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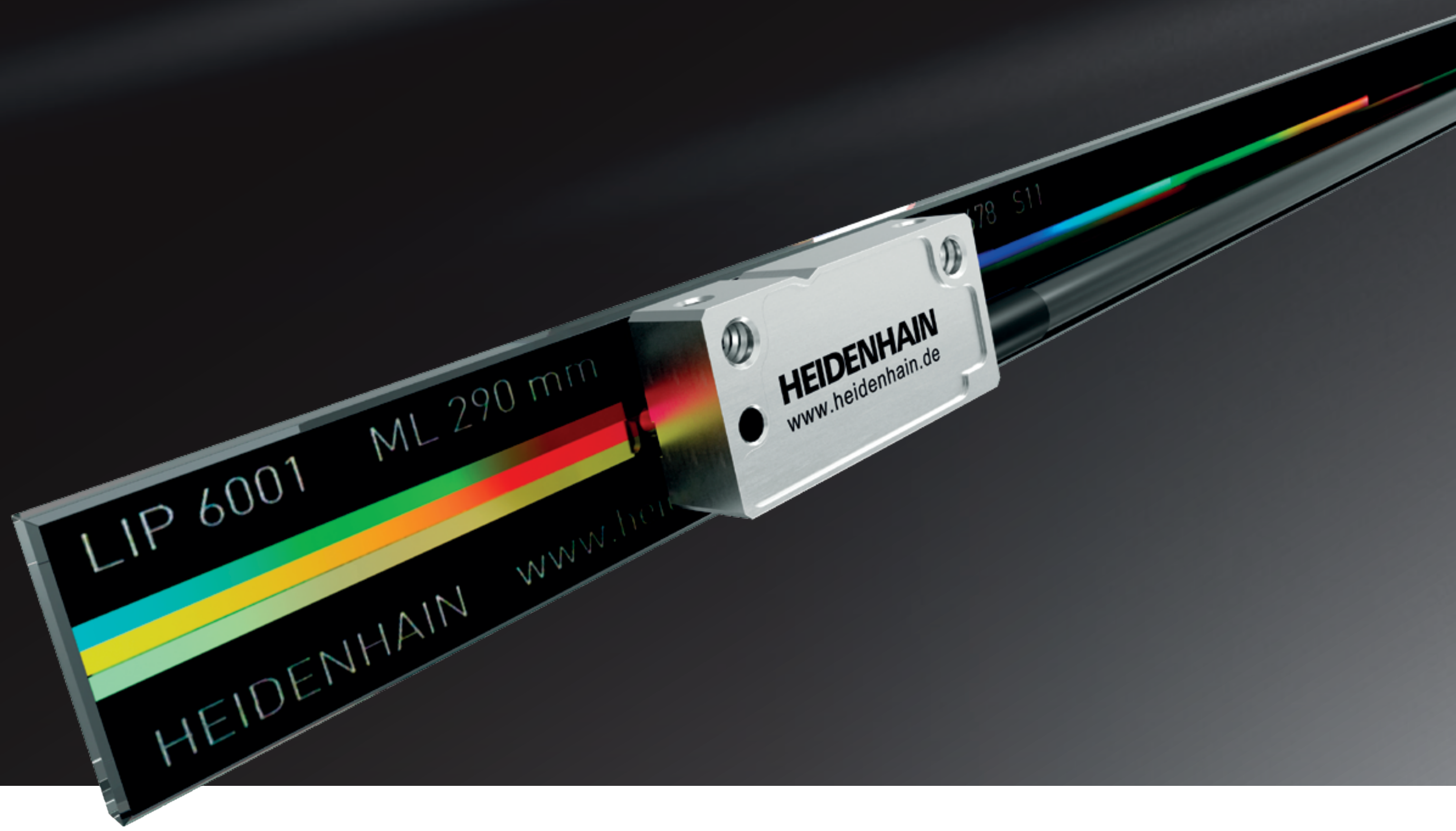

Exposed Linear Encoders

www.heidenhain.com/linear-encoders

02/2025

Exposed linear encoders

Linear encoders measure the position of linear axes without mechanical intermediaries, thereby eliminating multiple potential sources of error:
- Positioning error due to thermal changes in the recirculating ball screw
- Reversal error
- Kinematic error due to the ball-screw pitch error

Linear encoders are therefore essential components on machines requiring high **positioning accuracy** and **feed rates**.

Exposed linear encoders are used on machines that require high-accuracy measurement feedback. Typical applications include the following:
- Production and measurement equipment in the semiconductor industry
- PCB assembly machines
- Ultra-precision equipment such as diamond lathes for optical components, facing lathes for magnetic storage disks and grinding machines for ferrite parts
- High-accuracy machine tools
- Measuring machines, comparators, measuring microscopes and other precision measuring devices
- Direct-drive motors

Mechanical design
Exposed linear encoders consist of a scale or scale tape read by a non-contact scanning head.

Because the scale of an exposed linear encoder is fastened to a mounting surface, achieving high linear encoder accuracy requires a mounting surface with high evenness.

Information on the following topics is available upon request or online at *www.heidenhain.com:*
- Angle encoders with integral bearing
- Modular angle encoders with optical scanning
- Modular angle encoders with magnetic scanning
- Rotary encoders
- Encoders for servo drives
- Linear encoders for numerically controlled machine tools
- Interface electronics
- HEIDENHAIN controls

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

Standards (ISO, EN, etc.) apply only where explicitly stated in the brochure.

Further information:

For detailed descriptions of all available interfaces, as well as general electrical information, refer to the *Interfaces of HEIDENHAIN Encoders* brochure (ID 1078628-xx).

For the required cables, refer to the *Cables and Connectors* brochure (ID 1206103-xx).

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Absolute position measurement
The **LIC** exposed linear encoders permit absolute position measurement over long traversing distances of up to 28 m at high speeds.

Encoders for use in a vacuum environment
HEIDENHAIN standard encoders are suitable for use in rough or fine vacuums. Encoders used in high and ultrahigh vacuums must meet special requirements. The design and materials used for such encoders must be specially matched to these conditions. For more information, refer to the *Linear Encoders for Vacuum Technology* Technical Information document.

The LIC 4113V and LIC 4193V linear encoders are designed for use in high vacuums. For more information, refer to the appropriate Product Information documents.

	Baseline error		Substrate and mounting	Interpolation error	Measuring length	Interface	Model	Page
	Accuracy grade	Interval						
LIC 4100 For very high accuracy	±1 µm[1)] ±3 µm ±5 µm	≤ ±0.275 µm/ 10 mm	Glass or glass ceramic scale, adhesively bonded to the mounting surface or fastened with fixing clamps	±20 nm	240 mm to 3040 mm	EnDat 2.2	**LIC 4113** **LIC 4113V**	**24**
						4)	**LIC 4193** **LIC 4193V**	
	±5 µm	≤ ±0.750 µm/ 50 mm (typical)	Steel scale tape pulled through aluminum extrusions and tensioned	±20 nm	140 mm to 28440 mm	EnDat 2.2	**LIC 4115**	**26**
						4)	**LIC 4195**	
	±3 µm ±5 µm[2)] ±15 µm[3)]	≤ ±0.750 µm/ 50 mm (typical)	Steel scale tape pulled through aluminum extrusions and secured	±20 nm	240 mm to 6040 mm	EnDat 2.2	**LIC 4117**	**28**
						4)	**LIC 4197**	
	±3 µm ±15 µm[3)]	≤ ±0.750 µm/ 50 mm (typical)	Steel scale tape, adhesively bonded to mounting surface	±20 nm	70 mm to 1020 mm	EnDat 2.2	**LIC 4119**	**30**
						4)	**LIC 4199**	
					70 mm to 1820 mm	EnDat 2.2	**LIC 4119**	**32**
LIC 3100 For high accuracy	±15 µm[3)]	≤ ±0.750 µm/ 50 mm (typical)	Steel scale tape pulled through aluminum extrusions and fastened at center	±100 nm	Up to 10000 mm	EnDat 2.2	**LIC 3117**	**34**
						4)	**LIC 3197**	
			Steel scale tape, adhesively bonded to mounting surface			EnDat 2.2	**LIC 3119**	
						4)	**LIC 3199**	
LIC 2100 For simple mounting	±15 µm	–	Steel scale tape pulled through aluminum extrusions and secured	±2 µm	120 mm to 3020 mm	EnDat 2.2	**LIC 2117**	**38**
						4)	**LIC 2197**	
	±15 µm	–	Steel scale tape, adhesively bonded to mounting surface	±2 µm	120 mm to 3020 mm	EnDat 2.2	**LIC 2119**	**40**
						4)	**LIC 2199**	

1) Up to a measuring length (ML) of 1640 mm
2) For a measuring length (ML) of 1240 mm or greater
3) ±5 µm after linear-error compensation in the downstream electronics
4) Fanuc αi, Mitsubishi, Panasonic, Yaskawa


LIC 41x3


LIC 41x5


LIC 41x7


LIC 31x9


LIC 21x7


LIC 21x9

Selection guide
Incremental encoders

Very high accuracy
The **LIP** exposed linear encoders are characterized by their very small measuring steps combined with extremely high accuracy and repeatability. They utilize the interferential scanning principle and feature an OPTODUR phase grating as their measuring standard. The LIP 211 and LIP 291 linear encoders output their position information as a position value. For this to occur, the sinusoidal scanning signals are highly interpolated in the scanning head and converted into a position value by the integrated counter function. As with all incremental encoders, an absolute reference point is established by means of reference marks.

High accuracy
The **LIF** exposed linear encoders utilize the interferential scanning principle and possess a measuring standard made with the SUPRADUR process. They feature high accuracy and repeatability, are particularly easy to install and are equipped with limit switches and homing tracks. A special variant, the LIF 481V, can be used in high vacuums (see separate Product Information document).

High traversing speeds
The **LIDA** exposed linear encoders are designed for high traversing speeds of up to 10 m/s. Their various mounting options allow for particularly flexible deployment. Depending on the encoder version, steel scale tapes, glass, or glass ceramic are used as carriers for the METALLUR gratings. They also feature limit switches.

Two-coordinate measurement
The measuring standard of the **PP** two-coordinate encoder is an interferentially scanned planar phase grating manufactured with the DIADUR process. Position measurement is thereby possible within a plane.

Further information:
For an in-depth look at measuring technology for multiple degrees of freedom, see the *MULTI-DOF* brochure.

	Baseline error		Substrate and mounting	Interpolation error	Signal period	Measuring length	Interface	Model	Page
	Accuracy grade[1]	Interval							
LIP For very high accuracy	±1 μm[2] ±3 μm	≤ ±0.125 μm/ 5 mm	Scale made of Zerodur glass ceramic, fastened with fixing clamps	±0.4 nm[7]	0.512 μm	20 mm to 3040 mm	EnDat 2.2	**LIP 211**	**42**
							∿ 1 Vpp	**LIP 281**	
							Fanuc αi Mitsubishi	**LIP 291**	
	±1 μm[5] ±3 μm	≤ ±0.175 μm/ 5 mm	Scale made of Zerodur glass ceramic or glass, adhesively bonded or fastened with fixing clamps	–	4 μm	20 mm to 3040 mm	⊓⊔TTL	**LIP 6071**	**44**
				±4 nm			∿ 1 Vpp	**LIP 6081**	
LIF For high accuracy	±1 μm[8] ±3 μm	≤ ±0.175 μm/ 5 mm	Scale made of Zerodur glass ceramic or glass, adhesively bonded or fastened with fixing clamps	–	4 μm	70 mm to 3040 mm[4]	⊓⊔TTL	**LIF 171**	**Product Info doc.**
				±12 nm			∿ 1 Vpp	**LIF 181**	
	±1 μm[5] ±3 μm	≤ ±0.225 μm/ 5 mm	Scale made of Zerodur glass ceramic or glass, adhesively bonded by means of PRECIMET adhesive mounting film	–	4 μm	70 mm to 1640 mm	⊓⊔TTL	**LIF 471** **LIF 471V**	**46** **Product Info doc.**
				±12 nm			∿ 1 Vpp	**LIF 481** **LIF 481V** **LIF 481U**	
LIDA For high traversing speeds and long measuring lengths	±1 μm[9] ±3 μm ±5 μm	≤ ±0.275 μm/ 10 mm	Scale made of glass ceramic or glass, adhesively bonded to the mounting surface	–	20 μm	240 mm to 3040 mm	⊓⊔TTL	**LIDA 473**	**48**
				±45 nm			∿ 1 Vpp	**LIDA 483**	
	±5 μm	≤ ±0.750 μm/ 50 mm (typical)	Steel scale tape pulled through aluminum extrusions and tensioned	–	20 μm	140 mm to 30 040 mm	⊓⊔TTL	**LIDA 475**	**50**
				±45 nm			∿ 1 Vpp	**LIDA 485**	
	±3 μm[2] ±5 μm ±15 μm[6]	≤ ±0.750 μm/ 50 mm (typical)	Steel scale tape pulled through aluminum extrusions and secured	–	20 μm	240 mm to 6040 mm	⊓⊔TTL	**LIDA 477**	**52**
				±45 nm			∿ 1 Vpp	**LIDA 487**	
	±3 μm[2] ±15 μm[6]	≤ ±0.750 μm/ 50 mm (typical)	Steel scale tape, adhesively bonded to mounting surface	–	20 μm	Up to 6000 mm[4]	⊓⊔TTL	**LIDA 479**	**54**
				±45 nm			∿ 1 Vpp	**LIDA 489**	
	±15 μm	–	Steel scale tape pulled through aluminum extrusions and secured	–	200 μm	Up to 10 000 mm[4]	⊓⊔TTL	**LIDA 277**	**56**
				±2 μm			∿ 1 Vpp	**LIDA 287**	
	±15 μm	–	Steel scale tape, adhesively bonded to mounting surface	–	200 μm	Up to 10 000 mm[4]	⊓⊔TTL	**LIDA 279**	**58**
				±2 μm			∿ 1 Vpp	**LIDA 289**	
PP For two-coordinate measurement	±2 μm	–	Glass grid plate, secured with full-surface adhesive bond	±12 nm[7]	4 μm	Measuring area: 68 x 68 mm[4]	∿ 1 Vpp	**PP 281**	**60**

[1] At an interval of 1 m or a measuring length < 1 m (accuracy grade)
[2] Up to a measuring length of 1020 mm or 1040 mm
[3] Higher accuracy grades upon request
[4] Other measuring lengths/ranges upon request
[5] Only for Zerodur glass ceramic up to a measuring length of 1020 mm
[6] ±5 μm after linear-error compensation in the downstream electronics
[7] With HEIDENHAIN interface electronics
[8] Up to a measuring length of 1640 mm
[9] Only for Robax glass ceramic up to a measuring length of 1640 mm

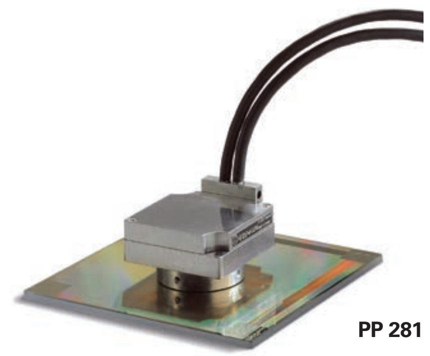

LIP 281


LIP 6081


LIF 481


LIDA 489


LIDA 287


PP 281

Measuring principles

Measuring standard

HEIDENHAIN encoders with optical scanning incorporate measuring standards consisting of periodic structures known as graduations.

These graduations are applied to a carrier substrate made of glass or steel. For encoders with long measuring lengths, steel tape is used as the scale substrate.

HEIDENHAIN manufactures the precision graduations in the following specially developed, photolithographic processes:

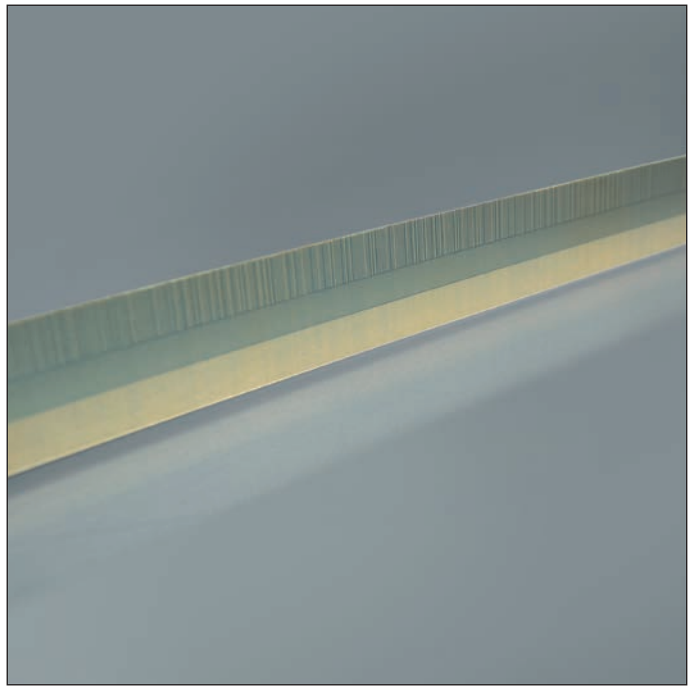
- METALLUR: contamination-tolerant graduation consisting of metal lines on gold; typical grating period: 20 µm
- SUPRADUR phase grating: optically three-dimensional, planar structure; particularly tolerant to contamination; typical grating period: 8 µm and finer
- OPTODUR phase grating: optically three-dimensional, planar structure with particularly high reflectance; typical grating period: 2 µm and finer
- TITANID phase grating: exceptionally robust, optically three-dimensional structure with a high degree of reflectance; typical grating period: 8 µm

Along with the very fine grating periods, these processes permit high edge resolution and excellent homogeneity of the graduation. In combination with the photoelectric scanning method, these characteristics are critical for attaining high-quality output signals.

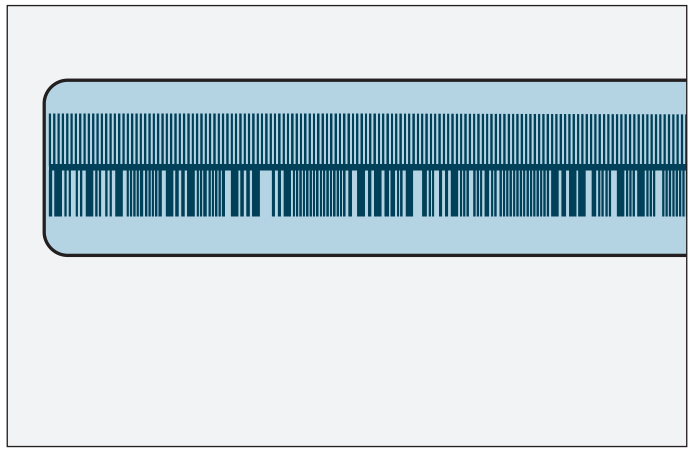
The master graduations are manufactured by HEIDENHAIN on custom-built, high-precision dividing engines.

Absolute measuring method

In the absolute measuring method, the position value is available immediately upon encoder switch-on and can be requested by the downstream electronics at any time. There is therefore no need to search for the reference position by jogging the axes. The absolute position information is read **from the graduation on the measuring standard**, which is designed as a serial absolute code structure. A separate incremental track is interpolated for the position value and, depending on the interface version, is also used to generate an optional incremental signal.



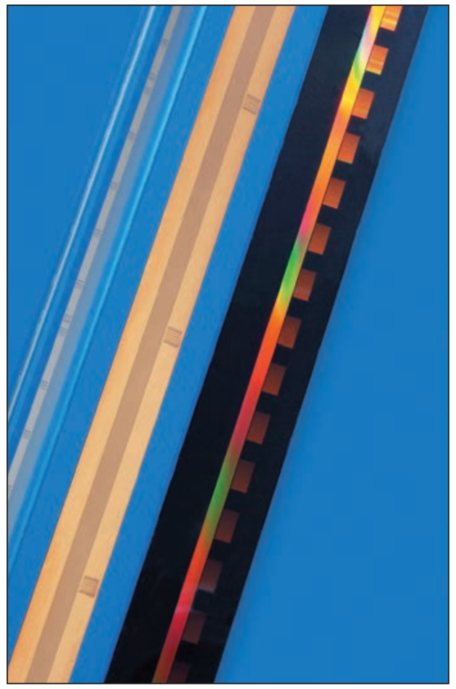
Graduation of an absolute linear encoder



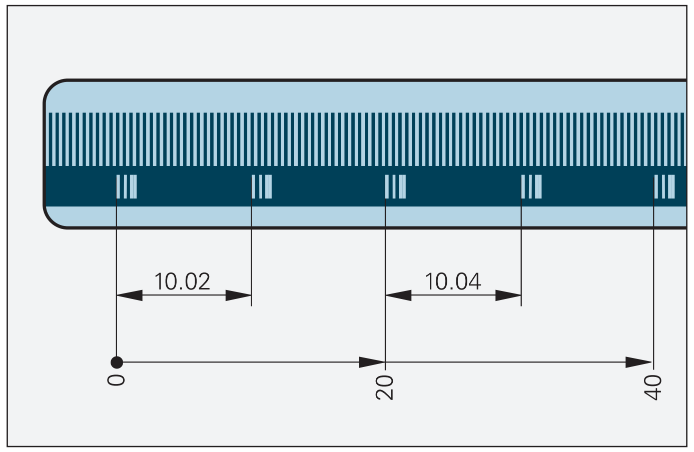
Schematic representation of a code structure with an additional incremental track (example from the LIC 411x)

Incremental measuring method

With the incremental measuring method, the graduation consists of a periodic grating structure. Position information is obtained **through the counting of individual increments** (measuring steps) starting from a freely settable point of origin. Since an absolute reference is required to ascertain positions, the measuring standard is provided with an additional track that bears a **reference mark**. The absolute position on the scale, which is established by the reference mark, is assigned to exactly one signal period. Thus, before absolute referencing can be established or the most recently selected reference point can be refound, this reference mark must first be crossed.



Graduations of incremental linear encoders



Schematic representation of an incremental graduation with distance-coded reference marks (example from the LIDA 4x3C)

In the most unfavorable case, machine movements over sizeable sections of the measuring range may be necessary. To speed up and simplify such "reference runs," many HEIDENHAIN encoders feature **distance-coded reference marks**—multiple reference marks that are individually spaced in accordance with a mathematical algorithm. The downstream electronics find the absolute reference point after traversing two successive reference marks—thus after only a few millimeters of traversing distance (see table below).

Encoders with distance-coded reference marks are identified with a "C" following the model designation (e.g., LIF 181 C).

With distance-coded reference marks, the **absolute reference point R** is calculated by counting the increments between two reference marks and by applying the following formula:

$$P_1 = (\text{abs } R - \text{sgn } R - 1) \times \frac{N}{2} + (\text{sgn } R - \text{sgn } D) \times \frac{\text{abs } M_{RR}}{2}$$

where:

$$R = 2 \times M_{RR} - N$$

Definitions:

P_1 = Position of the first traversed reference mark in signal periods

abs = Absolute value

sgn = Algebraic sign function ("+1" or "–1")

M_{RR} = Number of signal periods between the traversed reference marks

N = Nominal increment between two fixed reference marks in signal periods (see table below)

D = Direction of traverse (+1 or –1). Traverse of scanning unit to the right (when properly installed) equals +1

	Signal period	Nominal increment N in signal periods	Maximum traverse
LIF 1x1 C	4 µm	5000	20 mm
LIDA 4x3 C	20 µm	1000	20 mm

Photoelectric scanning

Most HEIDENHAIN encoders utilize the photoelectric scanning principle. Because photoelectric scanning is a non-contact process, it does not induce wear. This method detects even extremely fine graduation lines down to a width of only a few micrometers and generates output signals with very small signal periods.

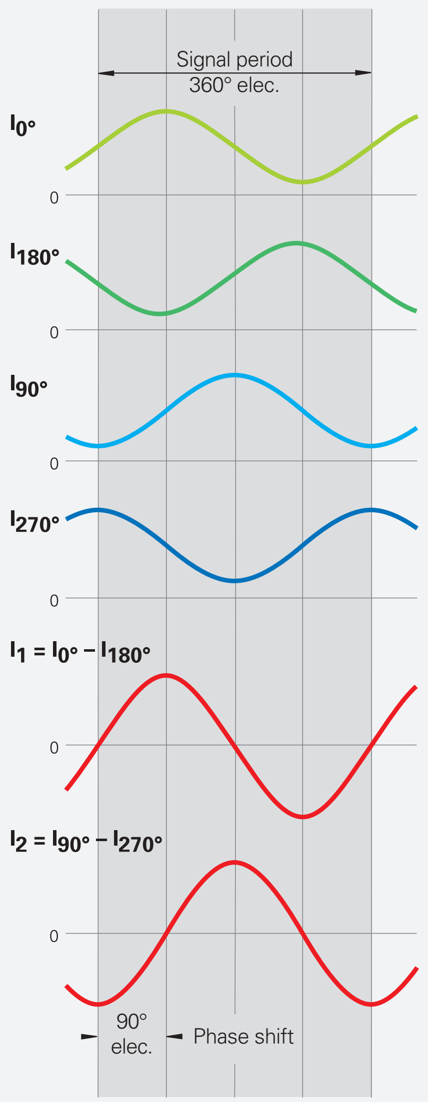
The finer the grating period of a measuring standard, the greater the effect of diffraction on photoelectric scanning. HEIDENHAIN linear encoders employ two scanning principles:

- The **imaging scanning principle** for grating periods ranging from 10 µm to 200 µm
- The **interferential scanning principle** for very fine grating periods of 4 µm and smaller

Imaging scanning principle
Put simply, the imaging scanning principle uses projected-light signal generation by which two gratings with equal or similar grating periods (the scale and the scanning reticle) are moved relative to each other. The carrier material of the scanning reticle is transparent, whereas the graduation of the measuring standard may be applied to a transparent material or to a reflective material.

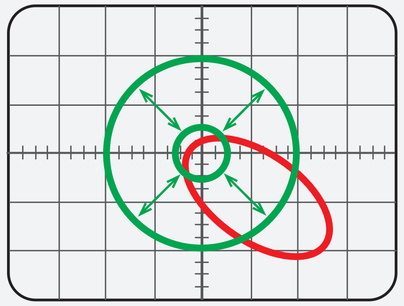
When parallel light passes through a grating structure, light and dark fields are projected at a certain distance where there is an index grating with the same or similar grating period. When the two gratings move relative to each other, the incident light is modulated: If the gaps are aligned, then light passes through. If the lines cover the gaps, then no light passes through. This fluctuating light is converted into electrical signals by photocells. The specially structured grating of the scanning reticle filters the light so as to generate nearly sinusoidal output signals. The smaller the graduation period of the grating structure, the closer and more tightly toleranced the gap must be between the scanning reticle and the scale. In encoders that use the imaging scanning principle, workable mounting tolerances are attainable starting at a minimum grating period of 10 µm.

The **LIC** and **LIDA** linear encoders use the imaging scanning principle.

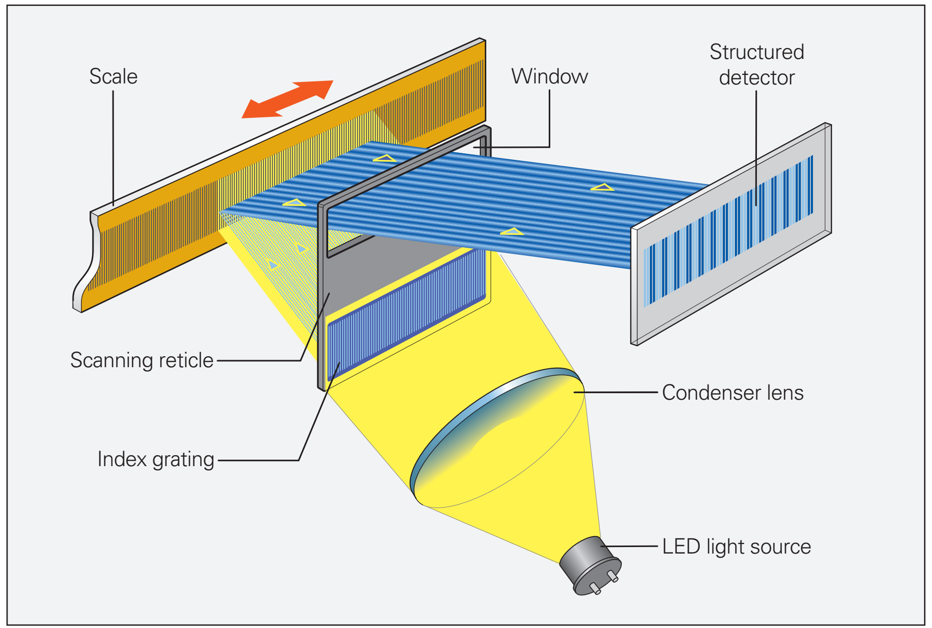


The sensor generates four nearly sinusoidal current signals ($I_{0°}$, $I_{90°}$, $I_{180°}$, and $I_{270°}$), phase-shifted relative to each other by 90° elec. These scanning signals do not initially exhibit symmetry about the zero line. For this reason, the photocells are connected in anti-parallel, thereby producing two 90° elec. phase-shifted output signals, $\mathbf{I_1}$ and $\mathbf{I_2}$, which are symmetrical about the zero line.

In the xy-representation on an oscilloscope, the signals form a Lissajous figure. Ideal output signals appear as a centered circle. Deviations in circularity and position are caused by position errors and therefore go directly into the measurement result. The size of the circle, which corresponds to the amplitude of the output signal, can vary within certain limits without influencing the measuring accuracy.



Xy-representation of the output signals



Photoelectric scanning in accordance with the imaging principle with a steel scale and single-field scanning (LIDA 400)

Interferential scanning principle
The interferential scanning principle exploits the diffraction and interference of light on finely divided gratings in order to produce the signals used to measure displacement.

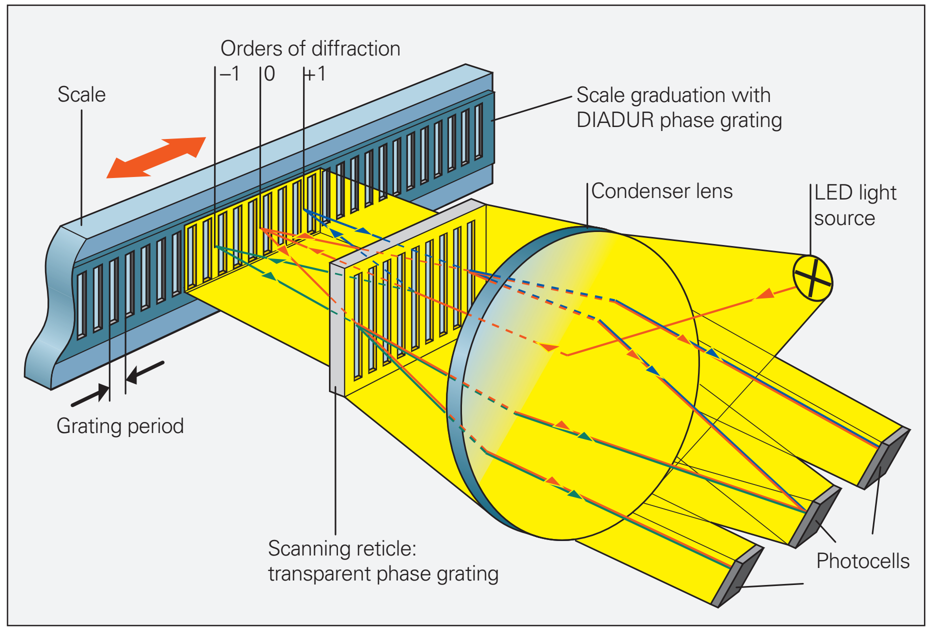
A step grating is used as the measuring standard: reflective lines with a height of 0.2 µm are applied to a flat, reflective surface. In front of this is the scanning reticle—a transparent phase grating with the same grating period as the scale.

When a light wave passes through the scanning reticle, it is diffracted into three partial waves of the orders +1, 0 and –1, with nearly equal luminous intensity. The waves are diffracted by the scale such that most of the luminous intensity is found in the reflected diffraction orders +1 and –1. These partial waves meet again at the phase grating of the scanning reticle, where they are diffracted again and interfere. This produces essentially three waves that leave the scanning reticle at different angles. Photocells convert these alternating light intensities into electrical signals.

When there is relative motion between the scale and the scanning reticle, the diffracted wavefronts undergo a phase shift: movement by the amount of one grating period shifts the positive first-order diffraction wavefront by one wavelength in the positive direction, while the negative first-order diffraction wavefront is displaced by one wavelength in the negative direction. Since the two waves interfere with each other upon exiting the phase grating, these waves are shifted relative to each other by two wavelengths. This results in two signal periods when there is relative motion of just one grating period.

Interferential encoders use grating periods of, for example, 8 µm, 4 µm, or finer. Their scanning signals are largely free of harmonics and can be highly interpolated. These encoders are therefore especially well-suited for small measuring steps and high accuracy. They nevertheless feature workable mounting tolerances.

The **LIP**, **LIF** and **PP** linear encoders use the interferential scanning principle.



Photoelectric scanning in accordance with the interferential measuring principle and single-field scanning

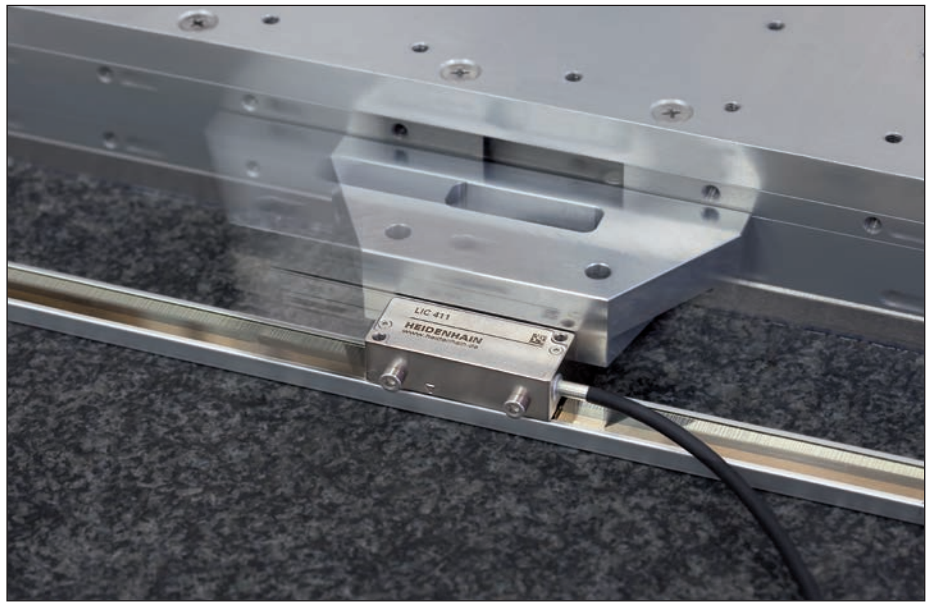
Reliability

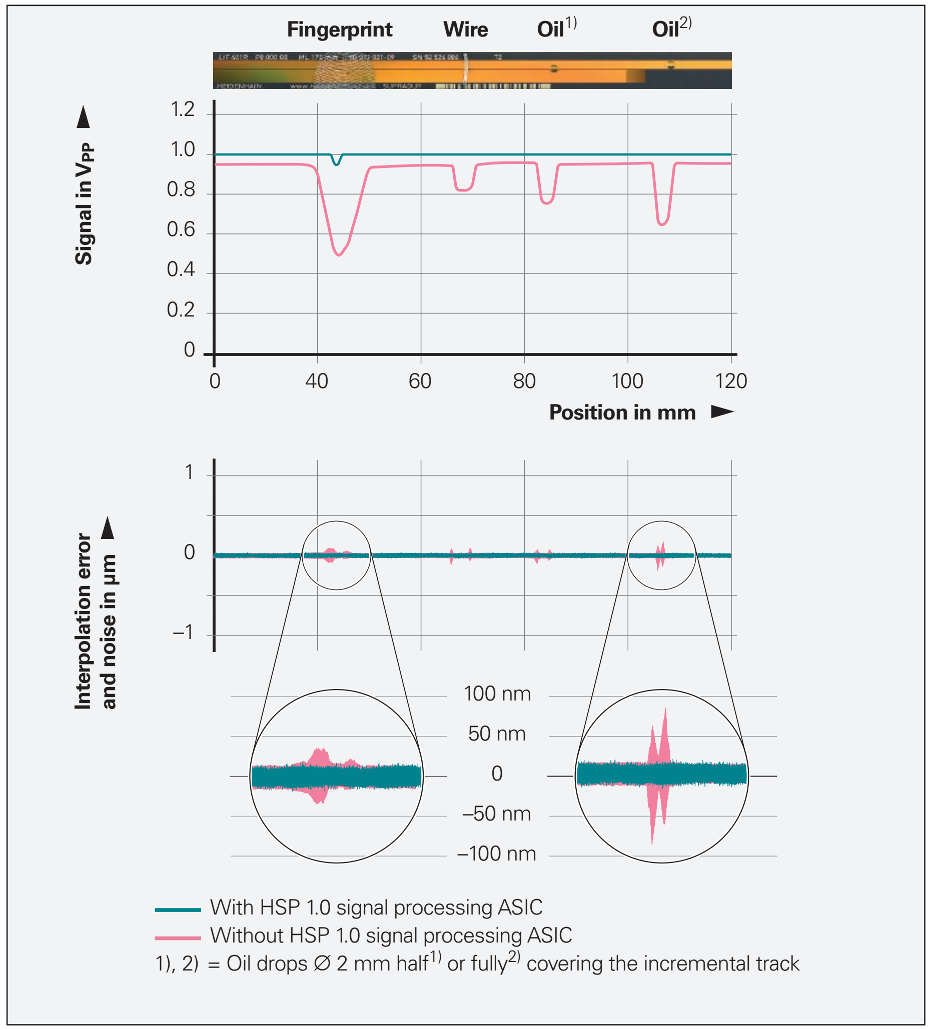
Exposed linear encoders from HEIDENHAIN are optimized for use on fast, precise machines. Despite their exposed mechanical design, these encoders are highly insensitive to contamination, ensure high long-term stability, and are both fast and easy to install.

Low sensitivity to contamination
Both the high quality of the grating and the scanning method are responsible for the accuracy and reliability of linear encoders. Exposed linear encoders from HEIDENHAIN employ **single-field scanning** in which a single large scanning field is used to generate the scanning signals. Local contamination on the measuring standard (e.g., fingerprints from the mounting process or oil residues from guideways) has only a slight influence on the light intensity of the signal components and thus on the scanning signals. Although this contamination does cause a change in the amplitude of the output signals, their offset and phase position remain unaffected. The signals remain highly interpolable, and the position error within one signal period remains small.

A **large scanning field** further reduces the encoder's sensitivity to contamination. Depending on the nature of the contamination, this feature can even prevent encoder failure. This is particularly true of the LIDA 400 and LIF 400, which feature a very large scanning surface area (14.5 mm^2) relative to their grating period. The same goes for the LIC 4100, which has a scanning surface area of 15.5 mm^2. Even in the case of contamination from printer's ink, PCB dust, or drops of water or oil of up to 3 mm in diameter, these encoders continue to provide high-quality signals. The position error remains far below the values specified for the accuracy grade of the scale.

The LIDA, LIF, and LIP 6000 encoders are equipped with the HSP 1.0 signal processor ASIC from HEIDENHAIN. This ASIC continuously monitors the scanning signal and nearly fully compensates for fluctuations in signal amplitude. If the signal amplitude decreases as the result of contamination on the scanning reticle or measuring standard, the ASIC reacts by increasing the LED current. The ensuing increase in LED light intensity barely raises the noise level, even in the case of strong signal stabilization. As a result, contamination has only a very slight effect on interpolation error and position noise.





Measuring standard with contamination and the associated signal amplitudes with conventional scanning and scanning with the HSP 1.0 signal processing ASIC

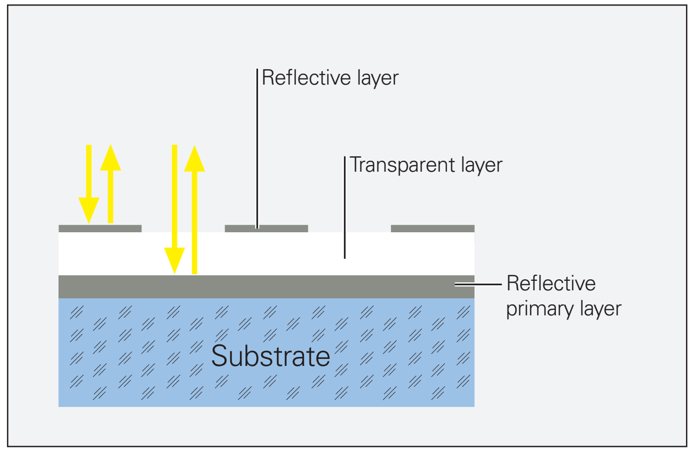
Resilient measuring standards
By virtue of their design, the measuring standards of exposed linear encoders are less protected from their environment. For this reason, HEIDENHAIN always uses robust graduations manufactured in special processes.

In the OPTODUR and SUPRADUR processes, a transparent layer is first applied onto the reflective primary layer. For creating an optically three-dimensional phase grating, an extremely thin, hard chromium layer is applied at a thickness of only a few nanometers. The graduations for the imaging scanning principle exhibit a similar design and are manufactured in the METALLUR process. A reflective gold layer is covered with a thin layer of glass. On it are chromium lines acting as absorbers. Since they are only several nanometers thick, these lines are semitransparent. Measuring standards with OPTODUR, SUPRADUR or METALLUR graduations have proven to be particularly robust and insensitive to contamination because the low height of their structure leaves practically no surface for dust, dirt, or water particles to accumulate.

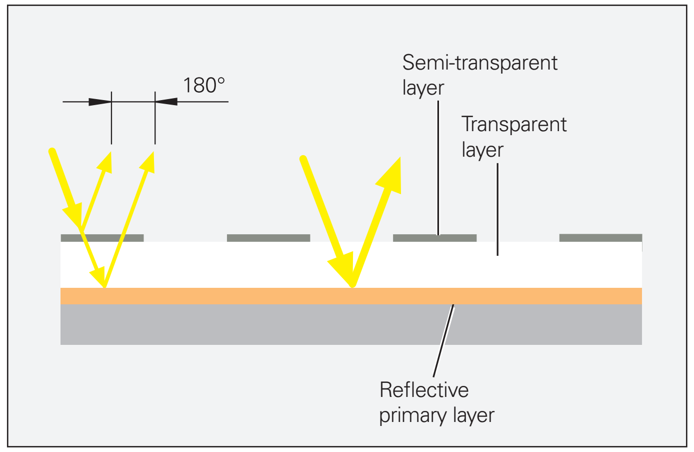
Workable mounting tolerances
Very small signal periods usually come with very narrow mounting tolerances for the gap between the scanning head and scale tape. This is the result of diffraction caused by the grating structures. Such diffraction can lead to a signal attenuation of 50 % upon a gap change of only ±0.1 mm. The interferential scanning principle and innovative index gratings on encoders that use the imaging principle allow for workable mounting tolerances despite tiny signal periods.

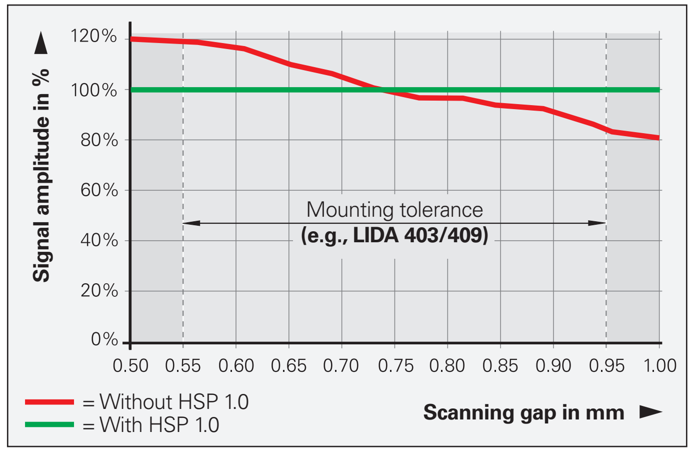
The mounting tolerances of exposed linear encoders from HEIDENHAIN have only a slight influence on the output signals. In particular, the specified distance tolerance between the scale and scanning head (scanning gap) causes only a negligible change in the signal amplitude. During operation, the reliability and stability of the signals are additionally improved by the HSP 1.0. The two diagrams illustrate the correlation between the scanning gap and signal amplitude for the encoders of the LIDA 400 and LIF 400 series.

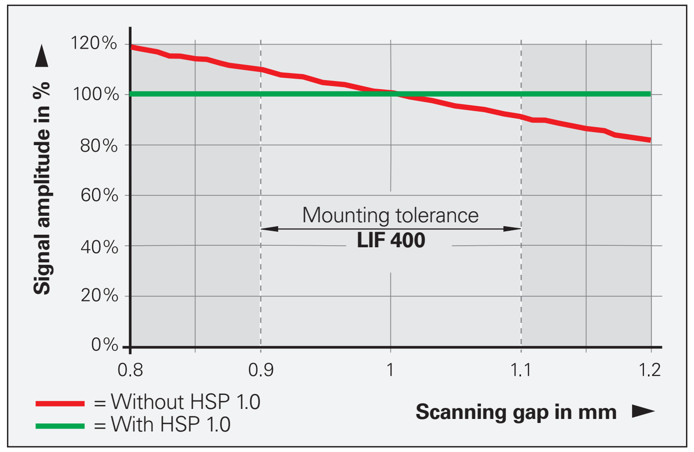
OPTODUR
SUPRADUR



METALLUR







Measuring accuracy

The accuracy of the linear measurement is mainly determined by the following factors:
- The quality of the graduation
- The quality of the graduation carrier
- The quality of the scanning process
- The quality of the signal processing electronics
- How the encoder is installed in the machine

These factors can be subdivided into encoder-specific position errors and application-dependent factors. For assessment of the attainable system accuracy, all of the individual factors must be taken into account.

Encoder-specific position error

Encoder-specific position error includes:
- The accuracy of the measuring standard
- The accuracy of interpolation
- Position noise

Accuracy of the measuring standard

The accuracy of the measuring standard is mainly determined by:
- The homogeneity and period resolution of the graduation
- The alignment of the graduation on its carrier
- The stability of the graduation carrier

The accuracy of the measuring standard is indicated by the uncompensated maximum value of the ***baseline error****. This accuracy is ascertained under ideal conditions via measurement of the position error with a serially produced scanning head. The distance between the measuring points is equivalent to the integer multiple of the signal period. As a result, interpolation errors have no effect.*

The accuracy grade ***a*** *defines the upper limit of the baseline error within any section up to one meter in length. For certain special encoders, an additional baseline error is stated for defined intervals of the measuring standard.*

Accuracy of interpolation

The accuracy of interpolation is mainly influenced by:
- The fineness of the signal period
- The homogeneity and period resolution of the graduation
- The quality of the scanning filter structures
- The characteristics of the sensors
- The quality of the signal processing

The accuracy of interpolation is ascertained with a serially produced measuring standard and is indicated by a typical maximum value ***u*** *of the interpolation error. Encoders with an analog interface are tested with a HEIDENHAIN electronic device (e.g., EIB 741). The maximum values do not include position noise and are indicated in the specifications.*

The interpolation error begins having an effect even at very low traversing speeds and during repeated measurements. Fluctuations in the traversing speed are a result, particularly within the speed control loop.

Position noise

Position noise is a random process leading to unpredictable position errors. The position values are grouped around an expected value in the form of a frequency distribution.

The amount of position noise depends on the signal processing bandwidths necessary for forming the position values. It is ascertained within a defined time interval and is stated as a product-specific RMS value.

In the speed control loop, position noise influences the speed stability at low traversing speeds.

Application-dependent position error

In addition to the given encoder-specific position error, **installing the encoder in the machine** normally has a significant effect on the accuracy attainable by encoders without integral bearings. The application-dependent error values must be measured and considered individually in order to evaluate the **overall accuracy**.

Deformation of the graduation

Errors due to a deformation of the graduation are not to be neglected. Such deformation occurs when the measuring standard is mounted on an uneven surface (e.g., a convex surface).

Mounting location

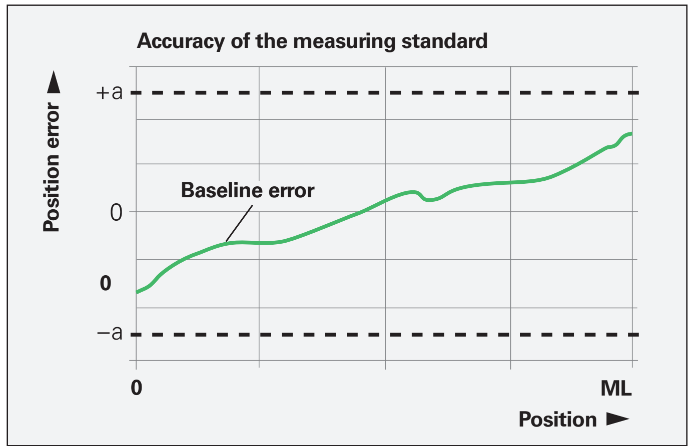
Poor mounting of linear encoders can aggravate the effect of guideway error on measuring accuracy. To keep the resulting Abbé error as small as possible, the scale should ideally be mounted to the machine slide and at the height of the table. It is important to ensure that the mounting surface is parallel to the machine guideway.

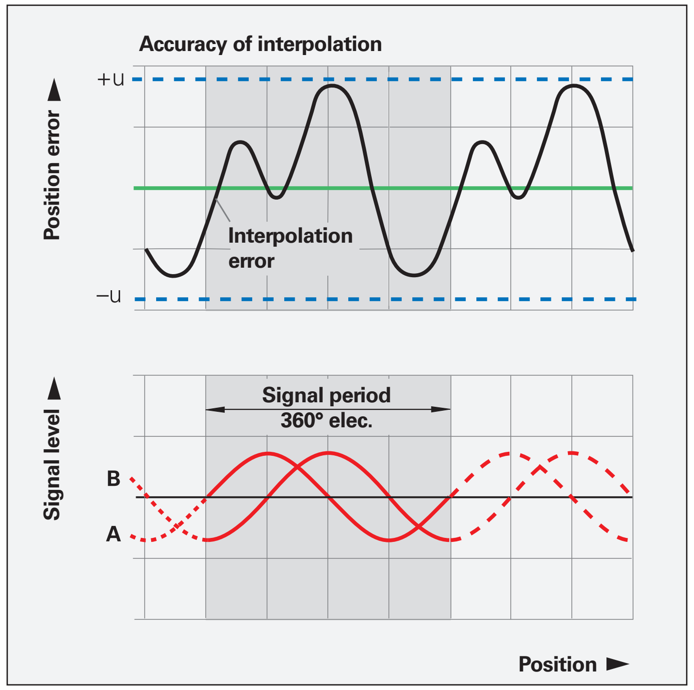
Vibration

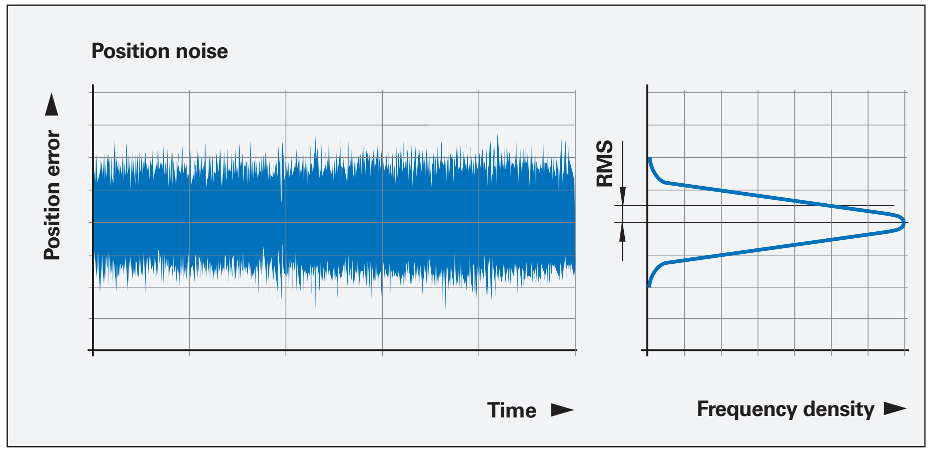
To function properly, linear encoders must not be continuously subjected to strong vibration. The best mounting surfaces are therefore solid and stable machine elements. Encoders should not be mounted on hollow parts or with adapter blocks, etc.

Influence of temperature

In order to avoid temperature effects, the linear encoders should not be mounted in close proximity to heat sources.







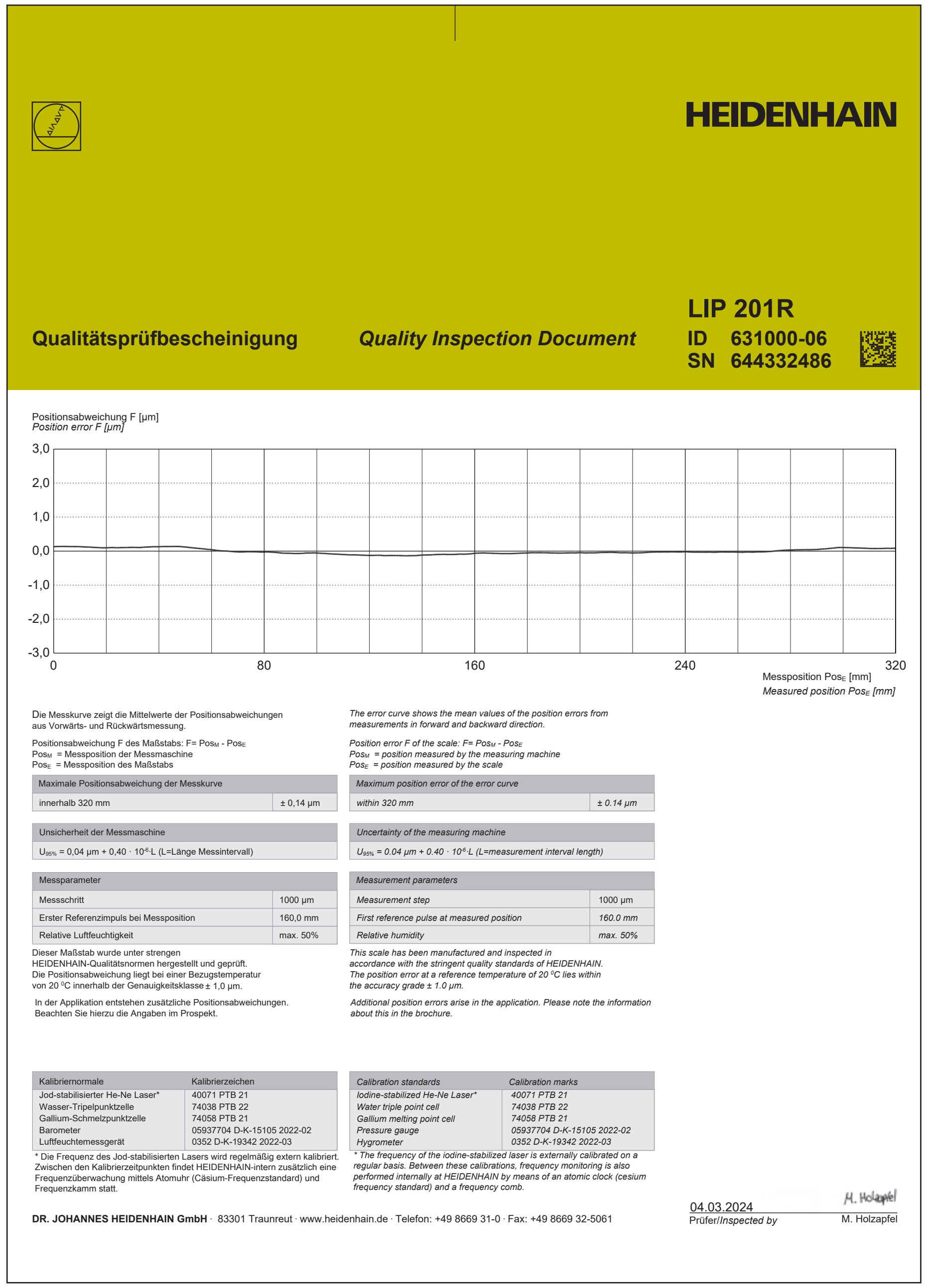
All HEIDENHAIN linear encoders are inspected for accuracy and proper functioning prior to shipping.

The accuracy of the linear encoders is ascertained during traversing movements in both directions. The number of measuring positions is selected such that not only the long-range errors but also the position errors within a single signal period are very accurately determined.

A **Quality Inspection Document** confirms the stated graduation accuracy of each encoder. The listed **calibration standards** ensure traceability to recognized national or international standards, such as required by EN ISO 9001.

For the LIP and PP encoder series, an additional calibration chart documents the ascertained **position error** over the measuring range. It also specifies the measuring parameters and the measurement uncertainty.

Temperature range
The linear encoders are calibrated at a **reference temperature** of 20 °C. The position error documented in the calibration chart is valid at this temperature.



HEIDENHAIN

Qualitätsprüfbescheinigung | *Quality Inspection Document*

LIP 201R
ID 631000-06
SN 644332486

Positionsabweichung F [µm]
Position error F [µm]

Die Messkurve zeigt die Mittelwerte der Positionsabweichungen aus Vorwärts- und Rückwärtsmessung.

The error curve shows the mean values of the position errors from measurements in forward and backward direction.

Positionsabweichung F des Maßstabs: F= Pos_M - Pos_E
Pos_M = Messposition der Messmaschine
Pos_E = Messposition des Maßstabs

Position error F of the scale: F= Pos_M - Pos_E
Pos_M = position measured by the measuring machine
Pos_E = position measured by the scale

Maximale Positionsabweichung der Messkurve	
innerhalb 320 mm	± 0,14 µm

Maximum position error of the error curve	
within 320 mm	*± 0.14 µm*

Unsicherheit der Messmaschine
$U_{95\%}$ = 0,04 µm + 0,40 · 10^{-6}·L (L=Länge Messintervall)

Uncertainty of the measuring machine
$U_{95\%}$ = 0.04 µm + 0.40 · 10^{-6}·L (L=measurement interval length)

Messparameter	
Messschritt	1000 µm
Erster Referenzimpuls bei Messposition	160,0 mm
Relative Luftfeuchtigkeit	max. 50%

Measurement parameters	
Measurement step	1000 µm
First reference pulse at measured position	*160.0 mm*
Relative humidity	*max. 50%*

Dieser Maßstab wurde unter strengen HEIDENHAIN-Qualitätsnormen hergestellt und geprüft. Die Positionsabweichung liegt bei einer Bezugstemperatur von 20 °C innerhalb der Genauigkeitsklasse ± 1,0 µm.

In der Applikation entstehen zusätzliche Positionsabweichungen. Beachten Sie hierzu die Angaben im Prospekt.

This scale has been manufactured and inspected in accordance with the stringent quality standards of HEIDENHAIN. The position error at a reference temperature of 20 °C lies within the accuracy grade ± 1.0 µm.

Additional position errors arise in the application. Please note the information about this in the brochure.

Kalibriernormale	Kalibrierzeichen
Jod-stabilisierter He-Ne Laser*	40071 PTB 21
Wasser-Tripelpunktzelle	74038 PTB 22
Gallium-Schmelzpunktzelle	74058 PTB 21
Barometer	05937704 D-K-15105 2022-02
Luftfeuchtemessgerät	0352 D-K-19342 2022-03

* Die Frequenz des Jod-stabilisierten Lasers wird regelmäßig extern kalibriert. Zwischen den Kalibrierzeitpunkten findet HEIDENHAIN-intern zusätzlich eine Frequenzüberwachung mittels Atomuhr (Cäsium-Frequenzstandard) und Frequenzkamm statt.

Calibration standards	*Calibration marks*
*Iodine-stabilized He-Ne Laser**	*40071 PTB 21*
Water triple point cell	*74038 PTB 22*
Gallium melting point cell	*74058 PTB 21*
Pressure gauge	*05937704 D-K-15105 2022-02*
Hygrometer	*0352 D-K-19342 2022-03*

** The frequency of the iodine-stabilized laser is externally calibrated on a regular basis. Between these calibrations, frequency monitoring is also performed internally at HEIDENHAIN by means of an atomic clock (cesium frequency standard) and a frequency comb.*

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04.03.2024 M. Holzapfel
Prüfer/*Inspected by* M. Holzapfel

Mechanical design types and mounting
Linear scales

Exposed linear encoders are made up of two separate components: the scanning head and linear scale or scale tape, which are brought together solely over the machine guideway. For this reason, the machine must be designed from the very beginning to meet the following requirements:

- The machine guideway must be designed such that the **scanning gap tolerances** are complied with at the location where the encoder is installed (see *Specifications*)
- The mounting surface of the scale must meet the **flatness** requirements
- To facilitate adjustment of the scanning head to the scale, the scanning head should be fastened with a **mounting bracket**

Scale versions
HEIDENHAIN provides the appropriate scale version for the given application and accuracy requirements.

LIP 201
LIP 6001
LIC 4003
The graduation carriers are fastened directly to the mounting surface with clamps. A holder is used to define the thermal fixed point.

Accessories for the LIC 41x3 and LIP 60x1:

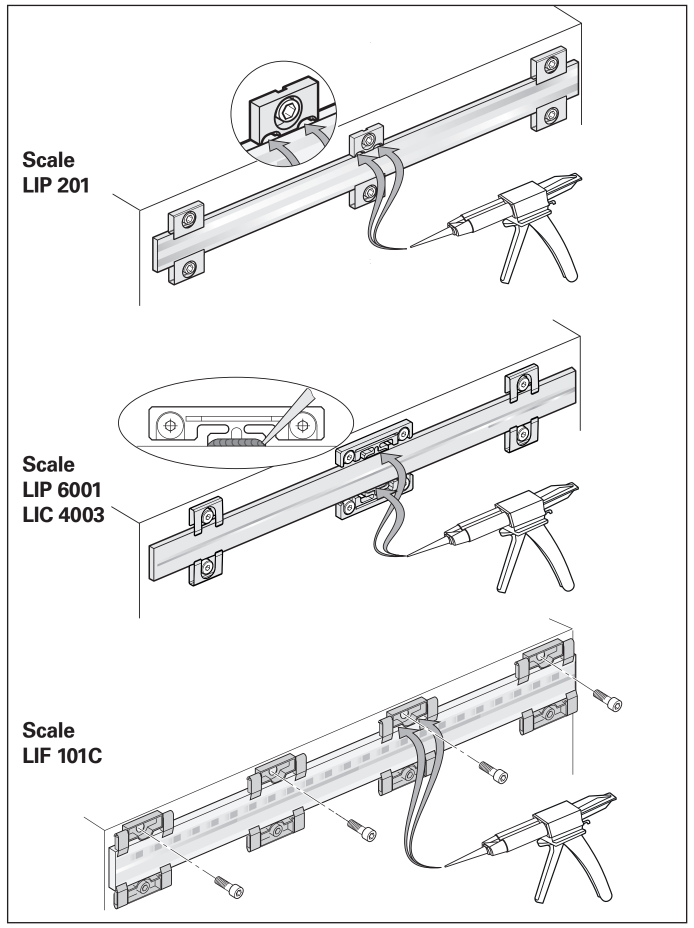
Fixing clamps	ID 1176458-01
Holder for thermal fixed point	ID 1176475-01
Spacer shims	ID 1176441-01
Adhesive*	ID 1180444-01
Double-cartridge gun	ID 1180450-01
Dispensing nozzles and mixing tubes	ID 1176444-01

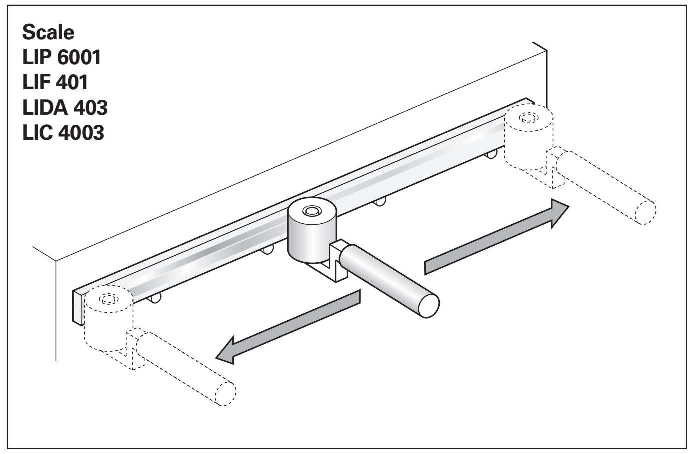
LIP 6001
LIF 401
LIDA 403
LIC 4003
The graduation carriers are adhesively bonded directly to the mounting surface with PRECIMET adhesive mounting film, with even pressure applied by means of a roller. A thermal fixed point can be established at a location with epoxy adhesive.

Accessory

Roller	ID 276885-01

* Caution: no transport by air (dangerous goods)
Trade name: 3M Scotch-Weld Epoxy Adhesive DP-460 EG



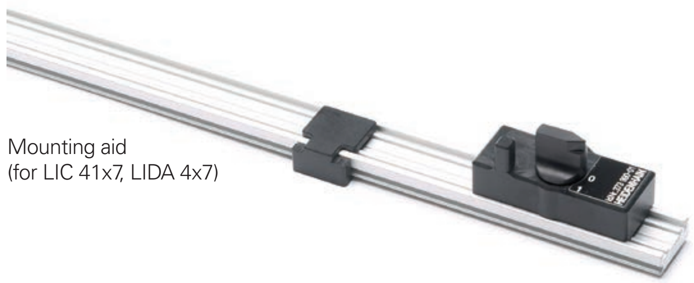


LIC 41x5
LIDA 4x5
Linear encoders of the LIC 41x5 and LIDA 4x5 series are specially designed for long measuring lengths. They are mounted with scale carrier sections screwed onto the mounting surface or adhesively bonded with PRECIMET adhesive mounting film. The single-piece steel scale tape is then pulled through the carrier sections, **tensioned as specified**, and **secured at its ends** to the machine base. The LIC 41x5 and LIDA 4x5 encoders thereby exhibit the same thermal behavior as that of the mounting surface.

LIC 21x7
LIC 31x7
LIC 41x7
LIDA 2x7
LIDA 4x7
The encoders of these series are also designed for long measuring lengths. The scale carrier sections are adhesively bonded to the mounting surface with PRECIMET adhesive mounting film; the single-piece scale tape is pulled through, and **the midpoint is secured** to the machine base. This mounting method allows the scale tape to expand freely at both ends and ensures a defined thermal behavior.

Accessory for LIC 41x7, LIDA 4x7

Mounting aid	ID 373990-01



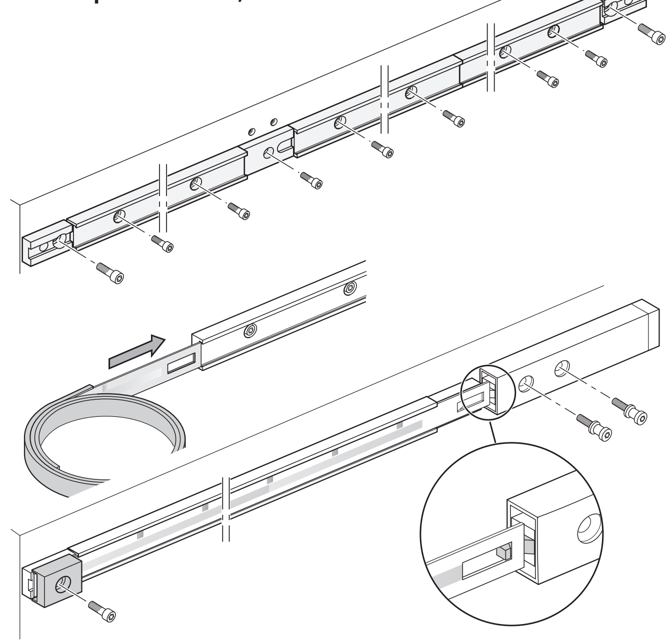
Mounting aid
(for LIC 41x7, LIDA 4x7)

LIC 21x9
LIC 31x1
LIC 41x9
LIDA 2x9
LIDA 4x9
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. A ridge or aligning rail with a height of 0.3 mm must be provided for the horizontal alignment of the scale tape.

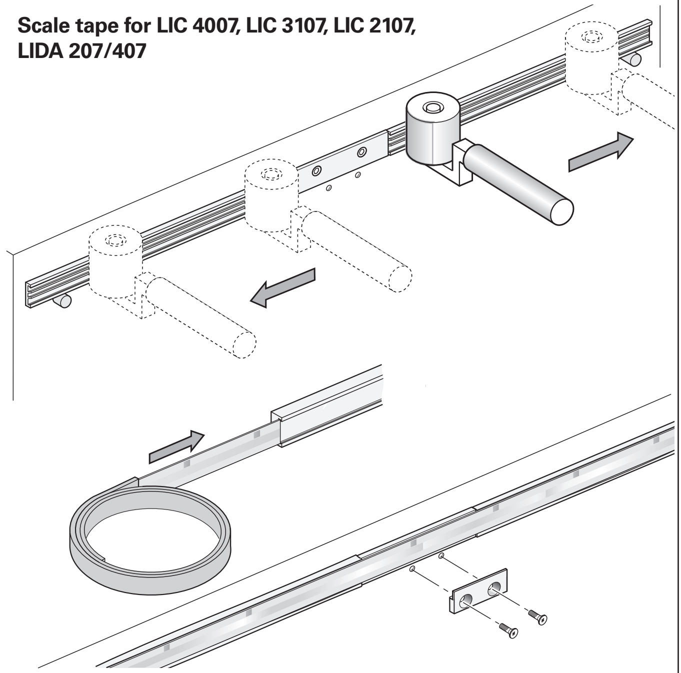
Accessories for versions with PRECIMET

Roller	ID 276885-01
Mounting aid, LIDA 2x9	ID 1070307-01
Mounting aid, LIC 21x9	ID 1070853-01

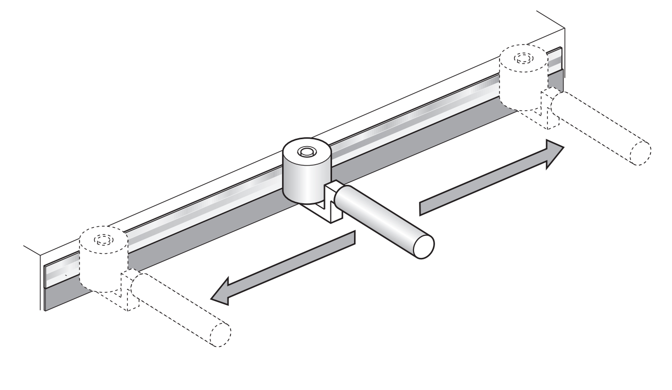
Scale tape for LIC 4005, LIDA 405



Scale tape for LIC 4007, LIC 3107, LIC 2107, LIDA 207/407



Scale tape for LIC 4009, LIC 3109, LIC 2109, LIDA 209/409



Because exposed linear encoders are assembled on the machine, they must be precisely adjusted after mounting. This adjustment determines the final accuracy of the encoder. It is therefore advisable to design the machine such that this adjustment is as easy as possible, while also ensuring the greatest possible degree of mounting stability.

Mounting the LIP 2x1
The LIP 2x1 can be fastened from the side as well as from above. The housing cover has a raised contact surface for the thermal connection to ensure optimal heat dissipation. The contact surface is compressed against the mounting element during mounting.

Mounting the LIP 60x1
The LIP 60x1 can be fastened from the side as well as from above. When mounted from above, it is additionally possible to define a fixed center of rotation by inserting an alignment pin with Ø 2 mm or Ø 3 mm. This facilitates the alignment of the scanning head parallel to the scale. The alignment pin can be removed when mounting is completed.

Mounting the LIF
This scanning head features a centering collar with which the scanning head can be rotated in the location hole of the angle bracket and thereby aligned parallel to the scale.

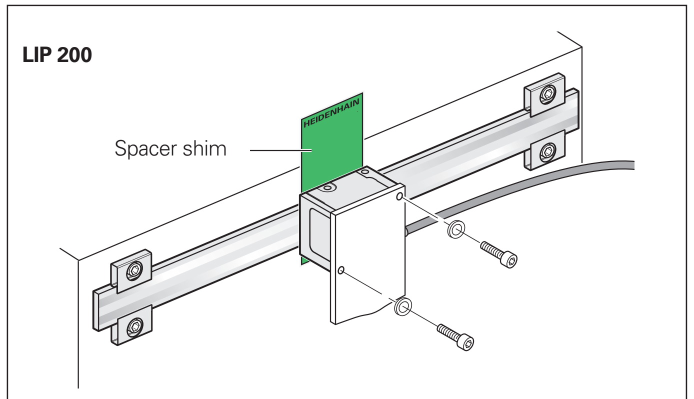
Mounting the LIC/LIDA
There are three options for mounting the scanning head (see dimensions). A spacer shim makes it easy to set the gap between the scanning head and the scale or scale tape. It is helpful to fasten the scanning head from behind with a mounting bracket. The scanning head can be precisely adjusted through a hole in the mounting bracket with a tool.

Adjustment
The gap between the scale and scanning head is easily adjusted with a spacer shim.

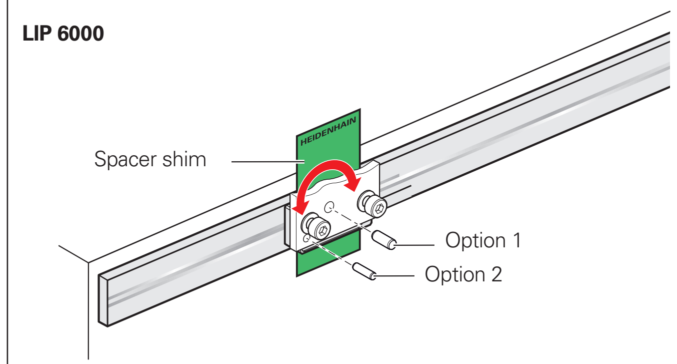
The signals from the LIC, LIP 6000, and LIP 200 can be readily adjusted with the PWM 20/21 adjustment and testing package. For all other exposed linear encoders, the incremental and reference mark signals are adjusted through a slight rotation of the scanning head (for the LIDA 400, a tool is used).

HEIDENHAIN offers measuring and testing devices for adjustment (see “Testing and inspection devices, and diagnostics”).

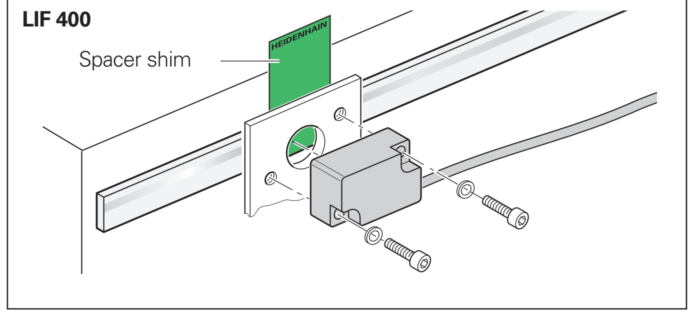
LIP 200



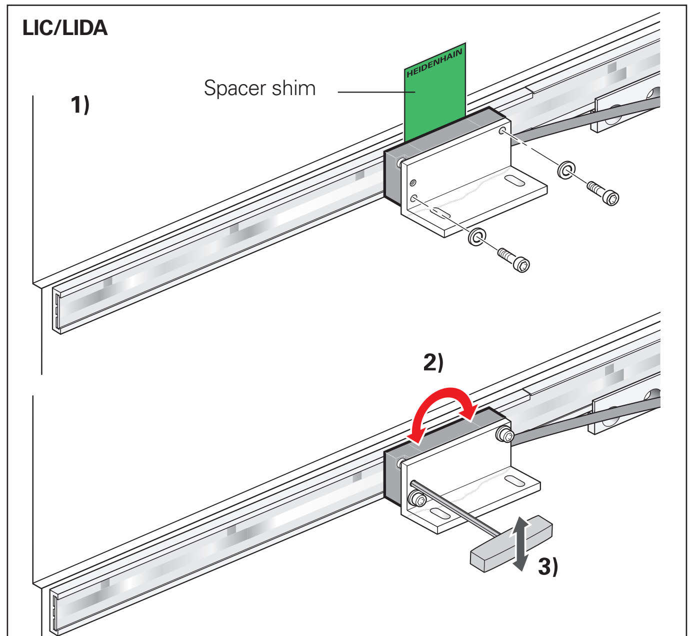
LIP 6000



LIF 400



LIC/LIDA



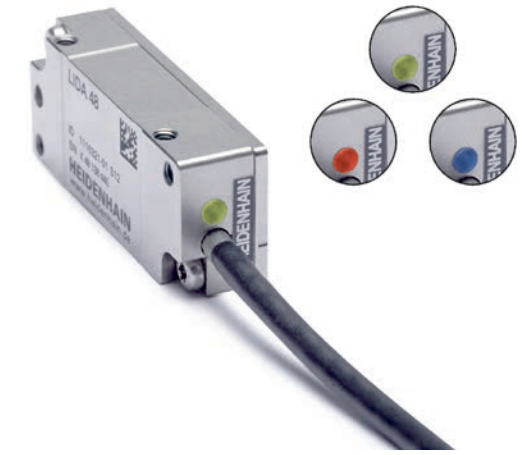
3) Only with the LIDA 400

Signal-quality indicator

The LIDA, LIF, and LIP 6071 linear encoders feature an integrated signal-quality indicator with a multicolor LED, permitting fast and easy signal-quality checks during operation.

This feature provides a number of benefits:
- Scanning-signal quality visualization through a multicolor LED
- Continuous monitoring of incremental signals over the entire measuring length
- Indication of reference-mark signal behavior
- Quick signal-quality checks in the field without additional aids

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.



LIDA: Signal-quality indicator in the scanning head

LIF, LIP 6071: Signal-quality indicator in the interface electronics

LED indicator for incremental signals

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

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 control margin
A flashing LED that turns dark every 2.5 seconds indicates that the control margin of the scanning ASIC is almost exhausted. In this case you should clean the measuring standard and the scanning window of the scanning head in compliance with the relevant information in the mounting instructions. The encoder may also need to be checked for correct mounting.

General mechanical information

Temperature range
The **operating temperature range** states the limits of ambient temperature within which the specifications of the linear encoder are complied with.
The **storage temperature range** of –20 °C to +70 °C applies when the unit remains in its packaging.

Thermal characteristics
The thermal behavior of the linear encoder is an essential criterion for the working accuracy of the machine. As a general rule, the thermal behavior of the linear encoder should match that of the workpiece or measured object. During temperature changes, the linear encoder should expand or contract in a defined, reproducible manner.

The graduation carriers of HEIDENHAIN linear encoders (see *Specifications*) have differing coefficients of thermal expansion. This makes it possible to select the linear encoder with the thermal behavior best suited to the application.

Parts subject to wear
Encoders from HEIDENHAIN are designed for a long service life. Preventive maintenance is not required. However, they do contain components that are subject to wear, depending on the application and how they are deployed. This especially applies to cables that are subjected to frequent flexing.
Other parts subject to wear are the bearings in encoders with integral bearing, the radial shaft seal rings in rotary encoders and angle encoders, and the sealing lips on sealed linear encoders.

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Zerodur is a registered trademark of Schott-Glaswerke, Mainz, Germany.

Protection (EN 60529)
The scanning heads of exposed linear encoders feature the following degrees of protection:

Scanning head	Protection
LIC	IP67
LIDA	IP40
LIF	IP50
LIP 200	IP40
LIP 6000	IP50
PP	IP50

The scales have no special protection. If the scales are exposed to contamination, protective measures must be taken.

Acceleration
Linear encoders are subject to various types of acceleration during operation and mounting.
- The indicated maximum values for **vibration** apply to frequencies of 55 Hz to 2000 Hz **(EN 60068-2-6)**. If, depending on the application and the mounting scenario, the permissible acceleration values are exceeded (e.g., in the case of resonances), then the encoder can become damaged. **Extensive testing of the entire system is therefore required**
- The maximum permissible acceleration values (semi-sinusoidal shock) for **shock and impact loads** are valid for 11 ms or 6 ms **(EN 60068-2-27).** Under no circumstances should a hammer or similar implement be used to adjust or position the encoder

System tests
Encoders from HEIDENHAIN are usually integrated as components into complete systems. Applications of this type require full-system, **extensive testing**, regardless of the encoder's specifications.

The specifications provided in this brochure apply only to the encoder and not to the entire system. Any operation of the encoder outside of the specified range or outside of its proper and intended use is at the user's own risk.

In safety-related systems, the encoder's position value must be tested by the higher-level system after switch-on.

Mounting
The steps and dimensions that must be complied with during mounting are specified solely in the mounting instructions supplied with the device. All mounting-related information in this brochure is therefore provisional and non-binding, and will not become the subject matter of a contract.

Functional safety

With the absolute linear encoders of the LIC 4100 series, HEIDENHAIN offers an ideal solution for position acquisition on 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: • Vibration • Shock See mounting information: • Usable materials • Mounting conditions
Scanning head	Mounting configurations I and II: Screw connection:[2)] M2x25 ISO 4762 8.8 screws		
	Mounting configuration III: Screw connection:[2)] 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.

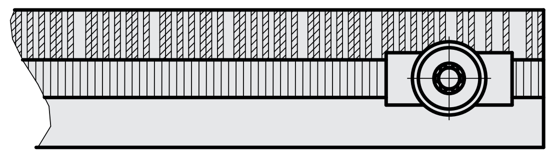
Note:
The scanning head may be operated only within the permissible mounting tolerances and measuring length of the measuring standard.

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

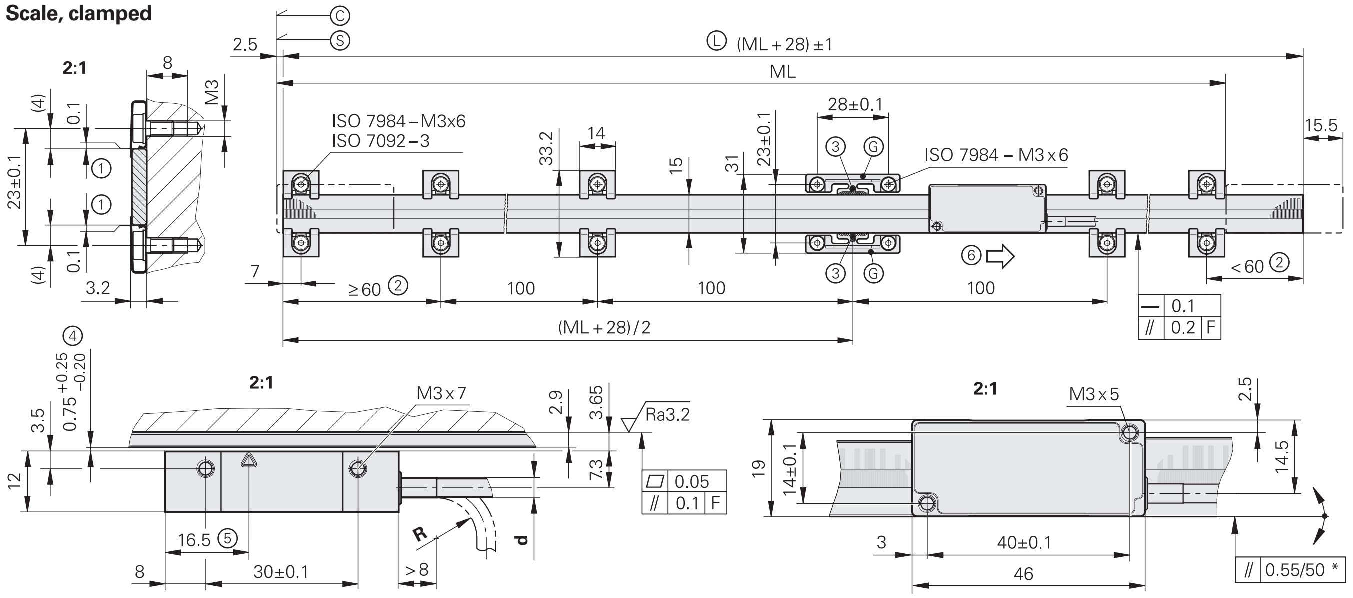
	Angle bracket for scanning head		Mounting surface for measuring standard
Material	Steel	Aluminum	Steel, aluminum
Tensile strength R_m	$\geq 600\ N/mm^2$	$\geq 220\ N/mm^2$	Not applicable
Shear strength τ_B	$\geq 390\ N/mm^2$	$\geq 130\ N/mm^2$	Not applicable
Elastic modulus E	$\geq 200000\ N/mm^2$ to $215000\ N/mm^2$	$\geq 70000\ N/mm^2$ to $75000\ N/mm^2$	Not applicable
Coefficient of thermal expansion α_{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 $25 \cdot 10^{-6}\ K^{-1}$



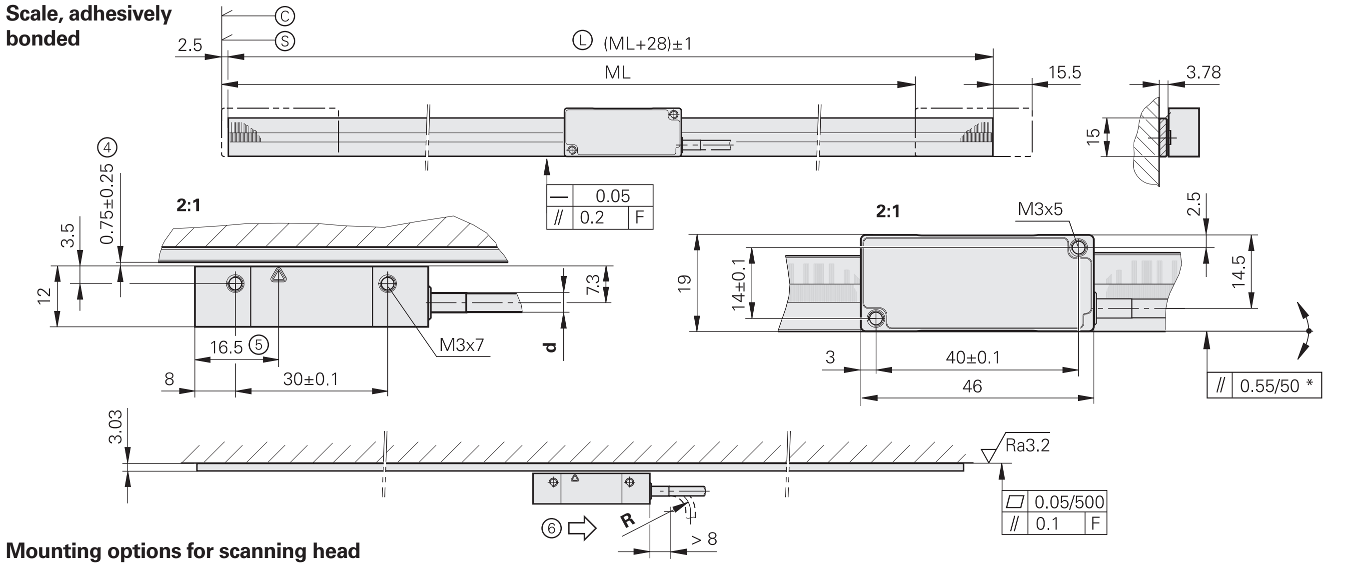
LIC 4113, LIC 4133, LIC 4193

Absolute linear encoders for measuring lengths of up to 3 m
- **Measuring steps of down to 1 nm**
- **Glass or glass ceramic measuring standard**
- **Measuring standard secured with adhesive film or fixing clamps**
- **Consisting of a linear scale and scanning head (with straight or angled cable outlet)**
- **Available version for use in a high vacuum (see separate Product Information document)**

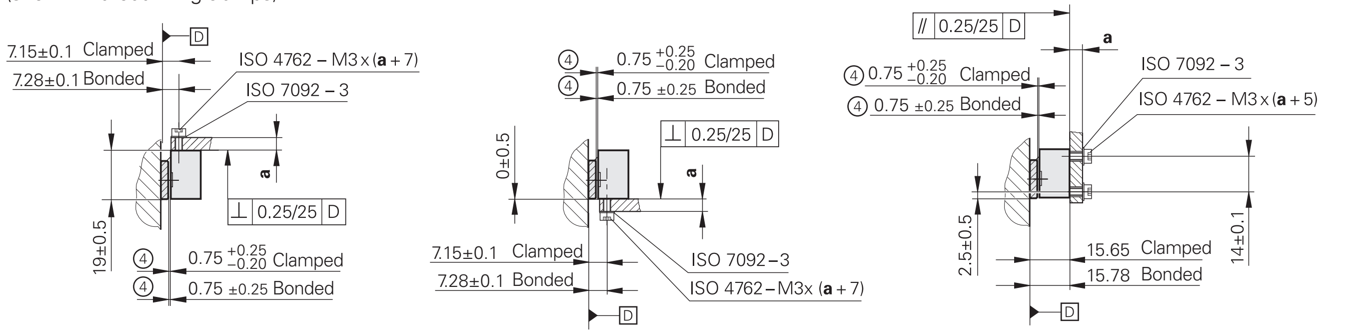
Scale, clamped



Scale, adhesively bonded



Mounting options for scanning head
(shown without fixing clamps)



F = Machine guideway
* = Mounting error plus dynamic guideway error
Ⓢ = Beginning of measuring length (ML)
Ⓒ = Code start value: ≥ 100±1 mm
Ⓛ = Scale length
Ⓖ = Fixed-point element for defining the thermal fixed point
1 = Gap is adjusted with a spacer shim during mounting
2 = Depending on the measuring length (ML), use an additional pair of fixing clamps
3 = Adhesive
4 = Mounting gap between scanning head and scale
5 = Optical centerline
6 = Direction of motion of the scanning unit for increasing position values

mm
Tolerancing ISO 8015
ISO 2768:1989-mH
≤ 6 mm: ±0.2 mm

	d	R	
PUR	Ø 3.7 mm	> 8 mm	≥ 40 mm
Vacuum	Ø 3.5 mm	> 10 mm	≥ 50 mm
PUR	Ø 2.9 mm	> 6 mm	≥ 30 mm

Linear scale	**LIC 4003**
Measuring standard Coefficient of linear expansion*	METALLUR grating on glass or glass ceramic $\alpha_{therm} \approx 8 \cdot 10^{-6}\ K^{-1}$ (glass) $\alpha_{therm} = (0\pm0.5) \cdot 10^{-6}\ K^{-1}$ (Robax glass ceramic)
Accuracy grade*	±1 µm (only for Robax glass ceramic), ±3 µm, ±5 µm
Baseline error	≤ ±0.275 µm/10 mm
Measuring length (ML)* in mm	240 340 440 640 840 1040 1240 1440 1640 1840 2040 2240 2440 2640 2840 3040 (Robax glass ceramic only up to ML of 1640)
Mass	3 g + 110 g/m of measuring length

Scanning head	**LIC 411**	**LIC 413**	**LIC 419F**	**LIC 419M**		**LIC 419P**	**LIC 419Y**
Interface	EnDat 2.2	EnDat 3	Fanuc Serial Interface αi	Mitsubishi high speed interface		Panasonic Serial Interface	Yaskawa Serial Interface
Ordering designation*	EnDat22	E30-RB E30-R4	Fanuc05	Mit03-4	Mit03-2	Pana02	YEC07
Measuring step*[1)]	10 nm, 5 nm, 1 nm	1 nm	10 nm, 5 nm, 1 nm				
Calculation time t_{cal} Clock frequency	≤ 5 µs ≤ 16 MHz	–					
Traversing speed[2)]	≤ 600 m/min						
Interpolation error	±20 nm						
Electrical connection*	Cable (1 m or 3 m) with 8-pin M12 coupling (male) (for all interfaces except EnDat 3: E30-R4) or 15-pin D-sub connector (male) (for all interfaces except EnDat 3: E30-R4) or 4-pin MINI-SNAP connector (male) (for EnDat 3: E30-R4)						
Cable length (with HEIDENHAIN cable)	≤ 100 m		≤ 50 m	≤ 30 m		≤ 50 m	
Supply voltage	DC 3.6 V to 14 V						
Power consumption[2)] (max.)	*At 3.6 V:* ≤ 700 mW *At 14 V:* ≤ 800 mW	*At 3.6 V:* ≤ 850 mW *At 14 V:* ≤ 950 mW					
Current consumption (typical)	*At 5 V:* 75 mA (without load)	*At 12 V:* 35 mA (without load)	*At 5 V:* 95 mA (without load)				
Vibration 55 Hz to 2000 Hz **Shock** 6 ms	≤ 500 m/s² (EN 60068-2-6) ≤ 1000 m/s² (EN 60068-2-27)						
Operating temperature	–10 °C to 70 °C						
Mass	Scanning head: ≤ 18 g (without cable) Cable: *M12 coupling and D-sub connector:* 20 g/m; *MINI-SNAP connector:* 15 g/m Connectors: *M12 coupling:* 15 g; *D-sub connector:* 32 g; *MINI-SNAP:* 8 g						

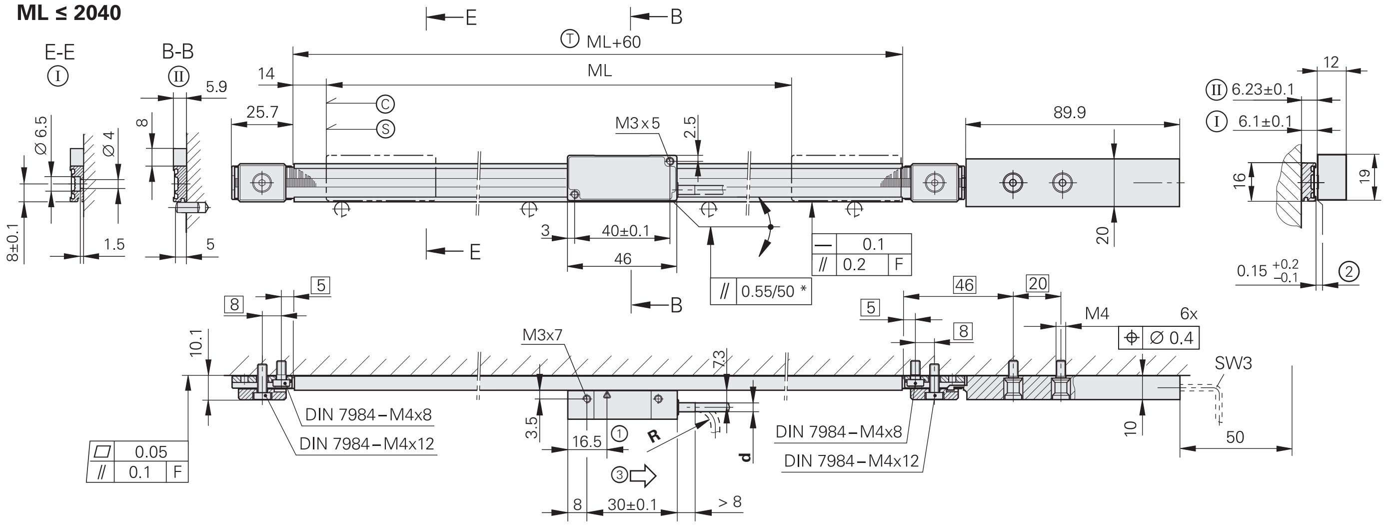
* Please select when ordering
[1)] *Mitsubishi:* ML ≤ 2040 mm / *Yaskawa:* ML ≤ 1840 mm
[2)] See *General electrical information* in the *Interfaces of HEIDENHAIN Encoders* brochure

Robax is a registered trademark of Schott-Glaswerke, Mainz, Germany

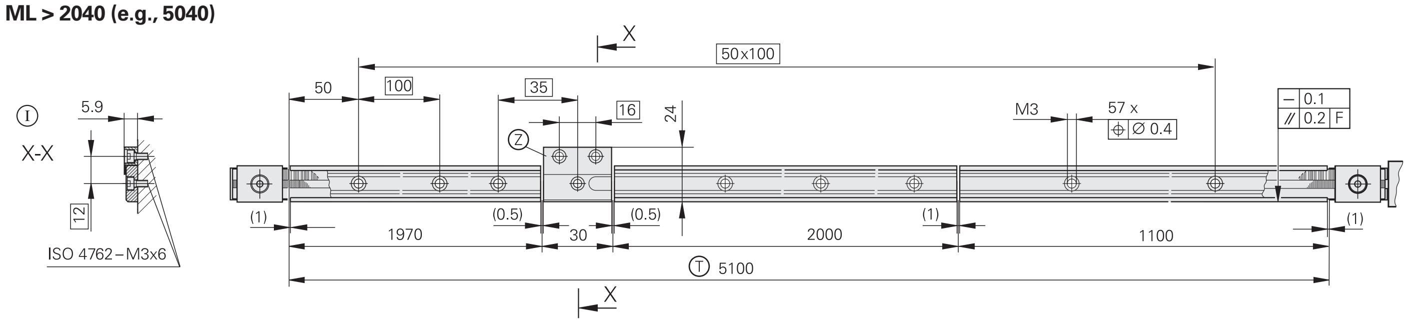
LIC 4115, LIC 4135, LIC 4195

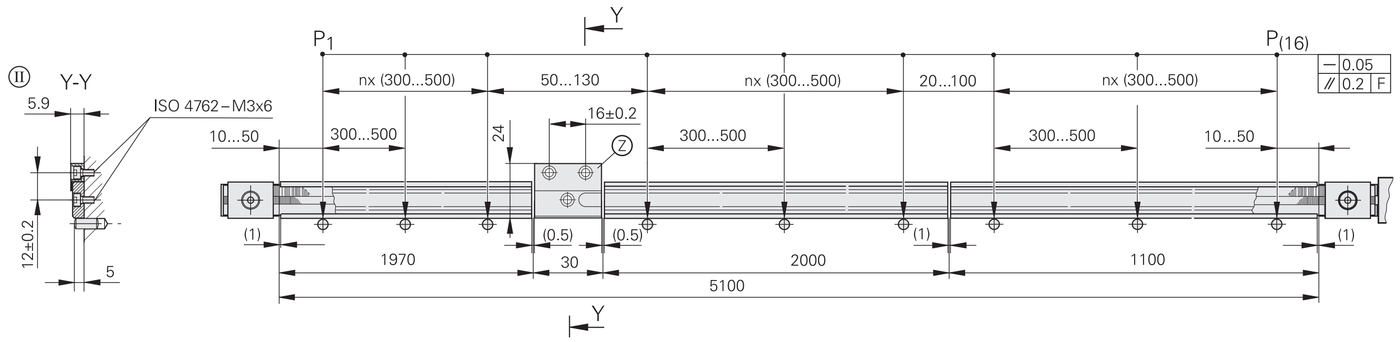
Absolute linear encoders for measuring lengths of up to 28 m
- **For measuring steps of down to 1 nm**
- **Steel scale tape pulled through aluminum extrusions and tensioned**
- **Consisting of a linear scale and scanning head (with straight or angled cable outlet)**

ML ≤ 2040

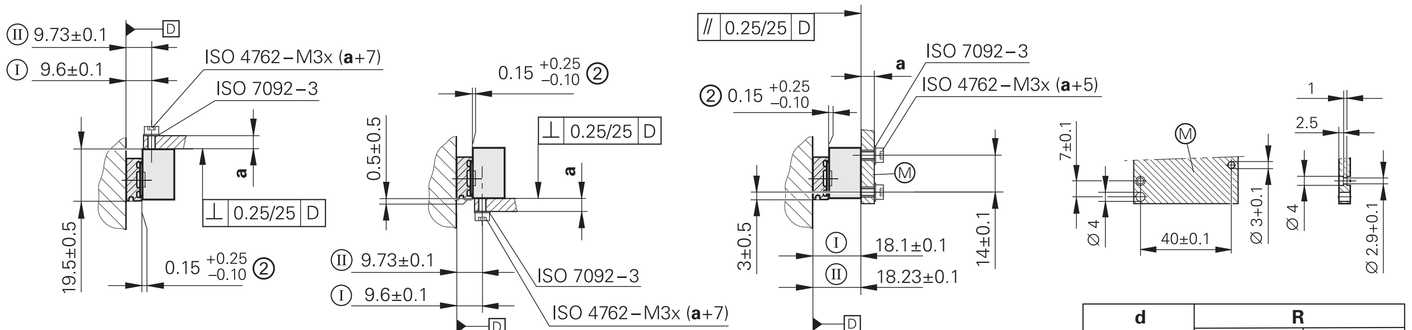


ML > 2040 (e.g., 5040)





Mounting options for scanning head



d	R	
Ø 3.7 mm	> 8 mm	≥ 40 mm
Ø 2.9 mm	> 6 mm	≥ 30 mm

Ⓘ = Scale carrier sections secured with screws
Ⓘ Ⓘ = Scale carrier sections adhesively bonded with PRECIMET
F = Machine guideway
P = Measuring points for alignment
* = Mounting error plus dynamic guideway error
© = Code start value: ≥ 100 mm

Ⓢ = Beginning of measuring length (ML)
Ⓩ = Spacer for measuring lengths of 3040 mm or greater
Ⓣ = Carrier length
Ⓜ = Mounting surface for scanning head
1 = Optical centerline
2 = Mounting gap between scanning head and extrusion
3 = Direction of motion of the scanning unit for ascending position values

mm
Tolerancing ISO 8015
ISO 2768:1989-mH
≤ 6 mm: ±0.2 mm

Scale	**LIC 4005**
Measuring standard Coefficient of linear expansion*	Steel scale tape with absolute and incremental METALLUR track Depends on the mounting surface
Accuracy grade*	±5 µm
Baseline error	≤ ±0.750 µm/50 mm (typical)
Measuring length (ML)* in mm	140 240 340 440 540 640 740 840 940 1040 1140 1240 1340 1440 1540 1640 1740 1840 1940 2040 Greater MLs (up to 28440 mm) with a single-section scale tape and individual scale carrier sections
Mass	Scale tape: 31 g/m; assembly parts: 80 g + n[1] · 27 g; scale tape carrier: 187 g/m

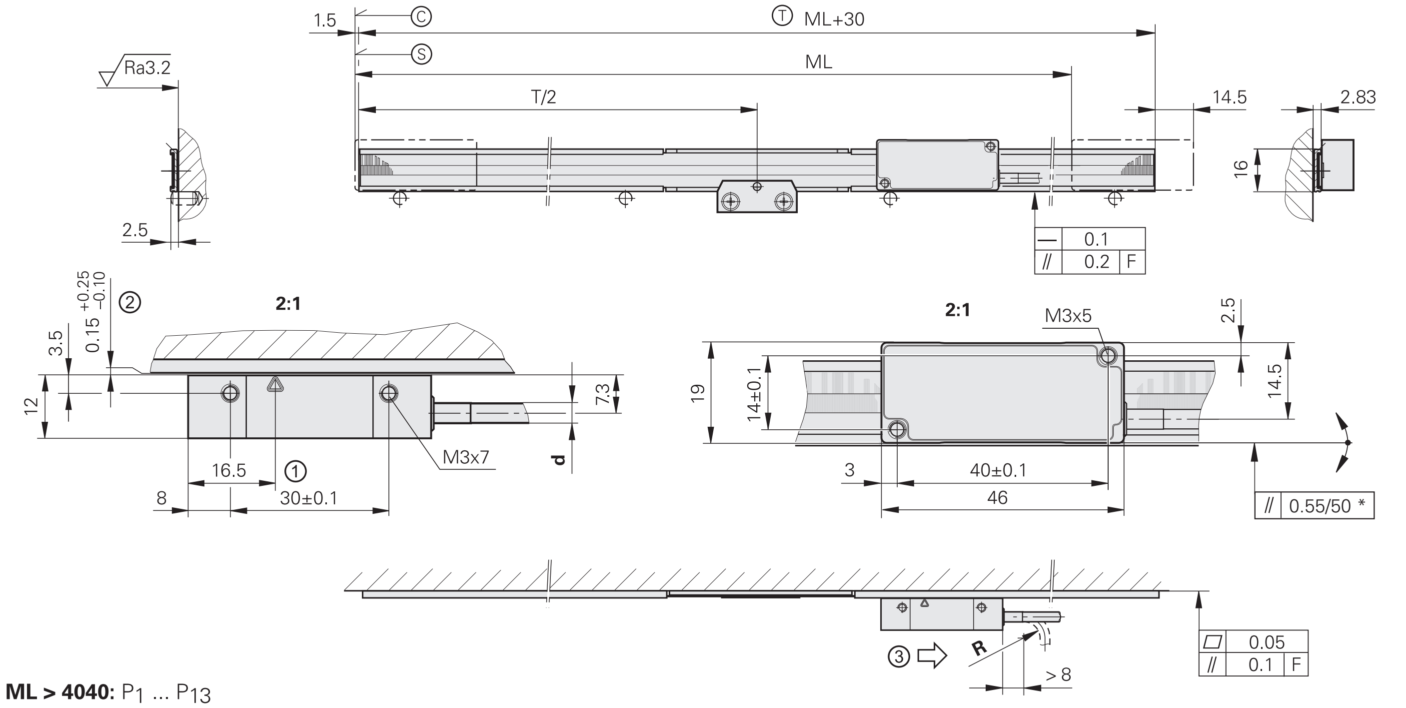
Scanning head	**LIC 411**	**LIC 413**	**LIC 419F**	**LIC 419M**		**LIC 419P**	**LIC 419Y**
Interface	EnDat 2.2	EnDat 3	Fanuc Serial Interface αi	Mitsubishi high speed interface		Panasonic Serial Interface	Yaskawa Serial Interface
Ordering designation*	EnDat22	E30-RB E30-R4	Fanuc05	Mit03-4	Mit03-2	Pana02	YEC07
Measuring step*[2)]	10 nm, 5 nm, 1 nm	1 nm	10 nm, 5 nm, 1 nm				
Calculation time t_{cal} Clock frequency	≤ 5 µs ≤ 16 MHz	–					
Traversing speed[3)]	≤ 600 m/min						
Interpolation error	±20 nm						
Electrical connection*	Cable (1 m or 3 m) with 8-pin M12 coupling (male) (for all interfaces except EnDat 3: E30-R4) or 15-pin D-sub connector (male) (for all interfaces except EnDat 3: E30-R4) or 4-pin MINI-SNAP connector (male) (for EnDat 3: E30-R4)						
Cable length (with HEIDENHAIN cable)	≤ 100 m		≤ 50 m	≤ 30 m		≤ 50 m	
Supply voltage	DC 3.6 V to 14 V						
Power consumption[3)] (max.)	*At 3.6 V:* ≤ 700 mW *At 14 V:* ≤ 800 mW	*At 3.6 V:* ≤ 850 mW *At 14 V:* ≤ 950 mW					
Current consumption (typical)	*At 5 V:* 75 mA (without load)	*At 12 V:* 35 mA (without load)	*At 5 V:* 95 mA (without load)				
Vibration 55 Hz to 2000 Hz **Shock** 6 ms	≤ 500 m/s² (EN 60068-2-6) ≤ 1000 m/s² (EN 60068-2-27)						
Operating temperature	–10 °C to 70 °C						
Mass	Scanning head: ≤ 18 g (without cable) Cable: *M12 coupling and D-sub connector:* 20 g/m; *MINI-SNAP connector:* 15 g/m Connectors: *M12 coupling:* 15 g; *D-sub connector:* 32 g; *MINI-SNAP:* 8 g						

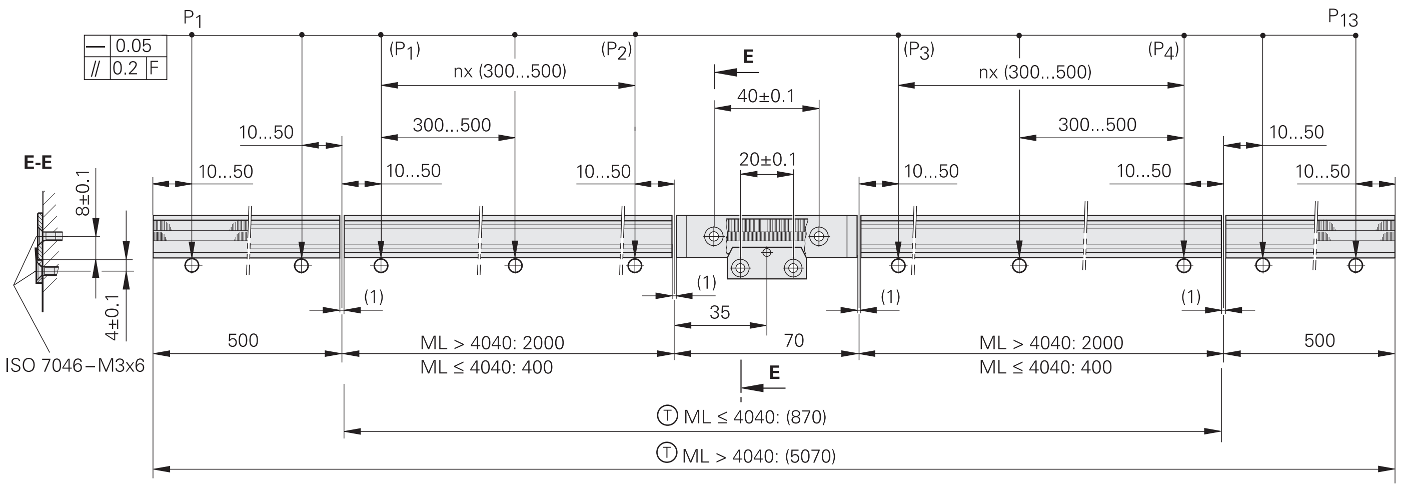
* Please select when ordering
1) n = 1 for ML 3140 mm to 5040 mm; n = 2 for ML 5140 mm to 7040 mm; etc.*
2) *Mitsubishi:* 1 nm: ML ≤ 2040 mm; 5 nm: ML ≤ 10040 mm; 10 nm: ML ≤ 20040 mm
Yaskawa: 1 nm: ML ≤ 1840 mm; 5 nm: ML ≤ 9040 mm; 10 nm: ML ≤ 18040 mm
3) See *General electrical information* in the *Interfaces of HEIDENHAIN Encoders* brochure

LIC 4117, LIC 4137, LIC 4197

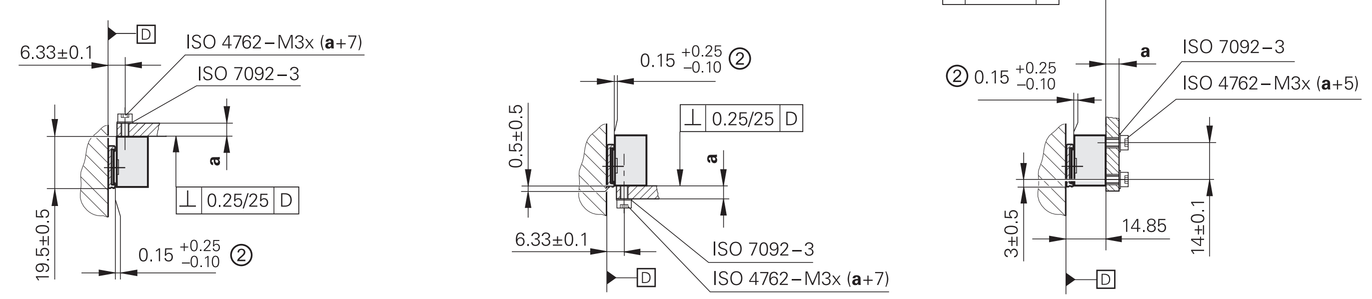
Absolute linear encoders for measuring lengths of up to 6 m

- **For measuring steps of down to 1 nm**
- **Steel scale tape pulled through aluminum extrusions and fastened at center**
- **Consisting of a linear scale and scanning head (with straight or angled cable outlet)**





Mounting options for scanning head



mm

Tolerancing ISO 8015
ISO 2768:1989-mH
≤ 6 mm: ±0.2 mm

F = Machine guideway
P = Measuring points for alignment
* = Mounting error plus dynamic guideway error
Ⓒ = Code start value: ≥ 100 mm
Ⓢ = Beginning of measuring length (ML)
Ⓣ = Carrier length
1 = Optical centerline
2 = Mounting gap between scanning head and extrusion
3 = Direction of motion of the scanning unit for ascending position values

d	R	
Ø 3.7 mm	> 8 mm	≥ 40 mm
Ø 2.9 mm	> 6 mm	≥ 30 mm

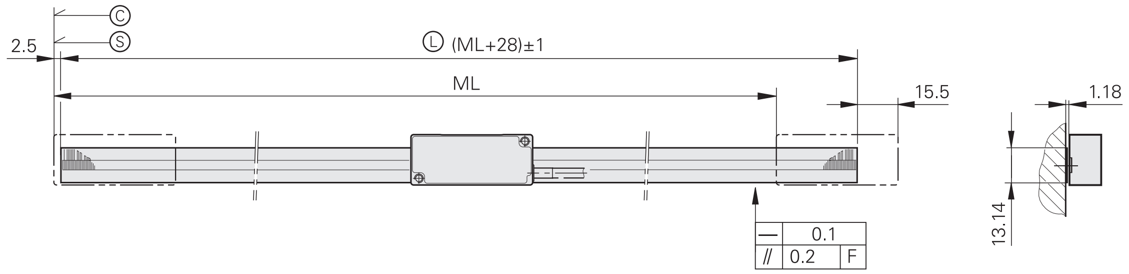
Scale	**LIC 4007**
Measuring standard Coefficient of linear expansion*	Steel scale tape with absolute and incremental METALLUR track $\alpha_{therm} \approx 10 \cdot 10^{-6}\ K^{-1}$
Accuracy grade*	±3 µm (up to ML 1040), ±5 µm (for ML 1240 or greater), ±15 µm1)
Baseline error	≤ ±0.750 µm/50 mm (typical)
Measuring length (ML)* in mm	240 440 640 840 1040 1240 1440 1640 Scale tape cut from roll*: 2 m, 4 m, 6 m 1840 2040 2240 2440 2640 2840 3040 3240 3440 3640 3840 4040 4240 4440 4640 4840 5040 5240 5440 5640 5840 6040
Mass	Scale tape: 31 g/m; assembly parts: 20 g; scale tape carrier: 68 g/m

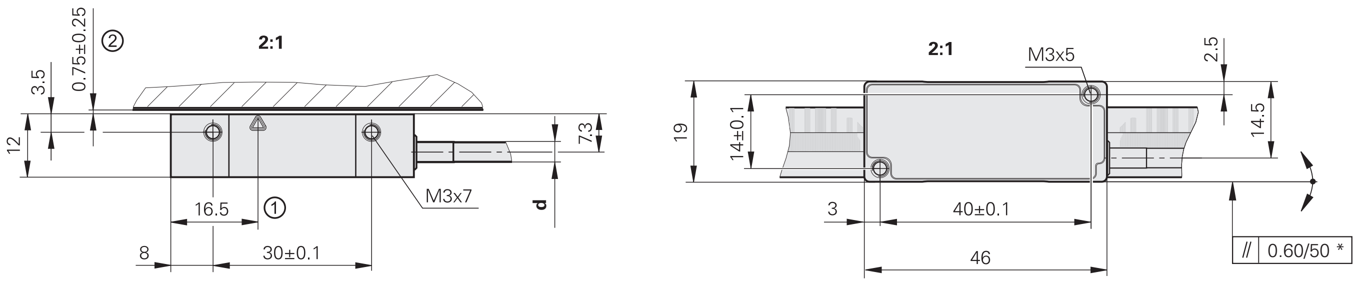
Scanning head	**LIC 411**	**LIC 413**	**LIC 419F**	**LIC 419M**		**LIC 419P**	**LIC 419Y**
Interface	EnDat 2.2	EnDat 3	Fanuc Serial Interface αi	Mitsubishi high speed interface		Panasonic Serial Interface	Yaskawa Serial Interface
Ordering designation*	EnDat22	E30-RB E30-R4	Fanuc05	Mit03-4	Mit03-2	Pana02	YEC07
Measuring step*2)	10 nm, 5 nm, 1 nm	1 nm	10 nm, 5 nm, 1 nm				
Calculation time t_{cal} Clock frequency	≤ 5 µs ≤ 16 MHz	–					
Traversing speed3)	≤ 600 m/min						
Interpolation error	±20 nm						
Electrical connection*	Cable (1 m or 3 m) with 8-pin M12 coupling (male) (for all interfaces except EnDat 3: E30-R4) or 15-pin D-sub connector (male) (for all interfaces except EnDat 3: E30-R4) or 4-pin MINI-SNAP connector (male) (for EnDat 3: E30-R4)						
Cable length (with HEIDENHAIN cable)	≤ 100 m		≤ 50 m	≤ 30 m		≤ 50 m	
Supply voltage	DC 3.6 V to 14 V						
Power consumption3) (max.)	*At 3.6 V:* ≤ 700 mW *At 14 V:* ≤ 800 mW	*At 3.6 V:* ≤ 850 mW *At 14 V:* ≤ 950 mW					
Current consumption (typical)	*At 5 V:* 75 mA (without load)	*At 12 V:* 35 mA (without load)	*At 5 V:* 95 mA (without load)				
Vibration 55 Hz to 2000 Hz **Shock** 6 ms	≤ 500 m/s² (EN 60068-2-6) ≤ 1000 m/s² (EN 60068-2-27)						
Operating temperature	–10 °C to 70 °C						
Mass	Scanning head: ≤ 18 g (without cable) Cable: *M12 coupling and D-sub connector:* 20 g/m; *MINI-SNAP connector:* 15 g/m Connectors: *M12 coupling:* 15 g; *D-sub connector:* 32 g; *MINI-SNAP:* 8 g						

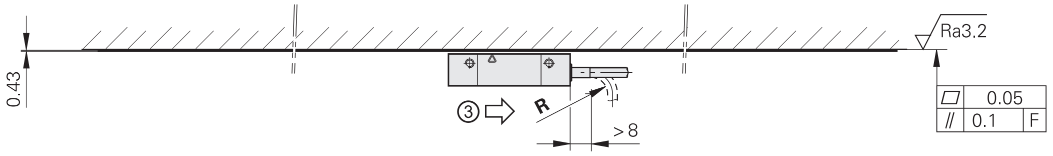
* Please select when ordering
1) ±5 µm after linear-error compensation in the downstream electronics
2) *Mitsubishi:* ML ≤ 2040 mm / *Yaskawa:* ML ≤ 1840 mm
3) See *General electrical information* in the *Interfaces of HEIDENHAIN Encoders* brochure

LIC 4119, LIC 4139, LIC 4199

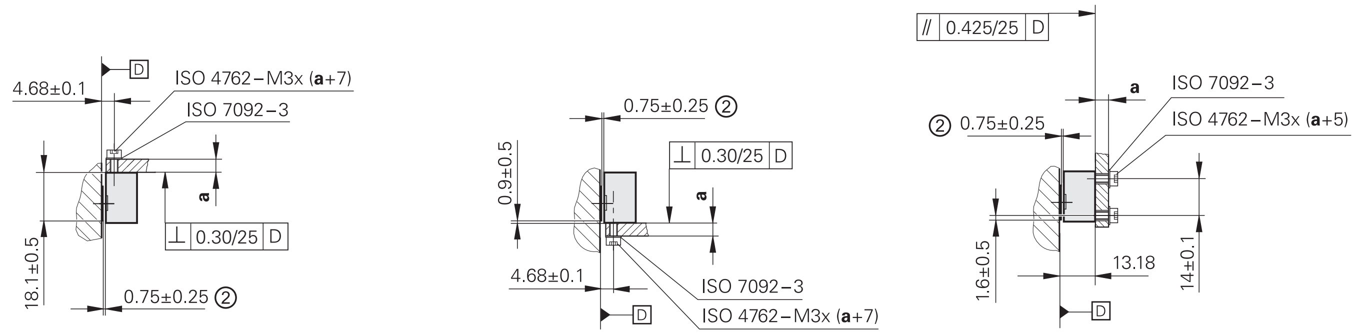
Absolute linear encoders for measuring lengths of up to 1 m
- **For measuring steps of down to 1 nm**
- **Steel scale tape adhesively bonded to mounting surface**
- **Consisting of a linear scale and scanning head (with straight or angled cable outlet)**







Mounting options for scanning head



d	R	
Ø 3.7 mm	> 8 mm	≥ 40 mm
Ø 2.9 mm	> 6 mm	≥ 30 mm

mm
Tolerancing ISO 8015
ISO 2768:1989-mH
≤ 6 mm: ±0.2 mm

F = Machine guideway
* = Mounting error plus dynamic guideway error
Ⓒ = Code start value: ≥ 100 mm
Ⓢ = Beginning of measuring length (ML)
Ⓛ = Scale tape length
1 = Optical centerline
2 = Mounting gap between scanning head and scale
3 = Direction of motion of the scanning unit for ascending position values

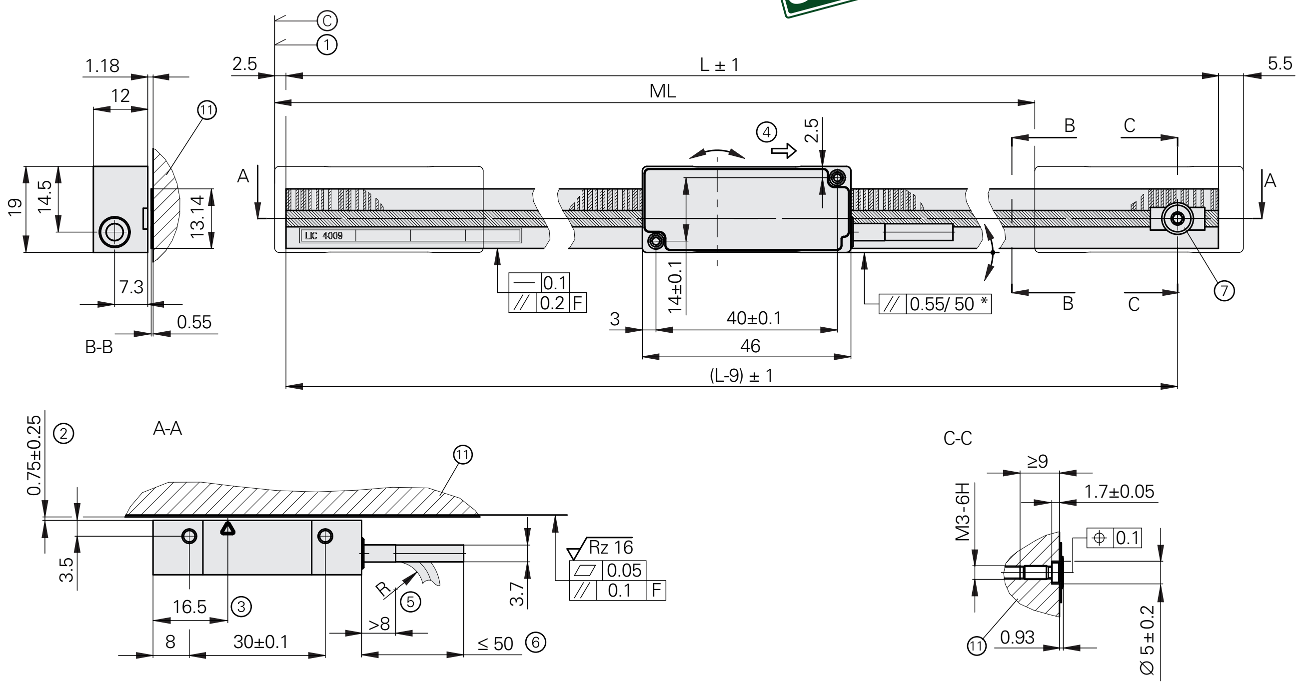
Scale	**LIC 4009**
Measuring standard Coefficient of linear expansion*	Steel scale tape with absolute and incremental METALLUR track $\alpha_{therm} \approx 10 \cdot 10^{-6}\ K^{-1}$
Accuracy grade*	±3 µm, ±15 µm[1]
Baseline error	≤ ±0.750 µm/50 mm (typical)
Measuring length (ML)* in mm	70 120 170 220 270 320 370 420 Scale tape cut from roll*: 2 m, 4 m, 6 m 520 620 720 820 920 1020
Mass	31 g/m

Scanning head	**LIC 411**	**LIC 413**	**LIC 419F**	**LIC 419M**		**LIC 419P**	**LIC 419Y**
Interface	EnDat 2.2	EnDat 3	Fanuc Serial Interface αi	Mitsubishi high speed interface		Panasonic Serial Interface	Yaskawa Serial Interface
Ordering designation*	EnDat22	E30-RB E30-R4	Fanuc05	Mit03-4	Mit03-2	Pana02	YEC07
Measuring step*[2]	10 nm, 5 nm, 1 nm	1 nm	10 nm, 5 nm, 1 nm				
Calculation time t_{cal} Clock frequency	≤ 5 µs ≤ 16 MHz	–					
Traversing speed[3]	≤ 600 m/min						
Interpolation error	±20 nm						
Electrical connection*	Cable (1 m or 3 m) with 8-pin M12 coupling (male) (for all interfaces except EnDat 3: E30-R4) or 15-pin D-sub connector (male) (for all interfaces except EnDat 3: E30-R4) or 4-pin MINI-SNAP connector (male) (for EnDat 3: E30-R4)						
Cable length (with HEIDENHAIN cable)	≤ 100 m[4]		≤ 50 m	≤ 30 m		≤ 50 m	
Supply voltage	DC 3.6 V to 14 V						
Power consumption[3] (max.)	*At 3.6 V:* ≤ 700 mW *At 14 V:* ≤ 800 mW	*At 3.6 V:* ≤ 850 mW *At 14 V:* ≤ 950 mW					
Current consumption (typical)	*At 5 V:* 75 mA (without load)	*At 12 V:* 35 mA (without load)	*At 5 V:* 95 mA (without load)				
Vibration 55 Hz to 2000 Hz **Shock** 6 ms	≤ 500 m/s² (EN 60068-2-6) ≤ 1000 m/s² (EN 60068-2-27)						
Operating temperature	–10 °C to 70 °C						
Mass	Scanning head: ≤ 18 g (without cable) Cable: *M12 coupling and D-sub connector:* 20 g/m; *MINI-SNAP connector:* 15 g/m Connectors: *M12 coupling:* 15 g; *D-sub connector:* 32 g; *MINI-SNAP:* 8 g						

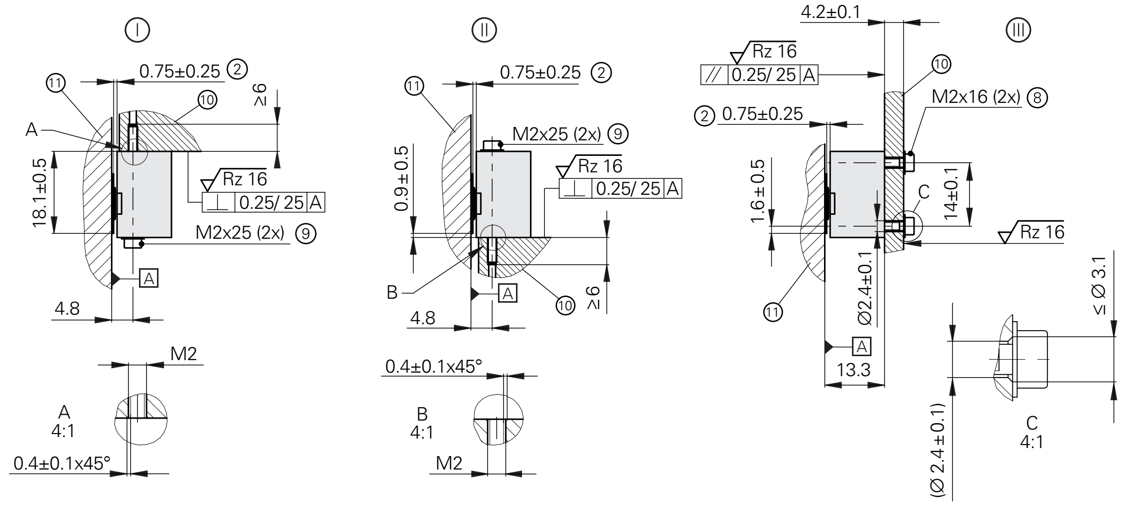
* Please select when ordering
1) ±5 µm after linear-error compensation in the downstream electronics
2) *Mitsubishi:* ML ≤ 2040 mm / *Yaskawa:* ML ≤ 1840 mm
3) See *General electrical information* in the *Interfaces of HEIDENHAIN Encoders* brochure
4) *With LIC 411 FS scanning head:* clock frequency: 8 MHz

LIC 4119

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



Mounting options for scanning head



①, Ⅱ,
Ⅲ = Mounting options
F = Machine guideway
* = Mounting error plus dynamic guideway error
© = Code start value: ≥ 100 mm
ML = Measuring length
L = Scale tape length (L = ML+38)
1 = Beginning of measuring length
2 = Mounting gap between scanning head and 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 2768:1989-mH
≤ 6 mm: ±0.2 mm

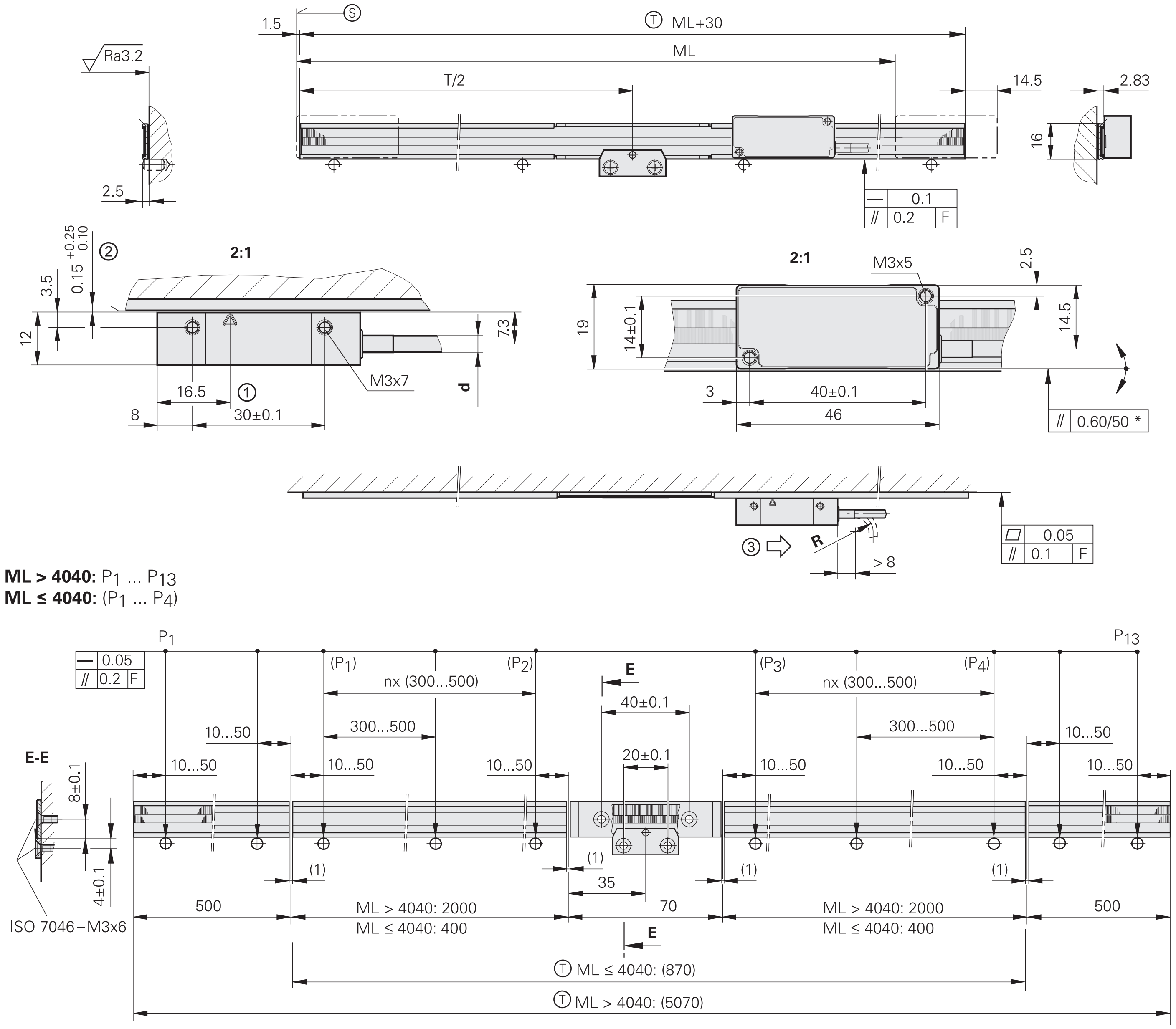
Scale	LIC 4009
Measuring standard Coefficient of linear expansion	Steel scale tape with absolute and incremental METALLUR track $\alpha_{therm} \approx 10 \cdot 10^{-6}\ K^{-1}$
Accuracy grade* **Baseline error**	±3 µm[1], ±15 µm[2] ≤ ±0.750 µm/50 mm (typical)
Measuring length (ML)* in mm (at operating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

Scanning head	LIC 411
Interface	EnDat 2.2 (ordering designation: EnDat22)
Measuring step*	0.01 µm (10 nm); 0.005 µm (5 nm); 0.001 µm (1 nm)
Calc. time t_{cal}/clock freq.	≤ 5 µs/≤ 16 MHz
Functional safety for applications with up to	• SIL 2, as per EN 61508 (further basis for testing: IEC 61800-5-3) • Category 3, PL "d" as per EN ISO 13849-1:2015
PFH	$\leq 20 \cdot 10^{-9}$ (up to 6000 m above sea level)
Safe position[4]	Encoder: ±550 µm (safety-relevant measuring step: SM = 220 µm); mechanical coupling: fault exclusions for the loosening of the scanning head and scale (see "Functional safety")
Traversing speed[5]	≤ 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[6]	≤ 100 m
Supply voltage	DC 3.6 V to 14 V
Power consumption (max.)	*At 3.6 V:* ≤ 700 mW; *at 14 V:* ≤ 800 mW
Current consumption (typical)	*At 5 V:* 75 mA (without load)
Vibration 55 Hz to 2000 Hz **Shock** 11 ms	≤ 200 m/s² (EN 60068-2-6) ≤ 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); condensation excluded
Mass	Scanning head: ≤ 18 g (without cable) Cable: 20 g/m Connectors: *M12 coupling:* 15 g; *D-sub connector:* 32 g

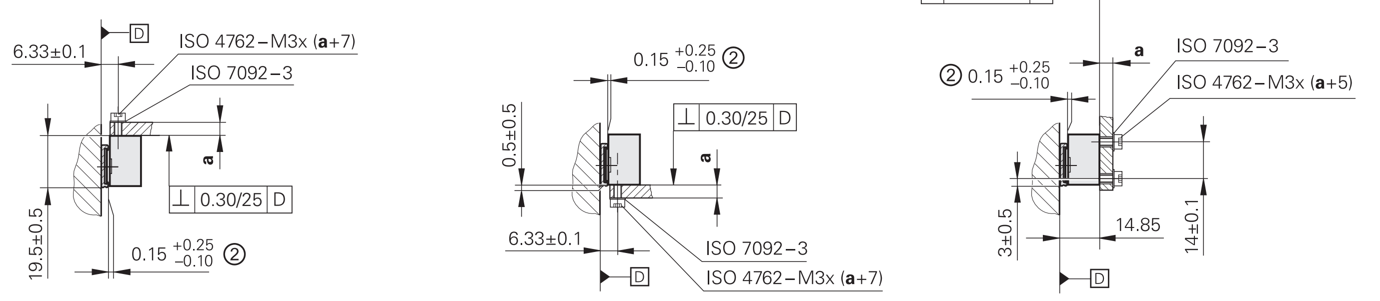
* Please select when ordering
[1] Up to a measuring length of 1020 mm
[2] ±5 µm after linear-error compensation in the downstream electronics
[3] Additional measuring length only on steel mounting surface
[4] Further tolerances may arise in the downstream electronics after position value comparison (contact mfr. of downstream electronics)
[5] See *General electrical information* in the *Interfaces of HEIDENHAIN Encoders* brochure
[6] With HEIDENHAIN cable; clock frequency ≤ 8 MHz

LIC 3117, LIC 3137, LIC 3197

Absolute linear encoders for measuring lengths of up to 10 m
- **For measuring steps of down to 10 nm**
- **Steel scale tape pulled through aluminum extrusions and fastened at center**
- **Consisting of a linear scale and scanning head**



Mounting options for scanning head



mm
Tolerancing ISO 8015
ISO 2768:1989-mH
≤ 6 mm: ±0.2 mm

F = Machine guideway
P = Measuring points for alignment
* = Mounting error plus dynamic guideway error
Ⓢ = Beginning of measuring length (ML)
Ⓣ = Carrier length
1 = Optical centerline
2 = Mounting gap between scanning head and extrusion
3 = Direction of motion of the scanning unit for ascending position values

d	R	
Ø 3.7 mm	> 8 mm	≥ 40 mm
Ø 2.9 mm	> 6 mm	≥ 30 mm

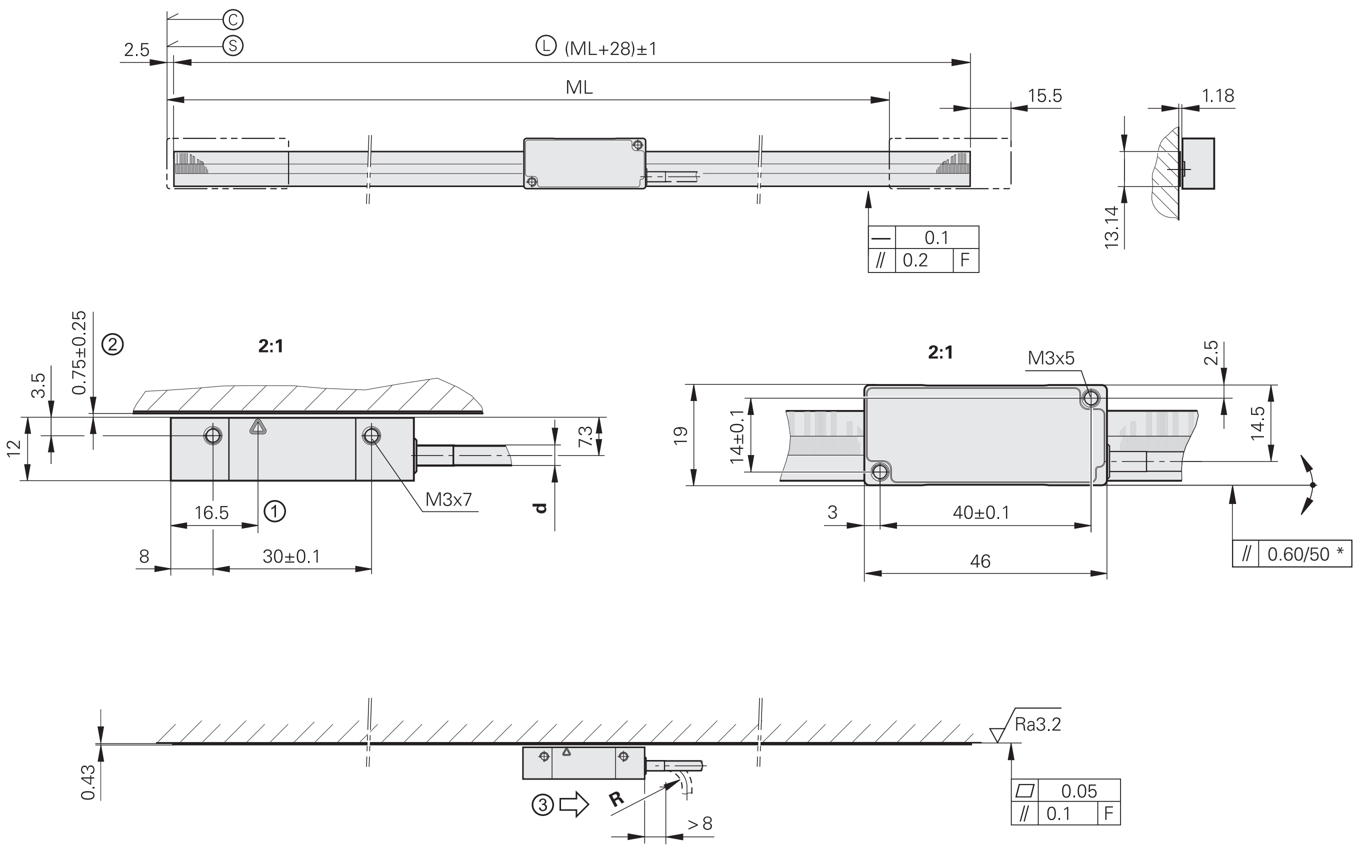
Scale	**LIC 3107**
Measuring standard Coefficient of linear expansion	Steel scale tape with absolute track and incremental track $\alpha_{therm} \approx 10 \cdot 10^{-6}\ K^{-1}$
Accuracy grade	±15 µm[1]
Baseline error	≤ ±0.750 µm/50 mm (typical)
Scale tape from roll*	3 m, 5 m, 10 m
Mass	Scale tape: 31 g/m Assembly parts: 20 g Scale tape carrier: 68 g/m

Scanning head	**LIC 311**	**LIC 313**	**LIC 319F**	**LIC 319M**		**LIC 319P**	**LIC 319Y**
Interface	EnDat 2.2	EnDat 3	Fanuc Serial Interface αi	Mitsubishi high speed interface		Panasonic Serial Interface	Yaskawa Serial Interface
Ordering designation*	EnDat22	E30-RB E30-R4	Fanuc05	Mit03-4	Mit03-2	Pana02	YEC07
Measuring step	10 nm	8 nm	10 nm				
Calculation time t_{cal} Clock frequency	≤ 5 µs ≤ 16 MHz	–					
Traversing speed[2]	≤ 600 m/min						
Interpolation error	±100 nm						
Electrical connection*	Cable (1 m or 3 m) with 8-pin M12 coupling (male) (for all interfaces except EnDat 3: E30-R4) or 15-pin D-sub connector (male) (for all interfaces except EnDat 3: E30-R4) or 4-pin MINI-SNAP connector (male) (for EnDat 3: E30-R4)						
Cable length (with HEIDENHAIN cable)	≤ 100 m		≤ 50 m	≤ 30 m		≤ 50 m	
Supply voltage	DC 3.6 V to 14 V						
Power consumption[2] (max.)	*At 3.6 V:* ≤ 700 mW *At 14 V:* ≤ 800 mW	*At 3.6 V:* ≤ 850 mW *At 14 V:* ≤ 950 mW					
Current consumption (typical)	*At 5 V:* 75 mA (without load)	*At 12 V:* 35 mA (without load)	*At 5 V:* 95 mA (without load)				
Vibration 55 Hz to 2000 Hz **Shock** 6 ms	≤ 500 m/s² (EN 60068-2-6) ≤ 1000 m/s² (EN 60068-2-27)						
Operating temperature	–10 °C to 70 °C						
Mass	Scanning head: ≤ 18 g (without cable) Cable: *M12 coupling and D-sub connector:* 20 g/m; *MINI-SNAP connector:* 15 g/m Connectors: *M12 coupling:* 15 g; *D-sub connector:* 32 g; *MINI-SNAP:* 8 g						

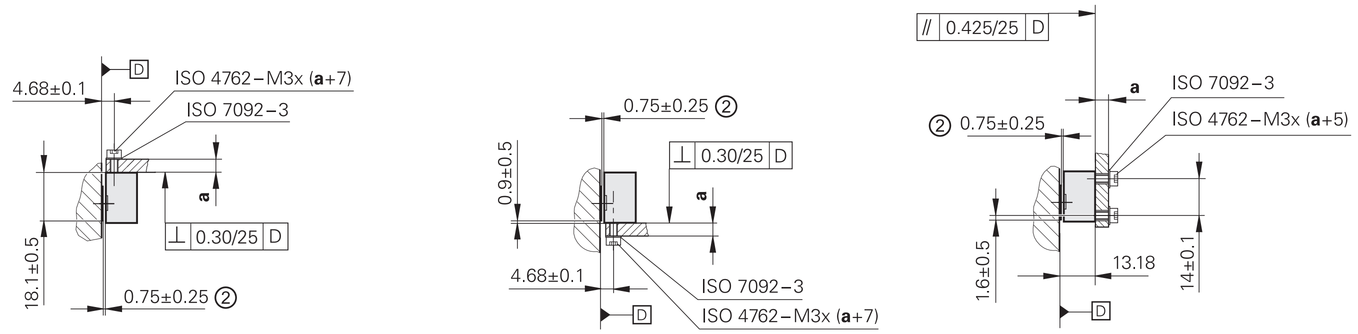
* Please select when ordering
1) ±5 µm after linear-error compensation in the downstream electronics
2) See *General electrical information* in the *Interfaces of HEIDENHAIN Encoders* brochure

LIC 3119, LIC 3139, LIC 3199

Absolute linear encoders for measuring lengths of up to 10 m
- **For measuring steps of down to 10 nm**
- **Steel scale tape adhesively bonded to mounting surface**
- **Consisting of a linear scale and scanning head**



Mounting options for scanning head



d	R	
Ø 3.7 mm	> 8 mm	≥ 40 mm
Ø 2.9 mm	> 6 mm	≥ 30 mm

mm

Tolerancing ISO 8015
ISO 2768:1989-mH
≤ 6 mm: ±0.2 mm

F = Machine guideway
* = Mounting error plus dynamic guideway error
Ⓢ = Beginning of measuring length (ML)
Ⓛ = Scale tape length
1 = Optical centerline
2 = Mounting gap between scanning head and scale
3 = Direction of motion of the scanning unit for ascending position values

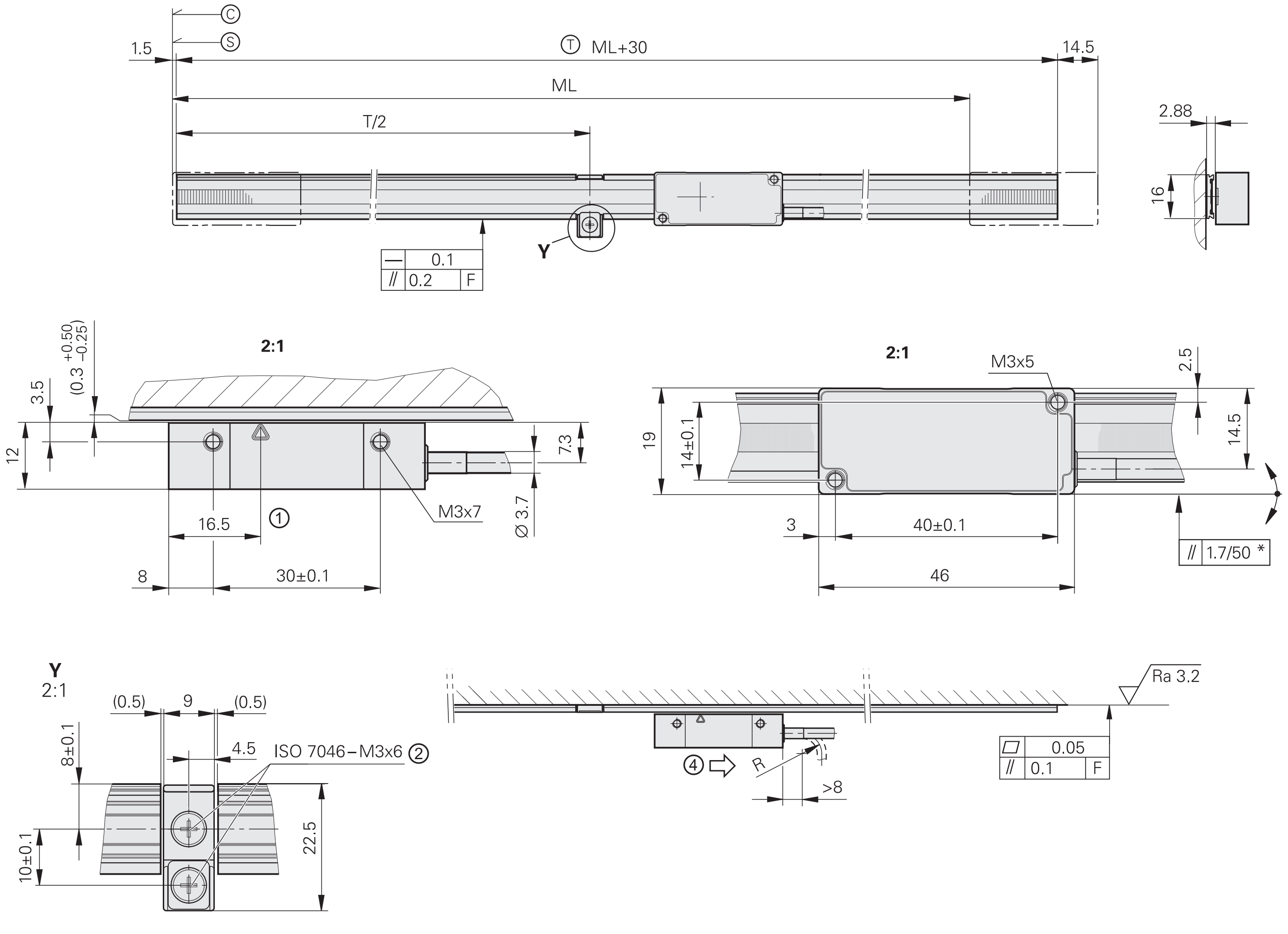
Scale	**LIC 3109**
Measuring standard Coefficient of linear expansion	Steel scale tape with absolute track and incremental track $\alpha_{therm} \approx 10 \cdot 10^{-6}\ K^{-1}$
Accuracy grade	±15 µm[1]
Baseline error	≤ ±0.750 µm/50 mm (typical)
Scale tape from roll*	3 m, 5 m, 10 m
Mass	31 g/m

Scanning head	**LIC 311**	**LIC 313**	**LIC 319F**	**LIC 319M**		**LIC 319P**	**LIC 319Y**
Interface	EnDat 2.2	EnDat 3	Fanuc Serial Interface αi	Mitsubishi high speed interface		Panasonic Serial Interface	Yaskawa Serial Interface
Ordering designation*	EnDat22	E30-RB E30-R4	Fanuc05	Mit03-4	Mit03-2	Pana02	YEC07
Measuring step	10 nm	8 nm	10 nm				
Calculation time t_{cal} Clock frequency	≤ 5 µs ≤ 16 MHz	–					
Traversing speed[2]	≤ 600 m/min						
Interpolation error	±100 nm						
Electrical connection*	Cable (1 m or 3 m) with 8-pin M12 coupling (male) (for all interfaces except EnDat 3: E30-R4) or 15-pin D-sub connector (male) (for all interfaces except EnDat 3: E30-R4) or 4-pin MINI-SNAP connector (male) (for EnDat 3: E30-R4)						
Cable length (with HEIDENHAIN cable)	≤ 100 m		≤ 50 m	≤ 30 m		≤ 50 m	
Supply voltage	DC 3.6 V to 14 V						
Power consumption[2] (max.)	*At 3.6 V:* ≤ 700 mW *At 14 V:* ≤ 800 mW	*At 3.6 V:* ≤ 850 mW *At 14 V:* ≤ 950 mW					
Current consumption (typical)	*At 5 V:* 75 mA (without load)	*At 12 V:* 35 mA (without load)	*At 5 V:* 95 mA (without load)				
Vibration 55 Hz to 2000 Hz **Shock** 6 ms	≤ 500 m/s² (EN 60068-2-6) ≤ 1000 m/s² (EN 60068-2-27)						
Operating temperature	–10 °C to 70 °C						
Mass	Scanning head: ≤ 18 g (without cable) Cable: *M12 coupling and D-sub connector:* 20 g/m; *MINI-SNAP connector:* 15 g/m Connectors: *M12 coupling:* 15 g; *D-sub connector:* 32 g; *MINI-SNAP:* 8 g						

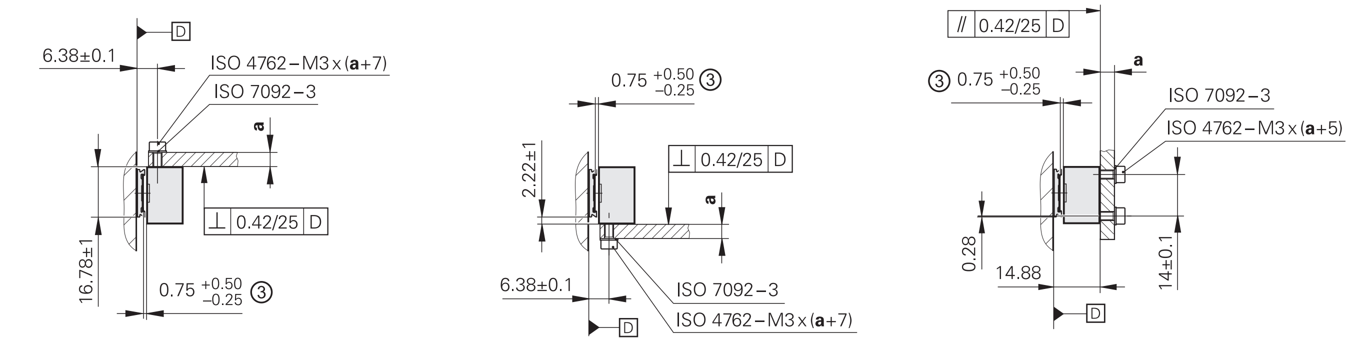
* Please select when ordering
[1] ±5 µm after linear-error compensation in the downstream electronics
[2] See *General electrical information* in the *Interfaces of HEIDENHAIN Encoders* brochure

LIC 2117, LIC 2197

Absolute linear encoders for measuring lengths of up to 3 m
- **Measuring step: 100 nm or 50 nm**
- **Steel scale tape pulled through aluminum extrusions and fastened at center**
- **Consisting of a linear scale and scanning head**



Mounting options for scanning head



mm
Tolerancing ISO 8015
ISO 2768:1989-mH
≤ 6 mm: ±0.2 mm

F = Machine guideway
* = Maximum change during operation
© = Code start value: ≥ 100 mm
Ⓢ = Beginning of measuring length (ML)
Ⓣ = Carrier length
1 = Optical centerline
2 = M3 threaded mating hole, 5 mm deep
3 = Mounting gap between scanning head and scale tape
4 = Direction of motion of the scanning unit for increasing position values

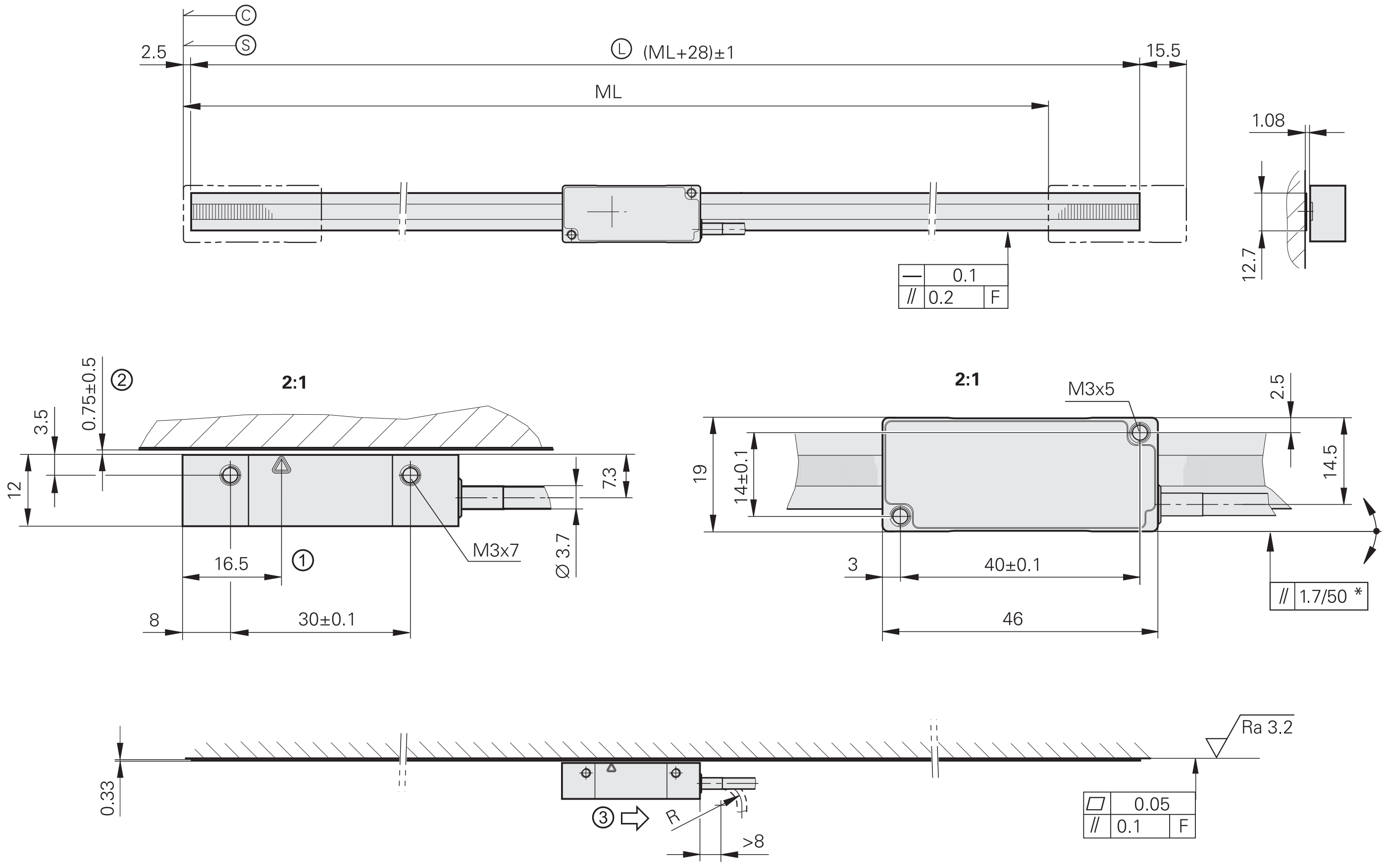
Scale	LIC 2107
Measuring standard Coefficient of linear expansion	Steel scale tape with absolute track $\alpha_{therm} \approx 10 \cdot 10^{-6} K^{-1}$
Accuracy grade	±15 µm
Scale tape from roll*	3 m, 5 m, 10 m
Mass	Scale tape: 20 g/m Scale tape carrier: 70 g/m

Scanning head	LIC 211	LIC 219F	LIC 219M	LIC 219P	LIC 219Y
Interface	EnDat 2.2	Fanuc Serial Interface αi	Mitsubishi high speed interface	Panasonic Serial Interface	Yaskawa Serial Interface
Ordering designation*	EnDat22	Fanuc05	Mit03-4 / Mit03-2	Pana02	YEC07
Measuring step*	100 nm, 50 nm				
Bit width	32 bits				
Calculation time t_{cal} Clock frequency	≤ 5 µs ≤ 16 MHz	– –			
Traversing speed[1]	≤ 600 m/min				
Interpolation error	±2 µm				
Electrical connection*	Cable (1 m or 3 m) with 8-pin M12 coupling (male) or 15-pin D-sub connector (male)				
Cable length (with HEIDENHAIN cable)	≤ 100 m	≤ 50 m	≤ 30 m	≤ 50 m	
Supply voltage	DC 3.6 V to 14 V				
Power consumption[1] (max.)	*At 3.6 V:* ≤ 700 mW *At 14 V:* ≤ 800 mW	*At 3.6 V:* ≤ 850 mW *At 14 V:* ≤ 950 mW			
Current consumption (typical)	*At 5 V:* 75 mA (without load)	*At 5 V:* 95 mA (without load)			
Vibration 55 Hz to 2000 Hz **Shock** 6 ms	≤ 500 m/s2 (EN 60068-2-6) ≤ 1000 m/s2 (EN 60068-2-27)				
Operating temperature	–10 °C to 70 °C				
Mass	Scanning head: ≤ 18 g (without cable) Cable: 20 g/m Connector: *M12 coupling:* 15 g; *D-sub connector:* 32 g				

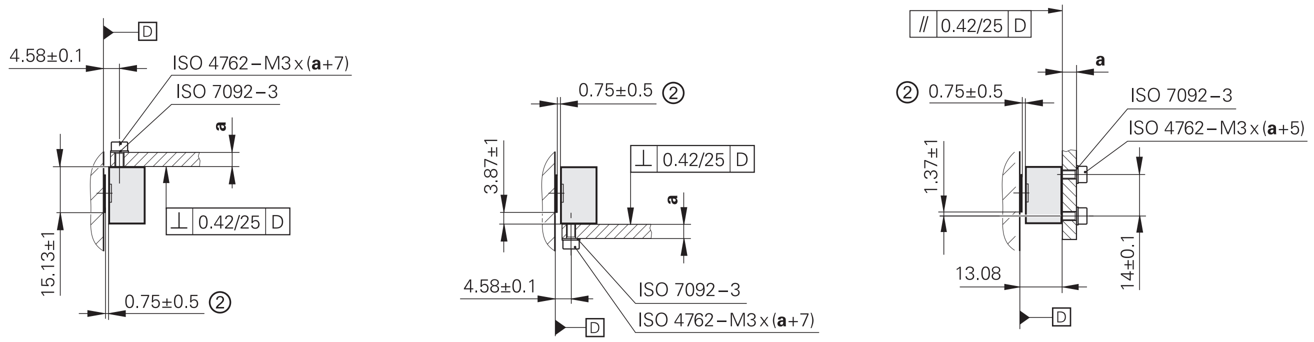
* Please select when ordering
[1] See *General electrical information* in the *Interfaces of HEIDENHAIN Encoders* brochure

LIC 2119, LIC 2199

Absolute linear encoders for measuring lengths of up to 3 m
- **Measuring step: 100 nm or 50 nm**
- **Steel scale tape adhesively bonded to mounting surface**
- **Consisting of a linear scale and scanning head**



Mounting options for scanning head



mm
Tolerancing ISO 8015
ISO 2768:1989-mH
≤ 6 mm: ±0.2 mm

F = Machine guideway
* = Maximum change during operation
© = Code start value: ≥ 100 mm
Ⓢ = Beginning of measuring length (ML)
Ⓛ = Scale tape length
1 = Optical centerline
2 = Mounting gap between scanning head and scale tape
3 = Direction of motion of the scanning unit for ascending position values

Scale	**LIC 2109**
Measuring standard Coefficient of linear expansion	Steel scale tape with absolute track $\alpha_{therm} \approx 10 \cdot 10^{-6}\,K^{-1}$
Accuracy grade	±15 µm
Scale tape from roll*	3 m, 5 m, 10 m
Mass	20 g/m

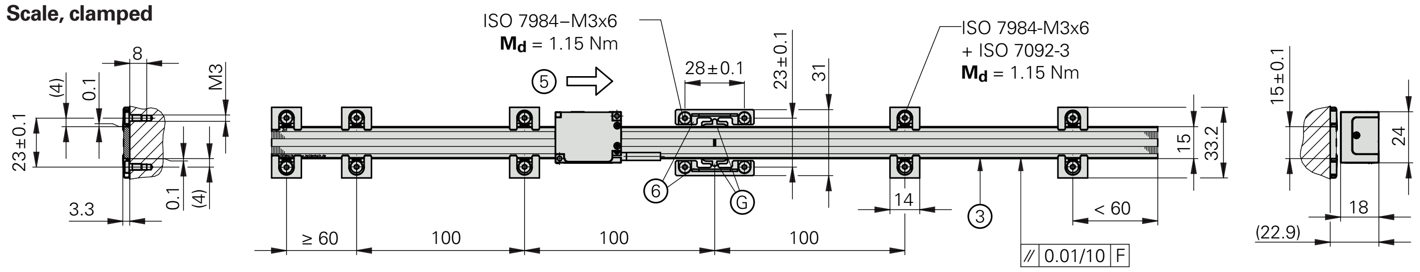
Scanning head	**LIC 211**	**LIC 219F**	**LIC 219M**	**LIC 219P**	**LIC 219Y**
Interface	EnDat 2.2	Fanuc Serial Interface αi	Mitsubishi high speed Interface	Panasonic Serial Interface	Yaskawa Serial Interface
Ordering designation*	EnDat22	Fanuc05	Mit03-4 Mit03-2	Pana02	YEC07
Measuring step*	100 nm, 50 nm				
Bit width	32 bits				
Calculation time t_{cal} Clock frequency	≤ 5 µs ≤ 16 MHz	– –			
Traversing speed[1]	≤ 600 m/min				
Interpolation error	±2 µm				
Electrical connection*	Cable (1 m or 3 m) with 8-pin M12 coupling (male) or 15-pin D-sub connector (male)				
Cable length (with HEIDENHAIN cable)	≤ 100 m	≤ 50 m	≤ 30 m	≤ 50 m	
Supply voltage	DC 3.6 V to 14 V				
Power consumption[1] (max.)	*At 3.6 V:* ≤ 700 mW *At 14 V:* ≤ 800 mW	*At 3.6 V:* ≤ 850 mW *At 14 V:* ≤ 950 mW			
Current consumption (typical)	*At 5 V:* 75 mA (without load)	*At 5 V:* 95 mA (without load)			
Vibration 55 Hz to 2000 Hz **Shock** 6 ms	≤ 500 m/s^2 (EN 60068-2-6) ≤ 1000 m/s^2 (EN 60068-2-27)				
Operating temperature	–10 °C to 70 °C				
Mass	Scanning head: ≤ 18 g (without cable) Cable: 20 g/m Connector: *M12 coupling:* 15 g; *D-sub connector:* 32 g				

* Please select when ordering
1) See *General electrical information* in the *Interfaces of HEIDENHAIN Encoders* brochure

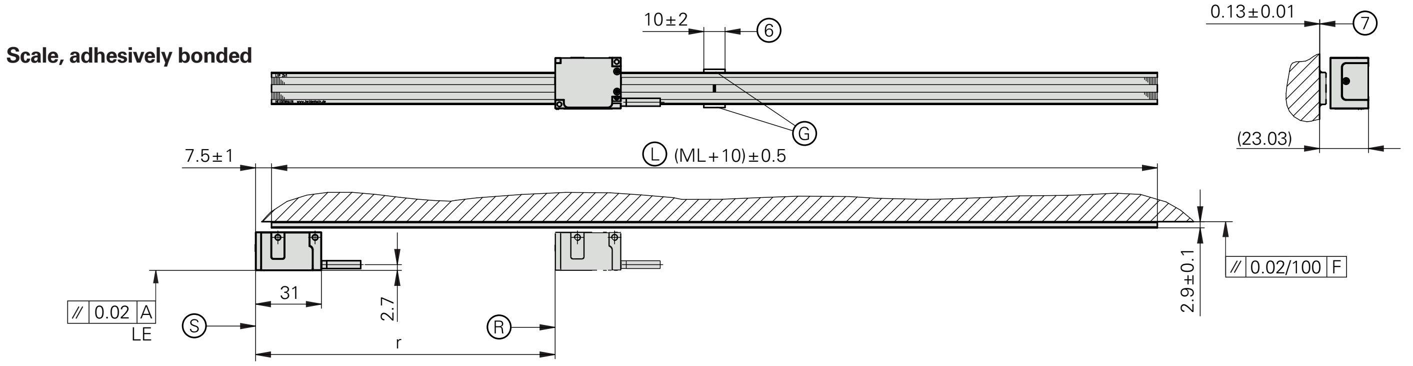
LIP 211, LIP 281, LIP 291

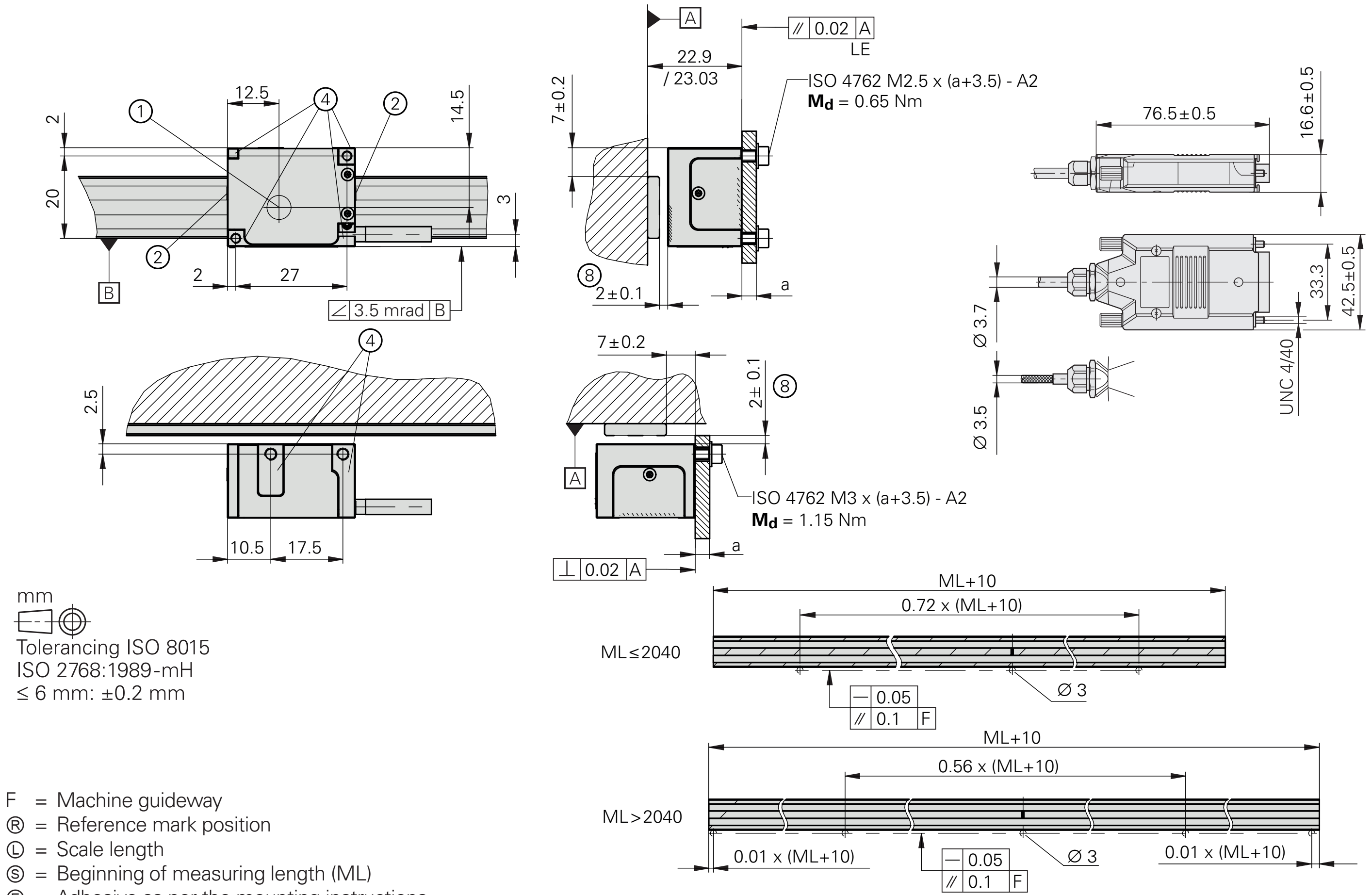
Incremental linear encoders for very high accuracy and high position stability
- **For measuring steps of 1 nm and smaller**
- **For high traversing speeds and long measuring lengths**
- **Measuring standard secured with fixing clamps**
- **Consisting of a linear scale and scanning head**

Scale, clamped



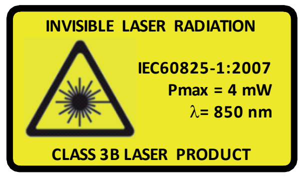
Scale, adhesively bonded





mm
Tolerancing ISO 8015
ISO 2768:1989-mH
≤ 6 mm: ±0.2 mm

F = Machine guideway
Ⓡ = Reference mark position
Ⓛ = Scale length
Ⓢ = Beginning of measuring length (ML)
Ⓔ = Adhesive as per the mounting instructions
1 = Optical centerline
2 = Maximum protrusion of screw head: 0.5 mm
3 = Scale stop surface
4 = Mounting surface
5 = Direction of scanning head motion for output signals in accordance with interface description
6 = Fixed point for defining the thermal fixed point
7 = Adhesive tape (only if the scale is adhesively bonded)
8 = Mounting gap between scanning head and scale; adjusted by means of a spacer shim



Scale	**LIP 201**	
Measuring standard Coefficient of linear expansion	OPTODUR phase grating on Zerodur glass ceramic; graduation period: 2.048 µm α_{therm} = (0±0.1) · 10^{-6} K^{-1}	
Accuracy grade*	±1 µm	±3 µm (higher accuracy grades upon request)
Baseline error	≤ ±0.125 µm/5 mm	
Measuring length (ML)* in mm	20 30 50 70 120 170 220 270 320 370 420 470 520 570 620 670 720 770 820 870 920 970 1020	370 420 470 520 570 620 670 720 770 820 870 920 970 1020 1140 1240 1340 1440 1540 1640 1840 2040 2240 2440 2640 2840 3040
Reference marks	One at midpoint of measuring length	
Mass	1.1 g + 0.11 g/mm of measuring length	

Scanning head	**LIP 21**	**LIP 29F**	**LIP 29M**	**LIP 28**
Interface	EnDat 2.2[1]	Fanuc Serial Interface[1]	Mitsubishi high speed[1]	∼ 1 V_{PP}
Ordering designation	EnDat22	Fanuc02	Mit02-4	–
Integrated interpolation	16384-fold (14 bits)			–
Clock frequency	≤ 16 MHz	–		–
Calculation time t_{cal}	≤ 5 µs	–		–
Measuring step	0.03125 nm (31.25 pm)			–
Signal period	–			0.512 µm
Cutoff frequency –3 dB	–			≥ 3 MHz
Traversing speed	≤ 120 m/min			≤ 90 m/min
Interpolation error **RMS position noise**	±0.4 nm[4] 0.12 nm			±0.4 nm[4] 0.12 nm (3 MHz[3])
Electrical connection*	Cable (0.5 m) or 1 m (2 m and 3 m with 1 V_{PP}) with interface elec. in connector (15-pin D-sub (male))			
Cable length	See interface description; however ≤ 15 m (≤ 30 m with 1 V_{PP}) with HEIDENHAIN cable During signal adjustment with the PWM 21: ≤ 3 m			
Supply voltage	DC 3.6 V to 14 V			DC 5 V ±0.25 V
Power consumption[2] (max.)	*At 14 V:* 2500 mW; *at 3.6 V:* 2600 mW			–
Current consumption	*At 5 V:* 300 mA (without load, typical)			≤ 390 mA
Laser	*Mounted scanning head and scale:* Class 1; *non-mounted scanning head:* Class 3B			
Vibration 55 Hz to 2000 Hz **Shock** 11 ms	≤ 200 m/s² (IEC 60068-2-6) ≤ 400 m/s² (IEC 60068-2-27)			
Operating temperature	0 °C to 50 °C			
Mass	*Scanning head:* 59 g; *connector:* 140 g; *cable:* 22 g/m			

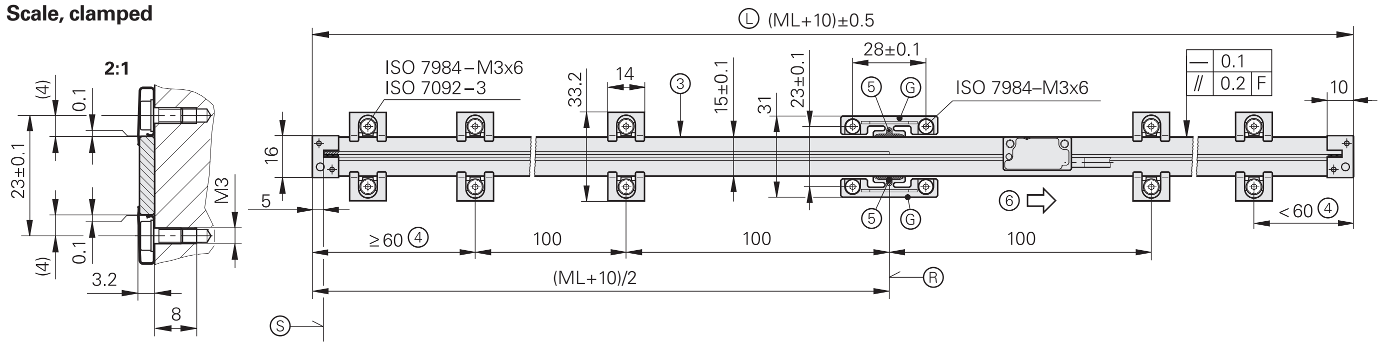
* Please select when ordering; for measuring lengths < 70 mm, the “adhesively bonded” mounting type is recommended
1) Absolute position value after crossing of the reference mark in “Position value 2”
2) See *General electrical information* in the *Interfaces of HEIDENHAIN Encoders* brochure
3) –3 dB cutoff frequency of the downstream electronics
4) With HEIDENHAIN interface electronics

LIP 6071, LIP 6081

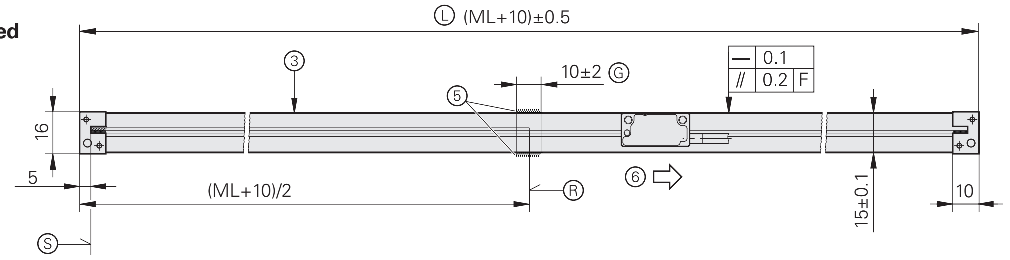
Incremental linear encoders with very high accuracy

- **For limited installation space**
- **For measuring steps of down to 1 nm**
- **For high traversing speeds and long measuring lengths**
- **Position detection through homing track and limit switches**
- **Measuring standard secured with adhesive or fixing clamps**

Scale, clamped

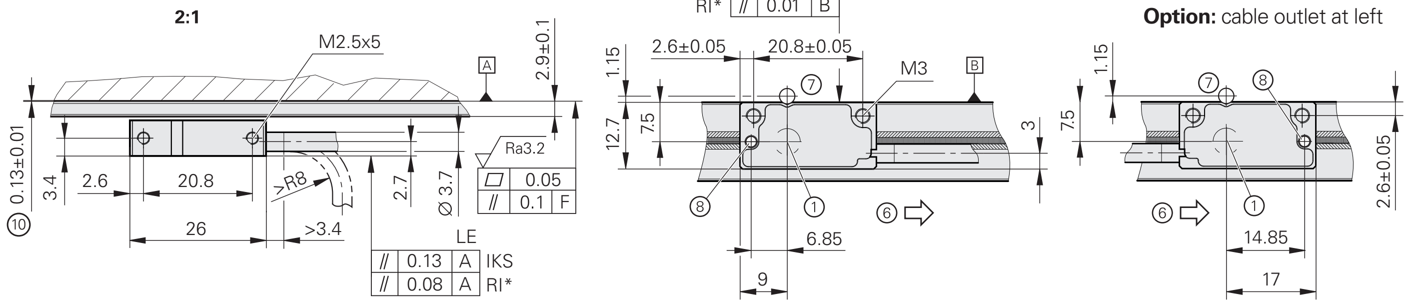


Scale, adhesively bonded

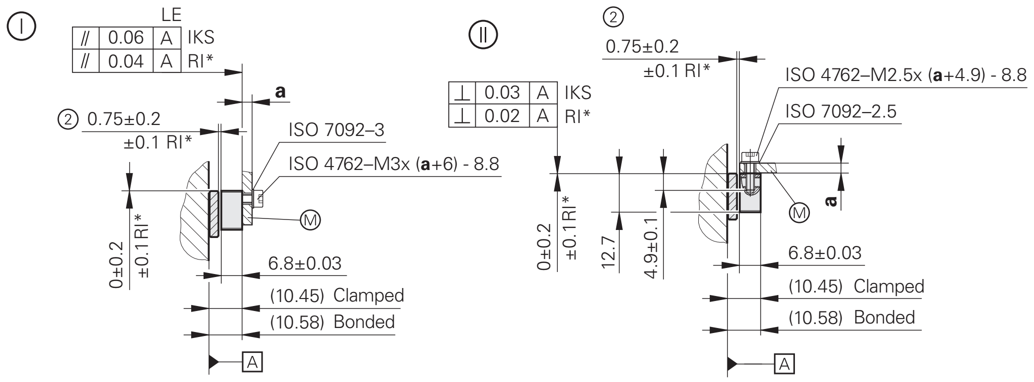


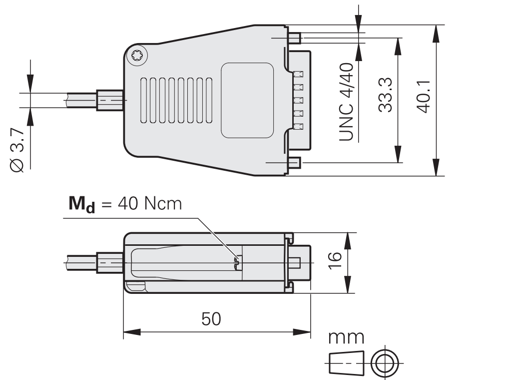
Scanning head and scale clamped / adhesively bonded

Option: cable outlet at left



Mounting options for scanning head
(shown without fixing clamps)





F = Machine guideway
* = Maximum change during operation
IKS = Incremental track
RI = Reference mark track
Ⓜ = Mounting surface
Ⓛ = Scale length
Ⓢ = Beginning of measuring length (ML)
Ⓒ = Fixed point for defining the thermal fixed point
Ⓡ = Reference mark position
1 = Optical centerline
2 = Mounting gap between scanning head and scale; adjusted by means of a spacer shim
3 = Scale stop surface
4 = Depending on the measuring length (ML), use an additional pair of fixing clamps
5 = Adhesive
6 = Direction of motion of the scanning unit for increasing position values
7 = Moiré adjustment option 1: alignment pin, Ø 3m6, possible only with mounting option Ⓘ
8 = Moiré adjustment option 2: alignment pin Ø 2m6
9 = Recommended: Ø 3
10 = Adhesive tape (only if the scale is adhesively bonded)

mm
Tolerancing ISO 8015
ISO 2768:1989-mH
≤ 6 mm: ±0.2 mm

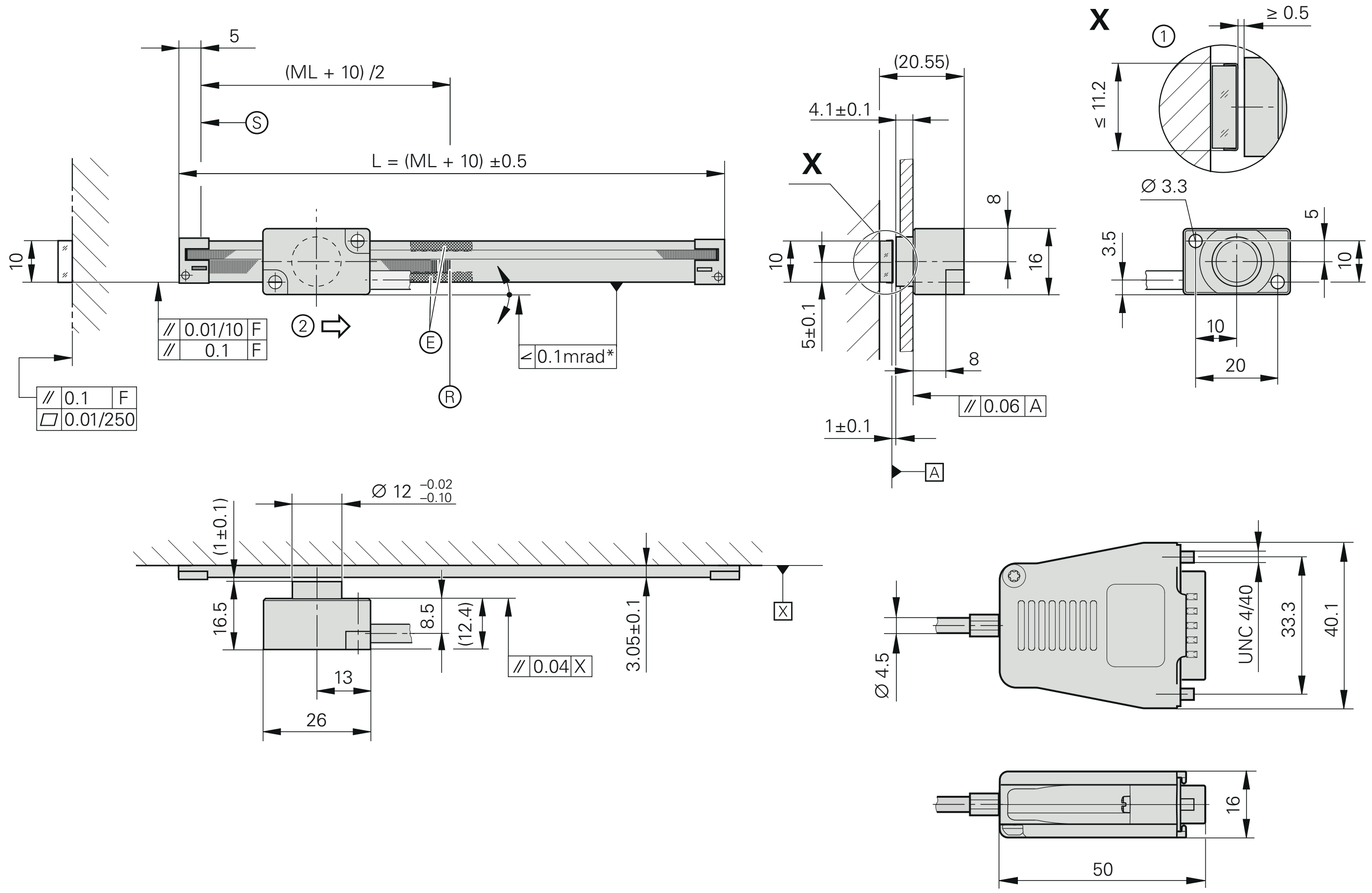
Scale	LIP 6001						
Measuring standard* Coefficient of linear expansion	OPTODUR phase grating on Zerodur glass ceramic or glass; grating period: 8 µm $\alpha_{therm} = (0\pm0.1) \cdot 10^{-6}\,K^{-1}$ (Zerodur glass ceramic); $\alpha_{therm} \approx 8 \cdot 10^{-6}\,K^{-1}$ (glass)						
Accuracy grade*	±1 µm (only for Zerodur glass ceramic up to a measuring length of 1020 mm); ±3 µm						
Baseline error	≤ ±0.175 µm/5 mm						
Measuring length (ML)* in mm	20 30 50 70 120 170 220 270 320 370 420 470 520 570 620 670 720 770 820 870 920 970 1020 1140 1240 1340 1440 1540 1640 1840 2040 2240 2440 2640 2840 3040						
Reference mark	One at midpoint of measuring length						
Mass	1.1 g + 0.11 g/mm of measuring length						
Scanning head	**LIP 608**	**LIP 607**					
Interface	∿ 1 V_{PP}	TTL[1]					
Integrated interpolation* Signal period	– 4 µm	5-fold 0.8 µm	10-fold 0.4 µm	25-fold 0.16 µm	50-fold 0.08 µm	100-fold 0.04 µm	500-fold 0.008 µm
Cutoff frequency –3 dB	≥ 1 MHz						
Scanning frequency	–	– – ≤ 312.5 kHz	– ≤ 312.5 kHz ≤ 156.25 kHz	≤ 250 kHz ≤ 125 kHz ≤ 62.5 kHz	≤ 125 kHz ≤ 62.5 kHz ≤ 31.25 kHz	≤ 62.5 kHz ≤ 31.25 kHz ≤ 15.63 kHz	≤ 12.5 kHz ≤ 6.25 kHz ≤ 3.13 kHz
Edge separation *a*	–	– – ≥ 0.135 µs	– ≥ 0.07 µs ≥ 0.135 µs	≥ 0.03 µs ≥ 0.07 µs ≥ 0.135 µs			
Traversing speed[2]	≤ 240 m/min	— – ≤ 75 m/min	– ≤ 75 m/min ≤ 37 m/min	≤ 60 m/min ≤ 30 m/min ≤ 15 m/min	≤ 30 m/min ≤ 15 m/min ≤ 7.5 m/min	≤ 15 m/min ≤ 7.5 m/min ≤ 3.7 m/min	≤ 3 m/min ≤ 1.5 m/min ≤ 0.75 m/min
Interpolation error **RMS position noise**	±4 nm 0.4 nm (1 MHz[3])	–					
Electrical connection*	Cable outlet on the left or right and straight or angled *1 V_{PP}:* Cable (0.5 m/1 m/3 m) with 15-pin D-sub connector (male) *TTL:* Cable (0.5 m or 1 m) with interface electronics in the 15-pin D-sub connector (male)						
Cable length	With HEIDENHAIN cable: homing, limit: ≤ 10 m; incremental only: ≤ 20 m; during signal adjustment with the PWM 21: ≤ 3 m						
Supply voltage	DC 5 V ±0.5 V						
Current consumption	≤ 150 mA	≤ 300 mA (without load)					
Vibration 55 Hz to 2000 Hz **Shock** 6 ms	≤ 500 m/s^2 (IEC 60068-2-6) ≤ 1000 m/s^2 (IEC 60068-2-27)						
Operating temperature	–10 °C to 70 °C						
Mass	Scanning head: ≈ 5 g (without cable) Connector: *AK LIP 608:* ≈ 71 g; *AK LIP 607:* ≈ 74 g Cable: ≈ 24 g/m						

* Please select when ordering; for measuring lengths < 70 mm, the "adhesively bonded" mounting type is recommended
[1] Unclocked TTLx1 possible upon request
[2] With TTL: maximum traversing speed during referencing: 16.8 m/min (70 kHz)
[3] –3dB cutoff frequency of the downstream electronics

LIF 471, LIF 481

Incremental linear encoders for simple installation

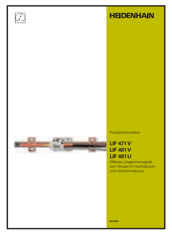
- **For measuring steps of down to 2 nm**
- **Position detection through homing track and limit switches**
- **Measuring standard secured with adhesive film**
- **Consisting of a linear scale and scanning head**
- **Versions available for high vacuum (see *Product Information document*)**
- **Interface electronics integrated in the connector**



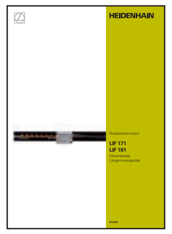
mm

Tolerancing ISO 8015
ISO 2768:1989-mH
≤ 6 mm: ±0.2 mm

F = Machine guideway
* = Maximum change during operation
ML = Measuring length
Ⓡ = Reference mark position
Ⓢ = Beginning of measuring length
Ⓔ = Epoxy for ML < 170
1 = Dimensions of limit plate
2 = Direction of motion of the scanning unit for increasing position values



Note:
For more information about vacuum variants, see the *LIF 471 V, LIF 481 V, LIF 481 U* Product Information document.



Note:
For distance-coded reference marks or larger measuring lengths, see the *LIF 171, LIF 181* Product Information document.

Scale	**LIF 401 R**
Measuring standard* Coefficient of linear expansion	SUPRADUR phase grating on Zerodur glass ceramic or glass; grating period: 8 µm $\alpha_{therm} = (0\pm0.1) \cdot 10^{-6}\ K^{-1}$ (Zerodur glass ceramic) $\alpha_{therm} \approx 8 \cdot 10^{-6}\ K^{-1}$ (glass)
Accuracy grade*	±1 µm (only for Zerodur glass ceramic up to a measuring length of 1020 mm), ±3 µm
Baseline error	≤ ±0.225 µm/5 mm
Measuring length (ML)* in mm	70 120 170 220 270 320 370 420 470 520 570 620 670 720 770 820 870 920 970 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

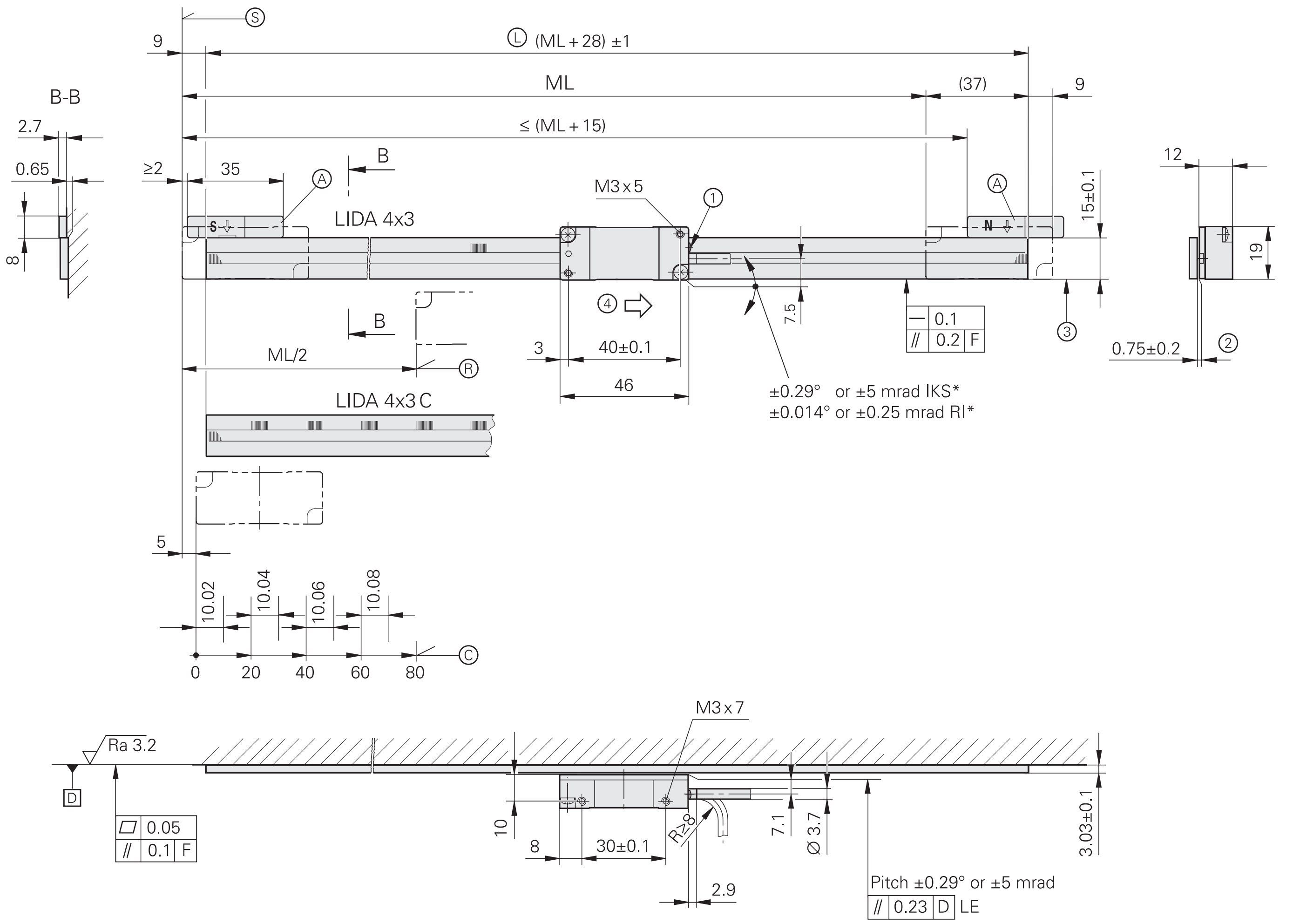
Scanning head	**LIF 48**	**LIF 47**				
Interface	∿ 1 V_{PP}	⎍TTL				
Integrated interpolation* Signal period	– 4 µm	5-fold 0.8 µm	10-fold 0.4 µm	20-fold 0.2 µm	50-fold 0.08 µm	100-fold 0.04 µm
Cutoff frequency –3 dB	≥ 1 MHz	–				
Scanning frequency*	–	≤ 500 kHz ≤ 250 kHz ≤ 125 kHz	≤ 250 kHz ≤ 125 kHz ≤ 62.5 kHz	≤ 250 kHz ≤ 125 kHz ≤ 62.5 kHz	≤ 100 kHz ≤ 50 kHz ≤ 25 kHz	≤ 50 kHz ≤ 25 kHz ≤ 12.5 kHz
Edge separation *a*	–	≥ 0.080 µs ≥ 0.175 µs ≥ 0.370 µs	≥ 0.080 µs ≥ 0.175 µs ≥ 0.370 µs	≥ 0.040 µs ≥ 0.080 µs ≥ 0.175 µs	≥ 0.040 µs ≥ 0.080 µs ≥ 0.175 µs	≥ 0.040 µs ≥ 0.080 µs ≥ 0.175 µs
Traversing speed[1]	≤ 240 m/min	≤ 120 m/min ≤ 60 m/min ≤ 30 m/min	≤ 60 m/min ≤ 30 m/min ≤ 15 m/min	≤ 60 m/min ≤ 30 m/min ≤ 15 m/min	≤ 24 m/min ≤ 12 m/min ≤ 6 m/min	≤ 12 m/min ≤ 6 m/min ≤ 3 m/min
Interpolation error **RMS position noise**	±12 nm 0.6 nm (1 MHz[2])	–				
Electrical connection*	Cable (0.5 m / 1 m / 3 m) with 15-pin D-sub connector (male); interface electronics in the connector					
Cable length	See interface description; however: *Incremental:* ≤ 30 m; *homing, limit:* ≤ 10 m (with HEIDENHAIN cable)					
Supply voltage	DC 5 V ±0.25 V					
Power consumption (max.)	*Scanning head:* 130 mW; *LIF 48 connector:* 640 mW; *LIF 47 connector:* 720 mW (without load)					
Current consumption	< 150 mA	< 165 mA (without load)				
Vibration 55 Hz to 2000 Hz **Shock** 11 ms	≤ 400 m/s^2 (EN 60068-2-6) ≤ 500 m/s^2 (EN 60068-2-27)					
Operating temperature	0 °C to 50 °C					
Mass	Scanning head*: *For scale made of Zerodur glass ceramic:* 25 g *For scale made of glass:* 9 g Cable: 38 g/m Connector: 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 the downstream electronics

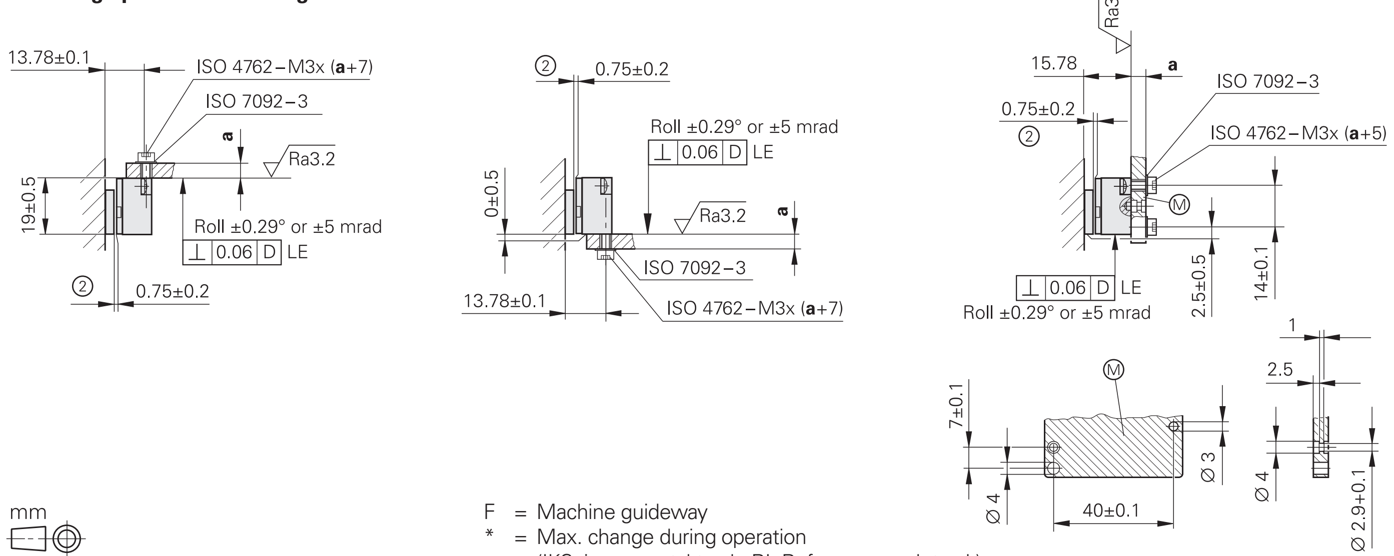
LIDA 473, LIDA 483

Incremental linear encoders with limit switches

- **For measuring steps of down to 10 nm**
- **Glass or glass ceramic measuring standard**
- **Measuring standard secured with adhesive film**
- **Consisting of a linear scale and scanning head**



Mounting options for scanning head



mm

Tolerancing ISO 8015
ISO 2768:1989-mH
≤ 6 mm: ±0.2 mm

F = Machine guideway
* = Max. change during operation
(IKS: incremental track, RI: Reference mark track)
Ⓢ = Beginning of measuring length (ML)
Ⓡ = Reference-mark position on LIDA 4x3
Ⓒ = Reference-mark position on LIDA 4x3 C
Ⓛ = Scale length
Ⓐ = Selector magnet for limit switch
Ⓜ = Mounting surface for scanning head
1 = Signal-quality indicator
2 = Scanning gap
3 = Scale stop surface
4 = Direction of motion of the scanning unit for increasing position values

Scale	**LIDA 403**
Measuring standard Coefficient of linear expansion*	METALLUR scale grating on glass or glass ceramic; grating period: 20 µm $\alpha_{therm} \approx 8 \cdot 10^{-6}$ K^{-1} (glass) $\alpha_{therm} = (0\pm0.5) \cdot 10^{-6}$ K^{-1} (Robax glass ceramic)
Accuracy grade*	±1 µm (only for Robax glass ceramic), ±3 µm, ±5 µm
Baseline error	≤ ±0.275 µm/10 mm
Measuring length (ML)* in mm	240 340 440 640 840 1040 1240 1440 1640 1840 2040 2240 2440 2640 2840 3040 (Robax glass ceramic only up to ML of 1640)
Reference marks*	*LIDA 4x3:* one at midpoint of measuring length; *LIDA 4x3 C:* distance-coded
Mass	3 g + 0.11 g/mm of measuring length

Scanning head	**LIDA 48**	**LIDA 47**			
Interface	∿ 1 V_{PP}	⊓⊔TTL			
Integrated interpolation* Signal period	– 20 µm	5-fold 4 µm	10-fold 2 µm	50-fold 0.4 µm	100-fold 0.2 µm
Cutoff frequency –3 dB	≥ 500 kHz	–			
Scanning frequency*	–	≤ 400 kHz ≤ 200 kHz ≤ 100 kHz ≤ 50 kHz	≤ 200 kHz ≤ 100 kHz ≤ 50 kHz ≤ 25 kHz	≤ 50 kHz ≤ 25 kHz ≤ 12.5 kHz	≤ 25 kHz ≤ 12.5 kHz ≤ 6.25 kHz
Edge separation *a*[1]	–	≥ 0.100 µs ≥ 0.220 µs ≥ 0.465 µs ≥ 0.950 µs	≥ 0.100 µs ≥ 0.220 µs ≥ 0.465 µs ≥ 0.950 µs	≥ 0.080 µs ≥ 0.175 µs ≥ 0.370 µs	≥ 0.080 µs ≥ 0.175 µs ≥ 0.370 µs
Traversing speed[1]	≤ 600 m/min	≤ 480 m/min ≤ 240 m/min ≤ 120 m/min ≤ 60 m/min	≤ 240 m/min ≤ 120 m/min ≤ 60 m/min ≤ 30 m/min	≤ 60 m/min ≤ 30 m/min ≤ 15 m/min	≤ 30 m/min ≤ 15 m/min ≤ 7.5 m/min
Interpolation error	±45 nm	–			
Limit switches	L1/L2 with two different magnets; *output signals*: TTL (without line driver)				
Electrical connection	Cable (0.5 m/1 m/3 m) with 15-pin D-sub connector (male)				
Cable length	See interface description; however, *limit:* ≤ 20 m (with HEIDENHAIN cable)				
Supply voltage	DC 5 V ±0.5 V				
Current consumption	< 130 mA	< 150 mA (without load)			
Vibration 55 Hz to 2000 Hz **Shock** 6 ms	≤ 500 m/s² (EN 60068-2-6) ≤ 1000 m/s² (EN 60068-2-27)				
Operating temperature	–10 °C to 70 °C				
Mass	Scanning head: 20 g (without cable) Cable: 22 g/m Connector: 32 g				

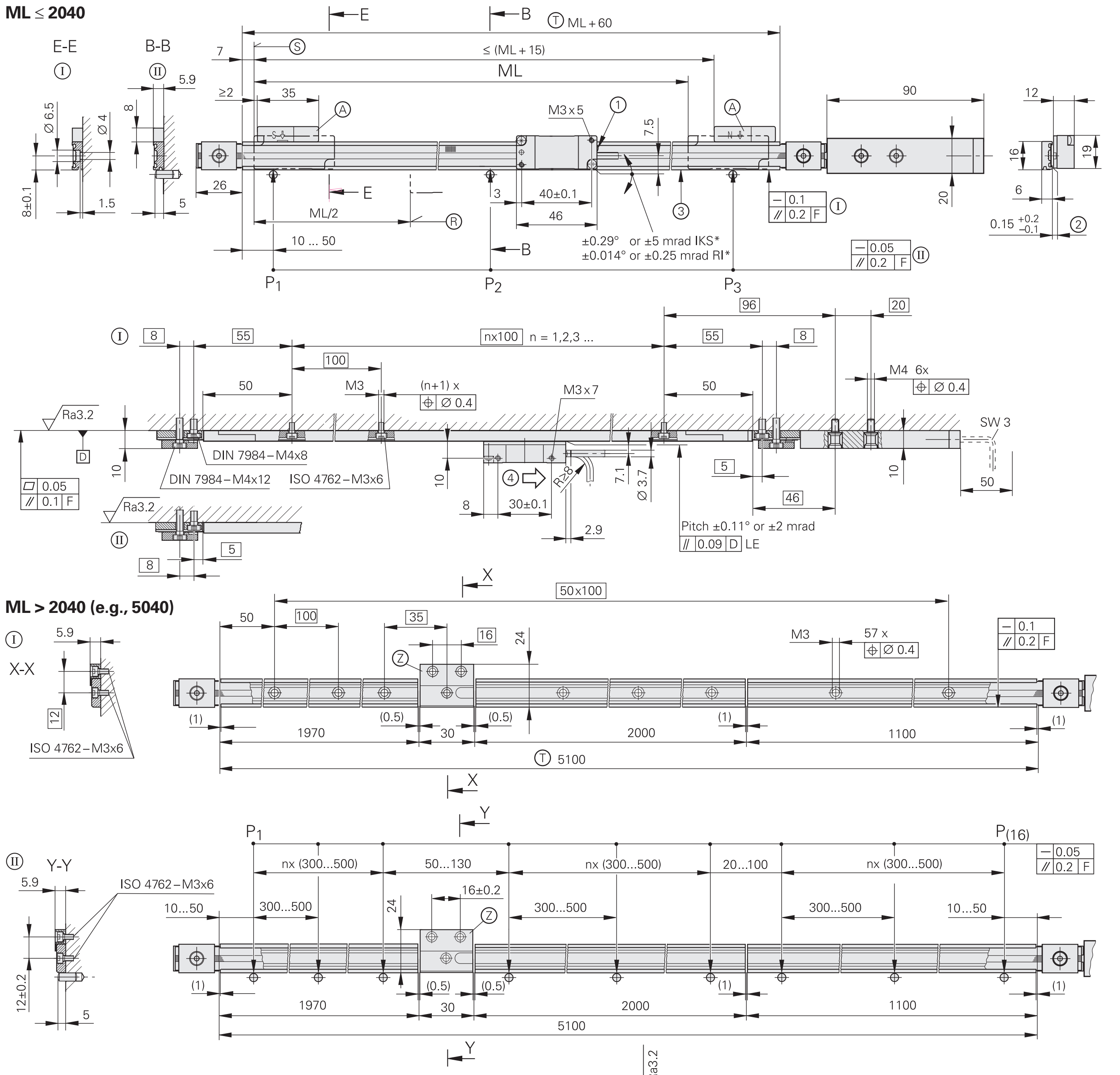
* Please select when ordering
1) At a corresponding cutoff or scanning frequency

Robax is a registered trademark of Schott-Glaswerke, Mainz, Germany

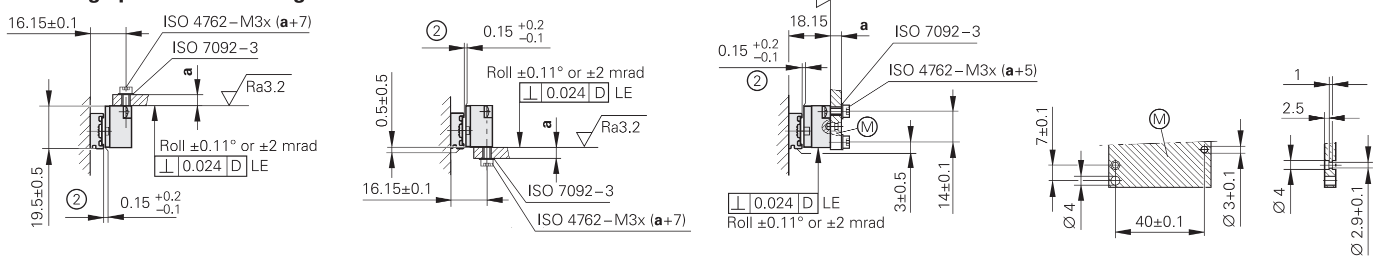
LIDA 475, LIDA 485

Incremental linear encoders for measuring lengths of up to 30 m

- **For measuring steps of down to 10 nm**
- **Limit switches**
- **Steel scale tape pulled through aluminum extrusions and tensioned**
- **Consisting of a linear scale and scanning head**



Mounting options for scanning head



mm

Tolerancing ISO 8015
ISO 2768:1989-mH
≤ 6 mm: ±0.2 mm

Ⓘ = Scale carrier sections secured with screws
Ⓘ = Scale carrier sections adhesively bonded with PRECIMET
F = Machine guideway
* = Maximum change during operation (IKS: incremental track, RI: reference mark track)
P = Measuring points for alignment
Ⓢ = Beginning of measuring length (ML)
Ⓡ = Reference mark position
Ⓐ = Selector magnet for limit switch
Ⓣ = Carrier length
Ⓩ = Spacer for measuring lengths of 3040 mm or greater
Ⓜ = Mounting surface for scanning head
1 = Signal-quality indicator
2 = Scanning gap
3 = Carrier stop surface
4 = Direction of motion of the scanning unit for increasing position values

Scale	**LIDA 405**
Measuring standard Coefficient of linear expansion	Steel scale tape with METALLUR scale grating; grating period: 20 µm Depends on the mounting surface
Accuracy grade	±5 µm
Baseline error	≤ ±0.750 µm/50 mm (typical)
Measuring length (ML)* in mm	140 240 340 440 540 640 740 840 940 1040 1140 1240 1340 1440 1540 1640 1740 1840 1940 2040
	Longer meas. lengths (up to 30 040 mm) with one-piece scale tape and individual scale carrier sections
Reference marks	One at midpoint of measuring length
Mass	115 g + 0.25 g/mm of measuring length

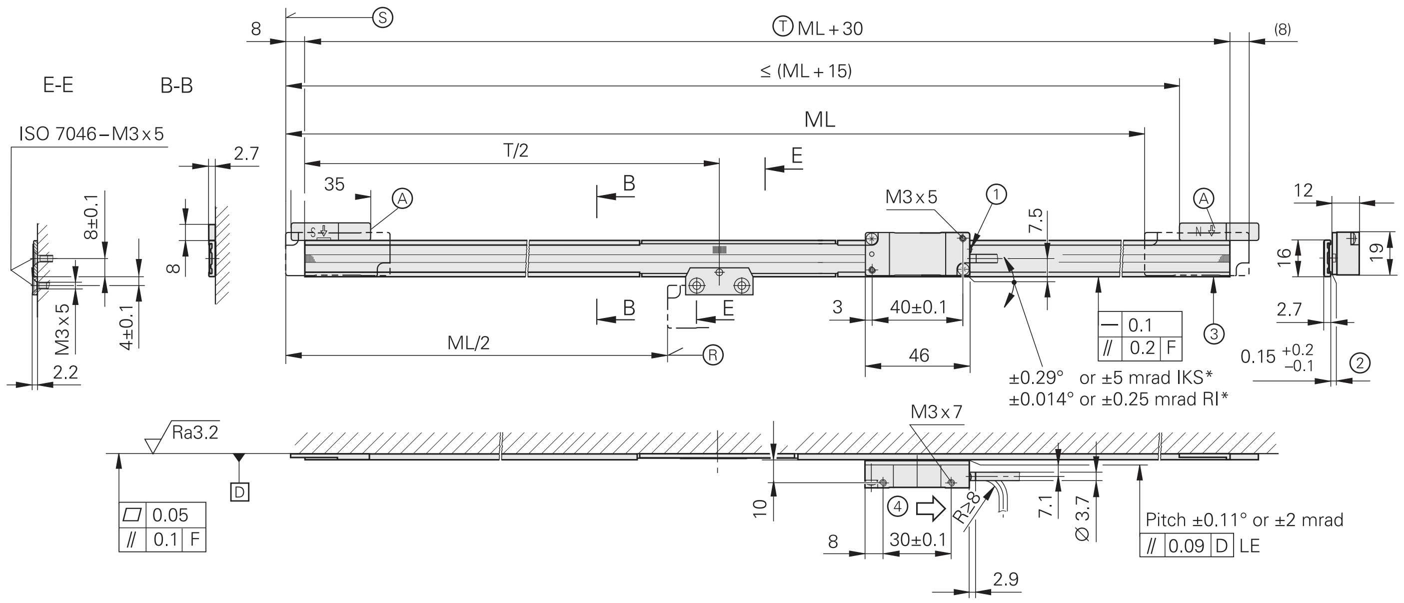
Scanning head	**LIDA 48**	**LIDA 47**			
Interface	∿ 1 V_{PP}	⊓⊔TTL			
Integrated interpolation* Signal period	– 20 µm	5-fold 4 µm	10-fold 2 µm	50-fold 0.4 µm	100-fold 0.2 µm
Cutoff frequency –3 dB	≥ 500 kHz	–			
Scanning frequency*	–	≤ 400 kHz ≤ 200 kHz ≤ 100 kHz ≤ 50 kHz	≤ 200 kHz ≤ 100 kHz ≤ 50 kHz ≤ 25 kHz	≤ 50 kHz ≤ 25 kHz ≤ 12.5 kHz	≤ 25 kHz ≤ 12.5 kHz ≤ 6.25 kHz
Edge separation *a*[1]	–	≥ 0.100 µs ≥ 0.220 µs ≥ 0.465 µs ≥ 0.950 µs	≥ 0.100 µs ≥ 0.220 µs ≥ 0.465 µs ≥ 0.950 µs	≥ 0.080 µs ≥ 0.175 µs ≥ 0.370 µs	≥ 0.080 µs ≥ 0.175 µs ≥ 0.370 µs
Traversing speed[1]	≤ 600 m/min	≤ 480 m/min ≤ 240 m/min ≤ 120 m/min ≤ 60 m/min	≤ 240 m/min ≤ 120 m/min ≤ 60 m/min ≤ 30 m/min	≤ 60 m/min ≤ 30 m/min ≤ 15 m/min	≤ 30 m/min ≤ 15 m/min ≤ 7.5 m/min
Interpolation error	±45 nm	–			
Limit switches	L1/L2 with two different magnets; *output signals*: TTL (without line driver)				
Electrical connection	Cable (0.5 m/1 m/3 m) with 15-pin D-sub connector (male)				
Cable length	See interface description; however, *limit:* ≤ 20 m (with HEIDENHAIN cable)				
Supply voltage	DC 5 V ±0.5 V				
Current consumption	< 130 mA	< 150 mA (without load)			
Vibration 55 Hz to 2000 Hz **Shock** 6 ms	≤ 500 m/s² (EN 60068-2-6) ≤ 1000 m/s² (EN 60068-2-27)				
Operating temperature	–10 °C to 70 °C				
Mass	Scanning head: 20 g (without cable) Cable: 22 g/m Connector: 32 g				

* Please select when ordering
[1] At a corresponding cutoff or scanning frequency

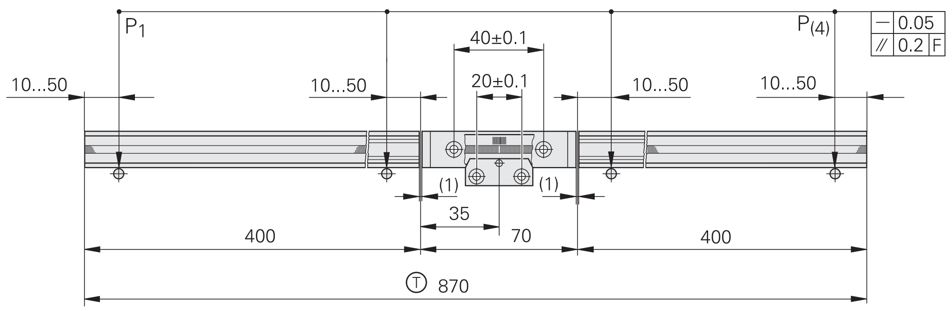
LIDA 477, LIDA 487

Incremental linear encoders for measuring ranges of up to 6 m

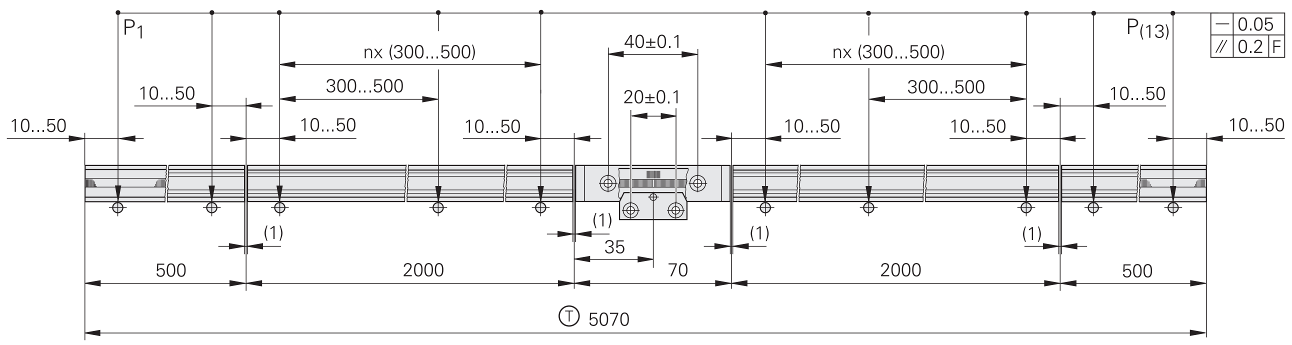
- **For measuring steps of down to 10 nm**
- **Limit switches**
- **Steel scale tape pulled through adhesive aluminum extrusions and secured at center**
- **Consisting of a linear scale and scanning head**



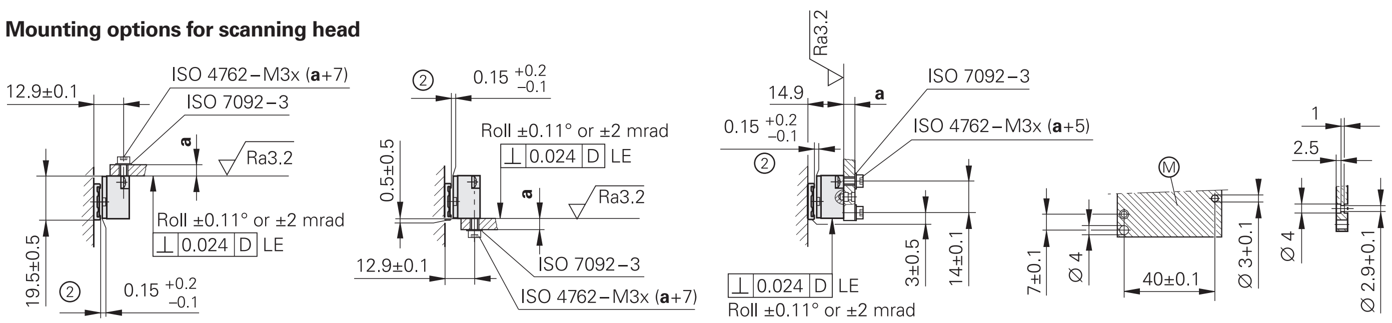
ML ≤ 2040
(e.g., 840)



ML > 2040
(e.g., 5040)



Mounting options for scanning head



mm
Tolerancing ISO 8015
ISO 2768:1989-mH
≤ 6 mm: ±0.2 mm

F = Machine guideway
* = Maximum change during operation
(IKS: incremental track,
RI: reference mark track)
P = Measuring points for alignment
Ⓢ = Beginning of measuring length (ML)
Ⓡ = Reference mark position
Ⓐ = Selector magnet for limit switch

Ⓣ = Carrier length
Ⓜ = Mounting surface for scanning head
1 = Signal-quality indicator
2 = Scanning gap
3 = Carrier stop surface
4 = Direction of motion of the scanning unit for increasing position values

Scale	**LIDA 407**	
Measuring standard Coefficient of linear expansion	Steel scale tape with METALLUR scale grating; grating period: 20 µm $\alpha_{therm} \approx 10 \cdot 10^{-6}$ K^{-1}	
Accuracy grade*	±3 µm (up to ML 1040); ±5 µm (for ML 1240 or greater); ±15 µm[1]	
Baseline error	≤ ±0.750 µm/50 mm (typical)	
Measuring length (ML)* in mm	240 440 640 840 1040 1240 1440 1640 1840 2040 2240 2440 2640 2840 3040 3240 3440 3640 3840 4040 4240 4440 4640 4840 5040 5240 5440 5640 5840 6040	Scale tape cut from roll*: 2 m, 4 m, 6 m
Reference marks	One at midpoint of measuring length	Every 50 mm[3]
Mass	25 g + 0.1 g/mm of measuring length	

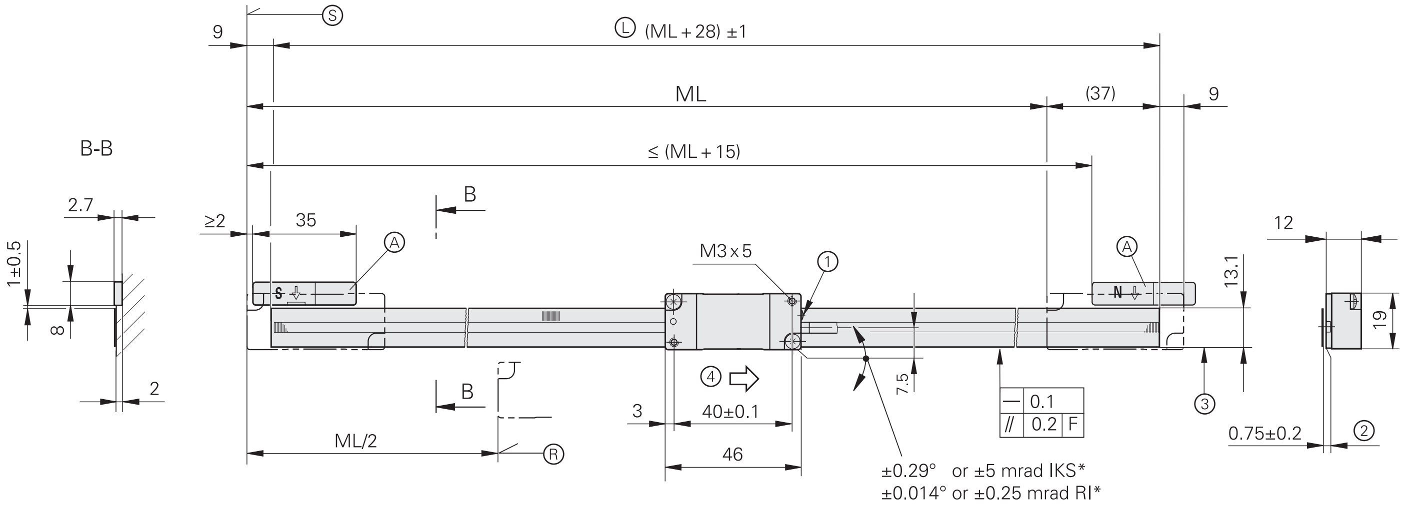
Scanning head	**LIDA 48**	**LIDA 47**			
Interface	∿ 1 V_{PP}	⊓⊔TTL			
Integrated interpolation* Signal period	– 20 µm	5-fold 4 µm	10-fold 2 µm	50-fold 0.4 µm	100-fold 0.2 µm
Cutoff frequency –3 dB	≥ 500 kHz	–			
Scanning frequency*	–	≤ 400 kHz ≤ 200 kHz ≤ 100 kHz ≤ 50 kHz	≤ 200 kHz ≤ 100 kHz ≤ 50 kHz ≤ 25 kHz	≤ 50 kHz ≤ 25 kHz ≤ 12.5 kHz	≤ 25 kHz ≤ 12.5 kHz ≤ 6.25 kHz
Edge separation *a*[2]	–	≥ 0.100 µs ≥ 0.220 µs ≥ 0.465 µs ≥ 0.950 µs	≥ 0.100 µs ≥ 0.220 µs ≥ 0.465 µs ≥ 0.950 µs	≥ 0.080 µs ≥ 0.175 µs ≥ 0.370 µs	≥ 0.080 µs ≥ 0.175 µs ≥ 0.370 µs
Traversing speed[2]	≤ 600 m/min	≤ 480 m/min ≤ 240 m/min ≤ 120 m/min ≤ 60 m/min	≤ 240 m/min ≤ 120 m/min ≤ 60 m/min ≤ 30 m/min	≤ 60 m/min ≤ 30 m/min ≤ 15 m/min	≤ 30 m/min ≤ 15 m/min ≤ 7.5 m/min
Interpolation error	±45 nm	–			
Limit switches	L1/L2 with two different magnets; *output signals*: TTL (without line driver)				
Electrical connection	Cable (0.5 m/1 m/3 m) with 15-pin D-sub connector (male)				
Cable length	See interface description; however, *limit:* ≤ 20 m (with HEIDENHAIN cable)				
Supply voltage	DC 5 V ±0.5 V				
Current consumption	< 130 mA	< 150 mA (without load)			
Vibration 55 Hz to 2000 Hz **Shock** 6 ms	≤ 500 m/s^2 (EN 60068-2-6) ≤ 1000 m/s^2 (EN 60068-2-27)				
Operating temperature	–10 °C to 70 °C				
Mass	*Scanning head:* 20 g (without cable); *cable:* 22 g/m; *connector:* 32 g				

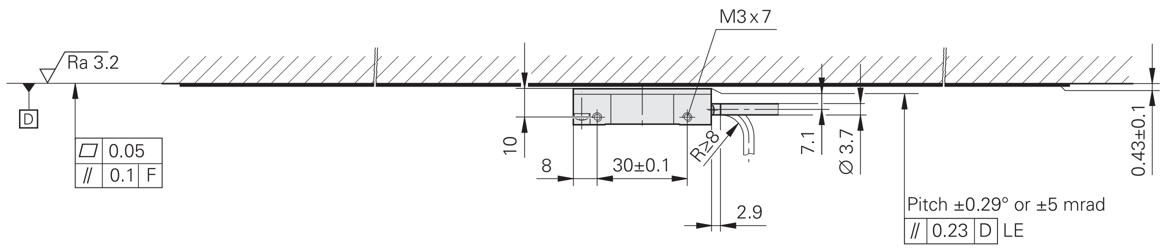
* Please select when ordering
[1] ±5 µm after linear-error compensation in the downstream electronics
[2] At a corresponding cutoff frequency or scanning frequency
[3] Only one reference mark may be used during operation. *Recommended:* use the LIDA 4xR special scanning head

LIDA 479, LIDA 489

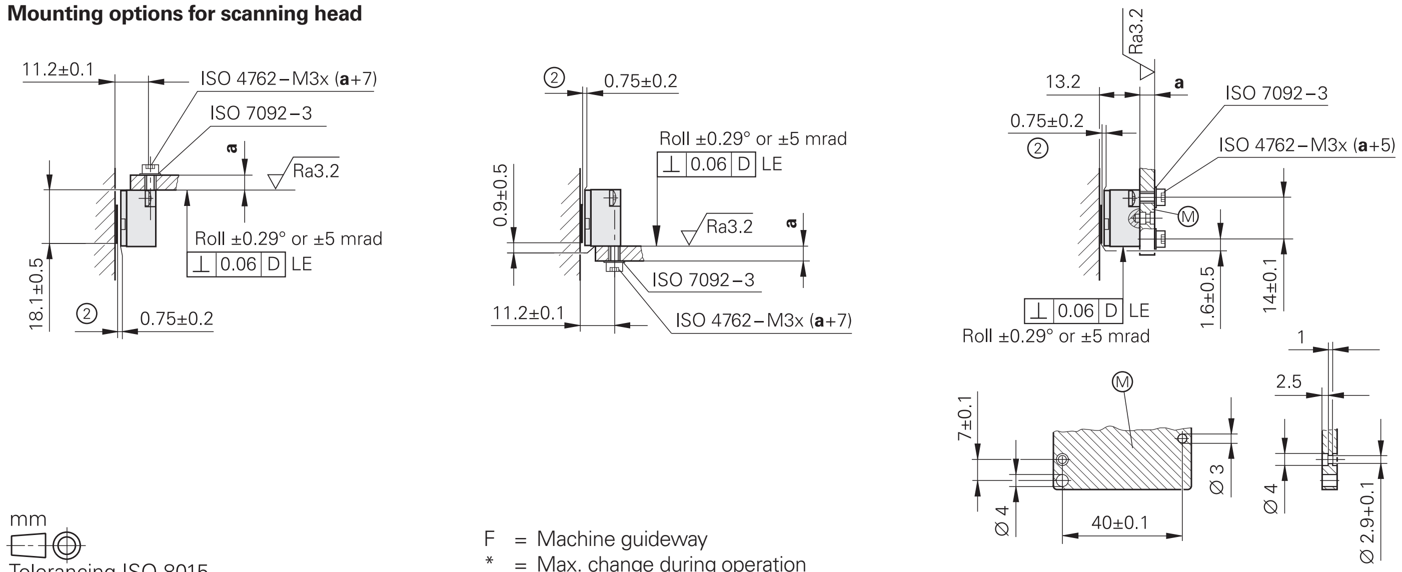
Incremental linear encoders for measuring ranges of up to 6 m

- **For measuring steps of down to 10 nm**
- **Limit switches**
- **Steel scale tape adhesively bonded to mounting surface**
- **Consisting of a scale tape and scanning head**





Mounting options for scanning head



mm

Tolerancing ISO 8015
ISO 2768:1989-mH
≤ 6 mm: ±0.2 mm

F = Machine guideway
* = Max. change during operation
(IKS: incremental track, RI: Reference mark track)
Ⓢ = Beginning of measuring length (ML)
Ⓡ = Reference mark position
Ⓛ = Scale tape length
Ⓐ = Selector magnet for limit switch
Ⓜ = Mounting surface for scanning head
1 = Signal-quality indicator
2 = Scanning gap
3 = Scale-tape stop surface
4 = Direction of motion of the scanning unit for increasing position values

Scale	**LIDA 409**	
Measuring standard Coefficient of linear expansion	Steel scale tape with METALLUR scale grating; grating period: 20 µm $\alpha_{therm} \approx 10 \cdot 10^{-6}\ K^{-1}$	
Accuracy grade*	±3 µm, ±15 µm[1]	
Baseline error	≤ ±0.750 µm/50 mm (typical)	
Measuring length (ML)* in mm	70 120 170 220 270 320 370 420 520 620 720 820 920 1020	Scale tape cut from roll*: 2 m, 4 m, 6 m
Reference marks	One at midpoint of measuring length	Every 50 mm[3]
Mass	31 g/m	

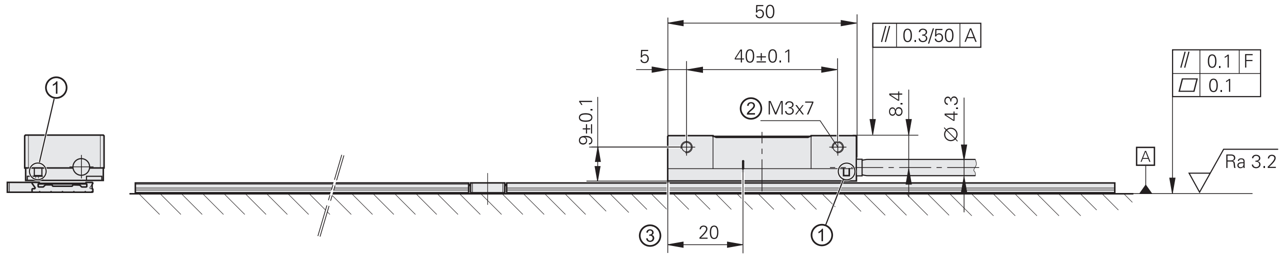
Scanning head	**LIDA 48**	**LIDA 47**			
Interface	∿ 1 V_{PP}	⊓⊔TTL			
Integrated interpolation* Signal period	– 20 µm	5-fold 4 µm	10-fold 2 µm	50-fold 0.4 µm	100-fold 0.2 µm
Cutoff frequency –3 dB	≥ 500 kHz	–			
Scanning frequency*	–	≤ 400 kHz ≤ 200 kHz ≤ 100 kHz ≤ 50 kHz	≤ 200 kHz ≤ 100 kHz ≤ 50 kHz ≤ 25 kHz	≤ 50 kHz ≤ 25 kHz ≤ 12.5 kHz	≤ 25 kHz ≤ 12.5 kHz ≤ 6.25 kHz
Edge separation *a*[2]	–	≥ 0.100 µs ≥ 0.220 µs ≥ 0.465 µs ≥ 0.950 µs	≥ 0.100 µs ≥ 0.220 µs ≥ 0.465 µs ≥ 0.950 µs	≥ 0.080 µs ≥ 0.175 µs ≥ 0.370 µs	≥ 0.080 µs ≥ 0.175 µs ≥ 0.370 µs
Traversing speed[2]	≤ 600 m/min	≤ 480 m/min ≤ 240 m/min ≤ 120 m/min ≤ 60 m/min	≤ 240 m/min ≤ 120 m/min ≤ 60 m/min ≤ 30 m/min	≤ 60 m/min ≤ 30 m/min ≤ 15 m/min	≤ 30 m/min ≤ 15 m/min ≤ 7.5 m/min
Interpolation error	±45 nm	–			
Limit switches	L1/L2 with two different magnets; *output signals*: TTL (without line driver)				
Electrical connection	Cable (0.5 m/1 m/3 m) with 15-pin D-sub connector (male)				
Cable length	See interface description; however, *limit:* ≤ 20 m (with HEIDENHAIN cable)				
Supply voltage	DC 5 V ±0.5 V				
Current consumption	< 130 mA	< 150 mA (without load)			
Vibration 55 Hz to 2000 Hz **Shock** 6 ms	≤ 500 m/s² (EN 60068-2-6) ≤ 1000 m/s² (EN 60068-2-27)				
Operating temperature	–10 °C to 70 °C				
Mass	Scanning head: 20 g (without cable) Cable: 22 g/m Connector: 32 g				

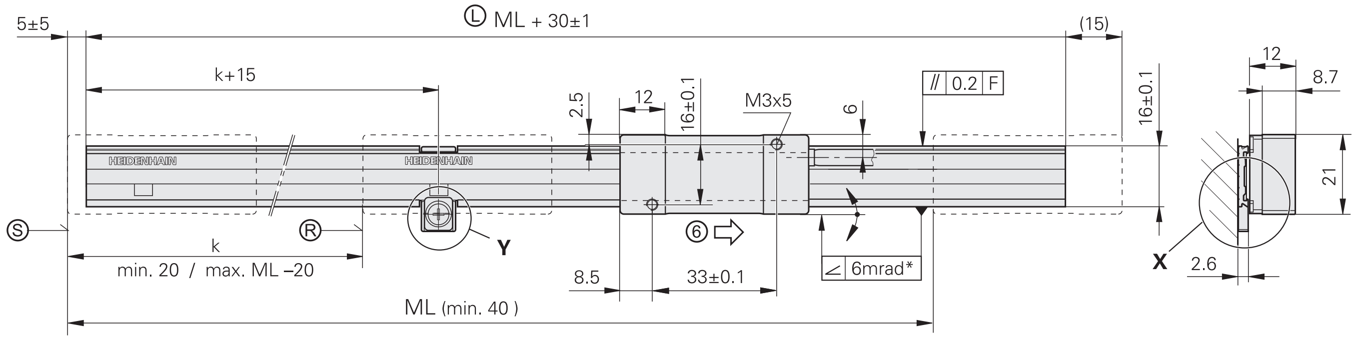
* Please select when ordering
[1] ±5 µm after linear-error compensation in the downstream electronics
[2] At a corresponding cutoff or scanning frequency
[3] Only one reference mark may be used during operation. *Recommended:* use the LIDA 4xR special scanning head

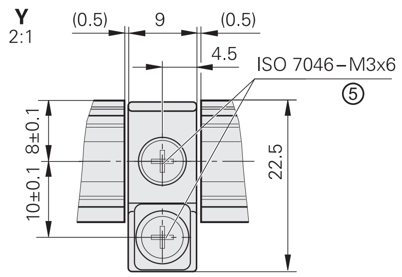
LIDA 277, LIDA 287

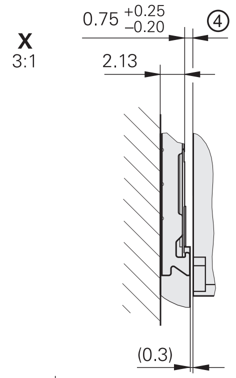
Incremental linear encoder with wide mounting tolerances

- **For measuring steps of down to 100 nm**
- **Scale tape cut from roll**
- **Steel scale tape pulled through adhesive aluminum extrusions and secured**
- **Integrated three-color LED signal-quality indicator**
- **Consisting of a linear scale and scanning head**

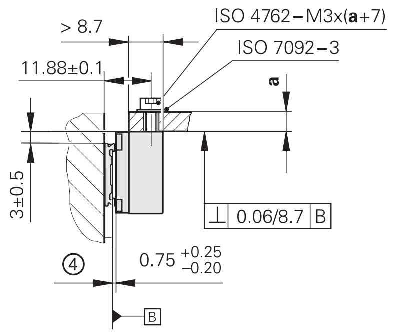


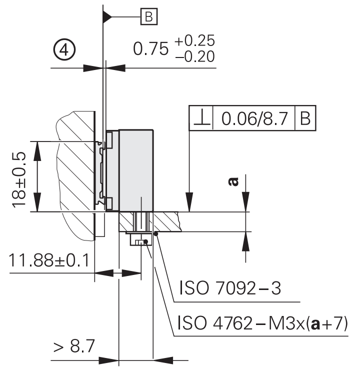


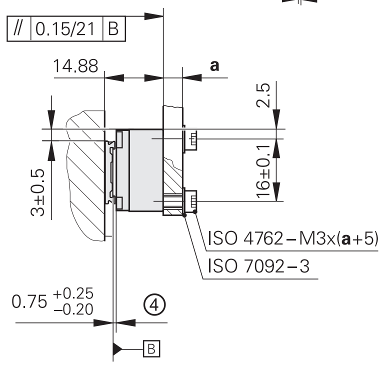




Mounting options for scanning head







mm

Tolerancing ISO 8015
ISO 2768:1989-mH
≤ 6 mm: ±0.2 mm

* = Maximum change during operation
F = Machine guideway
Ⓡ = Reference mark
Ⓛ = Scale tape length
Ⓢ = Beginning of measuring length (ML)
1 = LED (integrated mounting checker)
2 = Thread at both ends
3 = Scanning-head reference mark
4 = Mounting gap between scale and scanning head
5 = M3 threaded mating hole, 5 mm deep
6 = Direction of motion of the scanning unit for increasing position values

Reference mark:
k = Any position of the selected reference mark starting from the beginning of the measuring length (depending on where the scale tape is cut)

Scale	LIDA 207
Measuring standard Coefficient of linear expansion	Steel scale tape; grating period: 200 µm $\alpha_{therm} \approx 10 \cdot 10^{-6}\ K^{-1}$
Accuracy grade	±15 µm
Scale tape from roll*	3 m, 5 m, 10 m
Reference marks	Selectable every 100 mm
Mass	Scale tape: 20 g/m Scale tape carrier: 70 g/m

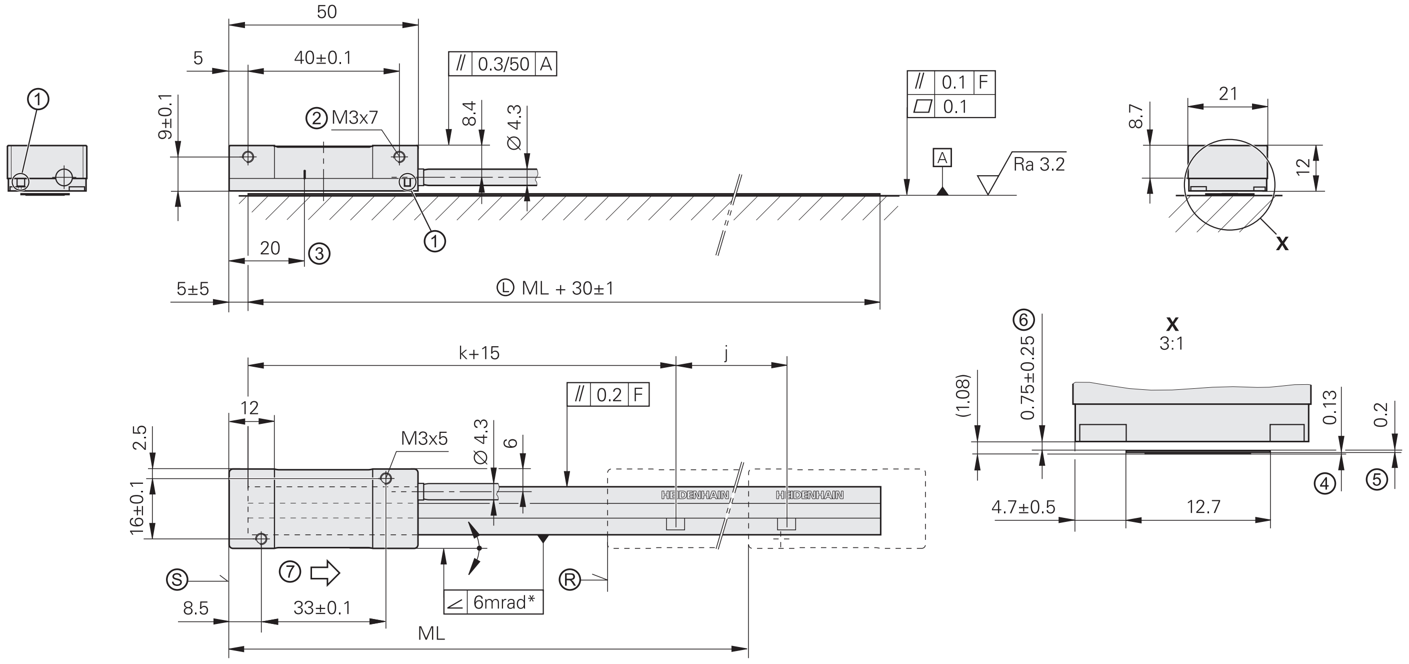
Scanning head	LIDA 28	LIDA 27		
Interface	∿ 1 V_{PP}	⊓⊔TTL		
Integrated Interpolation* Signal period	– 200 µm	10-fold 20 µm	50-fold 4 µm	100-fold 2 µm
Cut-off frequency Scanning frequency Edge separation *a*	≥ 50 kHz – –	– ≤ 50 kHz ≥ 0.465 µs	– ≤ 25 kHz ≥ 0.175 µs	– ≤ 12.5 kHz ≥ 0.175 µs
Traversing speed	≤ 600 m/min		≤ 300 m/min	≤ 150 m/min
Interpolation error	±2 µm	–		
Electrical connection*	Cable (1 m or 3 m) with 15-pin D-sub connector (male)			
Cable length	See the interface description; however ≤ 30 m (with HEIDENHAIN cable)			
Supply voltage	DC 5 V ±0.25 V			
Current consumption	< 155 mA	< 140 mA (without load)		
Vibration 55 Hz to 2000 Hz **Shock** 11 ms	≤ 200 m/s² (EN 60068-2-6) ≤ 500 m/s² (EN 60068-2-27)			
Operating temperature	–10 °C to 70 °C			
Mass	Scanning head: 20 g (without cable) Cable: 30 g/m Connector: 32 g			

* Please select when ordering

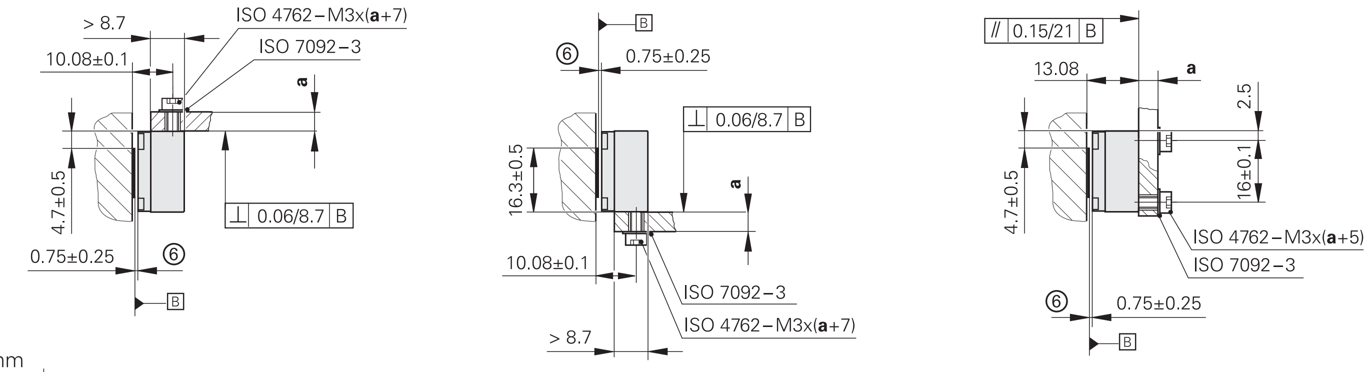
LIDA 279, LIDA 289

Incremental linear encoder with wide mounting tolerances

- **For measuring steps of down to 100 nm**
- **Scale tape cut from roll**
- **Steel scale tape adhesively bonded to mounting surface**
- **Integrated three-color LED signal-quality indicator**
- **Consisting of a linear scale and scanning head**



Mounting options for scanning head



mm

Tolerancing ISO 8015
ISO 2768:1989-mH
≤ 6 mm: ±0.2 mm

Scale	LIDA 209			
Measuring standard Coefficient of linear expansion	Steel scale tape; grating period: 200 µm $\alpha_{therm} \approx 10 \cdot 10^{-6}$ K^{-1}			
Accuracy grade	±15 µm			
Scale tape from roll*	3 m, 5 m, 10 m			
Reference marks	Selectable every 100 mm			
Mass	20 g/m			

Scanning head	LIDA 28	LIDA 27		
Interface	∼ 1 V_{PP}	⊓⊔TTL		
Integrated Interpolation* Signal period	– 200 µm	10-fold 20 µm	50-fold 4 µm	100-fold 2 µm
Cut-off frequency Scanning frequency Edge separation *a*	≥ 50 kHz – –	– ≤ 50 kHz ≥ 0.465 µs	– ≤ 25 kHz ≥ 0.175 µs	– ≤ 12.5 kHz ≥ 0.175 µs
Traversing speed	≤ 600 m/min		≤ 300 m/min	≤ 150 m/min
Interpolation error	±2 µm	–		
Electrical connection*	Cable (1 m or 3 m) with 15-pin D-sub connector (male)			
Cable length	See the interface description; however ≤ 30 m (with HEIDENHAIN cable)			
Supply voltage	DC 5 V ±0.25 V			
Current consumption	< 155 mA	< 140 mA (without load)		
Vibration 55 Hz to 2000 Hz **Shock** 11 ms	≤ 200 m/s² (EN 60068-2-6) ≤ 500 m/s² (EN 60068-2-27)			
Operating temperature	–10 °C to 70 °C			
Mass	Scanning head: 20 g (without cable) Cable: 30 g/m Connector: 32 g			

* Please select when ordering

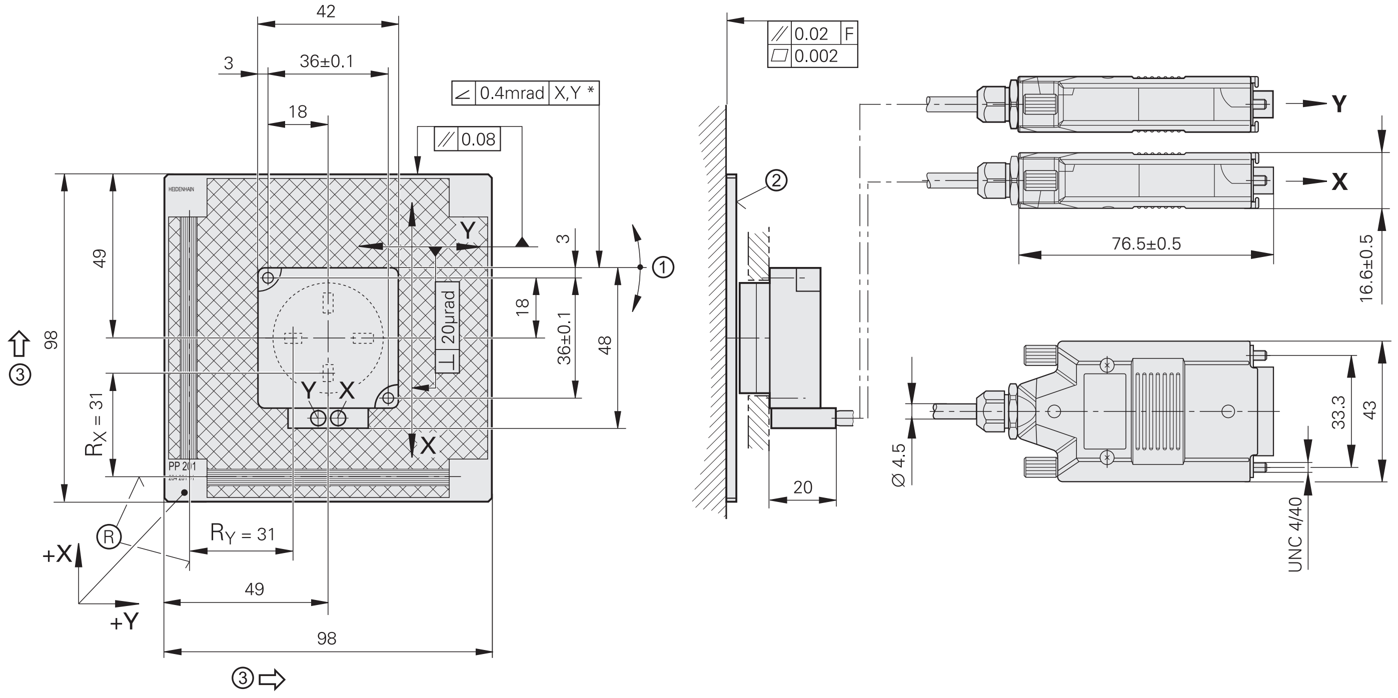
* = Maximum change during operation
F = Machine guideway
Ⓡ = Reference mark
Ⓛ = Scale tape length
Ⓢ = Beginning of measuring length (ML)
1 = LED (integrated mounting checker)
2 = Thread at both ends
3 = Scanning-head reference mark
4 = Adhesive tape
5 = Steel scale tape
6 = Mounting gap between scale and scanning head
7 = Direction of motion of the scanning unit for increasing position values

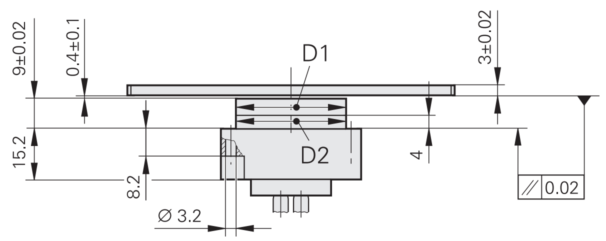
Reference mark:
k = Any position of the selected reference mark starting from the beginning of the measuring length (depending on the cut)
j = Additional reference marks spaced every n x 100 mm

PP 281 R

Two-coordinate incremental encoder

- **For measuring steps of 1 µm to 0.05 µm**

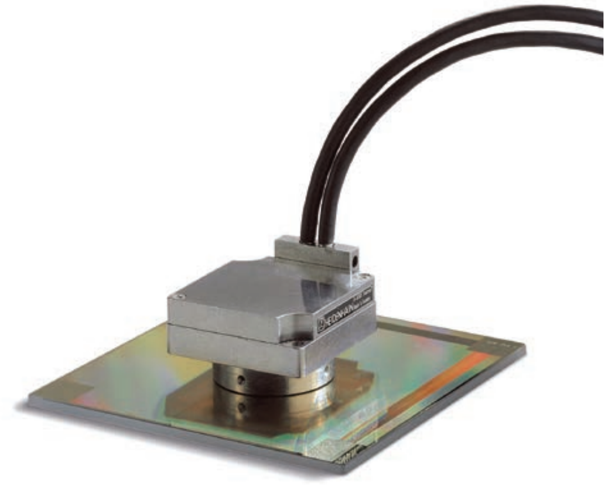




D1	D2
Ø 32.9 –0.2	Ø 33 –0.02/–0.10

mm
Tolerancing ISO 8015
ISO 2768:1989-mH
≤ 6 mm: ±0.2 mm

* = Maximum change during operation
F = Machine guideway
® = Reference-mark position relative to center position shown
1 = Adjusted during mounting
2 = Graduation side
3 = Direction of motion of the scanning unit for ascending position values



	PP 281 R
Measuring standard Coefficient of linear expansion	Two-coordinate TITANID phase grating on glass; grating period: 8 µm $\alpha_{therm} \approx 8 \cdot 10^{-6}\ K^{-1}$
Accuracy grade	±2 µm
Measuring area	68 mm x 68 mm, other measuring ranges upon request
Reference marks[1]	One reference mark in each axis, 3 mm after beginning of measuring length
Interface	∼ 1 V_{PP}
Signal period	4 µm
Cutoff frequency –3 dB	≥ 300 kHz
Traversing speed	≤ 72 m/min
Interpolation error **RMS position noise**	±12 nm[3] 2 nm (450 kHz[2])
Electrical connection	Cable (0.5 m) with 15-pin D-sub connector (male); interface electronics in the connector
Cable length	See the interface description; however ≤ 30 m (with HEIDENHAIN cable)
Supply voltage	DC 5 V ±0.25 V
Current consumption	< 185 mA per axis
Vibration 55 Hz to 2000 Hz **Shock** 11 ms	≤ 80 m/s^2 (EN 60068-2-6) ≤ 100 m/s^2 (EN 60068-2-27)
Operating temperature	0 °C to 50 °C
Mass	Scanning head: 170 g (without cable) Grid plate: 75 g Encoder cable: 37 g/m Connector: 140 g

[1] The reference mark signal deviates from the interface specification in its zero crossovers K, L (see the mounting instructions)
[2] –3 dB cutoff frequency of the downstream electronics
[3] With HEIDENHAIN interface electronics (e.g., EIB 741)

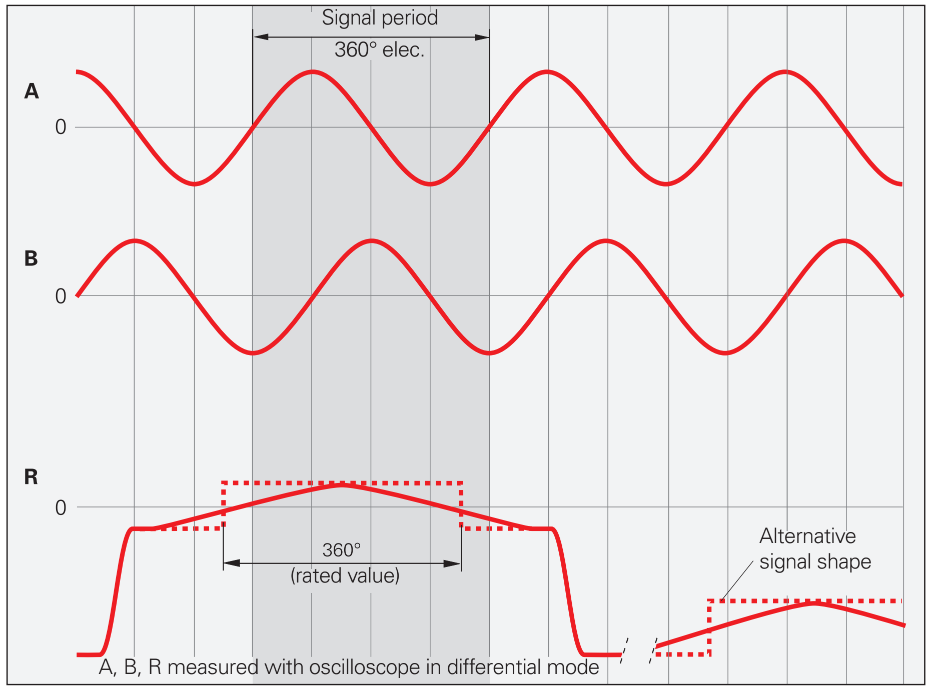
Interfaces

1 V_{PP} incremental signals

HEIDENHAIN encoders with the 1 V_{PP} interface provide voltage signals that are highly interpolatable.

The sinusoidal **incremental signals** A and B are phase-shifted by 90° elec. and have a typical amplitude of 1 V_{PP}. The illustrated sequence of output signals, with B lagging A, applies to the direction of motion shown in the dimension drawing.

The **reference mark signal** R has a unique assignment to the incremental signals. The output signal may be lower next to the reference mark.



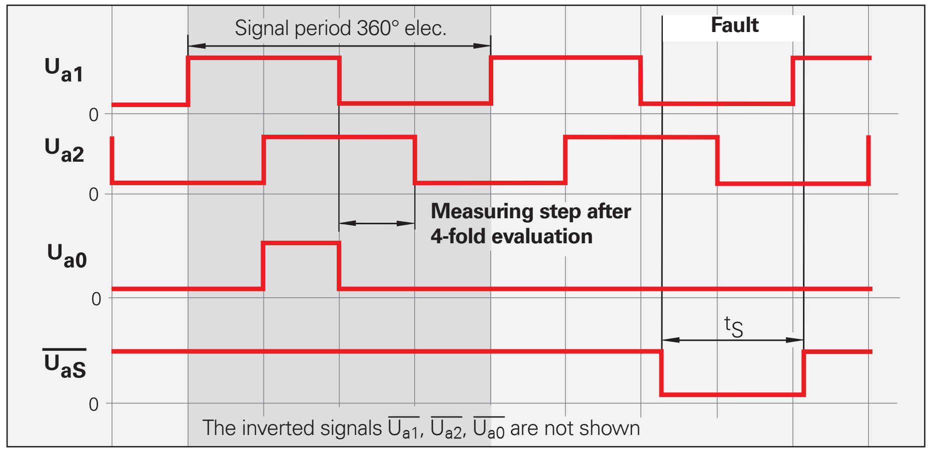
Further information:

For detailed descriptions of all available interfaces, as well as general electrical information, refer to the *Interfaces of HEIDENHAIN Encoders* brochure.

TTL incremental signals

HEIDENHAIN encoders with the TTL interface incorporate electronics that digitize sinusoidal scanning signals with or without interpolation.

The **incremental signals** are output as the square-wave pulse trains U_{a1} and U_{a2} with a 90° elec. phase shift. The **reference mark signal** consists of one or more reference pulses U_{a0}, which are gated with the incremental signals. In addition, the integrated electronics generate the **inverted signals** $\overline{U_{a1}}$, $\overline{U_{a2}}$, and $\overline{U_{a0}}$ for noise-immune transmission. The illustrated sequence of output signals—with U_{a2} lagging U_{a1}—applies to the direction of motion shown in the dimension drawing.



The **fault detection signal** $\overline{U_{aS}}$ indicates fault conditions such as an interruption in the supply lines, failure of the light source, etc.

The distance between two successive edges of the incremental signals U_{a1} and U_{a2} through 1-fold, 2-fold, or 4-fold evaluation is one **measuring step.**

Further information:

For detailed descriptions of all available interfaces, as well as general electrical information, refer to the *Interfaces of HEIDENHAIN Encoders* brochure.

Limit switches

LIDA 400 encoders are equipped with two limit switches that enable limit-position detection and the formation of homing tracks. The limit switches are activated by differing adhesive magnets, thereby permitting precise switching of the right or left limit switches. The magnets can be configured in series for the creation of homing tracks. The **signals from the limit switches L1** and **L2** are transmitted over separate lines and are therefore directly available. Nevertheless, the cable has only a very thin diameter of 3.7 mm in order to keep the forces on movable machine elements to a minimum.

The incremental signals conform with the 1 V_{PP} or TTL interface.

Further information:

For detailed descriptions of all available interfaces, as well as general electrical information, refer to the *Interfaces of HEIDENHAIN Encoders* brochure.

Position detection

Besides the incremental graduation, the **LIF 4x1** and **LIP 60x1** encoders feature a homing track and limit switches for limit position detection.

The **signals for position detection H** and **L** are transmitted at the TTL level over the separate lines H and L and are therefore directly available. Yet the cable has only a very thin diameter of 4.5 mm (LIF 4x1) or 3.7 mm (LIP 60x1) in order to keep the forces on movable machine elements to a minimum.

The incremental signals conform with the 1 V_{PP} or TTL interface.

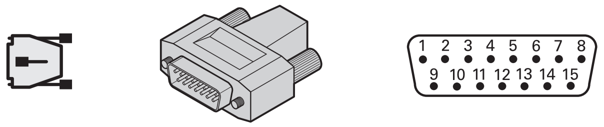
Further information:

For detailed descriptions of all available interfaces, as well as general electrical information, refer to the *Interfaces of HEIDENHAIN Encoders* brochure.

Interfaces
Pin layouts ($1 V_{PP}$/TTL)

LIDA

15-pin D-sub connector



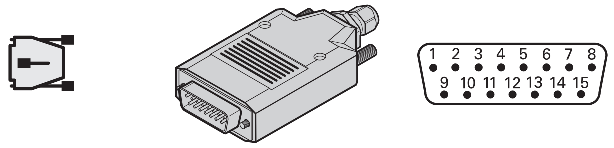
	Power supply				Incremental signals						Other signals				
	4	**12**	**2**	**10**	**1**	**9**	**3**	**11**	**14**	**7**	**13**	**8**	**6**	**15**	**5**
TTL	U_P	**Sen-sor**[4] 5 V	**0 V**	**Sen-sor**[4] 0 V	U_{a1}	$\overline{U_{a1}}$	U_{a2}	$\overline{U_{a2}}$	U_{a0}	$\overline{U_{a0}}$	$\overline{U_{aS}}$	**L1**[3]	**L2**[3]	**PWT**[1]	**Vacant**
$1 V_{PP}$					**A+**	**A–**	**B+**	**B–**	**R+**	**R–**	**As-signed**			**As-signed**	**Vacant**
2)	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 line.
Vacant pins or wires must not be used.

1) TTL/11 µA$_{PP}$ conversion for the PWT
2) Color assignment of the connecting cable
3) Valid only for the LIDA 400
4) LIDA 200: vacant

LIP 281 and PP 281 R

15-pin D-sub connector



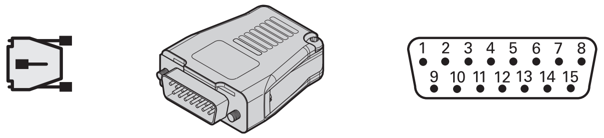
	Power supply				Incremental signals						Other signals			
	4	**12**	**2**	**10**	**1**	**9**	**3**	**11**	**14**	**7**	**13**	**5**	**6/8**	**15**
$1 V_{PP}$	U_P	**Sensor** 5 V	**0 V**	**Sensor** 0 V	**A+**	**A–**	**B+**	**B–**	**R+**	**R–**	**As-signed**[1] **Vacant**[3]	**As-signed**[1] **Vacant**[3]	**/**	**As-signed**[1] **Vacant**[3]
2)	Brown/Green	Blue	White/Green	White	Brown	Green	Gray	Pink	Red	Black	Violet	Red/Black	/	Yellow

Shield on 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.

1) Only for adjusting, do not use in normal operation
2) Color assignment of the connecting cable
3) PP 281 R

LIF 400 and LIP 6000

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**[3]	**L**[3]	**PWT**[1]	**Vacant**
$1 V_{PP}$					**A+**	**A–**	**B+**	**B–**	**R+**	**R–**	**As-signed**			**As-signed**	**Vacant**
2)	Brown/Green		White/Green		Brown	Green	Gray	Pink	Red	Black	Violet	White	Blue	Yellow	/

Shield on 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.

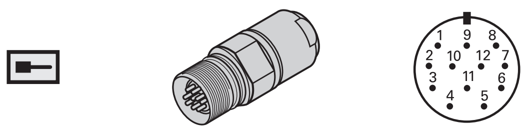
1) TTL/11 µA$_{PP}$ conversion for the PWT
2) Color assignment of the cable
3) Valid only for LIP 6000/LIF 400 with home track and limit switch

Further information:

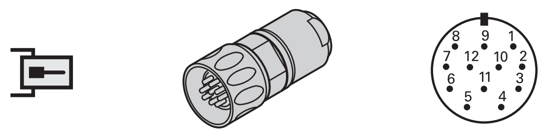
For detailed descriptions of cables, refer to the *Cables and Connectors* brochure.

Alternative: LIDA 400

12-pin M23 coupling



12-pin M23 connector



	Supply voltage				Incremental signals						Other signals	
	12	**2**	**10**	**11**	**5**	**6**	**8**	**1**	**3**	**4**	**7**	**9**
TTL	U_P	**Sensor** U_P	**0 V**	**Sensor** 0 V	U_{a1}	$\overline{U_{a1}}$	U_{a2}	$\overline{U_{a2}}$	U_{a0}	$\overline{U_{a0}}$	$\overline{U_{aS}}$	**PWT**[1]
$1 V_{PP}$					**A+**	**A–**	**B+**	**B–**	**R+**	**R–**	**L1**	**L2**
2)	Brown/Green	Blue	White/Green	White	Brown	Green	Gray	Pink	Red	Black	Violet	Yellow

Shield on 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.

1) TTL/11 µA$_{PP}$ conversion for the PWT
2) Color assignment of the connecting cable

Further information:

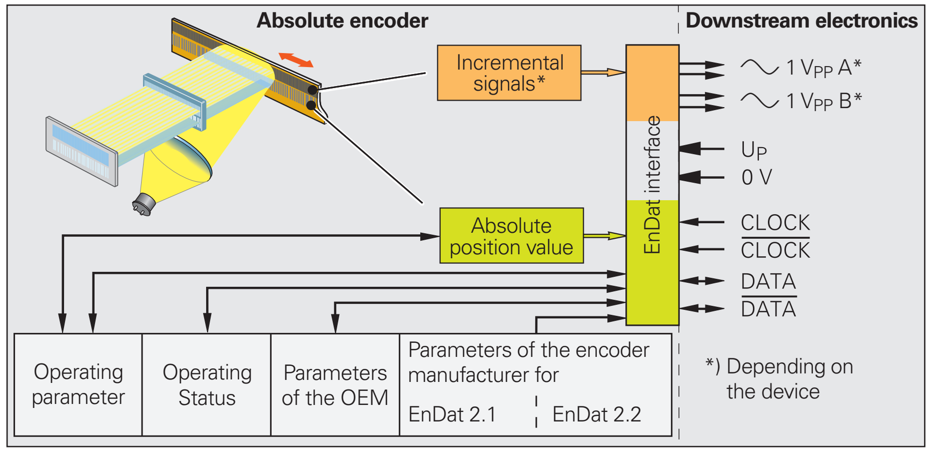
For detailed descriptions of cables, refer to the *Cables and Connectors* brochure.

Interfaces
Position values EnDat

The EnDat interface is a digital **bidirectional** interface for encoders. It is capable of outputting **position values**, reading and updating information stored in the encoder, and storing new information in the encoder. Thanks to the **serial transmission method**, only **four signal lines** are required. The data (DATA) are transmitted **synchronously** with the CLOCK signal from the downstream electronics. The type of transmission (position values, parameters, diagnostics, etc.) is selected via mode commands that the downstream electronics send to the encoder. Some functions are available only with EnDat 2.2 mode commands.

Ordering designation	Command set	Incremental signals
EnDat01	EnDat 2.1 or EnDat 2.2	With
EnDat21		Without
EnDat02	EnDat 2.2	With
EnDat22	EnDat 2.2	Without

Versions of the EnDat interface



Further information:

For detailed descriptions of all available interfaces, as well as general electrical information, refer to the *Interfaces of HEIDENHAIN Encoders* brochure.

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**	**$\overline{\text{DATA}}$**	**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!

Further information:

For detailed descriptions of cables, refer to the *Cables and Connectors* brochure.

Fanuc and Mitsubishi pin layouts

Fanuc pin layout
HEIDENHAIN encoders with the code letter F following the model designation are suitable for connection to Fanuc controls and drive systems.

Fanuc Serial Interface (αi Interface)
The ordering designation is Fanuc05. Its high speed, one-pair transmission contains the α interface (normal and high speed, two-pair transmission)

Further information:

For detailed descriptions of cables, refer to the *Cables and Connectors* brochure.

Fanuc 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	**Serial Data**	**$\overline{\text{Serial Data}}$**	**Request**	**$\overline{\text{Request}}$**
	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!

Mitsubishi pin layout

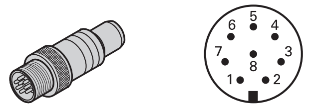
Mitsubishi pin layout
HEIDENHAIN encoders with the code letter M following the model designation are suitable for connection to Mitsubishi controls and drive systems.

Mitsubishi high speed interface
- Ordering designation: Mitsu01 two-pair transmission
- Ordering designation: Mit02-4 Generation 1, two-pair transmission
- Ordering designation: Mit02-2 Generation 1, one-pair transmission
- Ordering designation: Mit03-4 Generation 2, two-pair transmission

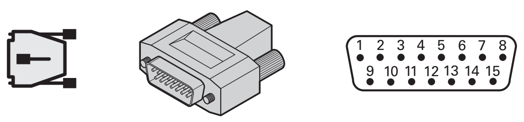
Further information:
For detailed descriptions of cables, refer to the *Cables and Connectors* brochure.

Mitsubishi 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**
Mit03-4	**U_P**	**Sensor** U_P	**0 V**	**Sensor** 0 V	**Serial Data**	**$\overline{\text{Serial Data}}$**	**Request Frame**	**$\overline{\text{Request Frame}}$**
Mit03-2					**Vacant**	**Vacant**	**Request/ Data**	**$\overline{\text{Request/ Data}}$**
	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!

Panasonic pin layout

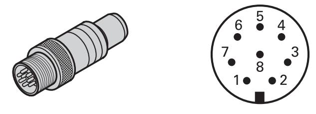
Panasonic pin layout
HEIDENHAIN encoders with the code letter P following the model designation are suitable for connection to Panasonic controls and drive systems.

- Ordering designation: Pana02

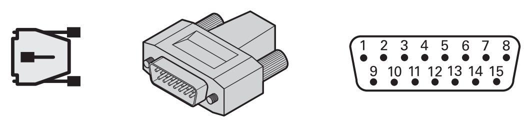
Further information:
For detailed descriptions of cables, refer to the *Cables and Connectors* brochure.

Panasonic 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	**Vacant**[1]	**Vacant**[1]	**Request Data**	**$\overline{\text{Request Data}}$**
	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!
[1] Required for adjustment/testing with the PWM 21

Yaskawa pin layout

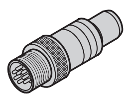
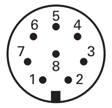
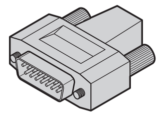
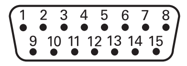
Yaskawa pin layout
HEIDENHAIN encoders with the code letter Y following the model designation are suitable for connection to Yaskawa controls and drive systems.

- Ordering designation: YEC07

Further information:

For detailed descriptions of cables, refer to the *Cables and Connectors* brochure.

Yaskawa pin layout

8-pin M12 coupling  					15-pin D-sub connector  			
	Power supply				Serial data transmission			
M12	**8**	**2**	**5**	**1**	**3**	**4**	**7**	**6**
D-sub	**4**	**12**	**2**	**10**	**5**	**13**	**8**	**15**
	U_P	**Sensor** U_P	**0 V**	**Sensor** 0 V	**Vacant** [1]	**Vacant** [1]	**Data**	**$\overline{\text{Data}}$**
Cable	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!
[1] Required for adjustment/testing with the PWM 21

Testing and inspection devices, and diagnostics

HEIDENHAIN encoders provide all of the information needed for setup, monitoring and diagnostics. The type of information available depends on whether the encoder is incremental or absolute and on which interface is being used.

Incremental encoders have 1 V_{PP}, TTL or HTL interfaces. TTL and HTL encoders monitor their signal amplitudes internally and generate a simple fault-detection signal. With 1 V_{PP} signals, an analysis of the output signals is possible only with external testing devices or by expending computation resources in the downstream electronics (**analog diagnostic interface**).

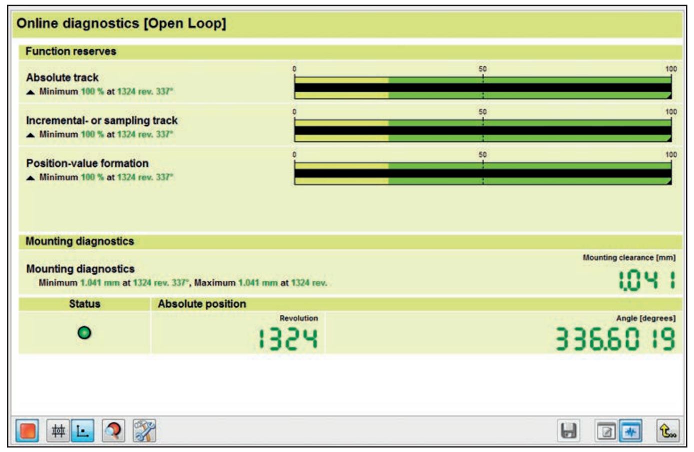
Absolute encoders employ serial data transmission. Depending on the interface, additional 1 V_{PP} incremental signals can be output. The signals are extensively monitored within the encoder. The monitoring results (particularly valuation numbers) can be transmitted to the downstream electronics along with the position values via the serial interface (**digital diagnostics interface**). The following information is available:

- Error message: position value is not reliable
- Warning: an internal functional limit of the encoder has been reached
- Valuation numbers:
  - Detailed information about the encoder's function reserve
  - Identical scaling for all HEIDENHAIN encoders
  - Cyclic reading capability

This enables the downstream electronics to evaluate the current status of the encoder with little effort, even in closed-loop mode.

For the analysis of these encoders, HEIDENHAIN offers the appropriate PWM inspection devices and PWT testing devices. Based on how these devices are integrated, a distinction is made between two types of diagnostics:

- Encoder diagnostics: the encoder is connected directly to the testing or inspection device, thereby enabling a detailed analysis of encoder functions.
- Monitoring mode: the PWM inspection device is linked into the closed control loop (via suitable testing adapters if needed). This enables real-time diagnosis of the machine or equipment during operation. The available functions depend on the interface.



Diagnostics with the PWM 21 and ATS software

Initial setup with the PWM 21 and ATS software

Further information:

For detailed descriptions regarding diagnostics, inspection devices and testing devices, refer to the *Interfaces of HEIDENHAIN Encoders* brochure.

PWT 101
The PWT 101 is a testing device for the functional testing and adjustment of absolute and incremental HEIDENHAIN encoders. Thanks to its compact and rugged design, the PWT 101 is ideal for portable use.

Further information:

For a detailed description, refer to the *PWT 101* Product Information document.

	PWT 101
Encoder input only for HEIDENHAIN encoders	• EnDat • Fanuc Serial Interface • Mitsubishi high speed interface • Panasonic Serial Interface • Yaskawa Serial Interface • 1 V_{PP} • 11 μA_{PP} • TTL
Display	4.3-inch color flat-panel display (touchscreen)
Supply voltage	DC 24 V Power consumption: max. 15 W
Operating temperature	0 °C to 40 °C
Protection EN 60529	IP20
Dimensions	≈ 145 mm × 85 mm × 35 mm

PWM 21
The PWM 21 phase-angle measuring unit, in conjunction with the included ATS adjusting and testing software, serves as an adjusting and testing package for the diagnosis and adjustment of HEIDENHAIN encoders.

Further information:

For detailed descriptions, refer to the *PWM 21/ATS Software* Product Information document.

	PWM 21
Encoder input	• EnDat 2.1, EnDat 2.2 or EnDat 3 (absolute value with or without incremental signals) • DRIVE-CLiQ • Fanuc Serial Interface • Mitsubishi high speed interface • Yaskawa Serial Interface • Panasonic serial interface • SSI • 1 V_{PP}/TTL/11 μA_{PP} • HTL (via signal adapter)
Interface	USB 2.0
Supply voltage	AC 100 V to 240 V or DC 24 V
Dimensions	258 mm × 154 mm × 55 mm

	ATS
Languages	German or English (selectable)
Functions	• Position display • Connection dialog • Diagnostics • Mounting wizard for the EBI/ECI/EQI, ERP 1000, ERO 2000, and others • Additional functions (if supported by the encoder) • Memory contents
System requirements and recommendations	PC (dual-core processor > 2 GHz) RAM > 2 GB Operating systems: Windows 7, 8 and 10 (32-bit / 64-bit) 500 MB of free hard drive space

DRIVE-CLiQ is a registered trademark of Siemens Aktiengesellschaft.

Signal converters

Signal converters from HEIDENHAIN adapt the encoder signals to the interface of the downstream electronics. They are used when the downstream electronics are unable to directly process the output signals of HEIDENHAIN encoders or when additional interpolation of the signals is necessary.

Input signals of the signal converters
HEIDENHAIN signal converters can be connected to encoders with 1 V_{PP} sinusoidal signals (voltage signals) or 11 μA_{PP} sinusoidal signals (current signals). Encoders with the EnDat or SSI serial interface can be connected to various signal converters as well.

Output signals of the signal converters
The signal converters are available with the following interfaces to the downstream electronics:
- TTL square-wave pulse trains
- EnDat 2.2
- DRIVE-CLiQ
- Fanuc Serial Interface
- Mitsubishi high speed interface
- Yaskawa Serial Interface
- Profibus

Interpolation of the sinusoidal input signals
In addition to performing signal conversion, signal converters also interpolate the sinusoidal encoder signals. This permits finer measuring steps, resulting in higher control quality and superior positioning behavior.

Generation of a position value
Various signal converters feature an integrated counter function. Starting from the last set reference point, an absolute position value is generated and output to the downstream electronics when the reference mark is crossed.

Box design

Plug design

Cable design

Top-hat rail design

Outputs		Inputs		Design – IP rating	Interpolation[1] or subdivision	Model
Interface	Status	Interface	Status			
⊓⊔TTL	1	∼ 1 V_{PP}	1	Box design – IP65	5/10-fold	**IBV 101**
					20/25/50/100-fold	**IBV 102**
					Without interpolation	**IBV 600**
					25/50/100/200/400-fold	**IBV 660 B**
				Plug design – IP40	5/10-fold	**IBV 3171**
					20/25/50/100-fold	**IBV 3271**
		∼ 11 μA_{PP}	1	Box design – IP65	5/10-fold	**EXE 101**
					20/25/50/100-fold	**EXE 102**
⊓⊔TTL/ ∼ 1 V_{PP} (adjustable)	2	∼ 1 V_{PP}	1	Box design – IP65	2fach	**IBV 6072**
					5/10-fold	**IBV 6172**
					5/10-fold and 20/25/50/100-fold	**IBV 6272**
EnDat 2.2	1	∼ 1 V_{PP}	1	Box design – IP65	≤ 16 384-fold subdivision	**EIB 192**
				Plug design – IP40	≤ 16 384-fold subdivision	**EIB 392**
			2	Box design – IP65	≤ 16384-fold subdivision	**EIB 1512**
DRIVE-CLiQ	1	EnDat 2.2	1	Box design – IP65	–	**EIB 2391 S**
				Cable design – IP65	–	**EIB 3392 S**
Fanuc Serial Interface	1	∼ 1 V_{PP}	1	Box design – IP65	≤ 16 384-fold subdivision	**EIB 192 F**
				Plug design – IP40	≤ 16 384-fold subdivision	**EIB 392 F**
			2	Box design – IP65	≤ 16 384-fold subdivision	**EIB 1592 F**
Mitsubishi high speed interface	1	∼ 1 V_{PP}	1	Box design – IP65	≤ 16 384-fold subdivision	**EIB 192 M**
				Plug design – IP40	≤ 16 384-fold subdivision	**EIB 392 M**
			2	Box design – IP65	≤ 16 384-fold subdivision	**EIB 1592 M**
Yaskawa Serial Interface	1	EnDat 2.2	1	Plug design – IP40	–	**EIB 3391Y**
PROFIBUS DP	1	EnDat 2.2	1	Top-hat rail design	–	**PROFIBUS gateway**
PROFINET IO	1	EnDat 2.2	1	Top-hat rail design	–	**PROFINET gateway**

[1] Switchable

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Mastering nanometer accuracy

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