HEIDENHAIN


Functional Safety

Product Information

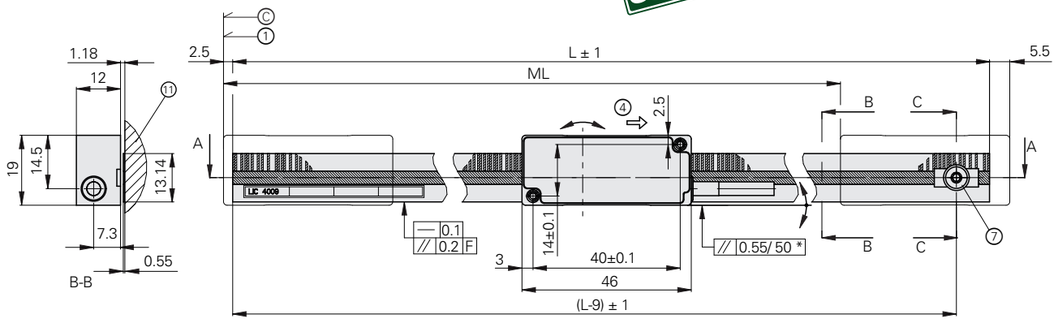
# LIC 4119

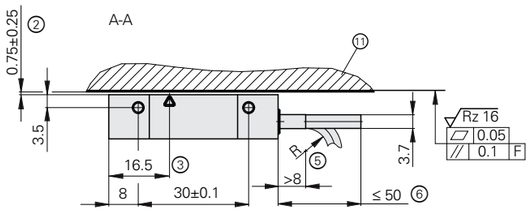
Absolute Linear Encoder for Safety-Related Applications

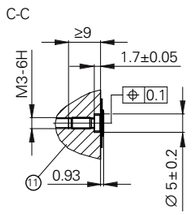
02/2024

# LIC 4119

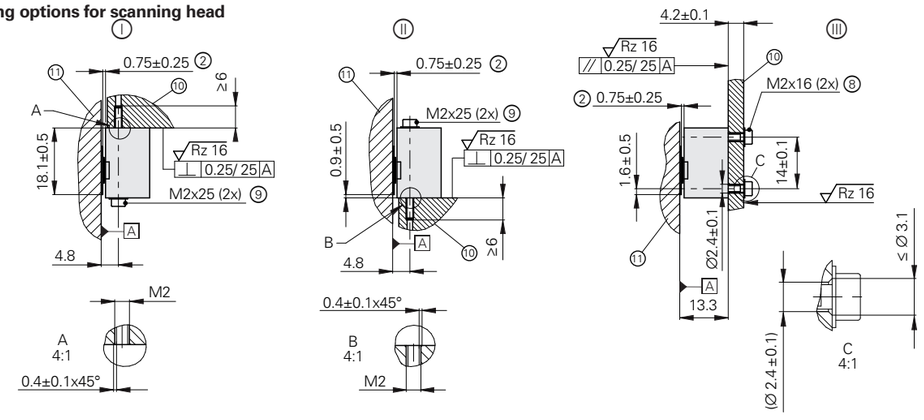
**Absolute linear encoder with high accuracy for safety-related applications**
- **For measuring steps of down to 1 nm**
- **Steel scale tape adhesively bonded to mounting surface**
- **Consisting of a linear scale and scanning head**
- **Fault exclusion for the loosening of the mechanical connection**




**Mounting options for scanning head**




I, II,
III = Mounting options
F = Machine guideway
* = Mounting error plus dynamic guideway error
C = Code start value: ≥ 100 mm
ML = Measuring length
L = Scale tape length (L = ML+38)
1 = Beginning of measuring length
2 = Mounting clearance from scanning head to scale tape
3 = Optical centerline
4 = Direction of scanning unit motion for output signals in accordance with interface description
5 = Bend radius R of the cable:
– Fixed cable ≥ 8 mm
– Frequent flexing ≥ 40 mm
6 = Cable support
7 = Screw (symmetrical alignment relative to punched hole), hexalobular socket: ISO 10664- 10; materially bonding threadlocker required; tightening torque = 40 ±2.4 Ncm
8 = M2x16 ISO 4762- 8.8 + ISO 7089- 2- 200HV
9 = M2x25 ISO 4762- 8.8 + ISO 7089- 2- 200HV
10 = Angle bracket for scanning head
11 = Mounting surface for measuring standard

mm
Tolerancing ISO 8015
ISO 2768 - m H
≤ 6 mm: ±0.2 mm




| **Scanning head** | **LIC 411** Functional Safety |
|---|---|
| **Interface** | EnDat 2.2 |
| Ordering designation | EnDat22 |
| **Measuring step*** | 0.01 µm (10 nm)<br>0.005 µm (5 nm)<br>0.001 µm (1 nm) |
| Calculation time $t_{cal}$<br>Clock frequency | ≤ 5 µs<br>≤ 16 MHz |
| **Functional safety**<br>for applications with up to | • SIL 2 as per EN 61508<br>(further basis for testing: IEC 61800-5-3)<br>• Category 3, PL "d" as per EN ISO 13849-1:2015 |
| PFH | ≤ 20 · $10^{-9}$ (up to 6000 m above sea level) |
| **Safe position**[1] | Encoder: ±550 µm (safety-related measuring step SM = 220 µm)<br>Mechanical connection: fault exclusions for loosening of the scanning head and scale<br>(see *Functional safety*) |
| **Traversing speed**[2] | ≤ 600 m/min |
| **Interpolation error** | ±20 nm |
| **Electrical connection*** | Cable (1 m or 3 m) with 8-pin M12 coupling (male) or 15-pin D-sub connector (male) |
| Cable length[3] | ≤ 100 m |
| Supply voltage | DC 3.6 V to 14 V |
| Power consumption (max.) | *At 3.6 V:* ≤ 700 mW<br>*At 14 V:* ≤ 800 mW |
| Current consumption (typical) | *At 5 V:* 75 mA (without load) |
| **Vibration** 55 Hz to 2000 Hz<br>**Shock** 11 ms | ≤ 200 m/s² (EN 60068-2-6)<br>≤ 200 m/s² (EN 60068-2-27) |
| **Operating temperature** | –10 °C to 70 °C |
| **Relative air humidity** | ≤ 93% (at 40 °C/4d as per EN 60068-2-78);<br>condensation excluded |
| **Protection** EN 60529[4] | IP67 |
| **Mass** Scanning head<br>Connecting cable<br>Connector | ≤ 18 g (without cable)<br>20 g/m<br>*M12 coupling:* 15 g; *D-sub connector:* 32 g |

***** Please select when ordering
[1] Further tolerances may arise in the downstream electronics after position value comparison (contact mfr. of downstream electronics)
[2] See *General electrical information* in the *Interfaces of HEIDENHAIN Encoders* brochure
[3] With HEIDENHAIN cable; clock frequency ≤ 8 MHz
[4] In the application, the device must be protected from contamination by solids and liquids.
If necessary, use a suitable enclosure with seal and sealing air.


| Scale | LIC 4009 Functional Safety |
|---|---|
| **Measuring standard**<br>Coefficient of linear expansion | Steel scale tape with absolute and incremental METALLUR track<br>$\alpha_{therm} \approx 10 \cdot 10^{-6}\ K^{-1}$ |
| **Accuracy grade***<br>**Baseline error** | ±3 µm[1], ±15 µm[2]<br>≤ ±0.750 µm/50 mm (typical) |
| **Measuring length (ML)***<br>in mm<br>(at operating temperature –10 °C to 70 °C) | 70 120 170 220 270 320 370 420 520 620 720 820 920<br>1020 1220 1420 1620 1820 2020 2220[3] 2420[3] 2620[3] 2820[3] 3020[3] 3220[3] 3420[3]<br>3620[3] 3820[3] 4020[3] 4220[3] 4420[3] 4620[3] |
| **Measuring length (ML)***<br>in mm<br>(at operating temperature –10 °C to 50 °C) | 70 120 170 220 270 320 370 420 520 620 720 820 920<br>1020 1220 1420 1620 1820 2020 2220 2420 2620 2820 3020 3220 3420[3]<br>3620[3] 3820[3] 4020[3] 4220[3] 4420[3] 4620[3] 4820[3] 5020[3] 5220[3] 5420[3] 5620[3] 5820[3] 6020[3] |
| **Mass** Scale tape<br>Screw | 31 g/m<br>< 1 g |
| **Protection** [4] | IP00 |

* Please select when ordering
[1] Up to a measuring length of 1020 mm
[2] ±5 µm after linear-error compensation in the downstream electronics
[3] Additional measuring length only on steel mounting surface
[4] In the application, the device must be protected from contamination by solids and liquids. If necessary, use a suitable enclosure with seal and sealing air.



# Functional safety

The absolute linear encoders of the LIC 4100 series are an ideal position feedback solution for linear axes in safety-related applications. In conjunction with a safe control, the encoders can be used as single-encoder systems in applications with control category SIL 2 (as per EN 61508) or performance level "d" (as per EN ISO 13849).

The reliable transmission of the position is based on two independently generated absolute position values and on error bits provided to the safe control. The functions of the encoder can be used for numerous safety functions of the complete system as per EN 61800-5-2.

The LIC 4100 linear encoder can provide a safe, absolute position value at any time—including immediately after switch-on. Purely serial data transfer is performed via the bidirectional EnDat 2.2 interface.

In addition to the data interface, the mechanical connection of the encoder to the drive is also safety-relevant. In table D8 of the standard for electrical drive systems (EN 61800-5-2), the loosening of the mechanical connection between the encoder and the motor is listed as a fault that requires consideration. Since it cannot be guaranteed that the control will detect such errors, fault exclusion for the loosening of the mechanical connection is required in many cases.

Unless otherwise specified, HEIDENHAIN encoders are designed for a service life of 20 years (in accordance with ISO 13849).

**Fault exclusion for the loosening of the mechanical connection**
The machine manufacturer is responsible for the dimensioning of mechanical connections in a drive system. During the mechanical design phase, the OEM will ideally consider the conditions within the application. Verifying a safe connection, however, is both cost- and time-intensive. That's why HEIDENHAIN has developed a type-examined mechanical fault exclusion for the LIC 4100 series.

**Mounting and operating conditions**
This fault exclusion has been qualified for a wide range of encoder applications and is ensured for the operating conditions listed below.

| Mechanical connection | Fastening | Safe position for the mechanical coupling | Limited specifications[3] |
|---|---|---|---|
| **Scale** | Screw connection[1] [2] | ±0.0 mm | See specifications:<br>• Vibration<br>• Shock<br><br>See mounting information:<br>• Usable materials<br>• Mounting conditions |
| **Scanning head** | Mounting configurations I and II:<br>Screw connection:[2]<br>M2x25 ISO 4762 8.8 screws | | |
| | Mounting configuration III:<br>Screw connection:[2]<br>M2x16 ISO 4762 8.8 screws | | |

[1] A material bonding anti-rotation lock is to be used for the screw connections of the scale (mounting/servicing)
[2] Friction class B as per VDI 2230
[3] When compared with an LIC 4100 without functional safety

**Material**
The material used for the mounting surfaces of the scanning head and measuring standard must comply with the specifications provided in the table.

**Mounting temperature**
All information on screw connections is based on a mounting temperature of 15 °C to 35 °C.

**Measuring length**
During temperature changes, different coefficients of thermal expansion result due to the different materials of the scale tape and the mounting surface. The localized shift resulting from different coefficients of thermal expansion between the scale tape and the mounting surface (shearing of the adhesive film) must not exceed a value of 0.75 mm. It is from this that the stated measuring lengths arise. Longer measuring lengths are possible in individual cases. This must be checked for the given customer application.

**Mounting the scanning head**
M2 screws as per ISO 4762 8.8 are to be used for the mechanical fault exclusion (included in delivery). A PWM20/21 and the mounting wizard of the ATS software must then be used to check and optimize mounting.

**Mounting the scale tape**
The steel scale tape of the graduation is adhesively bonded directly to the mounting surface with PRECIMET adhesive mounting film, with pressure applied evenly with a roller. The scale tape is additionally secured by a screw (punched hole in scale tape). The mounting aid (included in delivery) facilitates the symmetrical alignment of the screw to the punched hole.

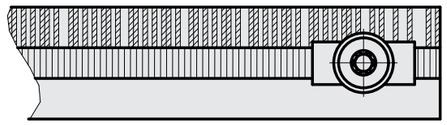
**Note:**
The scanning head may be operated only within the permissible mounting tolerances and measuring length of the measuring standard.

**Included in delivery:**
Scanning head
- Fastener kit (two screws: M2x16) ID 1233536-01
- Fastener kit (two screws: M2x25) ID 1233536-02
- Spacer shim ID 578983-06

Scale
- One screw ID 1233558-02
- Mounting aid ID 1244387-02

**Accessories:**
- Mounting wizard in ATS software
- Roller ID 276885-01

| | Angle bracket for scanning head | | Mounting surface for measuring standard |
|---|---|---|---|
| **Material** | Steel | Aluminum | Steel, aluminum |
| **Tensile strength $R_m$** | ≥ 600 N/mm² | ≥ 220 N/mm² | Not applicable |
| **Shear strength $\tau_B$** | ≥ 390 N/mm² | ≥ 130 N/mm² | Not applicable |
| **Elastic modulus E** | ≥ 200 000 N/mm² to 215 000 N/mm² | ≥ 70 000 N/mm² to 75 000 N/mm² | Not applicable |
| **Coefficient of thermal expansion $\alpha_{therm}$** | $10 \cdot 10^{-6}$ K$^{-1}$ to $17 \cdot 10^{-6}$ K$^{-1}$ | $25 \cdot 10^{-6}$ K$^{-1}$ | $10 \cdot 10^{-6}$ K$^{-1}$ to $25 \cdot 10^{-6}$ K$^{-1}$ |

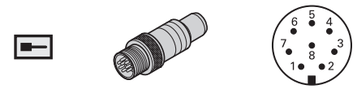




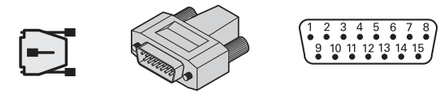
# Electrical connection

## EnDat pin layout

**8-pin M12 coupling**



**15-pin D-sub connector**

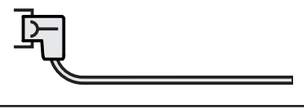



| | Power supply | | | | Serial data transmission | | | |
|---|---|---|---|---|---|---|---|---|
| | **8** | **2** | **5** | **1** | **3** | **4** | **7** | **6** |
| | **4** | **12** | **2** | **10** | **5** | **13** | **8** | **15** |
| | **$U_P$** | **Sensor** $U_P$ | **0 V** | **Sensor** 0 V | **DATA** | **$\overline{DATA}$** | **CLOCK** | **$\overline{CLOCK}$** |
| | Brown/Green | Blue | White/Green | White | Gray | Pink | Violet | Yellow |

**Cable shield** connected to housing; **$U_P$** = Power supply voltage
**Sensor:** The sense line is connected in the encoder with the corresponding power line.
Vacant pins or wires must not be used!

When engaged, the connections provide **protection** to IP67 (D-sub connector: IP50; EN 60529).
When not connected, there is no protection.

## EnDat adapter cables and connecting cables

| | | | |
|---|---|---|---|
| **PUR adapter and connecting cable** | 4 × (2 × 0.09 mm²); $A_P$ = 0.09 mm² | | |
| **PUR adapter and connecting cable** | (4 × 0.16 mm²) + (4 × 0.34 mm²); $A_P$ = 0.34 mm² | Ø 6 mm | Ø 3.7 mm[1)] |
| **Adapter cable** with 8-pin M12 connector (female) and 15-pin D-sub connector (male) |  | 524599-xx | 801129-xx |
| **Adapter cable** with 8-pin M12 right-angle connector (female) and 15-pin D-sub connector (male) |  | 722025-xx | 801140-xx |
| **Connecting cable** with 8-pin M12 connector (female) and 8-pin M12 coupling (male) |  | 368330-xx | 801142-xx |
| **Connecting cable** with 8-pin M12 right-angle connector (female) and 8-pin M12 coupling (male) |  | 373289-xx | 801149-xx |
| **Connecting cable** with 8-pin M12 connector (female) and free cable end (not stripped) |  | 634265-xx | – |
| **Connecting cable** with 8-pin M12 right-angle connector (female) and free cable end (not stripped) |  | 606317-xx | – |

[1)] Max. total cable length: 6 m
$A_P$: Cross section of power supply lines

HEIDENHAIN

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This Product Information document supersedes all previous editions, which thereby become invalid. The basis for ordering from HEIDENHAIN is always the Product Information document edition valid when the order is placed.

**More information:**

Comply with the requirements described in the following documents to ensure correct and intended operation:

- Operating Instructions: AK LIC 411 FS 1424229
- Operating Instructions: LIC 4009 FS parts kit 1424230

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