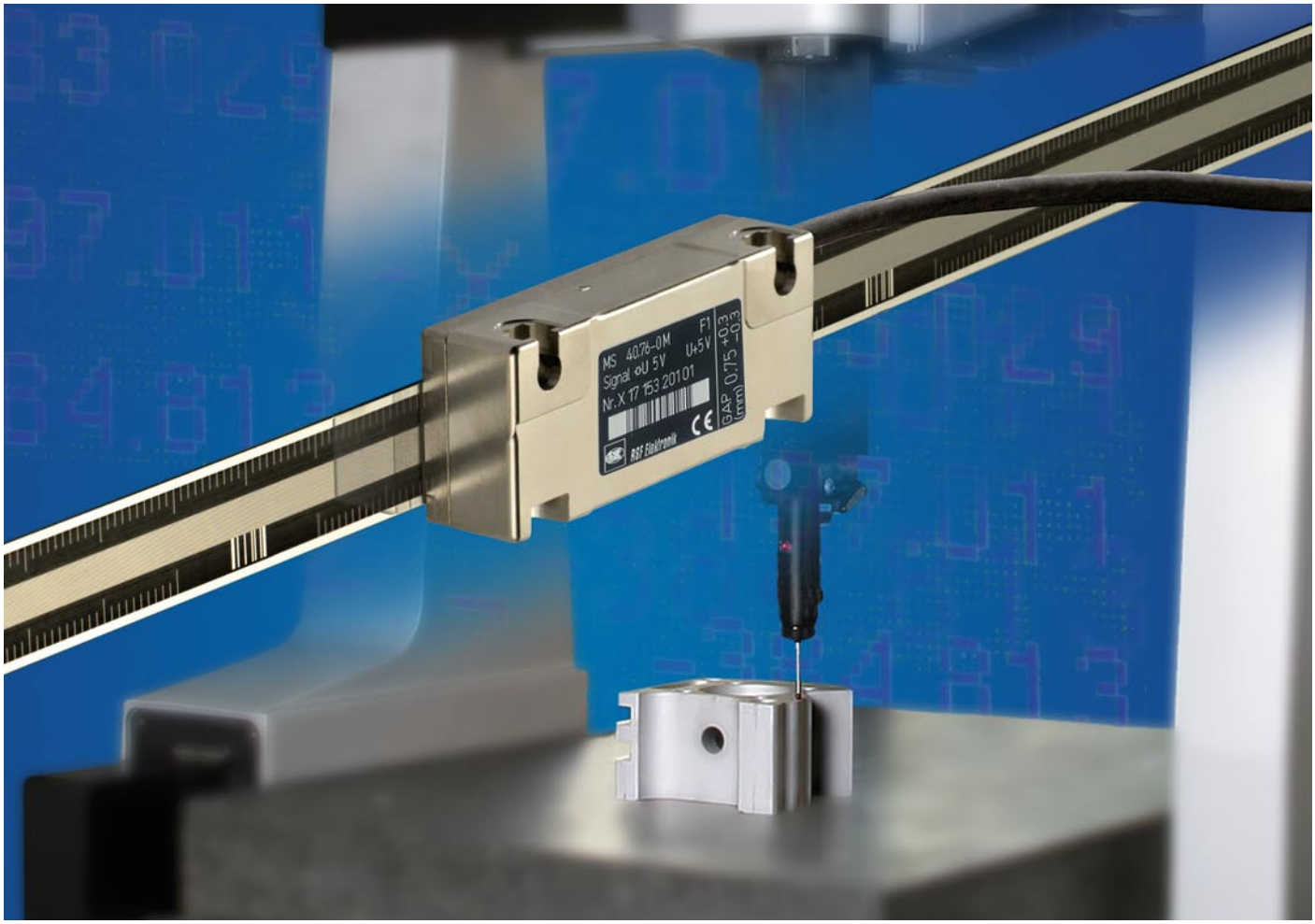
RSF Elektronik

Technik, die zählt
Technology that counts

MS 40

Open Linear Encoder
with singlefield scanning



Special highlights:

- Small dimensions
- Easy mounting as a result of large mounting tolerances
- Contamination resistance
- High traversing speed
- Reference mark (accurate and repeatable from both traversing directions)
- Integrated subdividing electronics in the encoder head for up to times 100 interpolation

Term-explanation

Grating Pitch (Interval)
A grating is a continuous series of lines and spaces printed on the scale. The width of one line and one space is called the pitch (sometimes referred to as the interval) of the grating. The lines and spaces are accurately placed on the scale.

Signal Period
When scanning the grating, the encoder head produces sinusoidal signals with a period equal to the grating pitch.

Interpolation
The sinusoidal signal period can be electronically divided into equal parts. The interpolation circuitry generates a square wave edge for each division.

Reference Pulse (Reference Mark)
There is an additional track of marks printed next to the grating to allow a user to find an absolute position along the length of the scale. A one increment wide signal is generated when the encoder head passes the reference mark on the scale.
This is called a “true” reference mark since it is repeatable in both directions. Subsequent electronics use this pulse to assign a preset value to the absolute reference mark position.

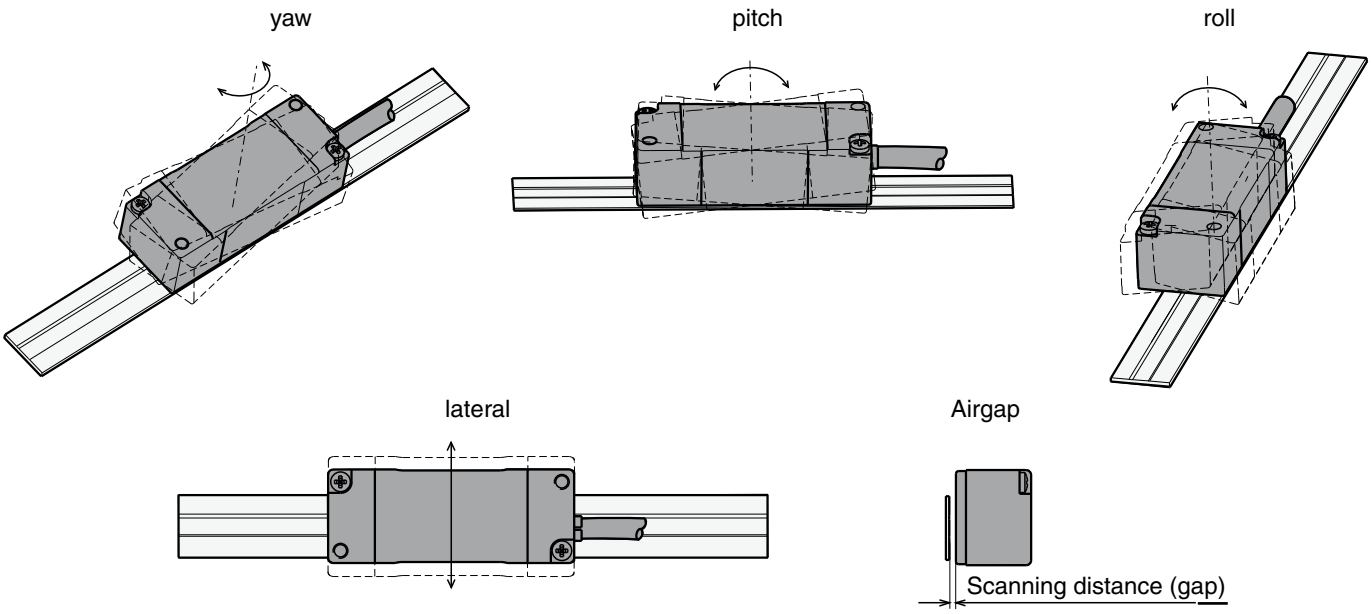
Error Signal
This signal appears when a malfunctioning encoder generates faulty scanning signals.

Measuring Step (Resolution)
The smallest digital counting step produced by an encoder.

Accuracy
This is a fundamental characteristic of a measuring system. It is the maximum permissible deviation of a measured value to a reference value. Accuracy is stated in (±) microns per meter of travel. Scales are specified with an accuracy grade (e.g. ±5µm/m).

Abbe Error
Measuring error due to lateral distance between the measuring system and the machine guideway.

Yaw Angle, Pitch Angle, Roll Angle, Lateral, Airgap
Mounting tolerances of the encoder head relative to the scale.



What design characteristics do you require in an Open Linear Encoder?

- Small dimensions
- Contamination resistance
- High resolution
- High speed
- Large mounting tolerances
- Low Cost and High Quality

The new MS 40 meets all these requirements!

The trend today in motion control applications is for open Linear Encoder Systems.
This is driven by steadily increasing demands for
- Higher traversing speed
- Higher operating cycles
- Lower mechanical backlash
- Zero frictional force induced by the encoder.

Only open, non-contact encoders fulfill all these requirements.

A drawback of many open linear encoders is their sensitivity to dirt and contamination on the scale.
The MS 40 encoder´s unique optical design minimizes the effect of dirt and contamination normally associated with the Open Linear Encoders.

The MS 40 utilizes a unique scanning principle which allows for high traversing speeds (up to 10 m/s),
large mounting tolerances and contamination on the scale.

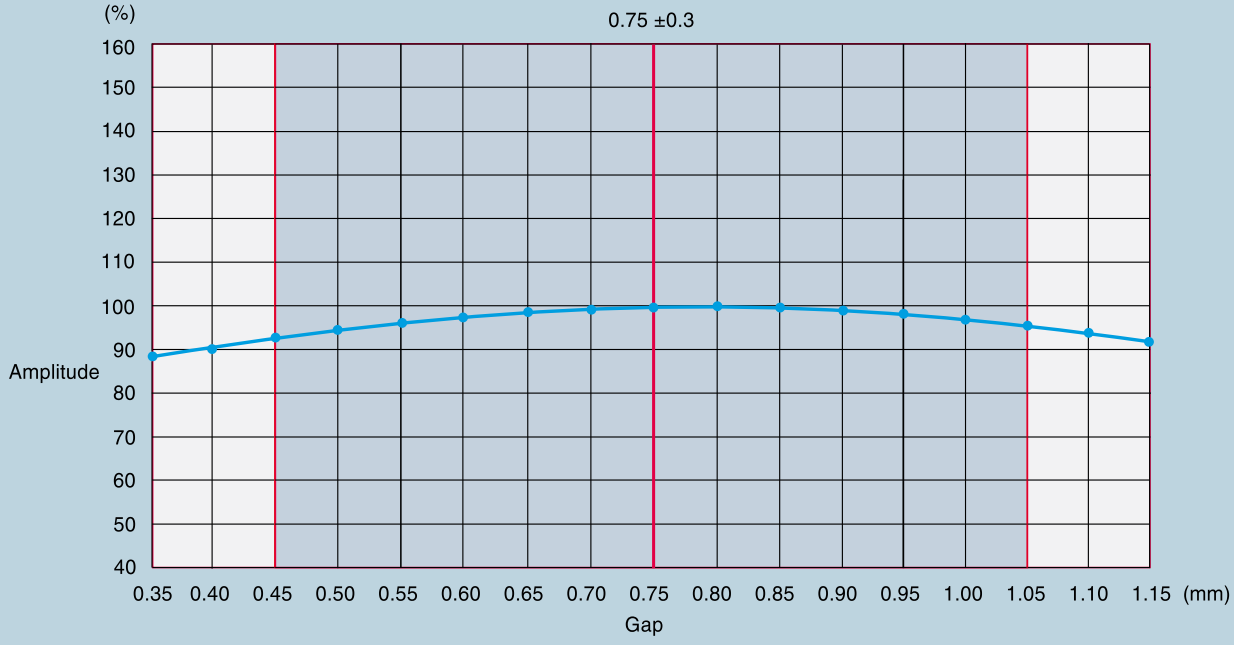
Reference marks, accurate and repeatable from both traversing directions, are standard.

A wide range of interpolation electronics, integrated into the encoder head, enables resolutions from 10 µm to 0,5 µm. Squarewave signals, single ended, or via Line Driver RS 422, are provided at the output of the encoder head.

Units with sinusoidal outputs 1Vpp are also available.

Due to recent advancements in technology, all of these benefits are now available in a small package design.

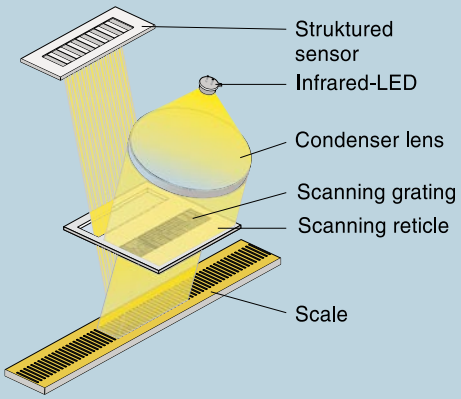
Reading head gap (mm) - vs. - Change in signal amplitude (%)



Scanning principle

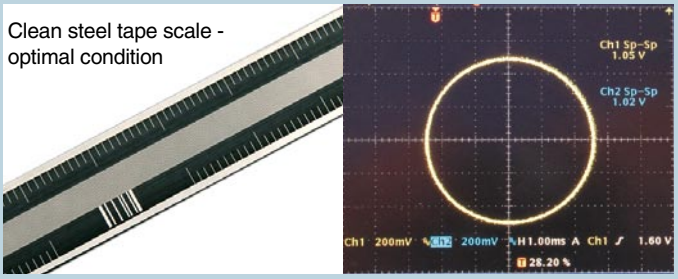
The model MS 40 incremental Linear Encoder works with the imaging, photoelectric measuring principle and a **singlefield reflective scanning** method.
A scale graduation pattern with 200 µm grating pitch is used on a steel tape.
The light from an infrared LED with a small light emitting surface is collimated parallel by a condenser lens and directed through the scanning reticle to the scale. When the scale is moved relative to the encoder head, the light is modulated by the scale gratings and produces a periodic intensity signal that is converted into electrical signals by photo elements back in the encoder head.
The scanning reticle is designed to allow for a large mounting gap and liberal mounting tolerances. This system is insensitive to waviness of the steel tape due to poor mounting conditions. Any minor differences in the grating period of the scale or the scanning reticle will not cause a measuring problem due to the large continuous pattern reflected onto the structured sensor.
This sensor consists of multiple photo elements connected in a pattern to generate four sinusoidal signals, each shifted by 90°. All four signals are generated from one scanning field and all four signals are equally influenced by any contamination simultaneously. When all four signals are influenced at the same time by the same amount, interpolation error is eliminated.

Scanning principle

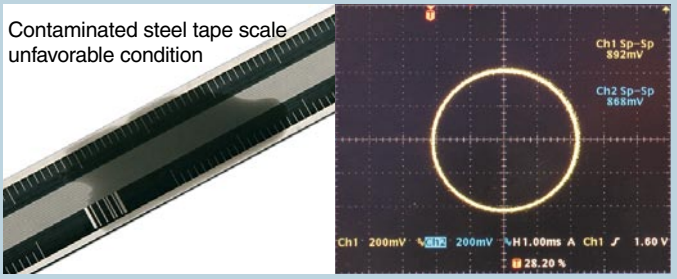


Effect of contamination on the quality and size of the scanning signal (before interpolation)

Clean steel tape scale - optimal condition



Contaminated steel tape scale unfavorable condition



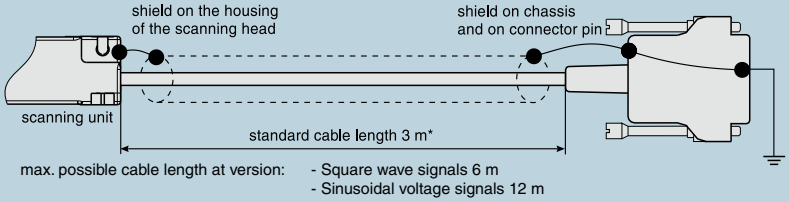
High insensitivity to contamination by use of a new scanning principle.

Cable and connector shielding, standard connector pin outs

Encoder head shielding and cable type is determined by the signal type.
The standard is a 3 meter cable with a PUR jacket material.
Cables for use in vacuum applications to 10^{-7} torr are also available upon request.

Square wave signals
Sinusoidal voltage signals

Single shielded cable, standard, Ø 4.3 mm
permissible bending radii: fixed mounting 25 mm, continuous flexing 45 mm
(typical 50 x 10^6 bending cycles)
The connector must be connected to protective ground



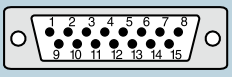
max. possible cable length at version: - Square wave signals 6 m
- Sinusoidal voltage signals 12 m

Connector LD15 15-pin

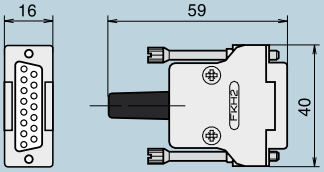
PIN	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Square wave signals via Line Driver	nc	GND	$\overline{Us}$	$\overline{RI}$	$\overline{T2}$	$\overline{T1}$	+5 V	+5 V	GND	nc	nc	RI	T2	T1	Shield

PIN	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Voltage signals	nc	GND	nc	$\overline{RI}$	$\overline{A2}$	$\overline{A1}$	+5 V	+5 V	GND	nc	nc	RI	A2	A1	Shield

- The shield is connected with the chassis



PIN outs
(View on pins)



Output signals

Sinusoidal voltage signals (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. 130 mA (unloaded)
Reference voltage of the output signals: V+/2 (approx. 2.5 V)
Track signals (differential voltage A1 to $\overline{A1}$ resp. A2 to $\overline{A2}$):
Phaseshift 90° ±10° el.
Signal amplitude 0.6 Vpp to 1.2 Vpp
typ. 1 Vpp with terminating impendance Zo = 120 Ω
Reference Mark (differential voltage RI to $\overline{RI}$):
El. position typical 135° (referenced to A1)
El. width typical 360°
Useable component 0.2 up to 0.85 V, typical 0.5 V
with terminating impedance Zo = 120 Ω

Advantage:
- High traversing speed with long cable lengths possible

Square wave signals (drawing shows “positive counting direction”)
With interpolation electronics (for times 5, -10, -50 or -100)
the photoelement output signals are converted into two square wave signals that have a phase shift of 90°.
Output signals either can be single ended or Line Driver differential (RS 422).
For measuring systems with single ended output signals
the max. cable length is 10 m, including extension cable
One measuring step reflects the measuring distance between two edges of the square wave signals.

The controls/DRO´s must be able to detect each edge of the square wave signals.
The minimum edge separation a_{min} is listed in the technical data and refers to a measurement at the output of the interpolator (inside the scanning head).
Propagation-time differences in the Line Driver, the cable and the Line Receiver reduce the edge separation.

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

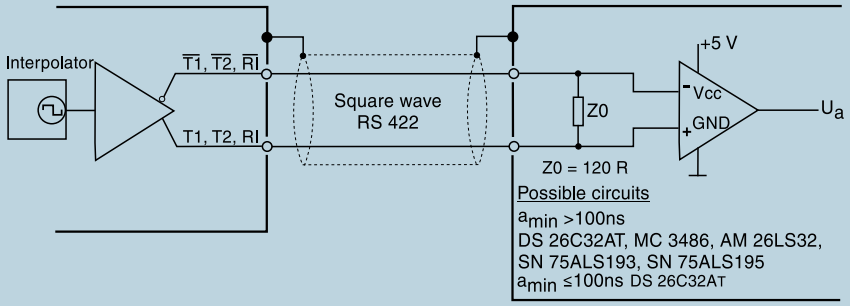
To prevent counting errors, the controls/DRO´s must be able to process the resulting edge separation.

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

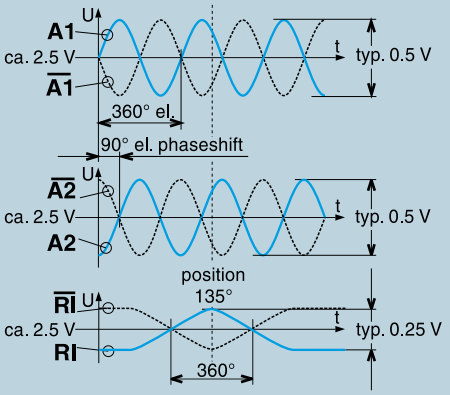
Power supply: +5 V ±5%, max. 165 mA (unloaded)

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

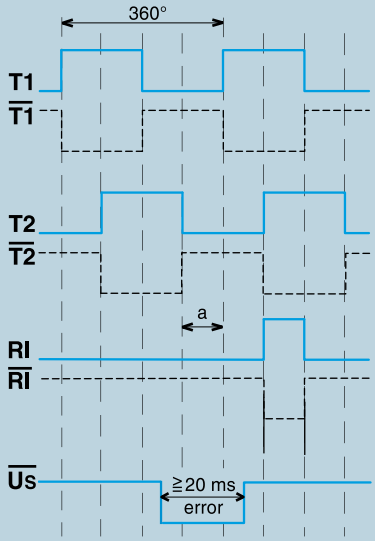
Recommended Line Receiver circuit



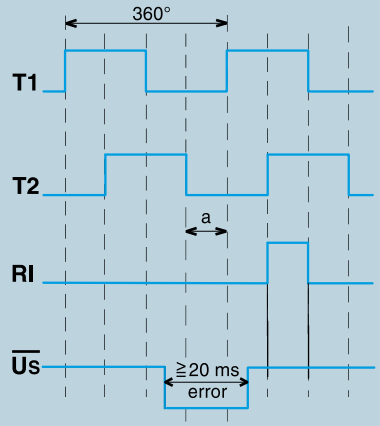
Voltage signals



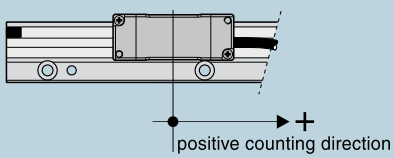
Square wave signals „differential“



Square wave signals „single ended“



Counting direction



MS 40 Technical data

Features:

- **Small dimensions**
- **Easy mounting as a result of large mounting tolerances**
- **High insensitivity to contamination by use of an extensive singlefield scanning principle**
- **High traversing speed**
- **Reference mark (accurate and repeatable from both traversing directions)**
- **Integrated subdividing electronics in the encoder head for up to times 100 interpolation (before quadrature)**

Scanning unit: 200 µm grating pitch, system resolution from 10 µm to 0,5 µm

Scale model	System resolution	Grating pitch	Integrated interpolation	Max. velocity	Max. output frequency resp. Edge separation a_{min}
• **Sinusoidal voltage signals**					
MS 40.06	depending on external interpolation	200 µm	--	10 m/s	50 kHz
• **Square wave Line Driver signals with integrated Subdividing**					
MS 40.66	10 µm	200 µm	times 5	10 m/s	500 ns
MS 40.76	5 µm	200 µm	times 10	9 m/s	500 ns
MS 40.86	1 µm	200 µm	times 50	4.5 m/s	200 ns
MS 40.96	0.5 µm	200 µm	times 100	2.25 m/s	200 ns

Scale unit: Grating carrier steel tape scale

Mechanical features of the grating carrier	MS 40 Grating carrier Steel tape scale
Grating pitch	200 µm
Accuracy grades	±30 µm/m
Max. measuring length	30040 mm
Reference marks (RI) Standard:	separated by distances of n x 100 mm
Reference marks (RI) at any location:	selected by customer
Steel tape scale without carrier	MS 40.xx **MO**
Steel tape scale with adhesive tape	MS 40.xx **MK**
Steel tape scale in aluminum profile with adhesive tape	MS 40.xx **MP**

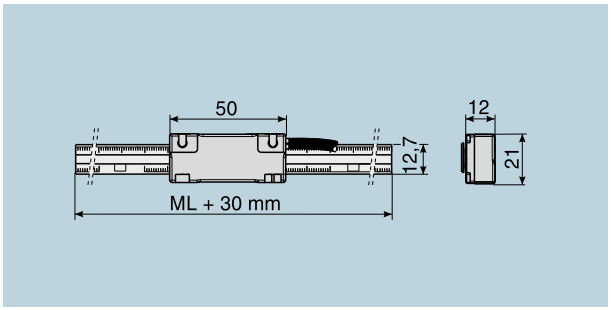
Mounting-adjustment/Test: With electronic signal test/set-up box PG or PS to optimize or check the mounting (see page 10)

Permissible vibration: 150 m/s^2 (40 bis 2000 Hz)
Permissible shock: 750 m/s^2 (8 ms)

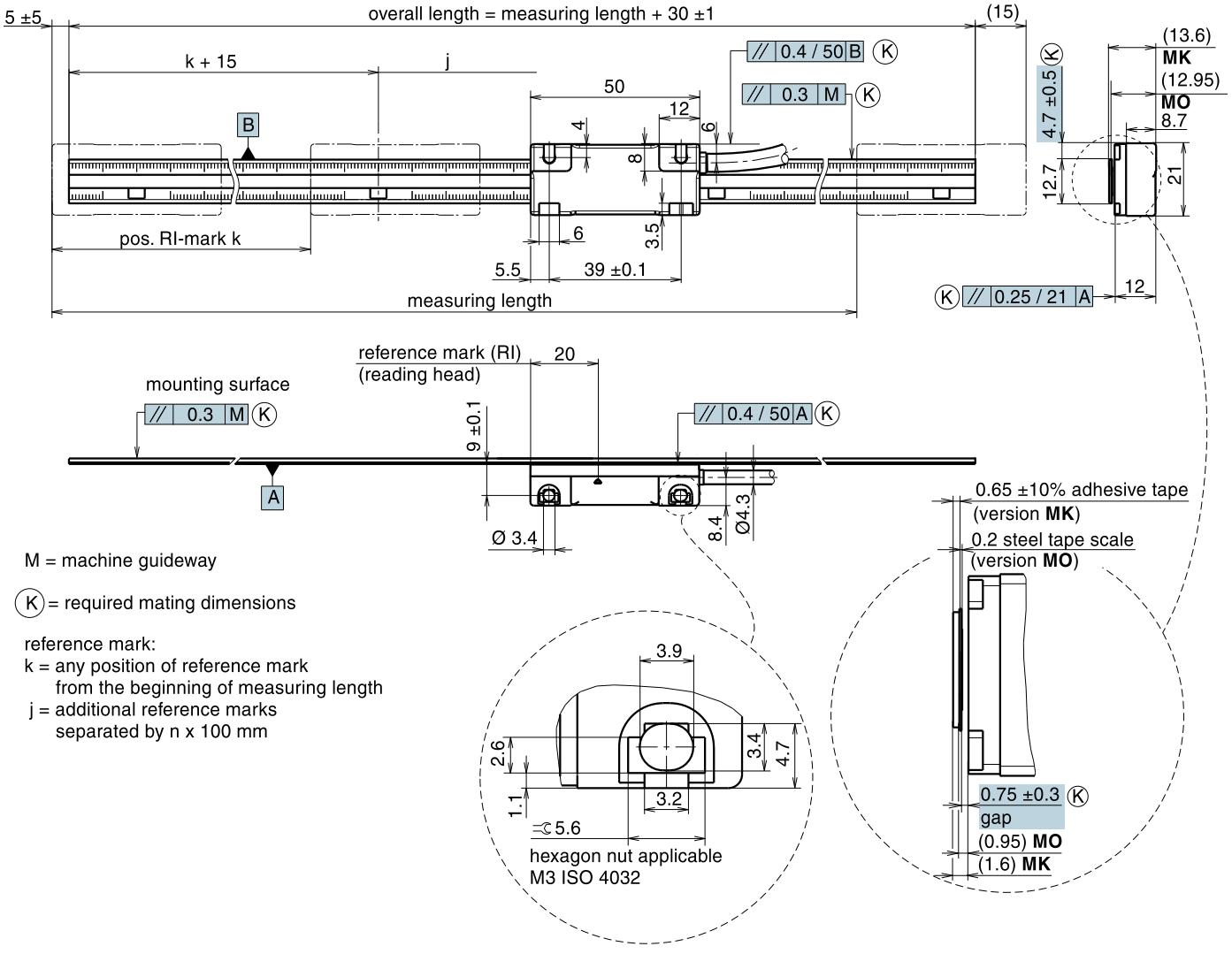
Permissible temperature:
-20°C bis +70°C (storage), 0°C bis +50°C (operation)

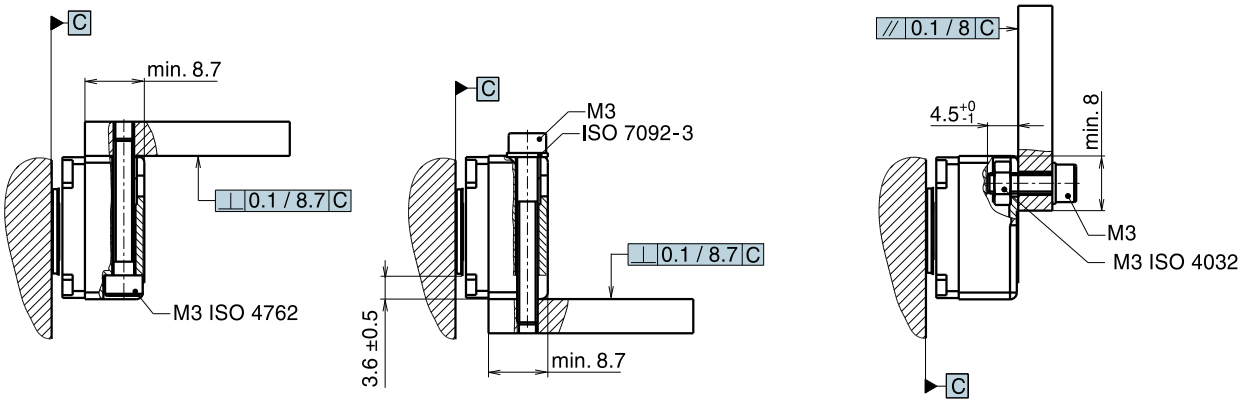
Weight depending on scale version (approx.)
20 g/m (MO = Steel tape scale only)
25 g/m (MK = Steel tape scale with adhesive tape)
115 g/m (MP = Steel tape scale in aluminum carrier, carrier glued) + 2 g clamping element
+ 17 g (scanning unit without cable)

MS 40.xx MO, MS 40.xx MK steel tape scale without carrier (MO) with adhesive tape (MK)

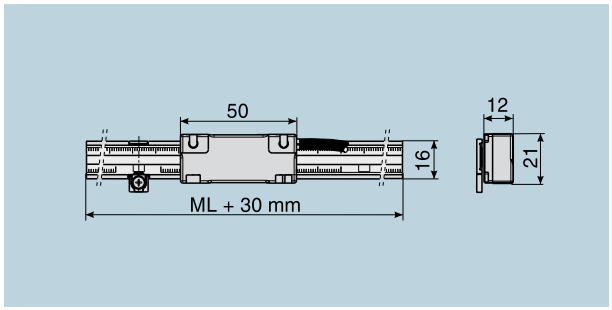


Dimensions, mounting tolerances, mounting possibilities:

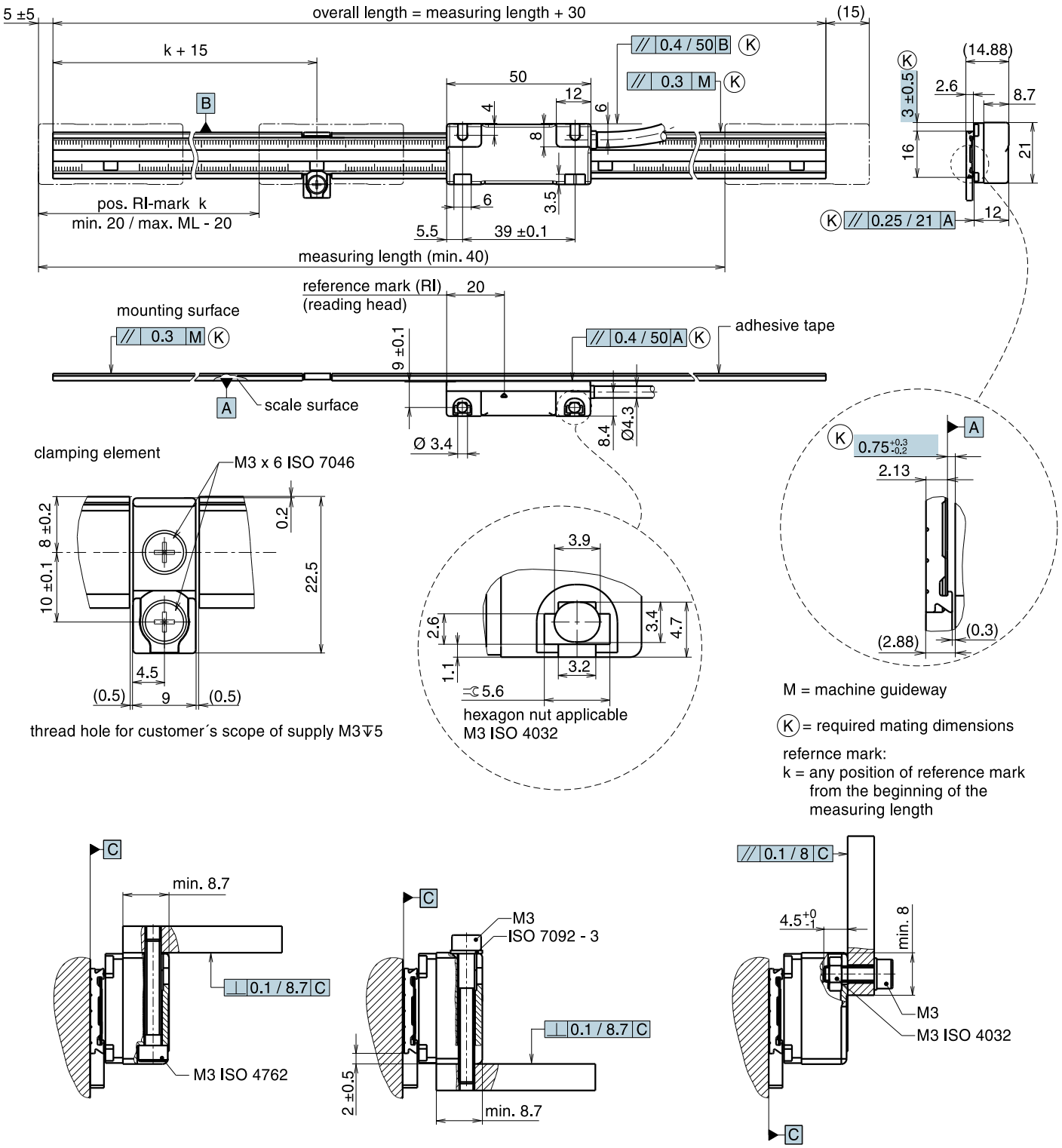




MS 40.xx MP steel tape scale in aluminum carrier with clamping element, carrier with adhesive tape



Dimensions, mounting tolerances, mounting possibilities:



PG, PS electronic signal test/set-up boxes

Open linear encoders are adjusted at the factory to provide the signal specifications at the specified mounting conditions.

Even though the linear encoders in the MS 40 series allow for large mechanical mounting tolerances,
it is recommended to inspect the mounting by checking the quality of the output signals.

There are various methods of checking the quality of the output signals.
The signals can be connected to an oscilloscope and checked for conformity with signal specifications.
This method requires effort, training and expensive test equipment (oscilloscope). Often one or all of these items are unavailable to the installing technician.
As an alternative to this method, RSF offers different signal test boxes. With these test boxes all encoder signals can be quickly and easily checked.

The **PG1-U** is an all-purpose signal test box where all the relevant signals are displayed on LCD Bars.

The **PG1-U** allows the quantitative as well as the qualitative evaluation of the encoder signals.

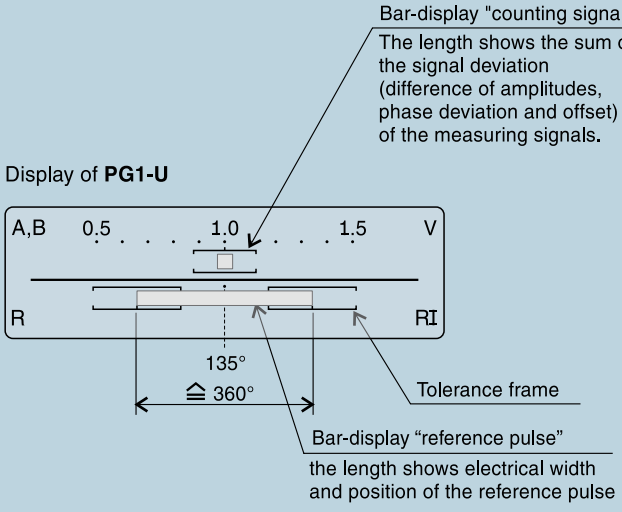
The **PG-U, PG4** and **PS4** test box checks all relevant signals; amplitude, phase and offset, and displays the results in a **qualitative** format on a polychromatic LED display.
PG-U and **PG4 =** stand alone test
PS4 = in-circuit test

PG1-U

PG-U, PG4

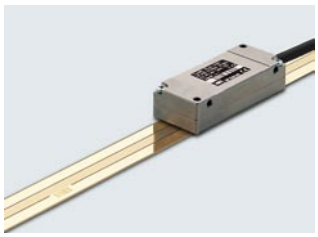
PS4

Display of **PG1-U**



Intended PG-use		MS 40 Output signals square wave	sinus (1 Vpp)
PG1-U		--	✓
PG-U		--	✓
PG4		✓	--
PS4		✓	--

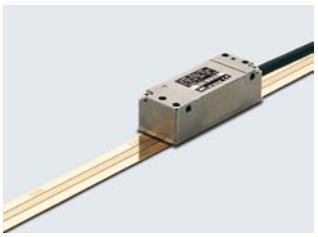
Other RSF products, short description



MS 20

Linear Encoder with singlefield reflective scanning

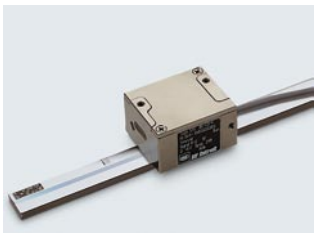
- small dimensions
- easy mounting as a result of large mounting tolerances
- high traversing speed
- high insensitivity to contamination
- reference mark
- integrated subdividing up to times 100 interpolation
- max. measuring length 9440 mm



MS 30

Reflective scanning Linear Encoder

- two independent switch signals for individual functions
- small dimensions
- easy mounting as a result of large mounting tolerances
- high traversing speed
- high insensitivity to contamination
- integrated subdividing up to times 100 interpolation
- max. measuring length 9440 mm



MS 8x

Interferential Linear Encoder

- two switch tracks for individual special functions
- non-contact reflective scanning
- for high displacement velocities
- small version
- scale version: glass scale or ROBAX glassceramic with phase grating
- max. measuring length to 3140 mm

TDE 60

Two dimensional Encoder

- non-contact reflective scanning
- small version
- scale version: glass scale
- measuring range 360 x 360 mm

MSA 170

- enclosed version
- guided by ball bearings
- distance coded RI marks (K)
- extremely small cross section
- mounting holes on the extrusion ends
- max. measuring length 520 mm

MSA 670

- enclosed version
- distance coded RI marks (K)
- small cross-section
- mounting holes on the extrusion ends
- max. measuring length 2240 mm

MSA 370

- enclosed version
- distance coded RI marks (K)
- large cross-section
- rigid mounting
- mounting holes on the extrusion ends and with mounting supports
- max. measuring length 3040 mm

Z 7x Reihe

Digital Readouts for universal application

- number of alpanumeric axis 1, 2 or 3 (depends on version)
- clearly readable display
- robust cast aluminum housing
- clear keyboard
- practice-oriented functions
- standard version for lathe or milling machine
- version for spark erosion machines and surface grinders on request

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