INCREMENTAL LINEAR ENCODERS
Sealed Versions
RSF Elektronik is one of the world's leading companies in the field of electronic linear measuring systems and it offers an extensive portfolio which includes almost all designs which are required by the market. The typical resolutions or measuring steps range from a few micrometres down to the nanometre range. Another core element of the product range are high-precision and resistant graduations which are manufactured in thin-layer technology on glass or other carrier substrates. RSF Elektronik also develops customized cable systems for the widest range of sectors and areas of application, and these are manufactured by the Chotěšov subsidiary. In order to safeguard the company’s high quality standard, a comprehensive quality assurance and environmental management system – certified according to DIN EN ISO 9001 and DIN EN ISO 14001 – has been put in place. Thanks to the company’s extensive distribution network, optimum customer service is guaranteed in practically all regions.
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DESIGN AND OPERATION

The Linear Encoders from RSF are all-purpose. They are suited for manual applications; yet they are also particularly suitable for closed-loop drive systems.

Owing to their sealed design, the Linear Encoders of the MSA 4, MSA 5, MSA 7 and MSA 8 series are predestined for usage in machine tools. They are also very well suited for applications in automation and production technology, in which a protection for scale and reading head is required.

MSA 4, MSA 5, MSA 7 and MSA 8 represent a systematic advancement of tried-and-tested systems and feature improved construction details. During development, RSF paid particular attention to the optimization of system accuracy. We achieved this goal thanks to the perfect combination of several individual components. Beyond that, details that are stressed more intensively were built to be more robust so as to heighten long-term stability.

Measuring systems are made up of two components: extrusion and reading head. Preferably, the extrusion is to be mounted on the moveable part of the linear axis, and the reading head to the fixed part (cable duct) of the linear axis. The extrusion consists of a stable aluminum profile, fastening elements, a scale and sealing lips. Drip caps at the profile and specially formed sealing lips prevent the intrusion of dust, filings and liquids into the extrusion.

The fiber-reinforced sealing lips made of fluororubber (Viton®) are highly lubricant-resistant and coolant-resistant. High velocities are feasible due to the high degree of rigidity, coupled with the ideally formed blade area of the reading head. Optionally, a sealing air inlet for a greater demand for tighter sealing is on offer.

The scale is fastened by dint of a flexible adhesive film in the profile, which compensates for the differing linear expansion between the glass or glass ceramics and the aluminum. Thus a reproducible thermal behavior is ensured (symmetrical expansion or shortening of the scale to the profile in case of temperature changes). The scale can be fixed additionally in the profile in order to adjust the thermal zero point to each measuring requirement. Expansion differences between aluminum profile and machine slide are evened out by flexible fastening elements.

Depending on the model, the reading head is available with cable or device connector plug. The reading head houses the evaluation electronics. The reading carriage includes a reticle and the optoelectronics for signal generating. Reading head and reading carriage are coupled to each other.

Hall-sensors are integrated in the reading head, which generate switch signals for an additional position detection or enable a selection of reference marks. They are activated by magnets that can be optionally positioned in any way on the extrusion by the customer.

The reading carriage evens out alignment deviations between extrusion and machine guide. It rolls by dint of roller bearings on the scale and is pressed down by magnets that affect the ferromagnetic tapes on the extrusion (magnet guide). Hence there are no forces between reading head and extrusion that could stress guide parts of the linear axis. Moreover, the extrusion is not subjected to any bending strain.

In the measuring direction, reading carriage and reading head are connected by a wear-free and maintenance-free magnetic coupling. A ferromagnetic ball rolling freely between two magnetic plates makes for a connection that is very stiff in the measuring direction, yet flexible in all other degrees of freedom. Thus any deviation (within the tolerance) will be evened out by the ideal mounting of the measurement system.

The combination of magnetic guide and magnetic coupling allows for generous mounting tolerances without any negative influence on accuracy. Hence substantial benefits are achieved in comparison to traditional technologies.
A high accuracy grating is deployed as scale graduation. Depending on the model, glass ($\alpha = 8.5 \times 10^{-6}$/K) or glass ceramics ($\alpha = 0 \times 10^{-6}$/K) is employed as base.

The grating is the consistent series of lines and spaces of the same width. The width of one line and one space is called a grating pitch (T).

Parallel to the grating, there are one or more reference marks (RI) on a second track. Within the measuring length, any position is possible and additional reference marks can be chosen at will in a distance of 50 mm.

Linear Encoders with a suffix "K" in the model designation are equipped with distance-coded reference marks. After traveling a distance of 20 mm at maximum, the absolute tool position is available with these models. By dint of the optical scanning, a position-accurate evaluation of the reference marks is ensured.

The incremental Linear Encoders work according to an imaging photoelectric measuring principle with a transmissive singlefield scanning.

The regulated light of an infrared LED is collimated by a condenser lens, passes through the grid of the reticle and the scale and generates a periodic intensity distribution on the structured sensor.

The sensor generates sinusoidal signals of the highest quality that prove to be widely insensitive to possible contaminations, which can never be entirely ruled out despite all technical precautions.

The regulation of the LED ensures a constant light output, guaranteeing stability in the case of temperature fluctuations as well as with long-run operation.
OUT put Signals

**Sinusoidal voltage signals 1Vpp**
(drawning shows “positive counting direction”)
Two sinusoidal voltage signals A1 and A2 and one reference mark signal
(all with inverted signals).

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

**Track signals (differential voltage A1 to A1 resp. A2 to A2):**
Signal amplitude 0.6 Vpp to 1.2 Vpp; typ. 1 Vpp
(with terminating impedance Zo = 120 Ω between A1 to A1 resp. A2 to A2)

**Reference mark (differential voltage RI to RI):**
Square-wave pulse with an amplitude of 0.8 to 1.2 V; typ. 1 V
(with terminating impedance Zo = 120 Ω between RI to RI)

**Advantage:**
High traversing speed with long cable lengths possible

**Square-wave signals**
(drawning shows “positive counting direction”)
With a Schmitt-Trigger (for times 1) or interpolation electronics
(for times 2, -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).
The resolution equates to the 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:**
$a_{min} = 125$ ns, 10 m cable
$125$ ns - $10$ ns - $10 \times 0.2$ ns - $10$ ns = $103$ ns

**Power supply:** +5 V ± 5%, max. 180 mA (unloaded)

**Advantage:**
- Noise immune signals
- No further subdividing electronics necessary
According to the specific signal outputs of the Encoder, several connectors are possible. Standard cable length is 3 m. The PUR-cable jacket is a special thermoplastic, resistant to commercial coolants and lubricants. Cables should be protected with a metallic armour 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

Shielding

Shielded PUR-cable, Ø: 4.3 mm
Bending radius fixed mounting: > 10 mm, continuous flexing: > 50 mm
Torsion: > 300,000 cycles
Drag chain: > 5,000,000 cycles

Detachable connecting cable MSA 5 and MSA 8

Cable length is graduated up to 9 m (other lengths on request)

Max. permissible cable length according to power supply MSA 4, MSA 5, MSA 7 and MSA 8
According to factory default setting the actuator magnets are placed at the beginning (S1) and at the end (S2) of measuring length. The magnets can be moved by the customer.

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**VERSION 1**

TTL output (active high)

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**VERSION 2**

open collector output (active high impedance)

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**VERSION 3**

TTL output (active low)

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**VERSION 4**

open collector output (active low)

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According to factory default setting the actuator magnets are placed at the beginning (S1) and at the end (S2) of measuring length. The magnets can be moved by the customer.
The accuracy of the Linear Encoders is classified with a ± tolerance in µm/m (e.g. ±5 µm/m).

The accuracy refers to any meter within the measuring length. For measuring lengths less than 1000 mm, the accuracy specification applies to the whole measuring length.

For best system accuracy, the encoder should be mounted near the machining level and as parallel as possible to the motion direction.

Example of a typical calibration chart for a MSA 810 scale:
The Linear Encoders of the MSA 4 and MSA 7 series are equipped with a fixed connecting cable. Alternatively, RSF offers the MSA 5 and MSA 8 series with a detachable connecting cable. Depending on the electrical version, the detachable connecting cable is available in graduated lengths up to 9 m (other lengths on request).

The Linear Encoders MSA 7xx and MSA 8xx series are characterized by a considerably improved thermal behavior. Flexible fastening elements at the scale unit compensate repeatedly the length-extension resp. -contraction, which appears due to temperature variations at the machine.

With a fixed fastening element (left side, middle or right side) a datum-point (thermal fixed-point) is defined. Additionally, it is also possible to fix the scale inside of the extrusion.

MSA 7

- Small cross section
- Max. measuring length: up to 3040 mm (only at 20 µm grating pitch)
- Connecting cable
- System height: 46 resp. 54 mm

MSA 8

- Small cross section
- Max. measuring length: up to 3040 mm (only at 20 µm grating pitch)
- Detachable connecting cable
- System height: 49 resp. 57 mm

MSA 4

- Large cross section
- Max. measuring length: up to 3040 mm (only at 20 µm grating pitch)
- Detachable connecting cable
- System height: 77 resp. 75 mm

MSA 5

- Large cross section
- Max. measuring length: up to 3040 mm (only at 20 µm grating pitch)
- Detachable connecting cable
- System height: 77 resp. 75 mm
OVERVIEW, SELECTION GUIDE

Symbols:

= Fixed fastening element

= Flexible fastening element

= Additional fixed-point of the scale in the extrusion (optional)

MSA 70 XX-X XX

- Mounting holes at the ends
- Fixed fastening elements
- Max. measuring length:
  1240 mm (MSA 770, MSA 870)
  3040 mm (MSA 470, MSA 570)

Available versions:
- MSA 470, MSA 570
- MSA 770, MSA 870

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MSA 10 XX-X XX

- Fixed mounting-point left
- Flexible fastening element right
- Max. measuring length: 1240 mm

Available versions:
- MSA 710, MSA 810

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MSA 20 XX-X XX

- Fixed mounting-point centered
- Flexible fastening element left and right
- Max. measuring length: 1240 mm

Available versions:
- MSA 720, MSA 820

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MSA 30 XX-X XX

- Fixed mounting-point right
- Flexible fastening element left
- Max. measuring length: 1240 mm

Available versions:
- MSA 730, MSA 830

Page 19
Mounting holes along the scale unit

- Fixed fastening elements
- Max. measuring length: 3040 mm (only at 20 µm grating pitch)

MSA 711, MSA 811  Page 26

MSA 721, MSA 821  Page 27

MSA 731, MSA 831  Page 28

Symbols:

▲ = Fixed fastening element
▼ = Flexible fastening element
● = Additional fixed-point of the scale in the extrusion (optional)
Output signals and integrated subdividing

<table>
<thead>
<tr>
<th>Signal Type</th>
<th>Subdividing Times</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 = sinusoidal voltage signals 1 Vpp</td>
<td>0</td>
</tr>
<tr>
<td>2 = square-wave signals, times 1</td>
<td>1</td>
</tr>
<tr>
<td>3 = square-wave signals, times 2</td>
<td>2</td>
</tr>
<tr>
<td>4 = square-wave signals, times 20</td>
<td>20</td>
</tr>
<tr>
<td>5 = square-wave signals, times 25</td>
<td>25</td>
</tr>
<tr>
<td>6 = square-wave signals, times 5</td>
<td>5</td>
</tr>
<tr>
<td>7 = square-wave signals, times 10</td>
<td>10</td>
</tr>
<tr>
<td>8 = square-wave signals, times 50</td>
<td>50</td>
</tr>
<tr>
<td>9 = square-wave signals, times 100</td>
<td>100</td>
</tr>
</tbody>
</table>

Grating pitch

- 0 = 8 µm
- 1 = 10 µm
- 3 = 20 µm

Reachable system resolution [µm] = \(\frac{\text{grating pitch [µm]}}{\text{subdividing}}\) : 4

Version of the switch signal

(only for Linear Encoders with actuator magnets)

-0 = without switch signals
-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

K = distance-coded reference marks
N = all reference marks active
P = air inlet M5
F = fixed point-bonding scale with extrusion
B = glass ceramic scale

Example

Small cross section, reading head with connecting cable, mounting holes at the ends, fixed mounting point right, flexible fastening element left.
Square-wave signals, integrated subdividing times 5.
Grating pitch 20 µm
Switch signal with TTL output (active high)
Air inlet, fixed point-bonding scale with the extrusion.
## TECHNICAL DATA MSA 4, MSA 5, MSA 7, MSA 8 SERIES

<table>
<thead>
<tr>
<th>Scale model electronic version</th>
<th>Output signals</th>
<th>System resolution [µm]</th>
<th>Accuracy grades [µm/m]</th>
<th>Grating pitch [µm]</th>
<th>Integrated interpolation</th>
<th>Max. velocity [m/s]</th>
<th>Max. output frequency [kHz]</th>
</tr>
</thead>
<tbody>
<tr>
<td>MSA xxx.03</td>
<td>~1 Vpp</td>
<td>dep. on external interpolation</td>
<td>±3, ±5</td>
<td>20</td>
<td>--</td>
<td>2.0</td>
<td>100</td>
</tr>
<tr>
<td>MSA xxx.01</td>
<td>~1 Vpp</td>
<td>dep. on external interpolation</td>
<td>±3, ±5</td>
<td>10</td>
<td>--</td>
<td>2.0</td>
<td>200</td>
</tr>
<tr>
<td>MSA xxx.00</td>
<td>~1 Vp</td>
<td>dep. on external interpolation</td>
<td>±2, ±3, ±5</td>
<td>8</td>
<td>--</td>
<td>2.0</td>
<td>250</td>
</tr>
</tbody>
</table>

### Edge separation

<table>
<thead>
<tr>
<th>Scale model electronic version</th>
<th>Edge separation $a_{\text{min}}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>MSA xxx.23</td>
<td>1.25 µs</td>
</tr>
<tr>
<td>MSA xxx.33</td>
<td>625 ns</td>
</tr>
<tr>
<td>MSA xxx.63</td>
<td>250 ns</td>
</tr>
<tr>
<td>MSA xxx.73</td>
<td>250 ns</td>
</tr>
<tr>
<td>MSA xxx.61</td>
<td>250 ns</td>
</tr>
<tr>
<td>MSA xxx.71</td>
<td>250 ns</td>
</tr>
<tr>
<td>MSA xxx.51</td>
<td>125 ns</td>
</tr>
<tr>
<td>MSA xxx.81</td>
<td>125 ns</td>
</tr>
<tr>
<td>MSA xxx.30</td>
<td>250 ns</td>
</tr>
<tr>
<td>MSA xxx.70</td>
<td>250 ns</td>
</tr>
<tr>
<td>MSA xxx.80</td>
<td>125 ns</td>
</tr>
<tr>
<td>MSA xxx.90</td>
<td>125 ns</td>
</tr>
</tbody>
</table>
Standard measuring lengths (ML): [mm]

70, 120, 170, 220, 270, 320, 370, 420, 470, 520, 570, 620, 670, 720,
770, 820, 870, 920, 970, 1040, 1140, 1240, 1340, 1440, 1540, 1640,
1740, 1840, 1940, 2040, 2240, 2440, 2640, 2840, 3040 (only possible with 20 µm grating pitch),
(8 or 10 µm grating pitch only possible up to measuring length 1140 mm)
(other measuring lengths on request)

Scale unit:
- Glass scale (α=8.5x10⁻⁶/K)
- Glass ceramic scale (α=0x10⁻⁶/K)
  up to ML 1440 mm (longer measuring lengths on request)

Location of reference mark (RI): 
- Distance-coded reference mark (K)
  after travelling max. 20 mm the absolute position is available
- Optional: one reference mark at any location
  additional reference marks can be selected by distances of n x 50 mm

Required moving force:
- With standard sealing lips: < 2.0 N
- With low drag respectively without any sealing lips: < 0.1 N

Environmental sealing acc. EN 60529:
- With standard sealing lips: IP 53
- With DA 400: IP 64 (see Page 33)

Permissible vibration: 100 m/s² (40 up to 2000 Hz)

Permissible shock: 200 m/s² (8 ms)

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

Weight of Linear Encoder (approx.):
- MSA 470, MSA 570: 460 g + 2.5 g/mm (ML)
- MSA 4x1, MSA 5x1: 295 g + 2.5 g/mm (ML)
  + 175 g (reading head without cable)
- MSA 7xx, MSA 8xx: 75 g + 0.57 g/mm (ML)
  + 50 g (reading head MSA 7xx without cable)
  + 65 g (reading head MSA 8xx without cable)

Weight of cable (approx.): 30 g/m

Power supply:
- Sinusoidal voltage signals ~ 1 Vpp
  + 5 V ±5 %, max. 150 mA (unloaded)
- Square-wave signals via Line Driver \(\mathcal{L}\)
  + 5 V ±5 %, max. 180 mA (unloaded)

RoHS-conformity: The Linear Encoders of the MSA 4, MSA 5, MSA 7 and MSA 8 series comply with the guideline of the RoHS-directive 2011/65/EU on the restriction of the use of certain hazardous substances in electrical and electronic equipment
Dimensions, mounting tolerances MSA 770:

Dimensions, mounting tolerances MSA 870:

- **M** = machine guideway
- **ML** = measuring length
- **G** = gauging points
- **A** = cable
- **LHI12** = male connector
- **≠** = required mating dimensions

Optional:
- **P** = M5 air inlet
- **S1, S2** = switch signals
- **RI** = selectable reference mark
- **+** = actuator magnet
- **=** = sensor position

Connecting cable detachable (accessory)
MSA 710, MSA 810

Dimensions, mounting tolerances MSA 710:

Dimensions, mounting tolerances MSA 810:

Symbols:
- M = machine guideway
- ML = measuring length
- G = gauging points
- → = 0 ... ML
- A = cable
- LHI12 = male connector
- ⊙ = required mating dimensions
- optional:
  - P = M5 air inlet
  - S1, S2 = switch signals
  - RI = selectable reference mark
  - * = actuator magnet
  - ** = sensor position

Note: Dimensions and tolerances are shown in the diagram with specific values and tolerances indicated for each component.
MSA 720, MSA 820

Dimensions, mounting tolerances MSA 720:

Dimensions, mounting tolerances MSA 820:

M = machine guideway
ML = measuring length
G = gauging points
→ = 0 = ML
A = cable
LH12 = male connector
= required mating dimensions
optional:
P = M5 air inlet
S1, S2 = switch signals
RI = selectable reference mark
* = actuator magnet
** = sensor position

connecting cable detachable (accessory)
Dimensions, mounting tolerances MSA 730:

Dimensions, mounting tolerances MSA 830:

M = machine guideway
ML = measuring length
G = gauging points
0...ML = cable
A = required mating dimensions

LHI12 = male connector

optional:
P = M5 air inlet
S1, S2 = switch signals
* = selectable reference mark
** = sensor position
Dimensions, mounting tolerances MSA 771:

- **MSA 771**

Dimensions, mounting tolerances MSA 871:

- **MSA 871**

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Legend:
- **M** = machine guideway
- **ML** = measuring length
- **A** = cable
- **LH12** = male connector
- **K** = required mating dimensions
- **optional**: P = M5 air inlet
- **S1, S2** = switch signals
- **RI** = selectable reference mark
- **+** = actuator/magnet
- **+** = sensor position

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Connecting cable detachable (accessory)
Dimensions, mounting tolerances MSA 711:

Dimensions, mounting tolerances MSA 811:

ML = machine guideway
ML = measuring length
A = cable
LH112 = male connector
A = customer connector
FX = fixed mounting
FL = flexible mounting
optional:
P = M5 air inlet
S1, S2 = switch signals
Ri = selectable reference mark
* = actuator magnet
** = sensor position
Dimensions, mounting tolerances MSA 721:

Dimensions, mounting tolerances MSA 821:

- M = machine guideway
- ML = measuring length
- A = cable
- LH12 = male connector
- = customer mounting dimensions
- FX = fixed mounting
- FL = flexible mounting
- P, S1, S2 = M5 air inlet
- L1 = switch signals
- R = selectable reference mark
- = actuator magnet
- = sensor position

connecting cable detachable (accessory)
Dimensions, mounting tolerances MSA 731:

Dimensions, mounting tolerances MSA 831:

M = machine guideway
ML = measuring length
A = cable
LHI12 = male connector
K = customer connector
FX = fixed mounting
FL = flexible mounting
P = M5 air inlet
S1, S2 = switch signals
RI = selectable reference mark
+ = actuator magnet
** = sensor position

connecting cable detachable (accessory)
Dimensions, mounting tolerances MSA 470:

MSA 470, MSA 570

Dimensions MSA 570:

option P: air inlet scale left or right side mountable

accessory: air inlet reading head (ID 1079056-01)

connecting cable detachable (accessory)

M = machine guideway
ML = measuring length
G = gauging points
<— = 0 ... ML
A = cable
= required mating dimensions

option:
P = air inlet M5
S1, S2 = switch signals
RI = selectable reference mark
= actuator magnet
** = sensor position

quantity and position of the mounting support per measuring length

<620 mm

620 ... <1140 mm

1140 ... <2240 mm

2240 ... 3040 mm
**MSA 471, MSA 571**

**MSA 471**

**Dimensions, mounting tolerances MSA 571:**

![Diagram showing dimensions and tolerances for MSA 571]

- **M** = machine guideway
- **ML** = measuring length
- **A** = cable
- **K** = required mating dimensions

Optional:

- **P** = air inlet M5
- **S1, S2** = switch signals
- **RI** = selectable reference mark
- *** = actuator magnet
- **** = sensor position

Option P: air inlet scale left or right side mountable

Accessory: air inlet reading head (ID 1079056-01)

**Dimensions MSA 571:**

![Diagram showing dimensions of MSA 571]

- Connecting cable detachable (accessory)
MSA 411, MSA 511

Dimensions, mounting tolerances MSA 411:

Dimensions MSA 511:
Dimensions, mounting tolerances MSA 421:

**Dimensions MSA 521:**

option P: air inlet scale
left or right side mountable

accessory: air inlet reading head (ID 1079056-01)
MSA 431, MSA 531

Dimensions, mounting tolerances MSA 431:

Dimensions MSA 531:
**MSA 170**

<table>
<thead>
<tr>
<th>Scale model electronic version</th>
<th>Output signals</th>
<th>System resolution [µm/m]</th>
<th>Accuracy grades [µm]</th>
<th>Grating pitch [µm]</th>
<th>Integrated interpolation</th>
<th>Max. velocity [m/s]</th>
<th>Max. output frequency [kHz]</th>
</tr>
</thead>
<tbody>
<tr>
<td>MSA 170.03</td>
<td>~ 1 Vpp</td>
<td>dep. on external interpolation</td>
<td>±3, ±5</td>
<td>20</td>
<td>--</td>
<td>1.0</td>
<td>50</td>
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<tr>
<td>MSA 170.23</td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>MSA 170.63</td>
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<td>MSA 170.73</td>
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<td>MSA 170.83</td>
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**Standard measuring lengths (ML): [mm]**
50, 70, 120, 170, 220, 270, 320, 370, 420, 470, 520

**Scale unit:** Glass scale ($\alpha = 8.5 \times 10^{-6}/K$)

**Location of reference mark (RI):**
- Distance-coded reference mark (K)
  - after travelling max. 20 mm the absolute position is available
- One reference mark in the middle of measuring length, or 10 mm from either end of measuring length (excluding ML 50 mm)
- Optional: one reference mark at any location, additional reference marks can be selected by distances of $n \times 25$ mm

**Required moving force:** $< 1$ N

**Environmental sealing acc. EN 60529:** IP 53
- With DA 400: IP 64 (see page 33)

- **Permissible vibration:** 100 m/s² (40 to 2000 Hz)
- **Permissible shock:** 150 m/s² (8 ms)
- **Permissible temperature:** $-20 \degree C$ to $+70 \degree C$ (storage), $0 \degree C$ to $+50 \degree C$ (operation)
- **Weight** (approx.): 20 g + 0.17 g/mm (ML) + 35 g (reading head without cable)
- **Power supply:** +5 V ±5%
  - max. 75 mA (unloaded) ~ 1 Vpp, max. 120 mA (unloaded)
- **RoHS-conformity:** The Linear Encoders of the MSA 170 series comply with the guideline of the RoHS directive 2011/65/EU on the restriction of the use of certain hazardous substances in electrical and electronic equipment

**Overall length** = measuring length (ML) + 80

**Hole distance** = measuring length + 72 ± 0.2

**Detail X**
- M = machine guideway
- $\Omega$ = measuring points for alignment
- $\mathbb{P}$ = air inlet M3 (on both sides)
- $\mathfrak{K}$ = required mating dimensions

---

**Visual Diagram**

- Overall length is the sum of measuring length and an additional 80 mm.
- The hole distance is the sum of the measuring length and a deviation of 72 ± 0.2 mm.
- Detail X includes additional dimensions and alignments for proper installation.
Standard measuring lengths (ML): [mm]
70, 120, 170, 220, 270, 320, 370, 420, 470, 520, 620, 720, 770, 820, 920, 1040, 1140, 1240 (other ML on request)

Scale unit: Glass scale \((\alpha = 8.5 \times 10^{-6} / \text{K})\)

Free positionable actuator magnets for special functions:
The position of the two switch-points (S1 und S2) can be selected by the customer within measuring length.

Location of reference mark (RI):
- One reference mark in the middle of measuring length, or 35 mm from either end of measuring length
- Optional: one reference mark at any location, additional reference marks can be selected by distances of \(n \times 50 \text{ mm}\)

Required moving force: < 1 N

Environmental sealing acc. EN 60529: IP 53
- With DA 400: IP 64 (see page 33)

 ACCESSORY: CB8-150 COUPLING BAR (ONLY FOR MSA 373 AND MSA 375)

Axis distance: 150 mm (other axis distances on request)
Included in delivery: 2 hexagon socket screws M8 x 20 ISO 4762 for mounting
ACCESSORY: CB8-150 COUPLING BAR

(ONLY FOR MSA 373 AND MSA 375)

MSA 373

ML + 164
ML + 150
120
112
4.2
112
22 + 0.018
空气入口 M5

on both sides

(ML + 150) ±0.5

ML = measuring length
M = machine guideway
OT = overtravel

S1, S2 position of the sensors in the encoder head, switching length typ. 12 mm

switch positions S1 and S2 free selectable (Allen wrench 0.9 mm)
spring rod clamping left side possible (Allen wrench 3 mm)

* clamping length spring rod
** fastening screw thread for coupling bar

MSA 374

MSA 375
## MALE AND FEMALE CONNECTORS, PIN ASSIGNMENTS

### SUB MIN-D

**Connector LD15** 15-pin  
(weight: 25 g)

![Connector LD15 15-pin](image)

**Pin assignment**  
(view on pins)

![Pin assignment](image)

**LD15**

<table>
<thead>
<tr>
<th>Pin</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
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<th>11</th>
<th>12</th>
<th>13</th>
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<td>nc</td>
<td>0 V sensor</td>
<td>nc</td>
<td>RI</td>
<td>A2</td>
<td>AT</td>
<td>+5 V sensor</td>
<td>+5 V</td>
<td>0 V</td>
<td>S1*</td>
<td>S2*</td>
<td>RI</td>
<td>A2</td>
<td>A1</td>
<td>shield</td>
</tr>
<tr>
<td>Square-wave signals via Line Driver</td>
<td>nc</td>
<td>0 V sensor</td>
<td>US</td>
<td>RI</td>
<td>T2</td>
<td>TT</td>
<td>+5 V sensor</td>
<td>+5 V</td>
<td>0 V</td>
<td>S1*</td>
<td>S2*</td>
<td>RI</td>
<td>T2</td>
<td>T1</td>
<td>shield</td>
</tr>
</tbody>
</table>

Sensor: The sensor-Pins are bridged in the chassis with the particular power supply  
*Version without switch signals (version 0) = nc*  
Shield is additionally connected with the chassis

### CONNEI

**Connector L121** 12-pin  
(weight: 75 g)

![Connector L121 12-pin](image)

**Pin assignment**  
(male connector on pins)

**Female connector K121** 12-pin

**Female connector KM121** 12-pin

![Connector L121, K121, KM121](image)

<table>
<thead>
<tr>
<th>Pin</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
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</thead>
<tbody>
<tr>
<td>Sinusoidal voltage signals 1 Vpp</td>
<td>A2</td>
<td>+5 V sensor</td>
<td>RI</td>
<td>RI</td>
<td>A1</td>
<td>AT</td>
<td>nc</td>
<td>A2</td>
<td>nc</td>
<td>0 V</td>
<td>0 V</td>
<td>+5 V sensor</td>
</tr>
<tr>
<td>Square-wave signals via Line Driver</td>
<td>T2</td>
<td>+5 V sensor</td>
<td>RI</td>
<td>RI</td>
<td>T1</td>
<td>TT</td>
<td>US</td>
<td>T2</td>
<td>nc</td>
<td>0 V</td>
<td>0 V</td>
<td>+5 V sensor</td>
</tr>
</tbody>
</table>

Sensor: The sensor-pins are bridged in the chassis with the particular power supply  
Shield is additionally connected with the chassis

### DIN

**Connector L120** 12-pin  
(weight: 20 g)

![Connector L120 12-pin](image)

**Pin assignment**  
(male connector on pins)

**Female connector K120** 12-pin

![Connector L120, K120](image)

<table>
<thead>
<tr>
<th>Pin</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
<th>H</th>
<th>J</th>
<th>K</th>
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<tbody>
<tr>
<td>Sinusoidal voltage signals 1 Vpp</td>
<td>nc</td>
<td>0 V</td>
<td>A1</td>
<td>AT</td>
<td>A2</td>
<td>S1*</td>
<td>RI</td>
<td>TR</td>
<td>S2*</td>
<td>+5 V</td>
<td>A2</td>
<td>nc</td>
</tr>
<tr>
<td>Square-wave signals via Line Driver</td>
<td>nc</td>
<td>0 V</td>
<td>T1</td>
<td>TT</td>
<td>T2</td>
<td>S1*</td>
<td>RI</td>
<td>TR</td>
<td>S2*</td>
<td>+5 V</td>
<td>T2</td>
<td>US</td>
</tr>
</tbody>
</table>

Shield is additionally connected with the chassis  
*Version without switch signals (version 0) = nc*
AIR PRESSURE UNIT DA 400

For applications where the Linear Encoders are used in harsh environments (e.g., oil and coolants), RSF offers a method of extra protection beyond the enclosed unit’s standard set of sealing lips.

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.

To ensure fail-safe operation of the Linear Encoder, only “clean” and pretreated air should be put into the scale housing.

The scale cavity should have a flow rate of about 7 to 10 l/min (per Linear Encoder). The setted overpressure (adjustable from 0.5 to 3 $\times 10^5$ Pa) depends on the number of the connected Linear Encoders (max. 10 Linear Encoders) and the design of the compressed-air supply.

DA 400 consists of three filter stages (prefilter, fine filter and activated carbon filter) and a pressure regulator with pressure gauge.

To reach the promised accuracy of the measuring system, the air temperature has to be +20 °C.
PRODUCT DIRECTORY

MS 2x Series
Reflective scanning Linear Encoder with integrated mounting control (only MS 25, MS 26)
Easy mounting; no test box or oscilloscope needed
Quality of the scanning signals is directly visible at the reading head via a 3-coloured LED
Two independent switch signals for individual special functions
Position of reference mark selectable
High insensitivity against contamination
High traversing speed
Integrated subdividing: up to times 100 interpolation
Max. measuring length
Glass scale: 3140 mm
Steel tape scale: 20000 mm

MS 30, MS 31 Series
Reflective scanning Linear Encoder
Two independent switch signals for individual special functions
Position of reference mark selectable
Small dimensions
Easy mounting as a result of large mounting tolerances
High traversing speed
High insensitivity against contamination
Integrated subdividing: up to times 100 interpolation
Max. measuring length
Glass scale: 3140 mm
Steel tape scale: 11940 mm

MS 45 Series
Reflective scanning Linear Encoder with integrated mounting control
Easy mounting; no test box or oscilloscope needed
Quality of the scanning signals is directly visible at the reading head via a 3-coloured LED
Two independent switch signals for individual special functions
Position of reference mark selectable
Small dimensions
Easy mounting as a result of large mounting tolerances
High traversing speed
High sensitivity against contamination
Integrated subdividing: up to times 100 interpolation
Max. measuring length
Steel tape scale: 30000 mm

MS 82 Series
Interferential Linear Encoder
Two switch tracks for individual special functions
Non-contact reflective scanning
High traversing speed
Small dimensions
Scale unit: glass scale or ROBAX® glass ceramic scale with phase grating
Max. measuring length
Glass scale: 3140 mm
Glass ceramic: 1840 mm

MS 14 Series
Reflective scanning Linear Encoder with integrated mounting
Easy mounting; no test box or oscilloscope needed
Quality of the scanning signals is directly visible at the reading head via a 3-coloured LED
Extremely small dimensions
Easy mounting as a result of large mounting tolerances
High insensitivity against contamination
High traversing speed
Integrated subdividing: up to times 100 interpolation
Max. measuring length
Steel tape scale: 20000 mm

MSR 40
Modular Rotary Encoder with steel tape scale
Different versions
Full-circle or segment version
Grating pitch: 200 µm
Accuracy of the grating (stretched): ±30 µm/m
High rotational speed resp. circumferential speed
Integrated subdividing: up to times 100 interpolation

MSR 20
Segment version
Grating pitch: 40 µm
Accuracy of the grating (stretched): ±15 µm/m
High circumferential speed
Integrated subdividing: up to times 100 interpolation

DG 118, DG 120
Rotary Encoder for universal application
Standard line/rev.: graduated from 100 to 5400

DIT 10, DIT 30, DIT 48
Precision Measuring Probes
For universal applications
Stroke length: 10, 30, 48 mm
Mounting on shaft sleeve
Mounting with two tapped holes on body (DIT 30, DIT 48)
With cable lifter
Integrated pneumatic lifter optional
Sealing bellows optional (DIT 30, DIT 48)
**MSA 65x, MSA 35x**

Sealed Linear Encoders

- For retrofit of machine tools
- Large mounting tolerances
- Guided by ball bearings
- Distance-coded reference marks
- Two sets of sealing lips for additional contamination protection (only MSA 352)
- Mounting holes on the extrusion ends (MSA 650, MSA 35x)
- Mounting holes on top of the extrusion - improves vibration rating (MSA 651)
- Mounting supports (MSA 35x)
- Max. measuring lengths:
  - MSA 650: 1740 mm
  - MSA 651: 2240 mm
  - MSA 35x: 3040 mm

**Z 300**

Digital Readouts for universal application

- Number of alphanumeric axes: 2 or 3
- Monochrome flat screen
- Clearly readable display
- Robust cast aluminum housing
- Splash-proof fulltravel keypad
- Practice-oriented functions
- Standard version for turning, drilling or milling machine

**UFC 430**

USB-Interface-Module

- USB-interface acc. to spec. 2.0
- Available inputs: 1 Vpp max. 200 kHz or TTL (RS 422) max. 500 kHz
- Interpolation: up to times 400 for measuring systems with output 1 Vpp and up to times 4 for measuring systems with square-wave Line Driver signals
- Three 15-pin Sub-D female connectors for 3 encoder inputs
- 32 Bit counter with preset and latch register

**IFC 430R**

Encoder-interface-card

- PC interface board for quadrature encoder signal evaluation: times 1, -2 or -4
- Latch logic for measured values
- Three counter channels à 32 bit, one load and two latch registers for each channel
- PC bus
- Signal edge separation: up to 100 ns
- Demo program with examples and driver software

**Precision Graduations**

- Length graduations on glass, chromium coated
- Length graduations on steel tape, gold coated or polished surface
- Circular graduations on glass, chromium coated
- Graticules
- Antireflex coatings
- Coatings

**Cable Systems**

- Individual cable design
- Hybrid cable
- Trailing cable
- System solutions
- Function control
<table>
<thead>
<tr>
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<th>Address</th>
<th>Phone Numbers</th>
<th>Email</th>
<th>Website</th>
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<td>Austria</td>
<td>RSF Elektronik Ges.m.b.H. A-5121 Tarsdorf</td>
<td>+43 (0) 6278 8192-0/79</td>
<td><a href="mailto:info@rsf.at">info@rsf.at</a></td>
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<td>+33 1 41 14 30 00/30 30</td>
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<td><a href="mailto:sales@heidenhain.co.uk">sales@heidenhain.co.uk</a></td>
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<td><a href="mailto:info@heidenhain.it">info@heidenhain.it</a></td>
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<td>Switzerland</td>
<td>RSF Elektronik (Schweiz) AG Vieristrasse 14 CH-8603 Schwerzenbach</td>
<td>+41 44 955 10 50/10 51</td>
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<tr>
<td>Korea</td>
<td>HEIDENHAIN LTD. 202 Namsung Plaza, 9th Ace Techno Tower, 130, Digital-Ro, Geumcheon-Gu, Seoul, Korea 153-782</td>
<td>+82 (0) 220 28 74 30</td>
<td><a href="mailto:info@heidenhain.co.kr">info@heidenhain.co.kr</a></td>
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