RSF Elektronik

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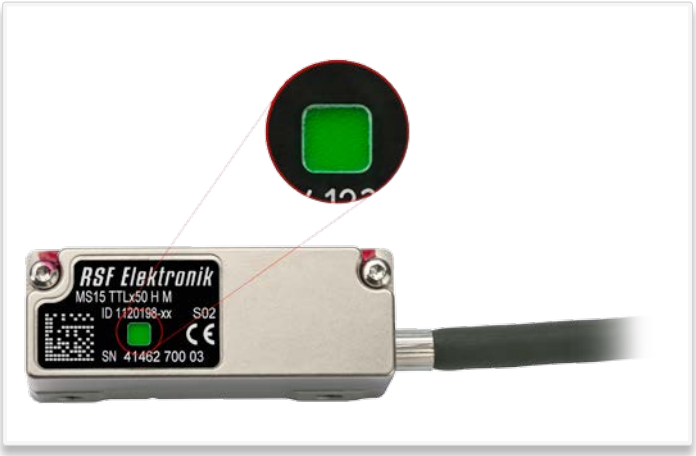
MS 15

EXPOSED LINEAR ENCODERS WITH HOMING AND LIMIT FUNCTION



- ONLINE SIGNAL STABILIZATION
- QUALITY OF THE SIGNAL DISPLAYED DIRECTLY AT THE UNIT VIA A TRI-COLORED LED
- PERMANENT CONTROL OF THE SIGNALS OVER THE WHOLE MEASURING LENGTH
- HIGH QUALITY OF THE SIGNALS DUE TO SINGLEFIELD SCANNING
- SWITCH SIGNALS AND HOMING FUNCTION
- REFERENCE MARK POSITION CUSTOMIZABLE

TERM EXPLANATIONS

Grating pitch (interval)
A grating is a continuous series of lines and spaces printed on the scale. The width of one line and one space is called the pitch (somentimes referred to as the interval) of the grating. The lines and spaces are accurately placed on the scale.

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

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 (resolution)
The smallest digital counting step produced by an encoder.

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

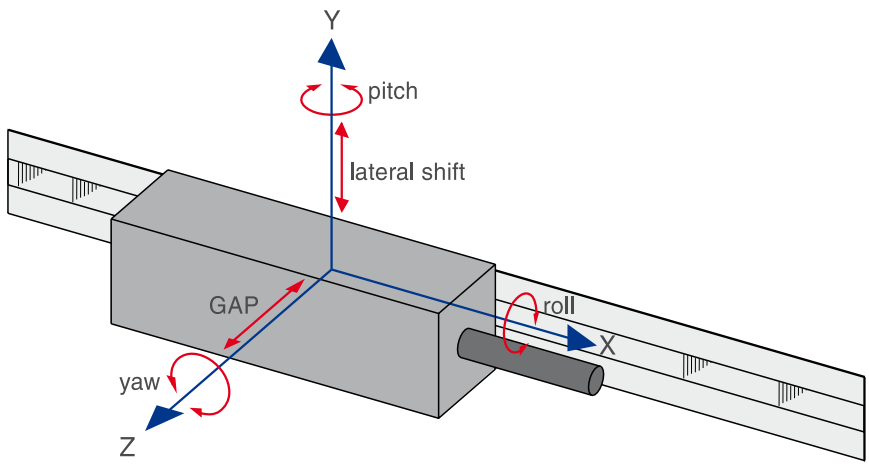
Error signal
This signal appears when a malfunctioning encoder generates faulty scanning signals.

Accuracy
This is a fundamental characteristic, which is specified with an accuracy grade (e.g. ±5 µm/m).

Online signal stabilization
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.

Yaw angle, pitch angle, roll angle, lateral shift, air gap
Mounting tolerances of the encoder head relative to the scale.



REQUIREMENTS ON AN EXPOSED LINEAR ENCODER

The trend in motion control applications is towards exposed linear encoder systems.
This is driven by steadily increasing demands for

- CONTAMINATION RESISTANCE
- IMMUNITY AGAINST AGING AND TEMPERATURE CHANGES
- HIGH TRAVERSING SPEED
- EASY MOUNTING
- SMALL DIMENSIONS
- OPERATING CYCLES
- NO MECHANICAL BACKLASH
- ZERO FRICTIONAL FORCE

THE MS 15 MEETS ALL THESE REQUIREMENTS!

For special requirements like closed loop, speed control, highest accuracy and others it is important to minimize the interpolation errors.
Historically, the small grating periods used had the disadvantages of smaller mounting gaps and very tight overall mounting tolerances.
The MS 15 encoders´ 40 µm grating period minimizes interpolation errors and can be mounted with a large gap due to large mounting tolerances.

A drawback of many exposed linear encoders is their sensitivity to dirt and contamination on the scale. The MS 15 encoders´ unique optical design minimizes the effect of dirt and contamination normally associated with the exposed linear encoders. Furthermore the MS 15 utilizes a unique scanning principle which allows high traversing speeds (up to 10 m/s), large mounting tolerances and contamination on the scale.

Reference marks, accurate and repeatable from both traversing directions, are standard.
The position of the reference mark can be selected by the customer.

A wide range of interpolation electronics, integrated into the encoder head, enables resolutions up to 100 nm.
Square-wave signals, single ended, or via line driver RS 422, are provided at the output of the encoder head.
Units with sinusoidal output, 1Vpp, are also available. Two separate optical switch signals are available directly out of the scanning head.
The end of travel signal locations can be easily set by the user.

Due to recent advancements in technology, all of these benefits are now available in a small package design.

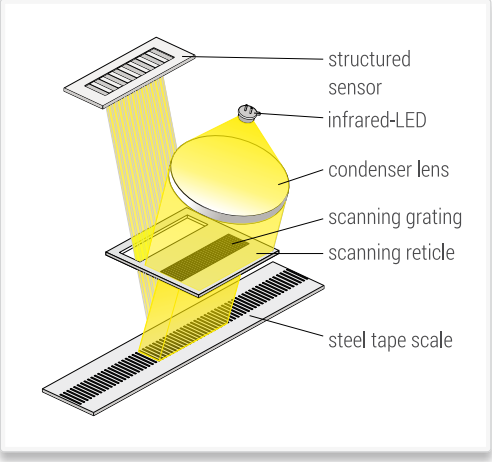
SCANNING PRINCIPLE

The model MS 15 incremental linear encoder system works with the imaging, photoelectric measuring principle and a **singlefield reflective scanning method**.

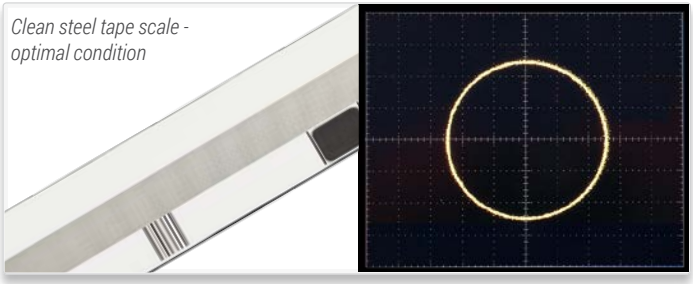
The regulated light of an infrared LED is collimated by a condenser lens and passes through the grid of the reticle. After being reflected from the scale, the infrared LED generates a periodic intensity distribution on the structured sensor.

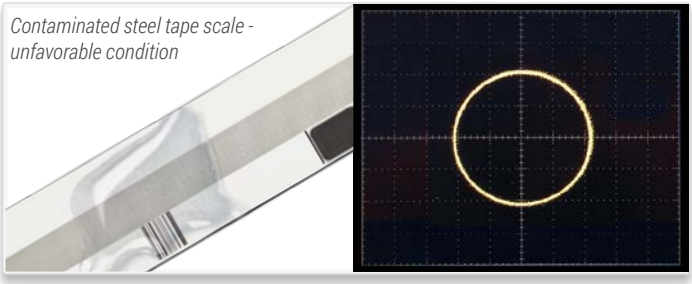
The sensor generates high quality sinusoidal signals which are highly insensitive to possible contaminations.

The regulation of the LED ensures a constant light output, guaranteeing stability in the case of temperature fluctuations as well as with long-run operation.



Effect of contamination on the quality and size of the scanning signal (prior to online signal compensation)

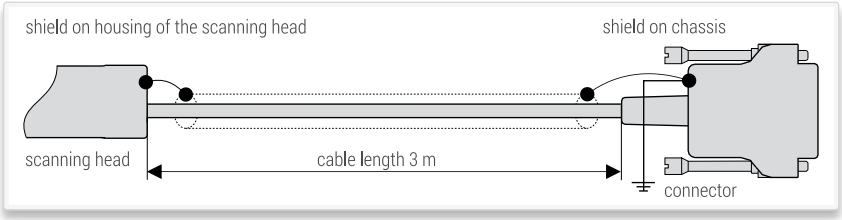




High insensitivity to contamination by use of a new scanning principle.

SHIELDING, PIN ASSIGNMENT

Shielded PUR-cable, Ø: 4.3 mm
Bending radius fixed mounting: > 10 mm,
continuous flexing: > 20 mm
Drag chain qualified

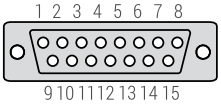


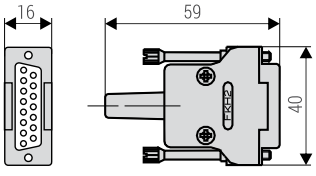
LD15 (Sub-D connector, male 15-pin)

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	nc	$\overline{RI}$	$\overline{A2}$	$\overline{A1}$	+5 V sensor	+5 V	0 V	S1***	S2***	RI	A2	A1	nc
Square-wave signals via line driver	test*	0 V sensor	$\overline{US}$	$\overline{RI}$	$\overline{T2}$	$\overline{T1}$	+5 V sensor	+5 V	0 V	S1***	S2***	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.
- 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.
- Not connected pins or wires (nc) must not be used.

Pin assignment
(view on pins)





weight: 28 g

OUTPUT SIGNALS

SINUSOIDAL VOLTAGE SIGNALS 1 VPP

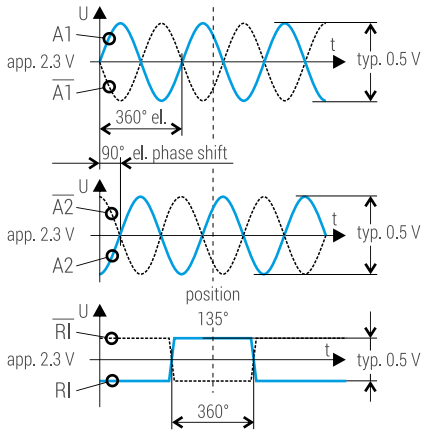
(drawing shows "positive counting direction")
Two sinusoidal voltage signals A1 and A2 and one reference mark signal (all with inverted signals).

Power supply: +5 V ±10 %, max. 140 mA (unloaded)
Track signals (differential voltage A1 to $\overline{A1}$ resp. A2 to $\overline{A2}$):
Signal amplitude 0.6 Vpp to 1.2 Vpp; typ. 1 Vpp
(with terminating impendance Zo = 120 Ω between A1 to $\overline{A1}$ resp. A2 to $\overline{A2}$)

Reference mark (differential voltage RI to $\overline{RI}$):
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.

Output signals (1 Vpp)



SQUARE-WAVE SIGNALS

(drawing shows "positive counting direction")
With the integrated interpolation electronics (for times -1, -5, -10, -20, -25, -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/m
Line receiver:	max. 10 ns (referred to the recommended line receiver circuit)

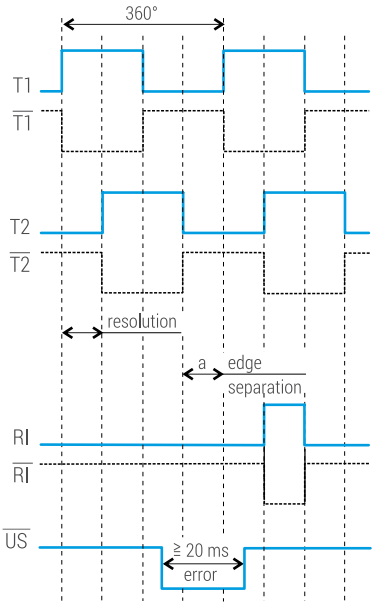
To prevent counting errors, the controls/DRO's must be able to process the resulting edge separation.

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

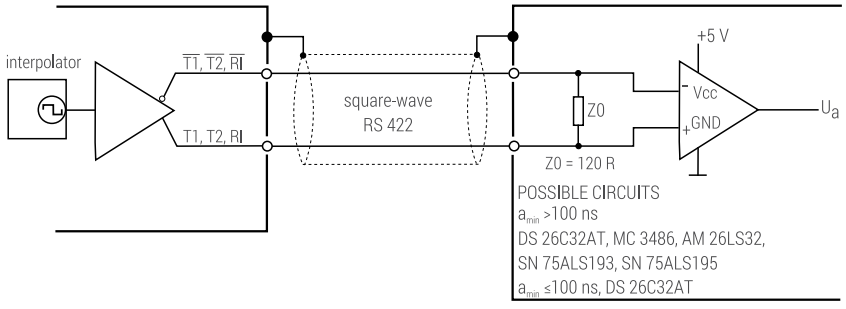
Power supply: +5 V ±10 %, max. 160 mA (unloaded)

Advantage:
- Noise immune signals
- No further subdividing electronics necessary

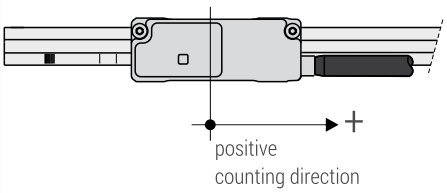
Square-wave signals „differential"



Recommended line receiver circuit



Counting direction

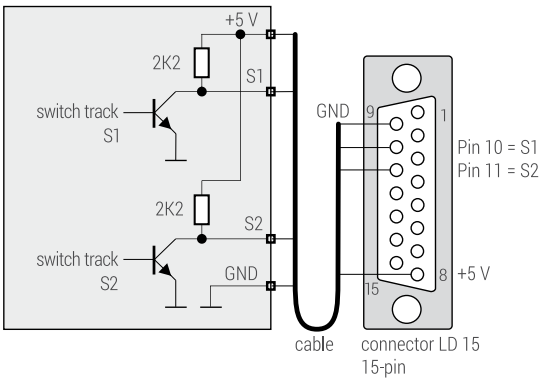


SWITCH SIGNAL OUTPUT

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

VERSION H

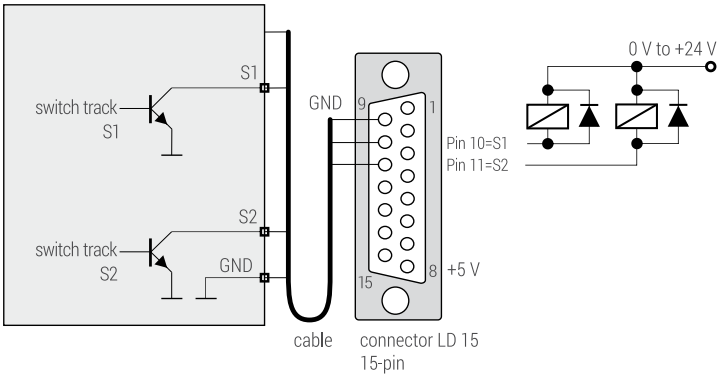
TTL output (active high)



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

VERSION Z

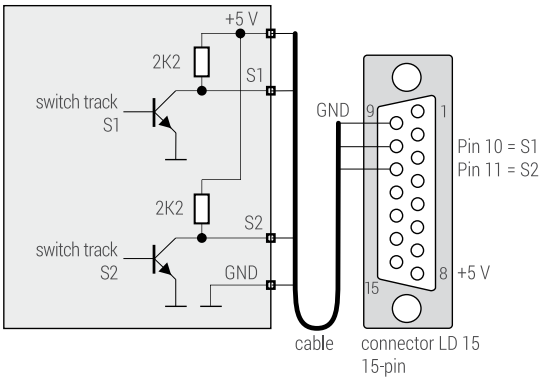
open collector output (active high impedance)



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

VERSION L

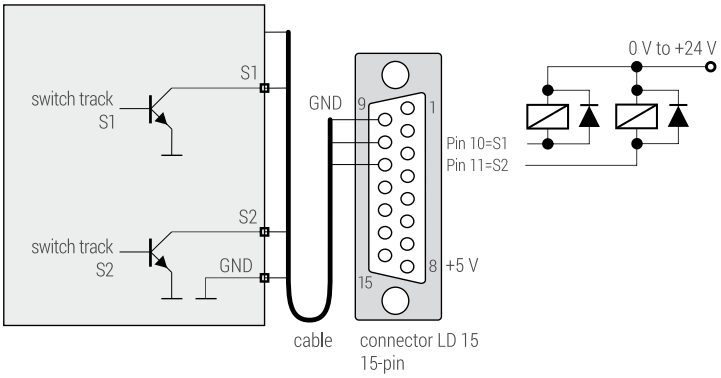
TTL output (active low)



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)

TECHNICAL DATA

SCANNING HEAD: 40 µm grating pitch

Scale model	Output signals	System resolution [µm]	Integrated interpolation	Max. velocity [m/s]	Max. output frequency [kHz]
MS 15 1Vpp	~	depending on external interpolation	--	10	250
					Edge separation a_{min}
MS 15 TTLx1	⎍	10	times 1	10	800 ns
MS 15 TTLx5	⎍	2	times 5	6.4	300 ns
MS 15 TTLx10	⎍	1	times 10	3.2	300 ns
MS 15 TTLx20	⎍	0.5	times 20	2.4	200 ns
MS 15 TTLx25	⎍	0.4	times 25	1.92	200 ns
MS 15 TTLx50	⎍	0.2	times 50	1.92	100 ns
MS 15 TTLx100	⎍	0.1	times 100	0.96	100 ns

Permissible vibration:
150 m/s² (40 to 2000 Hz)

Permissible shock:
750 m/s² (8 ms)

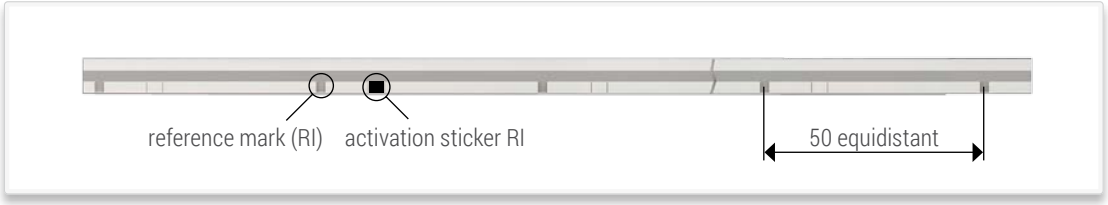
Permissible temperature:
–20 °C to +70 °C (storage), 0 °C to +60 °C (operation)

RoHS-conformity:
MS 15 linear encoders comply with the guideline of the RoHS-directive 2011/65/EU on the restriction of the use of certain hazardous substances in electrical and electronic equipment.

GRADUATION CARRIER

Mechanical features of the scale unit	
Graduation carrier	steel
Grating pitch	40 µm
Accuracy grades	±5, ±15 µm/m
Non-linearity	±3 µm/m
Maximum measuring length (ML)	20 000 mm
Reference marks (RI)	standard: 50 mm equidistant position selectable by customer

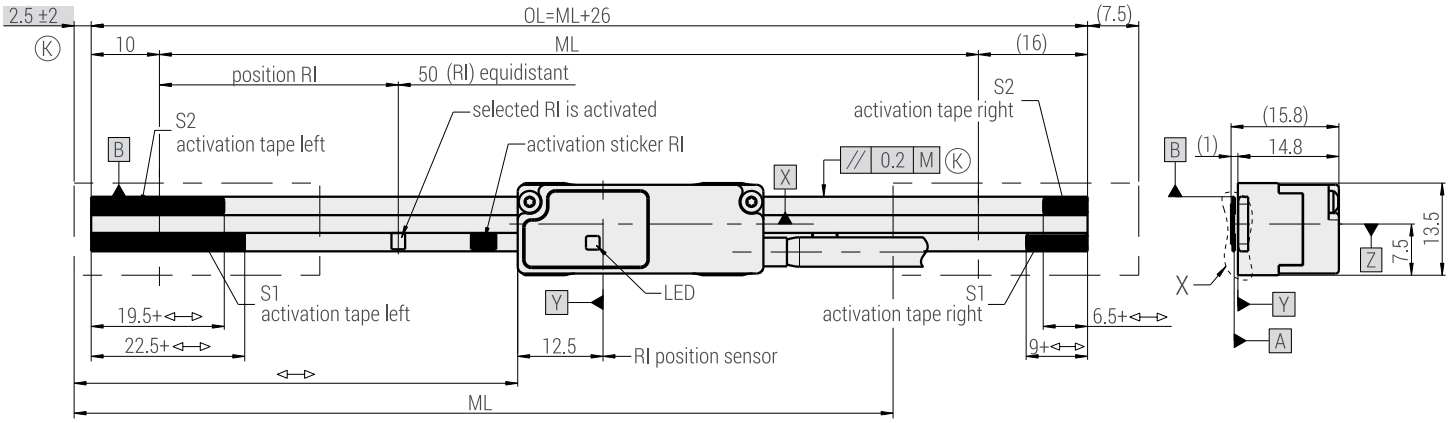
Principle of the standard reference marks

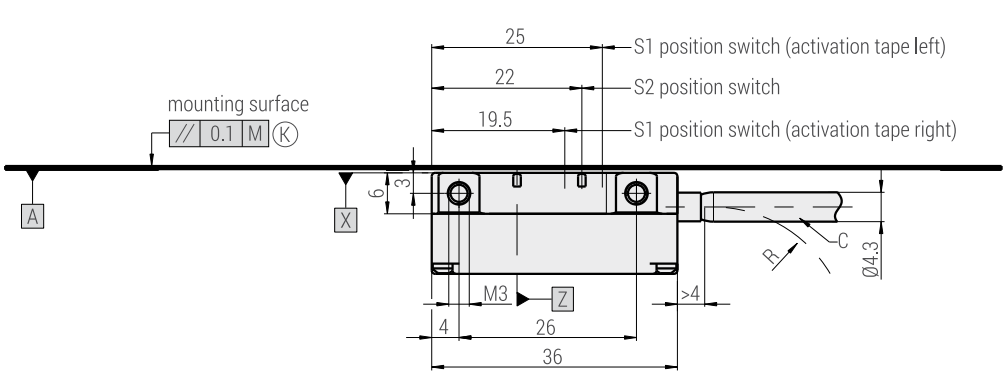


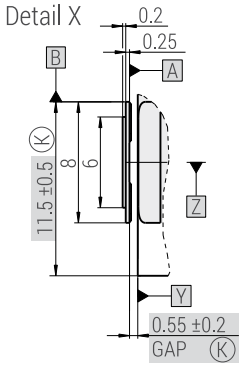
MS 15 MK

- Version MK: steel tape scale with adhesive tape

Dimensions, mounting tolerances:







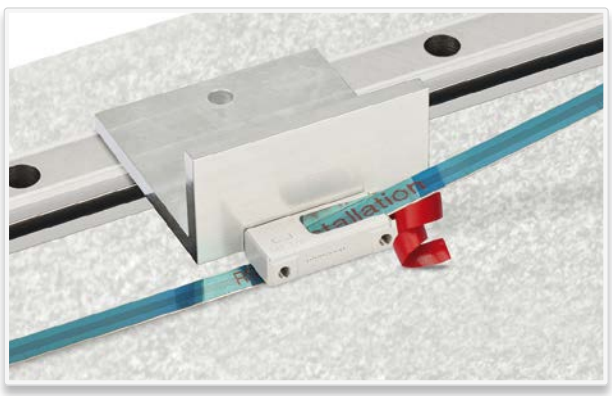
M = machine guideway
ML = measuring length
OL = overall length
<⟷> = 0....ML
RI = reference marks
C = cable
(K) = required mating dimensions
LED = integrated mounting control via RGB-LED
R = bending radius
stat. R >10 mm, dyn. R >20 mm
S1, S2 = switch signal

Permissible position deviation scanning head - scale tape
reference plane A-B
Z = ±0.2 mm (airgap)
Y = ±0.5 mm (lateral)
∠ Z = ±1.00 mrad or ±0.06° (yaw angle)
∠ Y = ±3.50 mrad or ±0.20° (pitch angle)
∠ X = ±4.00 mrad or ±0.23° (roll angle)

Weight (approx.):
- Version MK: 17 g/m
  scanning head with connector and cable 40 g
  + 30 g/m cable

Tape mounting tool **TMT 14 MK** (optional)
For safe and precise mounting of the steel tape scale.

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



INSPECTION OF MOUNTING

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 scale
Function-control reference impulse RI		only by passing the reference mark
▪ LED blinks RED	RI out of tolerance	check mounting, clean scale
▪ LED blinks BLUE	RI within tolerance	
With external test box		
Function-control main track		
▪ LED displays GREEN	scanning head supplied with power	evaluation of counting signals not active
Function-control reference impulse RI		only by passing the reference mark
▪ LED blinks RED	RI out of tolerance	check mounting, clean scale
▪ LED blinks BLUE	RI within tolerance	

Note! The status display of the reference mark signal is switched off at higher velocities, in order to avoid permanent blinking.
The information of the incremental signals would otherwise no longer be displayed.

EXTERNAL TEST/SET-UP BOX PG5

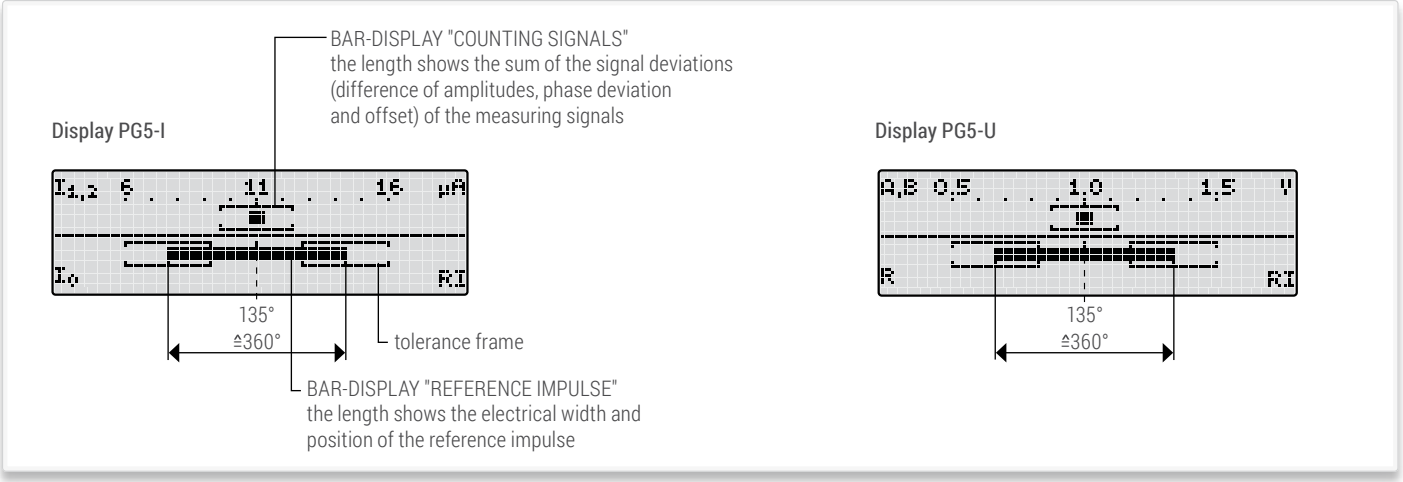
Even though the MS 15 linear encoders allow large mechanical mounting tolerances, it is recommended to inspect the mounting by checking the quality of the output signals.

The signals can be controlled directly via the integrated LED mounting control or connected to an oscilloscope and checked for conformity with signal specifications. The last mentioned method requires effort, training and expensive test equipment (oscilloscope).

As an alternative to this method, RSF offers different signal test boxes. With these test boxes all encoder signals can be quickly and easily checked. The **PG5-I** / **PG5-U** is an all-purpose signal test box where all the relevant signals are displayed on LCD Bars.

The **PG5-I** / **PG5-U** allows the quantitative as well as the qualitative evaluation of the encoder signals.

PG5-I for linear encoders with square-wave output signals
PG5-U for linear encoders with sinuoidal voltage signals 1 Vpp



PRODUCT OVERVIEW

MS 2x Series

Reflective scanning linear encoder with and without 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
- 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 glass scale: 3140 mm steel tape scale: 20 000 mm

MS 30, MS 31

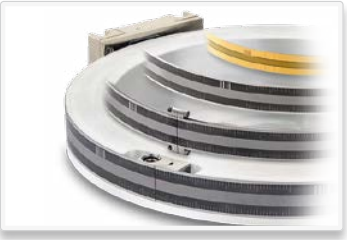
Reflective scanning linear encoder

- Two independent switch tracks for individual special functions
- Position of reference mark selectable by customer
- Easy mounting due to large mounting tolerances
- High insensitivity against contamination
- High traversing speed
- Integrated subdividing up to times 100
- Max. measuring length glass scale: 3140 mm steel tape scale: 11 940 mm

MS 45

Reflective scanning 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
- Flat dimensions
- Easy mounting due to large mounting tolerances
- High insensitivity against contamination
- High traversing speed
- Integrated subdividing: up to times 100
- Max. measuring length steel tape scale: 30 000 mm



MSR 45

Modulary angle measurement system with steel tape scale - different versions

- Full-circle or segment version
- Grating pitch: 200 µm
- Accuracy of the grating (stretched): ±30 µm/m
- High rotational speed resp. circumferential speed
- Integrated subdividing: up to times 100

MSR 25

- Segment version
- Grating pitch: 40 µm
- Accuracy of the grating (stretched): ±15 µm/m
- High circumferential speed
- Integrated subdividing: up to times 100

Precision Graduations

- Lenght graduations on glass, chromium coated
- Length graduations on steel tape, gold coated or polished surface
- Circular graduations on glass, chromium coated
- Graticules
- Antireflection coatings
- Other coatings

Z 300

Digital Readouts for universal application

- Number of alphanumeric axes: 2 or 3
- Monochrome flat screen
- Clearly readable display
- Robust cast aluminum housing
- Splash-proof fulltravel keypad
- Practice-oriented functions
- Standard version for turning, drilling or milling machine

UFC 430

USB-interface-module

- USB-interface acc. to spec. 2.0
- Available inputs: 1 Vpp max. 200 kHz or TTL (RS 422) max. 500 kHz
- Interpolation: up to times 400 for linear encoders with output 1Vpp and up to times 4 for linear encoders with square-wave line driver signals
- Three 15-pin Sub-D female connectors for 3 encoder inputs
- 32 Bit counter with preset and latch register

IFC 430R

Encoder-interface-card

- PC interface board for quadrature encoder signal evaluation: times 1, -2 or -4
- Latch logic for measured values
- Three counter channels à 32 bit, one load and two latch registers for each channel
- PC bus
- Signal edge separation: up to 100 ns
- Demo program with examples and driver software

MSA 170

Sealed linear encoder

- Miniaturized system
- Guided by ball bearings
- Distance-coded reference marks
- Mounting holes on the extrusion ends
- Max. measuring length: 520 mm

MSA 7xx, MSA 8xx series

(small cross-sectional profile)

MSA 4xx, MSA 5xx series

(large cross-sectional profile)

- Optimized thermal behavior
- Connection cable detachable (optional)
- Distance-coded reference marks
- Mounting holes at the ends or along the scale unit for improved vibration stability
- Max. measuring length: 3040 mm

MSA 373

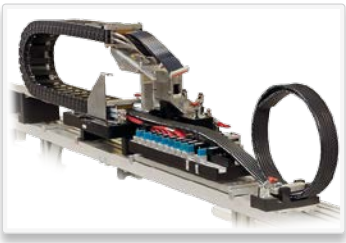
Sealed linear encoder

- With integrated guide rail system
- For application on presses, bending machines and hydraulic cylinders
- Roller bearing dual guided scanning carriage
- Free positionable switch magnets for special functions
- Distance-coded reference marks
- Mounting holes on the extrusion ends
- Max. measuring length: 1240 mm

MSA 65x, MSA 35x

Sealed linear encoder

- For retrofit of machine tools
- Large mounting tolerances
- Guided by ball bearings
- Distance-coded reference marks
- Two sets of sealing lips for additional contamination protection (MSA 352)
- Mounting holes on the extrusion ends (MSA 650, MSA 35x)
- Mounting holes on top of the extrusion - improves vibration rating (MSA 651)
- Mounting supports (MSA 35x)
- max. measuring length:
  MSA 650: 1740 mm
  MSA 651: 2240 mm
  MSA 35x: 3040 mm



Cable Systems

- Individual cable design
- Hybrid cable
- Trailing cable
- System solutions
- 100 % function control

DISTRIBUTION CONTACTS

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