RSF Elektronik

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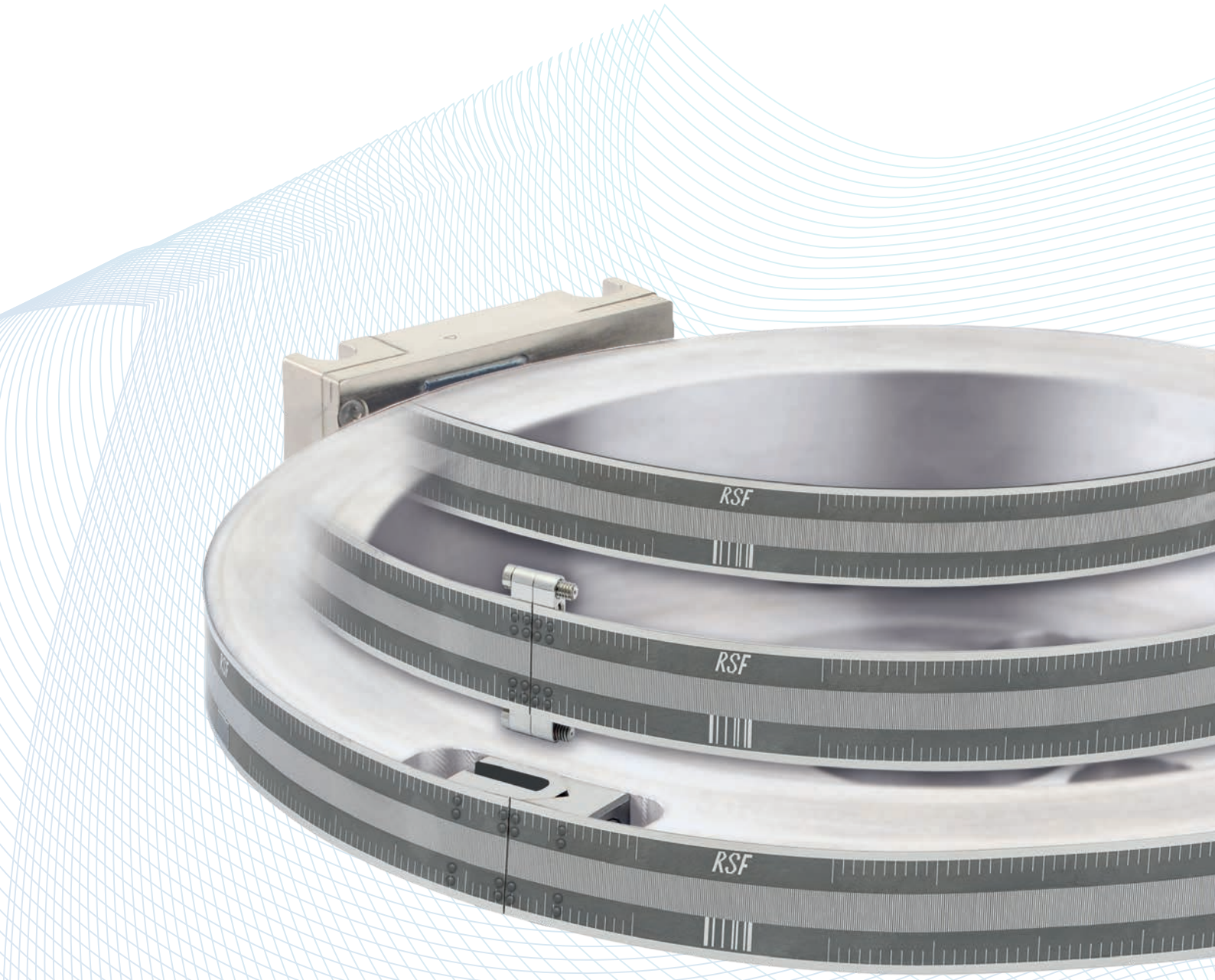
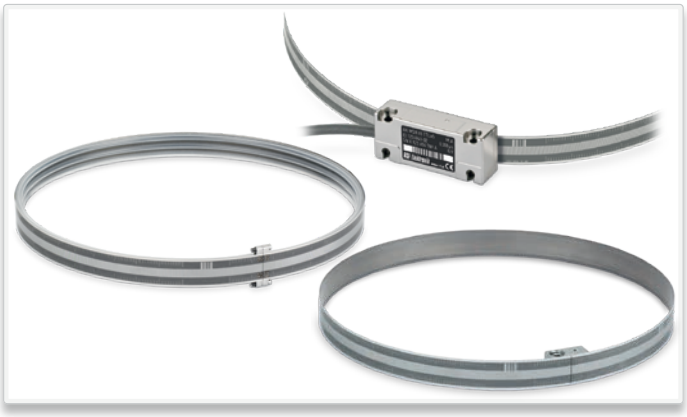
MSR 45

INCREMENTAL MODULAR ANGLE ENCODERS



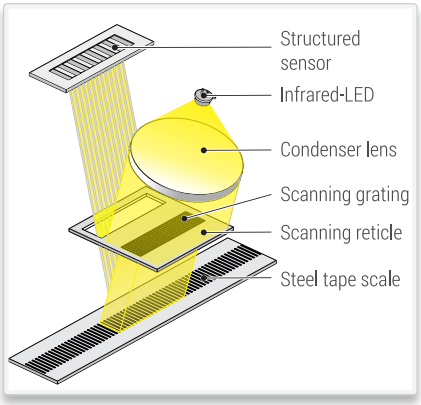


PERFORMANCE CHARACTERISTICS

- Contamination resistance
- Immunity against aging and temperature changes
- High traversing speed
- Easy mounting - large mounting tolerances
- Small dimensions
- No mechanical backlash; no frictional force
- Reference marks, repeatable from both traversing directions

SCANNING PRINCIPLE

The MSx 45 incremental modular angle encoders work with the imaging, photoelectric measuring principle and a **singlefield reflective scanning method**.
The regulated light of an infrared LED is collimated by a condenser lens and passes through the grid of the reticle. After being reflected from the graduation carrier, the infrared LED generates a periodic intensity distribution on the structured sensor.
The sensor generates high quality sinusoidal signals which are highly insensitive to possible contaminations.
The regulation of the LED ensures a constant signal amplitude, guaranteeing stability in the case of temperature fluctuations and with long-run operation.



TERM EXPLANATIONS

Grating period
A grating is a continuous series of lines and spaces printed on the graduation carrier. The width of one line and one space is called the period of the grating. The lines and spaces are accurately placed on the scale.

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

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

Measuring step
The smallest digital counting step produced by an encoder.

Yaw angle, pitch angle, roll angle, displacement, gap tolerance
Mounting tolerances of the scanning head relative to the scale.

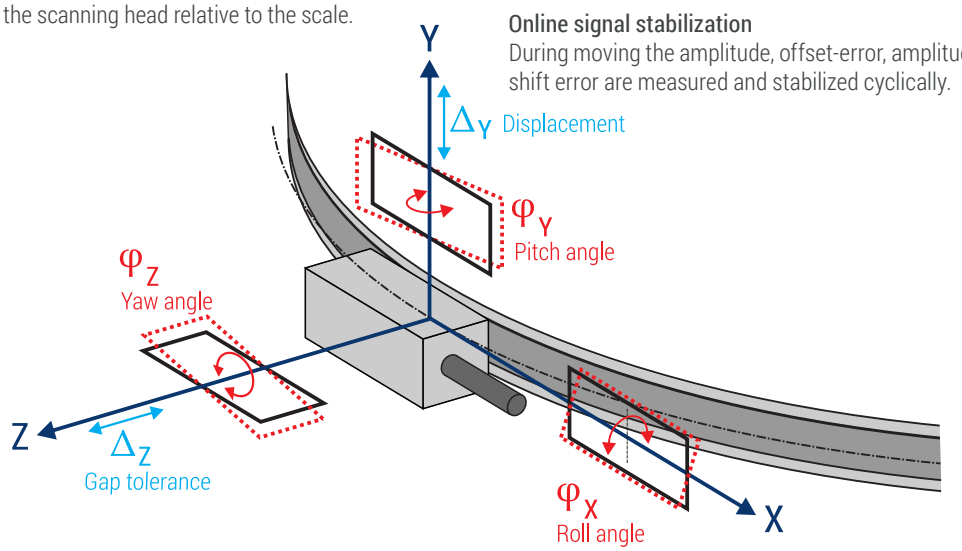
Δ .....Delta
φ .....Phi

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 graduation carrier.
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.

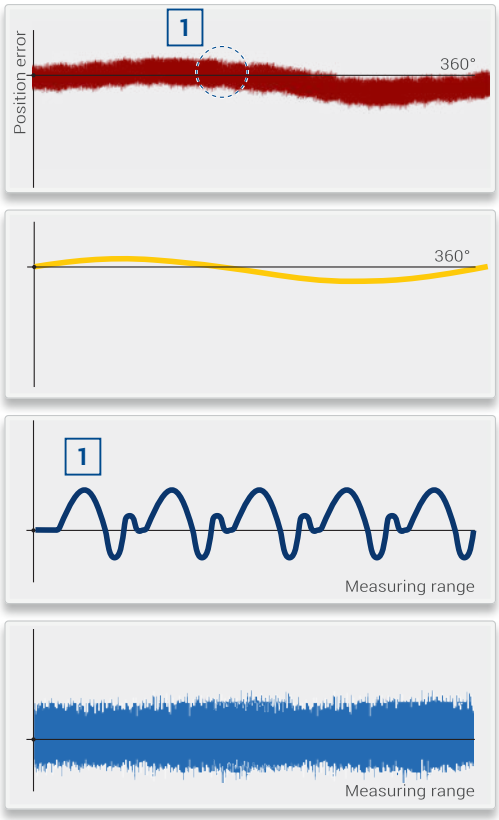
Fault detection signal ($\overline{US}$)
The fault detection signal indicates fault conditions such as an interruption in the supply lines, failure of the light source, etc. For example, it can be used in the automated production for the machine switch-off.

Line rates, LPR
Number of the grating periods per rotation.

Online signal stabilization
During moving the amplitude, offset-error, amplitude differences and phase shift error are measured and stabilized cyclically.



ACCURACY DEFINITION



Overall error

=

Baseline error

+

Interpolation error

+

Position noise

The accuracy of an encoder is mainly determined by the baseline error of the scale unit, the interpolation error of the optoelectronic scanning and the position noise.

The baseline error is the error of the scale unit identified in a measurement room under optimum conditions, along a determined measuring length, without any interpolation error and position noise.

With modular angle encoders, an eccentric mounting of the graduation carrier additionally results in a measurement error. In addition, dimensional and form errors of the customer's shaft can result in added eccentricity.

The measuring error results from the following formula:

$$\Delta\varphi = \pm \frac{412 \times e}{D}$$

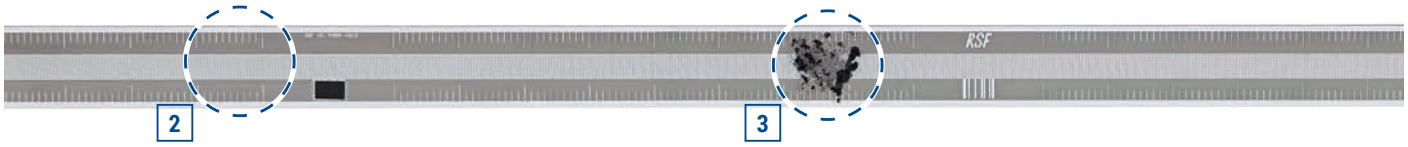
$\Delta\varphi$ = Measuring error due to eccentricity ["]

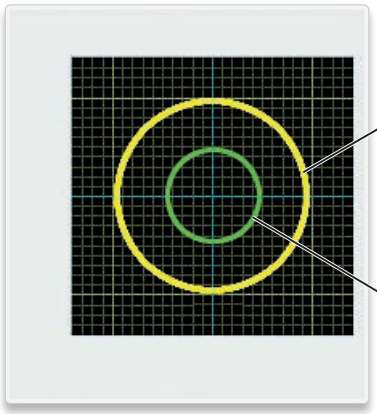
e = Resulting eccentricity of the graduation carrier in [µm]
- $0.5 \times \Delta_{max}$ = 1/2 concentricity for closed tape scale ring

D = Scanning diameter [mm]

Effect of contamination on the quality and amplitude of the scanning signal

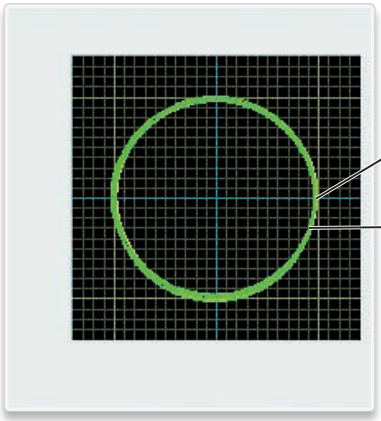
Graduation carrier contaminated by fluids, dust, particles, fingerprints etc.





2 Scanning signals without signal stabilization - graduation carrier clean

3 Scanning signals without signal stabilization - graduation carrier contaminated

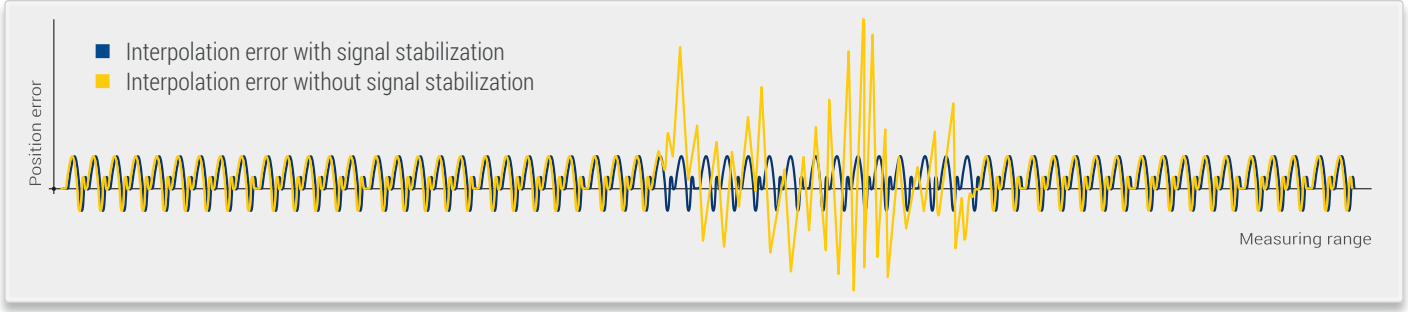


2 Scanning signals with Signal stabilization - Graduation carrier clean and

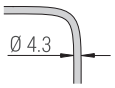
3 contaminated

Effect of contamination on the interpolation error

Graduation carrier contaminated by fluids, dust, particles, fingerprints etc.

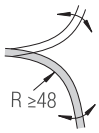


SHIELDING, PIN ASSIGNMENT

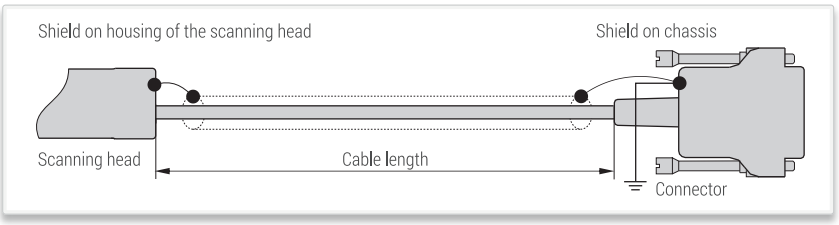


Shielded PUR-cable.
Drag chain qualified.

Bending radius fixed mounting



Bending radius continuous flexing

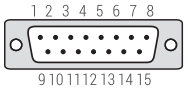


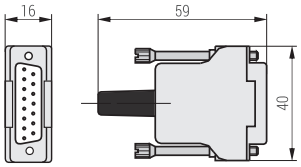
D-sub connector, male, 15-pin

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

- * Test = **Analog signal switch-over for set-up**.
  By applying +5 V to the test pin, the NOT correctet test signals (1 Vpp) are switched to the output connector.
- ** Test = **Analog signal switch-over for set-up**.
  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 connected with the chassis.
- Pins or wires marked “occupied” or “nc” must not be used by the customer.

Pin assignment
(view on pins)





Mass : 28 g

INTERFACES

SINUSOIDAL VOLTAGE SIGNALS 1 Vpp

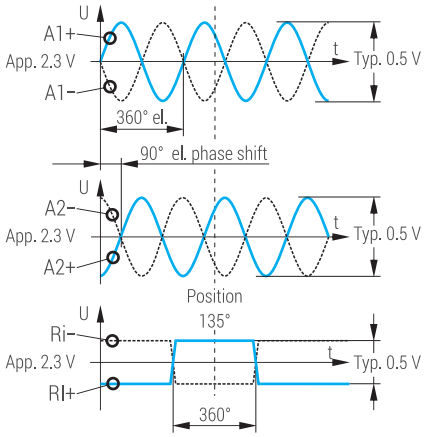
(drawing shows "positive counting direction")

Power supply: +5 V ±10 %, max. 130 mA (unloaded)
Track signals (differential voltage A1+ to A1− resp. A2+ to A2−):
Signal amplitude 0.6 Vpp to 1.2 Vpp; typical 1 Vpp
(with terminating impedance Zo = 120 Ω between A1+ to A1− resp. A2+ zu A2−)

Reference mark (differential voltage RI+ to RI−):
Square-wave pulse with an amplitude of 0.8 up to 1.2 V; typical 1 V
(with terminating impedance Zo = 120 Ω between RI+ to RI−)

Advantage:
- High traversing speed with long cable lengths possible.

Voltage signals (1 Vpp)



SQUARE-WAVE SIGNALS

(drawing shows "positive counting direction")
With the integrated 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°.
The output signals are „differential" via line driver (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)

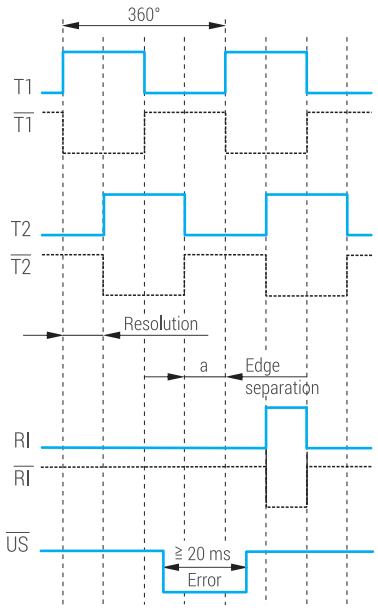
To prevent counting errors, the controls/DRO's must be able to process the resulting edge separation.

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

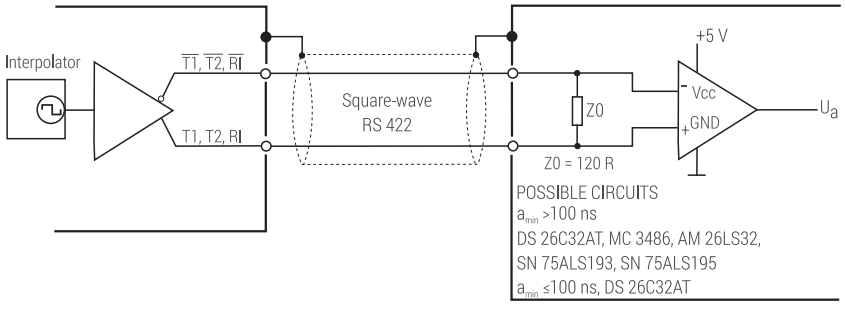
Power supply: +5 V ±10 %, max. 140 mA (unloaded)

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

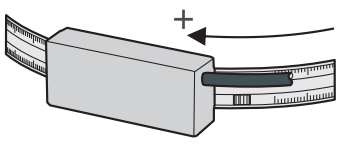
Square-wave signals „differential"



Recommended line receiver circuit



Positive direction of rotation



MSR 45 MOR

SCANNING HEAD

Model			AK MSR 45 1Vpp	AK MSR 45 TTLx5	AK MSR 45 TTLx10	AK MSR 45 TTLx50	AK MSR 45 TTLx100
System resolution [°]			Depending on external interpolation	360° / (LPR × 20)	360° / (LPR × 40)	360° / (LPR × 200)	360° / (LPR × 400)
Interface			~ 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 LPR	Mating diameter	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 mm	± 80"	200	200	200	200	200
2 500	159.07 mm	± 80"	200	200	200	200	200
3 600	229.15 mm	± 60"	200	200	200	200	200
5 000	318.34 mm	± 40"	200	200	200	200	144
7 200	458.50 mm	± 30"	200	200	200	200	100
10 000	636.88 mm	± 20"	150	150	150	144	72
10 800	687.85 mm	± 20"	139	139	139	133	67
14 400	917.19 mm	± 15"	104	104	104	100	50
18 000	1 146.54 mm	± 15"	83	83	83	80	40

Electrical connection	Cable, 3 m with D-sub connector, male, 15-pin
Voltage supply	+5 V ±10 %
Power consumption	▪ 1 Vpp: max. 715 mW (unloaded) ▪ TTL: max. 770 mW (unloaded)
Current consumption	▪ 1 Vpp: max. 130 mA (unloaded) ▪ TTL: max. 140 mA (unloaded)
Vibration 55 Hz to 2000 Hz Shock 8 ms	150 m/s² (EN 60 068-2-6) 750 m/s² (EN 60 068-2-27)
Temperature	Operating temperature: 0 °C to +60 °C, storage temperature: −20 °C to +70 °C
Mass	Scanning head: 17 g (without cable), cable: 30 g/m, connector: D-sub connector: 28 g

*Without mounting, additional deviations due to mounting and bearing of the measured shaft, are not respected. Further line rates or higher rotational speed on request.

GRADUATION CARRIER

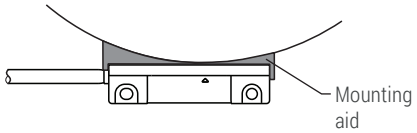
Model	MSR 45 MOR: Steel tape scale with clamping element								
Accuracy (grating stretched)	±30 µm/m								
Coefficient of expansion	Steel: $\alpha_{therm} \approx 10 \times 10^{-6}\ K^{-1}$								
Reference mark	25 mm from scale-joint, additional reference marks separated by n x 100 mm								
Shaft diameter D	152.70 mm	159.07 mm	229.15 mm	318.34 mm	458.50 mm	636.88 mm	687.85 mm	917.19 mm	1146.54 mm
Lines LPR	2400	2500	3600	5000	7200	10000	10800	14400	18000
Mass	≈ 21 g	≈ 22 g	≈ 26 g	≈ 32 g	≈ 40 g	≈ 51 g	≈ 54 g	≈ 68 g	≈ 82 g

CONFORMITIES AND CERTIFICATIONS

RoHS	2011/65/EU, 2015/863/EU
EMV	2014/30/EU
UL-Product-Certifications	B 022705 0009, U8V 022705 0005, CB 022705 0006

OPTIONAL ACCESSORIES

Mounting aid:

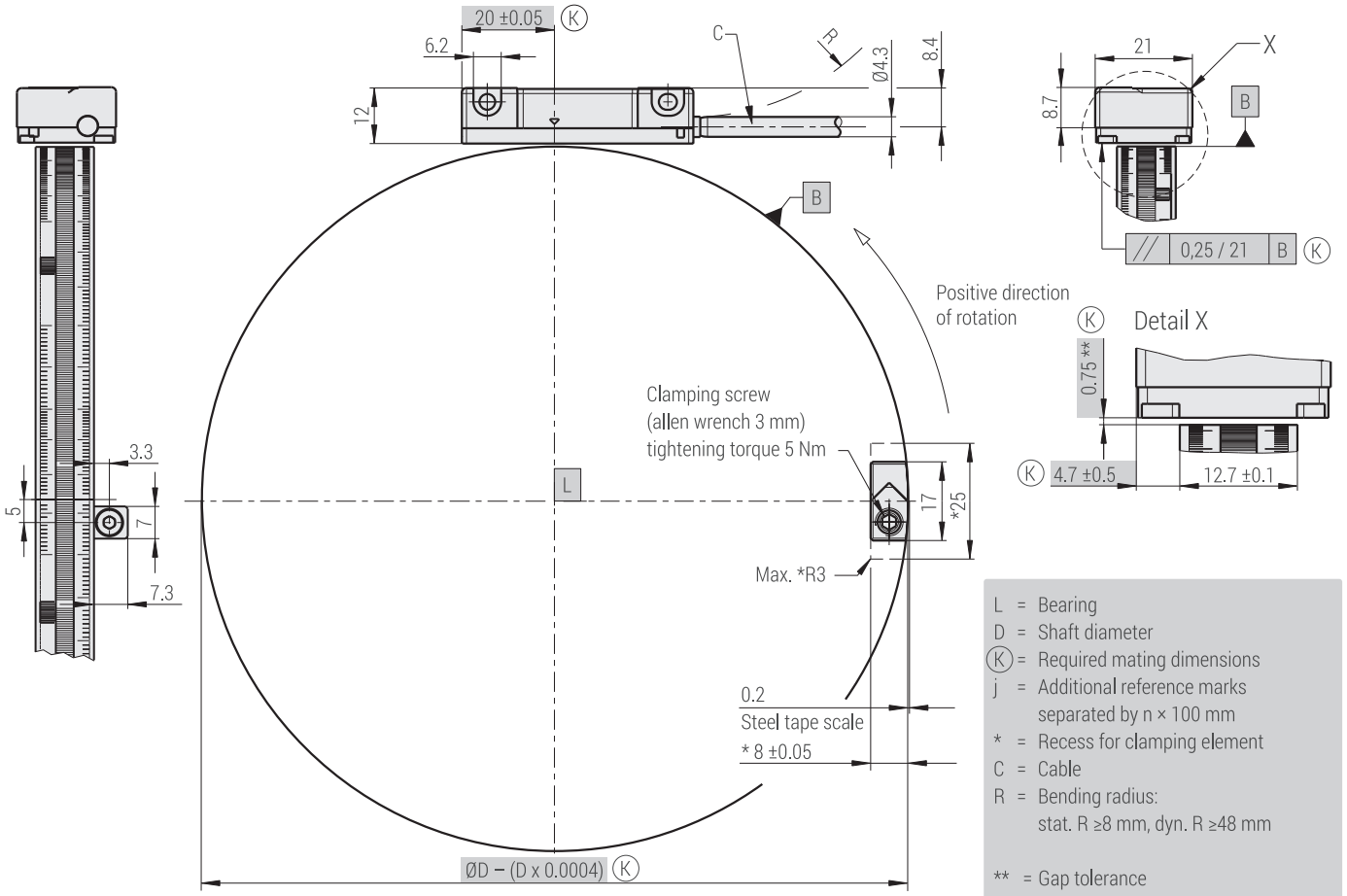


Installation kit:

External testing device PWT 101:

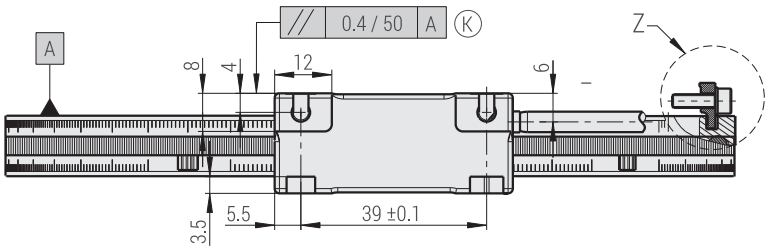
- Function control scanning signals and reference pulse.

DIMENSIONS, MOUNTING TOLERANCES



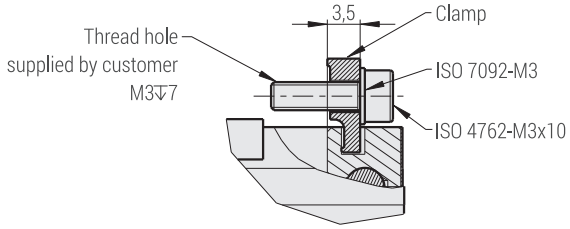
L = Bearing
D = Shaft diameter
K = Required mating dimensions
j = Additional reference marks separated by n × 100 mm
* = Recess for clamping element
C = Cable
R = Bending radius: stat. R ≥8 mm, dyn. R ≥48 mm

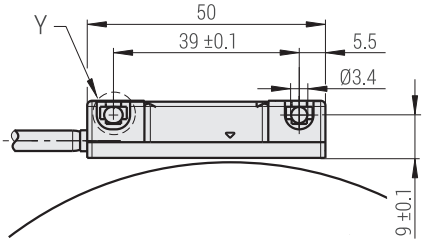
** = Gap tolerance
D < Ø500 = +0.2 mm / -0.1 mm
D ≥ 500 = +0.4 mm / -0.2 mm



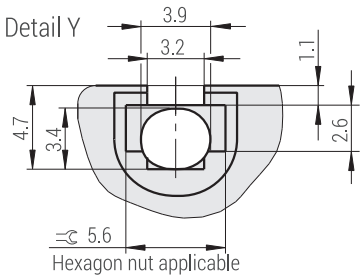
mm
Tolerancing ISO 8015
ISO 2768:1989 - m H
< 6 mm: ±0.2 mm

Detail Z
Optional: installation kit

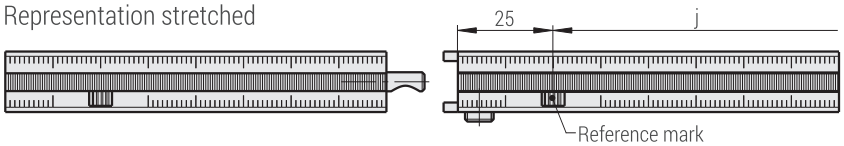




Detail Y



Representation stretched



MSR 45 MER

SCANNING HEAD

Model			AK MSR 45 1Vpp	AK MSR 45 TTLx5	AK MSR 45 TTLx10	AK MSR 45 TTLx50	AK MSR 45 TTLx100
System resolution [°]			Depending on external interpolation	360° / (LPR × 20)	360° / (LPR × 40)	360° / (LPR × 200)	360° / (LPR × 400)
Interface			~ 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 LPR	**Mating diameter**	**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 mm	± 400"	200	200	200	200	200
2 500	153.35 mm	± 350"	200	200	200	200	200
3 600	223.38 mm	± 250"	200	200	200	200	200
5 000	312.51 mm	± 200"	200	200	200	200	144
7 200	452.57 mm	± 150"	200	200	200	200	100
10 000	630.82 mm	± 100"	150	150	150	144	72
10 800	681.75 mm	± 100"	139	139	139	133	67
14 400	910.93 mm	± 75"	104	104	104	100	50
18 000	1 140.12 mm	± 50"	83	83	83	80	40
20 000	1 267.44 mm	± 50"	75	75	75	72	36
Electrical connection			cable, 3 m with D-sub connector, male, 15-pin				
Voltage supply			+5 V ±10 %				
Power consumption			▪ 1 Vpp: max. 715 mW (unloaded)	▪ TTL: max. 770 mW (unloaded)			
Current consumption			▪ 1 Vpp: max. 130 mA (unloaded)	▪ TTL: max. 140 mA (unloaded)			
Vibration 55 Hz to 2000 Hz Schock 8 ms			150 m/s^2 (EN 60 068-2-6) 750 m/s^2 (EN 60 068-2-27)				
Temperature			Operating temperature: 0 °C to +60 °C, Storage temperature: −20 °C to +70 °C				
Mass			Scanning head: 17 g (without cable), cable: 25 g/m, connector: D-sub connector: 28 g				

* Without mounting, additional deviations due to mounting and bearing of the measured shaft, are not respected. Further line rates or higher rotational speed on request.

GRADUATION CARRIER

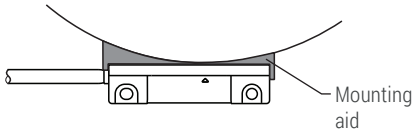
Model	**MSR 45 MER:** Steel tape scale with elastic layer and clamping element									
Accuracy (grating stretched)	±30 µm/m									
coefficient of expansion	Steel: $\alpha_{therm} \approx 10 \times 10^{-6}\ K^{-1}$									
Reference mark	25 mm from scale-joint, additional reference marks separated by n x 100 mm									
Shaft diameter D	146.99 mm	153.35 mm	223.38 mm	312.51 mm	452.57 mm	630.82 mm	681.75 mm	910.93 mm	1140.12 mm	1267.44 mm
Lines LPR	2400	2500	3600	5000	7200	10000	10800	14400	18000	20000
Mass	≈ 32.50 g	≈ 34.50 g	≈ 48.50 g	≈ 66.50 g	≈ 94.50 g	≈ 130.50 g	≈ 140.50 g	≈ 186.50 g	≈ 233.50 g	≈ 258.50 g

CONFORMITIES AND CERTIFICATIONS

RoHS	2011/65/EU, 2015/863/EU
EMV	2014/30/EU
UL-Product-Certifications	B 022705 0009, U8V 022705 0005, CB 022705 0006

OPTIONAL ACCESSORIES

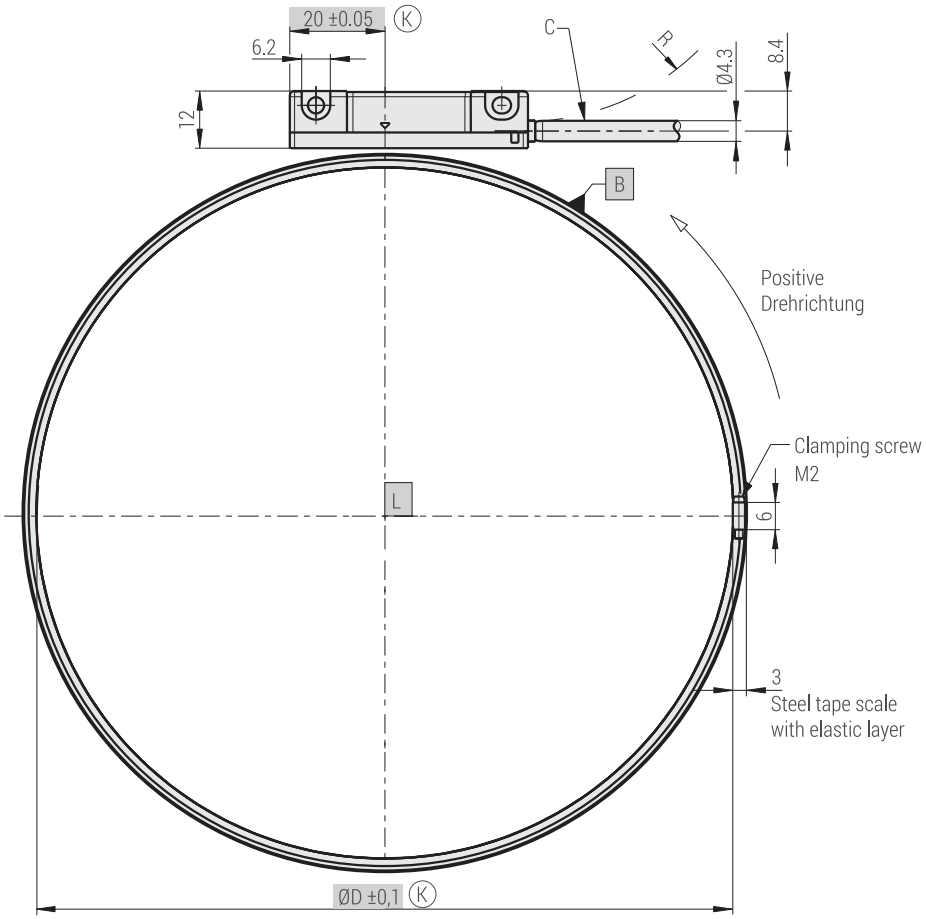
Mounting aid:

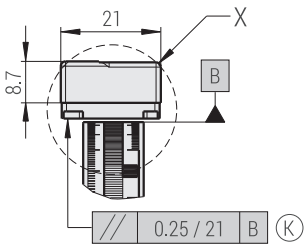


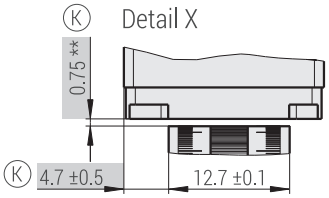
External testing device PWT 101:

- Function control scanning signals and reference pulse.

DIMENSIONS, MOUNTING TOLERANCES



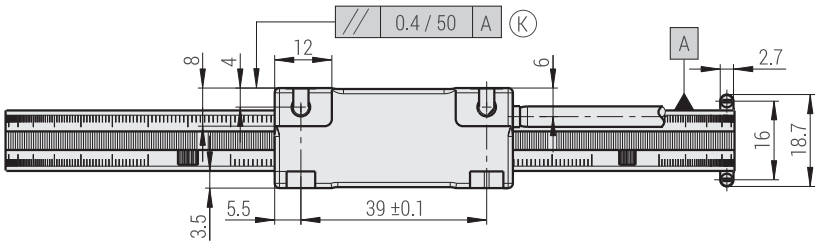


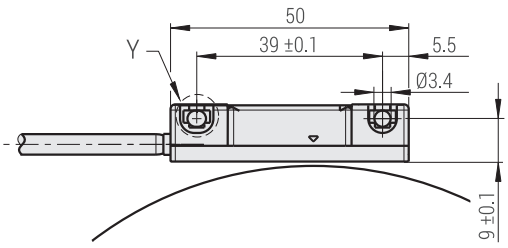


L = Bearing
D = Shaft diameter
Ⓚ = Required mating dimensions
j = Additional reference marks separated by n × 100 mm
C = Cable
R = Bending radius:
stat. R ≥8 mm, dyn. R ≥48 mm

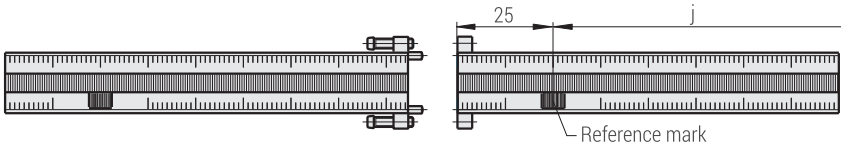
** = Gap tolerance
D < Ø500 = +0.2 mm / -0.1 mm
D ≥ 500 = +0.4 mm / -0.2 mm

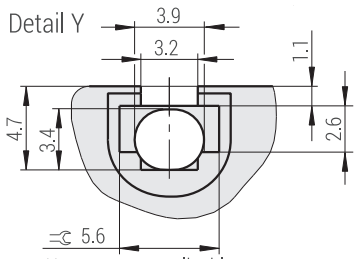
mm
Tolerancing ISO 8015
ISO 2768:1989 - m H
< 6 mm: ±0.2 mm





Representation stretched





MSR 45 MKS

SCANNING HEAD

Model	AK MS 45 1 Vpp	AK MS 45 TTLx5	AK MS 45 TTLx10	AK MS 45 TTLx50	AK MS 45 TTLx100
Interface	~	⎍	⎍	⎍	⎍
Measuring step [°]	Depending on external interpolation	360° / (LPR × 20)	360° / (LPR × 40)	360° / (LPR × 200)	360° / (LPR × 400)
Integrated interpolation	--	Times 5	Times 10	Times 50	Times 100
Max. velocity	15.00 m/s	10.00 m/s	9.60 m/s	4.80 m/s	2.40 m/s
Max. output frequency	75 kHz	--	--	--	--
Edge separation a_{min}	--	500 ns	500 ns	200 ns	200 ns
Interpolation error with signal stabilization	Typisch ± 1 µm (Spitze-Spitze)				
Electrical connection	Cable, 3 m mit D-sub connector, male, 15-pin				
Voltage supply	+5 V ±10 %				
Power consumption	▪ 1 Vpp: max. 715 mW (unloaded) ▪ TTL: max. 770 mW (unloaded)				
Current consumption	▪ 1 Vpp: 130 mA (unloaded) ▪ TTL: 140 mA (unloaded)				
Vibration 55 Hz – 2000 Hz Shock 8 ms	≤ 150 m/s² (EN 60 068-2-6) 750 m/s² (EN 60 068-2-27)				
Operating temperature Storage temperature	0 °C to 60 °C −20 °C to 70 °C				
Mass	Scanning head: 17 g (without cable), cable: 30 g/m, connector: D-sub connector: 28 g				

GRADUATION CARRIER

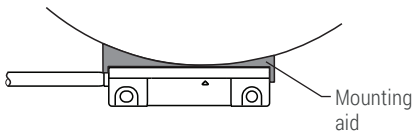
Model	**MSR 45 MKS:** Steel tape scale with adhesive tape
Accuracy (grating stretched)	±30 µm/m
Coefficient of expansion	Steel: $\alpha_{therm} \approx 10 \times 10^{-6}\ K^{-1}$
Reference mark	▪ Any position of the reference mark ▪ Additional reference marks separated by n x 100 mm
Shaft diameter D	▪ ≥ 150 mm to ≤ 400 mm: scale segment is pre-bent in factory ▪ > 400 mm: scale segment is not pre-bent
Theoretical lines per revolution (360°)	LPR = (DA + 0.46) × π / 0.2 (round down result to integer)
Mass	25 g/m

CONFORMITIES AND CERTIFICATIONS

RoHS	2011/65/EU, 2015/863/EU
EMV	2014/30/EU
UL-Product-Certifications	B 022705 0009, U8V 022705 0005, CB 022705 0006

OPTIONAL ACCESSORIES

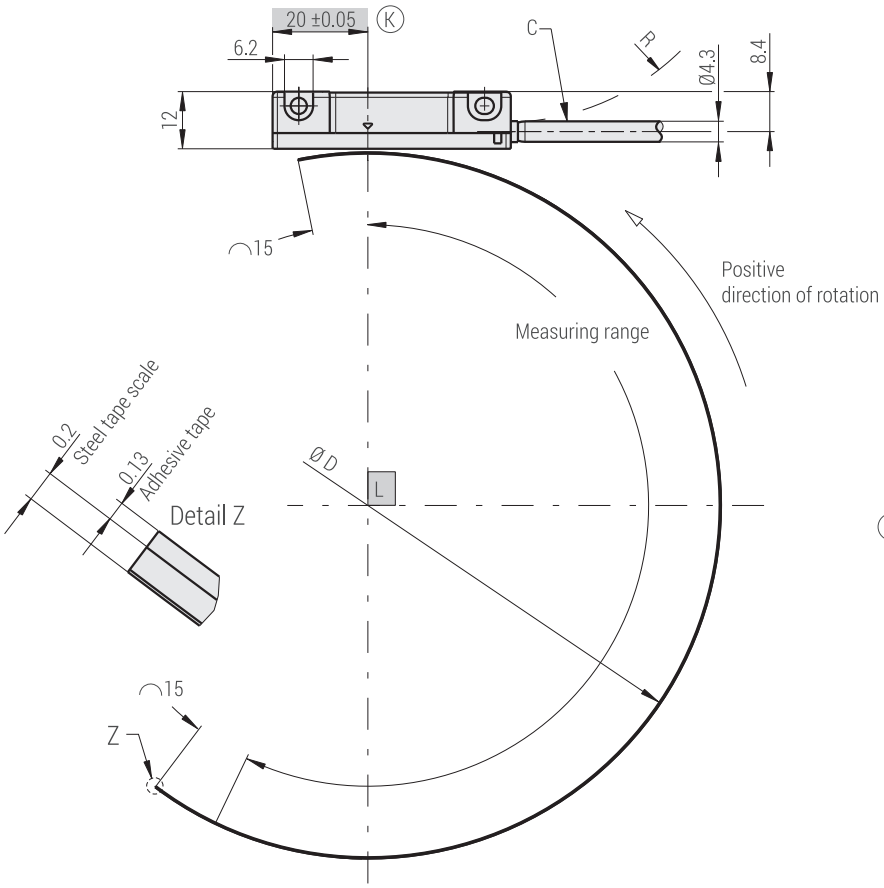
Mounting aid:

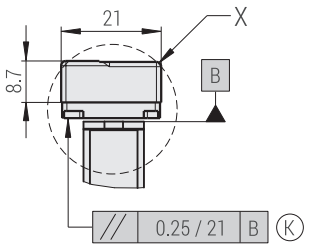


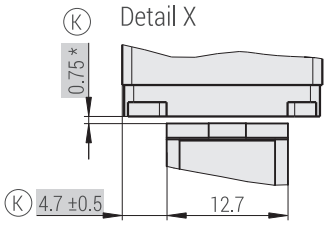
External testing device PWT 101:

- Function control scanning signals and reference pulse.

DIMENSIONS, MOUNTING TOLERANCES



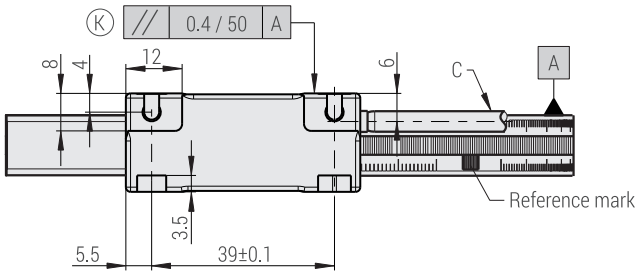


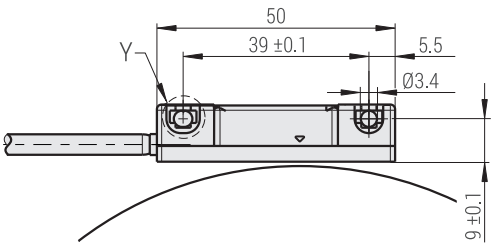


L = Bearing
D = Shaft diameter
(K) = Required mating dimensions
k = Any position of the reference mark from the beginning of the measuring range
j = Additional reference marks separated by n × 100 mm
C = Cable
R = Bending radius: stat. R ≥8 mm, dyn. R ≥48 mm

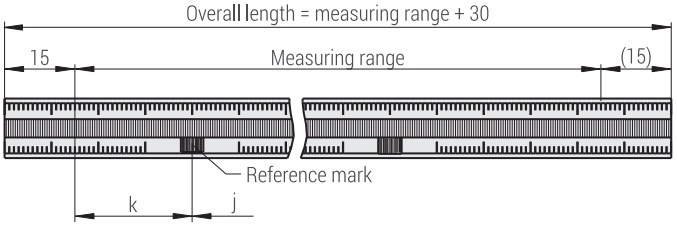
* = Gap tolerance
D < Ø500 = +0.2 mm / -0.1 mm
D ≥ 500 = +0.4 mm / -0.2 mm

mm
Tolerancing ISO 8015
ISO 2768:1989 - m H
< 6 mm: ±0.2 mm

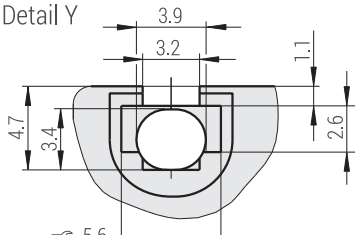




Representation stretched



Detail Y



Hexagon nut applicable
M3 ISO 4032

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