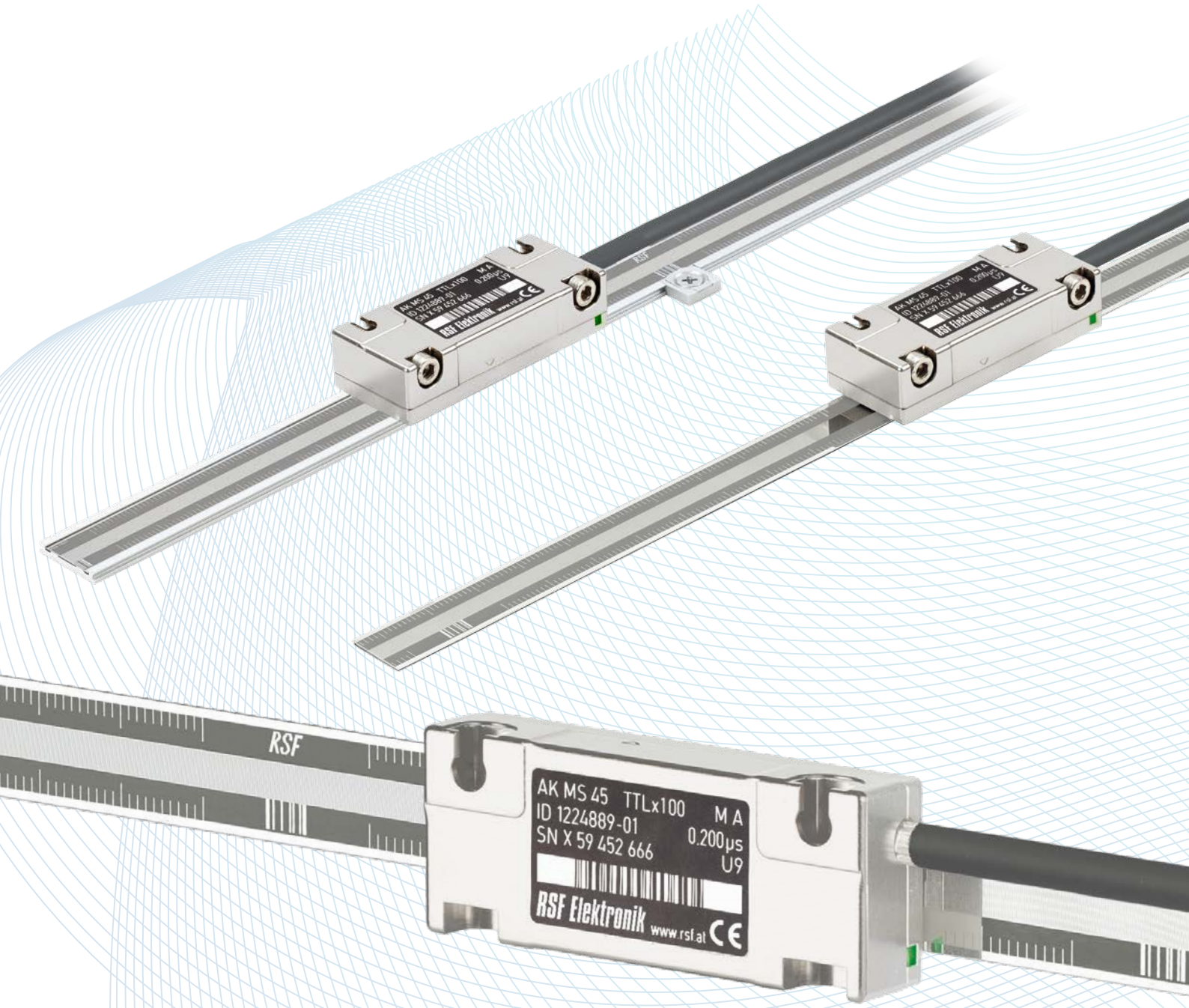
RSF Elektronik

www.rsf.at

MS 45

EXPOSED LINEAR ENCODER WITH SINGLEFIELD SCANNING



CONTENTS

TERM-EXPLANATIONS

Grating pitch (interval, T)
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 a user to find an absolute position along the length of the scale. A 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.

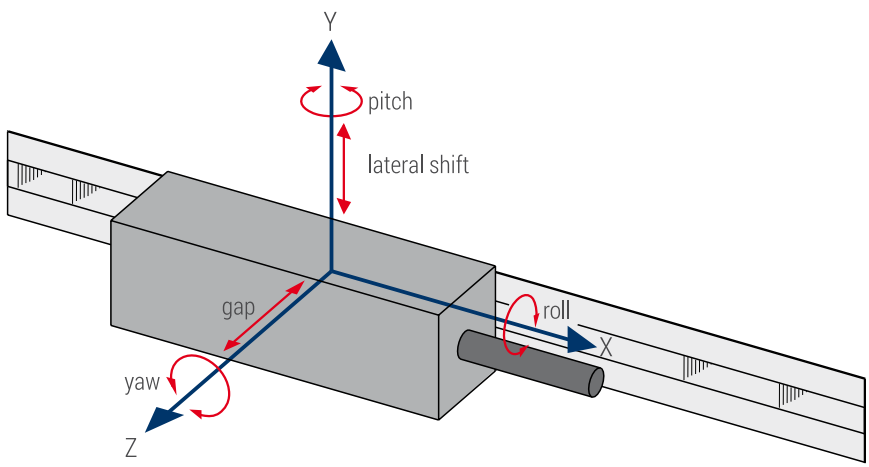
Error signal ($\overline{US}$)
This signal appears when a malfunctioning encoder generates faulty scanning signals.

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, airgap
Mounting tolerances of the encoder head relative to the scale.



REQUIREMENTS ON AN EXPOSED LINEAR ENCODER

- CONTAMINATION RESISTANCE
- IMMUNITY AGAINST AGING AND TEMPERATURE CHANGES
- HIGH TRAVERSING SPEED
- EASY MOUNTING - LARGE MOUNTING TOLERANCES
- LOW COST AND HIGH QUALITY
- FLAT DIMENSIONS
- OPERATING CYCLES
- NO MECHANICAL BACKLASH
- ZERO FRICTIONAL FORCE
- REFERENCE MARKS, REPEATABLE FROM BOTH TRAVERSING DIRECTIONS
- RESOLUTION: 10 µm – 0.5 µm

THE MS 45 MEETS ALL THESE REQUIREMENTS!

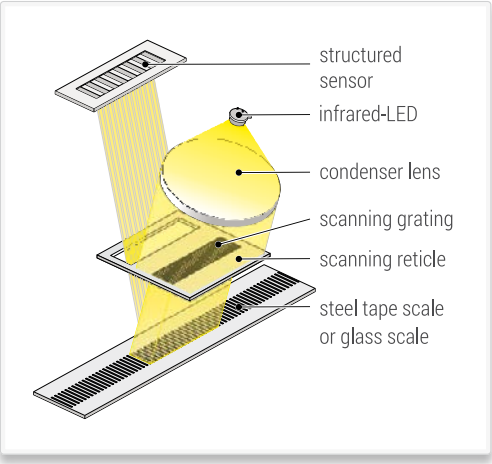
SCANNING PRINCIPLE

The model MS 45 incremental linear encoder works with the imaging, photoelectric measuring principle and a **singlefield reflective scanning** method. A scale graduation pattern with 200 µm grating pitch is used on a steel tape.

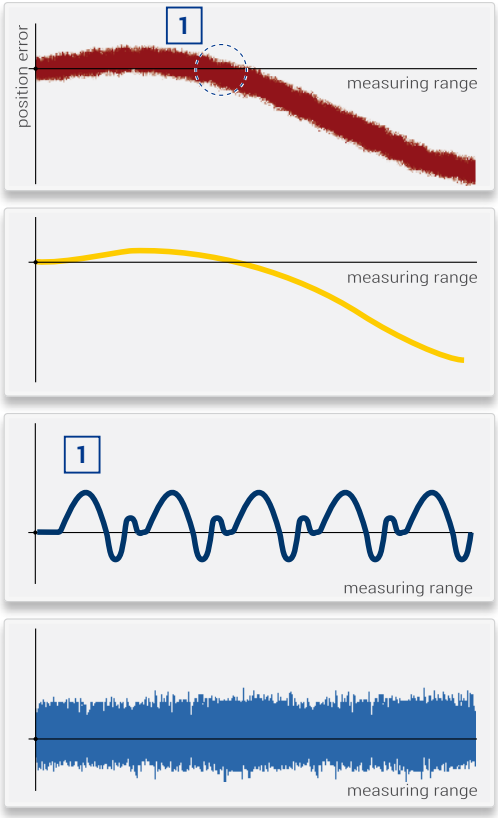
The regulated light of an infrared LED is collimated by a condenser lens and passes through the grid of the reticle. After being reflected from the scale the infrared LED generates a periodic intensity distribution on the structured sensor.

The sensor generates high qualitiy 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 as well as with long-run operation.



ACCURACY DEFINITION



Overall error

=

Baseline error

+

Interpolation error

+

Position noise

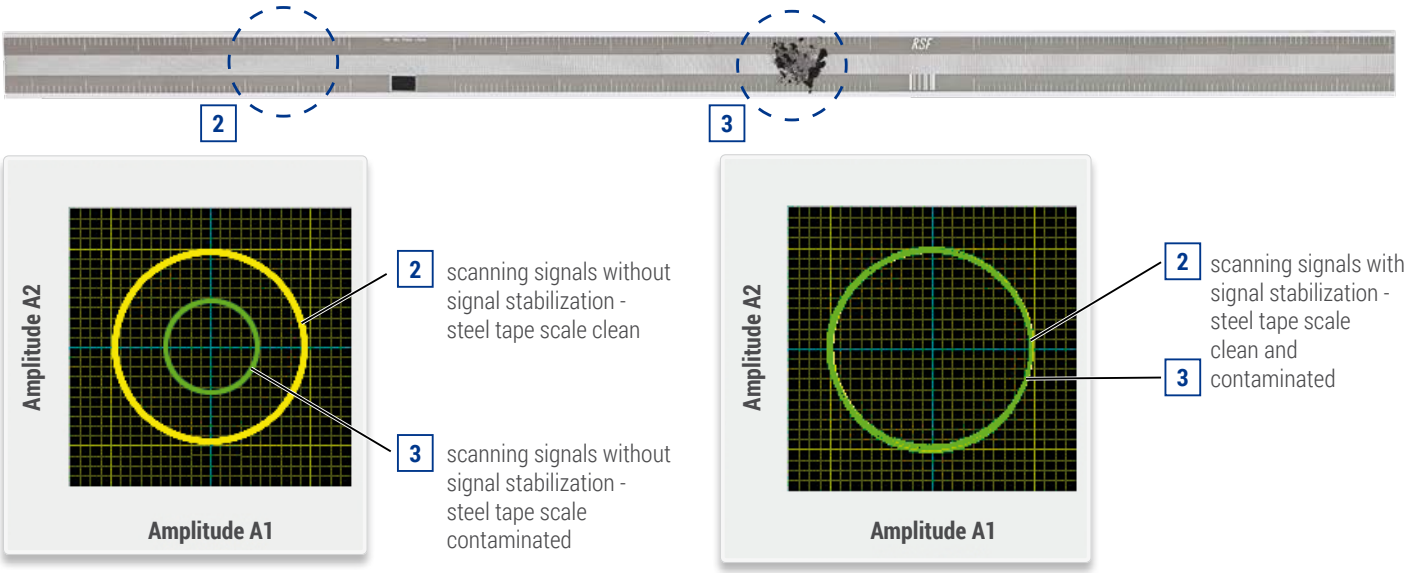
The accuracy of a linear encoder is mainly determined by the baseline error of the scale unit, the interpolation error of the optoelectronic scanning and the position noise.

The baseline error is the error of the scale unit 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.

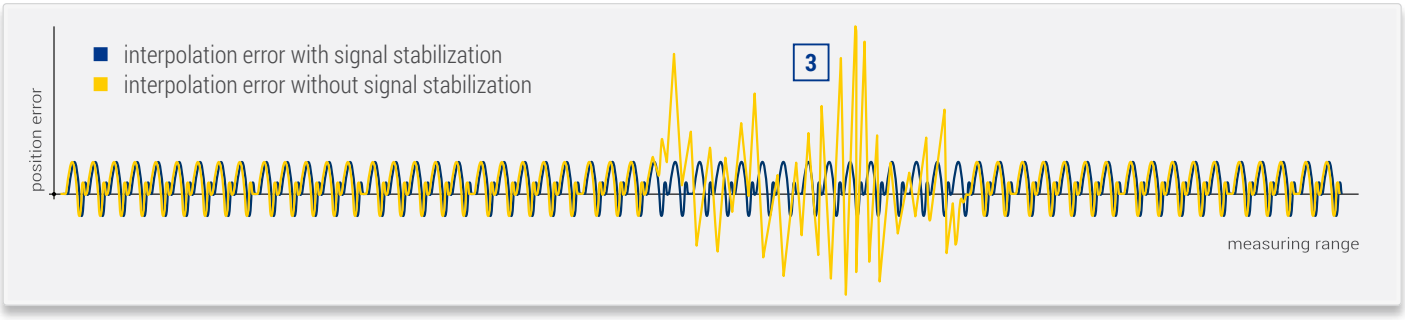
Effect of contamination on the quality and amplitude of scanning signal

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

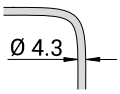


Effect of contamination on the intepolation error

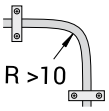
Steel tape scale contaminated by fluids, dust, particles, fingerprints etc.



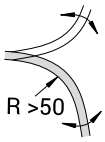
SHIELDING, PIN ASSIGNMENTS



Shielded PUR-cable

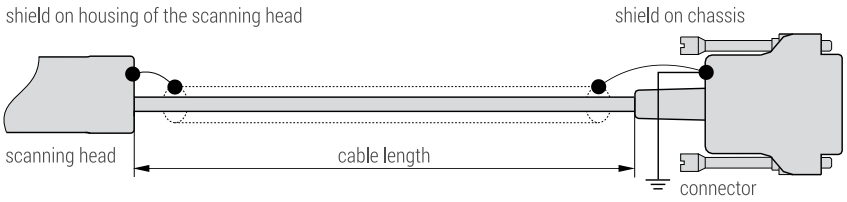


Bending radius fixed mounting



Bending radius continuous flexing

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

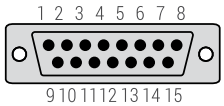


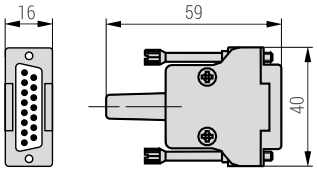
15-pin D-sub

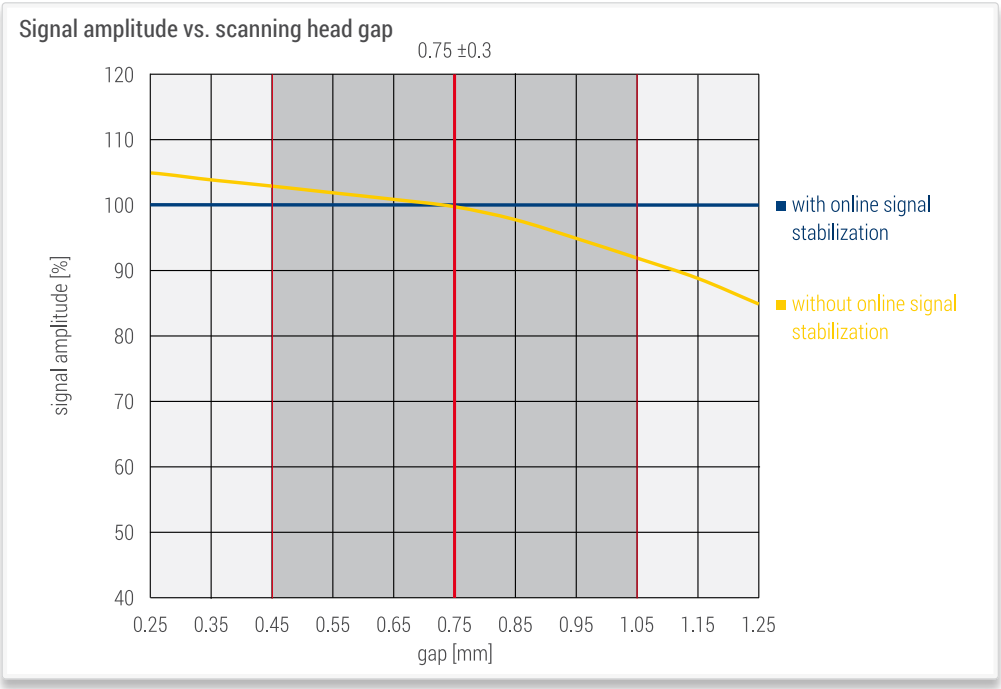
Pin	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Sinusoidal voltage signals 1 Vpp	Test*	0 V sensor	occupied	$\overline{RI}$	$\overline{A2}$	$\overline{A1}$	+5 V sensor	+5 V	0 V	occupied	occupied	RI	A2	A1	nc
Square-wave signals via line driver	Test**	0 V sensor	$\overline{US}$	$\overline{RI}$	$\overline{T2}$	$\overline{T1}$	+5 V sensor	+5 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 µApp) are switched to the output connector.
- Sensor: the sensor-pins are bridged in the chassis with the particular power supply.
- The shield is additional connected with the chassis.
- Not connected pins or wires (nc) must not be used.

Pin assignment
(view on pins)







OUTPUT SIGNALS

SINUSOIDAL VOLTAGE SIGNALS 1Vpp

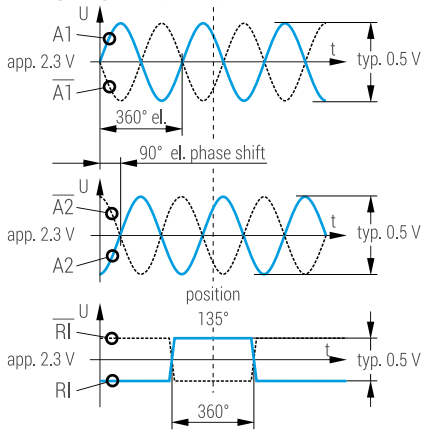
(drawing shows "positive counting direction")
Two sinusoidal voltage signals A1 and A2 and one reference mark signal (all with inverted signals).

Power supply: +5 V ±10 %, max. 130 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 $\overline{RI}$):
Useable component 0.8 up to 1.2 V; typical 1 V
(with terminating impedance Zo = 120 Ω between RI to $\overline{RI}$)

Advantage:
- High traversing speed with long cable lengths possible

Voltage signals (1 Vpp)



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 refered to the recommended line receiver circuit

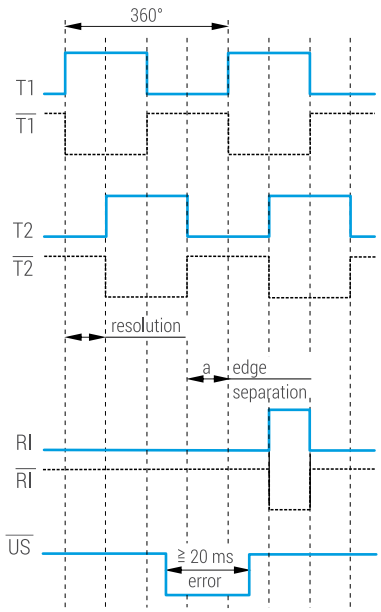
To prevent counting errors, the controls/DRO´s must be able to process the resulting edge separation.

Example:
a_{min} = 200 ns, 10 m cable
200 ns - 10 ns - 10 x 0.2 ns - 10 ns = 178 ns

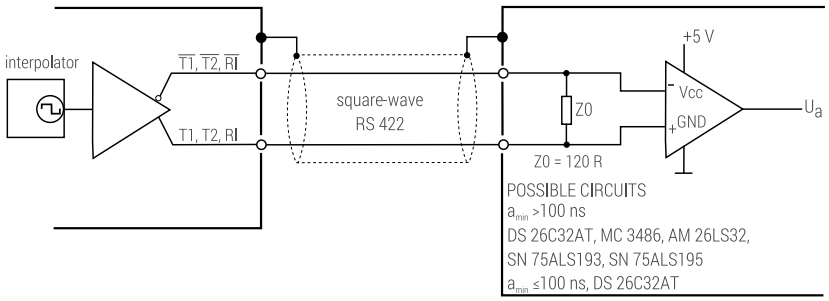
Power supply: +5 V ±10%, max. 140 mA (unloaded)

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

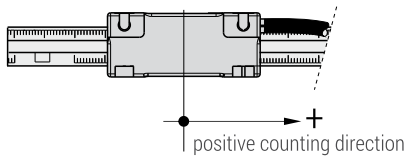
Square wave signals „differential"



Recommended line receiver circuit



Counting direction



TECHNICAL DATA

SCANNING HEAD: 200 µm grating pitch

Model	Output signals	System resolution [µm]	Integrated interpolation	Max. velocity [m/s]	Max. output-frequency [kHz]
MS 45 1 Vpp	∿	depending on external interpolation	--	15.00	75
					Edge separation amin
MS 45 TTLx5	⎍	10	times 5	10.00	500 ns
MS 45 TTLx10	⎍	5	times 10	9.60	500 ns
MS 45 TTLx50	⎍	1	times 50	4.80	200 ns
MS 45 TTLx100	⎍	0.5	times 100	2.40	200 ns

Permissible vibration: 150 m/s² (55 up to 2000 Hz)

Permissible shock: 750 m/s² (8 ms)

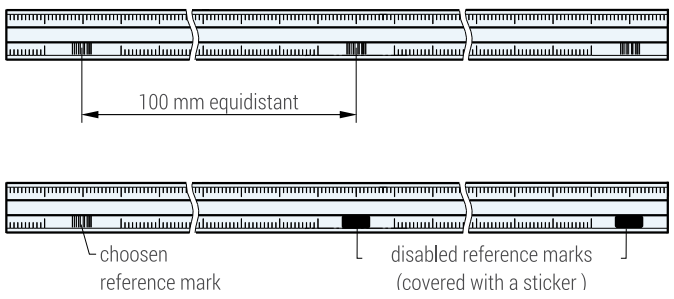
Permissible temperature: –20 °C up to +70 °C (storage), 0 °C up to +60 °C (operation)

RoHS-conformity: The linear encoders MS 45 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 (T)	200 µm
Accuracy grades	±15 µm/m
Non-linearity	±5 µm/m
Maximum measuring length (ML)	30 000 mm
Reference marks (RI)	standard: 100 mm (equidistant)
	at any location, on request

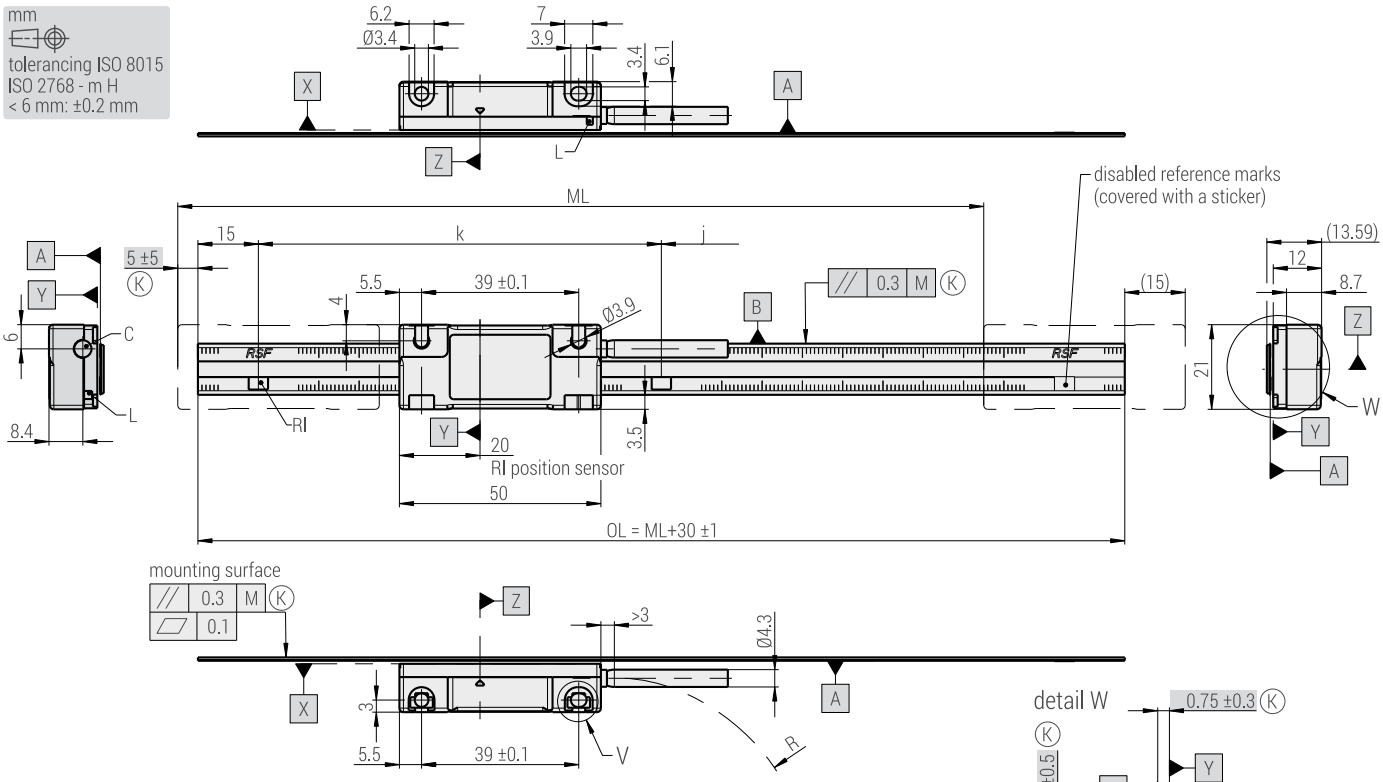
Principle of the standard reference marks

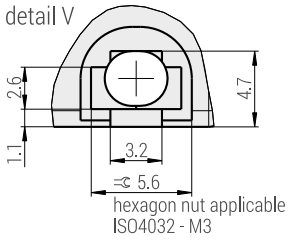


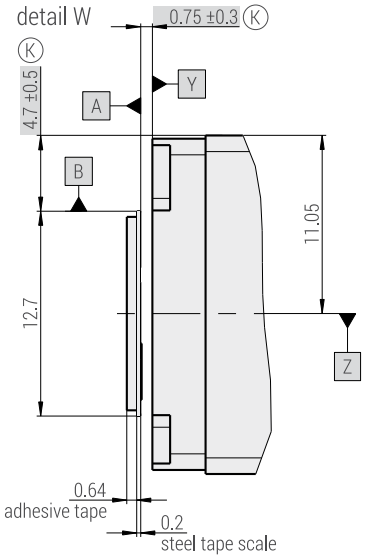
MS 45 MO/MK

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

Dimensions, mounting tolerances:







M = machine guideway
ML = measuring length
OL = overall length
RI = reference mark
C = cable
K = required mating dimensions
L = LED function control
R = bending radius: stat. R > 10 mm, dyn. R > 50 mm

REFERENCE MARK:
k = any position of the selected reference mark from the beginning of measuring length
j = additional reference marks separated by n x 100 mm

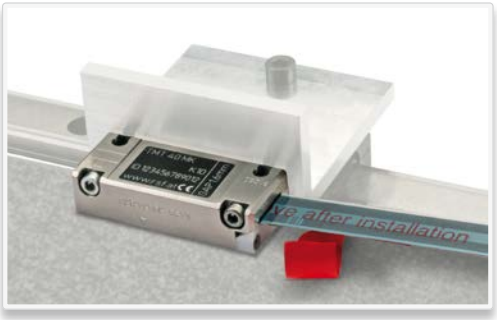
weight (approx.):
- Version MO: 20 g/m
- Version MK: 25 g/m

+ 17 g (scanning head without cable)

permissible position deviation scanning head - steel tape scale
reference plane A | B
Z = ±0.3 mm (gap)
Y = ±0.5 mm (lateral)
∠ Z = ±8 mrad or ±0.46° (yaw angle)
∠ Y = ±8 mrad or ±0.46° (pitch angle)
∠ X = ±12 mrad or ±0.69° (roll angle)

Tape mounting tool **TMT 40 MK** (optional)
For safe and precise mounting of the steel tape scale.

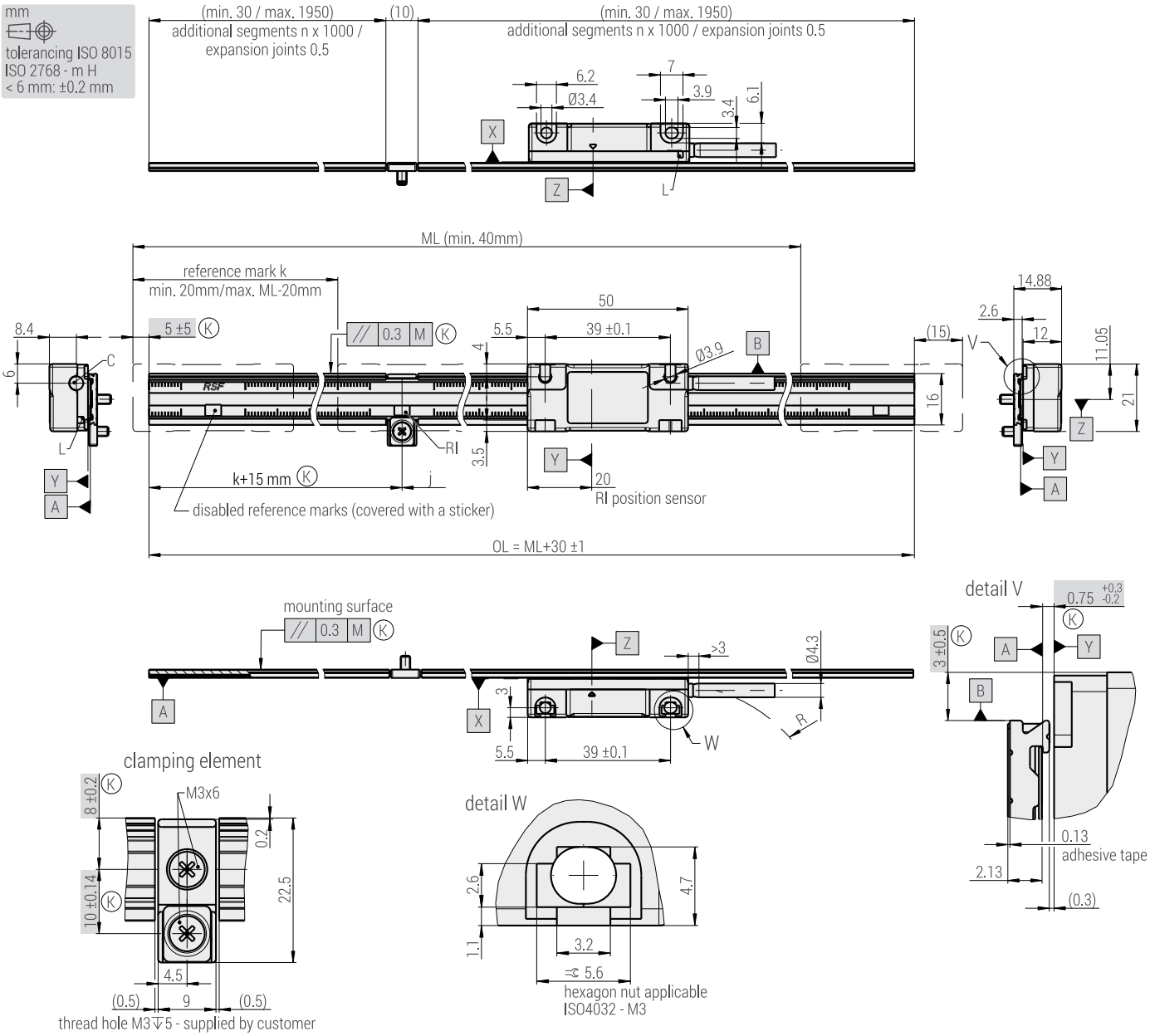
- Mount TMT 40 MK instead of the MS 45 scanning head
- Thread steel tape scale (version MK) and move along the scale length
- Remove TMT 40 MK, mount MS 45 scanning head



MS 45 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
RI = reference mark
C = cable
(K) = required mating dimensions
L = LED function control
R = bending radius: stat. R > 10 mm, dyn. R > 50 mm

REFERENCE MARK:
k = any position of the reference mark from the beginning of measuring length
j = additional reference marks separated by n x 100 mm

weight (approx.):
115 g/m + 2 g clamping element
+ 17 g (scanning head without cable)

permissible position deviation scanning head - steel tape scale
reference plane A | B
Z = ±0.3 / -0,2 mm (gap)
Y = ±0.5 mm (lateral)
∠ Z = ±8 mrad or ±0.46° (yaw angle)
∠ Y = ±8 mrad or ±0.46° (pitch angle)
∠ X = ±12 mrad or ±0.69° (roll angle)

INSPECTION OF FUNCTION

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 via LED 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! 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 TEST/SET-UP BOX PG5

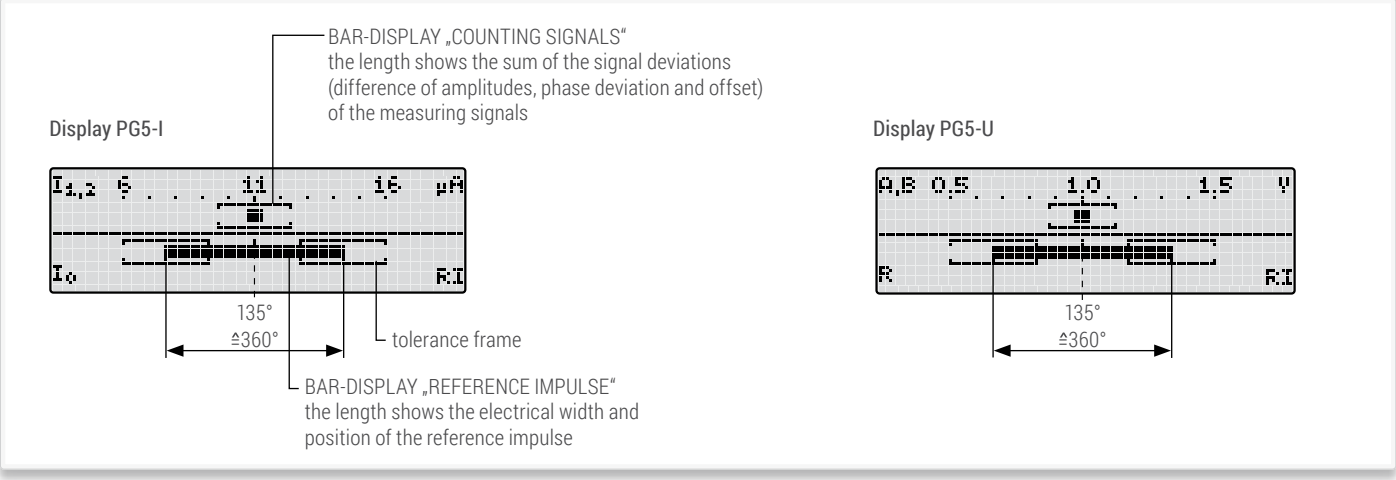
Even though the MS 45 linear encoders allow large mechanical mounting tolerances, it is recommended to control the function of counting signals and reference impulse.

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.

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.



DISTRIBUTION CONTACTS

AUSTRIA *Corporate Head Quarters*	**RSF Elektronik Ges.m.b.H.**	A-5121 Tarsdorf 93	☏ +43 62 78 81 92-0 FAX +43 62 78 81 92-79	e-mail: info@rsf.at internet: www.rsf.at
BELGIUM	**HEIDENHAIN NV/SA**	Pamelse Klei 47 1760 Roosdaal	☏ +32 (54) 34 3158 FAX +32 (54) 34 3173	e-mail: sales@heidenhain.be internet: www.heidenhain.be
FRANCE	**HEIDENHAIN FRANCE sarl**	2 Avenue de la Christallerie 92310 Sèvres	☏ +33 1 41 14 30 00 FAX +33 1 41 14 30 30	e-mail: info@heidenhain.fr internet: www.heidenhain.fr
GREAT BRITAIN	**HEIDENHAIN (GB) Ltd.**	200 London Road Burgess Hill West Sussex RH15 9RD	☏ +44 1444 247711 FAX +44 1444 870024	e-mail: sales@heidenhain.co.uk internet: www.heidenhain.co.uk
ITALY	**HEIDENHAIN ITALIANA S.r.l.**	Via Asiago, 14 20128 Milan	☏ +39 02 27075-1 FAX +39 02 27075-210	e-mail: info@heidenhain.it internet: www.heidenhain.it
NETHERLANDS	**HEIDENHAIN NEDERLAND B.V.**	Copernicuslaan 34 6716 BM EDE	☏ +31 318-581800 FAX +31 318-581870	e-mail: verkoop@heidenhain.nl internet: www.heidenhain.nl
SPAIN	**FARRESA ELECTRONICA S.A**	Les Corts 36-38 08028 Barcelona	☏ +34 93 4 092 491 FAX + 34 93 3 395 117	e-mail: farresa@farresa.es internet: www.farresa.es
SWEDEN	**HEIDENHAIN Scandinavia AB**	Storsätragränd 5 SE-12739 Skärholmen	☏ +46 8 531 933 50 FAX +46 8 531 933 77	e-mail: sales@heidenhain.se internet: www.heidenhain.se
SWITZERLAND	**HEIDENHAIN (SCHWEIZ) AG**	Vieristrasse 14 8603 Schwerzenbach	☏ +41 44 806 27 27 FAX +41 44 806 27 28	e-mail: verkauf@heidenhain.ch internet: www.heidenhain.ch
CHINA	**DR. JOHANNES HEIDENHAIN (CHINA) Co., Ltd**	Tian Wei San Jie, Area A, Beijing Tianzhu Airport Industrial Zone Shunyi District, Beijing 101312	☏ +86 10 80 42-0000	e-mail: sales@heidenhain.com.cn internet: www.heidenhain.com.cn
HONG KONG SAR	**HEIDENHAIN LIMITED**	Unit 2007-2010 Apec Plaza 49 Hoi Yuen Road, Kwun Tong Kowloon, Hong Kong	☏ +852 27 59 19 20 FAX +852 27 59 19 61	e-mail: service@heidenhain.com.hk
ISRAEL	**MEDITAL Hi-Tech**	7 Leshem Str. 47170 Petach Tikva	☏ +972 0 3 923 33 23 FAX +972 0 3 923 16 66	e-mail: avi@medital.co.il internet: www.medital.co.il
JAPAN	**HEIDENHAIN K.K.**	Hulic Kojimachi Bldg., 9F 3-2 Kojimachi, Chiyoda-ku Tokyo, 102-0083	☏ +81 3 3234 7781 FAX +81 3 3262 2539	e-mail: sales@heidenhain.co.jp internet: www.heidenhain.co.jp
KOREA	**HEIDENHAIN LTD.**	202 Namsung Plaza, 9th Ace Techno Tower, 130, Digital-Ro, Geumcheon-Gu, Seoul, Korea 153-782	☏ +82 2 20 28 74 30	e-mail: info@heidenhain.co.kr internet: www.rsf.co.kr
RUSSIA	**ООО «HEIDENHAIN»**	ul. Goncharnaya, d. 21 115172 Moscow	☏ +7 (495) 777 34 66 FAX +7 (499) 702 33 31	e-mail: info@heidenhain.ru internet: www.heidenhain.ru
SINGAPORE	**HEIDENHAIN PACIFIC PTE LTD.**	51, Ubi Crescent 408593 Singapore	☏ +65 67 49 32 38 FAX +65 67 49 39 22	e-mail: info@heidenhain.com.sg internet: www.heidenhain.com.sg
TAIWAN	**HEIDENHAIN CO., LTD.**	No. 29, 33rd Road; Taichung Industrial Park Taichung 40768	☏ +886 4 2358 89 77 FAX +886 4 2358 89 78	e-mail: info@heidenhain.tw internet: www.heidenhain.com.tw
USA	**HEIDENHAIN CORPORATION**	333 East State Parkway Schaumburg, IL 60173-5337	☏ +1 847 490 11 91	e-mail: info@heidenhain.com internet: www.rsf.net

Date 12/2017 ■ Art.Nr.1034109-02 ■ Dok.Nr. D1034109-02-A-01 ■ Technical adjustments in reserve!

RSF Elektronik
Ges.m.b.H.

Linear Encoders
Cable Systems
Precision Graduations
Digital Readouts

Certified acc. to
DIN EN ISO 9001
DIN EN ISO 14001

✉ A-5121 Tarsdorf ■ ☏ +43 (0)6278 / 8192-0 ■ FAX +43 (0)6278 / 8192-79 ■ e-mail: info@rsf.at ■ internet: www.rsf.at