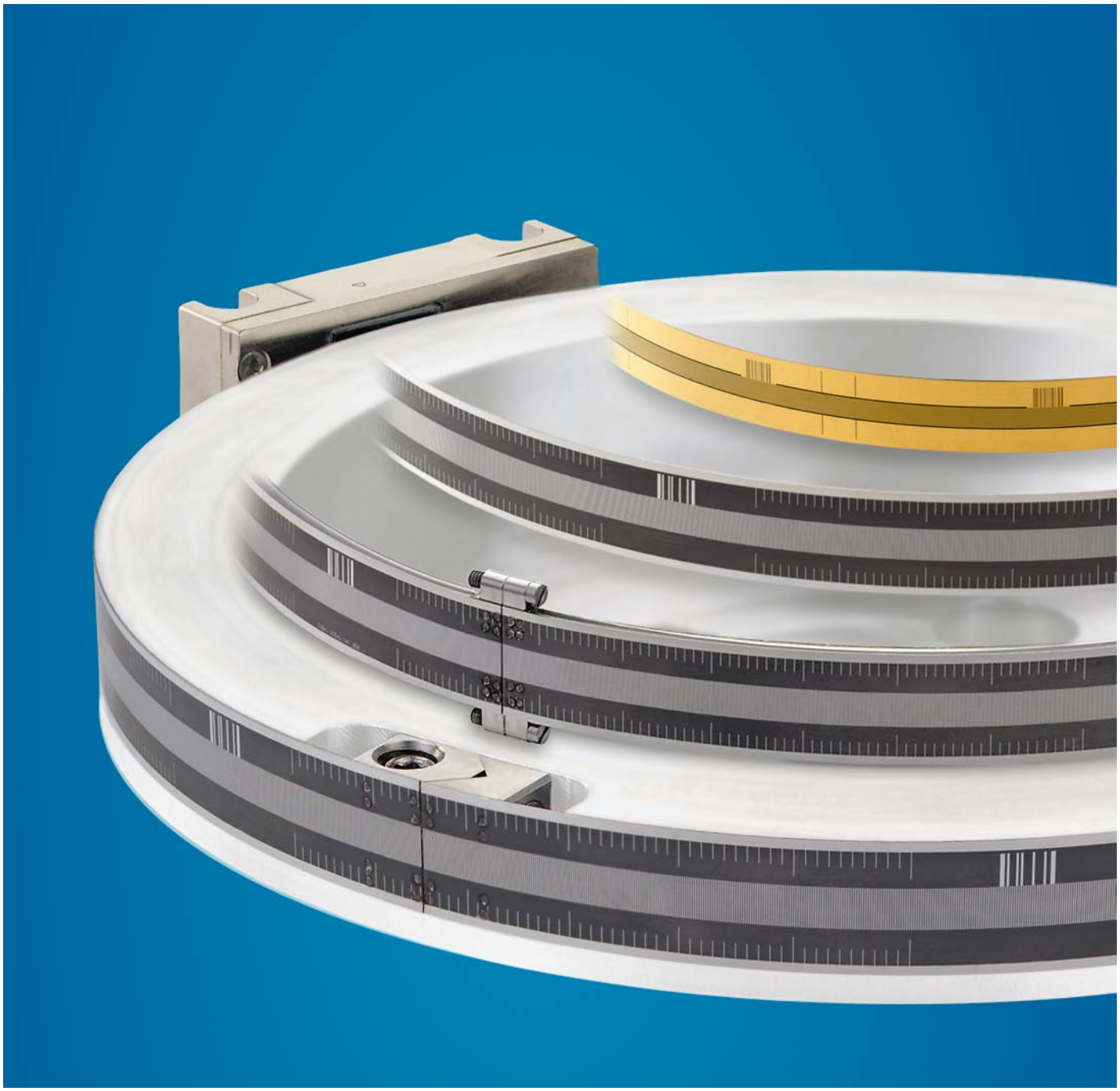
RSF Elektronik

RELIABLE. SOPHISTICATED. FLEXIBLE.

MSR 20, MSR 40

Modular Rotary 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.

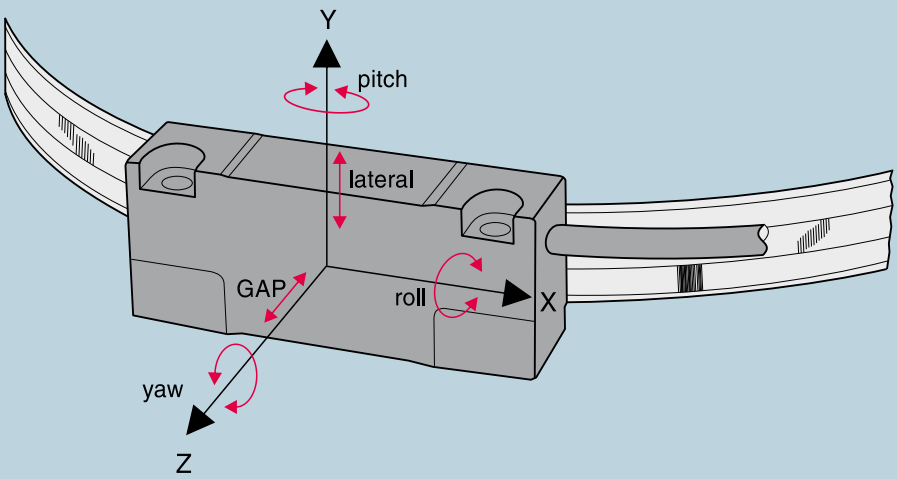
Error Signal
This signal appears when a malfunctioning encoder generates faulty scanning signals.

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

Line Rates
Number of the grating pitches per rotation.

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

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 modular Rotary Encoder

- small dimensions
- high contamination resistance
- high resolution
- high circumferential speed
- large mounting tolerances

The new MSR meets all these requirements!

The trend today in motion control applications is for open Encoder Systems.
This is driven by steadily increasing demands for
- Higher circumferential speed
- Higher operating cycles
- 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 MSR encoder´s unique optical design minimizes the effect of dirt and contamination normally associated with the Open 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. Squarewave signals, single ended, or via Line Driver RS 422, are provided at the output of the encoder head.

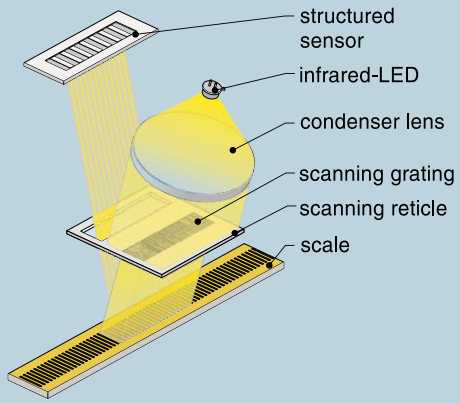
Units with sinusoidal outputs 1Vpp are also available.

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

Scanning principle

The model MSR x0 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 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.

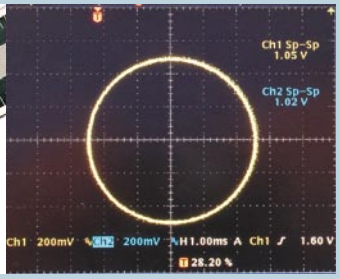
Scanning principle



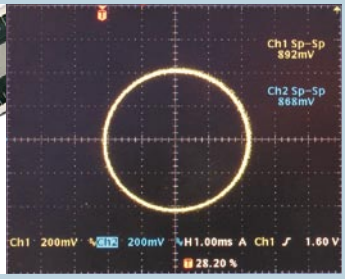
Effect of contamination on the quality and size of the scanning signal (before interpolation)

Clean steel tape scale - optimal condition

ex.g.: MSR 40



Contaminated steel tape scale unfavorable condition



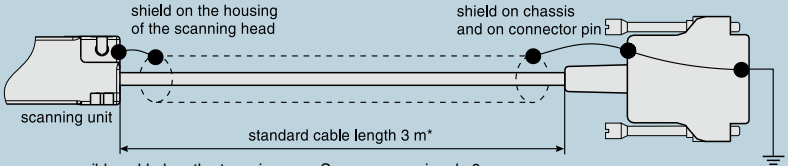
High insensitivity to contamination by use of a new scanning principle.

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



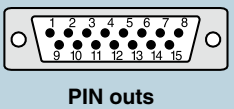
max. possible cable length at version: - Square wave signals 6 m
- Sinusoidal voltage signals 12 m

Connector LD15 15-pin

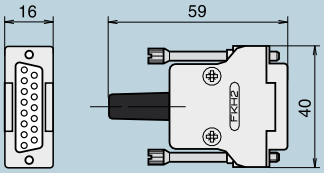
PIN	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Square wave signals via Line Driver	nc	GND	$\overline{Us}$	$\overline{RI}$	$\overline{T2}$	$\overline{T1}$	+5 V	+5 V	GND	nc	nc	RI	T2	T1	Shield

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 rotation 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 rotation 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

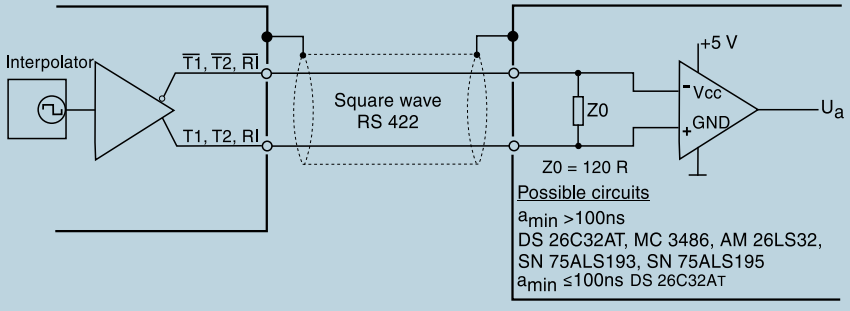
To prevent counting errors, the controls/DRO´s must be able to process the resulting edge separation.

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

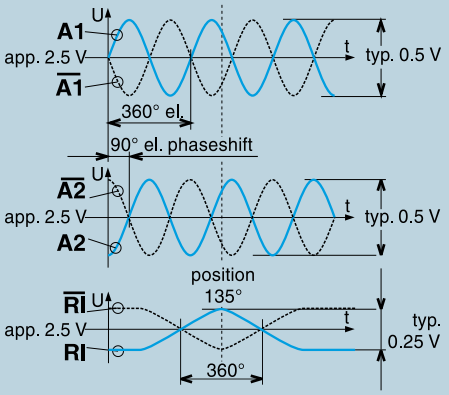
Power supply: +5 V ±5%, max. 165 mA (unloaded)

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

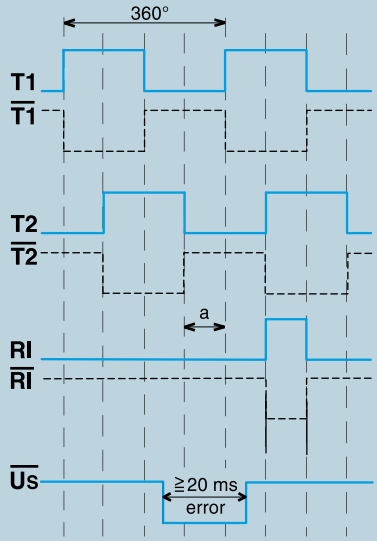
Recommended Line Receiver circuit



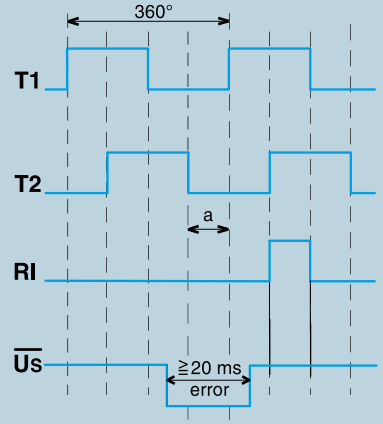
Voltage signals



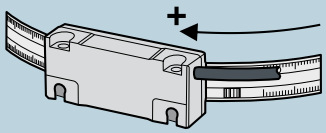
Square wave signals „differential“



Square wave signals „single ended“



Rotation direction



MSR 20 MKS

Technical data

Special highlights:

- **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**

Scale model	Grating pitch	integrated interpolation	max. circumferential speed	max. output frequency resp. edge separation a_{min}
• Sinusoidal voltage signals				
MSR 20.04	40 µm	-	10 m/s	250 kHz
• Square wave signals via Line Driver with integrated subdividing				
MSR 20.64	40 µm	times 5	6,4 m/s	300 ns
MSR 20.74	40 µm	times 10	3,2 m/s	300 ns
MSR 20.44	40 µm	times 20	2.4 m/s	200 ns
MSR 20.54	40 µm	times 25	1.9 m/s	200 ns
MSR 20.84	40 µm	times 50	1.9 m/s	100 ns
MSR 20.94	40 µm	times 100	0.96 m/s	100 ns

Scale unit: MKS = steel tape scale with adhesive tape

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

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

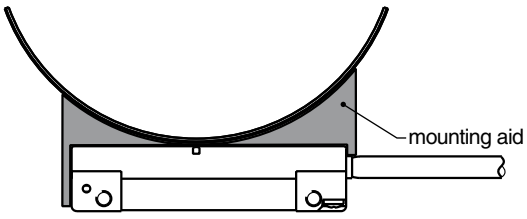
Accuracy of the grating pitch (stretched): ±15 µm/m

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

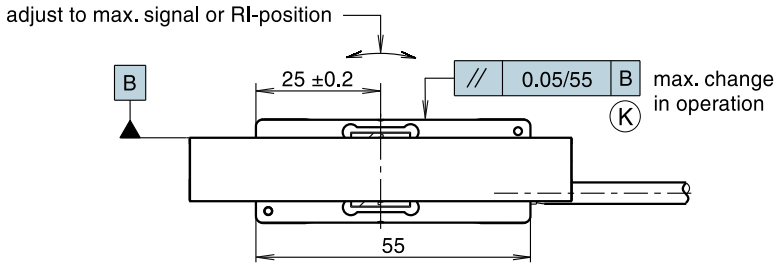
Operating temperature range: 0°C up to +50°C (coefficient of expansion of the shaft between 9 x 10^{-6} K^{-1} and 12 x 10^{-6} K^{-1})
Temperature range of storage: -20°C up to +70°C

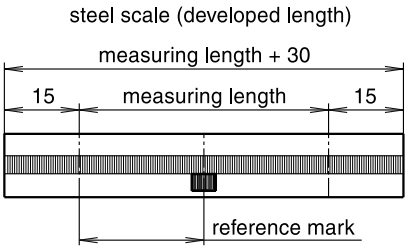
Weight depending (approx.): 30 g (scanning unit without cable), 20 g/m (steel tape scale)

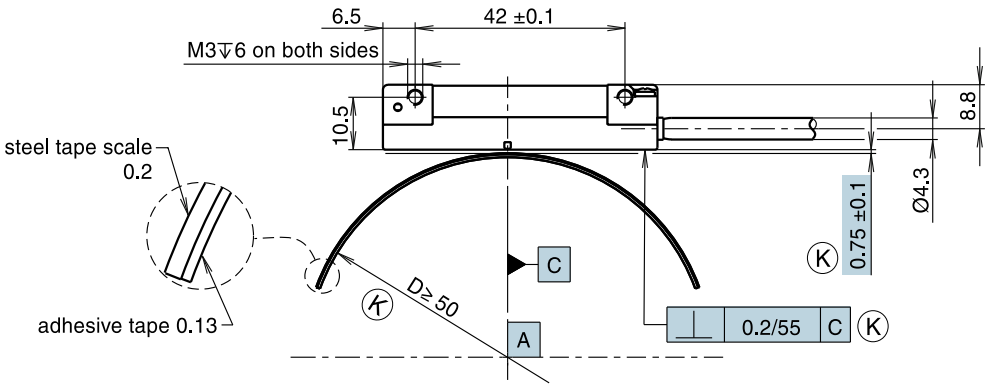
Mounting aid: optional accessory

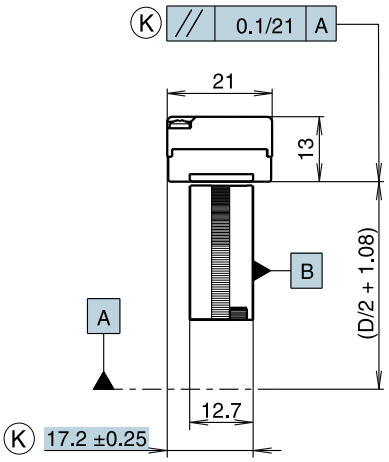


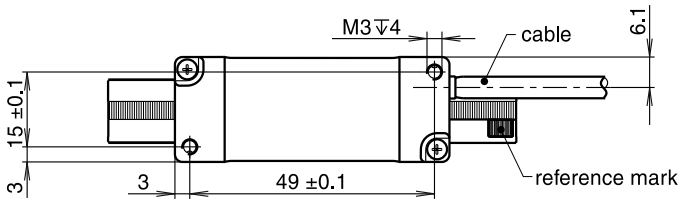
Dimensions, mounting tolerances, mounting possibilities



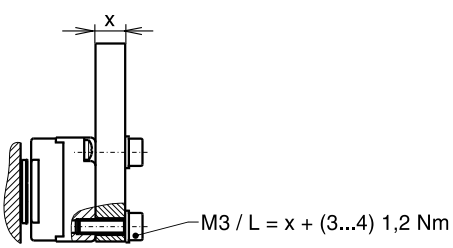


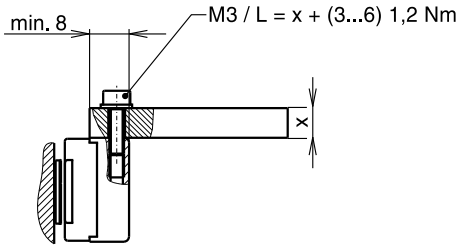


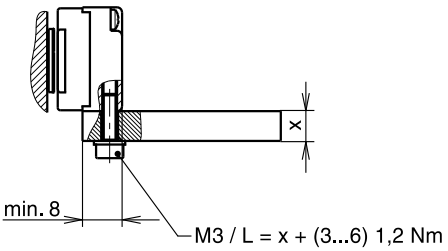




Ⓚ = required mating dimensions
D = shaft diameter
reference mark (RI):
any position, additional reference marks
separated by n x 50 mm







MSR 40 MOR

Technical data

Special highlights:

- **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**

Scale model			MSR 40.06	MSR 40.66	MSR 40.76	MSR 40.86	MSR 40.96
System resolution [°]			dep. on external interpolation	360° / Lines x 20	360° / Lines x 40	360° / Lines x 200	360° / Lines x 400
System resolution [µm]			dep. 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. rot. speed [min^{-1}]**	**max. rot. speed [min^{-1}]**	**max. rot. speed [min^{-1}]**	**max. rot. speed [min^{-1}]**	**max. rot. 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	91719	±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

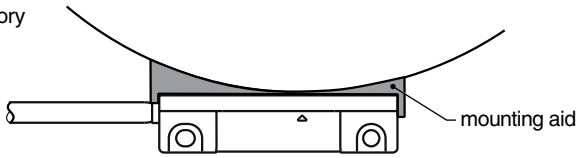
Accuracy of the grating pitch (stretched): ±30 µm/m

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 x 10^{-6} K^{-1} and 12 x 10^{-6} K^{-1})
Temperature range of storage: -20°C up to +70°C

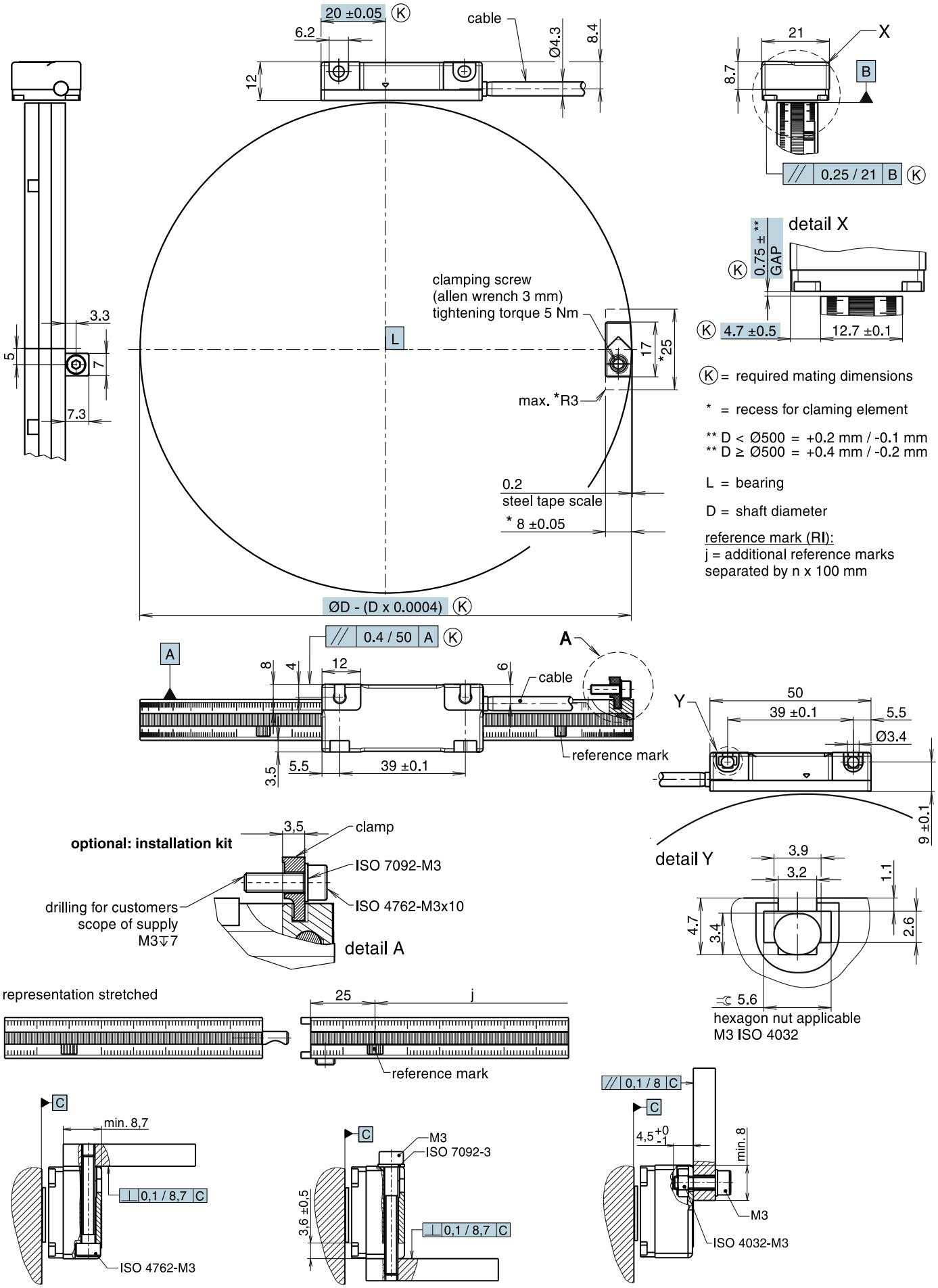
Weigth depending (approx.): 17 g (scanning unit without cable), 20 g/m (steel tape scale), 12 g (clamping element)

Mounting aid: optional accessory



installation kit: optional accessory

Dimensions, mounting tolerances, mounting possibilities



MSR 40 MER

Technical data

Special highlights:

- **Full-cirlce version with clamping element**
- **Steel tape scale with elastic layer compensates Ø-change of the shaft ($\Delta D_{max.}$ ±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**

Scale model			MSR 40.06	MSR 40.66	MSR 40.76	MSR 40.86	MSR 40.96
System resolution [°]			dep. on external interpolation	360° / Lines x 20	360° / Lines x 40	360° / Lines x 200	360° / Lines x 400
System resolution [µm]			dep. on external interpolation	10	5	1	0.5
Signal form			1 Vss	⎍	⎍	⎍	⎍
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. rot. speed [min^{-1}]**	**max. rot. speed [min^{-1}]**	**max. rot. speed [min^{-1}]**	**max. rot. speed [min^{-1}]**	**max. rot. 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

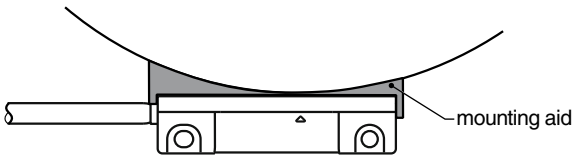
Accuracy of the grating pitch (stretched): ±30 µm/m

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

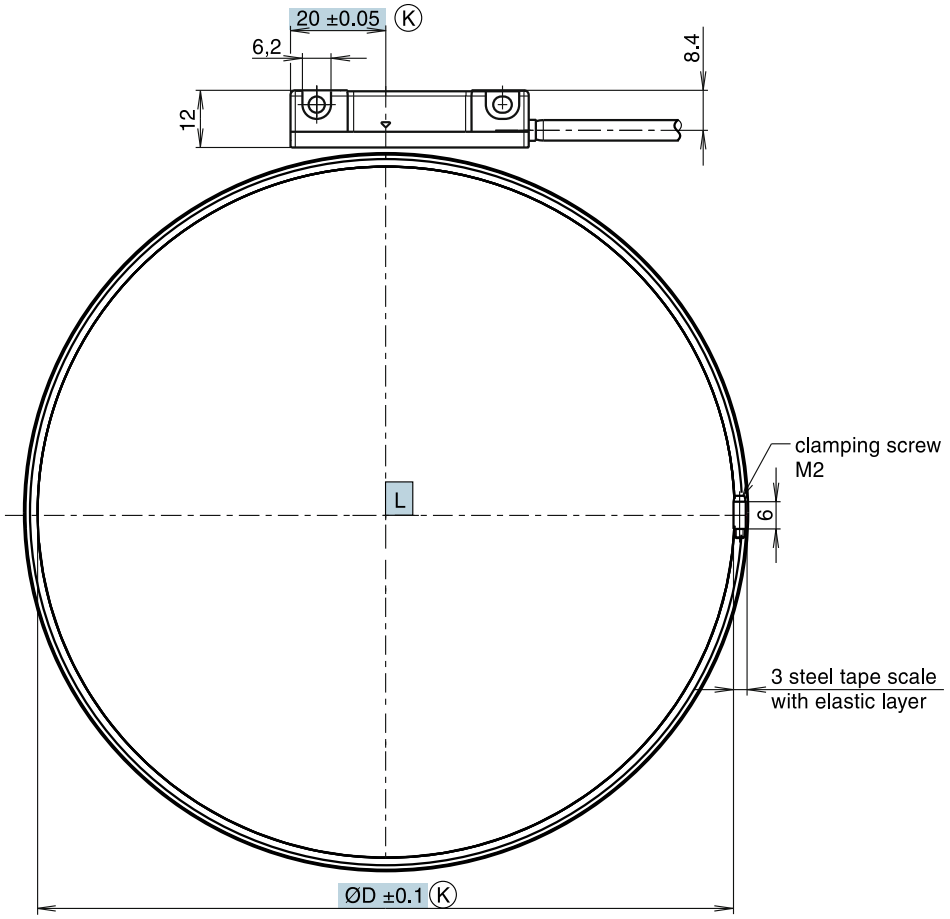
Operating temperature range scanning unit: 0 °C bis +50 °C
Operating temperature range scale unit: range of temperature is dependent on the coefficient of the expansion of the shaft.
Max. Ø difference of the shaft to steel tape scale ΔD ±0.2 mm (steel tape scale α = 10.5 x 10^{-6} K^{-1}).
Temperature range og storage: -20 °C up to +70 °C

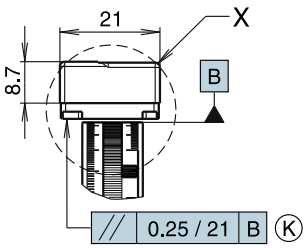
Weight depending (approx.): 17 g (scanning unit without cable), 45 g/m (steel tape scale with elastic layer), 2.5 g (clamping element)

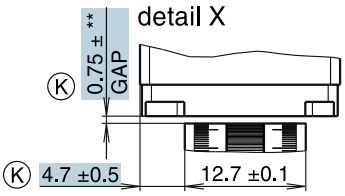
Mounting aid: optional accessory



Dimensions, mounting tolerances, mounting possibilities







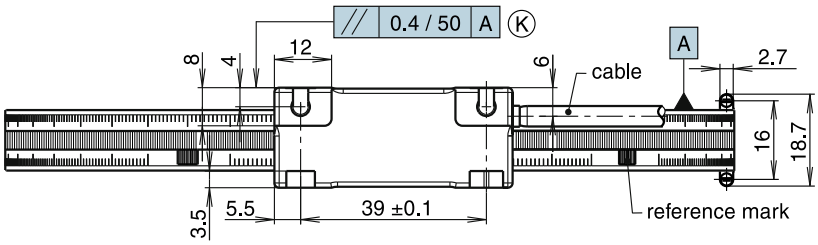
Ⓚ = required mating dimensions

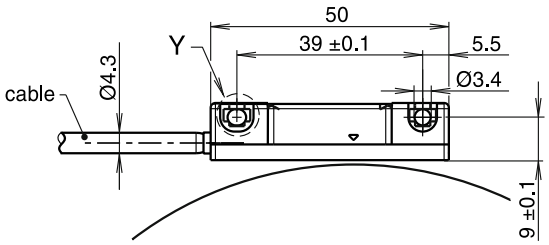
** D < Ø500 = +0.2 mm / -0.1 mm
** D ≥ Ø500 = +0.4 mm / -0.2 mm

L = bearing

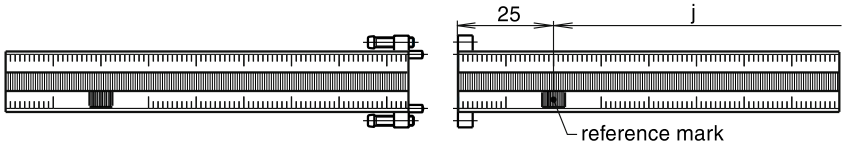
D = shaft diameter

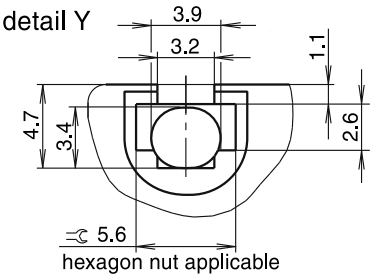
reference mark:
j = additional reference marks
separated by n x 100 mm

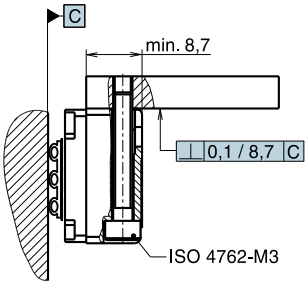


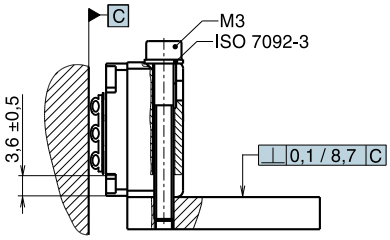


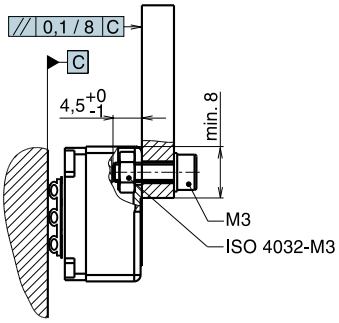
representation stretched











MSR 40 MKS

Technical data

Special highlights:

- **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**

Scale model	Grating pitch	Integrated interpolation	Max. circumferential speed	Max. output frequency resp. edge separation a_{min}
• Sinusoidal voltage signals				
MSR 40.06	200 µm	-	15 m/s	75 kHz
• Square wave signals via Line Driver with Subdividing				
MSR 40.66	200 µm	times 5	15 m/s	500 ns
MSR 40.76	200 µm	times 10	9.6 m/s	500 ns
MSR 40.86	200 µm	times 50	4.8 m/s	200 ns
MSR 40.96	200 µm	times 100	2.4 m/s	200 ns

Scale unit: MKS = steel tape scale with adhesive tape

Possible shaft diameters: Ø ≦ 150 - 400 mm, scale-segment pre-bended in factory
over 400 mm, scale-segment is not pre-bended

Reference mark (RI): 25 mm from the beginning of measuring range (see drawing), additional reference marks separated by n x 100 mm

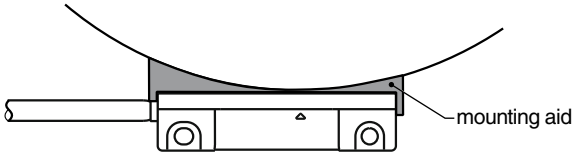
Accuracy of the grating pitch (stretched): ±30 µm/m

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

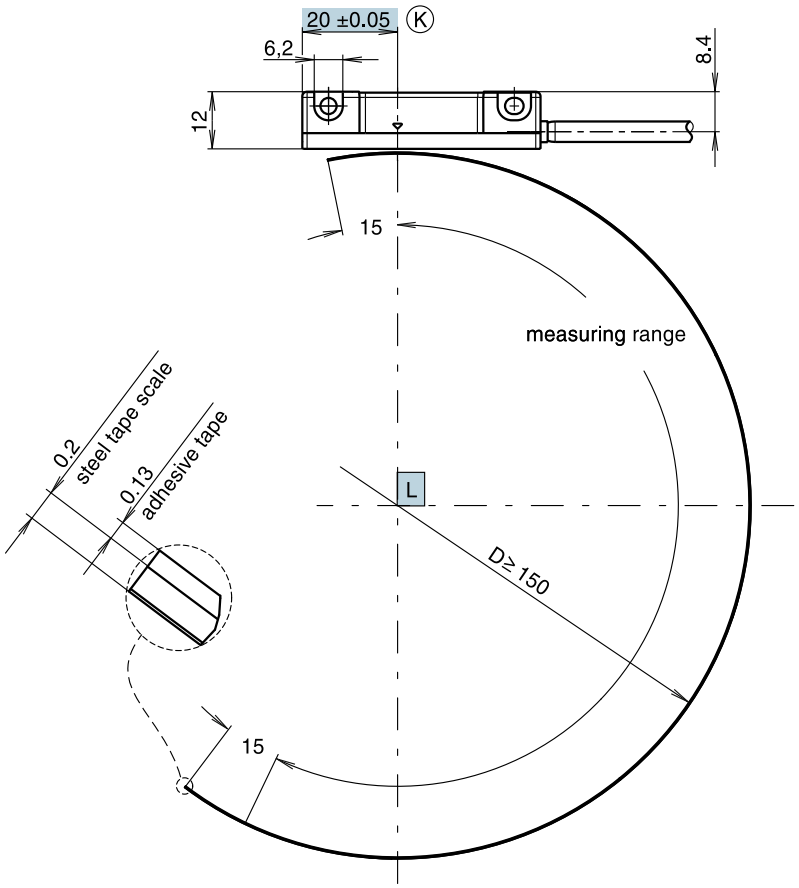
Operating temperature range: 0 °C up to +50 °C
Temperature range of storage: -20 °C up to +70 °C

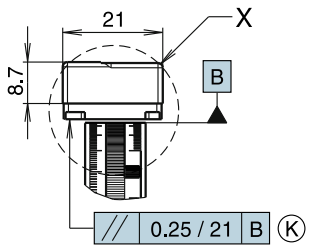
Weight depending (approx.): 17 g (scanning unit without cable), 25 g/m (steel tape scale with adhesive tape)

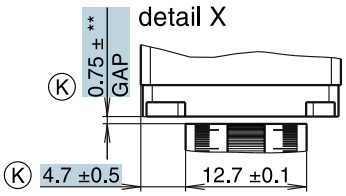
Mounting aid: optional accessory



Dimensions, mounting tolerances, mounting possibilities







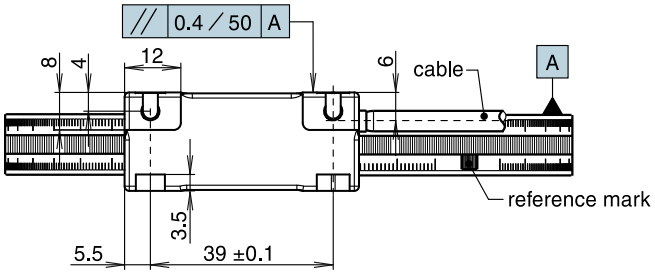
Ⓚ = required mating dimensions

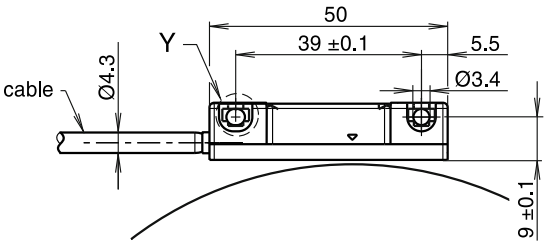
** D < Ø500 = +0.2 mm / -0.1 mm
** D ≥ Ø500 = +0.4 mm / -0.2 mm

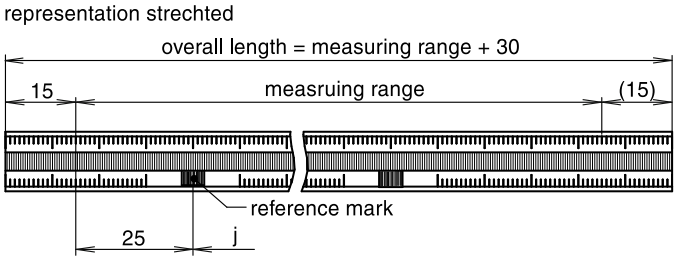
L = bearing

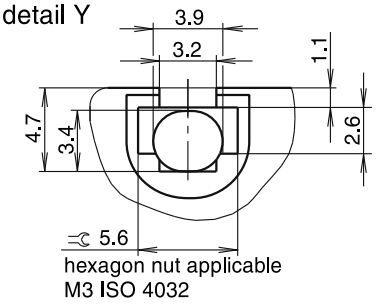
D = shaft diameter

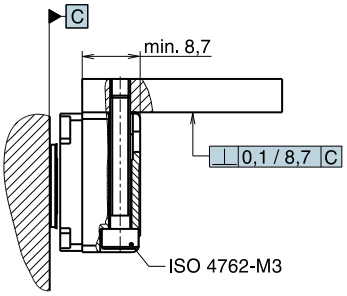
reference mark:
j = additional reference marks
separated by n x 100 mm

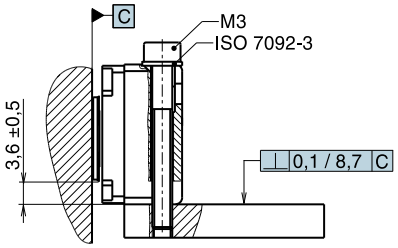


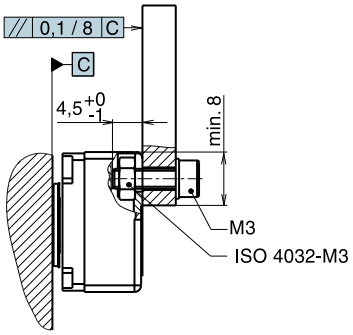












PG electronic signal test/set-up boxes for MSR 20

Open 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 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.

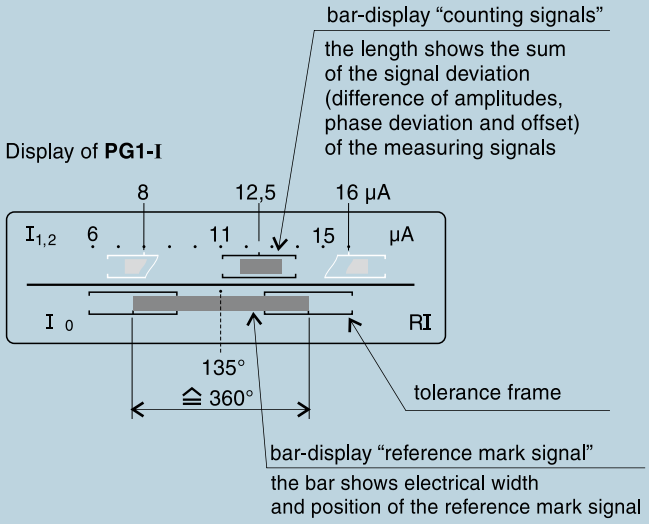
The **PG1-I / PG1-U** is an all-purpose signal test box where all the relevant signals are displayed on LCD Bars.
The **PG1-I / PG1-U** allows the quantitative as well as the qualitative evaluation of the encoder signals.

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

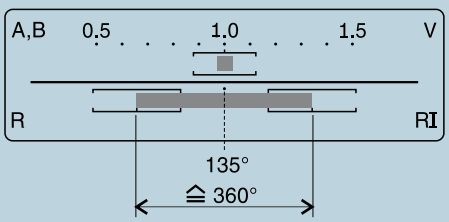
PG1-I / PG1-U

PG2

Display of **PG1-I**



Display of **PG1-U**



Intended PG-use		MSR 20, Output signals square wave	sinus (1 Vpp)
PG1-I		✓	--
PG1-U		--	✓
PG2-I		✓	--
PG-U		--	✓

PG, PS electronic signal test/set-up boxes for MSR 40

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 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-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.

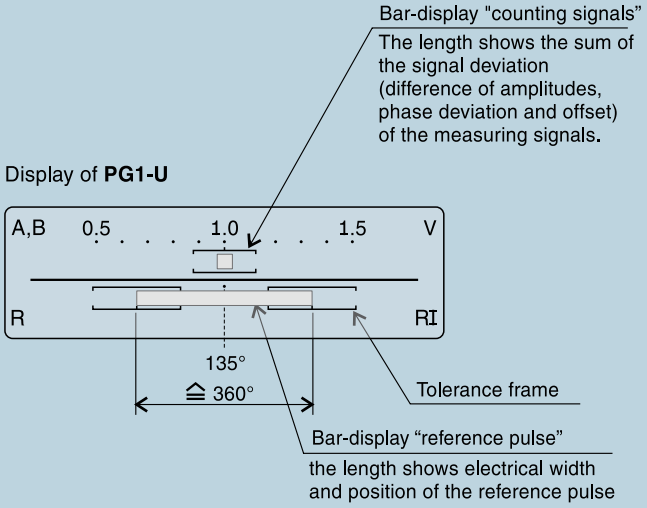
The **PG-U, PG4** and **PS4** test box checks all relevant signals; amplitude, phase and offset, and displays the results in a **qualitative** format on a polychromatic LED display.
PG-U and **PG4 =** stand alone test
PS4 = in-circuit test

PG1-U

PG-U, PG4

PS4

Display of **PG1-U**



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

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