The LM10 is a contactless high-speed linear magnetic encoder designed for use in harsh environments.

The LM10 features a compact sealed readhead that rides at up to 1.0 mm from the self-adhesive magnetic strip scale, which brings up to 100 m travel.

Simple to install, the LM10 features an integral set-up LED on the readhead, wide installation tolerances and an applicator tool for the adhesive-backed magnetic scale. A bidirectional reference is provided that can be actuated either by a preset mark integrated within the scale or by adding a reference sticker on top of the scale with the help of a self-aligning installation tool.

The encoders come in digital or analogue output variants and offer a range of customer selectable resolutions including 1 µm, 2 µm, 5 µm, 10 µm, 20 µm and 50 µm. The LM10 is capable of velocities up to 25 m/s; even at 1 µm resolution it is capable of 4 m/s.

Engineered for extreme service, the solid-state LM10 linear encoders operate from -10 °C to +80 °C, have water-proof sealing to IP68 and are highly resistant to shock, vibrations and pressure. The robust magnetic scale is also resistant to a range of chemicals commonly found in industry.

The non-contact, frictionless design eliminates wear while reducing hysteresis.

The LM10 encoders bring reliable solutions to tough, hard-working applications including woodworking, stone-cutting, sawing, metalworking, textiles, printing, packaging, plastics processing, automation and assembly systems, laser/flame/water-jet cutting, electronic assembly equipment etc.

- Customer selectable resolutions from 50 µm to 1 µm
- Stick-on reference mark
- Distance coded reference mark option
- High speed operation
- Excellent dirt immunity
- Integral set-up LED
- Axis lengths of up to 100 m
- High reliability from proven non-contact sensing technology
- Industry standard digital and analogue output options
**LM10 dimensions**

Dimensions and tolerances in mm.

<table>
<thead>
<tr>
<th>Magnetic scale thickness (D)</th>
<th>Ride height (H)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No cover foil, cut or magnetised reference mark</td>
<td>1.5 (±0.2)</td>
</tr>
<tr>
<td>No cover foil, stick-on reference mark</td>
<td>1.5 (±0.2)</td>
</tr>
<tr>
<td>With cover foil, cut or magnetised reference mark</td>
<td>1.65 (±0.2)</td>
</tr>
<tr>
<td>With cover foil, stick-on reference mark</td>
<td>1.65 (±0.2)</td>
</tr>
</tbody>
</table>

* For larger ride height (H) please see LM15 linear encoder system (LM15D01).

**LM10 installation tolerances**

- **Ride height**
- **Pitch**
- **Yaw**
- **Lateral offset**
- **Roll**
LM10 technical specifications

System data

Maximum length for MS scale 50 m (100 m special order)
Pole length 2 mm
Available resolutions 1 µm, 2 µm, 5 µm, 10 µm, 20 µm and 50 µm
Sinusoidal period length 2 mm

Maximum speed

For analogue voltage output: 25 m/s
For digital output signals:

<table>
<thead>
<tr>
<th>Resolution (µm)</th>
<th>Maximum speed (m/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>4.16 1.04 0.52 0.26 0.13</td>
</tr>
<tr>
<td>2</td>
<td>8.32 2.08 1.04 0.52 0.25</td>
</tr>
<tr>
<td>5</td>
<td>20.80 5.20 2.59 1.30 0.63</td>
</tr>
<tr>
<td>10</td>
<td>25.00 10.40 5.20 2.59 1.27</td>
</tr>
<tr>
<td>20</td>
<td>25.00 10.40 5.20 2.59 1.27</td>
</tr>
<tr>
<td>50</td>
<td>25.00 6.50 3.25 1.62 0.79</td>
</tr>
</tbody>
</table>

Edge separation (µs) 0.12 0.50 1 2 4

Count frequency (kHz) 8333 2000 1000 500 250

Precision class for MS scales ±20 µm/m and ±40 µm/m

Linear expansion coefficient for MS scale ~ 17 × 10⁻⁶/K

Repeatability Better than unit of resolution for movement in the same direction

Hysteresis < 3 µm up to 0.5 mm ride height

Sub divisional error ±3.5 µm for < 0.7 mm ride height
±7.5 µm for 1 mm ride height

Mass Readhead (1 m cable, no connector) 57 g, Cable (1 m) 34 g
Magnetic scale (1 m) 60 g, Cover foil (1 m) 3.5 g

Cable data

Voltage drop over cable ~ 13 mV/m – without load
~ 54 mV/m – with 120 Ω load

Cable Ø4.2±0.2 mm, PUR high flexible cable, drag-chain compatible, double-shielded
8 × 0.05 mm²; durability: 20 million cycles at 20 mm bend radius

Environmental conditions

Temperature Operating -10 °C to +80 °C (cable under non-dynamic conditions: -20 °C to +85 °C)
Storage -40 °C to +85 °C

Environmental sealing IP68 (according to IEC 60529)

EMC Immunity

IEC 61000-6-2 (particularly: ESD: IEC 61000-4-2; EM fields: IEC 61000-4-3; Burst: IEC 61000-4-4; Surge: IEC 61000-4-5; Conducted disturbances: IEC 61000-4-6; Power frequency magnet fields: IEC 61000-4-8; Pulse magnetic fields: IEC 61000-4-9)

EMC Interference

IEC 61000-6-4 (for industrial, scientific and medical equipment: IEC 55011)

Vibrations (55 Hz to 2000 Hz) 300 m/s² (IEC 60068-2-6)

Shocks (11 ms) 300 m/s² (IEC 60068-2-27)
**LM10IB – Digital output signals, Open Collector NPN**

Square wave output

<table>
<thead>
<tr>
<th>Power supply</th>
<th>5 V to 30 V</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power consumption</td>
<td>&lt; 35 mA</td>
</tr>
<tr>
<td>Output signals</td>
<td>A, B, Z</td>
</tr>
<tr>
<td>Reference signal</td>
<td>1 or more square-wave pulses Z</td>
</tr>
<tr>
<td>Maximum load</td>
<td>10 mA</td>
</tr>
<tr>
<td>Cable length</td>
<td>See table below</td>
</tr>
</tbody>
</table>

### Maximum cable length **

<table>
<thead>
<tr>
<th>Power supply voltage</th>
<th>5 V</th>
<th>12 V</th>
<th>24 V</th>
<th>30 V</th>
</tr>
</thead>
<tbody>
<tr>
<td>Edge separation (µs)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.12</td>
<td>3</td>
<td>2.5</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>0.5</td>
<td>10</td>
<td>7</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>1</td>
<td>10</td>
<td>10</td>
<td>9</td>
<td>6</td>
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<tr>
<td>2</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>4</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>$R_L$ (Ω) *</td>
<td>500</td>
<td>1200</td>
<td>2400</td>
<td>3000</td>
</tr>
</tbody>
</table>

* Recommended values. For higher values of $R_L$ shorter cables should be used.

** Encoder cable length and all other cable extensions should be taken into account.

---

Set-up LED in the case of poor signal strength is flashing red.

---

**LM10IC – Digital output signals, RS422**

Square wave differential line driver to EIA RS422

<table>
<thead>
<tr>
<th>Power supply *</th>
<th>4.7 V to 7 V – voltage on readhead</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power consumption</td>
<td>&lt; 35 mA</td>
</tr>
<tr>
<td>Power supply rise time</td>
<td>&lt; 1 ms (for PRG option only)</td>
</tr>
<tr>
<td>Output signals</td>
<td>3 square-wave signals A, B, Z and their inverted signals A-, B-, Z-</td>
</tr>
<tr>
<td>Reference signal</td>
<td>1 or more square-wave pulse Z and its inverted pulse Z-</td>
</tr>
</tbody>
</table>
| Signal level | Differential line driver to EIA standard RS422:

  - $U_H \geq 2.5 \text{ V at } -I_I = 20 \text{ mA}$
  - $U_L \leq 0.5 \text{ V at } I_I = 20 \text{ mA}$

| Permissible load | $Z_2 \geq 100 \text{ Q between associated outputs}$
|-----------------|-----------------------------------|
| $I_I \leq 20 \text{ mA max. load per output}$
| Capacitive load ≤ 1000 pF
| Outputs are protected against short circuit to 0 V and to +5 V
| Alarm | High impedance on output lines A, B, A-, B- |
| Switching time (10 to 90 %) | $t^+,- < 30 \text{ ns (with 1 m cable and recommended input circuit)}$
| Cable length * | max. 100 m |

* Please consider voltage drop over cable.
LM10AV – Analogue output signals (1 Vpp)
2 channels \( V_1 \) and \( V_2 \) differential sinusoidals (90° phase shifted)

<table>
<thead>
<tr>
<th><strong>Power supply</strong> *</th>
<th>4.7 V to 7 V – voltage on readhead</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Reverse polarity protection</td>
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<tr>
<td><strong>Power consumption</strong></td>
<td>&lt; 50 mA</td>
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<tr>
<td><strong>Output signals</strong></td>
<td>( V_1, V_2, V_0 )</td>
</tr>
<tr>
<td><strong>Sine / cosine signals</strong></td>
<td>Amplitude 0.6 Vpp to 1.2 Vpp</td>
</tr>
<tr>
<td></td>
<td>(with 120 Ω termination)</td>
</tr>
<tr>
<td></td>
<td>Phase shift 90° ± 0.5°</td>
</tr>
<tr>
<td><strong>Reference signal</strong></td>
<td>Amplitude 0.8 Vpp to 1.2 Vpp</td>
</tr>
<tr>
<td></td>
<td>(with 120 Ω termination)</td>
</tr>
<tr>
<td></td>
<td>Position 45°</td>
</tr>
<tr>
<td></td>
<td>Width 22.5°</td>
</tr>
<tr>
<td><strong>Termination</strong></td>
<td>( Z_0 = 120 ) Ω between associated outputs</td>
</tr>
<tr>
<td><strong>Cable length</strong> *</td>
<td>max. 50 m</td>
</tr>
</tbody>
</table>

* Please consider voltage drop over cable.

---

**Timing diagram**

- \( (V_1^+)-(V_1^-) \)
- \( (V_2^+)-(V_2^-) \)
- \( (V_0^+)-(V_0^-) \)

- Amplitude: 0.6 Vpp to 1.2 Vpp (with 120 Ω termination)
- Phase shift: 90° ± 0.5°
- Position: 45°
- Width: 22.5°

* Please consider voltage drop over cable.
Reference mark

The repeatable bi-directional reference signal can be provided in 4 ways.

1) **Stick-on reference mark.** The LM10 readhead should be ordered with the reference mark option. After installation of the scale a reference mark sticker can be applied to the scale at the required position using the reference mark applicator tool. Ensure that the reference sticker is oriented to the corresponding side of the readhead that has the reference mark designator marked.

   ![](image1)

   Reference mark designator

2) **Selected at point of order.** The LM10 readhead should be ordered with the reference mark option. If required, the cover foil can be installed over the cut reference mark.

   ![](image2)

   Cut reference mark

   **NOTE:** The shape of the cut and position is critical so this option is only available as factory order.

3) **Every 2 mm.** The LM10 readhead should be ordered with this specific mode activated only.

4) **Distance coded reference mark.** The distance coded reference mark option provides multiple reference marks that are individually spaced according to specific mathematical algorithm. Absolute position is calculated after traversing 2 successive reference marks. Maximum length and minimal traverse depend on basic spacing (K) between reference marks, which is customer selectable at point of order. For further information please refer to Distance coded reference mark data sheet (LM10D17).

   ![](image3)

   Set-up LED

   After the installation of the magnetic scale (see LM10 Installation guide) the readhead can be easily adjusted on the machine using the set-up LED indicator.

   ![Set-up LED](image4)

   Green LED = good signal strength / set-up

   Red LED = poor signal strength – adjustment required

   A, B, A-, B- outputs become high impedance

   **NOTE:** IB output type: LED flashes red.

**Programming** (for IC output only)

Readheads can be ordered preset to the required resolution or provided so that they can be programmed as needed on the machine to the chosen resolution. This programming is carried out by connecting the readhead to a computer via a programming interface. The readhead must be ordered with the PRG option to use this function.

Positive direction

- **Digital output signals** – A leads B
- **Analogue output signals** (1 V_{pp}) – V_{i} leads V_{o}
**LM10 readhead part numbering**

LM10 system = Readhead + Scale

**Readhead part number**

eg LM10IC010CA10F00

**Magnetic scale part number**

eg MS10B1000B0032

### Output type
- **IB** - Incremental, Open Collector NPN; 5 V - 30 V
- **IC** - Incremental, RS422; 5 V
- **AV** - Analogue voltage, 1 Vpp; 5 V

### Resolution
- **000** - for **AV** output type
- For **IB** and **IC** output types:
  - **001** - 1 µm
  - **002** - 2 µm
  - **005** - 5 µm
  - **010** - 10 µm
  - **020** - 20 µm
  - **050** - 50 µm
- **PRG** - Programmable from 1 µm to 50 µm - preset to 1 µm (for **IC** output type)

### Minimum edge separation
- For **AV** output type
  - **A** - N/A
- For **IB** and **IC** output types:
  - **A** - 0.12 µs (8.3 MHz)*
  - **B** - 0.5 µs (2 MHz)
  - **C** - 1 µs (1 MHz)
  - **D** - 2 µs (0.5 MHz)
  - **E** - 4 µs (0.25 MHz)

* Default for **PRG** option.

### Special requirements
- **00** - No special requirements (standard)

### Connector option
- **A** - 9 pin D type plug
- **D** - 15 pin D type plug (for **IC** output type)
- **L** - 15 pin D type plug (for **AV** output type)
- **H** - 15 pin HD type plug (for **IC** output type)
- **P** - 9 pin D type plug (for **AV** output type)
- **F** - Flying lead (no connector)

### Cable length
- **10** - 1.0 m (standard)

### Reference
- **A** - With reference
- **B** - No reference
- **C** - Periodic as per scale pitch (2 mm)

---

The diagram illustrates the parts of the LM10 readhead system, including the readhead and magnetic scale, and provides a breakdown of the part numbers for both components. The text provides detailed specifications for each part, including output types, resolutions, edge separations, and special requirements.
Magnetic scale part numbering

Ends prepared for end clamping (option C)

Positive counting

Cut or magnetised reference mark

Hole to hole distance

Scale length

Measuring length

End clamp

Min. distance of reference mark from left edge

Min. distance of reference mark from right edge

Position of reference mark

1 Hole to hole distance = scale length + 6±1 mm (for end clamp mounting)

2 Measuring length = scale length - 17 mm

MS10 B 1000 B 0032

Precision class
A - ±20 µm/m
B - ±40 µm/m

Scale length
xxxx - Where xxxx equals scale length in cm

Reference mark
0000 - No reference mark
xxxx - Where xxxx equals position of machined reference mark in cm (reference mark position will be within ±1 cm from requested position)
Dxxx - Distance coded reference mark; where xxx equals basic increment in mm

Options
A - No cover foil
B - Cover foil supplied (separately - 5 cm longer than tape)
C - No cover foil, ends prepared for end clamping
G - Track system *

Accessories part numbering

Cover foil CF10 1000

Foil length
xxxx - Where xxxx equals foil length in cm

Stick-on reference mark LM10SRM00
Applicator tool for stick-on reference mark LM10ARM00
Applicator tool for magnetic scale and cover foil LM10ASC00
End clamp kit (2 clamps + 2 screws) LM10ECL00

* For details on TRS track system please refer to data sheet LM10D18
### Document issues

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<th>Date</th>
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<td>02</td>
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<td>Minor text errors corrected; Corrected Maximum speed table data on page 3</td>
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<td>Analogue output signal specifications added</td>
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<td>Ride height table added, lateral offset and yaw updated</td>
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<td>6</td>
<td>Distance coded reference mark option added</td>
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<td>Power supply voltage rise time added, Cable dimensions and weight added</td>
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