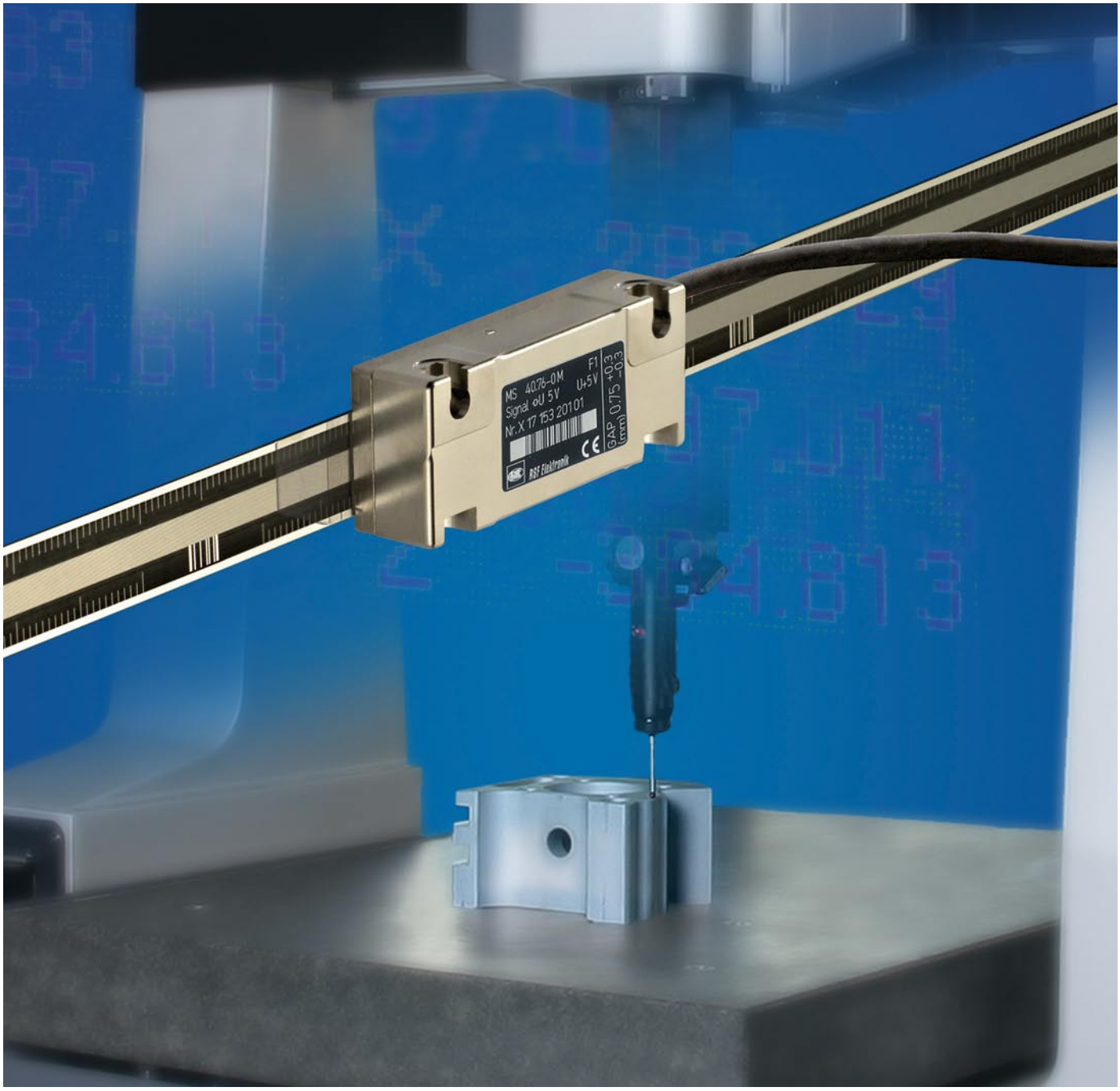
RSF Elektronik

RELIABLE. SOPHISTICATED. FLEXIBLE.

MS 40

Open Linear Encoder
with Singlefield Scanning



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.

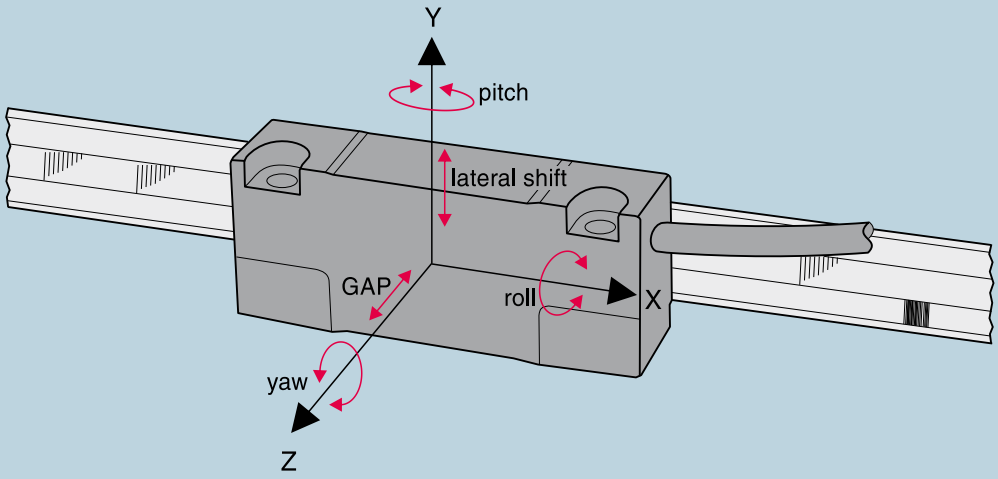
Error Signal
This signal appears when a malfunctioning encoder generates faulty scanning signals.

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

Accuracy
This is a fundamental characteristic, which is specified by an accuracy grade (e.g. ±30 µm/m).

Abbe Error
Measuring error due to lateral distance between the measuring system and the machining level.

Yaw Angle, Pitch Angle, Roll Angle, Lateral Shift, 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 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 15 m/s),
large mounting tolerances and contamination on the scale.

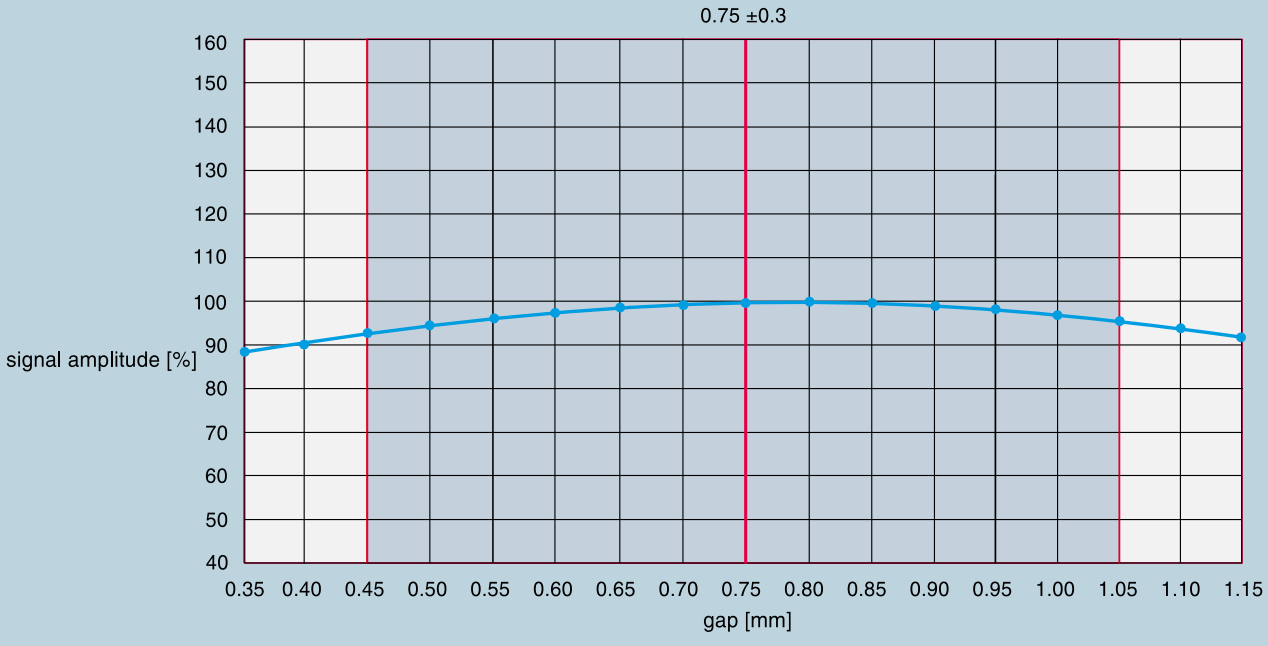
Reference marks, accurate and repeatable from both traversing directions, are standard.

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.

Signal amplitude vs. reading head gap



Scanning Principle

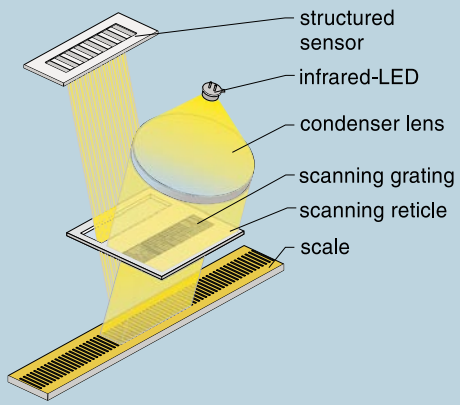
The model MS 40 incremental Linear Encoder works with the imaging, photoelectric measuring principle and a **singlefield reflective scanning** method. A scale graduation pattern with 200 µm grating pitch is used on a steel tape.

The 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 highly insensitive to possible contaminations, which can never be entirely ruled out despite all technical precautions.

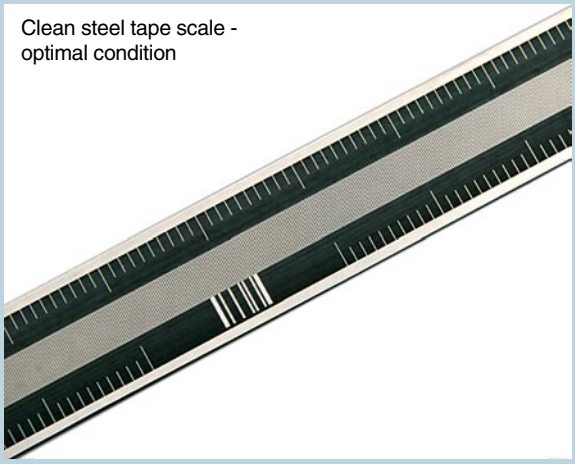
The regulation of the LED ensures a constant light output, guaranteeing stability in the case of temperature fluctuations as well as with long-run operation.

Scanning principle

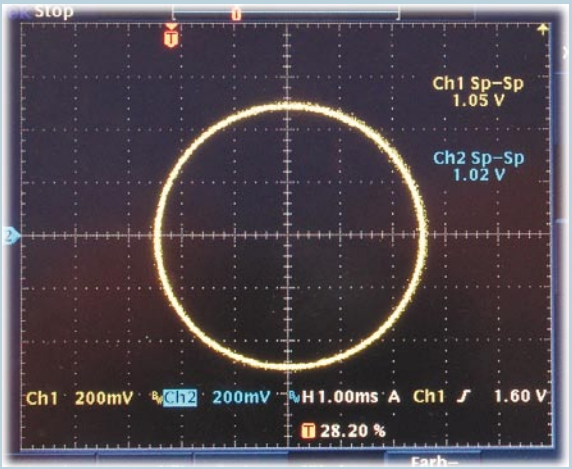


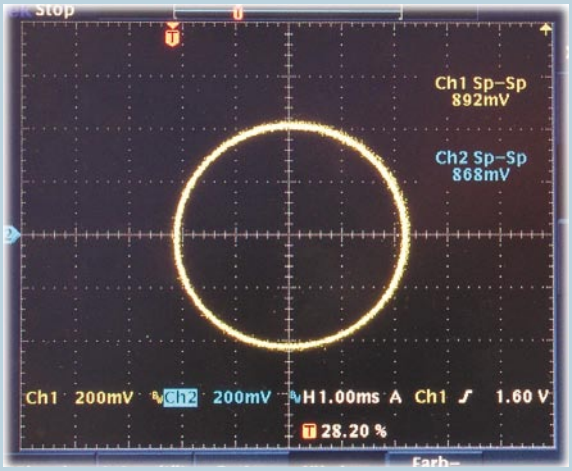
Effect of contamination on the quality and size of the scanning signal (before interpolation)

Clean steel tape scale - optimal condition



Contaminated steel tape scale unfavorable condition





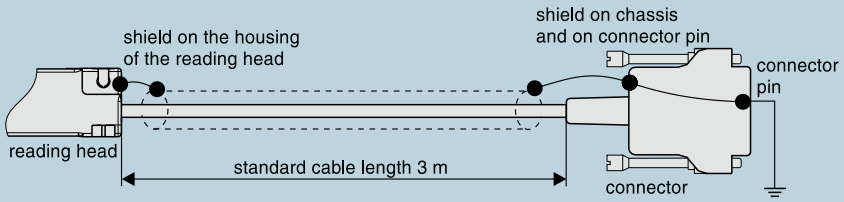
High insensitivity to contamination by use of a new scanning principle.

Cable and Connector Shielding, Standard Connector pin-out

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 available on request.

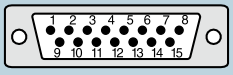
Square wave signals
Sinusoidal voltage signals

shielded PUR-cable, Ø 4.3 mm
bending radius fixed mounting > 10 mm, continuous flexing > 50 mm
torsion > 300.000 cycles, dragchain > 5.000.000 cycles



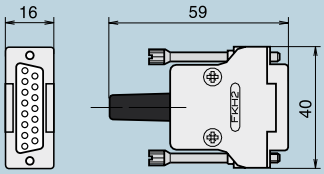
Connector LD15 15-pin

PIN	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Square-wave sig. via Line Driver	nc	Sensor 0 V	$\overline{Us}$	$\overline{RI}$	$\overline{T2}$	$\overline{T1}$	Sensor +5 V	+5 V	0 V	nc	nc	RI	T2	T1	Shield



pin-out
(view on pins)

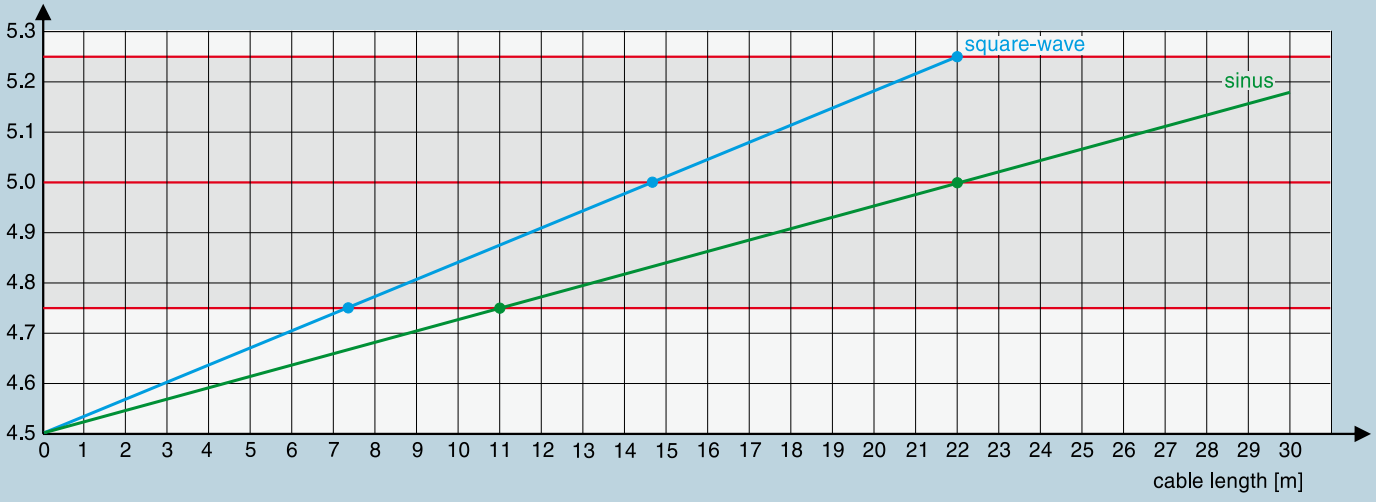
PIN	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Sinusoidal voltage signals	nc	Sensor 0 V	nc	$\overline{RI}$	$\overline{A2}$	$\overline{A1}$	Sensor +5 V	+5 V	0 V	nc	nc	RI	A2	A1	Shield



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

Max. permissible cable length according to power supply

power supply [V]
on connector - control sided



Output Signals

Sinusoidal voltage signals 1Vpp

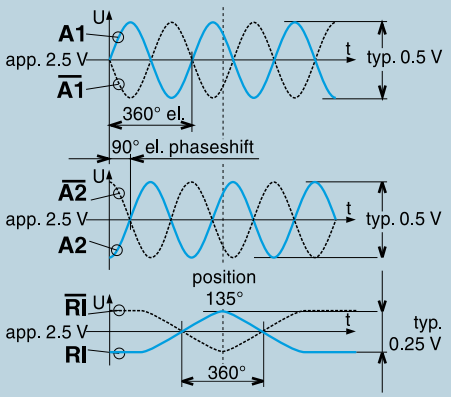
(drawing shows “positive counting direction”)
Two sinusoidal voltage signals A1 and A2 and one reference mark signal (all with inverted signals).

Power supply: +5 V ±5 %, max. 130 mA (unloaded)
Track signals (differential voltage A1 to $\overline{A1}$ resp. A2 to $\overline{A2}$):
Signal amplitude 0.6 Vpp to 1.2 Vpp; typ. 1 Vpp
(with terminating impendance Zo = 120 Ω between A1 to $\overline{A1}$ resp. A2 to $\overline{A2}$)

Reference mark
(differential voltage RI to $\overline{RI}$):
Useable component 0.2 up to 0.85 V; typical 0.5 V
(with terminating impedance Zo = 120 Ω between RI to $\overline{RI}$)

Advantage:
- High traversing speed with long cable lengths possible

Voltage signals (1 Vpp)



Square-wave signals

(drawing shows “positive counting direction”)
With a Schmitt-Trigger (for times 1) or 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).
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

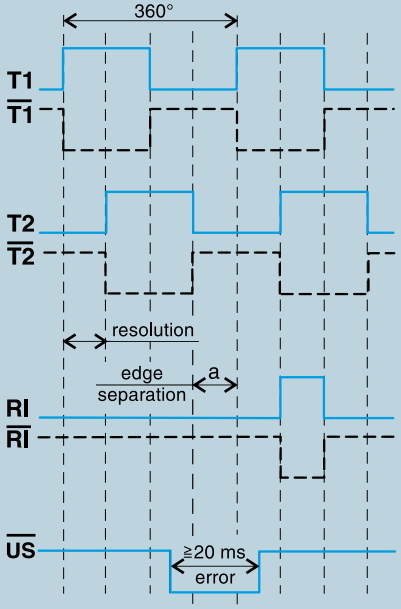
To prevent counting errors, the controls/DRO´s must be able to process the resulting edge separation.

Example:
a_{min} = 200 ns, 10 m cable
200 ns - 10 ns - 10 x 0.2 ns - 10 ns = 178 ns

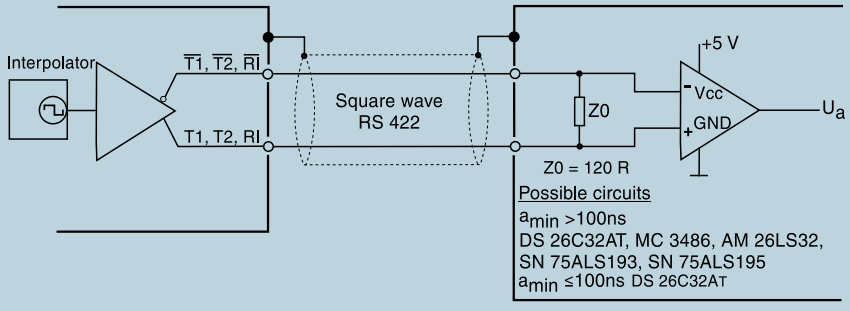
Power supply: +5 V ±5%, max. 140 mA (unloaded)

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

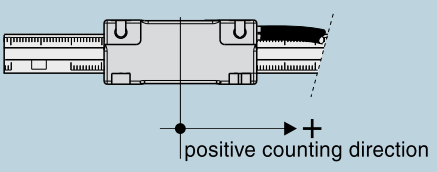
Square wave signals „differential“



Recommended Line Receiver circuit



Counting direction



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: 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**	**Integrated interpolation**	**Max. velocity**	**Max. output frequency resp. Edge separation a_{min}**
• Sinusoidal voltage signals				
MS 40.06	depending on external interpolation	-	15 m/s	75 kHz
• Square-wave signals with integrated Subdividing				
MS 40.66	10 µm	times 5	10 m/s	500 ns
MS 40.76	5 µm	times 10	9.6 m/s	500 ns
MS 40.86	1 µm	times 50	4.8 m/s	200 ns
MS 40.96	0.5 µm	times 100	2.4 m/s	200 ns

Scale unit	**Grating carrier Steel tape scale**
Grating pitch	200 µm
Accuracy grades	±30 µm/m
Max. measuring length	20 000 mm (longer on request)
Reference marks (RI) standard	separated by distances of n x 100 mm
Reference mark (RI) at any location	selected by customer

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

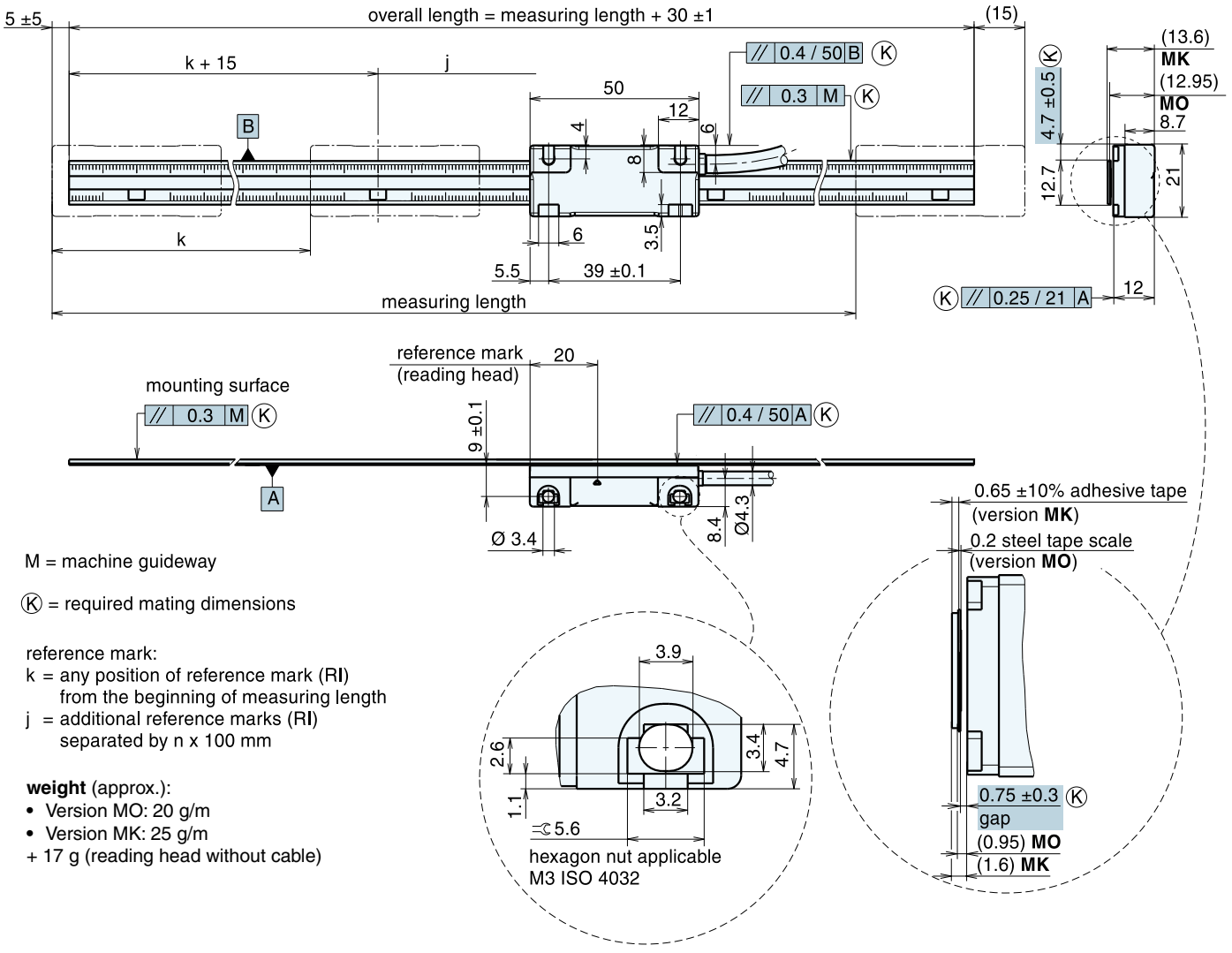
Permissible vibration: 150 m/s² (40 up to 2000 Hz)
Permissible shock: 750 m/s² (8 ms)

Permissible temperature:
–20 °C up to +70 °C (storage), 0 °C up to +70 °C (operation)

MS 40.xx MO, MS 40.xx MK

- Version MO: steel tape scale only
- Version MK: steel tape scale with adhesive tape

Dimensions, mounting tolerances, mounting possibilities:



M = machine guideway

Ⓚ = required mating dimensions

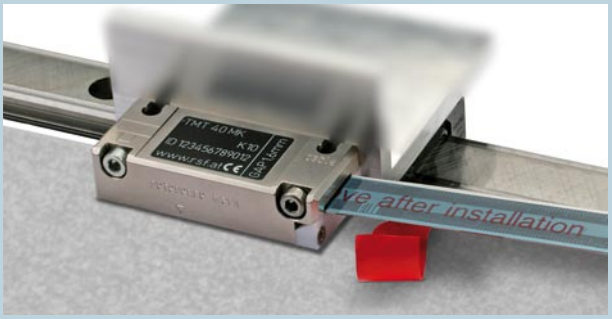
reference mark:
k = any position of reference mark (RI) from the beginning of measuring length
j = additional reference marks (RI) separated by n x 100 mm

weight (approx.):
- Version MO: 20 g/m
- Version MK: 25 g/m

+ 17 g (reading head without cable)

Tape mounting tool **TMT 40 MK** (optional)
For safe and precise mounting of the steel tape scale.

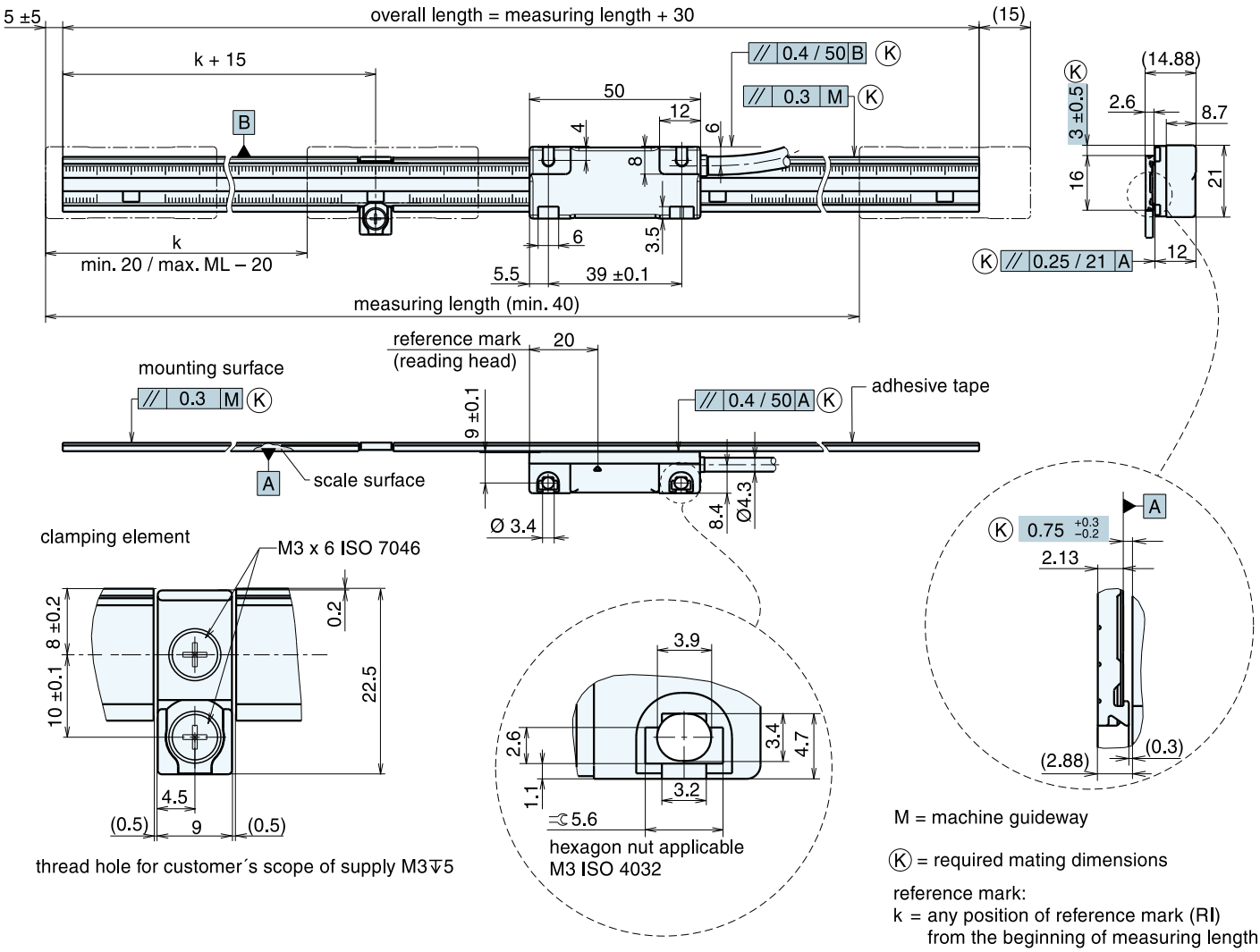
- Mount TMT 40 MK instead of the reading head MS 40
- Thread steel tape scale (version MK) and move along the scale length
- Remove TMT 40 MK, mount reading head MS 40



MS 40.xx MP

- Steel tape scale in aluminum carrier with clamping element
- Carrier with adhesive tape

Dimensions, mounting tolerances, mounting possibilities:



M = machine guideway

Ⓚ = required mating dimensions

reference mark:
k = any position of reference mark (RI) from the beginning of measuring length

weight (approx.):
115 g/m + 2 g clamping element
+ 17 g (reading head without cable)

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 and 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.

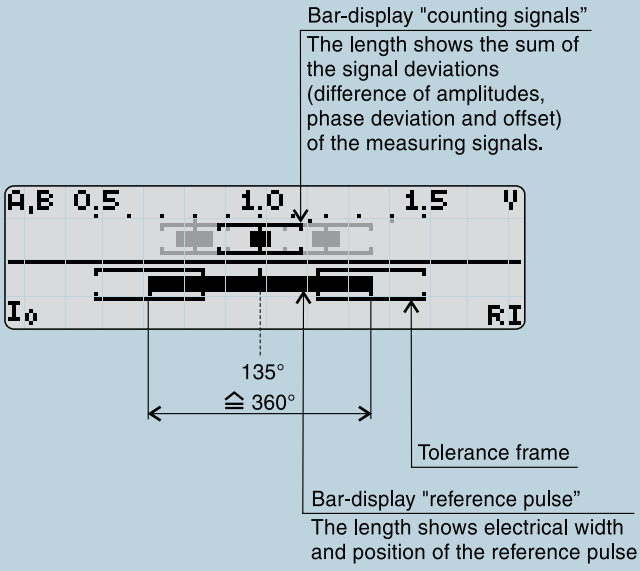
PG-U and **PG4 =** stand alone test
PS4 = in-circuit test

PG1-U

PG-U, PG4

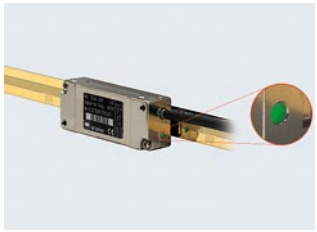
PS4

Display of **PG1-U**



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

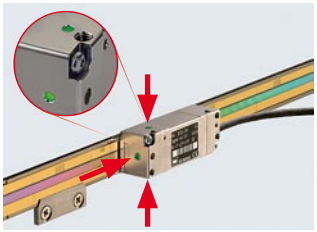
Other RSF Products, Short Description



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-colored 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 3x series

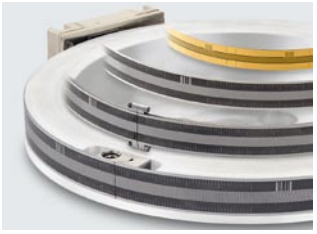
Reflective scanning Linear Encoder with integrated mounting control (only MS 35, MS 36)

- easy mounting; no test box or oscilloscope needed
- quality of the scanning signals is directly visible at the reading head via three 3-colored LEDs
- two independent switch signals for individual special functions
- 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: 20000 mm

MS 82

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: 3140 mm



Modular Rotary Encoder with steel tape scale

MSR 40

different versions

- full-circle or segment version
- grating pitch: 200 µm
- accuracy of the grating pitch (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 pitch (stretched): ±15 µm/m
- high circumferential speed
- integrated subdividing: up to times 100 interpolation

MSA 170

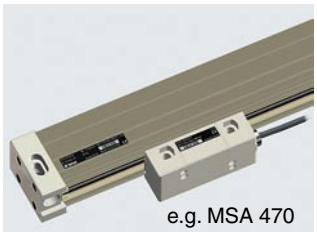
- extremely small cross section
- enclosed version
- guided by ball bearings
- distance coded reference marks
- mounting holes on the extrusion ends
- max. measuring length: 520 mm

MSA 374

Enclosed Linear Encoder

- for application on presses bending machines and hydraulic cylinders
- roller bearing dual guided scanning carriage
- free positionable switching magnets for special functions
- distance coded reference marks
- mounting holes on the extrusion ends
- max. measuring length: 720 mm

e.g. MSA 730



e.g. MSA 470

MSA 7xx, MSA 8xx series

(small dimensions)

MSA 4xx, MSA 5xx series

(large dimensions)

- optimized thermal behavior
- connection cable pluggable (optional)
- enclosed version
- distance coded reference marks
- mounting holes at the ends or along the scale unit for improved vibration stability
- max. measuring length: 3040 mm

Z 7xx series

Digital Readouts for universal applications

- number of alphanumeric 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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