RSF Elektronik

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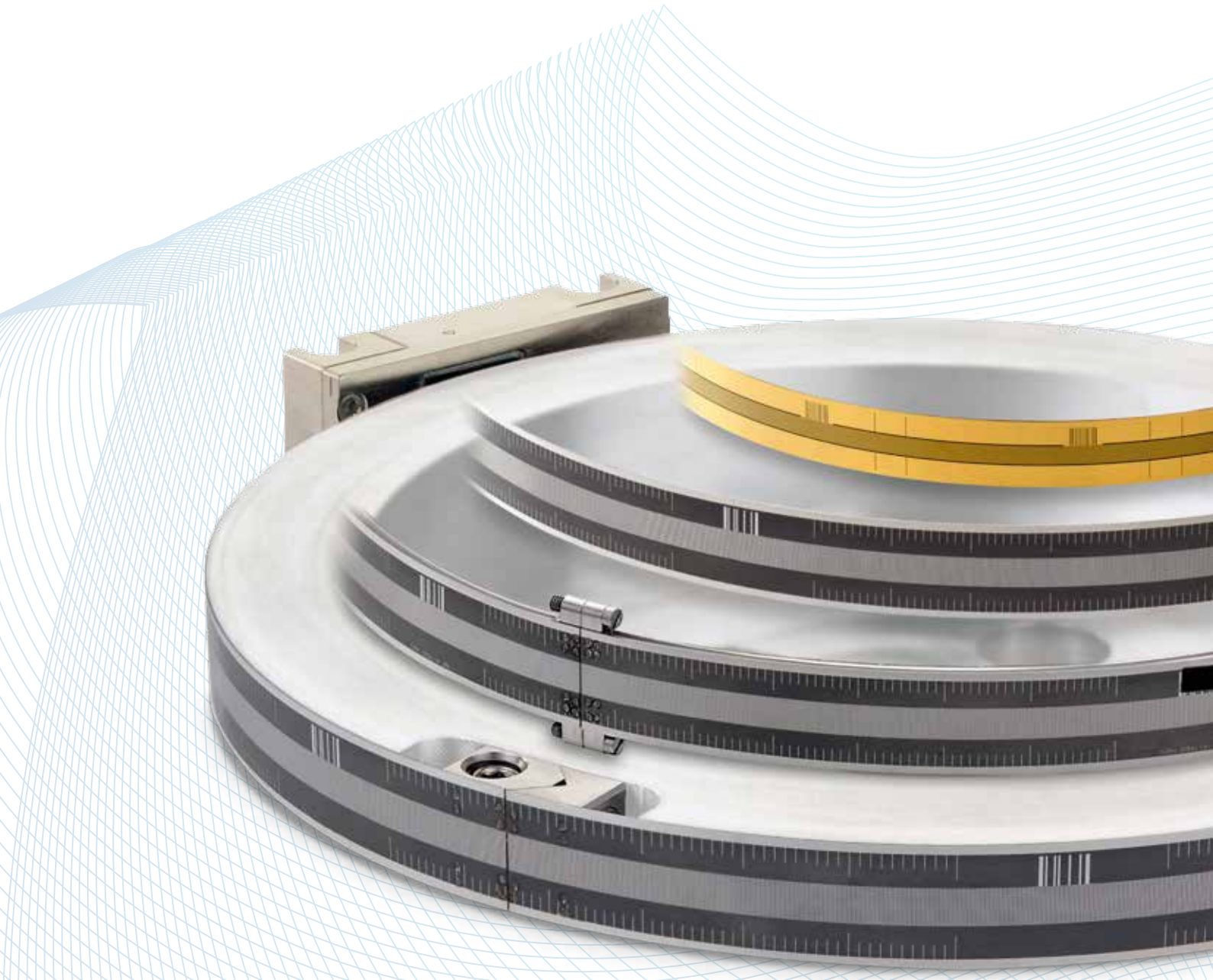
MSR 20, MSR 40

MODULAR ANGLE MEASUREMENT DEVICES WITH SINGLEFIELD SCANNING



CONTENT

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 an user to find an absolute position along the length of the scale. An 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.

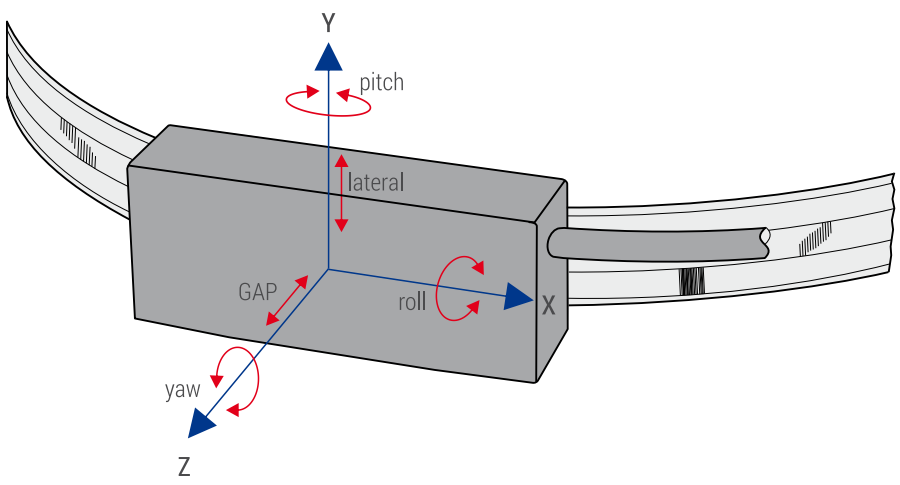
Error signal ($\overline{US}$)
This signal appears when a malfunctioning encoder generates faulty scanning signals.

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, air gap (GAP)
Mounting tolerances of the encoder head relative to the scale.



REQUIREMENTS ON A MODULAR ANGLE MEASUREMENT DEVICE

The trend today in motion control applications is for exposed encoder devices.
This is driven by steadily increasing demands for

- CONTAMINATION RESISTANCE
- IMMUNITY AGAINST AGING AND TEMPERATURE CHANGES
- HIGH TRAVERSING SPEED
- EASY MOUNTING
- SMALL DIMENSIONS
- NO MECHANICAL BACKLASH
- ZERO FRICTIONAL FORCE

MODULAR ANGLE MEASUREMENT DEVICES FROM RSF ELEKTRONIK MEET ALL THESE REQUIREMENTS!

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

The MSR utilizes an 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.

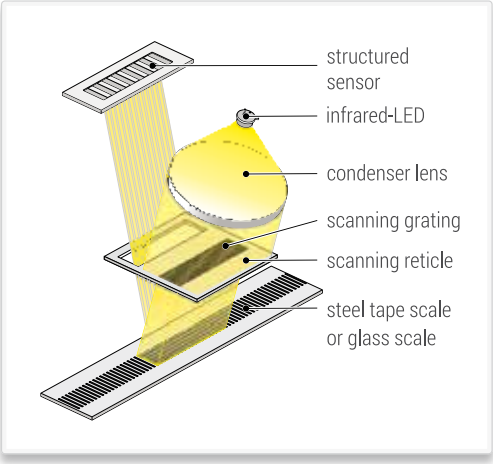
SCANNING PRINCIPLE

The MSR 20 resp. MSR 40 modular angle measurement device work 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.

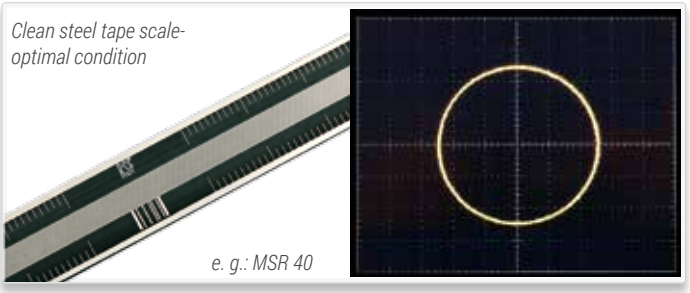
The regulated light of an infrared LED is collimated by a condenser lens, passes through the grid of the reticle and the scale and generates a periodic intensity distribution on the structured sensor.

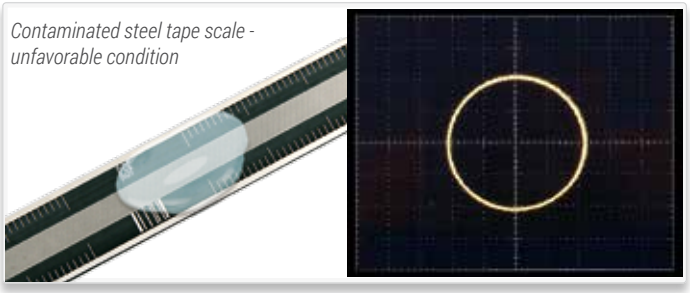
The sensor generates sinusoidal signals of the highest quality that prove to be highly insensitive to possible contaminations, which can never be entirely ruled out despite all technical precautions.

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.



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

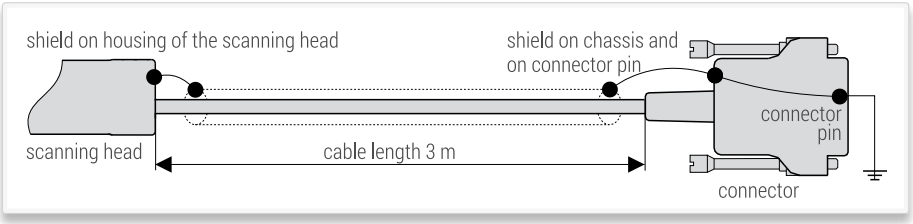




High insensitivity to contamination by use of a new scanning principle.

SHIELDING, PIN ASSIGNMENT

Shielding 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
Cables for use in vacuum applications to 10^{-7} torr are also available upon request.

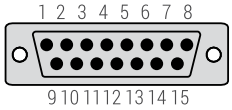


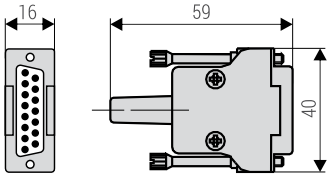
15-pin D-sub (LD15, male, 15-pin)

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

- * Test = **analog signal switch-over for setup** (only MSR 20).
  By applying +5 V to the test pin, the test signals (sinusoidal micro-current signals 11 µApp) are switched to the output connector.
- Sensor: the sensor pins are bridged in the chassis with the particular power supply.
- The shield is additional connected with the chassis.
- Not connected pins or wires (nc) must not be used.

Pin assignment
(view on pins)





weight: 28 g

OUTPUT SIGNALS

SINUSOIDAL VOLTAGE SIGNALS 1 VPP

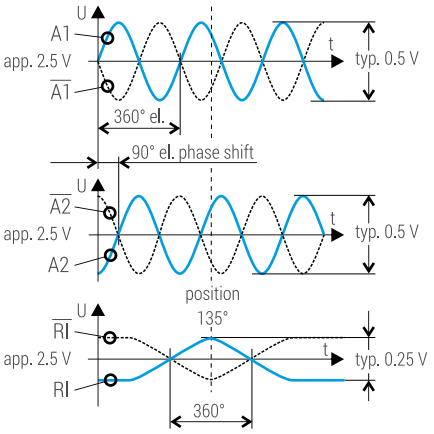
(drawing shows "positive counting direction")
Two sinusoidal voltage signals A1 and A2 and one reference mark signal (all with inverted signals).

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 pulse
(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 $\overline{RI}$)

Advantages:
- High traversing speed with long cable lengths possible

Voltage signals (1 Vss)



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 amin 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/m
Line receiver:	max. 10 ns (referred to the recommended line receiver circuit)

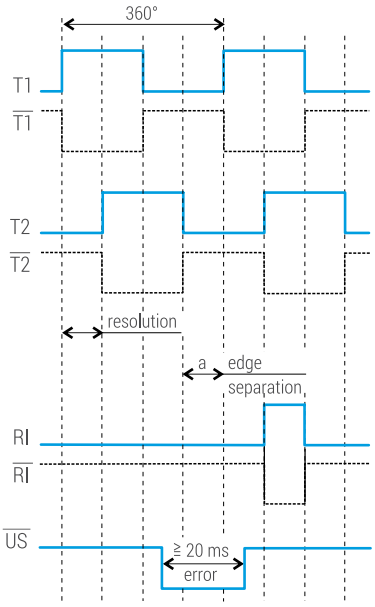
To prevent counting errors, the controls/DRO's must be able to process the resulting edge separation.

Example:
a_{min} = 100 ns, 10 m cable
100 ns - 10 ns - 10 x 0,2 ns - 10 ns = 78 ns.

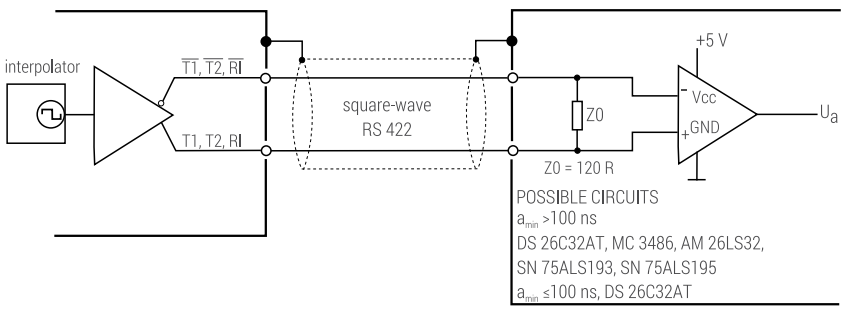
Power supply: +5 V ±5 %, max. 165 mA (unloaded)

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

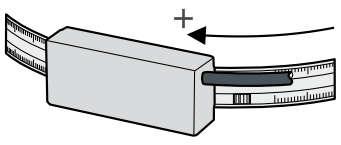
Square-wave signals „differential"



Recommended line receiver circuit

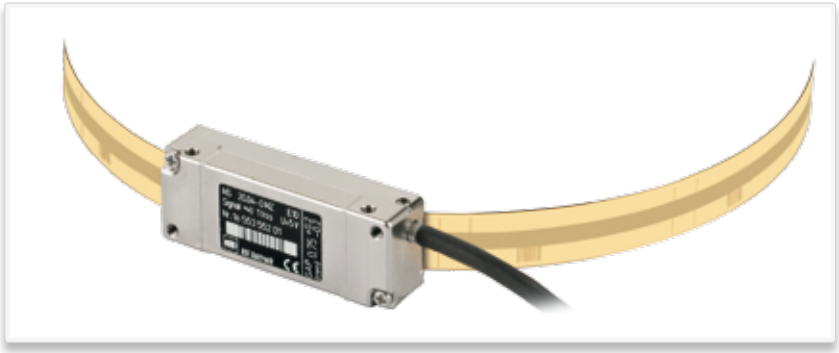


Rotation direction



MSR 20 MKS

- 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



SCANNING HEAD: 40 µm grating pitch

Model	Output signals	Integrated interpolation	Max. circumferential speed [m/s]	Max. output frequency [kHz]
MSR 20.04	~ 1 Vpp	--	10.0	250
				Edge separation a_{min}
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

GRADUATION CARRIER

Scale unit: MKS = steel tape scale with adhesive tape.

Possible shaft diameters: Ø ≥50 to Ø 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.

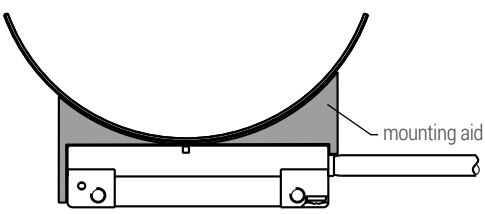
Accuracy of the grating pitch (stretched): ±15 µm/m.

Mounting control: with electronic signal test/set-up boxes PG-x.

Operating temperature range: 0 °C up to +60 °C (coefficient of expansion of the shaft between 9 x 10^{-6} K^{-1} and 12 x 10^{-6} K^{-1}).

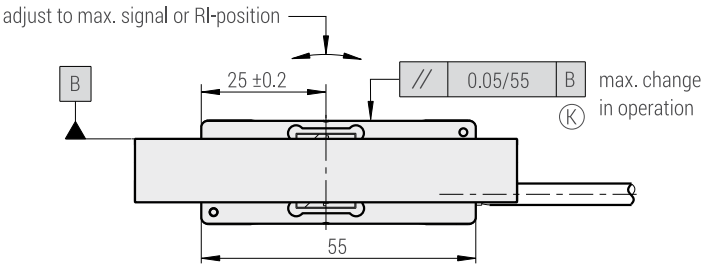
Temperature range of storage: –20 °C up to +70 °C.

Mounting aid: optional accessory.

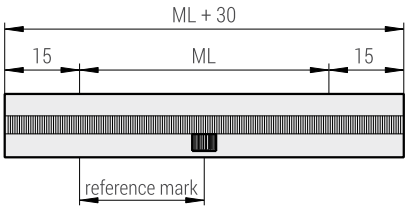


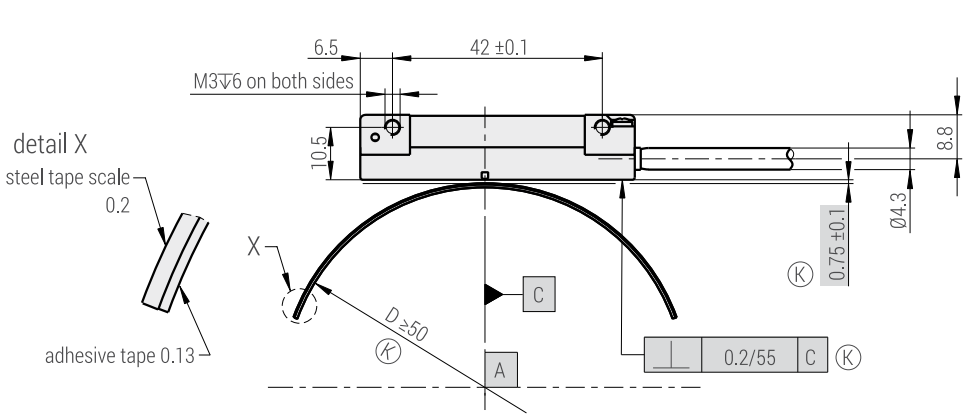
RoHS-conformity: The MSR 20 rotary encoders comply with the guideline of the RoHS-directive 2011/65/EU on the restriction of the use of certain hazardous substances in electrical and electronic equipment.

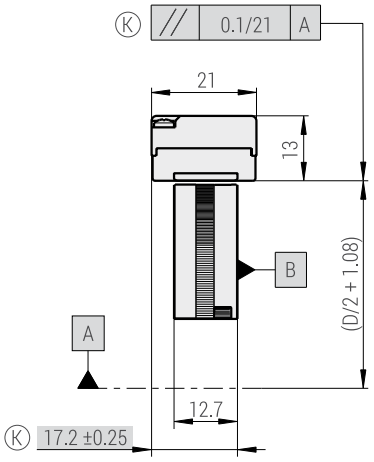
DIMENSIONS, MOUNTING TOLERANCES

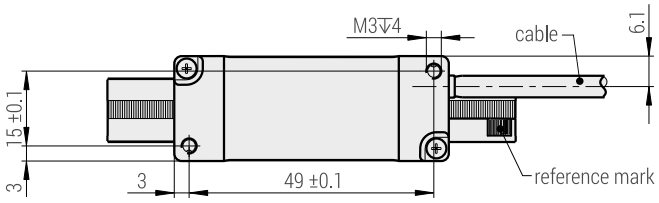


steel scale (developed length)









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

weight (approx.):
- 20 g/m steel tape scale

+ 30 g (scanning head without cable)

MSR 40 MOR

- 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

SCANNING HEAD: 200 µm grating pitch

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. rotational speed [min^{-1}]	max. rotational speed [min^{-1}]	max. rotational speed [min^{-1}]	max. rotational speed [min^{-1}]	max. rotational speed [min^{-1}]
2 400	152.70	± 80"	200	200	200	200	200
2 500	159.07	± 80"	200	200	200	200	200
3 600	229.15	± 60"	200	200	200	200	200
5 000	318.34	± 40"	200	200	200	200	144
7 200	458.50	± 30"	200	200	200	200	100
10 000	636.88	± 20"	150	150	150	144	72
10 800	687.85	± 20"	139	139	139	133	67
14 400	917.19	± 15"	104	104	104	100	50
18 000	1 146.54	± 15"	83	83	83	80	40

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

Further line rates or higher rotational speed on request.

GRADUATION CARRIER

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.

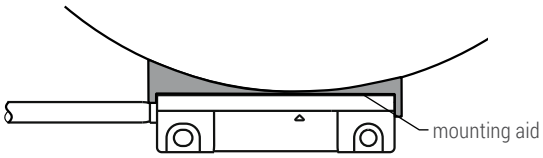
Mounting control: electronic signal test/set-up boxes PG-x resp. PS4.

Operating temperature range: 0 °C up to +60 °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.

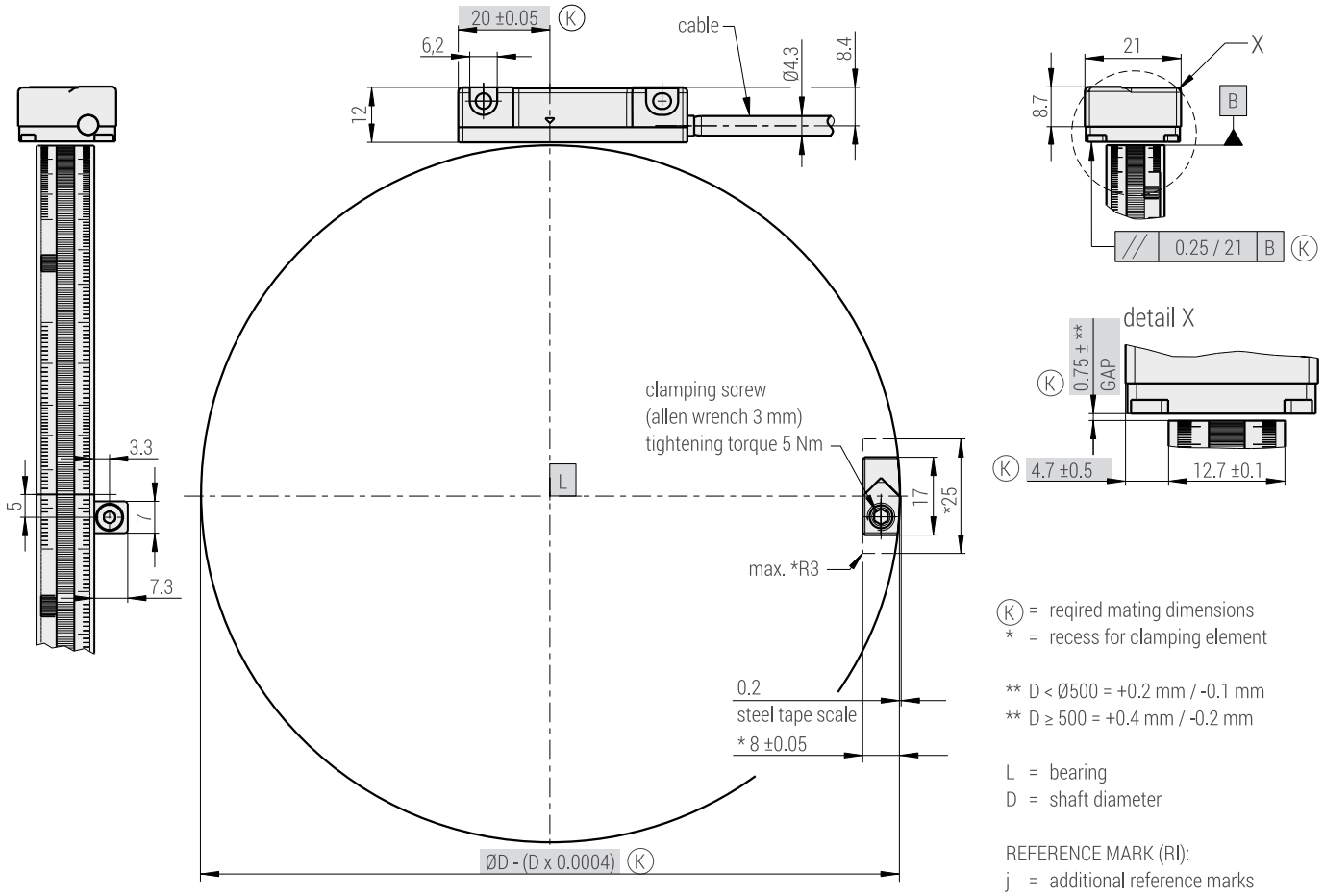
RoHS-conformity: The MSR 40 rotary encoders comply with the guideline of the RoHS-directive 2011/65/EU on the restriction of the use of certain hazardous substances in electrical and electronic equipment.

Mounting aid: optional accessory



Installation kit: optional accessory

DIMENSIONS, MOUNTING TOLERANCES



K = reqired mating dimensions
* = recess for clamping element

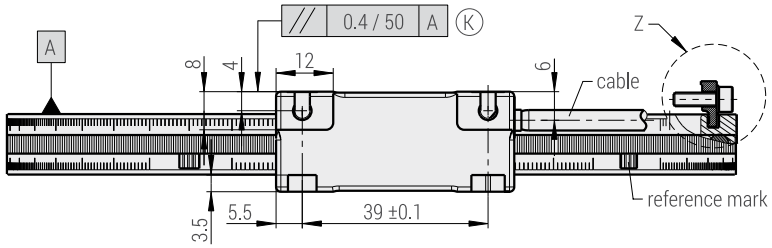
** D < Ø500 = +0.2 mm / -0.1 mm
** D ≥ 500 = +0.4 mm / -0.2 mm

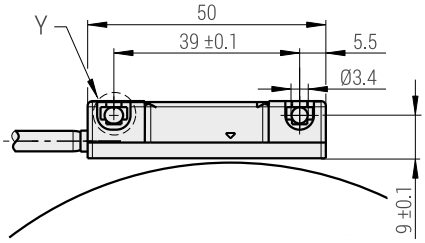
L = bearing
D = shaft diameter

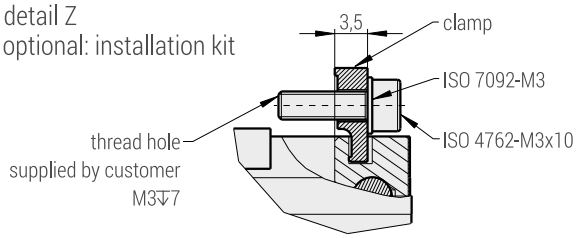
REFERENCE MARK (RI):
j = additional reference marks
separated by n x 100 mm

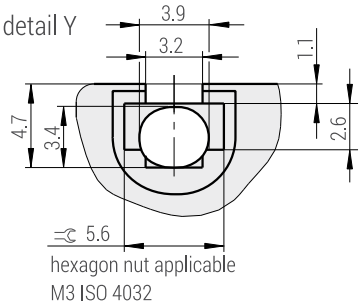
weight (approx.):
- 20 g/m steel tape scale
- 12 g clamping element

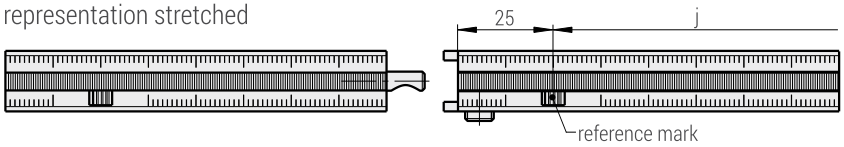
+ 17 g (scanning head without cable)











MSR 40 MER

- 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
- Hight rotational speed
- Integrated subdividing electronics: up to times 100

SCANNING HEAD: 200 µm grating pitch

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. rotational speed [min^{-1}]	max. rotational speed [min^{-1}]	max. rotational speed [min^{-1}]	max. rotational speed [min^{-1}]	max. rotational speed [min^{-1}]
2 400	146.99	± 400"	200	200	200	200	200
2 500	153.35	± 350"	200	200	200	200	200
3 600	223.38	± 250"	200	200	200	200	200
5 000	312.51	± 200"	200	200	200	200	144
7 200	452.57	± 150"	200	200	200	200	100
10 000	630.82	± 100"	150	150	150	144	72
10 800	681.75	± 100"	139	139	139	133	67
14 400	910.93	± 75"	104	104	104	100	50
18 000	1 140.12	± 50"	83	83	83	80	40
20 000	1 267.44	± 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.

GRADUATION CARRIER

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: electronic signal test/set-up boxes PG-x resp. PS4.

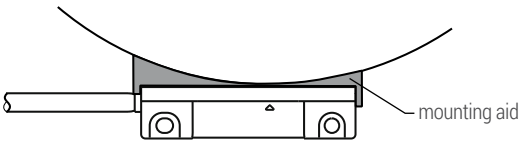
Operating temperature range scanning unit: 0 °C up to +60 °C .

Operating temperature: 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}).

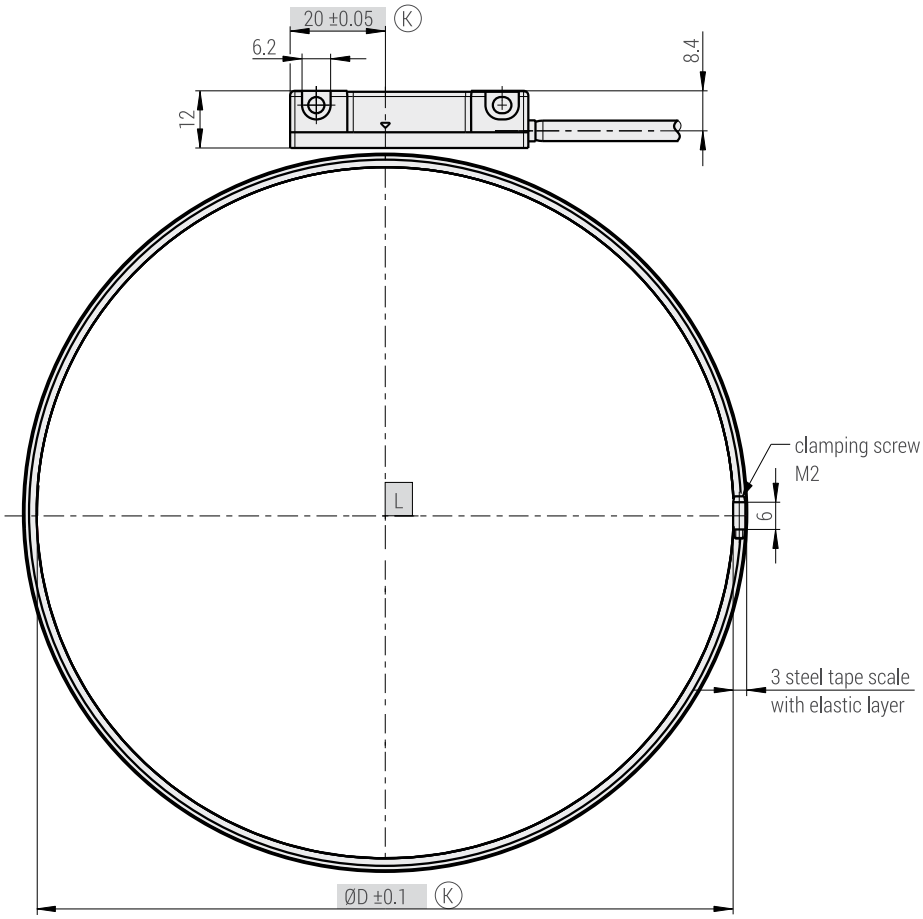
Temperature range of storage: –20 °C up to +70 °C.

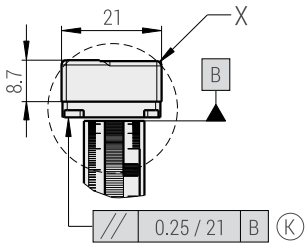
RoHS-conformity: The MSR 40 rotary encoders comply with the guideline of the RoHS-directive 2011/65/EU on the restriction of the use of certain hazardous substances in electrical and electronic equipment.

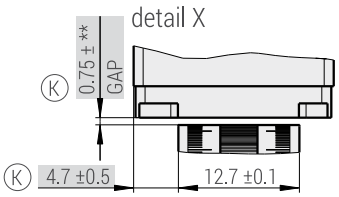
Mounting aid: optional accessory



DIMENSIONS, MOUNTING TOLERANCES







Ⓚ = reqired mating dimensions

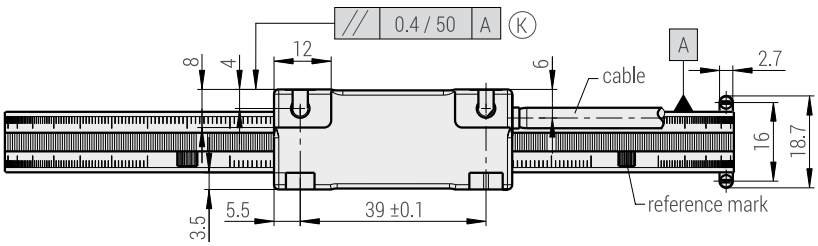
** D < Ø500 = +0.2 mm / -0.1 mm
** D ≥ 500 = +0.4 mm / -0.2 mm

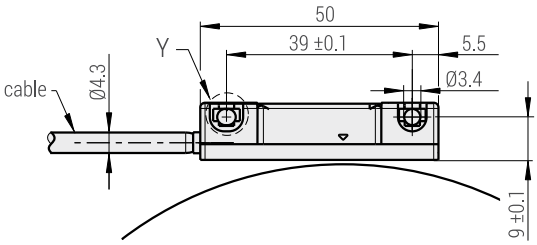
L = bearing
D = shaft diameter

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

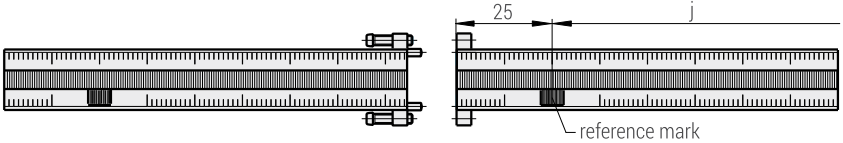
weight (approx.):
- 45 g/m steel tape scale with elastic layer
- 2,5 g clamping element

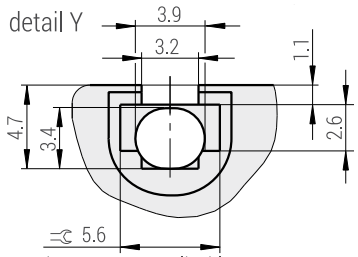
+ 17 g (scanning head without cable)





representation stretched





MSR 40 MKS

- Segment version
- Steel tape scale with adhesive tape
- Grating pitch: 200 µm
- Easy mounting due to large mounting tolerances
- High circumferential speed
- Integrated subdividing electronics: up to times 100

SCANNING HEAD: 200 µm grating pitch

Model	Output signals	Integrated interpolation	Max. circumferential speed [m/s]	Max. output frequency [kHz]
MSR 40.06	~ 1 Vpp	--	15.0	75
				Edge separation a_{min}
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

GRADUATION CARRIER

Scale unit: MKS = steel tape scale with adhesive tape.

Possible shaft diameter: Ø ≥150 mm to Ø 400 mm, scale-segment pre-bent in factory,
over Ø 400 mm, scale-segment is not pre-bent.

Reference mark (RI): any position of reference mark (see drawing),
additional reference marks separated by n x 100 mm.

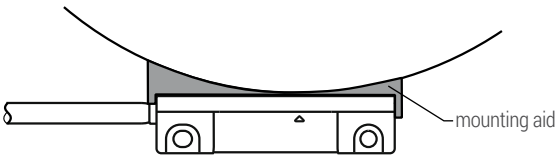
Accuracy of the grating pitch (stretched): ±30 µm/m.

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

Operating temperature range: 0 °C up to +60 °C.

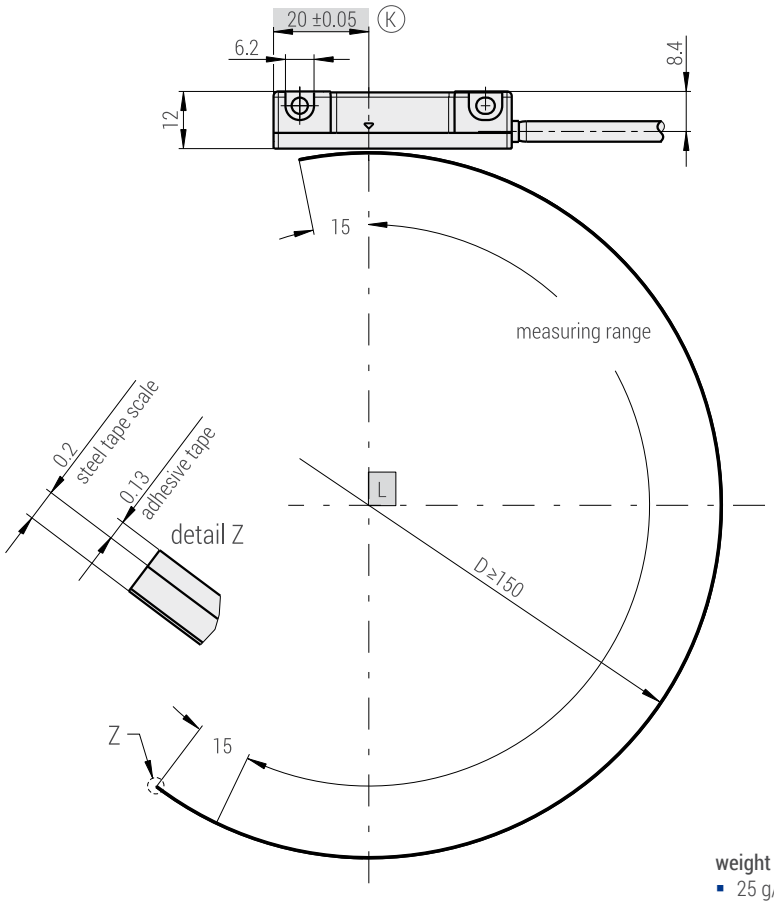
Temperature of storage range: –20 °C up to +70 °C.

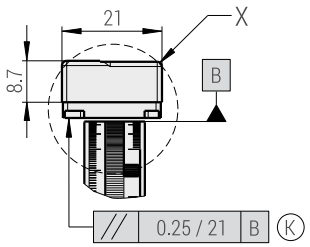
Mounting aid: optional accessory.

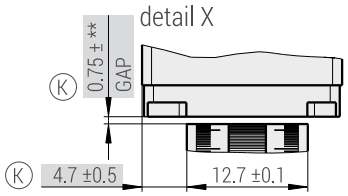


RoHS-conformity:
The MSR 40 rotary encoders comply with the guideline of the RoHS-directive 2011/65/EU
on the restriction of the use of certain hazardous substances in electrical and electronic equipment.

DIMENSIONS, MOUNTING TOLERANCES







Ⓚ = required mating dimensions

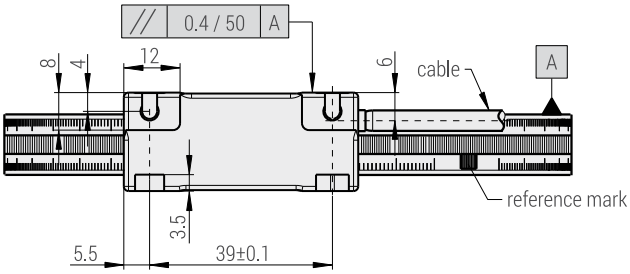
** D < Ø500 = +0.2 mm / -0.1 mm
** D ≥ 500 + 0.4 mm / -0.2 mm

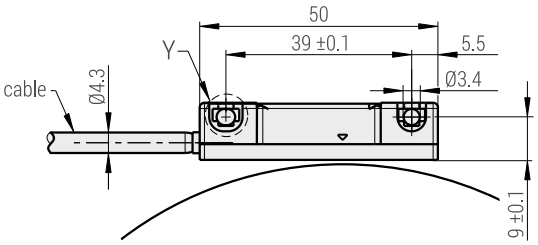
L = bearing
D = shaft diameter

weight (approx.):
- 25 g/m steel tape scale

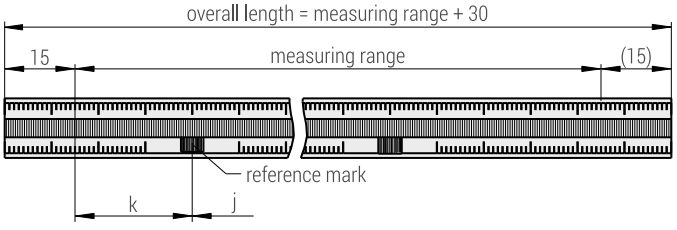
+ 17 g (scanning head without cable)

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

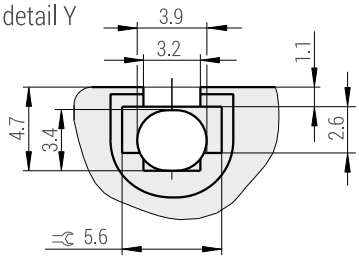




representation stretched



detail Y



hexagon nut applicable
M3 ISO 4032

ELECTRONIC SIGNAL TEST/SET-UP BOXES PG AND PS

Modulary angle measurement devices are adjusted at the factory to provide optimal signals at the specified mounting conditions.

Even though the MSR 20 and MSR 40 encoders 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 Elektronik 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.

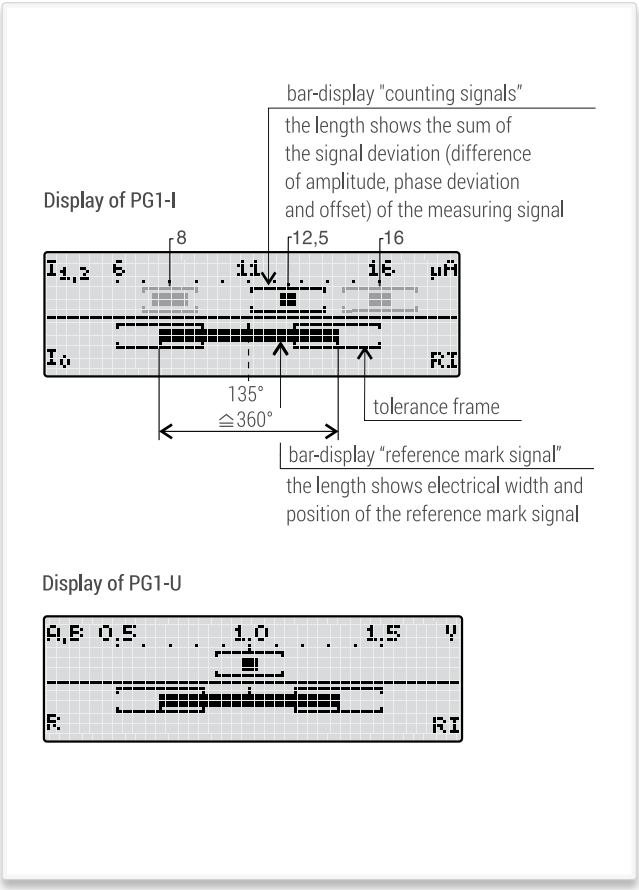
The **PG2-I** / **PG-U**, **PG4** and **PS4** test box checks all relevant signals; amplitude, phase and offset, and displays the results in a qualitative format on a polychromatic LED display.

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 40 output	
	⎍	∿ 1 Vpp	⎍	∿ 1 Vpp
PG1-I 	■	--	--	--
PG1-U 	--	■	--	■
PG2-I 	■	--	--	--
PG-U 	--	■	--	■
PG4 	--	--	■	--
PS4 	--	--	■	--

■ intended
-- not intended

DISTRIBUTION CONTACTS

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