



# HEIDENHAIN



## Linear Encoders

For Numerically Controlled  
Machine Tools

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Further information is available on the Internet at [www.heidenhain.com](http://www.heidenhain.com) as well as upon request.

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- Angle encoders with integral bearing
- Angle encoders without integral bearing
- Rotary encoders
- HEIDENHAIN subsequent electronics
- HEIDENHAIN controls
- Measuring devices for machine tool inspection and acceptance testing

Technical information regarding:

- Interfaces of HEIDENHAIN encoders
- Accuracy of feed axes
- Safety-related position measuring systems
- EnDat 2.2—bidirectional interface for position encoders
- Encoders for 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 made.*

*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 heat generation 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  $\pm 0.2$  mm to  $\pm 0.3$  mm between the scale and mounting block are permissible.

## 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.

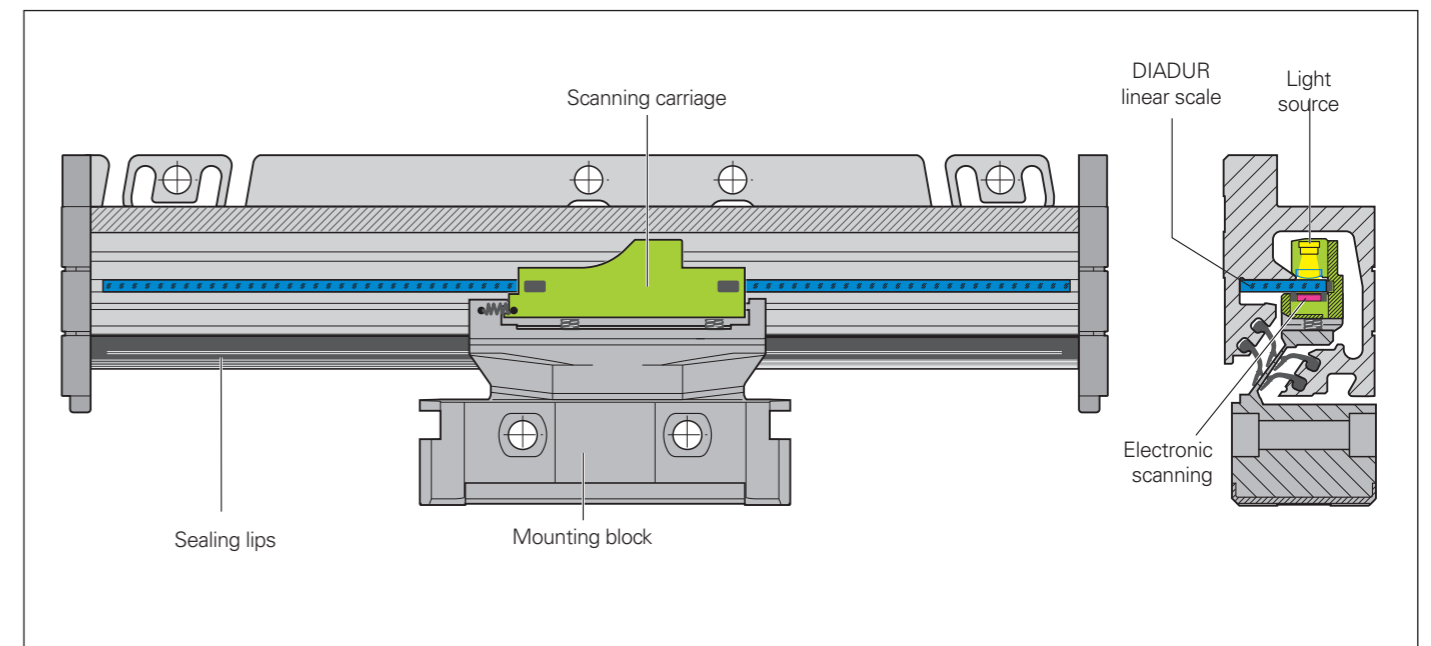
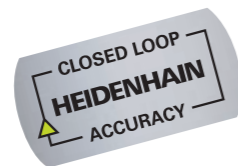
## Availability

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.

### Further information:

Please request further documentation or inform yourself on the Internet at [www.heidenhain.de](http://www.heidenhain.de).

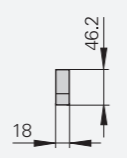
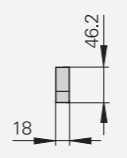
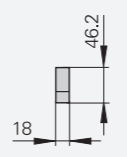


Schematic design of the LC 115 sealed linear encoder

# 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)   | Signal period    | Interface                      | Model                | Page |
|--|--|--|--------------------------|---|------------------|--------------------------------|----------------------|------|
| <b>Absolute position measurement</b><br>• Glass scale  |   | $\pm 5 \mu\text{m}$<br>$\pm 3 \mu\text{m}$ | $\pm 0.1 \mu\text{m}$    | 70 mm to 1240 mm<br><i>With mounting spar or clamping elements:</i><br>70 mm to 2040 mm | –                | EnDat 2.2                      | LC 415 <sup>2)</sup> | 22   |
|  |  |  |                          |   | 20 $\mu\text{m}$ | EnDat 2.2 with $\sim 1 V_{PP}$ | LC 485               |      |
|  |  |  |                          |   | –                | DRIVE-CLiQ                     | LC 495 S             | 24   |
|  |  |  |                          |   |                  | Fanuc $\alpha$ i               | LC 495 F             |      |
|  |  |  |                          |   |                  | Mitsubishi                     | LC 495 M             |      |
|  | Panasonic  | LC 495 P                                   |                          |   |                  |                                |                      |      |
| <b>Incremental linear measurement with very high repeatability</b><br>• Steel scale<br>• Small signal period |   | $\pm 5 \mu\text{m}$<br>$\pm 3 \mu\text{m}$ | $\pm 0.04 \mu\text{m}$   | 50 mm to 1220 mm  | 4 $\mu\text{m}$  | $\sim 1 V_{PP}$                | LF 485               | 34   |
| <b>Incremental linear measurement</b><br>• Glass scale   |  | $\pm 5 \mu\text{m}$<br>$\pm 3 \mu\text{m}$ | $\pm 0.2 \mu\text{m}$    | 70 mm to 1240 mm<br><i>With mounting spar:</i><br>70 mm to 2040 mm                      | 20 $\mu\text{m}$ | $\sim 1 V_{PP}$                | LS 487               | 38   |
|  |  |  |                          |   | –                | TTL                            | LS 477               |      |



LC 415



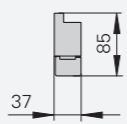
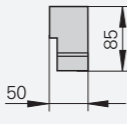
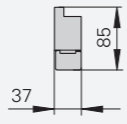
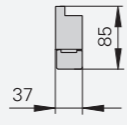
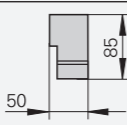
LF 485  
LS 487



LC 115

## 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.

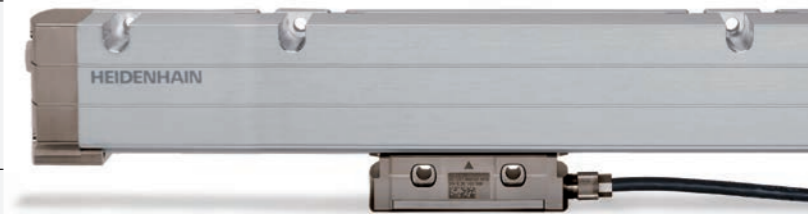
|  |   |  |                            |   |                  |                                |                      |    |
|--|---|--|----------------------------|---|------------------|--------------------------------|----------------------|----|
| <b>Absolute position measurement</b><br>• Glass scale  |  | $\pm 5 \mu\text{m}$<br>$\pm 3 \mu\text{m}$ | $\pm 0.1 \mu\text{m}^{1)}$ | 140 mm to 4240 mm                                 | –                | EnDat 2.2                      | LC 115 <sup>2)</sup> | 26 |
|  |   |  |                            |   | 20 $\mu\text{m}$ | EnDat 2.2 with $\sim 1 V_{PP}$ | LC 185               |    |
|  |   |  |                            |   | –                | DRIVE-CLiQ                     | LC 195 S             | 28 |
|  |   |  |                            |   |                  | Fanuc $\alpha$ i               | LC 195 F             |    |
|  |   |  |                            |   |                  | Mitsubishi                     | LC 195 M             |    |
|  | Panasonic   | LC 195 P                                   |                            |   |                  |                                |                      |    |
| <b>Absolute position measurement</b><br>For large measuring lengths<br>• Steel scale tape                    |  | $\pm 5 \mu\text{m}$                        | $\pm 0.4 \mu\text{m}$      | 440 mm to 28040 mm                                | –                | EnDat 2.2                      | LC 211               | 30 |
|  |   |  |                            |   | 40 $\mu\text{m}$ | EnDat 2.2 with $\sim 1 V_{PP}$ | LC 281               |    |
|  |   |  |                            |   | –                | Fanuc $\alpha$ i               | LC 291 F             |    |
|  |   |  |                            |   |                  | Mitsubishi                     | LC 291 M             |    |
| <b>Incremental linear measurement with very high repeatability</b><br>• Steel scale<br>• Small signal period |  | $\pm 3 \mu\text{m}$<br>$\pm 2 \mu\text{m}$ | $\pm 0.04 \mu\text{m}$     | 140 mm to 3040 mm                                 | 4 $\mu\text{m}$  | $\sim 1 V_{PP}$                | LF 185               | 36 |
| <b>Incremental linear measurement</b><br>• Glass scale   |  | $\pm 5 \mu\text{m}$<br>$\pm 3 \mu\text{m}$ | $\pm 0.2 \mu\text{m}$      | 140 mm to 3040 mm                                 | 20 $\mu\text{m}$ | $\sim 1 V_{PP}$                | LS 187               | 40 |
|  |   |  |                            |   | –                | TTL                            | LS 177               |    |
| <b>Incremental linear measurement for large measuring lengths</b><br>• Steel scale tape                      |  | $\pm 5 \mu\text{m}$                        | $\pm 0.8 \mu\text{m}$      | 440 mm to 30040 mm<br>Up to 72040 mm upon request | 40 $\mu\text{m}$ | $\sim 1 V_{PP}$                | LB 382               | 42 |



LC 115



LF 185



LC 211

<sup>1)</sup> For measuring lengths > 3040 mm:  $\pm 0.4 \mu\text{m}$  at the butt joint (at approx. 3100 mm)

<sup>2)</sup> Connectable to Yaskawa interface via EIB 3391Y

# 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 large measuring lengths, steel tape is used as the scale substrate.

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

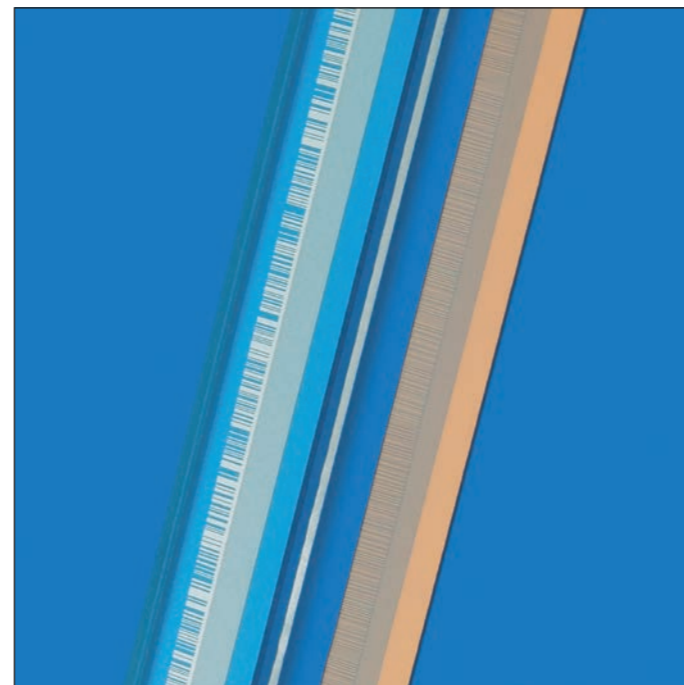
- METALLUR: contamination-tolerant graduation consisting of metal lines on gold; typical grating period: 40 µm
- DIADUR: extremely robust chromium lines on glass (typical grating period: 20 µm) or three-dimensional chromium structures (typical grating period: 8 µm) on glass
- SUPRADUR phase grating: 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 permit high edge definition and excellent homogeneity of the graduation. Together with the photoelectric scanning method, this high edge definition is critical for the high quality of the output signals.

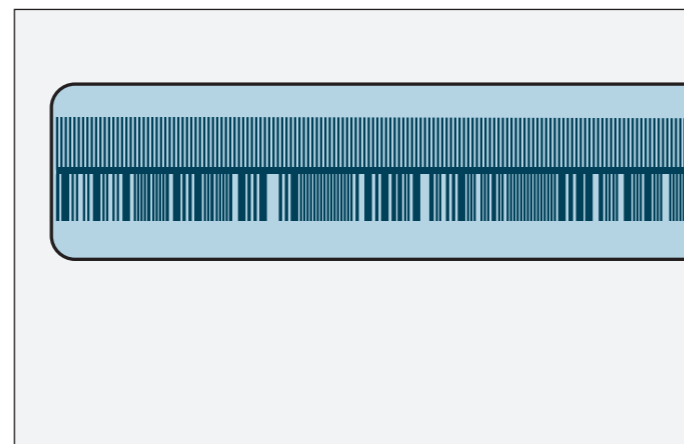
The master graduations are manufactured by HEIDENHAIN on custom-built, high-precision dividing engines.

## Absolute measuring method

With the **absolute measuring method**, the position value is immediately available upon switch-on of the encoder and can be requested at any time by the subsequent electronics. There is no need to jog 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

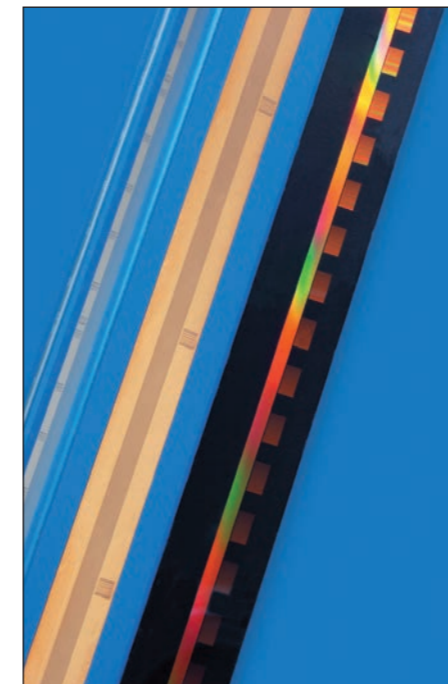


Schematic representation of an absolute code structure with an additional incremental track (LC 485 as example)

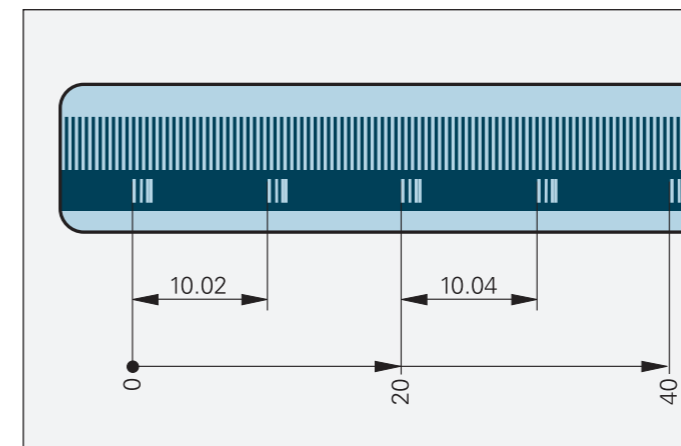
## Incremental measuring method

With the **incremental measuring method**, the graduation is arranged as a periodic grating structure. The position information is obtained **through the counting** of individual increments (measuring steps) from any set 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.

The reference mark must therefore be traversed before an absolute reference can be established or before the most recently selected reference point is found.



Graduations of incremental linear encoders



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

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 subsequent 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:

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

and

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

Where:

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

abs = Absolute value

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

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

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

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

|    | Signal period | Nominal increment N in signal periods | Maximum traverse |
|----|---------------|---------------------------------------|------------------|
| 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 performed without contact and thus does not induce wear. This method detects even extremely fine graduation lines with 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  $\mu\text{m}$  and 40  $\mu\text{m}$
- The **interferential scanning principle** for very fine graduations with grating periods of, for example, 8  $\mu\text{m}$ .

## Imaging scanning principle

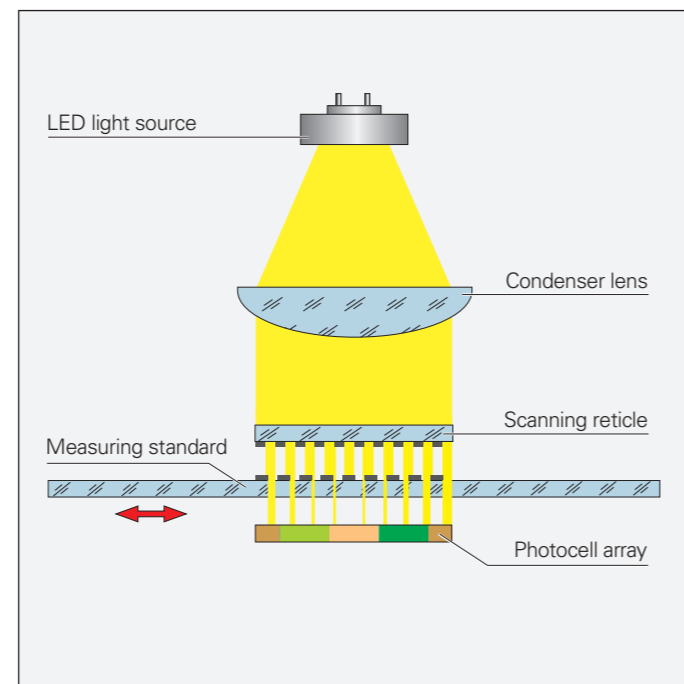
Put simply, the imaging scanning principle uses projected-light signal generation: two gratings with equal or similar grating periods—the scale and the scanning reticle—are moved relative to each other. The carrier material of the scanning reticle is transparent, whereas the graduation of the measuring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

When parallel light passes through a grating, light and dark fields are projected at a particular 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. An array of photovoltaic cells 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 tolerated 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 exploits the diffraction and interference of light on finely divided gratings in order to produce the signals used to measure displacement.

A step grating is used as the measuring standard: reflective lines with a height of 0.2  $\mu\text{m}$  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  $\mu\text{m}$ , 4  $\mu\text{m}$ , 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.

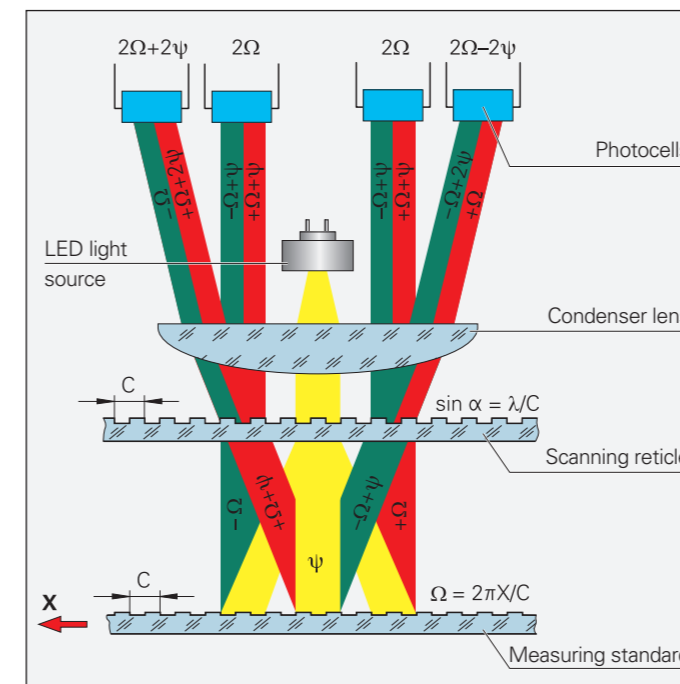
Sealed linear encoders that use the interferential scanning principle are given the designation LF.

Interferential scanning principle (optics schematics)

C Grating period

$\psi$  Phase shift of the light wave when passing through the scanning reticle

$\Omega$  Phase shift of the light wave due to motion X of the scale



# Measuring accuracy

The accuracy of the linear measurement is mainly determined by

- The quality of the scale grating
- The quality of the scanning process
- The quality of the signal processing electronics
- The error from the scanning unit guideway to the scale

A distinction is made between position errors over relatively large paths of traverse—for example the entire measuring length—and interpolation errors within one signal period.

## Position error over the measuring range

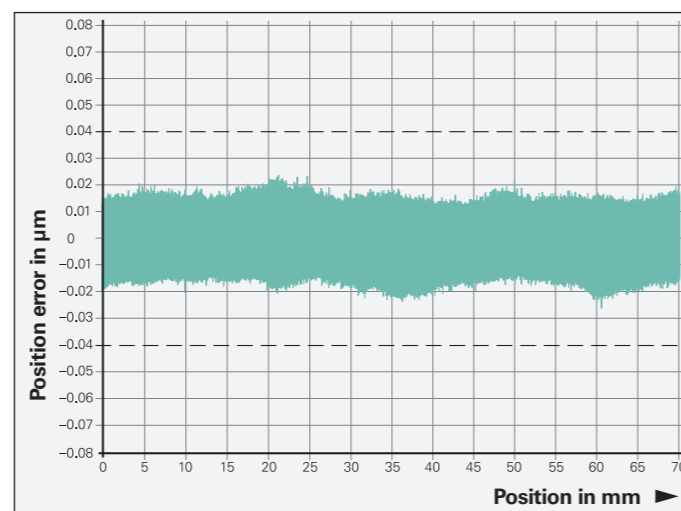
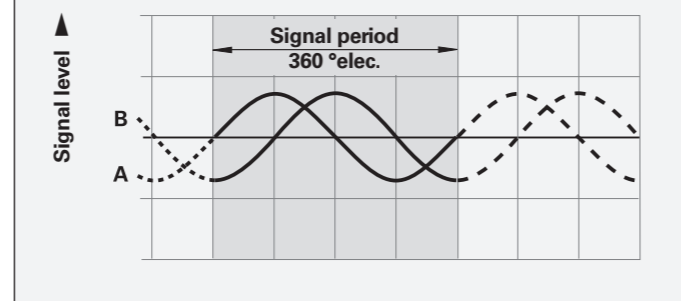
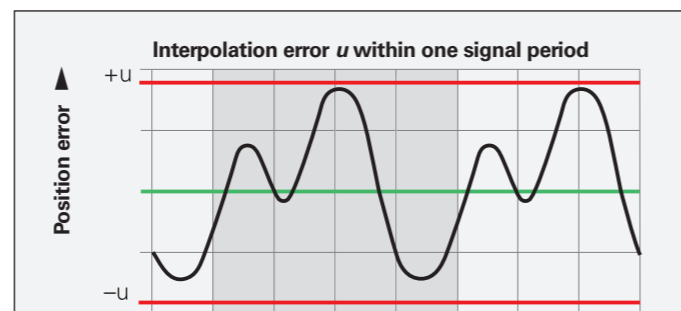
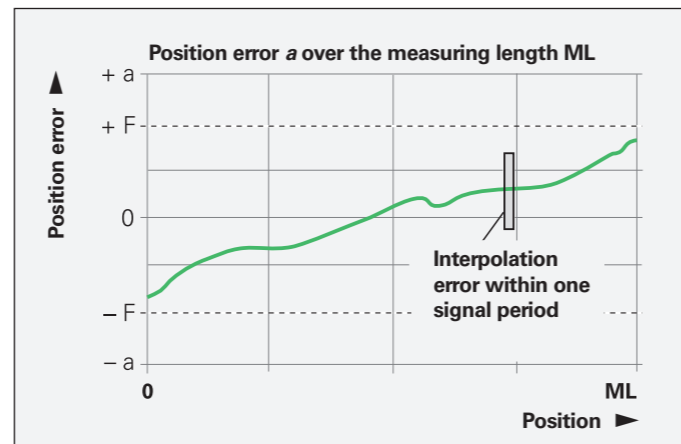
The accuracy of sealed linear encoders is specified in grades, which are defined as follows:

The extreme values  $\pm F$  of the measuring curves over any max. one-meter section of the measuring length lie within the accuracy grade  $\pm a$ . They are measured during the final inspection and documented in the calibration chart.

For sealed linear encoders, this data refers to the scale including the scanning unit, which is then the system accuracy.

## Interpolation error within one signal period

The interpolation error within one signal period is determined by the signal period of the encoder, as well as the quality of the graduation and the scanning thereof. At any measuring position, it typically lies at  $\pm 2\%$  to  $\pm 0.5\%$  of the signal period (see *Selection guide, page 6*). The smaller the signal period, the smaller the interpolation error within one signal period. It is of critical importance both for accuracy of a positioning movement as well as for velocity control during the slow and even traverse of an axis, and therefore for surface quality and the quality of the machined part.



Interpolation error within one signal period for a measuring range of 70 mm for LF encoders

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

The position errors are measured by traversing in both directions, and the averaged curve is shown in the calibration chart.

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

For the LC, LF, and LS series listed in this brochure, a calibration chart documents the **position error** ascertained for the measuring length. It also specifies the measuring parameters and the measurement uncertainty.

## Temperature range

The linear encoders are inspected at a **reference temperature** of 20 °C. The system accuracy 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 115**  
 ID 689694-10  
 SN 56927573 F

**Qualitätsprüf-Zertifikat**  
DIN 55 350-18-4.2.2

**Quality Inspection Certificate**  
DIN 55 350-18-4.2.2

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

Position error F of the linear encoder:  $F = Pos_u - Pos_b$   
 $Pos_u$  = Messposition der Messmaschine  
 $Pos_b$  = Messposition des Längemessgerätes

|   |  |
|---|--|
| <b>Maximale Positionsabweichung der Messkurve</b> | <b>Maximum position error of the error curve</b> |
| innerhalb 1000 mm                                 | within 1000 mm                                   |
| ± 1,06 µm   | ± 1,06 µm  |

**Unsicherheit der Messmaschine**  
 $U_{me} = 0,2 \mu\text{m} + 0,6 \cdot 10^{-4} L$  (L=Messintervall)

**Uncertainty of the measuring machine**  
 $U_{me} = 0,2 \mu\text{m} + 0,6 \cdot 10^{-4} L$  (L=measurement interval/length)

|                           |                               |
|---------------------------|-------------------------------|
| <b>Messparameter</b>      | <b>Measurement parameters</b> |
| Messschritt               | Measurement step              |
| Relative Luftfeuchtigkeit | Relative humidity             |
| 1000 µm                   | 1000 µm                       |
| max. 50%                  | max. 50%                      |

Dieses Längemessgerät wurde unter strengen HEIDENHAIN-Qualitätsnormen hergestellt und geprüft. Die Positionsabweichung liegt bei einer Bezugstemperatur von 20 °C innerhalb der Genauigkeitsklasse ± 5,0 µm/m.

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 ± 5,0 µm/m.

| Kalibriernormale               | Kalibrierzeichen            | Calibration standards      | Calibration marks           |
|--------------------------------|-----------------------------|----------------------------|-----------------------------|
| Jod-stabilisierter He-Ne Laser | 40151 PTB 11                | Jod-stabilized He-Ne Laser | 40151 PTB 11                |
| Wasser-Tripelpunktzelle        | 74055 PTB 15                | Water triple point cell    | 74055 PTB 15                |
| Gallium-Schmelzpunktzelle      | 74056 PTB 15                | Gallium melting point cell | 74056 PTB 15                |
| Barometer                      | 02759032 D-K-15-105 2016-11 | Pressure gauge             | 02759032 D-K-15-105 2016-11 |
| Luftfeuchtemessgerät           | 0591 D-K-19342 2016-11      | Hygrometer                 | 0591 D-K-19342 2016-11      |

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22.03.2017  
 Prüfer/Inspected by: D. Smykalis

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 for LC 4x5).

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*).

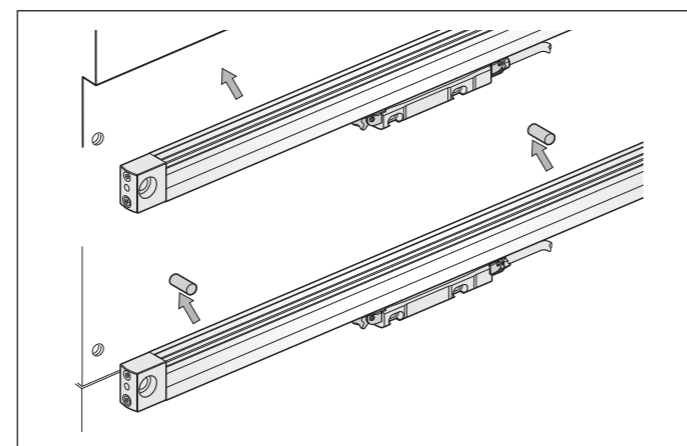
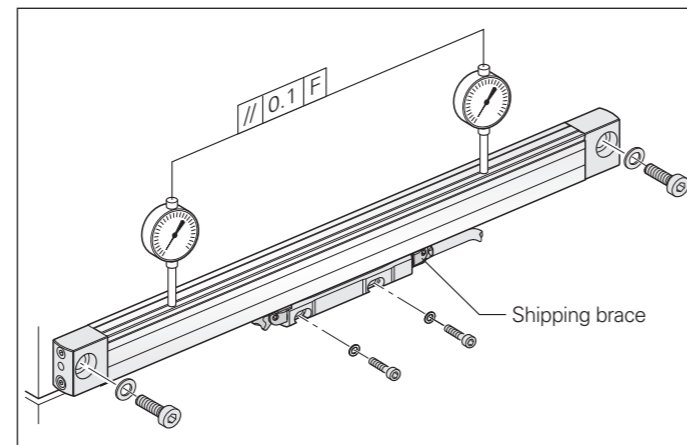
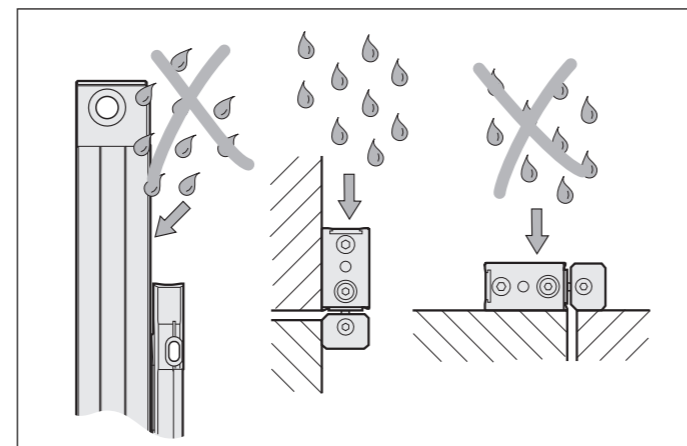
### Thermal characteristics

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.



### 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.

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 4x5, LF 4x5, and LS 4x7 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.

### Accessory:

#### MSL 41 mounting spar

ID 770902-xx

#### Mounting aid for scanning unit

ID 753853-01

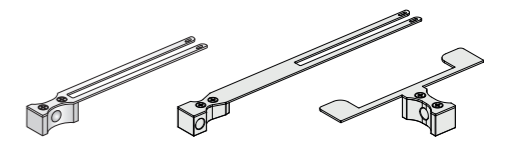
#### Mounting with clamping elements

If the cable outlet is to the right, the LC 4x5 scanning unit, 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.

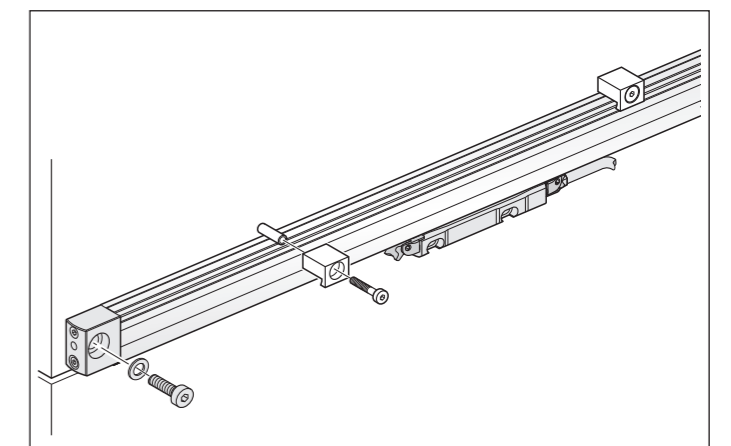
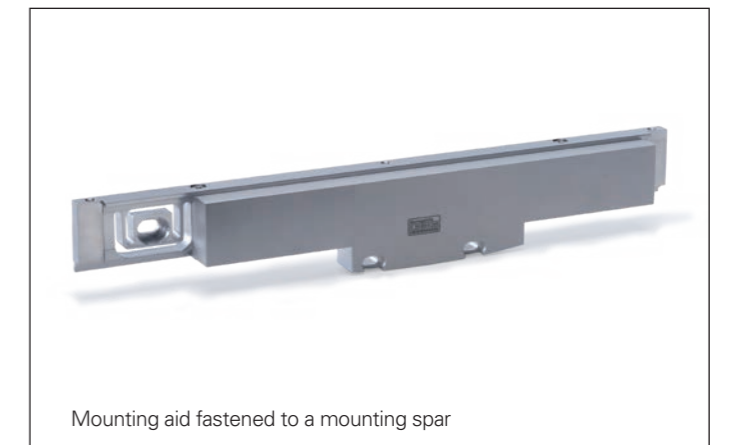
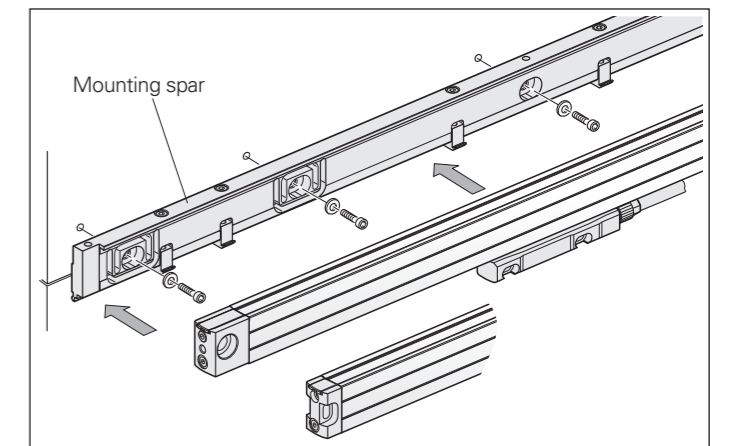
### Accessory:

#### Clamping elements

With pin and M5x10 screw  
ID 556975-01 (10 per package)



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





# 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:

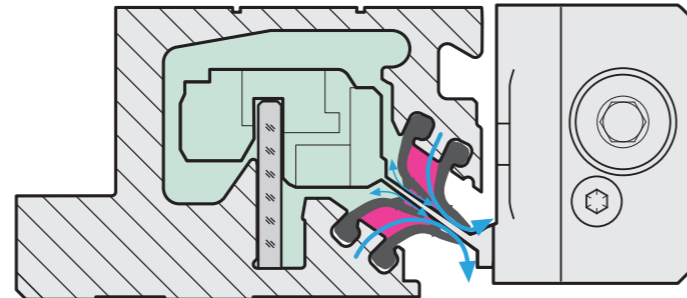
On the **LF**, the steel scale is cemented to a steel carrier that is fastened directly to the machine element.

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.

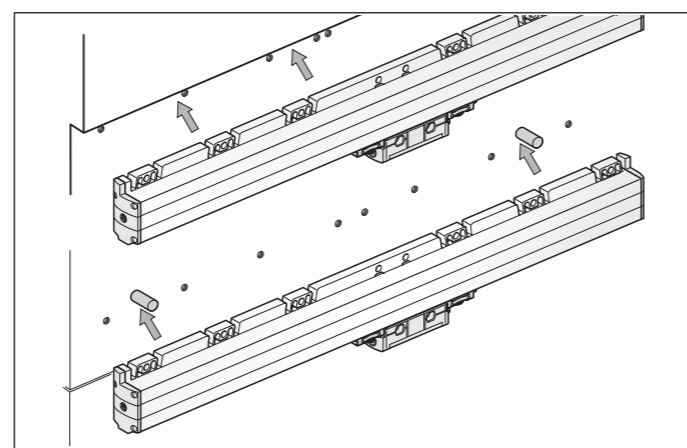
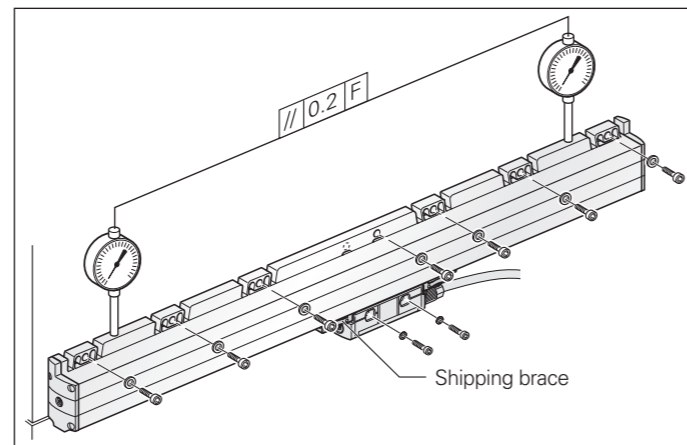
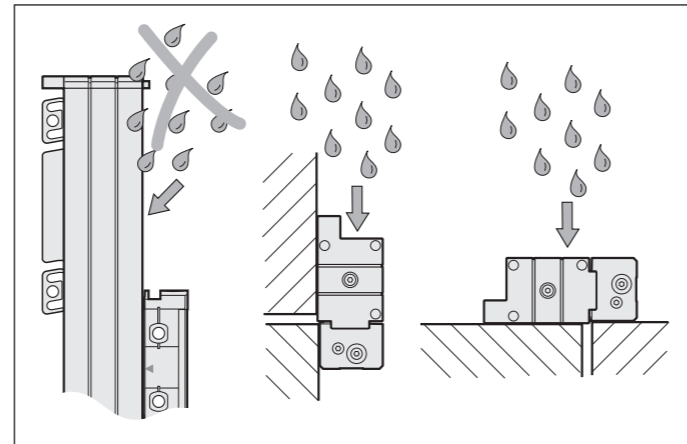
The **LC** and **LS** are fixed to the mounting surface at their midpoint. The flexible fastening elements permit reproducible thermal behavior.

### 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 382

The LC 2x1 and LB 382 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 up to  $\pm 100 \mu\text{m/m}$ .

### Accessory:

#### Mounting aids

- For LC 1x3, LS 1x7 ID 547793-02
- For LC 1x5 ID 1067589-02
- For LC 2x1, LB 382 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.

### Accessory:

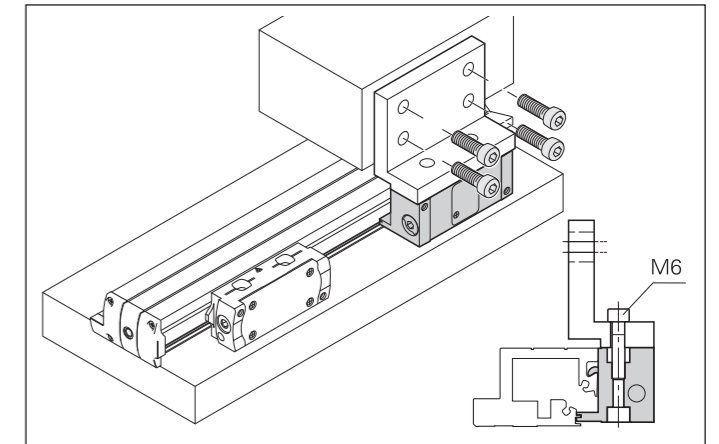
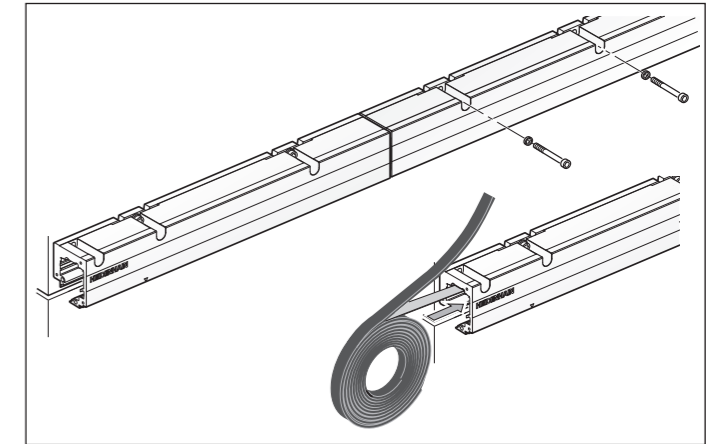
#### Mounting and test gauges for full-size linear encoders

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.

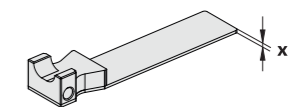
### Accessory:

#### Lubricating device

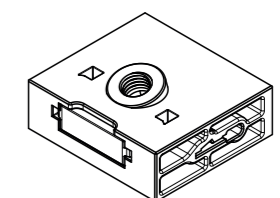
- For LC 2x1, LB 382 sealing lips ID 1104590-05



Example



|                               | LC 1xx, LS 1xx |           | LB 382/LC 2x1 |           |
|-------------------------------|----------------|-----------|---------------|-----------|
|                               | x              | ID        | x             | ID        |
| <b>Mounting gauge (gray)</b>  | 1,5 mm         | 575832-11 | 1,0 mm        | 772141-11 |
| <b>Test gauge max. (red)</b>  | 1,8 mm         | 575832-12 | 1,3 mm        | 772141-12 |
| <b>Test gauge min. (blue)</b> | 1,2 mm         | 575832-13 | 0,7 mm        | 772141-13 |



# 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 coolant and 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 onto the encoders must be cleaned by a microfilter and must comply with the following quality classes as per **ISO 8573-1** (2010 edition):

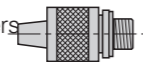
- Solid contaminants: **Class 1**  
Particle size No. of particles per m<sup>3</sup>
- 0.1 µm to 0.5 µm ≤ 20 000
- 0.5 µm to 1.0 µm ≤ 400
- 1.0 µm to 5.0 µm ≤ 10
- Max. pressure dew point: **Class 4**  
(pressure dew point at 3 °C)
- Total oil content: **Class 1**  
(max. oil concentration 0.01 mg/m<sup>3</sup>)

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 · 10<sup>5</sup> Pa (1 bar).

Accessory:

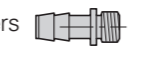
### Connecting piece

With throttle and gasket, for tube 6x1 for linear encoders (on the end block) ID 226270-02



### Connecting piece

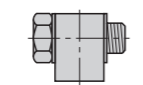
With throttle and gasket, for tube 6x1 for linear encoders (on the mounting block) ID 275239-01



Also suitable:

### Swiveling screw fitting 90°

With seal 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 the introduction of compressed air into encoders.

The DA 400 consists of three filter stages (prefilter, microfilter, and activated carbon filter) and a pressure regulator with manometer. The sealing air function can be effectively monitored using a manometer and pressure switch (available as 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 No. of particles per m<sup>3</sup>
- 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 ≤ 100 000
- Max. pressure dew point: **Class 6**  
(pressure dew point at 10 °C)
- Total oil content: **Class 4**  
(max. oil concentration 5 mg/m<sup>3</sup>)



DA 400

### Further information:

For more 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 indicated maximum values for the **vibration rating** apply for frequencies of 55 Hz to 2000 Hz (**EN 60068-2-6**), except when mechanical resonance arises. **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 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 linear encoders.

## System tests

Encoders from HEIDENHAIN are usually integrated as components into complete systems. Such applications require **comprehensive testing of the complete system**, irrespective 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 applicable 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 pay note the following documents for planning and assembly:
- Brochure: *Cables and Connectors*
  - Brochure: *Interfaces of HEIDENHAIN Encoders*
  - Mounting instructions for the respective encoder
  - Mounting instructions for output and adapter cables

|                | Ø 3.7 mm | Ø 4.5 mm | Ø 6.0 mm<br>Ø 6.8 mm | Ø 6.6 mm<br>Ø 10 mm | Ø 8.0 mm                |
|----------------|----------|----------|----------------------|---------------------|-------------------------|
| <br>T ≥ -40 °C | ≥ 8 mm   | ≥ 10 mm  | ≥ 20 mm              | ≥ 35 mm             | R <sub>1</sub> ≥ 40 mm  |
| <br>T ≥ -10 °C | ≥ 40 mm  | ≥ 50 mm  | ≥ 75 mm              | ≥ 75 mm             | R <sub>2</sub> ≥ 100 mm |

Minimum bend radii for rigid configuration or for frequent flexing

# Functional safety

## Safe axes

Driven axes on machine tools usually represent a great hazard for humans. Particularly if the human interacts with the machine (e.g., during workpiece setup), it must be ensured that the machine does not make any uncontrolled movements. Here, the position information of axes is needed to conduct a 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. Here, it is to be noted that the safety designs of control manufacturers differ from one another. This also means that the requirements to be fulfilled by the connected encoders can sometimes differ.

## 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. The reliable transmission of the position is based on two independently generated absolute position values and on error bits provided to the safe control. The purely serial data transmission also offers other advantages, such as 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<sub>PP</sub> signals) can also be used in safe axes. In these cases, the characteristics of the encoders must be matched to the

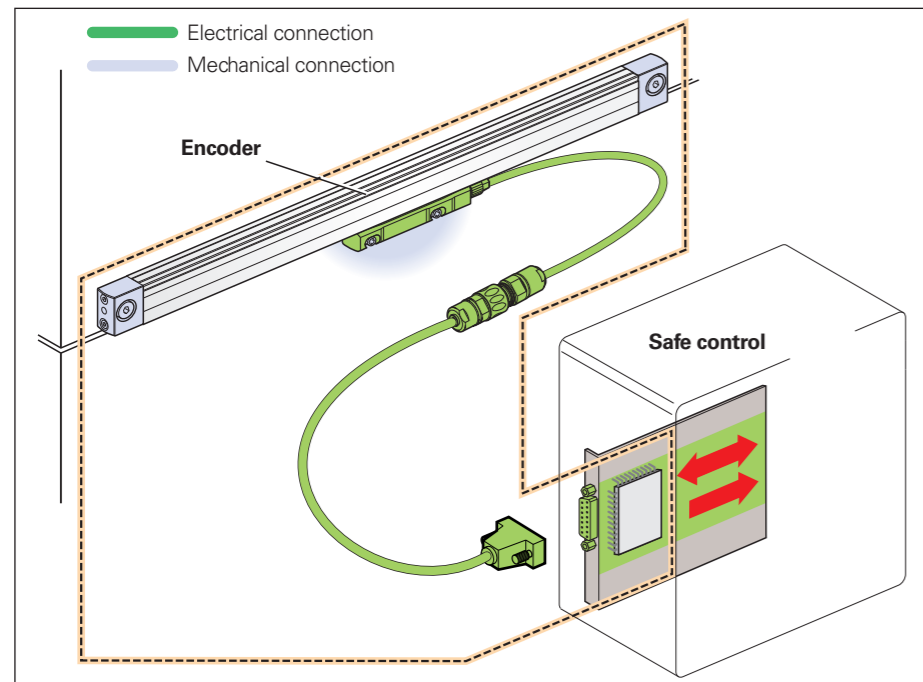
requirements of the respective control. HEIDENHAIN can provide additional data on the individual encoders (failure rate, fault model as per EN 61800-5-2).

## Service life

Unless otherwise specified, HEIDENHAIN encoders are designed for a service life of 20 years (in accordance with ISO 13849).

### Further information:

The safety-related characteristic values are listed in the specifications of the encoders. The Technical Information document *Safety-Related Position Encoders* provides explanations of the characteristic values. 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

## 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 drives, EN 61800-5-2, includes the loosening of the mechanical connection between the encoder and the drive as a fault that requires consideration. Since it cannot be guaranteed that the control will detect such errors, fault exclusion is required

in many cases. The requirements on a fault exclusion can result in additional constraints in the permissible limit values in the specifications. In addition, fault exclusions for the loss or loosening of the mechanical coupling usually require additional measures when mounting the encoders 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 a 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 <sup>2)</sup>                | Safe position for the mechanical connection <sup>1)</sup> | Limitation of specifications                                      |
|---------------|---|--|---|---|
| <b>LC 1x5</b> |   |  |   |   |
| 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  |
| <b>LC 4x5</b> |   |  |   |   |
| Housing       | Mounting option I<br>End blocks 12A for M8                  | M8 ISO 4762 8.8/A70<br>M8 DIN 6912 8.8 | ±0 µm   | No  |
|               | Mounting option III<br>MSL 41 mounting spar<br>ID 770902-xx | M6 ISO 4762 8.8/A70                    | ±0 µm   | For acceleration in measuring direction up to 60 m/s <sup>2</sup> |
| 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.

<sup>1)</sup> Fault exclusions are given only for the explicitly mentioned mounting options

<sup>2)</sup> 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:

- Mounting instructions: *LC 115/LC 195S* 743390  
*LC 415/LC 495S* (end block 14A) 737907  
(end block 12A) 737908  
(mounting spar MSL 41) 894918
- Technical Information: *Safety-Related Position Measuring Systems* 596632

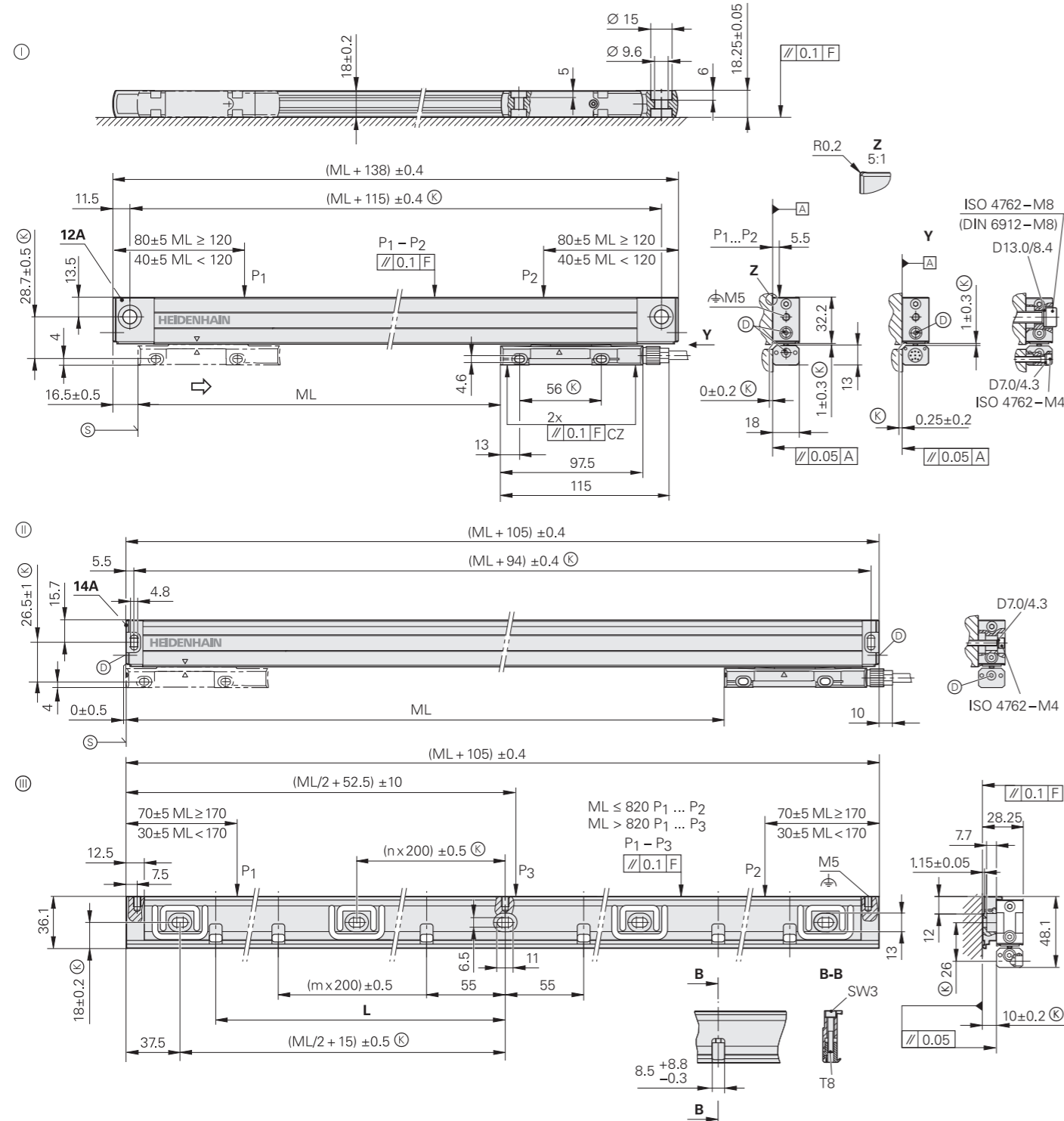
For implementation in a control:

- Specification for Safe Control 533095

# LC 400 series

Absolute 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 | 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 - m H  
 < 6 mm: ±0.2 mm
- ⊖ = End block 12A; for mounting with and without mounting spar
  - ⊕ = End block 14A; for mounting with mounting spar (specifications are restricted if attached directly with M4 screws)
  - ⊙ = 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 scanning unit for ascending position values



| Specifications   | LC 415  | LC 415 | LC 485                      |
|--|---|--------|-----------------------------|
| <b>Measuring standard</b><br>Coefficient of linear expansion | DIADUR glass scale with absolute track and incremental track, grating period: 20 µm<br>$\alpha_{\text{therm}} \approx 8 \cdot 10^{-6} \text{ K}^{-1}$ (mounting mode ⊖/⊕); with mounting spar: $\alpha_{\text{therm}} \approx 9 \cdot 10^{-6} \text{ K}^{-1}$ (mounting mode ⊙) |        |                             |
| <b>Accuracy grade*</b>                                       | ±3 µm, ±5 µm  |        |                             |
| <b>Measuring length ML*</b><br>in mm                         | Mounting spar* or clamping elements* optional up to ML 1240, required as of ML 1340<br>70 120 170 220 270 320 370 420 470 520 570 620 670 720<br>770 820 920 1020 1140 1240 1340 1440 1540 1640 1740 1840 2040  |        |                             |
| <b>Functional safety</b><br>for applications with up to      | <ul style="list-style-type: none"> <li>• SIL 2 as per EN 61508</li> <li>• Category 3, PL "d" as per EN ISO 13849-1:2015</li> </ul>  |        | –                           |
| PFH (per axis)   | ≤ 15 · 10 <sup>-9</sup> (up to 2000 m above sea level)  |        | –                           |
| Safe position <sup>1)</sup>                                  | 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)  |        |                             |
| <b>Interface</b>   | EnDat 2.2   |        |                             |
| Ordering designation   | EnDat22   |        | EnDat02                     |
| Measuring step<br>At ± 3 µm<br>At ± 5 µm                     | 0.001 µm<br>0.010 µm  |        | 0.005 µm<br>0.010 µm        |
| Clock freq. (calc. time t <sub>cal</sub> )                   | ≤ 16 MHz (≤ 5 µs)   |        | ≤ 2 MHz (≤ 5 µs)            |
| <b>Incremental signals</b>                                   | –   |        | ~ 1 V <sub>PP</sub> (20 µm) |
| Cutoff frequency –3 dB                                       | –   |        | ≥ 150 kHz                   |
| <b>Electrical connection</b>                                 | Separate adapter cable (1 m/3 m/6 m/9 m) connectable on mounting block  |        |                             |
| Cable length   | ≤ 100 m <sup>2)</sup>   |        | ≤ 150 m <sup>2)</sup>       |
| Supply voltage   | DC 3.6 V to 14 V  |        |                             |
| Power consumption (max.)                                     | 3.6 V: ≤ 1.1 W; 14 V: ≤ 1.3 W   |        |                             |
| <b>Traversing speed</b>                                      | ≤ 180 m/min (max. acceleration in measuring direction ≤ 100 m/s <sup>2</sup> )  |        |                             |
| <b>Required moving force</b>                                 | ≤ 5 N   |        |                             |
| <b>Vibration</b> 55 Hz to 2000 Hz affecting the              | Scanning unit: ≤ 200 m/s <sup>2</sup> (EN 60068-2-6)<br>Housing without mounting spar: ≤ 100 m/s <sup>2</sup> (EN 60068-2-6)<br>Housing with mounting spar, and cable outlet at right: ≤ 150 m/s <sup>2</sup> , left: ≤ 100 m/s <sup>2</sup> (EN 60068-2-6)                     |        |                             |
| <b>Shock</b> 11 ms   | ≤ 300 m/s <sup>2</sup> (EN 60068-2-27)  |        |                             |
| <b>Operating temperature</b>                                 | 0 °C to 50 °C   |        |                             |
| <b>Protection</b> EN 60529 <sup>3)</sup>                     | IP53 when installed according to instructions in the brochure, IP64 with sealing air from DA 400  |        |                             |
| <b>Mass</b>  | 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 occur in subsequent electronics after position value comparison (contact manufacturer of subsequent electronics)  
 2) With HEIDENHAIN cable (see the *Interfaces of HEIDENHAIN Encoders* brochure)  
 3) In the application, the LC must be protected from the ingress of particles and liquids

# LC 400 series

Absolute linear encoders with slimline scale housing

- For limited installation space
- Identical dimensions for LC 415/LC 485/LC 495



| Specifications   | LC 495S    | LC 495S | LC 495F   | LC 495M                         | LC 495P                    |
|--|---|---------|---|---------------------------------|----------------------------|
| <b>Measuring standard</b><br>Coefficient of linear expansion | DIADUR glass scale with absolute track and incremental track, grating period: 20 µm<br>$\alpha_{\text{therm}} \approx 8 \cdot 10^{-6} \text{ K}^{-1}$ (mounting mode ①/②);<br><i>with mounting spar:</i> $\alpha_{\text{therm}} \approx 9 \cdot 10^{-6} \text{ K}^{-1}$ (mounting mode ③) |         |   |                                 |                            |
| <b>Accuracy grade*</b>                                       | ±3 µm, ±5 µm  |         |   |                                 |                            |
| <b>Measuring length ML*</b> in mm                            | Mounting spar* or clamping elements* optional up to ML 1240, required as of ML 1340<br>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  |         |   |                                 |                            |
| <b>Functional safety</b><br>for applications with up to      | <ul style="list-style-type: none"> <li>• SIL 2 as per EN 61508</li> <li>• Category 3, PL “d” as per EN ISO 13849-1:2015</li> </ul>  | –       |   |                                 |                            |
| PFH (per axis)   | $25 \cdot 10^{-9}$ (up to 1000 m above sea level NN)  | –       |   |                                 |                            |
| Safe position <sup>1)</sup>                                  | Encoder: ±550 µm (safety-related measuring step SM = 220 µm)  | –       |   |                                 |                            |
|  | <i>Mechanical connection:</i> fault exclusions for the loosening of the housing and scanning unit (page 21)   |         |   |                                 |                            |
| <b>Interface</b>   | DRIVE-CLiQ  |         | Fanuc Serial Interface/αi interface                                   | Mitsubishi high speed interface | Panasonic Serial Interface |
| Ordering designation   | DQ01  |         | Fanuc05   | Mit03-04                        | Pana01                     |
| Measuring step<br>At ±3 µm<br>At ±5 µm                       | 0.001 µm<br>0.010 µm  |         | αi interface/α interface<br>0.00125 µm/0.010 µm<br>0.0125 µm/0.050 µm | 0.001 µm<br>0.010 µm            |                            |
| Clock frequency (calculation time $t_{\text{cal}}$ )         | –   |         |   |                                 |                            |
| <b>Electrical connection</b>                                 | Separate adapter cable (1 m/3 m/6 m/9 m) connectable on mounting block  |         |   |                                 |                            |
| Cable length   | ≤ 30 m <sup>2)</sup>  |         | ≤ 50 m  | ≤ 30 m                          | ≤ 50 m                     |
| Supply voltage   | DC 10 V to 28.8 V   |         | DC 3.6 V to 14 V  |                                 |                            |
| Power consumption (max.)                                     | 10 V: ≤ 1.5 W; 28.8 V: ≤ 1.7 W  |         | 3.6 V: ≤ 1.1 W; 14 V: ≤ 1.3 W   |                                 |                            |
| <b>Traversing speed</b>                                      | ≤ 180 m/min (max. acceleration in measuring direction ≤ 100 m/s <sup>2</sup> )  |         |   |                                 |                            |
| <b>Required moving force</b>                                 | ≤ 5 N   |         |   |                                 |                            |
| <b>Vibration</b> 55 Hz to 2000 Hz affecting the              | Scanning unit: ≤ 200 m/s <sup>2</sup> (EN 60068-2-6)<br>Housing without mounting spar: ≤ 100 m/s <sup>2</sup> (EN 60068-2-6)<br>Housing with mounting spar, and cable outlet at right: ≤ 150 m/s <sup>2</sup> , left: ≤ 100 m/s <sup>2</sup> (EN 60068-2-6)                               |         |   |                                 |                            |
| <b>Shock</b> 11 ms   | ≤ 300 m/s <sup>2</sup> (EN 60068-2-27)  |         |   |                                 |                            |
| <b>Operating temperature</b>                                 | 0 °C to 50 °C   |         |   |                                 |                            |
| <b>Protection</b> EN 60529 <sup>3)</sup>                     | IP53 when installed according to instructions in the brochure, IP64 with sealing air from DA 400  |         |   |                                 |                            |
| <b>Mass</b>  | Encoder: 0.2 kg + 0.55 kg/m of measuring length; mounting spar: 0.9 kg/m  |         |   |                                 |                            |

\* Please select when ordering

<sup>1)</sup> Further tolerances may occur in subsequent electronics after position value comparison (contact manufacturer of subsequent electronics)

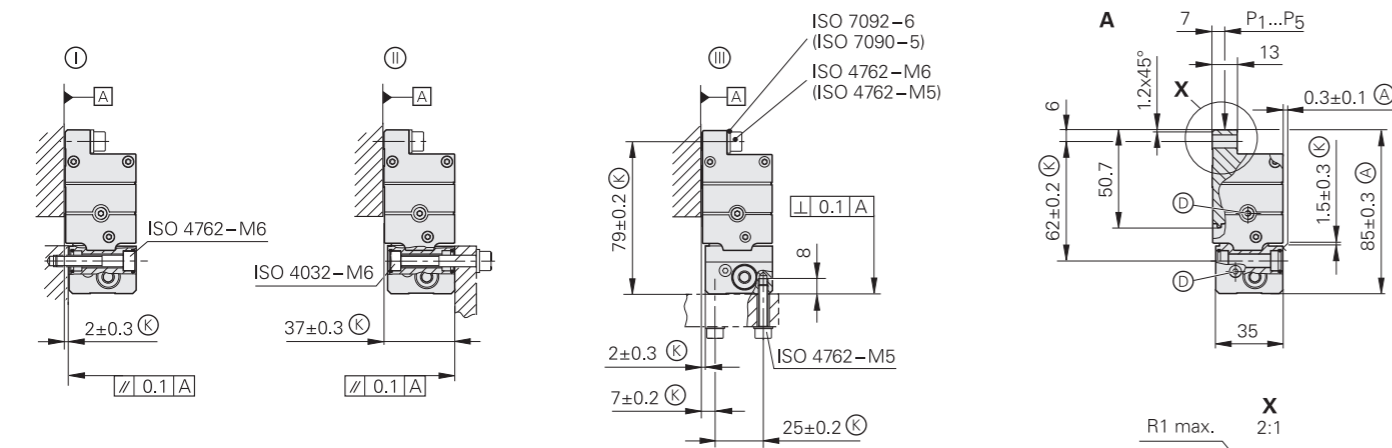
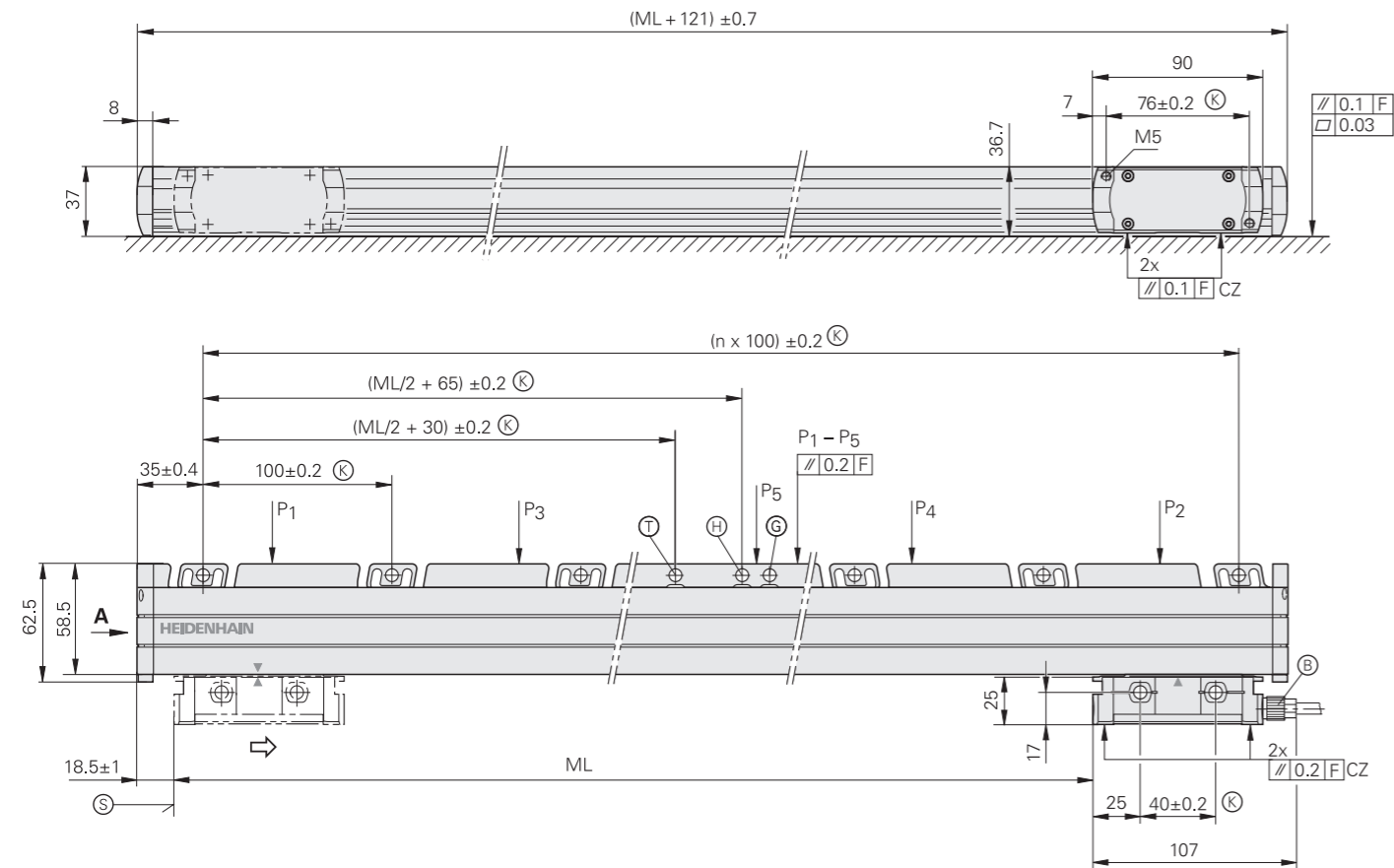
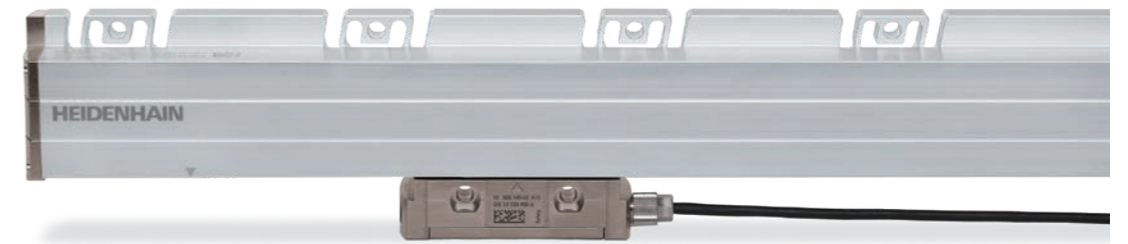
<sup>2)</sup> Greater cable lengths upon request

<sup>3)</sup> In the application, the LC must be protected from the ingress of particles and liquids

# LC 100 series

Absolute linear encoders with full-size scale housing

- High vibration rating
- Reclining mounting possible
- High reliability through double sealing lips



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

- Ⓚ, Ⓛ, Ⓜ = 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 (coincides with the spacing interval of 100 mm)
- Ⓢ = Beginning of measuring length ML (= 20 mm absolute)
- Ⓜ = Mating surfaces
- ⇒ = Direction of motion of scanning unit for ascending position values

| Specifications  | LC 115  | LC 115              | LC 185                      |
|---|---|---------------------|-----------------------------|
| <b>Measuring standard</b><br>Coefficient of linear expansion  | DIADUR glass scale with absolute track and incremental track, grating period: 20 µm<br>$\alpha_{\text{therm}} \approx 8 \cdot 10^{-6} \text{ K}^{-1}$ |                     |                             |
| <b>Accuracy grade*</b>  | ±3 µm up to a measuring length of 3040 mm; ±5 µm  |                     |                             |
| <b>Measuring length ML*</b><br>in mm  | 140<br>1540<br>4040   | 240<br>1640<br>4240 | 340<br>1740<br>4400         |
| <b>Functional safety</b><br>for applications with up to   | <ul style="list-style-type: none"> <li>• SIL 2 as per EN 61508</li> <li>• Category 3, PL "d" as per EN ISO 13849-1:2015</li> </ul>                    |                     | –                           |
| PFH (per axis)  | 15 · 10 <sup>-9</sup> ; ML > 3040 mm: 25 · 10 <sup>-9</sup><br>(up to 2000 m above sea level)   |                     | –                           |
| Safe position <sup>1)</sup>   | Encoder: ±550 µm;<br>ML > 3040 mm: ±2050 µm<br>(safety-related measuring step SM = 220 µm)  |                     | –                           |
| <i>Mechanical connection: fault exclusions for the loosening of the housing and scanning unit (page 21)</i> |   |                     |                             |
| <b>Interface</b>  | EnDat 2.2   |                     |                             |
| Ordering designation  | EnDat22   |                     | EnDat02                     |
| Measuring step<br>At ±3 µm<br>At ±5 µm  | 0.001 µm<br>0.010 µm  |                     | 0.005 µm<br>0.010 µm        |
| Clock freq. (calc. time $t_{\text{cal}}$ )  | ≤ 16 MHz (≤ 5 µs)   |                     | ≤ 2 MHz (≤ 5 µs)            |
| <b>Incremental signals</b>  | –   |                     | ~ 1 V <sub>PP</sub> (20 µm) |
| Cutoff frequency –3 dB  | –   |                     | ≥ 150 kHz                   |
| <b>Electrical connection</b>  | Separate adapter cable (1 m/3 m/6 m/9 m) connectable at either end of mounting block  |                     |                             |
| Cable length  | ≤ 100 m <sup>2)</sup>   |                     | ≤ 150 m <sup>2)</sup>       |
| Supply voltage  | DC 3.6 V to 14 V  |                     |                             |
| Power consumption (max.)  | 3.6 V: ≤ 1.1 W; 14 V: ≤ 1.3 W   |                     |                             |
| <b>Traversing speed</b>   | ≤ 180 m/min (max. acceleration in measuring direction ≤ 100 m/s <sup>2</sup> )  |                     |                             |
| <b>Required moving force</b>  | ≤ 4 N   |                     |                             |
| <b>Vibration</b> 55 Hz to 2000 Hz<br>affecting the  | Housing: ≤ 200 m/s <sup>2</sup> (EN 60068-2-6)<br>Scanning unit: ≤ 200 m/s <sup>2</sup> (EN 60068-2-6)  |                     |                             |
| <b>Shock</b> 11 ms  | ≤ 300 m/s <sup>2</sup> (EN 60068-2-27)  |                     |                             |
| <b>Operating temperature</b>  | 0 °C to 50 °C   |                     |                             |
| <b>Protection</b> EN 60529 <sup>3)</sup>  | IP53 when installed according to instructions in the brochure, IP64 with sealing air from DA 400  |                     |                             |
| <b>Mass</b>   | 0.55 kg + 2.9 kg/m of measuring length  |                     |                             |


\* Please select when ordering  
 1) Further tolerances may occur in subsequent electronics after position value comparison (contact manufacturer of subsequent electronics)  
 2) With HEIDENHAIN cable (see the *Interfaces of HEIDENHAIN Encoders* brochure)  
 3) In the application, the LC must be protected from the ingress of particles and liquids

# LC 100 series

Absolute linear encoders with full-size scale housing

- High vibration rating
- Reclining mounting possible
- High reliability through double sealing lips



| Specifications   | LC 195S   | LC 195S | LC 195F   | LC 195M  | LC 195P  |
|--|--|---------|---|--|--|
| <b>Measuring standard</b><br>Coefficient of linear expansion             | DIADUR glass scale with absolute track and incremental track, grating period: 20 µm<br>$\alpha_{\text{therm}} \approx 8 \cdot 10^{-6} \text{ K}^{-1}$            |         |   |  |  |
| <b>Accuracy grade*</b>   | ±3 µm up to a measuring length of 3040 mm; ±5 µm   |         |   | ±3 µm up to a measuring length of 2040 mm; ±5 µm | ±3 µm up to a measuring length of 3040 mm; ±5 µm       |
| <b>Measuring length ML*</b> 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 |
| <b>Functional safety</b><br>for applications with up to                  | <ul style="list-style-type: none"> <li>• SIL 2 as per EN 61508</li> <li>• Category 3, PL "d" as per EN ISO 13849-1:2015</li> </ul>                               | –       |   |  |  |
| PFH (per axis)   | $25 \cdot 10^{-9}$ ; <i>ML &gt; 3040 mm</i> : $40 \cdot 10^{-9}$<br>(up to 1000 m above sea level)   | –       |   |  |  |
| Safe position <sup>1)</sup>  | <i>Encoder</i> : ±550 µm; <i>ML &gt; 3040 mm</i> : ±2050 µm<br>(safety-related measuring step SM = 220 µm)   | –       |   |  |  |
|  | <i>Mechanical connection</i> : fault exclusions for the loosening of the housing and scanning unit (page 21)   |         |   |  |  |
| <b>Interface</b>   | DRIVE-CLiQ   |         | Fanuc Serial Interface/αi interface                                   | Mitsubishi high speed interface                  | Panasonic Serial Interface                             |
| Ordering designation   | DQ01   |         | Fanuc05   | Mit03-04   | Pana01   |
| Measuring step<br><i>At ±3 µm</i><br><i>At ±5 µm</i>                     | 0.001 µm<br>0.010 µm   |         | αi interface/α interface<br>0.00125 µm/0.010 µm<br>0.0125 µm/0.050 µm | 0.001 µm<br>0.010 µm                             |  |
| Clock frequency (calculation time $t_{\text{cal}}$ )                     | –  |         |   |  |  |
| <b>Electrical connection</b>   | Separate adapter cable (1 m/3 m/6 m/9 m) connectable at either end of mounting block   |         |   |  |  |
| Cable length   | ≤ 30 m <sup>2)</sup>   |         | ≤ 50 m  | ≤ 30 m   | ≤ 50 m   |
| Supply voltage   | DC 10 V to 28.8 V  |         | DC 3.6 V to 14 V  |  |  |
| Power consumption (max.)   | <i>10 V</i> : ≤ 1.5 W; <i>28.8 V</i> : ≤ 1.7 W   |         | <i>3.6 V</i> : ≤ 1.1 W; <i>14 V</i> : ≤ 1.3 W                         |  |  |
| <b>Traversing speed</b>  | ≤ 180 m/min (max. acceleration ≤ 100 m/s <sup>2</sup> )  |         |   |  |  |
| <b>Required moving force</b>   | ≤ 4 N  |         |   |  |  |
| <b>Vibration</b> 55 Hz to 2000 Hz<br>affecting the<br><b>Shock</b> 11 ms | <i>Housing</i> : ≤ 200 m/s <sup>2</sup> (EN 60068-2-6)<br><i>Scanning unit</i> : ≤ 200 m/s <sup>2</sup> (EN 60068-2-6)<br>≤ 300 m/s <sup>2</sup> (EN 60068-2-27) |         |   |  |  |
| <b>Operating temperature</b>   | 0 °C to 50 °C  |         |   |  |  |
| <b>Protection</b> EN 60529 <sup>3)</sup>                                 | IP53 when installed according to instructions in the brochure, IP64 with sealing air from DA 400   |         |   |  |  |
| <b>Mass</b>  | 0.55 kg + 2.9 kg/m of measuring length   |         |   |  |  |

\* Please select when ordering

<sup>1)</sup> Further tolerances may occur in subsequent electronics after position value comparison (contact manufacturer of subsequent electronics)

<sup>2)</sup> Greater cable lengths upon request

<sup>3)</sup> In the application, the LC must be protected from the ingress of particles and liquids

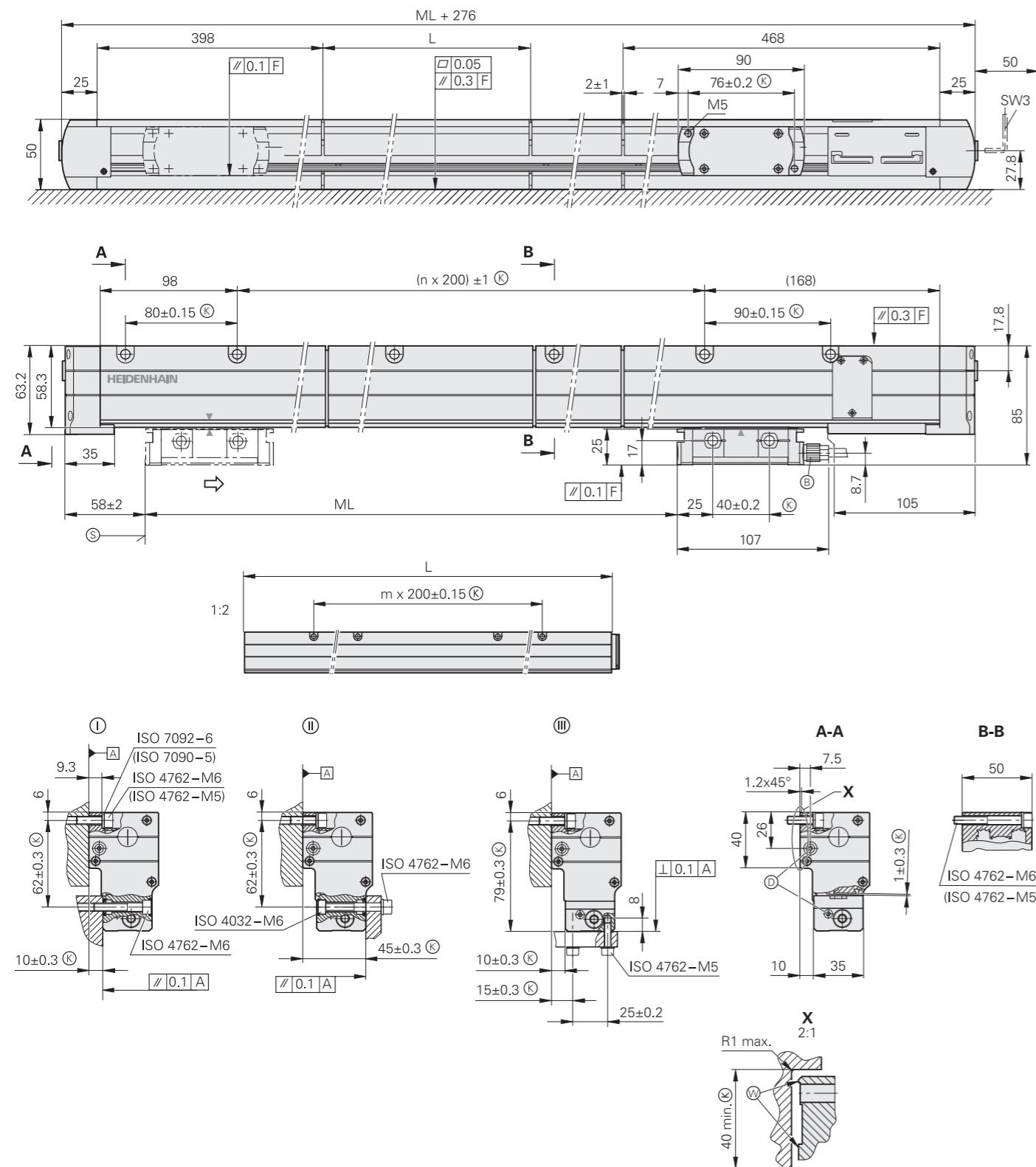




# LC 200 series up to 28 040 mm (multi-section housing)

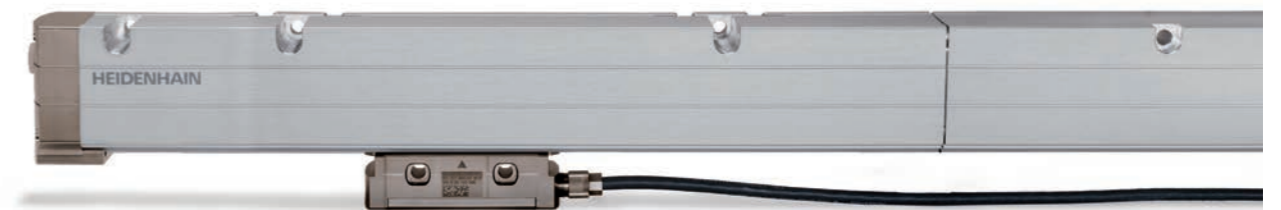
Absolute linear encoders with full-size scale housing

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



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

- ⓪, Ⓛ, Ⓜ = 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 scanning unit for ascending position values



| Specifications   | LC 211  | LC 281              | LC 291 F                                       | LC 291 M                           |
|--|---|---------------------|--|------------------------------------|
| <b>Measuring standard</b><br>Coefficient of linear expansion             | METALLUR steel scale tape with absolute track and incremental track, grating period: 40 μm<br>Same as machine base (e.g., $\alpha_{\text{therm}} \approx 10 \cdot 10^{-6} \text{ K}^{-1}$ for gray cast iron) |                     |  |                                    |
| <b>Accuracy grade</b>  | ±5 μm   |                     |  |                                    |
| <b>Measuring length ML*</b><br>in mm                                     | 3240 mm to 28040 mm in steps of 200 mm <sup>2)</sup><br>Kit with single-section METALLUR steel scale tape and housing sections  |                     |  |                                    |
| <b>Interface</b>   | EnDat 2.2   |                     | Fanuc Serial Interface<br>αi interface         | Mitsubishi high speed<br>interface |
| Ordering designation   | EnDat22   | EnDat02             | Fanuc05  | Mit03-04                           |
| Measuring step   | 0.010 μm  |                     | αi interface/α interface<br>0.0125 μm/0.050 μm | 0.010 μm                           |
| Diagnostics interface  | Digital   |                     |  |                                    |
| Clock frequency  | ≤ 16 MHz  | ≤ 2 MHz             | –  | –                                  |
| Calculation time $t_{\text{cal}}$  | ≤ 5 μs  | ≤ 5 μs              | –  | –                                  |
| <b>Incremental signals</b>   | –   | ~ 1 V <sub>PP</sub> | –  | –                                  |
| Signal period  | –   | 40 μm               | –  | –                                  |
| Cutoff frequency –3 dB   | –   | ≥ 250 kHz           | –  | –                                  |
| <b>Electrical connection</b>   | Separate adapter cable (1 m/3 m/6 m/9 m) connectable at either end of mounting block  |                     |  |                                    |
| Cable length <sup>1)</sup>   | ≤ 100 m (at clock<br>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<br>At 3.6 V: ≤ 1.1 W   |                     |  |                                    |
| Current consumption (typical)  | At 5 V: 225 mA (without load)   |                     |  |                                    |
| <b>Traversing speed</b>  | ≤ 180 m/min (max. acceleration in measuring direction ≤ 100 m/s <sup>2</sup> )  |                     |  |                                    |
| <b>Required moving force</b>   | ≤ 15 N  |                     |  |                                    |
| <b>Vibration</b> 55 Hz to 2000 Hz<br>affecting the<br><b>Shock</b> 11 ms | Housing: 200 m/s <sup>2</sup> (EN 60068-2-6)<br>Scanning unit: 300 m/s <sup>2</sup> (EN 60068-2-6)<br>≤ 300 m/s <sup>2</sup> (EN 60068-2-27)  |                     |  |                                    |
| <b>Operating temperature</b>   | 0 °C to 50 °C   |                     |  |                                    |
| <b>Protection</b> EN 60529   | IP53 when installed according to mounting instructions, IP64 with sealing air from DA 400   |                     |  |                                    |
| <b>Mass</b>  | 1.3 kg + 3.6 kg/m of measuring length   |                     |  |                                    |

\* Please select when ordering  
<sup>1)</sup> With HEIDENHAIN cable  
<sup>2)</sup> LC 291 M up to 20040 mm

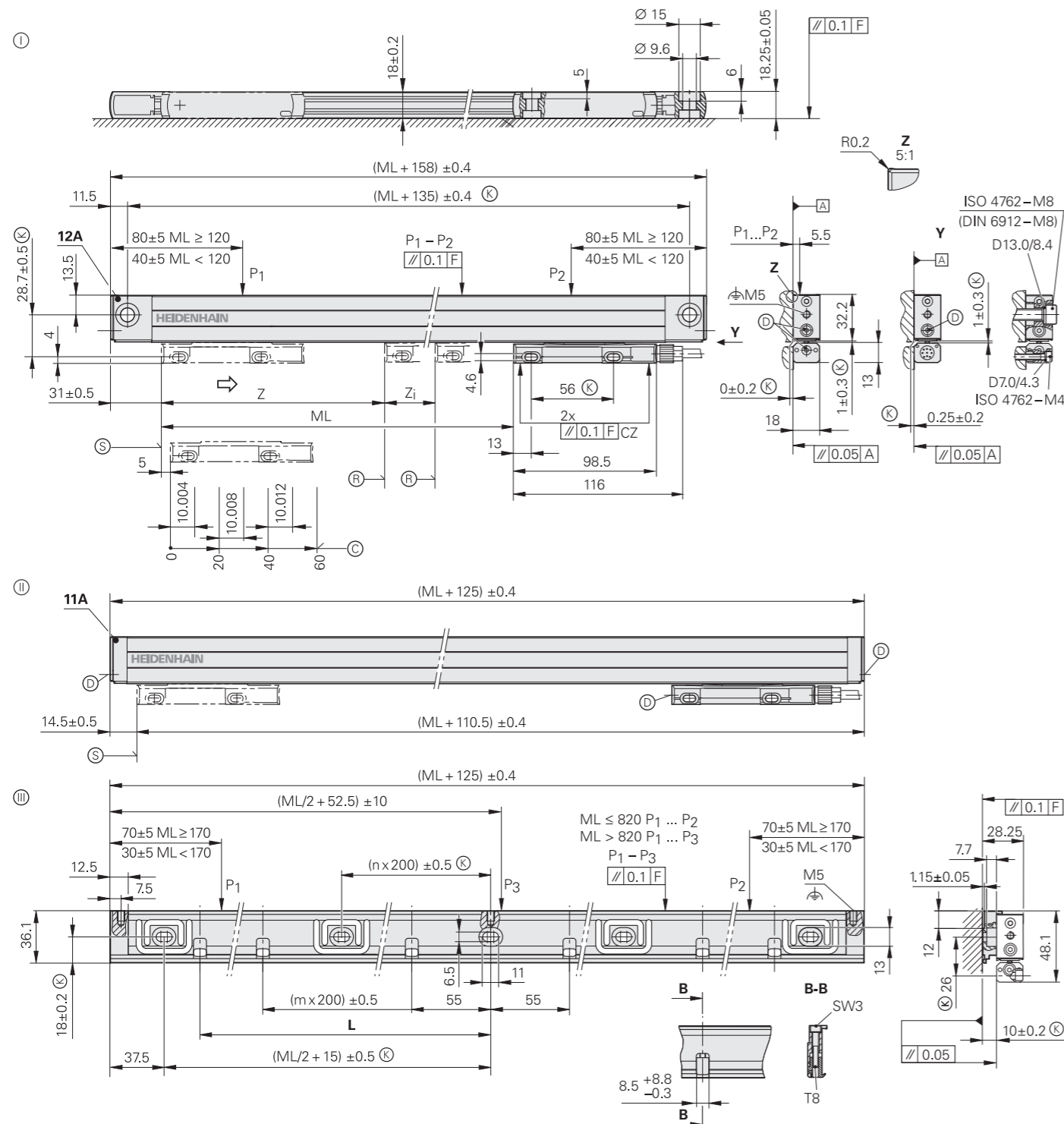
# LF 485

Incremental linear encoders with slimline scale housing

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

LF 485 without mounting spar

LF 485 with mounting spar



|           |      |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |      |      |      |      |      |      |      |      |      |      |      |
|-----------|------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|------|------|------|------|------|------|
| <b>ML</b> | 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 |
| <b>L</b>  | 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 - m H  
 < 6 mm: ±0.2 mm

- ⊖ = End block 12A; for mounting with and without mounting spar
- ⊙ = End block 11A; 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 = 35 mm  
 z<sub>1</sub> = ML - 50 mm | z<sub>1</sub> = ML - 70 mm
- ⊙ = Reference mark position on LF 485C
- ⊕ = Compressed air inlet
- ⊖ = Beginning of measuring length (ML)
- ⇒ = Direction of motion of scanning unit for ascending position values

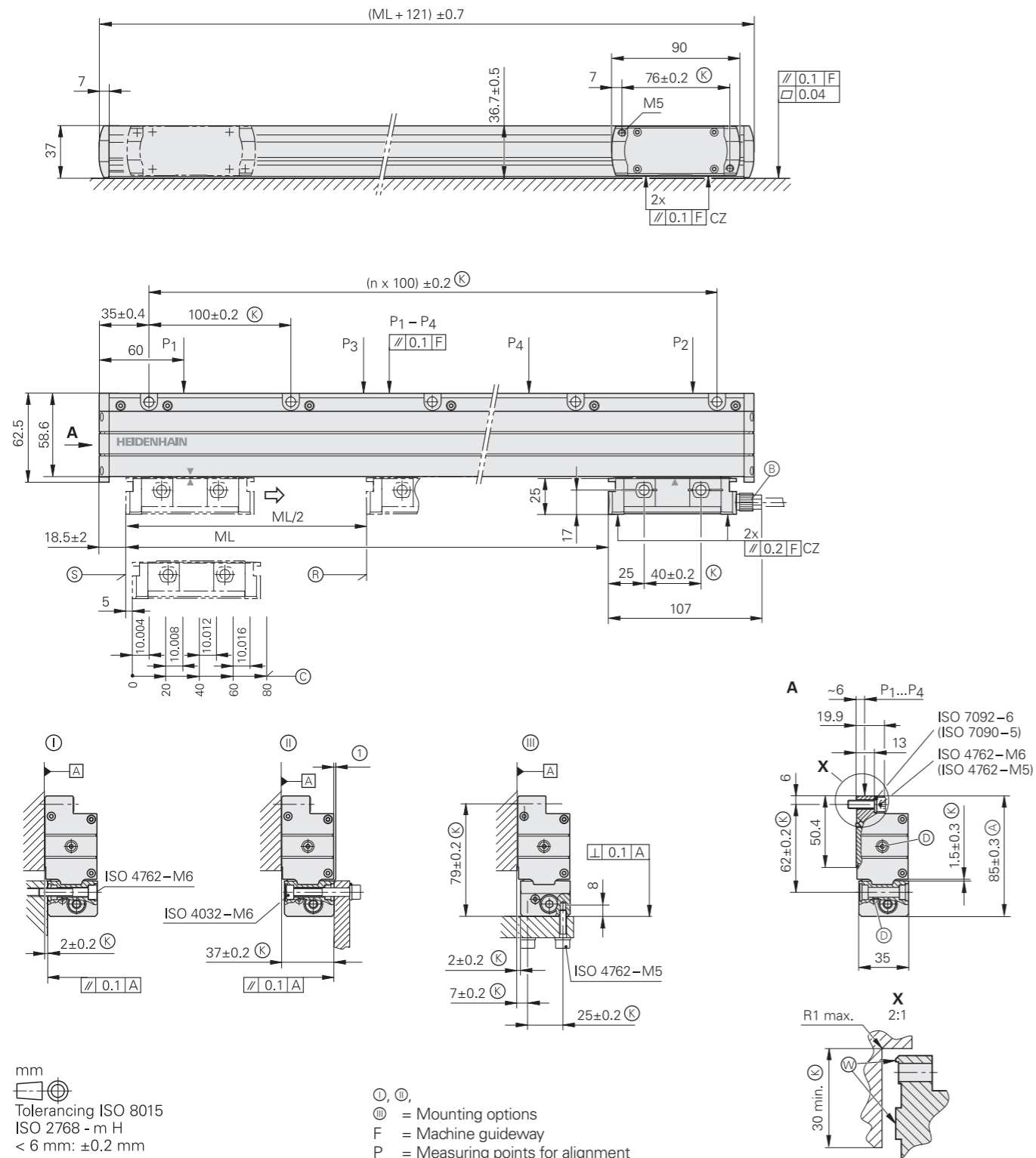
| Specifications   | LF 485   |
|--|--|
| <b>Measuring standard</b><br>Coefficient of linear expansion | SUPRADUR phase grating on steel, grating period: 8 μm<br>α <sub>therm</sub> ≈ 10 · 10 <sup>-6</sup> K <sup>-1</sup>  |
| <b>Accuracy grade*</b>                                       | ±5 μm; ±3 μm   |
| <b>Measuring length ML*</b><br>in mm                         | Mounting spar* optional<br>50 100 150 200 250 300 350 400 450 500 550 600 650 700<br>750 800 900 1000 1120 1220  |
| <b>Interface</b>   | ~ 1 V <sub>PP</sub>  |
| Signal period  | 4 μm   |
| Reference marks*<br>LF 485<br>LF 485C                        | <ul style="list-style-type: none"> <li>• One reference mark at midpoint of measuring length</li> <li>• 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</li> </ul> Distance-coded |
| Diagnostics interface  | Analog   |
| Cutoff frequency   | -3 dB ≥ 250 kHz  |
| <b>Electrical connection</b>                                 | 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  |
| <b>Traversing speed</b>                                      | ≤ 60 m/min (max. acceleration in measuring direction ≤ 100 m/s <sup>2</sup> )  |
| <b>Required moving force</b>                                 | ≤ 4 N  |
| <b>Vibration</b> 55 Hz to 2000 Hz<br>affecting the           | Housing with mounting spar: ≤ 150 m/s <sup>2</sup> (EN 60068-2-6)<br>Scanning unit: ≤ 200 m/s <sup>2</sup> (EN 60068-2-6)  |
| <b>Shock</b> 11 ms   | ≤ 300 m/s <sup>2</sup> (EN 60068-2-27)   |
| <b>Operating temperature</b>                                 | 0 °C to 50 °C  |
| <b>Protection</b> EN 60529                                   | IP53 when installed according to instructions in the brochure<br>IP64 with sealing air from DA 400   |
| <b>Mass</b>  | 0.4 kg + 0.6 kg/m of measuring length  |

\* Please select when ordering

# LF 185

Incremental linear encoders with full-size scale housing

- Very high repeatability
- Thermal behavior similar to steel or gray cast iron
- Reclining mounting possible



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

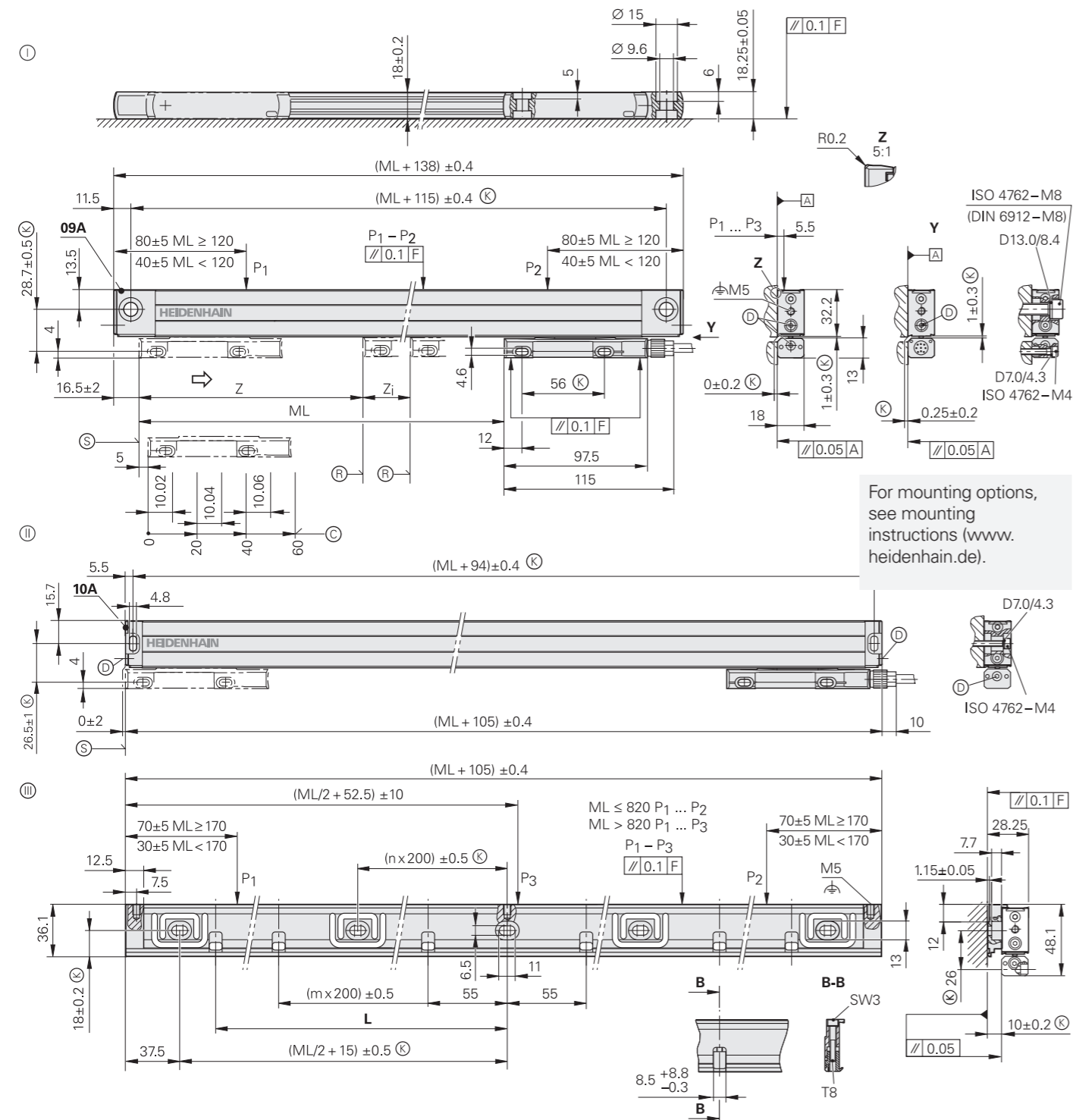
- Ⓚ, Ⓛ, Ⓜ = Mounting options
- F = Machine guideway
- P = Measuring points for alignment
- ML = Measuring length
- Ⓚ = Required mating dimensions
- Ⓛ = Alternative mating dimensions
- Ⓛ = Cable connection usable at either end
- Ⓛ = Compressed-air inlet usable at either end
- Ⓛ = Beginning of measuring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

| Specifications   | LF 185   |
|--|--|
| <b>Measuring standard</b><br>Coefficient of linear expansion | SUPRADUR phase grating on steel, grating period: 8 μm<br>$\alpha_{\text{therm}} \approx 10 \cdot 10^{-6} \text{ K}^{-1}$ |
| <b>Accuracy grade*</b>                                       | ±3 μm; ±2 μm   |
| <b>Measuring length ML*</b><br>in mm                         | 140 240 340 440 540 640 740 840 940 1040 1140 1240 1340 1440<br>1540 1640 1740 1840 2040 2240 2440 2640 2840 3040        |
| <b>Interface</b>   | ~ 1 V <sub>PP</sub>  |
| Signal period  | 4 μm   |
| Reference marks* LF 185<br>LF 185C                           | One reference mark at midpoint; other reference mark positions upon request<br>Distance-coded                            |
| Diagnostics interface  | Analog   |
| Cutoff frequency -3 dB                                       | ≥ 250 kHz  |
| <b>Electrical connection</b>                                 | 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   |
| <b>Traversing speed</b>                                      | ≤ 60 m/min (max. acceleration in measuring direction ≤ 100 m/s <sup>2</sup> )  |
| <b>Required moving force</b>                                 | ≤ 4 N  |
| <b>Vibration</b> 55 Hz to 2000 Hz<br>affecting the           | Housing: ≤ 150 m/s <sup>2</sup> (EN 60068-2-6)<br>Scanning unit: ≤ 200 m/s <sup>2</sup> (EN 60068-2-6)                   |
| <b>Shock</b> 11 ms   | ≤ 300 m/s <sup>2</sup> (EN 60068-2-27)   |
| <b>Operating temperature</b>                                 | 0 °C to 50 °C  |
| <b>Protection</b> EN 60529                                   | IP53 when installed according to instructions in the brochure<br>IP64 with sealing air from DA 400                       |
| <b>Mass</b>  | 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 - m H  
 < 6 mm: ±0.2 mm

- ⊖ = End block 09A; for mounting with and without mounting spar
- ⊕ = End block 10A; for mounting with mounting spar
- ⊗ = Mounting spar MSL 41
- 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 <sub>1</sub> = ML - 70 mm | z <sub>1</sub> = ML - 90 mm |
- ⊗ = Reference mark position on LS 4x7C
- ⊗ = Compressed air inlet
- ⊗ = Beginning of measuring length (ML)
- ⇒ = Direction of motion of scanning unit for ascending position values

LS 4x7 without mounting spar

LS 4x7 with mounting spar



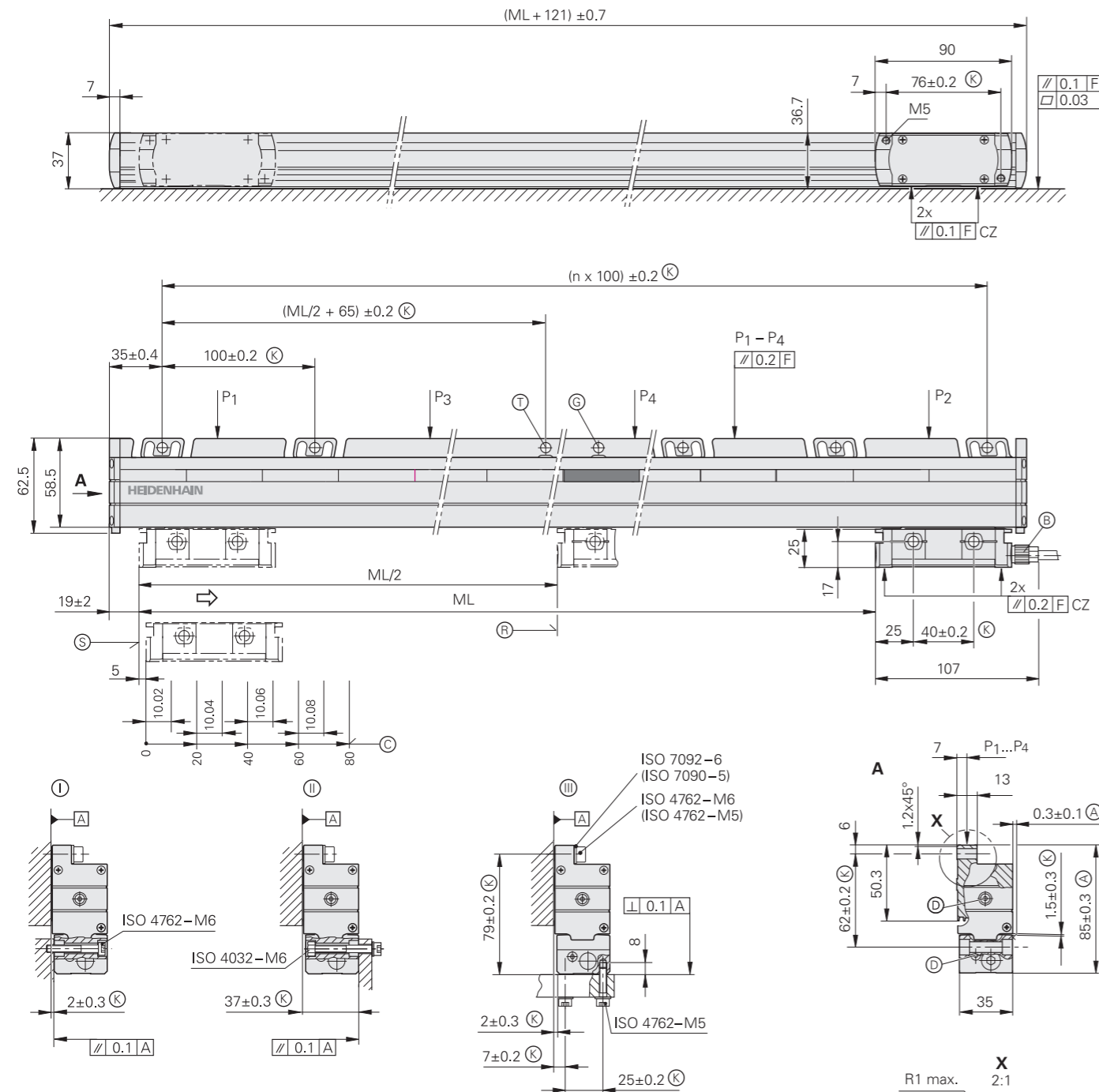
| Specifications   | LS 487   | LS 477 |                         |                  |                      |                    |                       |                     |                    |      |      |      |     |     |     |     |     |     |     |     |     |     |     |     |     |     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

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

# LS 100 series

Incremental linear encoders with full-size scale housing

- High vibration rating
- Reclining mounting possible



mm  
Tolerancing ISO 8015  
ISO 2768 - m H  
< 6 mm:  $\pm 0.2$  mm

- Ⓛ, Ⓞ, Ⓜ = 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 (coincides with the spacing 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 scanning unit for ascending position values

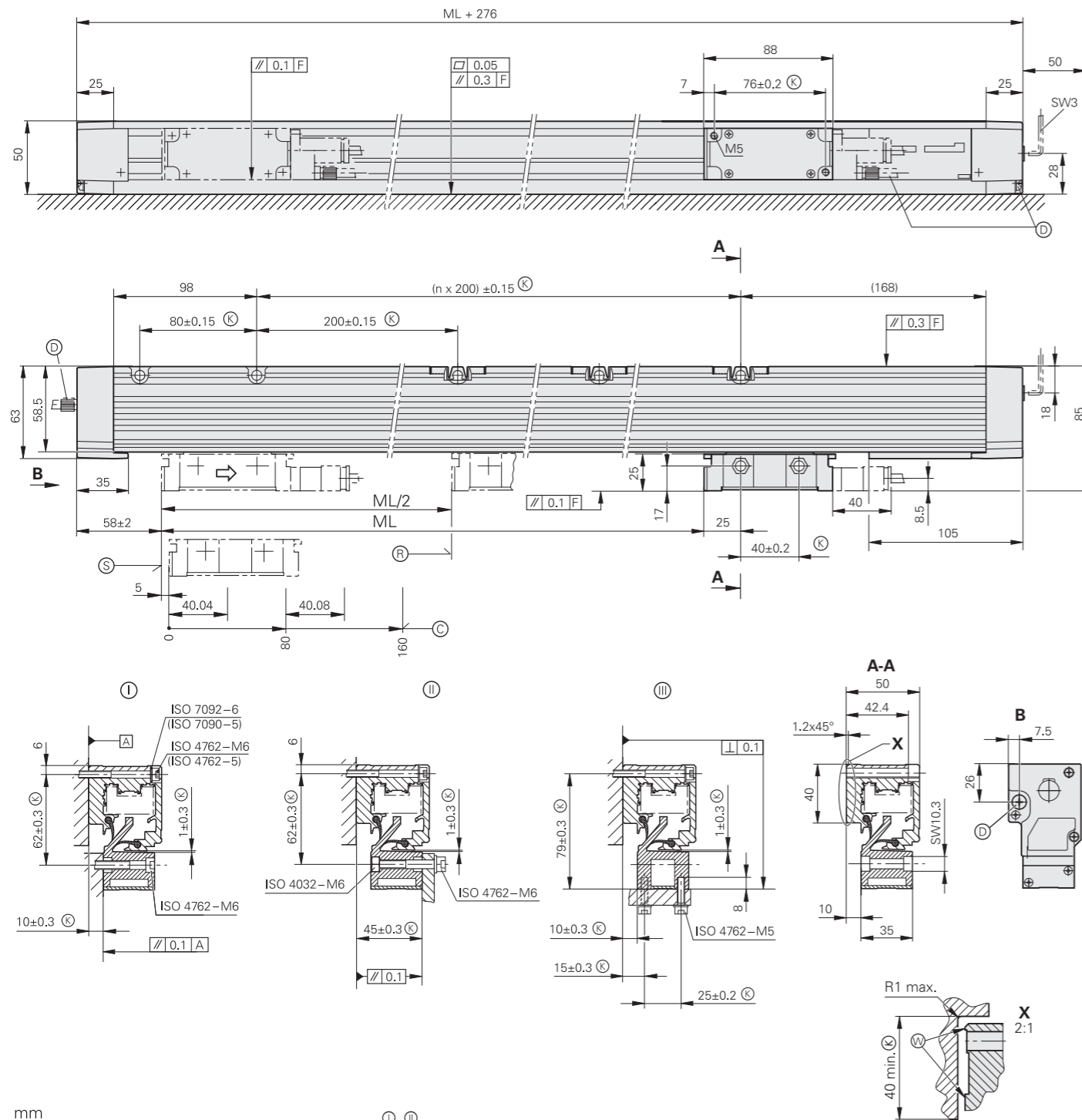
| Specifications   | LS 187  | LS 177 |                                   |     |   |     |                                    |     |                                  |      |                                |      |                                   |      |                                  |  |
|--|---|--------|-----------------------------------|-----|---|---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

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

# LB 382 up to 3040 mm (single-section housing)

Incremental linear encoders with full-size scale housing

- Reclining mounting possible
- Also available in mirrored version (mating dimensions upon request)



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

- Ⓚ, Ⓛ, Ⓜ = Mounting options
- F = Machine guideway
- Ⓚ = Required mating dimensions
- Ⓛ = Compressed air inlet
- Ⓜ = Reference mark position on LB 3x2
- Ⓚ = Reference mark position on LB 3x2C
- Ⓛ = Beginning of measuring length (ML)
- Ⓜ = Mating surfaces
- = Direction of motion of scanning unit for ascending position values

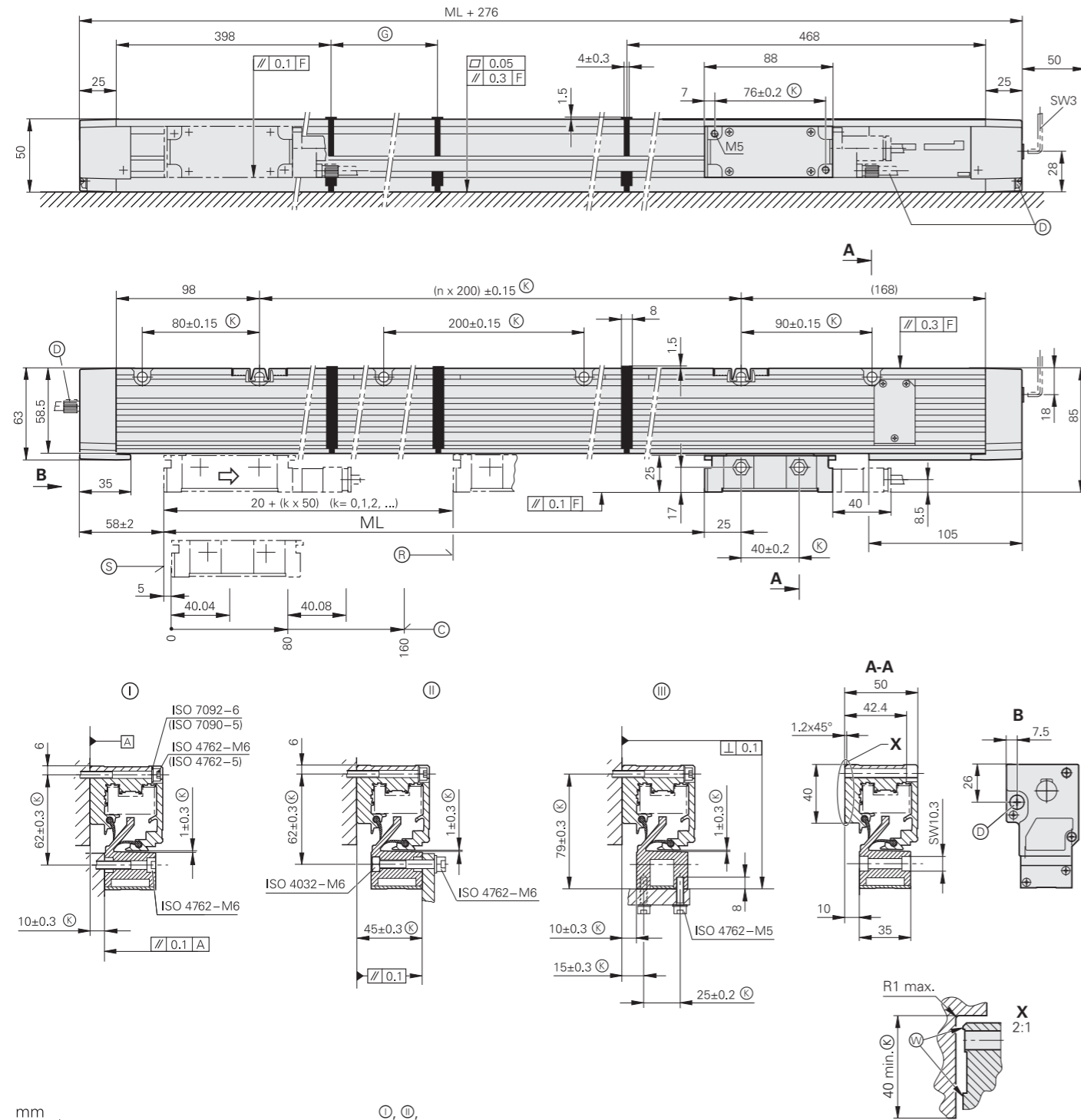
| Specifications   | LB 382 up to ML 3040 mm   |
|--|---|
| <b>Measuring standard</b><br>Coefficient of linear expansion | METALLUR steel scale tape, grating period: 40 μm<br>$\alpha_{\text{therm}} \approx 10 \cdot 10^{-6} \text{ K}^{-1}$ |
| <b>Accuracy grade</b>  | ±5 μm   |
| <b>Measuring length ML*</b><br>in mm                         | Single-section housing<br>440 640 840 1040 1240 1440 1640 1840 2040 2240 2440 2640 2840 3040                        |
| Reference mark*<br>LB 382<br>LB 382C                         | Selectable by selector plate every 50 mm; standard setting: one reference mark in the center<br>Distance-coded      |
| <b>Interface</b>   | ~ 1 V <sub>PP</sub>   |
| Signal period  | 40 μm   |
| Diagnostics interface  | Analog  |
| Cutoff frequency<br>-3 dB                                    | ≥ 250 kHz   |
| <b>Electrical connection</b>                                 | Separate adapter cable (1 m/3 m/6 m/9 m) connectable on mounting block  |
| Cable length <sup>1)</sup>                                   | ≤ 150 m   |
| Supply voltage without load                                  | DC 5 V ±0.25 V / < 150 mA   |
| <b>Traversing speed</b>                                      | ≤ 120 m/min (max. acceleration in measuring direction ≤ 60 m/s <sup>2</sup> )                                       |
| <b>Required moving force</b>                                 | ≤ 15 N  |
| <b>Vibration</b> 55 Hz to 2000 Hz<br><b>Shock</b> 11 ms      | ≤ 300 m/s <sup>2</sup> (EN 60068-2-6)<br>≤ 300 m/s <sup>2</sup> (EN 60068-2-27)                                     |
| <b>Operating temperature</b>                                 | 0 °C to 50 °C   |
| <b>Protection</b> EN 60529                                   | IP53 when mounted according to the mounting information and instructions<br>IP64 with compressed air from DA 400    |
| <b>Mass</b>  | 1.3 kg + 3.6 kg/m of measuring length   |

\* Please select when ordering  
 1) With HEIDENHAIN cable

# LB 382 up to 30040 mm (multi-section housing)

Incremental linear encoders with full-size scale housing

- Measuring lengths up to 30 m (up to 72 m upon request)
- Reclining mounting possible
- Also available in mirrored version (mating dimensions upon request)



mm  
 Tolerancing ISO 8015  
 ISO 2768 - m H  
 < 6 mm:  $\pm 0.2$  mm

- ⓪, Ⓛ, Ⓜ = Mounting options
- F = Machine guideway
- Ⓚ = Required mating dimensions
- Ⓢ = Compressed air inlet
- Ⓡ = Reference mark position on LB 3x2
- ⓐ = Reference mark position on LB 3x2C
- Ⓣ = Beginning of measuring length (ML)
- Ⓤ = Housing section lengths
- Ⓜ = Mating surfaces
- ⇨ = Direction of motion of scanning unit for ascending position values

| Specifications   | LB 382 starting from ML 3240 mm  |
|--|--|
| <b>Measuring standard</b><br>Coefficient of linear expansion | METALLUR steel scale tape, grating period: 40 $\mu$ m<br>Same as machine main casting  |
| <b>Accuracy grade</b>  | $\pm 5$ $\mu$ m  |
| <b>Measuring length ML*</b>                                  | Kit with single-section AURODUR scale tape and housing sections for measuring lengths from 3240 mm to 30040 mm in 200 mm steps (up to 72040 mm upon request)<br>Housing sections: 1000 mm, 1200 mm, 1400 mm, 1600 mm, 1800 mm, 2000 mm |
| Reference mark*<br>LB 382<br>LB 382C                         | Selectable by selector plate every 50 mm<br>Distance-coded   |
| <b>Interface</b>   | $\sim 1$ V <sub>PP</sub>   |
| Signal period  | 40 $\mu$ m   |
| Diagnostics interface  | Analog   |
| Cutoff frequency<br>-3 dB                                    | $\geq 250$ kHz   |
| <b>Electrical connection</b>                                 | Separate adapter cable (1 m/3 m/6 m/9 m) connectable on mounting block   |
| Cable length <sup>1)</sup>                                   | $\leq 150$ m   |
| Supply voltage without load                                  | DC 5 V $\pm 0.25$ V / < 150 mA   |
| <b>Traversing speed</b>                                      | $\leq 120$ m/min (max. acceleration in measuring direction $\leq 60$ m/s <sup>2</sup> )  |
| <b>Required moving force</b>                                 | $\leq 15$ N  |
| <b>Vibration</b> 55 Hz to 2000 Hz<br><b>Shock</b> 11 ms      | $\leq 300$ m/s <sup>2</sup> (EN 60068-2-6)<br>$\leq 300$ m/s <sup>2</sup> (EN 60068-2-27)  |
| <b>Operating temperature</b>                                 | 0 °C to 50 °C  |
| <b>Protection</b> EN 60529                                   | IP53 when mounted according to the mounting information and instructions<br>IP64 with compressed air from DA 400   |
| <b>Mass</b>  | 1.3 kg + 3.6 kg/m of measuring length  |

\* Please select when ordering  
<sup>1)</sup> With HEIDENHAIN cable

## Testing equipment and diagnostics

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

Incremental encoders primarily have 1 VPP, TTL, or HTL interfaces. TTL and HTL encoders monitor their signal amplitudes internally and generate a simple fault detection signal. With 1 VPP signals, the analysis of output signals is possible only with external testing devices or through computation in the subsequent electronics (analog diagnostics interface).

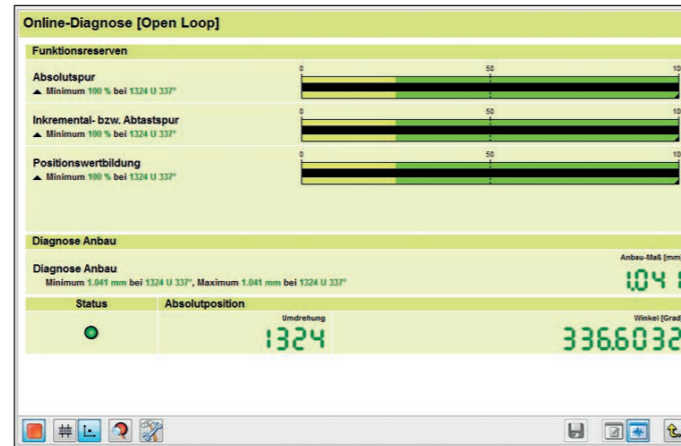
Absolute encoders use serial data transmission. Depending on the interface, additional 1 VPP incremental signals can be output. The signals are comprehensively monitored within the encoder. The monitoring result (particularly in the case of valuation numbers) can be transmitted to the subsequent electronics along with the position values via the serial interface (digital diagnostics interface). The following information is available:

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

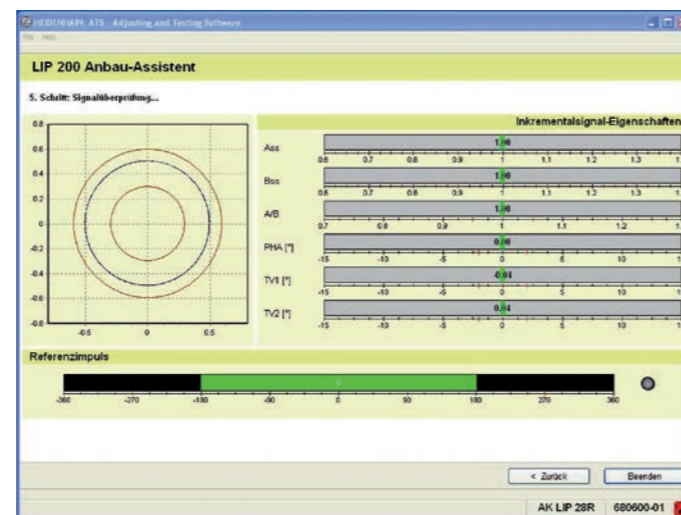
This enables the subsequent electronics to evaluate the current status of the encoder with little effort, even in closed-loop mode.

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

- Encoder diagnostics: The encoder is connected directly to the testing or inspection device. This makes a detailed analysis of encoder functions possible.
- Monitoring mode: The PWM testing unit is linked into the closed control loop (e.g., via a suitable testing adapter). This enables real-time diagnosis of the machine or system during operation. The available functions depend on the interface.



Diagnostics using PWM 21 and ATS software



Commissioning using PWM 21 and ATS software

### Further information:

For comprehensive descriptions of testing equipment and diagnostics, please refer to the *Interfaces of HEIDENHAIN Encoders* brochure.

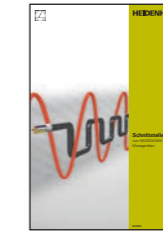
## Related documents

### Linear encoders



#### Brochure **Cables and Connectors**

Contents:  
Technical properties, cable overviews, and cable lists



#### Brochure **Interfaces of HEIDENHAIN Encoders**

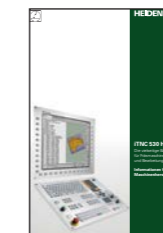
Contents:  
Information on serial interfaces, sinusoidal signals, square-wave signals, and commutation signals

### Further HEIDENHAIN products



#### Brochures **TNC 128 Straight-Cut Control** **TNC 320 Contouring Control** **iTNC 530 Contouring Control** **TNC 620 Contouring Control** **TNC 640 Contouring Control**

Contents:  
Information for the user



#### OEM brochures **TNC 128 Straight-Cut Control** **TNC 320 Contouring Control** **iTNC 530 Contouring Control** **TNC 620 Contouring Control** **TNC 640 Contouring Control**

Contents:  
Information for the machine tool builder



#### Brochures **MANUALplus 620 Contouring Control** **CNC PILOT 640 Contouring Control**

Contents:  
Information for the user



#### OEM brochures **MANUALplus 620 Contouring Control** **CNC PILOT 640 Contouring Control**

Contents:  
Information for the machine tool builder



#### 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**



#### Brochure **Angle Encoder Modules**

Contents:  
Angle encoder modules  
**MRP2000, MRP5000, MRP8000**  
Angle encoder modules with integrated torque motor **SRP5000, AccurET**



#### Brochure **Modular Angle Encoders** *With Optical Scanning*

Contents:  
Incremental angle encoders  
**ERP, ERO, ERA**



#### Brochure **Touch Probes**

Contents:  
Tool touch probes  
**TT**  
Workpiece touch probes  
**TS**



#### Brochure **Measuring Devices For Machine Tool** **Inspection and Acceptance Testing**

Contents:  
Incremental linear encoders  
**KGM, VM**



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