HEIDENHAIN



Linear Encoders

For Numerically Controlled Machine Tools

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Further information is available on the Internet at *www.heidenhain.com* as well as upon request.

Brochures regarding:
- Exposed linear encoders
- Angle encoders with integral bearing
- Angle encoder modules
- Modular angle encoders with scale drum or scale tape
- Rotary encoders
- HEIDENHAIN controls
- Encoders for machine tool inspection and acceptance testing
- Interfaces of HEIDENHAIN encoders

Technical information regarding:
- Accuracy of feed axes
- Safety-related position measuring systems
- EnDat 2.2: bidirectional interface for position encoders
- Encoders for feed axes with direct drives

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

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

Further information:

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

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Linear encoders for numerically controlled machine tools

Linear encoders from HEIDENHAIN for numerically controlled machine tools can be used nearly everywhere. They are ideal for machines and other equipment whose feed axes are in a closed loop, such as milling machines, machining centers, boring mills, lathes, and grinding machines. The beneficial dynamic behavior of linear encoders, their high permissible traversing speed, and their acceleration in the direction of measurement predestine them for use on highly-dynamic conventional axes as well as on direct drives.

HEIDENHAIN also supplies linear encoders for other applications, such as:
- Manual machine tools
- Presses and bending machines
- Automation and production equipment

Advantages of linear encoders
If a linear encoder is used for measurement of the slide position, the position control loop includes the complete feed mechanics. This is referred to as Closed Loop operation. Transfer errors from the mechanics can be detected by the linear encoder on the feed axis, and corrected by the control electronics. This makes it possible to eliminate a number of potential error sources:
- Positioning error due to thermal changes in the recirculating ball screw
- Reversal error
- Kinematic error through the ball-screw pitch error

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

Mechanical design
Linear encoders for numerically controlled machine tools are sealed measuring devices: an aluminum housing protects the scale, the scanning carriage, and its guide from chips, dust, and splashing water. Downward-oriented elastic lips seal the housing.

The scanning carriage travels along the scale on a low-friction guide. A coupling connects the scanning carriage with the mounting block and compensates the misalignment between the scale and the machine slide.

Depending on the encoder model, lateral and axial offsets of ±0.2 mm to ±0.3 mm between the scale and mounting block are permissible.

Further information:
Please request further documentation or inform yourself on the Internet at *www.heidenhain.com*.



Thermal characteristics
Increasingly faster machining times with fully encapsulated machines cause ever higher temperatures in the machine's working space. Therefore, the thermal behavior of the linear encoders used becomes increasingly important, since it 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 must expand or contract in a defined, reproducible manner. Linear encoders from HEIDENHAIN are designed for this.

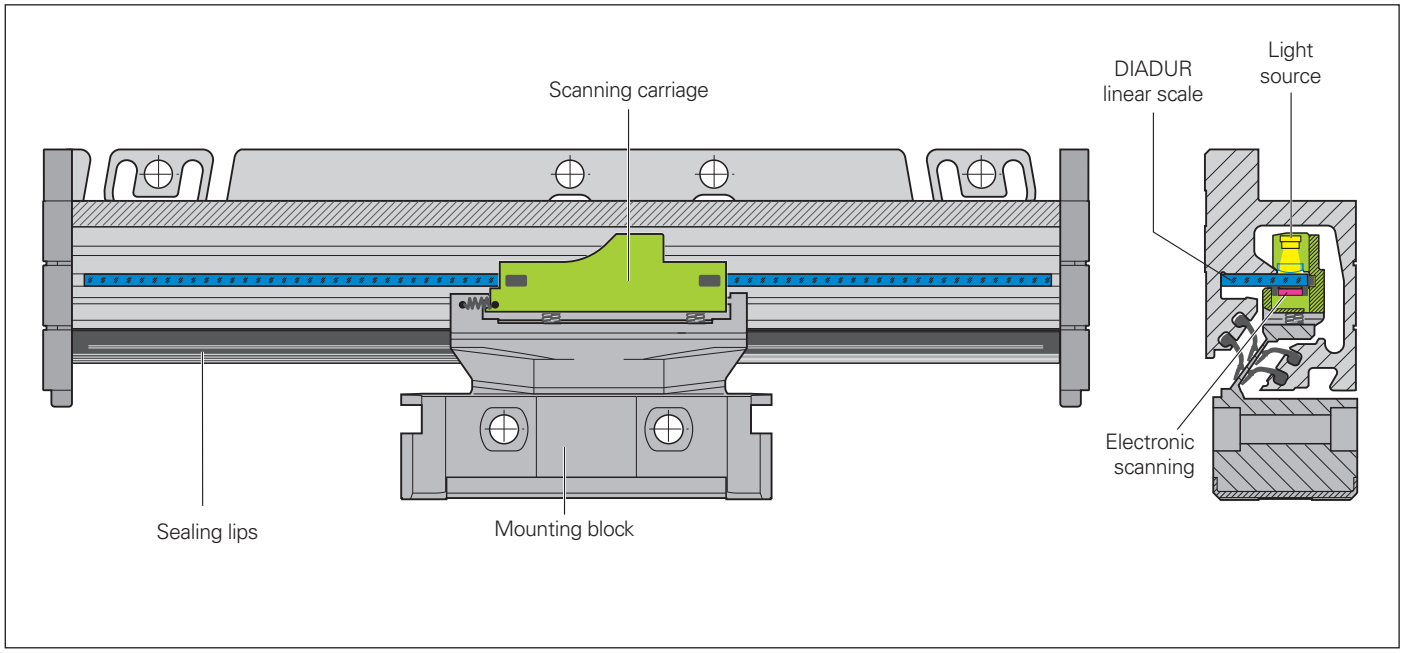
The graduation carriers of HEIDENHAIN linear encoders have defined coefficients of linear thermal expansion (see *Specifications*). This makes it possible to select the linear encoder whose thermal behavior is best suited to the application.

Dynamic behavior
Efficiency and performance improvements in machine tools require ever higher feed rates and accelerations. Of course, they must not compromise machining accuracy. In order to transfer rapid and yet exact feed motions, very high demands are placed on rigid machine design as well as on the linear encoders used.

Linear encoders from HEIDENHAIN are characterized by their high rigidity in the measuring direction. This is a very important prerequisite for high-quality contouring accuracy of a machine tool. In addition, the low mass of moving components contributes to their excellent dynamic behavior.

Availability
The feed axes of machine tools travel quite large distances—a typical value is 10000 km in three years. This is why sturdy encoders with good long-term stability are especially important: they ensure the constant availability of the machine.

Due to the details of their design, linear encoders from HEIDENHAIN function properly even after years of operation. A long service life is ensured by the contact-free photoelectric scanning of the measuring standard and by the ball-bearing guidance of the scanning carriage in the scale housing. Thanks to their enclosure, special scanning principles, and—if required—a sealing air connection, the linear encoders are particularly tolerant to contamination. The complete shielding design ensures a high degree of electrical noise immunity.

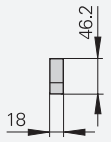
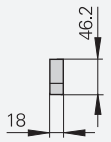
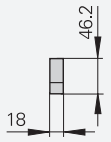


Schematic design of the **LC 115** sealed linear encoder

Selection guide

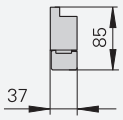
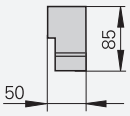
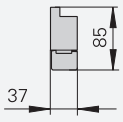
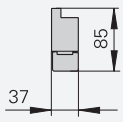
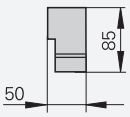
Linear encoders with slimline scale housing

The linear encoders with **slimline scale housing** are designed for **limited installation space**. Larger measuring lengths and higher acceleration loads are possible through the use of a mounting spar or clamping elements.

	Cross section	Accuracy grade	Max. interpolation error	Measuring length (ML)
Absolute position measurement • Glass scale		±5 µm ±3 µm	±0.1 µm	70 mm to 1240 mm *With mounting spar or clamping elements:* 70 mm to 2040 mm
Incremental linear measurement with very high repeatability • Steel scale • Small signal period		±5 µm ±3 µm	± 0.04 µm	50 mm to 1220 mm
Incremental linear measurement • Glass scale		±5 µm ±3 µm	±0.2 µm	70 mm to 1240 mm *With mounting spar:* 70 mm to 2040 mm

Linear encoders with full-size scale housing

Linear encoders with **full-size scale housing** are characterized by their **sturdy design, high resistance to vibration,** and **large measuring lengths**. As a connection between the scanning carriage and the mounting block, they have an "oblique web," which permits **vertical and horizontal mounting** with the same degree of protection.

Absolute position measurement • Glass scale		±5 µm ±3 µm	±0.1 µm[1)]	140 mm to 4240 mm
Absolute position measurement For large measuring lengths • Steel scale tape		±5 µm	±0.4 µm	440 mm to 28040 mm
Incremental linear measurement with very high repeatability • Steel scale • Small signal period		±3 µm ±2 µm	± 0.04 µm	140 mm to 3040 mm
Incremental linear measurement • Glass scale		±5 µm ±3 µm	± 0.2 µm	140 mm to 3040 mm
Incremental linear measurement for large measuring lengths • Steel scale tape		±5 µm	±0.8 µm	440 mm to 30040 mm Up to 72040 mm upon request

[1)] For measuring lengths > 3040 mm: ±0.4 µm at the butt joint (at approx. 3100 mm)

Further information:

For further information about linear encoders with optimized scanning, please see the *LC 116/LC 196/LC 416/ LC 496 Product Information* document or go to *www.heidenhain.com*.

	Signal period	Interface	Model	Page
	–	EnDat 2.2	**LC 415**[2]	**22**
	20 µm	EnDat 2.2 with ~ 1 V_{PP}	**LC 485**	
	–	DRIVE-CLiQ	**LC 495 S**	**24**
		Fanuc αi	**LC 495 F**	
		Mitsubishi	**LC 495 M**	
		Panasonic	**LC 495 P**	
	4 µm	~ 1 V_{PP}	**LF 485**	**34**
	20 µm	~ 1 V_{PP}	**LS 487**	**38**
	–	⊓⊔ TTL	**LS 477**	
	–	EnDat 2.2	**LC 115**[2]	**26**
	20 µm	EnDat 2.2 with ~ 1 V_{PP}	**LC 185**	
	–	DRIVE-CLiQ	**LC 195 S**	**28**
		Fanuc αi	**LC 195 F**	
		Mitsubishi	**LC 195 M**	
		Panasonic	**LC 195 P**	
	–	EnDat 2.2	**LC 211**	**30**
	40 µm	EnDat 2.2 with ~ 1 V_{PP}	**LC 281**	
	–	Fanuc αi	**LC 291 F**	
		Mitsubishi	**LC 291 M**	
	4 µm	~ 1 V_{PP}	**LF 185**	**36**
	20 µm	~ 1 V_{PP}	**LS 187**	**40**
	–	⊓⊔ TTL	**LS 177**	
	40 µm	~ 1 V_{PP}	**LB 383 C**	**42**

[2] Connectable to Yaskawa interface via EIB 3391Y



LC 415



LF 485
LS 487



LC 115



LF 185



LC 211

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 made of glass or steel. For encoders with long measuring lengths, steel tape is used as the scale substrate.

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

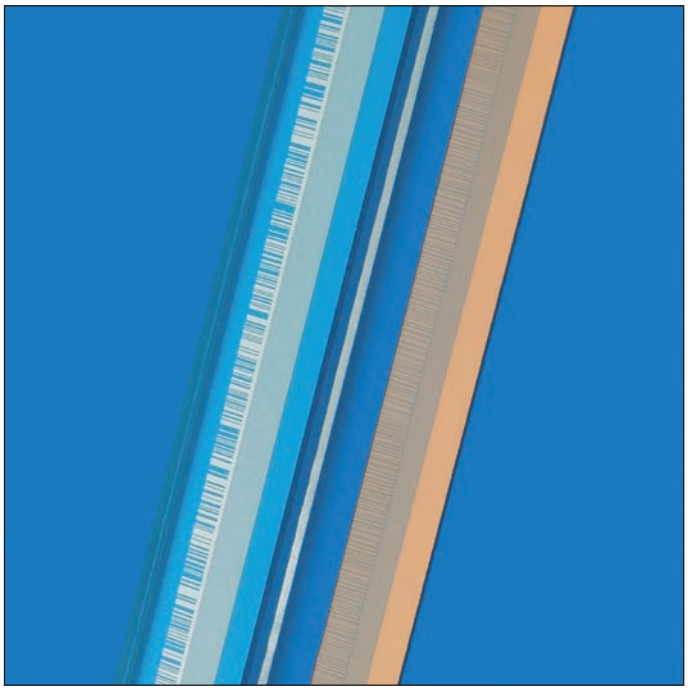
- METALLUR: contamination-tolerant graduation consisting of metal lines on gold; typical grating period: 40 µm
- DIADUR: extremely robust chromium lines on glass (typical grating period: 20 µm), or three-dimensional chromium structures (typical grating period: 8 µm) on glass
- SUPRADUR phase grating: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

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

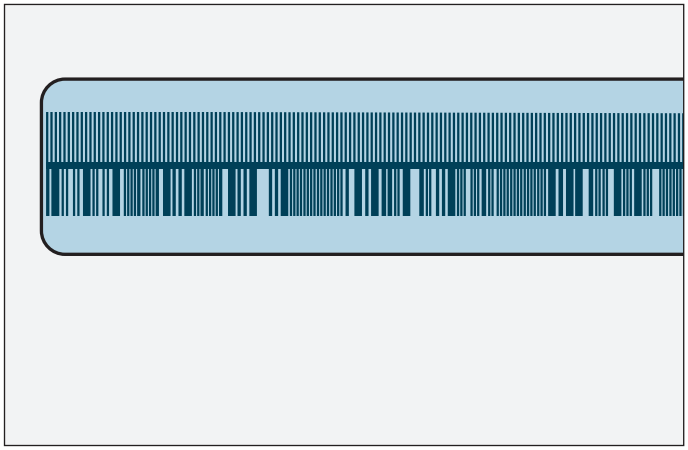
The master graduations are manufactured by HEIDENHAIN on custom-built, high-precision dividing engines.

Absolute measuring method

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



Graduations of absolute linear encoders



Schematic representation of an absolute code structure with an additional incremental track (LC 485 as example)

Incremental measuring method

In the **incremental measuring method**, the graduation is a periodic grating structure. The position information is obtained **through counting** the individual increments (measuring steps) starting at a freely selectable point of origin. Since the ascertainment of positions requires an absolute reference, the scales or scale tapes feature an additional track bearing a **reference mark**. The absolute position on the scale, established by the reference mark, is gated with exactly one signal period.

Thus, before an absolute reference can be established or the most recently selected reference point can be refound, this reference mark must first be traversed.

In the most unfavorable case, machine movements over sizeable sections of the measuring range may be necessary. To speed up and simplify such "reference runs," many HEIDENHAIN encoders feature **distance-coded reference marks**—multiple reference marks that are individually spaced in accordance with a mathematical algorithm. The downstream electronics find the absolute reference after traversing two successive reference marks—thus after a traverse path of only a few millimeters (see table below). Encoders with distance-coded reference marks are identified with a "C" following the model designation (e.g., LS 487C).

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

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

and

$$R = 2 \cdot M_{RR}\text{–}N$$

Definitions:

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

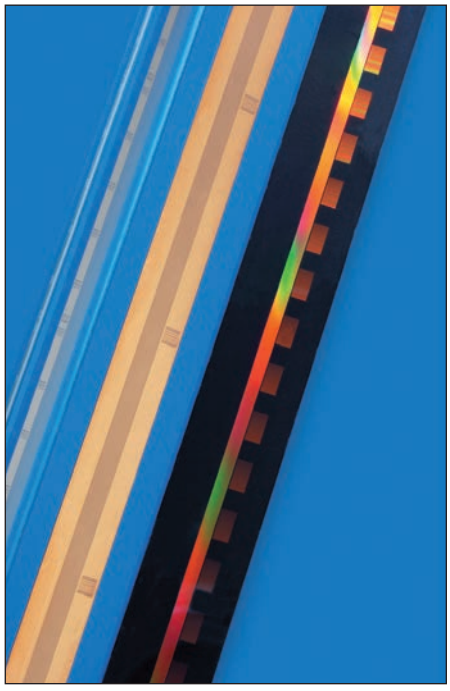
abs = Absolute value

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

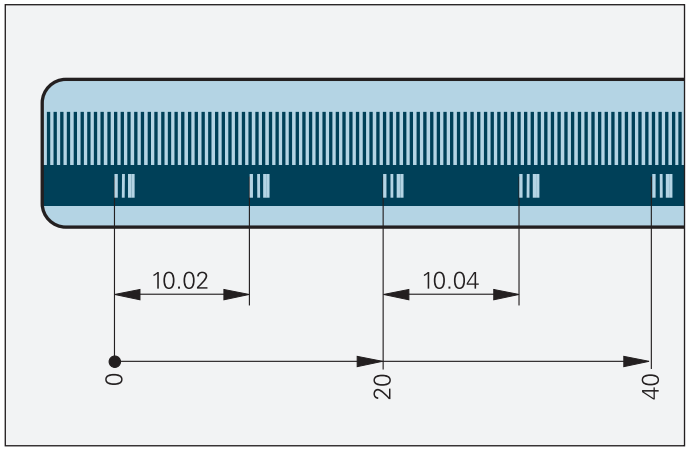
M_{RR} = Number of signal periods between the traversed reference marks

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

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



Graduations of incremental linear encoders



Schematic representation of an incremental graduation with distance-coded reference marks (LS as example)

	Signal period	Nominal increment N in signal periods	Maximum traverse
LF	4 µm	5000	20 mm
LS	20 µm	1000	20 mm
LB	40 µm	2000	80 mm

Photoelectric scanning

Most HEIDENHAIN encoders utilize the photoelectric scanning principle. Photoelectric scanning is touchless and therefore does not induce wear. This method detects even extremely fine graduation lines down to a width of only a few micrometers and generates output signals with very small signal periods.

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

- The **imaging scanning principle** for grating periods of 20 µm and 40 µm
- The **interferential scanning principle** for very fine graduations with grating periods of, for example, 8 µm.

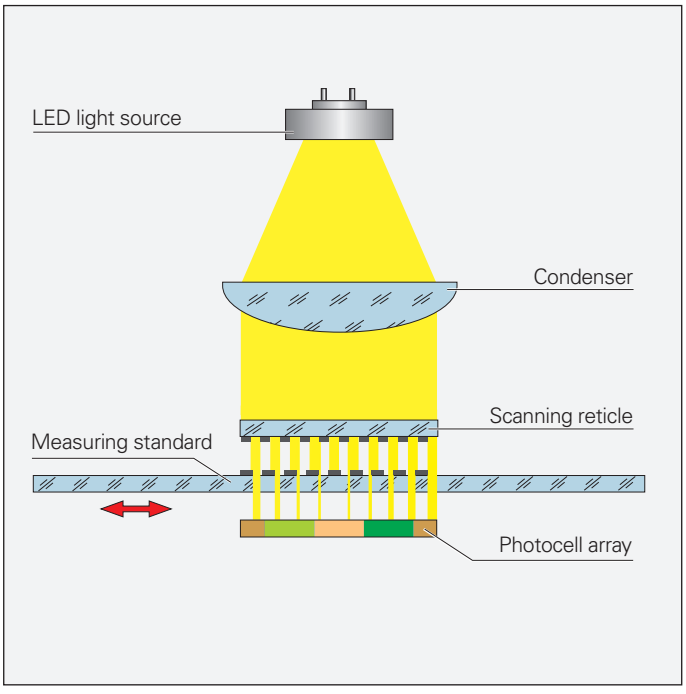
Imaging scanning principle
Put simply, the imaging scanning principle uses projected-light signal generation: two gratings with equal or similar grating periods—the scale and the scanning reticle—are moved relative to each other. The carrier material of the scanning reticle is transparent, whereas the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

When parallel light passes through a grating structure, light and dark fields are projected at a certain distance. At this location there is an index grating. When the two gratings move relative 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. A photocell array converts these variations in light intensity into electrical signals. The specially structured grating of the scanning reticle filters the light to generate nearly sinusoidal output signals.

The smaller the grating period of the grating structure is, the closer and more tightly toleranced the gap must be between the scanning reticle and the scale.

The LC, LS, and LB linear encoders use the imaging scanning principle.

Imaging scanning principle



Interferential scanning principle
The interferential scanning principle uses the diffraction and interference of light on finely divided gratings in order to produce the signals from which motion is measured.

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

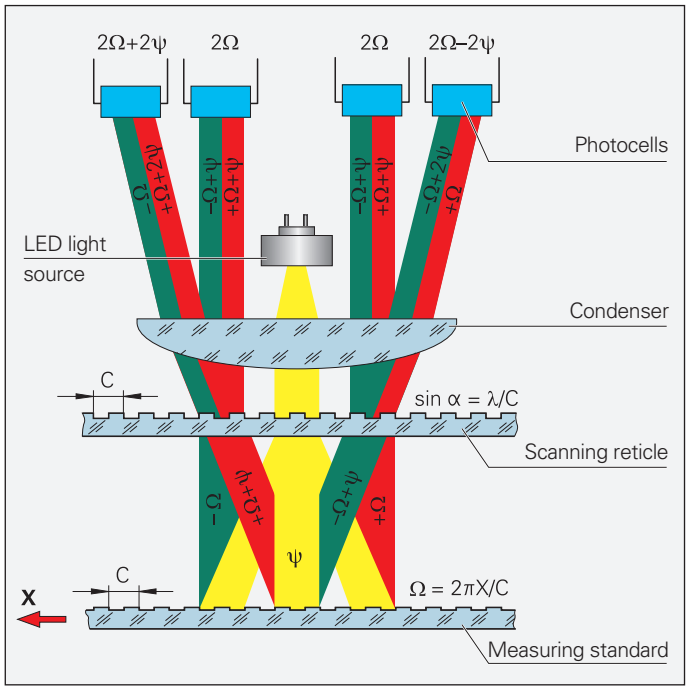
When a light wave passes through the scanning reticle, it is diffracted into three partial waves of the orders +1, 0, and –1, with nearly equal luminous intensity. The waves are diffracted by the scale such that most of the luminous intensity is found in the reflected diffraction orders +1 and –1. These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

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

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

Sealed linear encoders that use the interferential scanning principle are given the designation LF.

Interferential scanning principle (optical diagram)
C Grating period
ψ Phase shift of the light wave when passing through the scanning reticle
Ω Phase shift of the light wave due to motion X of the scale



Measurement accuracy

The accuracy of the 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
- The quality of the encoder mechanics
- How the encoder is installed within the machine

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

Encoder-specific position error

Encoder-specific position error includes
- The accuracy of the measuring standard
- The interpolation accuracy
- The position noise
- The quality of the encoder's mechanical design

Accuracy of the measuring standard
The accuracy of the measuring standard is primarily dictated by the homogeneity of the graduation.

It is stated as the maximum value of the **baseline error**. The distance between the measuring points is equivalent to the integer multiple of the signal period. As a result, interpolation errors have no effect. The sealed linear encoders are separated into accuracy grades for easier differentiation. The **accuracy grade *a*** defines the upper limit of the baseline error within any section of up to one meter in length. The baseline error *F* is ascertained during final inspection and is indicated on the quality inspection document.

Interpolation accuracy
The interpolation error already has an effect at very low traversing speeds and during repeated measurements. This error leads to fluctuations in the traversing speed, particularly within the speed control loop. Within the application, the interpolation error affects the machining quality, such as the surface quality.

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

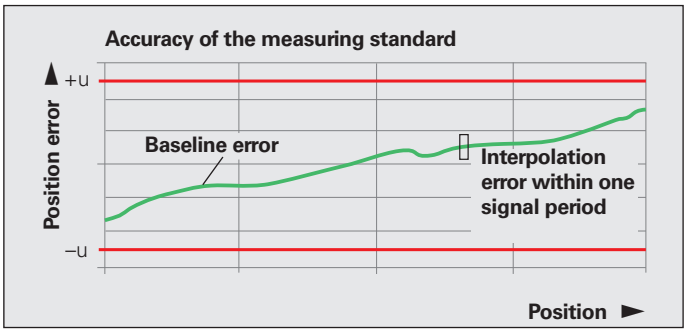
The interpolation accuracy is stated in the form of a maximum value ***u*** of the interpolation error. Encoders with an analog interface are tested with an electronic unit from HEIDENHAIN (e.g., EIB 741).

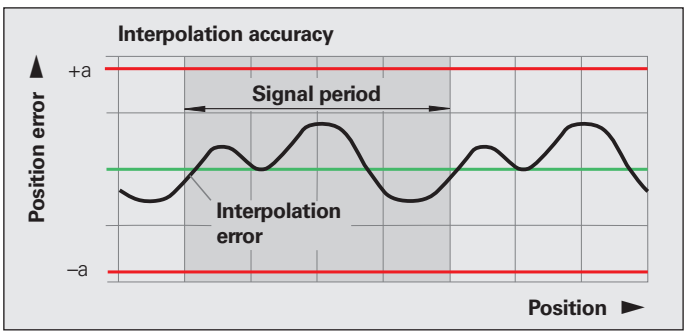
Position noise
Position noise causes small, random deviations from the expected value. Position noise also depends on the quality of the signal processing. Typically, the position noise is less than 1 ‰ of the signal period.

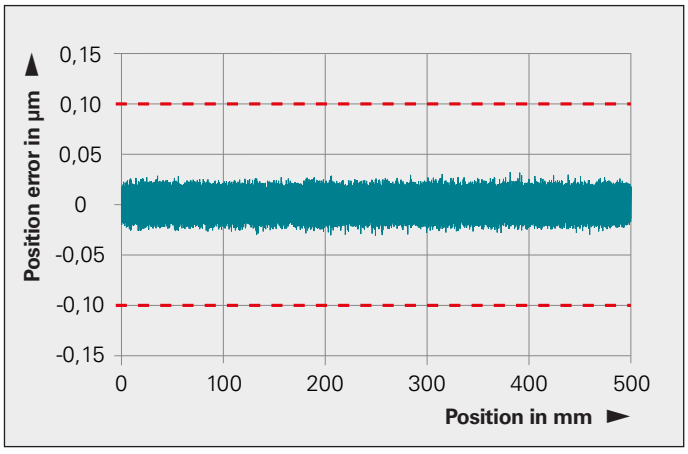
Application-dependent position error

Mounting
Guided linear encoders from HEIDENHAIN compensate for movements between the scale and scanning unit that are not in the direction of movement. This makes it possible to realize very wide mounting tolerances with minimal effect on the **overall accuracy**.

Influence of temperature
Linear encoders from HEIDENHAIN provide a defined and repeatable thermal behavior upon changes in temperature. The coefficient of linear thermal expansion is listed in the encoder specifications.







LC 415 interpolation error:
The diagram above shows the measured interpolation error of an LC 415 over a measuring range of 500 nm. The area marked red indicates the maximum interpolation error *u*.

Calibration chart

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

The position error is determined from the average value of one forward and one reverse measurement during final inspection.

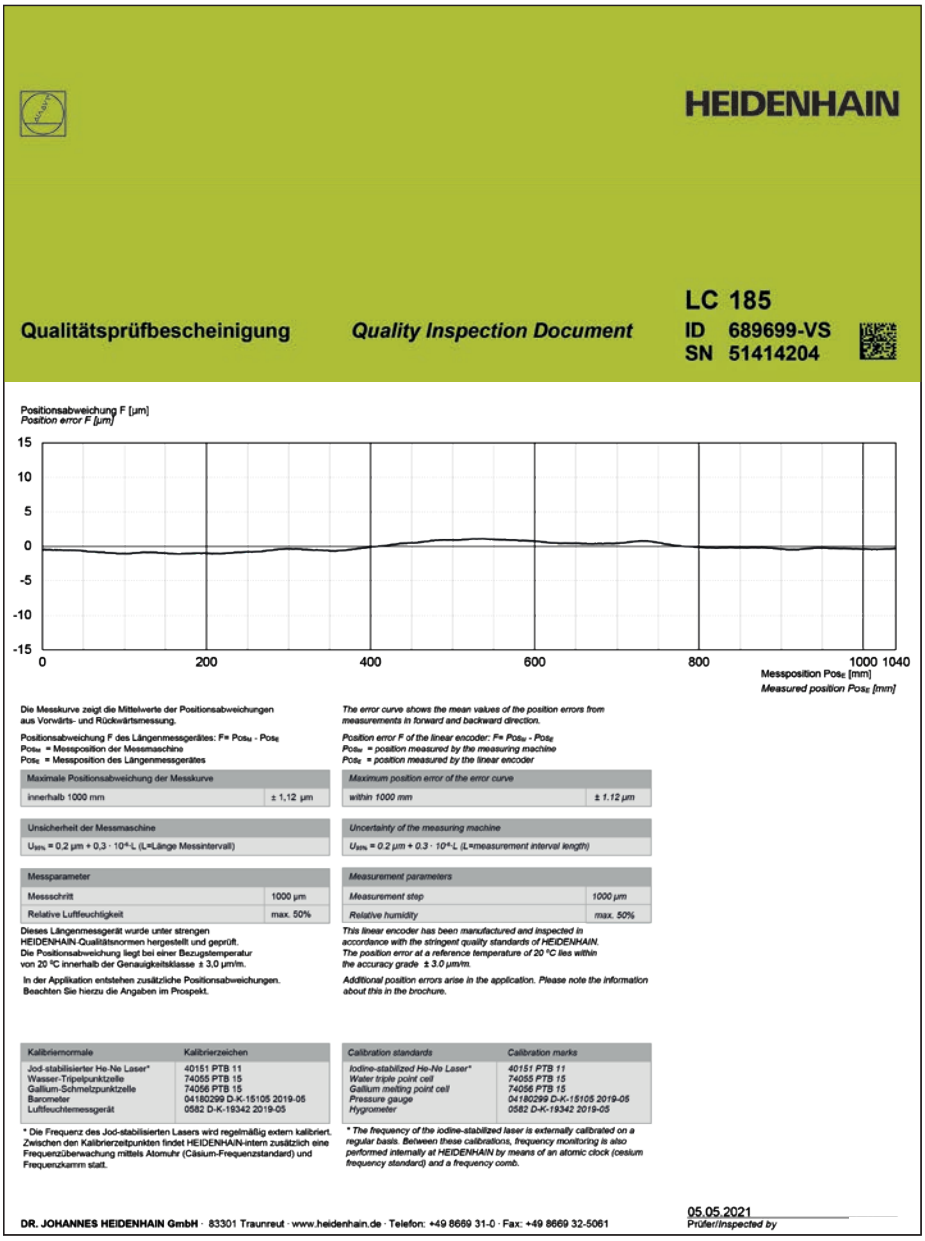
The **Quality Inspection Document** confirms the stated **graduation accuracy** of each encoder. The **calibration standards** ensure the traceability, as required by EN ISO 9001, to recognized national or international standards.

For the LC 100, LC 400, LF and LS series, as well as single-section scale tapes, the Quality Inspection Document also documents the position error ascertained for the entire measuring length. This is stated as the baseline error *F*. The measuring parameters and the measurement uncertainty are also provided.

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

The **operating temperature range** states the limits of ambient temperature within which the linear encoder will function properly.

The **storage temperature range** of –20 °C to +70 °C applies when the unit remains in its packaging. Starting from a measuring length of 3240 mm, the permissible storage temperature range for the LC 1x5 encoders is limited to –10 °C to +50 °C.



HEIDENHAIN

LC 185
ID 689699-VS
SN 51414204

Qualitätsprüfbescheinigung — ***Quality Inspection Document***

Positionsabweichung F [µm]
Position error F [µm]

15
10
5
0
-5
-10
-15

0 200 400 600 800 1000 1040

Messposition Pos_E [mm]
Measured position Pos_E [mm]

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

Positionsabweichung F des Längenmessgerätes: $F = Pos_M - Pos_E$
Pos_M = Messposition der Messmaschine
Pos_E = Messposition des Längenmessgerätes

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

Position error F of the linear encoder: $F = Pos_M - Pos_E$
Pos_M = position measured by the measuring machine
Pos_E = position measured by the linear encoder

Maximale Positionsabweichung der Messkurve	
innerhalb 1000 mm	± 1,12 µm

Maximum position error of the error curve	
within 1000 mm	*± 1.12 µm*

Unsicherheit der Messmaschine
$U_{95\%} = 0{,}2\ \mu m + 0{,}3 \cdot 10^{-6} \cdot L$ (L=Länge Messintervall)

Uncertainty of the measuring machine
$U_{95\%} = 0.2\ \mu m + 0.3 \cdot 10^{-6} \cdot L$ (L=measurement interval length)

Messparameter	
Messschritt	1000 µm
Relative Luftfeuchtigkeit	max. 50%

Measurement parameters	
Measurement step	*1000 µm*
Relative humidity	*max. 50%*

Dieses Längenmessgerät wurde unter strengen HEIDENHAIN-Qualitätsnormen hergestellt und geprüft. Die Positionsabweichung liegt bei einer Bezugstemperatur von 20 °C innerhalb der Genauigkeitsklasse ± 3,0 µm/m.

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

This linear encoder has been manufactured and inspected in accordance with the stringent quality standards of HEIDENHAIN. The position error at a reference temperature of 20 °C lies within the accuracy grade ± 3.0 µm/m.

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

Kalibriernormale	Kalibrierzeichen
Jod-stabilisierter He-Ne Laser*	40151 PTB 11
Wasser-Tripelpunktzelle	74055 PTB 15
Gallium-Schmelzpunktzelle	74056 PTB 15
Barometer	04180299 D-K-15105 2019-05
Luftfeuchtemessgerät	0582 D-K-19342 2019-05

Calibration standards	*Calibration marks*
*Iodine-stabilized He-Ne Laser**	*40151 PTB 11*
Water triple point cell	*74055 PTB 15*
Gallium melting point cell	*74056 PTB 15*
Pressure gauge	*04180299 D-K-15105 2019-05*
Hygrometer	*0582 D-K-19342 2019-05*

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

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

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05.05.2021
Prüfer/*Inspected by*

Example

Mechanical design types and mounting guidelines
Linear encoders with small cross section

The LC, LF, and LS slimline linear encoders should be mounted on a machined surface over the entire length—particularly for high dynamic requirements. Larger measuring lengths and a higher vibration load capacity can be achieved by using a mounting spar or clamping elements (only the LC 400 series).

The slimline linear encoders feature identical mounting dimensions. This makes it possible, for example, to exchange an incremental LS or LF for an absolute LC on a specific machine design (please note that the measuring length of the LF is smaller by 20 mm than that of the LC or LS). In addition, the same mounting spars can also be used, regardless of the encoder version (LC, LF, or LS).

The encoder is mounted such that the sealing lips are directed downward or away from splashing water (also see *General information on page 18*).

Thermal characteristics
Because they are rigidly fastened using two M8 screws, the linear encoders largely adapt themselves to the mounting surface. When fastened over the mounting spar, the encoder is fixed at its midpoint to the mounting surface. The flexible fastening elements ensure reproducible thermal behavior.

The **LF 485** with its graduation carrier of steel has the same coefficient of thermal expansion as a mounting surface of gray cast iron or steel.

Mounting
It is surprisingly simple to mount the sealed linear encoders from HEIDENHAIN: you need only align the scale unit at several points along the machine guideway. Stop surfaces or stop pins can also be used for this. The shipping brace already sets the proper gap between the scale unit and the scanning unit, as well as the lateral tolerance. If the shipping brace needs to be removed before mounting due to a lack of space, then the mounting gauge is used to set the gap between the scale unit and the scanning unit easily and exactly. Lateral tolerances must also be maintained.



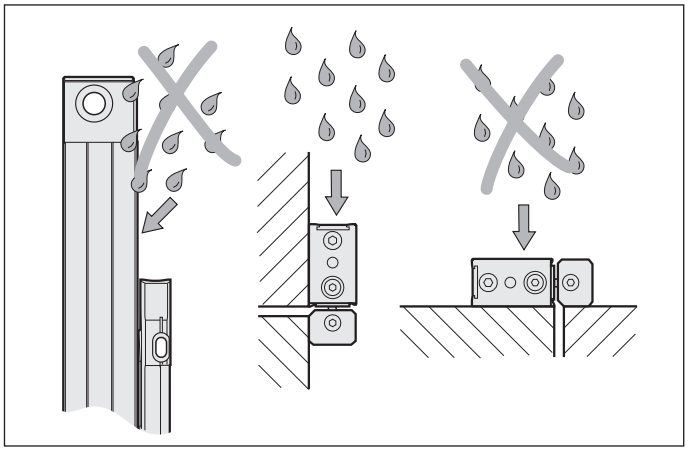
LF 485

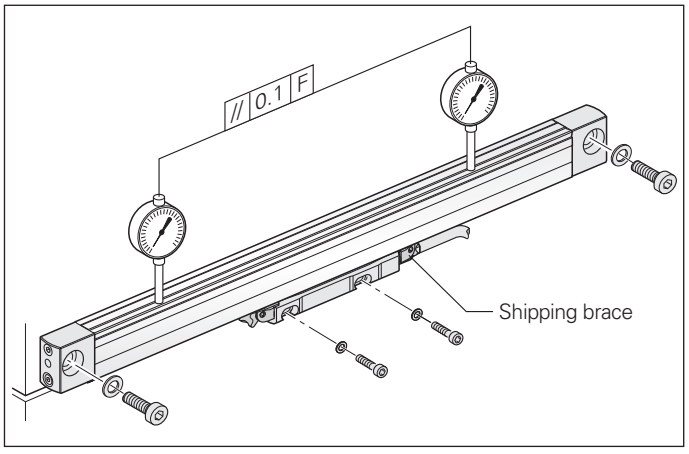


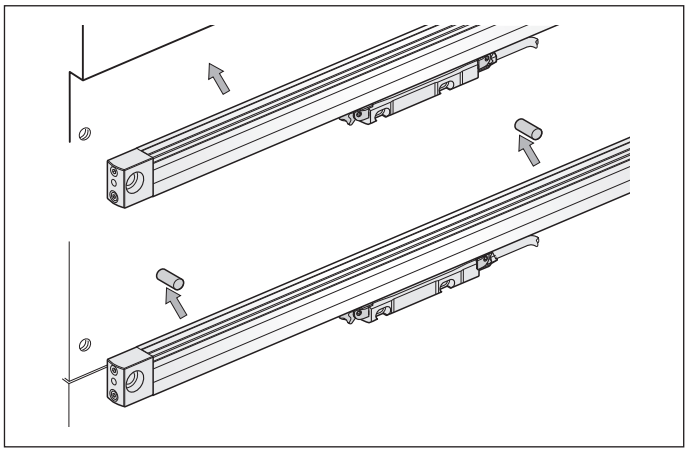
LC 415



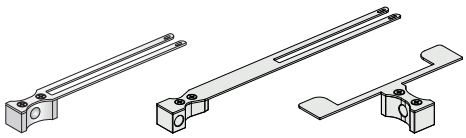
LS 487







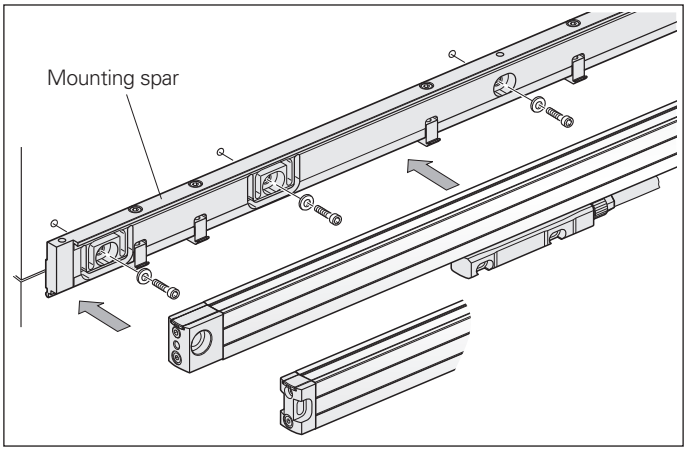
Accessory:
Mounting and test gauges for slimline linear encoders
The **mounting gauge** is used to set the gap between the scale unit and the scanning unit if the shipping brace needs to be removed before mounting. The **test gauges** are used to quickly and easily check the gap of the mounted linear encoder.



	ID		
Mounting gauge 1.0 mm (gray)	737748-01	1211268-01	1211239-01
Test gauge max. 1.3 mm (red)	737748-02	1211268-02	1211239-02
Test gauge min. 0.7 mm (blue)	737748-03	1211268-03	1211239-03

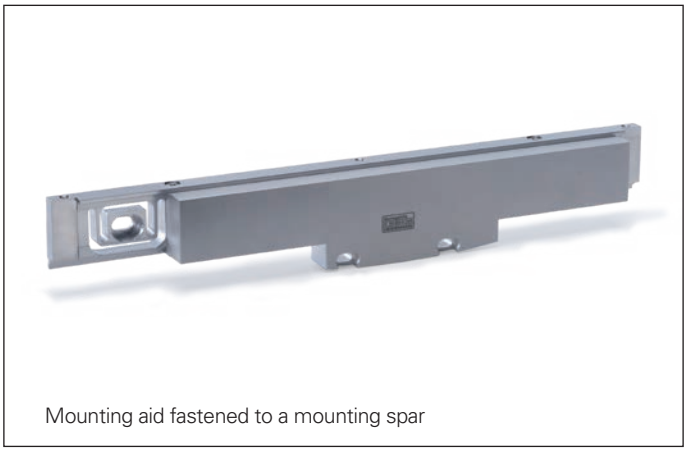
Along with the standard procedure of using two M8 screws to mount the scale unit on a plane surface, there are also other mounting possibilities:

Installation with mounting spar
Mounting the encoder with a mounting spar can be especially beneficial. The mounting spar can be fastened as part of the machine assembly process. The encoder is then simply clamped on during final mounting. Easy exchange also facilitates servicing. HEIDENHAIN recommends mounting with the mounting spar when measuring lengths are greater than 620 mm and dynamic requirements are high. The mounting spar is always required for measuring lengths greater than 1240 mm.



For the **MSL 41 mounting spar**, the components required for clamping are already preassembled. This mounting spar is designed for linear encoders with normal or short end blocks. The LC 400, LF 4x5 and LS 4x7 series can be mounted by either side to enable a cable outlet at either end. The MSL 41 mounting spar must be ordered separately.

The **mounting aid** is locked onto the mounted spar and therefore simulates an optimally mounted scanning unit. The customer's fastening for the scanning unit can be easily aligned to it. Then the mounting aid is replaced by the linear encoder.

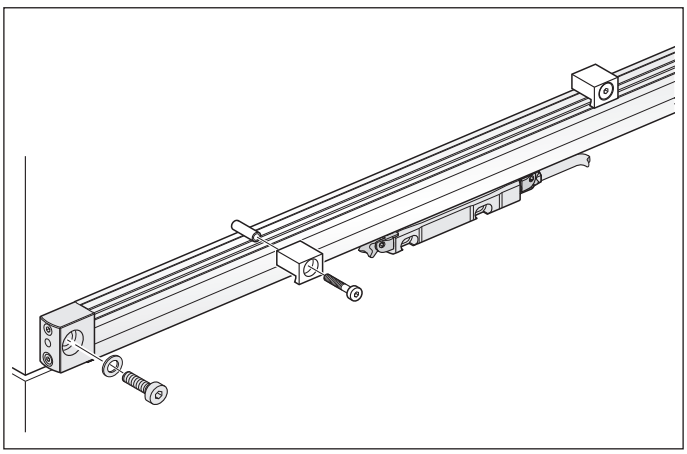


Mounting aid fastened to a mounting spar

Accessory:
MSL 41 mounting spar
ID 770902-xx

Mounting aid for scanning unit
ID 753853-01

Mounting with clamping elements
If the cable outlet is to the right, the scanning unit of the LC 400 series, which is fastened by its end blocks, can additionally be fixed by clamping elements. This eliminates the need of a mounting spar for measuring lengths greater than 620 mm.



Accessory:
Clamping elements
With pin and M5x10 screw
ID 556975-01 (10 per package)

Linear encoders with large cross section

The LB, LC, LF, and LS full-size linear encoders are fastened over their entire length onto a machined surface. This gives them a **high vibration rating**. The oblique arrangement of the sealing lips permits **universal mounting** with vertical or horizontal scale housing with equally high protection rating.

The LC 1x5 features an optimized sealing system with two successive pairs of sealing lips. When cleaned compressed air is introduced into the scale housing, it effectively seals the two pairs of sealing lips against ambient air. This optimally protects the interior of the encoder from contamination.

The flow rate is set through a connecting piece with integrated throttle (see separate accessories under *Protection*, page 18).

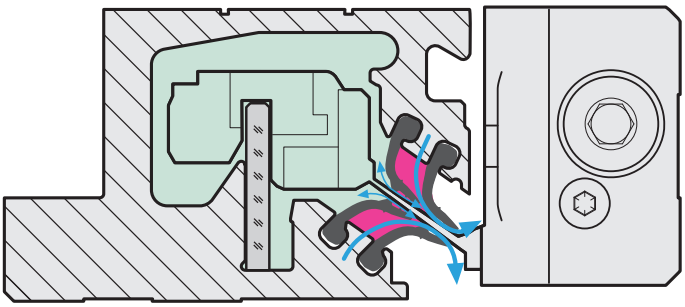
Thermal characteristics
The thermal behavior of the LB, LC, LF, and LS 100 full-size linear encoders has been optimized:

On the **LF**, the steel scale is cemented to a steel carrier that is fastened directly to the machine element.

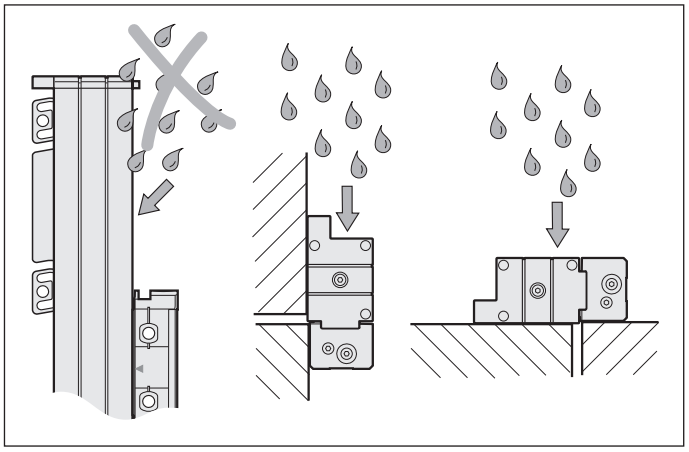
For the multi-section **LC 200** and **LB**, the steel scale tape is clamped directly onto the machine element. In this way, the encoders are subject to the same thermal changes in length as the bearing surface.

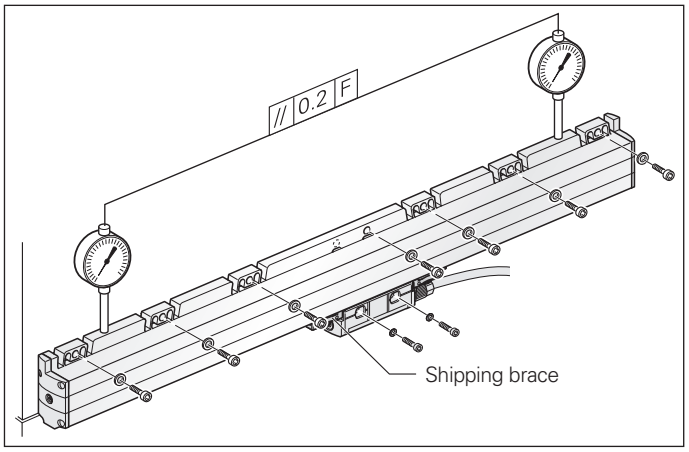
The **LC** and **LS** are fixed to the mounting surface at their midpoint. The flexible fastening elements permit reproducible thermal behavior.

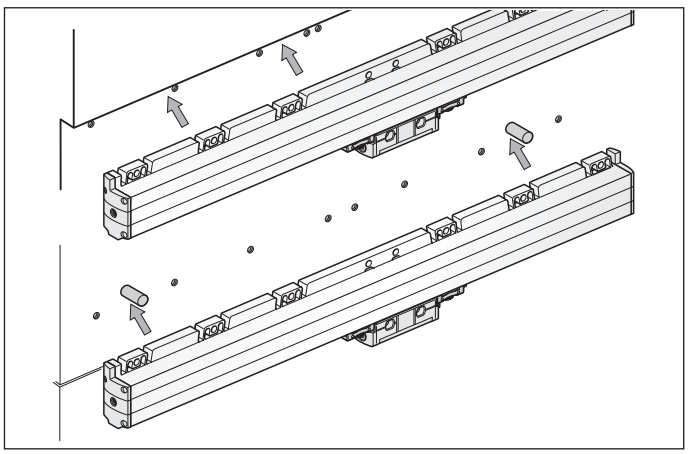
Mounting
It is surprisingly simple to mount the sealed linear encoders from HEIDENHAIN: you need only align the scale unit at several points along the machine guideway. Stop surfaces or stop pins can also be used for this. The shipping brace already sets the proper gap between the scale unit and the scanning unit. The lateral gap is to be set during mounting. If the shipping brace needs to be removed before mounting due to a lack of space, then the mounting gauge is used to set the gap between the scale unit and the scanning unit easily and exactly. Lateral tolerances must also be maintained.



Sealing system of the LC 1x5





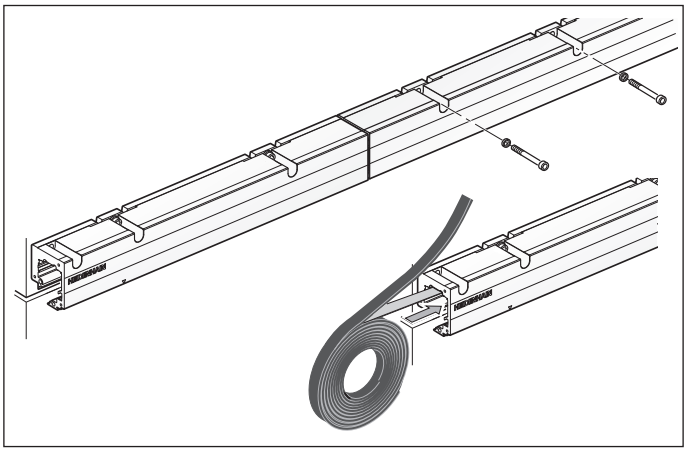


Mounting the multi-section LC 2x1 and LB 383

The LC 2x1 and LB 383 with measuring lengths over 3240 mm are mounted on the machine in individual sections:

- Mount and align the individual housing sections
- Pull in the scale tape over the entire length and tension it
- Lubricate the sealing lips and pull them in
- Insert the scanning unit

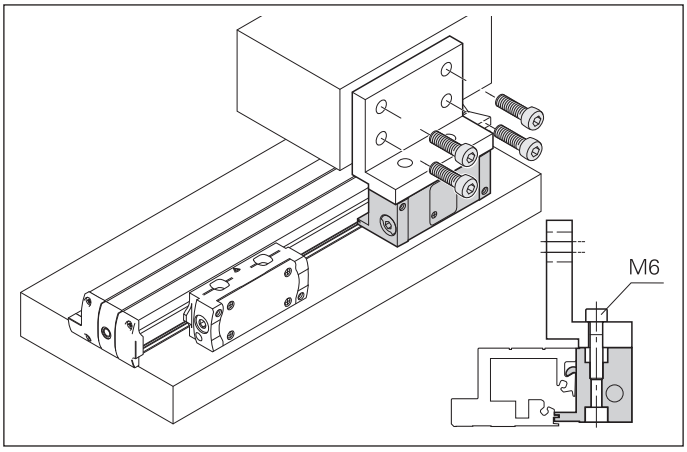
Adjustment of the scale tape tension enables linear machine error compensation of up to ±100 µm/m.



Accessory:
Mounting aids

For LC 1x3, LS 1x7	ID 547793-02
For LC 100	ID 1067589-02
For LC 2x1, LB 383	ID 824039-01

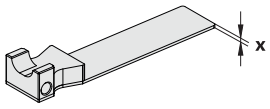
The mounting aid is locked onto the scale unit, simulating an optimally adjusted scanning unit. The customer's fastening for the scanning unit can be easily aligned to it. The mounting aid is then removed and the scanning unit is attached to the mounting bracket.



Example

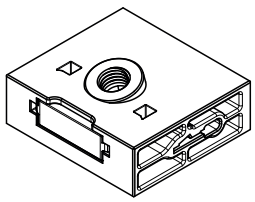
Accessory:
Mounting and test gauges for full-size linear encoders

The **mounting gauge** is used to set the gap between the scale unit and the scanning unit if the shipping brace needs to be removed before mounting. The **test gauges** are used to quickly and easily check the gap of the mounted linear encoder.



	LC 1xx, LS 1xx		LB 383/LC 2x1	
	x	**ID**	**x**	**ID**
Mounting gauge (gray)	1.5 mm	575832-11	1.0 mm	772141-11
Test gauge max. (red)	1.8 mm	575832-12	1.3 mm	772141-12
Test gauge min. (blue)	1.2 mm	575832-13	0.7 mm	772141-13

Accessory:
Lubricating device
For LC 2x1, LB 383 sealing lips
ID 1104590-05



General information

Protection
Sealed **linear encoders** fulfill the requirements for IP53 protection according to **EN 60529** or **IEC 60529** provided that they are mounted with the sealing lips facing away from splash water. If necessary, provide a separate protective cover. If the encoder is exposed to particularly heavy concentrations of dust or coolant mist, sealing air can be used to provide IP64 protection to more effectively prevent the ingress of contamination. To apply the compressed air for sealing the housing, the LB, LC, LF, and LS sealed linear encoders are therefore equipped with inlets at both end blocks and on the mounting block of the scanning unit.

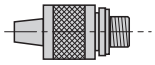
The compressed air introduced directly into the encoders must be cleaned by a microfilter and must comply with the following quality classes as per **ISO 8573-1** (2010 edition):

- Solid contaminants: **Class 1**
  Particle size: Number of particles per m^3
  0.1 µm to 0.5 µm ≤ 20000
  0.5 µm to 1.0 µm ≤ 400
  1.0 µm to 5.0 µm ≤ 10
- Max. pressure dew point: **Class 4**
  (pressure dew point at 3 °C)
- Total oil content: **Class 1**
  (max. oil concentration 0.01 mg/m^3)

For an optimal supply of sealing air to the sealed linear encoders, the required air flow is 7 l/min to 10 l/min per encoder. Ideally, the air flow is regulated by the HEIDENHAIN connecting pieces with integrated throttle. The throttles ensure the prescribed flow quantities at an input pressure of approx. $1 \cdot 10^5$ Pa (1 bar). On some encoders the throttle is already integrated in the connection (see the information in the technical drawings).

Accessories:
Connecting piece with throttle
for 6 mm x 1 mm pressure tubing:

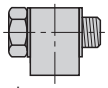
For connection to the linear encoder end block
ID 226270-02



For connection to the scanning unit
ID 275239-01



Also suitable:
Swiveling screw fitting 90°
With seal
On full-size linear encoders it can be connected only to the encoder housing.
ID 207834-02



Accessory:
DA 400 compressed air unit
ID 894602-01

DA 400
HEIDENHAIN offers the DA 400 compressed-air filter system for purifying the compressed air. It is designed specifically for conducting compressed air into encoders.

The DA 400 consists of three filter stages (prefilter, microfilter, and activated carbon filter) and a pressure regulator with a manometer. The sealing air function can be effectively monitored using a manometer and pressure switch (available as an accessory).

The compressed air introduced into the DA 400 must fulfill the requirements of the following purity classes as per **ISO 8573-1** (2010 edition):

- Solid contaminants: **Class 5**
  Particle size: Number of particles per m^3
  0.1 µm to 0.5 µm Not specified
  0.5 µm to 1.0 µm Not specified
  1.0 µm to 5.0 µm ≤ 100000
- Max. pressure dew point: **Class 6**
  (pressure dew point at 10 °C)
- Total oil content: **Class 4**
  (max. oil concentration 5 mg/m^3)



DA 400

Further information:
For further information, ask for our *DA 400* Product Information document.

Mounting
To simplify cable routing, the mounting block of the scanning unit is usually screwed onto a stationary machine part, and the scale housing on the moving part. The **mounting location** for the linear encoders should be carefully considered in order to ensure both optimum accuracy and the longest possible service life.

- The encoder should be mounted as closely as possible to the working plane to keep the Abbe error small.
- 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 adapters. A mounting spar is recommended for sealed linear encoders with small cross section.
- In order to avoid temperature effects, the linear encoders should not be mounted in close proximity to heat sources.
- During cable routing, the minimum bend radius for fixed installation or for frequent flexing must be observed (see table).
- Both the scanning unit and the scale housing are to be connected with low resistance (< 1 Ω) to functional earth.

Cable assembly
Accessory:
1/4" socket wrench
The socket wrench makes it possible to mount the encoder connector to the adapter cable when space is limited.
ID 618965-02



Required moving force
The required moving force stated is the maximum force required to move the scale unit relative to the scanning unit.

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

- The abovementioned extreme values for the **vibration tolerance** apply to frequencies of 55 Hz to 2000 Hz **(EN 60068-2-6),** except when mechanical resonances occur. **Comprehensive testing of the entire system is therefore required.**
- The maximum permissible acceleration values (semi-sinusoidal shock) for **shock and impact** are valid for 11 ms **(EN 60068-2-27).** Under no circumstances should a hammer or similar implement be used to adjust or position the encoder.

RoHS
HEIDENHAIN has tested its products to ensure the use of non-hazardous materials in accordance with the European Directives 2002/95/EC (RoHS) and 2002/96/EC (WEEE). For a Manufacturer's Declaration on RoHS, please consult your sales agency.

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

System tests
Encoders from HEIDENHAIN are usually integrated as components into complete systems. Applications of this type require full-system, **comprehensive testing**, regardless of the encoder's specifications.
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 outside of its proper and intended use is at the user's own risk.

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

Further information:
Please also comply with the following documents for planning and mounting:

- Brochure: *Cables and Connectors*
- Brochure: *Interfaces of HEIDENHAIN Encoders*
- Mounting instructions for the respective encoder
- Mounting instructions for encoder cables and adapter cables

Ø	Ø 3.7 mm	Ø 4.5 mm	Ø 6.0 mm Ø 6.8 mm	Ø 6.6 mm Ø 10 mm	Ø 8.0 mm
T ≥ -40 °C	≥ 8 mm	≥ 10 mm	≥ 20 mm	≥ 35 mm	R_1 ≥ 40 mm
T ≥ –10 °C	≥ 40 mm	≥ 50 mm	≥ 75 mm	≥ 75 mm	R_2 ≥ 100 mm

Minimum bend radii for rigid configuration or for frequent flexing

Functional safety

Safe axes
Driven axes on machine tools usually represent a significant hazard for humans. It must be ensured that the machine does not make any uncontrolled movements, especially when a person is interacting with the machine (e.g., workpiece setup). This requires position information about the axes for proper implementation of safety function. As an evaluating safety module, the control has the task of detecting faulty position information and reacting to it accordingly.

Various safety strategies can be pursued, depending on the topology of the axis and the evaluation capabilities of the control. In a single-encoder system, for example, only one encoder per axis is evaluated for the safety function. However, on axes with two encoders, such as a linear axis with a rotary and a linear encoder, the two redundant position values can be compared with each other in the control.

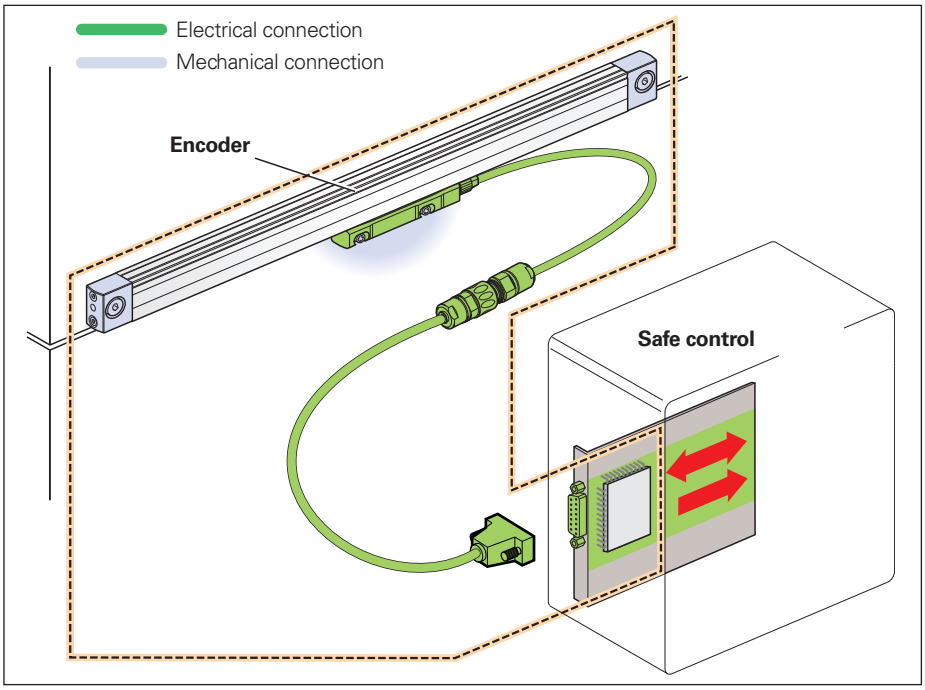
Safe fault detection can be ensured only if the two components—control and encoder—are properly adapted to one another. It must be noted that the safety designs of control manufacturers differ from one another. As a result, the requirements to be fulfilled by the connected encoders may also differ to an extent.

Type-examined encoders
Sealed linear encoders from HEIDENHAIN are used successfully on a variety of controls in widely differing safety designs. This applies particularly to the type-examined encoders LC 1x5/LC 4x5 with EnDat and DRIVE-CLiQ interfaces. The encoders can be operated as single-encoder systems in conjunction with a suitable control in applications with the control category SIL 2 (according to EN 61508) or performance level "d" (of EN ISO 13849). Unlike incremental encoders, the absolute LC 1x5/LC 4x5 linear encoders always provide a safe absolute position value—including immediately after switch-on or a power failure. Reliable position transmission is based on two independently generated absolute position values and on error bits provided to the safe control. The purely serial data transmission also provides other benefits, including greater reliability, improved accuracy, diagnostic capabilities, and reduced costs through simpler connection technology.

Standard encoders
In addition to those encoders explicitly qualified for safety applications, standard encoders (e.g., with Fanuc interface or 1 V_{PP} signals) can also be used in safe axes. In such cases, the characteristics of the encoders must be matched to the requirements of the respective control. For this purpose, HEIDENHAIN can provide additional data about the individual encoders (failure rate, fault model as per EN 61800-5-2).

Service life
Unless otherwise specified, HEIDENHAIN encoders are designed for a service life of 20 years (as per ISO 13849).

Further information:
The safety-related characteristic values are listed in the encoder specifications. These characteristic values are explained in the Technical Information document *Safety-Related Position Encoders*. Upon request, HEIDENHAIN can likewise provide additional data about the individual products (failure rate, fault model as per EN 61800-5-2) for the use of standard encoders in safety-related applications.



Encoder with mechanical connection and electrical interface

DRIVE-CLiQ is a registered trademark of SIEMENS AG.

Fault exclusion for the loosening of the mechanical connection
Irrespective of the interface, many safety designs require the safe mechanical connection of the encoder. The standard for electric motors, EN 61800-5-2, requires that the loosening of the mechanical connection between the encoder and the motor be considered as a fault. Since it cannot be guaranteed that the control will detect such errors, fault exclusion is required in many cases. The requirements on fault exclusion can result in additional constraints in the permissible limit values in the specifications. In addition, fault exclusions for the loosening of the mechanical coupling usually require additional measures during installation of the encoder or in the event of servicing (e.g., anti-rotation lock for screws). These factors must be considered for the selection of a suitable encoder or mounting mode.

Fault exclusion for LC 1x5 and LC 4x5 series
There are various mounting options for the LC 1x5/LC 4x5 encoders that offer fault exclusion for the loosening of the mechanical connection. The fault exclusion applies for all LC 4x5 and LC 1x5 encoders, regardless of the interface.

	Mounting	Fastening[2]	Safe position for the mechanical connection[1]	Limitation of specifications
LC 1x5				
Housing		M6 ISO 4762 8.8/A70	±0 µm	No
Scanning unit	Mounting options I and II	M6 ISO 4762 8.8/A70	±0 µm	No
LC 4x5				
Housing	Mounting option I 12A end blocks for M8	M8 ISO 4762 8.8/A70 M8 DIN 6912 8.8	±0 µm	No
	Mounting option III MSL 41 mounting spar ID 770902-xx	M6 ISO 4762 8.8/A70	±0 µm	For acceleration in measuring direction of up to 60 m/s^2
Scanning unit	All mounting options	M6 ISO 4762 8.8/A70	±0 µm	No

All of the information provided on screw connections assumes a mounting temperature of 15 °C to 35 °C.
[1] Fault exclusions are given only for the explicitly mentioned mounting options
[2] A suitable anti-rotation lock must be used for the screw connections (in the case of mounting/servicing)

Further information:

Adhere to the information in the following documents to ensure the correct and intended operation of the encoder:

- Operating Instructions
  - *LC 115* 1382648
  - *LC 195 S* 1382643
  - *LC 415* (14A end block) 1382631
  - (12A end block) 1382647
  - *LC 495 S* (14A end block) 1382640
  - (12A end block) 1382650
- Technical Information: *Safety-Related Position Measuring Systems* 596632

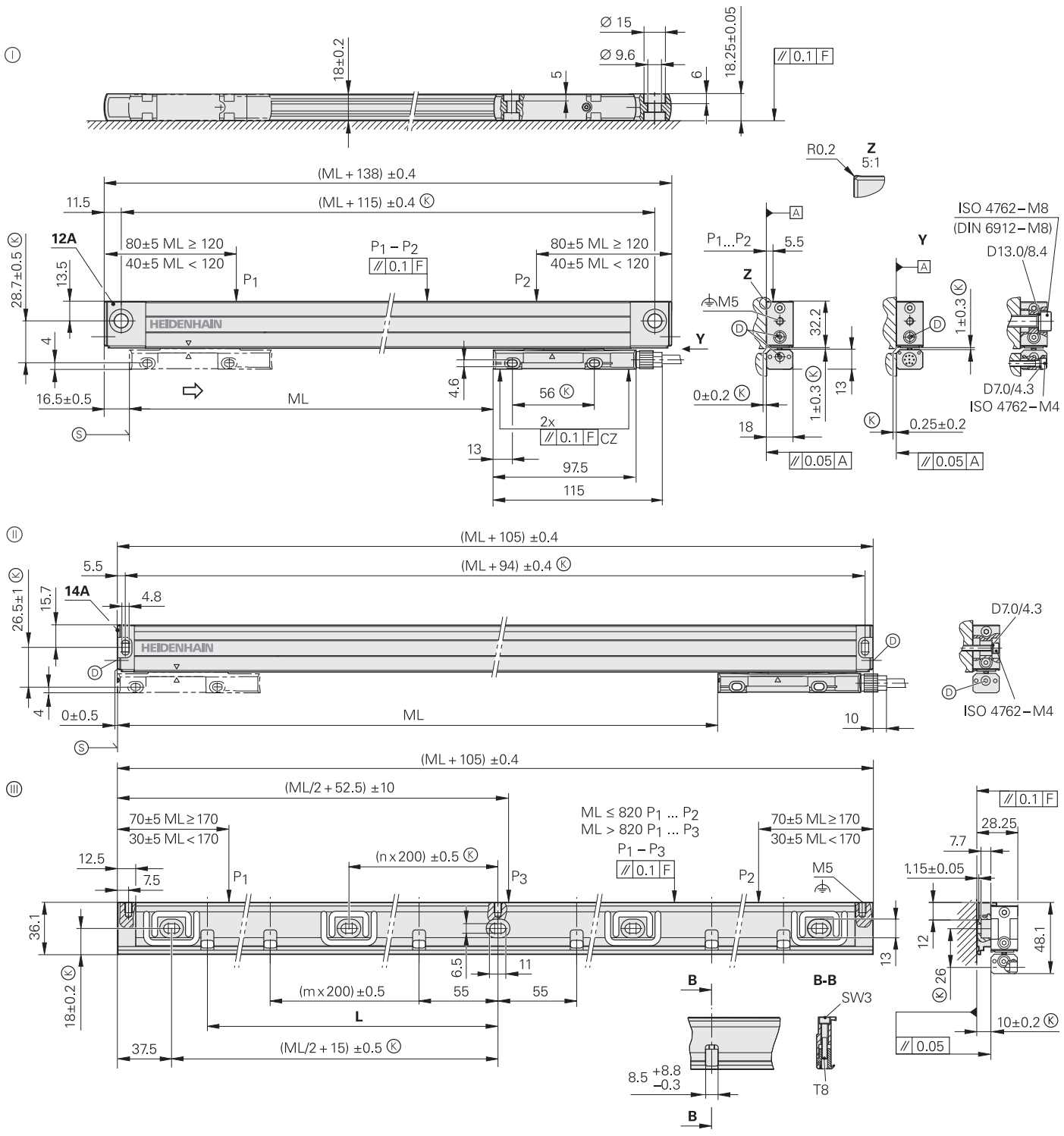
For implementation in a control:

- Specifications for Safe Control 533095

LC 400 series

Absolute linear encoders with slimline scale housing

- **For limited installation space**
- **LC 416/LC 496 with optimized scanning (see Product Information document *1327049*)**



ML	70	120	170	220	270	320	370	420	470	520	570	620	670	720	770	820	920	1020	1140	1240	1340	1440	1540	1640	1740	1840	2040
L	37.5	55	75	100	115	140	175	200	225	250	275	300	325	350	375	400	450	500	555	610	655	710	760	810	855	910	1010

mm

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

Ⓘ = 12A end block; for mounting with and without mounting spar
Ⓘⓘ = 14A end block; for mounting with mounting spar
(if directly attached with M4 screws, then specifications are subject to constraints)
Ⓘⓘⓘ = MSL 41 mounting spar
F = Machine guideway
P = Measuring points for alignment
Ⓚ = Required mating dimensions
Ⓓ = Compressed air inlet
Ⓢ = Beginning of measuring length ML (= 20 mm absolute)
⇨ = Direction of motion of the scanning unit for ascending position values



Specifications	LC 415 (Functional Safety)	LC 415	LC 485
Measuring standard Coefficient of linear expansion	DIADUR glass scale with absolute track and incremental track; grating period: 20 µm $\alpha_{therm} \approx 8 \cdot 10^{-6}$ K^{-1} (mounting type ①/⑪); *with mounting spar:* $\alpha_{therm} \approx 9 \cdot 10^{-6}$ K^{-1} (mounting type ⑩)		
Accuracy grade*	±3 µm, ±5 µm		
Measuring length (ML)* in mm	Mounting spar* or clamping elements* up to ML 1240 optional; necessary for ML 1340 or greater 70 120 170 220 270 320 370 420 470 520 570 620 670 720 770 820 920 1020 1140 1240 1340 1440 1540 1640 1740 1840 2040		
Functional safety for applications with up to	• SIL 2, as per EN 61508 (further basis for testing: IEC 61800-5-3) • Category 3, PL "d" as per EN ISO 13849-1:2015	–	
PFH (per axis)	≤ 15 · 10^{-9} (up to 2000 m above sea level)	–	
Safe position[1]	*Encoder:* ±550 µm (safety-related measuring step SM = 220 µm)	–	
	Mechanical connection: fault exclusions for the loosening of the housing and scanning unit (page 21)		
Interface	EnDat 2.2		
Ordering designation	EnDat22		EnDat02
Measuring step *At ±3 µm* *At ±5 µm*	0.001 µm 0.010 µm		0.005 µm 0.010 µm
Clock frequency (calculation time t_{cal})	≤ 16 MHz (≤ 5 µs)		≤ 2 MHz (≤ 5 µs)
Measurement of direct-drive motor temperature[2]	With EIB 5211 or EIB 5181		With EIB 5281 or EIB 5181
Incremental signals	–		~ 1 V_{PP} (20 µm)
Cutoff frequency –3 dB	–		≥ 150 kHz
Electrical connection	Separate adapter cable (1 m/3 m/6 m/9 m) connectable on mounting block		
Cable length	≤ 100 m[3]		≤ 150 m[3]
Supply voltage	DC 3.6 V to 14 V		
Power consumption (maximum)	*3.6 V:* ≤ 1.1 W; *14 V:* ≤ 1.3 W		
Traversing speed	≤ 180 m/min (max. acceleration in measuring direction ≤ 100 m/s^2)		
Required moving force	≤ 5 N		
Vibration 55 Hz to 2000 Hz *acting on* **Shock** 11 ms	*Scanning unit:* ≤ 200 m/s^2 (EN 60068-2-6) *Housing without mounting spar:* ≤ 100 m/s^2 (EN 60068-2-6) *Housing with mounting spar and cable outlet on the right:* ≤ 150 m/s^2, *or left:* ≤ 100 m/s^2 (EN 60068-2-6) ≤ 300 m/s^2 (EN 60068-2-27)		
Operating temperature	0 °C to 50 °C		
Protection EN 60529[4]	IP53 when installed in conformity with instructions in the brochure; IP64 with sealing air from DA 400		
Mass	*Encoder:* 0.2 kg + 0.55 kg/m of measuring length; *mounting spar:* 0.9 kg/m		

***** Please select when ordering; [1] Further tolerances may arise in the downstream electronics after position value comparison (contact mfr. of downstream electronics); [2] Depending on the serial number index of the encoder; please consult HEIDENHAIN; [3] With HEIDENHAIN cable (see the *Interfaces of HEIDENHAIN Encoders* brochure); [4] In the application, protect the LC from the ingress of particles and liquids

LC 400 series

Absolute linear encoders with slimline scale housing

- **For limited installation space**
- **LC 416/LC 496 with optimized scanning (see Product Information document *1327049*)**

Specifications	**LC 495 S** Functional Safety	**LC 495 S**
Measuring standard Coefficient of linear expansion	DIADUR glass scale with absolute track and incremental track; grating period: 20 µm $\alpha_{therm} \approx 8 \cdot 10^{-6}$ K^{-1} (mounting mode ①/⑩); *with mounting spar:* $\alpha_{therm} \approx 9 \cdot 10^{-6}$ K^{-1} (mounting mode ⑪)	
Accuracy grade*	±3 µm, ±5 µm	
Measuring length (ML)* in mm	Mounting spar* or clamping elements* optional up to ML 1240, required as of ML 1340 70 120 170 220 270 320 370 420 470 520 570 620 670	
Functional safety for applications with up to	• SIL 2 as per EN 61508 • Category 3, PL "d" as per EN ISO 13849-1:2015	–
PFH (per axis)	$25 \cdot 10^{-9}$ (up to 1000 m above sea level NN)	–
Safe position[1]	*Encoder:* ±550 µm (safety-related measuring step SM = 220 µm)	–
	Mechanical connection: fault exclusions for the loosening of the housing and scanning unit (page 21)	
Interface	DRIVE-CLiQ	
Ordering designation	DQ01	
Measuring step *At ±3 µm* *At ±5 µm*	 0.001 µm 0.010 µm	
Clock frequency (calculation time t_{cal})	–	
Measurement of direct-drive motor temperature[2]	–	
Electrical connection	Separate adapter cable (1 m/3 m/6 m/9 m) connectable on mounting block	
Cable length	≤ 30 m[3]	
Supply voltage	DC 10 V to 28.8 V	
Power consumption (maximum)	*10 V:* ≤ 1.5 W; *28.8 V:* ≤ 1.7 W	
Traversing speed	≤ 180 m/min (max. acceleration in measuring direction ≤ 100 m/s^2)	
Required moving force	≤ 5 N	
Vibration 55 Hz to 2000 Hz *acting on* **Shock** 11 ms	*Scanning unit:* ≤ 200 m/s^2 (EN 60068-2-6) *Housing without mounting spar:* ≤ 100 m/s^2 (EN 60068-2-6) *Housing with mounting spar and cable outlet on the right:* ≤ 150 m/s^2, *or left:* ≤ 100 m/s^2 (EN 60068-2-6) ≤ 300 m/s^2 (EN 60068-2-27)	
Operating temperature	0 °C to 50 °C	
Protection EN 60529[4]	IP53 when installed in conformity with instructions in the brochure; IP64 with sealing air from DA 400	
Mass	*Encoder:* 0.2 kg + 0.55 kg/m of measuring length; *mounting spar:* 0.9 kg/m	

***** Please select when ordering

[1] Further tolerances may arise in the downstream electronics after position value comparison (contact mfr. of the downstream electronics)

[2] Depending on the serial number index of the encoder; please consult HEIDENHAIN

[3] Greater cable lengths upon request

[4] In the application, the LC must be protected from the ingress of particles and liquids

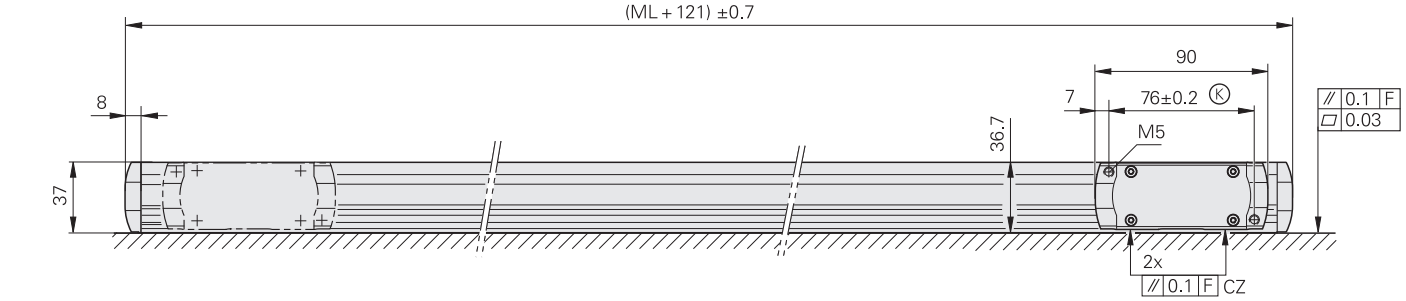


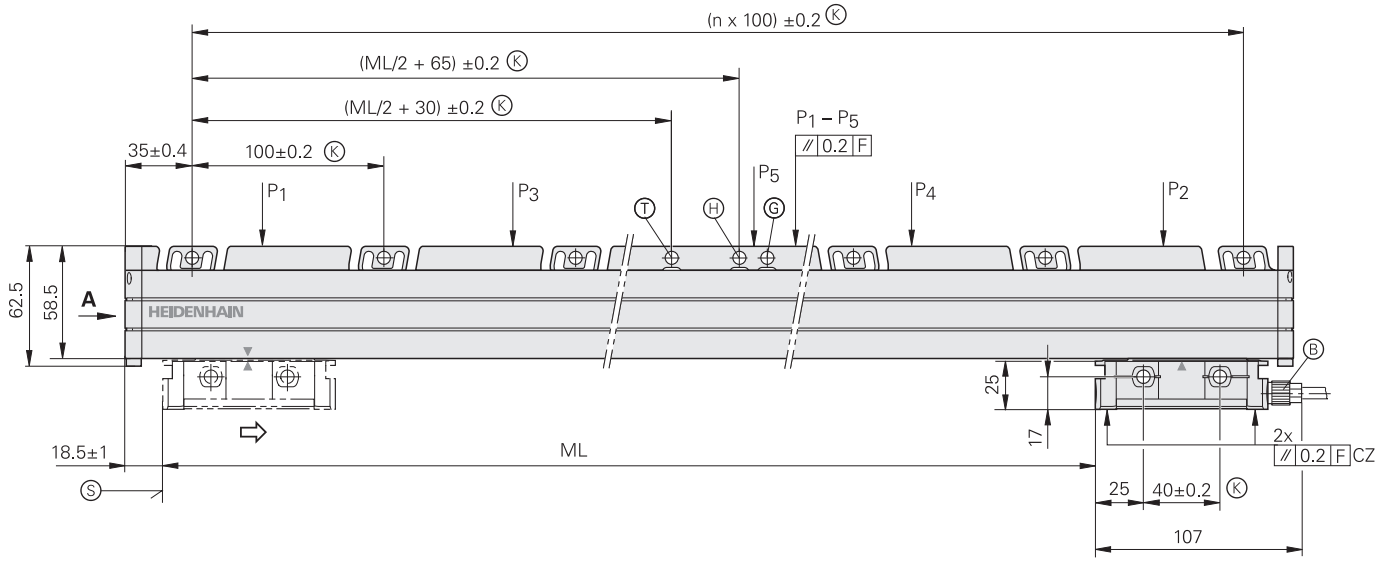
	LC 495 F	LC 495 M	LC 495 P
	720 770 820 920 1020 1140	1240 1340 1440 1540 1640 1740	1840 2040
	Fanuc Serial Interface/αi interface	Mitsubishi high speed interface	Panasonic Serial Interface
	Fanuc05	Mit03-04	Pana01
	αi interface/α interface 0.00125 µm/0.010 µm 0.0125 µm/0.050 µm	0.001 µm 0.010 µm	
	With EIB 5211	–	
	≤ 50 m	≤ 30 m	≤ 50 m
	DC 3.6 V to 14 V		
	3.6 V: ≤ 1.1 W; *14 V:* ≤ 1.3 W		

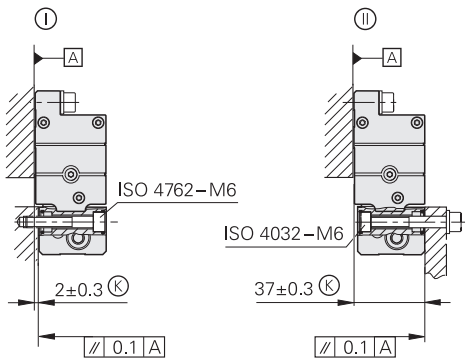
LC 100 series

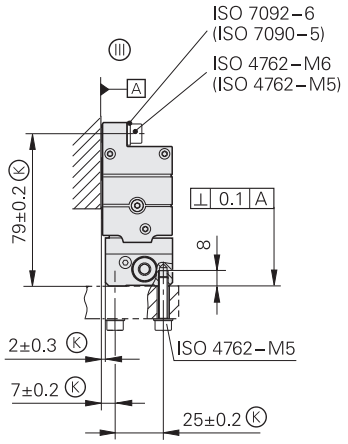
Absolute linear encoders with full-size scale housing

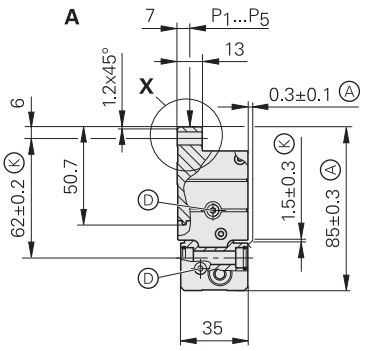
- **High vibration tolerance**
- **Flat-lying installation possible**
- **High reliability through double sealing lips**
- **LC 116/LC 196 with optimized scanning (see Product Information document *1327049*)**

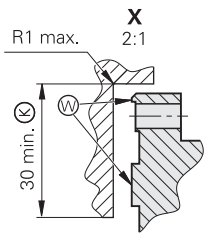












mm

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

Ⅰ, Ⅱ,
Ⅲ = Mounting options
F = Machine guideway
P = Measuring points for alignment
Ⓚ = Required mating dimensions
Ⓐ = Alternative mating dimensions
Ⓑ = Cable connection usable at either end
Ⓓ = Compressed-air inlet usable at either end
Ⓣ = Mechanical fixed point (to be preferred)
Ⓗ = Mechanical fixed point (compatible with predecessor model)
Ⓖ = Mechanical fixed point (repeated at an interval of 100 mm)
Ⓢ = Beginning of measuring length ML (= 20 mm absolute)
Ⓦ = Mating surfaces
⇨ = Direction of motion of the scanning unit for ascending position values



Specifications	LC 115 Functional Safety	LC 115	LC 185
Measuring standard Coefficient of linear expansion	DIADUR glass scale with absolute track and incremental track; grating period: 20 µm $\alpha_{therm} \approx 8 \cdot 10^{-6}\ K^{-1}$		
Accuracy grade*	±3 µm up to a measuring length of 3040 mm; ±5 µm		
Measuring length (ML)* in mm	140 240 340 440 540 640 740 840 940 1040 1140 1240 1340 1440 1540 1640 1740 1840 2040 2240 2440 2640 2840 3040 3240 3440 3640 3840 4040 4240		
Functional safety for applications with up to	• SIL 2, as per EN 61508 (further basis for testing: IEC 61800-5-3) • Category 3, PL "d" as per EN ISO 13849-1:2015	–	
PFH (per axis)	$15 \cdot 10^{-9}$; *ML > 3040 mm:* $25 \cdot 10^{-9}$ (up to 2000 m above sea level)	–	
Safe position[1]	*Encoder:* ±550 µm; *ML > 3040 mm:* ±2050 µm (safety-related measuring step SM = 220 µm)	–	
	Mechanical connection: fault exclusions for the loosening of the housing and scanning unit (page 21)		
Interface	EnDat 2.2		
Ordering designation	EnDat22		EnDat02
Measuring step *At ±3 µm* *At ±5 µm*	0.001 µm 0.010 µm		0.005 µm 0.010 µm
Clock frequency (calc. time t_{cal})	≤ 16 MHz (≤ 5 µs)		≤ 2 MHz (≤ 5 µs)
Measurement of direct-drive motor temperature[2]	With EIB 5211 or EIB 5181		With EIB 5281 or EIB 5181
Incremental signals	–		~ 1 V_{PP} (20 µm)
Cutoff frequency –3 dB	–		≥ 150 kHz
Electrical connection	Separate adapter cable (1 m/3 m/6 m/9 m), connectable at either end of mounting block		
Cable length	≤ 100 m[3]		≤ 150 m[3]
Supply voltage	DC 3.6 V to 14 V		
Power consumption (maximum)	*3.6 V:* ≤ 1.1 W; *14 V:* ≤ 1.3 W		
Traversing speed	≤ 180 m/min (max. acceleration in measuring direction ≤ 100 m/s²)		
Required moving force	≤ 4 N		
Vibration 55 Hz to 2000 Hz *acting on* **Shock** 11 ms	*Housing:* ≤ 200 m/s² (EN 60068-2-6) *Scanning unit:* ≤ 200 m/s² (EN 60068-2-6) ≤ 300 m/s² (EN 60068-2-27)		
Operating temperature	0 °C to 50 °C		
Protection EN 60529[4]	IP53 when installed in conformity with instructions in the brochure; IP64 with sealing air from DA 400		
Mass	0.55 kg + 2.9 kg/m of measuring length		

***** Please select when ordering; [1] Further tolerances may arise in the downstream electronics after position value comparison (contact mfr. of downstream electronics); [2] Depending on the serial number index of the encoder; please consult HEIDENHAIN; [3] With HEIDENHAIN cable (see the *Interfaces of HEIDENHAIN Encoders* brochure); [4] In the application, protect the LC from the ingress of particles and liquids

LC 100 series

Absolute linear encoders with full-size scale housing

- **High vibration tolerance**
- **Flat-lying installation possible**
- **High reliability through double sealing lips**
- **LC 116/LC 196 with optimized scanning (see Product Information document *1327049*)**

Specifications	**LC 195 S** Functional Safety	**LC 195 S**
Measuring standard Coefficient of linear expansion	DIADUR glass scale with absolute track and incremental track; grating period: 20 µm $\alpha_{therm} \approx 8 \cdot 10^{-6}\ K^{-1}$	
Accuracy grade*	±3 µm up to a measuring length of 3040 mm; ±5 µm	
Measuring length ML* in mm	140 240 340 440 540 640 740 840 940 1040 1140 1240 1340	
Functional safety for applications with up to	• SIL 2 as per EN 61508 • Category 3, PL "d" as per EN ISO 13849-1:2015	–
PFH (per axis)	$25 \cdot 10^{-9}$; *ML > 3040 mm:* $40 \cdot 10^{-9}$ (up to 1000 m above sea level)	–
Safe position[1]	*Encoder:* ±550 µm; *ML > 3040 mm:* ±2050 µm (safety-related measuring step SM = 220 µm)	–
	Mechanical connection: fault exclusions for the loosening of the housing and scanning unit (page 21)	
Interface	DRIVE-CLiQ	
Ordering designation	DQ01	
Measuring step *At ±3 µm* *At ±5 µm*	 0.001 µm 0.010 µm	
Clock frequency (calculation time t_{cal})	–	
Measurement of direct-drive motor temperature[2]	–	
Electrical connection	Separate adapter cable (1 m/3 m/6 m/9 m), connectable at either end of mounting block	
Cable length	≤ 30 m[3]	
Supply voltage	DC 10 V to 28.8 V	
Power consumption (maximum)	*10 V:* ≤ 1.5 W; *28.8 V:* ≤ 1.7 W	
Traversing speed	≤ 180 m/min (max. acceleration ≤ 100 m/s²)	
Required moving force	≤ 4 N	
Vibration 55 Hz to 2000 Hz *acting on* **Shock** 11 ms	*Housing:* ≤ 200 m/s² (EN 60068-2-6) *Scanning unit:* ≤ 200 m/s² (EN 60068-2-6) ≤ 300 m/s² (EN 60068-2-27)	
Operating temperature	0 °C to 50 °C	
Protection EN 60529[4]	IP53 when installed in conformity with instructions in the brochure; IP64 with sealing air from DA 400	
Mass	0.55 kg + 2.9 kg/m of measuring length	

***** Please select when ordering
1) Further tolerances may arise in the downstream electronics after position value comparison (contact mfr. of downstream electronics)
2) Depending on the serial number index of the encoder; please consult HEIDENHAIN
3) Greater cable lengths upon request
4) In the application, protect the LC from the ingress of particles and liquids

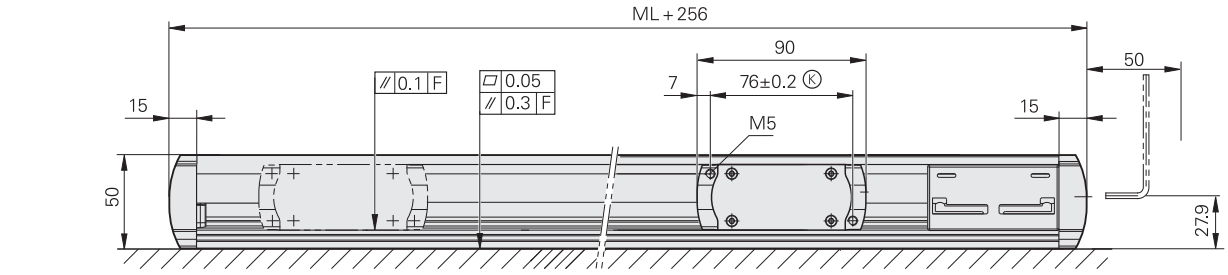


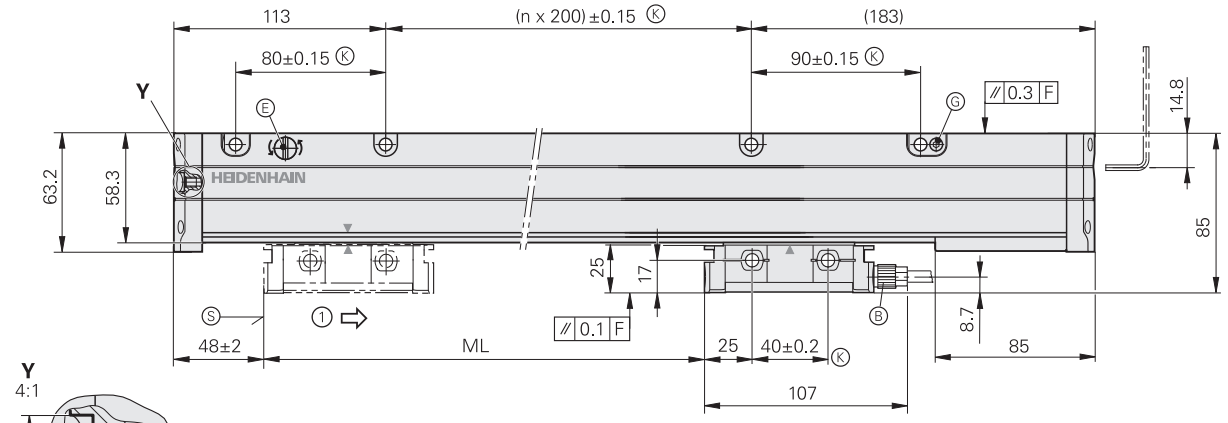
	LC 195 F	LC 195 M	LC 195 P
		±3 µm up to a measuring length of 2040 mm; ±5 µm	±3 µm up to a measuring length of 3040 mm; ±5 µm
	1440 1540 1640 1740 1840 2040	2240 2440 2640 2840 3040 3240	3440 3640 3840 4040 4240
	Fanuc Serial Interface/αi interface	Mitsubishi high speed interface	Panasonic Serial Interface
	Fanuc05	Mit03-04	Pana01
	αi interface/α interface 0.00125 µm/0.010 µm 0.0125 µm/0.050 µm	0.001 µm 0.010 µm	
	With EIB 5211	–	
	≤ 50 m	≤ 30 m	≤ 50 m
	DC 3.6 V to 14 V		
	3.6 V: ≤ 1.1 W; *14 V:* ≤ 1.3 W		

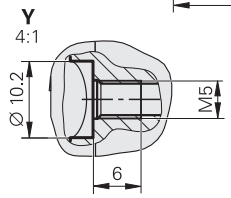
LC 200 series up to 4240 mm (single-section housing)

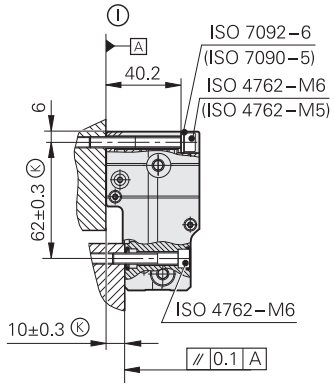
Absolute linear encoders with full-size scale housing

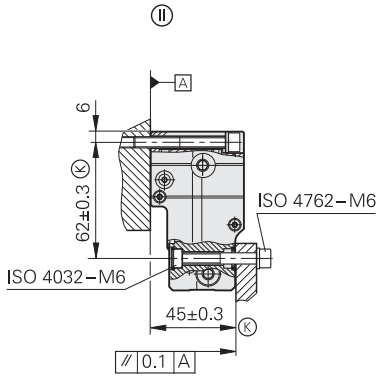
- **Measuring length up to 4240 mm**
- **Flat-lying installation possible**
- **Also available in mirrored version (mating dimensions upon request)**
- **Thermal behavior varies depending on the mounting option being used**

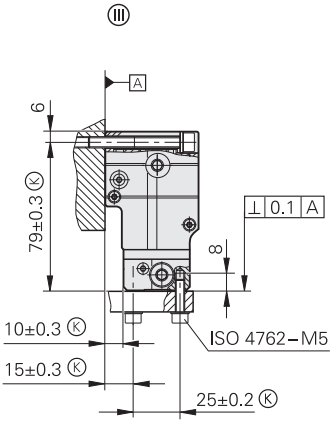


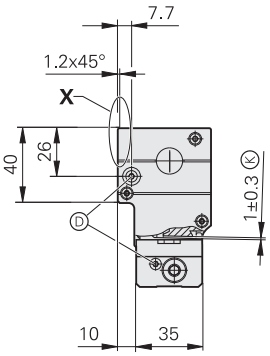


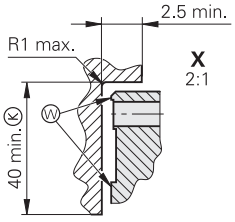












mm

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

①, ②,
③ = Mounting options
F = Machine guideway
Ⓚ = Required mating dimensions
Ⓑ = Cable connection usable at either end
Ⓓ = Compressed-air inlet with integrated throttle usable at either end
Ⓔ = Fixed stop
Ⓖ = Clamping screw for scale tape
Ⓢ = Beginning of measuring length ML (= 100 mm absolute)
Ⓦ = Mating surfaces
⇨ = Direction of motion of the scanning unit for ascending position values



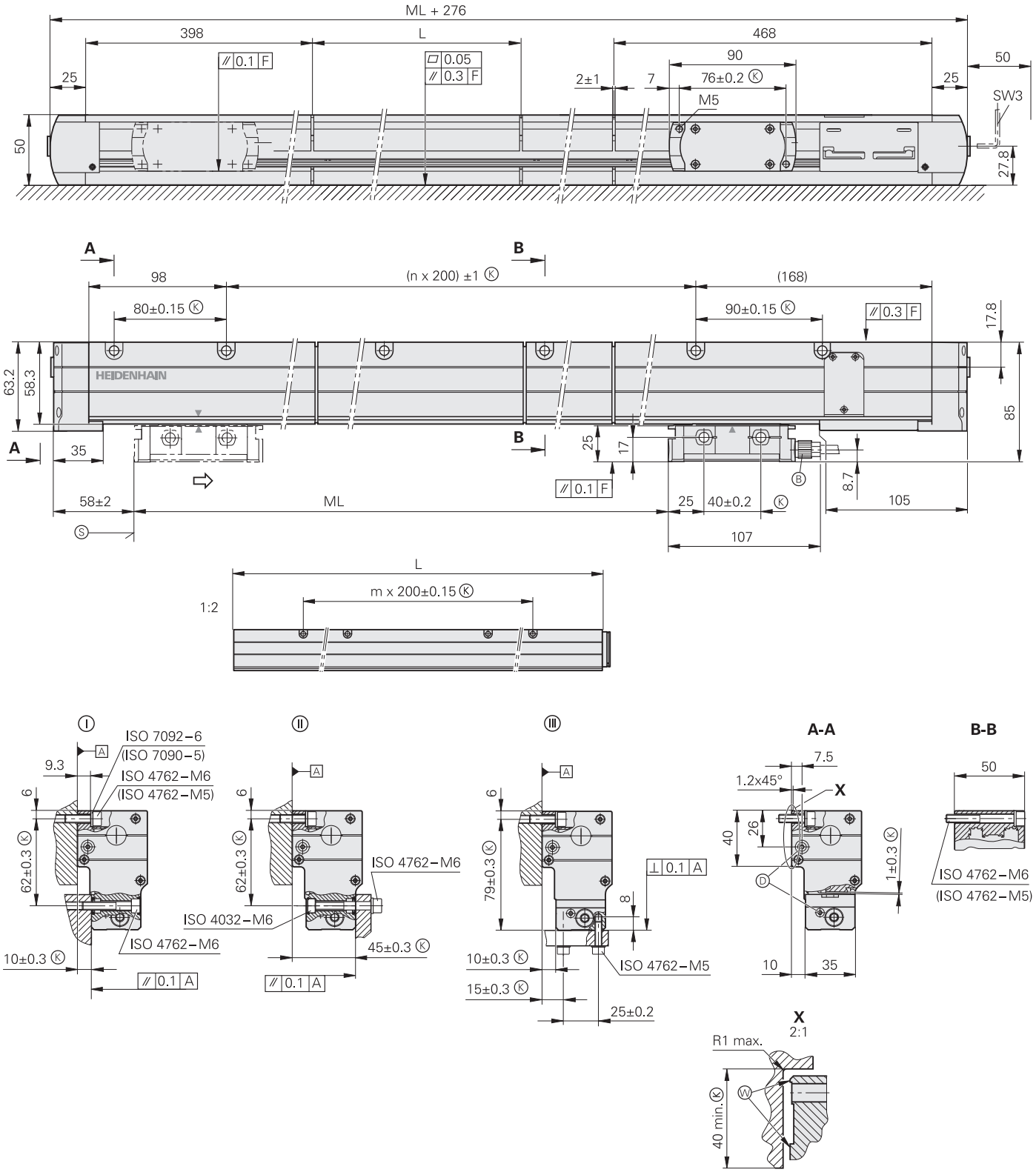
Specifications	LC 211	LC 281	LC 291F	LC 291M
Measuring standard Coefficient of linear expansion	METALLUR steel scale tape with absolute track and incremental track, grating period: 40 µm $\alpha_{therm} \approx 10 \cdot 10^{-6}\ K^{-1}$			
Accuracy grade	±5 µm			
Measuring length ML* in mm	440 640 840 1040 1240 1440 1640 1840 2040 2240 2440 2640 2840 3040 3240 3440 3640 3840 4040 4240			
Interface	EnDat 2.2		Fanuc Serial Interface αi interface	Mitsubishi high speed interface
Ordering designation	EnDat22	EnDat02	Fanuc05	Mit03-04
Measuring step	0.010 µm		αi interface/α interface 0.0125 µm/0.050 µm	0.010 µm
Diagnostics interface	Digital			
Clock frequency Calculation time t_{cal}	≤ 16 MHz ≤ 5 µs	≤ 2 MHz ≤ 5 µs	– –	
Measurement of direct-drive motor temperature	–	With EIB 5281 or EIB 5181	–	
Incremental signals	–	⌒ 1 V_{PP}	–	
Signal period	–	40 µm	–	
Cutoff frequency –3 dB	–	≥ 250 kHz	–	
Electrical connection	Separate adapter cable (1 m/3 m/6 m/9 m), connectable at either end of mounting block			
Cable length[1)]	≤ 100 m (at clock frequency ≤ 8 MHz)	≤ 150 m	≤ 50 m	≤ 30 m
Supply voltage	DC 3.6 V to 14 V			
Power consumption (max.)	*At 14 V:* ≤ 1.3 W *At 3.6 V:* ≤ 1.1 W			
Current consumption (typical)	*At 5 V:* 225 mA (without load)			
Traversing speed	≤ 180 m/min (max. acceleration in measuring direction ≤ 100 m/s^2)			
Required moving force	≤ 15 N			
Vibration 55 Hz to 2000 Hz *acting on* **Shock** 11 ms	*Housing:* 200 m/s^2 (EN 60068-2-6) *Scanning unit:* 300 m/s^2 (EN 60068-2-6) ≤ 300 m/s^2 (EN 60068-2-27)			
Operating temperature	0 °C to 50 °C			
Protection EN 60529	IP53 when installed according to mounting instructions, IP64 with sealing air from DA 400			
Mass	1.3 kg + 3.6 kg/m of measuring length			

***** Please select when ordering
[1)] With HEIDENHAIN cable

LC 200 series up to 28 040 mm (multi-section housing)

Absolute linear encoders with full-size scale housing

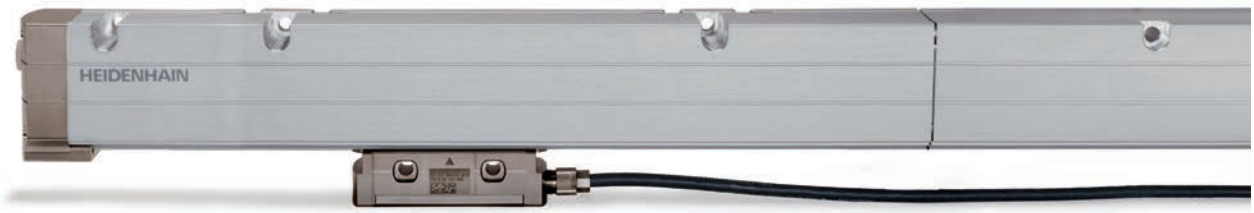
- **Measuring lengths up to 28 m**
- **Simplified mounting (upright or flat)**
- **Also available in mirrored version (mating dimensions upon request)**



mm

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

Ⅰ, Ⅱ,
Ⅲ = Mounting options
F = Machine guideway
L = Housing section lengths
Ⓚ = Required mating dimensions
Ⓑ = Cable connection usable at either end
Ⓓ = Compressed-air inlet usable at either end
Ⓢ = Beginning of measuring length ML (= 100 mm absolute)
Ⓦ = Mating surfaces
⇨ = Direction of motion of the scanning unit for ascending position values



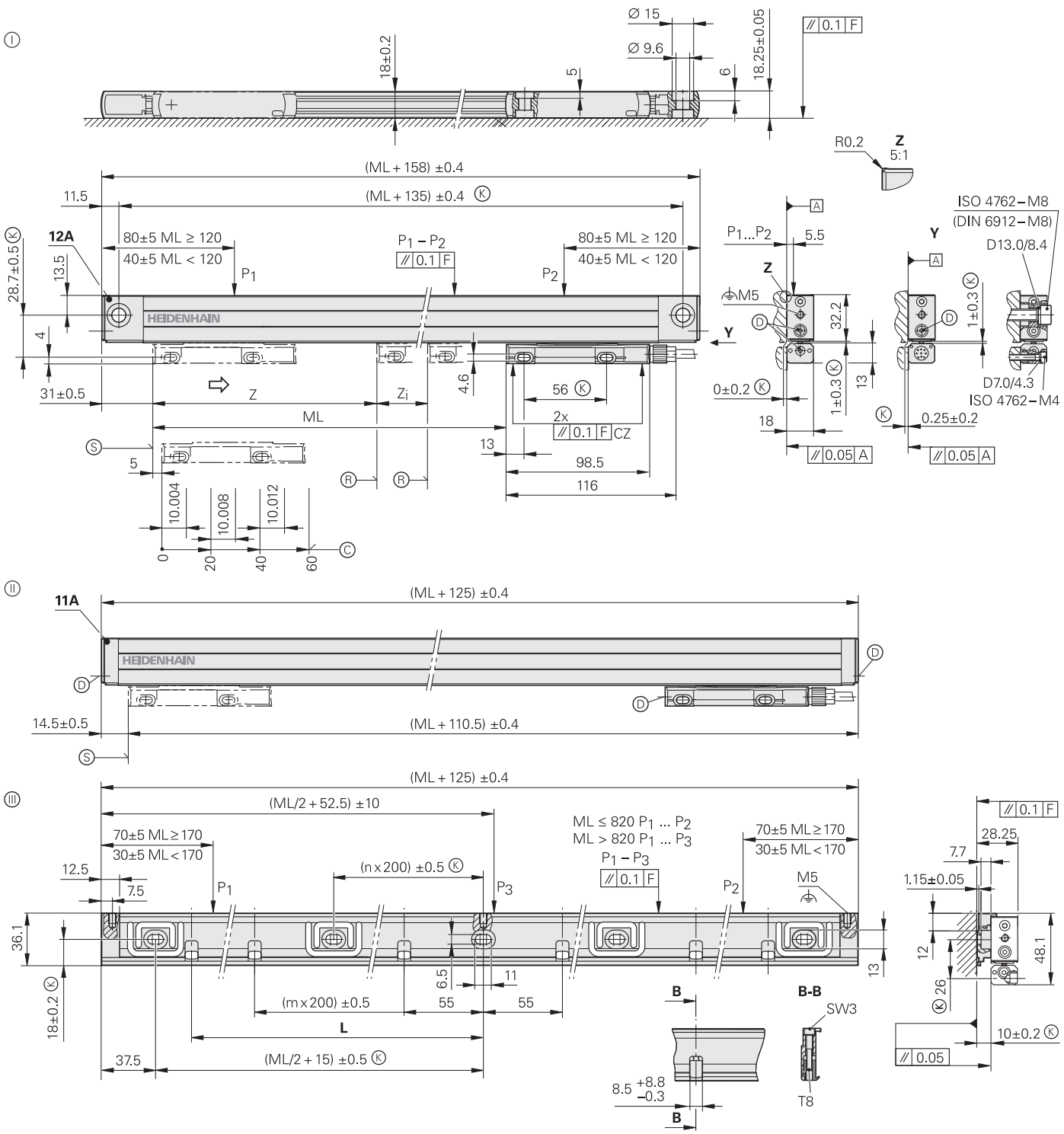
Specifications	LC 211	LC 281	LC 291 F	LC 291 M
Measuring standard Coefficient of linear expansion	METALLUR steel scale tape with absolute track and incremental track, grating period: 40 µm Same as machine main casting			
Accuracy grade	±5 µm			
Measuring length ML* in mm	3240 mm to 28040 mm in steps of 200 mm[2)] Kit with single-section METALLUR steel scale tape and housing sections			
Interface	EnDat 2.2		Fanuc Serial Interface αi interface	Mitsubishi high speed interface
Ordering designation	EnDat22	EnDat02	Fanuc05	Mit03-04
Measuring step	0.010 µm		αi interface/α interface 0.0125 µm/0.050 µm	0.010 µm
Diagnostics interface	Digital			
Clock frequency Calculation time t_{cal}	≤ 16 MHz ≤ 5 µs	≤ 2 MHz ≤ 5 µs	– –	
Measurement of direct-drive motor temperature	–	With EIB 5281 or EIB 5181	–	
Incremental signals	–	~ 1 V_{PP}	–	
Signal period	–	40 µm	–	
Cutoff frequency –3 dB	–	≥ 250 kHz	–	
Electrical connection	Separate adapter cable (1 m/3 m/6 m/9 m), connectable at either end of mounting block			
Cable length[1)]	≤ 100 m (at clock frequency ≤ 8 MHz)	≤ 150 m	≤ 50 m	≤ 30 m
Supply voltage	DC 3.6 V to 14 V			
Power consumption (max.)	*At 14 V:* ≤ 1.3 W *At 3.6 V:* ≤ 1.1 W			
Current consumption (typical)	*At 5 V:* 225 mA (without load)			
Traversing speed	≤ 180 m/min (max. acceleration in measuring direction ≤ 100 m/s^2)			
Required moving force	≤ 15 N			
Vibration 55 Hz to 2000 Hz *acting on* **Shock** 11 ms	*Housing:* 200 m/s^2 (EN 60068-2-6) *Scanning unit:* 300 m/s^2 (EN 60068-2-6) ≤ 300 m/s^2 (EN 60068-2-27)			
Operating temperature	0 °C to 50 °C			
Protection EN 60529	IP53 when installed according to mounting instructions, IP64 with sealing air from DA 400			
Mass	1.3 kg + 3.6 kg/m of measuring length			

***** Please select when ordering
1) With HEIDENHAIN cable
2) LC 291 M up to 20040 mm

LF 485

Incremental linear encoder with slimline scale housing

- **Very high repeatability**
- **Thermal behavior similar to steel or gray cast iron**
- **For limited installation space**



ML	50	100	150	200	250	300	350	400	450	500	550	600	650	700	750	800	850	900	950	1000	1050	1120	1220	1320	1420	1520	1620	1720	1820	2020
L	37.5	55	75	100	115	140	175	200	225	250	275	300	325	350	375	400	425	450	475	500	515	555	610	655	710	760	810	855	910	1010

mm

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

Ⓘ = 12A end block; for mounting with and without mounting spar
Ⓘⓘ = 11A end block;for mounting with mounting spar
Ⓘⓘⓘ = Mounting spar MSL 41
F = Machine guideway
P = Measuring points for alignment
Ⓚ = Required mating dimensions

Ⓡ = Reference mark position on LF 485
Two reference marks for measuring lengths

50 ... 1000	1120 ... 1220
z = 25 mm z_i = ML – 50 mm	z = 35 mm z_i = ML – 70 mm

Ⓒ = Reference mark position on LF 485C
Ⓓ = Compressed air inlet
Ⓢ = Beginning of measuring length (ML)
⇨ = Direction of motion of the scanning unit for ascending position values

LF 485 without mounting spar

LF 485 with mounting spar



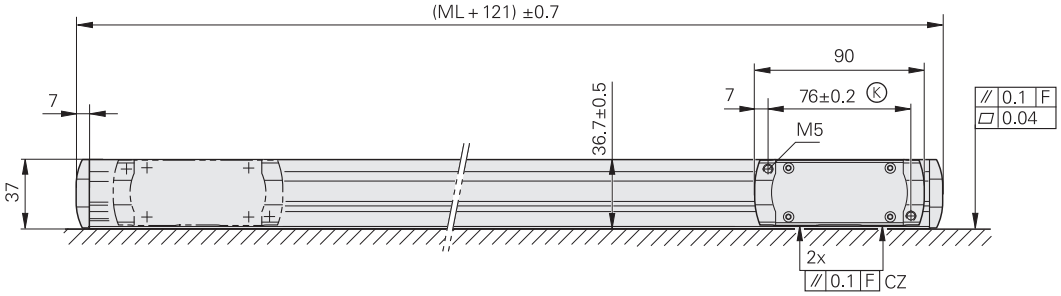
Specifications	LF 485
Measuring standard Coefficient of linear expansion	SUPRADUR phase grating on steel, grating period: 8 µm $\alpha_{therm} \approx 10 \cdot 10^{-6}\ K^{-1}$
Accuracy grade*	±5 µm; ±3 µm
Measuring length ML* in mm	Mounting spar* optional 50 100 150 200 250 300 350 400 450 500 550 600 650 700 750 800 900 1000 1120 1220
Interface	⁓ 1 V_{PP}
Signal period	4 µm
Reference marks* *LF 485*	• One reference mark at midpoint of measuring length • Two reference marks, each 25 mm (for ML ≤ 1000 mm) or 35 mm (for ML ≥ 1120 mm) from the beginning and end of the measuring length
LF 485 C	Distance-coded
Diagnostics interface	Analog
Cutoff frequency –3 dB	≥ 250 kHz
Electrical connection	Separate adapter cable (1 m/3 m/6 m/9 m) connectable on mounting block
Cable length	≤ 150 m (with HEIDENHAIN cable)
Supply voltage without load	DC 5 V ±0.25 V/< 150 mA
Traversing speed	≤ 60 m/min (max. acceleration in measuring direction ≤ 100 m/s^2)
Required moving force	≤ 4 N
Vibration 55 Hz to 2000 Hz *acting on* **Shock** 11 ms	*Housing with mounting spar:* ≤ 150 m/s^2 (EN 60068-2-6) *Scanning unit:* ≤ 200 m/s^2 (EN 60068-2-6) ≤ 300 m/s^2 (EN 60068-2-27)
Operating temperature	0 °C to 50 °C
Protection class EN 60529	IP53 when installed according to instructions in the brochure IP64 with sealing air from DA 400
Mass	0.4 kg + 0.6 kg/m of measuring length

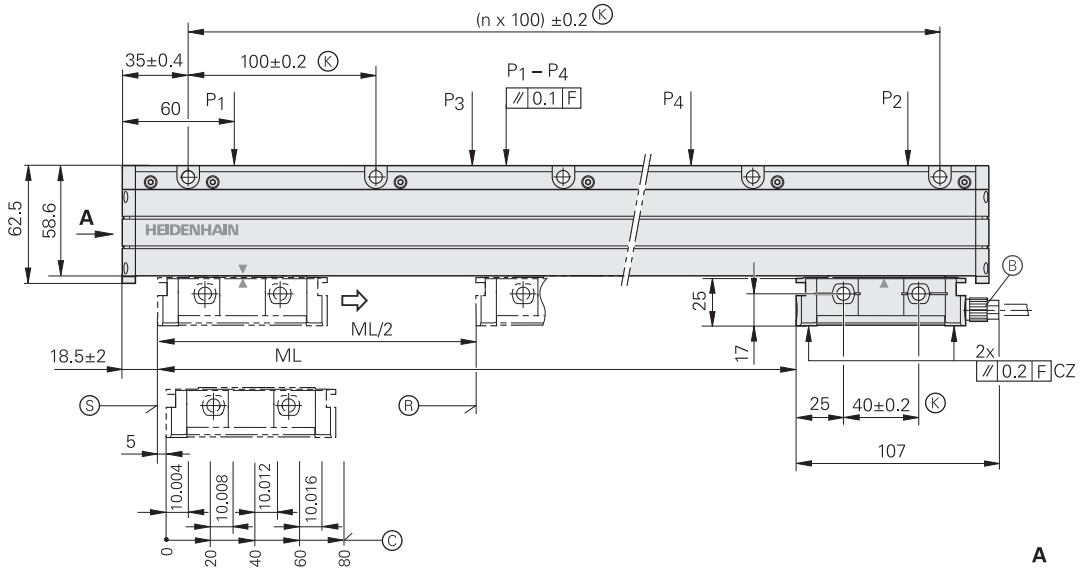
* Please select when ordering

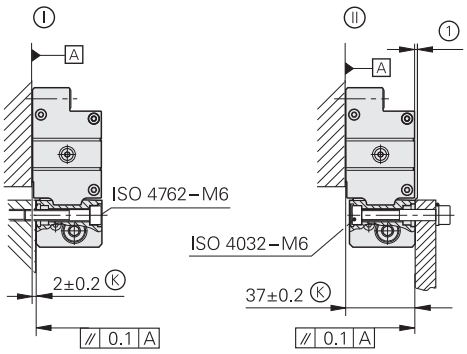
LF 185

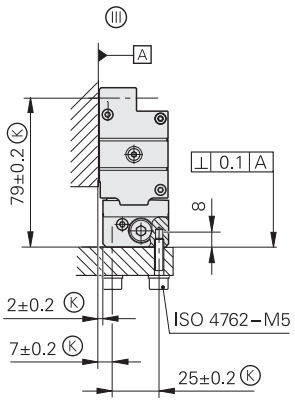
Incremental linear encoder with full-size scale housing

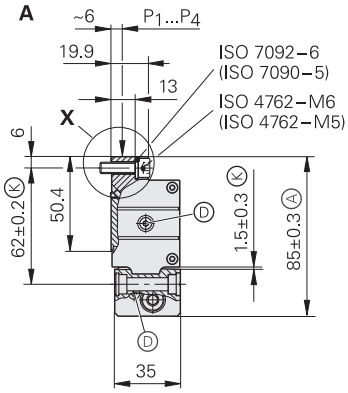
- **Very high repeatability**
- **Thermal behavior similar to steel or gray cast iron**
- **Flat-lying installation possible**

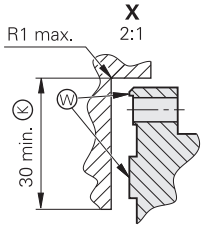












mm

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

Ⅰ, Ⅲ,
Ⅲ = Mounting options
F = Machine guideway
P = Measuring points for alignment
ML = Measuring length
Ⓚ = Required mating dimensions
Ⓐ = Alternative mating dimensions
Ⓑ = Cable connection usable at either end
Ⓓ = Compressed-air inlet usable at either end
Ⓢ = Beginning of measuring length (ML)
Ⓡ = Reference mark position on LF 185
Ⓒ = Reference mark position on LF 185C
Ⓦ = Mating surfaces
① = Not an alternative mating dimension, as opposed to LS/LC 100
⇨ = Direction of motion of the scanning unit for ascending position values



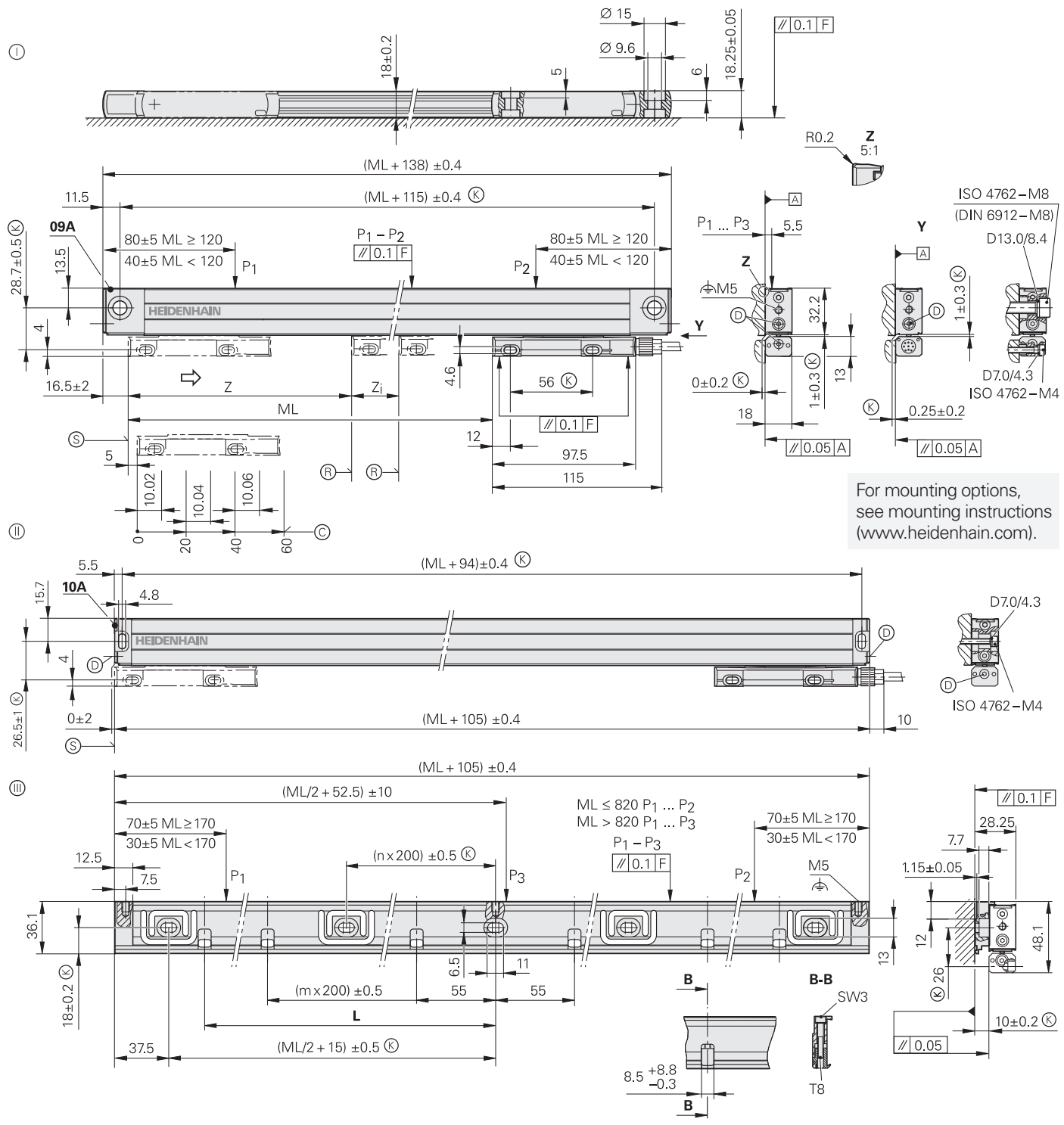
Specifications	LF 185
Measuring standard Coefficient of linear expansion	SUPRADUR phase grating on steel, grating period: 8 µm $\alpha_{therm} \approx 10 \cdot 10^{-6}\ K^{-1}$
Accuracy grade*	±3 µm; ±2 µm
Measuring length (ML)* in mm	140 240 340 440 540 640 740 840 940 1040 1140 1240 1340 1440 1540 1640 1740 1840 2040 2240 2440 2640 2840 3040
Interface	⁓ 1 V_{PP}
Signal period	4 µm
Reference marks* *LF 185* *LF 185C*	One reference mark at midpoint; other reference mark positions upon request Distance-coded
Diagnostics interface	Analog
Cutoff frequency –3 dB	≥ 250 kHz
Electrical connection	Separate adapter cable (1 m/3 m/6 m/9 m) connectable on mounting block
Cable length	≤ 150 m (with HEIDENHAIN cable)
Supply voltage without load	DC 5 V ±0.25 V/< 150 mA
Traversing speed	≤ 60 m/min (max. acceleration in measuring direction ≤ 100 m/s^2)
Required moving force	≤ 4 N
Vibration 55 Hz to 2000 Hz *acting on* **Shock** 11 ms	*Housing:* ≤ 150 m/s^2 (EN 60068-2-6) *Scanning unit:* ≤ 200 m/s^2 (EN 60068-2-6) ≤ 300 m/s^2 (EN 60068-2-27)
Operating temperature	0 °C to 50 °C
Protection class EN 60529	IP53 when installed according to instructions in the brochure IP64 with sealing air from DA 400
Mass	0.8 kg + 4.6 kg/m of measuring length

***** Please select when ordering

LS 400 series

Incremental linear encoders with slimline scale housing

- **For limited installation space**



ML	70	120	170	220	270	320	370	420	470	520	570	620	670	720	770	820	870	920	970	1020	1070	1140	1240	1340	1440	1540	1640	1740	1840	2040
L	37.5	55	75	100	115	140	175	200	225	250	275	300	325	350	375	400	425	450	475	500	515	555	610	655	710	760	810	855	910	1010

mm

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

Ⓘ = 09A end block; for mounting with and without mounting spar
Ⓘⓘ = 10A end block; for mounting with mounting spar
Ⓘⓘⓘ = MSL 41 mounting spar
F = Machine guideway
P = Measuring points for alignment
Ⓚ = Required mating dimensions

Ⓡ = Reference mark position on LS 4x7
Two reference marks for measuring lengths

70 ... 1020	1140 ... 2040
z = 35 mm	z = 45 mm
z_i = ML – 70 mm	z_i = ML – 90 mm

Ⓒ = Reference mark position on LS 4x7C
Ⓓ = Compressed air inlet
Ⓢ = Beginning of measuring length (ML)
⇨ = Direction of motion of the scanning unit for ascending position values

LS 4x7 without mounting spar

LS 4x7 with mounting spar



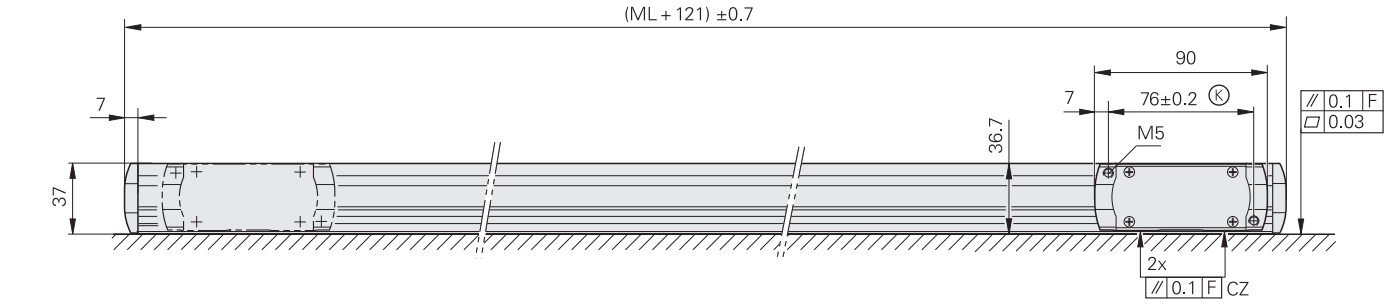
Specifications	LS 487	LS 477						
Measuring standard Coefficient of linear expansion	Glass scale with DIADUR grating, grating period: 20 µm $\alpha_{therm} \approx 8 \cdot 10^{-6}\ K^{-1}$ (mounting type ①/⑪); *with mounting spar:* $\alpha_{therm} \approx 9 \cdot 10^{-6}\ K^{-1}$ (mounting type ⑩)							
Accuracy grade*	±5 µm; ±3 µm							
Measuring length (ML)* in mm	Mounting spar* optional up to ML 1240, required as of ML 1340 70 120 170 220 270 320 370 420 470 520 570 620 670 720 770 820 920 1020 1140 1240 1340 1440 1540 1640 1740 1840 2040							
Reference marks* *LS 4x7*	• Selectable with magnets every 50 mm • One reference mark at midpoint of measuring length • Two reference marks, each 35 mm (for ML ≤ 1020 mm) or 45 mm (for ML ≥ 1140 mm) from the beginning and end of the measuring length							
LS 4x7C	Distance-coded							
Interface	⁓ 1 V_{PP}	⊓⊔ TTL						
Integrated interpolation* Signal period	– 20 µm	5-fold –		10-fold –			20-fold –	
Diagnostics interface	Analog	–						
Cutoff frequency –3 dB	≥ 160 kHz	–		–			–	
Scanning frequency* Edge separation *a*	–	100 kHz ≥ 0.5 µs	50 kHz ≥ 1 µs	100 kHz ≥ 0.25 µs	50 kHz ≥ 0.5 µs	25 kHz ≥ 1 µs	50 kHz ≥ 0.25 µs	25 kHz ≥ 0.5 µs
Measuring step	Depends on interpolation	1 µm[1)]		0.5 µm[1)]			0.25 µm[1)]	
Electrical connection	Separate adapter cable (1 m/3 m/6 m/9 m) connectable on mounting block							
Cable length[2)]	≤ 150 m	≤ 100 m						
Supply voltage without load	DC 5 V ±0.25 V/< 120 mA	DC 5 V ±0.25 V/< 140 mA						
Traversing speed	≤ 120 m/min	≤ 120 m/min	≤ 60 m/min	≤ 120 m/min	≤ 60 m/min	≤ 30 m/min	≤ 60 m/min	≤ 30 m/min
Required moving force	≤ 5 N							
Vibration 55 Hz to 2000 Hz **Shock** 11 ms **Acceleration**	*Without mounting spar:* ≤ 100 m/s^2 (EN 60068-2-6) *With mounting spar, cable outlet at right:* ≤ 200 m/s^2, *left:* 100 m/s^2 (EN 60068-2-6) ≤ 300 m/s^2 (EN 60068-2-27) ≤ 100 m/s^2 in measuring direction							
Operating temperature	0 °C to 50 °C							
Protection EN 60529	IP53 when installed according to mounting information and instructions IP64 with compressed air from DA 400							
Mass	0.4 kg + 0.5 kg/m of measuring length							

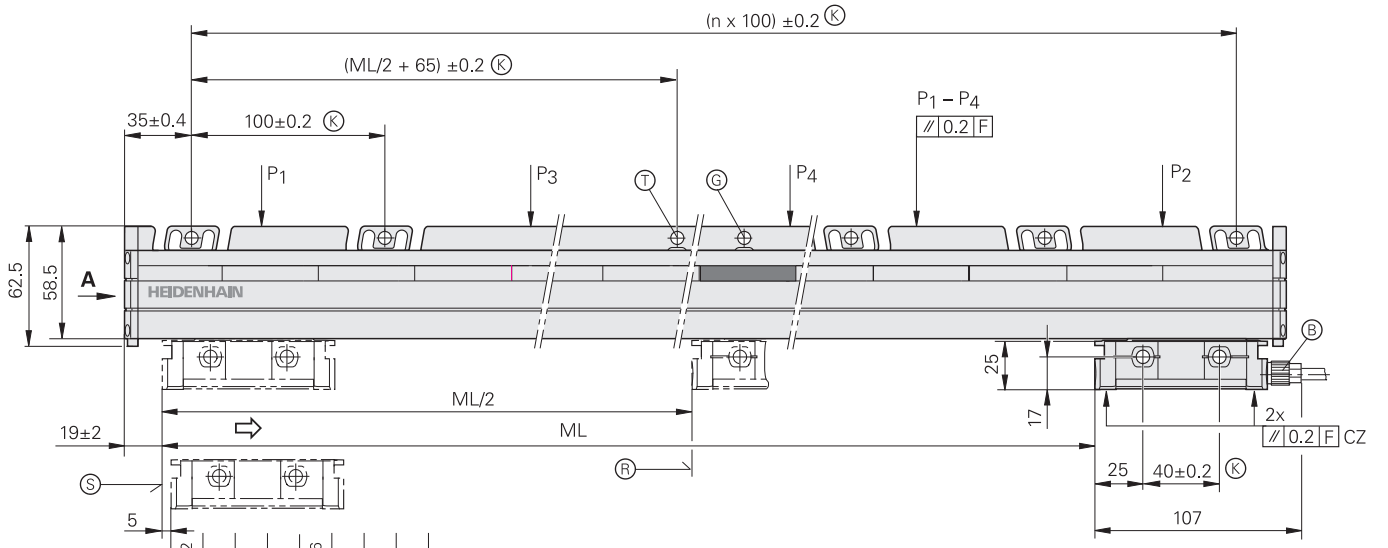
***** Please select when ordering
1) After 4-fold evaluation in the downstream electronics
2) With HEIDENHAIN cable

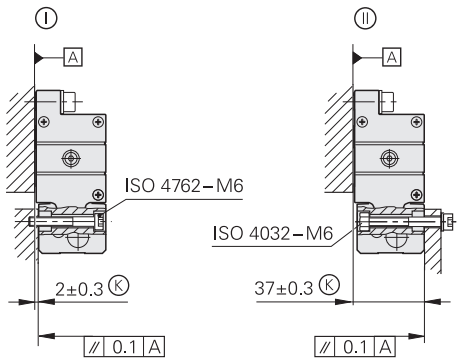
LS 100 series

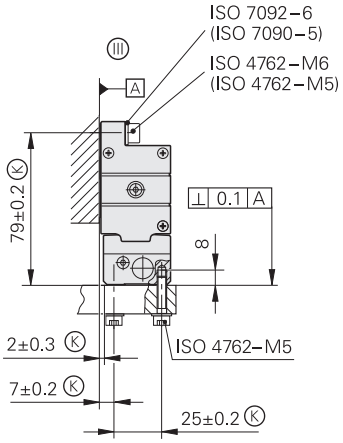
Incremental linear encoders with full-size scale housing

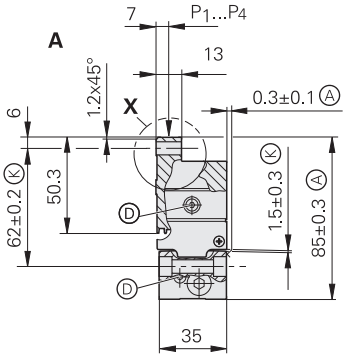
- **High vibration rating**
- **Flat-lying installation possible**

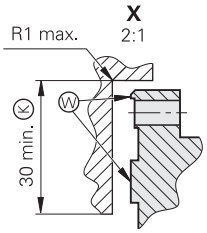












mm

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

Ⅰ, Ⅱ,
Ⅲ = Mounting options
F = Machine guideway
P = Measuring points for alignment
Ⓚ = Required mating dimensions
Ⓐ = Alternative mating dimensions
Ⓑ = Cable connection usable at either end
Ⓓ = Compressed-air inlet usable at either end
Ⓣ = Mechanical fixed point (preferred)
Ⓖ = Mechanical fixed point (repeated at an interval of 100 mm)
Ⓡ = Reference mark position on LS 1x7
Ⓒ = Reference mark position on LS 1x7C
Ⓢ = Beginning of measuring length (ML)
Ⓦ = Mating surfaces
⇨ = Direction of motion of the scanning unit for ascending position values



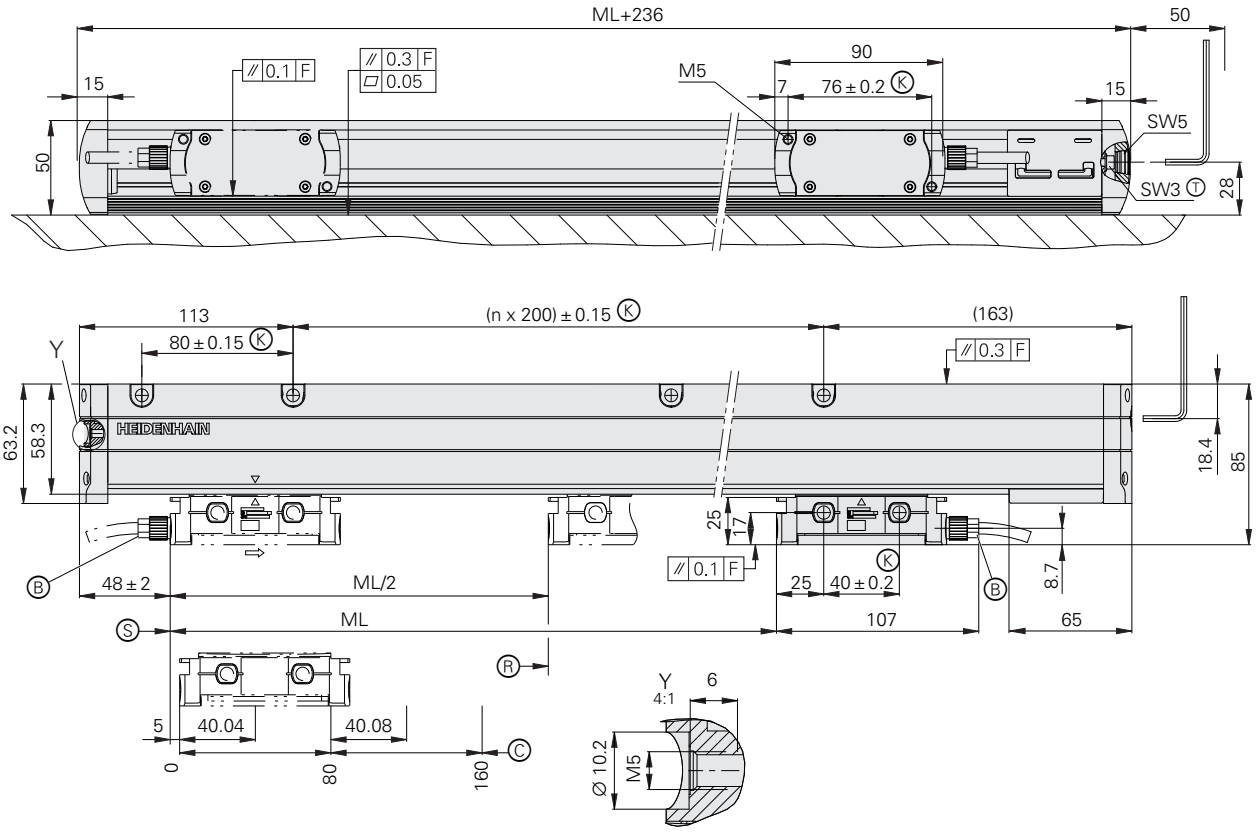
Specifications	LS 187	LS 177						
Measuring standard Coefficient of linear expansion	Glass scale with DIADUR grating, grating period: 20 µm $\alpha_{therm} \approx 8 \cdot 10^{-6}\ K^{-1}$							
Accuracy grade*	±5 µm; ±3 µm							
Measuring length (ML)* in mm	140 240 340 440 540 640 740 840 940 1040 1140 1240 1340 1440 1540 1640 1740 1840 2040 2240 2440 2640 2840 3040							
Reference marks* *LS 1x7* *LS 1x7C*	Selectable with magnets every 50 mm; standard setting: one reference mark in the center Distance-coded							
Interface	⌒ 1 V_{PP}	⊓⊔ TTL						
Integrated interpolation* Signal period	– 20 µm	5-fold –		10-fold –			20-fold –	
Diagnostics interface	Analog	–						
Cutoff frequency –3 dB	≥ 160 kHz	–		–			–	
Scanning frequency* Edge separation *a*	–	100 kHz ≥ 0.5 µs	50 kHz ≥ 1 µs	100 kHz ≥ 0.25 µs	50 kHz ≥ 0.5 µs	25 kHz ≥ 1 µs	50 kHz ≥ 0.25 µs	25 kHz ≥ 0.5 µs
Measuring step	Depends on interpolation	1 µm[1)]		0.5 µm[1)]			0.25 µm[1)]	
Electrical connection	Separate adapter cable (1 m/3 m/6 m/9 m) connectable on mounting block							
Cable length[2)]	≤ 150 m	≤ 100 m						
Supply voltage without load	DC 5 V ±0.25 V/< 120 mA	DC 5 V ±0.25 V/< 140 mA						
Traversing speed	≤ 120 m/min	≤ 120 m/min	≤ 60 m/min	≤ 120 m/min	≤ 60 m/min	≤ 30 m/min	≤ 60 m/min	≤ 30 m/min
Required moving force	≤ 4 N							
Vibration 55 Hz to 2000 Hz **Shock** 11 ms **Acceleration**	≤ 200 m/s^2 (EN 60068-2-6) ≤ 400 m/s^2 (EN 60068-2-27) ≤ 60 m/s^2 in measuring direction							
Operating temperature	0 °C to 50 °C							
Protection class EN 60529	IP53 when mounted according to the mounting information and instructions IP64 with compressed air from DA 400							
Mass	0.4 kg + 2.3 kg/m of measuring length							

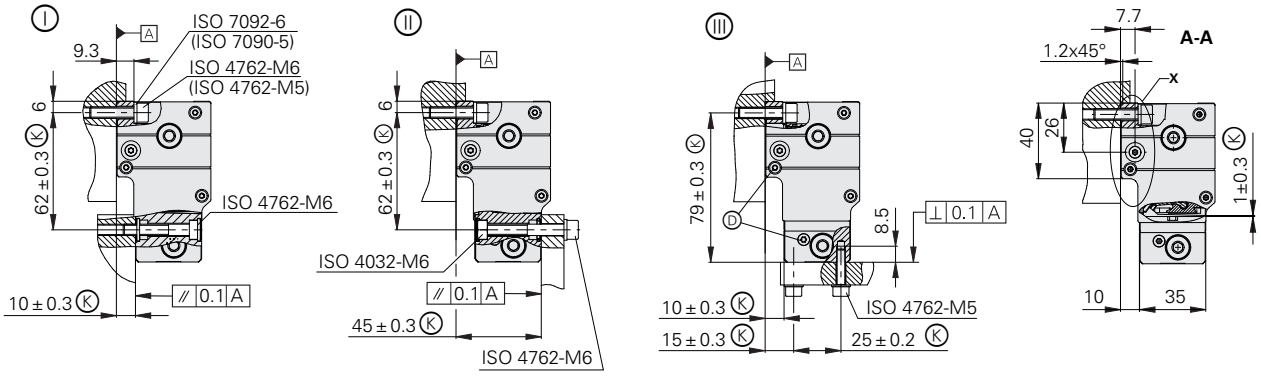
***** Please select when ordering
1) After 4-fold evaluation in the downstream electronics
2) With HEIDENHAIN cable

LB 383C up to 3040 mm (single-section housing)

Incremental linear encoder with full-size scale housing

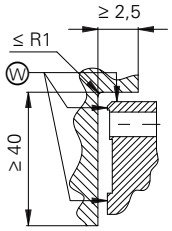
- **Flat-lying installation possible**
- **Also available in mirrored version (mating dimensions upon request)**





mm

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



Ⅰ, Ⅱ,
Ⅲ = Mounting options
F = Machine guideway
Ⓚ = Required mating dimensions
Ⓑ = Cable connection, usable at either end
Ⓣ = Tensioning screw for scale tape
Ⓓ = Compressed air inlet with integrated throttle, usable at either end
Ⓡ = Reference mark position on LB 3x3
Ⓒ = Reference mark position on LB 3x3C
Ⓢ = Beginning of measuring length ML;
starting value for version with distance-coded reference marks between 0 mm and 71600 mm
Ⓦ = Mating surfaces
⇨ = Direction of motion of the scanning unit for ascending position values
ML = Measuring length



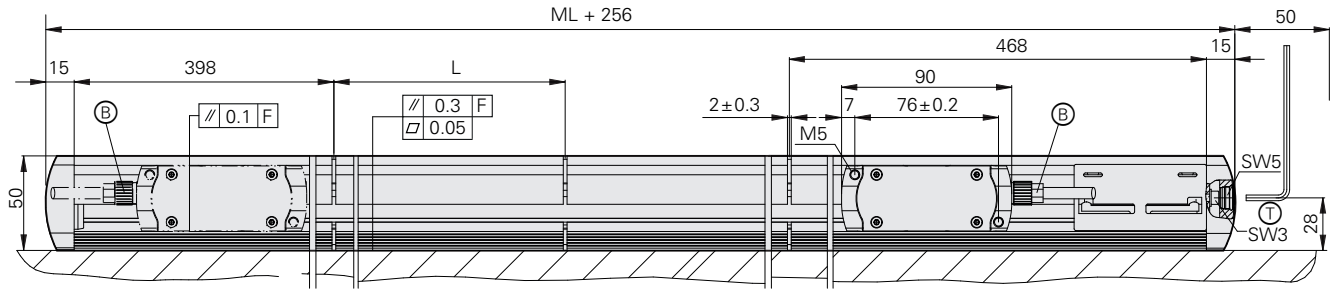
Specifications	**LB 383C** up to ML 3040 mm
Measuring standard Coefficient of linear expansion	METALLUR steel scale tape, 40 µm grating period $\alpha_{therm} \approx 10 \cdot 10^{-6}\ K^{-1}$
Accuracy grade	±5 µm
Measuring length (ML)* in mm	Single-section housing 440 640 840 1040 1240 1440 1640 1840 2040 2240 2440 2640 2840 3040
Reference marks *LB 383 C*	Distance-coded
Interface	⁓ 1 V_{PP}
Signal period	40 µm
Diagnostics interface	Analog
Cutoff frequency –3 dB	≥ 250 kHz
Electrical connection	Separate adapter cable (1 m/3 m/6 m/9 m), connectable at either end of mounting block
Cable length[1)]	≤ 150 m
Supply voltage without load	DC 5 V ±0.25 V/< 150 mA
Traversing speed	≤ 180 m/min (max. acceleration in measuring direction ≤ 100 m/s^2)
Required moving force	≤ 15 N
Vibration 55 Hz to 2000 Hz *acting on* **Shock** 11 ms	*Housing:* 200 m/s^2 (EN 60068-2-6) *Scanning unit:* 300 m/s^2 (EN 60068-2-6) ≤ 300 m/s^2 (EN 60068-2-27)
Operating temperature	0 °C to 50 °C
Protection class EN 60529	IP53 when mounted according to the mounting information and instructions IP64 with compressed air from DA 400
Mass	1.3 kg + 3.6 kg/m of measuring length

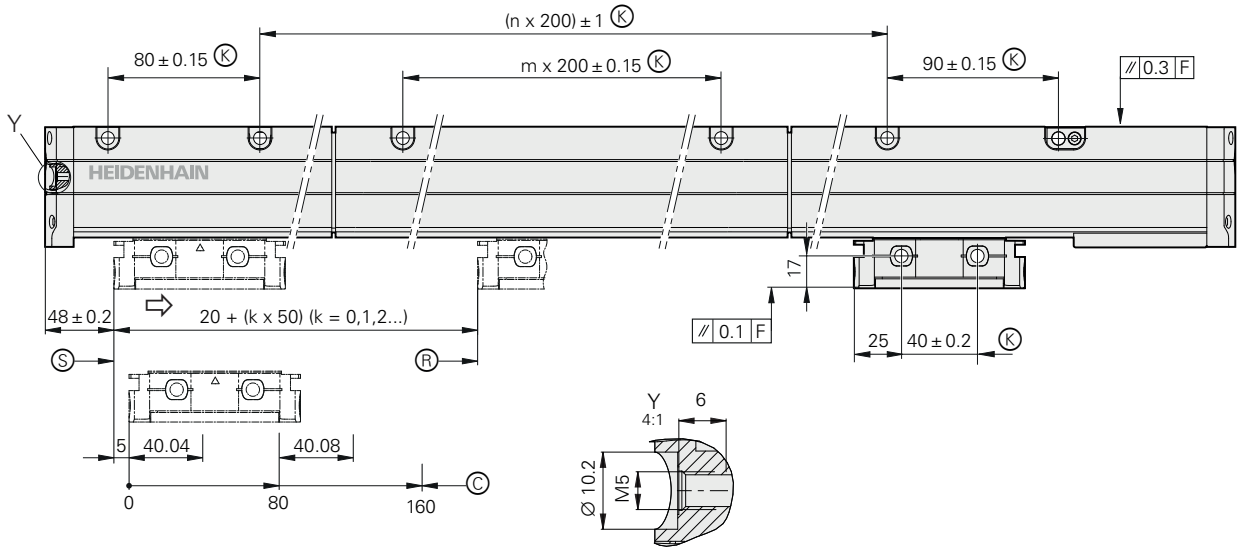
***** Please select when ordering
1) With HEIDENHAIN cable

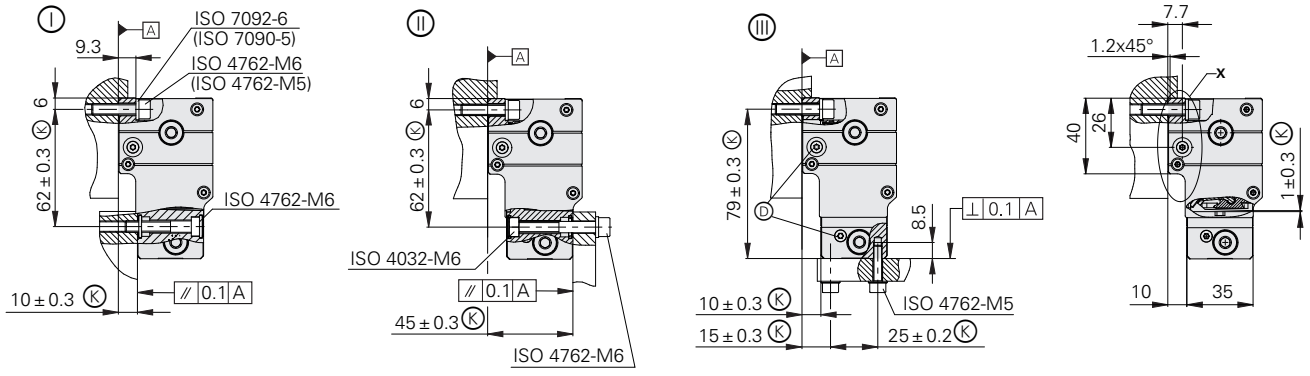
LB 383C up to 30040 mm (multi-section housing)

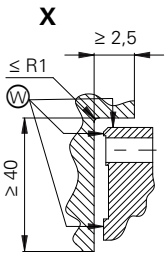
Incremental linear encoder with full-size scale housing

- **Measuring lengths of up to 30 m (up to 72 m upon request)**
- **Flat-lying installation possible**
- **Also available in mirrored version (mating dimensions upon request)**









mm

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

Ⓘ, Ⓘ,
Ⓘ = Mounting options
F = Machine guideway
Ⓚ = Required mating dimensions
Ⓑ = Cable connection, usable at either end
Ⓓ = Compressed air inlet with integrated throttle, usable at either end
Ⓡ = Reference mark position on LB 3x3
Ⓒ = Reference mark position on LB 3x3C
Ⓢ = Beginning of measuring length ML;
starting value for version with distance-coded reference marks between 0 mm and 71600 mm
Ⓦ = Mating surfaces
⇨ = Direction of motion of the scanning unit for ascending position values
ML = Measuring length
L = Housing section lengths



Specifications	**LB 383C** starting from ML 3240 mm
Measuring standard Coefficient of linear expansion	METALLUR steel scale tape, 40 µm grating period Same as machine main casting
Accuracy grade	±5 µm
Measuring length ML*	Kit with single-section METALLUR scale tape and housing sections Measuring lengths from 3240 mm to 30040 mm in 200 mm steps (up to 72040 mm upon request)
Reference marks* *LB 383C*	Distance-coded
Interface	⁓ 1 V_{PP}
Signal period	40 µm
Diagnostics interface	Analog
Cutoff frequency –3 dB	≥ 250 kHz
Electrical connection	Separate adapter cable (1 m/3 m/6 m/9 m), connectable at either end of mounting block
Cable length[1)]	≤ 150 m
Supply voltage without load	DC 5 V ±0.25 V/< 150 mA
Traversing speed	≤ 180 m/min (max. acceleration in measuring direction ≤ 100 m/s^2)
Required moving force	≤ 15 N
Vibration 55 Hz to 2000 Hz **Shock** 11 ms	≤ 300 m/s^2 (EN 60068-2-6) ≤ 300 m/s^2 (EN 60068-2-27)
Operating temperature	0 °C to 50 °C
Protection class EN 60529	IP53 when mounted according to the mounting information and instructions IP64 with compressed air from DA 400
Mass	1.3 kg + 3.6 kg/m of measuring length

***** Please select when ordering
[1)] With HEIDENHAIN cable

Testing and inspection devices, and diagnostics

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

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

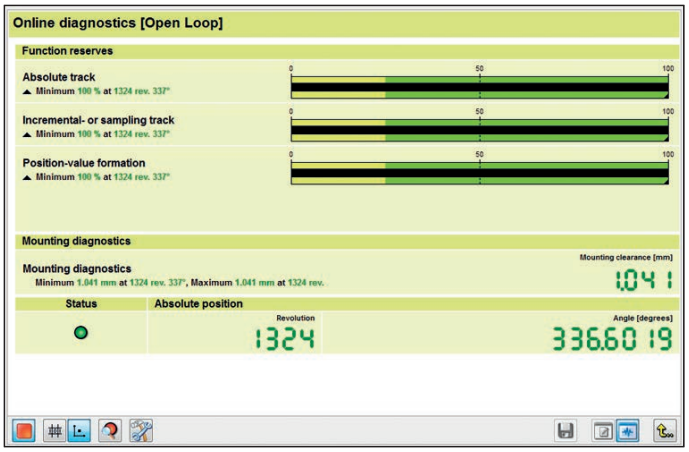
Absolute encoders use serial data transmission. Depending on the interface, additional 1 V_{PP} incremental signals can be output. The signals are extensively monitored within the encoder. The monitoring results (particularly valuation numbers) can be transmitted to the downstream electronics along with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

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

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

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

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



Diagnostics with the PWM 21 and ATS software



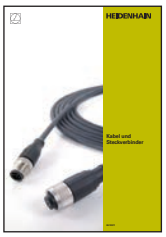
Initial setup with the PWM 21 and ATS software

Further information:

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

Related documents

Further HEIDENHAIN products



Brochure
Cables and Connectors

Contents:
Technical characteristics, cable overviews, and cable lists



Brochure
Interfaces of HEIDENHAIN Encoders

Contents:
Information on serial interfaces, sinusoidal signals, square-wave signals, and commutation signals



Brochures
TNC 128 Straight-Cut Control
TNC 320 Contouring Control
TNC 620 Contouring Control
TNC 640 Contouring Control
TNC7 Contouring Control

Contents:
Information for end users



OEM brochures
TNC 128 Straight-Cut Control
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Information for machine manufacturers



Brochures
MANUALplus 620 Contouring Control
CNC PILOT 640 Contouring Control

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Brochure
Encoders for Servo Drives

Contents:
Rotary encoders
Angle encoders
Linear encoders



Brochure
Angle Encoders with Integral Bearing

Contents:
Absolute angle encoders
RCN, ECN
Incremental angle encoders
RON, RPN, ROD



Product Information
LC 116, LC 196F/LC 196M,
LC 416, LC 496F/LC 496M
Absolute linear encoders with optimized scanning



Brochure
Modular Angle Encoders
with Scale Drum or Scale Tape

Contents:
Incremental angle encoders
ECA, ERA, ECM, ERM



Brochure
Touch Probes

Contents:
Tool touch probes
TT
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TS



Brochure
Measuring Devices For Machine Tool Inspection and Acceptance Testing

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KGM, VM

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Mastering nanometer accuracy



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