

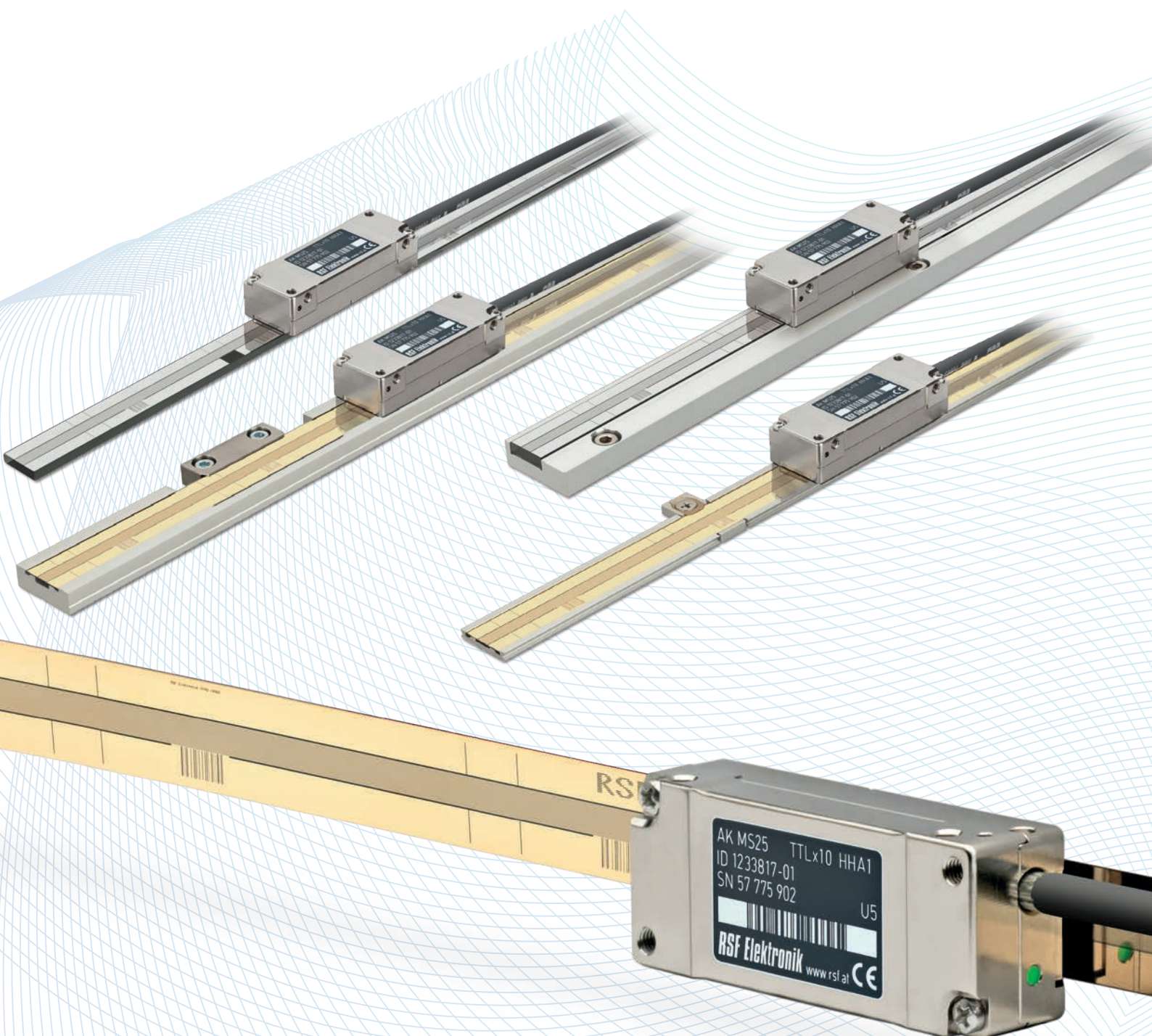


# RSF Elektronik

www.rsf.at

MS 25

EXPOSED LINEAR ENCODERS  
WITH SINGLEFIELD SCANNING



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# 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 graduation carrier.

### 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 graduation carrier.

### 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 graduation carrier. A one increment wide signal is generated when the scanning 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 ( $\overline{US}$ )

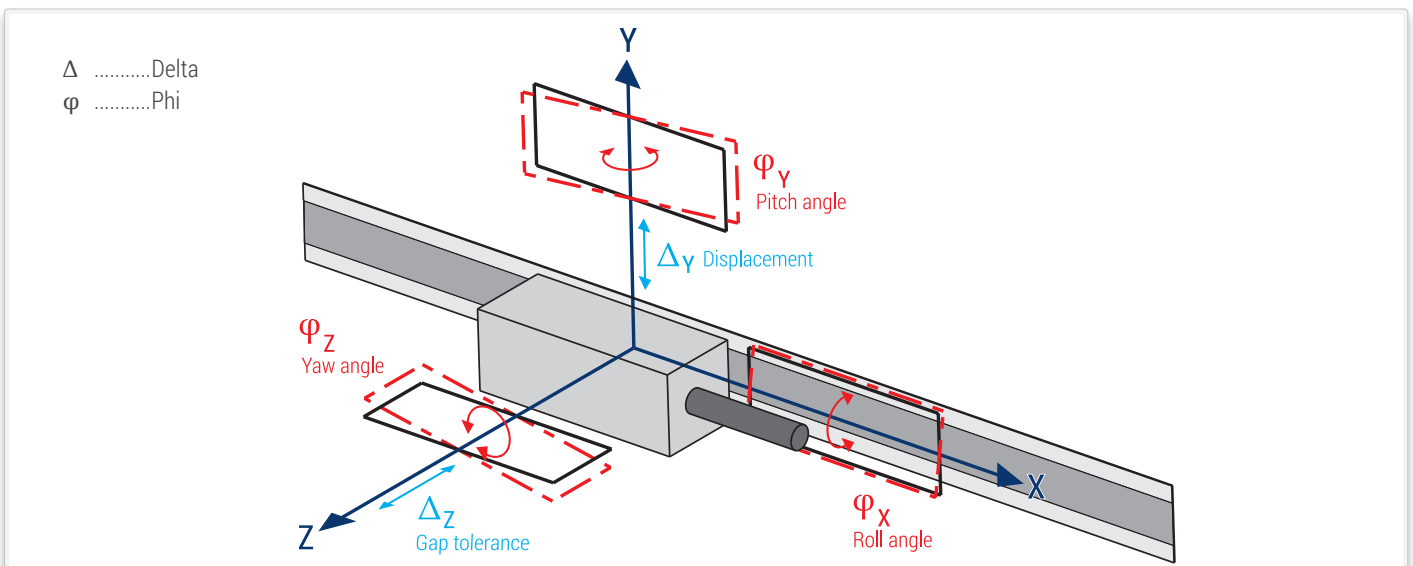
The fault detection signal indicates fault conditions such as an interruption in the supply lines, failure of the light source, etc. For example, it can be used in the automated production for the machine switch-off..

### Online signal stabilization (HSP)

During moving the amplitude, offset-error, amplitude differences and phase shift error are measured and stabilized cyclic.

### Abbe error

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



## PERFORMANCE CHARACTERISTICS

- CONTAMINATION RESISTANCE
- IMMUNITY AGAINST AGING AND TEMPERATURE CHANGES
- HIGH TRAVERSING SPEED
- EASY MOUNTING
- COMPACT DIMENSIONS
- NO MECHANICAL BACKLASH
- NO FRICTIONAL FORCE
- TWO SEPARATE SWITCH SIGNALS
- HIGH ACCURACY
- RESOLUTION:  $10\ \mu\text{m} - 0.05\ \mu\text{m}$

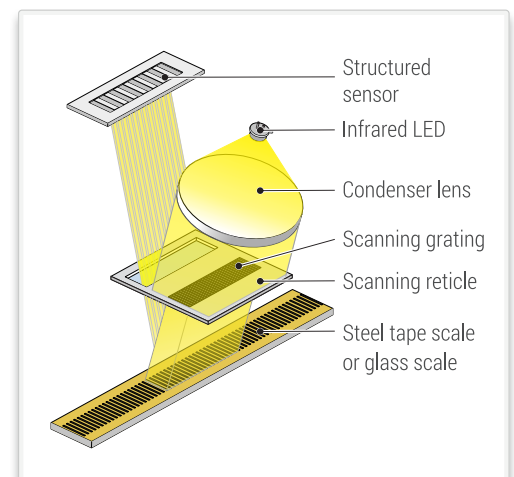
## SCANNING PRINCIPLE

The incremental MS 25 linear encoders work with a photoelectric measuring principle and a **singlefield reflective scanning** method. A graduation pattern on a steel tape (gold grating) or a glass scale (chrome grating) with  $40\ \mu\text{m}$  grating period is used.

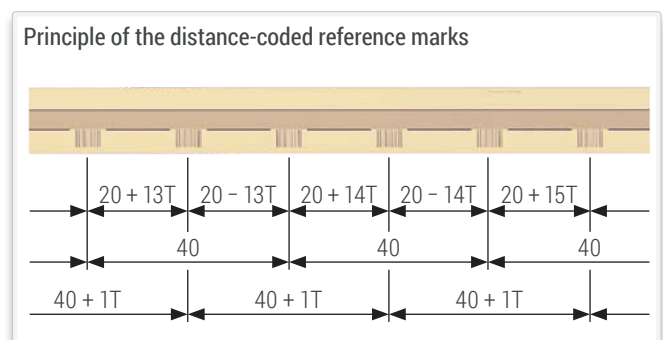
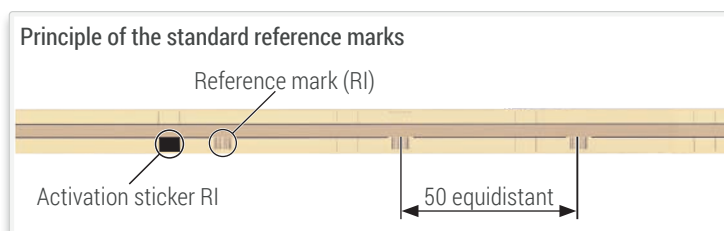
The regulated light of an infrared LED is collimated by a condenser lens and passes through the grid of the reticle. After being reflected from the grating, the light generates a periodic intensity distribution on the structured sensor.

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.



## REFERENCE MARKS



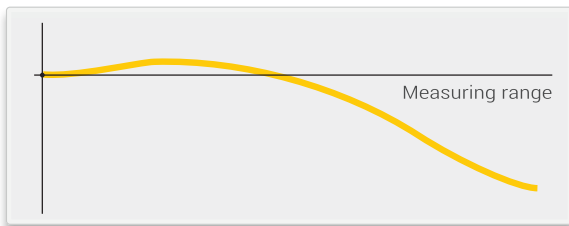
# ACCURACY DEFINITION

The accuracy of a linear encoder is mainly determined by the baseline error of the graduation carrier, the interpolation error of the optoelectronic scanning and the position noise.

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

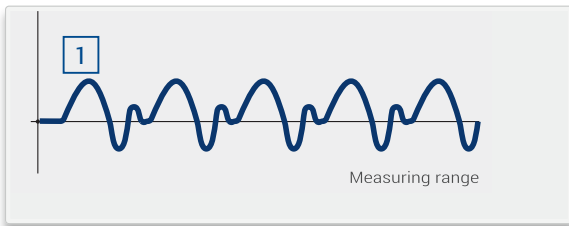
The indicated accuracy grade represents the maximum possible baseline error. It is calculated within any section with a maximum length of one meter.

Baseline error



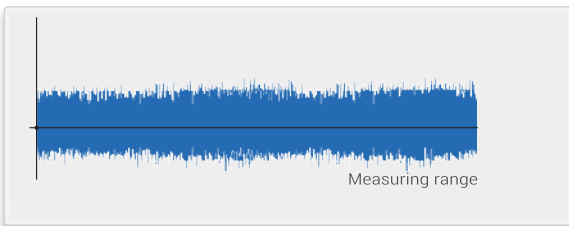
+

Interpolation error



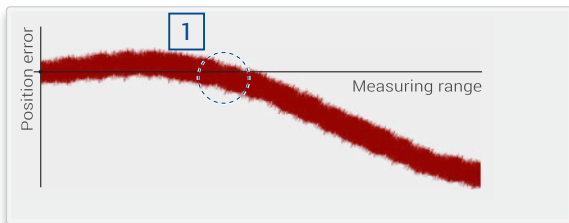
+

Position noise



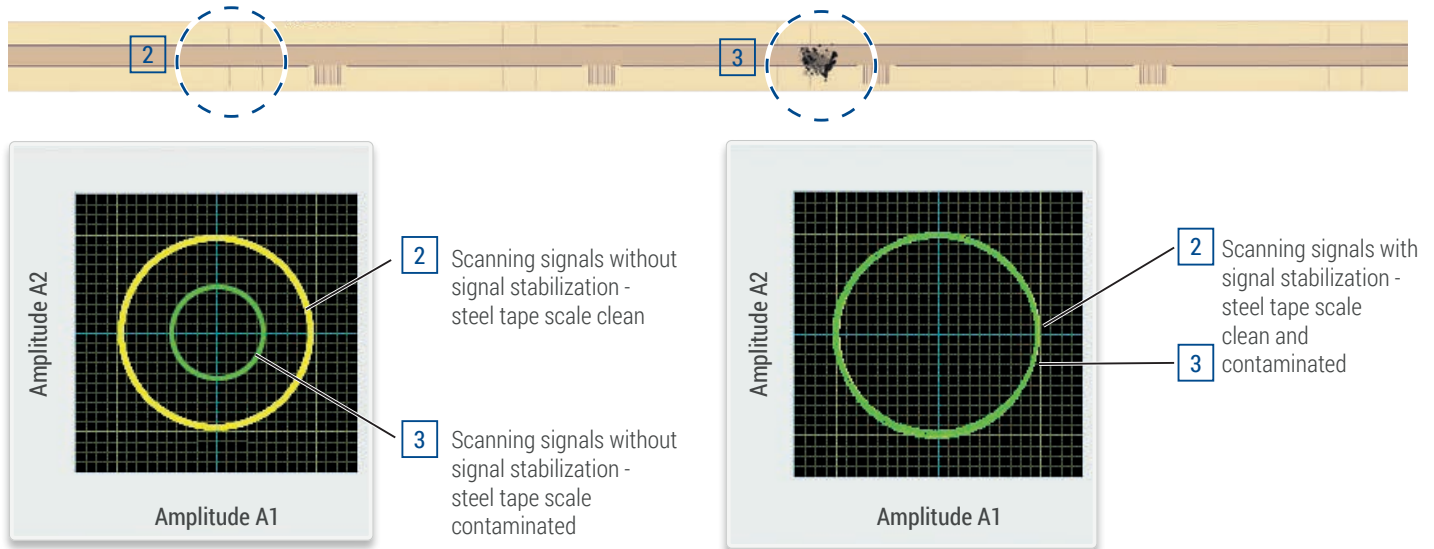
=

Overall error



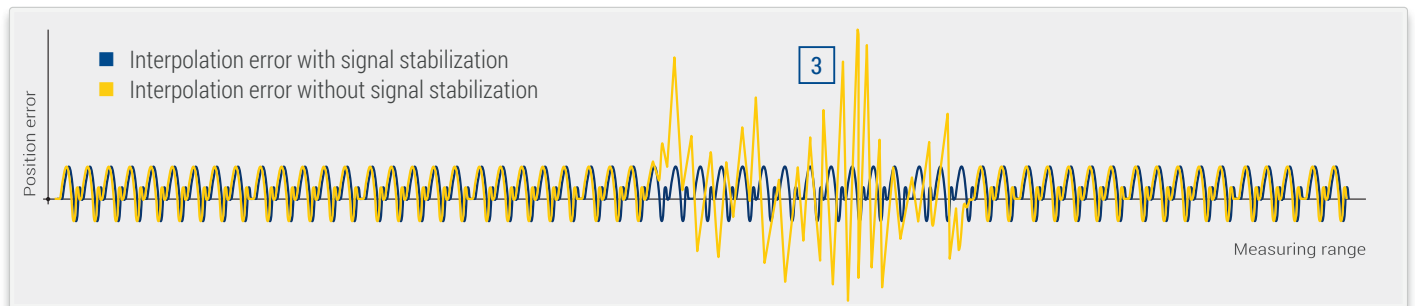
## Effect of contamination on the quality and amplitude of scanning signal

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

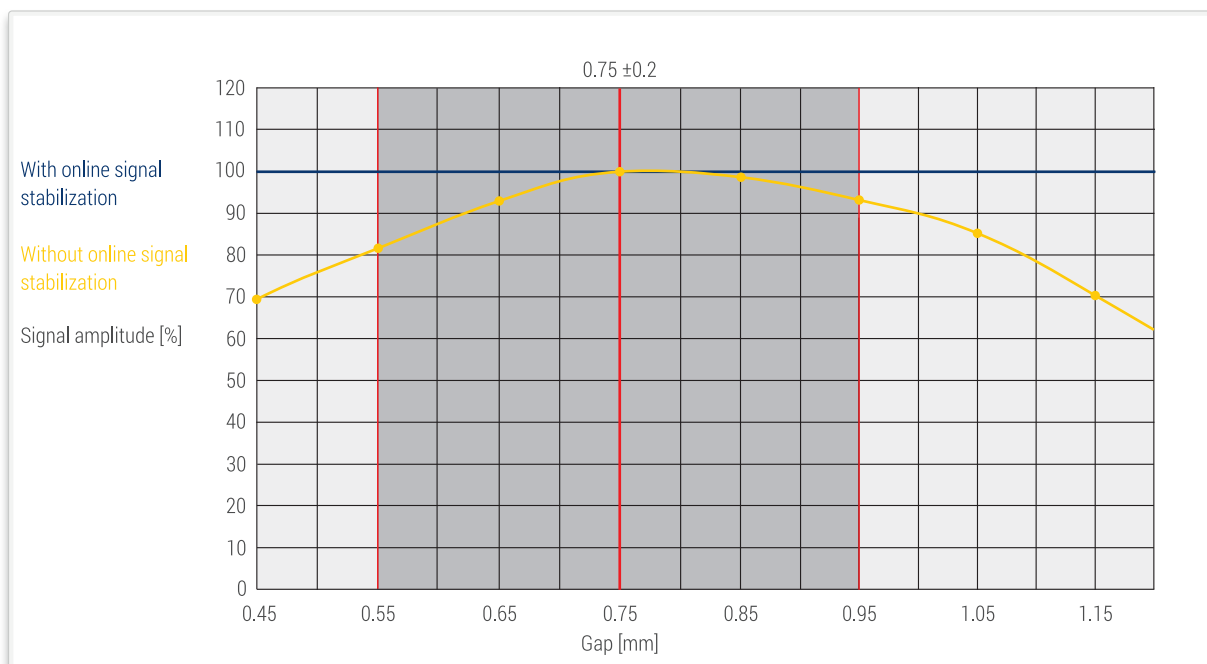


## Effect of contamination on the interpolation error

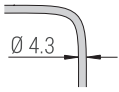
Graduation carrier contaminated by fluids, dust, particles, fingerprints etc.



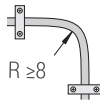
## Effect of the gap between scanning head and graduation carrier on the scanning signal amplitude



## SHIELDING, PIN ASSIGNMENT



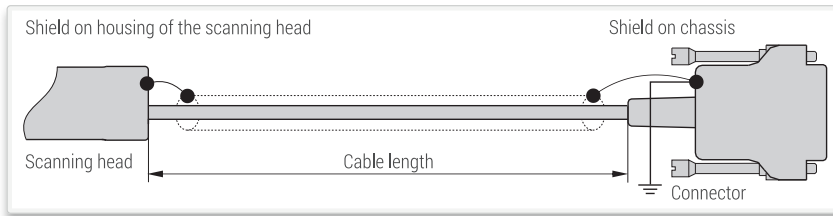
Shielded PUR-cable;  
Drag chain qualified.



Bending radius fixed mounting



Bending radius continuous flexing

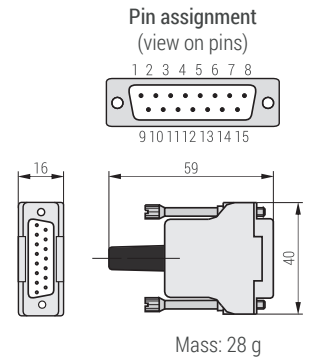


### D-sub connector, male, 15-pin

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	S1***	S2***	RI+	A2+	A1+	nc
Square-wave signals via line driver	Test**	0 V Sensor	US	RI	T2	T1	V+ Sensor	V+	0 V	S1***	S2***	RI	T2	T1	nc

RSF standard pin assignment, other pin assignments on request.

- \* Test = **Analog signal switch-over for set-up.**  
By applying +5 V to the test pin, the NOT corrected 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.
- S1, S2 = Switch signals.
- \*\*\* Version without switch signals (version K) = without function.
- Sensor: The sensor pins are bridged in the connector chassis with the particular power supply.
- The shield is connected with the connector chassis.
- Pins or wires marked "occupied" or "nc" must not be used by the customer.



## INTERFACES

### SINUSOIDAL VOLTAGE SIGNALS 1Vpp

(drawing shows "positive counting direction")

**Power supply:** +5V ±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; typ. 1 Vpp

(with terminating impedance  $Z_0 = 120 \Omega$  between A1+ to A1- resp. A2+ to A2-)

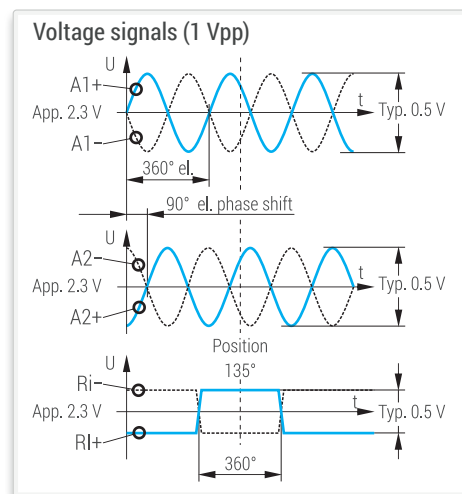
**Reference mark** (differential voltage RI+ to RI-):

Square-wave pulse with an amplitude of 0.8 up to 1.2 V; typical 1 V

(with terminating impedance  $Z_0 = 120 \Omega$  between RI+ to RI-)

**Advantage:**

- High traversing speed with long cable lengths possible.



### SQUARE-WAVE SIGNALS

(drawing shows "positive counting direction")

With an interpolation electronics (for times -1, -2, -5, -10, -20, -25, -50, -100 or -200) 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  $a_{\min}$  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 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:**

$a_{\min} = 200 \text{ ns}$ , 10 m cable

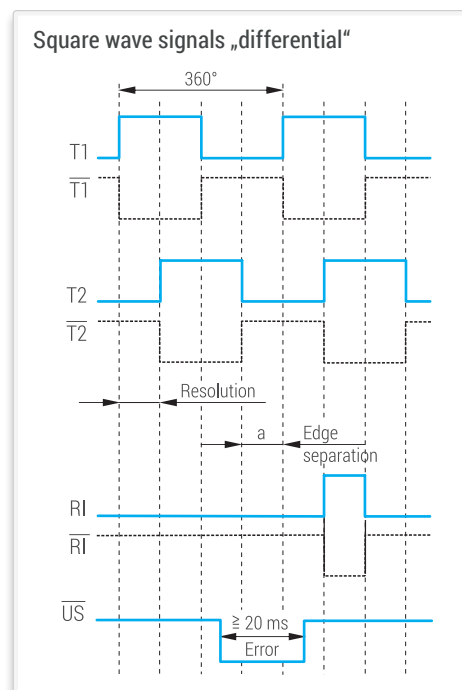
$200 \text{ ns} - 10 \text{ ns} - 10 \times 0.2 \text{ ns} - 10 \text{ ns} = 178 \text{ ns}$

**Power supply:** +5 V ±10%, max. 165 mA (unloaded)

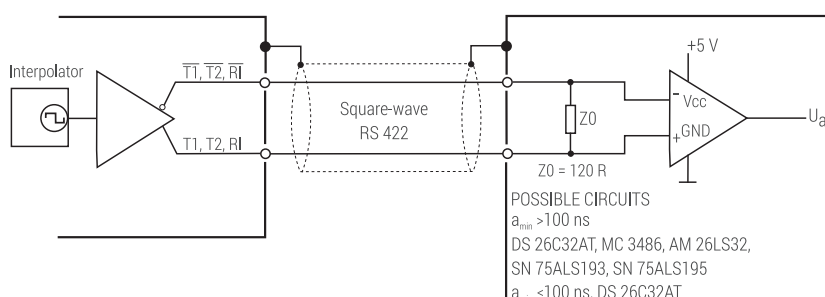
**Advantage:**

- Noise immune signals

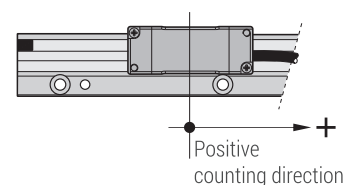
- No further subdividing electronics necessary



### Recommended line receiver circuit



### Counting direction



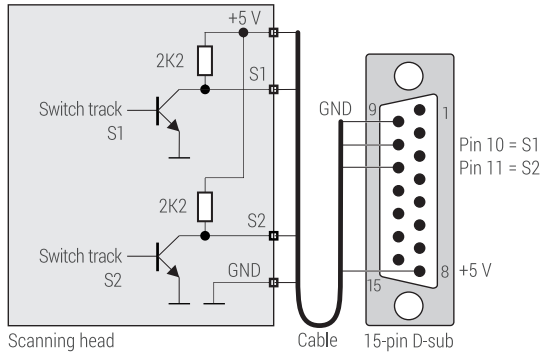
## SWITCH SIGNAL OUTPUT

For individual special functions there are two additional switch tracks on the glass scale/metal tape.  
The switching point position can be chosen by the user by placing self-adhesive covering tapes.

For version with selectable reference mark there is just one switch signal available.  
The second track of this version is used to select the reference mark.  
This feature makes the selection of the reference mark position, by the user, very easy.

### VERSION H

TTL output (active high)

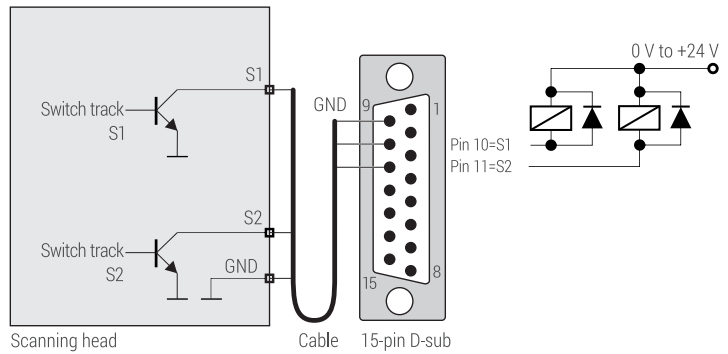


S1, S2 = TTL output  
 $I_{SOURCE} = 1 \text{ mA}$  (high level  $> 2 \text{ V}$ )  
 $I_{SINK} = 20 \text{ mA}$  (low level  $< 0.8 \text{ V}$ )

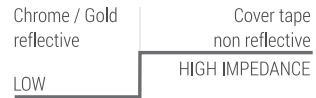


### VERSION Z

Open collector output (active high impedance)

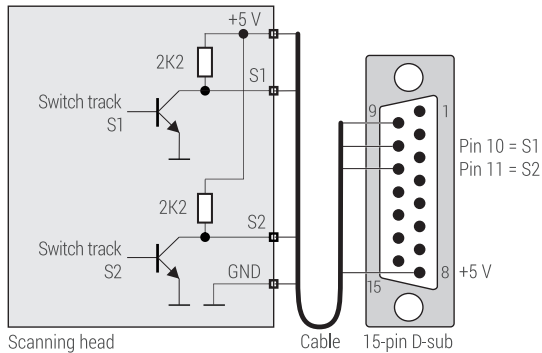


S1, S2 = open collector output  
 $I_{SINK} = 20 \text{ mA}$  (low level  $< 0.8 \text{ V}$ )

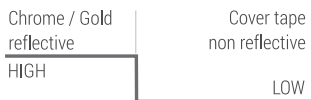


### VERSION L

TTL output (active low)

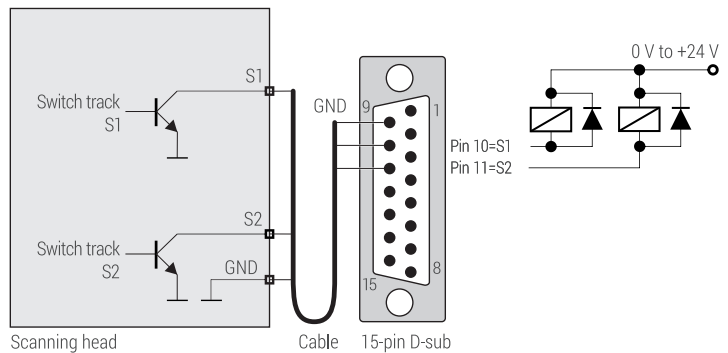


S1, S2 = TTL output  
 $I_{SOURCE} = 1 \text{ mA}$  (high level  $> 2 \text{ V}$ )  
 $I_{SINK} = 20 \text{ mA}$  (low level  $< 0.8 \text{ V}$ )



### VERSION C

open collector output (active low)



S1, S2 = open collector output  
 $I_{SINK} = 20 \text{ mA}$  (low level  $< 0.8 \text{ V}$ )



# TECHNICAL DATA

## SCANNING HEAD

Model	AK MS 25 1 Vpp	AK MS 25 TTLx1u	AK MS 25 TTLx2	AK MS 25 TTLx5	AK MS 25 TTLx10	AK MS 25 TTLx20	AK MS 25 TTLx25	AK MS 25 TTLx50	AK MS 25 TTLx100	AK MS 25 TTLx200
Interface	~	⌋	⌋	⌋	⌋	⌋	⌋	⌋	⌋	⌋
Measuring step [μm]	*	10.00	5.00	2.00	1.00	0.50	0.40	0.20	0.10	0.05
Integrated interpolation	--	Times 1	Times 2	Times 5	Times 10	Times 20	Times 25	Times 50	Times 100	Times 200
Max. velocity [m/s]	10.00	10.00	10.00	6.40	3.20	2.40	1.92	1.92	0.96	0.96
Max. output frequency	250 kHz	--	--	--	--	--	--	--	--	--
Edge separation a <sub>min</sub>	--	500 ns	250 ns	300 ns	300 ns	200 ns	200 ns	100 ns	100 ns	50 ns
Interpolation error with signal stabilization	Typical ±65 nm (peak-peak)									
Electrical connection	Cable, 0.5 m, 1 m or 3 m with D-sub connector, male, 15-pin									
Voltage supply	+5 V ±10 %									
Power consumption	<ul style="list-style-type: none"> <li>1 Vpp: max. 715 mW (without load)</li> <li>TTL: max. 907 mW (without load)</li> </ul>									
Current consumption	<ul style="list-style-type: none"> <li>1 Vpp: 130 mA (without load)</li> <li>TTL: 165 mA (without load)</li> </ul>									
Vibration 55 Hz – 2000 Hz Shock 8 ms	≤ 150 m/s <sup>2</sup> (EN 60 068-2-6) 750 m/s <sup>2</sup> (EN 60 068-2-27)									
Operating temperature Storage temperature	0 °C to 60 °C -20 °C to 70 °C									
Mass	Scanning head: 21 g (without cable), cable: 30 g/m, connector: D-sub connector: 28 g									

\* Depending on external interpolation

## GRADUATION CARRIER

Model	MS 25 MO/MK	MS 25 MA/MS	MS 25 MP	MS 25 MT	MS 25 GK	MS 25 BK	MS 25 GA
Graduation carrier	Steel tape scale				Glass scale	Glass ceramic scale	Glass scale
Coefficient of expansion	$\alpha_{\text{therm}} \approx 10 \times 10^{-6} \text{ K}^{-1}$				$\alpha_{\text{therm}} \approx 8.5 \times 10^{-6} \text{ K}^{-1}$	$\alpha_{\text{therm}} \approx 0 \times 10^{-6} \text{ K}^{-1}$	$\alpha_{\text{therm}} \approx 8.5 \times 10^{-6} \text{ K}^{-1}$
Grating period	40 μm						
Accuracy grades **	±5, ±15 μm/m				±3, ±5 μm/m		
Non-linearity	±3 μm/1000 mm				≤±1 μm/70 mm ≤±3 μm/1000 mm		
Baseline error	≤ ±0.75 μm/50 mm (typical)				≤ ±0.30 μm/10 mm		
Measuring length ML	20 000 mm	3640 mm	20 000 mm	20 000 mm	3140 mm	1920 mm ***	3140 mm
Reference marks	<ul style="list-style-type: none"> <li>Standard: 50 mm equidistant</li> <li>At any location, on request</li> </ul>				<ul style="list-style-type: none"> <li>Position selectable by customer</li> <li>Optional: distance-coded</li> </ul>		
Mass	MO: 20 g/m MK: 25 g/m	MA: 530 g/m	90 g/m + 2 g clamping	325 g/m + 30 g clamping	100 g/m	70 g/m	515 g/m

\*\* At 20 °C

\*\*\* Longer lengths on request

## CONFORMITIES AND CERTIFICATIONS

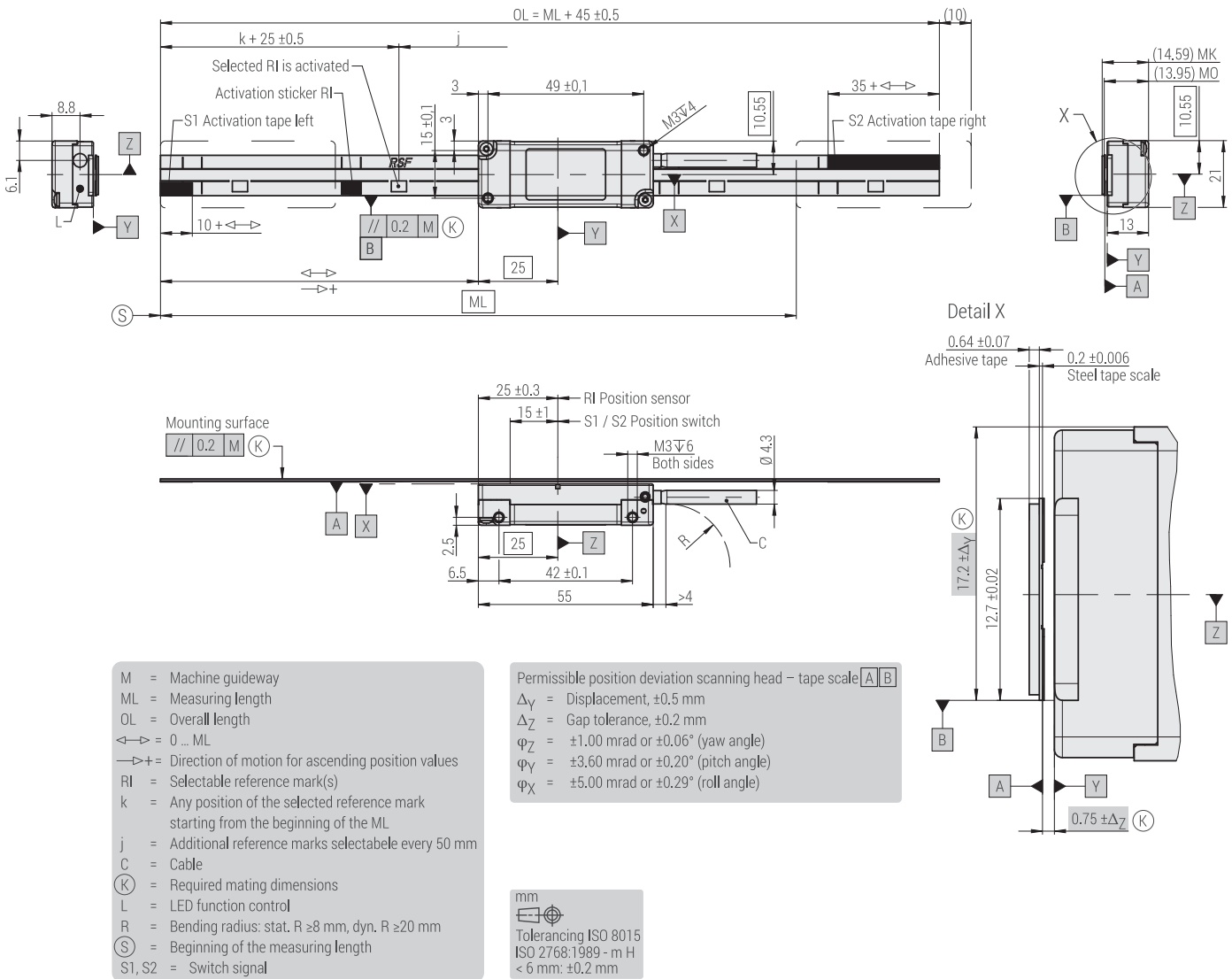
RoHS	2011/65/EU, 2015/863/EU
EMV	2014/30/EU
Product-Certifications	UL, CSA, EN, IEC 61010-1

## MS 25 MO/MK

- Version MO: Steel tape scale
- Version MK: Steel tape scale with adhesive tape

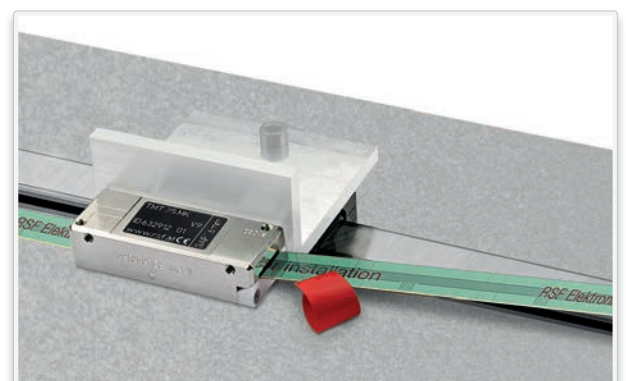


Dimensions, mounting tolerances:



Tape mounting tool **TMT MS 25 MK** (optional)  
For safe and precise mounting of the steel tape scale.

- Mount TMT MS 25 MK instead of the scanning head MS 25
- Thread steel tape scale (version MK) and move along the scale length
- Remove TMT MS 25 MK, mount scanning head MS 25

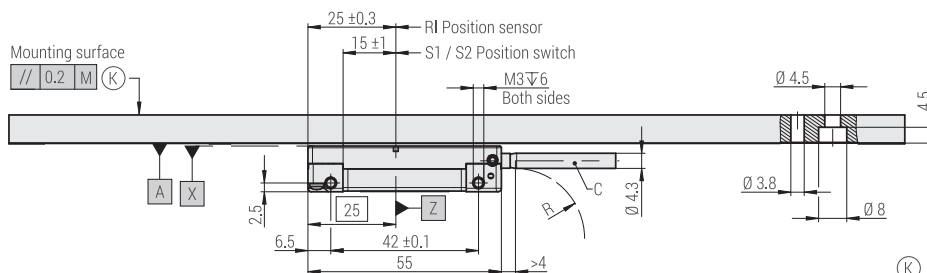
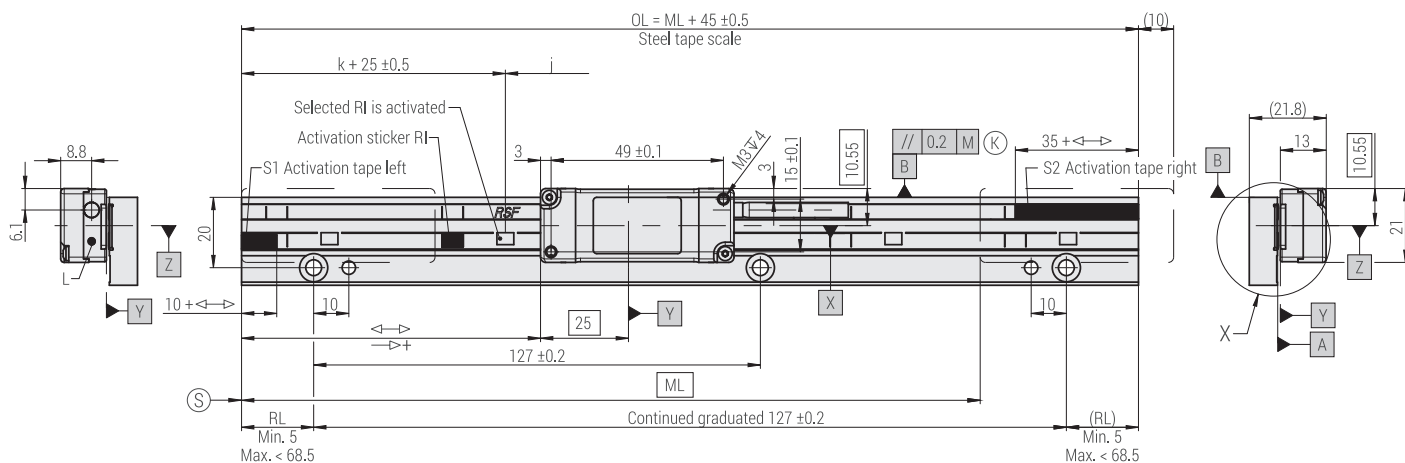


# MS 25 MA/MS

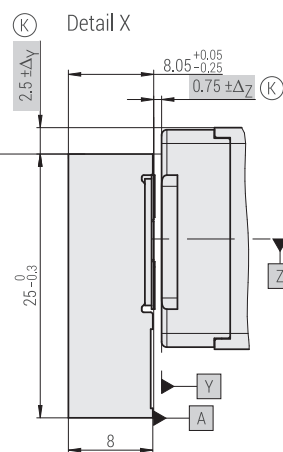
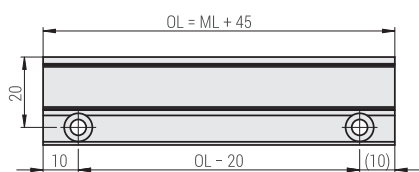
- Version MA: Steel tape scale on aluminum carrier
- Version MS: Steel tape scale on steel carrier
- Version MA, MS: Carrier bolted



Dimensions, mounting tolerances:



Scale carrier for measuring length < 92mm



- M = Machine guideway
- ML = Measuring length
- OL = Overall length
- ↔ ... ML
- + = Direction of motion for ascending position values
- RI = Selectable reference mark(s)
- k = Any position of the selected reference mark starting from the beginning of the ML
- j = Additional reference marks selectable every 50 mm
- C = Cable
- (K) = Required mating dimensions
- L = LED function control
- R = Bending radius: stat. R ≥ 8 mm, dyn. R ≥ 20 mm
- RL = Residual length
- (S) = Beginning of the measuring length
- S1, S2 = Switch signal

- Permissible position deviation scanning head – tape scale (A, B)
- Δ<sub>Y</sub> = Displacement, ±0.5 mm
  - Δ<sub>Z</sub> = Gap tolerance, ±0.2 mm
  - φ<sub>Z</sub> = ±1.00 mrad or ±0.06° (yaw angle)
  - φ<sub>Y</sub> = ±3.60 mrad or ±0.20° (pitch angle)
  - φ<sub>X</sub> = ±5.00 mrad or ±0.29° (roll angle)

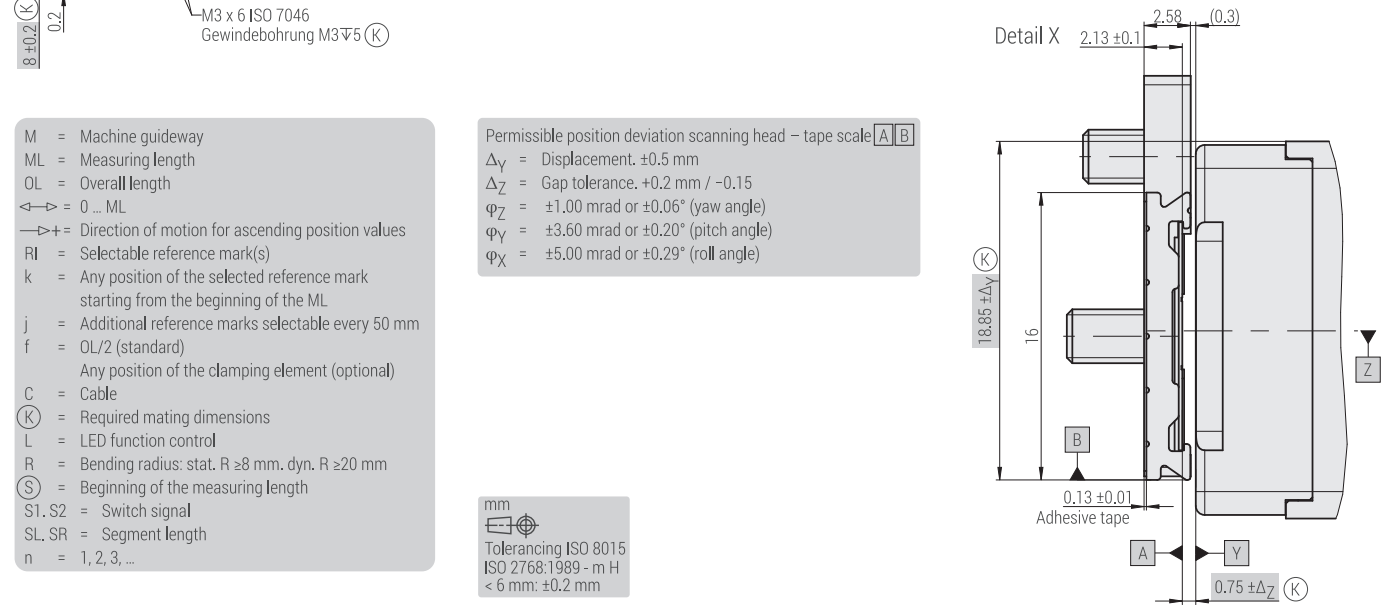
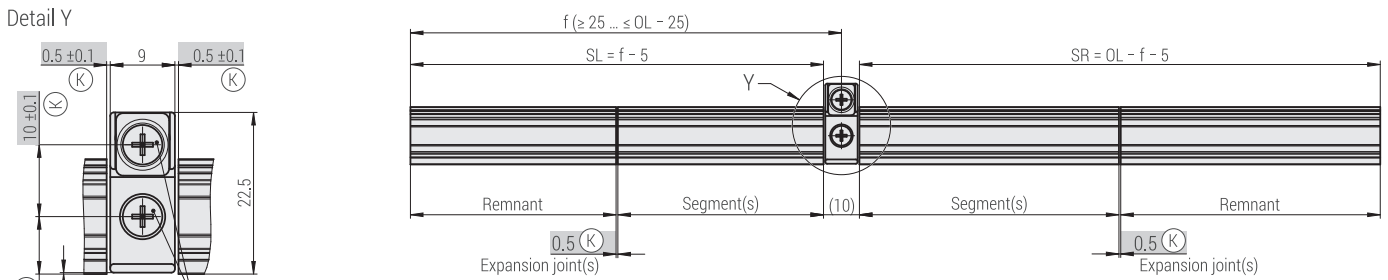
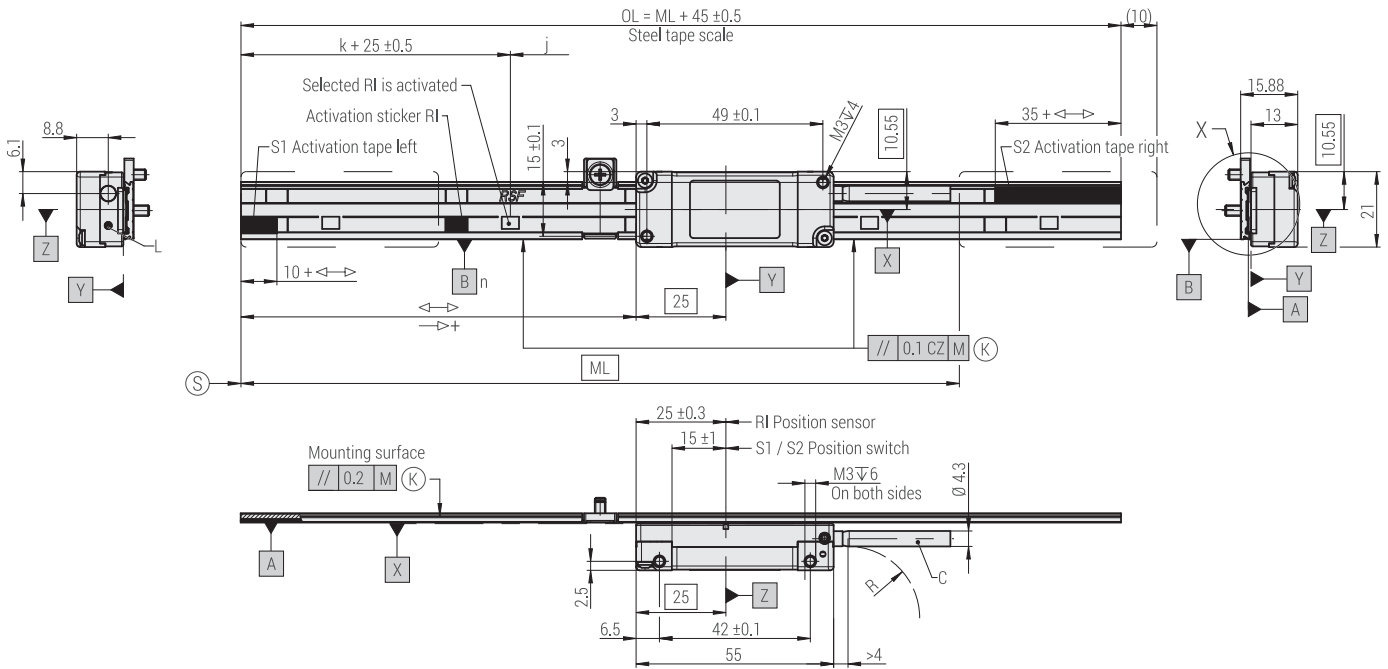
mm  
  
 Tolerancing ISO 8015  
 ISO 2768:1989 - m H  
 < 6 mm: ±0.2 mm

## MS 25 MP

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



Dimensions, mounting tolerances:



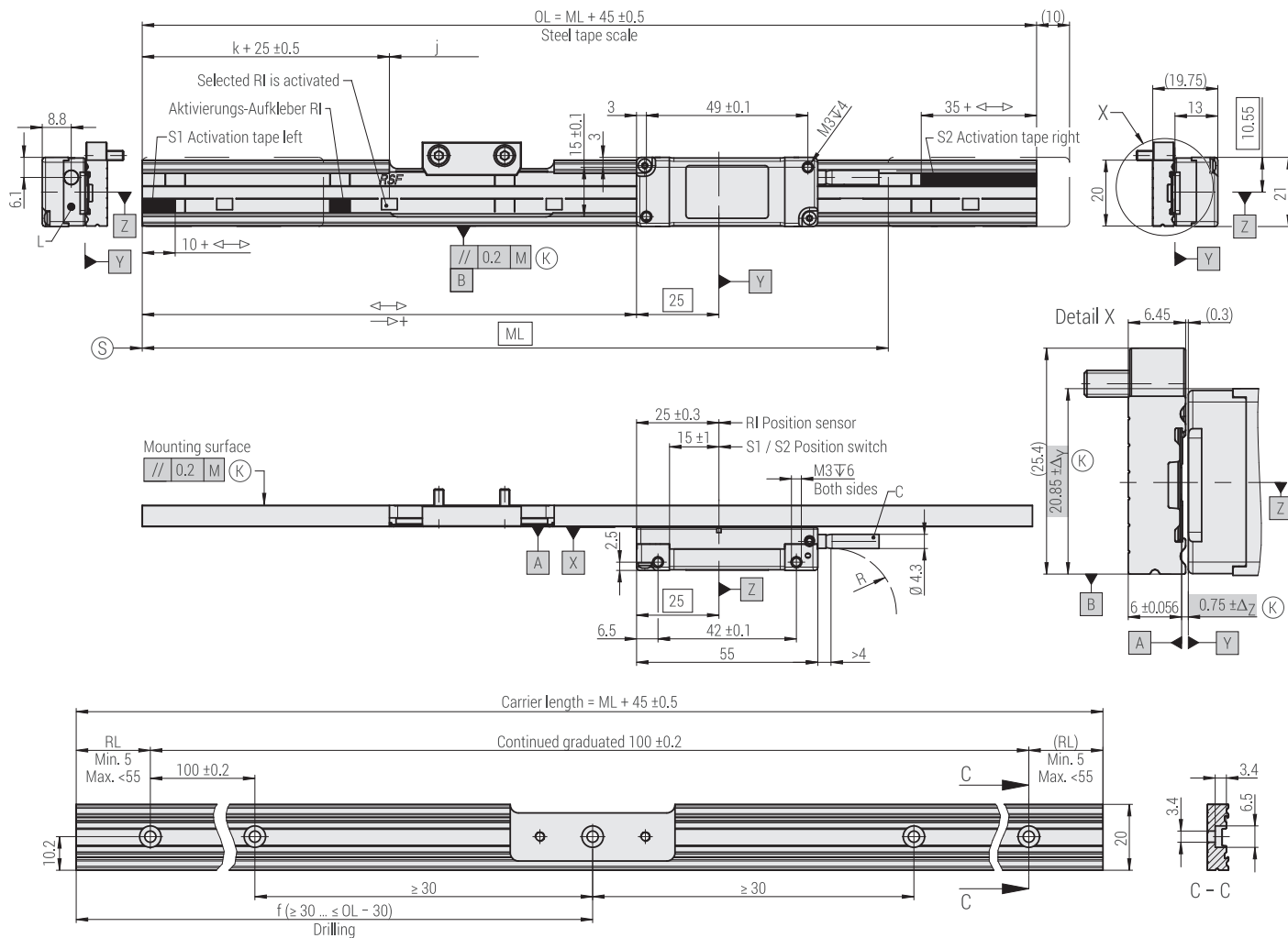
- M = Machine guideway
- ML = Measuring length
- OL = Overall length
- ↔ = 0 ... ML
- + = Direction of motion for ascending position values
- RI = Selectable reference mark(s)
- k = Any position of the selected reference mark starting from the beginning of the ML
- j = Additional reference marks selectable every 50 mm
- f = OL/2 (standard)
- Any position of the clamping element (optional)
- C = Cable
- (K) = Required mating dimensions
- L = LED function control
- R = Bending radius: stat. R ≥ 8 mm. dyn. R ≥ 20 mm
- (S) = Beginning of the measuring length
- S1, S2 = Switch signal
- SL, SR = Segment length
- n = 1, 2, 3, ...

# MS 25 MT

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



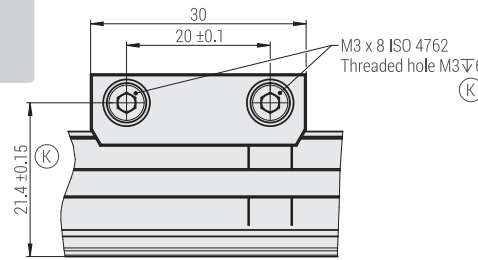
Dimensions, mounting tolerances:



- M = Machine guideway
- ML = Measuring length
- OL = Overall length
- ↔ = 0 ... ML
- += Direction of motion for ascending position values
- RI = Selectable reference mark(s)
- k = Any position of the selected reference mark starting from the beginning of the ML
- j = Additional reference marks selectable every 50 mm
- f = Any position of the clamping element
- C = Cable
- (K) = Required mating dimensions
- L = LED function control
- R = Bending radius: stat. R ≥ 8 mm, dyn. R ≥ 20 mm
- RL = Residual length
- (S) = Beginning of the measuring length
- S1, S2 = Switch signal

- Permissible position deviation scanning head – tape scale (A) (B)
- Δ<sub>Y</sub> = Displacement, ±0.5 mm
  - Δ<sub>Z</sub> = Gap tolerance, +0.2 mm / -0.1
  - φ<sub>Z</sub> = ±1.00 mrad or ±0.06° (yaw angle)
  - φ<sub>Y</sub> = ±3.60 mrad or ±0.20° (pitch angle)
  - φ<sub>X</sub> = ±5.00 mrad or ±0.29° (roll angle)

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







## REFERENCE MARK (RI)- AND SWITCH POINTS-SELECTION

### Reference mark (RI)-selection



### Selection of the switch points

$S1_L$  = Switch point signal S1 from the beginning of the measuring length ML

$S1_R$  = Switch point signal S1 before end of the measuring length ML

$S2_L$  = Switch point signal S2 from the beginning of the measuring length ML

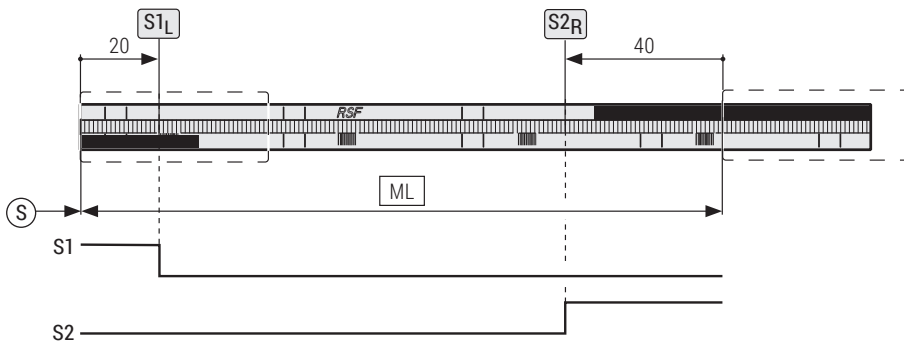
$S2_R$  = Switch point signal S2 before end of the measuring length ML

(S) = Beginning of the measuring length ML

#### EXAMPLE 1:

$S1_L$  : 20 mm from beginning of ML

$S2_R$  : 40 mm before end of ML



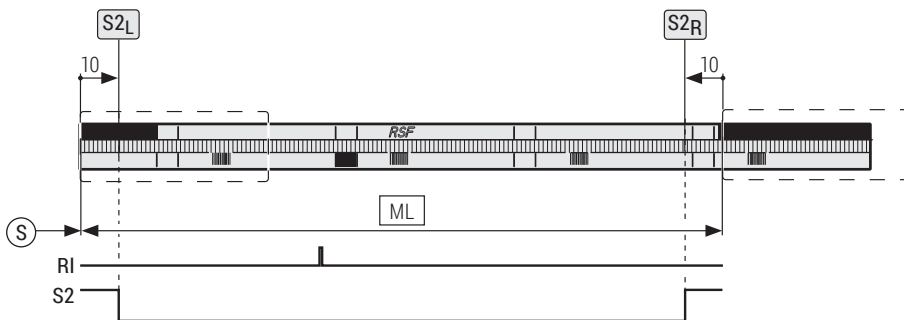
### Reference mark (RI)-selection and positioning of the activation tapes

#### EXAMPLE 2:

$S2_L$  : 10 mm from beginning of ML

$S2_R$  : 10 mm before end of ML

RI: Measuring length / 2



#### Note!

Dimensions and rules for activation tapes are described in the mounting instructions.

## INSPECTION OF FUNCTION

STATUS OF LED	INFORMATION	NOTE
<b>Without external test box</b>		
<b>Function-control main track</b>		
▪ LED displays GREEN	Counting signals very good	After successful mounting
▪ LED blinks GREEN	Counting signals good	At mounting not allowed → allowed during operation
▪ LED blinks RED	Counting signals out of tolerance → error	Check mounting, clean scale
<b>Function-control reference impulse RI</b>		<b>Only by passing the reference mark</b>
▪ LED blinks BLUE	RI within tolerance	
▪ LED blinks RED	RI out of tolerance	Check mounting, clean graduation carrier
<b>With external test box</b>		
<b>Function-control main track</b>		
▪ LED displays GREEN	Scanning head supplied with power	Evaluation of counting signals via LED not active
<b>Function-control reference impulse RI</b>		<b>Only by passing the reference mark</b>
▪ LED blinks BLUE	RI within tolerance	
▪ LED blinks RED	RI out of tolerance	Check mounting, clean graduation carrier

**Note!** If the scanning head passes a further reference mark within 0.5 s the information of the reference mark will not be stated by the function control. Thus the information of the incremental signals will also be displayed at high traversing speed and/or many active reference marks.

## EXTERNAL TESTING DEVICE PWT 101

Even though the MS 25 linear encoders allow large mechanical mounting tolerances, it is recommended to control the function of counting signals and reference impulse.

The signals can be controlled directly via the integrated LED function control or connected to an oscilloscope and checked for conformity with signal specifications. The last mentioned method requires some effort.

The PWT 101 is a testing device for checking the function and adjustment of RSF Elektronik encoders. At encoders with pin assignment according to RSF standard (compare page 05) the pinout adapter PA2 must be used additionally. At alternative pin assignments other pinout adapters could be necessary.

Thanks to its compact dimensions and robust design, the PWT 101 is ideal for mobile use. A 4.3-inch touchscreen provides for display and operation.

### Available functions

The performance range of the PWT 101 can be expanded by firmware update. Appropriate firmware files that can be imported to the PWT 101 through a memory card (not included in delivery) will be made available at [www.heidenhain.de](http://www.heidenhain.de).



## FURTHER PRODUCTS



### MCR 16

*Absolute modular angle encoders with small dimensions*

- Diverse serial interfaces
- Status display directly at the scanning head via LED function
- Optimized interpolation error
- Easy mounting as a result of large mounting tolerances
- High insensitivity against contaminations
- Possible drum diameter (TTR): 75.06 mm to 350.23 mm (outside)
- Possible scanning diameter (MBR): 75.06 mm to 350.23 mm (outside)
- Possible scanning diameter (MCS): from  $\varnothing$  75 mm

### MCR 15 | MCS 15

*Absolute modular angle encoders with small dimensions*

- Diverse serial interfaces
- Status display directly at the scanning head via LED function
- Easy mounting as a result of large mounting tolerances
- High insensitivity against contaminations
- Possible drum diameter (TTR): 50.00 mm to 350.23 mm (outside)
- Possible scanning diameter (MBR): 59.93 mm to 350.23 mm (outside)
- Possible scanning diameter (MCS): from  $\varnothing$  75 mm

### MSR 15 | MSS 15

*Incremental modular angle encoders with small dimensions*

- Quality of the scanning signals is directly visible at the scanning head via a tricolored LED function
- Easy mounting as a result of large mounting tolerances
- High insensitivity against contaminations
- Possible drum diameter (TTR): 50.00 mm to 350.23 mm (outside)
- Possible scanning diameter (MBR): 59.93 mm to 350.23 mm (outside)
- Possible scanning diameter (MSS): from  $\varnothing$  75 mm

### MSR 45

*Modular angle encoders with steel tape scale - various versions*

- Full-circle or segment version
- Grating period: 200  $\mu$ m
- Accuracy of the grating (stretched):  $\pm$ 30  $\mu$ m/m
- High permissible rotational speed resp. circumferential speed
- Integrated subdividing: up to times 100
- Possible diameter: Full-circle from  $\varnothing$  146.99 mm  
Segment from  $\varnothing$  150 mm



### MC 15

*Absolute linear encoders with status display*

- Diverse serial interfaces
- Status display directly at the scanning head via LED function
- Easy mounting as a result of large mounting tolerances
- High insensitivity against contaminations
- Max. measuring length  
Steel tape scale: 10 000 mm

### MS 14

*Exposed linear encoder with integrated mounting control*

- Easy mounting; no test box or oscilloscope needed
- Quality of the scanning signals is directly visible at the scanning head via a tricolored LED function
- Position of reference mark selectable by customer
- High insensitivity against contamination
- High permissible traversing speed
- Integrated subdividing: up to times 200
- Max. measuring length  
Steel tape scale: 10 000 mm

### MS 15

*Exposed linear encoder with integrated mounting control*

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

### MS 45

*Exposed scanning linear encoders with integrated mounting control*

- Easy mounting; no test box or oscilloscope needed
- Quality of the scanning signals is directly visible at the scanning head via a tricolored LED function
- Flat dimensions
- Easy mounting due to large mounting tolerances
- High insensitivity against contamination
- High permissible traversing speed
- Integrated subdividing: up to times 100
- Max. measuring length: Steel tape scale: 30 000 mm

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**RSF Elektronik**

Ges.m.b.H.

Linear and Angle Encoders  
Precision Graduations

Certified acc. to  
ISO 9001  
ISO 14001

