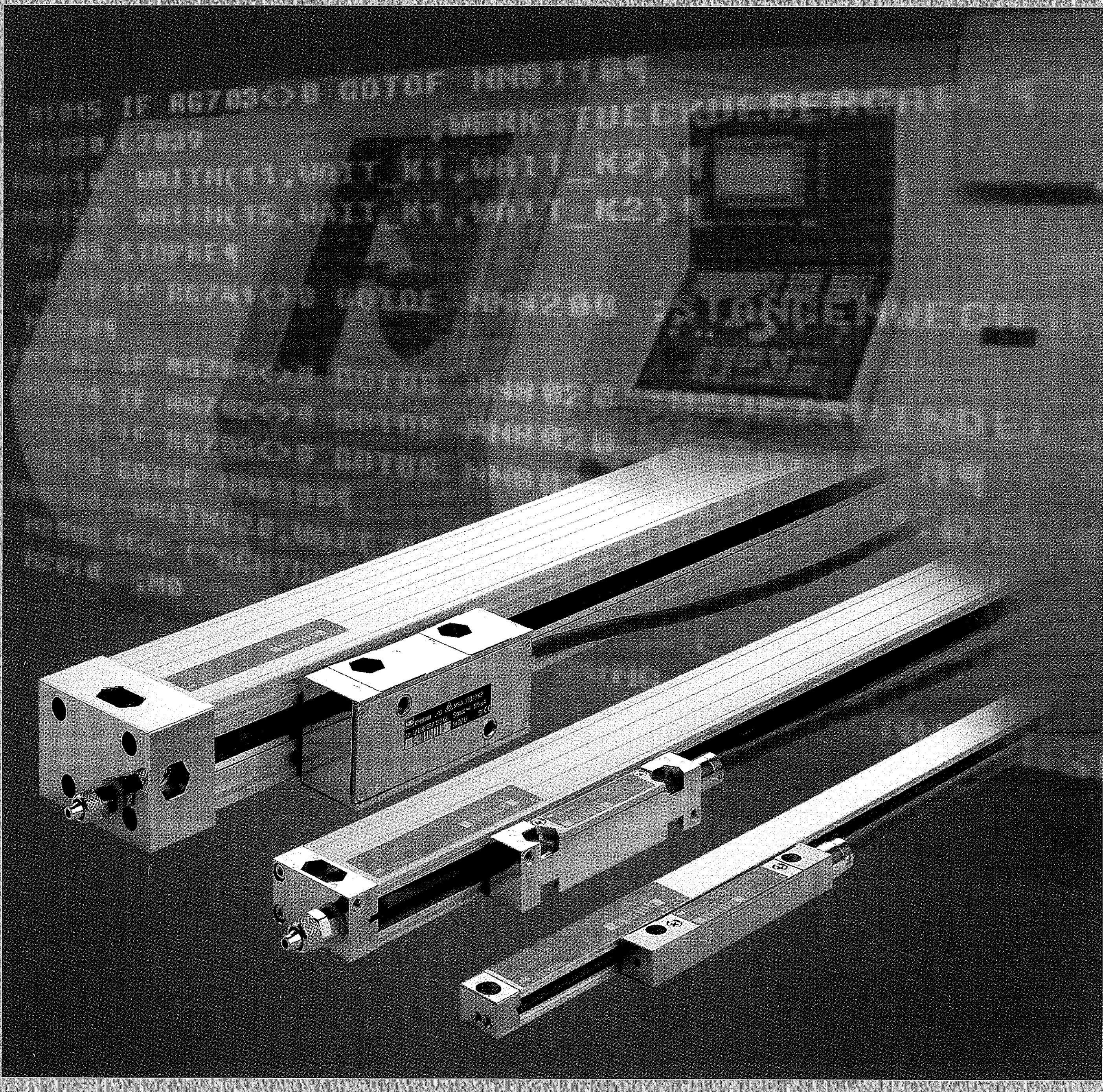
RSF Elektronik

Technik, die zählt
Technology that counts

Incremental Linear Encoders

Enclosed Models



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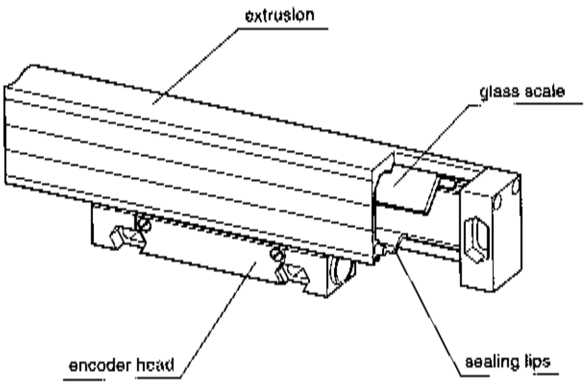
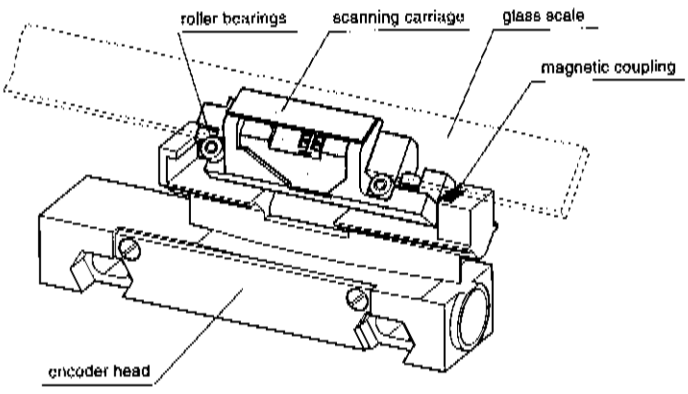
Design and operation

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.

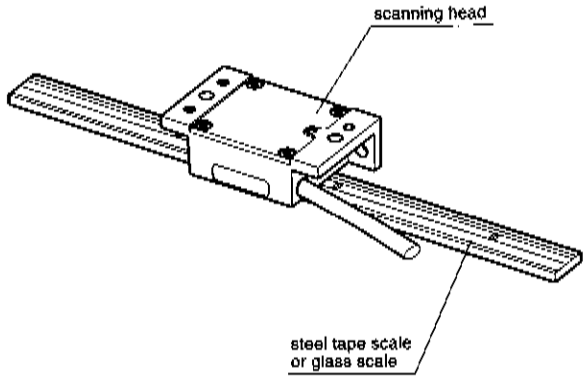
The non-contact open measuring systems are for high displacement velocities and high accuracies, commonly used in clean environments.

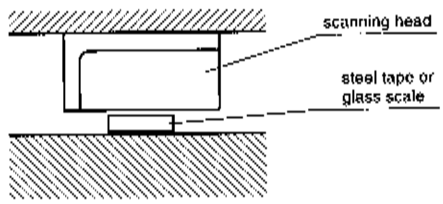
Enclosed systems with guided scanning carriage





Open systems with non-contact scanning carriage



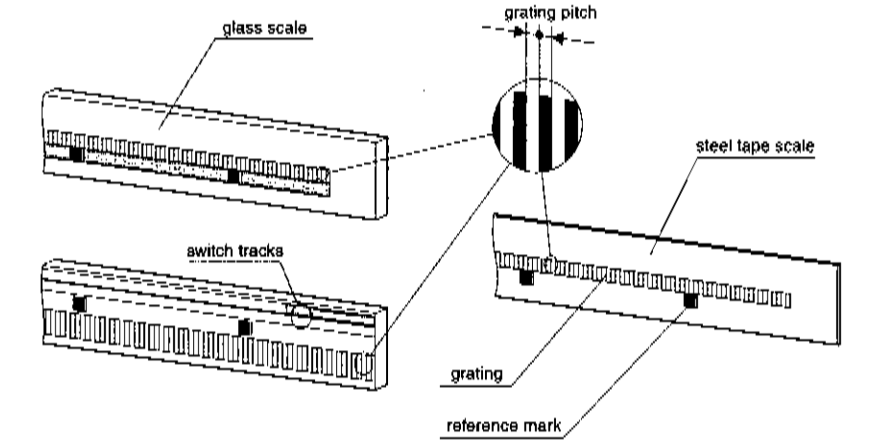


Enclosed Linear Encoders have a roller bearing self-guided scanning carriage. The scanning carriage is spring loaded to track properly within the encoder head mounting tolerance range. A set of rare earth magnets couple the scanning carriage to the mounting base of the encoder head.

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

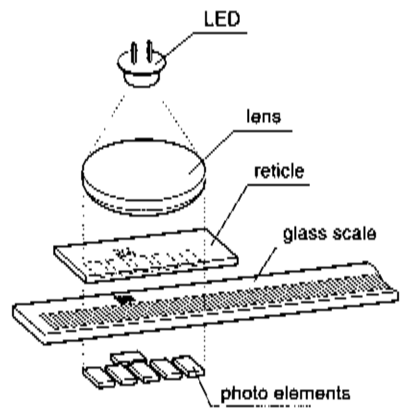


Linear Encoders with the suffix "**K**" in the model type have distance coded Reference marks. The absolute position is available after a measuring move of 20 mm maximum.

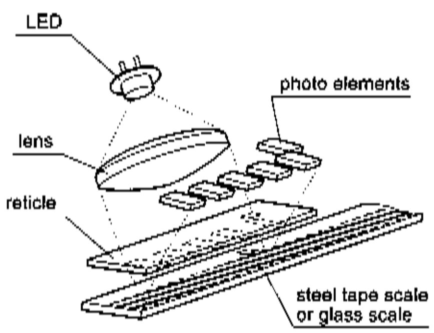
Cause of the optical scanning version a accurate reference mark is warranted.

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



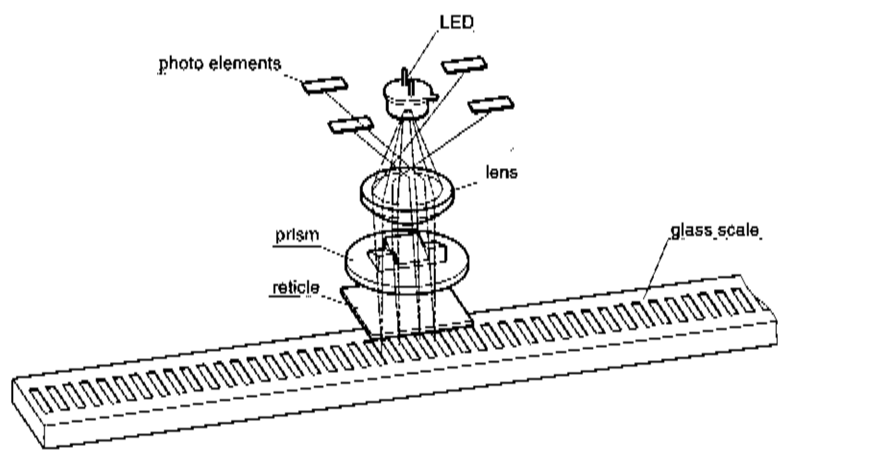
Reflective scanning principle



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 a 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, depending on the change of position phase shifted, beams 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.

Reflection-type phase grating



Output signals

Sinusoidal voltage signals
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)
output signals A1 and 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

Output signal Reference mark (RI):
El. position typical 135° (referenced to A1)
El. width typical 360° 0,2 to 0,85 V typical 0,4 V (effective quota) with terminating impedance Zo = 120 Ω

Advantage: High traversing speed with long cable lengths possible.
Connection possibilities any suitable CNC resp. Feed-back-Systems.

Sinusoidal micro-current signals
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)

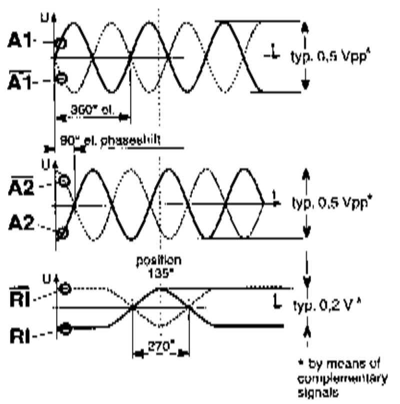
Output signal Reference mark (RI):
El. Position typical 135° (referenced to 0°)
El. width typical 360°
2 to 8 μA, (typical 5 μA)

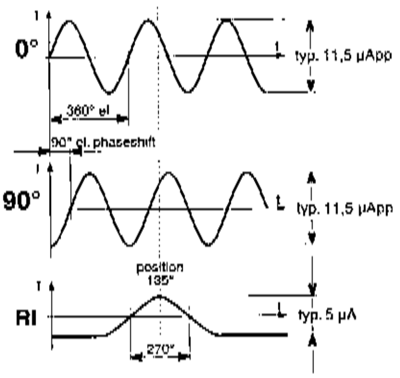
These signals can be input to External Subdividing Electronics or NC Controls with built-in Subdividing Electronics.

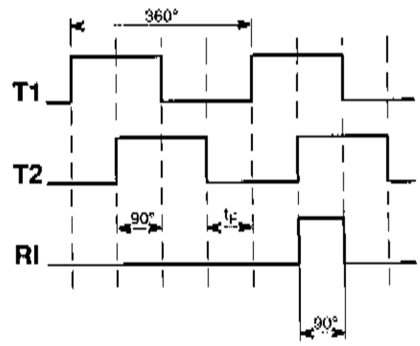
Square wave signals
The photoelement output signals are converted into two square wave signals that have a phase shift of 90° either with a Schmitt-Trigger (for times 1) or interpolation electronics (for times 5, -10, -20, -25, -50 or -100).
Output signals can be either single ended or Line Driver differential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

Machine controls/DRO's have a minimum allowable distance between A and B changes of state, measures in time (inverse of max. frequency).
The minimum edge distance t_F is shown in the technical data.

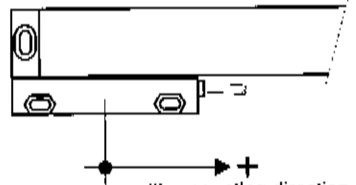
Drawing in "positive counting direction"

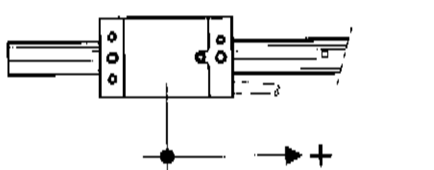




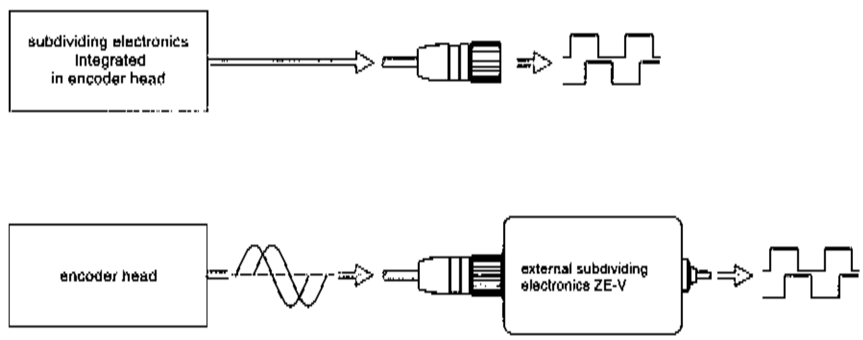


Positive counting direction orientation





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)

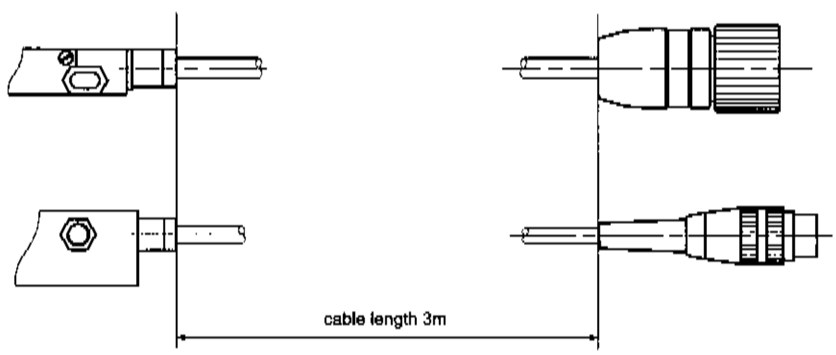
Both versions can output differential Line Driver RS 422 square wave signals.

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, high flex double, 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, with metal braiding single	25 mm 25 mm	50 mm 45 mm

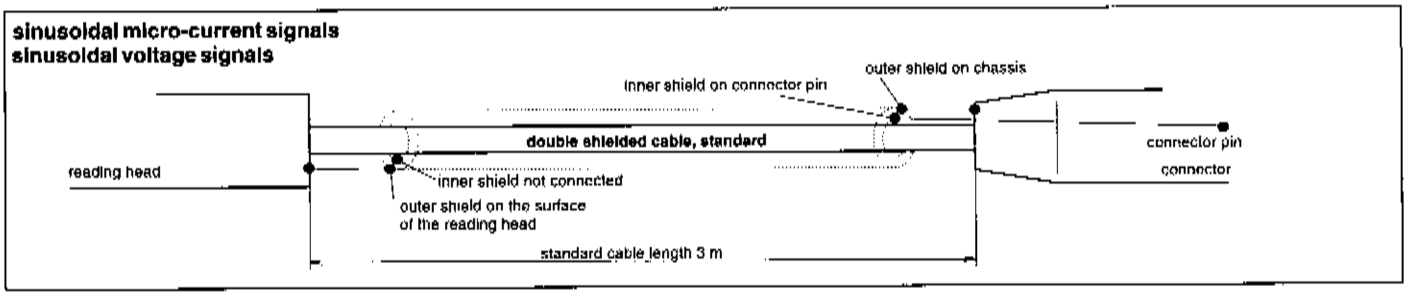
*** cycle of bending typical 50 million**

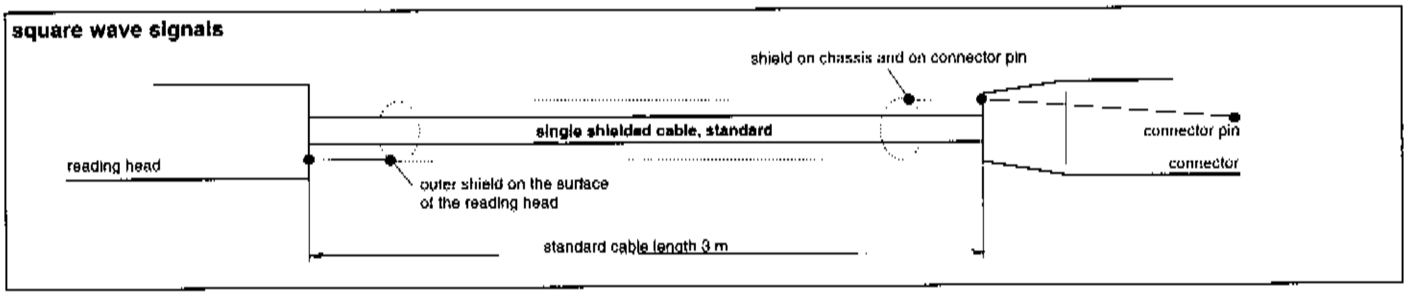
Encoder heads have cables designed for the specific signal outputs.
Standard cable length is 3 m.
The cable jacket is a special thermoplastic, resistant to commercial coolants and lubricants.
Cables should be protected with a metallic armor if exposed to a harsh environment like "hot metal chips".
The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

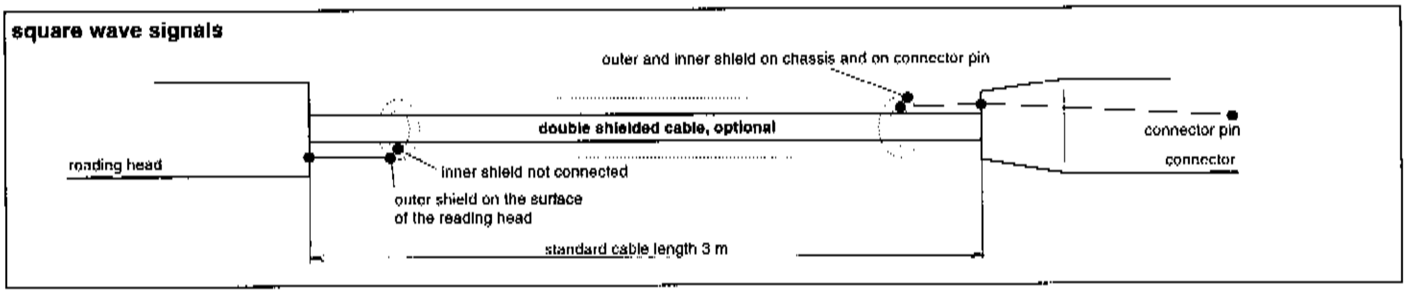
Definition of the cable length



Shield connections

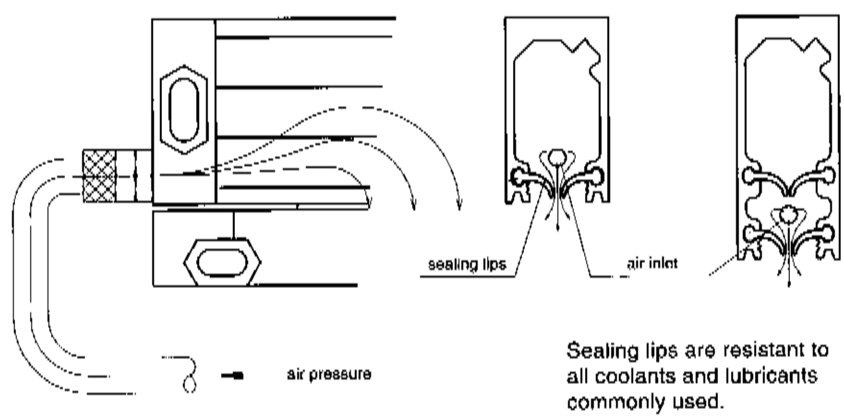






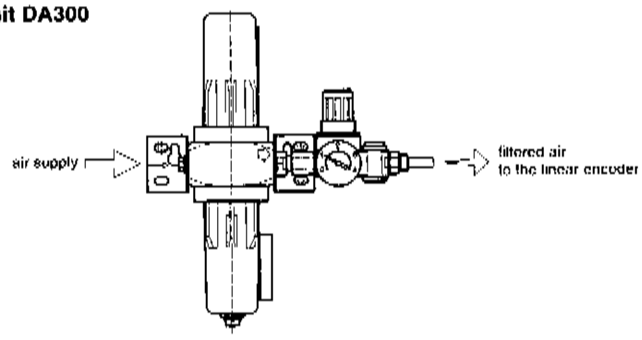
Environmental sealing

Environmental sealing



Sealing lips are resistant to all coolants and lubricants commonly used.

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 improve the sealing against oil and coolants.
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**

Encoder Type
(design features) — **XXX.**

Output signals and integrated Subdividing — **.X**

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 — **.X**

0 = 8 µm	5 = 100 µm	A = 6,35 µm	F = 101,60 µm
1 = 10 µm	6 = 200 µm	B = 10,16 µm	G = 25,40 µm
2 = 16 µm	7 = 400 µm	C = 12,70 µm	H = 35 µm
3 = 20 µm	8 = 50 µm	D = 20,32 µm	K = 2160 L/Inch
4 = 40 µm		E = 50,80 µm	L = 21,167 µm

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

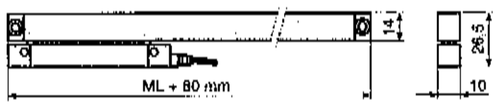
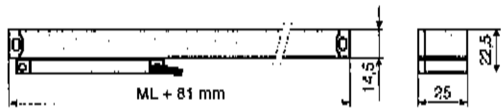
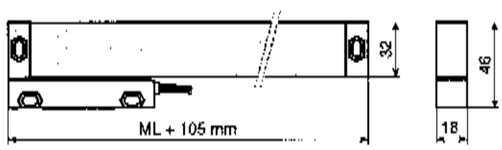
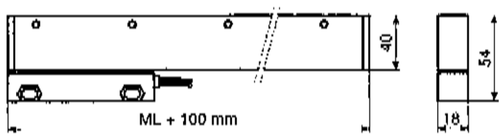
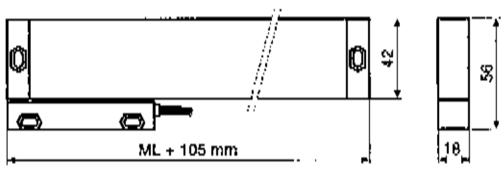
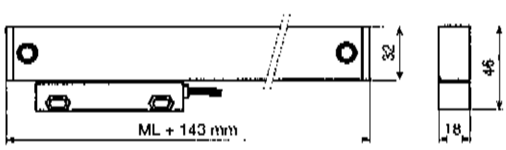
-0 = without switch signal
-1 = TTL output (active high)
-2 = open collector output (active high impedance)
-3 = TTL output (active low)
-4 = open collector output (active low)

Possible options — **. 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

Overview, Selection guide

Design features	Basic dimensions ML = measuring length	Scale type	Page
• **extremely small cross section** • **guided by ball bearings** • distance coded Reference marks (K) • max. measuring length 520 mm • enclosed version • mounting holes on the extrusion ends • resolution from 5 µm up to 0,1 µm		**MSA 170**	14-15
• **extremely small cross section** • **MSA 002 with stainless steel construction for optimal thermal characteristics** • **MSA 003 with aluminium construction** • max. measuring length 520 mm • enclosed version <u>without</u> sealing lips • mounting holes on the extrusion ends • resolution from 1 µm up to 0,1 µm		**MSA 002** **MSA 003**	16-17
• distance coded Reference marks (K) • max. measuring length 2240 mm • small cross-section • enclosed version • mounting holes on the extrusion ends • resolution from 10 µm up to 0,1 µm		**MSA 670**	18-19
• distance coded Reference marks (K) • max. measuring length 2440 mm • small cross-section • enclosed version • mounting holes on top of the extrusion improves vibration rating • resolution from 10 µm up to 0,1 µm		**MSA 671**	20-21
• **two sets of sealing lips for additional contamination protection** • distance coded Reference marks (K) • max. measuring length 2240 mm • small cross-section • enclosed version • mounting holes on the extrusion ends • resolution from 10 µm up to 0,1 µm		**MSA 672**	22-23
• **with optimized thermal performance** • distance coded Reference marks (K) • max. measuring length 1240 mm • small cross-section • enclosed version • mounting holes on the extrusion ends • resolution from 5 µm up to 0,1 µm		**MSA 680**	24-25

MSA 670 Technical data

Scale model		System resolution	Accuracy grades *	Grating pitch *	Max. velocity (Edge distance) 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**:
Distance coded Reference marks (**K**): after travelling 20 mm the absolute position will shown on the display.

MSA 670.xx:
Up to measuring length 920 mm one Reference mark in the middle of the measuring length or 35 mm from both ends of measuring length, measuring length 1040 mm and longer, 45 mm from both ends of measuring length.

Option:
One Reference mark at any location, or two or more RI's separated by distances of n x 50 mm

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 57)

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 Vss, 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

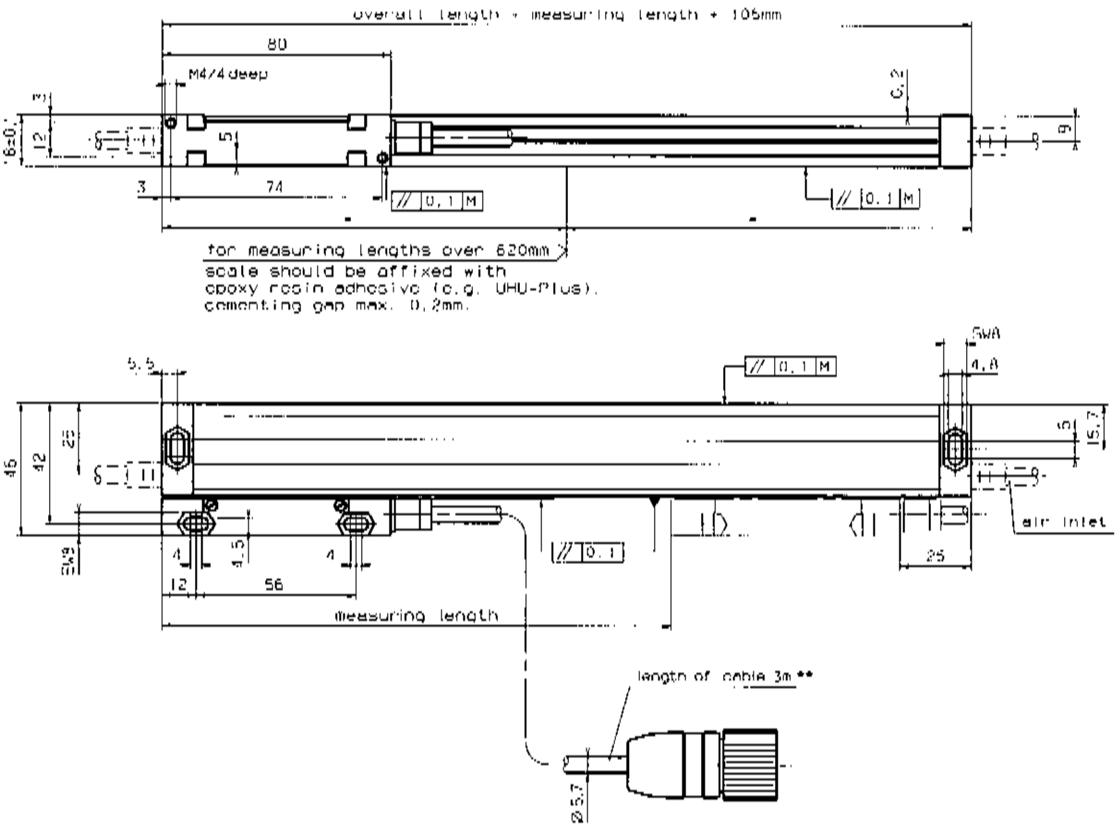
Max. output frequency:
100 kHz (with 3 m cable)

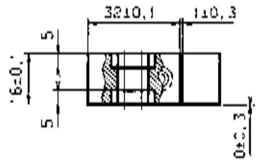
• square wave signals (single ended)
with integrated Subdividing Electronics

• square wave signals (differential)
via Line Driver RS 422 standard
with integrated Subdividing Electronics
MSA 670.23 = times 1
MSA 670.24 = times 1
MSA 670.63 = times 5
MSA 670.64 = times 5
MSA 670.73 = times 10
MSA 670.74 = times 10
MSA 670.51 = times 25

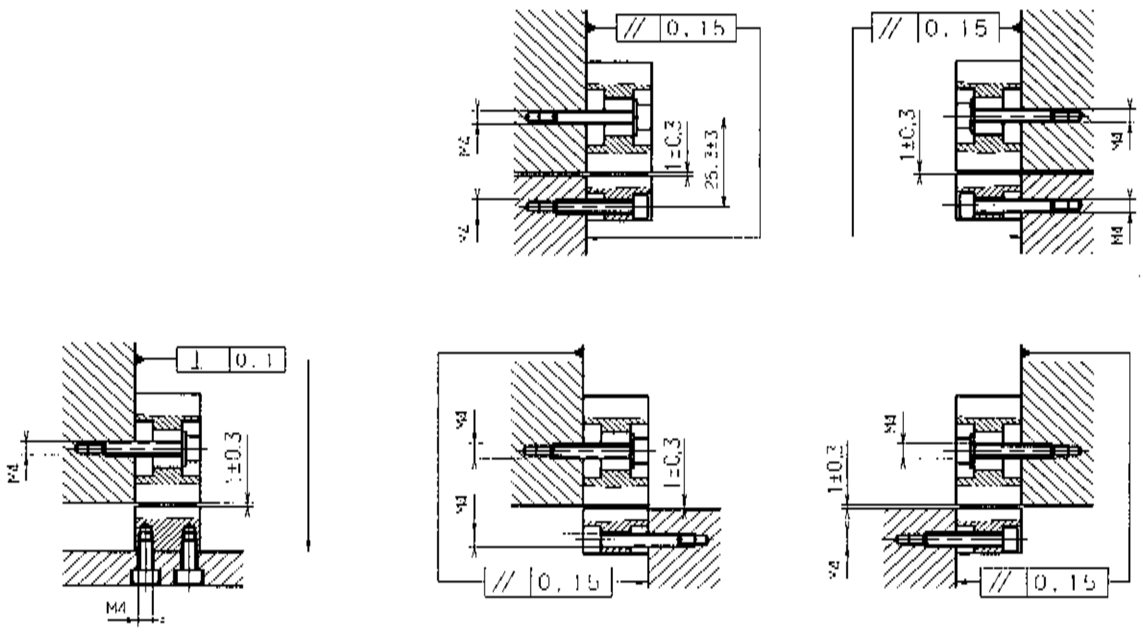
Power supply:
+5 V ±5%, max. 150 mA (unloaded)

MSA 670 Dimensions - Mounting tolerances - Mounting possibilities:





M = machine guideway

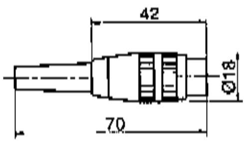


** armoured cable optional

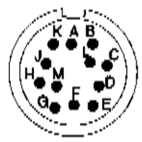
Connectors, pin-outs

DIN

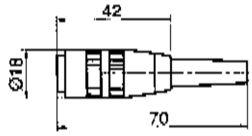
Male connector L 120 12-pin



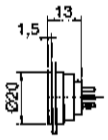
PIN outs connector view on pins



Female connector K 120 12-pin



Female connector panel mountable F 120 12-pin



L120

PIN	A	B	C	D	E	F	G	H	J	K	L	M	
Voltage signals	Inner shield	0 V	A1	$\overline{A1}$	A2	0 V	RI	$\overline{RI}$	0 V	+5 V	$\overline{A2}$	+5 V	(outer shield on chassis)

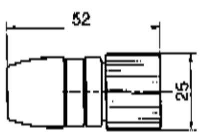
L120, K120, F120

PIN	A	B	C	D	E	F	G	H	J	K	L	M
Square wave signals + LD	shield*	GND	T1/0°	$\overline{T1}$/0°	T2/90°	GND	RI	$\overline{RI}$	GND	5 V	$\overline{T2}$/90°	5 V

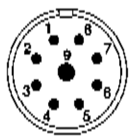
* shield is on housing additional

CONNEI

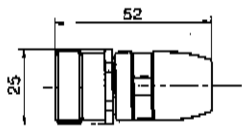
Male connector L 91 9-pin



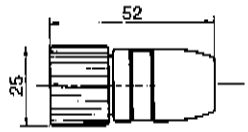
PIN outs connector view on pins



Female connector K 91 9-pin



Female connector KM 91 9-pin

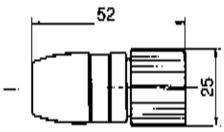


L 91, K 91, KM 91

PIN	1	2	3	4	5	6	7	8	9	
Sinusoidal micro-current signals	0°+	0°-	5 V	0 V	90°+	90°-	RI+	RI-	inner shield	(outer shield on chassis)

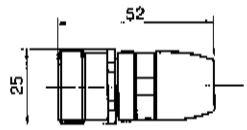
CONNEI

Male connector L 121 12-pin

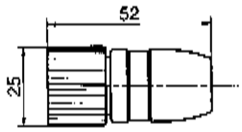


PIN outs connector view on pins

Female connector K121 12-pin



Female connector KM 121 12-pin



L 121

PIN	1	2	3	4	5	6	7	8	9	10	11	12	
Voltage signals	$\overline{A2}$	+5 V Sensor	RI	$\overline{RI}$	A1	$\overline{A1}$	+5 V	A2	inner shield	GND	GND Sensor	+5 V	(outer shield on chassis)

L121, K121, KM 121

PIN	1	2	3	4	5	6	7	8	9	10	11	12
Square wave signals + LD	$\overline{T2}$/90°	5 V	RI	$\overline{RI}$	T1/0°	$\overline{T1}$/0°	5 V	T2/90°	shield*	0 V	0 V	5 V

* shield is on housing additional

SUB MIN-D

LD 9

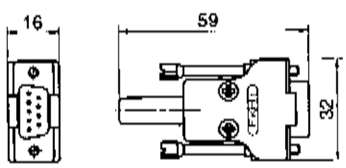
PIN	1	2	3	4	5	6	7	8	9
Square wave signals (single ended)	shield*	RI	T2	T1	+V	nc	nc	nc	GND

LD 9

PIN	1	2	3	4	5	6	7	8	9
Square wave signals (differential)	T1	$\overline{T1}$	T2	$\overline{T2}$	RI	$\overline{RI}$	+5 V	0 V	shield*

* shield is on housing additional

Male connector LD 9 9-pin



PIN outs connector view on pins