RSF Elektronik

www.rsf.at

MS 15

Exposed Linear Encoders
with Homing and Limit Function

SPECIAL FEATURES

- Online signal stabilization
- Display of signal quality directly at the scanning head via tricolored LED
- Permanent control of the signals over the whole measuring length
- High quality of the signals due to singlefield scanning
- Homing and limit function
- 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.

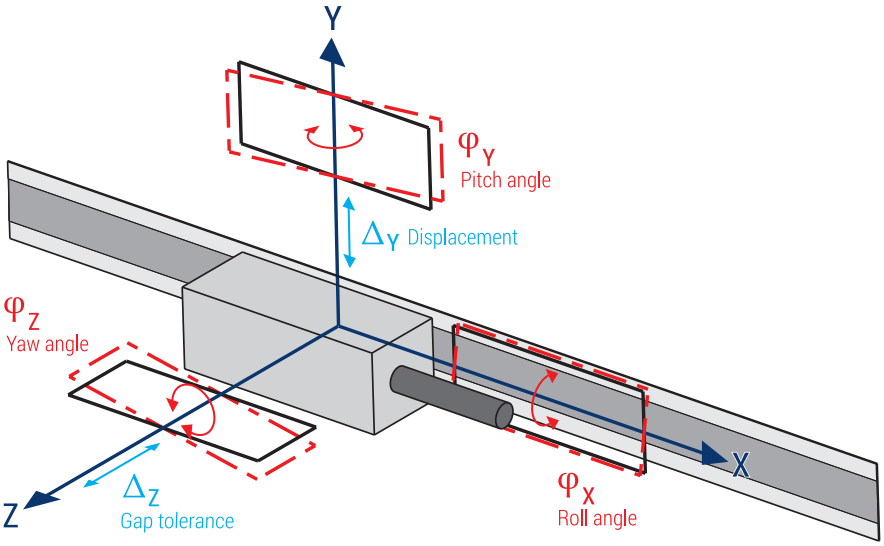
Reference pulse (reference mark)
There is an additional track of marks printed next to the grating to allow a user to find an absolute position along the length of the graduation carrier. A one increment wide signal is generated when the scanning head passes the reference mark on the graduation carrier.
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.

Δ .....Delta
φ .....Phi



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
- TWO SEPARATE SWITCH SIGNALS
- RESOLUTION: 10 µm – 0.05 µm

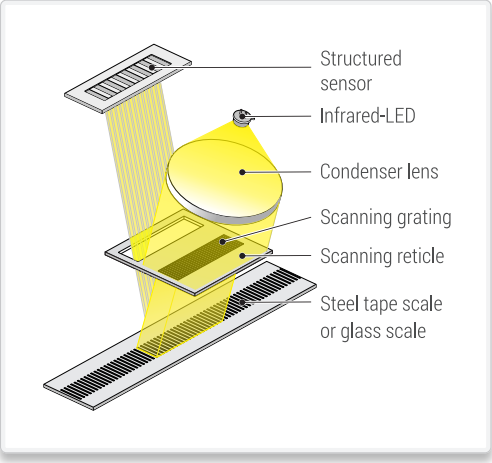
SCANNING PRINCIPLE

The model MS 15 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.

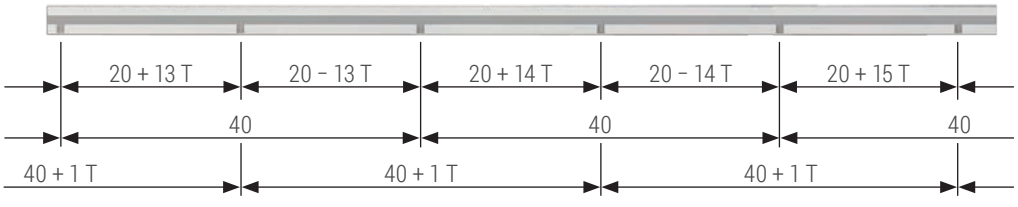
The regulation of the LED ensures a constant signal amplitude, guaranteeing stability in the case of temperature fluctuations and with long-run operation.



REFERENCE MARKS

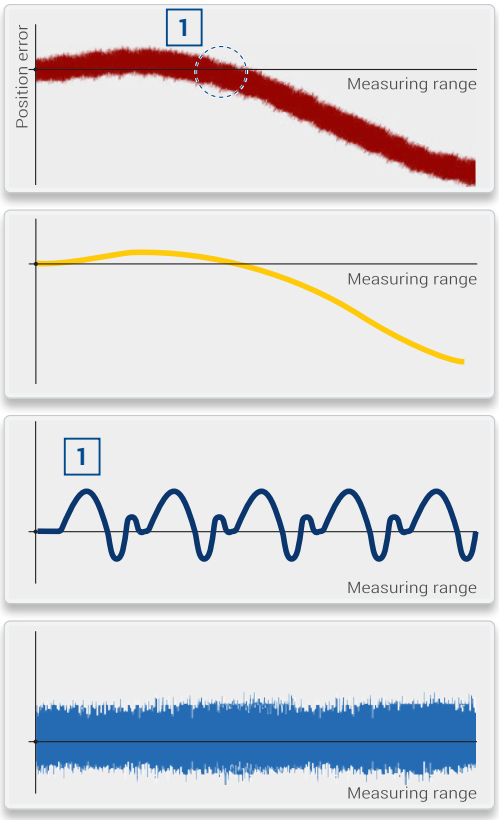
Principle of the standard reference marks

Principle of the distance-coded reference marks



T = Grating period

ACCURACY DEFINITION



Overall error

=

Baseline error

+

Interpolation error

+

Position noise

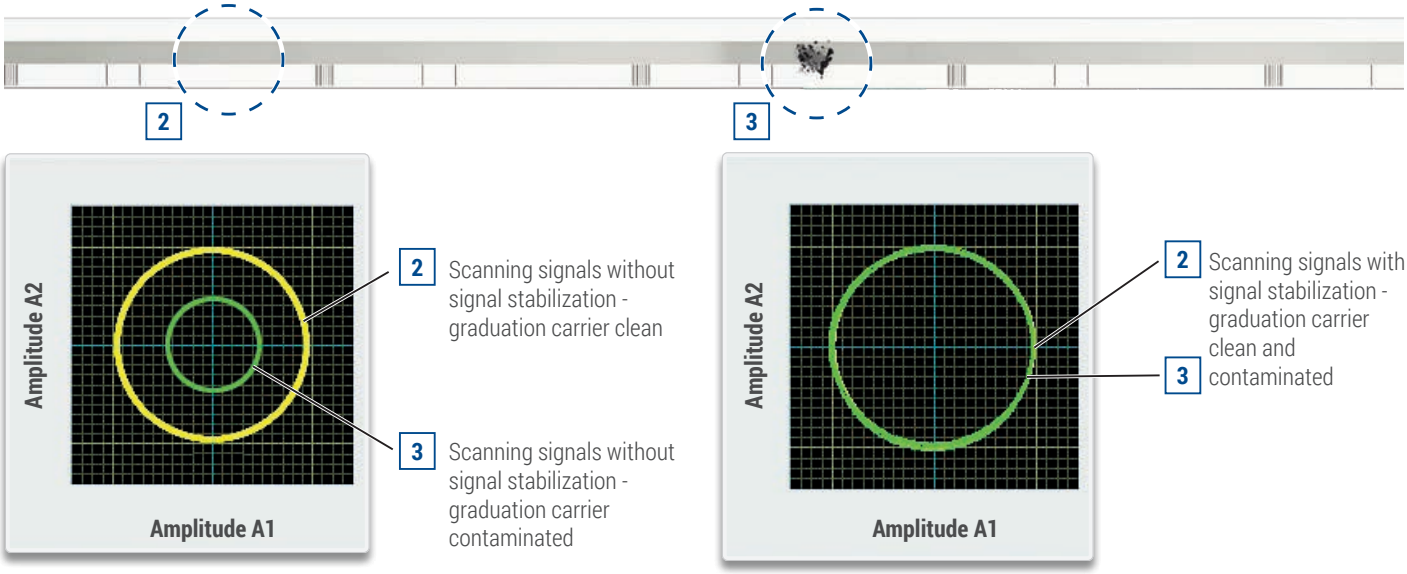
The accuracy of a linear encoder is mainly determined by the baseline error of the graduation carrier, the interpolation error of the optoelectronic scanning and the position noise.

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.

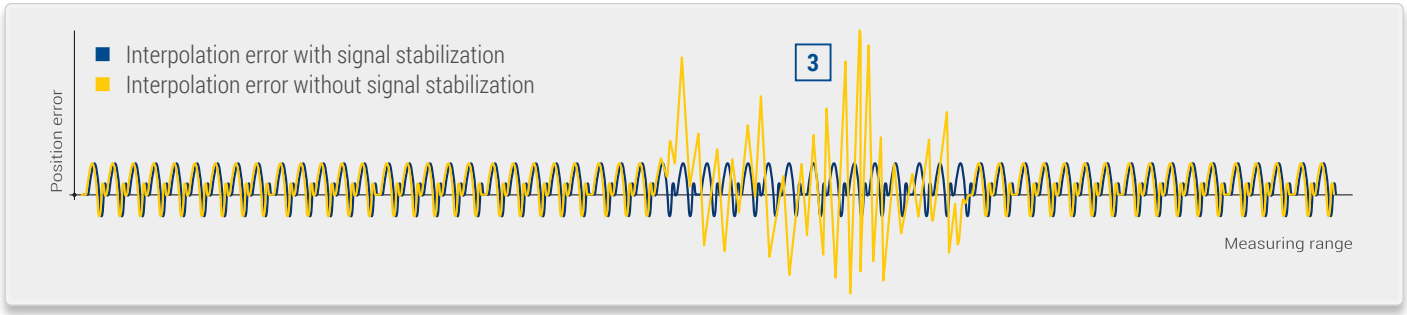
Effect of contamination on the quality and amplitude of scanning signal

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

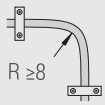


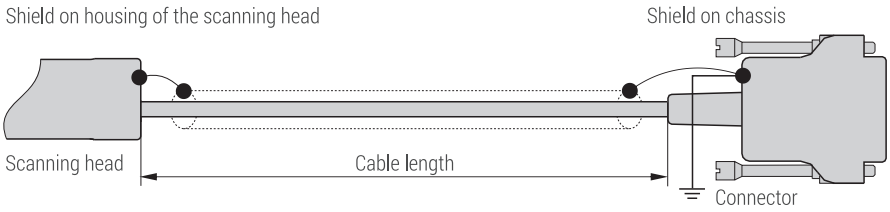
Effect of contamination on the interpolation error

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



SHIELDING, PIN ASSIGNMENT

Cable	4.3 mm	
Material	Shielded PUR-cable Drag chain qualified	
Bending radius	Bending radius fixed mounting	
	Bending radius continuous flexing	



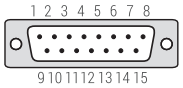
D-sub connector, male, 15-pin

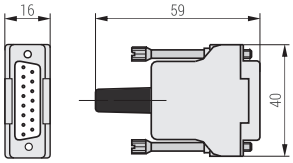
Pin	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Sinusoidal voltage signals 1 V_{PP}	Test**	0 V Sensor	Occup-ied	RI−	A2−	A1−	V+ Sensor	V+	0 V	S1***	S2***	RI+	A2+	A1+	nc
Square-wave signals via line driver	Test*	0 V Sensor	$\overline{US}$	$\overline{RI}$	$\overline{T2}$	$\overline{T1}$	V+ Sensor	V+	0 V	S1***	S2***	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 test signals (sinusoidal micro-current signals 11 μA_{PP}) 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 V_{PP}) 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 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.

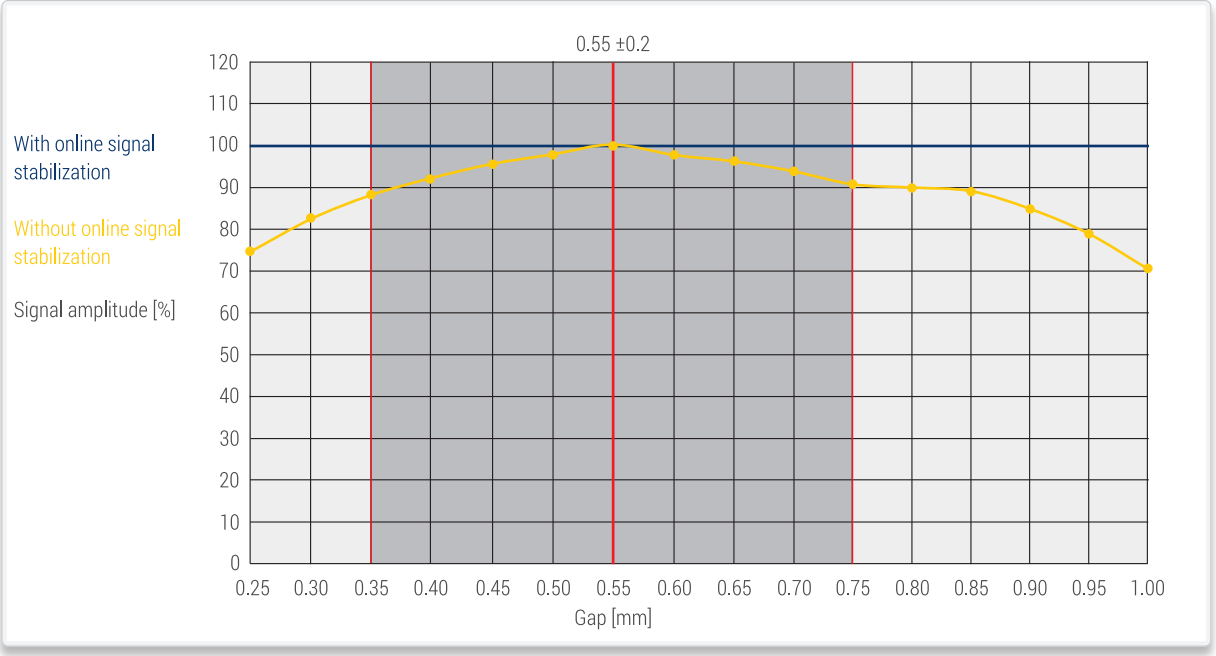
Pin assignment
(view on pins)





Mass: 28 g

Effect of the scanning head gap on the signal amplitude



INTERFACES

SINUSOIDAL VOLTAGE SIGNALS 1 V_{PP}

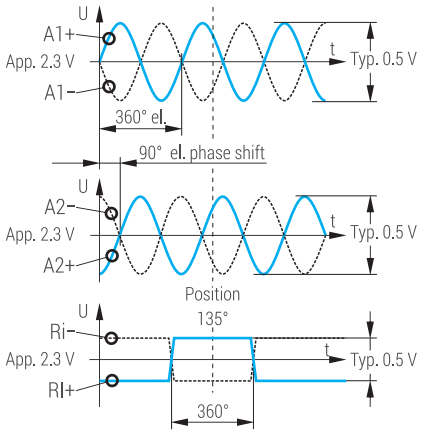
(drawing shows "positive counting direction")

Power supply: +5 V ±10 %, max. 160 mA (unloaded)
Track signals (differential voltage A1+ to A1− resp. A2+ to A2 −):
Signal amplitude 0.6 V_{PP} to 1.2 V_{PP}; typ. 1 V_{PP}
(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 V_{PP})



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)

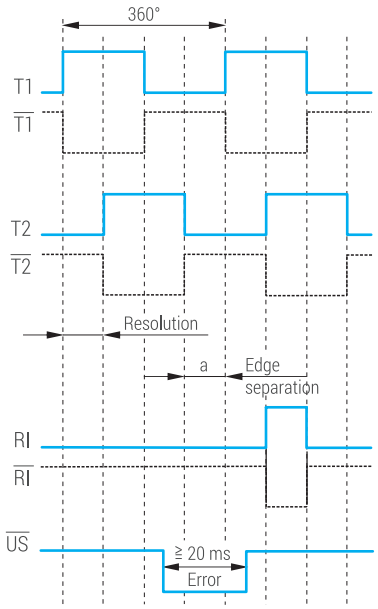
To prevent counting errors, the controls/DRO's must be able to process the resulting edge separation.

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

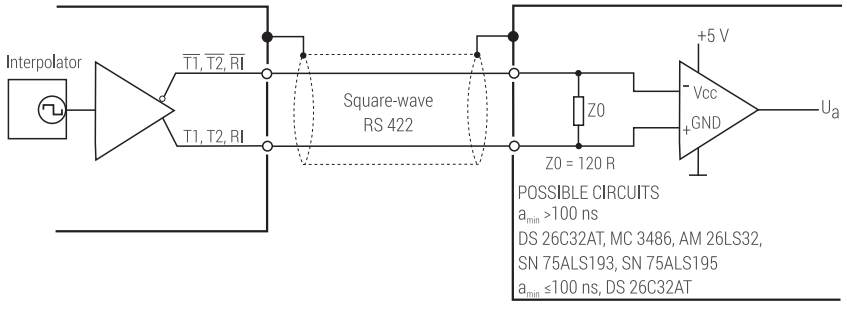
Power supply: +5 V ±10 %, max. 160 mA (unloaded)

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

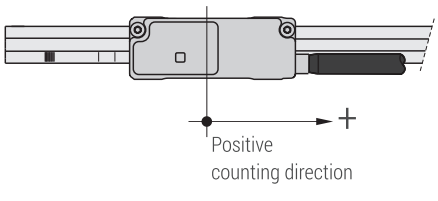
Square-wave signals „differential"



Recommended line receiver circuit



Counting direction

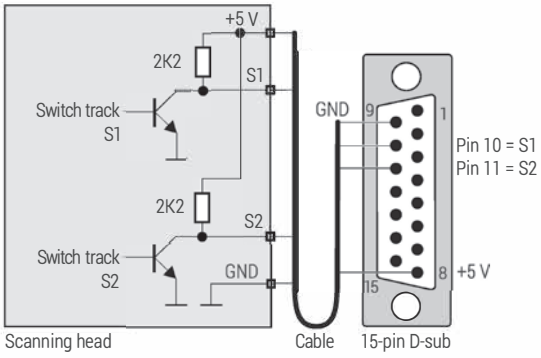


SWITCH SIGNAL OUTPUT

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

VERSION H

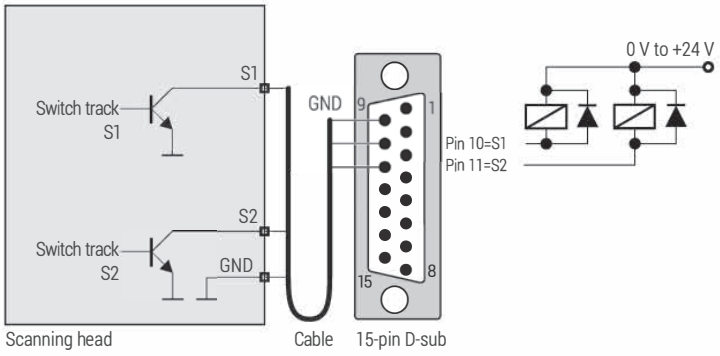
TTL output (active high)



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

VERSION Z

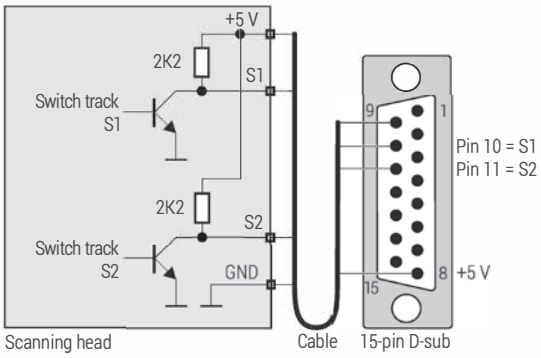
Open collector output (active high impedance)



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

VERSION L

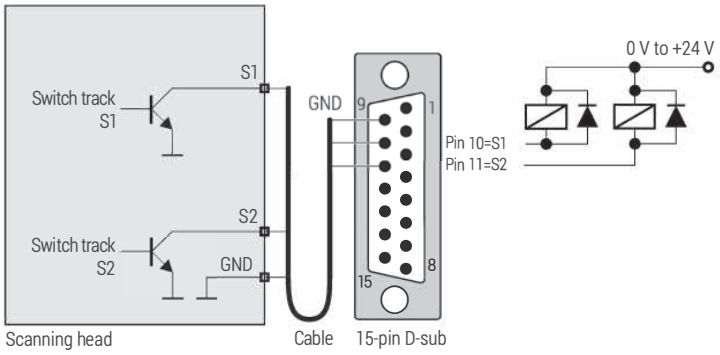
TTL output (active low)



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

VERSION C

Open collector output (active low)

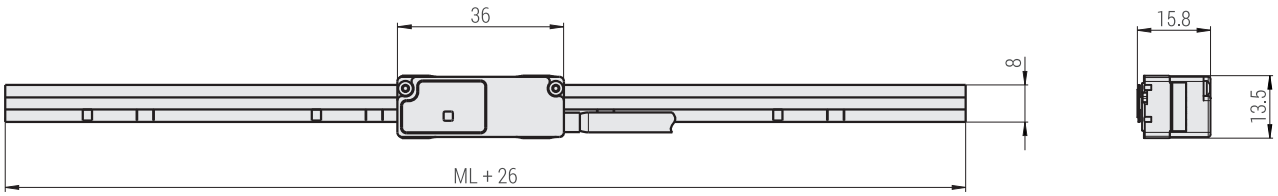


S1, S2 = open collector output
I_{SINK} = 20 mA (low level < 0.8 V)

MS 15 MK

- Steel scale tape with adhesive tape
- Mounting: adhesive tape, tape mounting tool available
- Display of signal quality directly at the scanning head via tricolored LED
- Homing and limit function
- Reference mark position customizable

Main dimensions without tolerance specifications



Technical drawings and further documents at www.heidenhain.com/documentation

Mating dimensions
ID 1090261

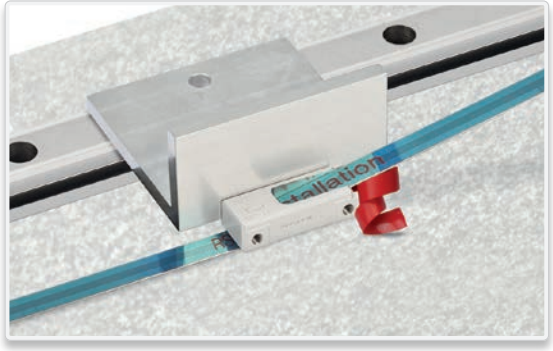
Scanning head	AK MS 15 1 Vpp	AK MS 15 TTLx1u	AK MS 15 TTLx5	AK MS 15 TTLx10	AK MS 15 TTLx20	AK MS 15 TTLx25	AK MS 15 TTLx50	AK MS 15 TTLx100	AK MS 15 TTLx200
Interface	~	⎍	⎍	⎍	⎍	⎍	⎍	⎍	⎍
Measuring step [µm]	Depending on external interpolation	10.00	2.00	1.00	0.50	0.40	0.20	0.10	0.05
Signal period [µm]	40								
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								
Supply voltage	+5 V ±10 %								
Power consumption	Max. 880 mW (without load)								
Current consumption	Max. 160 mA (without load)								
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 50 °C –20 °C to 70 °C								
Mass	Scanning head: 12 g (without cable), cable: 30 g/m, connector: D-sub connector: 28 g								

Scale tape	MB MS 15 MK
Graduation carrier Coefficient of expansion	Steel scale tape, grating period: 40 µm $\alpha_{therm} \approx 10 \times 10^{-6} K^{-1}$
Accuracy grade *	±5, ±15 µm/m
Non-linearity	±3 µm/m
Baseline error	≤ ±0,75 µm/50 mm (typical)
Max. measuring length ML	20 000 mm
Reference marks	Standard: 50 mm equidistant / Position selectable by customer / Distance-coded on request
Mass	17 g/m

* At 20 °C

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

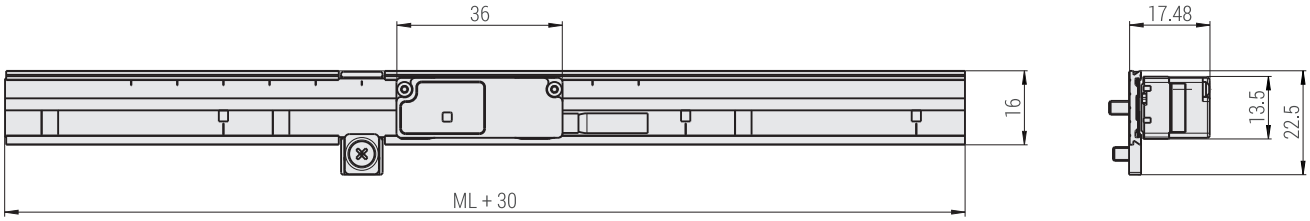
- Mount TMT Mx 15 MK instead of the MS 15 scanning head.
- Thread steel scale tape (version MK) and move along the scale length
- Remove TMT Mx 15 MK, mount MS 15 scanning head.



MS 15 MP

- Steel scale tape in aluminum carrier with clamping element
- Mounting: aluminum carrier with adhesive tape, clamping element bolted
- Display of signal quality directly at the scanning head via tricolored LED
- Homing and limit function
- Reference mark position customizable

Main dimensions without tolerance specifications



Technical drawings and further documents at www.heidenhain.com/documentation

Mating dimensions
ID 1171349

Scanning head	AK MS 15 1 V_{PP}	AK MS 15 TTLx1u	AK MS 15 TTLx5	AK MS 15 TTLx10	AK MS 15 TTLx20	AK MS 15 TTLx25	AK MS 15 TTLx50	AK MS 15 TTLx100	AK MS 15 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
Signal period [µm]	40								
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								
Supply voltage	+5 V ±10 %								
Power consumption	Max. 880 mW (without load)								
Current consumption	Max. 160 mA (without load)								
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 50 °C –20 °C to 70 °C								
Mass	Scanning head: 12 g (without cable), cable: 30 g/m, connector: D-sub connector: 28 g								

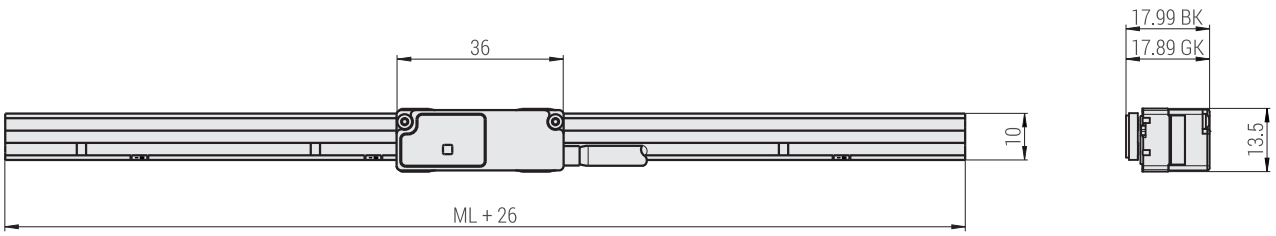
Parts kit	MS 14 MP
Graduation carrier Coefficient of expansion	Steel scale tape, grating period: 40 µm $\alpha_{therm} \approx 10 \times 10^{-6}\ K^{-1}$
Accuracy grade *	±5, ±15 µm/m
Non-linearity	±3 µm/m
Baseline error	≤ ±0,75 µm/50 mm (typical)
Max. measuring length ML	20 000 mm
Reference marks	Standard: 50 mm / Position selectable by customer / Distance-coded on request
Mass	90 g/m + 2 g clamping

* At 20 °C

MS 15 GK, BK

- GK: Glass scale with adhesive tape
- BK: Glass ceramic scale with adhesive tape
- Mounting: adhesive tape
- Display of signal quality directly at the scanning head via tricolored LED
- Homing and limit function
- Reference mark position customizable

Main dimensions without tolerance specifications



Technical drawings and further documents at www.heidenhain.com/documentation

Mating dimensions
ID 1131280

Scanning head	AK MS 15 1 Vpp	AK MS 15 TTLx1u	AK MS 15 TTLx5	AK MS 15 TTLx10	AK MS 15 TTLx20	AK MS 15 TTLx25	AK MS 15 TTLx50	AK MS 15 TTLx100	AK MS 15 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
Signal period [µm]	40								
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								
Supply voltage	+5 V ±10 %								
Power consumption	Max. 880 mW (without load)								
Current consumption	Max. 160 mA (without load)								
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 50 °C –20 °C to 70 °C								
Mass	Scanning head: 12 g (without cable), cable: 30 g/m, connector: D-sub connector: 28 g								

Scale	MS 15 GK	MS 15 BK
Graduation carrier Coefficient of linear expansion	Glass scale $\alpha_{therm} \approx 8.5 \times 10^{-6}\ K^{-1}$, grating period: 40 µm	Glass ceramic scale $\alpha_{therm} \approx 0 \times 10^{-6}\ K^{-1}$, grating period: 40 µm
Accuracy grades *	±3, ±5 µm/m	±3, ±5 µm/m
Non-linearity *	±3 µm/m	±3 µm/m
Baseline error	≤ ±0.30 µm/10 mm	≤ ±0.30 µm/10 mm
Measuring length ML	3140 mm	1920 mm **
Reference marks	Standard: 50 mm equidistant / Position selectable by customer / Distance-coded on request	
Mass	55 g/m	57 g/m

* At 20 °C

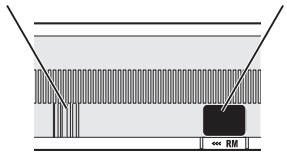
** Longer lengths on request

REFERENCE MARK (RI)- AND SWITCH POINTS-SELECTION

Reference mark (RI)-selection

Selected reference mark is activated

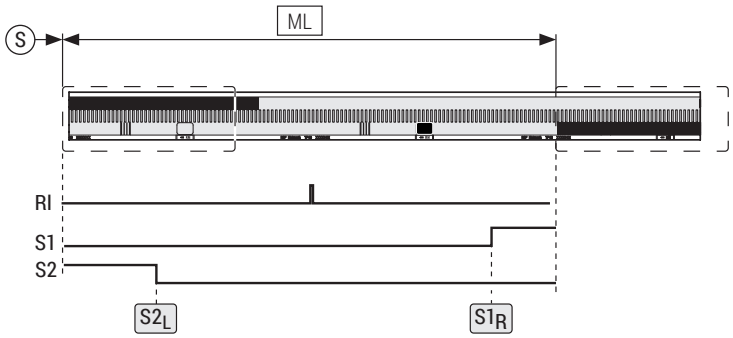
RI-activation sticker



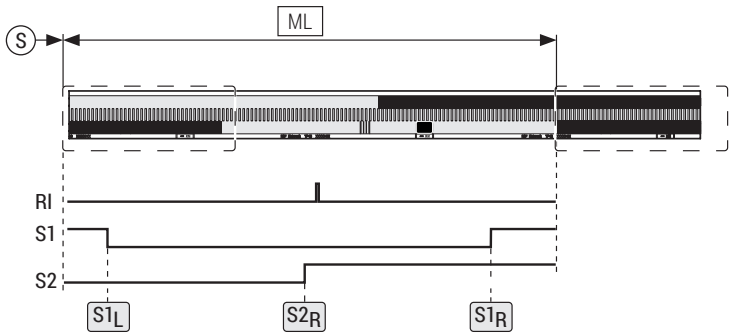
Selection of the switch points

RI = Reference impulse
$S1_L$ = Switch point signalS1 from the beginning of the measuring length ML
$S1_R$ = Switch point signalS1 before end of the measuring length ML
$S2_L$ = Switch point signalS2 from the beginning of the measuring length ML
$S2_R$ = Switch point signalS2 before end of the measuring length ML
Ⓢ = Beginning of the measuring length ML

EXAMPLE 1: LIMIT FUNCTION
$S1_R$: before end of ML
$S2_L$: from beginning of ML



EXAMPLE 2: LIMIT FUNCTION AND HOMING
$S1_L$: from beginning of ML
$S1_R$: before end of ML
$S2_R$: before end of ML, near RI (Homing)



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

INSPECTION OF FUNCTION

STATUS OF LED	INFORMATION	NOTE
Without external test box		
Function-control main track		
▪ LED shining GREEN	Scanning signals are very good	After successful mounting
▪ LED blinking GREEN	Scanning signals are good	Not permitted during mounting → Permitted during operation
▪ LED blinking RED	Scanning signals out the tolerance → error	Clean the scale, check the mounting
Function-control reference impulse RI		**Only when traversing the reference mark**
▪ LED blinking BLUE	RI within tolerance	
▪ LED blinking RED	RI outside the tolerance	Check mounting, clean graduation carrier
With external test box		
Function-control main track		
▪ LED shining GREEN	Scanning head is powered	Evaluation of counting signals via LED not active
Function-control reference impulse RI		**Only when traversing the reference mark**
▪ LED blinking BLUE	RI within tolerance	
▪ LED blinking RED	RI outside the tolerance	Clean the scale, check the mounting

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 15 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.

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