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 events 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.
OUTPUT SIGNALS

Sinusoidal voltage signals 1Vpp
(drawing 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 Z₀ = 120 Ω between A1 to A1 resp. A2 to A2)

Reference mark (differential voltage RI to R̅I):
Square-wave pulse with an amplitude of 0.8 to 1.2 V; typ. 1 V
(with terminating impedance Z₀ = 120 Ω between RI to R̅I)

Advantage:
High traversing speed with long cable lengths possible

Square-wave signals
(drawing 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 aₘᵟᵦ 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:
aₘᵦ = 125 ns, 10 m cable
125 ns - 10 ns - 10 x 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**

<table>
<thead>
<tr>
<th>power supply [V] on connector - control side</th>
<th>4.5</th>
<th>4.6</th>
<th>4.7</th>
<th>4.8</th>
<th>4.9</th>
<th>5.0</th>
<th>5.1</th>
<th>5.2</th>
<th>5.3</th>
</tr>
</thead>
<tbody>
<tr>
<td>cable length [m]</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
</tr>
<tr>
<td>square-wave</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>sine</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
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:
SCALE OVERVIEW

SELECTION GUIDE

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 repeatably 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 X70 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
Available versions: MSA 770, MSA 870

**MSA X10 XX-X XX**
- Fixed mounting-point left
- Flexible fastening element right
- Max. measuring length: 1240 mm

Available versions: MSA 710, MSA 810

**MSA X20 XX-X XX**
- Fixed mounting-point centered
- Flexible fastening element left and right
- Max. measuring length: 1240 mm

Available versions: MSA 720, MSA 820

**MSA X30 XX-X XX**
- Fixed mounting-point right
- Flexible fastening element left
- Max. measuring length: 1240 mm

Available versions: MSA 730, MSA 830
OVERVIEW, SELECTION GUIDE

Symbols:

- = Fixed fastening element
- = Flexible fastening element
- = Additional fixed-point of the scale in the extrusion (optional)

**MSA X71.XX-X XX**
- Mounting holes along the scale unit
- Fixed fastening elements
- Max. measuring length: 3040 mm (only at 20 µm grating pitch)

- MSA 471, MSA 571 Page 25
- MSA 771, MSA 871 Page 20

**MSA X11.XX-X XX**
- Fixed mounting-point left
- All other fastening elements flexible
- Max. measuring length: 3040 mm (only at 20 µm grating pitch)

- MSA 411, MSA 511 Page 26
- MSA 711, MSA 811 Page 21

**MSA X21.XX-X XX**
- Fixed mounting-point centered
- All other fastening elements flexible
- Max. measuring length: 3040 mm (only at 20 µm grating pitch)

- MSA 421, MSA 521 Page 27
- MSA 721, MSA 821 Page 22

**MSA X31.XX-X XX**
- Fixed mounting-point right
- All other fastening elements flexible
- Max. measuring length: 3040 mm (only at 20 µm grating pitch)

- MSA 431, MSA 531 Page 28
- MSA 731, MSA 831 Page 23
Output signals and integrated subdividing

0 = sinusoidal voltage signals 1 Vpp
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

0 = 8 µm
1 = 10 µm
3 = 20 µm
Reachable system resolution [µm] = \left( \frac{\text{grating pitch [µm]}}{\text{subdividing}} \right) \times 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

Example: MSA 730.63-1 PF
## 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>
<th>Edge separation $a_{\text{min}}$</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>
<td></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>
<td></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>
<td></td>
</tr>
<tr>
<td>MSA xxx.23</td>
<td>∼</td>
<td>5.0</td>
<td>±3, ±5</td>
<td>20 times 1</td>
<td>2.0</td>
<td>1.25 µs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MSA xxx.33</td>
<td>∼</td>
<td>2.5</td>
<td>±3, ±5</td>
<td>20 times 2</td>
<td>2.0</td>
<td>625 ns</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MSA xxx.63</td>
<td>∼</td>
<td>1.0</td>
<td>±3, ±5</td>
<td>20 times 5</td>
<td>2.0</td>
<td>250 ns</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MSA xxx.73</td>
<td>∼</td>
<td>0.5</td>
<td>±3, ±5</td>
<td>20 times 10</td>
<td>1.92</td>
<td>250 ns</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MSA xxx.61</td>
<td>∼</td>
<td>0.5</td>
<td>±3, ±5</td>
<td>10 times 5</td>
<td>1.92</td>
<td>250 ns</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MSA xxx.71</td>
<td>∼</td>
<td>0.25</td>
<td>±3, ±5</td>
<td>10 times 10</td>
<td>0.96</td>
<td>250 ns</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MSA xxx.51</td>
<td>∼</td>
<td>0.1</td>
<td>±3, ±5</td>
<td>10 times 25</td>
<td>0.77</td>
<td>125 ns</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MSA xxx.81</td>
<td>∼</td>
<td>0.05</td>
<td>±3, ±5</td>
<td>10 times 50</td>
<td>0.38</td>
<td>125 ns</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MSA xxx.30</td>
<td>∼</td>
<td>1.0</td>
<td>±2, ±3, ±5</td>
<td>8 times 2</td>
<td>2.00</td>
<td>250 ns</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MSA xxx.70</td>
<td>∼</td>
<td>0.2</td>
<td>±2, ±3, ±5</td>
<td>8 times 10</td>
<td>0.77</td>
<td>250 ns</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MSA xxx.80</td>
<td>∼</td>
<td>0.04</td>
<td>±2, ±3, ±5</td>
<td>8 times 50</td>
<td>0.30</td>
<td>125 ns</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MSA xxx.90</td>
<td>∼</td>
<td>0.02</td>
<td>±2, ±3, ±5</td>
<td>8 times 100</td>
<td>0.15</td>
<td>125 ns</td>
<td></td>
<td></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, 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 ($\alpha=8.5 \times 10^{-6}$/K)
- Glass ceramic scale ($\alpha=0 \times 10^{-6}$/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 $\sim$ 1 Vpp
  + 5 V ±5%, max. 150 mA (unloaded)
- Square-wave signals via Line Driver $\mathcal{U}$
  + 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:

![MSA 770 Diagram]

Dimensions, mounting tolerances MSA 870:

![MSA 870 Diagram]

Legend:
- **M** = machine guideway
- **ML** = measuring length
- **G** = gauging points
- **LHI12** = male connector
- **A** = cable
- **05 / 13** = required mating dimensions
- **0.05 / 0.03** = switch signals
- **0.65 / 0.16** = selectable reference mark
- **0.65 / 0.16** = actuator magnet
- **0.65 / 0.16** = sensor position
- **50 S2** = M5 air inlet
- **30 S1** = connecting cable detachable (accessory)
Dimensions, mounting tolerances MSA 710:

Dimensions, mounting tolerances MSA 810:

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)
**MSA 720, MSA 820**

**Dimensions, mounting tolerances MSA 720:**

**Dimensions, mounting tolerances MSA 820:**

---

<table>
<thead>
<tr>
<th>M</th>
<th>M = machine guideway</th>
</tr>
</thead>
<tbody>
<tr>
<td>ML</td>
<td>ML = measuring length</td>
</tr>
<tr>
<td>G</td>
<td>G = gauging points</td>
</tr>
<tr>
<td>A</td>
<td>A = cable</td>
</tr>
<tr>
<td>LH12</td>
<td>LH12 = male connector</td>
</tr>
<tr>
<td>**</td>
<td>= required mating dimensions</td>
</tr>
</tbody>
</table>

optional:

| P | P = M5 air inlet |
|S1, S2 | S1, S2 = switch signals |
|R1 | R1 = 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
- **A** = cable
- **LHI12** = male connector
- **①** = 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 771:

Dimensions, mounting tolerances MSA 871:

M = machine guideway
ML = measuring length
← = 0 ... ML
A = cable
LH12 = male connector
前置 = 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 711:

```
<table>
<thead>
<tr>
<th>Measuring Length</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td>ML &gt; 56 - 600</td>
<td>2</td>
</tr>
<tr>
<td>ML &gt; 600 - 1200</td>
<td>4</td>
</tr>
<tr>
<td>ML &gt; 1200 - 1800</td>
<td>6</td>
</tr>
<tr>
<td>ML &gt; 1800 - 2400</td>
<td>8</td>
</tr>
<tr>
<td>ML &gt; 2400 - 3000</td>
<td>10</td>
</tr>
<tr>
<td>ML &gt; 3000 - 3040</td>
<td>12</td>
</tr>
</tbody>
</table>
```

M = machine guideway
ML = measuring length
A = cable
LH112 = male connector
K = customer connector dimensions
FX = fixed mounting
FL = flexible mounting

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 721:

Dimensions, mounting tolerances MSA 821:

<table>
<thead>
<tr>
<th>Measuring Length</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td>ML &gt; 56 - 600</td>
<td>2</td>
</tr>
<tr>
<td>ML &gt; 600 - 1200</td>
<td>4</td>
</tr>
<tr>
<td>ML &gt; 1200 - 1800</td>
<td>6</td>
</tr>
<tr>
<td>ML &gt; 1800 - 2400</td>
<td>8</td>
</tr>
<tr>
<td>ML &gt; 2400 - 3000</td>
<td>10</td>
</tr>
<tr>
<td>ML &gt; 3000 - 3040</td>
<td>12</td>
</tr>
</tbody>
</table>

- M = machine guideway
- ML = measuring length
- A = cable
- LH11 = male connector
- M = measuring length
- FL = flexible mounting

Optional:
- P = M5 air inlet
- S1, S2 = switch signals
- R = selectable reference mark
- * = actuator magnet
- ** = sensor position
Dimensions, mounting tolerances MSA 731:

Dimensions, mounting tolerances MSA 831:

- M = machine guideway
- ML = measuring length
- A = cable
- LH112 = male connector
- Φ = customer connector dimensions
- FX = fixed mounting
- FL = flexible mounting
- P = M5 air inlet
- S1, S2 = switch signal
- RI = selectable reference mark
- * = actuator magnet
- ** = sensor position
Dimensions, mounting tolerances MSA 470:

- ML = measuring length
- G = gauging points
- A = cable
- M = machine guideway
- <ML = <1140 mm
- 1140 <ML = <2240 mm
- 2240 <ML = 3040 mm

Option P: air inlet scale left or right side mountable

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

Dimensions MSA 570:

Connecting cable detachable (accessory)
MSA 471, MSA 571

MSA 471

Dimensions, mounting tolerances MSA 571:

Dimensions MSA 571:

option P: air inlet scale
left or right side mountable

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

connecting cable detachable
(accessory)
Dimensions, mounting tolerances MSA 411:

Dimensions MSA 511:
MSA 421, MSA 521

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)

connecting cable detachable (accessory)
MSA 431, MSA 531

Dimensions, mounting tolerances MSA 431:

Dimensions MSA 531:
Standard measuring lengths (ML): [mm]
50, 70, 120, 170, 220, 270, 320, 370, 420, 470, 520

Scale unit: Glass scale ($\alpha=8.5\times10^{-6}$/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 x 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 °C to +70 °C (storage), 0 °C to +50 °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) $\sim$ 1 Vpp, max. 120 mA (unloaded) $\sim$
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
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 ($\alpha = 8.5 \times 10^{-6}$/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 x 50 mm

Required moving force: < 1 N

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

Permissible vibration: 150 m/s$^2$ (40 to 2000 Hz)
Permissible shock: 300 m/s$^2$ (8 ms)

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

Weight (approx.): 250 g + 1.34 g/mm (ML) + 210 g (reading head without cable)

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

RoHS-conformity:
The Linear Encoders of the MSA 373, 374, 375 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.

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 hexagone socket screws M8 x 20 ISO 4762 for mounting

<table>
<thead>
<tr>
<th>Scale model electronic version</th>
<th>Output signals</th>
<th>System resolution [µm/m]</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 37x.65</td>
<td>(\n)</td>
<td>5 µm</td>
<td>±10</td>
<td>100</td>
<td>times 5</td>
<td>1.0</td>
<td>1.6 µs</td>
</tr>
<tr>
<td>MSA 37x.55</td>
<td>(\n)</td>
<td>1 µm</td>
<td>±10</td>
<td>100</td>
<td>times 25</td>
<td>1.0</td>
<td>800 ns</td>
</tr>
</tbody>
</table>

Output signals

- System resolution
- Accuracy grades
- Grating pitch
- Integrated interpolation
- Max. velocity
- Max. output frequency

MSA 373, MSA 374, MSA 375

MSA 373

MSA 373, MSA 374, MSA 375
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

ML = measuring length
M = machine guideway
OT = overtravel
K = required mating dimensions
### MALE AND FEMALE CONNECTORS, PIN ASSIGNMENTS

**SUB MIN-D**

- **Connector LD15 15-pin**
  - Weight: 25 g
  - View on pins

**Pin assignment**

<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>
<th>13</th>
<th>14</th>
<th>15</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sinusoidal voltage signals 1 Vpp</td>
<td>nc</td>
<td>0 V</td>
<td>nc</td>
<td>AT</td>
<td>A2</td>
<td>AT</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>
<td></td>
</tr>
<tr>
<td>Square-wave signals via Line Driver</td>
<td>nc</td>
<td>0 V</td>
<td>sensor</td>
<td>US</td>
<td>RI</td>
<td>T2</td>
<td>TT</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

---

**LD15**

- **Connector L121 12-pin**
  - Weight: 75 g
  - Male connector

**Pin assignment**

<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>
</tr>
</thead>
<tbody>
<tr>
<td>Sinusoidal voltage signals 1 Vpp</td>
<td>A2</td>
<td>+5 V</td>
<td>sensor</td>
<td>RI</td>
<td>T2</td>
<td>A1</td>
<td>AT</td>
<td>nc</td>
<td>A2</td>
<td>nc</td>
<td>0 V</td>
<td>0 V</td>
</tr>
<tr>
<td>Square-wave signals via Line Driver</td>
<td>T2</td>
<td>+5 V</td>
<td>sensor</td>
<td>RI</td>
<td>T2</td>
<td>T1</td>
<td>TT</td>
<td>US</td>
<td>T2</td>
<td>nc</td>
<td>0 V</td>
<td>0 V</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

---

**L121, K121, KM121**

- **Connector L120 12-pin**
  - Weight: 20 g
  - Male connector

**Pin assignment**

<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>
</tr>
</thead>
<tbody>
<tr>
<td>Sinusoidal voltage signals 1 Vpp</td>
<td>A2</td>
<td>+5 V</td>
<td>sensor</td>
<td>RI</td>
<td>T2</td>
<td>A1</td>
<td>AT</td>
<td>nc</td>
<td>A2</td>
<td>nc</td>
<td>0 V</td>
<td>0 V</td>
</tr>
<tr>
<td>Square-wave signals via Line Driver</td>
<td>T2</td>
<td>+5 V</td>
<td>sensor</td>
<td>RI</td>
<td>T2</td>
<td>T1</td>
<td>TT</td>
<td>US</td>
<td>T2</td>
<td>nc</td>
<td>0 V</td>
<td>0 V</td>
</tr>
</tbody>
</table>

---

**DIN**

- **Connector L120 12-pin**
  - Weight: 20 g
  - Male connector

**Pin assignment**

<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>
<th>L</th>
<th>M</th>
</tr>
</thead>
<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>T2</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>T2</td>
<td>S2*</td>
<td>+5 V</td>
<td>T2</td>
<td>US</td>
</tr>
</tbody>
</table>

---

**L120, K120**

- **Connector L120 12-pin**
  - Male connector

**Pin assignment**

<table>
<thead>
<tr>
<th>Pin</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
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<td>S2*</td>
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<td>T2</td>
<td>S1*</td>
<td>RI</td>
<td>T2</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 x 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.

---

* = required space for filter change
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
- High insensitivity against contamination
- High traversing speed
- 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 phasse 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
  - Glass scale: 3140 mm
  - 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 axis: 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

Precise Gradients
- 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
DISTRIBUTION CONTACTS

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Certified acc. to
DIN EN ISO 9001
DIN EN ISO 14001

RSF Elektronik
Ges.m.b.H.
Linear Encoders
Digital Readouts
Precision Graduations
Cable Systems

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