

MS

Incremental Magnetic Scales

The robust MS incremental magnetic scales consist of a stainless steel carrier and an elastomer-bonded ferrite. The elasto-ferrite layer is magnetised with 2 mm, 2.032 mm or 5 mm long alternating magnetic poles that form an incremental magnetic pattern.

ACCURACY UP
TO $\pm 10 \mu\text{m/m}$

UP TO 150 m
LENGTH

DISTANCE
CODED
REFERENCE
MARK



Features and benefits

- ▶ Customer selectable position of reference mark
- ▶ Four accuracy grades available: $\pm 10 \mu\text{m/m}$, $\pm 20 \mu\text{m/m}$, $\pm 40 \mu\text{m/m}$, $\pm 100 \mu\text{m/m}$
- ▶ Partial arc application possibility
- ▶ Optional protective cover foil for heavy duty applications
- ▶ Excellent resistance to dirt, dust and humidity
- ▶ Easy installation with adhesive tape, end clamps or track section



SMT PICK AND PLACE



PRINTING TECHNOLOGY



LINEAR MOTOR



INDUSTRIAL AUTOMATION

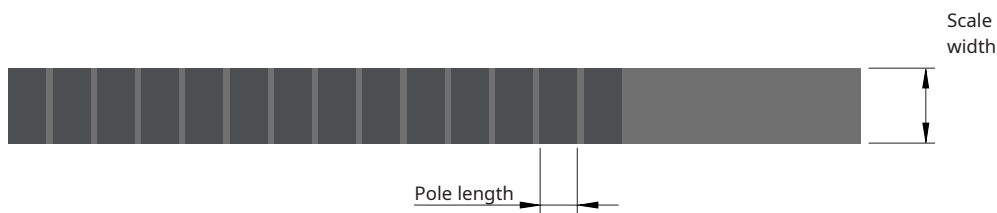


ASSEMBLY LINES

General information

The incremental RLS magnetic scales are compatible with RLS standard LM and component level RoLin readheads, which ensure reliable operation due to the non-contact design.

Selection guide



| Scale | Pole length [mm] | Scale width [mm] | Accuracy [μm/m] | Compatibility with readheads | | | | | | |
|-------------|------------------|------------------|-----------------|------------------------------|---------|---------|-------|--------|---------|---------|
| | | | | LM10 | LM13 | LM15 | RLB2 | RLC2HD | RLC2IC | RLM2 |
| MS05 | 2 | 5 | ±10 / ±20 / ±40 | - | - | - | No Ri | No Ri | Ri+DCRM | Ri+DCRM |
| MS07 | 2.032 | 5 | ±40 | - | - | - | - | - | - | Ri* |
| MS10 | 2 | 10 | ±10 / ±20 / ±40 | Ri+DCRM | Ri+DCRM | - | - | - | - | - |
| MS12 | 2.032 | 10 | ±40 | Ri* | Ri* | - | - | - | - | - |
| MS15 | 5 | 10 | ±100 | - | - | Ri+DCRM | - | - | - | - |

Ri - Unique and multiple reference mark or only incremental track available

No Ri - No unique and multiple reference mark option, only incremental track available

Ri+DCRM - Unique, multiple, distance-coded reference mark or only incremental track available

* Compatible with DPI version only.

For readhead specifications see data sheets available at [RLS Media center](#).

Storage and handling

Storage temperature



–40 °C to +60 °C

Operating temperature



Scale applied on the linear guide:

–40 °C to +100 °C

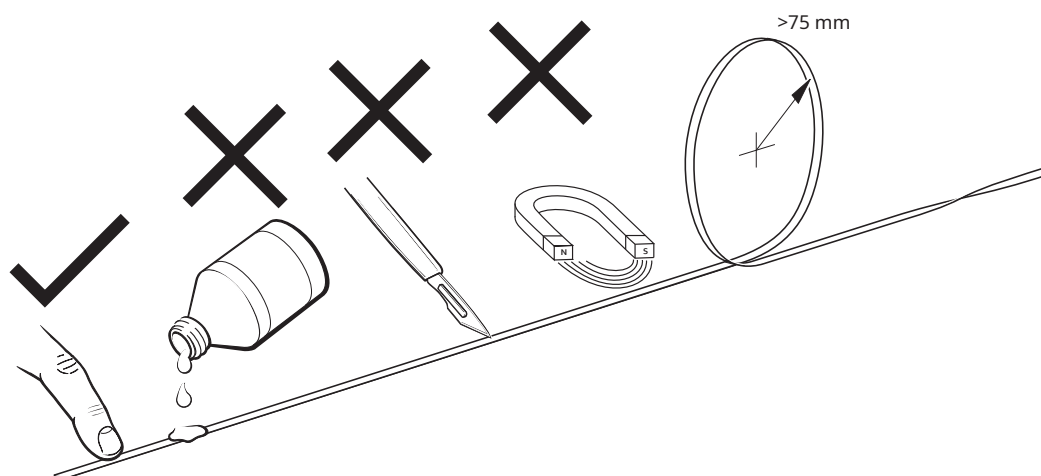
Scale applied on the curved surface:

–40 °C to +80 °C

Humidity



High resistance to humidity



It is strongly recommended that the scale is factory cut at RLS or the product warranty does not apply.

The magnetic scale should not be exposed to magnetic field densities higher than 50 mT on its surface, as this may damage the scale.

Chemical resistance

The use of alcohol for cleaning is considered safe, but it is not allowed to immerse the scale in alcohol. Furthermore, the scale surface print and drawn reference mark may disappear if the scale is not carefully cleaned.

For more information on chemical resistance [contact RLS](#).

Packaging

The type of packaging depends on both the length of the magnetic scale and its accuracy class. Shorter scales are packed individually, while scales with a longer length are rolled.

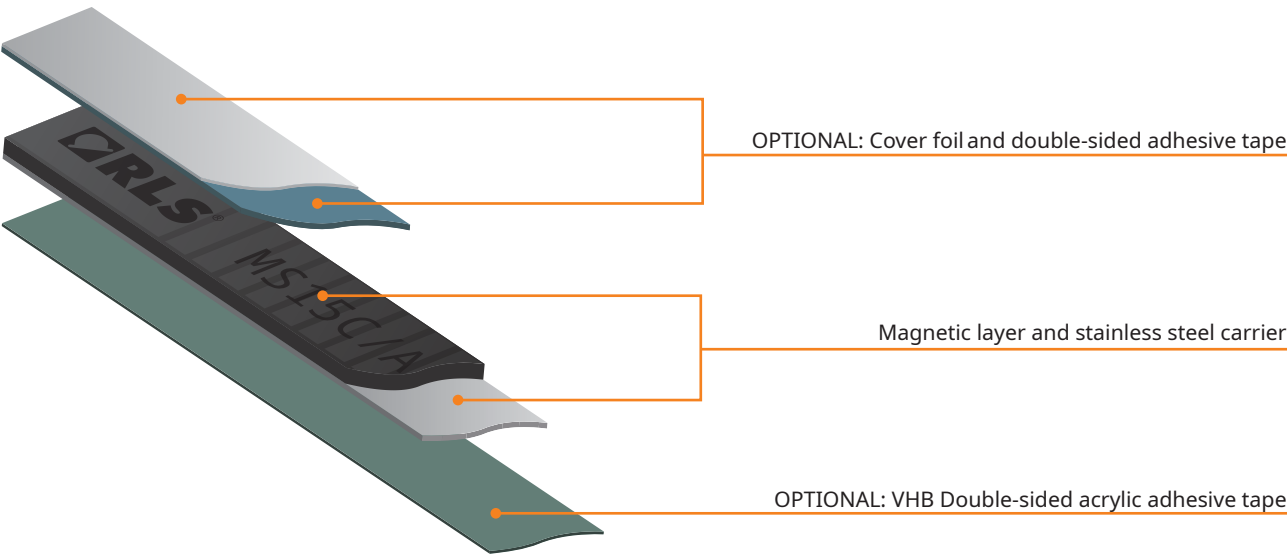
To maintain accuracy, special packaging is used for magnetic scales of accuracy class D; Scales shorter than 1 m are packed in a plastic tube, while spiral packaging is used for longer lengths. This prevents demagnetisation of the scale by maintaining the distance between the scale rolls.

When option B, H or N is selected, the protective cover foil is supplied with the scale. The cover foil is not mounted on the scale.

All MS magnetic scales have 12 months shelf life and should be installed within this period.

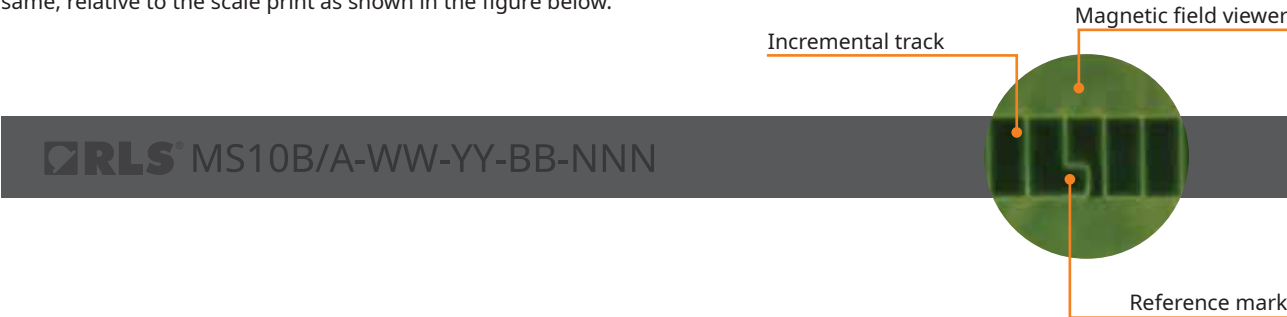
Magnetic scale design

Structure



Appearance and print

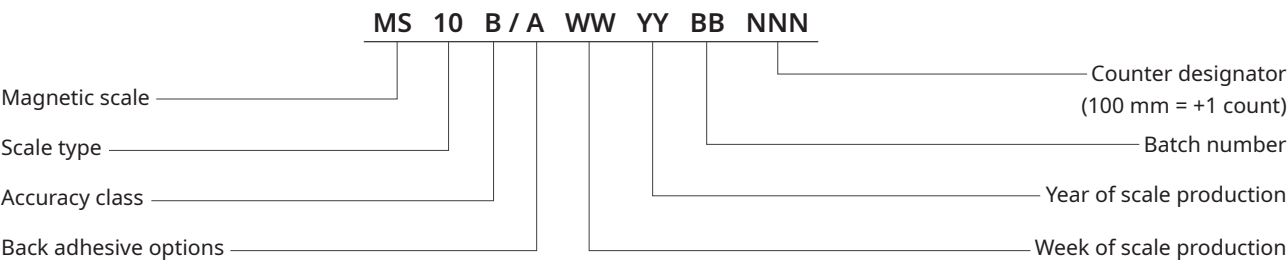
The orientation of the magnetised reference mark and the incremental track is always the same, relative to the scale print as shown in the figure below.



The shape of the reference mark may vary. The image is for representation purposes only.

Scale surface print description

Scale surface print appears every 100 mm and contains the RLS logo and a unique code.



Technical specifications

System data

| | | |
|------------------------|--|-----------|
| Pole length | 2 mm, 2.032 mm, 5 mm | |
| Reference mark | Unique, DCRM, multiple reference marks | |
| Scale accuracy* | Class A | ±20 µm/m |
| | Class B | ±40 µm/m |
| | Class C | ±100 µm/m |
| | Class D | ±10 µm/m |

*For more information about the accuracy please see the MST01 technical article at [RLS Media center](#).

Mechanical data

| | | |
|--|---|--|
| Material | Carrier | 1.4310 stainless steel |
| | Magnetic scale | NBR elasto-ferrite |
| Thickness | Carrier | 0.3 ±0.05 mm |
| | Double-sided acrylic adhesive tape VHB 3M9469 | 0.13 mm |
| | Cover foil | 0.076 ±0.006 mm |
| | Double sided tape | 0.05 mm |
| | Scale | 1.43 ±0.1 mm (with back adhesive) 1.3 ±0.1 mm (without back adhesive) |
| | | |
| Mass | MS05, MS07 | 0.031 kg/m |
| | MS10, MS12, MS15 | 0.062 kg/m |
| Width | MS05, MS07 | 5 ^{+0.15} _{-0.05} mm |
| | MS10, MS12, MS15 | 10 ^{+0.15} _{-0.05} mm |
| Cover foil width | CF05 (MS05, MS07) | 4.8 ±0.35 mm |
| | CF08 (MS10, MS12, MS15) | 7.6 ±0.35 mm |
| | CF10 (MS10, MS12, MS15) | 9.5 ±0.1 mm |
| Maximum length | Accuracy class A, B, C | 50 m (150 m with longer lead time*) |
| | Accuracy class D | 20 m |
| Expansion coefficient (carrier) | | ~17 × 106 [m/mK] |
| Minimum bending radius | | 75 mm |

*Not applicable for MS05 and MS07.

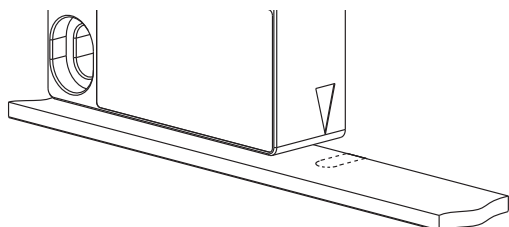
Environmental data

| | | |
|--------------------|-----------|---|
| Temperature | Operating | Scale applied on the linear guide: -40 °C to +100 °C Scale applied on the curved surface: -40 °C to +80 °C |
| | Storage | -40 °C to +60 °C |

Reference mark options

Unique reference mark

The readhead must be ordered with reference mark option A (see corresponding readhead data sheet). The magnetic scale must be ordered with reference mark (see **Part numbering**). If required, the cover foil can be installed over the reference mark. Magnetised reference mark will have a visible marking.



Magnetised reference mark

The shape and the position of the magnetised reference mark are critical so these options are only available as factory order.

Multiple reference mark

The readhead must be ordered with reference mark option A (see corresponding readhead data sheet). The magnetic scale must be ordered with reference mark option P (see **Part numbering**). Multiple reference marks are magnetised, factory predefined and spaced every 50, 100, or 200 mm on a 20 m long scale. For custom options please **contact RLS**.

Distance coded reference marks (DCRM)

The readhead must be ordered with reference mark option A (see corresponding readhead data sheet). The magnetic scale must be ordered with reference mark option D and a basic increment value specified as K (see **Part numbering**). The distance coded reference mark option provides multiple magnetised reference marks that are individually spaced according to a specific mathematical algorithm. The absolute position is calculated after traversing 2 consecutive reference marks. Maximum length and minimum traverse depend on basic spacing (K) between the reference marks, as shown in the figure below. which is customer selectable at point of order.

The basic increment K (in mm) is chosen at the point of order and must be divisible by $2 \times P$ with no remainder. **K** determines:

Maximum codable length:

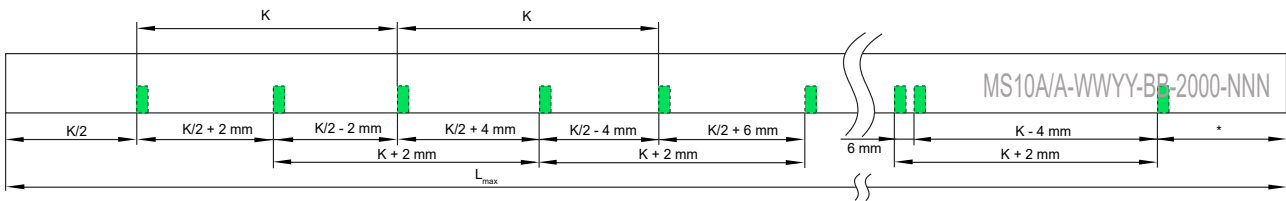
$$L_{\max} = K \left(\frac{K}{2P} - 1 \right) - 2P$$

L_{\max} - Maximum codable length (in mm)
K - Basic increment (in mm)
P - Pole length (in mm)

Minimum distance along the measuring scale which needs to be traversed in order to calculate the absolute position.

The minimum travel distance equals the basic increment **K - 2P**.

The distribution of the reference marks is shown in the figure below. DCRMs are produced by additional magnetisation of the magnetic scale.



* Depends on magnetic scale length.

| K (mm) | Maximum codable length (mm) | |
|--------|-----------------------------|----------|
| | P = 2 mm | P = 5 mm |
| 20 | 76 | |
| 40 | 356 | |
| 60 | 836 | |
| 80 | 1,516 | |
| 100 | 2,396 | 890 |
| 200 | 9,796 | 3,790 |
| 300 | 22,196 | 8,690 |
| 400 | 39,596 | 15,590 |
| 500 | 61,996 | 24,490 |
| 600 | 89,396 | 35,390 |
| 700 | | 48,290 |
| 800 | | 63,190 |
| 900 | | 80,090 |
| 1,000 | | 98,990 |

There must be at least 3 reference marks on the scale.

Basic increment (K in mm) - Represents the distance in mm between odd reference marks; it determines the maximum codable length over which the absolute position can be defined. It also determines the minimum distance which needs to be traversed to capture 2 adjacent reference marks. The basic distance should be divisible by the length of 2 poles (in mm). K is customer selectable.

Maximum codable length (L_{max} in mm) - Is the maximum length of the magnetic scale over which the DCRM feature can be applied and still provide a unique absolute position. Lengths shorter than the maximum length may be used (see Table 1).

Pole length (P in mm) - Is the length of a magnetised pole (S or N). We currently offer magnetic scales with pole lengths of 2 mm (MS10) and 5 mm (MS15).

How the absolute position is evaluated

The absolute position of the first traversed reference mark is calculated by the following formula:

$$RI1 = \left[\frac{1}{P} \times \text{abs}(2 \times \Delta RI - K) - \text{sgn}(2 \times \Delta RI - K) - 1 \right] \times \frac{K}{2} + [\text{sgn}(2 \times \Delta RI - K) - \text{sgn}(D)] \times \frac{\text{abs}(\Delta RI)}{2}$$

Variables

- RI1** - Absolute position of first traversed reference mark (in mm)
 ΔRI - Distance between two successively traversed reference marks (in mm)
K - Basic increment between two fixed reference marks (in mm)
D - Direction of movement (+1 or -1)

Operators

- abs** - Absolute value
sgn - Sign function (+1 or -1)

Timing of reference mark capturing

The minimum distance between 2 successive reference marks is equal to $3 \times P$. Subsequent electronics must be able to detect the position of 2 successive reference marks under the maximum speed condition. The minimum time for 2 successive reference marks to appear is given by the formula:

$$T_{Rimin} = \frac{3P}{v_{max}}$$

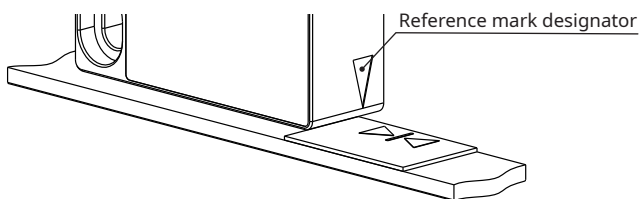
- T_{Rimin}** - Minimum time between 2 successive reference marks (in ms)
P - Pole length (in mm)
 v_{max} - Maximum traverse speed (in m/s)

Periodic reference mark

The readhead must be ordered with reference mark option C (see corresponding readhead data sheet). The magnetic scale must be ordered without reference mark option (see **Part numbering**). The position information is output in incremental quadrature format with periodic reference pulses. The periodic reference pulses correspond to the magnetic pole length.

Stick-on reference mark

The readhead must be ordered with reference mark option A (see corresponding readhead data sheet). The magnetic scale must be ordered without reference mark option (see **Part numbering**). After the scale is installed, a reference mark sticker can be applied to the desired position on top of the scale using the reference mark applicator tool. Make sure that the reference mark sticker is aligned with the corresponding side of the readhead where the reference mark designator is located. It is recommended that the stick-on reference mark is applied for prototyping purposes only. As soon as the applications go to serial production, it is recommended to use a predefined magnetised reference mark. For the part number of the reference mark and applicator tool, see Accessories on **page 27**.



Stick-on reference mark is only available for MS10 scale.

Installation instructions

Installation with adhesive tape

Applicable for MS05, MS07, MS10, MS12 and MS15

Installation surface preparation

Magnetic scales can be equipped with VHB backside adhesive tape. Most substrates are best prepared by cleaning with a 50:50 mixture of isopropyl alcohol and water before applying the magnetic scale. Exceptions to the general procedure that may require additional surface preparation include:

- Heavy oil/grease: To remove heavy oil or grease from a surface, a degreaser or solvent-based cleaning agent may be required, followed by cleaning with IPA/water.
- Abrasion: Sanding a surface and then cleaning with IPA/water can remove heavy dirt or oxidation and improve adhesion.
- Adhesion promoters: Priming a surface can significantly improve initial and ultimate adhesion to many materials such as plastics and paints.
- Porous surfaces: Most porous and fibrous materials such as wood, chipboard, concrete, etc. must be sealed to provide a unified surface.
- Unique materials: Special surface preparation may be required for glass and glass-like materials, copper and copper-containing metals, plastics or rubber containing migrating components (e.g. plasticisers).

Further information can be found online under "Surface Preparation for 3M™ VHB™ Tape Applications".

Scale application

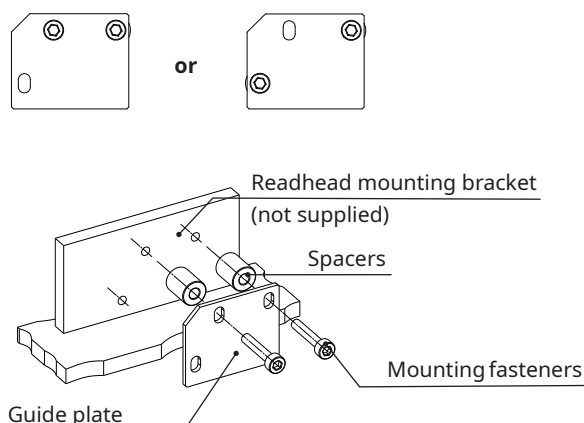
To simplify the scale installation use the scale applicator tool LMA10ASC00 with LM10/LM15 readhead or LM13ASC00 applicator tool with LM13 readhead. Mount the applicator tool to the readhead mounting bracket. Use two fasteners as per readhead mounting configuration.



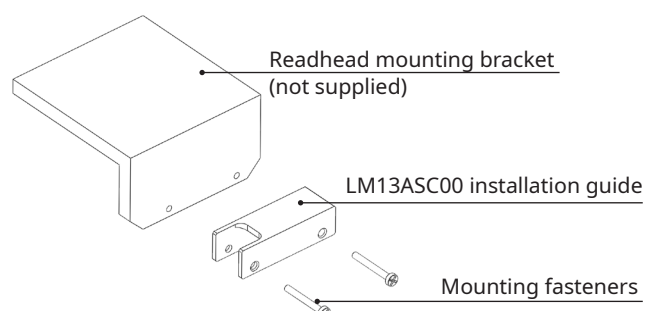
Explainer video: Installation process using applicator tool for LM10/LM15

Fastener mounting variants

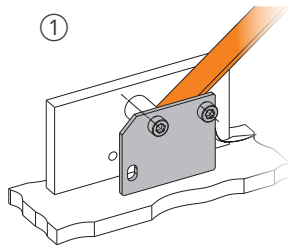
LM10 readhead with LMA10ASC00 applicator tool



LM13 readhead with LM13ASC00 applicator tool

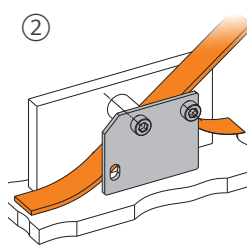


Good surface contact can be achieved by applying a pressure of about 100 kPa. At room temperature, approximately 50 % of the final bond strength is achieved after 20 minutes, 90 % after 24 hours and 100 % after 72 hours. Dynamic overlap shear (peak force to separate is measured after 72 hours dwell time): 830 kPa.



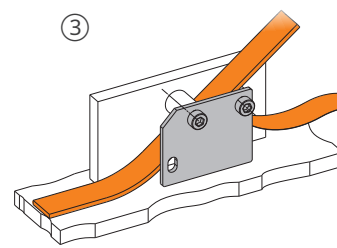
Load the scale into the applicator tool.

Separate the backing paper from the first 40 mm of scale and feed the scale into the applicator tool.



Apply the scale.

Push the scale carefully through to the end of scale mark, ensuring that it does not stick to the mounting surface until it is in position. Attach the end of the scale to the mounting surface with light finger pressure.



Ensure complete adhesion.

Apply firm finger pressure along the full length of the scale from the centre outwards to each end.

To prevent the scale sticking to the mounting surface during this operation it may be necessary to re-apply approximately 20 mm of backing paper to the end of the scale before inserting through applicator tool.

Traverse the axis through its full travel at a slow, steady speed. While moving the axis apply a light pressure (with a finger) to the scale behind the applicator tool to attach it to the mounting surface and gently pull the backing paper away from the applicator tool as it is separated.

4. Apply cover foil (if used).

Degrease the scale surface with alcohol and install as per scale installation instructions in step 3 onwards.

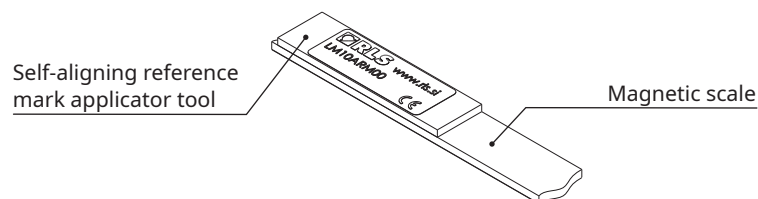
5. Remove the applicator tool.

When the scale has been applied unbolt the applicator tool from the readhead mounting bracket.

Steps 6-10 apply for MS10 system only.

6. Apply the stick-on reference mark (if used).

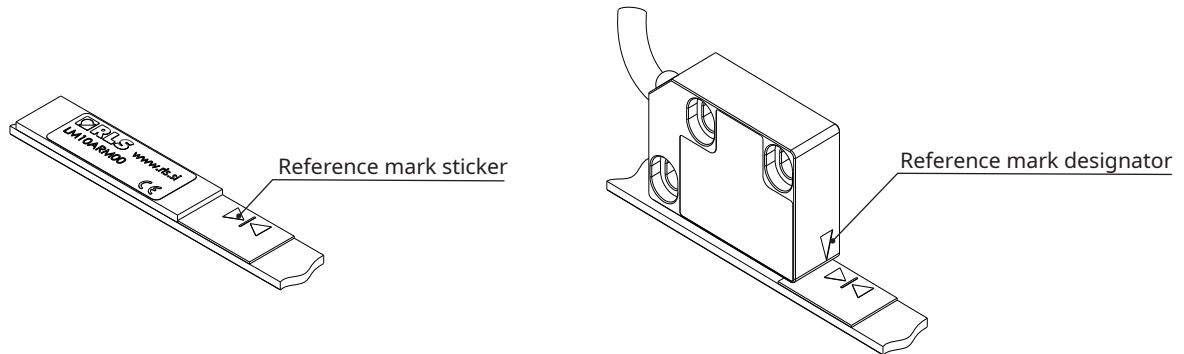
Place the LM10ARM00 reference mark applicator tool on scale in the correct orientation/required position along the length.



9. Stick the reference mark on the scale.

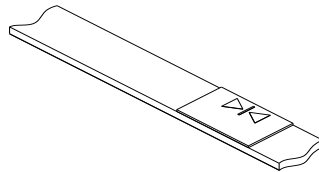
Remove the backing paper from the reference mark sticker and carefully attach it to the surface of the scale by placing it next to the applicator tool.

Correct orientation of the reference mark is crucial. The mark on the sticker should be on the same side as the reference mark designators.



10. Remove the stick-on reference mark applicator tool.

Remove the applicator tool leaving the reference mark sticker in the desired position.



Do not remove the scale for refitting or use elsewhere once it has been applied to the mounting surface. The scale can be applied only once.

Partial arc installation

Applicable for MS05, MS07, MS10, MS12 and MS15

The minimum bending radius of the magnetic scale is 75 mm. It is advised using the end-clamps on both ends to prevent the scale from peeling off the surface.

Please note that installing the scale around the circular part will reduce the system total accuracy.

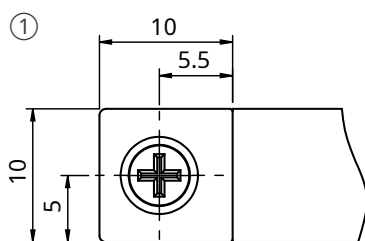
Installation with end clamps

Applicable for MS10, MS12 and MS15

End clamp kit has been designed to anchor the ends of the MS magnetic scale. Make sure the installation surface is clean and free of debris. Included in the kit are 2 end clamps and 2 fasteners M2.5 × 6 DIN 965.

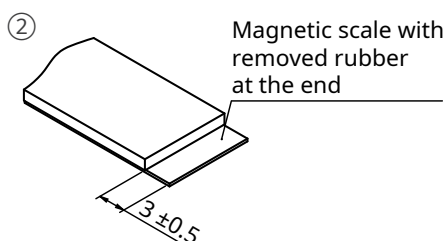
Installation process

All dimensions are in mm.



Prepare the mounting surface.

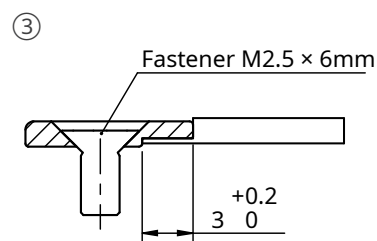
Drill the holes to the mounting surface as shown above. Refer to the table below for the minimum distance of the reference mark from the edge.



Prepare the magnetic scale.

If the scale was not ordered pre-prepared for installation with end clamps, please make sure that:

- the hole to hole distance is correct (Scale length + 6 mm),
- the rubber surface at the ends of the scale was cut and removed as shown in the figure above.



Install the scale to the surface.

Make sure that the scale has been cut to the correct length and the mounting surface has been cleaned. Install the self-adhesive scale using the scale applicator tool.

Install the end clamp.

Use the supplied fasteners and attach the end clamps so that the magnetic scale is held under the clamp.

| Magnetic scale | Minimum distance of the reference mark from the edge |
|----------------|--|
| MS10, MS15 | 13 mm |
| MS12 | 10 mm |

Magnetic scales can be mounted with end clamps only, without adhesive tape. However, in this case the mounting surface should be prepared for mounting. To prevent the magnetic scale from moving in the lateral axis, mill a 10 mm wide and >0.3 mm deep groove in the mounting surface.

If you mount the scale with end clamps only, without combining it with VHB, the recommended maximum length of the scale is 100 mm. End clamps are used to better fix the ends of the scale. We highly recommend to use both end clamps together with the VHB adhesive option.

Installation with TRS

Applicable for MS10 and MS15

TRS system is designed for applications that require an easily removable scale. The track system consists of aluminium guide rails, available in 1 m and 2 m sections, and a scale clamp element. It holds the magnetic scale securely while allowing it to expand and contract freely. The scale clamp provides a fixed point from which the MS scale can expand.

If damaged, the scale can be pulled out of the guide rails and replaced even if access is limited, reducing machine downtime. This feature also makes the system ideal for large machines that need to be disassembled for transport.

The design of the track section allows installation next to most standard guide rails or freely on any surface. This makes it suitable for many applications, such as automated assembly lines, packaging equipment, printing and other machines where the scale must be installed/removed for transport, or simply for all applications where the thermal expansion of the scale must be independent of the machine structure.

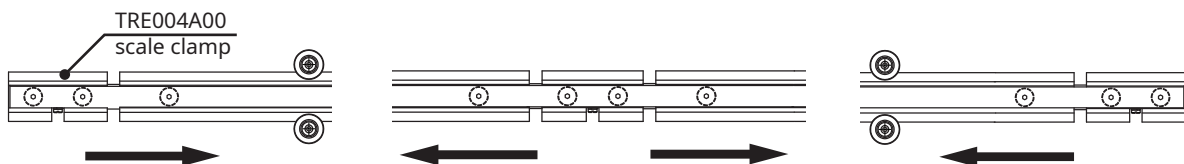
TRS technical specifications

| | |
|-----------------------------------|---|
| Material | Aluminium, EN AW-6060 |
| Mass | 157 g/m |
| Thermal expansion | ~25 $\mu\text{m}/\text{m}/^\circ\text{C}$ |
| Dimensions - cross section | 20 mm \times 4 mm |
| Available section lengths | 1 m, 2 m |

Installation tips

Thermal expansion control

The scale can be fixed either at the left/right end or at the center depending on the thermal expansion scheme.



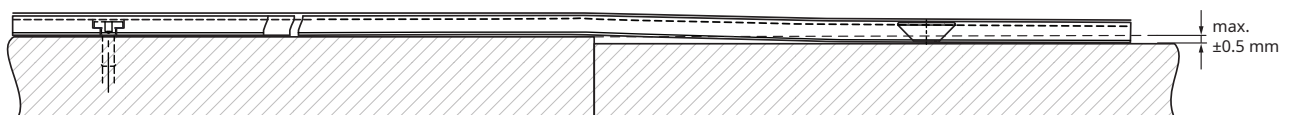
The scale expands to the **right**.

The scale expands in **both directions**.

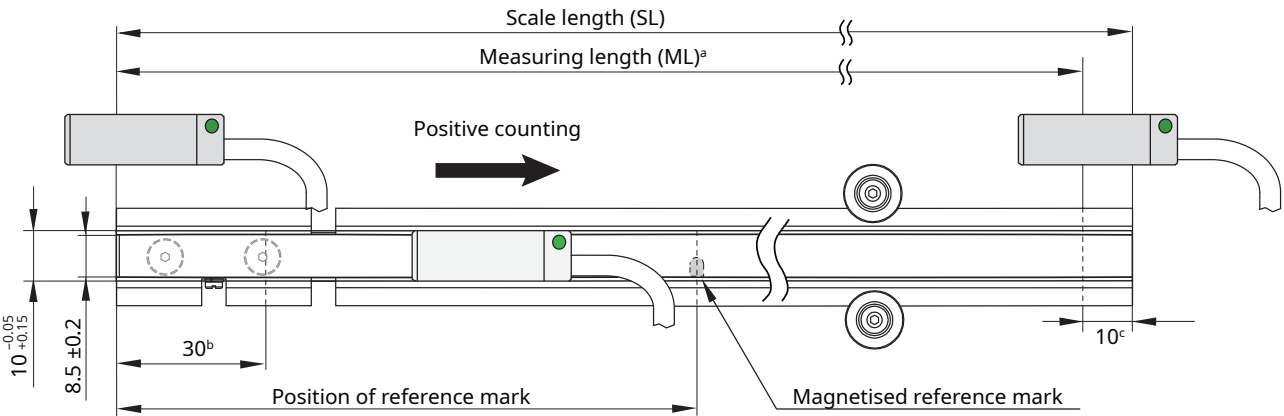
The scale expands to the **left**.

Alignment of different-level-substrate

The TRS system helps secure the level alignment of the scale across the whole axis.



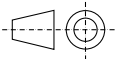
Example: LM10 on MS10 scale with track system



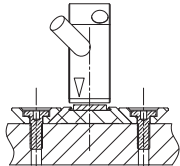
- ^a $ML = SL - 10 \text{ mm}$
^b Minimum distance of reference mark from left edge
^c Minimum distance of reference mark from right edge

Installation methods

All dimensions are in mm.

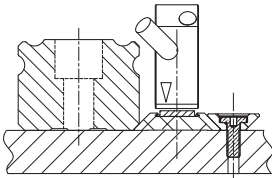


Installation method 1
(see [page 15](#))



No reference surface available.

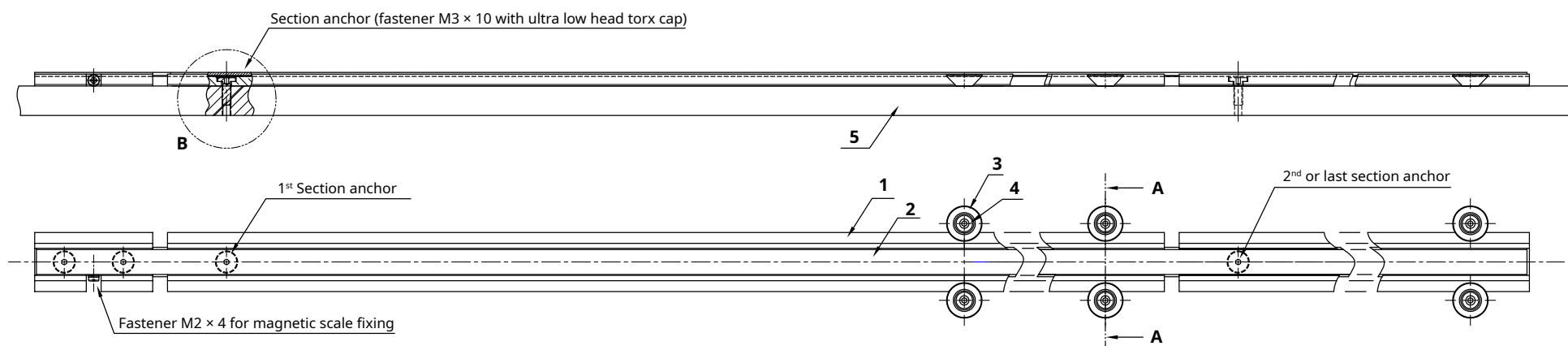
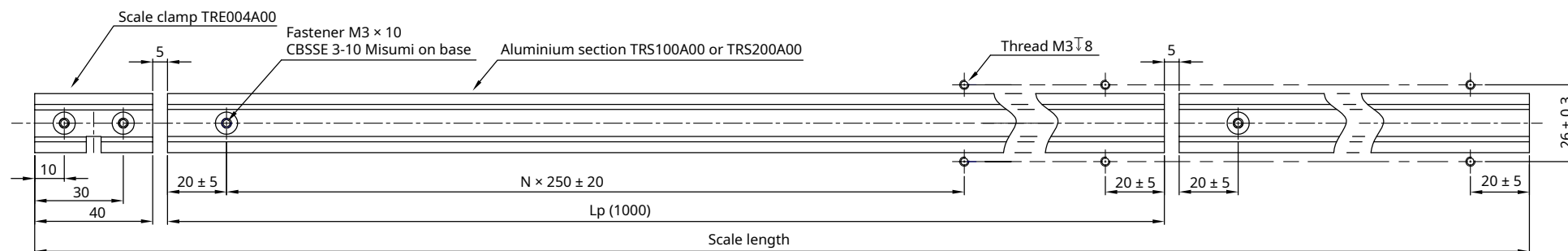
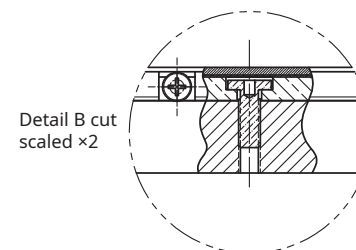
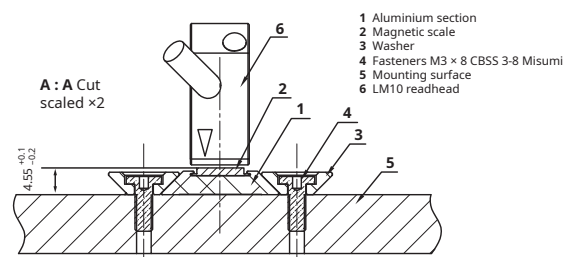
Installation method 2
(see [page 16](#))



Reference surface available for alignment of track section.

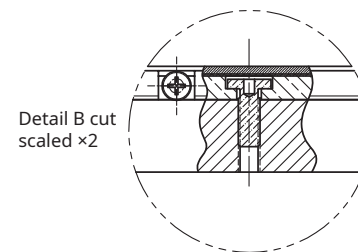
| Track section | Number of TRC00 (fasteners and washers) required | |
|---------------|--|-----------------------|
| | Installation method 1 | Installation method 2 |
| TRS100A00 | 8 | 4 |
| TRS200A00 | 16 | 8 |

Installation method 1



A: A Cut scaled x2

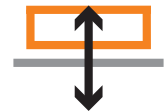
1 Aluminium section
 2 Magnetic scale
 3 Washer
 4 Fasteners M3 x 8 CBS5 3-8 Misumi
 5 Rail example
 6 Mounting surface
 7 LM10 readhead



Installation tolerances

Ride height

| Values in mm. | | LM10/LM13 | LM15 | RLB, RLC, RLM |
|-----------------|---------------|-------------------------------------|-------------------------------------|-------------------------------------|
| No cover foil | No Ri | 0.3 ^{+1.2} _{-0.2} | 0.5 ^{+3.5} _{-0.4} | 0.3 ^{+0.5} _{-0.2} |
| | Magnetised Ri | 0.3 ^{+0.7} _{-0.2} | 0.5 ^{+2.5} _{-0.4} | |
| | Stick-on Ri | 0.6 ^{+0.4} ₀ | – | – |
| With cover foil | No Ri | 0.3 ^{+1.1} _{-0.2} | 0.5 ^{+3.4} _{-0.4} | 0.3 ^{+0.4} _{-0.2} |
| | Magnetised Ri | 0.3 ^{+0.6} _{-0.2} | 0.5 ^{+2.4} _{-0.4} | |



Lateral offset

| Values in mm. | LM10/LM13 | LM15 | RLB, RLC, RLM |
|---------------|-----------|---------|---------------|
| No Ri | 0 ± 1 | 0 ± 1 | 0 ± 0.5 |
| Magnetised Ri | 0 ± 0.7 | 0 ± 0.7 | |
| Stick-on Ri | 0 ± 1 | – | – |



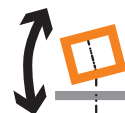
Roll

| Values in °. | LM10/LM13/LM15 | RLB, RLC2HD | RLM, RLC2IC* |
|--------------|----------------|-------------|--------------|
| | ±3 | ±2 | ±1 |



Pitch

| Values in °. | LM10/LM13/LM15 | RLB, RLC2HD | RLM, RLC2IC* |
|--------------|----------------|-------------|--------------|
| | ±3 | ±2 | ±1 |



Yaw

| Values in °. | LM10/LM13/LM15 | RLB, RLC2HD | RLM, RLC2IC* |
|--------------|----------------|-------------|--------------|
| | ±3 | ±2 | ±1 |



*Values apply for all RLC2IC encoder variants.

 Readhead
 Magnetic scale

Maximum speed tables

MS05, MS10

Readheads LM10, RLB, RLC2HD, RLC2IC, RLM

| Resolution [μm] | Counts / 2 mm | Maximum speed [m/s] | | | | | | | | |
|-------------------------------|---------------|---------------------|-------|-------|-------|-------|-------|-------|-------|------|
| ≈ 0.244 | 8,192 | 1.82 | 0.91 | 0.23 | 0.11 | 0.06 | 0.03 | 0.02 | 0.01 | 0.01 |
| ≈ 0.488 | 4,096 | 3.65 | 1.82 | 0.46 | 0.23 | 0.12 | 0.06 | 0.05 | 0.02 | 0.01 |
| ≈ 0.976 | 2,048 | 7.30 | 3.65 | 0.91 | 0.46 | 0.24 | 0.12 | 0.10 | 0.05 | 0.02 |
| 1 | 2,000 | 7.47 | 3.73 | 0.93 | 0.47 | 0.24 | 0.12 | 0.10 | 0.05 | 0.02 |
| 1.25 | 1,600 | 9.33 | 4.67 | 1.17 | 0.58 | 0.30 | 0.16 | 0.12 | 0.06 | 0.03 |
| ≈ 1.953 | 1,024 | 14.58 | 7.30 | 1.82 | 0.91 | 0.48 | 0.24 | 0.19 | 0.10 | 0.05 |
| 2 | 1,000 | 14.93 | 7.47 | 1.87 | 0.93 | 0.49 | 0.25 | 0.20 | 0.10 | 0.05 |
| 2.5 | 800 | 18.67 | 9.33 | 2.34 | 1.17 | 0.61 | 0.31 | 0.25 | 0.12 | 0.06 |
| ≈ 3.906 | 512 | 29.17 | 14.58 | 3.65 | 1.82 | 0.95 | 0.49 | 0.38 | 0.19 | 0.10 |
| 4 | 500 | 29.87 | 14.93 | 3.73 | 1.87 | 0.97 | 0.50 | 0.39 | 0.20 | 0.10 |
| 5 | 400 | 37.33 | 18.67 | 4.67 | 2.34 | 1.22 | 0.62 | 0.49 | 0.25 | 0.12 |
| 6.25 | 320 | 46.67 | 23.33 | 5.84 | 2.91 | 1.52 | 0.78 | 0.61 | 0.31 | 0.16 |
| ≈ 7.812 | 256 | 58.34 | 29.17 | 7.30 | 3.65 | 1.90 | 0.97 | 0.77 | 0.39 | 0.19 |
| 10 | 200 | 74.67 | 37.33 | 9.33 | 4.67 | 2.43 | 1.24 | 0.98 | 0.50 | 0.25 |
| 12.5 | 160 | 46.67 | 23.33 | 5.84 | 2.91 | 1.52 | 0.78 | 0.61 | 0.31 | 0.16 |
| 15.625 | 128 | 80.00 | 58.34 | 14.58 | 7.30 | 3.81 | 1.94 | 1.53 | 0.77 | 0.39 |
| 20 | 100 | 74.67 | 37.33 | 9.33 | 4.67 | 2.43 | 1.24 | 0.98 | 0.50 | 0.25 |
| 25 | 80 | 46.67 | 23.33 | 5.84 | 2.91 | 1.52 | 0.78 | 0.61 | 0.31 | 0.16 |
| 31.25 | 64 | 80.00 | 80.00 | 29.17 | 14.58 | 7.62 | 3.89 | 3.07 | 1.55 | 0.78 |
| 50 | 40 | 46.67 | 23.33 | 5.84 | 2.91 | 1.52 | 0.78 | 0.61 | 0.31 | 0.16 |
| 62.5 | 32 | 80.00 | 80.00 | 58.34 | 29.17 | 15.22 | 7.78 | 6.14 | 3.10 | 1.56 |
| 125 | 16 | n/a | 80.00 | 80.00 | 58.34 | 30.43 | 15.56 | 12.28 | 6.19 | 3.11 |
| 250 | 8 | n/a | n/a | 80.00 | 80.00 | 60.86 | 31.11 | 24.56 | 12.39 | 6.23 |
| Minimum edge separation [μs] | | 0.07 | 0.13 | 0.50 | 1 | 2 | 4 | 5 | 10 | 20 |
| Maximum count frequency [MHz] | | 15 | 8 | 2 | 1 | 0.5 | 0.25 | 0.2 | 0.1 | 0.05 |
| Part numbering | | K | A | B | C | D | E | F | G | H |

MS05, MS10

Readheads LM13 and LM13_20 (high speed version)

| Resolution [μm] | Counts / 2 mm | Maximum speed (values in orange for special option 20) [m/s] | | | | | | | | |
|-------------------------------|---------------|--|------------|------------|------------|------------|------------|------------|-------|------|
| ≈ 0.244 | 8,192 | 1.82 | 0.91 | 0.23 | 0.11 | 0.06 | 0.03 | 0.02 | 0.01 | 0.01 |
| ≈ 0.488 | 4,096 | 3.65 | 1.82 | 0.46 | 0.23 | 0.12 | 0.06 | 0.05 | 0.02 | 0.01 |
| ≈ 0.976 | 2,048 | 7.30 | 3.65 | 0.91 | 0.46 | 0.24 | 0.12 | 0.10 | 0.05 | 0.02 |
| 1 | 2,000 | 7.47 | 3.73 | 0.93 | 0.47 | 0.24 | 0.12 | 0.10 | 0.05 | 0.02 |
| 1.25 | 1,600 | 9.33 | 4.67 | 1.17 | 0.58 | 0.30 | 0.16 | 0.12 | 0.06 | 0.03 |
| ≈ 1.953 | 1,024 | 14.58 | 7.30 | 1.82 | 0.91 | 0.48 | 0.24 | 0.19 | 0.10 | 0.05 |
| 2 | 1,000 | 14.93 | 7.47 | 1.87 | 0.93 | 0.49 | 0.25 | 0.20 | 0.10 | 0.05 |
| 2.5 | 800 | 18.67 | 9.33 | 2.34 | 1.17 | 0.61 | 0.31 | 0.25 | 0.12 | 0.06 |
| ≈ 3.906 | 512 | 20 / 29.17 | 14.58 | 3.65 | 1.82 | 0.95 | 0.49 | 0.38 | 0.19 | 0.10 |
| 4 | 500 | 20 / 29.87 | 14.93 | 3.73 | 1.87 | 0.97 | 0.50 | 0.39 | 0.20 | 0.10 |
| 5 | 400 | 20 / 37.33 | 18.67 | 4.67 | 2.34 | 1.22 | 0.62 | 0.49 | 0.25 | 0.12 |
| 6.25 | 320 | 20 / 46.67 | 20 / 23.33 | 5.84 | 2.91 | 1.52 | 0.78 | 0.61 | 0.31 | 0.16 |
| ≈ 7.812 | 256 | 20 / 58.34 | 20 / 29.17 | 7.30 | 3.65 | 1.90 | 0.97 | 0.77 | 0.39 | 0.19 |
| 10 | 200 | 20 / 74.67 | 20 / 37.33 | 9.33 | 4.67 | 2.43 | 1.24 | 0.98 | 0.50 | 0.25 |
| 12.5 | 160 | 20 / 46.67 | 20 / 23.33 | 5.84 | 2.91 | 1.52 | 0.78 | 0.61 | 0.31 | 0.16 |
| 15.625 | 128 | 20 / 80 | 20 / 58.34 | 14.58 | 7.30 | 3.81 | 1.94 | 1.53 | 0.77 | 0.39 |
| 20 | 100 | 20 / 74.67 | 20 / 37.33 | 9.33 | 4.67 | 2.43 | 1.24 | 0.98 | 0.50 | 0.25 |
| 25 | 80 | 20 / 46.67 | 20 / 23.33 | 5.84 | 2.91 | 1.52 | 0.78 | 0.61 | 0.31 | 0.16 |
| 31.25 | 64 | 20 / 80 | 20 / 80 | 20 / 29.17 | 14.58 | 7.62 | 3.89 | 3.07 | 1.55 | 0.78 |
| 50 | 40 | 20 / 46.67 | 20 / 23.33 | 5.84 | 2.91 | 1.52 | 0.78 | 0.61 | 0.31 | 0.16 |
| 62.5 | 32 | 20 / 80 | 20 / 80 | 20 / 58.34 | 20 / 29.17 | 15.22 | 7.78 | 6.14 | 3.10 | 1.56 |
| 125 | 16 | N/A | 20 / 80 | 20 / 80 | 20 / 58.34 | 20 / 30.43 | 15.56 | 12.28 | 6.19 | 3.11 |
| 250 | 8 | N/A | N/A | 20 / 80 | 20 / 80 | 20 / 60.86 | 20 / 31.11 | 20 / 24.56 | 12.39 | 6.23 |
| Minimum edge separation [μs] | | 0.07 | 0.13 | 0.50 | 1 | 2 | 4 | 5 | 10 | 20 |
| Maximum count frequency [MHz] | | 15 | 8 | 2 | 1 | 0.5 | 0.25 | 0.2 | 0.1 | 0.05 |
| Part numbering | | K | A | B | C | D | E | F | G | H |

MS07, MS12

Readhead LM13 (DPI), RLM (DPI)

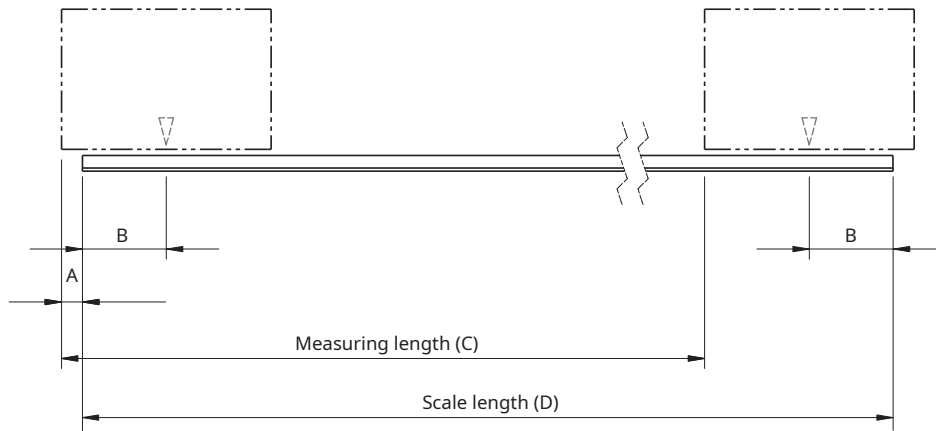
| Resolution [dpi] | Counts / 2 mm | Maximum speed [m/s] | | | | |
|-----------------------|---------------|---------------------|-------|-------|-------|-------|
| 25,600 | 2,048 | 4.11 | 1.03 | 0.52 | 0.25 | 0.13 |
| 25,000 | 2,000 | 4.23 | 1.06 | 0.53 | 0.25 | 0.13 |
| 20,000 | 1,600 | 5.28 | 1.32 | 0.66 | 0.31 | 0.16 |
| 12,800 | 1,024 | 8.24 | 2.05 | 1.03 | 0.49 | 0.25 |
| 12,500 | 1,000 | 8.45 | 2.11 | 1.06 | 0.50 | 0.26 |
| 10,000 | 800 | 10.57 | 2.63 | 1.32 | 0.63 | 0.32 |
| 6,400 | 512 | 16.50 | 4.11 | 1.59 | 0.98 | 0.50 |
| 6,250 | 500 | 16.91 | 4.23 | 2.11 | 1.01 | 0.52 |
| 5,000 | 400 | 21.13 | 5.28 | 2.63 | 1.26 | 0.64 |
| 4,000 | 320 | 25.00 | 6.60 | 3.30 | 1.57 | 0.81 |
| 3,200 | 256 | 25.00 | 8.24 | 4.11 | 1.95 | 1.01 |
| 2,500 | 200 | 25.00 | 10.57 | 5.28 | 2.50 | 1.29 |
| 2,000 | 160 | 25.00 | 6.60 | 3.30 | 1.64 | 0.81 |
| 1,600 | 128 | 25.00 | 16.50 | 8.24 | 3.92 | 2.00 |
| 1,250 | 100 | 25.00 | 10.57 | 5.28 | 2.50 | 1.29 |
| 1,000 | 80 | 25.00 | 6.60 | 3.30 | 1.64 | 0.81 |
| 800 | 64 | 25.00 | 25.00 | 16.50 | 7.85 | 4.02 |
| 500 | 40 | 25.00 | 6.60 | 3.30 | 1.57 | 0.81 |
| 400 | 32 | 25.00 | 25.00 | 25.00 | 15.72 | 8.05 |
| 200 | 16 | N/A | 25.00 | 25.00 | 25.00 | 16.09 |
| 100 | 8 | N/A | 25.00 | 25.00 | 25.00 | 25.00 |
| Edge separation [μs] | | 0.12 | 0.50 | 1 | 2 | 4 |
| Count frequency [kHz] | | 8333 | 2000 | 1000 | 500 | 250 |

MS15

Readhead LM15

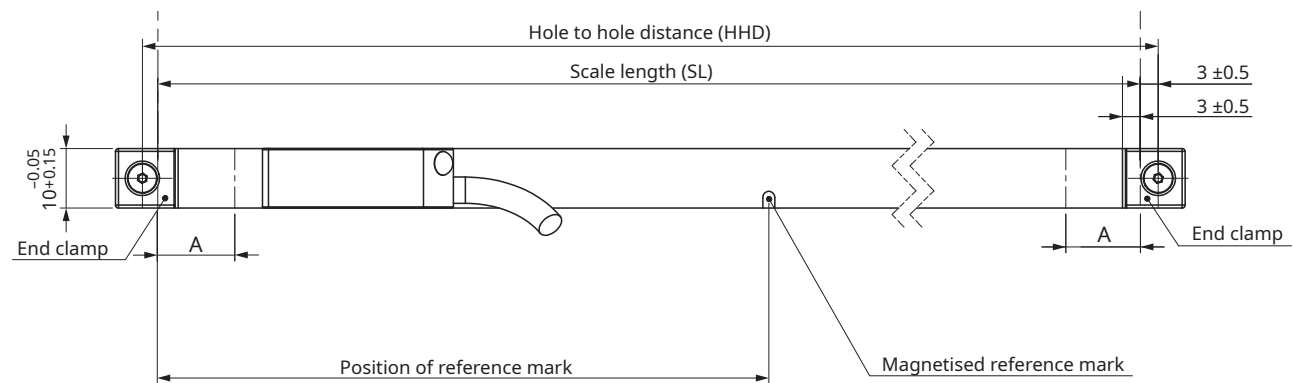
| Resolution [μm] | Counts / 5 mm | Maximum speed [m/s] | | | | | | | | |
|-------------------------------|---------------|---------------------|--------|--------|--------|--------|-------|-------|-------|-------|
| ≈ 0.61 | 8,192 | 4.56 | 2.28 | 0.57 | 0.28 | 0.15 | 0.08 | 0.06 | 0.03 | 0.02 |
| ≈ 1.22 | 4,096 | 9.12 | 4.56 | 1.14 | 0.57 | 0.30 | 0.15 | 0.12 | 0.06 | 0.03 |
| ≈ 2.441 | 2,048 | 18.24 | 9.12 | 2.28 | 1.14 | 0.59 | 0.30 | 0.24 | 0.12 | 0.06 |
| 2.5 | 2,000 | 18.68 | 9.32 | 2.33 | 1.17 | 0.61 | 0.31 | 0.25 | 0.12 | 0.06 |
| 3.125 | 1,600 | 23.32 | 11.68 | 2.92 | 1.46 | 0.76 | 0.39 | 0.31 | 0.15 | 0.08 |
| ≈ 4.882 | 1,024 | 36.44 | 18.24 | 4.56 | 2.28 | 1.19 | 0.61 | 0.48 | 0.24 | 0.12 |
| 5 | 1,000 | 37.32 | 18.68 | 4.68 | 2.33 | 1.22 | 0.62 | 0.49 | 0.25 | 0.12 |
| 6.25 | 800 | 46.68 | 23.32 | 5.84 | 2.92 | 1.52 | 0.78 | 0.61 | 0.31 | 0.16 |
| ≈ 9.765 | 512 | 72.92 | 36.44 | 9.12 | 4.56 | 2.38 | 1.22 | 0.96 | 0.48 | 0.24 |
| 10 | 500 | 74.68 | 37.32 | 9.32 | 4.68 | 2.43 | 1.24 | 0.98 | 0.50 | 0.25 |
| 12.5 | 400 | 93.32 | 46.68 | 11.68 | 5.84 | 3.04 | 1.56 | 1.23 | 0.62 | 0.31 |
| 15.625 | 320 | 116.68 | 58.32 | 14.60 | 7.28 | 3.80 | 1.94 | 1.54 | 0.77 | 0.39 |
| ≈ 19.531 | 256 | 145.84 | 72.92 | 18.24 | 9.12 | 4.76 | 2.43 | 1.92 | 0.97 | 0.49 |
| 25 | 200 | 186.68 | 93.32 | 23.32 | 11.68 | 6.08 | 3.11 | 2.46 | 1.24 | 0.62 |
| 31.25 | 160 | 116.68 | 58.32 | 14.60 | 7.28 | 3.80 | 1.94 | 1.54 | 0.77 | 0.39 |
| 39.0625 | 128 | 200.00 | 145.84 | 36.44 | 18.24 | 9.52 | 4.86 | 3.84 | 1.94 | 0.97 |
| 50 | 100 | 186.68 | 93.32 | 23.32 | 11.68 | 6.08 | 3.11 | 2.46 | 1.24 | 0.62 |
| 62.5 | 80 | 116.68 | 58.32 | 14.60 | 7.28 | 3.80 | 1.94 | 1.54 | 0.77 | 0.39 |
| 78.125 | 64 | 200.00 | 200.00 | 72.92 | 36.44 | 19.04 | 9.72 | 7.67 | 3.87 | 1.95 |
| 125 | 40 | 116.68 | 58.32 | 14.60 | 7.28 | 3.80 | 1.94 | 1.54 | 0.77 | 0.39 |
| 156.25 | 32 | 200.00 | 200.00 | 145.84 | 72.92 | 38.04 | 19.45 | 15.35 | 7.74 | 3.89 |
| 312.5 | 16 | n/a | 200.00 | 200.00 | 145.84 | 76.08 | 38.89 | 30.70 | 15.48 | 7.78 |
| 625 | 8 | n/a | n/a | 200.00 | 200.00 | 152.16 | 77.78 | 61.40 | 30.97 | 15.56 |
| Minimum edge separation [μs] | | 0.07 | 0.12 | 0.50 | 1 | 2 | 4 | 5 | 10 | 20 |
| Maximum count frequency [MHz] | | 15 | 8 | 2 | 1 | 0.5 | 0.25 | 0.2 | 0.1 | 0.05 |
| Part numbering | | K | A | B | C | D | E | F | G | H |

How to define scale length



| Readhead | A | B | C |
|----------|------|------------|-----------|
| LM10* | 9 mm | Min. 10 mm | D - 20 mm |
| LM13* | 7 mm | Min. 10 mm | D - 20 mm |
| LM15* | 9 mm | Min. 10 mm | D - 20 mm |
| RLB | 1 mm | - | D - 10 mm |
| RLC2HD | 1 mm | - | D - 10 mm |
| RLC2IC | 2 mm | Min. 8 mm | D - 16 mm |
| RLM | 0 | Min. 8 mm | D - 10 mm |

Installation of MS magnetic scale with end clamps



$$\text{HHD} = \text{SL} + (6 \text{ mm} \pm 1 \text{ mm})$$

$$\text{Measuring length with end clamps} = \text{SL} - 26 \text{ mm}$$

A - The minimum distance of the reference mark from the edge

Part numbering

| | MS | 10 | B | 1000 | B | 0032 |
|---|----|----|---|------|---|------|
| Scale type | | | | | | |
| 05 - 2 mm pole length, 5 mm width | | | | | | |
| 07 - 2.032 mm pole length, 5 mm width | | | | | | |
| 10 - 2 mm pole length, 10 mm width | | | | | | |
| 12 - 2.032 mm pole length, 10 mm width | | | | | | |
| 15 - 5 mm pole length, 10 mm width | | | | | | |
| Accuracy class | | | | | | |
| A - ±20 µm/m C - ±100 µm/m | | | | | | |
| B - ±40 µm/m D - ±10 µm/m | | | | | | |
| Scale length | | | | | | |
| xxxx - xxxx equals scale length in cm Mxxx - xxx equals scale length in mm (for scale lengths below 1 m) | | | | | | |
| See next page for scale length defining. | | | | | | |
| Options | | | | | | |
| A - VHB back adhesive tape (standard) | | | | | | |
| B - VHB back adhesive tape; with cover foil * | | | | | | |
| C - VHB back adhesive tape; ends prepared for end clamping | | | | | | |
| G - No VHB back adhesive tape; sides prepared for insertion into track section | | | | | | |
| H - No VHB back adhesive tape, sides prepared for insertion into track section; with cover foil * | | | | | | |
| I - No back adhesive tape | | | | | | |
| N - No back adhesive tape; with cover foil * | | | | | | |
| P - No back adhesive tape; ends prepared for end clamping ** | | | | | | |
| * Cover foil is not factory mounted on the scale and must be ordered separately. | | | | | | |
| ** It can only be used when the magnetic scale is installed in the groove to prevent lateral sliding. The groove dimension must correspond to the scale width. | | | | | | |
| Reference mark | | | | | | |
| 0000 - No reference mark | | | | | | |
| xxxx - Reference mark; xxxx equals position of reference mark in cm (Reference mark position will be within ±1 mm from requested position) | | | | | | |
| Mxxx - Reference mark; xxx equals position of reference mark in mm (Reference mark position will be within ±1 mm from requested position) | | | | | | |
| Dxxx - Distance coded reference mark; xxx equals basic increment K | | | | | | |
| Pxxx - Multiple reference marks in mm; xxx equals distance between magnetised reference marks in mm, factory predefined to 50 mm, 100mm and 200 mm. (each reference mark position will be within ±1 mm from requested position) | | | | | | |

Cover foil part numbering

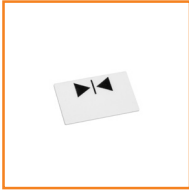
| | CF | 10 | 1000 |
|--|----|----|------|
| Cover foil width | | | |
| 05 - 5 mm | | | |
| 08 - 8 mm (for track system option only) | | | |
| 10 - 10 mm | | | |
| Cover foil length | | | |
| xxxx - xxxx equals foil length in cm | | | |

Not all part number combinations are valid. Please refer to the table of available combinations on the next page.

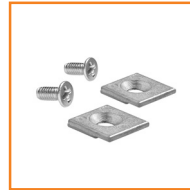
Table of available combinations

| Series | Scale type | Accuracy class | Scale length | Options | Reference mark |
|--------|------------|----------------|--------------|-------------------------------|---------------------------|
| MS | 05 | A / B / D | xxxx / Mxxx | A / B / C / I / N / P | 0000 / xxxx / Mxxx / Dxxx |
| | 07 | B | xxxx / Mxxx | | 0000 / xxxx / Mxxx |
| | 10 | A / B / D | xxxx / Mxxx | A / B / C / G / H / I / N / P | 0000 / xxxx / Mxxx / Dxxx |
| | | | 2000 | | P050 / P100 / P200 |
| | 12 | B | xxxx / Mxxx | | 0000 / xxxx / Mxxx |
| | 15 | C | xxxx / Mxxx | | 0000 / xxxx / Mxxx / Dxxx |

Accessories



Stick-on reference mark
LM10SRM00



End clamp kit
LM10ECL00

(2 clamps + 2 fasteners)



Applicator tool for stick-on
reference mark
LM10ARM00



Magnet viewer
MM0001



Applicator tool for magnetic
scale and cover foil
LM10ASC00



Applicator tool for magnetic
scale and cover foil
LM13ASC00



Track section, 1.00 m
TRS100A00

(1x fastener M3x10 included)



Track section, 2.00 m
TRS200A00

(1x fastener M3x10 included)



Fastener and washer
TRC00



Scale clamp with fasteners,
0.04 m
TRE004A00

(2x fastener M3x10 and 1x fastener
M2x4 included)

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Document issues

| Issue | Date | Page | Description |
|-------|-------------|---------|--|
| 1 | 3. 12. 2022 | General | New document |
| 2 | 11. 3. 2022 | General | Cut reference removed, AS output removed, Installation tolerances amended, Installation with adhesive tape amended, Installation with end clamps amended, TRS drawings amended, Part numbering amended |
| 3 | 22. 4. 2022 | 5 17 | Width tolerance amended RLM roll, pitch, yaw tolerance amended |

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