HEIDENHAIN


Functional Safety

Product Information

# LIC 4119

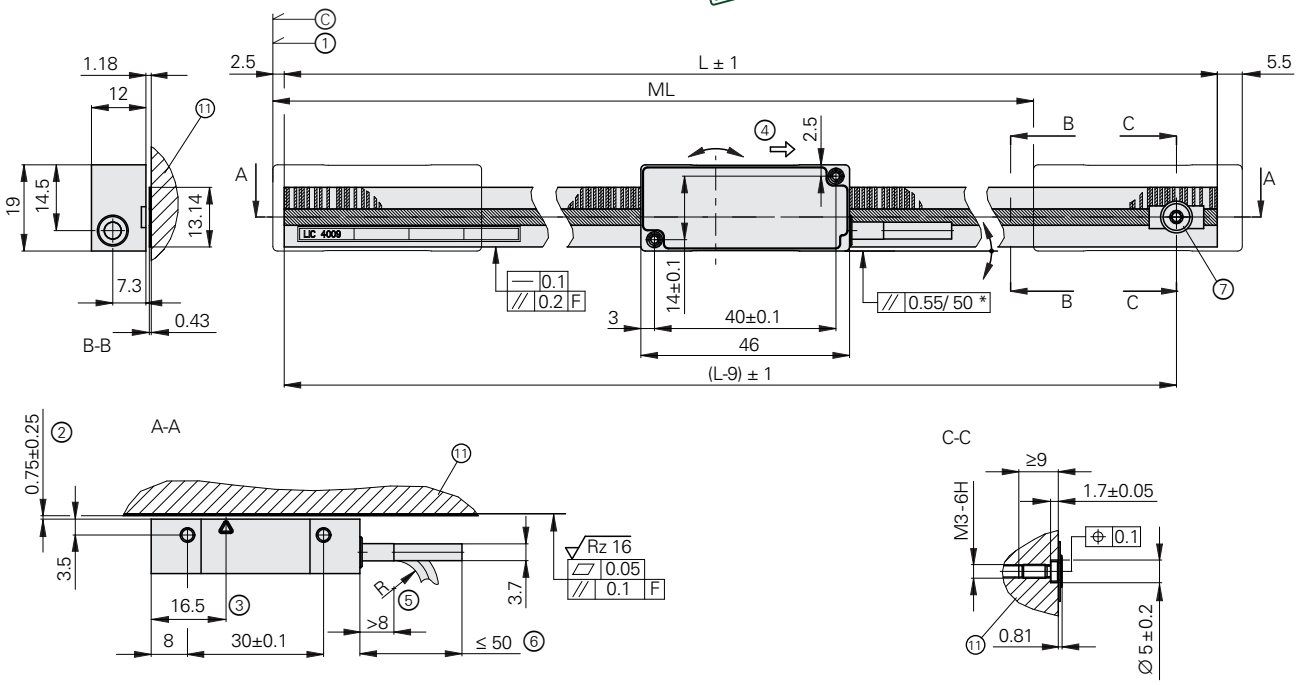
Absolute Linear Encoder for Safety-Related Applications

11/2018

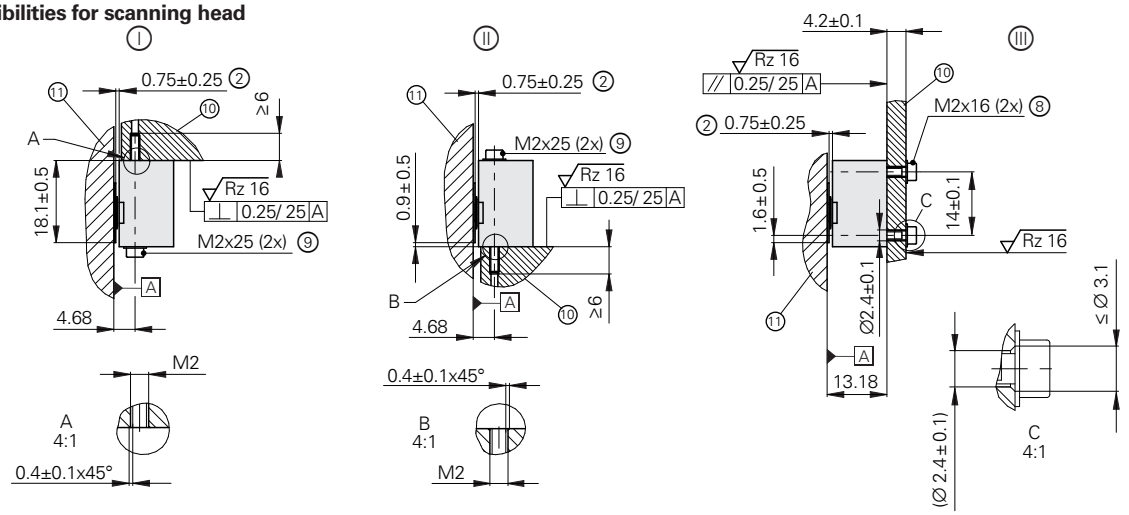
# LIC 4119

**Absolute linear encoder with high accuracy for safety-related applications**

- **For measuring steps down to 1 nm**
- **Steel scale tape is adhesively bonded to mounting surface**
- **Consists of a linear scale and scanning head**
- **Fault exclusion for the loosening of the mechanical connection**




**Mounting possibilities for scanning head**




F = Machine guideway
* = Mounting error plus dynamic guideway errors
C = Absolute track start value: 100 mm
ML = Measuring length
L = Length of scale tape (L = ML+38)
1 = Start of measuring length
2 = Mounting clearance between scanning head and scale tape
3 = Optical centerline
4 = Direction of motion of scanning unit for ascending position values
5 = Bend radius R of cable:
- Stationary cable ≥ 8 mm
- Frequent flexing ≥ 40 mm

6 = Cable support
7 = Screw (symmetrically aligned 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 up to | • SIL 2 as per EN 61508<br>(further basis for testing: EN 61800-5-2)<br>• Category 3, PL "d "as per EN ISO 13849-1:2015 |
| PFH | ≤ $20 \cdot 10^{-9}$ (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 $m/s^2$ (EN 60068-2-6)<br>≤ 200 $m/s^2$ (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>without condensation |
| **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 apply in subsequent electronics after position value comparison (contact manufacturer of subsequent 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.


| **Linear scale** | **LIC 4009** Functional Safety |
|---|---|
| **Measuring standard**<br>Coefficient of linear expansion | Steel scale tape with METALLUR absolute and incremental 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*** in mm | 70 120 170 220 270 320 370 420 520 620 720 820<br>920 [3] 1020 [3] 1220 [3] 1420 [3] 1620 [3] 1820 [3] |
| **Mass** Scale tape<br>Screw | 31 g/m<br>< 1 g |
| **Protection** [4] | IP00 |

***** Please select when ordering
[1] Up to measuring length 1020 mm
[2] ±5 µm after linear length-error compensation in the subsequent 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

With the absolute linear encoders of the LIC 4100 series, HEIDENHAIN offers an ideal solution for position acquisition 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 in the complete system as per EN 61800-5-2.

The LIC 4100 linear encoder provides a safe absolute position value at all times—including immediately after switch-on. Purely serial data transfer takes place via the bidirectional EnDat 2.2 interface.

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

Unless otherwise specified, HEIDENHAIN encoders are designed for a service life of 20 years (according to 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. The OEM should ideally consider the application conditions for the mechanical design. Providing objective evidence of a safe connection is time-consuming, however.
For this reason, HEIDENHAIN has developed a mechanical fault exclusion for the LIC 4100 series and confirmed it by way of a type examination.

**Mounting and operating conditions**
The qualification of the mechanical fault exclusion was performed for a broad application range of the encoders. This means that fault exclusion is ensured under 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:*<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 materially bonding anti-rotation lock is to be used for the screw connections of the scale (mounting or service)
[2)] Friction class B according to VDI 2230
[3)] When compared to an LIC 4100 with functional safety

**Material**
The data given in the table for the material of the mounting surfaces for the scanning head and measuring standard are to be complied with.

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

**Mounting the scanning head**
M2 screws according to 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 are then used to check and optimize the mounting.

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

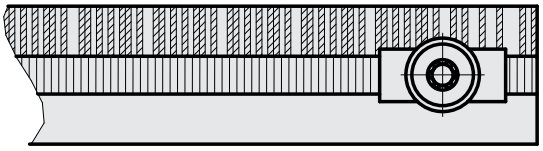
**Note:**
The scanning head may only be operated within the permissible mounting tolerances and measuring length of the measuring standard.

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

Scale
- One screw ID 1233558-01
- Mounting aid ID 1244387-02

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

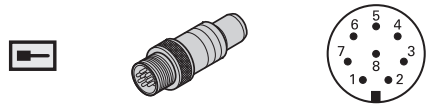
| | Angle bracket for scanning head | | Mounting surface for measuring standard |
|---|---|---|---|
| **Material** | Steel | Aluminum | Steel, aluminum |
| **Tensile strength $R_m$** | ≥ 600 N/mm$^2$ | ≥ 220 N/mm$^2$ | Not applicable |
| **Shear strength $\tau_B$** | ≥ 390 N/mm$^2$ | ≥ 130 N/mm$^2$ | Not applicable |
| **Elastic modulus E** | ≥ 200 000 N/mm$^2$ to 215 000 N/mm$^2$ | ≥ 70 000 N/mm$^2$ to 75 000 N/mm$^2$ | 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$^{-1}$ |



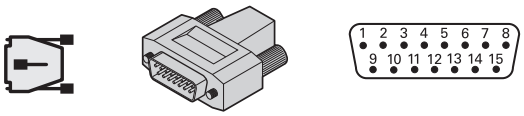
# Electrical connection

## EnDat pin layout

**8-pin M12 coupling**




**15-pin D-sub connector**




| | Power supply | | | | Serial data transfer | | | |
|---|---|---|---|---|---|---|---|---|
| | **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** | **$\overline{\text{DATA}}$** | **CLOCK** | **$\overline{\text{CLOCK}}$** |
| | 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 cables and connecting cables** | $4 \times (2 \times 0.09\ mm^2)$; $A_P = 0.09\ mm^2$ | | |
|---|---|---|---|
| **PUR adapter cables and connecting cables** | $(4 \times 0.16\ mm^2) + (4 \times 0.34\ mm^2)$; $A_P = 0.34\ mm^2$ | 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 made.

**More information:**

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

- Brochure: *Exposed Linear Encoders* 208960-xx
- Brochure: *Interfaces of HEIDENHAIN Encoders* 1078628-xx
- *Safety-Related Position Measuring Systems* Technical Information 596632-xx
- Specification for implementation in a safe control or inverter 533095-xx
- Mounting instructions: *LIC 4009* 1254218-01
  *AK LIC 411* 1254216-01
  *Mounting wizard* 1117241-01

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