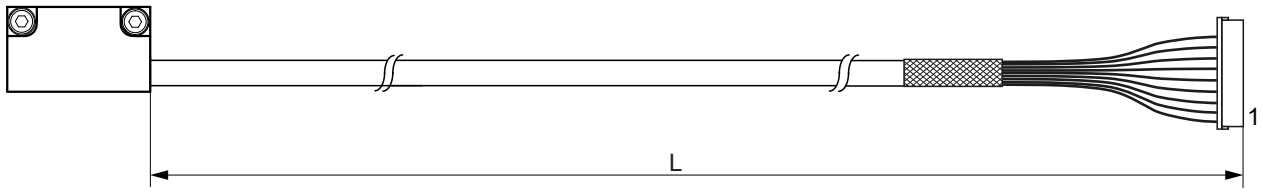
Electrical Connection

L = Cable length

For standard versions of the MiniCODER:
- The shield of the connection cable is connected to the MiniCODER housing.
- For metallized connectors, the shield of the connection cable is connected to the connector housing.
- For plastic connectors, the Shield of the connection cable is connected to a connector pin.

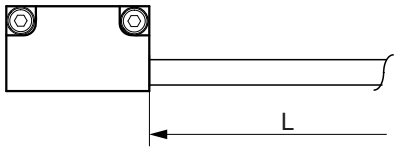
Connection example

MiniCODER cable outlet	Cable design	Connection type
L (tangential left)	**–** (without temperature sensor cable)	**P** (10-pin female connector)

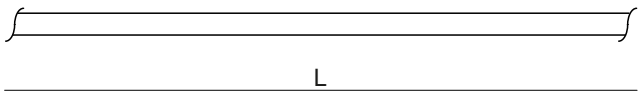
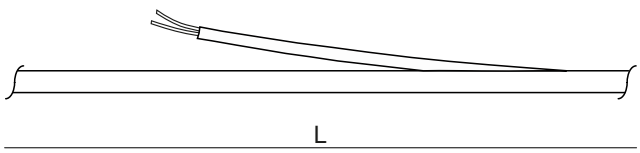
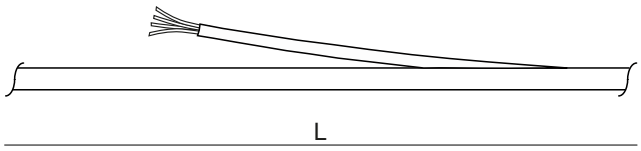
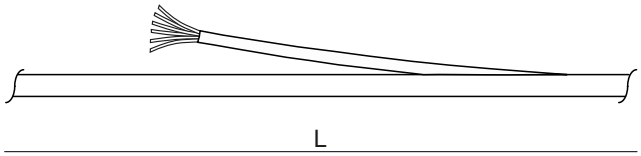


MiniCODER cable outlet

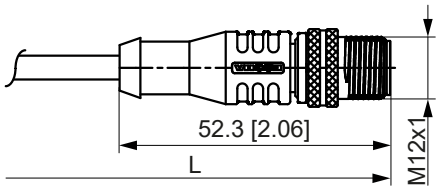
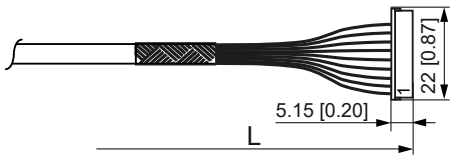
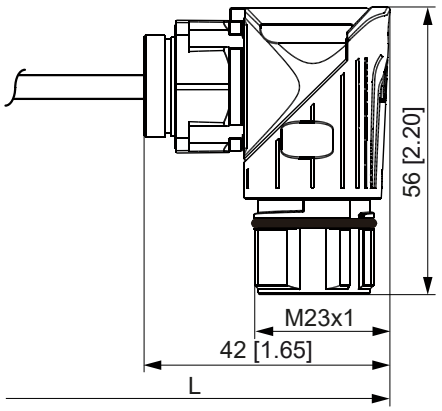
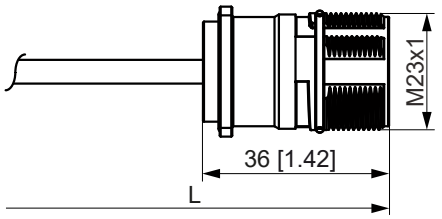
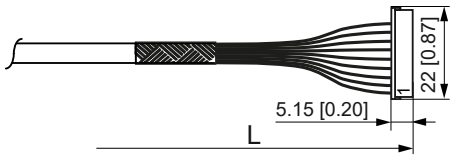
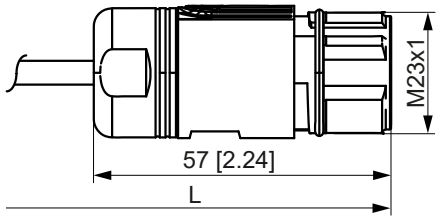
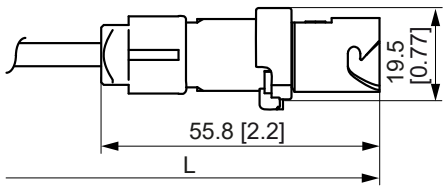
MiniCODER cable outlet
L (tangential left)



Cable designs

Cable design	
–: Without temperature sensor cable	
M: 2-wire temperature sensor cable, 2 m [78.74 in] long Cable Data ▪ TEFLON cable 2 × 0.14 mm² [26 AWG] ▪ Outer diameter: 2.8 mm ± 0.1 mm [110.24 mil ± 3.94 mil] ▪ Minimum bend radius: 20 mm [0.79 in]	
N: 4-wire temperature sensor cable, 2 m [78.74 in] long Cable Data ▪ ETFE Cable 4 × 0.14 mm² [26 AWG] ▪ Outer diameter: 3.5 mm ± 0.2 mm [137.8 mil ± 7.87 mil] ▪ Minimum bend radius: 7 mm [0.28 in]	
P: 6-wire temperature sensor cable, 2 m [78.74 in] long Cable Data ▪ ETFE Cable 6 × 0.14 mm² [26 AWG] ▪ Outer diameter: 3.5 mm ± 0.2 mm [137.8 mil ± 7.87 mil] ▪ Minimum bend radius: 7 mm [0.28 in]	

Connection types

Connection type	Dimensional Drawing of Connectors All dimensions in millimeters [inches]	Notes
J (12-pin male connector)		▪ Not available with temperature sensor cable! ▪ Available cable lengths: **030** / **050** / **250** / **600**
K (Flying lead) (1)		▪ Not available with temperature sensor cable! ▪ Available cable lengths: **030** / **050** / **150** / **250** / **600**
M (17-pin angled mounting box with male contacts)		▪ EMC shielding ▪ Strain relief and sealing ▪ IP67 (plugged in)
N (17-pin flush-mount connector with male contacts)		▪ EMC shielding ▪ Strain relief and sealing ▪ IP67 (plugged in)
P (10-pin female connector)		▪ Not available with temperature sensor cable! ▪ Cable length available to the nearest centimeter!
U (12-pin female connector with male contacts)		▪ Not available with temperature sensor cable!
Z (10-pin male connector)		▪ Not available with a temperature sensor cable! ▪ Available cable lengths: **120** / **200** / **250**

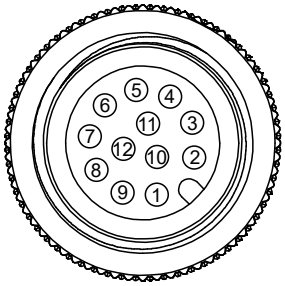
(1) The unit is shipped with a Lenord+Bauer test connector already attached.

Pin Assignments

With long power supply cables, the voltage drop across the cables can become so significant that it impairs the MiniCODER's operation. If using long power supply cables, be sure to use an external sense control!

Connection Type **J**

12-pin connector

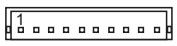


male contact
(plug-in view)

Pin designation	Signal designation	Function
1	U_{1+}	Signal track 1
2	U_{1-}	Inverse signal track 1
3	U_{N+}	Signal reference track N
4	0 V	GND
5	U_B	+5 V supply voltage
6	U_{2+}	Signal track 2
7	U_{2-}	Inverse signal track 2
8	U_{N-}	Inverse signal reference track N
9	Not used	
10	U_{Sense}	5 V Sense
11	Not used	
12	Not used	

Connection type **K**(1) and **P**

10-pin connector
(test plug)



female contact
(plug-in view)

Pin designation	Wire color	Signal designation	Function
1	Red	U_B	+5 V supply voltage
2	White	U_{1+}	Signal track 1
3	Brown	U_{1-}	Inverse signal track 1
4	Pink	U_{2+}	Signal track 2
5	Black	U_{2-}	Inverse signal track 2
6	Green	U_{Sense}	5 V Sense
7	Gray	U_{N+}	Signal reference track N
8	Yellow	U_{N-}	Inverse signal reference track N
9	Blue	0 V	GND
10	-	Not used	

The following applies when assembling a custom connector:

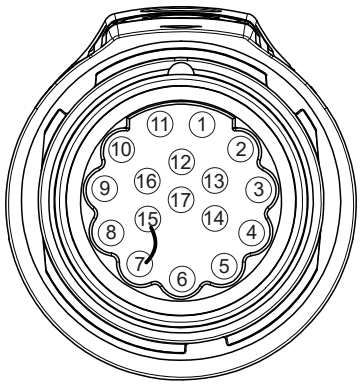
On MiniCODERs without a reference mark, the yellow and gray wires carry voltage. When connecting the cable, a short circuit between these wires can damage the MiniCODER. Insulate the wires or connect them via resistors (> 2 kΩ) to U_B or 0 V.

If a Mobile Service Unit is to be used for functional testing, the test plug must not be removed!

(1) The unit is shipped with the Lenord+Bauer test plug already attached.

Connection type **M** and **N**

17-pin mounting box



male contact
(plug-in view)

Pin designation	Signal designation	Function
1	U_{1+}	Signal track 1
2	U_{1-}	Inverse signal track 1
3	U_{N+}	Signal reference track N
4	Not used (1)	
5	Not used (1)	
6	Not used (1)	
7	0 V	GND
8	Not used (1)	
9	Not used (1)	
10	U_B	+5 V supply voltage
11	U_{2+}	Signal track 2
12	U_{2-}	Inverse signal track 2
13	U_{N-}	Inverse signal reference track N
14	Not used (1)	
15	0 V	GND (jumper pin 7)
16	U_{Sense}	5 V Sense
17	Not used	

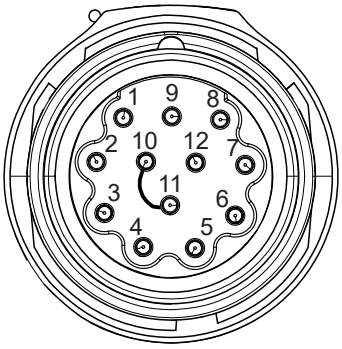
(1) Reserved for temperature sensor cable

Connection type **M** and **N**: Additional pin assignments when connecting a temperature sensor cable

Temperature sensor cable	Wire color	Pin designation	Signal designation
Cable design **M**: 2-wire temperature sensor cable	Brown	8	Temp +
	Blue	9	Temp –
Cable design **N**: 4-wire temperature sensor cable	Brown	8	Temp1 +
	White	9	Temp1 -
	Green	4	Temp2 +
	Pink	14	Temp2 –
Cable design **P**: 6-wire temperature sensor cable	Brown	8	Temp1 +
	White	9	Temp1 -
	Gray	6	Temp2 +
	Yellow	5	Temp2 -
	Green	4	Temp3 +
	Pink	14	Temp3 -

Connection type **U**

12-pin connector

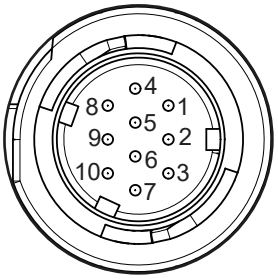


male contact
(plug-in view)

Pin designation	Signal designation	Function
1	U_{2-}	Inverse signal track 2
2	U Sense	5 V Sense
3	U_{N+}	Signal reference track N
4	U_{N-}	Inverse signal reference track N
5	U_{1+}	Signal track 1
6	U_{1-}	Inverse signal track 1
7	Not used	
8	U_{2+}	Signal track 2
9	Not used	
10	0 V	GND
11	0 V	GND (bridge pin 10)
12	U_B	+5 V supply voltage

Connection type **Z**

10-pin connector



male contact
(plug-in view)

Pin designation	Signal designation	Function
1	U_{2+}	Signal track 2
2	U_{2-}	Inverse signal track 2
3	Shield	-
4	U_B	+5 V supply voltage
5	U_{1+}	Signal track 1
6	U_{1-}	Inverse signal track 1
7	0 V	GND
8	U_{N+}	Signal reference track N
9	U_{N-}	Inverse signal reference track N
10	Not used	

Sense control not possible!

Instructions for properly assembling your own connector on the MiniCODER connection cable

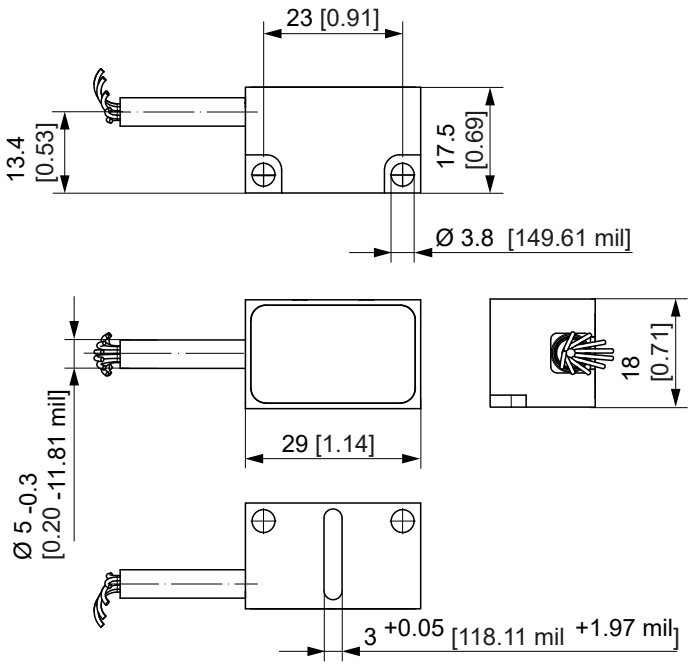
- The shield of the connection cable must not be connected to the “0 V” signal.
- The cable shield must be connected to the connector even for short cables (< 30 cm [11.81 in]).
- Ensure that no foreign objects or liquids can enter the cable to prevent damage to the MiniCODER.

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

Dimension Drawing

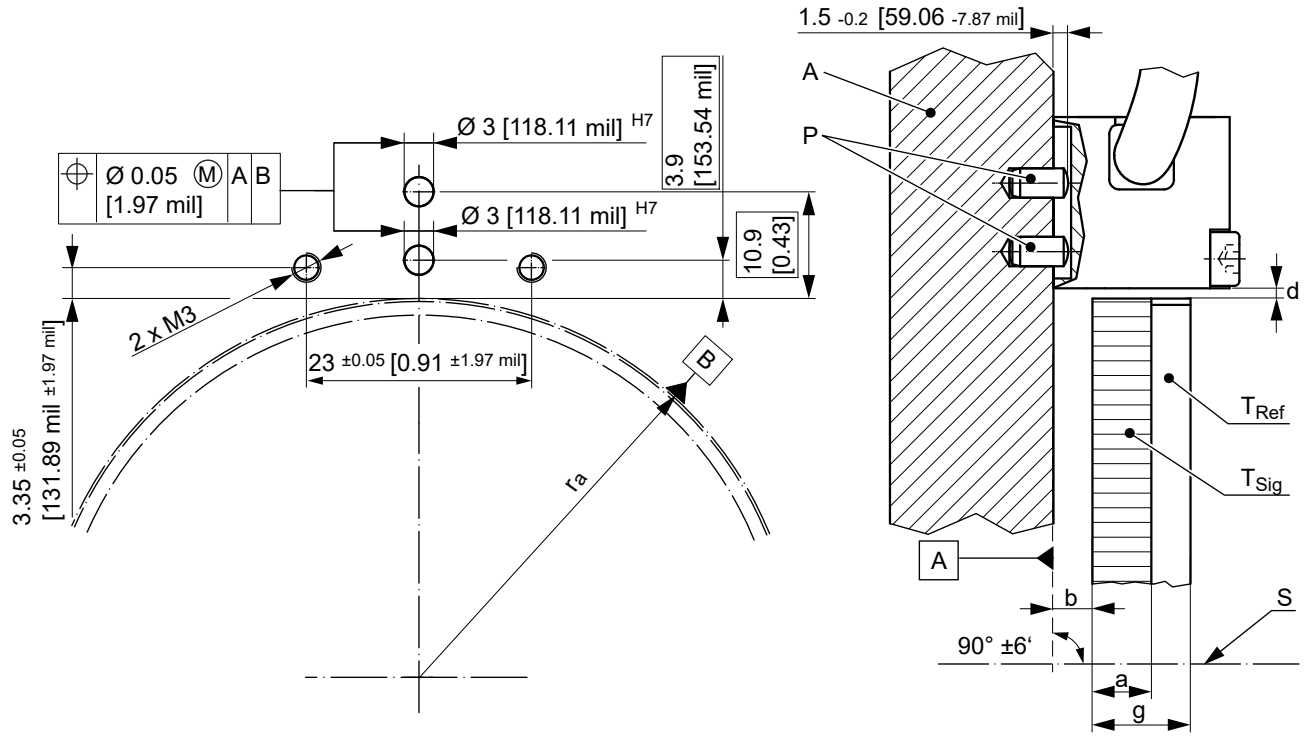
All dimensions in millimeters [inches]; general tolerance DIN ISO 2768 -mK

MiniCODER cable outlet: Tangential Left (**L**)



Drilling Pattern and Mounting Dimensions, Air Gap Table

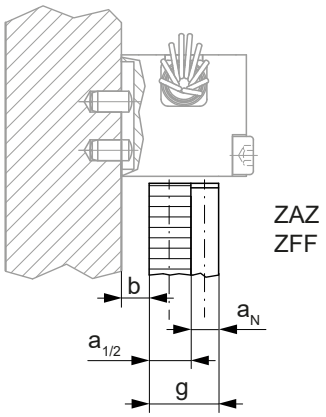
Drilling Pattern and Mounting Dimensions



All dimensions in millimeters [inches]

a Width of the signal track (depends on the target wheel)
b Distance from mounting surface to target wheel: depends on the geometry of the target wheel (for example, width of the signal track)
d Air gap: depends on the module (*see „air gap table“, page 13*)
g Width of the target wheel
r_a = $d_a/2$ (where d_a = face diameter of the target wheel)
A Mounting device
P M3 positioning pins
S Centerline of machine shaft / target wheel
T_{Ref} Reference track (target wheel)
T_{Sig} Signal track (target wheel)

Installation dimensions for standard target wheels		
Di-men-sion	ZAZ	ZFF
g	10 [0.39]	8.6 [0.34]
$a_{1/2}$	6 [0.24]	4.6 [181.10 mil]
a_N	4 [157.48 mil]	4 [157.48 mil]
b	4 ± 0.2 [157.48 mil ± 7.87 mil]	4.7 ± 0.2 [185.04 mil ± 7.87 mil]



Air Gap Table

Module	Module m	Nominal air gap d
1	1.0	0.50 mm ± 0.02 mm [19.69 mil ± 0.79 mil]
4	0.4	0.20 mm ± 0.01 mm [7.87 mil ± 0.39 mil]

To facilitate installation, the MiniCODER comes with a corresponding distance gauge.

Type Code

2449	**Product type**							
	K	**Signal pattern** Sin/Cos signals 1 V_{PP}						
		Z	**Reference mark** Tooth-to-tooth					
			P	**Optional features** Parameterizable				
				L	**MiniCODER cable outlet** Tangential, cable outlet on the left			
					1 1.0 **4** 0.4	**Module m** (1)		
						J 12-pin male connector (available only with cable lengths 030 / 050 / 250 / 600) **K** Flying lead (2) (available only for cable lengths 030 / 050 / 150 / 250 / 600) **M** 17-pin angled mounting box with male contacts **N** 17-pin flush-mount box with male contacts **P** 10-pin female connector (test connector), cable length selectable to the nearest centimeter **U** 12-pin connector with male contacts **Z** 10-pin male connector (available only in cable lengths of 120 / 200 / 250)	**Connection type**	
							030 0.3 m [11.81 in] **050** 0.5 m [19.69 in] **120** 1.2 m [47.24 in] **150** 1.5 m [59.06 in] **200** 2.0 m [78.74 in] **250** 2.5 m [98.43 in] **600** 6.0 m [236.22 in]	**Cable length L** (3)
								– Without temperature probe cable **M** With 2-wire temperature sensor cable (only for connection type **M**, **N**) **N** With 4-wire temperature sensor cable (only for connection type **M**, **N**) **P** With 6-wire temperature sensor cable (only for connection types **M**, **N**)	**Cable design for temperature sensor, 2 m [78.74 in]**
▼	▼	▼	▼	▼	▼	▼	▼	▼	
2449	–	–	–	–	–	–	– – –	–	**◄ Product code**

(1) Additional modules available upon request
(2) The product is shipped with a Lenord+Bauer test connector already attached.
(3) Other cable lengths available upon request; maximum cable length: 6.0 m [236.22 in]

If you have any questions, please contact our support team (support@lenord.de) or one of our company locations (*see „contact information“, page 20*).

Technical information on MiniCODERs with other Signal patterns is available online (*see „contact information“, page 20*).

Use in Security Applications

Fault detection has a significant impact on the availability of safety functions. This must be implemented by the controller, since no fault detection is integrated into the sensor.

Safety of the Overall System

The safety of the drive train and the machine can only be assessed by the machine manufacturer in accordance with the relevant guidelines, standards, and safety regulations.

$MTTF_d$ (1)

It is assumed that only 50% of hardware failures in electronic components are hazardous failures. Therefore, $MTTF_d$ values can typically be assumed to be twice the MTTF value (2) (Sources: EN ISO 13849-1:2008 (D); Annex C, Section 5.2 Semiconductors; EN 61800-5-2:2007, Annex B, Section 3.1.3 Proportion of Safe Failures). The expected operating temperature must be taken into account.

PFHd (3)

Performance levels or SIL levels do not refer to the reliability of individual components, but rather to the availability of safety functions.
The $MTTF_d$ values of the sensors are also included in these calculations.

Characteristic Values as a Function of Temperature		
Operating temperature	FIT in 10^{-9} h^{-1} (4)	MTTF in h (2)
55 °C [131 °F]	227	4,405,286

(1) Mean time to failure “dangerous”;
average operating time until a failure posing a hazard occurs

(2) Mean time to failure;
average operating time until failure

(3) Probability of dangerous failure per hour;
average probability of a dangerous failure

(4) Failure rate;
that is, failures per 10^9 hours

Safety Integrated

MiniCODER units with Sin/Cos signals (Signal Pattern **K**) have been tested by the IFA in conjunction with Siemens Sinumerik controllers in accordance with Safety Integrated.

IFA assessment
(IFA Test Report No. 2013 23874):

“The sensor is capable of providing two independent speed readings. Because of the error detection capability in the Sinumerik controllers, only one sensor needs to be used for safety applications.”

Controllers from other manufacturers

For controllers with safety functions from other manufacturers, error detection must take place within the controller, just as with the Sinumerik:

- Errors in the encoder function are detected by monitoring the differential Sin/Cos signals in the downstream controller. To this end, the amplitudes, frequency, offset, or phase of the Sin/Cos signals should be checked for plausibility.
- Mechanical slippage or the detachment of the target wheel from the shaft during operation or when the system is at a standstill should, for example, be prevented by a positive-lock connection.

Some measures for fault detection by controllers when using sinusoidal sensor signals are listed in DIN EN 61800-5-2, Table 16, for electric power drive systems with adjustable rotational speed.

Explanations Regarding the Target Wheel

Target wheels

To measure rotational motion, MiniCODERs are used in combination with target wheels. The size of the target wheel —and thus its diameter—depends directly on the module and the number of teeth.

Standard target wheels

Standard target wheels are available for immediate delivery ex works. For specifications and designs, see “Technical Information ZAx / ZFx (D-51T-ZAx/ZFx)”.

Custom target Wheels

Custom target wheels are manufactured individually upon customer request. Please send us a design drawing of your target wheel (preferably as a PDF file) to info@lenord.de.

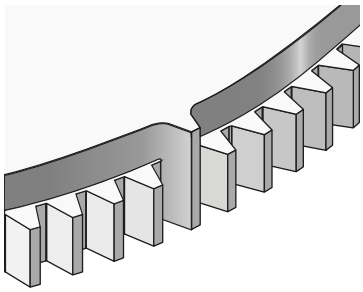
Reference marks

The MiniCODER can detect tooth-shaped reference marks. The captured reference signal can be used to establish the reference position. This is required, for example, for the automatic change of a tool on a milling or grinding spindle.

The selection of the reference mark is determined by the size and rotational speed of the target wheel being used, as both factors influence the forces acting on the reference mark.

Reference mark Z – Tooth-to-Tooth

These target wheels are manufactured from a single piece.



Z = Reference mark – tooth

Module

The module is a gear dimension for target wheels and describes the relationship between the number of teeth and the diameter of the target wheel. For the same number of teeth, the smaller the module, the smaller the outer diameter.

The MiniCODER must be ordered to match the reference mark design and the module of the target wheel.

Accessories

GEL 211CS04␣2M Mobile Service Unit

- Testing of Lenord+Bauer sensors with 1 V_{PP} Sin/Cos output, such as the MiniCODER
- Transmission of data via Wi-Fi or Ethernet to mobile devices (such as a tablet or PC)
- Visualization of data in a web browser, regardless of the operating system
- Used to verify that signals comply with configurable tolerance limits
  - Sin/Cos signals (amplitude, offset, phase offset)
  - Reference signal (amplitude, offset, position, and width)
  - Target wheel (damage, concentricity, tooth quality)
- Defining and saving different tolerance limits
- Used for configuring the MiniCODER
  - Automatic calibration of the Sin/Cos signals
  - Configuring/reading the operating hours meter (speed histogram)
  - Saving the 7 configured speed ranges of the operating hours meter in a data set; multiple data sets can be stored in the GEL 211

Accessories

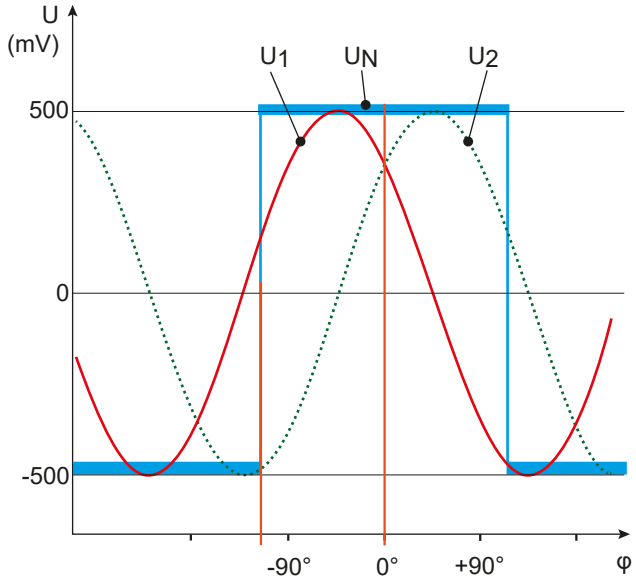
Part Number:	Description:
PK211C-244XK-E	Parameterization Kit (Ethernet), consisting of: ▪ GEL 211CS04E2M Mobile Service Unit ▪ GG211 sensor connection cable ▪ 5V power supply, ZB211CB ▪ Operating Instructions D-71B-211CS0 or D-53B-211CS0 ▪ Carrying case, XW1303
PK211C-244XK-W	Configuration Kit (Wi-Fi), consisting of: ▪ GEL 211CS04W2M Mobile Service Unit ▪ Sensor connection cable GG211 ▪ 5V power supply, ZB211CB ▪ Operating Instructions D-71B-211CS0 or D-53B-211CS0 ▪ Carrying case, XW1303
GEL SDA10 (1)	Precision Box for GEL 2444K or 2449K
GG211-JAE	Adapter cable for Mobile Service Unit — MiniCODER with connection type **Z**
GG211-12POL-M23	Adapter cable for Mobile Service Unit — MiniCODER with connection type **U**
GG211-17POL-M23	Adapter cable for Mobile Service Unit — Precision-Box GEL SDA10

(1) For more information on the Precision-Box, see Technical Information GEL SDA10

Sensors with Signal pattern **T** cannot be analyzed using the Mobile Service Unit.

Information on the Rectangular Reference Signal

A system controller evaluates the zero-crossings of the rising and falling edges of the reference signal to determine the width and position of the reference signal.



$U_1 = U_{1+} - U_{1-}$
$U_2 = U_{2+} - U_{2-}$
$U_N = U_{N+} - U_{N-}$

The rectangular reference signal depends on
- the width and shape of the reference mark
- the position of the reference mark relative to the teeth of the signal track
- the module of the target wheel

The following applies to the rectangular reference signal:
- The amplitude of the reference signal is independent of the air gap and is ideally set to +500 mV.
- The offset level of the open-circuit voltage is fixed at -500 mV to ensure a high signal-to-noise ratio.

The reference signal complies with standard specifications for reference signals when using a 1 V_{PP} interface.

If you have any questions, please contact our support team (support@lenord.de) or one of our company locations (*see „contact information“, page 20*).

Europe

Germany

Lenord, Bauer & Co. GmbH
Dohlenstrasse 32
46145 Oberhausen
Tel. +49 (0)208 9963 0
Email info@lenord.de
www.lenord.de

Italy

Lenord+Bauer Italia S.r.l.
Via Gustavo Fara, 26
20124 Milan
Tel. +39 340 1047184
Email salesitaly@lenord.com
www.lenord.com

Spain

Lenord Bauer Iberica, S.L.
Carrer de Balmes, 150, 5°
08008 Barcelona
Tel. +34 603 607 499
Email info@lenord.es
www.lenord.com

North America

USA

Lenord+Bauer USA Inc.
32000 Northwestern Highway, Suite 150,
Farmington Hills, MI 48334
Tel. +1 248 446 7003
Email orders@lenord.com
www.lenord.com

Asia

China

Lenord+Bauer Automation Technology (Shanghai) Co., Ltd.
Block 42, Room 302, No. 1000,
Jinhai Road, 201206 Shanghai
Tel. +86 21 50398270
Email Info@lenord.cn
www.lenord.cn

India

Lenord+Bauer India Private Limited
417 Golden Square Prime Serviced Office
Davanam Sarovar Portico Suites
Hosur Main Road, Bengaluru 560068
Karnataka
Tel. +919901516814
Email info@lenord.co.in
www.lenord.co.in

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