HEIDENHAIN


Product Information

# LIF 471 V
# LIF 481 V
# LIF 481 U

Exposed Linear Encoder for High- and Ultrahigh-Vacuum Applications

03/2024

# LIF 471 V/LIF 481 V/LIF 481 U

**Incremental linear encoder for high- and ultrahigh-vacuum applications**
- **Special, vacuum-compatible version**
- **For measuring steps of down to 2 nm**
- **Position detection through homing track and limit switches**

Illustration without limit plate and fixed point

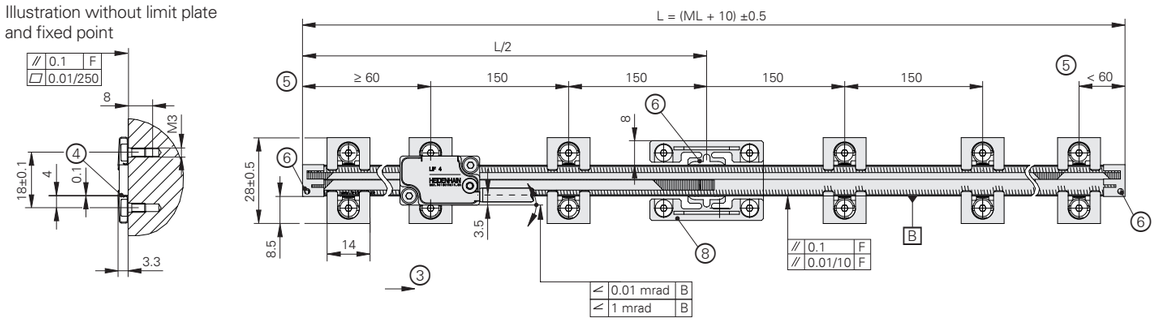
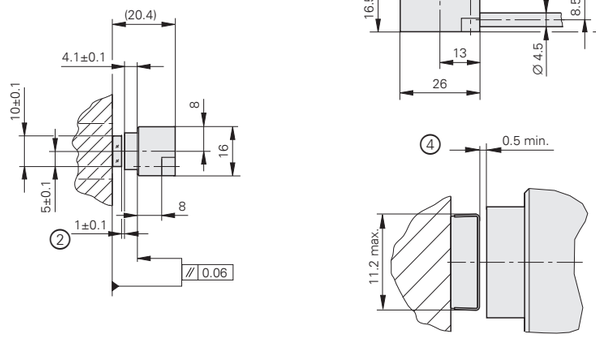
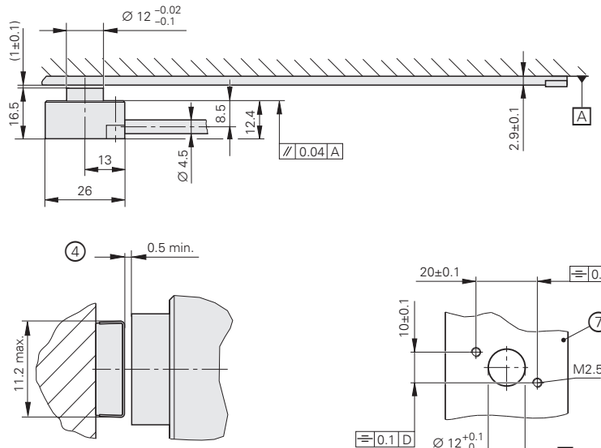



Illustration without fixing clamps, limit plates, and fixed point

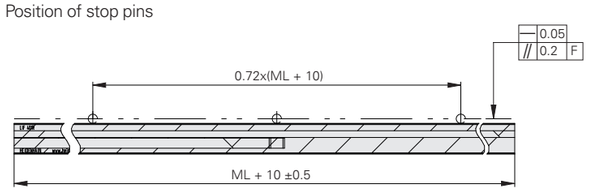


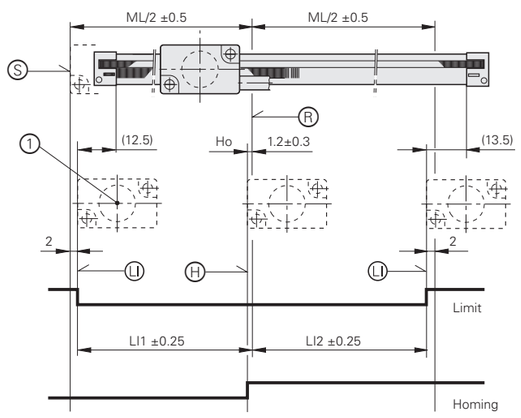







Position of stop pins




L = Scale length
F = Machine guideway
* = Maximum change during operation
ML = Measuring length
LI = Limit mark, adjustable
H = Switch for homing track, homing switching edges
Ho = Trigger point for homing
R = Position of reference mark
S = Beginning of measuring length
1 = Optical centerline
2 = Gap between scanning head / scale
3 = Positive direction of measurement
4 = Clearance set with spacer shim
5 = Additional pair of fixing clamps, depending on ML
6 = Vacuum adhesive, dries at room temperature in 24 h
7 = Mounting surface for scanning head
8 = Fixed-point element



| **Scale** | **LIF 401 R** |
|---|---|
| **Measuring standard*** Coefficient of linear expansion | SUPRADUR phase grating on Zerodur glass ceramic or glass; grating period: 8 µm<br>$\alpha_{therm} = (0 \pm 0.1) \cdot 10^{-6}\ K^{-1}$ (Zerodur glass-ceramic); $\alpha_{therm} \approx 8 \cdot 10^{-6}\ K^{-1}$ (glass) |
| **Accuracy grade** | ±3 µm |
| **Baseline error** | ≤ ±0.225 µm/5 mm |
| **Measuring length (ML)*** in mm | 70 120 170 220 270 320 370 420 470 520 570 620 670<br>720 770 820 870 920 970 1020 1140 1240 1340 1440 1540 1640 |
| Reference marks | One at midpoint of measuring length |
| **Mass** | 0.8 g + 0.08 g/mm of measuring length |

| **Scanning head** | **LIF 48 V/LIF 48 U** | **LIF 47 V** | | | | |
|---|---|---|---|---|---|---|
| **Interface** | ∿ 1 $V_{PP}$ | ⊓⊔ TTL | | | | |
| Integrated interpolation* Signal period | –<br>4 µm | 5-fold<br>0.8 µm | 10-fold<br>0.4 µm | 20-fold<br>0.2 µm | 50-fold<br>0.08 µm | 100-fold<br>0.04 µm |
| Cutoff frequency –3 dB | ≥ 1 MHz | – | | | | |
| Scanning frequency* | – | ≤ 500 kHz<br>≤ 250 kHz<br>≤ 125 kHz | ≤ 250 kHz<br>≤ 125 kHz<br>≤ 62.5 kHz | ≤ 250 kHz<br>≤ 125 kHz<br>≤ 62.5 kHz | ≤ 100 kHz<br>≤ 50 kHz<br>≤ 25 kHz | ≤ 50 kHz<br>≤ 25 kHz<br>≤ 12.5 kHz |
| Edge separation *a* | – | ≥ 0.080 µs<br>≥ 0.175 µs<br>≥ 0.370 µs | ≥ 0.080 µs<br>≥ 0.175 µs<br>≥ 0.370 µs | ≥ 0.040 µs<br>≥ 0.080 µs<br>≥ 0.175 µs | ≥ 0.040 µs<br>≥ 0.080 µs<br>≥ 0.175 µs | ≥ 0.040 µs<br>≥ 0.080 µs<br>≥ 0.175 µs |
| **Traversing speed**[1] | ≤ 240 m/min | ≤ 120 m/min<br>≤ 60 m/min<br>≤ 30 m/min | ≤ 60 m/min<br>≤ 30 m/min<br>≤ 15 m/min | ≤ 60 m/min<br>≤ 30 m/min<br>≤ 15 m/min | ≤ 24 m/min<br>≤ 12 m/min<br>≤ 6 m/min | ≤ 12 m/min<br>≤ 6 m/min<br>≤ 3 m/min |
| **Interpolation error**<br>**RMS position noise** | ±12 nm<br>0.6 nm (1 MHz[2]) | – | | | | |
| **Electrical connection*** | • *Interface electronics outside of vacuum:*<br>Cable (0.5 m, 1 m, 2 m or 2.5 m) up to vacuum feed-through; cable (0.5 m) up to 15-pin D-sub connector with built-in interface electronics<br>• *Interface electronics inside of high vacuum:*<br>Cable (0.5 m, 1 m, 2 m or 3 m) with 15-pin D-sub connector with built-in interface electronics | | | | | |
| Cable length | See interface description; however:<br>*Incremental:* ≤ 30 m; *Homing, Limit:* ≤ 10 m (with HEIDENHAIN cable) | | | | | |
| Supply voltage | DC 5 V ±0.25 V | | | | | |
| Current consumption | < 150 mA | < 165 mA (without load) | | | | |
| **Vibration** 55 Hz to 2000 Hz<br>**Shock** 11 ms | ≤ 400 m/s² (EN 60068-2-6)<br>≤ 500 m/s² (EN 60068-2-27) | | | | | |
| **Operating temperature** | 0 °C to 50 °C | | | | | |
| **Bake-out temperature** | 100 °C (LIF 4x V); 120 °C (LIF 48 U) | | | | | |
| **PCB material** | FR4 | | | | | |
| **Mass** Scanning head<br>Cable<br>Connector | 9 g<br>38 g/m<br>75 g | | | | | |

* Please select when ordering
[1] With TTL: maximum traversing speed during referencing: 9.6 m/min (40 kHz)
[2] –3 dB cutoff frequency of subsequent electronics

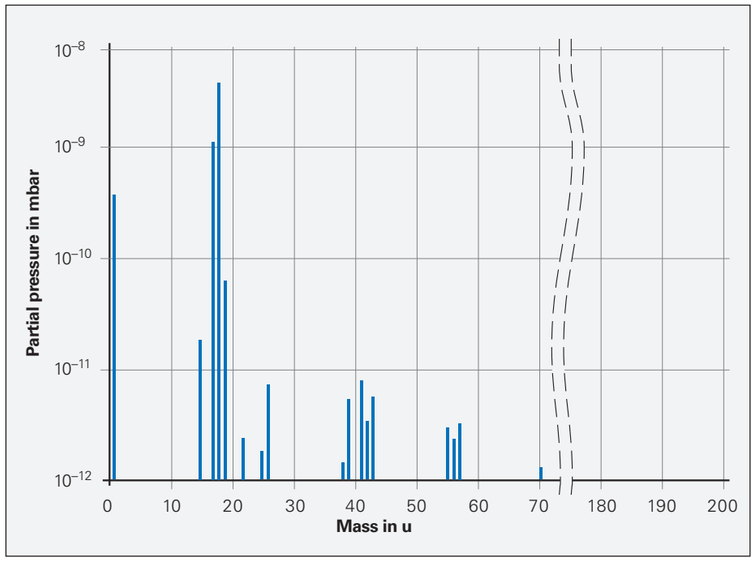
# Encoders for use in a vacuum

These vacuum-compatible encoders feature the following characteristics:
- Air vents
- Specialized cleaning and packaging
- Cable with PTFE insulation and tin-plated copper braiding

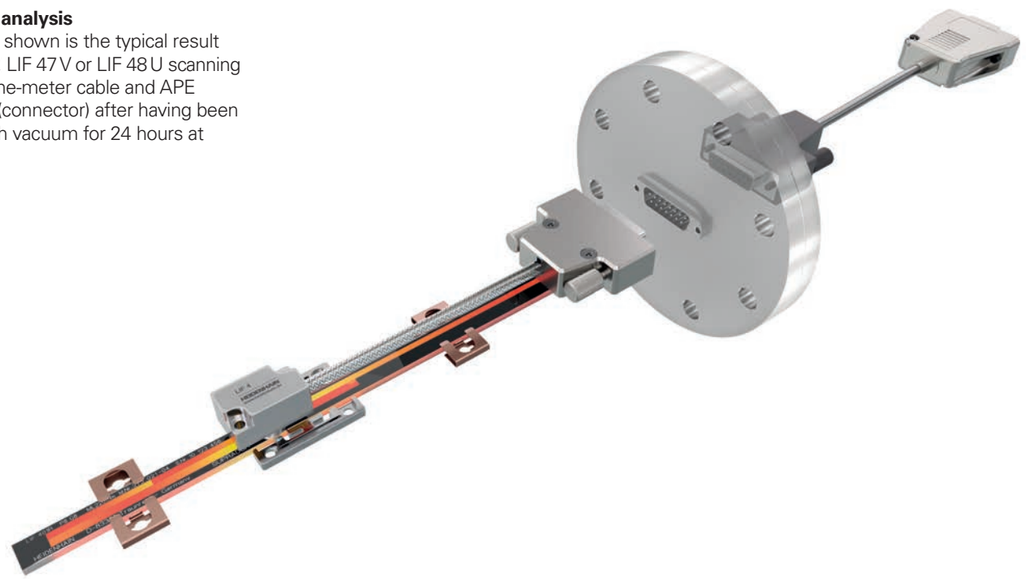
**Residual gas analysis of HEIDENHAIN vacuum components**
The influence of vacuum components on the quality of a vacuum can be determined through residual gas analyses. In these analyses, a sample in a vacuum chamber is pumped out to at least $10^{-6}$ mbar (turbomolecular pump, pumping speed 15 l/s to 200 l/s). The residual gases are measured with a mass spectrometer (Pfeiffer QMA 200) and an absolute pressure sensor (VACOM ATMION). The outgassing behavior of the examined sample can then be deduced by subtracting the typical residual gases of the empty chamber. The amount of remaining residual gases depends not only on the cleanliness of the sample and the tested materials, but also on the pump type used and its pumping speed. The higher the pumping speed for the measurement is, and the longer the gas is pumped out, the lower the amount of residual gases will be.

To attain the lowest possible outgassing values, HEIDENHAIN recommends baking at 100 °C for 48 hours under high vacuum conditions.

**Residual gas analysis**
The spectrum shown is the typical result for an LIF 48 V, LIF 47 V or LIF 48 U scanning head with a one-meter cable and APE interface unit (connector) after having been baked in a high vacuum for 24 hours at 100 °C.



The spectrum was determined with three scanning heads at an absolute pressure of $1.5^{-7}$ mbar and a pumping speed of 92 l/s.

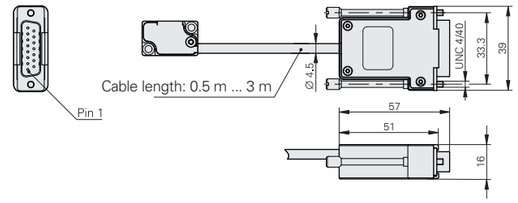

LIF 481 U variant



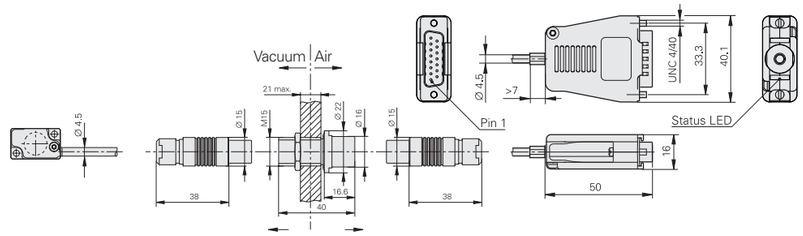
# Electrical connection

## High vacuum
The LIF 471 V/LIF 481 V is available with two different cable versions:

**Interface electronics inside of high vacuum:**
The scanning head cable has a 15-pin D-sub connector that contains the interface electronics. A vacuum feed-through (15-pin D-sub on DN63CF flange) and an extension cable are available as accessories.

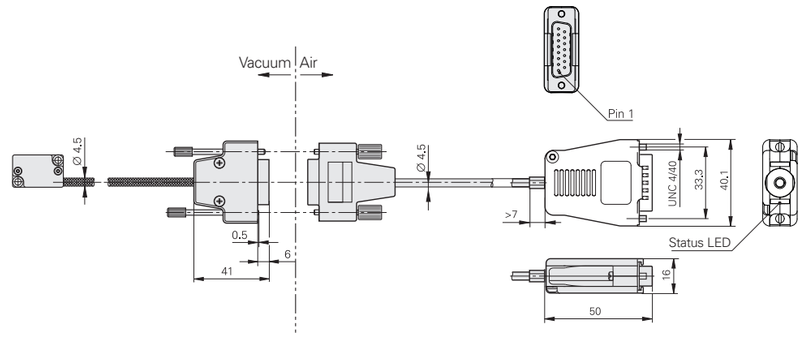



**Interface electronics outside of high vacuum:**
The scanning head cable has a high-vacuum-compatible round connector. Included with the encoder are the corresponding high-vacuum feed-through and the adapter cable with a 15-pin D-sub connector with integrated interface electronics.




## Ultrahigh vacuum
The LIF 481 U is available with the following cable feed-through:

When used in an ultrahigh vacuum, the encoder must not contain any electronic components such as signal converters. The LIF 481 U is equipped with a cable and an ultrahigh-vacuum-compatible D-sub connector. Included in delivery is an adapter cable with a signal converter integrated into the D-sub connector. A vacuum feed-through (15-pin D-sub connector on DN63CF flange) and an extension cable are available as accessories.



The built-in signal-quality indicator permits both a reliable assessment of the incremental signals and inspection of the reference-mark signal. The quality of the **incremental signals** is indicated by a range of colors, permitting quite detailed signal-quality differentiation. The tolerance conformity of the **reference-mark signal** is shown by means of a pass/fail indicator.

**LED indicator for reference-mark signal**
(operating check)
When the reference mark is traversed, the LED briefly lights up in red or blue:
- Out of tolerance
- Within tolerance

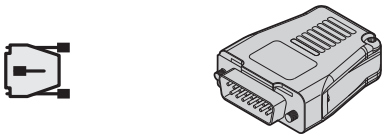
**LED indicator for incremental signals**

| LED color | Quality of the scanning signals |
|---|---|
| ● | Optimal |
| ● | Good |
| ● | Acceptable |
| ● | Unsatisfactory |

Signal-quality indicator in the signal converter (for variants in air)

## Pin layout

**15-pin D-sub connector**




| | Power supply | | | | Incremental signals | | | | | | Other signals | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **4** | **12** | **2** | **10** | **1** | **9** | **3** | **11** | **14** | **7** | **13** | **8** | **6** | **15** | **5** |
| ⊓⊔ TTL | **$U_P$** | **Sensor** 5 V | **0 V** | **Sensor** 0 V | **$U_{a1}$** | **$\overline{U_{a1}}$** | **$U_{a2}$** | **$\overline{U_{a2}}$** | **$U_{a0}$** | **$\overline{U_{a0}}$** | **$\overline{U_{aS}}$** | **H** | **L** | **PWT**[1] | **Vacant** |
| ~ 1 $V_{PP}$ | | | | | **A+** | **A–** | **B+** | **B–** | **R+** | **R–** | **As-signed** | | | **As-signed** | **Vacant** |
| | Brown/ Green | Blue | White/ Green | White | Brown | Green | Gray | Pink | Red | Black | Violet | Green/ Black | Yellow/ Black | Yellow | / |

**Shield** on housing; **$U_P$** = Power supply voltage
**Sensor:** The sense line is connected in the encoder with the corresponding power supply line.
Vacant pins or wires must not be used.
[1] TTL/11 $\mu A_{PP}$ conversion for the PWT


**HEIDENHAIN**

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**Further information:**

Comply with the requirements described in the following documents to ensure correct and intended operation:
- Brochure: *Exposed Linear Encoders* ID 208960-xx
- Technical Information: *Linear Encoders for Vacuum Technology* ID 627568-xx