RSF Elektronik

RELIABLE. SOPHISTICATED. FLEXIBLE.

Incremental Linear Encoders

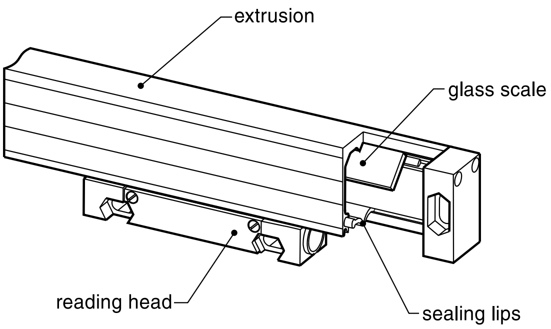
Enclosed Models

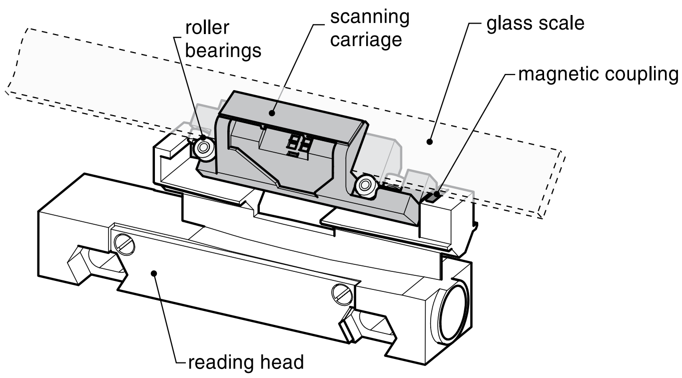
Design and operation

RSF manufactures Linear Encoders in enclosed and open versions.
The enclosed models are easy to install with large mounting tolerances.
They are also best suited for harsh environments. The sealing lips on the extrusion keep out coolants and contamination.

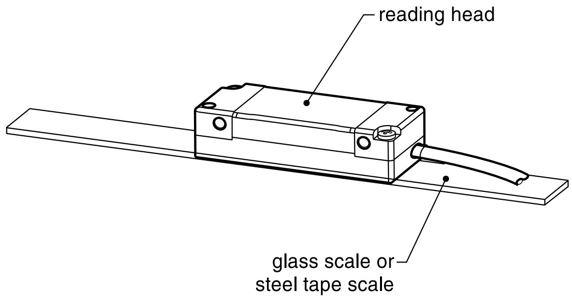
The non-contact open measuring systems are for high displacement velocities and high accuracies, commonly used in clean environments.

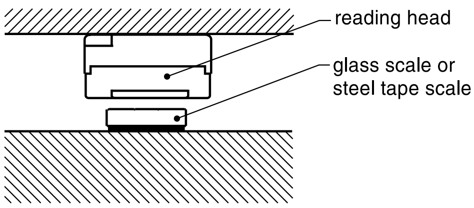
Enclosed systems with guided scanning carriage





Open systems with non-contact scanning carriage



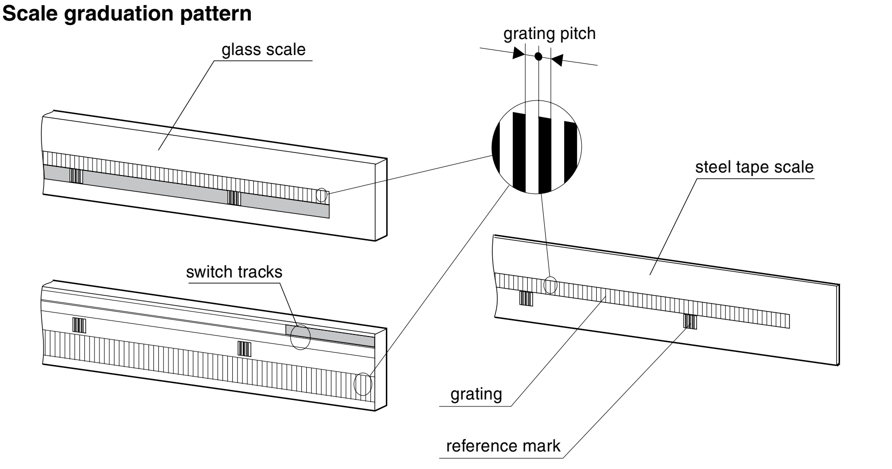


Enclosed Linear Encoders have a roller bearing, self-guided scanning carriage. The scanning carriage is spring loaded to track properly within the encoder head mounting tolerance range.
A set of rare earth magnets couple the scanning carriage to the mounting base of the encoder head.

This magnetic coupling compensates allowable mounting tolerances and machine guide non-parallelism.
Non-contact open encoders rely on the air gap between the encoder head and scale to be uniform over the measuring range. The flatness of the mounting surface and the parallelism of the machine guideway is important.

The scale graduation pattern has a high accuracy grating.
Scales can be produced on metal tape or spars, or glass substrates.
One cycle (period) of grating pitch, is defined as one chrome line and one corresponding line space, each with the same width.
The total width of one chrome line and one line space is called grating pitch.
A second track adjacent to the graduation pattern, contains the Reference Mark(s).
There are standard Reference Mark locations, or they can be specified upon request.
Multiple Reference Marks must be separated by n x 50 mm distances.

Scale graduation pattern

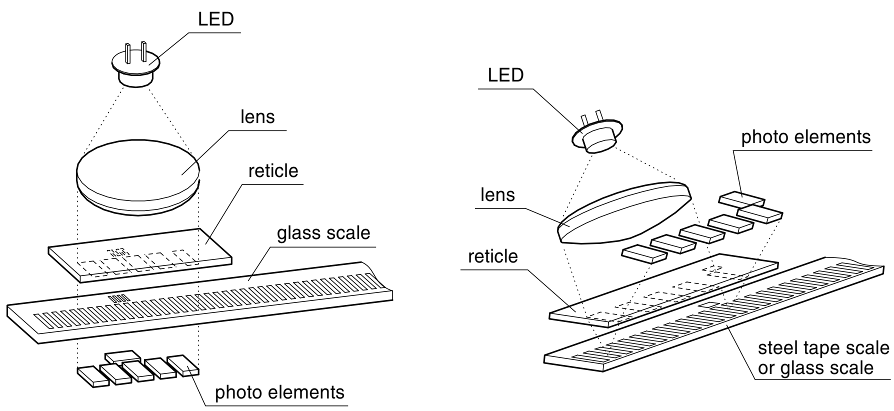


Linear Encoders with the suffix "**K**" in the model type have distance coded Reference Marks. The absolute position is available after a measured move of a maximum of 20 mm .

Cause of the optical scanning version a accurate Reference Mark is warranted.

When there is relative movement between the encoder head and the linear scale, LED light is modulated by the scale grating pitch and converted into electrical signals by the photo-elements. Solid state LEDs and silicon photo-elements are used for high reliability and durability.

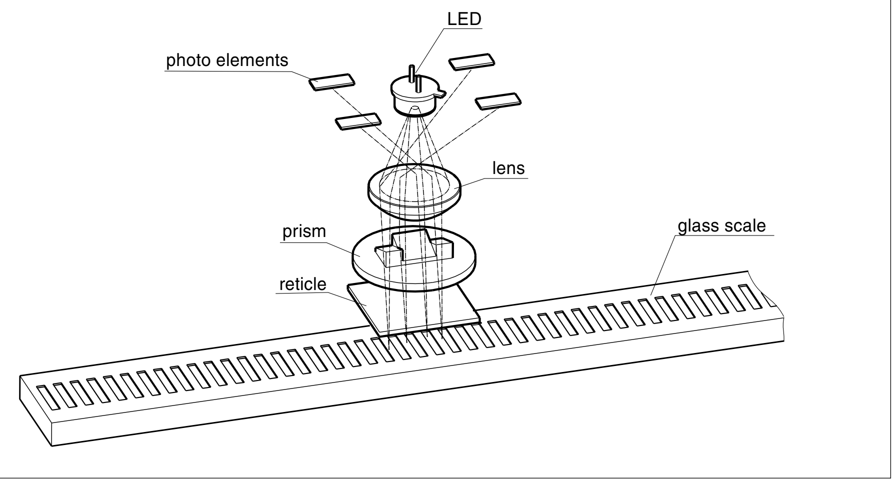
Transmissive scanning principle **Reflective scanning principle**



The scale consists of a glass carrier and reflection-type phase grating.
The scanning reticle acts as transmission phase grating.

The light beam, produced by an LED and collimated by a lens, is deflected by prisms and the phase grating of the reticle in different directions.
After reflection and diffraction at the scale grating, the different beams, depending on the change of position phase shifted, interfere after passing the reticle again, thus producing 2 by 90° shifted, sinusoidal measuring signals.
Using this interferential measuring principle, one signal period equals half of the scale grating pitch.

Reflection-type phase grating



Output signals

Sinusoidal voltage signals
There are two sinusoidal voltage signals (A1 and A2) and one Reference Index (with inverted signals).

Reference voltage of the output signals:
V+/2 (approx. 2.5 V)
Track signals (differential voltage A1 to $\overline{A1}$ resp. A2 to $\overline{A2}$):
Phaseshift 90° ±10° el.
electrical offset ±10% of the signal amplitude
Signal amplitude 0.6 Vpp to 1.2 Vpp
typ. 1 Vpp with terminating impedance Zo = 120 Ω

Reference Mark
(differential voltage RI to $\overline{RI}$):
El. position typically 135° (referenced to A1)
El. width typically 270°
Useable component 0.2 up to 0.85 V, typical 0.5 V with terminating impedance Zo = 120 Ω

Advantage: High traversing speed with long cable lengths possible. These signals are suitable for the connection to appropriate CNC and/or Feedback Systems.

Sinusoidal micro-current signals
There are two sinusoidal micro-current signals (0° and 90°) and one Reference Index (with inverted signals).

Output signals 0° and 90°:
Phaseshift 90° ±10° el.
electrical offset ±10% of the signal amplitude
Signal amplitude with a load of 1 kΩ:
7 to 16 µApp (11.5 µApp typical)

Output signal Reference Mark (RI):
El. Position typical 135° (referenced to 0°)
El. width typical 270°
2 to 8 µA, (typical 5 µA)

These signals can be input to External Subdividing Electronics or NC Controls with built-in Subdividing Electronics.

Square wave signals
With a Schmitt-Trigger (for times 1) or interpolation electronics (for times 5, -10, -20, -25, -50 or -100) the photoelement output signals are converted into two square wave signals that have a phase shift of 90°. Output signals either can be single ended or Line Driver differential (RS 422).

For measuring systems with single ended output signals the max. cable length is 10 m, including extension cable.
One measuring step reflects the measuring distance between two edges of the square wave signals. The controls/DRO´s must be able to detect each edge of the square wave signals.
The minimum edge separation a_{min} is listed in the technical data and refers to a measurement at the output of the interpolator (inside the scanning head).
Propagation-time differences in the Line Driver, the cable and the Line Receiver reduce the edge separation.

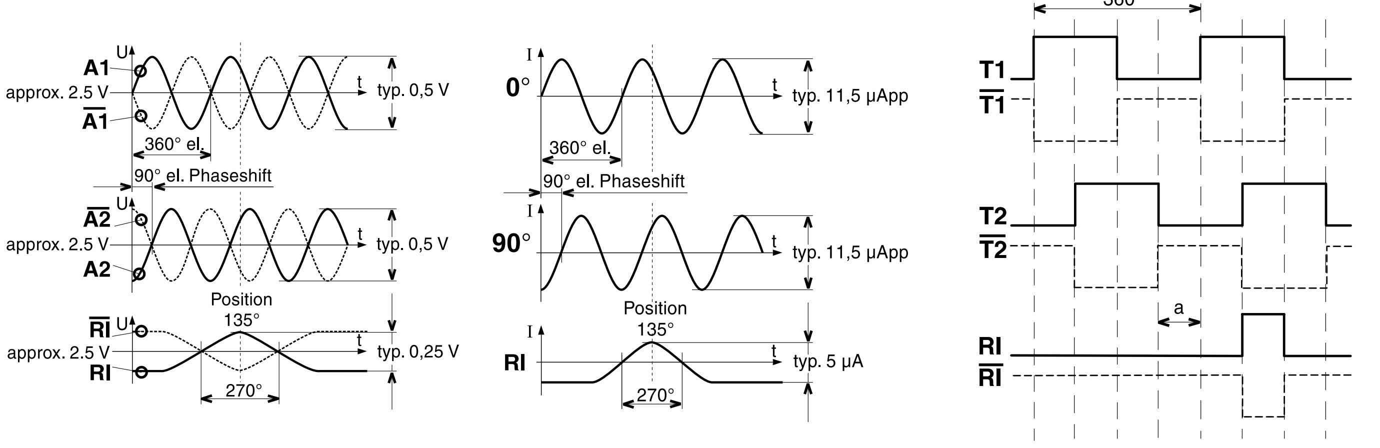
Propagation-time differences:
Line Driver: max. 10 ns
Cable: 0.2 ns per meter
Line Receiver: max. 10 ns refered to the recommended Line Receiver circuit

To prevent counting errors, the controls/DRO´s must be able to process the resulting edge separation.

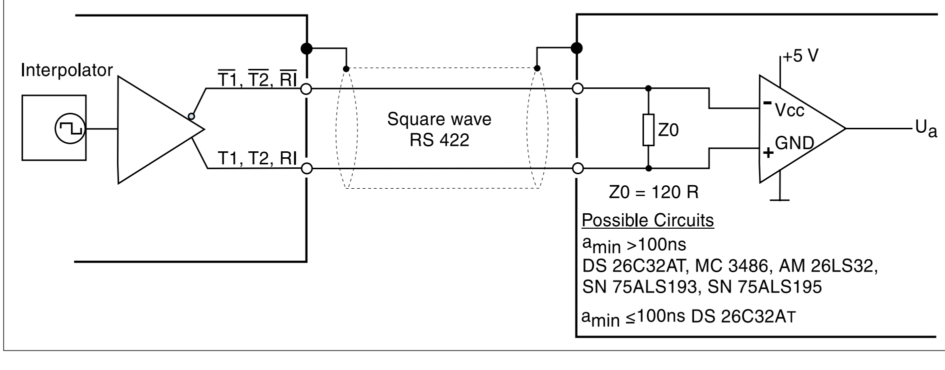
Example:
a_{min} = 100 ns, 10 m cable
The control/DRO must be able to detect 100ns - 10ns - 10 x 0.2ns - 10ns = 78ns

Advantage:
- Noise immune signals
- No further subdividing electronics necessary

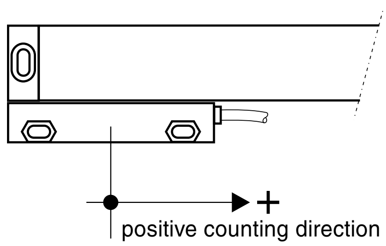
Drawing in "positive counting direction"



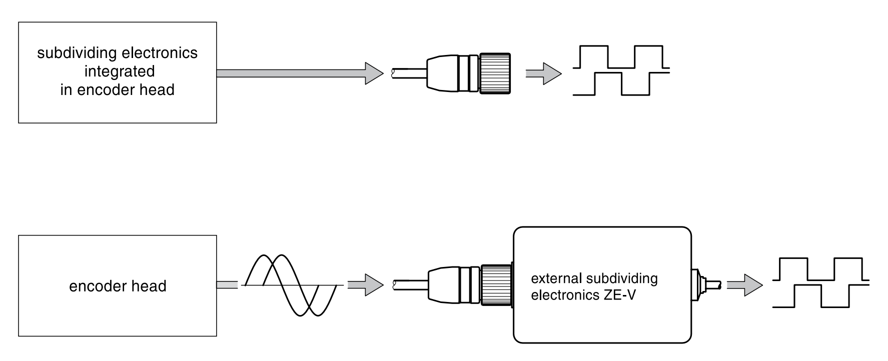
Recommended Line Receiver circuit



Positive counting direction orientation



Subdividing Electronics
Connecting cables



Signal interpolation is available in two versions.

- Subdividing Electronics integrated in the encoder head offer the advantage of reduced parts and labor, lower hardware cost, and it eliminates the need for space to mount an external subdividing electronic unit.
- External Subdividing Electronics require sinusoidal micro-current input signals (ZE-Vx) or sinusoidal voltage signal (ZE-Sx)

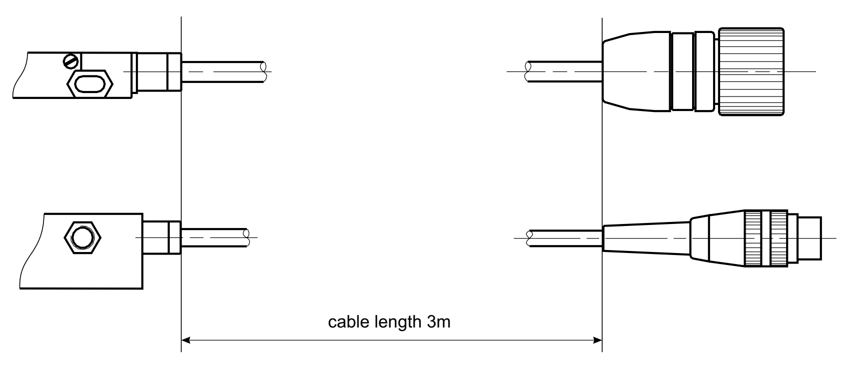
Both versions can output differential Line Driver RS 422 square wave signals.

Output signals resp. constructional features	Cable Ø mm	Shield		**Minimum Bend radius** Fixed mount	Continuous bending *
Sinusoidal micro-current signals and sinusoidal voltage signals	5.7 4.4 3.9	double double, double,	 high flex ultra high flex	45 mm 35 mm 30 mm	85 mm 70 mm 60 mm
Square wave signals	5.7	single		45 mm	85 mm
MSA 65x and MSA 35x	4.8 4.3	single, single	with metal braiding	25 mm 25 mm	50 mm 45 mm

*** Cycle of bending typical 50 million**

Encoder heads have cables designed for the specific signal outputs.
Standard cable length is 3 m.
The cable jacket is a special thermoplastic, resistant to commercial coolants and lubricants.
Cables should be protected with a metallic armor if exposed to a harsh environment like "hot metal chips".
The cables can be used in the following temperature ranges:
Fixed cable mounting: -20°C to +70°C
Continuous flexing: -5°C to +70°C

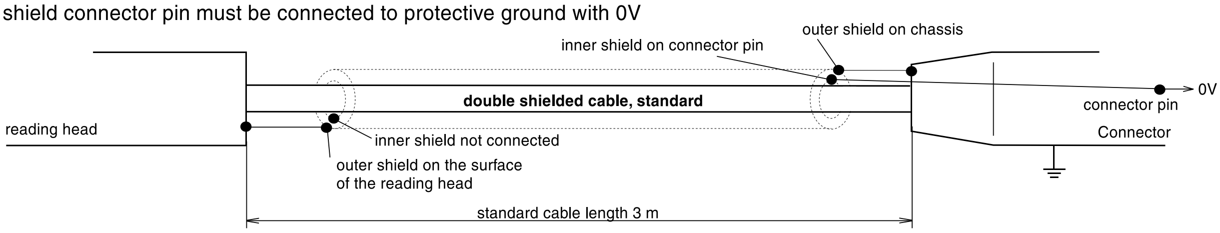
Definition of the cable length



Shield connections

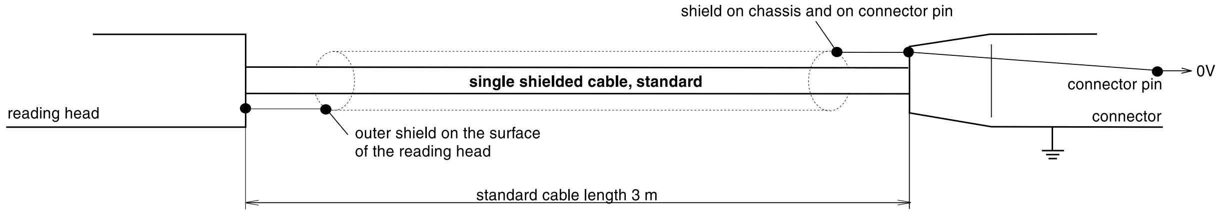
Sinusoidal micro-current signals
Sinusoidal voltage signals

The inner shield connector pin must be connected to protective ground with 0V



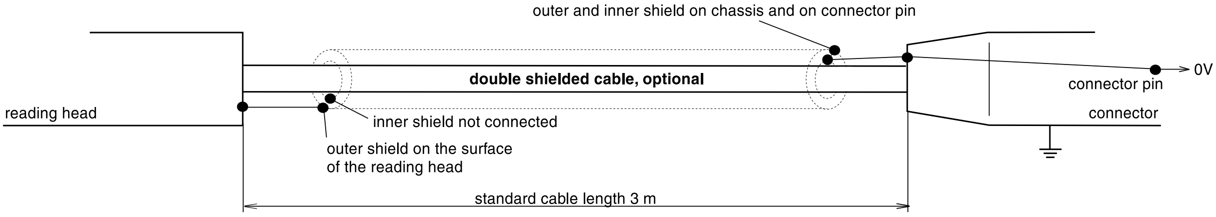
Square wave signals

The inner shield connector pin must be connected to protective ground with 0V



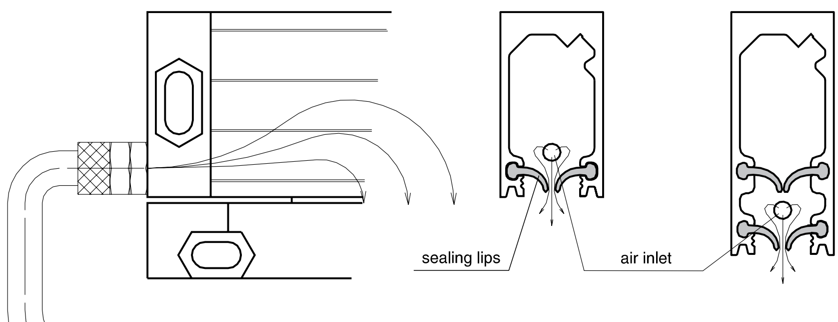
Square wave signals

The inner shield connector pin must be connected to protective ground with 0V



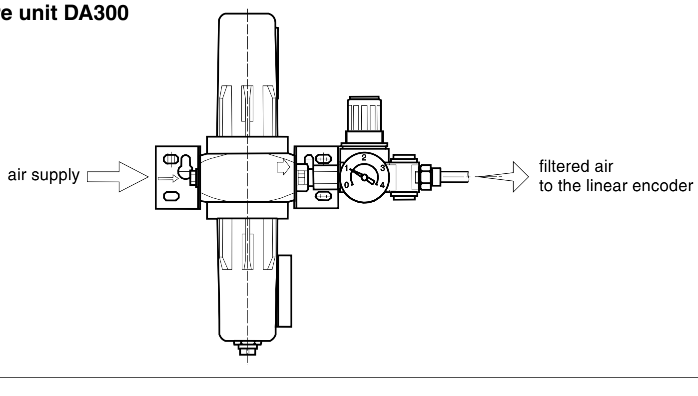
Environmental sealing

Environmental sealing



Commonly used sealing lips are resistant to all coolants and lubricants.

Air pressure unit DA300



For applications where the Linear Encoders are used in harsh environments (e.g. oil and coolants), there are two methods of extra protection beyond the enclosed unit´s standard set of sealing lips.
1. An air inlet can be provided for filtered air to be input into the scale spar.
A limiting flow restrictor helps set the optimum overpressure airflow inside the scale spar to further prevent oil and coolants from entering the seal.
2. Scale spars with two sets of sealing lips are available. The area between the two sets of sealing lips can also be pressurized to achieve the best possible environmental sealing.

When filtered air is not available, the **RSF Air Pressure Unit DA300**, or an equivalent, should be used. Pressure is adjustable. To avoid measuring errors due to thermal differences, it is absolutely necessary to provide pressurized air that has the same temperature as the machine tool. The DA300 requires standard compressed air at the input.

Nomenclature

Encoder Name — **XXX**XXX.XX-X XX

Encoder Type — XXX**XXX**.XX-X XX
(design features)

Output signals and integrated Subdividing — XXXXXX.**X**X-X XX

0 = sinusoidal voltage signals 1 Vpp
1 = sinusoidal micro-current signals 7 to 16 µApp
2 = square wave signals, times 1
3 = square wave signals, times 2
4 = square wave signals, times 20
5 = square wave signals, times 25
6 = square wave signals, times 5
7 = square wave signals, times 10
8 = square wave signals, times 50
9 = square wave signals, times 100

Grating pitch — XXXXXX.X**X**-X XX

0 = 8 µm	5 = 100 µm	A = 6,35 µm	F = 101,60 µm	M = 150 L/Inch
1 = 10 µm	6 = 200 µm	B = 10,16 µm	G = 25,40 µm	N = 360 L/Inch
2 = 16 µm	7 = 400 µm	C = 12,70 µm	H = 35 µm	R = 720 L/Inch
3 = 20 µm	8 = 50 µm	D = 20,32 µm	K = 2160 L/Inch	
4 = 40 µm		E = 50,80 µm	L = 1200 L/Inch	

Version of the switch signal — XXXXXX.XX**-X** XX
(only for Linear Encoder with switch magnets)

-0 = without switch signal
-1 = TTL output (active high)
-2 = open collector output (active high impedance)
-3 = TTL output (active low)
-4 = open collector output (active low)

Possible options — XXXXXX.XX-X **XX**
K = distance coded Reference marks
P = input for compressed air

For example: **MSA690.63-1 P**

- 690: small cross-section, mounting holes on the extrusion ends, with switch magnets
- 6: square wave output signals, integrated Subdividing times 5
- 3: grating pitch 20 µm
- -1: switch signal with TTL output (active high)
- P: input for compressed air

MSA 670
MSA 690 (with switch signals)

Scale model	System resolution	Accuracy grades *	Grating pitch *	Max. velocity (Edge separation a_{min}) continuous	momentary
• Sinusoidal voltage signals 1 V_{pp}					
MSA 670.03	depending on external subdividing	±3, ±5, ±10 µm/m	20 µm	1 m/s	2 m/s
MSA 670.01	depending on external subdividing	±2, ±3 µm/m	10 µm	1 m/s	1 m/s
• Sinusoidal micro-current signals					
MSA 670.13	depending on external subdividing	±3, ±5, ±10 µm/m	20 µm	1 m/s	2 m/s
MSA 670.11	depending on external subdividing	±2, ±3 µm/m	10 µm	1 m/s	1 m/s
• Square wave Line Driver signals with integrated Subdividing					
MSA 670.24	10 µm	±10 µm/m	40 µm	1 m/s (6.6 µs)	2 m/s (3.3 µs)
MSA 670.23	5 µm	±5, ±10 µm/m	20 µm	1 m/s (3.3 µs)	2 m/s (1.6 µs)
MSA 670.64	2 µm	±5 µm/m	40 µm	1 m/s (1.2 µs)	2 m/s (600 ns)
MSA 670.63	1 µm	±3, ±5 µm/m	20 µm	1 m/s (600 ns)	1 m/s (600 ns)
MSA 670.73	0.5 µm	±3, ±5 µm/m	20 µm	1 m/s (300 ns)	1 m/s (300 ns)
MSA 670.71	0.25 µm	±2, ±3, ±5 µm/m	10 µm	0.5 m/s (300 ns)	0.5 m/s (300 ns)
MSA 670.51	0.1 µm	±2, ±3,±5 µm/m	10 µm	0.45 m/s (200 ns)	0.45 m/s (200 ns)

* **Other accuracy grades or grating pitches (e.g. Inch) upon request**

Standard measuring lengths: (mm)
70, 120, 170, 220, 270, 320, 370, 420, 470, 520, 620, 720, 820, 920, 1040, 1140, 1240, 1340, 1440, 1540, 1640, 1740, 1840, 2040, 2240

Measuring type: glass scale

Reference Mark (RI): selectable
MSA 670.xx **K,** MSA 690.xx **K:**
Distance coded Reference Marks (**K**): after travelling 20 mm the absolute position will be shown on the display.

MSA 670.xx, MSA 690.xx:
Up to a measuring length of 920 mm, one Reference Mark can either be placed in the middle of scales 1040 mm or longer, or 35 mm from either end of measuring length. With a measuring length of 1040 mm or longer, a Reference Mark will be placed 45 mm from either end of the measured length.

Option:
One Reference Mark at any location, or two or more Reference Marks separated by distances of n x 50 mm

MSA 690.xx
Free positionable switching magnets for special functions:
The position of the 2 switch points (S1 and S2) within the measured length can be select ed by the customer (details on page 32 and 33)

Required moving force: with standard sealing lips < 3 N
with low drag sealing lips < 0.2 N

Environmental sealing DIN 40050: IP 53 (with standard sealing lips)
IP 64 with DA300 (DA300 see page 45)

Permissible vibration: 100 m/s² (40 to 2000 Hz)**,** Permissible shock: 200 m/s² (8 ms)

Permissible temperature: -20°C to +70°C (storage), 0°C to +50°C (operation)

Weight (approx.): 0.8 kg/m (scale spar) + 75 g (scanning head without cable)

Signal-outputs (optional):

- **Sinusoidal voltage signals**
  MSA 670.03
  MSA 670.01

Power supply:
+5V ±5%, max. 120 mA (unloaded)

Output signals:
Encoder signals: 0.6 to 1.2 Vpp, typical 1 Vpp
with terminating resistor Zo = 120 Ω
Reference pulse:
0.2 to 0.85 Vpp, typical 0.4 V (useable component)
with terminating resistor Zo = 120 Ω

Max. output frequency:
100 kHz (with 3 m cable)

- **Sinusoidal micro-current signals**
  MSA 670.13
  MSA 670.11

Power supply:
+5 V ±5%, max. 120 mA

Output signals:
Encoder signals: 7 to 16 µApp,
typical 11.5 µApp at 1 KΩ

Reference pulse: 2 to 8 µA,
typical 5 µA (useable component) at 1 KΩ

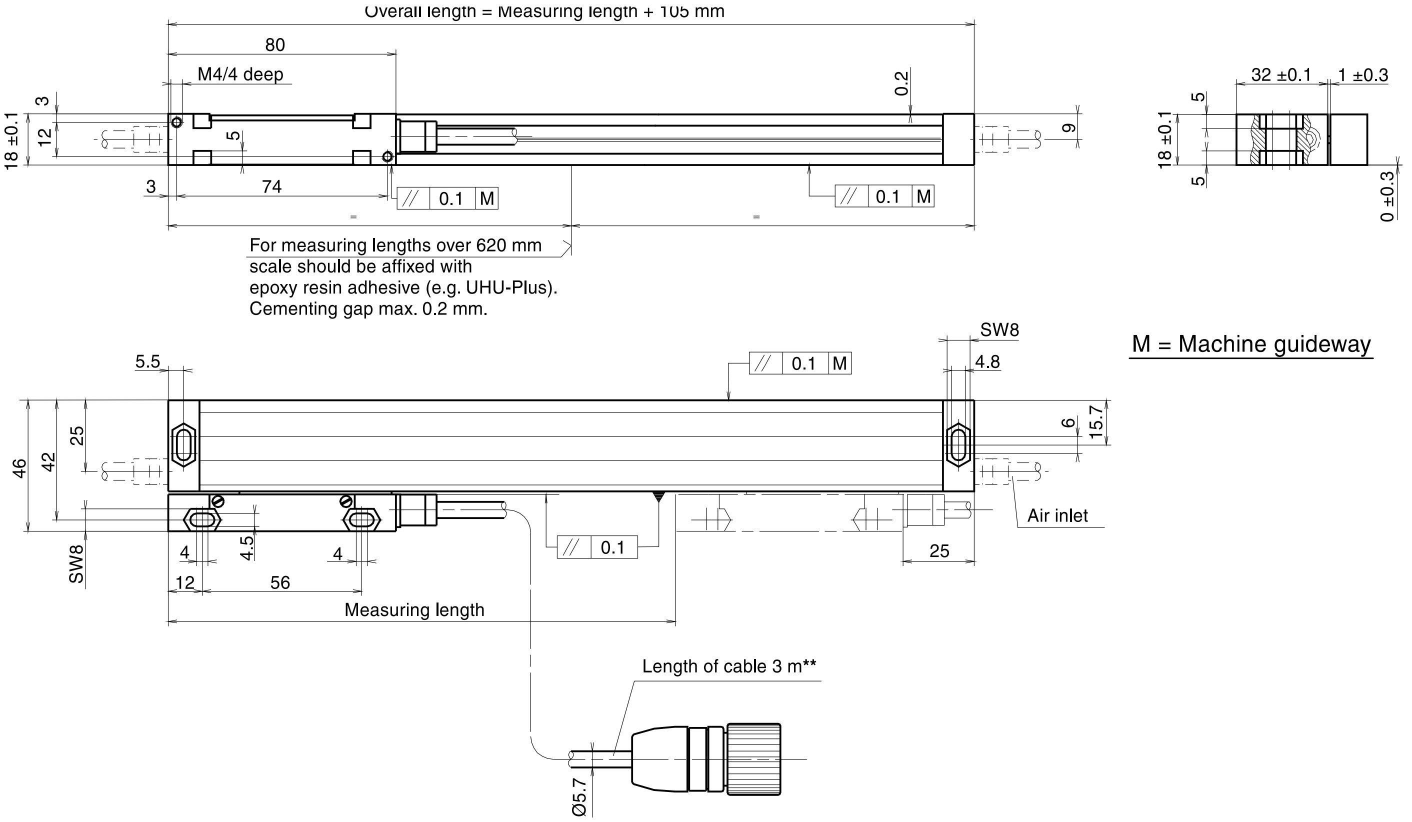
Max. output frequency:
100 kHz (with 3 m cable)

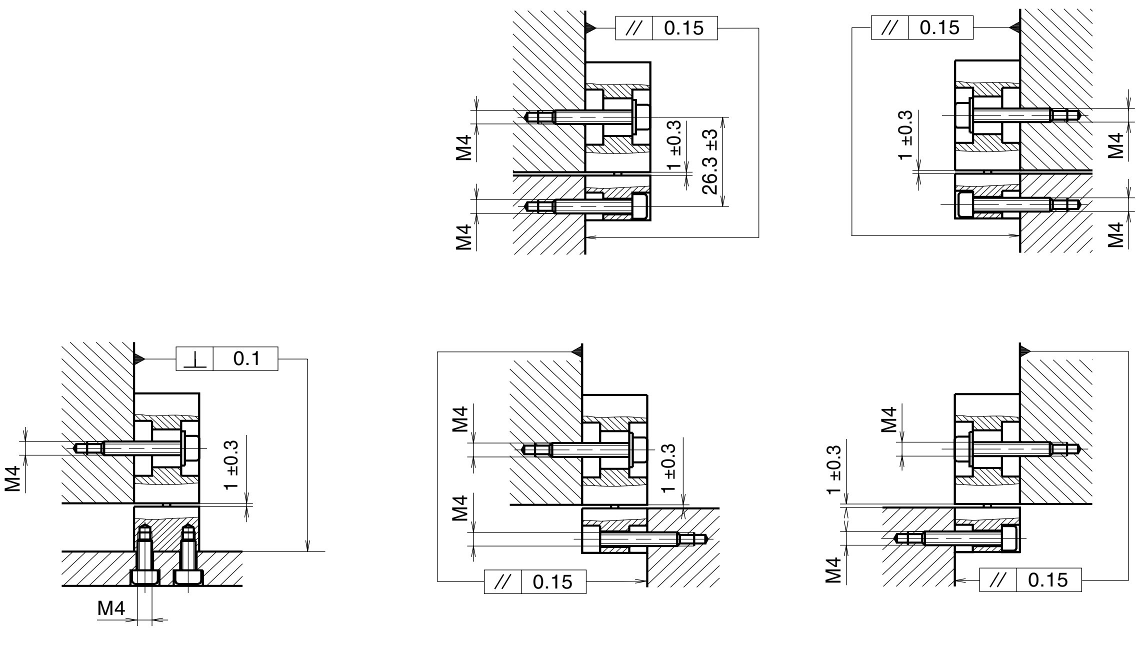
- **Square wave signals** (single ended)
  with integrated Subdividing Electronics

- **Square wave signals** (differential)
  via Line Driver RS 422 standard
  with integrated Subdividing Electronics
  MSA 670.23 = times1
  MSA 670.24 = times1
  MSA 670.63 = times5
  MSA 670.64 = times5
  MSA 670.73 = times10
  MSA 670.71 = times10
  MSA 670.51 = times25

Power supply:
+5 V ±5%, max. 150 mA (unloaded)

MSA 670, MSA 690 Dimensions - Mounting tolerances - Mounting possibilities:





** armoured cable optional