RSF Elektronik

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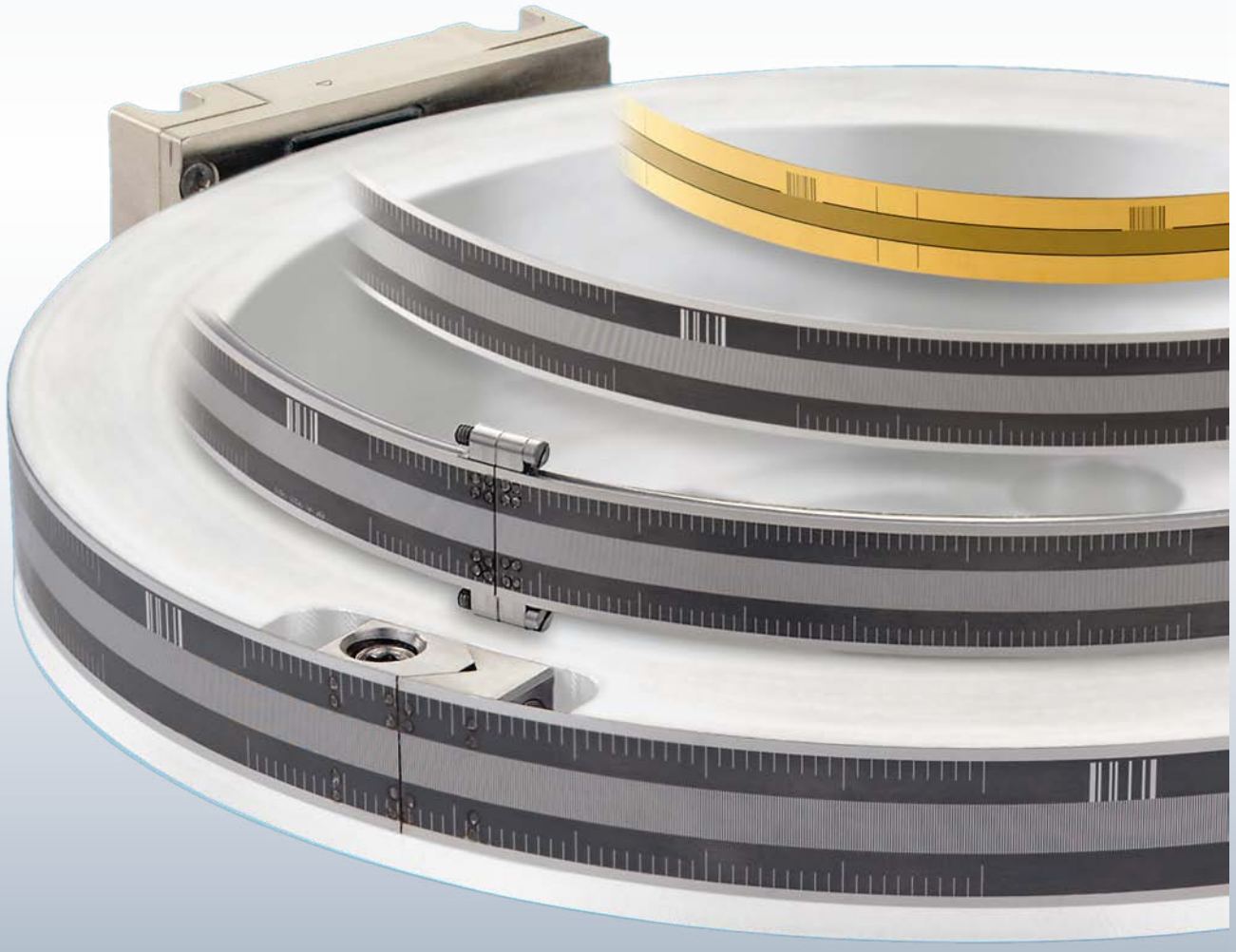
MSR 20, MSR 40

Modular Rotary Encoder with Singlefield Scanning



CONTENTS

TERM-EXPLANATIONS

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.

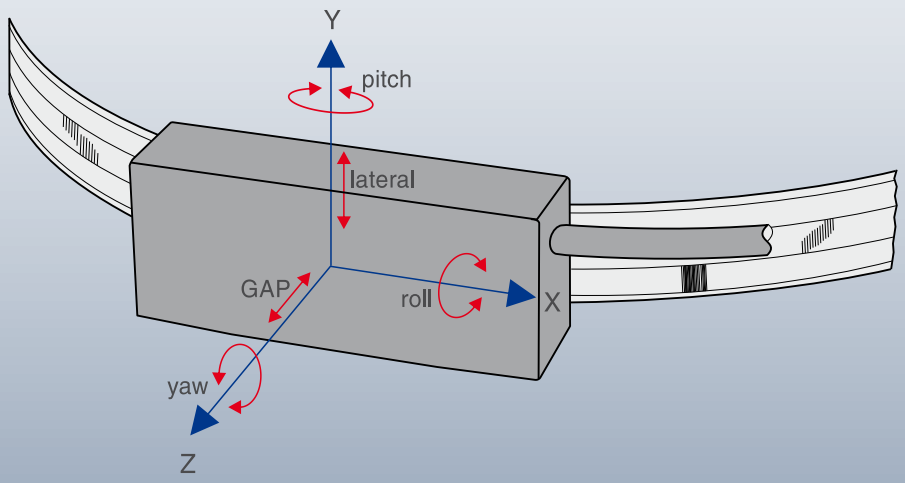
Error Signal
This signal appears when a malfunctioning encoder generates faulty scanning signals.

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

Line Rates
Number of the grating pitches per rotation.

Accuracy
This is a fundamental characteristic, which is specified with an accuracy grade (e.g. ±5 µm/m).

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



REQUIREMENTS IN AN MODULAR ROTARY ENCODER

- Small dimensions
- High contamination resistance
- High resolution
- High circumferential speed
- Large mounting tolerances

The MSR series meet all these requirements!

The trend today in motion control applications is for exposed Encoder Systems.
This is driven by steadily increasing demands for
- Higher circumferential speed
- Higher operating cycles
- Zero frictional force induced by the encoder.

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

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

The MSR 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 circumferential directions, are standard.

A wide range of interpolation electronics, integrated into the encoder head, enables resolutions from 10 µm to 0,1 µm. Square-wave 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.

SCANNING PRINCIPLE

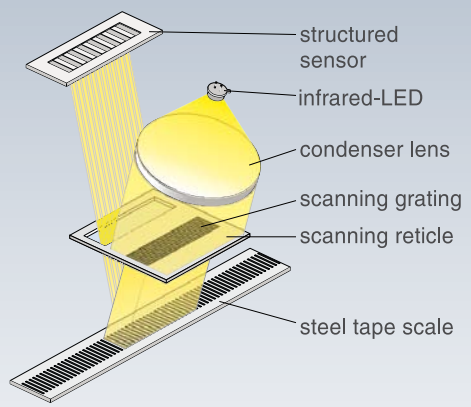
The model MSR 20 resp. MSR 40 modular Rotary Encoder works with the imaging, photoelectric measuring principle and a **singlefield reflective scanning** method. A scale graduation pattern with 200 µm (MSR 40) resp. 40 µm (MSR 20) grating pitch is used on a steel tape.

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.

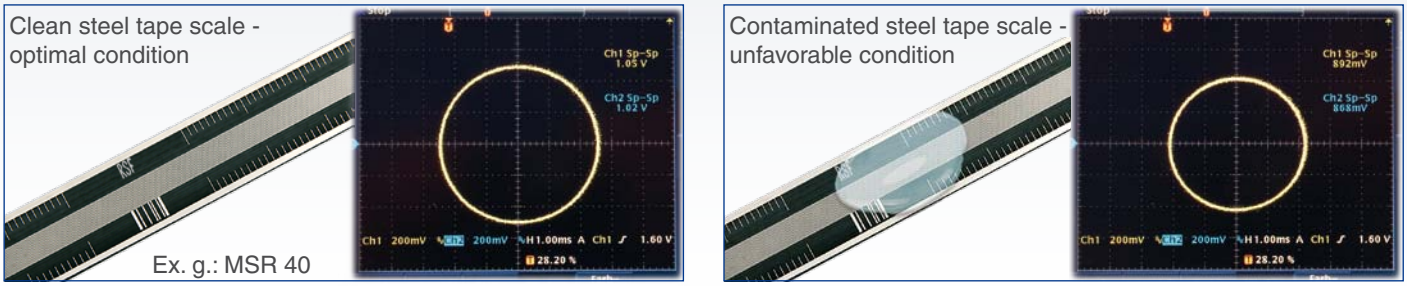
The sensor generates sinusoidal signals of the highest quality that prove to be highly insensitive to possible contaminations, which can never be entirely ruled out despite all technical precautions.

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



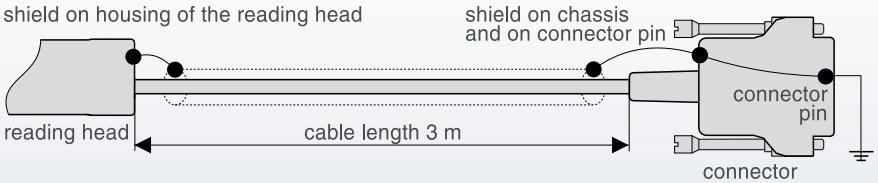
Effect of contamination on the quality and size of the scanning signal (before interpolation)



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

SHIELDING, PIN ASSIGNMENT

Single-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
Applicable cables for use in vacuum-applications are also available on request.

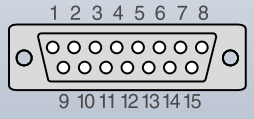


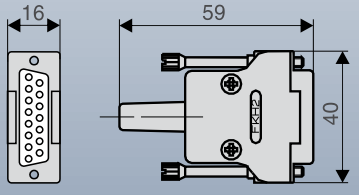
Connector LD15 15-pin

Pin	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Sinusoidal voltage signals 1 Vpp	nc	0 V sensor	nc	$\overline{RI}$	$\overline{A2}$	$\overline{A1}$	+5 V sensor	+5 V	0 V	nc	nc	RI	A2	A1	shield
Square-wave via Line Driver	nc	0 V sensor	$\overline{US}$	$\overline{RI}$	$\overline{T2}$	$\overline{T1}$	+5 V sensor	+5 V	0 V	nc	nc	RI	T2	T1	shield

- Sensor: The sensor-pins are bridged in the chassis with the particular power supply.
- The shield is additional connected with the chassis.

Pin assignment
(view on pins)





OUTPUT SIGNALS

Sinusoidal voltage signals 1Vpp

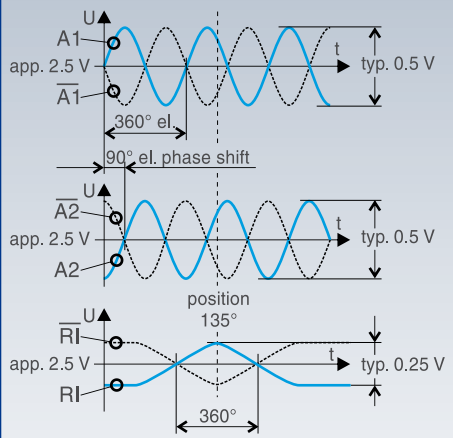
(drawing shows “positive counting direction”)
Two sinusoidal voltage signals A1 and A2 and one reference mark signal (all with inverted signals).

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

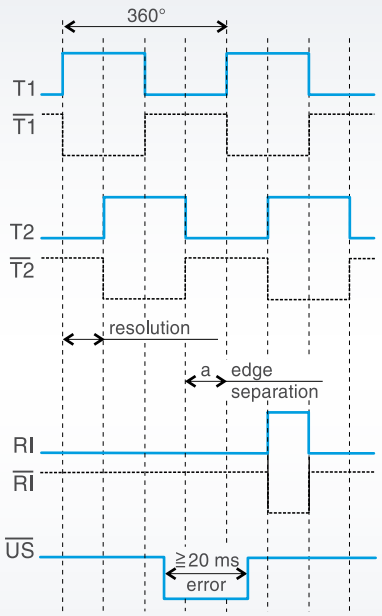
To prevent counting errors, the controls/DRO´s must be able to process the resulting edge separation.

Example:
a_{min} = 100 ns, 10 m cable
100 ns - 10 ns - 10 x 0.2 ns - 10 ns = 78 ns

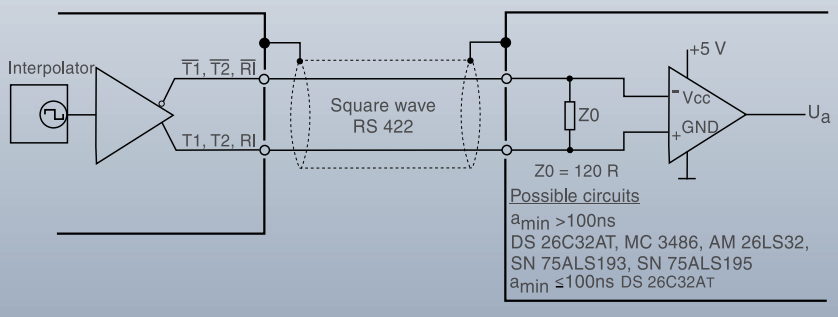
Power supply: +5 V ±5%, max. 165 mA (unloaded)

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

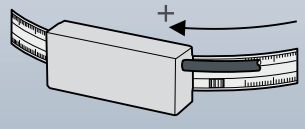
Square wave signals „differential“



Recommended Line Receiver circuit



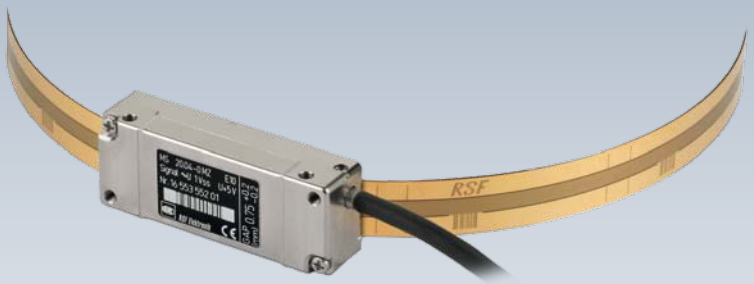
Counting direction



MSR 20 MKS TECHNICAL DATA

Features:

- Segment version
- Steel tape scale with adhesive tape
- Grating pitch: 40 µm
- Easy mounting as a result of large mounting tolerances
- High circumferential speed
- Integrated subdividing electronics: up to times 100



Reading head: 40 µm grating pitch

Scale model	Output signals	Integrated interpolation	Max. circumferential speed [m/s]	Max. output frequency [kHz]
MSR 20.04	∿ 1 Vpp	--	10.0	250
				Edge separation amin
MSR 20.64	⎍	times 5	6.4	300 ns
MSR 20.74	⎍	times 10	3.2	300 ns
MSR 20.44	⎍	times 20	2.4	200 ns
MSR 20.54	⎍	times 25	1.9	200 ns
MSR 20.84	⎍	times 50	1.9	100 ns
MSR 20.94	⎍	times 100	0.96	100 ns

Scale unit

Scale unit: MKS = steel tape scale with adhesive tape

Possible shaft diameters: Ø ≥50 – 400 mm, scale-segment pre-bent in factory
over Ø 400 mm on request, scale-segment is not pre-bent

Reference mark (RI): any position, additional reference marks separated by n x 50 mm

Accuracy of the grating pitch (stretched): ±15 µm/m

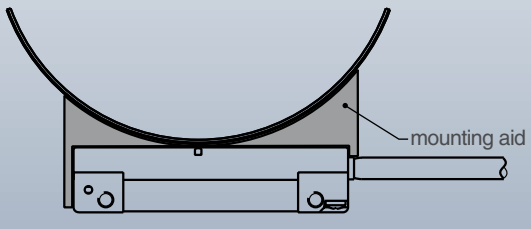
Mounting control: electronical signal test/set-up boxes PG-x resp. PS4

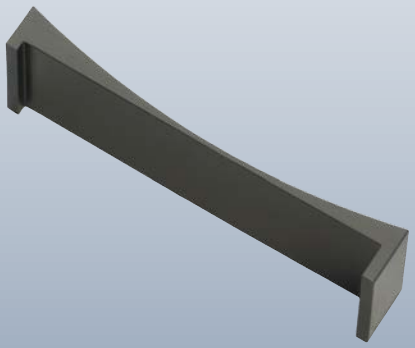
Operating temperature range: 0 °C up to +50 °C (coefficient of expansion of the shaft between 9×10^{-6} K^{-1} and 12×10^{-6} K^{-1})

Temperature range of storage: –20 °C up to +70 °C

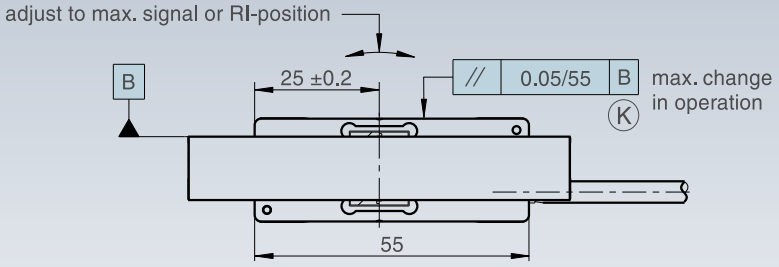
Weight depending (approx.): 30 g (scanning unit without cable), 20 g/m (steel tape scale)

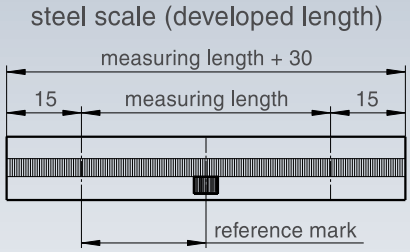
Mounting aid: optional accessory

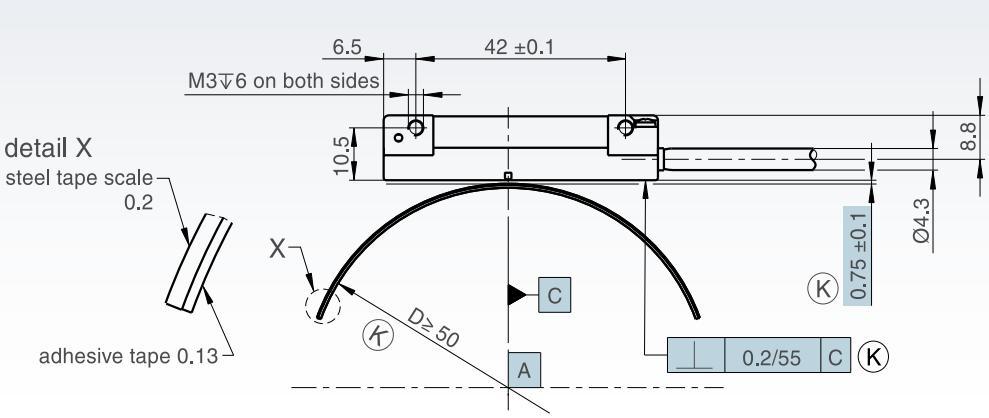


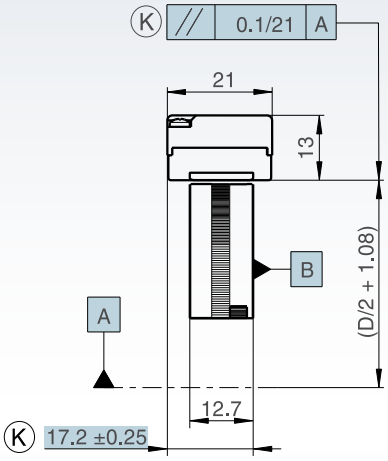


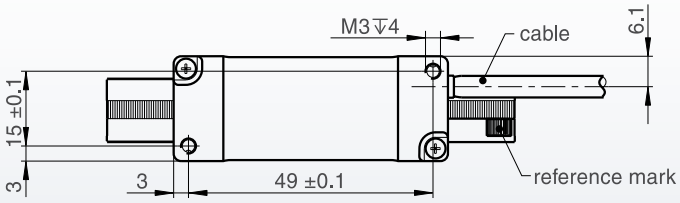
DIMENSIONS, MOUNTING TOLERANCES











Ⓚ = required mating dimensions
D = shaft diameter
reference mark (RI):
any position, additional reference marks separated by n x 50 mm

MSR 40 MOR TECHNICAL DATA

Features:

- Full-circle version with clamping element
- Steel tape scale
- Grating pitch: 200 µm
- Easy mounting as a result of large mounting tolerances
- High rotational speed
- Integrated subdividing electronics: up to times 100

Reading head: 200 µm grating pitch

Scale model			MSR 40.06	MSR 40.66	MSR 40.76	MSR 40.86	MSR 40.96
System resolution [°]			depends on external interpolation	360° / Lines x 20	360° / Lines x 40	360° / Lines x 200	360° / Lines x 400
System resolution [µm]			depends on external interpolation	10	5	1	0.5
Signal form			~ 1 Vpp	⎍	⎍	⎍	⎍
Integrated interpolation			--	times 5	times 10	times 50	times 100
Max. output frequency			90 KHz	--	--	--	--
Edge separation a_{min}			--	500 ns	500 ns	200 ns	200 ns
Lines	Shaft diameter [mm]	System accuracy*	max. rotational speed [min^{-1}]	max. rotational speed [min^{-1}]	max. rotational speed [min^{-1}]	max. rotational speed [min^{-1}]	max. rotational speed [min^{-1}]
2400	152.70	± 80“	200	200	200	200	200
2500	159.07	± 80“	200	200	200	200	200
3600	229.15	± 60“	200	200	200	200	200
5000	318.34	± 40“	200	200	200	200	144
7200	458.50	± 30“	200	200	200	200	100
10000	636.88	± 20“	150	150	150	144	72
10800	687.85	± 20“	139	139	139	133	67
14400	917.19	± 15“	104	104	104	100	50
18000	1146.54	± 15“	83	83	83	80	40

* without mounting, additional deviations as a result of mounting and storage of the measured shaft, are not respected.

Futher line rates or higher rotational speed on request

Scale unit:
MOR = steel tape scale with clamping element

Reference mark (RI): 25 mm from scale-joint (see drawing), additional reference marks separated by n x 100 mm

Accuracy of the grating pitch (stretched): ±30 µm/m

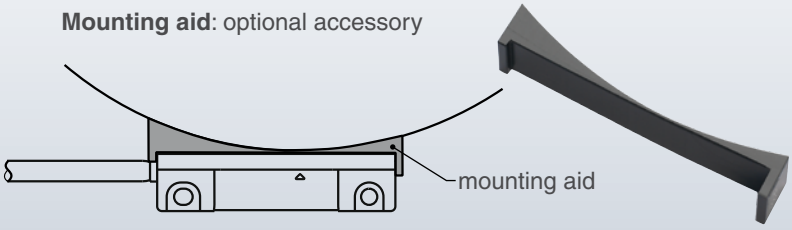
Mounting control:
electronical signal test/set-up boxes PG-x resp. PS4

Operating temperature range: 0 °C up to +50 °C (coefficient of expansion of the shaft between 9×10^{-6} K^{-1} and 12×10^{-6} K^{-1})

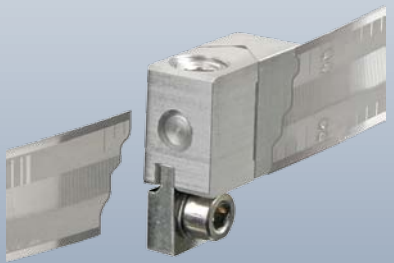
Temperature range of storage: –20 °C up to +70 °C

Weigth depending (approx.):
17 g (scanning unit without cable), 20 g/m (steel tape scale), 12 g (clamping element)

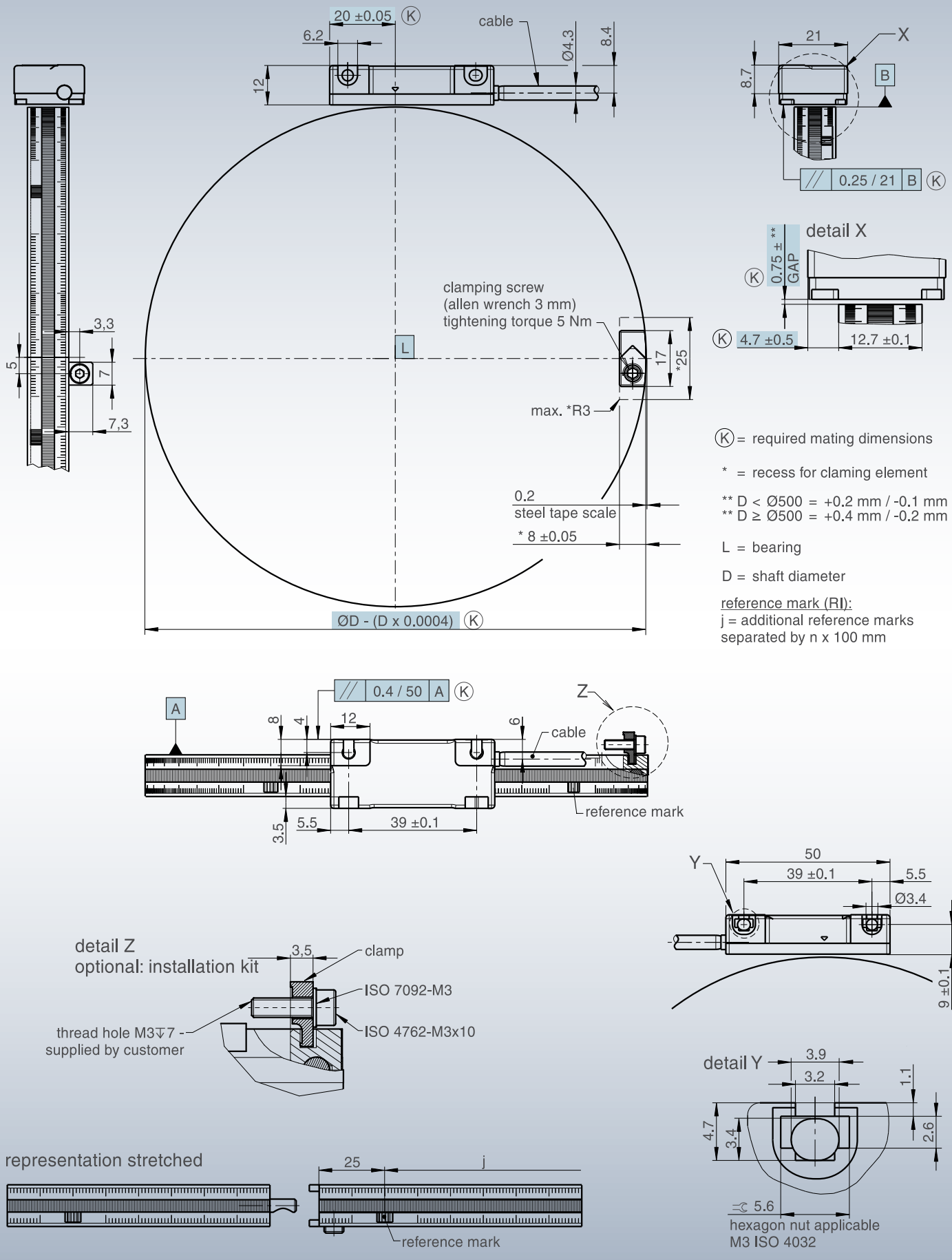
Mounting aid: optional accessory



Installation kit: optional accessory



DIMENSIONS, MOUNTING TOLERANCES



(K) = required mating dimensions

* = recess for claming element

** D < Ø500 = +0.2 mm / -0.1 mm
** D ≥ Ø500 = +0.4 mm / -0.2 mm

L = bearing

D = shaft diameter

reference mark (RI):
j = additional reference marks
separated by n x 100 mm

MSR 40 MER TECHNICAL DATA

Features:

- Full-circle version with clamping element
- Steel tape scale with elastic layer compensates Ø-change of the shaft (ΔDmax. ±0.2 mm)
- Grating pitch: 200 µm
- Easy mounting as a result of large mounting tolerances
- High rotational speed
- Integrated subdividing electronics: up to times 100

Reading head: 200 µm grating pitch

Scale model			MSR 40.06	MSR 40.66	MSR 40.76	MSR 40.86	MSR 40.96
System resolution [°]			depends on external interpolation	360° / Lines x 20	360° / Lines x 40	360° / Lines x 200	360° / Lines x 400
System resolution [µm]			depends on external interpolation	10	5	1	0.5
Signal form			~ 1 Vpp	⎍	⎍	⎍	⎍
Integrated interpolation			--	times 5	times 10	times 50	times 100
Max. output frequency			90 KHz	--	--	--	--
Edge separation a_{min}			--	500 ns	500 ns	200 ns	200 ns
Lines	Shaft diameter [mm]	System accuracy*	max. rotational speed [min^{-1}]	max. rotational speed [min^{-1}]	max. rotational speed [min^{-1}]	max. rotational speed [min^{-1}]	max. rotational speed [min^{-1}]
2400	146.99	± 400“	200	200	200	200	200
2500	153.35	± 350“	200	200	200	200	200
3600	223.38	± 250“	200	200	200	200	200
5000	312.51	± 200“	200	200	200	200	144
7200	452.57	± 150“	200	200	200	200	100
10000	630.82	± 100“	150	150	150	144	72
10800	681.75	± 100“	139	139	139	133	67
14400	910.93	± 75“	104	104	104	100	50
18000	1140.12	± 50“	83	83	83	80	40
20000	1267.44	± 50“	75	75	75	72	36

* without mounting, additional deviations as a result of mounting and storage of the measured shaft, are not respected.

Further line rates or higher rotational speed on request

Scale unit: MER = steel tape scale with elastic layer and clamping element

Reference mark (RI): 25 mm from scale-joint (see drawing), additional reference marks separated by n x 100 mm

Accuracy of the grating pitch (stretched): ±30 µm/m

Mounting control:
electronical signal test/set-up boxes PG-x resp. PS4

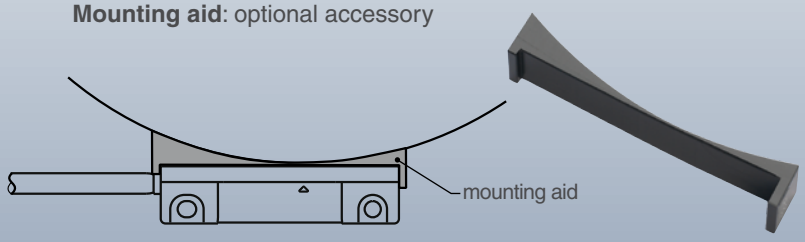
Operating temperature range scanning unit:
0 °C up to +50 °C

Operating temperature range scale unit:
range of temperature is dependent on the coefficient of the expansion of the shaft.
Max. Ø difference of the shaft to steel tape scale ΔD ±0.2 mm (steel tape scale α = 10.5 x 10^{-6} K^{-1}).

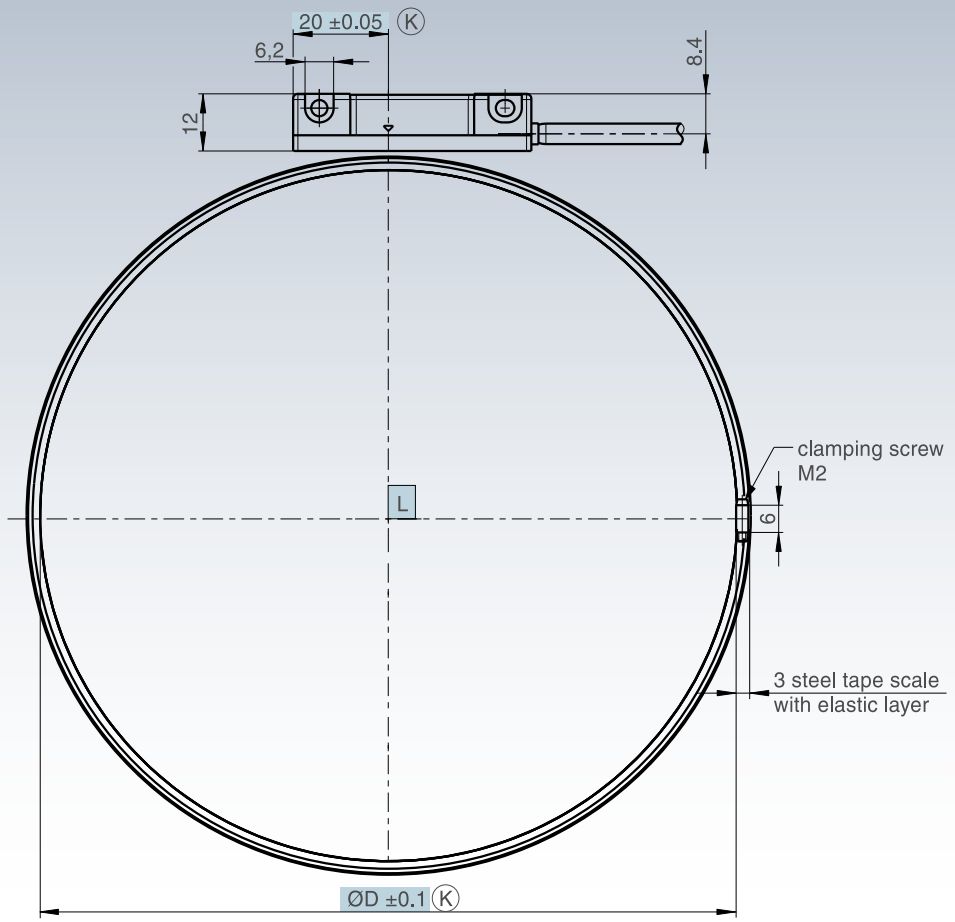
Temperature range og storage: –20 °C up to +70 °C

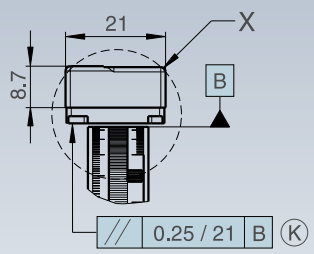
Weight depending (approx.):
17 g (scanning unit without cable),
45 g/m (steel tape scale with elastic layer),
2.5 g (clamping element)

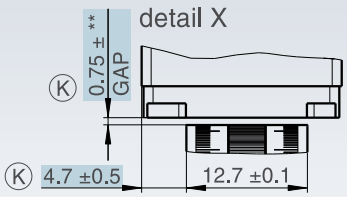
Mounting aid: optional accessory



DIMENSIONS, MOUNTING TOLERANCES







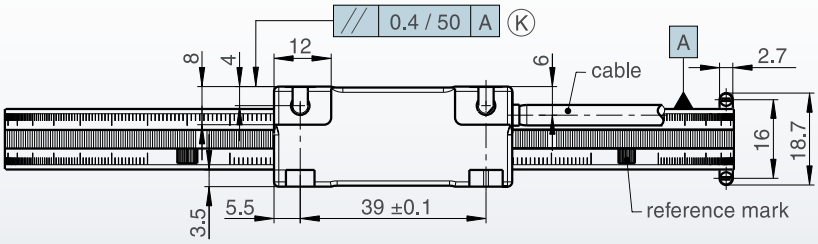
K = required mating dimensions

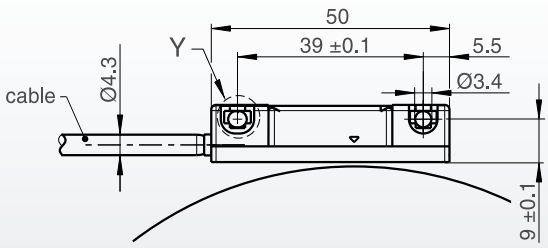
** D < Ø500 = +0.2 mm / -0.1 mm
** D ≥ Ø500 = +0.4 mm / -0.2 mm

L = bearing

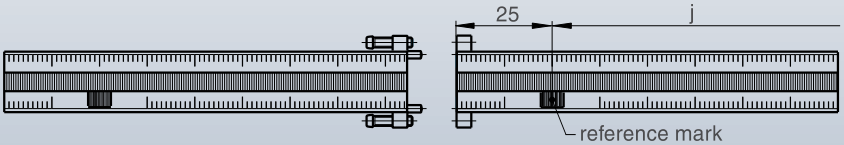
D = shaft diameter

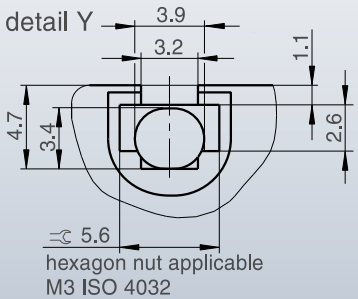
reference mark:
j = additional reference marks
separated by n x 100 mm





representation stretched





MSR 40 MKS TECHNICAL DATA

Features:

- Segment version
- Steel tape scale with adhesive tape
- Grating pitch: 200 µm
- Easy mounting as a result of adhesive tape
- High circumferential speed
- Integrated subdividing electronics: up to times 100

Reading head: 200 µm grating pitch

Scale model	Output signals	Integrated interpolation	Max. circumferential speed [m/s]	Max. output frequency [kHz]
MSR 40.06	∿ 1 Vpp	--	15.0	75
				Edge separation amin
MSR 40.66	⎍	times 5	15.0	500 ns
MSR 40.76	⎍	times 10	9.6	500 ns
MSR 40.86	⎍	times 50	4.8	200 ns
MSR 40.96	⎍	times 100	2.4	200 ns

Scale unit

Scale unit: MKS = steel tape scale with adhesive tape

Possible shaft diameters: Ø ≥150–400 mm, scale-segment pre-bendt in factory
over 400 mm, scale-segment is not pre-bendt

Reference mark (RI): any position of reference mark from the beginning of measuring length (see drawing), additional reference marks separated by n x 100 mm

Accuracy of the grating pitch (stretched): ±30 µm/m

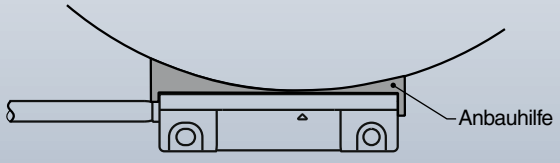
Mounting control: electronical signal test/set-up boxes PG-x resp. PS4

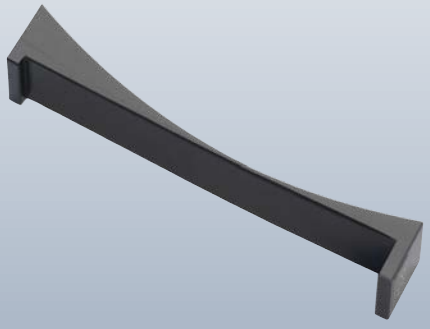
Operating temperature range: 0 °C up to +50 °C

Temperature range of storage: –20 °C up to +70 °C

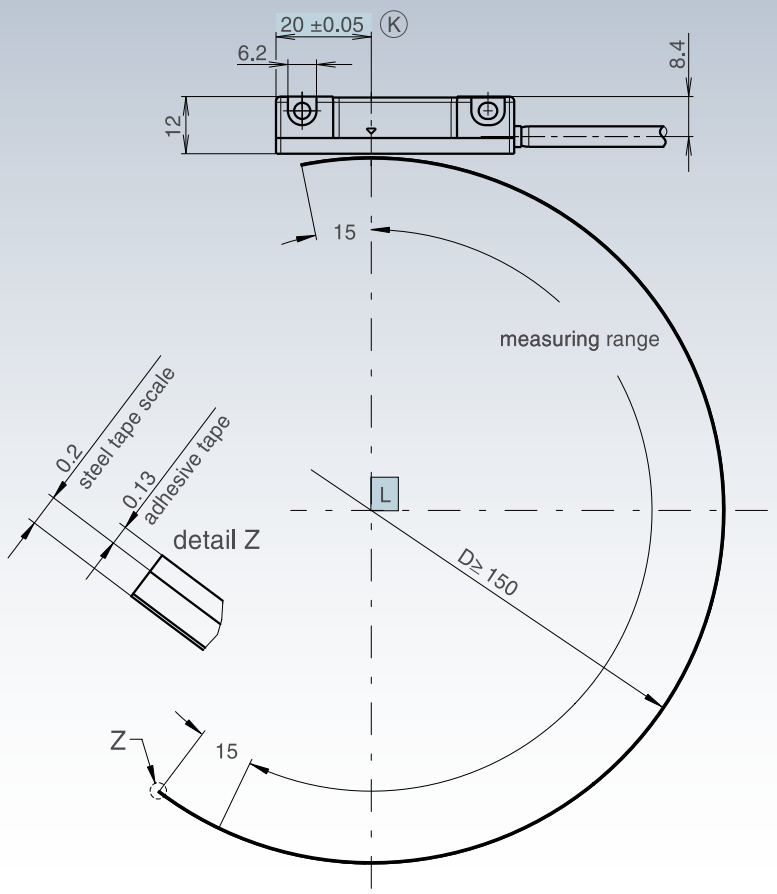
Weight depending (approx.): 17 g (scanning unit without cable), 25 g/m (steel tape scale with adhesive tape)

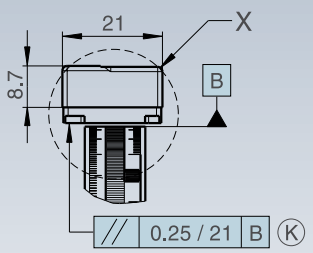
Mounting aid: optional accessory

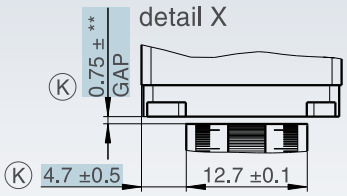




DIMENSIONS, MOUNTING TOLERANCES







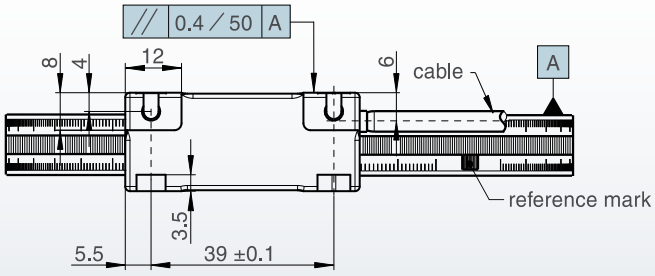
Ⓚ = required mating dimensions

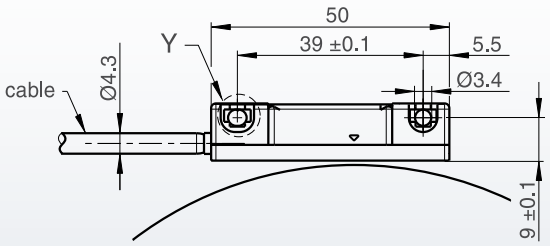
** D < Ø500 = +0.2 mm / -0.1 mm
** D ≥ Ø500 = +0.4 mm / -0.2 mm

L = bearing

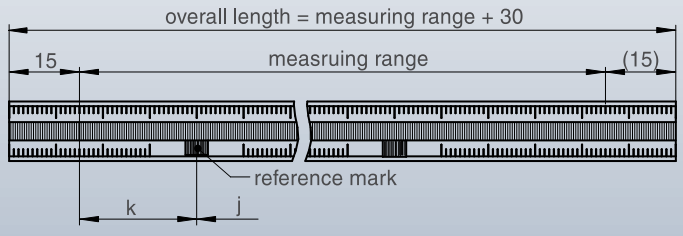
D = shaft diameter

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

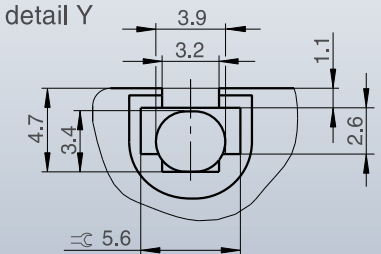




representation strechted



detail Y



hexagon nut applicable
M3 ISO 4032

PG AND PS: ELECTRONIC SIGNAL TEST/SET-UP BOXES

Exposed Linear Encoders are adjusted at the factory to provide optimal signals at the specified mounting conditions.

Even though the Linear Encoders in the MSR 20 and MSR 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-I** / **PG1-U** is an all-purpose signal test box where all the relevant signals are displayed on LCD Bars.

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

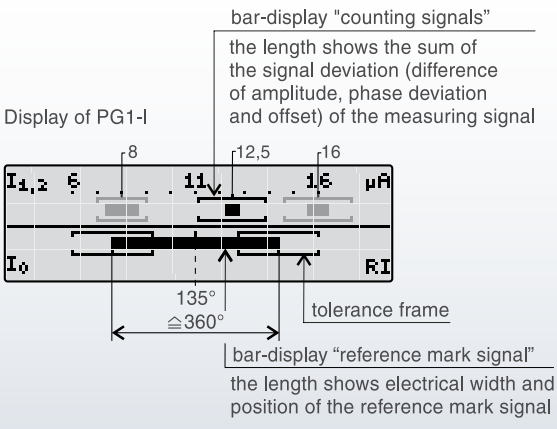
The **PG2-I** / **PG-U**, **PG4** and **PS4** test box checks all relevant signals; amplitude, phase and offset, and displays the results in a qualitative format on a polychromatic LED display.

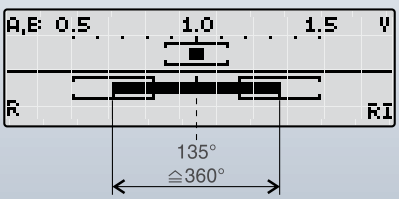
PG-U und **PG4** = stand alone test
PS4 = in-circuit test

PG1-I, PG1-U

PG2-I, PG-U, PG4

PS4





Intended PG/PS-use	MSR 20 Output ⎍	MSR 20 Output ∿ 1 Vpp	MSR 40 Output ⎍	MSR 40 Output ∿ 1 Vpp
PG1-I	■	--	--	--
PG1-U	--	■	--	■
PG2-I	■	--	--	--
PG-U	--	■	--	■
PG4	--	--	■	--
PS4	--	--	■	--

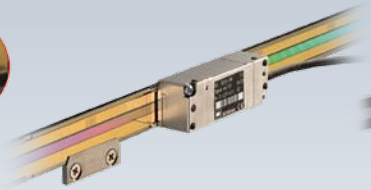
■ intended
-- not intended

PRODUCT DIRECTORY

MS 2x Series

Reflective scanning Linear Encoder with integrated mounting control (only MS 25, MS 26)

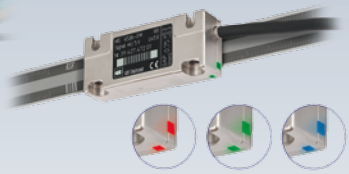
- Easy mounting; no test box or oscilloscope needed
- Quality of the scanning signals is directly visible at the reading head via a 3-coloured LED
- Two independent switch signals for individual special functions
- Position of reference mark selectable
- High insensitivity against contamination
- High traversing speed
- Integrated subdividing: up to times 100 interpolation
- Max. measuring length
  Glass scale: 3140 mm
  Steel tape scale: 20 000 mm



MS 30, MS 31 Series

Reflective scanning Linear Encoder

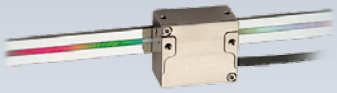
- Two independent switch signals for individual special functions
- Position of reference mark selectable
- Small dimensions
- Easy mounting as a result of large mounting tolerances
- High traversing speed
- High insensitivity against contamination
- Integrated subdividing: up to times 100 interpolation
- Max. measuring length
  Glass scale: 3140 mm
  Steel tape scale: 11 940 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
- Small dimensions
- Easy mounting as a result of large mounting tolerances
- High insensitivity against contamination
- High traversing speed
- Integrated subdividing: up to times 100 interpolation
- Max. measuring length
  Steel tape scale: 30 000 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 cramic scale with phasse grating
- Max. measuring length
  Glass scale: 3140 mm
  Glass ceramic: 1540 mm

MS 14 Series

Reflective scanning Linear Encoder with integrated mounting

- Easy mounting; no test box or oscilloscope needed
- Quality of the scanning signals is directly visible at the reading head via a 3-coloured LED
- Extremely small dimensions
- Easy mounting as a result of large mounting tolerances
- High insensitivity against contamination
- High traversing speed
- Integrated subdividing: up to times 100 interpolation
- Max. measuring length
  Steel tape scale: 20 000 mm

DG 118, DG 120

Rotary Encoder for universal application

- Standard line/rev.: graduated from 100 to 5400

Precision Graduations

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

Cable systems

- Individual cable design
- Hybrid cable
- Trailing cable
- System solutions
- Function control

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