

РЕМСТАНМАШ
ТЕХНОЛОГИИ ДЛЯ ПРОИЗВОДСТВА

ООО «РемСтанМаш»

Адрес: г. Смоленск, улица Верхне-Сенная улица, дом 4, офис № 409.

Телефон: 8-800-511-02-67

Телефон: +7-919-0-46-48-46

E-mail: info@cnchelp.ru

Сайт: www.cnchelp.ru

HEIDENHAIN



Exposed Linear Encoders

Exposed linear encoders

Linear encoders measure the position of linear axes without additional mechanical transfer elements. This eliminates a number of potential error sources:

- Positioning error due to thermal behavior of the recirculating ball screw
- Reversal error
- Kinematics error through ball-screw pitch error

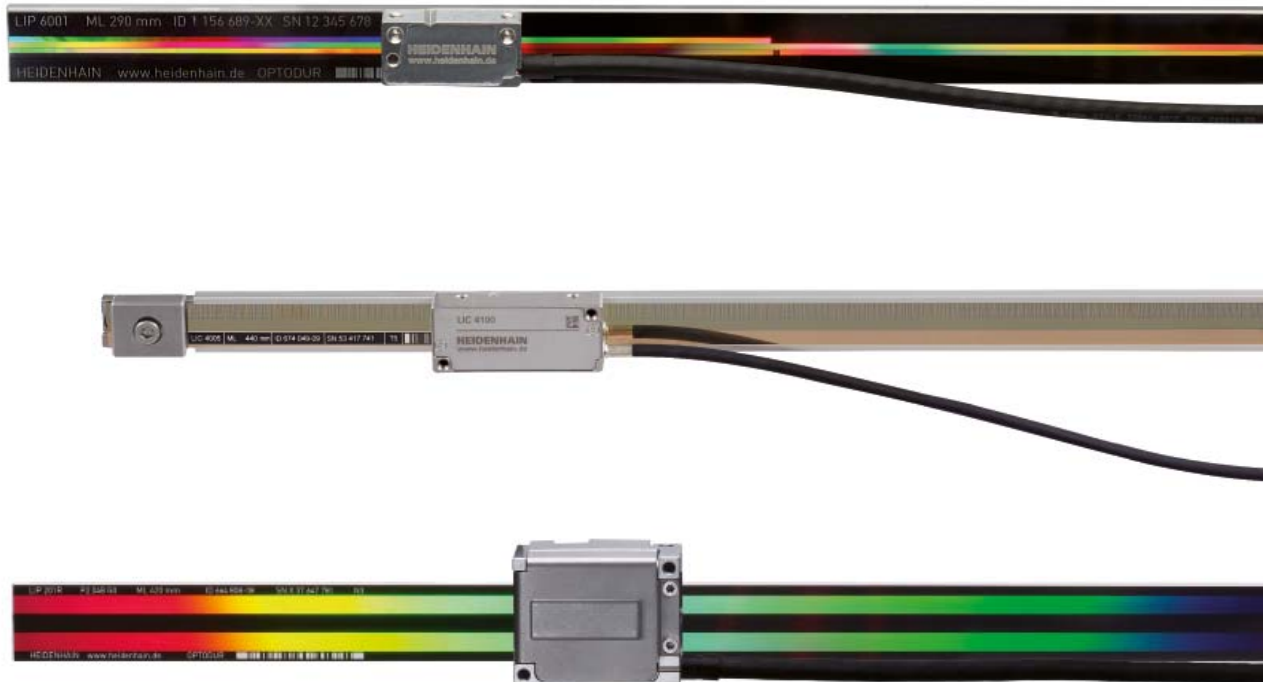
Linear encoders are therefore indispensable for machine tools on which high **positioning accuracy** and a high **machining rate** are essential.

Exposed linear encoders are designed for use on machines and installations that require especially high accuracy of the measured value. Typical applications include:

- Measuring and production equipment in the semiconductor industry
- PCB assembly machines
- Ultra-precision machines such as diamond lathes for optical components, facing lathes for magnetic storage disks, and grinding machines for ferrite components
- High-accuracy machine tools
- Measuring machines and comparators, measuring microscopes, and other precision measuring devices
- Direct drives

Mechanical design

Exposed linear encoders consist of a scale or scale tape and a scanning head that operate without mechanical contact. The scales of exposed linear encoders are fastened to a mounting surface. The flatness of the mounting surface is therefore a prerequisite for high accuracy of the encoder.



Information on

- 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
- is available on request as well as on the Internet at www.heidenhain.de

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 made.

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

More information:

Comprehensive descriptions of all available interfaces as well as general electrical information are included in the *Interfaces of HEIDENHAIN Encoders* brochure.

Contents

Overview		
	Exposed linear encoders	2
	Selection guide	4
Technical characteristics		
	Measuring principles	8
	Reliability	12
	Measuring accuracy	14
	Mechanical design types and mounting	17
	General mechanical information	21
Specifications		
For absolute position measurement	LIC 4113, LIC 4193	22
	LIC 4115, LIC 4195	24
	LIC 4117, LIC 4197	26
	LIC 4119, LIC 4199	28
	LIC 2117, LIC 2197	30
	LIC 2119, LIC 2199	32
For high accuracy	LIP 382	34
	LIP 211, LIP 281, LIP 291	36
	LIP 6071, LIP 6081	38
	LIF 471, LIF 481	40
For high traversing speed	LIDA 473, LIDA 483	42
	LIDA 475, LIDA 485	44
	LIDA 477, LIDA 487	46
	LIDA 479, LIDA 489	48
	LIDA 277, LIDA 287	50
	LIDA 279, LIDA 289	52
For two-coordinate measurement	PP 281 R	54
Electrical connection		
	Interfaces	56
	Cables and connecting elements	63
	Diagnostic and testing equipment	67
	Interface electronics	69

Selection guide

Absolute encoders and encoders with position value output

Absolute position measurement

The LIC exposed linear encoders permit absolute position measurement both over large traverse paths up to 28 m and at high traversing speed.

Encoders for application in vacuum

HEIDENHAIN standard encoders are suitable for use in a low or medium vacuum. Encoders used for applications in a high or ultrahigh vacuum need to fulfill special requirements. Design and materials used have to be specially adapted for it. For more information, refer to the Technical Information document *Linear Encoders for Vacuum Technology*.

The LIC 4113V and LIC 4193V linear encoders are specially adapted for use in high vacuum environments. For more information, please refer to the appropriate Product Information documents.

Incremental encoder with position value output

The LIP 211 and LIP 291 incremental linear encoders output the position information as a position value. The sinusoidal scanning signals are highly interpolated in the scanning head and converted to a position value by the integrated counter function. As with all incremental encoders, the absolute reference is established with the aid of reference marks.

	Baseline error		Substrate and mounting
	Accuracy grade	Interval	
LIC 4100 For high accuracy and high traversing speeds	±1 µm ¹⁾ ±3 µm ±5 µm	≤ ±0.275 µm/ 10 mm	Glass or glass ceramic scale, bonded to the mounting surface or attached with fixing clamps
	±5 µm	≤ ±0.750 µm/ 50 mm (typical)	Steel scale tape drawn into aluminum extrusions and tensioned
	±3 µm ²⁾ ±5 µm ³⁾ ±15 µm ⁴⁾	≤ ±0.750 µm/ 50 mm (typical)	Steel scale tape drawn into aluminum extrusions and fixed
	±3 µm ±15 µm ⁴⁾	≤ ±0.750 µm/ 50 mm (typical)	Steel scale tape, cemented on mounting surface
LIC 2100 For high traversing speed	±15 µm	–	Steel scale tape drawn into aluminum extrusions and fixed
	±15 µm	–	Steel scale tape, cemented on mounting surface
LIP 200 For very high accuracy	±1 µm ²⁾ ±3 µm	≤ ±0.125 µm/ 5 mm	Scale of Zerodur glass ceramic with fixing clamps

¹⁾ Up to measuring length ML = 1640 mm

²⁾ Up to measuring length ML = 1020 mm or 1040 mm

	Interpolation error	Signal period	Measuring length	Interface	Type	Page
	±20 nm	–	240 mm to 3040 mm	EnDat 2.2	LIC 4113	22
				Fanuc α i	LIC 4193 F	
				Mitsubishi	LIC 4193 M	
				Panasonic	LIC 4193 P	
	±20 nm	–	140 mm to 28440 mm	EnDat 2.2	LIC 4115	24
				Fanuc α i	LIC 4195 F	
				Mitsubishi	LIC 4195 M	
				Panasonic	LIC 4195 P	
	±20 nm	–	240 mm to 6040 mm	EnDat 2.2	LIC 4117	26
				Fanuc α i	LIC 4197 F	
				Mitsubishi	LIC 4197 M	
				Panasonic	LIC 4197 P	
	±20 nm	–	70 mm to 1020 mm	EnDat 2.2	LIC 4119	28
				Fanuc α i	LIC 4199 F	
				Mitsubishi	LIC 4199 M	
				Panasonic	LIC 4199 P	
	±2 μ m	–	120 mm to 3020 mm	EnDat 2.2	LIC 2117	30
				Fanuc α i	LIC 2197 F	
				Mitsubishi	LIC 2197 M	
				Panasonic	LIC 2197 P	
	±2 μ m	–	120 mm to 3020 mm	EnDat 2.2	LIC 2119	32
				Fanuc α i	LIC 2199 F	
				Mitsubishi	LIC 2199 M	
				Panasonic	LIC 2199 P	
	±0.4 nm ⁵⁾	0.512 μ m	20 mm to 3040 mm	EnDat 2.2	LIP 211	36
				Fanuc α i	LIP 291 F	
				Mitsubishi	LIP 291 M	



LIC 41x3



LIC 41x5



LIC 41x7



LIC 21x7



LIC 21x9



LIP 211

³⁾ As of measuring length ML = 1240 mm

⁴⁾ ±5 μ m after linear length-error compensation in the evaluation electronics

⁵⁾ With HEIDENHAIN interface electronics

Selection guide

Incremental encoders

Very high accuracy

The **LIP** exposed linear encoders are characterized by very small measuring steps together with very high accuracy and repeatability. They operate according to the interferential scanning principle and feature a DIADUR phase grating as the measuring standard (LIP 281: OPTODUR phase grating).

High accuracy

The **LIF** exposed linear encoders have a measuring standard manufactured in the SUPRADUR process on a glass substrate and operate on the interferential scanning principle. They feature high accuracy and repeatability, are especially easy to mount, and have limit switches and homing tracks. The special version LIF 481 V can be used in high vacuum up to 10^{-7} millibars (see separate Product Information document).

High traversing speeds

The **LIDA** exposed linear encoders are designed for high traversing speeds up to 10 m/s. They are particularly easy to mount with various mounting possibilities. Steel scale tapes, glass or glass ceramic are used as carriers for METALLUR graduations, depending on the respective encoder model. They also feature a limit switch.

Two-coordinate measurement

On the **PP** two-coordinate encoder, a planar phase-grating structure manufactured with the DIADUR process serves as the measuring standard, which is scanned interferentially. This makes it possible to measure positions in a plane.

Encoders for application in vacuum

HEIDENHAIN standard encoders are suitable for use in a low or medium vacuum. Encoders used for applications in a high or ultrahigh vacuum need to fulfill special requirements. Design and materials used have to be specially adapted for it. For more information, refer to the Technical Information document *Linear Encoders for Vacuum Technology*.

The following exposed linear encoders are specially adapted for use in high and ultrahigh vacuum environments.

- High vacuum: LIP 481V and LIF 481V
- Ultrahigh vacuum: LIP 481 U

For more information, please refer to the appropriate product information documents.

	Baseline error		Substrate and mounting
	Accuracy grade ¹⁾	Interval	
LIP For very high accuracy	$\pm 0.5 \mu\text{m}^{3)}$	$\leq \pm 0.075 \mu\text{m}/5 \text{ mm}$	Zerodur glass ceramic embedded in bolted-on Invar carrier
	$\pm 1 \mu\text{m}^{2)}$ $\pm 3 \mu\text{m}$	$\leq \pm 0.125 \mu\text{m}/5 \text{ mm}$	Scale of Zerodur glass ceramic, attached with fixing clamps
	$\pm 1 \mu\text{m}^{5)}$ $\pm 3 \mu\text{m}$	$\leq \pm 0.175 \mu\text{m}/5 \text{ mm}$	Glass or Zerodur glass ceramic scale, bonded or attached with fixing clamps
LIF For high accuracy	$\pm 1 \mu\text{m}^{8)}$ $\pm 3 \mu\text{m}$	$\leq \pm 0.225 \mu\text{m}/5 \text{ mm}$	Glass or Zerodur glass ceramic scale, bonded or attached with fixing clamps
	$\pm 1 \mu\text{m}^{5)}$ $\pm 3 \mu\text{m}$	$\leq \pm 0.225 \mu\text{m}/5 \text{ mm}$	Scale of Zerodur glass ceramic or glass, cemented with PRECIMET adhesive film
LIDA For high traversing speeds and large measuring lengths	$\pm 1 \mu\text{m}^{9)}$ $\pm 3 \mu\text{m}$ $\pm 5 \mu\text{m}$	$\leq \pm 0.275 \mu\text{m}/10 \text{ mm}$	Glass or glass ceramic scale, bonded to the mounting surface
	$\pm 5 \mu\text{m}$	$\leq \pm 0.750 \mu\text{m}/50 \text{ mm}$ (typical)	Steel scale tape drawn into aluminum extrusions and tensioned
	$\pm 3 \mu\text{m}^{2)}$ $\pm 5 \mu\text{m}$ $\pm 15 \mu\text{m}^{6)}$	$\leq \pm 0.750 \mu\text{m}/50 \text{ mm}$ (typical)	Steel scale tape drawn into aluminum extrusions and fixed
	$\pm 3 \mu\text{m}^{2)}$ $\pm 15 \mu\text{m}^{6)}$	$\leq \pm 0.750 \mu\text{m}/50 \text{ mm}$ (typical)	Steel scale tape, cemented on mounting surface
	$\pm 15 \mu\text{m}$	–	Steel scale tape drawn into aluminum extrusions and fixed
	$\pm 15 \mu\text{m}$	–	Steel scale tape, cemented on mounting surface
PP For two-coordinate measurement	$\pm 2 \mu\text{m}$	–	Glass grid plate, with full-surface bonding
LIP/LIF For application in high and ultrahigh vacuum technology	$\pm 0.5 \mu\text{m}$ $\pm 1 \mu\text{m}$	$\leq \pm 0.175 \mu\text{m}/5 \text{ mm}$	Scale of Zerodur glass ceramic or glass, attached with fixing clamps
	$\pm 3 \mu\text{m}$	$\leq \pm 0.225 \mu\text{m}/5 \text{ mm}$	

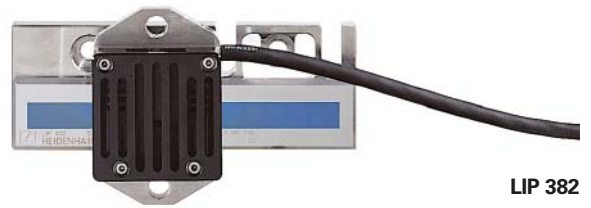
1) In the interval of 1 m or the measuring length < 1 m (accuracy grade)

2) Up to measuring lengths of 1020 mm or 1040 mm

3) Higher accuracy grades available upon request

4) Other measuring lengths/ranges upon request

	Interpolation error	Signal period	Measuring length	Interface	Type	Page
	±0.01 nm	0.128 µm	70 mm to 270 mm	~ 1 V _{PP}	LIP 382	34
	±0.4 nm ⁷⁾	0.512 µm	20 mm to 3040 mm	~ 1 V _{PP}	LIP 281	36
	–	4 µm	20 mm to 3040 mm	□ TTL	LIP 6071	38
	±4 nm			~ 1 V _{PP}	LIP 6081	
	–	4 µm	70 mm to 3040 mm ⁴⁾	□ TTL	LIF 171	Product Information
	±12 nm			~ 1 V _{PP}	LIF 181	
	–	4 µm	70 mm to 1640 mm	□ TTL	LIF 471	40
	±12 nm			~ 1 V _{PP}	LIF 481	
	–	20 µm	240 mm to 3040 mm	□ TTL	LIDA 473	42
	±45 nm			~ 1 V _{PP}	LIDA 483	
	–	20 µm	140 mm to 30040 mm	□ TTL	LIDA 475	44
	±45 nm			~ 1 V _{PP}	LIDA 485	
	–	20 µm	240 mm to 6040 mm	□ TTL	LIDA 477	46
	±45 nm			~ 1 V _{PP}	LIDA 487	
	–	20 µm	Up to 6000 mm ⁴⁾	□ TTL	LIDA 479	48
	±45 nm			~ 1 V _{PP}	LIDA 489	
	–	200 µm	Up to 10000 mm ⁴⁾	□ TTL	LIDA 277	50
	± 2 µm			~ 1 V _{PP}	LIDA 287	
	–	200 µm	Up to 10000 mm ⁴⁾	□ TTL	LIDA 279	52
	± 2 µm			~ 1 V _{PP}	LIDA 289	
	±12 nm ⁷⁾	4 µm	Measuring range 68 x 68 mm ⁴⁾	~ 1 V _{PP}	PP 281	54
	±7 nm	2 µm	70 mm to 420 mm	~ 1 V _{PP}	LIP 481V LIP 481U	Product Information
	±12 nm ⁷⁾	4 µm	70 mm to 1020 mm		LIF 481V	



LIP 382



LIP 281



LIP 6081



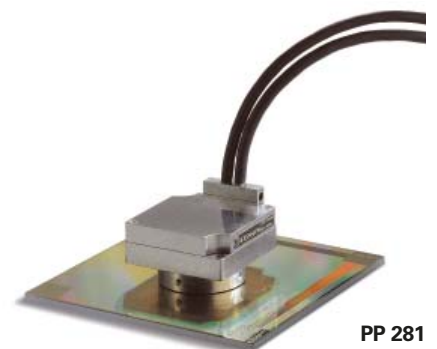
LIF 481



LIDA 489



LIDA 287



PP 281

⁵⁾ Only for Zerodur glass ceramic up to measuring length 1020 mm
⁶⁾ ±5 µm after linear length-error compensation in the subsequent electronics
⁷⁾ With HEIDENHAIN interface electronics, e.g. EIB 741
⁸⁾ Up to measuring length 1640 mm
⁹⁾ Only for Robax glass ceramic up to measuring length 1640 mm

Measuring principles

Measuring standard

HEIDENHAIN encoders with optical scanning incorporate measuring standards of periodic structures known as graduations. These graduations are applied to a carrier substrate of glass or steel. The scale substrate for large measuring lengths is a steel tape.

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

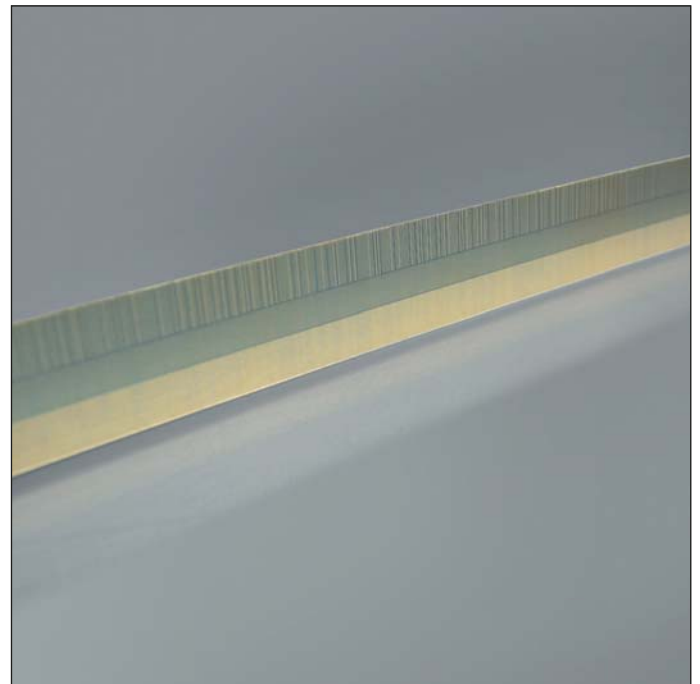
- AURODUR: matte-etched lines on gold-plated steel tape with typical graduation period of 40 μm
- METALLUR: contamination-tolerant graduation of metal lines on gold, with typical graduation period of 20 μm
- DIADUR: extremely robust chromium lines on glass (typical graduation period of 20 μm) or three-dimensional chromium structures (typical graduation period of 8 μm) on glass
- SUPRADUR phase grating: optically three dimensional, planar structure; particularly tolerant to contamination; typical graduation period of 8 μm and finer
- OPTODUR phase grating: optically three dimensional, planar structure with particularly high reflectance, typical graduation period of 2 μm and less

Along with these very fine grating periods, these processes permit a high definition and homogeneity of the line edges. Together with the photoelectric scanning method, this high edge definition is a precondition for the high quality of the output signals.

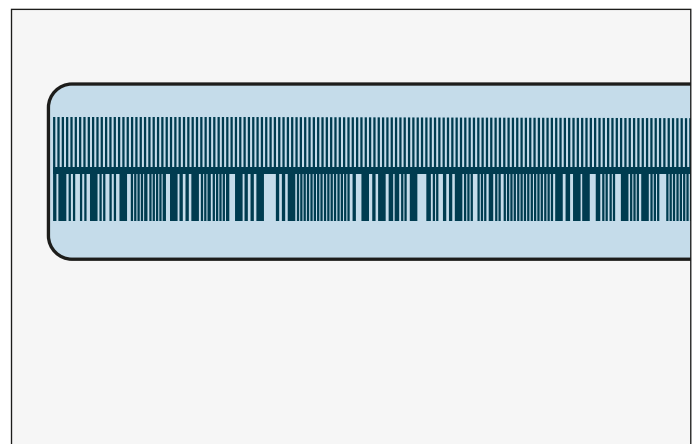
The master graduations are manufactured by HEIDENHAIN on custom-built, high-precision dividing engines.

Absolute measuring method

With the absolute measuring method, the position value is available from the encoder immediately upon switch-on and can be called at any time by the subsequent electronics. There is no need to move the axes to find the reference position. The absolute position information is read **from the graduated disk**, which is formed from a serial absolute code structure. A separate incremental track is interpolated for the position value and at the same time—depending on the interface version—is used to generate an optional incremental signal.



Graduation of an absolute linear encoder



Representation of an absolute code structure with an additional incremental track (LC 401x as example)

Incremental measuring method

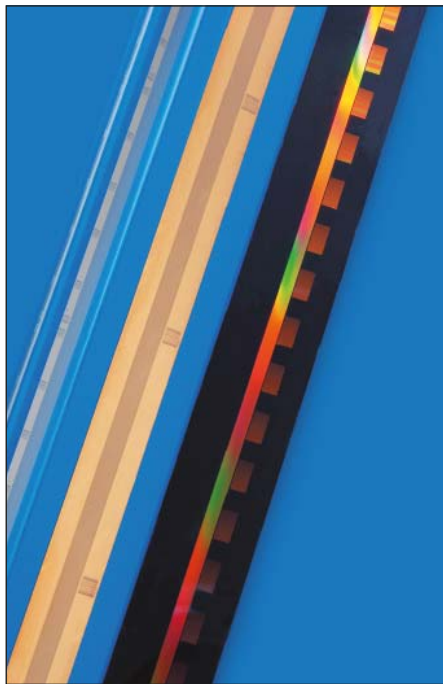
With the incremental measuring method, the graduation consists of a periodic grating structure. The position information is obtained **by counting** the individual increments (measuring steps) from some point of origin. Since an absolute reference is required to ascertain positions, the measuring standard is provided with an additional track that bears a **reference mark**. The absolute position on the scale, established by the reference mark, is gated with exactly one signal period.

The reference mark must therefore be scanned to establish an absolute reference or to find the last selected datum.

In the most unfavorable case, this may necessitate machine movements over large lengths of the measuring range. To speed and simplify such "reference runs," many HEIDENHAIN encoders feature **distance-coded reference marks**—multiple reference marks that are individually spaced according to a mathematical algorithm. The subsequent electronics find the absolute reference after traversing two successive reference marks—only a few millimeters traverse (see table below).

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

With distance-coded reference marks, the **absolute reference B** is calculated by counting the signal periods between two reference marks and using the following formula:



Graduations of incremental linear encoders

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

and

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

Where:

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

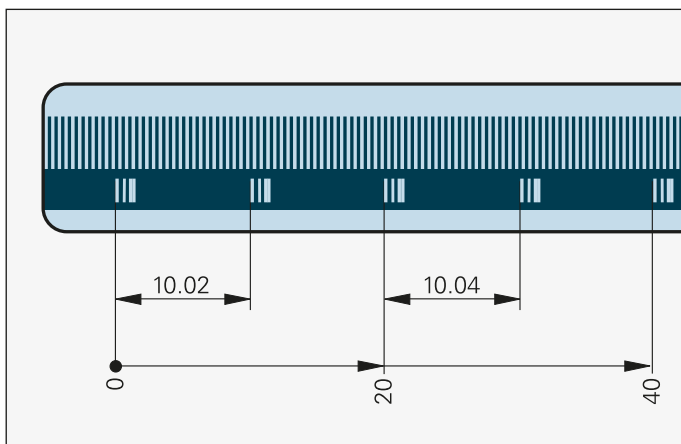
abs = Absolute value

sgn = Algebraic sign function ("+" or "-")

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.



Representation of an incremental graduation with distance-coded reference marks (LIDA 4x3C as example)

	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 principle

Most HEIDENHAIN encoders operate using the principle of photoelectric scanning. Photoelectric scanning of a measuring standard is contact-free, and as such, free of wear. This method detects even very fine lines, no more than a few micrometers wide, and generates output signals with very small signal periods.

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

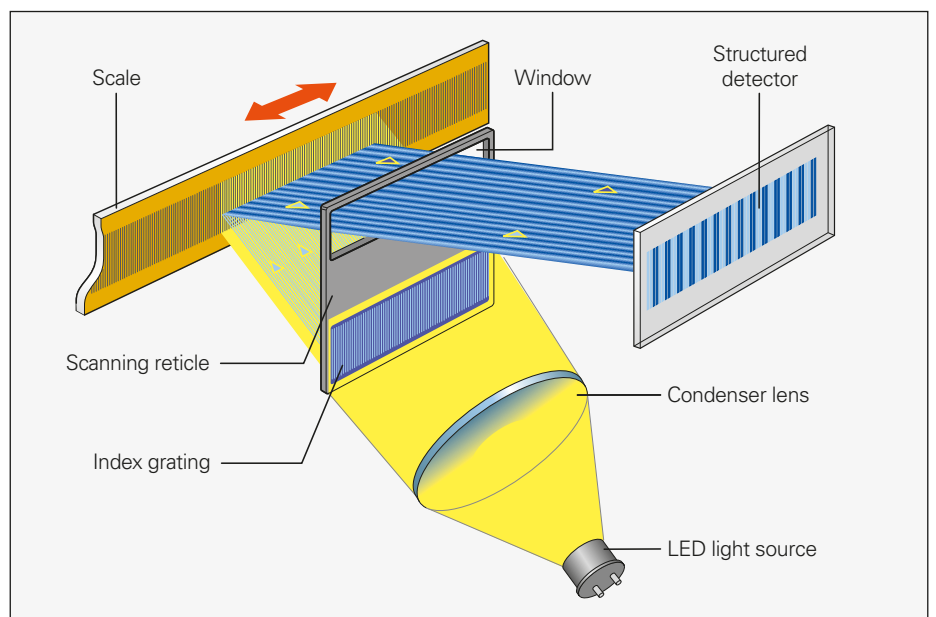
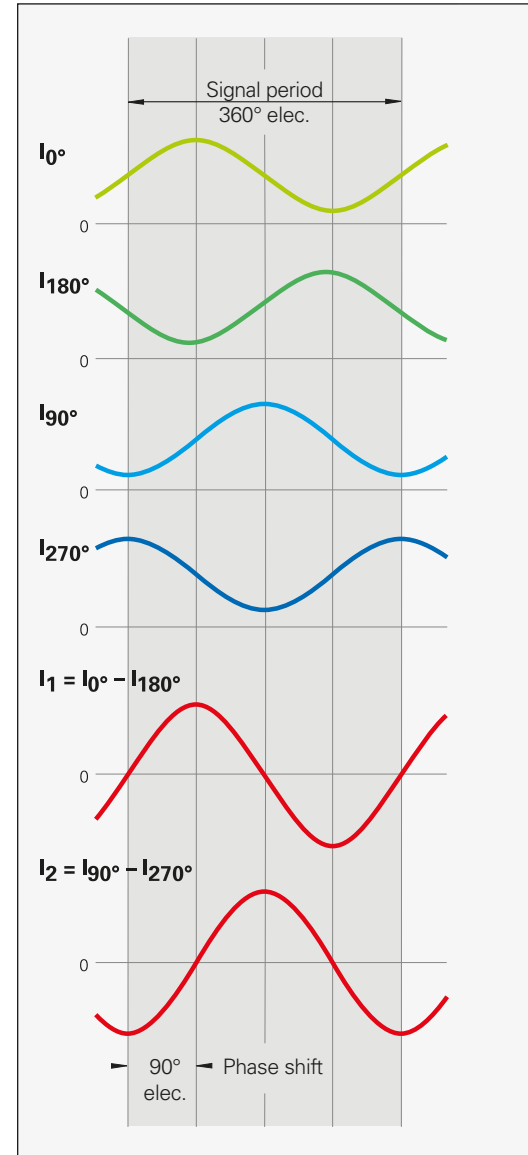
- The **imaging scanning** principle for grating periods from 10 μm to 200 μm .
- The **interferential scanning principle** for very fine graduations with grating periods of 4 μm and smaller.

Imaging principle

Put simply, the imaging scanning principle functions by means of projected-light signal generation: two graduations 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 on the measuring standard may be applied to a transparent or reflective surface.

When parallel light passes through a grating, light and dark surfaces are projected at a certain distance. An index grating with the same or similar grating period is located here. When the two graduations move in relation to each other, the incident light is modulated: if the gaps are aligned, light passes through. If the lines of one grating coincide with the gaps of the other, no light passes through. Photovoltaic cells convert these light fluctuations into electrical signals. The specially structured grating of the scanning reticle filters the light to generate nearly sinusoidal output signals. The smaller the period of the grating structure is, the closer and more tightly tolerated the gap must be between the scanning reticle and scale. Practical mounting tolerances for encoders with the imaging scanning principle are achieved with grating periods of 10 μm and larger.

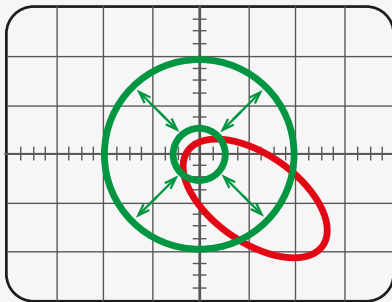
The **LIC** and **LIDA** linear encoders operate according to the imaging scanning principle.



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

The sensor generates four nearly sinusoidal current signals (I_{0° , I_{90° , I_{180° and I_{270°), electrically phase-shifted to each other by 90° . These scanning signals do not at first lie symmetrically about the zero line. For this reason the photovoltaic cells are connected in a push-pull circuit, producing two 90° phase-shifted output signals I_1 and I_2 in symmetry with respect to 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 the circular form and position are caused by position error and therefore go directly into the result of measurement. 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

Interferential scanning principle

The interferential scanning principle exploits the diffraction and interference of light on a fine graduation to produce signals used to measure displacement.

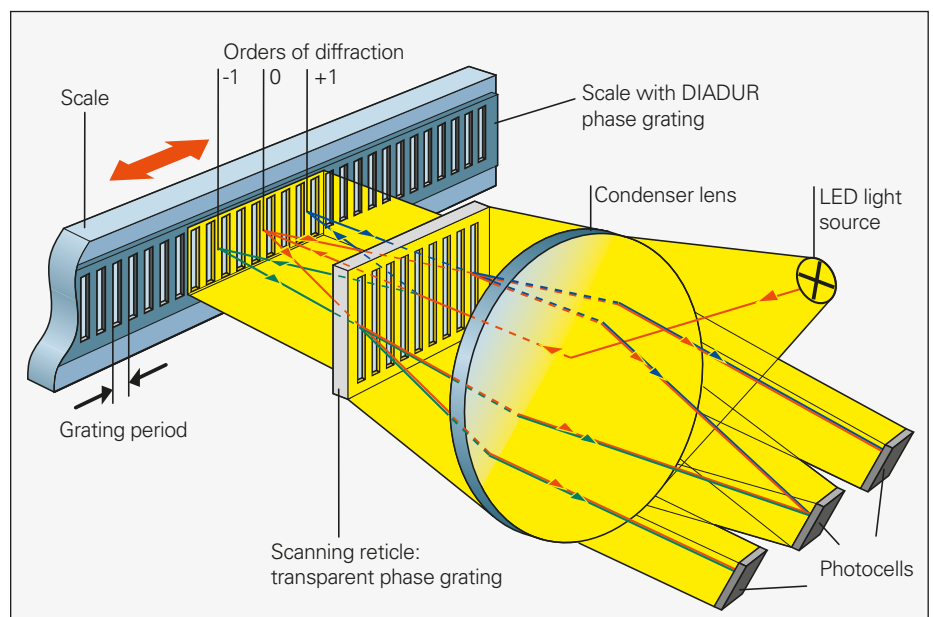
A step grating is used as the measuring standard: reflective lines $0.2 \mu\text{m}$ high are applied to a flat, reflective surface. In front of that is the scanning reticle—a transparent phase grating with the same grating period as the scale.

When a light wave passes through the scanning reticle, it is diffracted into three partial waves of the orders -1 , 0 , and $+1$, with approximately 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. Photovoltaic cells convert this alternating light intensity into electrical signals.

A relative motion of the scanning reticle to the scale causes the diffracted wave fronts to undergo a phase shift: When the grating moves by one period, the wave front of the first order is displaced by one wavelength in the positive direction, and the wavelength of diffraction order -1 is displaced by one wavelength in the negative direction. Since the two waves interfere with each other when exiting the grating, the waves are shifted relative to each other by two wavelengths. This results in two signal periods from the relative motion of just one grating period.

Interferential encoders function with grating periods of, for example, $8 \mu\text{m}$, $4 \mu\text{m}$ and finer. Their scanning signals are largely free of harmonics and can be highly interpolated. These encoders are therefore especially suited for small measuring steps and high accuracy. Even so, their generous mounting tolerances permit installation in a wide range of applications.

LIP, **LIF** and **PP** linear encoders operate according to the interferential scanning principle.



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

Reliability

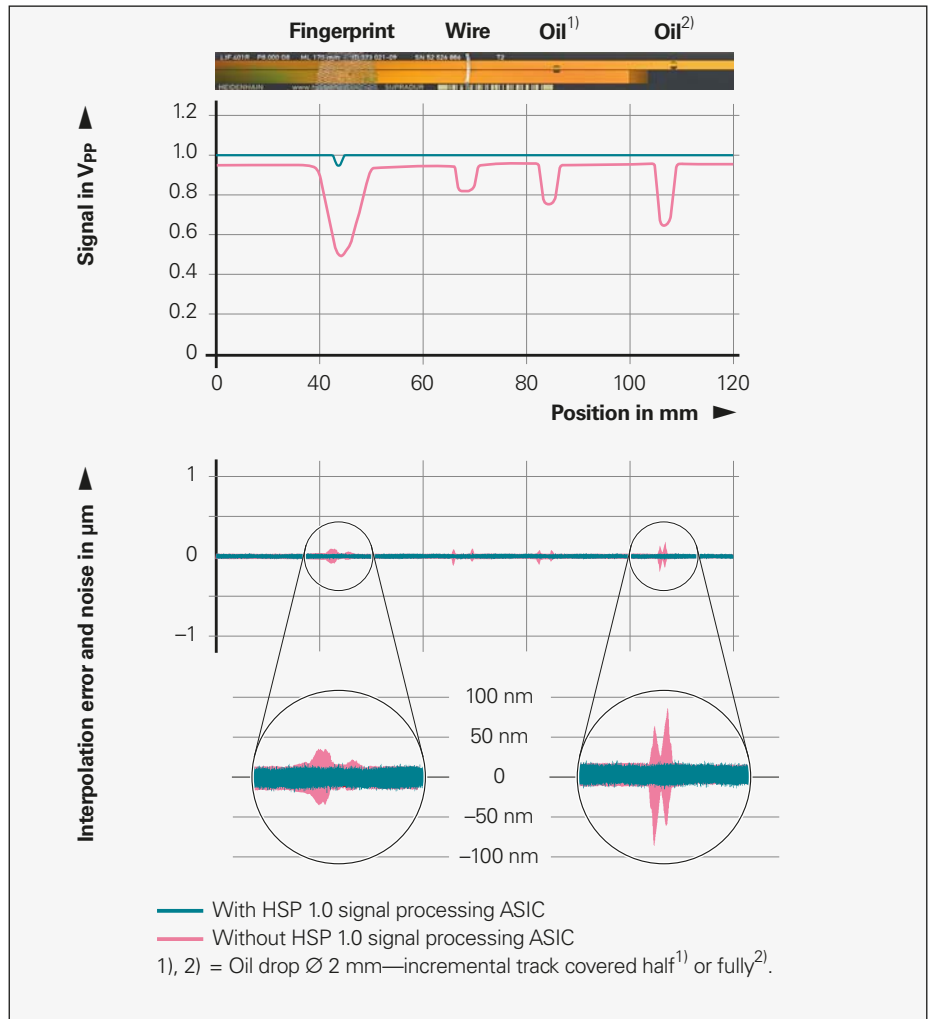
Exposed linear encoders from HEIDENHAIN are optimized for use on fast, precise machines. In spite of the exposed mechanical design, they are highly tolerant to contamination, ensure high long-term stability, and are quickly and easily mounted.

Lower 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 operate with **single-field scanning**. One large scanning field is used to generate the scanning signals. With single-field scanning, local contamination on the measuring standard (e.g., fingerprints from mounting or oil accumulation from guideways) only slightly influences the light intensity of the signal components, and therefore the scanning signals. The output signals do change in their amplitude, but not in their offset and phase position. They remain highly interpolable, and the position error within one signal period remains small.

The **large scanning field** additionally reduces sensitivity to contamination. In many cases this can prevent encoder failure. This is particularly clear with the LIDA 400 and LIF 400, which in relation to the grating period have a very large scanning surface of 14.5 mm² as well as the LIC 4100 with 15.5 mm². Even if the contamination from printer's ink, PCB dust, or drops of water or oil is up to 3 mm in diameter, the 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, LIC, LIF, and LIP 6000 encoders are equipped with the HSP 1.0 signal processor ASIC from HEIDENHAIN. The ASIC continuously monitors the scanning signal and almost completely compensates fluctuations in signal amplitude. If the signal amplitude decreases as the result of contamination on the scanning reticle or measuring standard, the ASIC corrects this by increasing the LED current. The ensuing increase in the LED light intensity barely raises the noise level, even when there is a high degree of signal stabilization. As a result, contamination has only a very slight influence on interpolation errors and the position noise.



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

Durable measuring standards

By the nature of their design, the measuring standards of exposed linear encoders are less protected from their environment. HEIDENHAIN therefore always uses tough gratings manufactured in special processes.

In the DIADUR process, hard chrome structures are applied to a glass or steel carrier.

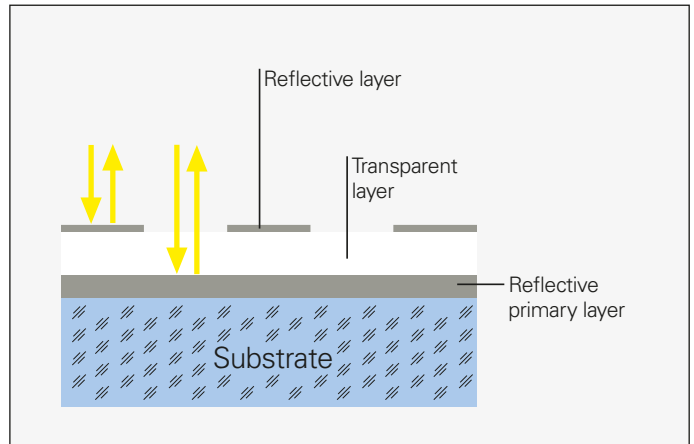
In the OPTODUR and SUPRADUR process, a transparent layer is applied first over the reflective primary layer. An extremely thin, hard chrome layer is applied to produce an optically three-dimensional phase grating. Graduations that use the imaging scanning principle are produced according to the METALLUR procedure, and have a very similar structure. A reflective gold layer is covered with a thin layer of glass. On this layer are lines of chromium only several nanometers thick, which are semitransparent and act as absorbers. Measuring standards with OPTODUR, SUPRADUR or METALLUR graduations have proven to be particularly robust and insensitive to contamination because the low height of the structure leaves practically no surface for dust, dirt or water particles to accumulate.

Application-oriented mounting tolerances

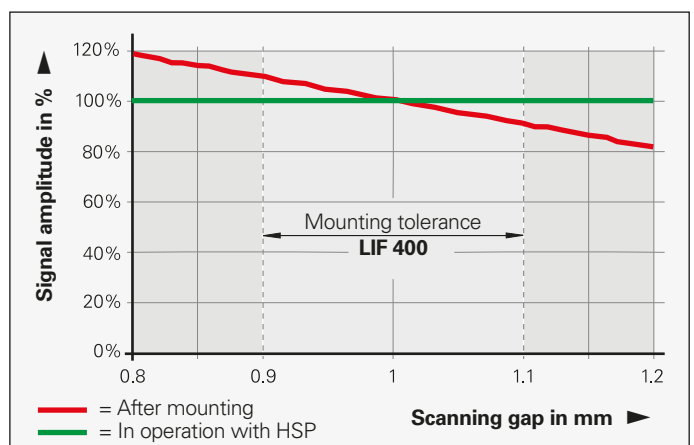
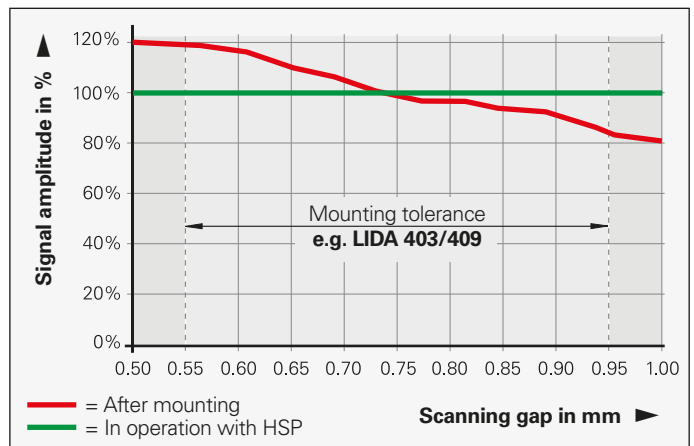
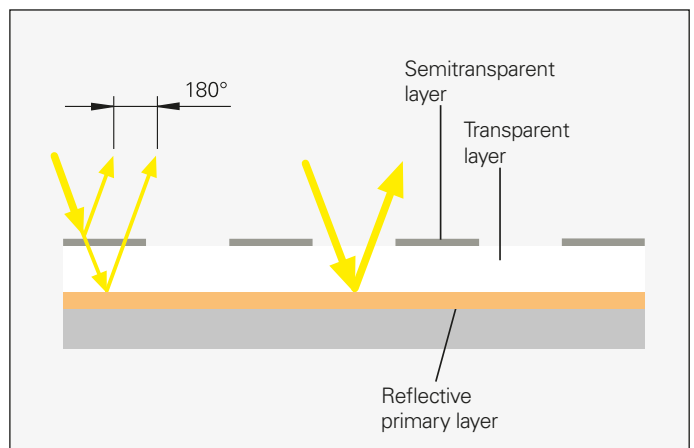
Very small signal periods usually come with very narrow mounting tolerances for the gap between the scanning head and scale tape. This is the result of diffraction caused by the grating structures. It can lead to a signal attenuation of 50 % with a gap change of only ± 0.1 mm. Thanks to the interferential scanning principle and innovative index gratings in encoders with the imaging scanning principle, it has become possible to provide ample mounting tolerances in spite of the small 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 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 linear measurement is mainly determined by

- 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 within the machine.

These factors of influence are comprised of encoder-specific position error and application-dependent issues. All individual factors of influence must be considered in order to assess the attainable overall accuracy.

Encoder-specific position error

Encoder-specific position error includes

- accuracy of the measuring standard,
- accuracy of the interpolation,
- position noise.

Accuracy of the measuring standard

The accuracy of the measuring standard is mainly determined by

- the homogeneity and period definition 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**. It is ascertained under ideal conditions by using a series-produced scanning head to measure position error. The spacing of measuring points is an integral multiple of the signal period, so that interpolation errors have no influence.

The accuracy grade **a** defines the upper limit of the baseline error within any max. one-meter section. For special encoders, a baseline error is additionally stated for defined intervals of the measuring standard.

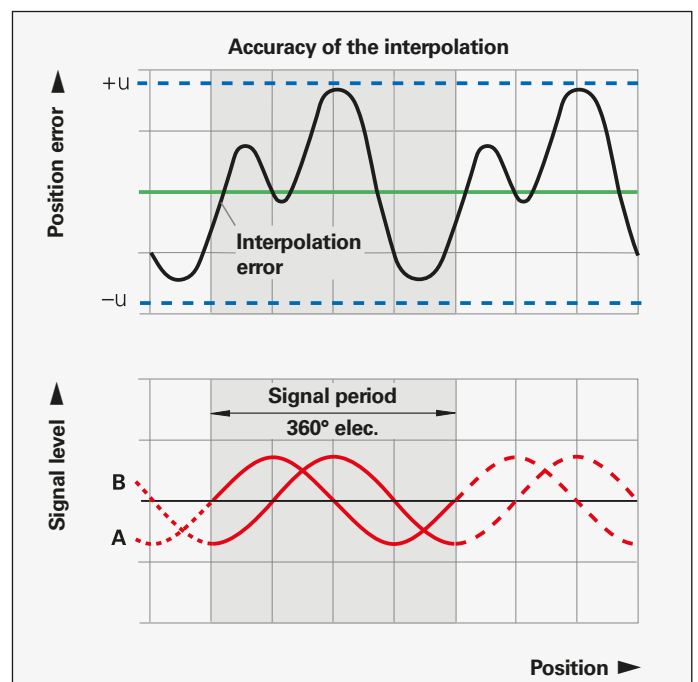
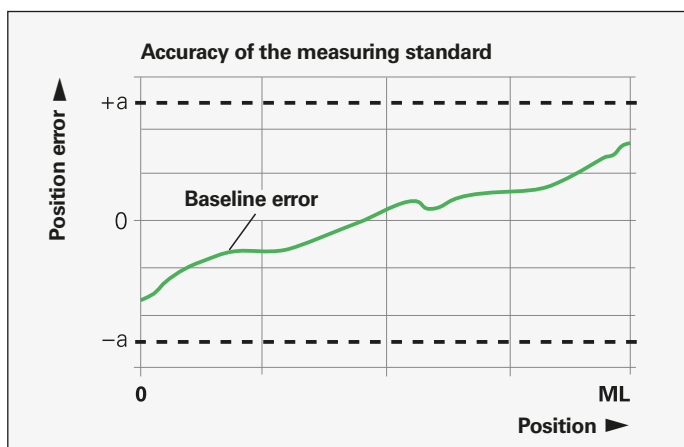
Accuracy of the interpolation

The accuracy of the interpolation is mainly influenced by

- the size of the signal period,
- the homogeneity and period definition of the graduation,
- The quality of scanning filter structures
- The characteristics of the sensors
- the quality of the signal processing.

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

The interpolation error has an effect with even very small traversing speeds and during repeat measurements. Especially in the speed control loop, it leads to fluctuations in traversing speed.



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 position noise depends on the signal processing bandwidths necessary for forming the position values. It is ascertained within a defined time period, and is indicated as a product-specific RMS value.

In the velocity control loop, position noise influences 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. It occurs when the measuring standard is mounted on an uneven, for example convex, surface.

Mounting location

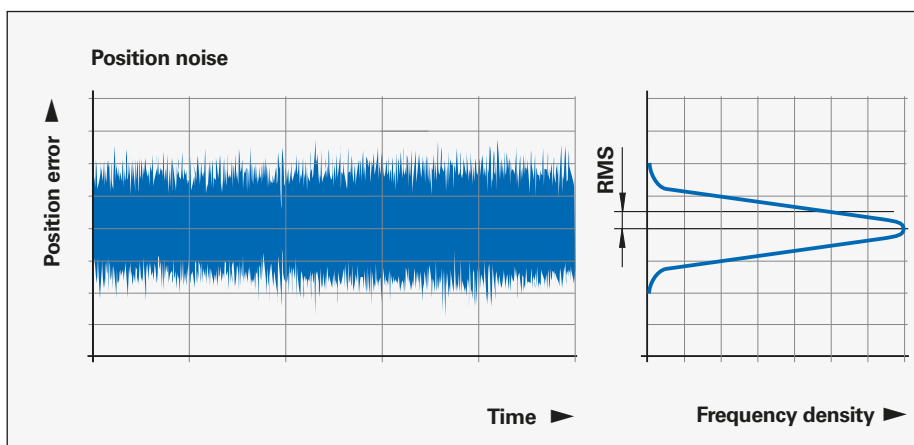
Poor mounting of linear encoders can aggravate the effect of guideway error on measuring accuracy. To keep the resulting Abbé error as small as possible, the scale should be mounted at table height on the machine slide. It is important to ensure that the mounting surface is parallel to the machine guideway.

Vibration

To function properly, linear encoders must not be continuously subjected to strong vibration; the more solid parts of the machine tool provide the best mounting surface in this respect. Encoders should not be mounted on hollow parts or with adapter blocks.

Temperature influence

The linear encoders should be mounted away from sources of heat to avoid temperature influences.



Calibration chart

All HEIDENHAIN linear encoders are inspected before shipping for accuracy and proper function.

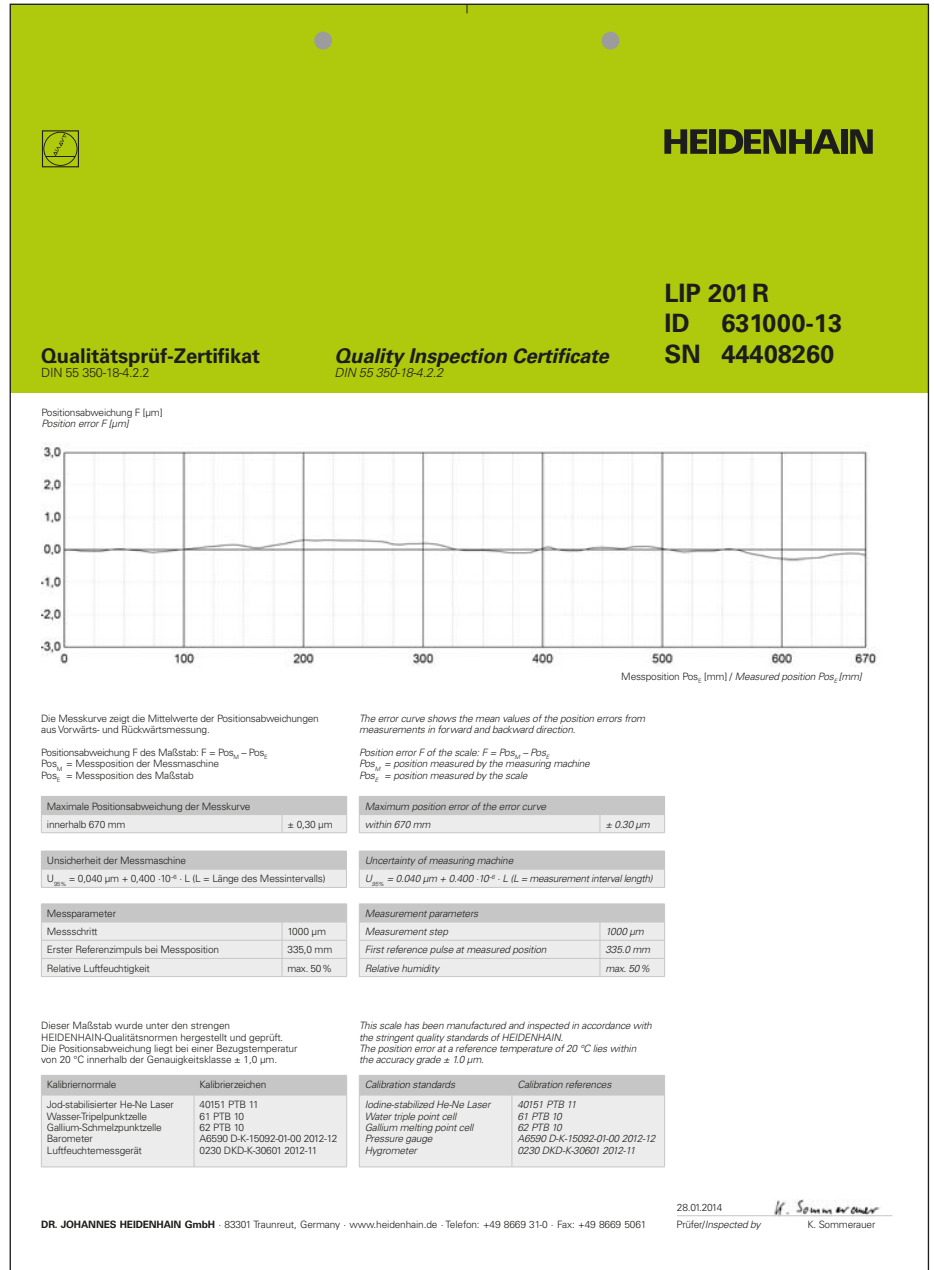
They are calibrated for accuracy during traverse in both directions. The number of measuring positions is selected to determine very exactly not only the long-range error, but also the position error within one signal period.

The **Quality Inspection Certificate** confirms the specified accuracy grades of each encoder. The **calibration standards** ensure the traceability—as required by EN ISO 9001—to recognized national or international standards.

For the encoders of the LIP and PP series, in addition a calibration chart documents the **position error** over the measuring range. It also indicates the measuring parameters and the uncertainty of the calibration measurement.

Temperature range

The linear encoders are calibrated at a **reference temperature** of 20 °C. The system accuracy given in the calibration chart applies at this temperature.



Mechanical design types and mounting

Linear scales

Exposed linear encoders consist of two components: the scanning head and the scale or scale tape. They are positioned to each other solely by the machine guideway. For this reason the machine must be designed from the very beginning to meet the following prerequisites:

- The machine guideway must be designed so that the mounting space for the encoder meets the **tolerances for the scanning gap** (see *Specifications*)
- The bearing surface of the scale must meet requirements for **flatness**
- To facilitate adjustment of the scanning head to the scale, it should be fastened with a **bracket**

Scale versions

HEIDENHAIN provides the appropriate scale version for the application and accuracy requirements at hand.

LIP 201 LIP 6001 LIC 4003

The graduation carriers are fastened onto the mounting surface with clamps. A holder is used to specify the thermal fixed point.

Accessories for LIC 41x3 and LIP 60x1:

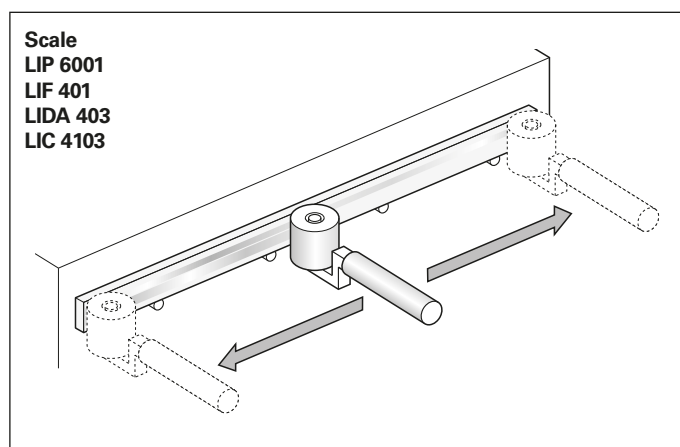
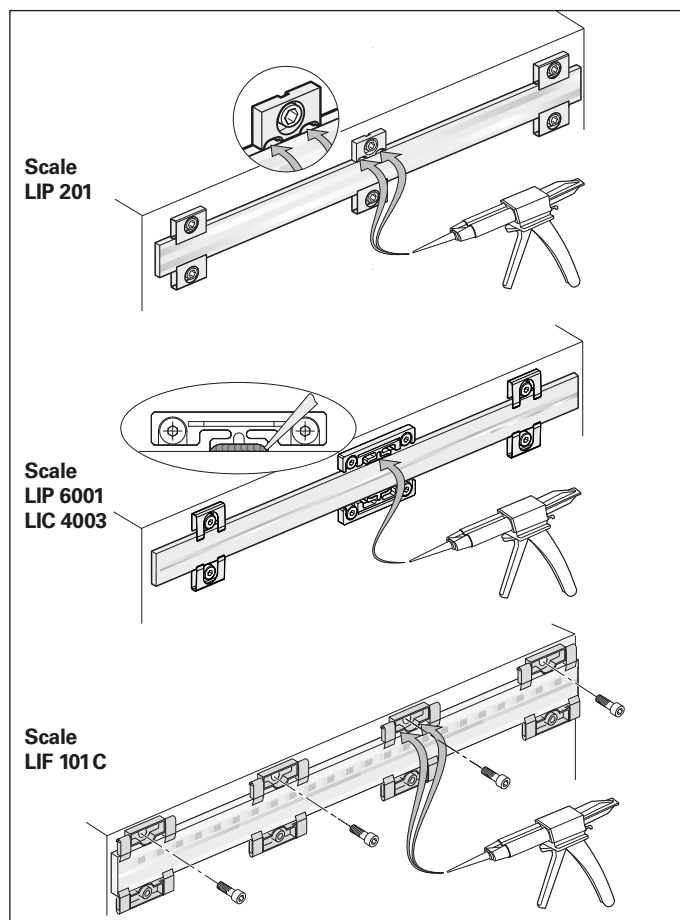
Fixing clamps	ID 1176458-01
Holder for thermal fixed point	ID 1176475-01
Spacer shims	ID 1176441-01
Adhesive	ID 1180444-01
Double-cartridge gun	ID 1180450-01
Dispensing nozzles and mixing tubes	ID 1176444-01

LIP 6001 LIF 401 LIDA 403 LIC 4103

The graduation carriers are glued directly to the mounting surface with PRECIMET adhesive film, and pressure is evenly distributed with a roller. A thermal fixed point can be fixed with epoxy adhesive.

Accessories

Roller	ID 276885-01
--------	--------------



**LIC 41x5
LIDA 4x5**

Linear encoders of the LIC 41x5 and LIDA 4x5 series are specially designed for large measuring lengths. They are mounted with scale carrier sections screwed onto the mounting surface or cemented with PRECIMET adhesive film. Then the one-piece steel scale-tape is pulled into the carrier, **tensioned** in a defined manner, and **secured at its ends** to the machine base. The LIC 41x5 and LIDA 4x5 therefore share the thermal behavior of their mounting surface.

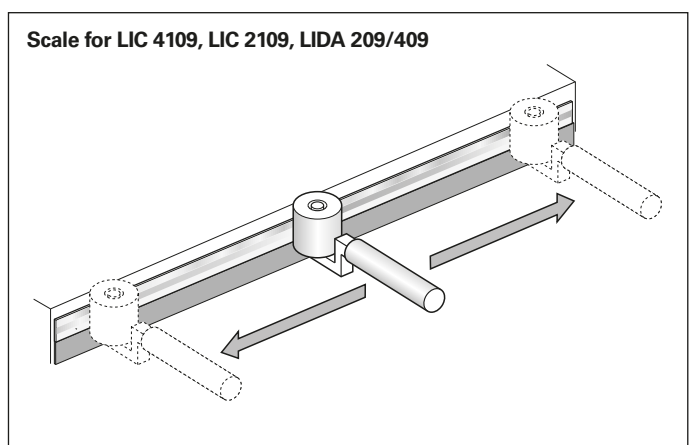
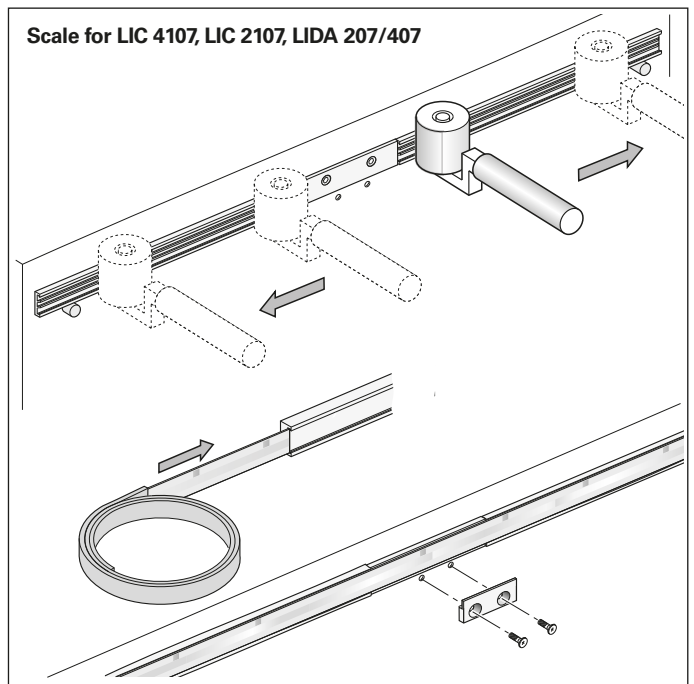
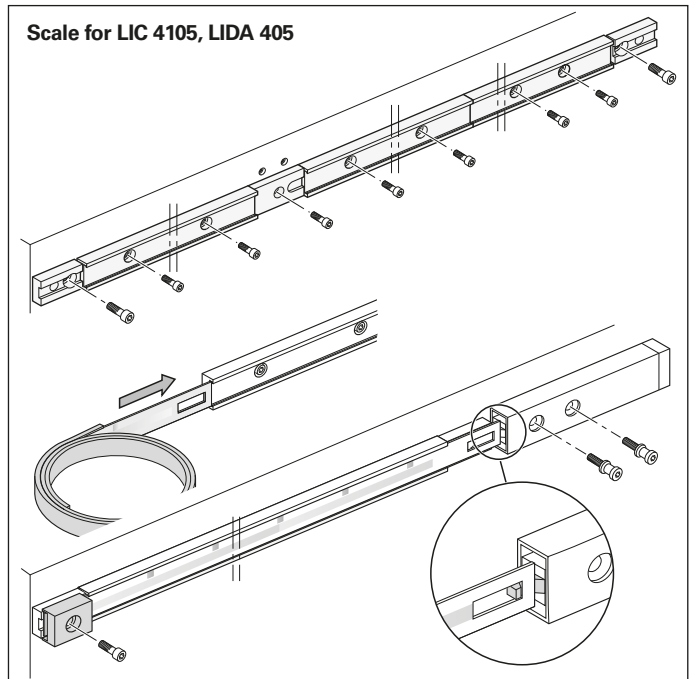
**LIC 21x7
LIC 41x7
LIDA 2x7
LIDA 4x7**

Encoders of the LIC 41x7, LIC 21x7, LIDA 2x7 and LIDA 4x7 series are also designed for large measuring lengths. The scale carrier sections are secured to the supporting surface with PRECIMET adhesive mounting film; the one-piece scale tape is pulled in and **the midpoint is secured** to the machine bed. This mounting method allows the scale 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 41x9
LIDA 2x9
LIDA 4x9**

The steel scale-tape of the graduation is cemented directly to the mounting surface with PRECIMET adhesive film, and pressure is evenly distributed with a roller. A ridge or aligning rail 0.3 mm high is to be used for 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

Mechanical design types and mounting

Scanning heads

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 for simplest and most practical adjustment as well as to ensure the most stable possible construction.

Mounting the LIP 2x1

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

Mounting the LIP 60x1

LIP 60x can be attached from the side as well as from above. When mounted from above, it is additionally possible to define a permanent center of rotation by inserting a dowel pin with $\varnothing 2$ mm or $\varnothing 3$ mm. This makes it easy to align the scanning head parallel to the scale. The dowel pin can be removed when mounting is completed.

Mounting the LIF

The scanning head features a centering collar that allows it to be rotated in the location hole of the angle bracket and aligned parallel to the scale.

Mounting the LIC/LIDA

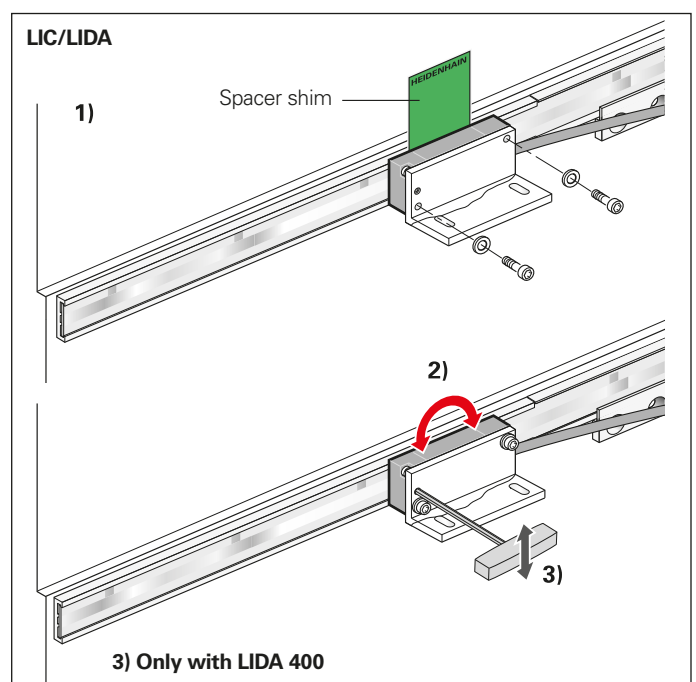
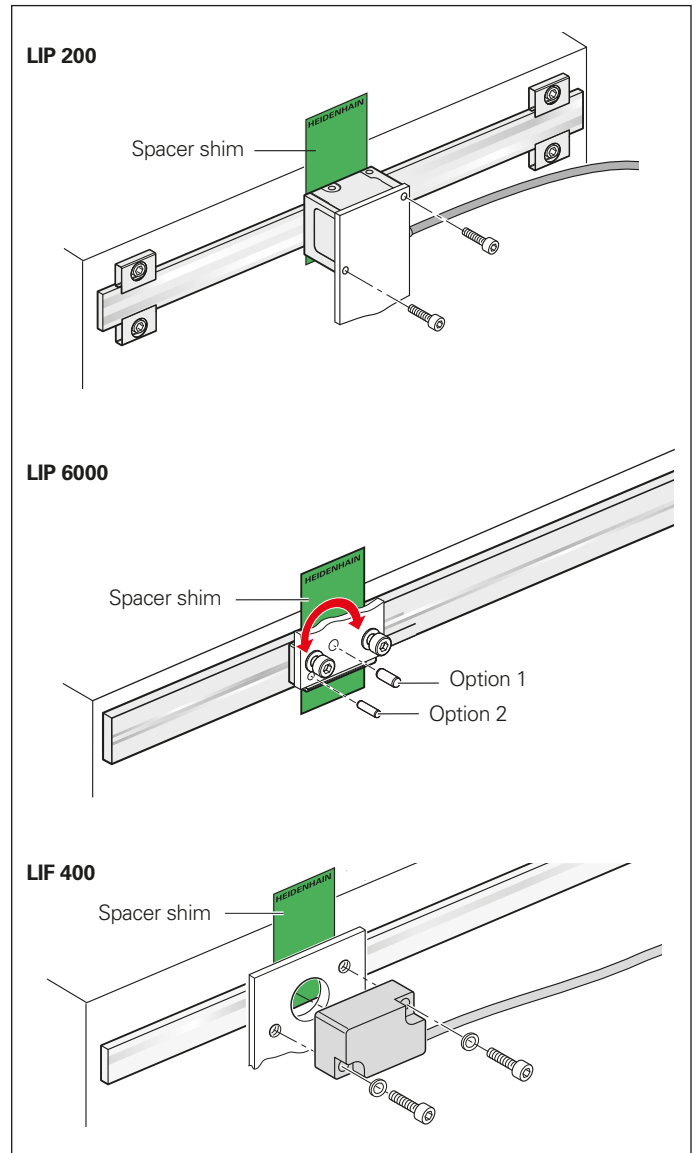
There are three options for mounting the scanning head (see *Dimensions*). A spacer shim makes it quite easy to set the gap between the scanning head and the scale or scale tape. It is helpful to fasten the scanning head from behind with a mounting bracket. The scanning head can be very precisely adjusted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

Adjustment

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

The signals from the LIC, LIP 6000, and LIP 200 are adjusted quickly and easily with the aid of 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 it is possible with the aid of a tool).

As adjustment aids, HEIDENHAIN offers the appropriate measuring and testing devices (see *Diagnostic and testing equipment*).



Function display

The LIDA, LIF, and LIP 6071 linear encoders feature an integrated function display with a multicolor LED. This makes it possible to quickly and easily check the signal quality during normal operation.

The function display offers a number of benefits:

- Quality of scanning signals displayed by multicolor LED
- Continuous monitoring of incremental signals over entire measuring length
- Function display of the reference-mark signal
- Quick check of correct operation in the field without technical aids

The integrated function display permits both a qualified judgment of the incremental signals as well as a check of the reference mark signal. The quality of the **incremental signals** is indicated by degrees of color. This makes a very detailed gradation of signal quality possible. The **reference mark signal's** compliance to tolerances is shown by a pass/fail display.



LIDA: Function display in the scanning head



LIF, LIP 6071: Function display in the interface electronics

LED display of incremental signals

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

LED reference-mark-signal display

(function check)

When the reference mark is scanned, the LED lights up briefly in blue or red.

- Out of tolerance
- Within tolerance

General mechanical information

Temperature range

The **operating temperature range** indicates the limits of ambient temperature within which the values given in the specifications for linear encoders are maintained.

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 thermal behavior best suited to the application.

Expendable parts

Encoders from HEIDENHAIN are designed for a long service life. Preventive maintenance is not required. However, they contain components that are subject to wear, depending on the application and manipulation. These include in particular cables with frequent flexing.

Other such components are the bearings of encoders with integral bearing, shaft sealing rings on rotary and angle encoders, and sealing lips on sealed linear encoders.

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 300 LIP 6000	IP50
PP	IP50

The scales have no special protection. Protective measures must be taken if the possibility of contamination exists.

Acceleration

Linear encoders are subjected to various types of acceleration during operation and mounting.

- The indicated maximum values for **vibration** apply for frequencies of 55 Hz to 2000 Hz (**EN 60068-2-6**). Any acceleration exceeding permissible values, for example due to resonance depending on the application and mounting, might damage the encoder.
Comprehensive tests of the entire system are therefore required
- The maximum permissible acceleration values (semi-sinusoidal shock) for **shock and impact** 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 in larger systems. Such applications require **comprehensive tests of the entire system** regardless of the specifications of the encoder.

The specifications shown in this brochure apply to the specific encoder, not to the complete system. Any operation of the encoder outside of the specified range or for any applications other than the intended applications is at the user's own risk.

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

Assembly

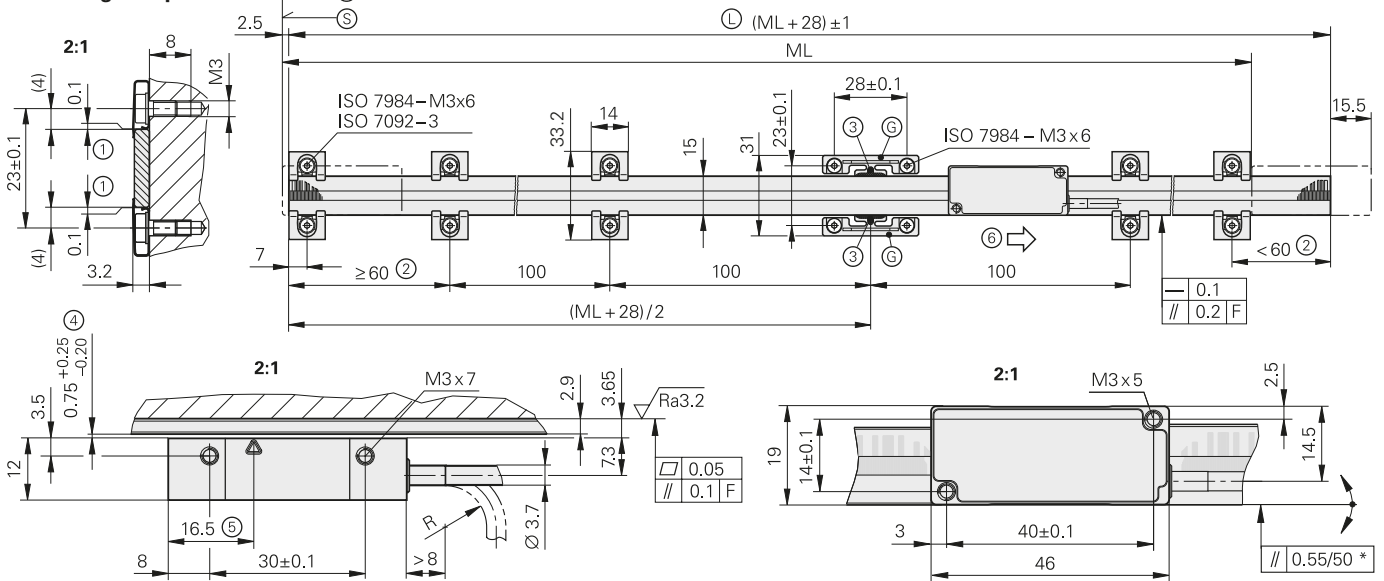
Work steps to be performed and dimensions to be maintained during mounting are specified solely in the mounting instructions supplied with the unit. All data in this brochure regarding mounting are therefore provisional and not binding; they do not become terms of a contract.

LIC 4113, LIC 4193

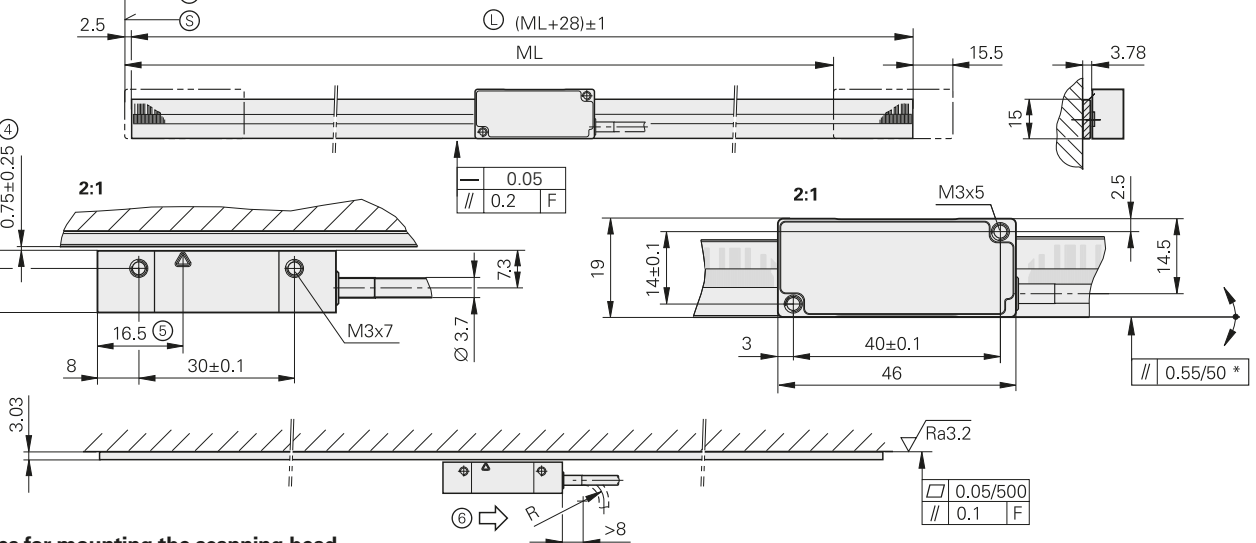
Absolute linear encoder for measuring lengths up to 3 m

- Measuring steps to 1 nm
- Measuring standard of glass or glass ceramic
- Measuring standard is fastened by adhesive film or with fixing clamps
- Consists of scale and scanning head
- Version available for high vacuum (see Product Information document)

With fixing clamps

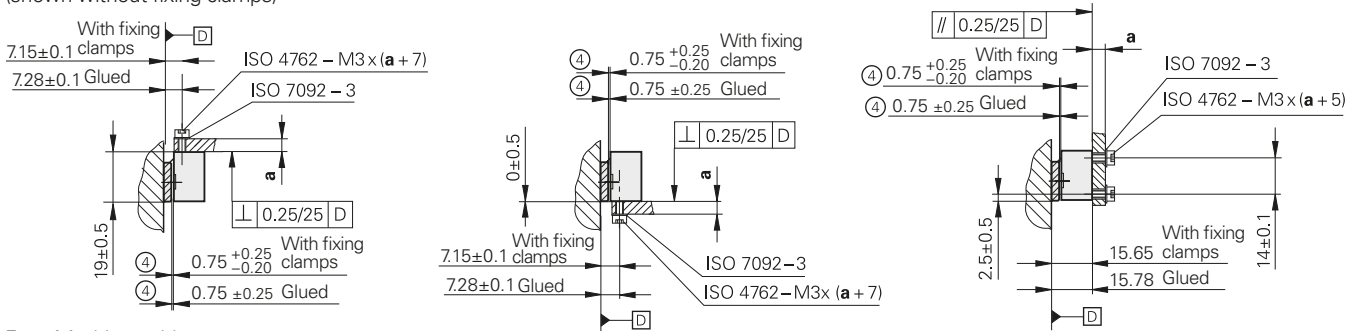


Glued



Possibilities for mounting the 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 set with a spacer foil during assembly

2 = Use additional fixing clamp pairs depending on the measuring length (ML)

3 = Adhesive

4 = Mounting clearance between scanning head and scale

5 = Optical centerline

6 = Direction of scanning unit motion for output signals in accordance with interface description

mm



Tolerancing ISO 8015

ISO 2768 - m H

< 6 mm: ±0.2 mm



Scale	LIC 4003
Measuring standard Coefficient of linear expansion*	METALLUR graduation on glass ceramic or glass $\alpha_{\text{therm}} \approx 8 \times 10^{-6} \text{ K}^{-1}$ (glass) $\alpha_{\text{therm}} = (0 \pm 0.5) \times 10^{-6} \text{ K}^{-1}$ (Robax glass ceramic)
Accuracy grade*	$\pm 1 \mu\text{m}$ (only for Robax glass ceramic), $\pm 3 \mu\text{m}$, $\pm 5 \mu\text{m}$
Baseline error	$\leq \pm 0.275 \mu\text{m}/10 \text{ mm}$
Measuring length ML* in mm	240 340 440 640 840 1040 1240 1440 1640 1840 2040 2240 2440 2640 2840 3040 (Robax glass ceramic up to max. ML 1640)
Mass	3 g + 0.11 g/mm measuring length

Scanning head	LIC 411	LIC 419F	LIC 419M	LIC 419P	
Interface	EnDat 2.2	Fanuc Serial Interface α i Interface	Mitsubishi high speed interface	Panasonic serial interface	
Ordering designation*	EnDat22	Fanuc05	Mit03-4	Mit02-2	Pana01
Measuring step*	0.01 μm (10 nm) 0.005 μm (5 nm) 0.001 μm (1 nm)		0.01 μm (10 nm) 0.005 μm (5 nm)		
Calculation time t_{cal} Clock frequency	$\leq 5 \mu\text{s}$ 16 MHz	-			
Traversing speed ¹⁾	$\leq 600 \text{ m/min}$				
Interpolation error	$\pm 20 \text{ nm}$				
Electrical connection*	Cable, 1 m or 3 m with 8-pin M12 coupling (male) or 15 D-sub connector (male)				
Cable length (with HEIDENHAIN cable)	$\leq 100 \text{ m}$	$\leq 50 \text{ m}$	$\leq 30 \text{ m}$	$\leq 50 \text{ m}$	
Voltage supply	DC 3.6 V to 14 V				
Power consumption ¹⁾ (max.)	At 3.6 V: $\leq 700 \text{ mW}$ At 14 V: $\leq 800 \text{ mW}$	At 3.6 V: $\leq 850 \text{ mW}$ At 14 V: $\leq 950 \text{ mW}$			
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	$\leq 500 \text{ m/s}^2$ (EN 60068-2-6) $\leq 1000 \text{ m/s}^2$ (EN 60068-2-27)				
Operating temperature	$-10 \text{ }^\circ\text{C}$ to $70 \text{ }^\circ\text{C}$				
Mass	Scanning head Connecting cable Connector	$\leq 18 \text{ g}$ (without cable) 20 g/m M12 coupling: 15 g; D-sub connector: 32 g			

* Please select when ordering

¹⁾ See *General electrical information* in the brochure *Interfaces of HEIDENHAIN Encoders*

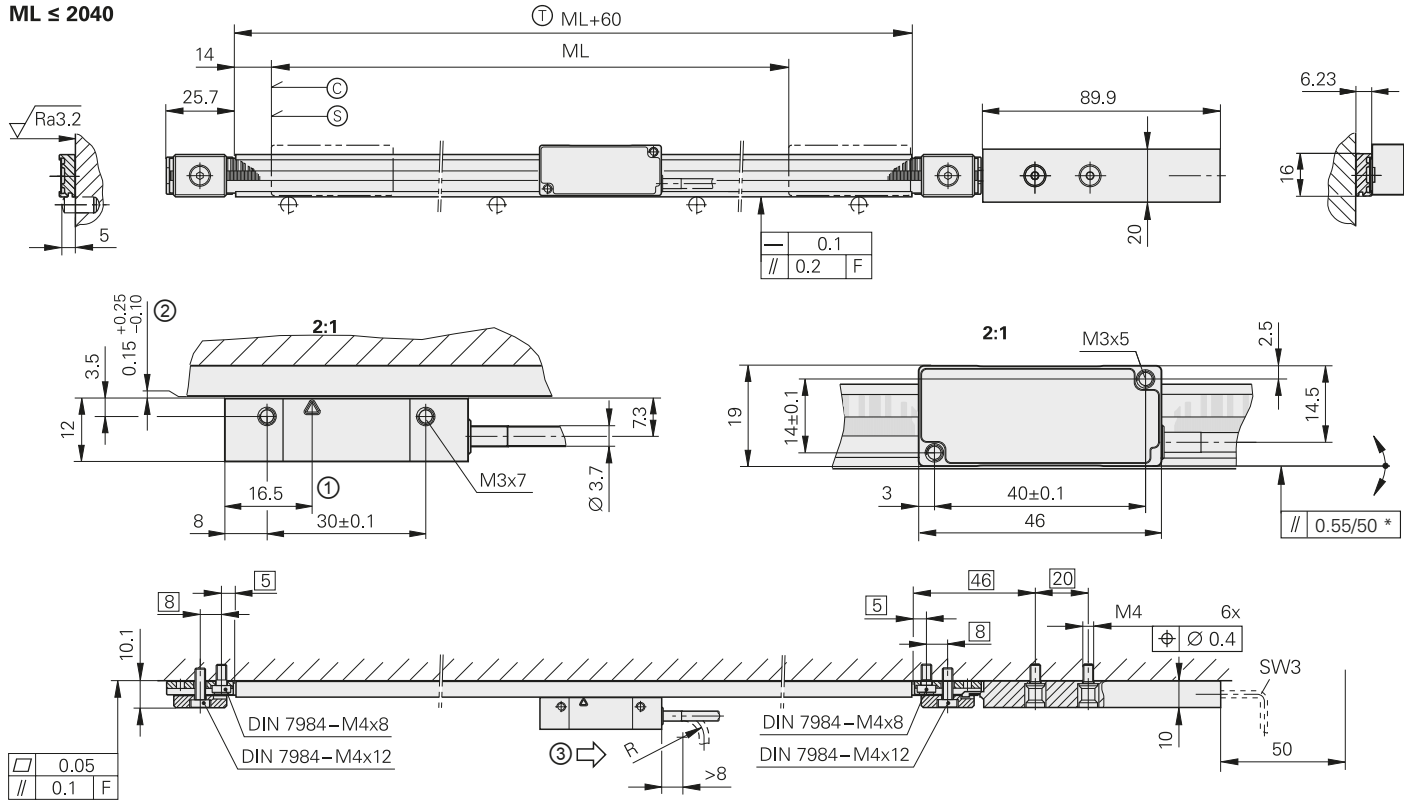
Robax is a registered trademark of Schott-Glaswerke, Mainz, Germany.

LIC 4115, LIC 4195

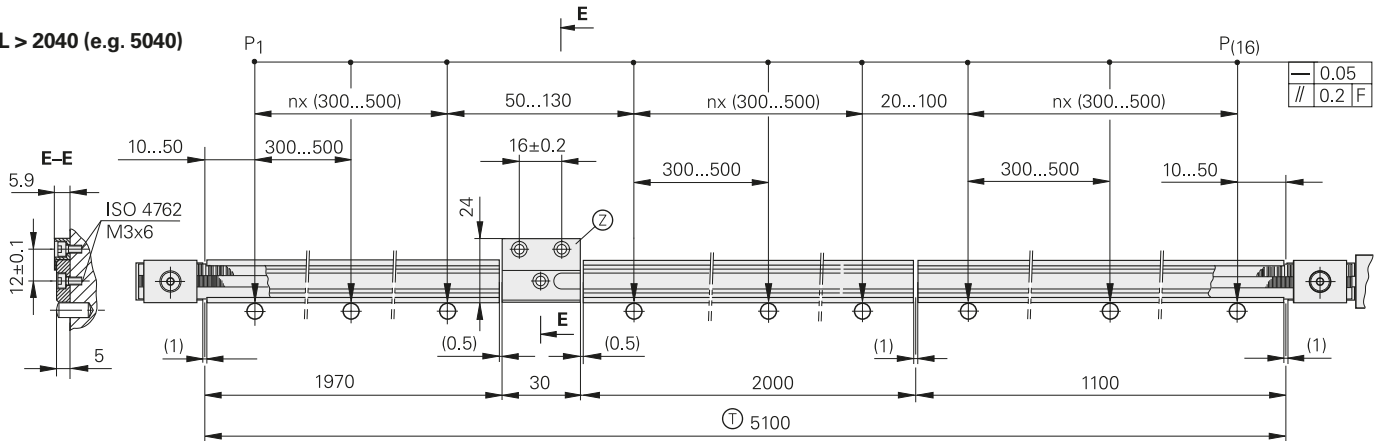
Absolute linear encoder for measuring lengths up to 28 m

- For measuring steps down to 1 nm
- Steel scale-tape is drawn into aluminum extrusions and tensioned
- Consists of scale and scanning head

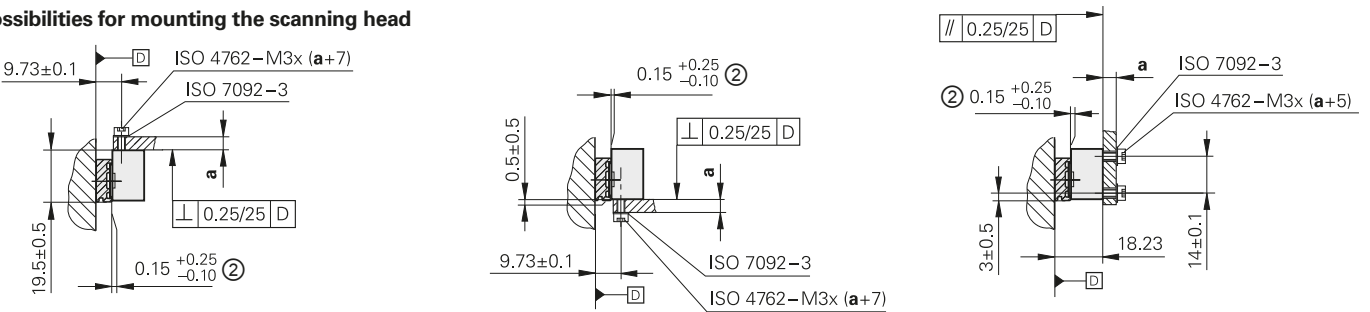
ML ≤ 2040



ML > 2040 (e.g. 5040)



Possibilities for mounting the scanning head



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

- F = Machine guideway
- P = Gauging points for alignment
- * = Mounting error plus dynamic guideway error
- ⊙ = Code start value: 100 mm
- ⊙ = Beginning of measuring length ML
- ⊙ = Carrier segment
- ⊙ = Spacer for measuring lengths from 3040 mm
- 1 = Optical centerline
- 2 = Mounting clearance between scanning head and extrusion
- 3 = Direction of scanning unit motion for output signals in accordance with interface description



Scale	LIC 4005
Measuring standard Coefficient of linear expansion	Steel scale tape with METALLUR absolute and incremental 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 Larger measuring lengths up to 28440 mm with a single-section scale tape and individual scale-carrier sections
Mass Scale tape Parts kit Scale-tape carrier	31 g/m 80 g + n ⁴⁾ × 27 g 187 g/m

Scanning head	LIC 411	LIC 419F	LIC 419M	LIC 419P
Interface	EnDat 2.2	Fanuc Serial Interface xi interface	Mitsubishi high speed interface	Panasonic serial interface
Ordering designation*	EnDat22	Fanuc05	Mit03-4	Mit02-2 Pana01
Measuring step*	0.01 µm (10 nm) 0.005 µm (5 nm) 0.001 µm (1 nm)		0.01 µm (10 nm) ³⁾ 0.005 µm (5 nm) ²⁾	
Calculation time t _{cal} Clock frequency	≤ 5 µs 16 MHz	–		
Traversing speed ¹⁾	≤ 600 m/min			
Interpolation error	±20 nm			
Electrical connection*	Cable, 1 m or 3 m with 8-pin M12 coupling (male) or 15 D-sub connector (male)			
Cable length (with HEIDENHAIN cable)	≤ 100 m	≤ 50 m	≤ 30 m	≤ 50 m
Voltage supply	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 Connecting cable Connector	≤ 18 g (without cable) 20 g/m M12 coupling: 15 g; D-sub connector: 32 g			

* Please select when ordering

¹⁾ See *General electrical information* in the brochure *Interfaces of HEIDENHAIN Encoders*

²⁾ Up to measuring length ML ≤ 10040

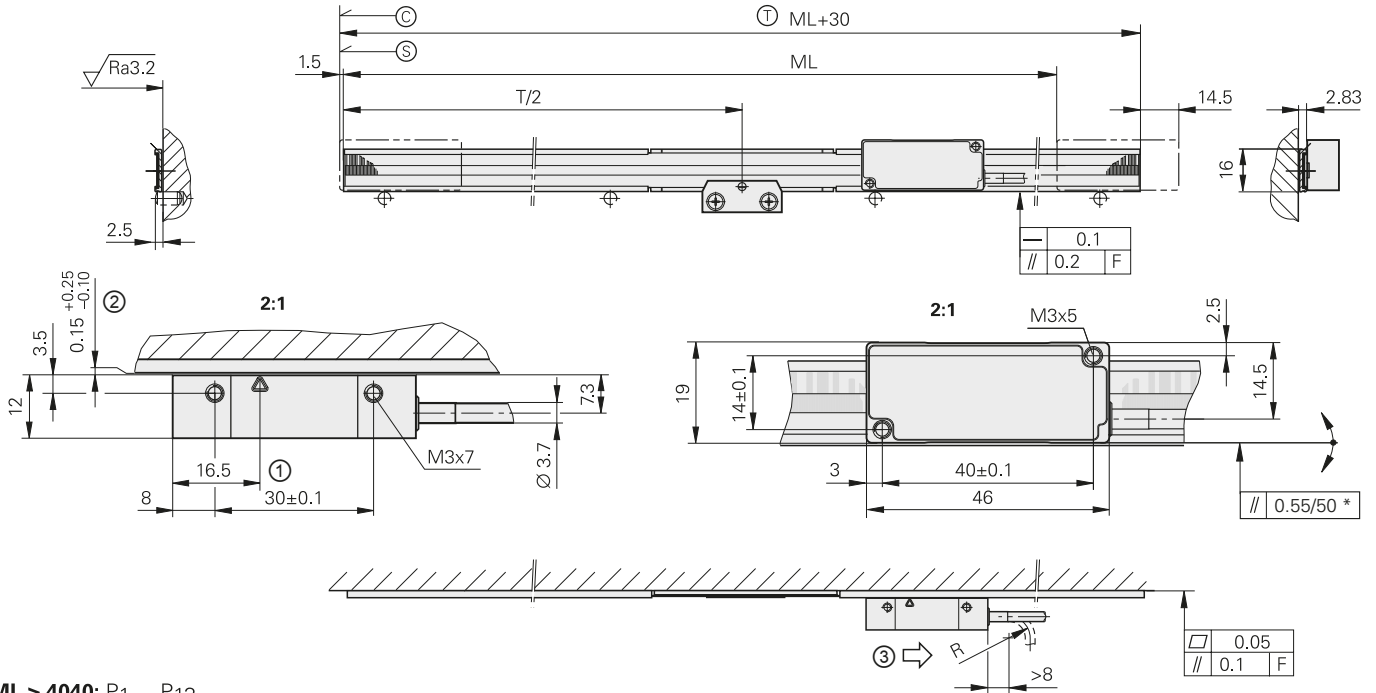
³⁾ Up to measuring length ML ≤ 20040

⁴⁾ n = 1 for ML 3140 mm to 5040 mm; n = 2 for ML 5140 mm to 7040 mm; etc.*

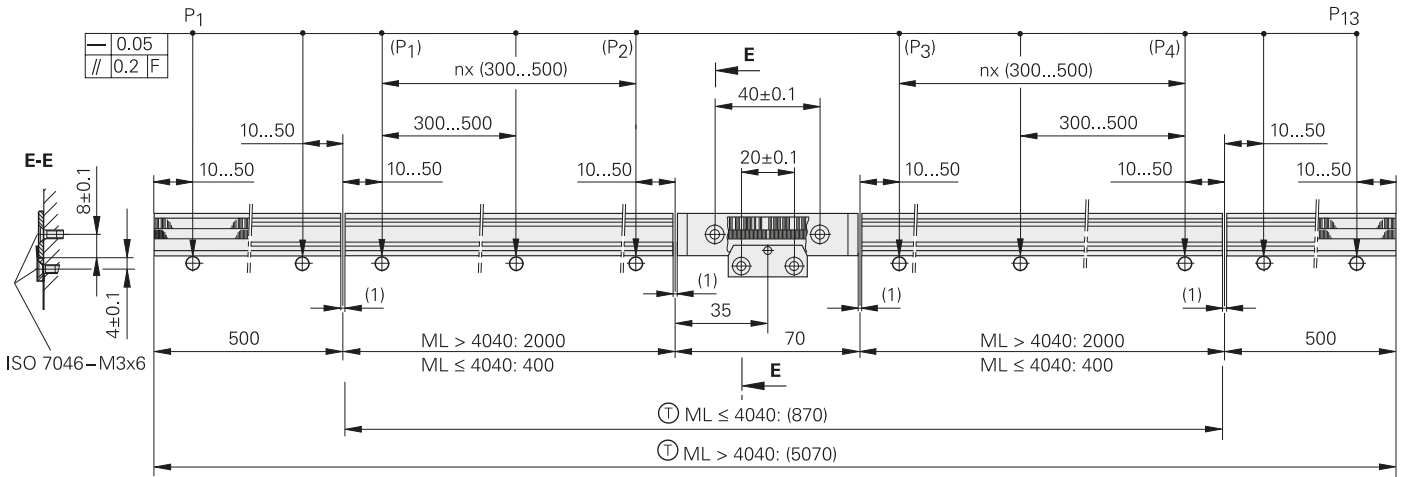
LIC 4117, LIC 4197

Absolute linear encoder for measuring lengths up to 6 m

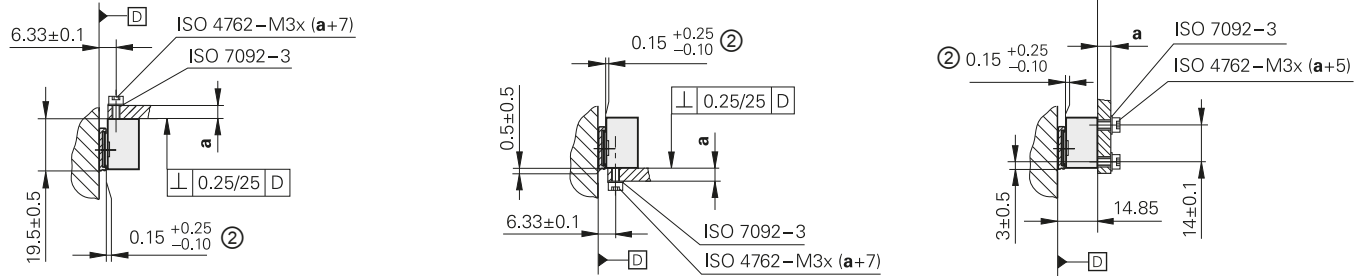
- For measuring steps down to 1 nm
- Steel scale-tape is drawn into aluminum extrusions and fixed at center
- Consists of scale and scanning head



ML > 4040: P₁ ... P₁₃
ML ≤ 4040: (P₁ ... P₄)



Possibilities for mounting the scanning head



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

- F = Machine guideway
 P = Gauging points for alignment
 * = Mounting error plus dynamic guideway error
 © = Code start value: 100 mm
 ⊙ = Beginning of measuring length ML
 ⊕ = Carrier segment
 1 = Optical centerline
 2 = Mounting clearance between scanning head and extrusion
 3 = Direction of scanning unit motion for output signals in accordance with interface description



Scale		LIC 4007														
Measuring standard Coefficient of linear expansion		Steel scale tape with METALLUR absolute and incremental track $\alpha_{\text{therm}} \approx 10 \times 10^{-6} \text{ K}^{-1}$														
Accuracy grade*		$\pm 3 \mu\text{m}$ (up to ML 1040), $\pm 5 \mu\text{m}$ (starting from ML 1240), $\pm 15 \mu\text{m}$ ¹⁾														
Baseline error		$\leq \pm 0.750 \mu\text{m}/50 \text{ mm}$ (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													
Mass		Scale tape: 31 g/m Parts kit: 20 g Scale-tape carrier: 68 g/m														

Scanning head	LIC 411	LIC 419F	LIC 419M		LIC 419P
Interface	EnDat 2.2	Fanuc Serial Interface α i interface	Mitsubishi high speed interface		Panasonic serial interface
Ordering designation*	EnDat22	Fanuc05	Mit03-4	Mit02-2	Pana01
Measuring step*	0.01 μm (10 nm) 0.005 μm (5 nm) 0.001 μm (1 nm)		0.01 μm (10 nm) 0.005 μm (5 nm)		
Calculation time t_{cal} Clock frequency	$\leq 5 \mu\text{s}$ 16 MHz	-			
Traversing speed ²⁾	$\leq 600 \text{ m/min}$				
Interpolation error	$\pm 20 \text{ nm}$				
Electrical connection*	Cable, 1 m or 3 m with 8-pin M12 coupling (male) or 15 D-sub connector (male)				
Cable length (with HEIDENHAIN cable)	$\leq 100 \text{ m}$	$\leq 50 \text{ m}$	$\leq 30 \text{ m}$		$\leq 50 \text{ m}$
Voltage supply	DC 3.6 V to 14 V				
Power consumption ²⁾ (max.)	At 3.6 V: $\leq 700 \text{ mW}$ At 14 V: $\leq 800 \text{ mW}$	At 3.6 V: $\leq 850 \text{ mW}$ At 14 V: $\leq 950 \text{ mW}$			
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	$\leq 500 \text{ m/s}^2$ (EN 60068-2-6) $\leq 1000 \text{ m/s}^2$ (EN 60068-2-27)				
Operating temperature	$-10 \text{ }^\circ\text{C}$ to $70 \text{ }^\circ\text{C}$				
Mass	Scanning head: $\leq 18 \text{ g}$ (without cable) Connecting cable: 20 g/m Connector: M12 coupling: 15 g; D-sub connector: 32 g				

* Please select when ordering

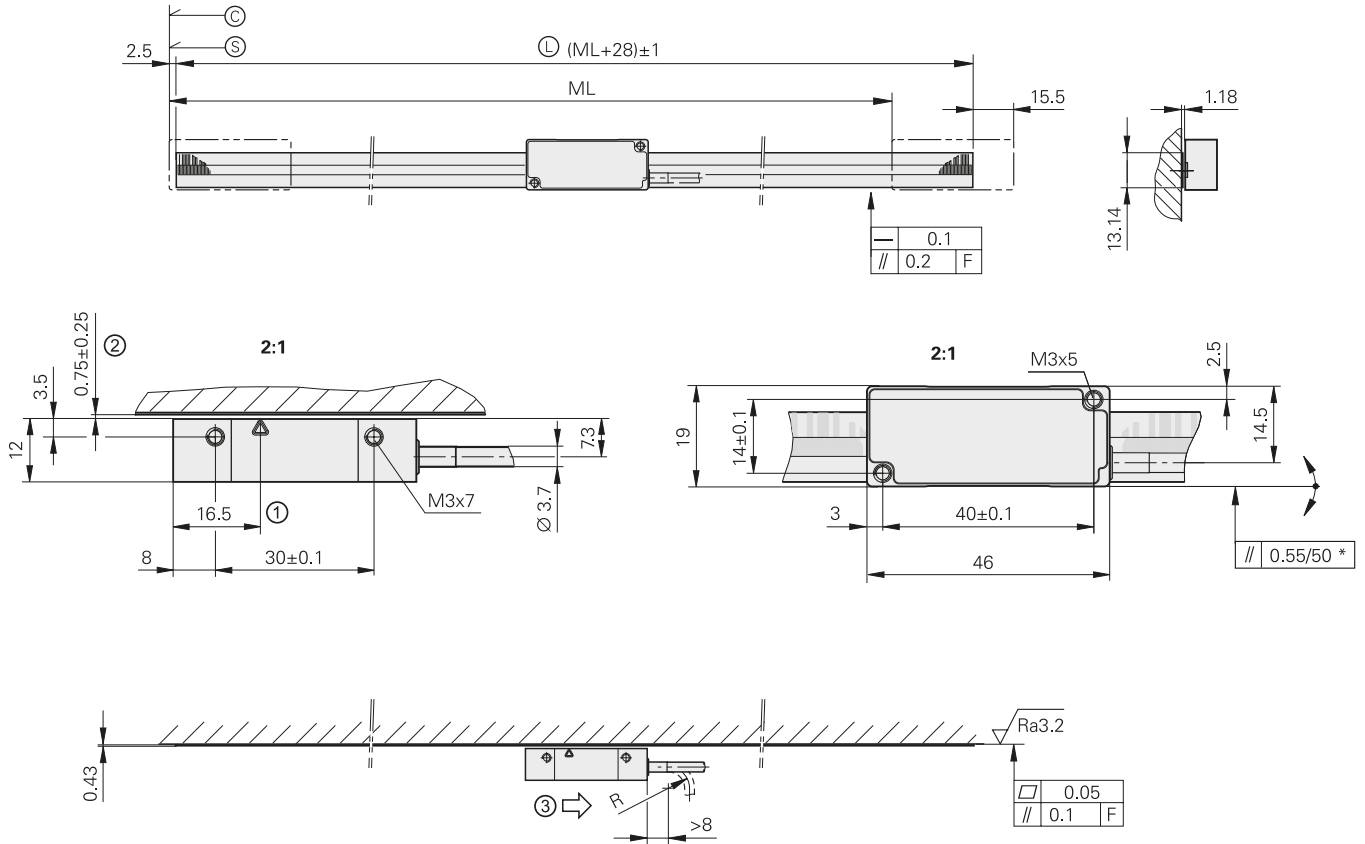
¹⁾ $\pm 5 \mu\text{m}$ after linear length-error compensation in the evaluation electronics

²⁾ See *General electrical information* in the brochure *Interfaces of HEIDENHAIN Encoders*

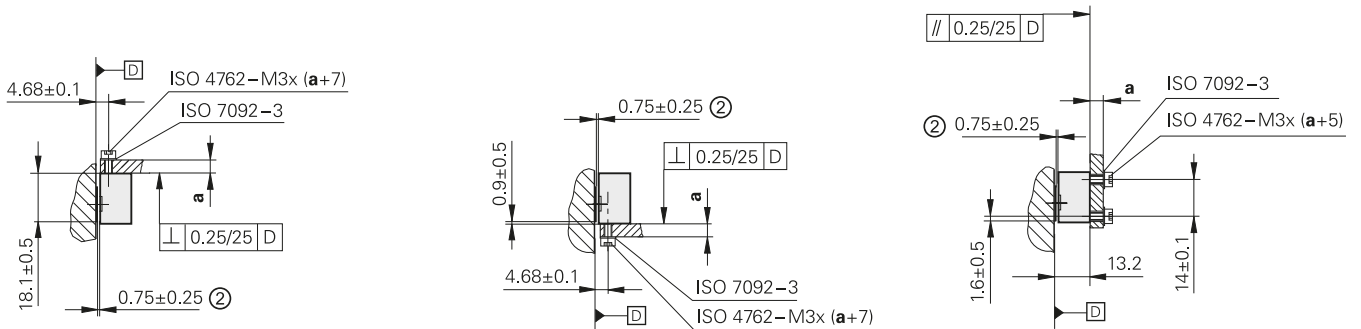
LIC 4119, LIC 4199

Absolute linear encoder for measuring lengths up to 1 m

- For measuring steps down to 1 nm
- Steel scale tape cemented on mounting surface
- Consists of scale and scanning head



Possibilities for mounting the scanning head



mm

 Tolerancing ISO 8015
 ISO 2768 - m H
 < 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 clearance between scanning head and scale
- 3 = Direction of scanning unit motion for output signals in accordance with interface description



Scale	LIC 4009
Measuring standard Coefficient of linear expansion	Steel scale tape with METALLUR absolute and incremental track $\alpha_{\text{therm}} \approx 10 \times 10^{-6} \text{ K}^{-1}$
Accuracy grade*	$\pm 3 \mu\text{m}$, $\pm 15 \mu\text{m}^{1)}$
Baseline error	$\leq \pm 0.750 \mu\text{m}/50 \text{ mm}$ (typical)
Measuring length ML* in mm	70 120 170 220 270 320 370 420 520 620 720 820 920 1020
Mass	31 g/m

Scanning head	LIC 411	LIC 419F	LIC 419M		LIC 419P
Interface	EnDat 2.2	Fanuc Serial Interface α i interface	Mitsubishi high speed interface		Panasonic serial interface
Ordering designation*	EnDat22	Fanuc05	Mit03-4	Mit02-2	Pana01
Measuring step*	0.01 μm (10 nm) 0.005 μm (5 nm) 0.001 μm (1 nm)		0.01 μm (10 nm) 0.005 μm (5 nm)		
Calculation time t_{cal} Clock frequency	$\leq 5 \mu\text{s}$ 16 MHz	–			
Traversing speed²⁾	$\leq 600 \text{ m/min}$				
Interpolation error	$\pm 20 \text{ nm}$				
Electrical connection*	Cable, 1 m or 3 m with 8-pin M12 coupling (male) or 15 D-sub connector (male)				
Cable length (with HEIDENHAIN cable)	$\leq 100 \text{ m}$	$\leq 50 \text{ m}$	$\leq 30 \text{ m}$	$\leq 50 \text{ m}$	
Voltage supply	DC 3.6 V to 14 V				
Power consumption ²⁾ (max.)	At 3.6 V: $\leq 700 \text{ mW}$ At 14 V: $\leq 800 \text{ mW}$	At 3.6 V: $\leq 850 \text{ mW}$ At 14 V: $\leq 950 \text{ mW}$			
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	$\leq 500 \text{ m/s}^2$ (EN 60068-2-6) $\leq 1000 \text{ m/s}^2$ (EN 60068-2-27)				
Operating temperature	$-10 \text{ }^\circ\text{C}$ to $70 \text{ }^\circ\text{C}$				
Mass Scanning head Connecting cable Connector	$\leq 18 \text{ g}$ (without cable) 20 g/m M12 coupling: 15 g; D-sub connector: 32 g				

* Please select when ordering

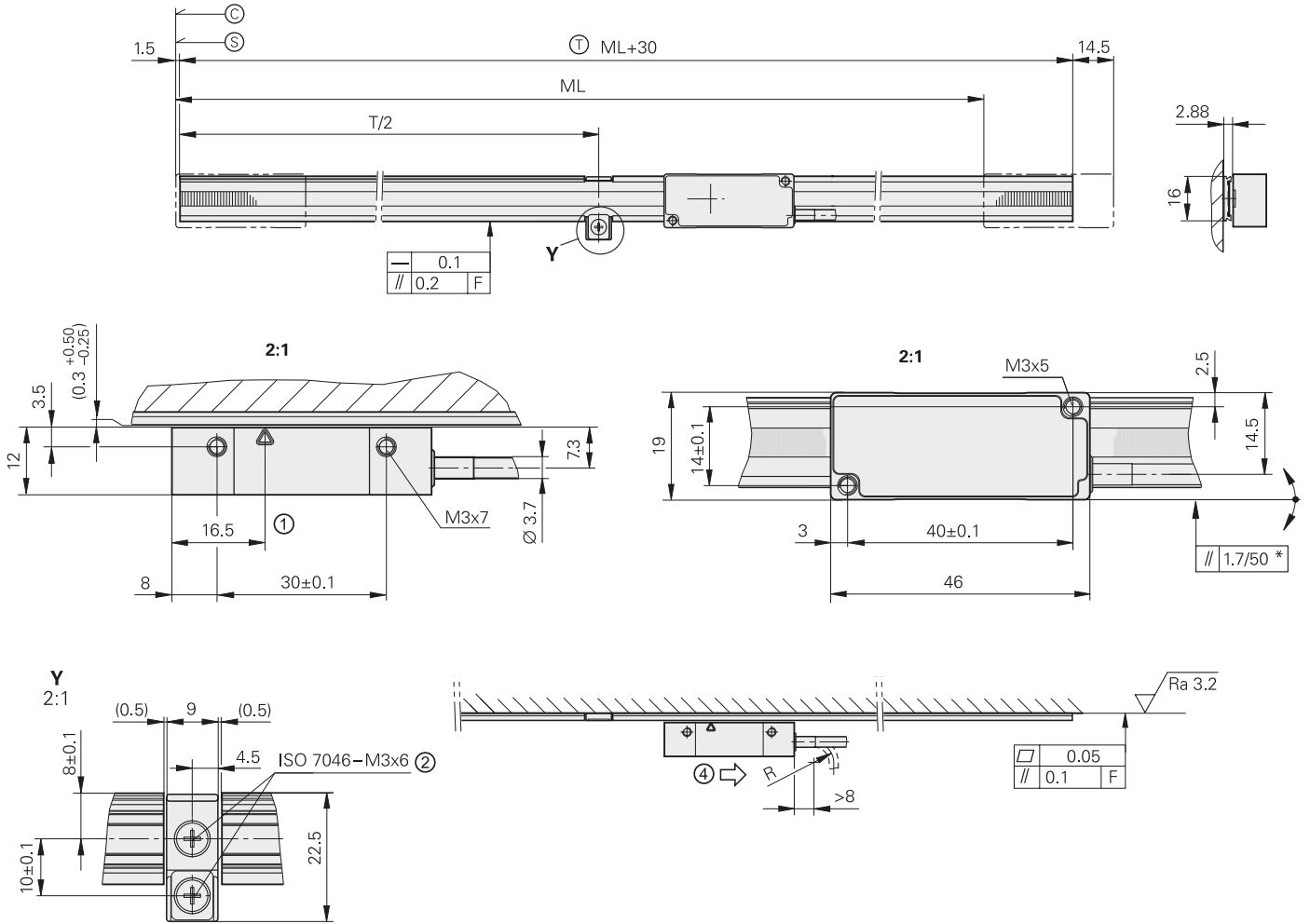
¹⁾ $\pm 5 \mu\text{m}$ after linear length-error compensation in the subsequent electronics

²⁾ See *General electrical information* in the brochure *Interfaces of HEIDENHAIN Encoders*

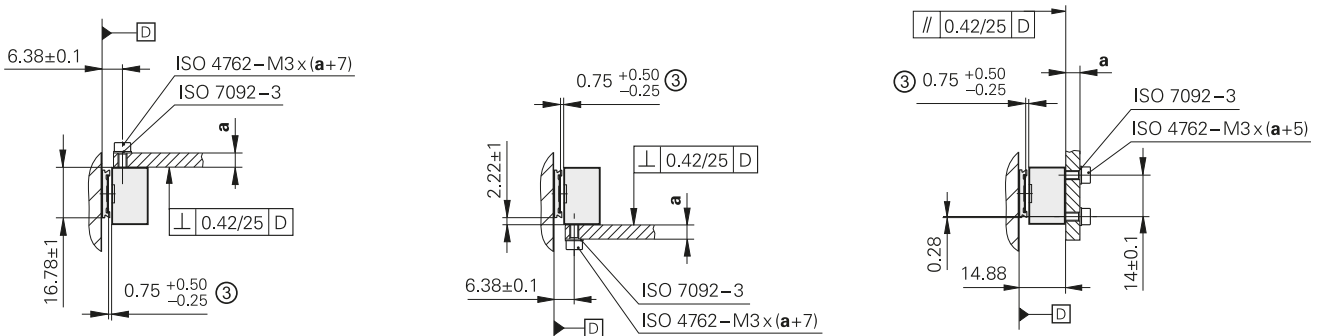
LIC 2117, LIC 2197

Absolute linear encoder for measuring lengths up to 3 m

- Measuring step 100 nm or 50 nm
- Steel scale-tape is drawn into aluminum extrusions and fixed at center
- Consists of scale and scanning head



Possibilities for mounting the scanning head



mm

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

- F = Machine guideway
- * = Max. change during operation
- ⊙ = Code start value: 100 mm
- ⊙ = Beginning of measuring length ML
- ⊙ = Carrier segment
- 1 = Optical centerline
- 2 = Mating threaded hole, M3, 5 mm deep
- 3 = Mounting clearance between scanning head and scale tape
- 4 = Direction of scanning unit motion for output signals in accordance with interface description



Scale	LIC 2107
Measuring standard Coefficient of linear expansion	Steel scale tape with absolute track $\alpha_{\text{therm}} \approx 10 \times 10^{-6} \text{ K}^{-1}$
Accuracy grade	$\pm 15 \mu\text{m}$
Measuring length ML* in mm	120 320 520 770 1020 1220 1520 2020 2420 3020 (measuring lengths greater than 6020 mm upon request)
Mass Scale tape Scale-tape carrier	20 g/m 70 g/m

Scanning head	LIC 211	LIC 219F	LIC 219M	LIC 219P
Interface	EnDat 2.2	Fanuc Serial Interface α i interface	Mitsubishi high speed interface	Panasonic serial interface
Ordering designation*	EnDat22	Fanuc05	Mit03-4	Mit02-2 Pana01
Measuring step*	0.1 μm (100 nm) 0.05 μm (50 nm)			
Calculation time t_{cal} Clock frequency	$\leq 5 \mu\text{s}$ $\leq 16 \text{ MHz}$	– –		
Traversing speed ¹⁾	$\leq 600 \text{ m/min}$			
Interpolation error	$\pm 2 \mu\text{m}$			
Electrical connection*	Cable, 1 m or 3 m with 8-pin M12 coupling (male) or 15 D-sub connector (male)			
Cable length (with HEIDENHAIN cable)	$\leq 100 \text{ m}$	$\leq 50 \text{ m}$	$\leq 30 \text{ m}$	$\leq 50 \text{ m}$
Voltage supply	DC 3.6 V to 14 V			
Power consumption ¹⁾ (max.)	At 3.6 V: $\leq 700 \text{ mW}$ At 14 V: $\leq 800 \text{ mW}$	At 3.6 V: $\leq 850 \text{ mW}$ At 14 V: $\leq 950 \text{ mW}$		
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	$\leq 500 \text{ m/s}^2$ (EN 60068-2-6) $\leq 1000 \text{ m/s}^2$ (EN 60068-2-27)			
Operating temperature	$-10 \text{ }^\circ\text{C}$ to $70 \text{ }^\circ\text{C}$			
Mass Scanning head Connecting cable Connector	$\leq 18 \text{ g}$ (without cable) 20 g/m M12 coupling: 15 g; D-sub connector: 32 g			

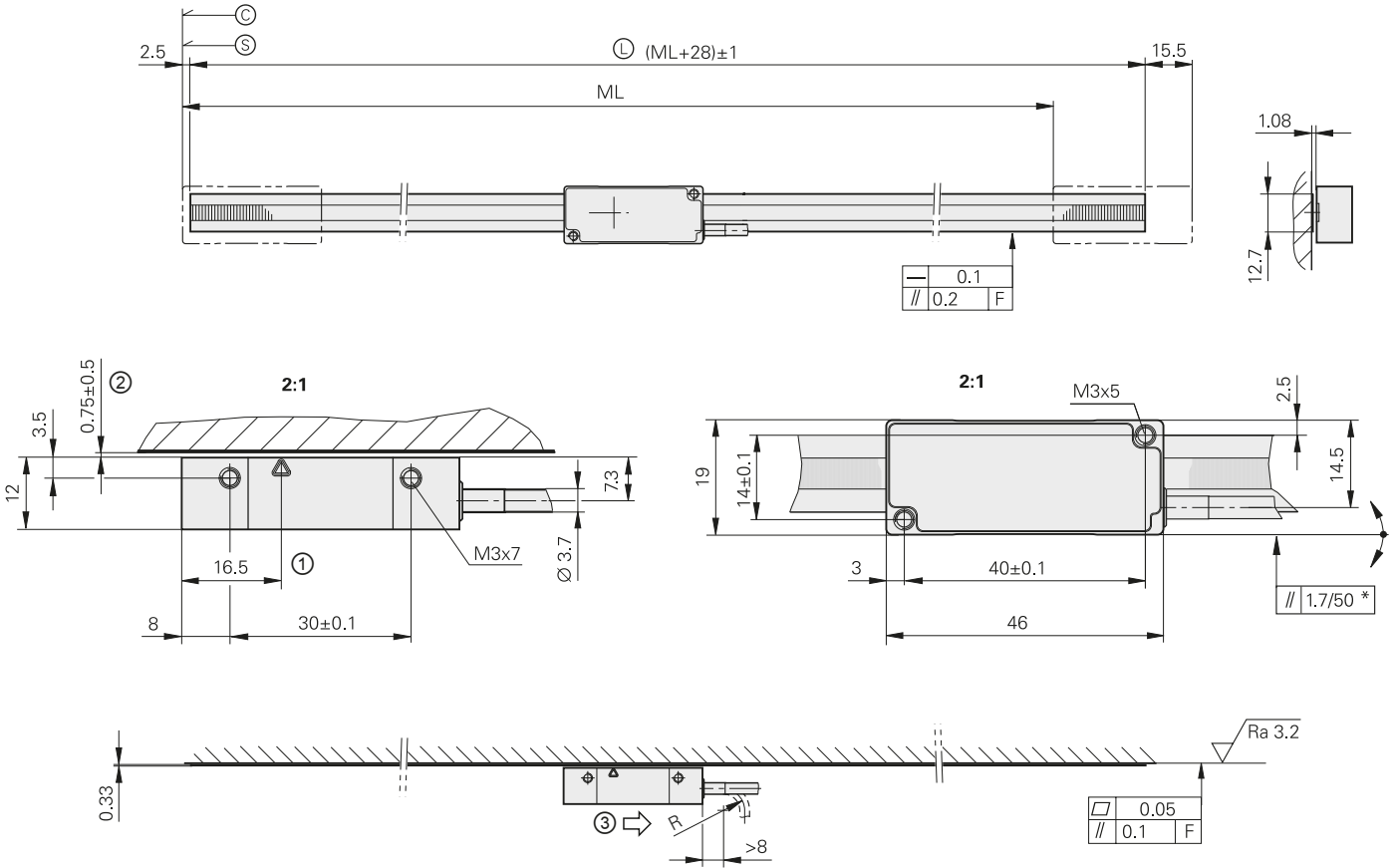
* Please select when ordering

¹⁾ See *General electrical information* in the brochure *Interfaces of HEIDENHAIN Encoders*

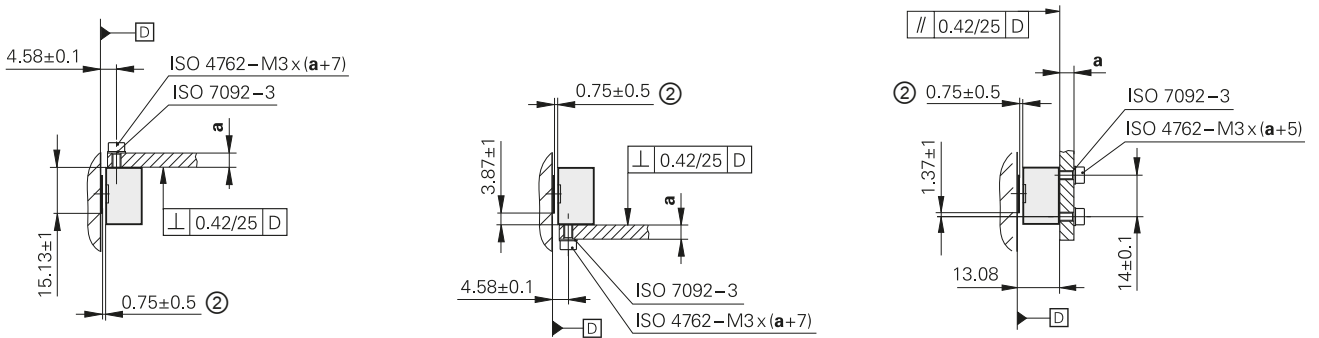
LIC 2119, LIC 2199

Absolute linear encoder for measuring lengths up to 3 m

- Measuring step 0.1 μm or 0.05 μm
- Steel scale tape cemented on mounting surface
- Consists of scale and scanning head



Possibilities for mounting the scanning head



mm

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

- F = Machine guideway
- * = Max. change during operation
- ⊙ = Code start value: 100 mm
- ⊙ = Beginning of measuring length ML
- ⊙ = Scale tape length
- 1 = Optical centerline
- 2 = Mounting clearance between scanning head and scale tape
- 3 = Direction of scanning unit motion for output signals in accordance with interface description



Scale	LIC 2109
Measuring standard Coefficient of linear expansion	Steel scale tape with absolute track $\alpha_{\text{therm}} \approx 10 \times 10^{-6} \text{ K}^{-1}$
Accuracy grade	$\pm 15 \mu\text{m}$
Measuring length ML* in mm	120 320 520 770 1020 1220 1520 2020 2420 3020 (measuring lengths greater than 6020 mm upon request)
Mass	20 g/m

Scanning head	LIC 211	LIC 219F	LIC 219M		LIC 219P
Interface	EnDat 2.2	Fanuc Serial Interface α i interface	Mitsubishi high speed interface		Panasonic serial interface
Ordering designation*	EnDat22	Fanuc05	Mit03-4	Mit02-2	Pana01
Measuring step*	0.1 μm (100 nm) 0.05 μm (50 nm)				
Calculation time t_{cal} Clock frequency	$\leq 5 \mu\text{s}$ $\leq 16 \text{ MHz}$	– –			
Traversing speed ¹⁾	$\leq 600 \text{ m/min}$				
Interpolation error	$\pm 2 \mu\text{m}$				
Electrical connection*	Cable, 1 m or 3 m with 8-pin M12 coupling (male) or 15 D-sub connector (male)				
Cable length (with HEIDENHAIN cable)	$\leq 100 \text{ m}$	$\leq 50 \text{ m}$	$\leq 30 \text{ m}$		$\leq 50 \text{ m}$
Voltage supply	DC 3.6 V to 14 V				
Power consumption ¹⁾ (max.)	At 3.6 V: $\leq 700 \text{ mW}$ At 14 V: $\leq 800 \text{ mW}$	At 3.6 V: $\leq 850 \text{ mW}$ At 14 V: $\leq 950 \text{ mW}$			
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	$\leq 500 \text{ m/s}^2$ (EN 60068-2-6) $\leq 1000 \text{ m/s}^2$ (EN 60068-2-27)				
Operating temperature	$-10 \text{ }^\circ\text{C}$ to $70 \text{ }^\circ\text{C}$				
Mass	Scanning head Connecting cable Connector	$\leq 18 \text{ g}$ (without cable) 20 g/m M12 coupling: 15 g; D-sub connector: 32 g			

* Please select when ordering

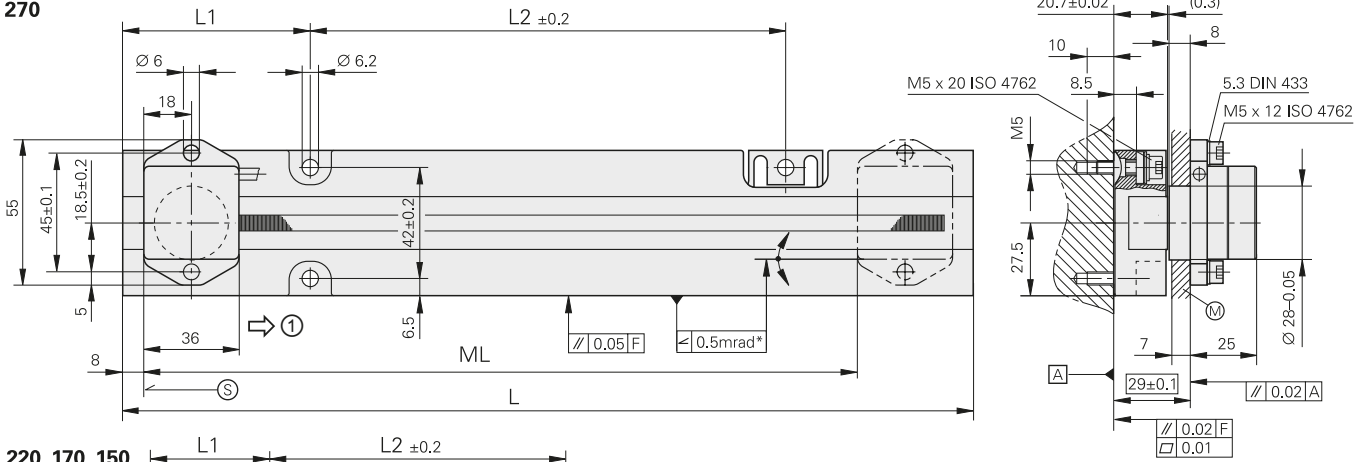
¹⁾ See *General electrical information* in the brochure *Interfaces of HEIDENHAIN Encoders*

LIP 382

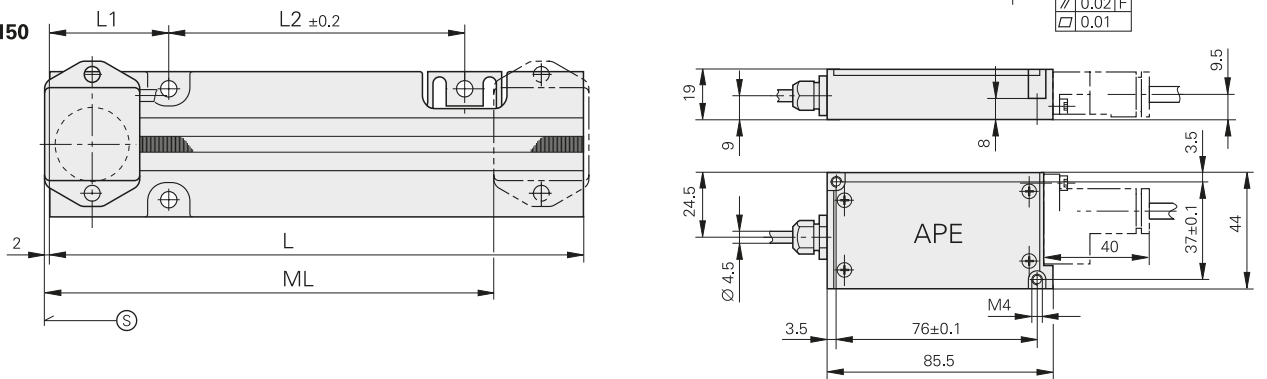
Incremental linear encoders with very high accuracy

- Measuring steps to 1 nm
- Measuring standard is fastened by screws

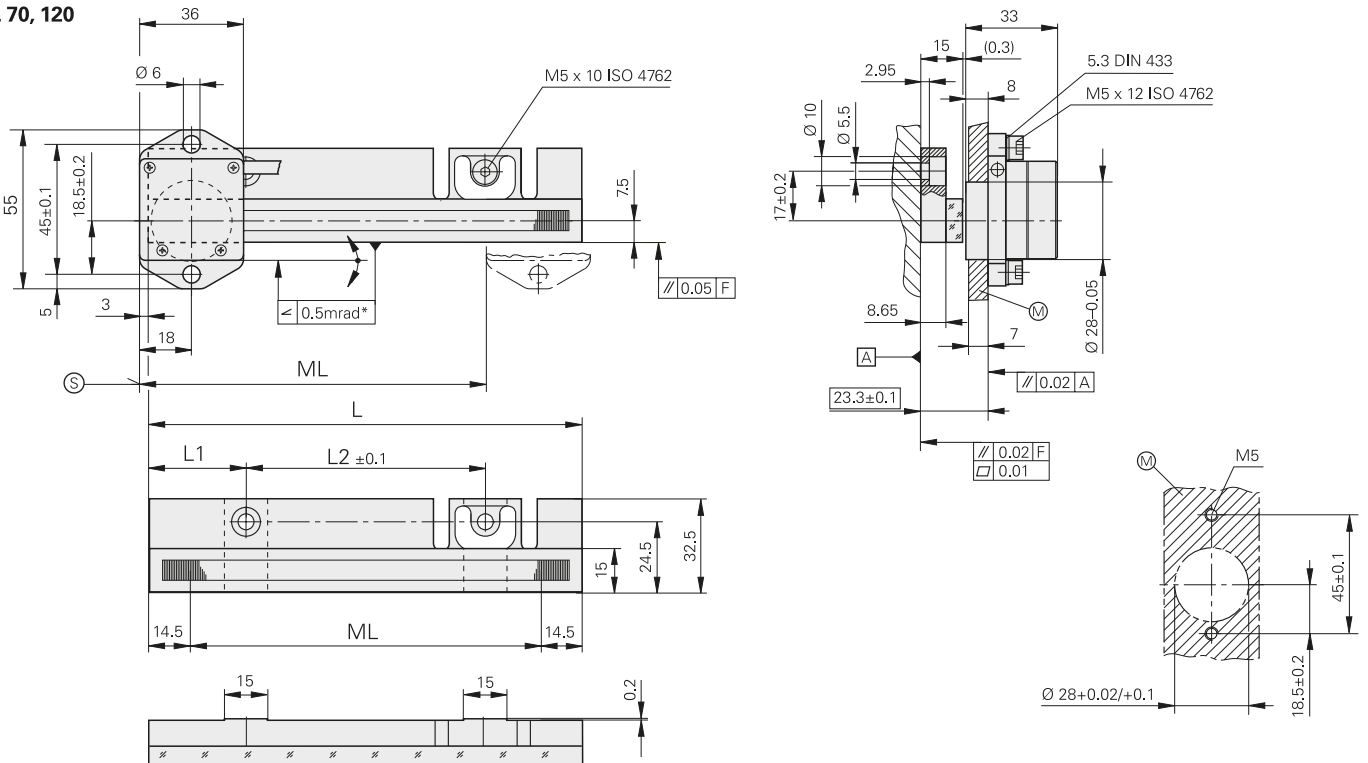
ML 270



ML 220, 170, 150



ML 70, 120



mm

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

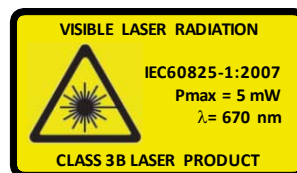
* = Max. change during operation

F = Machine guideway

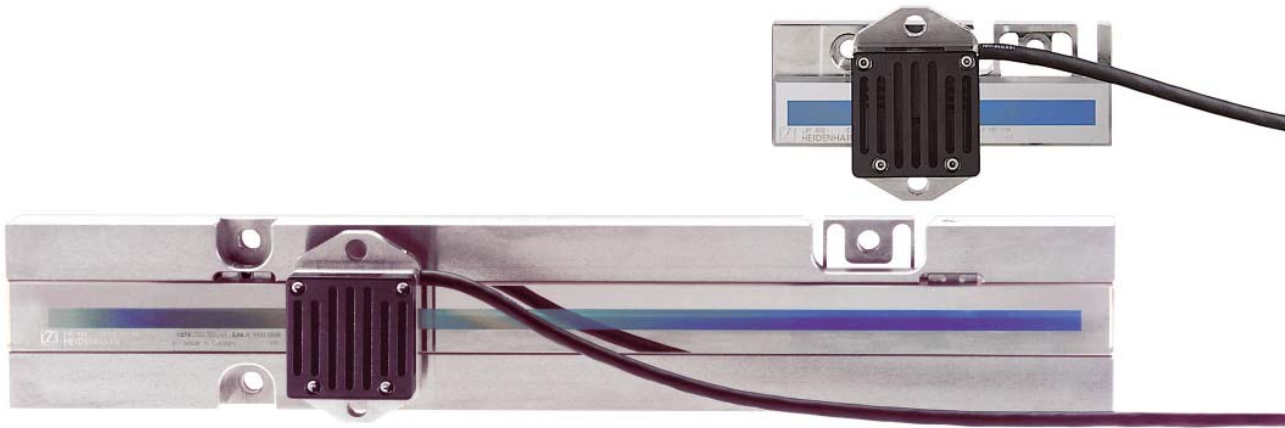
Ⓢ = Beginning of measuring length ML

Ⓜ = Mounting surface for scanning head

1 = Direction of scanning unit motion for output signals in accordance with interface description



ML	L	L1	L2
70	100	22.5	55
120	150	33.5	83
150	182	40	102
170	202	45	112
220	252	56	140
270	322	71	180



Specifications	LIP 382
Measuring standard Coefficient of linear expansion	DIADUR phase grating on Zerodur glass ceramic; grating period 0.512 μm $\alpha_{\text{therm}} = (0 \pm 0.1) \times 10^{-6} \text{ K}^{-1}$
Accuracy grade	$\pm 0.5 \mu\text{m}$ (higher accuracy grades upon request)
Baseline error	$\leq \pm 0.075 \mu\text{m}/5 \text{ mm}$
Measuring length ML* in mm	70 120 150 170 220 270
Reference marks	No
Interface	$\sim 1 \text{ V}_{\text{PP}}$
Integrated interpolation Signal period	– 0.128 μm
Cutoff frequency –3 dB	$\geq 1 \text{ MHz}$
Scanning frequency* Edge separation a	–
Traversing speed	$\leq 7.6 \text{ m/min}$
Interpolation error Position noise RMS	$\pm 0.01 \text{ nm}$ 0.06 nm (1 MHz ¹⁾)
Laser	Scanning head and scale mounted: Class 1 Scanning head not mounted: Class 3B Laser diode used: Class 3B
Electrical connection	0.5 m cable to interface electronics (APE), separate adapter cable (1 m/3 m/6 m/9 m) connectable to APE
Cable length	See interface description, but $\leq 30 \text{ m}$ (with HEIDENHAIN cable)
Power supply	DC 5 V $\pm 0.25 \text{ V}$
Current consumption	$< 190 \text{ mA}$
Vibration 55 Hz to 2000 Hz Shock 11 ms	$\leq 4 \text{ m/s}^2$ (EN 60068-2-6) $\leq 50 \text{ m/s}^2$ (EN 60068-2-27)
Operating temperature	0 °C to 40 °C
Mass	Scanning head 150 g Interface electronics 100 g Linear scale ML 70 mm: 260 g, ML $\geq 150 \text{ mm}$: 700 g Connecting cable 38 g/m

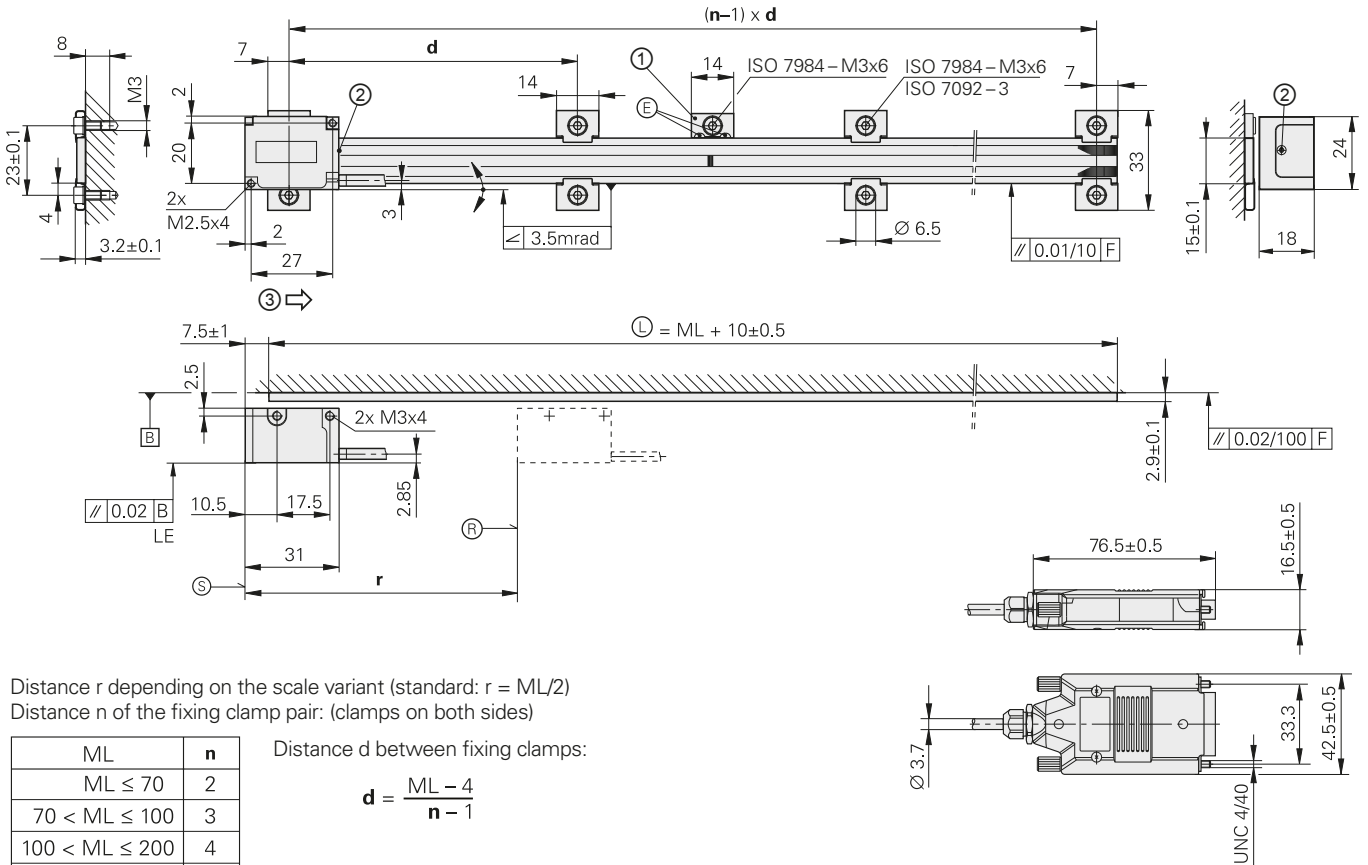
* Please select when ordering

¹⁾ –3 dB cutoff frequency of the subsequent electronics

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 large measuring lengths
- Measuring standard is fastened by fixing clamps
- Consists of scale and scanning head



Distance r depending on the scale variant (standard: $r = ML/2$)
 Distance n of the fixing clamp pair: (clamps on both sides)

ML	n
$ML \leq 70$	2
$70 < ML \leq 100$	3
$100 < ML \leq 200$	4
...	...

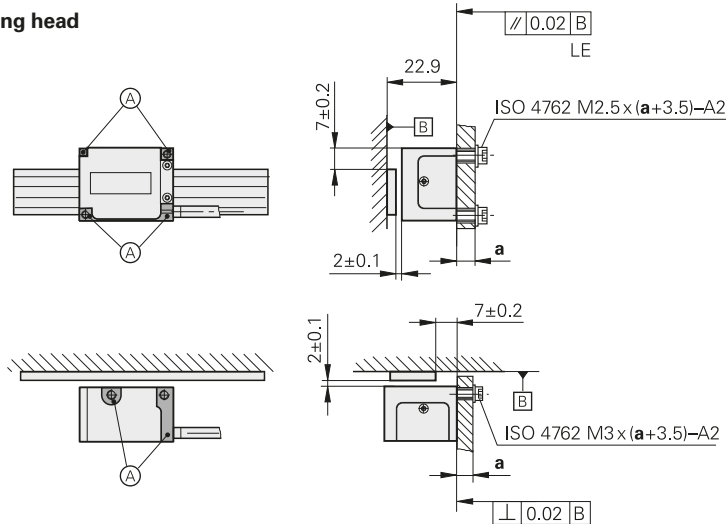
Distance d between fixing clamps:

$$d = \frac{ML - 4}{n - 1}$$

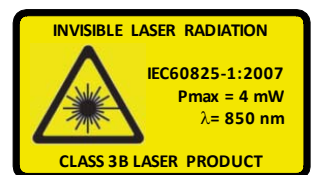
Possibilities for mounting the scanning head

mm

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



- F = Machine guideway
- Ⓡ = Reference mark position
- Ⓛ = Scale length
- Ⓢ = Beginning of measuring length ML
- ⓔ = Adhesive according to Mounting Instructions
- Ⓐ = Mounting surface
- 1 = Mounting element for hard adhesive bond in order to define the thermal fixed point
- 2 = Max. protrusion of screw head: 0.5 mm
- 3 = Direction of scanning unit motion for output signals in accordance with interface description





Scale	LIP 201																																															
Measuring standard Coefficient of linear expansion	OPTODUR phase grating on Zerodur glass ceramic; grating period 2.048 μm $\alpha_{\text{therm}} = (0 \pm 0.1) \times 10^{-6} \text{ K}^{-1}$																																															
Accuracy grade*	$\pm 1 \mu\text{m}$						$\pm 3 \mu\text{m}$ (higher accuracy grades upon request)																																									
Baseline error	$\leq \pm 0.125 \mu\text{m}/5 \text{ mm}$																																															
Measuring length ML* in mm	20	30	50	70	120	170	220	370	420	470	520	570	620	670	270	320	370	420	470	520	570	720	770	820	870	920	970	1020	620	670	720	770	820	870	920	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 measuring length																																															

Scanning head	LIP 21	LIP 29F	LIP 29M	LIP 28
Interface	EnDat 2.2 ¹⁾	Fanuc Serial Interface ¹⁾	Mitsubishi high speed Interface ¹⁾	$\sim 1 \text{ V}_{\text{PP}}$
Ordering designation	EnDat22	Fanuc02	Mit02-4	–
Integrated interpolation	16384-fold (14 bits)			–
Clock frequency	$\leq 16 \text{ MHz}$	–	–	–
Calculation time t_{cal}	$\leq 5 \mu\text{s}$	–	–	–
Measuring step	0.03125 nm (31.25 μm)			–
Signal period	–	–	–	0.512 μm
Cutoff frequency –3 dB	–	–	–	$\geq 3 \text{ MHz}$
Traversing speed	$\leq 120 \text{ m/min}$			$\leq 90 \text{ m/min}$
Interpolation error Position noise RMS	$\pm 0.4 \text{ nm}^4$ 0.12 nm			$\pm 0.4 \text{ nm}^4$ 0.12 nm (3 MHz ³⁾)
Electrical connection*	Cable, 0.5 m, 1 m, 2 m, or 3 m, with 15-pin D-sub connector (male); interface electronics in connector			
Cable length	See interface description, but $\leq 30 \text{ m}$ (with HEIDENHAIN cable)			
Voltage supply	DC 3.6 V to 14 V			DC 5 V $\pm 0.25 \text{ V}$
Power consumption ²⁾ (max.)	At 14 V: 2270 mW; at 3.6 V: 2400 mW			–
Current consumption	At 5 V: 300 mA (without load, typical)			$\leq 390 \text{ mA}$
Laser	Scanning head and scale mounted: class 1; scanning head not mounted: class 3B			
Vibration 55 Hz to 2000 Hz Shock 11 ms	$\leq 200 \text{ m/s}^2$ (IEC 60068-2-6) $\leq 400 \text{ m/s}^2$ (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; ¹⁾ Absolute position value after traverse of the reference mark in "position value 2"

²⁾ See *General electrical information* in the brochure *Interfaces of HEIDENHAIN Encoders*

³⁾ –3 dB cutoff frequency of the subsequent electronics

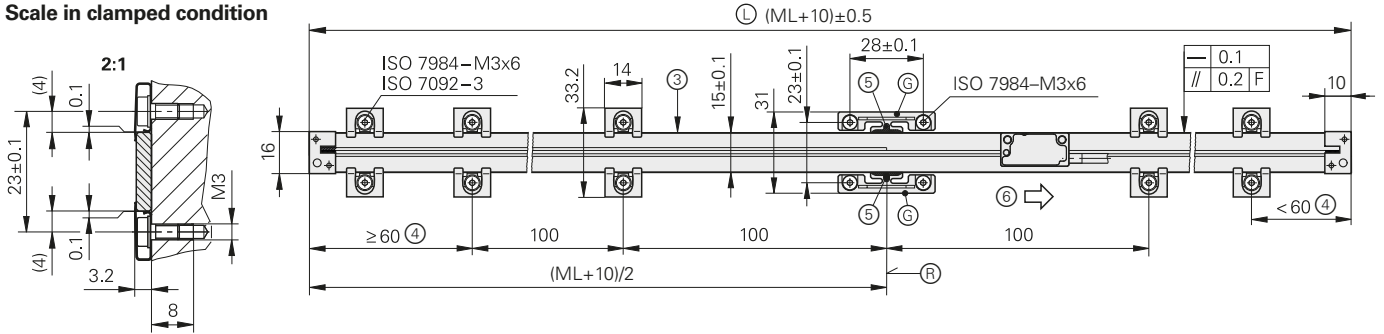
⁴⁾ With HEIDENHAIN interface electronics

LIP 6071, LIP 6081

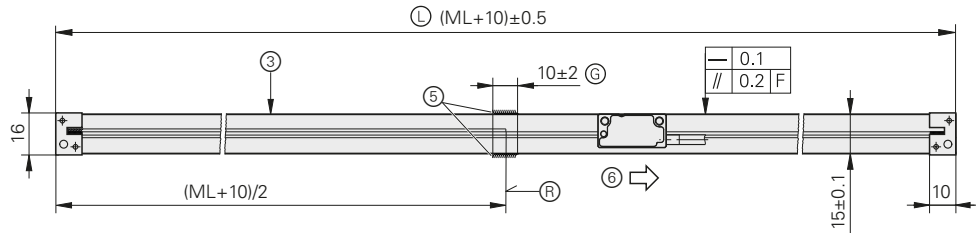
Incremental linear encoders with very high accuracy

- For limited installation space
- For measuring steps down to 2 nm
- For high traversing speeds and large measuring lengths
- Position detection through homing track and limit switches
- Measuring standard is fastened by adhesive or fixing clamps

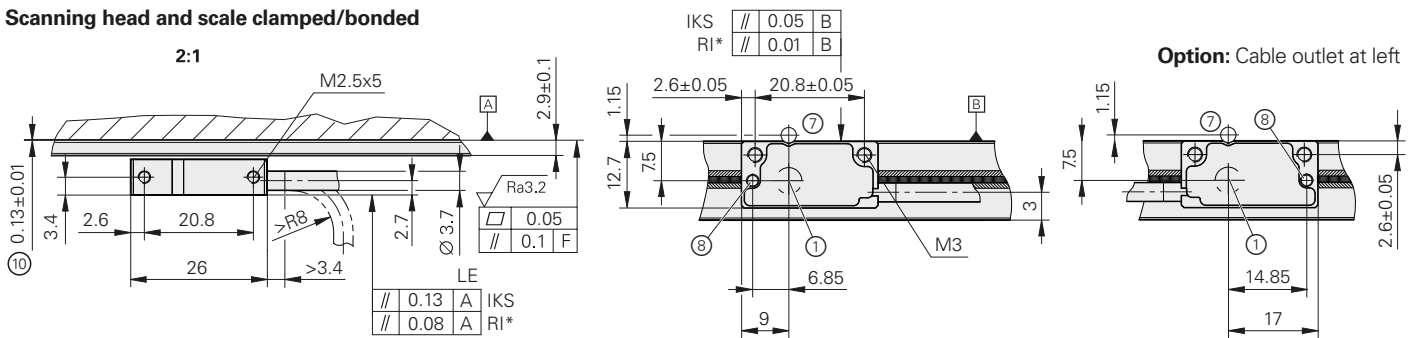
Scale in clamped condition



Scale in bonded condition

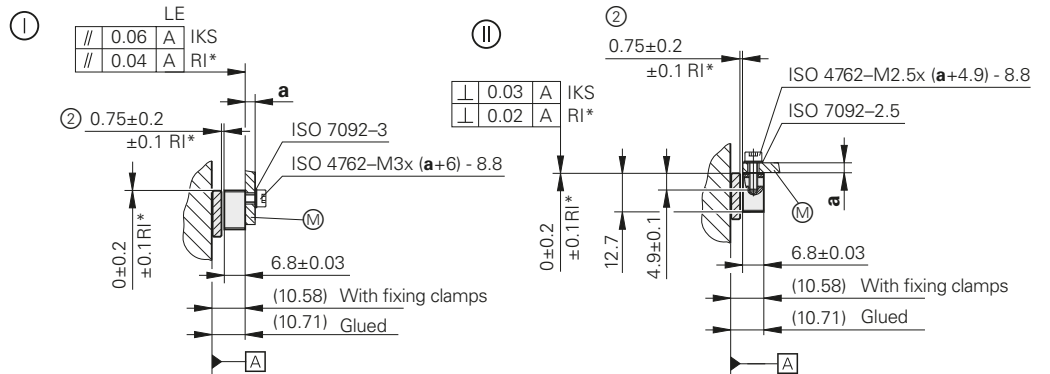


Scanning head and scale clamped/bonded



Possibilities for mounting the scanning head

Shown without fixing clamps



F = Machine guideway

* = Max. 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 center

2 = Mounting clearance of scanning head to scale; adjusted by means of a space shim

3 = Scale stop surface

4 = Use additional fixing clamp pairs depending on the measuring length (ML)

5 = Adhesive

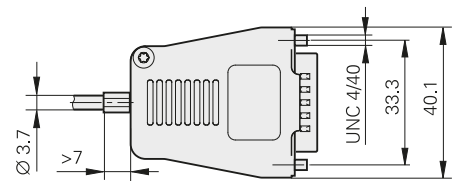
6 = Direction of scanning unit as per interface description

7 = Moiré adjustment option 1: Alignment pin, \varnothing 3m6, possible only with mounting option ①

8 = Moiré adjustment option 2: Alignment pin, \varnothing 2m6

9 = Recommendation: \varnothing 3

10 = Adhesive tape (only if the scale is glued)



$M_d = 40$ Ncm



mm

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



Scale	LIP 6001
Measuring standard* Coefficient of linear expansion	OPTODUR phase grating on Zerodur glass ceramic; grating period 8 μm $\alpha_{\text{therm}} = (0 \pm 0.1) \times 10^{-6} \text{ K}^{-1}$ (Zerodur glass ceramic) $\alpha_{\text{therm}} \approx 8 \times 10^{-6} \text{ K}^{-1}$ (glass)
Accuracy grade*	$\pm 1 \mu\text{m}$ (only for Zerodur glass ceramic up to measuring length 1020 mm); $\pm 3 \mu\text{m}$
Baseline error	$\leq \pm 0.175 \mu\text{m}/5 \text{ mm}$
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 2640 2840 3040
Reference mark	One at midpoint of measuring length
Mass	1.1 g + 0.11 g/mm measuring length

Scanning head	LIP 608	LIP 607					
Interface	$\sim 1 V_{PP}$	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	$\geq 1 \text{ MHz}$						
Scanning frequency	–	– $\leq 312.5 \text{ kHz}$	– $\leq 312.5 \text{ kHz}$ $\leq 156.25 \text{ kHz}$	$\leq 250 \text{ kHz}$ $\leq 125 \text{ kHz}$ $\leq 62.5 \text{ kHz}$	$\leq 125 \text{ kHz}$ $\leq 62.5 \text{ kHz}$ $\leq 31.25 \text{ kHz}$	$\leq 62.5 \text{ kHz}$ $\leq 31.25 \text{ kHz}$ $\leq 15.63 \text{ kHz}$	$\leq 12.5 \text{ kHz}$ $\leq 6.25 \text{ kHz}$ $\leq 3.13 \text{ kHz}$
Edge separation a	–	– $\geq 0.135 \mu\text{s}$	– $\geq 0.07 \mu\text{s}$ $\geq 0.135 \mu\text{s}$	$\geq 0.03 \mu\text{s}$ $\geq 0.07 \mu\text{s}$ $\geq 0.135 \mu\text{s}$			
Traversing speed ²⁾	$\leq 240 \text{ m/min}$	– $\leq 75 \text{ m/min}$	– $\leq 75 \text{ m/min}$ $\leq 37 \text{ m/min}$	$\leq 60 \text{ m/min}$ $\leq 30 \text{ m/min}$ $\leq 15 \text{ m/min}$	$\leq 30 \text{ m/min}$ $\leq 15 \text{ m/min}$ $\leq 7.5 \text{ m/min}$	$\leq 15 \text{ m/min}$ $\leq 7.5 \text{ m/min}$ $\leq 3.7 \text{ m/min}$	$\leq 3 \text{ m/min}$ $\leq 1.5 \text{ m/min}$ $\leq 0.75 \text{ m/min}$
Interpolation error Position noise RMS	$\pm 4 \text{ nm}$ 0.4 nm (1 MHz ³⁾)	–					
Electrical connection*	Cable outlet on the left/right and straight/angled $1 V_{PP}$: Cable, 0.5 m, 1 m, or 3 m, D-sub connector (male) 15-pin TTL: Cable, 0.5 m or 1 m, with 15-pin D-sub connector (male)						
Cable length	With HEIDENHAIN cable: Homing, limit: $\leq 10 \text{ m}$; only incremental: $\leq 20 \text{ m}$; during signal adjustment with PWM 21: $\leq 3 \text{ m}$						
Voltage supply	DC 5 V $\pm 0.5 \text{ V}$						
Current consumption	$\leq 150 \text{ mA}$	$\leq 250 \text{ mA}$ (without load)					
Vibration 55 Hz to 2000 Hz Shock 6 ms	$\leq 500 \text{ m/s}^2$ (IEC 60068-2-6) $\leq 1000 \text{ m/s}^2$ (IEC 60068-2-27)						
Operating temperature	$-10 \text{ }^\circ\text{C}$ to $70 \text{ }^\circ\text{C}$						
Mass	Scanning head Connector Connecting cable	$\approx 5 \text{ g}$ (without cable) AK LIP 608 $\approx 71 \text{ g}$; AK LIP 607 $\approx 74 \text{ g}$ $\approx 22 \text{ g/m}$					

* Please select when ordering

¹⁾ TTLx1 unlocked possible upon request

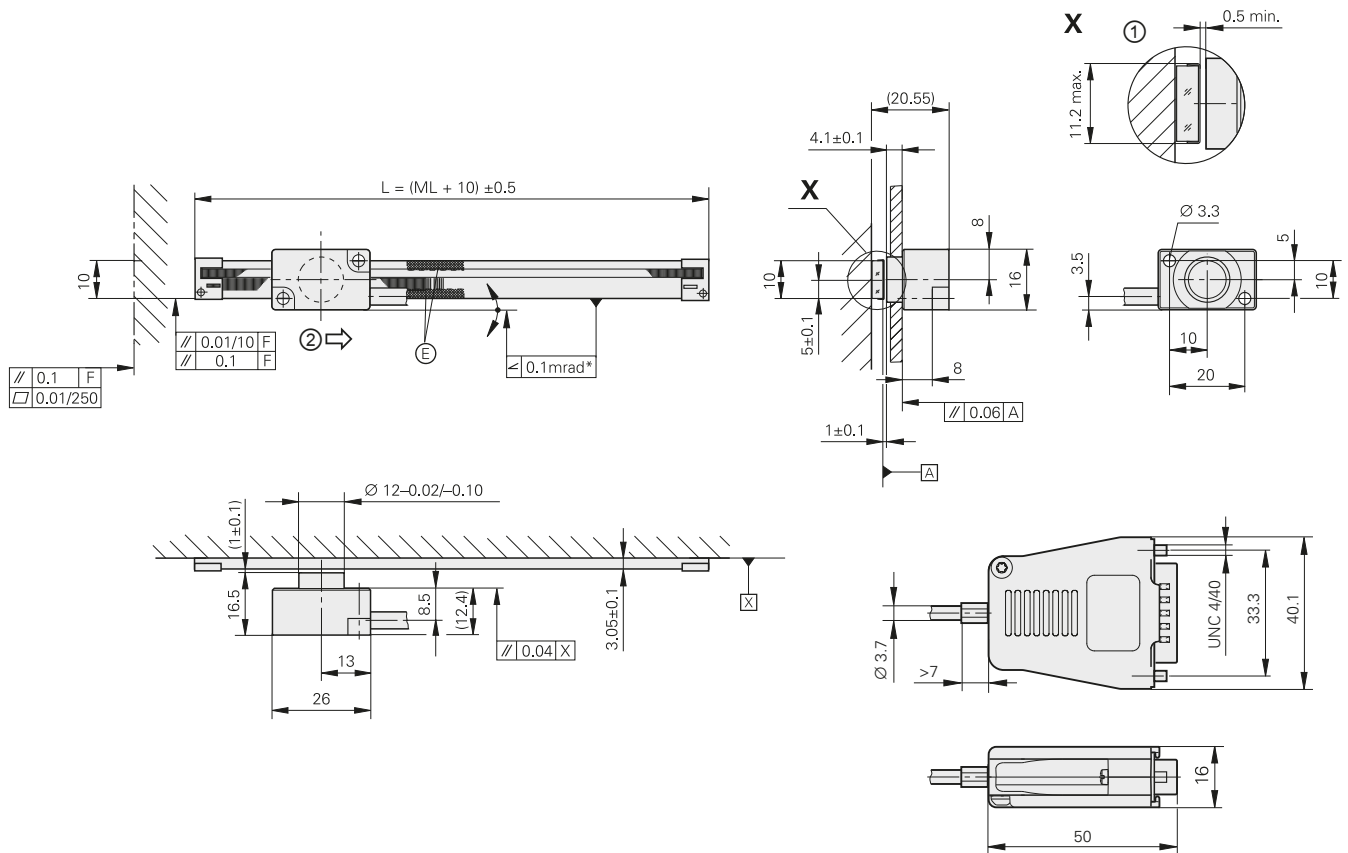
²⁾ Maximale Maximum traversing speed for referencing: 16.8 m/min (70 kHz)


³⁾ –3dB cutoff frequency of the subsequent electronics

LIF 471, LIF 481

Incremental linear encoders for simple installation

- For measuring steps down to 10 nm
- Position detection through homing track and limit switches
- Glass scale cemented with adhesive film
- Consists of scale and scanning head
- Versions available for high vacuum (see *Product Information* document)



mm

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

- * = Max. change during operation
- F = Machine guideway
- ML = Measuring length
- ⊕ = Epoxy for ML < 170
- 1 = Dimensions of limit plate
- 2 = Direction of scanning unit motion for output signals in accordance with interface description



Scale	LIF 401 R
Measuring standard* Coefficient of linear expansion	SUPRADUR phase grating on Zerodur glass ceramic or glass; grating period 8 μm $\alpha_{\text{therm}} = (0 \pm 0.1) \times 10^{-6} \text{ K}^{-1}$ (Zerodur glass ceramic) $\alpha_{\text{therm}} \approx 8 \times 10^{-6} \text{ K}^{-1}$ (glass)
Accuracy grade*	$\pm 1 \mu\text{m}$ (only for Zerodur glass ceramic up to measuring length 1020 mm), $\pm 3 \mu\text{m}$
Baseline error	$\leq \pm 0.225 \mu\text{m}/5 \text{ mm}$
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 measuring length

Scanning head	LIF 48	LIF 47				
Interface	$\sim 1 \text{ V}_{\text{PP}}$	\square 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	$\geq 1 \text{ MHz}$	–				
Scanning frequency*	–	$\leq 500 \text{ kHz}$ $\leq 250 \text{ kHz}$ $\leq 125 \text{ kHz}$	$\leq 250 \text{ kHz}$ $\leq 125 \text{ kHz}$ $\leq 62.5 \text{ kHz}$	$\leq 250 \text{ kHz}$ $\leq 125 \text{ kHz}$ $\leq 62.5 \text{ kHz}$	$\leq 100 \text{ kHz}$ $\leq 50 \text{ kHz}$ $\leq 25 \text{ kHz}$	$\leq 50 \text{ kHz}$ $\leq 25 \text{ kHz}$ $\leq 12.5 \text{ kHz}$
Edge separation a	–	$\geq 0.080 \mu\text{s}$ $\geq 0.175 \mu\text{s}$ $\geq 0.370 \mu\text{s}$	$\geq 0.080 \mu\text{s}$ $\geq 0.175 \mu\text{s}$ $\geq 0.370 \mu\text{s}$	$\geq 0.040 \mu\text{s}$ $\geq 0.080 \mu\text{s}$ $\geq 0.175 \mu\text{s}$	$\geq 0.040 \mu\text{s}$ $\geq 0.080 \mu\text{s}$ $\geq 0.175 \mu\text{s}$	$\geq 0.040 \mu\text{s}$ $\geq 0.080 \mu\text{s}$ $\geq 0.175 \mu\text{s}$
Traversing speed ¹⁾	$\leq 240 \text{ m/min}$	$\leq 120 \text{ m/min}$ $\leq 60 \text{ m/min}$ $\leq 30 \text{ m/min}$	$\leq 60 \text{ m/min}$ $\leq 30 \text{ m/min}$ $\leq 15 \text{ m/min}$	$\leq 60 \text{ m/min}$ $\leq 30 \text{ m/min}$ $\leq 15 \text{ m/min}$	$\leq 24 \text{ m/min}$ $\leq 12 \text{ m/min}$ $\leq 6 \text{ m/min}$	$\leq 12 \text{ m/min}$ $\leq 6 \text{ m/min}$ $\leq 3 \text{ m/min}$
Interpolation error Position noise RMS	$\pm 12 \text{ nm}$ 0.6 nm (1 MHz ²⁾)	–				
Electrical connection*	Cable, 0.5 m, 1 m, or 3 m, with 15-pin D-sub connector (male); interface electronics in connector					
Cable length	See interface description, however <i>Incremental:</i> $\leq 30 \text{ m}$; <i>homing, limit:</i> $\leq 10 \text{ m}$; (with HEIDENHAIN cable)					
Power supply	DC 5 V $\pm 0.25 \text{ V}$					
Current consumption	$< 175 \text{ mA}$	$< 180 \text{ mA}$ (without load)				
Vibration 55 Hz to 2000 Hz Shock 11 ms	$\leq 200 \text{ m/s}^2$ (EN 60068-2-6) $\leq 500 \text{ m/s}^2$ (EN 60068-2-27)					
Operating temperature	0 °C to 50 °C					
Mass	Scanning head*	For scale of Zerodur glass ceramic: 25 g For scale of glass: 9 g				
	Connecting cable	38 g/m				
	Connector	75 g				

* Please select when ordering

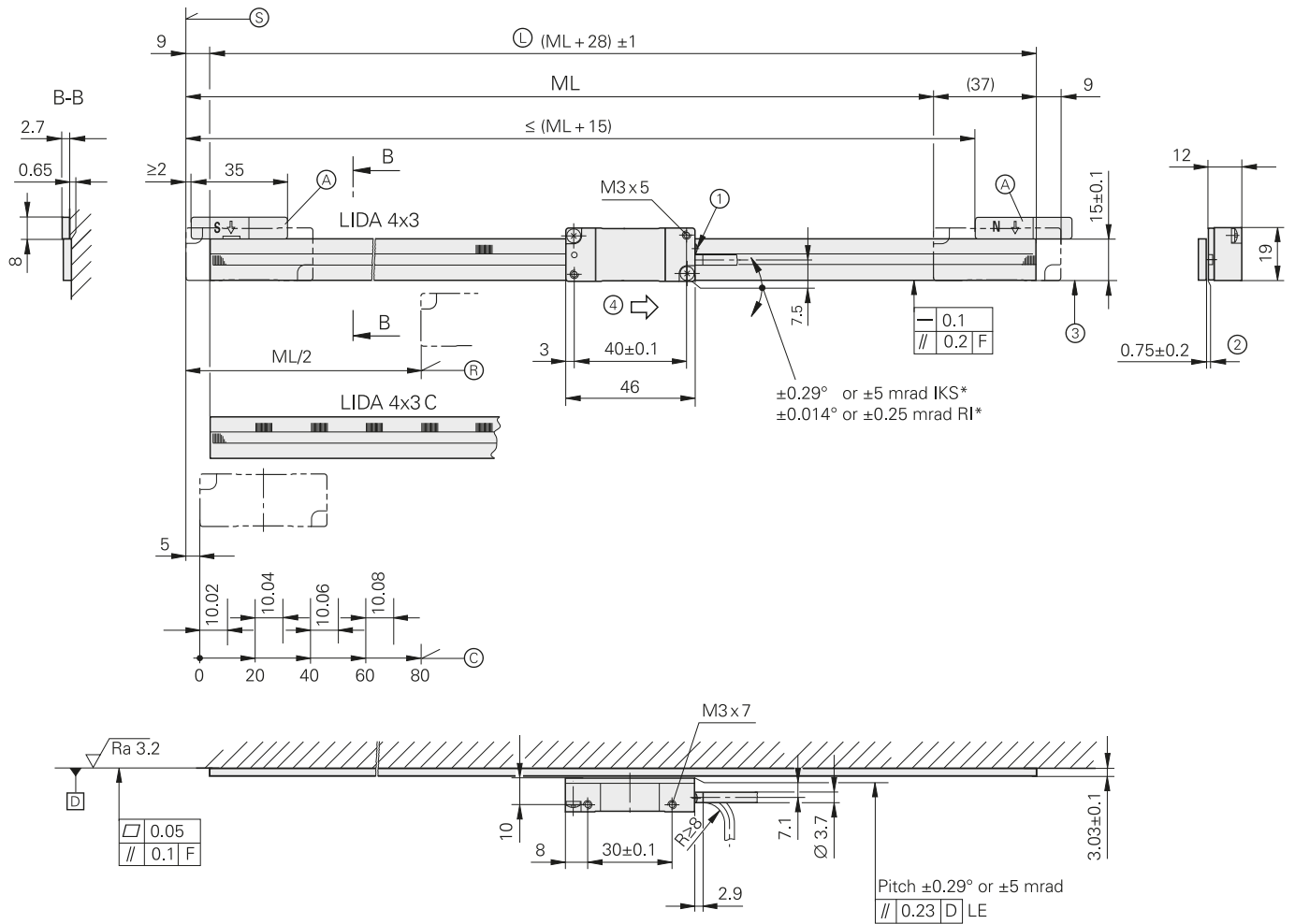
¹⁾ Maximum traversing speed for referencing: 9.6 m/min (40 kHz)

²⁾ –3 dB cutoff frequency of the subsequent electronics

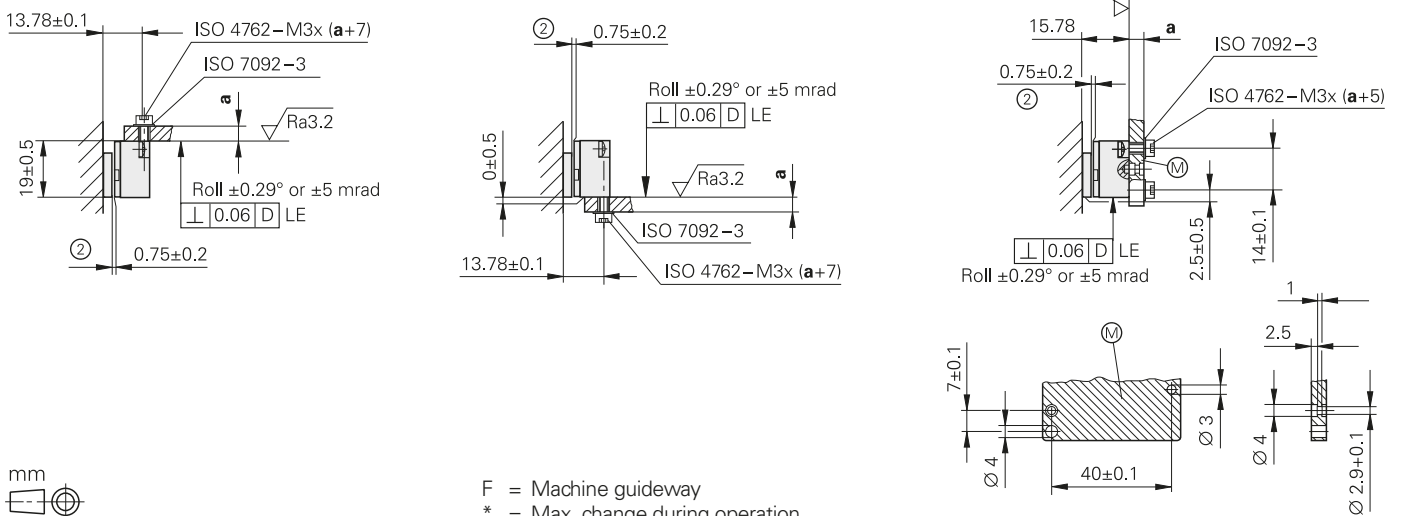
LIDA 473, LIDA 483

Incremental linear encoders with limit switches

- For measuring steps down to 50 nm
- Measuring standard of glass or glass ceramic
- Glass scale cemented with adhesive film
- Consists of scale and scanning head



Possibilities for mounting the scanning head



mm

 Tolerancing ISO 8015
 ISO 2768 - m H
 < 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 LIP 4x3
- Ⓢ = Reference-mark position on LIDA 4x3C
- Ⓢ = Scale length
- Ⓐ = Selector magnet for limit switch
- Ⓜ = Mounting surface for scanning head
- 1 = Function display
- 2 = Scanning gap
- 3 = Scale stop surface
- 4 = Direction of scanning unit motion for output signals in accordance with interface description



Scale	LIDA 403
Measuring standard Coefficient of linear expansion*	METALLUR scale grating on glass ceramic or glass; grating period 20 µm $\alpha_{\text{therm}} \approx 8 \times 10^{-6} \text{ K}^{-1}$ (glass) $\alpha_{\text{therm}} = (0 \pm 0.5) \times 10^{-6} \text{ K}^{-1}$ (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 up to max. ML 1640)
Reference marks*	LIDA 4x3: One at midpoint of measuring length; LIDA 4x3C: Distance-coded
Mass	3 g + 0.11 g/mm 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	≥ 400 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⁾	≤ 480 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; <i>output signals</i> : TTL (without line driver)				
Electrical connection	Cable, 0.5 m, 1 m, or 3 m, with 15-pin D-sub connector (male)				
Cable length	See interface description, but <i>limit</i> : ≤ 20 m (with HEIDENHAIN cable)				
Voltage supply	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 Connecting cable Connector	20 g (without cable) 22 g/m 32 g			

* Please select when ordering

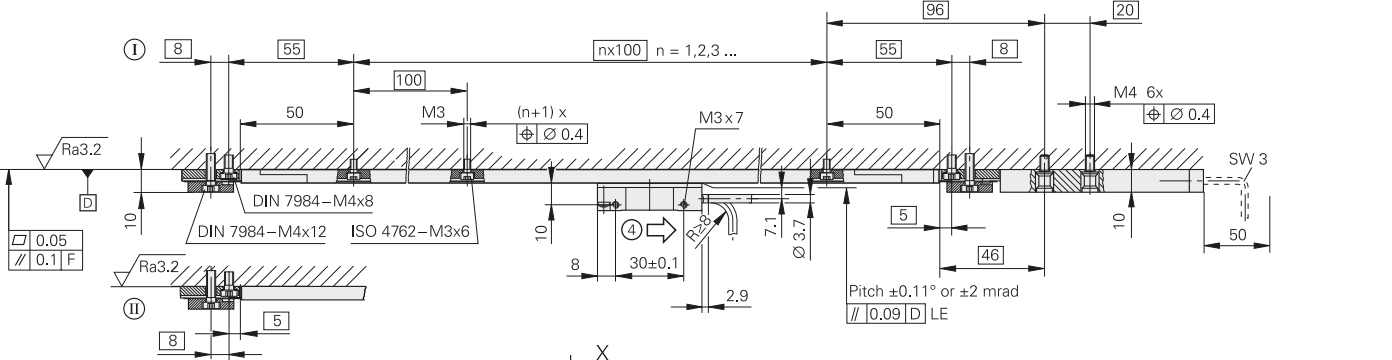
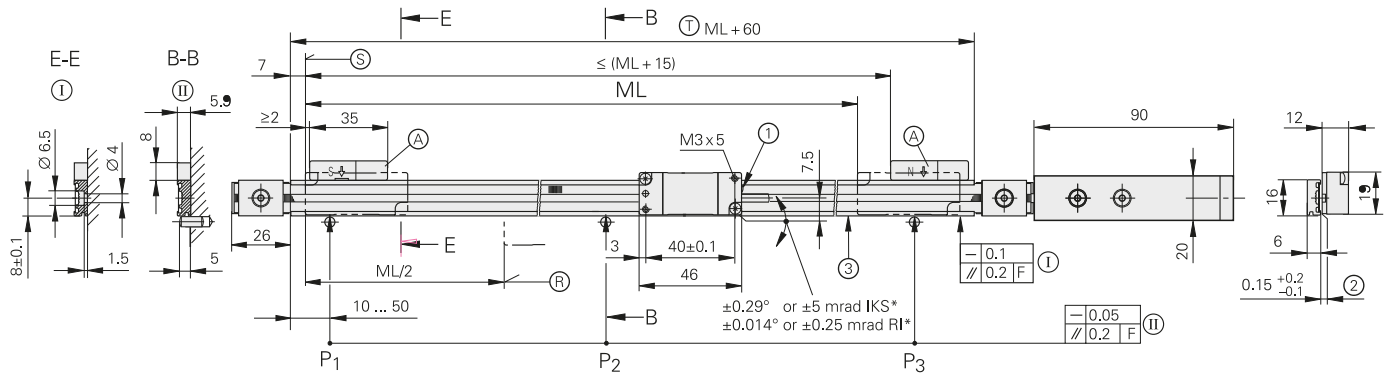
¹⁾ At a corresponding cutoff or scanning frequency

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

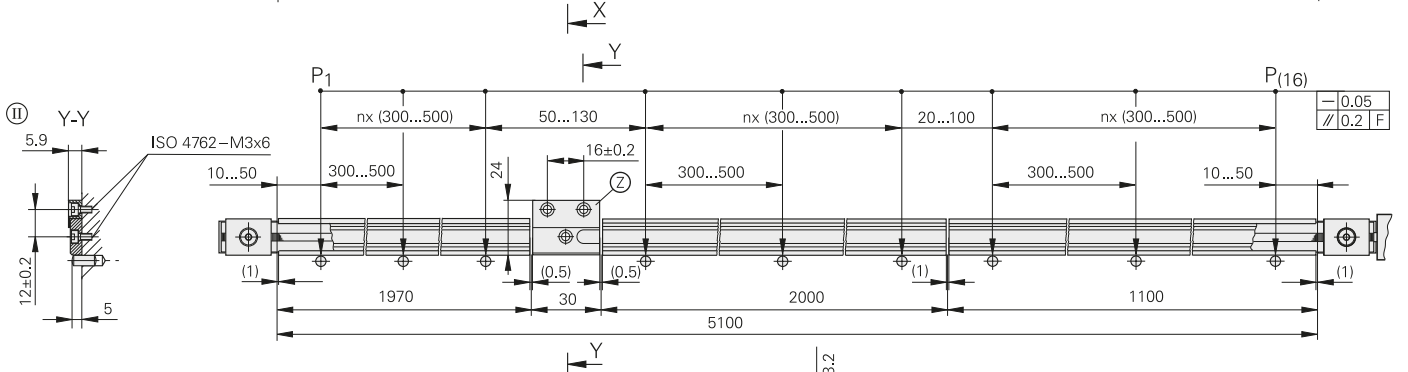
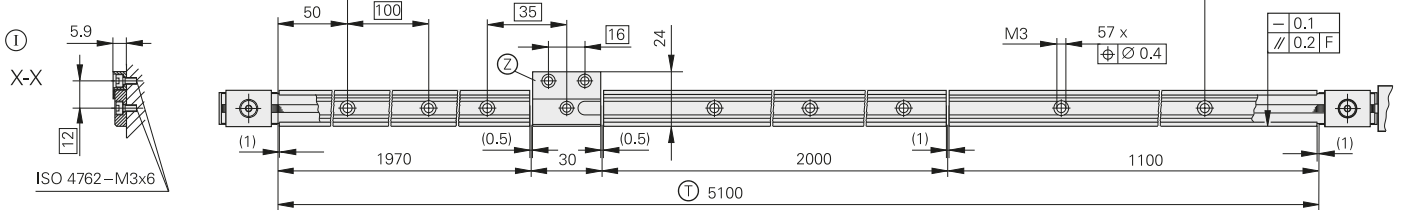
LIDA 475, LIDA 485

Incremental linear encoders for measuring lengths up to 30 m

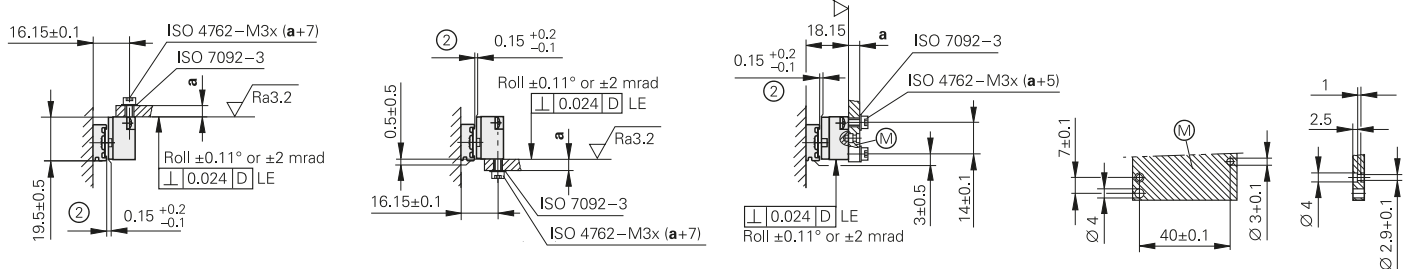
- For measuring steps down to 50 nm
- Limit switches
- Steel scale-tape is drawn into aluminum extrusions and tensioned
- Consists of scale and scanning head



ML > 2040 (e.g. 5040)



Possibilities for mounting the scanning head



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

- ① = Scale carrier sections fixed with screws
- ② = Scale carrier sections fixed with PRECIMET
- F = Machine guideway
- * = Max. change during operation (IKS: incremental track, RI: Reference mark track)
- P = Gauging points for alignment
- Ⓢ = Beginning of measuring length ML
- Ⓡ = Reference mark position
- Ⓐ = Selector magnet for limit switch
- Ⓣ = Carrier segment
- Ⓩ = Spacer for measuring lengths from 3040 mm
- Ⓜ = Mounting surface for scanning head
- 1 = Function display
- 2 = Scanning gap
- 3 = Carrier stop surface
- 4 = Direction of scanning unit motion for output signals as per interface description



Scale	LIDA 405
Measuring standard	Steel scale tape with METALLUR scale grating; grating period 20 µm
Coefficient of linear expansion	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
	Larger measuring lengths up to 30040 mm with a single-section scale tape and individual scale-carrier sections
Reference marks	One at midpoint of measuring length
Mass	115 g + 0.25 g/mm 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	≥ 400 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⁾	≤ 480 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; <i>output signals</i> : TTL (without line driver)				
Electrical connection	Cable, 0.5 m, 1 m, or 3 m, with 15-pin D-sub connector (male)				
Cable length	See interface description, but <i>limit</i> : ≤ 20 m (with HEIDENHAIN cable)				
Voltage supply	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 Connecting cable Connector	20 g (without cable) 22 g/m 32 g			

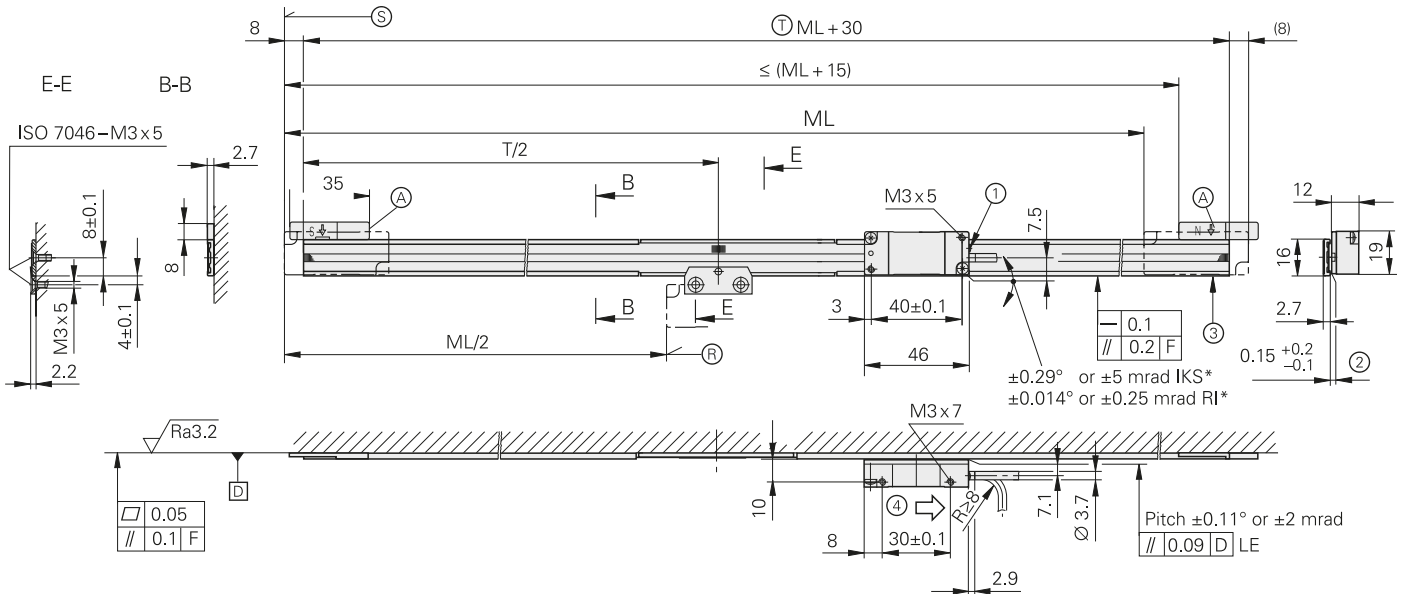
* Please select when ordering

¹⁾ At a corresponding cutoff or scanning frequency

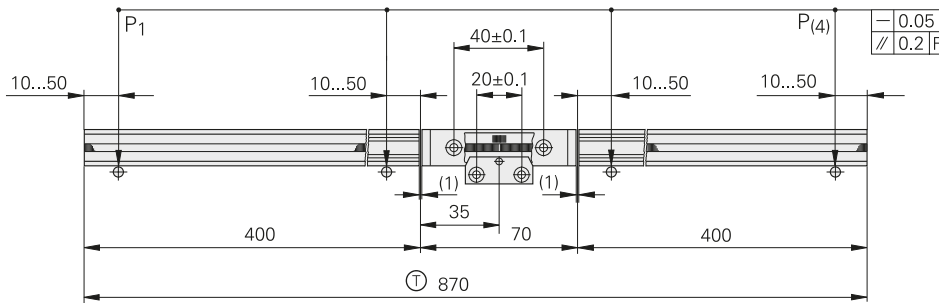
LIDA 477, LIDA 487

Incremental linear encoders for measuring ranges up to 6 m

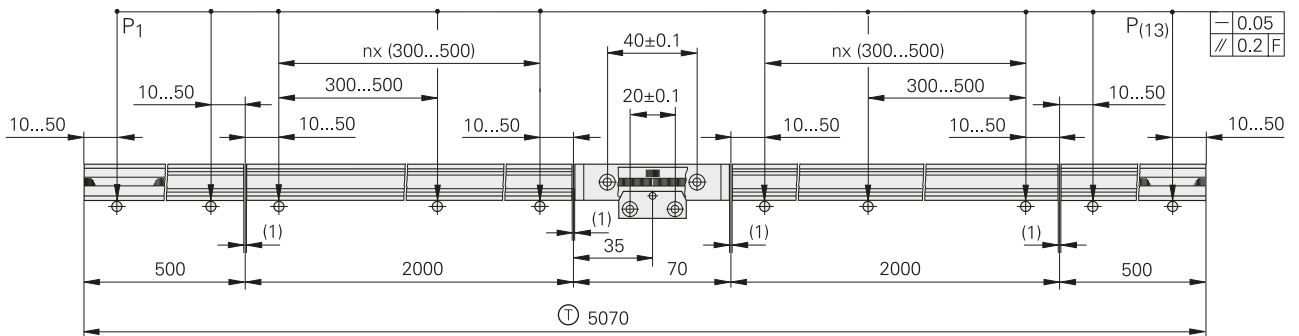
- For measuring steps down to 50 nm
- Limit switches
- Steel scale-tape is drawn into adhesive aluminum extrusions and fixed at center
- Consists of scale and scanning head



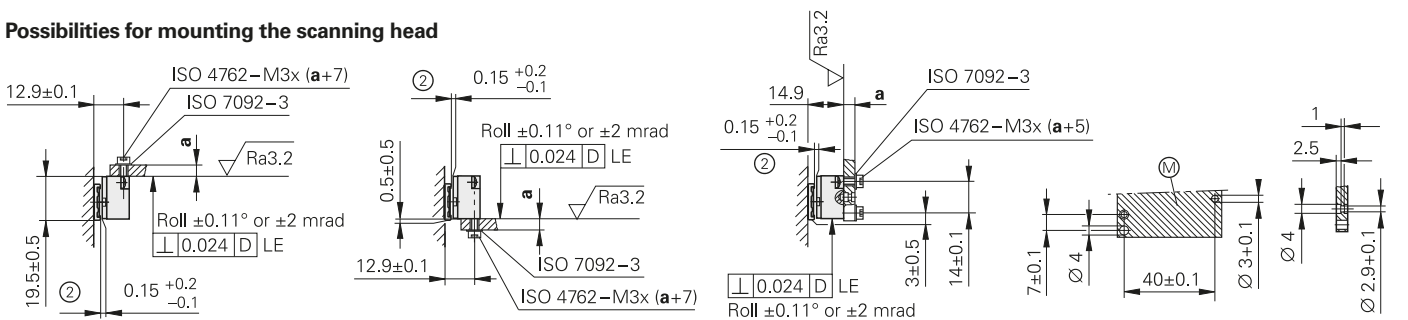
ML ≤ 2040
(e.g. 840)



ML > 2040
(e.g. 5040)



Possibilities for mounting the scanning head



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

- F = Machine guideway
- * = Max. change during operation (IKS: incremental track, RI: Reference mark track)
- P = Gauging points for alignment
- Ⓢ = Beginning of measuring length ML
- Ⓡ = Reference mark position
- Ⓐ = Selector magnet for limit switch
- Ⓣ = Carrier segment

- Ⓜ = Mounting surface for scanning head
- 1 = Function display
- 2 = Scanning gap
- 3 = Carrier stop surface
- 4 = Direction of scanning unit motion for output signals in accordance with interface description



Scale	LIDA 407
Measuring standard Coefficient of linear expansion	Steel scale tape with METALLUR scale grating; grating period 20 μm $\alpha_{\text{therm}} \approx 10 \times 10^{-6} \text{K}^{-1}$
Accuracy grade*	$\pm 3 \mu\text{m}$ (up to ML 1040); $\pm 5 \mu\text{m}$ (starting from ML 1240); $\pm 15 \mu\text{m}^{1)}$
Baseline error	$\leq \pm 0.750 \mu\text{m}/50 \text{mm}$ (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
Reference marks	One at midpoint of measuring length
Mass	25 g + 0.1 g/mm measuring length

Scanning head	LIDA 48	LIDA 47			
Interface	$\sim 1 \text{V}_{\text{PP}}$	\square 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	$\geq 400 \text{kHz}$	–			
Scanning frequency*	–	$\leq 400 \text{kHz}$ $\leq 200 \text{kHz}$ $\leq 100 \text{kHz}$ $\leq 50 \text{kHz}$	$\leq 200 \text{kHz}$ $\leq 100 \text{kHz}$ $\leq 50 \text{kHz}$ $\leq 25 \text{kHz}$	$\leq 50 \text{kHz}$ $\leq 25 \text{kHz}$ $\leq 12.5 \text{kHz}$	$\leq 25 \text{kHz}$ $\leq 12.5 \text{kHz}$ $\leq 6.25 \text{kHz}$
Edge separation $a^{2)}$	–	$\geq 0.100 \mu\text{s}$ $\geq 0.220 \mu\text{s}$ $\geq 0.465 \mu\text{s}$ $\geq 0.950 \mu\text{s}$	$\geq 0.100 \mu\text{s}$ $\geq 0.220 \mu\text{s}$ $\geq 0.465 \mu\text{s}$ $\geq 0.950 \mu\text{s}$	$\geq 0.080 \mu\text{s}$ $\geq 0.175 \mu\text{s}$ $\geq 0.370 \mu\text{s}$	$\geq 0.080 \mu\text{s}$ $\geq 0.175 \mu\text{s}$ $\geq 0.370 \mu\text{s}$
Traversing speed ²⁾	$\leq 480 \text{m/min}$	$\leq 480 \text{m/min}$ $\leq 240 \text{m/min}$ $\leq 120 \text{m/min}$ $\leq 60 \text{m/min}$	$\leq 240 \text{m/min}$ $\leq 120 \text{m/min}$ $\leq 60 \text{m/min}$ $\leq 30 \text{m/min}$	$\leq 60 \text{m/min}$ $\leq 30 \text{m/min}$ $\leq 15 \text{m/min}$	$\leq 30 \text{m/min}$ $\leq 15 \text{m/min}$ $\leq 7.5 \text{m/min}$
Interpolation error	$\pm 45 \text{nm}$	–			
Limit switches	L1/L2 with two different magnets; <i>output signals</i> : TTL (without line driver)				
Electrical connection	Cable, 0.5 m, 1 m, or 3 m, with 15-pin D-sub connector (male)				
Cable length	See interface description, but <i>limit</i> : $\leq 20 \text{m}$ (with HEIDENHAIN cable)				
Voltage supply	DC 5 V $\pm 0.5 \text{V}$				
Current consumption	$< 130 \text{mA}$	$< 150 \text{mA}$ (without load)			
Vibration 55 Hz to 2000 Hz Shock 6 ms	$\leq 500 \text{m/s}^2$ (EN 60068-2-6) $\leq 1000 \text{m/s}^2$ (EN 60068-2-27)				
Operating temperature	$-10 \text{ }^\circ\text{C}$ to $70 \text{ }^\circ\text{C}$				
Mass	Scanning head Connecting cable Connector	20 g (without cable) 22 g/m 32 g			

* Please select when ordering

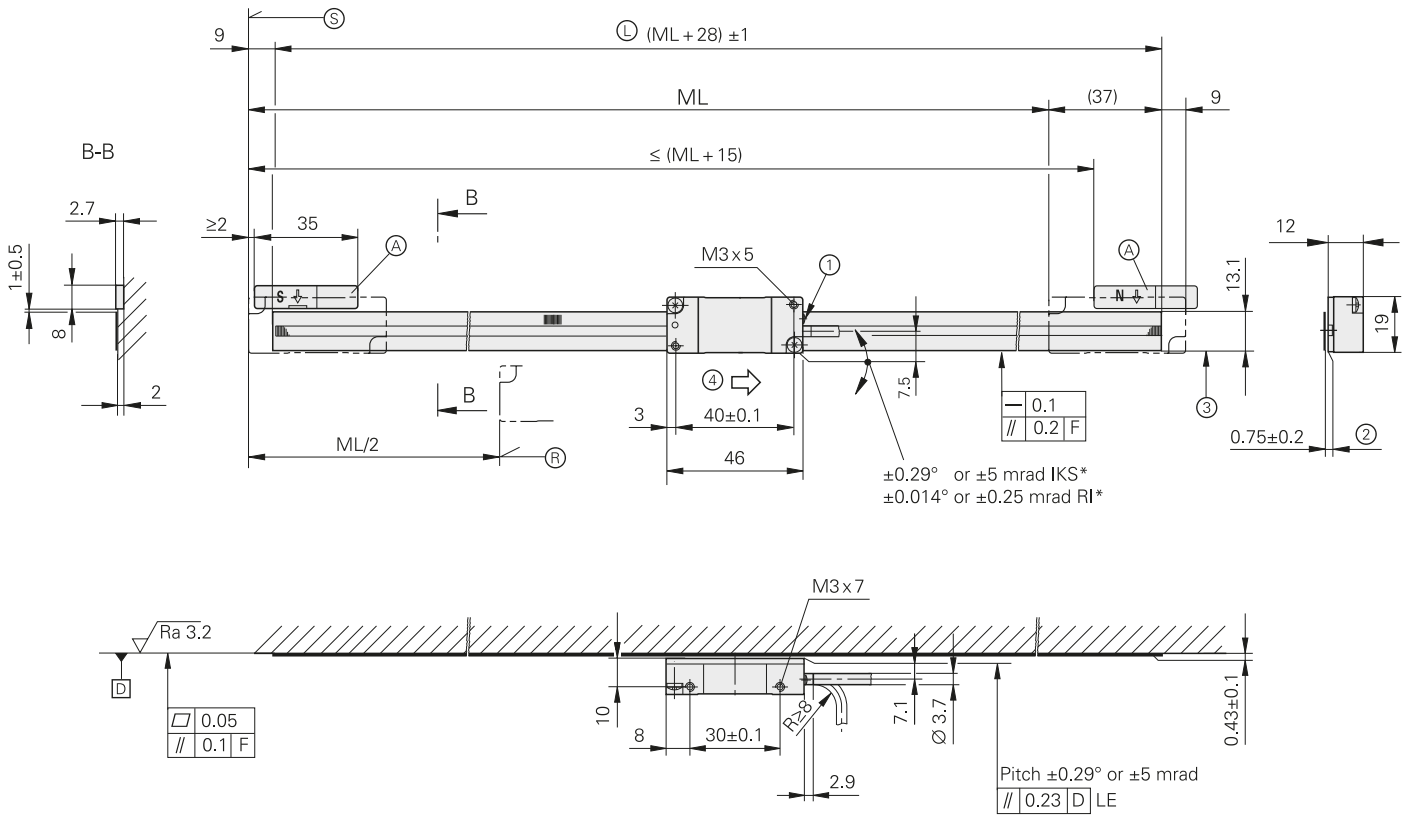
¹⁾ $\pm 5 \mu\text{m}$ after linear length-error compensation in the evaluation electronics

²⁾ At a corresponding cutoff or scanning frequency

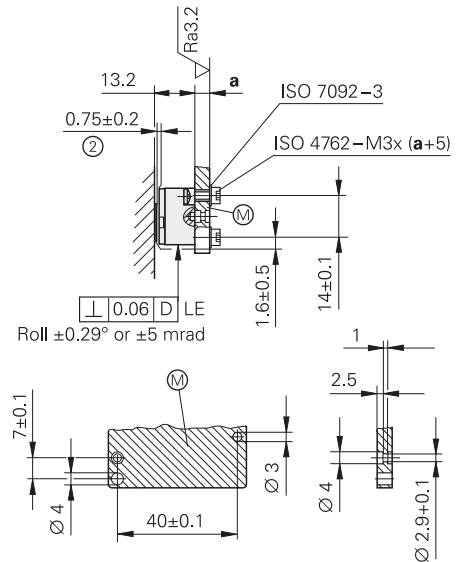
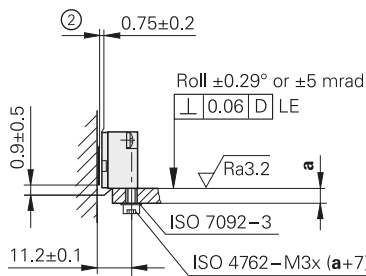
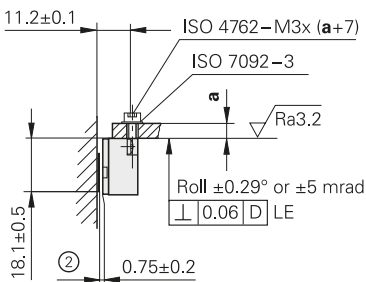
LIDA 479, LIDA 489

Incremental linear encoders for measuring ranges up to 6 m

- For measuring steps down to 50 nm
- Limit switches
- Steel scale tape cemented on mounting surface
- Consists of scale tape and scanning head



Possibilities for mounting the scanning head



mm
 Tolerancing ISO 8015
 ISO 2768 - m H
 < 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 = Function display
- 2 = Scanning gap
- 3 = Scale-tape stop surface
- 4 = Direction of scanning unit motion for output signals in accordance with interface description



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

Scanning head	LIDA 48	LIDA 47			
Interface	$\sim 1 \text{ V}_{\text{PP}}$	\square 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	$\geq 400 \text{ kHz}$	–			
Scanning frequency*	–	$\leq 400 \text{ kHz}$ $\leq 200 \text{ kHz}$ $\leq 100 \text{ kHz}$ $\leq 50 \text{ kHz}$	$\leq 200 \text{ kHz}$ $\leq 100 \text{ kHz}$ $\leq 50 \text{ kHz}$ $\leq 25 \text{ kHz}$	$\leq 50 \text{ kHz}$ $\leq 25 \text{ kHz}$ $\leq 12.5 \text{ kHz}$	$\leq 25 \text{ kHz}$ $\leq 12.5 \text{ kHz}$ $\leq 6.25 \text{ kHz}$
Edge separation a ²⁾	–	$\geq 0.100 \text{ µs}$ $\geq 0.220 \text{ µs}$ $\geq 0.465 \text{ µs}$ $\geq 0.950 \text{ µs}$	$\geq 0.100 \text{ µs}$ $\geq 0.220 \text{ µs}$ $\geq 0.465 \text{ µs}$ $\geq 0.950 \text{ µs}$	$\geq 0.080 \text{ µs}$ $\geq 0.175 \text{ µs}$ $\geq 0.370 \text{ µs}$	$\geq 0.080 \text{ µs}$ $\geq 0.175 \text{ µs}$ $\geq 0.370 \text{ µs}$
Traversing speed ²⁾	$\leq 480 \text{ m/min}$	$\leq 480 \text{ m/min}$ $\leq 240 \text{ m/min}$ $\leq 120 \text{ m/min}$ $\leq 60 \text{ m/min}$	$\leq 240 \text{ m/min}$ $\leq 120 \text{ m/min}$ $\leq 60 \text{ m/min}$ $\leq 30 \text{ m/min}$	$\leq 60 \text{ m/min}$ $\leq 30 \text{ m/min}$ $\leq 15 \text{ m/min}$	$\leq 30 \text{ m/min}$ $\leq 15 \text{ m/min}$ $\leq 7.5 \text{ m/min}$
Interpolation error	$\pm 45 \text{ nm}$	–			
Limit switches	L1/L2 with two different magnets; <i>output signals</i> : TTL (without line driver)				
Electrical connection	Cable, 0.5 m, 1 m, or 3 m, with 15-pin D-sub connector (male)				
Cable length	See interface description, but <i>limit</i> : $\leq 20 \text{ m}$ (with HEIDENHAIN cable)				
Voltage supply	DC 5 V $\pm 0.5 \text{ V}$				
Current consumption	$< 130 \text{ mA}$	$< 150 \text{ mA}$ (without load)			
Vibration 55 Hz to 2000 Hz Shock 6 ms	$\leq 500 \text{ m/s}^2$ (EN 60068-2-6) $\leq 1000 \text{ m/s}^2$ (EN 60068-2-27)				
Operating temperature	-10 °C to 70 °C				
Mass	Scanning head Connecting cable Connector	20 g (without cable) 22 g/m 32 g			

* Please select when ordering

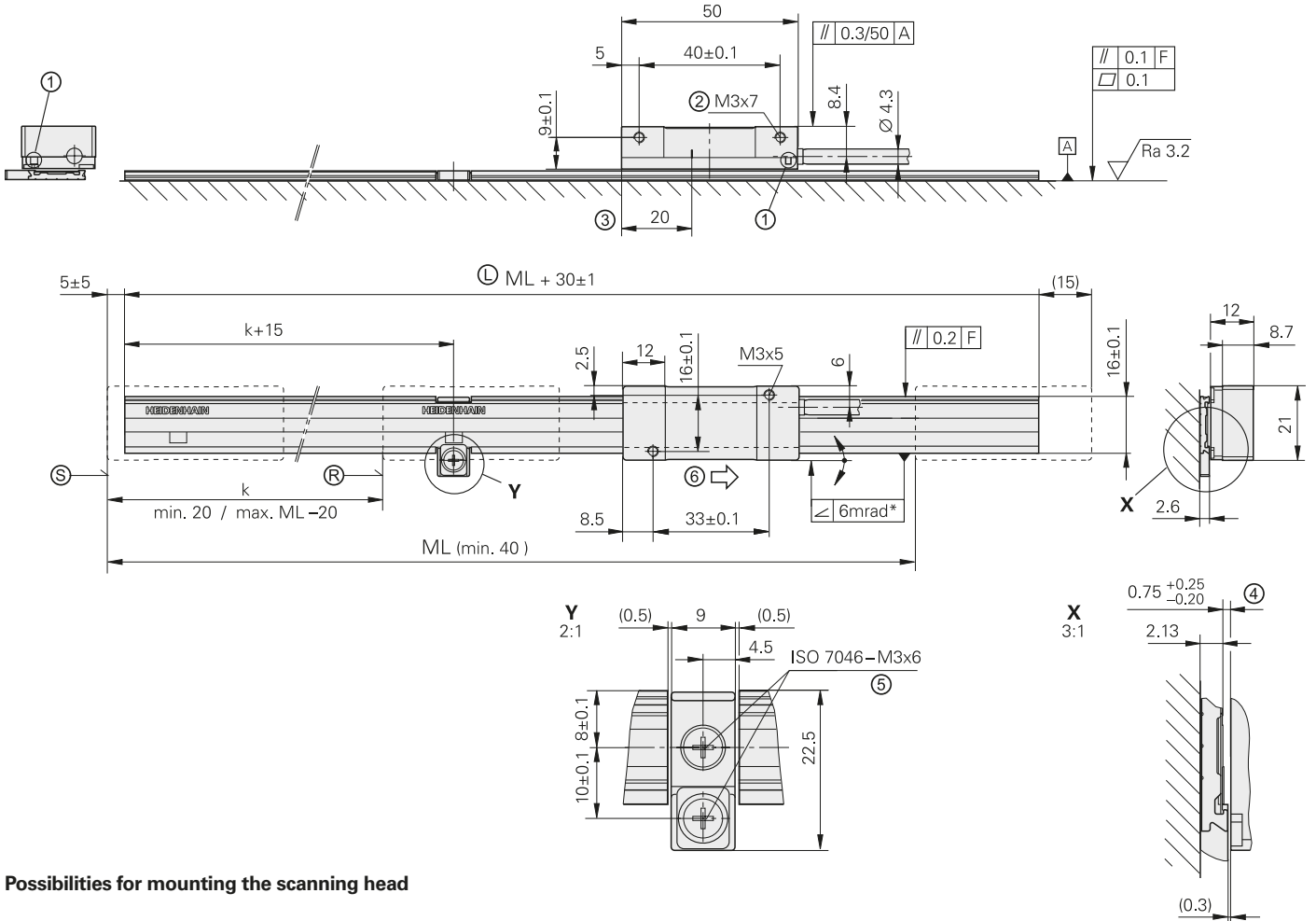
¹⁾ $\pm 5 \text{ µm}$ after linear length-error compensation in the evaluation electronics

²⁾ At a corresponding cutoff or scanning frequency

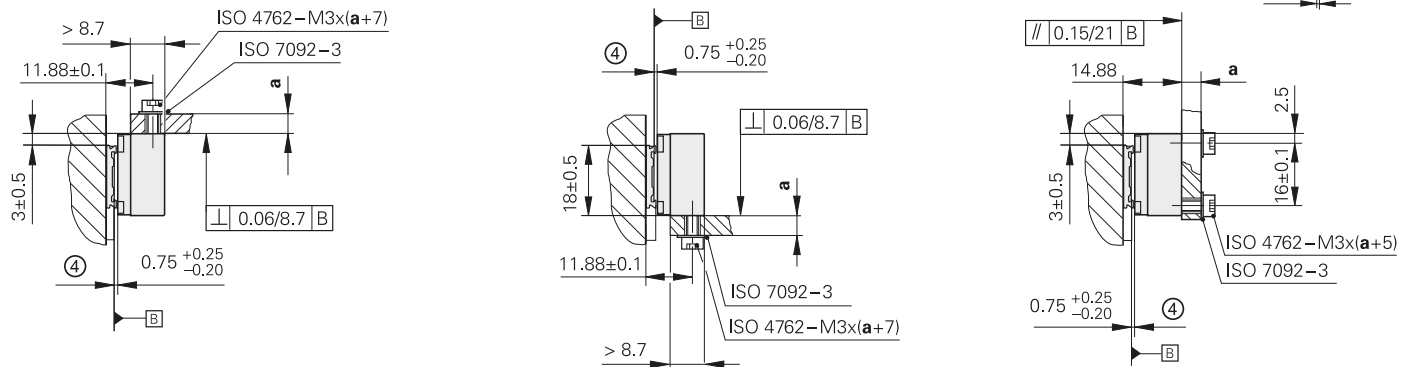
LIDA 277, LIDA 287

Incremental linear encoder with large mounting tolerance

- For measuring steps to 0.5 μ m
- Scale tape cut from roll
- Steel scale-tape is drawn into adhesive aluminum extrusions and fixed
- Integrated function display with three-color LED
- Consists of scale and scanning head



Possibilities for mounting the scanning head



mm

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

- * = Max. change during operation
- F = Machine guideway
- Ⓜ = Reference mark
- Ⓛ = Scale tape length
- Ⓢ = Beginning of measuring length ML
- 1 = LED (integrated mounting check)
- 2 = Thread at both ends
- 3 = Position of reference mark relative to scanning head
- 4 = Mounting clearance between scale and scanning head
- 5 = Mating threaded hole, M3, 5 mm deep
- 6 = Direction of scanning unit motion for output signals in accordance with interface description

Reference mark:

k = Any position of the selected reference mark starting from the beginning of the measuring length (depending on the cut)



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

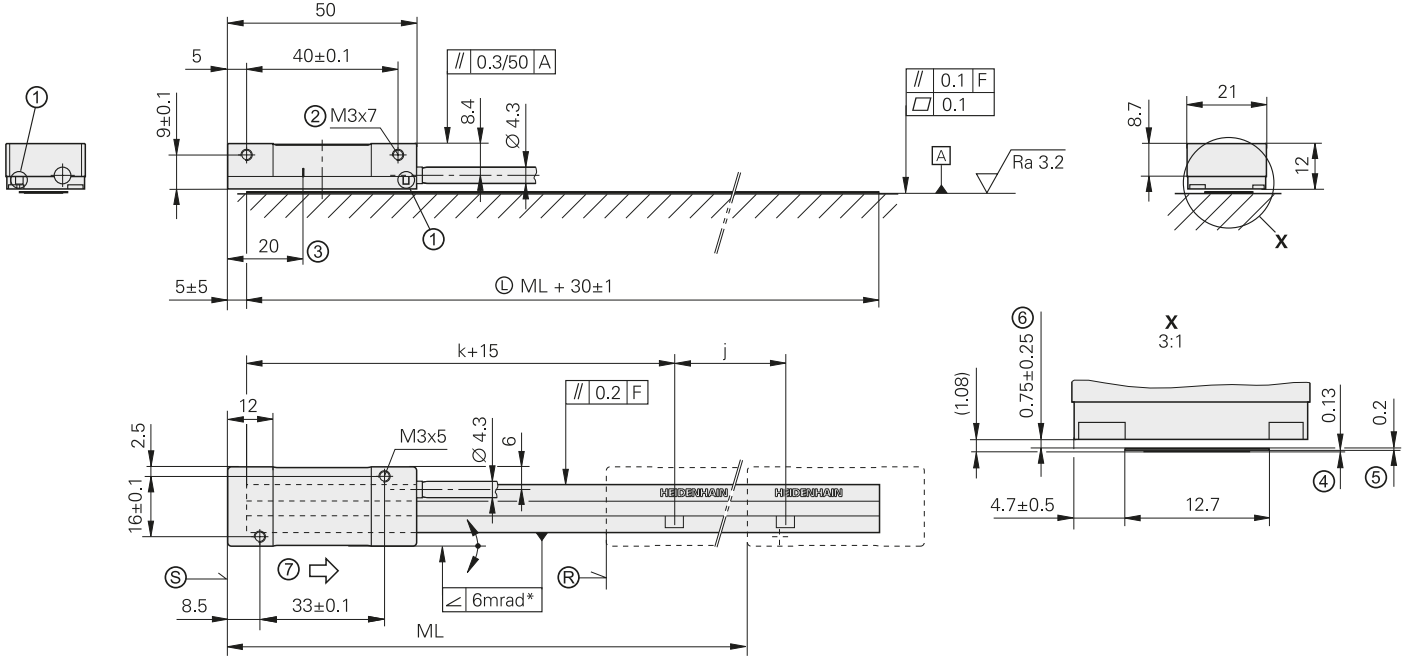
Scanning head	LIDA 28	LIDA 27		
Interface	~ 1 V _{PP}	□□TTL		
Integrated interpolation* Signal period	– 200 µm	10-fold 20 µm	50-fold 4 µm	100-fold 2 µm
Cut-off frequency Scanning frequency Edge separation a	≥ 50 kHz – –	– ≥ 50 kHz ≥ 0.465 µs	– ≤ 25 kHz ≥ 0.175 µs	– ≤ 12.5 kHz ≥ 0.175 µs
Traversing speed	≤ 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 interface description, but ≤ 30 m (with HEIDENHAIN cable)			
Power supply	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/s ² (EN 60068-2-6) ≤ 500 m/s ² (EN 60068-2-27)			
Operating temperature	–10 °C to 70 °C			
Mass Scanning head Connecting cable Connector	20 g (without cable) 30 g/m 32 g			

* Please select when ordering

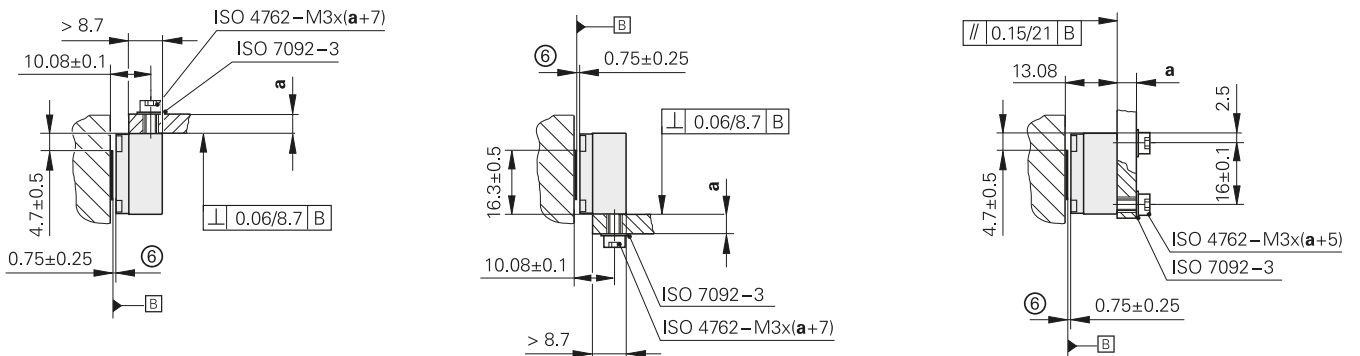
LIDA 279, LIDA 289

Incremental linear encoder with large mounting tolerance

- For measuring steps to 0.5 μm
- Scale tape cut from roll
- Steel scale cemented on mounting surface
- Integrated function display with three-color LED
- Consists of scale and scanning head



Possibilities for mounting the scanning head



mm



Tolerancing ISO 8015

ISO 2768 - m H

< 6 mm: ±0.2 mm

- * = Max. change during operation
- F = Machine guideway
- Ⓐ = Reference mark
- Ⓞ = Scale tape length
- Ⓢ = Beginning of measuring length ML
- 1 = LED (integrated mounting check)
- 2 = Thread at both ends
- 3 = Position of reference mark relative to scanning head
- 4 = Adhesive tape
- 5 = Steel scale tape
- 6 = Mounting clearance between scale and scanning head
- 7 = Direction of scanning unit motion for output signals in accordance with interface description

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



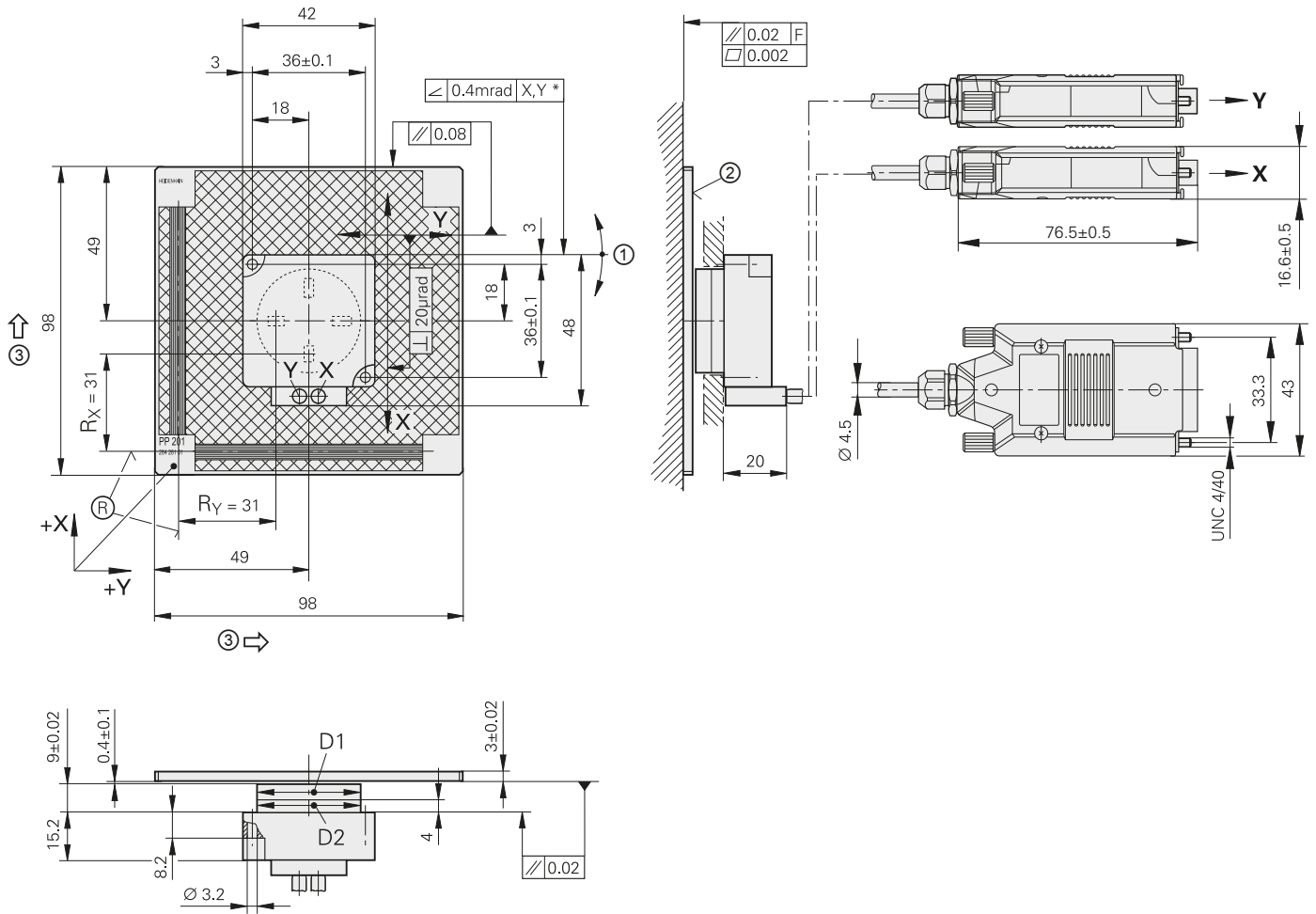
Scale	LIDA 209
Measuring standard Coefficient of linear expansion	Steel scale tape; grating period 200 µm $\alpha_{\text{therm}} \approx 10 \times 10^{-6} \text{ K}^{-1}$
Accuracy grade	±15 µm
Scale tape cut from roll*	3 m, 5 m, 10 m
Reference marks	Selectable every 100 mm
Mass	20 g/m

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 interface description, but ≤ 30 m (with HEIDENHAIN cable)			
Power supply	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/s ² (EN 60068-2-6) ≤ 500 m/s ² (EN 60068-2-27)			
Operating temperature	–10 °C to 70 °C			
Mass	Scanning head	20 g (without cable)		
	Connecting cable	30 g/m		
	Connector	32 g		

* Please select when ordering

PP 281 R

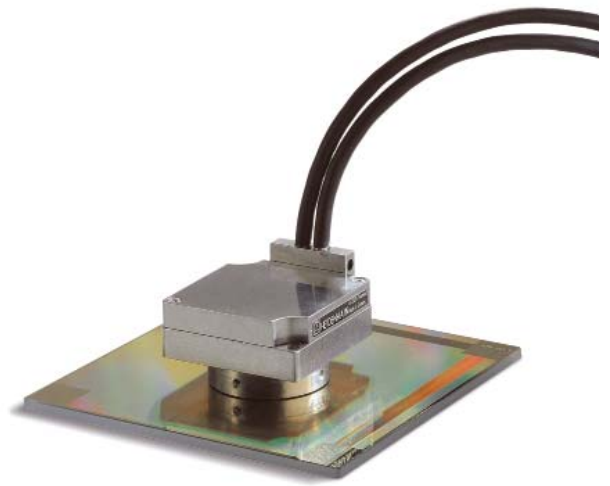
Two-coordinate incremental encoder
For measuring steps of 1 μm to 0.05 μm



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

- * = Max. change during operation
- F = Machine guideway
- Ⓜ = Reference-mark position relative to center position shown
- 1 = Adjusted during mounting
- 2 = Graduation side
- 3 = Direction of scanning unit motion for output signals in accordance with interface description

D1	D2
∅ 32.9 -0.2	∅ 33 -0.02/-0.10



		PP 281 R
Measuring standard	Two-coordinate TITANID phase grating on glass; grating period 8 μm	
Coefficient of linear expansion	$\alpha_{\text{therm}} \approx 8 \times 10^{-6} \text{ K}^{-1}$	
Accuracy grade	$\pm 2 \mu\text{m}$	
Measuring range	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	$\sim 1 \text{ V}_{\text{PP}}$	
Signal period	4 μm	
Cutoff frequency	-3 dB	$\geq 300 \text{ kHz}$
Traversing speed	$\leq 72 \text{ m/min}$	
Interpolation error	$\pm 12 \text{ nm}^3$	
Position noise RMS	2 nm (450 kHz ²⁾)	
Electrical connection	0.5 m cable with 15-pin D-sub connector (male); interface electronics in connector	
Cable length	See interface description, but $\leq 30 \text{ m}$ (with HEIDENHAIN cable)	
Power supply	DC 5 V $\pm 0.25 \text{ V}$	
Current consumption	$< 185 \text{ mA}$ per axis	
Vibration 55 Hz to 2000 Hz	$\leq 80 \text{ m/s}^2$ (EN 60068-2-6)	
Shock 11 ms	$\leq 100 \text{ m/s}^2$ (EN 60068-2-27)	
Operating temperature	0 °C to 50 °C	
Mass	Scanning head	170 g (without cable)
	Grid plate	75 g
	Connecting cable	37 g/m
	Connector	140 g

¹⁾ The reference mark signal deviates in its zero crossovers from the interface specification (see Mounting Instructions)

²⁾ -3 dB cutoff frequency of the subsequent electronics

³⁾ With HEIDENHAIN interface electronics, e.g. EIB 741

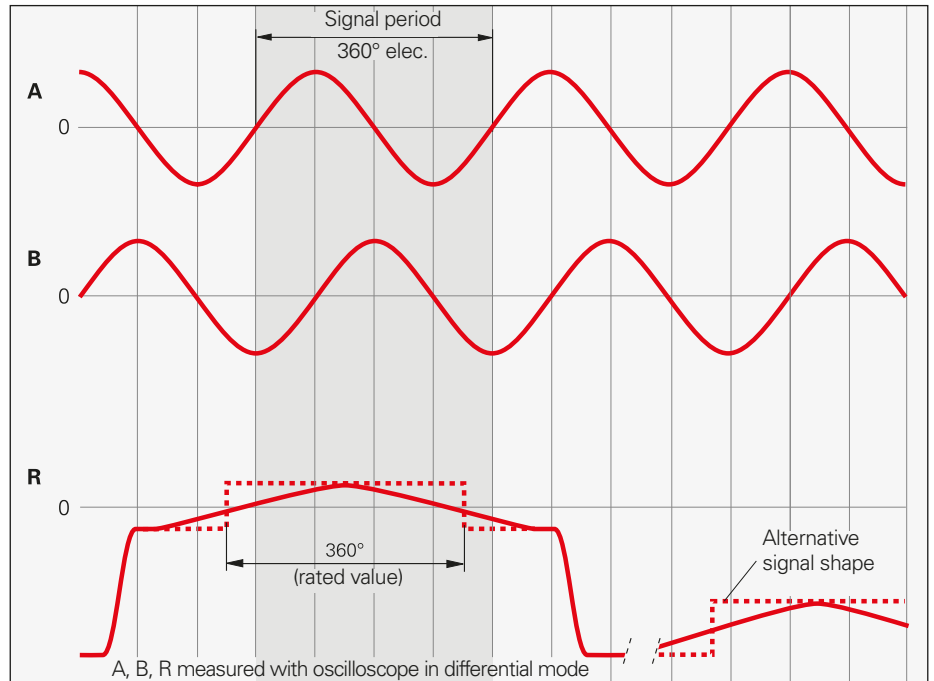
Interfaces

Incremental signals $\sim 1 V_{PP}$

HEIDENHAIN encoders with $\sim 1 V_{PP}$ interface provide voltage signals that can be highly interpolated.

The sinusoidal **incremental signals** A and B are phase-shifted by 90° elec. and have amplitudes of typically $1 V_{PP}$. The illustrated sequence of output signals—with B lagging A—applies for the direction of motion shown in the dimension drawing.

The **reference mark signal** R has an unambiguous assignment to the incremental signals. The output signal might be somewhat lower next to the reference mark.



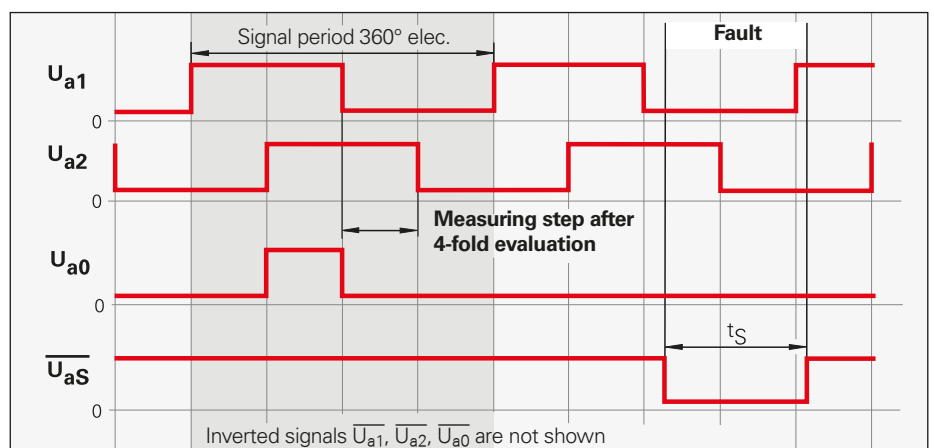
More information:

Comprehensive descriptions of all available interfaces as well as general electrical information are included in the *Interfaces of HEIDENHAIN Encoders* brochure.

Incremental signals \square TTL

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

The **incremental signals** are transmitted as the square-wave pulse trains U_{a1} and U_{a2} , phase-shifted by 90° elec. 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 produce their **inverted signals** $\overline{U_{a1}}$, $\overline{U_{a2}}$ and $\overline{U_{a0}}$ for noise-proof 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**.



More information:

Comprehensive descriptions of all available interfaces as well as general electrical information are included in the *Interfaces of HEIDENHAIN Encoders* brochure.

Limit switches

LIDA 400 encoders are equipped with two limit switches that make limit-position detection and the formation of homing tracks possible. The limit switches are activated by differing adhesive magnets to enable switching between the left or right limit. The magnets can be configured in series to form 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.



More information:

Comprehensive descriptions of all available interfaces as well as general electrical information are included in the *Interfaces of HEIDENHAIN Encoders* brochure.

Position detection

Besides the incremental graduation, the **LIF4x1** 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 in 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.



More information:

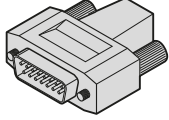

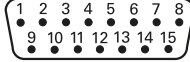
Comprehensive descriptions of all available interfaces as well as general electrical information are included in the *Interfaces of HEIDENHAIN Encoders* brochure.





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	Sensor ⁴⁾ 5V	0V	Sensor ⁴⁾ 0V	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
 1V _{PP}					A+	A-	B+	B-	R+	R-	As-signed				
 2)	Brown/ Green	Blue	White/ Green	White	BN	Green	Gray	Pink	Red	Black	Violet	Green/ Black	Yellow/ Black	Yellow	/

Shield on housing; **U_P** = Power supply voltage

Sensor: The sensor line is connected in the encoder with the corresponding power line.

Unused pins or wires must not be assigned!

¹⁾ Conversion of TTL/11 μA_{PP} for PWT

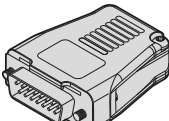

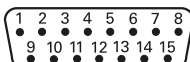
²⁾ Color assignment of the connecting cable


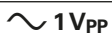


³⁾ Valid only for the LIDA 400

⁴⁾ LIDA 200: vacant

LIF 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 5V	0V	Sensor 0V	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
 1V _{PP}					A+	A-	B+	B-	R+	R-	As-signed				
 2)	Brown/ Green	Blue	White/ Green	White	BN	Green	Gray	Pink	Red	Black	Violet	Green/ Black	Green/ Black	Yellow	/

Shield on housing; **U_P** = Power supply voltage

Sensor: The sensor line is connected in the encoder with the corresponding power line.

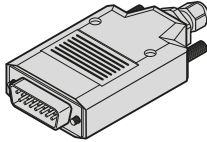

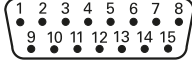



Unused pins or wires must not be assigned!

¹⁾ Conversion of TTL/11 μA_{PP} for PWT

²⁾ Color assignment of the connecting cable

³⁾ Valid only for the LIP 6000/LIF 400

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
 TTL  1V _{PP}	U _P	Sensor 5V	0V	Sensor 0V	U _{a1}	\overline{U}_{a1}	U _{a2}	\overline{U}_{a2}	U _{a0}	\overline{U}_{a0}	\overline{U}_{aS}	Vacant	Vacant	PWT ¹⁾
					A+	A-	B+	B-	R+	R-	Vacant	Vacant As- signed ³⁾		Vacant As- signed ³⁾
²⁾ 	Brown/ Green	Blue	White/ Green	White	BN	Green	Gray	Pink	Red	Black	Violet	/	/	Yellow

Shield on housing; **U_P** = Power supply voltage

Sensor: The sensor line is connected in the encoder with the corresponding power line.


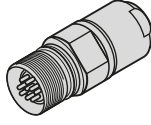
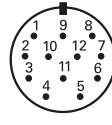

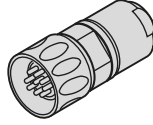
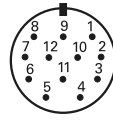



Unused pins or wires must not be assigned!

¹⁾ Conversion of TTL/11 μA_{PP} for PWT

²⁾ Color assignment of the connecting cable

³⁾ LIP 28

Alternative: LIDA 400

12-pin M23 coupling					12-pin M23 connector							
  					  							
	Power supply				Incremental signals						Other signals	
	12	2	10	11	5	6	8	1	3	4	7	9
 TTL  1V _{PP}	U _P	Sensor U _P	0V	Sensor 0V	U _{a1}	\overline{U}_{a1}	U _{a2}	\overline{U}_{a2}	U _{a0}	\overline{U}_{a0}	\overline{U}_{aS}	PWT ¹⁾
					A+	A-	B+	B-	R+	R-	L1	L2
²⁾ 	Brown/ Green	Blue	White/ Green	White	BN	Green	Gray	Pink	Red	Black	Violet	Yellow

Shield on housing; **U_P** = Power supply voltage

Sensor: The sensor line is connected in the encoder with the corresponding power line.

Unused pins or wires must not be assigned!

¹⁾ Conversion of TTL/11 μA_{PP} for PWT

²⁾ Color assignment of the connecting cable

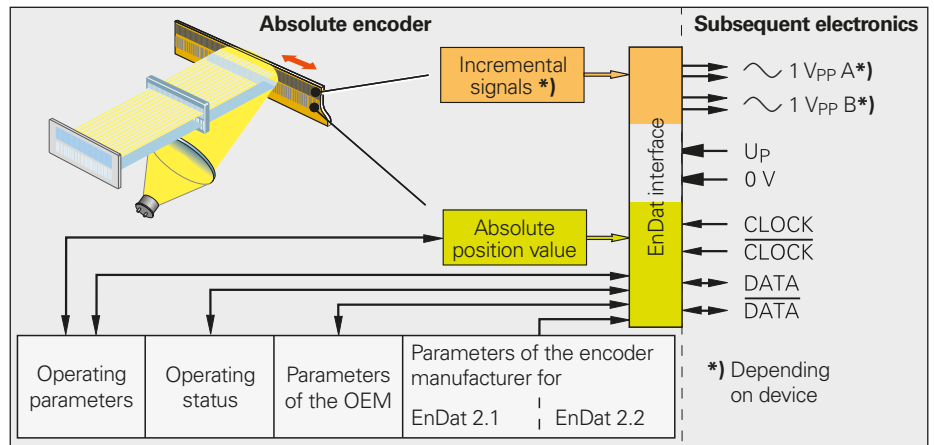
Interfaces

Position values

The EnDat interface is a digital, **bidirectional** interface for encoders. It is capable both of transmitting **position values** as well as transmitting or updating information stored in the encoder, or of saving new information. Thanks to the **serial transmission method**, only **four signal lines** are required. The DATA is transmitted in **synchronism** with the CLOCK signal from the subsequent electronics. The type of transmission (position values, parameters, diagnostics etc.) is selected by mode commands that the subsequent 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


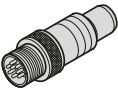


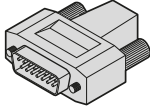
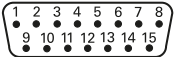



Versions of the EnDat interface



More information:

Comprehensive descriptions of all available interfaces as well as general electrical information are included in the *Interfaces of HEIDENHAIN Encoders* brochure.

EnDat pin layout

8-pin M12 coupling					15-pin D-sub connector			
								
	Power supply				Serial data transfer			
	8	2	5	1	3	4	7	6
	4	12	2	10	5	13	8	15
	U_P	Sensor U_P	0V	Sensor 0V	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 sensor line is connected in the encoder with the corresponding power line. Vacant pins or wires must not be used.

Fanuc and Mitsubishi pin layouts





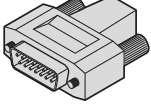
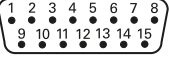



Fanuc pin layout

HEIDENHAIN encoders with the code letter F after the model designation are suited for connection to Fanuc controls and drive systems.

Fanuc Serial Interface – α Interface

Ordering designation: Fanuc05
high speed, one-pair transmission
Contains α interface (normal and high speed, two-pair transmission)

Fanuc pin layout

8-pin M12 coupling					15-pin D-sub connector				
									
	Power supply				Serial data transfer				
	8	2	5	1	3	4	7	6	
	4	12	2	10	5	13	8	15	
	U_P	Sensor U_P	0V	Sensor 0V	Serial Data	Serial Data	Request	Request	
	Brown/Green	Blue	White/Green	White	Gray	Pink	Violet	Yellow	

Cable shield connected to housing; U_P = Power supply voltage

Sensor: The sensor line is connected in the encoder with the corresponding power line.

Vacant pins or wires must not be used.

Mitsubishi pin layout


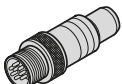
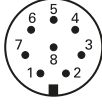

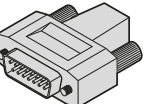
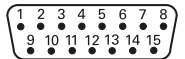



HEIDENHAIN encoders with the code letter M after the model designation are suited for connection to Mitsubishi controls and drive systems.

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

Mitsubishi pin layout

8-pin M12 coupling					15-pin D-sub connector				
									
	Power supply				Serial data transfer				
	8	2	5	1	3	4	7	6	
	4	12	2	10	5	13	8	15	
Mit03-4	U_P	Sensor U_P	0V	Sensor 0V	Serial Data	Serial Data	Request Frame	Request Frame	
Mit02-2					Vacant	Vacant	Request/ Data	Request/ Data	
	Brown/Green	Blue	White/Green	White	Gray	Pink	Violet	Yellow	

Cable shield connected to housing; U_P = Power supply voltage

Sensor: The sensor line is connected in the encoder with the corresponding power line.

Vacant pins or wires must not be used.


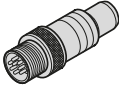


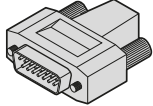
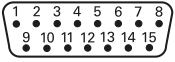



Panasonic pin layout

Panasonic pin layout

HEIDENHAIN encoders with the code letter P after the model designation are suited for connection to Panasonic controls and drive systems.

- Ordering designation: Pana01

Panasonic pin layout

8-pin M12 coupling					15-pin D-sub connector			
								
	Power supply				Serial data transfer			
	8	2	5	1	3	4	7	6
	4	12	2	10	5	13	8	15
	U_P	Sensor U _P	0V	Sensor 0V	Vacant ¹⁾	Vacant ¹⁾	Request Data	Request Data
	Brown/Green	Blue	White/Green	White	Gray	Pink	Violet	Yellow

Cable shield connected to housing; **U_P** = Power supply voltage

Sensor: The sensor line is connected in the encoder with the corresponding power line.

Vacant pins or wires must not be used.

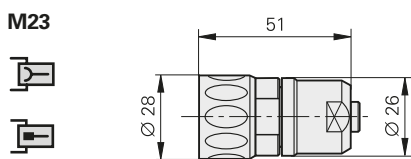
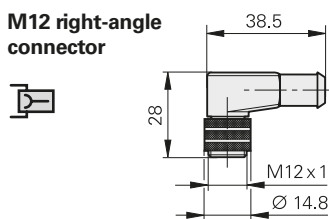
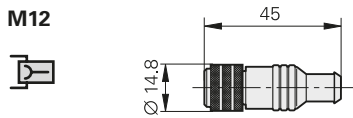
¹⁾ Required for adjustment/inspection by PWM 21

Connecting elements and cables

General information

Connector insulated: Connecting element with coupling ring, available with male or female contacts (see *Symbols*).

Symbols



Coupling insulated: Connecting element with outside thread, available with male or female contacts (see *Symbols*).

Symbols



Mounted coupling with central fastening

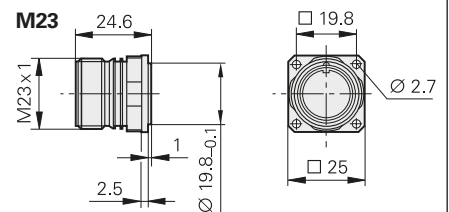
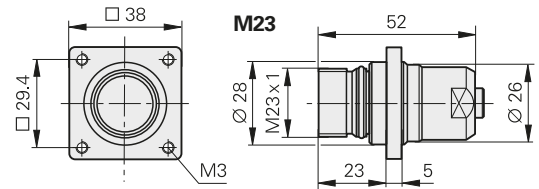
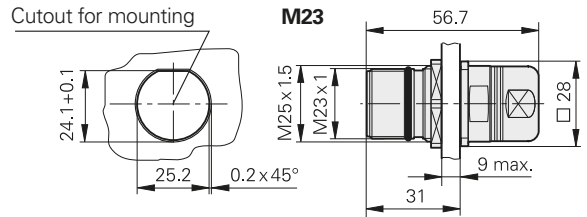
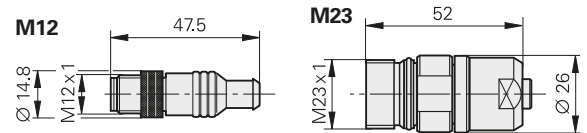


Mounted coupling with flange



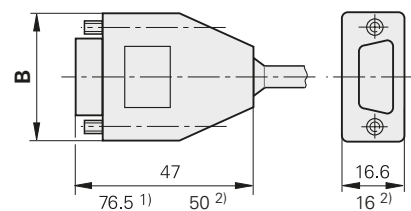
Flange socket with external thread; permanently mounted on a housing, available with male or female contacts.

Symbols



D-sub connector for HEIDENHAIN controls and evaluation electronics.

Symbols



- 1) Interface electronics integrated in connector (LIP 200 and PP)
- 2) Interface electronics integrated in connector (LIF and LIP 6071)

The **pin numbering** on connectors is in the direction opposite to those on couplings or flange sockets, regardless of whether the connecting elements have

male contacts or



female contacts.



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

Accessories for flange sockets and M23 mounted couplings

Threaded metal dust cap

ID 219926-01

Accessory for M12 connecting element

Insulation spacer

ID 596495-01







Connecting cables for 1 V_{PP}, TTL

		LIP/LIF/LIDA Without limit or homing signals		LIF 400/LIDA 400 With limit and homing signals	
PUR connecting cable [6 x (2 x 0.09 mm ²) + (4 x 0.14 mm ²)]; A _P = 0.14 mm ²					
PUR connecting cable [4 x (2 x 0.14 mm ²) + (4 x 0.5 mm ²) + 2 x (2 x 0.14 mm ²)]; A _P = 0.5 mm ²					
PUR connecting cable [6 x (2 x 0.19 mm ²)]; A _P = 0.19 mm ²					
PUR connecting cable [4 x (2 x 0.14 mm ²) + (4 x 0.5 mm ²)]; A _P = 0.5 mm ²		Ø 8 mm	Ø 6 mm ¹⁾	Ø 8 mm	Ø 6 mm ¹⁾
With 15-pin D-sub connector (female) and 12-pin M23 connector (male)		331693-xx	355215-xx	–	–
With 15-pin D-sub connector (female) and free cable end		332433-xx	355209-xx	354411-xx	355398-xx
With 15-pin D-sub connector (female) and 15-pin D-sub connector (male)		335074-xx	355186-xx	354379-xx	355397-xx
With 15-pin D-sub connector (female) and 15-pin D-sub connector (female) Pin layout for IK 220		335077-xx	349687-xx	–	–
Cable without connecting elements		816317-xx	816323-xx	354341-01	355241-01
Adapter cable for LIP 3x2 with 12-pin M23 coupling (male)		–	310128-xx	–	–
Adapter cable for LIP 3x2 with 15-pin D-sub connector, assignment for IK 220		298429-xx	–	–	–
Adapter cable for LIP 3x2 without connector		–	310131-xx	–	–
With 12-pin M23 connector (female) and 12-pin M23 connector (male)		298399-xx	–	–	–
With 12-pin M23 connector (female) and free cable end		309777-xx	–	–	–
D-sub connector for encoder connector on connecting cable	D-sub coupling, 15-pin 	For cable	Ø 6 mm to Ø 8 mm	315650-14	
M23 connector for encoder connecting element on connecting cable	M23 connector (female), 12-pin 	For cable	Ø 8 mm	291697-05	
M23 connector for connection to subsequent electronics	M23 connector (male), 12-pin 	For cable	Ø 8 mm Ø 6 mm	291697-08 291697-07	
M23 flange socket for installation in the subsequent electronics	M23 flange socket (female), 12-pin 			315892-08	
Adapter ~ 1 V _{PP} /11 μA _{PP} For converting the 1 V _{PP} signals to 11 μA _{PP} ; 12-pin M23 connector (female) and 9-pin M23 connector (male)					364914-01

¹⁾ Cable length for Ø 6 mm: max. 9 m

A_P: Cross section of the supply lines

EnDat connecting cables

PUR connecting cable [(4 × (2 × 0.09 mm ²)); A _P = 0.09 mm ²]			
PUR connecting cable [(4 × 0.14 mm ²) + (4 × 0.34 mm ²); A _P = 0.34 mm ²]		Ø 6 mm	Ø 3.7 mm ¹⁾
With 8-pin connector (female) and 8-pin coupling (male)		1036372-xx	801142-xx
With 8-pin right-angle connector (female) and 8-pin coupling (male)		373289-xx	801149-xx
With 8-pin connector (female) and 15-pin D-sub connector (male), for PWM 20, EIB 74x etc.		524599-xx	801129-xx
With 8-pin right-angle connector (female) and 15-pin D-sub connector (male), for PWM 20, EIB 74x etc.		722025-xx	801140-xx
With 8-pin connector (female) and free cable end		634265-xx	–
With 8-pin right-angle connector (female) and free cable end		606317-xx	–






¹⁾ Max. total cable length 6 m

A_P: Cross section of power supply lines

Connecting cables

Fanuc Mitsubishi





Fanuc

PUR connecting cable $[4 \times (2 \times 0.09 \text{ mm}^2)]; A_P = 0.09 \text{ mm}^2$			
PUR connecting cable $[(4 \times 0.14 \text{ mm}^2) + (4 \times 0.34 \text{ mm}^2)]; A_P = 0.34 \text{ mm}^2$		$\varnothing 6 \text{ mm}$	$\varnothing 3.7 \text{ mm}^{1)}$
With 8-pin M12 connector (female) and 8-pin M12 coupling (male)		368330-xx	801142-xx
With 8-pin M12 right-angle connector (female) and 8-pin M12 coupling (male)		373289-xx	801149-xx
With 8-pin M12 connector (female) and Fanuc connector (female)		646807-xx	–
With 8-pin M12 connector (female) and free cable end		634265-xx	–
With 8-pin M12 right-angle connector (female) and free cable end		606317-xx	–

¹⁾ Max. total cable length 6 m

A_P : Cross section of power supply lines

Mitsubishi

PUR connecting cable $[(1 \times 4 \times 0.14 \text{ mm}^2) + (4 \times 0.34 \text{ mm}^2)]; A_P = 0.34 \text{ mm}^2$		$\varnothing 6 \text{ mm}$
With 8-pin M12 connector (female) and 20-pin Mitsubishi connector	 Mitsubishi 20-pin	646806-xx
With 8-pin M12 connector (female) and 10-pin Mitsubishi connector	 Mitsubishi 10-pin	647314-xx
With 8-pin M12 connector (female) and free cable end		634265-xx
With 8-pin M12 right-angle connector (female) and free cable end		606317-xx

A_P : Cross section of power supply lines

Diagnostic and testing equipment

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

Incremental encoders mainly 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, the analysis of output signals is possible only in external test devices or through computation in the subsequent electronics (analog diagnostics interface).

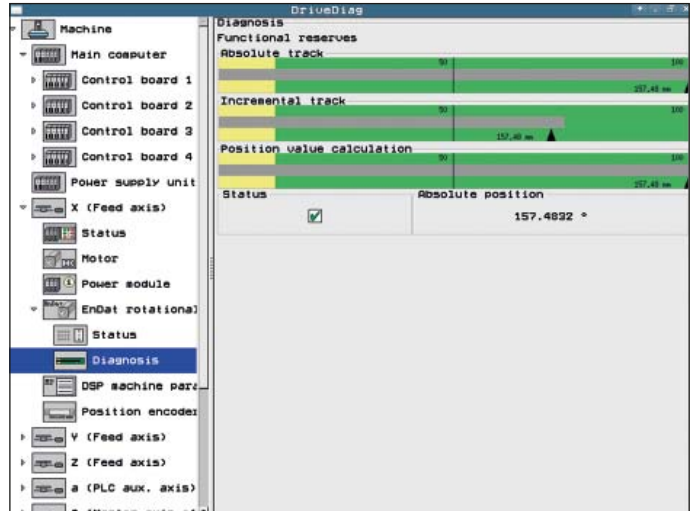
Absolute encoders operate with serial data transfer. Depending on the interface, additional 1 V_{PP} incremental signals can be output. The signals are monitored comprehensively within the encoder. The monitoring result (especially with valuation numbers) can be transferred along with the position values through the serial interface to the subsequent electronics (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 on the encoder's functional reserve
 - Identical scaling for all HEIDENHAIN encoders
 - Cyclic output is possible

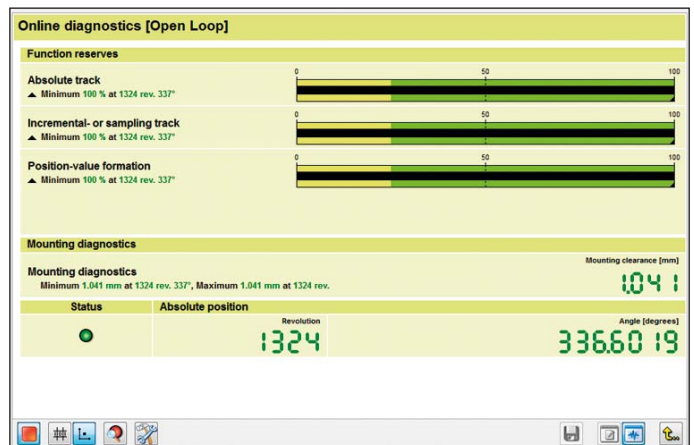
This enables the subsequent electronics to evaluate the current status of the encoder with little effort even in closed-loop mode.

HEIDENHAIN offers the appropriate PWM inspection devices and PWT test devices for encoder analysis. There are two types of diagnostics, depending on how the devices are integrated:

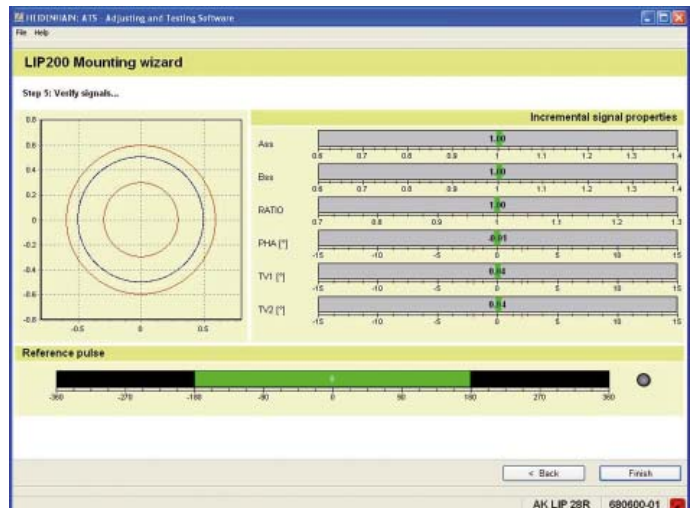
- Encoder diagnostics: The encoder is connected directly to the test or inspection device. This makes a comprehensive analysis of encoder functions possible.
- Diagnostics in the control loop: The PWM phase meter is looped into the closed control loop (e.g., through a suitable testing adapter). This makes a real-time diagnosis of the machine or system possible during operation. The functions depend on the interface.



Diagnostics in the control loop on HEIDENHAIN controls with display of the valuation number or the analog encoder signals



Diagnostics using PWM 21 and ATS software



Commissioning using PWM 21 and ATS software

Diagnostic and testing equipment

PWM 21

The PWM 21 phase angle measuring unit serves together with the provided ATS adjusting and testing software for diagnosis and adjustment of HEIDENHAIN encoders.



For more information, see the *PWM 21/ATS Software* Product Information document.

	PWM 21
Encoder input	<ul style="list-style-type: none"> • EnDat 2.1 or EnDat 2.2 (absolute value with or without incremental signals) • DRIVE-CLiQ • Fanuc Serial Interface • Mitsubishi high speed interface • Yaskawa serial interface • SSI • 1 V_{PP}/TTL/11 μA_{PP}
Interface	USB 2.0
Voltage supply	AC 100 V to 240 V or DC 24 V
Dimensions	258 mm x 154 mm x 55 mm

	ATS
Languages	Choice between English and German
Functions	<ul style="list-style-type: none"> • Position display • Connection dialog • Diagnostics • Mounting wizard for EBI/ECI/EQI, LIP 200, LIC 4100 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 system: Windows XP, Vista, 7 (32-bit/64-bit), 8 200 MB free space on hard disk

DRIVE-CLiQ is a registered trademark of SIEMENS AG.

PWT 100

The PWT 100 is a testing device for checking the function and adjustment of incremental and absolute HEIDENHAIN encoders. Thanks to its compact dimensions and robust design, the PWT 100 is ideal for mobile use.



	PWT 100
Encoder input Only for HEIDENHAIN encoders	<ul style="list-style-type: none"> • EnDat • Fanuc Serial Interface • Mitsubishi high speed interface • Panasonic Serial Interface • Yaskawa Serial Interface • 1 V_{PP} • 11 μA_{PP} • TTL
Display	4.3" color flat-panel display (touch screen)
Voltage supply	DC 24 V Power consumption: max. 15 W
Operating temperature	0 °C to 40 °C
Protection EN 60529	IP20
Dimensions	≈ 145 mm x 85 mm x 35 mm

Interface electronics

Interface electronics from HEIDENHAIN adapt the encoder signals to the interface of the subsequent electronics. They are used when the subsequent electronics cannot directly process the output signals from HEIDENHAIN encoders, or if additional interpolation of the signals is necessary.

Input signals of the interface electronics

Interface electronics from HEIDENHAIN can be connected to encoders with sinusoidal signals of 1 V_{PP} (voltage signals) or 11 μA_{PP} (current signals). Encoders with the serial interfaces EnDat or SSI can also be connected to various interface electronics.

Output signals of the interface electronics

Interface electronics with the following interfaces to the subsequent electronics are available:

- 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 being converted, the sinusoidal encoder signals are also interpolated in the interface electronics. This permits finer measuring steps and, as a result, higher control quality and better positioning behavior.

Formation of a position value

Some interface electronics have an integrated counting function. Starting from the last reference point set, an absolute position value is formed when the reference mark is traversed, and is transferred to the subsequent electronics.

Box design



Plug design



Version for integration



Top-hat rail design



Outputs		Inputs		Design – degree of protection	Interpolation ¹⁾ or subdivision	Model	
Interface	Qty.	Interface	Qty.				
□□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 660B	
				Plug design – IP40	5/10/20/25/50/100-fold	APE 371	
				Version for integration – IP00	5/10-fold	IDP 181	
			20/25/50/100-fold	IDP 182			
		~ 11 μA _{PP}	1	Box design – IP65	1	5/10-fold	EXE 101
						20/25/50/100-fold	EXE 102
						Without/5-fold	EXE 602E
25/50/100/200/400-fold	EXE 660B						
	Version for integration – IP00	5-fold	IDP 101				
□□TTL/ ~ 1 V _{PP} Adjustable	2	~ 1 V _{PP}	1	Box design – IP65	2-fold	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	≤ 16384-fold subdivision	EIB 192	
				Plug design – IP40	≤ 16384-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	
Fanuc Serial Interface	1	~ 1 V _{PP}	1	Box design – IP65	≤ 16384-fold subdivision	EIB 192F	
				Plug design – IP40	≤ 16384-fold subdivision	EIB 392F	
			2	Box design – IP65	≤ 16384-fold subdivision	EIB 1592F	
Mitsubishi high speed interface	1	~ 1 V _{PP}	1	Box design – IP65	≤ 16384-fold subdivision	EIB 192M	
				Plug design – IP40	≤ 16384-fold subdivision	EIB 392M	
			2	Box design – IP65	≤ 16384-fold subdivision	EIB 1592M	
Yaskawa Serial Interface	1	EnDat 2.2 ²⁾	1	Plug design – IP40	–	EIB 3391Y	
PROFIBUS-DP	1	EnDat 2.1; EnDat 2.2	1	Top-hat rail design	–	PROFIBUS Gateway	

¹⁾ Switchable

²⁾ Only for LIC 4100 with 5 nm measuring step, or LIC 2100 with 50 nm or 100 nm measuring steps



ООО «РемСтанМаш»

Адрес: г. Смоленск, улица Верхне-Сенная улица, дом 4, офис № 409.
Телефон: 8-800-511-02-67
Телефон: +7-919-0-46-48-46
E-mail: info@cnchelp.ru
Сайт: www.cnchelp.ru