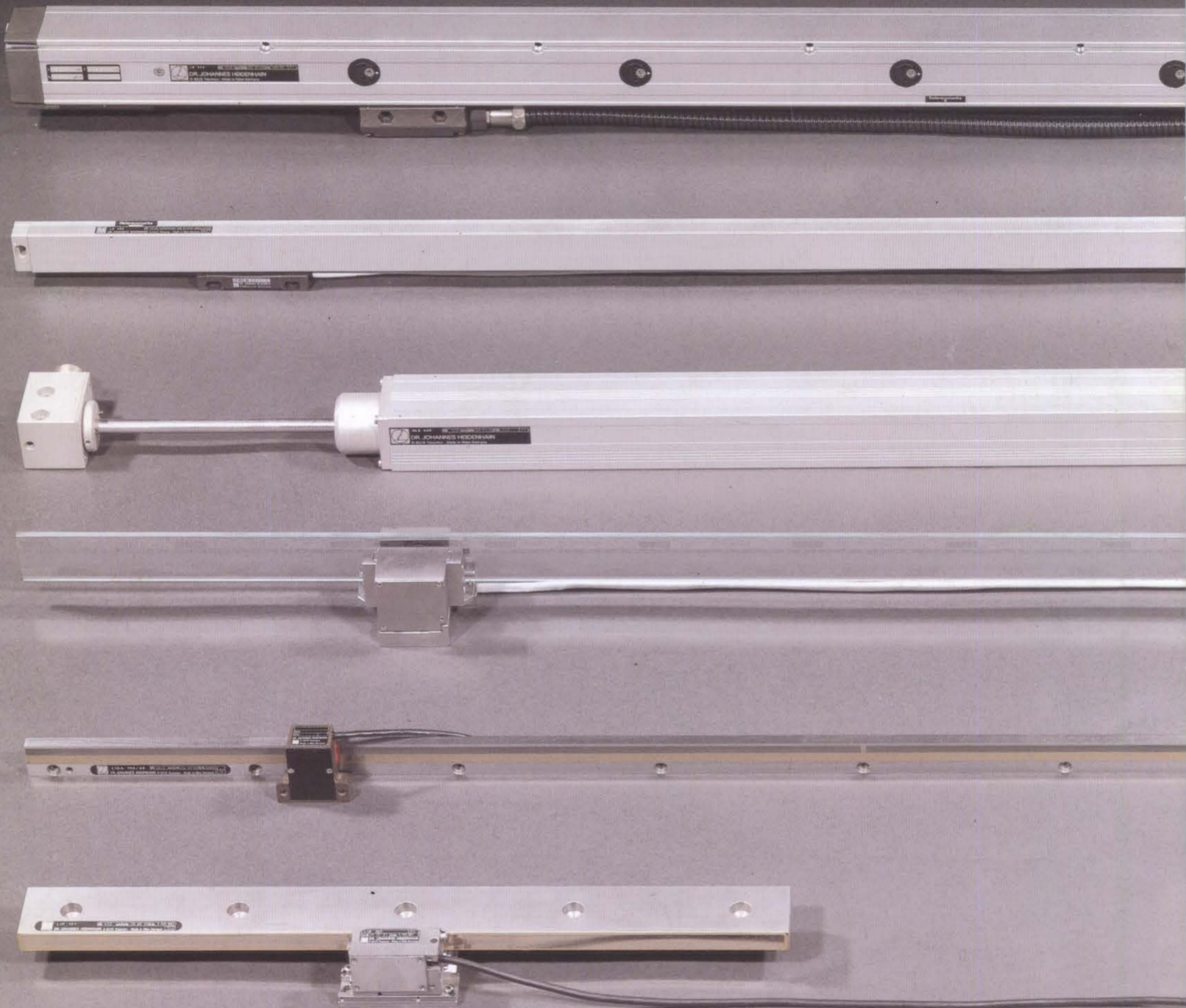


# NC-Linear Encoders



November '88



**HEIDENHAIN**



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DR. JOHANNES HEIDENHAIN GmbH  
Traunreut, West Germany



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The history of the company is based on the manufacture of precision graduations – linear scales, angular scales, reticles etc.

In 1889 Wilhelm Heidenhain, a young mechanic, founded a metal etching company in Berlin. In the following decades it grew into the largest of its kind in Europe. In 1923 Dr. Johannes Heidenhain joined his father's enterprise. The first major step was in 1928 when HEIDENHAIN developed the lead sulphide (METALLUR) process for making exact copies of master graduations. In 1948, after the destruction and loss of its plants in Berlin, Suhl (East Germany) and Gars (Austria) the company was re-established under the name of DR. JOHANNES HEIDENHAIN in Traunreut, Bavaria. A pioneer achievement was the new DIADUR copying process for the production of highly durable precision graduations (1950).

The company grew steadily. Optical projection measuring devices (for machine tools, rotary tables, measuring and test equipment) were developed; the display of the complete measurement value as a number (down to 0.001 mm or 1 angular second) was a HEIDENHAIN innovation.

For over 25 years HEIDENHAIN has been supplying digital electronic linear and angle measuring systems for machine tools, precision equipment and instrumentation,

for over 20 years digital readouts for machine tools and

for over 10 years shop-floor-programmable numerical controls for milling machines.

Some 2450 people work in the HEIDENHAIN sales and production facilities – over 200 of whom are devoted to research and development.

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## General Notes

Lengths, distances, traverses or positions can either be measured with a scale, i. e. directly, or indirectly e. g. via a time measurement.

The standard "meter" was defined in 1983 by an indirect measurement as being "the distance that a light wave travels within a vacuum during a time interval of  $1/299\,792\,458$  second".

**Linear measuring systems** can be categorized by the type of measuring standard being used or the physical measuring principle, respectively:

- . graduated scales
- . photoelectrically scanned line gratings and phase gratings
- . scales with cyclically variable magnetic zones and magnetic scanners
- . Inductosyn scales (induction based measuring signals)
- . capacitive measuring standards
- . mechanical measuring standards (racks or ballscrews)
- . laser interferometers
- . gage blocks
- and others.

The **photoelectric measuring principle** distinguishes itself from other principles (with exception of laser interferometers) by scanning scales with relatively wide graduations as well as with very fine graduations as measuring standards. The grating period (the distance from the forward edge of one line to the next) of a HEIDENHAIN linear encoder can be e. g.  $8\,\mu\text{m}$ ,  $10\,\mu\text{m}$ ,  $20\,\mu\text{m}$ ,  $40\,\mu\text{m}$  or  $100\,\mu\text{m}$ .

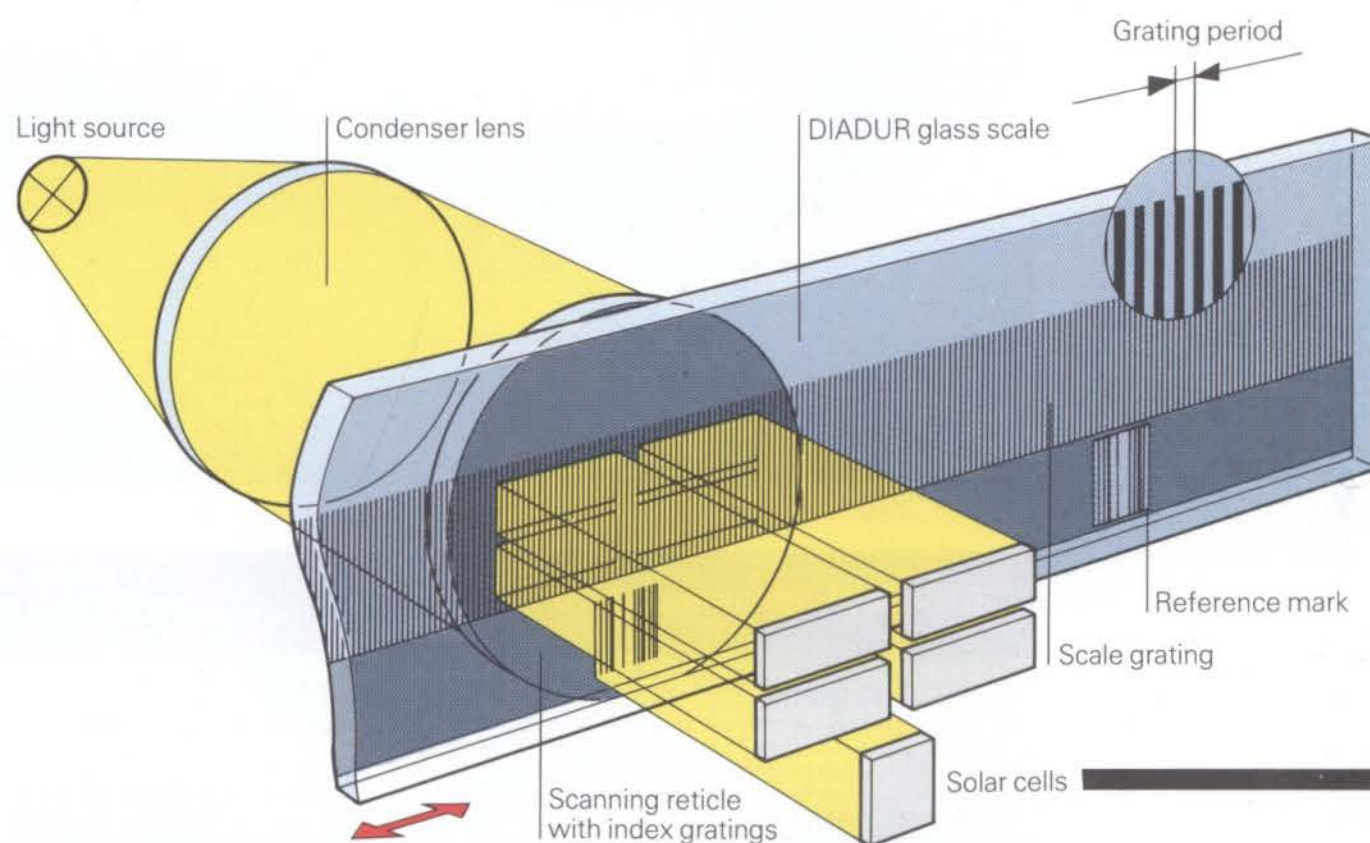
**Rotary encoders** in conjunction with mechanical measuring standards such as ball screws or racks can also measure linear movements (see "HEIDENHAIN Rotary Encoders" overview  $\leq 5000$  lines, pp. 50 ... 51).

For rotary encoders employed as measured value sensing units for position determination on rotary axes see "HEIDENHAIN Angle Encoders" overview  $\geq 6000$  lines, pp. 52 ... 53.

## Photoelectric Scanning of Incremental Encoders

HEIDENHAIN linear encoders of the **LS and LID construction**, for example, contain a glass scale with a **line grating** applied with the DIADUR-process. The scale grating produced by the DIADUR-process consists of opaque lines and transparent spaces of equal width. One or more reference marks constitute a second track. The **scanning unit** is comprised of a light source, a condenser lens for collimating the light beam, the scanning reticle with the index gratings and silicon solar cells.

When the scale is moved relative to the scanning unit, the lines and spaces of the scale alternately coincide with those of the index gratings. The corresponding fluctuations of the light are sensed by the solar cells, which generate two sinusoidal output signals  $I_{e1}$  and  $I_{e2}$  and a reference mark signal  $I_{e0}$ . Signals  $I_{e1}$  and  $I_{e2}$  of approx.  $10\,\mu\text{A}_{pp}$  are phase-shifted by  $90^\circ$  el.



**Photoelectric scanning of a DIADUR glass scale**

Linear encoders of the **LIDA and LB construction** operate on the same principle. They contain steel scales with AURODUR line gratings consisting of highly reflective gold lines and mat etched gaps. The light source and the scanning unit are next to one another.

The **LIP 101** is based on quite a different conception. The scale of the LIP 101 is a reflective type diffraction grating. Two sinusoidal output signals with  $4\,\mu\text{m}$  cycle are provided.

# Signal Processing of Incremental Encoders

HEIDENHAIN NC-linear encoders contain no electronics other than the solar cells, and in some instances a semiconductor light source. The measuring signals are processed by an **interpolation and digitizing circuitry**, either contained in a separate box (**EXE**) or in the numerical control (e.g. HEIDENHAIN-**TNC**) or counter (e.g. HEIDENHAIN-**VRZ**).

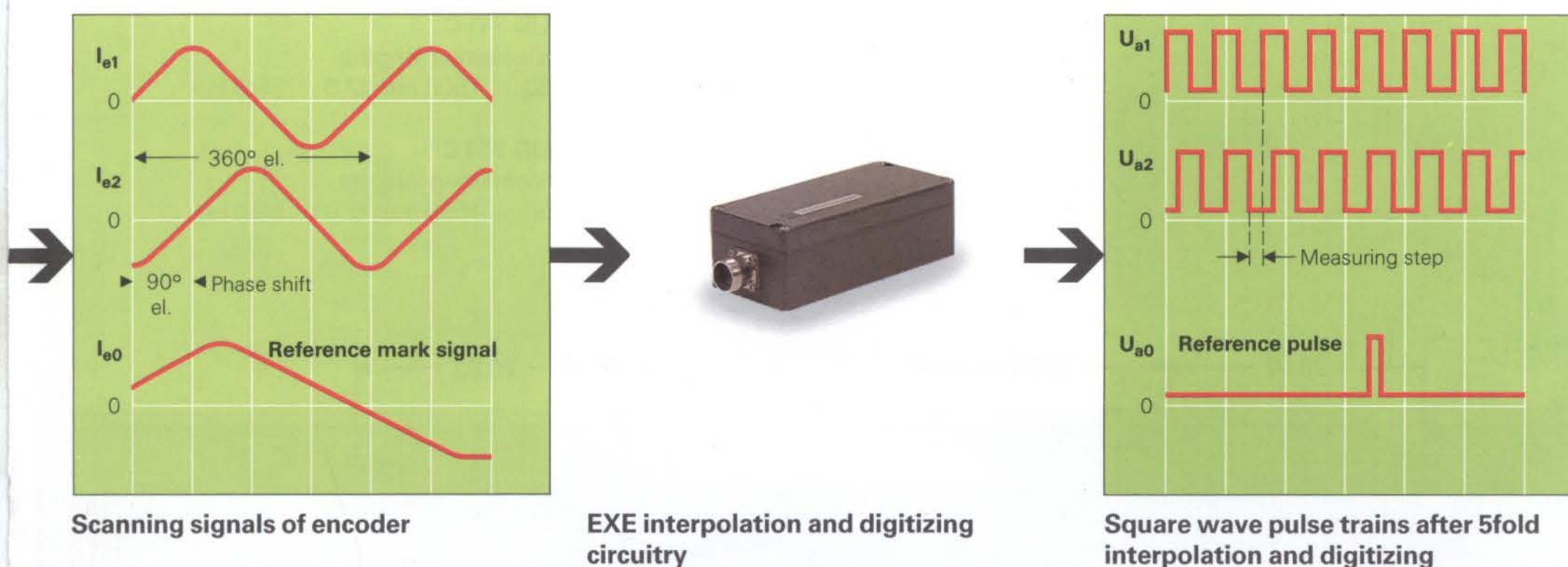
The periodic signals of the solar cells may be interpolated  $\times 5$ ,  $\times 10$ ,  $\times 25$  or  $\times 50$  e.g. by resistor networks which produce additional phase-shifted signals via vectorial addition. All signals are subsequently transformed into

squarewaves by Schmitt-triggers and logically gated such that two square wave pulse trains  $U_{a1}$  and  $U_{a2}$  – phase-shifted by  $90^\circ$  el. – and a reference pulse  $U_{a0}$  are available as an output. The  $90^\circ$  phase shift of the pulse trains  $U_{a1}$  and  $U_{a2}$  is used to determine direction of movement. Since four edges within one signal cycle are provided for computation of the measured value, the **measuring step** depends on the interpolation factor ( $\times 5$ ,  $\times 10$ ,  $\times 25$  or  $\times 50$ ) as follows:

The measuring step of a linear encoder is  $1/20$ ,  $1/40$ ,  $1/100$  or  $1/200$  of the grating period.

If all four signal edges of both pulse trains are utilized to produce the measured value ( $4\times$  evaluation), then the counting step corresponds to the measuring step. If only 1 pulse train is utilized ( $2\times$  evaluation), the counting step corresponds to double the measuring step, or four times of the measuring step when only 1 edge per cycle is evaluated.

For all outputs of the interpolation and digitizing electronics the **inverted signals** are also available for **noise suppression** measures. Additionally a **fault detection signal** (EXE units) indicates malfunctions, e.g. breaks in the lamp filament or wiring.



# Reference mark

The **reference mark** serves as a datum for the machine slides. Before machining begins, a reference point must first be established on the workpiece relative to the machine's fixed reference point. With incremental encoders the **setting of a datum** is quite easy; a certain value is allocated to the reference pulse as an absolute value, e.g. zero. However, after numerical control switch-off or power failure, the correlation between workpiece-related actual position values and machine slide positions is lost. This correlation can be easily reproduced by traversing the reference mark, thereby generating a reference signal that can be evaluated within the control electronics.

## Distance-coded reference marks

When using linear encoders with distance-coded reference marks, the absolute position value can be reproduced by crossing two consecutive reference marks, i.e. with a traverse of maximally 20 mm (0.8 in.).

The scale comprises a grating and an adjacent track of reference marks. The distances between the reference marks vary by a defined rule. By determining the distance between two consecutive reference marks, their absolute position can be established.

The following linear encoders are available with distance-coded reference marks:

### LS 101 C

Measuring lengths  
140 ... 1240 mm (5.5 ... 48.8 in.)

### LS 107 C

Measuring lengths  
240 ... 3040 mm (9.5 ... 120.0 in.)

### LS 403 C

Measuring lengths  
70 ... 2040 mm (2.7 ... 80.3 in.)

### LS 404 C

Measuring lengths  
70 ... 620 mm (2.7 ... 24.4 in.)

### LS 704 C

Measuring lengths  
170 ... 3040 mm (6.7 ... 120.0 in.)

### ULS 300 C

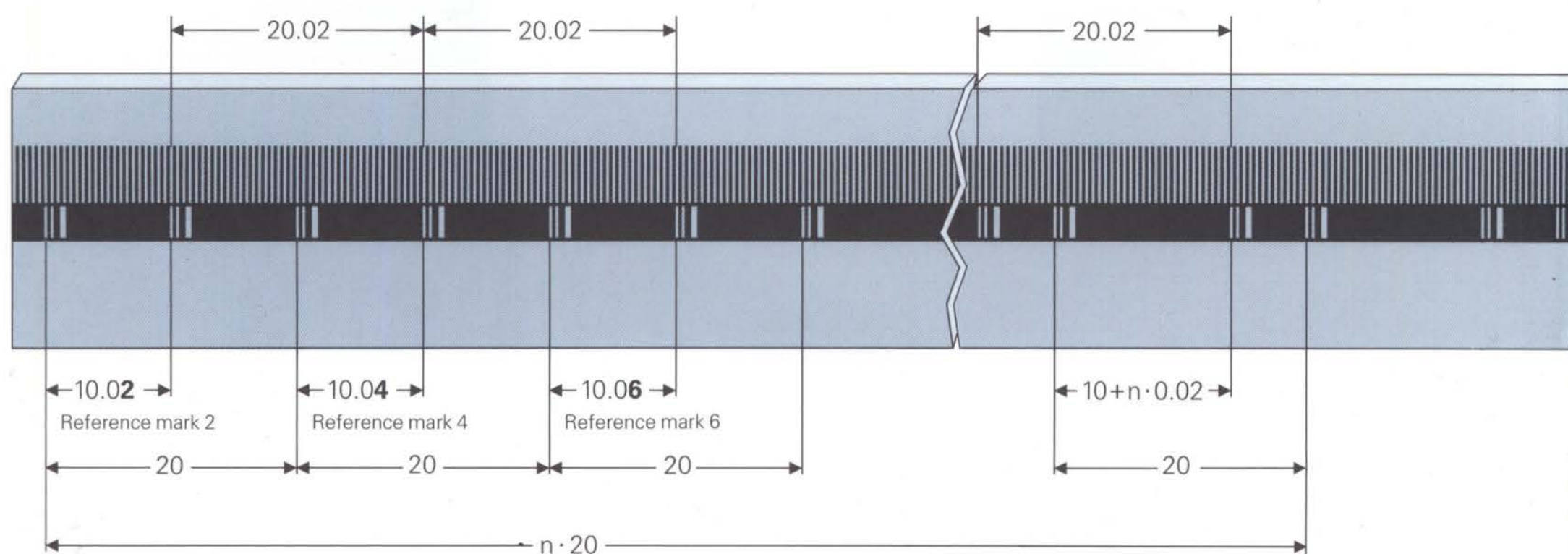
Measuring lengths  
170 ... 520 mm (6.7 ... 20.5 in.)

### LID 311 C

Measuring lengths  
50 ... 1500 mm (2.0 ... 59.0 in.)

### LID 351 C

Measuring lengths  
50 ... 1500 mm (2.0 ... 59.0 in.)



Dimensions in mm

**DIADUR glass scale with distance-coded reference marks**

# Measuring accuracy

Specification of the measuring accuracy is made in **accuracy grades**. The accuracy grade  $\pm a \mu\text{m}$  or  $\pm b \text{ in.}$ , respectively is defined as follows:

The extreme values of the deviation  $F$  with reference to their mean value lie within  $-a \mu\text{m} \leq F \leq +a \mu\text{m}$  for any random max. 1 m section of the measuring length ( $-b \text{ in.} \leq E \leq +b \text{ in.}$  for 40 in. sections).

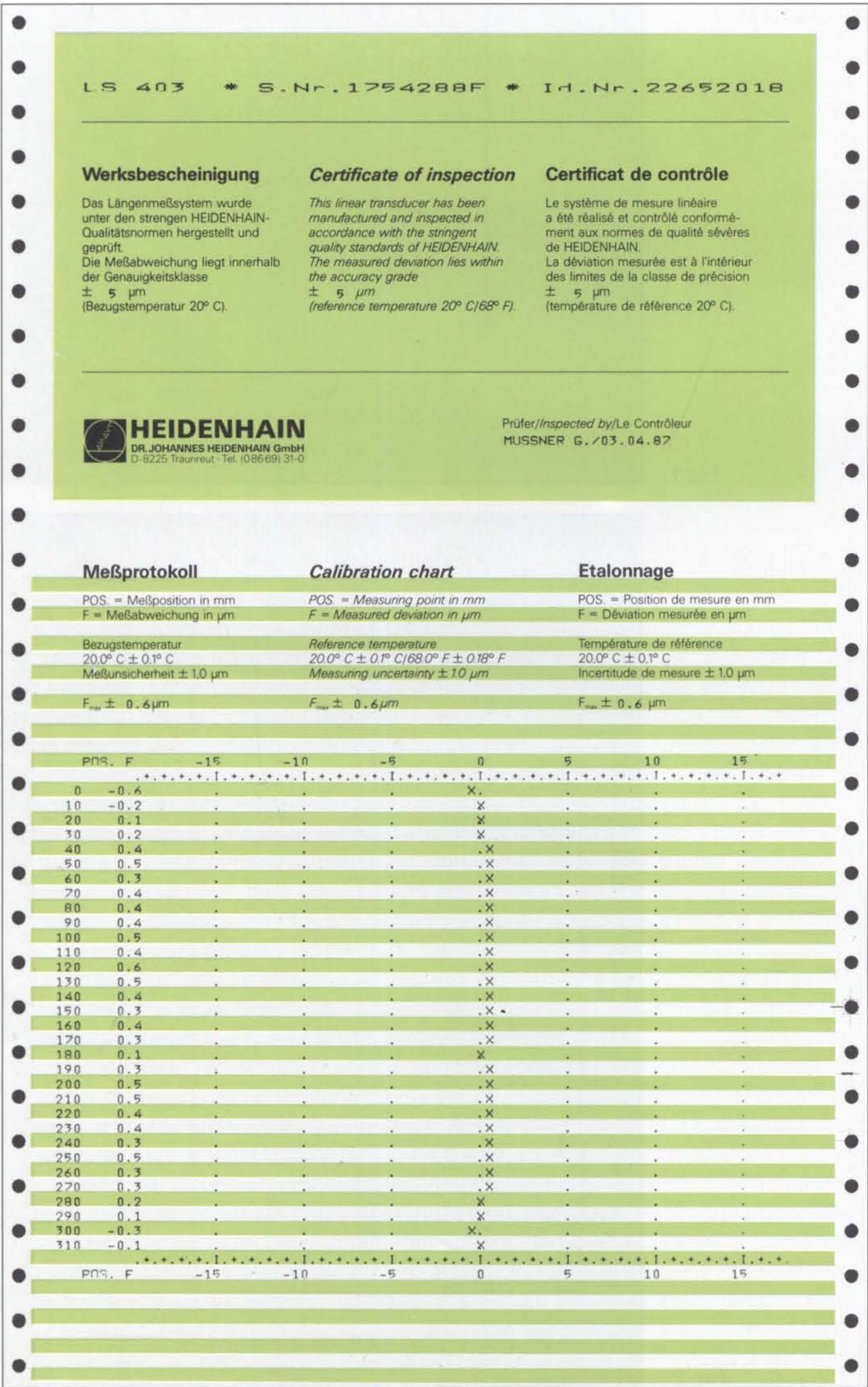
With **sealed linear encoders**, this value applies to the complete scale unit; this is referred to as the system accuracy. With **exposed linear encoders** the definition of the accuracy grade refers to the scale (scale accuracy).

A **calibration chart** is supplied with every HEIDENHAIN NC-linear encoder.

## Machine error compensation

HEIDENHAIN linear encoders LS 107, LB 326 and LIDA 225 offer a possibility for systematic compensation of geometrical machine errors. By tensioning the tape scale (LIDA 225, LB 326), machine errors can be compensated linearly over the total measuring length.

An adjustable chain of correction guiders within the encoder with adjustment points either at 100 mm (4 in.) intervals for LS 107, or at 200 mm (7.9 in.) intervals for LB 326 is provided for compensation of local machine errors.



# Traversing Speed

The **max. traversing speed** of linear encoders is dependent on:  
 the **mechanically** permissible traversing speed  
 the max. input frequency of the **interpolation and digitizing electronics**  
 the min. permissible edge separation of the squarewave output signals  $U_{a1}$  and  $U_{a2}$  of the digitizing electronics for further processing within the **control electronics**.

The **mechanically permissible traversing speed** for each linear encoder is indicated in this catalogue under mechanical data.  
 The max. traversing speed depending on the max. input frequency of the **interpolation and digitizing electronics** is derived as follows:

$$v_{\max} \text{ (mm/s)} = p \cdot f_{\max}, \text{ or}$$

$$v_{\max} \text{ (m/min)} = p \cdot f_{\max} \cdot 6 \cdot 10^{-2}, \text{ or}$$

$$v_{\max} \text{ (ft/min)} = p \cdot f_{\max} \cdot 19.68 \cdot 10^{-2}$$

$v_{\max}$ : maximum traversing speed  
 $p$ : grating period of scale in  $\mu\text{m}$ , or signal cycle of linear encoders with phase grating  
 $f_{\max}$ : input frequency of interpolation electronics in kHz

In Fig. 1 this relationship is illustrated for the various max. permissible input frequencies of the HEIDENHAIN interpolation and digitizing electronics EXE. The max. input frequency for each EXE version is given in the EXE catalogue, or in the table of types in the supplement.

In general, the **control electronics** only allow a certain minimum edge separation for the squarewave output signals of the digitizing electronics.  
 The relationship between input frequency " $f$ " of the HEIDENHAIN-EXE and the edge separation " $a$ " of output signals  $U_{a1}$  and  $U_{a2}$ , with a given interpolating factor of the interpolation electronics is illustrated in Fig. 2. The input frequency can be derived as follows:

$$f \text{ (kHz)} = \frac{v \text{ (m/min)}}{p \text{ (}\mu\text{m)}} \cdot \frac{1}{6} \cdot 10^2$$

$$f \text{ (kHz)} = \frac{v \text{ (ft/min)}}{p \text{ (}\mu\text{m)}} \cdot \frac{1}{19.68} \cdot 10^2$$

$v$ : traversing speed

$p$ : grating period of scale or signal cycle of linear encoders with phase grating

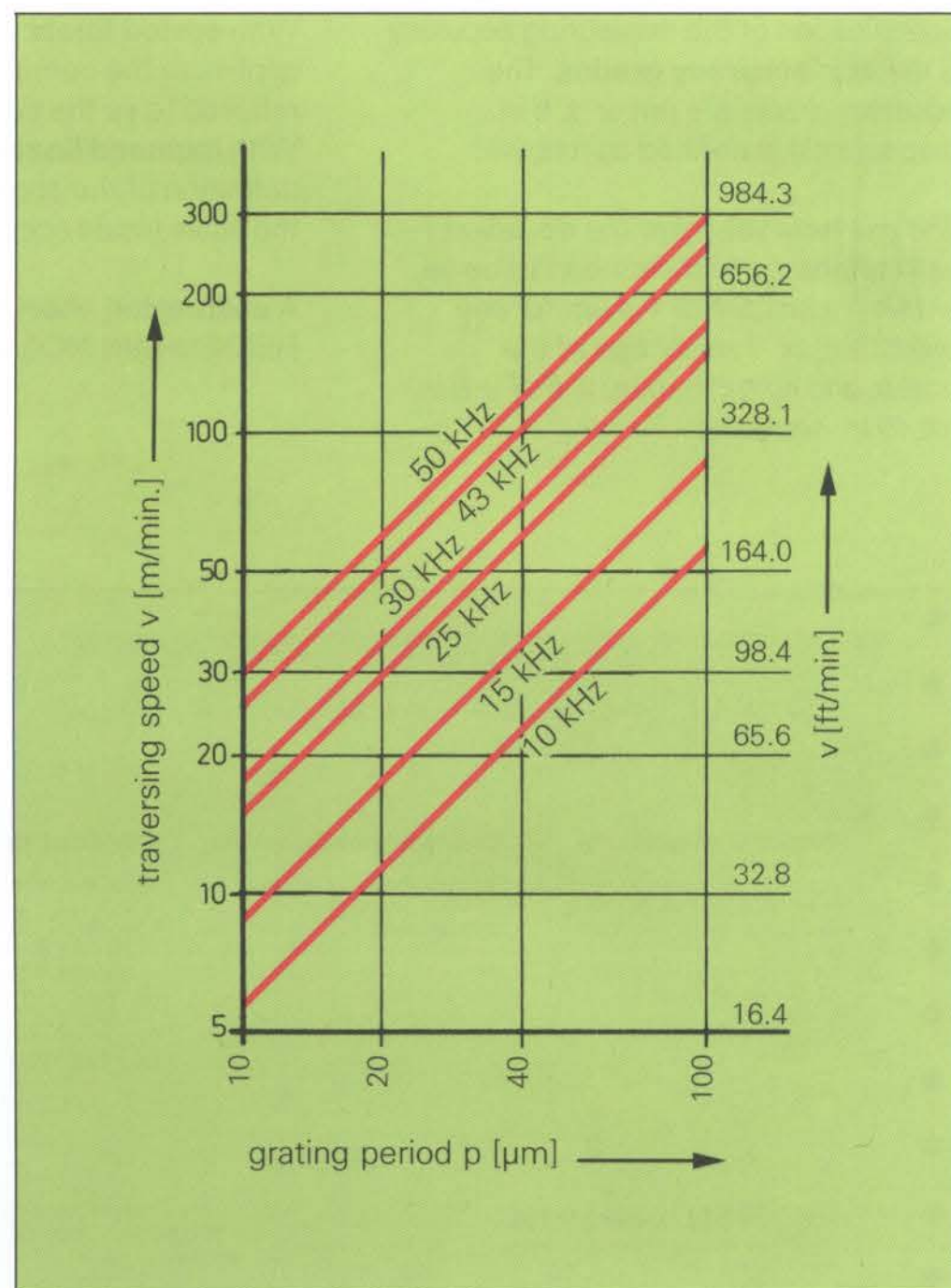


Fig. 1

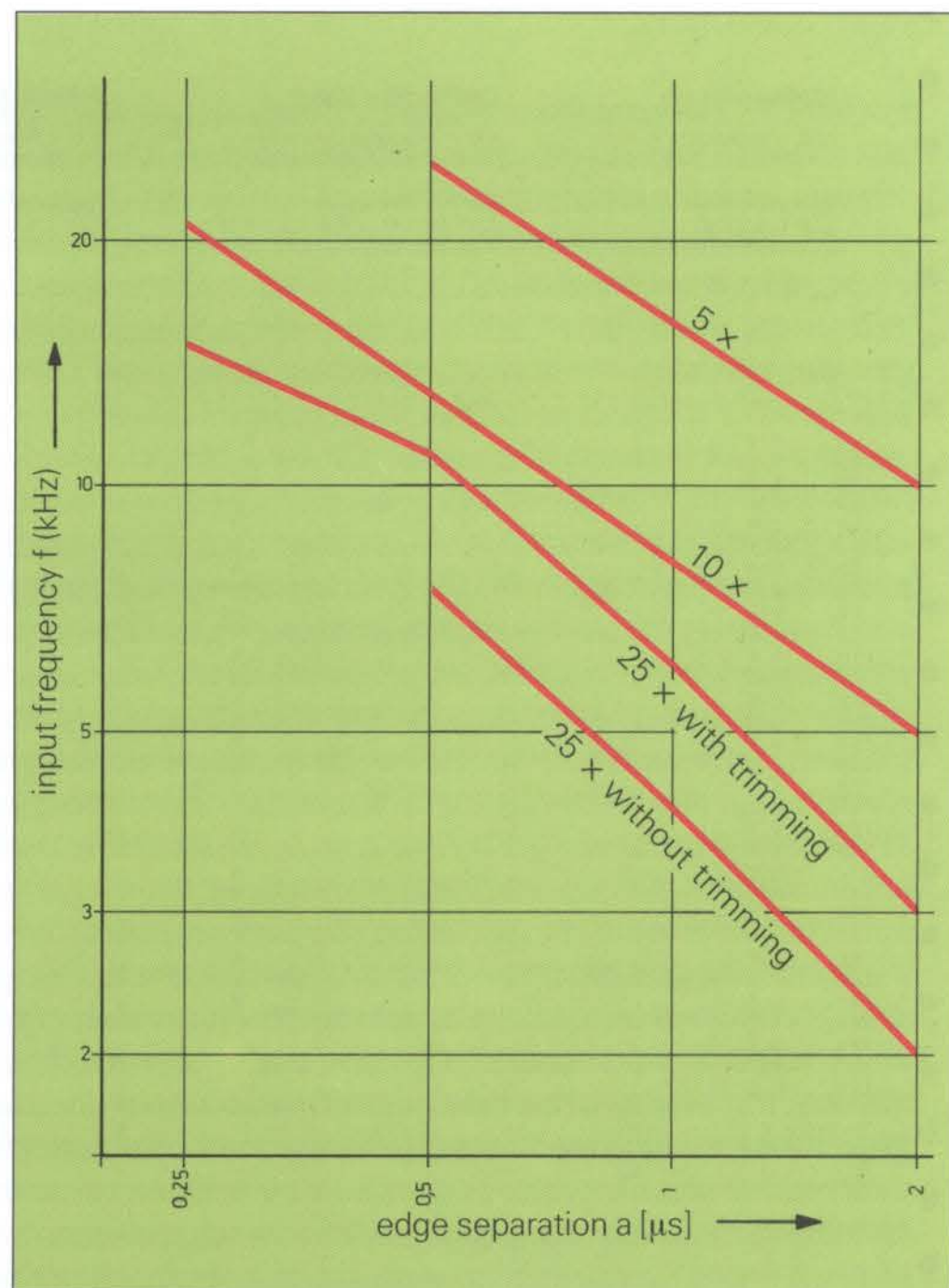


Fig. 2

# Mechanical Design

## Sealed linear encoders

Scale and scanning unit of sealed linear encoders are protected against chips, swarf, dust and splashwater by an aluminum housing with flexible sealing lips.

The scanning unit is guided within the scale unit with low friction. It is connected to the external mounting block via a coupling which compensates for lateral offsets without measuring errors.

Distance variations between scale and mounting block of  $\pm 0.2$  mm ( $\pm 0.008$  in.) with LS 101/LS 107 and  $\pm 0.3$  mm ( $\pm 0.012$  in.) with LS 403/LS 404, LS 704, LB 326 are compensated.

The mounting block is normally fixed to the stationary member of the machine. The electrical wiring extends through the connecting web and then from the mounting block to the subsequent electronics via a shielded cable.

All sealed linear encoders are available with metal-armored cable (standard feature with LS 101, LS 107, LB 326).

The sealed linear encoders LS 403 and LS 404 are employable for **limited installation space**; their maximum measuring length is limited to 2040 mm or 80.3 in. (LS 403), and 620 mm or 24.4 in. (LS 404).

When mounted in the recommended attitude, **dust and splashwater protection** corresponds to IP 53 of standards IEC 529 or IEC 144.

By generating a small positive air **pressure** within the encoder, additional protection against contamination, e.g. coolant/lubricant can be achieved. For **air purging**, all LS and LB 326 linear encoders are provided with a standard inlet in one or both scale end pieces. Compressed air can also be connected at the mounting block of the scanning unit. The compressed air must be cleaned by a microfilter. The recommended flow rate is 3...5 l/min per encoder. The HEIDENHAIN product program includes units for preparation of the compressed air as well as T-joints, tubing and connection pieces with incorporated throttles.

## Exposed linear encoders

With exposed linear encoders, the light source and scanning unit are sealed within the scanning head in accordance with IP 50 for LID and IP 53 for LIDA versions. It is recommended that the scale be protected against contamination. In order to guarantee satisfactory operation, the specified mounting clearances and tolerances (see dimensions) between scanning head and scale, i.e. from  $\pm 0.015$  mm ( $\pm 0.0006$  in.) with LID 351 to  $\pm 0.2$  mm ( $\pm 0.008$  in.) with LIDA 201, must be observed and permanently ensured by the machine guideway.

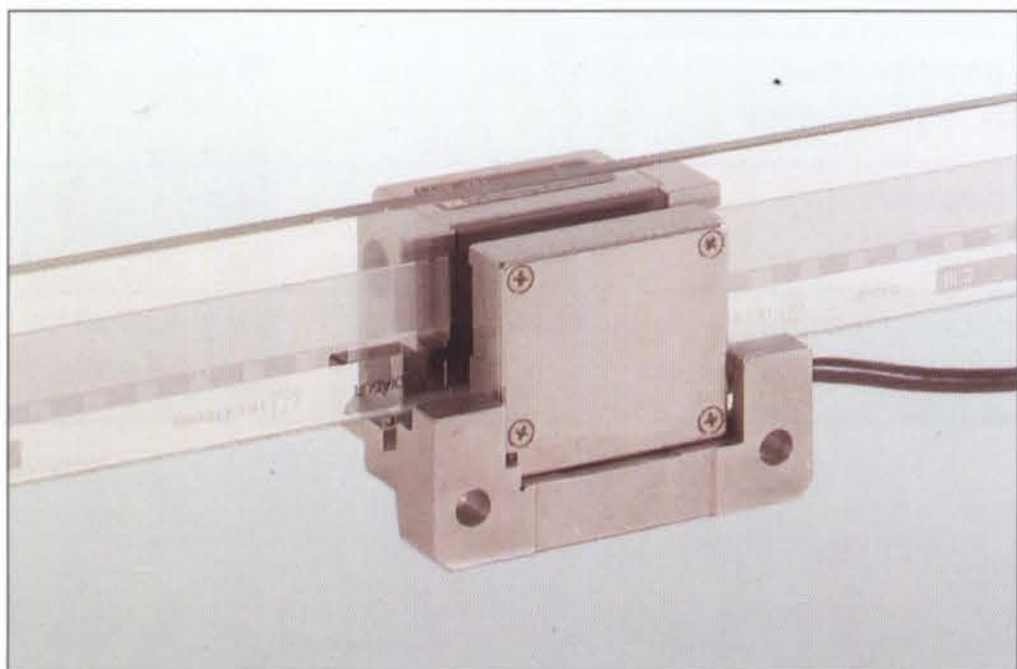
## Cabling

Remarks on connecting and leading the cable are contained in the mounting instructions.

Providing that the wiring regulations have been observed, all HEIDENHAIN encoders are insensitive to electrical or magnetic interference caused by e.g. electrical discharge machines or electrical motors which are located nearby.



Sealed  
linear encoder  
LS 403



Exposed  
linear encoder  
LID 351

# NC-Linear Encoders

## Sealed linear encoders

| Recommended measuring steps   | Linear encoder                                                                    | System accuracy grades     | Grating period |
|-------------------------------|-----------------------------------------------------------------------------------|----------------------------|----------------|
| 1 µm/0.5 µm/<br>0.2 µm/0.1 µm | <b>LS 101, LS 101 C</b> Sealed linear encoder with highest resolution             | ± 5 µm<br>± 3 µm<br>± 2 µm | 10 µm          |
| 1 µm/0.5 µm                   | <b>LS 107, LS 107 C</b> With sectional machine error compensation                 | ± 5 µm<br>± 3 µm<br>± 2 µm | 20 µm          |
| 1 µm/0.5 µm                   | <b>LS 403, LS 403 C</b> For limited installation place<br><b>LS 404, LS 404 C</b> | ± 5 µm<br>± 3 µm*          | 20 µm          |
| 1 µm/0.5 µm                   | <b>LS 704, LS 704 C</b> Standard linear encoders, robust design                   | ± 5 µm<br>± 3 µm*          | 20 µm          |
| 1 µm                          | <b>LB 326</b> For large traverses, with machine error compensation                | ± 5 µm                     | 100 µm         |
| 1 µm/0.5 µm/<br>0.2 µm        | <b>ULS 300, ULS 300 C</b> Fully sealed universal linear encoders                  | ± 3 µm<br>± 2 µm**         | 20 µm          |

\* up to 1240 mm (48.8 in.) only

\*\* 170 mm (6.7 in.) and 270 mm (10.6 in.) only

## "Exposed" linear encoders

| Recommended measuring steps               | Linear encoder                                                                          | Scale accuracy grades                    | Grating period            |
|-------------------------------------------|-----------------------------------------------------------------------------------------|------------------------------------------|---------------------------|
| 1 µm/0.2 µm/<br>0.1 µm/0.02 µm            | <b>LIP 101</b> Very high resolution, with very high accuracy                            | ± 2 µm/± 1 µm<br>± 0.5 µm*<br>± 0.2 µm** | 8 µm (signal period 4 µm) |
| 1 µm/0.5 µm/<br>0.2 µm/0.1 µm<br>0.05 µm  | <b>LID 311, LID 311 C</b> For measuring machines, high resolution with high accuracy    | ± 1 µm<br>± 0.5 µm***<br>± 0.2 µm****    | 10 µm                     |
| 1 µm/0.5 µm/<br>0.2 µm/0.1 µm/<br>0.05 µm | <b>LID 351, LID 351 C</b> High resolution with high accuracy, integrated adjustment aid | ± 1 µm<br>± 0.5 µm***<br>± 0.2 µm****    | 10 µm                     |
| 1 µm                                      | <b>LIDA 190</b> Reference mark positions as required                                    | ± 5 µm<br>± 3 µm                         | 40 µm                     |
| 1 µm                                      | <b>LIDA 201</b> Large installation tolerances                                           | ± 5 µm<br>± 3 µm                         | 100 µm                    |
| 1 µm                                      | <b>LIDA 225</b> For large traverses, with linear machine error compensation             | ± 5 µm                                   | 100 µm                    |

\* up to 520 mm (20.5 in.) only

\*\* up to 220 mm (8.6 in.) only

\*\*\* up to 500 mm (19.7 in.) only

\*\*\*\* up to 200 mm (7.9 in.) only

## Special linear encoders

| Recommended measuring steps              | Linear encoder                                                      | System accuracy grade | Grating period            |
|------------------------------------------|---------------------------------------------------------------------|-----------------------|---------------------------|
| 1 µm/0.5 µm/<br>0.2 µm/0.1 µm<br>0.05 µm | <b>MT 60K</b> Length gage for small traverses, high accuracy        | ± 0.5 µm              | 10 µm                     |
| 1 µm/0.5 µm/<br>0.2 µm/0.1 µm<br>0.05 µm | <b>MT 101K</b> Length gage for small traverses                      | ± 1 µm                | 10 µm                     |
| 1 µm/0.2 µm/<br>0.1 µm/0.02 µm           | <b>VM 101</b> Comparator system for calibrating small machine tools | ± 1 µm                | 8 µm (signal period 4 µm) |

### Measuring lengths

mm (inch)

|                                   |                           |                                                         |                                                            |
|-----------------------------------|---------------------------|---------------------------------------------------------|------------------------------------------------------------|
| 140<br>(5.5)                      | up to 1240<br>(48.8)      | <b>LS 101, LS 101 C</b>                                 |                                                            |
| 240<br>(9.5)                      |                           | up to 3040<br>(120.0)                                   | <b>LS 107, LS 107 C</b>                                    |
| 70 (2.7)                          | up to 1240 (48.8)         | 1340 (57.7) <sup>+</sup> up to 2040 (80.3) <sup>+</sup> | <b>LS 403, LS 403 C</b><br><sup>+</sup> with mounting spar |
| 70 (2.7)                          | up to 620 (24.4)          | <b>LS 404, LS 404 C</b>                                 |                                                            |
| 170<br>(6.7)                      |                           | up to 3040<br>(120.0)                                   | <b>LS 704, LS 704 C</b>                                    |
|                                   |                           |                                                         | <b>LB 326</b>                                              |
|                                   | 440<br>(17.3)             |                                                         | up to 30 m<br>(98.4 ft)                                    |
| 170 up to 520<br>(6.7 up to 20.5) | <b>ULS 300, ULS 300 C</b> |                                                         |                                                            |

### Measuring lengths

mm (inch)

|              |                      |                      |                         |
|--------------|----------------------|----------------------|-------------------------|
| 120<br>(4.7) | up to 1020<br>(40.1) | <b>LIP 101</b>       |                         |
| 10 (0.4)     | up to 1500 (59.0)    | <b>LID 311</b>       |                         |
| 50 (2.0)     | up to 1500 (59.0)    | <b>LID 311 C</b>     |                         |
| 10 (0.4)     | up to 1500 (59.0)    | <b>LID 351</b>       |                         |
| 50 (2.0)     | up to 1500 (59.0)    | <b>LID 351 C</b>     |                         |
| 220<br>(8.6) |                      | up to 2040<br>(80.3) | <b>LIDA 190</b>         |
| 220<br>(8.6) |                      | up to 2040<br>(80.3) | <b>LIDA 201</b>         |
|              |                      |                      | <b>LIDA 225</b>         |
| 140<br>(5.5) |                      |                      | up to 30 m<br>(98.4 ft) |

### Measuring lengths

mm (inch)

|                                     |                |  |
|-------------------------------------|----------------|--|
| 60<br>(2.3)                         | <b>MT 60K</b>  |  |
| 100<br>(3.9)                        | <b>MT 101K</b> |  |
| 420 up to 1020<br>(16.5 up to 40.1) | <b>VM 101</b>  |  |

# Sealed Linear Encoders

In sealed linear encoders the scale and the scanning unit are protected by an aluminum housing and flexible synthetic rubber sealing lips against chips, swarf, dust and fluids.

The scanning unit is self-guided along the scale and is connected to the mounting block via a coupling with rigidity in the measuring direction only.

Sealed linear encoders are suited mainly for use on machines that generate dust, chips and water spray, such as machine tools (e.g. milling and boring machines, machining centers, lathes and grinding machines, electrical discharge machines etc.) but also on saws, welding machines, press brakes, wood-working and plastics machinery and other machines.



## LS 101, LS 101 C

Sealed linear encoders for highest resolution (0.1  $\mu\text{m}$ )



## LS 107, LS 107 C

with sectional machine error compensation



## LS 403, LS 403 C LS 404, LS 404 C

Linear encoders with small cross section for limited installation space



## LS 704, LS 704 C

Standard linear encoders of robust design



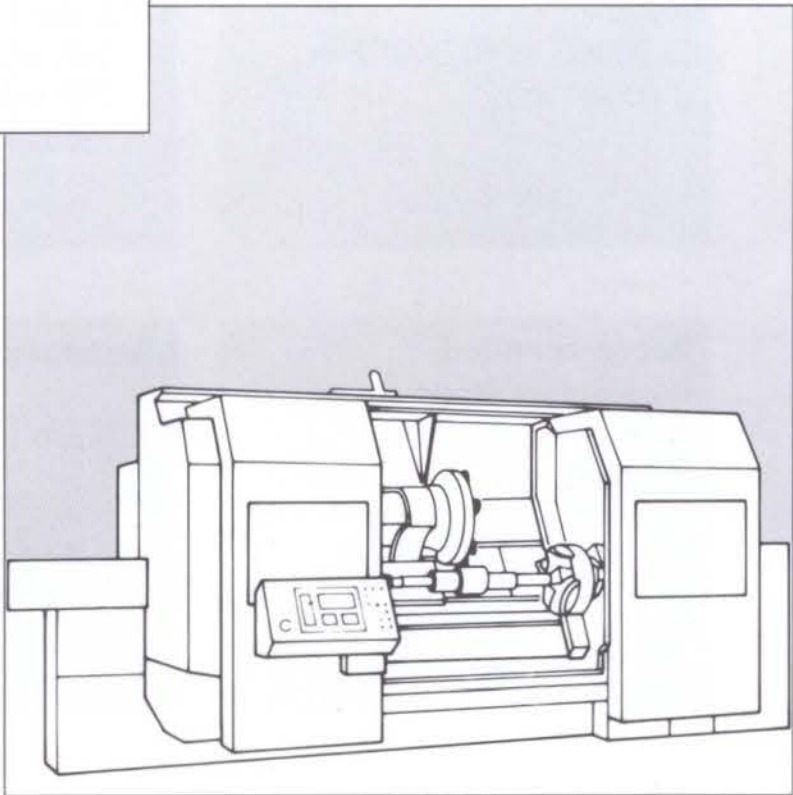
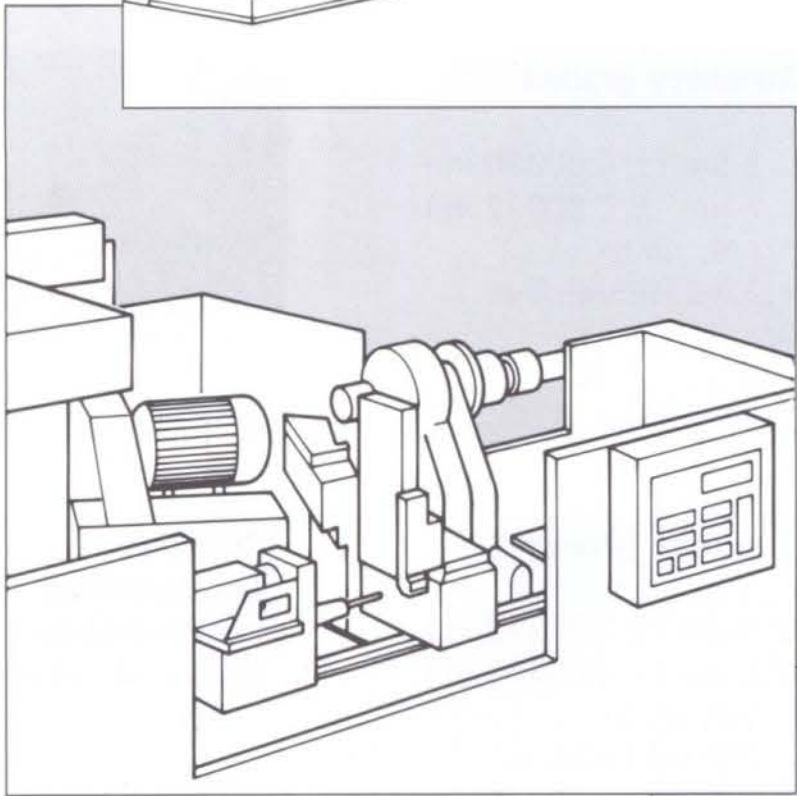
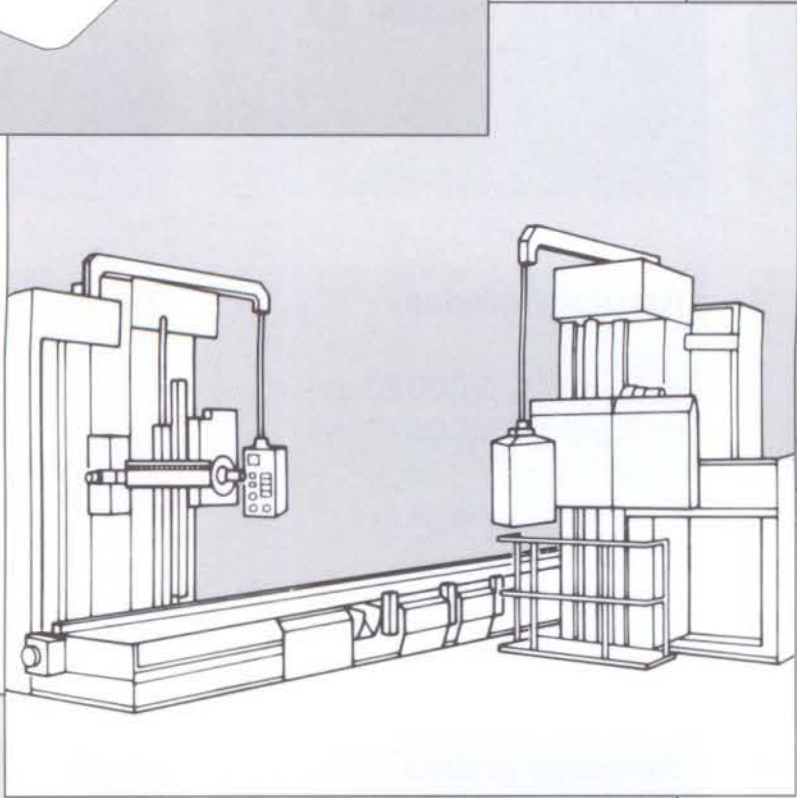
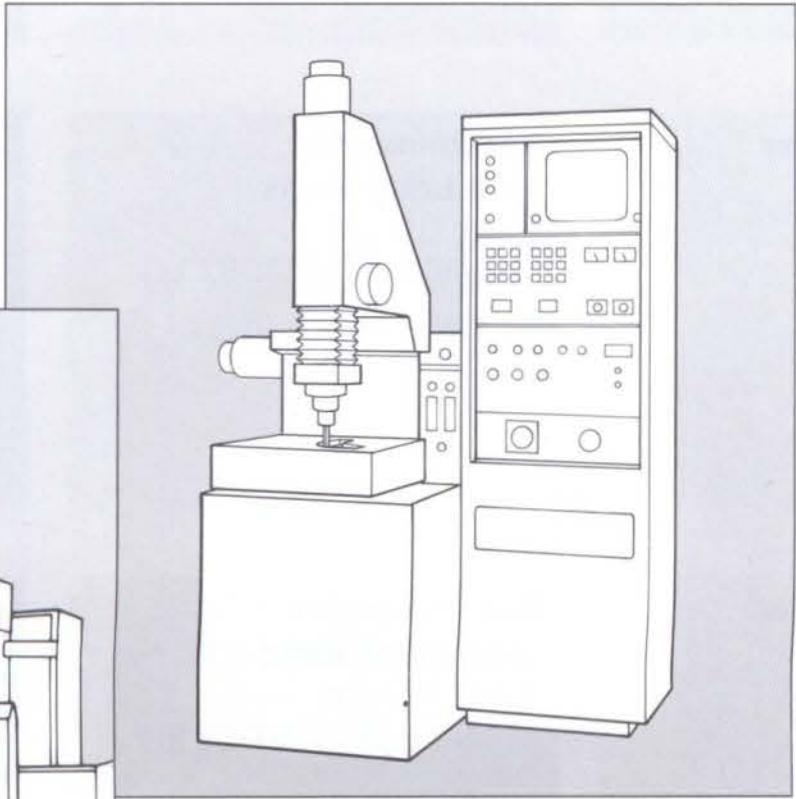
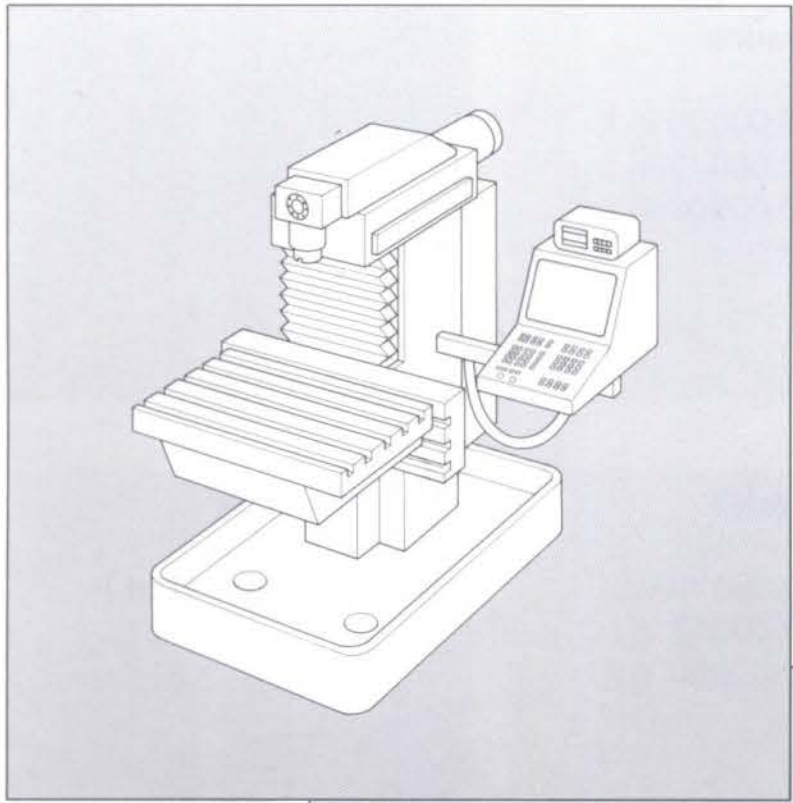
## ULS 300, ULS 300 C

Fully encapsulated universal linear encoders



## LB 326

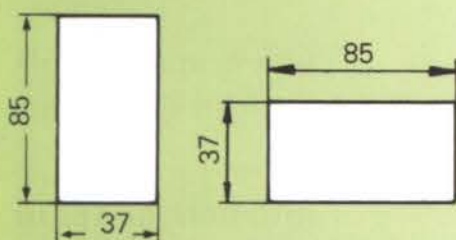
Linear encoder for machine tools with large lengths of traverse with machine error compensation



# Sealed Linear Encoders

|                                                          |                                                                                                                                                                                                            |                                                                                                                                                                     |                                                                                                           |
|----------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------|
| <b>Measuring lengths</b><br>up to 1240 mm<br>(48.8 in.)  | <b>Recommended measuring steps</b><br>1 $\mu\text{m}$ , 0.5 $\mu\text{m}$ ,<br>0.2 $\mu\text{m}$ , <b>0.1 <math>\mu\text{m}</math></b><br>(0.00005 in., 0.00002 in.,<br>0.00001 in., <b>0.000005 in.</b> ) | <b>Accuracy grades</b><br>$\pm 5 \mu\text{m}$ ( $\pm 0.00020$ in.)<br>$\pm 3 \mu\text{m}$ ( $\pm 0.00012$ in.)<br>$\pm 2 \mu\text{m}$ ( $\pm 0.00008$ in.)          |                                                                                                           |
| <b>Measuring lengths</b><br>up to 3040 mm<br>(120.0 in.) | <b>Recommended measuring steps</b><br>1 $\mu\text{m}$ , 0.5 $\mu\text{m}$<br>(0.00005 in., 0.00002 in.)                                                                                                    | <b>Accuracy grades</b><br>$\pm 5 \mu\text{m}$ ( $\pm 0.00020$ in.)<br>$\pm 3 \mu\text{m}$ ( $\pm 0.00012$ in.)<br>$\pm 2 \mu\text{m}$ ( $\pm 0.00008$ in.)          | <b>Machine error compensation</b><br>every 100 mm (4 in.)                                                 |
| <b>Measuring lengths</b><br>up to 2040 mm<br>(80.8 in.)  | <b>Recommended measuring steps</b><br>1 $\mu\text{m}$ , 0.5 $\mu\text{m}$<br>(0.00005 in., 0.00002 in.)                                                                                                    | <b>Accuracy grades</b><br>$\pm 5 \mu\text{m}$ ( $\pm 0.00020$ in.)<br>$\pm 3 \mu\text{m}$ ( $\pm 0.00012$ in.)<br>only up to<br>1240 mm/48.8 in.                    |                                                                                                           |
| <b>Measuring lengths</b><br>up to 3040 mm<br>(120.0 in.) | <b>Recommended measuring steps</b><br>1 $\mu\text{m}$ , 0.5 $\mu\text{m}$<br>(0.00005 in., 0.00002 in.)                                                                                                    | <b>Accuracy grades</b><br>$\pm 5 \mu\text{m}$ ( $\pm 0.00020$ in.)<br>$\pm 3 \mu\text{m}$ ( $\pm 0.00012$ in.)<br>only up to<br>1240 mm/48.8 in.                    |                                                                                                           |
| <b>Measuring lengths</b><br>up to 520 mm<br>(20.5 in.)   | <b>Recommended measuring steps</b><br>1 $\mu\text{m}$ , 0.5 $\mu\text{m}$ ,<br>0.2 $\mu\text{m}$<br>(0.00005 in., 0.00002 in.,<br>0.00001 in.)                                                             | <b>Accuracy grades</b><br>$\pm 3 \mu\text{m}$ ( $\pm 0.00012$ in.)<br>$\pm 2 \mu\text{m}$ ( $\pm 0.00008$ in.)<br>only up to<br>270 mm/10.6 in.<br>measuring length | <b>Completely encapsulated linear encoder with push rod activation</b>                                    |
| <b>Measuring lengths</b><br>up to 30 m<br>(98.4 ft)      | <b>Recommended measuring steps</b><br>1 $\mu\text{m}$<br>(0.00005 in.)                                                                                                                                     | <b>Accuracy grades</b><br>$\pm 5 \mu\text{m}$ ( $\pm 0.00020$ in.)                                                                                                  | <b>Machine error compensation</b><br>linear over total length<br>. additionally every<br>200 mm (7.9 in.) |

**Cross-section and mounting attitudes**

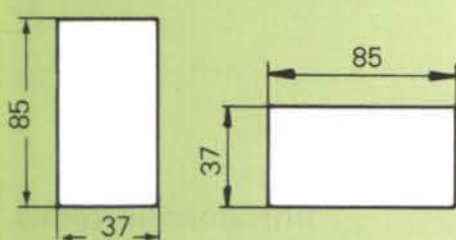


**LS 101  
LS 101 C**

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**Cross-section and mounting attitudes**

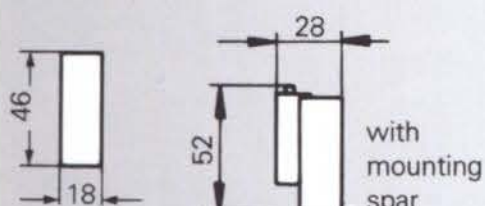


**LS 107  
LS 107 C**

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**Cross-section and mounting attitudes**

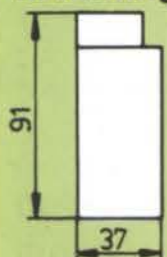


**LS 403, LS 403 C  
LS 404, LS 404 C**

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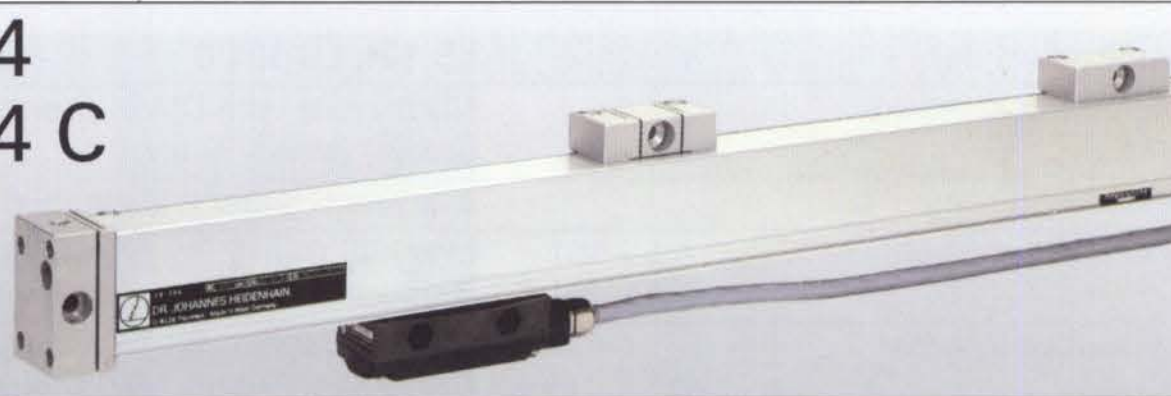


**Cross-section and mounting attitude**

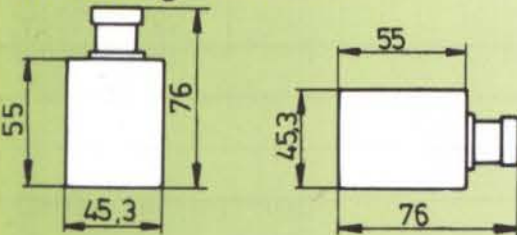


**LS 704  
LS 704 C**

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**Cross-section and mounting attitudes**

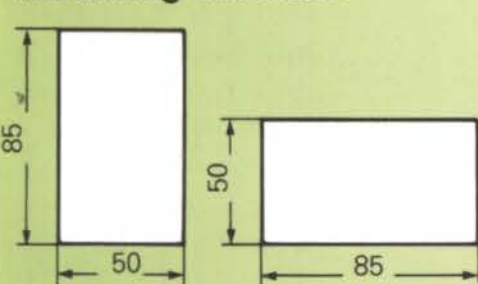


**ULS 300  
ULS 300 C**

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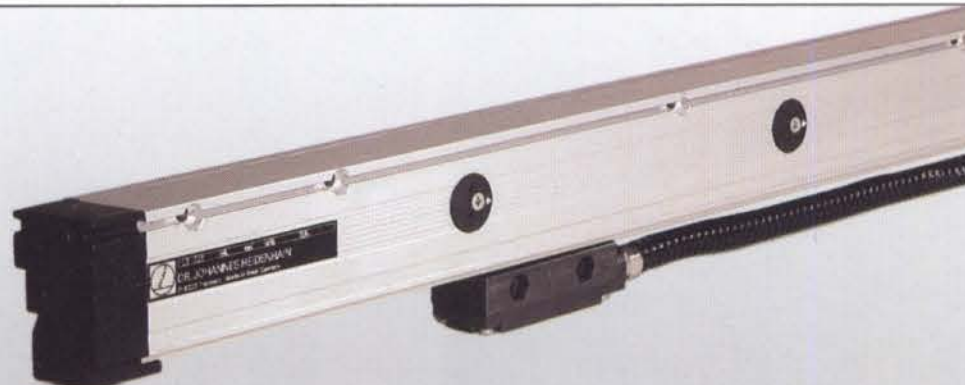


**Cross-section and mounting attitudes**



**LB 326**

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# Linear Encoders LS 101, LS 101 C – especially for high resolution

Incremental, sealed linear encoders

2 mounting attitudes

**Measuring lengths** up to 1240 mm (48.8 in.)

**Grating period** 10  $\mu\text{m}$

**Accuracy grades**  $\pm 5 \mu\text{m}/\pm 3 \mu\text{m}/\pm 2 \mu\text{m}$  ( $\pm 0.00020 \text{ in.}/\pm 0.00012 \text{ in.}/\pm 0.00008 \text{ in.}$ )

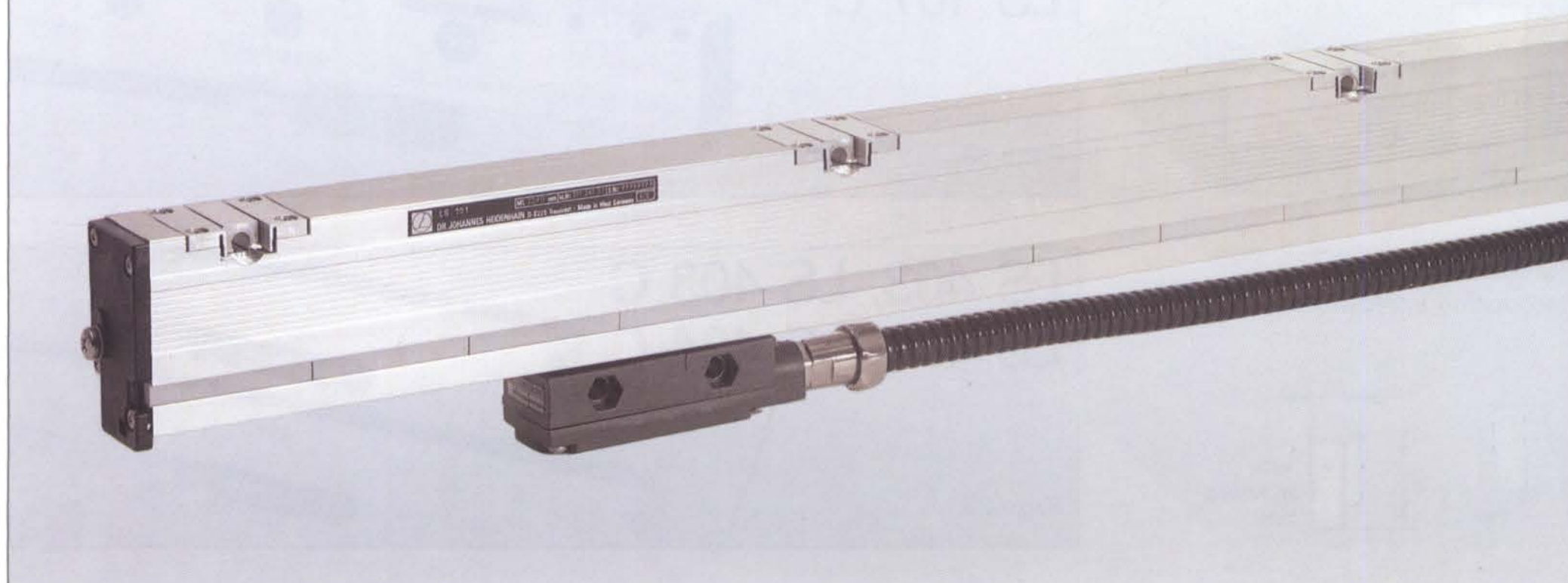
**Recommended measuring steps**

1  $\mu\text{m}/0.5 \mu\text{m}/0.2 \mu\text{m}/0.1 \mu\text{m}$

(0.00005 in./0.00002 in./0.00001 in./0.000005 in.)

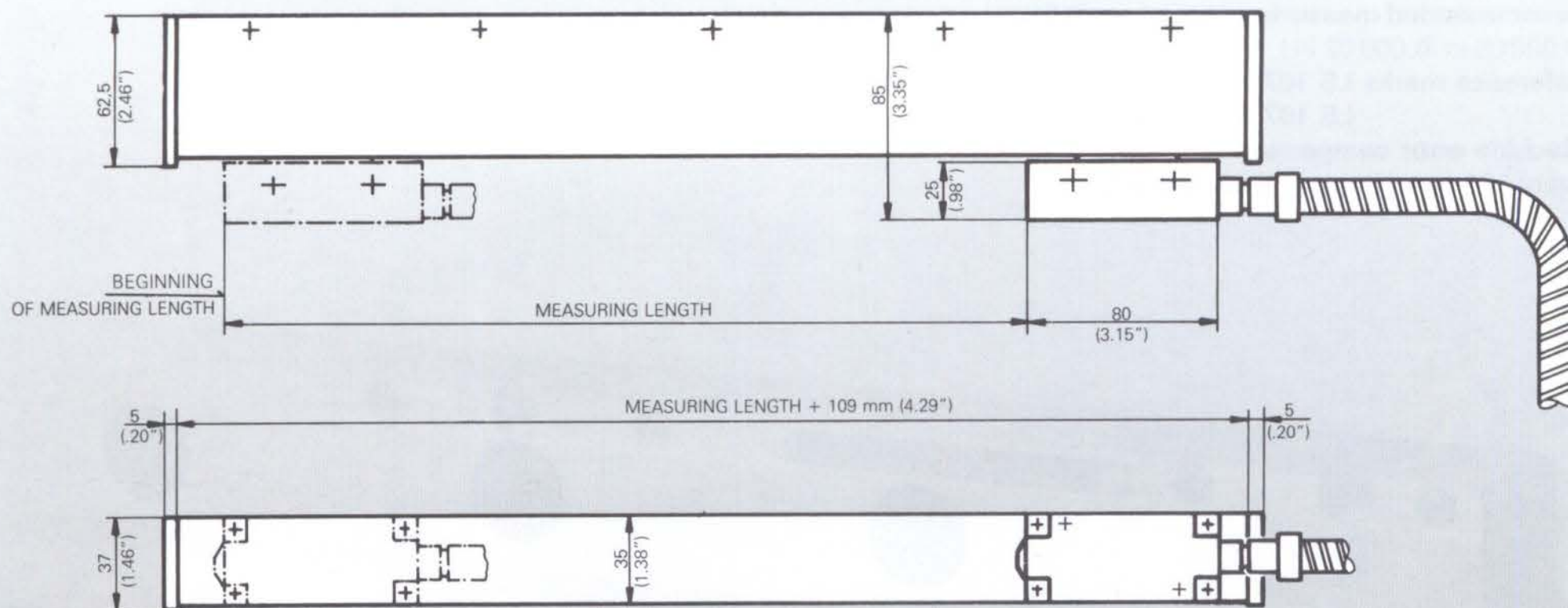
**Reference marks LS 101:** every 50 mm (2 in.), via selector magnets

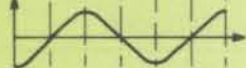
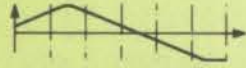
**LS 101 C:** distance-coded



| Mechanical data                 |                    | LS 101, LS 101 C                                                                                                                     |
|---------------------------------|--------------------|--------------------------------------------------------------------------------------------------------------------------------------|
| Measuring standard              |                    | Glass scale with DIADUR-grating<br>Grating period 10 $\mu\text{m}$                                                                   |
| Accuracy grades                 |                    | $\pm 5 \mu\text{m}/\pm 3 \mu\text{m}/\pm 2 \mu\text{m}$ ( $\pm 0.0002 \text{ in.}/\pm 0.00012 \text{ in.}/\pm 0.00008 \text{ in.}$ ) |
| Reference marks                 | LS 101<br>LS 101 C | every 50 mm (2 in.) possible (activated via selector magnets)<br>distance-coded reference marks                                      |
| Measuring lengths               | mm<br>inch         | 140/190/240/340/440/540/640/740/840/940/1040/1140/1240<br>5.5/7.5/9.5/13.4/17.3/21.3/25.2/29.0/33.0/37.0/41.0/44.9/48.8              |
| Max. traversing speed           |                    | 30 m/min (100 ft/min)                                                                                                                |
| Permissible acceleration        |                    |                                                                                                                                      |
| Max. vibration (50 ... 2000 Hz) |                    | 30 $\text{m/s}^2$                                                                                                                    |
| Max. shock (11 ms)              |                    | 200 $\text{m/s}^2$                                                                                                                   |
| Required moving force           |                    | $\leq 4 \text{ N}$                                                                                                                   |
| Operating temperature           |                    | 0 ... 40°C (32 ... 104°F)                                                                                                            |
| Storage temperature             |                    | -20 ... 70°C (-4 ... 158°F)                                                                                                          |
| Weight                          |                    | 1 kg + 2,6 kg/m measuring length (2.2 lb + 1.74 lb/ft)                                                                               |
| Connecting cable                |                    | 3 m (10 ft), with connector and armored sheathing (standard)                                                                         |

Dimensions in mm (inch)



| Electrical data                      |                     | LS 101, LS 101 C                                                                                                                                                           |
|--------------------------------------|---------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Light source                         |                     | LED                                                                                                                                                                        |
| Operating voltage                    |                     | 5 V $\pm$ 5 %/120 mA                                                                                                                                                       |
| Output signals                       | Incremental signals | 2 sinusoidal signals $I_{e1}$ and $I_{e2}$                                                                                                                                 |
|                                      |                     | <br> |
|                                      | Reference signal    | 1 signal $I_{e0}$                                                                                                                                                          |
|                                      |                     |                                                                                         |
| Signal levels with 1 k $\Omega$ load |                     | $I_{e1}$ approx. 7 ... 16 $\mu A_{pp}$<br>$I_{e2}$ approx. 7 ... 16 $\mu A_{pp}$<br>$I_{e0}$ approx. 2 ... 8 $\mu A$ (usable portion)                                      |
| Total permissible cable length       |                     | 20 m (65.6 ft)                                                                                                                                                             |

# Standard Linear Encoders LS 107, LS 107 C – with sectional machine error compensation

Incremental, sealed linear encoder

2 mounting attitudes

**Measuring lengths** up to 3040 mm (120 in.)

**Grating period** 20  $\mu\text{m}$

**Accuracy grades**  $\pm 5 \mu\text{m}/\pm 3 \mu\text{m}/\pm 2 \mu\text{m}$

( $\pm 0.00020 \text{ in.}/\pm 0.00012 \text{ in.}/\pm 0.00008 \text{ in.}$ )

**Recommended measuring steps** 1  $\mu\text{m}/0.5 \mu\text{m}$

(0.00005 in./0.00002 in.)

**Reference marks LS 107:** every 50 mm (2 in.), via selector magnets

**LS 107 C:** distance-coded

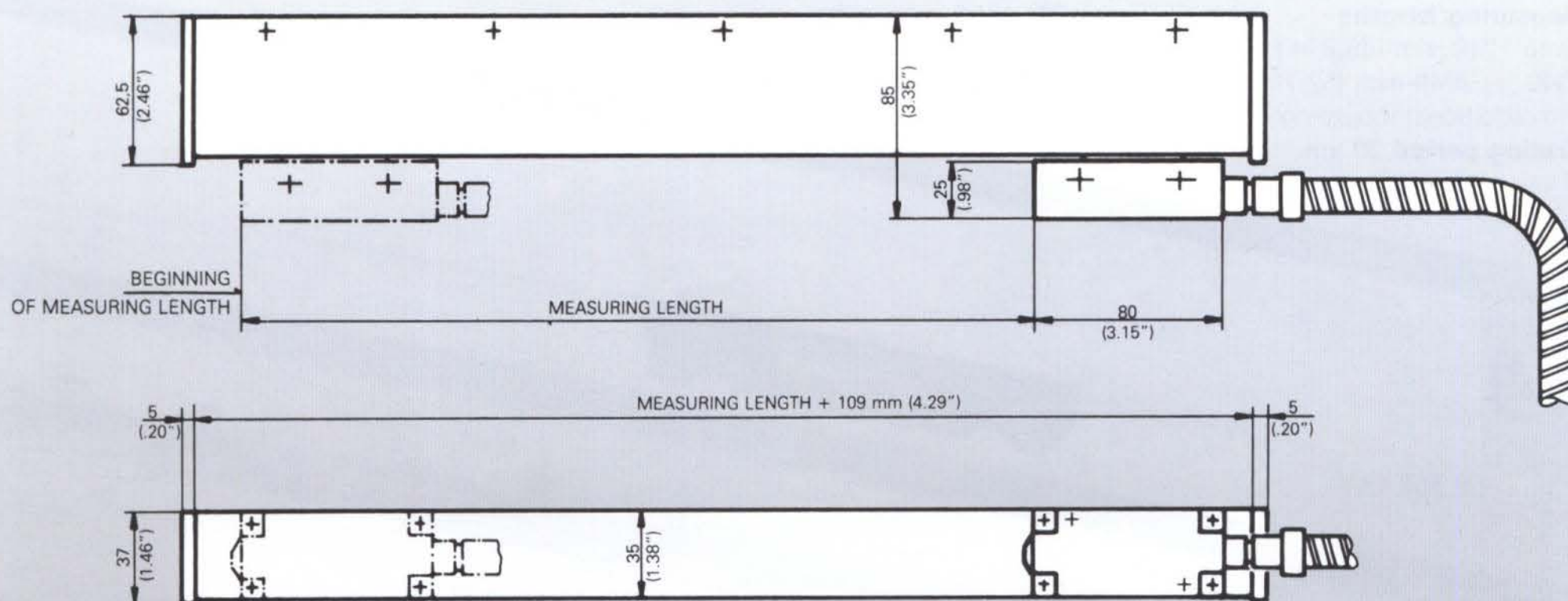
**Machine error compensation**

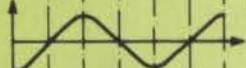
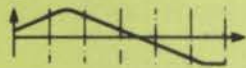
every 100 mm (4 in.) via linear guiders



| Mechanical data                 |                    | LS 107, LS 107 C                                                                                                                      |
|---------------------------------|--------------------|---------------------------------------------------------------------------------------------------------------------------------------|
| Measuring standard              |                    | Glass scale with DIADUR-grating<br>Grating period 20 $\mu\text{m}$                                                                    |
| Accuracy grades                 |                    | $\pm 5 \mu\text{m}/\pm 3 \mu\text{m}/\pm 2 \mu\text{m}$ ( $\pm 0.00020 \text{ in.}/\pm 0.00012 \text{ in.}/\pm 0.00008 \text{ in.}$ ) |
| Machine error compensation      |                    | every 100 mm (4 in.) via linear guiders, max. $\pm 20 \mu\text{m}$ ( $\pm 0.0008 \text{ in.}$ ) per meas. length                      |
| Reference marks                 | LS 107<br>LS 107 C | every 50 mm (2 in.) possible (activated via selector magnets),<br>distance-coded reference marks                                      |
| Measuring lengths               | mm                 | 240/340/440/540/640/740/840/940/1040/1140/1240/1340/1440/1540/1640/1740/<br>1840/2040/2240/2440/2640/2840/3040                        |
|                                 | inch               | 9.5/13.4/17.3/21.3/25.2/29.0/33.0/37.0/41.0/44.9/48.8/52.7/56.7/60.6/<br>64.6/68.5/72.4/80.3/88.2/96.0/104.0/112.0/120.0              |
| Max. traversing speed           |                    | 30 m/min (100 ft/min)                                                                                                                 |
| Permissible acceleration        |                    |                                                                                                                                       |
| Max. vibration (50 ... 2000 Hz) |                    | 30 $\text{m/s}^2$                                                                                                                     |
| Max. shock (11 ms)              |                    | 200 $\text{m/s}^2$                                                                                                                    |
| Required moving force           |                    | $\leq 5 \text{ N}$                                                                                                                    |
| Operating temperature           |                    | -20 ... 40°C (32 ... 104°F)                                                                                                           |
| Storage temperature             |                    | -20 ... 70°C (-4 ... 158°F)                                                                                                           |
| Weight                          |                    | 1 kg + 2.6 kg/m measuring length (2.2 lb + 1.74 lb/ft)                                                                                |
| Connecting cable                |                    | 3 m (10 ft), with connector and armored sheathing (standard)                                                                          |

Dimensions in mm (inch) 



| Electrical data                |                                      | LS 107, LS 107 C                                                                              |
|--------------------------------|--------------------------------------|-----------------------------------------------------------------------------------------------|
| Light source                   |                                      | Miniature lamp 5 V/0.6 W                                                                      |
| Operating voltage              |                                      | 5 V $\pm$ 5 %/120 mA                                                                          |
| Output signals                 | Incremental signals                  | 2 sinusoidal signals $I_{e1}$ and $I_{e2}$                                                    |
|                                |                                      | $I_{e1}$  |
|                                |                                      | $I_{e2}$  |
|                                | Reference signal                     | 1 signal $I_{e0}$                                                                             |
|                                |                                      | $I_{e0}$  |
|                                | Signal levels with 1 k $\Omega$ load | $I_{e1}$ approx. 7 ... 16 $\mu A_{pp}$                                                        |
|                                |                                      | $I_{e2}$ approx. 7 ... 16 $\mu A_{pp}$                                                        |
|                                |                                      | $I_{e0}$ approx. 2 ... 8 $\mu A$ (usable portion)                                             |
| Total permissible cable length |                                      | 20 m (65.6 ft)                                                                                |

# Miniaturized Sealed Linear Encoders

## LS 403, LS 403 C

## LS 404, LS 404 C

Incremental, sealed linear encoders with **miniature cross-section** (18 mm × 46 mm/.7 in. × 1.8 in.) for **limited installation space**.

### LS 403/LS 403 C

#### Measuring lengths

up to 1240 mm (48.8 in.)

1340 ... 2040 mm (52.7 ... 80.3 in.)

with additional mounting spar

**Grating period** 20 µm

### LS 404/LS 404 C

The glass scale is fixed to the left-hand end of the carrier (aluminum extrusion) to prevent displacement between the glass scale and the carrier during temperature changes.

#### Measuring lengths

up to 620 mm (24.4 in.)

Otherwise as with LS 403

### Recommended measuring steps

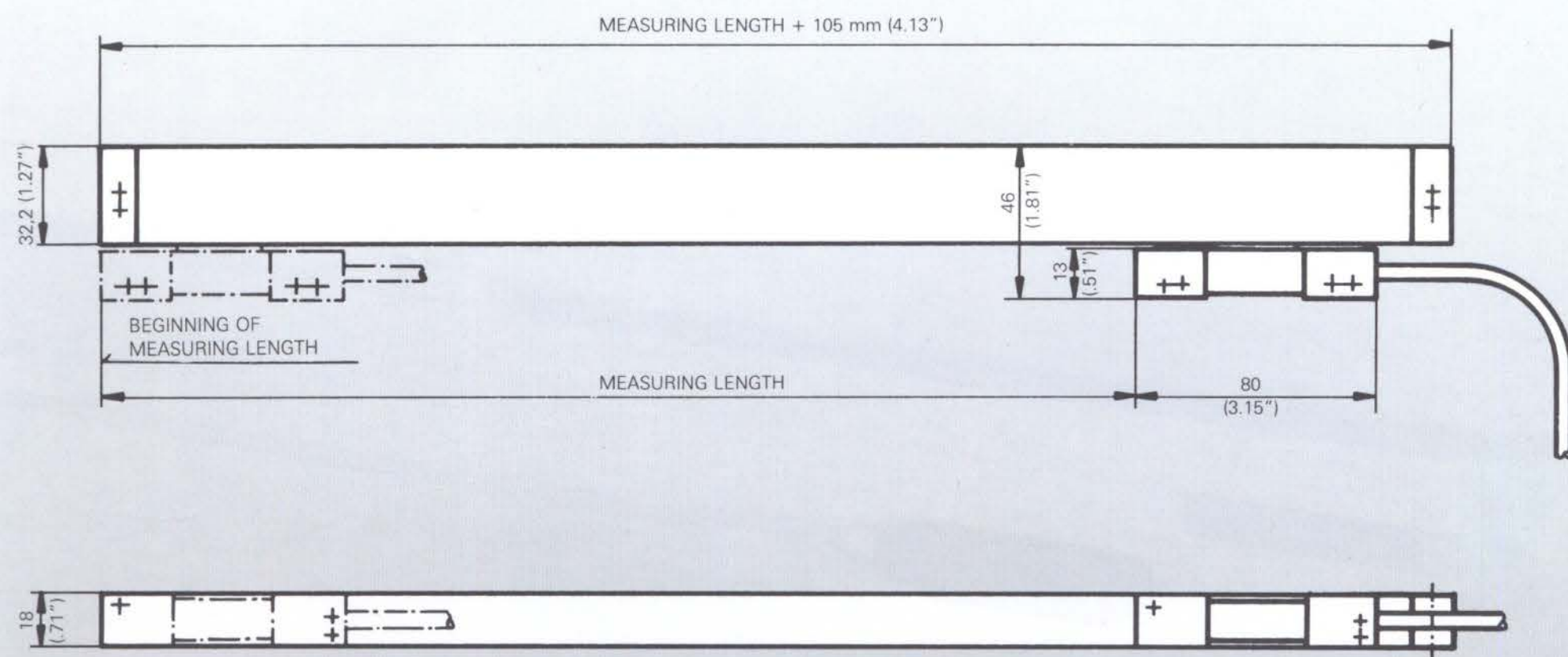
1 µm/0.5 µm

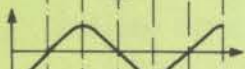
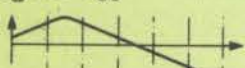
(0.000 05 in./0.000 02 in.)



| Mechanical data                 | LS 403, LS 403 C                                                                                                                                                                                                                                                                                                                                                                                         | LS 404, LS 404 C |
|---------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|
| Measuring standard              | Glass scale with DIADUR-grating<br>Grating period 20 µm                                                                                                                                                                                                                                                                                                                                                  |                  |
| Accuracy grades                 | ± 5 µm/± 3 µm up to 1240 mm (48.8 in.) only (± 0.000 20 in./± 0.000 12 in.)                                                                                                                                                                                                                                                                                                                              |                  |
| Reference marks (standard-type) | LS 403/LS 404 2 reference marks<br>– with measuring lengths up to 1020 mm (40.1 in.) each 35 mm (1.4 in.) from beginning and end of the measuring length<br>– with measuring lengths 1140 mm (44.9 in.) up to 2040 mm (80.3 in.) each 45 mm (1.8 in.) from beginning and end of the measuring length<br>further reference mark locations on request<br>LS 403 C, LS 404 C distance-coded reference marks |                  |
| Measuring lengths               | LS 403, LS 403 C/ mm 70/120/170/220/270/320/370/420/470/520/570/620                                                                                                                                                                                                                                                                                                                                      |                  |
|                                 | LS 404, LS 404 C inch 2.7/4.7/6.7/8.6/10.6/12.6/14.5/16.5/18.5/20.5/22.4/24.4                                                                                                                                                                                                                                                                                                                            |                  |
|                                 | LS 403, LS 403 C mm 720/770/820/920/1020/1140/1240                                                                                                                                                                                                                                                                                                                                                       |                  |
|                                 | inch 28.3/30.3/32.3/36.2/40.1/44.9/48.8                                                                                                                                                                                                                                                                                                                                                                  |                  |
|                                 | LS 403, LS 403 C mm 1340/1440/1540/1640/1740/1840/2040                                                                                                                                                                                                                                                                                                                                                   |                  |
|                                 | with mounting spar inch 52.7/56.7/60.6/64.6/68.5/72.4/80.3                                                                                                                                                                                                                                                                                                                                               |                  |
| Max. traversing speed           | 48 m/min (160 ft/min)                                                                                                                                                                                                                                                                                                                                                                                    |                  |
| Permissible acceleration        |                                                                                                                                                                                                                                                                                                                                                                                                          |                  |
| Max. vibration (50 ... 2000 Hz) | 30 m/s <sup>2</sup>                                                                                                                                                                                                                                                                                                                                                                                      |                  |
| Max. shock (11 ms)              | 100 m/s <sup>2</sup> without mounting spar<br>200 m/s <sup>2</sup> with mounting spar (LS 403/LS 403 C only)                                                                                                                                                                                                                                                                                             |                  |
| Required moving force           | ≤ 6 N                                                                                                                                                                                                                                                                                                                                                                                                    |                  |
| Operating temperature           | 0 ... 50°C (32 ... 122°F)                                                                                                                                                                                                                                                                                                                                                                                |                  |
| Storage temperature             | –20 ... 70°C (–4 ... 158°F)                                                                                                                                                                                                                                                                                                                                                                              |                  |
| Weight                          | 0.1 kg + 0.5 kg/m measuring length (0.22 lb + 0.34 lb/ft)                                                                                                                                                                                                                                                                                                                                                |                  |
| Connecting cable                | 3 m (10 ft), with connector (standard);<br>0.3 m (1 ft), with flange socket (male) on mounting block (special type);<br>3 m (10 ft), with armored sheathing with connector (special type)                                                                                                                                                                                                                |                  |

Dimensions in mm (inch) 



| Electrical data                      |                     | LS 403, LS 403 C/LS 404, LS 404 C                                                                                                                                                            |
|--------------------------------------|---------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Light source                         |                     | Miniature lamp 5 V/0.6 W                                                                                                                                                                     |
| Operating voltage                    |                     | 5 V $\pm$ 5 %/120 mA                                                                                                                                                                         |
| Output signals                       | Incremental signals | 2 sinusoidal signals $I_{e1}$ and $I_{e2}$                                                                                                                                                   |
|                                      |                     | $I_{e1}$ <br>$I_{e2}$  |
|                                      | Reference signal    | 1 signal $I_{e0}$                                                                                                                                                                            |
|                                      |                     | $I_{e0}$                                                                                                  |
| Signal levels with 1 k $\Omega$ load |                     | $I_{e1}$ approx. 7 ... 16 $\mu A_{pp}$<br>$I_{e2}$ approx. 7 ... 16 $\mu A_{pp}$<br>$I_{e0}$ approx. 2 ... 8 $\mu A$ (usable portion)                                                        |
| Total permissible cable length       |                     | 20 m (65.6 ft)                                                                                                                                                                               |

# Standard Linear Encoders LS 704, LS 704 C

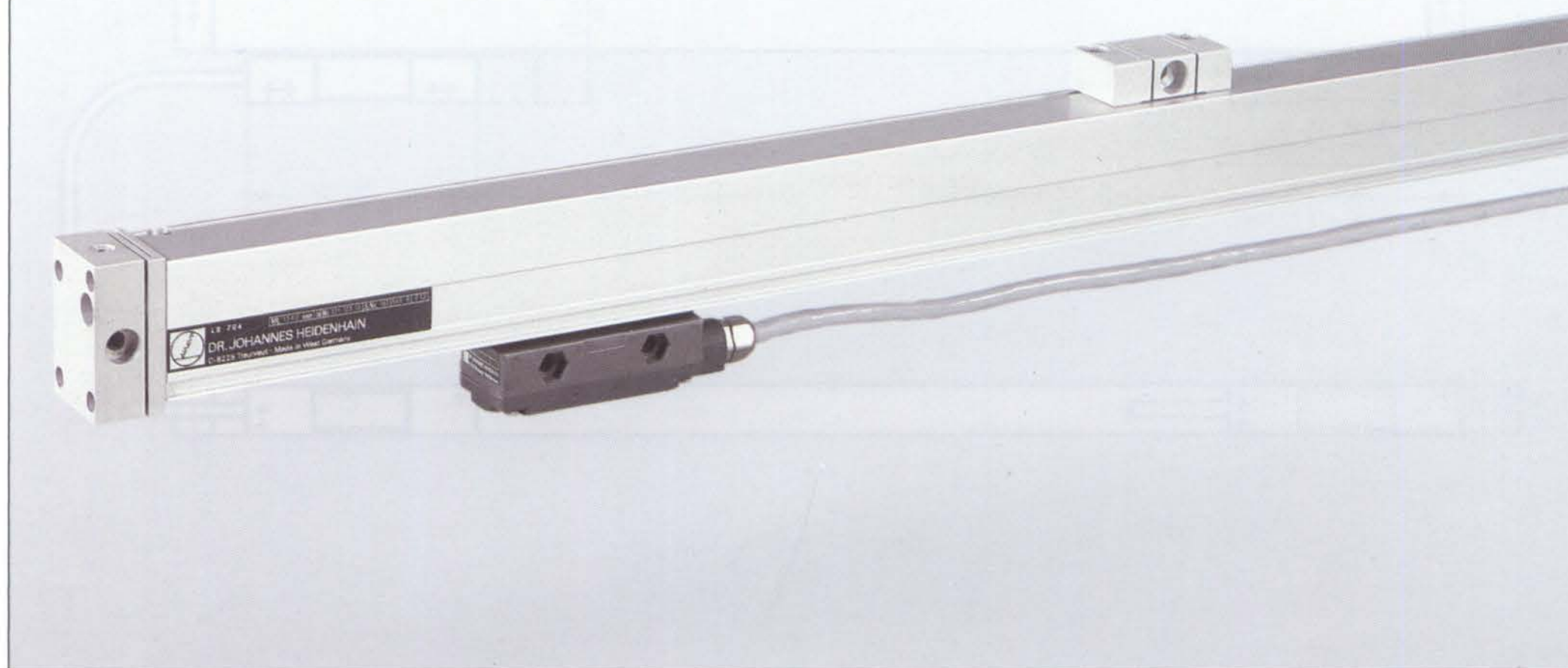
## robust design

Incremental, sealed linear encoders

**Measuring lengths** up to 3040 mm (120.0 in.)

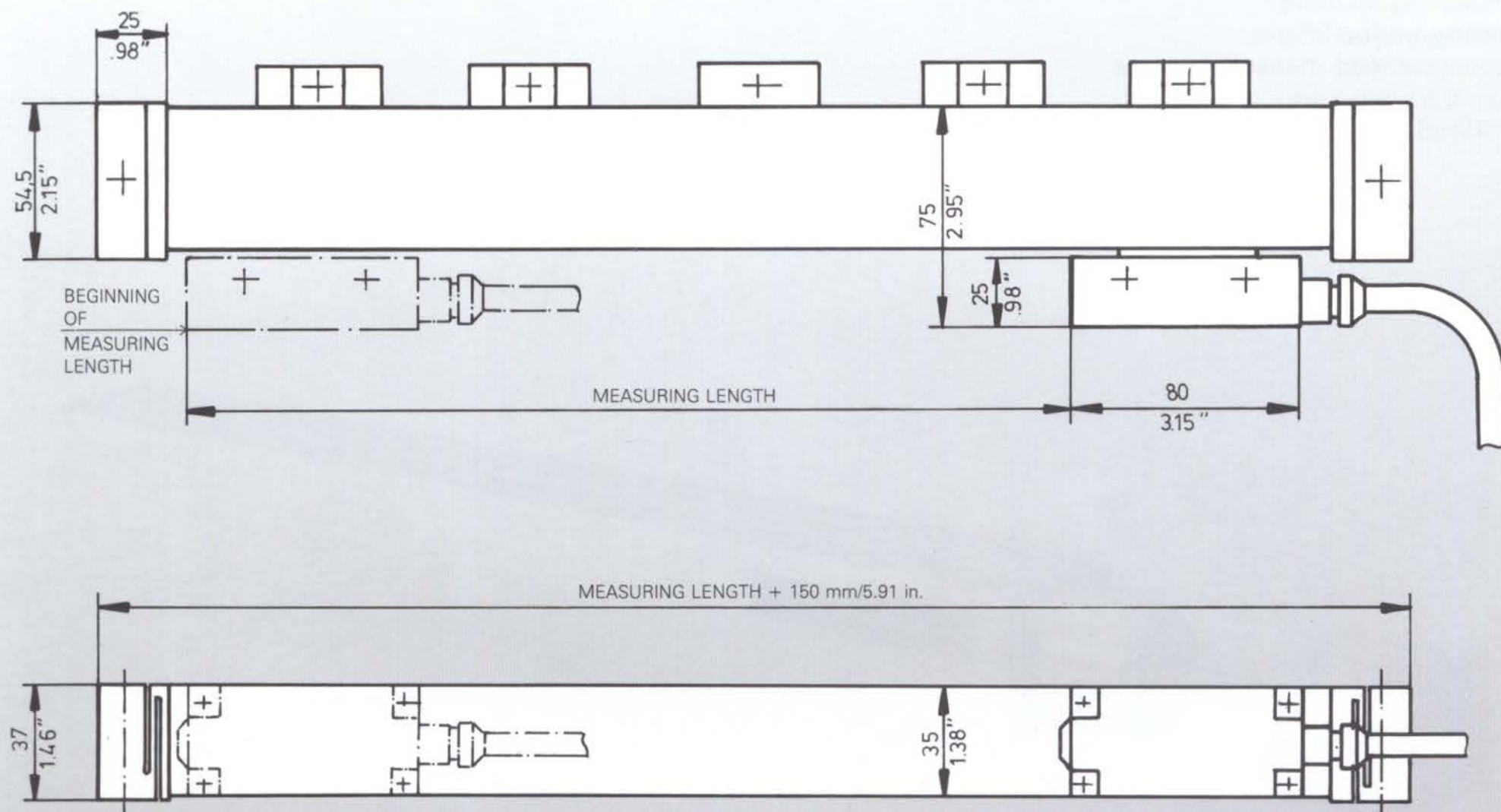
**Grating period** 20  $\mu\text{m}$

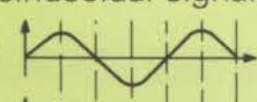
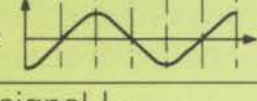
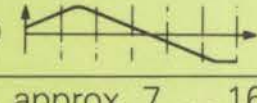
**Recommended measuring steps** 1  $\mu\text{m}$ /0.5  $\mu\text{m}$   
(0.000 05 in./0.000 02 in.)



| Mechanical data                 |          | LS 704, LS 704 C                                                                                                                                                                          |
|---------------------------------|----------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Measuring standard              |          | Glass scale with DIADUR-grating<br>Grating period 20 $\mu\text{m}$                                                                                                                        |
| Accuracy grades                 |          | $\pm 5 \mu\text{m}/\pm 3 \mu\text{m}$ up to 1240 mm (48.8 in.) only ( $\pm 0.00020$ in./ $\pm 0.00012$ in.)                                                                               |
| Reference marks                 | LS 704   | One reference mark at mid-point of measuring length (standard) or several reference marks on 50 mm (2 in.) module from mid-point of measuring length. Further reference marks on request  |
|                                 | LS 704 C | distance-coded reference marks                                                                                                                                                            |
| Measuring lengths               | mm       | 170/220/270/320/370/420/470/520/620/720/770/820/920/1020/1140/1240/1340/1440/1540/1640/1740/1840/2040/2240/2440/2640/2840/3040                                                            |
|                                 | inch     | 6.7/8.6/10.6/12.6/14.5/16.5/18.5/20.5/24.4/28.3/30.3/32.3/36.2/40.1/44.9/48.8/52.7/56.7/60.6/64.6/68.5/72.4/80.3/88.2/96.0/104.0/112.0/120.0                                              |
| Max. traversing speed           |          | 48 m/min (160 ft/min)                                                                                                                                                                     |
| Permissible acceleration        |          |                                                                                                                                                                                           |
| Max. vibration (50 ... 2000 Hz) |          | 30 $\text{m/s}^2$                                                                                                                                                                         |
| Max. shock (11 ms)              |          | 200 $\text{m/s}^2$                                                                                                                                                                        |
| Required moving force           |          | $\leq 10 \text{ N}$                                                                                                                                                                       |
| Operating temperature           |          | 0 ... 50°C (32 ... 122°F)                                                                                                                                                                 |
| Storage temperature             |          | -20 ... 70°C (-4 ... 158°F)                                                                                                                                                               |
| Weight                          |          | 0.7 kg + 2 kg/m measuring length (1.54 lb + 1.34 lb/ft)                                                                                                                                   |
| Connecting cable                |          | 3 m (10 ft), with connector (standard);<br>0.3 m (1 ft), with flange socket (male) on mounting block (special type);<br>3 m (10 ft), with armored sheathing with connector (special type) |

Dimensions in mm/inch



| Electrical data   |                                      | LS 704, LS 704 C                                                                                                                                                                                                         |
|-------------------|--------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Light source      |                                      | Miniature lamp 5 V/0.6 W                                                                                                                                                                                                 |
| Operating voltage |                                      | 5 V $\pm$ 5 %/120 mA                                                                                                                                                                                                     |
| Output signals    | Incremental signals                  | 2 sinusoidal signals $I_{e1}$ and $I_{e2}$<br><br> |
|                   | Reference signal                     | 1 signal $I_{e0}$<br>                                                                                                                 |
|                   | Signal levels with 1 k $\Omega$ load | $I_{e1}$ approx. 7 ... 16 $\mu A_{pp}$<br>$I_{e2}$ approx. 7 ... 16 $\mu A_{pp}$<br>$I_{e0}$ approx. 2 ... 8 $\mu A$ (usable portion)                                                                                    |
|                   | Total permissible cable length       | 20 m (65.6 ft)                                                                                                                                                                                                           |

# Completely Sealed Linear Encoders

## ULS 300, ULS 300 C

Incremental, completely encapsulated  
linear encoder with push-rod activation  
2 mounting attitudes

**Grating period** 20  $\mu\text{m}$

**Recommended measuring steps**

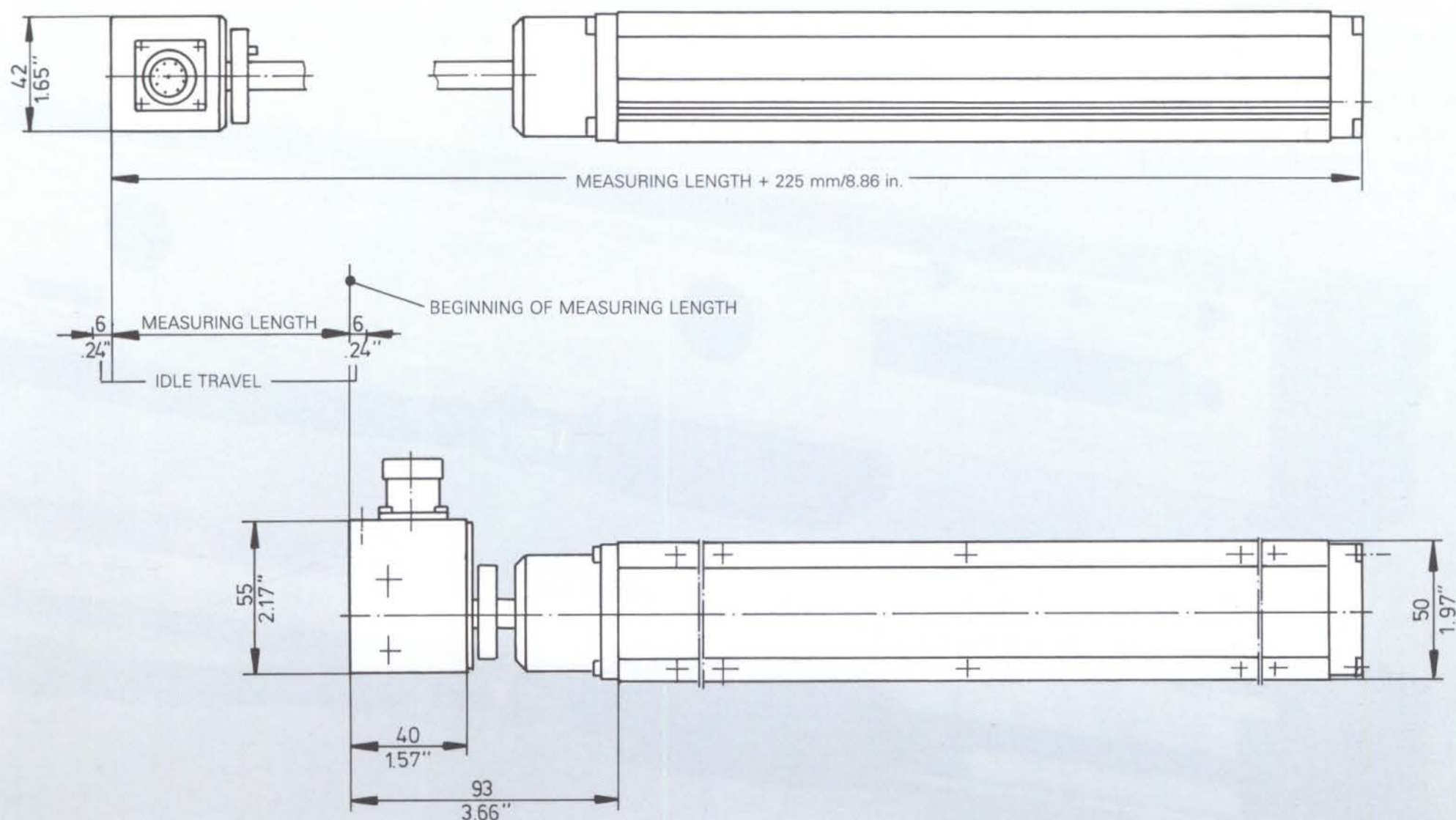
1  $\mu\text{m}$ /0.5  $\mu\text{m}$ /0.2  $\mu\text{m}$

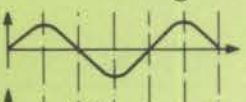
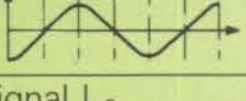
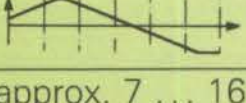
(0.000 05 in./0.000 02 in./0.000 01 in.)



| Mechanical data                               |           | ULS 300, ULS 300 C                                                                                                                                                                                      |
|-----------------------------------------------|-----------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Measuring standard                            |           | Glass scale with DIADUR-grating<br>Grating period 20 $\mu\text{m}$                                                                                                                                      |
| Accuracy grades                               |           | $\pm 3 \mu\text{m}$ ( $\pm 0.00012$ in.)/2 $\mu\text{m}$ ( $\pm 0.00008$ in.) measuring lengths 170 mm (6.7 in.) and 270 mm (10.6 in.) only                                                             |
| Reference mark                                | ULS 300   | Standard: one reference mark at mid-point of traverse or several reference marks on 50 mm (2 in.) module from mid-point of measuring length<br>Special type: one reference mark at any desired location |
|                                               | ULS 300 C | distance-coded                                                                                                                                                                                          |
| Measuring lengths                             | mm        | 170/270/370/520                                                                                                                                                                                         |
|                                               | inch      | 6.7/10.6/14.5/20.5                                                                                                                                                                                      |
| Max. traversing speed                         |           | 30 m/min (100 ft/min)                                                                                                                                                                                   |
| Permissible acceleration                      |           |                                                                                                                                                                                                         |
| max. vibration (50 ... 2000 Hz)               |           | 30 $\text{m/s}^2$                                                                                                                                                                                       |
| max. shock (11 ms)                            |           | 200 $\text{m/s}^2$                                                                                                                                                                                      |
| Required moving force                         |           | 1 ... 3 N                                                                                                                                                                                               |
| Permissible guideway error of connected slide |           | $\pm 0.5$ mm ( $\pm 0.02$ in.)                                                                                                                                                                          |
| Operating temperature                         |           | 0 ... 50°C (32 ... 122°F)                                                                                                                                                                               |
| Storage temperature                           |           | -20 ... 70°C (-4 ... 158°F)                                                                                                                                                                             |
| Weight                                        |           | 1.25 kg (2.75 lb) + 0.15 kg/100 mm (1.0 lb/ft) measuring length                                                                                                                                         |

Dimensions in mm/inch



| Electrical data                      |                     | ULS 300, ULS 300 C                                                                                                                                                                           |
|--------------------------------------|---------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Light source                         |                     | LED                                                                                                                                                                                          |
| Operating voltage                    |                     | 5 V $\pm$ 5 %/120 mA                                                                                                                                                                         |
| Output signals                       | Incremental signals | 2 sinusoidal signal $I_{e1}$ and $I_{e2}$                                                                                                                                                    |
|                                      |                     | $I_{e1}$ <br>$I_{e2}$  |
|                                      | Reference signal    | 1 signal $I_{e0}$                                                                                                                                                                            |
|                                      |                     | $I_{e0}$                                                                                                  |
| Signal levels with 1 k $\Omega$ load |                     | $I_{e1}$ approx. 7 ... 16 $\mu A_{pp}$<br>$I_{e2}$ approx. 7 ... 16 $\mu A_{pp}$<br>$I_{e0}$ approx. 2 ... 8 $\mu A$ (usable portion)                                                        |
| Total permissible cable length       |                     | 20 m (65.6 ft)                                                                                                                                                                               |

# Sealed Linear Encoder for large traverses LB 326 with machine error compensation

Incremental, sealed linear encoder with **steel tape scale**.

2 mounting attitudes

**Measuring lengths** up to 30 m (98.4 ft)

Single length steel tape up to 30 m (98.4 ft)

Scale housing in sections (single housing)

Single completely assembled systems up to 3040 mm (120.0 in.)

**Grating period** 100  $\mu\text{m}$

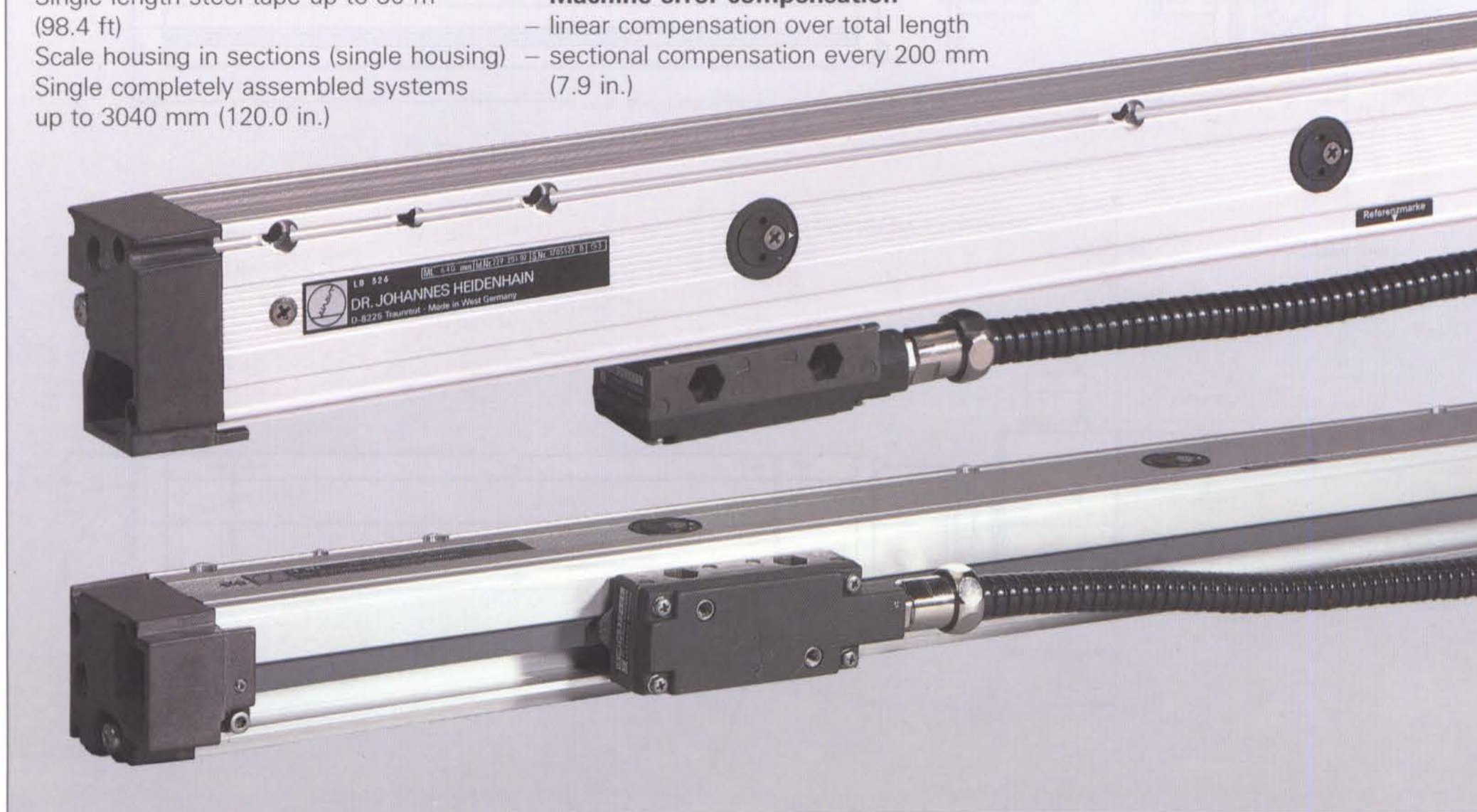
**Recommended measuring steps**

1  $\mu\text{m}$  (0.00005 in.)

**Reference marks** every 50 mm/2 in. via selector magnets

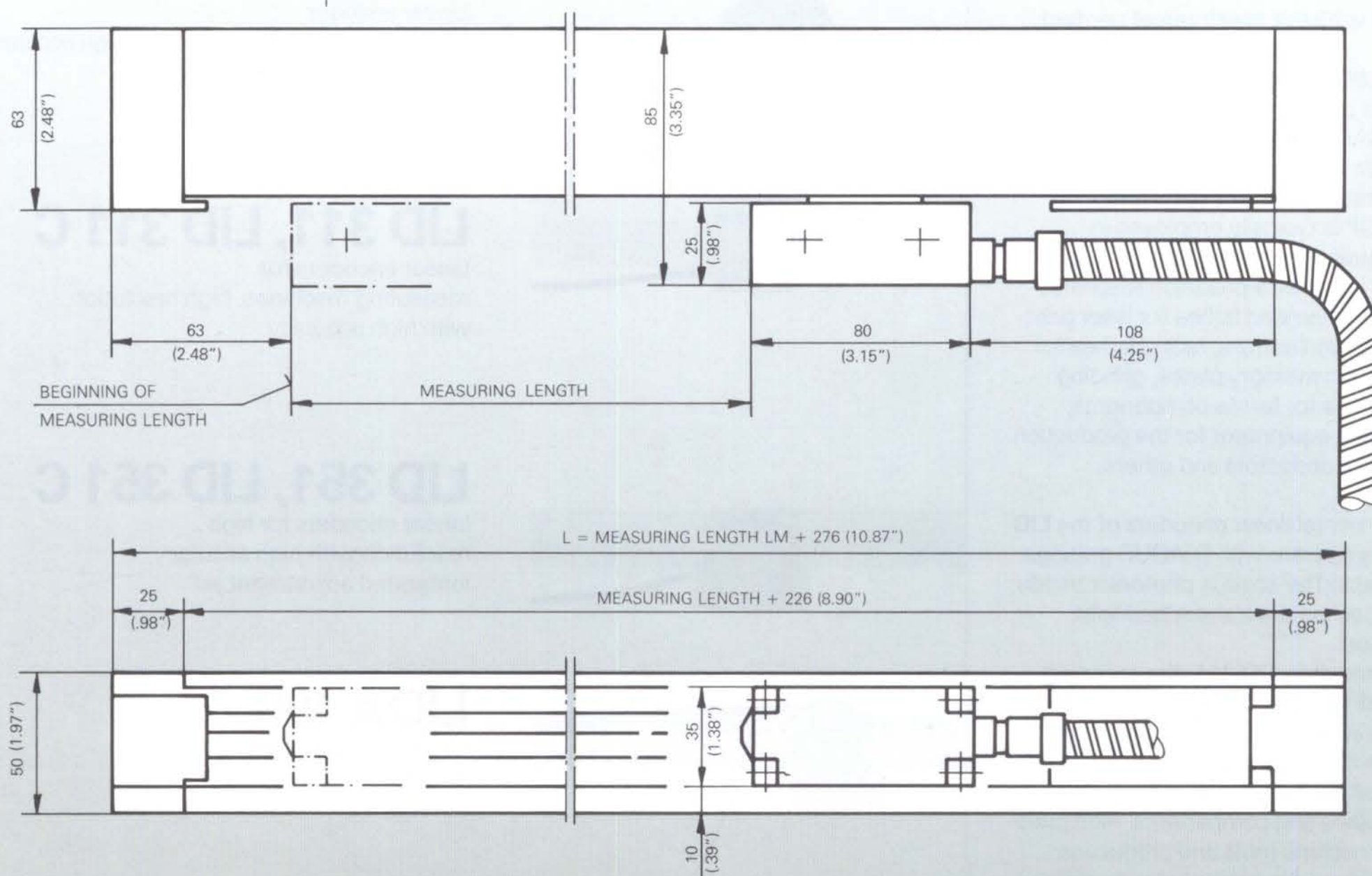
**Machine error compensation**

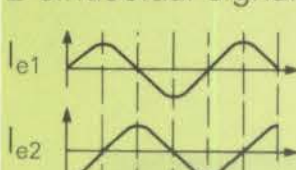
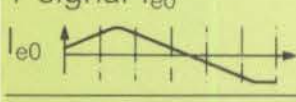
- linear compensation over total length
- sectional compensation every 200 mm (7.9 in.)



| Mechanical data                 |            | LB 326                                                                                                                                                                                                                                                                                                                                                                                                                    |
|---------------------------------|------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Measuring standard              |            | Stainless steel tape scale with AURODUR-grating<br>Grating period 100 $\mu\text{m}$                                                                                                                                                                                                                                                                                                                                       |
| Accuracy grades                 |            | <ul style="list-style-type: none"> <li>• single system (up to 3040 mm/120.0 in.) <math>\pm 5 \mu\text{m}</math> with <math>\pm 2 \mu\text{m}/200 \text{ mm}</math> (<math>\pm 0.00020 \text{ in.}</math> <math>\pm 0.00008 \text{ in.}/7.9 \text{ in.}</math>)</li> <li>• multi-section system (over 3040 mm/120 in.) <math>\pm 5 \mu\text{m}</math> (<math>\pm 0.00020 \text{ in.}</math>)</li> </ul>                    |
| Machine error compensation      |            | 1) with tape tensioning screw; range max. $\pm 100 \mu\text{m}/\text{m}$ ( $\pm 100 \text{ ppm}$ )<br>2) by setting correction discs (every 200 mm, 7.9 in.);<br>range $\pm 20 \mu\text{m}$ (0.0008 in.) per meas. length, max. $\pm 10 \mu\text{m}/200 \text{ mm}$ ( $\pm 50 \text{ ppm}$ )                                                                                                                              |
| Reference marks                 |            | every 50 mm/2 in. (selector magnets)                                                                                                                                                                                                                                                                                                                                                                                      |
| Measuring lengths               | mm<br>inch | Single completely assembled systems:<br>440/640/840/1040/1240/1440/1640/1840/2040/2240/2440/2640/2840/3040<br>17.3/25.2/33.0/41.0/48.8/56.7/64.6/72.4/80.3/88.2/96.0/104.0/112.0/120.0<br>Kit comprising single-length AURODUR scale and housing section lengths for measuring lengths up to 30 000 mm (98.4 ft)<br>Housing section lengths: 1000, 1200, 1400, 1600, 1800 and 2000 mm (39.4/47.2/55.1/63.0/70.9/78.7 in.) |
| Max. traversing speed           |            | 60 m/min (200 ft/min)                                                                                                                                                                                                                                                                                                                                                                                                     |
| Permissible acceleration        |            |                                                                                                                                                                                                                                                                                                                                                                                                                           |
| Max. vibration (50 ... 2000 Hz) |            | 60 $\text{m/s}^2$                                                                                                                                                                                                                                                                                                                                                                                                         |
| Max. shock (11 ms)              |            | 1000 $\text{m/s}^2$ for measuring lengths up to 3040 mm (120.0 in.)<br>400 $\text{m/s}^2$ for measuring lengths over 3040 mm (120.0 in.)                                                                                                                                                                                                                                                                                  |
| Required moving force           |            | $\leq 15 \text{ N}$                                                                                                                                                                                                                                                                                                                                                                                                       |
| Operating temperature           |            | 0 ... 45°C (32 ... 113°F)                                                                                                                                                                                                                                                                                                                                                                                                 |
| Storage temperature             |            | -20 ... 70°C (-4 ... 158°F)                                                                                                                                                                                                                                                                                                                                                                                               |
| Weight                          |            | 1.8 kg + 3.3 kg/m measuring length (4.0 lb + 2.2 lb/ft)                                                                                                                                                                                                                                                                                                                                                                   |
| Connecting cable                |            | 3 m (10 ft), with connector and armored sheathing (standard);<br>0.5 m (1.7 ft), with connector (special type);<br>1.5 m (5 ft), without connector (special type)                                                                                                                                                                                                                                                         |

Dimensions in mm (inch) 



| Electrical data                                                                       |                     | LB 326                                                                                                                                |
|---------------------------------------------------------------------------------------|---------------------|---------------------------------------------------------------------------------------------------------------------------------------|
| Light source                                                                          |                     | LED                                                                                                                                   |
| Operating voltage for light source and switching circuit for reference mark selection |                     | 5 V $\pm$ 5 %/140 mA                                                                                                                  |
| Output signals                                                                        | Incremental signals | 2 sinusoidal signals $I_{e1}$ and $I_{e2}$                                                                                            |
|                                                                                       |                     |                                                   |
|                                                                                       | Reference signal    | 1 signal $I_{e0}$                                                                                                                     |
|                                                                                       |                     |                                                   |
| Signal levels with 1 k $\Omega$ load                                                  |                     | $I_{e1}$ approx. 7 ... 16 $\mu A_{pp}$<br>$I_{e2}$ approx. 7 ... 16 $\mu A_{pp}$<br>$I_{e0}$ approx. 2 ... 8 $\mu A$ (usable portion) |
| Total permissible cable length                                                        |                     | 20 m (65.6 ft)                                                                                                                        |

# "Exposed" Linear Encoders

On exposed linear encoders the scale is unprotected. The scanning takes place **without mechanical contact**.

The **LIP 101** linear encoder operates with a phase grating applied to steel in the GALVADUR process. A glass lamella secured with cement protects the grating from contamination. The LIP is typically employed in measuring machines, measuring microscopes, ultra-precision machines such as diamond lathes for laser printing polygon mirrors, facing lathes for magnetic memory plates, grinding machines for ferrite components, masking equipment for the production of semiconductors and others.

Incremental linear encoders of the **LID series** operate with DIADUR gratings on glass. The scale is photoelectrically scanned via the transmitted light method.

In contrast to LID 311, the scanning unit of the LID 351 includes an adjustment aid which enables easy installation with less expense.

Typical applications are measuring machines and comparators, high precision machine tools and production machinery, for example for semiconductor manufacture.

Incremental linear encoders of the **LIDA series** operate with AURODUR gratings on steel. The scale is photoelectrically scanned via the reflected light method.

LIDA 190 and LIDA 201 have grating periods of 40  $\mu\text{m}$  and 100  $\mu\text{m}$ , respectively. The electronic interpolation must therefore be greater for the LIDA 201 than for the LIDA 190 in order to achieve a certain measuring step. However the tolerances for the clearance between scale and scanning unit on the LIDA 190 are considerably smaller.

The quality of the machine guide is therefore of utmost importance in deciding which of the two units to employ.

Typical applications are coordinate measuring machines, test equipment, type setting machines, automatic component insertion machines, PCB drilling machines, precision handling equipment and others.



## LIP 101

Linear encoder  
for highest resolution with very high accuracy  
for ultra precision machines



## LID 311, LID 311 C

Linear encoders for  
measuring machines, high resolution  
with high accuracy



## LID 351, LID 351 C

Linear encoders for high  
resolution with high accuracy,  
integrated adjustment aid



## LIDA 190

Linear encoder with  
reference mark positions  
as required



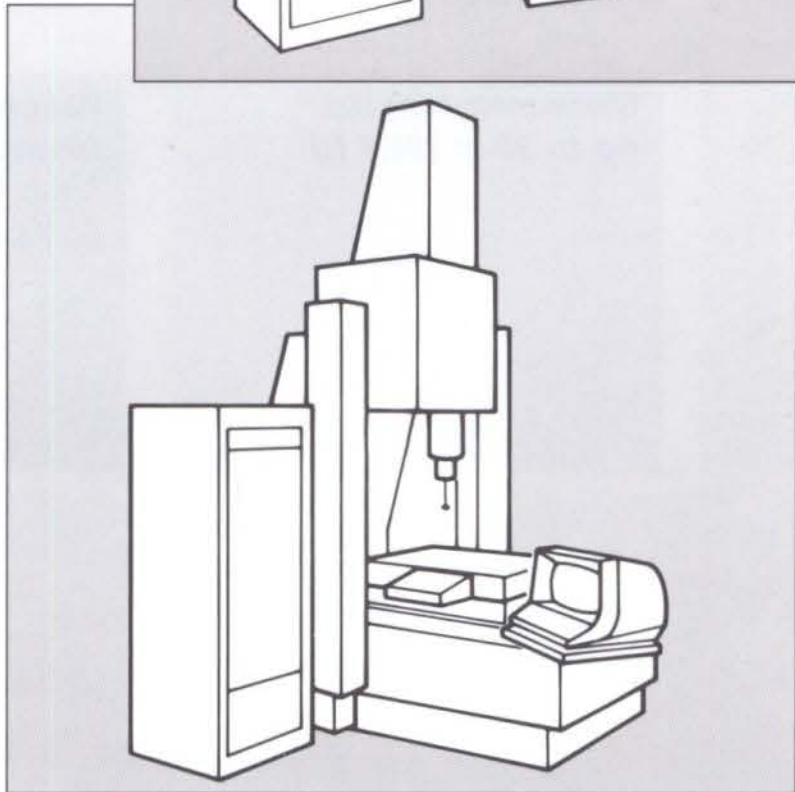
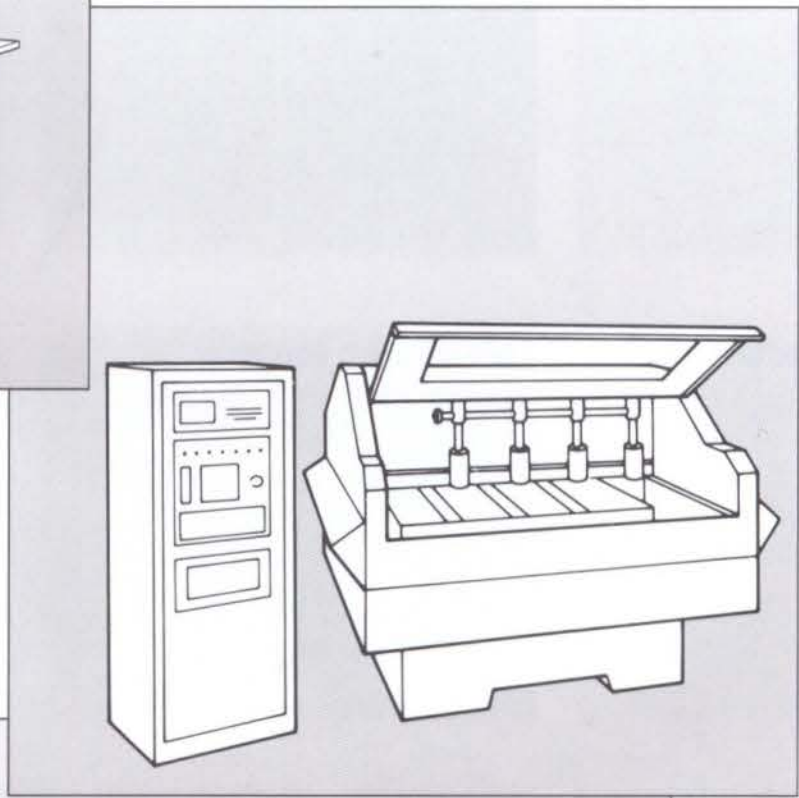
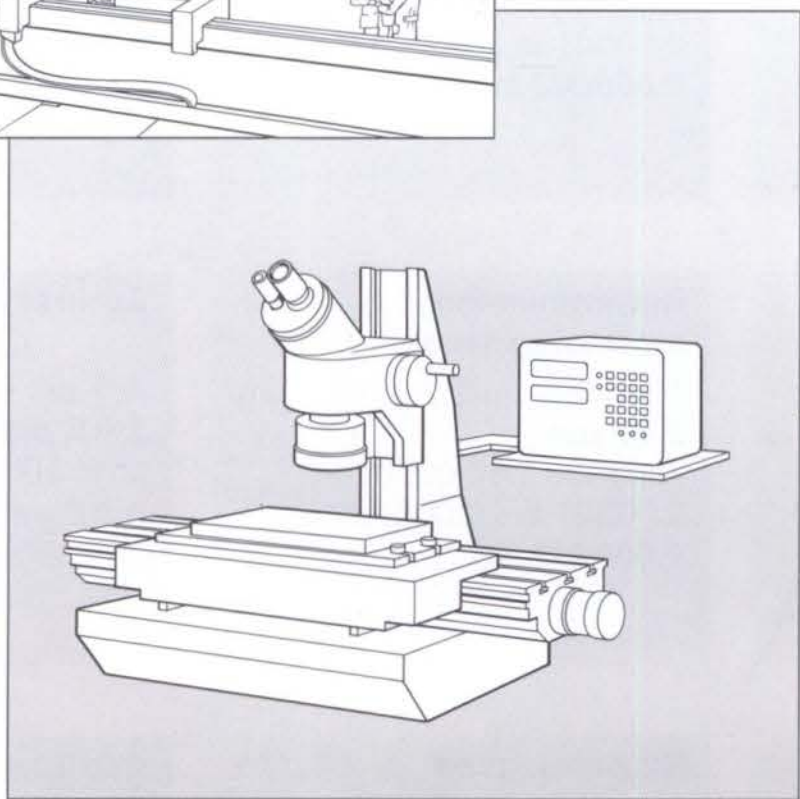
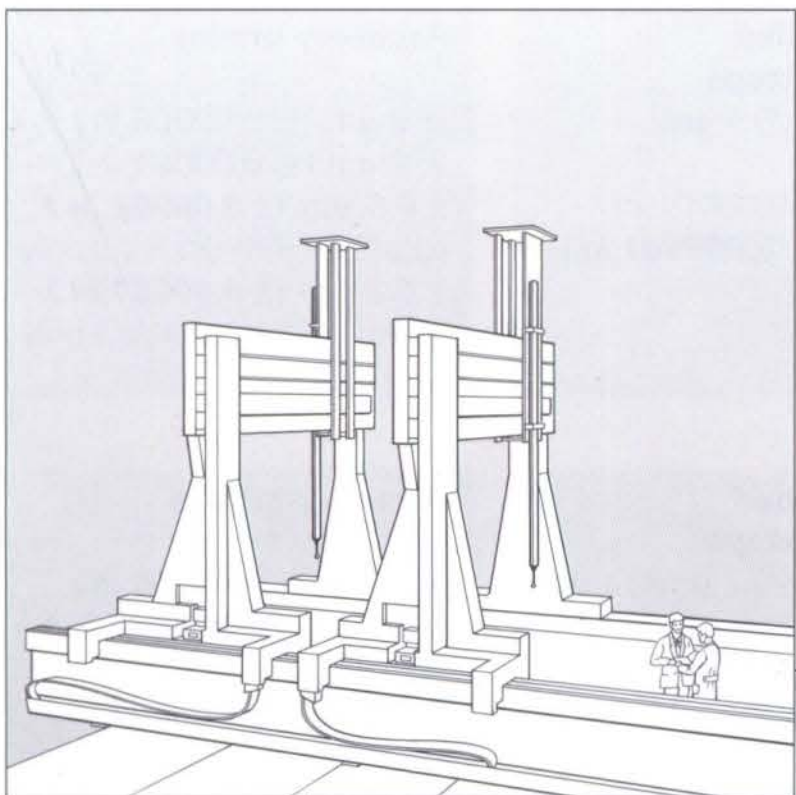
## LIDA 201

Linear encoder with  
large installation tolerances



## LIDA 225

Linear encoder  
for large traverses  
with linear machine error  
compensation



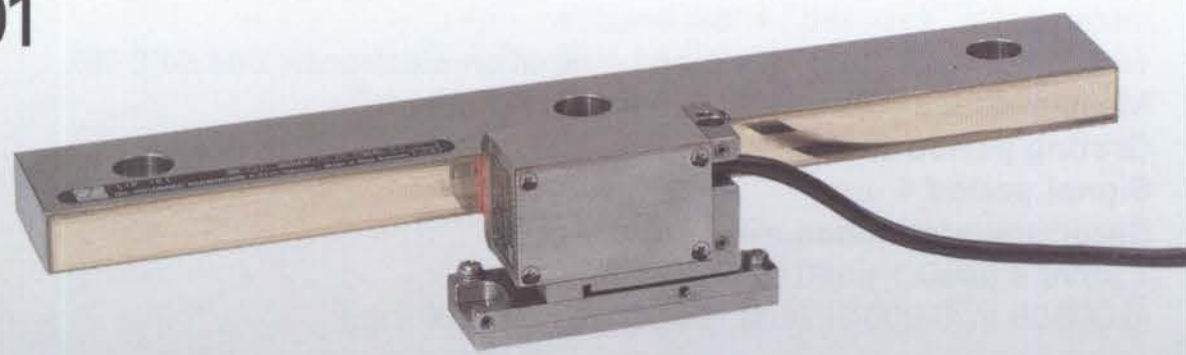
# "Exposed" Linear Encoders

|                                                      |                                                      |                                                                                                                                                                                                                                              |                                                                                                                                                                                                                                                                                                                                   |
|------------------------------------------------------|------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Measuring standard</b><br>GALVADUR<br>steel scale | <b>Measuring lengths</b><br>up to 1020 mm (40.1 in.) | <b>Recommended measuring steps</b><br>1 $\mu\text{m}$ /0.2 $\mu\text{m}$ /0.1 $\mu\text{m}$ /<br><b>0.02 <math>\mu\text{m}</math></b><br>(0.00005 in./0.00001 in./<br>0.000005 in./ <b>0.000001 in.</b> )                                    | <b>Accuracy grades</b><br>$\pm 2 \mu\text{m}$ ( $\pm 0.00008$ in.)<br>$\pm 1 \mu\text{m}$ ( $\pm 0.00004$ in.)<br><b><math>\pm 0.5 \mu\text{m}</math> (<math>\pm 0.00002</math> in.)</b><br>up to 520 mm (20.5 in.) only<br><b><math>\pm 0.2 \mu\text{m}</math> (<math>\pm 0.00001</math> in.)</b><br>up to 220 mm (8.6 in.) only |
| <b>Measuring standard</b><br>DIADUR<br>glass scale   | <b>Measuring lengths</b><br>up to 1500 mm (59.0 in.) | <b>Recommended measuring steps</b><br>1 $\mu\text{m}$ /0.5 $\mu\text{m}$ /0.2 $\mu\text{m}$ /0.1 $\mu\text{m}$ /<br><b>0.05 <math>\mu\text{m}</math></b><br>(0.00005 in./0.00002 in./<br>0.00001 in., 0.000005 in.,<br><b>0.000002 in.</b> ) | <b>Accuracy grades</b><br>$\pm 1 \mu\text{m}$ ( $\pm 0.00004$ in.)<br><b><math>\pm 0.5 \mu\text{m}</math> (<math>\pm 0.00002</math> in.)</b><br>up to 500 mm (19.7 in.) only<br><b><math>\pm 0.2 \mu\text{m}</math> (<math>\pm 0.00001</math> in.)</b><br>up to 200 mm (7.9 in.) only                                             |
| <b>Measuring standard</b><br>DIADUR<br>glass scale   | <b>Measuring lengths</b><br>up to 1500 mm (59.0 in.) | <b>Recommended measuring steps</b><br>1 $\mu\text{m}$ /0.5 $\mu\text{m}$ /0.2 $\mu\text{m}$ /0.1 $\mu\text{m}$ /<br><b>0.05 <math>\mu\text{m}</math></b><br>(0.00005 in./0.00002 in./<br>0.00001 in., 0.000005 in.,<br><b>0.000002 in.</b> ) | <b>Accuracy grades</b><br>$\pm 1 \mu\text{m}$ ( $\pm 0.00004$ in.)<br><b><math>\pm 0.5 \mu\text{m}</math> (<math>\pm 0.00002</math> in.)</b><br>up to 500 mm (19.7 in.) only<br><b><math>\pm 0.2 \mu\text{m}</math> (<math>\pm 0.00001</math> in.)</b><br>up to 200 mm (7.9 in.) only                                             |
| <b>Measuring standard</b><br>AURODUR<br>steel scale  | <b>Measuring lengths</b><br>up to 2040 mm (80.3 in.) | <b>Recommended measuring step</b><br>1 $\mu\text{m}$<br>(0.00005 in.)                                                                                                                                                                        | <b>Accuracy grades</b><br>$\pm 5 \mu\text{m}$ ( $\pm 0.00020$ in.)<br>$\pm 3 \mu\text{m}$ ( $\pm 0.00012$ in.)                                                                                                                                                                                                                    |
| <b>Measuring standard</b><br>AURODUR<br>steel scale  | <b>Measuring lengths</b><br>up to 30 m (98.4 ft)     | <b>Recommended measuring step</b><br>1 $\mu\text{m}$<br>(0.00005 in.)                                                                                                                                                                        | <b>Accuracy grade</b><br>$\pm 5 \mu\text{m}$ ( $\pm 0.00020$ in.)                                                                                                                                                                                                                                                                 |

- Clearance between scale and scanning head  $1 \pm 0.5 \text{ mm}$  ( $0.039 \pm 0.02 \text{ in.}$ )

## LIP 101

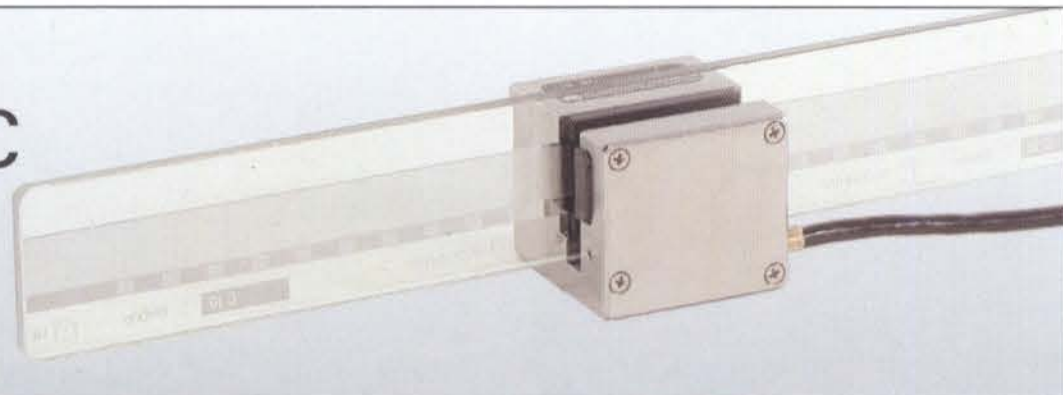
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- Clearance between scale and scanning head  $0.095 \pm 0.015 \text{ mm}$  ( $0.0037 \pm 0.0006 \text{ in.}$ )
- LID 311 C: distance-coded reference marks

## LID 311 LID 311 C

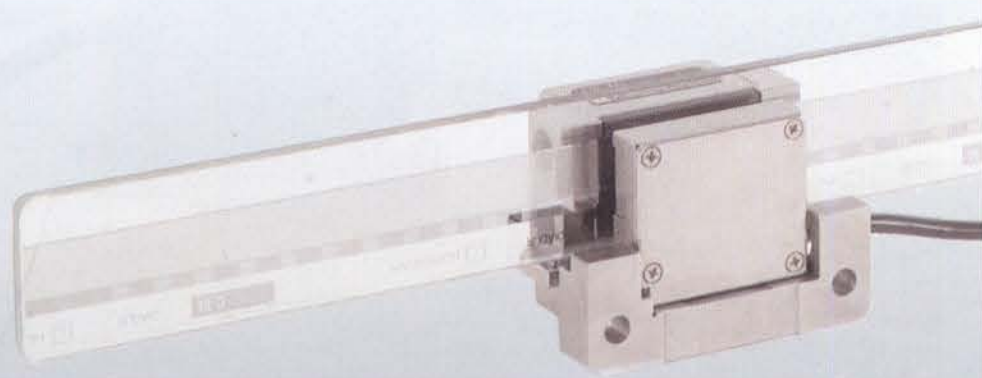
Page 34



- Clearance between scale and scanning head  $0.095 \pm 0.015 \text{ mm}$  ( $0.0037 \pm 0.0006 \text{ in.}$ )
- *Easy installation with integrated adjustment aid*
- LID 350 C: distance-coded reference marks

## LID 351 LID 351 C

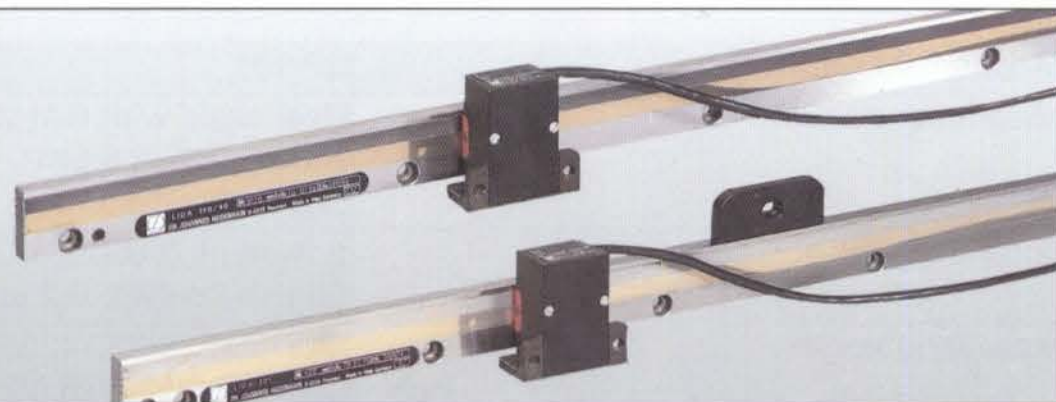
Page 36



- LIDA 190: Clearance between scale and scanning head  $0.1 \pm 0.05 \text{ mm}$  ( $0.0039 \pm 0.0020 \text{ in.}$ )
- reference mark positions as required
- LIDA 201: Large installation tolerances. Clearance between scale and scanning head  $0.8 \pm 0.2 \text{ mm}$  ( $0.031 \pm 0.008 \text{ in.}$ )

## LIDA 190 LIDA 201

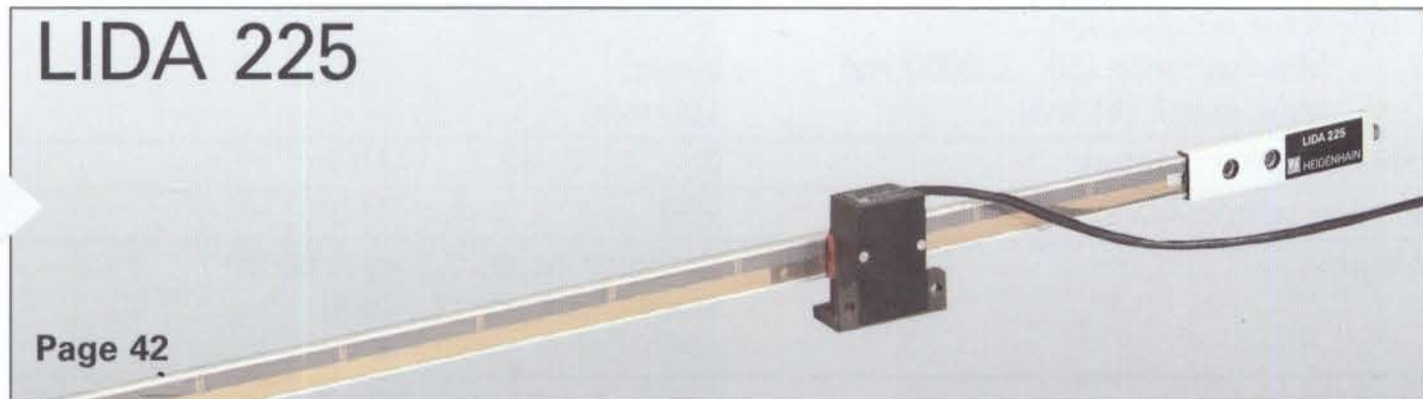
Page 38 and 40



- *Compensation of linear machine errors by tape tensioning*
- Clearance between scale and scanning head  $0.2 \pm 0.05 \text{ mm}$  ( $0.008 \pm 0.002 \text{ in.}$ )

## LIDA 225

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# "Exposed" Linear Encoder LIP 101 for very high resolutions with high accuracy

Incremental "exposed" linear encoder  
with GALVADUR steel scale and evaluation electronics unit APE 101

**Measuring lengths** up to 1020 mm (40.1 in.)

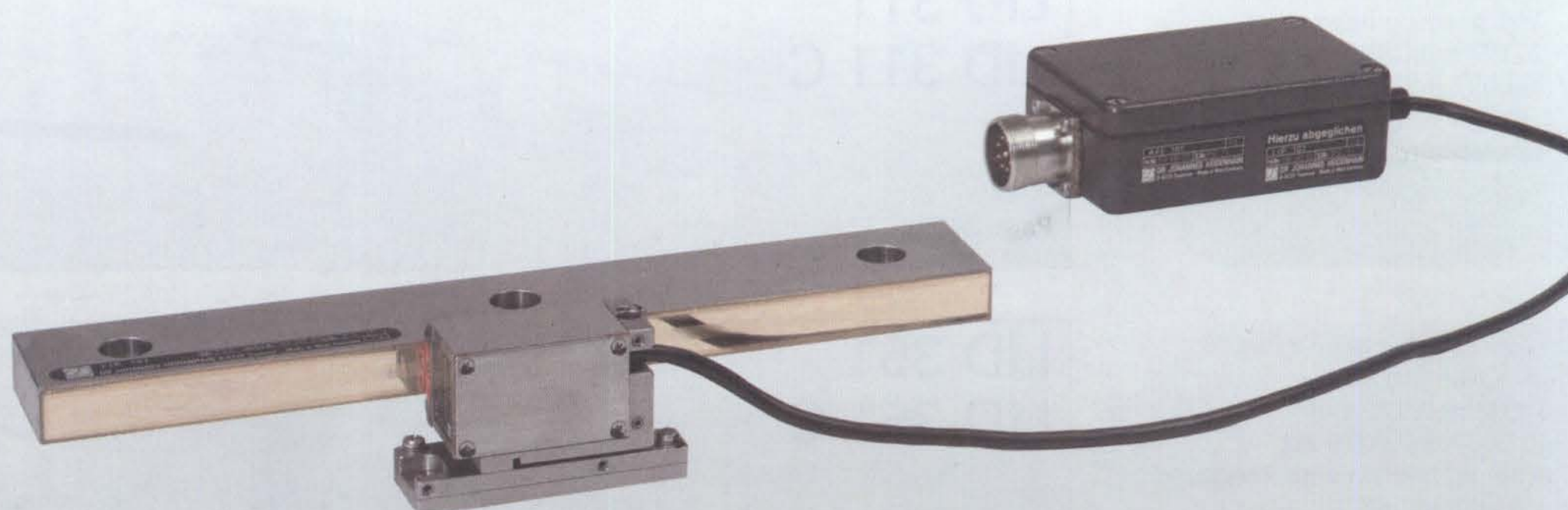
**Grating period** 8  $\mu\text{m}$

**Signal period** 4  $\mu\text{m}$

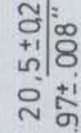
**Recommended measuring steps**

1  $\mu\text{m}$ /0.2  $\mu\text{m}$ /0.1  $\mu\text{m}$ /0.02  $\mu\text{m}$

(0.00005 in./0.00001 in./0.000005 in./0.000001 in.)



| Mechanical data                 |            | LIP 101                                                                                                                                                                                                                             |
|---------------------------------|------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Measuring standard              |            | Steel scale with GALVADUR-grating<br>Grating period 8 $\mu\text{m}$<br>Signal period 4 $\mu\text{m}$                                                                                                                                |
| Accuracy grades                 |            | $\pm 2 \mu\text{m}$ ( $\pm 0.00008$ in.)/ $\pm 1 \mu\text{m}$ ( $\pm 0.00004$ in.)/ $\pm 0.5 \mu\text{m}$ ( $\pm 0.00002$ in.) up to 520 mm (20.5 in.) only/ $\pm 0.2 \mu\text{m}$ ( $\pm 0.00001$ in.) up to 220 mm (8.6 in.) only |
| Measuring lengths               | mm<br>inch | 120/170/220/320/420/520/620/720/820/920/1020<br>4.7/6.7/8.6/12.6/16.5/20.5/24.4/28.3/32.3/36.2/40.1                                                                                                                                 |
| Max. traversing speed           |            | depends on subsequent electronics                                                                                                                                                                                                   |
| Permissible acceleration        |            |                                                                                                                                                                                                                                     |
| Max. vibration (50 ... 2000 Hz) |            | 8 m/s <sup>2</sup>                                                                                                                                                                                                                  |
| Max. shock (11 ms)              |            | 100 m/s <sup>2</sup>                                                                                                                                                                                                                |
| Operating temperature           |            | 0 ... 45°C (32 ... 113°F)                                                                                                                                                                                                           |
| Storage temperature             |            | -20 ... 70°C (-4 ... 158°F)                                                                                                                                                                                                         |
| Weight                          |            | Scanning head: 0.3 kg (0.66 lb)<br>Scale: 4.5 kg/m (3.0 lb/ft)<br>APE 101: 0.3 kg (0.66 lb)                                                                                                                                         |
| Connecting cable                |            | 0.5 m (1.7 ft) cable between scanning head and APE 101<br>Flange socket (9 pole) on APE 101                                                                                                                                         |

LIP 101

# "Exposed" Linear Encoders (transmitted light)

## LID 311, LID 311 C for high resolution with high accuracy

Incremental "exposed" linear encoder  
with DIADUR glass scale

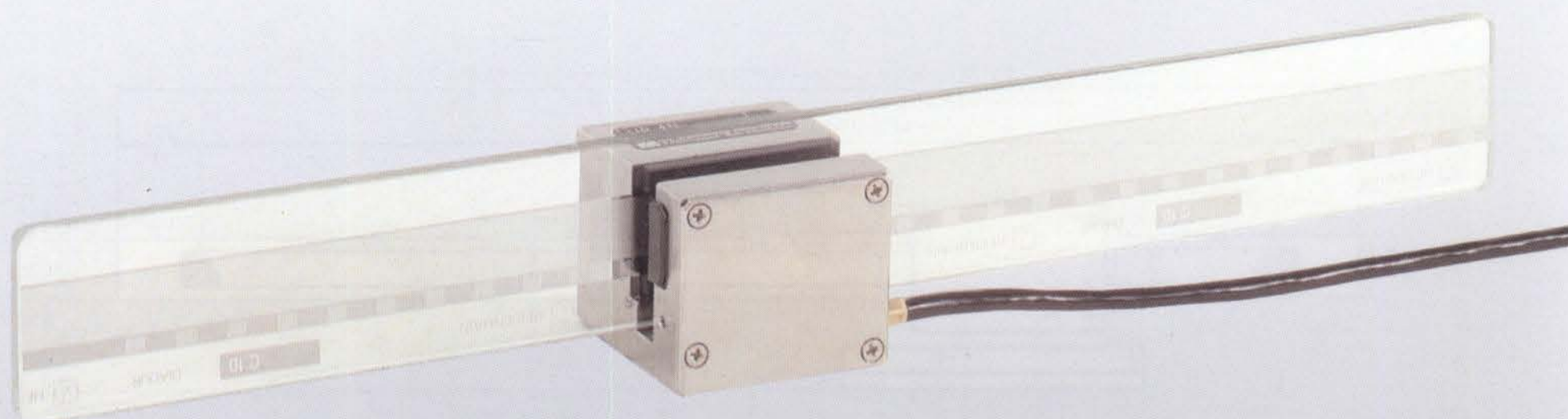
**Measuring lengths** up to 1500 mm  
(59.0 in.)

**Grating period** 10  $\mu\text{m}$

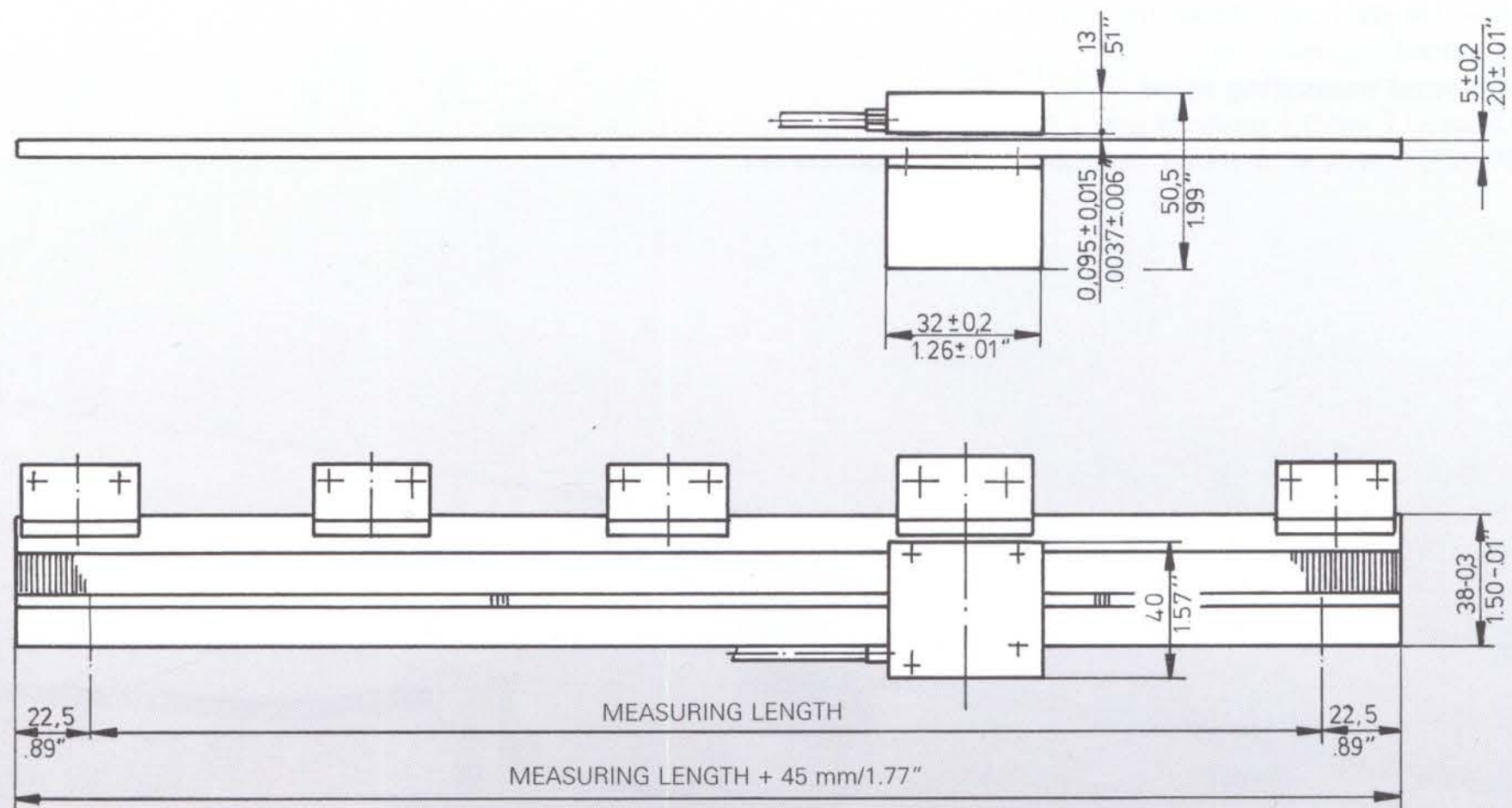
**Recommended measuring steps**

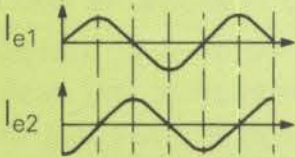
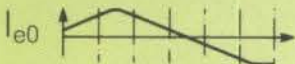
1  $\mu\text{m}$ /0.5  $\mu\text{m}$ /0.2  $\mu\text{m}$ /0.1  $\mu\text{m}$ /0.05  $\mu\text{m}$

(0.00005 in./0.00002 in./0.00001 in./0.000005 in./0.000002 in.)



| Mechanical data                 |           | LID 311, LID 311 C                                                                                                                                                                                                  |
|---------------------------------|-----------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Measuring standard              |           | Glass scale with DIADUR-grating<br>Grating period 10 $\mu\text{m}$                                                                                                                                                  |
| Accuracy grades                 |           | $\pm 1 \mu\text{m}$ ( $\pm 0.00004$ in.)/ $\pm 0.5 \mu\text{m}$ ( $\pm 0.00002$ in.) up to 500 mm (19.7 in.) meas. length only/ $\pm 0.2 \mu\text{m}$ ( $\pm 0.00001$ in.) up to 200 mm (7.9 in.) meas. length only |
| Reference marks                 | LID 311   | – Standard: one reference mark at mid-point of measuring length<br>– Special type: one reference at any desired location or several reference marks at 20 mm (0.8 in.) spacings or multiples thereof                |
|                                 | LID 311 C | distance-coded                                                                                                                                                                                                      |
| Measuring lengths               | mm        | 50/70/120/170/220/270/320/370/420/470/520/570/620/670/720/770/820/870/920/970/1020/1140/1240/1340/1440/1500                                                                                                         |
|                                 | inch      | 2.0/2.7/4.7/6.7/8.6/10.6/12.6/14.5/16.5/18.5/20.5/22.4/24.4/26.4/28.3/30.3/32.3/36.2/40.1/44.9/48.8/52.7/56.7/59.0                                                                                                  |
| Max. traversing speed           |           | depends on subsequent electronics                                                                                                                                                                                   |
| Permissible acceleration        |           |                                                                                                                                                                                                                     |
| Max. vibration (50 ... 2000 Hz) |           | 8 m/s <sup>2</sup> with resolution 0.5 $\mu\text{m}$ (0.000002 in.) up to 0.5 $\mu\text{m}$ (0.00002 in.)<br>50 m/s <sup>2</sup> with resolution 1 $\mu\text{m}$ (0.00005 in.) and greater                          |
| Max. shock (11 ms)              |           | 100 m/s <sup>2</sup>                                                                                                                                                                                                |
| Operating temperature           |           | 0 ... 50°C (32 ... 122°F)                                                                                                                                                                                           |
| Storage temperature             |           | –20 ... 70°C (–4 ... 158°F)                                                                                                                                                                                         |
| Weight                          |           | Scanning head 0.3 kg (0.66 lb)<br>Scale 0.5 kg/m (0.34 lb/ft)                                                                                                                                                       |
| Connecting cable                |           | 3 m (10 ft), with connector                                                                                                                                                                                         |



| Electrical data   |                                         | LID 311, LID 311 C                                                                                                                                      |
|-------------------|-----------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------|
| Light source      |                                         | LED                                                                                                                                                     |
| Operating voltage |                                         | 5 V $\pm$ 5 %/120 mA                                                                                                                                    |
| Output signals    | Incremental signals                     | 2 sinusoidal signals $I_{e1}$ and $I_{e2}$<br>                       |
|                   | Reference signal                        | 1 signal $I_{e0}$<br>                                                |
|                   | Signal levels with<br>1 k $\Omega$ load | $I_{e1}$ approx. 7 ... 16 $\mu\text{A}_{pp}$<br>$I_{e2}$ approx. 7 ... 16 $\mu\text{A}_{pp}$<br>$I_{e0}$ approx. 2 ... 8 $\mu\text{A}$ (usable portion) |
|                   | Total permissible cable length          | 20 m (65.6 ft)                                                                                                                                          |

# "Exposed" Linear Encoders (transmitted light)

## LID 351, LID 351 C for high resolution with high accuracy

Incremental "exposed" linear encoders  
with DIADUR glass scale

Easy installation with integrated adjustment aid

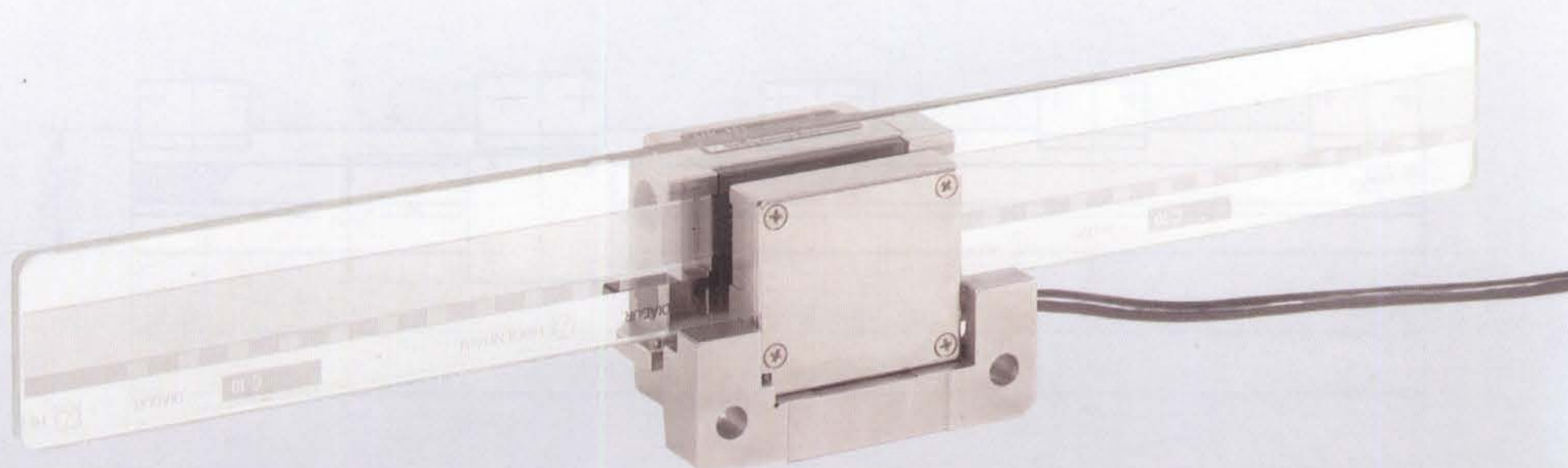
**Measuring lengths** up to 1500 mm (59 in.)

**Grating period** 10  $\mu\text{m}$

**Recommended measuring steps**

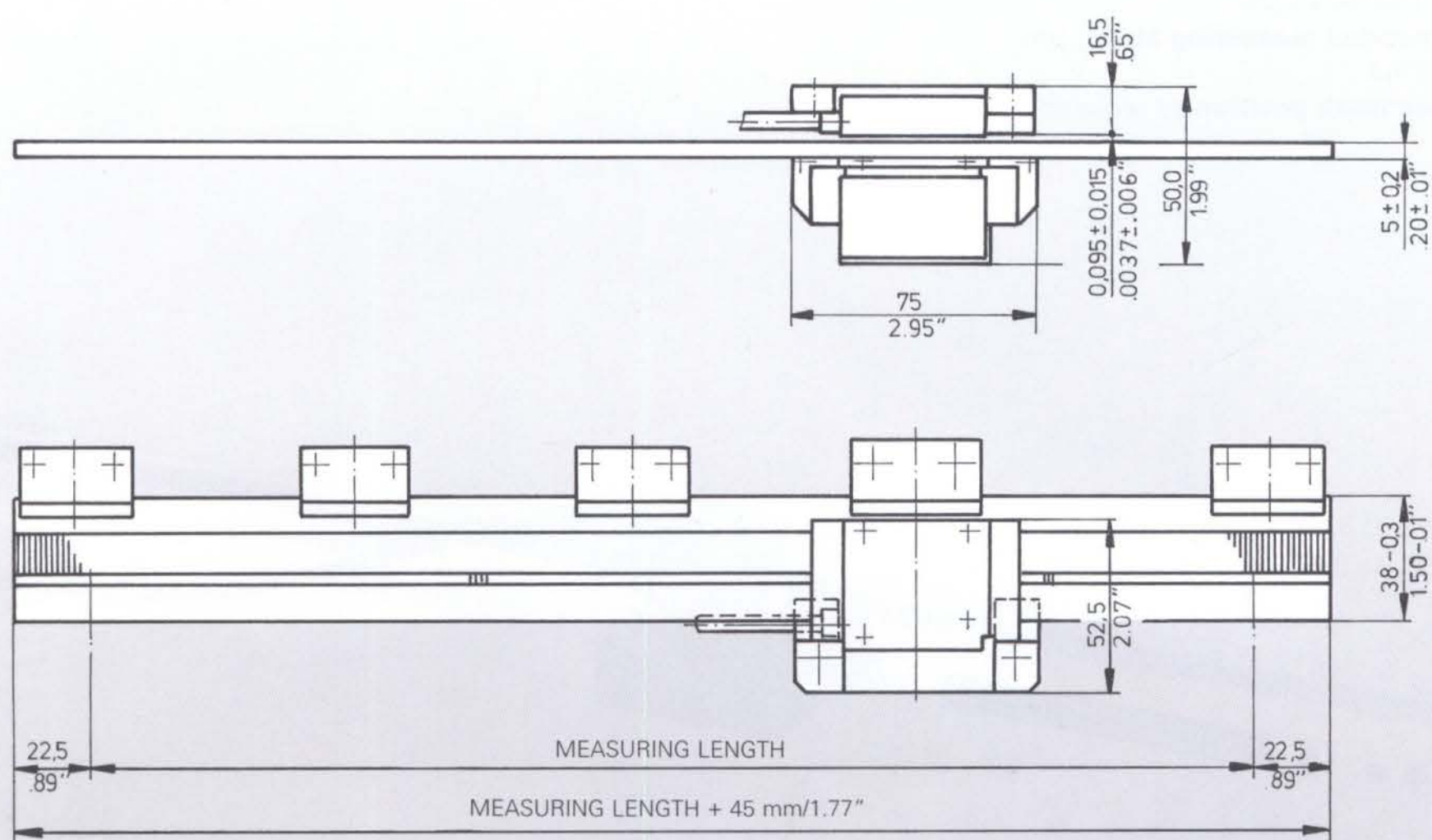
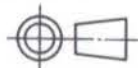
1  $\mu\text{m}$ /0.5  $\mu\text{m}$ /0.2  $\mu\text{m}$ /0.1  $\mu\text{m}$ /0.05  $\mu\text{m}$

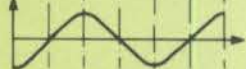
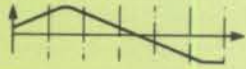
(0.00005 in./0.00002 in./0.00001 in./0.000005 in./0.000002 in.)



| Mechanical data                 |           | LID 351, LID 351 C                                                                                                                                                                                                  |
|---------------------------------|-----------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Measuring standard              |           | Glass scale with DIADUR-grating<br>Grating period 10 $\mu\text{m}$                                                                                                                                                  |
| Accuracy grades                 |           | $\pm 1 \mu\text{m}$ ( $\pm 0.00004$ in.)/ $\pm 0.5 \mu\text{m}$ ( $\pm 0.00002$ in.) up to 500 mm (19.7 in.) meas. length only/ $\pm 0.2 \mu\text{m}$ ( $\pm 0.00001$ in.) up to 200 mm (7.9 in.) meas. length only |
| Reference marks                 | LID 351   | – Standard: one reference mark at mid-point of measuring length<br>– Special type: one reference at any desired location or several reference marks at 20 mm (0.8 in.) spacings or multiples thereof                |
|                                 | LID 351 C | distance-coded                                                                                                                                                                                                      |
| Measuring lengths               | mm        | 50/70/120/170/220/270/320/370/420/470/520/570/620/670/720/770/820/870/920/970/1020/1140/1240/1340/1440/1500                                                                                                         |
|                                 | inch      | 2.0/2.7/4.7/6.7/8.6/10.6/12.6/14.5/16.5/18.5/20.5/22.4/24.4/26.4/28.3/30.3/32.3/36.2/40.1/44.9/48.8/52.7/56.7/59.0                                                                                                  |
| Max. traversing speed           |           | depends on subsequent electronics                                                                                                                                                                                   |
| Permissible acceleration        |           |                                                                                                                                                                                                                     |
| Max. vibration (50 ... 2000 Hz) |           | 8 m/s <sup>2</sup> with resolution 0.05 $\mu\text{m}$ (0.000002 in.) up to 0.5 $\mu\text{m}$ (0.00002 in.)<br>50 m/s <sup>2</sup> with resolution 1 $\mu\text{m}$ (0.00005 in.) and greater                         |
| Max. shock (11 ms)              |           | 100 m/s <sup>2</sup>                                                                                                                                                                                                |
| Operating temperature           |           | 0 ... 50°C (32 ... 122°F)                                                                                                                                                                                           |
| Storage temperature             |           | –20 ... 70°C (–4 ... 158°F)                                                                                                                                                                                         |
| Weight                          |           | Scanning head 0.85 kg (1.87 lb)<br>Scale 0.5 kg/m (0.34 lb/ft)                                                                                                                                                      |
| Connecting cable                |           | 3 m (10 ft), with connector                                                                                                                                                                                         |

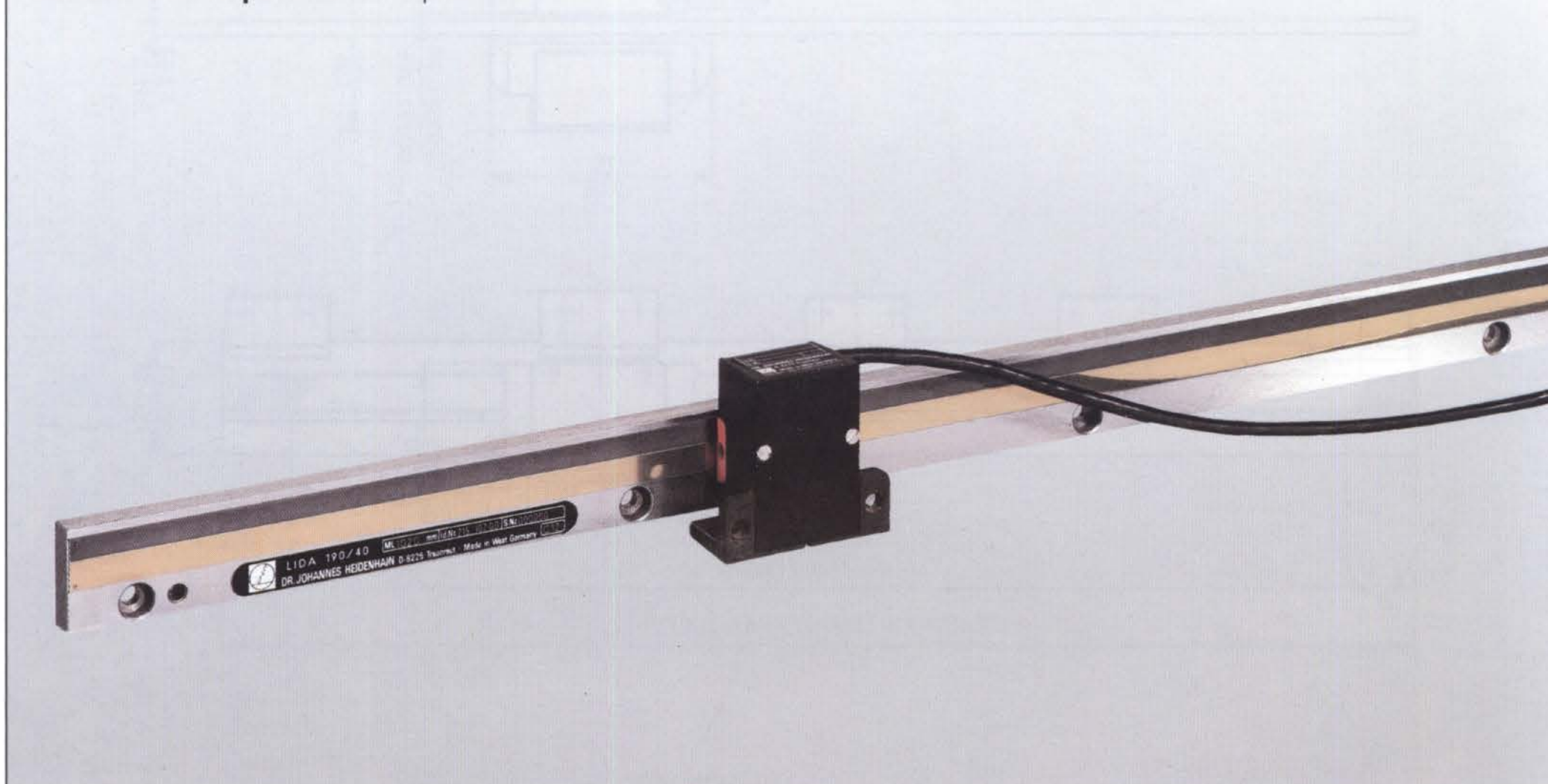
Dimensions in mm/inch



| Electrical data                |                     | LID 351, LID 351 C                                                                                                                                                                           |
|--------------------------------|---------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Light source                   |                     | LED                                                                                                                                                                                          |
| Operating voltage              |                     | 5 V ± 5 %/120 mA                                                                                                                                                                             |
| Output signals                 | Incremental signals | 2 sinusoidal signals $I_{e1}$ and $I_{e2}$                                                                                                                                                   |
|                                |                     | $I_{e1}$ <br>$I_{e2}$  |
|                                | Reference signal    | 1 signal $I_{e0}$                                                                                                                                                                            |
|                                |                     | $I_{e0}$                                                                                                  |
| Signal levels with 1 kΩ load   |                     | $I_{e1}$ approx. 7 ... 16 $\mu A_{pp}$<br>$I_{e2}$ approx. 7 ... 16 $\mu A_{pp}$<br>$I_{e0}$ approx. 2 ... 8 $\mu A$ (usable portion)                                                        |
| Total permissible cable length |                     | 20 m (65.6 ft)                                                                                                                                                                               |

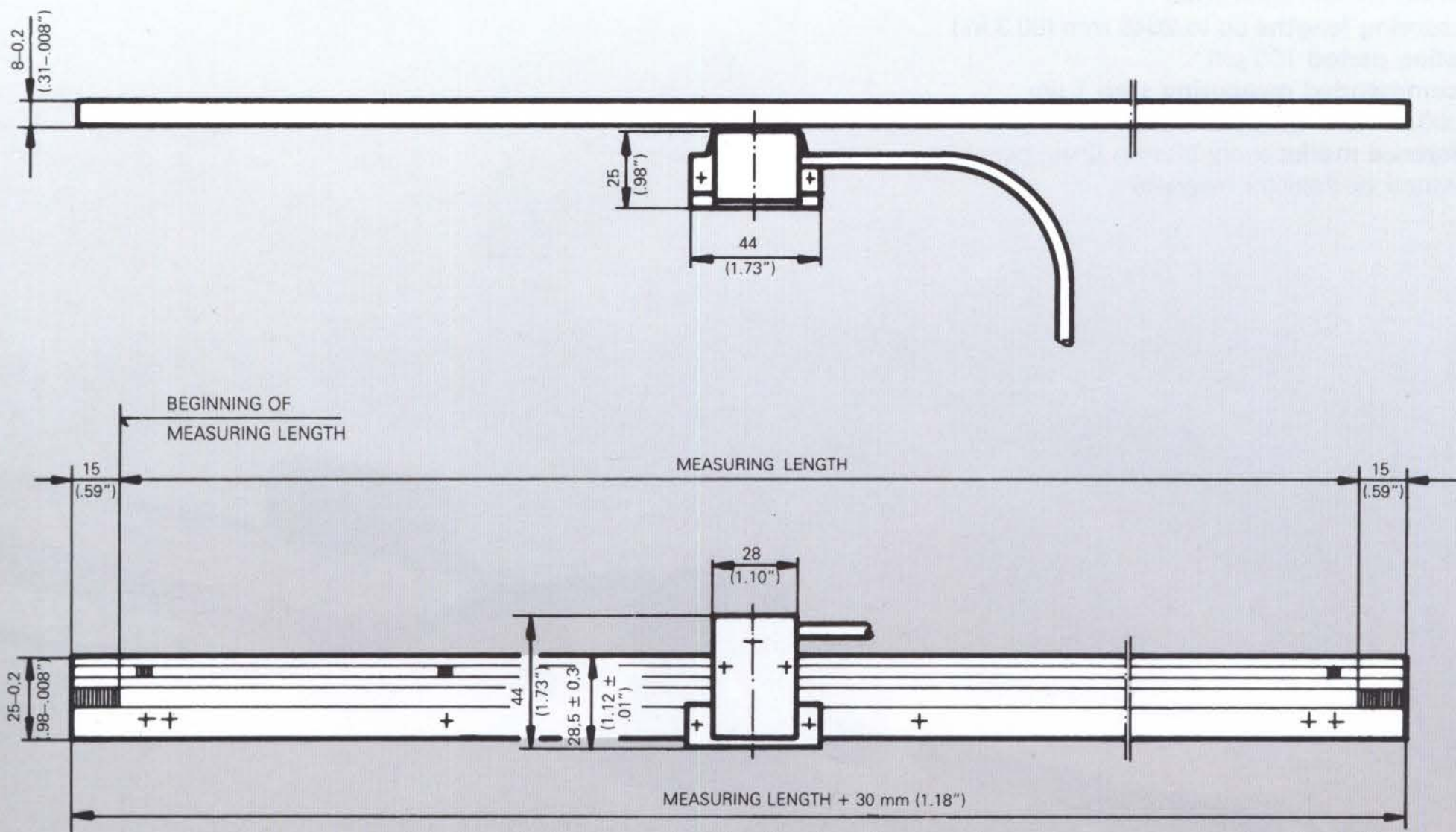
# "Exposed" Linear Encoder (reflected light) LIDA 190

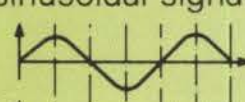
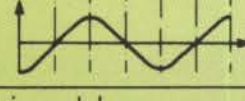
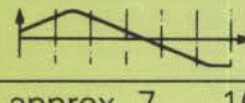
Incremental "exposed" linear encoder  
with AURODUR steel scale  
**Measuring lengths** up to 2040 mm (80.3 in.)  
**Grating period** 40  $\mu\text{m}$   
**Recommended measuring step** 1  $\mu\text{m}$   
(0.000 05 in.)  
**Reference mark position** as required



| Mechanical data                           |      | LIDA 190                                                                                                                                                    |
|-------------------------------------------|------|-------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Measuring standard                        |      | Steel tape scale with AURODUR-grating<br>Grating period 40 $\mu\text{m}$                                                                                    |
| Accuracy grades                           |      | $\pm 5 \mu\text{m}/\pm 3 \mu\text{m}$ ( $\pm 0.00020 \text{ in.}/\pm 0.00012 \text{ in.}$ )                                                                 |
| Reference marks                           |      | one at any desired location                                                                                                                                 |
| Measuring lengths                         | mm   | 220/270/320/370/420/470/520/620/720/770/820/920/1020/1240/1440/1640/<br>1840/2040                                                                           |
|                                           | inch | 8.6/10.6/12.6/14.5/16.5/18.5/20.5/24.4/28.3/30.3/32.3/36.2/40.1/48.8/56.7/64.6/<br>72.4/80.3                                                                |
| Max. traversing speed                     |      | depends on subsequent electronics                                                                                                                           |
| Permissible acceleration of scanning head |      |                                                                                                                                                             |
| Max. vibration (50 ... 2000 Hz)           |      | 100 $\text{m/s}^2$                                                                                                                                          |
| Max. shock (11 ms)                        |      | 500 $\text{m/s}^2$                                                                                                                                          |
| Operating temperature                     |      | 0 ... 50°C (32 ... 122°F)                                                                                                                                   |
| Storage temperature                       |      | -20 ... 70°C (-4 ... 158°F)                                                                                                                                 |
| Weight                                    |      | Scanning head: 50 g (1.8 oz)<br>Scale: approx. 1.6 kg/m (1.1 lb/ft)                                                                                         |
| Connecting cable                          |      | 3 m (10 ft), with connector (standard);<br>0.3 m (1 ft), with connector on mounting block (special type);<br>1 m (3.3 ft), without connector (special type) |

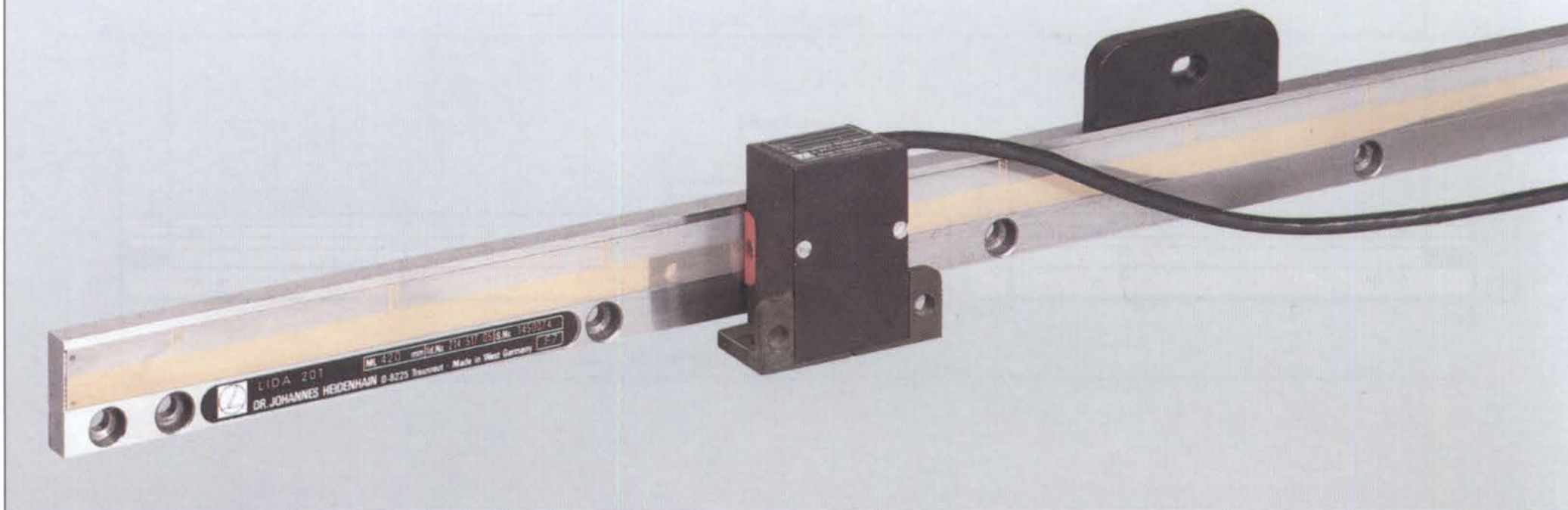
Dimensions in mm (inch) 



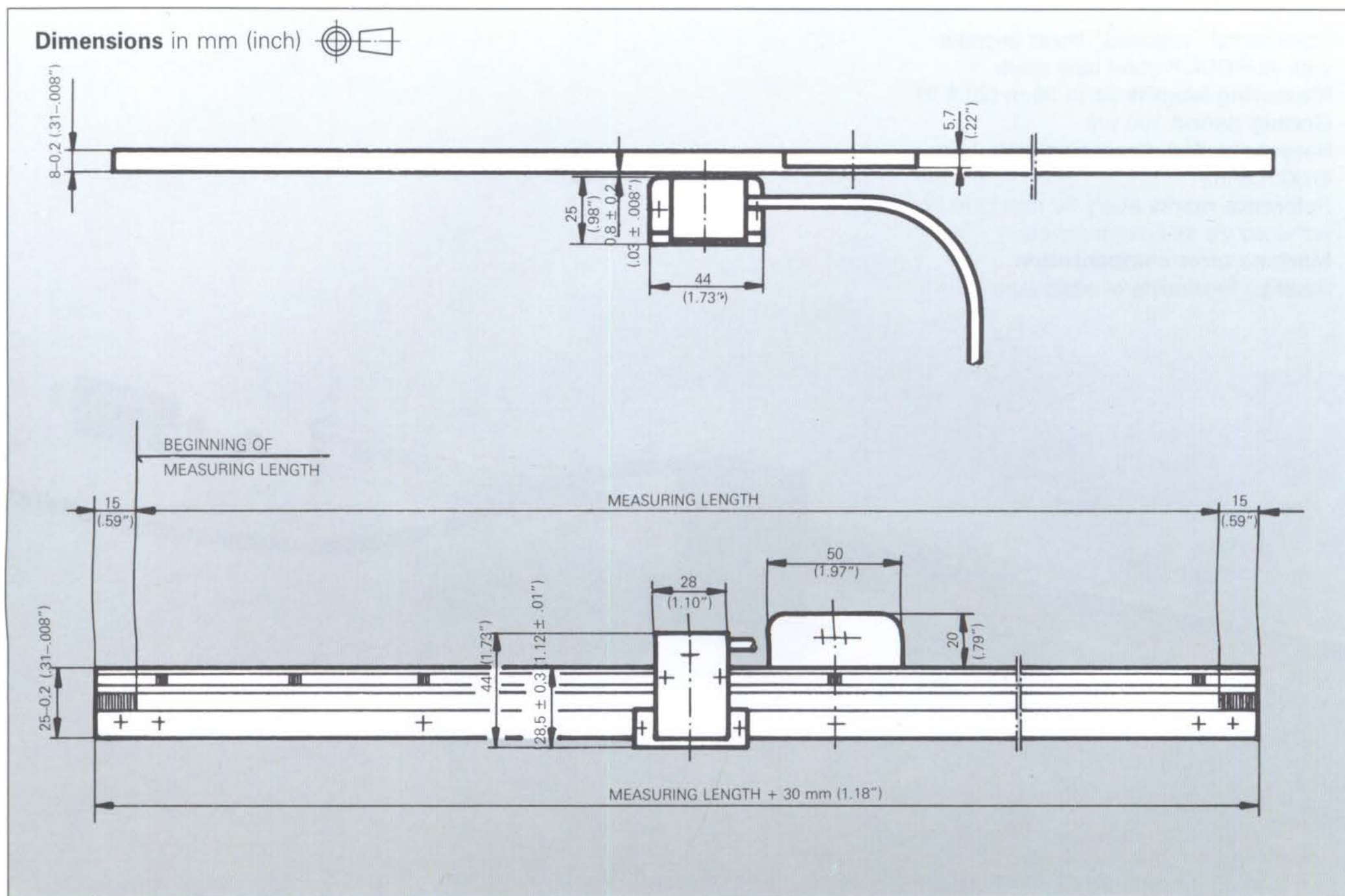
| Electrical data                      |                     | LIDA 190                                                                                                                                                                                     |
|--------------------------------------|---------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Light source                         |                     | LED                                                                                                                                                                                          |
| Operating voltage                    |                     | 5 V $\pm$ 5 %/120 mA                                                                                                                                                                         |
| Output signals                       | Incremental signals | 2 sinusoidal signals $I_{e1}$ and $I_{e2}$                                                                                                                                                   |
|                                      |                     | $I_{e1}$ <br>$I_{e2}$  |
|                                      | Reference signal    | 1 signal $I_{e0}$                                                                                                                                                                            |
|                                      |                     | $I_{e0}$                                                                                                  |
| Signal levels with 1 k $\Omega$ load |                     | $I_{e1}$ approx. 7 ... 16 $\mu A_{pp}$<br>$I_{e2}$ approx. 7 ... 16 $\mu A_{pp}$<br>$I_{e0}$ approx. 2 ... 8 $\mu A$ (usable portion)                                                        |
| Total permissible cable length       |                     | 20 m (65.6 ft)                                                                                                                                                                               |

# "Exposed" Linear Encoder (reflected light) LIDA 201

Incremental "exposed" linear encoder  
with AURODUR steel scale  
**Measuring lengths** up to 2040 mm (80.3 in.)  
**Grating period** 100  $\mu\text{m}$   
**Recommended measuring step** 1  $\mu\text{m}$   
(0.000 05 in.)  
**Reference marks** every 50 mm (2 in.) possible,  
activated via selector magnets



| Mechanical data                 |      | LIDA 201                                                                                                                                                    |
|---------------------------------|------|-------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Measuring standard              |      | Steel tape scale with AURODUR-grating<br>Grating period 100 $\mu\text{m}$                                                                                   |
| Accuracy grades                 |      | $\pm 5 \mu\text{m}/\pm 3 \mu\text{m}$ ( $\pm 0.00020 \text{ in.}/\pm 0.00012 \text{ in.}$ )                                                                 |
| Reference marks                 |      | every 50 mm/2 in. (selector magnets)                                                                                                                        |
| Measuring lengths               | mm   | 220/270/320/370/420/470/520/620/720/770/820/920/1020/1240/1440/1640/<br>1840/2040                                                                           |
|                                 | inch | 8.6/10.6/12.6/14.5/16.5/18.5/20.5/24.4/28.3/30.3/32.3/36.2/40.1/48.8/56.7/64.6/<br>72.4/80.3                                                                |
| Max. traversing speed           |      | depends on subsequent electronics                                                                                                                           |
| Permissible acceleration        |      |                                                                                                                                                             |
| Max. vibration (50 ... 2000 Hz) |      | 100 $\text{m/s}^2$                                                                                                                                          |
| Max. shock (11 ms)              |      | 500 $\text{m/s}^2$                                                                                                                                          |
| Operating temperature           |      | 0 ... 50°C (32 ... 122°F)                                                                                                                                   |
| Storage temperature             |      | -20 ... 70°C (-4 ... 158°F)                                                                                                                                 |
| Weight                          |      | Scanning head: 50 g (1.8 oz)<br>Selector magnet: 10 g (0.35 oz)<br>Scale: 1,5 kg/m (1.0 lb/ft)                                                              |
| Connecting cable                |      | 3 m (10 ft), with connector (standard);<br>0.3 m (1 ft), with connector on mounting block (special type);<br>1 m (3.3 ft), without connector (special type) |



| Electrical data                                                                         |                     | LIDA 201                                                                                                                              |
|-----------------------------------------------------------------------------------------|---------------------|---------------------------------------------------------------------------------------------------------------------------------------|
| Light source                                                                            |                     | LED                                                                                                                                   |
| Operating voltage for miniature lamp and switching circuit for reference mark selection |                     | 5 V ± 5 %/140 mA                                                                                                                      |
| Output signals                                                                          | Incremental signals | 2 sinusoidal signals $I_{e1}$ and $I_{e2}$                                                                                            |
|                                                                                         |                     | <br>                                                                                                                                  |
|                                                                                         | Reference signal    | 1 signal $I_{e0}$                                                                                                                     |
|                                                                                         |                     |                                                                                                                                       |
| Signal levels with 1 kΩ load                                                            |                     | $I_{e1}$ approx. 7 ... 16 $\mu A_{pp}$<br>$I_{e2}$ approx. 7 ... 16 $\mu A_{pp}$<br>$I_{e0}$ approx. 2 ... 8 $\mu A$ (usable portion) |
| Total permissible cable length                                                          |                     | 20 m (65.6 ft)                                                                                                                        |

# "Exposed" Linear Encoder (reflected light) for large traverses LIDA 225

Incremental "exposed" linear encoder  
with AURODUR steel tape scale

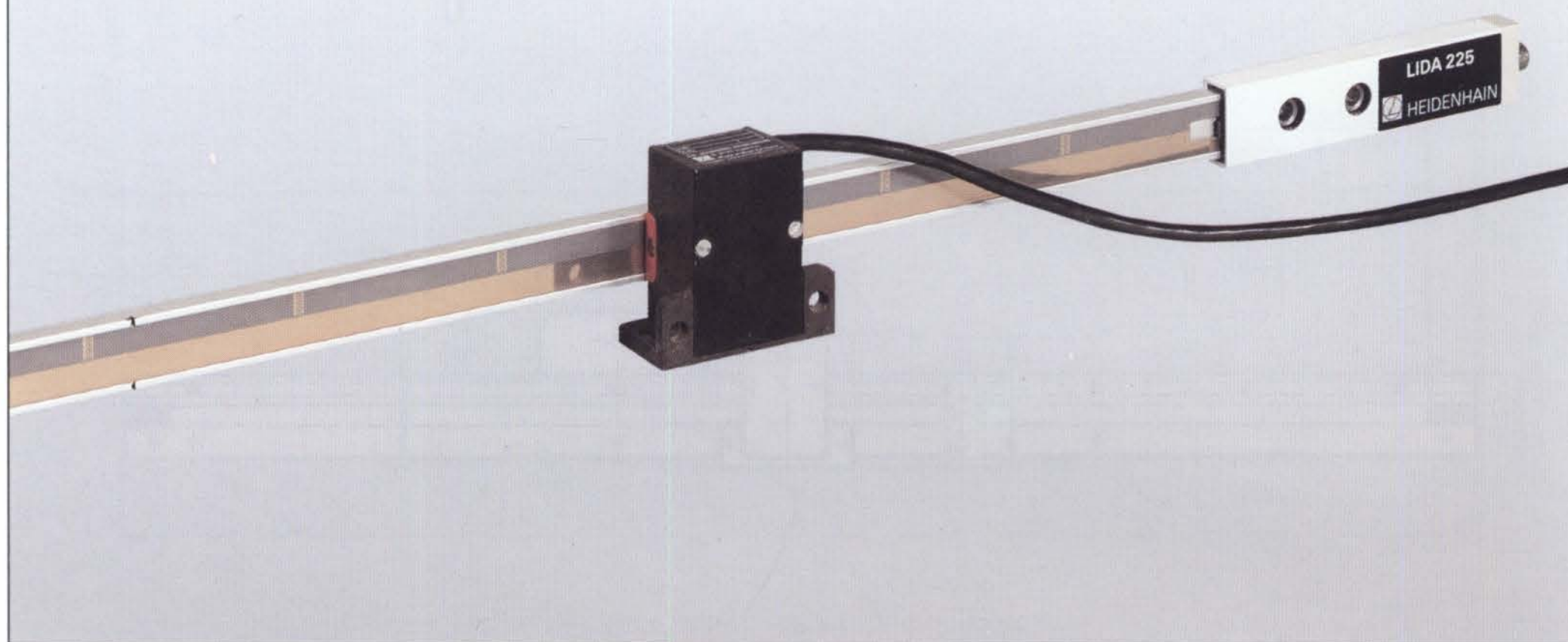
**Measuring lengths** up to 30 m (98.4 ft)

**Grating period** 100  $\mu\text{m}$

**Recommended measuring step** 1  $\mu\text{m}$   
(0.000 05 in.)

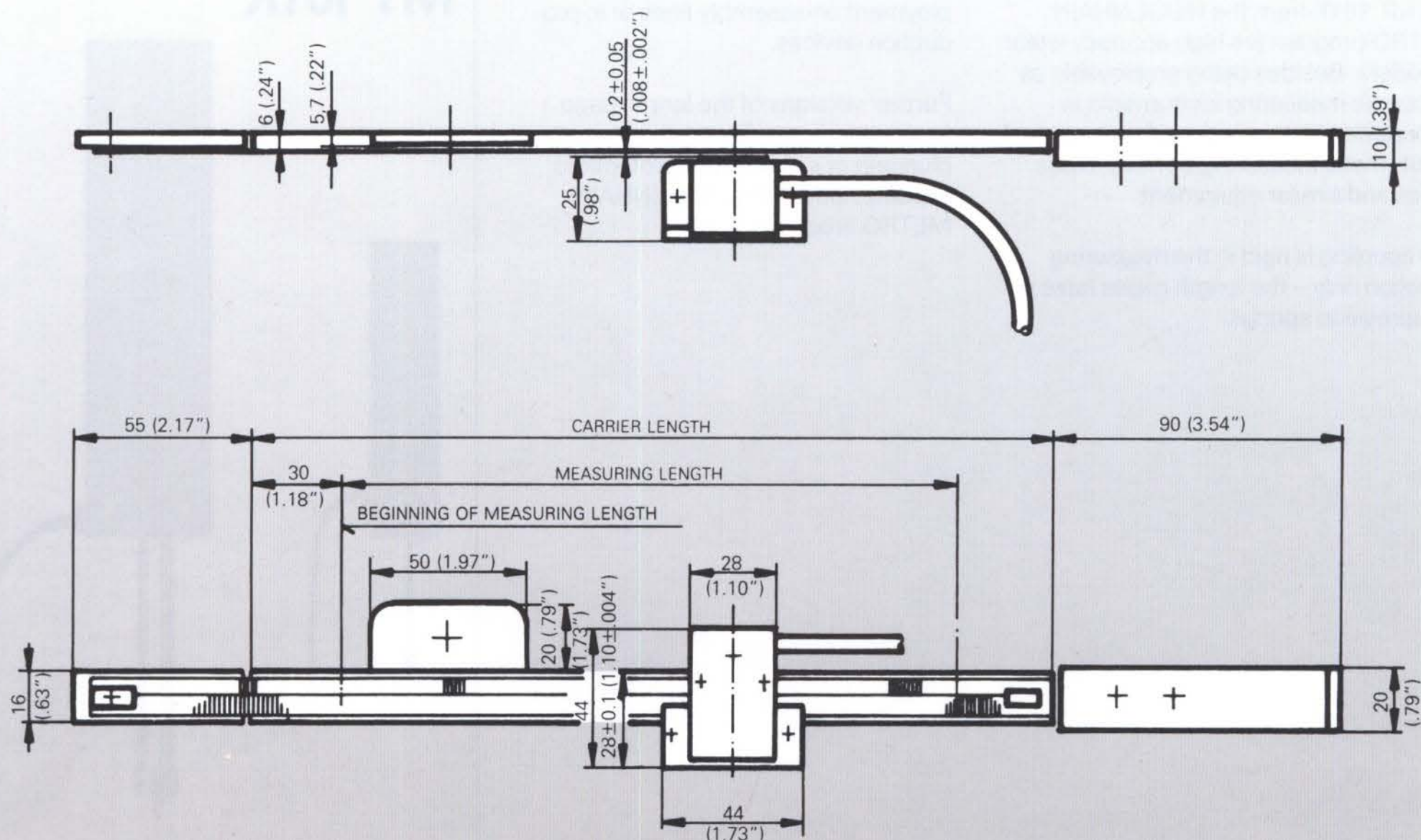
**Reference marks** every 50 mm (2 in.) possible,  
activated via selector magnets

**Machine error compensation**  
linear by tensioning of scale tape



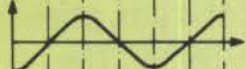
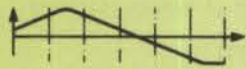
| Mechanical data                 | LIDA 225                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|---------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Measuring standard              | Steel tape scale with AURODUR-grating<br>Grating period 100 $\mu\text{m}$                                                                                                                                                                                                                                                                                                                                                                                           |
| Accuracy grade                  | $\pm 5 \mu\text{m}$ ( $\pm 0.00020$ in.)                                                                                                                                                                                                                                                                                                                                                                                                                            |
| Machine error compensation      | Adjustable, max. $\pm 100 \mu\text{m/m}$ ( $\pm 100$ ppm)                                                                                                                                                                                                                                                                                                                                                                                                           |
| Reference marks                 | every 50 mm (2 in.) (selector magnets)                                                                                                                                                                                                                                                                                                                                                                                                                              |
| Measuring lengths               | Assembly kit with single-length AURODUR-scale tape for measuring lengths<br>140 mm (5.5 in.) to 30 m (98.4 ft)<br>– single-length scale tape carrier (aluminum) for measuring lengths<br>mm 140/240/340/440/540/640/740/840/940/1040/1140/1240/1340/1440/1540/<br>1640/1740/1840/1940/2040<br>inch 5.5/9.5/13.4/17.3/21.3/25.2/29.0/33.0/37.0/41.0/44.9/48.8/52.7/56.7/60.6/<br>64.6/68.5/72.4/76.4/80.3<br>– larger lengths by butting scale tape carrier sections |
| Max. traversing speed           | depends on subsequent electronics                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| Permissible acceleration        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| Max. vibration (50 ... 2000 Hz) | 100 $\text{m/s}^2$                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| Max. shock (11 ms)              | 500 $\text{m/s}^2$                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| Operating temperature           | 0 ... 50°C (32 ... 122°F)                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| Storage temperature             | -20 ... 70°C (-4 ... 158°F)                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Weight                          | Scanning head: 50 g (1,8 oz)<br>Selector magnet: 10 g (0.35 oz)<br>Scale: 100 g + 250 g/m (3.5 oz + 2.7 oz/ft) measuring length                                                                                                                                                                                                                                                                                                                                     |
| Connecting cable                | 3 m (10 ft), with connector (standard);<br>0.3 m (1 ft), with connector on mounting block (special type);<br>1 m (3.3 ft), without connector (special type)                                                                                                                                                                                                                                                                                                         |

Dimensions in mm (inch)



#### Electrical data

#### LIDA 225

|                                                                                         |                     |                                                                                                                                                                                              |
|-----------------------------------------------------------------------------------------|---------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Light source                                                                            |                     | LED                                                                                                                                                                                          |
| Operating voltage for miniature lamp and switching circuit for reference mark selection |                     | 5 V ± 5 %/140 mA                                                                                                                                                                             |
| Output signals                                                                          | Incremental signals | 2 sinusoidal signals $I_{e1}$ and $I_{e2}$                                                                                                                                                   |
|                                                                                         |                     | $I_{e1}$ <br>$I_{e2}$  |
|                                                                                         | Reference signal    | 1 signal $I_{e0}$                                                                                                                                                                            |
|                                                                                         |                     | $I_{e0}$                                                                                                  |
| Signal levels with 1 kΩ load                                                            |                     | $I_{e1}$ approx. 7 ... 16 $\mu A_{pp}$<br>$I_{e2}$ approx. 7 ... 16 $\mu A_{pp}$<br>$I_{e0}$ approx. 2 ... 8 $\mu A$ (usable portion)                                                        |
| Total permissible cable length                                                          |                     | 20 m (65.6 ft)                                                                                                                                                                               |

# Special Linear Encoders

## Incremental Length Gages

The incremental length gages MT 60K and MT 101K from the HEIDENHAIN METRO program are high-accuracy linear encoders. Besides being employable as electronic measuring instruments in laboratories, they can operate just as well in automatic measuring devices, cross tables and similar equipment.

The coupling is rigid in the measuring direction only – the length gages have no compression springs.

The sturdy construction permits employment on assembly lines or in production devices.

Further versions of the length gage (e. g. with motor-driven or pneumatic plungers or splashwater protection) are described in the HEIDENHAIN METRO brochure.

## MT 60K MT 101K



## Comparator System

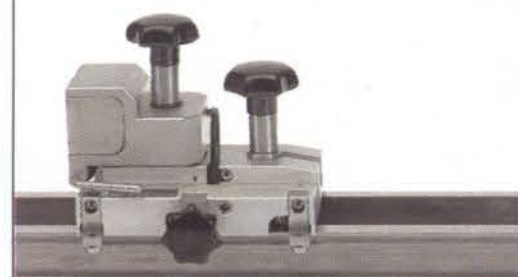
The VM 101 comparator system is an exposed incremental linear encoder with very high measuring accuracy. It serves primarily as a reference measuring system for calibrating small machine tools. It is also suited, however, for determining position errors on cross tables (e. g. PCB drilling machines) or testing equipment.

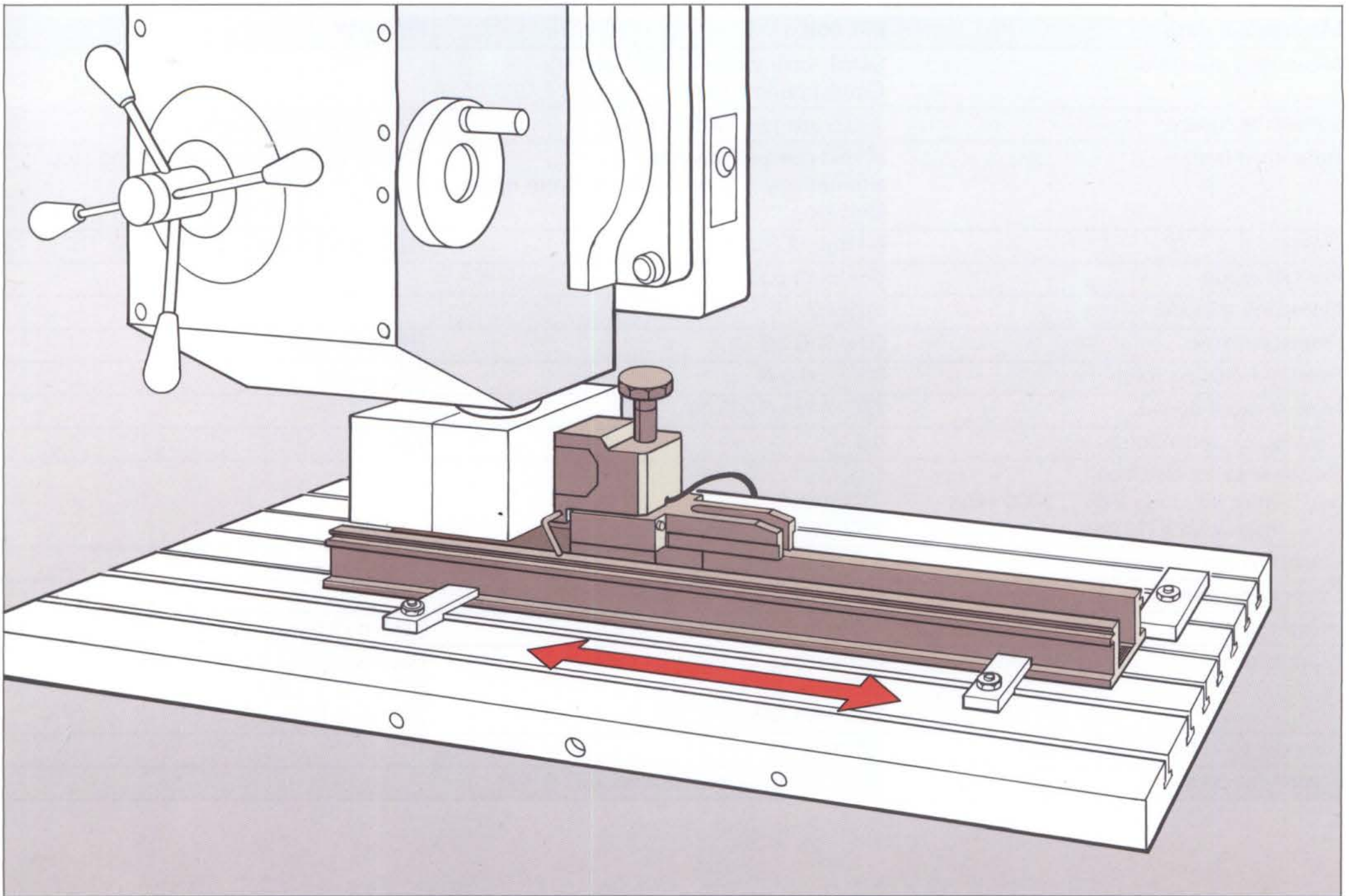
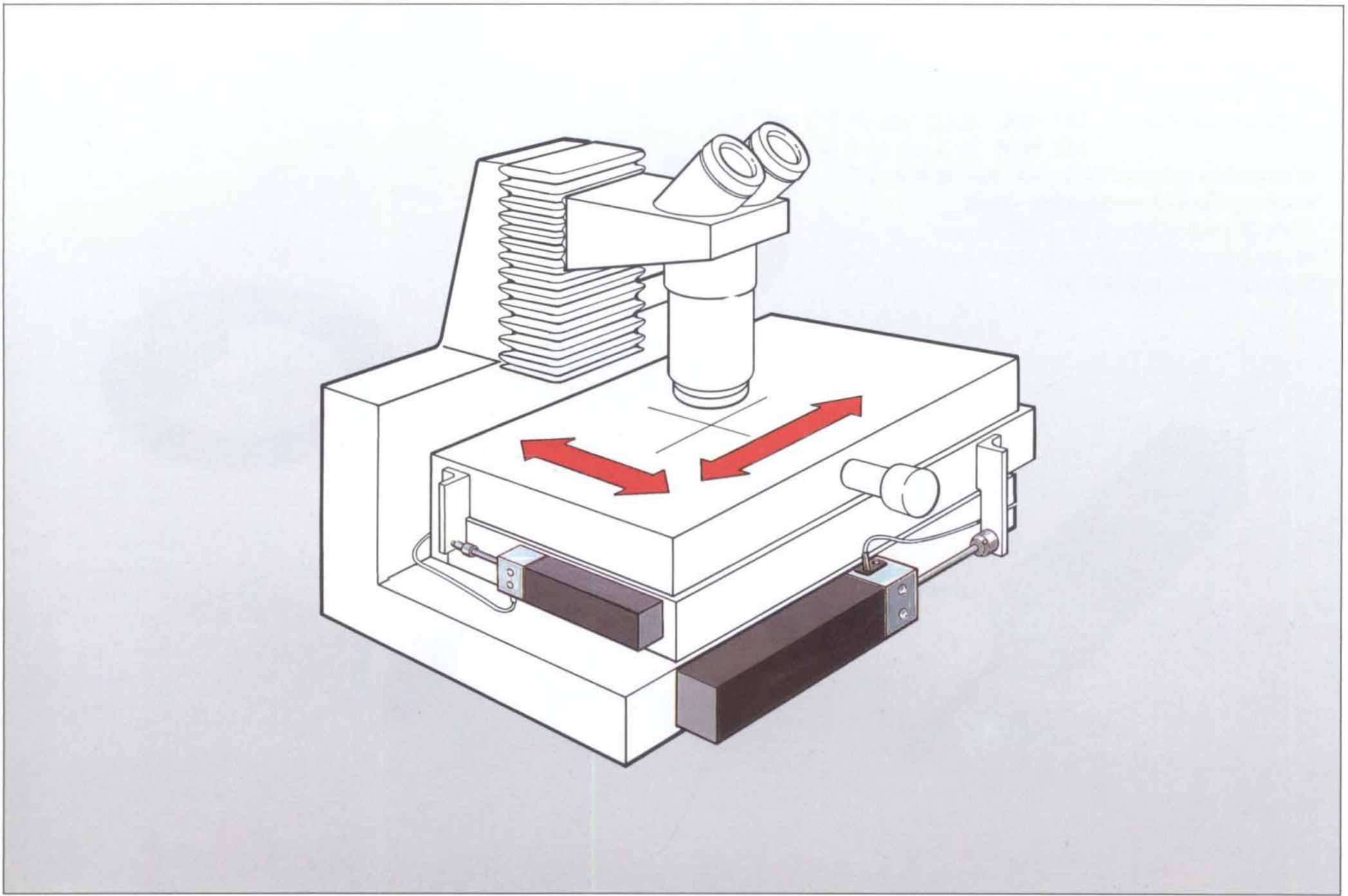
The VM 101 consists of the scale carrier with a precision scale, the scanning unit, an auxiliary carriage for set up and an interface electronics. The sturdy **scale carrier** is constructed of stainless steel in the shape of a U beam. The measuring standard – a precision scale with a phase grating graduation, grating period  $8\text{ }\mu\text{m}$  – is mounted on the neutral stress zone of the U beam. A glass lamella secured with cement protects the grating from contamination.

The **scanning unit** runs along the scale without making mechanical contact.

The **interface electronics** – electrically adjusted to the scanning unit by HEIDENHAIN – forms out of the scanning signals two sinusoidal output signals with a signal period of  $4\text{ }\mu\text{m}$ , phase-shifted to one another by  $90^\circ$  el. The small signal period and the high scale accuracy of  $\pm 1\text{ }\mu\text{m}$  permit measuring steps as small as  $0.02\text{ }\mu\text{m}$ . Relatively large installation tolerances simplify mounting and adjustment.

## VM 101





# Incremental Length Gages MT 60K/MT 101K

Incremental length gages  
with DIADUR glass scale

**Grating period** 10  $\mu\text{m}$

**System accuracy** **MT 60K**  $\pm 0,5 \mu\text{m}$  ( $\pm 0.00002 \text{ in.}$ )  
**MT 101K**  $\pm 1 \mu\text{m}$  ( $\pm 0.00004 \text{ in.}$ )

**Measuring lengths** 60 or 100 mm (2.4 or 4.0 in.)

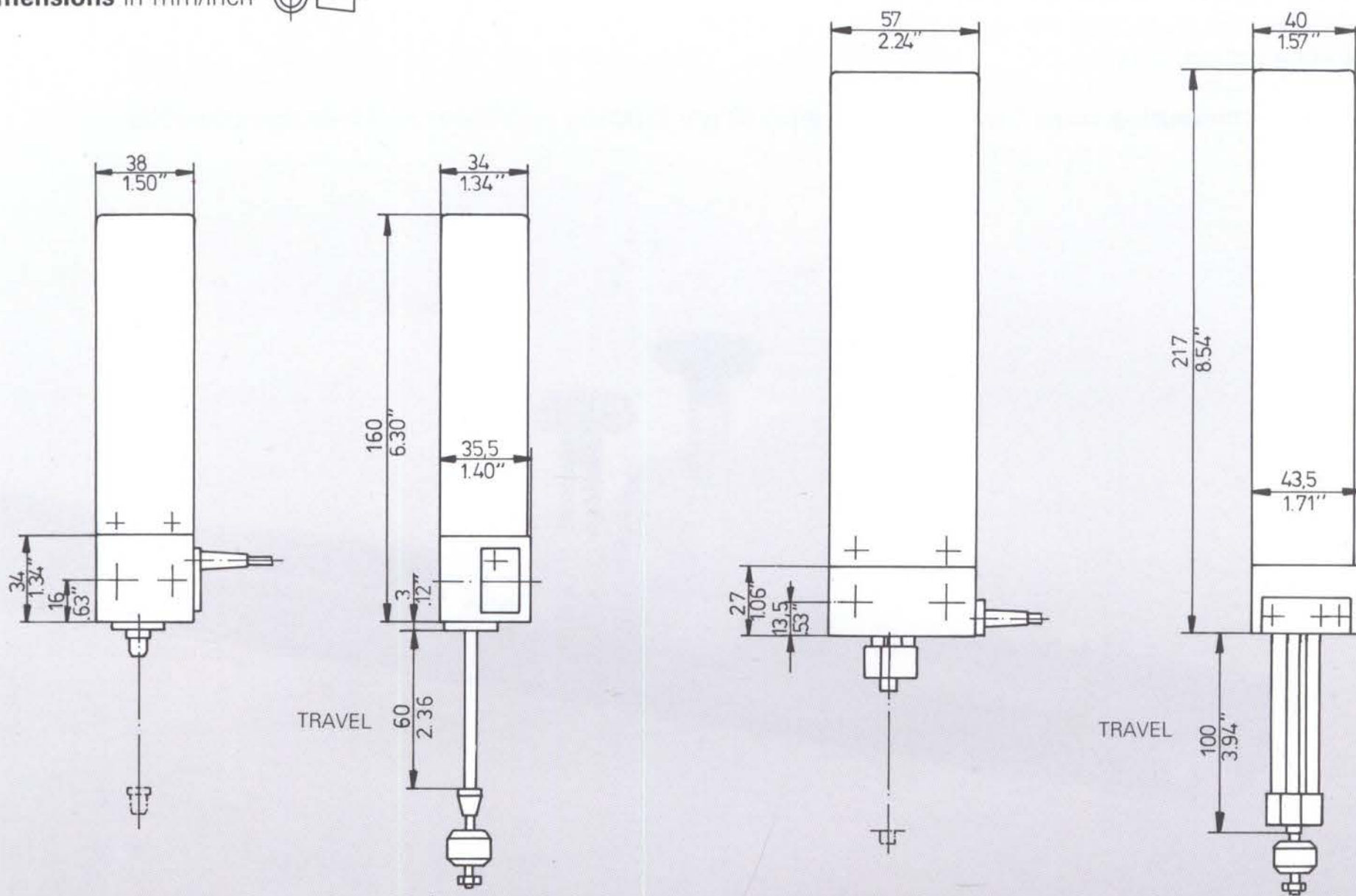
**Recommended measuring steps**

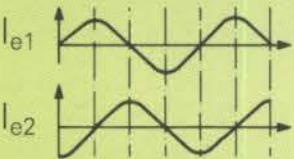
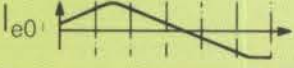
1  $\mu\text{m}$ /0.5  $\mu\text{m}$ /0.2  $\mu\text{m}$ /0.1  $\mu\text{m}$ /0.05  $\mu\text{m}$   
(0.00005 in./0.00002 in./0.00001 in./  
0.000005 in./0.000002 in.)



| Mechanical data                  | MT 60K                                                                                | MT 101K                                                         |
|----------------------------------|---------------------------------------------------------------------------------------|-----------------------------------------------------------------|
| Measuring standard               | Glass scale with DIADUR-grating<br>Grating period 10 $\mu\text{m}$                    |                                                                 |
| System accuracy                  | $\pm 0,5 \mu\text{m}$ ( $\pm 0.00002 \text{ in.}$ )                                   | $\pm 1 \mu\text{m}$ ( $\pm 0.00004 \text{ in.}$ )               |
| Reference marks                  | at mid-point of traverse;<br>alternatively 1.5 mm (0.06 in.) from upper<br>limit stop | 10 mm (0.4 in.) from upper limit stop                           |
| Travel                           | 60 mm (2.3 in.)                                                                       | 100 mm (3.9 in.)                                                |
| Plunger guide                    | Ball-bush guide                                                                       |                                                                 |
| Operating attitude               | optional                                                                              |                                                                 |
| Displaced mass                   | 50 g (1.8 oz)                                                                         | 165 g (5.8 oz)                                                  |
| Required moving force            | 0.1 ... 0.6 N                                                                         | 0.5 ... 2 N                                                     |
| Max. plunger speed               | 250 mm/s (10 in./s)                                                                   |                                                                 |
| Permissible radial force         | 0.5 N                                                                                 | 2 N                                                             |
| Permissible acceleration         |                                                                                       |                                                                 |
| max. vibration (50 ... 2000 Hz)  | 100 $\text{m/s}^2$                                                                    |                                                                 |
| max. shock (11 ms)               | 1000 $\text{m/s}^2$                                                                   |                                                                 |
| Operating temperature            | 0 ... 50°C (32 ... 122°F)                                                             |                                                                 |
| Storage temperatur               | -20 ... 70°C (-4 ... 158°F)                                                           |                                                                 |
| Weight                           | 700 g (1.5 lb)                                                                        | 1200 g (2.6 lb)                                                 |
| Mounting                         | Flat surface 38 mm×34 mm<br>(1.5 in. × 1.3 in.),<br>2 screws M5                       | Flat surface 57 mm×27 mm<br>(2.2 in. × 1.1 in.),<br>2 screws M8 |
| Connecting cable to display unit | 1.5 m (5 ft)                                                                          |                                                                 |
| Thread for coupling              | M2.5 (6 mm/0.24 in. deep) ISO/R 463                                                   |                                                                 |

Dimensions in mm/inch



| Electrical data                      |                     | MT 60K                                                                                                                                | MT 101K |
|--------------------------------------|---------------------|---------------------------------------------------------------------------------------------------------------------------------------|---------|
| Light source                         |                     | Miniature lamp 5/0.6 W                                                                                                                | LED     |
| Operating voltage                    |                     | 5 V $\pm$ 5 %/120 mA                                                                                                                  |         |
| Output signals                       | Incremental signals | 2 sinusoidal signals $I_{e1}$ and $I_{e2}$                                                                                            |         |
|                                      |                     |                                                    |         |
|                                      | Reference signal    | 1 signal $I_{e0}$                                                                                                                     |         |
|                                      |                     |                                                    |         |
| Signal levels with 1 k $\Omega$ load |                     | $I_{e1}$ approx. 7 ... 16 $\mu A_{pp}$<br>$I_{e2}$ approx. 7 ... 16 $\mu A_{pp}$<br>$I_{e0}$ approx. 2 ... 8 $\mu A$ (usable portion) |         |
| Total permissible cable length       |                     | 20 m (65.6 ft)                                                                                                                        |         |

# Incremental Comparator System VM 101

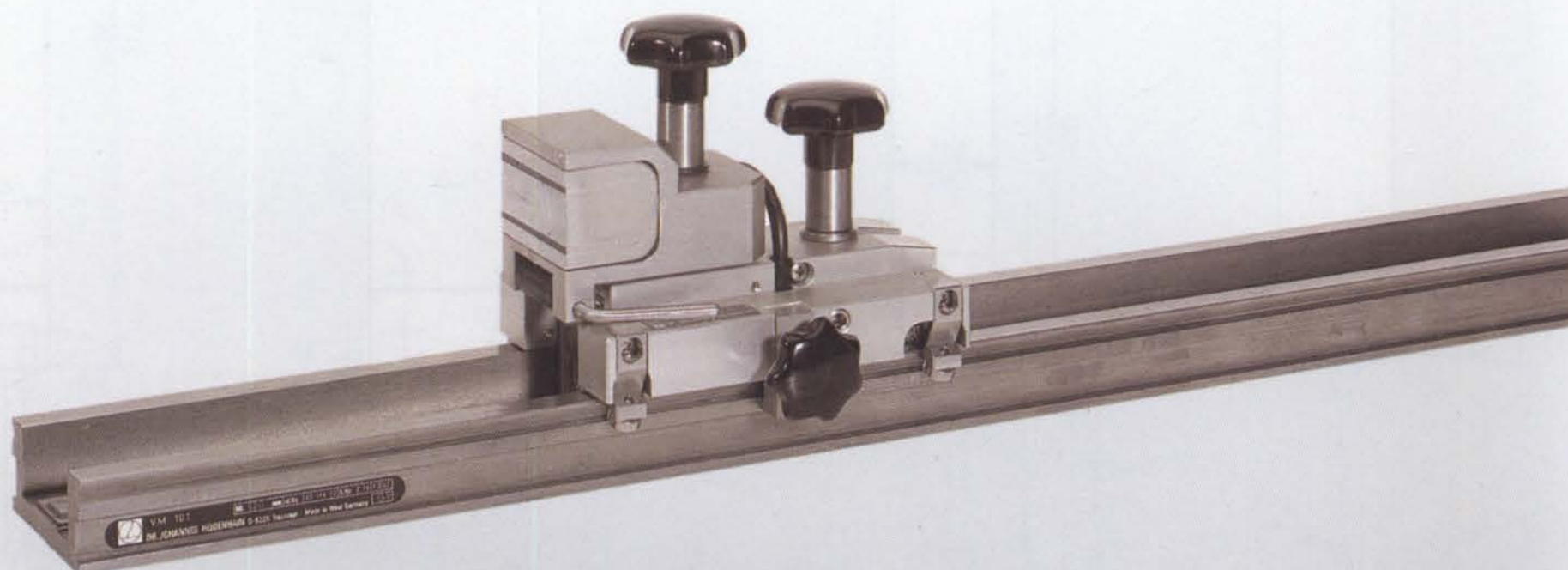
Incremental "exposed" comparator system

**Measuring lengths** up to 1020 mm (40.1 in.)

**Scale grating period** 8  $\mu\text{m}$

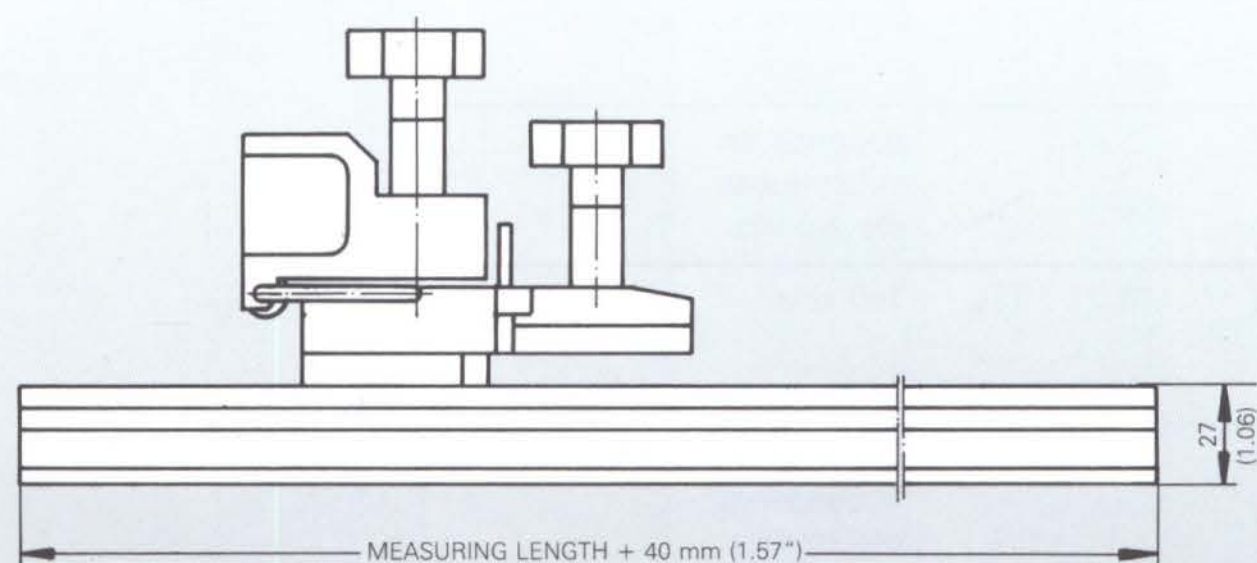
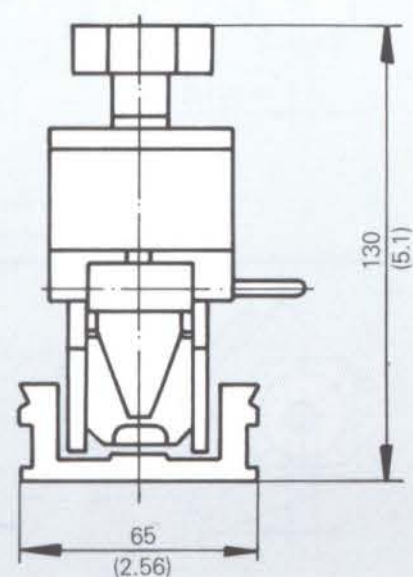
**Signal period** 4  $\mu\text{m}$

**Recommended measuring steps** 1  $\mu\text{m}$ /0.2  $\mu\text{m}$ /0.1  $\mu\text{m}$ /0.02  $\mu\text{m}$  (0.00005 in./0.00001 in./0.000005 in./0.000001 in.)



| Mechanical data                 | VM 101                                                                                                                                 |
|---------------------------------|----------------------------------------------------------------------------------------------------------------------------------------|
| Measuring standard              | Phase grating without reference mark<br>Scale grating period 8 $\mu\text{m}$<br>Signal period 4 $\mu\text{m}$                          |
| Accuracy grade                  | $\pm 1 \mu\text{m}$ ( $\pm 0.00004$ in.)                                                                                               |
| Measuring lengths               | 420/520/1020 mm (16.5/20.5/40.1 in.)                                                                                                   |
| Max. traversing speed           | depends on subsequent electronics                                                                                                      |
| Permissible acceleration        |                                                                                                                                        |
| max. vibration (50 ... 2000 Hz) | 5 $\text{m/s}^2$                                                                                                                       |
| max. shock (11 ms)              | 10 $\text{m/s}^2$                                                                                                                      |
| Operating temperature           | 10 ... 30°C (50 ... 86°F)                                                                                                              |
| Storage temperature             | -20 ... 50°C (-4 ... 122°F)                                                                                                            |
| Weight                          | Scanning unit: approx. 1.2 kg (2.64 lb.)<br>Scale: approx. 6.5 kg/m (4.36 lb./in.)<br>APE 101 interface electronics: 0.3 kg (0.66 lb.) |
| Connecting cable                | 0.5 m (1.64 ft.) between scanning unit and APE<br>flange socket (9-pole) on APE                                                        |

Dimensions in mm (inch)



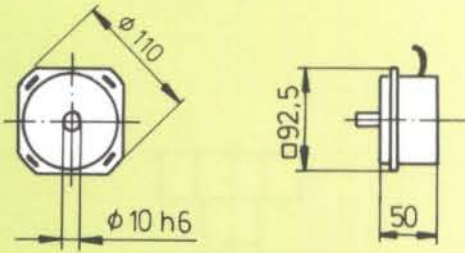
| Electrical data                |                                      | VM 101                                                                                             |
|--------------------------------|--------------------------------------|----------------------------------------------------------------------------------------------------|
| Light source                   |                                      | LED                                                                                                |
| Supply voltage                 |                                      | 5 V $\pm$ 5 %/120 mA                                                                               |
| Output signals                 | Incremental signals                  | 2 sinusoidal signals $I_{e1}$ and $I_{e2}$                                                         |
|                                |                                      |                                                                                                    |
|                                | Signal levels with 1 k $\Omega$ load | $I_{e1}$ approx. 7 ... 16 $\mu$ A <sub>pp</sub><br>$I_{e2}$ approx. 7 ... 16 $\mu$ A <sub>pp</sub> |
| Total permissible cable length |                                      | 20 m (65.6 ft.)                                                                                    |

# HEIDENHAIN Rotary Encoders

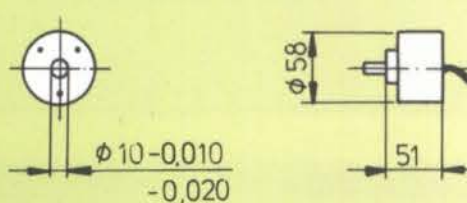
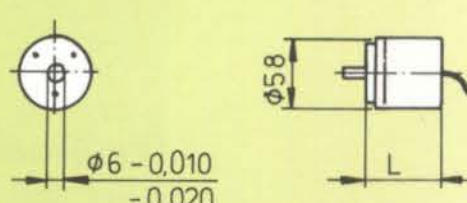
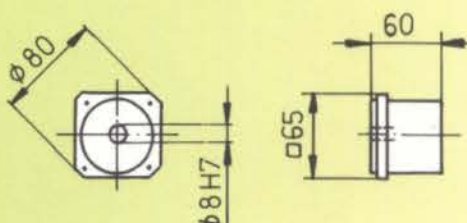
In conjunction with a rack and pinion or lead screw as measuring standard, incremental rotary encoders can also be

employed for linear measuring applications i.e. determination of lengths or traverses.

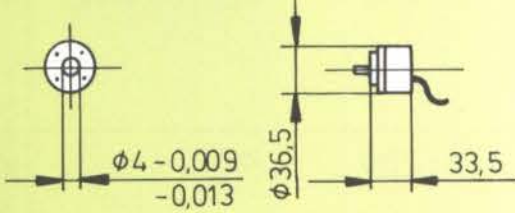
## ROD 100/RON 100 Series

| Model   | Output signals                                                                        | max. scanning frequency           | Operating voltage | Line numbers                                                                                     | Overall dimensions in mm                                                            |
|---------|---------------------------------------------------------------------------------------|-----------------------------------|-------------------|--------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|
| ROD 121 |  TTL | 100 kHz                           | 5 V               | 360/400/500/512/600/720/800/900/1000/1024/1156/1250/1500/1800/2000/2048/2080/2500/3600/4096/5000 |  |
| ROD 131 |  HTL | 100 kHz                           | 10 ... 16 V       |                                                                                                  |                                                                                     |
| ROD 151 |      | depends on subsequent electronics | 5 V               |                                                                                                  |                                                                                     |
| RON 125 |  TTL | 160 kHz                           | 5 V               |                                                                                                  |                                                                                     |
| RON 155 |    | depends on subsequent electronics | 5 V               |                                                                                                  |                                                                                     |

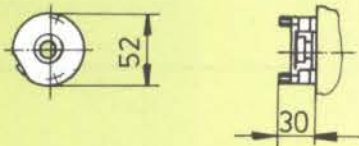
## ROD 400/RON 400 Series

| Model     | Output signals                                                                                                           | max. scanning frequency           | Operating voltage | Line numbers                                                                                                                                                                             | Overall dimensions in mm                                                              |                                                                                       |
|-----------|--------------------------------------------------------------------------------------------------------------------------|-----------------------------------|-------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
| ROD 420   |  TTL                                  | 160 kHz                           | 5 V               | 50/60/100/120/125/128/150/180/200/250/254/256/360/400/420/500/512/600/625/635/720/800/900/1000/1024/1080/1125/1250/1270/1500/1750/1800/2000/2048/2500/2540/3000/3600/3750/4096/4500/5000 |  |                                                                                       |
| ROD 450   |                                       | depends on subsequent electronics | 5 V               |                                                                                                                                                                                          |                                                                                       |                                                                                       |
| ROD 426 A |  TTL                                  | 300 kHz                           | 5 V               |                                                                                                                                                                                          |                                                                                       |                                                                                       |
| ROD 426 E |  TTL                                  | 160 kHz                           | 5 V               |                                                                                                                                                                                          |                                                                                       | ROD 426 E: up to 3600                                                                 |
| ROD 428   |  TTL<br>(with fault detection signal) | 300 kHz                           | 5 V               |                                                                                                                                                                                          |                                                                                       |                                                                                       |
| ROD 436   |  HTL                                  | 75 kHz                            | 10 ... 16 V       | Length L   Type<br>72   ROD 426 A/ROD 428/<br>ROD 436/ROD 446<br>56   ROD 426 E<br>63   ROD 456                                                                                          |  |                                                                                       |
| ROD 446   |  HTL,<br>24 V                         | 100 kHz                           | 15 ... 29 V       |                                                                                                                                                                                          |                                                                                       |                                                                                       |
| ROD 456   |                                       | depends on subsequent electronics | 5 V               |                                                                                                                                                                                          |                                                                                       |                                                                                       |
| RON 425   |  TTL                                  | 160 kHz                           | 5 V               |                                                                                                                                                                                          |                                                                                       |                                                                                       |
| RON 455   |                                       | depends on subsequent electronics | 5 V               |                                                                                                                                                                                          |                                                                                       |  |

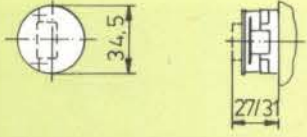
MINIROD 400 Series

| Model       | Output signals                                                                        | max. scanning frequency           | Operating voltage | Line numbers                                                            | Overall dimensions in mm                                                            |
|-------------|---------------------------------------------------------------------------------------|-----------------------------------|-------------------|-------------------------------------------------------------------------|-------------------------------------------------------------------------------------|
| MINIROD 420 |  TTL | 160 kHz                           | 5 V               | 100/200/250/360/500/600/720/900/1000/1024/1080/1250/1500/2000/2500/3600 |  |
| MINIROD 450 |      | depends on subsequent electronics | 5 V               |                                                                         |                                                                                     |

ERO 1200 Series

| Model    | Output signals                                                                          | max. scanning frequency           | Operating voltage | Line numbers                                                                                                                                          | Overall dimensions in mm                                                                                                 |
|----------|-----------------------------------------------------------------------------------------|-----------------------------------|-------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------|
| ERO 1221 |  TTL | 100 kHz                           | 5 V               | 50/60/100/120/125/128/150/180/200/250/254/256/360/400/420/500/512/600/625/635/720/800/900/1000/1024/1080/1125/1250/1270/1500/1800/2000/2048/2080/2500 | <br>Hub inside diameter 4/6/8/10 mm |
| ERO 1251 |      | depends on subsequent electronics | 5 V               |                                                                                                                                                       |                                                                                                                          |

ERO 1400 Series

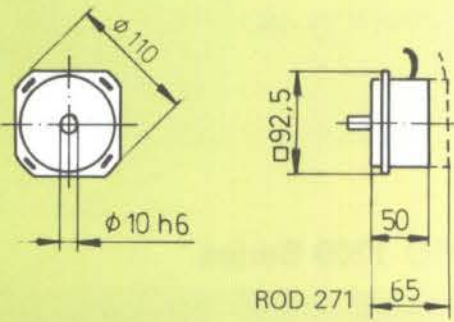
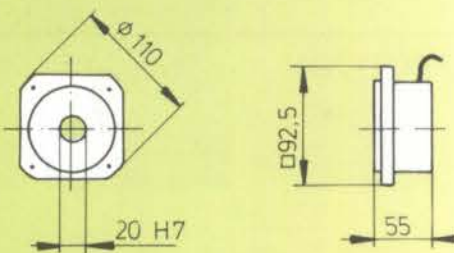
| Model    | Output signals                                                                          | max. scanning frequency           | Operating voltage | Line numbers                                             | Overall dimensions in mm                                                              |
|----------|-----------------------------------------------------------------------------------------|-----------------------------------|-------------------|----------------------------------------------------------|---------------------------------------------------------------------------------------|
| ERO 1420 |  TTL | 160 kHz                           | 5 V               | 100/200/250/360/500/600/720/900/1000/1024/1080/1250/1500 |  |
| ERO 1450 |      | depends on subsequent electronics | 5 V               |                                                          |                                                                                       |

Please request our brochure "Rotary Encoders".

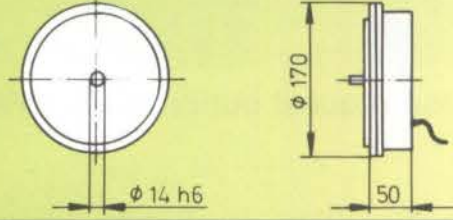
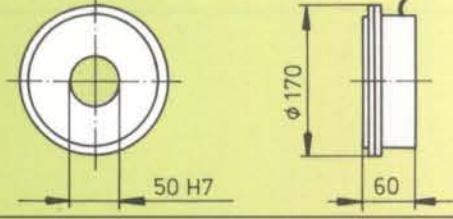
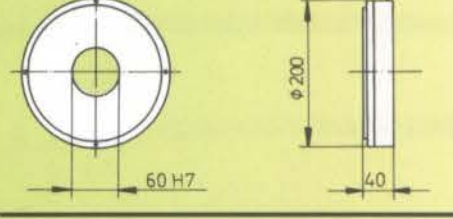
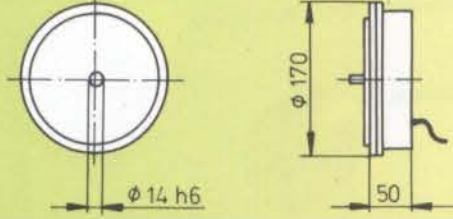
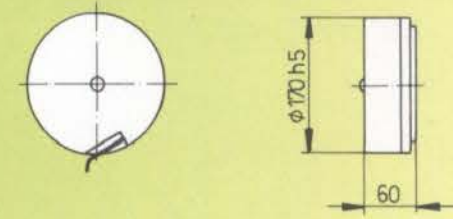


# HEIDENHAIN Angle Encoders

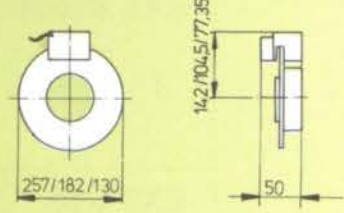
## ROD 200/RON 200 Series

| Model                                       | Output signals                                                                                                           | max. scanning frequency           | Operating voltage | Line numbers/Accuracy                                                                                 | Overall dimensions in mm                                                              |
|---------------------------------------------|--------------------------------------------------------------------------------------------------------------------------|-----------------------------------|-------------------|-------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
| ROD 230                                     |  HTL                                    | 100 kHz                           | 10 ... 16 V       | 6000 / $\pm 10''$<br>7854 / $\pm 9''$<br>8192 / $\pm 8''$<br>9000 / $\pm 7''$                         |    |
| ROD 250                                     |                                         | depends on subsequent electronics | 5 V               | 10000 / $\pm 6''$<br>10800 / $\pm 6''$<br>12500 / $\pm 5''$<br>16384 / $\pm 5''$<br>18000 / $\pm 5''$ |                                                                                       |
| ROD 260                                     |  TTL                                    | 1 MHz                             | 5 V               |                                                                                                       |                                                                                       |
| ROD 271<br>(integrated 5fold interpolation) |  TTL<br>(with fault detection signal) | 25 kHz                            | 5 V               |                                                                                                       |                                                                                       |
| RON 255                                     |                                       | depends on subsequent electronics | 5 V               |                                                                                                       |  |
| RON 275<br>(integrated 5fold interpolation) |  TTL<br>(with fault detection signal) | 25 kHz                            | 5 V               |                                                                                                       |                                                                                       |

## ROD 700/RON 700, ROD 800 and RON 900 Series

| Model   | Output signals                                                                      | max. scanning frequency           | Operating voltage | Line numbers/Accuracy                                                                                      | Overall dimensions in mm                                                              |
|---------|-------------------------------------------------------------------------------------|-----------------------------------|-------------------|------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
| ROD 700 |  | depends on subsequent electronics | 5 V               | 9000 / $\pm 5''$<br>18000 / $\pm 2,5''$<br>25920 / $\pm 2,5''$<br>32400 / $\pm 2,5''$<br>36000 / $\pm 2''$ |  |
| RON 705 |  | depends on subsequent electronics | 5 V               | 9000 / $\pm 5''$<br>18000 / $\pm 2,5''$                                                                    |  |
| RON 706 |  | depends on subsequent electronics | 5 V               | 18000 / $\pm 2,5''$                                                                                        |  |
| ROD 800 |  | depends on subsequent electronics | 5 V               | 18000 / $\pm 1''$<br>25920 / $\pm 1''$<br>36000 / $\pm 1''$                                                |  |
| RON 905 |  | depends on subsequent electronics | 5 V               | 36000 / $\pm 0,2''$                                                                                        |  |

## ERO 700 Series

| Model   | Output signals | max. scanning frequency           | Operating voltage | Line numbers/Accuracy                                                                                                                 | Overall dimensions in mm                                                            |
|---------|----------------|-----------------------------------|-------------------|---------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|
| ERO 725 | ~              | depends on subsequent electronics | 5 V               | 9000/18000/36000<br>Factors to be considered for assessing measuring accuracy are errors from imperfect centering and bearing errors. |  |

Please request our brochure „Rotary Encoders“



ROD 200/RON 200 Series



ROD 700/ROD 800



RON 705



RON 706



RON 905



ERO 725

# Recommended Combination of Linear Encoder and EXE –

| Encoder inputs | Model     | Interpolation                                              | Maximum input frequency    | Output signals per axis                                                                                                                                                                    | Line driver          | Supply voltage                                  |
|----------------|-----------|------------------------------------------------------------|----------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|-------------------------------------------------|
| <b>1</b>       | EXE 602 D | without<br>5-fold                                          | 50 kHz<br>25 kHz           | 1 TTL                                                                                                   | MC 3487              | 5 V                                             |
|                | EXE 610 B | 10-fold                                                    | 25 kHz                     | 1 TTL                                                                                                   | MC 3487              | 5 V                                             |
|                | EXE 630   | without<br>4-fold<br>5-fold                                | 50 kHz<br>30 kHz<br>25 kHz | 1 HTL                                                                                                   | MC 3487              | 10 ... 16 V                                     |
|                | EXE 650   | 50-fold or 25-fold<br>selectable                           | 43 kHz                     | 1 TTL                                                                                                   | MC 3487              | 5 V                                             |
|                | EXE 702   | 25-fold                                                    | 15 kHz                     | 1 TTL                                                                                                 | SN 75113<br>SN 75114 | 100 ... 240 V~<br>integral power<br>supply unit |
|                | EXE 816   | 25-fold                                                    | 10 kHz                     | 2 TTL                                                                                                 | SN 75114             | 115/220 V~<br>integral power<br>supply unit     |
| <b>2</b>       | EXE 801   | without or 5-fold<br>selectable                            | 50 or 25 kHz               | 2 TTL                                                                                                 | SN 75114             | 115/220 V~<br>integral power<br>supply unit     |
|                | EXE 804   | without or 5-fold<br>selectable<br>additionally<br>without | 50 or 25 kHz<br><br>50 kHz | 1 TTL <br><br>1  | SN 75114             | 115/220 V~<br>integral power<br>supply unit     |
|                | EXE 808   | 25-fold                                                    | 15 kHz                     | 2 TTL                                                                                                 | SN 75114             | 115/220 V~<br>integral power<br>supply unit     |
| <b>3</b>       | EXE 802   | without or 5-fold<br>selectable                            | 50 or 25 kHz               | 2 TTL                                                                                                 | SN 75114             | 115/220 V~<br>integral power<br>supply unit     |
|                | EXE 805   | without or 5-fold<br>selectable<br>additionally<br>without | 50 or 25 kHz<br><br>50 kHz | 1 TTL <br><br>1  | SN 75114             | 115/220 V~<br>integral power<br>supply unit     |
|                | EXE 837   | Axis 1: 25-fold<br>Axis 2: 5-fold<br>Axis 3: 5-fold        | 15 kHz<br>25 kHz<br>25 kHz | 2 TTL                                                                                                 | MC 3487              | 100 ... 240 V~<br>integral power<br>supply unit |
|                | EXE 838   | Axis 1: 25-fold<br>Axis 2: 25-fold<br>Axis 3: 5-fold       | 15 kHz<br>15 kHz<br>25 kHz | 2 TTL                                                                                                 | MC 3487              | 100 ... 240 V~<br>integral power<br>supply unit |
|                | EXE 839   | Axis 1: 25-fold<br>Axis 2: 25-fold<br>Axis 3: 25-fold      | 15 kHz<br>15 kHz<br>15 kHz | 2 TTL                                                                                                 | MC 3487              | 100 ... 240 V~<br>integral power<br>supply unit |

# Measuring Steps

| LS 101, 101 C<br>LID 311, 311 C<br>LID 351, 351 C<br>MT 60, MT 101                                                           | LS 107, 107 C<br>LS 403, 403 C<br>LS 404, 404 C<br>LS 704, 704 C<br>ULS 300, 300 C      | LIDA 190                                                      | LIDA 201<br>LIDA 225<br><br>LB 326                                                                                                  | LIP 101                                           |
|------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------|---------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------|
| 0.5 µm<br>1 µm<br>(0.00002 in.<br>0.00005 in.)                                                                               | 1 µm<br>(0.00005 in.)                                                                   | 2 µm<br>10 µm<br>(0.0001 in.<br>0.0005 in.)                   | 5 µm<br>10 µm<br>(0.0002 in.<br>0.0005 in.)                                                                                         | 0.2 µm<br>(0.00001 in.)                           |
| 0.5 µm<br>(0.00002 in.)                                                                                                      | 0.5 µm<br>(0.00002 in.)                                                                 | 1 µm<br>(0.00005 in.)                                         | 5 µm<br>(0.00020 in.)                                                                                                               | 0.1 µm<br>0.2 µm<br>(0.000005 in.<br>0.00001 in.) |
| 0.5 µm<br>1 µm<br>(0.00002 in.<br>0.00005 in.)                                                                               | 1 µm<br>2 µm<br>(0.00005 in.<br>0.0001 in.)                                             | 1 µm<br>2 µm<br>(0.00005 in.<br>0.0001 in.)                   | 5 µm<br>10 µm<br>(0.0002 in.<br>0.0005 in.)                                                                                         | 0.2 µm<br>0.5 µm<br>(0.00001 in.<br>0.00002 in.)  |
| 0.05 µm<br>0.1 µm<br>(0.000002 in.<br>0.000005 in.)                                                                          | 0.1 µm<br>(0.000005 in.)                                                                | 0.2 µm<br>(0.00001 in.)                                       | 0.5 µm<br>1 µm<br>(0.00002 in.<br>0.00005 in.)                                                                                      | 0.02 µm<br>(0.000001 in.)                         |
| 0.1 µm<br>0.2 µm<br>(0.000005 in.<br>0.00001 in.)                                                                            | 0.2 µm<br>(0.00001 in.)                                                                 | —                                                             | 1 µm<br>2 µm<br>(0.00005 in.<br>0.0001 in.)                                                                                         | —                                                 |
| 0.1 µm<br>0.2 µm<br>(0.000005 in.<br>0.00001 in.)                                                                            | 0.2 µm<br>(0.00001 in.)                                                                 | —                                                             | 1 µm<br>2 µm<br>(0.00005 in.<br>0.0001 in.)                                                                                         | —                                                 |
| 0.5 µm<br>1 µm<br>(0.00002 in.<br>0.00005 in.)                                                                               | 1 µm<br>(0.00005 in.)                                                                   | 2 µm<br>10 µm<br>(0.0001 in.<br>0.0005 in.)                   | 5 µm<br>10 µm<br>(0.0002 in.<br>0.0005 in.)                                                                                         | 0.2 µm<br>(0.00001 in.)                           |
| 0.5 µm<br>1 µm<br>(0.00002 in.<br>0.00005 in.)                                                                               | 1 µm<br>(0.00005 in.)                                                                   | 2 µm<br>10 µm<br>(0.0001 in.<br>0.0005 in.)                   | 5 µm<br>10 µm<br>(0.0002 in.<br>0.0005 in.)                                                                                         | 0.2 µm<br>(0.00001 in.)                           |
| 0.1 µm<br>0.2 µm<br>(0.000005 in.<br>0.00001 in.)                                                                            | 0.2 µm<br>(0.00001 in.)                                                                 | —                                                             | 1 µm<br>2 µm<br>(0.00005 in.<br>0.0001 in.)                                                                                         | —                                                 |
| 0.5 µm<br>1 µm<br>(0.00002 in.<br>0.00005 in.)                                                                               | 1 µm<br>(0.00005 in.)                                                                   | 2 µm<br>10 µm<br>(0.0001 in.<br>0.0005 in.)                   | 5 µm<br>10 µm<br>(0.0002 in.<br>0.0005 in.)                                                                                         | 0.2 µm<br>(0.00001 in.)                           |
| 0.5 µm<br>1 µm<br>(0.00002 in.<br>0.00005 in.)                                                                               | 1 µm<br>(0.00005 in.)                                                                   | 2 µm<br>10 µm<br>(0.0001 in.<br>0.0005 in.)                   | 5 µm<br>10 µm<br>(0.0002 in.<br>0.0005 in.)                                                                                         | 0.2 µm<br>(0.00001 in.)                           |
| A1: 0.1 µm<br>(0.000005 in.)<br>A2: 0.5 µm/1 µm<br>(0.00002 in./0.00005 in.)<br>A3: 0.5 µm/1 µm<br>(0.00002 in./0.00005 in.) | A1: 0.2 µm<br>(0.00001 in.)<br>A2: 1 µm<br>(0.00005 in.)<br>A3: 1 µm<br>(0.00005 in.)   | A1: —<br>A2: 2 µm<br>(0.0001 in.)<br>A3: 2 µm<br>(0.0001 in.) | A1: 1 µm/2 µm<br>(0.00005 in./0.0001 in.)<br>A2: 5 µm/10 µm<br>(0.0002 in./0.0005 in.)<br>A3: 5 µm/10 µm<br>(0.0002 in./0.0005 in.) | —                                                 |
| A1: 0.1 µm<br>(0.000005 in.)<br>A2: 0.1 µm<br>(0.000005 in.)<br>A3: 0.5 µm/1 µm<br>(0.00002 in./0.00005 in.)                 | A1: 0.2 µm<br>(0.00001 in.)<br>A2: 0.2 µm<br>(0.00001 in.)<br>A3: 1 µm<br>(0.00005 in.) | A1: —<br>A2: —<br>A3: 2 µm<br>(0.0001 in.)                    | A1: 1 µm/2 µm<br>(0.00005 in./0.0001 in.)<br>A2: 1 µm/2 µm<br>(0.00005 in./0.0001 in.)<br>A3: 5 µm/10 µm<br>(0.0002 in./0.0005 in.) | —                                                 |
| 0.1 µm<br>(0.000005 in.)                                                                                                     | 0.2 µm<br>(0.00001 in.)                                                                 | —                                                             | 1 µm<br>2 µm<br>(0.00005 in./<br>0.0001 in.)                                                                                        | —                                                 |

## EXE600 Series

Height 57 mm (2.24 in.)  
Width 80 mm (3.15 in.)  
Depth 175 mm (6.89 in.)



## EXE700 Series

Height 82 mm (3.23 in.)  
Width 262 mm (10.31 in.)  
Depth 263 mm (10.35 in.)



## EXE800 Series

Height 115 mm (4.53 in.)  
Width 280 mm (11.02 in.)  
Depth 270 mm (10.63 in.)





# HEIDENHAIN

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