

# LM10 linear magnetic encoder system



**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  $\mu\text{m}$ , 2  $\mu\text{m}$ ,

5  $\mu\text{m}$ , 10  $\mu\text{m}$ , 20  $\mu\text{m}$  and 50  $\mu\text{m}$ . The LM10 is capable of velocities up to 25 m/s; even at 1  $\mu\text{m}$  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.

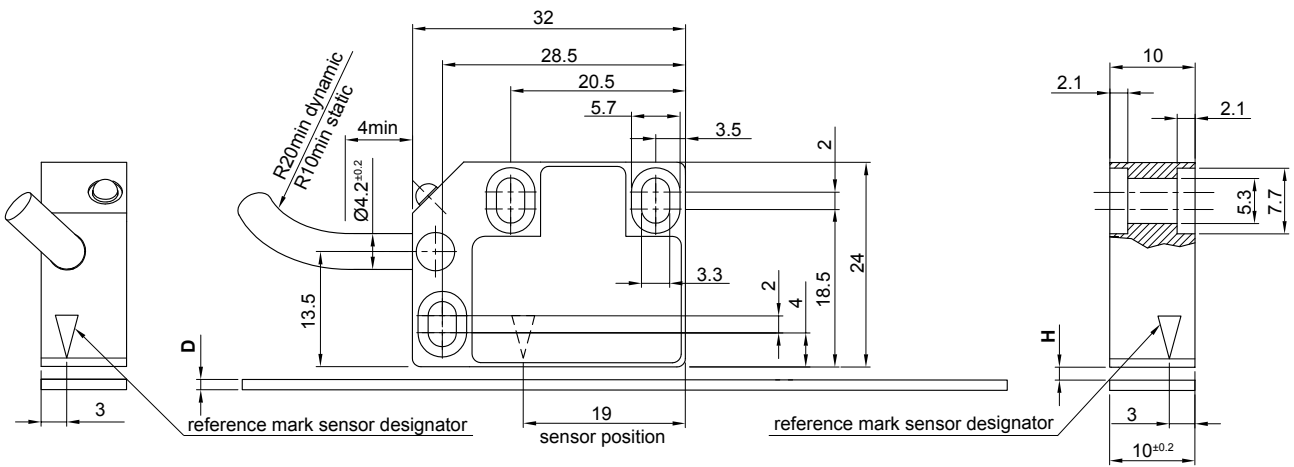
The non-contact, frictionless design eliminates wear while reducing hysteresis.

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  $\mu\text{m}$  to 1  $\mu\text{m}$
- 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.

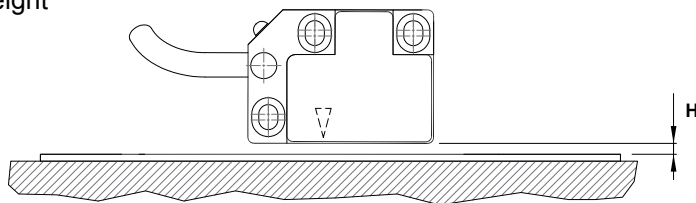


	Magnetic scale thickness (D)	Ride height (H)	
		Maximum range	Recommended range *
No cover foil, cut or magnetised reference mark	1.5 <sup>-0.2</sup>	0.1 - 1.5	0.1 - 1.0
No cover foil, stick-on reference mark	1.5 <sup>-0.2</sup>	0.5 - 1.5	0.5 - 1.0
With cover foil, cut or magnetised reference mark	1.65 <sup>-0.2</sup>	0.1 - 1.3	0.1 - 0.9
With cover foil, stick-on reference mark	1.65 <sup>-0.2</sup>	0.5 - 1.3	0.5 - 0.9

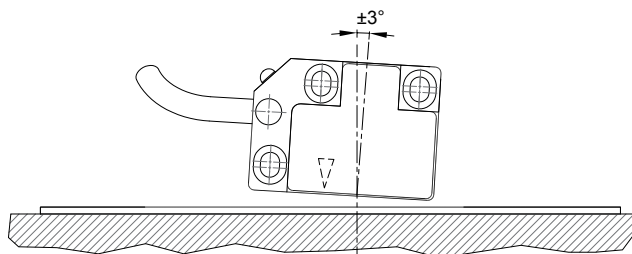
\* For larger ride height (H) please see LM15 linear encoder system (LM15D01).

### LM10 installation tolerances

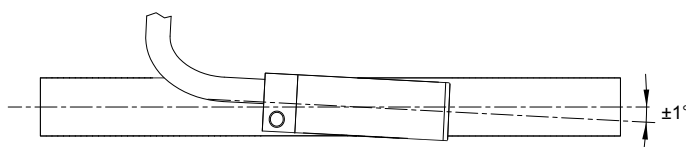
Ride height



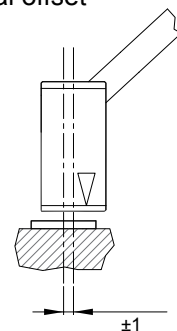
Pitch



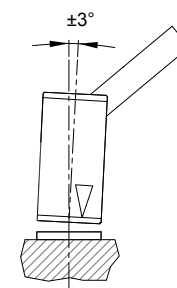
Yaw



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 border="1"> <thead> <tr> <th>Resolution (µm)</th> <th colspan="5">Maximum speed (m/s)</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>4.16</td> <td>1.04</td> <td>0.52</td> <td>0.26</td> <td>0.13</td> </tr> <tr> <td>2</td> <td>8.32</td> <td>2.08</td> <td>1.04</td> <td>0.52</td> <td>0.25</td> </tr> <tr> <td>5</td> <td>20.80</td> <td>5.20</td> <td>2.59</td> <td>1.30</td> <td>0.63</td> </tr> <tr> <td>10</td> <td>25.00</td> <td>10.40</td> <td>5.20</td> <td>2.59</td> <td>1.27</td> </tr> <tr> <td>20</td> <td>25.00</td> <td>10.40</td> <td>5.20</td> <td>2.59</td> <td>1.27</td> </tr> <tr> <td>50</td> <td>25.00</td> <td>6.50</td> <td>3.25</td> <td>1.62</td> <td>0.79</td> </tr> <tr> <td>Edge separation (µs)</td> <td>0.12</td> <td>0.50</td> <td>1</td> <td>2</td> <td>4</td> </tr> <tr> <td>Count frequency (kHz)</td> <td>8333</td> <td>2000</td> <td>1000</td> <td>500</td> <td>250</td> </tr> </tbody> </table>	Resolution (µm)	Maximum speed (m/s)					1	4.16	1.04	0.52	0.26	0.13	2	8.32	2.08	1.04	0.52	0.25	5	20.80	5.20	2.59	1.30	0.63	10	25.00	10.40	5.20	2.59	1.27	20	25.00	10.40	5.20	2.59	1.27	50	25.00	6.50	3.25	1.62	0.79	Edge separation (µs)	0.12	0.50	1	2	4	Count frequency (kHz)	8333	2000	1000	500	250
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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 <sup>-6</sup> /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 <sup>+0.2</sup> mm, PUR high flexible cable, drag-chain compatible, double-shielded 8 × 0.05 mm <sup>2</sup> ; 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/s <sup>2</sup> (IEC 60068-2-6)																																																						
Shocks (11 ms)	300 m/s <sup>2</sup> (IEC 60068-2-27)																																																						

## LM10IB – Digital output signals, Open Collector NPN

Square wave output

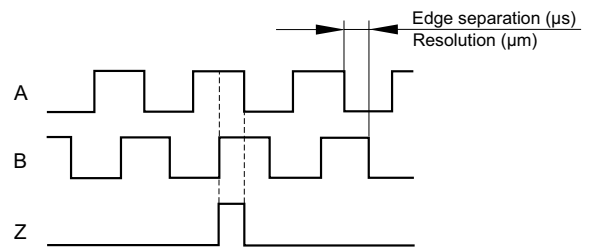
<b>Power supply</b>	5 V to 30 V
<b>Power consumption</b>	< 35 mA
<b>Output signals</b>	A, B, Z
<b>Reference signal</b>	1 or more square-wave pulses Z
<b>Maximum load</b>	10 mA
<b>Cable length</b>	See table below

Power supply voltage	Maximum cable length ** (m)			
	5 V	12 V	24 V	30 V
Edge separation (μs)				
0.12	3	2.5	1	1
0.5	10	7	4	3
1	10	10	9	6
2	10	10	10	10
4	10	10	10	10
<b>R<sub>L</sub> (Ω) *</b>	<b>500</b>	<b>1200</b>	<b>2400</b>	<b>3000</b>

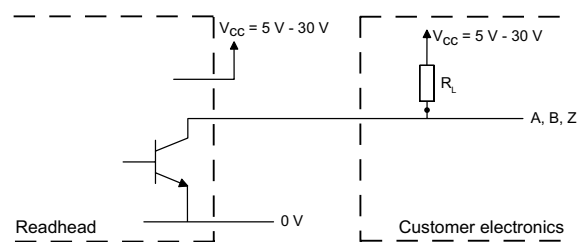
\* Recommended values. For higher values of R<sub>L</sub> shorter cables should be used.

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

### Timing diagram



### Recommended signal termination



V <sub>CC</sub>	R <sub>L, min</sub>
5	500
12	1,200
24	2,400
30	3,000

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

## LM10IC – Digital output signals, RS422

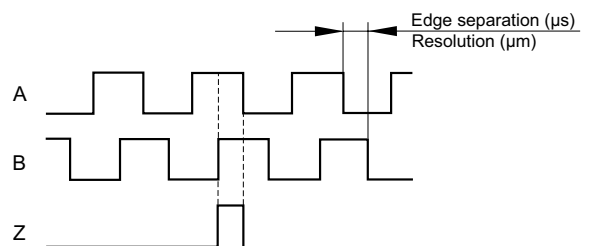
Square wave differential line driver to EIA RS422

<b>Power supply *</b>	4.7 V to 7 V – voltage on readhead Reverse polarity protection
<b>Power consumption</b>	< 35 mA
<b>Power supply rise time</b>	< 1 ms (for PRG option only)
<b>Output signals</b>	3 square-wave signals A, B, Z and their inverted signals A-, B-, Z-
<b>Reference signal</b>	1 or more square-wave pulse Z and its inverted pulse Z-
<b>Signal level</b>	Differential line driver to EIA standard RS422: U <sub>H</sub> ≥ 2.5 V at -I <sub>H</sub> = 20 mA U <sub>L</sub> ≤ 0.5 V at I <sub>L</sub> = 20 mA
<b>Permissible load</b>	Z <sub>0</sub> ≥ 100 Ω between associated outputs I <sub>L</sub> ≤ 20 mA max. load per output Capacitive load ≤ 1000 pF Outputs are protected against short circuit to 0 V and to +5 V
<b>Alarm</b>	High impedance on output lines A, B, A-, B-
<b>Switching time (10 to 90 %)</b>	t <sub>+</sub> , t <sub>-</sub> < 30 ns (with 1 m cable and recommended input circuit)
<b>Cable length *</b>	max. 100 m

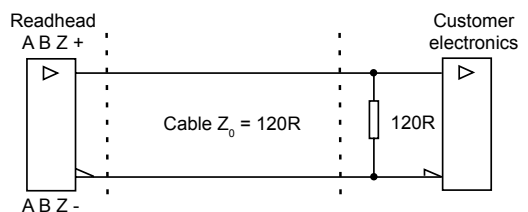
\* Please consider voltage drop over cable.

### Timing diagram

Complementary signals not shown



### Recommended signal termination



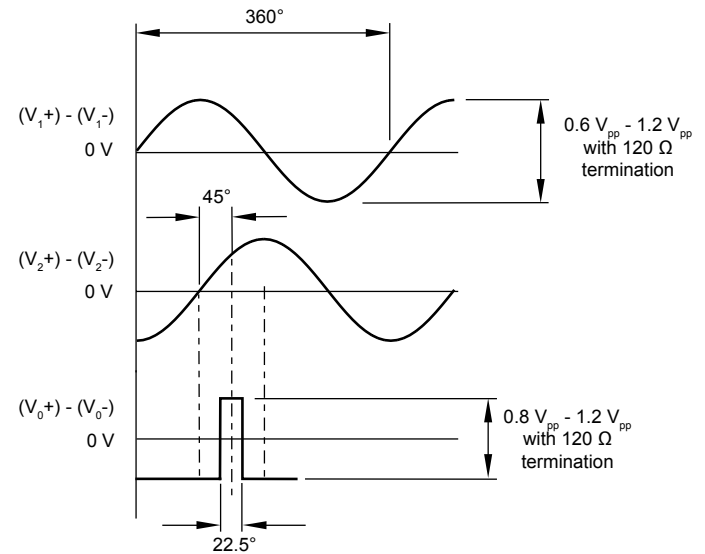
## LM10AV – Analogue output signals (1 V<sub>pp</sub>)

2 channels V<sub>1</sub> and V<sub>2</sub> differential sinusoidals (90° phase shifted)

<b>Power supply</b> *	4.7 V to 7 V – voltage on readhead Reverse polarity protection	
<b>Power consumption</b>	< 50 mA	
<b>Output signals</b>	V <sub>1</sub> , V <sub>2</sub> , V <sub>0</sub>	
<b>Sine / cosine signals</b>	<b>Amplitude</b>	0.6 V <sub>pp</sub> to 1.2 V <sub>pp</sub> (with 120 Ω termination)
	<b>Phase shift</b>	90° ± 0.5°
<b>Reference signal</b>	<b>Amplitude</b>	0.8 V <sub>pp</sub> to 1.2 V <sub>pp</sub> (with 120 Ω termination)
	<b>Position</b>	45°
	<b>Width</b>	22.5°
<b>Termination</b>	Z <sub>0</sub> = 120 Ω between associated outputs	
<b>Cable length</b> *	max. 50 m	

\* Please consider voltage drop over cable.

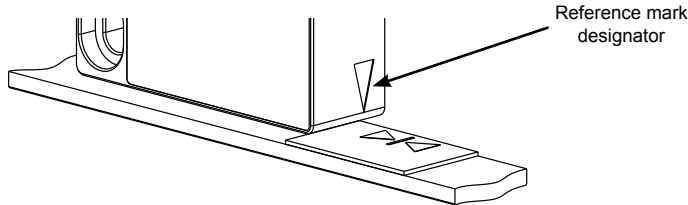
### Timing diagram



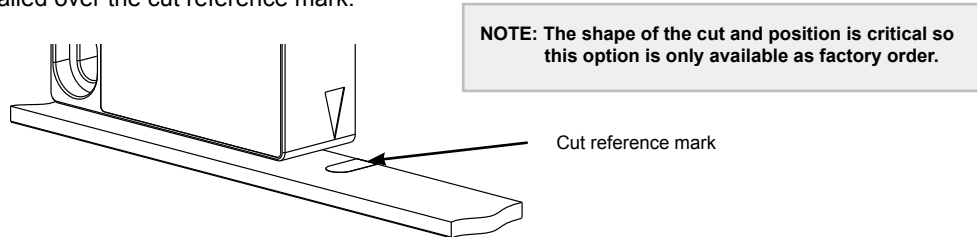
## Reference mark

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

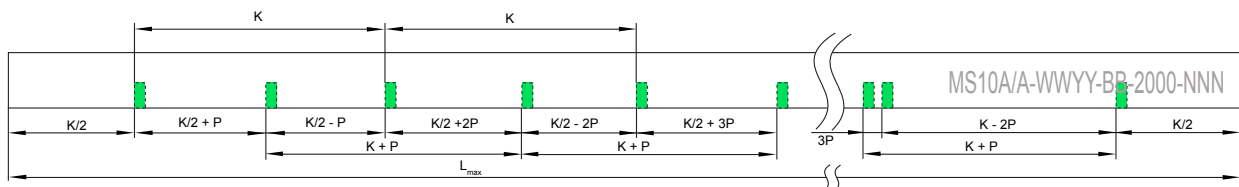
- 1) **Stick-on reference mark.** The LM10 readhead should be ordered with the reference mark option. After installation of the scale a reference mark sticker can be applied to the scale at the required position using the reference mark applicator tool. Ensure that the reference sticker is oriented to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



- 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.

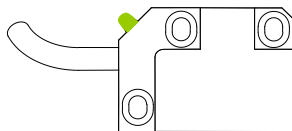


- 3) **Every 2 mm.** The LM10 readhead should be ordered with this specific mode activated only.
- 4) **Distance coded reference mark.** The distance coded reference mark option provides multiple reference marks that are individually spaced according to specific mathematical algorithm. Absolute position 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).

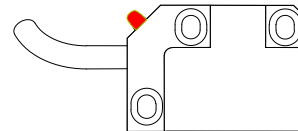


## Set-up LED

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.



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.

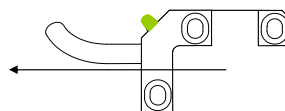
## Programming (for IC output only)

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.

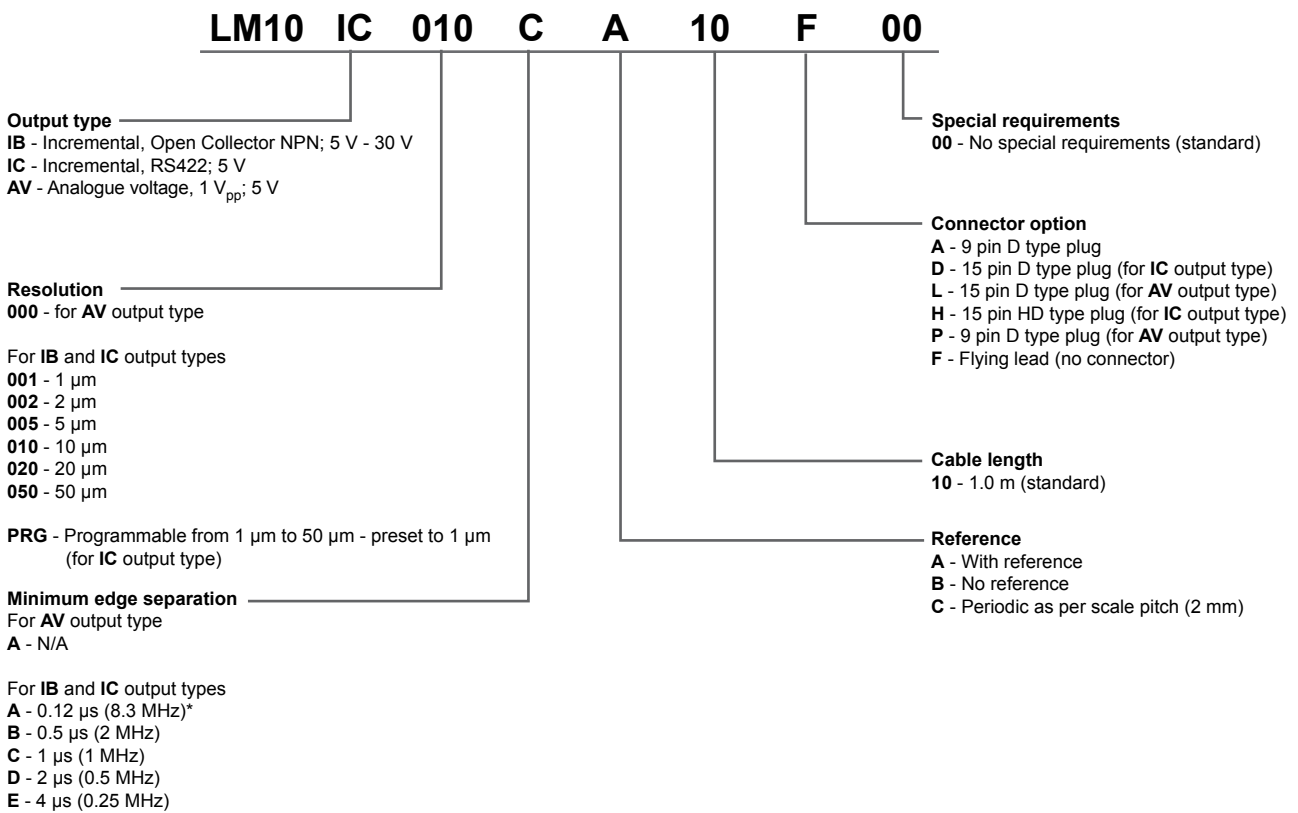
## Positive direction

Digital output signals – A leads B

Analogue output signals ( $1 V_{pp}$ ) –  $V_1$  leads  $V_2$

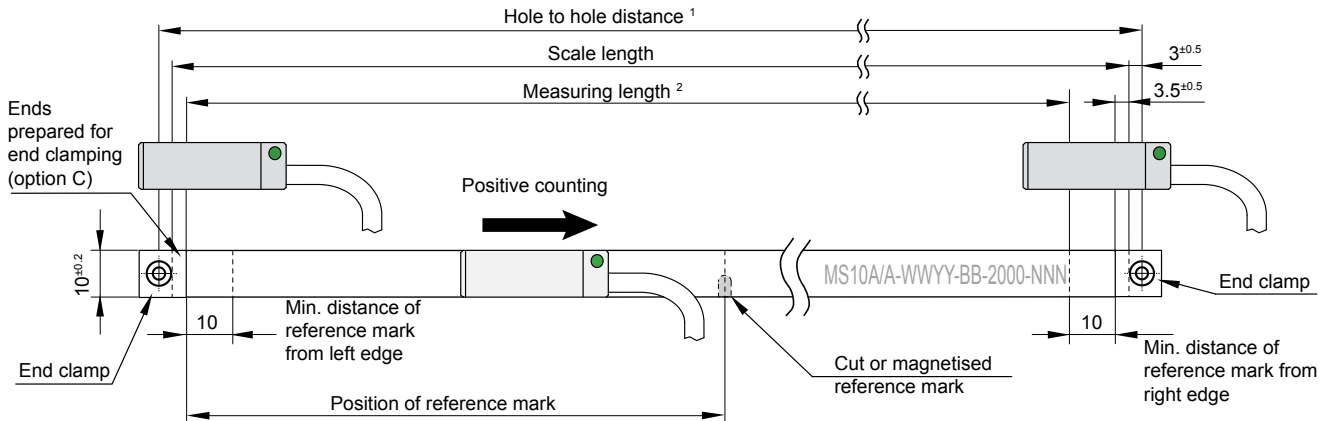


## LM10 readhead part numbering



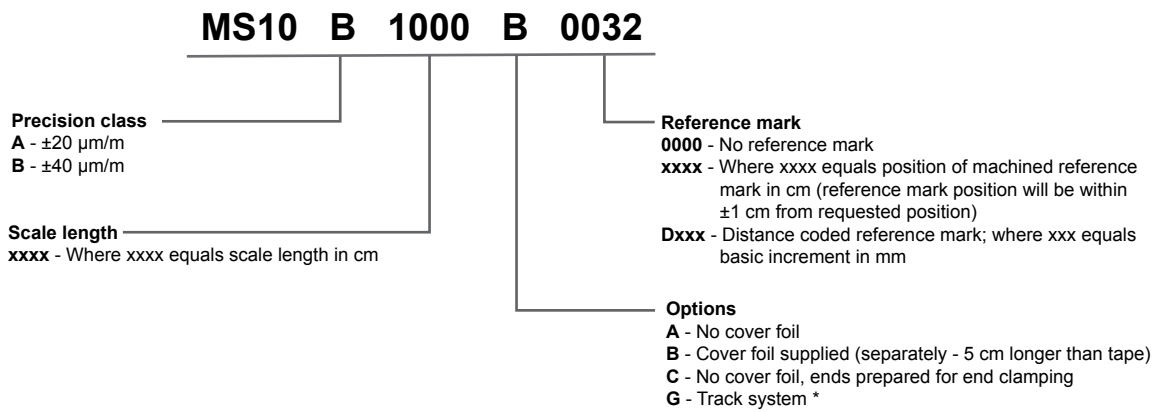
\* Default for **PRG** option.

## Magnetic scale part numbering



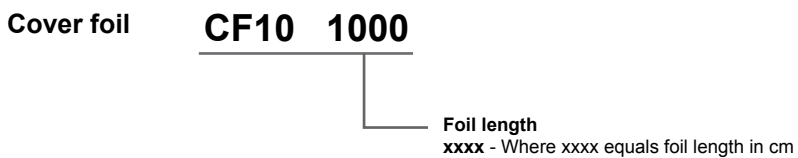
<sup>1</sup> Hole to hole distance = scale length + 6<sup>±1</sup> mm (for end clamp mounting)

<sup>2</sup> Measuring length = scale length - 17 mm



\* For details on TRS track system please refer to data sheet LM10D18

## Accessories part numbering



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



## Document issues

Issue	Date	Page	Corrections made
01	8. 11. 2007	-	New document
02	29.11.2007	-	Minor text errors corrected, Corrected Maximum speed table data on page 3
	30.11.2007	2	Changed Pitch and Yaw description and image layout
	15. 1. 2008	3, 4, 5	Minor text errors corrected
03	28. 2. 2008	1, 3, 7	Removed the 100 $\mu\text{m}$ option
		2	Added the Reference mark detection side symbol
		5	New reference mark images
		8	Added the magnetic scale dimensions image
04	6. 6. 2008	2, 5	New installation drawing
		-	Reference mark installation moved to LM10 Installation guide
		4, 6	Analogue output signal specifications added
		6	IB output type removed, AC output type and connector option L added
05	25. 11. 2008	4, 7, 8	IB output type, new magnetic scale diagram and end clamping option added
06	5. 12. 2008	3	Hysteresis data added
07	14. 1. 2009	-	New layout
08	29. 7. 2009	5	Amended reference signal width for 1 $V_{pp}$ output variant
09	4. 8. 2009	5	Amended reference signal width for 12 $\mu\text{A}$ output variant
10	30. 4. 2010	2	Ride height table added, lateral offset and yaw updated
		6	Distance coded reference mark option added
		8	End clamp option added to technical drawing; distance coded reference mark and track section option added; reference mark magnetiser added to accessories
11	5. 5. 2011	3	Power supply voltage rise time added, Cable dimensions and weight added
		4	IB output type: maximum cable length table added
		3, 5, 7	AC output type removed
		3, 7	Special requirement option 01 removed

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