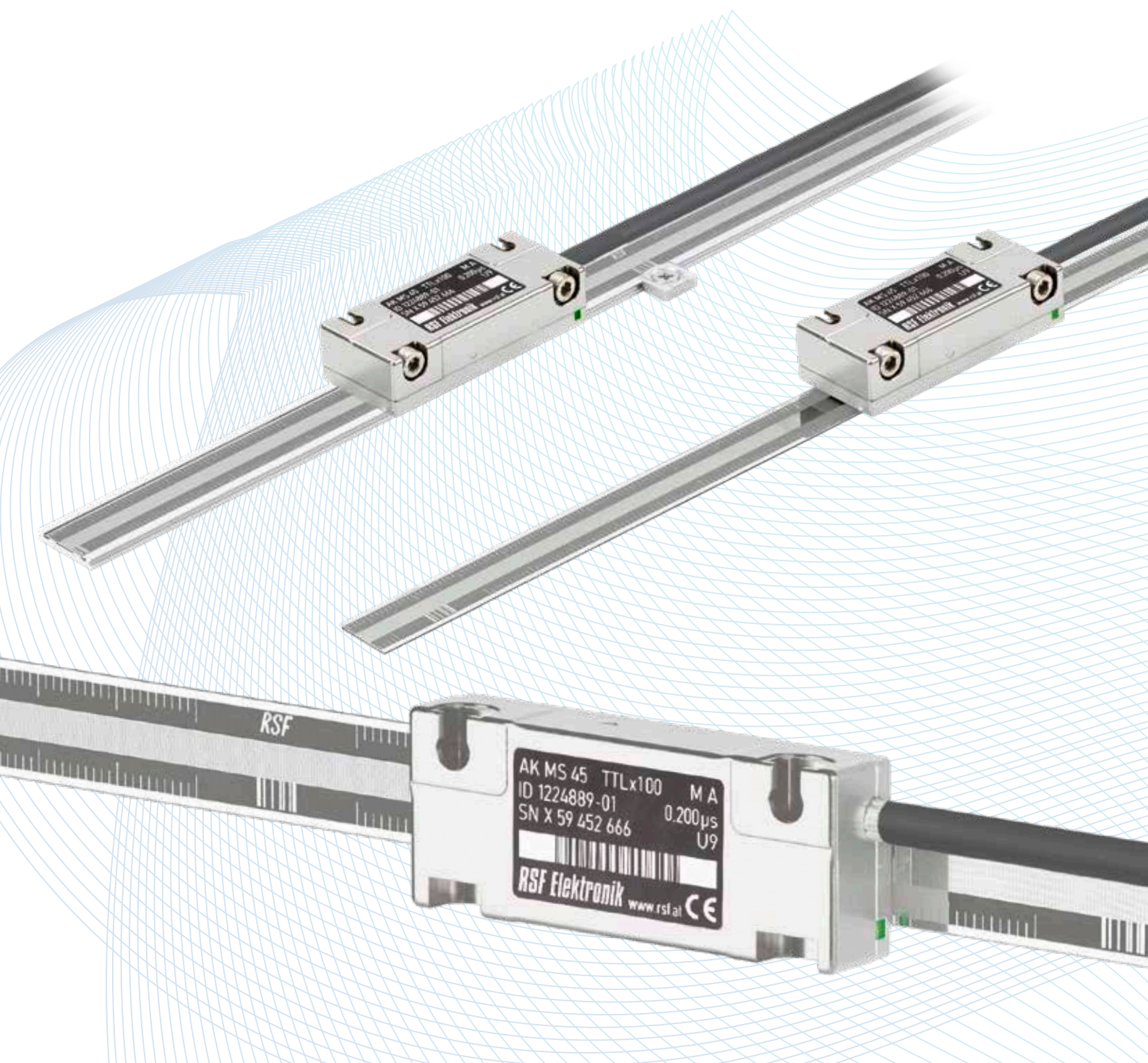




# RSF Elektronik

[www.rsf.at](http://www.rsf.at)

## MS 45 EXPOSED LINEAR ENCODER WITH SINGLEFIELD SCANNING



# CONTENTS

Performance characteristics, scanning principle, reference marks ....	03	MS 45 MO/MK .....	08
Accuracy definition .....	04	MS 45 MP .....	09
Shielding, pin assignments .....	05	Inspection of function .....	10
Interfaces .....	06	External testing device PWT 101 .....	11
Technical data .....	07	Distribution contacts, addresses .....	12

# 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.

### Error signal ( $\overline{US}$ )

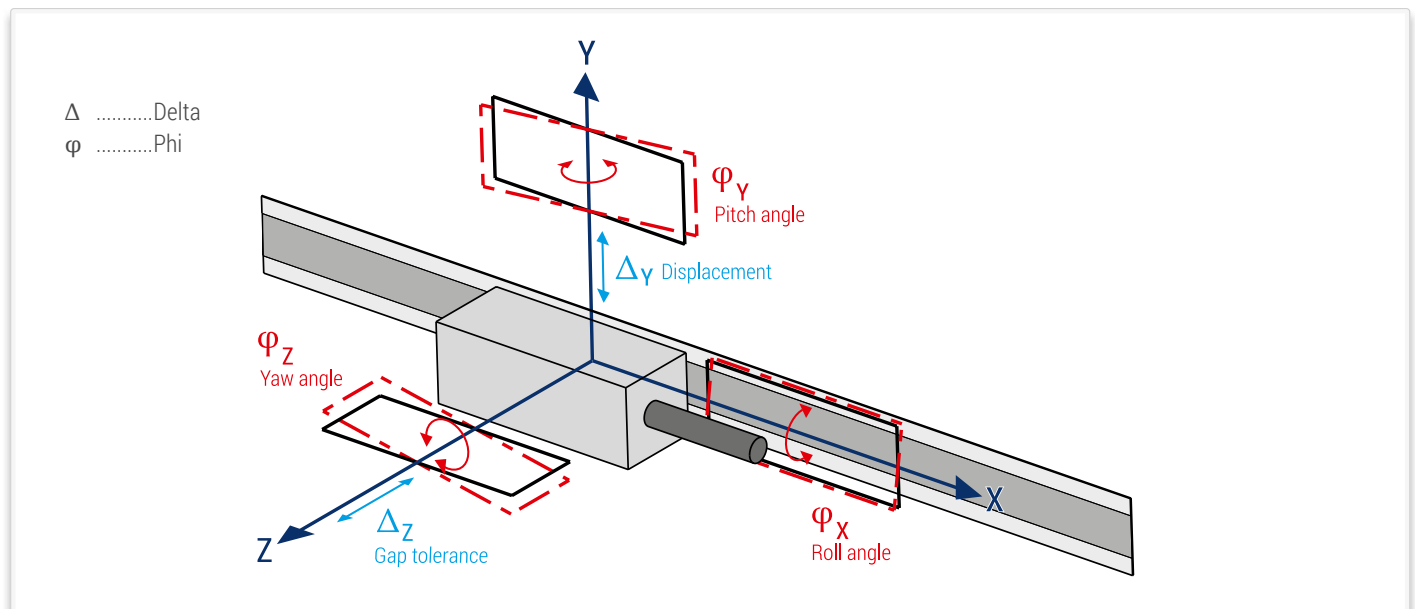
This signal appears when a malfunctioning encoder generates faulty scanning signals.

### 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 - LARGE MOUNTING TOLERANCES
- LOW COST AND HIGH QUALITY
- FLAT DIMENSIONS
- NO MECHANICAL BACKLASH
- NO FRICTIONAL FORCE
- REFERENCE MARKS, REPEATABLE FROM BOTH TRAVERSING DIRECTIONS
- MEASURING STEP: 10  $\mu\text{m}$  – 0.5  $\mu\text{m}$

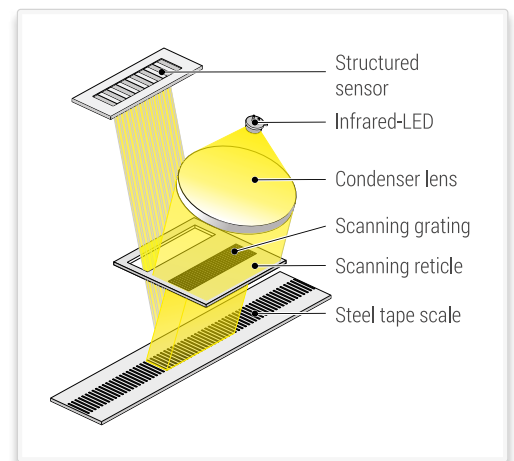
## SCANNING PRINCIPLE

The incremental linear encoder MS 45 works with a photoelectric measuring principle and a **singlefield reflective scanning** method. A graduation pattern with 200  $\mu\text{m}$  grating period is used on a steel tape.

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.

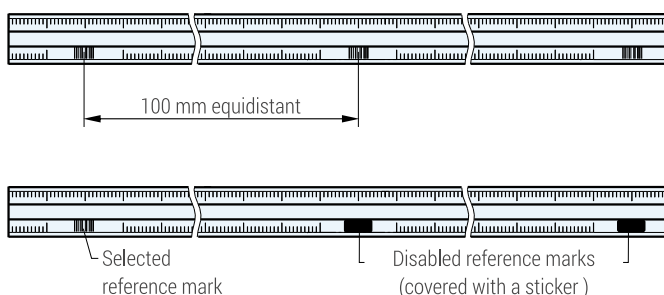
The sensor generates high quality sinusoidal signals which are highly insensitive to possible contaminations.

The regulation of the LED ensures a constant signal amplitude, guaranteeing stability in the case of temperature fluctuations and with long-run operation.

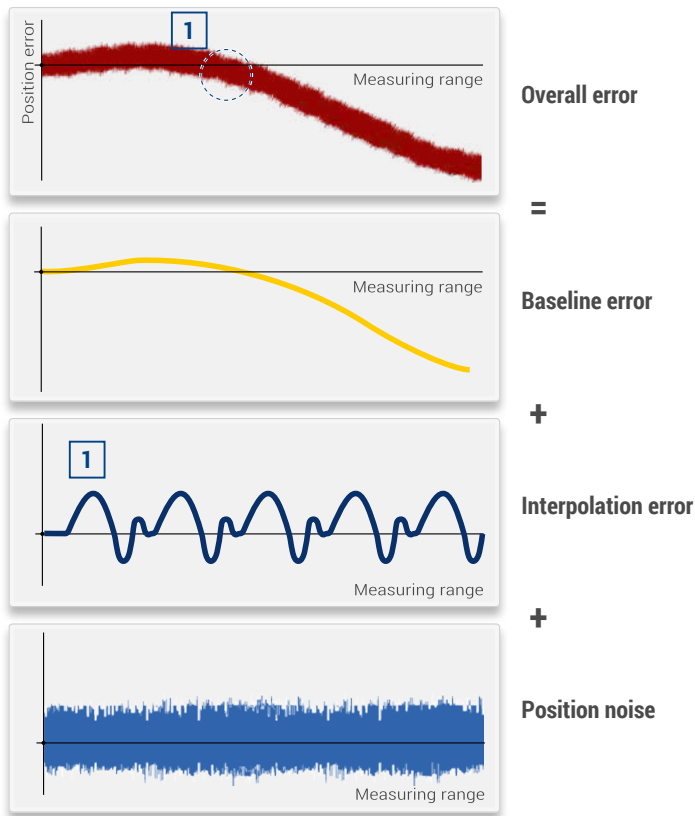


## REFERENCE MARKS

Principle of the standard reference marks



## ACCURACY DEFINITION



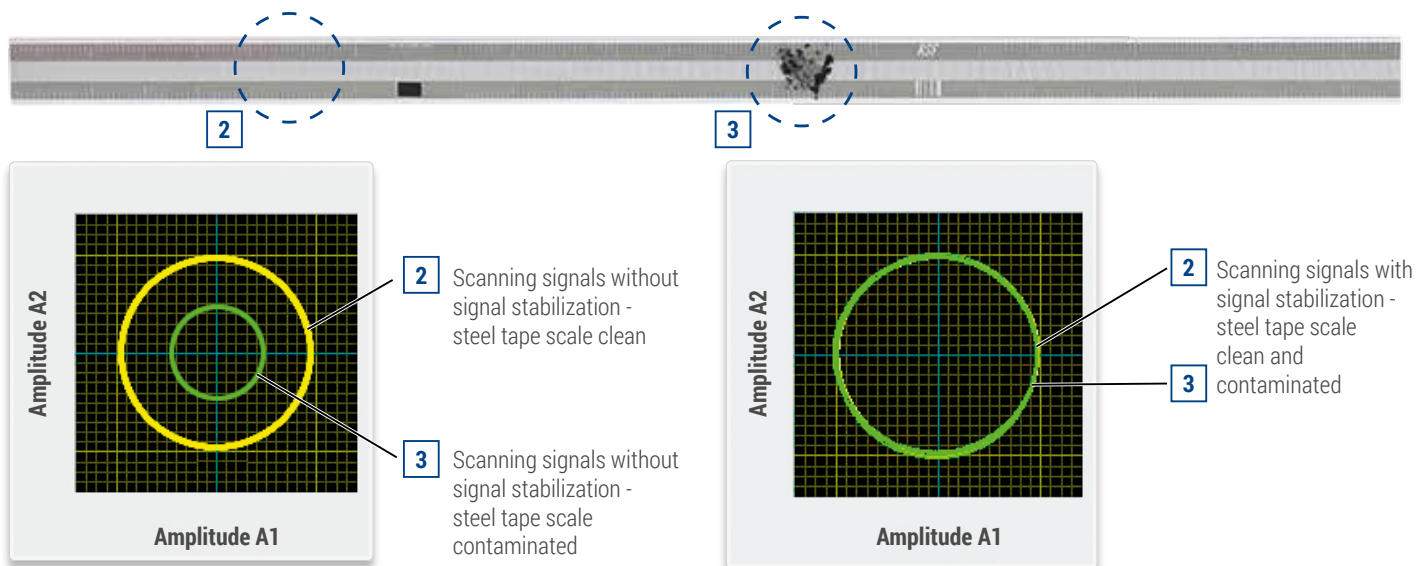
The accuracy of a linear encoder is mainly determined by the baseline error of the graduation carrier, the interpolation error of the optoelectronic scanning and the position noise.

The baseline error is the error of the graduation carrier determined in a measurement room under optimum conditions.

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

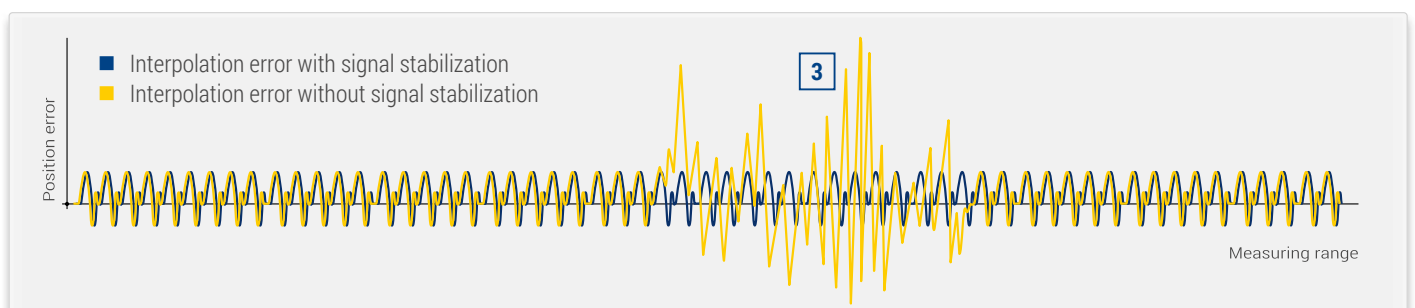
### Effect of contamination on the quality and amplitude of scanning signal

Steel tape scale contaminated by fluids, dust, particles, fingerprints etc.

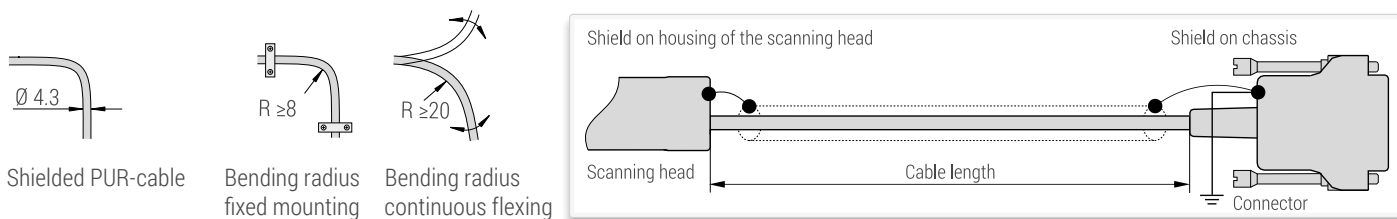


### Effect of contamination on the interpolation error

Steel tape scale contaminated by fluids, dust, particles, fingerprints etc.



## SHIELDING, PIN ASSIGNMENTS

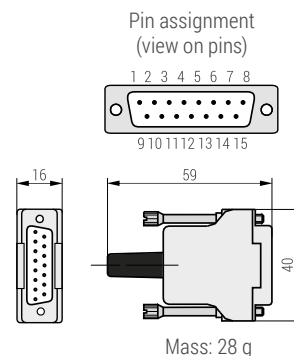


- Torsion > 300.000 cycles
- Drag chain > 5.000.000 cycles
- Cables for use in vacuum applications are available on request.

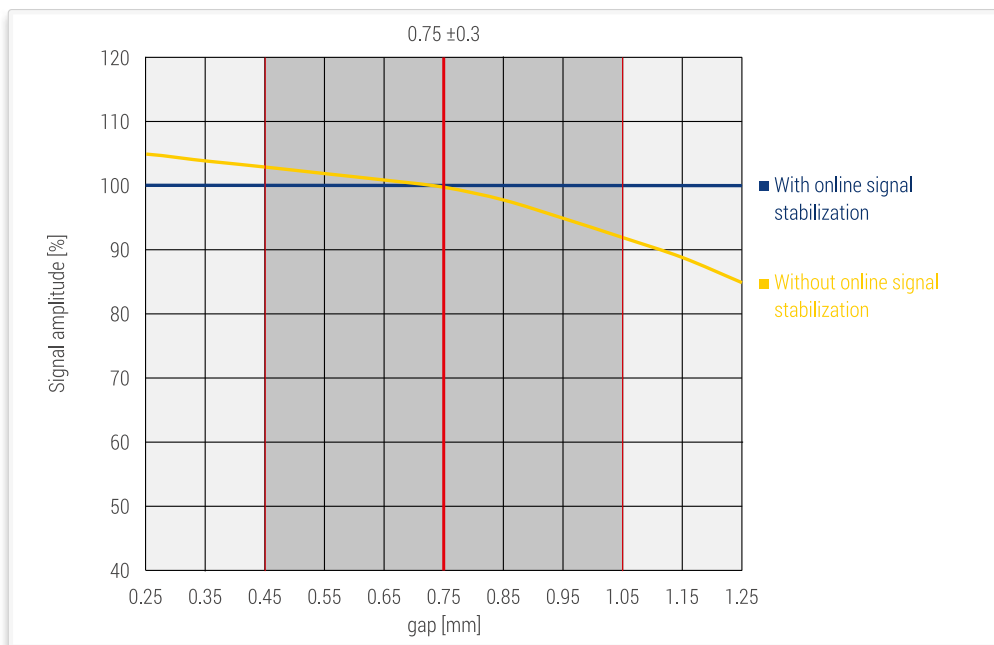
### D-sub connector, male, 15-pin

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 setup. By applying +5 V to the test pin, the NOT stabilized test signals (1 Vpp) are switched to the output connector.
- \*\* Test = analog signal switch-over for setup. By applying +5 V to the test pin, the test signals (sinusoidal micro-current signals 11  $\mu$ App) are switched to the output connector.
- Sensor: the sensor-pins are bridged in the chassis with the particular power supply.
- The shield is additionally connected with the chassis.
- Pins or wires marked "occupied" or "nc" must not be used by the customer.



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



# INTERFACES

## 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:** +5V ±10 %, max. 130mA (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-):

Useable component 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 -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  $a_{min}$  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

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

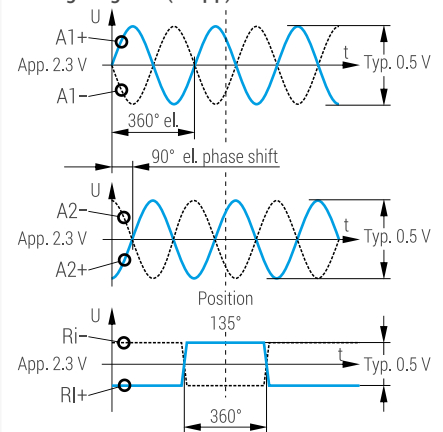
**Power supply:** +5 V ±10%, max. 140 mA (unloaded)

**Advantage:**

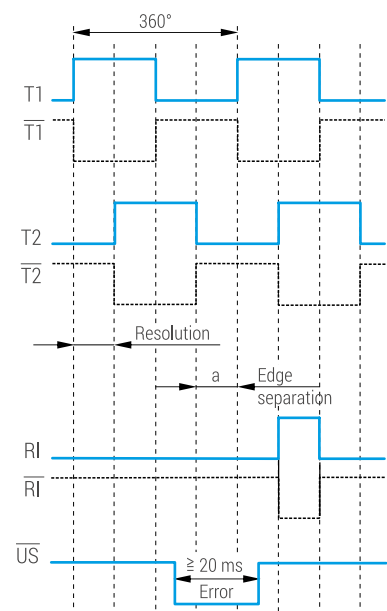
- Noise immune signals

- No further subdividing electronics necessary

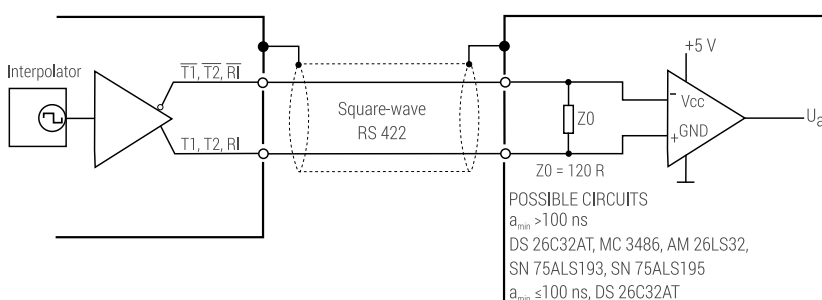
### Voltage signals (1 Vpp)



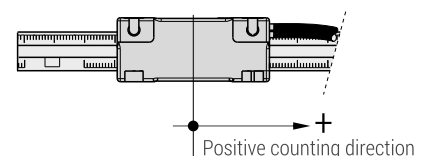
### Square wave signals „differential“



### Recommended line receiver circuit



### Counting direction





## TECHNICAL DATA

### 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 [μm]	Depending on external interpolation	10.00	5.00	1.00	0.50
Integrierte Interpolation	--	Times 5	Times 10	Times 50	Times 100
Max. velocity [m/s]	15.00	10.00	9.60	4.80	2.40
Max. output frequency	75 kHz	--	--	--	--
Edge separation a <sub>min</sub>	--	500 ns	500 ns	200 ns	200 ns
Interpolation error with signal stabilization	Typical ± 1 μm (peak-peak)				
Electrical connection	Cabel, 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. 770 mW (without load)</li> </ul>				
Current consumption	<ul style="list-style-type: none"> <li>▪ 1 Vpp: 130 mA (without load)</li> <li>▪ TTL: 140 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: 17 g (without cable), cable: 30 g/m, connector: D-sub connector: 28 g				

### GRADUATION CARRIER

Model	MS 45 MO/MK	MS 45 MP
Graduation carrier	Steel tape scale	
Coefficient of linear expansion	$\alpha \approx 10 \times 10^{-6}/K$	
Grating period	200 μm	
Accuracy grade *	±15 μm/m	
Non-linearity	±5 μm/m	
Measuring length ML	30 000 mm	
Reference marks	Standard: 100 mm equidistant / at any location, on request	
Mass	MO: 20 g/m MK: 25 g/m	115 g/m + 2 g clamping

\* At 20 °C

### CONFORMITIES AND CERTIFICATIONS

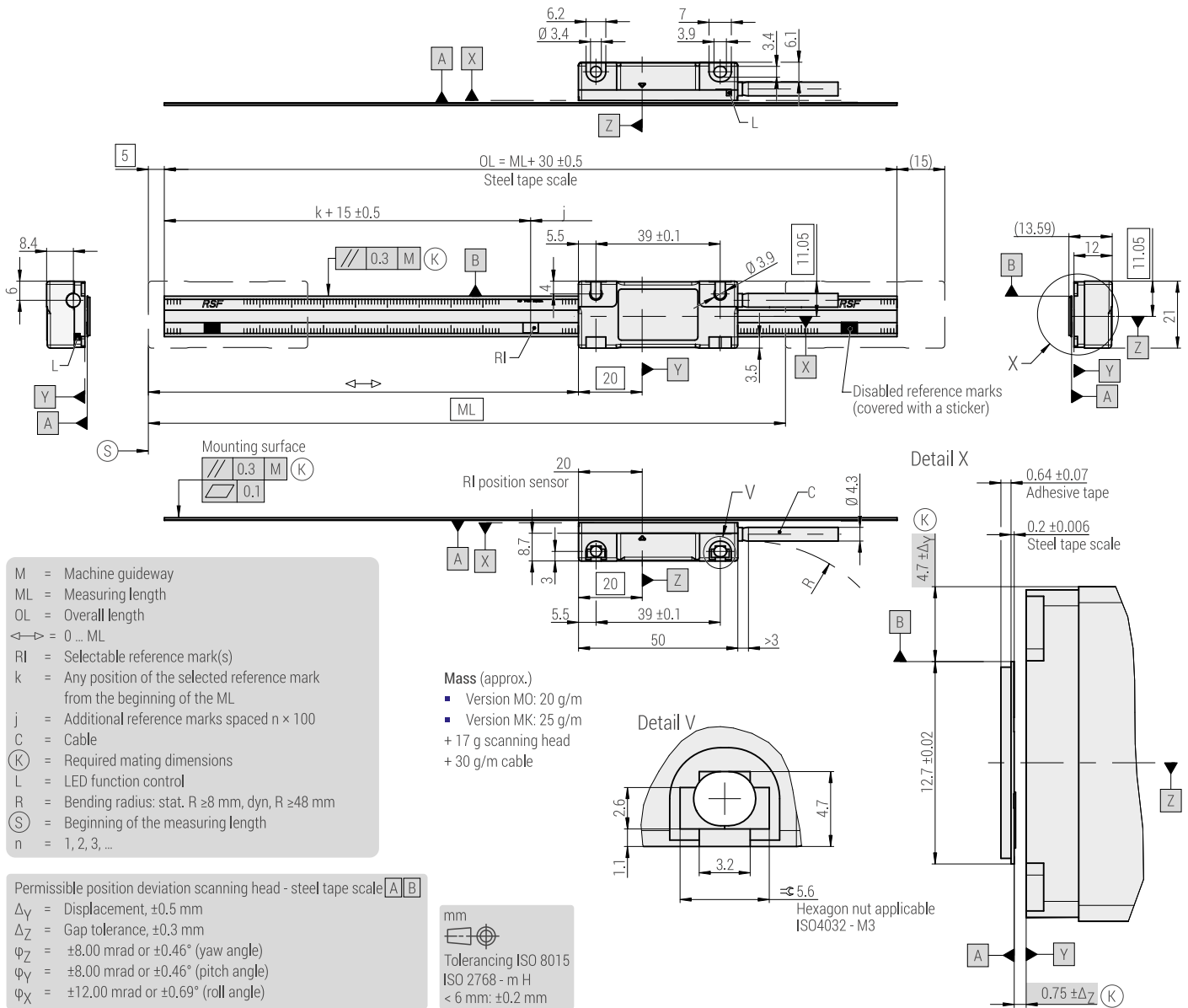
RoHS	2011/65/EU, 2015/863/EU
EMV	2014/30/EU
Product-Certifications	UL, CSA, EN, IEC 61010-1

## MS 45 MO/MK

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

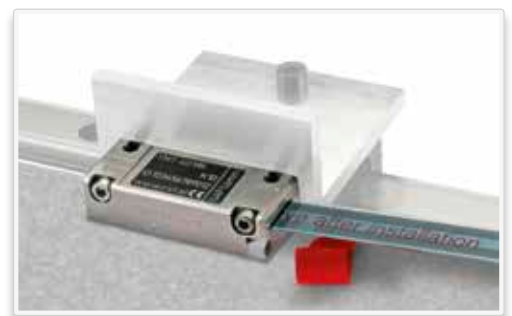


Dimensions, mounting tolerances:



Tape mounting tool TMT MS 45 MK (optional)  
For safe and precise mounting of the steel tape scale.

- Mount TMT MS 45 MK instead of the MS 45 scanning head
- Thread steel tape scale (version MK) and move along the scale length
- Remove TMT MS 45 MK, mount MS 45 scanning head







## 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 45 linear encoders allow large mechanical mounting tolerances, it is recommended to control the function of counting signals and reference impulses.

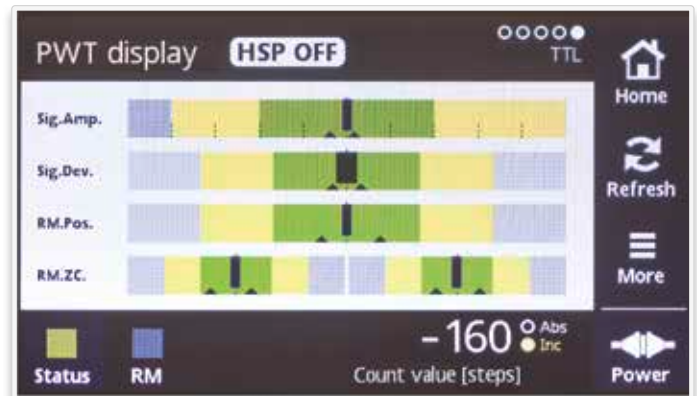
The signals can be controlled directly via the integrated LED function-control or connected to an oscilloscope and checked for conformity with signal specifications. The last mentioned method requires some effort.

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).



## DISTRIBUTION CONTACTS

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Date 06/2021 ■ Art.Nr.1034109-03 ■ Dok.Nr. D1034109-03-A-01 ■ Technical adjustments in reserve!



**RSF Elektronik**

Ges.m.b.H.

Linear and Angle Encoders  
Precision Graduations

Certified acc. to  
ISO 9001  
ISO 14001

