RSF Elektronik

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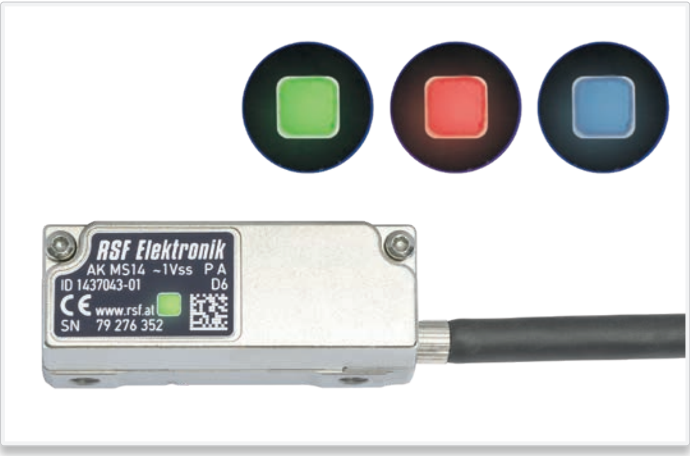
MS 14

EXPOSED LINEAR ENCODERS



SPECIAL FEATURES

- Online signal stabilization
- Display of the signal quality directly at the scanning head via 3-coloured LED function
- Permanent control of the signals over the whole measuring length
- High quality of the signals due to singlefield scanning
- Reference mark position customizable

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.

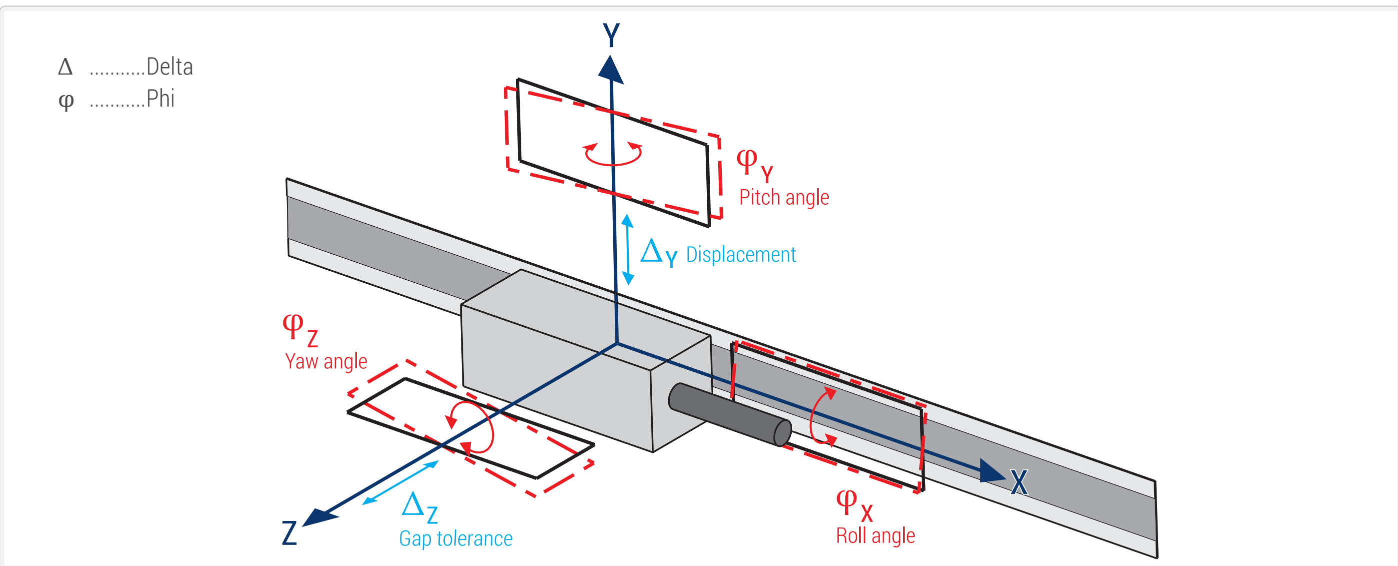
Yaw angle, pitch angle, roll angle, displacement, gap tolerance
Mounting tolerances of the scanning head relative to the graduation carrier.

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 PERMISSIBLE TRAVERSING SPEED
- EASY MOUNTING
- SMALL DIMENSIONS
- NO MECHANICAL BACKLASH
- NO FRICTIONAL FORCE
- REFERENCE MARKS REPEATABLE FROM BOTH TRAVERSING DIRECTIONS
- RESOLUTION: 10 µm – 0.05 µm

MS 14 MEETS ALL THESE REQUIREMENTS!

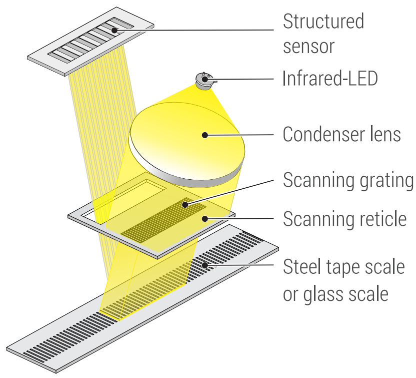
SCANNING PRINCIPLE

The model MS 14 incremental linear encoder system works with the 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.

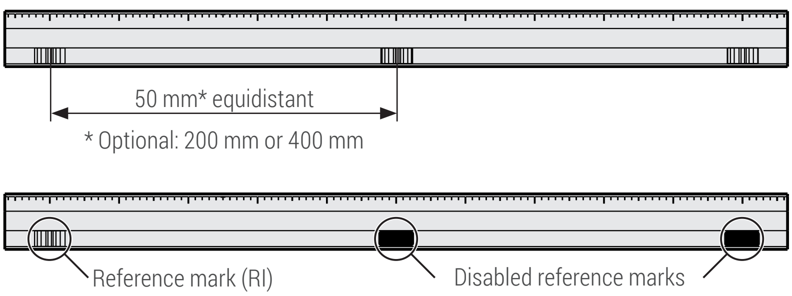
The sensor generates high quality sinusoidal signals which are highly insensitive to possible contaminations.

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



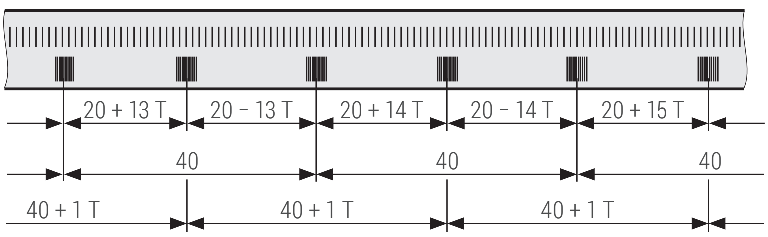
REFERENCE MARKS

Principle of the standard reference marks

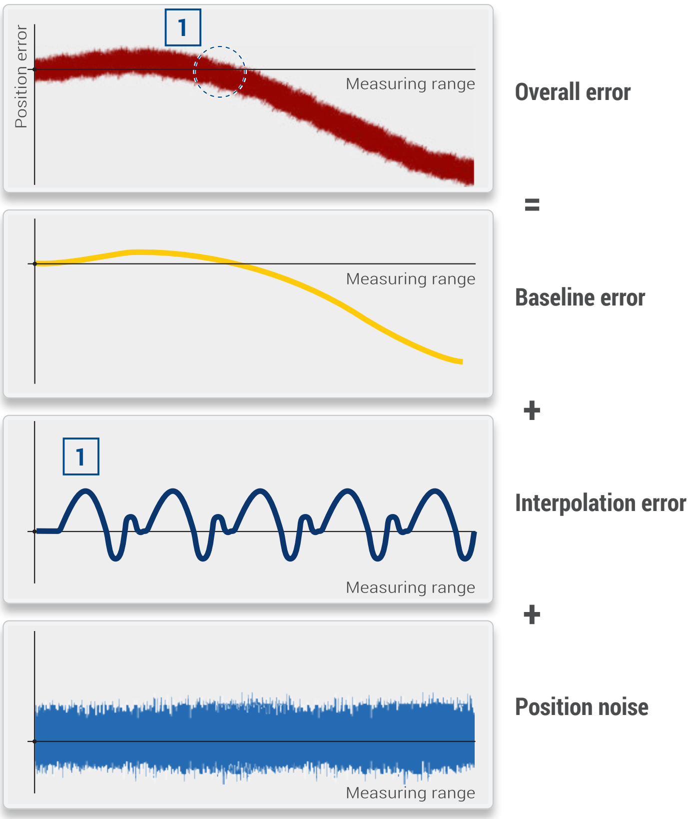


Principle of the distance-coded reference marks

T = Grating period



ACCURACY DEFINITION



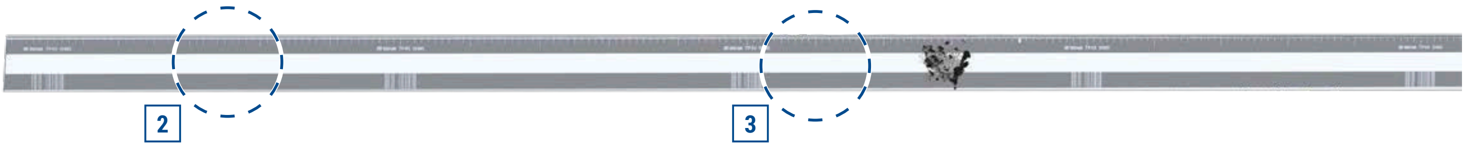
The accuracy of a linear encoder is mainly determined by the baseline error of the graduation carrier, the interpolation error of the optoelectronic scanning and the position noise.

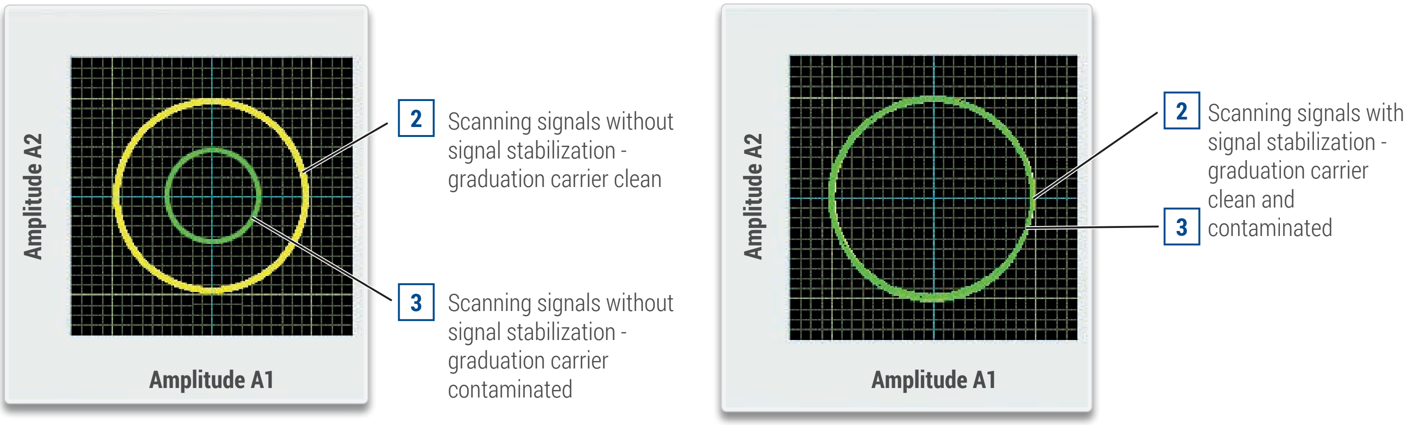
The baseline error is the error of the graduation carrier identified in a measurement room under optimum conditions, along a determined measuring length, without any interpolation error and position noise.

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

Effect of contamination on the quality and amplitude of scanning signal

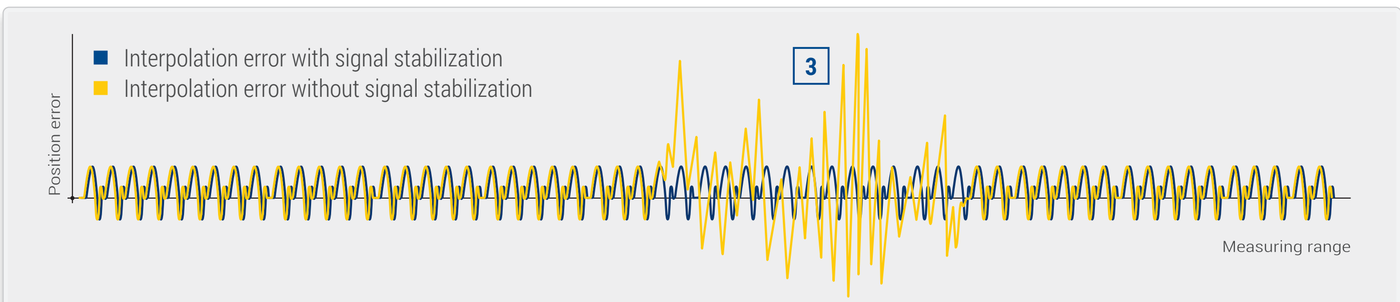
Graduation carrier contaminated by fluids, dust, particles, fingerprints etc.



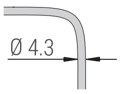


Effect of contamination on the interpolation error

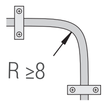
Graduation carrier contaminated by fluids, dust, particles, fingerprints etc.



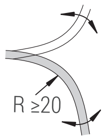
SHIELDING, PIN ASSIGNMENT



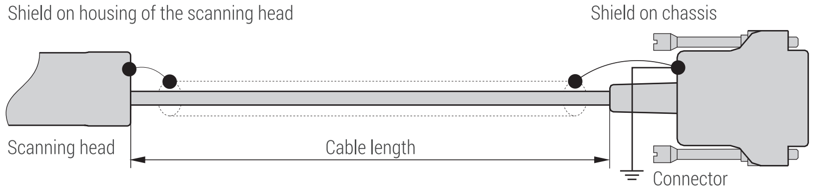
Shielded PUR-cable;
Drag chain qualified.



Bending radius
fixed mounting



Bending radius
continuous flexing

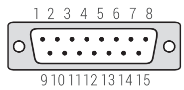


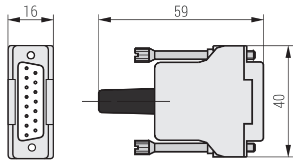
D-sub connector, male, 15-pin

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	nc	nc	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	nc	nc	RI	T2	T1	nc

- * 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.
- ** 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.
- 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.

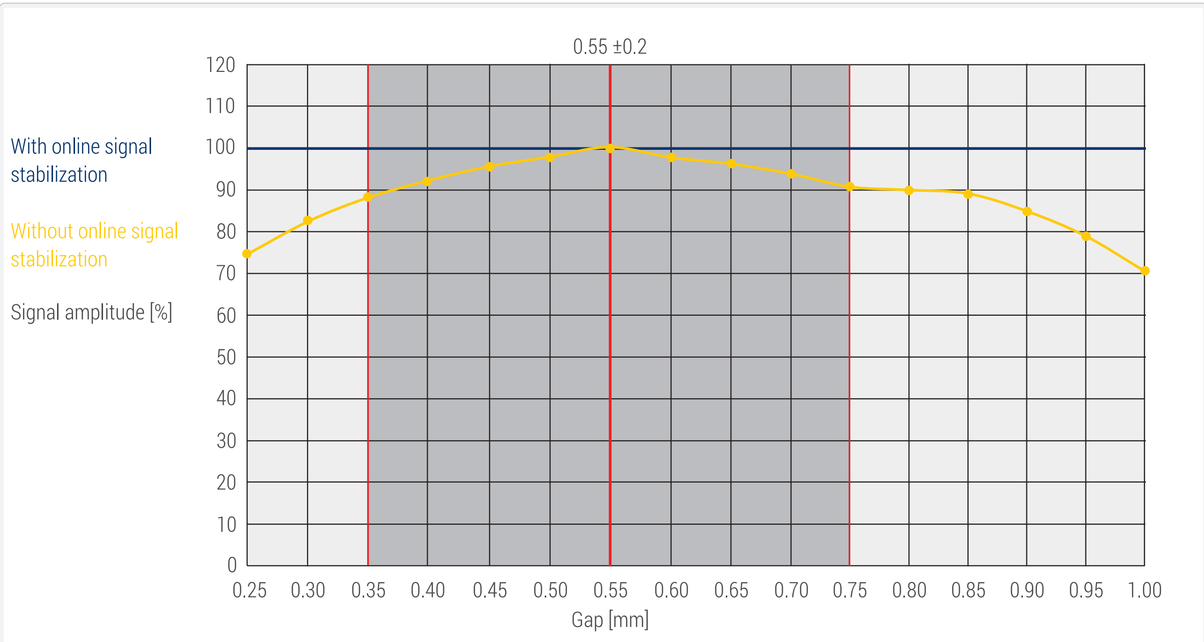
Pin assignment
(view on pins)





Mass: 28 g

Effect of the scanning head gap on the signal amplitude



INTERFACES

SINUSOIDAL VOLTAGE SIGNALS 1 VPP

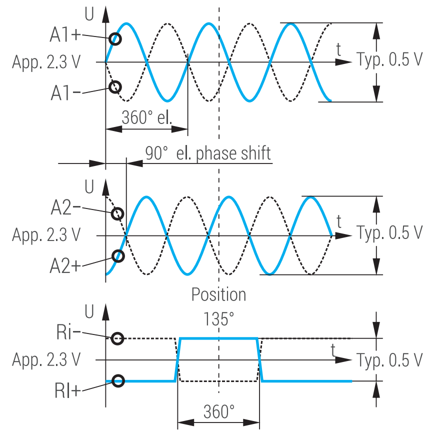
(drawing shows "positive counting direction")

Power supply: +5 V ±10 %, max. 140 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 Zo = 120 Ω 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 Zo = 120 Ω between RI+ to RI–)

Advantage:
- High permissible 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 -1, -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/m
Line receiver:	max. 10 ns (referred to the recommended line receiver circuit)

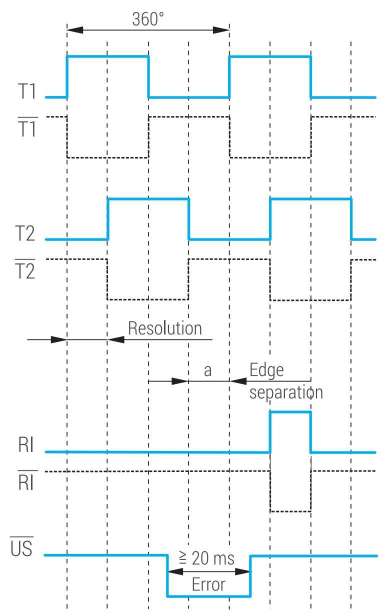
To prevent counting errors, the controls/DRO's must be able to process the resulting edge separation.

Example:
a_{min} = 100 ns, 10 m cable
100 ns - 10 ns - 10 x 0.2 ns - 10 ns = 78 ns

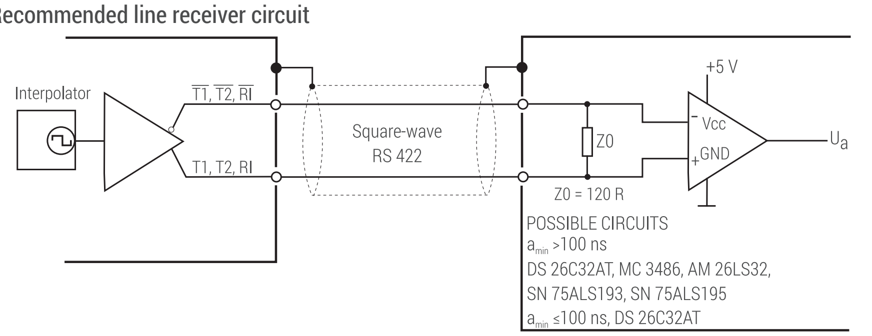
Power supply: +5 V ±10 %, max. 140 mA (unloaded)

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

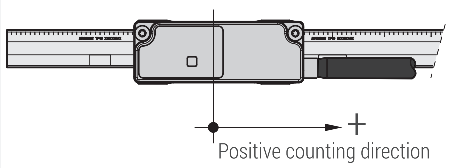
Square-wave signals „differential"



Recommended line receiver circuit



Counting direction



TECHNICAL DATA

SCANNING HEAD

Model	AK MS 14 1 V_{PP}	AK MS 14 TTLx1u	AK MS 14 TTLx5	AK MS 14 TTLx10	AK MS 14 TTLx20	AK MS 14 TTLx25	AK MS 14 TTLx50	AK MS 14 TTLx100	AK MS 14 TTLx200
Interface	∿	⎍	⎍	⎍	⎍	⎍	⎍	⎍	⎍
Measuring step [µm]	Depending on external interpolation	10.00	2.00	1.00	0.50	0.40	0.20	0.10	0.05
Integrated interpolation	--	Times 1	Times 5	Times 10	Times 20	Times 25	Times 50	Times 100	Times 200
Max. output frequency [kHz]	250	--	--	--	--	--	--	--	--
Velocity typ. [m/s]	10.00	10.00	6.40	3.20	2.40	1.92	1.92	0.96	0.96
Edge separation a_{min} [ns]	--	500	300	300	200	200	100	100	50
Velocity max. [m/s]	10.00	10.00	9.60	9.60	9.60	9.60	4.80	2.40	1.20
Edge separation a_{min} [ns]	--	500	200	100	50	40	40	40	40
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	Max. 770 mW (without load)								
Current consumption	Max. 140 mA (without load)								
Vibration 55 Hz – 2000 Hz Shock 8 ms	≤ 150 m/s^2 (EN 60 068-2-6) ≤ 750 m/s^2 (EN 60 068-2-27)								
Operating temperature Storage temperature	0 °C to 50 °C −20 °C to 70 °C								
Mass	Scanning head: 14 g (without cable), cable: 30 g/m, connector: D-sub connector: 28 g								

GRADUATION CARRIER

Model	MB MS 14 MK	MS 14 MP
Graduation carrier	Steel tape scale	Steel tape scale
Coefficient of expansion	$\alpha_{therm} \approx 10 \times 10^{-6} K^{-1}$	$\alpha_{therm} \approx 10 \times 10^{-6} K^{-1}$
Grating period	40 µm	40 µm
Accuracy grades *	±15 µm/m	15 µm/m
Non-linearity	±3 µm/m	±3 µm/m
Baseline error	≤ ±0,75 µm/50 mm (typical)	≤ ±0,75 µm/50 mm (typical)
Max. measuring length ML	10 000 mm **	10 000 mm **
Reference marks	Standard: 50 mm, 200 mm or 400 mm equidistant / Position selectable by customer / Distance-coded on request	
Mass	17 g/m	90 g/m + 2 g clamping

* At 20 °C

** Longer lengths on request

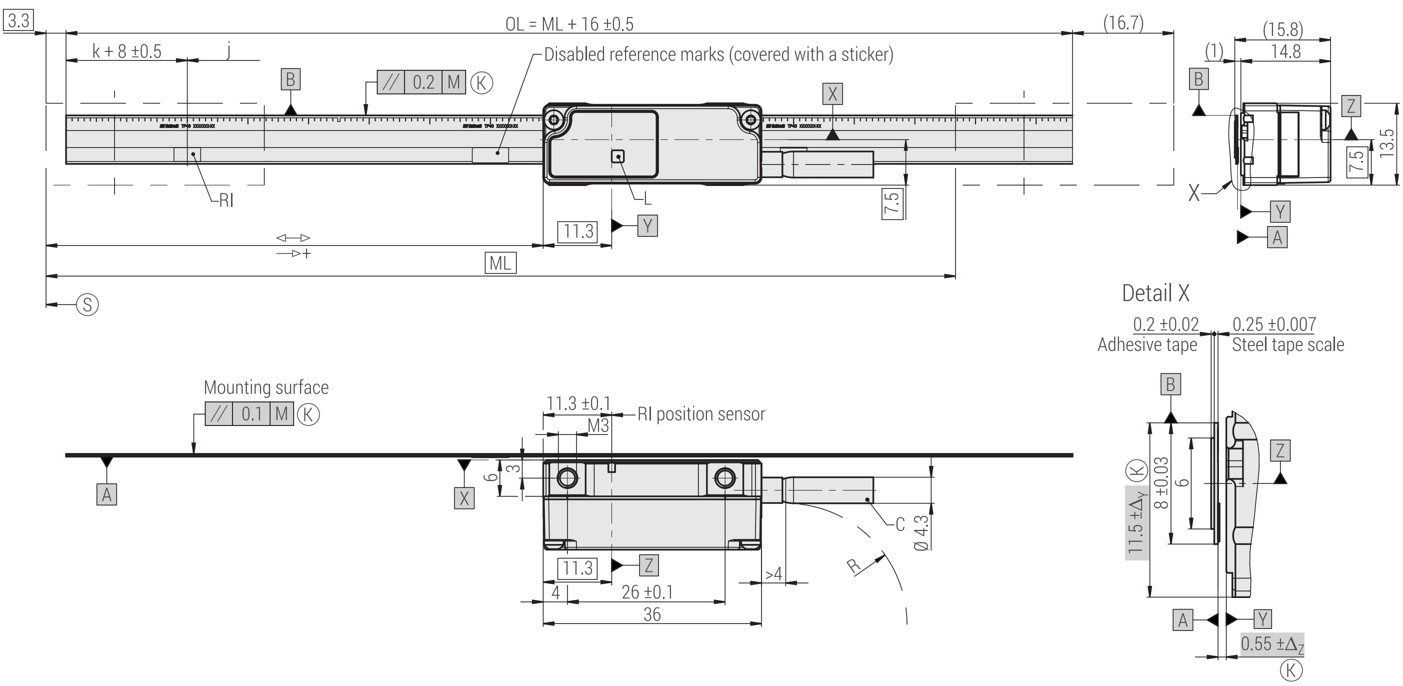
CONFORMITIES AND CERTIFICATIONS

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

MS 14 MK

- Steel tape scale 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	=	Reference mark(s)
k	=	Any position of selected reference mark starting from the beginning of the ML
j	=	Additional reference marks selectable every 50 mm (optional every 200 mm or 400 mm)
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 ML

Permissible position deviation scanning head - tape scale A B

Δ_Y	=	Displacement, ±0.5 mm
Δ_Z	=	Gap tolerance, ±0.2 mm
φ_Z	=	±1.00 mrad or ±0.06° (yaw angle)
φ_Y	=	±3.50 mrad or ±0.20° (pitch angle)
φ_X	=	±4.00 mrad or ±0.23° (roll angle

mm

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

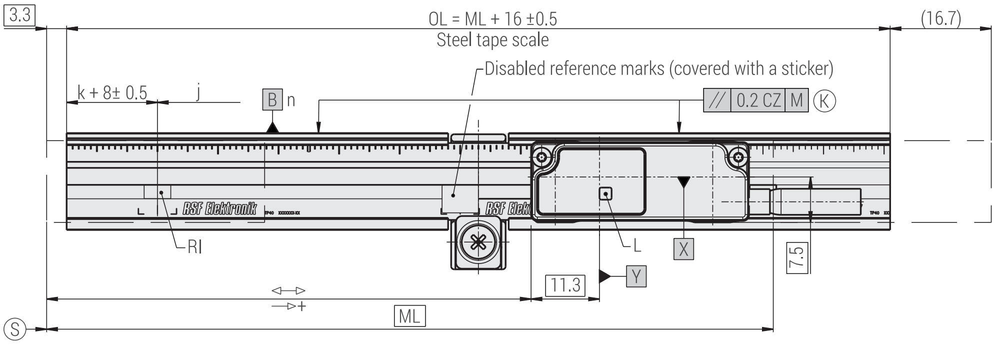
Tape mounting tool **TMT MS 15 MK** (optional)
For safe and precise mounting of the steel tape scale.

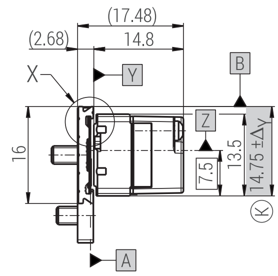
- Mount TMT MS 15 MK instead of the MS 14 scanning head.
- Thread steel tape scale (version MK) and move along the scale length
- Remove TMT MS 15 MK, mount MS 14 scanning head.

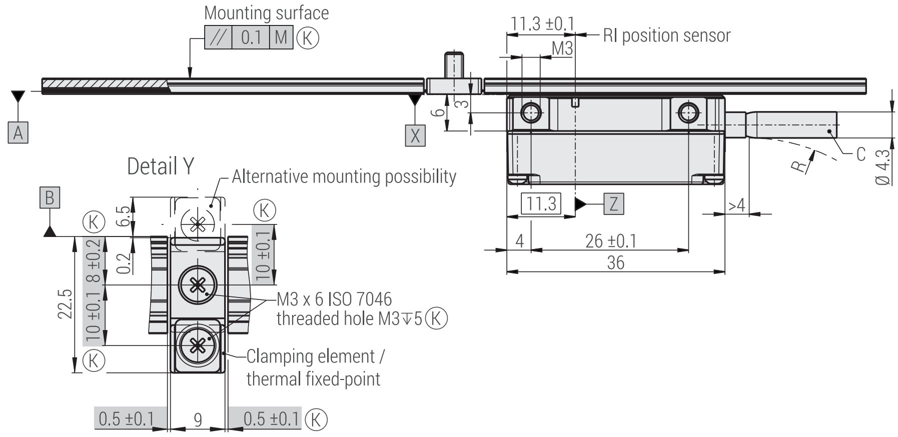
MS 14 MP

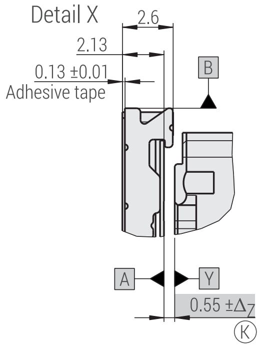
- Steel tape scale in aluminum carrier with clamping element
- Clamping element bolted
- Carrier with adhesive tape

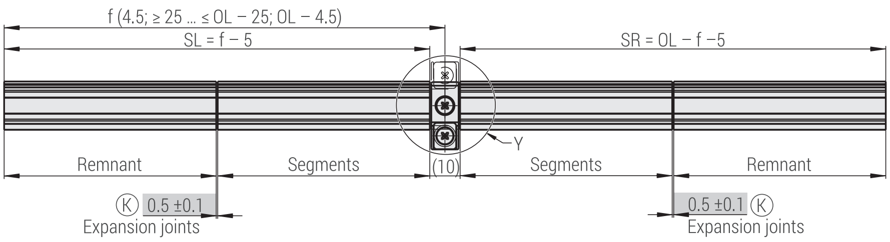
Dimensions, mounting tolerances:











M = Machine guideway
ML = Measuring length
OL = Overall length
◁—▷ = 0....ML
—▷+ = Direction of motion of the scanning head for ascending position values
RI = Reference marke(s)
k = Any position of the selected reference mark starting from the beginning of the ML
j = Additional reference marks selectable every 50 mm (optional every 200 mm or 400 mm)
f = Position of the clamping element
Standard: f = OL/2
Optional: f = { 4.5 ; ≥ 25 ... ≤ OL – 25 ; OL – 4.5 }
Ⓒ = Cable
K = Required mating dimensions
L = LED fucntion control
R = Bending radius: stat. R ≥8 mm. dyn. R ≥20 mm
Ⓢ = Beginning of the ML
n = 1, 2, 3 ... (number of segments)
SL, SR = Segment length

Permissible position deviation scanning head - tape scale A B
Δ_Y = Displacement, ±0.5 mm
Δ_Z = Gap tolerance, ±0.2 mm
φ_Z = ±1.00 mrad or ±0.06° (yaw angle)
φ_Y = ±3.50 mrad or ±0.20° (pitch angle)
φ_X = ±4.00 mrad or ±0.23° (roll angle

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

INSPECTION OF FUNCTIONS

STATUS OF LED	INFORMATION	NOTE
Without external test box		
Function-control main track		
▪ 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 graduation carrier
Function-control reference impulse RI		Only by passing the reference mark
▪ LED blinks BLUE	RI within tolerance	
▪ LED blinks RED	RI out of tolerance	Check mounting, clean graduation carrier
With external test box		
Function-control main track		
▪ LED displays GREEN	Scanning head supplied with power	Evaluation of counting signals via LED not active
Function-control reference impulse RI		Only by passing the reference mark
▪ 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 reference marks.

EXTERNAL TESTING DEVICE PWT 101

Even though the MS 14 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.

DISTRIBUTION CONTACTS

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Date 07/2023 ■ Art. No.1437281-01 ■ Doc. No. D1437281-00-B-01 ■ Technical adjustments in reserve!

RSF Elektronik Ges.m.b.H.

Linear and Angle Encoders
Precision Graduations

Certified acc. to
ISO 9001
ISO 14001

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