LM10
Incremental Magnetic Encoder

ROBUST

UNIQUE REFERENCE MARK

WEAR-FREE MEASURING PRINCIPLE

The LM10 is a non-contact high-speed magnetic encoder designed for linear or rotary motion sensing in harsh environments. It features a compact readhead that rides at up to 1.0 mm from the self-adhesive magnetic scale or ring.
Simple to install, the LM10 features a set-up LED and wide installation tolerances. The encoder comes in digital or analogue output variants and offers a range of customer selectable resolutions from 0.244 µm to 250 µm.

Features and benefits

- Customer selectable resolutions
- High speed operation
- Excellent dirt immunity to IP68
- Linear or rotary position sensing
- Unique bidirectional reference mark
- Non-contact and wear-free measuring principle
- CE compliant, including RoHS
- Highly resistant to shock, vibration and pressure

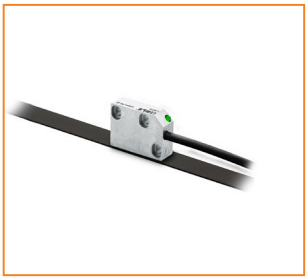
INDUSTRIAL AUTOMATION | ASSEMBLY LINES | LINEAR MOTOR | PRINTING TECHNOLOGY | LABORATORY EQUIPMENT

General information

The LM10 is a compact, non-contact magnetic encoder designed to provide reliable linear and rotary position feedback in demanding industrial environments. Its sealed readhead and robust magnetic scales and rings deliver accurate measurement even in the presence of dust, moisture, vibration and shock. With IP68 protection, an operating temperature range from –10 °C to +80 °C and wear-free operation, the LM10 offers long-term performance with minimal maintenance.

Choose your LM10 system

The LM10 readhead can be used with magnetic scales, radial rings, axial rings or the FlexIN system. For detailed specifications, installation guidelines and available options, refer to datasheets **MSD01** (Incremental scales), **MR01D01** (Axial rings), **MR02D02** (Radial rings) and **FID01** (FlexIn system), available at **RLS Media Center.**



LM10 + magnetic scale

LM10 + radial ring

LM10 + axial ring

LM10 + FlexIN

Encoder variants

The LM10 readhead is available in two variants. The standard LM10 supports analogue 1 Vpp, incremental RS422, push-pull and open-collector outputs. For harsh environments, it can also be supplied with a flexible stainless-steel conduit while retaining the standard LM10 outputs.

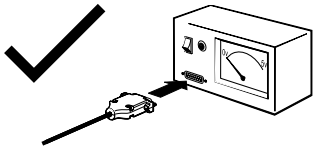
LM10

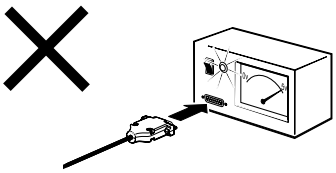
LM10 + cable with flexible stainless-steel conduit

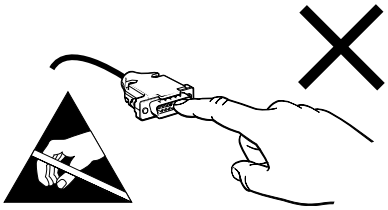
Storage and handling

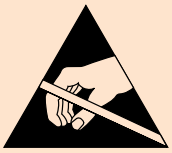
All data given below refer to the readhead only. Complete systems with magnetic scale or ring may have other limitations. For more information, see the **MSD01**, **MR01D01**, **MR02D02** and **FID01**, available at **RLS Media Center.**

Storage temperature	Operating temperature	IP protection
–40 °C to +85 °C	–10 °C to +80 °C	IP68

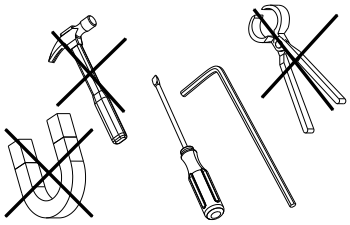








Readhead is ESD sensitive - handle with care.
Do not touch electronic circuit, wires or sensor area without proper ESD protection or outside of ESD controlled environment.



This encoder system is a high performance metrology product and must be handled carefully. The use of industrial tools during installation or exposure to strong magnets such as a magnetic base is not recommended as it carries the risk of damaging parts of the system which as a result might not perform in accordance with specifications.

Environmental and operational conditions

Effects of external magnetic field

The magnetic encoder system is sensitive to external magnetic fields. The extent to which the magnetic encoder system is affected depends on the magnitude and direction of the external magnetic field. In particular, the rapidly changing stray magnetic fields affect the system and can change its function. Field strengths greater of 1 mT can cause the system to malfunction, resulting in the readhead reporting an invalid position despite inactive error and warning bits in the detailed status and a green LED.

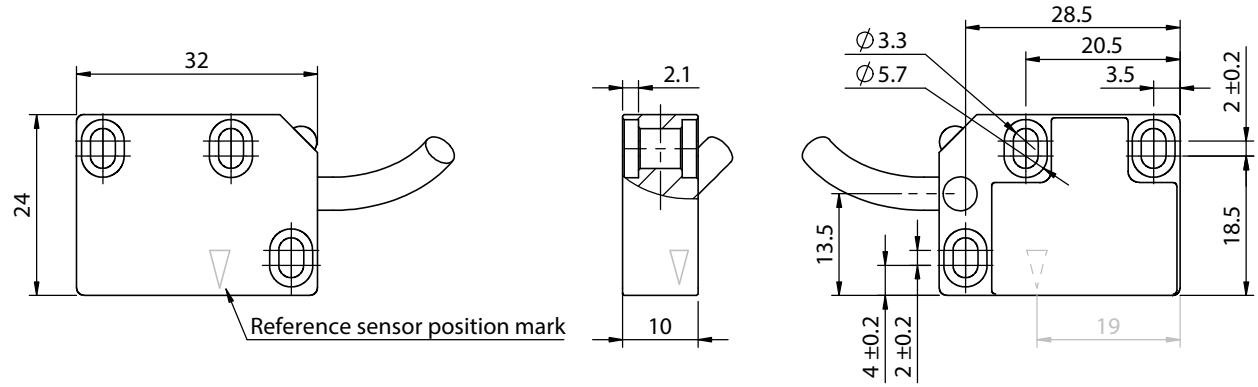
Magnetic field strengths of more than 25 mT cause irreversible damage to the magnetic ring or scale and must be replaced.

Product identification and markings

Label on the readhead contains: full PN, 6 digits long serial number and 2D code containing the serial number.

Dimension drawings

Dimensions and tolerances are in mm. Dimensions without tolerance values are in accordance with ISO 2768-m.

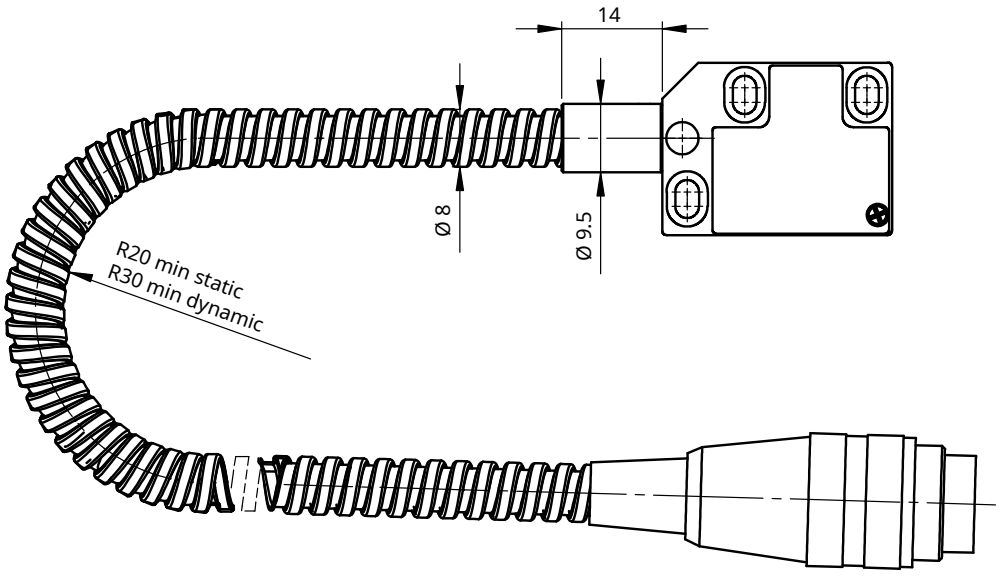


General tolerances for linear dimensions according to ISO 2768 m			
Tolerance class	up to 6	6-30	30-120
m (medium)	±0.1	±0.2	±0.3

3D model available at **RLS Media center.**

LM10 readhead with cable with stainless-steel protection tube

Maximum length of cable with flexible stainless-steel conduit is 10 m.



Installation instructions

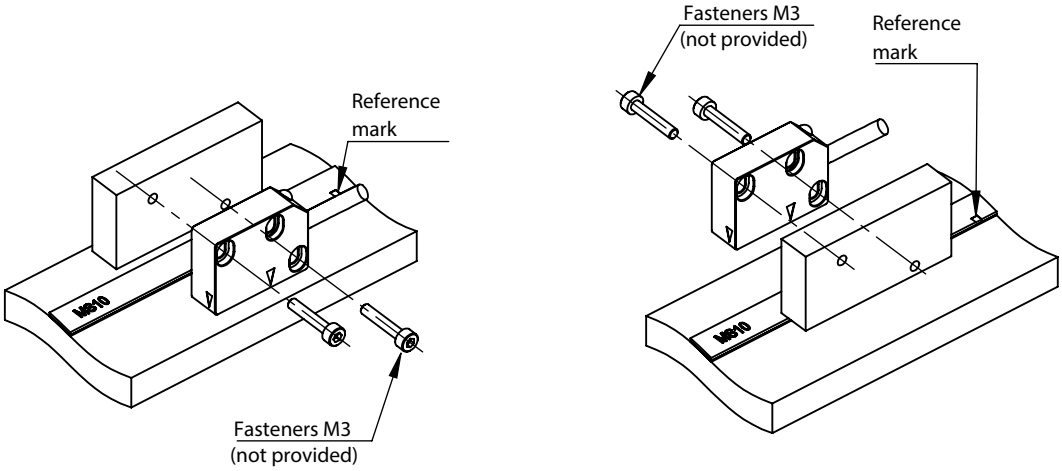
Plan the installation orientation of the readhead and the magnetic ring or scale in advance. The correct orientation is indicated by the engraving on the ring and the printed marking on the scale.

Recommended use of M3 fasteners with washers. For more information see **Table of recommended fastener tightening torques** at **RLS Media center.**

The magnetic encoder system must be installed and mounted in strict compliance with the dimensions and tolerances given on **page 4**. All permissible distance and angle tolerances must be strictly complied according to the mounting instructions found at **MSD01** (Incremental scales), **MR01D01** (Axial rings), **MR02D02** (Radial rings), and **FID01** (FlexIn system), available at **RLS Media Center.**

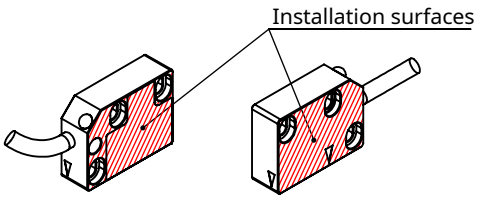
It is important that the space between the readhead and the magnetic scale is maintained over the entire measuring range. The 0.1 mm to 1.0 mm thick plastic spacer (shim) can be used to facilitate installation. For optimal installation, the recommended thickness of the shim is 0.3 mm. After mounting the magnetic scale, place the plastic shim and the readhead on the magnetic scale. Make sure that the readhead, shim and magnetic scale are in full contact.

The readhead LED must be green at all measuring length positions. Otherwise, the installation is not performed correctly. During installation, rotate the ring or scale and verify that the LED illuminates green at all measuring positions. If the LED does not indicate green status, the installation must be checked and corrected. Further information is provided in the chapter **Status indicator LED.**



Images are for illustration purposes only. Valid for all versions.

Improper mounting of the magnetic scale and readhead can impair the function of the magnetic encoder system and lead to total failure.



The magnetic encoder system must be used in accordance with the specified degree of protection. The following factors must be taken into account: IP protection class, operating temperature, external magnetic field, mechanical load and EMC compatibility.

Technical specifications

System data

Pole length		2 mm
Maximum measuring length		50 m (up to 150 m per request)
System accuracy	**Linear application MS magnetic scale**	±10 µm/m / ±20 µm/m / ±40 µm/m Different accuracy grades of MS magnetic scale are available. Refer to MSD01 available at **RLS Media center.**
	Rotary application	**Axial:** Refer to MR01D01 available at **RLS Media center.** **Radial:** Refer to MR02D02 available at **RLS Media center.**
Hysteresis		< 3 µm at 0.3 mm ride height
Repeatability		< 1 µm at 25 °C
Reference mark		Unique / Periodic / DCRM (information about distance coded reference mark can be found in the MSD01 at **RLS Media center**).
Resolution		Max. 13 bit (~0.244 µm) For details refer to the **Table of available resolutions**.
Maximum speed	**Linear application**	Refer to speed calculator available at **RLS website.**
	Rotary application	**Axial:** Refer to speed calculator available at **RLS website.** **Radial:** Refer to speed calculator available at **RLS website.**

Electrical data

For electrical data, refer to the specific output type in the **Output types** chapter.

Mechanical data

Mass	23 g
Material	Die-cast, Zamak-5

Environmental data

Temperature	**Operating**	–10 °C to +80 °C (–20 °C to +85 °C if cable under non-dynamic conditions)
	Storage	–40 °C to +85 °C
Environmental sealing		IP68 (according to IEC 60529)*
EMC Immunity		IEC 61000-6-2
EMC Emission		IEC 61000-6-4
Vibrations (55 Hz to 2000 Hz)		300 m/s² (IEC 60068-2-6)
Shocks (6 ms)		300 m/s² (IEC 60068-2-27)
External magnetic field during operation		1 mT

* Limited by the connector.

Cable

Type	PUR high flexible cable, drag-chain compatible, double-shielded	
Number of wires	8	12*
Outer diameter	4.2 mm ±0.2 mm	4.5 mm ±0.2 mm
Jacket material	Extruded polyurethane (PUR)	
White wire	0.14 mm², 26 AWG, 0.13 Ω/m	0.08 mm², 28 AWG, 0.23 Ω/m
Other wires	0.05 mm², 30 AWG, 0.35 Ω/m	
Durability	20 million cycles at 25 mm bend radius	20 million cycles at 50 mm bend radius
Weight	34 g/m nominal	38 g/m nominal
Bend radius (internal radius)	Dynamic: 25 mm, static: 10 mm	Dynamic: 50 mm, static: 10 mm
Dynamic torsion	Not allowed**	

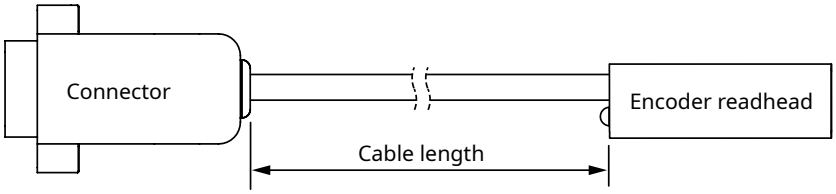
* Applied only for option with additional alarm output (for IA, IC; not available for PRG option).

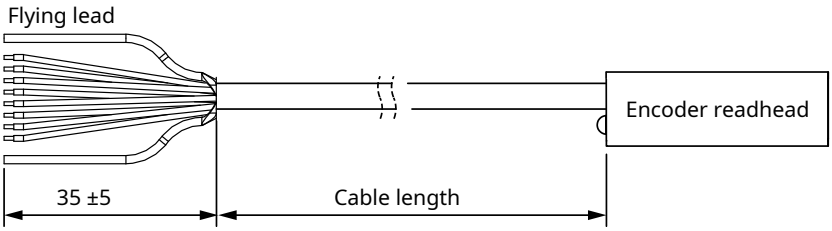
** Cable is not torsion specified. A continuous torsion of the cable in a dynamic application could result in malfunctioning of the encoder system.

Cable tolerances

LM10 with cable

Cable length [m]	Tolerance [mm]
< 3	±45
≥ 3 < 10	±60
≥ 10 < 20	±75
≥ 20	±150





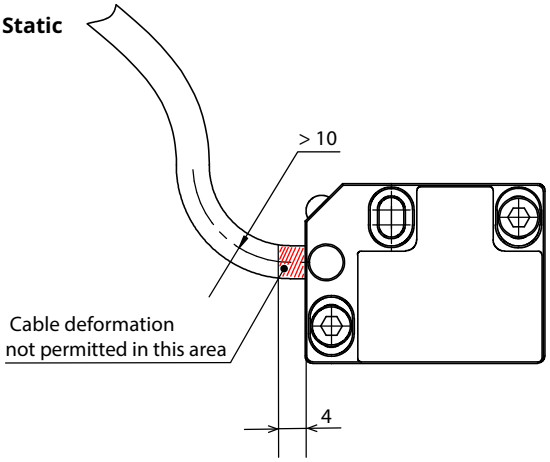
LM10 with cable with stainless-steel protection tube

Cable length [m]	Tolerance [mm]
< 3	±45
≥ 3 < 10	±60

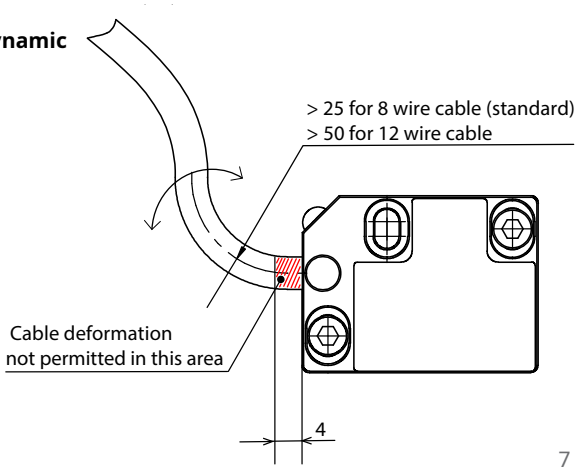
Cable installation

Dimensions and tolerances are in mm. Dimensions without tolerance values are in accordance with ISO 2768-m.

Static



Dynamic



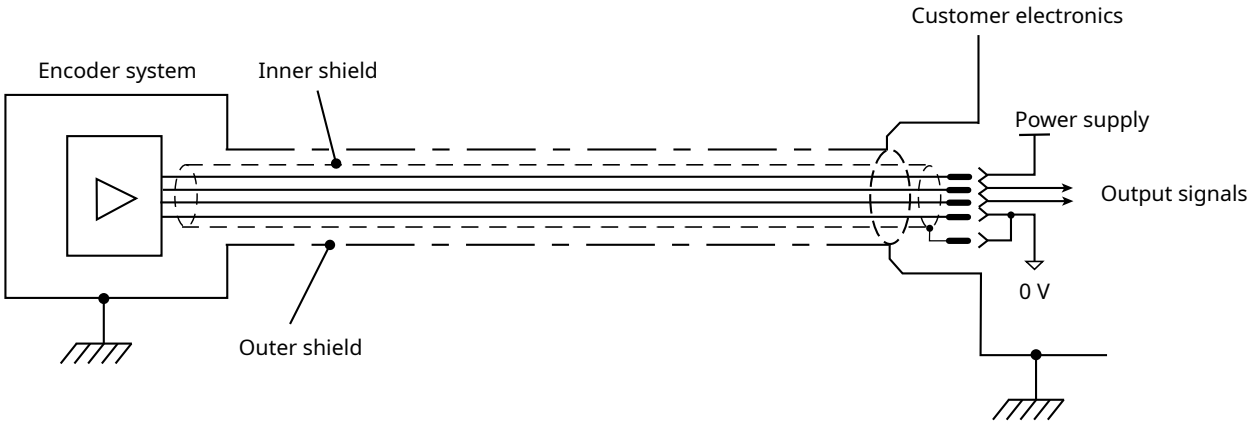
Electrical connections

Function	Signal	Colour (option F)	9 pin D type plug (option A)	15 pin D type plug (option D)
Power	Vdd	Brown	5	7
	GND	White	9	2
Incremental / analogue signals	A / V_1	Green	4	14
	A– / V_1–	Yellow	8	6
	B / V_2	Blue	3	13
	B– / V_2–	Red	7	5
Reference signals	Z / V_0	Pink	2	12
	Z– / V_0–	Grey	6	4
Alarm*	E	Violet	–	11
	E–	Black	–	3
Shield	Inner	–	1	15
	Outer	–	Case	Case

* For alarm output “07” option must be ordered.

Shield connection

Figure below shows a recommended shield termination in order to ensure electromagnetic compatibility.



The encoder housing is galvanically connected to the connector housing. To achieve EMC compliance, the encoder system must be correctly integrated. In particular, attention to shielding arrangements is essential.

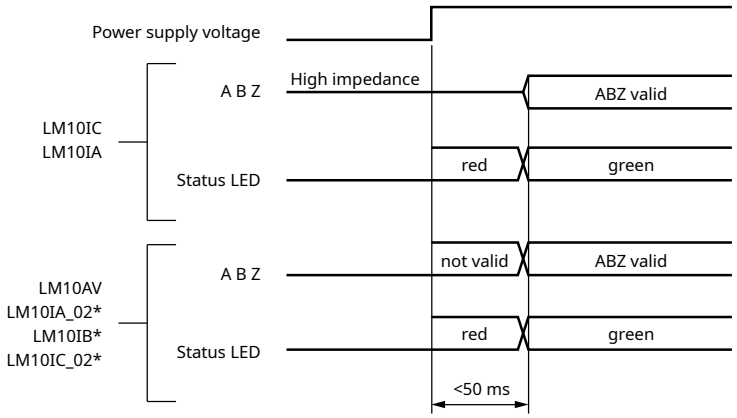
Response time

	LM10AV	LM10IB	LM10IC_02*	LM10IA_02*	LM10IA	LM10IC
Set-up time	<100 ms	<100 ms	<100 ms	<100 ms	<100 ms	<100 ms
Interpolation conversion time	—	<250 ns	<250 ns	<250 ns	<250 ns	<250 ns
Transition time	<10 µs	<10 µs	<10 µs	<10 µs	<100 ms	<100 ms

* Shortened reaction time option.

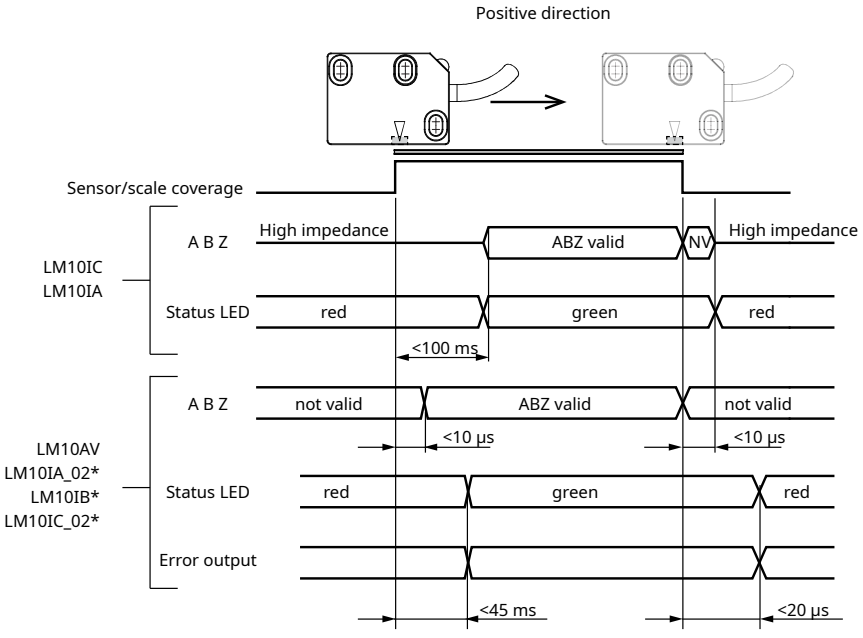
Set-up time is the time needed for the encoder readhead to start reading the position information after power-on (see diagram 1).
Interpolation conversion time is the time needed for the encoder readhead to convert the position information into an output signal.
Transition time is the time it takes the encoder readhead to switch from an alarm state to a valid output signal (see diagram 2).

Diagram 1: Set-up time



*In alarm state LED flashes red/green.

Diagram 2: Transition time



Status indicator LED

After installation of the magnetic scale or ring (**MSD01**, **MR01D01**, **MR02D02** and **FID01**, available at **RLS Media Center**), the readhead can be easily adjusted on the machine using the set-up LED indicator.

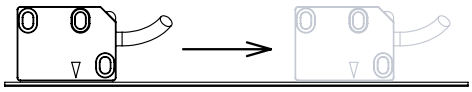
LED Signal		Status	Error output (special option 07)			
			IC (E)	IC (E–)	IA (E)	IA (E–)
●	**Green**	Good signal strength/set-up	$U_L \leq 0.5$ V	$U_H \geq 2.5$ V	$U_L \leq 1.15$ V	$U_H \geq 3.45$ V
●	**Red**	Poor signal strength. Possible reasons: • Incorrect readhead orientation. • Readhead installation out of tolerance. • Demagnetisation of measuring scale. • Insufficient power supply voltage.	$U_H \geq 2.5$ V	$U_L \leq 0.5$ V	$U_H \geq 3.45$ V	$U_L \leq 1.15$ V
●●● ●●●	**Red/green flashing**	IB, IC_02, IA_02: poor signal strength Poor signal strength. Possible reasons: • Incorrect readhead orientation. • Readhead installation out of tolerance. • Demagnetisation of measuring scale. • Insufficient power supply voltage.	Not applicable.			

The LED signal functions listed in the table above do not indicate non-optimal installation of the readhead, such as accuracy outside the specified range or improper operation of the reference mark.

Positive direction

Digital output signals – A leads B (magnetic scale is stationary)

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



For more information, refer to the data sheets **MSD01**, **MR01D01**, **MR02D02** and **FID01,** available at **RLS Media Center.**

Output types

Analogue output signals (1 V_{pp})

LM10AV

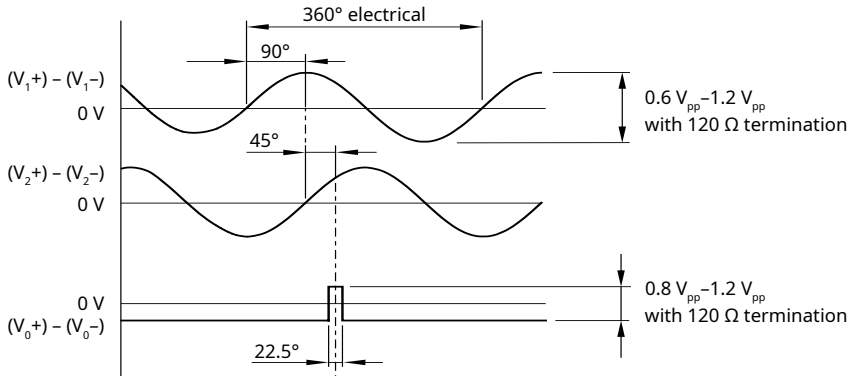
Specifications

Power supply* (voltage on readhead)	4.7 V to 7 V Reverse polarity protection	
Current consumption	< 50 mA (without load)	
Voltage drop over cable**	~24 mV/m (without load)	
Output signals	V_1, V_2, V_0	
Sinusoidal period length	2 mm	
Sine / cosine signals	Amplitude (with 120 Ω termination)	0.6 V_{pp} to 1.2 V_{pp}
	Phase shift	90° ± 0.5°
Reference signal	Amplitude (with 120 Ω termination)	0.8 V_{pp} to 1.2 V_{pp}
	Position	45°
	Width	22.5°
Termination	Z_0 = 120 Ω between associated outputs	
Maximum cable length*	30 m	

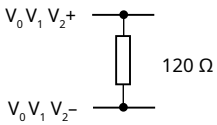
* Please consider voltage drop over cable.

** At added termination expect higher current consumption, which will result in a higher voltage drop over cable.

Timing diagram



Recommended signal termination



Incremental, Push-Pull output

LM10IA

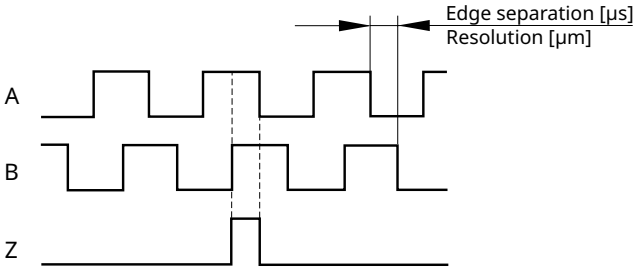
Specifications

Power supply* (voltage on readhead)	4.7 V to 30 V Without reverse polarity protection
Current consumption	< 35 mA (without load)
Voltage drop over cable**	~17 mV/m (without load)
Output signals	3 square-wave signals A, B, Z and their inverted signals A–, B–, Z–
Reference signal	1 or more square-wave pulse Z and its inverted pulse Z–
Signal level	For 30 V: $U_H \geq 29.2$ V at $-I_H = 30$ mA $U_L \leq 0.5$ V at $I_L = 30$ mA For 5 V: $U_H \geq 4.2$ V at $-I_H = 20$ mA $U_L \leq 0.5$ V at $I_L = 20$ mA
Permissible load	$I_L \leq 50$ mA max. load per output Outputs are protected against short circuit to 0 V and to +5 V
Alarm	High impedance on output lines A, B, A–, B– Special option 02: Alarm is not signaled by high impedance state of the A, B, A–, B– signals Special option 07: Alarm signal is output parallel as line driver signal
Switching time - A, B, Z signals (10 to 90 %)	For 24 V: t+ = t– < 380 ns (typ. 120 ns) For 5 V: t+ = t– < 200 ns (typ. 42 ns) Measured at C_{LOAD} = 1000 pF
Maximum cable length*	30 m

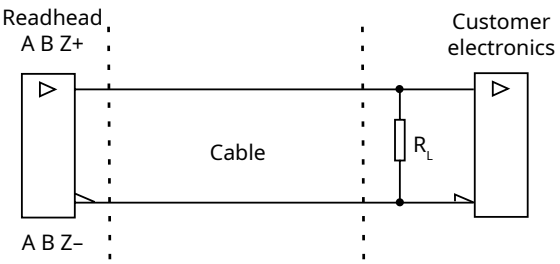
* If power supply voltage is <10 V, please consider voltage drop over cable.
** At added termination expect higher current consumption, which will result in a higher voltage drop over cable.

Timing diagram

Complementary signals are not shown



Recommended signal termination



V_{supply}	R_L	I_{load}
5 V	250 Ω	20 mA
30 V	1 kΩ	30 mA

Incremental, Open Collector NPN

LM10IB

Specifications

Power supply	5 V to 30 V Without reverse polarity protection
Current consumption	< 35 mA (without load)
Voltage drop over cable*	~17 mV/m (without load)
Output signals	A, B, Z
Reference signal	1 or more square-wave pulses Z
Maximum load	10 mA
Maximum cable length	See table below

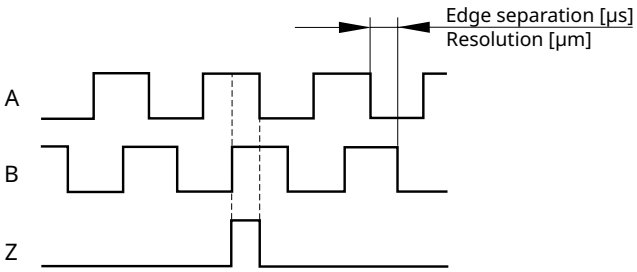
* At added termination expect higher current consumption, which will result in a higher voltage drop over cable.

Edge separation [µm]	**Maximum cable length [m]**			
0.07	0.2	0.3	1	1.5
0.12	3	2.5	1	1
0.5	10	7	4	3
1	10	10	9	6
2, 4, 5, 10, 20	10	10	10	10
Power supply voltage [V]	5	12	24	30
R_L [Ω]*	500	1200	2400	3000

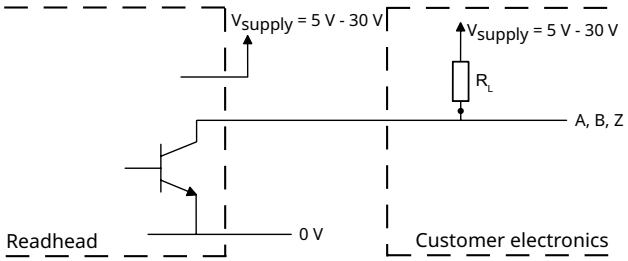
*Recommended values. For higher values of R_L shorter cables should be used.

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

Timing diagram



Recommended signal termination



Incremental, RS422

LM10IC

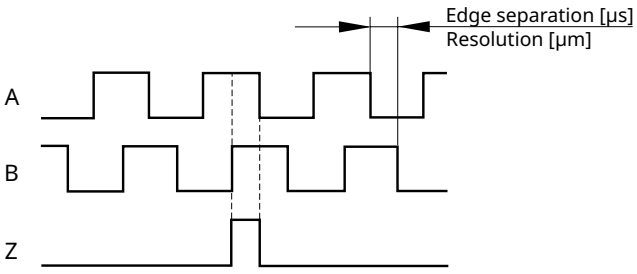
Specifications

Power supply* (voltage on readhead)	4.7 V to 7 V Reverse polarity protection
Current consumption	< 35 mA (without load)
Voltage drop over cable**	~17 mV/m (without load)
Output signals	3 square-wave signals A, B, Z and their inverted signals A–, B–, Z–
Reference signal	1 or more square-wave pulse Z and its inverted pulse Z–
Signal level	Differential line driver according to EIA standard RS422: $U_H \geq 2.5$ V at $-I_H = 20$ mA $U_L \leq 0.5$ V at $I_L = 20$ mA
Permissible load	$Z_0 \geq 100\ \Omega$ between associated outputs $I_L \leq 20$ mA max. load per output Capacitive load ≤ 1000 pF Outputs are protected against short circuit to 0 V and to +5 V Only one output shorted at a time
Alarm	High impedance on output lines A, B, A–, B– Special option 02: Alarm is not signaled by high impedance state of the A, B, /A, /B signals*** Special option 07: Alarm signal is output parallel as line driver signal
Switching time – A, B, Z signals (10 to 90 %)	t+, t– < 30 ns (with 1 m cable and recommended input circuit)
Maximum cable length*	30 m

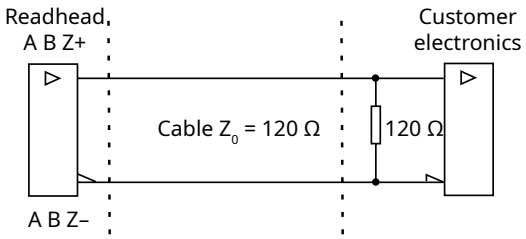
* Please consider voltage drop over cable.
** At added termination expect higher current consumption, which will result in a higher voltage drop over cable.
*** See diagrams 1 and 2 on **page 9.**

Timing diagram

Complementary signals not shown



Recommended signal termination



Programming (for IC output only)

Readheads can be ordered preset to the required resolution or supplied so they can be programmed on the machine to the selected resolution. This programming is done by connecting the readhead to a computer via a programming interface **UPRG01**. The readhead must be ordered with the PRG option to use this function. For more information on the programming function of the LM10 readhead, see **UPRG01 Programming interface website**.

Part numbering

LM10 IC 010 C A 10 F 00

Output type

AV - Analogue voltage 1 V_{pp}
IA - Incremental Push-Pull outputs
IB - Incremental, Open Collector NPN
IC - Incremental, RS422

Interpolation factor — **Max Speed Calculator**

AV:
000 - N/A

IA, IB and **IC:**

13B - 8192 (0.244 µm)
12B - 4096 (0.488 µm)
11B - 2048 (0.977 µm)
001 - 2000 (1 µm)
1D6 - 1600 (1.250 µm)
10B - 1024 (1.953 µm)
002 - 1000 (2 µm)
D80 - 800 (2.500 µm)
09B - 512 (3.906 µm)
D50 - 500 (4 µm)
005 - 400 (5 µm)
D32 - 320 (6.250 µm)
08B - 256 (7.813 µm)
010 - 200 (10 µm)
D16 - 160 (12.500 µm)
07B - 128 (15.625 µm)
020 - 100 (20 µm)
D08 - 80 (25 µm)
06B - 64 (31.250 µm)
050 - 40 (50 µm)
05B - 32 (62.500 µm)
04B - 16 (125 µm)
03B - 8 (250 µm)

PRG - Programmable (preset to 1 µm)

For DPI resolution see **Table of available resolutions**.

Minimum edge separation — **Max Speed Calculator**

IA, **IB** and **IC:**

K - 0.07 µs (15 MHz)
A - 0.12 µs (8 MHz)
B - 0.5 µs (2 MHz)
C - 1 µs (1 MHz)
D - 2 µs (0.5 MHz)
E - 4 µs (0.25 MHz)
F - 5 µs (0.2 MHz)
G - 10 µs (0.1 MHz)
H - 20 µs (0.05 MHz)

AV:
A - N/A

The customer's controller must support the selected edge separation time even if the encoder is used below the maximum speed.

Reference mark sensor

A - With reference mark sensor
Magnetic scale or ring must be ordered with reference mark. If required, the cover foil can be installed over the magnetic scale.

B - Without reference mark sensor

C - Without reference mark sensor but with periodic reference impulse as per scale pitch (every 2 mm)
Reference periods correspond to pole length of magnetisation. Magnetic scale or ring must be ordered with no reference mark.

Cable length

02 - 0.2 m
05 - 0.5 m
10 - 1 m
20 - 2 m
30 - 3 m
50 - 5 m
10 - 10 m (when special requirement 0M is selected)

Connector

A - 9 pin D type plug
D - 15 pin D type plug
F - Flying lead, no connector
For PRG option, connector JST 13ZR-3H-P is attached.

Special requirements

00 - No special requirements (standard)
02 - Shortened reaction time
05 - For DPI resolution
07 - Additional alarm output
10 - Not potted, protected to IP50
19 - Stainless steel housing
40 - Protective stainless-steel tube for cable
0M - Cable length in meters
4M - Protective stainless-steel tube and cable in meters
72 - Additional alarm output and shortened response time

Not all part number combinations are valid. Refer to the table of available combinations on the next page for options.

Table of available combinations

Series	Output type	Interpolation factor	Minimum edge separation	Reference mark	Cable length	Connector	Special requirements
LM10	IC	PRG**	A	A / B / C	02 / 05 / 10 / 20 / 30 / 50 / 10***	A** / D / F	00 / 02/ 05 / 10 / 19 / 40 / 0M / 4M
		xxx*	K / A / B / C / D / E / F / G / H			A** / D / F	00 / 02/ 05 / 07 / 10 / 19 / 40 / 0M / 4M
		04B	A / B / C / D / E / F / G / H	B / C			
		03B	B / C / D / E / F / G / H				
	IA	xxx*	K / A / B / C / D / E / F / G / H	A / B / C		A** / D / F	
		04B	A / B / C / D / E / F / G / H	B / C			
		03B	B / C / D / E / F / G / H				
	IB	xxx*	K / A / B / C / D / E / F / G / H	A / B / C		A / F	00 / 05 / 10 / 19 / 40 / 0M / 4M
		04B	A / B / C / D / E / F / G / H	B / C			
		03B	B / C / D / E / F / G / H				
	AV	000	A	A / B / C		A / F	

* See chapter **Available resolutions** for available interpolation factors.
** Not available with special option 07.
*** 10 meters, when special requirement 0M is selected.

For the part numbering of the MS incremental magnetic scale, FlexIn system or the MR radial and axial incremental magnetic ring, refer to the data sheets **MSD01**, **MR01D01**, **MR02D02**, and **FID01,** available at **RLS Media Center.**

Accessories

USB encoder interface
E201-9Q

Compatible only with LM10IC

Programmable interface
UPRG01

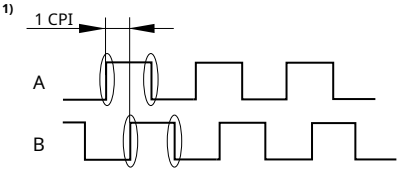
Compatible only with LM10IC

Available resolutions

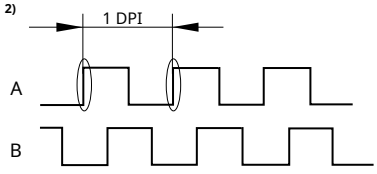
Table of available resolutions

Part number	Interpolation factor	Resolution		
		In µm with 2 mm poles	CPI (counts per inch 2,032 mm)[1]	DPI (pulse per inch 2,032 mm)[2]
13B	2^{13}	0.244140625	102,400	25,600
12B	2^{12}	0.48828125	51,200	12,800
11B	2^{11}	0.9765625	25,600	6,400
001	2000	1	25,000	6,250
1D6	1600	1.25	20,000	5,000
10B	2^{10}	1.953125	12,800	3,200
002	1000	2	12,500	3,125
D80	800	2.5	10,000	2,500
09B	2^{9}	3.90625	6,400	1,600
D50	500	4	6,250	1,562.5
005	400	5	5,000	1,250
D32	320	6.25	4,000	1,000
08B	2^{8}	7.8125	3,200	800
010	200	10	2,500	625
D16	160	12.5	2,000	500
07B	2^{7}	15.625	1,600	400
020	100	20	1,250	312.5
D08	80	25	1,000	250
06B	2^{6}	31.25	800	200
050	40	50	500	125
05B	2^{5}	62.5	400	100
04B	2^{4}	125	200	50
03B	2^{3}	250	100	25

1)



2)



Resolutions calculation

For linear applications:

$$\text{Resolution [µm]} = \frac{\text{Pole length [µm]}}{\text{Interpolation factor}} = \frac{2000}{\text{Interpolation factor}}$$

For ring applications:

Resolution [CPR] = Pole number* × Interpolation factor

CPR – Counts per revolution (resolution)

PPR – Pulses per revolution

$$\text{Resolution [PPR]} = \frac{\text{Resolution [CPR]}}{4}$$

Resolutions calculation for CPI/DPI

$$\text{Resolution [µm]} = \frac{\text{Pole length [µm]}}{\text{Interpolation factor}} = \frac{2032}{\text{Interpolation factor}}$$

$$\text{Resolution [CPI]} = \frac{\text{Inch [µm]}}{\text{Resolution [µm]}} = \frac{\text{Inch [µm]} \times \text{Interpolation factor}}{\text{Pole length [µm]}} = \frac{25400 \times \text{Interpolation factor}}{2032}$$

$$\text{Resolution [DPI]} = \frac{\text{CPI}}{4}$$

*See pole numbers in the data sheets **MR01D01 (Axial rings)**, **MR02D02 (Radial rings),** available at **RLS Media Center.**

Packaging

Each readhead is packed individually in antistatic bag, according to ESD protection measures.

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Document issues

Issue	Date	Page	Description
24	17. 12. 2025	8	Cable drawing with flying leads added
		16	Part numbering - note to connector option F added
25	25. 8. 2026	9, 16-17	Connector options removed
		16-17	Cable length amended

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